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Application of multi criteria analysis in the design of energy policy: Space and water heating in households – City Novi Sad, Serbia

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ABSTRACT

The Republic of Serbia has taken important commitments to increase the participation of renewable energy sources in meeting energy needs. Significant part of final energy consumption i.e. 36,93% is realized in the residential sector. A multi-criteria analysis of local energy profile of the City of Novi Sad was carried out with the help of PROMETHEE (Preference Ranking Organization Method for Enriching Evaluation) methods. Initial screening of the energy problem will be used for assessing the needs of local introduction of instruments of support and their possible precisely designing. The model enables the aggregation of assessments which have quantitative character with those assessments that are based on qualitative criteria and transparent ranking of alternatives. It enables the analysis of secondary accompanying phenomena, which are caused by impact of proposed policies / measures. By the example of the application of price environment in Hungary, it was shown that local rates are more likely to succeed if they rely on already implemented reforms in the energy sector at the national level, which allows you to test situations in which there is a synergy of policies /measures at different levels.

1. Introduction

An ambitious binding target for the Republic of Serbia, which amounts to 27% of renewable energy sources (RES) in gross final consumptions of its needs in 2020, was determined by the decision of the Ministral Council of the Energy Community of 18 October 2012. After that, the National Action Plan for the use of RES, was passed and made in accordance with the pattern provided by the Decision 2009/548/EC, which sets national goals in the field of transport, electricity, heating and cooling down until 2020 taking into account the measures related to energy efficiency.

The latest estimates of the energy resources of the Republic of Serbia dedicate dominant position to the deposits of coal – lignite. By contrast, technically exploitable potential of RES is 5.6 Mtoe/a. Their use can substantially reduce the use of fossil fuels and contribute to achieving the proclaimed goals. Biomass potential is about 3.4 Mtoe/a (2.3 Mtoe/a is unused and 1.1 Mtoe/a already in use). In addition to the importance of biomass we can stresses the hydropower potential, which is estimated at 1.7 Mtoe/a (unused portion of the potential is at the level of 0.8 Mtoe/a, while the exploited one is at the level of 0.9 Mtoe/a) (Ministry of Energy, Development and Environmental Protection, 2013). In accordance with the projected plans, the RES must be designed to achieve 2563.6 ktoe in 2020, which means that in the period from 2009 to 2020 it will be necessary to achieve an increase of 621 ktoe. The Ministry in charge of energy affairs monitors implementation of the National action plan, and adopts of the report submitted by the Secretariat of the Energy Community. The first report was submitted in late 2014 and contains data for 2012 and 2013. Based on the data in the Table 1 it can be clearly concluded that it is necessary to intesify activities for implementation of declared goals by 2020.

A more detailed picture of the final energy consumption in the Republic of Serbia we can get from the data shown in the Table 2. In the Republic of Serbia, 35.20% of final energy consumption in households has been conducted. If this data is compared with the situation in EU-28 we can note that this percentage is much lower and amounts to 24.79% (Eurostat, 2014). Insight into the structure of the final consumption in this sector, which is seen in the Table 3, shows a high prevalence of electricity of 43%. This represents undesirable data and signal that it is necessary to take measures to reduce this percentage.

All this leads to the unambiguous conclusion that in this area there is a huge space for savings energy consumption and implementation of energy efficiency measures. According to the above mentioned it is clear that energy policy makers need to design such a set of incentives that will encourage and stimulate users to transition towards greater use of RES, especially biomass for heating living space, but at the same time they must ensure an increase of energy efficiency and the promotion of new technological solutions.

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Table 1
Participation of RES in gross final energy consumption in the Republic of Serbia in 2013.
Source: (Ministry of Mining and Energy, Republic of Serbia, 2014)

	ktoe	%
RES participation in the sector of cooling & heating	1034	21.86
RES participation in the sector of electricity	880	37.81
Participation of RES in gross final consumption	1914	19.10

Table 2
Final energy consumption the Republic of Serbia in 2014 by sector.
Source: (Eurostat, 2014)

	ktoe	%
Final energy consumption	7841	100.00
Industry	2068	26.37
Transport	2115	26.97
+Road transport	1996	25.45
+Domestic&International aviation	71	0.01
Other sectors	3659	46.66
+Services	739	9.42
+Residential	2760	35.20

Table 3
Final energy consumption in the Republic of Serbia in 2014 by fuels.
Source: (Eurostat, 2014)

	ktoe	%
Residential	2760	100.00
Solid fossil fuels	177	6.41
Crude oil & petroleum products	44	1.6
Gas	143	5.18
RES	852	30.86
Electricity	1187	43.00
Derived heat	358	12.97

2. Energy performance of family houses in the Republic of Serbia

Group of authors from the Faculty of Architecture in Belgrade has analyzed the characteristics of family homes in six regions in the Republic of Serbia and defined their basic typology. Information is has been collected by means of so-called two-tier list that has included the 6.000 building (Jovanović Popović et al., 2011). This research has shown that there is a very large number of unfinished buildings, constructed without a facade in which people live for more than 30 years, while 51% of windows are older than 30 years (Fig. 1). It is not necessary to prove the existence of high thermal losses in these facilities. In addition they have emphasized that, 87.35% of all residential buildings in the Republic of Serbia represent the family buildings, which is the most common form of housing outside the densely populated urban areas. If we look at the typologies of family houses in the territory of Republic of Serbia, it is noticeable that the electric water heater is used for heating the domestic hot water. This fact probably clarifies the increased use of electric energy in the Republic of Serbia in relation to the EU-28 member states. The authors of guidelines for the collection and processing of statistical data related to energy consumption in households (Eurostat, 2013) indicate these are studies in some EU member states, that 14% of total energy consumption in the household goes to water heating.

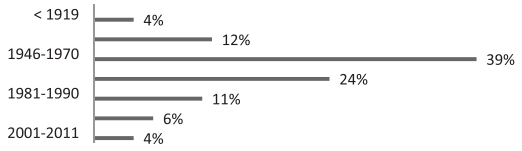

Fig. 1. Period of construction of family houses in the Republic of Serbia.
Source: (Jovanović Popović et al., 2011)

3. Local energy profile – City of Novi Sad

According on Census to Population, Households and Dwellings in the Republic of Serbia from 2011, 335.701 residents who live in 163.128 apartments have been listed in the City of Novi Sad (Statistical Office of the Republic of Serbia, 2011). Database which is used for billing utilities (heating, water, sanitation, hygiene, etc.) has more operative data. It is organized into two main sections: the individual residential buildings with 45.600 users and collective residential buildings with 106.400 users. Analysis treats 29,92% of consumption areas measured by the number of residential buildings. On this basis, it is reasonable to conclude that the problem of energy consumption in the households is relevant for decision-making on designing energy policies/measures at the local (City of Novi Sad) and national levels (Republic of Serbia).

A more detailed picture of the structure of energy consumption completes the data on the consumption of natural gas in the territory of Novi Sad. In December 2014 there were 34.888 connections to individual objects while 392 were collective facilities. Based on the a.m. data it is noticeable that 76,5% of individual housing units in Novi Sad are covered by natural gas network. It should be noted that some or even most of owners of these objects are used, at the same time, from several technological options that are available and depending on the movement of energy prices they choose one of them. There are situations in which people simultaneously use several types of energy. For example, natural gas is used for cooking, while heating domestic hot water is performed with the help of electricity and heating of living space by biomass boilers.

If we are considering district heating that provides local public company, it can be noticed that this technological solutions is predominantly intended for customers in the highly urbanized areas of the city in collective residential buildings. This utility takes care of heating 85.500 households in collective residential buildings with heating surface area of 4.400.000 m^2 while individual housing remote system provide heating for 1.600 users with an area of 143.000 m^2. A relatively small number of existing connections, and difficult to predict and extremely high costs of connecting eliminate this option from further consideration.

4. Methodology, and identification of alternatives

There are numerous academic literature and published scientific papers on the topic of decision-making, as well as a number of developed methods (AHP, ANP, MAUT, ELECTRE, TOPSIS, Goal Programming etc.) for solving these problems (Ishizaka and Nemery, 2013). Every day people are faced with making decisions that can be classified into four main types (Roy, 1981): a) The choice problem – the goal is to select the single best option; b) The sorting problem - options are sorted into predefined groups; c) The ranking problem – options are ordered from best to worst by means of scores or pairwise comparisons; d) The description problem – the goal is to describe options and their consequences. The PROMETHEE and GAIA visual modelling method (Geometrical Analysis for Interactive Assistance) have a wide spectrum of ability to cover the previously described types of choice, ranking, and description problems that is necessary for performing the analysis. This method was introduced in 1985 in the journals “Management Science” (Brans and Vincke (1985); A Preference Ranking Organization Method