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ECONOMICS CONSIDERATION ON WOODEN BIOMASS CONSUMPTION

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Abstract: *Energy is the important element that ensures the economic and social development level in the world. According to the research made in this field a lot of researches are orientated to the development of the alternative source of energy. The importance to ensure the necessary energy will be observed from the moment when will start to exhaust the fossil combustible. This paper describes the efficiency use of the fossil combustible and renewable source of energy (SRE) on Romanian energetically market. The accessibility of the renewable energy source in the world directed the economical and social increase in the developing state. Energy is a source that generates the progress of the state. The main objectives of the paper are the accessibility of the energetically source in Romania and the fuel consumption for heating. Important obtained results in the research describes the biomass (pellets, briquettes and wood) as an accessibility solid combustible for producing energy in the world, being widely spread and the cheapest on the energetically market.*

Keywords: *biomass, combustible produce, energy, fuels, heat*

1. INTRODUCTION

In present all researches in Romania and Europe try to exploit the alternative field in energy production and bringing a lot of new scientifically date about the renewable source of energy, especially about the production of energy from the biomass. Energy represents an important point for all the developing countries because energy offers comfort on social and economical plan.

In this moment, main energetically source are the fossil fuels like oil, coal, natural gas, nuclear energy and a low percent from the SRE (Source of Renewable Energy) contributes in European Union (EU) with about 10% to the energy production in 2010. According to statistics, the field of the energy production from fossil combustible will touch the peak point in 2020, after which the chart of availability will decrease [6, 12]. The importance to research the energetically market in the SRE production has a significant and actual role for the population. Countries like Germany, Finland and Sweden ensure 30% for their energy consumption from the SRE production and especially from biomass.

In the 2006, the biomass contribution to the production of the energy in EU was about 86.6 Mtoe (Millions tone equivalent oil) from firewood, briquettes and pellets [19]. The prognoses show that the biomass will cover 60% from the total energy consumption compare with others SRE, with a production of 190-200 PJ/an ($1J=10^{15}$ PJ) [3].

In present, firewood is the principal energy source for producing energy for about 2 billons of people in rural areas and provides more than 14 % from the all energy consumption in the world, comparable with

coal (12%), gas (15%) and electricity (14%) [1, 2, 6]. A major problem with which a lot of researches are confronting is that the consumers use all kinds of thermal furnaces with lower yield for producing energy heat [15].

In the last years according to researches, there were recorded significant increases in imports of the fossil combustible (natural gas) in EU, which were used to produce heat energy. In the energetically field, there were made a lot of research about the efficiency of the thermal furnaces [5, 7, 9, 10, 16, 18]. The thermal furnace in present has a yield of 92% for natural gas use and 85-90% for biomass fuel use.

The amount of released heat from the biomass is influenced by a series of factors as moisture content from the material that absorbs energy in the burning process, the volatile substance, the chemical composition (C, H, O and N) etc.

In Serbia, there are found about 40.9 % of the consumers that use renewable combustible as firewood, briquettes and pellets to produce heat [7]. In Romania the major parts of the consumer use firewood for heating in the rural areas, but these thermal furnaces have a lower yield about 10-15% or natural gas with a higher yield of 90%. The biomass in Romania is the most used combustible in the rural areas.

An important aspect in the use of wooden biomass to produce heat is that that biomass is an ecologically material with lower CO_2 emission in the burning process. The exploitation of the SRE in the entire world can ensure the necessary energy for life and to contribute to the environment protection.

The paper presents a theoretical and experimental research based on a study made to determine the most accessible fuel for producing the heat. The energetically market in Romania knows a lot of combustible materials. In the process of the determination which is the best combustible for heating process were taken in consideration the ecologically aspects and the economical ones.

The main objectives of the paper consist in highlighting the most effective and ecologically solid combustible to produce thermal energy (heat) for the housing and the cost for this energy. The motivation of the necessity of this research occurs from the aspects of the highest costs on the fossil combustible which increased five times since 2000 and in the future it expects to still increase and the availability of them will decrease.

2. MATERIALS AND METHOD

2.1. Materials. Investigating the energetically market were founded a lot of materials which can be used in thermal furnace as ecologically combustible. These materials are firewood, briquettes and pellets from different kinds of species. The pellets/ briquettes are obtained from the forest waste and are considerate energetically products which are used to produce heat in residential and industrial buildings [20].

Table 1.
Chemical characteristics of the solid fuels

Species	Energetically characteristic, %				
	C	H	O	N	A
Firewood					
Willow	51.7	6.1	41.1	0.9	0.48
Beech	49.9	8.2	37.1	0.7	0.5
Spruce	49.1	9.2	38.9	0.6	0.32
Poplar	49.1	9.2	38.9	0.6	0.32
Ash	50.7	8.0	37.5	0.6	0.51
Briquettes					
Beech	50.2	8.1	37.1	0.7	0.41
Willow	51.8	6.1	41.1	0.9	0.72
Spruce	49.9	8.2	38.1	0.6	0.5
Straw	45.6	5.8	42.4	0.5	5.7
Pellets					
Beech	50.2	8.1	37.1	0.6	0.5
Willow	51.7	6.1	41.1	0.9	0.48
Fossils combustible					
Pit coal	65.9	4.6	23.0	0.7	1.2
Natural gas	75	25	-	-	-

In this paper where analysed five energetically species. The raw materials were taken from Willow (*Salix alba* L.), Spruce (*Picea abies* Karrsten.), Beech (*Fagus sylvatica* L.), Ash (*Fraxinus excelsior* L.) and Poplar (*Populus tremula* L.), (Table 1) species. The results were compared with the fossils combustible as gas and pit coal. These species are considerate as energetically species because they have higher calorific power, quickly grow and are widely spread in Europe.

The raw materials were analysed in laboratory to investigate the calorific power of the species.

The chemical composition (Table 1) of the materials is considerate as another important energetically characteristic that are described in others scientifically papers [17, 21]. These elements are presented in different quantity in all kind of combustible materials.

2.2. Method. Experimental method used consists of the determination of the calorific power of wood species and briquettes/pellets with the calorimeter with explosive burning OXY-1C [8]. The amount of the moisture content was determinate through the drying method with the laboratory oven at the temperature of 103^{o}C.

Economical aspects were made on the Romanian energetically market taking in consideration the cost of the combustible displayed by the suppliers.

2.3. Case study. The economically parts were made for a house with a surface of 100 m^2 and the ceiling height is 2.65 m. It is a house for a family with four members. The obtained results from experimental research there were studied in theoretical way. In account were taken the necessary of heat (1) for the houses surface, the quantity of combustible consumption (2) for this surface [13] and was determinate the kWh cost for every type of combustible.

$$Q = Q_T\left(1 + \frac{\Sigma A}{100}\right) + Q_i\ [W] \qquad (1)$$

where:
Q – Necessary of heating, in W;
Q_T – Released heat flux through transmission, in W;
Q_i – Thermal load for heating the interior air, in W;
ΣA – Sum of the additions of the affected thermal flux released through transmission, in %.

$$B = \frac{Q}{c_i}\ \left[\frac{kg}{h}\right] \qquad (2)$$

where:
B - Consumption of combustible, in kg/h;
Q - Necessary of heating, in W;
C_i – Lower calorific power, in kJ/kg.

In case, the consumer wants to replace the existing heating system it is necessary to determinate what elements need to be replaced (pipe, valves, thermal furnace, accessories, etc). These elements need to be described in a draft plan. The main aspect in this part is to determinate the economical ones like the investment costs, maintenance costs and how much costs the thermal furnace for different kinds of combustible.

The chosen combustible materials were selected from the energetically market in Romania. These species present energetically character with higher calorific power and there are most used materials to produce briquettes and pellets [11, 14, 18].

3. RESULTS AND DISCUSSIONS

The heat amount released by biomass described by Kausley et al [15] in their research is calculated like sum of heat released by the elements that compound the burning process: like time of burning, the heat of flame released and temperature of ignition. The obtained experimental results yield the Lower Calorific Power (LCP) that was used in accounting process. In practice wood materials present the higher calorific power that cannot be used effectively. This amount of heat in the burning process is evaporated with formed volatile substance through the chimney.

The moisture content used for determination was 20% for wood and 10% for pellets and briquettes. The moisture degree in the material is an important element from which depends the amount of heat released in a burning process. These are the limit of the moisture contents for the sold combustible materials by the suppliers. The calorific power resulted in the experimental research (Figure 1 and 2) are determinate for moisture content of 20% for wood samples and 10% for briquettes and pellets samples. An analysis of the received results shows that the briquettes and pellets have a higher calorific power in compare with the wood sample. The pellets have calorific power about 18,299 kJ/kg (4.685 kWh/kg) and briquettes about 16,868 kJ/kg (4.227 kWh/kg) at the moisture content of 10%. The compare fossil combustibles have a LCP of 35,500 kJ/m^3 (9.861 kWh/m^3) for gas and 29,000 kJ/kg (8.055 kWh/kg) for pit coal.

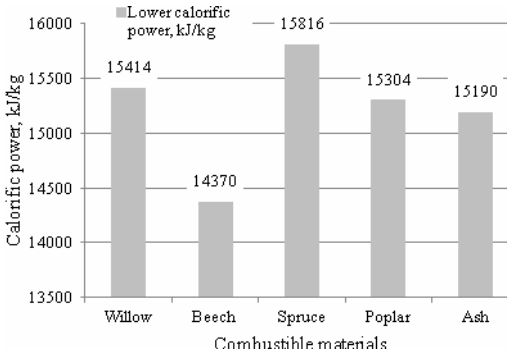

Figure 1.
Lower calorific power of wood species, kJ/kg

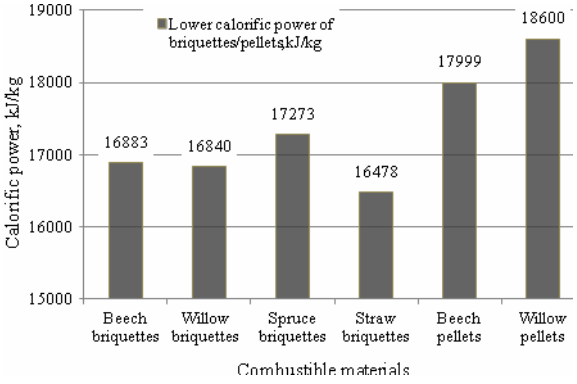

Figure 2.
Lower calorific power of the briquettes and pellets, kJ/kg

The experimental results are described in table 2. The Beech specie (11.63 kJ/cm^3) like firewood presents a bigger energy density than the Willow specie (11.56 kJ/cm^3). An appreciable energy density was obtained for the Spruce (11.78 kJ/cm^3) and Ash (12.91 kJ/cm^3) species. The highest energy density from all the SRE combustible materials has the Spruce briquettes (13.47 kJ/cm^3)The burning rate means the degree of maintenance of the heat released from the woody species in the burning process. Taking in consideration this aspect the biggest burning rate presents the Beech (0.392 kJ/min) and Willow (0.351 kJ/min) species. Compare firewood with the briquettes and pellets sample, the biggest burning rate present the Beech (0.428 kJ/min) and Spruce (0.435 kJ/min) briquettes. This is way a lot of products have 70% percent Beech sawdust and 30% Spruce sawdust. From the pellets materials the biggest burning rate presents Willow (0.419 kJ/min) pellets. This aspect is important when consumers want to heat a house and to maintain it, and to have a lower combustible consumption.

Table 2.
Energetically characteristics of the solid fuel

Species	Mass, g	Density, g/cm^3	Burning time, min	Burning rate, kJ/min	Energy density, kJ/cm^3
Firewood					
Willow	0.639	0.75	28	0.351	11.56
Beech	0.683	0.81	25	0.392	11.63
Spruce	0.546	0.77	28	0.308	11.78
Poplar	0.539	0.69	29	0.285	10.55
Ash	0.618	0.85	31	0.303	12.91
Briquettes					
Beech	0.634	0.54	25	0.428	9.11
Willow	0.645	0.65	29	0.374	10.94
Spruce	0.681	0.78	27	0.435	13.47
Straw	0.632	0.72	27	0.362	11.14
Pellets					
Beech	0.560	0.45	26	0.398	8.32
Willow	0.580	0.56	28	0.419	10.41
Fossil combustible					
Pit coal	1.0	1.30	42	0.692	37.83
Natural gas	1.0	0.717	38	0.921	25.09

In present the energetically market of the SRE will encourage the consumers through the governmental programs to orient to the alternative source of energy because these are ecologically and cheap fuels that can be used by everyone. From the 2007 in European Union is accessible a lot of grant programs for producing energy from the alternative source of energy, and till 2020 is trying to reduce the noxious emissions comparative with the 1990 and to increase the effectiveness of the alternative energy [17].

Table 3.
The account of the necessary of the heat and consumption of the combustible

Surface, mp	Heat necessary, kW	Consumption of: kg/h				
		Firewood	Briquettes	Pellets	Coal	Gas
100	18.2	1.2	1.1	0.98	0.5	0.3

The necessary heat for 100 m^2 from the accounted procedure results 18.2 kW in the winter season for about 100 days (Table 3).

Considering this heat necessary is determinate the consumption of the combustible in thermal furnace for different kind of fuels. The producing necessary energy from firewood consumes about 700 kg by the wooden thermal installation with a yield of 80%. The briquettes and pellets installation will consume in cold season about 550-650 kg with a yield of 85-90%. From the lasts research [4] and taking in account the investment cost, the pellets are the expensive fuels for producing heat than firewood.

Table 4.
Cost of the solid combustible in Romania

Combustible	Firewood	Briquette	Pellet	Coal	Gas
Unit price, €/kg; €/m^3	0.04	0.2	0.2	0.1	0.3
Price €/kWh	0.009	0.04	0.01	0.01	0.03
Energy consumption, kWh/year	10800				
Annual cost for energy, €/year	97.2	432	108	108	324
Cost thermal furnace, €	1000	2700	4700	1800	955
Total costs, €	1000	2700	4700	1800	955
Maintenance costs, €/year	110	110	110	110	40
Current repairs, €/year	45	45	45	45	25

The costs of the combustible materials displayed by the Romanian suppliers (Table 4) were used to determinate the cost for a kg or m^3 of combustible. In this case the energy consumption for a year will be 10,800 kWh. According to this the cheapest fuel for heating the house is firewood (97.2 euro/year) (Table 4). The expensive fuels are the briquettes and pellets and natural gas for heating the house. These are because of two aspects. One is because the thermal installation is expensive and another one is because the costs of the material. Analysing the maintenance costs and the investment costs the firewood furnace with higher yields are not so cheap. Costs of amortization will achieve evident in a longer period of time from 7 to 10 years.

The energy represented by heat touch about 50% from the final energy consumption in a lot of developing countries [20]. Biomass will became a priority in energy producing from the moment when the fossil combustible will decrease.

3. CONCLUSIONS

The necessity to ensure the quantity of heat in the cold season is an important factor and from the results it is evident that biomass products are the cheapest combustible.

Important aspect results in this paper that firewood is a cheap form to produce energy and save about thrice compares with the gas form. Combustion with solid biomass is the most important sector for bio energy production, being the efficiency in the heat production process.

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