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ENERGY FUTURE

The Complete Energy Magazine
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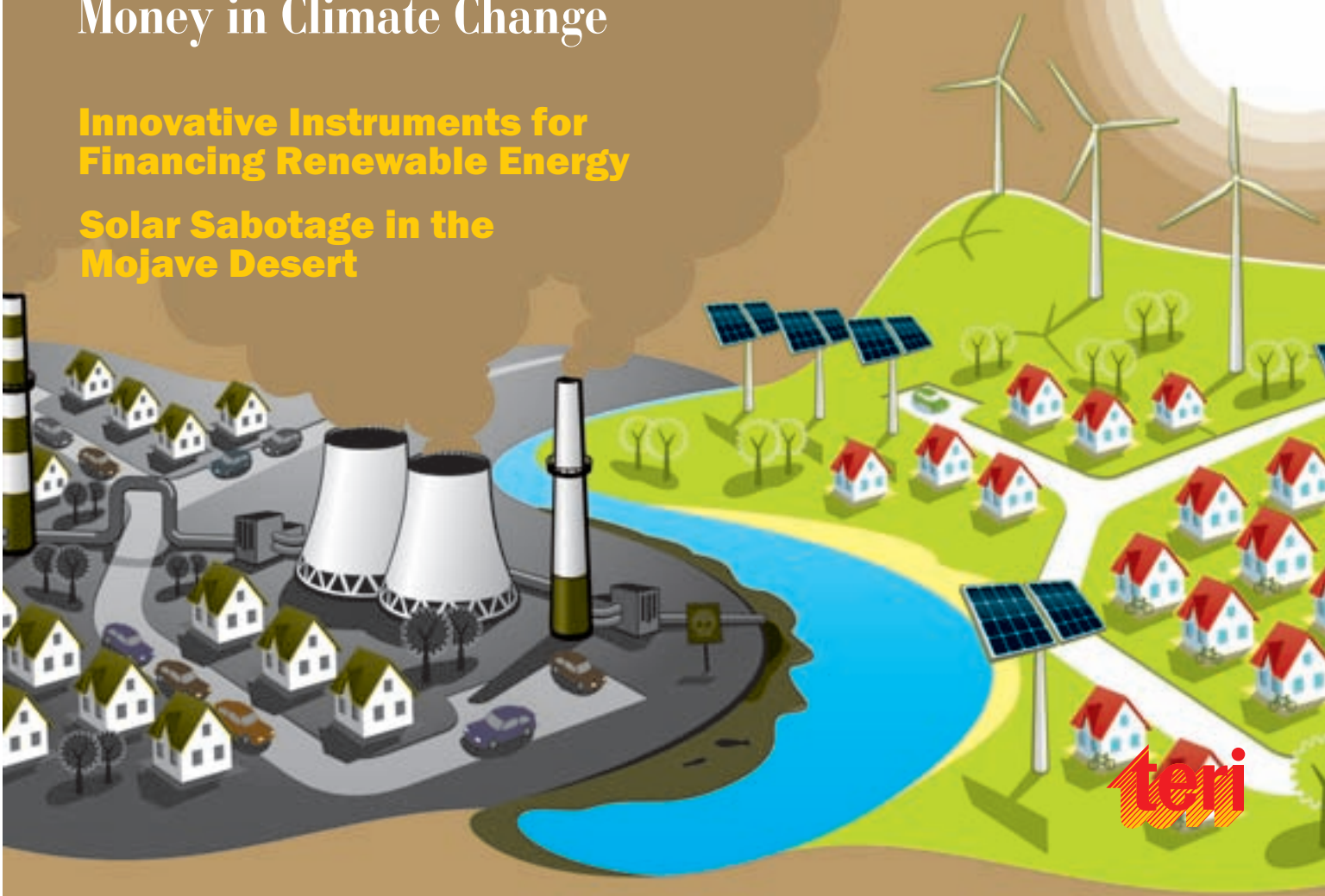
Innovative Instruments for Financing Renewable Energy

Solar Sabotage in the Mojave Desert

VIEWPOINT

Rajeshwara Bhat
MD, Juwi India Renewables Ltd



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ENERGY FUTURE

The Complete Energy Magazine

By looking at the technologies, policy decisions, and business ventures that have the potential to overcome energy shortage and our crippling dependence on depleting fossil fuels, Energy Future draws from a deep well of expertise at TERI (The Energy and Resources Institute), India's leading research institute on energy and green growth. Knowledge of energy security and development is a critical requirement in the modern global economy, and Energy Future aims to educate and inform you about the wide world of energy; its history, its future, how the energy industry works, how it has affected the world, and how it continues to affect you and me.

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From the editor's desk...

The recently released `Summary for Policy Makers' report of the Working Group 3 of the Intergovernmental Panel on Climate Change (IPCC) very clearly brings out the peril of climate change if it is left unattended. It says that "Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute decadal increases toward the end of this period." It further states that "CO_2 emissions from fossil fuel combustion and industrial processes contribute about 78 per cent of the total GHG emission increase from 1970 to 2010." Thus, to limit climate change within acceptable limits, immediate measures are suggested at both the ends, namely, at energy supply as well as at energy end-use levels. Accordingly, "Decarbonizing (reducing the carbon intensity) electricity generation is a key component of cost-effective mitigation strategies..." On the other hand, mitigation strategies have to be put in action to reduce carbon intensities in the transport, industry, and building sectors.

Given that impacts of climate change are going to be enormous on human and socio-economic development, and that energy generation and consumption are the key drivers, time-bound action plan for improving the energy efficiencies in conjunction with much greater penetration of renewable energy cannot be overemphasized. This not only calls for major shifts in the policy and pricing mechanisms but also in behavioural aspects. The technological choices also gain importance if we were to avoid the `lock-in' risks of wrong kind of energy systems and processes considering long asset lifespans. It is clear now that the future of the planet earth is closely intertwined with the energy future.

Amit Kumar

Amit Kumar
Director, TERI

Editor: Amit Kumar Radheyshayam Nigam
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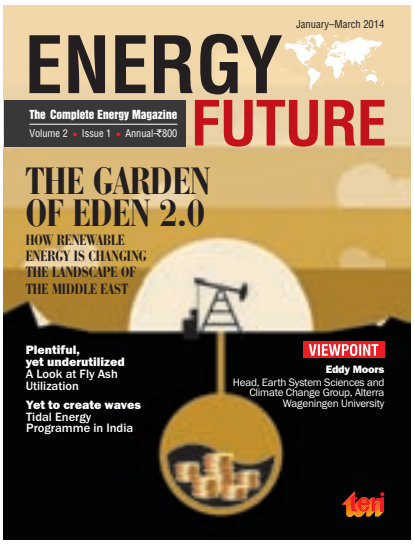

I really enjoyed reading this issue of *Energy Future*. The cover story on the renewable energy sector in Middle East is very informative. The article unfolds the fact that how renewable resources can not only empower the Middle-east economy, but can also lead to women empowerment. The article describing the unconventional drilling techniques is really very informative. If these techniques are followed systematically, it can solve the energy crisis prevailing in lot of countries.

Ruchita Dubey
Hyderabad

Solar and wind energy are the most abundantly available source of renewable energy that can be harnessed for energy production. To obtain a high quality of solar energy, high quality of PV modules are required. To harness large amount of wind energy, effective turbine system with programmed algorithm is required. This issue of *Energy Future* has covered some very interesting facts related to these two technologies. I would like to congratulate the entire team of Energy Future for enlighting us with such information.

Manosh Dutta
Assam

Thank you very much for your encouragement. The editorial team of Energy Future will ensure that the magazine caters to your information and knowledge needs. We welcome your suggestions and comments to further improve our content and presentation.

Email: teripress@teri.res.in

Editor
Energy Future

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EAST INDIA'S FIRST NET-ZERO BUILDING COMING UP AT BHUBANESWAR

Producing as much energy as it consumes by using geothermal cooling systems and solar energy, eastern India's first net-zero energy building will come up at Bhubaneswar next year.

Spread over three acres, the project will house the new office of the Grid Corporation of Odisha Ltd (GRIDCO), under the Odisha government's energy department. "The building invites direct natural sunlight and screen radiation. It would have photovoltaic glass panels and geothermal cooling systems at strategic places along with its indigenous solar generating systems so that it sustains itself with its own energy," said Kolkata-based architect Abin Chaudhuri, who has designed the structure. The average running cost of energy for a standard building of this capacity amounts to Rs 10 per square feet, however, for this green project it will not be more than Rs 2 per square feet. "Very roughly I am assuming that the Energy Performance Index (EPI) of the building will be roughly 90 kWh/sq. m/year. The same can be generated with 180kWp of solar panels," the architect said.

Divided into three buildings, the eco-friendly campus with a built-up area of about 1.7 lakh square feet has the capacity to accommodate about 300 people. The building has been designed on the basis of sun-path of Bhubaneswar by calculating the tolerable level of the direct sunlight radiation by human habitat using computer simulation. With rising energy costs and increasing awareness to protect the environment, the concept of green buildings has been catching up in the country. ■

Source: www.freepressjournal.in

HC NOTICES TO RIL, AP, CENTRE, AND CBI ON KG BASIN SUPPLY ISSUE

The Andhra Pradesh High Court issued notices to Reliance Industries (RIL), the CBI, Andhra Pradesh Government, the Centre, and the Directorate General of Hydrocarbons on the issue of gas supplies from KG-D6 Basin.

Based on a petition filed by Palem Srikanth Reddy, President of the Jana Palana Party, a division bench comprising justices G Rohini and T Sunil Chowdary, issued notices and posted the matter for further hearing. Alleging that the RIL has been hoarding the natural gas produced out of the KG basin, the petitioner sought the court to order CBI probe into the whole issue and also requested the court to direct the government to take appropriate steps to see that Andhra Pradesh gets gas allocation as the oil and gas field are located near the state. Due to short supply of gas to AP-based power plants, the state government is forced to purchase the electricity at the cost of the public exchequer resulting in exorbitant power bills to consumers. Earlier, a bench comprising Chief Justice Kalyan Jyoti Sengupta and Justice PV Sanjay Kumar recused itself from hearing the case and referred the matter to the registry to post it before another bench as Justice Sanjay Kumar was not inclined to hear the case. ■

Source: www.financialexpress.com

INDIA AND SUDAN AGREE TO PROMOTE COOPERATION IN RENEWABLE ENERGY

India has offered to provide assistance for developing renewable energy resources in Sudan. The talks between the two countries focussed on the areas of possible cooperation especially in the development of wind energy, solar energy, biomass, and small hydro resources. It was also agreed that the Ministry of New and Renewable Energy would provide support for resource assessment and training in the areas of wind and solar energy through its technical institutions, viz., Centre for Wind Energy Technology, Chennai and the National Institute of Solar Energy, Gurgaon.

Indian Renewable Energy Development Agency (IREDA), and the Indian Green Energy Financial Institution would provide knowledge and technical appraisal assistance in developing renewable energy projects on commercial basis. A team comprising officials from the Ministry of New and Renewable Energy, IREDA, CWET, and NISE would soon visit Sudan to discuss a framework for further cooperation between the two countries. ■

Source: www.business-standard.com

INDIA TO HAVE HIGHEST GROWTH IN ENERGY DEMAND

The growth in energy demand in India would be the highest among all countries by 2030–35, beating even China, says the 2014 Energy Outlook Report issued by British oil giant, BP. According to the report, India's energy production would rise by 112 per cent, while consumption would grow by 132 per cent. Oil imports would rise by 169 per cent and account for over 60 per cent of the net increase in imports, followed by increasing imports of gas (+573 per cent) and coal (+85 per cent). Demand for all fossil fuels would expand, led by gas (+183 per cent), oil (+121 per cent), and coal (+108 per cent), while renewables in power would expand by 539 per cent as would nuclear (+366 per cent) and hydro (+127 per cent). India's share of global demand would zoom to 7 per cent in 2035, accounting for the second largest share of the BRIC countries, compared to China (27 per cent), Russia (5 per cent), and Brazil (3 per cent). The country's demand growth of 132 per cent would outpace each of the BRIC countries as Russia (+20 per cent), China (+71 per cent), and Brazil (+71 per cent) would expand slower. India's growth is almost double the non-OECD aggregate of 69 per cent. India's energy production as a share of consumption would drop from 61 per cent today to just 56 per cent by 2035 as imports would rise by 163 per cent. ■

Source: www.business-standard.com

INDIA LAUNCHES US$163 MILLION PV WATER PUMP PROGRAMME

India's Ministry of New and Renewable Energy (MNRE) will be installing 17,500 solar photovoltaic water pumps across the country. Each pump will use multi or mono crystalline modules to power 1,800 W or 5,000 W peak power arrays for each solar pump. SunEdison launched a PV water pump for the Indian market at the end of 2013.

The states to receive the solar powered pumps include Rajasthan, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Maharashtra, Chhattisgarh, Madhya Pradesh, and Bihar. States have to pay 15 per cent of the project cost and submit a monthly progress report. The Ministry will provide 30 per cent of the project cost as a subsidy. Responsibility for managing the project will lie with each state's renewable energy development agency — there is an open tender for each agency to apply, however, all pumps have to meet an MNRE standard. Training is also to be provided by MNRE selected manufacturers.

SunEdison recently announced that it is teaming up with the Global Academy of Technology (GAT) based in Bengaluru to create a research and development facility at the college's Bengaluru campus. SunEdison will collaborate with GAT to improve the technology used for solar water pumps, as well as energy storage solutions, hybrid energy systems, and PV power plant monitoring, and mounting structures. ■

Source: www.pv-tech.org

INDIA RECONSIDERS WIND FORECASTING ON INACCURATE RESULTS

An Indian rule requiring wind farms to predict output or face fines has been temporarily suspended as the regulator reconsiders the best way to ensure stability of the grid, which suffered the world's biggest outage in 2012. The Central Electricity Regulatory Commission said it would penalize wind farms that failed to predict their day-ahead generation within a 30 per cent band. Developers, including Tata Power (TPWR) Co. and Goldman Sachs Group Inc.'s ReNew Wind Power Pvt., protested the directive saying it was impossible to comply with and that fines would wipe out profits in an industry that has been drawing about $10 billion of investments since 2011.

Based on the feedback from the industry, the Central Electricity Regulatory Commision decided that the mechanism needed review and suspended the commercial portion, the commission said in an e-mailed response to questions. Wind farms still have to submit estimates, it said. Forecasting of wind generation, an intermittent energy source, is carried out to help stabilize the grid in some parts of the US and Europe, where surging wind output has driven wholesale electricity prices below zero and forced utilities to pay consumers to take power as supply exceeded demand. In India, scheduling would allow wind power to be sold across states and help authorities prepare network upgrades to accept more clean energy in the future. The industry is asking for the rules to be modified so that a centralized, state-level load dispatcher can compile more accurate, region-wide predictions, which is how scheduling is done in Europe. ■

Source: www.bloomberg.com

SOLAR TARIFF REACHES NEW LOW

India has recently allocated 750 MW of solar power under the first batch of its National Solar Mission's second phase. The allocations were done through a reverse bidding mechanism, with projects seeking the minimum government funding getting shortlisted. With 2.1 GW being installed within three years, this allocation signals steady progress made by India in achieving its clean energy targets.

Indian government body will purchase solar power for 25 years from 47 projects developed by private players, at a tariff of USD 0.09/kWh, one of the lowest in the world. To make these projects viable at these tariffs, Indian government will provide Viability Gap Funding (VGF) of a total of USD 200m, with an average of USD 267,000 per MW, thereby setting a new record for policy support to solar energy. To promote local manufacturing, half of the projects are reserved for mandatory use of domestic content, whereas the remaining 375 are open to use international supplies as well. With separate biddings for the two categories, projects with domestic content have sought a total of USD 137m as VGF, whereas projects under the 'Open' category have sought half of the total amount. EDF, the French utility major, has backed Indian project developer Acme Power, which has emerged as one of the biggest winners of the bidding process. ■

Source: www.openpr.com

MOBILE TOWER RADIATION CLIPS SPARROWS' WINGS

An environmental science expert team — led by Sainudeen Pattazhy — attributes the disappearance of sparrows to the electromagnetic fields and radiation effects created by mobile towers and mobile phones.

Navigation skills of the birds and earth's magnetic system are correlated. Natural electromagnetic radiation (EMR) and the earth-oriented magnetic vibration are directly proportional, whereas technology-induced EMR is inversely proportional. All mobile phone towers emit microwave radiation, which is radio frequency radiation (RFR), part of the spectrum of electromagnetic waves. Long-term exposure to low level RFR has damaging effects on the nervous system and immune system of small animals. Studies indicate that short-term exposure of pulsed mobile phone radiation with carrier frequency 900 MHz reduce the reproductive capacity of insects by 60 per cent. Sainudeen Pattazhy suggests regulation of mobile towers in thickly populated areas and restricting them to remote areas. If a tower is installed at a place, another tower should not be permitted within a radius of one kilometre, he says. According to a survey in 2010, the number of house sparrows (*Passer domesticus*) declined in coastal areas, including Kerala, by 80 per cent and by 2003 the sparrows had almost disappeared from the capital city. Various other reasons are cited for the disappearance of house sparrows such as introduction of unleaded petrol — combustion of which produces compounds such as methyl nitrite, which is highly toxic for insects that form a major part of young sparrow's diet, widespread use of garden pesticides, vanishing open grasslands, rising air temperature, and modern bird-unfriendly architecture. ■

Source: www.timesofindia.indiatimes.com

AROUND 80 PER CENT OF EUROPEANS WANT A LOW CARBON ECONOMY

A survey conducted in Europe showed that nine in ten Europeans consider climate change a serious problem. A large majority — 69 per cent — believe it is a 'very serious' problem and 21 per cent consider it to be a 'fairly serious' problem. Only 9 per cent do not consider it as a serious problem. Around 80 per cent of respondents agreed that fighting climate change and using energy more efficiently can boost the economy and jobs, with 31 per cent agreeing totally and 49 per cent tending to agree. People were most likely to agree totally in Spain (52%), Sweden (50%), Malta (44%), Ireland, and Cyprus (43%), and Greece (42%). The lowest share of respondents either agreeing totally or tending to agree was 65 per cent in Estonia.

The survey also found that seven in ten citizens agree that reducing fossil fuel imports from outside the EU could bring economic benefits and 90 per cent of the respondents said it was important for Governments to commit to national 2030 targets for the expansion of renewable energy. European Commission President José Manuel Barroso said, "There is no choice to make between good economics and climate protection; cost-effective climate action is indeed good economics. I am very encouraged that European citizens recognize that too. "This poll sends a strong signal to EU leaders to take bold climate action for a sustainable economic recovery. It is an encouragement also for us in the Commission to continue fighting for ambitious

climate action in Europe." Connie Hedegaard, European Commissioner for Climate Action, added, "The citizens understand that climate change did not go away while their governments were busy handling the economic crisis. I hope that EU leaders will listen and act accordingly at the European Council when they will discuss our 2030 climate and energy proposals. ■

Source: www.enn.com

CHINA TO BEAT 2020 NUCLEAR TARGETS

China is set to beat its 2020 targets for nuclear power after getting back on track with projects that were halted after Japan's Fukushima disaster.

Beijing is undertaking the world's biggest expansion of civilian nuclear power as the government aims to increase its use of cleaner energy. At the same time, China is seeking to expand its power grid by as much as 80 per cent over this decade. The expansion plans were suspended in 2011 following the earthquake and nuclear disaster at Fukushima, Japan, but are now back on track as construction on new plants is expected to resume with approvals granted in the coming months. "Nuclear plants will play an important role in reaching the government's 2020 goal of raising the proportion of energy produced by non-fossil fuel to 15 per cent," said Sun Qin, chairman of China National Nuclear Corp (CNNC).

China will surpass its goal of having 58 gigawatts (GW) of installed nuclear power capacity by the end of the decade, said Sun, adding that the country may build 20 or more nuclear reactors in the next six years. In 2013, non-fossil fuel accounted for nearly 10 per cent of China's primary energy consumption.

CNNC, which has listed its uranium resources arm CNNC International Ltd (2302.HK) in Hong Kong, is also preparing to raise as much as $3 billion for its expansion plans through an initial public offer in Shanghai, as other media has reported. ■

Source: www.reuters.com

CALIFORNIA TO SLASH GASOLINE CONSUMPTION BY 9 PER CENT BY 2020

By the end of the decade, California may cut gasoline consumption by 9 per cent due to state policies and rapidly improving fuel efficiency. As Californians switch over to more efficient vehicles, they will be able to slash their gasoline consumption to 11.2 billion gallons in 2020.

California has been a pioneer in clean energy and energy efficiency policies, and several state laws will push California drivers towards using less gasoline. Back in the 1990s, California required the production of zero-emission vehicles, and the state has offered tax credits for hybrid electric and fully electric vehicles, allowing it to be the number one state for sales of those types of cars. More recently, California's cap-and-trade programme has taken effect, which requires large stationary sources of greenhouse gases to cut their emissions. Next year, the program will target the transportation sector, forcing fuel distributors to also cut their carbon pollution.

A greater penetration of alternative fuel infrastructure such as electric charging stations, as well as falling costs for hybrids and electric vehicles will allow drivers to further cut their fuel consumption. Greater efficiency and altered driving patterns have already led to a drop of three billion gallons per year of gasoline consumption since 2002. A drop

in net fossil fuel demand may put pressure on California Oil Refiners' margins in the coming seven years. For this reason, it is clear why companies such as these vociferously opposed several of California's green policies in the past. ■

Source: www. oilprice.com

ONGC'S MOZAMBIQUE GAS FIELD HOLDS LARGER RESERVES AT 45–70 TCF

ONGC's giant gas field in Mozambique holds 45 to 70 trillion cubic feet (tcf) of recoverable reserves, 28 per cent more than the minimum estimated resources when it invested $4.12 billion.

ONGC Videsh Ltd, the overseas arm of state-owned Oil and Natural Gas Corp (ONGC), bought a 16 per cent stake in the offshore Rovuma Area 1 over the past one year. Oil India Ltd has a 4 per cent stake and a unit of BPCL owns 10 per cent in the block. "Appraisal and exploration activities carried out in the block increased the estimated recoverable natural gas resources to a range of 45 to 70 plus tcf, up from the previous range of 35 to 65 tcf," block operator Anadarko Petroleum Corp, said in its 2014 capital programme and guidance statement. OVL teamed up with Oil India last year to buy Videocon's 10 per cent in Rovuma Area 1 for USD 2.475 billion. It later bought another 10 per cent stake in the field on its own from Anadarko for USD 2.64 billion. The 10 per cent stake that belonged to Videocon was split in a 60:40 ratio and the total payout for OVL for the back-to-back acquisitions was USD 4.125 billion. An estimated USD 18.4 billion will be required to bring the first set of discoveries to production and convert the gas into liquid (liquefied natural gas or LNG) for ease of shipping to consuming nations such as India. ■

Source: www.financialexpress.com

PCRET TO ILLUMINATE VILLAGES WITH SOLAR ENERGY

Pakistan Council of Renewable Energy technologies (PCRET) has initiated a project under which different villages throughout the country will be electrified though promotion of clean and renewable solar energy through Photovoltaic process. The basic objective of this project is upgradation of silicon crystal growing and wafering, cell fabrication, and lamination facilities.

Pakistan is blessed with abundance of renewable energy potential, including solar potential of more than 5–6 kWH/m^2/day of irradiation in many areas. The potential is feasible for both Solar PV and Solar Thermal application, while the area with highest solar potential is Balochistan, followed by Eastern Sindh, and Southern Punjab, promising technically and financially viable solar energy projects. Photovoltaic (PV) is a clean and environment friendly technology that converts the sun's energy directly into electric power.

During last five years, the PV sector has seen a growth rate of about 50 per cent per year, he said, adding there is now awakening realization in Pakistan about the importance of the use of PV, for providing electric power to the people living in far flung areas to improve their socio-economic conditions.

PCRET has taken a start on some serious programmes regarding the development and use of renewable energy technologies including solar energy, windmills, biogas, and thermal solar devices. New energy policy of the government also envisages the harnessing of this new and clean source of energy to support conventional methods. ■

Source: http://pakobserver.net

EU PARLIAMENT EXCLUDES SHALE GAS FROM TOUGHER ENVIRONMENTAL CODE

EU politicians voted for tougher rules on exposing the environmental impact of oil and conventional gas exploration, while excluding shale gas. Member states such as Britain and Poland are pushing hard for the development of shale gas, seen as one way to lessen dependence on Russian gas as well as to lower energy costs as it has in the United States.

Under the planned law, assessments of a range of infrastructure projects, as well as oil and gas, will include their impact on biodiversity and climate change plus measures to ensure authorities granting approval have no conflict of interest. Industry said that the new law avoided placing too many restrictions on projects during their early phases when commercial viability is unclear.

"While not imposing unnecessary requirements on the upstream oil and gas industry, the new rules will guarantee that any development, including exploration for shale gas, will be subject to strict environmental standards," Roland Festor, Director for EU affairs at the International Association of Oil and Gas Producers, said. "Shale gas could potentially play an important role in meeting Europe's acute energy challenges," Marcus Pepperell, spokesman for Shale Gas Europe, said. Green politicians, however, said the decision to leave out shale gas was a major setback and that the fracking process, which involves using chemicals to extract gas from the shale rock, posed risks to health and the environment. "The Greens believe there is already sufficient evidence to ban fracking but ensuring informed permit decisions through the environmental impact assessment procedure must be the absolute minimum," Sandrine Belier, environment spokeswoman for the European Greens, said. ■

Source: www.reuters.com

US HOUSE PANEL INVESTIGATES EPA'S POWER PLANT RULE SETTING

Republican lawmakers launched an investigation of the US Environmental Protection Agency's decision-making process leading up to establishing emissions standards for new power plants. Leaders of the House of Representatives Energy and Commerce Committee have written to EPA Administrator Gina McCarthy requesting documents they will use to determine whether the agency complied with the law when it developed its proposals for new power plants, announced in September 2013. The congressmen questioned whether the EPA was correct to assert that technology used to capture and store carbon emissions from power plants was already viable on a commercial scale.

Under part of the Clean Air Act known as Section 111(b), which forms the basis of the proposed rule, the EPA must set pollution standards using the "best system of emission reduction" that uses "adequately demonstrated" technology. Opponents of the EPA regulations, such as lawmakers from large coal-producing states, have zeroed in on this argument and are likely to use it to challenge the agency in court once the final rules are handed down. The EPA official in charge of writing the rule, known as the New Source Performance Standard for new power plants, defended the commercial potential of the technology in an appearance before the House Science Committee. Janet McCabe, EPA's acting Assistant Administrator for air and radiation, said regulations under the Clean Air Act have had a history of accelerating newer technologies. "We are seeing it in the marketplace. This is the way technology develops," McCabe said. It starts with a few projects and then it grows. The EPA has extended the public comment period for its rules on new power plants by 60 days, to May 9, 2014 due to intense interest in the guidelines. ■

Source: www.reuters.com

OWA ADDS TO BEST PRACTICES FOR HYDROELECTRIC POWER DEVELOPERS

The Ontario Waterpower Association (OWA) has released two new best management practices (BMPs) for hydroelectric power development in conjunction with Canada Water Week.

The first was developed in partnership with conservation group Ducks Unlimited, Canada and focuses on minimizing the impact of hydropower projects on wetland form and function during construction. The BMP also works to identify opportunities for wetland creation and enhancement. "Working with industry partners is an important means of protecting and increasing the number of wetland acres in Ontario," said Mark Gloutney, Director of Regional Operations, Eastern Region for Ducks Unlimited Canada. "It is encouraging to see that the importance of wetlands is being kept firmly in mind."

The second BMP addresses key considerations with regard to migratory birds and was created with guidance from the Canadian Wildlife Service. The guideline aims to protect and conserve migratory bird populations and their habitats during construction activities, and to identify opportunities for habitat enhancement.

"I am extremely pleased with the products of this positive partnership," OWA President Paul Norris said. "These new BMPs are another example of our organization's commitment to continued improvement."

Both the BMPs are supported by the Ministry of Natural Resources and authored by Natural Resource Solutions Inc., OWA said. The practices will be added to its "Best Management Practices Guide for the Mitigation of Impacts of Waterpower Facility Construction, which was released in 2012. ■

Source: www. renewableenergyworld.com

THE DARK POWERS

The Role of Politics and Money in Climate Change

Climate change is a highly contentious subject.It raises the hackles of the naysayers and has vested interests reaching for their chequebooks and the phone to call their lobbyists. It is also a topic that has the man in the street bewildered. **Guy Noronha** reports.

Have you ever had the experience of being stuck in a traffic jam and a train or a plane to catch? There is that same sinking feeling of helplessness and frustration, at being unable to do anything, arises when seeing the seeming immobility or inaction when tackling the climate change crisis.

The drive to mitigate global warming is stuck in a traffic jam too. The frustration and powerlessness in this case cannot be resolved by a traffic policeman or an accident tow-truck. The causes of climate change are multifaceted but mainly due to energy driven carbon emissions.

Narrow nationalistic self-interest hampers any policy consensus. The claims and counter-claims on effective mechanisms to deal with issues are tied in with the global economic slowdown. Then there are numerous (sometimes exotic) technologies to limit greenhouse gases, which are very often works-in-progress. Add to these the mutual finger-pointing by the developing and poorer economies towards the developed nations and you have just a few of the factors blocking the road to resolving the rapidly looming disaster.

The Current Climate Is Hotting Up

It is now incontrovertible scientific fact that the earth is warming up – fast! You don't need any great science to tell you that. Our own every day observations and memories over the last few years do that. Our skins tell us that the weather is growing hotter every year and for longer periods. Every day the images on television show storms, hurricanes, droughts and rainfall are more protracted and severe than the last year. Every weather occurrence is regularly of disaster proportions.

Some would argue that the climate is changing all the time and that human contribution is no greater than the sun's behaviour or volcanic action. True, the climate has been changing. However, it has been over hundreds of thousands of years. We, humans, have unnaturally accelerated that process.

US National Oceanic and Atmospheric Administration (NOAA) research data shows that over the last three glacial cycles going back to some 400,000 years or so the highest that carbon dioxide (CO_2) concentrations ever reached were well below 300 parts per million. In the last 60 years alone that CO_2 concentration has shot up to 400 parts per million and continues to climb.

Such a drastic rise is directly caused by human activities such as fossil fuels combustion. The United States Environmental and Protection Agency admits that the "use of energy (most of which comes from fossil fuels) also contributes to climate change, accounting for more than 80% of US greenhouse gas emissions." Those emissions rose by a further 2% in 2013, according to the US Energy Information Administration. That impact is massive given that the US is still the largest producer of carbon dioxide.

Data from NASA's Goddard Institute for Space Studies (GISS), the Japanese Meteorological Agency and the Met Office Hadley Centre / Climatic Research Unit in the UK all show unusually high global surface temperature trends over the last 40 years. These rising temperature trends are really steep when compared to the last 120 to 130 years. Records analysed by NASA, the University of East Anglia and the National Climatic Data Center (NCDC) all agree that the years between 2000 and 2009 has been the hottest since modern records began more than a century ago. Temperatures in 2010 have been running slightly warmer still.

The UN's Intergovernmental Panel on Climate Change report (2013) states that overall the average land and ocean surfaces, temperatures warmed roughly 1.53 °F (0.85 ºC) from 1880 to 2012. The IPCC report adds that in the Northern Hemisphere, where most of Earth's land mass is located, the three decades from 1983 to 2012 were likely the warmest 30-year period of the last 1400 years! What is even scarier is that the greatest rates of temperature increase are in the higher latitudes around the Arctic region.

There is almost universal agreement that climate change is one of the greatest threats to the planet and all creatures on it. Coincidentally the latest IPCC report just released in Yokohama highlights that very scary scenario for the near future.

So what is causing the rise in global temperatures? Carbon emissions from fossil fuels are the biggest villains, of course!

Rising Energy Demand

It is amazing how viciously tight the climate change cycle is! The more carbon dioxide released into the atmosphere the more the atmosphere and oceans heat up. That has disrupted the "normal" cycle of seasons and

> "Unfortunately the global warming hysteria, as I see it, is driven by politics more than by science."
>
> **Freeman Dyson**
> **Theoretical Physicist and Mathematician**

weather patterns. Summers have become hotter and longer; winters colder and more intense. So we consume more energy to either heat or cool our homes and offices.

In November 2013, the UK Environment Agency's Sustainable Business Report stated that the previous cold winter contributed to a "19% increase in sulphur emissions as power companies burned more coal to keep up with increased demand..." That was a similar situation for other parts of Europe.

The US Energy Information Administration reported that emissions by the energy sector rose in by 2% in 2013 because of a rise in coal consumption. The same report also highlighted another finding that together American cars and factories released 5.38 billion tonnes of carbon dioxide in 2013.

Two other great contributors to the viciously spinning wheel of carbon emission related global warming are China and India.

Thus it goes. In order to stay cool or warm and supply the needs of our growing population we consume more and more fossil fuels. That leads to ever worsening climate related problems. The danger now is not just to the existence of flora and fauna, the threat has now spread to human social and political systems.

There Is Big Money in Fighting Climate Change

One of the most threatening reasons why climate change mitigating solutions and reduction in carbon emissions are often stuck and blocked is the power of money. There are vast fortunes and profits to be lost if climate change mitigation and carbon emission regulations are put in place and enforced. This section of the article has many references to the US but the fight by anti-climate change organisations and the methods they use there, are universal and replicated around the world to a lesser or greater extent. Arguably the climate change battle in the US Congress and public domain could have a huge impact on the outcome of similar battles across the world.

There are many industries ranging from the automobile to the energy to fossil fuel extraction and mining that feel threatened by any move to reduce carbon emissions or even regulate their production. They have been more than willing to put hundreds of millions of dollars into numerous seemingly high-browed, principled institutions or have funded many of them to protect their interests.

Their intention is to change thinking, refute and discredit climate science to win the hearts and minds of legislators, government institutions and the public.They use money and the lobbying route to influence politicians, media, scientists, and the government to drive policies and actions to their benefit.

Their financial muscle helped to derail President Barak Obama's environmental mission and stop Congressional action too. They also have many tame media channels to propagate and broadcast their denial arguments.

> The conversation on global warming has been stalled because a shrinking group of denialists fly into a rage when it's mentioned.
>
> **Al Gore**

Halldór Thorgeirsson, Director of the Implementation Strategy Unit (ISU) of the United Nations Framework Convention on Climate Change, warned that vested interests are paying for the discrediting of scientists all the time.We need to be ready for that He is not the only one making that warning.

Dr Robert J Bruelle, PhD, Professor of Sociology and Environmental Science at Drexel University had this to say on publishing his study on anti-climate change funding (Institutionalizing delay: foundation funding and the creation of US climate change Counter-movement organizations)."The climate

change countermovement has had a real political and ecological impact on the failure of the world to act on the issue of global warming.

Dr Bruelle has carried out one of the most comprehensive investigations on how and where the money funding anti-climate change is coming from and going. His paper, while absolutely fascinating and an eye-opener, is apparently not enough. He also says, "Thus, despite the importance of the organized effort to deny climate change and the need to deal with it, there has yet to be a comprehensive analysis of the funding flows that maintain this campaign."

The brief listing below is only the tip of the proverbial iceberg but will hopefully provide an insight into the organizations and people who are trying to undermine the work of alleviating the issues of climate change.

- The Global Climate Coalition, had such heavy-weights as the Ford Motor Company, Diamler-Chrysler, Texaco, British Petroleum, Exxon, the Southern Company and General Motors funding them. Discredited for their lies and unscientific campaigns GCI shut down in 2002. Not before they did some damage. They managed to influence the US Senate and Administration into not ratifying the Kyoto Protocol or accept cuts in carbon emissions.
- Dr Bruelle found that 'dark money' to the tune of $118 million was distributed to various anti-climate lobbyists, think tanks, and action groups to deny the human factor in climate change and oppose any environmental regulations or action.
- His study also showed that funding for many groups came from about 20 cash-rich donors such as Mellon heir, Richard Scaife ($39.6 million).
- The Lynde and Harry Bradley Foundation dispenses more than $30 million a year. Since the 1980s, they have concentrated on funding organizations that oppose environmental actions including those that block the registration of endangered species.
- The Brothers Koch have major investments in products such as asphalt, chemicals, energy, fertilizers, minerals, natural gas, plastics and petroleum. So it is not surprising that most of the $50 million they spent in lobbying Washington have gone towards opposing regulations on limiting greenhouse gases ($26 million). Greenpeace says that they play a major role in influencing climate change policy in the US.
- Donors Trust spent almost $79 million funding climate change denial groups and think tanks. Their USP is offering anonymity to wealthy donors who do not want to make their donations publicly. About 70% of their funding sources are not even known.
- In the UK, secretive funding of roughly $120 million went to 100 groups to oppose and discredit climate change science and change public opinion.
- In 2007 many reports (including The Guardian) revealed that the American Enterprise Institute for Public Policy Research (AEI) offered $10,000 and travel expenses to scientists to bash the IPCC Fourth Assessment Report. The offers were termed as outright bribery.
- The Union of Concerned Scientists accused petroleum giant Exxon

of "funnelling about $16 million between 1998 and 2005" to such organisations. In 2006 Exxon declared that they had discontinued their funding to these groups. Greenpeace however disputes this.

Some of the sources for anti-climate change funding are public and well-known. However, there is an increasing trend to hide such contributions – especially from the bigger companies.

The Deniers

The greatest stumbling block to any concerted and meaningful action on climate change mitigation are deniers, otherwise known as 'climate sceptics,' 'contrarians' and members of the 'countermovement.'

Climate change sceptics come in two shades. The first are those who say and believe that there is no conclusive evidence that global warming is even happening. Then there are those who hold that while global warming is real and happening, humans are not the cause. That flies in the face of the assertions of 97% of the world's scientists.

Denialists cite convenient short-term weather forecasts and extrapolate them to long-term climate movements. They then throw in some quotes from malleable scientists or 'experts' not qualified or conversant with climate studies and mix in some dodgy statistics. Winston Churchill once eloquently said, 'it's an unfortunate fact of life that a lie will go halfway around the world before the truth has got its pants on.' That pithy observation aptly describes the tactics of the sceptics.

An example of the climate change deniers' tactics was the issue of the IPCC's Fourth Assessment Report (2014). There were allegations that IPCC findings were altered to justify a political agenda and falsely claim that global warming is a real and present threat. Minor errors were picked up and blown so out of proportion that it almost discredited the scientifically credible and peer reviewed report. That whole incident is now known as "Climategate".

Their lies shot around the world before the IPCC even reached out for their collective pants. In time contrarian criticisms were refuted but doubts still linger in many peoples'

minds whenever another report or finding on climate change is published.

One popular counter argument to human-induced climate change is that 'climate change is a natural process' and that it has a '1,500 year cycle.' The argument that global temperature rise is the result of other natural causes (such as volcanoes) and not greenhouse gases emitted by human activity.

Let's examine the volcano theory. Collectively, volcanoes around the world spectacularly spew out 0.2 billion tonnes of CO_2 per year. However volcanoes produce less than 1% of human fossil fuel carbon emissions.

Yes, the climate does change and has been doing so over the course of the Earth's existence. The fact is that the climate is subject to and influenced by whatever forces are in play. The dominant force and influencer over the last 100 years has been mankind's energy requirements. The human factor is of course vigorously denied.

Another major criticism against climate change proponents including the IPCC, are that they are alarmist. In fact, it would be more accurate to state that the reverse is true. The IPCC has been accused of underestimating the pace of climate change and their models may actually be conservative in the predictions they produce. Attack the science of climate change is a common gambit. This is despite vast data collected by thousands of scientists over 20 years. Unable to refute the facts, deniers complain that records are incomplete, data insufficient, that the time lines on which studies and analysis' are made are too short and climate change models have not been tested rigorously enough. They argue that the data on the upward trend in global temperatures is historically too brief and the data isn't clear enough.

Another track that the climate change doubters (and there are a few scientists among them) take is accusing IPCC and climate scientists of crying 'wolf.' They argue that climate change proponents go out and look for evidence and analyse the statistics and data to prove the 'wolf's' existence, rather than examine it objectively.

The climate change deniers clear strategy is to deny, fight and delay any consensus or action to clean up or reduce carbon emissions. This was probably what Prince Charles, that dogged and outspoken champion of environmental causes, realised. He came out strongly against the deniers when he said last year, "A scientific hypothesis is tested to absolute destruction, but medicine can't wait. If a doctor sees a child with a fever, he can't wait for (endless) tests. He has to act on what is there." The success of the climate change denial machine can be gauged by a survey of US nationals in October 2013, carried out by the Pew Research Center. Their poll

showed that only 44% say there is solid evidence of human activity causing global warming. In a November 2013 survey, the Yale School of Forestry and Environmental Studies, found that 23% of Americans don't believe there is evidence of global warming or that it's real. It would appear that the ranks of the doubters are rising – in the US at least.

While it may seem that fewer Americans feel threatened by global climate change than the rest of the world (54%) their numbers matter. After all the US is one of the largest producers of greenhouse gases in the world, which is driven by the largest economy. They have the economic muscle and the political weight to swing the climate change war one way or the other. The relative public indifference in the US is obviously reflected in the political establishment and corridors of power.

There is however, one positive aspect to the subversive influence and voices of the sceptics. Their opposition ensures the climate change advocates and scientists are held to account. They act as eagle-eyed overseers who guarantee that the science and people (including researchers and scientists) combating climate change carry out rigorous testing, meticulous analysis and use robust methodologies based on good science. Or else…!

> "Ten people who speak make more noise than ten thousand who are silent."
>
> **Napoleon Bonaparte**

Napoleon's remark succinctly encapsulates the problem. To put it differently - there are none so blind, who refuse to see. Their selective blindness and tunnel vision makes them dangerous to the rest of the world. It is rather like a blind man crossing a highway. He is bound to cause a pile-up.

The doubters are like Napoleon's ten – they make a big noise and have well-funded megaphones (read politicians) to make themselves heard.

Not Acting Could Cost More

Dr Peter Tsigaris, an economist at Thompson Rivers University, says that taking steps to curb global warming makes sense from both an environmental and an economic standpoint. He estimates that addressing global warming by changing our dependency on fossil fuels and other behaviour would cost an estimated one percent of global Gross Domestic Product (GDP) per year, while taking no action could cost 5 percent of global GDP each year. Extreme climate change could result in a cost of 20 percent GDP or greater.

The Politics Of Climate Change

On the 10th of March 2014, Larry Reid, the Senate Majority leader in the US Congress said, "Despite overwhelming scientific evidence and overwhelming public opinion, climate change deniers still exist. They exist in this country and in this Congress."

Those comments came at the start of a marathon, all night session to "wake up" Congress to the threat of climate change. Commendable and a step in the right direction! It's something that should have been done a long time ago.

However, the whole initiative was rather futile and sterile from the start. Nothing came of it; no legislation or bills will be presented nor any commitment for action. This is unfortunate because legislation and government policies (and frameworks) can alter the balance in the production and consumption of fossil fuels. They will also provide incentives and make it attractive for the private sector to invest in carbon neutral technologies and move away from fossil fuel usage. The positive though (and it is a straw to be grasped) is that the US politicians are realising that the 'climes they are a-changin'.

The laudable attempt by Democrat politicians to launch the "opening salvo" only highlights the problems and hurdles that the climate change activists have to face. They have to battle think tanks and sophisticated and clever anti-climate deniers with deep coffers who work tirelessly to misinform (despite overwhelming scientific evidence) discredit and change policy and public opinion that would help to save our planet. Fend off well-heeled, selfish and strong opposition from carbon emitting industries.

> America's political system has evolved over the last 50 years in ways that has enhanced the power of business lobbies.
>
> **Al Gore**

Then there are the unscrupulous politicians and the staggering indifference and ignorance of the general public.

To illustrate this opposition, prior to the all night Congressional debate mentioned above, Republication leader Mitch McConnell of Kentucky said "For everybody who thinks it's warming, I can find somebody who thinks it isn't." He derives his votes and support from the workers of the coal industry in that state. Every attempt to introduce some kind of carbon emission reduction set of rules or arrive at a climate change consensus is thwarted by suspicions and opposition between the developed and developing nations. No agreement only leads to delays in dealing with the climate change and global warming threat. Even alarm cries of having reached (or crossed) the "tipping point" has had no effect on the people sitting in government councils around the world.

The well-funded and loud-voiced politicians are spokespersons who misrepresent and mislead the media and public into thinking that there is actually widespread doubt and divisions among scientists on the subject of global warming.

A good example is a documentary made by the Australian Broadcasting Company (ABC) on how lobby groups, funded by the coal, electricity, aluminium, petroleum, mineral and cement industries, influenced the Australian government into backing off from reducing greenhouse gas emissions. They also accused these special interest groups of silencing climate scientists within the Australian government!

The sceptics have not always had to subvert or convert people to their line of thinking. Take the case of the global warming sceptic, the late Professor Reid Bryson. What he taught, wrote and said had a strong impact because he did not need any funding for his views. He declared that, "All this argument is the temperature going up or not, it's absurd. Of course it's going up. It has gone up since the early 1800s, before the Industrial Revolution, because we're coming out of the Little Ice Age, not because we're putting more carbon dioxide into the air."

An opinion coming from a man such as Reid Bryson who was an atmospheric scientist, geologist and meteorologist carries a lot of weight. He was a professor emeritus of the University of Wisconsin–Madison. He was even made a Global Laureate by the United Nations Global Environment Program in 1990!

One of the most prominent and loudest anti-climate changes voices is that of US Senator Jim Inhofe. He is a member of the United States Senate Committee on Environment and Public Works. From 2003 to 2007 he was the Committee's chairman. He has raked in more than $700,000 from oil and coal companies. That made him the largest recipient of oil money in US politics - we know of.

He is a die-hard anti-global warming advocate and is a member the 'cooling earth' tribe. Very little of his numerous claims and "scientific facts" stand any kind of test but his stentorian voice is heeded in influential chambers and the corridors of power.

In January 2005 in his speech given at the opening senate session, his words eerily reflect that of the good Professor Bryson when he said: "We are in the midst of a natural warming trend that began about 1850, as we emerged from a 400 year cold spell known as the Little Ice Age." The damage this man has done to the global warming fight is incalculable.

There are many like the late Professor Bryson and the good Senator Inhofe around the world. They are in corporate boardrooms, college classrooms, government buildings, parliaments and on TV screens. The views and arguments by members of the climate change counter-movement (CCCM) are summarised in the points below:

- A change in the United States' policies in emissions and carbon production could result in a loss of jobs. A cry echoed by many countries.
- Renewable energy or so called 'clean energy' cannot meet the current or even future demands.

> The failure of world leaders to act on the critical issue of global warming is often blamed on economic considerations.
>
> **David Suzuki (Environmental Activist)**

- Lack of (and access to) advanced and cheap green technologies make developing countries extremely reluctant to give up cheaper fossil fuels. Thus making them opponents to any carbon curbing regulations.
- Governments use environmental scares as another excuse to raise taxes.
- India and China, both of which continue to rely heavily on coal for their main source of energy, will continue to cause environmental problems even if the United States changes its energy policies. So why give up the current fossil consuming practices?
- When developed countries such as the United States, Russia, Canada, Japan, and New Zealand have either not ratified the Kyoto Protocol or withdrawn from the Kyoto Protocol, why should we?
- Developing countries see their economic and industrial growth as their right. Submitting to carbon-neutral or reduction regimes will retard, if not harm, their progress.
- Both developed and developing countries see greenhouse gas restraints as a barrier to economic activity and in the case of developing nations retarding their attempts to alleviate poverty.
- Since scientific evidence is about probabilities rather than certainties, we can't be certain that human behaviour is contributing to global warming, that our contribution is significant, or that we can do anything to fix it.
- Technology will find a way to get us out of the global warming mess, so any change in our policies will ultimately be unnecessary and expensive.

Climate change is real, the science is settled, consequences clear, and the outlook gloomy. By 2035, globally, there will be a huge increase of 40 to 43% in carbon dioxide emissions because of energy usage in countries such as China, India and others. That spurt will have even worse repercussions. As the recent IPCC report highlights…

"Observed impacts of climate change have already affected agriculture, human health, ecosystems on land and in the oceans, water supplies, and some people's livelihoods. The striking feature of observed impacts is that they are occurring from the tropics to the poles, from small islands to large continents, and from the wealthiest countries to the poorest." (IPCC Press Release 31 March 2014) ■

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Innovative Instruments for Financing Renewable Energy

Sapan Thapar

Today, India is marching steadily towards the development and deployment of Renewable Energy (RE) technology based power generating systems to meet its ever-increasing energy demand as well as reducing its ecological footprint. Due to a conducive policy framework, the scale of addition of RE-based projects during the last few years has been unprecedented (witnessed a growth rate of over 20 per cent in the 11th Plan period) and matched the growth experienced in the conventional power sector. The sector enjoys over 13 per cent share of the total installed power capacity in India, with over 30,000 MW of green power currently under operation. Also, the generation cost of mature RE

technologies is reaching parity with newly set up fossil-fuel based power plants (which can be further lowered if the environmental externalities associated with fossil plants are not discounted).

In order to further augment and stimulate the harnessing of RE sources in the country, especially with a view to make them attractive for utilities and end-consumers (industrial, commercial, and domestic users), the Levellized Cost of Energy Generation (LCOE) needs to be reduced. This shall pave the way to reach 15 per cent renewable purchase obligations set under the National Action Plan on Climate Change by the year 2020.

Unlike conventional power plants, the RE technologies are associated with high upfront project cost, though the operational and maintenance expenses are at a bare minimal (no fuel required for wind, hydro, and solar projects). As such, cost of capital (both debt and equity) weigh heavily in the overall in the LCOE (in form of interest repayment and returns towards equity), constituting more than 2/3rd of the overall cost, i.e, interest repayment at 37 per cent and equity returns at 28 per cent. The high cost of capital needs to be scrutinized so as to design and develop new financial instruments with an intent to lower the cost of generation and make it attractive for the end-consumers to procure green power. Discussed below are some financial instruments/tools which may be utilized to lower the effective capital cost (both dent and equity) with an objective to reduce the LCOE.

Different types of businesses, stages of technology or project development, and degrees of risk associated with investments require different types of investors. Financing in renewable energy sector can be done in many ways — from venture capital (kind of angel investments) provided by an investment firm to a rapidly growing new company (Renewables are considered as new technologies), from a private equity typically involving institutional investors providing capital to a professionally run privately-held company, from a bank extending long-term loans to raising of bonds (debt) and equity from market, and finally sourcing funds from the international community (multilateral/ bilateral agencies).

Base Case

For a typical wind project costing Rs 6.00 crore and generating power at a CUF of 23 per cent, the LCOE would be Rs 5.64 after taking a debt (70 per cent of project cost) at an interest rate of 13 per cent with 20 per cent returns

on equity (contributing to 30 per cent of project cost) at a repayment period of 12 years with one year moratorium. Under these circumstances, the weighted cost of total capital employed would come a little more than 15 per cent. The other parameters determining LCOE are similar to those used in Central Electricity Regulatory Commission's (CERC) terms and conditions for tariff determination from renewable energy sources.

Mezzanine Finance

It is a form of quasi debt/equity instrument, wherein sector-specific investors or short-term investors park their funds assuring higher returns (typically 15 per cent more than the debt instruments). This facilitates availability of low cost equity to project promoters enabling reduction in LCOE and sparing the costly equity to be invested in other projects/ventures. The investment is secured by charging on assets after assigning first charge to the term-loan lenders. Mezzanine Finance is typically associated with debentures offered to the investor with an option to convert them to equity at a later stage.

Taking Mezzanine investments at 10 per cent of project cost (at 15 per cent interest rate), promoter contribution at 20 per cent, and debt at 70 per cent, the LCOE is expected to reduce by 2.6 per cent in comparison to the base case mentioned above. With respect to 15 per cent of project cost coming each from Mezzanine Finance and promoter contribution, the LCOE is expected to decrease by 3.9 per cent. The other values are similar to those taken by CERC in their calculation of RE tariff.

International Funds

In developing economies like India, which is experiencing high rates of GDP growth, funds are required for multiple and competing causes (such as housing, education, health care, highways, etc.). This increases the cost of debt funds and perhaps their availability. As such, infrastructure sectors like RE having high upfront cost, have to pass on these costs to the end-consumers of power generated (high LCOE). In developed economies (OECD Countries) the GDP growth is low, thus resulting in availability of low-cost funds. The Indian renewable energy sector has received significant support from the international community in the form of low-interest loans. Several international and bilateral financial institutions are engaged in renewable energy financing in India. The funds available are for long tenure and at low rates (indexed to LIBOR/EURIBOR + spread and other conversion charges). However, the debt is required to be hedged due to currency fluctuation, resulting in hike in effective rates. An international debt supporting 35 per cent of project cost (50 per cent of total debt) at an interest rate of 10 per cent, with 20 per cent of remaining debt from domestic commercial lenders (at an interest rate of 13 per cent) and promoter contribution at 30 per cent can reduce the LCOE by 3.5 per cent approximately.

Subordinate Debt

Though, the subordinate debt is charged at a higher rate (15 per cent) than senior debt, it provides an excellent way to reduce the share of equity investments in a project as its rate is lower than the expected rate of returns on equity. This kind of debt has been in vogue since a long-time and is easily available in the market. The sub-debt lender is provided second charge on assets. Taking sub-debt at 5 per cent of project cost, promoter contribution towards equity at 25 per cent, and senior debt at 70 per cent, the LCOE is expected to be reduced by 1.25 per cent approximately.

Revolving Funds

Cess/taxes need to be charged on fossil fuels on the model of polluter-pays-principle. These funds can be utilized to substitute high cost promoter equity in selected RE projects (rated by accredited agencies on certain parameters) for a certain period (say repayment of 50 per cent of debt is expected in five years). Utilizing these funds would prove beneficial because of their revolving nature, i.e., utilizing them for next round of projects after exiting from the first set of projects and making modest returns. Taking quasi-equity at reduced cost (12 per cent) towards 10 per cent of project cost (2/3rd of promoter contribution), the LCOE is expected to reduce by 4.2 per cent.

Market Equity

Renewable power generation capacity in India has been set up largely by private sector investments. In the last 2–3 years, the profile of investors has changed from balance-sheet-based financing to project-based financing (non-recourse mode), with a series of entrepreneurs setting up RE projects under Independent Power Producer (IPP) mode. These are professionally run companies with an aim to exit the ventures in medium term (5–7 years). These companies would invariably fall under the ambit of Small and Medium Enterprises (SME) sector and can list their companies in the SME bourse at the Bombay Stock Exchange for raising equity from the market to fund their future projects. With the sector blooming and attaining certain level of maturity, it is expected that the equity offered by renewable companies would get sufficient response from the investors, who may also feel their contribution towards the environment. The listing would further provide low cost equity funds to the sector as there is no assurance on the returns (though some upper limit may be specified). Taking equity at reduced cost of 15 per cent towards promoter contribution (say 15 per cent of project cost), the LCOE is expected to reduce by 3.94 per cent.

Green Mutual Funds

Thematic mutual funds were in vogue few years ago with funds earmarked for industry verticals (power, petroleum, highways, etc.). On a similar rationale, mutual funds can be floated to fund the renewable industry with returns capped (at say 15 per cent). The funding house can undertake a comprehensive due diligence of projects to be supported by their funds and can limit their participation to 50 per cent of envisaged promoter contribution (15 per cent of project cost), with a lock-in period of five years. Taking equity at reduced cost of 15 per cent towards 15 per cent of project cost, the LCOE is expected to reduce by 3.94 per cent.

Green Bonds

Infrastructure finance companies (IFC) are eligible to raise money through bonds in the market. These bonds are typically of a long-term period (10–15 years) and offer interest of around 8 per cent. There can be green bonds dedicated for financing the clean energy sector. Taking a spread (including risk premium) of 300 basis points, the IFC can provide debt finance to RE projects at less than 11 per cent for 12 year period. This could reduce the cost of LCOE by 4.3 per cent.

Lease Financing

As the renewable projects are invariably capital intensive and are associated with a working life of 15 years, the depreciation rates taken for computing returns are around 6–7 per cent per annum. With the business model moving away from balance sheet financing towards IPP mode, the new class of investors may not have the ability to utilize depreciation benefits which could have helped in obviating a part of their tax obligations. As such, lease-based model can be a workable solution, wherein cash rich companies (including equipment suppliers and EPC companies) can fund RE projects in form of silent investors and claim tax depreciation in their balance sheets. The project implementers and operators can pay lease rentals to the corporate/company in lieu of their funding support.

Pension and Insurance Funds

The existing retirement funds corpus is in range of Rs 12–15 trillion and India's life insurance segment collected

new business premiums worth Rs 11,742.7 crore for the period of April–May 2013. Pension and insurance funds are ideal for financing RE projects as they are available for a long-term period (typically 20 years) and at a moderate cost (9–11 per cent) as the fund managers intend to invest these funds in low-risk instrument or projects according to profile and requirement of investors. These funds can be utilized to substitute part of the overall debt (say 50 per cent of project cost) based upon due-diligence of projects. Now, if 50 per cent of the debt is available from pension or insurance funds at say 10 per cent, the LCOE is expected to decrease by 3.2 per cent. This shall further help in servicing the debt due to reduce repayment load.

DSM Funds for Rooftops

With respect to rooftop solar, local utilities/DISCOMs can utilize DSM funds to support deployment of rooftop modules. Domestic usage can be limited to certain percentage of total generation (say 50 per cent) and the remaining energy can be fed into the grid. In lieu of green energy procured by DISCOM, their DSM funds can be utilized for making repayments to the rooftop solar project integrators. To ensure seriousness on the part of household owners, a certain contribution (say 10 per cent) may be taken from them. This programme can be developed on similar lines of PACE (Property Assessed Clean Energy) programme financing as practised in the United States of America.

Sweat Equity

For projects being set up in rural areas, equity in the form of human capital and local resources can be considered as part of promoter contribution. The bank may consider this favourably while parting with its debt contribution. Project implementation, construction material, and community land would aggregate to around 15 per cent of the project cost. Remaining equity can be shared by the local community, or can be taken from funds meant for local area development. Taking 15 per cent of project cost by sweat equity (half of envisaged promoter contribution) could substantially reduce the LCOE of the project by 16 per cent.

Equity from Social Stock Exchange

The entities involved in providing clean energy services to the bottom of the pyramid (grassroot level) can raise funds under the proposed Social Stock Exchange, which is meant for attracting investments in social welfare projects in India. RE in decentralized format is considered a part of social welfare and would certainly qualify for such kind of initiatives. Further, income-tax payers can support the green movement of India by donating to social causes, including energy services to the poor. Under section 80G and 35(i)(ii) of the IT Act, donors are entitled to weighted deduction of one and one-fourth times of the donations paid by them. If properly communicated, a substantial contribution can come from four lakh tax payers earning more than

Rs 20 lakh per annum. It is expected that the sector can raise over Rs 400 crore even if 10 per cent of the citizens contribute Rs 1 Lakh each towards the sector and get in-turn benefited by way of tax savings.

CSR Funds

Under the Companies Bill 2013, all companies are expected to utilize at least two per cent of their average net profits made during the three immediately preceding financial years on Corporate Social Responsibly (CSR) activities. The list of eligible activities covers environmentally sustainability works. As per a study done on 84 of the listed 100 top companies in BSE, the total funds to be earmarked for CSR would accrue over Rs 6,300 crore. Allocating 10 per cent of these funds (on an annual basis) to implement captive RE projects would help in making them an attractive investment proposition by meeting their energy needs as well as green procurement norms (RPO). Assuming that half of the total promoter contribution is coming from CSR funds, the LCOE would substantially reduce by 16 per cent. Further, this would be a perpetual business as earnings would continue to get accrued till the 15 year life of project, which can be suitably redeployed to expand the RE-based power generating assets.

The Way Forward

The aforementioned financial instruments or ideas can help in suitable leveraging the debt and equity markets towards ensuring the availability of low-cost and long-tenure funds to the renewable energy sector, thus resulting in reduced power generation cost. This shall increase the acceptability of green power among the end-users as well as the power regulators. ■

The ideas expressed above are personal views of the author.

Sapan Thapar is a certified Energy Manager, has got more than a decade of work experience in the field of energy, including clean energy technologies.

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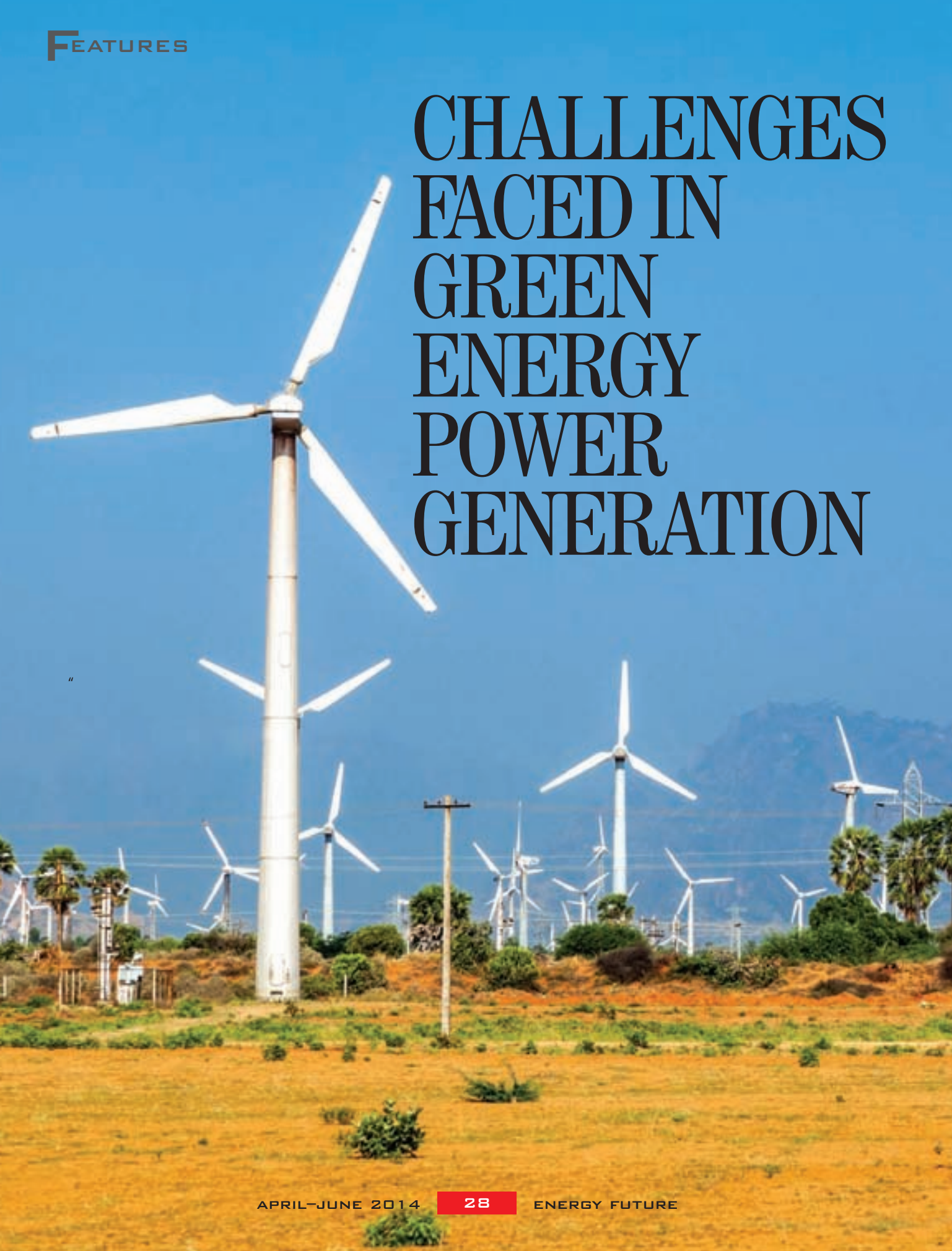
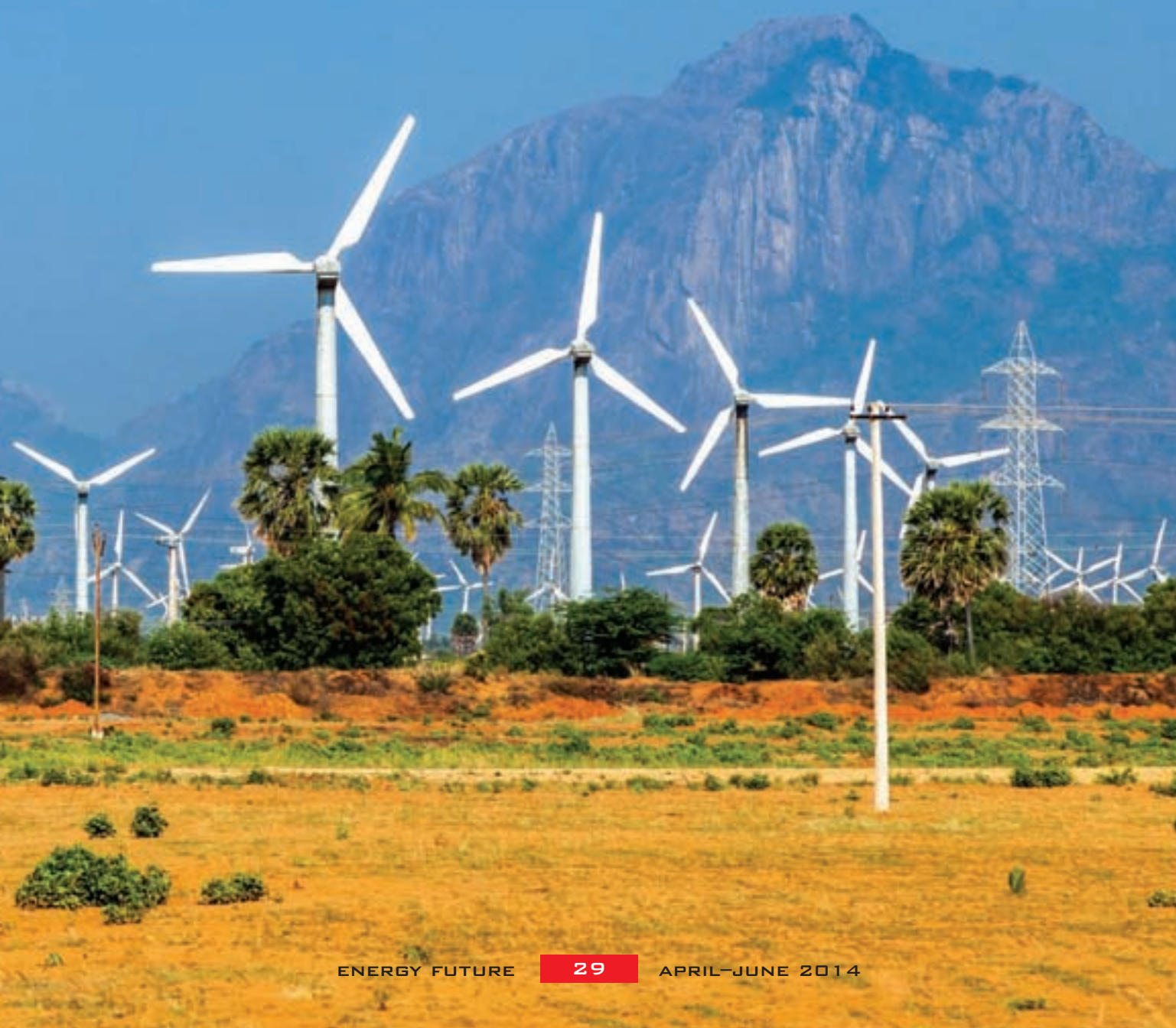
CHALLENGES FACED IN GREEN ENERGY POWER GENERATION



According to CO2Now.org, a non-governmental organization, which organizes the climate data inputs from noted global science and media sources, the atmospheric carbon dioxide emission levels have reached 393.66 parts per million (ppm) as on October 2013 from 310 ppm in 1958. The environmental researchers fear, reaching of 400 ppm mark will increase the global temperature by another 2 degrees and induce further decline in arctic ice formation. They suggest an increased use of renewable energy sources to save the earth from such catastrophe.

The renewable energy power generation debuted in 1990s and steadily grew in the decade that followed it. Globally, a whopping $260 billion was invested in green energy power generation in 2011. Supportive government policies, increase in the costs of conventional energy generation, and notable reduction in the renewable energy production expenses, were attributed as reasons for such massive investments. The renewable power has the capability to replace the conventional power use in the heating and cooling requirements, transport sector, and in meeting the electric power requirement at far off places that are not connected to the grid.

Jyothi Mahalingam



Present Scenario

The renewable energy power generation includes hydropower, solar (PV and concentrated solar power and solar water heating), wind power (onshore and offshore), geothermal power, biodiesel based power generation, fuel cells, and ocean power generation.

The hydropower generation leads the table of renewable power production. During the last few decades the large-scale hydropower projects were not favoured within the renewable energy segment. There is a change in the renewable energy outlook towards the hydropower generation. Nowadays the large-scale hydropower development projects are approached with a fresh promising vision. In the case of geothermal power generation, it is confined to countries where the geothermal energy is available. Efforts are going on to find more new geothermal locations. The renewable power generation using biodiesel is also restricted to locations where biodiesel producing crops are grown in abundance. The use of fuel cells, in near future, appears promising with emerging researches on the use of cost-effective catalysts. Deploying the ocean power to generate electricity is still in its infant stage and it makes minuscule contribution to renewable power. This leaves with the solar and wind as the next big contributors to global renewable energy generation following hydropower.

Challenges Faced by Solar and Wind Power Generation

- One of the major arguments placed against the solar and wind power generation is the large amount of land required for such installations. The commercial solar panels available offer around 13 per cent power generation efficiency and requires large parcel of land area for commercial level power generation.
- The diffused power generation characteristic of a solar or wind farm increases the investment on infrastructure required to collect the generated power and assemble it to a single location before connecting the total power to the grid.
- Unpredictable power generation is another challenge that plagues the growth of renewable power generation. In the case of solar, the power generation is possible only during the day time. An overcast sky condition will limit the solar power availability and cut down the power generation for the day. Similarly, a drop in the blowing wind power or no wind conditions will arrest the movement of turbine blades and the wind power generation will come to zero level.
- In order to offset the erratic power generation of solar and wind and to match it with the prerequisites of the grid, additional infrastructure in the form storage or back up is needed. Also, fossil fuel run generators are used to upscale the fall in the supply of generated power before transferring it to the grid. Though the produced energy can be stored in rechargeable batteries, the cost of deploying and maintaining such solutions will again make the renewable power generation quite expensive.

Specific Challenges Faced by Solar Power

Solar Photovoltaic (PV)

The power generation performances of the PV modules continue to pose problems. Most of the presently deployed PV cells are capable of transforming only 13 to 15 percent of the received energy into electric power. Also, the higher cost of the panels persisted as a major hurdle in photovoltaic penetration.

Concentrating Solar Power (CSP)

Its conceptual construction and novel technology enables it to hold the heat energy for a longer duration to allow generation of power even after the eclipse of the sun. But, its prohibitive construction costs and operation and maintenance expenses continue to pose as a challenge. Environmentalists oppose the use of large quantity of water to clean its reflective surfaces, to generate steam to run turbines, and for cooling.

Coping with the Challenges

Continuous researches have helped in cutting down the use of costly components in solar power generation, thereby decreasing the kW cost of solar panels by around 60 per cent as compared to the beginning of 2011. Replacing of the costly silicon-based solar cells by cost-effective organic solar cells allows manufacturing of cost effective solar cells from polymers. Further, researches in the use of graphene, with remarkably high electron mobility in the solar cells, are expected to improve the cell efficiency.

Innovative technologies are used in the CSP plant construction by deploying superior kind of components to cut down the power production costs of CSP. The plant configuration and operations have also undergone changes to reduce the use of water to cut its environmental foot print. The changes, along with bringing down the installation investments, also improve the performance of the plant.

Specific Challenges Faced by Wind Farms

Onshore Wind Farms

The biggest obstacle faced in the onshore wind power generation is its unpredictable nature. Though, adequate precautions are taken to install the turbines at pre-assessed windy locations, the erratic wind still plays a crucial part in the success of power generation. Also, the need of large land requirement away from the cities restricts the growth. The massive size of wind turbines and the noise generated during rotation of turbine blades makes it difficult for the wind farms to get permission from the government and private agencies. Non-availability of land and long haul of generated power to the grid plagues the growth of onshore wind farms.

Offshore Wind Farms

Higher level of fabrication, erection, maintenance costs, and infrastructure required to carry the generated power to the onshore position are the points that go against the offshore wind power generation. Safety in construction continues to be a major obstruction in the growth of offshore wind farms.

Coping with the challenges

The onshore wind power generators are now equipped with increased capacity factor. Software based computer simulations virtually enables the designers to measure the wind

Renewable Power Generation Using Hydropower

- The hydropower generation produces power using 100 per cent natural and non-polluting source, water. Though, it contributes the most towards green power generation in terms of kWh, for several decades, hydropower was not even included in the renewable energy power generation mix as it requires large investment.
- Now there is a change in the stance towards hydropower generation projects. Many countries are contributing towards the development of such facilities in other countries, where the potential exists. For instance K-Water and Star Hydro Power Limited (SHPL) of South Korea has made 25 per cent (US $400 million) investment in Patrnid Hydropower, a 147 MW power generation facility in Pakistan. Similarly, China contributed 15 per cent of the $1.65 billion on 600MW Karuna hydropower project on the White Nile River in Uganda. The USA is also planning to contribute around $12 billion on Inga 3 hydropower project in Congo. The year 2012 alone saw the commissioning of around 30 GW power generating projects globally. The countries such as Africa, Asia and South America drew more investments.
- The outlook towards small hydropower projects is also slowly changing. A recently released United Nations Industrial Development Organization (UNIDO) report estimated that out of around 173 GW of potential worldwide hydropower production, only 75 GW, i.e., less than half of it is presently generated. It anticipates that sharing of technical know-how and investment opportunities will improve the situation and benefit the countries with small hydro power projects.

properties at various levels to design the blades. Large size of the rotor blades with length up to 100 meters, quality and reliable design of the rotors, presence of gearbox, and efficient turbine control systems to handle higher level of wind thrust or shut down to protect the blades effectively reduce the power generation costs. Investments in various researches helped to increase the average power production availability of wind turbines to about 98 per cent. The emergence of local grid concept to distribute the generated power locally also helped in cutting down the distribution costs.

The offshore wind projects no more deploy the similar technology of onshore wind turbines. The turbines are designed robustly to operate in grueling offshore conditions. To cut down the higher costs of constructing underwater foundations, floating type of turbine structures are deployed. The latest 3D modelling technologies and computer simulations accurately perform the demanded tests before actually making the offshore installations. Such innovations, while cutting down the investment on offshore location tests, also help in installing a right type of offshore wind turbine at a predetermined offshore site.

Biofuels

Biofuel is produced from various organic materials such as animal fats, algae, seaweed, fungi, seeds, grasses, shrubs, trees, etc. The biggest challenge faced by bio-energy is its usage of food products for fuel conversion. For instance over 40 per cent of the maize produced in USA is presently used for ethanol production. The prohibitive initial investments make the biofuel production in large quantities a challenge. The limitations of biofuel use only in the vehicle modified for the purpose also restricts its proliferation. The paper manufacturers and builders oppose the use of wood for biofuel.

Government Policies

It is a fact the maturing renewable energy sector is not adequately supported by government policies. The recent years have shown a slackening pace in having supportive policies for renewable power generation. The global economic slowdown also played a crucial role in slowing down the pace. Countries with rigid budget allocations were not able to offer much support to the growth of renewable energy sector. In some of the cases it went against the renewable energy in the form of incentive cuts.

Meeting the Challenges

In order to overcome the challenges, governments all over the world are considering the following points:

- Fixing feed-in tariffs for renewable power and bulk power purchase
- Introduction of cost-cutting incentives, such as tax credits, subsidies, etc.
- Setting energy efficiency standards for materials and equipment used
- Introduction of right policies in the collection of generated power
- Carbon taxes
- Cutting down the subsidies offered to nuclear and fossil fuels
- Change in building construction codes to include renewable energy generation
- Mandate for transport fuel usage
- Introduction of energy policies that echo the beneficial impacts of renewable energy on social and environmental costs

Conclusion

A recent report titled 'Renewable Energy Medium Term Market Report 2013—Market Trends and Projections 2018' from International Energy Agency (IEA), an autonomous agency, starts with a positive note. The report estimates that the energy generation from renewable energy sources, such as solar, wind, hydro, and other sources will almost contribute to 25 per cent of the global power mix by the year 2018, i.e., about 5 per cent increase from 20 per cent in 2011. It also indicates that the power generated from solar, wind, geothermal and bio energy sources will grow to 8 per cent from 4 per cent in 2011. According to the report, the renewable energy power generation will grow from its present 4, 860 TWh to 6, 850 TWh, thus achieving 40 per cent growth from 2012 to 2018.

Efforts are going on to increase the renewable energy sources deployment and to bring down the present power generation costs. There is an urgent need to try qualitative changes towards renewable energy production. Efforts should be made to introduce changes in infrastructure and technology and to include futuristic changes in government policies, business, and social approach. Efforts should be not to equip the renewable energy generation to fit into the available systems, but to introduce new technologies and systems for the growth of renewable energy. While it is not going to be a smooth sailing, but optimism suggests, such introductions will help the green energy generation to successfully tide over its present challenges. ■

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SOLAR SABOTAGE IN THE MOJAVE DESERT

Mike Roddy

Linkages between water and indices of human development as the main drivers of economic growth and sustainable development are undeniable. Availability of safe drinking water and appropriate sanitation facilities are indispensable for the survival, health, growth, and development of human beings.

It is ironic that at a time when many countries have met the MDG target for water supply and sanitation, South Asia still lacks in this regard. According to broad estimates, about a billion people do not use improved sanitation facilities and around 700 million people practice open defecation in South Asia. The pace of sanitation improvements has not kept up with population growth in the region. Such a sordid state of affairs can adversely affect the pace of human development in this part of the globe.

Human development refers to the availability and provision of opportunities to the people to lead a healthy life. Clearly, the notion of human development is a holistic one, i.e., putting people at the centre of all development. The people are perceived to be the main actors as well as the beneficiaries of this process.

In the summer of 2009, Interior Secretary Salazar and Senator Reid announced fast track initiatives for up to 100,000 megawatts of solar energy development on Western public lands, mostly in arid and sunny deserts. The Southwest American desert may be the most ideal location in the world to site solar farms, with half the rainfall of the Sahara, and closer to the equator besides. Startups staffed with engineers and physicists from Berkeley and Caltech began competing furiously to develop the most advanced and cheapest way to deliver electricity, putting coal and even gas plants out of business once and for all. This would be the most effective way to slow global warming and allow America to once again show technical and environmental leadership. Other countries would follow suit, leading to a global effort to avoid a runaway greenhouse, an event which many scientists now believe could doom us all. Climate activists and other Americans who had kept pace with the science were brimming with excitement.

Since 2009, solar technology has advanced much faster than anticipated, as cheap silicon and software advances have brought solar close to the cost of coal and gas, even without accounting for fossil fuels' massive greenhouse gas and environmental impacts. First Solar recently signed a Power Purchase Agreement with a New Mexico utility for less than $.07 per kWh, an accomplishment few predicted any time this decade.

Five years later, despite these advances, utility scale solar power is bleeding and in disarray. Many large projects have either gone bankrupt, changed ownership, or placed on indefinite hold. Solar firms and investors have blown hundreds of millions of dollars. Development capital has dried up or become very expensive. We knew that the coal and gas companies would fight solar, but their strategy was ingenious: work with attorneys and false flag environmental groups to fight proposed desert solar projects in court. Accusations included disregard of the Endangered Species Act and desert protection in general, or disturbance of Native American geoglyphs. Dozens of state and federal environmental laws are on the books, and all it takes to create long delays are good attorneys with thick briefcases and plenty of time to do damage. Salazar's fast track become a Mojave sand trap. There is no effective defense against attorneys citing any of 41 different environmental statutes as methods to delay or defeat construction of solar farms. BLM recently announced another round of solar leases in the Mojave, and there were no takers. Solar utility scale projects in the entire US now total 3,218 megawatts, with another 4,995 megawatts under construction, less than 1% of the American grid.

Startup solar companies were naive about land development challenges, which govern feasibility no matter what is being built. The notion that concerns about species such as the desert tortoise — a threatened, not endangered creature — could end up blowing up projects. As a result, Brightsource Solar ended up spending tens of millions for tortoise relocation and mitigation on one site alone, on top of the $5k per acre for basic entitlements, plus attorneys' fees to contest lawsuits. Interest on funds caused by multiyear delays created another drain.

Most of these suits were filed by environmental organizations, all while claiming they support solar, as long as it's "done right". Back door funding from gas and coal companies is strongly suspected, since legal costs for these kinds of actions can be huge, and they are the ones who benefit from solar projects being sabotaged. Unfortunately, hard evidence is not available. Attorneys don't have to reveal who is paying their fees, and environmental organizations can keep large donations and the strings that come with them anonymous.

Utility companies are said to be pleased with solar's stumble. Funding, previously from conservative pension funds or merchant banks, now comes from investment banks and 30 year bonds. Utility executives live in fear of stranded assets, in the form of shuttered gas and coal plants. Wall Street firms would be able to seize any utility assets in order to recover their power plant plays. The best way for utilities to keep this from occurring is to continue to stall solar or, as with Jim

Rogers of Duke Energy, try to persuade the public that solar and wind will only achieve market domination "by 2050". This allows plenty of time for coal, gas, bondholders, and executives to feed at the fossil trough throughout their careers. It also enables additional CO_2 emissions that humanity will have great difficulty in surviving, according to recent scientific reports.

Media companies have been brilliantly managed by the fossil fuel companies. *The Los Angeles Times*, formerly one of the country's best newspapers, fired Margot Roosevelt, its top environmental and climate reporter, while she was on assignment in Antarctica in 2011. Margot is a Harvard graduate, great granddaughter of Teddy Roosevelt, and the winner of an award for excellence from the American Meteorological Society. Her replacement, Julie Cart, went to Arizona State, and has spent most of her career as a sports reporter. After Cart took over the *Times* solar beat, we began to see her byline under headlines such as these: "Another mega solar plant nearing approval in California"; "Land speculators see silver lining in solar projects"; "Officials study valley fever outbreak at solar power projects" and "Sacrificing the desert to save the earth".

Care2.com's Judy Molland chipped in with these stories: "Destroying the Mojave Desert: The Dark Side of Solar Power"; "Desert Tortoises and Solar Power: Which Side Will Win?"

The Sun Runner, a high desert publication, may be worst of all. *The Spring 2013* issue features a ghoulish, eyeless dead tortoise, with the headline "Are We Killing the Desert?" The main culprit: Wind and solar farms, an absurd notion taken up by other local authors such as Chris Clarke and Zach Behrens. Both are associated with KCET, a big recipient of Koch donations. Behrens has won journalism awards, as has *New York Times*' Andy Revkin, a supporter of fracking and tar sands pipelines. American media has failed, and is a big reason for our predicament. The comparative land use and environmental impacts to the desert for solar and fossil fuel development will be addressed in the next installment.

This chart clarifies solar's land and species impacts compared to that of fossil fuels, without even considering blasted mountaintops and poisoned aquifers from fracking.

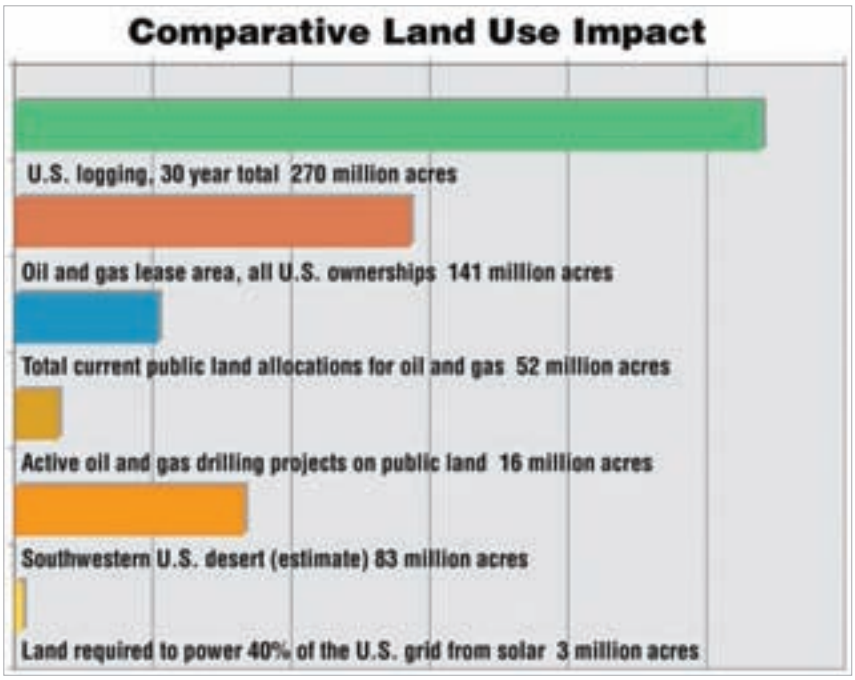
Land suitable for solar is more barren, for economic reasons. The sunniest and easiest to build locations are on flat, dry terrain, at lower elevation, typically creosote monocultures. This bush secretes poisons from its roots to reduce competition, even against baby creosotes. You see few holes in the sand in these ecosystems (many desert creatures are nocturnal), and biomass is low.

At above 3,000 feet of elevation, the terrain tends to be broken, cooler, and with marvelous species diversity, including yuccas, bobcats, Joshua trees, and a rich variety of plants.

Solar opponents try to confuse the public by implying that fecund desert at high elevations near places like Joshua Tree National Park is a target of solar developers. In reality, putative environmentalists and journalists opposed to solar in the Mojave have been fighting for some of the most dessicated land on earth, and not very much of it at that. Forests, by contrast, continue to be ferociously clearcut around the country, with only token opposition from the green groups that are fighting solar. These same environmental groups parrot the false claim that natural gas is "clean", and "50% of the emissions of coal". Natural gas has been found by a NOAA study to cause as much or more GHG emissions than coal, through methane leakage. Mainstream media routinely repeats the 50 per cent figure. Tortoises do travel through the lower Mojave, and in some locations could have difficulty navigating around solar farms until they learn to alter routes. Far more problematic to desert flora and fauna is ORV use, which takes up 1.5 million acres in California alone. Beer soaked desert dwellers stage full moon midnight races on 4 wheel drive vehicles of all kinds, tearing through rough terrain and sometimes killing each other by accident. The crust is damaged, and jerry rigged engines spew pollution. Few object, and local politicians are lobbying for more ORV land, while objecting to solar.

According to the peer reviewed Biology literature, the greatest hazards to desert creatures are climate change exacerbated drought, air pollution from fossil fuels, invasive species, and ORV use. One study calculates that with only a 2 °C increase, tortoises will lose 88 per cent of their habitat in the Sonora Desert section of Joshua Tree National Park, and 65 per cent of their habitat in the Mojave Desert section of the Park. Another study predicts that due to global warming, in 2100 Joshua Tree Park will have a hotter climate than the current temperatures of Death Valley: (http://www.pe.com/local-news/topics/topics-environment-headlines/20101027-joshua-tree-temperatures-could-rival-death-valley-study-finds.ece).

Transmission lines also affect the desert, but less so, and proposed solar plants will access existing corridors close to the I-15- I-10, and I-8 freeways. Little is yet known about solar plant impacts, but developers such as Brightsource employ recycled water for cleaning and do not scrape the soil, allowing for plants beneath and around the collectors. Solar opponents objected strenuously to this water consumption, but seem to have no problem with the 3 to 10 million gallons of toxic water blasted into each fracked natural gas well. In opposing



solar, they are supporting gas, currently enjoying a boom, including new gas utility plants and surpluses for export. Solar opponents are the spiritual and intellectual descendants of Dick Cheney. NOx pollution from coal plants and other fossil fuels has taken a major toll on the desert, according to local biologists. Desert plants don't tolerate excess nitrogen well, and invasive species whose growth is stimulated by nitrogen are less nutritious. A major study has identified NOx from fossil fuel burning as a key reason for tortoise population crashes, as poor nutrition has led to increased incidence of upper respiratory infections.

Drought is another stressor, as rainfall in the central Mojave has declined from a 4.3" annual average to less than 1.4" the last two years, according to Wunderground. Increased drought in the Southwest was predicted by climate models, and is expected to get far worse this century.

Obstruction of large scale solar development is deeply irrational. Or is it? Big Green organizations have histories of accepting funding and even seats on their Boards from extractive industries, including fossil fuel companies. Wildlands Conservancy is different, mostly funded by hedge fund billionaire David Gelbaum, and has been proactive in buying and protecting large swaths of land throughout the West. Ignorance of current global warming science and a desert fetish appear to be the culprits here. WC is also conflicted, as Gelbaum has made substantial investments in solar companies that meet his specifications- siting must be on either rooftops or degraded land, typically in Kern County or urban infill close to Los Angeles. Such land is available in the Southwest, but whether it meets the key feasibility criteria- proximity to transmission, annual insolation, and scale- has not been proven in the marketplace. Gelbaum's preferred firms have achieved only tentative market penetration, as competitors' large solar farm proposals have died, effectively extending the lives of fossil fuel power plants. One Gelbaum favourite, eSolar, is ramping up for China.

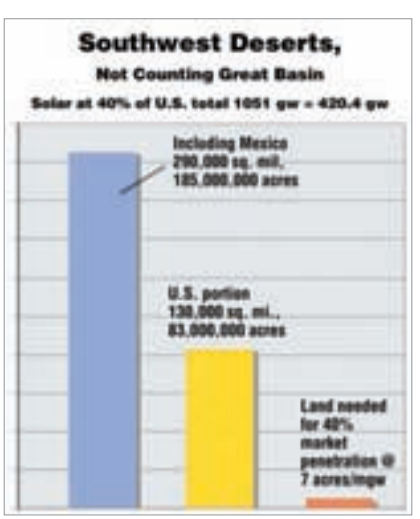
Delays in desert solar development have caused great damage. The key to any new technology is deployment, as repetition creates scale in the supply and construction chain, enables field tested innovations, develops utility customers, and leads to transmission improvements. Worse, the rest of the world has observed solar's puny market share in the American desert, and even wind markets are damaged. Wind tends to blow when the sun isn't shining, and vice versa, leading to more efficient grids. We need both- wind and solar could be Thor and Odin, delivering hammer blows to the monsters who keep trying to get us to burn as much fossilized carbon as we possibly can.

Ambitious solar projects such as the huge plants in the Sahara designed for the European market have stalled. Costly transmission lines were planned through the Mediterranean Sea, and construction and land transmission risked terrorist attacks in volatile regions. European solar developers, eager to further reduce Europe's carbon footprint, are incredulous that tortoises and lawsuits in one of the most barren regions on earth have kept US fossil fuel plants in business, and indirectly damaged their own access to risk capital.

Coal and natural gas plants rarely face these challenges. Drill rigs, each of which blasts millions of gallons of water and toxic chemicals into the ground, are individually small, unlikely to affect migration or nesting sites enough to cause court challenges. Poisoning of aquifers is perfectly legal, since gas drilling was granted an exemption from the Safe Water Drinking Act by Dick Cheney's Energy Task Force in 2005, a bizarre rule that Obama and Congress have not overturned. Devastating coal mining occurs in states such as Wyoming, Montana, and West Virginia, where courts are sympathetic to the coal industry, and mining company payments to the US on federal land are a ridiculous $2 per ton of coal.

Since the days of Ronald Reagan, fossil fuel companies' grip on our leadership has extended to all branches of government. The Interior Secretary won't get nominated unless he has ties to oil or coal. The CO_2 emissions and deadly pollution from NOx, SOx, mercury, ozone, arsenic, and fracking chemicals cost these companies nothing. Gas and coal power plant components are commodities, easily erected, with plenty of technical and construction support, while solar is still in the testing and development stage, and struggles to compete in spite of zero fuel cost. In 30 years, when solar plants are paid off and fuel is still free, solar and wind electricity will be the cheapest available. For an investor or accountant, however, 30 years from now may as well not exist, due to the discount rate.

We have already seen major consequences from the nascent solar industry's setbacks in court. The old and filthy Navajo coal plant in Arizona spews 15 million tons of CO_2 into the atmosphere per year. Plumes containing nitrogen from the plant drift into the Grand Canyon and surrounding desert, stimulating non native plant growth. Possibly thanks to clean energy plants being stalled, the Navajo plant's original 2020 closure date has now been extended to 2025. The 30 per cent federal solar Investment Tax Credit is set to expire in 2016, making feasibility for new solar plants far more difficult, a major victory for coal and gas. Solar plant federal loan guarantees have already expired, making risk capital hard to come by in view of endless lawsuits. The result of stalling large scale solar deployment has been a great victory for Koch Industries, Exxon Mobil, Peabody Coal, and Conoco Phillips, helping to enable the fracking boom and new gas power plant construction. Fossil fuel lobbyists in Washington DC are beaming with pride at what they have accomplished.



Meanwhile, in the real world, climate scientists are terrified by what they have learned. Price Waterhouse Cooper believes that decarbonization must proceed six times faster than at present if we are to avoid a 6 °C catastrophe (http://www.theguardian.com/sustainable-business/blog/pwc-climate-change-reduction-business-investments).

Tyndall Centre for Climate Change Research, and many other organizations predict utter catastrophe on our current course, including the deaths of countless humans. A recently scheduled Radical Emissions Reduction Conference in London has the feel of a last ditch effort.

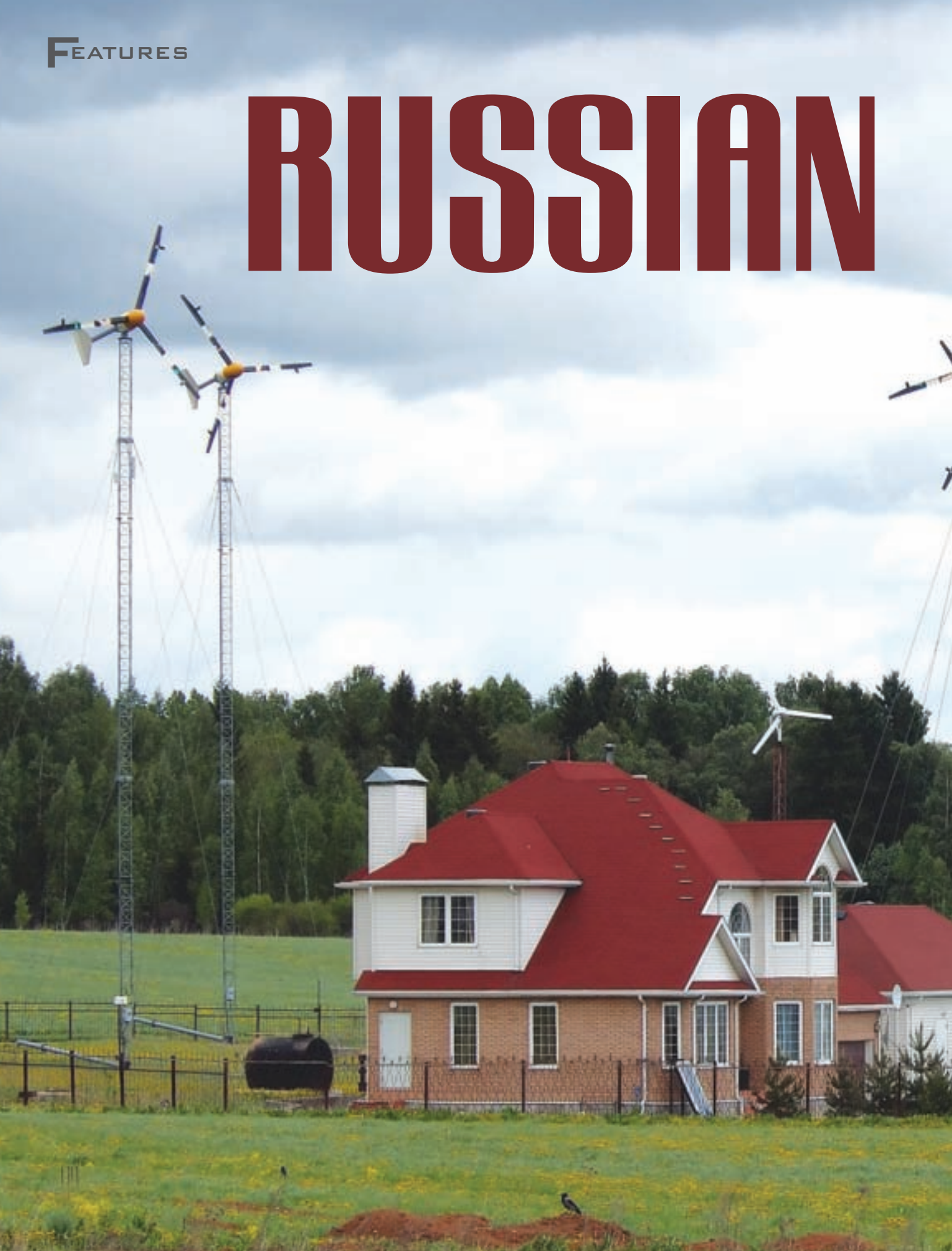
We are headed to at least a 3°C global temperature increase this century, and 4 °C and up is considered more likely by the recent reports. Either temperature will trigger feedback loops leading to abrupt and irreversible changes. Feedbacks such as 1 km wide methane plumes in the Arctic and accelerated permafrost melting have already been observed. There is little question about the outcome of a large and abrupt temperature increase: massive extinction, possibly on the scale of the Permian, and maybe even worse than that: http://lasthours.org/ Dr. Hansen, whose record of climate change prediction is excellent, has said that if fossil fuel barons continue to rule, we will become Venus' sister planet, incapable of harboring any life at all, not even microbes.

It's bad enough that the fossil fuel companies have bribed our government and media, keeping the truth from the public. Worse is the fact that few are standing up to them, and "green" organizations and government leaders, mostly on board with natural gas, appear resigned to defeat. Some climate scientists feel hopeless and fatalistic. If things don't change very soon, there will be nobody left to tell the history of why it all happened.

We know why managers and stockholders of the gas and coal companies want to stop solar, and Big Green executives have similar motivations- money and "careers". David Gelbaum, who has done many good deeds, is more of a mystery. More than any American, Gelbaum has spent hundreds of millions of dollars of his own money trying to do the right thing for the earth. His weakness is a lack of awareness of global warming consequences, and the need to act now. Milan Kundera has the explanation for David and all of us, remarking about Flaubert: "And in the soul of things, in the soul of all things human everywhere, he sees it dancing, the sweet fairy of stupidity. That unobtrusive fairy adapts marvelously to both good and evil, to learning and ignorance, to Emma as well as to Charles, to you as to me. Flaubert brought her to the ball of the great enigmas of existence." ■

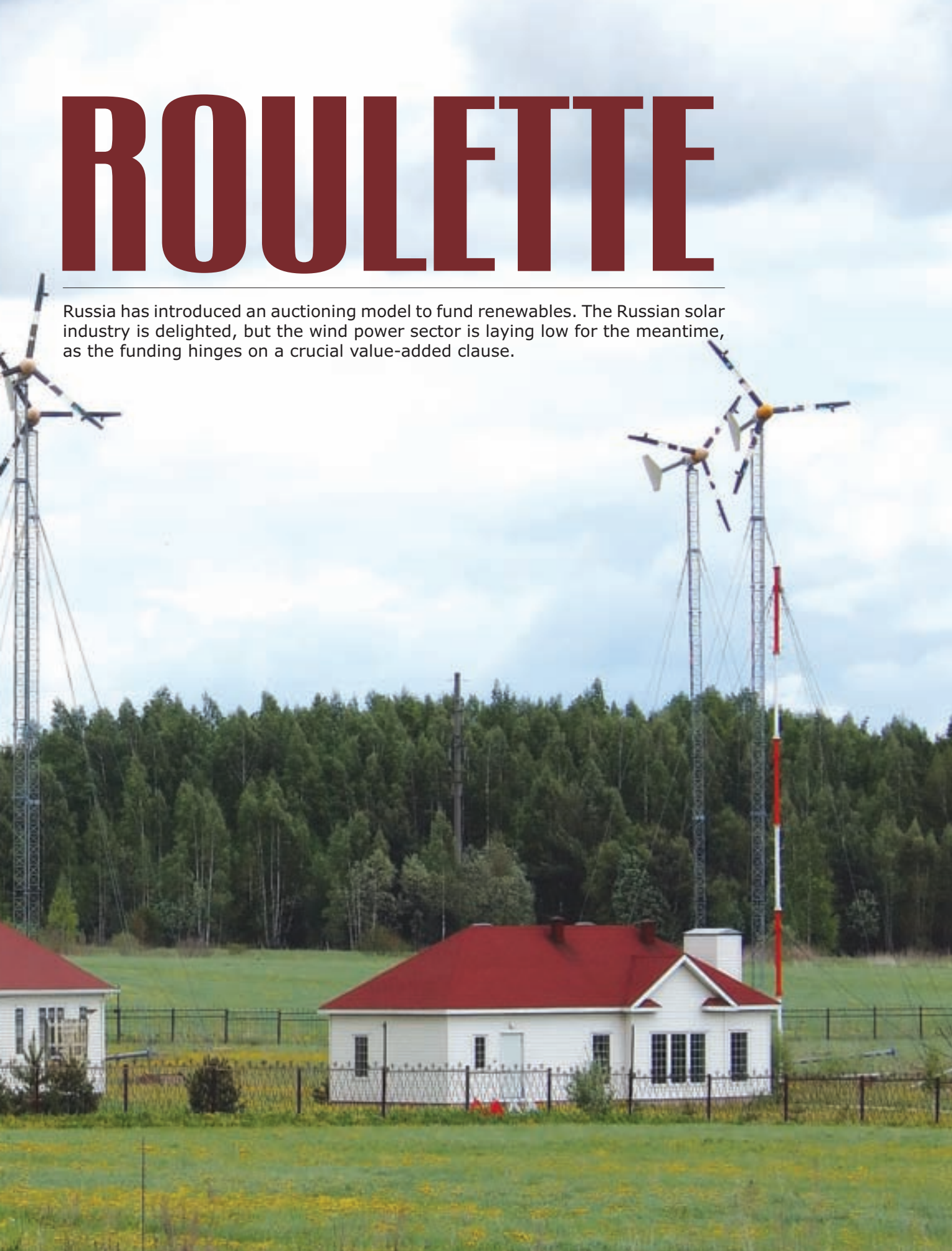
Mr Mike Roddy grew up in Los Altos, California, and graduated from the University of California at Berkeley. Business activity has included real estate development, low cost housing construction in international markets, and consulting for firms such as Parsons, SAIL, and HUDCO, and governments in Venezuela and Japan. Current focus is on global warming research and communication. Roddy is the author of 15 articles on environmental and construction issues, and exchanges information with top American climate scientists. Email: greenframe@aol.com.

RUSSIAN



ROULETTE

Russia has introduced an auctioning model to fund renewables. The Russian solar industry is delighted, but the wind power sector is laying low for the meantime, as the funding hinges on a crucial value-added clause.



If you take a look at the names of the inventors honoured in the Solar Hall of Fame for their outstanding work on solar power, the name Valentin A Baum is sure to catch your eye. In 1977, Baum became the second-ever winner of the prestigious Farrington Daniels Award, and his name thus stands high up on the list of celebrated solar researchers on the International Solar Energy Society's website. Baum invented a panel that combines solar electricity with the use of Concentrated Solar Power (CSP).

He is also regarded as a pioneer in the construction of CSP plants. But the reason why his name stands out on the list is that he is the only Russian.

However, Baum was certainly not the only Russian scientist whose research helped to advance solar energy. The solar batteries used to supply Sputnik and other spacecraft with electricity during the 1950s were developed by a veritable army of researchers. In the 1980s, Sadik Azimov built one of the world's biggest solar thermal concentrators in what was then the Uzbek Soviet Socialist Republic. Zhores Alferov, former director of the Ioffe Physical Technical Institute in St. Petersburg, received the Nobel Prize in Physics in 2000 for his research into semiconductors. The institute has a reputation for research on highly efficient solar cells that dates back to before Alferov's time.

Yet if you look at the renewables landscape, the biggest country in the world is no more than a minor player. Solar, wind and bioenergy do not even generate one percent of Russia's electricity supply between them. Between Moscow and Vladivostok, no more than three megawatts (MW) of solar capacity are online. By contrast, Germany has 11,000 times as much photovoltaic (PV) output. When it comes to wind energy, the figures do not look much better for Russia either, with a mere 16 MW of installed capacity.

Research rather than Action

The research findings of the venerable Russian Academy of Sciences were not enough to convince the political and economic leaders of the enormous nation to switch to renewables. The confusion and upheaval following the fall of the Iron Curtain made it especially difficult for alternative energies to gain ground. Some renewables initiatives did not survive the 1990s, including Baum's 5-MW solar tower power plant in Ukraine, the largest such project in the world at the time. Since the collapse of the Soviet Union, the country's ample supplies of fossil fuels have primarily been at the heart of political and economic interests. Solar researcher Oleg S. Popel, head of the Laboratory of Renewable Energy Sources and Energy Conservation in Moscow, identifies another problem: "Unfortunately, the prevailing opinion here is that since the collapse of the Soviet Union, and the independence of its former republics in Central Asia and the south, Russia has become a northern country that does not have sufficient levels of insolation for large-scale projects." Popel is trying to combat this misconception by making information on the subject available. His institute is creating an atlas of solar energy potential and developing a geographic information system for renewables.

The project has produced surprising results: Russia actually offers far higher yields of solar energy — from 1,300 to 1,400 kilowatt-hours (kWh) — than, for example, Central Europe, with its 1,000 kWh of insolation per square metre. Interestingly, Russia's greatest insolation potential is not found in its southern provinces but rather in the Baikal region, in Ptimorsky Krai (the coastal region at the Sea of Japan) and even in freezing Sakha in eastern Sibetia, where the sun is rarely clouded over and low temperatures enable PV panels t6 operate more efficiently than, for example, in the hot desert regions of Africa. It is also striking that only a third of Russian territory is connected to the power grid and that 20 million people live in regions with decentralized or autonomous energy supplies. In some locations in Sakha, Popel explains, electricity costs more than EUR 1 per kWh — and even up to EUR 3 in some cases — because of transport costs.

Even the Russian government appears to have realized that tapping into the country's renewable energy

potential would not just benefit the regions directly involved. Exporting oil and natural gas is significantly more lucrative for the country than burning fossil fuels for its own use. Following years of rumours and disputes about the possible introduction of a feed-in tariff for renewable energies, the government finally adopted a resolution in April 2013.

Guaranteed Payments for 15 years

By passing Decree No. 449, the Russian government has adopted a funding system for renewable energy projects in the form of an auctioning model similar to the Dutch auction type. At the auction in September, investors had to submit the investment costs of their projects and provide evidence of a contract with an energy provider guaranteeing purchase of the electricity. The bidders with the lowest costs per kilowatt were awarded funding. For its part, the Russian government defined the capital and operating costs for the construction of the renewables plants in advance, and set these as the starting offers.

Development of Russian local content requirements

Difficult conditions for the wind sector

RES-E technologies	Commissioning year	(1) Local content in per cent	(2) Local content in per cent	(3) Local content in per cent	(4) New proposal in per cent
Wind farms	2014	0	20	35	20
	2015	0	20	55	20
	2016	20	35	65	35
	2017	35	45	65	45
	2018	45	55	65	45
	2019–2020	45	55	65	65
Solar PV	2014–2015	50	-	50	50
	2016–2020	70	-	70	70
Small hydropower plants	2014–2015	20	-	20	20
	2016–2017	45	-	45	45
	2018–2020	65	-	65	65

The Table shows how the percentages of domestic value added - the local content requirements - changed during the planning phase for Russia's renewable energy funding model. The "(3) Local content" column shows the final percentages, while column (4) presents local content requirements that the new Russian Wind Energy Association regards as realistic. The particularly drastic changes that the local content proportion for wind energy underwent over the course of the negotiations, as shown in the Table above could be due to the influence of several industry magnates, who are trying to get hold of the greatest possible share of contracts but who lack by a long way, the expertise of major industry players in the West.

Source: RWEA

The providers who have been granted funding are guaranteed payments for 15 years, and the premiums are based on the investment costs.

This form of reverse auction for renewables projects has also been implemented in countries including Brazil. On behalf of the Russian Ministry of Energy, the agency Sovet Rynka auctioned the first licences in September to the providers with the lowest bids.

Russia intends to install just under six gigawatts (GW) of renewables capacity by 2020, thus covering two percent of the country's energy needs. The energy ministry has also decided how many renewables projects will receive funding each year and how the volume of new capacity will be distributed across hydropower, solar and wind-energy projects. The ministry has budgeted for 3.6 GW of wind energy capacity, while the funding pot for solar energy will cover a total of 1.5 GW, and state assistance will be given to small hydropower projects totalling a capacity of 750 MW. The decree does not include any funding for bioenergy.

The first stage of the auction in September involved funding for 2.1 GW of power-plant capacity to go online between 2014 and 2017. "I was surprised by the result," says Anatoly Kopylov, vice-president of the newly formed Russian Wind Energy Association (RWEA). He explains that the auction went disastrously for hydropower, as no bids were submitted, as well as for wind power scarcely a tenth of the potential 1,100 MW of new wind-power capacity actually came under the hammer. Meanwhile, he is certain that this auction marked the birth of a new solar industry in Russia: 400 MW of the 710 MW planned for installation by 2017 was allocated. Kopylov relates that there was an unexpectedly high demand for solar projects, with project developers bidding for over 1,000 MW in total.

He believes that a solar capacity of just 400 MW will kick-start an expansion of the solar industry because of a clause included by the Russian government in its decree as a prerequisite for funding: providers have to furnish evidence that a certain percentage of their plants has been manufactured in Russia, thus ensuring that the expansion of renewables will help to generate domestic value added over time. This local content requirement will remain at 50 per cent for the next few years for PV plants. But from 2016 onwards, solar plants will need to have a local content of 70 per cent. This means that project developers cannot simply import panels, inverters and solar stand systems cheaply from abroad. The expansion of the Russian

solar manufacturing industry is thus, to a certain extent, inevitable. Anton Usachev, director of the Russian Association of Solar Energy (RASE), is expecting the country's marginal production capacities, currently at 10 MW, to be expanded to 110 MW as early as next year. For example, billionaire Viktor Vekselberg's Russian solar company Hevel Solar is drawing on the expertise of the Swiss mechanical engineering firm Oerlikon, in which Hevel Solar holds shares through its parent company Renova, to build a manufacturing facility for thin-film solar modules in the Chuvash Republic.

Could the Russian market also be of interest to German mechanical engineering firms? Solar suppliers' opinions are still divided on the subject. "Of course, local content requirements essentially play into our hands," says Nathalie Albrecht, spokesperson for Centrotherm in Blaubeuren, Baden-Wurttemberg. The equipment supplier has already played a leading role in the expansion of China's solar industry. Since demand is now rising again across the world, Albrecht explains, the company is focusing on core markets such as India for the time being, but also sees Brazil and Russia as important future markets. Centrotherm's Reutlingen-based competitor Manz also considers the Russian market as insufficiently advanced and is therefore abstaining from entering it for now. The Black Forest based solar supplier Schmid, on the other hand, has already opened a branch in Moscow. At any rate, Usachev describes the conditions in Russia as very attractive for the solar industry: in some cases, he says, we can expect returns of 16 per cent each year. Meanwhile, the wind sector has greeted the local content requirements with little enthusiasm. While it is relatively easy to build turnkey manufacturing plants for thin film modules, expanding production capacities for wind turbines is significantly more difficult. There is still no wind industry to speak of in Russia. The sector — particularly the leading turbine manufacturers — therefore reacted with dismay to the high local content requirements: the local content proportion was set at 35 per cent from the outset, rising to 65 per cent by 2016.

During Chancellor Angela Merkel's visit to Russia in July 2010, Siemens optimistically announced that it would construct wind turbines with a capacity of 1,250 MW in Russia in 2015. Today, the company could not be less interested in following through on these promises. "Russia is an interesting market for us," says onshore wind energy specialist Hannes Reuter of Siemens Wind Power diplomatically. "But export companies can only meet the local content requirement by making substantial local investments," he adds. "A longer-term order pipeline for wind-power projects still appears very uncertain for now."

Anatoly Kopylov also rakes a sceptical view of the local content requirements. When asked how he sees the chances of the 35-per cent local content requirement being met this year, the Russian wind power expert replies, "as absolutely unrealistic." ■

Source: New Energy magazine

RENEWABLE ENERGY REVOLUTION

Mini-grids hold the key

Entrepreneurs are lighting up India's remote villages through renewable energy-based mini-grids. These decentralised projects are eradicating darkness from the lives of thousands of rural families. However, the real challenge lies in scaling up these projects, bringing down the costs and making decentralised systems grid-interactive within a regulatory framework.

Nidhi Jamwal

Darewadi is a small village inhabited by 39 families of Mahadev Koli tribal in Junnar taluka of Pune district in Maharashtra. Till some 20 months ago, Darewadi, which does not even exist in official records, used to plunge into darkness as soon as the sun would set. Children could not study and adults had to retire early due to fear of wild boars, snakes and leopards in the fields.

However, Diwali of 2012 was a watershed in the lives of 200 odd population of this village. That was the first time the villagers celebrated the festival of lights by lighting up their homes through a solar system. Ever since then, there has been no going back for Darewadi. The 9.4 kWp (kilowatt-peak) solar photo-voltaic (PV) mini-grid, jointly set up by Bosch Solar AG and Pune-based Gram Oorja Solutions Private Limited, provides basic lighting (2 to 3 bulbs totalling 10 W) and one plug point for mobile charging to each household in the village. Street lighting is also a part of the mini-grid.

Villagers of Darewadi are no more power less. Women now cook in lighted up kitchens without burning their hands in the *chulha*. Children study till late in the evening, and farmers easily harvest rice at night.

Somewhat similar is the story of Meerwada, a remote village in Guna district of Madhya Pradesh. Till 2011, this village had no electricity and women had to walk three kilometres to fetch drinking water. "Clearance issues with the forest department made it difficult to bring power to our area,

so we were always forced to depend on kerosene lamps to light up the dark homes after sunset," said Daulat Ram, the village *Sarpanch* (chief) of Meerwada.

The plight of 400 villagers of Meerwada came to an end when SunEdison India, a solar power producer, built a 14.3 kW solar energy-based mini-grid in 2011. The plant, constructed in four months, now delivers power to all the 70 households of the village.

Rampura village in Jhansi district of Uttar Pradesh is also enjoying the fruits of a solar mini-grid. This village was electrified on January 26, 2009 through 8.7 kWp mini-grid constructed by a Norwegian Company, Scatec Solar. Managed completely by the local community, this mini-grid is run by a village energy committee.

Mini-grids are fast catching up in India's hinterland, which remains unelectrified even after 66 years of Independence. A large number of entrepreneurs and private companies are coming forward to electrify villages in rural India. "In a large number of remote villages, it is not economically feasible to extend the main grid. In such hamlets, decentralised renewable energy-based mini-grids offer a solution. Villagers can draw power when needed and improve the quality of their lives," says Manoj Sinha, co-founder of Patna-based Husk Power Systems, a company that is running decentralised mini-grids across 300 villages of Bihar.

Realising the limitations of large grids, the Indian government is also promoting mini-grids through various schemes and incentives. If steered properly, the proposed Rural Energy Access Programme (REAP) of the Union Ministry of New and Renewable Energy (MNRE) can revolutionise India's renewable energy (RE) sector through decentralised mini-grids that can be integrated with the main grid (see Box 1: Mini-grids).

Energy poverty in India

India is a rapidly growing economy with the world's second largest population. It is facing a surging energy demand, but because of constraints of scarce resources, climate change and

"Off-grid clean energy solutions such as the ones based on solar photovoltaic products have a key role to play in both the remote un-electrifiable villages as well as that in gird electrified villages where the power supply is unreliable."

Ibrahim H Rehman, Director, Social Transformation Division, TERI

Mini-grids

A mini-grid is defined as one or more local generation units supplying electricity to domestic, commercial, or institutional consumers over a local distribution grid. Although mini grids can use diesel generators, renewable energy-based mini-grids use electricity generation technologies that utilize locally available sources like solar, wind, biomass, and run-of-river hydro.

India's first mini-grid was set up in Lamni, Chhattisgarh in 1992, followed by in Sunderbans in Bengal in 1997. Latter consists of 15 solar PV mini-grids (900 kW), 3 biomass gasifier based mini-grids (1500 kW), 6 wind solar hybrids (24 kWp).

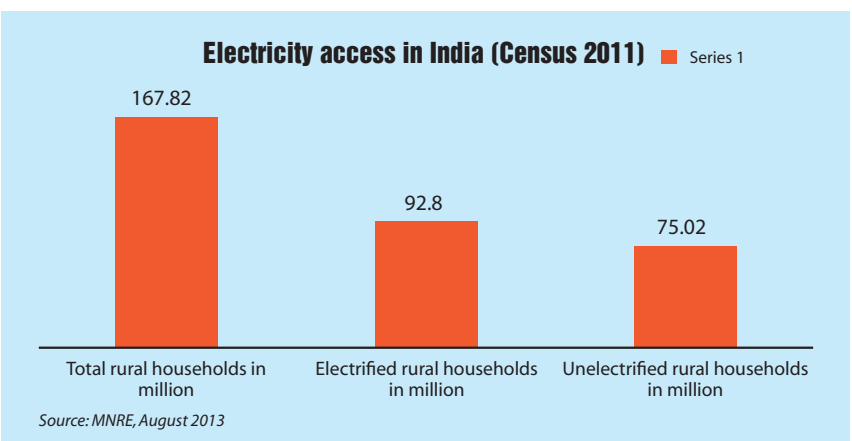
high energy costs, the country cannot pursue the traditional model of energy generation and distribution. However, it has to reach electricity to the millions of its population that is still forced to live in the dark ages due to no access to the main grid.

According to Central Electricity Authority, 31,981 villages in India remain unelectrified as on December 31, 2013. Further, Census 2011 shows that of the 246 million households, 67 per cent get electricity from the grid, while 31 per cent have no option but to use kerosene lamps (see graph 1: Electricity access in India). Also, over 55 million unelectrified households are concentrated in six states (see graph 2: Unelectrified households in six Indian states).

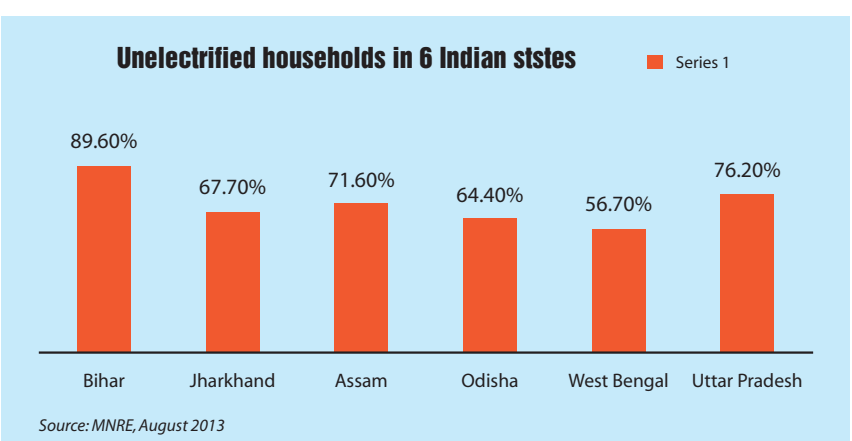
Indian government has been working towards the goal of 100 per cent electrification. The Electricity Act, 2003 provides for supply of electricity to all areas, and no licence is required for supply of electricity in notified rural area. In 2005, Union Ministry of Power launched Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) aiming at 100 per cent electrification. This scheme works on grid extension model. The other programme of power ministry — Decentralised Distributed Generation (DDG), whose core committee member was New Delhi-based The Energy and Resources Institute (TERI) — is meant for those areas where grid supply is not feasible or cost-effective.

Apart from the power ministry, MNRE had initiated another nationwide programme, Remote Village Electrification Programme (RVEP), which was sanctioned till March 31 last year. This programme aimed at providing off-grid, clean alternatives, mostly solar, in remote areas. So far, over a million households have been lighted through solar energy. Whereas the main focus of RVEP has been solar home lighting system (SHS), renewable energy experts claim that rather than using SHS as a stop-gap arrangement till grid reaches remote areas, interactive mini-grids can provide a decentralised and long-term solution.

Realising the potential of mini-grids, in mid-2012, MNRE released a draft revision of RVEP guidelines known as REAP. The draft guidelines focus on mini-grids between 10 kW and 250 kW capacities, and have proposed 90 per cent subsidy on the capital costs from the Central government. After mini-grids, the priority is for micro-grids up to 10 kW capacity. The states will fix the



Graph 1: Electricity access in India
Source: MNRE, August 2013



Graph 2: Unelectrified households in six Indian states
Source: MNRE, August 2013

consumer tariff. Street lighting system (11 W CFL) is an integral part of this programme and project developers have to open service centres for a cluster of villages or hamlets. The REAP is still in draft stages.

Mini-grid Players in India

A number of local and international companies have joined the fray and are setting up mini-grids to light up rural households. Some are interesting stories in themselves. For instance, about three years ago, Yashraj Khaitan, a young graduate from University of California, Berkeley set up his own company, Jaipur-based Gram Power, to electrify Indian villages through smart micro-grids.

In 2012, Gram Power installed its first smart micro-grid in a village close to Todarsingh Mandal Tonk district of Rajasthan. Under this system, a local entrepreneur purchases bulk energy credit from Gram Power and sells it to the villagers using prepaid energy selling device. The 2kWp solar system caters to varied needs of 150 villagers, such as lights, televisions, air coolers, cell phones, etc. Gram Power plans to scale up its smart micro-grids to 200, and is also expanding access to Bihar and Uttar Pradesh.

For the last 15 years, Bangalore-based Decentralised Energy Systems (I) Pvt. Ltd (DESI Power) is running EmPower Partnership model, which is an integrated solution where power plants, energy services, local enterprises and agriculture work closely together to make each other profitable. "DESI Power's model is not limited to lighting up villages alone. It is strongly involved in village-level micro-enterprise to create jobs and build rural economy," says Eklavya Sharan of DESI Power.

Patna-based Husk Power Systems is also doing something similar. It designs, installs and operates biomass-based mini-grids. Each plant uses proprietary gasification technology to

convert abundant agricultural residue (procured from local farmers) into electricity, which is then distributed to rural households and micro-enterprises through a micro-grid system. Since 2008, Husk Power Systems has installed more than 80 plants in Bihar, providing electricity to over 200,000 people across 300 villages and hamlets.

"So far, our decentralised mini-grids have not faced any major problems. In some villages were our plants are running, the main grid has also reached. But, villagers realise that power supplied through the main grid is unreliable and has low voltage. Hence, they still consume electricity generated by decentralised mini-grids," claims Sinha.

Some state governments have also incentivised setting up of decentralised mini-grids. Chhattisgarh is leading this race. According to a February 2014 article, 'Mini-Grids: Challenges and the Way Forward', published in *Akshay Urja*, about 1,500 villages in Chhattisgarh have been electrified in the last 10 years under RVEP through 4 to 15 kilowatt solar power mini-grids installed by Chhattisgarh Renewable Energy Development Agency (CREDA). These mini-grids have lighted up more than 75,000 households.

Under the Chhattisgarh model, the state government subsidizes the capital expenditure entirely and levies only a nominal charge of Rs 5 per month per household to cover operational expenses. This model has already run into rough weather due to indiscriminate drawing of power by the villagers and its financial implications.

Several rural energy entrepreneurs are also setting up low voltage solar direct current (DC) micro-grids, either on their own or under different programs such as Lighting a Billion Lives by TERI. These micro-grids generate DC electricity from solar panels and the power is distributed over a short distance from the battery banks to cluster of around 20 to 100 households. They usually supply at 12V or 24V DC for providing lighting services for 5-7 hours using LED lamps of 2-6 watt per households (2 -3 light points per household) and power mobile phone charging facilities, explain Debajit Palit and Gopal K Sarangi in their recent article, 'Renewable Energy based Mini-grids for Enhancing Electricity Access: Experiences and Lessons from India'. Both Palit and Sarangi are associated with TERI, New Delhi.

TERI is also part of the Off-Grid Access System in South Asia (OASYS South Asia) programme, which was launched in October 2009 and is expected to end in March 2015. This project attempts a systematic analysis and research to find appropriate local solutions to sustainable rural electricity supply, especially for off-grid. The main objective of OASYS South Asia

is to find appropriate local solutions, which are techno-economically viable, institutionally feasible, socio-politically acceptable and environmentally sound, for sustainable off-grid electricity supply.

Under this project, a community managed AC/DC micro grid has already been implemented in Dhenkanal district of Odisha. It is implemented in a cluster of five villages inside the Kandhara Reserve Forest and is managed by a village committee, and has also been linked to a local non-profit organisation for continuous hand-holding. Apart from lighting up rural households, these micro-grids are also helping villagers earn a livelihood through grinding and packaging, saal leaf plate making and irrigation.

The Challenge of Grid-interactive Systems

"The biggest challenge we are facing today is in the villages where the grid has reached and our decentralised system has to compete with the main grid. Even though our supply is more reliable, we cannot compete with the per unit electricity cost of the main grid," laments Sharan. "However, villagers do realise that power supplied by the main grid is unreliable, so they use electricity generated by our decentralised units as a back-up. They also use our supply to run various industrial appliances because decentralised mini-grids generate three-phase power," adds Sharan.

What DESI Power is facing today may soon be a reality for a large number of RE-based mini-grids functioning in India. The existing, and even the proposed mini-grids are not grid-interactive. Hence, they cannot switch between island operation mode (off-grid) and grid-connected mode. This means that mini-grids cannot directly feed electricity into the main grid.

As of now, a large number of villages still remain unelectrified in India. However, the Indian government is pursuing electrification through the extension of main grid. So, the big question that RE-based mini-grids will face sooner or later, like DESI Power is facing today, is how to remain viable even when the main grid reaches the village. Whereas some private developers are not ready to look into long-term challenges, others are already searching for solutions.

"We are in a fix and do not know how to move forward. The only reason we are still able to run our decentralised systems is because we also run micro-enterprises in the villages. But, the day high voltage, three-phase power supply reaches the villages, villagers will not use our electricity to even run their industrial appliances," fears Sharan. This is already happening in several places in Chhattisgarh and Sunderbans.

"Regulations are required to protect the business of the developer. If the electricity grid reaches a village with a mini-grid set up, the developer is forced to compete with the conventional tariff of the electricity grid. The tariff charged by RE-based mini-grids is definitely high, given their high cost of generation. This leaves very little chance for the mini-grid developer to survive in the same village forcing him to move out," says a renewable energy researcher based in New Delhi.

Building interactive-grids is not easy. However, it is also not impossible. Several developed countries have interactive-grids where electricity can be directly fed into the main grid. "Technical solution for interactive-grid exists. In India, there are no guidelines to cover off-grid rural projects. The government must come up with a comprehensive regulatory mechanism for mini-grids, which will provide some direction to the private developers for setting up interactive-grid projects," says a member of Pune-based Prayas Energy Group.

Some private developers are demanding the same. The want clarifications on the cost at which the private developer will feed electricity from a decentralised mini-grid into the main grid; who will bear the cost of connecting with the main grid; what will be the power purchase agreement between distribution companies and private developers, etc.

"A private developer can evacuate power from decentralised mini-grid into the main grid only when latter is alive and has current running in it. Who will ensure the main grid is alive when private developer wants to feed in

"Green mini-grids based on locally available renewable energy resources has a huge potential to provide reliable electricity services in hamlets and off-grid habitations in India to achieve the universal electricity access for all. However, for scaling up of the mini-grid program, especially involving the private sector, will require innovative financing such as long tenure low cost capital from infrastructure lending companies, risk mitigation by combing with output based aid from a universal service obligation fund and most importantly bringing in light-handed regulation to ensure quality of service and tariff parity with the grid consumers through cross-subsidisation.

Debajit Palit, Associate Director, LaBL, TERI

electricity from its independent plant?" questions Sharan. Decentralised mini-grids and the main grid must complement each other and not compete with each other, he adds.

Manoj Sinha of Husk Power Systems claims the future lies in grid-interactive systems. "Yes, decentralised systems should be grid-interactive, so that they can feed extra power straight into the main grid. That would be a win-win situation. But, in India, there is a complete lack of regulatory framework, which does not allow integration of grids. Indian government must come up with a clear policy on this issue," says Sinha.

In 2012, the Forum of Regulators (FoR) proposed a new business model called Off-grid Distributed Generation Based Distribution Franchise (ODGBDF) that can be implemented as a new regulatory mechanism. This model keeps the consumer tariffs equitable with the grid-connected consumers and yet ensures sufficient returns on investments to developers.

Prayas Energy Group is also supporting regulatory framework for mini-grids in India. Last year, it released a report, 'Sustainable Development of Renewable Energy Mini-grids for Energy Access: A Framework for Policy Design', discussing mini-grid policies of various countries and proposing elements of RE-based mini-grid policy for India. The report clearly said that very little data is available in the public domain about RE-based mini-grids, their installed capacity and generation details.

Scaling up Mini-grids

"There is a need to aggregate number of mini-grid projects to create scale. Policy framework and government facilitation is required to achieve standardisation of equipment and design. Subsidies should be shifted from kerosene, fossil fuels to RE technologies as it is one-time assistance, which is not the case for fossil fuels," B V Rao, chief general manager of Indian Renewable Energy Development Agency (IREDA) said during a recent public meeting in New Delhi. Experts claim scaling up of mini-grids will require active government support, both at policy and financial level. "Scaling up will need financial assistance from the government at two levels – some basic capital subsidy, and generation-based incentives. Latter will ensure there are no fly-by-night developers who disappear after availing huge capital subsidy," says Sinha.

He supports a combination of small capital subsidy, not more than 25 per cent, and topping it up with feed-in tariff FiTs or other generation-based incentives. "Capital subsidy will help in starting up decentralised projects, which will accelerate rural electrification. FiTs will ensure private developers run the systems efficiently, and operations and maintenance is taken care of," recommends Sinha.

Both FoR and Prayas Energy Group are supporting a regulatory mechanism for fixing consumer tariff under mini-grid projects. At present, private developers and the consumers (mostly villagers) sign an agreement for the tariff. This tariff is not known in public domain and the government has no role to play in regulating it. This should change and mini-grids sector should be made more transparent.

Private developers, however, have some inhibitions. "RE-based mini-grids are costly to set up and run, hence we are forced to charge high," says Sharan. This can be addressed through the ODGBDF model. Under this model, consumer tariffs are equitable with their grid counterparts and the viability gap funding comes from the utility, so that the developer can still charge the same amount as is being charged at present.

Sinha has a different point of view. "The government can at best set a ceiling price or benchmark taking into consideration the production, transmission and maintenance of mini-grids. However, the rest market should decide," suggests Sinha.

Experts believe the government needs to take in the views of the existing developers, financial institutions, and other relevant stakeholders before these policies are framed. The process needs to be transparent, holistic, and inclusive.

Grid interactive is the future, and the Indian government cannot afford to abdicate its regulatory role at a time when mini-grids could usher in a renewable energy revolution in the country. ■

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LIGHT EMITTING DIODE

A Small Wonder in a Big Role

I witness a glow on many faces as the Delhi metro train makes its way out of the tunnel into the Qutab Minar station. All this coincided with the age old aspiration that "from darkness, lead me to the light". This brings into focus the importance of lighting, be it in home, office, or a commuting facility. Let us now see it from a different perspective. "Small is beautiful" is made true with the new generation lighting wonder, the Light Emitting Diode (LED). These small lighting points present a pleasing glow and can be woven up to make large light assemblies. **Suneel Deambi** writes on the science and technology, and other allied issues behind the LEDs in the article.

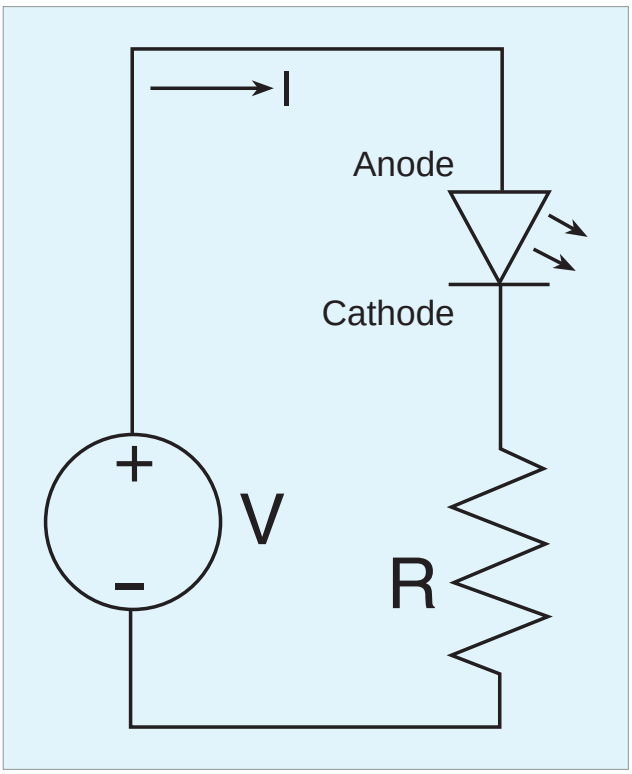
LED from then to Now

LED is primarily a semiconductor based light source, which originated as a practical electronic component way back in 1962. The early versions of LEDs emitted low-intensity red light. However, modern day versions emit light of visible, ultraviolet (UV), and infrared (IR) wavelengths with very high brightness. The process by which LEDs emit light is commonly known as electro-luminescence. In general, the colour of the light is determined by the energy gap of the semiconductor. These wonder bulbs are advantageous in several ways over the incandescent light sources:

- Smaller size
- Faster switching
- Reduced energy consumption
- Longer life span
- Improved physical robustness

Science at Work

A light emitting diode is generally made up of a chip of semiconducting material. It is doped with impurities to produce a p-n junction. Like other diodes, current flows easily from the p-side or anode to the n-side or cathode. The LED development began with infrared and red devices made with gallium arsenide. As the material science technology leapfrogged, it became easy to produce devices with even shorter wavelength, emitting light in various colours. Majority of materials used for LED production possess very high refractive indices. This means that much light will be reflected back into the material/air surface interface. Figure 1 shows a schematic representation of a commonly used LED.



LEDs at Variance

There are several types of LEDs available nowadays. Among these, the main types are miniature LEDs, high power LEDs, and customized LEDs, such as alphanumeric or multi-coloured.

Miniature (Pinned LEDs)

These are mostly single-die LEDs used as indicators. They come in various sizes from 2 mm to 8 mm, through-hole and surface mount packages.

Mid-range (Surface Mounted)

Medium-power LEDs are often through-hole-mounted and used when an output of few lumens is needed. Such LEDs are most commonly used in light panels, emergency lighting, and automotive tail-lights. Due to large amount of metal in these LEDs, they are able to handle higher currents than miniature LED, say around 100 mA.

High-power

High-power LEDs (HPLED) can be driven at currents from hundreds of mA to more than an ampere, compared with the tens of mA for other LEDs. Some can emit over a thousand lumens. It is a desirable requirement to mount these high power LEDs on a heat sink to enable dissipation of heat.

Chip on Board

This type of LED use die bonded directly to a PCB or substrate. It eliminates the need of a soldered LED body or a lead frame. Further, it is very low cost in high volume applications.

Advantages of LEDs

LEDs offer numerous advantages over the other bulbs, as highlighted in Table 1 below:

Table 1: Advantages of LEDs

Feature	Remarks
Size	LEDs can be smaller than 2 mm and are easily populated onto printed circuit boards.
Diversity of colours	Can emit light of different colours without use of any colour filters, thus are efficient and cost effective.
Quick on-off time	Light up very quickly. For example, a typical red indicator will obtain full brightness in less than a micro-second.
Frequent on-off cycling	Ideal for those which are subjected to frequent on-off cycling unlike fluorescent lamps .
Cool light	Minimal heat emission in the form of infrared light. Heat generated makes its way through the base of LED.
Focus	Can be designed to focus its light. Use of an external reflector to collect light in case of an incandescent and fluorescent lighting sources.
Dimming	Can be dimmed quite easily either by reducing the forward current or by any other way.
Slow failure	LEDs fail mostly by dimming over time, rather than sudden failure of incandescent bulbs.
Shock resistance	Can withstand external shock and are less vulnerable to damage. Other lamp types, such as incandescent and fluorescent bulbs are fragile in comparison to LEDs.
Efficiency	Emit more light per watt than incandescent bulbs. Efficiency not affected by shape and size, unlike fluorescent lights or bulbs.
Lifetime	35000–50000 hours of useful life as compared to a rated life of around 10000–15000 hours for CFL and 1000–2000 hours for incandescent light bulbs.

LED versus the Rest

LED is a relatively recent entrant in the lighting arena. There is a sense of urgency worldwide to replace the old lamps by the most modern LED lamps. In reality, each of these lamp types has its own niche areas of use. However, saving energy via use of more energy efficient lamps is welcomed . CFLs are in a wide use today for a variety of reasons. The same is going to happen with the LEDs someday. Table 2 presents a comparative evaluation of the commercially available lamp types.

Table 2: LED vesus the rest

Light Source	FTL	Mercury	Sodium	CFL	LED
Lumens/Watt (source)	60–90	50–65	65–105	50–70	100–130
Lumens/Watt (applications)	40–60	25–35	30–55	30–50	70–110
Rated life (hours)	4000	4000	4000	5000	50,000
Eco-friendly	Mercury used	Mercury used	Mercury used	Mercury used	Eco-friendly

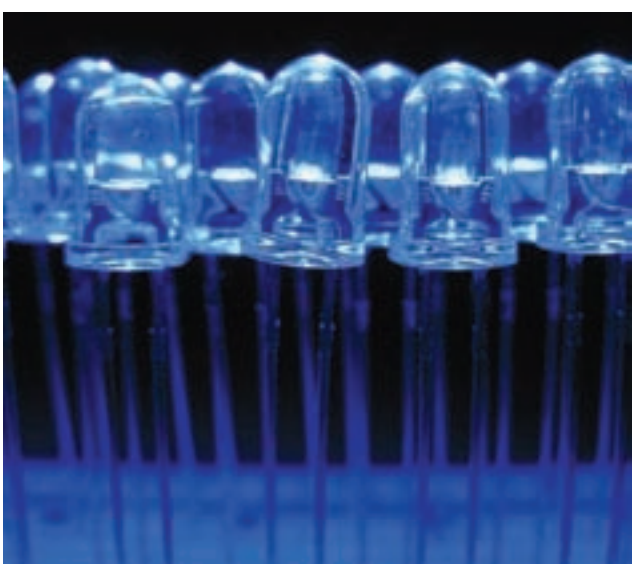
Quite clearly, LED based lamp is a clear winner scoring on every possible front. Its higher lumen output per watt is going to increase further with rapid technological advancements.

LED Creating Glow Far and Wide

Today LED lamp finds use in a wide range of applications. One of its most novel uses is its growing synergy with solar PV based indoor and outdoor lighting systems. In present times solar LED based systems are making inroads everywhere. These are used in many diverse applications, such as in aviation lighting, automotive lighting, advertising, general lighting, traffic signaling, etc. More recently LEDs are also used in video displays and sensors. Their high switching rates are quite useful in advanced communication technology. Moreover, infrared LEDs are also used in the remote control units of DVD players, televisions, and other domestic appliances as well.

Municipalities Switching Roles

As per the available estimates, the municipal corporations in India consume around 4 per cent of the total conventional power generation. Conventional street lighting systems based on high wattage lamps (sodium vapour lamps, etc.) are deployed in very sizeable numbers across the length and breadth of our country. The municipalities are now steadily, but surely showing a growing favour towards the use of LED lamps as these offer high energy saving potential. The payback period for migration from HPSV lamps to the LED lamps for street lighting generally ranges between



2–3 years. Some municipal corporations, such as in Surat, Kolkata, and Hyderabad, have put up demonstration based LED street lighting systems. The resultant outcome so far has been quite positive, thus indicating a significant potential for energy savings via street lighting application alone, not to talk of other multiple uses.

Manufacturing Base for LEDs

An ever increasing demand for high quality LEDs has encouraged many lighting manufacturers in India to enter this industry. Table 3 enlists India's ten best companies on the basis of their manufacturing range, market volume, product acceptability, etc.

Table 3: LED manufacturing companies

Company	Year of Establishment	Website Link (for additional information)
Philips Electronics India Ltd	1942	www.India.philips.com
GE Lighting India	1992	www.ge.com/in
Osram India Pvt Ltd	1994 (LED operations)	www.osram.in
Havells India Ltd	2010 (LED)	www.havells.com
Reiz Electro Controls Pvt. Ltd	1987	www.reizindia.com
MIC Electronics Ltd	1988	www.mic.in
Innovlite India Pvt. Ltd	2005	www.innovlite.com
Sanarti Group	1987	www.sanartigroup.com
Goldwyn Ltd	1991	www.goldwynled.com
Laaj Lighting	1989	www.laajlighting.com

Some Problems with LED

Light emitting diodes too suffer from their dose of problems. Some of these are inherently of a technical nature. Design considerations are quite important to minimize negative effects due to the following few aspects:

Temperature dependence

LED performance depends on temperature. Majority of manufacturers publish ratings of LEDs for an operating temperature of 250 °C. Thus, the performance of this lamp type largely depends on ambient temperature of the operating environment. Over-driving an LED in high ambient temperatures may result in overheating the LED package, thus leading to device failure. A heat sink is needed to maintain a long life.

Voltage sensitivity

It is important for LEDs that a voltage above the threshold and a current below the rating should be supplied. This is usually done via the use of series resistors or current-regulated power supplies.

Efficiency drop

The efficiency of LEDs tends to decrease as the current increases.

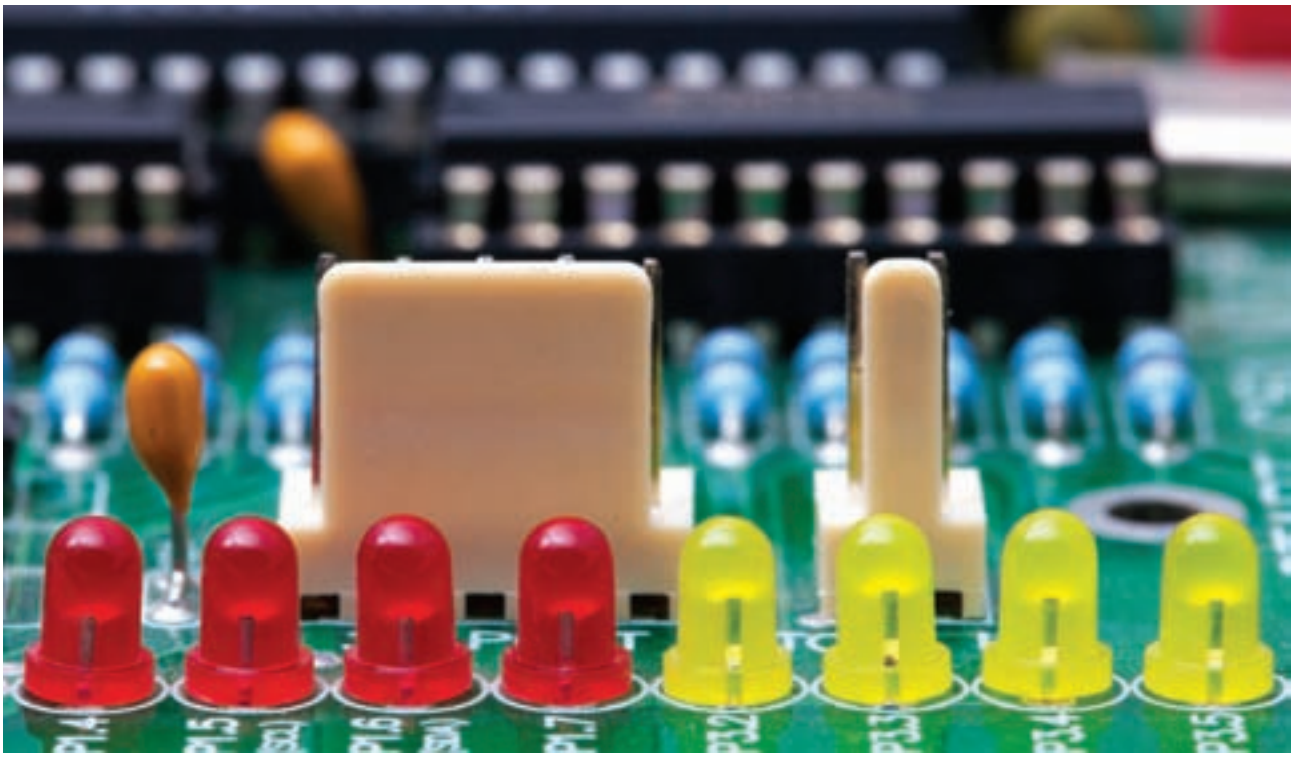
High initial price

LEDs are currently more expensive, price per lumen on an initial capital cost basis, than most conventional lighting technologies.

Case for Solar LED Lighting Systems in Developing Countries

As per the available estimates, around 1.3 billion people worldwide use kerosene oil lamps to light up their households at night. The fuel is not always available and is dangerous to use. World Health Organization's (WHO) reports indicate that indoor air pollution from kerosene and similar fuels used for lighting and cooking results in more than 1.5 million deaths annually. Added to this is the risk of fire from the use of kerosene lamps.

The poor people living in remotely located habitats spend an average of 4 per cent of their household budget on the purchase of kerosene. Even then, it does not assure them good quality lighting. A LED lamp, on the other hand, is much more energy efficient and provide more useful light. Solar power gives an added incentive to use these new generation lamps. Today there are a growing number of villages energized through the route of LED lighting. Most common end-use applications are portable



lighting (lanterns), indoor lighting home lighting systems), and outdoor lighting (street lighting systems). The energy consumption of LEDs being very low makes it a viable lighting option to go with solar power.

The glimmer of hope is that the corporate entities may show a growing favour to the use of solar PV lighting systems under their well mandated Corporate Social Responsibility (CSR) programme. This will not only help to light up the villages, but also lead to capacity building amongst the beneficiary, i.e., the village community.

LED Revolution in India

The country has witnessed two major revolutions, i.e., the Green and the White revolutions in the past. Perhaps, it is the time for a LED revolution. There seems to be a sound reason to this growing optimism amongst the stakeholders involved in the development of LEDs at various levels. Lighting consumes around 17 per cent of total energy available in India. In 2010, the share of traditional lighting was about 87 per cent, while the LED lamps attracted a market share of around 13 per cent. In 2015, these shared contributions are estimated to get near equal, i.e., 50 per cent each.

Indian LED market was around USD 73.3 million in 2010. It is estimated to increase upto USD 470 million by 2015. Street lighting is supposed to account for approximately 60 per cent of LED market in 2015. Higher acceptability of the government together with energy efficiency considerations will be a pivotal factor for quick adoption of LED technology in the following sectors:

- Street lights
- Outdoor lightings
- Industrial sector
- Railways sector
- Automotive sector
- Indoor lightings

In totality, LED market in India is expected to grow at the rate of 40 per cent till 2015. Undermentioned drivers may catalyze the growth of this wonder bulb market:

- Investment of the government in energy efficient lighting system
- Decline in the average prices of LED
- Improvement in technology
- Worldwide strong concern to combat global warming

The Glowing Path Forward

As of now market penetration of light emitting diodes is low in cumulative terms. However, numbers can increase manifolds with genuine realization of the wholesome benefits of LED technology. Currently LEDs are making inroads into Solar Photovoltaic systems for lighting applications. Thus, it is very important to have a sound operation and maintenance mechanism in place. ■

Dr Suneel Deambi is a technical consultant in the area of Renewable Energy and a prolific writer on "science in society issues".

2014 WOULD BE A MUCH BETTER YEAR FOR THE SOLAR INDUSTRY

In this freewheeling interview with Mr Rajeshwara Bhat, MD, Juwi India Renewables Ltd, **Ravikumar Gurumurti** for *Energy Future*, seeks the reasons for the current slowdown in the PV industry in India and the way forward to exploit the huge solar resources India is blessed with.

The solar PV capacity addition in India in 2013 has seen a sharp drop from the previous two years. How has the industry coped with the abrupt slow down and when do you think the situation would improve?

Projects which triggered massive growth under Gujarat and JNNSM policies in the earlier two years almost dried up. The only business available was under state FiT PPA's signed earlier, or Third Party PPAs (Power Purchase Agreement) and APPCs (Average Power Purchase Cost). As for REC (Renewable Energy Certificates, the projects became unviable because of lower demand and expected returns were not forthcoming. The slowdown has hit the manufacturing industry hard with many cutting down their production or even closing down operation. Even project developers and EPC companies had to rethink their strategy as business was becoming unsustainable .

We believe that with JNNSM phase 2 roll-out and project allocations by states like Punjab, Tamil Nadu, Karnataka, UP, and MP, year 2014 would be much better year for the solar industry. For a business, especially like Solar Power (where the initial price is perceived to be marginally higher) to be sustainable, there has to be support in terms of policies, regulation, concessions, and low cost funding to sustain growth in the market, year after year, especially if we are to realize our national objective of achieving grid parity by 2017. For this we need to come up with a five-year plan to add capacities of 3 to 4 GWp every year, year after year. This will give confidence to investors, manufacturing industries, IPPs, developers, and EPC contractors to put in resources to develop technologies, have innovation, cerate human capital, increase productivity, and improve product, system quality and efficiencies across the value chain.

The introduction of DCR should also boost the capacity addition with manufacturing facilities and new state-of-the-art concepts.

A substantial number of projects executed in 2013 were outside of the national and state policies. The industry seems to be pretty happy with it. How do you think this market needs to be developed?

Electricity tariff has been steadily rising and there will be many takers

for solar power provided we have no wheeling, banking, and cross-subsidy charges for 12 to 15 years, which is the debt period of the investment for such infrastructure projects. Enabling policies would make the banks more forthcoming to invest in solar projects. Certain states have paid attention to this and have framed enabling polices while some have not. This would also encourage different solutions for different segments. In time to come we need to look at applications combined with distribution. For example, it is possible to offer an industry that runs DG set for most of the day, an economically viable PV system in combination with controllers which will provide 24x7 power. This would help reduce diesel consumption and also reduce carbon emission. This system is called "Fuel Saver", an ideal solution for segments like mining, FMCG, logistics including cold-chains, process and other allied industries. The operating cost can be reduced to Rs 8-10 per kWh against Rs 15-25 per kWh in case of diesel power . This investment in solar can have a pay-back of just 3 to 4 years. This concept has already been established by us across many installations in countries outside India including African and American continent.

Another opportunity is to utilize the strength of PV as a localized source of generation and its DC power generation. We can eliminate the huge conversion losses approximately 30% that are inevitable in our current generation and transmission of AC power. The loads could be replaced with LED lights, brushless DC pumps, fans, motors, etc. This could relieve the grid by 15 to 20 Gw. Also the solar capex cost would reduce by 20 to 30 per cent making it more cost effective. Some Indian companies have developed DC products and have begun marketing them.

PV module prices crashed between 2010 and 2012, and in 2013 prices were stabilizing. Some market researchers predict that module prices would actually start rising from 2014. What is your assessment and how this would impact future projects and those projects for which PPAs have just been signed?

Module prices are likely to increase as the global market in 2014 is expected to be in the range of 40 to 45 GWp in 2014 with China likely to be the largest consumer adding 14 to 15 GWps. This is leading to higher demand and we are already seeing the ingot prices rising. However, under the volatile global market conditions, it is difficult to predict the trend in price. Under current circumstances it looks like that for projects that have been firmed up, it may be better to sign up quickly, source the various components, and execute the project at an early date.

How is the MW size plants installed two years before performing? What have been the key learnings?

Most of the plants installed and commissioned by established and reputed EPC companies have been performing well. In early 2010, when large scale solar power plants were beginning to be set up in India, there was wide-spread scepticism on plant performances/energy yield. With the successful demonstration of the overall performance of the installed power plants, the confidence level has gone up especially amongst the banking community, which is very crucial for the growth of the industry. However there had been instances of improperly designed and executed projects. Design inadequacy combined with compromises on the specification and choice of products, and components major issues created such as structural corrosion, burnt cable connectors, leaking transformers etc. It also impacted the output (10 to 30% lower than the predicted). Lower performance really hits hard the return on investment and it is very important that due diligence is made to evaluate and select the EPC contractor.

Ever since the JNNSM programme was introduced, Domestic Content Requirement (DCR) has become a very contentious issue. What would be your suggestion to bridge the gap?

All our efforts should be to reach grid parity and make solar a viable option. To achieve this, we need to develop technologies across the value chain (ingots to modules) to manufacture and offer modules of international quality at international market prices. We need policy stimulus to develop technology, infrastructure for setting up large manufacturing facilities, such as developing industrial parks in suitable locations, assured power, water, ports for imports, exports, transport infrastructure, local vendors for various items, etc.

Besides we will have huge opportunities to export our modules to international markets. We need to encourage the manufacturers to produce high quality products at internationally competitive prices rather than protect them if we want to achieve grid parity and energy security.

The Indian PV market, before the Gujarat and JNNSM policies came in, was dominated by off-grid market. How do you think the large power plant initiative has benefitted our country especially considering that millions of people in our country still have no access to electricity?

Before large grid connected projects were taken up, our solar market was confined to off-grid systems: solar home systems, lanterns, street lights, small off-grid projects, water pumps and some industrial applications like unmanned oil platforms, railway-

signaling, stand-by power, etc. The system prices were then in the range of Rs 300 to 400/Watt. The shift in focus to power projects lead to a dramatic rise in the grid connected system capacity from a mere 80 MW to over 2 GW in two years and the price dropped to Rs 100 to 130 Rs/ Wp. The growth of international market also contributed to a sharp fall in prices of modules. By cutting down the prices dramatically, we have made giant stride in our efforts to reach grid-parity. If we can gradually switch to LVDC generation and consumption and create mini-grids, the overall cost would further go down. Moving to LVDC would also provide reliable power to clusters of remote villages, create thousands of small enterprises serving local needs and creating millions of jobs. Simultaneously, health and education delivery systems would improve and would bring in a visible and positive social transformation among the rural poor. Solar is uniquely placed to bring a revolution of this sort.

Are the banks and other lending institutions now more open to funding solar projects and what are the key concerns that needs to be addressed to successfully secure funding?

The key concerns that need to be immediately addressed for giving confidence to the banking community relates to clarity on polices especially relating to wheeling and banking charges. Lot of work has been done by MNRE and certain regulators to build confidence with the investing community by showcasing executed projects. In the interest of the sustained growth, all of us in the industry have to ensure that banks and other investors do not end up with non-performing assets. Luckily, unlike fossil fuel projects which are chronically dependent on insecure supply of fuel, solar does not face this problem, for Sun is available all the time for free and delivers fuel at no cost at the point of generation. So to a large extent we reduce the risk of NPAs. We can also make efforts to campaign with the banking community to allocate 5% of their project financing for solar to start with. Banking community can and should also start to qualify and rate EPC companies based on their past performance and the confidence it enjoys with the customers. This would help reduce financial closure cycle and see many more projects coming up.

What measures you would like the next government at the centre, to take to accelerate the growth of solar in particular.

The vision of 20GWp by 2022 is indeed very heartening. However the implementation process has to be accelerated. To achieve grid parity by 2017 as envisaged, all measures required have to be taken up: creating a market of 3 GWp / year, enabling the setting up of local integrated manufacturing of 3 GWp by making land available at suitable locations, stable and assured sale of power etc. The benefits of promoting growth of solar in India is immense to make sure that it fulfill our dream of Energy security of the country .

Deterrents could be stringent and effective enactment of environmental laws and making RE compulsory for all those polluting system to conserve, protect and restore the health and integrity of the Earth's ecosystem.

Energy Security is a major concern of many nations. How do you think our country, dependent critically on imports, move forward to achieve reasonable levels of energy security?

We just cannot wish away imports. But certainly we should find alternate means to reduce our imports. Our energy basket should have a good mix of fossil fuel and RE based generation to achieve long term energy security. An integrated approach is called for to manage energy resources, generate and distribute energy in a sustainable way. Currently policies relating to energy are framed and driven by multiple ministries such as Ministry of Petroleum, Ministry of Power, Ministry of Coal, MNRE and MoEF. Here, a consistent and integrated approach is called for. As a nation blessed with abundance of sunlight, we need to invest to exploit solar energy on a large scale. Consider for example, India's oil import bill in 2012-13 which was a mind boggling Rs 7.85 Lakh crores. Compare this with the amount the government would have to spend in buying power from 1 GWp solar power plant at the FIT rate of Rs. 8/kwh. At 1.5Mn units / MW, a GWp of PV power plant would generate 1.5 bn units and the outflow for buying the entire energy generated by 1 GW of solar per year would be a measly sum of Rs.1,200 crores. The immediate action we could therefore take would be to replace captive generation by diesel generator sets with solar power. We have a huge opportunity to reduce our dependence on expensive imported oil and enhance our energy security and our efforts at sustainability

In conclusion we have to make this world a better place to live in. Energy being one of the prime drivers for sustainable life, we need to make renewable energy to be part of our energy mix and have policies, incentives, effective implementation to achieve 10% solar contribution in our energy mix. ■

Ravikumar Gurumurti is associated with the PV industry for over 30 years. Currently, he is operating independently as a consultant offering technical services to the PV industry and is also engaged in conducting training programmes on PV technology and application, system design, I&C, and O&M.

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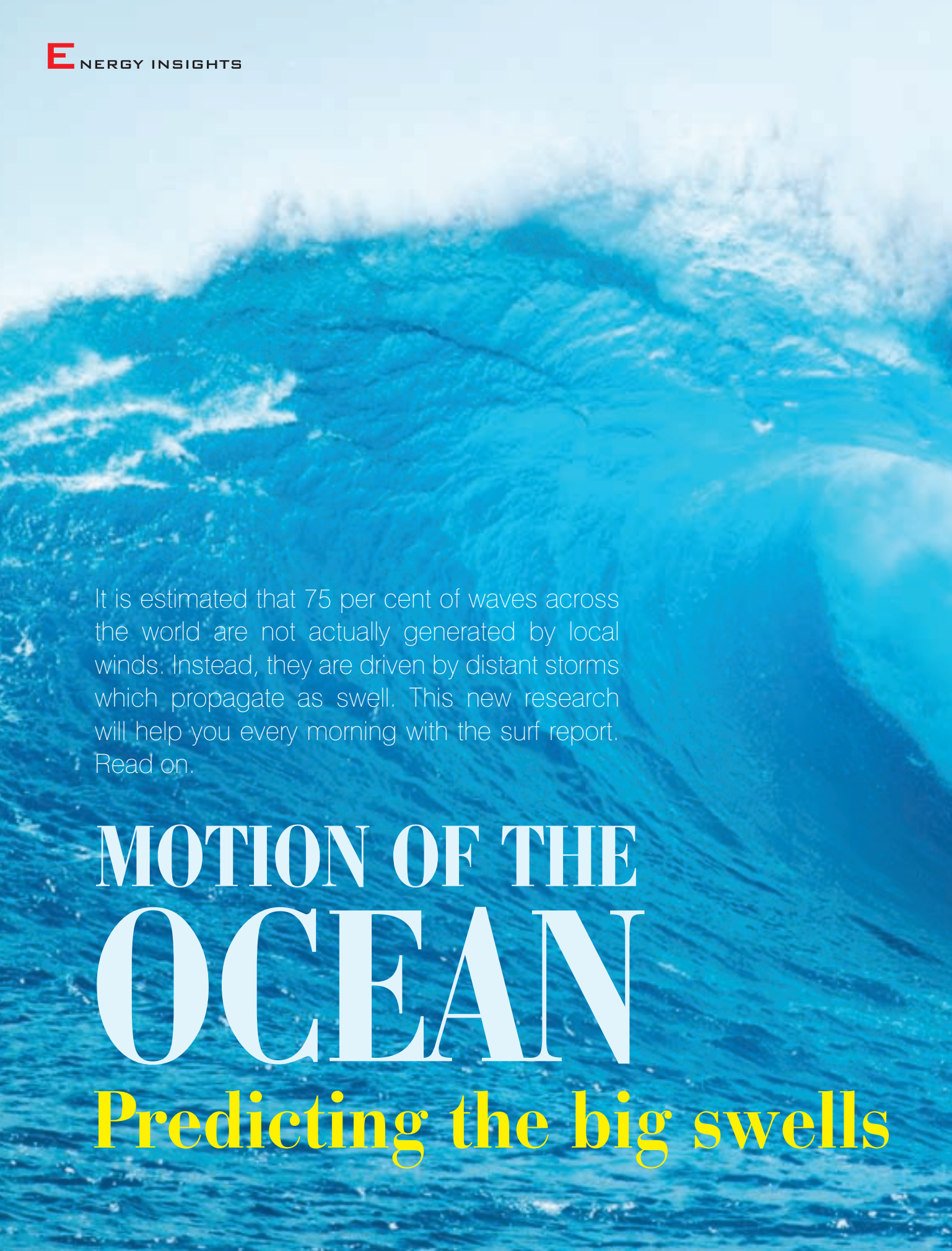

It is estimated that 75 per cent of waves across the world are not actually generated by local winds. Instead, they are driven by distant storms which propagate as swell. This new research will help you every morning with the surf report. Read on.

MOTION OF THE OCEAN

Predicting the big swells

Research led by the Vice-Chancellor will allow oceanographers and meteorologists to better predict the rate at which ocean swells decay or deteriorate, as they travel across the globe.

"Ocean cargo shipping, offshore oil and gas production, and even recreational activities such as surfing, are all dependent on wave action," says Professor Young. "It is therefore critical that we are able to predict swell."

It is estimated that 75 per cent of waves across the world are not actually generated by local winds. Instead, they are driven by distant storms which propagate as swell.

"Imagine you drop a rock in a pond. Waves radiate out from the rock. You don't need anything to push the waves. Once generated, they propagate by themselves.

"So, for most of the Indian, Pacific and South Atlantic oceans, it is actually the weather in the Southern Ocean thousands of kilometres away that dominates the wave conditions," explains Professor Young.

"The Southern Ocean is dominated by big low pressure systems that move across it year round. These systems generate waves that grow and can travel tens of thousands of kilometres from where they were actually formed, to crash on a beach in Australia."

Professor Young, who is affiliated with the Research School of Earth Sciences, used orbiting satellites to track swell generated in the Southern Ocean and measure the rate of decay as it travelled north towards Australia.

The results showed that the decay of the swell depends on how steep the wave actually is.

"Steep waves decay very quickly. However, typical swell is not very steep and can travel across oceanic basins with only a relatively small loss of energy."

Over 200 individual cases were tracked, making this study the first to provide such comprehensive data of this decay.

"What we were able to do is track the swell from the satellite as it moved from the south to the north, some 1400 kilometres. We only chose cases where there was no wind so that we could be confident that all we were measuring was the swell decay.

"We can take these results and put them into a mathematical formula that can be put straight into computer models used by national weather bureaus.

"This will increase our ability to better predict wave action. As 70 per cent of the world's oceans are dominated by swell, it's extremely important to be able to predict them accurately." ■

Source: Science Daily

CURRENT R&D RENEWABLES

Performance Enhancement of Solar Photovoltaic System Using Novel Maximum Power Point Tracking
International Journal of Electrical Power and Energy Systems, Volume 60, September 2014, Pages 1–5
N Ponkarthik, K Kalidasa Murugavel

The electrical power supplied by the photovoltaic (PV) array depends on insolation, temperature, and load. On the other hand, the actual power produced by the PV array is not fully transferred to the load. Therefore, it is necessary to extract maximum power from PV array. Maximum Power Point Tracking (MPPT) is a power electronic system that extracts maximum power from PV system. MPPT varies the electrical operating point of the PV modules and enables them to deliver maximum available power. In this work, a new MPPT algorithm is designed that uses open circuit voltage and short circuit current, sampled from a reference PV panel. Using these measurements, the maximum power is tracked from the main panel without breaking the power transferred to load.

Frequency Regulation for Large Load Variations on Micro-hydro Power Plants with Real-time Implementation
International Journal of Electrical Power and Energy Systems, Volume 60, September 2014, Pages 6–13
Issam Salhi, Saïd Doubabi, Najib Essounbouli, Abdelaziz Hamzaoui

Micro-hydro power plants (MHPP) are usually built on mountains to provide electricity to the rural communities. As most of them are isolated from the national grid, thus they require good control system to ensure the stability of both MHPP frequency and voltage outputs in spite of varying users, load. This paper treats a new approach for frequency regulation of a MHPP against large load variations. For our simulation studies, a MHPP model is constructed from the mains physical equations that describe the nonlinear behaviour of the plant. A self-tuning fuzzy proportional–integral (PI) controller, in which the controller gains are adjusted in real-time using a fuzzy logic inference system, is proposed. To demonstrate the effectiveness of the proposed controller, practical results under different loading conditions are presented. Those results show overall a good correlation between the computer simulation and the field-testing data.

Underwater Compressed Air Energy Storage Improved through Vortex Hydro
Energy Sustainable Energy Technologies and Assessments, Volume 7, September 2014, Pages 1–5
Ahmadreza Vasel-Be-Hagh, Rupp Carriveau, David SK Ting

A power generating energy storage system is presented. The proposed self-powered energy storage technology (UWCAES–VHE) is a hybrid of Underwater Compressed Air Energy Storage (UWCAES) and the Vortex Induced Vibration Aquatic Clean Energy (VIVACE) converter invented by Bernitsas and Raghavan to harness Vortex Hydro Energy (VHE). The present technology significantly improves the round trip efficiency of conventional UWCAES. Through this hybridization, the energy conversion efficiency of the VIVACE converters performing as the accumulator–converters of the UWCAES–VHE is expected to be higher than that of the conventional VIVACE converters. It is further demonstrated that the round trip efficiency of the UWCAES–VHE and the VHE conversion efficiency of the VIVACE are linearly related. UWCAES–VHE and conventional UWCAES are quantitatively compared.

Impact of Pine Oil Biofuel Fumigation on Gaseous Emissions from a Diesel Engine

Fuel Processing Technology, Volume 124, August 2014, Pages 44–53

R Vallinayagam, S Vedharaj, WM Yang, CG Saravanan, PS Lee, KJE Chua, SK Chou

This study aims to investigate the emission reduction potential of pine oil, a plant based bio-fuel, when fumigated in a single cylinder diesel engine. Despite the feasibility of using pine oil for diesel engine application, big revelation has not been made yet on its utility in a diesel engine. Therefore, we embarked on a research work to capitalize the renewable source of energy from bio-derived fuel, pine oil, which is much greener to the environment. Pine oil possesses lower viscosity, boiling point, and flash point compared to other plant based fuels. However, due to its lower cetane number, its usage in a diesel engine demands ignition support and its lower viscosity necessitates modification with the fuel injection system to avert long term durability issues. This study has attempted to fumigate pine oil in the inlet while diesel was injected through the main injection system. By this measure, homogenized pine oil/air mixture was inducted into the cylinder and ignited by the auto-ignition of diesel. From the experimental investigation, it has been observed that pine oil can replace diesel up to 60 per cent and 36 per cent at low and full load conditions, respectively. Significantly, smoke emission has been drastically reduced by 64.2 per cent than normal diesel operation at full load condition, with a slight increase in NOX (oxides of nitrogen) emission. Moreover, CO (carbon monoxide) and HC (hydrocarbon) emissions have found to be 67.5 per cent and 47.8 per cent lower than that of diesel at full load condition. On the other hand, CO and HC emissions were found to be increased at low load condition.

Biofuel from Biomass via Photo-electrochemical Reactions: An Overview

Journal of Power Sources, Volume 259, 1 August 2014, Pages 33–42

N Ibrahim, SK Kamarudin, LJ Minggu

Biomass is attracting a great deal of attention as a renewable energy resource to reduce carbon dioxide (CO_2) emissions. Converting biomass from municipal, agricultural, and livestock into biofuel and electrical power has significant environmental and economic advantages. The conversion of biomass into practical energy requires elegant designs and further investigation. Thus, biomass is a promising renewable energy source due to its low production cost and simple manufacturing processes. Biofuel (hydrogen and methanol) produced from biomass can be used for transportation with near-zero air pollution. It involves efficient uses of land and plays a major role to reduce dependence on insecure source of petroleum. Photoelectrochemical (PEC) reactions study provides a potential pathway for producing fuel from biomass and bio-related compound in the near future. This review highlights recent work related to the PEC conversion of biomass and bio-related compounds into useful biofuels and electricity. This review covers different types of photochemical reaction cells utilizing various types of organic and inorganic waste. It also presents recent developments in photoelectrodes, photocatalysts, and electrolytes.

Hybrid Nanocatalysts containing Enzymes and Metallic Nanoparticles for Ethanol/O_2 Biofuel Cell

Journal of Power Sources, Volume 259, 1 August 2014, Pages 25–32

S Aquino Neto, TS Almeida, LM Palma, SD Minteer, AR de Andrade

We report the preparation of hybrid nanostructured bio-anodes containing alcohol dehydrogenase (ADH) enzyme with Au, Pt, or $Pt_{0.75}Sn_{0.25}$ nanoparticles to be used in ethanol/O_2 hybrid biofuel cells. We describe two different methodologies for the preparation of the bioanodes. In the first case, multi walled carbon nanotubes (MWCNTs) were employed as a support for the metallic nanoparticles and TBAB-modified Nafion® aided enzyme immobilization. In the second case, we immobilized the enzymes using dendrimersencapsulated nanoparticles as the agent for enzyme anchoring. The biofuel cell tests showed that the addition of metallic nanoparticles to the bioanode structure enhanced the overall biofuel cell performance. The bioelectrode containing Au nanoparticles display the best performance, with an open circuit potential of 0.61 ± 0.05 V and a maximum power density of 155 ± 11 μW cm^{-2}. NADH cyclic voltammetry experiments indicated that Au nanoparticles behaved as a catalyst toward NADH oxidation. Comparing the two protocols we used to synthetised nanoparticles, the sample containing the Au nanoparticles supported on MWCNTs furnished fourfold higher value. Therefore, it can be inferred that the combination of small amounts of metallic nanoparticles with enzymes improve bio-anode performance.

Development and Evaluation of Portable and Wearable Fuel Cells for Soldier Use

Journal of Power Sources, Volume 259, 1 August 2014, Pages 276–281

T Thampan, D Shah, C Cook, J Novoa, S Shah

A number of fuel cell systems have been recently developed to meet the US Army's soldier power requirements. The

operation and performance of these systems are discussed based on laboratory results and limited soldier evaluation. The systems reviewed are primarily intended for soldier use in an austere environment with minimum access to resupply and vehicular transportation. These applications require high power and energy density sources that are portable (300 W) and wearable (20 W) to minimize the soldier's load burden. Based on soldier field evaluations of portable fuel cell systems, improvements in power density and compatibility with logistical fuels are required to be successfully deployed. For soldier worn applications, a novel chemical hydride system has shown significant advances in power and energy density while maintaining a small form factor. The use of a high energy dense fuel cartridge (800 Wh kg^{-1}), based on AlH_3 (Alane) thermolysis, allows a power density of 28 W kg^{-1}, which offers promising weight savings compared to the standard military batteries.

Theoretical Guidelines to Designing High Performance Energy Storage Device Based on Hybridization of Lithium-Ion Battery and Supercapacitor

Journal of Power Sources, Volume 259, 1 August 2014, Pages 1–14

Hong Soo Choi, Chong Rae Park

We discuss the theoretical approaches for various electrochemical capacitor systems via performance-potential estimation in regard to specific energy and power densities. Typical energy storage systems, such as symmetric capacitor system and asymmetric capacitor system are classified with the symmetry of the electrodes (symmetric/asymmetric), and the types of electrolytes (aqueous/organic). Energy and power densities of each system are theoretically calculated using various factors and coefficients for performance comparison. Theoretical modelling for the BatCap system is conducted to indicate the electrochemical performance of this new concept device followed by consideration of ideal structure of the BatCap electrode material. Conclusively, this study successively indicates the performance of each energy storage system depending on the specified conditions of the electrodes and electrolyte which consist of the energy storage systems.

Thru-life Impacts of Driver Aggression, Climate, Cabin Thermal Management, and Battery Thermal Management on Battery Electric Vehicle Utility

Journal of Power Sources, Volume 259, 1 August 2014, Pages 262–275

Jeremy Neubauer, Eric Wood

Battery electric vehicles (BEVs) offer the potential to reduce both oil imports and greenhouse gas emissions, but have a limited utility that is affected by driver aggression and effects of climate—both directly on battery temperature and indirectly through the loads of cabin and battery thermal management systems. Utility is further affected due to wearing of battery through life in response to travel patterns, climate, and other factors. In this paper we apply the National Renewable Energy Laboratory's Battery Lifetime Analysis and Simulation Tool for Vehicles (BLAST-V) to examine the sensitivity of BEV utility to driver aggression and climate effects over the life of the vehicle. We found that the primary challenge to cold-climate BEV operation to be inefficient cabin heating systems, and to hot-climate BEV operation to be high peak on-road battery temperatures and excessive battery degradation. Active cooling systems appear necessary to manage peak battery temperatures of aggressive, hot-climate drivers, which can then be employed to maximize thru-life vehicle utility.

Renewable Energy Production in Spain: A Review

Renewable and Sustainable Energy Reviews, Volume 33, May 2014, Pages 509–531

Francisco G Montoya, Maria J Aguilera, Francisco Manzano-Agugliaro

This paper reviews the production and consumption of traditional and renewable energy in Spain over the past two decades. It also presents an overview on the development of renewable energy, such as solar (photovoltaic and photothermal), wind, biomass, hydropower, marine, and geothermal energies in Spain. A brief overview of the legislation regulating renewable energy in Spain is also presented in the paper. It was shown that the installed renewable energy of 32,472 MW represented 11.6 per cent of the country's primary energy consumption. Furthermore, the installed renewable energy average of electric power in Spain was 0.7 kW per capita and 59 kW/km^2. Wind energy continues to experience a good growth rate and does not seem to be affected by regulations, which has made it the most sustainable renewable energy in Spain. Finally, an analysis of energy production and consumption of renewable and non-renewable energy by province is made. The data indicates that highly populated and industrialized provinces made more efficient use of their energy from an electrical consumption viewpoint. This uneven growth was not motivated solely by the existence or lack of renewable energy resources, but by the autonomous community or province in their socio-economic context. ■

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Clarity/RP/042014

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Pepsi's New Green PET Bottle

PepsiCo is one of the leading food and beverage businesses in the world. Since 2010, it has been focussing on protecting the earth's natural energy resources with competent use of soil, water, power and developing innovative ways to do so. Recently, PepsiCo developed the world's first plastic bottle made entirely from renewable and plant-sourced raw materials. This, in contrast to the traditional PET bottle leaves less carbon trace on our planet.

Artificial Electronic Super Skin – Powered By Stretchable Solar Cells

Zhenan Bao, Stanford researcher, is keen to create "Super skin" that will be self-powered with renewable clean solar energy. This skin is not just flexible, but stretchable and are capable of being stretched up to 30 per cent beyond their original length and snap back without any damage or loss of power. It consists of a highly elastic rubber layer that is moulded onto a matrix of microscopic inverted pyramids. This rubber film is sandwiched between two parallel electrodes, which register compressions and rebounds as electrical signals of various strengths.

PowerMod: To the Rescue

With man-made or natural disasters occurring unexpectedly in all corners of earth, rescue efforts would be a lot easier and more successful if portable energy sources such as solar power or wind power would become more readily available. PowerMod is one solution that makes solar power more accessible. PowerMod is a portable solar tent that is ready to help in relief work serving victims of disaster. PowerMod is the simplest kind of shelter – a 20×20 ft roof of flexible panel. The panel is made by integrating FTL Solar lightweight fabric and Ascent Solar's thin-film solar cells. It is supported in the center by a pole. It gives a power output of 4.5 kilowatt hours/day. It weighs approximately 165 pounds. It can be assembled in 15 minutes and does not require more than two people for assembly.

Solar Tracker Solar Panels

A German owned company IMO has set-up a plant in USA that will make the largest solar tracker solar panels to tap solar energy. As per Ruediger Unverzagt and Klaus Pless, respectively the CEO and vice-president of this company, these solar tracker solar panels are the largest in Summerville in South California. IMO is looking forward to commercially sell these solar tracker solar panels. Despite being huge in size, they are very easy to assemble and one can assemble them just outside the building where they are to be installed.

The New Role of Microbes in Biof uel Production

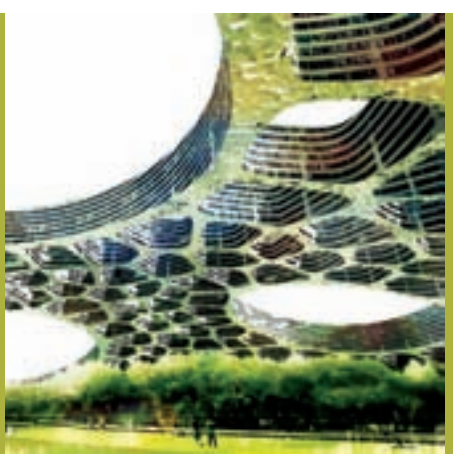
Currently biofuel is produced from plants as well as from microbes. The oils, carbohydrates, or fats generated by the microbes or plants are refined to produce biofuel. This is a green and renewable energy that helps in conserving fossil-fuel usage. But a new research has led to a new discovery of getting the microbes to produce fuel from the proteins instead of utilizing the protein for its own growth. The research is being done at the premises of University of California in Los Angeles.

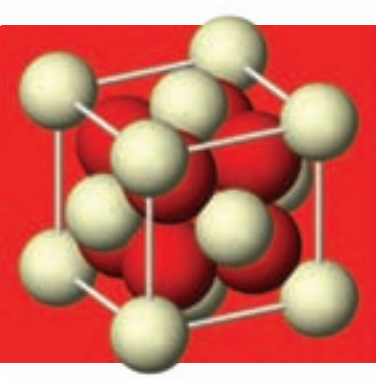
E-Reader Going Green: Biblio Leaf

Glad tidings for book lovers with green ethics! Maybe the e-reader does not consume much power. But if you love to read online and think you should do your bit towards using renewable energy, you have Toshiba and KDDI joining the ranks of LG to provide solar-powered e-readers. Biblio Leaf is the new kid in the e-reader block to match LG's Solar eReader.

Flat Tower: Innovative Architectural Solution

High-rise buildings and skyscrapers have been the most favoured architectural solutions for highly populated cities. It is a commendable idea for combining height - growing more vertically - and for its small footprint without hogging precious soil which is at a premium in most cities. But sporadic eruptions of skyscrapers do not add to the beauty of the skyline of any city nor does it add any way to the locale topographical charm. The solution seems to be structures that solve housing problem for the populace without spoiling the beauty of the city.

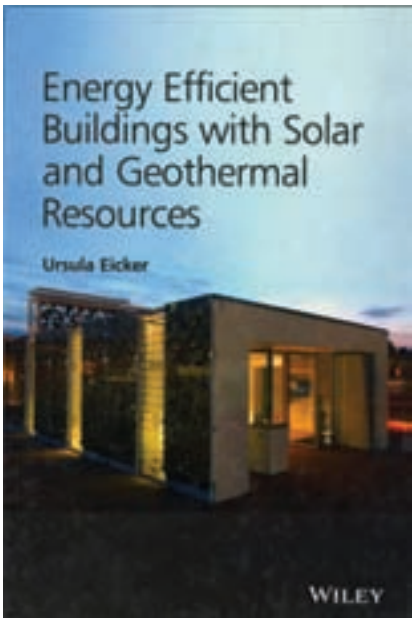




Ceria Mimics Plant Life

Newer and more exciting devices are being invented to harness renewable energy - especially solar energy. One such device is a prototype which uses one of the rare earth metals—ceria, otherwise known cerium oxide, utilizing its natural propensity of alternatively exhaling and inhaling oxygen as it heats up or cools down.

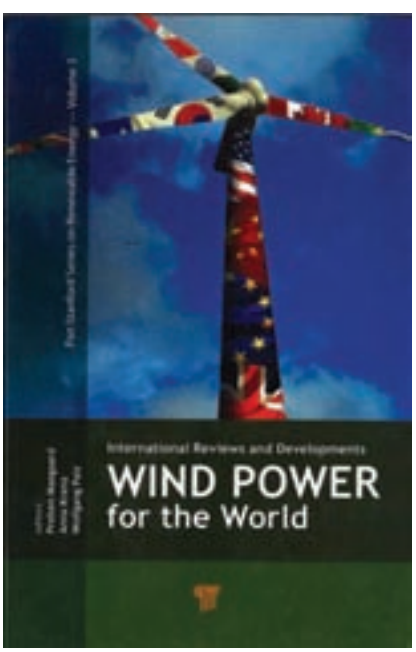
Energy Efficient Buildings with Solar and Geothermal Resources



A modern and unique perspective on solar and geothermal technologies for heating and cooling buildings. This book will have a broad appeal reaching practising engineers in the industry as well as the students. With introductory sections for each technology described, material includes chapters on: geothermal energy use for the heating and cooling of buildings; a chapter on electrically driven heat pumps/chillers; material on night radiative cooling, photovoltaic thermal collectors, temperature modelling and thin film photovoltaic modelling. It includes general introductory sections for each technology with market potential and applications, covers an increasingly important component of energy courses, and considers a broad range of alternative renewable energy supplies relevant to the building sector, such as geothermal energy with heat pump. This book lays a special focus on solar cooling, provides detailed physical models of all technologies and example calculations, and covers the fundamentals of meteorological modeling. ■

Author: Ursula Eicker

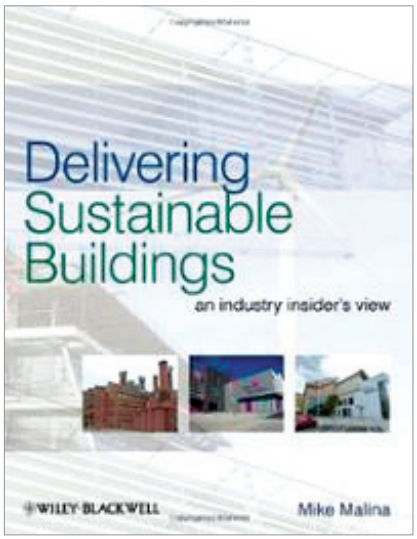
Wind Power for the World - International Reviews and Developments



The book's richly facetted stories describing stages of the development of modern wind industry, from the early stage till now (part 1), and reviews of wind power history and status quo in selected countries (part 2) are presented by 56 international experts from various areas of the renewable energy sector.
In the second part of the book "International Reviews and Developments", we collected reports and overviews of wind power status and history in various countries. The uphill struggle, wind energy strategies and policies that paved the way, the creative persons in politics, agencies, institutes, and in industries, the world societies at large, and how the challenges found a solution in different countries at the end are the main issues. Several of contributing authors are seniors who have made it all the way. Early they were involved in their home countries, at the international scene, at the scientific, engineering, organizational or political level and have made valuable contributions to the successful emergence of wind power. Without their professionalism, dedication and persistency wind power still might have been in its infancy. With rising global climate and resource crisis and increasing energy prices, time worked for wind energy as well while an astonishing technological development and reduced costs of equipment gradually made wind energy a realistic substitute for the conventional fossil fuels. The visionary persons that created the way out of the feared fossil fuel and uranium trap have interesting stories to tell. The book is made for non-specialists. Wind energy science and technology are covered to the strict minimum. The story we want to tell is how it became possible that wind power during a 35 year period has emerged and became a worldwide business of EUR 30 billion per year that, by 2012, employs almost one million people. ■

Author: Preben Maegaard

Delivering Sustainable Buildings: An Industry Insider's View



Author: Mike Malina

The book offers peer-to-peer insights and advice from a leading practitioner in this field and brings together in one book an overview of the main issues to consider when creating energy-efficient and sustainable buildings. A resource to dip into for practical advice, which is both highly readable and also backed up by in-depth technical knowledge, giving the important points to note and common pitfalls to avoid. Based on observations of an author with hands-on experience of dealing with the various elements of the building services engineering industry, the book gives a unique insight into the particular challenges faced by designers, project managers, contractors and installers working to deliver lower carbon and sustainable building projects and operation. There is a lot of guidance on sustainable buildings available from reputable sources including BRE, CIBSE, B&ES, ECA and BSRIA. This book is different in that it speaks directly to contractors and practitioners, with practical messages dealing with real on-site challenges, offering practical advice based on experience. Many contractors are now faced with a business choice of offering services related to issues of the energy hierarchy, minimizing energy use, providing good building automation and controls and then looking further at microgeneration/renewables. Here they must decide what technologies might be suitable for their businesses, as well as considering what level of training is required before they or their employees can start to work with these technologies. ■

Ecohouse 4th Edition

Author: Sue Roaf, Manuel Fuentes, Stephanie Thomas-Rees

Sue Roaf is famed for her approach to design and her awareness of energy efficiency. Here she reveals the concepts, structures and techniques that lie behind the realization of her ideals. By using her own house as a case study, Roaf guides the reader through the ideas for energy-efficient design or 'eco-design'.

Now in its fourth edition, the bestselling Ecohouse continues to be both a technical guide and an inspiration for thousands of architects, designers and eco-builders all over the world.

Ecohouse provides design information about the latest low-impact materials and technologies, showcasing the newest and best 'green' solutions. Revised and updated, this edition also includes new case studies inspiring readers with more real-life examples of how to make an ecohouse work. ■

RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT

First Solar surges on strong guidance, big efficiency gains and lower cost

First Solar, a vertically integrated thin-film solar EPC, had an analyst day on Wednesday that was full of industry-impacting announcements.

- First Solar has updated its module efficiency with a guidance that confronts average Chinese c-Si performance head-on by 2016
- It is speaking of a "split" manufacturing line that decouples front-end and back-end processes, a markedly new approach for the firm.
- The firm's new systems cost forecast is below $1.00 per watt by 2017.
- The new module cost forecast is less than 40 cents per watt by 2018.
- More than 4 gigawatts of deployable capacity will be in place by 2017.
- First Solar bumped up the CdTe module efficiency record to 17 percent, from the April 2013 mark of 16.1 percent.

First Solar is extracting heretofore unanticipated performance and cost metrics from the cadmium-telluride materials system. While solar companies are in the habit of providing ambitious guidance, there is reason to be optimistic about First Solar's prospects given that the company has a consistent history of beating expectations. Since First Solar's ability to participate in the world's two largest markets,, Japan and China is extremely limited and with the uncertain future of the US utility solar market in a post-RPS and post-ITC world, the key challenge ahead for the company is in winning large volumes of utility-scale solar projects in currently small-volume markets, such as the Middle East, Latin America, and Southeast Asia.

New efficiency roadmap

- First Solar asserts that it can equal efficiencies of average c-Si modules by the end of 2015.
- The company believes it can hit ~19.5 per cent efficiency in 2017 (that's up from a previous target of 17.2 per cent).
- The firm also sees credible long-term paths to 23-per cent-efficient and 25-per cent-efficient CdTe cells.

http://www.greentechmedia.com/articles/read/First-Solar-Surges-On-Strong-Guidance-New-Efficiency-Gains-and-Lower-Cost

No, renewables aren't going to blow up the grid

The German experience shows that there are some real challenges associated with renewable integration, but they're not technical. They are mostly related to rate structures, high costs of legacy renewable energy subsidies, and overlapping energy markets between countries.

America's largest wholesale competitive energy market PJM once again shows that high amounts of renewables can be integrated without harming the grid or necessarily raising energy prices and it doesn't take a whole lot of engineering muscle. In this week's show, we'll look at PJM's analysis of renewable energy integration, and ask why so many myths persist about renewables' role on the grid.

We'll also take a look at what Minnesota's new "value of solar" tariff means for the solar industry, and ask if a proposal from environmentalists to buy out the entire coal industry is feasible.

http://www.greentechmedia.com/articles/read/no-renewables-arent-going-to-blow-up-the-grid

Five crucial solar manufacturing stats for 2014

Most solar manufacturing statistics released over the last few years focussed on the severity of oversupply and its painful ramifications, i.e., how much excess capacity existed, how steeply prices had fallen, how many firms had been forced out of the market, and how many millions of dollars in losses suppliers had racked up.

The last six months, however, have witnessed a strong turnaround in market conditions and a significant improvement in solar supply fundamentals. Thanks to burgeoning demand (primarily out of China, Japan, and US) and the retreat, however temporary, of uncompetitive suppliers, pricing has been up stably, profit margins are back in the black, and shipments to all markets outside of Europe have been on the rise.

With 2014 expected to witness a continuation of the supply sector's resurgence, now is a good time for industry participants and observers to move past the overcapacity-induced doldrums of the previous few years and turn their attention to the path ahead. Here are five figures that illustrate the state of solar manufacturing in 2014.

Across the key segments of the solar value chain, polysilicon, wafers, cells, modules, and inverters, GTM Research estimates show that 90 solar manufacturing facilities now have an annual production capacity of one gigawatt or greater, more than double the count from 2010. Of these 90 "gigafabs," 36 are inverter assembly plants, 19 are polysilicon plants, and 19 are module production facilities (including both standalone module assembly plants and integrated wafer-cell-module fabs). The increasing number of such large plants (owned mostly by established producers such as REC, GCL, Motech, and Solar Frontier) and their constantly growing scale means that the barrier to entry for new entrants or potentially disruptive technologies is more daunting than ever before.

http://www.greentechmedia.com/articles/read/no-renewables-arent-going-to-blow-up-the-grid

Module manufacturing cost: $0.48 per watt

For the first time in history, a module company achieved a manufacturing cost of less than 50 cents a watt. That firm is China-based JinkoSolar, which achieved the feat in the dying light of 2013, using good old-fashioned multicrystalline silicon technology. Jinko managed to do so ahead of other Chinese peers, such as Trina and Yingli, largely due to high exposure to the polysilicon spot market as well as a high degree of upstream integration. Not only does Jinko own the production process from ingot to module, it also manufactures consumables, such as junction boxes and frames. While Jinko stood alone in attaining $0.50 per watt-cost in 2013, we expect other Chinese firms to catch up this year, and First Solar's Malaysian plant is also making great strides toward this mark.

Factors, such as a low-cost production location (even for China), the latest in Siemens-based technology, and generous government assistance have given a significant advantage to Daqo New Energy's brand-spanking-new polysilicon plant in the Xinjiang autonomous province. At its current capacity of roughly 6,000 metric tons (MT), manufacturing costs are around $14 per kilogram, which the company aims to reduce to $12 per kilogram after another 6,000 MT comes on-line in 2014. With other new plants from firms such as Wacker, Hemlock and Tokuyama also scheduled to begin operation in 2014-2015 (also employing more modern, lower-cost technology), a pricing environment of less than $20/kg – until recently associated with a grossly oversupplied market – can be a sustainable reality.

While the cost curve for polysilicon, especially pertaining to new technologies, will only head further south, don't expect this to be reflected in 2014 pricing trends. Spot prices for solar-grade silicon have rebounded strongly since bottoming out at less than $16 per kilogram in early 2013, and are now above $20 per kilogram for the first time in more than a year and a half. With demand expected to grow strongly in 2014 and only a limited amount of low-cost supply available, we believe this trend will continue over the course of the year. Fortunately for module suppliers and their customers, this shouldn't make too large a dent in their bottom lines even if, as GTM Research expects, average pricing for polysilicon increases by 25 percent in 2014, improvements in processing costs and silicon consumption mean that module costs would only rise by a few percentage points.

Thin film's relevance to the solar market at large has been on the wane since 2009, when it reached a high of 19 percent of total module production. The reasons for this are simple: barring some notable exceptions, thin film is more expensive, less efficient, and less bankable than Chinese crystalline silicon technology, which dominates the marketplace today. While thin film production levels have increased steadily over the years, they have been easily outpaced by growth in c-Si output, and despite what is expected to be a strong year for industry leaders First Solar and Solar Frontier, GTM Research estimates indicate that thin film will only make up 10 percent of total module production in 2014, its lowest share of the market since in 2006.

http://www.greentechmedia.com/articles/read/Five-Crucial-Solar-Manufacturing-Stats-for-2014-GTM-Research ■

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NATIONAL AND INTERNATIONAL EVENTS

SECOND INTERNATIONAL CONFERENCE ON SUSTAINABLE HUMAN DEVELOPMENT
April 2nd–3rd, 2014

London, United Kingdom
Website: http://ishud2014.eduservgroup.com/wp/

2014 International Conference on Coastal and Ocean Engineering (ICCOE 2014)
April 4th–5th, 2014

Dubai, United Arab Emirates
Website: http://www.iccoe.net/

4th Global Conference: Living Responsibly
April 6th–8th, 2014

Lisbon, Portugal
Website: http://www.inter-disciplinary.net/probing-the-boundaries/persons/ethics-everyday-life/call-for-papers/

CSP Today South Africa 2014

April 8th–9th, 2014
Cape Town, South Africa
0: http://www.csptoday.com/southafrica/

Wind Energy Summit South Africa

April 9th–10th, 2014
Cape Town, South Africa
Website: http://goo.gl/jbG8XX

6th Annual Wind Energy Operations and Maintenance Summit USA

April 15th–16th, 2014
Dallas, Texas, United States of America
Website: http://goo.gl/k8SP4p

1st National Power & Energy System Conference (NPESC-2014)

April 25th–26th, 2014
Sultanpur, UP, India
Website: http://knit.ac.in/pdf/notice_14oct2013.pdf

Next Generation Batteries

April 29th–30th, 2014
San Diego, California, United States of America
Website: http://bit.ly/NextGenerationBatteries

The 14th International Conference on Clean Energy
May 18th–22nd, 2014

Istanbul, Turkey
Website: http://www.icce2014.net

3rd Annual Weather Risk Management for the Energy Markets

June 12th–13th, 2014
Berlin, Germany
Website: http://www.marcusevans-conferences-paneuropean.com/3WRN_confalerts

International Conference on "Energy Technology, Power Engineering & Environmental Sustainability" (ETPEES-2014)
June 21st–22nd, 2014
New Delhi, Delhi, India

Website: http://www.krishisanskriti.org/energy.html

HydroVision International

July 22nd–25th, 2014
Nashville, TN, United States of America
Website: http://www.hydroevent.com

3rd International Renewable Energy and Environment Conference
July 4th–6th, 2014
Kuala Lumpur, Malaysia

Website: http://sciconference.net/ireec/index.php

Waterpower Hydro Basics Course Workshop

July 21st–22nd, 2014
Nashville, TN, United States of America
Website: http://www.hydroevent.com/waterpower-hydro-basics-course.html

2014 International Conference on Mechatronics, Materials and Manufacturing (ICMMM 2014)

August 2nd–3rd, 2014
Chengdu, China
Website: http://www.icmmm.org/

2014 4th International Conference on Environmental and Agriculture Engineering (ICEAE 2014)
August 6th–7th, 2014
Singapore

Website: http://www.iceae.org/

2014 International Conference on Mechatronics, Electronics and Automation Engineering (ICMEAE 2014)
August 15th–17th, 2014

Lijiang, China
Website: http://www.icmeae.net/

International Conference on Global Sustainability and Chemical Engineering
August 20th–22nd, 2014

Kuala Lumpur, Malaysia
Website: http://www.icgsce.com

Inter Solar India
November 18th–20th, 2014

Mumbai, India
Website: http://www.intersolar.in

RENEWABLE ENERGY AT A GLANCE

	Target		Achievements during the Month of January		Achievements during the Year (up to Jan-2013)		Cumulative Achievements	
	2012-13	2013-14	2012-13	2013-14	2012-13 (% of Target)	2013-14 (% of Target)	(as on 31.01.2013)	(as on 31.01.2014)
I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)								
Wind Power	2500.00	2500.00	131.30	149.35	1199.00 (48.00%)	1245.88 (49.83 %)	18551.70	20298.83
Small Hydro Power	350.00	300.00	10.10	11.00	110.93 (31.70 %)	141.90 (47.30 %)	3506.24	3774.15
Biomass Power & Gasification	105.00	105.00	-	1.00	98.50 (93.50 %)	22 .00(20.95 %)	1248.60	1285.60
Bagasse Cogeneration	350.00	300.00	41.30	0.00	297.70 (84.5 %)	175.45 (58.48 %)	2280.93	2512.88
Waste to Power	20.00	20.00	-	0.00	6.40 (32 %)	3.00 (15 %)	96.08	99.08
Solar Power	800.00	1100.00	60.23	28.36	295.30 (36.90 %)	523.49 (47.59 %)	1236.48	2208.36
Total	4125.00	4325.00	242.93	188.71	2005.83 (48.60 %)	2110.83 (48.80 %)	26920.03	30177.90
II. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN MWEQ)								
Waste to Energy	20.00	10.00	0.90	0.00	12.76 (63.80 %)	4.06 (40.60 %)	114.50	119.63
Biomass(non-bagasse) Cogeneration	60.00	80.00	12.00	7.56	55.53 (92.60 %)	46.19 (57.73 %)	438.04	517.34
Biomass Gasifiers -Rural	1.50	1.00	0.096	0.160	0.672 (44.80 %)	0.576 (57.60 %)	16.79	17.63
-Industrial	10.00	9.00	1.2	1.10	6.02 (60.20 %)	4.73 (52.56 %)	140.10	146.40
Aero-Genrators/Hybrid systems	0.50	1.00	0.11	0.03	0.21 (42.00 %)	0.07 (7 %)	1.85	2.18
SPV Systems	30.00	40.00	1.47	15.39	17.59 (58.60 %)	35.09 (87.72 %)	35.09	159.77
Water Mills/Micro Hydel	2.00 (500 nos)	2.00 (500 nos)	(10 nos)		(70 nos)	1.66 (83 %) (416 nos)	(2131 nos)	10.18 (2547 nos)
Bio-gas Based Energy System	2.00	2.00	-	-	-	-	-	-
Total	126.00	145.00	15.776	24.33	92.78 (73.60 %)	92.38 (63.71 %)	819.02	973.13
III. OTHER RENEWABLE ENERGY SYSTEMS								
Family Biogas Plants (numbers in lakh)	1.25	1.06	0.26	0.00	0.66 (52.80 %)	0.50 (47.16 %)	46.11	47.10
Solar Water Heating – Coll. Areas(million m^2)	0.60	0.50	0.7	0.04	1.41 (235.00 %)	0.51 (102.00 %)	6.87	7.51

Source: www.mnre.gov.in

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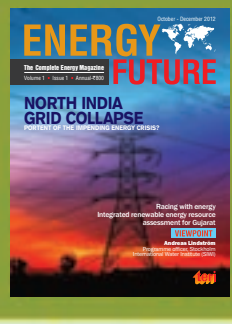

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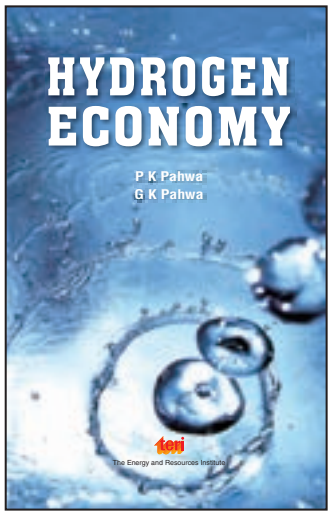

HYDROGEN ECONOMY

P K Pahwa
G K Pahwa

2014 • ISBN: 9788179935040
Pages: 390 • Binding: Hardback
Size: 160 × 240 mm • Price: ₹995.00

As the dependence on the depleting fossils fuels continues and global warming increases, we need to find an energy system that is renewable and sustainable, efficient and cost-effective, convenient and safe. Hydrogen has been proposed as the perfect fuel to sustain the energy system. The availability of a reliable and cost-effective supply, safe and efficient storage, and convenient end use of hydrogen will be essential for a transition to a hydrogen economy. Research is being conducted throughout the world for the development of safe, cost-effective hydrogen production, storage, and end-use technologies that support and foster this transition.

Hydrogen Economy discusses the strategies and roadmaps of introducing hydrogen as the alternate source of fuel for sustainable development. The book examines the link between development and energy, prospects of sustainable development, significance of hydrogen energy economy. It provides an authoritative and up-to-date scientific account of hydrogen generation, storage, transportation, and safety.

Key features

- Explains the significance of hydrogen economy
- Examines the feasibility of transporting, distributing and utilizing hydrogen
- Assesses the safety of using hydrogen and potential hazards

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