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Renewable Energy Akshay Urja

COVER PHOTOGRAPH



The first Solar Park of India at Charanka, district Patan, Gujarat of 590 MW designed capacity. At present, 350 MW has already been commissioned. The solar electricity is being purchased at ₹4.50 per kWh. Another 240 MW is under installation by the Solar Energy Corporation of India.

Courtesy: GPCL, Charanka Solar Park

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Energy is the most important of infrastructural requirements and uninterrupted supply of energy is essential for development. In this article, **Onkar Nath** talks about how electricity supply from micro-hydro power projects has shaped economic development in remote regions of Uttarakhand.



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In this case study, **Dr Ashok Das** discusses the innovative Smart Village Nanogrid™ solution and their pilot village in Chhotkei, Odisha. He highlights that SunMoksha has invested years of effort to closely understand the challenges of energy access and has developed a holistic solution with a 'systems' approach to address these challenges.



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This success story article discusses about the implementation of solar thermal systems in Kargil under the 'Ladakh Renewable Energy Initiative' scheme of the MNRE. It also highlights the Ladakh Renewable Energy Initiative by the LREDA in Leh, Ladakh.

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The news item published in the April 2016 issue of *Akshay Urja* regarding India and France launching the \$1 trillion potential solar programme for developing countries is very encouraging for the development of the solar energy movement in the world. The Honourable minister Shri Piyush Goyal is correct in expressing his confidence that these programmes will serve the interests of the farming communities in the prospective ISA member countries and ensure that there is sufficient flow of affordable finance for solar projects.

Sudha Ganguly,
Kolkata, West Bengal

मैंने 'अक्षय ऊर्जा' पत्रिका का विगत अंक अपने पुस्तकालय में पढ़ा था। पढ़कर बहुत ही अच्छा लगा। पर्यावरण को बचाने और बिजली के खपत को कम करने के लिए लोगों को इस पत्रिका के माध्यम से जागरूक किया जा रहा है, जो एक बहुत ही सराहनीय कदम है। मैं भी आपकी पत्रिका के माध्यम से अक्षय ऊर्जा के क्षेत्र में अपनी जानकारी बढ़ाना चाहता हूँ जिससे मैं अपने मित्रों और परिचितों को भी इसके बारे में विस्तार से बता सकूँ कि पर्यावरण को बचाने हेतु क्या-क्या प्रयास किए जा रहे हैं। अतः मुझे 'अक्षय ऊर्जा' पत्रिका भेजने का कष्ट करें।

प्रवीन कुमार
न्यू पटेल नगर,
पटियाला, पंजाब

I and two of my colleagues had an opportunity to visit your regional office at Bhubaneswar. We were presented with your publication, *Akshay Urja*. I must say that it is highly informative and rich in content regarding renewable energy. Ours is a state level organization with more than 600 qualified members drawn from different disciplines. I am sure the members of our Society will be immensely benefitted by reading the

periodical magazine, *Akshay Urja* and other publications.

Dr S N Patro,
Orissa Environmental Society, Odisha

The feature article "Microgrids: Opening New Possibilities for the Electricity Grid" published in the April 2016 issue of *Akshay Urja* is very informative for the readers regarding the new concept of microgrids. The authors are correct in pointing out that energy users are becoming more aware of alternative power approaches and are more willing to consider on-site generation options than in the past. Many are interested in combined heat and power as well as reliability enhancements. The article on battery-operated vehicles also highlights that concerns on emissions and their effects on climate change are currently the drivers behind automotive technology.

Surendra Bakshi,
New Delhi

मुझे अपने कार्यालय में अक्षय ऊर्जा, अप्रैल 2016 पढ़ने का सुअवसर प्राप्त हुआ। डा. ओम प्रकाश नांगिया द्वारा लिखा गया लेख—"स्मार्ट भंडारण प्रौद्योगिकी" पढ़कर यह ज्ञात हुआ कि ऊर्जा भंडारण को कुशलता से ग्रिड के प्रबंधन और अबाधित ऊर्जा वितरण के लिए परिवर्ती संसाधनों को एकीकृत करने में बहुत महत्वपूर्ण माना जाता है। सौर ऊर्जा और भंडारण के भावी रुझान पढ़कर यह आशा जगी है कि भंडारण तकनीकों में प्रगति को और अधिक समर्थन मिलेगा और मिलजुलकर ये ऊर्जा के परिदृश्य में बदलाव लाएंगे।

आकांक्षा दीक्षित
नई दिल्ली

The article "Environment Affects Solar Power Generation" very appropriately describes about the effects of high temperature, shading, clouding, dust,

and pollution on the efficiency of solar panels. The author rightly says that solar panels work best in certain weather conditions, but since the weather is constantly changing and as engineers are installing solar panels at various parts of the world in different climate regions, most panels do not operate under ideal conditions. That is why it is important for engineers to understand how panels react to different weather conditions before installing them. It was also nice to read about the Suryamitra programme that proves itself to be life-changing journey from unskilled to skilled solar technician.

Vipin Pandey,
Chandigarh

"असम राज्य में अक्षय ऊर्जा की अपार संभावना" लेख पढ़कर काफी सुखद अनुभूति हुई। असम ऊर्जा विकास एजेंसी की भूमिका वास्तव में काफी सराहनीय है। भारत में देश के विभिन्न हिस्सों में और विकिरण की उपलब्धता के कारण सौर विद्युत उत्पादन की उच्च संभाव्यता है, यह तथ्य असम राज्य बिल्कुल सही सिद्ध करता है। पंजाब कृषि विश्वविद्यालय द्वारा प्रबलित परिसंचरण और ड्रायर काफी प्रभावित करने वाला आविष्कार लगता है। इसे खुले स्थान पर धूप में हल्दी सुखाने के लिए एक वरदान के रूप में देखा जा सकता है। अक्षय ऊर्जा में ऐसे ज्ञानवर्धक लेख प्रकाशित करने के लिए साधुवाद।

हरिकृष्ण गोखले
औरंगाबाद, महाराष्ट्र



Dear Readers, 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



उपेन्द्र त्रिपाठी

Upendra Tripathy

सचिव

भारत सरकार

नवीन और नवीकरणीय ऊर्जा मंत्रालय

SECRETARY

GOVERNMENT OF INDIA

MINISTRY OF NEW AND RENEWABLE ENERGY



MESSAGE

Starting with the 'Charanka Solar Park' in Gujarat, and closely followed by the 'Bhadla Solar Park-Phase I' in Rajasthan, solar parks have gradually emerged as a powerful instrument for the rapid development of solar power projects in the country. Charanka Solar Park in Gujarat is the first-of-its-kind large scale solar park in India with contiguous developed land, transmission connectivity, and provision of other amenities and infrastructure. The MNRE has rolled out scheme plans to set up solar parks in the country, each with a capacity of 500 MW and above; thereby targeting around 20,000 MW of solar power installed capacity. Smaller solar parks are also considered in Himalayan and other hilly States where contiguous land may be difficult to acquire and States where there is acute shortage of non-agricultural land. Under the scheme, 33 solar parks with a total aggregate capacity of 20,000 MW capacity have been sanctioned in 21 States so far. The solar parks in the country enable the States to meet their solar targets and renewable purchase obligations. In addition, the clean power generated by these solar projects play a vital role in reducing India's carbon footprint, promoting high-end technical investments and empowering local communities. Solar parks have also attracted many foreign investors.

The renewable energy sector has gained tremendous momentum over the last two years due to the announcement of conducive policies, national tariff policy with provision of 8 per cent for renewable purchase obligations (RPOs) to come from solar by 2022, boost to solar rooftops with a provision of ₹5,000 crore, and enhancement in the overall target to about five folds. Various States in India are playing a vital role to promote renewable energy in their respective areas and today 17 States have exclusive policy for solar energy and 26 States/ Union Territories (UTs) have announced net metering policies for solar rooftops.

I am very glad to interact with you all through *Akshay Urja* magazine and I seek your valuable suggestions for promoting renewable energy in the country. I am very sure and optimistic that *Akshay Urja* is fulfilling its role by creating awareness and motivation amongst all our fellow countrymen to support the use of renewable energy as much as possible, even in their daily lives. I would urge upon our readers to adopt at least one device/system that utilizes renewable energy in their daily life and, therefore, contribute towards mitigation of greenhouse gas (GHG) emissions.

With best wishes!

Upendra Tripathy
Secretary



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From the Editor's Desk

Dear Readers,

The National Solar Mission (NSM) is marching ahead with its aim of reducing the cost of solar power generation in the country through long-term policy, large-scale deployment, aggressive R&D, domestic production of critical raw materials, components and products, besides achieving grid tariff parity at the earliest. More or less, we can say that the grid parity will be achieved shortly, if we compare the cost of power generation from the new conventional power plants. However, as compared to average pool purchase cost (APPC) of power in most of the States, it may take some time, because APPC also considers the availability of cheap power from the old plants. So far, the NSM has been successful in creating enabling policy framework to achieve this objective and is poised to make India a global leader in solar energy.

Solar parks and the ultra mega power projects scheme is a flagship scheme which has been fully subscribed with 20,000 MW allocations for 33 solar parks in 21 States and there is a plan to further augment this with another 20,000 MW capacity. This will bring India on the World's solar map because India is going to make few 'firsts', i.e., largest solar power plants, largest solar programme, etc. Solar rooftop is another flagship scheme which has now taken off in the country—the enabling mechanism with State/UT wise conducive net metering policies has been created. The Government of India has also provided substantial funds for this sector.

Access to infrastructure, particularly energy, is one of the basic requirements for the development of an economy and it holds its importance especially in the context of off-grid rural areas which are generally lagging behind in most of the developing countries. Access to electricity is also

perceived to be a key requirement for poverty reduction by enabling the creation and improvement of income-generating activities. In this direction, the concept of 'smart village nanogrid™' has been successfully demonstrated by 'SunMoksha' at Chhotkei village in Angul, Odisha. The concept consists of a hybrid power generation unit from locally available renewable sources, i.e., solar, wind, biomass, biogas, pico-hydro, etc. This could perhaps be replicated in other remote villages also after detailed analysis for its feasibility and viability.

Besides, an overview on NSM, the present issue focusses on and presents case studies and feature articles about some aspects of sustainable rural electrification in India; energizing rural hinterland through an innovative programme; and access to electricity for productive uses of energy and economic development. A few success stories related to utilization of solar energy in India are also presented.

I am also very happy to share with our readers that *Akshay Urja* (Hindi) has received the first prize from 'Rajbhasha Seva Sansthan'. I am sure that all the articles and information in the present issue will be a useful reading material and you will find it informative and interesting. Please do not forget to share your views and suggestions. Happy reading

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RENEWABLE ENERGY NEWS

IREDA Awarded the India Pride Award 2015–16 by Dainik Bhaskar Group

Indian Renewable Energy Development Agency Limited (IREDA)—a Central PSU under the Ministry of New and Renewable Energy (MNRE)—was awarded the India Pride Award 2015–16 by Dainik Bhaskar

Group of Publications under the category—India Image Enhancement/Creating a Global Brand. The Award was presented by Shri Ravi Shankar Prasad, Union Minister for Communications and Information Technology to Shri K S Popli, Chairman and Managing Director, IREDA, at a glittering function in New Delhi on April 4, 2016.



The awards function saw felicitation of organizations who work tirelessly towards India's sustainable growth. The award function was also graced by Shri Venkaiah Naidu, Union Minister for Urban Development, Housing & Urban Poverty and Parliamentary Affairs, and Shri Radha Mohan Singh, Union Minister for Agriculture. 🇮🇳

Source: www.ireda.gov.in

3,460 MW Wind Energy Capacity Addition in FY 2015–16 Exceeds Target

India added a record 3,460 MW of wind energy capacity in 2015–16, way ahead of its target of 2,400 MW. The previous highest was 3,197 MW added in 2011–12. More than a third of the capacity added in 2015–16 was by Madhya Pradesh, which commissioned 1,291.90 MW, according to figures released by the Indian Wind Turbine Manufacturers Association (IWTMA).

The next largest addition was in Rajasthan, 687.90 MW, while Gujarat adding 385.65 MW, and Andhra Pradesh adding 362.50 MW were in third and fourth place, respectively. "India's wind energy capacity exceeded this year's target by 44.2 per cent, proving our commitment towards green energy," Shri Piyush Goyal, Minister of State with Independent Charge for Power, Coal, and New & Renewable Energy, Government of India, said. At the end of 2015–16, India's cumulative wind energy capacity stood at 26,904.16 MW against 23,443.61 MW in 2014–15. India has set itself a target of 60,000 MW of wind energy by 2022. Despite a growing reluctance of late among some state DISCOMS to draw wind energy, the segment is expected to surpass its 2016–17 target of 4,100 MW as well. 🇮🇳



Source: economictimes.indiatimes.com



LM Wind Power Sets up €25-m Turbine Blade Plant at Halol

Danish wind turbine blades maker LM Wind Power commissioned its second manufacturing facility in India at Halol near Vadodara with an investment of €25 million (about ₹190 crore). With the commissioning of the new plant, LM Wind Power's total installed capacity in the country has increased to 1.6 GW per annum, which includes 1 GW from its existing facility at Dabaspet in Karnataka. Buoyed by the government's emphasis on renewable energy sources for generating electricity, the company has set an ambitious revenue target of ₹1,200 crore for 2016 against ₹760 crore in 2015. "We are very optimistic about the growth of the wind energy sector in India with the government setting a target of 60 GW by 2022. We have over 20 years of experience of operations in India," said Marc de Jong, CEO of the company.

The Halol plant is spread across 50 acres, employs over 400 workers from nearby villages, and has capacity to build blades up to 60 metres in length. The company also has a global technical centre for research, development, and services in Bangalore. It plans to enhance its existing installed capacity of 1.6 GW per annum to 2.5 GW per annum in the next 2–3 years with an additional estimated investment of €13 million. 🇮🇳

Source: www.thehindubusinessline.com



After LED Bulbs, EESL to Roll out Energy Efficient Fan Plan

After distributing more than one crore LED bulbs in Rajasthan under UJALA scheme, Energy Efficiency Services Ltd (EESL) is now setting sights on replacing traditional high energy consumption fans by energy-efficient variants under National Energy Efficient Fan Programme (NEEFP). "We want to replicate the same success in the energy efficient fan programme also," said Ritu Singh, project manager, EESL, Rajasthan. Under NEEFP Scheme, EESL aims to provide high quality 5-star rated fans to domestic consumers at a concessional rate of ₹1,200–1,300 per unit, whereas the same is available in the market at a higher price of ₹1,600–1,900. As per EESL's calculation, these fans are expected to help save ₹720 annually from the electricity bill; a consumer will be able to recover the complete cost in around two years. Even though the PAYS (pay as you save) model has been developed for faster adoption, Singh said initially the fans will be available at an upfront cost in Rajasthan. For the distribution of the fans across the cities, towns,



and villages, EESL is looking to tap the e-mitra network that it used for LED bulbs. "For the UJALA scheme, we used the 3,800 distribution centres in 33 districts. Apart from the energy savings benefits that this scheme has brought to the consumers, it has also helped the State government to create almost 7,000 additional jobs across centres in 33 districts. These jobs included awareness through various advertising platforms, distribution of LED bulbs,

procurement of these bulbs, etc. We expect similar roll out for the efficient fans," added Singh.

With EESL floating tenders for bulk supply of LED bulbs, offering the contract to the lowest price bidder, the prices have come down to 80 per unit from the market price of around ₹320. In the case of energy efficient fans also, such a bidding process is expected to bring down the cost of fans to ₹1,200–1,300. 🇮🇳

Source: timesofindia.indiatimes.com

Solar Energy Corporation of India Plans to Set Up More Solar Plants

The Solar Energy Corporation of India (SECI) plans to become a renewable energy developer itself. After setting up a solar project in Rajasthan, it will soon embark on two projects: a 300-MW hybrid project comprising both solar and wind energy in Andhra Pradesh and floating solar plants across Kerala (10 MW), Andhra Pradesh (10 MW), and Lakshadweep Islands (5 MW). In hybrid projects, solar panels are mounted in the space between wind turbines; while in floating projects, solar plants are set up on lakes or tanks. India's first floating plant, a pilot effort of 10 kW (0.01 MW) built by Arka-Ignou Community College of Renewable

Energy, has already been commissioned at Rajarhat New Town near Kolkata. Another 100 kW plant is being built on Loktak Lake in Manipur. "Floating solar plants are a somewhat fanciful idea in the Indian context," said Vinay Rustagi, Managing Director of solar consulting firm Bridge to India. "They are very costly with capex up to 2–3 times the normal solar projects and debatable benefits. Operational challenges are also a big issue and so



far, we simply do not have enough supporting evidence to make a strong business case for floating solar plants." 🇮🇳

Source: economictimes.indiatimes.com

Solar Power Plants on Waste Land

The Government is encouraging use of waste land for installation of solar power plants. Setting up of solar parks is a step in that direction. This was stated by Shri Piyush Goyal, Minister of State (IC) for Power, Coal & New and Renewable Energy in a written reply to a question in the Rajya Sabha. Under the scheme, 32 solar parks of 19,400 MW capacity have been sanctioned in 20 states so far.

The Minister further stated that a solar capacity of 20,000 MW has been

targeted under the existing solar park scheme, which includes use of waste land also. The total target for grid connected solar power plants is 60,000 MW by 2022. Government is monitoring the scheme in close coordination with States and other stakeholders so as to complete the projects in time for which various fiscal and promotional incentives. For example, capital subsidy, generation based incentive, accelerated depreciation, viability gap funding



(VGF), concessional excise, and custom duties, etc., are provided to project developers, the Minister added. ■

Source: www.pib.nic.in

NDB Sanctions \$250 mn for India's Renewable Energy Projects

The New Development Bank (NDB), commonly known as BRICS bank, has sanctioned its first batch of loans, including \$250 million to India's renewable energy projects. The NDB has approved four green renewable energy projects from India, China, Brazil, and South Africa entailing financing of \$811 million, the finance ministry said in a statement. The project from India entails provisioning of multi-tranche loan of \$250 million to Canara Bank for on lending to renewable energy projects. The project would result in generation of 500 MW of renewal energy and savings of about 800,000 tonnes of carbon emissions, it said. Meanwhile, on the sidelines of IMF–World Bank spring meeting in Washington, the BRICS countries deliberated on efficacy of establishment of New Development Bank Institute and BRICS rating agency. It was decided that a technical working group would examine the issues in detail and present their findings to the BRICS finance ministers and central bank governors in their next meeting. ■



Source: www.financialexpress.com

Dyal Singh College to Light up Homes with Solar Power

Delhi University's Dyal Singh College's latest initiative could come as a relief to many homes in South Delhi which suffer from power shortage. The college has installed solar panels which will not only fulfill the electricity requirement of the college but will also supply power to the vicinity. The college has become the first to install high intensity solar panels. This project is being executed in two phases of 100 kW each. The first phase was completed at a cost of ₹62 lakh and an inspection was held on April 16. The project was granted a 15 per cent subsidy.

"We have decided that the excessive power produced will be shared with the community. These solar panels will reduce the electricity bill by almost 30 per cent," said I S Bakshi, Principal of Dyal Singh College. "This

is our way to save the environment.

The entire college will be using the energy generated by the solar panels installed on the roof," he added. The second phase of the 200 kW solar project would materialize in future with which the college would become self-sufficient to fully power up the college without any help from BSES Rajdhani Power Limited (BRPL), one of the electricity suppliers in the Capital.

The college administration hopes that with the use of solar panels, electricity bills will go down. The plant is being used according to 'Net Metering System' through which the energy generated by this plant is first used by the college and the surplus is sold to the BSES Rajdhani Power Limited. Since the college is not open



throughout the year and electricity consumption is less on some days, the power generated on such days will be sold to BSES Rajdhani Power Limited. Therefore, it is estimated that within three years, the cost of installing would be reimbursed by the college. The college is also building an effluent treatment plant, which will treat the chemical waste generated from chemistry labs. ■

Source: indiatoday.intoday.in

Gamesa Installed 1 GW Wind Energy Turbines in FY 2015–16

Gamesa continued its dominance in the Indian wind energy market in financial year 2015–16 with highest installations. Gamesa India reported installation of 1 GW wind energy turbines. This is the first time the company has reached the milestone in a financial year. With the installation of 1 GW capacity, the company also secured 30 per cent market share in India for FY 2015–16. A total of 3.3 GW wind energy capacity was added in the country in FY 2015–16. India remains a huge market for Gamesa

with the emerging renewable energy market contributing as much as 29 per cent to the total global sales at the company. Earlier this year, Gamesa reported that total order intake in India during 2015 surpassed 1,300 MW—an increase of 54 per cent over 2014. However, with crucial financial incentives set to expire at the end of the current financial year industry watchers expect a sharp decline in installed capacity. Gamesa



has already geared up such developments. 🇮🇳

Source: cleantechies.com

Educational Institutions Most Open to Solar Power

Data released by power DISCOMS reveal educational institutions in the Capital to be most receptive to green energy. Power major BSES has announced that its rooftop 'net metering' initiative for solar energy has got a major push in the Capital with as many as 113 projects generating over 4,600 kW of energy. A BSES spokesperson said that the domestic category saw the largest number of net metering connections, while educational institutions category had the largest net metering load.

"Apart from this, over 20 solar net metering projects with a cumulative

sanctioned load of over 800 kW are under various stages of commissioning at the consumers' end. As many as 26 schools and educational institutes have opted for it," the official added.

According to the data released, the rooftop solar energy potential in the BSES area is in excess of 250–300 MW.

Net metering involves setting up rooftop solar panels and producing power for self-consumption, while the surplus can



be sold to the DISCOMS at rates approved by the Delhi Electricity Regulatory Commission (DERC). 🇮🇳

Source: www.thehindu.com

Suzlon Commissions 900 MW Wind Energy Projects in FY16 in India

Wind energy solutions provider Suzlon Group has commissioned 900 MW wind energy projects during the financial year 2015–16, of which 520 MW was commissioned in Q4FY 2015-16. This amounts to a more than 100 per cent increase in installations, vis-à-vis 442 MW installed during the financial year 2014–15, the company said in a statement. Suzlon continues to maintain market leadership in India with 36 per cent cumulative market share and diversified presence across eight states. The year also marked the debut of Telangana in the wind energy sector with maiden capacity addition of 78 MW installed by Suzlon, it said. The projects were executed for a variety of customers including Independent power producers (IPPs), public sector units (PSUs), and small and medium enterprises (SMEs). Suzlon's newest product variant S97 120m hybrid tower constituted 31 per cent (134 wind turbines) of its total commissioned capacity. With the installation of 900 MW in FY16, Suzlon's cumulative global wind energy installations reach 15.50 GW of which 9.50 GW installations are in India. 🇮🇳



Source: energy.economictimes.indiatimes.com

Papua, New Guinea First to Finalize Climate Plan under Paris Agreement

Papua, New Guinea, recently became the first country to formally submit the final version of its national climate action plan (called 'Nationally Determined Contribution', or NDC) under the Paris Agreement. The small Pacific nation's plan to switch to 100 per cent renewable energy by 2030 is no longer just an "intended" nationally determined contribution (INDC)—it is now the country's official climate plan. Papua, New Guinea's, NDC marks a step forward

in the process of implementing the landmark international climate agreement adopted at the COP21 in Paris in Dec. 2015. In the lead up to COP21, countries submitted INDCs, setting out what climate actions they proposed to take to contribute to the global community's collective effect to limit global warming. To date, 161 INDCs have been submitted representing the national climate plans of 188 countries and covering 98.7 per cent of global GHG



emissions. The Paris Agreement provides a legal framework for these climate plans. 🚩

Source: www.renewableenergyworld.com

France Fires Up Push for Renewable Energies

France has announced that it was raising its renewable energy goals and would become the first country to issue "green bonds" to fund projects that benefit the environment. French President Mr François Hollande also confirmed that the country's oldest nuclear power plant, Fessenheim would be closed. Speaking at a national environment conference in Paris, he sought to further carve out his country's role as a leader in energy transition.

At the same conference, Environment Minister Segolene Royal said a roadmap for France's energy transition up to 2023 would be published soon, with higher objectives than initially planned. She said the number of wind farms would double in France, while electricity obtained from solar energy would triple.

The amount of renewable energy sources used for heat production would increase by over 50 per cent.

Hollande said that to achieve the goal of decreasing the share of nuclear energy in electricity production from 75 per cent to 50 per cent by 2025 "renewables must be increased even faster." The goal was written into France's energy transition law, signed in August 2015. To show the way, he announced today that France would be the first country to issue "green bonds", which up until now have only been issued by companies or finance institutions such as the World Bank. The proceeds of such bonds are used to finance projects to address climate change.

Hollande also announced that energy giant EDF would close several nuclear power stations from



2018, while others will see their lives extended. He said the first to close would be Fessenheim, which Germany complained earlier this year was, at nearly 40-years-old, "too old to still be in operation." 🚩

Source: articles.economicstimes.indiatimes.com

Hitachi Zosen Wins Order for Waste-to-Energy Plant in Thailand

Hitachi Zosen Corp. won an order for a waste-to-energy plant from KPN Green Energy Solution Co. in Thailand's Nong Khai province. The 6-MW plant will be operated by Nongkhainayu Co., Hitachi Zosen said in a statement. KPN is in charge of engineering, procurement, and construction work for the station and ordered Hitachi Zosen to provide incinerators and waste-gas processing equipment.

Nongkhainayu has a contract with a local government office to operate a waste-processing business for 25 years, according to Osaka-based Hitachi Zosen, which also designs and builds industrial plants and water treatment systems. 🚩



Source: www.renewableenergyworld.com



First Wind-Solar Hybrid Streetlight Installed in Caribbean

Irish company AirSynergy's wind- and solar-powered off-grid remote power unit (RPU) has become the very first renewable hybrid streetlight to be installed in the Caribbean island country of Grenada. The hybrid streetlight made history following a collaborative pilot project between New York-based Aris Wind—the company licensed to sell AirSynergy products in the US—and the Caribbean and local Caribbean operator Grenlec Utilities.

Gerry Ryan, CEO of Aris Wind, said, "As we sought demonstration sites, end users and partners throughout the Caribbean Islands, Grenada's strong wind and sun resource made it a perfect place to start our Caribbean launch and we are delighted that Grenlec Utilities embraced the project."

The streetlight is positioned at the highest traffic area on the island at an area known as the Sugar Mill Roundabout—a key intersection that opens all traffic to and from the airport and the university to the centre of St George's and the business district. The off-grid RPU powers an 80-Watt LED bulb with inbuilt battery storage lasting up to five days. Once the preparation work in laying the foundation was set, the RPU was installed within a few hours as a result of tilt up tower technology that sees the entire unit lifted by a crane and slotted into position. 🚧

Source: www.renewableenergyworld.com

Statoil Buys Half of \$1.4 Billion EON German Wind Project

Statoil ASA, Norway's biggest oil company, bought 50 per cent stake in EON SE's Arkona offshore wind farm, entering the German market and widening its renewable energy portfolio as it scales back its funding for traditional fossil-fuel projects.

Statoil and EON will invest more than €1.2 billion (\$1.4 billion) in the project, which lies 35 kilometres (56 miles) off the German island of Ruegen, the Stavanger-based company said in an e-mailed statement. Electricity production is scheduled to start in 2019 and will power as many as 400,000 households, it said. Siemens AG will supply the turbines.

"There's no getting around for the big utilities to gear up investments in renewable power," said Christopher Rodler, an analyst at equity researchers Montega AG in Hamburg. "Financial clout and staying power is needed for offshore."

The project is Statoil's first wind-power venture outside the UK, where it holds a stake in the Sheringham Shoal wind farm, the company's only commercial wind project in production. For EON, it is the second large-scale renewable power development announced in as many months and is part of a strategy to invest as much as €1.5 billion annually in new clean energy projects. 🚧

Source: www.renewableenergyworld.com



Mexico's First Power Auction Awards 1,720 MW of Wind, Solar

Renewable energy developers won contracts to produce 1,720 MW of power in Mexico during the country's first-ever private auction, after the government ended decades long state electricity monopoly in 2013.

Seven wind and solar companies including Enel Green Power, SunPower Systems Mexico, and Recurrent Energy won 15-year contracts to rights to provide the state-owned Comision Federal de Electricidad with power beginning in 2018, Cesar Emiliano Hernandez, Mexico's deputy electricity minister, said in Mexico City. The contracts are expected to generate more than \$2.1 billion in investment by 2018, he said. The Mexican government has set a goal of getting 35 per cent of its energy from clean sources by 2024, up from 25 per cent now. Eleven packages of wind and solar projects and certificates were sold at an average price of \$41.80 per megawatt-hour. Solar energy accounted for 1,100 MW sold, and 620 MW of wind projects were awarded long-term contracts. "The auction was an important signal to Mexico's energy market," said Lilian Alves, a New Energy Finance analyst in Sao Paulo. 🚧



Source: www.renewableenergyworld.com



THE NATIONAL SOLAR MISSION

India Marching Ahead in Solar Energy

⚡ Background

The National Solar Mission (NSM) launched in January 2010, is a major initiative of the Government of India involving States, R&D institutions, and industries to promote solar energy while addressing energy security

and climate change challenges of the country. Thus, it will constitute a major contribution by India to the global effort to meet the challenges of climate change. The Mission is one of the several initiatives that are part of National Action Plan on Climate Change (NAPCC).

India, with its large population and rapidly growing economy, needs access to clean, affordable, and reliable sources of energy. India lies in the high solar insolation region, endowed with huge solar energy potential with most of the country having about 300 days of sunshine per year with the daily solar radiation incident varying from 4–6 kWh per square metre of surface area depending upon the location and time of the year. The total solar power potential in the country is estimated as approximately 748.98 GW.



⚡ The Charanka solar park in Gujarat

⚡ Objective of the Mission

The objective of the Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its large scale diffusion across the country as quickly as possible, abatement of carbon emissions, and creation of direct and indirect employment opportunities for both skilled and unskilled persons.



▲ Gujarat solar park

⚡ Goals and Targets

The Mission had set a target, amongst others, for deployment of grid connected solar capacity of 20,000 MW by 2022 to be achieved in three phases (first phase up to 2012–13, second phase from 2013 to 2017 and the third phase from 2017 to 2022).

The first phase (up to 2013) focussed on promoting scale-up in grid-connected solar power capacity addition of 1,000 MW through scheme of bundling with thermal power operated through NTPC's Vidyut Vyapar Nigam Ltd (NVVN) for minimizing the financial burden on Government, and a small component of 100 MW with GBI support through the Indian Renewable Energy Development Agency Limited (IREDA).

Recognizing the potential of solar energy to contribute to energy security of the country, and encouraged by the falling PV prices and the likelihood of reaching grid parity sooner and rapid increase in solar installation in the country, the Government in July 2015 had enhanced the target to 100 GW solar capacity to be set up by 2021–22. Out of this, 60 GW will come through large scale solar power and 40 GW through Grid Connected Solar Rooftops.

⚡ Implementation Strategy

The Ministry of New and Renewable Energy (MNRE) has formulated several schemes for achieving 100 GW by 2022. Few possible options, such as bundling, Generation-Based Incentive (GBI), and Viability Gap Funding (VGF) are being tried. The scheme-wise strategy and achievements are presented below.

⚡ Phase-I of the NSM

🔋 1,000 MW capacity grid solar projects through NVVN

In the Phase 1 of the Mission, 950 MW solar power projects (excluding 84 MW selected under migration scheme) were selected in two batches (batch-I

during 2010–11 and batch-II during 2011–12) through a process of reverse bidding. The resulting tariffs in Batch-I for SPV projects ranged between 10.95 and 12.76 per unit, with average of 12.12 per unit and for solar thermal projects the tariff ranged between 10.49 and 12.24 per unit, with average tariff being 11.48 per unit. In Batch-II, for solar PV projects, the tariff ranged between 7.49 and 9.44 per unit, with average tariff being 8.77 per unit.

The power from the plants is being purchased by the NVVN and being sold to distribution utilities/ Discoms after bundling with power from the unallocated quota of power from coal-based stations of NTPC on equal capacity basis, thus effectively reducing the average per unit cost of solar power. A total capacity of 420 MW has been commissioned under these batches by the end of Phase-1 (31.3.2013). In addition, a capacity of 50.5 MW under migration scheme, 88.8 MW under IREDA-GBI scheme, and 21.5 MW under old Demonstration scheme has been commissioned, taking the total capacity commissioned during Phase-I to 580.8 MW.

🔋 Solar water heater installations

Over 8 million sq. m solar water heaters have been installed in the country.



▲ Astonfield 12.3 MW Solar Plant, Patan, Gujarat

☀ Installations of solar off-grid systems

Around 320 MW capacity solar off-grid systems have been installed in the country.

⚡ Phase-II of the NSM

☀ Solar parks and ultra mega power projects

- The Ministry has rolled out a Scheme to set up at least 25 Solar Parks, each with a capacity of 500 MW and above, thereby targeting around 20,000 MW of solar power installed capacity. These solar parks will be put in place within a span of five years starting from 2014–15. However, smaller parks may be considered in Himalayan region and other hilly States where contiguous land may be difficult to acquire in view of difficult terrain and in States where there is acute shortage of non-agricultural land.
- The solar parks will be developed in collaboration with the State Governments and their agencies. The choice of implementing agency for developing and maintaining the park is left to the State Government.
- The total budget support required for the Solar Park Scheme is 4,050 crore.
- Under the scheme, the Ministry provides Central Financial Assistance (CFA) of 25 lakh per solar park for preparation of Detailed Project Report (DPR), conducting surveys, etc. Beside this, CFA of up to 20.00 lakh per MW or 30 per cent of the project cost, including grid-connectivity cost, whichever is lower, is also provided on achieving the prescribed milestones in the scheme. The approved grant is released by SECI as per milestones prescribed in the scheme.
- Till date, 34 Solar Parks in 21 States with aggregate capacity of 20,000 MW have been approved.



📍 105 MW Grid Connected Solar Power Plant at Neemuch, Madhya Pradesh

☀ Solar PV power plants on canal banks and canal tops

- This Scheme is formulated so as to encourage the State Power Generation Companies/ State Government Utilities/ any other State Government Organizations/ PSUs to set up grid-connected solar PV power plants of 1 to 10 MW capacity with an aggregate capacity of 100 MW; 50 MW on canal tops and 50 MW on canal banks by providing capital subsidy (up to 3 crore per MW or 30 per cent of the project cost, whichever is lower, for canal-top solar PV projects and up to 1.50 crore per MW or 30 per cent of the project cost, whichever is lower, for canal-bank solar PV power projects). Besides gainful utilization of the unutilized space over canal tops/unutilized land on canal banks for power generation, the plants will enable the participating States to meet their Renewable Purchase Obligation (RPO) mandates and also provide opportunities to local population.
- Approvals have been given for 50 MW canal-top and 50 MW canal-bank solar PV power projects. Andhra Pradesh, Gujarat, Karnataka, Kerala, Punjab, Uttarakhand, Uttar Pradesh, and West Bengal are implementing this Scheme.

☀ Solar PV power by defence establishments

The Scheme envisages setting up 300 MW of grid-connected solar PV power projects by Defence Establishments under the Ministry of Defence and Para Military Forces with Viability Gap Funding. The Schemes aim at utilizing land/rooftop available with the defence establishments and also boost domestic manufacturing in the country. The projects would be set up under developer and EPC mode selected through competitive bidding, during the period 2014–19. Out of the above, 150 MW has been allocated to Ordnance Factory Board under the Ministry of Defence.

☀ 1,000 MW of solar PV power by CPSUs and Government of India organizations

The above Scheme aims to motivate CPSUs to procure equipment from domestic manufacturers and participate in various Central/State Government Schemes, from time to time, during the period from 2014–15 to 2016–17, for sale of solar power to the State Utilities/ Discoms at competitive tariffs. The MNRE has already allocated 924.50 MW capacity to various CPSUs and Central Government Organizations. Balance

capacities are being allocated by the Ministry based on the requests received.

⚡ **3,000 MW solar PV power under bundling mechanism with unallocated conventional power**

NTPC is implementing the Scheme and will purchase the solar power from the selected solar PV plants at a quoted tariff determined through bidding and Thermal Power at tariff as determined by the Central Electricity Regulatory Commission (CERC) from time to time from the respective thermal power plant from which power was allocated. The bundling of the power would be on 2:1 basis (2 MW of solar power with 1 MW of thermal power), and selling of the bundled power to willing State Utilities under 25 years Power Purchase Agreements at a weighted average tariff. The projects are at various stages of tendering.

⚡ **2,000 MW solar PV power projects with VGF**

The Scheme envisages setting up 2,000 MW of solar PV projects by Solar Power Developers (SPDs) on 'Build, Own, Operate' basis. A VGF shall be given to the selected SPDs based on his bid, with upper limit of 1 crore/MW for projects under open category and 1.31 crore/MW for projects under DCR category. The levelized tariff for the term of the PPA will be 5.79 per kWh, with first year tariff as 5.43 per kWh escalated annually @ 0.05 per kWh for next 20 years and thereafter at a tariff of 6.43 per kWh up to end of the term. The projects are under tendering process.

⚡ **5,000 MW solar PV power projects through VGF**

The Scheme is same as the earlier one with capacity enhanced to 5,000 MW. The entire capacity shall be implemented in four tranches

of 1,250 MW each. The tariff for the first tranche shall be the same as the earlier Scheme. For the balance capacity, the tariff shall be reduced @ 0.10 per kWh in each subsequent tranches. The projects are under tendering process.

⚡ **Grid connected solar rooftops**

The scheme has targeted 4,200 MW solar rooftops through 30 per cent financial incentives for selected categories and some achievements based incentives for government buildings including PSUs and other government organizations. Rupees Five thousand crore have been allocated by the Government. So far, 27 States have notified regulations for the net-metering and connectivity. About 300 MW rooftop capacity have been installed so far.

🚩 **New Initiatives**

⚡ **5,000 MW solar PV power by CPSUs/ Government of India organizations/states**

The Scheme is envisaged to be implemented as Phase-2 of the earlier Scheme with enhanced solar capacity of 5,000 MW with VGF. The tariff payable to the Project Developers would be fixed at 4.50 per kWh or as may be specified by the MNRE

based on market conditions, for the entire PPA period of 25 years. The projects would be selected through bidding process. The project would be developed by either developer mode or EPC mode or both, as decided by the MNRE. The Scheme is under approval stage.

⚡ **Solar parks and ultra mega power projects**

Keeping in view the success of the solar power park, another 20,000 MW solar parks are being considered for approval. This will make a total 40,000 MW solar parks in the country and probably the largest solar power in the world. The Scheme is envisaged to be implemented as Phase-2 of the earlier Scheme keeping the solar capacity of 20,000 MW.

⚡ **Solar power projects by defence establishments**

Another 500 MW scheme is under approval.

⚡ **Support to existing manufacturers of solar cells and modules with production subsidy**

The Scheme envisages providing Production Subsidy to the existing solar manufacturers for manufacturing



📍 50 MW solar energy project Phalodi, Jodhpur, Rajasthan under JNNISM



⚡ There is tremendous potential for solar energy in India

of 6,375 MW of solar cells and 15,775 MW of solar modules in the country for supply to project developers for setting up the solar power projects under any Scheme. The Scheme is under approval.

⚡ Small grid-connected solar PV power projects (1 to 5 MW)

The Scheme envisages setting up 10,000 MW of solar capacity in the country. The Scheme is under approval.

⚡ The Way Forward

The solar capacity has grown with a CAGR of 46 per cent since the last five years, taking solar capacity from 1,023 MW in 2011–12 to 6,763 MW in 2015–16. India stands among the top six countries in terms of solar capacity, and with the present trend, India may move up in global solar capacity position.

India with its vast solar-power potential would be a leading source of electricity ahead of fossil based power, which is fast depleting. Growth in competition and scale has led to significant decline in solar tariff, which are very competitive as compared with the conventional power. The latest round of reverse bidding saw the lowest bid dropping to 4.34 per kWh for a project in Rajasthan.

The conducive policies initiated by the Government of India have helped in bringing about competitive rates through bidding process. The Tariff Policy has been amended to increase the solar power consumption and mentioned that “within the percentage so made applicable, to start with, the SERCs shall also reserve a minimum percentage for purchase of solar energy from the date of notification of this policy which shall be such that it reaches 8 per cent of total consumption of energy, excluding hydropower, by March 2022 or as notified by the Central Government from time to time”. The Tariff Policy would mandate the States to buy solar power.

The Government is also coming up with schemes for providing production incentives to encourage growth in manufacturing in solar cells and solar modules. This will help in increase in domestic manufacturing of solar cells and solar modules at competitive rates as the imported solar equipments. Other new initiatives are also being considered.

At the state level too, many state governments are actively promoting the development of solar power through a supportive policy and regulatory framework.

Achievement of 100 GW of solar power will lead to abatement of

170.482 million tonnes of CO₂ over its life cycle. With an enhanced target of 100,000 MW, up to 1 million jobs will be created. More employment and investment opportunities will enhance income. Higher solar power targets will augment power generation in India improving energy security and energy access. Solar manufacturing will also pick up after visibility on this investment opportunity to support these targets. Power generation through solar will offset conventional power generation, reducing the need to import coal and gas and lead to foreign reserve savings. Revenue to the Government through taxes and duty, etc., from plants in power generation and manufacturing will also increase and solar projects will provide a productive use of abundant wastelands.

Further, there are growing concerns about the viability of the newly bid projects. With project auctions becoming increasingly competitive, margins are coming under pressure and leading players to take increasingly more risks. Increased domestic manufacturing of solar cells and modules capacity may take care of the risk and help in capacity addition programme of the Government of India. **AU**

Contributed by Shri Dilip Nigam, Advisor/ Scientist 'G', MNRE; Email: dilipnigam@nic.in

National Workshop on ROOFTOP SOLAR POWER AND THE LAUNCH OF THE 'SURYA MITRA' MOBILE APP

The National Workshop on Rooftop Solar Power was held at Vigyan Bhawan in New Delhi on June 7, 2016.

While addressing on this occasion, Shri Piyush Goyal, Minister of State (IC) for Power, Coal and New & Renewable Energy said that efforts and commitment of all stakeholders made renewable energy (RE) targets achievable. On the occasion, Shri Piyush Goyal gave away 41 awards to the best performing Ministries/ Departments, State/UT Governments, State Nodal Agencies, State/UT Electricity Regulatory Commissions, and Channel Partners. Congratulating the awardees, Shri Goyal said that such awards not only encourage awardees to excel but also inspire the rest of us to put in our best efforts in the cause.

Forty-four Ministries and Departments also presented Commitment Certificates for developing Rooftop Solar (RTS) power. Speaking on the occasion, Shri P K Sinha, Cabinet Secretary, said that the biggest challenge comes from within the sector. He stressed that we have to work out business model in consultation with the regulators, which is beneficial for both Discoms and consumers. Shri Sinha said that although involving residential house tops for installing rooftop solar projects will not be that easy but will be worth the effort since it will provide volume to our initiative. Interacting with the stakeholders, Shri Upendra Tripathy, Secretary, Ministry of New and Renewable Energy (MNRE) told that the Government has received 3,200 MW commitment certificates from 44 Ministries and



▲ Shri Piyush Goyal launching the Surya Mitra mobile app at the event

Departments. He also informed about the ten point step-by-step agenda to encourage rooftop solar power in the country. Around 1,400 participants including Secretaries from the Central Government, Chief Secretaries from the State Governments, Power and Urban Development Principal Secretaries of State Governments, State Nodal Agencies, Chiefs of DISCOMs, banking and financial institutions, Channel Partners of rooftop schemes, major solar power developers, international agencies, such as GIZ, KFW, US Aid, the World Bank, and other stakeholders across the country attended the Workshop.

The Minister Shri Goyal also launched a mobile app called 'Surya Mitra' App at the event.

The GPS-based mobile app has been developed by the National Institute of Solar Energy (NISE), which is an autonomous institution of MNRE. The Surya Mitra Mobile App is currently available in Google Play Store, which can be downloaded and used across India. This App is a high end technology platform

which can handle thousands of calls simultaneously and can efficiently monitor all visits of Suryamitras. The trained Suryamitras who opt for entrepreneurship have joined in the Mobile App in several states. This innovative mobile approach shall enhance the employment of trained youth in solar PV technology and also improve the businesses of solar entrepreneurs because quality servicing, maintenance, and repairing professionals are now available to customers at the click of a button on their mobiles. MNRE has an ambitious target of installing 100,000 solar photovoltaic (PV) pumps in several states. Suryamitra Mobile App would come handy with respect to O&M, repair, and maintenance of solar pumps. Similarly, millions of square metres of solar water heater systems are already installed in various states. In order to maintain the existing system and to install new systems properly, Surya Mitra App would be very useful. **AU**

Source: MNRE

INITIATIVE 'GO GREEN' AT DPS G SCHOOL, PALAM VIHAR, GURGAON

The large flat roof of a school building is a great place for solar panels. Using the space to generate clean solar electricity cuts energy costs and makes a lasting impression on students. So, DPS G School, Palam Vihar, Gurgaon has installed a 6 kW power grid rooftop solar panel in their school in June 2015. Also, they have motivated the community people to install solar panels. The principal of the school, Ms Sangeeta Saxena said, "Not only will these systems contribute to environmental sustainability in our region, but the cost savings will also contribute to the financial stability of our schools in the years ahead."



Parents, faculty, and the community appreciate a school's effort to reduce spending while creating a richer learning experience. Students want to be a part of what happens around them. Solar schools bring a real world solar energy experience into the classroom. The principal further said, "Students can become a partner in the daily monitoring of solar generation and any correlation to our energy consumption and cost. We dedicated our curriculum fair to the topic of green energy. School administrators are leaders in their communities. Using solar energy shows leadership in energy efficiency, sustainability, and environmental stewardship. A school with a solar energy system is a better place to work and learn. Beyond the cost savings, solar power is a key component of long-term sustainability strategy as we seek innovative ways to reduce our carbon footprint." The total electricity generated is 596 kWh. The final calculations showed that the total money saved in a year is ₹1,135,380. **AU**

Courtesy: Ms Renuka Sahu, DPS G School

Prakritik Urja Puraskar Yojna

Ministry of New and Renewable Energy, Government of India, is operating "Prakritik Urja Puraskar Yojna" to encourage original book-writing in Hindi/translation of books in Hindi in the field of New and Renewable Sources of Energy. Under the scheme, there is a provision to award a first prize of ₹1,00,000/- (Rs. One Lakh), second prize of ₹60,000/- (Rs. Sixty Thousand) and a third prize of ₹40,000/- (Rs. Forty Thousand) for the books originally written in Hindi. For the books translated into Hindi, the amount of first, second and third prize is ₹50,000/- (Rs. Fifty Thousand), ₹30,000/- (Rs. Thirty Thousand), and ₹20,000/- (Rs. Twenty Thousand), respectively. All authors, whether Government employees or Non-Governmental persons, can participate in the scheme. Entries are invited for the award for the calendar year 2015. Under the Scheme, books originally written in Hindi or translated into Hindi should be published from the year 2011 to 2015. The last date of receipt of entries is August 31, 2016. Entries will be accepted in prescribed proforma only. For further details, please contact Under Secretary (OL)/Hindi Section, Ministry of New and Renewable Energy, Block No. 14, C.G.O. Complex, Lodi Road, New Delhi- 110003 (Phone No. 011 24360707/1002) or visit this Ministry's website www.mnre.gov.in



ENERGY ACCESS THROUGH OFF-GRID MICRO HYDRO PROJECTS

Access to infrastructure is one of the basic requirements for development of an economy, and it holds its importance especially in the context of off-grid rural areas that generally lag behind in most of the developing countries. Energy is the most important of these infrastructural requirements and uninterrupted supply of energy is essential for development. In this article, **Onkar Nath** talks about how electricity supply from micro-hydro power projects has shaped economic development in remote regions of Uttarakhand.

There are different elements that constitute infrastructure, such as road, water, sanitation, electricity, health, telecommunication, etc. Each one contributes and complements other elements in achieving overall development of a region or a country. Access to electricity is perceived to be a key requirement for poverty reduction by enabling the creation and improvement of income-generating activities.

India being a fast developing country is actively pursuing rural electrification since decades. However, major push for electricity for all came in 2003 with the passing of Electricity Act 2003. The significance of access to electricity were mainly for two purposes, that is, (i) Household consumption and (ii) Commercial consumption. Although government has extended its support in laying down grid infrastructure to the villages and also supported BPL families by providing free of cost connection, there was limited focus on active promotion of electricity for commercial uses. Although Rural Electrification Policy acknowledges the role of electricity in productive activity and livelihood generation in rural areas, it requires special efforts for promoting economic activities through electricity provision. There are few studies that attempted to establish a direct relationship between access to electricity and productive uses of energy leading to economic development. The relationship between access to electricity and productive uses of energy is inconclusive and need more comprehensive research. Most of the studies are country specific, adopt different methodologies, control group, and time frame. In the context of India, we have one positive example where providing electricity for irrigation pumps by heavily subsidizing electricity rate has resulted in an increase in agriculture productivity but this is grid connected and not an off-grid example.

The relationship between access to electricity and productive uses of energy is inconclusive and needs more comprehensive research. Most of the studies are country-specific, adopt different methodologies, control group, and time frame. In the context of India, we have one positive example where providing electricity for irrigation pumps by heavily subsidizing electricity rate has resulted in an increase in agriculture productivity but this is grid connected and not an off-grid example.

In context of Uttarakhand, Uttarakhand Renewable Energy Development Agency (UREDA) has been providing electricity to villages located in remote and far-flung areas through decentralized off-grid micro-hydro projects (MHPs). About 42 MHPs having cumulative capacity of 4,210 kW (4.2 MW) have been constructed so far and are providing electricity to about 136 villages and 148 hamlets. UREDA has adopted an approach that calls for greater communities/society participation towards establishing and management of these MHPs. Electricity is being used at the household as well as commercial level. However, in order to assess economic development in these areas due to access of electricity has not been thought about or has limited research.

Under this context, a study was undertaken to investigate whether MHPs have led to productive use of energy and in turn led to economic development in local area. The research presented in this report has sought to explore the question through a review of existing literature, filed survey that included semi-structured interview and informal group discussions. The survey was conducted at five micro-hydro sites and villages who are beneficiaries of the power plants. These sites are Milkhet, Ramgaad, Toli, Taluka, and

Istergaad. The sites were selected where some cognizable instances of use of micro-hydro power for productive purposes were reported.

While there are some evidences of positive relationships between access of electricity and productive uses of energy, it has not been possible to directly establish relationship between level of access of electricity

UREDA has adopted an approach that called for greater communities/society participation towards establishing and management of these MHPs. Electricity is being used at household level as well as commercial level. However, in order to assess economic development in these areas due to access of electricity has not been thought about or has limited research.



Picture 1: Availability of flour mill in the village has relieved women of grinding wheat/grains, etc.

and economic development. The relationship is ambiguous and localized in nature.

There are few cases, as mentioned below, of use of power generated through MHP may be treated as the cases having resemblance to productive use of energy:

- People/women undertake threshing work in the night/ people undertake grading/ cleaning/sorting of farm produce (2.2%)—mainly Jakhana, Gogina, and Taluka
- Due to availability of flour mill in the village, women are relieved of grinding wheat/ grains, etc. manually (3%)—mainly Milkhet, Toli, Bursole, Ramgaad (Picture 1)
- Has enabled taking up sewing work through electrically driven machine (0.6%)—mainly Ramgaad and Istargaad
- It is now possible to setup small enterprises (0.2%)—mainly Milkhet
- Enables lifting of water from lower level through use of pump for minor irrigation (0.4%)—mainly Ramgaad (Picture 2)

- Carpenters are able to use electrically driven plainer (0.2%)—mainly Ramgaad (Picture 3)
- Some people in the village have got employment (0.4%)—mainly Leeti
- Welding facility becomes available within the village itself (0.2%)—mainly Gogina.

On a social development front, majority of the respondents highlighted the gains relating access of electricity, such as children now getting extra time in evening for their study, women save time as now extra hours are available to them in late evening and early morning due to availability of light, which they used for disposing of household chores, access to television has resulted in entertainment and infotainment, etc.



Picture 2: Productive use of energy in the sense that it enables lifting of water from lower level through use of pump for minor irrigation



Picture 3: Carpenters using electrically driven planer



Picture 4: Helping community to get employment through energy access

Overall, in terms of the definition of productive use of energy, there are rare cases that may be termed as productive use of renewable energy. The research highlighted three major findings:

- Access to electricity is virtually used for consumptive purposes across the entire state.
- Use of electricity for productive purposes is hardly made except for a few cases
- Frequent breakdown of power plants has also prevented any attempt of productive uses of energy by local people.

The study has also highlighted unidirectional causality running from economic growth to electricity consumption. In religious places, such as Gangotri and Yamunotri, many enterprises in the form of hotels, restaurants have mushroomed up. Due to requirement of electricity for the temple, government has established micro-hydro power plants mainly for consumptive purposes. However, access to electricity has also resulted into increased hours of operation in the markets, less dependency on diesel in the market, pilgrims are able to reach

the temple during night time, safety of women is enhanced, and protection from wild animals ensured.

The findings have also revealed that profitability of micro-hydro power plants sometimes increases due to intermittent uses of electricity for commercial purposes, such as wood cutting during the construction of houses, use of welding machines during construction of houses, marriage ceremonies where power plants charged fixed cost and made some profit. However, these uses are not consistent.

On a social development front, majority of the respondents highlighted the gains relating access of electricity, such as children now getting extra time in evening for their study, women save time as now extra hours are available to them in late evening and early morning due to availability of light, which they used for disposing of household chores, access to television has resulted in entertainment and infotainment, etc.

Based on the above findings, the research has strengthened past research outcomes where combining electricity access with other enabling

The study has also highlighted unidirectional causality running from economic growth to electricity consumption. In religious places, such as Gangotri and Yamunotri, many enterprises in the form of hotels, restaurants have mushroomed up.

factors to achieve economic development has been reiterated. It is clear that access to electricity is important but its contribution has to be matched by particular needs of the communities, access to finance, skill development, and market linkages (Picture 4). **AU**

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Enabling Concentrated Solar Thermal Systems in Desert Areas

The Challenges and Innovations

In this article, **Dr Laltu Chandra, Dr Ambesh Dixit,** and **Dr V Narayanan** tell us that for this purpose, devices, sub-systems, and innovative applications are being developed at the Indian Institute of Technology (IIT), Jodhpur as a part of the Ministry of New and Renewable Energy (MNRE) funded initiative on Solar Thermal Research and Education. They have presented a few examples in this article.



Desert areas, such as Rajasthan in India, receive reasonable direct normal irradiation (DNI) on account of being located at the equatorial belt. Concentrated solar thermal (CST) system, for example heliostat based, can be utilized for harnessing solar energy for applications, such as electricity, process heat and cooling. However, it must be emphasized that adaptation of such CST concepts to local conditions, such as the arid desert in Rajasthan, is necessary for long-term reliable operation.

Water-cooled Radiation Calorimeter

In heliostat based CST system, radiation is concentrated on, for example, an open volumetric air receiver (OVAR). For on-field evaluation

of OVAR and its control, measurement of concentrated solar irradiance (CSI) is necessary. Generally, high heat flux gauges or optical techniques are being used to estimate CSI. Water-cooled radiation calorimeter (RC) is being developed to measure CSI. However, there is an emphasis on the need for proper calibration. In view of such observations, requirements and reliability, a RC is developed and evaluated up to 400 suns (1sun= 1kW/m²). The developed potable device is shown in Figure 1. It depicts the working principle and the fabricated RC with Copper.

Optical and lumped parameter based heat transfer analyses of RC are performed. A semi-analytical validated approach is developed for calibration of the developed RC. Coatings are developed and evaluated for reflecting

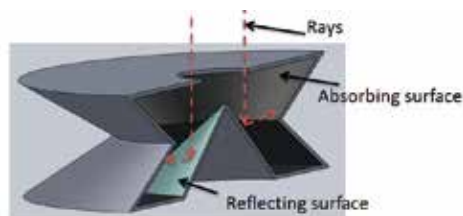


Figure 1: (a) Working principle; (b) Fabricated water-cooled radiation calorimeter

and absorbing surfaces of RC. The design prevents dust deposition on reflecting and absorbing surfaces. The performed experiments and analyses demonstrated that the RC body (Cu) temperature is $\sim 55^\circ\text{C}$ for a heating input equivalent to 400 suns of flux concentration with water mass-flow-rate of $\sim 2.2\text{ g/s}$ ($\sim 8\text{ l/h}$). Thus, it can be inferred that the developed RC can be operated, even at a higher concentration level, for evaluating OVAR based system.

Field-design: Current Practice and Adaptation to Desert Condition

An optimized staggered heliostat field layout with minimal land usage using radial stager pattern was designed with each individual heliostat mirror area of 6.25 m^2 . The field layout in Figure 2 (a) shows total required area

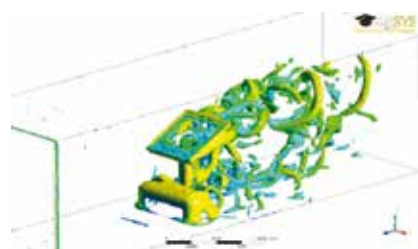
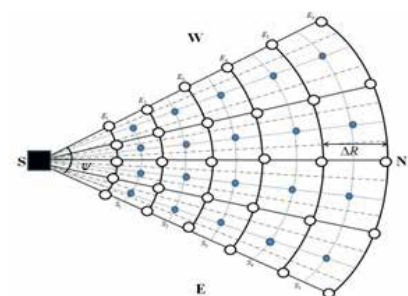


Figure 2: (a) Heliostat field layout using optical analysis, and (b) Wake behind a heliostat

of $2,200\text{ m}^2$ to generate 125 kWth for 600 W/m^2 , which can operate for 6–7 hours during a day having a tower height of 20 m. The layout is, generally, based on optical analysis considering, blockage, shading, spillage, etc. However, in desert area, gust wind speed is quite high, say 47 km/h in Rajasthan. In such a situation, dust will deposit on the mirror surface and will lead to reduced reflectivity of heliostats and therefore, the overall system efficiency. Moreover, the wake behind heliostat as a result of strong wind will induce vibration and damage the mirror surface or any coating that may be applied (Figure 2b). In view of these, the detailed analysis and experiment demonstrating such strong wind-related effect is presented in scientific research papers. The investigation clearly reveals the presence of wake-affected region behind a heliostat extending up to 3–4 times the size of heliostat. A distance based parameter will be recommended for wake-related effect to design heliostat field layout.

Solar Convective Furnace

Materials processing operations, primarily melting and heat treatment of metals are energy intensive processes, requiring furnaces operating at high temperatures. Aluminium is used globally for applications ranging from household to industry. In view of such observations and to reduce the direct energy requirement, a concept of a solar convective furnace (SCF) has been developed and is being evaluated at IIT Jodhpur as shown in

Figure 3, based on discussions with Aditya Birla Science and Technology Centre (ABSTC), Mumbai. Here, the obtained hot air from OVAR is used, after storage, for heat treatment of metal. An experimental solar air tower simulator (SATS) facility is developed as in Figure 3 (c)

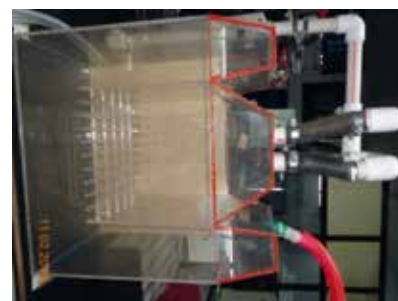
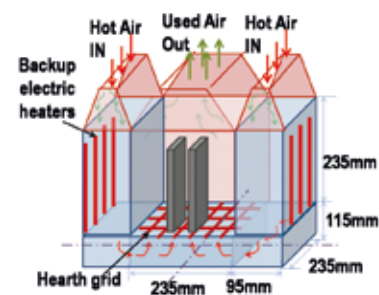


Figure 3: (a) Schematic of SCF; (b) fabricated (plexi-glass) model of SCF; and (c) SATS facility at IIT Jodhpur

for evaluation SCF system. In this setup, all the required sub-systems are manufactured and assembled locally. This clearly demonstrates that such a concept is viable and can be made available indigenously in future. **AU**

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POWER from Urine

Reimagining the Future

In order to provide safer and growing access to electricity, newer forms of technology are being developed by scientists and energy enthusiasts. In this article, **Dr S S Verma** describes in detail the urine-powered generator, its technological potential, applications, and the challenges.

With around one-seventh of the population lacking access to basic electricity and a dwindling of the global supply of oil and coal, scientists are eager to find solutions to power the world in more renewable and sustainable ways. As electric power has become the lifeline in modern times, so has the quest of human beings to find out ways to generate clean power from cheap and environment-friendly resources.

We are constantly presented with better ways of doing things, but rarely do we see a quick implementation or production of these technologies. These methods use very little input, and in some cases, achieve infinite output. In this context, one resource that is always available—human urine—has recently attracted the attention of energy enthusiasts as a resource to generate energy.

Urine—Composition and Power

Urine consists of approximately 98 per cent water and 2 per cent urea, which is made up of carbon, oxygen, nitrogen, and hydrogen atoms. Human urine has been turned into all sorts of things over the centuries, ranging from phosphorous to gunpowder. It has also served as the basis of myriad chemical substances, including the first types of plastics.

It is already well-known that manure or poop can be recycled for making products, such as paper as well as creating biogas power from methane gas. This readily available 'resource', whether from animal or human origin, is now being experimented to actually generate electricity by using its basic ingredients to create enough hydrogen to provide electricity for both homes and businesses. Today, over seven billion people populate our planet, which means on an average, around 10.5 billion litres (2.8 billion gallons) of human urine is produced and wasted each day.

However, scientists are now hopeful that they can use this to generate power—for homes, cities, and vehicles. The process of electrolysis uses a jolt of electricity to split the urea into hydrogen and oxygen atoms and then captures the hydrogen to produce energy. The nitrogen can be used for artificial fertilizers. Researchers have also built a urinal that converts urine directly into electricity. The urinal prototype uses fuel cells to generate a steady stream of electricity.

Students in Nigeria have come up with a power generator that runs on human urine. Their creation uses the process of electrolysis to isolate hydrogen gas from urine which is then used to power a generator. They earn a whopping six hours of power from one litre of urine, which does not seem like much until we consider that a normal person pees out roughly two litres per day. The model (Picture 1) was created by four students and the system developed works as follows:

- Urine is put into an electrolytic cell, which separates out the hydrogen
- The hydrogen enters a water filter for purification, which then gets pushed into a gas cylinder

- The gas cylinder pushes hydrogen into a cylinder of liquid borax, which is used to remove moisture from the hydrogen
- This purified hydrogen gas is pushed into the generator

⚡ Technological Potential

Prior to the development of this technology, a firm, E3 Technologies, LLC, based in Athens, Ohio (USA), has developed and patented a similar technology called the 'Greenbox', to clean commercial and agricultural waste water and produce hydrogen energy. It is a low-energy electrolysis process that converts ammonia and urea in waste water to hydrogen, nitrogen, and pure water. The electric current in the device creates an electrochemical reaction that oxidizes urea and turns it into carbon dioxide which is then moved into the electrolyte material in the machine, while, the kids are making use of urea electrolysis to generate hydrogen and using the hydrogen to create electricity. Although still a long way off from being implemented on a mass scale, this basic way of creating electricity from a substance normally disposed of can be a practical way to create electricity in places where regular electrical supply has been cut off due to devastation by natural disasters. Students and faculty at Bristol-based University of the West of England are being asked to use a special urinal that sends all the urine collected to be used to produce hydrogen for powering an electric generator that creates additional electricity for the campus (Picture 2). A technology like this would only require 1 kW of power to operate an entire commercial building with 300 employees.

A team from a Korean university has come up with a plan about the recovery of carbon atoms from human urine and then using it to produce cheap electricity. This will be achieved by replacing the platinum catalyst that is currently used in fuel cells with carbon that is naturally found in human waste. Fuel cells are quite promising and convert chemical energy into electrical energy by a reaction that occurs between hydrogen and oxygen. Scientists believe that they can use fuel cells on a larger scale to power up homes and vehicles by generating electricity; however, the current drawback to this approach is the fact that these fuel cells are expensive and the high cost prevents development of fuel cells at a commercial level. By using the approach explained here, Korean researchers are quite hopeful that they can lower the price for the fuel cells. This will be achieved by replacing the platinum catalyst that is used in fuel cells currently with carbon that is naturally found in human waste. Urine-tricity successfully demonstrated the charging of a commercially available mobile phone, using microbial fuel cells (MFCs) fed with real neat urine.

⚡ Applications

Today, the urine-based electric generators generate enough energy for a smart phone to text, browse the internet and make short phone calls, but, eventually these could help power houses, buildings, and maybe even entire off-grid villages.

⚡ Bottlenecks

Energy from urine could really be the energy of the future and a significant solution for billions of people around the world who lack access to electricity. Currently, the biggest hurdles are cost, scale, and output. Allowing the huge number of toilet/fuel cell combinations out in the field is itself a huge logistical problem along with the cost involved. At the commercial level, these systems could be applied to wastewater treatment plants, saving tremendous energy costs by effectively recovering energy during the process of treating urine, and feeding it back into the system. **AU**

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Picture 1: The model developed for utilizing energy from urine



Picture 2: Urine-based electricity generation

Smart Village Nanogrid

Energizing Rural Hinterland

In this case study, **Dr Ashok Das** discusses the innovative *Smart Village Nanogrid*TM solution and their pilot village in Chhotkei, Odisha. He highlights that SunMoksha has invested years of effort to closely understand the challenges of energy access and has developed a holistic solution with a 'systems' approach to address these challenges.

Smart Village NanoGrid: Chhotkei, Angul, Odisha.



⚡ Challenges of Smart Village Energy Access

A comprehensive definition of an ideal village was proposed by Late Dr APJ Kalam as 'PURA' village for provisioning urban amenities for rural areas. A smart village builds around the vision of PURA. In our view, a smart village addresses the elements of PURA through both 'hard' interventions, such as agricultural improvement, energy sufficiency, rural industry and locally relevant livelihood, water and waste management, and improved digital connectivity, as well as 'soft' interventions, such as good governance, better public health services, sanitation, civic services, education and skill development, along with climate change adaptation. A smart village must also move the villagers up the value chain to improve socio-economic status of the citizens.

India's rural economy revolves around agriculture; however, it most often does not fetch them enough earnings. Serious efforts need to be made in moving the farmers up the value chain. We must establish local 'micro-enterprise zones (MEZs)' for agro and/or non-agro livelihood activities. It will improve the economic status of the rural populace, leading to 'Gram Swaraj'. Creation of livelihood and enterprise activities through sustainable resources will, in turn, reduce the pressure on agriculture and land, and lead to triple bottom-line impact.

The agricultural economy, in turn, revolves around the nexus of food, water, and energy. Access to energy plays a key role in socio-economic development of a nation. However, according to IEA's report on World Energy Outlook 2011, 1.4 billion people in the world do not have access to electricity, with 400 million residing in India. India's latest census data shows that 43 per cent of the rural population does not have access to grid electricity. For those who do have access, electricity is of very poor power quality and low reliability. The 2011 census data also shows that 40 per cent of the 'electrified' villages have less than 60 per cent availability of electricity. Energy deficit is the root cause of this gap.

⚡ Smart Village Nanogrid™—Addressing Challenges of Energy Access

SunMoksha has invested years of effort to closely understand the challenges of energy access and has developed a holistic solution with a 'systems' approach to address these challenges. While several solutions have been and are being implemented to make the microgrid model succeed in the rural hinterland, these solutions have been unable to achieve scale, due to several challenges. Our technical intervention, *Smart Nanogrid™*, addresses these gaps and requirements. The word 'Nano' signifies small, modular, and affordable for the masses. Uninterrupted access to energy and digital connectivity is paramount in our solution.

The *Smart Nanogrid™ Village* consists of a hybrid power generation unit from locally available renewable sources (solar, wind, biomass, biogas, pico-hydro, etc.) or grid power, a distribution grid to make power available to homes, streets, and most importantly, to farms and micro-enterprises, and a complete automation system for managing the microgrid operations. This brings energy-sufficiency to the village, and eliminates grid-dependency. The solutions offered are applicable in both electrified and un-electrified villages. The key technical intervention is the IoT/IT-enabled *Smart Nanogrid™* which ensures reliable and predictable power supply through demand and supply management and citizen-centric power services. Citizens not only get quality, reliable power but can also schedule their power requirement accordingly to their convenience, view their electricity consumption and bill in real time, pay their bills and register their complaints through a Mobile App that is language-independent. In addition to electricity, the system monitors and controls other resources, such as water, waste, agriculture, and environmental parameters. The system also manages consumer relation, technical support, training, local value-add services to consumers,

SunMoksha has invested years of effort to closely understand the challenges of energy access and has developed a holistic solution with a 'systems' approach to address the challenges of energy access. While several solutions have been and are being implemented to make the microgrid model succeed in the rural hinterland, these solutions have been unable to achieve scale, due to several challenges.



Picture 1: Chhotkei is a village in Angul, Odisha where grid electricity is yet to reach



Picture 2: The village has been supplied with a 30 kWp Solar-powered *Smart Nanogrid*TM to meet the energy demands consuming about 20 kWp

and eGovernance. Reliable power and digital connectivity also enables tele-education, tele-medicine, and tele-panchayat facilities for the villagers, thereby, achieving the goals of digitally connected smart villages.

*Smart Nanogrid*TM not only ensures operational efficiency, but also the scalability, by remotely monitoring and technically supporting the village projects in a cost-efficient and timely manner. It makes data available to experts in real time for a timely intervention, in case of failures or malfunctions; thus bringing long-term sustainability and scalability. The cloud data is available to all remote stakeholders, such as sponsors, government agencies, implementers, O&M providers, and domain experts, to remotely monitor the performance of the project and intervene, if needed, bringing complete transparency. A special portal has been created at <www.smartnanogrid.net> to network all such Nanogrids for not only real time monitoring of the projects, but also for information exchange and cross-learning.

⚡ Social Interventions for Sustainability and Scalability

Innovative business models, access to finance, close partnerships with grassroots organizations and continuous skill development for scalable and sustainable operations and socio-economic development are key social interventions. The business model creates micro-enterprises in the villages in an MEZ (micro-enterprise zone) to not only make them self-sufficient, but also to create local economic growth and move the villagers up the economic value chain. The business model includes the *Smart Nanogrid*TM operations, citizen services such as health, education, governance, and other viable microenterprises in the village. This aligns with our nation's vision of 'Start Up India, Stand Up India'.

Training and skill development to run the *Nanogrid*TM and other microenterprises and livelihood activities, form the last important intervention. We have addressed this through integrated partnership with technical, vocational, and business institutions to develop skillset and entrepreneurial capacity. In a first-of-its-kind industry-academia partnership, R&D for *Smart Nanogrid*TM has been conducted at the Living Laboratory at National Institute of Science & Technology, Berhampur, Odisha (NIST). Here faculty, student, and administration worked hand-in-hand with SunMoksha to develop, test and implement the solutions. The Living Laboratory also doubles up as hands-on skill training laboratory of the local operators, so that their skills are continuously upgraded with technology, as envisaged in the national skilling programme, 'Skill India'.

⚡ Demonstration of Smart Village NanogridTM at Chhotkei, Angul, Odisha

The first *Smart Village Nanogrid*TM has been implemented at Chhotkei village in Angul district in the state of Odisha—the first such smart microgrid implementation in India. Chhotkei is a small remote village inside the hilly and scenic terrain of Satkosia Tiger Reserve about 160 km from the state capital, Bhubaneswar. While Angul is one of the most developed districts of Odisha, and the powerhouse of the state lighting the country, it unfortunately fails to expel the darkness underneath. Chhotkei is one such village in Angul where grid electricity is yet to reach. Approximately 600 villagers, living in 140 households spread over 235 ha of land, continue to live in darkness (Picture 1).

The village has been supplied with a 30 kWp Solar-powered *Smart Nanogrid*TM to meet the energy demands of 140 households, 20 streetlights, a temple, and three community centres consuming about 20 kWp. The rest 10 kWp has been set aside for day-time use by irrigation pumps and microenterprises, such as stitching, rice-puff machines, provision stores, poultry, refrigerators, oil mill, welding, cold-rooms, etc., to improve agricultural output, enable value-addition to agriculture, and generate employment (Picture 2).

Power is supplied to the distribution boxes, spread throughout the village, over underground electrical cables to minimize losses and set up long-lasting infrastructure. It is distributed to the consumers through metering & control system of the *Smart Nanogrid™*, managed by *NanoSoft Remote™*. Local underground optical fibre cables (OFC) and Wi-Fi hot spots for local area network and VSAT for Internet access to the cloud have been implemented for communication between the controllers and the server and for remote monitoring. *NanoSoft Remote™* manages metering, billing, payment, differential tariff, and alerts/cut-off, if unpaid. The system switches off power supply, if a consumer exceeds maximum energy or power allocated. It schedules demands of microenterprises, irrigation pumps, street lights, etc., to match the power generation constraints. The cloud data is available to all remote stakeholders, such as sponsors, government agencies, implementers, O&M providers, and remote experts for monitoring and timely interventions, if needed. In addition, a village MEZ has been created to develop micro-industries for livelihood. A community health and tele-medicine centre is being set up to provide basic health amenities. Similarly, tele-education and village-information-kiosk facilities are planned to be set up. Motivated local youth have been hired and trained for project implementation and O&M of the system post commissioning (Picture 3). This ensures sustainability of the project.

⚡ Impacts of Smart Village Nanogrid™

SunMoksha has addressed the challenges of smart socio-economic development by creating an ecosystem encompassing all key components of technology, business, skills, and social engineering. *Smart Nanogrid™* has a profound impact on the lives and livelihood of villagers. The solution works around the nexus of three E's – Energy, Education, and Employment for Empowerment. It establishes robust technical solutions and business models that can be rapidly deployed and scaled up in the villages, especially for the underserved and unserved communities. At the Chhotkei village, significant changes are creeping in, over the past few months since the project has been implemented. Children have started to study in the evening, women and adults have access to light and entertainment, and the youth have access to opportunities. A youth has returned from the nearby town to create own opportunity in the village. Another youth has started an electronic repair business. Street lights have enabled social interactions and fearless stroll through the village streets and pathways. The transformation is a journey and the long-term impact will be seen over the months and years to come (Picture 4).

⚡ Support, Recognition, Awards, and Accolades

The Smart Nanogrid™ at Chhotkei was financially supported by Wartsila India Pvt. Ltd, Navi Mumbai, a Finland-based MNC, under their CSR initiative. The Odisha Renewable Energy Development Agency played a significant role in this project. They facilitated the interaction and support of the villagers in implementing and running this project. They also interfaced with local authorities for necessary permissions and support. NIST Berhampur, provided support for R&D, testing and implementation of the project. Recently, the Ministry of New and Renewable Energy (MNRE), Government of India, along with The Department for International Development (UK-DfID), to showcase this first smart microgrid project to national and international stakeholders with interest in rural development. MNRE Secretary Shri Upendra Tripathy and Joint Secretary Shri Tarun Kapur (Picture 5) presided over the workshop and assured all support to adopt this model across states. The project also won Smart Village Award at the 2016 Smart Cities India Awards in Delhi. **AU**

Dr Ashok Das, Founder CEO, SunMokshaPower Pvt. Ltd, Email: das@sunmoksha.com. For more information, please visit www.sunmoksha.com and www.smartnanogrid.net.



⤴ Picture 3: Motivated local youth have been hired and trained for project implementation and O&M of the system post commissioning



⤴ Picture 4: Street lights have enabled social interactions and fearless stroll through the village streets and pathways. Youths have also started electronic repair business



⤴ Picture 5: Support to the project from the government



GENERATION OF GREEN ENERGY FROM PADDY STRAW

A NOVEL INITIATIVE IN SUSTAINABLE AGRICULTURE

Agriculture is a major contributor to India's gross domestic product (GDP). With a large agricultural produce comes equally large agricultural waste. Unfortunately, management of agricultural waste is lacking. Burning of crop residue is a common practice that leads to pollution, which further creates health hazards.

Dr Yogender Singh Yadav reports of one such novel initiative wherein agricultural waste is used to generate clean energy. In this case study, an initiative to generate electricity using biogas produced from paddy straw is brought to light.

Energy is the basic requirement for all progress and uninterrupted supply of energy from clean sources is essential for sustainable development. Energy is the driving force of all economic, social, and environmental processes that strengthen the global sequences. Sustainable development is a challenging task considering the energy needs of any country. It is an important component in the modern economy to be evolved and deployed in all aspects of the development process. Developing countries have additional considerations of energy quality for urban population, energy security for industries and agriculture, and of energy availability for rural subsistence as well as development. The energy resources around the globe are dispersed unevenly and have a progressive deviation in most of the renewable

sources. Biomass is one such source that can be used to provide sustainable supply of the required energy through biogas and other biofuels. The sustainability lies in the technical feasibility, economic viability, environment friendliness, and social acceptance. Recent developments in technology have opened the possibility of using paddy straw and other crop residue other than dung and vegetable waste for biogas generation. Thus, continuous endeavour needs to be expanded in the intersection zone by undertaking innovative projects involving leading edge technologies, such as paddy straw-based biogas power plant to overcome the air pollution and health hazards, resulting in sustainable agriculture for food and livelihood security.

⚡ About the Project

Sampurn Agri Ventures Pvt. Ltd (SAVPL), Fazilka, is working on an innovative integrated project on paddy straw based biogas power production including development of shrimp farms, biogas plant, and agro processing units (Pictures 1 to 8). The project started in 2006 at Panchanwali village of Fazilka, Punjab, with electricity production capacity of 1.0 MW by 10.0 tonnes paddy straw per day. The business model of SAVPL involves establishment of water bodies in existing water logged fields for commercial use that are further used as biogas digesters to process paddy straw. Bio-methanization technology is applied for production of bioenergy through processing of paddy straw.

The present scenario of biogas plant has changed its view from only biogas to sustainable development in agriculture. It reduced dependence on chemicals and fertilizers, enlightening a new era of organic farming through biofertilizers. This type of project is an asset to water logged area of Malwa region of Punjab, which works as synergy with overall development. In order to improve livelihood of the farmers, this project aims to supply renewable energy based power with biofertilizer as by-product and manure and paddy straw managements for extra income to the farmers. Paddy straw is available in abundant in this region and is used as the raw material to produce bioenergy in the form of biogas. The project envisages collection of paddy straw from the farmers' field divided into different clusters to simplify the logistics problems. A sustainable energy supply model for the purpose of generating income from paddy straw is demonstrated, which would serve as a model for creating future energy policies for rural regions in India for sustainable development. Moreover, it will provide opportunities for income generation to the farmers and also empowers for economic growth. Table 1 gives essential information about the project.

During an interactive session with Shri Sanjeev Nagpal, proprietor of SAVPL, Fazilka, said "It is promising solution for crop residue management with additional revenue to the farmers for sustainable agriculture and also resolving the issues, that is, straw burning, carbon emission, employment, organic manure and bio fertilizer for agriculture, electricity production."

Table 1: Typical information about the project

Capacity of Biogas plant	1.0 MW
Biogas Generation Capacity	12,000 m ³ /day
No. of working days	350 days/year
Paddy Straw requirement	25 tonnes/day
Power Generation	1,247 MWh/year
Manure (Compost)	439 tonnes/year
Slurry	560 kilolitres/year
Payback Period	5.16 years

In order to improve livelihood of the farmers, this project aims to supply renewable energy-based power with bio fertilizer as by-product and manure and paddy straw managements for extra income to the farmers. Paddy straw is available in abundant in this region and is used as the raw material to produce bioenergy in the form of biogas.



Picture 1: Paddy straw bales stored in open



Picture 2: Paddy straw bales at the storage site of plant



Picture 3: Paddy straw storage sheds

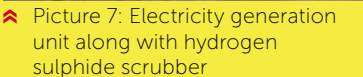
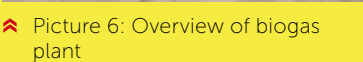
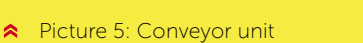
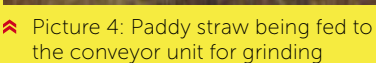
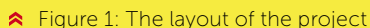


Figure 1 presents a flow diagram with the basic layout of the project.



 Paddy straw

 Biogas plant

 Biofertilizer

 Electricity production

The electricity generation unit comprise of German-make six cylinders Biogas Genset for electricity production with capacity 1.2 MW/H 3-phase 415V alternator with biogas

consumption about 500 m³/hour. The power produced from the electricity generation unit is being supplied to the government electricity grid through 11 kV transformer.

⚡ Sustainable Development Approach

The proposed biogas-based energy solution holds well on all the criteria of sustainability. The solution is 'technically feasible'. Various substrates given before have been observed for their potential outcome and functionality.

- Open field burning of paddy straw and other crop residue can be avoided through installation of commercial biogas production industries.
- It reduces methane emissions that taken place due to rotting of the substrate.
- The use of biogas can reduce the use of fertilizer, pesticides, and insecticides with enhanced soil health and having potential to recover damaged saline infertile land.
- The biofertilizers can help in overcoming the phosphate fixation problem.
- The government has heavily subsidized electricity and fertilizers and the products of the biogas plant have to compete with the subsidized price. Hence, organic fertilizer manufactured from the biogas plant can be retailed at the same price as phosphatic chemical fertilizer.
- It will also save foreign exchange outflow as most chemical phosphates are imported in India.
- Electricity produced from biogas can be retailed at differential prices.
- The current productivity of 300 m³/tonne of biogas from paddy straw could be improved with further research and development in this field to make it more sustainable.
- The project therefore helps in employment generation directly and indirectly due to which it is not just economically viable but also attractive.

⚡ Constraints

As per Shri Sanjeev Nagpal, "The major constraint that we are facing in this project is promotion of organic manure of biogas plant. Government department, particularly agriculture, does not mention the use of organic manure in package of practices of crops proposed by universities. Unlike chemical fertilizers, organic manure does not show immediate results but have long-term significant outcomes. Hence, government should take initiative to aware the farmers in more effective way to make it viable."

⚡ Conclusion

Thus to conclude, it can be said that given the benefits, supply of energy generating out of biogas would assist rural businesses and enterprises to grow and prosper, production and use of organic fertilizers would improve soil and increase yields, and the project would also help employment generation by creating local job opportunities; it would not be a questionable fact to say that biogas-based energy could provide sustainable solution for rural areas. Considerable savings in subsidy bills and foreign exchange outflow could be further achieved through such projects. Moreover, through availability of fuel and energy, the overall health and hygiene in the region will improve, and most importantly, the project promises 'empowerment' of rural community, which makes it appropriate to become a multipliable and scalable model. Due to their wide-reaching positive effect on environmental, energy, and agricultural sectors, paddy straw based biogas plants are important pillars of sustainable development with a novel initiative to create a profitable partnership for mutual benefit among farmers and the industry. **AU**



➤ Picture 8: Biogas genset

Due to their wide-reaching positive effect on environmental, energy, and agricultural sectors, paddy straw based biogas plants are important pillars of sustainable development with a novel initiative to create a profitable partnership for mutual benefit among farmers and the industry.

Dr Yogender Singh Yadav, Post-doctoral Fellow, Sardar Swaran Singh National Institute of Bio-Energy, Kapurthala, Punjab, India. Email: yogender784@yahoo.co.in.

Sustainable Rural Electrification

The Fascinating Stories of Dhenkanal District in Odisha and Kongwang Village in Meghalaya

In the process of finding solutions for sustainable rural electrification, The Energy and Resources Institute (TERI) along with a group of research partners, led by De Montfort University, the UK, implemented the 'Off-grid Access Systems for South Asia' (OASYS South Asia) project, where a systematic analysis was conducted to develop an off-grid delivery model framework and implement it through demonstration projects in un-electrified villages across different corners of India. These projects include mini-grids, microgrids, and picogrids, providing either AC or DC power to households and shops/micro-enterprises. One such project is discussed here; where it is employed in the five un-electrified villages lying within the Kandhara Reserve Forest of Dhenkanal district in Odisha, India.

Globally, there are more than 1.3 billion people who do not have access to electricity. Although conventional

grid connection has been the predominant mode of electrification, it has however, not been able to successfully reach numerous remotely located regions both in India and in many countries across the globe. In India, many households in grid connected areas do not take connection from the grid mainly due to unaffordability and unreliability of the central grid.

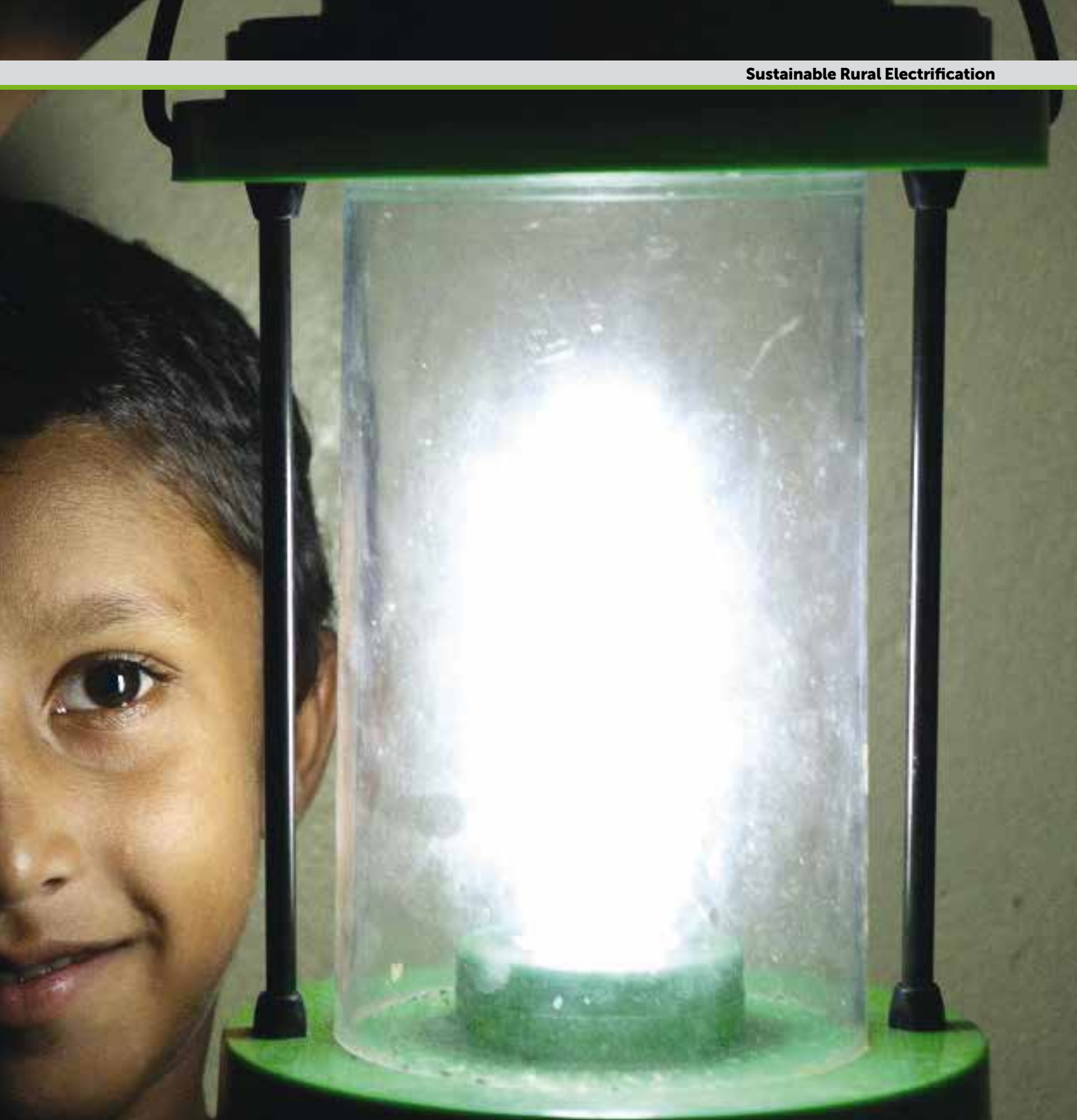
The situation is same for the five villages lying within the Kandhara Reserve Forest of Dhenkanal district in Odisha. These villages, namely the Rajanga village (and its hamlet), Kanaka village, Chadoi village, and Baguli village, were un-electrified as they did not have access to grid.

Steps Taken to Address the Problem

To overcome the problem of access to electricity, OASYS project came into existence. OASYS is an EPSRC/DfID

funded collaborative research project focussing on decentralized off-grid electricity generation in developing countries. Owing to the distance between the different villages in the cluster, for each of the five sites, their own power plant was designed.

- The three larger villages, namely Rajanga, Kanaka, and Chadoi have received AC microgrid (6, 5 and 2.5 kWp) and connected 34, 39, and 32 households as well as public buildings.
- The other two sites, Baguli village and Rajanga hamlet, were provided with DC micro-grids (400 kWp with 14 and 13 connections, respectively).
- Each household across all the five villages has been provided with same electricity supply configuration and illumination of two 3 W LEDs and a mobile charging point to ensure equity in service delivery.



The Process

- The villages being remote and located inside a forest, private developers were not willing to make investment risks in an area that is economically poor and scattered in terms of population and had unpredictable load growth.
- In this project, a subsidy driven model was used with collaboration of different funding agencies. The project cost was mainly borne by OASYS project and partially supported by the Rural Electrification Corporation (REC), a Government of India enterprise.
- The community also contributed in kind by way of land for the community hall cum power plant and labour and a token connection cost, which was vital for the project outcome.
- TERI acted as the main implementing agency for the project, overseeing

and coordinating all the activities of all other agencies involved. Using the one-time connection charges (500 per household), a maintenance fund was created to cover rectifications beyond warranty period, especially those caused by natural factors or force majeure and other maintenance needs as per the project requirements.

- The key stakeholders involved in this regard for the project are Village Energy Committee (VEC) members, Village operators, self-help groups (SHGs), community, and local partner NGO.
- Each of the stakeholders was given detailed training to run the model on sustained basis. There were other capacity building programmes conducted to spread awareness on the use of energy and agricultural practices and few other general workshops and exposure visits, such as:
 - » *Training of operators:* Each power plant is serviced by a village operator who is selected from the community by the VEC and is paid a monthly honorarium. These operators are trained on the operation and minor maintenance (O&M) of the grids and the livelihood appliances.
 - » *Training of SHGs:* Four SHGs with membership from all the five villages were identified as potential users and operating groups for the livelihood generating equipment. Capacity building sessions were organized with these SHGs to create awareness on energy issues and generate interest in the proposed livelihood generating opportunities.
 - » *Refresher technical orientation programme for VEC members:* The objective of the training was to understand, from the local stakeholders, the type of

faults that have occurred since the project commissioning and how they can address these in case it re-occurs.

- » *Community training programme:* In an effort to keep the communities involved in the project and spread awareness on energy use, a series of training and capacity building programmes were conducted during the initial pre-construction phase of the project. Such trainings and programmes covered topics related to training on livelihood activities, O&M of

the machines, marketing of local produce, etc.

Results

After the implementation of these off-grid plants, the people of these villages have received lots of benefits in their lives such as:

- Looking at the livelihood appliances installed at the community centre of Rajanga, IRADA (a local partner NGO), also put up six sewing machines in the community centre at Kanaka in order to promote livelihood opportunities.
- Short-term employment opportunities were created for the community to be involved in the activity of civil construction to set up the power plant infrastructure which helped villagers earn incremental income during the construction phase.
- Due to the commissioning of this project, the region has become lively. The condition of roads has now improved and connects these villages to other nearby areas.
- The children are able to study at night which has improved their grades in school.
- Owing to the connectivity development in the area, people have started coming from other towns and the capital city to buy the organic vegetables grown in these areas, thus, enhancing more income earning opportunities for the villagers.
- All the households attributed solar lights to the ease in carrying out chores and providing women with more free time. Women utilized this free time for doing household chores and other creative activities, such as stitching and spending time with family.

Source: <http://energy-access.gnesd.org/cases/44-empowering-the-poor-an-oasys-story-from-dhenkanal-district-odisha-india.html#affordability>

KEY FEATURES OF THE PLANT

- *Cluster-based approach for decentralization:* In this project, clustering has been seen in terms of institutional clustering wherein the VEC, a single institutional entity was established having representatives from all the villages to operate and manage multiple power plants installed in each village.
- *Choosing both AC and DC systems:* During baseline survey, it was found that the number of households in the Rajanga hamlet and Chadoi was limited to 14 and also, these two sites are not very close to the other larger sites where AC power plants were planned. Hence, a DC microgrid was designed to cater to lighting and mobile phone charging demand at these sites instead of extending the AC grid from the larger sites to these smaller sites, which would have been an expensive proposition.
- *Provision for demand growth:* The design value per household is taken as 30 W whereas the actual requirement is around 10 W. This has been done to address future increase in demand which may result from enhanced income due to the livelihood generation activities being promoted in the sites.
- *Distribution network and water pumping facility:* While, the distribution network in the villages of Baguli, Rajanga hamlet and Chadoi caters to only household and productive loads (if present), the villages of Rajanga and Kanaka also have provided connection facility for water pumping, located at some distance from the households.

Access to Reliable Electricity in God's Own Garden



Kongwang is a small village located in Amlarem of Jaintia Hills district, Meghalaya with total 13 families residing. Trailing up 30 minutes from a deserted road near the Bangladesh border, this village is so remote that it looks like it is in the middle of nowhere. With an approach that is narrow and traversable only by foot, the village is a pristine and untouched spot of Meghalaya with breathtaking views all around.

⚡ Problem of Reliable Energy Access in Kongwang Village

There was no access to reliable electricity for the people of Kongwang. Having light, for them meant smoky homes and inhaling fumes from kerosene lamps. Following are the few problems they faced in their daily life due to inaccessibility of electricity:

- Simple activities like cooking, washing, and binding betel leaves were impossible to perform after sunset as evenings were lit up only with the dim glimmers of candle lights, kerosene lamps, and intermittent bulbs run on dry-cell or rechargeable car batteries.
- Due to the unavailability of electricity, it was difficult to do any productive work. They could

merely navigate inside and around the house, making the villagers feel extremely unsafe, insecure, and immobile after dark.

- The car batteries provided a better level of lighting, but recharging them was a major challenge, not only because of their hefty weight, but also due to the unreliability of the quality of charging services that were sparsely available.

⚡ Steps Taken to Address the Problem

Kongwang was identified as one of the first villages for the installation of a solar charging station (SCS) and for the implementation of stand-alone integrated domestic energy systems (IDES) under the TERI-POSOCO CSR partnership in 2012-13.

Maintenance of SCS: Iashahlang Kongwang who is the village level entrepreneur (VLE) and his daughter Balanrika, who is the Secretary of the village cooperative society (VCS) and a teacher at the village school operates and manages the solar charging station.

⚡ Results

The success of the project has also been possible due to the

'sustainability' approach that was kept in mind during implementations and covered the following considerations:

- No operating cost towards feedstock
- No carbon dioxide emissions
- Replacement of a highly subsidized albeit non-renewable fuel such as kerosene
- Fee for service delivery model, which offered a simple and affordable renting arrangement.

Benefits and the impact experienced in the lives of the residents after the implementation of the project are as follows:

- Households saved an average of ₹500 per month by transitioning to clean energy alternatives. The money was earlier spent on procuring 5l of kerosene every month.
- Monthly incomes increased by nearly ₹8,000 on an average for households which operated and managed solar charging stations and rented out 35 lanterns daily.
- Women also earned more as they were able to work extra hours in the evenings to bind betel leaves and sell higher volumes in the local market.
- Men were able to use the lanterns after dark to collect betel nuts and firewood in the forest, increasing their productive use of time even after sunset.
- Children's grades improved considerably as they were able to study in the evenings.
- It became much safer and easier to navigate through the village at night and mobility was significantly enhanced.
- Members of the community had better opportunities to interact and congregate by the lamp lights in the evening, a social opportunity that was highly restricted due to poor light sources. **AU**

Source: TERI. 2015. *Lighting up Lives in God's Own Garden. Journey towards a Billion 8(2):10-11*

AKSHAY URJA (HINDI) AWARDED WITH THE FIRST PRIZE AT THE RAJBHASHA SAMMELAN

Akshay Urja was awarded the first prize as the best Hindi magazine by the 'Rajbhasha Seva Sansthan' at the 'Akshil Bharatiya Rajbhasha Sammelan Evum Chintan Shivir' held at Munnar in Kerala on June 3, 2016. A total of 150 participants attended the programme from different Ministries/Departments/Public Sector Undertakings, from all over the country. Several Ministries/Departments were given prizes for their special achievement on the focus given by them to Hindi language for magazines, newsletters, etc., wherein the Ministry of New and Renewable Energy (MNRE) was awarded the first prize for Hindi magazine *Akshay Urja*.

Ms V Prabha, Section Officer, received the prestigious award on behalf of MNRE. **AU**



INVITING ARTICLES

The need to have a sustainable energy supply necessitates the exploration of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent.

Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. *Akshay Urja* is an attempt to fulfil this need through the dissemination of 20,000 copies (bilingual) in India and abroad. The magazine publishes news, articles, research papers, case studies, success stories, and write-ups on RE.

Readers are invited to send material with original photographs and statistical data. The photographs should be provided in high resolution files on a CD or through email. *Akshay Urja* will pay an honorarium of ₹2,500 to the authors for each published article of 1,500 words and above. The publication material in two copies, along with a soft copy on CD/DVD/email may be sent to:

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

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CAPACITY BUILDING FOR SOLAR ROOFTOP SYSTEMS AT GWAL PAHARI, HARYANA



The Energy and Resources Institute (TERI) in association with the Ministry of New and Renewable Energy (MNRE), Government of India, organized a two-day training programme (third in the series) on 'Grid-Connected Rooftop Solar PV Systems' for the State Nodal Agencies, DISCOMs, and State Electricity Regulatory Commissions from May 5–6, 2016 at TERI RETREAT, TERI GRAM, Gwal Pahari, Haryana. The training programme was designed to enable the target groups to understand the technical, financial, and regulatory aspects of rooftop solar PV systems, including their quality standards, project management, grid-interconnection, metering arrangements, and remote monitoring mechanism. During the programme, various practitioners and renowned industry experts from TERI, MNRE, EE&REM, SECI, The World Bank, BSES, SBI, KfW, and Secure Meters shared their views and experiences on implementing solar rooftop PV systems. A total of 21 participants attended the training programme. **AU**

CHINTAN MEETING FOR SECI'S FUTURE GROWTH

The Solar Energy Corporation of India Ltd. (SECI) organized a "Chintan Baithak" for discussion on "SECI's Future Growth" on May 20, 2016. In this meeting, Shri Upendra Tripathy, Secretary, Ministry of New and Renewable Energy (MNRE), Government of India and other officials of SECI, IREDA, NISE, and MNRE were present. The MD, SECI, made a presentation on the future prospects of SECI. The Secretary asked SECI to start a 'SECI Videsh Wing' to spread its wings all over the world. The event also saw the release of two books published by NISE—*Advances in Solar Energy Science and Engineering* (Volume 1 and 2).

On this occasion, a small dance drama on Swachhata Mission was presented by the artists of Songs and Drama Division, a Government of India undertaking. It underlined the necessity of keeping our surroundings clean and to ensure that all households have a toilet. It also showed how we can harness solar energy to make cleanliness a self-sustaining effort. The dance drama is part of the SECI's swachhata mission. Also, a presentation on 'transcendental meditation' was made at the event by specialists in this field. **AU**



Solar Community LIFT IRRIGATION

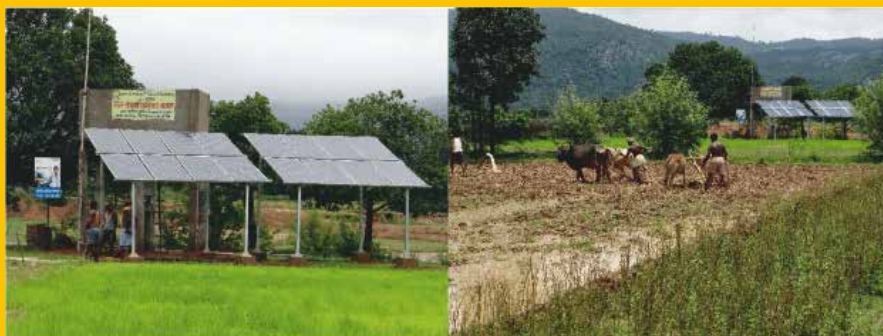
in Chhattisgarh



This success story article highlights the solar community lift irrigation schemes being implemented in the Jashpur district of Chhattisgarh. This project has proved to be a boon for the poor farmers since it has enhanced their productivity at a minimum cost and is serving as a cleaner and greener option of irrigation.

Eighty per cent population of the state of Chhattisgarh is rural and the main livelihood of the villagers is agriculture and agriculture-based small industries. The economy of the state is mainly based on agriculture and forestry. The agriculture sector contributes around 38 per cent to the state's net domestic product. In Chhattisgarh, agriculture is mainly done in rainfed conditions and variation in the yearly rainfall directly affects crops. Obviously, irrigation is the prime need of the state for its overall development and, therefore, the State government has given top priority to development of irrigation potential.

Chhattisgarh state consists of 27 districts; Jashpur is one of the backward districts of the state. It is situated in the north-eastern part of the state. The area of the district is 6,088 sq. km. It is rich in forest resources and the majority of its population belongs to the scheduled tribes (STs). Land is mainly of two types, Balua soil in hilly region, which is not fertile where mixed type of crop is grown, land in plain area is fertile. The main perennial rivers of the district are



Picture 1: Community lift irrigation systems installed at Village Choraidand and Khatanga, district Jashpur, Chhattisgarh

Lawa, Ib, Maini, and Shankh. Climate of the district is very peculiar with upper areas much colder while lower region is warm. The climate here is moist as heavy rainfall occurs here. The average rainfall of the district is 1,512.8 mm. The total irrigated area in Jashpur is 291,497 ha out of which 17,812 ha is net cropped area. As per the official data, there are 41 minor irrigation systems developed. There are many tiny and small stop dams proposed under various scheme which will bring more area under agriculture.

⚡ The Issues Faced By Jashpur District

Ever since the emergence of Jashpur as a district, it was evident that it has great potential to deliver true sense of high economic value to the state and the country. To keep up to expectation, it was necessary to fill the critical gaps in the area of infrastructure development, livelihood promotion, and other related activities. So, special scheme was required to meet the challenges ahead of tribal district Jashpur.

Considering all the above mentioned facts, the Chhattisgarh Renewable Energy Development Agency (CREDA) has formulated and completed two solar community lift irrigation schemes in villages Harradipa and Baghmudi of block Duldula of Jashpur district. In these villages, a large number of farmers did not have any means of electricity for irrigation. Approximately 130 acre

land was continuously not irrigated in other seasons except rainy season because of lack of electricity. They had only one bore-well near their agricultural lands in villages. But because of unavailability of electricity, the available bores were also not in use. Because of the unavailability of continuous electricity farmers have no choice except to take only one crop that too in rainy season. For irrigation they were dependent on diesel pumps for which they had to make lot of efforts to buy and bring diesel from distant places.

⚡ Solar Community Lift Irrigation Schemes

Under these lift irrigation schemes, two solar surface pumps one in each village were installed at common water source, i.e., stop dams on perennial rivers. Committees of Farmers were formed for daily operation and maintenance of the pumps, which also controls scheduling and distribution of



Picture 2: Solar community lift irrigation system in operation

water among farmers. Farmers also contributed land for installation of solar pumps and construction of overhead tanks of 5 kl in each village.

The outcome of these projects, so far, is as follows:

- A total of about 30 acres of farm land is being irrigated under this project.
- A total of about 2 lakh litres of water is provided for irrigation per day in each village.
- About 12 families were benefitted with this project, which are now growing crops, such as mustard, paddy, maize, potato, and other vegetables, etc.
- The economy of these farmers is increased substantially as they do not have to pay for diesel for irrigation after installation of the solar pumps.
- Training was given to farmers to handle troubleshooting related to pump sets. The basic outlay of providing water supply to the farms is done by constructing a RCC tank, nearby to the solar pump which serves a total of 108 acres of farm land annually. A total of 16 panels (300 W) were installed, which is sufficient to run a 5 HP solar pumpset.

⚡ Benefits and Impact of the Project

The impact of these kinds of projects on the villagers is immense. Earlier mono-cropping was the usual practice but with the advent of this community-based lift irrigation project, the farmers have started cultivating more crops annually. This project has proved to be a boon for the poor farmers since it has enhanced their productivity at a minimum cost and is serving as a cleaner and greener option of irrigation. Subsistence farming was a past and forgotten word for the farmers. This has really helped them to improve their standard of living. **AU**

Solar Energy Utilization in Kargil and Ladakh

The Twin Success Stories in Jammu & Kashmir

This success story article discusses about the implementation of solar thermal systems in Kargil under the 'Ladakh Renewable Energy Initiative' scheme of the Ministry of New and Renewable Energy (MNRE). It also highlights the Ladakh Renewable Energy Initiative by the Ladakh Renewable Energy Development Agency (LREDA) in Leh, Ladakh.



The Kargil Renewable Energy Development Agency (KREDA) has been implementing various renewable energy programmes in Kargil. One of the programmes is the solar thermal scheme. The scheme has been launched especially to accelerate widespread use of solar thermal systems for heating, cooking, and steam generating applications, as well as to bring into use the solar passive techniques in building design. Introduction of the various solar thermal systems in Kargil will surely reduce/ conserve the consumption of conventional energy through saving of electricity and fossil fuels in local and commercial buildings.

The following solar thermal systems have been promoted under the Ladakh Renewable Energy Initiative (LREI) programme in Kargil:

- Solar Evacuated Tube

Collector (ETC) based water heating systems

- Solar greenhouse for vegetable production during autumn and winter (CGH)
- Solar dish-type cooker.

⚡ Solar Water Heating Systems

The Ministry of New and Renewable Energy (MNRE), Government of India, has sanctioned 10,000 m² collector areas to be covered in Kargil under water heating system. As per the directions from the MNRE, KREDA has been installing the systems on subsidy basis, which are as follows:

- 60 per cent off for residential use
- 90 per cent off for government buildings
- 40 per cent off for commercial buildings.

ETC-based solar water heating system has been found to be very useful in Kargil, especially in winter months when the temperature falls tremendously (Picture 1). Hot water is required for all domestic purposes, such as bathing, washing, cleaning and cooking, etc. ETC-based water heating systems installed in houses in Kargil using solar energy as fuel for heating water can save a significant amount of fuel apart from improving the quality of life of the beneficiary and reducing the environmental pollution. The demand for solar water heating (SWH) system is rising day by day.



➤ Picture 2: Solar green houses installed in Kargil

⚡ Solar Green Houses

The best and the most favourable solar thermal system among the beneficiaries of solar thermal components is the 'Solar Green House'. The villagers in Kargil typically grow vegetables in open fields and are constantly plagued by pests and disease. Moreover, the season for growing vegetables is very limited. During the winter season mercury drops even to -30°C in Kargil and adjacent places, this makes cultivation impossible. Introduction of greenhouse technology in Kargil through KREDA is a step which has helped the local people to a large extent.

KREDA has so far constructed 3,250 green houses in Kargil (Picture 2). The demand for green house, especially for commercial green house, in Kargil is so high, that the sanctioned numbers of green houses could not meet the demand, and the agency has submitted a new proposal for green houses in the MNRE.

KREDA is also helping the greenhouse beneficiaries and other members from different villages

in understanding the sustainable development through renewable sources of energy. KREDA is working in Kargil-Main, Northern Zone Kgl, TSG-Central Kargil and Zaskar region to increase incomes and promote food security through smallholder production (through green houses) and employment generation among the people.

⚡ Solar Steam Cooking/ Direct Cooker

KREDA has also some direct cooking and steam cooking systems already sanctioned by the MNRE under its ST Scheme. The agency will be installing the demonstration plants soon. There would be training for beneficiaries of solar thermal systems and for other public as well. KREDA has been trying its best to achieve a remarkable growth in the contribution of solar thermal renewable energy in the district.

For successful implementation of the programme and for big mass awareness regarding solar thermal systems, KREDA has organized various



➤ Picture 1: Solar water heating systems installed in Kargil





▲ Commercial green house installed in district Leh, Ladakh



▲ Solar steam cooking systems installed in district Leh, Ladakh

Table 1: Details about the targets of the LREDA project

PROJECTS	TARGET	ACHIEVED
Solar water heaters (100LPD)	6,000	6,000
Solar water heaters (200 and above)	14,384	12,628
Commercial GH	250	250
Domestic GH	2,500	2,500
Dish cooker	2,250	2,250
Steam cooking	15	1 (balance to be completed by October 2016)

training programmes in Zaskar and Kargil. The participants were informed of various schemes of the MNRE, especially solar thermal projects. Sanctioned schemes of the Ministry which are under implementation of KREDA were also discussed.

⚡ Ladakh Renewable Energy Development Agency

Ladakh Renewable Energy Initiative was sanctioned by the MNRE, Government of India, on June 1, 2010. An amount of ₹32 crore was allocated for the solar thermal projects consisting of solar water heaters, solar dish cookers, commercial and domestic greenhouses, and solar community cooking systems.

The Ladakh Renewable Energy Development Agency (LREDA) being the nodal agency of the ministry in Leh District of Jammu & Kashmir



▲ Solar water heating system installed in Leh, Ladakh

was given the responsibility of implementing the project.

Leh District is the northernmost district of India sharing two international borders with China and Pakistan. Situated at an altitude of more than 11,000 ft this region is cut-off from the rest of the country for more than six months each year. Temperatures range from 30°C to -30°C in this region. With extremely harsh climatic conditions any productive work can only be done in summers making six months of winters unproductive for any physical work.

In spite of these hardships, the highly dedicated team of LREDA has completed most of the targets of the project within the stipulated time (Table 1).

The MNRE has now enhanced the target to include additional 7,500 units of solar water heating systems and 500 commercial green houses to be completed by December 2017. **AU**

CST & SOLAR COOKER EXCELLENCE AWARDS 2016

Presented by Shri Piyush Goyal



“India now will lead the world towards clean energy rather than follow”—
Shri Piyush Goyal

Shri Piyush Goyal, Minister of State (IC) for Power, Coal and New & Renewable Energy felicitated 102 awardees at the “CST & Solar Cooker Excellence Awards 2016” organized by the Ministry of New and Renewable Energy (MNRE) in New Delhi on April 29, 2016. The awards were given to various stakeholder groups including State Nodal Agencies, Manufacturers/ Suppliers of the technology, and a wide range of beneficiaries to recognize their achievements in the sector. He also released nine knowledge documents to provide information on Concentrated Solar Thermal Technology (CST) on the occasion. Speaking on the occasion, Shri Piyush Goyal said that India now will lead the world towards clean energy rather than follow. “With 21 GW of grid-connected new solar projects out in the market, India has signalled to the world that we’re ready to lead” he added.

He further said that solar programme will not only ensure energy security of our country but also provide power to the last

person at the bottom of the pyramid. Appreciating the awardees, the Minister said that such individual projects play a vital role in achieving holistic solar targets. Shri Goyal reiterated that Indian solar targets are achievable. He said that we have exceeded our solar targets by 116 per cent this year and have already awarded projects of 11,000 MW. With these awards, the achievements of the stakeholder groups including state nodal agencies, manufacturers/ suppliers of the technology, etc., were recognized.

The function was attended by Shri Upendra Tripathy, Secretary, MNRE; Mr Jaco Cilliers, Country Director ,UNDP; Ms Ayumi Fujino, UNIDO Representative & Regional Director; and senior officers of the Ministry. The Excellence Award ceremony is part of National Workshop on CST and Solar Cookers organized by the MNRE to recognize notable achievement in off-grid and decentralized solar application.

The MNRE is implementing the programme on Concentrating Solar Thermal (CST) technology under

the ‘Off-grid and Decentralized Solar Applications’ programme of the National Solar Mission (NSM). The programme aims to promote applications of CST technologies in the industrial sectors, commercial establishments and other institutions. CST technologies can be used to provide steam/hot oil/ pressurized water in the temperature range of 90–300°C for various applications including community cooking, laundry, space cooling, etc. While community cooking has become a popular application in both educational and religious organizations, CST technologies are being adopted to meet the process heat requirements in dairying, pharmaceuticals, chemicals, textiles, and many other industrial sectors. Over 200 systems covering a total area of around 45,000 m² have already been installed in various parts of the country. The Ministry is also preparing a roadmap to install 100 MW of CSTs by the year 2022. **AU**

Source: www.pib.nic.in

LOW-COST RENEWABLE ENERGY DEVICES

To Boost Rural Entrepreneurship

The rural people of our country mainly depend on agriculture as India is an agrarian economy. Thus, there exists a huge mass of unemployed youth who are facing constraints to continue their existence. Rural youth can find self-employment opportunity by fabricating low-cost renewable energy technologies and energy efficient devices. *In the present part of the series of articles, the author describes a few simple renewable energy technologies and energy efficient devices related to solar drying and a solar distillation plant to produce distilled water for automotive battery.* It is strongly believed that, if mass production of these devices is taken up, it would create an atmosphere of sustainable development in India.

⚡ Solar Drying

A solar dryer is used as a heat source for drying crops, such as corn, fruit, or vegetable.

⚡ Solar cabinet dryer

The solar cabinet dryer (Figure 1 and Picture 1) consists of a wooden or any insulated material box of length three times of its width, insulated at its base and at the sides and covered with a transparent roof. The inside surfaces of the box are coated with black paint and the product to be dried is kept in the trays made of wire mesh bottom. These loaded trays are kept through an openable door provided on the rear side of the dryer. Ventilation holes are made in the bottom through which fresh air from outside is sucked automatically. Holes are also provided on the upper sides of the

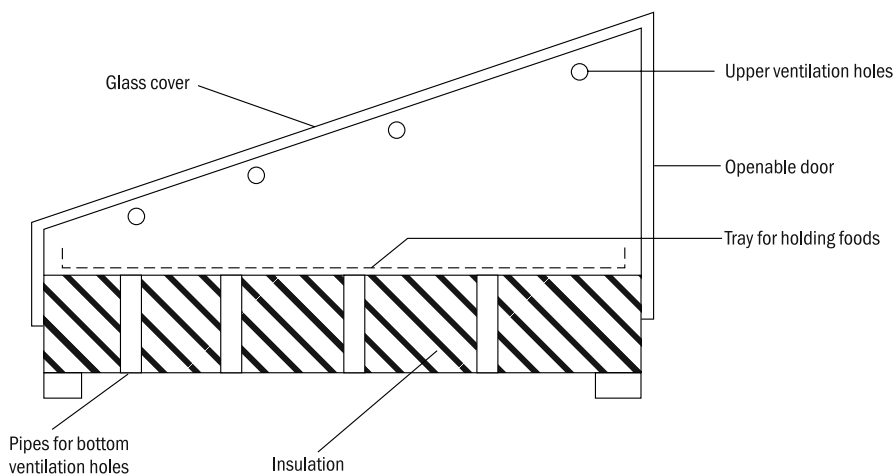
dryer through which moist warm air escapes.

⚡ Specifications

- *Dimensions of demonstrative model:* 2.5 ft x 1 ft
- *Raw materials required for fabrication:* Plywood, aluminium sheet, UV-resistant polythene sheet, black dull paint, etc.
- *Machinery used for fabrication:* Hand saw, portable drilling machine, hammer, screwdriver, pliers, measuring tape, etc.
- *Cost of fabrication of demonstrative model:* ₹600.

⚡ Solar rack-type dryer

The solar rack-type dryer (Picture 2) consists of a wooden box insulated at its base and at the sides and



⚡ Figure 1: Solar cabinet dryer



⚡ Picture 1: Photograph of solar cabinet dryer

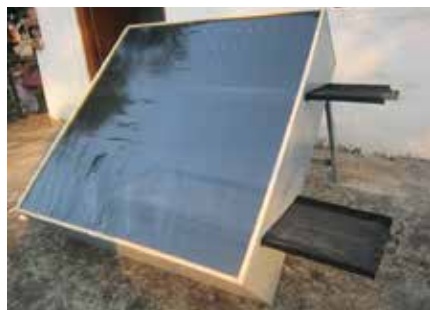
covered with one layer of UV-resistant transparent polythene sheet on the front side. The inside surfaces of the box are coated with dull black paint and the product to be dried is kept in the trays made of wire mesh bottom. These loaded trays are placed sideways opening of the dryer box. Ventilation holes are made at the bottom of the dryer box through which fresh outside air is sucked automatically. Holes are also provided on the upper sides of the dryer through which moist warm air escapes.

Specifications

- South facing frontal area: 3 ft x 3 ft
- Depth of the wooden box: 10 inches
- Ventilation holes: At the bottom and top side of the dryer box
- Number of perforated trays: 2 nos.
- Tray area: 3 ft x 1 ft
- Placement of trays: Sidewise
- Inclination of dryer box: 45° with the base
- Dryer box: 12 mm thick wooden box with dull black aluminium sheet layer inside
- Cover: Transparent polythene sheet
- Cost of fabrication of demonstrative model: ₹1,000.

Solar Distillation Plant to Produce Distilled Water for Automotive Battery

Impure water, in a glass-covered enclosure with a black bottom (to



Picture 2: Photograph of solar rack-type dryer

increase the absorption of solar radiation) is heated by solar rays and which evaporates. The vapour condenses on the underside of the glass cover and is collected as pure water through flow channels provided at the lower edge of the cover. The glass cover has a dual function, it helps retain heat inside the solar still (Figure 2 and Picture 3) by letting in short wave solar radiations and reflecting back long wave heat radiations re-radiated from the surface of the still and its underside acts as a cool surface (glass cover is at a lower temperature because it is in contact with the ambient air) for water vapour to condense. Considering the capacity to produce 2 l of distilled water/m²/day, production capacity of single unit of this particular plant will be approximately 0.8 l of distilled water. To produce 20 l of distilled water per day 25 units are required, estimated cost of which is approximately ₹80,000.

Specifications

- MS sheets are to be cut in the size of 122 cm x 122 cm to fabricate each basin.
- Ends of each sheet are to be folded 90° upward to form the basin.
- 10° slope is to be maintained at the top open side having a maximum 30 cm height at highest end.
- Top ends of each basin walls are folded inside to provide 2.5 cm wide seating for glass cover.
- Asphalt sheet is to be used as gasket in between seating and 3 mm thick



Picture 3: Photograph of solar still

transparent plain window glass to arrest the leakage.

- Asphalt gasket is to be further placed at the top of the glass cover at all sides and glass cover is then to be firmly held with seating by lightweight MS angles screwed with the sidewalls of the basin.
- A V-shaped aluminium/stainless steel channel is to be fixed at sloped edge to collect condensate from where distilled water can be taken out through outlet connection.
- Suitable inlet connection is to be arranged at upside of basin to fill impure water time to time and another pipe is used to control the level of impure water and to flush the basin.
- Interior of the basins are to be painted dull black by automobile muffler paint to absorb solar radiation. **AU**

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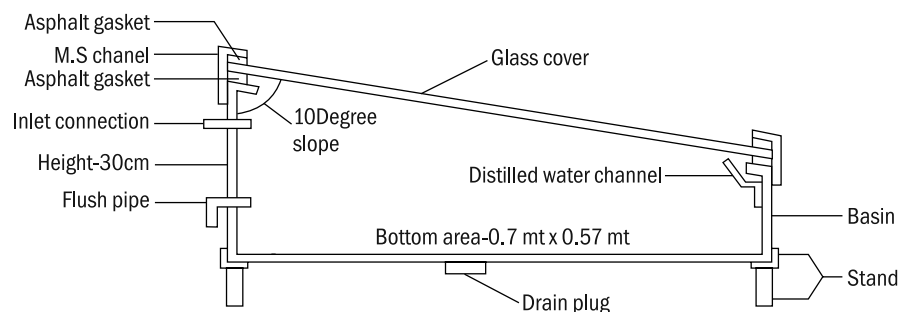


Figure 2: Solar still

LEARN TO MAKE BIOFUEL

TO PROMOTE GREEN MODE OF TRANSPORTATION



Hello children! A biofuel is a fuel that is produced through contemporary biological processes, such as agriculture and anaerobic digestion, rather than a fuel produced by geological processes such as those involved in the formation of fossil fuels, such as coal and petroleum, from prehistoric biological matter. Biofuels can be derived directly from plants, or indirectly from agricultural, commercial, domestic, and/or industrial wastes.

Learning how to make biofuel can help you reduce your greenhouse gas emissions as well as reduce your dependence on imported oil. Because our current fuel sources are steadily running out, considering biofuel as a fuel alternative is a logical choice. With the proper tools and know-how, you can do this at your own home.

⚡ Steps to Make Biofuel

1. Try your first batch of biofuel with unused vegetable oil.
2. Start with safety. Put your goggles on, work close to a sink and/or have a bucket of water ready for any body part that might come into contact with the chemicals.
3. Work in a well-ventilated room that is at least 21°C, and put down paper or plastic to plan ahead for any spills.



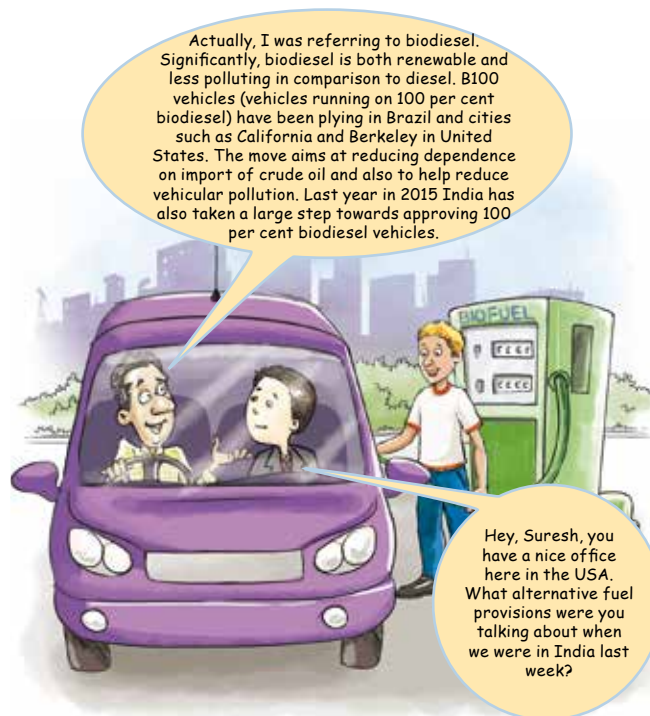
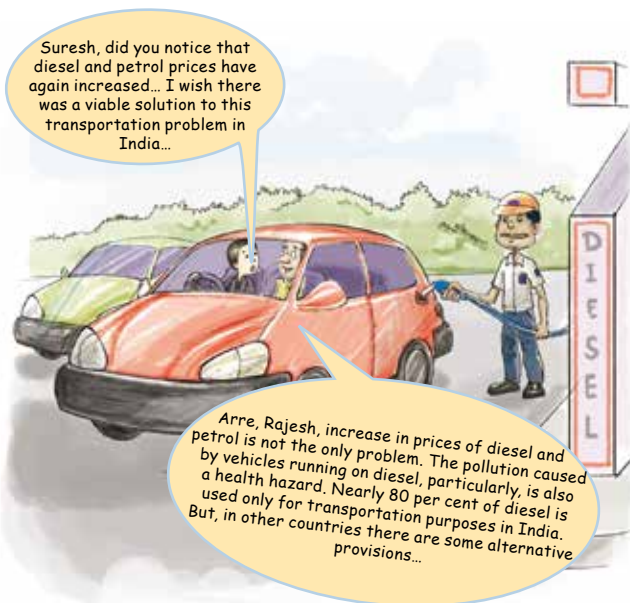
4. Begin adding your components as described below:
 - » Measure 200 ml of methanol. You can find methanol in gas tank antifreeze, available at hardware stores or auto part stores. Pour it in a blender.





- » Use a scale that will accurately measure out grams to weigh out 3.5 g of lye. You can use Red Devil Lye Drain Cleaner (sodium hydroxide), but take proper precautions because lye is poisonous. Drain cleaners that are chlorine-based (calcium hypochlorite) will not work.
 - » With the lid off, turn your blender on its slowest setting, and slowly begin adding the lye to the methanol inside. This will create sodium methoxide, but take precaution that the mixture does not splatter all over.
 - » It should take about two minutes for the lye to dissolve, so once it has, add 1 litre of vegetable oil.
5. Blend your mixture for approximately 20–30 minutes on the slow setting.
 6. Pour your mixture, once your blending is done, in a wide-mouth jar.
 7. Label it 'Biofuel'.
 8. Check out the separation. Approximately 30–60 minutes after you pour it into your container, you will see layers appearing in your mixture. The bottom layer is glycerin, and the lighter layer above it is biodiesel.
 9. Split your mix. Once the mixture has completely settled, you can pour off the biodiesel for use and discard the glycerin. **AU**

Source: <http://www.wikihow.com/Make-Biofuel>



www.newenergycorp.ca

New Energy Corporation | www.newenergycorp.ca

New Energy was formed for the express purpose of developing technology and products that harnesses the energy from moving water and turning it into a clean renewable energy source. While most companies involved with hydrokinetic power generation were focussed on large tidal projects, New Energy felt a more prudent approach was to start with small freshwater applications. The concept chosen for development was based on a vertical axis cross flow turbine utilizing conventional above water components (generator, gearbox, bearings) resulting in easy access to the drive train and rapid testing of the design concept. New Energy's vision is to provide clean, reliable, affordable, renewable, and environmentally responsible power to the world. Whether to reduce remote communities' reliance on fossil fuels, add to an existing mix of grid connected power sources, or to provide power where none currently exists, New Energy believes in providing environmentally responsible energy solutions that harness the power available from nature. **AU**

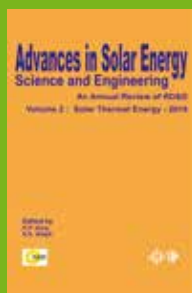
Advances in Solar Energy Science and Engineering (Volume 1 and 2)

Volume 1 edited by: Praveen Saxena, H P Garg, O S Sastry, and S K Singh

Volume 2 edited by: H P Garg and S K Singh

Today & Tomorrow's Printers and Publishers 365 pages

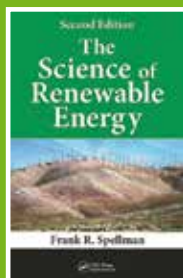
Advances in Solar Energy Science and Engineering (Volume 1 and 2) are specialized books with topics of recent research and development. This serial publication is an annual review of research and development and state-of-the-art technology in the field of solar energy, which has been edited by the National Institute of Solar Energy (NISE), towards providing quality literature to all the stakeholders in the field of solar energy. The scope of this serial publication is broad and encompasses recent developments in the field and is addressed to students, researchers, policy analysts, and energy planners seeking a fuller understanding of technical factors underlying renewable energy developments. **AU**



The Science of Renewable Energy, Second Edition

Frank R Spellman, CRC Press, 576 pages

This book presents a multidisciplinary approach to renewable energy, covering physical and engineering approaches and addressing the economic, social, environmental, and policy issues raised. It surveys all of the principal renewable energy sources in use today and uses straightforward language with little emphasis placed on math and theoretical science. Instead, the emphasis is placed on the technical aspects and practical applications of renewable energy. This new edition is updated throughout and adds information on the latest innovations related to all types of renewable energy sources as well as the related environmental implications. **AU**



Watt Footprint: The Smart Citizen's Guide to Save Energy in the Built Environment

Paul O'Reilly, ePrint, 315 pages

This inspiring and practical book presents a helpful seven-step guide to enable us make informed decisions about the type of energy we choose to power our modern lifestyles. The book also provides basic information to help us use energy more efficiently in our



homes and workplaces. This book also aims to help you to navigate the rules, to understand the genesis of regulations governing energy efficiency in buildings, and to make sensible decisions about some very basic issues that significantly affect the quality of our modern lives. The book provides a seven-step guide, written in plain and simple language to help people understand such issues as energy measurement, energy efficiency, insulation, airtightness, temperature control and renewable energy generation and the part water efficiency has to play in climate change. **AU**

National

July 15, 2016 | Hyderabad, India

Renewable Invest Telangana

Website: <http://10times.com>

July 22–24, 2016 | New Delhi, India

Govt Achievements & Schemes Expo

Website: www.nnsevents.com

August 17–19, 2016 | New Delhi, India

Waste & Sanitech India

Website: <http://10times.com/waste-sanitech-india>

August 21–23, 2016 | New Delhi, India

World Renewable Energy Technology Congress & Expo

Website: <http://wretc.in>

September 07–09, 2016 | Greater Noida, India

Renewable Energy India Expo

Website: <http://www.renewableenergyindiaexpo.com>

International

July 07–10, 2016 | Brighton, United Kingdom

The European Conference on Sustainability, Energy & the Environment 2016

Website: <http://iafor.org/conferences/ecsee2016>

July 11–14, 2016 | San Francisco, CA, United States

Intersolar North America 2016

Website: www.intersolarglobal.com

July 11–13, 2016 | Washington, DC, United States

National Town Meeting on Demand Response & Smart Grid

Website: www.solarelectricpower.org

July 19–20, 2016 | Portland, Maine, United States

AWEA Regional Wind Energy Conference 2016 – Northeast

Website: www.awea.org

July 25–29, 2016 | Paonia, Colorado, United States

PV303: Adv PV Multimode & Microgrid Design (Battery-Based)

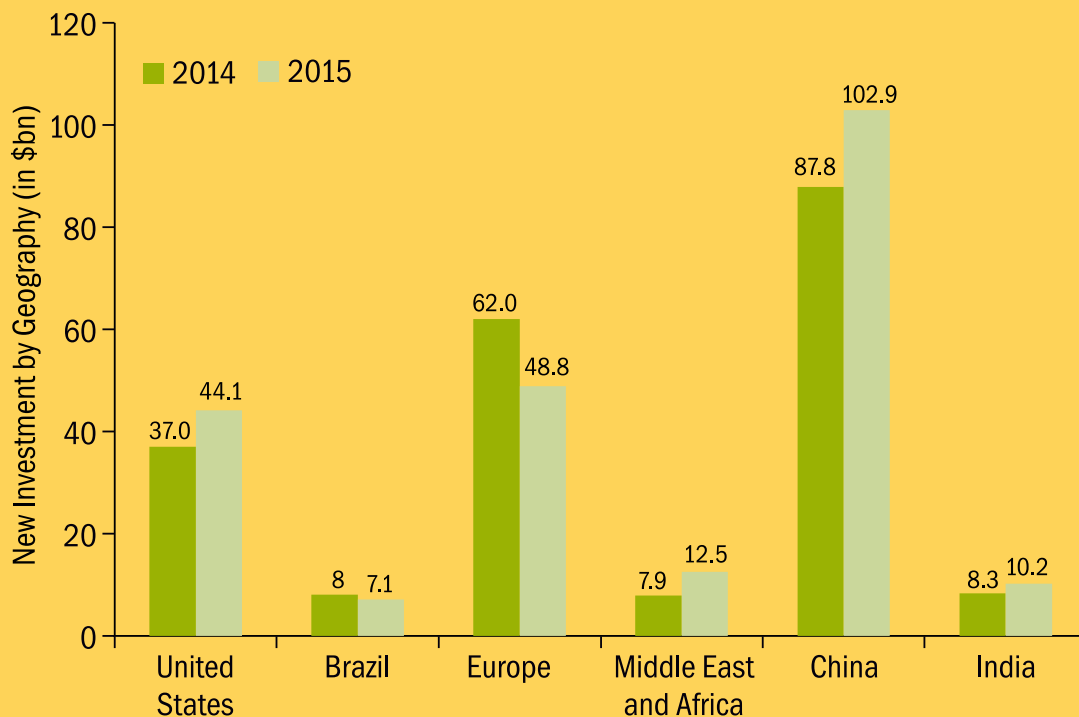
Website: www.solarenergy.org

July 28–30, 2016 | Berlin, Germany

World Congress and Exhibition on Wind & Renewable Energy

Website: <http://windenergy.omicsgroup.com>

RENEWABLE ENERGY AT A GLANCE: GLOBAL



GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2016 DATA TABLE, \$BN



GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED VS DEVELOPING COUNTRIES, 2004-2015, \$BN

Source: UNEP, Bloomberg New Energy Finance