Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 3 Issue 4, April - 2016

Solar collectors for hot water production in the city of Tirana

Estimation of needs for compensation of energy from central grid of electricity

Daniela Halili
[1]Department of physics, Faculty of Natural Science
"Aleksandër Xhuvani" University,
Elbasan, Albania
topciudaniela@yahoo.com

Përllumb Berberi
[2]Department of Engineering Physics, Faculty of Engineering Mathematics and Engineering Physics, Polytechnic
University of Tirana
Tirana, Albania
pellumb.berberi@gmail.com

***Abstract.* — Solar water heating technology is one of most economical renewable energy sources extensively used worldwide. Due to favorable geographical position, Albania has high potentials of solar energy and good opportunities to apply it for production of hot water for domestic needs. However, because of an uneven daily, monthly or yearly distribution of solar energy during the year, solar energy can result in certain periods insufficient to cover daily needs, making it necessary to use an alternative source of energy to compensate the insufficient solar energy . The aim of the study is to estimate the level of fulfillment of annual needs for producing hot water for sanitary needs through solar energy and consequently the needs for compensation of energy from central grid of electricity. Our study is focused in the city of Tirana, capital city of Albania. Three different types of solar collectors were estimated. The average monthly electrical energy compensation varies from 294.7 kilowatt hour to 43.5 kilowatt hour. The month with the highest need for electrical energy compensation for all three types results January, with an average value of about 10 kilowatt hours per day. The month with the lowest need for electrical energy compensation results July for the three models of solar collectors with an average value of about 2 kWh per day. Cost of electrical energy compensated varies from 23.87euro in January to 3.52 euro in July.**

Keywords— solar collector, solar energy, electrical energy compensation, cost of energy

I. INTRODUCTION

Use of solar heating systems for water or air heating for residential applications has had a rapid progress worldwide during last 30 years. Use of Solar Heating Systems SHS to produce hot water for sanitary needs offers an economical alternative replacing other conventional technologies as electric or gas boilers **[1].** In countries like Cyprus and Israel the use of solar systems for producing hot water for sanitary uses goes up to 80% - 90% of apartment buildings. Solar heating can provide 60% or more of the heat necessary for hotels. **[2]** However, globally, only 1.2% of the space and water heating in the residential sector is covered by solar heating systems

Albania is considered a country with a good regime of solar energy and with a high potential of solar radiation. It has about 240-260 sunny days through the year. Thanks to its geographical position and the potential of solar energy, the majority Albanian areas receive more than 1500 kWh / m^2 per year, varying from 1185 to 1690 kWh / m^2 per year. The use of solar energy in residential buildings for hot water production in Albania is actually growing at an annual rate of about 19 percent. Flat solar collectors are actually the best financial option **[3]**. The installed capacity of solar collectors at the end of 2013 was 78.4MWth and total area of 111 921 m^2 **[4]**. In Table 1 are shown total area of installed solar collectors, installed thermal capacities and their distribution by technologies in Albania in 2013**[5].**

Technology	***Total area m^2***	***Installed capacity (MWth)***	***Added during year 2013 (MW th)***
Glazed flat - plate solar collectors	111.135	77.8	14.7
Evacuated tube solar collectors	786	0.6	0.1

Table1: *Total area, installed thermal capacity of solar collectors installed in Albania till the year 2013 and their distribution by technologies used.*

Solar collectors' technology used in Albania is dominated by glazed flat - plate solar collectors with 99.2% of total installed capacity, compared with only 0.8% of evacuated tube solar collectors. National objective for the year 2020 is that the overall area of solar collectors to achieve 520,000 m^2 **[6].**

The amount of thermal energy produced by the solar collector in a specific area depends on the amount of solar energy that reaches it. Albanian family

consumes an average of about 12kWh energy per day equal to the average solar energy can be received by a solar collector with an active area of about $2m^2$, if the potential of solar energy would be distributed evenly throughout the year. Seasonal change of the intensity of radiation and variability cloud cover has an important impact on the possibility of practical use of this potential.

A solar collector of sufficient installed thermal capacity or active area to cover daily needs for hot water, due to uneven distribution of daily, monthly or yearly potential of solar energy in a given region, can results in certain periods insufficient to cover the needs. In this case, an alternative source of energy is needed to supply energy. In case of Albania, the only alternative source of energy is the electrical energy from central grid. This study we have estimated amount and added cost of electrical energy needed to assure e normal daily supply of hot water through the for hot water production. This energy is approximately year in an apartment house for a normal family of four persons situated in the city of Tirana.

II. MATERIALS AND METHOD

The amount of thermal energy received by a solar system at a particular site depends on how much of the sun's energy reaches it, the angle of inclination and orientation of the solar collector.

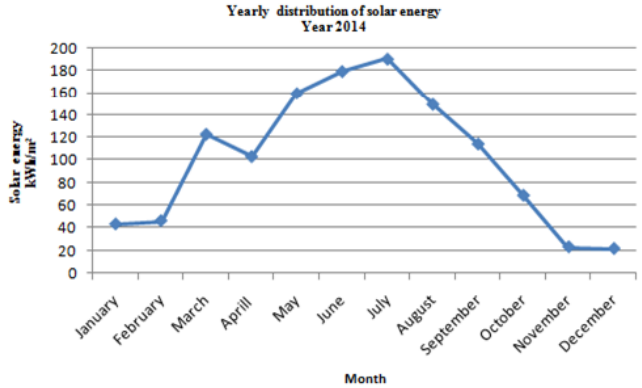
. The solar radiation data were obtained from a meteorological station, located in a building of about 25 meters high, near the building of FIMF, UPT, in Tirana. Solar collector is located at corner 41^0 and to the south direction. Solar radiation is measured every 10 minutes. Our study was done for a period of 4 years, but here we have represented only estimates for 2014. In Table 2 are shown the data of the average monthly amount of solar energy 2014 in Tirana.

•

Month	January	February	March	April	May	June	July	August	September	October	November	December
Solar energy kWh	43.4	46.3	122.8	103	159.7	179.4	190.4	149.4	114.1	68.7	23.2	21.7

Table 2: *Monthly solar energy for 2014*

As seen from Table 2 the amount of solar energy on every unit area of solar collectors varies from month to month. Higher values of solar radiation are taken in July and lowest in January. Solar energy values also vary from a day to another as well as within the day due to climate change and variability of cloud coverage. This means that the amount of energy that would be compensated from the central grid will be different from day to day and from month to month. Figure 1 shows the graph of yearly solar energy distribution given in Table 2.



." ***Figure 1:*** *Yearly distribution of solar energy per unit area installed, for collector tilt 41^o a in Tirana*

The current price of electricity supplied from the central grid is 0.081 euro per kWh. The energy required for hot water production, using rated by SRCC conditions, is 43302 kJ / day or 12.03 kWh per day **[8].**There are three different models of glazed flat plate solar collectors used in our study, that are present in the Albanian market for producing hot water: model 1 (gross area $2.24m^2$,aperture area $2.08m^2$, Fr 0.74,Fr UL $4.21(W/m^2)/^0C$), model 2(gross area $2.4m^2$,aperture area $2.36m^2$, Fr 0.72,Fr UL $4.22(W/m^2)/^0C$), and model 3(gross area $2.4m^2$,aperture area $2.26m^2$, Fr 0.71,Fr UL $4.21(W/m^2)/^0C$). It appears that effective surfaces are comparable for all collectors. Regarding the price, they can be very different from year to year and depends on the location, manufacturers, retailers, market fluctuations, etc. In our estimation we have used a mean value of actual prices in local market. The price is taken 1,600 € for the three models of glazed flat solar collectors. The simple method is used in our estimates. The electrical energy compensated is the difference between daily solar energy and daily needed energy

Based on the analysis and conclusions we will determine the most appropriate solar technology for the Albanian consumer.

III. COMPENSATED ENERGY FROM THE GRID AND ITS COST

Solar insulation observed in Albania fluctuates throughout the year, corresponding to seasonal and regional variation. Seasonal variation has a significant impact on the effective utilization of solar energy **[9]** .This is why it must be made a careful study in terms of fulfillment needs by the solar energy at different periods of the year. In Table 3 are given monthly and annual energy compensated from the central grid for the three types of the solar collectors in Tirana city

Month	January	February	March	April	May	June	July	August	September	October	November	December	Yearly
Electrical energy compensated (kWh)	300.7	259.8	169.1	189.9	110.2	71.8	62.7	63.2	159.3	162.6	105.8	180.5	1835.7
Relative value of electrical energy compensated (%)	80.7	77.2	45.4	52.7	29.6	19.9	16.8	16.9	44.2	43.6	29.4	48.3	41.8
Cost of electrical energy compensated (€)	24.4	21	13.7	15.4	8.9	5.8	5.1	6.072	12.9	13.2	8.6	14.6	148.7
Electrical energy compensated (kWh)	294.7	253.4	152.1	175.6	97.7	60.6	51.2	55.5	143.5	153	90.6	177.5	1693.5
Relative value of electrical energy compensated (%)	79	75.2	40.8	48.8	26.2	16.8	13.7	14.9	39.9	41.1	25.2	47.61	38.6
Cost of electrical energy compensated (€)	23.9	20.5	12.3	14.2	7.9	4.9	4.1	4.472	11.6	12.4	7.3	14.4	137.2
Electrical energy compensated (kWh)	297.4	256.3	159.6	181.9	102.8	65.4	56	63.5	150.5	157.2	92	178.8	1749.3
Relative value of electrical energy compensated (%)	79.8	76.2	42.8	50.5	27.6	18.2	15	17	41.8	42.2	25.6	48	39.9
Cost of electrical energy compensated (€)	24.1	20.8	12.9	14.7	8.3	5.3	4.5	4.2	12.2	12.7	7.5	14.5	141.7

Table 3: *Monthly electrical energy compensated, its relative values and cost, for the three models of solar collectors.*

In Table 3 is shown that the electrical energy compensated varies from month to month, because of variations of solar energy. Its values range from 294.7 kWh in 43.5 kWh. The relative values show clearly the variation of electrical energy compensated. They vary from 11.7% to 80.7%. The month with the highest value of energy compensated by the central grid is January to the three models of solar collectors, with an average value of about 10 kWh per day while, the month with the lowest value of compensated energy is July for the models with an average value of about 2 kWh per day.

In the graphs below are shown monthly distribution of solar energy produced by solar collector model 2 and the energy needed to produce hot water, in January and July as months respectively at the lower and the higher solar energy.

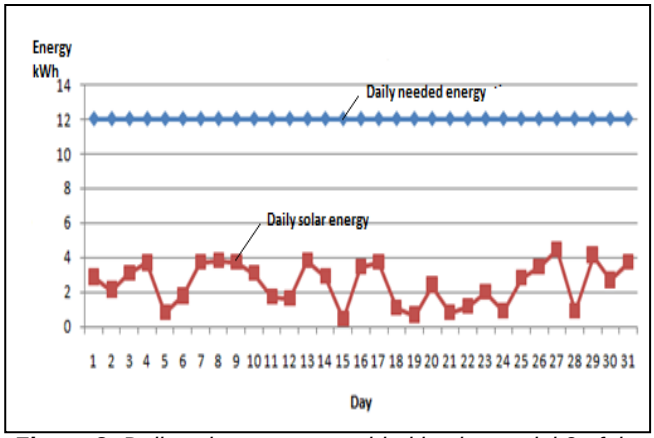


Figure 2: *Daily solar energy provided by the model 2 of the solar collectors, and the daily needed energy for hot water production in Tirana in January 2014.*

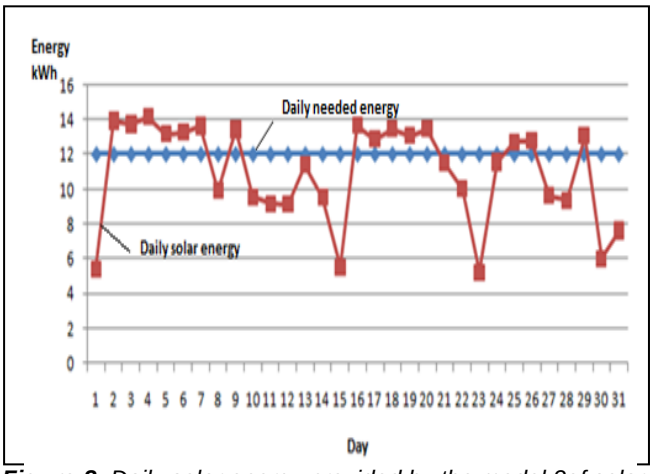


***Figure 3**: Daily solar energy provided by the model 2of solar collectors and the daily needed energy for hot water production in Tirana in July 2014*

The graphs above clearly show how solar energy values fluctuate from one day to another, because of that and the compensation of the energy requirements for the production of hot water from the central grid.

Although the monthly electrical energy compensated is lower in July. We can see that for 15 days in July the energy needs for the production of hot water are fulfilled only with solar energy, without using an alternative source, for 4 days 50% of energy needs to compensate by solar energy and for 11 days only a handful of electricity needed to compensate the requirements. It is obviously clear that is the same conclusion for two other models of solar collectors.

In this study we have estimated the value of compensated solar energy for every day of the year and the calculations for January and July are presented in the figure 4. We have used the sign '-' for values of energy that is compensated from central grid, and the sign '+' for the values larger than the needed energy.

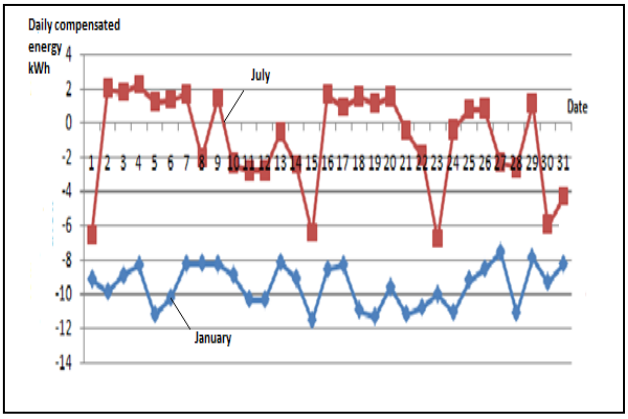


Figure 4: Variation of daily values of compensated energy by the electric grid in January and July

Regarding the monthly energy cost, it will be depending on the quantity of .electrical energy compensated. It ranges from 23.87 € in January to 3.52 € in July.

In figure 5 is given the variation of daily cost of electrical energy compensated for hot water production using model 2 of solar collectors on January and July.

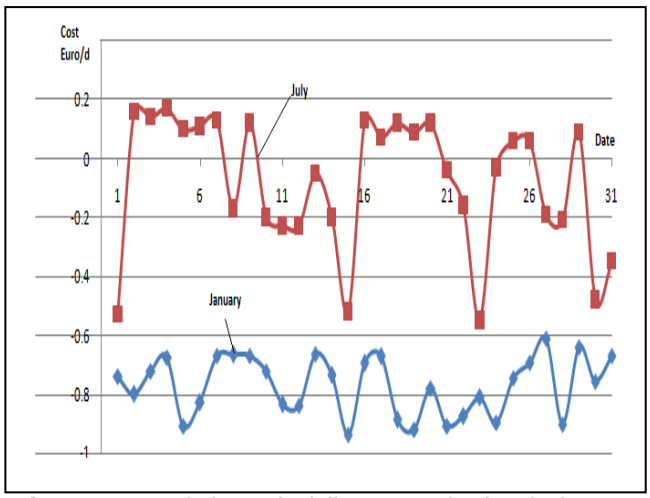


***Figure 5:** Variation of daily cost of electrical energy compensated in January and July*

It is evident the solar energy for heating water for sanitary use is very economical,

Judging from the data presented and the calculations made in our study, model 2 from the three models of solar collectors taken into consideration is more profitable to be used by the customer

IV. CONCLUSIONS

Solar water heating technology is one of most economical renewable energy sources extensively used worldwide. Due to favorable geographical position, Albania has high potentials of solar energy and good opportunities to apply it for production of hot water for domestic needs. However, because of an uneven daily, monthly or yearly distribution of solar energy during the year, solar energy can result in certain periods insufficient to cover daily making it necessary to use an alternative source of energy to compensate the insufficient solar energy. In case of Albania, the only alternative source of energy is the electrical energy from central grid. Our study is focused in the city of Tirana, capital city of Albania. Three different types of solar collectors were estimated. The average monthly electrical energy compensation varies from 294 7 kWh to 43.5 kWh. The month with the highest need for electrical energy compensation for all three types results January, with an average value of about 10kWh per day while the month with the lowest need for electrical energy compensation results July, about 2 kWh per day. The relative values show clearly the variation of electrical energy compensated. They vary from 11.7% to 80.7%. Cost of electrical energy compensated varies from € 23.87 in January to € 3.52 in July.

REFERENCES

[1] Eric Joseph Urban “Monitoring and Modeling Hot Water Consumption In Hotels For Solar Thermal Water Heating System Optimization.” Thesis, May 2011

[2] Mauthner. F, Weiss. W. “Solar Heat Worldwide, Markets and Contribution to the EnergySupply 2014”. IEA SHC, 2014. http://aee-intec.at/0uploads/dateien1016.pdf

[3] “.Mapping Regional Variation Of Cost Of Hot Water Produced By Conventional Solar Collectors In Albania”,In proceedings of The 8th General Conference of Balkan Physical Union, Constanta, Rumania, 2012, D.Halili,P. Berberi, D. Mitrushi, V. Muda - Lame,

[4] IEA-ETSAP and IRENA.: “Solar Heating and Cooling for Residential Applications”. 2015.http://www.irena.org/DocumentDownloads/Publications/IRENA_ETSAP_Tech_Brief_R12_Solar_Thermal_Residential_2015.pdf

[5] Mitchell Leckner, Radu Zmeureanu, Life cycle cost and energy analysis of a Net Zero Energy House with solar combisystem, Applied Energy 88 (2011) 232–241

[6] Mauthner. F, Weiss. W.: “Solar Heat Worldwide, Markets and Contribution to the Energy Supply 2014”. IEA SHC, 2014. http://aee-intec.at/0uploads/dateien1016.pdf

[7] “Effect Of Local Environmental Condition On Efficiency Solar Collectors For Production Of Hot Water For Domestic Use In Albania”,in Proceedings of The 9th General Conference of Balkan Physical Union,Istambul, Turkey 2015, ,D Halili, P Berberi, D Mitrushi ,V Muda, I Bërdufi, U Buzra.

[8] http://www.solar-rating.org/facts/system_ratings.html, visited on June 20, 2012.

[9] “Shpërndarja rajonale e potencialit të energjisë diellore në Shqipëri dhe kostot e prodhimit të energjisë elektrike me anë të sistemeve fotovoltaik”.Buletini i Elbasanit.”,Albania ,D. Halili, P. Berberi, D. Mitrushi, I. Bërdufi ,unpublished