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The effectiveness of the use of solar panels in hotels of Durres area.

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Abstract. In the present study is analyzing the case of the application of solar energy with vacuum tube collectors for heating water for sanitary needs in hotels of Durres areas. In recent years there has been a special interest by the leading authorities to the EU countries and the U.S., for the use of renewable energies in general and solar energy in particular. This is mainly related with the reduction of environmental pollution from gas CO₂, which directly influences the greenhouse effect and global warming.

Unlike other forms of renewable energy, like wind turbines, photovoltaic panels and biomass usages, the use of solar panels for hot water, constitutes a reliable source in Albania. In the study were analyzed the types of solar panels used in our country and the world. Collector with vacuum tubes is selected for heating water, which constitute a new technology with an efficiency 40% higher than other types.

For this case study were obtained tourism hotels in the coastal area of Durrës with a high level of solar intensity, which are calculated the cost for water heating with electric boiler (traditional method) and with solar panels. Results show a significant reduction of annual expenses up 3 times, compared with the use of electricity. While with interest it is the reduction of the amount of gas CO₂, to achieve reduction of environmental pollution, and the reduction of global warming in general.

Keywords: Environment, renewable energy, solar panel

1. Introduction

On completion of family needs for hot water in our country, it is used mainly the heating with electricity, while for various hotels in cities and tourist areas and water heating boilers with fuel (diesel, carbon, gas, etc.). The use of fuel is associated with the release of a large quantity of emissions of CO₂ and other gases that affect in environmental pollution, global warming and greenhouse, which have brought and climate change. For this purpose, the demand for the use of renewable energies is increased, where the solar energy is primary.

Since the beginning of 1990 solar thermal power market has had a positive development. So the Department of Energy ¹⁴ in 1995 has determined, that the U.S. will have a dominant position in the solar energy sector. According to the International Energy Agency (IEA) in 2008, in the world it was installed 45.1 million m² solar collectors, however the application rates for use of solar energy are small. This is why solar technology has been perfect in terms of increasing the absorption efficiency of solar energy and to reduce the losses.

One aspect is the use of solar energy water heating for domestic and sanitary needs, which are widely used today in the world, in countries with high solar intensity. Meanwhile, recent solar energy is used for heating buildings. Our neighboring countries Greece and Turkey, after 30 years of experience have managed to provide in national level, the producing of hot water at 80-85% [4].

Albania is considered as a country with a better mode of solar energy with high potential of solar radiation. The using solar panels for hot water has years that is started, mainly in villas and tourist hotels in coastal and low areas. The use of solar panels provides electricity saving, environmental protection and results with economic benefit in the housing sector and services.

National Agency of Energy¹⁵ in our country in cooperation with Austrian specialist of solar panels, have determined that in 2015, 15% of Albanian households will use solar panels to provide hot water [1]. To promote

¹⁴ .http://www.upi.com/Business_News/Energy-Resources/2011/08/03/US-wants-to-lead-world-in-solarenergy/UPI-3951312375269/#ixzz3pzA7llvV

¹⁵ The National Energy Strategy, Tirana 2003 p.23

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the use of solar panels for producing of hot water in the housing sector and the services, one of the main directions of energy policy, has also been requirement for installation of solar panels in tourist hotels.

In terms of global interest in various countries operates organizations, to promote the use of solar panels. In our country operates UNDP, which has 4-year program, part of global initiative for the use of solar hot water. In Albania it can gain a solar radiation for more than 2200 hours¹⁶ per year. Studies and applications of recent years¹⁷ show that using renewable energy sources of solar, wind and hydro and geothermal, the reliance on fossil fuels can be minimized, leading directly in reducing of CO₂ emissions. So on average for every kWh of energy produced from a coal power plant, is produced 1 kg CO₂. Combustion of natural gas for electricity production or water heating produces about 450 G CO₂ for every kWh energy produced. By installing solar panels for water heating can provide 50-70% of energy needs for hot water and it can reduce CO₂ emissions more than 20%.

For this purpose, we take study the coastal area of Durrës, as the tourist area filled with hotels and private experiences are more numerous than in other areas of Albania. Meanwhile, Durres enters in the area with a high solar radiation with an average 2500 hours per year. Below we will analyze the solar panels used today, in terms of effectiveness, to choose the most effective type to be used. The effectiveness of using solar panels in a average tourist hotel will be treated relative electricity. The study will take only tourist hotels in the area of Durres.

The results obtained will serve to sensitize residents of the area of Durres, for the necessity of using solar energy for hot water in residential buildings, where there is sun and the possibility of placing the solar panel. Use of solar panels can also be done in many apartments, which have balcony oriented from the south.

2. Types of solar panels

The solar panels in our country that used to provide hot water are solar panels with mirrors, which can be with boiler above mirrors, and boiler down mirrors. Most solar panels used in our country it is the boiler on the mirrors, known as "Greek model". This model prevails in private homes, in villages and tourist complexes in the coastal tourist hotels.

Performance of solar panels depends on the absorption efficiency of solar radiation and its conversion into thermal energy for sanitary water heating. In this regard, in recent years has introduced a more advanced technology, which is the use of vacuum tubes, that have managed to absorb, 40% more solar energy, than those with mirrors. Solar systems with vacuum tubes have these advantage [7]:

Efficiency of absorption of solar radiation regardless radius of the sun.

Higher heating efficiency, due to the cylindrical shape of the tubes

Durability in high temperature, due to absorption layers with high efficiency

Durability in a cold environment (up to -50 °C) due to the vacuum and better isolation - Maintains temperature longer, due to a better isolation of the tank

Lower cost

No need for maintenance

Time of depreciation is the greater, without reducing efficiency

These systems are equipped with a computerized intelligent controller, to maintain the temperature, water level and control of aid. The system is composed of solar collector panel formed by vacuum tubes, with diameter 58 mm and length 1800 mm and the water boiler with capacity 150l, 180l, 200L, etc. connected to pipes insulated. These can be: with natural motion (free) of water in vacuum tubes, which is used to warm water in small amounts (home and apartments)

with forced movement of heater liquid, that may be water or antifreeze, which moves through the pump in the copper tubes to achieve high temperatures up to 200°C. Heating of the water is through the serpentine into the boiler. In this case in vacuum tubes is not moving water and no water pressure, so the tubes do not suffer and have no need for cleaning. These are used in hotels and large businesses, but can also be used for domestic heating systems, due to the high temperatures insurance. In the use of these panels, China ranked first with 80.7%, EU 9.5%, Turkey 3.5%¹⁸. Recently they are introduced in our country, in Tirana and Durres. We will use the solar panel with vacuum tubes, as the model with higher effectiveness.

¹⁶ National agency of Natural resources; http://www.akbn.gov.al/index.php?ak=details&cid=25#Scene_1

¹⁷ <http://www.meidasolar.com/service.asp?keyno=113>

¹⁸ <http://www.meidasolar.com/service.asp?keyno=113>

3. Energy for water heating in Durres hotels

In the area of Durres work published over 50 hotels¹⁹ with a capacity of about 1600 rooms equipped with shower baths, and a total 60 bar coffee and 60 restaurants. In fact hotels range from the largest with 70 rooms equipped with bathrooms and other fixtures as 2 coffee bar, restaurant, night club and sauna (Hotel "Adriatic"), to the little ones with 12 rooms (Hotel "Ani ") with bar coffee and restaurant. Existing hotels are with 3 to 6 floors, with 1 or 2 coffee bar and 1 or 2 restaurants, but there is with 7 floors and a ground floor area up to 1000 m² (Hotel "Dolce Vita"). The average number of rooms results to be 32 for a hotel and 1.2 bar cafe and restaurants. We will take this to an average hotel, with all double rooms equipped with showers with hot water, while the ground floor there is coffee bar, restaurant and reception.

The effectiveness of providing hot water is calculated by analyzing the 2 methods: heating water using electricity (with electric boiler) and heating water with solar panels with vacuum tubes.

3.1 Heating of water with electric boiler.

In this case it is used the traditional system, the establishment in each bathroom, an electrical boiler. For all the hotel are planned: 32 boilers and 4 boiler for coffee bar, restaurant etc.. So should be 36 electrical boiler with capacity of 80 liters and 2 kwh electricity power each. Calculating the cost of electricity will be assuming that all the hotel rooms are in operation. From the literature [7] provided that for a person must be 58 liters of warm water with 42 °C- 45 °C in the day. By assuming that all the hotel rooms are doubles, and consumption of hot water at the bar and restaurant is the same with room boilers, in total with losses of water for all the hotel have to be about 3600 liters per day. According to a study by ERE²⁰, water heating in Albanian households is with electricity. The average value of consumed energy for a family is 58 kwh/ month, or 19% of all electricity consumed. Assuming that the people in the hotel shower for the day is done, we can assume that the energy values for a boiler with all anticipated losses, amounts to 120 kWh/ month. This value is consistent with the calculated energy required for heating 58 liter water. The consumed electricity will be:

- 4320 kwh/ month for average hotel
- 21600 kwh /month for all hotels in the area of Durres

3.2 Heating of water using solar panels

Energy production and the general efficiency of the solar system will depend on the installation location, climate, isolation, system configuration and many other factors. On rainy days or overcast dense, energy production will be reduced greatly. In determining the size of solar collectors needed to provide hot water should be given this information [6]:

- A - daily needs for hot water
 - B - water temperature at the outlet
 - C - area of the installation of solar panel
 - D - maximum monthly solar level
 - E - average efficiency of solar collector in the maximum radiation
 - F - water temperature at the entrance.
 - G - Specific heat in kal / kg °C
- Level of solar radiation is given available from the site of the sun. Maximum and minimum levels should be taken into account throughout the year, as well as the annual average value.

¹⁹ Albania online travel Agency; www.edialtour.com

²⁰ Energy Regulatory Office; ; www.ere.gov.al

Specifically in the area of Durres, the level of solar radiation measured [3] in kWh / m² is presented in Figure 1.

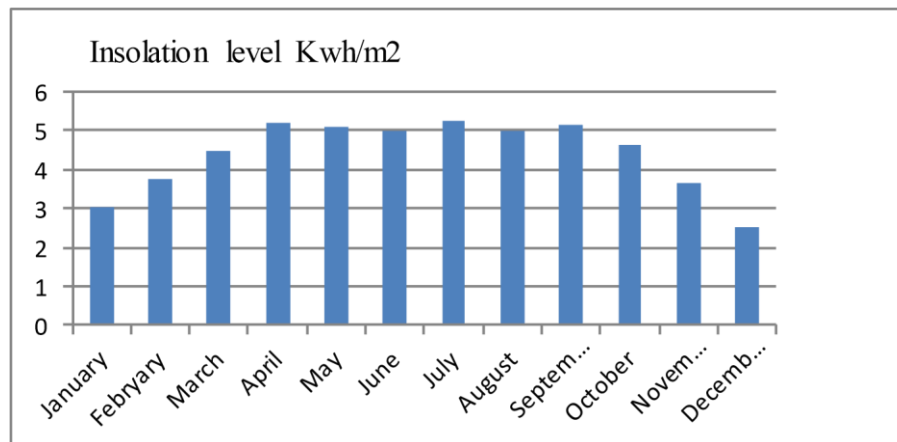


Figure 1 The level of solar radiation in the Durres area

The size of the collector is determined by absorber surface formed by vacuum tubes. The number of vacuum tubes, required for water heating will be determined [6]:

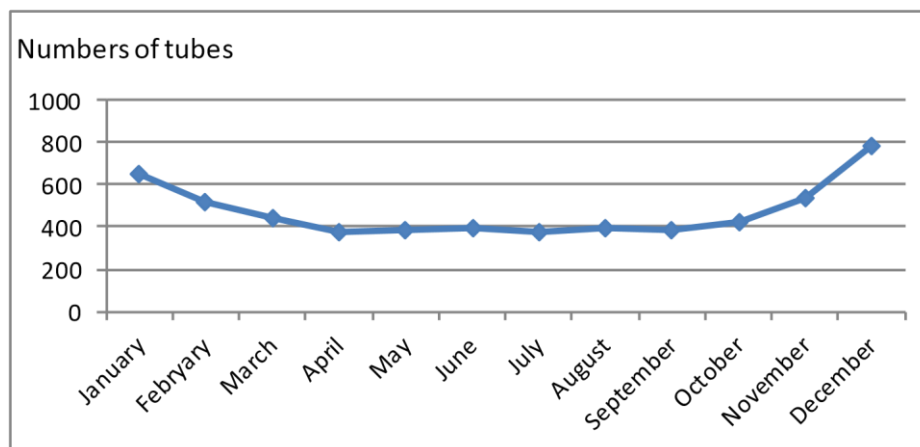
$$N = k \text{ AED (B- F) / S}$$

Where:

- k is the coefficient, that gives the amount of solar energy, which have to heat one liter of water, which depends on the level of solar technology and hydraulic losses in the network. ($k = 0.0256$) - S is the absorber surface for vacuum tubes, which is given by size of the tubes as follows [7]:

For tubes with dimensions 58mmx1800mm have $S = 0.08\text{m}^2$ per tube. Collectors are standardized with 12, 18, 24, 30, 36, 48 and 60 tubes, which correspond to the respective boilers with hot water capacity 100L, 150L, 200L, 250L, 300L, 400L and 500L. Capacity over 300 L used for hotels. Temperature of hot water should usually be around 42 °C to 45 °C. Cold water temperature is usually in the soft regions varies from 10 °C in winter to 20 °C in summer. We have received an average difference of water temperatures at the entrance and exit about 30 °C.

Besides the above used factors it should also be taken into account the Optimum installation angle, which must be: 20-70 ° Vertical, -5 to +5 ° horizontal, the installation required site of the collector in the roof and Part of days without sun, which makes that for the month to be taken 28 days and for year 336 days. Average loss coefficient taken 0.8W/m² °C, while the average efficiency of the absorber solar energy is taken 0.8-0.92. Recognizing the latitude for the area of Durres, referring collector tilt versus horizontal [5] it is fixed degrees of tilt of collectors. Thus the total number of tubes for heating 3600 liters of water, by months of the year, is calculated according to the given methodology²¹ shown in Figure 2.



²¹ http://www.apricus.com/html/solar_collector_faq.html

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The average number of pipes to realize water heating, results 472 tubes. With reserve (for January and December will be used and electric heater, if the hotel rooms are all in place), we chose collectors with 60 tubes with boiler 500 liters.

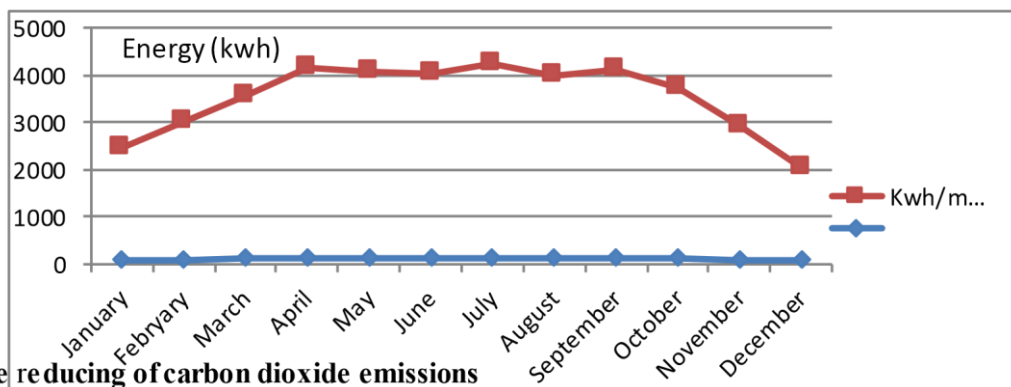
In this case the thermo-hydraulic scheme requires, that in the roof of average hotel it is placed 8 sets of collector with 480 tubes with a total area of 38.4 m². The total capacity of hot water boilers will be 4000 liters. The time of depreciation of equipment and solar panels is greater than 15 years. **Figure 2** The number of vacuum tubes by months of the year

The energy amount produced by solar panels for water heating in kWh will be calculated [6]:

$$W=K EDS$$

Where: K- is the average coefficient that determines the amount of energy equivalent to heating the water with one m² area solar panel, which depends on the level of solar technology and hydraulic losses in network [1] (k = 0.706). For the average hotel the amount of daily and monthly energy generated from solar panels by months of the year, calculated according to the given methodology, shown in Figure 3.

For the average hotel the average amount of daily energy saving would be 120 kWh / day or 3600 kWh / month. For all tourist hotels in the Durres area it will assure an electrical energy saving in the about 6000 kWh /day, or 30,000 kWh /month



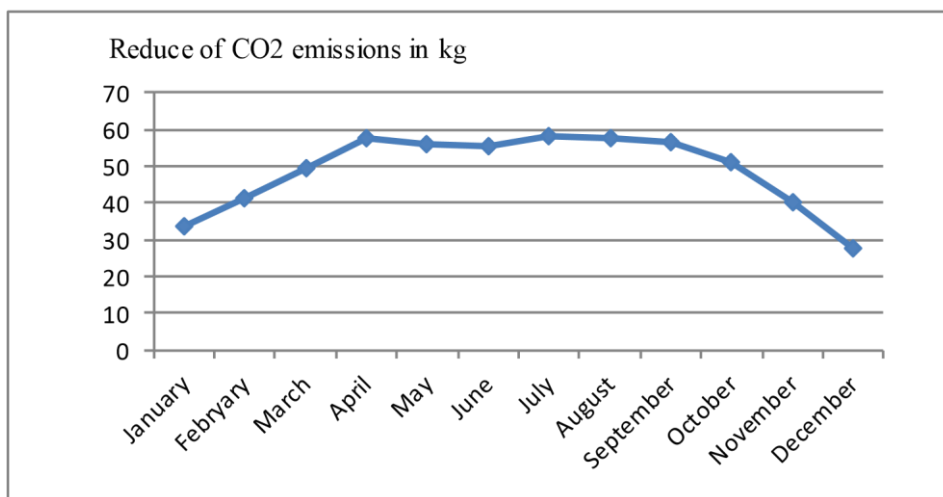
3.3 The reducing of carbon dioxide emissions

Figure 3 The amount of energy produced by solar panels

The burning of fossil fuels like coal to produce electricity and gas or diesel for water heating release large amounts of CO₂ in the atmosphere, but the use of solar panels for water heating also contributes to reducing environmental pollution.

For the given hotel, the reduction of CO₂ gas, calculated by the given methodology²², by months of the year is given in Figure 4:

Figure 4 Reduction of CO₂ gas during the year



²² <http://www.meidasolar.com/service.asp?keyno=113>

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The graph shows that the maximum amount of reducing gas CO₂ occurs during the summer months, when it is the tourism season, providing a significant reduction of environmental pollution from gas CO₂ to an average 48 kg / month and during the summer months to 55 kg. The average value of the amount of CO₂ gas will be 576 kg / year, only for this hotel.

For all tourist hotels in Durres area, we had a reduction of gas CO₂, to 240 kg/ month, or 2880 kg CO₂ per year, providing a major contribution in reducing global warming and in climate regulation

4. Average annual cost analysis

Average annual expenditures are made by calculating for 10 years, for each option the costs for:

- Initial investment of installing,
- Expenses incurred during the annual usage,
- Maintenance of installation

For heating systems with electric boiler investments for a bath go to 200 Euro, and the total for all hotel 7200 Euro. The period of amortization for the hydraulic system and boiler goes up to 8 years. In Expenses incurred during the annual usage, it is included the cost of electricity for 10 years. Electricity costs will be 432 Euro / month, acknowledging the current price of energy about 0.1 Euro / KWh. In maintaining of installation it is included changes of electric boilers and repairs of the tubes

For systems with solar panels, all investments with fixing²³ will be: $8 \times 5100 = 40,800$ Euro. Spending the use is free (solar energy). In maintaining of the installation it is included the change of broken pipe, and any faulty electrical equipment, which are too small. Average annual costs for heating water calculated for each variant are shown in Figure 5.

Results (Figure 5) show that initial investment for electric heating is small, while for solar heating is 3 times larger.

For electric heating annual operating costs are high, while for solar panels are very small. In conclusion we see that the annual average cost for 10 years to water heating with electric side is 3 times larger than it received through the use of solar panels. This coincides with the data of special literature, that the energy consumed for heating of 100 liters of water through solar panels with vacuum tubes, is 3.5 times smaller compared to electric heating. While it is noted that initial investment of solar panels can be deleted after 3 years.

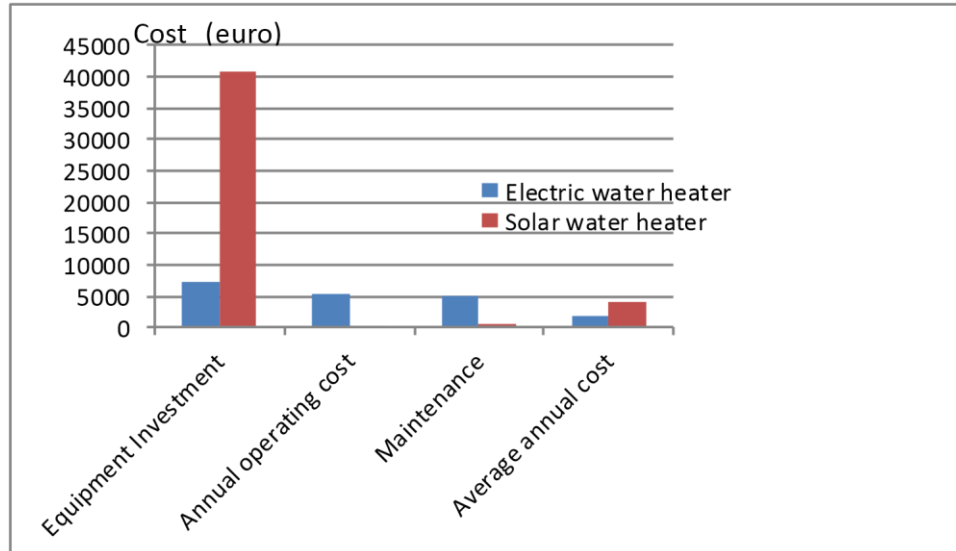


Figure 5 Expenditures for hot water with electric boiler and solar panels

²³ Multi Force shpk; multiforce_tirana@yahoo.com

5. Conclusions

Solar panels with vacuum tubes have an absorption efficiency of solar energy 40% greater than panels with mirrors and it does not depend on incline of the radius sun.

The using of solar panels systems with vacuum tubes to provide hot water in tourist hotels in Durres area, lead to a saving of electricity and the total expenditure up to 3 times.

Using the vacuum collector tubes can also be used in apartments which have a balcony from the face of the sun and is very efficient for providing of sanitary hot water, saving energy and costs up to 3 times.

Central and local government in our country, should set rules to force the introduction of new technologies of using solar energy, in the design phase of villas, hotels and buildings in coastal and low areas.

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