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**POSSIBILITIES OF BIOMASS ENERGY USE WITH A  
PARTICULAR REFERENCE TO HUNGARY**

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PHD THESIS (SUMMARY)

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## **Introduction, research objectives**

Renewable energy sources, "green energy" has become a very popular research area, a number of sciences examine their possibilities in the future. The rediscovery of these ancient energy sources was happened after the oil crises (years of 1970-1980-s), although the water was used for electricity production in the end of the 19th century. The application of the renewables is inspired principally in the developed countries of the world. Developed societies – particularly the European Union – have great expectations to renewable energy: the possible role in the issue of anthropogenic climate change, in reducing dependence on energy and – through the job creation – the rise of rural societies in. Therefore a fundamental question arises: How does the present and the future of the renewable energy sector look like? What kind of role will they play in the life of human societies in the future?

Among the renewable energy sources, biomass is the most frequently used. In Hungary also the biomass energy is the most usable renewable energy source, and - by the current technical standards – it has the most exploitable energy. So basically my dissertation dealt with the use of biomass energy source, and above all, I tried to answer the following questions:

- Which types of biomass can be best utilized best – with according to the requirements of sustainability – in our country and globally as well?
- Which can provide the highest energy-efficiency, environmental and social benefits?
- How can the social expectations – especially connecting with the biomass energy – harmonise with the opportunities?

The energy- and the climate policy and the connecting regulatory- and support system fundamentally affect the growing use of energy from renewable energy sources. Where these policies can't harmonise with other economic and environment policies, it might be problematic to integrate renewable energy sources in basic energy systems. Therefore, further research objectives are resulted in the following test direction

- How much are the use of renewable energy sources encouraged, and discouraged by the energy policy decisions, the regulatory environment and support system?
- Are there any undesirable consequences in the energy system, or in the development of certain sectors?

One part of the biomass production is resulted from agriculture, so further questions can be formulated:

- Have the production of energy crops any territorial limits or not? Is there any competition or compromise between the energy-related land use and cultivation of food crops?
- Is the increase of current use of biomass in Hungary consistent with the potential

opportunities?

- How much is the potential part of the resources, which is now also available (agricultural and forestry secondary products, organic wastes), and how many come from cultivation energy crops?

In the latter case I attempted to determine the extent of the usable area for this purpose, taking possible future changes in land use into account, and also tried to determine that which energy plants should be grown in this available land.

My PhD-research focused on the use of biomass energy connecting with environment and nature conservation and land use issues and problems. Other renewable energy issues were only tangentially discussed.

## **II. Methodology, the emphasis of the presentation**

A significant part of my dissertation is based on domestic and foreign literature. It is noteworthy that there is plentiful and useful literature – both at home and abroad – to help researchers in their work. The foreign-language literature was helpful in the general sections of the essay, while I worked with the Hungarian research results on the chapters with domestic relevance. Due to the nature of the topic I tried to present the opposing views and my own opinions as well. The literature was based on primarily the results of the agricultural, forestry and energy research.

Beyond the literature analysis calculations-based inspections were made and one of a region-wide potential measure. I used a variety of statistical database (FAOSTAT, Central Statistical Office, EUROSTAT, etc), and the results were illustrated in tables, charts and maps. The aim of the potential measure was to evaluate the potential amount of biomass for direct combustion in the sub-regions of Western Transdanubia region. The calculation was made with a very specific methodology. To quantify and approach to the issue, some database (together around 5000 data) was built.

I estimated by using the database the annual quantity of the firewood and the forestry residues in the sub-regions of West Transdanubia region by tree types, also the yield of corn-, maize-, sunflower stem and the residues of grape and fruit tree cultivations. I summed the results based on calorific value. So in this way I got the theoretical potential energy quantity of biomass for direct combustion in the certain sub-regions. I also determined – based on calorific value too – how much energy quantity is required to a 1 MW average production heating plant. Then based on these results I calculated that the individual sub-regions how much heating plant could be able to supply with their forestry and agricultural residues. Then the result with other factors was corrected, so with estimation the model calculation was extended to the whole country.

The paper consists of three distinct units. In the first substantive chapter the potential role of renewable energy sources is discussed, in the order of the social expectations. After discussing the problem of climate change, I analysed the relationship between the renewable energies and the energy crisis – and within this the role of energy dependency on import. Then I summarized the role of these energy sources in the solution of local problems, especially in the rural development. The next chapter discusses generally the types of biomass, the extent, advantages and disadvantages of their use.

The third and the longest unit of the essay introduce the renewable energy and the biomass energy subject in the case of Hungary. First I analyze the problems of domestic energy sector, the main relevant points of the dispute between conventional and renewable energy sources, and discuss the situation of domestic renewable energy sources with regard of the legal environment and the support system, and then I examine the current status of the certain renewable energy sources, future prospects and possibilities. Finally, the problem of domestic biomass energy utilization was analyzed. After examining the potential measures - including my calculation too – I tried to determine that, what proportion could be able to achieve with the currently available, but so far unused, and the potential energy plant cultivations in the domestic energy balance. I would also attempt to determine the maximum extent of the arable land for growing energy crops.

### **III. Research results and conclusions**

#### **1. The role of renewable energy sources in the solution of global and local problems**

With the increasing use of renewable energy sources the societies would like to mitigate the climate change, substitute a part of the fossil fuel and – through the rural development – to raise the relationship between man and the environment.

**1.1** It is now widely believed that our climate warms, it becomes extreme, and in this problem the main cause is the human activity, and the rising carbon-dioxide emission. Thus, the role of renewable energy to mitigate climate change – with the substitution a part of fossil energy – could be in reducing carbon-dioxide emissions. Although the so-called climate change sceptics query this opinion, the importance of renewable energy sources, however, will not lose their importance, because in many countries – as well as in our country – to reduce dependence on energy import is already at least as important, if not more important than to reduce carbon-dioxide emissions.

**1.2** The energy crisis is another global problem. It means in one hand the declining stocks and the increasingly difficult availability of fossil energy sources and on the other hand the fossil energy dependence, because the location of hydrocarbon reserves is significantly concentrated. Between the potential solutions of the energy crisis the nuclear energy, hydrogen and methanol are equally

considered, and the utilisation of renewable energy sources are also being considered as an alternative.

During my research, it concluded that: because the recent exploitable potential possibilities are limited, in the 21st century, renewable energy sources cannot be expected to have substitute, but only a supplementary role in the global energy consumption, unless there is no significant breakthrough in the research and development. Thus, it is also likely that the options for reduction of carbon-dioxide emission are also limited. The dependency on fossil fuels could be reduced in some countries – by the locally available renewable energy stocks – where these sources have not or only marginally utilized yet.

By developing energy policy inspiring the use of renewable energy sources we need to be aware, because the consequence of regulatory and support system must not create additional problems to be solved. For example, in the case of biomass: cultivation of energy crop must not induce decrease in the extent of arable land for food crops, where the latter is not abundant, and must not compromise the natural vegetation. Some developed societies, especially the European Union require the production of biofuels to be located outside its borders. But this could extent the confusion on the already characterized and unresolved problems in the global food supply, which can exacerbated by the crescent food prices. The globalisation of biofuel production instead of decentralization is changing the relations of energy dependence, but does not eliminate its state.

**1.3** The opportunities of renewable energy in rural development, in the job creation, in the appreciation of the rural lifestyle and the relationship between man and environment are manifested. This is achieved optimally if the agro-ecological goals are materialised too: cultivating energy plants without endangering the local natural vegetation, protecting biodiversity, developing varied sowing structure and at the same time - through the job creation – the goal of rural development. The latter goal can be reached principally through the biogas production based on agricultural residues.

## **2. Conflicts in the utilisation of biomass energy**

Biomass energy has the largest proportion from renewable energy sources; it is used for producing energy since the beginning of mankind. However, its dominant role in the initial was significantly, it was reduced by other energy sources with larger energy density. Today, the use of biomass energy – typically in the more developed countries –appreciated again, so its ten percent ratio of shares from the world's energy consumption is expected to preserve in the future. The simplest and the most favourable method in the aspect of energy balance is to apply biomass in the original, or close to original state. All this taking into account, the most optimal utilisation of the biomass is the

direct combustion of forestry and agricultural crops and residues, woody and herbaceous energy crops for heat and electricity production.

With regard of the environmental sustainability the most favourable methods using biomass for energy production are the way of low energy input-high energy output adaptations – this is also the direct combustion – and those adaptations, which can produce energy and dispose secondary and tertiary biomass at the same time (organic origin, such as municipal waste, liquid and organic fertilizers, sewage). The most favourable solution in this issue is the – already mentioned – biogas production.

With the consideration of agro-ecological goals and food safety the use of currently available biomass for energy production is mean has the lowest risk. The production of energy plants is a risk, if its extent doesn't meet with the sustainability requirements. The territory for growing food crops and nature reserves must be protected, and energy crops don't constitute an ecological risk to natural habitats (invasivity, genetic pollution).

In the case of biofuels, there would be important to support the research of their more effective use (versions of second and third generation). The currently used versions of first generation – because of its large fossil energy demand – does not play significant role in reducing carbon-dioxide, and the energy crops need large area.

### **3. The problems of the energy sector in Hungary**

Hungary has significant untapped renewable resource capacity; but before utilising these energy sources it must be examined, how the modern technical facilities, utilizing renewable energy sources can be connected to the Hungarian energy sector. What is the state of our energy sector like and how it relates to the international energy currents and what is the degree of energy import.

**1.4** The energy dependency is a serious problem in our country (> 60%), because of the high rate of hydrocarbons in the energy consumption. This is particularly worrying, because domestic source is relatively small – the  $\frac{3}{4}$  part of the use of hydrocarbons resulted from import – and the import of source is one-sided. So the role of renewable energy sources might be perhaps more important in reducing the import dependence, rather than environmental considerations in our country. The hydrocarbon dependence is a risk for the households too, since the pipeline of natural gas had spread. So the energy self-sufficiency of house holds would be very important, accordingly to household-sized renewable energy facilities (e.g., pellet boilers, solar panels), and some smaller plants which operated with the settlements own resources (e.g. biomass heating plants) should be developed. Only with renewable energy can not be expected to solve this problem, the government supports the continued use of nuclear energy, and looks for the alternative procurement routes of

hydrocarbons.

**3.2.** The use of renewables is hampered because the national electricity system is not enough modern and stable to integrate smaller decentralized units – operated with renewable energy – without regulatory problems - this is especially true in the case of wind power. The reform of the power plant park could solve this problem, and the way, with higher efficiency can reduce the environmental pressure as well.

#### **4. The situation of renewable energy sources in Hungary**

Because of the domestic legal and economic regulation system failures, and the lack of financial resources the use of renewable energy sources is still below the potential. In some cases the regulation system also hampers the utilisation of some renewable energy sources (water and geothermal energy). The energy policy is favourable for the spread of wind power plants, the utilisation of biofuels – mainly the bioethanol – the biomass combustion for electricity production. The latter exploitation method has the greatest proportion.

There are only few possibilities for the utilisation of currently available forestry and agricultural residues, as well as the using of secondary and tertiary biomass and the production of biogas. The sun, water and geothermal energy also have untapped potential. The direct firing of biomass - normally with firewood material – mostly utilised in the old electric power plants with poor efficiency, without heat utilisation, as a result of the regulation system. At the same time all of the potential amount of firewood will be used, moreover in some case, supplemented by imported raw material. The share of renewable energy sources is about 5,1% of the domestic energy supply, which is considerably below the potential opportunities.

On the example of countries using renewable energy sources for a long while is clearly visible that results could be reached with deliberate regulatory and supporting system. The undesirable problems of using renewables are rather the consequences of the failures of regulation than the lack of funds. We should examine the regulatory and support system of those countries, where renewable energy sources have already utilised. These examples may help us to correct domestic problems in the regulatory system flexible.

#### **5. The biomass as an energy source in Hungary**

Similarly to the average of the world, the dominant renewable energy source in Hungary is the biomass energy. Its share from the total domestic energy consumption is about 4,6%. The most significant part of the exploitation is the direct combustion (97%), which manifested mainly in some greater power plants for electricity generation, and in several small, decentralised heating

plants. The biogas (1%) and biofuels (2%) combustion are not significant.

The conclusions of the several different potential measures in Hungary have a common point: there is a significant energy reserve in the domestic biomass yields, which far surpasses the current exploitation.

**5.1** The utilisation of currently available secondary products from agricultural and forestry, landfill gas and biogas from sewage sludge are negligible, although they could be a considerable energy source. According to my calculations the secondary products, without the use of waste and sewage sludge, could reach at least 5% share from domestic energy consumption. However, without rethinking the energy policy, the regulatory- and supporting system, these energy sources will remain marginal.

**5.2** The ambitious energy policy plans, particularly in relation to the bioethanol production, consider the possible changes in land utilisation and the limits determined by the environmental consideration in the future insufficiently. However, taking this into account, it is clear that we award the available cropland too optimistic, although to cultivate energy crops in Hungary is possible.

**5.3** With cultivation of energy crops a further increase could be achieved in the domestic energy consumption, but according to my results the available cropland for growing energy crops will be only a half a million hectares in the future. In this regard, it would be important to rethink the objectives of energy policy, and to use the available arable land to produce sufficient energy crops with the highest benefits of energy, society and ecology, utilizing them with the most efficient manner. Although the extension of this land is not too notable, with using it for energy crop production about another 10% increase could be achieved in domestic energy consumption.

**5.4** My analysis suggests that the biomass could be a significant energy source (at least a 20% share) in Hungary, with the current utilisation, the available organic secondary products and the energy crop cultivation. With their use the long-term dependency on imported natural gas could be significantly reduced, without compromising the domestic food supply and the sustainability requirements. Using biomass in a local scale (instead of the centralized) can advance the self-sufficiency of local communities. The multi-faceted use of biomass can contribute to the power of population-observance of rurality, to a more valuable rural lifestyle, to a diversified and more aesthetic cultural landscape.

## **6. Conclusions, the practical values of the research**

After the examination of biomass energy utilization in general and in Hungary, two important establishments can be formulated.

**6.1** After measuring the biomass potential of the sub-regions of West Transdanubia, it became

clear that the energy from forestry and mainly the agricultural residues could play a significant role in our energy consumption, however, their utilisation is very marginal. On the one hand it is true that the collection of by-products is more labour-intensive than cultivating energy plants, but they are constantly, year to year available. The solutions of higher employment and labour-intensive production are not foreign for sustainable agriculture. Because of the diffused location, a local, decentralized utilisation would be optimal. In this case the maximum scale would be fine for small local heating plants, however – with briquettes or pellets – to smaller-scale household exploitation would be available too. In my opinion the systems like this would be necessary to be supported, because the rural population could be at least partially independent with this from imported energy sources, among others pipelined natural gas.

**6.2** In fact, the land for growing energy crops isn't notable in the future, despite the different optimistic estimates. So this scarce resource should be used with the maximum energy efficiency, ecological and social benefits by cultivation of adequate energy crops, and utilizing them in the most efficient manner. With growing energy crops the utilisation can be planned in a better way, in this case the electricity generation could also be considered in addition to the heat production.

The approach of geography, its analytical, synthesizing methods helped to see clear this diverse and complex problem. Maybe my dissertation demonstrates that the geography is competent to see the relationship between natural resources and the society in the most complex form, and to contribute to the revising of human-environment relations, and to the coordination of geographical, environmental, economic and social aspects.

#### **IV Publications on the topic of the dissertation**

- Jankó F.-Móricz N. Pappné Vancsó J.: A klímaváltozás diskurzusai 1. - Tudományos viták és a társadalomföldrajz perspektívái. Várható megjelenés: *Földrajzi Közlemények*: 2010/4. Megjelenés alatt.
- Jankó F.-Móricz N. Pappné Vancsó J.: A klímaváltozás diskurzusai 2. - A klíma katasztrófától a kételkedésig. Várható megjelenés: *Földrajzi Közlemények*: 2011/1. Megjelenés alatt.
- Jankó F.-Móricz N.-Pappné Vancsó J. 2010: Posztnormál tudomány? A klímaváltozás tudományos vitájának természete. A HUNGEO 2010 Magyar Földtudományi Szakemberek 10. Világtalálkozóján elhangzott előadás. Szombathely 2010. augusztus 17.
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