also watch out for snakes and poisonous insects. The job is now made easier with the solar lantern guiding the way.

Crop protection and avoidance of man-animal conflict

Attempts at wildlife conservation, especially in the areas of human habitation, are largely viewed as wrongly placed priorities. Particularly, in the protected areas, natural conservation and community welfare are not expected to go hand-in-hand. This myth of conflicting objectives of conservation and social welfare has been broken by TERI's solar lighting campaign. It has now largely met the dual challenge of providing clean lighting to the communities, in the forest areas, along with conserving the wildlife. Addressing both the issues together has resulted in the added benefit of winning the communities over for conservation, apart from the overall development of the area.

Several villages in and around the forest areas are marred with human-wildlife conflict stories, as the wild animals pose a serious threat to the safety and security of the communities. They also destroy the crops at times, which are the primary source of livelihood for the communities. The vulnerability of the people increases all the more in the dark. In self defence, the villagers often resort to ways that hamper conservation activities and, thus, pose a threat to wildlife. Solar lighting has not only benefited the conservation measures, but also come as a relief to the villagers.

Wild elephants destroy crops and homes as they move through villages. As a remedial measure in the Talapadia village, the farmers have constructed a watchtower over a tree. It helps to guard their fields from elephants at night. Every night, the villagers take turns to sit at the watchtower and guard their crop fields. Since the villagers can barely see in the dark, they basically watch out for sounds or any kind of movement.

Now the villagers carry the lanterns to the platform. The light from these lanterns enhances the visibility and keeps the animals at bay. The incidents of crop damages due to elephant trouble have come down from five or six per year to just one in a year, after the solar power intervention.

To conclude…

The benefits of the solar lantern have surpassed the expectations, with several intangible impacts clearly visible in the villages. These lanterns not only satisfy their needs, but are also part of the villagers' cultural life. In the two tribal villages, these lanterns are a part of all celebrations and festivities. Instead of lighting a fire during their traditional group dance, the village folks now choose to dance around their lanterns with unparalleled exhilaration. Along with lighting, the LaBL campaign aims to address similar other significant issues, which act as impediments to development, recognizing that the need is not only to light people's homes; it is to light their lives as well. It aims at promoting self reliance and local entrepreneurship at the rural areas. It is encouraging to see how a simple intervention can completely change people's lives. It is amazing to notice the magnitude of positive change that a simple lantern has brought about in the lives of some of the most marginalized and remote communities of the country. One feels optimistic about all such initiatives and programmes that address key challenges at the grassroot level. Thus, any technology that promises to go beyond serving its direct goals and has a multi-faceted effect on development is certainly the need of the hour.

Courtesy: LaBL, TERI

LIGHTING RURAL INDIA

A teacher by profession, Anne Marie is engaged in humanitarian work. She has worked in the development sector, with the Federation Humana People to People from 1980–2002 in Denmark and South Africa on volunteer training programmes, and as a project leader in development and relief-aid projects. Since 2002, she has worked for Humana People to People India on project design, public relations, and funds mobilization. Presently, she is engaged with the organization in the capacity of Senior Advisor, Partnership. Anne Marie has been associated with the LaBL programme, since the beginning of 2008. In an interview with Suneel Deambi, Anne Marie talks about her experiences of taking solar energy to the rural people and how it has changed their lives.

Q1. You have been working with the rural communities in India for the past eight years now. Please share with us the level of satisfaction both at an individual as well as organizational level.

I am very glad that at a young age I decided to work for the development and progress of the marginalized and vulnerable sections of the society. My last eight years in India have been very satisfying in many ways. I have had some very rich experiences of meeting people at the grassroot level, understanding their concerns, and working for their betterment. I had the privilege of being part of some very interesting projects, which have ushered in development for thousands of people. I have been part of Humana People to People India (HPPI) and seen it expand manifold. With support from partners and dedicated staff members, HPPI has been able to take huge steps forward. This is all very rewarding.

Q2. HPPI works on a diverse range of activities at a field level. In your view, which one of these activities has the maximum possible potential to improve the lot of rural communities?

Economic empowerment, which we can facilitate and strengthen through our work with women's self help groups (SHG) and microfinance, is an important key to improve the lives of people in the rural community. Through those activities, we have achieved important and sustainable results. At the same time, we felt that it is necessary to improve the general level of education, including teachers' training, childrens' education, health awareness, and awareness about the environment, and demonstrate how everyone can take part in protecting and improving the environment.

Q3. You originally belong to Denmark, which is one of the main wind power producing nations. How did your involvement with solar photovoltaic (PV) technology while begin in India?

Belonging to the 1970s generation, the time of the anti-atomic power movement and heated public debates about atomic power versus renewable energy, I developed a strong interest in renewable energy. Thus, I started looking out for opportunities by which we at HPPI could take part in facilitating renewable energy to power-deprived areas. My interface with PV began by discovering the existence of Lighting a Billion Lives

With the LaBL, I saw an immediate opportunity for our organization to reach out to the rural households with solar lanterns, something that would make an impact on childrens' education. Within a short time, we had facilitated installation of 32 more solar charging in the same area.

programme (LaBL), which exactly offered that opportunity.

Q4. Could you please elaborate exactly how HPPI got involved with LaBL, The Energy and Resources Institute's (TERI) flagship programme?

I was present at the inaugural session of the Delhi Sustainable Development Summit (DSDS) in 2008 when the LaBL programme was launched. With the LaBL, I saw an immediate opportunity for our organization to reach out to the rural households with solar lanterns, something that would have an impact on childrens' education. We were running 17 education centres for girls at that time. The best thing was that we would collaborate with LaBL staying within our structure. In May 2008, we started our partnership with TERI and installed two pilot solar charging stations in one of our community development projects in Jaipur district. The solar lanterns became so popular that our project leaders received letters from neighbouring villages, requesting solar charging stations to be installed in their villages. Within a short time, we had facilitated installation of 32 more solar charging stations in the same area.

Q5. Your organization till date has set up 100 community-based solar lantern charging stations in 100 villages spread over four districts in the state of Uttar Pradesh. How did you prepare for this massive programme from site identification, on one hand, to establishing SHG on the other hand?

We gained lot of knowledge from our experience in Rajasthan. Once we received the USAID grant, we decided to focus on Uttar Pradesh (UP), which is one of the most energy-deficient states of India. Narrowing down on the poorest districts of UP, and among those the most

energy-deficient districts, we made a rapid assessment of eight districts and decided on four as our implementation areas. We also had to consider the logistics aspect and focus on the districts that we could monitor. Having shortlisted four districts, we moved on to select the administrative blocks, which was based on the response that our team got from the block development officers.

Having finally decided on the blocks for implementation, four project offices were set up. Our teams then selected 100 villages of which 40 were completely un-electrified and 60 had minimum energy supply.

To build a good supportive environment for our action, we started out with forming women's SHGs, and then later on, in consultation with the SHGs, we (our team together with the SHGs) selected the LaBL entrepreneurs. This process took place simultaneously with selection of possible sites for which the LaBL scoping study was used (a detailed study of the village, the power coverage, usage of kerosene, and other fuels used for lighting).

Along with the formation of the SHGs, our implementation teams presented the project to the BDOs, the pradhans, bank managers, and many other key persons, who later became very supportive of the project.

In the end, all this has been possible to achieve due to a very strong and dedicated implementation team on the ground.

Q6. Today, about 35,000 people belonging to 6,000 households stand to gain from these solar charging stations put up by HPPI. Are there any major areas of concern, as far as routine operation and maintenance (O&M) requirements of these systems are concerned?

It is important that the solar charging stations and the lanterns function well and that eventual faults are identified and

dealt with immediately. To secure this, we have good systems in place. Firstly, the HPPI staff members provide hand holding support to new entrepreneurs. Secondly, in each of our implementation areas, we have a technical resource person, trained by TERI to provide technical support. The entrepreneurs fill a monthly technical fault report with data on the number of lanterns rented out and so on. The reports are sent to TERI, where they are analysed and corrective steps are taken.

Q7. Have the use of solar lanterns transformed into any widespread entrepreneurship opportunities by now? If not, what specific measures need to be put in place?

Yes, the example of a solar charging station demonstrates an opportunity in itself. Moreover, by installing 100 solar charging stations, the lantern users, all the people in the villages where the project is being implemented, and people in the neighbouring villages have become aware of the advantages and potential of solar energy. All shop owners keep their shops open during night hours, the same is the case for tailors and others who are engaged in handicraft work. Also, during the summer months, when the day temperature is very high to conduct any outdoor activities, the work can be completed during night hours with the help of solar lanterns.

Let us not forget about the students. I have frequently heard from youngsters, parents, and teachers how advantageous solar lanterns are for students. If we look at the bigger picture, some years from now, many young people will have reached a higher level of education because they had better conditions to do their homework, thanks to solar lanterns!

A demand for solar energy products has been generated. A *"Sor Urja"* shop has come up in one of the districts and some are interested in setting up businesses. To achieve a widespread entrepreneurship opportunity, we need to have a good supply chain in place, followed by availability of technical service. This must go hand-in-hand with awareness generation. People must know how it works and how to handle the equipment correctly.

Q8. The LaBL programme has grown from strength to strength, more so over the last few years. Are you going to continue your association with this programme in future too? If so, do you have any concrete suggestions that can make it beneficial for the village communities?

We will definitely continue our association with the LaBL programme. The way we can make it more beneficial for the village communities is by installing more solar charging stations and by facilitating purchase of individual solar lanterns and other stand-alone products for those who would want to purchase their own equipment. To install more solar charging stations, we need the entrepreneurs to cover part of the cost of a station, and we need the local banks to finance the stations with favourable loans. On top of that, with support from the corporate sector and specific funding programmes, which promote community development and renewable energy, implementing agencies, such as HPPI and many others, would be able to facilitate installation of many more solar charging stations. We have to be good at presenting the solar charging station, introducing it in new areas through pilot stations by which we can demonstrate its operation. We have to combine this with awareness activities at different levels. Together with TERI and many more partners, we are ready to move ahead and continue to be instrumental in "Lighting a Billion Lives".

Q9. Would you like to convey any special message to the readers of, "The Solar Quarterly" in the backdrop of your solar-related field observations and experiences?

Let us join hands in spreading solar power as much as possible to underdeveloped areas. Hardware suppliers must deliver high quality to ensure people's confidence in the products; we, the implementing agencies, that carry out the field work must provide the best possible initial support to the entrepreneurs and ensure availability of services and supplies. To those who are in a position to support financially, I would say, "Supporting the installation of solar energy in power-deprived areas is a very noble step through which you can bring about a visible and remarkable change in people's lives".

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MANAGING RENEWABLE ENERGY

Vijay Rai is the President and Chief Executive Officer of PowerCon, an innovative company engaged in the business of providing world class integrated knowledge management, global capacity building, renewable energy management, sustainable development, and research and thought leadership services, including benchmark conventions and highly specialized events, encompassing a wide gamut of issues and sectors.

Prior to joining PowerCon, Vijay worked as President and CEO of Solo Energy, an innovative company engaged in the business of developing world class solar power technology solutions and renewable energy projects management services. He has a rich and diverse experience of over 18 years, with national and international companies in manufacturing, infrastructure, retail, healthcare, consulting, telecom, energy, media, digital cinema, and so on. In November 2010, he was nominated as part of the CEO delegation accompanying Hon'ble President of India Pratibha Devisingh Patil to the West Asian countries.

Vijay holds a Masters in Business Administration and brings with him vast expertise, in business and people leadership and multicultural experience which he has acquired whilst working at senior management levels in various assignments.

In an interview with Arani Sinha, Vijay Rai talks about the aims and objectives of his company, renewable energy management, the JNNSM, and the future of solar energy in India.

Courtesy: Ashdenawards

Q1. You head a company with a diverse range of interests. How exactly do renewable energy and, more specifically, solar energy fit in your scheme of things?

Diversity is the new requirement to build sustainability, and unless we look beyond our boundaries the task of securing our future looks difficult. We have some daunting growth-related challenges like global warming, climate change, environment, and energy security before us, which pose a threat to our survival. The world's resources are being overused and conventional means of doing business are nearing the end. India has a large population and that bothers me most as it is putting pressure on the limited resources. Consequently, natural resource depletion is a greater cause of concern as we move from abundance to scarcity. The fundamental need is to use resources efficiently and also develop alternative options for value creation or else the idea of long-term survival will be in danger.

I strongly believe that we should exercise all possible means to experiment and innovate in order to create a green ecosystem for sustainable solar photovoltaic (SPV) power generation. To this extent solar energy generation makes business sense, if it is conducted with reasonable understanding and commitment.

My biggest motivation is the potential of renewable energy and sustainability as a game changer. I strongly believe that we should exercise all possible means to experiment and innovate, in order to create a green ecosystem for sustainable solar photovoltaic (SPV) power generation. To this extent, solar energy generation makes business sense, if it is conducted with reasonable understanding and commitment.

Q2. Does renewable energy management go into the actual realm of isolated village communities, which may be oblivious to such practices?

This question is quite important one, as we see tremendous power crisis the remote villages. I have been touring rural areas and was quite happy to see the initiatives taken by Gram Panchayats, especially in installing solar street lights and lanterns which are being used by households. The concept of solar energy is being propagated in villages under the state renewable development agency scheme for rural areas. Government grants and incentives are also being made available, which is surely going to help the village community.

I would like to emphasize here that villagers are more receptive to the solar concept, mainly because they do not have any set mindset. We need to leverage this positive trait in developing a deeper level of engagement with the village community. Solar energy farming and power generation in the villages is not only a workable, but a viable and cost-effective option, given the initial support that it needs.

Q3 One school of thought argues that solar technologies have matured over time. Please share your views regarding this argument. Also, do you think that awareness generation campaigns should now take precedence over everything else?

Globally, the developments in solar technologies have definitely progressed over time, but building innovative capacity, which supplements the implementation and delivery, is lacking in India. Our intent is very positive, but the pace of development in technology and scale does not match international standards. The benefits of solar energy are far more convincing than our ability to accelerate the commercialization of large SPV projects. We need to develop task forces at several levels in the country to spread rapid awareness generation campaigns and widen our outreach initiatives and network. Solar is environment friendly and is not expensive in the long run; unfortunately, it has not been adequately promoted as a viable alternative energy option.

Q4. One of your core areas of work is mentioned as global capacity building. Does that encompass the area of solar energy too and with what real goal-oriented objectives?

As I mentioned earlier, the implications of capacity building is with a premise of "thinking global and acting local". As


Courtesy: Ashdenawards

Since the solar energy sector is in its initial phase in India, it will take some time till it reaches a significant mass and revolutionizes the country. India needs effective technology, manpower core competencies, and capabilities for quicker development of the solar industry as a whole. We are moving towards that direction.

one of the fastest developing country, the scope for internal capacity building is profound. We can only achieve a leadership position in this field, if we have superior capability and have a track record of demonstrated capacity. In this regard, PowerCon believes in institutionalizing capacity building through awareness, engagement, and empowerment.

Q5. The JNNSM is being viewed as a path breaking initiative. Have you embarked upon any special activities under its ambit so far?

The Jawaharlal Nehru National Solar Mission (JNNSM) is surely a very robust framework, as it clearly lays down the policies and guidelines, as also various schemes which help the solar power generation reach its ambitious targets. We have not taken up any projects so far for ourselves, as we are undertaking research and development, helping spread awareness, and build capacity for some of our valued clients who are keen to undertake both SPV and solar thermal projects. We have recently signed a memorandum of understanding for exploring the possibility of developing a SPV project to support the telecom sector.

We are always looking for new ways to encourage development and deployment of renewable energy.

Q6. What exactly is the composite idea of a full service knowledge hub vis-à-vis the renewable energy programme? To what extent is it capable of ensuring checks and balances at the field implementation level, in particular?

Full service knowledge hub is a platform for creating cutting-edge knowledge, capability, and skills by investing in applied research and innovation and also in promoting sustainable development. Renewable energy sector is one of the focus areas. We are looking at developing strategic alliances and collaboration in the clean and green energy sector to speedily drive real-time implementation, both at qualitative and quantitative levels. The barriers of implementation could be at several levels, and we have to always ensure adequate checks built into the system depending upon several variables like the scope, size, and scale of the project.

Q7. Do you foresee any market-driven innovations in the solar energy sector materializing on the lines of the mobile telephony market some time in future?

I am an optimist and hope that we take bold initiatives in terms of market-oriented knowledge creation. This will pave the way for sound investments by the next generation, least cost hybrid technology that integrates both concentrated and solar thermal power for a highly energy-efficient footprint. Since the solar energy sector is in its initial phase in India, it will take some time till it reaches a significant mass and revolutionizes the country. India needs effective technology, manpower core competencies, and capabilities for quicker development of the solar industry as a whole. We are moving in that direction.

Q8. Presently, several efforts are underway to create a large contingent of solar energy trained manpower. What special skills should they be endowed with apart from the customary ones normally imparted?

Investment initiatives in the renewable or solar energy field are still believed to be more in the form of philanthropy by many people. Unfortunately, in this context, there is a lack of understanding. We should treat solar energy as a specialized sector involving high quality manpower and skill. Solar has never been a fast track career and, hence, specialized talent is rare in India. Efforts are required to design specialized curriculums, train people, and develop skill centres in this field.

Some of the hot skills, which I find most relevant are: product and technology design, project development appraisal and feasibility studies, equipment management, renewable energy financing models, energy-efficient thin-film solar panels, hybrid technology, operational excellence in project execution, knowledge management, and talent development.

Q9. Would you like to convey any special message to the readers of, "The Solar Quarterly" magazine, given the fact that your company is at the forefront of capacity-building initiatives?

I have a vision for our country that it should become self-sufficient in the alternative energy space. We will be at a turning point when the resources, which we created in few 100 years, will peak in terms of availability and usage. As we develop, both the demands and prices will rise, and we will keep exhausting all the energy resources, which took us so long to create. Renewable energy looks quite competitive as compared to oil prices. India is one of the most sun-friendly zones in the world and has the biggest potential. In future, more and more firms are likely to enter solar power generation from across the globe.

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SOLAR TECHNOLOGICAL UPDATE

Roof solar tiles for alternative power production

Needless to say, when it comes to alternative forms of energy, roof solar tiles or shingles are simply one of the best and innovative means by which a home owner is able to gather and harness the energy from the sun for generating sufficient electrical power needed to run the small appliances and devices at home. These days, home owners have access to roofing tile materials to cover up the homes and protect them from natural elements, but it seems to be such a waste that it just sits there and does nothing when, in fact, it can do more than just effective home covering. It is definitely time to put such tiles to useful work by generating significant power. If a person engages in photovoltaic roofing, the use of such high technology can save about 605% power that a person consumes in his/her house. For those who have small businesses, such as a grocery or a convenience store or even a small office, such sun power technology can definitely work to provide alternative energy in the form of solar power so long as one has a roof on which to install solar gadgets on.

Many consumers and home owners already know that sun-based power is a form of energy that is totally clean and does not cause any pollution to our environment. Solar roof tiles, for example, do not need any fuel to run, and they only need the rays of the sun to function; and, most importantly, they do it in a very quiet way. All that a consumer needs when he decides to utilize photovoltaic roof tiles is sunlight. As long as sunlight is available, solar shingles or tiles will keep generating solar energy.

Solar roof installation

It is also possible to replace the old roofing of the home with photovoltaic roofing. All one has to do is install solar panels on top of the roof. One can also employ a roof professional to do all the installing work.

Also, the components of such sun-powered devices are very light in weight, which means it will cause no damage to the roof, but instead will protect and secure it all the more.

Indeed, when it comes to getting alternative energy, particularly the energy coming from the sun, a home owner can take advantage of his/her rooftop by installing roof solar tiles all over it, instead of the conventional shingles. Nowadays, tiles are no longer just meant to provide security and protection, but they are also useful gadgets, which efficiently work to create viable alternative energy that is excellent for home use.

Source: http:my-solar-panel.blogspot.com/2011/03/roof-solar-tiles-for-alternative-power.html

Virginia man creates "sand battery" solar heating system

Use the term "solar heating" in a conversation, and your listener will likely think of "solar water heating" (or, maybe, a solar thermal system). But, solar space heating is certainly not a new concept, even if it is not the first thing to come to mind. Passive solar orientation makes use of it, and numerous designs exist for collecting the sun's energy for heating homes and buildings… from relatively simple DIY plan to more complex technologies. Dave Stets, co-owner of Richmond BySolar in Richmond, Virginia, has created one of those more complex plans. The solar heating system for his home in Henrico County is built on the concept of high-mass solar heating, and involves storing heat collected from solar panels in a bed of sand until it is ready for use. According to the *Richmond Times-Dispatch*, eight solar panels, 8 feet tall and 4 feet wide, collects the sun's warmth in Stets' backyard, just beyond the patio and bird feeder. That heat warms a non-toxic form of anti-freeze in the panels. Moved by a pump, the hot liquid leaves the panels in a pipe that runs underground. That heat warms a 15-cubic metre bed of sand. The hot sand warms a separate, water-filled pipe, which runs to Stets' house and provides heat under the floor.

While the use of high-mass solar heating is not particularly new, Stets' system was designed around the question "How can you use heat in summer to warm the house during winter?" Previous systems placed the sand bed directly below the house, making it impossible to "turn off" in the summer. Stets, along with Professor James T McLeskey Jr of Virginia Commonwealth University, moved the sand bed away from the building, and used the water-filled pipes to control the use of stored heat.

Source: solar.calfinder.com

Low cost solar cells: new European record in efficiency

Kesterites combine the low cost of thin film solar cell technologies with extremely low raw material cost. Their main component

consists of copper, zinc, tin, and sulphur or selenium, all abundant and low-cost elements. Several laboratories have reported that the loss of tin during preparation limits the ability to control deposition processes. The Laboratory for Photovoltaics has now developed a preparation process that allows controlling the tin loss and, in the first attempt, has led to record efficiency. Currently, thin film solar cells are significantly increasing their market share, because of their low production cost. These are mostly based on considerably lower material and energy consumption compared to the conventional wafer technologies.

The Laboratory for Photovoltaics of the University of Luxembourg is a group of researchers developing new materials and processes for solar cells. The laboratory focuses on furthering the physical understanding of the materials and interfaces involved in these solar cells.

Source: www.sciencedaily.com

MACtac launches the SOLARFAST UV cure adhesive system

With continued investments and advancements in alternative energy sources, specifically solar energy, equipment manufacturers are looking for new assembly solutions that meet the efficiency and durability requirements of the final component's end application. A long-time innovator and provider of customized assembly solutions, MACtac® Specialty Products has enhanced its line of solutions for solar cell assembly, with the launch of its SOLARFAST™ UV Cure Adhesive System. Designed for flexible solar applications, the new SOLARFAST UV Cure Adhesive System high-strength solar bonding tapes (SF-1003 and SF-1005) are designed to withstand a range of environmental conditions where a high-temperature, high-strength bond is required.

MACtac's SOLARFAST UV Cure Adhesive System includes SF-1003, a 75µ free film adhesive, and SF-1005, a 125µ free film adhesive. Both are protected by a two sided, 80# release coated, brown kraft liner. Initially, the free-film adhesive bonds like a typical pressure-sensitive adhesive, but the final bond is initiated through UV light. Once cured, the adhesive has extreme heat resistance, low creep, and excellent peel. Tested and proven to resist more than 200 °F while maintaining a secure bond, the free film adhesive featured on the new high-strength solar bonding tapes is an excellent substitute for liquid or complex cure adhesives and simplifies the manufacturing process.

Source: www.mactac-europe.com

PV Duo offers power and functionality of two micro-inverters in one package

The new 360-watt Enecsys Duo micro-inverter from Enecsys Ltd is designed to reduce system costs while supporting fully independent power point tracking of two connected photovoltaic (PV) modules. The direct current (DC) power generated by the two modules is converted into a single, grid-compliant alternating power (AC) output. By reducing the number of micro-inverters needed for each system, the Enecsys Duo simplifies the system layout and planning and reduces installation costs and time. Systems using this new micro-inverter will have comparable capital costs to those using string inverters, but are expected to deliver as much as 5%–20% more energy, with the degree of improvement dependent on installation configuration and operating environment. A large advantage that the Enecsys Duo offers over string inverters is that the systems adopting the architecture do not suffer from dramatic reductions of output when modules are mismatched, or when the output of one PV module—or part of a module—is lowered due to shading caused by trees, chimneys or debris on its surface. The SMI-D360W-72 Enecsys Duo micro-inverter, featuring dimensions of 262 160 x 35 mm, offers 95% peak efficiency and 93% Euro efficiency. As with other Enecsys micro-inverters, electrolytic capacitors, and other low-reliability components have been eliminated to ensure a life expectancy of greater than 25 years for the Enecsys Duo. Reliability has been verified using highly-accelerated life testing (HALT), highly-accelerated stress screening (HASS), and accelerated life tests to IEC61215, the same methodology used to test solar PV modules.

The Enecsys Monitoring System provides on-line and real-time information about the total energy generated, individual solar module performance, and the historical pattern of power generation. The Enecsys micro-inverter is equipped with a robust, built-in wireless system that connects to the Internet via a Gateway. This comprehensive monitoring, not available with string inverters, promptly gives users and installers precise information to ensure optimized performance over the life of the solar PV installation.

All Enecsys micro-inverters are designed for both North American (60 Hz) and European (50 Hz) electricity grid systems. The relevant agency approvals for the Enecsys Duo micro-inverter are expected during March 2011, at which time the products will be available in Europe.

Source: www.enecsys.com

Siliken modules generate 6.2% more energy than competing modules

According to testing of 47 solar modules by 36 manufacturers, Siliken modules were shown to generate 6.2% more energy than the average level of all other modules assessed. The study was conducted by Photon Laboratory from January–December 2010.

The laboratory, which has been conducting these studies, since 2005, randomly selects three modules from each company and installs them at an open-air site in Germany, in a south-facing position, 2.5 metres from the ground and at a 28˚ angle. Testing analyses the power of the modules under standard conditions, cell performance with low radiation, temperature co-efficients, power degradation over time, and other factors that influence the energy that the module can be expected to produce over its lifetime. Photon's technology measures and records the data for all modules automatically. In addition to generating 6.2% more

than the average level, the Siliken modules produced 13.1% more energy than the lowest performing modules in the study.

Source: www.siliken.com

Q-Cells polycrystalline solar module breaks world record

Q-Cells SE officially broke a world record in the field of polycrystalline solar modules recently when the European Solar Test Installation (ESTI), an independent photovoltaic calibration laboratory, confirmed that the company's module has a record efficiency rating of 17.84% in relation to the aperture area. The module's output is 268 Watts.

The module contains 60 high-efficiency polycrystalline cells with dimensions of 156 x 156 mm^2, produced in-house, and arranged in a conventional layout. The solar cells used in the module are conventional, 180-µm-thick polycrystalline silicon wafers, metallized on the back side and passivated in Q-Cells' in-house research centre with functional nanolayers. This new type of structure for the back side, consisting of dielectric layers combined with local contacts, improves the solar cell's aesthetic and electrical characteristics and significantly boosts its output compared to the back surface field (BSF) technology used till now. The independent calibration laboratory run by the Fraunhofer Institute for Solar Energy Systems confirmed that these high-efficiency cells have a peak efficiency rating of 18.45%. The innovative structure of the rear side is suitable for a range of silicon qualities and for very thin wafers. The technological development was supported with funds from, among others, the federal state of Saxony-Anhalt and the Federal Ministry for the Environment (BMU).

The implementation of this technological improvement at the German site will be followed by technological transfer to the production facility in Malaysia. The following are the technical data for record-breaking module made of polycrystalline silicon solar cells.

- Efficiency rating: 17.84% (in relation to aperture area)
- Module area: 1.492 m^2 (aperture area)
- Open circuit voltage: 38.86 v
- Short circuit current: 9.04 A
- Module output: 268 W

Technical data of high-efficiency cell made of polycrystalline silicon:

- Efficiency rating: 18.45%
- Open circuit voltage: 647 mV
- Short-circuit current density: 36.8 mA/cm^2

Source: www.globalsolartechnology.com

New DC filter FMER SOL

Modern solar inverters, that use maximum power point (MPP) trackers, generate disturbances into both the grid's AC power line, as well as the DC side of the solar module. An AC filter is normally used on the grid's AC power line, but the noise generated on the DC side tends to be overlooked. EMC standards EN 61000-6-3 and EN55014-1, however, also limits the noise generated from lines not connected to the grid, such as, for example, the line to the solar panels. Meeting these limits can be achieved by using a DC filter on the DC side of the inverter.

Large solar inverters installed in electrical installations will generally require a cooling system. Components, which provide high temperature resistance simplify the system and reduce the energy needed to cool. The FMER SOL filters are designed for rated currents from 25 A to 1500 A at 55 °C ambient temperature, and voltages up to 1200 VDC. The FMER SOL DC filters are designed with screw clamps for type of connections up to 150 A and copper bars for type of connections for more than 250 A. Other types of connections, such as wires or copper bars, which are less than 250 A, are available on request. Small adjustments can also be made to the electrical circuit or to the filter housing on request.

Technical data

- Rated currents: 25 A to 1500 A at 55 °C
- Operating voltage: up to 1200 VDC
- Temperature range: -40 °C to +100 °C

Source: www.schurter.ch

DuPont delivers new science-powered innovations for solar energy

DuPont has introduced a suite of science-powered photovoltaic innovations, including the following.

- Four new DuPont™ Solamet® photovoltaic metallizations to enable the industry goal for conversion efficiency of crystalline silicon solar cells for more than 20% in 2012.
- Solamet® PV17x, a new generation of front side silver photovoltaic metallization pastes formulated to deliver advanced efficiency and adhesion for solar cells.
- Solamet® PV361 and PV362 photovoltaic metallization pastes that outperform conventional aluminium compositions by delivering up to 0.8% greater conversion efficiency for solar cells when used in local back surface field (BSF) designs.
- Solamet® PV701, the newest generation of Metal Wrap Through (MWT) technology for backside interconnected silicon solar cell designs that enable up to 0.4% greater conversion efficiency for solar cells.
- DuPont™ PV5400 series thin ionomer-based encapsulant sheets have been introduced to protect sensitive thin-film solar modules, while offering manufacturers new ways to cut costs, speed throughput, and deliver more power over the life of each unit.
- *Tedlar® PV2400 film and processing technology for photovoltaic backsheets.* This novel technology enables backsheet to be produced in a single step and is a key element of DuPont's strategic intent to significantly increase the availability of DuPont™ Tedlar® films and backsheet offerings and to extend the lifetime of photovoltaic modules.

Source: photovoltaics.dupont.com

CURRENT R&D SOLAR

Wu Wenjun, Li Jing, Guo Fuling, Zhang Lei, Long Yitao, Hua Jianli. 2010. **Photovoltaic performance and long-term stability of quasi-solid-state fluoranthene dyes-sensitized solar cells**. *Renewable Energy* **35**(8): 1724–1728

Abstract

Two new fluoranthene-based organic dye sensitizers (I and II), in which 7, 12-diphenylbenzo[k]fluoranthene moiety is acted as electron donor, thiophene, and phenylethynyl units as electron spacers, and carboxylic acid as electron acceptor were successfully applied in quasi-solid-state dye-sensitized solar cells. The quasi-solid-state DSSCs based on the dye I showed better photovoltaic performance: a maximum monochromatic incident photon-to-current conversion efficiency (IPCE) of 66%, a short-circuit photocurrent density (Jsc) of 3.53 mA cm^{-2}, an open-circuit photovoltage (Voc) of 542 mV, and a fill factor (ff) of 0.70, corresponding to an overall conversion efficiency of 1.33% under standard global AM 1.5 solar condition. Moreover, the two sensitizers exhibited good stability during a long-term accelerated aging, in which the photovoltaic parameters retained more than 90% of its initial value even after 1000 hrs under light soaking at 60 °C.

Chung Dae Sung, Kong Hoyoul, Yun Won Min, Cha Hyojung, Shim Hong-Ku, Kim Yun-Hi, Park Chan Eon. 2010. **Effects of selenophene substitution on the mobility and photovoltaic efficiency of polyquaterthiophene-based organic solar cells**. *Organic Electronics* **11**(5): 899–904

Abstract

We investigated thin films comprised of a blend of poly (5,5′-bis[3-dodecylthiophene-2-yl]2–2′-biselenophene)/(6,6) and phenyl C61 butyric acid methyl ester (PDT2Se2/PCBM) for using in the bulk heterojunction photovoltaic cells. The charge transport characteristics of PDT2Se2 and its analog, poly (3,3″-didodecyl quaterthiophene) (PQT-12), were elucidated through analysis of the space charge limited current behaviour at various temperatures. PDT2Se2 showed higher mobility, lower field activation parameters, and a lower temperature dependence of these parameters than PQT-12, indicating better charge transport in PDT2Se2. Optimization of the PDT2Se2:PCBM composition ratio produced a bicontinuous donor–acceptor network with domain sizes on the order of 10 nm, which afforded power conversion efficiencies of 1.4%, a short circuit current density of 4.3 mA cm^{-2}, an open circuit voltage of 0.69 V, and a fill factor of 47%. This performance was much better than the performance achieved previously using PQT-12:PCBM blend systems. Selenophene substitution appears to be an effective strategy for enhancing the photovoltaic effect of thiophene-based polymeric semiconductors for high performance organic solar cells (OSCs).

Kelly Nelson A, Gibson Thomas L. 2010. **Increasing the solar photovoltaic energy capture on sunny and cloudy days**. *Solar Energy* **85**(1): 111–125

Abstract

This report analyses an extensive set of measurements of the solar irradiance made using four identical solar arrays and associated solar sensors (collectively referred to as solar collectors) with different tilt angles relative to the earth's surface and, thus, the position of the sun, in order to determine an optimal tracking algorithm for capturing solar radiation. The study included a variety of ambient conditions, including different seasons and both cloudy and cloud-free conditions. One set of solar collectors was always approximately pointed directly toward the sun (DTS) at noon. These solar collectors, thus, captured the direct beam component of the solar radiation that predominates on sunny days. We found that on sunny days, solar collectors with a DTS configuration captured more solar energy in accordance with the well-known cosine dependence for the response of a flat-surfaced solar collector to the angle of incidence with direct beam radiation. In particular, a DTS orientation was found to capture up to twice as much solar energy as a horizontal (H) orientation in which the array is tilted towards the zenith. Another set of solar collectors always had an H orientation, and this best captured the diffuse component of the solar radiation that predominates on cloudy days. The dependence of the H/DTS ratio on the solar-collector tilt angle was in approximate agreement with the Isotropic Diffuse Model derived for heavily overcast conditions. During cloudy periods, we found that an H configuration increased the solar energy capture by nearly 40% compared to a DTS configuration during the same period, and we estimated that the solar energy increase of an H configuration over a system that tracks the obscured solar disk could reach 50% over a entire heavily-overcast day. On an annual basis, the increase is predicted to be much less, typically only about 1%, because the contribution of cloudy days to the total annual solar energy captured by a

photovoltaic system is small. These results are consistent with the solar tracking algorithm optimized for cloudy conditions that we proposed in an earlier report and that was based on a much smaller data set. Improving the harvesting of solar energy on cloudy days deserves wider attention due to increasing efforts to utilize renewable solar energy. In particular, increasing the output of distributed solar power systems on cloudy days is important for developing solar-powered home fueling and charging systems for hydrogen-powered fuel-cell electric and battery-powered vehicles, respectively, because it reduces the system size and cost for solar power systems that are designed to have sufficient energy output on the worst (cloudy) days.

da Silva R M, Fernandes J L M. 2010. **Hybrid photovoltaic/thermal (PV/T) solar systems simulation with Simulink/Matlab**. *Solar Energy* **84**(12):1985–1996

Abstract

The purpose of this work consists in thermodynamic modelling of hybrid photovoltaic–thermal (PV/T) solar systems, pursuing a modular strategy approach provided by Simulink/Matlab. The PV/T solar systems are a recently emerging solar technology that allows for the simultaneous conversion of solar energy into both electricity and heat. This type of technology presents some interesting advantages over the conventional "side-by-side" thermal and PV solar systems, such as higher combined electrical/thermal energy outputs per unit area, and a more uniform and aesthetical pleasant roof area. Despite the fact that early research on PV/T systems can be traced back to the seventies, only recently it has received a renewed impetus. In this work, parametric studies and annual transient simulations of PV/T systems are undertaken in Simulink/Matlab. The obtained results show an average annual solar fraction of 67%, and a global overall efficiency of 24% (that is,15% thermal and 9% electrical), for a typical four-person single-familiar residency in Lisbon, with p-Si cells, and a collector area of 6 m^2. A sensitivity analysis performed on the PV/T collector suggests that the most important variable that should be addressed to improve thermal performance is the PV module emittance. Based on those results, some additional improvements are proposed, such as the use of vacuum, or a noble gas at low-pressure, to allow for the removal of PV cells encapsulation without air oxidation and degradation and, thus, reducing the PV module emittance. Preliminary results show that this option allows for an 8% increase on optical thermal efficiency, and a substantial reduction of thermal losses, suggesting the possibility of working at higher fluid temperatures. The negative effect of higher working temperatures in electrical efficiency was negligible, due to compensation by improved optical properties. The simulation results are compared with experimental data obtained from other authors and perform reasonably well.

The Simulink modelling platform has mainly been used worldwide on simulation of control systems, digital signal processing, and electric circuits, but, at times, they have also been used as application for solar energy systems modelling. This work uses the modular environment of Simulink/Matlab to model individual PV/T system components, and to assemble the entire installation layout. The results show that the modular approach strategy provided by Matlab/Simulink environment is applicable to solar systems modelling, providing good code scalability, faster developing time, and simpler integration with external computational tools, when compared to traditional imperative-oriented programming languages.

Parida B, Iniyan S, Goic R. 2011. **A review of solar photovoltaic technologies**. *Renewable and Sustainable Energy Reviews* **15** (3): 1625–1636

Abstract

Global environmental concerns and the escalating demand for energy, coupled with steady progress in renewable energy technologies, are opening up new opportunities for utilization of renewable energy resources. Till date, solar energy is the most abundant, inexhaustible, and clean of all the renewable energy resources. The power from sun intercepted by the earth is about 1.8 × 1011 MW, which is many times larger than the present rate of all the energy consumption. Photovoltaic technology is one of the finest ways to harness the solar power. This paper reviews the photovoltaic technology, its power generating capability, the different existing light absorbing materials used, its environmental aspect coupled with its various applications. The different existing performance and reliability evaluation models, sizing and control, grid connection, and distribution have also been discussed.

M Moharil Ravindra, S Kulkarni Prakash. 2010. **Reliability analysis of solar photovoltaic system using hourly mean solar radiation data**. *Solar Energy* **84**(4): 691–702

Abstract

This paper presents the hourly mean solar radiation and standard deviation as inputs to simulate the solar radiation over a year. Monte Carlo simulation (MCS) technique is applied and the MATLAB programme is developed for reliability analysis of small isolated power systems using solar photovoltaic (SPV). This paper is divided into two parts. Firstly, various solar radiation prediction methods along with hourly mean solar radiation (HMSR) methods are compared. The comparison is carried out on the basis of predicted electrical power generation with actual power generated by SPV system. Estimation of SPV power using HMSR method is close to the actual power generated by SPV system. The deviation in monsoon months is due to the cloud cover. Later in the paper, various reliability indices are obtained

by the HMSR method using MCS technique. Reliability indices, additional load hours (ALH), and additional power (AP) reduce exponentially with an increase in load, which indicates that a SPV source will offset maximum fuel when all of its generated energy is utilized. Fuel saving calculation is also investigated. Case studies are presented for Sagardeep Island in the state of West Bengal, India.

Fang Guiyin, Hu Hainan, Liu Xu. 2010. **Experimental investigation on the photovoltaic–thermal solar heat pump air-conditioning system on water-heating mode**. *Experimental Thermal and Fluid Science* **34** (6): 736–743

Abstract

An experimental study on the operation performance of photovoltaic–thermal solar heat pump air-conditioning system was conducted in this paper. The experimental system was first set up. The performance parameters, such as the evaporation pressure, the condensation pressure, and the coefficient of performance (COP) of heat pump air-conditioning system, the water temperature and receiving heat capacity in water heater, the photovoltaic (PV) module temperature and the photovoltaic efficiency, were investigated. The experimental results show that the mean photovoltaic efficiency of photovoltaic–thermal (PV/T) solar heat pump air-conditioning system reaches 10.4%, and can improve 23.8%, in comparison to that of the conventional photovoltaic module, the mean coefficient of performance (COP) of heat pump air-conditioning system may attain 2.88, and the water temperature in water heater can increase to 42 °C. These results indicate that the photovoltaic–thermal solar heat pump air-conditioning system can give better performances and is stable.

Jung Lim Su, Soo Kang Yong, Kim Dong-Won. 2010. **Photovoltaic performance of dye-sensitized solar cells assembled by in-situ chemical cross-linking**. *Electrochemistry Communications* **12**(8): 1037–1040

Abstract

Quasi-solid state dye-sensitized solar cells (DSSCs) were assembled by in-situ chemical cross-linking of a gel electrolyte precursor containing liquid electrolyte. The DSSCs assembled with this cross-linked gel polymer electrolyte showed higher open circuit voltage and lower short-circuit photocurrent density than those of DSSCs with liquid electrolyte. Addition of SiO_2 nanoparticles into the cross-linked gel polymer electrolyte significantly improved the photovoltaic performance and long-term stability of the DSSCs. The optimized quasi-solid state DSSC showed high conversion efficiency, 6.2% at 100 mW cm^{-2} with good durability.

Sarhaddi F, Farahat S, Ajam H, Behzadmehr A. 2010. **Exergetic performance assessment of a solar photovoltaic thermal (PV/T) air collector.** *Energy and Buildings* **42**(11): 2184–2199

Abstract

In this paper, an attempt is made to evaluate the exergetic performance of a solar photovoltaic thermal (PV/T) air collector. A detailed energy and exergy analysis is carried out to calculate the thermal and electrical parameters, exergy components, and exergy efficiency of a typical PV/T air collector. Some corrections are done on related heat loss coefficients. An improved electrical model is used to estimate the electrical parameters of a PV/T air collector. Further, a modified equation for the exergy efficiency of a PV/T air collector is derived in terms of design and climatic parameters. A computer simulation programme is also developed 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. It is observed that the modified exergy efficiency obtained in this paper is in good agreement with the one given by the previous literature. It is also found that the thermal efficiency, electrical efficiency, overall energy efficiency, and exergy efficiency of PV/T air collector is about 17.18%, 10.01%, 45%, and 10.75%, respectively, for a sample climatic, operating, and design parameters.

Dinçer F. 2011. **The analysis on photovoltaic electricity generation status, potential, and policies of the leading countries in solar energy** *Renewable and Sustainable Energy Reviews* **15**(1): 713–720

Abstract

Energy is crucial for our development. A number of countries hold frequent meetings and discussions on energy. These countries are working to balance the energy demand and supply. The need is to find efficient ways of using energy and renewable energy sources.

Among renewable energy technologies, photovoltaic energy power systems seem to be the most dominant sources. The most important reason is that it is an unlimited and clean source of energy for the solar power systems. Many studies show that, in future, photovoltaic power systems will form the major part of the electricity share.

In this study, electricity generation from solar energy using photovoltaic systems has a leading position in some European countries. US, China, and Japan's current status and future policies were analysed and various comments were made.

CENTRE FOR RENEWABLE ENERGY SYSTEMS TECHNOLOGY
LOUGHBOROUGH UNIVERSITY

About CREST

The Centre for Renewable Energy Systems Technology (CREST) was established in 1993, with the help of the funds made available by Prof. Tony Marmont. The centre undertakes research and education in the renewable energy technology. According to the centre website, it holds an excellent track record in research and education, with growing number of staff members. The MSc programme in Renewable Energy Systems Technology (both on-campus and distance learning study options) provided by the centre is a well established leading course on renewable energy in the UK and internationally, with over 300 graduates working in industry worldwide. Various UK professional Engineering institutes such as IET, IMechE, and Energy Institute have approved the CREST's MSc in Renewable Energy Systems Technology as Further Learning Requirements of the Engineering Council's UK SPEC. In other words, graduates who have already completed three-year undergraduate degrees can use the centre's MSc course as a direct route of chartered engineering.

The centre is also a member of the European Renewable Energy Centres Agency, which is a huge network of over 40 top renewable energy research centres. The CREST Team has an advisory committee comprising of experts from various industries, academic circles, and government organizational and departments. This team provides strategic inputs to the centre.

Some projects taken up by the centre

Advancing the efficiency and production of excitonic solar cells (APEX)

This project is centred on the development of the materials, device structures, materials processing, and PV-panel engineering of excitonic solar cells. These have the potential to greatly reduce both materials and also manufacturing costs.

Stability and performance of photovoltaics (STAPP)

The main objective of this programme is to deliver improvements in understanding the stability and reducing

the uncertainty in life-time energy yield prediction from PV systems. The programme is highly multidisciplinary in nature and presents an opportunity to determine and map the potential for photovoltaic energy in varying climates and operating environments. It also proposes solutions that will lead to advancements in photovoltaic technology.

Research groups

Group	*Leader*
Networks and systems	Murray Thomson
Wind and water power systems	Simon Watson
Applied photovoltaic systems	Ralph Gottschalg
Photovoltaic materials and devices	Mike Walls
Renewable energy in the built environment	Paul Rowley

People

CREST director: Prof. Phil Eames

CREST administrator: Christina Kokoroskou

Academic staff: Phil Eames, Tom Betts, Richard Blanchard, Gianfranco Claudio, Ralph Gottschalg, Paul Rowley, Murray Thomson, Hari Upadhyaya, Mike Walls, Simon Watson

Visiting professors: Leon Freris, Tony Marmont, Ayodhya Tiwari

Research and Education

The post-graduate programme is delivered by international experts. Students gain knowledge about the main renewable energy technologies, solar, wind, water and biomass along with electrical integration of renewables and policy issues. The MSc course is also available as flexible online course. Detail information on the online course is available the flexible learning website.

CREST is a partner in the European Master of Science in Renewable Energy led by the The European Renewable Energy Research Centres (EUREC) Agency. Students can attend the first semester at Loughborough University and then study at one of the partner institutions where they can specialize in any particular renewable energy technology.

CREST's research is focused on electricity generation from wind and solar energy and its integration into networks and systems.

CREST research operations are structured in the following five groups.

CREST's research is focused on electricity generation from wind and solar energy and its integration into networks and systems. Systems integration often involves the application of advanced power electronic interfaces where the Department of Electronic and Electrical Engineering has considerable expertise, helping to keep CREST at the leading edge of research in this competitive and fast moving field.

CREST research operations are structured in five groups (see Box above).

All information is gathered from the Loughborough University website.

For any further details access the link given below.

Source: http://www.lboro.ac.uk/departments/el/research/centres/crest/#tab=publications

SPARKLE
A UNIQUE SOLAR ROAD STUD

Sparkle is a very unique, state-of-the-art, and innovative road safety device, brought out by the Bengaluru-based Tata BP Solar Company. This device is completely powered by the sun. This device provides very clear and visible traffic guidance throughout the year. The best part of the product is that the stud works automatically throughout the day and does not depend on light reflected from the headlights of the vehicles. Thus, it can be very well argued that the solar road stud is a much better option than conventional road studs.

The main short coming of the conventional studs is that it provides visibility up to where the head beam of the vehicle can reach. This gives the driver a reaction time of only 3–4 seconds. The solar stud, on the other hand, can provide visibility up to almost 500 metres and that too without the help of the car's headlight. This increases the reaction time by more than 30 second and, therefore, reduces accidents.

Key features

- Improves driver's awareness.
- Increases visibility
- Reduce risk of accidents
- Dusk-to-dawn operation

Main areas of application

- Busy traffic intersections
- Dangerous and sharp road bends
- Road humps, hilly areas, ghat sections
- Centre line dividers, areas with foggy weather, airport guidance lights, flyovers, multi lane highways.
- Both edges on the carriageways, elevated corridors/flyovers, and so on.

Feature	Benefits
Single/double direction	Reduces the risk of accidents
State-of-the art LEDs	The life of LED is greater than 10 000 hrs
Bright, flickering light	Improves visibility by 500 metre for drivers
Integrated solar panel	The compact, sturdy design promotes maximum energy efficiency
Aluminium die cast casing	Ideal for highway road conditions
Automatic ON at dusk and OFF at dawn	Does not have to be manually operated

Source http://www.tatabpsolar.com/products_view.php?pr_id=Solar_Road_Stud
Photo credit http://www.tatabpsolar.com/products_view.php?pr_id=Solar_Road_Stud

NSOL: PERFECTING THE SOLAR PV SYSTEM DESIGN

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

Introduction

The solar module and the balance of system, like the battery and associated electronics form a complete solar photovoltaic (PV) system. The performance of a solar module depends on several external parameters, for example, solar insolation, ambient temperature, and so on. Thus, it becomes absolutely necessary to design a PV system with utmost care so that it works on all days of the year. Simply put, it means working out suitable capacities, both for the solar array and charge storage medium, that is, the batteries. We have so far dealt with a number of system design softwares, which are available either paid versions or for free. In this issue, let us take up NSOL, which has been in use in the PV industry for some time now. It is basically a sizing tool and not a simulation programme. NSOL is regarded as the industry standard for sizing software, which is used by the solar PV design professionals. It was originally developed way back in 1993 as an easy-to-use tool for an accurate design as-well-as performance estimation of stand-alone PV systems. There are several key features associated with this system design tool.

System sizing approach

The key objective for an accurate sizing of a standalone system is to choose an array and battery size/configuration that will support the loads during the design periods. The following are the most important steps to complete this system design exercise.

- Knowing the array tilt (based on knowledge of latitude of a given location)
- Proper selection of system components
- Choosing the proper battery size
- Choosing a correct array size

Key inputs mainly include the following.

- Solar module data
- Solar insolation
- Load profile
- Battery related data
- Standby power option

This software offers the convenience of a user-friendly database on solar insolation. In addition, customized database is also available for the solar modules and batteries. The following are the main system configurations, which can be dealt with under this specific software tool.

- Standalone
- PV-grid power systems
- PV-generator hybrid power systems

NSOL deals with the following two specific methods to work out the performance of a standalone solar PV system under consideration.

- Energy balance/ALR method
- Loss of load-probability method

Understanding the methods

Energy balance

In a PV system, the solar module is the power producing part. Simply put, we get energy supply from the module. This is also

known as 'Energy In'. On the other hand, load uses that amount of energy and is termed as 'Energy Out'. The PV supply is variable on a daily basis. It simply means making available some energy storage option. Still, the most widely used choice is a battery of varying capacities. It is also a well-known fact that PV supply generally varies from one day to the other. This demands an extra storage facility. Now, take the effect of different seasons in a year. The PV supply also varies from one season to the other. In short, in a given month, the energy balance method assumes constant insolation.

Loss of load probability

It simply calculates the probability of supplying the load and is based on variability of insolation. In this case, insolation is assumed to vary on a daily, monthly, and seasonal basis. Thus, it is in strong contrast to the fixed insolation value for the energy balance method. Use of standard statistical methods is made to gain an insight into the way a PV system may be behaving. The original work in this direction was carried out by Massachusetts Institute of Technology (MIT) Prof Bucciarelli and Department of Energy/National Aeronautics and Space Administration (NASA). The LOLP method may be interpreted in terms of percentage of days, during which a system may fail to perform. It also enables a thorough investigation into the battery analysis. In totality, the loss of load probability gives a concise estimate of the PV system reliability.

In addition, it is also possible to carry out a hybrid system analysis. These may basically involve performance calculations in respect of PV-battery-generator hybrids. That is not all as grid system analysis makes possible the basic performance calculations for utility-tied PV systems.

Inputting the design data

NSOL is a very useful system design tool. It basically takes into account the information under the following heads/sub-heads.

Site data

- Name of the site
- City/region/state/country
- Latitude
- Longitude
- Elevation (in metres)

Insolation/temperature data

- Average global horizontal insolation for each month of the year
- Average daily temperature at the site for each month of the year (in degrees Celsius)
- Temperature swing-average number of degrees between the average temperature and the high-low temperature. Take for example an average high of 18 °C and variation of 5 °C . Thus, average high is 23 °C and average low is 13 °C.
- Reflectance is normally taken as 0.2. It can range from 0.02 (2%) for the loose dark soil to 0.8 (80%).

The solar insolation /site database is intended to make data entry simpler. NSOL makes use of this data from National Renewable Energy Laboratory (NREL) (for sites within the US) and University of Lowell (international sites). Additionally, NASA's satellite database is available in the newer version of NSOL. It covers the entire globe at one degree latitude/ longitude intervals.

System data

- Battery voltage
- Maximum battery depth of discharge
- AC operating voltage
- Target battery days (system autonomy)
- System losses (with seasonal loss options)

Component data

- Batteries (cell amp-hour, unit volts, series, and parallel strings)
- PV module (Watt peak, module maximum power voltage, module maximum power current, open circuit voltage, short circuit current, voltage temperature compensation, current temperature compensation, series, and parallel strings)
- PV array
- Grid inverter

Hybrid components data

- Make/model of the generator
- Genset power rating
- Genset power factor rating
- Full load fuel consumption
- Quarter load fuel consumption

Inverter data

- Model/make
- Inverter rating in kW
- Average efficiency

Load data

- Type
- Size of the load
- AC/DC load
- Conversion efficiency
- Load hours
- Load profile (day only, day/night, night only)
- Seasonal load

Amongst others, the following are the main data entry links.

- Array tilt
- Tracking options
- Optimization

Any one interested in designing a PV system (stand-alone, grid-interactive or a hybrid system) can enter the relevant choices of data parameters as highlighted above. NSOL can maximize the gain from a PV system via the selection of all possible components/parameters. With improved versions of system design tools becoming available, a system designer's task becomes all the more interesting.

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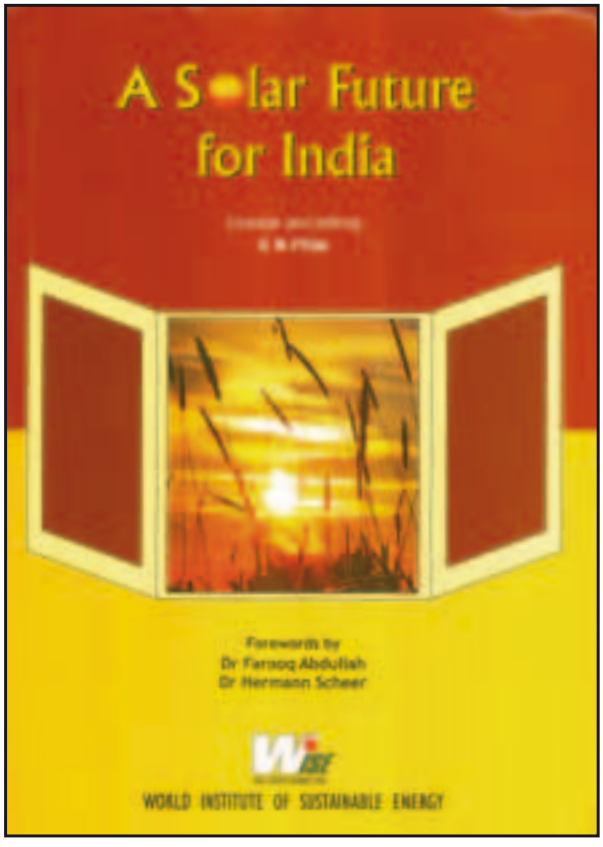

Lead author: **Pillai, G M (ed.)**
Year: **2011**
Pages: **650 pp.**
Publisher: **World Institute of Sustainable Energy**

The energy that the earth receives from the sun in one hour can meet our energy needs for one whole year, provided we can capture that energy, convert it, and deliver it to the point of use. Dr Farooq Abdullah, India's Minister for New and Renewable Energy, "heralds the beginning a new dawn illuminated by thousand suns distributed in myriad Indian homes, bringing power for all". India's future is indeed bright, literally as well as figuratively, and it is a solar future.

The Jawaharlal Nehru National Solar Mission aims to make India a global leader in solar energy. In more concrete terms, the mission aims to take India's grid-connected solar capacity to 20 000 MW by 2020. Considering that the country's present grid-connected solar capacity is only 15 MW, the target poses a challenge to us all. This book is written for the students of science and engineering who will play a more major role in meeting that challenge as well as for the policy makers, administrators, economists, scientists, and technologists who can set India on the path to sustainability.

- From global level to the level of a village household
- From the physics of solar energy and the chemistry of solar cells to the technology of smart grid and the environmental impact of solar cells
- From the century old technology of solar still to the latest organic photovoltaic cells
- From the human resources required for developing the solar sector to the economics of easy loans for development
- From the history of the solar sector development, in India, to the material limits on the sector's development across the world
- From financing the sector to policy and regulatory issues relating to the National Solar Mission as well as articulating a futuristic vision

The genesis of this book dates back to the "Solar India 2007", held by World Institute of Sustainable Energy (WISE) in Bengaluru, in July 2007. This was the first-of-its-kind comprehensive event on solar energy development in India, launched at a time when there was still widespread skepticism about the potential of solar energy to produce grid-connected power. The launching of the JNNSM was a major watershed for solar energy development in India. Thereafter, many follow-up actions have been taken. It was, therefore, imperative to cover these developments and, hence, the contents of the book underwent a major revision. The net result is a volume comprising of 36 papers segregated into following chapters, spanning over 650 pages.

Some of the major chapters covered in this volume are:

- Solar energy for the new millennium: some of the emerging areas covered in this chapter are global scenario of the energy system; solar cell technologies; organic photovoltaics; solar energy storage technology; and application nanotechnology for improvements in solar energy systems.
- Grid-connected solar power: this section covers the solar thermal electricity generation and the technical challenges experienced with grid-tied photovoltaic systems. The other areas covered are grid-connected photovoltaics and concentrating photovoltaics
- Major off-grid solar applications: this portion discusses how SPV is extensively used for irrigation and water management; usage of PV in industrial perspective is also looked into like stand-alone PV for energy-intensive industries and techno-economics feasibility of the solar industrial process heat.
- Solar energy development in India, solar mission, and the way forward: both the chapters gave an overview of the rise and future development of solar energy in India. It also discussed the various issue related to this such as human resource management, national solar mission, regulation and deployment of solar energy, economics of solar power, financing solar energy development, accelerating grid parity, and smart grid concept to support solar power.

This is a comprehensive, up-to-date, and reliable volume on all aspects of solar energy.

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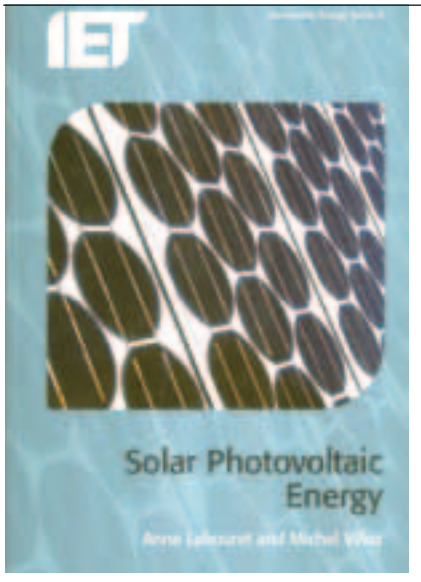


Labouret Anne and Villoz Michel
United Kingdom: The Institution of Engineering and Technology, UK
372 pp. • Year: 2010

Solar Photovoltaic Energy. IET Renewable Energy Series 9

This professional manual on photovoltaic energy gives designers, installers, and managers the tools and methods for:

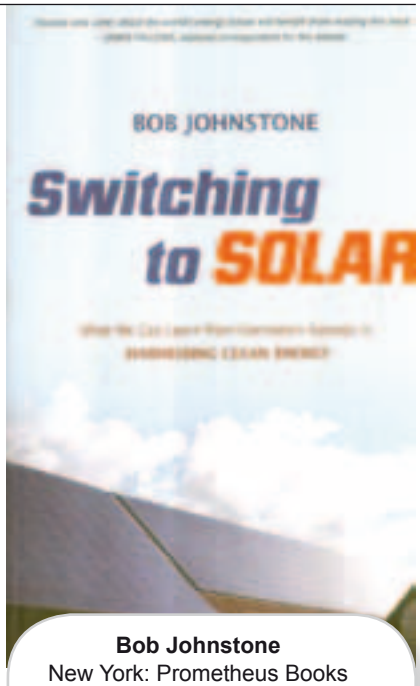
- effective technical reports writing
- calculating installing and maintaining the necessary components (solar panels, batteries, charge controllers, conductors, and so on.)

The main aim is to design and put in place photovoltaic installations adapted to specific needs; conserving energy and taking into account both the opportunities and limits of this new energy.

It gives a detail account of the physical phenomenon (conversion and storage of solar energy) as well as the available technology and the technology currently being developed. The edition includes a number of updates on the economical and technical aspects of this energy, as well as exploring the possibilities of connecting it to a network of photovoltaic systems. This books is an essential tool for technicians and engineers involved in the field of solar energy (installers and users), as well as professional researchers. It will also be a useful reference for engineering students, including electronic engineers.

Switching to solar: what we can learn from German's success in harnessing clean energy

This book charts the dramatic rise of solar power from its off-grid origins in the 1970s to the fast-growing multibillion-dollar industry it is today. Here, for the first time, technical journalist Bob Johnstone tells the inspiring and optimistic story of how determined activists and enlightened visionaries in Germany developed a surprisingly simple and innovative policy mechanism that is now driving the solar boom. This book explains why Germany leads the world in harnessing clean energy from the sun, and what valuable, cost-effective, and environmentally beneficial lessons we all can derive from this success.



Bob Johnstone
New York: Prometheus Books
402 pp.
Year: 2011

Affordable solar

The website provides details about various solar products at affordable prices. The website has a separate section on installers. This section provides details about installer applications and various installers who can help install solar applications. The website contains a separate section titled 'learn'. This section features the basic about solar, how to build and care for a system, system tools, and so on. It is a very comprehensive website on solar product and solar in general.

http://www.affordable-solar.com/

Solar news

This is an all inclusive website on solar news. The website features the latest news in the solar energy sector. It also has an archive section, wherein one can get date-wise news on solar energy. The website is divided into various sections, such as solar power, solar panel, emission, and so on, with latest news in each section.

http://solarnews.com/

SolarIndiaOnline.com

The website provides complete news on solar energy, specific to India. It has a separate section titled 'government authorities', which gives details about various ministries and government organization that are involved in the renewable energy sector. The website also has separate sections on the present status of solar energy, challenges, and as well as research and development in this area. Anyone who wants to get information about solar energy in India must visit this website.

http://solarindiaonline.com/solar-india.html

Solar Energy Solution

Solar energy solution is an alternative energy company. The website provides details about the company along the vision, product line, scope of work, and so on. It also has a separate section on feedback.

http://www.solarindiasolutions.com/home.htm

ANNOUNCEMENT

The Product Update section

The Solar Quarterly magazine invites updates and information on all new products in the solar energy sector. The update and information provided will be featured in the 'Product Update' section of the magazine.

Send in your write ups to

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NATIONAL AND INTERNATIONAL EVENTS

International

Conference and Exhibition Renewable Energy 2011
27–29 July 2011
Chiba, Japan
Tel +81/3/5294-3888
Fax -0909
E-mail council@renewableenergy.jp
Website www.renewableenergy.jp/english/index.html

Solar Asia 2011
28–30 July 2011
Kandy, Sri Lanka
Tel +94 81 2232002
Fax +94 81 2232131
E-mail solarasia2011@ifs.ac.lk
Website www.solarasia2011.ifs.ac.lk

Trade Fair: PV Japan 2011
27–29 July 2011
Tokya, Japan
Tel +81/3/32225-999
Fax -757
E-mail pvj@semi.org
Website www.pvjapan.org/en

3rd Guangzhou International Solar Photovoltaic Exhibition 2011
11–13 August 2011
Guangzhou, China
Tel +86/20/22106416/
E-mail pvguangzhou@vip.163.com
Website www.gzxny.com

Conference: ISES Solar World Congress 2011
28 August–2 September 2011
Kassel, Germany
Tel +49/761/45906-50
Fax -99
E-mail info@swc2011.org
Website www.swc2011.org

26th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC)
5–9 September 2011
Tel +49/89/72012-35
Fax -91
E-mail pv.conference@wip-munich.de
Website www.photovoltaic-conference.com

Conference Bio-inspired Material for Solar Energy Utilization (IC BIOSOL) 2011
12–17 September 2011
Tel +30/2810/5450-45
Fax -66
E-mail info@biosol2011.gr
Website www.biosolenuti.gr

Trade Fair: PV Rome Mediterranean 2011
14–16 September 2011
Tel +390/2/6630-6866
Fax -5510
E-mail artenergy@zeroemission.eu
Website zeroemission.eu

6th China (Beijing) International Exhibition of Solar Energy Products
19–21 September 2011
Beijing, China
Dong Wang
Tel +86/1 0/8-6401689
Fax -5863866
E-mail winderwang@163.com
Website www.chsolarpv.com

Conference and Exhibition: Gulfsol 2011
20–22 September 2011
Dubai, United Arab Emirates
Tel +44/203/2396759
Fax 207/1837196
E-mail des@gattacaltd.com
Website www.gulfsol.com

Trade fair: Semicon Korea 2011
21–23 September 2011
Seoul, South Korea
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E-mail jkim@semi.org
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Conference and Exhibition: Solar Power International (SPI) 2011
18–20 October 2011
Dallas, Texas, USA
Tel + 1/202-8570898
Fax -6820559
E-mail info@solarelectricpower.org
Website www.solarpowerinternational.com

National

5th Renewable Energy India 2011 Expo
10–12 August 2011
New Delhi, India
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E-mail rajneeshk@eigroup.in
Website renewableenergyindiaexpo.com

EMPOWER India 2011
20–22 October 2011
New Delhi, India
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Website www.urja.org.in

India's International Exhibition and Conference for the Solar Industry
14–16 December 2011
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Tel +86-25-5276 6681/6682/6684
E-mail sales@chinasunergy.com
Website www.chinasunergy.com

BIG SUN ENERGY TECHNOLOGY INC.

Professional maker of solar cell

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Website www.bigsun-energy.com

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RENEWABLE ENERGY AT A GLANCE

S.No.	Source/system	Estimated potential	Achievement as on 31 March 2011
I	**Power from renewables**		
A	**Grid-interactive renewable power**	(MW)	(MW)
1	Wind power	45,195	14,157.10
2	Bio power (agro residues and plantations)	16,881	997.10
3	Bagasse cogeneration	5,000	1,667.53
4	Small hydro power (up to 25 MW)	15,000	3,042.63
5	Energy recovery from waste (MW)	2,700	72.46
6	Solar photovoltaic power	—	37.66
	Sub total (A)	**84,776**	**19,974.48**
B	**Captive/combined heat and power/distributed renewable power**		(MW)
7	Biomass/cogeneration (non-bagasse)	—	301.61
8	Biomass gasifier	—	131.81
9	Energy recovery from waste	—	70.42
10	Aero generator/hybrid systems		1.12
11	Water mills/micro hydel	—	6.98
12	Solar PV power plants and street lights (>1 kW)	—	5.80
	Sub total (B)	**—**	**517.74**
	Total (A+B)	**—**	**20,492.22**
II	**Remote village electrification**	—	8,033 villages/hamlets
III	**Decentralized energy systems**		
13	Family-type biogas plants	1.20 million	4.31 million
14	Solar photovoltaic systems		
	i. Solar street lighting system	—	1,22,697 nos
	ii. Home lighting system	—	6,56,707 nos
	iii. Solar lantern	—	8,17,369 nos
	iv. Solar power plants	—	2.92 MW_p
	v. Solar photovoltaic pumps		7,495 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		.66 million
16	Wind pumps		1,352 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

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- Matte paper
- Number of pages: 96

Technical specifications

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