International Journal of Scientific & Engineering Research, Volume 7, Issue 3, MARCH-2016
ISSN 2229-5518

# Solar Energy: The long-term alternative to many other energies

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**Abstract**— This research paper discusses the potential uses of solar energy and its implications.

## 1. Introduction

Solar energy is one of the many different alternatives to current energies that utilize sources that are not renewable, and therefore may not be available in the future. World total annual consumption of all forms of primary energy increased more than ten-fold during the twentieth century, and in the year 2002 reached an estimated 451 exajoules (Boyle, 3). Therefore, many other types of energy must be considered as a long-term solution.

One of these long-term solutions is solar energy. Solar energy utilizes the natural resource of the sun to help create power. This can be a pretty ingenious solution if utilized properly, as the sun will not go away, and by storing and using this energy, there is little repercussions to its use. In fact, the sun has been used for heating, lighting, and warmth for centuries, and there is no reason why this couldn't be applied to current technologies.

This is because of the first law of thermodynamics, which says that in any transformation of energy from one rom to another, the total quantity of energy remains unchanged (Boyle, 4). What this implies with solar energy is that since the energy is already being used by the sun, and it can't be turned off, there is no reason why we can't harness the energy that is already being used.

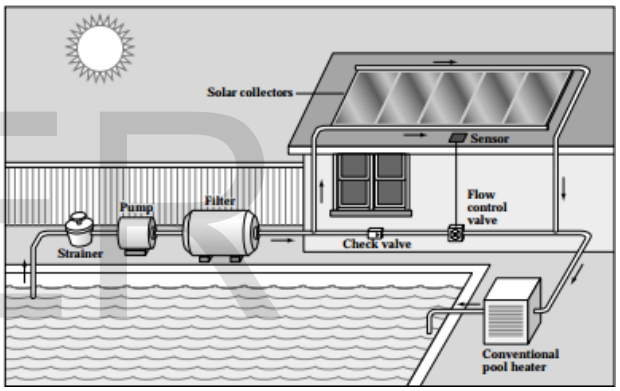
However, there are many reasons why it may not be a good idea. There are many benefits associated with this energy. There aren't many reasons why harnessing the sun's already used force would be harmful. However, there are many arguments that putting research and production efforts towards this energy may not be the best use of resources, and that research and production should be used for other forms of alternate sources of power in the United States.

## 2. Science of the Energy

Though solar energy is an idea that makes a lot of sense and would be a way of keeping our stock of nonrenewable energies, there are many different methods that can be implemented in order to collect this energy and transfer it into a power source for consumption.

There have been many different historical uses of the sun in the past, but the science that is currently being undertaken has become beneficial and standardized for sale to normal citizens to use in their homes, as well as government and business operations. Each system utilizes the sun slightly differently with the same end result. This result is the limited use of fossil fuels in the future.

One type of system for harnessing solar energy is through active solar heating. This system implements a solar collector on the roof of a building which gathers solar radiation (Boyle, 18). This can be utilized in order to warm domestic hot water or to heat swimming pools, for instance (Boyle, 18). See below for a diagram of this process (US Dept. Of Energy):




Solar thermal engines is another method of obtaining natural solar energy. This is like active solar heating, however they use collectors which are more complex to produce temperatures that are high enough to drive steam turbines which helps to produce electric power (Boyle, 18). The most prevalent use of this energy is in the Mohave desert in California, where 90% of the world's solar thermally-generated electricity is produced (Boyle, 18).

Passive solar heating is the natural process of absorbing heat through windows in buildings, which reduces the energy required by other forms of power in order to heat a building (Boyle, 18). This system can also include the process of creating buildings that can help to reduce the need for other energies to heat buildings in colder conditions (Boyle, 18).

Daylighting is another method of utilizing solar energy by using natural daylight whenever possible. This would then require less use of any other type of lighting which would require some form of energy usage. Though it technically doesn't produce any electricity, it helps to prevent the use of other types of electricity.

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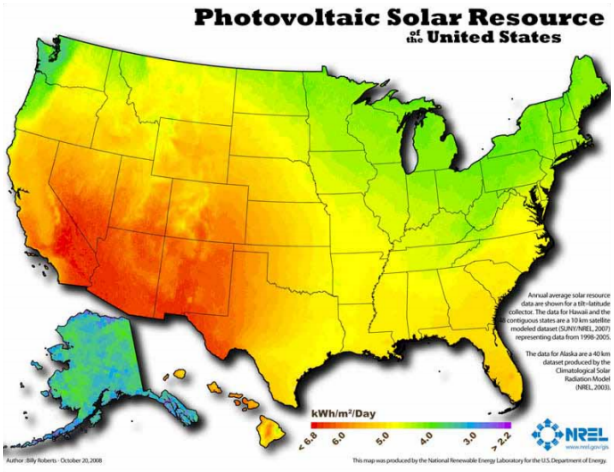
There is definitely an opportunity for current technologies to capture all of the available solar power available. In the United States alone, there are many opportunities for providing much of the country with solar energy. The below graphic shows the available solar energy in the United States:




Although certain areas of the country are able to produce more power from solar output, there is still the opportunity for many areas to produce a significant amount of energy every single day. There is also the ability to harness the energy and preserve it for times when certain areas are not able to produce the energy. Areas with warmer climates year-round seem to be the places where the most solar energy can be captured. Those which have more seasonal or colder climates can also produce solar powered energy, but at a much lower scale.

This is especially true when looking at creating water tanks for residential use. In some of the warmer clients, there may be little need to ever supplement the heated water with extra electricity. As the map indicates, and as previously stated, there is a large solar farm in the desert because this region has the ability to produce the most solar radiation.

## 3. History of the Energy

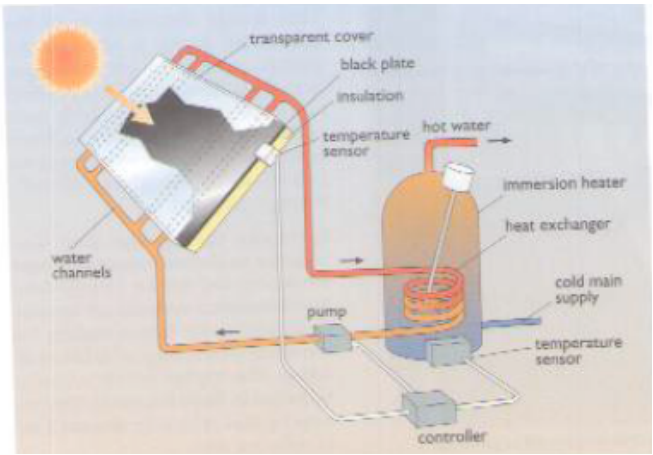
Using the sun as a method of natural heating has always occurred. However, the actual harnessing of the direct sunlight n order to produce heat to specific areas is much more recent, with the ability to store heat being even more recent. There were many very big dates in the history of solar energy (US Department of Energy):

- 7th Century B.C.- Magnifying glass used to concentrate sun's rays to make fire
- 3rd Century B.C.- Greeks and Romans use burning mirrors to light torches for religious purposes
- 1st Century A.D.- Roman bathhouses had large south facing windows to let in sun's warmth
- 6th Century A.D.- Sunrooms were so common that Justinian Code had sun rights to ensure access to the sun by civilians
- 1767- Swiss scientist Saussure credited with the world's first solar collector, used to cook food during a South Africa expedition
- 1860- French mathematician Mouchet created solar powered engines for use in steam-powered engines
- 1891- Baltimore inventor Kemp patented the first commercial solar water heater
- 1908- William Bailley invests a solar collector with copper coils and an insulated box
- 1950- Architect Frank Bridgers designed the world's first commercial office building using solar water heating
- 1964- NASA launches the Nimbus- a satellite powered by a photovoltaic array
- 1981- Paul MacCready builds the first solar-powered aircraft
- 1998- Subhendu Guha creates a flexible solar shingle for converting sunlight to energy
- 2000- The International Space Station installs solar panels on the wings of the station

Current Technologies

There are obviously many different ways that the solar energy can be collected, and many different technologies that are used in order for the process to be efficient given the circumstances. One of these technologies is the pumped solar water heater, which is the most common form of solar water heating in Northern Europe (Boyle, 19).

With this technology, a collector panel is tiled to face the sun and mounted on a pitched roof and sprayed black to maximize solar absorption (Boyle, 20). There is also a storage tank for around 200 liters of water which is essentially a hot water tank (Boyle, 20). Lastly, a pumped circulation system transfers the heat from the panel to the tank, keeping the water warm in the tank (Boyle, 20).




## 4. Environmental Impacts

Whenever you are dealing with energy and processes such as these, there has to be a discussion about possible environmental impacts. The biggest positive to solar energy is the ability to not use fossil fuels in order to create power. This can be both form the heating of water that is no longer needed to be heated from other electricity, as well as by conducting its own electricity for use by both residential and commercial applications.

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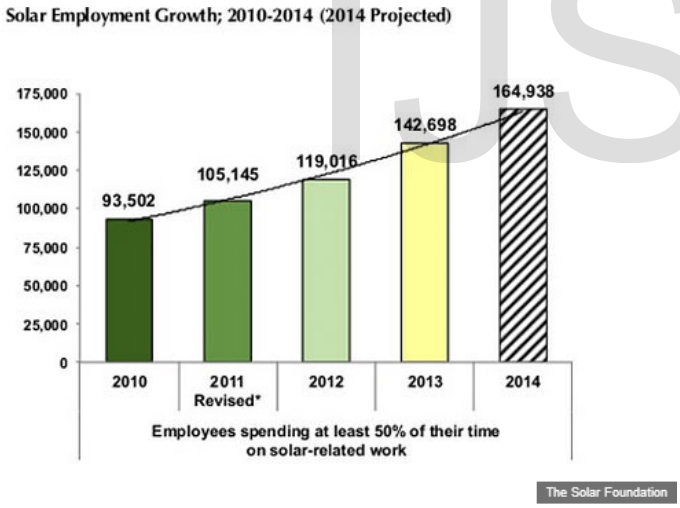
However, one of the arguments against this energy, though it is one of the most natural, is that production of solar panels to replace other energy sources can create more waste, as more energy sources being manufactured leave a lot of previous energy sources still standing and not operating. Solar energy really is the most environmentally friendly of all current methods of energy sources. This prevents most downfalls of other sources, and the non-utilization of other sources really is one of the only downfalls to this energy.

## 5. Conclusion

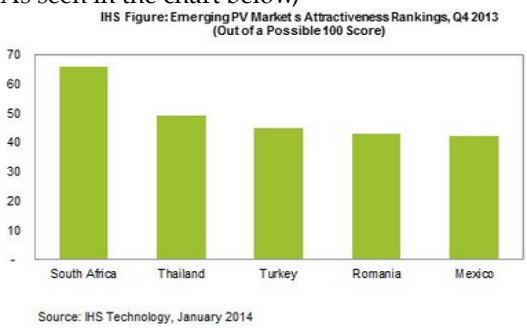
It is quite apparent that solar energy has the ability to be a long-term solution to many other energies. However, the disadvantages outlined do create some problems that need to be resolved before this solution can be the main energy source utilized throughout the world. However, with the proper development this energy source can be one of the long-term solutions to the current energy types.

In fact, this energy is on the rise. In his State of the Union address, President Barack Obama claimed that, "Every four minutes, another American home or business goes solar (Polifact). This is a positive not only for the environment, or for saving money for the end consumer, but also for job growth. As shown below, there is expected growth in the solar energy industry which has been progressively growing over the last five years (Assis):




These numbers are strictly in the United States. However, this trend is also growing worldwide and there are many markets that are beginning to pop up based on their location and need for sustainable energy sources.

As seen in the chart below,




Source: IHS Technology, January 2014

South Africa is the most attractive new market in Q4 2013, followed by Thailand, Turkey, Romania, and Mexico. Though they are all attractive locations, based on macroeconomic climate, market size potential, profitability, pipeline maturity bring the total score of South Africa well above any other country (Clean Technica):

IHS Table: Emerging PV Markets Attractiveness Rankings by Category, Q4 2013 (Out of a Possible 100 Score)

| Country | Macroeconomic Climate | Market Size Potential | Profitability | Pipeline Maturity | Total Score |
|---|---|---|---|---|---|
| South Africa | 56 | 64 | 62 | 80 | 66 |
| Thailand | 59 | 42 | 45 | 60 | 49 |
| Turkey | 55 | 49 | 53 | 20 | 45 |
| Romania | 62 | 19 | 45 | 55 | 43 |
| Mexico | 59 | 43 | 34 | 45 | 42 |

Source: IHS Technology, January 2014

Moving forward these locations, which have not been known for solar power in the past could become the new wave of solar power which could bring it further into the forefront as the next great energy source.



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