Dissemination of knowledge on prospective renewable energy benefits of forest by-products could minimize the irrational deforestation of the precious forest cover of this region. In the past, target-oriented education has prevented the misuse of natural resources, thereby protecting the environment.

participation of relevant stakeholders. The north-eastern region, in general, and Assam, in particular, has some essential characteristics pertaining to various aspects of development. These essential characteristics are also reflected on the available natural resources, which could be potential sources of renewable energy. In this region, success of renewable energy application will require careful consideration of such essential characteristics. Thus, the renewable energy programme of Tezpur University is centred on the (i) precise assessment, mapping, and characterization of locally available natural resources (ii) identification and/ or refinement of locally viable energy conversion technologies (iii) sustainable utilization of such technologies for the socio-economic development of the region.

Q. In your opinion, how significant is the linkage between education, environment, and natural resources?

Rational use of natural resources is immensely important for the benefit of the society. However, lack of proper awareness, linked with associated social factors, results in irrational use of natural resources causing irreparable damage to the environment and also leads to economic losses. Object-oriented education can play a very important role in preventing such harmful impacts. For example, dissemination of knowledge on prospective renewable energy benefits of forest by-products could minimize the irrational deforestation of the precious forest cover of this region. In the past, target-oriented education has prevented the misuse of natural resources, thereby protecting the environment.

Q. What, according to you, are the ways and means to realize the full solar energy potential of the north-eastern region?

As mentioned earlier, the solar energy package for the north-eastern region should suit the regional characteristics, in terms of available radiation and user needs. In general, available solar radiation intensity is lower in the north-eastern region as compared to the northern states of the country. Moreover, spatial and temporal variations, within this region, are also significant. First, the variability should be largely predictable. Second, a preferential list of specific users should be prepared whose demand matches with supply variability. For example, in Assam, solar pump irrigation for paddy fields during autumn could be an area where demand matches availability. Irrigation is critical during the sunny days. With technological upgradation and scale-up factors, coupled with encouraging outcomes from some users elsewhere, use of solar energy in the farm sectors could be economically viable, ensuring favourable growth of solar energy and benefits to farming. Similarly, the tea industry in Assam, where peak processing period synchronizes with maximum availability of solar radiation, could also use solar energy. Thermal energy, mainly for drying, is the predominant form of energy required in the tea industry. The hike in fossil fuel prices has badly affected the economic health of the tea industry. Given that the tea industry is an organized industrial sector in this region, the penetration of economically viable technology will be quicker. Similarly, with appropriate policy and techno-economic

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JOURNAL

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Resources, Energy, and Development focuses on research and integration of knowledge at the interface between resources and development. It provides a forum for comprehensive investigation, analysis, and review of issues in the fields of energy, environment, and natural resource management that confront decision makers, planners, consultants, politicians, and researchers. The current issue focuses on issues of urban sustainable development, particularly city networks, greenhouse gas emissions in urban spaces, and urban land use management.

Forthcoming (September 2011)

Special issue on Forests of South Asia

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- Gender and forests
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Besides our regular curriculum, we are planning to conduct short- and medium-term training courses, targeting the educated unemployed youth of this region on installation, repair, and maintenance of solar energy and other renewable energy gadgets.

intervention, the large-scale introduction of solar thermal and electrical appliances in the domestic, services, and commercial sectors could also be possible.

Appropriate human resource, technology, (preferably with local manufacturing facility for generating employment), and policy backup would be required for the success of large-scale application of solar energy in this region.

Q. The Jawaharlal Nehru National Solar Mission (JNNSM) has been initiated recently. Could you please enlighten us about any specific activities that your department wants to undertake under its purview?

The JNNSM has specifically mentioned the role of academic institutes in the field of research and development and human resource development to create and strengthen skills and enhance indigenous content to make the mission a success. To ensure the expected growth of solar energy, with additional support of other renewable energies, development of trained manpower will be critical. Besides our regular curriculum, we are planning to conduct short- and medium-term training courses, targeting the educated unemployed youth of this region on installation, repair, and maintenance of solar energy and other renewable energy gadgets. Faculty members of our department are involved in monitoring some of the solar energy programmes implemented by various government agencies in rural areas. Even in future, we shall continue to support such activities. Research and development activities pertaining to solar PV and thermal, in accordance with the mandate of the mission, will also be taken up.

Q. Universities such as Tezpur University are generally seen as natural incubators of any new technology development. Could you share information on the research and development activities that are underway in the solar energy area?

Technology related to solar-biomass hybrid mode for thermal application is in the pipeline. Moreover, students are also working on solar tracker and some useful techniques of photocatalytic applications.

The biofuel production from locally available, non-edible resources is one of the major research interests of the department. For this process, technology for substituting conventional thermal energy by solar thermal energy is also under consideration.

Q. The north-eastern region may be in need of a large number of solar technicians for solar energy installations and so on. Is your department running any capacity building initiatives to meet this requirement?

We are aware of such needs that are certainly going to arise in the near future. We have definite plans to meet such demands through a range of short, medium, and long-term programmes, which will train the youth to suit the requirements of the industry. Though, as of now, we do not have any such capacity building programme, but the process of planning is underway and, hopefully, we should be able to start very soon.

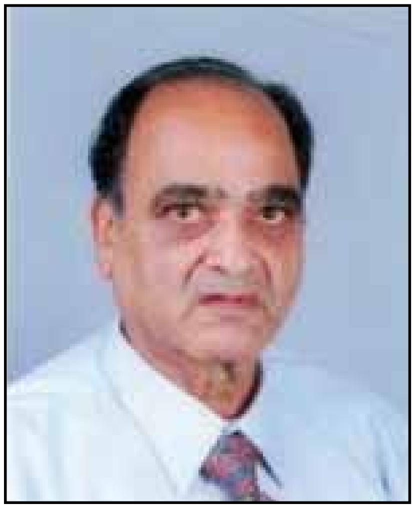
Q7. Do you have any special message to convey to the readers of *The Solar Quarterly* magazine?

We wish *The Solar Quarterly* magazine great success in its endeavour and also call upon its esteemed readers to realize the necessity of managing energy resources and services in a prudent manner for a green and sustainable future.

Courtesy: LaBL

WORKING TOWARDS A SUSTAINABLE FUTURE

Gopal Lal Somani is, presently, the President of Era Energy. In the past, Somani has worked for the Rajasthan Rajya Vidhyut Mandal. He was instrumental in developing the thermal power plants at Kota, Rajasthan. He has also worked towards the mainstreaming of the wind, solar, and biomass power plants. He served as Director of the Rajasthan Renewable Energy Corporation. Gopal Lal Somani is considered an expert on India's solar energy market potential.



From the electrification of 85 remote rural villages with off-grid PV to bringing the 140-MW ISCC Mathania Project in Rajasthan to financial closure, Somani has been at the helm of some of the leading solar energy projects in Rajasthan. He has also worked with the MNRE in establishing renewable energy policies and bankable feed-in tariff structures.

In an interview with Dr Suneel Deambi, Gopal Lal Somani talks about his company's vision, the dream to bring down the cost of solar in India, the projects that he has undertaken (especially in the state of Rajasthan), and the success of the Jawaharlal Nehru National Solar Mission.


Courtesy: LaBL

Q. You are strongly committed to taking your company, Era Energy, to new heights in the area of concentrated solar power generation. Could you kindly share your perception on the issues and prospects of this important method of power generation vis-à-vis your company's plans?

It is my dream to development solar energy at an affordable price in India, irrespective of any specific technology involved, be it photovoltaic (PV) or concentrated solar power (CSP).

It is true that Era Energy has an independent portfolio for developing renewable energy based projects and bringing solar energy projects into the mainstream. The company is aggressively preparing for a long-term investment plan, targeting Jawaharlal Nehru National Solar Mission (JNNSM) and the solar policy in Rajasthan. The company is also working towards the implementation of wind, biomass, and solar energy projects in Rajasthan.

Also, the company is working hard to strengthen its civil, structural, electrical

India has many attractions such as cheap and abundant manpower as well as talented design and engineering skills with a commitment to work hard. Also, it, has the resources and the competence to supply high quality mounting structures, fitting hardware and fasteners, compatibility in civil and electrical works, land, and infrastructure at affordable prices.

team, and sourcing balance of system (BOS) items locally, for the successful implementation of solar energy projects. Using indigenous resources and talents will result in cost cuts and, thus, bring solar energy within affordable limits of the Indian government. The company has registered 150-MW capacity solar energy projects in Rajasthan and is waiting for the solar energy policy to be issued by the Government of Rajasthan (GoR) and the announcement of the second phase by NVVN (NTPC) under the National Solar Mission.

Q. You shot into prominence due to the active association with the 140-MW Integrated Solar Storage Collector (ISSC) project at Maithania. It is understood that you brought it up to the stage of financial closure. However, despite all that, the highly ambitious project has faded into oblivion. Do you feel that it sidelined the solar CSP till the implementation of the JNNSM?

In India, over the last two decades, no development in CSP has taken place. This despite the fact that the western part of Rajasthan has the highest solar radiation (DNI) in the country. The 140-MW ISCC Mathania project, which was touted as one-of-its-kind project the world over, having achieved financial closure in 2003/04, with 35–40 MW, was put on hold. The Ministry of New and Renewable Energy (MNRE), Kfw, Global Environment Facility (GEF), GOR, and Gas Authority of India Ltd (GAIL) agreed on its implementation. In addition, key conditions of a long-term gas supply were finalized with GAIL and the public private agreement (PPA) signed with the Rajasthan Rajya Vidyut Prasaran Nigam Ltd. However, the following are the (known) reasons for the non-execution of the project.

- The CSP technology suppliers who qualified at the bidding stage failed to constitute a consortia group and, thus, extend operational guarantee in an integrated mode.
- The first bidding failed as no bid was received.
- The solar block suppliers did not match the cost of power to the expected/ affordable limit set by the Government of India.
- Capital cost on the solar block equipment remained prohibitive. Globally, the CSP technology remained dead for almost 15 years because of high capital cost. Issues related to long-term guarantees, integration, and technology transfer are the obstacles in the path of investment.
- Even recently, the turnkey EPC cost on CSP plant is prohibitive compared to PV technology as its market collapsed, both in demand and price.
- The Indian government had the vision to demonstrate ISCC technology as the plant would meet base load requirements and also the power produced would be affordable to utilities. Had this project been

implemented, our country would have led the solar community the world over.

Q. You are credited with the solar electrification of about 85 remote villages in the state of Rajasthan. Is this a case of PV grid power success, coming out of the shadow of diminished field performance reliability?

The policy of remote village electrification through off-grid PV solar system had facilitated the villages and *Dhanis* in Rajasthan, which do not have any access to grid power. The electrification of 85 villages in Rajasthan has been a welcome step and has been appreciated by the rural communities.

Q. You have worked quite closely with the policy formulation mechanisms in the area of renewable energy. Do you feel that the recently held bidding process pertaining to Phase I of the JNNSM was responsible for reducing the bid prices?

Yes, I do feel that the bidding process pertaining to Phase I of the JNNSM responsible for reducing the bid prices. A large number of applications were registered with NVVN against 150-MW PV and 480-MW CSP capacity allotments. Such an explosive response and willingness forced NVVN to opt for a competitive reverse bidding process for allotment of projects in a transparent manner. The allottees seem to be quite confident, since they have now entered into a PPA and furnished huge bank guarantees bonds in lieu of their commitment. The results of the transparent bidding process shall revolutionize the solar energy development and lead the solar mission's success.

Q. If so, what redressal measures need to be put in place so as to maintain a balance between the experienced and the less experienced market players?

The declining trend in the price and demand of PV module across the globe, has resulted into an over supply. The buyers of solar equipments are better placed to get quality products at the best price. The inefficient equipment and less experienced suppliers will have a hard time, under the existing circumstances.

Q. Given the present scenario, how optimistic are you about the overall success of the first phase of the JNNSM?

I believe that the first phase of JNNSM will attain full 100% success.

Q. Many argue that the indigenous capabilities to manufacture CSP is absent in our country. Do you subscribe to this point of view?

Except Evacuated Heat Collecting Elements (HCE), all other items of solar block in CSP can be sourced from the Indian market itself. The investors/developers are making serious efforts and are hopeful of their commitment regarding the timely completion of the projects at a cost that is lower, compared to the overseas suppliers.

Q. Is managing the finance for the rollout of CSP projects still a major issue in the country? If so, when should we expect easing out of this situation?

The affordable capital cost of CSP equipment, technical expertise, and commitments to long-term performance shall result in bankable proposals for financial institutions. The process is being streamlined with the help of the Ministry of Power and the MNRE.

Q. Is solar PV a better technology option than CSP considering its effectiveness for meeting various end-use applications? Or do you feel that PV has received more than its due in direct comparison to CSP?

The capital cost, efficiencies, generation yield, and long-term performance are the criterion for acceptability of any technology. The approach to achieve grid parity and the effectiveness of these two technologies will decide which technology is chosen by the end users.

Q. According to several experts, capacity building initiatives in the solar sector are a must. What special message do you wish to convey to the readers of *The Solar Quarterly*, some of whom may well be thinking of making a career in the solar energy sector?

India has many attractions such as cheap and abundant manpower as well as talented design and engineering skills with a commitment to work hard. Also, it, has the resources and the competence to supply high quality mounting structures, fittings hardware and fasteners, compatibility in civil and electrical works, land, and infrastructure at affordable prices. If all these local resources are explored for cost cutting, BOS and installation cost will fall sharply as compared to the EPC cost, which is being offered currently by the overseas suppliers for solar power plants.

Solar energy at an affordable cost, in the near future, will revolutionize India's situation and will lead to employment opportunities, social elevation, economic growth, and self-sustaining power supply.

SOLAR TECHNOLOGICAL UPDATE

Researchers using laser scribing to improve thin-film solar cells

At Purdue University, US, researchers are using an ultra fast pulsing laser to create tiny micro channels in thin-film solar cells to improve their efficiency. In order to connect solar panels into an array, tiny channels need to be etched into the film as cleanly and accurately as possible. Until now, a mechanical process of creating the channels, using a stylus, was the traditional way to etch these micro channels into the thin-film. However, the mechanical stylus method of producing these channels is inefficient, compared to the pulsing laser technique. The mechanical method produces channels, which are not very sharp and well defined, and as a result, less efficient than the super high speed pulsing laser. The pulses from the laser are so fast that there is no heat damage done to the layers of the film. The laser removes the material from each layer of the film in super precise patterns. This process is called 'cold ablation'. The researchers label this as a 'tricky' process as each layer of the film is extremely thin and easy to damage. The pulsing laser produces micro channels of precise depth and sharp edges, which helps to improve the efficiency of the thin-film solar cells. Efficiency reduces the manufacturing cost of the film, and ultimately lowers the cost of installing solar panel systems in private houses and business places.

As of now, thin-film solar counts for about 20% of the photovoltaic market, but is expected to reach 31% by 2013. Thin-film solar is currently used for building facades, rooftop shingles, and skylights, where flexible materials are needed.

Source: www.solarpowerbuzzmedia.com

BioBacksheet passes the critical material property tests

BioSolar, the developer of a breakthrough technology for producing bio-based materials from renewable plant sources that reduces the cost of photovoltaic (PV) solar modules, announced that production samples of its innovative BioBacksheet product have successfully completed all critical Underwriters Laboratories (UL) initial material property tests and will soon obtain the full UL material certification. The initial material property UL certification tests included material identification, partial discharge test, resistance to catching fire, and a long list of other tests that are required before BioBacksheet can be used commercially in solar panels. The last test remaining for BioBacksheet is the measurement of relative thermal index (RTI). A provisional RTI value will be assigned to BioBacksheet. After that, commercial solar panels using BioBacksheet can be submitted for final panel certification or recertification under UL 1703, prior to sale in the general marketplace.

Source: www.biosolar.com

Cree launches industry's first surface mount 1200 V silicon carbide schottky diode

Cree, Inc., a market leader in silicon carbide (SiC) power devices, announced the availability of the industry's first commercial 1200 V surface mount SiC Schottky diode. Packaged in an industry-standard surface mount TO-252 D-Pak, the Schottky diodes deliver the same proven performance as Cree's TO-220 through-hole devices, with a smaller footprint and lower profile. This can enable the design of smaller, lower cost, and more efficient solar power micro-inverters, compared to systems designed with larger and bulkier through-hole parts.

"Our customers designing high-efficiency micro-inverters for solar power applications wanted to simplify their designs without compromising system efficiency. They were looking for a surface mount device that could deliver the same performance as was expected from SiC Schottky diodes-zero reverse recovery losses, high frequency operation with a low EMI signature, and reduced operating temperatures," explained Cengiz Balkas, Vice President and General Manager, Power and RF, Cree. "Given Cree's experience in developing high-voltage

SiC power devices, the move to the surface mount D-Pak was a natural extension of the Schottky diode product line to serve this critical market."

"Design trends in solar power micro-inverters requires the use of surface mount components with smaller footprints and lower profiles," said Alessandro Di Nicco, design engineer new platforms, Power-One. "This enables us to both reduce the size of the inverter circuitry and lower the cost, while maintaining reliability and high efficiency, for physically integrating the micro-inverter into the solar panels. Cree's new surface mount, Schottky diodes, represent a significant step in that development." Cree C2D05120E Schottky diodes are rated for 5 A and 1200 V, with approximate board mounted dimensions of 6.6 mm wide x 9.9 mm long x 2.3 mm high. Operating junction and storage temperature is rated for -55 °C to +175 °C. The C2D05120E surface mount Schottky diodes are fully qualified and released for production use.

Source: www.cree.com/power

Targray unveils advanced solar module lamination diaphragm

One of the key steps in photovoltaic (PV) solar panel production is the lamination of solar modules. This is necessary to protect solar cells from harsh weather conditions and other external influences, and ensure the longevity and reliability of the module. The lamination process involves pumping the air out of the module layers in a vacuum chamber, applying pressure via the diaphragm, which allows the encapsulant to flow, thus, adhering together the delicate sandwich of encapsulant glass cells and the backsheet. The flexible diaphragm is attached to the top of the vacuum chamber, and a set of valves allows the space above the diaphragm to be evacuated. The vacuum process produces a perfectlaminate with no air bubbles or voids in the module for a high and reliable service life. This also maximizes uptime and increases productivity in the solar module lamination process.

Recently, the Targray Technology International launched its ToughSIL Classic solar module lamination diaphragm. Targray is now the global exclusive channel, which will market the Taein Chemical Company's Lamination Diaphragm. The ToushSIL diaphragm is one of the widest laminator membranes available in the market without a seam. Targray's diaphragm also has a consistently high life-cycle count of over 2500 cycles, dependant on set up and operating conditions. This impressive life-cycle is highly repeatable from batch-to-batch due to Taen's advanced proprietary manufacturing process. The material combines a number of important features, including a silicone-base, which does not emit health-hazardous volatile organic compounds (VOCs) as with butyl-based products, excellent elasticity and stability, and a high temperature resistance compared to EPDM diaphragms that do not always perform well when the temperature is high.

Source: www.targray.com

DuPont Microcircuit Materials introduces New Solamet® Photovoltaic Metallization for metal wrap through solar cell designs

DuPont Microcircuit Materials (MCM) has introduced DuPont™ Solamet® PV701 photovoltaic metallization paste as its newest generation of Metal Wrap Through (MWT) technology for back side interconnected silicon solar cell designs. This advanced product composition enables manufacturing of back contact cell designs delivering upto 0.4% greater conversion efficiency for solar cells, and is an important part of the business' roadmap of proposed technology options to help enable the industry goal for conversion efficiency of crystalline silicon (c-Si) solar cells beyond 20% by 2012.

DuPont™ Solamet® PV701 photovoltaic metallization paste is specifically developed to provide 0.4% greater efficiency in MWT cell designs versus standard cell designs. MWT is a specialized cell structure that transfers the bus bars from the frontside to the backside, reducing shading on the frontside of the cell. The connections are made through holes in the silicon with the same composition as the bus bars. Employed as a via paste and p-contact metallization for backside tabbing interconnects, Solamet® PV701 features excellent electrical contact to frontside silver grid structures, high-mechanical strength, low shunting, high-line conductivity, and outstanding solderability as a p-contact metallization. DuPont Microcircuit Materials has over 40 years of experience in development, manufacture, sale, and support of specialized thick film compositions for a wide variety of electronic applications in the photovoltaic, display, automotive, biomedical, industrial, military, and telecommunications markets.

Source: mcm.dupont.com

Quantum developing solar photovoltaic technology that eliminates the use of rare elements

Quantum Solar Power Corporation is developing a solar cell technology that could alter the solar power industry's dependence on rare elements. A rapidly growing sector of the solar cell market is thin-film photovoltaics. Although less efficient than silicon PV (most efficient), thin film is growing rapidly due to its lower manufacturing costs. This growth, however, may be limited by the use of exotic materials in thin-film device manufacture. Leading thin-film devices are based on cadmium telluride (CdTe) and copper indium gallium selenide (CIGS) technologies that utilize the rare elements indium ($285 per kg in January 2009; currently, $530 per kg), tellurium ($150 per kg in January; currently, $295 per kg), and gallium ($450 per kg in January 2010; currently, $750 per kg). These elements are scarce and critical to current thin-film production. Current global electrical consumption is 10 terawatts (10 trillion watts). If thin-film PV solar power is to replace fossil fuel-generated power in the future, it must be scalable to this level of production. Given the current limits on the elements used in its production, thin-film PV faces major challenges in its effort to compete with conventional power generation. Additionally, thin-film PV competes for these rare element resources with flat panel LCD TV's and other electronics. Research suggests that indium might be available only for the next 10 years.

Quantum believes their emerging next generation device (NGD) technology will provide high efficiency solar cells with competitive pricing vis-a-vis coal-generated electricity, without the use of any rare elements.

Source: www.quantumsp.com

Solar3D shapes its operational plan for 3-D solar cell development

Solar3D, the developer of a breakthrough 3-dimensional solar cell technology to maximize the conversion of sunlight into electricity, recently announced its plan to develop the company's solar cell. Inspired by light management techniques used in fibre optic devices, the company's innovative solar cell technology utilizes a 3-dimensional design to trap sunlight inside micro-photovoltaic structures where photons bounce around until they are converted into electrons. The company's management believes that this breakthrough will dramatically change the economics of solar energy.

Solar3D plans to have a working prototype by the end of 2011. During the course of the year, key milestones have been set to guide the efforts of the development team including the following.

- Design of the light-trapping element of the solar cell
- Determination of its expected efficiency
- Design of the 3-dimensional micro-photovoltaic structure of the cell
- Fabrication of prototype

Source: www.Solar3D.com

ROFIN introduces the Powerline L 400 for high-speed edge ablation of thin-film solar modules

With its new PowerLine L series, ROFIN introduced q-switched solid state lasers for thin film removal on glass and flexible materials, ablation of dielectric layers, silicon processing, drilling, and cutting. The q-switched solid state lasers are specifically designed for micro material processing applications, which require high average power and high pulse energy. In the 1064 nm class, ROFIN had great success with the Powerline L 300 for edge ablation of thin-film layers in the production of a-Si/μ-Si, CdTe, and CIS solar cells. Responding to shorter cycle time requirements of various customers, ROFIN has now introduced the PowerLine L 400 featuring higher laser power and shorter pulse length.

Powerline L 100 SHG with top hat beam profile for selective emitter solar cells

Currently, selective opening of dielectric layers and direct laser doping draws a lot of interest in crystalline solar cell manufacturing. For both applications, the frequency-doubled PowerLine L 100 SHG already proved its perfect applicability in mass production to various customers. The laser source offers optimum beam characteristics and sufficient power for large-scale production. Green lasers with 532 nm show the desired near-surface absorption in silicon and can equip a wide range of optical components and fibres. ROFIN now can officially announce the patent-pending beam delivery with a rectangular shaped fibre. This provides a top-hat beam profile and homogenous energy distribution within the entire laser spot area at sufficient depth of focus.

Reliable design and high performance scan heads

The Nd:YAG lasers are efficiently diode pumped and designed for industrially reliable 24/7 operation. The PowerLine L 100 SHG uses a high performance SHG assembly with harmonic generator crystal for frequency conversion. The unique principle of q-switching makes peak pulse performances possible that are 1000 times higher than the cw laser power. This process is repeated with frequencies up to 50 000 Hz. The pulse lengths are in the range of 50–300 ns. Standard configuration includes a fibre delivery to the processing head. Also, optionally accessories such as fibre outcoupling and scan head assemblies, supporting scan speeds of > 10 m/sec at unmatched precision, are being offered.

Source: www.rofin.com

New TCO sputtering targets improve solar cell efficiency

Tosoh SMD's new transparent conducting oxide (TCO) sputtering targets achieves higher solar cell efficiency than standard targets, according to the company. The new TCO targets, composed of either traditional indium tin oxide (ITO) or aluminium zinc oxide (AZO) are available in both planar and rotary configurations. They are also doped with performance-enhancing additives that improves the optical properties of thin films deposited from these targets. One of the enhancements is, notably, increased transparency. This increases the conversion efficiency of solar cells by more than one point, compared with solar cells using thin films from conventional TCO targets. In addition to producing highly transparent thin films, especially in the visible to infrared range, with high thermal stability, even under humid conditions, Tosoh's AZO TCO targets enable the deposition of textured surfaces that enhance light-trapping capability. Compared with thin films from conventional TCO targets, a single-junction thin film deposited by a Tosoh AZO TCO target in a silicon solar cell shows a one-point gain in conversion efficiency. Thin films, meanwhile, produced with Tosoh's ITO TCO target achieve a similar gain in a copper indium gallium selenide (CIGS)-based solar cell.

Source: www.tosohsmd.com

CURRENT R&D SOLAR

Roy Chowdhury Shubhajit, Saha Hiranmay. 2010. **Maximum power point tracking of partially shaded solar photovoltaic arrays.** *Solar Energy Materials and Solar Cells* **94**(9): 1441–1447

Abstract

The paper presents the simulation and hardware implementation of maximum power point (MPP) tracking of a partially shaded solar photovoltaic (PV) array, by using a variant of Particle Swarm Optimization known as Adaptive Perceptive Particle Swarm Optimization (APPSO). Under partially shaded conditions, the PV array characteristics get more complex with multiple maxima in the power-voltage characteristic. The paper presents an algorithmic technique to accurately track the MPP of a PV array, using an APPSO. The APPSO algorithm has also been validated in the current work. The proposed technique uses only one pair of sensors to control multiple PV arrays. This results in lower cost and higher accuracy of 97.7% compared to earlier obtained accuracy of 96.41% by using particle swarm optimization. The proposed tracking technique has been mapped onto a MSP430FG4618 microcontroller for tracking and control purposes. The whole system has been realized on a standard two-stage power electronic system configuration.

Sarhaddi F, Farahat S, Ajam H, Behzadmehr A, Adeli M Mahdavi. 2010. **An improved thermal and electrical model for a solar photovoltaic thermal (PV/T) air collector.** *Applied Energy* **87**(7): 2328–2339

Abstract

In this paper, an attempt is made to investigate the thermal and electrical performance of a solar photovoltaic thermal (PV/T) air collector. A detailed thermal and electrical model is developed to calculate the thermal and electrical parameters of a typical PV/T air collector. The thermal and electrical parameters of a PV/T air collector include solar cell temperature, back surface temperature, outlet air temperature, open-circuit voltage, short-circuit current, maximum power point voltage, maximum power point current, and so on. Some correction are done on heat loss coefficients in order to improve the thermal model of a PV/T air collector. A better electrical model is used to increase the precision of the calculations of PV/T air collector electrical parameters. Unlike the conventional electrical models used in the previous literature, the electrical model presented in this paper can estimate the electrical parameters of a PV/T air collector such as open-circuit voltage, short-circuit current, maximum power point voltage, and maximum power point current. Further, an analytical expression for the overall energy efficiency of a PV/T air collector is derived in terms of thermal, electrical, design, and climatic parameters. A computer simulation programme is developed in order to calculate the thermal and electrical parameters of a PV/T air collector. The results of numerical simulation are in good agreement with the experimental measurements, noted in the previous literature. Finally, parametric studies have been carried out. Since some corrections have been down on thermal and electrical models, it is observed that the thermal and electrical simulation results, obtained in this paper, are more precise than those given by the previous literature. It is also found that the thermal efficiency, electrical efficiency, and overall energy efficiency of PV/T air collector is about 17.18%, 10.01%, and 45%, respectively, for sample climatic, operating, and design parameters.

M Gordon Jeffrey, Babai Dotan, Feuermann Daniel. 2011. **A high-irradiance solar furnace for photovoltaic characterization and nanomaterial synthesis**. *Solar Energy Materials and Solar Cells* **95**(3): 951–956

Abstract

A high-irradiance solar furnace geared towards (a) elucidating the distinctive physics of concentrator photovoltaics and (b) driving high-temperature reactors for the generation of novel nanostructures is described, with target irradiance up to 12 W/sq mm. The opto-mechanical design permits real-sun flash illumination at a millisecond time scale so that solar cells can be characterized with only insubstantial increases in cell temperature even at irradiance levels of thousands of suns.

Kumar Shiv, Tiwari Arvind. 2010. **Design, fabrication, and performance of a hybrid photovoltaic /thermal (PV/T) active solar still**. *Energy Conversion and Management* **51**(6): 1219–1229

Abstract

Two solar stills (single slope passive and single slope photovoltaic/thermal (PV/T) active solar still) were

fabricated and tested at solar energy park, IIT-Delhi, India, for composite climate. The PV-operated DC water pump was used between solar still and PV-integrated flat plate collector to re-circulate the water through the collectors and transfer it to the solar still. The newly-designed hybrid (PV/T)-active solar still is self-sustainable and can be used in remote areas. It needs to transport distilled water from a distance and not connected to grid, but blessed with ample solar energy. Experiments were performed for 0.05 m, 0.10 m, and 0.15 m water depth, round the year 2006/07, for both the stills. It has been observed that maximum daily yield of 2.26 kg and 7.22 kg were obtained from passive and hybrid active solar still, respectively, at 0.05 m water depth. The daily yield from hybrid active solar still is about 3.2 and 5.5 times higher than the passive solar still in summer and winter months, respectively. The study has shown that this design of the hybrid active solar still also provides higher electrical and overall thermal efficiency, which is about 20% higher than the passive solar still.

Pal Singh Parm, Singh Sukhmeet. 2001. **Realistic generation cost of solar photovoltaic electricity.** *Renewable Energy* **35**(3): 563–569

Abstract

A solar photovoltaic (SPV) power plant has long working life with zero fuel and negligible maintenance cost, but requires huge initial investment. The generation cost of solar electricity is mainly the cost of financing the initial investment. Therefore, the generation cost of solar electricity in different years depends on the method of returning the loan. Currently, levelized cost, based on equated payment loan, is being used. The static-levelized generation cost of solar electricity is compared with the current value of variable generation cost of grid electricity. This improper cost comparison is inhibiting the growth of SPV electricity by creating wrong perception that solar electricity is very expensive. In this paper, a new method of loan repayment has been developed resulting in generation cost of SPV electricity that increases with time, same as in grid electricity. A generalized capital recovery factor has been developed for graduated payment loan. In this, capital and interest payment, in each installment, is calculated by treating each loan installment as an independent loan for the relevant years. Generalized results have been calculated, which can be used to determine the cost of SPV electricity for a given system at different places. The results show that for SPV system, with specific initial investment of 5.00 $/kWh/year, loan period of 30 years, and loan interest rate of 4%, the levelized generation cost of SPV electricity, with equated payment loan, turns out to be 28.92 ¢/kWh. However, the corresponding generation cost, with graduated payment loan, with escalation in annual installment of 8%, varies from 9.51 ¢/kWh in the base year to 88.63 ¢/kWh in the 30th year. So, in this case, the realistic current generation cost of SPV electricity is 9.51 ¢/kWh and not 28.92 ¢/kWh. Further, with graduated payment loan, extension in loan period results in sharp decline in the cost of SPV electricity in the base year. Hence, a policy change is required regarding the loan repayment method. It is proposed that to arrive at a realistic cost of SPV electricity, long-term graduated payment loans may be given for installing SPV power plants, such that the escalation in annual loan installments is equal to the estimated inflation in the price of grid electricity with loan period, close to the working life of the SPV system.

Chow T T, Fong K F, Pei G, Ji J, He M. 2010. **Potential use of photovoltaic-integrated solar heat pump system in Hong Kong.** *Applied Thermal Engineering* **30**(8–9): 1066–1072

Abstract

Most buildings in Hong Kong have electric/gas water heaters for hot water supply. An increase in hot water demand has partly contributed to the escalating energy use of the city, in the past decades. A photovoltaic-integrated solar heat pump (PV-SAHP) system, which can be seen as a scientific merge of the photovoltaic/thermal and solar assistant heat pump technology, is proposed as a sustainable alternative. Numerical analysis has been carried out making use of a dynamic simulation model and the TMY weather data of Hong Kong. It was found that the proposed system with R-134a is able to achieve a yearly-average COP of 5.93 and PV output efficiency of 12.1%. The energy output is, therefore, considerably higher than the conventional heat pump plus PV "side-by-side" system. Within a year, the PV-SAHP system has performed better during summers, when the monthly average COP reaches six or higher. Hence, in Hong Kong, its application potential is good.

Hung Chen Hsing, Pang Chuan. 2010. **Organizational forms for knowledge management in photovoltaic solar energy industry**. *Knowledge-Based Systems*. **23**(8): 924–933

Abstract

In recent years, China has made great efforts to combat global warming and achieve zero carbon emission. However, compared to other leading countries, such as Japan and Germany, China is under high pressure to further develop its photovoltaic (PV) solar energy industry, since its technologies are still far behind other countries. In a knowledge-intensive industry and as a participant within a certain industry, a firm needs to develop new products. This is mainly because knowledge has become a critical factor that affects the industry dynamics. In light of this situation, it is essential to propose a strategic policy to facilitate knowledge distribution, knowledge absorption, knowledge creation, and then to obtain competitive advantages. Until now, there has not been any such strategic policy in China. In order

to fulfil this vacancy, a conceptual model is proposed. First, the proposed model examines critical characteristics of successful PV solar energy industry in China. Second, a fuzzy analytic network process is developed to analyse suitable forms of organization for knowledge management in order to distribute existing as well as new knowledge.

Wiginton L K, Nguyen H T, Pearce J M. 2010. **Quantifying rooftop solar photovoltaic potential for regional renewable energy policy**. *Computers, Environment and Urban Systems* **34**(4): 345–357

Abstract

Solar photovoltaic (PV) technology has matured to become a technically-viable large-scale source of sustainable energy. Understanding the rooftop PV potential is critical for utility planning, accommodating grid capacity, deploying financing schemes, and formulating future adaptive energy policies. This paper demonstrates techniques to merge the capabilities of geographic information systems and object-specific image recognition to determine the available rooftop area for PV deployment, for example, in a large-scale region in south-eastern Ontario, US. A five-step procedure has been developed for estimating the total rooftop PV potential, which involves geographical division of the region; sampling using the Feature Analyst extraction software; extrapolation using roof area-population relationships; reduction for shading, other uses, and orientation; and conversion to power and energy outputs. Because, this aspect of the analysis uses an integral approach, PV potential will not be georeferenced, but rather presented as an agglomerate value for policy formulation at the regional level. A link across the region was found between total roof area and population of 70 sq m/capita ± 6.2%. With appropriate rooftops covered with commercial solar cells, the potential PV peak power output from the region considered is 5.74 GW (157% of the region's peak power demands) and the potential annual energy production is 6909 GWh (5% of Ontario's total annual demand). This suggests that 30% of Ontario's energy demand can be met with province-wide rooftop PV deployment. This new understanding of roof-area distribution and potential PV outputs will guide energy policy formulation in Ontario and will inform future research in solar PV deployment and its geographical potential.

Koussa M, Cheknane A, Hadji S, Haddadi M, Noureddine S. 2011. **Measured and modelled improvement in solar energy yield from flat plate photovoltaic systems utilizing different tracking systems and under a range of environmental conditions.** *Applied Energy* **88**(5): 1756–1771

Abstract

This work is performed to investigate the effect of using different sun tracking mechanisms on the performances of the flat plate photovoltaic (PV) system and the main parameters affecting the amount of their electrical energy output and those affecting their gains, compared to the traditional fixed PV systems. Thus, five configurations of sun tracking systems and two traditionally fixed panels have been considered. The sun tracking system's effect on the performances of PV system is improved by using the hourly data collected over 18 days for different weather conditions. The daily cumulative electrical energy produced by the different systems have been quantified separately for different weather conditions and the corresponding electrical gains have then been compared to those experienced with two traditional fixed PV systems. It is found that for a completely clear day, the highest obtained gains are those related to the two-axis sun tracker systems, which decrease gradually from the inclined to the vertical rotating axis when the same optimum slope is applied and from the seasonal to the yearly optimum slope if the same rotating axis is considered. On the other hand, for the partially clear days, the gain amounts are mainly dependant on the clearness index and on the seasonal variation of day length values. For a completely cloudy day, the results show that all considered systems produced closely the same electrical energy and the horizontal position of the PV panel presented the best performance.

Huang Huihui, Li Yuan, Wang Mingjun, Nie Wanyi, Zhou Wei, Peterson Eric D, Liu Jiwen, Fang Guojia, Carroll David L. 2011. **Photovoltaic–thermal solar energy collectors based on optical tubes.** *Solar Energy* **85**(3): 450–454

Abstract

This work examines the use of oil filled tubular optical concentrators coupled with a model organic bulk heterojunction photovoltaic (PV): poly-3-hexathiophene-[6, 6]-phenyl-C61-butyric-acid methyl-ester (P3HT:PCBM) to create a PV–photothermal hybrid solar collector. The organic PV cells were fabricated onto one half of a tubular light pipe and then silicone oil was flowed inside the pipe. This allows solar energy, in visible wavelengths, to be converted into electricity by photocell while, simultaneously, the silicone oil captures the infrared radiation (IR) part of the spectrum as heat energy. The VIS–IR power conversion efficiency for this model organic system, under normally incident AM1.5G illumination was found to be: PCE 28%, which is combined by the photovoltaic efficiency (PCE 2%) and the photothermal efficiency (PCE 26%). It is also observed that the oil filled tube acts as a passive optical element that concentrates the light onto the PV and, thereby, increases its overall efficiency and also the range of incident angles in which the light is efficiently captured.

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DEPARTMENT OF ENERGY
TEZPUR UNIVERSITY

Message from Prof. Mihir K Chaudhuri, Vice Chancellor, Tezpur University, Assam

It gives me immense pleasure to introduce the Department of Energy, Tezpur University, to the readers of *The Solar Quarterly* magazine. Established in the year 1996, Department of Energy is one of the very few full-fledged departments in the entire country, which is completely dedicated to teaching, research, and extension in the cross-cutting areas of energy.

In the present-day context of environment, climate change, and sustainable development, the field of energy is highly dynamic. It has a complex dependence on a number of parameters like development of new and renewable resources, and a gradual shift from the fossil-intensive energy resource portfolio to the renewable energy portfolio, higher energy efficiency coupled with better energy management and, above all, meticulous conservation of the present energy resources.

The Department of Energy has been continuously striving in its endeavour for quality education, high-quality research, and people-centric work. I am happy to state that the department has so far been successful in its endeavour, as is evident from their alumni placement, research publications, and need-based research output.

I am sure that the department will rise to newer heights in their endeavours. I, on behalf of the university community, would like to thank The Energy and Resources Institute (TERI) for selecting Tezpur University's Department of Energy for their publication. I hope this will enable the esteemed readers and others interested to consider the department as their destination for higher studies.

Tezpur University

The Tezpur University was established in 1994, by an Act of Parliament. The main objective of this central university is to offer employment oriented and interdisciplinary courses to meet the regional as well as national aspirations and the development of the state of Assam. Another objective of the university is to offer courses and promote research in areas that are of special and direct relevance to the region and in the emerging areas of science, technology, humanities, and social sciences.

Department of Energy

The Department of Energy started in 1996 with an aim to produce skilled resources in the field of energy, developing new and efficient energy technologies, conducting research and development activities, and extending outreach services in diverse areas of energy. The following are the thrust areas of teaching, research, and extension activities of the department.

i) New and renewable energy sources and technologies
ii) Energy management with distinct focus on policy, economics, and environment
iii) Fossil-based energy recovery, conversion, and utilization

At present, it is a DST-FIST sponsored department. Apart from the teaching and research, the department also organizes training programmes, workshops, and seminars in the relevant areas of energy.

Academic programmes

The department offers the following programmes.

i) Two-year (four semesters) The All India Council for Technical Education (AICTE)-approved MTech programme in energy technology
ii) PhD in energy related areas

MTech in energy technology

The department offers a two-year AICTE- approved MTech programme in energy technology. This programme was started in 2000, primarily to create manpower with comprehensive understanding on energy systems with focus on resources and technologies, policies and economics, and environment and sustainability.

The alumni of the department are working in organizations/institutes such as GE Energy, The Energy and Resources Institute (TERI), Winrock, TUV-Nord, TUV-Rheinland, Siemens, SGS India, Ministry of New and Renewable Energy (MNRE), Tezpur University, North Eastern Regional Institute of Science and Technology (NERIST), Sikkim Manipal Institute of Technology (SMIT), AMITY University, Maulana Azad National Institute of Technology (MANIT), and so on. Apart from that, the alumni are also pursuing higher studies at various Indian Institutes of Technology (IITs), India; National University of Singapore (NUS), Singapore; Nanyang Technological University (NTU), Singapore; Heriot-Watt University, UK; Cardiff University, UK; Chubu University, Japan; University College of Cork, Ireland, and so on.

Curriculum

MTech in Energy Technology

The two-year MTech (Energy Technology) programme is designed encompassing 12 core courses (theory and laboratory), two elective courses (out of eight choices), and project works. The curriculum has a right balance of theory and experiment, covering courses on renewable and traditional sources of energy.

First semester

- Fuel technology
- Biomass energy
- Solar energy utilization
- Heat transfer
- Other non-conventional energy sources
- Numerical methods and computational techniques
- Energy laboratory-I

Second semester

- Power plant engineering
- Energy, ecology, and environment
- Energy management and auditing
- Energy economics and planning
- Energy laboratory-II
- Elective-I and Elective-II (advanced bio-energy, advanced solar thermal energy, solar photovoltaic energy, petroleum refining, petroleum exploration, drilling and production, wind energy utilization, hydrogen energy and fuel cell and energy, climate change and carbon trade)

Third and fourth semesters

Students undergo major project (part I) and major project (part II) in these two semesters. Core courses are designed for a broad-based study in the main fields, whereas, elective courses enable diversification of training and broadening of the outlook. Theoretical knowledge gathered during the first two semesters are applied through project work in practical field problems.

Intake, eligibility, and admission procedure for MTech

The present intake capacity for the MTech course is 35. Candidates with BE/BTech/AMIE in mechanical/ electrical/electronics /instrumentation/ chemical/agricultural engineering/ energy engineering or MSc in physics and chemistry with a minimum of 50% marks in aggregate are eligible to apply. Students are selected on the basis of performance in the Tezpur University Entrance Examination, conducted in specified centres throughout the country in the last week of May every year (details are available on the website). The Graduate Aptitude Test in Engineering (GATE)-qualified candidates get preference. Seats are reserved as per the Government of India rules. Some seats are also reserved for sponsored candidates, provided they qualify the Tezpur University Entrance Examination.

MTech scholarships

There is provision for scholarships for meritorious MTech students from different government agencies, such as AICTE, MNRE, North Eastern Council, University Grants Commission (UGC), and Oil and Natural Gas Corporation Limited (ONGC).

PhD in energy

Eligibility and selection

Candidates with MSc/ME/MTech degree in energy technology/ energy management/ energy related engineering and technology/physics/ chemistry/agriculture/allied subjects are eligible to apply for PhD programme. Selection of candidates is strictly done on the basis of merit, which is based on the qualifying examinations, performance in the entrance test, and interview.

Research areas of PhD programme

- Bio-energy (different aspects of bio-diesel, such as identification of sources, process improvement, engine testing and modelling, socio-economic analysis; wood energy,

biomass gasification and utilization, conversion of biowaste into energy through thermo-chemical and mechanical routes)

- Solar energy and energy materials (bio- and-waste based CNT, solar thermal optimization, photocatalysis)
- Energy management and planning (GIS-based renewable energy resources mapping, rural energy planning, spatial energy modelling)
- Energy-environment interaction (sustainable mitigation of oil field pollution)

PhD fellowships

In addition to the Tezpur University PhD fellowship, research scholars can also avail scholarships from different government Agencies, such as MNRE and UGC, as per specific procedures. There is also provision for assistance from sponsored research projects of the department.

Laboratories and other facilities

The department is equipped with various specialized equipments and energy conversion gadgets such as bio-diesel production pilot plant, PV power plant (1 kW), biomass gasifier systems for thermal and electricity generation, laboratory scale hydro-electricity power plant, wind electric generator, solar thermal collectors' including test set-up, solar dryer, IC engine test rigs for engine performance testing (computerized), devices for measurement of solar and wind data (including automatic weather station), digital power analyser, bio-diesel characterization facilities (including calorific value, viscosity, density, oxidation stability, pour point, flash point, acid value as per ASTM standard), fibertech apparatus, exhaust gas analyser, air quality monitor, UV-visible spectrophotometer, TOC analyser, hydrocarbon type analyser, pyrolyser, vacuum distillation apparatus, ultrasonicator, programmable muffle furnace, and so on.

A good number of books on diversified areas of energy are available in the department. A number of national and international journals related to energy are also subscribed. The department also houses one of the computer clusters with 31 personal computers with LAN connectivity and adequate scanning and printing facilities for students.

Research and extension activities of the Department of Energy

The department is actively engaged in research in emerging areas of energy, such as solar, biomass, bio-diesel, energy conservation, management and planning, as a result of which quality articles, in the national and international journals, are regularly published. Some promising technologies, primarily on waste-to-energy conversion, are also in the pipeline. Seeds of indigenous tree species have been identified as prospective sources of bio-diesel production. Externally funded research projects are being carried out in the department, besides research collaborations with national and international organizations such as IIT, Chennai; IIP Dehradun, University of Nottingham, UK; Abu Academy University, Finland, in specific areas of research.

Manpower generation and future plan

Till date, 97 students have obtained MTech degrees from this department and are posted in different parts of the country, as well as outside the country. During the initial period, the department also produced 27 PG Diploma/Diploma in renewable energy and non-conventional energy technology. Six scholars obtained PhD degrees from this department in diverse fields of energy and all are serving in various reputed organizations.

The department foresees cumulative production of about 150 MTech degree holders in energy technology besides about 15 PhD degrees by the year 2015. The department also plans to introduce short-term employment-oriented courses on renewable energy technologies and master's degree course on energy management, suiting the needs of working professionals, in near future.

Faculties

- Prof S K Samdarshi: solar energy, energy material synthesis and testing, photocatalysis)
- Prof D C Baruah: energy management, renewable energy planning (head of the department)
- Dr D Deka: bio-energy, energy-environment, wood energy
- Dr Rupam Kataki: biofuels, energy, and environment interface
- Dr Dilip Kumar Bora: performance, engine testing, and assessment of alternative fuels
- Sadhan Mahapatra: biomass gasification, climate responsive buildings, decentralized energy options, energy conservation.

For further details contact

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The Energy and Resources Institute

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SIMULATING ENERGY NEEDS OF RURAL HEALTH CLINICS

Dr Suneel Deambi, Consultant, TERI <sdeambi@airtelmail.in>

Background

By the end of 2011, the world population is expected to reach seven billion. Out of this, about 37% of the world population will reside in China and India. In fact, Asia constitutes about 60% of the total global population. In other words, a very large portion of the world population resides in the developing countries. Unfortunately, even today, many regions of the developing countries, especially the remote rural areas, often lack access to conventional power. And, one of the outcomes of this is the absence of well-equipped rural health clinics. These are required to store vaccines at a minimum prescribed temperature, for example, under the Cold Chain Programme initiated by the World Health Organization (WHO). Few rural health clinics in the developing countries may have grid connection, but suffer from frequent power cuts. Thus, it becomes quite important to power such clinics using alternate energy sources like solar energy or an appropriate mix of solar, wind, and biomass.

HOMER: showing the way

We have already covered the use of HOMER software for system designing in previous issues of this magazine. Very recently, HOMER Energy has created a simplified interface to HOMER and designed it as an online tool. It delivers valuable information in a user-friendly format within no time. It has been sponsored by the US Agency for International Development (USAID). The programme is quite appropriately named as, "Powering Health". This new optimization model from HOMER takes into account a mix of energy sources like diesel generators, batteries, grid power, and photovoltaic arrays. The following are the most important steps, which need to be followed by a system designer.

Location and time zone

We all know that the amount of energy received from the sun depends on the location. HOMER obtains monthly average solar resource values from a number of databases at the National Renewable Energy Laboratory (NREL) and the National Aeronautics and Space Administration (NASA). These are calculated based on the longitude and latitude of a given site accompanied by the satellite measurements of annual cloud cover.

Power assumptions

There are certain areas where grid power is available for only some part of the day. In such locations, the grid power timings can have a significant bearing on the design of a suitable power system. Further, the availability and cost of supply and associated installation of a photovoltaic (PV) array, batteries, and diesel fuel will change, in accordance with the site under consideration.

Electrical load inputs

A table is provided to choose the list of equipments that suit the needs of a rural health clinic. The power ratings of the chosen equipment are also available in this table. It is important to mention here that the peak power demand, along with the time of day, has some bearing on the size of equipment. Thus, one should be aware of all these aspects prior to working on this improved model of HOMER.

Financial assumption

This specific model also gives a clear idea of initial capital cost, future operating cost, interest rates, discount rates, and so on. It is quite clear that lower rates of interest will tilt the ultimate choice more towards PV, in direct comparison to a diesel generator.

To conclude

Make sure that all the desired values are provided as inputs, following which, HOMER will analyse all possible combinations of the power supply options. Then it is up to an end user to pick up the most suitable choice. The cost per unit of power generated from such choices is evaluated for the sake of comparison. In all, it is quite a useful tool bound to have a positive impact on rural health.

SOLAR-CHARGED USB DRIVE

If we take a USB drive, put a solar panel on it, make it compatible with a number of portable devices, then we get what is know as the Solmate Fusion USB drive with an embedded solar panel. In other words, the Solmate Fusion is a mini charger that can be used wherever you go.

The Solmate Fusion is a portable mini charger that keeps your mobile devices juiced up wherever you go. The Fusion automatically charges its internal battery when it is exposed to sunlight. It also charges from the USB port of your computer, even as its in-built flash memory is being used to store or transfer data. The charging time varies depending on the mechanism used to charge the port, with the 5.5 V, 45 mA panel fully filling up the battery in up to eight hours under normal sunlight, while the USB takes up to a maximum of three.

At present, the Solmate Fusion is available in 4 and 8 GB memory configurations. Also, these USB drives can charge as well as transfer data back and forth in a host computer, simultaneously. Also, a generic USB cable can be connected into the Fusion's build-in USB port to charge the device. A variety of tips come with the drive for compatibility with a wide range of devices, with other tips available for purchase separately, either from the company or through various retail outlets.

The Solemate Fusion is available with four adapter tips that enable compatibility with a range of devices.

➔ Standard adapter tips (included with the product)

- Micro USB tip (Compatible with select new generation smart phones from Blackberry, HTC, Samsung, and so on)
- Nokia small round tip (compatible with current generation Nokia phones)
- Sony Ericsson tip (compatible with current generation Sony Ericsson phones)
- Samsung S20 series tip (compatible with all Samsung S20 pin phones)

The only thing that is not mentioned very clearly is how long it will take for the Solmate Fusion to recharge a connected device's battery.

➔ Solmate fusion specifications

- Solar panel: 5.5 V, 45 mA
- Li-ion battery: 3.7 V, 600 mAh
- USB input: 5 V, 500 mA
- USB output: 5 V, 300 mA
- USB charging time: 2.5–3 hrs
- Solar charging time: About 8 hrs (Subject to light conditions)
- Flash memory capacity: 4GB

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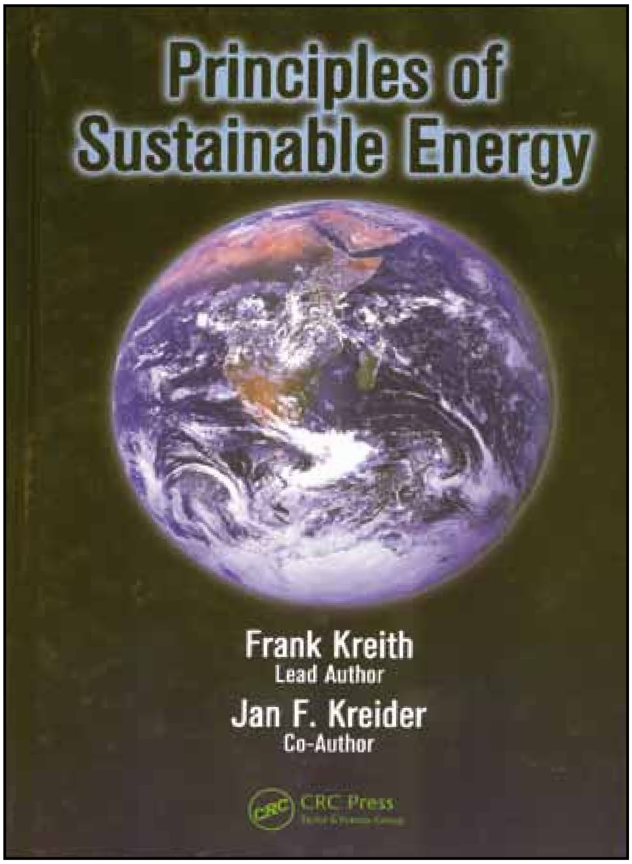

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Pages: **855 pp.**
Publisher: **CRC Press**

This book is a combination of lecture notes for a course on sustainable energy and the contributions by experts in wind energy, passive solar design, bioconversion, and so on. This book is not merely a revised edition, but has also changed its focus, mainly because the transition from a fossil fuel-based economy to a sustainable energy system that utilizes renewable energy sources has now become inevitable and that this transition along with economic and environmental considerations will also pose a challenge for engineers. This book can now be used for engineering courses that have a broad perspective for planning a sustainable energy future. It is also suitable for courses that give importance to solar thermal energy technology. The book is designed for courses at the senior or first-year graduate level in engineering, and assumes that the reader has a basic understanding of thermodynamics and heat transfer, as well as knowledge of spreadsheets and computer skills. During the past decade, the National Renewable Energy Laboratory (NREL) and other organizations have developed websites that make it possible to obtain information regarding renewable energy.

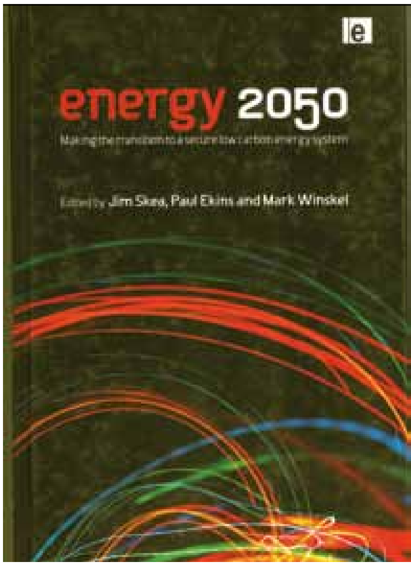
Chapter 1 of this book presents an overview of the physical limitations that the global availability of water, food, and energy place upon a sustainable population of our planet. It emphasizes the interrelation between the social, economic, environmental, and technical aspects of the sustainability challenge. It presents a summary of available resources, options for energy generation and conservation, and the need to consider the financial ramifications, as well as the energy return on energy investment of various technologies for future energy generation.

Chapter 2 covers the fundamentals of engineering economics with emphasis on the levelized cost of both energy conservation and generation. It also introduces a convenient method of estimating the energy return on energy investment (EROI) of technologies for conservation measures and generation of energy. Chapter 3 deals with wind energy, which is, at present not only one of the most advanced renewable technologies, but is also economically competitive with fossil fuels. Moreover, it has the highest return on energy investment of all renewable energy generation technologies. This is followed by chapter 4 on biomass and biofuels, which are likely to play an important role, particularly in the future transportation sector. Chapter 5 deals with the fundamentals of solar radiation, followed by photovoltaic (PV) energy in chapter 6. PV is currently experiencing an exponential growth in deployment, both for rooftop applications and for utility scale generation of electricity and its cost is constantly decreasing. Traditional topics related to solar thermal heating and cooling, process heat, and power are presented in chapters 7 and 8, followed by passive solar design methods and day lighting in chapter 9. Part of chapter 8 is devoted to technologies for concentrating solar radiation, because this may be an important facet of several future sustainable technologies.

Chapter 11 deals with ocean energy. Despite many ideas that have been proposed for conversation technologies such as wave and ocean thermal, the future of this form of energy is uncertain mainly because no major plants have been built. The final chapter (chapter 12) deals with ground transportation, which will become increasingly important as the availability of oil diminishes and its prices escalate. The book has covered EROI and economics of nuclear power, but not the details of nuclear fuel technology. Several well-known authors have contributed towards this book. Dr Gary Pawlas has written the chapter on wind energy. The chapter on biomass and biofuels has been contributed by Prof. Robert Brown and Dr Mark M Wright.

The field of sustainable energy is vast and changing rapidly. A single book cannot cover all aspects of sustainable and renewable energy. Therefore, it has provided a list of websites that the reader will find useful and, which can give them an insight into any topic covered in the book.

NEW BOOK INFORMATION



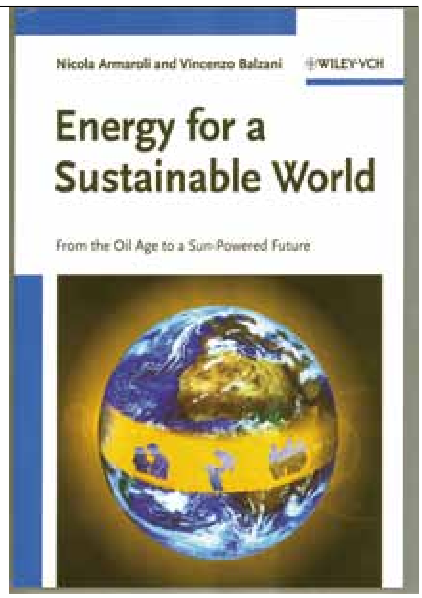
Edited by Skea J, Ekins P, and Winskel M
Earthscan, 381 pp.
Year: 2011

Energy 2050: making the transition to a secure low carbon energy system

The U32K is committed to reducing its greenhouse gas emissions by at least 80% by 2050, a target that will only be achieved by transforming the way that energy is supplied and used. At the same time, there are anxieties about the security of energy provision in terms of European dependency on natural gas and the reliability of electricity supply. This book explores in detail the factors, which could help or hinder the attainment of the UK's climate change targets, and examines how these factors interact with the parallel objective of maintaining a robust and secure energy system. The book is the result of a major national energy research effort by the UK Energy Research Centre, which includes some of the UK's leading energy experts. The results and recommendations are essential reading for policy-makers, professionals, researchers, and anyone concerned with achieving large-scale reductions in carbon emissions, both from the UK and other parts of the world.

Energy for a Sustainable World: from the oil age to a sun-powered future

An easy read, balancing the pros and cons, this book surveys the energy issue from a broad scientific perspective, while considering environmental, economic, and social factors. It explains the basic concepts, provides a historical overview of energy resources, assesses our unsustainable energy system based on fossil fuels, and shows that the energy crisis is not only a tough challenge, but also an unprecedented opportunity to become more concerned about the world in which we live and the society that we have built. By outlining the alternatives for today and the future, it gives an extensive overview on nuclear energy, solar thermal and photovoltaics, solar fuels, wind power, ocean energies and other renewables, highlighting the increasing importance of electricity and the long-term perspective of a hydrogen-based economy. An excellent source of updated and carefully documented information on the rather complicated issue of energy, this book is a guide for scientists, students, and teachers, looking for ways out of the energy and climate crisis, and the problems and disparities generated during the fossil fuel era.



Nicola Armaroli and Vincenzo Balzani
Wiley-VCH Verlag GmBH and Co., KGaA, Germany, 368 pp.
Year: 2011

Build It Solar

Build It Solar is a renewable energy site for do-it-yourselfers. The website contains plans, tools, and information to carry out renewable energy and conservation projects. The website contains hundreds of projects, from changing a light bulb to building a solar home. It also contains design information and tools for building renewable energy projects. It also has an experimental section for backyard inventors.

http://builditsolar.com/

National Renewable Energy Laboratory

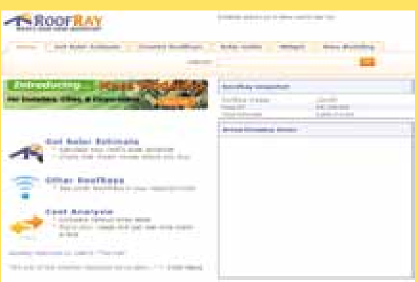
The National Renewable Energy Laboratory (NREL) is the only federal laboratory dedicated to the research, development, commercialization, and deployment of renewable energy and energy efficiency technologies. The website contains all the information about the NREL, including general information about the laboratory, how to locate the NREL employees, how we operate and do business, and how one can do business with the NREL. The website has a very impressive image gallery, specifically on solar energy.

http://www.nrel.gov/

Nanosolar

At Nanosolar, the mission is to reinvent the design and manufacturing of photovoltaics to create the lowest cost solar cell and panel. To that end, the organization persistently pursues innovation and refuses to accept the limitations of existing approaches and practices. The website offers a preview into how the innovative and new solar technology will impact the trillion-dollar energy market. The website also contains details about solar power plant built with the nanosolar utility panel. The website has all the information about nanosolar utility panel. The website also gives details on rooftop-mounted and ground-mounted technologies. The website has details about the various project partners.

http://nanosolar.com/



RoofRay

RoofRay is a solar array modelling service and community determined to help consumers evaluate solar for their home or business and to create greater awareness for solar overall. Thus, the website provides all the details how to create solar array, the current electrical cost, financial analysis, and free estimates. The website also has a separate news section, which has the latest news about solar photovoltaic, solar arrays, and so on. The website also has separate sections on solar modelling application for citizens, Roofray's modelled marketing services for installers, full regional modelling for cities and corporations, and so on.

http://roofray.com/

NATIONAL AND INTERNATIONAL EVENTS

National

PV+Solar India Expo 2011
19–21 April 2011
Mumbai, India
Tel 91 22 26730-869
Fax 91 22 26730-547
E-mail sswarn@bom5.vsnl.net.in
Website www.electronicstoday.org

World Renewable Energy Technology Congress and Expo 2011
21–23 April 2011
New Delhi, India
Tel 91 99 71500028
Fax 11 43019379
E-mail dranilgarg@wretc.in
Website www.wretc.in

Renewable Energy World India 2011: conference and exhibition
5–7 May 2011
New Delhi
Tel +44 1992 656 621, +91 124 4524102
E-mail amyn@pennwell.com, aarti@interadsindia.com
Website www.renewableenergyworldindia.com

International

7th International Congress and Exhibition on Energy Efficiency and Renewable Energy Sources for South-East Europe
13–15 April 2011
Sofia, Bulgaria
Tel/Fax +359 32/ 945459, 960011
E-mail office@viaexpo.com
Website www.viaexpo.com

The Solar Future Netherlands III
21 April 2011
Utrecht, the Netherlands
Tel +32/10/280-9198
Fax -7265
Email info@solarplaza.com
Website www.thesolarfuture.nl

Ecomed 2011: conference and exhibition
27–30 April
Hammamet, Tunisia
Tel +261/71/454545271
Fax 71452189
Email communication@medina.com.tn
Website www.ecomed-exp.com

Santa Barbara Summit on Energy Efficiency
26–27 April
Santa Barbara, California, United States
Tel 805-893-4191
Fax 805-893-7119
E-mail information@iee.ucsb.edu
Website www.iee.ucsb.edu/sbsee2011

4th International Exhibition on Renewable Energy and Environment in Africa
27–30 April 2011
Dakar, Senegal
Tel (221) 33.865.66.88
Fax (221) 33 824 21 91
E-mail info@sinergie-afrique.com
Website www.sinergie-afrique.com

2011 China (Tianjin) International Solar and Photovoltaic Engineering Exhibition
28–30 April 2011
Tianjin, China
Tel +86 10 65426818
Fax +86 10 65702428
E-mail weina16888@163.com
Website www.tice-expo.com

12th Solarexpo: International Exhibition and Conference on Renewable Energy and Distributed Generation
4–6 May
Verona, Italy
Tel +39 0439 84 98 55
Fax +39 0439 84 98 54
E-mail marketing@solarexpo.com
Website www.solarexpo.com

Trade fair: Genera 2011
11–13 May
Madrid, Spain
Tel +34/91/7225-000
Fax -788
E-mail genera@ifema.es
Website www.ifema.es

4th European Renewable Energy Policy Conference (EREC 2011)
23–24 May
Brussels, Belgium
Tel +32/2/5461 93-3
Fax -4
E-mail erec@erec.org
Website www.erec.org

International Renewable Energy Fair
24–26 May
Poznan, Poland
Tel +48/61/8692-000
Fax -999
E-mail joanna.kucharska@mtp.pl
Website greenpower.mtp.pl/en

2nd Photovoltaic Technical Conference 2011
25–27 May
Aix en Provence, France
Tel +33/4/4217417-4
Fax -5
E-mail contact@photovoltaic-technical-conference.com
Website www.photovoltaic-technical-conference.com

BITEC: conference and exhibition
1–4 June
Bangkok, Thailand
Tel +662/642/691-1313
Fax -920
E-mail info@cmpthailand.com
Website www.entechpollutec-asia.com

2nd Symposium: small PV applications, rural electrification and commercial use
6–7 June
Ulm, Germany
Tel +49/941/29688-29,
Fax -17
E-mail gabriele.struthoff-muell er@otti.de
Website www.otti.de

INDUSTRY REGISTRY

SOLARTEC S R O

Photovoltaic solar cells producer (standard. concentrator, colour for shingling) and PV modules producer.

Televizni 2618, CZ-75661 Roznov p R
Czech Republic
Tel +42/575/750-011
Fax -038
E-mail solartec@solartec.cz
Website www.solartec.cz

SPECTRAWATT

Manufacturer of high performance multicrystalline silicon solar cells.

8334 Zip 23A, 2070 Route 52
Hopewell Junction, 12533 USA
Tel. +1/845/440-2100
Fax +1/503/844-4270
E-mail sales@spectraWatt.com
Website www.spectraWatt.com

TARGRAY TECHNOLOGY INTERNATIONAL INC.

Targray is a worldwide, full line supplier of raw materials and consumables to leading manufacturers within the solar cell and module industry.

18105 Transcanadienne
Kirkland Quebec, Canada H9J3Z4
Tel +1/514/695/8095
Fax -0593
E-mail info@targray.com
Website www.targray.com

BHEL ELECTRONICS DIVISION

Manufactures and supplies solar cells and PV modules and undertakes concept to commissioning of PV systems.

P B 2606, Mysore Road
Bengaluru, India
Tel +91/80/26989171
Fax 26989217
E-mail scpv@bheledn.co.in
Website www.bheledn.com

CANADIAN SOLAR INC.

Canadian Solar Inc. is a vertically integrated manufacturer of ingots, wafers, cells, solar modules, and custom-designed solar power systems.

650 Riverbend Drive,
Suite B, Kitchener
Ontario Canada N2K 3S2
Tel +1-519-9542057
E-mail inquire.ca@canadian-solar.com
Website www.canadian-solar.com

KINVE SOLAR

Vertically integrated PV manufacturer specializing in the production, sale, and research and development of ingots, wafers, cells, and modules.

Meishan Road 2, Maanshan ETDT
Anhui, China
Tel +86/25/84571161-801
Fax -804
E-mail market@kinve.com
Website www.kinve.com

MOTECH INDUSTRIES INC.

Motech is one of the largest solar cell manufacturers worldwide.

No 2, Da-Shun 9th Road, Hsin-Shi
Tainan 74145, Taiwan
Tel +886 6 5050789
Fax +886 6 5051789
E-mail sales_marketing@motech.com.tw
Website www.motech.com.tw

SYNERGY RENEWABLE ENERGY (P) LTD.

Specialized in designing and manufacturing of high quality and high efficiency mono and polycrystalline modules..

35- Rowland Road, Kolkata - 700020
India
Tel +91/33/24745146
E-mail reachus@synergysolar.in
Website www.synergysolar.in

PHOCOS AG

Manufacturer of solar charge and hybrid system controllers 12 to 48 V, 4 to 300 A, CFL and LED lamps, solar refrigerators, micro hydro turbines, and fuel cell hybrid systems..

Magrius-Deutz Standard 12
D-89077 Ulm, Germany
Tel +49/731/9380688-0
E-mail info@phocos.com
Website www.phocos.com

CALCARB LTD.

Innovative solutions for the solar and semiconductor industries.

11 Woodside, Eurocentral
Holytown ML1 4XL , Scotland UK
Tel +44/1698-838710
Fax -838711
E-mail sales@calcarb.com

M+W GROUP

M+W Group's solutions range from polysilicon plants, through production of ingots, wafers, cells and modules, to setting up power plants in PV parks or even with alternative solar-based technologies.

Lotterbergstr 30, 70499 Stuttgart, Germany
Tel +497118804 -1900
E-mail photo@mwgroup.net
Website mwgroup.net

OTB SOLAR B V

Offers solar cell manufacturing equipment

Luchthavenweg 10
NL -5657 EB Eindhoven
Postbus 7005, 5605 JA Eindhoven
The Netherlands
Tel +31(0) 40 2581
Fax +31 (0)40 2509 855
E-mail info@otb-solar.com
Website www.otb-solar.com

RENEWABLE ENERGY AT A GLANCE

S.No.	Source/system	Estimated potential	Achievement as on 31 December 2010
I	**Power from renewables**		
A	**Grid-interactive renewable power**	(MW)	(MW)
1	Wind power	45 195	13 065.78
2	Bio power (agro residues and plantations)	16 881	997.10
3	Bagasse cogeneration	5 000	1 562.03
4	Small hydro power (up to 25 MW)	15 000	2939.33
5	Energy recovery from waste (MW)	2 700	72.46
6	Solar photovoltaic power	—	17.82
	Sub total (A)	**84 776**	**18654.52**
B	**Captive/combined heat and power/distributed renewable power**		(MW)
7	Biomass/cogeneration (non-bagasse)	—	274.22
8	Biomass gasifier	—	128.16
9	Energy recovery from waste	—	67.99
10	Aero generator/hybrid systems		1.07
11	Rural waste-to-energy	—	0.45
12	Solar PV power plants and street lights (>1 kW)	—	4.42
	Sub total (B)	**—**	**483.83**
	Total (A+B)	**—**	**19138.35**
II	**Remote village electrification**	—	8033 villages/hamlets
III	**Decentralized energy systems**		
13	Family-type biogas plants	120 lakh	43.10 lakh
14	Solar photovoltaic systems		
	i. Solar street lighting system	—	122 697 nos
	ii. Home lighting system	—	656 707 nos
	iii. Solar lantern	—	817 369 nos
	iv. Solar power plants	—	2.92 MW_p
	v. Solar photovoltaic pumps		7495 nos
15	Solar thermal systems		
	i. Solar water heating systems	140 million m^2 collector area	3.97 million m^2 collector area
	ii. Solar cookers		6.64 lakh
16	Wind pumps		1352 nos
IV	**Awareness programmes**		
17	Energy parks	—	511 nos
18	Aditya Solar Shops	—	302 nos
19	Renewable energy clubs	—	521 nos
20	District Advisory Committees	—	560 nos

MW – megawatt; kW – kilowatt; MW_p – megawatt peak; m^2 – square metre; km^2 – kilometre square
Source www.mnre.gov.in