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REGIONAL DEVELOPMENT WITH RENEWABLE ENERGY UTILIZATION

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Abstract. Most of the European countries favour the utilisation of renewable resources – mainly biomass – for energy purposes. Secondary products as energy resources have become more valuable, the production of energy crops has begun. Annual natural gas consumption in Hungary is about 15 billion m^3; the country imports ca. 11–12 m^3 of natural gas every year that costs 1000 billion HUF (3.7 billion EUR). We could save considerable sum of this money for the country, if we use local power supply to minimise gas import and modernise the buildings energetically. A possible solution to this problem can be the solid biomass-based decentralised (local, small-scale energy generation in several places) energy supply. High-efficiency wood chip burning combustion equipments are suitable for large consumers (e.g.: settlements, public institutions, industrial and agricultural buildings), while pellet or briquette burning systems are ideal for small consumers and households. The paper analyses the economic and social aspects of woodchips based district-heating on the examples of heating plants in Hungary.

Key words: heating plants, woodchips utilization, decentralised energy supply, regional development

INTRODUCTION

There are considerable efforts all over the world to set up independent power generation systems organised in smaller networks and adjusted to the natural endowments. This can be a model to be followed by Hungary as well. The topic of renewable energy is essentially important for Hungary, because the country is poor in mineral based energy resources. From renewable energy resources: solar-, wind-, geothermal energy and biomass are the areas where Hungary has great potential. At the same time the use of these energy resources is not widespread. The potential of the renewable energy utilization is higher

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than the current use, the most important is the biomass [Barótfi, 1996, 1998; Bohoczky, 2005; Marosvölgyi, 2002].

Several technologies are available nowadays for the utilization of biologic based energy resources and more technologies are under development, improving the efficiency and reducing the costs. The spread of these solutions are affected by the available agricultural land, annual yields and the applicability of by-products [Ragossnig, 2007; Réczey, 2007].

Perspective area in the utilization of biomass is woodchips burning. Steam, hot water or flue-gas can be used for heating, electric supply, or combined (heat and electric) energy production. Burning equipments can be automatized with power feeding of woodchips and with the control of power. In the case of small scale burning equipments, the woodchips can be stored (for a year) next to the boilers, in the case of bigger power stations separate woodchips store rooms can be established for few months' quantity.

The evaluation of the environmental and social effects of biologic based energy resources is very inconsistent. Referred periodicals contain approximately 7000 papers annually which are dealing with the topic in different aspects [Várhegyi, 2007].

The most important reason for the decentralised energy use is the reduction of problems caused by fossil energy use. Researchers agree that the use of biomass shall not exceed a certain limit, because the renewable ability of natural resources is limited.

It is widely accepted that biomass production (for energy purpose) is more favourable than the conventional production in terms of environmental aspects. The 'revitalisation' of rural areas is one of the most frequently cited advantages [McKay, 2006; Hillring, 2002; Domaca et al., 2005].

Some authors say that probably the environmental aspects of biomass utilization are more significant than the gain of energy [Vágvölgyi and Szesztai, 2003]. Others consider work place creation as the most important effect of 'renewable energy industry'.

In Hungary, authors agree that the utilization of our potential, further increase of the share of bio-energy in the energy balance has energy import decreasing and environmental protective function, connected to the agricultural and rural development [Bohoczky, 2001; Kerényi, 2001; Pálvölgyi – Faragó, 1995].

All regions and settlements should find the way of development which fits the local advantages. If the renewable energy utilization is part of this development strategy, the environmental, social and economic impacts must be considered. According to our hypothesis, decentralised energy supply systems (based on the burn of woodchips) in given settlements of Hungary are suitable to substitute fossil energy resources and they are competitive energy producers besides having positive effects on the development of their direct environment. With the use of locally produced biomass, part of the money spent for energy resources will stay in the region. The saving will serve further development of the region, and it contributes to the decrease of energy import dependence.

MATERIAL AND METHODS

The initial subtask in the research project was to investigate the 1.2 MW woodchip-fuelled heating plant in Pornóapáti (West Hungary), to check the technical and

operation parameters, and to analyse its environmental and economic impacts. The settlement is near to the Austrian border; its population is around 380.

The energy for heating and domestic hot water preparation is provided by the plant in the village. Thermal transmission line network conveys the energy to the heat centres of the houses. Depending on the weather, the system works from the end of September till next April. It costed 360 million HUF (1.35 million euro), and it was financed mainly from the structural funds. Domestic hot water preparation is available out of the heating season through individual heat-generating installations.

The quantity of the energy substituted by the woodchips burning was analysed. During the analysis we calculated the costs of heating energy with gas, domestic hot water preparation with electricity, the quantities were calculated from the annual consumption. We considered the percentage distribution of energy consumption in households provided by Barótfi et. al. (2007): heating energy consumption 84%, domestic hot water preparation 16%.

The money spared by the use of the heating plants (in the village and in the region) was also calculated at regional level, by the use of the locally produced wood chips. The calculation was based on the average annual wood chips use of the wood-chip-fuelled heating plants in Pornóapáti (1.2 MW), Körmend (5 MW), and Szombathely (7.5 MW). The price of the wood chips showed significant changes in the examined period. The calculated price equalled to the average cost of the wood chips under 30% moisture content (appropriate for store and use), transported to the heating plant depot.

RESULTS

The alternative of wood chips burning in Pronóapáti was the building of gas network. The choosing of alternative energy was confirmed by the price increase of gas and the last years' debates about gas service in the neighbour countries. These systems in the Austrian villages work well. The municipality and the population of the examined village were familiar with these best practices. The operational experiences of the Austrian heating plants showed that they are able to produce heat at competitive price. The feasibility was supported by the high number of individual junctions (emerging from the lack of gas network), the availability of locally produced wood based biomass, the shortness of heating network (because of the location) and the successful involvement of structural funds.

The use of gas for heating energy, the use of electricity for domestic hot water (DHW) preparation in the examined period would have used the following quantities according to our calculation (Table 1).

According to our calculations, if the necessary energy had been provided with natural gas and electricity, 203.206 m^3 gas and 365.6 MWh electricity would have been used, which costs 37.4 million HUF (139 000 EUR) in nominal price. On the other hand, energy supply from the heating plant cost is 23.1 million HUF (86 000 EUR) in nominal price altogether, during the examined period.

Although the savings are small-scaled due to the size of the heating plant, they may serve as an additional source of income for the local forestry, saw-mills and farmers,

Table 1. The substituted quantities of gas and electricity in the examined period
Tabela 1. Zastępowane ilości gazu i energii elektrycznej w badanym okresie

Heating season	Public energy use GJ	Substituted energy quantities		Price of substituted quantities* million HUF (1000 EUR)	Sell of heating plant energy** million HUF (1000 EUR)
		Gas for heating GJ	Electricity for DHW preparation MWh		
2006/2007	2471	2076	109.7	10.2 (38)	6.5 (24)
2007/2008	3063	2573	136.1	13.5 (50)	8.3 (31)
2008/2009	2691	2260	119.7	13.8 (51)	8.3 (31)
Total	**8225**	**6909**	**365.6**	**37.4 (139)**	**23.1 (86)**

* Gross public energy prices for gas and electricity in the heating seasons. Average price of gas: 2.871 HUF/MJ (1 Aug 2006 – 1 July 2007), 3.030 HUF/MJ (1 July 2007 – 1 July 2008), 3.735 HUF/MJ without subsidy at < 20 m^3/h (1 Oct 2008 – 1 July 2009) based on the 44/2006 (VI. 30), 56/2007. (VI. 1.), 97/2007. (XII. 1.) GKM regulations and 24/2008. VIII. 31. KHEM regulation. Price of electricity: 37,68 HUF/kWh (from 1 Aug 2006), 39.36 HUF/kWh (from 2 Febr 2007, the average: 38.52 HUF/kWh), 44.4 HUF/kWh (1 Jan 2008 – 30 June 2009, "A" public general price (24h), over 1320 kWh/year consumption, based on the 48/2006. (VII. 21.), 12/2007. (I. 26.) GKM regulations, MEH.

** The prices of heating plant energy: 2611 HUF/GJ (2006/2007), 2713 HUF/GJ (2007/2008), 3082 HUF/GJ (2008/2009).

* Ceny brutto gazu i energii elektrycznej w sezonach grzewczych. Przeciętna cena gazu: 2.871 HUF/MJ (1 sierpnia 2006 – 1 lipca 2007), 3.030 HUF/MJ (1 lipca 2007 – 1 lipca 2008), 3.735 HUF.MJ bez dopłaty poniżej 20 m^3/h (1 października 2008-1 lipca 2009) na podstawie regulacji GKM nr 44/2006 (VI. 30), 56/2007. (VI. 1.), 97/2007. (XII. 1.) oraz regulacji KHEM nr VIII. 31. Cena energii elektrycznej: 37,68 HUF/kWh (od 1 sierpnia 2006), 39,36 HUF/kWh (od 2 lutego 2007, przeciętnie 38,52 HUF/kWh), 44,4 HUF/kWh (1 stycznia 2008 – 30 czerwca 2009), taryfa „A" (24 godz.), zużycie ponad 1320 kWh/rok, na podstawie regulacji GKM, MEH nr 48/2006. (VII. 21.), 12/2007. (I. 26.)

** Ceny energii z elektrociepłowni: 2611 HUF/GJ (2006/2007), 2713 HUF/GJ (2007/2008), 3082 HUF/GJ (2008/2009)

Source: Own calculation.
Źródło: Obliczenia własne.

and help evolve this specific branch of rural development in Hungary. The wood-burning district heating plants in Pornóapáti (founded in 2005, output: 1.2 MW), Körmend (operates since 2003, output: 5 MW) and Szombathely (since 2004, output: 7.5 MW) retained a considerable sum of money in the region (Figure 1).

The calculations were based on the data in Table 2. The results show that the heating plants mentioned above retained 867.9 million HUF (3.2 million EUR) in nominal price altogether in the region, during the examined period.

Similar investments may profit from the savings of consumers on wood chips costs, by attracting companies with high energy demand, and by trading CO_2 quota. Additionally, they can create also jobs directly (e.g.: workers in heating plants) or indirectly (e.g.: designers, contractors), launch local machine production and have positive impacts on local values and environment protection (Németh, 2011).

However, it must be stressed that such projects need long-term, uninterrupted flow of quality feedstock at a fair price. High efficiency plants located in towns and cities require more raw materials, which may cause quality, quantity and price problems. Sometimes these higher demands can be satisfied only by applying long-distance delivery.

Fig. 1. The location of the heating plants
Rys. 1. Rozmieszczenie elektrociepłowni

Source: Own work.
Źródło: Opracowanie własne.

Table 2. Retained money in the region from the operation of the three heating plants
Tabela 2. Środki finansowe zatrzymane w regionie dzięki działaniu trzech elektrociepłowni

Heating season	Price of wood chips* net 1000 HUF/t (EUR/t)	Money retained in the region net million HUF (1000 EUR)		
		Körmend 6000 t/year	Szombathely 8000 t/year	Pornóapáti 377 t/year
2003/2004	6.4 (24)	38.4 (142)	0	0
2004/2005	7.9 (29)	47.4 (176)	63.2 (234)	0
2005/2006	10.0 (37)	60.0 (222)	80.0 (296)	3.8 (14)
2006/2007	12.5 (46)	75.0 (278)	100.0 (370)	4.7 (17)
2007/2008	13.5 (50)	81.0 (300)	108.0 (400)	5.1 (19)
2008/2009	14.0 (52)	84.0 (311)	112.0 (415)	5.3 (20)
Total	–	**385.8 (1429)**	**463.2 (1715)**	**18.9 (70)**

* Prices used for the calculation are average prices, referring to the price of wood chips under 30% moisture content (appropriate for store and use), transported to the heating plant depot
* Ceny wykorzystane w obliczeniach są cenami przeciętnymi, odnoszącymi się do ceny wiór drzewnych poniżej 30% wilgotności (odpowiednich do przechowywania i wykorzystania), dostarczonych do elektrociepłowni

Source: Own research, based on Fogarassy 2009; Gonczlik et al., 2007; Németh I., 2007; Bohoczky, 2005; Purker and Tímár, 2004.
Źródło: Badania własne na podstawie Fogarassy 2009; Gonczlik et al., 2007; Németh I., 2007; Bohoczky, 2005; Purker i Tímár, 2004.

DISCUSSION

The heating plant in Pornóapáti was founded in 2005. It is a standard, well-adjusted, central system that replaced the old, inefficient heat networks. The research verified that well-designed, purposeful utilisation of energy like this offers an alternative to fossil fu-

els. The heating plant uses 377 tons of wood material in a year, its output is 1.2 MW and has 51% overall efficiency, which is a comfortable and competitive solution to consumers, replacing gas.

According to our research results, if the amount of energy produced in the heating plant had been provided with natural gas and electricity during the examined period (from 2006 to 2009), 203.206 m^3 gas and 365.6 MWh of electricity would have been used, which costs 37.4 million HUF (appr. 139 000 EUR). On the other hand, energy supply from the heating plant cost 23.1 million HUF (86 000 EUR) altogether during the three heating seasons, in nominal prices. The importance of local energy supply is that some amount of money spent on energy supply does not fall into the hands of multinational energy companies, but it is kept in the region.

Settlements can save on energy resources, withhold money and reduce national gas import by using local energy supply. Three district heating plants are located in Pornóapáti (founded in 2005, output: 1.2 MW), Körmend (operates since 2003, output: 5 MW) and Szombathely (since 2004, output: 7.5 MW), which utilise secondary products of local silviculture – woodchips, shaving, saw-dust – and retained 867.9 million HUF (3.2 million EUR) in nominal price in the region. This sum of money can serve – as an additional source of income – the local forestry, saw-mills and farmers, and help evolving a specific branch of rural development in Hungary.

Besides energy saving, similar projects may also contribute to workplace creation directly (e.g.: workers in heating plants) or indirectly (e.g.: designers, contractors), launch local machine production and have positive impacts on local values and environment.

The best practices of efficient use of renewable energy resources are basic conditions of the spread of environment-conscious approach. Transfer of knowledge is the least calculable, but probably the most important effect of such projects. Experiences during the establishment and operation can ease the investment decisions of settlements which plan the introduction of decentralized energy supply systems, they can reduce the time-consuming process of planning and implementation.

The rational use of natural resources can spread with effective communication. Pornóapáti joined the International Renewable Energy Road Network in 2007, which means e.g. the introduction of the project for visiting groups and common communication. The network is in the Austrian-Slovenian-Hungarian border region; its stations are renewable energy using establishments. The aim of the network was to introduce and propagate the possibilities of renewable energy resources. So not only the inhabitants, but visitors, leaders of settlements, innovative experts are also stakeholders of the project.

CONCLUSIONS

The directions of developments in the energy sector are driven by energy saving and environment protection issues. As a result of the last two decades' technical-technological development, modern industrial solutions emerged. Their share in the total energy production is not really significant yet, but their development and spread is dynamic.

In the Hungarian and European Union policy, there are several initials to subsidize the strategic areas of research, technical development, energy production and supply, and

environment protection from different funds. Hungary is poorly supplied with energy resources, the rational use of them is crucial in all areas.

The key questions of researches in this topic are the utilisation of solid biomass for heating purposes and its technology (efficiency, costs). The results support our hypothesis that alternative systems offer economical heating solutions for settlements, but they can rarely be realised without adequate state support. There are also positive results that cannot be measured with money (value creation, environmental aspects) but have to be considered. Unfortunately, these factors are less important than economic ones, before decisions.

The heating plant in Pornóapáti and the other Hungarian and Austrian ones' demand in the region give the possibility for farmers to produce energy plants. This new direction of production can contribute to the rational land use and marketable products. As an additional activity, it can assure the diversification of farmers. With long-term contracts it can guarantee fix income for the entrepreneurs, which helps to keep people in the region.

The available Hungarian biomass potential should be exploited, based on local, regional systems. The paper analyzed some factors which should be considered for decisions. The results of the research and the strict environment protection regulations predict favourable future to the examined or similar technologies which are environmentally friendly and prefer local interests and values.

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ROZWÓJ REGIONALNY Z WYKORZYSTANIEM ODNAWIALNEJ ENERGII

Streszczenie. Większość krajów europejskich przychylnie odnosi się do wykorzystania odnawialnej energii – przede wszystkim biomasy – na cele energetyczne. Produkty uboczne jako źródła energii stały się bardziej wartościowe, rozpoczęto produkcję roślin na cele energetyczne. Roczne zużycie gazu na Węgrzech wynosi około 15 miliardów m^3, kraj importuje około 11–12 m^3 gazu rocznie, co generuje koszty w wysokości 1000 miliardów HUF (3,7 miliardów EUR). W skali kraju można byłoby oszczędzić znaczącą kwotę, jeżeli w celu zmniejszenia importu gazu podjęte zostałyby działania zmierzające do wykorzystania lokalnych zasobów energii i modernizacji energetycznej budynków. Rozwiązaniem tego problemu może być stworzenie zdecentralizowanej opartej na biomasie podaży energii (lokalne wytwarzanie energii na małą skalę w wielu miejscach). Wysokowydajne instalacje do spalania wiór drzewnych są odpowiednie dla dużych odbiorców energii (np. osiedla, instytucje publiczne, budynki przemysłowe i rolnicze), podczas gdy systemy spalania peletów i brykietów są idealne dla małych odbiorców oraz gospodarstw domowych. Autorzy artykułu dokonują analizy spolecznych i ekonomicznych aspektów wdrożenia lokalnego systemu ogrzewania opartego na spalaniu wiór drzewnych bazując na przykładach takich ciepłowni funkcjonujących na Węgrzech.

Słowa kluczowe: elektrociepłownie, zużycie wiór drzewnych, zdecentralizowana podaż energii, rozwój regionalny.

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