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Grid-connected solar rooftop PV project on a single roof in Beas, Amritsar

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CORRIGENDUM
Vol. 8 | Issue 2 | October 2014
RE Tech Update (pages 42–45) had been contributed by Mr Sonal Kumar and Mr Sameer Maithel.
RE Feature, (pages 38–41), had been contributed by Er Kapil K Samar, Dr Surendra Kothari, and Er Prashant Kapurkar.

Deependra Prashad and Saswati Chetia explore the Indira Paryavaran Bhawan situated in New Delhi, which is based on the concept of Net Zero Building (NZEB). This building aims to be self-reliant in every aspect of its overall functioning as a sustainable structure.

By 2019, the new government plans to ensure that every home in India will be able to run at least one light bulb powered by solar energy. Anuradha Bhavnani finds out how social entrepreneurs and the private sector can support this goal.

Deependra Prashad
Saswati Chetia

Shrirish S Garud and Sangeeta Gohain Baruah look into the future prospects of this sector in India.
Dear Reader,

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

Editor, Akshay Urja
Dear Readers,

The growth of industrial sector has a direct relationship with the development of other significant sectors of the country. Indigenous manufacturing is a backbone for overall growth of a particular sector, besides, the intangible benefits of employment generation and economic development. Today in this competitive world, the indigenous manufacturing is facing a challenge of providing quality products at a competitive price.

Now, the renewable energy is poised to become a big industry in the entire world; more so in our country where the power deficit situation on supply side has to depend more on renewable power. The share of renewable power today stands at 13 per cent and this has to grow exponentially in order to cater to the requirement of energy. Despite of this, insofar as the last decade is concerned, the manufacturing industry is facing a great difficulty, particularly in solar sector due to constant price reduction of solar photovoltaic panels and solar water heating system globally. Many industries either have switched over to other alternative manufacturing, or closed down their manufacturing units. This is not a good sign. Also, it is not conducive to the growth of renewable energy sector.

The targets set for the Jawaharlal National Solar Mission are being revised within four years from 20,000 MWp solar power by 2020 to 100,000 MWp by 2020. This calls for massive manufacturing of solar panels and related equipment indigenously. The grid-connected solar rooftop has emerged as a priority sector and a massive target of about 40,000 MWp is being set. A largest grid-connected solar rooftop plant of 7.524 MWp capacity on a single roof has been already installed at Dera Beas in Amritsar District of Punjab and probably, this is within the five largest solar rooftop plants installed in the world. It was an amazing experience to see the quality and quantity of 30,096 solar PV modules of 250 Wp each on a single roof with 11.5 km walkway.

The concept of green buildings has been promoted by the Ministry of New and Renewable Energy (MNRE) since long. A landmark of green building at Indira Paryavaran Bhawan, a building of the Ministry of Environment and Forest (MoEF) located at Jorbagh, New Delhi, has a reason for others to follow suit. It has a 930 kWp solar rooftop plant on a single roof and is a paradigm of self-sufficiency. It is based on net-zero building concept and aims to function as a sustainable structure. This saves over 40 per cent of the energy requirement and 50 per cent of the water requirement as compared to a conventional building.

An overview of growth of renewable energy industry, a report on the largest solar rooftop plant, and the interesting material on improved cook stoves has been presented in this issue. We are very encouraged with the response of our readers and would like to meet their expectations in the forthcoming issues.

With best wishes for forthcoming New Year 2015.

ARUN K TRIPATHI
aktripathi@nic.in
Skill development centre to be set up at Charanka solar park

With Gujarat being the leading solar power producer in the country, there is also an increase in demand for skilled persons to maintain solar panels and related infrastructure at solar power parks.

To bridge this gap, the state government plans to set up a skill development centre at the Gujarat Solar Park in Charanka village of Patan district of north Gujarat. Asia’s largest solar park spreads across 5,384 acres with solar power generating capacity of 590 MW.

The skill development centre will be set up by the state-run Public Sector Unit (PSU) Gujarat Power Corporation Ltd (GPCL), which has already appointed a consultant for the project. “The skill development centre is likely to come up in the next fiscal year 2015–16,” said a senior official of the GPCL. He informed that they plan to build a secondary and higher secondary school in the region where students can study science.

The primary objective of the project is to impart skills to youth studying in classes 9, 10, 11, and 12 in the villages around the vicinity of the solar park. Under the project, the GPCL also plans to impart skills such as plumbing, agriculture, handicraft, and repair of electrical and electronic equipment. There will also be special skill development programmes for women of villages, near the solar park.

20,000 solar pumps to provide drinking water to remote parts of India

The Ministry of Drinking Water and Sanitation has set a target of installing 20,000 solar power-based pumping systems in tribal and inaccessible hamlets/habitation during this financial year to provide potable piped water to the locals.

In such areas, piped drinking water is almost inaccessible due to non-availability of electricity. As per the plan, Chhattisgarh, Jharkhand, Odisha, and Rajasthan will get 2,000 pumping systems each. Other states that have been identified for 1,500 such pumps are Bihar, Madhya Pradesh, and Uttar Pradesh while Andhra Pradesh, Maharashtra, and Telangana will get 1,000 pumps each.

The Central government has implemented similar innovative scheme in the Integrated Action Plan (IAP) districts during the last financial year in which a single phase, one horse power, solar energy-based submersible pump was installed in a high-yield borewell, which already is a hand pump. In such cases, water pumped from the system can be stored in an elevated tank and the water can reach every household through pipes. Such schemes can meet the requirement of about 250 persons—the population of a small village. Each of such a system costs ₹ 4.9 lakh, excluding the borewell and cost of water treatment.

Source: www.mea.gov.in
Solar-powered electronic toll plazas to be set up pan-India

Close on the heels of the Centre’s announcement to install advanced electronic toll collection system pan-India, the Ministry of Road Transport and Highways has said that the plazas will be solar-powered.

“The Ministry proposes to develop solar-powered toll plazas on National Highways (NHs) across the country, in order to reduce their carbon footprint,” a Ministry official said.

The Ministry has sought designs for such advanced solar plazas from architects, professionals, and qualified engineers announcing a prize of ₹10 lakh for the best entry followed by ₹7 lakh and ₹5 lakh for entries qualifying for second and third places, respectively, the official said. Considering the complexities and geographical spread, the nationwide Electronic Toll Collection (ETC) will be first-of-its kind in the whole world, the Ministry added.

The ETC system on Delhi–Mumbai stretch of the NHs is in the process of operationalization and a nationwide rollout will be carried out by the end of the year. This initiative is taken by the Ministry of Road Transport and Highways, NHAI, and Indian Highways Management Company Ltd (IHMCL) for implementation of unified ETC on Indian national highways. ETC enables road users to pay highway tolls electronically without stopping at the toll plazas.

Source: www.articles.economictimes.indiatimes.com

Solar plant inaugurated at Government College for Girls, Chandigarh

Shri Upendra Tripathy, Secretary, the Ministry of New and Renewable Energy (MNRE) inaugurated the 495kWp Rooftop Grid Interactive Solar Photovoltaic Power Plant at Government College for Girls (GCG), Sector 11, Chandigarh. While interacting with media persons, Shri Tripathy lauded the move taken by Chandigarh in installing solar rooftop plants on government buildings but desired that in future, more emphasis should be laid on its promotion by private individuals. He also said that the Union Territory (UT) administration should motivate private players to install solar power plant atop their buildings in the city.

Santosh Kumar, Director, Science and Technology, UT, said that the 495kWp Rooftop Solar Photovoltaic (SPV) Power Plant had been installed by Chandigarh Renewal Energy, Science and Technology Promotion Society. The total cost of the project is ₹501.19 lakh, which includes operation and maintenance charge for 10 years. The SPV Power Plant will first meet the load of the college building during the day time and the surplus power will be exported to the Chandigarh Electricity Department.

A bi-directional energy meter capable of measuring import and export readings has been installed in the project from where the annual import of power from the Electricity Department and solar power exported to the Electricity Department will be measured. The total electric consumption of this college will be met by this Solar Power Plant. A state-of-the-art technology inverter has been installed in the SPV power plant with the help of which, the authorities will be able to review power generation and other operational parameters online across the world.

Source: www.tribuneindia.com
SACH Project to generate electricity for tribal areas

SACH, a Mini Hydro Electric Project having the capacity of 2 x 450 kW, was constructed by Himurja under the scheme ‘Remote Village Electrification Programme’ of the Government of India, Ministry of New and Renewable Energy (MNRE) and Tribal sub-plan of State Government in Pangi valley of Chamba District of Himachal Pradesh.

The Pangi valley is a remote, rugged, and poorly developed tribal area in Himachal Pradesh. It is 498 km away from the state capital Shimla. Pangi valley is divided into the Saichu, Hudan, and Sural valleys. The SACH Project is located on the way to Killar near Cherry, 14 km before its headquarters. The project envisages utilization of Galwat Nallah water for 0.88 cusecs of discharge through 135 m head to generate 900 kW of power.

This project is a milestone for the tribal people living in the remote area of the state who were deprived of electricity since generations. The project has brought a ray of light in their dark lives. Specifically, such an unexploited potential of inherent nature could be harnessed due to the support of the MNRE. There are several economic and ecological benefits of this project such as limited investment, zero consumption of valuable raw material, no ecological disturbances, low maintenance and operation cost, no uprooting of people and trees, and reduced transmission losses.

Source: www.mnre.com

Norms for 3,000 MW solar projects released

In a revamped National Solar Mission (NSM) programme, the Union Ministry of New and Renewable Energy (MNRE) has now come out with draft guidelines for setting up 3,000 MW of solar PV projects under Tranche-I. Earlier planned allocation of 1,500 MW under Batch II of Phase II is reported to have been cancelled.

The proposed 3,000 MW Solar PV projects will be implemented by National Thermal Power Corporation (NTPC) Vidyut Vyanrp Nigam (NVVN) on solar parks to be developed through association of central and state agencies. Under Part-I of Tranche-I scheme, which seeks suggestions and comments from all stakeholders, a capacity of 1,000 MW of the grid-connected solar projects will be developed at a solar park in Andhra Pradesh. Of the 1,000 MW, a capacity 250 MW is reserved for bidding with domestic content requirement. The individual project size has been decided at 50 MW and a single group (including its subsidiaries and associates) can apply for a maximum of five projects. The power produced by these projects will be bundled with coal power and sold to utilities by the NVVN.

Source: www.cleantechnica.com
IREDA, US Exim Bank sign MoU for cooperation on clean energy

A Memorandum of Understanding (MoU) has been signed between the Indian Renewable Energy Development Agency Limited (IREDA) and the US Exim Bank with respect to cooperation on clean energy investment. The MoU was signed by Mr K S Popli, Chairman and Managing Director, IREDA; and Mr Fred P Hochberg, Chairman and President, Export-Import Bank of the United States, in the presence of Shri Upendra Tripathy, Secretary, the Ministry of New and Renewable Energy (MNRE), and other senior officials from the MNRE, IREDA, and the US Exim Bank.

This MoU is intended to establish a framework for cooperation in the financing of creditworthy entities for renewable energy projects and facilitate the export of goods and services of the US origin or manufactured in India and various forms of collaboration between IREDA and the US Exim Bank. According to the MoU, the US Exim Bank shall provide $1 billion medium and long-term guaranteed and/or direct loans to finance the US technologies, products, and services utilized during commercial development activities within the clean energy sector by IREDA. The proposed credit facility carries no specific commitment on the part of IREDA and will depend on the import of the US equipment to India and attractiveness of credit facility to the project developers in India. This US Exim Bank facility will be available for financing of imported US equipment, in addition to financing of 30 per cent of domestic component.

Source: www.livemint.com

Government signs pact for offshore wind power project

The government announced signing of an initial pact for setting up a joint venture firm for executing an offshore wind power project in Gujarat.

“A Memorandum of Understanding (MoU) for setting up a Joint Venture (JV) company towards undertaking the offshore wind power project in the country along the Gujarat coast has been signed,” an official statement said.

The MoU was signed by the Ministry of New and Renewable Energy (MNRE), National Institute of Wind Energy (NIWE), and consortium of partners including NTPC, Power Grid Corporation, Indian Renewable Energy Development Agency (IREDA), Power Finance Corporation, Power Trading Corporation, and Gujarat Power Corporation. Power and Coal Minister Piyush Goyal described it as a great opportunity in the development of renewable energy resources in the country. The Minister also suggested building partnership with Defence, Coast Guard, and Shipping to ensure seamless and time-bound approval process.

The JV Company will undertake detailed feasibility study based on the inputs received from pre-feasibility studies and necessary steps for implementation of the first offshore demonstration wind power project. The first planned demonstration of offshore wind power project will be of about 100 MW.

Source: www.pib.nic.in
India ranks fourth in clean energy investment

India ranks fourth among the 55 developing nations in clean energy investment, according to a new country-by-country study. Released by the Inter-American Development Bank, the results of the new study ‘Climatescope 2014’ suggest that renewable technologies can be just as cost-competitive in emerging parts of the world as they are in richer nations.

According to the report, China ranks number one followed by Brazil. It is the largest manufacturer of wind and solar equipment in the world and has the largest demand market for these equipment. India has a score of 1.85 points against China’s 2.23. “Climatescope is a critical resource for the Power Africa initiative and our partners, providing an in-depth and objective evaluation of low-carbon energy opportunities in emerging markets, including Africa,” said Dr Rajiv Shah of the US Agency for International Development Administrator.

India also had its best performance on Low Carbon, the report said, adding that business and Clean Energy Value Chain Parameter III developed clean energy value chains and service providers. Steadily rising power demand, good-to-excellent renewable resources, and often-impaired fossil fuel supply chains make India a growth market for clean energy. The country received $6 billion in clean energy investment in 2013 out of a total of $62 billion from 2006 to 2013.

IEA releases EE market report

A new report by the International Energy Agency (IEA) confirms the position of Energy Efficiency (EE) as the world’s ‘first fuel’ and the global EE market is estimated to be worth at least $310 billion a year and growing. The report also finds that energy efficiency finance is becoming an established market segment, with innovative new products and standards helping to overcome risks and bringing stability and confidence to the market.

“Energy efficiency is the invisible powerhouse in IEA countries and beyond, working behind the scenes to improve our energy security, lowering our energy bills, and moving us closer to reaching our climate goals,” IEA Executive Director Maria van der Hoeven said at the Verona Efficiency Summit as she launched the IEA’s Energy Efficiency Market Report 2014.

The annual report, now in its second year, shows that investments in energy efficiency are helping to improve energy productivity—the amount of energy needed to produce a unit of Gross Domestic Product (GDP). Among 18 IEA countries evaluated in the report, total final energy consumption was down 5 per cent between 2001 and 2011 primarily as a result of investments in energy efficiency. Cumulative avoided energy consumption over the decade from energy efficiency in IEA countries was larger than the energy demand of the United States and Germany combined in 2012.

The report reveals that a huge potential for energy efficiency exists in emerging economies outside the Organisation for Economic Co-operation and Development (OECD), with efficient vehicles and transport infrastructure as a major opportunity. The IEA estimates that efficiency can reduce up to $190 billion in fuel costs in transport globally by 2020 and can help alleviate local air pollution and even address critical congestion issues in rapidly developing urban transport systems.
Russia's renewables sector is set to match the Chinese share in the country's energy market, opening the door for the Chinese to significantly shape the development of Russia's hydro and solar sectors.

RusHydro JSC, Russia's biggest hydropower company, announced that it is considering a partnership with Power Construction Corp. of China Ltd. (PowerChina). From the new programme, it aimed to subsidize the construction of small hydro plants eligible for renewables subsidies in Russia. RusHydro may invest as much as 65 billion rubles ($1.7 billion) by 2020 in more than 30 projects in collaboration with PowerChina. Russian President Vladimir Putin approved a subsidy programme that boosts clean energy generation in a bid to curb reliance on oil, gas, and coal while cutting emissions. The country plans to expand the share of renewables to 2.5 per cent of the power mix by the end of the decade from the current 0.8 per cent.

In the solar sector, the second Russian renewable energy project auction last summer granted the bulk of the state-supported solar capacity to China-based Amur Sirius. The Chinese snatched 175 MW of the offered 496 MW of solar for the years 2015, 2016, 2017, and 2018, while state-owned Energija Solnce was left with 165 MW and Avelar Solar Technologies, part of Renova Group—and the winner of last year’s solar auction—was allotted a mere 155 MW.

Source: www.renewableenergyworld.com

SunEdison develops polysilicon technology

SunEdison, a well-known name in solar technology space, has claimed that it has developed an advanced polysilicon technology. Consequently, it is on target to produce solar material at the lowest cost, says a company release.

“This represents a step-change in technology, and will enable SunEdison to deliver a 400 W peak solar panel at a cost of $0.40 per watt peak by 2016,” the release adds.

“Solar energy is at a transformational moment in time, and innovative technology is what will power that transformation,” Ahmad Chatila, Chief Executive Officer, SunEdison, said. “Our latest advance in technology will enable solar power to become the lowest cost energy solution—not just an alternative to other renewable sources, but the cost-winner over fossil fuels as well,” he further adds.

The technology, called ‘High Pressure Fluidized Bed Reactor (HP-FBR)’, the company claims, produces high purity polysilicon 10 times more efficiently, and with 90 per cent less energy used than non-FBR technologies.

The HP-FBR technology, it is pointed out, requires less land, less capital, and fewer natural resources. HP-FBR technology is now in production at Ulsan in Korea.

It is a joint venture facility of SunEdison, SunEdison Semiconductor, and Samsung Fine Chemicals (SFC). The capacity of the Korean plant was originally designed for 10,000 tonnes per year but has been enhanced to 13,500 tonnes. The plant is expected to operate at full capacity by the first quarter of 2015.

Source: www.thehindu.com
INDIA’S LARGEST Grid-connected Solar Rooftop PV Project of 7.524 MWp Capacity on a Single Roof

It was a moment of fascination and pride for the team of Renewable Energy experts from 25 States/Union Territories (UTs) who visited this 7.524 MWp capacity grid-connected solar rooftop PV power project for the first time in India, reports Dr Arun K Tripathi.
The state of Punjab, a land of green revolution in agriculture, has accomplished another green revolution in the country. This time, the green revolution pertains to green electricity generation from the grid-connected solar rooftop PV power project on a single roof in the campus of Radha Soami Satsang Beas (RSSB).

**Radha Soami Satsang Beas (RSSB)**

The RSSB located in Beas in the Amritsar district of Punjab, is a philosophical organization based on the spiritual teachings of all religions and dedicated to a process of inner development under the guidance of a spiritual teacher. It is a registered not-for-profit society with no affiliation to any political or commercial organizations. RSSB Educational & Environmental Society (RSSB-EES) is a sister concern of the RSSB. It is a not-for-profit and charitable society and is an independent body with its base of operations at Beas. This project has been conceptualized and realized by RSSB-EES in the sprawling RSSB campus.

In a conference organized by the Punjab Energy Development Agency (PEDA), Shri Upendra Tripathy, Secretary, Ministry of New and Renewable Energy (MNRE) applauded the initiatives and efforts of the organization of setting up this largest plant in the country.

**The Largest Project in India**

This solar PV power project, spread over 24 acres of rooftop on a single roof is undoubtedly the largest plant in India. Germany also possesses such grid-connected rooftop plants but not of this size on a single roof. The RSSB project has around 30,096 PV modules of 250 Wp each, 11.5 km walkway, 14 central type inverters of 500 kWp each, seven transformers, 140 junction boxes, and 44,000 of J-Bolts used for Module Mounting Structure and Walkway (see Table 1). The project has been erected and commissioned by Larsen & Toubro Limited, a reputed engineering organization of our country.

**Solar Electricity Generation**

The Project generated over 1 million kWh of electricity per month during April–June 2014. In the months of July, August, September, and October, the generation ranged between 0.72–0.99 million kWh per month depending upon the weather conditions and availability of sunshine hours (see Figure 1). The plant generated highest electricity of 44,200 kWh on April 20, 2014 and maximum of 1,060,604 kWh in May 2014 (see Tables 2 and 3).

**Project Cost**

The total cost of the project is about ₹48 crore which includes the cost of transmission network, substation, and transformers installations. It also claims to have a simple payback period of around six years.
Future Plans
By 2016, the RSSB plans to set up a total of 27 MWp capacity peak grid-connected rooftop plant. Out of this, the 5 MWp capacity will be added soon to make the total capacity upto 12.524 MWp. The campus has an estimated potential of further addition of about 45 MWp grid-connected rooftop plants in approximately 200 acres of land.

Conclusion
The project is attracting a number of visitors from all over the world and India. It is a spot of technological innovation, education, and field demonstration of this largest facility in the country. Recently, a team of Renewable Energy (RE) experts from about 25 State Nodal Agencies visited the project site and appreciated the commitments and efforts of the organization. This certainly sets an example for others to follow suit.

Figure 1: Solar Electricity Export, Month-wise (in kWh)
## India’s Largest Grid-connected Solar Rooftop PV Project of 7.524 MWp Capacity on a Single Roof

### Table 1: Interesting statistics

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Solar PV Modules</td>
<td>30,096</td>
</tr>
<tr>
<td>Walkway Length on Rooftop</td>
<td>11.5 km</td>
</tr>
<tr>
<td>Number of J-Bolts used for Module Mounting Structure and Walkway</td>
<td>44,000</td>
</tr>
<tr>
<td>Junction boxes</td>
<td>140</td>
</tr>
<tr>
<td>Number of Modules in each String</td>
<td>24</td>
</tr>
<tr>
<td>Number of Strings in each Junction Box</td>
<td>9</td>
</tr>
<tr>
<td>Number of Junction Box in each Inverter</td>
<td>10</td>
</tr>
<tr>
<td>Number of Inverters</td>
<td>14</td>
</tr>
<tr>
<td>Number of Transformers</td>
<td>7</td>
</tr>
<tr>
<td>Number of Incoming Feeders</td>
<td>7</td>
</tr>
<tr>
<td>Number of Outgoing Feeders</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 2: Solar power generation

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Peak Power of the day (AC)</td>
<td>6.844 MW as on July 6, 2014 at 11:28 am</td>
</tr>
<tr>
<td>Maximum Global Solar Irradiance on July 6, 2014</td>
<td>1151.51 W/m²</td>
</tr>
<tr>
<td>Highest Energy Generation of the Day</td>
<td>44,200 kWh as on April 20, 2014</td>
</tr>
<tr>
<td>Maximum Energy of the Month</td>
<td>10,60,604 kWh in May 2014</td>
</tr>
<tr>
<td>Maximum Average Temperature of the Day</td>
<td>45.89 °C as on June 8, 2014 at 14.01 pm</td>
</tr>
</tbody>
</table>
Table 3: Technical Details and Specifications at a Glance

<table>
<thead>
<tr>
<th>Technical Details</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capacity</td>
<td>7.52 MWp</td>
</tr>
<tr>
<td>Location</td>
<td>Beas (Amritsar district)</td>
</tr>
<tr>
<td>Latitude</td>
<td>31.54 °N</td>
</tr>
<tr>
<td>Longitude</td>
<td>75.32 °E</td>
</tr>
<tr>
<td>Altitude</td>
<td>234 m</td>
</tr>
<tr>
<td>Area Covered</td>
<td>24 acres of rooftop</td>
</tr>
<tr>
<td>Roof Type</td>
<td>Single roof of asbestos Corrugated Cement (ACC)</td>
</tr>
<tr>
<td>Modules Type</td>
<td>Poly Crystalline</td>
</tr>
<tr>
<td>Module Wattage</td>
<td>250 Wp</td>
</tr>
<tr>
<td>Inverter Rating</td>
<td>500 kW (central type)</td>
</tr>
<tr>
<td>Inverter Duty Transformer</td>
<td>1.25 MVA</td>
</tr>
<tr>
<td>Grid Evacuation Voltage</td>
<td>132 kV</td>
</tr>
<tr>
<td>Module Capacity</td>
<td>250 Wp</td>
</tr>
<tr>
<td>String Current</td>
<td>8.3 Adc</td>
</tr>
<tr>
<td>String Voltage</td>
<td>720 Vdc</td>
</tr>
<tr>
<td>Junction Box (JB) Output Current</td>
<td>74.7 Adc</td>
</tr>
<tr>
<td>Junction Box (JB) Output Voltage</td>
<td>720 Vdc</td>
</tr>
<tr>
<td>Inverter Rating</td>
<td>500 kW</td>
</tr>
<tr>
<td>Inverter Output</td>
<td>320 Vac 3φ</td>
</tr>
<tr>
<td>Transformer Output</td>
<td>11 kV</td>
</tr>
<tr>
<td>Capacity of Vacuum Circuit Breaker (VCB)</td>
<td>630 A, 11 kV</td>
</tr>
<tr>
<td>Protection Relays Operating Voltage</td>
<td>110 Vdc</td>
</tr>
<tr>
<td>SCADA* for Plant Monitoring with MET Station</td>
<td>Online</td>
</tr>
<tr>
<td>132 kV Substation</td>
<td>11 kV / 132 kV</td>
</tr>
<tr>
<td>Grid Connectivity</td>
<td>To PSTCL 132 kV S/S</td>
</tr>
</tbody>
</table>

*Supervisory Control and Data Acquisition (SCADA)

Dr A K Tripathi, Director, MNRE. Email: aktripathi@nic.in (RSSB is a registered not-for-profit society with no affiliation to any political or commercial organizations. Data courtesy: Mr S S Chadha)
Akshay Urja Invites RE Case Studies

Theme: Renewable energy technology based project.

Readers are invited to share with us the case study of any project based on renewable energy. The following parameters should be specified in the case study:

- Name and location of the site of the project
- Technical specifications of the project
  - Technology used and its specifications
  - Implementation year
  - Duration of the project running successfully
  - Details about the application of the project
- Benefits occurred from the project
  - Financial benefits
  - Social benefits

In addition to these points, any additional points, high resolution images, diagrams, tables, etc., are a welcome in the case study paper. The best selected entries will be featured in the forthcoming issue of Akshay Urja.

Please send in your entries to akshayurja@nic.in and sangeeta.paul@teri.res.in.
In this fast-paced world of industrialization where natural resources are depleting at an alarming rate, Renewable Energy (RE) resources can act as a saviour. There is an urgent need to promote the RE industry to address this problem in a timely manner. **Shirish S Garud** and **Sangeeta Gohain Baruah** look into the future prospects of this sector in India.
Concerns about climate change, fast depletion of natural resources, pollution due to excessive use of fossil fuels, and energy security have brought clean and renewable energy technologies in the limelight in recent times. Hence, it is appropriate to understand the Renewable Energy (RE) industry in India and its future in forthcoming years in the light of recent government initiatives and international developments. The focus is on the various global developments and the status of Indian RE industry with a special focus on the solar energy sector.

Renewable Energy Industry Across the Globe

Renewable energy sector is growing steadily over the last few decades. In 2012, renewable energy provided an estimated 19 per cent of global final energy consumption. Similarly, global installed capacity of renewable energy-based power generation reached 1,560 GW in 2013.

Globally, investments in the RE sector grew from $40 billion to $214 billion during the period of 2004–13 (Figure 1). Investments in the RE sector peaked in 2011, when global investments touched $279 billion. In 2013, significant investment of about $93 billion took place in developing countries of which India’s share was $6.6 billion.

Across the world, 6.5 million people worked directly or indirectly in the renewable energy sector from 2012 to 2013. Some of the major players in the RE sector are China, the United States, Germany, Spain, and Brazil. India ranks fifth in terms of installed capacity in the wind energy sector.

Figure 1: Global Investments in the RE Sector
Renewable Energy Industry: India
Development of the RE Sector in Early Years

Renewable energy activities started in India after the oil crisis of 1973. The initial focus was on developing products, such as solar street lights, solar lanterns, biogas plants, and so on through national research laboratories and manufacturing was done through public sector companies like Central Electronics Ltd, Bharat Heavy Electronics Ltd (BHEL), Bharat Electronics Ltd, etc. However, in spite of having government backing and first mover’s advantage, these companies could not establish themselves as leaders in manufacturing. BHEL, for example, was one of the first manufacturers of solar photovoltaic cells, modules, and systems; it also had collaboration for wind turbine manufacturing and was also engaged in production of solar collectors for water heating applications besides investment in research and development of fuel cells and hydrogen technologies. In mid-1980s, the Renewable Energy Systems Ltd, Hyderabad and Udhaya SemiConductors Ltd, Coimbatore were the first private sector manufacturers of solar photovoltaic modules, systems, and devices. The Indian renewable energy technology manufacturing sector has a long way to go. The list of the manufacturers for manufacturing different renewable energy technologies is given in Table 1.

Foreign Direct Investments in Indian RE sector

There has been Foreign Direct Investment (FDI) inflow to the tune of ₹ 8,569 crores ($1,756 million) in the renewable energy sector during 2009–12 (as on December 31, 2012). Hundred per cent FDI through an automatic route is available to the investors of renewable energy projects. The government offers fiscal and monetary incentives to renewable energy developers to promote investment.

Wind Energy Sector

With an installed capacity of more than 21 GW, India is currently placed fourth on the global ranking of wind energy installed capacity. Interestingly, wind energy technology infusion in India was more rapid during 1990–2010 primarily due to the massive demonstration programme of the MNES (Ministry of Non-Conventional Energy Sources renamed as Ministry of New and Renewable Energy [MNRE] in 2006) on grid-connected wind energy projects, special tariff schemes introduced by MNES for the period of 1993–2003 and thrust on local manufacturing. The sector developed rapidly through collaborations of Indian private and public sector companies with leading European manufacturers. Indigenization and local manufacturing including...
manufacturing of blades and gear box happened fairly quickly from 1990–2010. This also resulted in the development of robust wind industry and ancillary industries like erection and servicing companies, project developers, and independent power producers. The prime enabling factors were accelerated depreciation, subsidies, generation-based incentives, and other incentives from MNES/MNRE and state governments, thrust on establishing wind data monitoring stations and establishment of Centre for Wind Energy Technology (C-WET) for testing and development of wind turbines. According to a report by the Global Wind Energy Association on India’s Wind energy outlook, wind energy generation capacity in India could reach to 89 GW by 2020. This will attract investments of over $16.5 billion, and is estimated to create 1.79 lakh jobs. National Institute of Wind Energy (NIWE), formally known as Centre for Wind Energy Technology, is the apex body for certification and approvals of the wind turbines in India. According to the latest communication, NIWE has approved 20 manufacturers of wind turbines and 53 various models of wind turbines ranging from 225 kW to 2,100kW capacity. The Indian wind industry has grown substantially and has a wide scope for further development. Apart from wind turbine manufacturing, there are companies supplying equipment and subsystems for wind energy projects. A comprehensive list of such service providers is available in the Directory on Indian Wind Power annually published by Consolidated Energy Consultants Limited (CECL). Independent Power Producers (IPPs) and wind farm developers are also major players and investors in the Indian wind energy sector.

End Use Sectors for Energy

Energy is used to perform various end use activities which are: 1) motive application, such as transport and industrial equipment; 2) heating, cooking, and cooling applications; and finally, 3) electricity generation. Sector-wise energy end use activities, energy resources/fuels used, and appropriate renewable energy interventions are given in Table 2 for easy reference.

Table 2: End Use Activities and Appropriate Renewable Energy Interventions

<table>
<thead>
<tr>
<th>Sectors</th>
<th>End Use Activities</th>
<th>Required Energy Form</th>
<th>Currently Used Energy Resources</th>
<th>Renewable Energy Interventions</th>
<th>Status of Renewable Energy Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential and commercial sector</td>
<td>Cooking</td>
<td>Heat</td>
<td>• Traditional biomass</td>
<td>Solar energy-based cooking technologies</td>
<td>Matured technology for solar water heating, which is locally designed and manufactured</td>
</tr>
<tr>
<td></td>
<td>Lighting</td>
<td>Light</td>
<td>• Kerosene</td>
<td>Solar photovoltaic and small wind turbines for electricity production</td>
<td>Matured technology, which is locally produced mainly through solar PV</td>
</tr>
<tr>
<td></td>
<td>Space and water heating</td>
<td>Heat</td>
<td>• Electricity</td>
<td>Passive solar techniques for space heating and solar water heating technologies</td>
<td>Solar passive designs becoming popular; efficient use of biomass through improved devices</td>
</tr>
<tr>
<td></td>
<td>Space cooling</td>
<td>Cool</td>
<td>• Electricity</td>
<td>Solar passive technologies, solar PV-based air conditioning, and solar thermal-based air conditioning</td>
<td>Emerging solar air conditioning technologies but not commercially viable</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous gadgets</td>
<td>Motive power, electricity</td>
<td>• Electricity</td>
<td>Electricity generated from solar PV, hydro, wind, and other energy resources</td>
<td>Small solar PV-powered devices available</td>
</tr>
</tbody>
</table>

Contd.
<table>
<thead>
<tr>
<th>Sectors</th>
<th>End Use Activities</th>
<th>Required Energy Form</th>
<th>Currently Used Energy Resources</th>
<th>Renewable Energy Interventions</th>
<th>Status of Renewable Energy Options</th>
</tr>
</thead>
</table>
| Transport sector | Short-distance travel            | Motive power         | • Human energy (walking, cycling)  
• Animal energy (horses, bulls, camel, yak, etc.)  
• Electricity | Small electric bicycles |                                                            |
|                  | Medium- and long-distance travel | Motive power         | • Petroleum-based products (petrol, diesel, kerosene, LPG)  
• Natural gas  
• Electricity | Biofuels such as ethanol, bio diesel from bio-oils; Biogas | Biodiesel and ethanol mixing in diesel is being done; Ethanol manufacturing industry is growing; Bio-oils are being developed |
| Industrial sector| Motive power for industrial activities | Motive power       | • Electricity  
• Diesel | Wind, solar plants, and biomass power plants | Solar and wind power plants for electricity are viable under current policies |
| Thermal energy   | Heat                             | Heat                 | • Petroleum products (diesel, furnace oil, etc.)  
• Coal  
• Biomass (fuelwood)  
• Waste heat  
• Electricity | Concentrated solar thermal biomass gasifier, biogas-based heating systems, and syngas-based heating system | Solar thermal systems for water heating and Steam generation are commercially available; Biomass gasifiers are also used by SMEs; Bio-oils may emerge as alternate fuels |
| Agriculture      | Irrigation                       | Motive power         | • Electricity  
• Diesel | Solar PV, wind, biomass gasifier | Solar PV, biomass gasifier-powered pumps are commercially available |
|                  | Pre and post-harvest activities  | Motive power         | • Animal power  
• Diesel  
• Electricity | Solar dyers are being promoted |                                                            |
| Power generation**| Generation of electricity for various end-uses | Motive power to run generators | • Coal  
• Hydro  
• Diesel | Wind  
Solar  
Bioenergy  
Small hydro***  
Geothermal  
Ocean energy  
Others | Solar, wind, hydro, and biomass power plants for various capacities are commercially available |

* Conventional hydro power plants are also considered as renewable power  
** One of the major applications of renewable energy is in power generation  
*** Small hydro plants of less than 25 MW capacity run of the river type without any dam

**Solar Energy Industry**

The solar energy industry can be broadly categorized into two types, namely, solar thermal industry and solar PV (photovoltaic) industry.

**Solar PV industry**

The solar photovoltaic industry is fairly complicated. The value chain in solar photovoltaic manufacturing and deployment is shown in Figure 2.

The Indian industry does not operate in the fields of poly silicon ingot, wafer manufacturing, and thin film manufacturing, except for a manufacturer of thin film.

In 2007, the Indian solar photovoltaic manufacturing industry comprised about 19 solar module manufacturers, nine solar cell manufacturers, and almost 60 companies in assembly and supply of solar PV systems. These companies produced nearly 45 MW of solar cells and 80 MW of solar PV modules of which 60 MW of solar PV products were exported.

However, global economic crises and sudden increase in global
manufacturing capacity, particularly in China, resulted in overproduction and reduction in prices. This situation is prevalent even today due to which the Indian solar PV module and cell manufacturers are suffering huge losses in spite of the demand generated by the National Solar Mission and state solar policies and programmes. Due to expansion of markets post 2010, after announcement of the National Solar Mission and introduction of state solar policies, the industry has seen growth and investment in Engineering, Procurement, and Commissioning (EPC) and IPPs segment. And major Indian corporates and groups like L&T, Reliance, Thermax, Aditya Birla Group, and so on are making huge investments in the Indian solar PV sector. According to the data available with the MNRE, as on June 2014, the installed manufacturing capacity is 1,216 MW of solar cell manufacturing and 2,348 MW of solar PV module manufacturing. However, only 240 MW of solar cell and 661 MW of solar PV module manufacturing were operational till then. Scale of manufacturing and lack of vertically integrated manufacturing crossing the value chain are some of the major issues for the Indian industry. The MNRE is providing support by creating dedicated market for Indian solar PV manufacturing through domestic content and separate tendering for domestic procurement.

The Semiconductor Policy of 2007 also aimed to support large-scale investment in integrated solar PV manufacturing by providing capital subsidies to the tune of 25 per cent for projects having capital investment of more than ₹1,000 crores. However, the current status of the projects proposed under this policy is not available. The Indian solar PV power plant industry is booming under the National Solar Mission and according to the latest estimates 1,660-MW capacity power plants will be commissioned over the next year. These projects would account for an investment of over ₹116 billion ($1.9 billion).

Apart from large-scale grid-connected solar PV power plants, the other segments such as village electrification through mini grids, smart metering, and solar devices, such as solar lanterns, torches, etc., have also shown growth in recent times. A number of start-up companies are also entering the sector through venture capital investments which is a promising sign for the Indian solar PV industry.

The Government of India is also discussing plans for increasing solar mission targets from existing 22 GW by 2020 to about 100 GW. This would open huge opportunities for Indian solar PV industries and can also offer them ideal market push to achieve economies of scale and be competitive in the global market.

**Conclusion**

Indian RE industry is poised to grow substantially in the coming years. In particular, solar PV and wind energy industries can see immense growth. The industry should be careful about quality and economical manufacturing.
The concept of waste-to-energy is of utmost importance in today’s energy-consuming world. Sarita Brara brings forth the evolution of rice husk from being a waste to a useful resource.

Once, money was offered to clear rice husks from the mills in Punjab. Today this agro-biomass is fetching a high price, thanks to its increased demand by the processing industry over the last decade for captive and cogeneration of power. A large number of small industrial units and a number of the processing units are now using rice husk for generating steam and electricity required for running their industrial units. In this way, they are reducing their dependence on fossil fuels as well as on the State Electricity Board that imposes frequent load-shedding leading to interruption of power supply, severely affecting the production.

A paper mill at SAIL Khurd, over 100 km away from Chandigarh, Punjab, is one among the many processing industrial units in the state that use electricity produced from rice husk. The first power plant using rice husk was installed in 2008 by the Kuantum Papers Ltd (earlier called ABC Paper Mills Ltd). At present, the processing unit has three power plants of 10 MW, 5 MW, and 1 MW capacity each. A 19-MW capacity plant that will replace the two smaller ones is in the pipeline. Once this is done, the Plant that has the capacity to make 100,000 tonnes of finished paper will have 28.5 MW capacity of power generation, which would be enough to meet its growing electricity demand.

Satia Paper Mills Ltd at Muktsar, Punjab started captive power production from rice husk about a decade back with one-and-a-half MW capacity. However, today it produces 12.5 MW of power, which is sufficient to meet its in-house requirements. The processing unit takes power from the grid only when there is a breakdown. The boiler at the plant is designed for captive power from rice husk only.

Situated in Sherpur industrial area in Ludhiana district, the Oswal Woollen Mills (OWM) Ltd has a 3.5 MW-capacity power plant using rice husk to fulfil their power requirement. The rice husk-based cogeneration plant generates steam and electricity displacing an equivalent amount of electricity that they earlier used to purchase from
Rice Husk Powering Industrial Units in Punjab

Rice husk is being extensively used as a boiler fuel in different processing industries as well as power boilers. For producing one unit of power, 1.7 kg of rice husk is required. At present, a rice husk-based power plant costs between ₹350–400 lakh per MW power generation. Rice husk has a heating value (calorific value) of 3,000 kcal per kg. Hence, it is an excellent fuel.
Although production of power from rice husk in Punjab began much earlier, it was only from July 2003 onwards that the Punjab Energy Development Agency (PEDA) started facilitating these units. Presently, the PEDA is facilitating 400 MW of cogeneration power plants and 62.5 MW of captive power generation plants from biomass in which rice husk is a major biomass.

**Rice Husk Power Generation Technology**

Rice husk is the hard protective coating that surrounds the rice. Over 20 per cent of paddy weight is that of the husk. There are two main technological options to generate electricity using rice husk as a fuel—combustion and gasification. Heating rice husks at high temperature causes the materials to decompose into a mix of combustible gases. The gases are then burnt to produce heat or steam that activates a gas turbine and produces electricity. The advantage of this technology is similar to that of a thermal power plant that uses coal as a fuel, except for the boiler.

**Preference for Rice Husk over Other Biomass**

After bagasse, rice husk is probably the largest mill-generated source of biomass available for energy use. Naturally, one can ask as to why rice husk is a preferred biomass for production of power by industrial units in Punjab. Given below are some of its characteristics that may answer this question.

**Easy Availability**

Called the Granary of India, Punjab is a major contributor of wheat and rice to the bread basket of the country. Paddy is grown in almost all the districts of the state. There are more than 3,000 rice mills spread over these districts and thus, rice husk is available in abundance. Therefore, the availability of rice husk is more stable and reliable in the state than coal which not only requires material handling facilities, but also has to be transported from the Eastern part of the country.

**Cost-effective, Easy Storage, and Handling**

Storage and handling is easy and cheaper because rice husk, unlike other types of biomass, does not require a processing before being fed into the boiler. This also cuts down the cost.
In addition to these, there are several other advantages that come with biomass power projects, which include rice husk as well. As for biomass which is produced and consumed locally, losses associated with transmission and distribution are reduced. These projects also have low gestation period.

With the generation of revenue at the local level, these projects help in bringing good returns to rural population. The centre and all the states also offer incentives for setting up of biomass power generating units. These include:

- Capital subsidy to the tune of ₹ 20 lakh (with certain conditions) for generation of power from biomass that includes rice husk.
- Exemption from payment of excise duty on machineries and equipment purchased for initial setting up of a power plant.
- Apart from these Clean Development Mechanism (CDM) benefits on reduction of CERs, preferential tariff for power exported to the grid is also available.

According to the PEDA, Punjab has substantial availability of biomass/agro-waste in the state, sufficient to produce about 1,000 MW of electricity. The State Agency has plans to develop some of the available potential talukas/tehsils with the aim to promote and install biomass/agro-waste based projects. It has allocated 18 sites with the capacity of 165.5 MW.

Although Punjab produces nearly 55 per cent of the total rice production in the country and is one of the leading producers of paddy, production of electricity from rice husk is still far below its potential. Both Punjab and the neighbouring state of Haryana do not have much installed capacity in comparison to their potential even though tariff rates offered to them are more than ₹ 5 per unit, better than most of the other states.

While Punjab needs to tap the full potential of rice husk biomass available to the state in abundance, several other rice producing states (our country is among the top producers of rice) also need to exploit the full potential of this biomass for captive and cogeneration of power; specifically, when the centre is promoting biomass and cogeneration programmes by offering several incentives for optimum use of the country’s huge biomass resources. According to a study sponsored by the Ministry of New and Renewable Energy (MNRE), 18,000 MW of power can be produced from the agricultural and forestry residues, in addition to the 5,000 MW from bagasse-based cogeneration from sugar mills.

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A Paradigm of Self-Sufficiency—INDIRA PARYAVARAN BHAWAN

Deependra Prashad and Saswati Chetia explore the Indira Paryavaran Bhawan situated in New Delhi, which is based on the concept of Net Zero Building (NZEB). This building aims to be self-reliant in every aspect of its overall functioning as a sustainable structure.

In this era of climate change and environmental degradation, a large variety of mitigation measures such as, initiatives targeting sustainable building are urgently required. These include the construction of green buildings, utilization of building rating systems, energy codes, and many other prescriptions. With this background, there are projects which have been developed at the cutting edge of sustainable building and are developing a new paradigm of self-sufficiency. Net Zero Building projects (NZEBs) are targeting to push the envelope further, by being self-sufficient, not just in terms of their electricity consumption but with an overall minimal dependence on other resources.

Background

Indira Paryavaran Bhawan, the new structure, housing the Ministry of Environment and Forests (MoEF) is targeted as the first large-scale building in the country to achieve the Net Zero and Energy Positive tag and also the first government building to do so. This building, which includes the minister’s office and various administrative sections of the ministry, is located at Aliganj on Jor Bagh Road in South Delhi (Picture 1).

The land on which the building is constructed, was originally a single storey decrepit government housing which under a change of land use was reassigned.
to the government office function. Despite the change in land use, the mandate of the Ministry’s building remained as providing minimum change and disturbance to the surrounding ecosystem, including the predominantly green character of the surroundings, while still optimally utilizing the tight urban site of almost a hectare.

This building reflects the growing role of the ministry in regulating and channelizing India’s development into a sustainable paradigm. This mandate was carried forward by the Central Public Works Department (CPWD) and the sustainable design consultants, Deependra Prashad, Architects and Planners (DPAP) at every level to design a building which is not just energy efficient but is also able to create more energy onsite than it consumes over a functional year. Apart from aiming to be a Net Zero Building, the project has also achieved the 5-star GRIHA Green Rating and is targeting the LEED India NC Platinum rating system through a slew of measures both in the passive and the active design of building envelope, the usage of materials, service provision, and also by following a range of environment-friendly processes within the construction programme.

**Developing Indira Paryavaran Bhawan**

One of the first design considerations was to try and preserve as many numbers of the existing trees as was possible, given the site constraints of the building without compromising on its functional efficiency and user comfort. The building design went through various iterations with the final design being a twin North-South facing blocks with a large open space court in the center (Figure 1). The maximum allowed ground coverage was used to keep the building height in tune with the surroundings. Although permission was granted for cutting down 46 trees, the proposed design and measures helped reduce the chopping to only 19 trees. Even so, a large number of native trees, much higher than the basic GRIHA requirement of three times those cut, have been replanted onsite. The project landscaping has been designed not just to act as a climate modifier but to also showcase the plant diversity within the country (Picture 2).

![Figure 1: The building design underwent various stages and the final design was that of a twin North-South facing blocks with a large open space court in the center.](image1)

**Water Efficiency**

The site management and landscaping also contribute to a water-efficient site. Planting native species and utilization of efficient irrigation systems, lead up to a 50 per cent reduction in landscaping water requirement. This reduced demand will be met by recycling, reusing the building’s waste water, and rainwater harvesting. The building’s water requirement has been brought down by the usage of water-efficient fixtures. The emphasis here is not just on water-efficiency but effective site water
management and zero-discharge with no water being let out into the city storm water system or the sewer system (Figure 2).

![Figure 2: Efficient water-use and reuse cycle in Indira Paryavaran Bhawan makes it a zero-discharge building](image)

Besides being water-efficient in design, the building’s construction managers, i.e., the CPWD have been quite innovative in its construction process. It involved a large dewatering process of the construction pit due to the high groundwater level of the site which is 9m tall. To ensure that the dewatering process does not deprive the local ecosystem of water, the extracted water was recharged into the ground at a distance of 250m from the site. In addition, this extracted water was also supplied free of cost to the New Delhi Municipal Corporation (NDMC) water tankers on a regular basis to augment the water supply of the city. This contrasts with the usual practice of pushing the water into municipal drains which creates an added burden on the city’s infrastructure.

Another major design intervention was zero tolerance to surface parking as planned by the design team. A state-of-the-art three level parking is provided to cater to peak load during office hours with preferred parking for CNG/electric vehicles and carpools. This along with the proximity of the site to the bus and metro-transit lines also provides incentive to use the public transport system rather than private vehicles. The building is also planned to provide preferred front entrance directly, in a way creating a ‘priority for the pedestrians’. Vehicles enter from the side and need to go to the back for entering the basement. This decision taken by the client and the architect has resulted in less paved area on the site, wherein grass pavers have been provided all around. Instead of the usual concrete grass pavers, a large number of polymer plastic grids have been provided, which make the surface completely soft, resulting in the reduced surface run-off and increasing water percolation (Picture 3). Another tangible benefit of less paved area is a lower contribution of the building to the Urban Heat Island (UHI) effect. The UHI effect leads to an overall build up of temperatures in highly urbanized/concretized areas by the absorption and reradiation of solar heat on hard surfaces. The parking itself has been planned as a compact robotic parking, which due to efficient usage of space, accommodates the required cars within three storeys, as compared to the six basement storeys provided in usual basements.

**Building Configuration and Envelope: Passive Means of Reducing Operational Energy**

The building configuration and the passive design of the building envelope are planned to reduce its operational energy requirements. The building orientation, which is
developed primarily as North–South, by dividing it into two long blocks, reduces the heat ingress into the building and develops a shaded central landscaped court (Figure 3). This central courtyard, along with the large lower level punctures into the building envelope, aid in cross ventilation (see Figure 3).

Some of the other significant design measures include:

- The fenestration shading design is appropriate for the entire building and the reduction in the window-to-wall ratio helps to lessen the heat gain as well the need for a high efficiency glass.
- The window shading and the courtyard openings are designed to reduce summer heat gain and also to allow in the winter sun. Most of the fenestration and habitable areas are located on the outer periphery, which permits good daylighting and view of the scenic surroundings from most of the locations of the office floorplate (Figure 4).
- A large number of spaces including passages and lobbies are developed as non-conditioned spaces with provision for natural cooling and shading through stone jaalis. These designed stone jaalis also showcase a strong craft tradition of the country (Picture 4).
Green Material Choices

The choice of materials is governed by two main criteria—reduction in embodied energy of the construction and further reduction in the operational energy. The first criteria necessitated using materials with:

- Recycled content viz., PPC (fly ash-based cement), AAC blocks which uses fly ash in its constitution in place of the normal bricks for the walls, Terrazo tile flooring which includes reusing waste stone pieces.
- Local availability of materials viz. Kota stone, marble from Rajasthan, Jhansi granite, and simultaneously avoiding granite from afar, say South India.
- Rapidly renewable content viz, bamboo jute composite doors wherein bamboo is a natural resource which can be replenished faster than regular timber trees.

The reduction in operational energy by reduced HVAC load occurs by utilizing good insulation in the building interiors, for instance, AAC blocks for the walls have been chosen. Similarly, high albedo tiles are used on the roof and UPVC windows with composite sections are used for better insulation which reduces the cooling requirement of the building.

Active Measures of Promoting Energy Efficiency

With the building designed to reduce the energy demand, the next step automatically was to equip it with efficient mechanical and lighting systems. The HVAC system at IPB has used the Adaptive Comfort Model that accounts for our physiological capacities to adapt to a wider range of temperature and humidity conditions in real life. Using this model, the performance parameters for different electrical uses was made more efficient in comparison to the conventional standards for instance, air-conditioning load is designed for 450 sq. ft per TR instead of 150 sq. ft per TR, lighting power density at 0.5 W per sq. ft instead of 1.1 W per sq. ft and other electrical loads at 4.5 W per sq. ft instead of 10 W per sq. ft (Picture 6).

An important decision by the ministry was to regulate the set point temperature to 26 °C ± 1 with an emphasis on lowering the thermal shock when moving between outdoors and indoors. This is more appropriate than the usual 20–22 °C and also promotes a climatically appropriate lifestyle. The other measures proposed for making the space conditioning in the building energy-efficient are:

- Part condenser water heat rejection by geothermal mechanism with a closed loop piping which minimizes the need for make-up water. This also helps in water conservation in cooling towers for the HVAC system.
- Chilled beam technology which reduces energy consumption by utilizing radiative cooling panels that depend on localized induction cooling by chilled water. This also reduces the AHU/FCU fan power consumption as it avoids the need for large quantities if air travel from the user space to the heat exchange point.
- Chilled water pumping system through DPS (Differential Pressure Sensor) and VFD (Variable Frequency Drive) which allows for separate control for the various spaces.
- VFD on cooling towers fans and air handling units
- Pre-cooling of fresh air from the toilet exhaust air through sensible and latent heat energy recovery wheel.

AN IMPORTANT DECISION BY THE MINISTRY WAS TO REGULATE THE SET POINT TEMPERATURE TO 26 °C ± 1 WITH AN EMPHASIS ON LOWERING THE THERMAL SHOCK WHEN MOVING BETWEEN OUTDOORS AND INDOORS.
Other measures promoting energy-efficient systems (Figure 6) include:

- Better daylighting of the workspaces.
- Energy-efficient lighting fixtures fittings (T-5/T-8/LED lamps, etc.) improving the requirements as enshrined in the Energy Conservation Building Code, 2007 to reduce energy demand.
- Use of Lux level sensor to optimize operation of artificial lighting.
- Integrated Building Management System (IBMS) for optimizing energy consumption, performance monitoring, etc.
- High-efficiency Cast Resin Dry Transformers for electric substation. DG sets for captive power generation.
- Regenerative lifts which also produce some power in the course of their functioning.
- Entire hot water generation through solar hot water heating system.
- Shared usage of office equipment.
- Promotion of usage of BEE rated appliances within the building.
- Usage of ‘thin client’ systems which provide only terminals to the end-user with common servers for groups of terminals. This highly reduces power usage of separate computer CPUs.
- Solar-powered external lighting.

**Going Beyond Energy-efficiency**

With the goal of not just being energy-efficient but also energy-positive, the MoEF seeks to set an example of energy conservation and best practices regarding the same. A solar photovoltaic system of 930 kWp is installed on the rooftop and on cantilevers protruding out from the building. Highly efficient solar panels above the terrace and the southern façade would produce more energy than required by the building over the period of a functional year. The photovoltaic panels, besides producing energy, also shade the roof, some parts of the walls and the courtyard, thus creating a cooler ground space (Picture 7). It is hoped that this endorsement of large-scale rooftop photovoltaics shall lead to research and development and manufacturing of indigenous high-efficiency solar panels in the future and their widespread usage in a decentralized manner.

**A Larger Vision**

The Indira Paryavaran Bhawan is an ambitious endeavour to direct future building growth towards a path that is sustainable in all respects, be it self-sufficiency in energy and water or in ensuring the least possible environmental damage in developing urban areas. As a best practice for disseminating ideas incorporated, a separate website has been created for the project, which highlights its construction updates, features, and green provisions.

As described above, the challenges of creating a Net-Zero building on a tight urban site are not just to do with a provision of an on-site energy generation—in this case a solar photovoltaic system—but more to do with a systematic reduction of electrical loads through passive and active measures at all levels of the building and service design. The success of this endeavour is expected to pave the way for many other decentralized urban initiatives aimed at self-sufficiency in energy and other resources within the built environment.

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**Deependra Prashad and Saswati Chetia, Professional Architectures, DPAP Studio.**

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A Gokul Raj, Dr V Siva Reddy, and Avipsa Dey explore the design of an innovative Programmable Intelligent Computer (PIC) microcontroller-based solar tracking system which is cost effective and also increases the overall energy output.
The concerns for climate change and energy security have given impetus to the exploitation of solar energy. The Jawaharlal Nehru National Solar Mission (JNNSM), launched a few years ago, has given a much needed boost to the solar energy utilization for power as well as for thermal applications including capacity-building for the manufacturing sector. Solar tracking devices maximize the energy collected by solar panel placing the photovoltaic (PV) panels perpendicular to the sun’s direct radiation throughout the day. The PV panels have a low conversion efficiency of around 12 per cent. A solar tracking system increases the input energy to the PV panels and, thereby, the energy output of the PV panels with almost the same conversion efficiency. Solar tracked PV panels may generate up to 15 per cent (single axis) and 25 per cent (dual axis) more electricity as compared to the fixed PV panels.

Sun tracking systems are, in general, timer controller-based (15° per hour rotation) and require manual intervention for starting and stopping the system because solar time changes throughout the year. The electro-optical automatic, two axis sun trackers, based on the imported technology, are very expensive and the local facilities for their repairs are generally not available. Keeping this in view, a Programmable Intelligent Computer (PIC) microcontroller-based solar tracking system using commercially available low cost components has been designed and developed at the Sardar Patel Renewable Energy Research Institute (SPRERI).

The system has been working effectively since January 2013 and required negligible maintenance except for cleaning of the PV panels periodically. The average daily energy output of the tracked panels was found to be 16–20 per cent more than the stationary panels (Picture 1).
Salient Features of the Tracking System

The system has the following noticeable features:

- It is low cost, has a simple design, and is easy to operate.
- There is a single pole support system suitable for mounting up to 105 kg mass of PV panels.
- It can sustain up to 1 kWp of PV panels (around 7.75 m² area).
- Photo sensors, DC motor, PIC microcontroller, and all the other components are low cost and commercially available.
- The minimum angle of tracking is 0.1°.
- The electricity generated by the PV panels is used for operation of the system. It may also be adapted for the state grid supply.
- North west setting of the tracker is done manually once every three months.
- It may be scaled up for mounting PV panels up to 35 m² area by increasing the number of the supporting poles.

Design and Development

The system comprises a solar PV panel mounting structure with tilting adjustment and a rigid pole at the center. The PV panels of 1 kWp capacity are mounted on the tracker. Two photo sensors (photo diodes) are fitted at 45°. A control circuit is used for moving the solar PV panel in the high solar intensity region. The semi-circular structure provides smooth and controlled movement of the tracking system. The combinations of chain and sprocket and compound wheel drives are used to achieve the desired speed. Figure 1 shows the schematics of the solar tracking system (Picture 2). All the components of the solar tracking system are low cost and commercially available. Figure 2 illustrated the schematics of the control circuit. The microcontroller has been programmed such that when the intensity of light is less than 98 per cent and greater than 60 per cent the microcontroller drives the motor in forward direction (towards west) and if the intensity is more than 102 per cent and less than 150 per cent it drives the motor in reverse direction (towards east).

Tracker Performance

In tracking mode, the PV panel surface rotated slowly and remained perpendicular to the sun throughout the day, thereby reducing the cosine losses at the PV panel surface. The PV system output was connected to a DC pumping system and efficiency of the tracking system was worked out. Various parameters of the tracker system were
monitored and recorded for tracking and fixed modes of operation. Total electrical energy outputs in the fixed and tracking modes were 3.12 and 3.68 kWh, respectively, for solar radiation of 5.24 kWh/m²/day (Table 1). As compared to the fixed mode, the PV panels generated 18 per cent more energy in the tracking mode. Besides, variations in the electrical energy output were lower in the tracking mode than the fixed mode. The sun tracking system was found to be more effective during morning and late afternoon hours. Figure 3 shows the energy gained in the tracking mode (1 per cent tracking error) as compared to the fixed mode.

Table 1: Daily energy generated and energy gained

<table>
<thead>
<tr>
<th>Mode</th>
<th>Energy generated (kWh)</th>
<th>Energy gained (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>3.12</td>
<td>NA</td>
</tr>
<tr>
<td>Tracking</td>
<td>3.68</td>
<td>18</td>
</tr>
</tbody>
</table>

![Figure 3: Energy Gained in the Tracking Mode as Compared to the Fixed Mode](image)

Financial Aspects

The system has the following financial aspects:
- The estimated cost of the tracker for mounting 1kWp PV panel is ₹ 30,000.
- The pay-back period has been worked out to be six years as against expected service life of around 25 years.

Suitability for Specific Conditions

In India, good solar radiation is normally available for 300 days in a year. The operation of the system is automatic, only the tilt angle is required to be changed depending on the season (3–4 times a year). The system is maintenance-free except for protection of the gear reduction drive and the DC motor from the rainwater. A low-cost solar tracker appears ideal for solar pumping, roof top PV, and other similar applications.

Conclusion

A low-cost indigenous solar tracking system has been developed for small capacity solar power applications. The solar tracker increased energy generation by 18 per cent as compared to the fixed mode.

A Gokul Raj is an Associate Scientist at SPRERI, Dr V Siva Reddy is a Principal Scientist at SPRERI, and Avipsa Dey is an Assistant Professor at ITM Universe, Vadodara. Email: solar@spreri.org
With increasing health ailments due to indoor air pollution, there is a dire need for environment-friendly cookstoves. Recently, an improved wood-burning cookstove with a thermal efficiency of 28.3 per cent has been designed and fabricated to tackle this problem. This cookstove uses wood pellets, and twigs as fuel and its power output rating is 2.5 kWh. One of the striking features of this cookstove is its economical price.

Portable Cookstoves

At present, a large number of metallic wood stoves exist. Among these designs, one similar design, a multi-fuel portable stove (Picture 1) has been developed recently. The portable stoves are used for cooking which reduces fuel consumption and pollution. A variety of solid fuels such as wood, twig, leaf, dung cake, agricultural waste, raw coal, briquettes, etc., can be burnt in these stoves at high thermal efficiency, irrespective of different physical and chemical characteristics. The fuel saving is 50 per cent more than the traditional cookstoves.

For complete combustion of the fuels with low excess air, the fixed carbon and volatile parts of fuels burn separately in the corrugated grate and the perforated combustion chamber of the stove with the help of preheated primary and secondary air streams. The ash scraper helps to remove ash intermittently during burning. Otherwise, ash is discharged from the stove automatically. The design facilitates clean high temperature flame.

The Present Design

In the new stove, primary air enters throughout the perforated lower circumferential wall of the combustion chamber. The lower perforated portion of the combustion chamber is formed by two rows of air entry holes and is surrounded by a bottom-opened cylindrical cover. Stacked wooden sticks in combustion chamber get air from surroundings. A rectangular fuel feed opening is located just above the perforated wall. There is a sliding cover plate with the fuel feed opening. This cover can be slid easily to close the open portion of the opening above the wooden sticks, to prevent the entry of cold air during combustion. A fuel rest plate also exists at the bottom of the perforated wall on which the wooden sticks are placed. These sticks remain inclined when placed on the fuel rest plate. For the arrangement, primary air is available throughout the surroundings of the burning wooden sticks for better mixing during combustion. Thus, the wooden sticks burn well rather than if they were placed horizontally. Both primary and secondary air enters from the annular air space provided in between the combustion chamber and the surrounded bottom opened large cylindrical cover at the lower portion of the stove. The secondary air stream then enters the smaller diameter portion of the stove. This air is preheated in annular air passage surrounding the combustion chamber wall and mixed with effluent gas through upper perforated wall in which two rows of air entry holes are there. One
row is located above the fuel feed opening and the other row is aligned with upper level of the opening. The primary air is preheated when it comes in contact with the perforated lower circumferential wall of the combustion chamber enclosed by the large cylindrical cover. The secondary air also initially heated in the same region.

In the new stove, as primary air enters through the perforated wall located above the fuel rest plate, not through conventional grate at bottom, the deposited ash is unable to block the air passage. The deposited ash also helps to preheat this primary air. In the stove, ash removal is possible after a long interval, practically after completion of cooking. To facilitate ash deposition on fuel rest plate, the primary air entry holes are cut, keeping a reasonable gap from fuel rest plate. The ash removal process is very simple in the stove. One end of the fuel rest plate is hinged with the lower part of combustion chamber wall and the other end is arranged with a hinged lock clip fitted with outer wall of the stove. By opening the lock clip, one end of the rest plate is dropped down to clear the ash from the stove. The provision of an ash chamber below the grate is thus eliminated in this design. This design also avoids implementation of the complicated shaker grate system of present day’s metallic wood stoves (Figure 1 and Pictures 2–6).

![Figure 1: Sketch of the Stove](image1)

**Specifications of the stove (Table 1)**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of combustion chamber</td>
<td>20 cm</td>
</tr>
<tr>
<td>Height of the combustion chamber</td>
<td>20 cm</td>
</tr>
<tr>
<td>Diameter of fuel rest plate</td>
<td>21 cm</td>
</tr>
<tr>
<td>Smaller diameter portion of stove surrounding combustion chamber</td>
<td>27 cm</td>
</tr>
<tr>
<td>Height of the annular secondary air passage (i.e., height of stove body at smaller diameter portion)</td>
<td>13.5 cm</td>
</tr>
<tr>
<td>Diameter of stove at large diameter portion</td>
<td>33.5 cm</td>
</tr>
<tr>
<td>Height of stove body at large diameter portion</td>
<td>6.5 cm</td>
</tr>
<tr>
<td>Height of the cooking pot supports</td>
<td>2.5 cm</td>
</tr>
<tr>
<td>Total height of the stove from support stand to pot support</td>
<td>33 cm</td>
</tr>
<tr>
<td>Height of lower perforated wall of combustion chamber</td>
<td>7.5 cm</td>
</tr>
</tbody>
</table>

contd.
AT PRESENT, A LARGE NUMBER OF METALLIC WOOD STOVES EXIST. AMONG THESE DESIGNS, ONE SIMILAR DESIGN, A MULTI-FUEL PORTABLE STOVE HAS BEEN DEVELOPED RECENTLY. THE PORTABLE STOVES ARE USED FOR COOKING WHICH REDUCES FUEL CONSUMPTION AND POLLUTION. A VARIETY OF SOLID FUELS SUCH AS WOOD, TWIG, LEAF, DUNG CAKE, AGRICULTURAL WASTE, RAW COAL, BRIQUETTES, ETC., CAN BE BURNT IN THESE STOVES AT HIGH THERMAL EFFICIENCY. 

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gap in between fuel rest plate and lowermost row of holes for ash deposition</td>
<td>2.5 cm</td>
</tr>
<tr>
<td>Height of upper perforated wall of combustion chamber</td>
<td>6 cm</td>
</tr>
<tr>
<td>Distance in between fuel feed opening top to top of the stove body</td>
<td>5 cm</td>
</tr>
<tr>
<td>Diameter of air entry holes in both lower and upper perforated walls</td>
<td>2 cm</td>
</tr>
<tr>
<td>Total number of holes in lower perforated wall of the combustion chamber (in two rows, 21 number holes in each row)</td>
<td>42 nos.</td>
</tr>
<tr>
<td>Total numbers of holes in upper perforated wall of the combustion chamber (21 number holes in one row above fuel feed opening and 17 holes in other row aligned with upper level of fuel feed opening)</td>
<td>38 nos.</td>
</tr>
<tr>
<td>Length x height of fuel feed opening</td>
<td>11.5 cm x 7.5 cm</td>
</tr>
<tr>
<td>Mean circumferential length of fuel feed opening</td>
<td>12 cm</td>
</tr>
<tr>
<td>Height of fuel feed opening bottom from fuel rest plate</td>
<td>7.5 cm</td>
</tr>
<tr>
<td>Inclination angle in between centre of fuel rest plate and bottom of the fuel feed opening</td>
<td>35°</td>
</tr>
</tbody>
</table>

Materials used in the stove

Table 2 shows the specifications of the materials used to make the new cookstove.

Table 2: Specifications of the Material

<table>
<thead>
<tr>
<th>Material</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stove body</td>
<td>18 gauge MS sheet</td>
</tr>
<tr>
<td>Fuel rest plate</td>
<td>16 gauge MS sheet</td>
</tr>
<tr>
<td>Pot stand and stove stands</td>
<td>6 mm MS strips</td>
</tr>
</tbody>
</table>

Design calculations

Table 3 presents the stove specific design calculations.

Table 3: Design Calculations

<table>
<thead>
<tr>
<th>Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross sectional area of combustion chamber</td>
<td>314 sq.cm</td>
</tr>
<tr>
<td>Cross sectional area of solid fuel rest plate</td>
<td>346.2 sq.cm</td>
</tr>
<tr>
<td>Cross sectional area of larger diameter portion of stove</td>
<td>880.9 sq.cm</td>
</tr>
<tr>
<td>Cross sectional area of clearance space for both primary and secondary air entry from bottom of the stove</td>
<td>534.7 sq.cm</td>
</tr>
<tr>
<td>Area required at the bottom of the stove for primary air entry is equal to the cross sectional area of combustion chamber</td>
<td>314 sq.cm</td>
</tr>
<tr>
<td>Available area at the bottom of the stove for secondary air entry</td>
<td>220.7 sq.cm</td>
</tr>
<tr>
<td>Desirable height of the perforated wall below fuel feed opening for primary air entry</td>
<td>5 cm</td>
</tr>
<tr>
<td>Available area of annular space in between combustion chamber and surrounded smaller diameter cover wall for secondary air entry</td>
<td>258.2 sq.cm</td>
</tr>
<tr>
<td>Actual available area of annular passage due to blockage for fuel feed opening</td>
<td>216.2 sq.cm</td>
</tr>
<tr>
<td>Percentage of secondary air passage area with respect to area available for primary air</td>
<td>68.80%</td>
</tr>
<tr>
<td>Mean circumferential length of unblocked section of annular passage in between combustion chamber and surrounded cover</td>
<td>61.8 cm</td>
</tr>
<tr>
<td>Designed height of perforated wall at upper portion of combustion chamber</td>
<td>3.5 cm</td>
</tr>
</tbody>
</table>

contd.
**Specification**

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual height taken to cut one row of air entry holes above fuel feed opening and another row of holes aligned with upper level of fuel feed opening. The additional height at upper section of stove also helps for better mixing with effluent gas for complete combustion.</td>
<td>6 cm</td>
</tr>
</tbody>
</table>

**Merits of the Newly Designed Cookstove**

The new cookstove has the following merits:

- It has high thermal efficiency along with reduced smoke emission.
- For better mixing with wood fuel during combustion, the primary air in the stove is supplied throughout the perforated circumferential wall at the lower part of combustion chamber.
- In addition to the typical preheating system of secondary air, which while passing through the annular air passage surrounding the combustion chamber wall, the primary air is also preheated as it comes in contact with the perforated lower circumferential wall of the combustion chamber.
- The primary air is allowed to enter through the perforated wall located above the fuel rest plate, in spite of the conventional grate at the bottom. It helps to prevent the blockage of air passage for primary air entry by ash deposited on fuel rest plate.
- Ash removal is very easy; it can be done by just opening the holding clip of the fuel rest plate.
- Sliding cover plate of fuel feed opening prevents the entry of the external cold air inside the combustion chamber.

**Testing of the Stove as per IS Specifications**

The new cookstove went through two important tests—determination of burning capacity rate and thermal efficiency; the results of which were 7,642.88 kcal per hour and 28.3 per cent, respectively (see Pictures 7 and 8). Thereafter, the author calculated the power output, which is 2.5 kW (1 kW = 860 kcal).

According to the size of the stove, its main application is seen in the rural areas, both for domestic and community cooking purposes.

**Process for Mass Production**

First, the MS sheet pieces are cut into appropriate sizes by shear cutting machine. Then the roller bender is used to make cylindrical combustion chamber and the surrounding covers. Finally, riveting and gas welding are used for the necessary joints.

**Estimated Project Cost for Mass Production**

The project cost for mass production includes the costs of the land, shad building, electricity connection, machineries, equipment (light duty shear cutting machine, drilling machine, roller bender, gas welding apparatus, portable grinder, hand tools, etc.), salary of staff/employees, raw material, utility and other expenses and working capital per month. The total expenditure is around ₹ 1,865,000. Similarly, the total cost of production per annum (which includes the annual fixed cost and variable cost) is ₹ 5,202,907. If one sells 500 stoves per month at the rate of ₹ 1,000 as ex-factory price, then the annual sales revenue will be ₹ 6,000,000. In this way, the net profit=sales revenue per annum – (total production cost + 12.5 per cent tax on operating profit) will be ₹ 697,456. Thus, the break-even production level will be 66 per cent. Therefore, this new green stove not only helps us in keeping our environment clean but is also very cost-effective.

Sankha Subhra Datta is a Senior Section Engineer (Mechanical) in the Diesel Locomotive Shed. N.F. Railway, Siliguri Junction, West Bengal. Email: subhradatta611@gmail.com
Accelerating ENERGY ACCESS in Indian Villages

By 2019, the new government plans to ensure that every home in India will be able to run at least one light bulb powered by solar energy. Anuradha Bhavnani finds out how social entrepreneurs and the private sector can support this goal.

Shell Foundation, an independent charity, has been working in India since 2002 to increase the provision of energy to low income communities, by creating and scaling decentralized energy solutions in under-served areas. The Foundation’s experience has shown that when private, public, and philanthropic resources are harnessed collectively, social and economic goals can be achieved more effectively.

Rural Energy Reality
For more than 850 million people residing in the rural parts of India, energy is an issue that significantly impacts their health, education, and income-generating opportunities. Often people on low income are treated as ‘poor’, not as consumers that need modern energy solutions tailored to their needs and budget. Where energy solutions do exist, like solar lights or clean cookstoves, in the past they have been made available through giveaway programmes that rely on long-term donor support.

The main question is could a sustainable and scalable market be created to deliver high-performance modern energy products and services that people can afford, want to buy, and generate economic and health benefits.

Catalysing a New Generation of Energy Products and Services
With 70 per cent of India’s population living in remote, low-density, rural areas where centralized electricity grids are unviable, new solutions need to be developed to meet the growing demand for energy in ways that can accommodate their income levels.

The lack of affordable and accessible energy products is a major barrier to inclusive economic growth. Recognizing this, the Foundation has focussed on developing long-term partnerships with pioneering energy entrepreneurs who aim to overcome this challenge.

The Foundation also provides its partners with patient grant-funding and extensive business support to create new business models, build new value chains, and achieve financial viability—with the ultimate aim of delivering large-scale impact.

Increasing Access to Safer and Brighter Lighting for Rural Households
For example, one of their partners, Husk Power Systems an innovative start-up based in Bihar has pioneered a mini-grid system to provide affordable electricity to rural communities, and d.light, a social enterprise is a manufacturer of high-quality, low-cost solar lanterns.

The Foundation has helped d.light develop innovative models to make solar lanterns more accessible. For instance, d.light has established partnerships with microfinance institutions so that loans could be made available to purchase the lanterns. With Husk Power Systems, the Foundation created a new model for distributed energy that provides rural consumers with reliable and affordable electricity on a pay-as-you-go plan.
Accelerating Energy Access in Indian Villages

for ₹ 60 a month. So far, d.light and Husk Power Systems have improved more than 33 million livelihoods globally.

While bringing these energy products and services to rural communities, it was observed that a number of challenges exist which prevent energy enterprises from scaling up faster. Firstly, rural consumers are unaware of the impact of using traditional fuels, and are risk averse to investing in products and services that have previously not existed. As a result, market demand for modern energy products and services needs to be created. To do this, the Foundation worked closely with their partners to organize rural marketing campaigns that educated communities on the social, economic, and health benefits of solar lanterns and affordable electricity.

However, this is not enough to deliver scale. Despite developing low cost solutions, consumer finance continues to be a key barrier to scale. The Foundation worked on a range of new financing solutions to make modern energy products and services more affordable. The new government’s policy of financial inclusion through bank accounts for everyone could play a major part in making affordable consumer credit available for energy.

The biggest challenge for manufacturers such as d.light and another partner Envirofit—a clean cookstove business—has been in creating a large-scale distribution network to reach consumers in remote areas.

The Last Mile Distribution Challenge

Clean cookstoves, solar lights, or water purifiers are examples of social impact products that offer consumers a chance to enhance their quality of life and earning potential, and help to drive inclusive development in rural areas. However, due to the lack of infrastructure, low margins, and consumer awareness, manufacturers of these products find it difficult to serve these markets at scale.

Dharma Life, a social enterprise which the Foundation co-created in 2010, seeks to address this. The business has created a network of village entrepreneurs to sell social impact products developed by enterprises and corporates to rural consumers. Products include affordable energy solutions such as solar lanterns, as well as health and livelihood products like sewing machines from Singer and Usha, cycles from Hero, baby products from Johnson & Johnson and an iron-fortified nutritional drink from Coca-Cola. So far, more than one million livelihoods have been improved through their network of over 2,000 village-level entrepreneurs that operate in Uttar Pradesh, Maharashtra, Bihar, Karnataka, and Rajasthan.

Growth Financing for Early Stage Energy Enterprises

India is a hotbed of entrepreneurial activity. However, early stage energy enterprises rarely access finance to enable them to grow beyond the startup phase, due to a lack of track record and collateral to secure debt from banks. According to recent estimates, the debt gap for India’s small and medium-sized enterprises (SMEs) now exceeds $20 billion. In 2010, Shell Foundation formed a strategic partnership with IntelleCap, a social investment consultancy. Together they co-created IntelleGrow, a financial intermediary that provides missing debt finance to small and growing businesses serving low-income communities in India, with a major focus on access to energy. IntelleGrow takes a different approach to lending; they provide tailored loans to SMEs-based upon viability (not the availability of collateral) that can demonstrate both high growth potential and an ability to deliver social and environmental impact. By September 2014, they had dispersed more than ₹ 100 crores, and already funded 60 companies, among them Husk Power Systems and Envirofit.

Scaling-up Solutions

These enterprises are examples of disruptive and innovative solutions that are working to increase energy access. However, they alone cannot solve an issue that affects 850 million people. Whether it is directly supporting social enterprises to scale-up, leveraging distribution networks to improve access to products and services, creating an inclusive business, developing a new product, or building the infrastructure to support a sector—all of these are necessary to addressing India’s energy challenges. The Shell Foundation has found that patient and flexible grant support can help prove and validate new models, which can then open up the social investment sector and allow others to scale highly impactful inclusive businesses.

In India, there is an emerging range of foundations, investors, corporates, and government departments interested in bringing these solutions to scale. By creating more collaborative and coordinated action, it aims to achieve universal energy access in the country far quicker than expected.

Anuradha Bhavnani is the Regional Director, Shell Foundation. Email: anuradha.bhavnani@shell.com.
The state of Madhya Pradesh has come a long way and progressed immensely from a stage of power-deficiency to being power-rich. Proud to have achieved self-reliance in energy, the state is now striving to ensure energy security for all.

Energy for the future is everybody’s concern. This is a common knowledge that conservation of energy is more important than generation. The ever-increasing biological pressures on the natural resources are leading to multiple problems. The conventional sources of energy have limitations. The sustainable power generation to satiate the energy demands of humans and industries is a challenge across the world. Harnessing inexhaustible green energy therefore, remains the only solution in sight. The alternative sources of energy need to be tapped in such a manner that energy as a resource becomes affordable and accessible to the neediest. Another logic that goes in favour of renewable energy is that it is environment-friendly and has potential of creating jobs. The manufacturing, installation, and maintenance wings within the renewable sector can employ a young workforce on a massive scale.

Great Start

Madhya Pradesh has made a good start. Just three years back, Madhya Pradesh started its journey. Today, the state is shining on India’s renewable energy map. Several milestones have been achieved in this regard. Many records have been made and now a history is in the making.

Aggressive progression with futuristic policies and a strong leadership of Chief Minister Shri Shivraj Singh Chouhan will make the state a hub of renewable energy of India. The journey has certainly gained pace.

Investors and green energy developers are now looking towards Madhya Pradesh as an ideal destination. The Global Investors Summit (GIS) at Indore witnessed a host of companies keen on investing in the state. The untapped potential in renewable sector has drawn an investment of nearly ₹50,000 crore. Encouraged by the policy support and enabling investment-friendly atmosphere, major players in the renewable sector have readily agreed to invest. Close to 250 developers have been registered, conveying their intention to invest. Also about 50 proposals were discussed during the business sessions.

Undoubtedly, it is a significant positive change at a nascent stage; though, there are ‘miles to go’. Madhya Pradesh is also going to experience a complete transformation in the energy sector with the central leadership and support. Prime Minister Shri Narendra
Modi has clearly spelt out his vision of promoting renewable energy in the country.

Potential Unlimited
Madhya Pradesh today remains the most preferred destination for genuine investors. The investors wish to assure themselves of uninterrupted power supply. Their choice falls on alternative sources, which they can afford to possess. This is a significant change in the investment behaviour. Madhya Pradesh has readily given space for this in its well-designed policies. The state has a potential of more than 5,000 MW in wind power, 1,200 MW in biomass, 750 MW in small hydro, and 5,000 MW in solar sector. In 2012, the total installed capacity in wind, solar, biomass, and hydro power sectors were 438.24 MW. The installed capacity in solar sector was only 2 MW. At present, it is 868.65 MW and in next three years it will be 6,400 MW. The solar sector will have 2,654 MW installed capacity and the wind sector will have 3,261 MW. The centre has proactively come forward with enthusiastic support to help the state increase its share of renewables in the total power production up to 30 per cent. Currently, it is 4.61 per cent.

Milestones
India’s largest 130 MW solar power project has been set up at Neemuch in a record time of eight months. The world’s largest 750 MW ultra mega solar power project is coming up at Rewa. It is a joint venture of the state government and the Solar Energy Corporation of India along with The World Bank. The largest project for repowering of a wind farm is being taken up in Dewas. This will repower 8 MW wind farm to more than 45 MW. Besides, 4,000 MW renewable energy transmission plant which will cost around ₹ 2100 crore, has been proposed to be taken up in the green corridor. Five solar cities—Bhopal, Indore, Gwalior, Rewa, and Jabalpur—will also be coming up soon.

Consequently, Madhya Pradesh has not only emerged as an investment destination but also as a hub of renewable energy in India. Investing in green energy simply means investing in the future.

Rajendra Shukla is the Minister for New and Renewable Energy, Government of Madhya Pradesh.
Shri Bhavani Museum, owned by the state government, is situated on a picturesque hillock in Aundh, Satara district, Maharashtra. It is surrounded by lush green hills, rivers, and lakes. The annual average wind speed of this area is 5.2 m/s at 20 m and 6.3 m/s at a height of 50 m. One of the large wind farms with voluminous megawatt capacity wind turbines are also located nearby. In December 2013, a Windistar 4500 (4.5 kW) wind turbine developed and manufactured by Luminous Renewable Energy, Pune was installed here on a mast of 18 m. The brand name ‘WindiStar’ is derived from the three words namely Wind +India +Star, i.e., a star performer wind turbine from India. It was developed after more than 18 months of research and development by Luminous Renewable Energy, Pune. The main technology focus was on the two main components of a wind turbine, namely the blades and the alternator. With this wind turbine and 3.6 kW solar panels, storage batteries, and inverter, the hybrid power plant provides most of the electricity required by this museum. It also takes care of full backup power during power cuts, which last for four hours or more on most of the days.

Since last one year, this wind solar hybrid system has been generating around 1,300 kWh units of DC energy/month during windy season and 700 kWh/month during non-windy season. The solar panels generate around 300 kWh/month during monsoon and 450 kWh/month during other seasons. The 4.5 kW WindiStar wind turbine generates the balance energy between 1,000 kWh/month in monsoon and 350 kWh/month during other seasons. After efficiency loss in the battery and inverter, the museum gets about 550–1,000 kWh of 230 VAC power of grid quality.

This wind turbine spins absolutely in silence. It provides more than 5 kW output at 12.5 m/s wind speed and almost 6 kW at a little higher wind speed. It weighs only 113 kg as against other internationally reputed 5 kW wind turbines which weigh more than 250 kg. Hence, heavy and expensive tower is not required.

Rajarshi Sen, Shweta Kamble, and Prashant Tippe work with Luminous Renewable Energy Solutions Private Limited, Pune. Email: shweta@luminousrenewable.com
Punjab Net Metering Policy Launched

Mr Bikram Singh Majithia, Non-Conventional Energy Minister of Punjab, inaugurated Conference on Rooftop Solar Power generation under Net Metering Policy. The event was organized by the Punjab Energy Development Agency (PEDA) and Confederation of Indian Industry (CII).

He said that as the Prime Minister has made Swacchh Bharat a pan-India mission, making clean energy as the part of this mission would serve twin purposes of making India power surplus without polluting our environment. Speaking on the occasion, Shri Upendra Tripathy, Secretary, Ministry of New and Renewable Energy (MNRE), pointed out that the Union government has set a target of 1 lakh MW Solar power in next five years and it would be possible only through active cooperation of states. He said that solar potential of the country was being re-assessed and the Union government was also contemplating to set up a “Solar Army” comprising of 15,000 Industrial Trained Institute (ITI)-trained students to take care of big solar power projects being planned on vacant spaces available along with major roads, railway tracks, deserts, or in non-agricultural lands besides roof tops of major governmental as well as public sector undertakings.

S K Shukla, CEO, CREDA, wins prestigious Sourya Urja Vibhushan Award

Mr S K Shukla, Chief Executive Officer (CEO), Chhattisgarh Renewable Energy Development Agency (CREDA); Vice President (VP), Association of Renewable Energy Agencies of States (AREAS), won the Prestigious Award of “Sourya Urja Vibhushan” for his outstanding and yeomen contribution to the solar energy in Chhattisgarh.

Shukla’s work on solar rooftops and “Renewable Remote Access Distributed Power Generation (RRADPG)” is commendable and has brought far-reaching impact to a large section of the state’s population, giving them access to “Clean and Green Energy” and related resources. His work and leadership at CREDA has laid National Benchmarks for development of “Solar Rooftops and De-Centralized Systems (SRDS)” in India, starting with the CREDA headquarters that has been one of the most-awarded government buildings in the country. He was instrumental in powering the assembly building and secretariat of state government with “1MW Solar Captive facility” and has been at the forefront of driving the theme of “Sustainable Energy Access for All (SEAA)” in the state of Chhattisgarh.
One new idea for storing energy and helping the grid use more wind and solar power is about as unflashy as it gets. It involves turning a lot of electric heaters on and off really fast. Demonstrations from Hawaii to Pennsylvania to the eastern banks of Canada are showing that a ‘fleet’ of water or space heaters can act as a sort of fast-acting sponge that absorbs extra electricity on the grid, especially wind power.

The idea is both simple and extremely complex. A handful of companies are rolling out wireless controllers that work with existing water heaters—that is the easy part—and building ‘virtual power plants’ that may make a crowd of heaters as responsive as a traditional power plant. Those who have developed and studied the technology say it is just about the cheapest form of energy storage there is, though it lacks some crucial abilities that are found in batteries. And the kinks are still being worked out.

A four-year test is wrapping up in the maritime provinces of Canada (New Brunswick, Nova Scotia, and Prince Edward Island). There, 16 or 17 MW of heaters in homes and businesses are storing energy in tandem with the forecast output from wind turbines. New Brunswick now gets 8 per cent of its electricity from wind.

“If every water heater in North America becomes capable of storing energy, you have a huge battery,” said Michel Losier, a programme director at NB Power, the primary utility for New Brunswick. “I think what we are demonstrating is that this works,” he adds.
The emerging term for this technology is the Grid-integrated Water Heater (GIWH). The unit’s controller is connected to the internet or to a cell network, and it switches the heat on or off very quickly, even in microseconds. A connected space heater works in much the same way. Meanwhile, the customer’s water (or air) remains consistently hot.

In the US, a leading player is Battelle, the giant not-for-profit research group, which plans to spin off a GIWH business ‘very, very soon,’ said spokesman TR Massey. Another is Steffes Corp. of North Dakota, (Picture 1) whose mainstay business is building oil tanks for the fracking industry.

“The biggest opportunity in the US is the country’s 40–50 million electric water heaters. Many are concentrated in the Pacific Northwest, where electricity rates are cheap, and in the South, where rural communities rely on electric heaters because they have no gas lines,” said Dan Flohr, the founder of Sequentric, a GIWH startup that is collaborating with Battelle.

Canada has those water heaters and a lot of electric space heaters, which store heat in ceramic bricks. Both bricks and water can store heat for long periods. That means the heating can occur any time of day.

A hundred water heaters are undergoing tests at Hawaiian Electric Co. (HECO). They are part of a simulation that has them soaking up power from wind farms when the turbines produce more power than the grid can use, according to Earle Ifuku, Director of HECO’s demand response division.

HECO’s eventual plan is to have the water heaters smooth the output from wind farms so the utility can turn its attention to the even more unpredictable output from the state’s many rooftop solar installations. In a different pilot project in Pennsylvania, water heaters were used for ‘frequency regulation,’ or keeping the grid in the narrow frequency band where it is stable. Internet-connected water heaters were installed last year at two buildings on the campus of PJM Interconnection, which oversees the grid in 13 eastern states. At two-second intervals, they determined whether to heat water based on signals from other power plants and users. PJM participated in a similar test last year in Washington, DC, with 30 water heaters.

‘I was surprised how quickly they can respond,’ said Scott Baker, a PJM engineer.

The Downside

However, there are important ways in which a GIWH is not as flexible as a battery, Baker said. A heater fleet can absorb power but cannot send it back to the grid, like a battery can. Where the problem is congestion—a choke point where wires simply cannot accommodate any more electrons, batteries can be placed at strategic points, while water heaters cannot.

Such limitations mean GIWHs do not meet the rules for incentive programmes for energy storage in the country’s two largest markets, California and New York, Flohr said.

In fact, many of today’s water heaters are already radio-controlled, but in a more blunt fashion. Since the 1970s, utilities have offered rebates and giveaways for water heaters that the utility can turn off for a few hours at a time on the hottest summer days or coldest winter days, when overall electricity demand is high. The new generation of fast-response, internet-enabled water heaters may find their way into homes with incentives like this. But that day may still be a way off. The controllers and the platforms are still expensive. As with any new technology platform, competing standards are creating confusion and slowing things down.

‘It works, but it is a bit clunky yet,’ said Losier of NB Power. ‘It is going to take some time.”
Portable Solar Water Purifier

Water purification comprises various processes such as removing suspended solid particles, undesirable chemicals, and gases from contaminated water. Most water is purified for human consumption (drinking water), but water purification may also be designed for a variety of other purposes, including meeting the requirements of medical, pharmacological, chemical, and industrial applications.

Purification of water mainly consists of two processes, i.e., filtration and disinfection. The Solar Water Purifier presented here makes use of both these processes.

Water filtration is carried out using pre-filter (washable debris filter), 0.5 micron sediment filter, and activated carbon filter where solid particles like sand, debris, fine particles are removed from water. Water disinfection is carried out using UV filtration.

As UV light from the sun is known for its ability to destroy micro-organisms, in recent years, equipments producing UV light have been manufactured for residential use. UV energy is produced by low mercury vapour enclosed in a tubular lamp. Energy produced by the UV lamp has the ability to destroy micro-organisms such as parasites, bacteria, etc.

This water purifier is compactly assembled on a four wheel trolley for easy transportation from one place to another in nearby locations. It also facilitates charging the battery from mains supply during low sunshine days or in rainy season when the sun’s radiation level is insufficient to charge the battery. Also, one can take external DC supply from a vehicle to operate this equipment.

The design is made considering the aspect of human machine interface. Various and displays are provided for the operating parameters, which makes this machine very easy to operate. The filtration capacity of this water purifier is 300–500 L/Hr. Capacity may slightly vary according to the type of water used. This purifier can be used to purify water from any fresh water source such as stream, pond, lake, well, etc.

Depending on the type of water, the user needs to change only the cartridges in the filter to ensure quality of filtration water. If required, one can use Reverse Osmosis (RO) filtration methods powered by solar energy according to the type of water. This is a very useful product for both rural and urban areas.

Sanket Deshmukh, Executive, Samved Energy Systems Pvt. Ltd
Email: samvedenergy@gmail.com

Key Features
- Portable and easy to install and operate
- Uses solar energy as primary source for water filtration
- Used to purify water from stream, pond, well, lake, or any fresh water source
- Ideal for both rural and urban areas
- Filters as well as disinfectant (UV Disinfection), pre-filter, micron sediment, activated carbon, and UV filter
- Powered by 125 Wp PV Module and 12V, 150 Ah
- Battery and four axis tracking module frame for direction adjustment

Akshay Urja (bilingual) is widely circulated to all stakeholders of renewable energy. We invite advertisements (in colour) from interested organizations, manufacturers, institutions, etc. The advertisement tariffs are as follows:

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It’s fun time kids. Let’s see how much you have learnt about the renewable energy terminology. Try out this crossword puzzle.

**Down**

1. .................. is a tall thin structure with parts that turn around, and is used to change the power of wind into electricity.

4. .................. is generally defined as the energy that comes from sources which are naturally replenished.

7. .................. is a method of generating electrical power by converting sunlight into direct current electricity.

**Across**

2. .................. is a process that converts organic material into carbon monoxide, carbon dioxide, and hydrogen.

3. .................. is the power derived from the energy of falling or running water.

5. .................. is a modern, small-scale version of centralized electricity system.

6. .................. refers to a solar thermal energy panel or a set of solar photovoltaic modules.

8. .................. is a type of energy generated and stored in the Earth.

9. .................. is biological material derived from living organisms.

10. .................. is a device which uses the energy to heat, cook or pasteurize food or drinks.

For answers of this crossword puzzle, refer to the next issue of ‘Akshay Urja’.
IREEED website, a publicly available database of renewable energy and energy efficiency

Indian Renewable Energy and Energy Efficiency Policy Database (IREEED) is a publicly available database that is a repository of all central and state government policies, incentives, and programmes related to renewable energy and energy efficiency. The Ministry of New and Renewable Energy Sources (MNRE) has developed an online database to disseminate information on the renewable energy and energy efficiency policy and regulatory framework in India. The entire database has been made available online at the website www.ireeed.gov. IREEED summarizes the policies of renewable energy and energy efficiency published by the MNRE, the Bureau of Energy Efficiency (BEE), and other State Nodal Agency (SNA) and State Designated Agency (SDA). Information on Feed-in Tariff (FIT), Renewable Purchase Obligations (RPOs), and Open Access (OA) regulations pertaining to renewable energy is included in IREEED.

Sustainable Bioenergy Production
Editor: Lijun Wang
Publisher: CRC Press
583 Pages

It is essential to move towards a sustainable bioenergy-based economy considering the environmental concerns and declining availability of fossil fuels, in addition to the growing population worldwide. But, it is also imperative to address sustainability in the bioenergy industry just to avoid depleting necessary biomass resources. Sustainable bioenergy production encompasses comprehensive knowledge and skills for the analysis and design of sustainable biomass production, bioenergy processing, and biorefinery systems for professionals in the bioenergy field. The book has four sections—Fundamentals of Engineering Analysis and Design of Bioenergy Production Systems, Sustainable Biomass Production and Supply Logistics, Sustainable Bioenergy Processing, and Sustainable Biorefinery Systems.

World Energy Outlook 2014
Type: Study
Publisher: International Energy Agency
748 Pages

The global energy landscape is evolving at a rapid pace, reshaping long-held expectations for our energy future. The 2014 edition of the World Energy Outlook incorporates all the latest data and developments to produce a comprehensive and authoritative analysis of medium- and longer-term energy trends, with projections for the first time extended to 2040. Oil, natural gas, coal, renewables and energy efficiency are covered, along with updates on trends in energy-related CO2 emissions, fossil-fuel, and renewable energy subsidies, and universal access to modern energy services. The WEO-2014 provides in-depth analysis of some topical energy sector issues, i.e., Energy sector investment, Africa, and Nuclear power. The report finds that investment in sub-Saharan energy supply has been growing.

Understanding Wind Power Technology
Editor: Alois Schaffarczyk
Publisher: Wiley
482 Pages

Wind energy technology has progressed enormously over the last decade. In the forthcoming years, it will continue to develop in terms of power ratings, performance, and installed capacity of large wind turbines worldwide, with exciting developments in offshore installations. Designed to meet the training needs of wind engineers, this introductory text puts wind energy in context, from the natural resource to the assessment of cost-effectiveness, and bridges the gap between theory and practice. The thorough coverage spans the scientific basics, practical implementations, and the modern state of technology used in onshore and offshore wind farms for electricity generation.
Forthcoming Events

28–31 January 2015 | Mumbai, India
**Refining and Petrochemicals Expo**
Website: [http://10times.com/refining-petrochemicals-expo](http://10times.com/refining-petrochemicals-expo)

5–7 February, 2015 | New Delhi, India
**15th Delhi Sustainable Development Summit (DSDS 2015)**

15–17 February, 2015 | New Delhi, India
**RE-Invest, Global Renewable Energy Investment Promotion Meet & Expo**
Website: [http://www.re-invest.in](http://www.re-invest.in)

3–5 March, 2015 | Goa, India
**International Battery Expo & Recycling Conference**
Website: [http://10times.com/ibrx-india](http://10times.com/ibrx-india)

3–5 May, 2015 | New Delhi, India
**Isrmax Biomass Expo**
Website: [http://10times.com/isrmax-biomass-expo](http://10times.com/isrmax-biomass-expo)

3–5 May, 2015 | New Delhi, India
**IAI Biomass Expo**
Website: [http://10times.com/iai-biomass-expo](http://10times.com/iai-biomass-expo)

28–31 January, 2015 | Orlando, FL, USA
**Renewable Energy World Conference & Expo North America**
Website: [http://www.renewableenergyworld-events.com/index.html](http://www.renewableenergyworld-events.com/index.html)

22 January 2015 | London, UK
**Investing in the UK green economy: priority sectors, challenges, and next steps for policy**

16 February 2015–13 March 2015 | Various places, UK
**Solar Energy UK Roadshows**
Website: [http://www.solarpowerportal.co.uk/events/solar_energy_uk_roadshows](http://www.solarpowerportal.co.uk/events/solar_energy_uk_roadshows)

25–26 February, 2015 | London, UK
**Energy from Waste**
Website: [http://www.efwlondon.eu](http://www.efwlondon.eu)

3–4 March, 2015 | Nairobi, Africa
**Solar Energy East Africa**
Website: [http://africa.solarenergyevents.com/](http://africa.solarenergyevents.com/)

10–11 March, 2015 | London, UK
**Solar PV Investment and Financing**
Website: [http://finance.solarenergyevents.com/](http://finance.solarenergyevents.com/)
Renewable Energy at a Glance: India

Cumulative Installed Capacity (MW) of Grid Interactive Power

Cumulative Installed Capacity (MW) of Off-Grid Captive Power

Cumulative Installed Capacity (MW) of Other Renewable Systems

Source: www.mnre.gov.in
RE-Invest

- The event is a sequence of the “Make in India” initiative launched by Mr Narendra Modi, Prime Minister of India.
- The central theme of RE-Invest is to attract large-scale investments for the renewable energy sector in India.

Objective

- RE-Invest will be the first major platform for investment promotion in renewable energy sector at the Government of India level to signal India’s commitment to the development and up-scaling of renewable energy to meet its energy requirement in a sustainable manner.
- This will enable the global investment community to connect with renewable energy stakeholders in India.
- The event is expected to be attended by over 200 investors and over 1000 delegates, both domestic and international.
- In addition, representatives from State Governments, Public Sector enterprises, renewable power developers and manufacturers, state renewable energy nodal agencies, and other related stakeholders will play important roles.

Organizing Agencies

- Indian Renewable Energy Development Agency (IREDA)
- Confederation of Indian Industry (CII)
- Federation of Indian Chambers of Commerce and Industry (FICCI)
- Associated Chambers of Commerce and Industry of India (ASSOCHAM)
- PHD Chamber of Commerce and Industry

Conference and Exhibition Participants

- Manufacturers
- Project developers
- Investors
- Technologies
- Financing options
- Investment opportunities
- International companies

Readers can join us in this unique opportunity to meet and interact with the global investment community, renewable energy businesses across the world, and Central and State Government officials from India.

Details about schedule, agenda, subjects, registration procedure, pricing for exhibition space, accommodation can be gathered from the following websites:


The RE-Invest website has gone live on October 7, 2014
http://www.reinvest.in

For further information, please contact

gkumar.mnre@nic.in | cmd@ireda.gov.in | soma.banerjee@cii.in | rita.roychoudhury@ficci.com
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