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SOLAR AIR HEATING COLLECTORS IN TWO MODULAR SOLAR PANELS BUILD INTO A „DO-IT-YOURSELF" TYPE PROJECT USING PHOTOVOLTAIC CELLS AND RECYCLED ALUMINUM CANS

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Abstract: This paper shows a DIY ("do-it-yourself") type project. "Do-it-yourself" (DIY) is the method of building, modifying, or repairing something without the aid of experts or professionals. Academic research describes DIY as behaviors where individuals engage raw and semi-raw materials and component parts to produce, transform, or reconstruct material possessions. By promoting projects of this kind, students can understand that unconventional energy is available for everyone, at a minimal cost and with good results comparing to systems that are on the market. Students can also make a general impression that using unconventional energy represents the next stop towards the future in all the branches of the industry and protecting the environment. This paper presents the processes of designing and development of a heating system that uses solar energy. The heating system consists of two parts. The first part consists of a photovoltaic solar panel made from 36 photovoltaic cells capable of developing 65 W and 3.6 A. The second part is made of recycled materials (aluminum cans), forming radiant tubes.
Keywords: heating systems, solar energy, photovoltaic solar panel, radiant tubes

INTRODUCTION

These days, people have been talking a lot about renewable energy. The world is growing too dependent on non-renewable energy, such as fossil fuel, natural gas, oil and coal. There needs to be another idea to be green and environmentally friendly. These renewable energy sources can be used for hundreds of years without hurting the environment. There has been much research going on in science labs and farms across the country, so these sources are always evolving into better and better things. The sources are almost limitless, but there are some common ones. The most widely used heating installations in current technologies are based on burning fossil fuel but we should take in consideration that health policies nowadays are directed towards lowering the use of this kind of fuel. Nowadays, to ensure the proper conditions we need to live in, every home must be built with a heating system, with enough efficiency to ensure the optimal use of heat and water. An example of a heating system of this kind transforms the solar energy, which is unlimited into heat. The uses of heating systems based on renewable energy represent the cheapest solution to produce heat. [1-4, 7-9, 12, 15]

If effective support policies are put in place in a wide number of countries during this decade, solar energy in its various forms – solar heat, solar photovoltaic, solar thermal electricity, solar fuels – can make considerable contributions to solving some of the most urgent problems the world now faces: climate change, energy security, and universal access to modern energy services.

The largest solar contribution to our energy needs is currently through solar heat technologies. The potential for solar water heating is considerable. Solar energy can provide a significant contribution to space heating needs, both directly and through heat pumps. Direct solar cooling offers additional options but may face

tough competition from standard cooling systems run by solar electricity. Solar energy offers a clean, climate-friendly, very abundant and inexhaustible energy resource to mankind, relatively well-spread over the globe. Its availability is greater in warm and sunny countries.

Taking into consideration the time that needs to be taken to develop new technologies and at the same time the replacement of old and outdated current equipment's, it is necessary to speed up the development of technologies that can sustain the production of cheap and clean energy. [1-4, 7-9, 15] At the same time, the line of thought and the lifestyle in the society that we live in, needs to be stimulated and rejuvenated for a change to really happen.

Today, renewable energy accounts for over 20% of total global electricity generation, with solar ranking fourth after hydro, bioenergy and wind. The majority of solar energy technologies on the market today are based on the 'photovoltaic effect', whereby an electric current is produced in a material when exposed to light. [7-9, 15] Solar energy could account for 8–15% of global electricity in 2050, depending on factors such as market demand, energy policy, manufacturing costs and technological advances. [7-9, 12, 15]

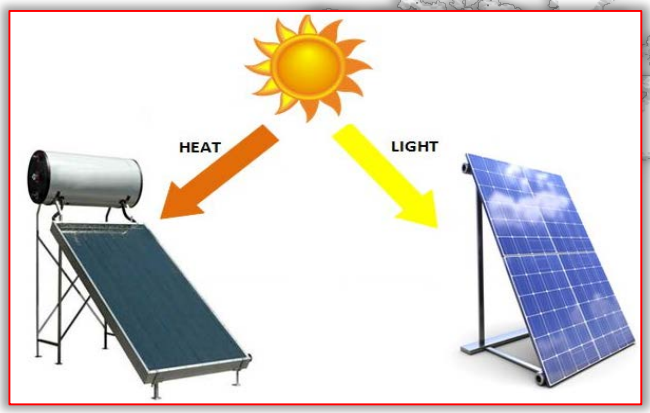

Figure 1. Solar heat and solar photovoltaic

The main concern is that on short and medium notice, renewable energy sources cannot be a complete alternative. However due to the huge possibilities that these new technologies can bring, we are experiencing heavy funding in these area of research. Renewable technologies are advantageous because of many reasons [1-4, 7-9, 15]:

- they do not polluted,
- they require minimal cost of productions, and
- the solar energy is inexhaustible, and so on.

The solar energy is without doubt the most widely used renewable energy source. Every day the sun provides our planet 20.000 times the energy that the population of Earth needs, and in just three days, the Earth receives from the sun the equivalent of all the fossil fuels that our planet disposes of. Solar-based electricity can also take part in preserving our planet's climate changes that area alarming lately. Photovoltaic solar panel transforms energy coming from the sun into electrical energy. These panels do not have to be watched and require a minimal maintenance. Current photovoltaic modules show a minimal degradation after 20 years. [1-4, 7-9, 15]

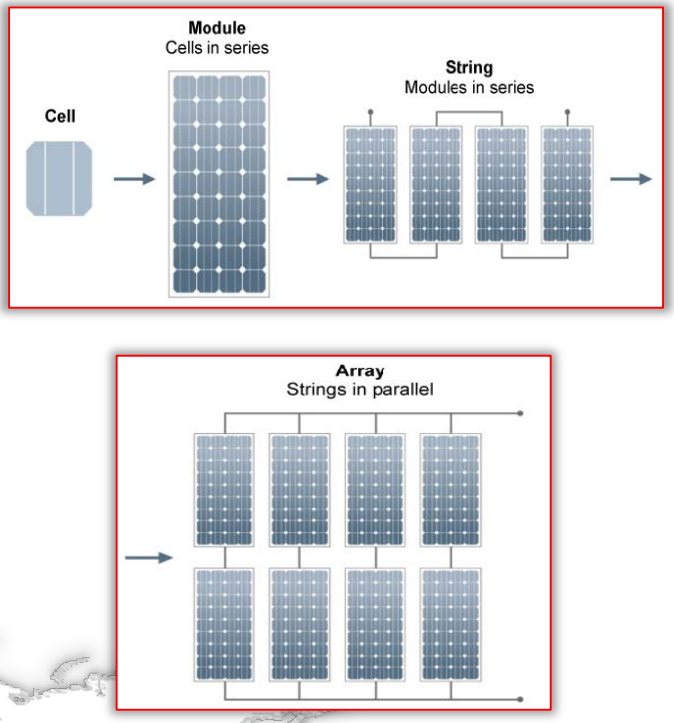

Figure 2. Current photovoltaic modules built into solar panels

Photovoltaic solar modules, commonly referred to as "solar panels," are the main collection devices in a renewable solar energy system and are the components that actually convert the Sun's rays into a daily source of clean and sustainable power. Simply put, photovoltaic solar panels create electricity by converting radiant sunlight into usable electrical power via a phenomena coined the "photovoltaic effect." They work by using individual solar cells (PV cells) that contain a photovoltaic material that converts energy from the Sun into a flow of electrons. [7-9, 14-15] Now, modern renewable energy systems have come around and are economically viable for both commercial and residential applications. Solar panels are not all you need, modern systems require supporting components including high tech batteries, charge controllers and junction boxes. [1-4, 7-9, 15]

METHODS / DESCRIPTION OF WORK

The paper shows the design and the production of a heating system using solar energy. The system is composed from two modules. The plant uses in whole energy collected from the sun, namely: radiant panel absorbs energy emitted by solar rays and converts it into heat. For directing heat formed in the aluminum tubes used was photovoltaic panel, which transforms the solar energy into electrical current. For the evacuation of air has been used fan supplied in the same way. [4-6, 16, 17]

Figure 3. The first module – the photovoltaic panel [4-6]

The first solar module consists of a handmade photovoltaic panel made from 36 solar cells that produces 65W and 3.6 A. [4-6]

The second solar module consists of recycled aluminum soda cans, cut from the top and connected at their top forming radiant tubes. The tubes are being placed in a wooden box containing two rooms: one of evacuation and one of admission. These two rooms are being connected through the tubes. The airflow is provided from two air fans placed in the two special rooms inside the wooden box. [4-6]

In figure 4 the few steps to follow showing you how to make a solar panel out of soda cans are presented. It is advisable to perform a thorough assessment of your home insulation in order to improve heating efficiency and minimize all possible losses. [4-6, 13, 16-18] This is very important because after minimizing heat loss in your home, you can actually install smaller solar system and get the same result as with the twice-bigger heating system.

First, we build the housing for solar collector, which is typically, is made of wood. Solar absorber is made out of beer and soda aluminum cans, painted in matte-black paint resistant to high temperature. The upper part (cover) of cans is specifically designed to provide more efficiency in heat exchange between the cans and the passing air. [4-6, 13, 16-18]

Figure 4. The second module – the panel from recycled aluminum soda cans [4,5]

Glue the cans together to form a column the same length the wood frame has. We used heat resistant metal adhesive to fix them. Then paint the columns a deep shade of true black, using a thermally conductive paint. It is important to have this dark shade because this is what converts the solar energy into heat, which can be harnessed in the form of flowing hot air. [4-6, 13, 16-18]

MATERIALS AND EQUIPMENT USED FOR MAKING THE INSTALLATION

For the photovoltaic module the following were used 36 photovoltaic solar cells, Plexiglas, glass (0.77 x 0.67 m), led used for verifying that the panel works and flux markers. [4-6, 13, 16-20] For the radiant panel were used 110 recycled aluminum soda cans, wooden boards, easily expandable poliuretanic foam, and cellulosic isolating material. In both cases, special equipment used for montage (boring mill, milling drill, jig saw, cutter) are used. [4-6]

The systems above presented are simple small passive solar heaters made from recycled aluminum drinks cans and a simply photovoltaic cells, and are used to heat a

garage. If the building to be heated is well insulated, a solar heater such as this can lift the temperature by a significant number of degrees. A larger heater or a number of similar heaters can be used to heat larger spaces, or to heat smaller spaces to a higher temperature. [4-6, 13, 16-20]

"Do-it-yourself" solar air heating collectors are one of the better solar projects. They are easy to build, cheap to build, and offer a very quick payback on the cost of the materials to build them. They also offer a huge saving over equivalent commercially made collectors. [4-6, 13, 16-20]

Figure 5. Modular panels

Two of the more popular designs are the pop can collector and screen absorber collector. The pop can collector uses columns of ordinary aluminum soda pop cans with the ends cut out. The sun shines on the black painted pop cans heating them, and air flowing through the inside of the can columns picks up the heat and delivers it to the room. [4-6, 13, 16-20] The screen collector uses two or three layers of ordinary black window insect screen as the absorber. The sun shines on the screen and heats it, and the air flowing through the screen picks up the heat and delivers it to the room.

We have seen that soda cans can be repurposed in many ways in our homes, especially by transforming them into decorative items. This time, soda cans find themselves a practical role in our homes by becoming a solar panel. Of course, it takes some ingenuity, patience and basic knowledge of thermodynamics to turn those beverage empties into a powerful and efficient passive solar energy cell. Passive means that it does not generate electricity directly, but rather passively assists a standard generator or serves as heating. More specifically, the heat energy from the sun then transfers through the very conductive aluminum into the air inside. [4-6, 13, 16-20]

This solution fits as a glove to those homes built in isolated areas, while it is also an efficient means of saving money in urban areas as well.

ECOLOGICAL ASPECTS

Aluminum cans (soda or beer) are easy to recycle and there are huge environmental benefits for doing this - yet many cans still go to landfill. If we recycle more cans we can reduce the amount of raw materials needed to produce new products. All the soda cans came from a local recycling depot.

Many of the drink products we buy are packaged in cans made from aluminum and this material can be recycled after we have finished with them to make either new cans or other products.

Figure 6. Blank aluminum cans

Aluminum cans are very easy to recycle. Aluminum can be melted down and made into new products repeatedly because it never breaks down or loses quality. Most recycled aluminum is used to make new cans. From the time a can arrives in a recycling facility, it takes just 60 days to melt it down, turn it into a new can, fill it with a new beverage and place it back on store shelves. Recycled cans are also used to make other kind of products.

Due to the lightweight and smaller price tag, it does not move as much as the other, more expensive metals does. In fact, when compared with copper, lead, nickel, tin and

zinc, it is the least expensive metal. This is generally because it is also the most prevalent.

CONCLUSIONS AND FUTURE IMPROVEMENTS

Over the last few years, DIYers have mostly settled on a few types of solar air heaters to make. This type was inspired by the commercial solar air heater, which uses recycled aluminum soda/beer cans stacked end-to-end to create long tubes for the air to flow through. The cans are painted black and act as the absorber. Many DIYers make this type, probably due to the abundant supply of cans and the „coolness" of the approach. Just as with the can solar air heater, the air flows inside the downspout taking heat from the inner surface as it makes contact with it. This paper shows an experimental heating system that uses solar energy. With further research, we can add many improvements to the installation.

At the current level of development, the first step in upgrading the photovoltaic module is to assemble a storage battery that can accumulate the energy, so that it can function overnight. The second step is to assemble an invertor that inverts the continuous electricity into alternative electricity. That way household device can be powered from the photovoltaic module.

It is really easy and simple to build cheap pop can DIY solar panels for supplemental home heating, by re-using scrap parts and empty pop cans. Pop can DIY solar panels are actually thermal panels that heat and recirculate the air inside the room. Water, or any kind of liquid is not used here, which makes these panels resilient to extremely low temperatures and winter freezing accidents.

The construction of a solar water heater and a solar air heater can be DIYers projects. Basically air or water is conducted through pipes or conduits to a panel where the heat exchange takes place. A growing fad in the construction of homemade air-heating solar panels is to build the collector with empty aluminum soda or beer cans. The tops and bottoms of the cans are punched or drilled out and the cans are glued together to form a continuous airtight pipes. The box that holds everything is well insulated (sides and bottom) every interior surface exposed to sunlight is spray painted a dark, sunlight absorbing color – preferably using a high quality, high temp, UV protected paint.

Solar absorbent / collector is crafted using empty beer and soda aluminum cans, painted in matte-black paint resistant to high temperature. The upper part (cover) of cans is specifically designed to provide more efficiency in heat exchange between the cans and the passing air.

DIY solar air heating collectors are one of the better solar projects. They are easy to build, cheap to build, and offer a very quick payback on the cost of the materials to build them. They also offer a huge saving over equivalent commercially made collectors.

The radiative solar energy reaching the earth during each month is approximately equivalent to the entire world supply of fossil fuels. Thus, from a purely thermodynamic point of view, the global potential of solar energy is many times larger than the current energy use. However, many technical and economic problems must be solved before large-scale use of solar energy can occur. The future of solar power deployment depends on how we deal with these constraints, which include scientific and technological problems, marketing and financial limitations, and political and legislative actions including equitable taxations of renewable energy sources.

However, even with all the research and development in the solar industry, one thing is for certain, solar panels are the best way for homeowners to create electricity simply and efficiently. Regardless of the myriad of technological advances, solar panels will remain the primary component of home solar energy production systems for the near future. There will always be various different types of photovoltaic cells being developed in an effort to improve efficiency and production costs, but the modern solar panels are amazing.

Note

This paper is based on the paper presented at The VIth International Conference Industrial Engineering and Environmental Protection 2016 – IIZS 2016, organized by University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin, in Zrenjanin, SERBIA, October 13–14, 2016, referred here as [21].

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