

# Rural Populations and Renewable Energy Sources – Experiences of the Republic of Serbia

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**ABSTRACT:** During the last decade of the twentieth century the use of renewable (green) energy became the imperative not only in developed countries worldwide, but also in the poorer countries of Asia and Africa. The change from traditional to renewable energy sources carries valuable improvements in environmental protection and economic efficacy. Using individual examples this paper deals with the possibility of replacing traditional energy with renewable energy sources such as solar, wind, geothermal, small hydroelectric power plants, etc. worldwide and in rural Serbian communities.

**Keywords:** renewable energy, green energy, economic benefits, female participation

## 1. INTRODUCTION

The use of different forms of energy has been the driving force behind human development throughout the ages. Energy was obtained from sources present in human's immediate surroundings. Throughout history these sources were taken for granted and considered inexhaustible. The 20<sup>th</sup> century brought with it a new knowledge of resource exploitation. People came to realize not only that the sources they were using (oil, coal) were irreplaceable, but also that their exploitation produced secondary by products such as greenhouse gases, with multiple deleterious effects on the environment.

One such problem is the *greenhouse effect* that results from increased concentrations of carbon dioxide, methane, nitrogen oxides and other gases in the atmosphere. Accumulation of gases around dust particles in the atmosphere emanate heat, and the subsequent gradual increase of temperature results in global warming and climate changes in large expanses of our planet [1]. Thus, it has become necessary to examine other sources of energy that would fulfill two criteria: (i) that the emission of toxic materials into the atmosphere is reduced during energy production, and that (ii) access to the energy source is relatively simple and possible at regular intervals. These criteria are met by so-called "green energy", based on solar radiation.

Green energy can be defined as the energy that is obtained from renewable sources. Green energy is also sustainable and its production and consumption does not put the environment at risk. Green energy includes wind and solar energy, energy of the oceans, energy derived from biomass, hydro power plants, waste energy that is obtained from different waste products (biomass waste, heat waste generated during/in the course of industrial production, and energy derived from the processing of communal waste). Use of renewable energy is increasing worldwide. Aside from reducing greenhouse gas emissions, it can also ensure energy-independence at

local and national levels. One of the important aims of the use of green energy is to secure local consumers to have a greater degree of energy independence, whether from imports or from national and regional energy suppliers through large distribution systems [2]. Green energy is mainly produced from local sources that are immediately available to the consumer. Also, it is suitable for small, private investments that in turn foster a balanced development of rural communities.

## 2. SUSTAINABLE DEVELOPMENT AND RENEWABLE ENERGY SOURCES (RES)

Many declarations deal with the use of RES which is one of the basic postulates of the *idea of sustainable development* elaborated in detail in Agenda 21 in Rio de Janeiro in 1992 [3], and in Habitat II in Istanbul in 1996. As the concept of sustainable development implies the preservation and revitalization of the environment and its resources for the coming generations, the use of RES has become a priority in many countries. Aside from the idea of sustainable development, the concept of applying RES has been supported by signatory countries of the Kyoto Protocol from 1997. These countries are obliged to reduce emissions of toxic gasses from 2008 to 2012 by an average of 5.2% compared to the level in 1990. As the application of these concepts is based on local energy sources and their exploitation in limited areas, such programmes have already been applied in many countries worldwide, regardless of their level of development. Thereby a healthy environment and an improved quality of life are not anymore solely privileges of the "rich". The main results of these programmes' application throughout the world are the attainment of a certain level of independence from large energy systems, as well as a reduction of exploitation of otherwise traditional forms of energy such as wood, coal and oil.

The positive effects of applying RES in rural communities are:

1. *Ecological.* Decreased air pollution with carbon dioxide and other contaminants; prevention of further deforestation and resulting erosion; reduced health-risks for lung-related diseases among the local population (primarily women and children) from harmful gasses present in the atmosphere.

2. *Economic.* Green energy exploitation should create new jobs and promote the participation of the local population in the process of energy production.

3. *Social.* The active participation of the local population in decision-making dealing with energy sources could exert a positive psychological effect on the entire community and facilitate the implementation of certain programmes. It is thereby necessary to establish permanent education programmes at the local level for all members of the rural community, especially for female population. The incentive for the local population to participate in these programmes lies in concrete, clearly defined aims that bring results in a relatively short time. These results do not always have to be impressive, but the activities leading to them should be carefully planned so to provide everyone with the general atmosphere of "something happening" and the sense of being active participants. The results have mostly to do with economic benefits, such as the creation of new jobs, improved living standards, increased work comfort and environmental preservation.

Rural communities are engaged in many programmes which are often coordinated at an international level, supported by local authorities and involve the active participation of the local population. In order to achieve these aims, joint action is necessary between energy suppliers, state and local authorities and beneficiaries. It is very important that all the participants are well-informed. The local authorities assume a crucial role because of their contacts with beneficiaries. They also have at their disposal different means of transferring knowledge to the local population. If this is done in the right way, the public could become the strongest supporter in attempts to promote green energy [4].

### 3. APPLICATION OF RES IN RURAL AREAS

In order to establish a particular RES that could be used in villages, it is necessary to define the basic forms of energy (in relation to their possible use), as follows:

1. *Household energy* – includes electricity which is supplied to rural areas through large centralized, electro-energetic systems, and energy for heating which the local population mainly obtains by burning wood or low calorie coal during the winter months.

2. *Energy used for technological processing* – includes the energy necessary for performing specific production processes in rural areas, such as milking, making various dairy products, drying fruits, vegetables and medicinal herbs, etc.

Rural areas possess a great potential for energy production. The only traditional form of green energy

that has been present in the past decades in rural mountain areas of the world is water energy (mills have been running on it for ages). It was the basis of early industrial development in these areas, especially in the textile industry. Modern technologies based on solar and wind energy further not only the economic development of villages and lower health hazards, but to a large extent they provide a substitute for traditional sources of electrical energy [5]. Solar energy is also widely used in heating houses (e.g. in Pakistan, Nepal and Tibet). It also has considerable potential for use in telecommunications.

#### 3.1. Preconditions necessary for local population involvement

In order to introduce any sort of initiative at a local level, it is necessary to have the government's support through the general strategy and policy for energy development, as well as its laws, tax policy, administrative and financial relief and technical support, all of which should stimulate the use of local energy sources. Sustainable development of rural communities implies the development of specific policies, laws and programmes that are based on research and sound knowledge of specific situations and the active participation of the local population. Rural communities often lack in political and financial power as well as in critical mass for implementing the planned aims. Remote mountain communities are often physically isolated, far from major roads and other lines of communication [6].

In order to accomplish a wider application of RES in rural communities, it is necessary to establish coordination and communication between the key participants in this process [7]. Communication creates an important bond between different groups by bringing together their mutual levels of awareness and information to the decision-makers. Many developing countries need to provide rural communities with modern energy servicing which requires a degree of financial, human and technical resources [8]. There is no standardized instruction to be followed in developing energy programme for a certain region. The ever-changing political map, the comparatively large number of active participants and the diversity of energy sources make impossible a single approach to dealing with the problem. Thus, as a general rule it is best to have a number of possible scenarios at hand. Policies and regulations that recognize local property laws are very important for sustainable development of the village. Rural communities need to establish control over processes of decision making when local resources are in question, as well as incentives for their management.

Although rural regions have the right to exploit all of the available sources, a country's energy policy should make the move to facilitate green energy use. Green energy should be seen as being a reliable, locally accessible source that can be adapted to suit small and medium-sized needs, and that it is ecologically acceptable. The problem of ownership of energy produced by the local community hasn't been solved – the local population does not supervise it and has not obtained concessions over it. The current situation in Serbia and the world has changed

somewhat. There is increased awareness that large power plants have negative environmental as well as sociological consequences. The local authorities can be powerful initiators of change. However, they are often restricted by the existing large systems of centralized energy servicing and the current high price of renewable energy sources.

Bearing in mind that in mountainous regions women are the most important beneficiaries, securing their active participation in programs for RES promotion and implementation is one of the main objectives in all countries, regardless of their socio-economic development. Introducing them to green energy sources can have very positive sociological and cultural implications on the overall population, especially with regard to the adoption of programmes [5], notably in countries whose economic structure is such that a poorer population prevails.

### 3.2. Socio-economic aspects of RES application

The eradication of poverty is an important aim of green energy implementation programmes in under-developed countries. The surplus of produced sustainable energy should be in the hands of the local population. The purchase and distribution of stocks opens the possibility of improving the economic status of the local population, thus reducing emigration to urban centers with its negative consequences. Natural resources are often under-estimated or even given for free. Governments can help rural communities in establishing the value of resources and securing that money eventually returns to the local economy. There are examples in which the rural population renounces property rights for the construction of holiday houses at market price, and then receives concessions for wood-cutting and lumber transport. Tourist revenues, through tax policies, contribute to the development of rural communities. Training is organized to provide employment for the locals, especially women.

Green energy offers great possibilities in avoiding "dirty industrial" development that the West has already witnessed. However, the adoption of these programs is not simple. Lobbies that support the use of conventional energy sources and exploit resources at a global level are not keen on green energy use. The economic disparity resulting from the uneven development of infrastructure (roads, systems of energy supply) is noticeable in mountainous regions that have not developed into important tourist centers. However, due to the slow penetration of negative aspects of development, natural resources have been preserved in these areas. Green energy does not have any negative effects on the environment. Also, it secures a decentralized production of energy [9].

### 3.3. Introducing RES: world experiences

The use of green energy has shown to be more efficient when it is applied at a local level as it cannot compete with traditional energy systems covering larger areas. That is why the governments of a number of under-developed countries (India, Bangladesh, and Botswana) have, through the Agency for Non-Conventional Energy and Rural Technology (ANERT), India [10] (UNESCO, 1986),

commenced with programmes aimed at introducing non-conventional energy forms to local rural communities [11]. A special part of the ANERT programme was intended to stimulate the active participation of the female population in these programmes and train them in the application of RES. Solar energy, obtained through the use of different types of energy-transforming systems, is used more and more in mountain regions around the world (China, Tibet, Bolivia, and Nepal). Also, wind energy is widely used in many western countries (Germany, Upper Austria). Of particular interest are types of RES that are used to a lesser extent than others, such as the use of biomass and plant oils for generating heat.

## 4. POSSIBILITIES OF APPLYING RES IN RURAL MOUNTAIN REGIONS OF SERBIA

The Republic of Serbia has very poor results in applying green energy. Elementary sources of energy such as low-calorie coal and liquid fuels are not renewable and up to 40% are imported. It is important to consider the use of other sources of energy that would significantly decrease the irrational exploitation of resources that are being slowly exhausted, thereby creating a much healthier environment. The main problem is the relatively low price of electrical energy and the lack of personnel which could work with RES. The necessary legislative that would set this problem in an institutional framework, as well as an economic programme that would support the use of green energy, also are lacking.

Hydro-energy, along with non-commercial uses of RES contribute to only about 15% of the total energy production in Serbia [9]. Therefore, one of the main objectives of Serbia's energy planning strategy should be to stimulate the use of local energy sources that do not pollute the environment and that could reduce imports of non-renewable energy sources. According to international experience and research conducted in Serbia in the past years, Serbia's mountain villages would be the main beneficiaries of RES. Mountain villages are in an extremely unfavourable position for the distribution of energy from centralized systems due to their scattered nature and considerable distance from distributing networks.

Serbia occupies an area of 88,361 km<sup>2</sup> out of which as much as 22,500 km<sup>2</sup> are considered mountainous (based on the criteria used for determining whether a region is mountainous, i.e. that more than half of the land-registry municipalities are 600 m above the sea-level). This area is inhabited by a population of 721,453 out of a total of 7,479,437. According to the programs sponsored by foreign donations in undeveloped countries, rural populations are considered to be the most likely active participant in the application of RES. Since more than 44% (as registered in 2002) of the overall population of the Republic Serbia is rural and uses traditional energy sources, it can be concluded that it is necessary to conduct programmes for RES use in rural, particularly mountain regions [12].

### 4.1. A draft model of RES application

As a starting point, by using the example of countries that are at the same or similar level of

economic development as Serbia, a model was created according to which RES would replace to a great extent the existing traditional sources of energy (in Serbia's rural areas these are wood and low-calorie coal), as well as it would secure a degree of independence from large energy systems (at a sub-regional, regional and national level) that these areas have so far relied upon. Due to the unavailability of expensive sources of energy such as coal and oil, the mountain regions of Serbia have been devastated in the last ten years as a result of systematic deforestation and subsequent erosion. The unreasonable and unprofessional management of certain energy sources such as low-calorie coal has brought about an increase in the number of cases of pulmonary infections, especially amongst the younger, female population. Solar energy, wind energy, the energy of small hydroelectric power plants and especially geothermal energy are the future for Serbia's rural communities. Here lies an economic potential that could help solve the energy map of Serbia and high unemployment. It could help decrease the number of people among the rural population that receive state benefits.

#### 4.2. The participation of women in programmes for RES implementation

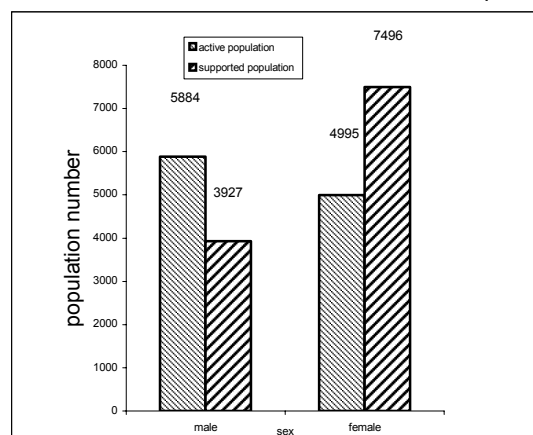
Education of the local population should be based on a previously decided national strategy and after potential RES have been established. It should primarily focus on women who will assume a key role in using RES not only in households and farms, but also in power plants. Educating women is the first step in implementing a programme for RES use. Through lectures that would be held either at the municipal level or at local community centers, women would be introduced to the basic principles of application of different types of RES in households (installation of photo-voltage panels on roofs of houses that could heat and possibly produce electrical energy; use of wind energy or electrical energy; bio-gas production by burning and processing certain categories of communal waste, etc.). Bearing in mind that women have more responsibilities in the household (which is reflected in their choice of energy sources for cooking or heating water), they should have the freedom to choose the source of energy. Attention should focus on the training of women in the essentials of efficient food preparation and maintenance of the equipment used in energy production. In this way the female population would achieve a degree of independence in decision-making and in the upkeep of appliances [13]. Problems appear in agricultural production which, as still relatively inefficient in Serbia, could be improved by the use of RES at smaller production facilities. Namely, the introduction of heat and electrical energy production and supply from renewable sources at a local level would shift the production of food to a higher technological level. It is envisaged that the system would be controlled and maintained by the female population previously educated in this area. Up to a certain extent the substitution of traditional with RES would solve the problem of unequal employment opportunities for both sexes which are

still present in Serbian society. Due to a traditional (patriarchal) way of life in the Balkans women in rural societies have been the victims of discrimination for years when it comes to working outside the household. The sex/age structure and percentage participation of women in agriculture that belong to the total population involved in agriculture of the mountain municipalities of Valjevo, Brus, Knjaževac, Pirot and Raška, will illustrate the prevailing conditions.

#### a) A model for the engagement of the active female population of the Valjevo municipality

The municipality of Valjevo belongs to the Kolubara district. It covers an area of 905 km<sup>2</sup>. According to the census from 1991, its population is 98,226 [14]. As according to preliminary results from 2002 the number of inhabitants fell to 96,761 [15], a slight tendency towards depopulation appears to be taking place. Like most mountain areas in Serbia, the Valjevo municipality traditionally has a larger female population in all of the age groups. Growth of the female population was most pronounced in the 30 to 40 year-old group, which is a favourable trend seeing that "the fittest workers" reside in this group.

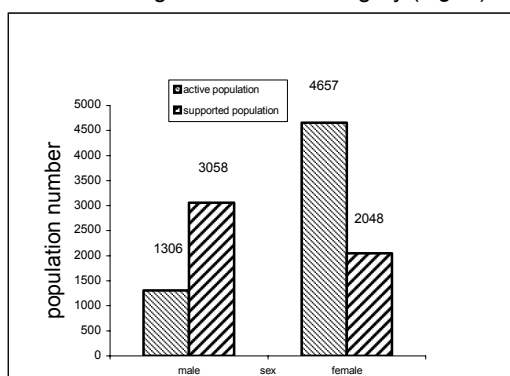
The Census from 2002 revealed certain changes in the sex/age structure. In spite of the same general trend, the better part of women belonged to the 20 to 39 age group [15]. In agreement with the global increase in size of the female population, the number of women fit for work (from 18 to 60 years of age) continue to exert pressure on employment. Valjevo municipality has a great problem with the number of women fit for work that receive state benefits. Women often work in the household or in small farms. The graph shows that the female population is more numerous and that a few women work in agriculture. Therefore, according to the Valjevo municipality census, there is a large population of women relying on state benefits that could work in RES application. It is precisely this group that has been engaged in using RES in other developing countries, not only at the household level, but also in agricultural production. A similar situation was observed in other municipalities.



**Figure 1:** Sex and employment profile of the agricultural population in the Valjevo municipality according to the 1991 census.

*b) A model for the engagement of the active female population of the Brus municipality*

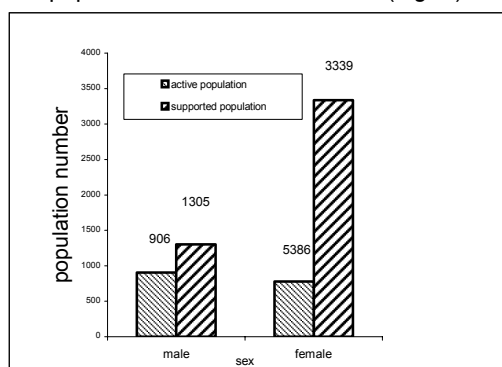
Brus municipality belongs to the Ras district. It covers an area of 606 km<sup>2</sup>. Like other mountain municipalities in Serbia it is depopulated. From the 1991 to the 2002 census its population decreased by 13%. The sex and age classification is similar to the Valjevo municipality, although in Brus significant population aging has also been observed. However, regardless of the age structure, the sex classification clearly shows that a large number of women could be included in RES application with the help of different education projects. Also, according to the diversity of the population based on sex and work, a strong need for stimulating employment at a local level is present. Statistics show that the active population is mostly male. Such a situation should be used for implementing programmes for RES application, thus offering increased employment and improved standards of living to this social category (Fig. 2).



**Figure 2:** Sex and employment profile of the agricultural population in the Brus municipality according to the 1991 census.

*c) A model for the engagement of the active female population of the Knjaževac municipality*

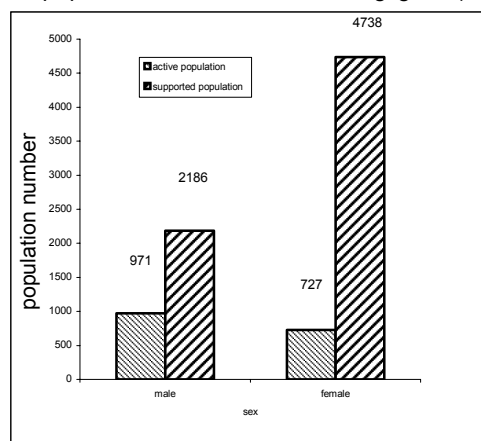
The Knjaževac municipality belongs to the Zaječar district. It covers an area of 1,202 km<sup>2</sup>. Like the previously examined municipalities in Serbia, Knjaževac has a negative age structure with a strong tendency towards depopulation. Programmes for RES application (use of solar energy, wind energy, etc.) should focus on stimulating the dominant elderly female population at a household level (Fig. 3).



**Figure 3:** Sex and employment profile of the agricultural population in the Knjaževac municipality according to the 1991 census.

*d) A model for the engagement of the active female population of the Pirot municipality*

The Pirot municipality belongs to the Pirot district. It covers an area of 1,232 km<sup>2</sup>. Of all of the examined municipalities, the population of the Pirot municipality has the best economic structure, as the percentage of female population on sustenance is negligible (Fig. 4).

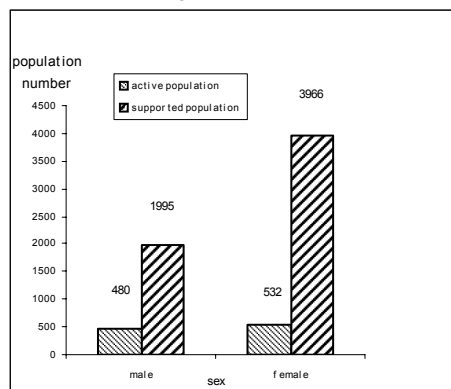


**Figure 4:** Sex and employment profile of the agricultural population in the Pirot municipality according to the 1991 census.

The population that works in traditional energy systems should be trained for work in alternative energy sources as part of the programme for RES application. The local rural population should be continuously educated in the use of energy alternatives to primarily low-quality coal and wood, thereby securing the active participation of the female population in programmes for RES implementation. Since the female population predominates in the 20-39 and 40-59 age groups, the sex and age structure is just one of the advantages of this municipality, making it suitable for the introduction of RES.

*e) A model for the engagement of the active female population of the Raška municipality*

Raška municipality covers an area of 666 km<sup>2</sup>. Its population is characterized by a stagnating tendency which makes this municipality similar to the Valjevo municipality, despite the fact that 24% of the population works in agriculture.



**Figure 5:** Sex and employment profile of the agricultural population in the Raška municipality according to the 1991 census.

Also, the supported female population within the total population active in agriculture is relatively low. This means that in the coming period, as part of the program for RES implementation, a strategy that would educate the female population in promoting use of RES in meeting local demands should be created (Fig. 5).

The age structure in this municipality is also very favourable. A younger female population in the 30-39 age group is prominent and works in agricultural production which could in turn become economically more profitable with the use of RES as primary energy sources.

#### 4.3. Problems in model making

In the RES of the examination of the age and sex structures of the above mentioned municipalities, we arrived at the problem of relevant statistical information absence concerning the educational level of the female population in the different age groups. This information would be valuable in determining the possibilities for employment of the female population. In undeveloped countries, due to a very low level of education women are employed in positions that do not require college or higher education (the use of RES at a household level or the maintenance of systems at a household level that do not require advanced technical knowledge). There are signs that the situation in Serbia is different. Namely, the educational structure is generally higher than in undeveloped countries, which means that the requirement for university educated personnel in power plants can be met.

## 5. CONCLUSION

The switch from traditional energy sources to renewable ones is a necessity of the modern world. It is the consequence of a grave environmental situation and many economic reasons. Man's need for more energy is growing by the day, albeit in disproportion to the existing energy supplies. This means that it is necessary to focus on local sources of energy that have been unjustly ignored. International experience shows that only joint actions of institutions at local, regional and national levels can create a uniform strategy that would result in an increased use of green energy.

The use of RES at a local level is in its infancy in Serbian rural communities. Ideas that are being systematically implemented in countries less developed than ours have yielded amazing results in the first years of application. The same should be expected in Serbia. Also, such a trend would exert a positive influence on demographic tendencies and rural development. Aside from obvious positive ecological implications, use of RES would bring Serbian rural areas closer to the level of development of their European counterparts. Based on the statistics of the examined municipalities, we concluded that the sex and age structures of the rural areas are suitable for implementing RES application programmes. Bearing in mind the favourable results of scientific research of climatic parameters we also

concluded that Serbia is ready to apply these energy sources. The use of alternative energy sources would improve not only the country's overall energy but also the ecological and economic situation in accord with the basic principals of *sustainable development*.

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