



SOLAR AIR HEATING COLLECTORS IN TWO MODULAR SOLAR PANELS BUILD INTO A „DO-IT-YOURSELF” TYPE PROJECT

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ABSTRACT

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. And with the use of renewable energy source, the world can be a better place. 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. This paper presents the processes of designing and development of a heating system that uses entirely 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

1. INTRODUCTION

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. [1-3, 6-8, 11, 14]

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the time that needs to be taken to develop new technologies and at the same time the replacement of old and outdated current equipment's, it is absolutely necessary to speed up the development of technologies that can sustain the production of cheap and clean energy. [1-3, 6-8, 14] 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. [6-8,14] 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. [6-8, 11, 14]

The main concern is that on short and medium notice, renewable energy sources can not 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: they do not polluted, they require minimal cost of productions, and the solar energy is inexhaustible and so on. [1-3, 6-8, 14]

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. [1-3, 6-8, 14]

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 energy. 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. [1-3, 6-8, 13, 14] 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. [1-3, 6-8, 14]

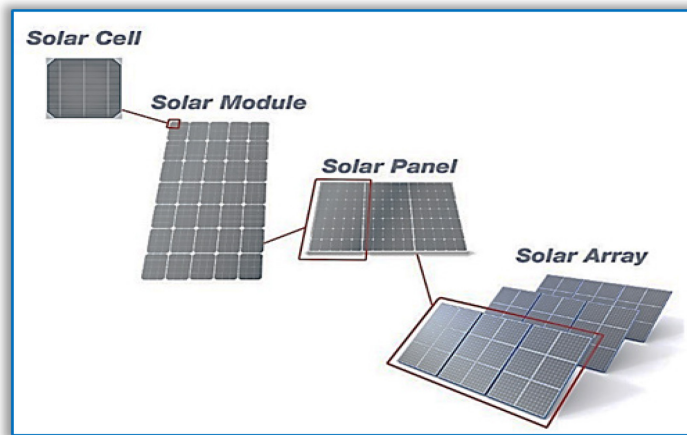


Figure 1. The solar panel's elements (cell – module – simple panel – combined panel) [1-3, 6-8,14]

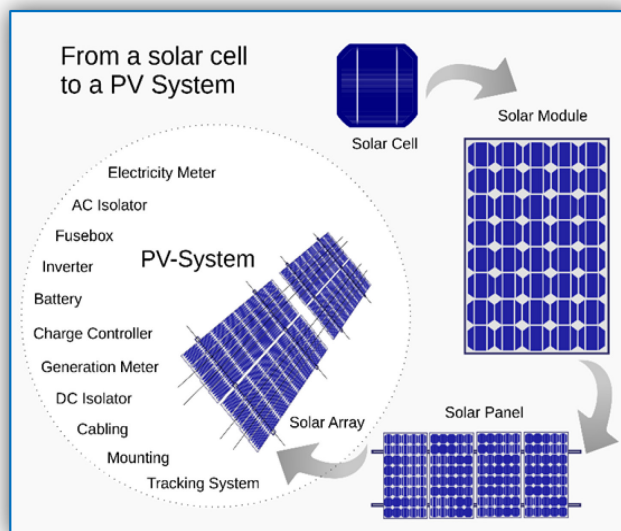


Figure 2. From a solar cell to a photovoltaic solar system [1-3, 6-8, 14]



The radiative energy from the Sun that keeps our planet warm exceeds by far the current primary energy supply used by mankind for its comfort, leisure and economic activities. It also exceeds vastly other energy sources at ground level such as geothermic or tidal energy, nuclear power and fossil fuel combustion. Sunrays also drive hydraulics, wind and wave power and biomass growth. [1-3, 6-8, 9-14]

Two families of technologies emerge from this review for their maturity: the active and passive use of low-temperature thermal heat for direct water and building heating and ventilation or cooling, and the concentrating solar power technologies for producing electricity. [1-3, 6-8, 9-14] Other technologies necessitate further research, demonstration and development efforts before being available for wider dissemination. Together, these two technologies offer an enormous potential worldwide for clean and carbon-free energy production, for the first in delivering energy services such as water heating, space heating or cooling, for the second in producing dispatchable or even base load electricity.

At present, solar heating provides by far the largest solar contribution to energy needs. The main technologies belong to either “passive” and “active” solar energy forms. Passive solar energy relates to the design of buildings collecting and transforming solar energy used for passive heating, day lighting and natural ventilation. [1-3, 6-8] Active solar energy relates to the use of solar collectors for water or space heating purposes, active solar cooling, heat pumps, desalinization and industrial high temperature heat.

Passive solar heating can involve extensive sun-facing glazing, various wall- or roof-mounted solar air collectors, double-facade wall construction, air-flow windows, thermally massive walls behind glazing, or preheating of ventilation air through buried pipes. [1-3, 6-8, 9-14] Lighting and ventilation can be directly supplied through solar energy: interior light through a variety of simple devices that concentrate and direct sunlight deep into a building, and ventilation through the temperature and hence pressure differences that are created between different parts of a building when the sun shines.

Small scale, low temperature solar thermal systems (the “active” solar energy) can supply heat for domestic hot water and space heating in residential, commercial and institutional buildings. The technology may be considered mature but continues to improve. [1-3, 6-8] Aluminum, being cheaper and lighter than copper, is being used in manufacturing absorbers.

Although energy fuels economic growth, and it is therefore a key concern for all countries, access to and use of energy vary widely among them, as well as between the rich and poor within each country. In fact, 2 billion people - one third of the world’s population - rely almost completely on traditional energy sources and so are not able to take advantage of the opportunities made possible by modern forms of energy. Moreover, most current energy generation and use are accompanied by environmental impacts at local, regional, and global levels that threaten human well-being now and well into the future. [1-3, 6-8, 9-14] Finding ways to expand energy services while simultaneously addressing the environmental impacts associated with energy use represents a critical challenge to humanity.

2. HOW THE HEATING SYSTEM WORKS

The installation uses entirely solar energy. The radiant module captures solar energy and transforms it into heat. For directing the heat that develops inside the aluminum tubes we used an air fans powered from the photovoltaic module. The photovoltaic panel also transforms solar energy into electricity. For evacuating the air from the radiant module another air fan was used powered in the same way as the other one.

For the making of a radiant tube 10 aluminum soda cans were attached to each other from the top. The aluminum cans were previously cut at their top and pierced at the bottom using a 8 mm drill, 4 drills at the bottom of each soda cans were made to ensure the best air flow through the tubes. In this way 11 tubes of 10 aluminum cans were made. [4, 5, 15-16]

The tubes were placed in a well isolated box at the inside. The link between the soda cans must be well done so it won’t lose any of the air flowing through them. The radiant tubes were painted in black mat paint for increasing the absorption of sun rays. [4, 5, 9-14]

For the photovoltaic module we used 36 photovoltaic solar cells linked together through interconnection bands made from a special alloy with special electrical conductivity properties. The link was realized

using a clinching pistol. The photovoltaic cells are very frail so they must be handled with care. Any crack inside a solar cells leads to decreasing the solar panel efficiency. [4, 5, 9-14]

The final operation was attaching glass on top of the solar cells using silicon. The diode was attached to the photovoltaic cells for their protection so that possible electrical fluctuations don't destroy them.

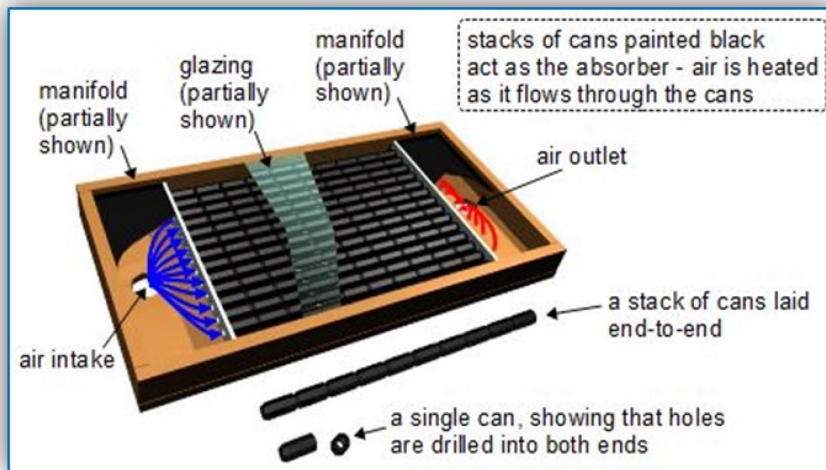


Figure 3. How the heating system works [4,5, 9-14]

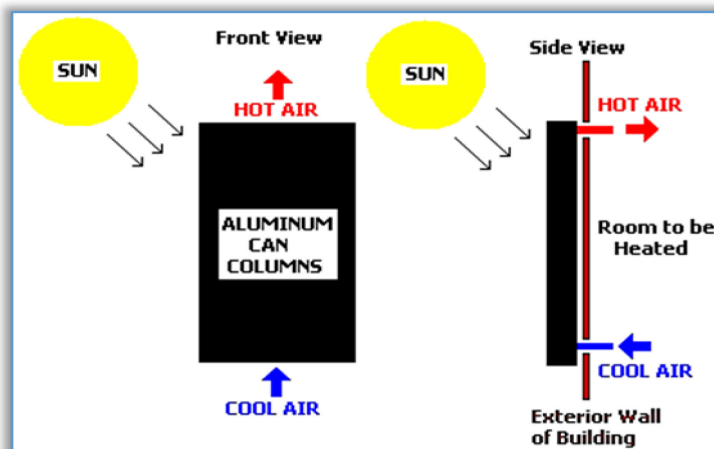


Figure 4. The solar space heater working [9-14]

Pictured above is a simple small passive solar heater made from recycled aluminum drinks cans and it is 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. [9-14]

This type of solar space heater works by drawing the air to be heated into the bottom can of a column of cans. The air is then heated inside the cans by the sun's energy and the hot air within them rises upwards (thanks to convection) to be fed into a pipe which re-enters the building to be heated. [4, 5, 9-14]

This solar thermal system is not able to accumulate thermal energy after producing it. When it is sunny, solar collector produces heat, but it is necessary to use it immediately for heating the room. If the sun does



not shine, it is necessary to interrupt the air supply to the solar collector, otherwise the room will begin to slowly cool off. This can be solved by installing shut-off valve, which will reduce unnecessary heat loss.

3. DESCRIPTION OF THE RESEARCH WORK

The paper presents the design and the production of a heating system using entirely 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, 5, 12, 15, 16]
The first solar module consists of a handmade photovoltaic panel made from 36 solar cells that produces 65W and 3.6 A. [4, 5]



Figure 5. The first module – the complete photovoltaic panel [4, 5]



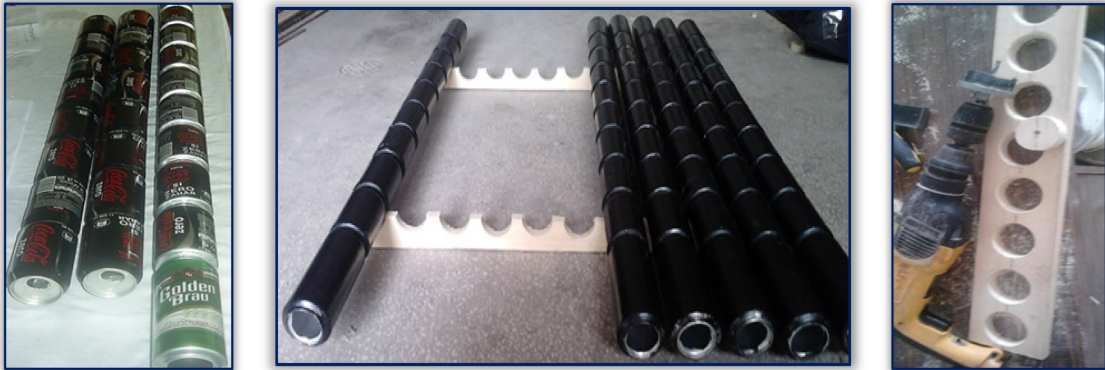


Figure 6. The second module – the panel from recycled aluminum soda cans [4,5]

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 2 rooms: one of evacuation and one of admission. These 2 rooms are being connected through the tubes. The air flow is provided from 2 air fans placed in the 2 special rooms inside the wooden box. [4, 5]

Above are presented the few steps to follow showing you how to make a solar panel out of soda cans. It is advisable to perform a thorough assessment of your home insulation in order to improve heating efficiency and minimize all possible losses. [4, 5, 12, 15, 16] 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 of all, 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, 5, 12, 15, 16] 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, 5, 12, 15, 16]

4. MATERIALS AND EQUIPMENT USED FOR MAKING THE INSTALLATION

For the photovoltaic module the following were used 36 photovoltaic solar cells, plexiglass, glass (0.77 x 0.67 m), led used for verifying that the panel works and flux markers. [4, 5, 12, 15, 16] For the radiant panel were used 110 recycled aluminum soda cans, wooden boards, easily expandable poliuretanic foam, and cellulosic isolating material. [4, 5] In both cases, special equipment used for montage (boring mill, milling drill, jig saw, cutter) are used. [4, 5]

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, 5, 12, 15, 16]

“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, 5, 12, 15, 16]



Figure 7. 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, 5, 12, 15, 16] The screen collector uses 2 or 3 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 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, 5, 12, 15, 16] 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.

5. CONCLUSIONS AND FUTURE IMPROVEMENTS

This paper presents a DIY (“do-it-yourself”) type project. [4, 5, 12, 15, 16] “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. The term “do-it-yourself” has been associated with consumers since at least 1912 primarily in the domain of home improvement and maintenance activities. The phrase “do-it-yourself” had come into common usage (in standard English) by the 1950s, in reference to the emergence of a trend of people undertaking home improvement and various other small craft and construction projects as both a creative-recreational and cost-saving activity. 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 step towards the future in all the branches of the industry and protecting the environment. [4, 5]

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. A lot of 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 entirely 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 inverter that inverts the continuous electricity into alternative electricity. That way household device can be powered from the photovoltaic module.

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.

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.

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.

However, even with all the research and development in the solar industry, one thing is for certain, solar panels are the best way for home-owners 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 foreseeable 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.

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