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EVALUATION OF RETURN ON INVESTMENT FOR PROPOSED USE OF SOLAR SYSTEMS IN POLAND

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This paper focuses on the assessment of possibilities to subsidize the purchase and installation of solar collectors in Poland by government or local government grants and special funds designed for this purpose. It analysis of costs and profits resulting from the application of solar installations in the process of heat generation for household requirements, by calculating the payback time, with taking into account prices of other energy carriers and the above mentioned subsidies. Collectors at present are manufactured solely from metals (copper, aluminium, Al-Mg alloys). The use of these materials is tied to considerable energy demand and the production technology is complex. This affects the economy of running a solar device.

Key words: renewable energy, solar energy, Poland, payback period, cost savings.

Procjena povratka investicija za predloženo rabljenje solarnih sustava u Poljskoj. Članak je usmjeren na procjenu mogućnosti novčane potpore nabavke instalacija solarnih kolektora u Poljskoj od vlade ili lokalnih pokrovitelja te posebni fondovi utemeljeni u tu svrhu. Analizirani su troškovi i dobit kao rezultat primjene solarnih instalacija u procesima zagrijavanja po zahtjevima, proračuna povratka investicije, uzimajući u obzir cijene računa ostalih, tj. više drugih usporednih energija. Sadašnji kolektori ustrojeni su od metala (bakra, aluminija, Al-Mg legure). Rabljenje ovih materijala je u svezi energetskim zahtjevima i proizvodnom tehnologijom. Utjecaji ekonomije ovisni su o solarnim uređajima.

Ključne riječi: obnovljiva energija, solarna energija, Poljska, termin povratka ulaganja, uštede troškova.

INTRODUCTION

Energy plays an important role in our lives. According to several experts, without changing the way we use fuel-energy resources it is not possible to ensure sustainable development of society [1].

Solar energy-situation abroad

The largest share of solar energy per inhabitant is currently in Cyprus, where up to 90 % of residential buildings have solar collectors installed.

In 2010 the government of Czech Republic passed the law on supporting renewable energy, in which photovoltaic will lose support in 2011. This amendment responded to continuous and uncontrolled development in the construction of solar power plants [2].

The world´s largest photovoltaic (PV) solar plant open in Southern Spain With an installed peak power of 23 MW (updated), the solar park at Jumilla, Murcia (Southeastern Spain) is the world's current highest capacity PV plant and the most efficient to-date [3].

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Subsidies for the solar collectors in Poland

- On June 17 2010 the Board of the National Fund for Environmental Protection and Water Management signed agreements with six banks, launching a program of subsidies to bank loans for the purchase and installation of solar collectors. It means that subsidized loans will be available in 4,5 thousand banks establishments all over Poland [4].

For natural persons and housing communities, not connected to the district heating system, the National Fund for Environmental Protection and Water Management offers, through the banks, 45 % subsidies to the purchase and installation of solar collectors used for usable water heating. The subsidies include loans for the purchase and installation of solar collectors as well as equipment required for their proper functioning. The offered budget of subsidies to partial repayments of bank loans designed for the purchase and installation of solar collectors for natural persons and housing communities for a period. The table 1 shows scheduled and planned subsidy of goverment from 2010 to 2014 [5].

Eco Fund offers subsidies to the installation and purchase of vacuum and flat solar systems. Applications for the installation of solar collectors can be submitted by the owners of ready-to-use private houses or houses which are still under construction. The subsidized amount is 252 € for one square meter of the solar sys-

Table 1 **The total of scheduled and planned subsidy from the government [5]**

Scheduled Payments in	Year				Total [EUR]
	2010	2011	2012	2013 -2014	
2010	1 057	-	-	-	1 057
2011	4 215	12 342	-	-	16 557
2012	-	5 058	21 211	-	26 269
2013	-	-	6 441	8 555	14 996
2014	-	-	-	12 581	12 581
2015	-	-	-	4 026	4 026
Total	5 272	17 400	27 652	25 162	75 486

tem, but it cannot exceed 40% of the investment. However the amount of subsidies shouldn't be lower than 12 581 €, so the sunlight absorbing surface should not be less than 50 m^2 . An annual limit of resources for the installation of solar collector projects amounts to 2 516 166 € (for 10 000 m^2 / year) in EcoFund [6].

Expenses involved in the production of solar collectors can be partially financed by the Agency for Restructuring and Modernization of Agriculture within the framework of the following measures constituting part of the Rural Area Development Program for 2007 – 2013:

- Measure 123 Adding value to agricultural and forestry products
- Measure 312 Creation and development of micro enterprises
- Measure 121 Modernization of farms.

However it should be noted that the investment will be subsidized only when the collector is used in accordance with the purpose of the supported operation. Subsidies for farmers are financed from the Agency for Restructuring and Modernization of Agriculture, which covers up to half of the total costs involved in the purchase and installation of necessary equipment. Recommended systemic instruments supporting solar power engineering are based on existing experience (for example: investment subsidies), and they comply with the legal conditions and requirements specified in the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. Furthermore these instruments correspond with the proposals of the Ministry of Economy, included in the project „Polish Energy Policy till 2030". They also refer to support systems which have been successfully applied to promote green electricity and biofuels in Poland, but never to support the „green heat" idea [7].

CLIMATIC CONDITIONS

Meteorological conditions in Poland are characterized by an uneven distribution of solar radiation in the annual cycle. 80 % of the total annual insolation falls on six months of the spring and summer season (from the beginning of April to the end of September). Time of the solar activity in winter is shortened to 8 hours a day, and in summer this time amounts to as many as 16 hours a day.

A characteristic feature is a significant participation of diffused radiation in the total radiation. It exceed 50 % in the annual scale, and during the four winter months (November – February) it amounts to 65-73 %. The annual solar radiation density on the horizontal plane ranges from 950 to 1 250 kWh/m^2. Many years of analyses have proved that the highest values of the solar radiation flux occur in the Baltic area and in the eastern part of Poland. Total annual average insolation amounts to 1 600 hours [8].

COSTS AND PROFITS

The initial investment of selected collector TS 300 is its purchase. Based on the assessment of technical-operational parameters of commercially produced and available collectors on the market can be concluded that currently manufactured collectors are solely based on a metal base, while in the construction of the absorber are mainly used metals with high thermal conductivity: copper and aluminum. The usage of metallic materials is associated with a considerable degree of energy and technology intensity production, reflecting into the price of the equipment. In terms of design solutions to manufacturers of specific products resulting from concepts, high thermal conductivity of metal elements plays an important role, which can be negatively reflected in increased rates of energy losses of body collector due to the possibility of unwanted thermal bridges existence, which is immediately reflected in the nature of heat balance of the collector and then in the economic efficiency of the whole solar equipment operation as a comprehensive energy system. The costs of metallic construction collector elements such as copper respectively aluminum absorber with the piping elements and collector metal bath, which is mostly made of Al-Mg alloys have a significant share on cost structure of individual structural elements of standard solar collector [9].

Total costs incurred for the purchase and usage of solar installations consist of investment outlays - on average 503 € to 1 007 € per one square meter of the solar collector area (in case of a four-person family the total costs amount to 2 013-4 026 €) and operation costs (costs connected with the operation of the circulating pump of about 10 €/year and periodic maintenance and refilling of the working factor - an amount of 50-76 € once every few years). Apart from the thermal parameters of the collector, the amount of the solar yield is also affected by: location, hot water demand profile, position of the collector against the directions of the world, its inclination, insulation thickness, flow of the passing heating factor, size of the heat accumulator, and assumed level of demand coverage.

In the economic assessing of the systems it is necessary to know the investment costs, operating costs and payback period of the investment. When calculating the economic profitability index values, one should take into account trends in the fuel and energy market. For

Table 2 **Economic profitability of investments in solar collectors [10]**

Type of collector		Flat collectors					
Solar yield [KWh/(m² year)]		405			435		
Investment outlays [EUR]		3 397			4 227		
Conventional system		El. energy	Natural gas	coal	El. energy	Natural gas	coal
Price of energy carrier		for kWh 0,11 €	for m³ 0,5 €	for t 132 €	for kWh 0,11 €	for m³ 0,5 €	for t 132 €
Annual savings [EUR/year]		2 84	153	73	289	156	75
Return period, without taking into account [years]	price increase	12	22	48	15	28	59
	a 10% price increase	8	12	18	10	14	20
	a 10% price increase and a subsidy of 155 €	7	11	16	8	12	18

Table 3 **Economic profitability of investments in solar collectors II [10]**

Collector area	7 m²	Number of persons using hot water	4
Investment outlays (629 €/m²)	4 403 €	Tax scale	18 %
Amount of effective energy from collectors	10,08 GJ/years	Coverage of demand for hot usable water	60 %
Subsidy from the National Fund for Environmental Protection and Water Management (without taxation)	1 982 € 45 % of outlays	Effective subsidy from the National Fund for Environmental Protection and Water Management	1 625 € 36,9 % of outlays
Conventional system Preparation of hot usable water	electrical energy	natural gas	coal
Annual savings (in the first year)	399 €	184 €	98 €
Return period, without taking into account price increase [years]	12	22	48
Investment outlay return period	6 years	11 years	17 years

many years in the EU, and especially in Poland, one has seen a regular increase in the conventional energy prices In the years 2000-2009 average fuel and energy prices increased by about 85 %, while the highest price increase concerned the natural gas (over 160 %) and electric energy (over 90 %). Midyear fuel and energy price growth rate in the years 2000-2009 was over 7 % and it was much higher than the average inflation rate. It should also be remembered that energy prices in Poland are still lower than the prices in the EU, and the disproportions will be systematically leveled.

Economic profitability calculations can be performed with the help of available performance calculators (for example: www.inwestujwkolektory.pl) or programs for a selection of solar installations, solar yield calculation and heat demand coverage (www.kolektorek.pl). The following two Tables 2, 3 present such a comparison [10].

CONCLUSION

To conclude, it must be pointed out that solar installations are in many cases economically viable. The payback time is shorter than the product lifetime, and the cost of energy unit generated by the collector is lower than the cost of energy generated by conventional heat sources. The cost-effectiveness depends mainly on the type of the basic heating system. The most profitable installations are those in which electricity is the main source of heating, whereas the least profitable ones are those based on coal or wood (also in case of mains heating). What also matters is the type of solar collectors, their application, applied technical solutions, quality of workmanship and installation assembly. An important element that should be taken into account while calculating the payback time is dynamics of the fossil fuel prices. It illustrates an actual return on solar collector installations, which is not as low as the skeptics say. On the other hand, profitability of the solar collectors is rarely as high as claimed by enthusiastic declarations of the majority of retail offers, even when we take into account the received financial support in the form of subsidies.

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