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Capturing Solar Energy through Photovoltaic Panels, Installed Capacity of Photovoltaic Parks and Financials Investment in the Production of Electricity in Prahova County

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Abstract *Using solar energy in Romania, not only in Prahova County, presents great development perspectives. Solar energy is considered a primary energy source, free and safe, an investment recoverable in record time and satisfactory to the investor and has countless technological applications, such as the production of electricity and heat, irrigation etc. Also, use of solar energy contributes to: saving conventional energy resources; reduction of environmental pollution; helps to reduce the costs of obtaining electricity; provides partially in most cases or completely energy independence of the user etc. Following investigations was confirmed that it we receive from the Sun - in about one hour – the energy consumption for a year of the whole planet, so solar radiation that reaches the Earth's surface is higher than global energy needs.*

Key words:
Solar radiation, electricity, capture, photovoltaic panel, investment, Prahova

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1. Introduction

Evolution and prosperity of human society has exerted great pressure on the climate and natural resources. Thus, in dozens of national and international conferences on climate change and energy price fluctuations and problems developed by nuclear power plants following discussions concluded that it is necessary reconstruction of energy industry as global warming problem will not be solved by a treaty.

Also, the conclusion generally accepted by participants in various scientific manifestations is that the only organisms that can deliver solutions are local communities through various initiatives, to help human society evolve in safe and sustainability conditions. Initiatives arose from the analysis of the quality of human activities, thereby, being possible, the emergence and development of energy concepts, but also the possibility of implementing sustainable energy projects.

These projects aim to support anthropogenic activity, desiring this to be carried out under equilibrium conditions between economic development and environmental protection, without depletion of available resources, without destroying the environment and finding viable alternative resources useful for further development.

For this reason it is necessary to develop methods of generating electricity to help preserve the planet's natural ecosystems.

In a Europe that wants sustainable development, Romania has the chance to position itself strategically in the best position, because sources of sustainable development are already undeniable economic realities. Thereby the global trend to move towards renewable energy has taken root in Prahova County.

Small communities were able to establish local committees for planning electricity that helps promote sustainable energy solutions, energies, generally, climate friendly. Also, these committees analyzed the local needs and tried alongside investors to implement projects in the region, especially where it was possible to build solar parks. Technologies used were supplied by small firms or through businesses active in the field of renewable energy.

The electricity produced by photovoltaic panels can be inserted into the national transport network In the case of systems connected to the network or may be stored into accumulators, for autonomous systems. Stored energy can be used for current domestic consumption, power different lighting installations, antennas located in remote places etc.

For proper placement of photovoltaic parks is useful to assess the solar potential, but also knowing the particularities of the regime and distribution of solar

radiation and the radiative and caloric balance components, an analysis of all the factors in the region where there will be located new targets for power generation.

2. Meteorological observations and their importance in achieving green energy

For a proper capture of solar radiation is necessary to analyze, based on data provided by National Meteorology Administration, from meteorological observations, actual duration of sunshine, direct, diffuse and global solar radiation, atmospheric opacity, but also other weather elements.

Duration of sunshine presents a practical importance, because knowing the characteristics helps to determine the duration of manifestation, the period of the year in which they operate on different surfaces and indicates the rate of maximum brightness of the atmosphere. Direct solar radiation was defined, in the scientific literature, the unchanged radiation flux that reaches, by diffusion, reflection, refraction etc. the earth's surface. In reality, a part of this stream at the meeting of the fine particles suspended in air is diffused by it in all directions.

Also, the intensity of solar radiation is conditioned by internal activity of the Sun, variable according to the time, by the variability of the distance Earth - Sun during the year, by the physical state of the atmosphere and the height of the Sun above the horizon, which decreases with increasing air humidity, but increases with the height of the Sun above the horizon and decreases with the increasing degree of cloudiness.

Prahova County includes areas stretching from the high peaks of the mountains to the plains. This arrangement gives the county a great variety of physical and geographical conditions. Thus, according to relief we distinguish climate shades of mountain, hills and plains each with specific characteristics (Table 1).

Knowledge of climatic characteristics underlying the calculation of photovoltaic productivity. For feasibility studies of solar energy applications more detailed information are useful both on radiation and the number of hours in which collecting items are subjected to illumination.

Operation of solar installations is dependent on the time that the sun is shining. Insolation fraction is equal to the ratio of the number of hours of brightness and potential number of hours the sun can shine.

Solar collectors work best on days with clear sky as well as on days with cloudy sky.

Table 1. Climatic indicators based on unit of relief underlying the calculation of Photovoltaic plant productivity

Mountain area	Hill area	Plain area
Duration of sunshine (hours / year)		
1800	2000	2150
Global solar radiation (Kcal/m^{2}year)		
110	120	125
Nebulosity (days / year)		
175	150	100
Snow days (days / year)		
100	25	15
Days with snow cover (days / year)		
170	70	50
Snow depth (cm)		
110	35	15
Average annual air temperature (°C)		
0	9,2	10,5
Average air temperature of January / July (°C)		
-11,1 / 5,7	-1,9 / 19,6	-2 / 22
The amount of average annual rainfall (mm)		
1200	700	600
Annual average wind speed (m/sec.)		
9,8	4,7	2,3

Source: National Meteorology Administration

3. Photovoltaic systems and operating principle

For capturing solar power the photovoltaic panel was constructed according to certain principles of operation, an active system for electricity production, consisting of several photovoltaic cells connected in series - parallel, because a single cell does not produce enough power.

The receiving part has the property of absorbing particles of light called photons falling on its surface. Each photon is known to contain a small amount of energy, and through his absorption by the cell material an electron is released and through other components useful in the operation is produced electricity, which can be used immediately or through means of a cable can be stored in the batteries.

Manufacturing companies offer for sale several types of cells, such as: monocrystalline, polycrystalline, amorphous, thin film, copper indium diselenide and cadmium telluride etc. The differences between these cells is in the structure and how atoms are arranged, differences that provide a specific aspect of each cell. The biggest difference however lies in the efficiency, measured in percentage of light energy converted into electricity. Monocrystalline cells have an efficiency of 15-18%, polycrystalline 13-15%, amorphous 5-8% and cadmium Telluride 6-9%. Monocrystalline and polycrystalline cells have almost the same efficiency being the highest of the existing market.

Electricity generation plants have few moving parts and compared with other technologies - operate at low temperatures fact which ensure them a sufficient service life, without intervention for repair and without

requiring maintenance.. Photovoltaic panels have operating temperatures from the freezing to the hot and are resistant to wind and hail. The materials from which cells are produced are semiconductor and have a lifetime of at least 20 years. Also, their efficiency decreases over time, decreasing rate guaranteed by the manufacturers. Wear of panels is given by the environment and the method of assembly.

Photovoltaic panels are produced in different sizes, with varying powers, most commonly used being those of 50 and 75 W, and for high power photovoltaic power plants, the panels can have an output of 220 W. For example, the surface of crystalline panel of 50 W is about 0,5 m^2. Electricity is produced as long as the solar panels are exposed to the light from the sun, all in the same direction and inclination and should not be shadowed. Photovoltaic panels generate electricity 9h / day.

4. The installed capacity of photovoltaic parks and financial investment in electricity generation in Prahova County

Solar potential of Prahova County came in the sight of big investors in the alternative energy sources, because has been outlined already as a major growth area of new businesses towards which come investment of hundreds of millions of euro. Thus, investment in photovoltaic parks in the county is estimated at 300 million Euros.

Also, investment cost was calculated, for each MW installed, this amounts to about 1.8 million Euros. According to Transelectrica, highest concentration of solar projects in Romania will grow in the South, the center of the development of photovoltaic parks being Prahova County.

Localities suitable for placement of photovoltaic power plants are those in the central and southern part of the county, as they offer the highest level of solar radiation.

The installed power (officially) in the photovoltaic parks in Prahova County, currently is:

- photovoltaic parks in operation: Măgurele – 3,4 MW; Păuleşti – 9,1 MW; Pantazi - 6 MW; Baba Ana - 8 MW; Ariceştii Rahtivani - 5 MW; Dumbrava - 6 MW; Băicoi - 1,89 MW; Floreşti - 0,009 MW; Făget - 0,0008 MW;
- photovoltaic parks with connection contract: Ciorani – 65 MW; Berceni – 20,25 MW; Ariceştii Rahtivani - 9,5 MW; Dârvari - 5 MW; Buda - 2,5 MW; Cocorăştii Colţ - 5,38 MW; Mizil - 2,9 MW; Urlaţi - 6 MW; Bălţeşti - 5 MW;
- photovoltaic parks with technical connection approval: Ariceştii Rahtivani - 27 MW; Ploieşti - 0,2525 MW; Gorgota - 3 MV; Baba Ana - 2 MW; Valea Călugărească - 2,5 MW; Filipeştii de Târg -1 MW; Dârvari - 5 MW; DN 72 - 4 MV; Ciorani - 2,5 MW; Păuleşti - 8 MW; Băicoi - 2,55 MW; Gornet - 2,5 MW; Dumbrăveşti - 0,1 MW; Scorţeni - 2 MW; Băneşti - 0,14 MW; Câmpina - 0,25 MW; Cornu - 1,247 MW.

The largest solar energy center will be Ciorani, where the final operating capability of the solar park was approved at the amount of 67,5 MW. Next will be Ariceşti-Rahtivani with a value of 41,5 MW, Berceni with 20,25 MW, Păuleşti with 17,1 MW and Baba Ana with 10 MW. In the discussions are also parks from Dumbrava and Lipăneşti.

So, at a quick mathematical calculation, in October 2013 the total capacity approved in Prahova County is **224,5693 MW.** Analyzing the three types of photovoltaic parks the situation is as follows: total capacity in operation is 38,8998 MW; total capacity with connection contracts: 121,53 MW; total capacity with connection technical approval: 64,1395 MW.

The electricity produced by photovoltaic parks in Prahova County is sufficient to cover the energy needs of the entire county in particular times of the day. In the peak load in the afternoon photovoltaic energy cannot be used, because it cannot be stored. It is replaced by nuclear, hydro and thermal produced energy.

In terms of financial investment, some information may be presented, as long as there was transparency in the communication system, for example: Măgurele (spread over an area of 2,25 ha) 5 million Euros; Păuleşti - 8 million Euros; Baba Ana - 3 million Euros; Bălţeşti – 6 million Euros; Ciorani – 3,5 million Euros; Buda – 4 million Euros; Mizil – 45.000.000 Lei; Dârvari - 83.989.754 Lei ; Cornu – 37.000.000 Lei; Valea Călugărească - 106.836.000 Lei, Urlaţi – 106.000.000 Lei, Dumbrăveşti – 27.000.000 Lei, Comarnic – 14.000.000 Lei, Gorgota – 18.000.000 Lei, Băicoi – 15.000.000 Lei.

5. Conclusions

According to the conclusions of International Energy Agency (AIE) efficient use of energy is a powerful tool and at low cost to achieve in the future aspirations for sustainable energy. Improvements in energy efficiency can reduce the need for investment in traditional energy infrastructure, to cut fuel costs, to decrease the use of fossil fuels imported, to increase energy security, to increase competitiveness and to improve the living standards of consumer.

The benefits to the environment can also be achieved by reducing greenhouse gases and local air pollution, the benefic effect being visible in lower CO2 footprint. Actions necessary to achieve energy efficiency involves an amalgam of regulations, technologies, economic interests, communications and best practices.

Also, use of solar energy requires a recoverable investment, having relatively low cost prices compared to the efficiency of energy intake. The most important advantage, however, is for the citizen, the consumer.

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