Use of solar energy for water heating

Bedri Dragusha, Besim Veselaj, Xhevat Berisha

***Abstract*—**In this paper is presented the possibility of using solar energy and the promotion of use of this energy source. It is being worked hard in this way to promote the use of this source of energy through the installation of solar panels. The important sources of renewable energy which can be used in Kosovo are solar energy. Kosovo has suitable climate conditions and solar radiation about 1400 [kWh/m^{2}year] that is approximately 40% greater than in some European countries where the use of solar energy for heating of sanitary water use has major trends. Once that has a large amount of solar radiation will be presented and the implementation of a project in a university clinical center**.**

***Keywords*—**Solar energy, thermal energy, electricity, European directives, environmental pollution, the student center.

I. Introduction

RADIATION has great importance, especially for heating because represents an additional source, even it is an unstable. In winter season the position of the sun is low and length of radiation is significantly lower. However benefit of radiation through windows is very important especially in facilities that are thermo insulation. The solar radiation is also important in the winter, especially to fulfill the amount of heat in certain cases. In older buildings with large windows in the months March or April, so in early spring solar radiation is dominant for this reason is very important protection from the sun in this period and in summer.

II. Solar Content

If the land does not have the envelope of air, then the average distance of surface solar radiation normal to the sun will radiate from 1:37 kW/m^2. In Figure 1 is that maximum radiation is in the area where the air waves are visible for approximately μ = 0.5μm practically the full energy transferred in the area of waves of 0.2-0.3. Area under the curve represents solar constant.

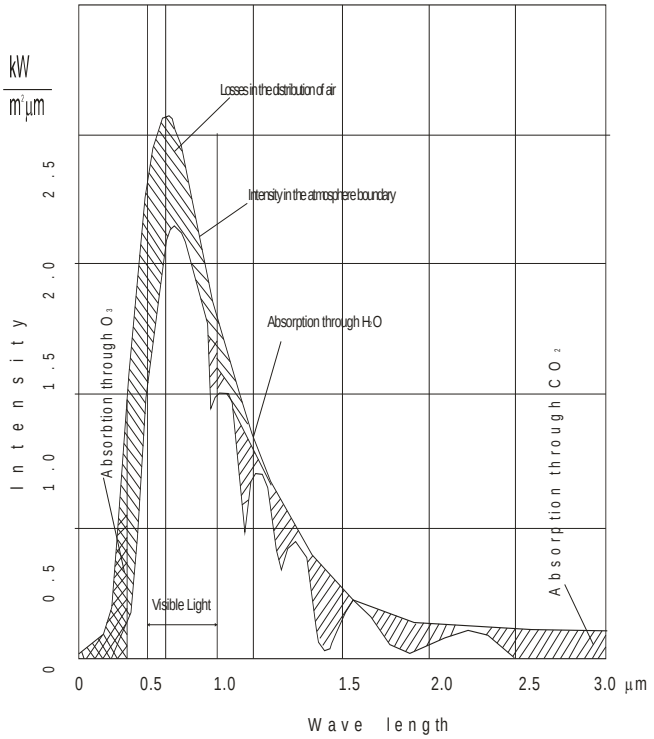

Fig1. The intensity of radiation of the sun

The radiation through the atmosphere causes weakening of solar lighting due to different phenomena: profusion and reflection in the air molecules and the different composition (dust and steam, air humidity). As shorter is the length of wave the distribution is higher. Absorption-spectrally different in gases most atomic, especially O_3, H_2O, CO_2 (see Fig. 1) and two atomic gases N_2, O_2, allows the infiltration of ray almost without obstacles.

The distribution of energy in the surface of the earth:

Ultraviolet rays 6%

Visible rays - 50%

infra red rays - 44%

III. Direct Radiation and Diffusion

During the solar radiation a part of radiation reaches directly into the surface of the earth and is called direct radiation E_{dir}. A part of radiation which dissolved through molecules in the air when passing through the atmosphere of the earth, reaches the surface of the earth in the form of so-called diffusion radiation E_{dif}, and if the atmosphere is darkly that means the radiation directly is weakening and increase the diffusion radiation. A part of the diffusion radiation is also the reflected

Manuscript received September 22, 2009:.This work was supported in part by the University of Prishtina Kosovo

Bedri Dragusha. Author is Lecturer at the Faculty of Mechanical Engineering, University of Prishtina, KOSOVO (e-mail: bedridragusha@gmail.com).

Besim Veselaj, Authoris chief of Energy sector in Ministry of Ernergy and Mining, Government of Kosovo, (e-mail: besim.veselaj@ks-gov.net).

Xhevat Berisha Author is a Professor at the Faculty of Mechanical Engineering, University of Prishtina, KOSOVO (xhevatberisha@hotmail.com).

radiation from the surfaces (houses, walls, hillock and roads), E_{ref}, this radiation is approximately 20% of global radiation.
The power of radiation in general Q_{rr} at the flat surface in the earth consists from the directly power radiation Q_{dir} and the diffusion radiation Q_{dif} without environmental impact.

$$Q_{rr} = Q_{dir+} Q_{dif} \quad (1)$$

General radiation

The amount of direct radiation and diffusion radiation represents the overall (Q_{rr}) or the global radiation in horizontal surface (no environmental impact). The amount of annual global radiation is different and depends on geographical position, weather and air pollution. In the world the global radiation reaches the value of 2200 kW/m^2 while in Europe ranges from 800 kW/m^2 at north and 1750 kW/m^2 at south. Kosovo radiation in general is about 1400 kW/m^2.

Solar radiation in Kosovo

Latitude: from 41°52 'to 43°16' (N)
Latitude: from 19°59 'to 21°16' (E)
Solar radiation: 1400 kW/m2

The solar radiation in three cities of Kosovo can be taken as the average of all country level.

Sunny hours per year:
Prishtina 2153.2 hours,
Prizreni 2131.8 hours,
Peja 1974 hours.
Their average: 2086.3 hours of sun per year.

According to this data Kosovo have a good climatic conditions and with large amount of solar radiation which can be used for heating, heating of sanitary water and for generation of electricity.

IV. Passive Space Solar Heating in Building

Passive solar systems make use of energy accumulation and the sun without help of mechanical or electrical equipment. For most buildings should be established passive solar systems and priorities direct use of solar radiation through windows and glass roofs. When sunlight falls on the walls, floors and other objects they convert in heat (fig. 2). Designing better building helps reduce additional heat during the cold period, but it should take care due to overheating during the summer, this can be achieved by extending the roofs Shelter or setting sun protection which are mobile. And with this protections can be controlled the amount of sun rays that penetrate the object.
Passive Solar Heating has especially great application in agriculture. Serra, which are covered with glass or transparent plastic material through which the sun's rays penetrate to the interior warms needed space and without additional heating agricultural crops cultivated in early spring and late autumn.

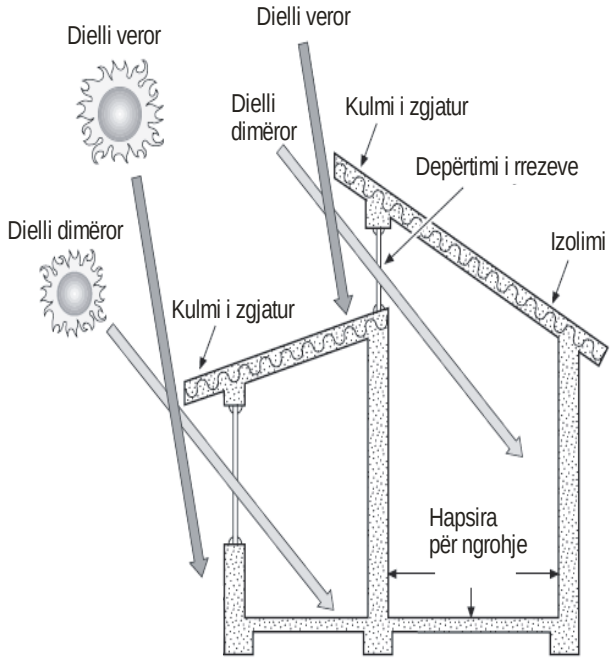

Fig. 2. Shelter extended to accept rays to prevent them during winter and summer

V. Demand for Heating of Sanitary Water

Current consumption for heating of water in Kosovo is about 668 GWh/year and total demand is about 1.338 GWh/year. Limited current consumption is approximately 15 l day/person that corresponds with an energy requirement of 318 kWh year/person. Unlimited demand is 30 l day/person that corresponds to 637 kWh year/person, and average number of members in a family is 6 people.
Currently, demand for energy for water heating is covered by fuel, wood and electricity. In rural areas, demand for energy for water heating is covered through wood and in urban areas the demand for energy covered mostly for water heating by electricity.
The total number of households in Kosovo is about 320.000 which participate with about 33% of total energy consumption.
Heating sanitary water

In the summer: (90-100)%
In the winter: (15-25)%
Spring-Autumn: (50-75)%

Average savings: (55-70)%

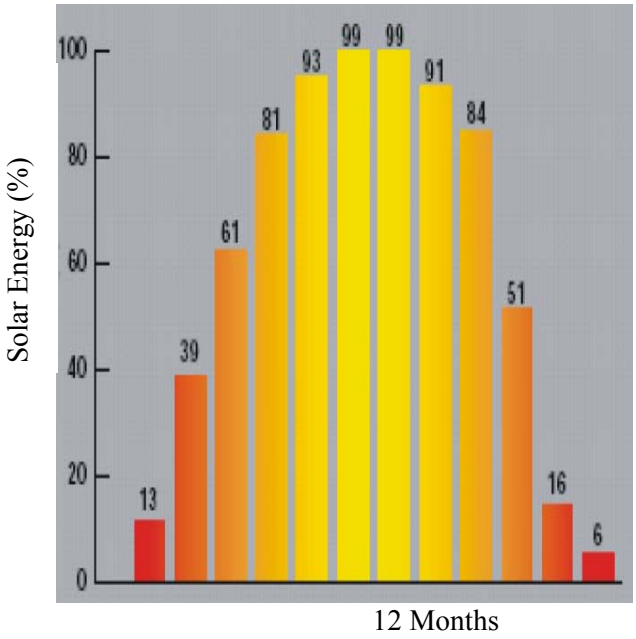

Fig 3. Coverage requirements for hot water

VI. THE FLAT SOLAR COLLECTOR

In the summer months to the horizontal collector the temperature of fluid that transmits heat reaches the maximum value about 100 ° C, while if the collector has no water (fluid) temperature reaches up to 200 ° C. According to the producer of the collector, the average gain of heating energy over the year is (250 - 450) kWh/m^2 at the outlet of collector.

Fig. 2 The solar flat collectors located at roof

The Hut of collector is very well isolated at the bottom and of the sides, but the collector has heat losses, mostly during the change of temperature between air and absorber, with thermal convection and thermal radiation. Losses are caused by convection due to air movement (wind) while the radiation losses caused due to heat exchange between the glass and the external environment. Also a part of solar radiation is reflected from the glass collector.

Collectors can be integrated to the roof, on the roof, parallel to the roof and through the flat roof which are not oriented in the south located on metal holder.
Flat collectors in Kosovo are produced in two locations in Gjilan and Rahovec.

Dimension	750X1650X87 mm	950X1650X87 mm
Axial distance	600 mm	850 mm
Fluid contents	2.2 (l)	3.2 (l)
Worked pressure	0.3Mpa=3 bar	
Testing pressure	0.5 Mpa=5 bar	
Maximum effect	840 Wh=3000 kJ	1200 Wh=4400 kJ
Average effect	420 Wh=1500 kJ	600 Wh=2200 kJ
Net weight	42 kg	56 kg
Recommending fluid	Water, mixed water, antifreeze, thermal oil.	

Tab. 1 Technical characteristics of flat collector of the radiator factory in Gjilan.

The SI unit for magnetic field strength H is A/m. However, if you wish to use units of T, either refer to magnetic flux density B or magnetic field strength symbolized as $\mu_0 H$. Use the center dot to separate compound units, e.g., "A·m^2."

VII. PIPE COLLECTORS WITH VACUUM

The convection losses during the movement of air within the large collector can be reduced if a vacuum is created between the front cover and the collector of the flat absorber. Since the pressure of external air can affect that front covers of the collector to make pressure in flat absorber, then are needed that between the front and back of the collector enforcement to keep unchanged the form of collector. It is difficult to hold vacuum for a long time, since the air could find the way and soak in the space between the cover glass and absorber. For this reason, is needed from the collector to remove periodically air to hold space it with vacuum.
This weakness can be avoided with the use of the vacuum pipe. Based on the shape the pipes glass can resist pressure more to the external air.

Efficiency of the pipe collectors with vacuum is very high due to the geometric shape of the pipe and the high quality of absorber, allowing the acquisition of solar energy from diffusion radiation, for this reason these are called as the no season collectors because they may be active through the year. The pipe collector can absorb up 97% of solar radiation, but then loses are about 6% with radiation.

Temperature in the tube in inactive state (in empty) reaches up to (250 ÷ 300)°C, while the working temperature to 120°C. The price of tube collectors is higher than the flat collectors.

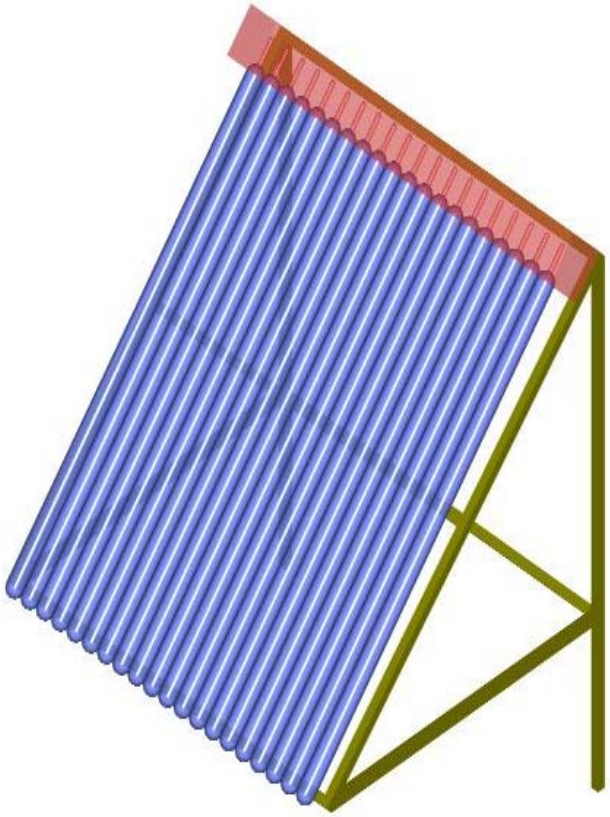

Fig. 3a Tube collectors

Fig. 3b Tube collectors

VIII. AIR COLLECTORS

Systems for air heating are using solar energy collectors for directly heating of external air. Through the entrance channel to leak into the air collector, absorber of sunlight that absorb witch penetrate through the cover glass, which heat the air, the warm air drought through channels in the building (Figure 4). In combination with mechanical systems for airing of housing and equipment for air heating, air collectors in the future will find more and more use. Given the relatively low temperature of the chamber from 20°C, air collectors are suitable for heating. Air collectors are used in agriculture for dry of grass, grain, seeds for planting, etc. At the exit of the solar energy collector gives 100-150 kWh/m^2 for agriculture, whereas for heating of buildings about 500 kWh/m^2. Solar air heaters have wide range of applications in drying agriculture products, space heating, industrial processes as papers etc.

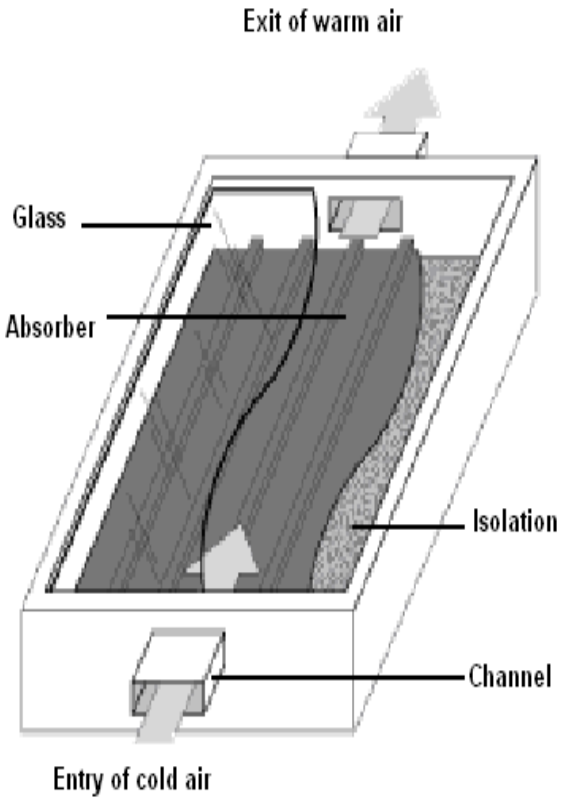

Fig. 4 Air collectors

IX. THERMAL SYSTEMS FOR HEATING WATER

The needs of solar energy for household can be used in several ways. They are: photovoltaic systems (PV) that sun energy converts in electricity, solar systems for air heating and solar systems for water heating. Subject of our review will be systems for heating water and heating assistance for the air (space).

X. THERMO SIPHON SYSTEM

Thermo siphon system consists of solar collectors, which may be flat collector or pipe collector with vacuum entrance pipe, exit pipe and boiler which must be settled above the level of collectors.

Solar collector makes absorption of rays of the sun, which directly make water heating collector. The heated water becomes easier and rises at the top of boiler. Water located in the bottom of the boiler from hot water pressure moves down and enters in the collector (see Figure 5). In this way is created naturally circle heat.

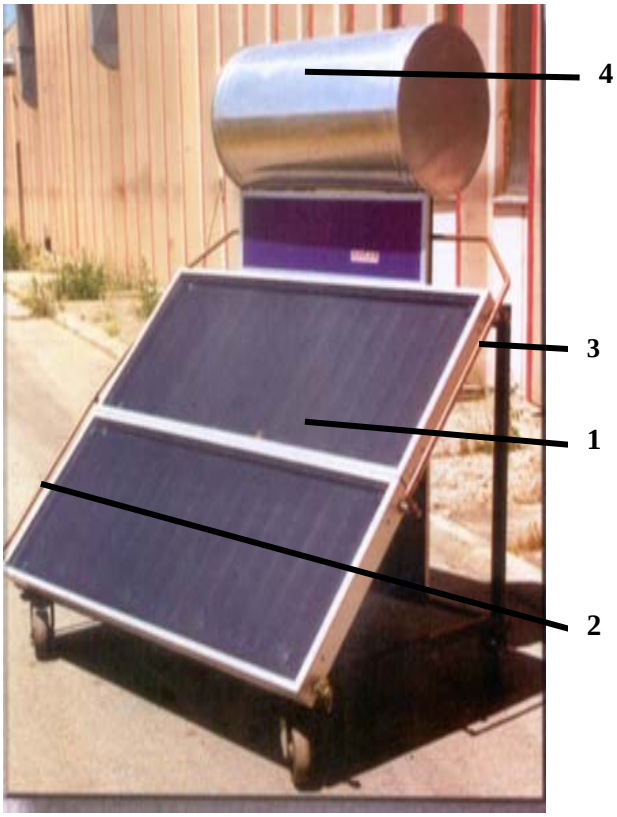

Fig 7. Thermo siphon system for heating water, which are: 1 - horizontal collector, 2 – pipe cold water, 3 - pipe warm water and 4 - boiler.

XI. DIRECT ACTIVE SYSTEMS FOR SANITARY WATER HEATING

Directly system with circulating pump is illustrated in Figure 6, has one or more solar collector installed on roof and water reservoir (boiler) somewhere below in the subject. Pump circulates water from the boiler in the collector and vice versa. This is called direct system (or open circuit) because the sun's heat is transmitted directly to the water that circulates through the collectors and pipes in boiler. There is no heat exchange and the system is not protected with antifreeze from frost. The system has controllers with a differential thermostat that controls the temperature differences in the exit of the collector and the boiler exit. When the temperature difference grows to the exit of the collector and the boiler, controller gives a signal to activate the circulating pump. Pump pushes cold water from the boiler in the collector and in this way is closed thermal circuit. The boiler is equipped with pipe that brings cold water from the waterworks and the pipe that removes warm water from the boiler for daily use.

The main weakness of this system is the risk of water freezing in the winter season. During the work of these systems large amount of the air circulate with water and while taking in account the empty out of the system in winter season the collector can create the mineral deposits that reduce the efficiency of collectors.

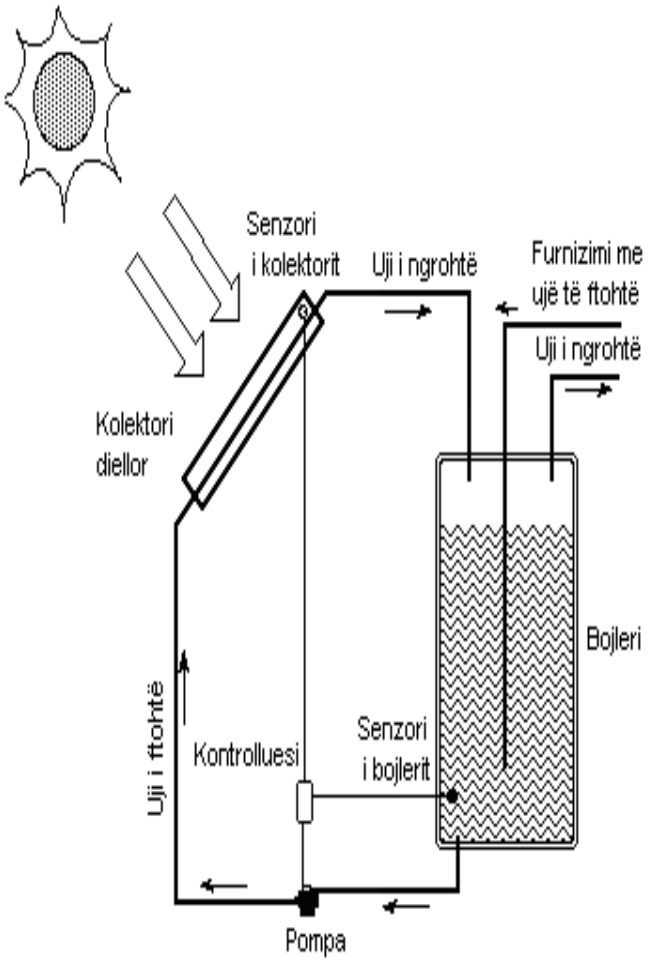

Fig. 8. System for direct heating of water with circulating pump

XII. Solar collector with boiler for sanitary water

A pilot project of solar collectors with boilers for sanitary water is analyzed.

To heat sanitary water in the amount of 5000 liters is needed 30 piece of solar panel, for two boilers are planed 60 pieces of solar panels.

Solar collectors are located in the roof of the building which was a must for our case. To achieve the angle of 45^0 are used construction of 65mm U-profiles and profiles 65x65-L that are anchored in line with fittings Φ12.

In places where was possible are set 5 collectors with one supply and return.

In the lower part of the roof are located 5 (five) rows and 6 (six) columns with five collector.

Connection of the collector is made with copper pipes 22x1mm and strong welded.

At the higher points are put automatic valve for aeration network of collectors and pipes.

XIII. Heating of swimming pool water

Heating of water pools is done with simple absorber, which have low price, because the temperature of water pools for swimming is below 30 ° C. Basin in this case serves as the accumulator of solar energy so that, in comparison with sanitary water heating, there is no need for special earmarked for water storage. For heating water basin from May to September is mainly available solar energy as much as needed. For this reason solar heating equipment are economically reasonable. There are two types of systems for heating swimming pool water: a circuit system or direct heating system and system with two circles or indirect heating system with water.

XIV. Conclusion

In this paper is analyzed the possibility of using the renewable energy resources in Kosovo. The solar energy for water heating is one possibility in this region. It is possible to conclude that sun shine and using of this energy helps to keep low value of CO_2.

Acknowledgment

The paper was completed with help of Faculty of Mechanical Engineering, University of Prishtina, Kosova. Also thanks to the Ministry of Energy and Mining for thy financial support of the pilot project that is elaborated in this paper.

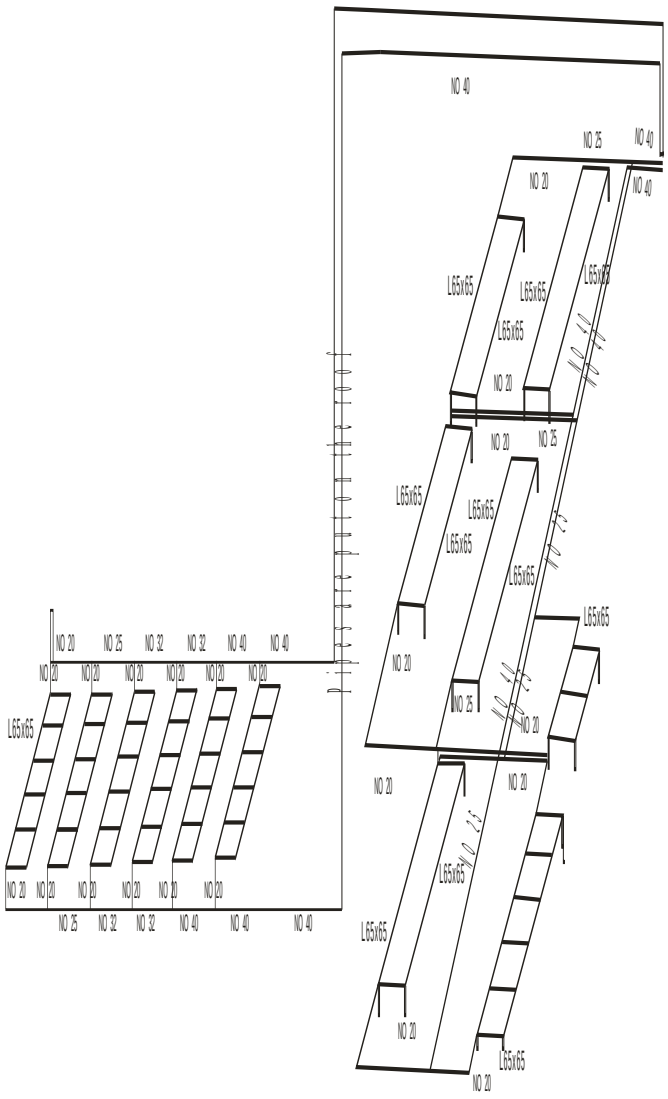

Fig.6. Solar collectors on the roof

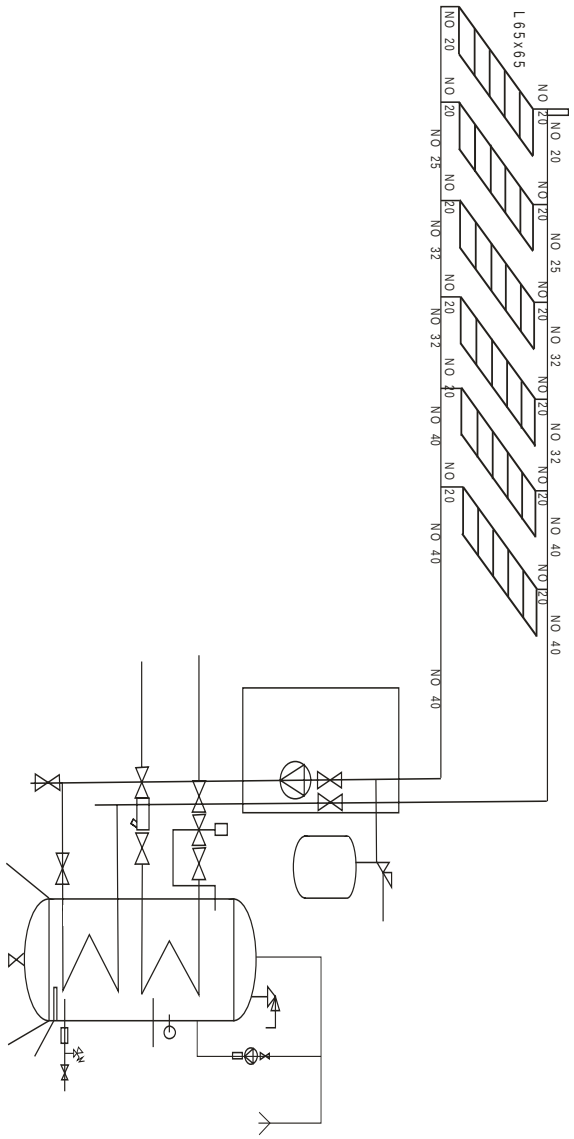

Fig. 7. Boiler connection of solar collectors

XV. REFERENCES

[1] Maliq Pireci, "*Shfrytëzimi i energjisë diellore ne ngrohjen e ujit sanitar*", Prishtine, 2006.

[2] Maliq Pireci, Besim Veselaj, Isa Elshani "*Burimet e Riperteritshme te energjisë*", Prizren 2008.

[3] Sylë Tahirsylaj, "*Disa veçori te rrezatimit te diellit dhe shpejtësisë se erës ne Kosovë-potenciali energjetik natyror, punim shkencor*".

[4] Ndërmarrja Projektuese dhe Montues "Termo" Ferizaj - kolektorë solar me bojler për ujë sanitar për objektin Konvikti Nr.5 në Prishtinë

[5] Production company radiator factory Gjilan - solar collector.

[6] MEM Informer, periodical Bulletin of Ministry of Energy and Mining, year II, No. 4, pp. 12-13. May 2009.

[7] Bashria A., A. Yousuf, Adam N. M., K Sopian, A. Zaharim and M. Alghhoul, Analysis of Single and Double Passes V-Grooves Solar Collector without Porous Media, International Journal of Energy and Environment, Issue 2, Volume 1, 2007, pp. 109-114.

[8] Hasim Altan, Ian Ward, Jitka Mohelnikova and Frantisek Vajkay, Daylight, Solar gains and Overheating Studies in a Glazed Office

Building, International Journal of Energy and Environment, Issue 2 Volume 2, 2008, pp. 129-138.

[9] Matei Mihaela Florentina, Luiza Popa, Claudia Popescu and Mihai Octavian Popescu, Models for the Analysis. Equipments meant for producing energy from renewable sources, solar energy, 4th IASME/WSEAS International Conference on Energy, Environment, Ecosystems and Sustainable Developmetn (EEESD'08), Algavre, Portugal June 11-13, 2008, pp. 101-106.

[10] Nistor-Daniel Trip, Viorel Popescu, Adrian Schiop, Low Power Portable Renewable Solar Energy Sources, 2nd WSEAS/IASME International Conferenc on Renewable Energy Sources (RES'08), Corfu, Greece, October 26-28, 2008, pp. 35-39.