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ECONOMIC JUSTIFIABILITY OF SOLAR ENERGY USAGE IN SLAVONIJA AND BARANJA

EKONOMSKA OPRAVDANOST KORIŠTENJA SOLARNE ENERGIJE U SLAVOVNIJI I BARANJI

ABSTRACT

Solar energy use in Slavonija and Baranja region meets both natural and technical preconditions. However, it is important to manage solar energy investments rationally in order to meet also economic preconditions. Therefore, the initiall research question on which this paper has been founded on is economic adequacy of investments into different usages of solar energy.At the beginning of the research authors have examined relevant literature that covers energy in general and especially solar energy scope.That survey indicated three main conclusions: energy needs of the mankind are growing, total world energy consumption comes mainly from environmentally harmful fossil fuels, renewables have a significant energy potential. Finally, analysis of investments into solar energy in Slavonija and Baranja region has been done. Both thermal collectors and photovoltaic systems have been analysed. Application of payback period method established currant financial unacceptability of these investments but in conclusion of economic analysis they have been positively evaluated. Because of that and in order to manage solar energy investments rationally, authors of this paper strongly advise steadily implementation of incentives stipulated by valid Strategy of energetic growth of Republic of Croatia.

Key words: *management, investment effectiveness, solar energy, thermal collectors, photovoltaic system*

SAŽETAK

Za korištenje solarne energije u Slavoniji i Baranji postojeiprirodni i tehnički preduvjeti ali važno je racionalno upravljati investicijama u solarnu energiju kako bi se ispunili i ekonomski preduvjeti.Zbog togaje osnovno istraživačko pitanje od kojeg se polazi u ovom znanstvenom radu ekonomska opravdanost ulaganja u različite načine iskorištavanja solarne energije. Na početku istraživanja napravljen je pregled relevantne literature koja se bavi pitanjima energije općenito i posebice solarne energije. Zaključci donešeni temeljem tog pregleda odnose se prije svega na rastuće energetske potrebe čovječanstva, štetne utjecaje trenutno većinski korištenih fosilnih goriva te ogromni potencijal obnovljivih izvora energije. U konačnici, provedena je analiza ulaganja u solarnu energiju na području Slavonije i Baranje. Analiza je provedena za dva osnovna principa

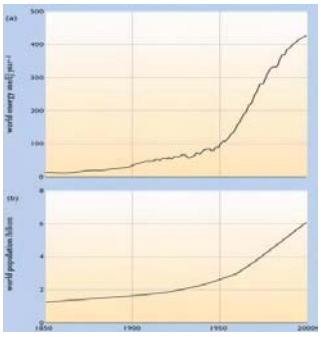
direktnog iskorištavanja solarne energije: za solarne toplinske kolektore i za fotonaponske sustave za proizvodnju električne energije. Metodom perioda povrata investicije utvrđena je trenutna financijska neprihvatljivost ovih projekata ali s aspekta ekonomske analize ulaganja u solarnu energiju imaju apsolutno pozitivnu ocjenu. Zbog toga autori ovog rada u smislu upravljanja investicijama u solarnu energijupreporučaju sustavno primjenjivanje poticaja predviđenih postojećom Strategijom energetskog razvoja Republike Hrvatske.

Ključne riječi: *menadžment, isplativost ulaganja, solarna energija, toplinski kolektori, fotonaponske ćelije*

1. Introduction

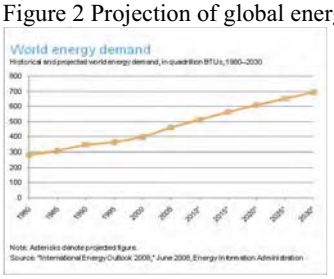
„Energy is physical dimension that describes interaction and state of particlesof an element and their interaction with other particles or elements, i.e. ability of activity performance.“ (Labudović, 2002, 17).Important energy characteristic is that it can not either incur or evanish, which leads to the conclusion that quantity of energy is always constant in a closed system.
Global needs for energy are becoming bigger and bigger every day. Continuous rise of the population and the need for increasing efficiency and comfort have resulted in rising energy consumption and everlasting searchfor energy sources that would adequately satisfy the energy needs. Comparison of world's population increase and total energy necessarities is presented with Figure 1. and projection of global energy needs is presented with Figure 2.

Figure 1 Comparison of world's population increase and total energy necessarities



Source: www.our-energy.com

Figure 2 Projection of global energy needs



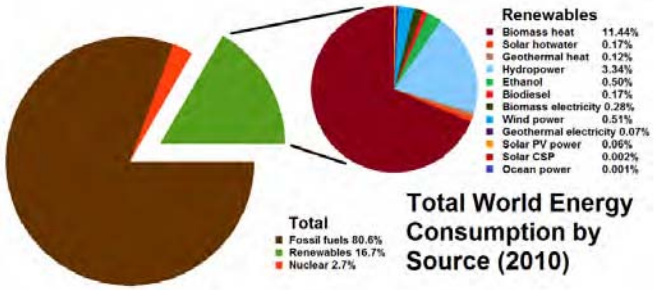
Source:www.kids.esdb.bg

2. Ways of meeting world's energy needs and related problems

Nonrenewable energy sources

Because of ever rising energy demand, scientists are continuously in search for new energy sources, that is new ways of energy usage, which would increasetechnological and financial efficiency and thus increase the use of alternative energy sources. Figure 3. Shows contribution of different energy sources in total energy consumption, as it was in 2010.

Figure 3 Structure of the world energy consumption, by sources



Source: www.en.wikipedia.org

Evidentlly, world energy consumption is currently met mostly by non-renewable energy sources, majority of which are fossil fuels. “Fossil fuels include energy sources that originate from organic matter (animal or vegetative) that has been subject of long-term procedures under high pressure and temperatures in depth of Earth.They include coals, oil and petroleum derivatives and natural gas and other gases extracted from it.” (Labudović, 2002, 36)
There are two major problems related to nonrenewable energy sources. The first is that their quantity is limited which shall lead to theirextinction in time. The second reason lies in the fact that they emit huge amounts of carbon dioxide (CO_2) and thus pollute the environment.Despite those disadvantages there are, of course, reasons for which fossil fuels are still dominant energy source. Those reasons are tradition and their price.(http://www.izvorienergije.com)

2.2.Climate changes and the Greenhouse effect

Since it is not expected that fossil fuels shall reach the price that would lead to significant turn in favour of alternative fuels in the short-run, it is considered that only actual climate changes could seriously undermine that domination and put forward clean energy sources. As stated before, the biggest fault of fossil fuels is pollution, and especially global warming that comes out of it. Global warming is for sure one of the greatest challenges of the mankind ever. (www.izvorienergije.com)

Figure 4 The Greenhouse effect

Source: www.energis.ba and www.ajme-meni.site90.com

As shown in Figure 4., some of the reflected solar radiation is absorbed by the greenhouse gas molecules. The direct effect is the warming of the Earth's surface and the troposphere, so this determines temperature on Earth.If there was no greenhouse effect, temperature on Earth would be 30°C lower, so in that sense the greenhouse effect is a positive phenomenon that enables life existence.However, concentration of carbon dioxide has been increased in the last century so the greenhouse effect is being more and more expressed, which resulted in average temperature on Earth increase up to critical values.

2.3. Renewable energy sources

Upon definition, "renewable energy sources are those that are disposable in unlimited quantities. Although they are being disbursed during transformation processes, their quantities are only temporarily used up and can always be recovered or renewed." (Labudović, 2002, 25).
Currantly, as shown in Figure3.,enormous amount of renewable energy is being obtained from water and biomass. Other renewable energy sources are negligible at present. The reason for that is their usage price and small quantities of energy that can be obtained from them due to technological ineffectiveness.Namely, potential of renewable energy sources is huge, but level of technology development today does not allow (or enable) us to rely only on them. Since people will be forced tofulfill all their energy needs in the future only from renewable energy sources, many studies are focused on invention of efficient ways of transformation of renewable energy sources into productive energy. In so doing, solar energy is one of the most interesting energy sources.

3. Solar energy

The Sun has been producing energy for 5 billion years and upon present estimations it shall continue producing it for the next 5 billion years.Solar energy is a term used only for the part of the energy produced at the Sun, the part that reaches the Earth. It has been calculated that the Earth receives enough energy to satisfy the total human energy need for the whole year, only in 71 minutes!(www.pmfbl.org)
The basic principles of direct solar energy exploitation are (www.izvorienergije.com):

- Solar thermal collectors (panels) –direct transformation of solar energy into thermal energy
- Photovoltaic (solar) cells - direct transformation of solar energy into electric power

3.1. Solar thermal collectors

Solar thermal collectors transform the solar energy directly into a thermal energy of water (or some other fluid).Because of that, for water heating there is no need to use expensive solar cells that would produce electric power which could later be used for water heating. Solar collectors are adequate for water heating during the period of sunny weather, and when the weather is bad, they can be used in a combination with electric water heater.

In south Croatia insolation is significant and it has been calculated that 1 $m^2$of solar collectors saves up to 750 kWh per year. This means that an average household of 4-5 members needs approximately 4 – 6 $m^2$of solar collectors for water heating. Under those conditions, payback period of initial investment is 7 years (www.ee.undp.hr).However, measurement under conditions regarding insolation in Slavonija and Baranja shows that in that region it is not possible to achieve the maximal savings of 750 kWh/m^2 per year.

Table 1 Calculation of energy savings out through usafe of solar hot water system (SHV) for the household of 4-6 members in the city of Osijek

Needed thermal energy for SHV	3845	kWh/year
Specific produced thermal energy with solar system / m2 of collectors' utility area	451	kWh/m2
Produced thermal energy with solar system	2102	kWh/year
Needed thermal energy from a conventional source	1743	kWh/year
Degree of power efficiency of the solar system	34	%
Solar coverage rate (energy savings)	55	% / year

Source: www.centar-energije.com

In order to decide on economic efficiency of solar thermal collectors usage in Slavonija and Baranja, beside the mentioned savings, one should also take into account total investment expenses needed. They include:

- Calculation, dimensioning and selection of an optimal system,
- Supply and installation of the equipment (solar collectors, storage tank, pipeline, isolation, control, pump, expansice container, solar fluid and other needed material),
- Hydraulic balancing of the system,
- Regulation of the system,
- Breaking-in by a professional,
- Guarantee for installed equipment,
- Functional guarantee

Since the price of such a system amounts around 30.000 kn (includingVAT) at respectable supplier sand calculation shows possibilityof 2102 kWh/year energy savings, meaning 2207 HRK/ year financial savings (average price of 1 kWhis 1,05 HRK, including VAT), itarises the fact that payback period of that investment in Slavonija and Baranja would be 14 years. With 20 year life expetancy of the system, this is not appealing.

3.2. Photovoltaic cells

"Photovoltaic transformation of solar energy, i.e. light energy into electric power is done in a solar cell, whilst reversible electrochemical process of transformation related to charging and discharge of accumulator is done in the accumulator. Electric power is transformed into different types of energy in different electric devices: mechanical energy, thermal, light etc." (Majdandžić, 2010, 407)

Solar photovoltaic systems can be divided in two basic categories: photovoltaic systems that are not connected to electrical network (so called off-grid), which are often refered to as stand-alone systems and photovoltaic systems connected to public electrical network, so called on-grid system."(Majdandžić, 2010, 369).

Beside differences regarding open (on-grid) and closed (off-grid) systems, photovoltaic systems differe also in terms of integrated and non-integrated systems. "Integrated solar power plants are power plants located on buildings (on the roof, screens, shadows, balconies, terraces, balustrades, facades, windows, doors...) andinfra structural objects (substations, bridge sand similar objects) whilst nonintegrated solar power plants are located as autonomous constructions."(Tarifni sustav, NN No. 63/2012). In Croatia, as well as in Slavonija and Baranja, far more present are integrated solar systems so this paper will focus primarily on them.

Table 2 Components of investment into photovoltaic system on the roof of a household in Osijek, with power of 9,55kWp

ITEM	PRICE IN HRK
SUPPLY AND INSTALATION OF EQUIPMENT	
Solar modules, max power 245W, guaranteed 90% of power for 10 years and 80% of power for 25 years	81.510,00
Solar inverter, max AC power 10.000VA	25.656,00
Distribution board for DC circle equipment installation	5.800,00
Distribution board for AC circle equipment installation	5.550,00
Set of wiring and fittings	5.810,00
Metal subconstruction for installation of solar modules	10.500,00
TOTAL without VAT	***134.826,00***
Techno-economicanalysis of photovoltaic power plant	9.500,00
Concept design, main design and construction design of photovoltaic power plant	13.000,00
Authorisation needed for obtaining necessary approvals and contracts	10.000,00
Supervision during installation of photovoltaic power plant	15.000,00
Breaking-in andoperation training	3.000,00
Typical testing of photovoltaic power plant	15.000,00
Maintenance and annual technical inspection	According to actual price list
TOTAL	***200.326,00***
TOTAL with VAT	***250.407,50***

Source: actual commercial offer

Price of the turnkey 10 kW solar power plantamounts from 110,000 HRKtill 170,000 HRK, depending on built-in components, complexity of installation and investor's whishes.However, as shown in Table 2., price of technical components is approximately only one half of the total investment.

Regarding investment revenues, they can easily be calculated based on produced quantity of electric power and the price of 1 kWh of power. Produced quantity of electric power depends on many factors- insolation, shading, inclination, orientation, internal losses of the system etc.

It is estimated that the solar powerplant in Osijek will produce approximately 10.900 kWh of electric power annualy (http://enersynth.com). But the price has been changed significantly. Until recently, subventioned buy off price of 1 kWh of power produced in solar powerplants up to 10 kWh of power was 2,63 HRK + VAT. Under those conditions, payback period of this investment in Slavonija and Baranja would be acceptable 7-8 years. However, in year 2012 a new Rate system for production of electric power from renewable energy sources and cogeneration was introduced (NN No. 63/2012). After it, agreement on electric power buy off is being concluded for the prolonged period of 14 years (previously the period was 12 years) but the subventioned buy off price is

diminished to 1,10 HRK /1 kWh. Because of that, payback period of concerned investments is increased up to 20 years, which makes these projects, from a financial point of view, unacceptable.

4. CONCLUSION

As presented in this paper, there is more than enough available energy to fulfill world's needs. The only problem is to find efficient ways of clean and safe exploitation of different energy sources. One of those sources is definitely solar energy, whose costefficiency cannot compete with traditional energy sources at the moment, but is expected that results of numerous scientific studies will reduce the price and increase the efficiency of this source in the future.

Justifiability of investment is generally assessed based on three types of analysis: technical, financial and economic. Insodoing, economic analysis evaluates contribution of the investment to economic welfare and quality of life in a region. This paper proved the adequacy of natural condition sand tecnical feasibility of investments into solar energy in Slavonija and Baranja. However, its howed financial in efficacy of those investments. Finally, it must be emphasized that in terms of economic analysis, investments into solar energy have been positively evaluated, because decrease of fossil fuel sutilization brings to decrease of environment pollution. It is expected that this should be the main reason for realisation of existent Strategy of energetic development of Republic of Croatia (NN No. 130/2009) in a near future. The Strategy plans stimulation of renewable energy sources usage and it is evident that the currant key word of acceptability of these source and rational management of solar energy investments is - incentives. Although our reality today is far from systematic stimulation of investments into solar energy, economic recovery of the national economy will for sure lead to that, because beside the Strategy, we have all necessary natural preconditions that could make solar energy the area of so much needed investments expansion.

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