

# Essay on design of the solar power plant

[Environment](#), [Electricity](#)



## **Introduction.**

Solar radiation is the energy source which has been used by humans in all ages. The discovery of photovoltaic effect brought revolution in the industry. It was discovered by Becquerel in 1839 and the first device based on the principle of photovoltaic effect was developed in 1950. Since the development of first device it has been there has been a major shift in the energy generation industry (Jayakumar). Over the past two decades the solar electricity generation is gaining an increasing market share. Intermittency is being widely addressed and more efforts are made in the development of more efficient storage devices such as batteries and thermal storage units (Fischlein). In this essay different design processes involved in the solar energy generation and their impacts on entire process are discussed.

## **Solar Radiation**

Solar radiation is electromagnetic in nature. It is emitted from the Sun's surface and the cause of these electromagnetic waves is the bulk fusion reactions taking place on Sun converts hydrogen (H) into helium (He). An estimated amount of  $3.89 \times 10^{26}$  J of nuclear energy is released every second from the Sun. Nuclear energy created is then converted into thermal energy and emitted through the star's surface into the space. The power density emitted from the surface of the sun is of 64 MW/m<sup>2</sup> (Fischlein). Approximately 1370 W/m<sup>2</sup> is the power emitted reaches the Earth's surface without any absorption in the space and is known as the solar constant (TAP).

## **Design approaches for Solar Energy**

Design plays an important role in the development of a reliable and efficient electricity generation and distribution. The design approaches selected to discuss are Solar Energy Grid Integration Systems (SEGIS) and Hybrid Renewable Energy System (HRES) while designing the solar power plant few parameters are estimated listed below:

- Deployment.
- Cost of electricity.
- Environmental Aspects.
- Deployment

Solar Energy Grid Integration Systems (SEGIS) are designed to increase the penetration of Solar Energy systems into the utility grid. Despite its numerous advantages the major source of electricity is still fossil fuels. Approaches like SEGIS are used to integrate the solar energy into the electricity grid already present in an area. Highly integrated, innovative, advanced inverters and associated balance-of-system (BOS) are critical points on which this entire approach is dependent (SNL). The value of the energy produced can be increased by using advanced communication interfaces and controls. It can be presented by the following diagram.

Figure 2: SEGIS Feeders.

The generation of solar power is dependent on the weather and thus it cannot generate cost effective and reliable power. To counter this problem the combination of different sources, including solar energy can be used and such systems are called Hybrid Renewable Energy Systems (HRES). To rule out the fluctuations, energy storage capabilities are also required to be

improved. Storage systems should be designed according to the site and load on the system (Jahanban and Riay). It should be noted that this approach is different from SEGIS as it can use multiple sources of energy.

The overview of HRES is presented by the following diagram:

Figure 3: Hybrid Renewable Energy Systems.

#### - Costs of Electricity

The high capital costs of renewable energy sources are one of the major barriers in the use of renewable energy sources for the electricity generation. The costs range from \$0.35/kWh to \$0.60/kWh (SEGIS) and \$0.085/kWh to \$0.135/kWh (Hybrid) compared to \$0.045/kWh and \$0.040/kWh for gas and oil respectively (Jahanban and Riay) (SNL). Since 1970's oil embargo placed by the Kingdom of Saudi Arabia (KSA) on the United States during the Arab-Israel wars increased efforts are made to produce low-cost wafer silicon and thin films for the operations of photovoltaic cells. The efforts made have resulted in the increased efficiency of thin-films, bringing down the cost to range from \$0.03/kWh to \$0.05/kWh (Jahanban and Riay) (SNL). Despite the progress made in the improvement of efficiencies of all these technologies the values are much lower than ideal efficiencies of devices. The solar to electricity efficiency is dependent upon the solar flux concentration factor, the temperature of thermal intermediary and efficiency of the thermal cycle. Dish Stirling Systems used for electricity generation systems in both SEGIS and Hybrid approaches have increased the efficiency closer to an approximate value of 30% (Jahanban and Riay) (SNL).

Figure 4: Commutative Cash Flow/Year (SEGIS).

In case of hybrid renewable energy systems the costs are high and only for

combined solar-wind energy systems the estimated costs are \$5-40/kWh for commercial users and \$2-12/kWh for domestic users (Jahanban and Riay).

#### - Environmental Aspects

Solar energy is considered as a sustainable energy supply due to the source of energy Sun is available in almost all parts of the earth equal. Greenhouse gas-free electricity is produced during their lifetime. Environmental impacts of electricity generation are measured in terms of energy and carbon paybacks. The conversion efficiency of sunlight is assumed to 12%/year. The energy flux of 190 W/m<sup>2</sup> is assumed for making calculations (SNL).

Figure 5: Controller Operations Home.

### **Budget estimations and cash flow for such systems can be represented by the following diagram:**

Figure 6: Commutative Cash Flow/Year (SEGIS).

Dish Stirling Systems used for electricity generation systems in both SEGIS and Hybrid approaches have increased the efficiency closer to an approximate value of 30%.

Figure 7: Dish Stirling Systems.

### **Conclusion**

Electricity generation using solar radiation is crucial for the development of reliable energy generation systems. Sun is the only source of energy which is used humans in all ages. Solar radiations are caused by the fusion reactions taking place in the core of the sun and transmitted through its surface in the form of electromagnetic waves. The spectrum of the radiation emitted by the sun is very large, ranging from nanometers to meters. The design approaches used for discussion are SEGIS and HRES. SEGIS is designed for

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integrating solar energy into the utility grid and HRES is designed to use multiple sources of energy for electricity generation. From analysis and discussion, it is clear that the energy generation of fossil fuels is much cheaper than solar energy, but solar energy more reliable and cost effective in the long run. SEGIS has lower costs than HRES but it is estimated to payback in 30 years while HRES can payback in 20 years.

## **Works Cited and Readings**

Coring, Dow. How Solar Panels Work. Washington: Department of Energy, 2014. Print.

Fischlein, Miriam. Renewable Energy Deployment in the Electricity Sector: Three Essays on Policy Design, Scope and Outcomes. Mineesota: University of Minneesota, 2010. Print.

Foroudastan, Saeed, and Olivia Dees. Solar Power and Sustainability in Developing Countries. College of Applied Technology and Industrial Studies Middle Tennessee State University, 2006. Print.

Jahanbani, Fatimah, and Ghulam Riay. Optimum Design of Hybrid Renewable Energy Systems. InTech, 2011. Print.

Jayakumar. Solar Energy. NY: Asian and Pacific Centre for Transfer of Technology of the United Nations (ESCAP), 2009. Print.

OIS. Basic Research Needs for Solar Energy Utilization. London: Office of Science, 2005. Print.

SNL. Solar Energy Grid Integration Systems. 2007. Print.

TAP. An Assessment of Solar Energy Conversion Technologies and Research Opportunities. Global Climate and Energy Project, 2006. Print.