Renewables in North Eastern Region
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www.wretc.in
Dear Readers,

‘Unity in diversity’ has been a motto for India and underlines the fact that the country is indeed a land of the diverse - be it the geography, people, language, culture… the list could go on. And no more is this diversity more obvious than in the north eastern part of the country. Though clubbed together as the north eastern region (NER) each of the eight states - Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura - is unique in its own way.

The states are blessed with abundant natural resources and have a tremendous potential for the utilisation of renewable energy (RE). Recognising this, the Ministry of New and Renewable Energy (MNRE) has been giving a special focus to the region as a whole and each state individually through a separate budget allocation of about 10 per cent under various renewable energy programmes. The NER is also provided higher rates of central financial assistance, normally up to 90 per cent in most of the cases. Dr Farooq Abdullah, Minister of New and Renewable Energy called upon the power ministers of the north eastern states to maximise the use of RE and to review the implementation of RE polices and programmes in the NER in a meeting on 2 July 2011 in New Delhi. The enthusiasm and commitment expressed by all ministers towards use of renewable energy is quite encouraging.

The NER is a true ‘frontier’ - each state shares part of the over 2000 km border with Bhutan/China/Myanmar or Bangladesh and is connected to the rest of India only by a narrow 20 km wide corridor of land. The remote village electrification (RVE) programme of MNRE has energised 2392 remote villages and hamlets mostly in the border areas. Seven cities namely Agartala, Kohima, Jorhat, Guwahati, Imphal, Itanagar and Dimapur are also being developed as solar cities. The Prime Minister’s special package of about Rs 550 crores for illumination/electrification of households/villages located in the international border districts of Arunachal Pradesh through a mix of RE technologies mainly solar, small hydro and biomass is also being implemented by MNRE.

In this issue, we bring you glimpses of each state from a renewable perspective. The potential and implementation in each state may seem ‘small’ when compared to the rest of India only by a narrow 20 km wide corridor of land. The remote village electrification (RVE) programme of MNRE has energised 2392 remote villages and hamlets mostly in the border areas. Seven cities namely Agartala, Kohima, Jorhat, Guwahati, Imphal, Itanagar and Dimapur are also being developed as solar cities. The Prime Minister’s special package of about Rs 550 crores for illumination/electrification of households/villages located in the international border districts of Arunachal Pradesh through a mix of RE technologies mainly solar, small hydro and biomass is also being implemented by MNRE.

In this issue, we bring you glimpses of each state from a renewable perspective. The potential and implementation in each state may seem ‘small’ when compared to the rest of the country; a closer look will help the readers understand the reasons and constraints faced by the people in the region.

I invite all readers and those who are concerned about renewable energy to share their views and experiences with us to help us expand the scope and reach of Akshay Urja, and hope that the readers will enjoy this issue.

Happy reading.
We are a company dealing with a range of solar photovoltaic systems. Akshay Urja newsletter is very educative and a great help to organisations like ours to broaden our awareness on new technologies, renewable energy, latest news in the field and much more.

Anurag Srivastava, Engineer, Jay Ushin Limited, Gurgaon, Haryana.

I teach the subject ‘non conventional energy sources’ in our college. I appreciate the Akshay Urja newsletter because it helps me to supplement my teaching. I have found the newsletter interesting and informative and hope that it will continue to publish about the latest development in various areas of renewable energy.

Deba Kumar Mahanta, Assistant Professor, Assam Engineering College, Guwahati, Assam.

I am an architect working for an organisation providing consultancy for Green Buildings, I would like to receive a copy of the Green Buildings special issue of Akshay Urja (Volume 4: Issue 5).

Chitra Chidambaram, Regional Manager, ICMQ India, New Delhi.

I would like to congratulate you for editing a very useful and educative newsletter, which meets the needs of the time. This is the first time I have read Akshay Urja and found that it incorporates articles from eminent authors in the field and other information is also explicitly presented. I would humbly like to make a suggestion - please include the latest achievements of each state in the renewable energy field in each issue of the newsletter.

Dr AN Arora, Professor, Kaulitya Institute of Technology and Engineering, Jaipur, Rajasthan

I am very much interested in renewable energy, particularly solar energy and wish to become a part of the solar industry. I had a chance to read Akshay Urja recently and found it interesting and very informative.

Shivali Pandya Thakar, Mumbai, Maharashtra.

We are a company based in Bihar and are working in renewable energy sector. Akshay Urja newsletter keeps us updated with the latest in the field of renewable energy.

Anil Mandal, Ripal Energy India Pvt. Ltd., Patna, Bihar.

I would like to subscribe to Akshay Urja newsletter to know more about the applications of renewable energy, to develop some research programmes. Our field is the design and development of circuitry, which requires low voltage power sources, like satellite payloads.

Sunil Singh, Sr. Technical Assistant-A (RF&MW), Space Applications Centre, Ahmadabad, Gujarat.

Dear Reader, 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 improvements in terms of content and presentation.

Editor: Akshay Urja
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- City heritage sites tap sun’s power, electricity bills dip
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- Ushdev may seek India wind farm acquisitions to boost capacity
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**Manipur Renewable Energy Development Agency has achieved installed capacity of about 3 MW till 31 March 2011, through solar PV, small hydel, wind-solar hybrid, biomass, solar thermal etc.**

**The Sikkim Renewable Energy Development Agency has been striving to keep itself updated and has been putting together all efforts to etch a name for itself in the RE sector in the country.**

**SHL systems have been installed and commissioned by Tripura Renewable Energy Development Agency at hamlets/villages where grid power is not available and is not likely to reach in the near future.**
Dr Farooq Abdullah calls upon Power Ministers of North Eastern States to maximize use of renewable energy

Minister of New and Renewable Energy, Dr Farooq Abdullah reviewed the implementation of renewable energy policies and programmes in the North Eastern States at a meeting in New Delhi on 2nd July 2011. The meeting was attended by the Chief Minister of Meghalaya and the Power Ministers of other North Eastern States, senior officials from the Ministry and the State governments.

It was informed during the meeting that out of 4,965 remote villages to be electrified/ illuminated through renewable energy systems in the region, 3,841 villages have already been provided solar lights. There are over 160 small/ micro hydel projects installed in the North Eastern States with 275 MW aggregate capacity. Apart from this, over 60,000 solar lanterns, home lighting systems and street lights have been set up. The region has over 1,18,000 biogas plants. The Ministry is now making a detailed assessment of wind resources in the North East. Arunachal Pradesh is implementing a special project to electrify/ illuminate all its villages along the international border through solar and micro hydel projects. Out of 1058 target villages under this project, 736 villages have already been covered.

Dr Abdullah appreciated the difficulties faced by the North Eastern States and assured them all possible help from the Ministry. The States agreed to take action to strengthen the renewable energy programme. Power Ministers from the North Eastern States requested for 90 per cent funding from the Ministry of New and Renewable Energy for the renewable energy projects in the region. They also requested for help in preparation of State specific action plans for renewable energy. Dr Abdullah agreed to get the resource mapping for solar, wind and micro/ small hydro prepared for these States. The States in the region have also been advised to put in more efforts for popularisation of renewable energy for maximising the use of these technologies. The Ministers and concerned officers of North Eastern States will be given opportunities to visit showcase projects within and outside the country.

Power Ministers from North Eastern States appreciated the leadership provided by Dr Farooq Abdullah in promoting renewable energy in the country especially in the North Eastern States and new policies under Jawaharlal Nehru National Solar Mission.

http://pib.nic.in, 2 July 2011

Secretary MNRE Inaugurates Administrative Block of SSS-NIRE

Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), at Wadala Kalan, District Kapurthala (Punjab) is an autonomous institution of the Ministry of New and Renewable Energy, Govt. of India. It is spread over a sprawling campus of about 75 acres. The Institute is marching towards developing into a centre of excellence in the biomass energy. The Institute is to conduct the-state-of-the-art research, design and development activities in all the areas of biomass energy, bio-fuels, synthetic fuels and new technologies. The Governing Council under the Chairmanship of Secretary, Ministry of New and Renewable Energy has been directing and monitoring the progress of the Institute. The Secretary,
Shri Deepak Gupta inaugurated the Administrative Block of the Institute on 15th July, 2011.

**Solkar makes colleges go green**

In its silver jubilee year Solkar has installed and commissioned 10 kW solar power plants at two colleges in Tamilnadu. The plants installed at DG Vaishnav College, Chennai and the PSG College of Technology, Coimbatore are capable of generating 50 units per day and can back up the loads of the lights, fans, computers, printers, fax machines, televisions, EPBX box and all other regular electrical appliances. The system comes with a data logger and has helped the colleges save handsomely on their electricity bills. Solkar plans to install such systems in 50 other institutions.

www.solkar.in, June 2011

**Gujarat to host Asia’s largest solar energy park**

Gujarat would house the largest solar energy park in Asia in two years, with a power production capacity of 500 MW. This would be set up with an investment of around Rs 8,000 crore flowing from companies such as GMR and Lanco, which have been assigned generation capacities under the Gujarat Solar Mission. Gujarat had announced a solar power policy in January 2009, with a target of installing 1,000 MW capacity by 2012 and 3,000 MW by 2014. The state has already signed power purchase agreements (PPAs) for 934 MW.

The park, on the lines of an industrial estate, is being developed by Gujarat Power Corporation Ltd (GCPL), as the sectoral nodal agency, on around 2,000 hectares of wasteland bordering the Rann of Kutch, in Patan district. When commissioned, the project would provide 800 million units of power. In the first phase, 15 solar power generation companies would produce 176 MW and Gujarat Energy Transmission Corporation would set up a power pooling station. The overall project cost in phase I would be Rs 1287 crore. This would include Rs 351 towards the cost of land and power infrastructure and Rs 624 crore for evacuation facilities.

The Planning Commission has already approved a one-time additional central assistance of Rs 210 crore for the development of the solar park. The Asian Development Bank has approved a soft loan of USD 100 million for the project. This includes development of a ‘smart grid’ for evacuation of power.


**Indian Oil seeks Khosla-backed ethanol technology with Jindal**

Indian Oil Corporation and Jindal Steel & Power Ltd. (JSP) are in talks to produce ethanol from waste gases using a technology backed by billionaire Vinod Khosla as India seeks to boost the use of green fuels amid rising crude prices. The two companies are seeking to build a commercial-scale ethanol plant with technology from LanzaTech, which uses microbes to convert industrial pollutants such as carbon monoxide into biofuels.

Waste gases from a Jindal steel plant could be used to produce the green fuel for blending with Indian Oil’s gasoline pool. India introduced
a national biofuel policy in 2008 to counter the rising costs of oil imports to meet 80 per cent of domestic needs. The policy requires refiners to blend gasoline for a 10 per cent ethanol content and proposes to raise that to 20 percent by 2017. A shortage of sugar-based ethanol in the country has made it difficult for companies to comply with those regulations.

www.bloomberg.com, 29 June 2011

**City heritage sites tap sun’s power, electricity bills dip**

The solar panels at Jantar Mantar and Safdarjung’s Tomb in New Delhi have helped slash the electricity bills of these centrally protected monuments almost by half. The Archaeological Survey of India (ASI) is now thinking of expanding the initiative and installing solar panels at 11 other heritage sites in the capital. The panels at these two heritage sites were installed around six months ago, following an initiative of the ASI and the Ministry of New and Renewable Energy (MNRE).

The power bill for Jantar Mantar has seen a dip of Rs 5,000 per month i.e. from monthly Rs 15,000 to Rs 10,000. At Safdarjung’s Tomb, where ASI also has an office, the bill was reduced from Rs 34,000 to Rs 25,000 per month. The daytime load at all heritage sites includes indoor lighting and fans, ventilation, solar photovoltaic pumps for irrigation, information kiosks and supply at the ticketing counters. The night load includes LED-based floodlights, garden and outdoor lights.

www.indianexpress.com, 28 June 2011

**Lanco Infra to invest Rs 1,700 crore in solar units**

Lanco Solar Energy plans to infuse Rs 1700 crore for the second phase of India’s first integrated solar photovoltaic (PV) manufacturing special economic zone (SEZ) project in Rajnandgaon district of Chhattisgarh. The investment will be used to manufacture polysilicon, ingots, wafers, PV cells and modules with capacities equivalent to 250 MW per year, said V Saibaba, CEO, Lanco Solar Energy.

The SEZ project, which commenced four months ago, is being developed in phases to put Chhattisgarh in the global map of polysilicon production bases. The first phase of the project, which involved an investment of Rs 1340 crore, will be fully operational in a couple of months. Moreover, the company is also strengthening its global market and plans to build solar farms in Germany, France, Italy, the US and the UK where it is already offering engineering, procurement and construction (EPC) solutions.

www.hindustantimes.com, 28 June 2011
Ushdev may seek India wind farm acquisitions to boost capacity

The clean-energy unit of Ushdev International Ltd. may seek to acquire wind farms to boost its capacity 10-fold by 2014. Ushdev Power Holdings plans to invest 18 billion rupees to add 100 MW of wind energy capacity annually over the next three years. By 2018, Ushdev Power may seek to build as much as 1000 MW of renewable energy capacity, which could also include solar, hydropower and biomass plants. Mumbai-based Ushdev Power currently owns 30.5 MW of wind farms in six different states that use turbines made by Denmark’s Vestas Wind Systems A/S, as well as Germany’s Enercon GmbH and Kenersys GmbH.

www.bloomberg.com, 28 June 2011

India plans 550 MW of concentrated solar power by 2013

German technologists and researchers have developed high efficiency solar technologies suitable for countries in the so-called sun belt, such as India. Solar photo voltaic (PV) technology has been used for long to generate power from the sun. However, its use has remained limited because of its low efficiency and other constraints. Now, concentrated solar power (CSP) is emerging as a viable alternative.

One of the biggest benefits of CSP is its ability to store thermal heat, which ensures continuous supply of power even when the sun is down and when it gets cloudy. India, with plans to install 550 MW of CSP by 2013, could emerge as a major player in this area. The Jawaharlal Nehru National Solar Mission recognises CSP as a key source of renewable power. The Ministry of New and Renewable Energy (MNRE) is setting up a string of demonstration projects. A 10 MW CSP plant is already under construction near Bikaner by ACME, a private company.

According to MNRE, CSP could be an attractive option for the country, given the fact that large areas of northwest India fall in the high radiation zone. The costs can be brought down if concentrating mirrors and receiving tubes are manufactured locally.

http://indiatoday.intoday.in, 1 July 2011

Suzlon receives 50.4 MW order from NALCO

Suzlon Energy Limited announced a new order from the National Aluminium Company Limited (NALCO) to set up, operate and maintain 50.4 MW of wind energy projects in Andhra Pradesh. The order comprises 24 units of Suzlon’s S88 – 2.1 MW wind turbines which will be set-up in the Gandikota region, Kadapa district, Andhra Pradesh. This order marks NALCO’s entry into the wind energy sector, with the project scheduled for completion and commissioning by January 2012. The power generated will be sold to the state electricity grid. NALCO plans to register the project under the clean development mechanism (CDM).

www.orissadiary.com, 26 June 2011

India a hotspot for solar venture capitalists

Solar energy, a growing favourite with venture capitalists worldwide, has another favourite now – India. Private equity firms putting their money on solar power equipment components such as modules, cells and waters are now looking at the country, moving away from advanced markets, say industry executives and analysts. As much as Rs 450 crore has flowed into India’s solar energy sector in the past 18 months, according to the estimates by venture capitalism blog VC circle. In 2011, the sector has received more than Rs 200 crore. The World Bank’s private sector lending arm, the International Finance Corporation (IFC) is also eyeing India’s solar sector.

www.hindustantimes.com, 22 June 2011
New solar charge for electric cars

Motorists with electric cars will be able to ‘fill-up’ directly from the sun when Britain’s first public solar-powered charger opens in London in July. Use The Sun, which is managing the eTap project in Rainham and carrying out the installation, says motorists will pay GBP 1 to plug in, and then 63 pence an hour. A three-hour charge will cost a motorist about GBP 2.90 and deliver a range of about 47 miles. A motorist driving a similar-sized traditional car would spend about GBP 5.90 to travel the same distance. Six cars can park underneath each booth at a time and draw current directly from the sun, into their cars’ batteries. When the sun is not shining, the charger draws power from the National Grid. The facility being installed at the Centre for Engineering and Manufacturing Excellence looks like a cross between a futuristic domestic carport and a giant sun canopy. The ‘solar garage’ contains hundreds of photosensitive cells.

When it is not charging up cars the eTap will produce enough electricity to power more than 100 40-watt light bulbs or 23 laptops. The cost of installing and buying a six-bay eTap is about GBP 55,000 but, it is claimed that it would cover its cost in 10 years.

www.usethesun.co.uk, 24 June 2011.

Less expensive solar cells based on rare earth elements

NUtech Ventures and Rare Earth Solar have announced an exclusive license agreement involving technology that replaces the typical semiconductor materials now used in solar cells with rare earth elements. NUtech Ventures is a nonprofit organisation that forms partnerships between University of Nebraska researchers and the private sector. University of Nebraska-Lincoln assistant professor of chemistry Chin Li “Barry” Cheung and his then-doctoral student Joseph Brewer developed the patent-pending technology. Rare earth elements are used to make many high-tech goods as they are more readily available and less expensive than competing commercial materials such as tellurium, indium, and gallium.

Allen Kruse, the co-founder and CEO of Rare Earth Solar, says “This is not a spin off of what currently exists; it truly is a completely new material system. We have been able to reproduce multiple cells at various sizes and are now working on the basic engineering to scale up to a full size module, essentially getting voltage and current where we want it, to meet the largest industry demand.” The company will be selling a glass-on-glass thin film photovoltaic module. Kruse says that the company’s unique process utilising rare earth elements and turnkey equipment will produce panels that are more durable and cost-effective than many thin film panels currently available in the market.

www.nutechventures.org, 26 June 2011

Record efficiencies for a single junction solar cell

Alta Devices achieved an efficiency of 27.6 per cent late last year and, more recently, 28.2 per cent with GaAs-based single junction solar cells. The National Renewable Energy Laboratory (NREL), USA has verified both results. To put the numbers into perspective, the previous highest demonstrated efficiency was 26.4 per cent, and the theoretical maximum solar cell efficiency limit – or Shockley-Queisser Limit – for a single junction device has been shown to be 33.5 per cent.

“Up until now it was understood that to increase the current from our best solar materials, we had to find ways to get the material to absorb more light,” said Alta co-founder Eli Yablonovitch, director of the NSF Centre for Energy Efficient Electronics Science and professor at the University of California at Berkeley. “But, the voltage is a different story. It was not recognised that to maximise the voltage, we needed the material to generate more photons inside the solar cell. Counter-intuitively, efficient light emission is the key for these high efficiencies.”

Alta has been energised by the Department of Energy’s goal of USD 1 per installed watt and the company says that maximising efficiency and, perhaps more importantly, energy density is essential to optimise the production economics of solar PV. The company is developing the processes and capabilities to manufacture GaAs solar cells, and the products they become embedded within, at its pilot manufacturing facility in Sunnyvale, California.

www.ieee-pvsc.org, 23 June 2011
**MIT’s ‘Artificial Leaf’ for solar water splitting moves forward**

An important step toward realising an inexpensive and simple ‘artificial leaf’ for harnessing sunlight through water splitting has been accomplished by two separate research teams at Massachusetts Institute of Technology (MIT), USA.

The teams produced devices that combine a standard silicon solar cell with a catalyst developed three years ago by professor Daniel Nocera. Eventually Nocera wants to produce a low-cost device for use where electricity is unavailable or unreliable. It would consist of a glass container and a solar cell with catalysts on each side attached to a divider separating the container into two sections. When exposed to sun, the electrified catalysts produce bubbles of hydrogen on one side and oxygen on the other, which could be collected and later recombined through a fuel cell or other device to generate electricity when needed.

The next step to producing a usable artificial leaf, explains Nocera, will be to integrate the final ingredient: an additional catalyst to produce the hydrogen atoms. The current devices dissociated hydrogen atoms into the solution as loose protons and electrons. If a catalyst could produce fully formed hydrogen molecules (H₂), the molecules could be used to generate electricity or to make fuel for vehicles.

Nocera encouraged two different teams to work on the project so that each could bring their special expertise to addressing the problem. Bringing together silicon solar cells with the cobalt phosphate (Co-Pi) catalyst material was no trivial matter because water splitting by the catalyst creates a “very aggressive” chemical environment that tends to rapidly degrade the silicon, destroying the device as it operates.

To overcome this, both teams found ways to protect the silicon surface while allowing it to receive the incoming sunlight and to interact with the catalyst. Both teams had to add an extra power source to the system, because the voltage produced by a single-junction silicon cell is not high enough to use for powering the water-splitting catalyst. In later versions, two or three silicon solar cells will be used in series to provide the needed voltage without the need for any extra power source, the researchers say. Although the two approaches to bonding the catalyst with a silicon cell appear to produce functioning, stable devices, so far they have only been tested over a few days. The researchers expect that they will be stable for long periods, but accelerated aging tests will need to be performed to confirm this.

http://web.mit.edu, 10 June 2011

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**Ricoh launches 100 per cent sustainable ‘eco-board’ in London**

Ricoh Europe unveiled Europe’s first ‘eco-board’, a billboard powered 100 per cent by wind and solar power. The Ricoh eco-board is the first of its kind in Europe in having dual natural sources of power so that it illuminates only when sufficient power is collected. The European eco-board joins Ricoh’s solar powered billboard launched in Times Square, New York last year.

www.ricoh-europe.com, 28 June 2011

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**Biofuels from algae, wood chips are approved for use by passenger airlines**

Airline boards won the backing of a US-based technical-standards group to power their planes with a blend of traditional fuel and biofuel from inedible plants, the Air Transport Association (ATA) said. Fuel processed from organic waste or non-food materials, such as algae or wood chips, may comprise as much as 50 per cent of the total fuel burned to power passenger flights, said ATA spokesperson Steve Lott and a Boeing Co. (BA) official. The decision to amend jet fuel specifications to include fuels from bio-derived sources “is a tremendous accomplishment for aviation and the result of tremendous collaboration across the entire industry,” said Boeing Vice President of Environment and Aviation Policy Billy Glover.

www.bloomberg.com, 13 June 2011
An overview of the various efforts, schemes and programmes that are being undertaken/implemented in the eight north eastern states of the country by the Ministry of New and Renewable Energy.

*Dr Arun K Tripathi*

The eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura together comprise the north eastern states of India. Each state has its own unique geography, people and culture and yet they are bound together by their distinct location within the country. Also, each of the eight states is a ‘border state’, that shares boundaries with another country.

The north eastern region (NER) as a whole has a tremendous potential for harnessing renewable energy
(RE) - be it solar, wind, geothermal, biogas or small hydro. Renewable energy systems and devices can play an important role in meeting power and energy requirements in remote areas of the region. To realise this potential special attention is being given to the development of the eight states in the region through a separate budget allocation under various RE programmes. For the year 2010-11 the Ministry of New and Renewable Energy (MNRE) has allocated 10 per cent of the budgetary support for the deployment of biogas plants, solar thermal systems, solar photovoltaic (PV) systems, remote village electrification (RVE), small hydro projects (SHPs), wind energy systems, village energy security projects and energy parks.

**Biogas Programme**
The National Biogas and Manure Management Programme (NBMMP) is being implemented in the NER through state government departments/state nodal agencies (SNA). The Khadi and Village Industries Commission (KVIC) also implements the programme in Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim and Tripura. The state wise achievements of family type biogas plants in the NER up to May 2011 is given in Table 1. The Biogas Development and Training Centre for the NER located at Indian Institute of Technology (IIT) Guwahati, Assam provides the technical and training support for the programme.

**Solar Photovoltaics**
During 2010-11, Central Electronics Limited a public sector company was sanctioned 27 projects for installation of stand-alone solar PV power projects aggregating to 935 kWp capacity. The installations were to be done in Sashastra Seema Bal (SSB) and educational institutions in Arunachal Pradesh (11 projects of total 320 kWp capacity), Assam (6 projects of total 500 kWp capacity) and Sikkim (10 projects of total 115 kWp capacity). In Manipur, 4 stand-alone solar PV power projects of 100 kWp capacity were sanctioned for installation at hospitals, the jail and the State Training Academy. While in Meghalaya 3,350 solar home lights (SHLs) and 171 stand-alone solar PV power projects of total 560 kWp capacity were sanctioned for installation at various institutions. For installation in hospitals and charitable institutions in Mizoram, 7 stand-alone solar PV power projects of totaling 121 kWp capacity were sanctioned. In Nagaland, 10 stand-alone solar PV power plants were sanctioned for installation in government institutions. SPS power plants of 168 kWp capacity were also sanctioned for installation in Tripura at different educational institutions.

**Solar Cities**
Six cities in the NER - Agartala, Guwahati, Jorhat, Imphal, Kohima and Itanagar are being developed as Solar Cities under the scheme. Sanctions have been issued and their master plans are under preparation. Solar City Cells have been created in the municipalities of these cities. Stakeholders committees have also been formed to ensure public participation.

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**Table 1: Family type biogas plants achievements in the north eastern region (NER)**

<table>
<thead>
<tr>
<th>State</th>
<th>Estimated Potential (Number of plants)</th>
<th>Cumulative physical achievements up to May 2011 (Number of plants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arunachal Pradesh</td>
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<td>Assam</td>
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<tr>
<td>Tripura</td>
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<td><strong>Total</strong></td>
<td><strong>4,23,500</strong></td>
<td><strong>1,21,337</strong></td>
</tr>
</tbody>
</table>
Special Area Demonstration Project
Under the Special Area Demonstration Project Scheme, for the north eastern states, the Ministry provides full support up to Rs 1 crore for world heritage sites and Raj Bhawans; Rs 50 lakhs for state assemblies; Rs 25 lakhs for secretariats; Rs 1 crore for State Level Energy Parks; 90 per cent support up to Rs 10 lakhs for collectorates, national parks, zoological gardens and science museums; and 50 per cent support up to Rs 25 lakhs for heritage institutions and religious locations with devotees visit of 10 lakhs or more annually.

Under the Scheme, the Ministry has so far supported 7 Energy Parks in Arunachal Pradesh, 23 in Assam, 10 in Manipur, 8 in Meghalaya, 8 in Mizoram, 7 in Nagaland, 8 in Sikkim and 10 in Tripura. It has also supported projects at the Raj Bhawans of Arunachal Pradesh, Manipur, Meghalaya and Tripura and the State Assembly of Sikkim.

Remote Village Electrification
The villages in the NER continue to receive special attention under the RVE programme as many of these are most suitable for electrification through stand-alone RE devices. A number of villages in these states are too remote to be electrified through grid extension. A portion of the budget of the RVE programme is earmarked for these 8 States. So far, 3092 remote villages and hamlets have been provided RE based systems. The status of the RVE programme in the North East States is given in the Table 2.

Table 2. Remote village electrification (RVE) programme in the North Eastern States

<table>
<thead>
<tr>
<th>State</th>
<th>Villages sanctioned</th>
<th>Villages completed</th>
<th>Hamlets sanctioned</th>
<th>Hamlets completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arunachal Pradesh</td>
<td>297</td>
<td>297</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Assam</td>
<td>2157</td>
<td>1688</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Manipur</td>
<td>237</td>
<td>191</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Meghalaya</td>
<td>163</td>
<td>97</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mizoram</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nagaland</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sikkim</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Tripura</td>
<td>62</td>
<td>60</td>
<td>944</td>
<td>715</td>
</tr>
<tr>
<td>Total</td>
<td>2947</td>
<td>2364</td>
<td>961</td>
<td>728</td>
</tr>
</tbody>
</table>
Small Hydro Power

The North Eastern States have a good potential to develop SHP projects. Among the 8 states, Arunachal Pradesh has the highest potential followed by Sikkim, Meghalaya and Mizoram. MNRE has been giving special emphasis for the development of SHP projects in the NER and a higher level of financial support has been provided under SHP schemes. So far, 164 SHP projects aggregating to 275.65 MW have been set up in the north eastern states and another 45 projects aggregating to 68.06 MW are under implementation (Table 3). Last year, two new projects were sanctioned in Arunachal Pradesh and Sikkim. The Ministry is implementing a project on electrification/illumination of 1058 border villages in Arunachal Pradesh through completion of ongoing and installation of new SHP projects and solar PV systems. Till date, 714 villages including 523 villages from solar PV HLS and 191 villages from small/micro hydel projects have been illuminated/electrified. A detailed exercise was undertaken to assess the renovation and modernisation requirement of existing SHP projects in Arunachal Pradesh, based on which, the Ministry has approved the renovation of 15 SHP projects in the State.

<table>
<thead>
<tr>
<th>State</th>
<th>Sites (Nos.)</th>
<th>Potential (MW)</th>
<th>Achievement (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arunachal Pradesh</td>
<td>550</td>
<td>1333</td>
<td>78.80</td>
</tr>
<tr>
<td>Assam</td>
<td>119</td>
<td>238</td>
<td>27.11</td>
</tr>
<tr>
<td>Manipur</td>
<td>114</td>
<td>109</td>
<td>5.45</td>
</tr>
<tr>
<td>Meghalaya</td>
<td>101</td>
<td>229</td>
<td>31.03</td>
</tr>
<tr>
<td>Mizoram</td>
<td>75</td>
<td>166</td>
<td>36.47</td>
</tr>
<tr>
<td>Nagaland</td>
<td>99</td>
<td>188</td>
<td>28.67</td>
</tr>
<tr>
<td>Sikkim</td>
<td>91</td>
<td>265</td>
<td>52.11</td>
</tr>
<tr>
<td>Tripura</td>
<td>13</td>
<td>46</td>
<td>16.01</td>
</tr>
</tbody>
</table>

Table 3. Small hydro power: State-wise potential and achievement in the North Eastern Region

Looking Forward

Sincere efforts from the states and focussed attention from the Ministry is assisting the North Eastern Region to slowly but surely make its mark on the renewable energy map of India. The data showing the deployment of various solar applications in the remote villages of the region and exploitation of other RE sources are hallmark of relentless effort made by the Ministry. ❖

For further details, please contact
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Ministry of New and Renewable Energy
Block – 14, CGO Complex, Lodhi Road,
New Delhi – 110 003
Tel. +91 11 24362356
or visit this Ministry’s website www.mnre.gov.in
Dr Farooq Abdullah, Minister for New and Renewable Energy, inaugurated the high efficiency solar thermal cooling system at the Solar Energy Centre of the Ministry in Gurgaon, Haryana on 1 July 2011. Shri Sushil Kumar Shinde, Minister of Power, was also present on the occasion.

The new 100 kW solar air conditioning system works at 30 per cent higher efficiency than the current available systems and has several unique features. It is based on the new triple effect absorption cooling technology. The system has indigenously built medium temperature high efficiency parabolic troughs for collection of solar energy and effective solar thermal energy storage in the form of phase change materials.

The present system will cater to air conditioning needs of 13 rooms of the Solar Energy Centre. To achieve this, 288 sq m of solar collector area has been installed which generates nearly 60 kW of 210°C pressurised hot water. This heat is used in a vapour absorption machine to generate 7°C chilled water, which in turn circulates through the fan coil unit installed in the thirteen rooms. The major attraction of this system is that the hottest days have the greatest need for cooling and simultaneously, offer the maximum possible solar energy gain.

The system has been developed in joint collaboration by Solar Energy Centre with M/s Thermax Limited, Pune and is expected to meet the growing demand for air conditioning in India in a highly efficient and cost effective way through the use of direct solar energy.
On 1 July 2011 a one day workshop on solar thermal systems was organised by Manipur Renewable Energy Development Agency (MANIREDA) at the conference hall of Hotel Classic, Imphal. Under a scheme supported by the Ministry of New and Renewable Energy (MNRE), MANIREDA will be supplying solar thermal systems or ‘solar water heaters’ to consumers in Manipur at a subsidised rate. The purpose of the workshop was to familiarise the consumers who have applied for the said systems as well as the general public on the working and benefits of the system in particular and solar technology in general.

In his address the chief guest Shri L Jayentakumar, Minister for Health and Family Welfare congratulated MANIREDA on doing “one of the best jobs”, stressing that, “the right to life includes the right to power”. He also emphasised that this was just the beginning of the use of renewable energy in the state.

The president of the inaugural session was Shri H Imocha Singh, Commissioner (Science & Technology) cum Member Secretary, MANIREDA. Present as guests of honour were Shri Anand Narwani, Senior Scientist MNRE, Shri Prem Chand, Under Secretary, MNRE, Shri DR Das, Director, MNRE (NE Region) and Shri RK Nimai, Commissioner (Art & Culture) and Secretary to the Governor of Manipur. As per the Manipuri tradition, a shawl was presented to all the dignitaries as a token of respect and appreciation.

In his welcome cum introduction talk Shri L Manglem Singh, Director MANIREDA highlighted the present role of the organisation in promoting alternative means of energy in the state as well as outlined the future plans especially with respect to the solar thermal systems.

In the technical session, T Ananth, CEO Nutech Solar Systems Pvt. Ltd., Bangalore gave a presentation on the working, installation, maintenance and benefits of a solar water heating system.

The workshop was attended by about 215 participants and ended with a lively interaction - with the delegates on one hand and the representatives from MNRE, officials of MANIREDA and Mr Ananth on the other.
Lok Sabha Speaker Inaugurates Solar Energy Systems at Parliament House Complex

The Parliament House took a major step towards sustainable energy when Lok Sabha Speaker Smt Meira Kumar inaugurated a 80 kWp solar photovoltaic (PV) power plant and a 2000 lt per day solar water heater system (SWHS) at the Parliament House Complex in New Delhi on 9 August 2011. The Minister of New and Renewable Energy, Dr Farooq Abdullah was also present on the occasion. The new systems are part of the demonstration of renewable energy systems at the Parliament House complex under the ‘Special Area Development Project’ of the Ministry of New and Renewable Energy (MNRE).

The 80 kWp solar PV rooftop plant installed at a cost of Rs 1,19,75,529 will help in reduction in the use of conventional electricity and diesel power and reduce dependence on conventional grid power. The SWHS will supply 2000 lt per day of hot water to Parliament House annexe canteen. It is expected to save 6,000 kg of LPG per year. 20 solar street lighting systems and a 500 kg per day kitchen waste based biogas plant are also under process of installation as part of the project.

Speaking on the occasion Smt Meira Kumar expressed her appreciation of the concerted efforts of the MNRE and the alacrity with which Dr Abdullah responded to her remarks made in Parliament on 11 December 2009, with respect to the incorporation of solar and other renewable energy systems in the Parliament House complex. She further mentioned that these initiatives would go a long way not only in making the Parliament House complex energy efficient but also in setting examples for other buildings and complexes. She further said that India has a vast potential for use of solar energy in meeting the energy needs of the people. She appreciated the progress made under the Jawaharlal Nehru National Solar Mission (JNNSM) and said that the Mission will help in providing energy access in remote and inaccessible areas.

Dr Farooq Abdullah thanked the Speaker for taking the initiative and providing an opportunity for his ministry to demonstrate the use and benefits of renewable energy systems at Parliament House complex. He mentioned that the role of new and renewable energy has been assuming increasing significance. In view of growing emphasis on the country’s energy security and to check global warming besides meeting energy needs in an environmentally benign manner, renewable energy was being promoted. He also informed the Speaker that renewable energy systems had been installed in over 50 places of national, historical and religious importance including 21 Raj Bhavans; Dargah Ajmer Sheriff; Shri Mata Vaishno Devi Shrine Board; Saifi Villa at Dandi; BSF Camp at Indo-Pak Border at Atari near Amritsar; Golden Temple, Amritsar; Chittorgarh fort, Badrinath and Kedarnath dhams; Jantar Mantar and Safdarjung Tomb, New Delhi etc.
Arunachal Pradesh

Illuminating Border Villages

The Prime Minister announced a special package for illumination/electrification of villages located in the border districts through a mix of grid connected/decentralised systems on 31 January 2008.

Marki Loya and Timi Muri

A 2X15 kW project under Component-III of the Prime Minister’s Package, Arunachal Pradesh
Arunachal Pradesh is also called the ‘land of the rising sun’ and the ‘land of dawn-lit mountains’, it is the largest state amongst the eight north eastern states, with a total area of 83,743 sq km. It stretches from the snow capped mountains in the north to the plains of the Brahmaputra valley in Assam in the south. A land of lush green forests, deep river valleys and beautiful plateaus, the people of Arunachal Pradesh are simple, peace-loving and hospitable with a glorious heritage of art, culture and colourful festivals. The state has a long international border with Bhutan in the west (160 km), China in the north (1030 km) and Myanmar in the east (440 km). Nagaland and Assam lie in the south.

Due to the different altitudes, the climate varies from the south to the north. While it is hot and humid along the foothills bordering Assam, it is cold along the international border in the north where the mountains are high and lofty and are permanently snowcapped even during summer. Numerous perennial rivers and rivulets originate from these mountains.

The State Nodal Agency
The Arunachal Pradesh Energy Development Agency (APEDA) was created out of the Rural Works Department (RWD) in the year 1996. It’s entity till then was an Energy

Prime Minister's Package
The Hon'ble Prime Minister of India, Dr Manmohan Singh on his maiden visit to the state of Arunachal Pradesh on 31 January 2008 announced a package for illumination/electrification of households/villages located in the international border districts of Arunachal Pradesh through a mix of grid connected/decentralised mini/micro/small hydro power projects and through solar photovoltaic (PV) systems. The total package announced was for an amount of Rs 550 crores. To accomplish this announcement, three departments of the State are involved namely APEDA, Department. of Hydro Power Development and Department of Power.

The following work components are assigned to APEDA under the Package:
Component-I: To illuminate 546 border villages through solar home lighting systems (SHLS) at an estimated cost of Rs 11.03 crores.
Component-II: To electrify 191 villages through setting up of 67 micro and mini hydel projects of capacities ranging from 10 kW to 200 kW at a sanctioned cost of Rs 43.67 crores.
Component-III: To complete 31 languishing micro hydel projects ranging from 5 kW to 40 kW (as resource-gap funding) at a cost of Rs 2.74 crores.

The Department of Hydro Power Development is engaged in the following works under the same Package:
1. To complete 42, incomplete on-going projects with capacity addition of 47.28 MW at an additional cost of Rs 169.11 crores to benefit 670 villages.
2. To complete 4 projects (2 on-going and 2 new) to give capacity addition of 17.03 MW to benefit 140 villages at an additional cost of Rs 105.31 lakhs.
3. To complete 14 on-going projects with a capacity addition of 6.62 MW at an additional cost of Rs 16.73 crores.
4. To complete 36 new projects to provide capacity addition of 10.62 MW for electrification of 419 border villages at a cost of Rs 146.94 crores.

The Department of Power is assigned to construct connectivity lines from the hydel projects constructed by the Department of Hydro Power Development to evacuate power to the targeted villages.
Wing in the RWD. It is now a state government agency of the Government of Arunachal Pradesh and is registered under the Societies Registration Act, 1860. APEDA is the State Nodal Agency (SNA) for all the programmes and schemes connected with renewable and non-conventional energy sources; all such programmes and schemes sponsored by the Ministry of New and Renewable Energy (MNRE) are either executed or routed through it.

Implementation of the PM’s Package by APEDA

Under Component-I, a total of 546 border villages, where the households were less than 30 in number and which had no perennial source of water for construction of hydel projects, were to be illuminated through SHLS of Model-II with 37 W module as per the MNRE specification under the Prime Minister’s Package. Out of 546 targeted villages, 523 villages were covered by installing SHLS in 5852 households (Table 1). The villages so illuminated are extremely remote and they are approachable by porter tracks only. Some of the villages take even two to three days walk to reach.

<table>
<thead>
<tr>
<th>Name of district</th>
<th>Number of villages illuminated</th>
<th>Number of households covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anjaw</td>
<td>197</td>
<td>1930</td>
</tr>
<tr>
<td>Changlang</td>
<td>5</td>
<td>169</td>
</tr>
<tr>
<td>Kurung Kumey</td>
<td>79</td>
<td>941</td>
</tr>
<tr>
<td>Dibang Valley</td>
<td>52</td>
<td>277</td>
</tr>
<tr>
<td>Tawang</td>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>West Kameng</td>
<td>11</td>
<td>155</td>
</tr>
<tr>
<td>West Siang</td>
<td>29</td>
<td>440</td>
</tr>
<tr>
<td>Upper Siang</td>
<td>8</td>
<td>112</td>
</tr>
<tr>
<td>East Kameng</td>
<td>77</td>
<td>1094</td>
</tr>
<tr>
<td>Upper Subansiri</td>
<td>61</td>
<td>696</td>
</tr>
<tr>
<td>Total</td>
<td>523</td>
<td>5852</td>
</tr>
</tbody>
</table>

The State Government has engaged the North East Development Financial Corporation (NEDFC) for third-party monitoring to evaluate the quality and quantity of all projects.

Under Component-II, 191 villages, where there were a perennial source of water and which had more than 30 households, were to be electrified by setting up of 67 mini and micro hydel projects of capacity ranging from 10 kW to 200 kW (Table 2). The works in these projects are going on in full swing and they are targeted to be completed by March 2012. All the sites are very remote and the construction materials are required to be carted manually. In some of the project sites the cartage cost of a bag of cement is more than the cost of the cement.

<table>
<thead>
<tr>
<th>Name of district</th>
<th>Number of projects</th>
<th>Number of villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tawang</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>West Kameng</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>East Kameng</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Kurung Kumey</td>
<td>11</td>
<td>46</td>
</tr>
<tr>
<td>Upper Subansiri</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>West Siang</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Upper Siang</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Dibang Valley</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Anjaw</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Tirap</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>191</td>
</tr>
</tbody>
</table>

The authors are Director and Information and Publicity Officer, Arunachal Pradesh Energy Development Agency (APEDA), Itanagar, Arunachal Pradesh, director@apeda.co.in
Assam RE Energising Rural Assam

After using the solar home lights (SHL) systems, there is a sea change within the rural communities - use of kerosene wick lamps has been cut drastically.

Dr Satyendra Kumar Choudhury and Mrinal Krishna Chaudhury

Assam is the sentinel of north east India and the gateway to seven north eastern states. The State is surrounded by Bhutan and Arunachal Pradesh in the north, Manipur, Nagaland and Arunachal Pradesh in the east and Meghalaya, Tripura and Mizoram in the south. It is endowed with a bounty of serene landscape, plenty of natural resources and the lush greenery of the tea gardens and wild life sanctuaries. The mighty Brahmaputra flows through the entire length of the state with a number of tributaries joining it from the Himalayan range in the north. With varying topography, the entire State has plenty of locations that usually remain cut off from the urban pockets.
Many places in the State which are now inhabited but sparsely populated, lie in the stabilised sandbars called ‘chars’ which are formed in the middle of the river, like a typical island, by the changing course of the river or due to siltation. These locations are very difficult to connect to the grid as the river and thin population, make it commercially unviable.

The State Nodal Agency
The Assam Energy Development Agency (AEDA) was earlier a part of Assam Science, Technology and Environment Council (ASTEC). ASTEC was constituted in 1986-87 as an autonomous council under the Department of Science, Technology and Environment, Government of Assam for implementation of some of the major programmes in the sectors of science and technology, remote sensing, energy (non conventional and renewable sources) and environment. AEDA was formally constituted in July 2002 under the Societies Registration Act (1860) to act independently as the nodal agency for implementing programmes related to new and renewable sources of energy under the Ministry of New and Renewable Energy (MNRE) (Table 1).

Development of Renewable Energy in the State
Apart from implementing different renewable energy programmes, AEDA is also implementing the remote village electrification (RVE) programme in the State. The MNRE initiative to meet the basic lighting demand of isolated villages throughout the NE region has found immense popularity particularly in Assam. After analysing the dimensions and merits of different alternatives of decentralised power, the ultimate source, which has been widely accepted by the rural masses, is the solar photovoltaic (PV) lighting system.

In Assam, a list of 2,139 villages, identified to be difficult to cater to through the conventional power grid, was prepared by the government agencies. It was suggested that these villages be provided with power from renewable resources.

Apart from providing lighting facility to the rural households the RVE programme has contributed immensely towards a sustainable and greener environment.

### Table 1. AEDA Implementing Programmes under MNRE

<table>
<thead>
<tr>
<th>Project/ Programme</th>
<th>Installation so far</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV - village electrification</td>
<td>771 villages</td>
</tr>
<tr>
<td>Solar PV- general programme</td>
<td>3,566 households</td>
</tr>
<tr>
<td>Solar hot water systems (SHWS)</td>
<td>15 locations</td>
</tr>
<tr>
<td>Micro hydel project</td>
<td>2 locations</td>
</tr>
<tr>
<td>Wind monitoring mast</td>
<td>10 locations</td>
</tr>
<tr>
<td>Institutional Energy Parks</td>
<td>20 locations</td>
</tr>
<tr>
<td>State Level Energy Park</td>
<td>1 locations</td>
</tr>
<tr>
<td>Solar Mini Power Plants</td>
<td>5 locations</td>
</tr>
</tbody>
</table>

Community lighting system installed at a temple in Hatukagaon village, Karbi Anglong District, Assam.

Solar street light under RVE programme in Lakshipathar village, Golaghat District, Assam.
Measuring the Success

Earlier, most villages used kerosene wick lamps as a source of lighting. After using the SHL systems, there is a sea change within the rural community. Use of kerosene oil has drastically come down and the environment inside the houses has become clean due to reduction of smoke and subsequent blackening of the walls due to the wick lamps.

Computing reduction of kerosene usage by 30,000 rural households that have been provided solar lighting facilities by AEDA, yield startling results. In case there is a reduction of 4 lt of kerosene oil per family per month, for 30,000 families, it totals to 1.2 lakh lt per month and 14.4 lakh lt of kerosene saving annually. Interpreted in monitory terms this would result in an annual saving of about Rs. 2.3 crores towards kerosene consumption. Similarly, one can quantify the amount of carbon reduction, which has been made using the solar lighting facility. One has to appreciate that apart from providing lighting facility to the rural households the RVE programme has contributed immensely towards a sustainable and greener environment.

Measuring the Success

Apart from providing the lighting facility to the rural houses, the village is also provided with such facilities for lighting of temples, mosques, churches, clubs and the like. Solar street lights are often provided at street corners, market places etc. The common facility is looked after and managed by a village energy committee (VEC) formed by the beneficiaries of the particular village. Two rural youth among the village are trained by the equipment suppliers to look after the day to day maintenance. If the trained youth are not able to address a problem, it is reported to the supplier since the systems are covered under 5 years comprehensive maintenance contracts. Having such a facility in a remote unelectrified household is really a boon to the rural community.

Endnote

In the context of present energy scenario AEDA through different renewable energy schemes and programmes of MNRE is committed to meet the RE requirements and demands of the State. 

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Mizoram

Exploring Wind and Hydro

Mizoram has a great potential for wind as also micro and small hydro power, however, the exact potential is waiting to be explored by the experts.

David C Zahmuaka and Thantluanga

Mizoram nestled in the picturesque and gentle rolling hills in the southern most tip of the north eastern region (NER) is a small State with 22 towns and as many as 817 census villages. Presently the State is on course for all round development with major thrust on growth in the rural areas.

One of the major hurdles in the development process of the State is the lack of access to electricity in urban as well as in rural areas. This is especially acute in the rural areas, perpetrating a passive energy crisis, where productive applications are constrained due to lack of effective access to energy, even if there could be affordability. Access to affordability is therefore a key element for poverty reduction in rural Mizoram.

The State Nodal Agency
Zoram Energy Development Agency (ZEDA) is an autonomous body established by the Government of Mizoram with its headquarters at Aizawl. ZEDA is registered as a society under the Societies Registration (Extension to Mizoram) Act,
ZEDA had submitted proposals to C-WET, Chennai for eight locations for Wind Resource Assessment with a mast of 50 m height.

1976 (Mizoram Act No. 3 of 1977), having a governing body headed by the Minister of Power of the State. It also has a Managing Committee headed by the Secretary of Power and Electricity Department, Government of Mizoram. The Agency became operational in 1999, exclusively to undertake all programmes in the field of non-conventional and renewable energy (RE) sources. Apart from this, ZEDA is also the Nodal Agency, which interacts with the Ministry of New and Renewable Energy (MNRE), to implement the centrally funded and sponsored scheme, in the field.

ZEDA is fully committed to boost the use of non-conventional and RE sources through the following steps:

- intensification of awareness campaigns by undertaking demonstration programmes all over the state;
- utilisation of all promotional schemes offered by MNRE;
- installation and commissioning of solar power plants, wind hybrid power projects etc. in the state;
- publication of brochures, booklets and pamphlets giving details of various RE schemes and devices available, for the benefit of the public;
- allocation of funds and holding of ‘popularisation/demonstration’ campaigns for effective implementation of RE programmes;
- collaboration with various governmental departments and non-governmental organisations for popularisation of RE systems and applications.
Wind and Hydro Potential

Mizoram has a great potential of wind energy; however, the exact potential is yet to be explored by experts. The Centre for Wind Energy Technology (C-WET), Chennai, under MNRE was entrusted to conduct a wind resource assessment including wind mapping throughout the country with the cooperation from the respective State Nodal Agencies (SNAs) and accordingly, ZEDA has been extending all possible help to C-WET in Mizoram. C-WET had done wind resource assessment at 5 locations - Sakawrhmuutuai, Reiek, Hmuifang, Lunglei and Mamte with a mast of 25 m height. However, the result was found to be unsatisfactory. Again, C-WET selected two locations i.e. Chalfilh and Ngopa for the assessment with a mast of 50 m height which was found to be adequate. They completed the foundation work for these two locations in the year 2009 but erection is yet to be done. Early completion of wind monitoring stations at these locations is earnestly awaited. In addition to the above two locations ZEDA had submitted proposals to C-WET Chennai for eight more locations for wind resource assessment with a mast of 50 m height.

The State is also blessed with a good micro and small hydro electricity potential, which needs to be adequately harnessed. If the hydro potential is achieved, the State will be self-sufficient in electricity and the SNA, ZEDA is taking every step possible to achieve this.

Development of RE in the State

ZEDA focuses on the promotion of solar thermal and solar photovoltaic (PV) systems/devices, hybrid projects (solar PV and wind) and rural energy activities, which include distribution of solar home lighting (SHL) systems in rural and semi-urban areas. Other activities of ZEDA involve promotion and establishment of non-conventional energy parks, biomass gasifiers and installation of power plant at various places.

A draft of the RE policy for the state of Mizoram has already been formulated and tentatively approved by the state government after incorporating suggestions from the public. The policy is called ‘The Mizoram Renewable Energy Policy 2003’. The policy designates ZEDA as the Nodal Agency for all RE activities in the State and further declares that ZEDA shall facilitate clearances for projects for producing electricity from non-conventional and RE sources on the lines of the facilitation provided by the Bureau of Industrial Promotion (BIP). The Agency is authorised to test for quality control of all the devices/equipment related to RE and as well as the energy saving devices to be used and sold in Mizoram.

Light in the Dark with Solar Energy

ZEDA had installed four 25 kWp solar PV power plants at various charitable homes and hospitals. Another 121 kWp is expected to be completed within this financial year. The charitable home, Thutak Nunpui Tute (TNT) is one of the largest in Asia. Although the Power Plant installed in TNT is only 25 kWp, it is of great help to the beneficiary as they save a lot in their electricity bills annually.

Apart from the above power plants, ZEDA had distributed 9073 solar lanterns, 6201 SHL systems and 40 solar power packs to the unelectrified and rural villages and NGO homes with the help of the fund received from MNRE and the State Government. Aizawl has been declared by MNRE as a Solar City. Master plan for the Solar City scheme had been submitted to the MNRE for approval. Mizoram has a great potential of solar energy, which needs to be exploited at a larger scale.

Suggestions for RE implementation

Almost all the power requirements of the State is met from the central sector, as the generation within Mizoram is negligible compared to the load requirement of the State. It is therefore necessary to explore and implement alternate energy projects, e.g. installation of solar power plants at various government buildings; provision of solar lanterns to the villagers; installation of mini grid connected SPV power plants at various villages; installation of grid connected SPV power plants in various parts of Mizoram; installation of solar PV street lighting system; and installation of SHL systems.

The authors are Director and Junior Engineer, Zoram Energy Development Agency (ZEDA), Aizwal, Mizoram, zedaaizawl@hotmail.com

ZEDA had distributed 9073 solar lanterns, 6201 SHL systems and 40 solar power packs to the unelectrified and rural villages and NGO homes.
Underlining its commitment to green energy, Nagaland is the first state in the north eastern region (NER) to establish a separate Department of New and Renewable Energy.

T S Angami and Kavito Chishi

Solar street light installed under the Remote Village Electrification programme at Lower Sinjol' A village, Peren District, Nagaland.
Basket making in the solar light in Sairhem village, Peren District, Nagaland.

To create direct and indirect employment opportunities especially in rural and backward areas.

Development of RE in the State

Vision: To harness green and clean RE sources for environmental benefits and to augment energy security.

Mission: Having RE projects across the State either on grid or off grid mode, will substantiate the total power generation and reduce the import of energy from the grid (Table 1). The Department also mandates the conservation of energy by taking necessary energy efficiency and energy conservation measures in industrial, commercial and government establishments including domestic buildings.

Table 1. Ongoing and planned activities (2011-12) under the Department of New and Renewable Energy, Nagaland

<table>
<thead>
<tr>
<th>Programme</th>
<th>Target</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar power plant</td>
<td>742 kWp</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Solar water heating system (SWHS)</td>
<td>3170 sq m</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Solar City</td>
<td>Dimapur</td>
<td>Data collection completed</td>
</tr>
<tr>
<td></td>
<td>Kohima</td>
<td>Master Plan completed</td>
</tr>
<tr>
<td>Solar street lights</td>
<td>136 villages</td>
<td>DPR submitted</td>
</tr>
<tr>
<td>Solar water pumps</td>
<td>12 locations</td>
<td>DPR under preparation</td>
</tr>
<tr>
<td>Hydro Power</td>
<td>1 MW</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>17 sites</td>
<td>Survey ongoing</td>
</tr>
<tr>
<td>Biogas family size</td>
<td>1000 numbers</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Biomass gasifier</td>
<td>2 sites</td>
<td>Ongoing</td>
</tr>
<tr>
<td>State Energy Park</td>
<td>1</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Wind-solar hybrid</td>
<td>20 kW</td>
<td>DPR under preparation</td>
</tr>
<tr>
<td>Remote village electrification (RVE)</td>
<td>38 villages/</td>
<td>DPR under preparation</td>
</tr>
<tr>
<td></td>
<td>hamlets</td>
<td></td>
</tr>
</tbody>
</table>

Nagaland, the 16th state of the Indian Union, was established on 1 December 1963. It is bound by Myanmar in the east, Arunachal in the north, Assam in the west and Manipur in the South. The state has an area of 16,579 sq km of mostly mountainous terrain except the areas bordering the Assam valley.

The State Nodal Agency

The Government of Nagaland recognising the importance of the green energy in view of global warming created a separate entity - the Department of New and Renewable Energy on 29 July 2009 to facilitate project development in the State in consonance with the various schemes and programmes of the Ministry of New and Renewable Energy (MNRE). The Department was created by merging the officers and staff of the erstwhile Non Conventional Energy (NCE) Cell under the Department of Rural Development forming the core group of the Directorate of New and Renewable Energy. The Department has also been mandated to take up hydel projects up to 1 MW. Therefore, the Department of NRE has 2 wings viz. NCE and Hydro Wing.

Aims and Objectives

- To harness the environment friendly renewable energy sources and to enhance their contribution to the socio-economic development of the State.
- To meet and supplement rural energy needs through sustainable RE projects.
- To provide decentralised energy supply to agriculture, industry, commercial and household sector.
- To supplement efforts in bridging the gap between demand and supply of power, with renewable energy sources and strengthening the grid system and evacuation arrangements for RE projects.
- To support efforts for developing, demonstrating and commercialising new and emerging technologies in the RE sector, and to this end, help establish linkages with national and international institutions for active collaboration.
- To create public awareness and involve users/local community along with capacity building in establishing, operating and managing RE projects.
- To establish dedicated renewable energy Special Economic Zones (SEZ) to promote renewable energy projects.
- To give necessary support and facilitation to the entrepreneurs and investors to successfully implement RE projects to produce more renewable energy without delay and to attract more investment in State by private developers.
- To initiate necessary measures in energy conservation as per the guidelines of Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India.
Intensive survey and data collection was carried out which was coordinated and cross verified with the Department of Power to ascertain whether these villages/hamlets were included in the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme. Clearances were obtained from the Department of Power for 8 villages under Peren District in the first phase (Table 2). The Detailed Project Report (DPR) was submitted to MNRE, which was later approved and sanctioned during 2010-11.

**Challenges:** While carrying out the survey as well as during the commissioning of the projects for these villages, poor road communication was one of the major hurdles for the department officers and staff. Head loading of materials had to be done in some of the villages. Village meetings were held and awareness training on RE with special reference to SHL systems and solar street lights was imparted to the villagers. A Village Energy Management Board was set up in all the villages for up keep and maintenance of the solar systems. Third Party Monitoring was carried out by Nagaland University.

**Table 2. RE implementation in 8 villages in Peren District, Nagaland (2010-2011)**

<table>
<thead>
<tr>
<th>Name of Village</th>
<th>Households</th>
<th>Solar home light (SHL)</th>
<th>Solar street lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shailhem</td>
<td>74</td>
<td>74</td>
<td>7</td>
</tr>
<tr>
<td>Phaikholum</td>
<td>49</td>
<td>49</td>
<td>5</td>
</tr>
<tr>
<td>New Soget</td>
<td>64</td>
<td>64</td>
<td>6</td>
</tr>
<tr>
<td>Old Soget</td>
<td>89</td>
<td>89</td>
<td>8</td>
</tr>
<tr>
<td>Songngou</td>
<td>44</td>
<td>44</td>
<td>4</td>
</tr>
<tr>
<td>Lower Sinjol ‘A’</td>
<td>46</td>
<td>46</td>
<td>4</td>
</tr>
<tr>
<td>Khelma</td>
<td>119</td>
<td>119</td>
<td>10</td>
</tr>
<tr>
<td>Songsang</td>
<td>64</td>
<td>64</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>549</strong></td>
<td><strong>549</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

**Implementation:** The Department of New & Renewable Energy has been making efforts to create conditions conducive to private/public/community participation and invite investors in RE power projects in the State. One of the tasks undertaken by the Department was to identify the unelectrified villages/hamlets in the State.

**Success Story: People speak**

Khelma, is one of the villages that has been covered under the RVE programme. Expressing his pleasure and satisfaction at light being available TS Jem, the village chief said it was a dream come true and it was like being in paradise. He said, now with the light, the children could study and the elders could work on handicrafts. He was sure that their economy would improve in the days to come.

Intensive survey and data collection was carried out which was coordinated and cross verified with the Department of Power to ascertain whether these villages/hamlets were included in the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme. Clearances were obtained from the Department of Power for 8 villages under Peren District in the first phase (Table 2). The Detailed Project Report (DPR) was submitted to MNRE, which was later approved and sanctioned during 2010-11.

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Manipur

Flying High with Renewable Energy

To upgrade Imphal Airport with night landing facility it was decided that solar powered obstruction lights (SPOLs) would be installed on 4 hills surrounding the Imphal valley.

L. Mangisem Singh

Manipur literally meaning ‘a jewelled land’ nestles deep within a lush green corner of north east India. The total area covered by the State is 22,327 sq km; it is bounded by Nagaland in the north, Mizoram in the south, Assam in the west, and by the international border with Myanmar in the east.

The State Nodal Agency
Manipur Renewable Energy Development Agency (MANIREDA) was set up by the State Government as an autonomous government institution for implementation of all the renewable energy (RE) schemes/programmes in the State and designated as the State Nodal Agency on 31 March 1999. The Agency is a registered Society under the Societies Registration Act 1989.

Although MANIREDA has implemented RE projects at selected locations purely on the basis of availability of RE resources of the specific site, no resource assessment on overall potential of RE in the state has been carried out.
till date. The matter was discussed as one of the important points in the meeting presided by Dr Farooq Abdullah, Minister for New and Renewable Energy with Ministers and officials of the north east region (NER) held on 2 July 2011 at New Delhi. The representatives of NER requested the Ministry of New and Renewable Energy (MNRE) for a detailed resource assessment of various resources of RE in the region on priority basis.

**Development of Renewable Energy in the State**

Commendable contributions have been made by MANIREDA for the promotion of RE in the State. Altogether installed capacity of about 3 MW has been achieved by the agency till 31 March 2011 through various RE sources such as solar photovoltaic (PV) (1715 kW including demonstration projects), small hydel (435 kW), wind-solar hybrid (140 kW including ongoing near completion projects), biomass (600 kW), solar thermal (48 kW) etc.

More than 200 remote villages/hamlets in difficult hilly regions were electrified through available RE sources and with active participation of the beneficiaries by constituting village energy committees (VECs) in all the beneficiary villages. The status of installed capacity and projected targets of various RE power/electrification projects in the State are given in Table 1.

**Table 1. Status of installed capacity and projected targets of various RE power/electrification projects in Manipur (in kW).**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Cumulative up to 31 March 2010</th>
<th>Cumulative up to 31 March 2011</th>
<th>Projected cumulative up to 31 March 2012</th>
<th>Projected cumulative up to 31 March 2013</th>
<th>Projected cumulative up to 31 March 2014</th>
<th>Projected cumulative up to 31 March 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind-solar hybrid systems</td>
<td>140.00</td>
<td>140.00</td>
<td>160.00</td>
<td>200.00</td>
<td>250.00</td>
<td>300.00</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>48.00</td>
<td>48.00</td>
<td>5058.00</td>
<td>12558.00</td>
<td>20058.00</td>
<td>27558.00</td>
</tr>
<tr>
<td>Biomass based</td>
<td>600.00</td>
<td>600.00</td>
<td>600.00</td>
<td>600.00</td>
<td>600.00</td>
<td>600.00</td>
</tr>
<tr>
<td>Small hydro</td>
<td>35.00</td>
<td>435.00</td>
<td>450.00</td>
<td>650.00</td>
<td>750.00</td>
<td>850.00</td>
</tr>
<tr>
<td>Solar photovoltaic</td>
<td>1514.25</td>
<td>1715.48</td>
<td>2871.94</td>
<td>3871.94</td>
<td>4871.94</td>
<td>5871.94</td>
</tr>
<tr>
<td>Total</td>
<td>2337.25</td>
<td>2938.48</td>
<td>9139.94</td>
<td>17879.84</td>
<td>26299.45</td>
<td>35179.94</td>
</tr>
<tr>
<td>Total (MW)</td>
<td>2.33</td>
<td>2.93</td>
<td>9.13</td>
<td>17.87</td>
<td>26.29</td>
<td>35.17</td>
</tr>
</tbody>
</table>

View of Imphal Valley and the SPOL panels from the Heibokching hilltop.
Success Story
Flying in the dark with solar powered obstruction lights:
In order to upgrade Imphal Airport with night landing facility lights were to be installed on 4 hills surrounding the Imphal valley. Since there is no grid lines in these hills it was decided that solar powered obstruction lights (SPOLs) would be installed. The Government of Manipur through the Transport Department entrusted MANIREDA with the installation of solar power plants at the 4 hilltops (Table 2). Expenditure for the four projects was borne by the State Government.

Table 2. Details of the 4 hilltops on which the SPOLs are installed

<table>
<thead>
<tr>
<th>Name</th>
<th>Area/District</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nongmaiching Hill Top</td>
<td>Imphal East District</td>
<td>East of Airport</td>
</tr>
<tr>
<td>Phunal Maring Hill Top</td>
<td>Imphal East District</td>
<td>South east of Airport</td>
</tr>
<tr>
<td>Heibokching Hill Top</td>
<td>Imphal West District</td>
<td>South of Airport</td>
</tr>
<tr>
<td>Chingphu Hill Top</td>
<td>Bishnupur District</td>
<td>West of Airport</td>
</tr>
</tbody>
</table>

(Presuming the runway strip at Imphal Airport is in the east-west direction).

The necessity: These hills are located in close surrounding of the airport. In order to facilitate night landing and also to prevent any eventualities during take-off and landing at night, solar powered obstruction lights are placed at the top of these hills mainly to indicate obstruction of the hills to the pilots.

The timelines: Approval for installation of the 4 SPOLs was accorded by the Executive Committee of MANIREDA in October 2008 and work orders were issued in November 2008. Completion of installation/handling over of these SPOLs by MANIREDA to Transport Department was done by 26 February 2009 for three sites, except Nongmaiching hilltop, which was completed on 14 July 2009.

The challenges: Initially, as there were no approach roads to these four sites, roads had to be made to take the materials required for the civil work as well as the solar PV modules, batteries, hardware etc. of the project. Even now, the roads to the Nongmaiching and Phunal Maring sites are difficult and not easily accessible which sometimes hampers the routine maintenance work.

On cloudy days: In the event of complete no sunshine days during monsoon/cloudy days, the storage capacity of the tubular plate batteries at the hilltops (@ 600 VA at 96 V per site), is able to supply three to four days system autonomy (capable of supplying power) easily. The solar plates however are capable of charging the batteries with some intensity (though less powerful) even on cloudy/less sunshine days. All the power plants are working satisfactorily since the last 2 years.

Maintenance: MANIREDA is responsible for 5 years comprehensive maintenance contract of the power plant. Further extension of maintenance period will be considered with approval of the State Government.

The night landing facility has changed the lives of the people. Improved connectivity with the rest of the country has its own cascading effect and implications for the State as a whole.

Night landing trial conducted
A trial run for aircraft landing at Tulihal Airport during night was successfully conducted today. A small aircraft with 10 officials of the Airport Authority of India (AAI) on board conducted successful landing and take-off trials at Imphal airport tonight. Notably, installation of night landing facility at Imphal airport was one of Chief Minister O Ibobi’s priority visions and he was duly supported by Prime Minister Dr Manmohan Singh. To facilitate night landing at the airport, four Solar Powered Obstructing Lights have been installed in different directions of the airport.

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In the event of complete no sunshine days during monsoon/cloudy days, the storage capacity of the tubular plate batteries is able to supply 3-4 days system autonomy.
Tripura
Energising through Renewsables

The implementation of various schemes involving renewable sources like solar, wind and biogas is energising and empowering the people of the State.

Subhash Chowdhury

Tripura is strategically situated between the river valleys of Myanmar and Bangladesh. Encircled almost on three sides by Bangladesh, it is linked with Assam and Mizoram in the north east. Tripura is the third smallest state of India and is accessible to the rest of country through the Cachar district of Assam and Aizawl district of Mizoram in the east.

The State Nodal Agency
Tripura Renewable Energy Development Agency (TREDA) is the State Nodal Agency (SNA) for implementing new and renewable energy (RE) projects in the State. TREDA was established in the year 1998 and the activities of TREDA were extended throughout the State. TREDA is dedicated to promoting new and renewable resources of energy.
A total of 500 solar lanterns were distributed free – one each to a girl child of below poverty line (BPL) families studying in Class IX to Class XI.

Remote Village Electrification Programme for hamlets and villages: A total of 18,000 solar home lighting (SHL) systems (Model V) were installed and commissioned at interior parts of the State in 341 hamlets and 29 villages covering the beneficiaries of 488 hamlets and 30 villages where grid power is not available and is not likely to reach in the near future. In addition, 180 solar street lights have been installed at prime locations where substantial public gathering takes place.

A total of 205 remote unelectrified hamlets were covered by providing SHL systems (Model – II) to 6,905 families of 191 hamlets covering all the beneficiaries of 205 hamlets.

SHL systems (Model – II) covering 5,378 families have been installed so far under this scheme. This is an ongoing scheme.

Solar Photovoltaic Programme: Under the solar photovoltaic (PV) programme, 15,000 solar lanterns were distributed to non-grid areas at a subsidised cost. Apart from these, as per the Ministry of New and Renewable Energy (MNRE) guidelines, a total of 500 solar lanterns were distributed free – one each to a girl child of below poverty line (BPL) families studying in Class IX to Class XI. Another 10,000 solar lanterns have been distributed recently out of 20,000 sanctioned by MNRE under the project ‘Supply, installation and commissioning of 20,000 solar lanterns throughout Tripura. This is an ongoing scheme.

Biogas Programme: Under the biogas programme a total of 322 biogas plants of 1 cu m and 2 cu m capacity have been installed and commissioned in the State for beneficiaries having a good number of cattle with them. These plants provide them gas mainly for cooking.

State RE Education Park: A State Energy Education Park has been installed and commissioned as per sanction and guidelines of MNRE in the premises of Tripura University.

Wind-Solar Hybrid System: A 2 kWp capacity wind-solar hybrid power plant (1 kWp solar + 1 kWp wind) was commissioned at the roof top of Vigyan Bhawan, Agartala in June 2008. The system provides power to the offices of TRED.

Solar Water Heating Systems: 10,000 litre per day (LPD) solar water heating systems (SWHS) have been installed in Tripura already. TRED has undertaken a programme to install SWHS of different capacities at government hospitals, primary health centres (PHCs), circuit houses, government tourist lodges and school hostels for ST/SCs and minorities etc. The aim is to meet the hot water requirement of these premises for bathing as well as cooking to reduce the consumption of conventional power. The total capacity sanctioned recently for the state is 54,500 LPD, out of which 20,000 LPD has been completed and the rest is in progress.

Awareness Programmes: Every year Rajiv Gandhi Akshay Urja Diwas is celebrated in the State in all 4 districts on 20 August and the celebrations continue for a month. The programmes include rallies by students, sit and draw competition for children, drama on the use and popularisation of non-conventional energy, debate and quiz competitions and a seminar where an expert on non-conventional energy is invited.
The main RE devices installed in the State Renewable Energy Education Park

Table 1. The main RE devices installed in the State Renewable Energy Education Park

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 kW solar power plant</td>
<td>10 kW solar power plant</td>
</tr>
<tr>
<td>10 kW gasifier power plant</td>
<td>10 kW gasifier power plant</td>
</tr>
<tr>
<td>Working exhibits of wind power</td>
<td>Working exhibits of wind power</td>
</tr>
<tr>
<td>Micro hydel</td>
<td>Micro hydel</td>
</tr>
<tr>
<td>Models of tidal, geothermal energy</td>
<td>Models of tidal, geothermal energy</td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>Fuel Cell</td>
</tr>
<tr>
<td>Solar street lights</td>
<td>Solar street lights</td>
</tr>
<tr>
<td>Solar cookers</td>
<td>Solar cookers</td>
</tr>
<tr>
<td>Solar road traffic flashers</td>
<td>Solar road traffic flashers</td>
</tr>
<tr>
<td>Solar powered cars for children</td>
<td>Solar powered cars for children</td>
</tr>
<tr>
<td>Battery operated solar bicycles</td>
<td>Battery operated solar bicycles</td>
</tr>
<tr>
<td>Battery operated 3-wheelers</td>
<td>Battery operated 3-wheelers</td>
</tr>
<tr>
<td>Solar boats etc.</td>
<td>Solar boats etc.</td>
</tr>
</tbody>
</table>

The author is Director, Tripura Renewable Energy Development Agency (TREDA), Agartala, Tripura, tredaagartala@gmail.com

In the Park, all renewable electricity devices that are available in the country today are installed and demonstrated for students and the common people (Table 1). The exhibits of the park show how our daily electricity needs can be met through RE sources. Truly, this park is playing a vital role in dissemination of information in the field of new and renewable sources of energy to the public at large.

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Promotion and development of hydro energy solutions as well as implementation of community oriented and sustainable micro hydro projects have been the focus in the State.

L B Chhetri
Sikkim is a small hilly state, bounded by vast stretches of the Tibetan Autonomous Region in the north, the Kingdom of Bhutan in the east, Nepal in the west and the state of West Bengal in the south. The State has a total area of 7,096 sq km and stretches over 112 km from north to south and 64 km from east to west.

**The State Nodal Agency**
The Sikkim Renewable Energy Development Agency (SREDA) was constituted and registered as a non-profit society in the year 1999. It is the designated State Nodal Agency (SNA) of the Ministry of New and Renewable Energy (MNRE) and owns the mandate for implementation of all renewable energy (RE) programmes in the State. SREDA is actively involved in various programmes of the government like National Biogas and Manure Management Programme (NBMMP), solar-wind hybrid systems, solar water heating and photovoltaic (PV) systems, education parks, and micro hydel projects.

**Development of Renewable Energy in the State**

**Micro Hydro Projects - The Community Centred Approach:** Amongst many developments in the field of RE, SREDA has been successful in implementing community oriented and sustainable micro hydro projects. Promotion of development of hydro energy solutions in the State has been the focus of the Agency lately. A very notable aspect of this development is the focus on community development through the use of hydro energy. This implies that a project is wholly owned, maintained and managed by the local community. A Village Electricity Committee (VEC) is formed in the potential village and after design, implementation and commissioning of the hydro plant; the ownership is transferred to the VEC. SREDA remains in the background, and provides technical support when required. The VEC fixes, collects and manages the revenue generated from the consumption in the village and the excess funds collected are utilised in local area development, e.g. footpath construction, irrigation channel repair, school repair, etc. Upon the arrival of the state grid, the power project is augmented to provide arrangement for synchronising with the grid to feed-in the excess energy generated by the plant. In essence, the plant would operate at maximum plant load factor.

**Achievements:** The Government of Sikkim has tied up with the Climate Change Division (CCD), Swiss Embassy and SREDA has been the cynosure of this collaboration.

The CCD has decided to support development of micro hydro projects in the State through SREDA and a Micro Hydro Project Development Unit has been established within SREDA. The objectives of this collaboration are:

- Micro hydro power potential mapping of streams in Sikkim;
- 2x200 kW Upper Hee Khola (UHK) micro hydro demo project; and,
- Micro-mini hydro project policy development.

An inception workshop for mini/micro hydro power development in the State was held in November 2010 in Gangtok preceding which SREDA was awarded the mandate by the State Government to develop power plants up to 500 kW. The workshop was successful in identifying the challenges involved, and measures to counter them were also formulated.

With the help of the Swiss technical guidance, a 400 kW Upper Hee Khola mini hydro project is being planned in

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**Geographical Information System (GIS) based mapping of all the potential streams of the State has been proposed and initiated by SREDA.**

- Solar water heating system (SWHS) at Namchi Zilla Bhawan, South District, Sikkim
West Sikkim. This plant is to showcase the new technologies in design and construction of small hydro plants in the State, and shall also demonstrate an ideal community owned and driven model in the region. Besides this model plant, a 80 kW Brum Kholo Micro Hydro Plant is being designed and developed by SREDA. This plant shall provide energy to an isolated hamlet where no electrical grid is present. The community centred model shall be followed here as well.

GIS Mapping of Potential Streams for Micro Hydro Development: Geographical Information System (GIS) based mapping of all the potential streams of the State has been proposed and initiated by SREDA. It was felt that if data attributes of potential sites and streams could be collected in a GIS database, the information would be useful for planning of future projects and would also help in coordination with other departments of the State like water supply, irrigation, etc. since they share the same water resource. The common attributes for mapping would include stream discharge, stream slope, grid outreach, energy demand, population density, water availability, rainfall data, road connectivity, etc.

Micro Hydro Policy: The lack of policy on micro hydro projects in the State has been a deterrent to effective planning and implementation of projects. The need for a policy confined to micro/mini hydro development was felt and SREDA has taken the initial step toward preparation of such a draft policy. In this regard, the CCD, Embassy of Switzerland has come forth and is helping SREDA in drafting the policy. The best practices of Switzerland and other parts of the Indian subcontinent are being analysed and would be taken into account in the draft.

Success Story
The 10 kW Karek micro hydro project in South Sikkim portrays the success of SPEDA in a definitive way. Installed with a hydraulic head of 9 m and a discharge of 0.20 cumec, the plant runs a single unit pump as turbine (PaT) to generate 10 kW firm power at 3-phase, 415 V, 50 hz supply. The plant caters to the basic lighting needs of 92 households including a Hindu shrine and a primary school. The once dark and kerosene dependent village, is now gleaming with a luminous self-owned electrical lighting systems. The plant is maintained, run and managed by the VEC and has become an example hub for capacity building and self-sustainability.

Following the successful commissioning of Karek micro hydro project, the 7 kW Banjhakri micro hydro project was installed in an energy park and caters to the energy requirements of the park in a stand alone mode of operation. A 20 kW Ghor micro hydro project in North Sikkim and a 25 kW Biri Kholo micro hydro project in West Sikkim are under commissioning stage.

Way Forward
With the growing international awareness on climate change and its mitigation efforts, RE has a very big role to play in developing countries like ours. SREDA, being the SNA for RE, has been striving to keep itself updated and has been putting together all efforts to etch a name in the RE sector in the country. The Swiss expertise, at this juncture, could provide the required thrust to these positive developments in the State.

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India is steadily venturing into renewable energy resources like wind and solar. With such unpredictable energy sources feeding the grid, it is necessary to have a grid that is highly adaptive (in terms of supply and demand). A good electric supply is one of the key infrastructure requirements to support overall development, hence, the opportunities for building smart grids in India are immense.

Navneet Gupta and Apurav Jain
To understand a smart grid’s benefits and applications it is important to first understand the working of the system that is presently being used. In the current system, the end user measurements are mostly with billing in mind, and not control. The other measurements in the grid are few and limited. The sources of power are also restricted to conventional power plants like coal fired or hydro power plants. The tariff rates are flat and are not related to demand or supply.

Smart Grid is a nebulous term spanning various functionalities geared towards modernising the electricity grid. At its core, a smart grid utilises digital communications and control systems to monitor and control power flows, with the aim to make the power grid more resilient, efficient and cost effective. The basic objectives of smart grids are to enable informed participation by customers; accommodate all generation (solar, wind etc.) and storage options; enable new products, services, and markets; provide the power quality needed for the range of needs in a 21st century economy; optimise asset utilisation and operation efficiently; address disturbances through automated prevention, containment and restoration; and operate resiliently against all hazards. The various components and the interlinkages between them for implementation of a smart grid are shown in Fig 1.

Role of Renewable Energy
The above situation makes it imperative to harness the renewable energy resources wherever and whenever possible. Renewable energy (RE) is no longer ‘alternate energy’, but will increasingly become a key part of the solution to the nation’s energy needs. In fact, a beginning has already been made and it is an important component of India’s energy planning process now. It has the potential to resolve the decentralised energy needs of the remotest corner of the country.

Need for smart grids in India
According to the Ministry of Power, India’s transmission and distribution losses are amongst the highest in the world, averaging 26 per cent of total electricity production, and as high as 62 per cent in some states. These losses do not include non-technical losses like theft etc.; if such losses are included, the average losses are as high as 50 per cent.

India loses money for every unit of electricity sold, since India has one of the weakest electric grids in the world. Some of the technical flaws in the Indian power grid are - it is a poorly planned distribution network, there is overloading of the system components, there is lack of reactive power support and regulation services, there is low metering.

Fig 1. A smart grid - components and interlinkages
efficiency and bill collection, etc.

India is venturing very fast into renewable energy (RE) resources like wind and solar. Solar has great potential in India with its average of 300 solar days per year. The government is also giving incentives for solar power generation in the form of subsidies for various solar applications; and has set a goal that solar should contribute 7 per cent of India’s total power production by 2022. With such high targets, solar is going to play a key role in shaping the future of India’s power sector.

A lacuna of renewable resources is that their supply can be intermittent i.e. the supply can only be harnessed during a particular part of the day, like day time for solar energy and windy conditions for harnessing wind energy, also these conditions cannot be controlled. With such unpredictable energy sources feeding the grid, it is necessary to have a grid that is highly adaptive (in terms of supply and demand). Hence, the opportunities for building smart grids in India are immense, as a good electric supply is one of the key infrastructure requirements to support overall development.

**Smart grid technologies**

**Smart metering/demand side management:** Smart meters are microprocessor based devices that provide a two way communication capability. They help homeowners and the suppliers to manage the respective electricity usage and supply in a more efficient and cost effective manner. With the help of the information provided by such smart meters the power companies will have the capability to set up real time pricing systems for electricity.

**Virtual power plants:** The goal of virtual power plants (VPPs) (Fig 2) is to allow discrete energy resources (DERs) to access the energy market i.e. to feed the electricity grid constantly and reliably.

**Micro grids:** A micro grid (Fig 3) is a cluster of local DERs and loads in such a way that an operation is possible within the grid or in independent mode. Usually it is connected at the low voltage level but sometimes also at the medium voltage level.

All these technologies can be used in India in different forms depending on the applications. Different algorithms can be used for the control of smart grids, VPPs etc.

**Challenges and solutions**

**Policy and regulation:** No defined standards and guidelines exist for the regulation of smart grid initiatives in India. The current policy and regulatory frameworks were typically designed to deal with the existing networks and utilities. With the move towards smart grids, the prevailing policy and regulatory frameworks must evolve in order to encourage incentives for investment. The new framework will need to match the interests of the consumers with the interests of the utilities and suppliers to ensure that the societal goals are achieved at the lowest cost to the consumers.

**Cost:** If smart grids had made easy business sense, they would have been the norm everywhere. Cost is clearly one
Any smart grid plan must be adaptable to the unique needs, cultural and political realities, and resource constraints.

of the biggest hurdles in implementing smart grids. Some older equipment that cannot be retrofitted to be compatible with smart grid technologies will have to be replaced. This may present a problem for utilities and regulators since keeping equipment beyond its depreciated life minimises the capital cost to consumers. The early retirement of equipment may be an issue. Cost of implementing smart grids runs in crores of rupees. The benefits from smart grids are not just meter readings but include reduction in equipment failure, better quality of supply and greater use of green energy. It takes careful societal cost-benefit analysis, beyond return of investment calculations, to justify the use of a smart grid.

Lack of awareness
The level of understanding of consumers about how power is delivered to their homes is often low. So, before going forward and implementing smart grid concepts, the consumers should be made aware of what a smart grid is, how it can contribute to a low carbon economy and what benefits they as users can drive from smart grids. Therefore, consumers must also be made aware of their energy consumption pattern at home, offices, etc.; policy makers and regulators must be very clear about the future prospects of smart grids; and the utilities need to focus on the overall capabilities of smart grids rather than mere implementation of smart meters.

Cyber security and data privacy
With the transition from analogous to digital electricity infrastructure comes the challenge of communication security and data management. Since digital networks are more prone to malicious attacks from software hackers, security becomes a key issue. In addition to this, concerns on invasion of privacy and security of personal consumption data arise. The data collected from the consumption information could provide a significant insight into a consumer’s behaviour and preferences. This valuable information could be abused, if correct protocols and security measures are not adhered to. These issues should be addressed in a transparent manner, to minimise any negative impact on a customer’s perception. The systems should be designed with security as a priority and should be well protected against software hacking and other such malicious activities.

The way forward
It is very difficult to analyse the performance and benefits of smart grids without actually implementing them. Techno-commercial pilot projects can offer interesting potential demonstrations of various benefits of smart grids. Overall, the major elements of any such projects should include, developing a smart grid vision, conducting appropriate awareness to educate and develop a consensus, identifying viable funding options and implementing appropriate policy and regulatory actions to set common standards and encourage innovation.

In tandem with these actions, certain pilot projects could be implemented to demonstrate their commercial viability. Small and medium sized projects should be tried at both, the rural and urban level to decide upon an optimal solution, which can be implemented, on a larger scale.

It should be emphasised that any plan must be adaptable to the unique needs, cultural and political realities, and resource constraints of different regions, states and localities. Perhaps the gravest error at this early stage of smart grid development would be to adopt a rigid, top-down and ‘one size fits all’ approach to achieve a smart grid vision. In conclusion, if implemented appropriately, smart grids can provide a very green and optimal solution to India’s energy needs.

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Rice husk has started getting entry into the restaurants and roadside eateries of Assam as an alternate cooking fuel primarily due to its cost competitiveness vis-à-vis conventional fuel.

D C Baruah

Rice husk stored in a roadside eatery’s premises.

Husk fired chullah.

Roadside food stalls are refreshing locations for travellers and these are increasingly being taken up as small scale entrepreneurial activities in Assam. Today, restaurants/dhabas are located alongside the national highways, major roads and in commercial places. With the increase in number of automobiles, particularly small cars, in recent times the roadside commercial activities have also picked up. The increased burden on petroleum, increased vehicle population and surge of development along the highways have become serious concerns.

Thermal energy demands for preparation of food in the restaurants and roadside eateries are escalating due to increase in their number and activities. Wood, coal and kerosene have been the conventional fuels to fulfil such thermal energy requirements. However, wood is collected from local forests and its supply is diminishing, mainly due to deforestation without consideration for re-plantation. Moreover, wood has other competitive uses and thus it is becoming unviable economically as a fuel. Similarly, coal and kerosene are becoming costlier. The accelerated
costs of the conventional fuels makes it necessary to look at alternatives for restaurants; as a major portion of their expenditure is attributed to cooking fuel.

**Rice husk as a saviour**

Rice husk has started getting entry into the restaurants and roadside eateries of Assam as an alternate cooking fuel primarily due to its cost competitiveness vis-à-vis conventional fuel. Rice is grown extensively in Assam and the husk could be considered as one of the potential and economically viable agro-residues for the renewable energy (RE) programme (Picture 1). The recent statistics of rice husk available in Assam is provided in Table 1. Annually more than 600 million kg of rice husk is produced by rice farmers of Assam and it is almost evenly distributed throughout the state.

Prospects of agro-residues for fulfilling energy demand are being consistently highlighted and practiced in several places in India and around the world. Use of sugarcane bagasse for cogeneration of heat and power has been the most successful example in our country. Similarly, use of rice husk through gasification and combustion is picking up momentum in some of the rice dominating regions. Thus, appropriate use of rice husk in large energy consuming sectors like restaurants and roadside eateries could be an effective option for the RE programme in Assam. Envisaged benefits through extensive use of this green fuel include reduction of undue pressure on forest cover and financial incentives for rice growers.

### Table 1. Annually available rice husk estimated for ten districts of Assam

<table>
<thead>
<tr>
<th>District</th>
<th>Available rice husk (million kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darrang</td>
<td>80</td>
</tr>
<tr>
<td>Goalpara</td>
<td>123</td>
</tr>
<tr>
<td>Kamrup</td>
<td>85</td>
</tr>
<tr>
<td>Lakhimpur</td>
<td>51</td>
</tr>
<tr>
<td>Dibrugarh</td>
<td>35</td>
</tr>
<tr>
<td>Nagaon</td>
<td>68</td>
</tr>
<tr>
<td>Sivasagar</td>
<td>67</td>
</tr>
<tr>
<td>Cachar</td>
<td>58</td>
</tr>
<tr>
<td>North Cachar</td>
<td>4</td>
</tr>
<tr>
<td>Karbi-Anglong</td>
<td>32</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>603</strong></td>
</tr>
</tbody>
</table>

**Interventions to reduce unit energy cost**

Until recently rice husk was not a commercial commodity in Assam. It was either burnt or dumped near the rice mill. Due to the initiation of its use in restaurants and roadside eateries dhabas and with prospects of extensive use in the future, the cost of rice husk is expected to increase (one prominent local food industry in Sonitpur District of Assam has already installed a 1 MW (thermal) rice husk based gasification unit for biscuit making).

Presently restaurants/dhabas collect rice husk through a supplier from the local rice mills. It is expected that soon rice husk will get an entry into the normal commercial chain like any other item. Further, it is observed that unlike other renewable technologies (like biogas, solar photovoltaic (SPV) etc.), the use of rice husk to replace conventional fuel is taking place on a wide scale, naturally i.e. without intervention of external agencies. However, to sustain it further, steps will have to be taken to address the following issues:

**Technology refinement:** Presently fireplaces/chullahs of the rice husk fuelled restaurants/dhabas in Assam are designed and constructed by the local artisans (Picture 2). The husk is allowed to pass into the fireplace by gravity, whereas the burnt ash is collected manually from the bottom grate. The air (into the combustion area) and flue gas are circulated by natural circulation using a chimney made of brick and clay. Improvement of chullahs to reduce heat loss and increase thermal efficiency would ensure a reduction in unit energy cost.

**Utilisation of ash:** Husk fired chullahs generate substantive quantities of ash. In some cases, it is re-circulated into the fields to replenish the soil with the useful minerals left after combustion. The appropriate utilisation of this component, including silica recovery, would also result in reduction of unit energy cost.

Appropriate research and development activities to cover the discussed and other aspects would assist in the optimum growth of this silent revolution of rice husk utilisation in Assam.

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At an altitude of more than 3500 m above sea level, Ladakh district of Jammu and Kashmir state is a cold desert characterised by cold breeze and a blazing sun. Ladakh receives a very low rainfall as it falls in the rain shadow area. In winters, the temperature can be as low as -25°C. The climate makes it very difficult to grow fresh vegetables and other crops in the open for nearly 9 months in a year as the plants freeze to death because of freezing. Airlifting the vegetables from the plains in winter and bringing them by road in summer is a normal practice, making the fresh vegetables expensive and limiting their availability. Most of the locals rarely get to eat fresh vegetables; as a result, many suffer from malnutrition.

Ladakh experiences clear sunny days for almost 300 days in a year. Exploiting this sunny climate of Ladakh, the Groupe Energies Renouvelables, Environment et Solidarites (GERES) started developing improved passive solar greenhouses to grow fresh vegetables and other crops indoors even during the winter. For the last ten years, GERES is working in this area in collaboration with the Ladakh Environmental Health Organisation (LEHO), Ladakh Ecological Development Group (LEDEG), Leh Nutrition Project and Skarchen and Spiti Transhimalayan Group/Ecosphere (STAG).

GERES developed an improved greenhouse (IGH), to maximise the capture of solar energy during the day, minimise the heat loss at night and thus prevent plants from dying due to freezing. The greenhouses are designed in such a way that they are sufficiently heated using only solar energy and do not require any supplementary heating. Some of the salient features of the improved green houses are:

- The greenhouse is oriented along an east-west axis with a long south facing side.
- This long south side has a transparent cover made of heavy duty polythene with an extra stabilizer to withstand the intense UV rays present in the sunlight. The polythene is built to last for a period of more than five years.
- The north, east and west side walls of the greenhouse are constructed using mud bricks in low and medium snow fall areas and with stone or rock in heavy snow fall areas to enable the green house to absorb maximum heat from the sun during the day and release the stored heat at night.
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to maintain a temperature suitable for healthy growth of plants inside the greenhouse.

- The walls on the north, east and west sides are constructed as cavity walls to help in minimising heat loss from the greenhouse. The 100 mm cavity in these walls is filled with insulating material such as sawdust or straw. The roof is slanted at an angle of 35° to allow maximum direct sunlight during the winter season. At night, the roof is covered with thatch and the polythene and the south side is covered with a cloth or tarpaulin to prevent heat loss.

Except the polythene used for covering the south side of the greenhouse: the entire greenhouse is constructed using locally available material. The main frame of the roof is made using local poplar wood, willow for struts and straw or water resistant local grass for the thatch. Rock, stone, mud bricks or rammed earth are used in walls construction. The polythene sheet has to be procured from places like Mumbai. Local masons are employed to construct the greenhouse by providing special training wherever required.

The greenhouse comes in two sizes: a smaller greenhouse with 4.5 m breadth and 9.7 m length for domestic use and a bigger greenhouse with 4.8 m breadth and 27.3 m length for commercial use. The construction cost of a domestic use IGH is approximately Rs 30,000. The owner of the domestic IGH has to either pay for or collect all the locally available material. The owner also has to provide the labour or pay for the labour required for construction. The NGO pays and provides the doors, vents and the special UV stabilised polythene, which comes to about 25 per cent of the total cost. Some subsidy is given for domestic IGH. Construction of the greenhouses is timed in such a way that they match the agricultural cycle of Ladakh.

GERES monitors the IGH construction by providing methodology and design. LEHO and other local non governmental organisations (NGOs) coordinate in selecting the prospective owners, training them on greenhouse maintenance and operation and providing other support needed for constructing the greenhouse to local owners. A wide variety of vegetables including spinach, coriander, garlic, radish, onions, lettuce, and strawberries are grown in winter. Tomatoes, cucumbers and grapes are grown in autumn and in spring seedlings are grown in the greenhouses.

IGHs have benefited the people of Ladakh, especially in terms of health. Prior to introduction of IGH, during winter people used to consume fresh vegetables only once or twice in month, but after the IGHs were introduced, the consumption of vegetables has increased to two to three times in a week. On an average, one IGH owner provides fresh vegetables to nine other families and barters with six other families, resulting in health improvement of the people. Villagers are able to save on an average Rs 500 to 1,000 on vegetable purchases as locally grown fresh vegetables cost less as compared to imported vegetables.

Production of fresh vegetables locally also reduces the dependency on imports from the plains, thus saving on expenditure on transportation. According to an estimate of GERES, the 560 greenhouses presently in operation are able to save about 460 tons of carbon emissions per year. IGH has also brought employment opportunities to locals. Around 220 masons and 15 carpenters have received training and support a livelihood through constructing greenhouses. IGHs have increased the income for their owners, as they can earn additional income by selling vegetables and seedlings for cash. Surveys conducted have revealed that on an average an IGH owner earns Rs 8,250 per year by selling their excess produce, which is about a 30 per cent increase in their income level.

The scale up potential for IGHs in high altitude regions of Himalayan states is very high. In Ladakh alone the potential demand for IGH to produce fresh vegetables for civilian consumption is about 3,000 units, it may double up to 6,000 units if military requirements for fresh vegetables is included. At present technological replacement of UV resistance polythene sheets every 5 years and lack of awareness among the agricultural/ horticulture departments at the state level is proving to be a barrier in the promotion of IGHs. The solar passive concepts of south facing glazing, high thermal mass and insulation can also be used in other constructions like individual houses, public buildings, schools, hospitals and government offices etc.
A solar air heater is a simple device to heat air by utilising solar energy having applications in drying agricultural products such as seeds and fruits and also in space heating. The present investigation is taken up with the objective of experimentation on a wire screen matrix to collect data on heat transfer and fluid flow characteristics. The data is presented in the form of Nusselt number plot to bring out clearly the effect of parameters and enhancement in heat transfer.

The experimental setup used in the investigation is shown in the schematic diagram as per Sukhatme (1987) and ASHRAE (1977). Both the ducts had an identical length of 1.60 m, width of 0.62 m, and depth of 0.025 m and were made of softwood; both were inclined at an angle of 25 degree to the horizontal. The smooth (or conventional) duct had an absorber plate of 2 mm GI sheet. The reason for using two ducts in the present set-up was to compare the performance at the same operating conditions such as mass flow rate, insolation and inlet fluid temperature. The packed bed duct had a 2 mm GI sheet having several layers of wire mesh screens arranged one above the other on the upper side of the GI sheet while below it there was 50 mm of thermocol and 2 mm plywood.

The experimental data has been collected by following the procedure described in ASHRAE Standard Handbook (1977) for testing the solar air collector operating in open loop mode. Data pertaining to a given mass flow rate was collected between 11 a.m. and 2 p.m. at an interval of 1 on a clear sky day. Before starting the experiment, all the joints of duct, inlet section, mixing device and pipe fittings were examined for leakage and it was sealed by using glass putty. While recording the temperature, the ice-bath and lead wire for micro-voltmeter were protected from direct solar radiation. The blower was run for an hour and thereafter, the thermocouple readings for wire mesh temperatures at various locations and inlet and outlet air temperatures, pyranometer readings for intensity of solar radiation and manometer readings for pressure drop across the duct were recorded for a particular day. Experimental data were collected for flow rates ranging from 0.0261 to 0.031 kg/s for four set of matrices. First of all a low porosity wire mesh of square shape with 6-layers is used. Afterwards same wire mesh with 5–layers, 4 & 3 was used and again the above mentioned data collected. The parameters measured were: pressure difference across orifice meter, temperature of the absorber plate, inlet and outlet temperature of air in the duct, ambient temperature and intensity of solar radiation.

Before collecting the data from the experimental set-up, the system was tested for validity by experimentation on a smooth plate to determine the Nusselt number and friction factor. These values of the Nusselt number and the friction factor were compared with those obtained from the Dittus and Boelter correlation and Blasius equation. The Nusselt number had absolute maximum deviation of 8 per cent while the maximum deviation of the friction factor is 4 per cent from the predicated values by Blasius equation.

It is seen that heat transfer increases as Reynolds number increases. Also, as porosities reduces in the duct, heat transfer increases. The decrease in porosity increases turbulence and thereby increases volumetric heat transfer coefficient and Nusselt number.

On the basis of this investigation on heat transfer characteristics in packed bed solar air duct it is concluded that Packed bed solar air heater having with lower porosity performs better than higher porosity due to greater turbulence. At Reynolds number of 1600, heat transfer enhancement is 70 per cent, 50 per cent and 25 per cent corresponding to porosity of 0.9614, 0.9678 and 0.9743 respectively as compared to porosity of 0.9807.

Make your own Mini Solar Balloon

The LOGIC:
A solar hot air balloon takes advantage of the fact that solar radiation provides about 1000 W energy per sq m. A balloon made of black plastic film and inflated with dry air absorbs enough solar energy to raise the temperature of the air inside the balloon; this reduces the air density significantly. The hot air bubble is lighter than the ambient air - thus the balloon rises. The mass of 1 cu m of ambient air at 15°C is 1,225 kg while the mass of 1 cu m of air at 35°C is 1,145 kg - the climbing aerostatics force or lift is therefore 80 g per cu m.

The MATERIALS:
1. One packet of black garbage bags (12 pieces) - available at all provision stores
2. One measuring tape
3. Scissors
4. Serrated knife with rounded tip
5. A roll of wide (19 mm) transparent tape
6. Sewing thread
7. A white fluid marker pen
8. A small plastic cup

The OUTCOME:
In about three hours you would have a flying machine that needs no propellant other than the sun's heat to make it soar. A balloon 1.9 m in diameter, that you can now put together, can support a small cup below it, with one or two of your 'light' favourite items, across the city.

The METHOD:
Clear out the floor in your room. Unfold the 12 garbage bags and stack them with the sealed side at your end. Cut the sealed side as close to the bonding as possible to have a tubular piece before you. Now, pick each bag and with the knife slit the side. The resultant piece of black plastic will be rectangular in size - around 167 cm x 100 cm.

The balloon has to be built in two parts. While making the lower part you will need to stack 6 sheets first and then fold them in the middle to get a long rectangular 167 cm x 50 cm stack. On the side that does not contain the fold - the open side, mark a diagonal line 20 cm away from the side with the white pen and cut across it with the scissors. Now you have 6 polygonal pieces that you need to tape up to give to a circular shape. Tape up the cut away sides. You will find a shape emerging which should look like a flower pot with a wide open top and a smaller opening at the bottom.

The upper part will follow a similar process, except how you need to draw not diagonal but curved line like a c written backwards. Once the sheets are cut, assembling the pieces will be a little painstaking as a dome shape has to emerge. Once complete the done will have no gap at the top while the bottom should fit the open top of the lower half.

Once the two parts are complete tape them together. Now take the roll of sewing thread, cut it into six long lengths and tape it along the 6 sides of the balloon, taking care to hang about 10 cm of it loose below the opening of the lower part of the solar balloon.

Check for leaks or gaps in the entire balloon. Tape up all gaps. Once done, turn the balloon inside out, one to make it look neater and also to avoid direct heat on the tape. Attach the cup below. Lo and behold! Your solar balloon is ready. It should weigh about 200 gms after it is finished. Go to your terrace or playground, puff up the balloon with your arms and hold it, preferably in the first half of the day. In about 5 to 10 minutes the balloon will be ready take off. Have fun.
व नवीकरणीय ऊर्जा (RENEWABLE ENERGY)

श्रीभू, रतन अवस्थि

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एन.एच.एसी., आई.आई.टी., रुडक्की की भूमिका पर प्रकाश डाला गया है।
दोस्त वायुमंडल से गैसीफायर के माध्यम से बिद्युत उपयोग अभावी
तथा पूर्व-अपशिष्ट से बायोग्लेस प्राप्त हेतु संयंत्रों को जानकारी दी
गई है। इसी पर वर्तमान शहरी एवं ओडियोग्लिक अपशिष्ट अभियान होते जा
रहे हैं। पुस्तक में समझाया गया है कि किस प्रकार समृद्धि प्राप्त
होगा अपशिष्ट का अभियान द्वारा अर्थव्यवस्था के संसाधनों के बवाल का
होगा।

भूतात्विक ऊर्जा एवं समुद्री ऊर्जा से बिद्युत उपयोग की विकासों,
उपकरणों द्वारा प्रकाश डाला गया है। भारत में इन योगें के दोहर
हेतु प्रयासों एवं अबानी कार्यक्रमों की जानकारी दी गई है।

भविष्य में ऊर्जा के प्रमुख ऊर्जा हाइड्रोजन के उपयोग, परिधान
एवं भविष्य सहित अंतरराष्ट्रीय स्तर पर समृद्धि प्राप्तों की जानकारी
दी गई है। भारतीय राष्ट्रीय हाइड्रोजन ऊर्जा बोर्ड एवं हाइड्रोजन बोर्ड
में कार्यक्रम में कार्य किया गया है।

लेखक गां 32 वर्ष से नवीकरणीय ऊर्जा के बिन्दुस्थ बांधे में कार्यरत
है। व.एच.एस.एल. से वर्ष 2010 में महाशक्ति के वर्तमान के फॉरमेन
के रूप में कार्य किया गया था तथा इस भारत सरकार के विभाग
एवं ओडियोग्लिक विभाग द्वारा आ. एन.आई. दरअसल परिषद
में कार्यरत किया गया।

इसी पूर्व लेखक की हाइड्रोजन के विकासकार वहाँ नामक
पुस्तक का लोकार्पण ताजावानी वापसी के उपयोग
श्री कुमार १ेंज के कर्मचार के रूप में किया गया था, तथा 
इस भारत सरकार के विभाग
एवं ओडियोग्लिक विभाग द्वारा आ. एन.आई. दरअसल परिषद
में कार्यरत किया गया।

प्रतिभा प्रकाशन, नई दिल्ली से प्रकाशित इस पुस्तक का मूल्य
250 रु. है। नवीकरणीय ऊर्जा संस्थाओं की जानकारी एवं अगस्त
समवेत उपयोग के लिए अद्वितीय अद्वितीय अद्वितीय अद्वितीय
द्वारा प्रकाशित इस पुस्तक का मूल्य
250 रु. है। नवीकरणीय ऊर्जा संस्थाओं की जानकारी एवं अद्वितीय
के लिए अद्वितीय अद्वितीय अद्वितीय अद्वितीय
द्वारा प्रकाशित इस पुस्तक का मूल्य
SHL systems have been installed and commissioned by Tripura Renewable Energy Development Agency at hamlets/villages where grid power is not available and is not likely to reach in the near future.
State Nodal Agencies

State Nodal Agencies (SNAs) are the designated agencies to coordinate, regulate and enforce the provisions of the Energy Conservation Act 2001, in each state. All the 8 SNAs in the North East Region (NER) do not have websites; however the links to the 6 websites that are available are listed here. These sites are a good source of information about all aspects related to renewable energy in each state.

Arunachal Pradesh Energy Development Agency (APEDA)
www.apeda.co.in

Assam Energy Development Agency
www.assamrenewable.org

Meghalaya Non-Conventional and Rural Energy Development Agency
http://mnreda.gov.in

Nagaland Department of New and Renewable Energy
http://nrengl.nic.in

Zoram Energy Development Agency (ZEDA)
http://zeda.mizoram.gov.in

Tripura Renewable Energy Development Agency (TREDA)
http://treda.nic.in

New Energy Portal
www.new-energy-portal.com

The Vision of New Energy Portal is to support development, growth and networking in all areas of green and renewable energy. Research has shown that with existing technologies and resources it is possible today to create 100 per cent green energy for the demand of the entire planet permanently. Current renewable energy technologies, smart grids and individual solutions can cover the energy demand of single homes and households.
Renewable Energy at a Glance
Cumulative deployment of various renewable energy systems/devices in India

<table>
<thead>
<tr>
<th>Renewable energy programme/systems</th>
<th>Cumulative achievements (as on 30 June 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Power from renewables</strong></td>
<td></td>
</tr>
<tr>
<td>A. Grid interactive power</td>
<td></td>
</tr>
<tr>
<td>Wind power</td>
<td>14550.68</td>
</tr>
<tr>
<td>Small hydro power</td>
<td>3105.63</td>
</tr>
<tr>
<td>Biomass power</td>
<td>1045.10</td>
</tr>
<tr>
<td>Bagasse cogeneration</td>
<td>1742.53</td>
</tr>
<tr>
<td>Waste to power (urban and industrial)</td>
<td>72.46</td>
</tr>
<tr>
<td>Solar power (SPV)</td>
<td>39.66</td>
</tr>
<tr>
<td><strong>Sub total (A)</strong></td>
<td>20556.06</td>
</tr>
<tr>
<td><strong>B. Off grid/ captive power</strong></td>
<td></td>
</tr>
<tr>
<td>Waste to energy (urban and industrial)</td>
<td>73.62</td>
</tr>
<tr>
<td>Biomass (non-bagasse) cogeneration</td>
<td>316.76</td>
</tr>
<tr>
<td>Biomass gasifier (rural and industrial)</td>
<td>133.63</td>
</tr>
<tr>
<td>Aero-generators/ hybrid systems</td>
<td>1.24</td>
</tr>
<tr>
<td>SPV systems (&gt;1 kW)</td>
<td>69.00</td>
</tr>
<tr>
<td>Watermills/ micro hydel</td>
<td>6.98 (1397 numbers)</td>
</tr>
<tr>
<td><strong>Sub total (B)</strong></td>
<td>601.23</td>
</tr>
<tr>
<td><strong>Total (A+B)</strong></td>
<td>21157.29</td>
</tr>
<tr>
<td><strong>II. Remote village electrification (villages/hamlets)</strong></td>
<td>8846</td>
</tr>
<tr>
<td><strong>III. Other renewable energy systems</strong></td>
<td></td>
</tr>
<tr>
<td>Family type biogas plants (in lakh)</td>
<td>44.08</td>
</tr>
<tr>
<td>Solar water heating systems-collector area (million sq m)</td>
<td>4.47</td>
</tr>
</tbody>
</table>

kW= kilowatt; MW = megawatt; Sq m = square metre
Always Inspiring


25 years back when we took off, it was a humble beginning. And the one thing that kept us going is inspiration. Inspiration from life, from each other, and from every little step we climbed. Over time, we’ve ventured into various aspects of infrastructure with a rapidly expanding global presence.

Today as we step into a new era adorning a new identity, we are more inspired than ever before to create a value-based high-performance organisation. And as we surge ahead, all inspired Lanconians have a dream of turning Lanco into “The most admired integrated enterprise.” Because we know all it takes to turn a dream into reality is a little inspiration.

LANCO
Always Inspiring
THE NORTH EAST
Energised with Renewables

The hills of the north east are coming alive with renewable energy installations. Wind-solar hybrid system is installed at Chorjeng Lunghar village, Ukhrul District, Manipur

Save Money and The Planet

For further information, visit: www.mnre.gov.in