

WOOD FUELS CONSUMPTION IN HOUSEHOLDS IN MONTENEGRO

by

Branko D. GLAVONJIĆ^{a*} and Nike KRAJNC^b

^a Faculty of Forestry, University of Belgrade, Belgrade, Serbia
^b Slovenian Forestry Institute, Ljubljana, Slovenia

Original scientific paper

DOI: 10.2298/TSCI130101029G

The paper presents the results of researching wood fuels consumption in households in Montenegro in the heating season 2011/2012. The research was conducted in the period October-November 2012 on the sample of 5% of the total number of households which stated to use solid fuels for heating purposes in the 2011 census. Results of the conducted researches on the presence and amounts of fuels consumed in households in Montenegro showed that total firewood consumption in the heating season 2011/2012 (both urban and rural households) was 703,571 m³. Wood consumption is the lowest in the households in the municipalities in the coastal zone, it is somewhat higher in central zone and the highest in the zone on the north of Montenegro. Average wood consumption in households in the coastal zone municipalities is 3.79 m³, in the central zone it is 5.02 m³ and on the north of Montenegro it is 6.74 m³/household. Observed on the level of Montenegro, average firewood consumption per household was 5.49 m³ and as such it best represents relatively low consumption level in the coastal zone and high consumption level on the north of Montenegro. Compared to the neighboring countries, average firewood consumption per household in Montenegro in the amount of 5.49 m³ is significantly lower than the average consumption in Serbia which is 7.3 m³/household as well as in Slovenia in the amount of 6.5 m³.

Key words: wood fuels, consumption, households, research

Introduction

For meeting its energy requirements, Montenegro largely depends on the import of fossil fuels the costs of which are rapidly increasing due to the increase of oil and gas prices. Large amounts of petroleum fuels, primarily heating oil or fuel oil, are imported and used for the purpose of heating numerous public facilities as well as commercial facilities and households. The fact is that wood and wood fuels cannot fully meet energy needs in Montenegro, however with increased and more efficient use as well as with fossil fuels conversion they can contribute to the significant reduction of petroleum fuels import and reduction of CO₂ emission.

To that effect, in the last decade a certain number of studies was done and several projects were implemented, which were supported by certain international organizations in co-operation with the Government of Montenegro and which dealt with the issue of available amounts of woody biomass, in particular wood residues from forestry and wood processing. The most significant studies are presented in the following with the description of objectives and effects of their implementation.

“*Biomasseheizwerk Kolašin*” feasibility study supported by Austrian Development Agency. The Study was done in 2005 by a consulting company SEEGEN from Salzburg, Aus-

* Corresponding author; e-mail: branko.glavonjic@sfb.bg.ac.rs

tria. Study objective was to identify potentials of woody biomass by amounts and energy values in the areas of municipalities Kolašin and Mojkovac [1].

Renewable Energy Resource of Republic of Montenegro done in 2006 by Italian consortium CETMA, financed by the Italian Ministry for Environment Protection, Land, and Sea. The Study included the segment of biomass as one of the forms of renewable energy sources where wood and agricultural biomass were treated together. Assessments of potentials and limitations in using woody biomass in the municipalities of Berane, Andrijevica, and Rožaje were given [2].

Feasibility Study on Commercial Usage of Wood Residue as a Resource for Economic Development in North Montenegro done in 2007 by the Faculty of Forestry from Belgrade, Serbia. The results of this study have been published in the paper [3]. Paper objective was to analyze potential resources in forestry and wood processing, calculate available amounts of wood residue and its energy value, analyze current situation in wood processing companies and propose models for collecting and using woody biomass from forestry for wood chips production and from wood processing for wood briquette and pellets production. Key stakeholders were identified in the study and measures were proposed to be undertaken by the Government of Montenegro so that the proposed model could be implemented.

According to [4] consumption of thermal energy for heating spaces and technological needs of primary wood processing companies in 2008 was at the level of 48.3% compared to maximum needed energy, which means that 106,116 m³ of wood residue remained for the needs of market and energy systems outside primary wood processing.

However, these studies and papers with the topic of woody biomass were based on the assessment of experts based on official statistical and other data published by certain institutions and organizations. In the same time, none of these studies, projects or papers involved comprehensive researches regarding the actual consumption of wood fuels in Montenegro, especially in the household segment which represents the area where wood fuels are most consumed. This statement represented one of the reasons for conducting researches in the FODEMO/MONSTAT project implemented in 2012, the most significant results of which are given hereafter.

Scope and objective of the work

The main scope of researches is wood fuels consumption for energy purposes of households in Montenegro which include heating, food preparation, hot water, brandy distilling, meat smoking, and other purposes. Research objective is to determine consumption level of all wood fuels for household purposes on the level of Montenegro as well as by individual zones bearing in mind the specific characteristic of Montenegro that a certain number of households are situated in the coastal zone where the consumption of wood fuels is significantly lower than the consumption in mountain zone in north Montenegro.

Methodology used for determining wood fuels consumption in households in Montenegro

Since there were no reliable statistical data on wood fuels production and consumption in Montenegro and as numerous studies dealing with the issue of woody biomass were based on the assessments of experts based on official statistical and other data published by certain institutions and organizations, the need to conduct a comprehensive research was imposed with the purpose to observe actual consumption and the related participation of wood based energy in total final energy consumption balance.

The stated research is based on the application of “new” methodological concept and adequate scientific methods with the purpose to get actual condition of wood fuels consumption in Montenegro.

In the segment of wood fuels consumption in households, the research was conducted by questionnaire method on the representative sample of 5% of the total number of households which stated to use solid fuels for heating purposes in 2011 census. Total number of the selected households for questionnaires was 6,550, 3,590 of which were urban households and 2,930 were rural households. Questionnaire method included 652 interviewing areas in 21 municipalities in Montenegro [5]. This segment also included collective households. Spatial distribution of samples for every household was determined in the package STATISTIKA V.5.0. After the field research had been conducted reached data were inputted in the ACCESS data base and their logical and calculation control was done. Thereafter appropriate requests were realised in the software program ACCESS and appropriate tables were reached as a result. Map with sample size by municipalities in Montenegro is given in fig. 1.

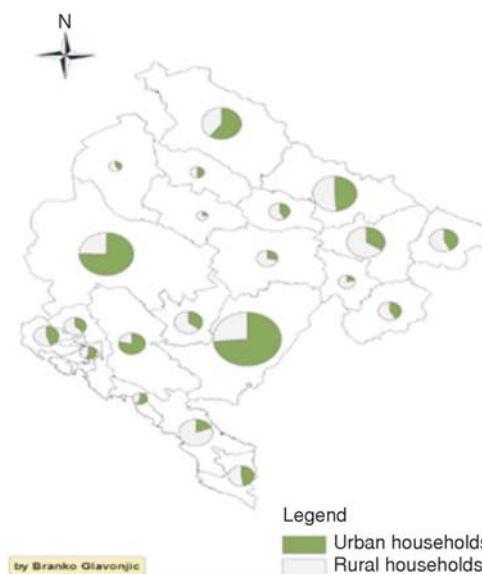


Figure 1. Spatial distribution, size and structure of the sample for questioning households by municipalities in Montenegro

Apart from solid fuels consumption for household purposes, data on the number of household members, facilities where they live in terms of type, construction material, age, insulation, total surface and heated surface, window and door age, wood fuels supply source, type and age of combustion appliances, and purpose of woody biomass use were also collected in this research.

Described manner of data collection provided high incorporation of all segments of wood fuels consumption in households in Montenegro. This way, the largest and most significant wood fuels consumers were included in the research, which made this research representative and the obtained data were made reliable for the needs of various types of analyses.

Wood fuels consumption in households in Montenegro

Current situation in the segment of wood fuels consumption in Montenegro is characterized by the use of the following wood fuel types for heating purposes: firewood, slabs from sawmills, wood briquettes, and wood pellets. Beside wood fuels, combinations of wood and other fuels are also used such as wood/coal, slabs/coal, wood/electricity, and other combinations of wood and other fuels.

According to the census conducted in 2011, total number of households in Montenegro was 192,911. Most households are in rural areas, namely 126,550 or 65.5% while urban households make 34.4% [6].

Results of the census conducted in 2011 showed that 32.09% of the total number of households in Montenegro used other fuels for heating purposes, namely mostly electricity, and

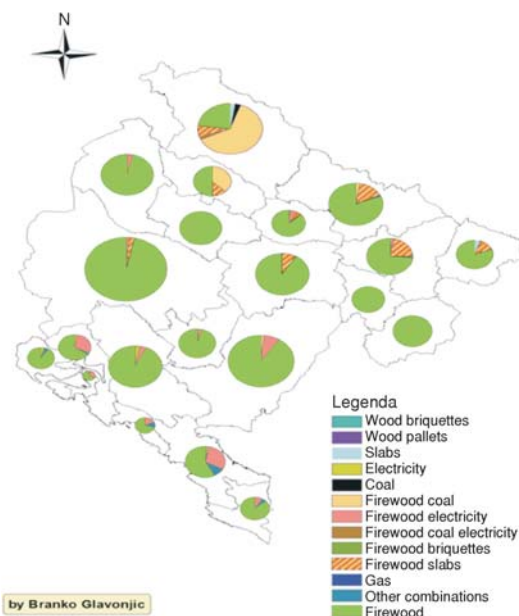


Figure 2. Participation of certain types of solid fuels for heating households in Montenegro by municipalities in 2011

pect of calculating total amounts of wood fuels consumed in Montenegro in 2011, analysis of the data from the conducted questionnaire on the participation of certain solid fuel types was done by municipalities and on the level of Montenegro. Results of the conducted researches on the participation of certain types of wood fuels for heating households on the level of Montenegro are given in fig. 3.

Data on fig. 3 show that almost 80% of households which used solid fuels for heating used wood, while the combination wood/electricity was present in 6.44% and combination wood/coal in 6.06% of the households.

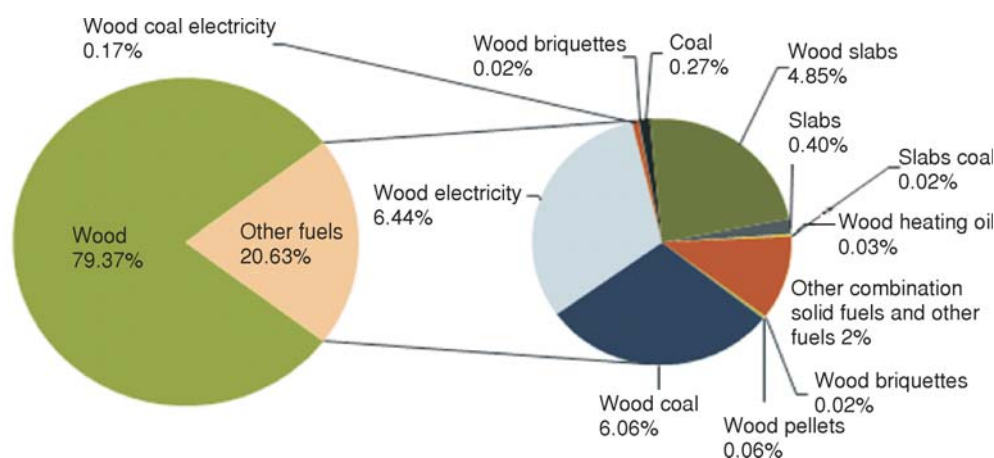


Figure 3. Participation of certain solid fuels for heating households in Montenegro in 2011

67.91% of households or 131,004 used solid fuels for heating purposes such as wood, coal, briquettes, pellets, and combinations of solid and other fuels.

The second important characteristic of fuel consumption for heating households is the fact that relatively high number of fuel combinations is present in consumption. Results of the conducted questionnaire showed that 13 different fuel combinations were present in 2011 (fig. 2). Here, it should be mentioned that firewood was the fuel with the highest participation, followed by combinations wood/electricity and wood/slabs while other fuel combinations were present in smaller degree. However, beside relatively low presence, they have to be taken into consideration when determining amounts of certain fuels used for heating households.

Since most households (131,004) in Montenegro use solid fuels (individually or combined) for heating purposes, from the as-

Results of the conducted questionnaire on the presence and amounts of fuels used in households in Montenegro showed that total consumption of firewood (both urban and rural households) was 703,571 m³ (tab. 1).

Table 1. Total firewood consumption for heating households in Montenegro in 2011

Municipality	Total firewood consumption in m ³	Number of households by municipalities which use firewood individually and combined with other fuels	Firewood consumption per household in solid m ³ (2 : 3)	Firewood consumption per household in stacked m ³ (5 = 4 × 1.43)
1	2	3	4	5
Bar	26,323	6,769	3.89	5.56
Budva	5,260	1,317	3.99	5.71
Kotor	9,144	2,937	3.11	4.45
Tivat	6,138	1,675	3.66	5.24
Ulcinj	17,426	4,106	4.24	6.07
Herceg Novi	13,981	3,832	3.65	5.22
COAST	78,272	20,636	3.79	5.42
Danilovgrad	23,897	5,020	4.76	6.81
Nikšić	97,926	18,554	5.28	7.55
Podgorica	142,686	29,463	4.84	6.93
Cetinje	24,529	4,537	5.41	7.73
CENTRAL PART	289,038	57,574	5.02	7.18
Bijelo Polje	83,009	12,364	6.71	9.60
Žabljak	10,860	1,206	9.00	12.88
Berane	64,712	9,488	6.82	9.75
Kolašin	20,675	2,773	7.46	10.66
Mojkovac	17,129	2,653	6.46	9.23
Plav	27,390	3,473	7.89	11.28
Plužine	7,829	1,088	7.20	10.29
Pljevlja	48,790	9,440	5.17	7.39
Rožaje	40,248	5,107	7.88	11.27
Šavnik	4,781	674	7.09	10.14
Andrijevica	10,837	1,660	6.53	9.34
NORTHERN PART	336,261	49,926	6.74	9.64
TOTAL MONTENEGRO	703,571	128,136	5.49	7.85

Sources: [6] and [7] – Calculations Prof. Dr. Branko Glavonjić and Dr. Nike Krajnc

Note: Total consumption of firewood includes firewood individually and combined with other fuels. Ratio 1 solid m³ = 1.43 stacked m³

Analysis of the data from tab. 1 shows that wood consumption in households largely depends on geographic area and its climate characteristics. Thus, the lowest wood consumption in households is in municipalities in coastal zone, it is somewhat higher in central and the highest in the north Montenegro zone. Average wood consumption in households in coastal zone municipalities is 3.79 m^3 (5.42 stacked $\text{m}^3/\text{household}$) and this consumption is almost equal in all towns in coastal zone as it ranges from $3.11 \text{ m}^3/\text{household}$ in Kotor to $4.24 \text{ m}^3/\text{household}$ in Ulcinj.

In the central zone, consisting of municipalities Danilovgrad, Cetinje, Nikšić, and Podgorica, average firewood consumption per household is 5.02 m^3 (7.18 stacked m^3) and compared to the average consumption in coastal municipalities it is 32.5% higher. Households in Cetinje have the highest average consumption in this zone amounting to 5.41 m^3 (7.73 stacked m^3) and households in Danilovgrad have the lowest in the amount of 4.76 m^3 (6.81 stacked m^3).

Wood consumption in households in the municipalities in north Montenegro is characterized by significantly higher average consumption compared to coastal and central zones. Average wood consumption on the north in the amount of $6.74 \text{ m}^3/\text{household}$ (9.64 stacked $\text{m}^3/\text{household}$) is 1.8 times higher than the average wood consumption in households in the coastal zone and 1.35 times higher than the average consumption in the central zone. Households on Žabljak have the highest wood consumption on the north in the amount of $9.0 \text{ m}^3/\text{household}$ (12.88 stacked $\text{m}^3/\text{household}$), and it is the lowest in Pljevlja 5.17 m^3 (7.39 stacked m^3). The main reason for relatively small average firewood consumption in households in Pljevlja is the use of coal. According to questionnaire results, average household in Pljevlja spent 5.17 m^3 of firewood and 2.5 tonnes of coal for heating purposes in 2011.

Observed on the level of Montenegro, average firewood consumption per household was 5.9 m^3 (7.85 stacked m^3) and as such it best represents relatively low level of consumption in coastal zone and high level of consumption in north Montenegro. Compared to the surrounding countries, average firewood consumption per household in Montenegro in the amount of 5.49 m^3 is significantly lower than average consumption in Serbia which is $7.3 \text{ m}^3/\text{household}$ (10.4 stacked m^3) and in Slovenia in the amount of 6.5 m^3 (9.3 stacked m^3) [8, 9].

Beside firewood and combinations of firewood and other wood fuels for heating purposes in Montenegro in 2011, relatively large amounts of large sawmill residue, so called slabs from sawmill production as well as briquettes and wood pellets were also used. According to the results of the conducted research, total consumption of certain wood fuels for household purposes in Montenegro in 2011 is given in tab. 2.

Table 2. Consumption of certain types of wood fuels in households in Montenegro in 2011

Wood fuel type	Measurement unit	Total consumption in measurement unit	Total procurement costs in EUR
Firewood	m^3	703,571	37,043,228
Slabs from sawmills	m^3	36,510	381,759
Wood briquettes	tonnes	62	8,268
Wood pellets	tonnes	667	121,343
Wood waste from civil construction (formwork), packaging wood, pallets, etc.	m^3	5,254	3,583
Charcoal	tonnes	939.2	–
Residues from vine pruning	stacked m^3	1,075	–

Source: [7]

Questionnaire results showed that wood pellets were present for the first time in Montenegro in the heating season 2010/2011 for the purpose of heating households.

Research results and conducted questionnaires show that there are certain differences in using wood fuels in urban and rural households both regarding the amounts and wood fuel types.

Consumption of all four wood fuel types (firewood, slabs from sawmills, wood briquettes, and wood pellets) is present in the consumption of urban households while firewood and in smaller scale slabs from sawmills are present in rural households. One of the reasons for such a situation is the fact that wood briquettes and wood pellets are accepted as fuels at a very slow pace in rural areas due to the present opinion that nothing useful could be made from “waste” on one hand, and because of low standard of living in households in these areas on the other.

Apart from the abovementioned, consumption continuity is an important characteristic of wood fuels consumption in rural areas. Namely, in most rural households in Montenegro wood is used all year round. In winter months it is used for heating and food preparation and during the remaining months it is used for brandy distilling, meat smoking, hot water, and other purposes. It should also be highlighted that in most rural households there is the need to heat rooms throughout the whole year even during summer months in the evenings, in particular in mountain regions. Use of electricity in rural households for food preparation is symbolic because of extremely poor income of most rural households.

In urban households, wood fuels consumption occurs mostly only during the heating season, while electricity is used for food preparation and other purposes.

Regarding urban households, researches have shown that “new” fuels, primarily wood pellets, are accepted more rapidly in households with relatively high incomes and members with high personal education. Due to comfort and efficiency as well as financial savings compared to fuel oil, the number of households using wood pellets is increasing.

Most households in Montenegro (68.40%) purchase firewood from traders on trucks in the form of one-meter log wood and split logs, and 13.72% gets it from own forests (fig. 4).

For all the others supply sources are warehouses of heating fuels, acquaintances/friends who possess forests, wood from meadows, village pastures, own orchard and other outside forests, state forests, tree lines along rivers, town parks and own forests.

Regarding the supply of other wood fuels, especially wood briquettes and pellets, these are mostly purchased from traders and slabs are mostly directly purchased from sawmills and in smaller scale from traders. Various supply sources also have a significant impact on the price at which wood fuels are purchased and thus on total procurement costs, which were 37.6 million EUR for all wood fuels on the level of Montenegro in 2011.

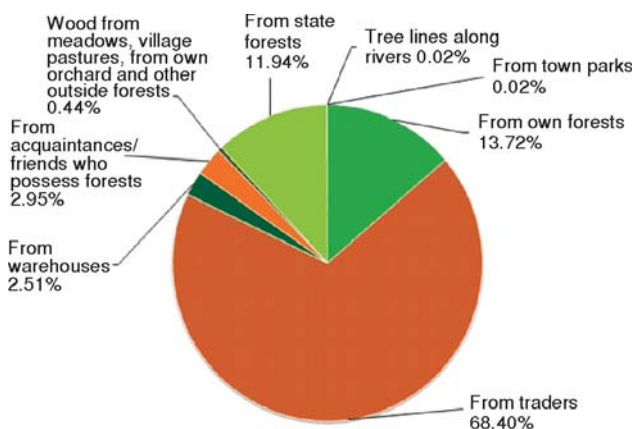


Figure 4. Firewood supply sources of households in Montenegro in 2011

Market of wood fuels in Montenegro

Main characteristic of wood fuels market in Montenegro is the presence of all forms in which it is produced in the consumption of various consumer categories. Firewood is the woody biomass form with the highest presence. Following market requirements, primarily buyers' request to buy firewood in amounts and dimensions which suit them (without additional costs for shortening one-meter logs), many distributors (traders) have included split logs beside one-meter log woods. Split wood is produced in the lengths of 25 cm and 33 cm for the purpose of burning in households and in the length of 50 cm and 1.0 m for the needs of pizzerias and burning in larger fireplaces.

Such orientation of distributors has also had an impact on the changes on firewood market as well in the sense that many producers started producing split wood in the abovementioned dimensions.

Warehouses of heating fuels and firewood distributors offer two types of stacks with chopped log woods of different dimensions (on pallets). Smaller pallet loads have the dimension of $1 \times 1 \times 1$ m and larger ones are $1 \times 1 \times 1.8$ m. According to the amount of split wood, the price of small pallets in Podgorica in September 2012 was 38 EUR [10].

Prices of one-meter firewood logs differ depending on the seller and assortment type. In private forests, prices range from 18-22 EUR/stacked m^3 at forest truck road side. Prices of firewood in towns which are offered to end users (households) by private entrepreneurs (selling from trucks) are higher than the prices on forest truck road and range from 30-35 EUR/stacked m^3 including transportation to buyer's house. Additional 2-4 EUR/stacked m^3 should be paid for the service of shortening one-meter log woods. Beside one-meter firewood logs, split wood in the lengths of 25 and 33 cm are offered to consumers at the price of 38 EUR/stacked m^3 (price in Podgorica, September 2012) [11].

Briquettes are mostly packed in sacks of about 35 kg of weight, the price of which is 100 EUR/ton. Prices are VAT excluded fco producers. Producers sell the largest amounts of briquettes to local consumers (households) because such form of selling is more profitable for them than to distribute it to other towns as such a system would require additional engagement of work labor and logistics [12].

Price of wood pellets among distributors in Pljevlja is 190 EUR/ton depending on the amount purchased and the period in the year when it is purchased. In 2011 pellets were imported from Serbia. Price of wood pellets was from 200 to 210 EUR/tonnes on the market in Podgorica in September 2012. Market of wood pellets is under development, thus there are numerous examples of claims by end users regarding the unharmonized quality of wood pellets and furnaces for their combustion. The reason for this is the fact that there are various models of imported furnaces without adequate attestations and certificates (primarily from China) [13] and there is no producer of wood pellet stoves in Montenegro.

Concerning the systems for wood fuels distribution and ways for supplying certain user categories on firewood market, distribution system via traders, so called sellers from trucks, is dominant while in larger towns (Podgorica, Nikšić) there are warehouses of heating fuels which perform wood distribution [14].

Such warehouses in larger towns are formed by sawmill owners who use concession system of technical roundwood procurement to produce firewood as well, and some of them have their own lines for wood chopping which they sell to households via their warehouses. One ship with firewood was shipped to Greece in October 2012 from the port of Bar.

Schools, pensioners' associations, other public buildings self-governments and certain number of other consumer categories are supplied with firewood from the Forest Administration [15].

The entire amount of wood briquettes produced in Montenegro are used for the needs of the national market. Households take a dominant position in the structure of wood briquette consumers, while among other consumers restaurants and schools are singled out. Each of the stated consumer types has its own ways for the supply and purchase of wood briquettes.

Researches show that in wood briquettes distribution system there are two dominant ways, namely: system of direct purchase from producers and system of supply via intermediaries (entrepreneurs).

Depending on the possibility to choose supply system, prices at which wood briquettes are purchased vary too. Researches show that distribution system via intermediaries is the most expensive and that prices in this system are 30-40% higher than the system of supply directly from producers [15].

Regarding wood pellets, at this moment traders and importers of boilers and furnaces for wood pellets hold a significant position in the distribution system. Importers appear in the distribution system by also offering wood pellets to buyers in the required amounts along with the sale of boilers and furnaces. With such offer to consumers, boiler and furnace importers achieve quite good effects in terms of selling their products. The offer refers both to households and other commercial consumers.

Conclusions

Results of conducted surveys showed that wood fuels individually or in combination with other fuels represent the most important fuel type for households heating in Montenegro. Furthermore, firewood represents dominant type of fuel which is used in 103.979 households (79.4% of number of households which use solid fuels in heating purposes). The usage of pellets in purpose of households heating has firstly started during 2011. Total consumption of pellets in the 2011 was 667 tonnes. Average consumption of wood fuels through a household is not equal and depends on climate characteristics. Therefore the consumption of firewood per household in northern Montenegro is 78% bigger comparing to average consumption per household in coastal zone. Compared to the surrounding countries, average firewood consumption per household in Montenegro in the amount of 5.49 m³ is significantly lower than average consumption in Serbia (7.3 m³/household) and in Slovenia (6.5 m³/household).

Most households in Montenegro (68.42%) purchase firewood from traders on trucks in the form of one-meter long wood and split logs, and 13.71% gets it from their own forests. Regarding the supply of other wood fuels, especially wood briquettes and pellets, these are mostly purchased from traders and slabs are mostly directly purchased from sawmills and in smaller scale from traders. Various supply sources also have a significant impact on the price at which wood fuels are purchased and thus on total procurement costs, which were 37.6 million EUR for all wood fuels on the level of Montenegro in 2011.

The fact is that wood and wood fuels cannot fully meet energy needs in Montenegro, however with increased and more efficient use as well as with fossil fuels conversion they can contribute to the significant reduction of petroleum fuels import and reduction of CO₂ emission.

References

- [1] ***, Biomasseheizwerk Kolašin, Feasibility Study, Austrian Development Agency, 2005
- [2] ***, Renewable Energy Resource of Republic of Montenegro, CETMA, Italy, 2006
- [3] Danon, G., *et al.*, Wood Biomass for Energy in Montenegro, *Thermal Science*, 14 (2010), 3, pp. 783-798
- [4] Glavonjić, B., Opportunities, Challenges and Current Progress with Developing Woody Biomass Fuels Application in Montenegro, Regional Conference: Renewable Energy Sources and their Application, Montenegrin Academy of Science and Arts, Podgorica, 2010, pp. 149-157

- [5] Žižić, M., *et al.*, Methods of Statistical Analysis, Faculty of Economics, University of Belgrade, Belgrade, 2001
- [6] ***, Census in Montenegro, Statistical Office of the Republic of Montenegro, Podgorica, 2011
- [7] ***, Questionnaire and Survey ŠUM BIO 1, MONSTAT, Podgorica, 2012
- [8] Glavonjić, B., Consumption of Wood Fuels in Households in Serbia – Present State and Possible Contribution to the Climate Change Mitigation, *Thermal Science*, 15 (2011), 3, pp. 571-585
- [9] ***, WISDOM Slovenia, FAO-Forestry Department-Wood Energy, Rome, 2006
- [10] ***, Wood Traders Companies, Internal Reports, Podgorica, 2012
- [11] ***, Chopped Logs Producers, Internal Reports, Kolašin, Montenegro, 2012
- [12] ***, Wood Briquettes Producers, Internal Reports. Nikšić and Bijelo Polje, Montenegro, 2012
- [13] ***, Wood Pellets Traders, Internal Reports, Pljevlja, Montenegro, 2012
- [14] Weinreich, A., Potential Sustainable Supply of Woody Biomass from Montenegro's Forests – the Ecological basis, Regional Conference, Budva, Montenegro, 2010
- [15] ***, Forest Directorate, Internal Reports, Pljevlja, Montenegro, 2012