Renewable Energy Akshay Urja

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India (Published in English and Hindi)

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Debajit Palit says that the Government of India's target date and IEA estimated date for achieving universal access in India is almost the same which further points out that the Saubhagya objective is achievable within the coming 2 years.

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Aayushi Awasthy and **Neha Pahuja** discuss some of the key energy sector transitions in India as well as in the world and feel that despite the resilience of oil demand, much of the changes in the energy sector are being made with the long-term aim of decarbonization.

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In this article, **Satish N Diwakar** outlines various aspects of solar photovoltaic (SPV) systems on rooftops, including evaluation of existing roofs where SPV systems can be safely installed.

अक्षय ऊर्जा का अगस्त-अक्तूबर 2017 अंक काफी जानकारी से लबरेज लगा। विशेष रूप से 'कॉप 23 में सौर ऊर्जा' लेख यह बताता है कि भारत 175 गीगावॉट का आर.आई. लक्ष्य प्राप्त करने में पूरी तरह से सक्षम है। गुजरात राज्य के सूरत शहर में स्मार्ट सिटी कार्यक्रम के सफल क्रियान्वयन के बारे में पढ़कर भी अच्छा लगा। निश्चित रूप से सूरत के विकास की प्रेरक गाथा देश के अन्य सभी आकांक्षी स्मार्ट शहरों के लिए मार्गदर्शक प्रकाशस्तंभ का कार्य करेगी।

गौतम सोलंकी
वदोदरा, गुजरात

I liked reading the article on Surat: India's leading 'Smart Solar City' published in August–October 2017 issue of *Akshay Urja*. The Government of India launched the smart cities mission in 2015, I am glad to know that TERI has been actively participating with the Surat Municipal Corporation [SMC] in planning and execution of various projects. In RE News, 'Indian scientists Develop Leaf that Absorbs Water, Sunlight to Create Fuel' is very interesting and informative. It may provide clean energy for powering eco-friendly cars in the future. Other articles on solar parks and solar tariff are good. As such, tariff is a major factor for the development of solar project in any country. Congratulations to MNRE and TERI team for such a wonderful publication.

Er. Anant B Tamhane
Consulting Engineer
Renewable Energy
Nagpur, Maharashtra

The feature article 'Escalation to the Renewables in India' is a very informative article that highlights the major achievements of the solar and wind sectors in the last 3–4 years and also the future for the sector. I also liked reading the article on wind power development in India as the author has traced the trajectory of wind energy in India via detailed policy measures, commercial viability, and wind power infirmity management guidelines. Thanks for publishing such useful articles and making the general public aware about the initiatives of the government for promoting renewable energy in the country.

B M Raju
Hyderabad, Telangana

I am a regular reader of ***Akshay Urja*** magazine. I noticed that you have changed the presentation style and layout of the magazine since the August–October 2017 issue; I really liked the new format of the magazine. As usual, the magazine is replete with information on renewable energy and other aspects of green energy. The article on green jobs in renewable energy is quite enlightening as the author has discussed the potential and scope of the generation of green jobs in the RE sector in India and also highlights that in the light of recent events in the climate change sphere, it becomes crucial to evaluate new opportunities and sustainable green jobs that can be generated by transition to RE.

Manoj K Arora
New Delhi

The 'Success Story of Solar Parks in India' very succinctly describes the critical success factors including development of solar parks in India and the related tariff trends. It is a good article to understand the critical issues and developments that have taken place with regards to solar parks in the country. The case study on Grid-connected Solar PV plants at AMU also highlights the initiative by the Aligarh Muslim University (AMU) for the installation of grid-connected solar PV plants in its campus with total capacity of 4.5 MW. The RE Event coverage on 'The Sun Reigns at COP23' has been presented very nicely with good pictures. Kudos!

Sandeep Banerjee
Lucknow, Uttar Pradesh

अक्षय ऊर्जा के नीवनतम् अंक में प्रकाशित विशेष रिपोर्ट काफी सारगर्भित लगी। शुल्क/टैरिफ आधारित प्रतिस्पर्धी बोली प्रक्रिया के लिए नए दिशा-निर्देशों की जानकारी इस क्षेत्र से जुड़े सभी लोगों के लिए बहुत लाभदायक है। गौरतलब है कि भारत में पवन ऊर्जा का उपयोग, बीते कुछ वर्षों में अनवरत अच्छी दर से बढ़ा है। लेखक ने विस्तृत नीतिगत उपायों, वाणिज्यिक व्यवहार्यता, और पवन शक्ति अस्थिरता प्रबंधन दिशा-निर्देशों के माध्यम से देश में पवन ऊर्जा की प्रगति-यात्रा का अच्छा ब्यौरा दिया है। अक्षय ऊर्जा पढ़कर आनंद की अनुभूति हुई। सधन्यवाद।

सुकेतु आचार्य
कोलकाता, पश्चिम बंगाल

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*

आनन्द कुमार
ANAND KUMAR

सचिव
भारत सरकार
नवीन और नवीकरणीय ऊर्जा मंत्रालय
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF NEW AND RENEWABLE ENERGY

Message

The year 2017-18 was a remarkable year in India's renewable energy landscape. Share of renewable energy continued to progressively increase in the electricity mix, renewable energy generation crossed 100 billion units for the year. Renewable power installed capacity has already reached over 69 GW. India is well on its way to achieving 175 GW target of installed renewable energy capacity by the year 2022. Low tariffs have been achieved for solar and wind power through transparent bidding and facilitation. Bidding trajectories for installing new solar and wind power capacities over next 3 years have been announced.

UNEP-Bloomberg "Global *Trends in Renewable Energy Investment 2018*" report released on 5 April 2018, stated that an investment of US $ 10.9 billion was made in renewable energy in India during the year 2017. India is progressively becoming a most favoured destination for investment in renewables.

On 11 March 2018, the Prime Minister of India and the President of France co-hosted the Founding Conference of the International Solar Alliance (ISA) in New Delhi. Forty eight countries, including India participated in this conference. In addition, there was representation from the United Nations, Multilateral Development Banks, energy-related think tanks, corporate sector and civil society. ISA is the first treaty-based international intergovernmental organization headquartered in India. 61 countries have already signed the International Solar Alliance (ISA) treaty, and many more are set to join. ISA is realization of idea and vision of our Prime Minister for providing clean and affordable energy to all.

In India, renewable energy has emerged as a true multi-benefit system, combining ecological necessities like climate change mitigation with society's visions and economic opportunities. I expect Akshay Urja newsletter to serve as a platform for informing about Government of India's plans and programmes and seeking information on aspirations of the masses. This process will immensely help us in policy formulation and effectively implementing the programmes.

With best wishes

[Anand Kumar]

गांव गांव बिजली, घर घर प्रकाश

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अक्षय ऊर्जा से देश विकास

सूरज एक रूप अनेक

From the Editor's Desk

Distinguished readers,

Akshay Urja is a humble effort to provide information on the latest renewable energy initiatives and developments in India.

The Founding Conference of the International Solar Alliance (ISA) was held on March 11, 2018, in New Delhi. The one-day Founding Conference was attended by Heads of State/ Heads of Government, dignitaries from the United Nations, Presidents of Multilateral Development Banks, and global funds/financial institutions, leaders from energy-related institutions, corporate sector, and civil society. The Hon'ble Prime Minister of India, Shri Narendra Modi inaugurated the conference along with the President of France, Mr Emmanuel Macron. In this issue, we have presented the Founding Conference of the ISA as the cover story. We hope you get all the relevant information about this important global event. Saubhagya scheme, another major initiative of the Government of India, have been detailed in this issue. We also seek suggestions for the next issue.

With best compliments and greetings!

P C Maithani
pcmaithani@nic.in

RE IN UNION BUDGET 2018/19

The Union Budget 2018/19 was tabled on February 1, 2018 by the Finance Minister, Government of India. It has proposed a budget estimate of ₹4,895.60 crore for renewable energy. Of this, highest allocation of ₹2,045 crore has been proposed for achieving a capacity addition of 11 GW solar power. This translates into a financial support of ₹18 lakh for 1 MW solar power capacity addition. Similarly for wind power, for each MW capacity additional financial support of approximately ₹2 lakh is envisaged. Emergence of renewables requires augmentation of grid infrastructure and for implementation of Green Energy Corridor project ₹600 crore has been allocated. In the off-grid and decentralized renewables, major allocations are for off-grid solar (₹848 crore) and biogas programme (₹135 crore). In monetary terms, the Budget estimate for 2018/19 has no quantum jump from the allocation for 2017/18.

MAJOR HIGHLIGHTS OF BUDGET ANNOUNCEMENTS (RELATED TO RENEWABLE ENERGY)

- Measures for purchasing surplus solar power from solar pumps in farmers' fields
- Reduction of customs duty on solar tempered glass or solar tempered (anti-reflective coated) glass for manufacture of solar cells/panels/ modules from 5% to zero.

In the past few years, a portion of renewable energy budget was being met from the National Clean Energy Fund (NCEF). The NCEF was created out of cess on coal produced/imported through Finance Bill 2010/11. NCEF guidelines of April 2011 were revised in March 2017, to expand the scope of the fund to include clean environment initiatives and re-named as National Clean Energy and Environment Fund (NCEEF).

The Goods and Services Tax (Compensation to States) Act, 2017 which has been notified in April 2017, provides that coal cess, along with some other cess would constitute GST Compensation Fund and the same would be utilized to compensate the States for five years for potential losses on account of GST implementation. After five years any amount left would be shared on 50% basis between the Centre and States. Budget proposals for 2018/19 are a reflection of the government's priority for renewables without any impact of subsuming NCEEF for GST purposes.

Renewable energy is considered as a merit good. Therefore, till the time the marginal social cost of the baseline energy options is more than the marginal private cost, there is strong justification to incentivize renewable energy systems and device. This is broadly accepted as a rationale and justification for affirmative action to develop and deploy renewable energy technologies.

Source: Energy Next, Volume 8, Issue 4.

RENEWABLE ENERGY NEWS

FOWIND COMMISSIONS INDIA'S FIRST LIDAR FOR OFFSHORE WIND RESOURCE ASSESSMENTS IN GUJARAT

The FOWIND Consortium has successfully commissioned India's first offshore LiDAR (Light Detection and Ranging), off the coast of Gujarat, in the Gulf of Khambhat. The data from this offshore LiDAR will support the Ministry of New and Renewable Energy's efforts towards exploring the full potential of offshore wind along India's long coastline. The National Institute of Wind Energy (NIWE) developed the offshore platform on which the FOWIND LiDAR has been commissioned. This activity is another significant contribution by the GWEC led FOWIND consortium towards ensuring that the offshore wind sector in India is supported by strong underlying technical data. This offshore LiDAR is a Leosphere WINDCUBE v2 procured by FOWIND from MeteoPole.

India has the world's 4th largest onshore wind market with a total installed capacity of close to 33 GW. However, India does have an acute need for large-scale, clean and indigenous energy generation to fuel its rapidly growing economy. Offshore wind power could play a very important role in India due to the large wind resources available near centres of high-energy demand. Globally, offshore wind power is becoming increasingly cost-effective with installations close to 14.5 GW at the end of 2016.

The four-year FOWIND project aims to put together a roadmap for developing a sustainable and commercially viable offshore wind industry in India. Upcoming offshore wind feasibility assessments by FOWIND, would further add to the knowledge of businesses and government institutions as to what is required for developing a successful offshore wind industry in India.

Source: communications@gwec.net

GOVERNMENT EXTENDS TRANSMISSION CHARGE WAIVER TO SOLAR, WIND POWER TILL MARCH 2022

The government has extended the waiver of inter-state power transmission charges and losses for the solar and wind power projects commissioned till March 31, 2022, with a view to giving a boost to clean energy sources.

Earlier, the waiver was available to solar and wind power projects commissioned till December 31, 2019, and March 31, 2019, respectively. The waiver was available for a period of 25 years from the date of commissioning of the project. "For generation projects based on solar and wind resources, no inter-state power transmission charges and losses will be levied on transmission of the electricity through inter-state transmission system for sale of power by such projects commissioned till March 31, 2022," according to an order issued by the Power Ministry.

The waiver will be available to these projects for 25 years from the date of commissioning provided the developers sign power purchase agreements with entities, including discoms, for sale of power for compliance of their renewable purchase obligation, the order said.

The order also provides that the waiver would be available to only those projects which are awarded through competitive bidding process as per the guidelines issued by the central government. Earlier the incentive was not available to firms other than power distribution companies. Thus, other entities procuring clean energy from these projects were at disadvantageous position. Now they can also avail the benefit.

Source: http://www.livemint.com/

LAUNCH OF BRPL SOLAR CITY INITIATIVE

As part of their initiative to promote clean energy, BSES Rajdhani Power Ltd (BRPL), one of Delhi's two electricity distribution companies (Discoms) along with GIZ, USAID, and TERI launched the country's first solar rooftop consumer aggregation programme 'BRPL Solar City Initiative' for residential buildings. The programme is designed to maximize rooftop solar power use in south and west Delhi.

The programme inaugurated by Delhi Power Minister Mr Satyendar Jain took place at the hotel, Vivanta by Taj, Dwarka, on January 7, 2018. Unlike conventional methods, under this programme, rooftop solar installations will be provided at a single point for the entire apartment complex. In the first phase of the programme, around 150 residential societies will be targeted in Dwarka. Evaluating the response, the programme will be extended to other

residential segments across BSES licensee areas. Mr Shirish Garud, Senior Fellow, RET Division, TERI, addressed the gathering of more than 200 residents across Dwarka and explained the benefits of installing solar PV system. TERI is an outreach partner of BRPL in its Solar City Initiative. BSES also launched the website conceptualized and designed by TERI during the event.

Source: http://www.teriin.org/

"INDIA TO ACHIEVE 175 GW RENEWABLE ENERGY AHEAD OF 2022 DEADLINE": SHRI ANAND KUMAR

"India would achieve its target of 175 GW of installed renewable energy capacity well before 2022 for which bidding process would be completed on time and International Solar Alliance (ISA) shall help mobilize sufficient funds for solar energy projects," said Shri Anand Kumar, Secretary, Ministry of New and Renewable Energy at Action to Transaction' Meet under the aegis of PHD Chamber of Commerce and Industry in New Delhi. Shri Kumar said in the statement issued by industry body that over the years the renewable energy has become cheaper and is set to replace conventional energy, which is a healthy development, and added that India has one of the fastest growing renewable energy programmes in the world.

"Prime Minister wants India to be an innovation hub for which we have to start thinking and supporting about the new

ideas for renewable sources particularly in solar energy with the objective of providing renewable energy to the common man as an affordable pricing," he added. He said the ISA is an excellent idea which helps millions of people to provide universal energy excess.

Source: economictimes.indiatimes.com

SECI COMMISSIONS INDIA'S SECOND-LARGEST GRID-CONNECTED ROOFTOP SOLAR PROJECT IN UP

The Solar Energy Corporation of India (SECI) has announced that it has commissioned the country's second largest rooftop solar PV power plant at GAIL's Petrochemical complex at Pata in Uttar Pradesh. The 5.76 MWp solar plant would generate about 7,930,000 units of electricity per annum for GAIL's captive use. The plant is expected to reduce approximately 6,000 tonnes per annum of carbon dioxide emission and contribute towards India's goals under COP21 commitment.

"GAIL as a marketer of benign fuel is thrilled to integrate captive solar PV towards achieving lower carbon footprint at our major installation," B C Tripathi, Chairman and Managing Director of GAIL said. The award for Turnkey execution of the project, including 5 years of operation and maintenance, was placed on Thermax Limited, selected through an open competitive bidding process by SECI.

"SECI being the PMC for this project is committed to provide its best services towards designing, engineering, procurement, construction, and commissioning of the project including its quality assurance to make it India's best rooftop installation," Jatindra Nath Swain, Managing Director at SECI said. SECI had also recently launched bids for 2 GW of ISTS-connected wind power and ISTS-connected solar power each.

Source: energy.economictimes.indiatimes.com

FOUR DELHI GURUDWARAS TO HARNESS SOLAR ENERGY FOR POWER

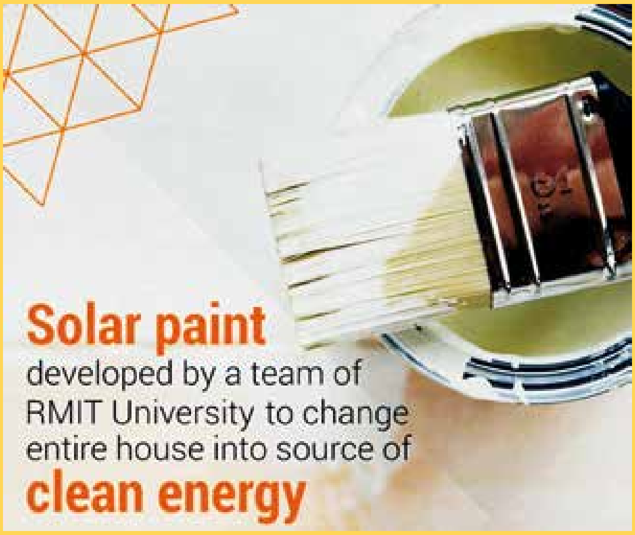
Four famous Sikh shrines in Delhi including Rakab Ganj and Bangla Sahib Gurudwaras will go green by employing solar energy to meet their daily power needs from April 2018. These four gurudwaras—Bangla Sahib, Gurudwara Rakab Ganj, Nanak Piao, and Majnu ka Tila—will be provided with rooftop solar panels having a total capacity of 1 MW, said Manjit Singh GK, the president of Delhi Sikh Gurudwara Management Committee (DSGMC). "The commissioning of solar plants will be completed by March-end," he said. A company enlisted with the Solar Energy Corporation of India (SECI) has been selected through competitive bidding, for executing the project, Singh said, adding a power purchase agreement has also been signed and the DSGMC is likely to save around ₹60 lakh per year as power bill. The solar project is a tribute to the 7th Sikh Guru Har Rai whose love for the nature and teaching for its preservation inspires the community to take care of the environment, he added. The DSGMC president said the project will generate around 4,000 units power per day, touching approximately 1.3 million units per year. "It will allow the gurudwaras to use peak-hour load during the day.

Source: http://www.business-standard.com/

A NEW 'SOLAR PAINT' LETS YOU TRANSFORM YOUR HOUSE INTO A SOURCE OF CLEAN ENERGY

Powering homes using clean energy is becoming easier thanks to a growing number of innovative technologies and initiatives. Some government programmes help homeowners with the financial burden of equipping their residences with energy-generating solar panels, and Elon Musk's Tesla has developed roofing tiles that double as solar panels to give solar power generation an aesthetic boost. A new innovation from Australia is poised to make clean energy even more appealing. A team of researchers from the Royal Melbourne Institute of Technology (RMIT) has developed a paint that can be used to generate clean energy. The paint combines the titanium oxide already used in many wall paints with a new compound: synthetic molybdenum-sulphide. The latter acts a lot like the silica gel packaged with many consumer products to keep them free from damage by absorbing moisture.

According to a report on RMIT's website, the material absorbs solar energy as well as moisture from the surrounding air. It can then split the water into hydrogen and oxygen, collecting the hydrogen for use in fuel cells or to power a vehicle. "The simple addition of the new material can convert a brick wall into energy harvesting and fuel production real estate," explained lead researcher Dr Torben Daeneke. The paint could be used to cover areas that wouldn't get enough sunlight to justify the placement of solar panels, maximizing the capability of any property to generate clean energy. Any surface that could be painted—a fence, a shed, etc.,—could be transformed into an energy-producing structure.



Source: https://futurism.com

EUROPE INCREASES SOLAR INSTALLATIONS AS 8.6 GW INSTALLED IN 2017

Estimates from SolarPower Europe show that Europe installed about 8.6 GW of solar power systems in 2017, a 28% increase over systems installed in 2016. SolarPower Europe said that EU member states installed about 6 GW in 2016, a 6% year-over-year increase.

"Solar in Europe is growing, this is good news for the energy transition; now we need the right policies in place to make sure the EU can fully benefit from our clean energy technology," James Watson, CEO of SolarPower Europe, said.

According to SolarPower Europe's estimate for solar installations, the largest European solar market in 2017 was Turkey, which gridconnected 1.79 GW in 2016, followed by Germany at 1.75 GW. SolarPower Europe said that final figures could place Germany in the first place.

The UK, which dropped its solar incentive programmes, lost its position as the leading European solar market. SolarPower Europe said that new installations dropped by 54% to around 912 MW in the UK, from 1.97 GW in 2016. "We are expecting strong growth in the coming years as several EU member states are choosing solar to meet their national binding 2020 renewables targets," Michael Schmela, executive advisor and head of market intelligence, SolarPower Europe, said. "This makes perfect sense as solar is the most popular energy source among EU citizens, due to its low-cost, versatility and reliability."-

Source: http://www.renewableenergyworld.com

STAND-ALONE SYSTEM TO PRODUCE DRINKING WATER BY MEANS OF SOLAR ENERGY

Researchers from the University of Alicante's research group in applied electrochemistry and electrocatalysis have developed a stand-alone system for desalinating and treating water through electrodialysis. The system is directly powered by solar energy and can be applied in off-grid areas. Designed only for desalinating water, it is a sustainable, eco-friendly technology, as its energy is supplied by solar photovoltaic panels in a CO_2-free process, thus not contributing to climate change.

According to research group director Vicente Montiel, "the new system requires no batteries and has none of the economic and environmental costs involved in managing empty batteries. Furthermore, it can be adapted and applied for treating water of many different origins, such as seawater, wells containing brackish water, treatment plants, industrial processes, etc., which makes it particularly well-suited to remote, off-grid areas." In this sense, this equipment can be employed to obtain clean water for human consumption, irrigation, street cleaning and others, both when there is no energy grid available and after natural disasters, such as earthquakes, floods, or fires. Among other advantages, this new technology makes it possible to recover approximately 80%– 90% of all treated water. Besides, it makes the most of

the maximum energy supplied by panels when exposed to sunlight, and its availability is also high, as it enables treated water accumulation for periods in which renewable sources do not provide enough energy.

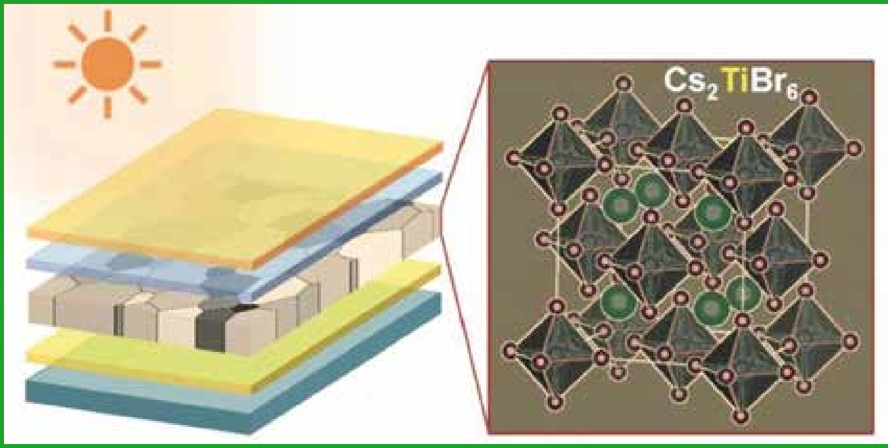
Source:www.sciencedaily.com

NEW LEAD-FREE PEROVSKITE MATERIAL FOR SOLAR CELLS

Perovskites have emerged as a promising alternative to silicon for making inexpensive and efficient solar cells. A group of researchers at Brown University and University of Nebraska—Lincoln (UNL) has come up with a new titanium-based material for making lead-free, inorganic perovskite solar cells. In a paper published in the journal *Joule*, the researchers show that the material can be a good candidate, especially for making tandem solar cells—arrangements in which a perovskite cells are placed on top of silicon or another established material to boost the overall efficiency.

"Titanium is an abundant, robust, and biocompatible element that, until now, has been largely overlooked in perovskite research," said the senior author of the new paper, Nitin Padture, the Otis E Randall University Professor in Brown's School of Engineering and director of Institute for Molecular and Nanoscale Innovation. "We showed that it's possible to use titanium-based material to make thin-film perovskites and that the material has favourable properties for solar applications which can be tuned."

Interest in perovskites, a class of materials with a particular crystalline structure, for clean energy emerged in 2009, when they were shown to be able to



convert sunlight into electricity. The first perovskite solar cells had a conversion efficiency of only about 4%, but that has quickly skyrocketed to near 23%, which rivals traditional silicon cells. And perovskites offer some intriguing advantages. They're potentially cheaper to make than silicon cells, and they can be partially transparent, enabling new technologies like windows that generate electricity.

"One of the big thrusts in perovskite research is to get away from lead-based materials and find new materials that are non-toxic and more stable," Padture said. "Using computer simulations, our theoretician collaborators at UNL predicted that a class of perovskites with cesium, titanium and a halogen component (bromine or/and iodine) was a good candidate. The next step was to actually make a solar cell using that material and test its properties, and that is what we've done here." The team made semi-transparent perovskite films that had bandgap—a measure of the energy level of photons the material can absorb—of 1.8 electron volts, which is considered to be ideal for tandem solar applications. The material had a conversion efficiency of 3.3%, which is well below that of lead-based cells, but a good start for an all-new material, the researchers say.

Source: www.sciencedaily.com

FOUNDING CONFERENCE OF THE INTERNATIONAL SOLAR ALLIANCE

The Founding Conference of the International Solar Alliance (ISA) was held on March 11, 2018, at the Rashtrapati Bhavan Cultural Center in New Delhi. The one-day Founding Conference was attended by Heads of State/Heads of Government, dignitaries from the United Nations, Presidents of Multilateral Development Banks, and global funds/financial institutions, leaders from energy-related institutions, corporate sector, and civil society. As the President of France, Mr Emmanuel Macron paid a State Visit to India from March 10–12, 2018, the Prime Minister of India, Shri Narendra Modi and the President of France co-hosted the Founding Conference of the ISA.

Apart from the President of France and the Indian Prime Minister, 21 Heads of State and Heads of Government, 6 Vice Presidents and Deputy Prime Ministers, 19 Ministers as Heads of Delegation attended the founding conference in addition to many other ministers who were accompanying the Heads of State and Heads of Government. Ten heads of multilateral banks, top representatives from UN agencies, corporate sector particularly in renewable energy, civil society, academic and research institutions and think tanks were present from India and from all over the world. Before the conference more than half the potential States, that is, 61 countries had signed the International Solar Alliance (ISA) Framework and 32 had ratified it already.

It was evident that there has been a huge surge and interest in joining the ISA as witnessed by the presence of so many high level dignitaries. It signifies the commitment at the highest level of these founding States of the ISA to go for clean, affordable, appropriate and sustainable energy to make our world a better place to live in. Sustainable development has received a very huge boost.

THE INAUGURAL SESSION

The inaugural session was launched with the soulful rendering of the 'We shall overcome' by the solar mamas who have all been trained in India under the ITEC (India Technical Economic Cooperation) programme. They stand as a symbol of what can be achieved at the grassroots level to bring about genuine change in the lives of local communities.

The Hon'ble Prime Minister of India, Shri Narendra Modi, in his inaugural address inter-alia announced India's commitment to extend nearly $1.4 billion worth of lines of credit which will cover 27 projects in 15 countries. This initiative has been widely welcomed by the ISA Founding States and the beneficiary countries. This is indeed one of the largest commitments to financing solar energy projects around the world. "Over the last few months, we have been intensely engaging with various signatory countries to ascertain their interest and seek proposals for potential solar projects in their respective countries. As you can see that our initiative has generated an overwhelming positive response. The projects which we will be looking at or taking up in these 15 countries include setting up of solar PV power plants, mini grid and off grid usage, irrigation, rural electrification, street lighting, solar power for urban infrastructure including for health, hospitals, colleges, schools, government establishments, low income families, etc."

A project preparation facility was announced by the Prime Minister to assist India's development partners towards preparation of project documentation as consultancy support. The Prime Minister also announced a path breaking initiative relating to solar technology mission. This is in line with Prime Minister's own initiative for India to take the lead internationally in solar energy development. The focus is on development of solar technology which is appropriate, innovative, and affordable for scaling up commercially and to become genuine alternative to unsustainable energy sources. Consequently, solar technology innovation and development including creation of a solar research and development base is essential. The Solar Technology Mission announced by the Prime Minister envisages a national mission with international focus. The Prime Minister also mooted a 10-point action plan for the world on solar energy. He said, "We are happy that in addition to making the contribution in the ISA Corpus Fund an amount of $62 million has been provided for the establishment of ISA Secretariat. I'm happy to announce that every year we will provide 500 training slots to ISA members in the field of solar energy. We have either completed 13 solar projects worth $143 million dollar in the entire world or they are in the process of being implemented. India is going to provide an assistance of $1.4 billion to 27 more projects in 15 other developing countries. We have set up a projects preparation facility which will provide consultancy support to partner countries for designing bankable projects."

ADOPTION OF THE DELHI SOLAR AGENDA

The leaders of the founding states of the ISA adopted the Delhi Solar Agenda. The agenda re-emphasizes the determination of the ISA member states to increase the share of solar energy in their respective national energy mix to facilitate affordable financing including innovative financing

» The Hon'ble Prime Minister of India, Shri Narendra Modi and the President of the French Republic Mr Emmanuel Macron at the Founding Conference of the International Solar Alliance in New Delhi

» The Hon'ble Prime Minister of India, Shri Narendra Modi addressing the Founding Conference of the International Solar Alliance in New Delhi

mechanisms to facilitate joint research and development effort to undertake off grid solar applications for poorer and/or remote communities, to enhance skills, to undertake capacity building, and to strengthen ISA to become an action-oriented and member-driven multilateral organization.

In the speeches of the leaders from France and other countries, the importance of this initiative for combating climate change and the need to ensure access to affordable and innovative solar energy especially for developing countries including for Africa and small island states was underlined. Scaling up of solar technology and production was re-emphasized.

The President of Rwanda, the Chair of African Union eloquently called the ISA a transformative initiative and called for implementing the twin mission of the ISA, namely, technology transfer and innovative financing. He reiterated that Africa stood to benefit from the ISA. As the Governor General of Australia mentioned, "ISA is the gift of India to the world". President of Togo mentioned that history will remember New Delhi as the place where the ISA was born.

TECHNICAL SESSIONS

There were a series of technical sessions also where discussions centered around solar priorities, low cost finance, scaling up of off-grid solar energy, women and energy, enhancing energy access in small islands states and on ISA as a catalyst for sustainable development goal (SDG) number 7, by panels of distinguished ministers from many countries, representatives from multilateral development banks (MDBs) and from other experts.

SIGNING OF JOINT DECLARATION BY IRENA AND ISA

On the occasion of the Founding Conference of the ISA, the Director General of the International Renewable Energy Agency (IRENA), Mr Adnan Z Amin, and the Interim Director General of ISA, Shri Upendra Tripathy signed a Joint Declaration to deepen the cooperation between the two organizations to accelerate solar energy deployment.

"Driven by remarkable cost declines, innovative policies and new business models, solar energy has emerged as the fastest growing renewable energy worldwide. There is an immense opportunity at hand to bring its benefits to more and more countries around the world," said Mr Amin. "IRENA estimates that solar must account for at least 35 per cent of global power capacity by 2050 to meet the objectives the Paris Agreement on climate," Mr Amin added. "In this context, IRENA stands ready to work with ISA and its members to scale-up solar energy deployment as a means to expanding affordable, reliable, and sustainable energy access, as well as to addressing climate and energy security concerns. IRENA looks forward to strengthening collaboration with ISA, sharing its knowledge and experience, and making available its project facilitation tools and platforms."

"The International Solar Alliance has a well-articulated goal to facilitate the mobilization of $1 trillion of capital to rapidly accelerate the adoption of solar energy all over the world," said Shri Upendra Tripathy. He further said, "While solar is fast becoming one of the most cost-effective ways to generate new power and deliver energy access, to deploy fast enough, complementarity must exist between our work and the broader renewable energy mandate and development tools established by IRENA. This fusion of capabilities will help to catalyse solar development in line with the goals set out under the Paris Agreement."

Driven by rapid advances in technology and economies of scale, the cost of electricity from solar photovoltaics decreased by almost 70 per cent between 2010 and 2016. IRENA estimates that average cost of electricity from solar photovoltaics can decrease by further 60 per cent in the coming decade. Solar power is also a significant employer of people worldwide, with around 3.1 million jobs working in the sector in 2016. The Joint Declaration affirms the commitment of IRENA and ISA to collaborate on advancing solar deployment and projects through helping countries develop policies and regulations around solar energy and through the implementation of IRENA initiatives such as the Clean Energy Corridors and the SIDS Lighthouses. IRENA's project facilitation tools and platforms such as the Global Atlas for Renewable Energy, the Project Navigator, and the Sustainable Energy Marketplace will be made available to ISA, in support of its project-focussed work in countries.

JOINT DECLARATIONS OF FINANCIAL PARTNERSHIPS

The International Solar Alliance (ISA) and the African Development Bank (AfDb), the Asian Development Bank (ADB), the Asian Infrastructure Investment Bank (AIIB), the Green climate fund (GCF), and the New Development Bank (NDB) signed Joint financial partnership Declarations and the International Energy Agency (IEA) signed Joint partnership Declaration in the presence of Shri Arun Jaitley, Hon'ble Minister of Finance and Shri R K Singh, Hon'ble Minister of State (I/C) for Power and New and Renewable Energy, Government of India, with an objective to deepen their cooperation in support of renewable energy. The previous three partnerships were signed by ISA with the World Bank, the European Investment Bank, and the European Bank for Reconstruction and Development. The signing ceremony took place on March 10, 2018 in Vigyan Bhawan, New Delhi. ISA is working for deployment of over 1,000 GW of solar energy and mobilizing more than $1,000 billion into solar energy by the year 2030. From ISA's side, Shri Upendra Tripathy, the Interim Director General, ISA and on behalf of the African Development Bank (AfDB), Mr Amadou Hott, Vice President for Power, Energy, Climate Change and Green Growth; the Asian Development Bank (ADB), Mr Bambang Susantono, Vice-President Knowledge Management and Sustainable Development; the Asian Infrastructure Investment Bank (AIIB), Dr Joachim Von Amsberg, Vice President - Policy and Strategy; the Green climate fund (GCF), Mr Kilaparti Ramakrishna, Head of Strategic Planning & Director of External Affairs; the New Development Bank (NDB), Mr K V Kamath, President; the International Renewable Energy Agency, Mr Adnan Amin, Director General; the International Energy Agency, Mr Keisuke Sadamori, Director of the Office for Energy Markets and Security, signed the declarations. During the signing ceremony Shri Anand Kumar Secretary, Ministry of New and Renewable Energy, Government of India was also present.

H E Shri Upendra Tripathy, the Interim Director General ISA informed that the ISA, AfDB, ADB, AIIB, GCF, and NDB have agreed to strengthen cooperation in pursuit of their shared goals of mobilizing green energy financing. The collaboration will provide an opportunity to AfDB, ADB, AIIB, the GCF, and NDB to support solar energy investment in the least developed countries especially in Africa, Asia, and the Pacific. This will also help funding of solar projects in these regions. He also stated that more such financial partnership deals shall be signed by the ISA in near future to achieve its mandate in a proper and effective manner. Shri Tripathy also underlined that the ISA, the International Renewable Energy Agency (IRENA) and the International Energy Agency (IEA) have agreed to deepen their collaboration to promote solar energy globally. The methodologies, tools, and analysis related to solar technologies developed by both agencies will help design policy environments that will facilitate solar projects in ISA member countries. Shri Arun Jaitley, Hon'ble Minister of Finance, Government of India, congratulated ISA, AfDB, ADB, AIIB, GCF, NDB, IEA, and IRENA for partnering with an objective to deepen cooperation in support of renewable energy. He also hoped that ISA would firm up such partnership deals with more multilateral and bilateral donor agencies in order to meet its stated objectives. He urged the signing parties to go in for innovation of new and dynamic mechanism for credit enhancement and risk mitigation in solar sector. Citing the first financial partnership collaboration of ISA with The World Bank, he urged that more and more multilateral and development banks should come forward and join hands with ISA in help fulfilling the objectives of massive and affordable deployment of solar among 121 ISA member countries. Shri R K Singh, Hon'ble Minister of State for Power and New and Renewable Energy, congratulated as well the signatories for providing wholehearted support to solar energy development and deployment in every possible manner. Recalling that the ISA initiative is the vision of the Hon'ble Prime Minister of India, Shri Narendra Modi, he reaffirmed Indian Government's continued support for the ISA. Shri Kumar also spoke about the Government plans to increase the share of renewable energy in India's energy mix, especially towards achieving cumulative installed renewable power capacity of 175 GW by 2022. AU

» The Union Minister for Finance and Corporate Affairs, Shri Arun Jaitley at the signing ceremony of the Joint Declarations between the International Solar Alliance (ISA) and ADB, AIIB, AfDB, GCF, IEA & NDB, in New Delhi on March 10, 2018. The Minister of State (I/C) for Power and New and Renewable Energy, Shri Raj Kumar Singh; the Secretary, Department of Economic Affairs, Shri S C Garg; and Shri Anand Kumar, Secretary, MNRE are also seen.

Compiled by Editorial team, TERI Press. Sources: http://www.pib.nic.in/; http://isolaralliance.org/

IREDA AND EIB SIGN EURO 150 MILLION LOAN AGREEMENT FOR RENEWABLE ENERGY FINANCING IN INDIA

European Investment Bank (EIB) and Indian Renewable Energy Development Agency (IREDA) Ltd. have signed a loan agreement for a second line of credit (LoC) of Euro 150 million on non-sovereign basis on March 10, 2018, in New Delhi. The line of credit is for tenure of 15 years including a grace period of 3 years, and it will be used for financing renewable energy and energy efficiency projects in India. More than 1.1 million households are expected to benefit from clean energy produced with these funds.

The loan agreement was signed by Shri K S Popli, Chairman and Managing Director, IREDA and Mr W Hoyer, President, EIB in the presence of Shri R K Singh, Union Minister of State (IC) Power and New & Renewable Energy and Shri Anand Kumar, Secretary, MNRE.

Speaking about India's fascinating journey to electrify every single village, Shri R K Singh said, "There are villages in Ladakh and Arunachal Pradesh where you track on foot for three to four days to reach. Our aim is to bring electricity to even these remote places. We have decided to go green, as we have a responsibility to future generations and the planet." Highlighting the fact that renewable energy has now become economically viable, he said that companies bidding for RE projects are getting funds from all over the world. Today, many countries want us to share our experience in this field."

Shri Anand Kumar, Secretary, MNRE said that two factors—efficient technology and easy finance, are important for the success of the RE sector. He expressed confidence that India will exceed its target of 175 GW renewable energy by 2022.

Shri K S Popli, CMD, IREDA said that the speed with which the second line of credit was negotiated shows the mutual confidence and comfort that EIB and IREDA had developed after working with each other for last 4 years. Moreover, the EIB has extended this line of credit without insisting for sovereign guarantee from Government of India, which also shows their commitment and confidence in the sector, he added. Mr W Hoyer, President, EIB appreciated India's role in International Solar Alliance and its commitment to Paris climate deal. He said that with much sunlight, solar energy is evidently a solution here.

Mr Tomasz Kozlowski, Ambassador of the European Union to India was among the dignitaries present along with other senior officials of MNRE, IREDA, and EIB. AU

Source: http://pib.nic.in/

ENERGY TRANSITIONS COMMISSION INDIA LAUNCHED

The Energy Transitions Commission India (ETC India) was launched by The Energy and Resources Institute (TERI) on the sidelines of the World Sustainable Development Summit (WSDS) 2018 on February 16, 2018. ETC India is a unique, high-level, multi-stakeholder platform on energy and electricity sector transitions in India. In the first year of inception, ETC India will focus on policy, research, and outreach on decarbonizing the power sector. ETC India will bring together a diverse group of individuals from the energy and climate communities: investors, energy companies, industry disruptors, equipment suppliers, energy-intensive industries, non-profit organizations, and academicians.

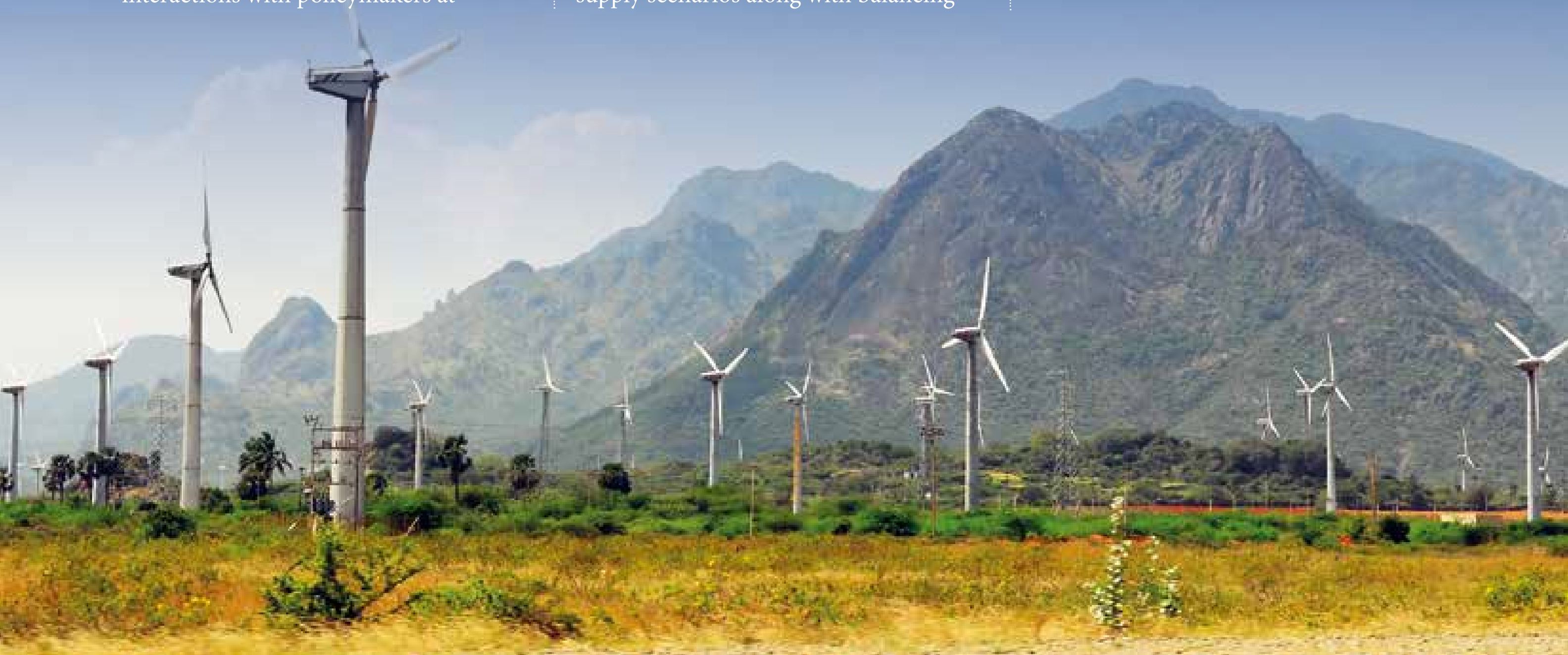
ETC India is the first country-specific Commission. India was chosen to have its own ETC as the country is taking great strides in transitioning towards renewable sources of energy. The Indian ETC can thus act as a model for other emerging economies as they seek to move to renewable energy sources. The deliberations at the platform will shape the research and engagement agenda, intended to support policy and strategy decisions in the years to come. There will be strong engagement and continuous interactions with policymakers at various levels of government, industry and associations, and media to test the analysis and hypothesis formulated through ETC activities in India.

Speaking on the occasion, Dr Ajay Mathur, Director General, TERI said," As India's energy mix and demand patterns change, due to significant addition of renewable energy in the grid and new energy efficiency measures, it is important that the policy and regulatory environment in the power sector rapidly adapts itself to the changing landscape. It is necessary to engage with all stakeholders—suppliers, consumers, funding agencies, developers, governments, and regulators to enable accelerated action and decarbonization. This is where ETC India will play the role of an enabler and facilitator for achieving pathways to low-carbon energy systems in India." TERI, in collaboration with Climate Policy Initiative, National Renewable Energy Laboratory and International ETC will provide a 'systems approach' to the challenges faced by India and help in addressing the global challenge with the same approach.

ETC India will support and facilitate Government of India's objective of decarbonization of energy systems through assessment of power demand and supply scenarios along with balancing reserves and flexibility requirements in the Indian power sector and continuous engagement with relevant stakeholders.

The Energy Transitions Commission was convened to help identify pathways for change in our energy systems to ensure both better growth and a better climate. This is inspired by the work of the Global Commission on the Economy and Climate and its flagship project the New Climate Economy. The Commissioners bring a diverse and remarkable range of viewpoints and extraordinary depth of experience. They come from across the energy spectrum, including investors, incumbent energy companies, innovators, industrial energy users, public and academic institutions and foundations, advisors, and academics from across the developed and developing world. What they share is a mission to accelerate change towards zero-carbon energy systems that enable robust economic development and limit the rise in global temperature to well below 2 °C. They will do this by providing decision-makers with insights and options for action at local and/or sector level. This will stem from objective research and wide engagement with actors in the energy system. AU

Source: http://wsds.teriin.org/



UNIVERSAL ENERGY ACCESS AND SAUBHAGYA SCHEME

Connecting the Unconnected in India

The recent International Energy Agency (IEA) publication *Energy Access Outlook* clearly credits India's achievement on electricity access: half a billion people have gained access to electricity since 2000, with electricity now reaching 82% of the population, up from 43% in 2000. The IEA further opines that if the pace is maintained, India will achieve universal access in the early 2020s and achieve one of the largest successes in the history of electrification. In this regard, **Debajit Palit** says that the Government of India's target date and IEA estimated date for achieving universal access in India is almost the same which further points out that the *Saubhagya* objective is achievable within the coming 2 years.

A little more than six years ago, the Sustainable Energy for All (SE4All) was launched in September 2011. We are now a third of the way to 2030, the year by which universal electrification for all has been targeted. In line with the global target to achieve universal electrification, the Indian government launched a new scheme, *Pradhan Mantri Sahaj Bijli Har Ghar Yojana* (*Saubhagya*), in September 2017 to achieve universal electrification for urban and rural households in India by March 31, 2019, which is 10 years ahead of the global target. Since then much of the attention has been on the viability and implementation of such an ambitious goal. The new goal is certainly challenging (if not impossible) within the given timeframe. However, *Saubhagya* did achieve some important advances worth noting.

The scheme estimates that about 25 million rural households remain to be electrified or are not covered under the broader rural electrification programme, Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY). According to the scheme, around 10 million rural below poverty line (BPL) households will be covered under the DDUGJY. Additionally, there are 5 million urban unelectrified households who will be covered under *Saubhagya*.

While the national rural electrification programme has been functioning since 2005, this is for the first time during the last decade Government of India recognized that there may be unelectrified households in urban slums and has devised a scheme to connect these households with electricity. *Saubhagya* will run parallel to DDUGJY, and any unfinished task of the scheme will continue concurrently with the DDUGJY till 2021/22. The total cost outlay for Saubhagya has been estimated at ₹16,320 crore, including a gross budgetary support of ₹12,320 crore from the Government of India.

SAUBHAGYA: CONNECTING THE UNCONNECTED IN INDIA

Three areas distinguish *Saubhagya* compared to previous efforts towards rural electrification in India.

First, besides expanding subsidies for electrification to include BPL households, it will now identify beneficiary households using the 2011 socio-economic and caste census (SECC) data and provide free connections to unelectrified households having at least one 'deprivation' (out of the seven identified under SECC). This is significant as the deprivation criteria are more encompassing and include parameters such as female-headed households, scheduled caste and tribal households, landless households, and so on.

Second, households not found eligible to get subsidy as per SECC data can choose to be connected by paying ₹500, which shall be recovered by the respective electricity distribution companies (DISCOMs) in 10 instalments along with their electricity bills. Based on the evaluation of the previous Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), The Energy and Resources Institute (TERI) had previously recommended such a micro-lending scheme to enhance household connection rate. Many non-BPL households have not taken connections (for a variety of reasons), thereby creating a huge gap between the number of grid-connected villages and the number of households actually connected. Despite a huge amount of money spent on creating electricity infrastructure for around 108,000 villages over the decade from 2004, the percentage of rural households electrified showed a marginal increase from 43% to around 60% as of March 2014.

Third, *Saubhagya* made a provision for solar power systems of 200–300 Wp capacity for the 0.5 million households in extremely remote areas. Most of the earlier programmes such as Remote Village Electrification Programme, though had the provision for solar home systems, were limited to meeting only basic lighting needs. With the advent of energy-efficient LEDs and other efficient appliances, a 300 Wp panel can now easily power lighting for a number of rooms, as well as energy-efficient fans and televisions and/or other communication devices.

While implementation will have a number of challenges, *Saubhagya* should be credited with tackling these previous shortcomings and aiming to provide universal access in such a short period of time. There is also an additional opportunity, which if tapped properly can assist in the creation of a large number of rural jobs. As the large number of electricity connections will also need electrical wiring in the houses

and their maintenance, this can provide opportunities to the rural youth to train as electricians and provide the services.

And while the *Saubhagya* goals seem unrealistic to some, there is a precedent in India. For instance, West Bengal's rural electrification rate more than doubled from 40% in 2011 to 95% in 2016, connecting an additional 7.8 million households. This was done primarily by the state DISCOM easing the process of connection, organizing camps, and reducing the connection cost to just ₹379. This also assisted in substantially bringing down the power theft.

More than 99% of people who have gained access in India since the year 2000 have done so as a result of grid extension, which has been the focus of government measures. At the same time, those who cannot be reached via grid expansion were covered via solar mini-grids and stand-alone solar home systems under the decentralized distributed generation component of DDUGJY. The major states with a large number of unelectrified households (e.g., Assam, Bihar, Jharkhand, Odisha, Madhya Pradesh, and Rajasthan) each have less than 6 million unconnected households, with the exception of only Uttar Pradesh, which has around 14.6 million unconnected households.

The recent International Energy Agency (IEA) publication *Energy Access Outlook* clearly credits India's achievement on electricity access: half a billion people have gained access to electricity since 2000, with electricity now reaching 82% of the population, up from 43% in 2000. The IEA further opines that if the pace is maintained, India will achieve universal access in the early 2020s and achieve one of the largest successes in the history of electrification. That the Government of India's target date and IEA estimated date for achieving universal access in India is almost the same further points that that the *Saubhagya* objective is achievable within the coming 2 years.

EVOLUTION OF RURAL ELECTRIFICATION IN INDIA: FROM VILLAGE TO HOUSEHOLDS

While the ultimate aim is to provide reliable and affordable 24x7 power supply to all households, we also need to appreciate that this can be done progressively and not overnight. Since 2002, progressive steps have been taken by the Government of India to extend rural electrification and to make both the centre and states obligated to universal access. For example, the then government recognized the importance of rural electrification for country's development and initiated the Rural Electricity Supply Technology Mission with the aim to electrify all villages and households progressively by the year 2012 through grid and off-grid options.Thereafter, the Electricity Act was enacted in 2003, which made both the centre and states obligated towards universal rural electrification. The Indian government launched the RGGVY in April 2005 and successfully created electricity infrastructure in more than 108,000 villages in less than a decade.

The current Indian government has progressed further, with 99% of Indian villages now provided with electricity infrastructure. The next logical step to the *Saubhagya* scheme would be to ensure that all villages and households, once provided with electricity connection, should also get 24×7 power supply in the most reliable and affordable manner. The electricity supply-side challenges that have persisted for a long time have been resolved to a large extent, and new capacities (especially based on grid-integrated renewable energy sources, including rooftop solar and mini-grids) are being added to the network at a fast pace, with the national goal to have 40% of the cumulative electric power installed capacity from non-fossil fuels by 2030.

24×7 POWER SUPPLY IN VILLAGES: THE CHALLENGES AHEAD

While the central government has been steering the sector towards a better scenario, the task for providing electricity supply round-the-clock primarily falls on DISCOMs, which are mostly state-run. DISCOMs not only have to ensure that they produce/buy and supply electricity to rural areas, but also do it in the most efficient manner possible and recover the revenues for long-term sustainability. Until such time, stand-alone solar photovoltaic (SPV) systems and micro-grids will continue to be favoured by many rural households as a coping measure.

Considerable improvement in the operational efficiency of DISCOMs is also required through extensive and

intensive change management and capacity-building programmes as well as strengthening the electricity sub-stations and sub-transmission network. While the accrued debt of DISCOMs has been reduced to a large extent because of different measures taken by the central government, such as the Ujwal DISCOM Assurance Yojana (UDAY), change management programmes will help to develop the needed working culture in DISCOMs. Further, DISCOMs need to move from purely 'administration' to a mode of 'enterprisation' in decision making and management and from providing 'public service' to a 'customer-centric service' model.

At the same time, electricity delivered to the rural areas must be priced rationally and the tariff structure is simplified for the consumers so that the consumers easily understand the bill and their willingness to pay increases and at the same time it is financially viable for the DISCOMs to serve. For efficient management of local power distribution, the government should also reactivate the rural electricity distribution franchise system, once change management programmes are initiated. The franchise system was operational in many states during the late 2000s and produced positive results towards revenue sustainability and efficient delivery of service as various TERI studies have found. However, the system was discontinued from 2012/13 in many states due to internal DISCOM issues. The franchise system can be operationalized by engaging local franchise entrepreneurs, including mini-grid operators (acting as independent electricity service providers), using their own generation and balance procuring at a wholesale price from DISCOMs, and then selling electricity at a weighted price. However, this may require some changes in the current regulation. These franchisees could be linked with the Skill India mission for building capacity on techno-managerial aspects and then supported with low-interest loans from the Micro Units Development and Refinance Agency (MUDRA) and others.

ELECTRICITY ACCESS ACHIEVEMENTS: BEYOND INDIA

While India has achieved considerable success in the last decade to connect the unconnected, the pace is also accelerating globally: The number of people gaining access has risen from 28 million per year between 2000 and 2012 to 41 million people per year in 2016. The World Energy Outlook (WEO) special report titled, 'Energy Access Outlook 2017: From Poverty to Prosperity' indicates that the number of people without access to electricity fell to 1.1 billion in 2016 from 1.7 billion in 2000. The access situation is on track to decline to 674 million by 2030 under the business-as-usual scenario. In Asia, China has already covered its entire population with electricity network, while 100 million people in Indonesia and 90 million in Bangladesh gained access during the last decade. Most of the developing countries in Asia are well on track to reach universal access by 2030 with many countries, such as India, Indonesia, and Bangladesh are expected to achieve the number well ahead of the target date.

Though electrification efforts in sub-Saharan Africa outpaced population growth for the first time in 2014, leading to a decrease in the number of people without access in the region, the electrification rate in sub-Saharan Africa currently is still less than 50%. The WEO special report further states that while several countries in sub-Saharan Africa, including Ethiopia, Gabon, Ghana, and Kenya, have reached or are on track to reach universal electricity access by 2030, progress across the region as a whole is uneven, and the number gaining access fails to keep pace with population growth. Thus, proactive efforts, including innovative business models and financing, would be needed for connecting the unconnected in most of the sub-Saharan African countries.

Although the new connections worldwide, similar to India, are mostly through a central grid, with power generation mostly from fossil fuels, the positive trend is that during the last 5 years, renewables have started to gain ground. While grid connectivity is feasible in countries such as India and Bangladesh because of the higher density of population, the same may not be the case for most of sub-Saharan African countries, which are sparsely populated. Thus, mini-grids and stand-alone off-grid solutions will be the key to achieve the universal access in such countries. The WEO special report estimates that by 2030, renewable energy sources will power more than 60% of new access, and off-grid and mini-grid systems will provide the means for almost half of the new access. The technologies used to provide access have started to shift, with renewables providing 34% of new connections since 2012, and off-grid and mini-grid systems accounting for 6%. The pace is going to further improve with new technological advancement especially in metering and control systems and reducing prices of solar panels and storage systems.

Another noteworthy development is the formation of the International Solar Alliance (ISA) at the United Nations Climate Change Conference in Paris on 30 November 2015. India took the lead in forming the alliance, consisting of 121 countries, to collaborate on increasing solar energy use around the world. The alliance is working with respective countries and trying to aggregate demand from various member countries to considerably reduce the cost of finance and technology and provide the required support for increasing the use of solar energy, including providing electricity access via mini-grids and off-grid options.

While the developments are positive, what is needed is to ensure that the challenges are addressed on priority and partnership models—both south–south cooperation and pro-poor public–private partnership models—are developed and operationalized to achieve universal electricity access and round-the-clock power for all by 2030 to build a new world paradigm. AU

Mr Debajit Palit is Associate Director and Senior Fellow in TERI, New Delhi. The views expressed in this article are personal.

Expression of Interest by SECI

For Setting up of Solar PV Manufacturing Capacities in India

The Solar Energy Corporation of India (SECI) has invited an Expression of Interest (EoI) from prospective manufacturers to set up an integrated solar manufacturing facility in India within a three-year time-frame. The total capacity to be set up is 20 GW. This move by the SECI assumes significance as it shows how the implementing and policymaking agencies are learning from experience. The selected manufacturers will be given an assured solar power project capacities to be set up by them in a phased manner. The allocation of solar power capacity will be done through an open tender to be floated by SECI. The tender document will be finalized based on the inputs received from this EOI. Within a fortnight, the MNRE has provided the Indian solar market with an adequate push and visibility for the next few years, both in terms of manufacturing and project development. **Sarvesh Devraj** discusses the major highlights of this EoI.

Recently, the Ministry of New and Renewable Energy (MNRE), Government of India, had stressed to strengthen India's manufacturing capabilities. For this MNRE released a concept note to upgrade country's solar manufacturing supply chain. In this concept note, MNRE proposed to reduce dependency on foreign imports and create demands for local products. The government is thinking to adopt three-pronged approach to encourage local manufacturing:

I. Imposition of anti-dumping duty on modules and cells;
II. Create local demand through domestic content requirement (DCR) programme; and
III. Supporting manufacturers financially by facilitating several subsidies.

Also, MNRE has declared a clean energy rollout trajectory, which requires power plants of 77 GW total capacities by the year 2020. To deploy such huge amount of solar power there must be a need of huge raw materials and equipments. Under the 'Make in India' initiative of the Government of India, MNRE has decided to promote local manufacturers for this. Keeping this in mind that current available manufacturing facilities are not sufficient to support the target of 77 GW, MNRE is ensuring to set up adequate indigenous manufacturing facilities in India. The value of establishing 77 GW solar projects will require an investment of $54.56 billion.

To boost up India's solar manufacturing sector, the Solar Energy Corporation of India (SECI) has invited Expression of Interest (EoI) for establishing 20 GW solar manufacturing facilities in India. Duration of setting up this integrated facility will be within 3 years. The aim of this scheme is to develop manufacturing facilities of at least 60% that should come from local manufacturing. MNRE will launch a programme, where power purchase agreements for 20 GW will be allocated though open tendering process. This scheme will ensure that the modules, wafers, and cells produced from manufacturing facilities, must be used in solar energy projects.

SALIENT FEATURES OF THE SCHEME

Selection of manufacturers

Selection of manufacturers will be decided by bidding process. Those who are willing to set up vertically integrated solar PV modules manufacturing facility will be able to participate in the bidding process. The manufacturing facility includes ingots, wafers, and cell and modules manufacturing. SECI has given freedom to prospective manufacturers to form joint ventures/consortiums with other entities. Even also as per the EOI document, the existing manufacturers, who are already in business of manufacturing of solar cells and modules and they intend to set up integrating solar manufacturing facilities are eligible to bid under this scheme. The set-up of manufacturing facilities by selected manufacturers should be done within the specified period.

Scheme capacity

The total scheme capacity will be of 20,000 MW in a single stage. The project is expected to complete in a phased manner within 4 years' time. Depending upon the response of this scheme that capacity could be increased at a later stage as an extension.

Power purchase agreement (PPA)

With selected manufacturers at specified tariff, comes through competitive bidding process PPA for 25 years, which will be signed by SECI. The PPA will cover the milestones of project of setting up integrated solar manufacturing facilities.

PROJECT ALLOCATION

A total of 20 GW project capacities will be allocated to selected manufacturers based on inputs received through EOI from various prospective manufacturers. The phasing of manufacturing set-up will be 12 months and 18 months, respectively,

for modules and ingot and wafers manufacturing from the issue date of the letter of intent.

DEVELOPMENT OF PROJECTS

The project can be developed anywhere in the country but shall be monitored through CTU or as directed by SECI in line with PSA arrangements with states. Also, it is said in the document that project could be set up in solar parks, if there is any capacity available in park. As per the EOI document, land for implementing projects will be arranged by the selected manufacturers only. In case of not meeting the deadlines or not able to attain milestone by the successful bidder the capacity allocation would be cancelled after 15 days' notice. However, extension of timeline for valid reasons can be permitted by the competent authority.

SCHEME IMPLEMENTATION

SECI is the implementing agency of this project. It will take care of all the necessary arrangements for bidding process, such as inviting bids, finalizations of bids, and signing PPA with selected bidders. SECI will be responsible for motoring of the scheme, its implementation, and ensuring the progress of milestones. For the ease of bidders, SECI will provide suitable payment security mechanism. It will also help bidders in getting land, connectivity, and other clearances. AU

Mr Sarvesh Devraj, Research Associate, Renewable Energy Technology Applications, Renewable Energy Technologies Division, TERI, New Delhi.

Solar Anti-Dumping Duty in India

Protection is Needed to Build a Bright Future

In this article, **Karunesh Chaturvedi** says that allowing import of solar modules within India has created an issue within capacity utilization for domestic manufacturers. In such a scenario, re-visiting the recent anti-dumping issue in the solar industry can bring the results India desperately needs to become solar reliant.

The Indian solar sector has shown incredible growth trajectory. The industry doubled its solar capacity in the last few years (5 GW in 2015, 10 GW in 2016, and ~16.6 GW in 2017), which is really very inspiring considering the country lacks enhanced industrial infrastructure that China, the US, and other market dominating countries have. India's aggressive solarization initiative made its intent of phasing out fossil fuels to bring in socio-economic change clear. However, the rise of solar module import year-after-year shows a completely opposite picture than what 'Indian Solar Vision' and 'Make in India' indicated.

Domestic solar manufacturers in India have highlighted (on multiple occasions) the negative effects of increasing solar import. And appealing against solar imports, while India has grown its solar manufacturing capacity to satisfy the in-country energy demand, can be considered valid. After nearly 5 years of appeals, on December 12, 2017, Office of the Directorate General of Anti-Dumping (DGAD) presiding over the anti-dumping petition filed by domestic solar manufacturers is seen as a step forward towards growth.

Allowing import of solar modules within India has created an issue within capacity utilization for domestic manufacturers. In such a scenario, re-visiting the recent anti-dumping issue in the solar industry can bring the results India desperately needs to become solar reliant.

IMPORTING SOLAR MODULES EXTINGUISHES DOMESTIC INDUSTRY POTENTIAL

Foreign solar suppliers have grown their manufacturing capacity with government (foreign) support and financial aid. This has allowed them to mass produce solar components (especially solar modules, as it is the finished product) and export at a much lower rate than the existing market price. Chinese modules used to be 8–10% cheaper than that of domestically manufactured modules. The lowered price and huge availability within the market has encouraged developers of Indian solar projects to go for foreign products.

Huge forex outflows can be identified as the result of importing solar components. India spent $821 mn in FY 2014/15, $2.3 bn in FY 2015/16, and $3.2 bn in FY2016/17 in solar equipment imports, which is about 35 times its solar equipment export. Indian solar industry has capability to create jobs, improve upon industrial infrastructure, bringing in socio-economic growth (since energy and economy are interrelated). Such growth and development can be facilitated through protecting domestic manufacturing capacities (just like China and the US) and not by importing.

Uncontrolled increase of module imports and lack of quality control have led to rise of low quality module usage on domestic projects, which threatens the energy security. Import of solar modules also brought consistent fall of solar tariff, which started to curb investor interest and scaring them away. Too much importing has also blocked the path of technological innovation (if a country concentrates on importing low-priced products, there will be little chance of in-country technology growth), and has allowed more than 80% domestic market share to foreign suppliers.

Indian solar industry has supported the initiative to impose anti-dumping duties on foreign solar suppliers. However, higher anti-dumping duties should be levied on solar modules, as they are the finished products.

WHY HIGHER ANTI-DUMPING DUTIES SHOULD BE LEVIED ON IMPORTED MODULES THAN CELLS?

If we were to compare between solar cells and solar modules, we would know that solar modules cost way more in the market as they are the finished products. Therefore, it is easy to translate that levying higher anti-dumping duties on solar modules would help Indian solar sector to reduce forex outflow considerably and open up more opportunities for profit through exports.

It is also important to note that India's current solar cell capacity of 3.1 GW is not capable of satisfying immensely growing (current 8.4 GW) solar module capacity. Therefore, it is important for Indian solar sector to continue to receive imported solar cells at a feasible price. Imposing higher or similar anti-dumping duties on cells as on solar modules would make the module manufacturing cost high, thus making the industry uncompetitive.

So, although imposing anti-dumping on imported solar modules is extremely necessary for the domestic industry to survive, duties on imported solar cells should be lower, until the country can satisfy existing and growing module manufacturing demand with domestic cell capacity.

India's dream of improving industrial, social, and economic infrastructure through solar adoption can only become reality through focus on domestic solar manufacturing. It has the potential of making India the third largest economy in the world, and the opportunity should be realized for success in solar revolution. AU

Mr Karunesh Chaturvedi, Head, Corporate Affairs, Vikram Solar.

ENERGY SECTOR TRANSITIONS

A Move towards the Future We Want

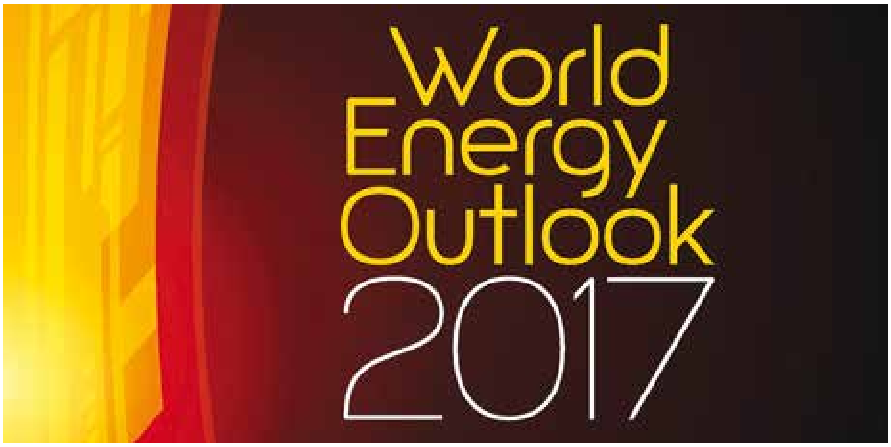
During the re-launch of the *World Energy Outlook* Report 2017 at TERI on December 6, 2017, Tim Gould, Head of Division, World Energy Outlook, IEA, said, "Our analysis in the *World Energy Outlook* confirms that India is emerging as a major driving force in global energy trends, with all modern fuels and technologies playing a part." In this article, **Aayushi Awasthy** and **Neha Pahuja** discuss some of the key energy sector transitions in India as well as in the world and feel that despite the resilience of oil demand, much of the changes in the energy sector are being made with the long-term aim of decarbonization. They conclude that dynamic changes in the energy system also demand innovations and solutions in terms of business models to suit the new dynamic market, governance structures, and regulations, to design incentives and disincentives to move towards the *Future We Want*.

Energy systems around the world are witnessing transformations at an unprecedented rate. There has been a very rapid increase in renewable energy technology, costs of which have been falling at an average of 60% since 2001. In terms of demand composition, more and more demand has been electrified; some of this demand is expected to be from increased penetration of electric vehicles, some from the newly electrified households in developing countries and increased intensity of electrification in the developed countries. In the last few years, especially since 2015, the majority of energy demand has been from emerging economies and not just the OECD (The Organization for Economic Cooperation and Development) countries. This has been a good step in terms of reduction of global energy inequality, which is a large gap. There were major changes in shares of consumption in 2016; the large part of this demand had been coming from China, which is a major manufacturing hub. However, China is witnessing a transition towards a more service oriented economy. This impacts the nature and intensity of demand for energy. China wants to make efforts to move away from a manufacturing intense base but towards a more innovation-based economy. This has implications on emissions and China's target of peaking CO_2 emissions by 2030. India also witnessed a steady increase in energy demand growth at an average of 5% per annum; however, this growth is lower than anticipated in the Indian intended nationally determined contribution (INDC).

GLOBAL CHANGES IN FUELS—RESILIENT OIL DEMAND BUT POSITIVE DEVELOPMENTS IN RENEWABLES

Fossil fuel markets have also seen a churn in the past 2–3 years. The oil market has been on a correction path, with prices still on the lower spectrum and only recently started seeing an increase. Oil inventories are at record high levels and the sector is yet to see impacts of cutback in investments in the past two years. The US shale revolution has led to the US being the largest producer and also the swing producer, a position held by the OPEC (The Organization of the Petroleum Exporting Countries) since the 1970s oil crisis. The IEA, in its latest, *World Energy Outlook* predicts that the US may become a net exporter of oil by 2020, the US is already a net exporter of gas. This has implications on what is popularly called peak oil. In the past many have predicted that the world has reached the inflection point of oil demand—in other words, going forward the demand for oil will decrease rapidly and not increase. However, the recent changes in oil market show that it is too early to write about the demise of oil. If anything, this fuel has been more resilient than ever, with shale revolution leading to manufacturers being able to adjust the output in the shorter term.

Despite this resilience of oil demand, much of the changes in the energy sector are being made with the long-term aim of decarbonization. The UN's Sustainable Development Solution Network (SDSN) lead 'Deep Decarbonization Pathways' Project has identified three so-called pillars of decarbonization: electrification, energy efficiency, and fuel switching. The world made enough headway in this direction. Electrification of demand saw a shift even in the transport sector. In 2016, the spending on electricity by consumers reached parity with spending on other fuels. Another way to look at this is two-thirds of the increase in global energy goes to power. Even in India a major policy announcement has been the aim to stop sales of petroleum vehicles post 2030. This announcement further raises the question of management of power system.



CHANGES IN THE POWER SECTOR—NETWORK STRENGTHENING, INCREASED CAPACITY

Power sector has been the most dynamic sector in terms of changes. Most of the INDCs submitted for the 2015 Paris Agreement had some commitment on power sector. The costs of renewable energy technologies have been falling very rapidly since 2010—solar PV costs fell by 70%, wind by 25%, and battery by 40%. It is because of these falling costs that the conversations have now turned towards optimal management of renewables in the system. There is no longer a dispute that high renewables is the future, the question remains how do we manage them? Given that renewables such as wind and solar are only available at a certain time of day and month, it is important for the system to develop in a way to be able to complement these 'fuel' sources. For this, the world looks towards battery technology. However, the costs of battery are still too high and given the flexibilities around natural gas, it can be used as a bridge fuel—a fuel that can temporarily make this transition possible. While this solution maybe viable for the world, this solution is still not viable for India as there are questions around the availability of natural gas. To illustrate this for India, if people would prefer to charge their EVs at night, it may exacerbate the already existing problem of a night peak, when solar energy would be unavailable. Therefore, development of storage solutions is critical for India. These don't

have to be limited to batteries, it could also be through development of fuels that can help in balancing such as small hydro and other ancillary services.

Discussions on integration notwithstanding, renewables are making headway and have seen a large uptake. In 2016, 161 GW of renewable capacity was added to the global system. The total capacity addition globally was about 2017 GW, an increase of 9% since the previous year. Close to 20% of total energy generation is from renewables as compared to the less than 5% in 2001.

INVESTMENTS—FACILITATING TRANSITION

These trends can also be seen in the investment trends in the energy sector. Oil and gas sector saw a rebound in investment by 6%, the investment had previously seen a falling trend, falling by 44% between 2014 and 2016. Much of these investments have been in the US Shale upstream investment, other places of investment were Russia and Mexico. The oil and gas industry is undertaking a major transformation in the way it operates, with an increased focus on activities delivering paybacks in a shorter period of time and the sanctioning of simplified and streamlined projects. Investment in electricity sector after achieving parity with oil has stagnated with a modest 1% increase. The investments are also being made towards upkeeping networks rather than generation, which was the trend earlier. In terms of different fuel sources, investment in renewables has slowed down and was 3% lower than five years ago, but capacity additions were 50% higher. This is because of decline in unit costs. Also, technology improvements in solar PV and wind ensured that this increased capacity is 35% more efficient in terms of generation.

Investment in coal-fired plants fell sharply, with nearly 20 GW less commissioned in 2017 than 2016. This of course, reflects the concerns about local air pollution and also concerns about over capacity in China. India, being on a different development stage

saw an increase in investments in coal. The total investment in power sector in 2016 was about $55 billion, with only 20 billion going in towards fossils and the other towards improving networks and renewable capacity addition. For the first time, India saw more investment in solar PV than wind.

TRANSITIONS IN INDIA—REDUCING RISKS TO MOVE TOWARDS A ROBUST POWER SYSTEM

In India, the demand for energy has been steadily growing at 5% increase than 7% increase in 2016. Some of this can be attributed to slower than expected growth in the country. However, this is not the whole picture; there were also claims of 'excess demand' in the system, meaning that there was power available at the exchanges but not being bought by anyone despite favourable prices. Currently, India's coal capacity is double than the peak demand in the country. However, the utilization of this capacity has been very low. Coal plant utilization has been falling since 2005 and reached to a plant load factor of 60%. This would put pressure on the attractiveness of coal in India. In the past two years, 7 GW each of capacity has increased for coal, the lowest levels since 2005. It may be pragmatic for India to use the coal capacity as the balancing mechanism, until more reliable technologies are available to balance the grid. This may also help increase the PLF for these capacities. This may also go a long way in solving the financial viability of distribution companies (DISCOMs).

The DISCOMs also have been in a financially difficult position for a combination of reasons of low prices and high AT&C losses. The DISCOMs tend to avoid buying power leading to cascading problems in the system, such as delayed payment to the generators, unreliable power supply, and insufficient investment in the grid infrastructure. However, the government of India has taken some very significant measures to reduce risks in investments in the power sector. The Ujjwal Discom Assurance Yojana (UDAY) scheme is aimed at debt restructuring and also increasing efficiency of the DISCOMs. The reverse bidding process is also reaping benefits, with proposed tariff falling to as low as ₹2.2 per unit. This also helps in de-risking the investment and increasing cost-effectiveness. With the success of the reverse bidding in solar, the government has also announced reverse bidding in wind, the proposed tariff for which has been at parity with solar.

The changes suggest that we are going in the right direction but the speed of changes need to increase. While in terms of electrification we have seen many positive changes, changes towards fuel switching outside the power sector are rather limited. There has been very slow growth of renewables in heating and other industrial uses. The investment in network technologies is encouraging but it is by no measure enough. The dynamic changes in the energy system also demand innovations and solutions in terms of business models to suit the new dynamic market, governance structures and regulations to design incentives and disincentives to move towards the *Future We Want.* AU

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OPTIMIZING TRANSMISSION FROM LARGE RENEWABLE ENERGY FARMS

and Impact of Using Energy Storage

In this article, **Snigdha Kala** evaluates the efficacy of strategies such as 'capped capacity transmission', 'local sale of surplus power', and 'energy storage'. Analysis suggests significant improvements in technical and cost performance upon using these strategies. The article also finds that at current costs, energy storage may not be viable, but with time, as the costs fall, it will start to play a more important role in large renewable energy farms.

Inter-state transmission system (ISTS) consumers face some challenges upon buying energy generated from large renewable farms, whether solar, wind, or solar–wind hybrid.

- Although renewables enjoy waiver of ISTS, transmission system cost for renewables is very high due to low plant load factors (PLFs).
- RE generation suffers from variability, intermittency, and inability to supply 24×7 power; hence grid/thermal power plants are needed on standby. These plants pay fixed cost/kWh for transmission which can be optimized. Further the technologies would benefit from better scheduling ability and maintaining more uniform supply.

BACKGROUND

So far, most renewable energy generators did not have to worry about transmission costs or the cost of scheduling.

- Wind or early solar projects, selling power under feed-in tariff (FIT) to distribution companies (DISCOMs), need only to connect to the grid. Additional transmission costs are not charged from either the generators or the consumers.
- Open-access consumers buying power using the state grid pay transmission and wheeling charges in INR/kWh and may see direct benefit of transmission capacity optimization.
- Most states offer banking facility, and the banked power can be used up to a year. Generator does not need to optimize generation schedule to match demand with supply.

Inter-state transmission of renewable energy was exempted from charges based on a gazetted notification dated 28 January 2016 till recently. As per a revision on 30 September 2016, this benefit was limited to only DISCOMs buying renewable power using inter-state transmission system (ISTS). For wind, this relief is available till March 31, 2019. For solar, it expired in June 2017.

In the future, such waivers and support to renewables are likely to be progressively withdrawn and renewable energy capacities will have to compete with thermal power plants for power evacuation services without multi-layered supports.

HIGH TRANSMISSION COSTS FOR RENEWABLES

Transmission costs for grids are charged in terms of INR/MW/m. Due to low plant load factors (PLFs) or MWh/MW transmitted, the transmission costs for renewable energy increase in terms of ₹/kWh.

The transmission costs for ISTS are profiled in Table 1.

As can be seen, transmission charges are high per unit of solar or wind energy.

- Compared to generation costs, which touched ~₹2.45/kWh for solar or wind projects in 2017, transmission would add significant costs of ~₹0.73–2.66/kWh (30%–100%).

Table 1 ISTS charges for renewable energy

	ISTS Charges INR/kWh		
State	Solar	Wind	Wind–solar
Maharashtra	2.66	1.70	1.37
Gujarat	2.44	1.56	1.26
Madhya Pradesh	1.39	0.89	0.72
Jharkhand	1.60	1.03	0.83
Karnataka	2.72	1.74	1.40
Telangana	2.09	1.34	1.08
Andhra Pradesh	2.72	1.74	1.40
Rajasthan	2.89	1.85	1.49
Tamil Nadu	1.42	0.91	0.73

- Generating higher MWh/MW lowers the transmission cost. Due to lower PLFs, standard solar installations at 1,600 MWh/MW would have the highest cost, and wind–solar hybrids at 3,100 MWh/MW would have the lowest cost.
- Since thermal power plants are able to evacuate 6,500–7,800 MWh/MW, thermal units have an advantage with respect to transmission costs in the range of 0.3–0.6/kWh (~10%–15% of generation costs).

POSSIBLE PROCUREMENT AND TRANSMISSION OPTIMIZATION STRATEGIES

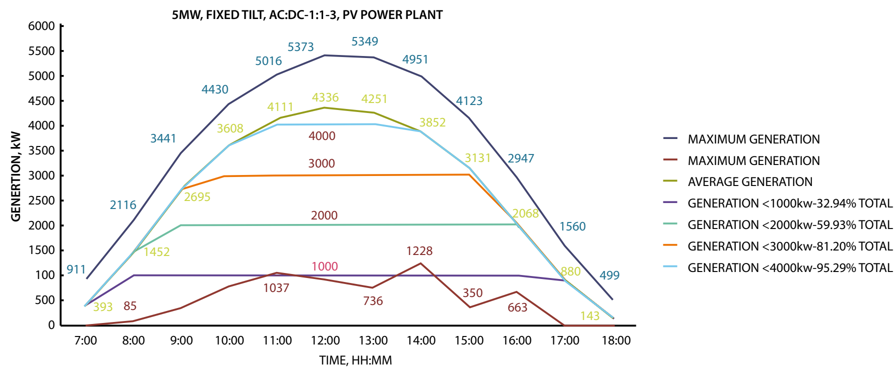
This section analyses various strategies that yield desired improvements in MWh/MW and/or accuracy of schedules.

Choice of Technology

Choice of technology can improve the MWh/MW factor. For example, Solar plants with high DC:AC ratio, higher performance ratio, or plants with trackers (single-axis tracker having proved viability) can yield higher MWh/MW. To demonstrate this, we evaluated the annual energy production of a 5 MW solar plant in Jaisalmer, Rajasthan. With DC:AC ratio of 1.3, the plant can generate 2.03 GWh/MW/annum. With tracker, the plant can generate 2.26 GWh/MW/annum. Clearly compared to 1.6 GWh/MW/annum generation from a solar plant with 1:1 DC:AC ratio, these figures are far superior and will result in 41% improvement in transmission cost. Similarly, wind–solar hybrid plants located in high wind zones can deliver more than 3.1 GWh/MW of capacity and would further optimize transmission cost per unit.

Procuring 'capacity-capped' part from renewable energy generation curve

Another strategy for reducing transmission costs would be to lower transmission capacity and procure only the 'capacity-capped generation'.



» **Figure 1** Hourly generation pattern of a solar plant in Rajasthan

One can see from Figure 1 that MWh/MW will improve with lower capacity caps, because the use of the transmission capacity or the procurement area covered under the flat-top/cap (depth of the curve) versus transmission capacity (Total area under transmission capacity) increases as we move from higher transmission capacity to lower transmission capacity.

Our assessments indicate that decreasing transmission capacity can improve transmission efficiency without significant loss of generation. The transmission efficiency for a wind solar hybrid plant is better than solar projects and will improve even more when transmission capacity is limited. Our results (Table 2) indicate that solar–wind hybrids generate at much better transmission efficiency (1.5–1.9 times), compared to a solar plants. For one such site we assessed that with rated hybrid capacity being 73% of nominal capacity of solar the overall loss of generation is only 0.3%. Thus, transmission capacity optimization is a good strategy for reducing overall costs until costs of additional transmission capacity is lower than the cost of surplus energy (energy not supplied to grid due to lower transmission capacity).

SURPLUS ENERGY ARISING FROM CAPACITY CAP AND ITS SALE

In order to complete this assessment, we estimated that if a buyer procures only the energy supplied under the transmission cap, what percentage of generated power is left un-procured and how this surplus energy can be used.

The relative performance of various technologies under capped procurement is outlined in Table 3. This assessment

Table 2 Improvement in GWh/MW for a plant with increasing capacity cap

Capacity Cap (% of peak capacity taken as evacuation capacity)	Transmission efficiency (GWh/MW)		
	Solar without tracker	Solar with tracker	Wind -Solar Hybrid
20% capacity cap	3.36	3.77	6.63
40% capacity cap	3.05	3.40	5.78
60% capacity cap	2.76	3.08	4.26
80% capacity cap	2.43	2.71	3.61

Table 3: Relationship of capacity caps with percentage of procured energy

	Percentage of generated energy which is procured		
Capacity cap	Solar without tracker	Solar with tracker	Wind–solar hybrid
20% capacity cap	32.94%	33.18%	43.71%
40% capacity cap	59.93%	59.85%	67.61%
60% capacity cap	81.20%	81.50%	84.15%
80% capacity cap	95.29%	95.64%	95.06%
100% capacity cap	100.00%	100.00%	100.00%

indicates that wind–solar hybrids are better at delivering higher energy to a buyer with reduced transmission capacity as the percentage of energy procured is highest for the hybrid system when compared with solar installations alone.

In case of wind–solar hybrid even when a buyer procures only 40% of nominal capacity (53% of rated capacity), they would still procure ~78.5% of generated power. Similarly, at 60% of rated capacities,[1] the buyer could procure more than 80% of energy generated by the system. It may be feasible to sell the balance 20% power to DISCOMs at lower value for local supply. Having local supply for surplus energy offers two benefits:

I. Realize value for surplus electricity beyond the cap.

II. Scheduling benefits: Schedules given to ISTS customers can be very accurate, and the variability could be absorbed by the local grid.

USE OF ENERGY STORAGE

In order to explore the other uses for surplus power, we simulated the benefits of using energy storage[2] in conjunction with renewable energy generation to improve the transmission efficiency for various technologies.

Use of energy storage with wind–solar hybrids

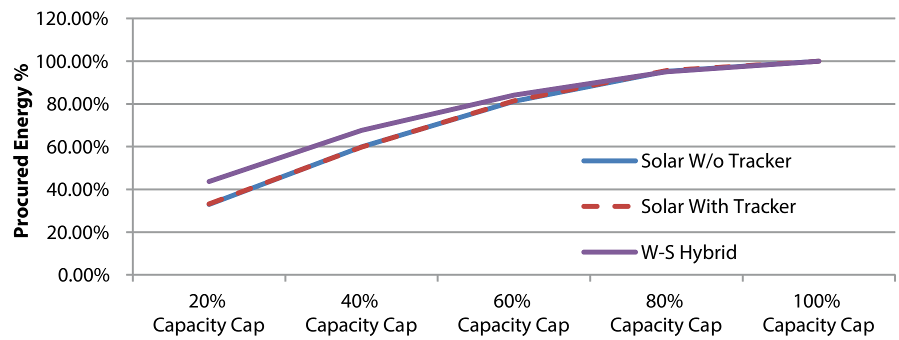
The following terms are defined for this study:

Capacity cap: Power load which is supplied to a customer, expressed as percentage of rated capacity of the plant.

Energy surplus: Means the energy surplus remaining after the capacity cap for ISTS buyer is supplied, can be expressed as percentage of plant generation.

1 Rated capacity of hybrids is equal to the evacuation capacity controlled by a controller.

2 Li-ion battery system with 7000 cycles life, 20% DOD, round trip efficiency of 85%.



» **Figure 2** Percentage (%) of energy procured vis-à-vis capacity cap for different technologies

Table 4 Impact of battery on wind–solar hybrids- MWh/MW, surplus energy

Wind Solar Hybrid					
Capacity Cap	100%	80%	60%	30%	20%
Battery hr	**Surplus Energy**				
0	0.0%	5.1%	15.9%	42.9%	56.5%
0.25	0.0%	3.4%	13.7%	40.4%	54.3%
1	0.0%	0.3%	7.9%	33.2%	48.7%
2	0.0%	0.0%	2.3%	25.3%	43.3%
3	0.0%	0.0%	0.0%	19.3%	41.1%
Battery hr	**Transmission Efficiency (MWh/MW)**				
0	3100	3680	4343	5897	6737
0.25	3100	3745	4457	6161	7083
1	3100	3863	4757	6904	7952
2	3100	3875	5051	7723	8792
3	3100	3875	5165	8338	9131

Our assessments of wind-solar hybrids demonstrate that:

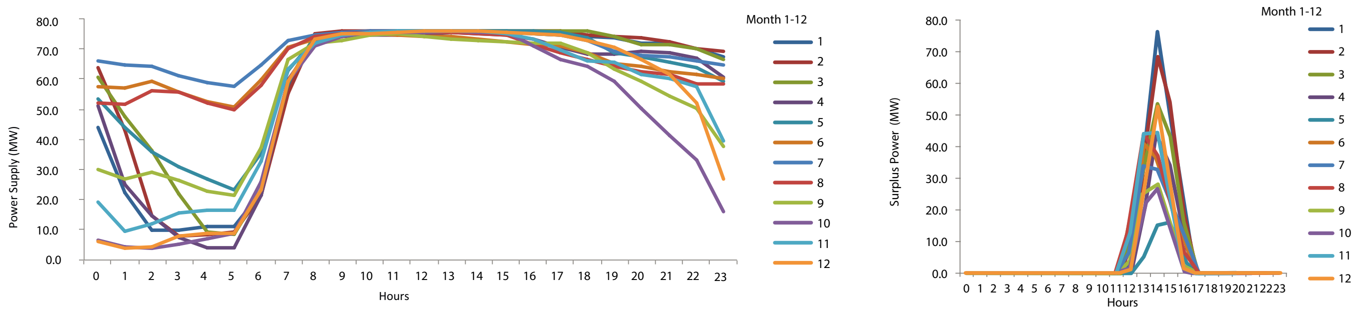
- Batteries will reduce energy surplus or MWh/MW as "capacity cap" is reduced.
- Capacity cap reduction improves MWh/MW.
- When capacity cap is reduced to 40% of rated capacity
  - With zero storage capacity, the system operates at 5,139 MWh/MW and would need yield 32.4% surplus energy.
  - With 3 h storage, the system would operate at 7,057 MWh/MW (which is equivalent to a thermal power plant) with 7.2% surplus energy.

It is evident from the profile in Figure 3 that with 3 h battery support and 76 MW cap, the system operates like a base load plant of 76 MW, except in the morning hours when the supply drops. The surplus power from this system would be exported during daytime hours, primarily between 9 a.m. and 4 p.m., peaking around 12–2 p.m.

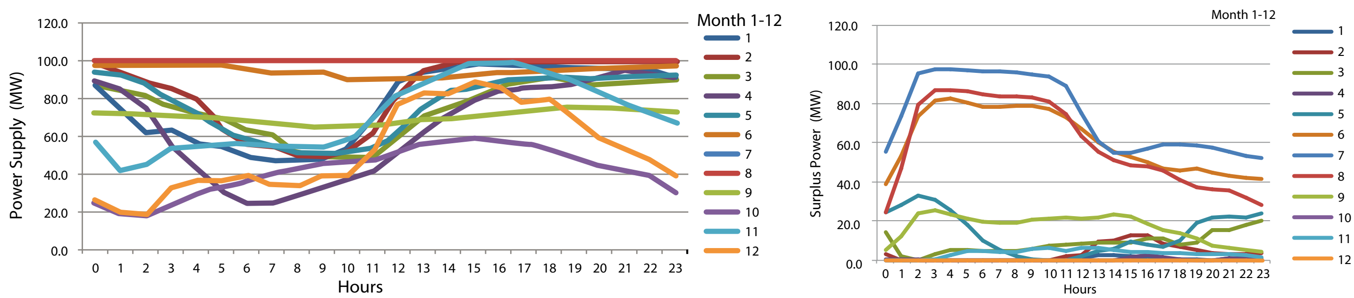
Use of energy storage with wind farms

Battery improves system MWh/MW even in the case of wind, but it leaves significantly high surplus energy to be sold to other customers, especially at reduced firm loads. For 40% firm load, wind–solar hybrid left only 7.2% surplus energy compared to 21.03% for wind-only case. The MWh/MW figures are also better for wind–solar hybrid compared to wind.

The supply curve to ISTS buyer, at 40% capacity cap, with 3 h battery, would appear as given in Figure 4. As evidenced in the surplus power profile and supply



» **Figure 3** Load firming for a wind–solar hybrid, cap at 30%, with 3 h battery



» **Figure 4** Variation of power supply to ISTS buyer with 3 h battery for a 250 MW wind plant

curve profile battery does not add significantly towards load firming.

Use of energy storage with solar farms

Battery support works quite efficiently with solar. With a 30% capacity cap a 3 h battery support leaves only 8.7% surplus energy and can achieve 7,901 MWh/MW supply for ISTS buyer. We assessed the impact of storage with 2 h battery support so as to limit battery costs. Generation was found to uniform for most of the day 8 am to 9 pm leaving only a few night time hours of no generation. This would work to support the peak load times and would be useful in grid balancing.

ECONOMIC BENEFITS OF ENERGY STORAGE

As we can see, battery impacts system performance by improving MWh/MW as well as reducing surplus energy. However, does it make economic sense? We modelled battery costs at $650/kWh (42,000/kWh), which reflects the likely market prices for li-ion battery systems today. This can be expected to result in an annualized rental value of the storage system of approximately ₹8,050/kWh. At these cost levels, overall cost of delivered energy would increase to ₹12.19/kWh on using battery system. Despite improved performance and grid benefits for the wind-solar hybrid the high cost of storage may be prohibitive.[3] If the costs of battery system fall to $100/kWh in the next 4–5 years, the cost profile will improve significantly. The delivered costs will be brought down to below ₹3.5/kWh with 1 h battery support. With the added benefits of reducing scheduling errors and unscheduled interchange (UI) charges, the overall benefits of batteries will be positive for capacities between 0.25 and 1.0 h.

We conclude that at the present cost–performance levels, batteries will not yield any improvements in the delivered costs of energy. However, in the future, batteries may become an economic and useful component of renewable energy systems.

CONCLUSION

Our assessments indicate that significant improvements are possible in transmission charges payable by renewable energy systems, by capping capacities to below 60% of nominal capacities. Wind–solar hybrids are most efficient in terms of transmission charges at present. Energy storage would allow generators to reduce surplus energy when working with lower capacity caps. However, at the current cost levels of li-ion batteries, the benefits of storage are not economical for saving transmission charges. As storage prices reduce going forward, the benefits will become substantial over time. AU

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3 This assessment assumes a discount of ₹1.0/kWh on surplus energy sale and assumes Renewable Energy Certificate (REC) benefits.

RENEWABLE ENERGY AND IMPROVED COOLING TECHNOLOGIES

Key to Reduce Water Use in India's Power Sector

A new policy brief co-authored by the International Renewable Energy Agency (IRENA) and the World Resources Institute (WRI) finds that increasing the share of renewables, in particular solar photovoltaic (PV) and wind, in India's power mix, and implementing changes in cooling technologies mandated for thermal power plants would not only lower carbon emissions intensity, but also substantially reduce water withdrawal and consumption intensity of power generation.

The brief, '*Water Use in India's Power Generation—Impact of Renewables and Improved Cooling Technologies to 2030*', finds that depending on the future energy pathways (IRENA's REmap 2030 and the Central Electricity Authority of India), a power sector (excluding hydroelectricity) transformation driven by solar PV and wind, coupled with improved cooling technologies in thermal and other renewable power plants, could yield as much as an 84% decrease in water withdrawal intensity by 2030, lower annual water consumption intensity by 25% and reduce carbon emissions intensity by 43%, compared to 2014 levels.

"India has emerged as a global leader in renewable energy achieving record-level growth in deployment, rapid cost reductions and many socio-economic benefits of the energy transformation." said Dr Henning Wuester, IRENA Director of the Knowledge, Policy and Finance Centre (KPFC). "Scaling up the use of renewables, especially solar PV and wind will yield further benefits, in particular long-term reductions in the dependency of the power sector on freshwater."

More than four-fifths of India's electricity is generated from coal, gas, and nuclear power plants which rely significantly on freshwater for cooling purposes. Moreover, the power sector's share in national water consumption is projected to grow from 1.4% to 9% between 2025 and 2050, placing further stress on water resources. Renewable energy, with the added potential to reduce both water demand and carbon emissions, must hence be at the core of India's energy future.

"India's move towards renewable energy is essential, especially as water stress puts increasing pressure on India's thermal power plants," said Dr O P Agarwal, CEO, WRI India. "Water risks to thermal power plants cannot be ignored when considering the cost of thermal energy. Renewables, especially solar PV and wind energy, present a win-win solution for both water and climate." The joint brief was launched at the World Future Energy Summit 2018 in Abu Dhabi. AU

Source: www.irena.org

MAXIMIZING Solar Power Generation

Making Use of Existing Roofs

In this article, **Satish N Diwakar** outlines various aspects of solar photovoltaic (SPV) systems on rooftops, including evaluation of existing roofs where SPV systems can be safely installed.

The demand for power in India is increasing with the growing population and the aspiration to become a developed nation. Hence, it has become necessary to explore the viability of power generation using renewable energy sources such as solar power since climate change is forcing us to bring down the dependency on fossil fuels.

India has high solar insolation, which provides a favourable condition for generating solar power. A huge potential is available for generating solar power using the unutilized existing and new roof spaces of industrial, commercial, educational, and residential buildings, or any other type of roof spaces available on buildings. Solar power can be used partially to cater to the captive power requirement of the individual facility or building and any excess power can be fed to the grid (on-grid system). So the best suitable long-term solution in India would be to install efficient individual rooftop power-generation systems to minimize the dependency on conventional power.

SOLAR POTENTIAL IN INDIA

Geographically, India falls in the bright sunny region of the world. Most parts of India receive solar radiation of approximately 4.7 kWh/m^2/day with 300–325 sunny days in a year. The Ministry of

New and Renewable Energy (MNRE) has been facilitating different initiatives for harnessing renewable energy in lighting, cooking, and motive power in rural areas, as well as in urban, industrial, and commercial applications. To maximize the use of solar power, the ministry is making all efforts in rural and urban areas to create awareness of the benefits of solar power. However, users might have apprehensions related to power output (yield) viś-a-viś roof area availability, strength of roof, cost of installation (including cost of roof strengthening, if any), payback period, installation and maintenance, and so on.

REQUIREMENTS: ROOFTOP SOLAR

A rooftop SPV installation consists of PV panels assembled in arrays, mounting frames to fix the panels on the roof, wiring, inverters, and other components depending on the type of installation. Battery back-up is an optional feature and can be provided depending on the requirement where grid power supply is expected to be intermittent.

The roof must be able to accommodate and support the components of the SPV system safely. To achieve this, the following minimum requirements should be met to fetch maximum benefit.

- *Desired captive power requirement:* It is necessary to assess the power that would be needed to meet the captive requirement and whether adequate roof area is available to generate such power considering the efficiencies of SPV modules.
- *Accessibility:* The roof must be accessible to carry out installation and maintenance of the panels. It should facilitate lifting and staking of the solar system components onto the roof and personnel to access the work area to install and maintain the system. A walkway between SPV panels needs to be provided for movement during and after the erection of SPV modules.
- *Roof configuration:* The roof plan configuration should be studied to know its location (including longitude and latitude), height, and slope, as well as any facilities already present on the roof. It is also very important to know the possible usage of the roof in the future, such as installation of water tank, water heater, any equipment, or communication antennae for calculating the space available for installation of SPV modules. Since India is in the northern hemisphere, the roof surface facing south or south-east direction is preferred for maximum power generation. Frame-mounted SPV panels facing south or south-east direction may be provided wherever roof slopes face other than south or south-east direction.

- *Solar orientation and shading:* It is preferred to have shade-free roof area for maximum utilization of SPV system. Roof area may get shaded due to the presence of adjoining buildings or trees or any other obstruction, which may lead to lower power output of the SPV system. Although shading changes during the year, observing the roof at different times during a day gives a fairly good idea of the approximate number of sunlight hours and the effective roof area that can be used for power generation. A sun path trajectory analysis for the entire year may also be performed to check shadow envelope.
- *Residual life of the roof:* The design life of an SPV system is estimated to be 25 years. Any existing roof having a residual life of at least 15 years should be considered for SPV installation for reaping maximum benefit as the payback period of SPV installation is generally between 5 and 7 years.
- *Aesthetics:* One needs to check whether SPV modules would affect the overall aesthetics of the building. From the road level, solar modules will be more visible on a sloped roof than on a flat roof. One may adopt a suitable design to camouflage SPV panels on sloping roofs without compromising the overall aesthetics of the building.
- *Maintenance:* Rooftop solar systems require regular maintenance after installation. The maintenance plan typically involves regular cleaning of the solar panels, checking and tightening of connections, servicing electrical accessories in the system, including the inverter, and regularly monitoring the output of the system. The cost of maintenance will be less in the initial period after the installation and will increase with the age of the system due to reduction in panel efficiency. The approximate maintenance cost is 2% per annum of the capital cost of the system installation.

EVALUATION OF AN EXISTING ROOF FOR SPV INSTALLATION

As mentioned earlier, any well-maintained roof having a residual life of at least 15 years can be considered for SPV installation. A structural evaluation should be carried out to assess the strength of the roof and the roof-supporting structure to sustain additional loads (30–50 kg/m^2) of the SPV system. If required, necessary repairs/replacements and strengthening measures should be adopted in order to achieve the required minimum strength and life of the roof.

Generally, in India sloped roofs are designed for live loads as per IS-875. When part of the roof area is occupied by SPV modules, the roof area may not experience the design live load. Since the load due to the SPV system is less than the design live load, it is safe to assume the additional weight of SPV panels as part of the live load on the roof and no additional load is required to be considered due to SPV modules. However, the load-carrying capacity of roof panels should be assessed for concentrated loads due to the SPV panel mounting frames.

Rooftop solar mountings should resist wind pressure acting below the panels during cyclones. This is a critical design consideration if the site is located in a cyclone-prone area. The type of mountings to be selected for supporting panels must be discussed with the SPV system supplier.

If the roof is required to be strengthened, then the project viability and payback period for solar installation should be calculated considering the cost of strengthening the roof and the roof-supporting structure. In the case of extensive rehabilitation cost and longer payback period (more than 7 years), the SPV installation may not be commercially viable. However, the decision to install SPV systems on existing roofs should be taken after proper commercial diligence.

Based on the available drawings and documents, the structural health of a roof should be determined considering the additional loads due to wind acting on the supporting structure of the SPV panel. In situ inspection and non-destructive testing may also be needed in certain cases to ensure structural adequacy.

The structural health analysis report should clearly indicate whether the roof is adequately strong to sustain additional loads throughout its balance life or any structural modifications required to ensure the desired life. If roof space is being leased out to a third party to install solar systems, the owner should appoint an architect or a structural engineer and a legal advisor who would confirm the feasibility of considering the roof for solar installation from structural and statutory aspects, respectively.

SLOPING METAL ROOF

These roofs should also be inspected to see any distress such as excessive deformations, open seams, and presence of water ponding due to sagging of roof sheets. The roof and roof-supporting structure should be inspected to check for any sag and other abnormalities. A sag or depression may indicate a structural deformation that may require further investigation and rehabilitation.

When evaluating the health of an existing roof for PV installation, factors such as the load-carrying capacity of the primary and secondary members, the type of roofing system (standing seam, corrugated, or trapezoidal sheet) and slope, the service life of the roof and the consumed life, and wind and seismic loads should be considered.

One of the primary considerations is whether to install a penetrating type or mechanically fastened system on the existing roof. It is preferred to have a non-penetrating system. In the case of standing seam roofs, the installation of SPV panels would be very fast by adopting a non-penetrating system. With standing seam metal roofs, special clamps are fitted over the seam to install the panel, thereby avoiding penetration of the roofing material and eliminating any possibility of leakages. Also, with the non-penetrating system, the leakage warranty of roofing manufacturers or

pre-engineered building (PEB) vendors is not compromised.

For existing low-slope roofs, it is recommended to use non-penetrating systems to avoid leakage issues during monsoon. If penetration is inevitable, then all the required precautions should be taken while fixing the SPV panels to prevent water leakage.

In the case of non-penetrating systems, the strength of the existing roofing material should be assessed by the sheet manufacturer and clear recommendation on whether the existing roofing material is strong enough to withstand panel loads should be provided. The roof sheeting supported over purlins with centre-to-centre distance of up to 1.5 m is considered reasonably safe to support SPV panels. However, a "no-objection" certificate or a "recommendation" from either the sheet manufacturer or the roofing contractor needs to be obtained.

Existing sloped roofs with metal sheets, tiles, or similar materials should be examined to find whether the primary rafters or trusses can support additional weight as per their residual strength available. This exercise is very important from the point of view that many steel buildings nowadays are PEBs, which are designed to the given loads without considering any margins in the loads. If the roofing installation and performance warranties offered by PEB vendors are still valid, check if installation of a rooftop solar system could nullify the performance warranty of the existing roof. A written confirmation should be obtained from the PEB vendor in this regard before making any decisions.

Prior to SPV installation, all the damaged areas should be repaired appropriately, sheeting replaced, structural member strengthened, and open seams sealed to maintain the structural integrity of the roof.

Some of the typical installations on sloped metal roofs are shown in Figure 1.

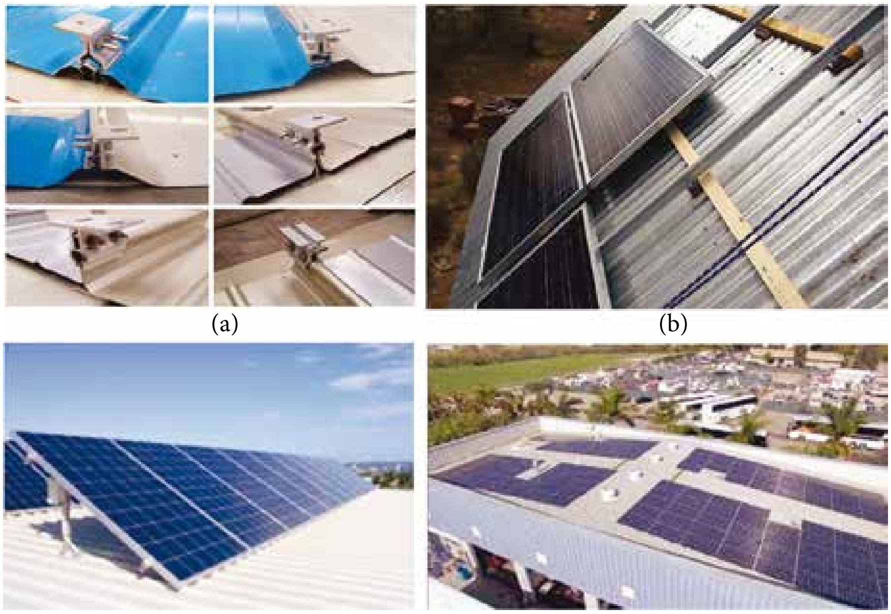
FLAT CONCRETE ROOF

Generally, a flat or even low-slope concrete terrace roof will normally have the strength to bear the additional weight of the panels and supporting structures.

In the case of flat concrete roofs, the primary concern is the performance warranty of water proofing provided over the roof. The type of water proofing provided over the roof and its slope needs to be examined and recommendation should be obtained from the waterproofing vendor on the modifications of the existing water-proofing system that are required to be carried out.

For fixing the mounting structure of the SPV module on an existing roof, the water-proofing treatment only in the designated area might have to be dismantled and redone with a similar or better water-proofing system. A well-designed framework of fixing arrangement of PV modules (with or without water-proofing modification) is preferred.

It is often seen that utility equipment such as air-handling units, cooling towers,



(a) (b) (c) (d)

» **Figure 1** (a) Typical panel clamping detail; (b) Typical panel installation on steep slope; (c) Panels mounted on frames; (d) Panels mounted on low sloped roof

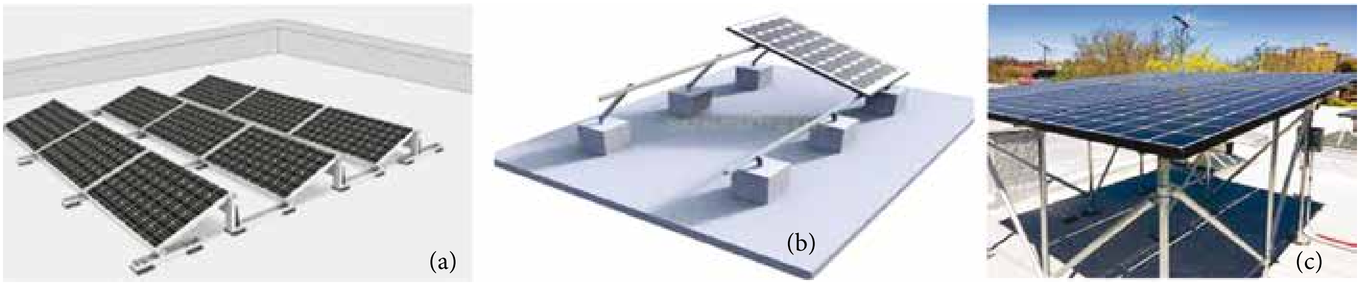


Figure 2 (a) Panels mounted on frames fixed directly on the roof; (b) Panel frames mounted on concrete pedestals; (c) Panels mounted on frames to get a shade-free area for SPV

water heaters, hot water tanks, and pumps are mounted on the roof. In such cases, a proper study of the available area for SPV installation and yield of the SPV system should be carried out. If the required area is not adequate to meet the captive requirement, it may not be viable to install an SPV system.

Some of the typical installations on flat roofs are shown in Figure 2.

CAPITAL COST AND PAYBACK PERIOD

The average shade-free roof area required for a typical 10 kWp SPV power plant is approximately 1000 ft^2 considering 15% panel efficiency. Table 1 gives a fair idea about the area required and desired power for different panel efficiencies.

Table 1: Roof area required for different power outputs

Desired power	1 kW	2 kW	5 kW	10 kW
Panel efficiency	Roof area required in square feet			
12%	125	250	625	1250
13%	115	230	550	1150
14%	107	214	536	1071
15%	100	200	500	1000
16%	94	188	469	938

The estimated cost of an on-grid 1 kWp rooftop SPV plant would be ₹0.9–1.1 lakh (without considering any subsidy and incentive). Similarly, a 1 kWp off-grid system with minimum battery back-up should require ₹1.2–1.7 lakh (without considering any subsidy and incentive) approximately. The above costs would further reduce if subsidies and incentives are considered.

Solar cell efficiencies vary from 6% for amorphous silicon-based solar cells to 44.0% with multiple-junction production cells and 44.4% with multiple dies assembled into a hybrid package. Solar cell efficiencies for commercially available multi-crystalline cells are around 12–16%.

The desired payback period for SPV installation over an existing roof should be between 5 and 7 years considering the efficiency of panels, maintenance cost, various losses in the system, and cost of roof strengthening, if applicable. The financial viability or feasibility of the project is determined through the net present value method.

TRENDS AND DEVELOPMENTS IN SPV SYSTEM AND APPLICATIONS

In the last 5 to 7 years, the solar industry has undergone a sea change in the quality of SPV systems and the type of applications to meet the challenging demands of sustenance. Some of the latest developments in SPV panels include frameless solar panels, clear (glass) solar panels, double-sided solar panels, and so on. The newer constructions in residential and industrial sectors have already commenced installing these SPV systems on the roofs.

In addition to rooftop or ground-mounted solar plants, different solar applications such as floating solar plants, solar installations over water canals, solar trees, and solar roadways are being experimented or piloted, which could transform the solar industry.

CONCLUSION

The Indian government has declared its solar expansion plans of targeting 100 GW of solar capacity, including 40 GW from rooftop solar, by 2022. India has witnessed an exponential growth in the last 5 years. The solar-generation capacity grew from 2650 MW to 12,289 MW during 2014–17. The country added 3.01 GW of solar capacity in 2015/16 and 5.525 GW in 2016/17, the highest of any year.

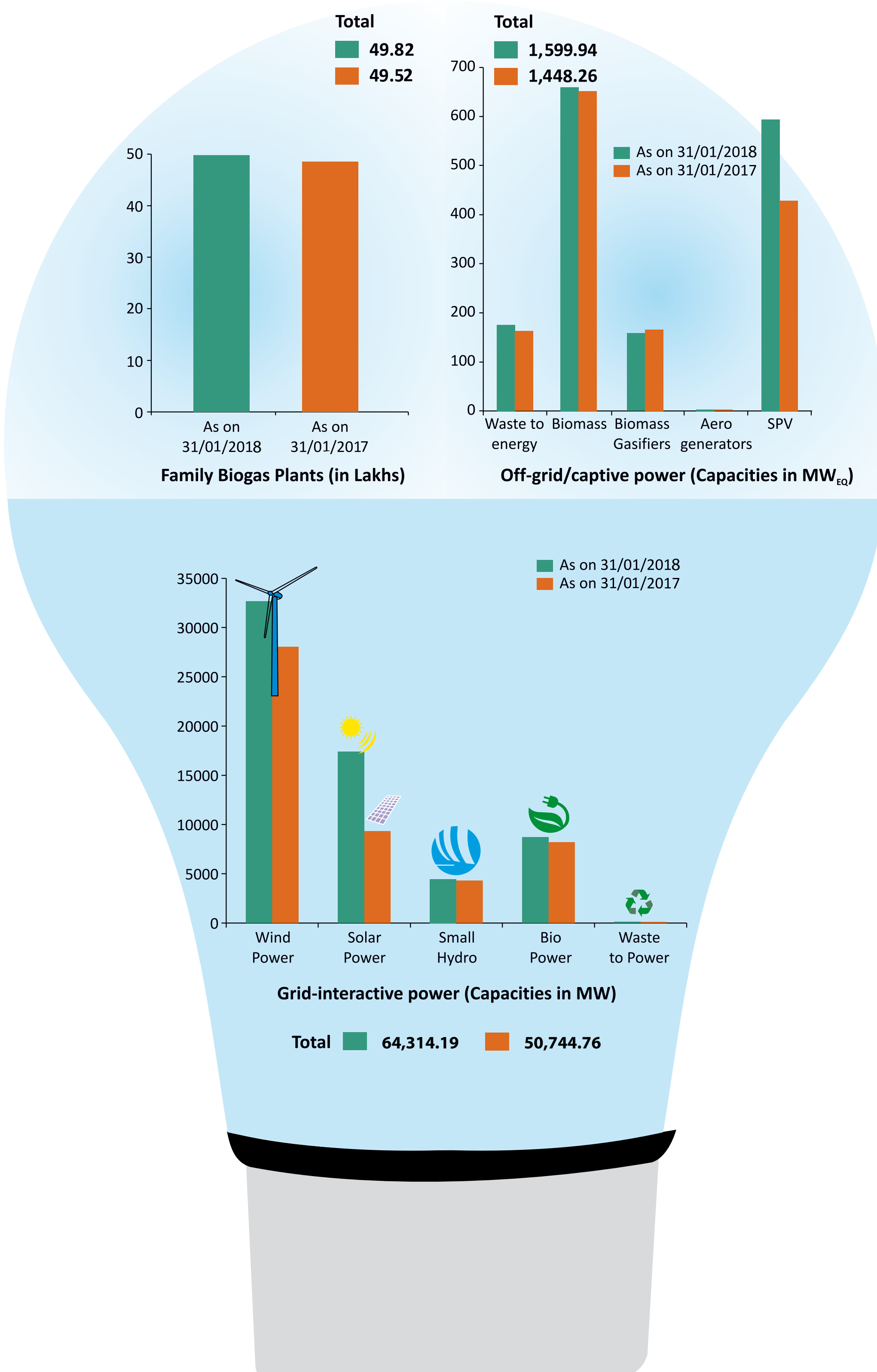
A rooftop SPV system connected to the grid distribution system and feeding the power in substations or load centres eliminates transmission and distribution losses. Also with grid-connected systems, the cost of batteries for storing power is eliminated. These are the strong reasons for promoting grid-interactive rooftop SPV systems for captive power generation.

Although SPV systems are being installed on the roofs of newer constructions, a large potential is available for generating solar power using unutilized roof spaces. It is now attractive and economical to install SPV systems over existing roofs considering the on-grid system promoted by DISCOMS. While roof is a convenient and suitable place for installing solar panels, a right approach is necessary for ensuring that the serviceability performance of the roof and the warranty offered by contractors for water tightness remain unaffected.

Roof spaces can also be leased out (roof leasing) for generating solar power either for captive requirement or for transmitting back to the grid. AU

Mr Satish N Diwakar, Senior General Manager—Civil (Discipline Head), Tata Consulting Engineers Limited.

RENEWABLE ENERGY AT A GLANCE: INDIA



Source: MNRE

OFFSHORE WIND ENERGY DEVELOPMENT

Indian Perspective

Wind in India's offshore and coastal areas is steady and has high speeds due to the absence of any obstruction and less surface roughness. Despite these favourable conditions, the offshore wind potential of the country remains unexplored and unexploited mostly because of several constraints. In this article, **Dr Siraj Ahmed** discusses the potential and developments in the field of offshore wind energy in India.

A consistent and smooth-flowing wind over the sea leads to a lower turbulence level. This exerts a steady load on wind turbines, thus offering a favourable operating condition and a reduced impact on the environment. Besides, higher wind speeds at the sea result in increased production of energy.

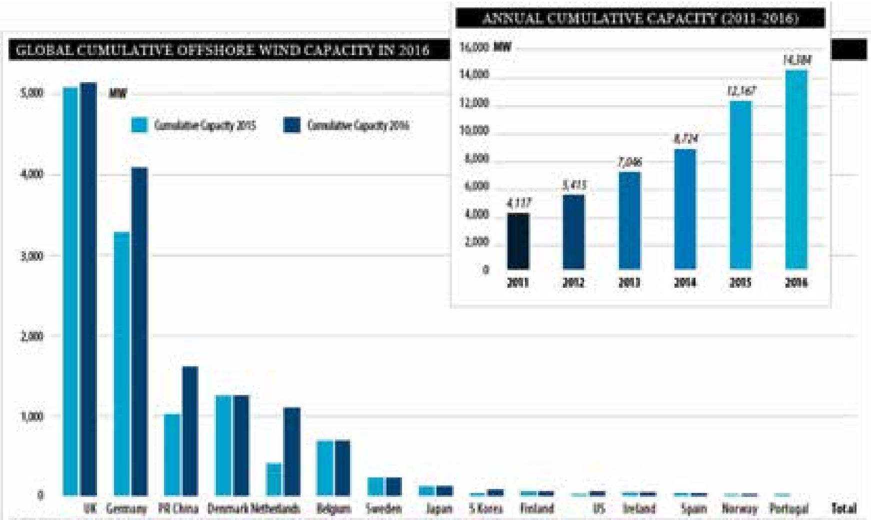
Despite these favourable conditions, the offshore wind potential of the country remains unexplored and unexploited mostly because of several constraints. In India, prior knowledge and experiences of offshore development of wind farms are not consolidated. In addition, essential datasets such as measured wind data, correlated mesoscale models, detailed Environmental Impact Assessment (EIA) studies, and oceanographic studies are not readily available. At the initial phase of development, social response and clearance activities provide significant challenge. Prior to construction, developers expect a detailed roadmap from the government with authenticated studies and technologies for harnessing the offshore wind potential. They would find it helpful if the government amends India's offshore wind policies before entering into a mass development phase.

Among the many challenges to harnessing the offshore wind potential are the varying cost drivers associated with different technologies required for setting up any new offshore market. The cost of an offshore project is massive and would escalate quickly as a function of seabed conditions and water depth, apart from operating wind climate conditions. Therefore, one has to map out in detail environmental constraints, seabed conditions and structure, wind resource, array layout and grid connection, turbine technology for the site as well as installation methods to understand the scale of the opportunity and the capital expenditure required to realize the development.

GLOBAL AND NATIONAL OVERVIEW

Approximately, 14 GW of offshore wind capacity has been installed around the world till 2016 (Figure 1) with an equal capacity under construction. The major installations are in the United Kingdom (5,078 MW), Denmark (1,271 MW), Germany (1,049 MW), Belgium (712 MW), China (670 MW), The Netherlands (247 MW), and Sweden (212 MW). Japan has an ambitious plan to install wind turbines on innovative buoyant steel frames stabilized with ballast and anchored to the seabed. The offshore wind power capacity is expected to increase manifold in the near future with significant contributions from China and the United States. Compared to onshore turbines, the rotor size and power capacity of individual wind turbines available for offshore installations are higher, which would contribute to the increase in capacity (Figure 2).

India has the right to install wind farms in the country's territorial waters, which extend up to 12 nautical miles (nm) from the baseline, and in the Exclusive Economic Zone (EEZ), beyond the 12 nm limit and up to 200 nm, under international laws. India's coastline is more than 7,500 km in length from the western coast of Gujarat, Maharashtra, Karnataka, and Kerala to the eastern coast of Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal. Under the Ministry of



	UK	Germany	PR China	Denmark	Netherlands	Belgium	Sweden	Japan	S Korea	Finland	US	Ireland	Spain	Norway	Portugal	Total
Total 2015	5,100	3,295	1,035	1,271	427	712	202	53	5	32	0.02	25	5	2	2	12,167
New 2016	56	813	592	0	691	0	0	7	30	0	30	0	0	0	-2	2,219
Total 2016	5,156	4,108	1,627	1,271	1,118	712	202	60	35	32	30	25	5	2	0	14,384

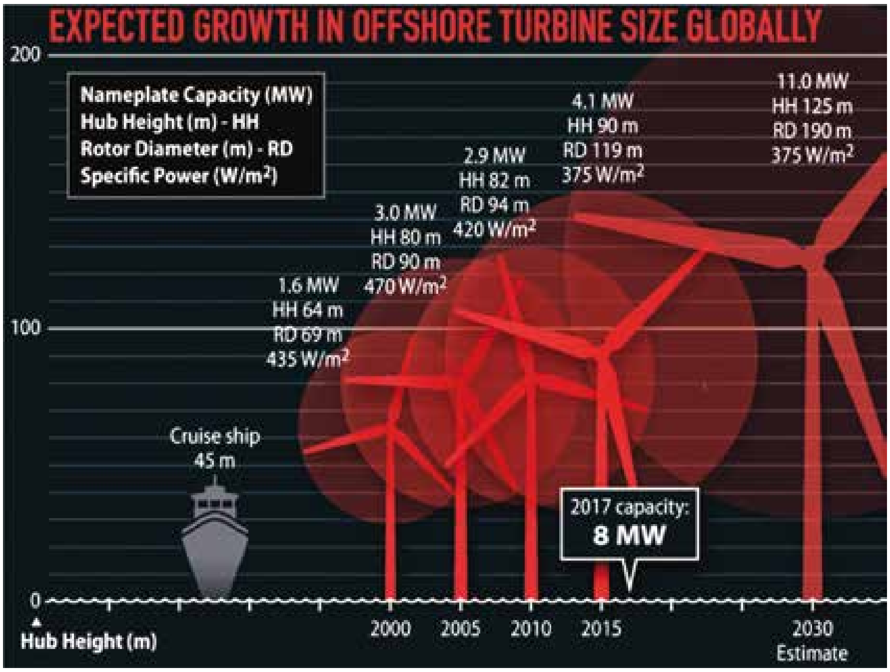
Source: GWEC

» **Figure 1** Offshore wind capacity worldwide

New and Renewable Energy (MNRE), the National Institute of Wind Energy (NIWE) has measured nearshore wind data at 78 locations along the Indian coast (Figure 3) by installing meteorological masts.

A preliminary assessment suggests the potential to establish wind farms, each of around 1 GW capacity, along the coastline of Rameshwaram and Kanyakumari in Tamil Nadu and in the Gulf of Khambhat, Gulf of Kutch, and Saurashtra open coast in Gujarat, where promising wind potential has been shown. These are two main maritime areas in which offshore wind farm structures can be built in the near future.

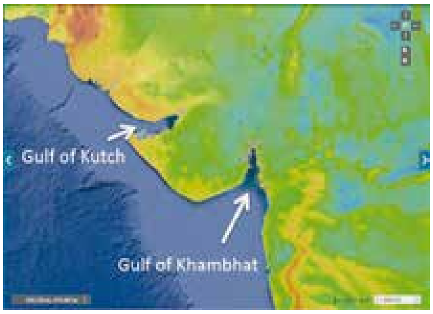
The study over Gujarat region (Figure 4) found higher average wind speeds. The areas of assessment included the Gulf of Kutch and the south coast of the peninsula. Using the remote-sensing technique of LIDAR (light detection and ranging), the



» **Figure 2** Offshore wind turbine size

» **Figure 3** Locations of meteorological masts in coastal India

Source: NIWE



» **Figure 4** Offshore potential areas of Gulf of Kutch and Gulf of Khambhat

NIWE found great potential for wind energy development at Dhanushkodi, Rameshwaram, in offshore Tamil Nadu.

OFFSHORE WIND RESOURCES

Different agencies have assessed wind resource potential with the help of buoy-based and ship-based floating LIDAR systems. These systems are equipped to measure weather parameters, such as air temperature, barometric pressure, as well as wind speed and direction. They report these data via satellite radio links using the purpose-built communication system or commercial satellite phone networks to meteorological centres for use in forecasting and climate study.

During the preparation of the Indian Wind Atlas, Risø DTU of Denmark, along with the NIWE, indicated some offshore wind potential around the coastline of southern India at 80 m above the ground level. Also in collaboration with Risø DTU, and facilitated through an MNRE-funded project, the NIWE carried out satellite-based wind resource mapping in

a small region between Rameshwaram and Kanyakumari in the southern part of Tamil Nadu. It based the measurement and analysis on the satellite synthetic-aperture radar (SAR) data from the European Space Agency (ESA), conducted under the ENVISAT/ASAR mission.

CHALLENGES TO OFFSHORE DEPLOYMENT

Deployment of offshore wind power faces significant challenges related to resource characterization, sub-sea cabling, turbine foundation, installation of turbines (including logistics), grid interconnection and operation, development of transmission infrastructure, and coastal security during construction and operation. Adding large capacities of offshore wind power generation to the power system requires reliable integration to the national grid. Moreover, measurements of wind potential in offshore regions are costly due to the higher cost of installing meteorological masts. Furthermore, the wind velocity can reach up to 200 km/h (55.55 m/s) during cyclones, and sea water may corrode the steel structure of wind turbines.

Other challenges include higher capital investment in offshore installations and submarine cables; complications of the offshore foundation, support structure, installation, and decommissioning; less accessibility than onshore installations; higher operations and maintenance costs; and downtime of machines.

Some technologies suitable for power transmission for offshore generation are as follows: For distances up to about 50 km, conventional three-phase high-voltage AC transmission is the most economical solution. For distances beyond 50 km, an alternative technical solution becomes increasingly attractive—high-voltage DC current (HVDC) transmission. For distances greater than 100 km, that is, for bulk transmission, HVDC is often used.

While land-based turbines are affected by wind alone, components of offshore turbines such as rotor, nacelle, and tower are affected by wind and the support structure is affected by winds, waves, ice, and water currents. The offshore turbines are subjected to additional loads such as sea wave loads, impact loads due to ship movement and ice movement, depth variation due to tidal and storm surges, effects of marine vegetation growth, earthquake loads, and scour effects.

INITIATIVES IN INDIA

The essential components of a policy for the development of offshore wind farms include the following: preliminary resource assessment and preliminary oceanographic and bathymetric studies for the demarcation of blocks; EIA of proposed offshore wind farms regarding aquatic life; studies relating to navigation, undersea mining and related exploration/exploitation activities, and other users of the sea. Detailed studies and surveys would determine the construction costs for special foundations and special ships for both operation and maintenance requirements. Other necessities include seabed lease arrangement; statutory clearances and no objection from regulatory authorities; grid connectivity and evacuation of power (both offshore and onshore); business model and technology development; incentives; security of offshore installations and confidentiality of the data collected during studies and surveys; and financing.

The MNRE is overseeing the following aspects of development: monitoring the overall offshore wind development in the country; coordinating with other ministries/departments; issuing guidelines/directives for the development of offshore wind energy; providing necessary support for smooth functioning; developing international cooperation and coordination towards tariff setting and regulatory issues; calling for proposals; entering into contract with project developers; carrying out and also coordinating resource assessment and surveys; coordinating and monitoring technical activities of projects; promoting indigenous research for technology development; evaluating technical and financial aspects and reviewing development; creating and maintaining an offshore wind energy database and archive system.

The environmental impact of offshore wind farms is considerably reduced compared with onshore wind farms; both noise and visual impact are unlikely to be issues, but still some considerations remain. For example, an environmental impact is possible from carrying out offshore work, such as localized disturbance of the seabed. Some studies have suggested that the noise from rotating turbines travels under water and disturbs sea life. Nonetheless, ships, boats, and engines have been a fact of life for more than 100 years.

In addition to environmental issues, financial issues are also considerable. Capital costs are higher than those of onshore farms due to larger machine size and costs of transporting and installing equipment at sea. But this is partially offset by higher energy yields, as much as 30%. Also similar to onshore, these prices are expected to drop as technology improves and more experience is gained.

According to studies in Denmark, wind resources up to 40 km from the shore are currently considered economically feasible, with the key factor being water depth. As interest grows and technology advances, offshore wind appears headed for a prominent position in the renewable energy mix. In June 2016, a project consortium led by the Global Wind Energy Council (GWEC), along with the Centre for Study of Science, Technology and Policy (CSTEP), DNV GL, Gujarat Power Corporation Ltd (GPCL), World Institute of Sustainable Energy (WISE), and NIWE, prepared a detailed report, *Facilitating Offshore Wind in India*, as a roadmap for offshore wind energy development in India. The report evaluated supply chain, port infrastructure, and logistics for offshore wind farm development in Gujarat and Tamil Nadu. A new era of offshore wind power has dawned for the wind industry in India. AU

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BUILDING GREEN

From Principle To Practice

Cost-effective implementation of a low-energy, sustainable design for a small office building requires commitment and planning, as well as an integrated application of advanced building technologies. The result can be exemplary low-energy performance as a prelude to a zero net energy building as demonstrated by this case study **(by K M Dharesan Unnithan)** of the office cum Energy Management Institute building of the Energy Management Centre (EMC) Kerala. The building is about to be announced as an IGBC LEED (Indian Green Building Council–Leadership in Energy and Environmental Design) gold-rated green building. EMC's new building is the first carbon neutral, net zero energy green building in the government sector.

The EMC office building cum Energy Management Institute complex consists of a 43,000 sq. ft headquarters office building in a 2 acre landscape and further 2 acre land demarcated for organic cultivation and social forestry, including parking and driveways, while retaining three old buildings of about 5,000 sq. ft in the premise as guest houses for the Energy Management Institute. The building is exemplary in its resource efficiency. Designed and built within a modest budget, the actual metered energy usage averages 12.5 kWh/sq. m-year in summer and about 10 kWh/sq. m-year in winter/rainy seasons, which along with renewable energy generations from the solar PV installations onsite assured that the payment to utility company towards energy cost is zero.

INTRODUCTION

The Energy Management Centre (EMC) Kerala, with support from the Government of Kerala, made a commitment to sustainable and energy-efficient building practices when it initiated the design of its office and training institute near Sreekariyam, Thiruvananthapuram, in Kerala. After considerable challenges in balancing design requirements, energy efficiency, sustainability, and construction cost issues, its dedication resulted in a high-performance, low-energy, and sustainable facility on a speculative office building budget. The building was inaugurated in February 2016.

Passive and active energy optimization was used to assist in the design of this naturally ventilated and passively cooled architecture. In this building, cooling solutions included natural ventilation with night cooling, using principles of stack effect combined with innovative material use. The design attempted a seamless integration of light, form, and the surrounding greenery.

The project design pre-dates the LEED IGBC (Leadership in Energy and Environmental Design–Indian Green Building Council) N.C v1.0 rating system for new construction and other similar

» **Picture 1** EMC office building: partial northwest elevation

best practice design guidelines available today. The important details of the building are as follows:

- Built-up area: 43,060 sq. ft
- Conditioned area: 9,794 sq. ft
- Number of floors: Ground + 1 floor
- North orientation: 205°
- Operating hours: 10:00 a.m. to 5:00 p.m. for 6 days in a week
- Climate zone as per ASHRAE 90.1: 1A/warm and humid as per ECBC 2007

DESIGN FEATURES

The design process was driven by commitment to a goal of low energy use and the application of computer simulation tools to evaluate building options supporting that goal. The design goals were as follows:

- *Reduce building energy consumption*: The EMC facility should serve as an example of innovative energy-efficient techniques adapted to commercial buildings.
- *Other sustainable design goals:* Selecting appropriate building materials; reducing the amount of building materials; and improving the ecology of the site.
    - To maximize solar access for daylighting and other solar systems and minimize east and west glass. Consider micro-climatic, micro-ecological, and geological conditions.
    - To consider the renewable energy resources at the site and the potential for implementing solar energy systems.

The final project design integrated a number of energy-efficient strategies that are innovative, straightforward, functional, and cost effective.

Daylighting and natural ventilation: The building adopted optimum orientation of blocks to ensure that only the north and south facades are fenestration for lighting and ventilation, while the east and west facades were made minimum and closed so that energy performance is greatly enhanced, comfort conditions are improved, and initial costs associated with cooling are reduced.

Reductions in cooling loads due to daylighting strategies enabled designers to downsize air conditioning systems, which reduced the initial cost of equipment. High-performance windows also helped to minimize heat gain in warmer months and heat loss in colder months. Although windows can create glare and skylights may cause overheating, properly designed daylighting strategies can reduce both lighting and cooling energy and control glare.

» **Picture 2** Central courtyard provides natural ventilation and daylight

The orientation of the building, the shape of the roof, and the materials used for the external envelope were designed to cut the glare and reduce the unwanted solar gain. The surrounding environment of dense deciduous vegetation and the prevailing wind directions were considered in making this structure climate responsive and more energy efficient.

The building's section energy concept equally divides the area into different logical thermal zones. Daylight control zones follow the same configuration with the exception that private offices in the north perimeter zone are controlled by two light sensors. Occupancy sensors were planned in public spaces such as toilets to turn lights off when the sensor detects the location is vacant.

Electrical demand of lighting systems: The equivalent lighting power density levels stipulated by ASHRAE 90.1 being at 10.7 W/sq. m, the actual connected lighting power density for the building is 2.28 W/sq. m.

RENEWABLE ENERGY

The designers were keen to incorporate onsite renewable energy facilities to meet the energy needs of the building. When evaluating site design issues, it is essential to investigate renewable systems early in the process.

- Considering building-integrated photovoltaic systems for electricity production, the rooftop of the building provides ample space for solar PV generation. Installing building-integrated solar thermal systems for domestic hot water, space heating, and absorption cooling for a future possibility was considered.

Initially, net-metered solar PV plants of 30 kWp were considered in the design stage. Later seeing the opportunity to make the building net energy positive, another 31.7 kWp through three different systems catering to different needs—10 kWp for lighting and server room air conditioning, 20 kWp for UPS charging, and 1.7 kWp for experimental set-up to run a split-type DC air conditioner—was installed. The solar panels are proposed to generate 103,000 kWh of energy.

Renewable energy usage: The total energy exported by the 30 kWp grid-connected solar PV unit is 48,160 units, which is

» **Picture 3** Solar PV and hot water installations

more than the power imported to the campus from the grid. Since the building's computer system consumed the highest amount of energy, the EMC installed a 21 kWp solar PV plant exclusively for catering the UPS load, which abates 35% of utility power. In addition, the lighting load is now being diverted into a 10 kWp PV unit with battery back-up that takes care of the lighting energy usage, which equals to another 35% of the utility power.

MEASURED RESULTS

To assess whether the project is performing in line with the design considerations, the building was monitored for more than 1 year with regard to detailed energy use, water usage, and renewable energy generation.

The utility company (KSEBL) meter measures the total site's electrical power for the building. An additional meter is provided after the utility meter for measuring the net solar energy being fed into the grid. Five sub-meters segregate the electrical power for the office building's lighting panels, HVAC panels, general plug loads, and the power utility services and UPS power panel to the maintenance facilities. The total of the five sub-meters reconciles with the utility premises meter. The metered data for 2016/17 indicate the office building used 40,188 kWh for the year, which translates to 3,162 BTU/sq. ft.

Analysing the energy usage over the last year at an EPI of 9.97 kWh/sq. m-year, EMC's new green building outperforms the EPI of BEE five-star-rated building in warm and humid region for buildings with less than 50% conditioned space. Even with a comparable star-rated building, the EMC green building saves close to 1.5 lakh units of electricity annually.

CONCLUSION

This facility creates a meaningful place that provides more than basic administrative offices, conference and training rooms, and paved parking lots, which are status quo with strip mall office developments. It demonstrates that a high-performance, energy-efficient, environmentally responsible small office building is possible on a speculative office building budget. The integrated design process coupled with an extended project team allowed the team to capture energy performance that is not possible with conventional project design approaches. The project's energy efficiency design goals were met or exceeded. The measured results of energy performance confirm that the energy goals were achieved and are sustainable over time. AU

Mr K M Dharesan Unnithan, Director, Energy Management Centre, Kerala.

YEAR END REVIEW 2017

The Ministry of New and Renewable Energy (MNRE) has taken several steps to realize the largest renewable capacity expansion programme in the world, which is being taken up by India. The government is aiming to increase the share of clean energy through massive thrust in renewables. Core drivers for development and deployment of new and renewable energy in India have been energy security, electricity shortages, energy access, climate change, etc.

Here, we present the highlights of the developments in renewable energy sector in India in 2017.

- Government is on its way to achieving 175 GW target for installed renewable energy capacity by 2022
- India attains global 4th and 6th position in global wind and solar power installed capacity
- By November 2017, a total of 62 GW renewable power installed, of which 27 GW installed since May 2014 and 11.79 GW since January 2017
- Historic low tariffs for solar (₹2.44/ unit) and wind (₹2.64/ unit) achieved through transparent bidding and facilitation
- Ambitious bidding trajectory for 100 GW capacity of solar energy and 60 GW capacity of wind over the next 3 years laid down.

A capacity addition of 27.07 GW of renewable energy has been reported during the last three and half years under grid connected renewable power, which include 12.87 GW from solar power, 11.70 GW from wind power, 0.59 from small hydro power, and 0.79 from bio-power. As on November 30, 2017, solar energy projects with an aggregate capacity of over 16,611.73 MW including 863.92 MW from solar rooftop projects has been installed in the country.

ACHIEVEMENTS

The details of year-round initiatives and achievements of the MNRE are as follows:

GREEN POWER CAPACITY ADDITION

A total of 11,788 MW of grid-connected power generation capacity from renewable energy sources was added in 2017 (January 2017 to November 2017) in the country.

A total of 11,319.71 MW of grid-connected power generation capacity from renewable energy sources, such as solar (5,502.38 MW) and wind (5,585.98 MW), small hydro power (105.90 MW), bio-power (161.95 MW) has been added during 2016/17 in the country against target of 16,660 MW. During 2017/18, a total 4,809.51 MW capacity was added till November 30, 2017, making cumulative achievement 62,053.73 MW.

SECTOR-WISE HIGHLIGHTS OF ACHIEVEMENTS

- Largest ever wind power capacity addition of 5,502.39 MW in 2016/17 exceeding target by 38%. During 2017/18, a total 467.11 MW capacity was added till November 30, 2017, making cumulative achievement 32,746.87 MW. Now, in terms of wind power installed capacity India is globally placed at fourth position after China, USA, and Germany.
- Biggest ever Solar Power capacity addition of 5,525.98 MW in 2017/18. During 2017/18, a total 4,323.1 MW (including 207.92 MW solar rooftop) capacity was added till November 30, 2017, making cumulative achievement 16,611.73 MW (including 863.92 MW solar rooftop).
- So far, 1.42 lakh solar pumps have been installed in the country as on

November 30, 2017 including 1.31 lakh during the last three and half years.

- Solar projects of capacity 23,656 MW have been tendered and LoI for 19,340 MW issued.
- A capacity addition of 0.59 GW has been added under grid connected renewable power since the last three and half years from small hydro power plants.
- Biomass power includes installations from biomass combustion, biomass gasification and bagasse co-generation making a cumulative achievement to 8,181.70 MW.
- Family-type biogas plants mainly for rural and semi-urban households are set up under the National Biogas and Manure Management Programme (NBMMP). During 2017/18, against a target of 1.1 lakh biogas plants, 0.15 lakh biogas plants installations has been achieved making a cumulative achievement to 49.8 lakh biogas plants as on November 30, 2017.

MAJOR INITIATIVES TAKEN BY THE MINISTRY

Solar Power

- Under National Solar Mission, the target for setting up solar capacity increased from 20 GW to 100 GW by 2021/22. Target of 10,000 MW, set for 2017/18 which will take the cumulative capacity over 20 GW till March 31, 2018.
- As on November 30, 2017, 23,656 MW has been tendered out, of which LOI issued for 19,340 MW.
- Capacity of the scheme for 'Development of Solar Parks and Ultra Mega Solar Power Projects' has been enhanced from 20,000 MW to 40,000 MW. 35 solar parks of aggregate capacity 20,514 MW have been approved in 21 States.
- Kurnool Solar Park in Andhra Pradesh with 1,000 MW capacity has already been commissioned and is operational. With commissioning of 1,000 MW capacity at single location, Kurnool Solar Park has emerged as the World's Largest Solar Park.
- 650 MW capacity commissioned in Bhadla Phase-II Solar Park in Rajasthan.
- 250 MW capacity commissioned in Phase –I of Neemuch Mandsaur Solar Park (500 MW) in Madhya Pradesh.
- Three new solar parks have been approved in 2017 at Rajasthan (1,000 MW), Gujarat (500 MW) and Mizoram (23 MW) after issue of Guidelines for Enhancement of capacity from 20, 000 MW to 40, 000 MW under Solar Park Scheme.
- Solar tariff has declined to lowest level of ₹2.44 /kWh.

Solar Rooftop

The Ministry is implementing Grid-Connected Rooftop and Small Solar Power Plants Programme which provides for installation of 2,100 MW capacity through CFA/ incentive in the residential, social, Government/PSU, and institutional sectors.

Under the programme, central financial assistance up to 30% of benchmark is being provided for such projects in residential, institutional, and social sectors in General Category States and up to 70% of the benchmark cost in Special Category States. For Government sector, achievement linked incentives are being provided. Subsidy/CFA is not applicable for commercial and industrial establishments in private sector.

- So far (till November 30, 2017), sanctions for 1767 MWp capacity solar rooftop projects has been issued and around 863.92 MWp capacity has been installed.
- All the 36 State / UT ERCs have now notified net/gross metering regulations and/or tariff orders for rooftop solar projects
- Concessional loans of around $1,375 million from World Bank (WB), Asian Development Bank (ADB), and New Development Bank (NDB) have been made available to State Bank of India (SBI), Punjab National Bank (PNB) and Canara Bank for solar rooftop projects.
- Suryamitra programme has been launched for creation of a qualified technical workforce and over 11,000 persons have been trained under the programme.
- An online platform for expediting project, approval, report submission, and monitoring of RTS projects has been created.
- Launched mobile app ARUN (Atal Rooftop Solar User Navigator) for ease of access of beneficiaries for request submission and awareness.

Wind Power

- During the year 2016/17, wind power capacity addition of 5.5 GW was made, which is highest ever wind power capacity addition in the country during a single year. The present wind power installed capacity in the country is around 32.75 GW. Now, in terms of wind power installed capacity India is globally placed at 4th position after China, USA, and Germany.
- India has a strong manufacturing base of wind power equipment in the country. Presently, there are 20 approved manufacturers with 53 models of wind turbines in the country up to a capacity of 3.00 MW single turbines. Wind turbines being manufactured in India are of international quality standards and cost-wise amongst the lowest in the world being exported to Europe, USA, and other countries.
- The wind power potential of the country has been reassessed by the National Institute for Wind Energy (NIWE), it has been estimated to be 302 GW at 100 meter hub-height. Online wind atlas is available on NIWE website. This will create new dimension to the wind power development in the country. AU

Source: http://pib.nic.in/

IREDA AND RUMSL SIGN AGREEMENT FOR LARGE-SCALE SOLAR PARKS IN MADHYA PRADESH

» The Interim DG of International Solar Alliance (ISA), Shri Upendra Tripathy witnessing the signing ceremony of sub-loan agreement between Indian Renewable Energy Development Agency (IREDA) and Rewa Ultra Mega Solar Limited (RUMSL), in New Delhi on January 31, 2018.

Indian Renewable Energy Development Agency Limited (IREDA) and Rewa Ultra Mega Solar Limited (RUMSL) signed an agreement on January 31, 2018, for financing the shared infrastructure of two large solar parks in Madhya Pradesh.

The Ministry of New and Renewable Energy (MNRE), The World Bank, and IREDA have been able to work out a proposal to channelize $100 million for creating common infrastructure for ultra-mega solar parks in India to achieve the 100 GW solar capacity addition target by 2022, set by the Prime Minister Shri Narendra Modi. Under the World Bank Line of Credit, IREDA has sanctioned its first loan of ₹210.62 crore to RUMSL to finance two such solar parks in the state of Madhya Pradesh. The agreement was signed by Shri S K Bhargava, Director (Finance), IREDA and Shri Avaneesh Shukla, Executive Engineer, RUMSL in the presence of Shri Upendra Tripathy, Interim Director General, International Solar Alliance (ISA).

The broad terms and condition of the agreement include fixed interest rate of 8.5% p.a. for entire loan tenure, moratorium from principal repayments up to 5 years, and loan repayment period of up to 20 years.

Speaking on the occasion, Shri K S Popli, CMD, IREDA, appreciated the initiative of MNRE, support of The World Bank and more specifically of DEA to reduce the sovereign guarantee fee to 0.5%. He further stated that this support from DEA will enable to expedite development of such proposals in other states also.

Shri Upendra Tripathy, Interim Director General, ISA, mentioned that India being in leading position in solar technologies, there is immediate attention for the development of 121 projects of solar technologies in 121 ISA member countries by April 21, 2018. He congratulated IREDA and RUMSL for achieving the feat in short time frame and also for the innovative Payment Security Mechanism which will ensure timely payment to the developer.

Shri Manu Srivastava, Principal Secretary and Managing Director, RUMSL, mentioned that RUMSL, at present, is implementing two solar parks, that is, Rewa with capacity of 750 MW and Mandsaur with 250 MW capacity in the state of Madhya Pradesh. With the solar park model, Payment Security Mechanism and the Line of Credit from The World Bank, the tariff for Rewa project is discovered as low as ₹3.30 on levelized basis. Out of the total power proposed to be generated at Rewa solar park, 24% has been agreed to be purchased by Delhi Metro Rail Corporation and balance 76% by Madhya Pradesh Power Management Company Ltd (MPPMCL). AU

Source: http://pib.nic.in/

INTERNATIONAL SOLAR ALLIANCE FORUM AT WORLD FUTURE ENERGY SUMMIT, ABU DHABI

In one of its first outreach programmes post-ratification, the International Solar Alliance (ISA) hosted a two-day event 'International Solar Alliance Forum' during January 17–18, 2018, at the Future World Energy Summit (WFES) 2018. WFES is a signature event of a global initiative, Abu Dhabi Sustainability Week, hosted by Masdar scheduled during January 15–18, 2018, at Abu Dhabi (UAE). During the ISA event, an ISA Pavilion was also set up for dissemination of information about ISA and its activities and programmes.

On the first day of the ISA Forum, January 17, 2018 the Ministerial Plenary of ISA Energy Ministers was held. The ISA Ministerial was attended by seven Energy Ministers of ISA Member countries. They presented their views on benefits of collaboration, synergies, and knowledge sharing at the international level to scale up solar energy for universal energy access and investing in innovations, technology, and R&D for solar projects followed by breakout sessions.

» Shri R K Singh, Hon'ble Minister for Power and New & Renewable Energy, delivering the keynote address at the International Solar Alliance Forum

Delivering the keynote address on the occasion, Shri Raj Kumar Singh, Minister of State(IC) for Power and New & Renewable Energy, Government of India, congratulated ISA for organizing the ISA Forum as its first overseas outreach activity. He stated that over the years the renewable energy has become cheaper and is set to replace conventional energy, which is a healthy development, and added that India has one of the fastest growing renewable energy programmes in the world and the country would achieve its target of 175 GW of installed renewable energy capacity well before 2020. The Minister said that ISA shall help mobilize sufficient funds for solar energy projects. During his address, Shri Singh announced setting up of a $350 million Solar Development Fund by the Government of India for financing of solar projects.

While formally opening the Ministerial session and welcoming the participants, Shri Upendra Tripathy, Interim Director General of ISA informed about exchange of LoIs/MoUs of ten solar related projects. He further stated that ISA shall stand for translating 'action into transaction'. He also informed that over 100 projects shall be signed by April 2018 under the ISA umbrella. He also thanked member countries and various stakeholders making ISA a reality in a short time. The Ministerial Plenary was followed by three technical panel discussions: 'ISA a Trillion Dollar Opportunity'; 'Networking of R&D Institutions in ISA Countries for Solar Innovation, Incubation & Start-Ups'; and 'Best Practices for Solar Capacity Building in ISA Countries'. These sessions were attended by energy ministers, policymakers, multilateral banks and finance institutions, R&D institutions and innovators, solar project developers and manufacturers, investors, and other stakeholders.

» Shri Upendra Tripathy during a discussion at the International Solar Alliance Forum

At the end of the ISA Ministerial session, the YES Bank committed financing solar projects of over $5 billion. M/s CLP and M/s NTPC Limited announced forging partnership deal with ISA and committed to make voluntary contribution of $1 million each to ISA fund corpus. IEA and GCF also announced entering into partnership with ISA. AU

Source: http://pib.nic.in/

ANNOUNCEMENT OF THE THIRD WIND POWER AUCTION SCHEME

» The Minister of State (I/C) for Power and New and Renewable Energy, Shri Raj Kumar Singh addressing the gathering at the announcement of the Third Wind Power Auction Scheme, in New Delhi on November 24, 2017. The Secretary, Ministry of New & Renewable Energy, Shri Anand Kumar and other dignitaries are also seen.

The Government has announced the trajectory for achieving its targets of commissioning 175 GW of Renewable Energy (RE), 100 GW of solar generating capacity and 60 GW of wind power, by 2022 on November 24, 2017.

Addressing the gathering, Union Minister of State (IC) for Power and New & Renewable Energy, Shri Raj Kumar Singh said that there was a long pending demand from the Industry to declare the RE roadmap of the government. Hence, with the declaration of this trajectory, the Government has clearly spelt out its plan of speeding up of RE installation in the country and strengthening the RE manufacturing base in India.

Shri Singh informed that to encourage the Make in India in RE sector, the Ministry of New & Renewable Energy (MNRE) is working out the scheme and going to issue an Expression of Interest (EoI) to the industry, for establishing domestic manufacturing facilities to the tune of 20 GW, in the near future. Further, the MNRE is exploring innovative ways to achieve additional installed RE capacity through floating solar power plants over dams, offshore wind energy systems and hybrid solar-wind power systems, which may provide over 10 GW additional capacity. The MNRE team of experts has already surveyed the Bhakra Nangal dam for floating solar power plants and off-shore Gujarat and Tamil Nadu for wind power plants, the Minister added. Shri Kumar also said that with wind power tariffs becoming competitive and State DISCOMs encouraged to buy more of renewable energy power, the government has doubled the auction capacity for the third national level wind auction from 4 GW in 2016 to around 9 GW in 2017.

The present scheme of Wind Power Auction is for setting up of 2,000 MW Wind Power Project connected to inter-state transmission system (ISTS). The bidder can bid for a minimum capacity of 50 MW and maximum up to 400 MW. The projects under this scheme are expected to be commissioned towards the end of 2019.

On the occasion, Power Sale Agreements (PSA) for purchase of wind power under second wind auction with States were also signed with Solar Energy Corporation of India with utilities of Uttar Pradesh, Bihar, Jharkhand, Assam, Punjab, Goa and Odisha. The reverse auction for SECI-II wind bid was conducted on October 4, 2017, which resulted in very competitive tariff of ₹2.64/2.65 per unit.

Other dignitaries present on the occasion were Shri Praveen Kumar, Additional Secretary MNRE; Shri K S Popli, CMD IREDA; Shri J S Swain, MD SECI; and other senior officers of the Ministry and State Governments. AU

Source: http://pib.nic.in/

Green QUIZ

1. Which of these is a type of green energy?
(a) A petrol pump (b) A coal burning fire
(c) A wind mill (d) An electric cable

2. An increase in the overall temperature of the atmosphere due to an increase in carbon dioxide is known as?
a) Global warming b) Heating
c) Summers d) Change in weather

3. When shopping for energy-saving lighting options for your home, which of the below-mentioned options would you consider buying?
a) Incandescent lights b) Halogen lamps
c) CFLs bulbs d) LED lamps/tube lights

4. Which village in Bihar is India's first solar-powered village?
a) Lucknow, Uttar Pradesh
b) Dharnai, Bihar
c) Ratnagiri, Maharshtra
d) Okha, Gujarat

5. Identify the lake which is the only floating lake in the world, is a source for hydropower generation, irrigation, drinking water supply, and is also a means of livelihood for the local fishermen.
a) Oguta Lake, Nigeria b) Loktak Lake, India
c) Kaptai Lake, Bangladesh d) Hamun Lake, Iran

6. Solar cells that convert sunlight into electricity are called:
a) Photovoltaic b) LED
c) None of the above d) All the above

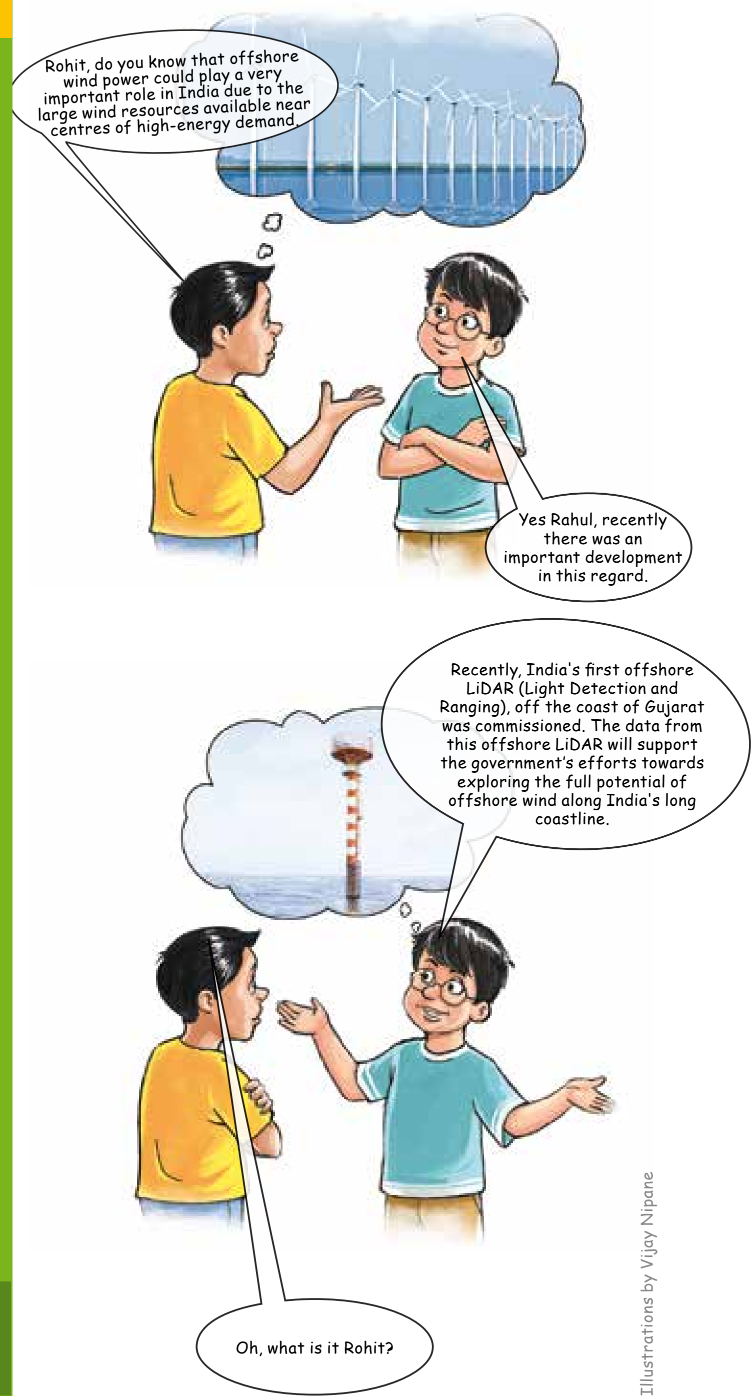
7. Greenhouse effect was first predicted in 1896 by:
a) William Nordhaus b) Sven Erikkson
c) Svante Arrhenius d) Brian Wilson

8. RDF a recycled waste product stands for:
a) Recycled Derived Fuel b) Refuse Derived Fuel
c) Reuse Derived Fuel d) Repair Derived Fuel

Answers
1. (c), 2. (a), 3. (d), 4. (b), 5. (b), 6. (a), 7. (c), 8. (b)

Source: http://edugreen.teri.res.in/

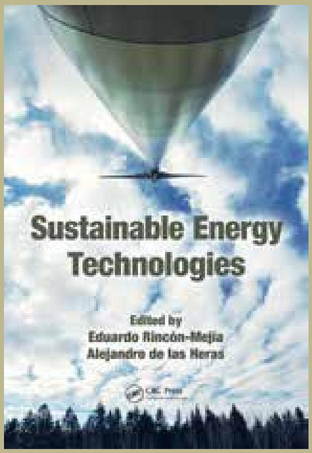
CON2PRESERVE



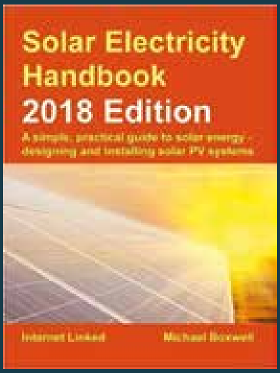
Illustrations by Vijay Nipane

Sustainable Energy Technologies

Eduardo Rincón-Mejía (Editor), Alejandro de las Heras (Editor); CRC Press, 399 pages



This book examines the key aspects that will define future sustainable energy systems: energy supply, energy storage, security and limited environmental impacts. It clearly explains the need for an integrated engineering approach to sustainable energies, based on mathematical, biogeophysical, and engineering arguments. Resilient and efficient alternatives are compared to non-sustainable options. This book results from the collaboration of 50 international contributors. The book provides updated and detailed description of sustainable technologies for an informed dialogue between engineers and allied professionals dedicated to different energy specialities (including but not limited to energy storage, chemistry, bioengineering, built environment, decentralized systems, appropriate technologies, etc.). The book covers comprehensively solar-based technologies, and key geoscience elements impinging on the future sustainability of the global energy system. AU



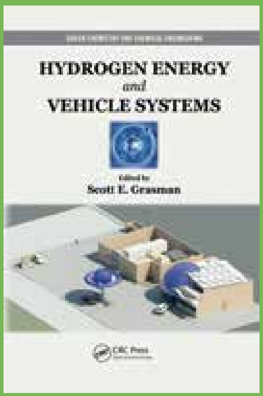
The Solar Electricity Handbook - 2018

Michael Boxwell; Greenstream Publishing, 186 pages

Solar Energy is a wonderful concept. Take free energy from the sun and use it to power electrical equipment. No ongoing electricity bills, no reliance on an electricity socket. 'Free' electricity that does not harm the planet. Generating electricity from sunlight alone is a powerful resource, with applications and benefits throughout the world. But how does it work? What is it suitable for? How much does it cost? How do I install it? This best-selling, internet linked book answers all these questions and shows you how to use the power of the sun to generate electricity yourself. Now in its twelfth edition, this book assumes no previous knowledge. It explains the advantages of solar energy and the drawbacks you need to take into account. While explaining the underlying principles, it provides a step-by-step guide so that you can successfully design and install a solar energy system from scratch. The website that accompanies this book includes online solar calculators and tools to simplify your solar installation, ensuring that building your system is as straightforward and successful as possible. Readers can also get in touch directly with the author to ask questions and get further support with their solar projects. AU

Hydrogen Energy and Vehicle Systems

Scott E Grasman; CRC Press, 366 pages

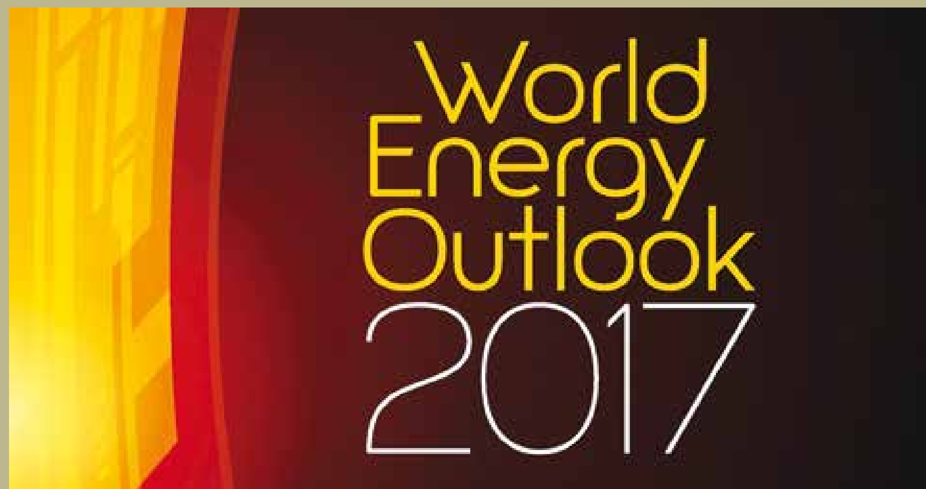


With contributions from noted laboratory scientists, professors, and engineers, ***Hydrogen Energy and Vehicle Systems*** presents a new comprehensive approach for applying hydrogen-based technologies to the transportation and electric power generation sectors. It shows how these technologies can improve the efficiency and reliability of energy and transportation systems.

The book's interdisciplinary approach to sustainable energy systems disproves common misconceptions regarding hydrogen technologies and demonstrates that hydrogen technologies are a viable part of a sustainable, stable, and secure energy infrastructure. The book discusses intelligent energy management schemes for hydrogen energy and vehicle systems, safety and environmental science related to hydrogen technologies, and the infrastructure required for safe, renewable hydrogen options.

A clear and up-to-date resource on hydrogen systems, this work provides a balanced presentation of theoretical/technical and application aspects of hydrogen technologies. It presents all stakeholder perspectives and connects hydrogen technology through proper systems analysis and integration, covering both quantitative and qualitative factors. AU

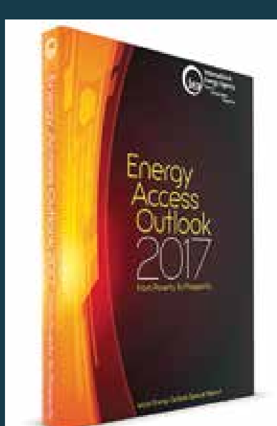
A World in Transformation: *World Energy Outlook 2017*



The resurgence in oil and gas production from the United States, deep declines in the cost of renewables and growing electrification are changing the face of the global energy system and upending traditional ways of meeting energy demand, according to the ***World Energy Outlook 2017***. A cleaner and more diversified energy mix in China is another major driver of this transformation. WEO-2017, the International Energy Agency's flagship publication, finds that over the next two decades the global energy system is being reshaped by four major forces: the United States is set to become the undisputed global oil and gas leader; renewables are being deployed rapidly thanks to falling costs; the share of electricity in the energy mix is growing; and China's new economic strategy takes it on a cleaner growth mode, with implications for global energy markets.

Solar PV is set to lead capacity additions, pushed by deployment in China and India, meanwhile in the European Union, wind becomes the leading source of electricity soon after 2030. As demand growth in China slows, other countries continue to push overall global demand higher—with India accounting for almost one-third of global growth to 2040.

WEO-2017 finds it is too early to write the obituary of oil. Global oil demand continues to grow to 2040, although at a steadily decreasing pace—while fuel efficiency and rising electrification bring a peak in oil used for passenger cars, even with a doubling of the car fleet to two billion. But other sectors—namely petrochemicals, trucks, aviation, and shipping—drive up oil demand to 105 million barrels a day by 2040. The World Energy Outlook does not offer a forecast of what the energy system will look like but instead presents various projections to 2040 based on different policy assumptions, in order to give policy makers the tools to decide what path to follow. The main case is called the New Policies Scenario, and it models current and announced energy policies, including those in the Paris Agreement. This year, the report introduces the Sustainable Development Scenario, which offers an integrated way to achieve a range of goals: climate stabilization, cleaner air, and universal access to modern energy. AU



WEO-2017 Special Report: Energy Access Outlook

The International Energy Agency (IEA) has produced a Special Report (***Energy Access Outlook***), which is part of its flagship World Energy Outlook (WEO) series.

The Energy Access Outlook report:

- Expands and updates the WEO's country-by-country electricity and clean cooking access database, and assesses the status for all developing countries, reviewing recent trends and policy efforts up to 2016.
- Presents a global and regional electricity and clean cooking access outlook to 2030, with a dedicated chapter on sub-Saharan Africa
- Provides a pathway for achieving access to modern energy for all by 2030, identifying policy priorities, detailing investment needs, and the role that decentralized and on-grid solutions may play
- Analyses how energy development can unleash economic growth in sectors such as agriculture, and explores how energy access intersects with other issues, such as gender, health, and climate change. AU

Source: www.iea.org

NATIONAL

May 11, 2018 | Kolkata, India
SolarRoofs West Bengal 2018
Website: http://firstviewgroup.com/

May 23–25, 2018 | New Delhi, India
Smart Cities India 2018 Expo
Website: http://www.smartcitiesindia.com/

May 23–25, 2018 | New Delhi, India
Solar India 2018 Expo
Website: http://www.solarindiaexpo.com/

June 14–16, 2018 | Chennai, India
Solar South 2018 Expo
Website: http://www.solarsouth.in/index.html

July 12–13, 2018 | Chennai, India
Green Power 2018
Website: http://www.greenpower-cii.com/

INTERNATIONAL

May 23, 2018 | Aberdeen, UK
Decom Offshore 2018
Website: http://decomnorthsea.com/decomoffshore2018

June 5–6, 2018 | Texas, USA
Solar Power Texas
Website: https://www.seia.org/events/solar-power-texas

June 13–14, 2018 | Berlin, Germany
BDEW Congress 2018
Website: https://www.bdew-kongress.de/

June 20–22, 2018 Yokohama, Japan
Grand Renewable Energy 2018 Exhibition
Website: http://www.renewableenergy.jp/2018/english/

July 10–12, 2018 San Francisco, USA
Intersolar North America
Website: https://www.intersolar.us/en/home.html