



Solar Energy

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INTRODUCTION

It is obvious that we are living in dramatically changeable world. Sometimes, it seems like anything is possible today. Industries are developing day by day, new manufacturers are appearing, product innovations, improved old products and prices oscillations are events that are occurring in our reality.

Recently, the renewable energy have been highlighted and it has put in focus various kinds of natural resources that can be used to make both planet and human kind better off. In the following paper, among all renewable industries, the solar energy will be emphasized. Why solar energy? Today's solar product offerings are much more than people think usually when they hear any phrase that can be connected with „solar power“. Solar electric panels on a roof that convert sunlight into electricity are only pieces of a pie. Many more solar- powered products and technologies utilizing sun energy exists today. For instance, solar hot water is used either for residential or commercial use. It is very efficient and truly cost-effective method, because it uses the sun's heat to warm a potable water supply instead of electricity. Other product examples are solar HVAC systems, battery- backed off- grid systems, solar farms and those products that are still at the forefront of the solar world future innovations.

According to these new trends in energetic world, many governments are supporting investments in renewable energy generation facilities. For example, U.S. government has several mechanisms thorough the tax code. Of course, these incentives often require outside investors and financial arrangement to allocate risk and shares among partners. These financial arrangements are called „advanced financial structures“(Mendelsohn, Kreycik, Bird, Schwabe, Cory, 2012). These structures were actually widely deployed by the wind industry and now more and more explored in solar energy.

Even though it has been assumed and predicted that USA solar energy market is one of the most developed due to the American world power in general, other parts of the world have shown significant competing potential and put American market currently on 4th place. Germany is a leader, and followers are Italy and Japan. Arabic countries are more and more investing in solar energy development. Probably, what has great potential in solar power use and could result in development of countries in general is the Balkans. In the following paper, mentioned topics are going to be described in more detail.

SOLAR ENERGY BACKGROUND

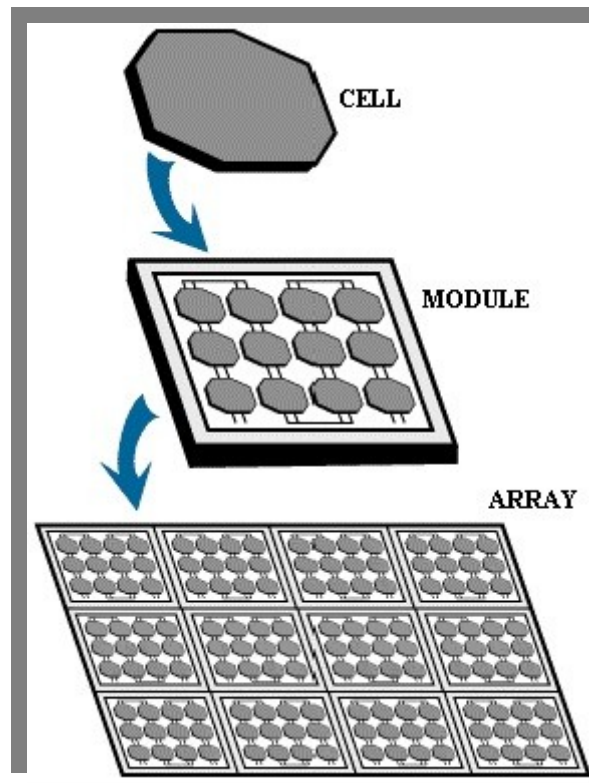
To be as specific as possible, the origins of mankind's use of the sun's energy go back to the beginnings of our development as a species. However, we are going to concentrate more on today's use and the level of development.

Without a doubt, fossil fuels have a limited quantity, whether we are talking a few decades or a few hundred years, the inevitable dead-end of burning oil, coal and gas has been there. There is no other way than to try to find alternatives. So people turned to inexhaustible source of energy- the sun.

The first thought when mentioning „solar energy“ is „PV“ which is acronym for Photo-Voltaic panels. Photovoltaics is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons (NASA, 2002). When these free electrons are captured, an electric current results that can be used as electricity.

The photoelectric effect was first noted by a French physicist, Edmund Bequerel, in 1839, who found that certain materials would produce small amounts of electric current when exposed to light. In 1905, Albert Einstein described the nature of light and the photoelectric effect on which photovoltaic technology is based, for which he later won a Nobel prize in physics. The first photovoltaic module was built by Bell Laboratories in 1954. It was billed as a solar battery and was mostly just a curiosity as it was too expensive to gain widespread use. In the 1960s, the space industry began to make the first serious use of the technology to provide power aboard spacecraft. Through the space programs, the technology advanced, its reliability was established, and the cost began to decline. During the energy crisis in the 1970s, photovoltaic technology gained recognition as a source of power for non-space applications. That is the time when it started to be used for other purposes.

A number of solar cells electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module. Modules are designed to supply electricity at a certain voltage, such as a common 12 volts system. The current produced is directly dependent on how much light strikes the module.



Picture 1. Solar cell, photovoltaic module and array

SOLAR ENERGY MARKET

Global Market Size

Solar electric energy demand has grown by an average 30% per year over the past 2 decades despite a backdrop of rapidly declining costs and prices. This decline in cost has been driven by economies of manufacturing scale, technology improvements in manufactory process, and the increasing efficiency of solar cells.

In 2009, the photovoltaic solar industry generated \$38.5 billion in revenues globally, which includes both the sale and the installation of solar modules and associated equipment of solar systems. Solarbuzz forecast various scenarios which, depending on the factors, see growth in the world PV market from \$46.3 billion to \$96.8 billion in 2014 (*Solarbuzz*, 2012).

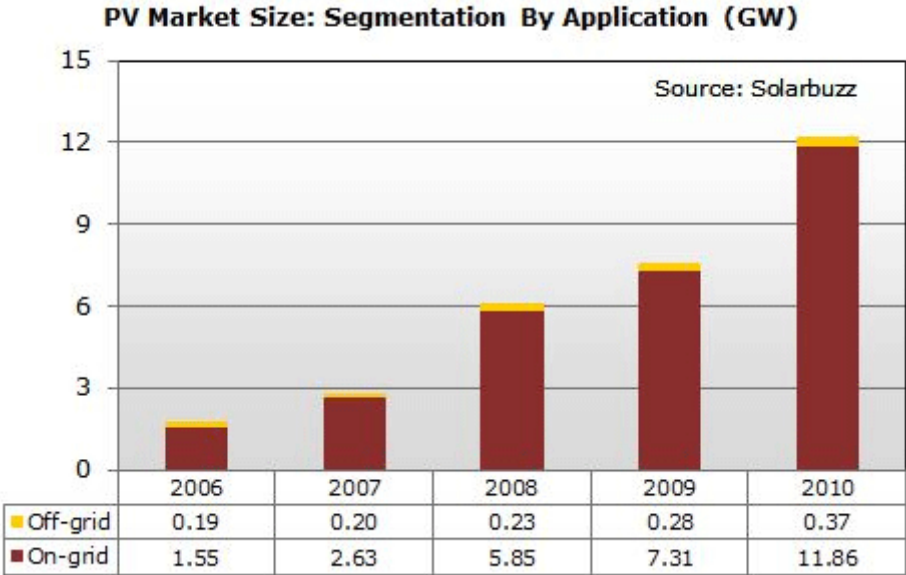
PV installations grew to 7.3 GW in 2009, up 20% from the prior year. For example, despite the world economy crisis, in USA solar PV market grew 36% in 2009. However, financial crisis was still heavily felt as this number is significantly smaller compared to 2008 when there was 62% growth of US solar energy market. According to this data from global

perspective in 2009, US was ranked as fourth largest solar photovoltaic market, behind Germany, Italy and Japan.



Picture 2. Solar energy panels in Germany

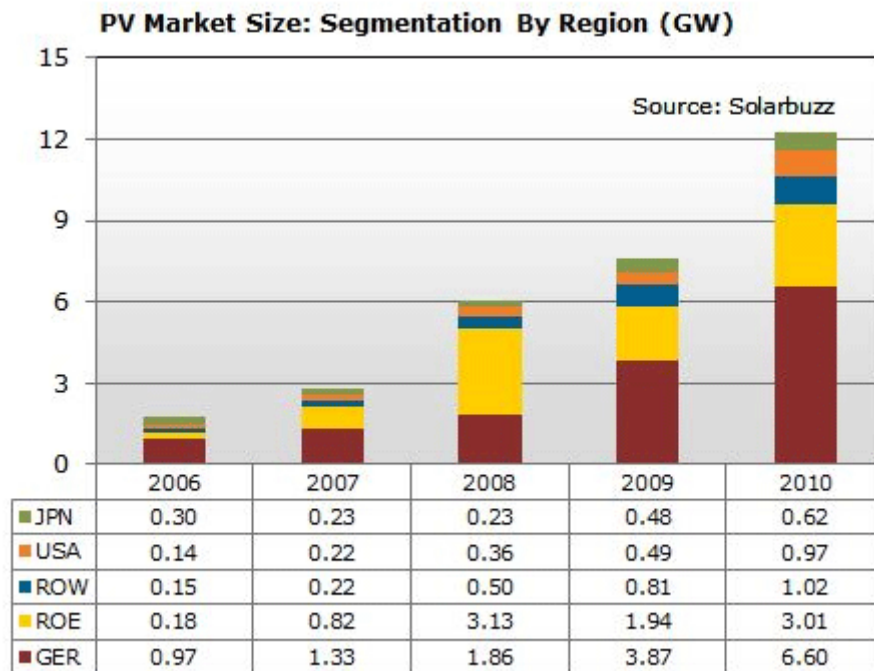
Solarbuzz stated that it was expected to reach 8.4 13.1 GW in 2010. On the other hand, the various forecast scenarios predict demand rising to 15.4 37 GW in 2014, more than five times the size of the 2009 market. The worldwide on-grid segment grew by 20% in 2009, and the off-grid market grew 23% in 2009.



Graph 1. PV market size- by application

Regional Market Growth

The largest on-grid market so far has been Germany, where demand has been subsidized by very attractive feed-in tariffs. This is followed by Japan, where grid-connected applications are also stimulated by market incentive programs.



Graph 2. PV market size- by region

Driving Forces of Growth in Country Markets

Among industrialized countries, the German and Japanese governments have led the way in legislating high incentives to stimulate development of their domestic solar markets (Solarbuzz, 2011). The German feed-in tariff model has been increasingly used in countries around Europe, including Italy and France. As a result, the industry structure has evolved, leading to strong distributor and dealer networks with well-trained installers and good customer support capabilities. Government policy is designed to reduce CO2 emissions via solar deployment and to create high-tech jobs through the development of a strong national solar industry. In the United States, the significant roles in market development were played by utilities.

Regional solar energy demand where the solar energy is connected to the electricity grid is driven by the following:

- Incentive programs led by national or state governments: Subsidies allow customers/investors to gain a financial return on the PV system
- Enthusiasm of customers for green energy, at the first place-solar.
- High electricity rates encourage alternative sources of energy, called local electricity tariffs.
- Sunlight conditions: Solar electricity prices fall by increasing sunlight levels.
- Marketing strategies by solar companies.
- Delivery infrastructure (the number of local suppliers and qualified installers).

In developing countries, markets have benefited from the steady decline in solar PV prices, but they have also been stimulated by continued multi-lateral and bi-lateral development aid. This has driven out conclusion that solar has been an enabling technology for developmental programs for education, clean water, and healthcare.

There is an increasing focus on micro-finance to improve the affordability of solar PV systems, which may be economical over their lifetime but have high initial costs (*Solarbuzz*, 2012). Such credit schemes have been effective at a small scale, but a culture of credit does not exist yet in many developing countries.

The Solar Foundation

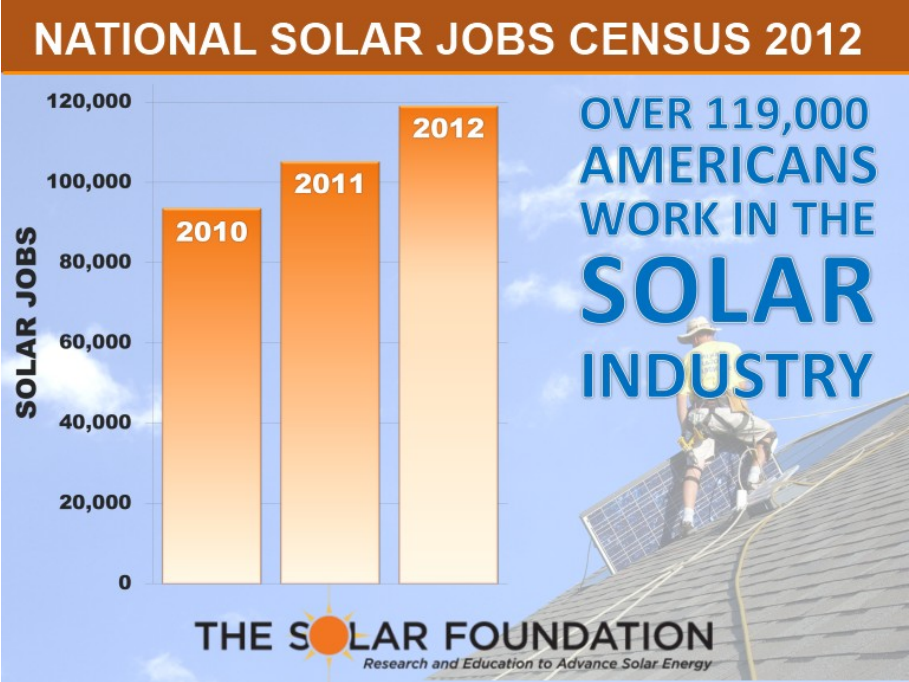
The Solar Foundation is an independent national 501(c)(3) nonprofit working to demonstrate the global benefits of solar energy through research and education. Founded in 1977 and based in Washington, DC, we are increasing the widespread adoption of solar energy and transforming the marketplace through our coordinated public education & outreach efforts, high-level data collection, and innovative research.

For over 30 years, they have worked to promote and expand the use of solar energy as a clean, sustainable, and secure way to meet global energy demand. They have a proven track record of producing high-impact policy studies that have not only helped to directly advance the use of solar energy in the U.S., but have also provided valuable lessons for other emerging solar markets worldwide.

In 2010, they published the *National Solar Jobs Census*, which received widespread media coverage for establishing the first credible solar jobs baseline. Prior to that, they published two reports that were critical to efforts in extending the federal solar investment tax credits (ITC) through 2016. The federal ITC represented the first long-term tax credit for the solar industry, and has rapidly led to expanding markets, increased jobs and significantly lower costs for solar energy.

Their latest Jobs Census results were announced on 14th of November 2012. They included following statements:

- 119,016 solar workers in the U.S. as of September 2012.
- 13.2% growth in solar employment from September 2011 to September 2012.
- Employment numbers for 2011 were revised up from 100,237 to 105,145.
- Falling component prices, pro-solar and pro-renewable state legislation, and federal consumer tax incentives were leading drivers of employment growth (*The Solar Foundation, 2012*).



Picture 3. The Solar Foundation Jobs Census 2012

Solar energy use in The Balkans

Recently, some of the Balkans countries have shown the high potential and improvements when it comes to the use of sun and converting it to the energy to produce power. Even with some obstacles, the important thing is that the solar energy value has been recognizable and in the focus of activities.

For instance, in Bosnia and Herzegovina in the first half of 2012, generated revenue was 2.500 Euros. That revenue was generated by the production of 2 solar power centres. In general, the value of electricity produced was more than 2.000 Euros. The owners of solar powers highlighted that more and more of population is aware of the fact that the renewable sources will be the main in the future. That is supported by statistical data which show that the purchase price of energy from renewable sources has risen by 2%.



Picture 4: Solar power in Kalesija, Bosnia and Herzegovina

In Ljubljana, Slovenia, the second half of 2012 was not so successful for the renewable sources of energy. The government reduced subsidies for solar power sources from 40 millions Euros to only 10 millions (*Finance journal*, 2012). Due to the article, there is prediction of defining quota of available resources of fund for solar energy and other renewable energies sources. The quota will depend on efficiency and effectiveness of those sources. However, now, there is a threat for jobs of 2500 people working in that energy branch.

By the end of 2012, the work on construction of solar power in Montenegro will start. The government has been supporting the project and is aware of importance of solar power and possible outcomes.

Another pioneer in solar power use is Serbia. As Al Jazeera Balkans announced, in the south of Serbia, the first solar power began with its work. Priorities in Serbian Ministry of Energy, Development and Protection of the Environment are increasing energetic efficiency and exploiting potentials of renewable energy sources. It will supply between 50 and 60 households.



Picture 5. Solar power

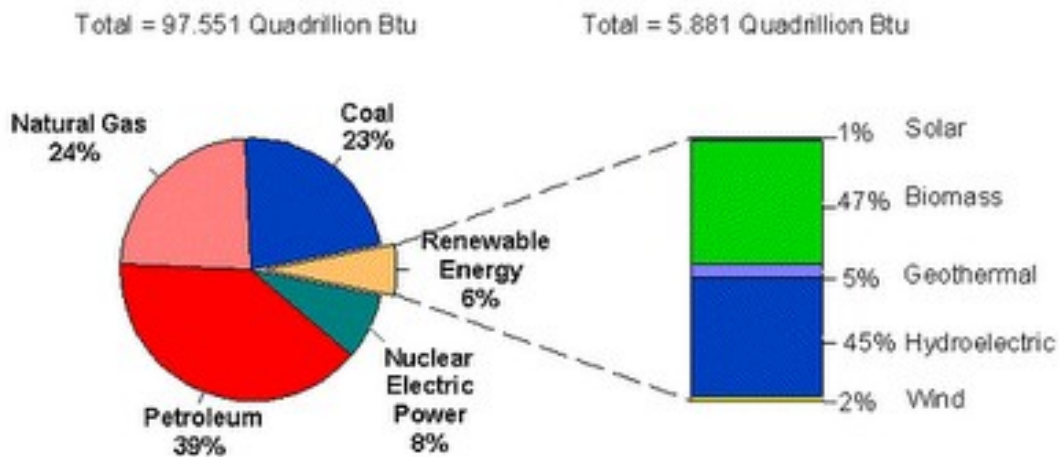
Macedonia, despite the small area, is one of the countries with the highest solar radiation in Europe (208 sunny days per year). However, the interest for using alternative energy sources has been present since recently. In energetic strategy, which was created by Macedonian Academy of Science and Art (MANU), there are plans to build solar powers from 10 to 30 MW (*AlJazeera*, 2012). They will produce only 0,2% of total electricity production in country. For example, the government used to subsidy around 500 families who inserted solar collectors in their households. For the bigger projects, the government would probably support more in order to achieve goals stated in the energetic strategy.

Germany, as a main player on solar energy market is investing in development of Croatian solar market. They are planning to invest 120 million EUR only in the first phase of the project that will start now, and last for 4 years (*AlJazeera*, 2012). In the Dalmacy, south of Croatia, German investors are planning to build the center for solar power and energy producing, that will supply the Croatian market at first, and then expand abroad.

Overall conclusion is that the Balkan countries have just recently started to turn to alternative energy sources, especially solar power. However, as long as there is a bright future, which is doubtless for the solar power, there should work on getting the best benefits of it.

WHY SHOULD WE USE SOLAR ENERGY?

Unfortunately, human kind still has not recognized all the positive sides of using solar power. The graph bellow show how small amount of solar energy is actually used nowadays.



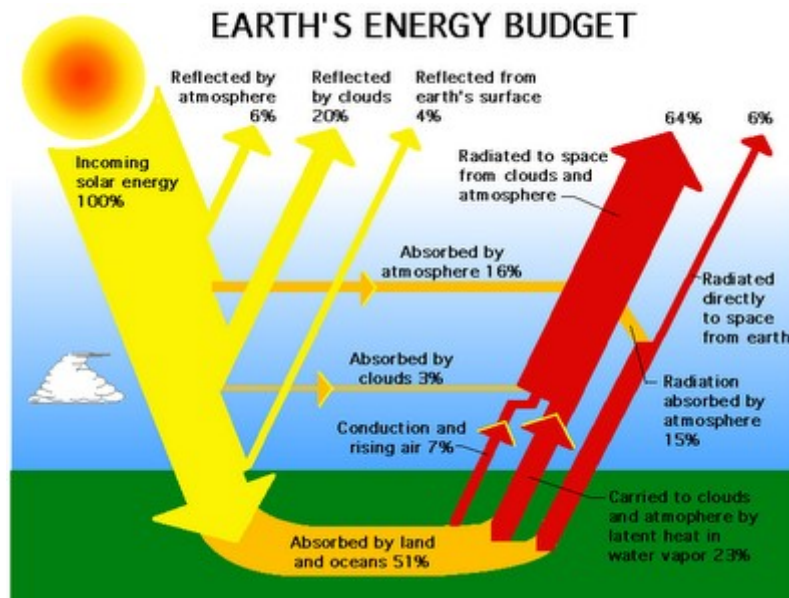
Picture 6. Use of energy worldwide

Only 1% of all renewable energy is solar. Some of the main advantages of solar power should be highlighted:

- The solar energy is free and clean energy source.
- It does not produce waste or pollution and is ecologically acceptable.
- It drives climate and weather and supports all life on Earth.
- Solar energy is renewable energy source.
- Solar energy technologies are using the Sun's energy for practical purposes.
- Solar energy's reduction in unit costs has yielded its growth rates and therefore solar energy has potential to become very important energy source.
- Solar energy once installed has almost no variable costs.
- Solar energy is not exposed to market price movements so there's no forward exchange rate risk.

FUTURE OF SOLAR ENERGY

Is solar energy worth investing in?



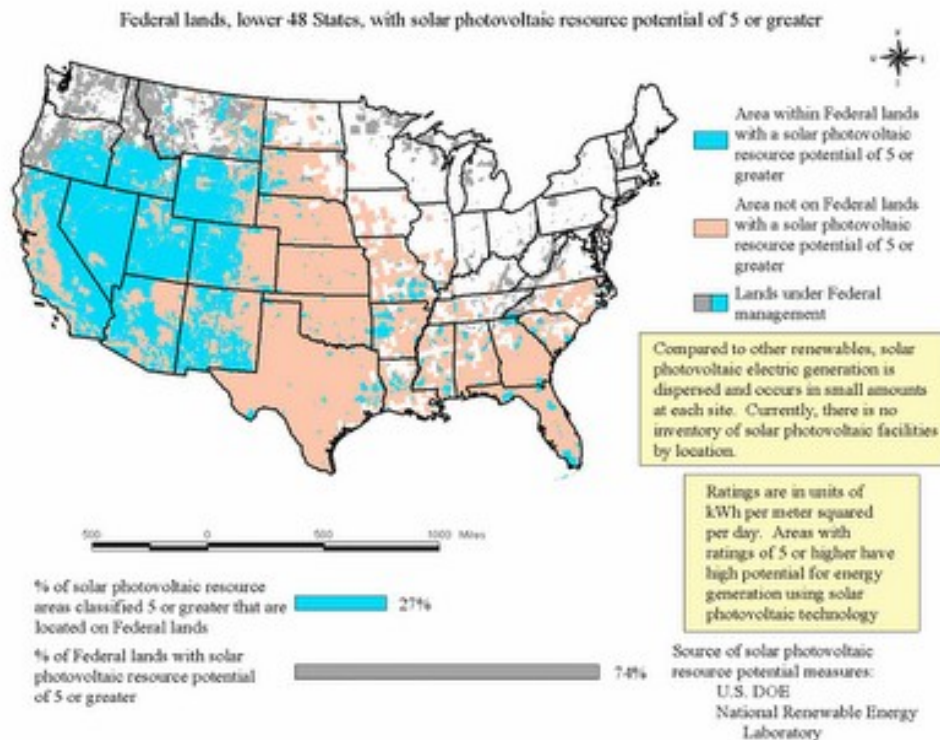
Picture 7. Earth's energy budget

Solar energy does have its own budget, which is represented on the scheme above. Its great potential should be more researched and more funds to this sector should be wise movement. Reason for that is that in the future energy's use will be gradually growing. All of the world's reserves of coal, oil and natural gas can be matched just 20 days' supply of sunshine.

Solar energy must be more affordable. The way to achieve it is with new scientific researches that should decrease the costs and increase the efficiency. That means that it must be at or even below the costs of fossil fuels in order to play more important role on global scale. Aim is to make solar energy more economically viable on every day basis.

In order to get more funds, value of this energy source must be recognized by politicians. For instance, some US states have potential to exploit solar energy. The picture below shows that. However, it does not have much promotion in public like other fuels do. Irony is that in coming years it can be used not only to decrease the use of fossil but also to decrease the price of fossil fuels.

Sooner or later, solar energy will be major energy source because of its massive potential and long-term advantages.



Picture 8. Photovoltaic resource potential

In last few years solar cell production is shifting from western countries to the east because of low-labor-cost countries in Asia, especially China. Last available data from 2011 says that eight out of ten largest producers are located in Asia; six of them are from China. This is huge expansion of solar cells production in China because in 2008 only 33 percent of solar cells were made in China, a share that grew to an impressive over 57 percent in 2011.

Charanka Solar Park in India is the largest photovoltaic solar power plant in the world with 214MW in production in April 2012 and growing to expected 500MW in year 2014. Agua Caliente Solar Project in Arizona, US, is the second largest photovoltaic solar power plant in the world with more than 200MW in production in June 2012 and growing to expected 290MW (AC) until year 2014. We can compare this also to average capacity of nuclear power plant which is 846MW in US.



Picture 9. Charanka Solar Park in India. The largest PV solar plant in the world

At the end of 2011 Germany was the world leader in installed capacity of photovoltaic solar power with installed 24,700MW peak power capacity. Italy is second with 12,500MW installed. Third is Japan with 4,700MW. Fourth place share United States and Spain, each with 4,200MW installed. World total installed capacity at the end of 2011 was around 68,000MW.

Despite of relatively bad geographic location, solar PV in Germany provided 18 TWh of electricity in 2011, which is about 3% of total electricity generated in country. Geographic position of the United States is much better, but lack of investment into solar PV power resulted with only 3.8TWh of generated electricity in 2011, which is less than 0.1% of US electricity production.

Market analysts expect that Germany will reach 25 percent of solar PV generated electricity in total electricity generated by 2050. In combination with other renewable energy sources this would be huge step into 100% clean electricity production era.

Does investing in solar power in the areas characterized by long winters and plenty of snow has any sense?

Simplest possible answer to this question is: Yes. Indeed, snow and solar cells are not 2 sides of the same coin, but they can still be worth of money. The major consequence of this combination could be the effect that snow can cause a solar-cell blackout for awile. That can significantly affect total output and reduce efficiency. However, there are not a lot of people

living in the areas characterized by snow more than few months meaning the PV panels do not stay under the snow for a long time and therefore do not require frequent snow cleaning.

Joshua Pearce, a scientist at the Michigan Technological University, even claims that in some cases snow is even able to improve the efficiency of solar panels (Habjanec, 2012). As he stated, this is the so called „albedo effect“, and it refers to situation when sunlight reflects back from snow. This reflected sunlight can make a panel generate even more electricity than in normal conditions. Simple example of albedo effect in every day life are skiers injuries, when they get sunburn during the sunny winter days.



Picture 10. A computer model in the USA

The team of U.S. scientists recently created a computer model that is able to predict how much power generation would be reduced in relation to various amounts of snow cover and on different types of solar modules mounted at different angles.

This study is yet another proof that solar energy industry is slowly but surely passing all the obstacles on the road to success. The prices of solar panels are constantly decreasing, solar power technologies are becoming more efficient, and solar panels are spreading all over the globe. The future is certainly looking good for solar energy industry as things have been lately definitely going in the right direction.

CONCLUSION

The trend of „going green“ is overall present today. However, using alternative sources of energy should not be considered only the way to follow that trend. The point should be more deep. Planet's resources are more and more becoming scarce and someday, the human kind will need something else. Solar energy is everlasting, and it would be nonsense not to recognize the potential and benefits it provides.

On the other hand, it is cost efficient, profitable in the long term and kind of investment that brings better off not only for the future of planet, but also for the cost reduction persistence of human kind.

To sum up, solar power is clean, renewable and cost effective, but it certainly needs time to develop. However, if humans keep going the way they have already been on, solar power could become the No.1 energy source. And, as Bill Gates stated: „It's really kind of cool to have solar panels on your roof.“

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