WOODEN BIOMASS AS A POSSIBLE SUBSTITUTE FOR FOSSIL FUELS – ENVIRONMENTAL AND ECONOMIC ASPECTS

DRVENA BIOMASA KAO MOGUĆA ZAMJENA ZA FOSILNA GORIVA – EKOLOŠKI I EKONOMSKI ASPEKTI

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Abstract: *This work discusses the possibilities for more intensive use of wooden biomass as substitute for fossil fuels in Slovenia. The energetic balance for Slovenia and the structure of energy sources in various sectors is shown. There is also presented comparison of costs of various energy sources when used in households for heating. The possibilities of wooden biomass use and advantages of biomass fuel are shown. At the end also environmental aspects of biomass fuel are discussed.*

Key words: *Wooden biomass, Heating costs, Emissions of pollutants, Comparison of energy sources*

Sažetak: *U radu prikazana je diskusija o mogučnosti intenzivnije potrošnje drvene biomase kao zamjene za fosilna goriva u Sloveniji. Prikazana je energetska bilancija Slovenije i struktura korištenja pojedinih izvora energije u različitim sektorima. Također je pokazana usporedba troškova korištenja različitih izvora energije za grijanje u domaćinstvima. Navedeni su i primjeri mogućnosti korištenja drvene biomase te njezine prednosti u odnosu na fosilna goriva. Na kraju su razmatrani i Ekološki aspekti korištenja drvene biomase.*

Ključne riječi*: drvena biomasa, troškovi grijanja, emisije polutanata, usporedba izvora energije*

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1. Introduction

When searching for an appropriate source of energy three factors are particularly important for the national energy supply– economic, strategic-political and environmental. For every country it is important to have secure source of energy accessible at moderate price and that the degree of pollution is as low as possible. However, as ideal energy source does not exist in practice always some compromise has to be accepted. External circumstances play very important role, too. In the period of economic crisis economic factor plays crucial role.

Wooden biomass presents convenient source of energy for many European countries due to economic, strategic-political and environmental reasons. Increase in oil prices is one of crucial factors for enhanced interest for wooden biomass. Besides this, the majority of European Union (EU) countries have not important own oil sources and except United Kingdom and Denmark all other EU countries are prominent net importers of oil. Therefore, it is particularly important in unclear political situation to reduce energetic independence of countries. In addition to these there are more and more pronounced demands to substitute fossil fuels with renewable energy sources.

The increasing of interest for biomass as fuel particularly for heating of individual houses can be clearly observed in the last years in Slovenia. The main reason for this is more convenient price of wooden biomass fuels in comparison to the other energy sources (particularly oil) which is especially outstanding because of heavy economic situation in the state. In addition to this Slovenia has on disposal considerable quantity of forest – about 60% of Slovenian territory is covered by forests which ranks Slovenia in the third place among EU countries. It was also characteristic that for the number of years in Slovenia increment of wooded areas is observed and the annual quantity of trees cut down is lower than it should be due to the establishment of equilibrium. According to this the increase of wooden biomass use seems convenient also from the environmental point of view. However, the actual situation is more complicated and besides certain positive environmental effects the increased utilization of wooden biomass as energy sources causes also undesired results. The situation in 2014 is particularly specific as due to the catastrophic consequences of sleet the large areas of forests have been destroyed. Consequently, there has still increased the quantity of available wooden biomass and still more convenient prices for users can be expected. However, in the following years undesired consequences of this natural catastrophe will become evident.

2. Use of energy in Slovenia

2.1. Common use

Various kinds of fossil fuels (oil, coal and natural gas) still present the main source of energy in Slovenia [1]. Total energy use in Slovenia lowered in the year 2012 about 2 % in comparison to the year 2011 nevertheless the forecasts promised even better results (reduction of energy consumption for about 3,5%). Forecasts for the year 2013 provided a little increase in comparison to the year 2012 (from 293.898 TJ to 295.749

TJ).The most obvious is reduction in the use of natural gas – in the three year period from 906,5 Sm^3 (2011) on 846,3 Sm^3 (forecast for 2013). The main reason for this decrease is the price of natural gas.
In comparison to the year 2011 there can be also observed reductions in the use of solid fuels and heat (both for 4%) and growth in the consumption of geothermal and solar energy (for 9%). There has been observed certain increase in the use of renewable sources of energy (RSE). It should be emphasized that in the case of RSE the majority were acquired at home from primary sources (it means direct use without transformation: 25.405 TJ in 2011 and 24.667 TJ in 2012 (estimation).
In 2012 almost one half of final energy use in Slovenia presented oil derivatives (49,2%), on the second place is electric energy (22%) and on the third place RSE (12%). In the structure of final use of RSE strongly prevailed wooden biomass (89%) and on the second place were biofuels (9%). There can be observed lowering of consumption for extra light heating oil (18%) as well as gasoline (8%).Contrary, the consumption of diesel fuel increased for 5% [2].

2.2. Use of energy in households

In Slovenian households in 2012 the prevailing fuel was wood in various forms (firewood, remnants of wood, woodchips, pellets, briquettes) with 40 %, followed by electric energy (23%), extra light heating oil (16%), natural gas (10%), district heating (7%) and other (4%). The majority of energy in households was used for heating of rooms (62%), for heating of sanitary water was used 19% of energy, 14% for illumination and electric devices and 5 % for cooking [2].

2.3. Use of energy from renewable sources

Contribution of RSE to the total consumption of energy in Slovenia was 20,1% which is 0,7 per cent point more than in 2011. Target value for the year 2020 for Slovenia is 25% share of RSE in total energy consumption.

When searching for an appropriate source of energy on the level of individual household economic and logistic aspects are the most emphasized. As have been mentioned above during the period of economic crisis many citizens often decide for a cheaper source of energy nevertheless it is less convenient from the view point of comfort. Therefore it is not seldom that oil or gas heating is substituted with wooden biomass. This has become still more interesting in the last years when heating systems using some kinds of biomass as are pellets enable practically the same degree of automatic operation as is the case of oil or gas heating systems. In such way wooden biomass becomes still more competitive as energy source.

3. Comparison of heating costs

Comparison of heating costs for various sources of energy is shown in Table 1. Calculations have been done for one-family house with the area of 150 m^2 and

adequate isolation. Calculations have been performed on the basis of data derived from literature [3].

Energy source	**Annual consumption**	**Price Eur/Unit**	**Annual cost in Eur**
Heating oil	2.300 l	0,997 €/l	2.293
Wood-firewood(kettle with inlet ventilator)	12 m^3	70 €/m^3	840
Woodchips	28 m^3	20 €/m^3	560
Pellets	4,8 t or 7,5 m^3	180 €/t 230 €/t (spruce)	864 1.104
Liquidized petrol gas - propane/butane	3.385 l	0,996 €/l	3.371
Natural gas	2.477 Sm^3	0,4258 €/Sm^3	1.055
*Heat pump air-water	30 kWh/day 150 days or 4.500kWh	0,13668 €/kWh	615
*Heat pump ground-water (ground collector)	20 kWh/ day 150 days or 3.000 kWh	0,14317 €/kWh	430
*Heat pump water-water (well)	20 kWh/ day 150 days or 3.000 kWh	0,14317 €/kWh	430
*Electric radiators 90 W/m^2	2.700 kWh /month 150 days or 13.500 kWh	0,12804 €/kWh	1.728
*Thermal accumulation stove 2kW /for 20m^2	3.600 kWh/ month 150 days or 18.000 kWh	0,1270 €/kWh	2.286

* heating season lasts 150 days

Table 1: Comparison of heating costs [3].

4. Wooden biomass as energy source in households

The term wooden biomass designates the most abundant biomass. Wooden biomass contains all natural wood from forests as well as lower quality wood deriving from agricultural or urban surfaces and wooden remnants from primary and secondary modification of wood (shavings, bark, sawdust etc.).Wooden packaging, furniture and waste paper when they do not contain chemical additives can be also classified as wooden biomass.

Wooden biomass can be used in many different heating systems:

- Individual heating systems
- District heating in urban areas or smaller systems
- Energetic systems for production of electricity and heat (cogeneration)
- In industry by production of processing heat
- Heating of public buildings

Size of particles can be accommodated to the heating devices. Biomass can be prepared directly in the forest or in special plants.

Following forms are used:

- woodchips
- firewood, length: 30-50cm
- firewood and cords, length 100 cm
- sawdust
- briquettes and pellets (made under pressure from sawdust

5. Discussion

As can be seen from the review of literature data wooden biomass is very convenient energy source from the view point of costs. Therefore, particularly in a period of economic crisis this is very important argument favouring the use of fuels deriving from biomass.

When regarding environmental view point the situation is not so straightforward. Wooden biomass presents renewable source of energy. It can be also considered as carbon neutral kind of fuel, as can be seen from Figure 1.

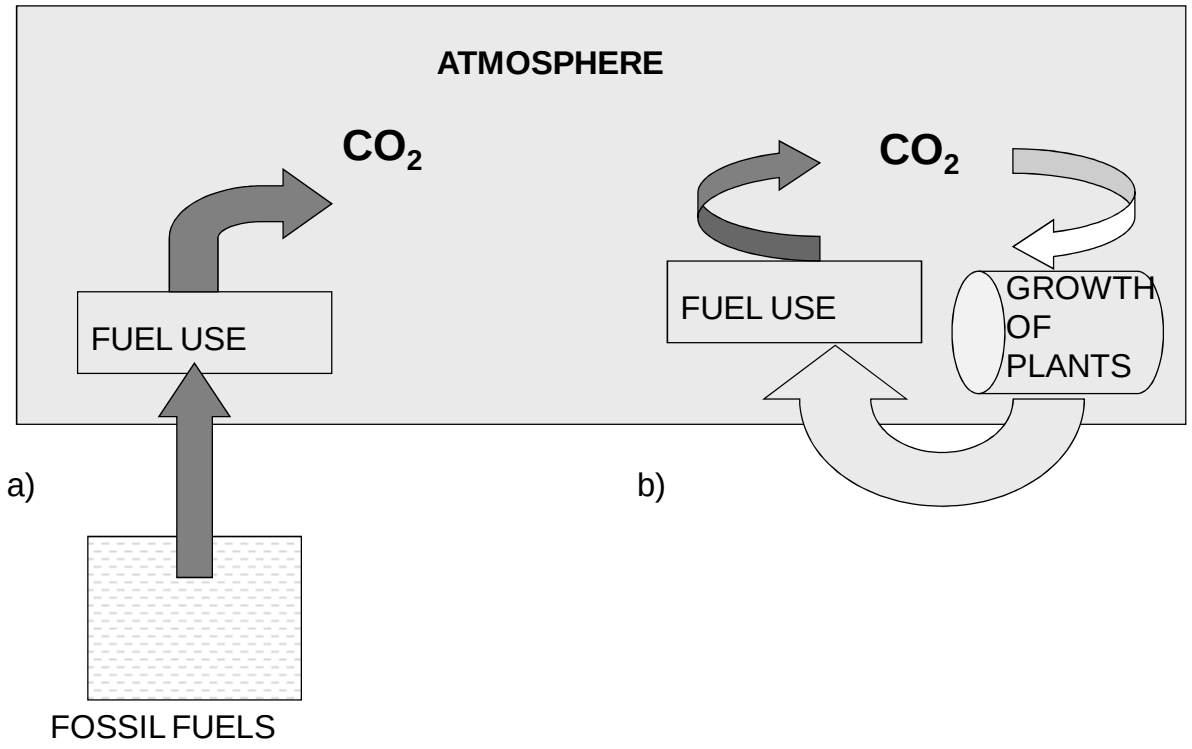

Figure 1: Schematic drawing of carbon dioxide flow in the case of fossil fuels (a) and fuels deriving from biomass (b).

From the environmental point of view substitution of fossil fuels for wooden biomass can help to reduce greenhouse gases emissions. This holds in the case when wood used as a fuel results from regular annual cleaning of forests or from wooden waste material (sawdust, woodchips etc.) and energetic exploitation of wood does not cause deforestation. In such cases wooden biomass actually can be considered as carbon neutral fuel as it has been mentioned above.

However, when regarding emissions of conventional pollutants as are carbon monoxide, sulphur dioxide, nitrogen oxides, hydrocarbons (formaldehyde, benzene, toluene, polyaromatic hydrocarbons, ...), and particulate matter (PM) wooden biomass does not automatically mean more environment friendly solution as fossil fuels (particularly when compared with natural gas). The emissions of pollutants depend considerably on the type of wooden fuel used (firewood, briquettes, pellets, sawdust etc.) as well as on the technology of combustion [4]. Modern heating systems enable much lower emissions of pollutants. Considerable attention should be devoted to this problem particularly in the case of particulate matter as elevated concentrations of particles presents a big problem and causes many health problems. When considering data about air quality in urban areas in Slovenia particulate matters

are the most problematic type of pollutant during the winter period [5]. In the situation when many households have substituted gas or oil heating for wooden biomass this may lead to elevated concentration of particulate matter in urban areas.

6. Conclusion

Wooden biomass in comparison to the other sources of energy when considering the price and availability presents an adequate solution for countries like Slovenia which have high share of forests. Besides geothermal energy it is a source of energy which is acceptable from the financial point of view. Nevertheless, wooden biomass is often favoured also from the environmental point of view certain precaution is necessary when discussing this question. There should be particularly emphasized the use of modern heating devices as they can increase efficiency, reduce use of fuel and emissions of pollutants and facilitate manipulation. The use of biomass is also important as it contributes to the maintenance and cleaning of forests and prevents out of control growing of forests. With better exploitation of biomass Slovenia can decrease its energetic and therefore also economic and political dependence.

7. Literature

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