



SUSTAINABLE ENVIRONMENT THROUGH SOLAR ENERGY

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ABSTRACT

Energy is an essential ingredient of socio-economic development and economic growth. It is a basic necessity for survival and a critical factor affecting economic development and employment. Increasing negative effects of fossil fuel combustion on the environment in addition to limited stock have forced many countries to explore and change to environment friendly alternatives that are renewable to sustain the increasing energy demand. Changing to renewable sources and implementation of effective conservation measures would ensure sustainability. Amongst the different renewable energy sources, solar energy is making a significant contribution to the grid power installed capacity across the globe as well as in India, and is emerging as one of the competitive options to mitigate pollution. Sustainability is the most precious gift that we can give to our future generations. Solar power, especially as it reaches more competitive levels with other renewable energy sources, may serve to sustain the lives and families of millions of underprivileged peoples in developing countries.

Key Words: Renewable Energy, Solar Energy, Photovoltaic Cell, Sustainable Environment

Introduction:

Energy is an essential ingredient of socio-economic development and economic growth. It is a basic necessity for survival and a critical factor affecting economic development and employment. Energy crisis has drawn attention of planners, on the impact of energy costs on economic growth, industrial production, employment, etc. It is the key element in the production process, and shortage of energy has serious impact on the economy. Increasing negative effects of fossil fuel combustion on the environment in addition to limited stock have forced many countries to explore and change to environment friendly alternatives that are renewable to sustain the increasing energy demand. Changing to renewable sources and implementation of effective conservation measures would ensure sustainability. RE also provides national energy security at a time when decreasing global reserves of fossil fuels threatens the long term sustainability. Amongst the different renewable energy sources, solar energy



is making a significant contribution to the grid power installed capacity across the globe as well as in India, and is emerging as one of the competitive options to mitigate pollution.

Renewable Energy:

There are several types of renewable energy sources in existence today. These include the sun, wind, flowing water, biomass, hydrogen gas, and geothermal heat. Because the transition into a new alternative energy phase may take at least 50 years, as well as huge investments, a set of criteria may be considered in order to decide the right energy source for a given region. These are the resource's:

1. availability in near future (15-25 years) and long term (25-50 years),
2. net energy yield,
3. cost to develop, phase in, and use resource, and
4. environmental effects from extracting, transporting, and using resource.

For all these reasons, solar energy is generally an excellent choice for consumer use. It might not be the best choice for every location, such as a windy region with less sunlight. Most areas in developing countries are, however, extremely well-suited for its applicability, making solar power one of the most widely known renewable energy sources chosen for projects funded therein.

Solar Energy:

The sun is the most plentiful energy source for the earth. All wind, fossil fuel, hydro and biomass energy have their origins in sunlight. Solar energy falls on the surface of the earth at a rate of 120 petawatts, (1 petawatt = 10^{15} watt). This means all the solar energy received from the sun in one days can satisfied the whole world's demand for more than 20 years. We are able to calculate the potential for each renewable energy source based on today's technology. Future advances in technology will lead to higher potential for each energy source. However, the worldwide demand for energy is expected to keep increasing at 5 percent each year. Solar energy is the only choice that can satisfy such a huge and steadily increasing demand.

Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaics, solar thermal energy, solar architecture and artificial photosynthesis. It is an important source of renewable energy and its



technologies are broadly characterized as either passive solar or active solar depending on the way they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air.

There are several applications for solar energy, for instance: electricity generation, photochemical, solar propulsion, solar desalination, and room temperate control. The collection of solar energy and its transfer to electricity energy will have wide application and deep impact on our society, so it has attracted the attention of the researchers. In developed country like the United States, electricity generation consumption occupies even larger shares. Electricity is high grade energy. This means it can be easily transferred into other forms like mechanical energy or heat. If we are able to generate economic and plentiful electricity energy, together with the easy transportation electricity energy transmission, the electric power will increase it shares in demand sectors dramatically.

Energy has an established positive correlation with economic growth. Providing adequate, affordable and clean energy is a prerequisite for eradicating poverty and improving productivity. The inevitable increase in the use of fossil fuels alongside a country's economic growth presents associated side effects of threat to the nation's energy security, as well as environmental degradation through climate change. A feasible alternative to the indiscriminate burning of fossil fuels lies in the accelerated use of renewable energy. In tropical countries, which have sunshine almost throughout the year in most parts, solar energy is one of the most viable options. Energy from the sun has been used to provide electricity for many years. This form of renewable energy occupies less space compared to the space occupied by hydropower projects. Developing countries can cover all their demands for energy by solar systems with 0.1% of the land area.

Advantages and Limitations of Solar Energy:

Renewable energy sources in general, and Solar Energy source in particular, has the potential to provide energy services with zero or almost zero emission. The solar energy is abundant and no other source in renewable energy is like solar energy. Every technology has its own advantages and disadvantages. As the solar insolation and atmospheric



conditions vary significantly from place to place, efficiency of solar energy also differs accordingly.

Advantages:

- It is an abundant Renewable Energy
- This technology is Omnipresent and it can be captured for conversion on a daily basis
- It is a Non-polluting technology, which means that it does not release green house gases
- It is a Noiseless technology as there are no moving parts involved in energy generation
- This technology requires Low-maintenance because of lack of moving parts
- It can be installed on modular basis and expanded over a period of time
- Most viable alternative for providing electricity in remote rural areas as it can be installed
- where the energy demand is high and can be expanded on modular basis.

Limitations:

- As the technology is in an *evolving stage*, the efficiency levels of conversion from light to electricity is in the range of 10 to 17%, depending on the technology used.
- The initial investment cost of this technology is high. At present the technology is basically surviving because of subsidy schemes available by the government.
- Solar energy is available only during daytime. Most load profiles indicate peak load in the evening/night time. This necessitates *expensive storage devices* like battery, which need to be replaced every 3 to 5 years. Generally, the cost of the Battery is 30 to 40% of the system cost.
- As the efficiency levels are low, the space required is relatively high. For instance, with the existing levels of technologies, the land required for putting up a 1 MW solar PV power plant is between 6 to 9 acres. However, research is going on to increase the efficiency levels of the cell.



- Solar energy is heavily dependent on atmospheric conditions.
- Solar insolation varies from location to location, so there are certain *geographic limitations* in generating solar power.
- With the existing module and inverter manufacturing technologies, it may not be worthwhile in terms of costs to deploy solar energy for certain loads which require very high starting power (e.g. air conditioners).

Passive solar design

Solar energy can heat buildings in two ways, which are passive and active heating systems. Passive solar design can capture sunlight in a structure such as a room or building and then convert it to low-temperature heat for use as space heating. Well-known examples of this solar collection are greenhouses, sunspaces, and energy-efficient windows. The most important aspect of passive design is the ability to capture the sun's energy as cheaply and efficiently as possible simply by the design of the structure and the types of materials with which it is built. In most climates, like those found in many developing nations, a backup heating system is not even needed with the passive solar gain. Materials which are frequently used for passive design walls and floors are concrete, adobe, brick, stone, salt-treated timber, and water in 55-gallon drums. During the day, these materials collect a large amount of solar energy as heat, and then release it slowly throughout the rest of the day and night. There are different ways in which these buildings can be designed because the combination of their position to other objects, direction towards the sun, and roof overhang can establish the desirable internal temperature for a given climate and location.

A passive solar design is optimal for any household's energy efficiency because once built, the materials do all the work. It allows for cooler summers and warmer winters with the reflective properties and heat sinks contained within. Daylighting uses windows on the walls and ceiling windows to produce a well-lit room during the daytime, and even allows for some moonlight at night. This concept is not only energy efficient; it also boosts mental well-being and cognitive functioning. Various school studies have shown that their students performed approximately 14% higher on tests after being exposed to their new day lit classrooms. By building a solar design house even before attaching solar PV panels, the most can be made out of the sun's energy. This will absolutely ensure the greatest efficiency and cheapest. Houses built in this way contribute to sustainability, by "development that meets the needs of the present without compromising the



ability of future generations to meet their own needs” 4. When contemplating solar power for developing countries, this is the route to go because it permanently allows impoverished families to maintain maximum comfort for minimal expenditure.

Solar Power – Future of environmentally clean and sustainable Energy:

Solar energy is clean and renewable. It doesn't emit carbon dioxide during operation. The major material of photovoltaic panel which is the most commonly used today is silicon. Silicon is abundant and environmentally safe. However, the application of solar energy technologies can be dangerous under several conditions. Multi-junction photovoltaic cells (III-V), which can achieve relatively higher energy converting efficiency than commonly used silicon cells, are usually made with poisonous materials like gallium arsenide (GaAs) or cadmium telluride (CdTe), can cause harm to the environment if leaked. More study about the safety and materials recycling for these cells must be conducted if we want to adopt these techniques into our solar industry. For concentrated solar power techniques, coolant and lubricant can be a problem if leaked. If these drawbacks are avoided, we are able to conclude that solar energy is clean and safe.

In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared".

Photovoltaics (PV) is a method of generating electrical power by converting solar into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaics include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulfide. Due to the increased demand for renewable energy sources, the manufacturing of solar cells and photovoltaic arrays has advanced considerably in recent years.



Solar photovoltaics is a sustainable energy source. By the end of 2011, a total of 71.1 GW had been installed, sufficient to generate 85 TWh/year and by end of 2012, the 100 GW installed capacity milestone was achieved. Solar photovoltaics is now, after hydro and wind power, the third most important renewable energy source in terms of globally installed capacity. More than 100 countries use solar PV. Installations may be ground-mounted (and sometimes integrated with farming and grazing) or built into the roof or walls of a building (either building-integrated photovoltaics or simply rooftop).

Driven by advances in technology and increases in manufacturing scale and sophistication, the cost of photovoltaics has declined steadily since the first solar cells were manufactured, and the levelised cost of electricity (LCOE) from PV is competitive with conventional electricity sources in an expanding list of geographic regions. Net metering and financial incentives, such as preferential feed-in tariffs for solar-generated electricity, have supported solar PV installations in many countries. With current technology, photovoltaics recoup the energy needed to manufacture them in 3 to 4 years. Anticipated technology would reduce time needed to recoup the energy to 1 to 2 years.

The remote homes and villages in these countries derive their energy from environmentally harmful practices due to unavailability of clean, renewable energy sources. The traditional and most important energy source is fuel wood and charcoal made from fuel wood. Also called potentially renewable biomass, these are “the main sources of energy for heating and cooking for roughly half the world’s population. Within a few decades one-fourth of the world’s population in developed countries may face an oil shortage, but half the world’s population in developing countries already faces a fuel wood shortage”.

Their traditional method of energy production continues to degrade the ecosystem. Especially with some types of soil, land can be over-harvested until it is rendered useless. Land that has been removed of all vitality cannot replenish itself adequately for another harvest. The world is already burdened with the threat of global unsustainability. To encourage sustainability, an increasing number of programs are being implemented to expand the use of alternative fuels and energy. Renewable energy resources can improve quality of life by promoting sustainable development. Systems such as solar power are “practical, reliable, cost-effective, and healthier for people and the environment”.



Competition and lower prices:

The diminishing supply of fossil fuels further addresses the need for cleaner, renewable fuel sources. Solar energy will be able to supply the power needed for housing and transportation alike. Competition created with additional solar automotive technologies will really put solar power on the map. Developing renewable energy resources would (1) save money, (2) create two to five times more jobs per unit of electricity produced than coal and nuclear power plants, (3) eliminate the need for oil imports, (4) cause much less pollution and environmental degradation per unit of energy used, and (5) increase military, economic, and environmental security”.

Incentives in solar energy:

Governmental incentives to strengthen the solar PV market within leading countries may positively affect installations for developing nations. Governments create budgets for solar because of the environmental and economic benefits, which are lower carbon dioxide emissions and the creation of high technology jobs within its industry. The use of high subsidies for stimulating domestic solar markets is led by Japan and Germany. “This has caused evolution of the industry structure in each country and led to strong distributor and dealer networks with well trained installers and good customer support capabilities” 3. More funding will make solar economical in on-grid markets, which will then lower the prices because of the high volume of manufacturing.

The driving forces of connecting regional solar energy to the electric grid are (1) regional, governmentally-led programs and the subsidies within, (2) customer enthusiasm for green energy, especially solar, (3) higher electricity rates, encouraging alternative energy sources, (4) higher levels of sunlight, making solar electricity prices fall, (5) solar company marketing strategies, and (6) the number of local suppliers and qualified installers. These forces have a powerful effect on the market, as solar energy is being used more than ever for single homes, entire blocks, and a growing list of other versatile product uses. Because we are learning how well these systems work in our own countries, we can better implement larger or smaller programs for others.

Conclusion:

Sustainability is the most precious gift that we can give to our future generations. Solar power, especially as it reaches more competitive levels with other renewable energy sources, may serve to sustain the lives and



families of millions of underprivileged peoples in developing countries. Solar energy can be directed both actively (by solar PV panels) and passively (by green building design) in order to shed the warm, bright light of opportunity upon the many dark recesses of the globe. Through engineering, this technology can also be applied to the transportation industry. So much has already been accomplished by countless international, governmental, and nongovernmental organizations in the funding and development of projects involving renewable energy systems for these nations. It is incredibly uplifting to view the pictures and read about the amazing work being done to transform uninhabitable conditions into cozy living spaces. The ability to simply cook indoors without gathering a dwindling supply of firewood is a luxury awaiting many more deserving families. Ecosystems, developing societies, and the solar energy market will only benefit from an increase solar PV system installations. Funding for these systems, however, is a challenging aspect when there is so much need. Fortunately, as more and more people give donations and volunteer their professional and technical services, solar energy will become cheaper. The initial installation is basically the only cost, so the investment will simply pay for itself for the rest of its life and for the lives shared beneath its comforting glow.

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