ORIGINAL RESEARCH PAPER

Mechanical Engineering

SOLAR WIND HYBRID ENERGY MODEL

KEY WORDS: Solar Energy, Hybrid System, Wind Energy

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ABSTRACT

The demand for electricity power is increasing day by day, which cannot be met with the satisfied level without non-renewable energy resource. Renewable energy sources such as wind, solar are universal and ecological. These renewable energy sources are best options to fulfill the world energy demand, but unpredictable due to natural conditions. The use of the hybrid solar and wind renewable energy system like will be the best option for the utilization these available resources. The objective of this research paper is to study the various aspects of hybrid solar and wind system. The application and different theories related to the development of hybrid also discussed in this paper.

1. LITERATURE REVIEW

For development of any country energy plays an important role. It is very essential part of growth & economy of country. Our primary source of generating energy is from coal, oil and natural gas. As we all know that energy is needed for industrial, agriculture, commercial and domestic purpose. World's energy demand is increasing day by day. There are many sources of generating energy from coal, fossil fuels, oil and other gases. But all these sources are harmful to the environment so that there are limitations of using these sources and they are limited. Due to global warming and pollution in environment we need clean energy source. In today's world all focus is on Eco green energy, means generating energy without harming environment. In that case we have option of renewable energy sources like solar, wind, small hydro & biomass, bio-fuel etc. Renewable energy is having very much potential to achieve energy demand. But there are also some difficulties occur to use these energy sources, many research is going on to improve the efficiency of renewable energy source. Because main aim is to conserve the natural resources, make system to avoid global warming & carbon emission. Generating energy from renewable source instead of coal or fossil fuel will be cost effective to the country. If we use this renewable source to generate energy it is predicted that it will reduce CO_2 emission . As mentioned above there are many renewable energy sources but wind & solar energy is most prominent. Because if we talk about renewable energy source the first thought is about wind-solar, it is well known source of energy and widely distributed everywhere. Single source of energy such as wind & PV is not totally reliable due to climate change or sunshine in night hours or rainy season and wind speed variation [1]

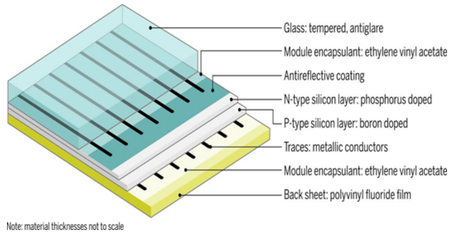
Normally wind & solar energy are separately used to generate power but both are having some losses. Like our environment is changes every day the climate changes affect these systems, solar radiations are not consistent and wind speed varies every time so it affect the system & its performance. Whatever cost require for installing single system it will reduced up to some extent in this combine hybrid system. So instead of using single system, if we combine these two it will help each other to overcome losses. Like when sunshine hour's solar PV system will generate electricity and wind turbine system will extract energy from wind source. When wind conditions are not strong enough to produce power that time its have backup to fulfill load demand & that will generate from the solar system. For more convenience of hybrid wind-solar system many researcher have used different combinations to make system more reliable. They used combination of wind-solar and other sources like diesel/wind/PV, wind/diesel, and PV/diesel hybrid system [2].

Because of its unmatched resource potential, solar energy utilization has been the subject of intense research, development, and deployment efforts that have accelerated during the past decade . Efforts have focused on the development of photovoltaic (PVs) for production of solar electricity, on conversion of solar energy into electricity or heat, and on artificial photosynthetic systems that directly produce fuels from sunlight. The dramatic increases in deployment and concomitant decreases in the cost of solar energy-conversion systems in the past decade attest to the importance of investments in innovation [3].

The cost-effectiveness of terrestrial solar energy systems is dictated by two fundamental constraints. First, as compared with fossil fuels or nuclear fission, the relatively low average terrestrial power density of sunlight, typically ~200 to 250 W/m2, requires very inexpensive materials and systems to cost-effectively cover the large areas needed to capture and convert solar power on a terawatt global scale (2, 3). Second, the intermittency of sunlight requires cost-effective energy-storage technologies to provide energy on demand with high reliability. This review provides an update on many of the developments that have occurred during the past decade (4) and identifies some of the promising opportunities for further research and development (R&D) in light of the present status and economics of solar energy-conversion technologies. [4]

PHOTOACTIVE MATERIALS

Solar cells can be conveniently categorized on the basis of the type of light-absorbing material in the photoactive layer. Devices based on crystalline silicon rely on a p-n junction formed through spatially directed doping of a planar silicon (Si) structure to effect charge separation and to allow for efficient production of photocurrent and photo voltage (Fig. 1) (5, 6). The cost of Si solar panels, measured in dollars per peak watt ($/Wp) has decreased by ~20% for each doubling in cumulative global module production (2, 3). Commercially available Si panels, which accounted for ~90% of total solar panel production in 2013, now have an energy payback period of <2.5 years and ~16 to 21% power-conversion efficiencies (2, 3). The dramatic reductions in panel cost have been realized largely through sustained, systemic reductions in specific manufacturing costs, including those of the polymer encapsulate, the screen-printing of the silver electrical contacts, and even the production of the Si wafers themselves, along with economies of scale enabled by construction of very large panel-production facilities. Research opportunities to further lower costs include methods to integrate higher band-gap materials with Si to create a high-efficiency tandem device in a scalable, cost-effective process that is compatible with existing Si PV manufacturing methods. [5]



(Fig. 1 Components of a typical silicon solar cell.)

Gallium arsenide and other "III–V" single-junction and multifunction PV devices are highly efficient and used on satellites but are currently only considered cost-effective for terrestrial applications by combining small device areas with high-concentration-factor optics that utilize active solar tracking and optical concentrating systems. Opportunities exist for obtaining improved efficiencies through spectral-splitting approaches as well as through novel designs for both one-dimensional (1D) and 2D optical concentration and tracking systems and structures, as well as in development of new approaches to the low-cost growth of high-quality, high-performance III–V monolithic devices and structures

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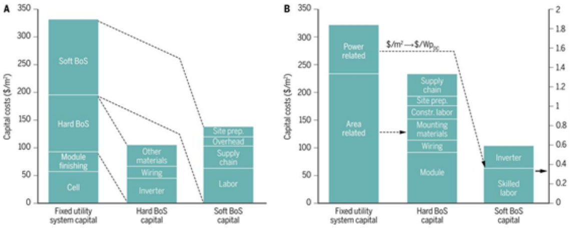
In contrast to active materials based on single-crystal substrates, thin-film materials, such as cadmium telluride (Cd Te), CuIn+GaSe$_2$, amorphous hydrogenated Si, and organic PVs can provide flexible, lightweight modules that could result in reduced system installation costs. Engineered CdS/CdTeheterostructures provide control over junction recombination at the metallurgical interface (*3*). Toxicity concerns related to release of Cd into the environment have been raised, especially in Europe, but have been addressed by rigorous encapsulation of the active material, in conjunction with proposed panel-recycling programs . Scarcity issues related to the availability of Te may preclude scaling of CdTe PV technology to terawatt levels , but the lower CdTe module efficiencies of <15%, as compared with 16 to 21% efficiencies for Si panels, are presently more important considerations in determining the cost-competitiveness of the various PV panel technologies. Research opportunities involve grain-boundary passivation to allow thin films to exhibit the high mobilities and efficiencies of single crystals. Solar cells based on perovskites formed from lead salts with organic ammonium cations have demonstrated that extraordinary performance can be obtained using simple deposition techniques in novel materials systems . The long-term stability of these materials at the highest reported efficiencies remains to be established .Intense efforts are currently being devoted to understanding the fundamental behavior of such systems, as well as to discover other similarly behaving classes of materials that are environmentally benign, do not release toxic lead ions upon dissolution in water, and combine efficiency with stability. Such considerations underscore the complex technological, political, and economic aspects associated with the development a sustainable, cost-effective solar energy-utilization system (*1*) [6].

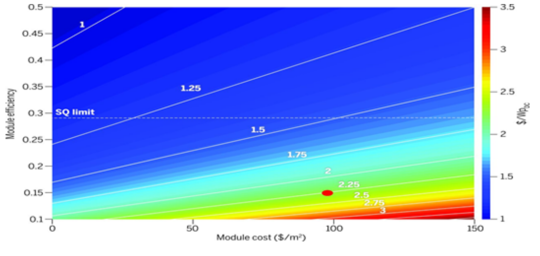
2. BALANCE OF SYSTEMS

The cost of Si solar panels now constitutes ~30% of the cost of a fully installed utility-scale system (**Fig. 2**) (*36*, *37*). The "hard" materials costs, including the inverter, support structures, and electrical wiring, make up ~30% of the system costs. "Soft" costs, including installation labor, permitting, inspection and interconnection, financing, and customer acquisition, make up ~40% of the installed system costs. These balance-of-systems costs have not declined nearly as rapidly as module costs.



(Fig. 2 Breakdown of capital costs for installed utility-scale PV systems.)

For an installation having a specific peak output power, increases in module efficiency would correspondingly reduce the area-related balance-of-systems cost (**Fig. 2B**). Any viable alternative to Si, or any PV technology that leverages or mates with Si PV technology will ultimately have to exhibit long-term stability and superior efficiency at competitive manufactured panel costs. Improvements in efficiency, especially through R&D, that result in the development of new materials and PV systems having efficiencies higher than the S-Q limit, would have more of an impact on lowering the cost of installed solar electricity than proportionate reductions in the manufacturing costs of present Si-based panels, as shown in **Fig. 3**. [7]



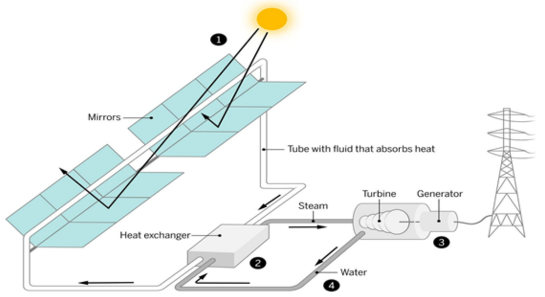
(Fig. 3 Costs for installed utility-scale PV projects as a function of module efficiency and module cost)

To be certified for sale in the marketplace, solar panels are required to contain protective glass that can survive a hailstorm. The cost of the float-glass material is relatively low but the stiffness and weight of the resulting panels produces sizable costs for shipping, requires the use of costly support structures, and produces substantial labor costs for installation. Soft costs are lower in Germany and Australia than in the United States, because permitting and installation processes and protocols have been streamlined . Obtaining much lower installed PV system costs will not only require ultra-lightweight, flexible, robust, and efficient materials and panel technology in the photoactive, encapsulating, and structural components, but also will require disruptive engineering approaches, including very inexpensive support structures, increasing automation, and streamlined protocols that minimize the skill level and effort associated with system installation (**Fig. 3**) [8]

Although the capital costs can be firmly established for a given PV installation (for example, **Figs. 2** and **3**), the leveled cost of electricity (LCOE) depends on the deployment site, which dictates the electrical energy that is produced by the panels over their useful lifetime and requires assumptions involving the discount rate (i.e., the time value of money), useful system life, and operating costs. For utility-scale Si PV systems having fully installed costs of $1.80/Wp, conventional assumptions yield LCOEs of $0.10 to $0.15/kWh, with the lower value for favorable sites, such as in California In 2014, the average U.S. electricity price for large industrial customers, including generation, transmission, and distribution costs, as well as profit, was ~$0.07/kWh [8]

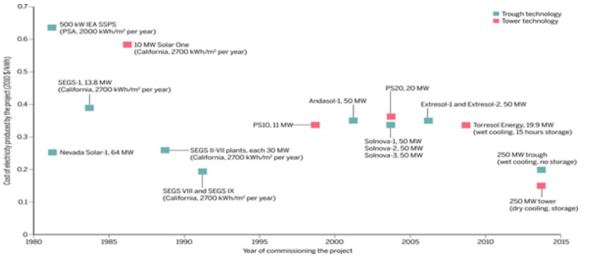
3. SOLAR THERMAL SYSTEMS

The four main types of solar collectors are parabolic trough collectors, linear Fresnel reflectors, power towers (i.e., central receiver systems), and dish-engine systems, which produce local temperatures of 550°C, 550°C, >1000°C, and 1200°C, respectively . To generate electricity, either an oil or a molten salt heat-storage fluid, typically an eutectic mixture of 60 weight % (wt %) sodium nitrate to 40 wt % potassium nitrate, known as solar salt, is heated. The heat then is exchanged to produce steam, which is used to drive a turbine to generate electricity (**Fig. 4**) . Power conversion units are either separate or combined Rankine-Brayton cycles. As of 2014, the installed global capacity of PV was 177 GWp, as compared with <5GWp of solar thermal capacity . Solar thermal installations are preferably sited in regions with a high direct normal irradiance value, typically in desert regions of the southwestern United States or Australia, or, for example, Morocco or southern Spain {9]



(Fig. 4 Schematic of a typical 1D concentrating solar thermal system.)

Although large-scale solar thermal electricity projects were planned both in the United States and in Morocco, driven by mandates, renewable portfolio standards, and low-carbon electricity incentives, the generation costs have proven to be greater than $0.15/kWh when all installation and operational expenses are included Between 6 and 8 hours of storage can be obtained by use of molten salts as the thermal fluid, but compensation for cloudy days requires 36 hours, or more, of storage. Improved thermal storage fluids are an active area of R&D . The all-inclusive costs for solar thermal systems have not declined substantially since the early 1980s (Fig. 5), in contrast to the costs of PV modules and installed PV systems. For example, the Ivanpah Solar Electric Generation system commissioned in 2013 in the Mojave Desert of California is an air-cooled, 392 MW capacity, power-tower system consisting of 300,000 mirrors and three towers. The project had a capital cost of $2.2 billion and is producing electricity under a 25-year power purchase agreement for a price estimated as >$0.13/kWh to the cognizant utilities . Research efforts include development of power cycles that allow for higher-temperature operation, along with the development of advanced materials for the fabrication of the collectors in conjunction with new engineering approaches to the design of the collectors and integration with the rest of the plant . Thermoelectrics could also serve as the technology that converts heat into electricity, provided that their performance can be improved to the necessary levels under the high temperatures that are produced in an operational solar thermal system [10]



(Fig. 5 Chronology of the total installed cost for some large solar thermal projects)

Extensive deployment of either PV or solar thermal electricity-generating systems in remote regions with high direct insolation would require installation of new transmission lines. The Sunrise Power link—a 117-mile-long, 1-GW capacity, 500-kV, >90% above-ground transmission line built between 2010 and 2012 to provide solar and wind power from the Imperial Valley to San Diego—had a project cost of $1.9 billion . Concentrated solar power can also be used to provide a source of heat to drive endothermic chemical reactions. In one demonstration system, solar heat is used as a supplement to process heat, to produce synthetic fuel from CO and H_2 (syngas) by using the Fischer-Tropicprocess . For the solar-driven process to be economically viable, the cost of solar-derived heat must be less than the cost of heat derived from combustion of fossil energy, such as natural gas. The capital costs of the solar thermal part of the facility—including the costs associated with siting constraints, as well as underutilization of the plant during night time and periods of off-peak insolation—must be covered by the value of the solar-derived heat production. [11]

REFERENCES

1. Sunanda Sinha, Prospects of solar photovoltaic–micro-wind based hybrid power systems western Himalayan state of Himachal Pradesh in India, Energy Conversion and Management 105 (2015) 1340–135.
2. Makbul A.M. Ramli et.al, Techno-economic energy analysis of wind/solar hybrid system: case study for western coastal area of Saudi Arabia, Renewable energy 91 (2016).
3. C. Zheng, D. M. Kammen An innovation-focused roadmap for a sustainable global photovoltaic industry. Energy Policy 67, 159–169 (2014). 10.1016/j.enpol.2013.12.006doi:10.1016/j.enpol.2013.12.006 CrossRefWeb of ScienceGoogle Scholar
4. I. S. E. Fraunhofer, PhotovoltaicsReport (2014); https://www.ise.fraunhofer.de/de/downloads/pdf-files/aktuelles/photovo ltaics-report-in-englischer-sprache.pdf.Google Scholar
5. N. S. Lewis, G. Crabtree, Basic Research Needs for Solar Energy Utilization: Report of the Basic Energy Sciences Workshop of Solar Energy Utilization, 21 to 15 April 2005, Washington, DC [Office of Basic Energy Science, U.S. Department of Energy (DOE), Washington, DC, 2005]. Google Scholar
6. DOE, SunShot Vision Study (2012); http://energy.gov/sites/prod/files/2014 /01/f7/47927.pdf. Google Scholar
7. Manners, Alta devices ramping GaAs solar cells with 29% efficiency [blog], Electronics Weekly, 29 October 2012; http://www.electronicsweekly.com /blogs/mannerisms/manufacturing /alta-devices-ramping-gaas-sola-2012-10/. Google Scholar
8. Sharp Corporation, Sharp develops concentrator solar cell with world's highest conversion efficiency of 44.4% [news release] (Sharp Corp., 2013): http://www.sharp-world.com. Google Scholar
9. J. M. Russo, D. Zhang, M. Gordon, S. Vorndran, Y. Wu, R. K. Kostuk, Spectrum splitting metrics and effect of filter characteristics on photovoltaic system performance. Opt. Express 22 (Suppl 2), A528–A541 (2014). 10.1364/OE.22.00A528pmid:24922262doi:10.1364/OE.22.00A528CrossRefPubMedGoogle Scholar
10. California Energy Commission, Recycling of CdTe Thin Film Photovoltaic Panels (2012); http://docketpublic.energy.ca.gov/PublicDocuments/Compliance/09-AFC-6C%20Blythe/TN%2067267%2009-24-12%20Recycling%20of%20CdTe%20Thin%20Film%20Photovoltaic%20Panels.pdf. Google Scholar
11. C. Candelise, M. Winskel, R. Gross, Implications for CdTe and CIGS technologies production costs of indium and tellurium scarcity. Prog. Photovolt. Res. Appl. 20, 816–831 (2012). 10.1002/pip.2216doi:10.1002/pip.2216CrossRefGoogle Schola