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STUDIES UPON VALORISATION OF NONCONVENTIONAL GREEN ENERGY GENERATED FROM INTEGRATED SYSTEM IN THE HISTORICAL CONTEXT OF FAGARAS MOUNTAINS

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Abstract

This paper presents studies of wooden installations which use the power of water flows for electric power generation and for other industrial activities. This paper focuses on the historical context as well by identifying the places where wooden installations have worked since the 15th century, in the Fagaras Mountains foothills, on the Berivoi River valley, by using the power of water flows for timber production activities, fulling mills and mills. The paper also aims through the archaeological sites which contain important material and highlight the traditions of the Romanian nation around these places and the development of these old craft techniques from ancient times. Apart the identification of these sites (which are not found on any map), other places with hydropower potential are rediscovered, and by using some low investments, they may become centres to produce electricity needed for holiday dwellings, guesthouses, agricultural and livestock facilities located far away from the power station. The implementation of 'green energy' which generates systems by using wood installations as mechanical subsystems of water flow energy conversion, in combination with modern subsystems of conversion, storage and transport, as well as the development of some integrated modules (hydroelectric, photovoltaic and eoalian) represent the optimal solution that contribute to the development of foothill areas, in the context of promotion of the Romanian traditional spirituality and the development of sustainable programs.

This paper proposes solutions to promote the small hydroelectric power stations on the watercourses of mountains and foothills regions by using fractions of minimum water flows thereof, of maintaining a water flow on the main valley as well, so as the aquatic fauna permanently regenerate, and to protect the specificity of the environment and of the surrounding areas. The studies were referred to Berivoi River valley from the northern part of the Fagaras Mountains. The region has a particular hydropower potential, such as a channel of river fitted up with small barrages. Traditions in water power operating on streams derived from the main channel of river, therefore the paper presented an optimal solution for the construction of small hydroelectric power stations.

Key words: *wood installations; hydro energy; green energy; Romanian traditions.*

INTRODUCTION

This paper is a part of a wide study entitled "Research for the settlement of new technical solutions of electrical power supply for Romanian traditional constructions from the Fagaras Mountains area, in the context of promotion of sustainable development programs." These traditional constructions are based on execution techniques and specific materials in the Fagaras Mountains foothills area and they are represented by: holiday dwellings, guesthouses, and constructions for agrarian and industrial activities.

Many sustainable development programs related to these activities are currently promoted. Major investments in studies and research on the development of new generating sources of energy were made. In this context, the implementation of an integrated system of electrical energy production through ecological techniques is proposed. The overall system aims to integrate the three subsystems of electrical power generation: by using the water flow power, wind force and solar radiation. The paper presents the performed studies with a view to implement one of these subsystems. The choice was the system focused on the production of “hydropower” using waterfalls in the Fagaras Mountains area, on the Berivoi River valley, by means of traditional wooden installations, which are very rustical compared to modern ones.

The studies investigated the Berivoi River Valley for several reasons; it has a constant water flow; the water was used for industrial purposes from ancient times (Barbat 1938), for fulling mills and sawmills, and agricultural activities (irrigations) in meadows and orchards. The valley has a special beauty and richness, and allowed the old Romanian community to develop itself. The area is registered in the documents as being one of the most developed in terms of handicraft centres and the

Romanian spirituality from Southern Transylvania. The activities were supported by old Orthodox monasteries in the area, true centres for education and culture. The secular development period suffered a decline during the Austro-Hungarian domination when monasteries were destroyed (Stan 1928). During the communist regime, through the land improvement programs, part of the manufacturing centres, orchards and reminiscences of small workshops were destroyed. During the 1970s, in order to have a better management of river water flows, used also in the Chemical Plant from Fagaras, in the sub-mountain area, roads and more accumulation barrages that adjusted the amount of water during floods were built. These special barrages protect even at present the Berivoi Valley, representing a very important investment, being the only one of this kind in the "Fagaras Country". In waterfalls area, in upstream and downstream river, water is rich in trout, and a diverse fauna was developed in the adjacent areas. Nowadays the lands from the region have returned to their previous owners and the traditional activities in the area were not developed due to the lack of electricity sources, although these places present a great transformation potential.

All the aspects mentioned above represent a characterization of the area, in the context of understanding the approach of this paper and the established objectives. It is also an alternative to other guidelines to avoid invasive actions in the protected area, by using ecological solutions of sustainable development.

OBJECTIVE

The first objective of the research was to determine the sites (areas) where small industrial centres have functioned from ancient times. The Romanian tradition is represented by wooden installations powered by water flow, which developed activities for fulling mills, mills, and wood cutting. The aim was to restore them in the context of promoting the ecological techniques of electric power generation and the sustainable development programs.

The second objective refers to the achievement of the principle diagrams and hydropower generation block diagram, the presentation of working and instructions within an integrated system. The third and perhaps the most important objective is to highlight the importance of promotion of techniques for ecological electricity generation, non-invasive in natural environment, on the old streams courses drawn from the Berivoi River high valley and returned in it, in the existing waterfalls area, as an alternative to realize one large hydro-electric power station on the upper course of the valley. The achievement of some extensive works to capture the river springs in the alpine zone will lead to a radical change for the valley environment, including the people's life in the "Fagaras Country".

MATERIAL, METHOD, EQUIPMENT

Definition and description of wooden installations and equipments that use the water power in generation of mechanical energy

The wooden installations using water power to generate mechanical energy were used from ancient times at groves for preparing the wool, at fulling mills, for final processing of thick wool fabrics and at sawmills for wood cutting in beams and timber (Antal 1972). The structure of these systems is formed of basic equipment and specific equipment. The basic equipment is formed of: cloth wooden penstocks and mobile sub-assemblies for leading the water, wooden wheels on horizontal or vertical axles. The specific equipment for groves is formed of the transmission elements of the rotary motion from axles to the sliding elements and to combs for wool combing; the sawmills have different final transmission elements of linear motion, these being represented by cutting saws; at fulling mills the final elements are represented by large wooden hammers for applying repeated blows (Fig.1) in order to confer a specific aspect, fluffy, to the wool fabrics. Depending on the specific occurred activities, all these installations were protected by the traditional constructions of river stone and wood, with one or more rooms that were used as dwellings by owners or workers. The sites of these manufacturing units are located on streams derived from the Berivoi river bed, usually in gardens and ancestral meadows. The used water in the presented activities was reintroduced in the large valley, thus preserving the natural environmental conditions.

Fig. 1.
Wooden installations used for the conversion of water power into mechanical energy for fulling mills

The used methods

In order to develop the area in the traditional vision, to promote the environmental technologies and the sustainable development programs, it was proceeded primarily to identify the places where these small industrial units have worked, and have used the water power for timber production activities, fulling mills, mills, in Fagaras Mountains area foothills, on the Berivoi valley. The methods used have consisted in analysis and advanced studies of older and newer documentation (some presented in the bibliography), in studying Josefine map (Josephiniche Land aufnahme) which represents the basic document that outlined the mapped history of Transylvania (1770 -1780), as resulted from discussions with old men from there. For diversification of information and determining the locations for fulling mills, sawmills and other small units which were not specified in Josefine Map or in other documents, the method of direct investigations on the spot, including the Berivoi valley area, was used. That way 20 objectives, which are not included in that map, but with visible ground prints were identified (Fig. 2). About 15-20 installations were mentioned as revealed from the studied sources and information gathered by the older men on the spot and just penstock streams of water remained (Bujor 1958).

Fig. 2.
Identification of archaeological sites of handicraft workshops and the related waterfalls
- (wooden installations used in fulling milling, milling and wood cutting)

Along with the identification of these sites (which are not found on any map) the sites having hydroelectric potential are rediscovered. By allocation of some low investments, they may become

production centres of electrical power for holiday dwellings, guesthouses and agricultural and livestock facilities in the region, located at a long distance from the electricity grid.

It was also aimed the impression of the archaeological sites which represent an important material basis that highlights the continuity of the Romanian people traditions in these places and the development of handicraft techniques from ancient times.

Ecological generation of electric power

The generation method is considering two options. A first version proposes for the system construction the use of the traditional elements, penstocks with wooden cloth and wooden wheels (Fig. 3) in combination with modern technology: blocks of generation and energy storage. This option is recommended to be used on penstock river streams in derivation from the Berivoi River, in areas intended for holiday dwellings and guesthouses. The rustic look of wooden installations will design a landscape and a traditional setting which is specific to the place.

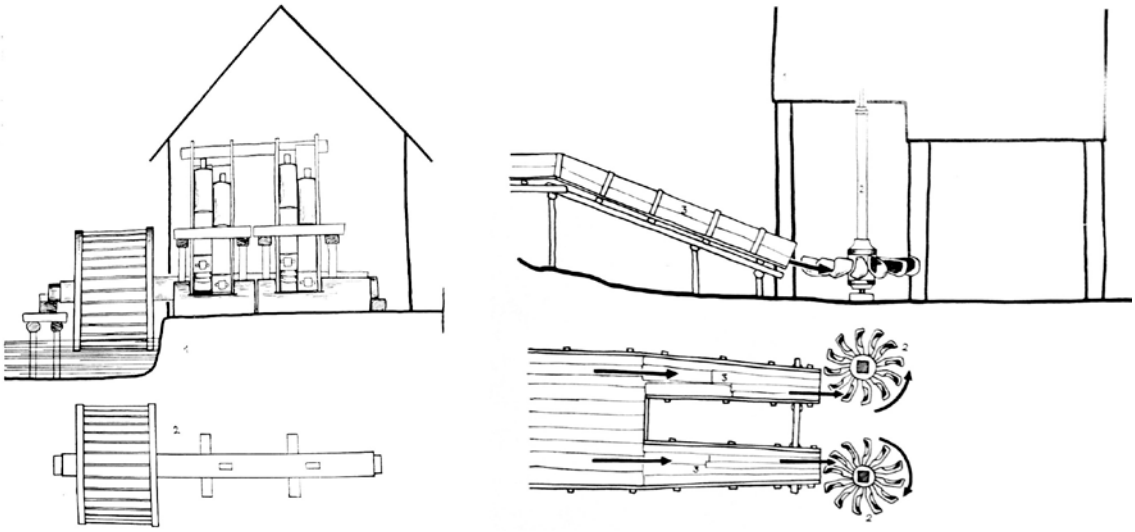

Fig. 3.
Penstocks and wooden wheels used to generate energy in ecological hydroelectric systems

The second option aims to use the dedicated equipment assigned to the small hydro power stations: penstock pipes and small turbines, the other components are similar to those described above. This system is recommended to be used on the main course of the river in the barrages area where you can virtually use the entire water flow. (Ecovolt-LP 2015)

The principle diagram for such hydroelectric system is presented in Fig. 4.

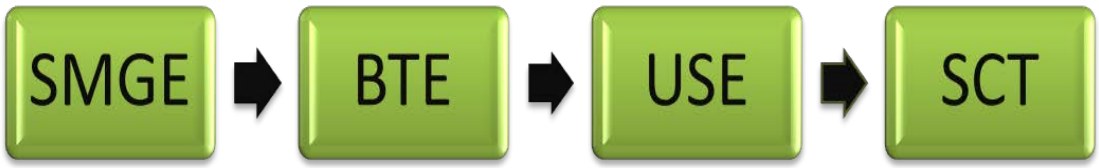

Fig. 4.
The principle diagram for the conversion of water kinetic energy into electrical energy (green energy)
a - Mechanical generation system; b - Block energy conversion; c - Energy storage unit; d - Connection and transport system

RESULTS AND DISCUSSION

As a result of the performed studies, there were identified the sites of 22 manufacturing units which are not located on Josefine map, on other maps or documents. These sites represent real archaeological sites which contain proofs of their history; information about these will be transmitted to the specialists in archeology for further research studies. In order to facilitate the information maintenance in time and the use into a unitary system, Josefine maps were completed with these sites (Fig.5). Thus it will be possible to establish the place of implementation of some hydropower production centres of hydro energy (of small hydro power stations) using even the old penstock springs and maintaining the actual environment conditions.

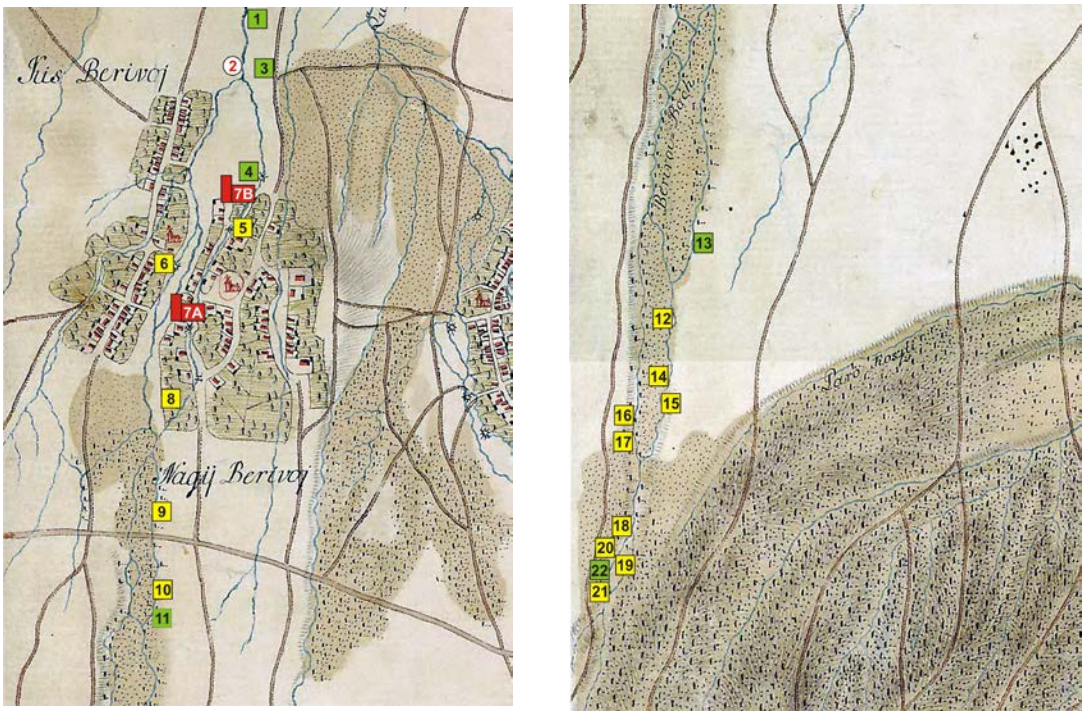

Fig. 5.
Impression on Josefina Map of the archaeological sites of the identified handicraft workshops and of the waterfalls for the wooden installations, used for fulling milling, milling and wood cutting
a – Sawmills (1;3;4;11); b – Fulling mills (5;6;8;9;10); c – Mills (7A;7B)

Another objective of these studies was the implementation of a block diagram for a hydroelectric power generation system, using wooden installations for converting the kinetic force of the water, presented in Fig. 6. Such a system will be able to produce from 1 to 4 KWh, depending on the water flow rate, the high of waterfall on the penstock channel, and also the used mechanical installations of waterpower transformation.

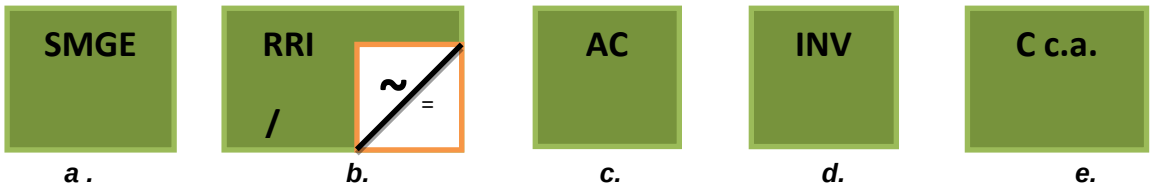

Fig.6.
Block diagram of making a hydroelectric system of energy generation
a - Mechanical generation system; b - rectifier and charging regulator; c - Battery; d - Inverter; e – Consumer

Systems of electric power generation using waterpower will be able to run near or even integrated in traditional constructions as shown in Fig. 7.

Fig. 7.
Traditional wooden installations and constructions used for energy generation into hydroelectric systems

Installations for electric power generation using waterpower can be exploited even in integrated systems. The integrated system allows an optimum exploitation of three generating sources: of hydro, photovoltaic (Fara L 2009) and eoalian energy (Lates T 2012). According to each given situation when one of the factors that the generation techniques depends on, such as water, wind or solar radiation are not available or the given parameters get minimal values (under technical revisions), its functions can be fulfilled by the other two. The system can run even with a single primary energy generator factor if it has normal functioning parameters. The integrated system is expected to produce 1 to 10 KWh depending on the fulfilled activities and exploiting requirements, respectively. The block diagram for such type of system is presented in Fig.8.

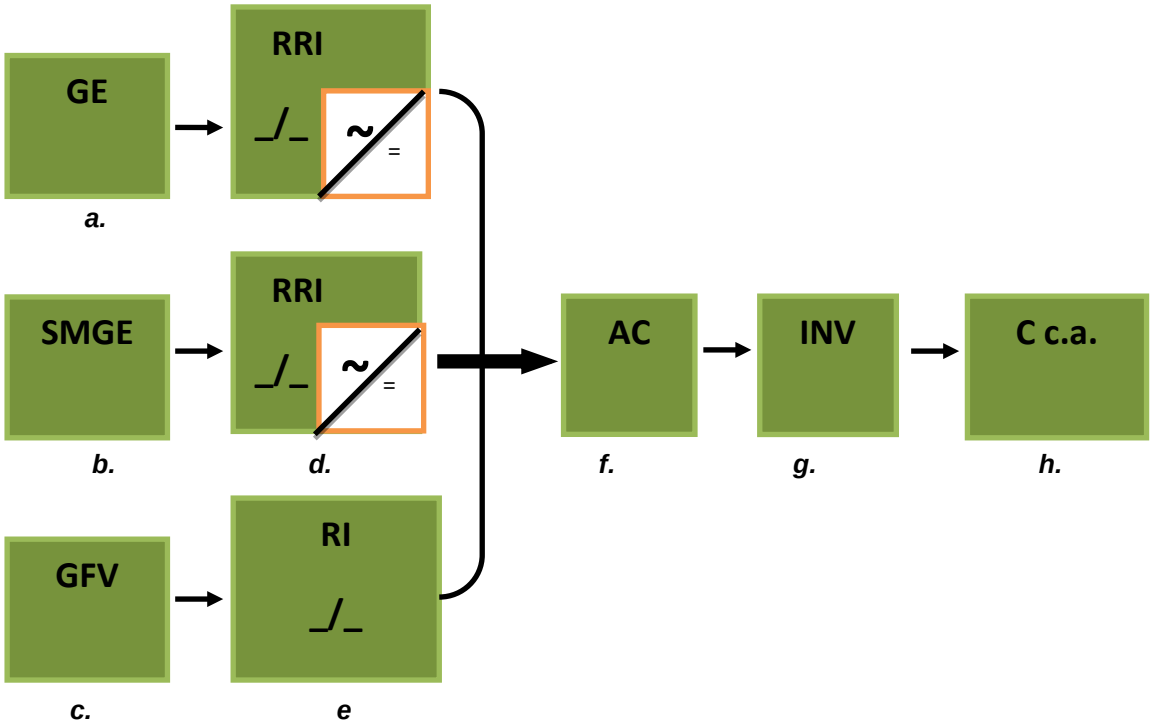

Fig. 8.
Block diagram of making an integrated system with three sources of energy generation, hydro, photovoltaic and eoalian
a – eoalian generator; b –hydromechanical system of power generation; c – photovoltaic generator; d – rectifier and charging regulator; e –charging regulator; f – battery; g – inverter; h –alternative current consumer;

CONCLUSIONS

The promotion of the integrated system for electric power generation for touristic, agrarian and industrial objectives, etc from the Fagaras Mountains foothills and Berivoi valley will lead to:

- Objectives for development (such as traditional constructions) according to sustainable programs
- Rediscovery and development of waterfalls in order to use them for electric power generation and other traditional activities (wood cutting)
- Development of small hydroelectric power stations on springs which can take the necessary water from Berivoi valley and its reintroduction in a large riverbed. Using and maintaining ecologically the environment (specific to Reserve Natura 2000)

Promotion of some ecological and non-invasive solutions for the environment as an alternative to the already proposed option to build a hydropower station by taking Berivoi river springs from the alpine zone.

The construction of a large hydropower station will lead to the destruction of the only arranged valley with high investments from all over the Fagaras Mountains area, which is an ecological environment throughout its length of about 20-25 km. The risk of disasters increases and also the ecosystem and people's lives may change.

As a last point, the promotion of the integrated electric power generation, whose "hydro" composition was described above in this paper, it can be extended in all Romanian regions which offer similar conditions and where people want to rediscover the environmental habitats for different activities: holiday, tourism, Eco agriculture, etc.

Development of small environmental area, independent of energy and with minimum existential resources, on the principle of unity in diversity, will definitely contribute to the communion in Romanian spirituality and national identity.

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