Akshay Urja

wishes all its readers a very
Happy and Prosperous New Year!

2009
Dear Reader

Energy is the key indicator and input for the social, economic, industrial, and technological development of a country. Man’s quest for leading a better and comfortable life has compelled him to use all available energy sources irrespective of the cost and environmental degradation. In the present era of massive growth in all spheres of life, which is increasing the energy demand manifolds, the use of renewable energy cannot be ruled out; rather it is emerging as an alternative to conventional fuels.

India has been striving hard to harness and popularize the use of renewable energy in the daily life of people over the last two and half decades. In this context, DACs (District Advisory Committees) for renewable energy comprising about 20–25 members from various fields have been constituted in 560 districts with a strength of about 13,000 members. These committees are popularizing the use of renewable energy at grass-roots level. The recent event, that is, All India Conference of DACs that was held on 17 December 2008 at New Delhi was inaugurated by the Hon’ble President of India herself and focused on encouraging these DACs to take more action on spreading the message of renewable energy. This also shows the concern of the Hon’ble President of India for renewable energy.

This issue of *Akshay Urja* has a diverse focus. From green buildings to an energy-efficient old age home, it covers almost all aspects of renewable energy. Something that one couldn’t miss was also the release of the *Akshay Urja* song. Covering every aspect of renewable energy, the song is very thought provoking and beautifully shot. Composed and sung by eminent artists, it is indeed a very good vehicle to promote large-scale use of renewable energy. The story on Sanjivan is also very inspiring. The way ‘Sanjivan’ an old age home in Nagpur has utilized renewable energy is appreciable. The present issue of *Akshay Urja* would be informative for the readers.

It really came as a surprise to know that with the present issue of *Akshay Urja* in your hand we have completed the journey of four years by publishing 24 issues. Today when we receive the news, articles, stories and letters from a *sarpanch* of the village, a farmer, a student, a lawyer, government officer, a professor, a businessman, and a common person about renewable energy, we feel that *Akshay Urja* is able to play its role for which it was conceptualized. The response from our readers is tremendous and overwhelming. I have no hesitation to mention that without your support its regular publication is not possible. I can assure that the entire team of *Akshay Urja* is constantly working hard to present contents as rich and latest as possible, improve its design and make it more attractive and informative to you.

I wish a very happy and prosperous 2009 to you.

Happy reading!

ARUN K TRIPATHI

Disclaimer

The views expressed by authors including those of the editor in this newsletter are not necessarily the views of the MNRE.
HVAPS-India is a Solan-based NGO serving the people for the last six years. I got an opportunity to go through the July–August 2008 issue of Akshay Urja. The material was very informative and the quality of the newsletter is also excellent.

Pawan Sharma
Himalayan Vikas Avam Paryavaran Samiti, Dist. Solan, Himachal Pradesh

I found the current edition of Akshay Urja very useful and informative. It is a very useful tool in motivating people to adopt renewable energy sources for their daily energy needs.

Vijay Shankar Saknal
Vishal Electrons, Ramchandrapur, Nalanda, Bihar

I am engaged in the promotion of renewable energy and energy efficiency in the state of Chhattisgarh. I have gone through the latest issue of MNRE's newsletter Akshay Urja. It is really very informative, comprehensive, and interesting.

Sanjeev Jain
Certified Energy Auditor, Raipur, Chhattisgarh

We are one of the manufacturer/supplier of solar water heaters in India and are registered with MNRE. We went through Akshay Urja and found it to be very informative and interesting. We would like to set up a 25-kW solar power plant at UP and have primarily calculated the cost. We would now like to know whether we can get any assistance in the form of capital subsidy, interest subsidy, and would also like to have a project report for the said project. Kindly guide us accordingly.

Samrat Laha
Solace Power, Kolkata

I congratulate the Ministry on publishing Akshay Urja. The magazine is very useful to our institution. Information on renewable sources of energy should be spread among one and all. Akshay Urja helps in doing just that.

Principal
Kirodimal Institute of Technology, Raigarh, Orissa

Akshay Urja is very informative. This shows the progress of the ministry for development of renewable energy sources for power generation to face the energy crisis. This magazine will create awareness about the potential of renewable energy for power generation and utilization.

D S Joshi
Thane

Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation.

Editor
Akshay Urja
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In order to promote renewable energy systems and devices in the country at grass-roots level in each district, it was felt that a coordinating mechanism should be created for integration of various renewable energy programmes and monitoring of their implementation at district level. In this context, the MNRE (Ministry of New and Renewable Energy) proposed setting up of DACs (District Advisory Committees) for renewable energy at the district level to create mass awareness and coordinate various renewable energy programmes. The Hon’ble Minister for New and Renewable Energy wrote personally to all the chief ministers to set up these DACs in each district of their state and to issue necessary instructions to all district collectors in their state for the setting up of the DACs for renewable energy in the respective districts. In July 2004, he also wrote to all the Hon’ble MPs to furnish a list of suitable names, along with bio-data of people who could be nominated on the committees.

Today as a result of the efforts put in by MNRE, there are 560 DACs in various states in 560 districts. These committees have been duly notified by the district collectors and endorsed by MNRE. These DACs have a strength of 12,689 members including 6,533 official members and 6,156 non-official members. Official members are those who are the representatives of the government departments, banks, and so on while non-official members are the representatives of NGOs, reputed citizens, associations, Nehru Yuva Kendra, Rotary/Lions clubs and nominees for the post of MPs (both Lok Sabha and Rajya Sabha).

Detailed guidelines indicating objectives, terms of reference, major activities, duration, members, financial support, and so on were also formulated for these DACs. These guidelines were circulated to all districts collectors/deputy commissioners/district
magistrates (who are also chairman of DACs), all official and non-official members, state nodal agencies, and various organizations. The ministry has also issued membership cards to the members of DACs. These cards were prepared at MNRE, New Delhi and were distributed to various members through the chairman DAC/district collectors all over the country. The meetings of DACs are held once in every quarter.

The regional-/state-level orientation-cum-training programmes have been organized in various states to apprise the DAC members with latest developments, systems and devices, their availability, costs, and so on. So far, a series of orientation programmes have been organized in eight states namely Maharashtra, Uttar Pradesh, Orissa, Rajasthan, Uttarakhand, Madhya Pradesh, Andhra Pradesh, Assam, and Haryana. The programmes in Kerala, Arunachal Pradesh, and Tamil Nadu are scheduled during 2008/09.

These DACs are in existence for the last four years and are functioning in respective districts. With a view to have a interaction with the DAC members and to apprise them with the latest developments on renewable energy in the country, the MNRE organized an All India Conference of District Advisory Committees on Renewable Energy at Vigyan Bhawan, New Delhi on 17 December 2008. The conference was inaugurated by Her Excellency the President of India, Smt. Pratibha Devisingh Patil.

In this conference, about two DAC members along with district collectors/district magistrates/deputy commissioners (who are chairmen of DAC) from all over the country, representatives of state nodal agencies, and so on were invited. About 1200 participants attended the conference, which also had some insightful speeches from the dignitaries present.

The conference started with a welcome address by Shri Deepak Gupta, Secretary MNRE. He welcomes all and sundry to the conference and said that people and media are the ambassadors for spreading the message of renewable energy. He said that energy use, like all other sectors, is undergoing major changes. It is important to spread the message of right usage of energy and use of renewable energy in a mission mode in villages and towns. One should promote the use of renewable energy systems and devices in all walks of life. He said that the ministry is in discussion with grameen banks for financing solar home systems. There are many challenges but we are ready to face them and move ahead.

A short 10-minute film called Akshay Urja aur Hum followed the welcome address. The film was really an eye opener on how the MNRE has developed over the years and what efforts it has done to give renewable energy a prominent place in the country. In fact, it has even gone international. The film was followed by an address by the Hon’ble Minister for New and Renewable Energy, Shri Vilas Muttemwar. He welcomed all present and said that Her Excellency, Pratibha Patil has given a boost to the ministry’s efforts with her presence. He informed the gathering that the idea behind setting up DACs was to create awareness about renewable energy systems and devices appropriate for all districts. He said it was his utmost desire for a long time to interact directly with the DAC members and the conference was organized for this very purpose only.

He said that the ministry regularly receives reports from the DACs and that their suggestions are incorporated in the various programmes from time to time. He requested all district collectors to actively participate in the meetings and give priority to the important task ahead of them. The minister then informed the gathering of the achievements made by the ministry in
vast fields. He said that so far, about 13,500 MW power generation capacity has been achieved through renewable energy sources such as wind, hydro, biomass, and solar and the electricity produced is being fed into the grid. Shri Muttemwar said that the Draft Biofuel Policy has been sent to the cabinet and is awaiting approval.

This was followed by the President’s address. She said that energy is the key input for the socioeconomic development of any country and achieving energy security is an essential national objective. She said that the fossil fuels took a lot of time to develop. However, humans are using it up at a very fast pace. There is also no escaping the fact that fossil fuels are limited in availability, and we need to explore alternative sources of energy. Smt. Patil reminded that natural energy sources – solar, wind, biomass, and hydro – are not only inexhaustible and renewable but are also cleaner sources of energy.

Human kind has been using these energy sources since the origin of life. Our ancient scriptures speak of Ekam Adityam, the sun as the one source of inexhaustible energy. The tapping of these sources of energy for broader uses is based on technological innovations, which have taken place mainly in the last century.

Time has come to multiply the use of renewable energy, she said. This can happen if efficient and cost-effective technologies are made available to popularize their use. The President appealed to work systematically to enhance work in the development and production of renewable energy technologies. Referring to the National Solar Mission, the President suggested that focus be on the research and development efforts to enable the creation of more affordable and more convenient solar power systems and to promote innovations that enable the storage of solar power for long-term use. The President expressed a view of generating energy through locally available renewable available resources, which can be useful in decentralized generation and distribution of energy.

About the recently launched ‘Roshni’ programme in Rashtrapati Bhavan, Smt. Patil said it includes initiatives like waste management, energy efficiency, and usage of new and renewable energy as essential components. The effort is to create awareness and a sense of responsibility in each individual living in the President’s estate, in keeping the environs clean. She said we have been fortunate to have had a political leadership committed to cleaner sources of energy. Our late Prime Minister, Smt. Indira Gandhi, created a separate Department of Non-Conventional Energy Sources in 1982 to work towards the utilization of the immense potential of renewable energy in the country. The President congratulated the MNRE for initiatives in the direction of moving India forward in renewable energy usage and encouraged it to continue with its efforts. She wished the conference all success. The session concluded with a vote of thanks by Smt. Gauri Singh, Joint Secretary, MNRE followed by the National Anthem.
President releases Akshay Urja song

On the occasion of the All India Conference of District Advisory Committees, the Hon’ble President of India released the Akshay Urja song. The song has been prepared by the MNRE and it is a national-level song aimed at promoting renewable energy among the common man. It covers various facets of renewable energy and puts forward the message of renewable energy in a very simple language easily understandable by people. The shooting was done at various project sites where renewable energy installations have been made. The song has been written by renowned lyricist Shri Javed Akhtar and the music has been given by the renowned music trio of Shankar, Ehsaan, and Loy. It has been sung by Shankar Mahadevan and Hansika Iyer.

The duration of the song is four minutes. In the song, the nature tells people that it has enormous energy and that it will provide ‘Akshay Urja’ from sun, wind, biomass, and waste sustainably for their use. The video version of the song is proposed to be telecast in various TV channels and will also be shown in theatres. The Akshay Urja song can be downloaded from the website of MNRE, www.mnre.gov.in.

Solar power cos cheer green initiatives

Obama’s encouragement to build alternate energy sources coupled with the eight-year extension of tax incentives for solar power projects, which was part of the $700 billion bail out passed by US Congress are good reasons for solar power companies in India to feel optimistic. The tax breaks announced by Congress will encourage private investment from photovoltaic companies such as Moser Baer which have planned investments to the tune of $3.6 billion in research, development, and manufacturing of products dedicated to generating solar power.

Other players who will benefit are Tata BP Solar and Reliance Industries Ltd, which announced last year its intention to set up a solar plant in West Bengal. According to industry experts, the demand for SPV (solar photovoltaic) is surging and has grown from $4 billion in 2003 to $22 billion in 2008 and is expected to experience robust growth through 2010—40% CAGR which translates into a $50 to $70 billion market by 2010.

Obama through his presidential campaign has spoken out for policies in favour of solar power projects and even suggested revitalizing the
automotive industry by including in the manufacturing outlets instruments for alternate energy sources such as solar panels and wind turbines. Ratul Puri, Executive Director of MoserBaer, which founded its PV business last year, responded to Obama’s victory positively saying, ‘Players in this industry in India will definitely feel the boost to invest and do business with US solar companies after Obama’s win’.

‘PV technology will help reduce solar electricity costs to match conventional energy price points thus making solar energy a more viable option,’ Puri adds. Germany, which is currently the world leader in solar power, comprises half the market for SPV but pro-solar policies such as the ones recently passed will make the US a significant market for SPV.

6 NOVEMBER 2008, THE FINANCIAL EXPRESS

More companies join photovoltaic bandwagon

Tough economic conditions notwithstanding, the PV (photovoltaic) juggernaut continues to roll. Two more companies – Emco Energy and Optisolar Inc. – have evinced interest in setting up facilities to produce thin-film modules and panels in the country, with investment adding-up to nearly Rs 14 000 crore. While these companies have written to the government outlining their PV plans, and are expected to shortly submit an application, the latest move takes the overall investment interest by various companies to Rs 1,50,000 crore, sources said.

‘Emco Energy has expressed interest in setting up a thin-film module with a proposed investment of Rs 9,000 crore. Another company, US-based Optisolar Inc., has said it plans to manufacture amorphous silicon thin-film panels at a proposed investment of Rs 5,400 crore. Both the companies are scouting for a suitable location,’ sources pointed out. The government has already received proposals from corporate giants such as Reliance Industries and Videocon Industries for incentives under Special Incentive Package Scheme (notified last year to encourage investments for semiconductor fabs and eco-system units).

While Videocon Industries plans to set up LCD fab (Rs 8,000 crore), Reliance Industries is planning a semiconductor wafer fab (Rs 18,521 crore). Proposals pertaining to SPV include Moser Baer PV Technologies (Rs 6,000 crore), Titan Energy Systems (Rs 5,880 crore), KSK Energy Ventures (Rs 3,211 crore), Signet Solar (Rs 9,672 crore), Reliance Industries (Rs 11,631 crore), Phoenix Solar India (Rs 1,200 crore), Tata BP Solar India (Rs 1,693 crore), Solar Semiconductor (Rs 11,821 crore), and TF SolarPower (Rs 2,348 crore). Besides this, the centre has recently received applications from EPV Solar, Vavasi Telegence, and Lanco Solar for setting up PV projects.

Under SIPS, the centre would provide incentive of 20% capital expenditure during the first 10 years for the units in SEZs and 25% of the capital expenditure in non-SEZ units. Any unit can claim incentives in the form of capital subsidy or equity participation.

10 NOVEMBER 2008, THE HINDU BUSINESS LINE
UP sops for solar water heaters

In order to popularize alternative methods of conventional energy, the UP (Uttar Pradesh) government has announced subsidy on solar water heating systems. The scheme will be carried out through the NEDA (Non-conventional Energy Development Agency), a state government nodal agency for renewable energy. Renewable energy is generated from natural resources such as sunlight, wind, rain, geothermal heat, and biomass, which are renewable. A subsidy of Rs 6,000 for FPC (flat-plate collectors) and Rs 5,000 for ETC (evacuated tube collectors) in domestic use has been announced.

Subsidy of such kind has been introduced for the first time. The state government is focused to promote solar water heater as an alternative option for heating water,” said Ashok Kumar Srivastava, Project Manager, NEDA. NEDA works as a nodal agency, implementing programmes, creating awareness in general public by research and development and publicity of non-conventional devices in the field of renewable energy.

‘This is an economically viable option as electricity cost is increasing day by day. The particular scheme is open for first 1000 bookings,’ he added. So far, 135 applications have been enrolled under the ongoing scheme. The fact that there will be reduced availability of petroleum products in future should encourage people to adopt products of solar energy,” Srivastava said. A solar expo was recently held in the city, which showcased various solar water heating systems and other solar energy products. About 20 manufacturers from cities like Delhi, Mumbai, Bangalore, and Hyderabad participated in the expo.

‘Till date we have given about 70,000 solar water heaters in the city. However, motivation is necessary to divert people’s attention towards alternative sources of energy, considering the fact that conventional fuel has limited life,’ said Srivastava. He further informed that under the latest

Gurgaon gets green building

Haryana governor A R Kidwai inaugurated a green building in the Millennium City, Gurgaon. An initiative of S M Sehgal Foundation, a non-profit organization working for rural development in Mewat and Kurukshetra, the building is located in Sector 44. A solar power generation unit, a water-harvesting mechanism to reuse rainwater and use it for groundwater recharge, and built in accordance with zero-waste concept are factors which contribute to the construction’s ‘greenness’. Speaking on the occasion, Kidwai said, ‘Solar energy is the future and we are wasting it. To meet the growing demand for electricity, hydro power combined with solar energy will be ideal for India’. He added that the Government of India had introduced a scheme of setting up 50 MW solar generators in different parts of the country.

Suri Sehgal, Chairman, S M Foundation, said green buildings increase the efficiency with which buildings and their sites use and harvest energy, water and materials and reduce the building’s impact on human health and environment through better design, construction, operation, and maintenance. The building has been constructed according to the platinum rating of LEED (Leadership in Energy and Environmental Design) standards set by the US Green Building Council. Experts said this was the first institutional building in Gurgaon that had been designed to minimize carbon dioxide emissions. Wood has been used in place of aluminum for doors and windows and the use of burnt brick has been minimized. No imported stones have been used in its construction.

‘An interesting feature of the building is that it derives beauty from waste. The entrance lobby, boardroom, and the central atrium use waste plywood wooden planks, broken tiles, and glass to demonstrate how waste can be converted into a beautiful resource,’ said Sehgal. ‘The 35 kW solar photovoltaic installations on the roof meet 100% of the building’s basic electricity needs, including computers, lighting, fans, and mechanical ventilation directly from solar energy,’ he further said. He added that though the cost of construction was 15% more than a traditional building, the extra cost incurred could be recovered by way of less electricity consumption in five to eight year’s time.

3 DECEMBER 2008, THE TIMES OF INDIA
decision of the state government, it has become necessary for the multistoried buildings, educational institutions, hostels, and so on to install solar water heaters in their premises.

10 NOVEMBER 2008, BUSINESS STANDARD

Renewable energy policy of Karnataka soon

The state government’s renewable energy policy, which was to have been unveiled this month, will now be released on 1 January 2009. Principal Secretary, Energy Department, K Jairaj announced this at a ‘Renewable energy summit and CEOs’ roundtable’ organized by the CII (Confederation of Indian Industry) in Bangalore. Mr Jairaj said that the new policy had been delayed because the government was holding consultations with various groups, industries, and experts on the nature of the policy support required for the promotion of the renewable energy sector.

The policy would give importance to solar, wind, and biomass projects. The state had the potential to tap 15,000 MW of wind power, but only a little over 1,000 MW had been tapped till now. The government was thinking of giving emphasis to grid-connected solar power projects. At present, setting up a rooftop solar unit was a costly exercise. Power generated from solar plants would cost Rs 18 to Rs 20 a unit. Hence, the cost of generation of solar power had to be brought down by using innovative technologies, he said.

Pointing out that the cost of generation of wind power had reduced from Rs 15 a unit to Rs 3–4 now after the scaling up of operations, he hoped that the cost of solar power generation would also similarly come down. Making a presentation on prospects for biodiesel in the state, former bureaucrat and Bio-diesel Society of India chairman V Balasubramanian said that the government could consider allowing corporate entities to cultivate plants, in shrub-forest areas, from which biofuel could be obtained.

Nearly 21% of the state’s geographical area is covered by forests. Nearly one-third of this is not really forest but inferior land where only shrubs grow. According to a conservative estimate, it is possible to get a minimum income of Rs 7,000 from 100 plants a year by merely selling the seeds, he explained. He cautioned against diverting land being used for cultivation of food crops to grow biofuel plants. Such a measure would not only lead to increase in prices of foodgrains but also affect the food chain itself.

12 NOVEMBER 2008, THE HINDU

MNRE to set up solar PV plant in Gurgaon

The centre is contemplating to formulate and launch a scheme regarding rooftop grid-interactive SPV (solar photovoltaic) system for generation of electricity for commercial establishments, housing complexes, and industries. This was stated by the Secretary, MNRE, Shri Deepak Gupta, while presiding over a consultation meet on rooftop grid-interactive SPV system for electricity generation held at Gurgaon. The meet was organized by the HAREDA (Haryana Renewable Energy Development Agency).

The meet was attended by various stakeholders like nursing homes, hospitals, IT parks, hotels, malls, housing complexes, industries, and schools. Shri Deepak Gupta was in Gurgaon to know the response of the stakeholders about launching of such scheme and after interacting with them he was happy with the overwhelming response. ‘In my opinion, the government should go ahead with the scheme,’ he remarked.

He called upon Gurgaon residents to make it a solar city by adopting solar equipments in place of Diesel.
Genset Captive power. He said that the power generated through gensets was not dependable for a longer period of time as the diesel prices were soaring high and petroleum reservoirs were constantly exhausting. Moreover, the emission of harmful gases like CO$_2$ causes environmental hazards. Shri Gupta also said that it was high time that people in every field thought about adopting solar energy systems as part of their life and added that the maintenance of this system was like dusting one’s house.

He asked the people present to start using solar energy system in some limited area of their premises or with some minimum load. At the same time, he observed that the glass used in buildings in Gurgaon was not energy efficient because in addition to the conventional electricity supply, hundreds of gensets were used to keep these buildings cool. In the interest of future generations and for saving the environment from pollution, one should think of solar energy system.

Sumita Mishra, Director, HAREDA said they have chosen Gurgaon for this project because here people with different line of thinking reside and they believe in bringing change. Moreover, the building sector in Gurgaon has a rapid growth rate of more than 20% as against national average of 11%. She told about the various schemes being run by HAREDA for promotion of solar energy systems.

IREDA gives green energy a 17,000 crore push

IREDA (Indian Renewable Energy Development Agency), an enterprise under the MNRE, would pump in approximately Rs 17,000 crore to fund renewable energy sector projects during the Eleventh Five-year Plan. The company would raise Rs 1,000 crore from foreign markets in the current financial year to finance the projects, a company official said. The Chairman and Managing Director of IREDA, Debashish Majumdar said that the company has been negotiating with several international lenders, including KfW Germany, European Investment Bank, and Nordic Bank to borrow funds. IREDA is expected to receive approximately 70 million euros from KfW Germany in January 2009. Other international lenders would raise the remaining funds, Majumdar added.

According to the Planning Commission estimates, renewable energy projects worth Rs 80,000 crore, which are expected to generate 15,000 MW power, would come up in the plan. Of this, Mazumdar said, IREDA would pump in Rs 17,000 crore to help generate 5,000 MW power via renewable energy. The company will extend its 70% of finance to wind energy sector while the remaining 30% would cover solar, biomass, and hydro projects. The company is also looking to issue zero coupon bonds to help raise funds, he added.

The government has established IREDA to promote, develop, and extend financial assistance for renewable energy and energy efficiency projects by raising funds from domestic and international markets. The company will nearly double its disbursement to Rs 1,000 crore in the current fiscal from Rs 580 crore disbursed in the last financial year, he added.
OTEC: tapping megawatts in the oceans

Oceans, covering more than 70% of the earth’s surface, are the world’s largest solar energy collector as well as storage system. In a day, tropical seas, spread over 60 million square kilometre, absorb solar radiation that equals heat content of 250 billion barrels of fossil oil. So, OTEC (ocean thermal energy conversion) can be an effective option for energy generation. OTEC is a process that converts solar radiation to electric power by using the ocean’s natural gradient. It uses the temperature differences between deep and shallow waters. If the temperatures of the warm water surface and the cold deep water differ by about 20 °C, the OTEC system can harness significant power.

According to experts, OTEC systems can produce about 1000 k million watts of base load power. If less than a tenth of one per cent of the solar energy stored in oceans can be converted into electricity, it would supply more than 20 times the total energy consumed in the US per day. India has piloted a 1 MW floating OTEC plant near Tamil Nadu and the government continues to sponsor various research projects in developing floating OTEC facilities. Among other countries, Japan is interested in funding researches in OTEC technology.

French physicist Jacques Arsene d’Arsonval first thought of tapping thermal energy from the oceans in 1881. Years later a d’Arsonval’s student, George Claude, built the first OTEC experimental plant in Cuba in 1930 for producing 22 kW of electricity with a low-pressure turbine. In 1935, Claude also constructed another plant aboard a 10,000-tonne cargo vessel off the coast of Brazil, but this was destroyed by waves. Later in 1956, French scientists designed another 3-MW plant for Abidjan, Cote d’Ivoire but that couldn’t be completed. In 1962, J Hilbert Anderson and James H Anderson Jr focused on developing new and more efficient component design with a view to complete Claude’s unfinished agenda.

The US got into OTEC research in 1974 when the Natural Energy Laboratory of Hawaii Authority was set up at Keahole Point on the Kona coast. This laboratory is one of the world’s leading test facilities for OTEC technology. In 1978, Richard Meyer became a well-known figure among OTEC technologists. In 1979, a tiny OTEC generator was set up off the coast of Hawaii for producing 18 kW power. Another plant, which continuously produced more than 50 kW power, soon followed. In 1984, the Solar Energy Research Institute (now known as the National Renewable Energy Laboratory) developed a vertical-spout evaporator to convert warm seawater into low-pressure steam for open cycle plants. Energy conversion efficiency, which was as high as 97%, was achieved on them. In May 1993, an open-cycle OTEC plant at Keahole Point produced 50,000 watt during a net power-producing experiment, breaking the record of 40,000 watt produced by the Japanese system in 1982.

Some proposed OTEC projects across the world include a small plant for the US Navy base on the British-administered island of Diego Garcia in the Indian Ocean. It is proposed that an 8 MW OTEC plant, backed up by a 2 MW gas turbine, would replace the existing 15 MW gas turbine plant. A US company has proposed building a 10 MW OTEC plant at Guam. OTEC plants can be of open, closed or hybrid cycles. In an open cycle system, lowering the pressure above warm water turns it into vapour, effectively ‘steam’, which runs a turbine before it is re-condensed by cold water. In closed cycle and hybrid systems, the water heats and cools—vaporizes and re-condenses—an intermediary fluid/gas that powers a turbine within a closed sub-system, which enables much larger energy output.

Newer designs and material choices have reduced the capital investment costs of OTEC plants. Indian Ocean, Caribbean, South Pacific, and the Hawaii regions are the most cost-effective sites for OTEC plants. More works are needed to reduce plant costs further. But certainly, harnessing the wealth of the oceans to replace the fossil fuel is an idea whose time has come. Another hassle in the way of OTEC plants is laws and treaties governing the seas. The UN Convention on the Law of the Seas
international news

OTEC facilities, which are stationary surface platforms and may be considered as artificial islands and, therefore, may invite legal problems. OTEC plants may be perceived as either a threat or potential partner to fisheries management or to future seabed mining controlled by the International Seabed Authority. World leaders need to put in place appropriate international law so that objective of tapping megawatts from oceans is not hindered.

4 NOVEMBER 2008, THE FINANCIAL EXPRESS

Wind to produce 12% of world energy in 12 years

A report indicating that 12% of the world’s energy needs could come from wind in 12 years, and 30% by 2050, has been published by the GWEC (Global Wind Energy Council) and Greenpeace International. The report, Global Wind Energy Outlook 2008, looks at the global potential of wind power up to 2050 and has found that it could play a key part in achieving a decline in CO₂ emissions by 2020.

The report explores three different scenarios for wind power: a reference scenario based on figures from the IEA (International Energy Agency); a moderate version that assumes that current targets for renewable energy are successful; and an advanced scenario that assumes that all policy options in favour of renewables have been adopted. These are then set against two demand projections for global energy demand.

‘Greenpeace expects wind power to play a leading role in a fossil fuel free electricity system of the future,’ says Sven Teske, Greenpeace International’s Senior Energy Expert. ‘This report is based on Greenpeace’s new Energy Revolution scenarios, which show that wind power can make a real difference between now and 2020. We urge governments to support wind power with a robust climate agreement, the necessary electricity market reforms and by cutting down subsidies for fossil fuels and nuclear energy.’

‘This report demonstrates that wind technology is not a dream for the future. It is working now, and it can be deployed on a large scale very rapidly,’ said Arthouros Zervos, GWEC’s Chairman. ‘The political choices of the coming years will determine the world’s environmental and economic situation for many decades to come. The wind industry stands ready to do its part in what the UN Secretary General has described as “the defining struggle of the 21st century”.’ With sufficient political will and the right frameworks, it could do even more.”

A coalition of wind companies, associations and NGOs will launch a campaign at the climate meeting in Poznan in December, to increase government action on wind energy. Entitled ‘Wind Power Works’, the campaign will run for a year until the COP15 climate talks in Copenhagen, December 2009.

10 NOVEMBER 2008, WWW.RENEWABLEENERGYFOCUS.COM

Canadian hydro opens Canada’s largest wind energy installation

Canadian Hydro Developers Inc. announced the official opening of the Melancthon EcoPower Centre. The 199.5-MW project is the largest wind energy installation in Canada. The Melancthon EcoPower Centre is 100% owned and operated by Canadian Hydro. Construction of the Melancthon EcoPower Centre began with the 67.5 MW Phase I in the spring of 2005 and achieved commercial operation on 4 March 2006. Construction of the 132 MW Phase II of the project began in the autumn of 2007 and is expected to achieve full commercial operation in the next two weeks.
All of the electricity and environmental attributes are sold to the Ontario Power Authority under two, 20-year Renewable Energy Supply contracts. Annual average generation from the EcoPower Centre is expected to be 545 GW-hours. ‘We are proud that Canadian Hydro Developers, Inc. picked Ontario as the location for Canada’s largest wind farm,’ said George Smitherman, Ontario’s Deputy Premier and Minister of Energy and Infrastructure. ‘This important investment not only has valuable spin-off benefits for the local community, but benefits all Ontarians by boosting our supply of nonpolluting power.’

13 NOVEMBER 2008, WWW.RENEWABLEENERGYACCESS.COM

51 countries to form international agency promoting renewable energy

If it seems like the world is rallying around renewable energy, that’s because it is. And why not? With huge recent fluctuations in oil prices, the economy on its knees, and climate

New ways of extracting greater cell efficiency

A team of physicists and engineers at MIT are using computer modelling and a host of advanced chip-manufacturing techniques to obtain more efficiency from the cells. They have applied an AR (anti-reflection) coating to the front and a novel combination of multi-layered reflective coatings in addition to a tightly spaced array of lines known as a diffraction grating to the backs of ultra-thin silicon films to enhance the cell output by as much as 50%.

In practice, the carefully designed layers deposited on the back of the cell cause the light to bounce around longer inside the thin silicon layer. Thus, it prolongs the time to deposit its energy and produce an electric current. If these coatings are not present, the light would just be reflected back out into the surrounding air. Ideally, the vexing issue is as to how far does light have to go (within silicon) prior to its high probability of being absorbed for producing some useful current. The MIT team started off by carrying out thousands of computer simulations in which, they tried out variations in the spacing of lines in the grid, thickness of silicon and importantly, the number and thickness of reflecting layers deposited on the back surface. In fact, this work is just a step forward in the direction of producing an economically viable solar cell. It is important to mention here that the MIT Deshpande Center selected the project for an ‘i-team’ study to evaluate its business potential. The team analysed the potential impact of this efficient thin solar cell technology and found significant benefits in both manufacturing and electrical power delivery, for applications ranging from remote off-grid to dedicated clean power.
change at our doorstep, windmills and solar panels have become iconic symbols of energy independence, a new green-collar job sector, and a response to climate change. Now, an international agency is emerging to lead the charge on a global scale.

The IRENA (International Renewable Energy Agency) will integrate regional clean energy progress into a coordinated, global effort. It will provide political recommendations and identify funding for renewable technologies. Moreover, IRENA will seek to even the playing field for countries that have had difficulty affording investment in renewable energy. To this end, the agency will fund its budget with contributions by member-countries on a sliding scale with unindustrialized countries paying less.

‘Acting as the global voice for renewable energies,’ says the agency’s website, ‘IRENA will provide practical advice and support for both industrialized and developing countries, help them improve their regulatory frameworks, and build capacity. The agency will facilitate access to all relevant information including reliable data on the potential of renewable energy, best practices, effective financial mechanisms, and state-of-the-art technological expertise.’

The agreement recently signed in Madrid signalled a successful Final Preparatory Conference, the second in a series of three rapid steps taken to establish IRENA. Earlier this year, wind energy rich Germany got the ball rolling with an invitation to 60 countries to meet at the Preparatory Conference in Berlin. The third and final step needed to establish the agency, the Founding Conference, is slated for January 26, 2009. Due to the enormity of the challenge of developing renewable energy infrastructures around the world and the urgency of curbing climate change, the nascent agency plans to begin operating immediately after it is founded.

Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. Akshay Urja is an attempt to fulfil this need. 20 000 copies are being disseminated in India and abroad.

Akshay Urja publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided on hard copy or as high resolution (minimum 300 DPI) files on a CD. Akshay Urja will pay suitable honorarium for each published article of about 1500 words and above to the authors. The publication material in two copies, along with a soft copy on CD/floppy/e-mail may be sent to

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wwwnmre.gov.in
Dutch-sponsored researcher Robin Gremaud has shown that an alloy of the metals magnesium, titanium, and nickel is excellent at absorbing hydrogen. This light alloy brings us a step closer to the everyday use of hydrogen as a source of fuel for powering vehicles. A hydrogen ‘tank’ using this alloy would have a relative weight that is 60% less than a battery pack. In order to find the best alloy, Gremaud developed a method, which enabled simultaneous testing of thousands of samples of different metals for their capacity to absorb hydrogen.

Hydrogen is considered to be a clean, and therefore important, fuel of the future. This gas can be used directly in cars in an internal combustion engine, like in BMW’s hydrogen vehicle, or it can be converted into electrical energy in so-called fuel cells, like in the Citaro buses in service in Amsterdam.

The major problem of using hydrogen in transport is the secure storage of this highly explosive gas. This can be realized by using metals that absorb the gas. However, a drawback of this approach is that it makes the hydrogen ‘tanks’ somewhat cumbersome. The battery, the competing form of storage for electrical energy, comes off even worse. Driving four hundred kilometres with an electric car, such as the Toyota Prius, would require the car to carry 317 kilograms of modern lithium batteries for its journey. With Gremaud’s light metal alloy, this same distance would require a hydrogen tank of ‘only’ two hundred kilograms. Although this new metal alloy is important for the development of hydrogen as a fuel, the discovery of the holy grail of hydrogen storage is still some way off.

**Hydrogenography**

In his research, Gremaud made use of a technique for measuring the absorbance of hydrogen by metals, based on the phenomenon of ‘switchable mirrors’, discovered at the VU University Amsterdam. About 10 years ago, researchers at the VU discovered that certain materials lose their reflection by absorbing hydrogen. This technique became known as hydrogenography, or ‘writing with hydrogen’. Using this technique, Gremaud was able to simultaneously analyse the efficacy of thousands of different combinations of the metals magnesium, titanium, and nickel. Traditional methods require separate testing for each alloy.

The analysis requires each of the three metals to be eroded from an individual source and deposited onto a transparent film in a thin layer of 100 nanometres using so-called sputtering deposition. This ensures that the three metals are deposited onto the film in many different ratios. When the film is exposed to different amounts of hydrogen, it is clearly visible, even to the naked eye, which composition of metals is best at absorbing hydrogen. Gremaud is the first to use this method for measuring hydrogen absorption.

The British company Ilika in Southampton has shown considerable interest. It wants to build a hydrogen analyser using this technique. Gremaud’s research was funded by NWO Chemical Sciences as part of the national programme ‘Sustainable Hydrogen’.

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Top hydrogen-absorbing metal alloy is sixty percent lighter than a battery pack. (Credit: Image courtesy of NWO (Netherlands Organization for Scientific Research))
India lies in the sunny regions of the world. Most parts of India receive 4–7 kWh (kilowatt-hour) of solar radiation per square metre per day with 250–300 sunny days in a year. The highest annual radiation energy is received in western Rajasthan while the north-eastern region of the country receives the lowest annual radiation. Solar energy, experienced by us as heat and light, can be used through two routes. The thermal route uses the heat for water heating, cooking, drying, water purification, power generation, and other applications. The photovoltaic route converts the light in solar energy into electricity, which can then be used for a number of purposes such as lighting, pumping, communications, and power supply in unelectrified areas.

SPV (solar photovoltaic) lighting systems are becoming popular in both the rural and urban areas of the country. In rural areas, SPV lighting systems are being used in the form of portable lanterns, home-lighting systems with one or more fixed lamps, and street-lighting systems. Applications in urban areas include glow-sign display systems on the streets, traffic signaling, message display systems based on LEDs (light-emitting diodes), and systems to illuminate advertisement hoardings.

**Solar lantern**

The solar lantern is a portable lighting system. Being light in weight, it is easy to carry around and therefore ideal for both indoor and outdoor usage. A typical solar lantern consists of a PV module of 8 MWp to 10 MWp capacity, a sealed maintenance-free battery of 12 V, 7 AH (ampere-hour) capacity, and a CFL (compact fluorescent lamp) of 5 W or 7 W rating. A solar lantern is usually meant to provide light for three to four hours daily, and designed to have a three-day autonomy, that is, to function in this manner for three days without sunlight.

No installation is required for a solar lantern. During the day, the PV module is placed in the sun and is connected through a cable to the lantern unit. The incident solar radiation is converted into electricity, which in turn, charges the battery. A green LED light indicates the charging of the battery. At night, the lantern is simply detached and used wherever required. The battery provides power to the lamp. The cost of a solar lantern with the above specifications is in the range of Rs 3000–3300. Low-cost models with smaller PV modules and battery capacity are also available.

**Availability and repair/servicing**

Solar lanterns and home-lighting systems can be obtained and installed through manufacturers, their dealers, and ‘Aditya’ Solar Shops. The list of BIS-certified manufacturers is given in the following pages. Repair and servicing facilities are also available with them. The state nodal agencies also provide information on their availability. IREDA can be contacted for the financing schemes and soft loans.
<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
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<td>M/s Rashmi Industries, Begur Road, Bommanahalli, Bangalore – 560 068</td>
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<td>Managing Director</td>
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<tr>
<td>Solkar Solar Industry Ltd</td>
<td>No.13.2, Jayalakshmiplr 1st Street Nungambakkam, Chennai – 600 034, India</td>
</tr>
<tr>
<td>Tel. 0909 44 2827 4142, 2827 1819</td>
<td>Fax 0909 44 2827 3435</td>
</tr>
<tr>
<td>Mr D T Barki, Chairman and M D</td>
<td>Noble Energy Solar Technologies Ltd Begumpet, Hyderabad – 500 016</td>
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<tr>
<td>Tel. 2776 9053</td>
<td>Andhra Pradesh</td>
</tr>
<tr>
<td>Mr S K Sangal</td>
<td>General Manager, Solar Photovoltaic Division</td>
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<td>Director, Suraj Solar System, Jogibattala, Baruipur, Kolkata – 700 145, West Bengal</td>
</tr>
<tr>
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</tr>
<tr>
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<td>Managing Director, Kvality Photonics Pvt. Ltd.</td>
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<tr>
<td>Tel. 09831047780</td>
<td>Tel. 040 2773 4115/1275 8011</td>
</tr>
<tr>
<td>Mr Anupam Baral, CEO</td>
<td>Geetanjali Solar Enterprises P/14, Kasba Industrial Estate , Phase I</td>
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<td>Tel. 91 9433084138/9433085262</td>
<td>91 33 2423 0365</td>
</tr>
<tr>
<td>Mr Amit Kumar</td>
<td>Head, North &amp; Central Region</td>
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<tr>
<td>TATA BP Solar India Ltd, 70-74 U G F</td>
<td>Ward Trade Centre, Barakhamba Lane, Connaught Place, New Delhi – 110 001</td>
</tr>
<tr>
<td>Tel. 2341 1537/8/9</td>
<td>Tel. 061 2231 8112/91 11 2695 8016</td>
</tr>
<tr>
<td>Mr Yashovir</td>
<td>CEO, Arsh Electronics Pvt. Ltd</td>
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<td>Mr Chanakya Patel, Partner</td>
<td>Vimal Electronics, Gandhi Nagar</td>
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<tr>
<td>Mr N K Dhyani, Managing Director</td>
<td>Info Power Technologies Ltd 21,Community Centre, Basant Lok Complex</td>
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<tr>
<td>Vimal Electronics, Gandhi Nagar</td>
<td>Vasant Vihar, New Delhi – 110 057</td>
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<td>Mr Arun Mishra,_general Manager</td>
<td>Maharshi Solar Technology Pvt. Ltd A-14, Mohan Cooperative Industrial Estate</td>
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<td>Mr Ashok K Wadhwa, Director, Ritika Systems Pvt. Ltd</td>
<td>Mathura Road, New Delhi – 110 003</td>
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<tr>
<td>Mr Mukesh Mathur, Dy General Manager (MKT-R) Rajasthan Electronics and Instrumentations Ltd</td>
<td>Dist. Anand (Gujarat)</td>
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<tr>
<td>Jain Irrigation Systems Ltd, Jain Plastic Park, Jalgaon – 425 001</td>
<td></td>
</tr>
<tr>
<td>Mr Kanak Mukhopadhyay, Managing Director</td>
<td>Agni Power and Electronics Pvt. Ltd 10/72, Bijoygarh, Kolkata – 700 092</td>
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<td>Mr N K Dhyani, Managing Director</td>
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<td>Tel. 91 11 2614 4056, 2614 3795</td>
<td>Fax 91 11 2615 2386</td>
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<tr>
<td>Jain Irrigation Systems Ltd, Jain Plastic Park, Jalgaon – 425 001</td>
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</tbody>
</table>
Easy Solar Industries  
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Disclaimer Inclusion in this list does not imply approval or recommendation of any company or its products by the Ministry of New and Renewable Energy
Indian solar photovoltaic programme

**Objective**
To provide an alternative for rural lighting/ water lifting/ small energy requirements through use of SPV (solar photovoltaic) system, and thereby reduce the consumption of kerosene/ diesel

**Pattern of CFA (Central Financial Assistance) for SPV systems**

<table>
<thead>
<tr>
<th>SPV system</th>
<th>CFA for general areas (50% of the cost subject to a maximum of)</th>
<th>CFA for north-east and special areas (90% of the cost subject to a maximum of)</th>
<th>Service charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar lanterns (10-W module, 7-W CFL)</td>
<td>Nil</td>
<td>Rs 2400</td>
<td>Rs 100</td>
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<tr>
<td>Solar home system</td>
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</tr>
<tr>
<td>■ Model 1 (18-W module, 1 light)</td>
<td>Rs 2500</td>
<td>Rs 4500</td>
<td>Rs 200</td>
</tr>
<tr>
<td>■ Model 2 (37-W Module, 2 lights)</td>
<td>Rs 4800</td>
<td>Rs 8660</td>
<td>Rs 200</td>
</tr>
<tr>
<td>■ Model 3 (37-W module, 1 light, 1 fan)</td>
<td>Rs 4800</td>
<td>Rs 8660</td>
<td>Rs 200</td>
</tr>
<tr>
<td>■ Model 4 (74-W module, 2 lights, 1 fan)</td>
<td>Rs 4800</td>
<td>Rs 8660</td>
<td>Rs 200</td>
</tr>
<tr>
<td>■ Model 5 (74-W module, 4 lights)</td>
<td>Rs 4800</td>
<td>Rs 8660</td>
<td>Rs 200</td>
</tr>
<tr>
<td>Street lighting system (74-W module, 1–2 lamps)</td>
<td>Rs 9600</td>
<td>Rs 17 300</td>
<td>—</td>
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<tr>
<td>Stand-alone power plant of capacity more than 1 kWp</td>
<td>Rs 1 25 000 / kWp</td>
<td>Rs 2 25 000 / kWp</td>
<td>Rs 10 000</td>
</tr>
<tr>
<td>Stand-alone power plants of capacity more than 10 kWp with distribution line</td>
<td>Rs 1 50 000 / kWp</td>
<td>Rs 2 70 000 / kW</td>
<td>Rs 10 000</td>
</tr>
<tr>
<td>Solar pumps</td>
<td>Rs 30/Wp, subject to a maximum of Rs 50 000 per system</td>
<td>Rs 30/Wp, subject to a maximum of Rs 50 000 per system</td>
<td>—</td>
</tr>
</tbody>
</table>

**Implementation arrangements**
The projects for solar home systems, street lighting systems, and power plants will be implemented through the state nodal agencies / departments / government corporations, Akshay Urja shops, and other organizations, as per the guidelines issued by the MNES. The SPV water-pumping programme is implemented through the state agencies and IREDA. Use of solar pumps for drinking water supply and other community applications is preferred.

**Training**
The Ministry will provide financial support to programme implementing organizations, manufacturer associations, authorized test centres, educational institutions, and professional bodies for organizing training programmes for users, technicians, designers, and field personnel dealing with the SPV systems. Support will also be provided for the preparation and publication of training material, and manuals on system design, maintenance, and standards.

**For further information please contact**
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About 30% (285.35 million people, 2001 census) of the Indian population resides in urban areas. In the post-independence era while population of India has grown three times, the urban population has grown five times. Urban areas are heavily dependent on fossil fuels (often imported), for the maintenance of essential public services, for powering homes, transport systems, infrastructure, industry, and commerce. The fossil fuels are increasingly becoming more expensive due to scarcity of fuel and increase in demand. In addition to this, the environmental and social impacts of the consumption of fossil fuels are increasingly becoming a concern. These impacts include air pollution, global warming, waste disposal problems, land degradation, and the depletion of natural resources. Urbanization and economic development are leading to a rapid rise in energy demand in urban areas. Urban areas have emerged as one of the biggest sources of GHG (greenhouse gas) emissions, with buildings alone contributing to about 40% of the total GHG emissions. As per a latest UN report, one million people are moving to urban areas each week. It is estimated that about two-thirds of the world population will be living in cities in 2050. This requires a tremendous shift in energy resources in urban areas. In recognition of this, various cities around the world are setting targets and introducing polices for promoting renewable energy and reducing GHG emissions. London has announced 20% carbon emission reduction by 2010; New York and 200 other US cities have set a similar target. Tokyo has announced 20% share of renewables in total consumption by 2020 and the Australian government has initiated a Solar Cities programme. Several Indian cities and towns are experiencing 15% growth in the peak electricity demand. The local governments and the electricity utilities are finding it difficult to cope with this rapid rise in demand and as a result most of the cities/towns are facing severe electricity shortages. There is a need to develop a framework that will encourage and assist cities in assessing their present energy consumption status, setting clear targets for and preparing action plans for generating renewable energy.
energy through renewable energy sources and in conserving energy utilized in conducting urban services.

The ministry has already initiated various programmes in the urban sector for promoting solar water heating systems in homes, hotels, hostels, hospitals, and industry; deployment of SPV (solar photovoltaic) systems/devices in urban areas for demonstration and awareness creation; establishment of ‘Akshay Urja Shops’; design of solar buildings; and promoting energy recovery from urban and industrial waste/biomass-to-energy projects. A National Rating System has also been developed in association with TERI (The Energy Resources Institute) for raising awareness and promotion of energy-efficient solar/green buildings. The system is suitable for all types of buildings in different climatic zones of the country. The programme aims to consolidate all the efforts of the ministry in the urban sector and address the energy problem of the urban areas in a holistic manner. Apart from the programme of this ministry, the BEE (Bureau of Energy Efficiency) under Ministry of Power has also launched the ECBC (Energy Conservation Building Code), which is aimed at energy efficiency measures and installation of renewable energy systems/devices in buildings including solar water heating systems. The programme on ‘Development of Solar Cities’ would support/encourage urban local bodies to prepare a roadmap to guide their cities in becoming ‘renewable energy cities’ or ‘solar cities’ or ‘eco/green cities’.

**Major activities to be conducted in the programme**

The programme has been designed to address challenges in delivering sustainable energy at city level through the following.

- Preparation of a Master Plan within a period of one year from the date of sanctioning by the ministry. The Master Plan prepared as per the indicative guidelines given in Annexure-I would provide total and sector-wise projections for energy demand and supply for the next ten years. Further, it would provide a complete sector-wise baseline on energy utilization and GHG
emissions in the city. Year-wise targets for energy conservation, renewable energy addition, and GHG abatement along with the action plan for implementation will be clearly brought out in the Master Plan. Potential sources of funding from respective organizations (both public and private) for providing financial support will be identified. Before finalization, the draft Master Plan would be discussed in a Stakeholders Consultation Workshop having representation from elected representatives, local research and academic institutions, resident welfare associations, industries and corporate organizations, NGOs, state nodal agencies, and other relevant stakeholder.

A ‘Solar City Stakeholders Committee’ will be set up for advisory support involving representation from elected representatives in the municipal bodies, local research and academic institutions, resident welfare associations, industries and corporate organizations, NGOs, state nodal agencies, and other relevant stakeholder.

Financial provisions
A. Up to Rs 50 lakh per city/town as given below would be provided depending upon the population and initiatives decided to be taken by the City Council/Administration.
B. Up to Rs 10 lakh for preparation of a Master Plan within a year.
C. Up to Rs 10 lakh for preparation of a Master Plan within a year.
D. Up to Rs 10 lakh for preparation of a Master Plan within a year.
E. Up to Rs 10 lakh for preparation of a Master Plan within a year.

- Organizing training programmes/workshops/business meets/awareness camps, and so on for various stakeholders such as elected representatives of the municipal bodies, municipal officials, architects/engineers, builders and developers, financial institutions, NGOs, technical institutions, manufactures and suppliers, RWAs (residents’ welfare association), and so on and visits/study tours within India.
- Preparation of proposals for carbon financing
- Organizing publicity and awareness campaign through print and electronic media

- Setting up of ‘Solar City Cell’ in the City Council including Senior Administrator and City Engineers for planning and implementation.
Up to Rs 10 lakh for oversight of implementation during five years
Up to Rs 10 lakh for setting up of Solar Cell and its functioning for a period of five years
Remaining amount of Rs 20 lakh to be utilized in five years for other promotional activities

Indicative measures and the list of energy conservation and renewable energy devices/systems that could help in preparing the Master Plan and developing cities as Solar Cities are given in Annexure II & III.

B. Financial assistance for installation of various renewable energy devices and systems can be availed as per the provisions of various schemes of the ministry. Support for various other activities will also be provided as per the scheme provisions. Priority for support will be given to cities identified as potential Solar Cities. These cities will be considered as priority cities by the ministry, IREDA (Indian Renewable Energy Development Agency), and other implementing institutions for promoting the use of renewable energy devices/systems. SNAs may also request the ministry to allocate higher targets for installation of various renewable energy devices/systems in these cities under its different schemes through subsidies.

The Ministry of Urban Development would also be approached for assistance under their schemes, for example, JNNURM, as well as the BEE.

Cities to be supported
A total of 60 cities/towns are proposed to be developed as ‘Solar Cities’ during the Eleventh Plan period. At least one city in each state, to a maximum of five cities in a state, will be supported by the ministry. The cities included in the programme will have a population of more than 0.5 million and less than 5 million. Relaxation could be considered in the case of special category states including north-eastern states.

Criteria for selection of cities
The programme encourages cities with high level of commitment and leadership quality. MNRE will consider the following while selection of cities.
- City population, regional setting, and prominence in region
- Political and administrative commitment towards adoption of sustainable energies (resolution

Box 1
Indicative guidelines for preparing Master Plan and organizing other activities for city to be developed as a ‘Solar City’.

A. Master Plan
1. Projection for energy demand and supply for 10 years
   i) Sector wise
   ii) Total
2. Base line of energy utilization and GHG (greenhouse gas) emissions
   i) Residential
   ii) Commercial/industrial
   iii) Institutional
   iv) Municipal services
   v) GHG emission
3. Energy planning (sector-wise)
   i) Resources
   ii) Options for energy savings and demand reduction
   iii) Supply side option based on renewables
   iv) Techno-economic of energy conservation and measures
4. Year-wise goals of savings in conservation energy through demand-side management and supply side measures based on renewables
5. Action Plan for achieving the set goals and expected GHG abatements. This will include capacity-building and awareness generation.
6. Budget estimates and potential sources of funding from respective sources (both public and private)

Note: Before finalization, the Master Plan would be discussed in a Stakeholders’ Consultation Workshop having representation from elected representatives, local research and academic institutions, resident welfare associations, industries and corporate organizations, NGOs, SNA, and so on. The Master Plan will set a goal of minimum 10% reduction in projected total demand of conventional energy at the end of five years to be achieved through energy saving from energy efficiency measures and generation from renewable energy installations.

B. Other activities
1. Details to be provided on ‘Solar City Cell’ and ‘Solar City Stakeholder Committee’ to be set up for implementation of the Master Plan
2. Details of training programmes/workshops/business meets and so on to be provided, which will be organized for implementation of the Master Plan
3. Details of publicity and awareness campaign to be provided
to be passed by the City Council/Administration for implementing all the activities specified in the ‘Solar Cities’ programme).

- Potential for adoption of energy conservation and renewable energy in the city activities
- Regulatory measures taken on adoption of energy conservation measures including promotion of energy-efficient solar buildings and deployment of renewable energy technologies.
- Initiatives already taken by City Council/Administration/private developers/industry/general public in promoting energy conservation and renewable energy.
- Urban local bodies’ previous experience in involving public participation and working with all stakeholders.
- Willingness to provide resources and sustenance of activities initiated under the programme

**Submission of proposals and release of funds**
Proposals as per the prescribed format (Annexure IV) will be submitted by the City Council/Administration through the state nodal agency. The proposals will be examined in terms of the provisions of the schemes. Up to 50% of the CFA (central financial assistance) will be released for the approved proposals along with the sanction letters, with the rest of the CFA being released on progressive achievements and utilization of funds released.

**Institution of awards**
Annual awards to identified solar cities will be given away by the ministry in the form of shields/certificates based on the information provided by City Council/Administration in regard to initiatives taken on developing their city as Solar City.

**Performance evaluation**
Sanctioned cities will be required to submit reports on half-yearly basis as per the details given in their Master Plan.

Energy saved and energy generated through energy conservation and renewable energy devices/systems will be clearly indicated in the report along

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**Box 2**
Indicative measures to be taken by City Council/Administration for developing their city/town as ‘Solar City’

1. To create a ‘Solar City Cell’ with in the City Administration/Council which will be fully responsible for city planning and implementation of projects towards making it a ‘Solar City’.
2. To conduct energy auditing of government/public sector buildings, water pumping, and street lighting in the city at regular intervals and take necessary steps towards conservation of electricity. Other establishments should also be encouraged for the same.
3. To reduce electricity consumption in street light/garden lights, traffic lights, blinkers, hoardings, and so on by using energy conservation and renewable energy devices.
4. To promote National Rating System for construction of energy-efficient green buildings in particular to commercial and institutional buildings.
5. To amend building by-laws for making the use of solar water heating systems mandatory in certain category of buildings.
6. To provide rebate in property tax through municipal corporations/municipalities and in electricity tariff though utilities/electricity boards to the users of solar water heaters especially in the domestic sector.
7. To issue GO with regard to construction of energy-efficient solar buildings at least in government/public sectors in accordance with ECBC:2006 and follow up its implementation rigorously.
8. To comply with MSW Rules 2000 notified by the MoEF (Ministry of Environment and Forests) and set up projects of suitable capacity for generating energy from the waste collected from the city/town.
9. To organize rigorous publicity, and also the training programmes/business meets for various stakeholders, for example, architects, engineers, builders and developers, financial institutions, NGOs, technical institutions, manufactures/suppliers, RWAs, and so on so as to involve them actively in meeting the objective of building a solar city.
10. To generate necessary funds from state government and other funding organizations for achieving the objective of making the city a ‘Solar City’. Benefits of the schemes of Government of India will also be taken in meeting the objectives.
11. To achieve targets set by the City Council/Administration for reducing consumption of electricity through renewable energy and energy conservation devices during five years of implementations for developing their city as Solar City.
with the promotional and policy measures taken by them in achieving the targets.

An evaluation of the experience of implementation of the programme would be undertaken at the end of Eleventh Five-year Plan and further extension and inclusion/calibration of programme activities will be decided.

* The MNRE invites proposals from municipal corporations, district administrations, and SNAs under this scheme to cover their city as a solar city. Initially 60 cities are proposed to be selected on first-come-first-serve basis on merit. Hurry up and send your proposals to the Ministry.

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**Box 3**

Renewable energy devices/systems/projects and energy conservation measures that can help to bring about reduction in consumption of conventional energy are as follows.

**Renewable energy devices/systems/projects**
- ii) Solar water heating systems
- iii) Solar cookers (box and dish type)
- iv) Scheffler cookers for indoor cooking
- v) Solar steam generating systems
- vi) Solar drying/air heating systems
- vii) Solar refrigeration and air conditioning plants
- viii) Solar concentrators for process heat applications
- ix) Solar lanterns
- x) Solar home lighting systems
- xi) Solar generators
- xii) Street light/solar control systems
- xiii) Solar hoardings
- xiv) Solar street light/garden lights
- xv) Solar traffic lights
- xvi) Solar blinkers
- xvii) Road studs
- xviii) Solar power packs
- xix) Building-integrated photovoltaic
- xx) SPV power plants for decentralization applications
- xxı) Power projects based on municipal and urban waste and also on industrial waste through combustion/bio-methanation technologies.
- xxıı) Power projects based on methane available from STPs
- xxııı) Biomass gasification and co-generation projects in industries
- xxıv) Biomass gasifier-based crematoriums
- xxv) Projects on methane utilization for thermal and electrical applications in industries
- xxvi) Wind turbines for power generation

**Energy conservation/measures**
- i) LEDs/CFLs instead of incandescent bulbs
- ii) LED traffic lights
- iii) Electronics chokes and fan regulators
- iv) Sensors for automatic on/off of streetlights
- v) Automatic speed regulating fans/motors
- vi) Plugging of leakages in the water supply system and use of efficient pumps and motors
- vii) Energy-efficient electrical appliances such as fans, refrigerators, air conditioners, coolers, room heaters, and water pumps
- viii) Use of insulating materials and low-energy/energy-efficient building materials, for example, fly ash bricks, hollow bricks, stabilized mud blocks, and so on in building construction

**Solar passive architecture in buildings/housing complexes**

Major components of solar passive architecture are orientation of building, sun shades, double-glazed windows, smart glazing window overhangs, thermal storage wall/roof, roof painting, ventilation, evaporative cooling, day lighting, wind towers, earth air tunneling, construction materials, and so on. Incorporation of specific components will depend in which climatic zone the building is being constructed.
Mainstreaming green buildings in India

Introduction

A green building depletes natural resources to the minimum during its construction and operation. A green building design aims to minimize the demand on non-renewable resources; maximize the utilization efficiency of the resources, when in use; and maximize the reuse, recycling, and utilization of renewable resources. It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions. The following aspects are integrated in a green building design.

- Sustainable site planning
- Building envelope design
- Building system design HVAC (heating ventilation and air conditioning), lighting, electrical, and water heating
- Integration of renewable energy sources to generate energy onsite
- Water and waste management
- Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, and so on)
- Indoor environmental quality (maintain indoor thermal and visual comfort, and air quality)

GRIHA: the national rating system

Keeping in view the Indian agro-climatic conditions, particularly the preponderance of non-AC buildings, a national rating system, GRIHA, has been developed. This rating system is suitable for all kinds of building in different climatic zones of the country. The system was initially conceived and developed by TERI (The Energy and Resource Institute) as TERI-GRIHA. This was then modified to GRIHA as the national rating system after incorporating various modifications suggested by a group of architects and experts. It takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 announced by BEE,
and other IS codes, local by-laws, local standards, and laws.

GRIHA evaluates the environmental performance of a building over its entire life cycle. The stages for evaluation that have been identified are the pre-construction (intra and inter site issues), building planning and construction (issues of resource conservation, and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well being). The third stage is the building operation and maintenance stage. Here, the issues of building operation and maintenance of building systems and processes, monitoring and recording of consumption and occupant health and well-being, and also issues that affect global and local environment are addressed.

Centre for Environmental Science and Engineering building at IIT, Kanpur: GRIHA case study

The CESE (Centre for Environmental Science and Engineering) building at IIT, Kanpur has been taken as an example to illustrate how the building attempted various GRIHA criteria to make it into a green building.

Sustainable site planning

The objective of this exercise was to maximize resource (land, water, natural habitat, fauna, and energy) conservation and enhance efficiency of systems and operation on site. Following are the measures incorporated at the CESE building, IIT, Kanpur.

- The contractor had demarcated the area to be disturbed during construction activity. He then installed dust screen around the disturbed area to prevent air pollution and spillage to the undisturbed site area.
- The topsoil was excavated, stored, and preserved outside the disturbed construction site.
- Erosion and sedimentation control was achieved by constructing sedimentation tank, which was used to for collecting, trapping, and storing the sediment produced by the construction activities, and as a flow detention facility for reducing peak run-off rates.
- All existing vegetation was marked and areas designated for preservation of natural vegetation were demarcated and preserved by providing a barrier/ fence.
- To increase the perviousness of the site and to reduce heat island effect caused due to hard paving around the building, the total paving around the building was restricted to 17%. More than 50% of the paving is either pervious or shaded by trees.
- Irrigation water demand has been reduced more than 50% in comparison to TERI-GRIHA benchmark.

Health and well-being of construction workers and site neighborhood

Health and well-being is an important commitment of green building practice. The objective is to protect health of construction workers and site neighborhood during construction on site.

- Safety measures, norms, and guidelines as outlined by the NBC (National Building Code) 2005 were followed and incorporated in the scope of work of the contractor.
- Safe drinking water tank and adequate number of decentralized latrines and urinals for construction workers are provided on construction site.
- First aid box was provided on site for construction workers. Sand buckets
were kept on site for fire fighting in case of an accident.

- Dustbins were provided on site to ensure minimum standards of cleanliness.

**Water conservation**

There are two ways water could be conserved post construction. One is landscape water demand and the second is building water demand.

- Reduction in landscape water demand by more than 50%.
- Minimum grass/lawn area, maximum green area under native vegetation and native trees.
- Low-flow plumbing fixtures are used in the building. Reduction in water consumption from GRIHA's benchmark in this building is 62%.
- During construction waste of water was prevented during curing by using gunny bags. All slabs were cured by ponding, and bunding is done by cement mortar.
- A common packaged treatment plant will be installed to treat waste water from different buildings including the new CESE building.
- Rainwater harvesting has been designed to provide water to the water body in rainy season and excess water will be used for recharging ground water.
- Treated waste water is being reused in the building for irrigation. Annual water reuse in the building is approximately 57%.

**Conservation and efficient utilization of resources: energy**

Maximum points weightage in GRIHA is given for energy conservation. The criteria and commitment for energy conservation could be divided into three parts.

- Energy: end use
- Energy: embodied and construction
- Energy: Renewable energy utilization

**Energy: end use**

The objective and the aim here is to reduce annual energy consumption of the building. This has been achieved in CESE building at IIT, Kanpur through the following ways.

- Architectural design optimized as per the climate of Kanpur, sun path analysis, predominant wind direction, and existing vegetation.
- Optimized building envelope to comply with the Energy Conservation Building Code, to reduce cooling load in the air-conditioned spaces and to achieve thermal comfort in the non air-conditioned areas.
Efficient window design by selecting efficient glazing, external shading to reduce solar heat gain but at the same time achieve glare free natural daylight inside all the laboratory spaces of the building.

Roof shaded by bamboo trellis and green cover to reduce external solar heat gains from the roof.

Common circulation areas are natural day lit and naturally ventilated through integration of skylights and ventilators.

Water-cooled chiller selected that complies with the efficiency recommended by the Energy Conservation Building code.

Variable frequency drive installed in the AHUs (air handling units).

Low energy strategies such as replacement of water cooler by water body to cool the condenser water loop, integration of thermal energy storage and earth air tunnels enabled reduction in chiller capacity.

Integration of energy-efficient lighting design that complies with the recommendations of ECBC.

Integration of daylight with artificial lighting.

Optimized architectural design and integration of energy efficient fixtures has resulted into reduction in annual energy consumption by 41% from GRIHA’s benchmark.

Energy: embodied and construction

GRIHA encourages replacement of high energy intensive materials with low energy intensive materials, to utilize regionally available materials, and materials which using low energy in their manufacturing process. Following are the measures incorporated at the CESE building.

PPC (Portland Pozzolona Cement) with fly ash content is used in plaster and masonry mortar.

Energy: renewable energy utilization

Following are the measures incorporated at the CESE building to integrate renewable sources of energy with the building.

Renewable energy from photovoltaic panels provides annual energy requirement equivalent to 30% of internal lighting connected load.

Hot water demand is met by solar hot water system.

Did You Know?

The photovoltaic cell was discovered in 1954 by Bell Telephone researchers examining the sensitivity of a properly prepared silicon wafer to sunlight.

The world’s largest wind farm, the Horse Hollow Wind Energy Center in Texas, has 421 wind turbines that generate enough electricity to power 2,20,000 homes per year.

Hot water near the earth’s surface can be piped directly into buildings and industries for heat. A district heating system provides heat for 95% of the buildings in Reykjavik, Iceland. California has 33 geothermal power plants that produce almost 90% of the nation’s geothermal electricity.
Global warming and climate change, primarily due to the emission of greenhouse gases like CO$_2$ (carbon dioxide), are the two major concerns facing the world today. If only 3% Indians were to cook with solar cookers, we would save 3.2 MT (million tonnes) of wood per year and reduce CO$_2$ emissions by 6.7 MT per year.

Gadhia Solar has been on the forefront of identifying appropriate technologies in the solar thermal area and indigenizing them. The company introduced Seifert Parabolic Solar Cookers for domestic cooking and Scheffler Parabolic Concentrators for community cooking. Slowly, catering to the consumer demand and need, Gadhia Solar, with the help of inventors, improved upon them. It is also working on newer applications of solar concentrators not just for cooking but also for industrial applications such as desalination, waste-water evaporation, incineration, drying, and food processing.

Scheffler concentrators/dishes are the building blocks for solar steam generation. The unique feature of Scheffler dish is that it has stationary focus, which is achieved by changing the curvature of the dish in different seasons using seasonal adjustment bars at its back.

Initially, Scheffler dishes were used for community cooking that had a mechanical counter weight driven tracking system, which moved the dish in the east–west direction and followed the sun. Thus, irrespective of the position, the sun rays are focused at a fixed point.

For direct solar cooking systems, solar rays are reflected through a small opening in the north-facing wall of the kitchen and further deflected and bundled onto secondary reflector placed below a blackened cooking vessel placed in the kitchen. This enables cooking within the comforts of the kitchen. The temperature at focus is about 400 °C. Therefore, practically, all items can be cooked. A single dish can cook for 50 persons per meal time.

Evolution of solar steam cooking system
It has been 10 years since the first solar steam cooking system was developed by Gadhia Solar Energy Systems Pvt. Ltd for the Brahma Kumari’s in cooperation with Mr. Golo Pilz of Brahma Kumari’s, Mr. Wolfgang Scheffler, and HTT company of Germany. Brahma Kumari’s needed a system to cook for 1200 persons for their Mt Abu Ashram.

The company’s initial idea was to offer a series of Scheffler dishes for direct cooking, to be aligned in rows in the conventional east–west direction. This was not found to be feasible since it would have meant a large kitchen and many cooking vessels. Thus, it was decided to generate steam with solar concentrators and supply it to the kitchen. Fortunately, Brahma Kumari’s were already cooking with steam, but it was generated with diesel-fired boilers. Therefore, it was proposed that they use solar generated steam.

The technology for generating steam with Scheffler dishes was provided by Ms HTT GmbH of Germany, where Deepak Gadhia had worked before returning to India in 1985. The funding agency GATE of GTZ, Germany provided funds under its prototype funding scheme. All these factors, together, helped the world’s first and largest solar steam cooking system (in 1997) to be installed at Brahma Kumari’s, helping them save 70 litres of diesel per day.
Working of solar steam cooking system

- Parabolic solar concentrators are arranged in pairs of sleeping and standing dishes in parallel modules, aligned in a perfect east–west direction.
- Receivers (heat exchangers painted black) are placed in the focus of each pair of dishes.
- Above the receiver is a header pipe half-filled with water.
- Cool water enters the receiver through the inner pipe coming from the header.
- Solar rays falling onto the dishes are reflected and concentrated onto the receivers.
- Due to the high temperatures achieved (450–650 °C), the water within the receiver is converted into steam.
- Steam is stored in the upper half (empty portion) of the header pipe, and if the steam is not drawn, the pressure keeps on increasing.
- This steam is then drawn/sent to the kitchen through insulated pipelines to the steam cooking vessels for fast and hygienic cooking in a clean environment.
- There are two types of steam cooking vessels: (1) vessels in which steam is injected directly into the food to cook items like dal, vegetable, and rice; and (2) double-jacketed vessels in which steam circulates through the outside jacket of the vessel heating the food inside. It can help boil milk, tea, soup, and so on, since injecting steam into the food would dilute it.
- On cloudy days, during monsoon, and at night, conventional fuel can be used in the boiler house as a back-up system.
- Depending on the quantity of food to be cooked, the number of pairs of dishes and number of modules will vary.
- All the dishes are connected with a metal wire rope, and the wire rope is connected to a winch, which in turn has a DC motor connected to a timer mechanism which keeps on moving the dish, aligning it with the movement of the sun. This type of tracking system is called central tracking.
- To ensure that food is cooked even when the sun is not there (at night and on cloudy days in monsoon), the solar steam-generating system is connected with a fuel-fired boiler that acts as a back-up system.

Some important installations

Solar steam generation has found more and more acceptance in India. At present, there are more than 23 solar steam-generating systems installed by Gadhia Solar, and many more are in the pipeline.

- World’s largest solar steam cooking system at TTD (Tirumala Tirupati Devasthanam), which cooks 30 000 meals per day. The system was installed on 12 October 2002 and has been working for more than five years. On an average, it saves 200 litres of diesel every day. TTD has recovered its investment in approximately four years. The system is expected to run for another 15 years, with only reflector plates to be replaced every five years.
- World’s highest solar steam cooking system for the Indian Army to cook for 500 jawans in Leh Ladakh, at a height of more than 3000 metres above sea level.
- Shri Saibaba Sansthan Temple at Shirdi has a solar cooking system, which cooks 7000 meals per day. The system has been working for the last seven years and the performance is improving day by day. Now the Shirdi Temple Sansthan is planning for a system to prepare food for 20000 people, equivalent to 40000 meals per day.

Gadhia Solar has learnt from its experiences. It offers and undertakes not only AMC (annual maintenance contract) but also the operating and maintenance contract. Gadhia Solar is at present testing a thermic fluid system at Muni Seva Ashram, where instead of steam, synthetic oil is being circulated in the solar loop, heating the oil to about 250 °C. Now with the MNRE support in place for Rs 3500/m² of concentrator area for commercial institutions, which can avail an accelerated depreciation benefit of 80% in the very first year and for Rs 5000/m² of solar concentrator area for NGOs, and so on, the use is bound to spread.

Gadhia Solar, through its NGO Eco Center ICNEER, in cooperation with MNRE and GEDA (Gujarat Energy Development Agency), conducted a training programme for dissemination of the technology, in which 18 industries participated.
Taking solar energy research to new heights
Asian Institute of Technology

PROF. SIVANAPPAN KUMAR
Energy Field of Study, School of Environment, Resources and Development, Asian Institute of Technology

Introduction

The AIT (Asian Institute of Technology), located 42 km north of Bangkok, Thailand, was established in 1959. Its mission is to develop highly qualified and committed professionals who play leading roles in the region’s sustainable development and its integration into the global economy. AIT promotes technological change and sustainable development in the Asia–Pacific region through higher education, research, and outreach. Since its establishment, AIT has become a leading regional postgraduate institution and is actively working with public and private sector partners throughout the region and with some of the top universities in the world. Recognized for its multinational, multi-cultural ethos, the institute operates as a self-contained international community. Besides the usual labs and academic buildings, the main campus includes housing, sports, and medical facilities, a conference centre, and a library with over 230 000 volumes, and 830 print and online periodicals.

Energy studies at AIT

The Energy FoS (Field of Study) of the SERD (School of Environment, Resources, and Development) at the AIT (Asian Institute of Technology) was established in 1979. The Energy FoS is interdisciplinary in nature, encompassing technology, planning, and management aspects, that addresses the current and emerging needs of the energy sector.

Energy technology is an area of specialization under the Energy FoS, which aims to train graduates for positions in national and international institutions, research and development departments of industries and energy utilities, energy conservation agencies, and consulting firms. The other areas of specialization include EEP (Energy Economics and Planning), and EPSM (Electric Power Systems Management). Energy technology focuses on RSE (Renewable Sources of Energy) and RUE (Rational Use of Energy). The RSE encompasses the fundamentals and practical aspects of solar thermal and PV (photovoltaic) conversion, thermo-chemical conversion of biomass, other renewable energy sources, and the environment. The topics covered in RUE are in the area of energy analysis and system optimization, energy conservation, energy management in industries and buildings, and clean energy technologies.

Solar research and training facilities

A well-equipped solar thermal and PV laboratory having a large outdoor testing area known as the energy park is used for teaching, research, and the testing of commercial products. The park, with an area of nearly 4000 m², contains solar and bio-energy devices, experimental set ups for day lighting and building energy studies, and a meteorological station. Other facilities available at the energy field of study include standard laboratory apparatus for the study of heat transfer, refrigeration, fluid mechanics, and combustion.

The meteorological station at the energy park has a pyrheliometer to measure direct radiation and pyranometers to measure global horizontal radiation, diffuse radiation, global radiation at 15-degree inclined surface, temperature probe to measure ambient temperature, and wind speed sensor. This collected data is used for students and researchers to carry out studies related to solar radiation and day lighting, as well as performance testing of different solar devices. This has led to many manufacturers of solar products to use the facility to test their
product performance, especially in a tropical setting. The testing services provided are for solar thermal collector performance test, solar water heater system performance test, and PV systems.

Solar energy research

In the area of energy technology, research in renewable sources of energy includes renewable energy and environment, solar thermal and PV processes, day lighting, renewable energy hybrid system, integrated renewable energy resources, and biomass conversion. Research area in RUE includes assessment of cogeneration in different types of industries, rational use of energy in industry, and energy management in buildings.

As tropical regions have abundant solar radiation, several studies of solar energy for various applications (as well as its characteristics) have been conducted under four main categories: solar radiation and day lighting, solar drying, solar thermal applications for heating/cooling, and PV applications.

Solar radiation and day lighting

Research on solar radiation has been in the area of estimation and analysis of solar radiation and its various components since the early 1980s, as well as its application to day lighting. These studies include analysis of radiation, development of models and measurement, and its analysis. The meteorological station at AIT with its array of pyranometers, pyrheliometers, and so on is used in this context. Some of the studies carried out under this topic in recent years include the following.

- Study of tropical daylight and its illuminance through window have been investigated considering indoor daylight quality.
- Day lighting through light pipes for deep interior illumination considering heat gain was studied by using an adjustable reflector for reflecting sunlight through light pipe. This can illuminate the deep interior space of a building.
- Studies on turbidity of the atmosphere indicate that it varies with seasons. Atmospheric turbidity is relatively low and quite stable during dryer months and increasing in wet season.
- Day lighting through unshaded and shaded windows is another topic being studied.

Solar drying

Studies on solar drying were initiated in the 1980s primarily for grain drying. Currently, research is concentrated on the application of solar energy for drying vegetables, fruits, and fish. Many dryers have been developed at AIT.

Theoretical and experimental investigation of a solar–biomass hybrid air heating system for drying applications was carried out by designing and investigating the performance of a renewable-energy-based (solar–biomass) hybrid air heating system with thermal storage. The air heating system using only renewable solar and biomass energy for its operation presents itself as a reliable alternative to other renewable-energy-based systems. solar energy systems.
A study on upgradation/storage of solar thermal energy by solid absorption chemical heat pumps used a zeolite–water solid adsorption chemical heat pump coupled to a solar water heater for energy storage and upgrading purpose. This was done by estimating the useful energy delivered and temperature of hot water produced by using the Transient System Simulation Program and the Artificial Neural Network, by developing mathematical models for solid adsorption heat pump system (NaX zeolite–water), solid–gas (ammonia) system, coupled solar–solid gas system, and the coupled solar–solid adsorption (zeolite–water) heat pump system. Once this was done, the theoretical predictions were compared by conducting experimental studies on a coupled solar–solid adsorption system. The study illustrated the feasibility of coupling renewable energy source to a chemical heat pump, and thus upgrading heat and store energy for useful purposes. Such systems will be useful for many applications in tropical locations where solar energy is available throughout the year.

Solar photovoltaic studies
Many studies have been carried out on the application of PV systems for electrification and income generation in the region. A study on renewable-energy-based hybrid system for rural electrification addressed the issues related to the use of PV hybrid system for rural electrification including the performance of the PV hybrid system, that is, PV, diesel generator, inverter, and battery for storing energy. This was done by developing a PV hybrid system model that incorporates technical, financial, and social aspects. Experimental studies and survey on a PV hybrid system installed in an island community and in laboratory showed the potential to use the PV hybrid system to supply basic energy services that is desired in rural settings.

Research on solar energy has been carried out through sponsored projects at AIT as well as in the region, in the areas of solardrying and PV (www.retsasia.ait.ac.th) with partner institutions (government, academic institutions, private sector, and non-governmental organizations) in Nepal, Bangladesh, Laos PDR, Cambodia, Vietnam, and the Philippines. These were aimed at promoting mature and nearly mature technologies.

**Conclusion**

In line with AIT’s research focus in the future – climate change and sustainable development – research and training on solar energy (fundamental and applications) is expected to grow, and studies will be linked to policy analysis for the promotion of solar energy technologies. Specifically, studies will focus on introducing solar energy for reducing the energy bill in buildings (cooling, thermal comfort and electricity), development and application of high-temperature solar collectors (concentrating), adaptation of solar technologies for applications in the food and manufacturing industry, and the role and potential of solar energy in the urban energy mix.
Renewal of energy  
the Sanjiwan way

Somebody has correctly said, ‘Life is a continuous process and consistency is the soul of life…’

The consistency of life is essentially an outcome of reinforcement, reorganization, and revitalization of assets you possess. Deriving a hope of life from an otherwise ‘hopeless’ lot of senior citizens and extracting energy from wastage is a ‘Sanjiwan’ way of blending social service with a cause for a better tomorrow. Sanjiwan is synonymous with serving those in need of help and compassion in the autumn of their lives. Sanjiwangram is located in a lush green and serene ambience on a hillock that has a magic of its own. It houses many senior citizens and revitalizes their hope for a better life and at the same time presents itself as a role model in the field of non-conventional energy.

The elderly have a wealth of experience with which they can enrich our lives. Yet, in many homes they become unwanted once their purpose is over. This generates a feeling of destitution in them. On top of these, physical disabilities also start cropping up. Sanjiwan is an organization that takes care of such people. It has resolved to continue this mission on the strength of society’s generosity and compassion.

Sanjiwangram is not merely a Vruddhashram (old-age home) now. Its countenance is that of an Urjagram (The Energy Village), rather than a village of senior citizens. And the man behind this energy is a doctor by profession. Dr Sanjay Ugemuge, a social servant par excellence, has poured precious eleven years of his life to make this dream come true. He initiated the process and organized people from various walks of life. As the name of the organization – Sanjiwan Socio-Medical Foundation – indicates, it proved to be a sanjiwani for senior citizens who had lost all hopes and couldn’t bear the pain of having to live in isolation. Dr Ugemuge, a famous ENT surgeon in Vidarbha, and his colleagues did not stop at just this. They provided best possible facilities to inmates and once they found that the Vruddhashram is settled and going at its own pace, they concentrated their efforts towards turning Sanjiwangram into an Urjagram…and they did it!
Nowadays Sanjiwangram does not use traditional electricity and thus does not face loadshedding since it is self-sufficient in its power needs. No LPG cylinder is used for cooking. No wood is burnt to provide warm water to aged inmates. It is completely independent and self-sufficient as far as energy needs are concerned and hence it saves and saves some more. It is said that saving is generating. Sanjiwan generates, Sanjiwan saves, and Sanjiwan shows the way… consistently…to renew and revitalize for a better tomorrow.

Presently, it’s the only Urjagram in the entire Vidarbha region in the true sense of the term and uses only non-conventional and renewable sources of energy with a backup of goshala that houses cattle and thus sufficient biogas slurry. Sanjiwangram now just breathes energy, cooks with energy, illuminate itself with energy, and renews the hopes of visitors to overcome the worst power crisis with alternative sources. It is really a role model of the best use of non-conventional energy.

Sanjiwangram has a biogas plant of capacity 25 cub/m with 15 kW capacity and 100% biogas engine to generate the power (12 kVA), which is used for kadba cutter with 5 HP machine, 2 borewell pumps of 2 HP each, open well pump of 5 HP, 30 fans, and 30 CFLs. The engine runs for 4 to 5 hours and provides 25 to 30 units a day. A wind–solar hybrid system of 3 kV (1+2) has also been installed with powers the old age home and temple with 8 to 9 units a day. Eleven streetlights of 74 W have also been installed in the premises. There are five homelighting systems that come useful in independent cottages, goshalas, varadahs, kitchen, and dining hall.

Two separate biogas plants provide sufficient cooking gas for the entire area and solar box-type cookers cook rice in the morning. A couple of solar water heaters with about 800 litres capacity suffice the needs of inmates and others living there. Five big and small solar lanterns are used as and when required. Yet to come is a big solar cooker, a 900 wt solar pump, and almost everything that is required to cater to the needs of the inmates and to upkeep the name it has earned.

Article courtesy
Dr Sanjay Ugemuge
With the world gradually shifting to sustainable energy use, RE (renewable energy) sources are becoming the order of the day. People are waking up to the benefits of using solar cookers, heaters, and so on, but a lot still needs to be done in terms of creating awareness on the positives of RE sources. During the last 25 years, significant progress has been made in the development and production of RE systems and devices in our country. Globally, India has attained the second position after China in biogas development and fourth position in wind energy development.

Still a lot needs to be done in terms of creating awareness among the general masses and different target groups. To commemorate its silver jubilee year, the MNRE participated in a big way in IITF (India International Trade Fair) 2008. The different pavilions showcasing RE products/devices at the IITF (India International Trade Fair) 2008 provided an insight into how RE could replace conventional energy sources, and thereby promote sustainable growth.

Under the umbrella of the ministry, many manufacturers showcased RE products/devices such as water heating systems of different capacities, photovoltaic systems, dish solar cookers, different models of solar lanterns, home lighting systems, solar fans, solar caps, solar torch, radio, transistor, street lighting, road studs, traffic signals, solar TV, invertors, mobile chargers, solar search light, solar power plant, solar agriculture system, solar education kit, solar still, and wind turbines. A mobile exhibition van outside the MNRE (Ministry of New and Renewable Energy) pavilion displayed a biogas plant, solar pump set, solar streetlight, biomass gasifier, and solar cooker. The working of these systems was explained and demonstrated to the visitors. The pavilion also demonstrated working of NRSE (new and renewable sources of energy) such as wind farm, small hydro, Urja Gram, solar hut, biogas plant, and solar water heating and lighting systems. There were also plasma TVs for screening NRSE films.

Picture this, a cap that shields you from the sun and utilizes solar energy to keep you cool. Sounds funny, but think again! Central Electronics Ltd, Uttar Pradesh, has manufactured a unique cap that has a small fan attached to it. A silicon photovoltaic chip absorbs solar energy and rotates the fan, blowing cool air on your face. In addition to this, there are solar lanterns, solar home lighting systems, solar inverters, and numerous such devices that are inexpensive yet very useful. Why, they even had solar toys for children and solar mobile battery chargers! The toys are a good way of educating children about the benefits of RE sources. The large turnout of visitors, and the number of enquiries received by MNRE and the NRSE manufacturers, shows the increasing interest of people in renewables. But there is much more to be achieved in this field.

The solar water pumps are operated by 2 HP DC motor with a 2” to 3” discharge pump. The motor is powered with 1800-watt solar panels. The daily water discharge is 1 20 000 to 1 40 000 litres. It works well in areas where water level is not more than 35 to 40 feet. Solar inverters manufactured by Xantrex Inc. USA convert 12 V (volts) of DC battery power in a vehicle, or solar power packs to 230 V of AC power. Available in
different sizes, the inverters can power a variety of electronic products including televisions, VCRs, fax machines, laptops, small power tools, mobile chargers, and wireless phones.

There were many manufacturers including state nodal agencies, public sector undertakings, and the private sector who put up stalls to create awareness on renewable sources like solar energy, wind, biomass, and small hydro. The agencies and manufacturers include the following: ANERT (Kerala), CREDA (Chhattisgarh), Delhi Transco Ltd, EE&REM (DTL), GEDA (Gujarat), HAREDA (Haryana), IREDA (Delhi), MEDA (Pune), NEDA (UP), PEDA (Punjab), Suzlon India Ltd, TEDA (Tamil Nadu), NEDCAP Ltd (Andhra Pradesh), TERI, WISE, Maharishi Solar Technology Pvt. Ltd, G S Enterprises, Manak Engineering Service, Telemats India Pvt. Ltd, Natural Energy Systems, Trans Solar Technologies, Bhambri Enterprises, Suryakiran Pvt. Ltd, EmmVee Solar Systems Pvt. Ltd, Rishipooya Enterprises (Gorakhpur), Arsh Electronics Pvt. Ltd, Kalli Sons Televent Pvt. Ltd, M/s Sour Oorja Solutions, Kavita Solar Energy Pvt. Ltd, Gill Associates, Raj Electronics, Solanand Solar Systems, Sharp Business System (India) Ltd (New Delhi), System Appliances Co. (New Delhi), Tarashawa Engineers (New Delhi), and Ankur Lamps and Lighting Pvt. Ltd.

The ministry’s stalls (indoor and outdoor) covered all the pavilions with many translights (backlit) on different programmes on RE, as also various systems and devices. In addition to this, working models, such as, wind farm, windmill for pumping water, biogas plant, small hydropower, greenhouse, solar hut, urja gram, and SPV water lifting pump. The ministry provided literature to all stallholders to distribute literature on NRSE in English and Hindi on demand by the public.

RE sources must be recognized and promoted on a large scale. The pavilions on RE at the IITF showcase the immense uses of RE devices. Why, you could even cook Maggi in a solar cooker! So how about becoming non-conventional for a change?

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**Inviting advertisements for Akshay Urja**

*Akshay Urja* is widely circulated to various stakeholders of renewable energy. *Akshay Urja* invites advertisements (in colour) from interested organizations, manufacturers, institutions, etc. The advertisement tariffs are as follows.

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* Avail 25% discount on booking for six issues and 20% discount on booking for three issues

The interested organizations may write to:

**Editor, Akshay Urja**
Ministry of New and Renewable Energy
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Tel. +91 11 2436 3035 or 2436 0707 • Fax +91 11 2436 3035 or 2436 1298
E-mail aktripathi@nic.in
ANNOUNCEMENT

F.No. 11 (149)/2004 – Power/-In Exercise of the power conferred by Section 18 of the Energy Conservation Act, 2001 (52 of 2001), read with the Government of India, Ministry of Home Affairs Notification No. S.O. 593 (E)/F. No. U- 11030/1/2005-UTL dated 24 April 2006 the Lt Governor of National Capital Territory of Delhi hereby issues the following directions for efficient use of energy and its conservation in the National Capital Territory of Delhi, namely:

1. Mandatory use of solar water heating systems
   (A) The use of solar water heating systems will be mandatory in the following categories of buildings namely
      (i) Industries where hot water is required for processing
      (ii) Hospitals and nursing homes including government hospitals
      (iii) Hotels, motels or banquet halls
      (iv) Jail barracks
      (v) Large canteens having the capacity to serve more than one hundred persons in a day
      (vi) Corporate building located on plots having an area of five hundred square metres and above
      (vii) All residential buildings built on a plot having an area of five hundred square metres or above falling within the National Capital Territory of Delhi, excluding Delhi Cantonment Area or areas exempted under section 61 of the Energy Conservation Act, 2001
      (viii) All government buildings, residential schools, educational colleges, hotels, technical or vocational education institutes, district institutes of education and training, tourism complexes and universities, and so on
   (B) All departments of the Government of National Capital Territory of Delhi including Tihar Jail, Delhi Police, MCD, and NDMC shall amend their rules/bylaws within a period of six months from the date of issue of this order to make the use of solar water heating systems mandatory
   (C) The government departments mentioned in Clause (2) shall designate a nodal officer to monitor and report the progress, the enforcement of the government decisions to the agency designated under Clause (d) of Section 15 of the aforesaid Act, for energy conservation of National Capital Territory of Delhi. The progress report shall be sent by the nodal officer on a quarterly basis to the designated agency.

2. The designated agency shall ensure the implementation of these directions in the National Capital Territory of Delhi as per the provisions of the Energy Conservation Act, 2001

3. Delhi Cantonment/Military Engineering Service/Defence Establishments shall endeavour to adopt measures for efficient use of energy and its conservation.

Issued by:
Energy Efficiency and Renewable Energy Management Centre
Department of Environment
Government of NCT of Delhi
A ten-day Teacher Training Programme for the vocational teachers of Haryana, Punjab, Andhra Pradesh, Madhya Pradesh, and Chhattisgarh state was organized at the SEC (Solar Energy Centre), Gwal Pahari, Gurgaon from 8–17 November 2008. It was a collaborative programme of the SEC, MNRE, and PSS Central Institute of Vocational Education (NCERT), Bhopal. This training programme was the first in the series for vocational teachers. The aim of this training programme was to acquaint the teachers with the latest technology in the field of solar energy and to operate, handle, and repair the solar energy gadgets used in the field. The programme was inaugurated by Dr Bibek Bandyopadhyay, Advisor, MNRE, New Delhi.

During the inaugural address, Dr Bandyopadhyay discussed the recent developments in the field of solar energy and renewable energy as such. Dr P C Pant, Head, Training Unit of SEC explained the importance of training in today’s changing environment. Mr Saurabh Prakash, Programme Coordinator, informed about the role of PSSCIVE in the field of vocational education. A brief introduction on the importance of training was also provided. About 22 participants from various states like Punjab, Haryana, and Andhra Pradesh participated in this programme.

During the training programme, skill training on PV cell lighting system, solar dryer, solar cooker, solar water heater, solar LED system, battery charging, servicing technique, battery testing, solar engine dismantling and assembly, carburetor testing, and so on was carried out. There were also discussions on various topics such as energy storage in solar systems, solar energy applications/resource assessment, solar thermal energy applications, solar PV system components, and testing.

Trainees carrying practical activities
The Energy Tech Expo 2008 was organized for the first time by the India Trade Promotion Organisation in association with TERI, Bureau of Energy Efficiency, and the other important government-based organizations in the energy sector. The Expo aimed at helping accelerate the growth of the energy sector in India and thereby, assist in achieving the target, ‘Energy Independence’ and ‘Power for all by 2012’. The Expo also
- highlighted the status, projections in each segment in energy and related sectors and the opportunities offered for greater public–private participation;
- showcased the latest technologies, products, and services to harness energy projects speedily, qualitatively and economically; and
- identified roadblocks, with the help of experts in the field both from India and abroad and discussed how these can be overcome.

The Expo brought together technocrats, industry leaders, and senior government officials from central and state governments as well as eminent experts from overseas, who have wide experience in the field of generation, transmission, distribution and maintenance, and specifiers, consultants, and contractors from energy and related sectors.

The MNRE (Ministry of New and Renewable Energy) also participated in the Expo. The ministry was represented by the Agency for Non-conventional Energy and Rural Technology, Punjab Energy Development Agency, Tamil Nadu Energy Development Agency, and Central Electronics Ltd. Various models, panels, systems and devices, and literature on renewable energy were displayed in the exhibition. Thousands of visitors, especially students, appreciated the renewable energy systems and devices. The MNRE was accorded the first prize in the category of government/PSUs.
### Energy Terms

Find the words hidden across, up and down and diagonally.

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Find these energy terms hidden in the letters above:
- CARPOOL
- GASOLINE
- COMPOST
- LIGHTS
- CONSERVE
- RECYCLE
- ENERGY
- SOLAR
- ELECTRIC
- SUN

Send in your answers to the following address. The first three correct entries will be published in the next issue of Akshay Urja. Happy code cracking!

**The Editor, Akshay Urja**  
Room No. 1009A, 10th Floor, Paryavaran Bhavan, CGO Complex  
Lodhi Road, New Delhi – 110 003  
E-mail aktripathi@teri.res.in or ambika@teri.res.in
SPV (solar photo-voltaic), as a viable renewable energy source, is accelerating towards greater acceptability as a dependable and durable technology with increasing number of applications. The various stages of solar cell development leading to efficient PV modules and the consequent systems-applications borrow skills from a gamut of scientific areas of research covering semiconductor physics to power electronics. Although expensive in the initial stage of installation, SPV is preferred because of the feasibility, eco-friendly conversion process, and promising returns. As the title suggest, this book is a consolidated study material covering relevant topics—from the physics of semiconductors, basic working principles, and SC materials to related components such as storage batteries. The chapters catering to the disparate sub-topics, covering the main areas of PV technology, are authored by experts from well-known research and educational institutions from across the country.

An article dedicated to thin-film solar cells elucidates the process of developing stable, high-efficiency, and low-cost variety. An exclusive chapter facilitates the understanding of the underlying conversion mechanism of PV cells with elaborate energy-level diagrams, concept of electron–hole pair generation, quantum efficiency, characteristic SC equation, and equivalent circuit. Another important issue is that of the ohmic-contact at the metal–semiconductor junction. The proceedings is a must-read for gaining an insight into the state-of-the-art and immensely worthwhile PV technology that the future beckons.

Reviewed by Dr Nivedita Dasgupta, TERI
Renewable energy in non-technical language
Chambers A. 2004
Tulsa, Oklahoma, USA: PennWell Corporation. 244 pp.
In this book, the author draws from her expertise on energy matters to deliver an unparalleled guide to renewable energy resources. Using a non-technical approach, she introduces sources of renewable energy such as wind, solar, biomass, and hydro supported by several pictures, graphs, and charts showing the usage of each energy type state-by-state for the US (United States). The author also covers renewable energy usage around the globe. Next, she details out each energy type, providing case studies, market conditions, usage leaders, and more. A chapter on fuel cells has also been introduced in the book. Besides, a comprehensive coverage of renewable gasoline additives, alternatives, ethanol, and bio-diesel is also provided.

ISBN 1-59370-005-9 • PRICE $82.95

Renewables in Russia: from opportunity to reality
Russia is rich in renewable energy resources. Russia’s renewables can cost-effectively provide energy services where conventional forms are expensive. The existing renewable energy installations can supplement energy from fossil fuels in a cost-effective manner. At the same time, new renewables such as wind and solar energy can serve remote populations and in the right circumstances, provide energy at competitive prices on the grid. This report demonstrates that renewable energy can offer a real means to address some of Russia’s energy and economic challenges. It identifies the first steps towards creating a Russian renewables market, and will contribute to a better understanding by both Russian and international industry, of the potential for profitable renewable projects, and the incentive to start undertaking them.

ISBN ISBN 92-64-10544-1 • PRICE €100

Biomass management for energy purposes: issues and strategies
Pathak B S and Srivastava N S L (eds). 200
Biomass is the most widely available source of stored energy in the renewable form. According to global estimates, the global annual production of biomass is 220 billion oven dry tonnes. However, there is a huge gap between the energy generation potential of biomass and its present utilization, mainly due to the absence of a management system, which can recover biomass from different sources and locations. This book is a compilation of deliberation given during the National Seminar on Biomass Management, 2004.

Internet resources

European Forum for Renewable Energy Sources
EUFORES (European Forum for Renewable Energy Sources) is a not-for-profit organization aiming at promoting renewable energy sources at the regional level. Through its sites, it promotes legislation and energy efficiency, and develops a network across Europe. The site also hosts political consulting, news, publications, legislations, energy efficiency and projects information, events, and links to other sites.

China Renewable Energy Information Network
This network in the new and renewable energy field covers information on solar, wind, biomass, geothermal, ocean, hydrogen, and small hydro renewable energy resources. The site is a collection of news, technology, publications, documents, and glossary of terms. It also hosts a bulletin board on the field.

Solar Energy International
SEI (Solar Energy International) provides education and training to decision-makers, technicians, and users of renewable energy sources on topics such as the practical use of renewable energy technologies, including electricity from sun, wind, or water by conducting workshops, programmes, and so on. The site is a rich collection of books, videos, and software related to renewable energy and sustainable building technologies, online education, training, technology transfer programme, and project reports on renewable energy. It also contains a newsletter and links to other related websites.
**Forthcoming Events**

### Renewable Energy India 2009 Expo
10–12 August 2009, New Delhi
Rajneesh Khattar
Exhibitions India Group
217-B, (2nd Floor)
Okhla Industrial Estate
Phase III, New Delhi – 110 020
Tel. +91 11 4279 5000/054
Fax +91 11 4279 5098/99
E-mail rajneeshk@eigroup.in

### International events

**Conference: fifth user forum on thin-film photovoltaics**
26–28 January 2009
Ott e.V. Erneuerbare Energien
Leonore Nanko
Tel. +49 941 29688–20
E-mail leonore.nanko@otti.de
Web www.otti.de

**Second Renewable Energy Finance Forum**
1–3 February 2009, Bangkok, Thailand
Web www.environmental-expert.com

**PV Expo 2009: Second International Photovoltaic Power Generation Expo**
25–27 February 2009, Tokyo, Japan
PV Expo Show Management
Takeshi Horiuchi
Tel. +81 3 334 985–76
E-mail pv@reedexpo.co.jp
Web www.pvexpo.jp

**PHOTON’S Seventh Solar Silicon Conference**
3 March 2009, Munich, Germany
Tel. 49 241 4003 102
Fax 49 241 4003 302
E-mail petra.boehne@photon.de
Web www.photon-expo.com

**PHOTON’S Seventh Solar Silicon Conference**
3 March 2009, Munich, Germany
Tel. 49 241 4003 102
Fax 49 241 4003 302
E-mail petra.boehne@photon.de
Web www.photon-expo.com

**Fifth International Congress & Exhibition on Energy and Renewable Energy Sources**
6–8 April 2009, Sofia, Bulgaria
Tel. 359 32 945459
Fax 359 32 960012
E-mail office@viaexpo.com
Web www.viaexpo.com

**Sixth China International Solar PV Exhibition**
13–15 April 2009, Shanghai, China
Tel. 86 21 3408 0383
Fax 86 21 3408 5383
E-mail nuogaisi2004@126.com
Web www.ch-solar.com

**International Exhibition and Conference on Renewable Energy and Distributed Generation**
7–9 May 2009, Verona, Italy
Tel. 39 0439 84 09 22
Fax 39 0439 84 98 54
E-mail info@solarexpo.com
Web www.solarexpo.com

**Solar 2009**
8–14 May 2009, Buffalo, New York, USA
Tel. 1 303 443 3130
Fax 1 303 443 3212
E-mail ases@ases.org
Web www.ases.org

**Intersolar 2009**
27–29 May 2009, Munich, Germany
Tel. 49 7231 58598–0
Fax 49 7231 58598–28
E-mail info@intersolar.de
Web www.intersolar.de

**24th European Photovoltaic Solar Energy Conference & Exhibition**
21–23 September 2009, Germany
WIP-Renewable Energies
Conference Secretariat
Tel. +49 89 720 127–35
E-mail pv.conference@wip-munich.de

**Sixth International Solar PV Exhibition**
13–15 April 2009, Shanghai, China
Web www.ch-solar.com
Renewable energy at a glance in the World

**2003 - 2030 Renewables Supply by Energy Source**

- Traditional biomass
- Commercial biomass
- Hydro
- Other renewables

Source: World Energy Outlook

**World Renewable Energy Supply by Region**

- Developing Countries
- OECD
- Transition economies

Source: World Energy Outlook
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For purchase and repair of Solar Lantern, Solar home lighting system and Solar water heater, please contact the State Renewable Energy Development Agencies/Akshay Urja Shops/Suppliers existing in the States. List of addresses and phone nos. are available at the website of the Ministry of New and Renewable Energy.

For more details, contact:
Indian Renewable Energy Development Agency Limited (IREDA), New Delhi
Phone: 011-24682214-21 Extn.-239

Ministry of New and Renewable Energy
Government of India
Block No. - 14, C.G.O. Complex, Lodi Road, New Delhi-110 003
Website: www.mnre.gov.in