July–September 2014

ENERGY FUTURE

The Complete Energy Magazine

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INDIA'S GROWING ENERGY BASKET

Prospects of Nuclear Power

Demystifying IESS 2047

Myths and Facts on Bio-Energy

VIEWPOINT

Madhusudan Khemka
Chairman, Indian Wind Turbine Manufacturers Association

teri

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...

Normally when we think about energy future, what comes to our mind are latest developments in clean energy resources such as renewables. In this persistent pursuit of inexhaustible energy supply options, a very important, and perhaps more critical aspect, gets overshadowed. And that pertains to the rational use of energy, the whole gamut of energy conservation and energy efficiency improvements. With rapid pace of urbanization, building sector is witnessing unprecedented growth, especially in the developing countries. As per the latest Intergovernmental Panel on Climate Change (IPCC) Working Group III report *"In 2010, the building sector accounted for around 32 per cent final energy use and 8.8 GtCO_2 emissions...with energy demand projected to approximately double and CO_2 emissions to increase by 50 per cent –150 per cent by mid-century in baseline scenarios".* Thus, buildings present a huge potential for energy conservation through incorporating solar passive design features and use of more efficient appliances and equipment. And green building rating systems like GRIHA and LEED facilitate this transition.

However, in order to chart out a course of action, whether on the policy front or even at a personal level, a clear understanding of actions and their implications is required. The India Energy Security Scenarios 2047 or `IESS 2047' developed specifically for India helps in understanding the implications of choices made today on India's energy security.

Talking of choices, all the projects, even if they are based on clean energy technologies, need to be examined comprehensively to rule out any unintentional impacts on the local ecology and society. Addressing such concerns right at the design stage goes a long way in overall acceptance of such solutions by the people at large who actually are the ultimate beneficiaries. After all the energy future is for all to share.

Amit Kumar

Amit Kumar
Director, TERI

Editor: Amit Kumar Radheyshayam Nigam
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I found the article 'The Dark Powers' very informative. The article gives a clear idea about how there is a difference in views among people about climate change. The number of 'deniers' is increasing day-by-day, who strongly believe that there is no such thing called 'global warming'. So to make them understand the impact of climate change is a very challenging thing to do. The various financial instruments/idea suggested by Sapan Thapar are indeed very doable. If our governments and various policy-makers can use these ideas, it shall sure increase the acceptability of green power among the people.

Aditi Thakur
Chandigarh

I found this issue of Energy Future really interesting and informative as well. It covered very crucial topics this time. 'The Dark Powers', which is the cover story, highlighted the bitter reality of climate change under the influence of politics and money. I also really liked the sections Energy Insights and Product Update, as they were very engrossing. But the article that really grabbed my attention was Renewable Energy Revolution as use of renewable energy in this fast-paced world of industrialization is the need of the hour. Setting up energy-based mini-grids for lighting up remote villages is a step towards development. With such initiatives India will soon be an energy sufficient country.

Satyendra Singh
Ranchi

The articles in the last issue of Energy Future were certainly very interesting. The feature article 'Challenges Faced in Green Energy Power Generation' is highly knowledgeable. Renewable power has the capability to replace fossil fuels to be used in transportation, heating and cooling, and in fulfilling electric requirements. So efforts should be made by everyone to overcome these challenges. I also found the product update section very interesting.

Deepanjoy Seal
Guwahati

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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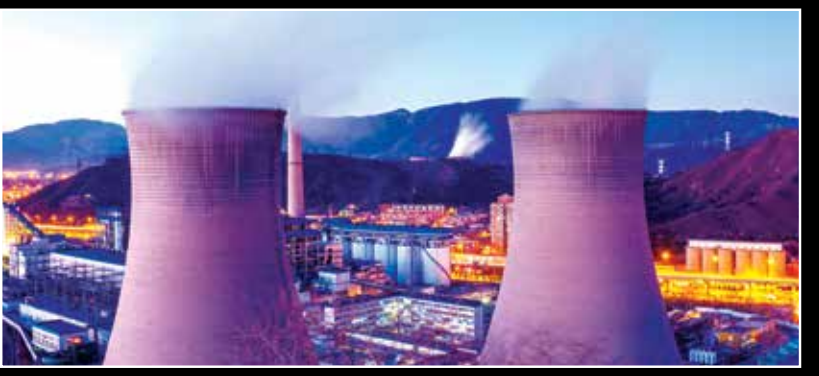

GRID-CONNECTED ROOFTOP SOLAR SYSTEM TO COME UP IN KOLKATA

The West Bengal Department of Power and the Kolkata Municipal Corporation, together with the UK government, are working on developing a grid-connected rooftop solar system.

"Over the next few months, we will be working with the West Bengal government and supporting Ashden India Renewable Energy Collective to help develop an affordable rooftop solar scheme through which people in Kolkata will be able to reduce their power bills and greenhouse gas emission in the city", said Scott Furssedonn-Wood, British Deputy High Commissioner to Eastern India.

Under this initiative, there will be a major emphasis on capacity-building programmes for key stakeholders to implement such schemes in the state. EF

Source: http://articles.economictimes.indiatimes.com

US GREEN BUILDING COUNCIL TO SUPPORT CERTIFICATION PROGRAMME IN INDIA

The US Green Building Council (USGBC) announced that it was expanding its support of Leadership in Energy and Environmental Design (LEED), the popular global green building programme, in India.

"The uptake of LEED across the globe has been extraordinary", said Rick Fedrizzi, President, CEO, and founding chair, USGBC.

"Because LEED buildings save energy, water, and precious resources, these are our first line of defence in the worldwide fight to slow the impacts of climate change and promote wellness. The multinational architectural, engineering, and construction companies that are leading the building boom around the world were early adopters of LEED in the US and they are now applying LEED's principles and benefits in more than 150 countries. USGBC wants to provide significant support that can underpin this strong growth", he said.

According to a report released by USGBC, India ranks third, globally, for countries outside the US with the most LEED-certified space, with nearly 12 million square metres.

The LEED system is the most widely-used rating system guiding the design, construction, operations, and maintenance of green buildings. Project teams in more than 150 countries and territories have implemented this in their building projects to create structures that mitigate greenhouse gas emissions, create healthier indoor environments for workers, students, and community members, and lower utility bills for building owners through reduced energy and water use. EF

Source: http://www.thehindubusinessline.com

INDIA DELIBERATES USE OF RENEWABLE ENERGY ON LARGE SCALE

A three-day exhibition on renewable energy sources, 'Renergy 2014' was held in Chennai. Hundreds of Indian and international companies set up stalls to exhibit products and participated in conferences and seminars that covered larger use of renewable energy sources. They discussed the use of solar energy, wind energy, waste-to-energy, biomass, and energy efficiency in India.

The aim of the exhibition was to give private companies a common platform where ideas on sustainable power generation could be exchanged. "We already know that renewable energy has huge scope in our country, whether it is wind or solar energy. Thousands of megawatts can be installed. However, the progress is very slow. To ensure the progress at a faster rate, different agencies need to sit together and discuss so that they can understand the issues, solve them, and move forward together", said Madhusudan Khemka, Chairman, Indian Wind Turbine Manufacturers Association. Companies showcased latest products and gave live demonstrations highlighting concepts and prevailing trends in renewable energy.

"India has a very strong ecosystem for wind manufacturers. In fact, some of Indian wind manufacturers are exporting globally and the global companies are all here. As you are aware, all wind manufacturing happens domestically. To my knowledge, the Indian wind industry is capable of producing 10 gigawatts annually", said convener, Renergy 2014, Vineeth Vijayaraghavan.

India's power generation has grown—the peak deficit is down to 5.4 per cent from 16.6 per cent in 2008, government data shows—but getting the supply to end consumers is far trickier. EF

Source: http://www.aninews.in

MEGA SOLAR PROJECT IN PURULIA

The state government has placed a proposal to the Centre for setting up a 250MW solar power project near the Purulia Pumping Storage Project (PPSP) at Baghmundi for an estimated cost of Rs 1,700 crore.

This will be the world's biggest solar power project if the state government can sort out the issues of land availability and funds and get the nod from the Ministry of New and Renewable Energy.

Power minister Manish Gupta spoke about the plan at a national seminar. "The Centre has agreed in principle", he said.

The biggest hurdle, however, before the state government is land. Around 700 acres will be required for the project. The PPSP of West Bengal State Electricity Distribution Company Limited has four units of 224MW hydel power each.

Gupta said the proposal will have to be approved by the state finance department and in the state cabinet. The state wants grants under the national clean energy funds to execute the project.

The PPSP site has been proposed by the state government as it is a natural source of water. The plan is to pump the water through solar power. Once this happens, it will become a complete natural water pumping system using water and solar power. EF

Source: http://timesofindia.indiatimes.com

FIRST MODULE OF ROOFTOP SOLAR POWER PLANT OF DELHI METRO INAUGURATED

The first module of Delhi Metro's rooftop solar power plant has been inaugurated. The plant was inaugurated at the Dwarka Sector 21 Metro station. An official of Delhi Metro Rail Corporation (DMRC) said the power produced from this plant will meet the power requirements of the DMRC at this station.

"The rooftop solar power plant is expected to start by end of July", he added. It has a power-generating capacity of 500 kWp.

The Delhi Metro is the first Metro system in the country to install such plants at its Metro stations. The official added a power purchase agreement (PPA) regarding the installation of the plant was signed in 2013 between the DMRC and a multinational firm that is engaged in installation of solar power plants.

This is the largest rooftop plant with such capacity in the Delhi National Capital Region under the Renewable Energy Service Company (RESCO) model. Under this model, the DMRC will pay for the units generated by the plant and the capital investment shall be provided by the developer. EF

Source: http://www.ianslive.in

GREEN INITIATIVES IN RAIL BUDGET 2014-15

Shri DV Sadananda Gowda, Hon'ble Railway Minister, Government of India, presented his maiden rail budget for FY 2014–15 on February 12, 2014. As per Prime Minister Narendra Modi's vision on harnessing renewable energy in rail sector to reduce dependence on fossil fuels, various 'Green' initiatives were proposed by him. The Minister notified that the Railway Energy Management Company has become functional and is working on setting up of windmill plants and solar power plants, with about 40 per cent subsidy from Ministry of New & Renewable Energy. The energy produced from these Green sources, to begin with, will be used in 200 railway stations, roof top of 26 buildings, and in functioning of 2,000 level crossing gates. With a view to improving aesthetic ambience along the track close to the approach of major stations, creation of 'Green Curtains' at Agra and Jaipur stations is being undertaken on pilot basis. A bio-toilet design has been adopted by the railways and the technology has been introduced in about 2,500 coaches. It is proposed to increase the coverage progressively. In the rail budget, it has been proposed to utilize rooftop spaces of stations, railway buildings, and barren land to set up SPV cells. This energy will then be used to produce bio-diesel, which will run the locomotives. EF

Source: http://www.indianrailways.gov.in

OVER 2/3rd POPULATION OF INDIA STILL RELIES ON DUNG-BASED FUEL: UN REPORT

More than two-thirds of India's one billion population continues to rely on carbon-emitting biomass and dung-based fuel to meet energy needs for cooking, according to a UN report.

"More than half of the global population lacking clean cooking facilities lives in India, China, and Bangladesh. Here, India sits at the top of the list as the country with the largest population lacking access to clean fuel for cooking", says the United Nation Industrial Development Organization report titled "*Sustainable Energy For All*".

"Roughly 85 per cent of the rural households are dependent on traditional biomass fuels for their cooking energy requirements and about 45 per cent do not have access to electricity", says the report.

In many poor rural communities, where biomass remains the most practical fuel, improved cook-stove can cut back indoor smoke levels considerably, says the UN.

"Burning solid fuels produces extremely high levels of indoor air pollution. Typically, 24 hour levels of PM10 in a biomass-using home range from 300 to 3000 micrograms per cubic metre", says the report. As cooking takes place every day of the year, most people using solid fuels are

exposed to small smoke particles at a level many times higher than the accepted annual limits for outdoor air pollution. "Thus, the health impact of burning biomass fuel is considerable, apart from being an obstacle to achieving a minimum standard of living", it says. EF

Source: www.business-standard.com

NDMC WASTE-TO-ENERGY PLANT SUPPLYING POWER TO 8,000 HOUSEHOLDS

As the residents in the national capital grapple with an acute power crisis, the New Delhi Municipal Council is doing its bit to ease the situation by daily contributing 16 megawatt of electricity generated from solid waste to 8,000 households in the city.

The civic body is generating power using solid waste as fuel at a 'Waste-to-Energy' plant on NDMC land in Okhla. This plant generates 16 megawatts of electricity per day which is being used by 8,000 households, said NDMC chairperson Jalaj Shrivastava.

The plant, set up in 2011, processes 1,300 Mt municipal waste of which 200 to 400 Mt is contributed by NDMC as fuel. It is equipped with modern systems and uses the latest technologies to minimize health and environmental risks, Shrivastava said. The civic agency has so far delivered an approximate quantity of about 2 lakh Mt of municipal solid waste at the plant site. The plant, set up as a Public-Private Partnership project on DBOT (Design, Built, Operate, Transfer) scheme, also ensures that it achieves burning of maximum level of segregated waste to minimize pollution levels. Besides generating electricity, NDMC is also saving Rs 2.73 crore per year through the plant which was earlier being used to dispose of the municipal waste. EF

Source: http://articles.economictimes.indiatimes.com

TRANSFORMATION: FROM WASTE TO ENERGY

In Edmonton, Canada, the waste is the same as at municipal waste plants around the world — shoes, sofas, and other items that can't be recycled and are destined for landfills or incinerators — but the fate that awaits Alberta's garbage is different as it's being turned into bio-fuels.

"We use heat and pressure to break down the materials that usually end up in the landfill", explains Vincent Chornet, chief executive of Enerkem, the company behind the technology. "We then turn it into methanol and ethanol. In total, the process from waste to final product takes about four minutes." Enerkem's technology produces renewable electricity, chemicals for plastic and, of course, ethanol for cars.

"Waste is now an opportunity." Montreal-based Enerkem's contract with the city of Edmonton includes treatment of 100,000 tonnes of garbage annually for 25 years. Enerkem, will yield 138m litres of ethanol per year from this, enough to fuel 400,000 cars driving on a 5 per cent ethanol blend.

Sweden is a leading practitioner of the fast-growing sector of garbage to energy. According to reports, environment-friendly energy from garbage heats 810,000 Swedish households.

Not only that, the garbage also produces enough electricity for 240,000 Swedish households. That's the equivalent to more than 1 million litre of oil per year.

The average Sweden produces 237.6 kg of non-recyclable garbage each year, according to the association, of which 49 per cent is burned and used as energy. EF

Source: http://www.thehindu.com/

WORLD BANK SAYS 'CLIMATE SMART' POLICIES BOOST GROWTH

Policies aimed at curbing climate change can boost economic growth, create jobs and save millions of lives, according to World Bank President Jim Yong Kim.

"Climate smart" policies to reduce emissions of carbon dioxide in Brazil, China, India, Mexico, the US, and European Union would increase global gross domestic product by $1.8 trillion per year, Kim said, referring to a World Bank study released in Washington.

The release of the World Bank report coincides with efforts by the EU to craft an agreement in October that would cut greenhouse gases by 40 per cent by 2030. It is the biggest initiative to combat global warming since the Kyoto climate treaty of 1997.

The report, co-written with San Francisco based ClimateWorks Foundation, measured the impact from regulations, taxes, and incentives aimed at reducing greenhouse gas emissions in transportation, industry, and the construction of energy-efficient buildings and appliances.

The study describes findings from four simulated case studies, including the adoption of more efficient cooking stoves in rural China and improved solid waste management in Brazil.

China would generate 22,000 jobs and yield almost $11 billion in economic benefits from the introduction of

70 million stoves over about 15 years, the bank said. Brazil by 2032 could increase GDP by more than $13.3 billion and create at least 44,000 jobs by disposing of solid waste in sanitary landfills.

A shift to a more energy-efficient industrial sector would save 52,000 lives a year in the six regions of the study. EF

Source: http://www.renewableenergyworld.com

BRAZIL'S COSAN SEES POTENTIAL TO TRIPLE BIOMASS POWER GENERATION

Billionaire Rubens Ometto's Cosan SA has the potential to triple its power generation by burning sugarcane leftovers if the government offers power-purchase contracts for biomass producers.

Brazil's biggest sugar and ethanol producer could generate a surplus of as much as three gigawatts of power if the company used all the bagasse and straw available in its units, Chief Financial Officer Marcelo Eduardo Martins said in an interview. Such a move wouldn't require the company to expand its sugar and fuel output.

Brazil's sugar producers say much of the industry's energy potential is wasted because the government does not provide the economic stimulus needed to increase biomass power generation, while hydroelectric power plants have been struggling with lack of rain.

Raizen Energia, Cosan's sugar and ethanol production venture with Royal Dutch Shell Plc., wastes about two-thirds of its sugarcane biomass.

"Our potential is huge", said Martins during a visit to Bloomberg's office in Sao Paulo."We can only invest if there are auctions at viable prices."He said the company would need to invest three million ($1.4 million) to four million reais for every additional megawatt of power-generating capacity. EF

Source: http://www.renewableenergyworld.com

BOSTON IS GETTING SOLAR-POWERED SMART BENCHES IN ITS PARKS

The next park bench you sit on may be smarter than you think. Boston is rolling out new smart benches to parks around the city, which will use solar power to allow anyone to charge their phone on the go and record data about their surroundings at the same time.

The benches, developed by MIT Media Lab spin-out Soofa, are able to charge devices plugged into them via USB, thanks to integrated solar panels. On-board sensors also allow the bench to record location-based environmental information, such as air quality and noise-level data, which is then uploaded to the cloud for future analysis. The first benches in Boston are funded by Cisco Systems. They will

first appear in Titus Sparrow Park in the South End, the Boston Common, and the Rose Kennedy Greenway, but it is hoped they will spread further over time. EF

Source: http://www.gizmodo.in

WHICH COUNTRIES ARE USING A LOT OF SOLAR ENERGY?

Britain and Germany have broken records for generating solar electricity in the last few weeks, according to new industry figures.

Germany generated over half its electricity demand from solar for the first time ever on June 9, and the UK, during the longest days of the year, nearly doubled its 2013 peak solar power output at the solstice weekend.

France, Italy, Denmark, and other countries are also believed to have generated record amounts in June.

In 2013, says the EPI report, China added "at least" 11.3 gigawatt and is now the second largest generator of solar power after Germany. The US added some 4.8 gigawatt, increasing its total capacity by 65 per cent to 12 gigawatt.

Elsewhere, Canada added 440 megawatts to reach 1.2 gigawatt in 2013, Mexico nearly doubled its PV capacity to 100 megawatt and is expected to reach 240 megawatt by the end of 2014, and Japan, spurred by the closure of nuclear power plants following Fukushima, more than doubled its capacity by adding 6.9 gigawatt in 2013. EF

Source: http://www.thehindu.com

GOVERNMENT POLICIES KEEP THE US AND CANADA AMONG THE WORLD'S LEADERS FOR RENEWABLE POWER GENERATION

According to GlobalData, a research and consulting firm, federal and state governments policies in the US and Canada are driving the growth of renewable energy.

Federal policies, such as the US government's Production Tax Credit (PTC) and Canada's ecoEnergy Program, alongside state policies including Renewable Portfolio Standards (RPS) in the US, are fundamental to the continued development of renewable power in North America.

Swati Singh, Analyst for GlobalData, says, "In the US, renewable power growth has been stimulated by state-level RPS led by California and Texas. Under RPS, most participating states have set targets to produce between 10 per cent and 20 per cent of their energy from renewable sources by specified dates from 2015 onwards. Some states have more ambitious targets, such as 33 per cent in California by 2020 and 40 per cent in Maine by as early as 2017." In Canada, the ecoEnergy Program has seen approximately $5 billion invested in a variety of federal schemes to provide Feed-in Tariffs (FiTs) and to fund renewable energy projects, finance technology initiatives, and support energy efficiency.

Quebec has a target of achieving 4,000 Megawatts of wind power by 2015, while provinces such as British Columbia and Saskatchewan are targeting 90 per cent and 100 per cent, respectively, of new power generation from renewable resources by 2016.

"Of all the Canadian provinces, Ontario has the greatest renewable energy capacity. Its Renewable Energy Standard Offer Programme sets a FiT for small renewable energy production projects, with the aim of making it easier and more economical for businesses to supply renewable power to the provincial grid", Singh concludes. EF

Source: http://www.energetica-international.com

ZNSHINE, MAP ENVIRONMENTAL PLAN 400 MW OF SOLAR POWER PROJECTS

Chinese solar photovoltaic module manufacturer ZNShine Solar announced that it will work with renewable technology provider MAP Environmental to develop approximately 400 Megawatts of solar projects in the United Kingdom — the largest solar agreement of its kind in the UK.

As part of the agreement, the two companies will together invest £400 million (US$680 million) overall to develop the new solar projects, which will range from social housing, commercial rooftop, and ground mounted installations.

The agreement marks a significant advancement towards the UK meeting its goal to cut carbon emissions by 80 per cent by 2050.

"Our pipeline is very healthy and in some cases quite advanced", Ross Gard, Marketing Manager of MAP Environment told Solar Power Portal. It ranges from very small to exceptionally large. I can't disclose exact figures per site at this time but our pipeline currently stands at around the 400 MW mark in total."

The deal was approved by the UK Government during Chinese Premier Li Keqiang's visit to the UK earlier in June. The agreement is expected to create up to 50 new jobs in

design, administration, and operation roles, and 500 new jobs in construction and maintenance at a local level.

"We are proud in cooperating with a valuable partner in supporting the UK´s commitment to reduce its carbon footprint", General Manager of ZNShine Solar, William Wang said in a statement. EF

Source: http://www.pennenergy.com

"GLOBAL CUMULATIVE WIND POWER CAPACITY TO MORE THAN DOUBLE BY 2020, LED BY CHINA," SAYS GLOBALDATA

Despite an overall slump in installations in 2013, the global cumulative wind power capacity will more than double from 319.6 GW at the end of 2013 to 678.5 GW by 2020, says research and consulting firm GlobalData.

The company's latest report states that China, the largest single wind power market responsible for 45 per cent of total global annual capacity additions in 2013, is expected to have a cumulative wind capacity of 239.7 GW by 2020. China overtook the US as the leading market for installations in 2010, when it added a massive 18.9 GW of wind capacity.

Harshavardhan Reddy Nagatham, GlobalData's Analyst covering Alternative Energy, says, "China doubled its cumulative wind capacity every year from 2006 to 2009 and has continued to grow significantly since then. Supportive government policies, such as an attractive concessional programme and the availability of low-cost financing from banks, have been fundamental to China's success.

"While China will continue to be the largest global wind power market through to 2020, growth for the forecast period will be slow due to a large installation base". EF

Source: http://energy.globaldata.com

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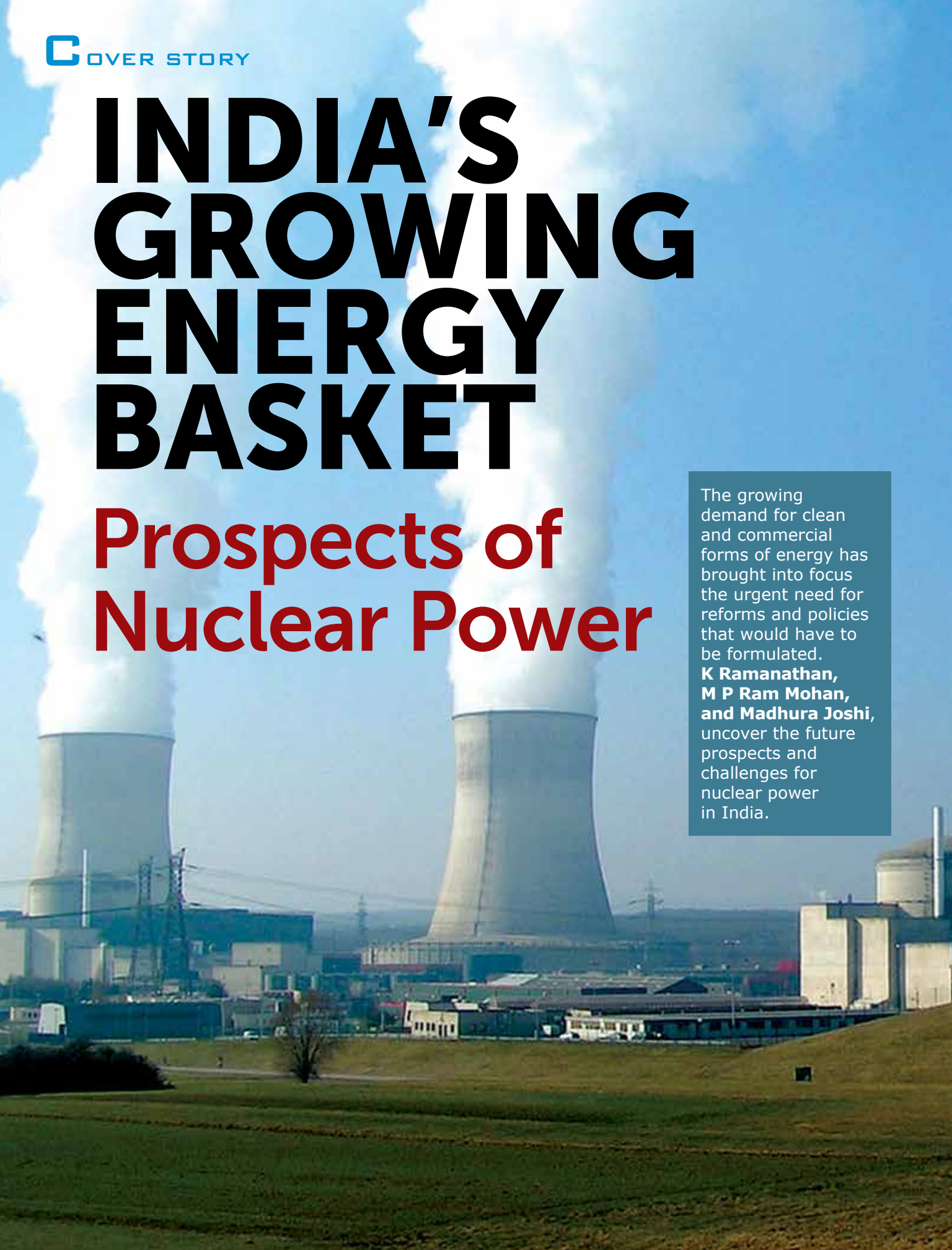


The growing demand for clean and commercial forms of energy has brought into focus the urgent need for reforms and policies that would have to be formulated. **K Ramanathan, M P Ram Mohan, and Madhura Joshi**, uncover the future prospects and challenges for nuclear power in India.

The energy sector in India has a challenging task ahead. The demand for clean and commercial forms of energy is increasing at a fast pace as a result of accelerated economic growth, growing aspirations of the people, and rapid urbanization. At the same time, in spite of various well intended efforts on part of the government on the reform, policy, and regulatory fronts, matching augmentation of supply has not been taking place. In the case of power sector, for example, we have been witnessing continuing shortages for many years now. It is also true that over 400 million rural population have no access to clean energy. This situation is no longer sustainable and a multipronged approach focusing on both supply and demand sides is considered necessary in this context. On the supply side we need to exploit all available resources giving due emphasis to all aspects of energy security including fuel availability, environmental and social impacts, pattern of resource availability, operational efficiency and flexibility, cost, etc. In this paper we focus on nuclear power, which can play a key role in meeting the growing energy needs, especially the base load in the medium and long term.

Evolution over the Years

India's nuclear programme has a long history studded with bright as well as some difficult periods. The programme was initiated in 1945 with the establishment of the Tata Institute of Fundamental Research in Bombay. The Atomic Energy Act (AEA) was passed in Parliament soon after the country gained independence in 1948, which set forth the country's objective for the development and utilization of atomic energy. The Act, after getting amended several times, got finalized on 1962. The Act has bestowed the Central Government monopoly over production, development, usage, and disposal of nuclear energy. The establishment of the Department of Atomic Energy (DAE) in 1954 being vested with the sole responsibility for all nuclear activities in the country was yet another landmark in the nuclear programme. In order to carry out regulatory and safety functions envisaged under the AE Act, the Atomic Energy Regulatory Board (AERB) was constituted on November 15, 1983 by the President of India. As per the Constitution order, AERB is given the power to lay down the safety standard, and frame rules and regulations. Recently, Parliament is debating on a new empowered regulatory structure replacing AERB.

The strategy for development was based on a three-stage closed nuclear fuel cycle. This was based on the fact that India has limited uranium reserves but has large reserves of thorium, one of the largest in the world. In the first stage, the focus was on natural uranium reactors and there has been a fair amount of success so far. DAE has successfully indigenized and commercialized around 17,220 MWe and 550 MWe Pressured Heavy Water Reactors (PHWRs) and four 770 MWe sized reactors are under construction. Alongside the indigenous self-reliant three-stage programme, the country has also ventured into the import of Light Water Reactor (LWR) technology from Russia. One such reactor has already been commissioned and another one is under construction.

The second stage, which envisages setting up of Fast Breeder Reactors (FBRs) backed by reprocessing plants and plutonium-based fuel fabrication plants, has also made some progress. A 500 MWe prototype FBR at Kalpakkam is now in its advanced stage of completion. Further, the public sector undertaking Bhavini under DAE has been mandated to build a series of breeder reactors, the first one of which is expected to be completed by 2015 (published in The Hindu, July 18, 2014). Preparatory work on the third stage, which proposes the use of thorium for the bulk fuel production instead of uranium, has also begun. Thorium, apart from resource availability point, can offer considerable advantages over uranium from an environmental perspective as it is a low-carbon, low-radioactivity fuel. The basic design of thorium-fuelled Advanced Heavy Water Reactor (AHWR) is reportedly ready. While the "trigger fuel" in the original design is a small quantity of plutonium, it is proposed to be low-enriched uranium (LEU) in the new one. It is envisaged that AHWR will eventually have design flexibility. The fuel to be used in the AHWR can be either plutonium-thorium or LEU-thorium combinations.

Though the country had formulated a well-structured and ambitious nuclear programme, there have been issues in its implementation. Since India is not a part of Nuclear Non-Proliferation Treaty (NPT), 1970, it could not seek assistance and collaboration from other countries. To join as an NPT member, India had to discard its nuclear weapons capability and join as Non-Nuclear Weapon State (NNWS)—a classification India was not willing to abide by. Following the peaceful nuclear testing experiments in 1974 and 1998, the country was further isolated in terms of withdrawal of foreign technical cooperation and supplies, and this caused a serious setback to the Indian nuclear programme. However, what ensued is that the embargoes spurred the growth of indigenous capability and ensured continuity. Even within the sanction phase, the second nuclear power plant in Rajasthan started its commercial operation in 1981. It also goes to India's credit that its first 40 MWe Fast Breeder Test Reactor (FBTR) attained criticality in 1985 using indigenously made plutonium-uranium mixed carbide fuel, etc. The technological isolation had its adverse impacts. Availability of uranium fuel became a concern and this had reduced the load factor of power plants (World Nuclear Association 2014).

But things are changing for the better. The agreement between India and the United States in 2005 to cooperate on civilian nuclear programme has removed decades of technological isolation. Recognizing India as an advanced nuclear technology country with impeccable non-proliferation record, the deal has allowed India to be part of nuclear trade. Subsequent to US Government ratification, India has negotiated with International Atomic Energy Agency (IAEA) for an India specific safeguards agreement, and Nuclear Supplier's Group for Wavier to allow trade with India. Similarly, India has already concluded civil nuclear cooperation

agreements with Argentina, Kazakhistan, France, United Kingdom, and with other countries. For large scale uranium imports, negotiations with Australia are in advanced stage. The resumption of international assistance marks a high growth oriented phase in nuclear energy production, both indigenous and imported. India is also now in a position to import uranium. It is expected that in the short and medium term, a number of projects with imported high capacity reactors would get commissioned. These include additional three to four reactors in Kudankulam, two 1,650 MWe reactors in Jaitapur, Maharashtra, two 1,500 MWe reactors in Kovvada, Andhra Pradesh, and two 1,000 MWe reactors in MithiVirdi, Gujarat. Negotiations with foreign suppliers for these reactors are reportedly under progress. Development of thorium based reactors is also expected to get a boost following permission granted under the Indo–US deal for import of LEU.

Presently, there have been talks about amendments to the AEA, which could pave the way for more organizations, other than government and PSUs owned by it, to set up nuclear power plants. If this happens, it would help accelerate the growth of nuclear power and would be yet another significant landmark in the evolution of our nuclear power programme. As per reports, the National Thermal Power Corporation (NTPC), Oil & Natural Gas Corporation (ONGC), Indian Oil Corporation, and NALCO have been roped in as possible joint venture partners with NPCIL.

Nuclear Power in India — Current Status and Future Plans

There are 21 reactors presently in operation with a total installed capacity of 5780 MWe. This constitutes about two per cent of the total installed power capacity in the country. In terms of electricity generation, nuclear power had contributed 35,333 MU during 2013–14, amounting to about four per cent of the total gross generation. As per the government plans, a substantial addition in capacity is envisaged in the coming years (see Table given below).

It is true that achievements in the past have fallen short of the targets. For example, the Integrated Energy Policy of 2006 had estimated an installed capacity of 11 MWe in an optimistic scenario and 9 MWe in a pessimistic scenario. Nevertheless, there are hopes of catching up with the targets given the recent developments including possibilities of import of uranium and high capacity reactors. As per recent reports, another 17,080 MWe is expected to be added by 2022. Public perceptions and international outlook could however impact the future growth targets.

Operational, under-construction, and proposed sites

States	Site	Capacity (MWe)		
		Operational	Under-construction	Proposed
Maharashtra	Tarapur	2x160 + 2x540	—	—
	Jaitapur*	—	—	2x1650
Rajasthan	Rawatbhata	100+200+(4x220)	2x700	—
	Mahi, Banswara*	—	—	2x700
Tamil Nadu	Kalpakkam	2x220	1x500	2x500
	Kudankulam	1000	1x1000	2x1000
Uttar Pradesh	Narora	2x220	—	—
Gujarat	Kakrapar	2x220	2x700	—
	Chhaya Mithi Virdi*	—	—	2x1100
Karnataka	Kaiga	4x220	—	2x700
Haryana	Gorakhpur *	—	—	2x700
Madhya Pradesh	Chutka *	—	—	2x 700
	Bhimpur *	—	—	Pre-project activities
Andhra Pradesh	Kovvada *	—	—	2x1500
West Bengal	Haripur *	—	—	Pre-project activities

*New sites

Source: Rajya Sabha, 2012 with updates by the authors.

Challenges to the Programme

While the potential of the nuclear programme is significant, there are also several challenges to the development of the programme.

Availability of Uranium

Domestic availability of uranium, the only fuel source as of now, is one of the major concerns in going ahead with the nuclear programme. Presently it is mined only in Jharkhand and Andhra Pradesh, which is also of low quality. A few other sites, including in Karnataka and Meghalaya, reportedly have uranium deposits (Figure 1). The techno-eco feasibility of opening new mines would however very much depend on the eco-sensitive nature of these sites and the public perception in the area. An estimate of resource availability is also a matter of contention. It varies from 80,000 tonnes to around 184,964 tonnes.

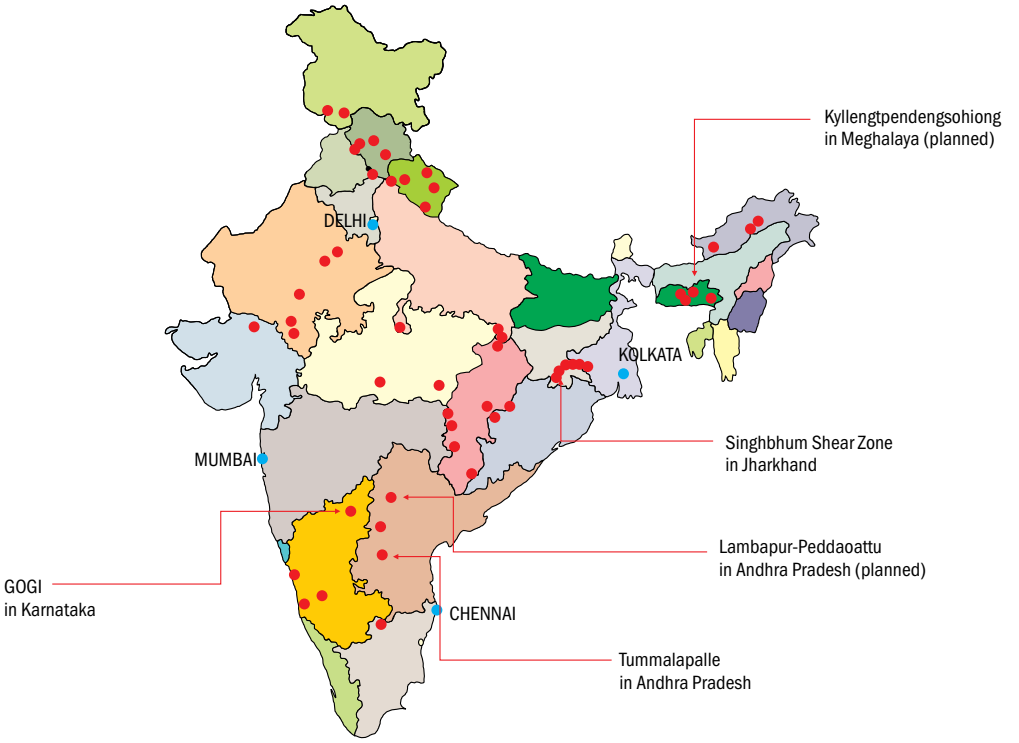
The possibility of import of uranium, which has opened up now, could ease the situation. The concern here is the somewhat varied perceptions and approaches on part of the potential exporting countries.

Cost of Imports

As mentioned earlier, the country is planning to import high capacity reactors from abroad. The costs of these are considerably higher compared to domestic ones. For example, while a domestic reactor costs around five crore per MWe (if overnight costs were to be considered), the estimated cost of an imported reactor is found to vary between 16 crore/MWe to 36 crore/MWe, based on the technology. This could have a significant impact on the cost of power.

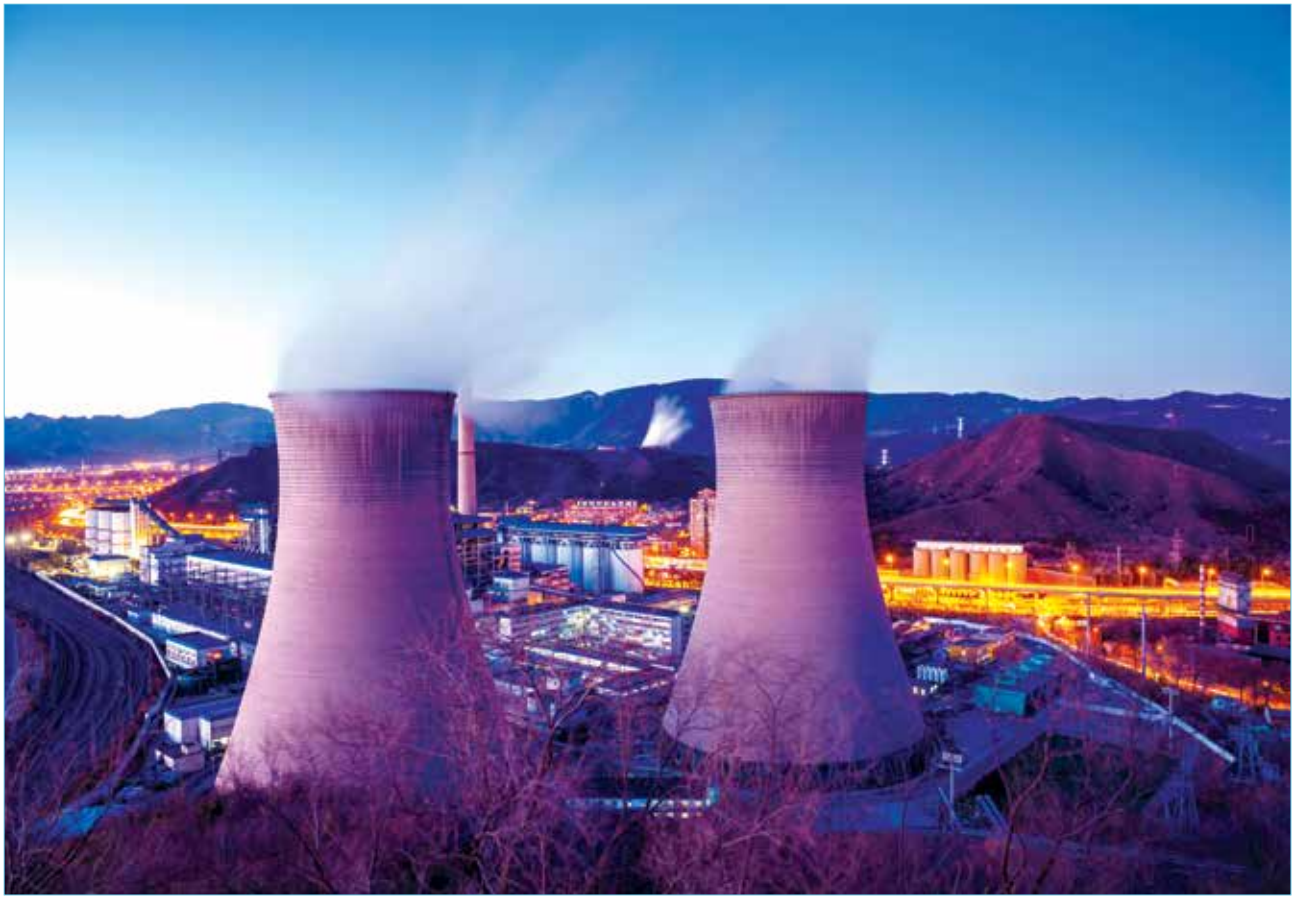
International Politics

Opening up the possibility of trade has helped India secure fuel supply for those reactors which are under the IAEA safeguards. These have performed at 80 per cent capacity factor due to improved supply. However, due to India's position on the NPT, India has to negotiate fuel supply agreements with the individual countries. While this in itself is not an issue, a growing dependence on imported fuel could be a cause for concern in the future as imports are contingent on international sentiment. Currently, the NSG has made an exception for India, though there are regular voices of displeasure due to this. For instance, both Australia and Japan have expressed reservations about India's position on the CTBT and NPT, with several within the countries demanding for more stringent controls on the Indian nuclear programme. While the current administrations in the two countries are more interested to fix a deal with India (uranium exports from Australia and technology from Japan), the negotiations have been



Uranium sources in India

Source: Uranium Corporation of India Ltd (2013)



protracted. Strategic considerations also become important while considering uranium imports.

Land Issues

Difficulties in acquiring land and issues faced in commencing work in previously acquired land are some of the crucial issues stalling the development of new power plants, as well as opening up of new mines (For instance, protests seen in Jaitapur, Kudankulum, and in Domiasiat in Meghalaya). Protests against large-scale infrastructural projects have been faced in several other sectors as well. While some of the reasons for these protests (across sectors) are systemic—insufficient compensation, bad implementation of rehabilitation, and resettlement, no social impact assessments are carried out to gauge the impact of resettlement of people, insufficient consultation with the public, etc., in the case of nuclear, these larger systemic issues are also back-grounded with public perception against nuclear. There is a need to develop more robust and inclusive programme for all sectors to address the concerns of people around large infrastructural facilities.

Public Perception

Nuclear in India, due to the international isolation, hitherto, had been a subject removed away from the public eye. There seemed to be very little information coming out of the administration or the government about the programmes. The sudden opening up of the sector post the US-India nuclear deal put it in the spotlight. After years of opacity, the information that was shared by the authorities was also suspected by many. In addition, there have been very little efforts on the part of the nuclear establishment to engage with the public at large. However, globally as well, post the Fukushima accident, the people's opinion about the nuclear energy was on a decline, with increasing safety concerns about nuclear. Reflection of this trend was seen in India as well, with a growing discontent against nuclear projects. A strong negative public perception regarding the nuclear power and its effect has stalled the development of new sites at several places. These protests and concerns however, need to be dealt sympathetically.

Civil Nuclear Liability Law

The Civil Liability for Nuclear Damage Bill was passed by the Parliament, and received the Presidential accent on September 21, 2010 (Act No. 38

of 2010). After a year and two months, the Act was notified, coming into force on November 11, 2011. The Civil Liability for Nuclear Damage Rules, 2011 (referred to as the 'Civil Liability Rules' or 'The Rules') have also been framed in respect of a few provisions and was notified on the same day along with the Act.

The conformity of the Act and the Rules with the internationally accepted principles of nuclear liability law, however, is an issue that is yet to be settled. In 2010, India became a signatory to the Convention on Supplementary Compensation for Nuclear Damage, 1997 (Compensation Convention or CSC). The US reportedly had asked India to "engage with the IAEA to ensure that the Indian nuclear liability law fully conforms to the Compensation Convention". In December 2012, a senior US Government official categorically stated, "India's nuclear liability law is not in line with the international nuclear liability principles reflected in the Convention on Supplementary Compensation for Nuclear Damage." The rules that were made pursuant to the Act have not clarified the issues, particularly the right of recourse provisions and liability limit. The international suppliers led by the US argue to introduce amendments to the law to harmonize it with the international principles. However, France and Russia, though have reservations publicly, stated that they are willing to work within the Indian domestic legal framework. Issues related to right of recourse and supplier liability, and extent of liability need to be sorted out soon.

Independent Regulator

The Atomic Energy Regulatory Body (AERB) has functioned as the regulator in-charge of the nuclear power reactors in the country. AERB draws professionals from DAE facilities as one cannot doubt the technical competence of the AERB professionals. However, recently, AERB's role and its importance as a regulator became prominent in public discourse on account of its structural dependency on Atomic Energy Commission.

With the separation of the military and civilian nuclear programme, it is imperative that the regulator is independent — financially, as well as statutorily. A close tie between the regulator and the regulated is never desirable. A move towards this has been made with the draft legislation on 'Nuclear Safety Regulatory Authority Act' under consideration in the Parliament. This will help provide the statutory independence to the regulator. However, a major challenge is finding suitable scientists with relevant knowledge outside the ambit of the nuclear establishment. However, it must be mentioned that several scientists are of opinion that the lack of any major accidents have shown

that the regulator in India has been effective. The insider knowledge of the technical and bureaucratic systems has helped in developing good safety measures. The question thus is, does this perceived subordination lead to erosion of public confidence on AERB?

Safety of the nuclear programme remains critical. The challenge for DAE is to maintain strict safety standards so that no accidents happen. In case of accident, the repercussions will be difficult to overcome; the continuity of entire programme will be in doubt.

The Way Forward

The role of nuclear becomes very important to sustainably meet the growing energy needs of the country. It also has the potential to reduce the country's dependence on fossil fuels. However, as seen above, there are challenges on many fronts, which need to be addressed in a pragmatic manner. Some of key steps required in this regard are:

- It is necessary to resolve ambiguities and concerns around the Civil Liability for Nuclear Damages Act without diluting the provisions of the Act. In fact, there might be a need to strengthen some of the existing provisions, such as the cap of liability. There needs to be clarity on the extent of liability, i.e., who all are covered and time frame of liability, along with the cap on liability.
- Considering the large-scale expansion planned, the Government plans to empower AERB through a legislatively mandated independent regulator. Many of the perceived structural and statutory problems associated with the current AERB structure is planned to be addressed through the new Nuclear Safety Regulatory Authority (NSRA) Bill, 2011, which has been introduced in the Parliament. The NSRA bill needs to be thoroughly debated and passed in the Parliament on a priority basis.
- The Government also needs to develop and strengthen supporting regulatory infrastructure and sectors for an expanded nuclear

programme; this is especially true for the insurance sector, which could help augment the cap on liability.

- In addition, specific expertise is needed in the health care sector to deal with any radiation related health issues needs to be strengthened. The disaster management response mechanisms of the district administration also need to be augmented.
- It is also essential to develop a robust and transparent communication programme. This should focus on regular engagement with the people around existing nuclear facilities to address their concerns and informs them about the energy source in their background. For green field sites, it is important to have robust pre, during, and post construction engagement. In addition, there needs to be an increased effort to spread awareness and information about nuclear across the country as well as provide platforms for frank discussions.
- For development of the area around the nuclear facility, some steps that need to be taken by NPCIL in addition to current practices are:
  - » Taking over the developmental works of affected villages and also nearby villages to create a positive atmosphere of inclusiveness.
  - » Developing programmes for a regular stream of revenue from the profits of the plant to the local community.
  - » Establishing schools and vocational training facilities in the villages around the power plant.
  - » Facilitating access to primary, secondary, and tertiary medical care to the locals.
  - » Providing subsidized electricity to the local community.
- There is a need to focus on increasing the educational institutions teaching nuclear sciences in India. EF

K Ramanathan, *Distinguished Fellow, TERI*
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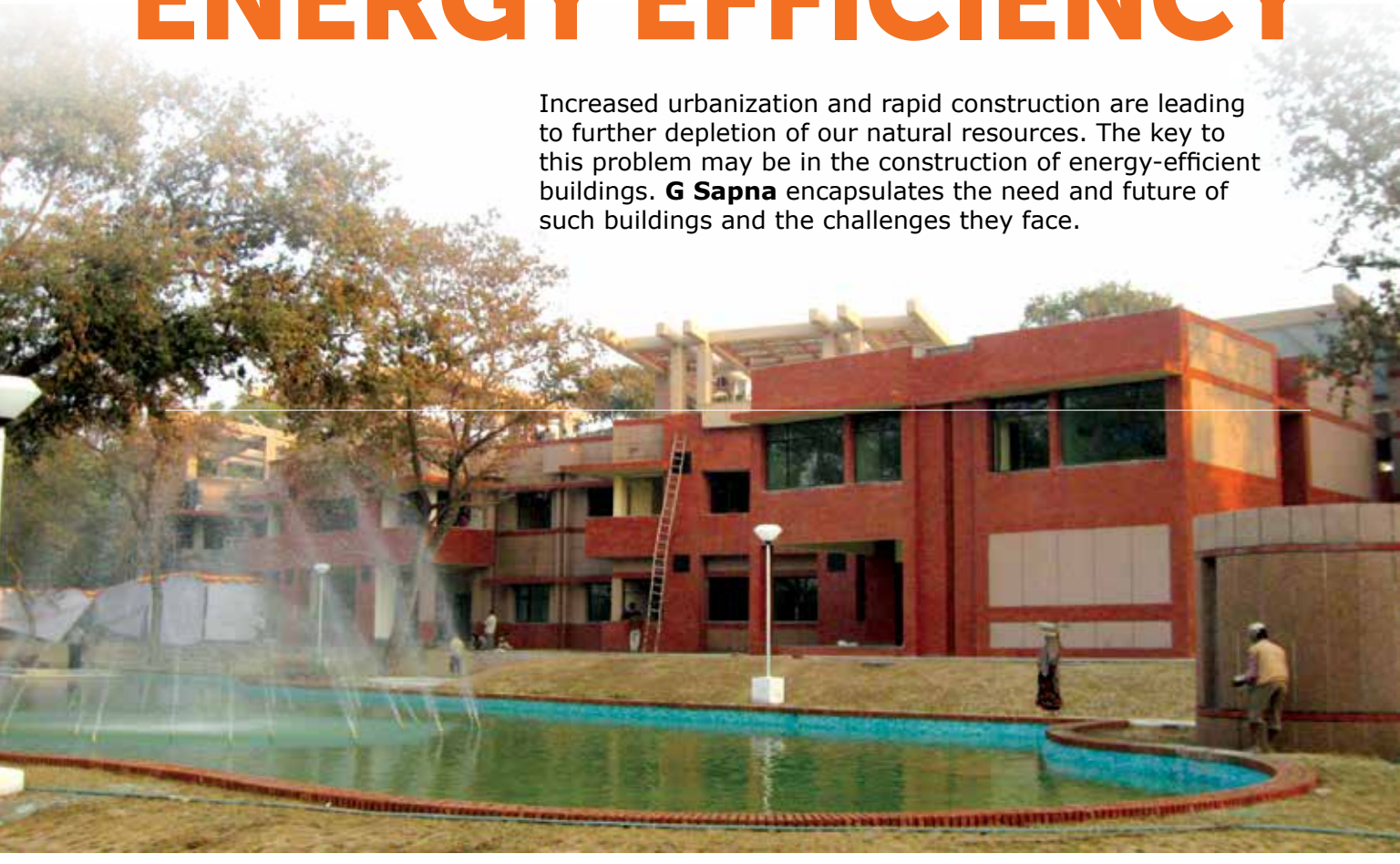
Madhura Joshi, *Associate Fellow, TERI*

Opting for ENERGY EFFICIENCY

Increased urbanization and rapid construction are leading to further depletion of our natural resources. The key to this problem may be in the construction of energy-efficient buildings. **G Sapna** encapsulates the need and future of such buildings and the challenges they face.



It is not just about laying the bricks, concrete, and cement anymore. Buildings in this day and age also have to adhere to energy-efficient norms. While this is true the world over, India is no exception either with the country's policy makers making a keen note. As a result, what was once voluntary for the states, has now been made mandatory by the Centre.

This was evident recently when it was announced that, "All state governments would have to compulsorily implement the minimum requirements for energy-efficient design and construction set by the Central Government by 2017 to meet the challenges of depleting resources, increased urbanization, and rapid construction."

On the sidelines of the "Urbanscapes: How Sustainable are our Buildings" workshop, Sanjay Seth, a senior energy economist at Bureau of Energy Efficiency (BEE), was quoted as telling IANS, "While the Energy Conservation Building Code (ECBC) has been developed by BEE, its enforcement lies with the state governments and urban local bodies through notification within their states as per their regional requirements. Seven states have notified the code, while 15 are on the way to doing so." The need to graduate towards energy-efficient buildings has found a consistent mention in most of the reports and studies. Take for instance, the one released by the Natural Resources Defense Council (NRDC) and the Administrative Staff College of India (ASCI), on presenting solutions and incentives to overcome the most common barriers to energy efficiency. Titled "Greener Construction Saves Money: Incentives for Energy Efficient Buildings across India", the report offers tools to motivate building developers to reap the savings of energy efficiency and mitigate the rising demand for energy. According to the study, "In light of the energy security risk posed by

the projected quadrupling of energy imports by 2027, the opportunity to cut energy demand domestically while developers and tenants of green buildings save money, makes energy-efficient construction a clear win for the country."

This only goes on to reinforce the analysis on "India Energy Security Scenarios 2047", by the Planning Commission. It reveals that if states across India who have adopted stronger building efficiency codes and developers participate in strong programmes for rating commercial buildings, an estimated 3,453 terawatt hours of cumulative electricity could be saved by 2030. This is equivalent to powering 358 million Indian homes annually between 2014 and 2030 based on current annual consumption levels for electrified homes.

Industry experts are of the opinion that creative incentives for energy efficiency investments in new construction, such as property tax rebates, creation of special economic zones, increased floor space index and expedited permit processes, can help reduce some of the biggest barriers to widespread adoption of energy efficiency. For instance, many states in India have limits on the Floor Space Index (FSI), a measure of the built-up floor area of a building relative to the size of the plot it is built on. To incentivize developers to build green, a portion of this extra FSI may be given to developers of efficient buildings for no cost, thus increasing the value of their properties. Energy Service Companies (ESCOs)—entities that can pay for energy efficiency investments upfront and recover the costs through surcharges on future energy savings—also offer a compelling model to potentially support the financing and scaling of efficiency upgrades.

Anjali Jaiswal, NRDC Senior Attorney and Director of the group's India Initiative, agrees that, "Indian states have an incredible opportunity to construct more efficient buildings today." By dramatically reducing energy demand through building codes and increased participation in ratings programmes, cities can avoid costly retrofits down the road and energy can save now for decades to come. Incorporating effective compliance mechanisms is key to ensuring codes are successfully establishing at least the minimum efficiency of buildings," she adds.

The Origin

Way back in 2001, the Energy Conservation Act, Section 15, mentioned the ECBC and aimed at more energy-efficient buildings. Originally developed by the BEE in 2007, its adoption was voluntary. While the Act listed that each and every state has to go forward with this code, with energy being a concurrent subject, the Centre could only guide on energy related matters, but could not enforce its implementation. Therefore, the state had to take a decision as to how it wanted to go about executing the ECBC.

Thus, in 2007, when the Ministry of Power, through BEE, came up with the ECBC, it could not make it compulsory for the states. As a result, the Centre came up with a voluntary Code in the same year. It allowed for flexibility in implementation by offering a Prescriptive Method, which provided a list of requirements for code compliance, and a Whole Building Performance Method, which used architectural design software to optimise the buildings, energy performance while minimizing costs. Having the option of either method, gave developers, architects, and designers the ability to respond to changing technologies and prices over time. Additionally, the ECBC also called for the use of energy-saving CFLs and LED lights, more natural lighting, more efficient electrical systems and solar water heaters.

Pressing Need

As per the new regulation, however, the ECBC will be made mandatory for all states by the end of the 12th Five Year Plan (2012-17). In fact, states like Rajasthan, Odisha, Uttarakhand, and Andhra Pradesh have already notified the code. Experts feel that a rapid expansion in India's real estate market has not only led to an increase in the demand for energy, but also the need for increasing the energy efficiency of buildings in India.

According to Ramdas Shenoy, Executive Director, Marketing & Business Excellence at Green India Building Systems and Services (GIBSS), "India has now become world's third largest economy in terms of PPP ahead of Japan, and being the world's second largest population, with a quest for improved quality of life, energy usage in India is expected to rise, fuelling the energy demand further. Increased energy consumption will lead to more greenhouse gas (GHG) emissions with serious impacts on the global environment; in particular, since the predominant usage of coal in the country's energy sector is expected to continue until 2020."

He goes on to add that the construction industry in India is growing at over 10 per cent, hence energy efficiency assumes tremendous importance. Buildings are the third largest consumers of energy after industry and agriculture, and annually consume more than 20 per cent of electricity used in an energy starved nation. Increasing energy efficiency of buildings will bring down its operating cost, specifically in the commercial building space.

Srinivas Chary Vedala, Dean of Research and Management Studies and Director, Urban Governance,

Infrastructure, Environment and Energy at the Administrative Staff College of India (ASCI), Hyderabad, avers that the ECBC is a regulatory instrument aimed at improving energy efficiency of commercial buildings. "These buildings account for a major share in the overall energy usage in a city and need immediate attention. The systematic implementation of ECBC can significantly bring down power consumption and enhances energy security of urban areas. Reduction of power consumption implies reduction of power bills to citizens, deferment of capital investment for the power utilities and most importantly the reduction of pollution. Thus, the benefits of ECBC are multifold and make business sense from the private sector and government perspective."

On the need for urgent measures, he explains, "It is recognizing the fact that there is a sense of urgency to push this agenda in the context of the urban sector. Now, India is modestly urbanized, compared to the Western world, which is at a very high level of urbsanization, Since we are just urbanizing, it means densification, vertical structures, concretization and higher levels of expectation. Given this scenario, the sense of urgency, which India is now recognizing through the ECBC is very important."

Stressing on the energy saving potential, Shenoy adds, "It can be as high as 40 to 50 per cent, if addressed at the right stage of building construction. The emphasis should be to reduce energy on the demand side, thereby reducing the electricity consumption of the buildings. At GIBSS too, our endeavour is to focus on energy efficiency technologies, namely geothermal cooling for air conditioning, LED lighting solutions, and hot-water co-generation solutions".

He believes that the building codes provide the much needed framework and institutional arrangement for initiating an energy efficiency drive. ECBC enables the states to modify it as per their climatic conditions. Implementation of building codes will definitely help buildings to reduce electricity consumption by 30 to 40 per cent, but if you look at adopting the right technologies like geothermal cooling and lighting, you can have savings up to 60 to 80 per cent.

"If building codes are implemented by states, one will see lot of development for energy-efficient products like building insulation, lighting system and air conditioning systems and people will start adopting new designs in lighting, day lighting, natural ventilation, thereby improving the building performance, elaborates Shenoy.

The Barriers

Despite the visible advantages, in terms of being cost-effective and environment-friendly, there are challenges when it comes to implementing the ECBC. Explaining the reluctance on part of the builders and financiers, Rajkiran V Bilolikar, Assistant Professor, Energy Area, Administrative Staff College of India (ASCI) states, in times of high power tariff for commercial buildings, the consumer gradually understands this concept that he should pay less to the electricity utility, either by conserving electricity or by using energy-efficient appliances/buildings. So, the consumer should be in such a premise which uses lesser energy. But since that kind of awareness is not yet there, builders are not ready to go for it. Also, financiers are not ready because they feel that anyways they (the builders) are benefiting, so why should we given them low interest rates.

"Normally in the building sector, once the real estate owner or developer, whoever constructs the building, the benefits of energy conservation are borne by the consumer or the person who is using the building premises. In commercial buildings, the real estate owner constructs the building and many consumers/utilizers can occupy that part of the building and use it. So, the builder will not get any kind of benefit out of it. Therefore, he feels that why should I invest more and construct an energy-efficient building?" he adds.

Concurring with his view, Shenoy also feels that the building developers are not interested, because they don't tend to gain from the initial investments in building energy-efficient buildings. "They have to understand that they can increase their profits through attractive premiums, lower energy bills, brand value and higher occupancy rates. Developers may also avail higher FARs & FSIs for projects which confirm to these codes. There is a clear cost saving advantage for tenants and owners because of lower utility bills."

Rajkiran is of the opinion that consumers in the Indian market do not think about the total utilization part over a period of time and all they are worried about is the first initial capital

investment. "Thus, the first barrier we have to address is the split incentive problem and convince builders to construct these kind of buildings."

Agreeing that it is a very sensitive subject, Chary elucidates, "The minute we say conserve energy, people will start questioning, what's in it for me? Of course, one can argue that one will save energy and money, but then they would argue that they may need upfront high capital investment, initially. The initial investment is coming from a builder, the benefit will be going to you and me, to the consumer, the one who occupies the building. Generally, the developer and the occupier are two different individuals. The question is there is no incentive for the builder to really put upfront costs, unless and until he presents it as a differentiator or a niche product."

Elaborating, he states, "You will see smart buildings and so many ways in which builders highlight the green aspect and say that the building that you are going to occupy from a buyer's point of view is a smart building. But by and large, there is an upfront cost,

but the incentives are not going to be there for a citizen, since incentive for a builder to spend that money does not exist."

Stressing on regulation, Chary adds, when it comes to common property resources, there is a need to have a sense of regulation. "Without regulation, voluntarism by itself cannot really get us the results. So, there is a recognition that voluntary compliance has its own limitation, India has recognized this and that is why they are going for a mandatory regulation."

For instance, it was decided in the state of Andhra Pradesh (before the bifurcation) that the compliance should not be with the service provider, (in this case, the municipality), instead, the mechanism should be kept outside the purview of the typical department and there should be a third party validation of all this. Explaining the need for this, Chary elucidates, "We have so many laws, implementation is a big issue, there are speed money components transparency related problems, so that's the reason we decided to keep the compliance issue and this validation exercise outside the purview of a conventional department. A third party financial auditor who comes and validates the book of accounts of an agency, will be able to do it more objectively."

Stressing on the need for capacity building, he adds, "Without good capacity, the ability to construct, design, is a big issue. Implementing it through municipal officers is also a big issue. So, that's where with the help of the AP government, the ASCI, NRDC, and Indian Institutes of Information Technology (IIIT) created a comprehensive capacity building framework. We need to build capacities upfront, even before a regulation comes into place, otherwise the credibility of that initiative would be undermined."

According to Bandana Jha, a research scholar at IIT Delhi and a green building consultant, who specializes in energy efficiency, the move for an ECBC is a good one. However, making it mandatory only for buildings that are going to come up is not going to help matters, she feels.

Arun Thomas, Vice-President, Strategic Business Development & Partnerships, GIBSS, believes that the landscape of awareness levels on energy-efficient practices is interestingly poised in the commercial building sector in India which comprise commercial buildings, institutional buildings, and industrial buildings. The motivation for adopting building construction codes and rating systems are therefore at varying degrees within these three segments.

"The institutional buildings are built with a moral responsibility and therefore have a very high appetite for conforming to the codes and rating systems and are keen to adopt innovative technologies that are energy efficient. Most buildings being built by the central and the state governments are by default 3 star Green Rating for Integrated Habitat Assessment (GRIHA) rated buildings and conform to the ECBC code. Few landmark projects aspire for 5 star rating and deploy innovative technologies," he explains.

The commercial buildings, Thomas adds, are primarily driven by project specific budgetary aspects. There are two sub-segments within commercial buildings with respect to their adoption drives — commercial buildings that house the mature industries such as IT and high-end hospitality demonstrates a high level of adoption as they are keen to be in the forefront of reducing cost through energy efficiency measures and the multi-tenanted commercial office buildings that are slower to adopt these technologies as this segment faces the outcome posed by "split incentive challenge" wherein the developer or owner invests and tenant

benefits. The "split incentive challenge" is a dampener in the adoption of such innovative technologies in the commercial buildings sector.

The industrial buildings demonstrates two main characteristics — the mature industries who are constantly seeking to reduce their specific energy consumption have very high awareness levels and seek many innovative measures and technologies to achieve this objective. "The energy intensive and large industries are on a mission to reduce their specific energy consumption and business cost across their operations and have developed clear roadmap at an industry level on how this shall be achieved collectively by the industry — a case in point is the cement industry in India that has a mission to reduce the energy and water footprint significantly by 2020 to remain globally competitive," states Thomas.

Shenoy believes that though a nationwide mandatory enforcement of the Code will yield considerable annual energy savings, it's in the building owner's own interest to implement energy-efficient measures. "Moreover one has to appreciate that access to electricity also means drinking water availability, infrastructure effectiveness, health care and overall quality of life. This has meaningful impact for India, which is energy starved as demand for electricity outstrips generation capacity."

Currently, the Code focuses on commercial buildings, which would be around 10 to 15 per cent of India's energy consumption, informs Shenoy. Energy consumed by these buildings could be attributed to lighting, running office equipment and HVAC. Solutions like geothermal, radiant cooling, Light Emitting Diodes (LED) based lighting and induction lighting with appropriate controls, hot water solutions, could bring considerable savings to the tune of 60 per cent to 80 per cent, thereby reducing the consumption significantly.

Lamenting that there is a lack of knowledge of benefits related to energy efficiency in buildings among the political fraternity and policy makers at state and national level, Shenoy questions as to whether the Centre, State and local bodies are equipped to enforce the ECBC in 'toto' is a big question. "Also everyone in the value chain will have to start appreciating the value that ECBC will bring on the table."

Old versus the New

Apart from new buildings, the ECBC also covers old buildings which are getting renovated and/or extended. However, whether issues of the old buildings need to be addressed or the new ones are to be tackled foremost, is a debate which continues to rage. In the recent past, there have been some notable instances such as the Express Towers in Mumbai and the Godrej Bhavan in Mumbai, which were renovated to be green, energy-efficient buildings.

Bandana Jha is of the firm opinion that we need to ensure energy efficiency in the existing buildings, if we want to achieve efficiency in the full sense. "One of the main things that needs to be done is to tackle the existing commercial buildings, which means reduce the energy input to a certain extent, as per the Indian Green Building Council (IGBC) benchmark or BEE star rating for existing commercial buildings. This will surely help in achieving energy efficiency. Presently, there are huge commercial buildings such as malls, which are energy guzzlers. Therefore, the need of the hour is to have mandatory norms, use energy-efficient fixtures, reduce their energy benchmarks, and reduce the EPI to the global benchmark. Also, they should depend on renewable energy so that a considerable amount of energy is saved."

She adds that 40 to 50 per cent energy can be saved and you can reduce demand in existing buildings, there will be a larger quantum of saving. Moreover, if there is a mandatory norm, the developer will have to adhere to energy efficiency measures whilst the building is getting made.

However, Chary feels that though there is a problem, we need to ensure that the ones which are going to come are energy efficient. "Let's start with that and then tackle the retrofit or the older buildings. The number of buildings which will come up in the next 20 years are going to be more than the ones which were built in the last 150 years."

"In the last 100 years, around a million buildings have been built. Yes, retrofitting is useful, but challenging. Concessional lending, financially viable and a sense of awareness are needed. Since this will take time, we have decided to first tackle the ones that have not been built and then the ones which already exist," he stresses.

What lies Ahead?

Mentioning the 'LEED approach', Shenoy explains, "It is the Learn, Execute, Enforce, and Develop. For enforcement,

the state and local bodies should provide fast clearances, tax rebates and other sops to implement ECBC.The bottom line is to get all the stakeholders together". Some of the other measures which he believes could help are: Real Estate Developers through a network of builders and financial institutions can highlight efficiency successes and support adoption of similar practices. Awareness could also be increased with regard to codes, rating systems and programs, and incentives through education. Financial Institutions can reap the rewards of the energy efficiency industry by supporting with financial products such as insurance and mortgages, with performance clauses and higher requirement ratios for energy savings, at an initial stage of construction.

Increasing interaction in the value chain like LEED, GRIHA, and other building certification groups to popularize green loan products and devise innovative business models would also help. Furthermore, state and local bodies can integrate locally-modified ECBC guidelines into municipal building bylaws. He also suggests creating builder incentives locally through single window processes, fee reductions, and tiered property tax structures. Corporate entities, he believes,can share their experiences with stakeholders encouraging employees to reduce energy use by providing reward programmes will also help a great deal. EF

State Scenario

Rajasthan was one of the first states in India to adopt ECBC as a mandatory code.It did so with minor additions on March 28, 2011 (through a stakeholder process) and on September 28, 2011, this became mandatory.

Union Territories and states which have already implemented the ECBC include Odisha, Puducherry, Andhra Pradesh, and Uttarakhand, while Haryana is in the process of doing so. According to the Bureau of Energy Efficiency (BEE), some of the other states which are in various stages of ECBC implementation and adoption include Uttar Pradesh, Karnataka, Kerala, Gujarat, Haryana, Madhya Pradesh, Tamil Nadu, Maharashtra, Chhattisgarh, and West Bengal.

In Punjab, it was announced that commercial and other major buildings would have to adhere to the ECBC. Thus, in February 2014, at a stakeholders' meeting held jointly by Punjab Energy Development Agency (PEDA), BEE, and Indian Institute of Architects (IIA) Chandigarh-Punjab Chapter, discussions were held on the implementation of Punjab Energy Conservation Building Code in the state.

Furthermore, the Andhra Pradesh government too announced it would accord top priority to energy efficiency measures to ensure guaranteed power supply in the state. In a release, it informed that the state will come out with a separate action plan under the guidance of the State Energy Conservation Mission (SECM) for implementing short-term and long-term programmes for the targeted energy savings by adopting latest technologies.

Prior to the state's bifurcation, the ECBC in AP was approved by a government steering committee consisting of developers, builders and efficiency experts, as well as ASCI, the IIIT, and NRDC. The government of AP, after consultations with real estate developers, stakeholders, came up with a mandatory notification in January 2014. After more than a year of technical review and extensive stakeholder consultation with real estate developers and experts, it formally adopted the ECBC into state law and it was announced that the Code would be effective from August 2014.

A study by NRDC and ASCI found that financial bodies and utilities were not all that keen on these measures. Financial institutions felt that there was no point in paying low interest rates to developers because energy conservation itself gives some kind of benefits, such as helping save money. In Ahmedabad, Mumbai, Chennai, and Jaipur, where the research team met real estate developers and financiers from across the country, they realised that if a building is sold as an energy-efficient one, then automatically, the market should be there.

"Even the utilities felt, why should we give them the benefits? As for the government, it believes that since there are enough property tax and other incentives, there is no need for any further incentives. Then, there are issues with capacity and control as well. Regulatory bodies feel that everything is in the civic body's hands, so what can they do. Therefore, as of now, it is an unorganized sector," revealed Rajkiran V Bilolikar, Assistant Professor, Energy Area, ASCI.

After considering the barriers, it was decided that the definition of ECBC would be tweaked. Earlier, for a 100 kW connected load, the building premises would come under ECBC compliance. Since the authority is with the municipal bodies, the definition was changed to, "If a building plot area is of 1,000 metre square or the built-up area is of 2,000 metre square, then that building should come under ECBC compliance. We developed third party compliance and handed it over them. So, the government will empower few firms or Mechanical, Electric and Plumbing companies," Rajkiran added.

Demystifying IESS 2047

Churchill has rightly said that "Let our advance worrying become advance thinking and planning". IESS 2047 is the result of this planning and thinking. **Riddhima Yadav** enlightens us on this much-needed tool that will help in improving energy efficiency.

Imagine if you could feed in a few numbers and design your own energy pathway for India until 2047? Not only that, you could also study the implications of your choices! This isn't a secret government tool or a bureaucratic luxury, it is an opportunity for each one of us to place ourselves in the shoes of a policy-maker and understand the macrocosmic significance of consumer choices on India's energy security and economy. The India Energy Security Scenarios 2047 (IESS 2047) is a scenario-building tool that makes the concept of energy modelling much more interactive and interesting. Far from being a tool accessible only to those with the technical know-how, the IESS 2047 is at one level a calculator and at another, a transparent and intensive simulation exercise. The guiding ambition of this is to develop energy pathways leading up to the year 2047, exploring a range of potential, future energy scenarios for India, across various energy supply sectors, such as renewable energy, oil, gas, coal, and nuclear, and energy demand sectors, such as transport, industry, agriculture, cooking, lighting, and appliances, etc. Modelling has found great relevance in the study of climate change and globally, organizations like the IPCC use various in-house models to predict the impact of changing climate patterns. In the field of energy computation, models are an attempt to simulate the energy operation of the future including but not limited to, projects that haven't been built as yet. But it is important to emphasize at the outset that the alternative scenarios that are generated using the IESS 2047 do not emerge from explicit modelling but on assumptions about sector level growth and energy demand. As a matter of fact, the IESS 2047 is based on the framework of the UK 2050 Pathways Calculator developed by the Department of Energy and Climate Change, Government of United Kingdom, as a scenario-building exercise for energy planning. The IESS 2047 tool was developed by the Energy and Research Division in the Planning Commission with key stakeholders, such as TERI, ISGF, Prayas, and CSTEP. As India faces the twin challenges of climate change and energy security, the IESS 2047 assumes great relevance as an energy-planning tool that will help understand and study the energy choices that are in our best interests. As for the significance of 2047 as a terminal year, it marks hundred years of India's independence. I believe that it is a metaphor for us to realize that the exhaustion of our resources may look a long way ahead, but we have to start acting early if we want to reduce the risks and damage emanating from over-dependence on non-renewable sources of energy.

In this article, I aim to make the IESS 2047 more accessible and understandable by demystifying its working principle and taking you through each of its features. As a first-time user, there are bound to be questions like — Why is it important in the first place? What's in it for me? What are its different levels? What do I make of all the 'energy terminology'? These were certainly some of the questions that I encountered when I first tried my hand at the tool so I hope I can provide a perspective to users and young students like myself who may want to study this tool.

Examining the Need for IESS 2047

One of the very first questions I was bound to ask was—What purpose does the IESS 2047 specifically address in the wake of so many other existing models and tools? I had recently been reading the India Hydrocarbon Vision

2025 document and the Integrated Energy Policy Report, and I couldn't help but notice the abundance of energy scenarios and demand-supply numbers already provided by agencies, such as the IEA, EIA, Mckinsey, etc. But coursing through the IESS tool, one striking feature is that the entire exercise is specifically and entirely dedicated to the Indian economic structures. The tool has been adapted to serve national interests and in that, it is unique. The tool has been built with the help of knowledge partners. The process included getting their views on broad estimates of the likely prices of different technologies/ fuels in the long term. They have in turn sourced this information from multiple organizations, including the industry. The most important feature is the availability of broad trends for the entire economy at a single place and free of cost. Further if you don't agree with a certain assumption, you can change it and personalize the tool according to your needs.

Our Twelfth Plan aims at achieving faster, more inclusive, and sustainable growth. A viable energy strategy is critical for realizing this objective. Increased production associated with growth requires an expanded supply of energy. But India is not well endowed with energy resources in comparison with the large population. While it supports 17 per cent of the world's population, it only has 0.6–0.4 per cent of the world's oil, gas, and coal reserves, respectively. This has led to large import dependence. The import dependence of India for energy has been sticky at nearly 35 per cent of its annual demand over the last several decades. It is evident that an integrated approach towards developing domestic energy resources and giving special attention to the ones in which India may have higher potentials, has been engaging the attention of India's economic planners. Energy efficiency is a common denominator

across the sectors and the Government has long back declared its intention to enhance energy intensity by 20–25 per cent till 2020. Similarly, development of renewable and nuclear energy sectors are also important elements of India's energy strategy. However, energy efficiency and renewable energy require large upfront funding with a robust policy support to ensure adequate returns over long periods of time. Technology is also a vital input, particularly in the area of energy efficiency. Therefore, India's energy strategy would necessarily comprise action on both demand and supply sides with due consideration to policy, finance, and technology. The IESS 2047 tool integrates all these parameters to come up with figures that indicate the impact of different levels of these inputs in various permutations and combinations.

De-structuring the Basic Design

The India Energy Security Scenarios, 2047 has been developed in an Excel Format using a web tool which allows graphic representations of the chosen outputs of the energy demand and supply levels leading up to the chosen terminal year. The tool is backed up by detailed excel sheets for all sectors. The data for some set scenarios has been loaded on the excel sheet on five yearly intervals basis up to 2047. This data has been obtained from a variety of public sources. Historical data has been sourced from published documents, while the projections up to 2047 have been made by different expert agencies, keeping in mind likely scenarios. However, according to the Planning Commission — "These data sets are not purported to be a source of authentic Government data. Although, greatest attention has been given to using both historical and future data sets from Government sources, however, the IESS 2047 is not intended to be a database of energy related sectors of India. The data sources in all the projections have been referenced to enhance the credibility of the scenario-building exercise. Therefore, the users are advised to use the data in the tool only as an input to decision-making and not as an energy database."

The main screen of the web tool is juxtaposed with three graphs — the first shows the different levels of energy demand for various sectors, the second shows the supply levels and the last one illustrates the import

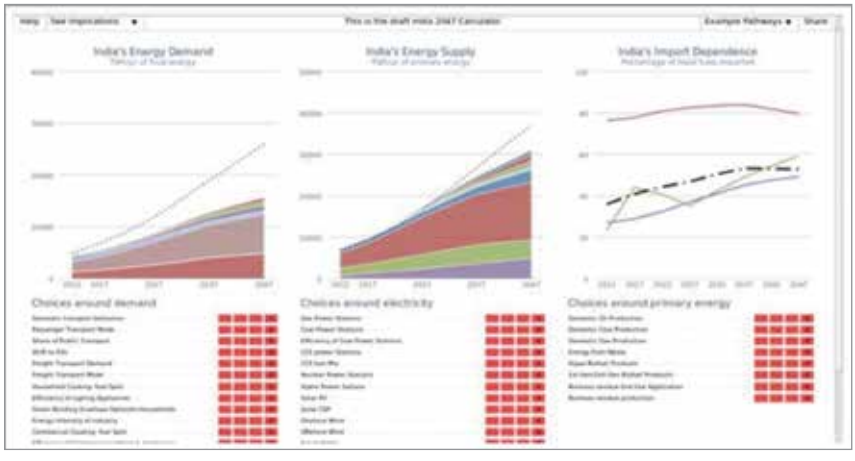


Figure 1: Screenshot of a graph for energy demand by web tool.

dependence (Figure 1). You can pick different levels of demand and supply parameters by choosing the relevant level boxes indicating a summary of the choices or you could also hover over the horizontal line items to discover the impact of your choices. Once you have made the selections, the tool will generate a pathway from now until 2047. Voila! You just created your own scenario for India's energy future! You can go a step further and study the impact of your pathway on electricity, energy imports, land use, and carbon dioxide emissions. Also, see the energy flows to and from different sectors of your chosen pathway using the Sankey (energy flows) diagram.

The tool can generate hundreds of such scenarios depending on your choices. But four standard levels of effort that better help understand the outcomes of the exercises you undertake. Don't be overwhelmed by the numbers or any other jargon, familiarizing yourself with the format of the tool and playing around with the web tool interface is most helpful!

Different Levels and Scenarios

- **LEVEL 1**: In this pessimistic pathway, there is an assumption that no new government policies are adopted both on the demand and the supply sides of energy systems. Technologies fail to achieve breakthrough or are not adopted, exploration activities for fossil fuels achieve minimum success, and there is insignificant change in the demand behaviour of the consumer.

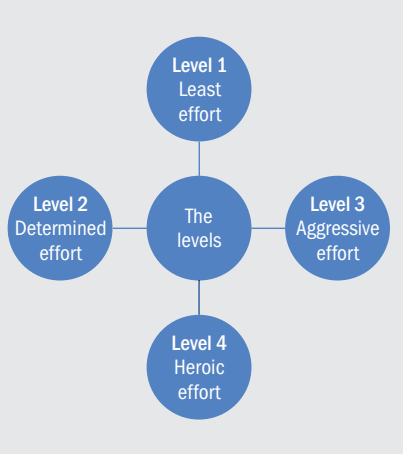


Figure 2: Levels and Scenarios

- **LEVEL 2**: In this pathway, there is expected implementation of the government policies on the demand side, and the supply mix is chosen in such a way that the overall import dependence is brought down to the minimum level in 2047. Hence, this pathway is one of all Level 2 on demand side, and a combination of choices on the supply side, such that import dependence is minimized.
- **LEVEL 3**: This pathway calls for massive demand reduction by determined efforts on the demand side including pricing and market reforms, technology breakthroughs, and policy innovation to implement energy-efficient programmes. Hence, this offers the least demand situation. This is the least energy demand growth rate that India could achieve.
- **LEVEL 4**: In this pathway, every sector contributes to both energy security and environment sustainability. Due to heroic efforts on demand side, the demand is

minimum in 2047. Theoretically, this pathway is also the one with the maximum energy security, because it involves abandoning all the coal and petroleum denominated consumption. However, this is a theoretical prescription as large coal-based capacities under construction, cannot be expected to be switched off in 2047.

What the IESS 2047 is NOT

(from the official website)

Early on, while explaining the tool to others, I would often make the mistake of assuming that the tool generates forecasts. I felt that since it would have a built-in matrix of relationships between demand and supply, it could create projections and estimates. But a closer look at the layout of the tool shows that the tool mimics the future given the assumptions or levels selected by the user. The data relating to implications — energy security, costs, land, and CO_2 emissions are merely indicative and not firm estimates. But it does take into account the known/estimated energy resources (potential) of the country and factors in pessimistic/optimistic outlooks on policy, costs, economic growth, and other assumptions. Therefore, this is a useful tool to see the big picture of worst and the best case scenarios. In fact, the tool does not even go as far as to recommend or prefer certain scenarios over others. It merely generates them and leaves it to the user to decide which one is suitable given the present economic climate. These pointers really helps to understand the capabilities and reach of this tool. It also avoid any over reliance on this tool for energy strategizing.

Conclusion

I have tried to answer some of my questions regarding the IESS 2047. These may be naive or even premature for experts, but the answers to these doubts are aimed at those people who may be greatly interested in the field of 'Energy' or those who are just starting out but may not necessarily know their way about complex systems, numbers, and terms. The IESS 2047 may not be the answer to our energy challenges and questions, but it definitely helps put together a comprehensive picture of the kind of issues we should be addressing. The tool is one of the pieces in the puzzle of India's energy choices. As the new government takes some key decisions on the energy and environmental policy, I hope they will do the kind of detailed background work and analysis that this tool propagates. The Environment ministry is all set to go digital with clearances and so are other ministries taking the route to e-governance. In this regard the India Energy Security Scenarios 2047 is a refreshing break from long descriptive energy reports. It is at once inclusive, accessible, and user friendly and this is the trilogy that we should be aiming at when it comes to sustainable growth. EF

A TERI LEADearth Fellow, Riddhima Yadav has been an avid environmentalist since the age of 10. Currently, a member of the Indian Youth Climate Network and a Freshman at Yale University, she is interested in Environmental Policy and Climate Change Negotiations. Riddhima was selected to be a part of the youth contingent at the Delhi Sustainable Development Summit 2014.

Myths and Facts on BIO-ENERGY

Jyothi Mahalingam

Global Energy Scenario

Energy is like an essential dynamic in a nation's development to achieve its economic growth. According to *The International Energy Outlook 2013 (IEO2013)* report, the global energy use will increase by 56 per cent in the period from 2010 to 2040. The report states, the economic growth in the developing countries, such as China and India, will add most to the increase. The extrapolate projections, on the global energy use through 2040, indicate that around 80 per cent of the energy will be generated using fossil fuels. The report states, the increase in intake of coal in China will make its use dominant in the energy generation till 2030. The report predicts that the demand for deployment of natural gas will grow fastest in the fossil fuel segment.

While, the resultant economic growth is an encouraging factor, the over-dependence on fossil fuel generated energy will have direct consequences on environment. According to IPCC (Intergovernmental Panel on Climate Change) report, published in March 2014, the continuous reliance on fossil fuels, since the beginning of first industrialization, has caused global warming and induced drastic changes in global climate. It warns of the failure to limit the raise in temperature levels within 2 °C and allowing it to go beyond 4 °C. This will lead to drastic consequences in global food production. The report cautions about extreme climatic conditions, such as rise in sea level, powerful storms, heavy rainfall, drought, and severe heat events. It further suggests for a rapid shift to increase the renewable energy use and advocates for significant changes in the global energy mix.

Renewable Energy

The use of renewable energy, primarily started as an alternative support to depleting fossil fuel sources, has come a long way. The *Global Status Report on Renewable Energy* points out an encouraging shift in the use of renewable energy. It explains that despite the challenges, such as waning policy support, economic uncertainty, recession in European countries and in US, restraints in linking the generated power to the distribution grid, and high level lobbying by fossil fuel companies, the renewable energy showed positive developments in the year 2013. The report observes that the renewable power generation has increased by over eight per cent in 2013 and contributed to over 56 per cent of net increase in the global power content.

Today, the renewable energy sources are not seen as a mere alternative to fossil fuel generated energy. They are regarded as effective tools to cut down the environmental impacts to give a boost to energy security, to produce more job opportunities, and to bring down the levels of greenhouse gas emissions. Energy from renewable sources has already joined the mainstream of traditional power

generation. Though, the renewable energy technologies offer a host of advantages over fossil fuel power generation, yet the technology suffer from inherent failings either in the form of cost or ecological impact. It is essential to identify the basic myths and facts to appreciate its use.

Bio-energy: An Introduction

Bio-energy is in use for thousands of years in the form of biomass. Earlier biomass was used for heating and cooking purposes only. At present, nearly 60 per cent of the global traditional biomass products, such as animal dung, crop residues, fuel wood, and others are used in energy generation. Its unique property of capturing more carbon dioxide during its growth stage, than the level of its greenhouse gas discharges when it is put to use, makes bio-energy carbon neutral and it is included in the renewable energy mix. According to the global power production estimates, presently renewable energy contributes to about 22.1 per cent of the total worldwide power generation. This includes 1.8 per cent power generated using bio-energy. The various bio-energy technology applications include bio-power, bio-fuels, bio-diesel, and bio-products.

Bio-power

Bio-power systems use biomass to produce electricity. The major systems that are used to generate power include direct-fired, co-firing, gasification, anaerobic digestion, and pyrolysis. The direct-fired systems burn the biomass feedstocks directly to generate steam and run a connected turbine to produce power. In cold countries, the heat generated in the process is also used to keep the buildings warm inside. The waste wood left unused is employed to manufacture paper pulp. The

co-firing feature is deployed along with the normal coal-burning facilities to cut down the sulphur dioxide discharges. The gasification systems need higher level of heat to convert the biomass into gas before use. The anaerobic digestion method use decaying biomass in landfills to generate power.

Bio-fuel (Ethanol)

Unlike wind and solar, which generate direct electricity for use, the bio-fuel from biomass offers the option to use it either for electric power generation or to run vehicles. To produce bio-fuel, the feedstocks and biomass, such as soybean, rapeseed, jatropha, sunflower seeds, palm oil, hemp, algae, and saltwater-grown halophytes are used. The biomass products with high level of cellulose, sugar, and starch content undergo fermentation to manufacture ethanol, a bio-fuel.

For the purpose of manufacturing advanced bio-fuels, presently a range of energy crops known as Lignocellulosic (LC) or cellulosic biomass are grown. These crops will have different levels of polymer, chain length, and variable stages of polymerization, which easily and effectively yield bio-fuel molecules. Methanol, another product from biomass, is produced using natural gas. Either the produced fuel is directly used as an additive to bring down the carbon monoxide levels in the vehicles or mixed with gasoline to power the specially equipped vehicles.

Bio-diesel

Unlike bio-fuel that uses biomass, the bio-diesel is manufactured using plant or animal fats. A chemical process known as transesterification converts the vegetable oil and animal fats into biodegradable fuel known as bio-diesel. The bio-diesel performs the same way as a fossil fuel diesel, but releases nearly 75 per cent less carbon dioxide than fossil fuel diesel. While bio-fuel ethanol need to be mixed with gas or petrol for use, the bio-diesel can be used as it is.

Bio-products

Researchers have helped to find more use of biomass by developing methods to substitute the use of fossil fuels in the manufacture of some of the products. The bio-degradable products are manufactured using comparatively less energy than the products from fossil fuel.

Uses

Residential homes in most of the European countries and the USA have started using bio-power for heating

purposes and to generate electricity. Even industries have shifted to the use of bio-energy instead of fossil fuels to run the Combined Heat and Power (CHP) systems. Similarly, the use of biogas as cooking medium is fast catching up in the developing countries globally. The liquid and gaseous bio-fuels (mainly ethanol and bio-diesel) are mostly used in the transport sector. They contribute about 3 per cent of the total energy fuel used in the vehicles globally. Some of the countries in the Europe, Brazil, and the USA account for this growth. The use of bio-fuel in transport sector though suffered a temporary respite, but is now showing a steady growth. The gasified bio-fuels, such as bio-methane are used in transport vehicles (cars and busses) in countries, such as Sweden, Germany, China, and North America. It is mixed with natural gas and offered in the form of Compressed Biogas (CBG).

The bio-products include artificial sweeteners, adhesives, plastics, toothpaste gel, and antifreeze plastics. Also, phenol a by-product produced from pyrolysis of oil, a product generated from biomass, is used in the manufacture of foam insulation, moulded plastic, and wood adhesives. The ability of bio-energy to get stored in the form of biomass resource, gas, and liquid fuel, gives it an edge over wind and solar power generation. The bio-energy comes as an effective step gap arrangement to balance any shortage in wind and solar power generation to ensure a steady supply of power.

Issues that shroud Bio-energy Generation

The carbon footprint of biomass is continued to be a major issue of discussion. Attempts are continuing to assess the greenhouse gas discharges, related to the direct and indirect land use for growing biomass, exclusively for bio-energy generation. But the usage of solid biomass, such as wood pellets in coal using power plants, wood chips in residential heating systems, and others continue to impede the completion of the assessment process.

There is a consensus among the bio-energy supporters that carbon released during the burning of biomass to generate power can be recaptured from the atmosphere, if we can develop a sustainable biomass growth process. But, there are still arguments about the hold time between the release of carbon dioxide due to burning of biomass and capturing of the released carbon by growing plants. The long rotation cycle between the two events stems the argument.

There are also issues related to carbon payback period associated with the use of tree trimmings, sawdust, shavings, small-diameter trees that grow fast and are cut for producing wood pulp, and the large diameter trees that grow slowly in forests.

Common Myths and Facts of Bio-energy

Though bio-energy is used for centuries, its use as a renewable energy source is still disputed. The use of wheat, corn, *jatropha*, and use of land for growing such crops is contested by those who oppose such usage to generate bio-energy. Efforts are being made to ward-off such criticisms and to popularize the use of bio-energy. It is essential to understand the myths and facts of bio-energy.

***Myth*—Bio-energy is not renewable because it produces carbon dioxide while generating power**

***Fact*—**Bio-energy is certainly renewable

because the source materials used in the generation get replenished. The plant feedstock, normally deployed in bio-power systems to generate bio-energy, sequesters the atmospheric carbon dioxide during its growth process. When such biomass are directly burnt for producing bio-power or the derived bio-fuel is used to run a vehicle, only the carbon dioxide collected during the growth process get released back to the atmosphere. Moreover, to offset the greenhouse gas release, a biomass (tree or plant) is planted again in place of the removed biomass. The newly planted tree or plant continue the process of capturing carbon dioxide from the atmosphere in its growth process before it is cut for fuel use, thus keeping the greenhouse gas emissions under control.

***Myth*—Use of bio-energy will endanger the forests**

Fact—To generate bio-power, only woody biomass such as sawdust, small wood chips, and barks that will otherwise go waste are used. It must be remembered that the unused and decaying biomass, in the forests release more carbon dioxide than when it is used as bio-power or bio-fuel. Most of the bio-fuel production facilities use only existing by-products or co-products of crops or trees. Even countries, such as the USA and Brazil, which use soybean for bio-fuel generation, did not expand into the forest areas for soybean cultivation. Though, such encroachments in the forestland took place in some of the African countries that have vast forestland area and stay sparsely populated. Most of the countries have regulations to prevent deforesting to grow energy crops. Such countries take adequate precautions to prevent any increase in the use of biomass cultivation land size at the cost of tropical rain forests.

***Myth*—Bio-energy from bio-fuel is only in experimental stage and it increases the pollution levels**

Fact—The derived bio-fuel from plant sources underwent gruelling tests before proving its worth for use in vehicles. The use of bio-fuel demonstrated to offer a better eco-friendly performance when compared to fossil fuel. Also, the bio-fuel produced using some of the source materials, such as rapeseed or sunflower oil, release 45–50 per cent less greenhouse gas emissions when compared to fossil fuel use. Presence of less quantity of aromatic hydrocarbons in bio-fuel helps in such performance. The bio-fuel is in use for nearly 15 years and is tested with all the American Society for Testing and Materials (ASTM) standards to be proved as less pollutant.

***Myth*—Bio-energy plantations affect the biodiversity**

Fact—The use of land for biomass production is not different from that of agricultural cultivation. While an agricultural land produces grains for food use, the biomass production offers feed or fibre for generating bio-fuel or bio-power. Though, the biomass plantations do not offer a biodiversity like a natural forest, but they certainly offer a better biodiversity than a food crop. The perennial bio-energy crops, harvested once in two years or more, give increased level of biodiversity when compared to annual food crops. In fact, a review conducted on the Short Rotation Coppice (SRC) in the UK proved that such crops experienced increased biodiversity with assorted flora and fauna. Also, the energy crops grown on unused barren lands help in improving the soil fertility, cut down soil erosion, and further stabilize it.

***Myth*—Bio-energy crops are the sole cause for the increase in food costs globally**

Fact—There is certainly an increase in the costs of food globally. The food prices have gone up due to drop in harvests, slump in worldwide agricultural investment, and increased demand for food due to population rise. In order to avoid competition in arable land used for growing food products, energy crops use degraded, small, and surplus land parts. The energy crops grown in saline and water-logged lands, and infertile agricultural land help in reclaiming or making the land fit for growing vegetation. The energy crops grown in barren lands adjacent to arable lands help the farmer with increased crops revenue.

***Myth*—Bio-energy harvests release dangerous pesticides and chemicals into the land and spoil the environment**

Fact—Being perennial, bio-energy crops do not need large measure of chemical fertilizers for growth. Also, due to improved recycling of soil nutrients, need of fertilizers get reduced. On the contrary, profuse use of fertilizers in food crop growth saturates the soil with phosphate, and nitrify the groundwater standards. The use of pesticides contaminates the air. In fact, the trees and plants grown for bio-energy generation improve the

environment with effective soil erosion control and also reduce the levels of land salinity, to better the biodiversity.

***Myth*—The advantages of bio-energy in the form of bio-fuel or bio-diesel on engine performance are overrated**

Fact—It is reverse actually. The researches performed by the automobile industry prove that the use of ethanol or bio-diesel increase the performance efficiency of the vehicle and also its lifespan. The E85 mix comprising 85 per cent ethanol and 15 per cent gasoline, while improving the performance of the vehicle, cut down the emission levels to nearly 39 per cent.

Similarly, the bio-diesel fuel has only ~ 0.88 g/cm density, which is lesser than water. The fluid enjoys a high level boiling point with reduced level of vapour pressure. The bio-diesel's flash point is higher than that of fossil fuel diesel. The estimated calorific value of bio-diesel is 32.27 MJ/L, i.e., around 9 per cent less than the fossil fuel diesel. The absence of sulphur content in 100 per cent bio-diesel stretches the lifespan of catalytic converters.

Myth—Bio-products are not proven yet for use

Fact—The bio-products manufactured using biomass and bio-fat are tested and have become popular in countries, such as Canada and the USA. The increased use of such products will help in switch over from fossil fuel related products and cut down pollution levels in the longer run. The bio-products are bio-degradable and do not pollute the earth for years.

Biggest Disadvantage of Bio-fuel

Though, bio-fuel is less dense than water and floats over it, the hygroscopic properties of ethanol, sops in moisture from the atmosphere and contaminates it. This happens due to observed lacuna in processing of bio-fuel and leaving molecules of mono and diglycerides in the processed bio-fuel. Such mono and diglycerides perform as surface-active agent to allow mixing of water in bio-fuel. Also, the residual of processing or storage tank condensation increases the chances of water presence in the bio-fuel.

The water contamination in bio-fuel has the following disadvantages:

- Presence of water reduces the combustion heat, produces less power, makes the starting difficult, and increases the smoke discharge.
- Corrode the fuel system components and act as a source for pitting in diesel engine pistons.
- Reduce the effective functioning of paper element filters leading to sudden failure of fuel pump.
- Freezing of water crystals in bio-fuel increase gelling of the leftover fuel.

However, introduction of sensors to detect water in bio-fuel has solved the problem a bit. The continuing researches to make bio-fuel 100 per cent water-free are taking shape and expected to provide positive results.

Conclusion

Despite the opposition from fossil fuel lobby and environmentalists, the bio-energy is expected to play an important role in the present energy supply backdrop. Its ability to improve the use of agricultural and forestland is expected to restore the confidence in the moribund agricultural segment. The adaptation of wise and effective practices in the biomass production is anticipated to deal with the plaguing environmental concerns, such as greenhouse gas emissions, land degradation, biodiversity worries, GHG and acid rain contaminants, and a range of health-related problems. The use of bio-energy comes as a boon to third world countries that have abundance of biomass but suffer from lack of right technologies to use such resource.

Bio-energy presently endures a number of technical, economic, social, and establishment constraints that prevents its widespread use. The introduction of suitable policies in the land planning, forestry, and agricultural sectors at regional, national, and global levels, and improving the funding features will help the bio-energy segment to achieve a significant growth to contribute to the renewable energy sector. EF

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E-CARS Can Be FUN

The BMW i3 is a compact, lightweight electric car made of carbon fibres, aluminium, and plastic. Combining great driving performance with the high quality you can expect of BMW and an ultramodern design, the i3 is set to become a role model for e-mobility.

When BMW announced the price of its long-awaited revolutionary e-car last summer, its competitors were shocked. The starting price for this state-of-the-art lightweight battery-driven car was a mere EUR 34,950. In the highly priced e-car segment, this figure put the competition under pressure. And not only has BMW completely rethought the power train concept, the body, and the materials, it has also taken a whole new approach to design, production, and sales. The last such shake-up in the automotive industry, which tends to stick to what it knows, came in 1998 with the launch of the Smart. BMW has not spared any expense either, investing an estimated EUR 3 billion in this high-risk strategy for the future.

It certainly looks like BMW got a lot right, as the i3 combines the advantages of an e-car with the driving dynamics and premium quality for which the Munich-based firm is famous. Unlike e-cars manufactured by companies, such as Smart, Volkswagen, Volvo, and Ford, the i3 was designed as an e-car right from the start and not as a petrol model with a built-in electric power train. This has resulted in an ideal use of space and distribution of weight in the vehicle. Despite its heavy battery, the i3 only weighs 1,195 kilograms because it is the first-ever mass-produced car to have a passenger cabin made of Carbon-Fibre-Reinforced Plastic (CFRP) installed on an aluminium floor panel and cladded with plastic. BMW says that the lightweight construction also provides a high level of crash safety for both the passenger cabin and the battery case.

The i3 doesn't break any new ground in terms of drive technology, but it does raise the bar for system technology, providing outstanding driving dynamics. The car's electric motor has an output of

125 kilowatts (kW)/170 horsepower (hp) and provides 250 newton metres of torque over the entire rotational speed range. This allows the i3 to accelerate from 0 to 100 kilometres per hour (km/h) in 7.2 seconds and to reach a speed of 60 km/h in just 3.7 seconds, making it the fastest car at almost every traffic light. On the motorway, the i3 can reach an electric top speed of 150 km/h. Moreover, it does all this so dynamically and holds the road and corners so well that you have to keep concentrating on the gentle hum of the engine to remind yourself that you are not actually driving a small sports car. Like other BMW models, the suspension tuning of this rear-wheel drive vehicle also has a sporty touch; it is tight but not uncomfortable, and despite its height from the ground, the chassis doesn't rock when subjected to hard successive jolts, as the lithium ion battery hidden flat in the undercarriage ensures the highest level of stability. The i3 also scores well when it comes to the slowest speeds and its minimum turning circle of 9.86 metres makes it a pleasure to manoeuvre.

The i3 has a standard electric range of around 160 km. A small two-cylinder combustion engine with an output of 25 kW/34 hp, available for an extra EUR 4,500, extends the range to 300 km, thus assuaging drivers' fears that the car will run out of power. Three driving modes regulate acceleration and energy recovery—the frugal Eco Pro+ mode switches energy-consuming features, such as the air-conditioning, ventilation, and heating to the energy-saving mode; the Eco Pro mode provides gentle acceleration and a high level of braking energy recovery; and the Comfort mode is the programme for normal to sporty driving. Depending on which driving mode is selected, the i3 has a range of between 200 km in Eco Pro+ and 130 km (manufacturer's specification) in the Comfort mode. The new energy test drive resulted in a range of 140 km on a drive including some fast speeds and with the heating set at a medium temperature.

The i3 also includes another innovation. It is the first-ever one-pedal car. E-cars typically allow drivers to recover energy via the brake and this feature has been perfected in the i3. If you take your foot off the accelerator, the car comes to a complete standstill from a speed of 50 km/h in just six seconds in the Eco Pro mode. This is possible because the accelerator has three different zones—in the first quarter, it manages energy recovery; in the second quarter, it allows the car to cruise (by disconnecting the engine from the power train); and from the halfway point to the floor panel it fulfils the usual function of controlling

acceleration. It sounds incredible, but after a while you only use the brake in an emergency.

Of course, today's driving is not just defined in terms of drive technology, but also by safety and driver-assistance systems. The selection provided in the i3 is state-of-the-art and includes collision warning with a braking function, pedestrian detection, camera -based cruise control when driving in heavy traffic, and traffic jam and parking assistance. While people generally agree that the i3 provides a great driving experience, the car's design has proved more contentious. The car looks bumpy from the side and pear-shaped from the back — it's not exactly what you would call elegant. But that doesn't matter—after all, a revolution doesn't have to look good. BMW has presented a contrast to Tesla's models, which are based on Apple designs, and has shown that it isn't afraid to go out on a limb. As a result, the i3 is certainly very eye-catching. But the shape isn't always functional. For example, the back doors can only be opened when the front doors are open and it's a bit of a scramble to get into the back seat. In fact, it isn't particularly comfortable in the back in the first place, as the i3 is less than four metres long and you can't open the back windows. The quality of some of the interior features is even more of a turn-off. Ridges on the plastic parts between the tail gate and the side window in the test car don't fit in with BMW's aim of producing premium cars. We can hope that these are just teething troubles—and not another example of how standards are slipping at BMW.

The i3's interior provides proof that BMW is serious about its new course. Light colours, organic lines, and unusual materials are the main features of the Lodge interior, which costs an extra EUR 1,990 and has a dashboard of open-pored eucalyptus from sustainable forests, naturally tanned leather upholstery, climate active wool, door panels made of renewable resources, such as kenaf fibres, and seats made of recycled plastic. The mixture of materials is more reminiscent of a Berlin loft than a Bavarian living room. The novel look also provides new quality, such as the extremely Rat, yet very comfortable seats. You won't find a traditional instrument panel in the car either. Instead, the i3 shows all the important information on two screens. A smaller monitor in front of the driver presents all of the driving data, while the second screen in the centre console shows the satnav and secondary data, such as, an energy row diagram. Instead of a gear lever, the car has a futuristic stick to the right of the steering wheel that you use to select the driving levels. You also notice the lack of a combustion engine and gears in the foot space. With no transmission hump, there is plenty of space—but it isn't used. This is a pity, as there isn't much storage space in the car. The boot is also small—with a volume of 260 litres, it is somewhat smaller than the boot in a VW Polo.

The i3's 22 kWh battery can be recharged in all the usual ways. It takes six to eight hours to recharge

it via a household socket and three to five hours if you use an alternating current wall box (available for EUR 895), depending on the type of box. A direct current rapid charging station is the fastest option. The blue LED ring around the charging socket (which shows the charging process) just has to light up for 30 minutes for the battery to be charged to 80 per cent. However, the wall-box cable is not included—it costs an expensive EUR 199 as an accessory. And because certain features that you would usually take for granted cost extra, the apparently low basic price quickly adds up. For example, you have to pay EUR 660 for efficient heat-pump heating, a standard feature of the Renault Zoe. Furthermore, just two months after market start, BMW surprisingly excluded the satnav from the standard equipment without further notice, to offer it as an extra for EUR 1,990. A sneaky manoeuvre that equals a price increase of 5.7 per cent and sheds a different light on the allegedly "low" initial price. As a result, hardly any i3s sold by the 46 selected dealerships in Germany are likely to cost less than EUR 40,000.

BMW offers better conditions as regards electricity. Thanks to a special cooperation agreement with green electricity supplier Naturstrom, BMW customers pay EUR 0.25 per kWh instead of the normal EUR 0.2695. i3 drivers can also buy a Solarwatt carport with a solar roof panel. But even with electricity costs of around EUR 3 for 100 km, and 20 per cent less expenditure on maintenance, it takes a long time before the i3 starts paying for itself. In that sense, it is like any other e-car. BMW provides an eight year guarantee on the battery. However, no long-term studies on the lifespan of traction batteries in cars are available yet. With the i3's market launch, BMW no longer wants to be seen merely as a car manufacturer, but also as a supplier of "individual mobility" with services ranging from the installation of charging stations to apps for intermodal mobility. The latter is a particularly innovative feature.

On request, the satnav with intermodal routes also shows options for switching to public transport and suggests the use of park-and-ride services or the carpooling network *Rinc* during the rush hour (initially only in Germany). You can also borrow a large BMW with a combustion engine for your holidays. However, if you want more connectivity, you will have to be prepared to pay more. Using the established BMW navigation system, i Connected-Drive, the i3 also has complete internet access via a SIM card. It has a subscription cost of EUR 670 for two years. The dynamic Range Map is particularly useful here. Taking topographical data into account, this accessory calculates the range and provides feedback on driving performance, traffic information, in real time, road information and charging stations run by the association Charge Now, which currently includes 700 operators of public charging stations. The direct connection between the car and driving is available free of charge, and you can programme

BMW i3 specifications

Drive system	Electric motor with an optional 0.65 litre combustion engine (Range Extender)
Body style	Hatchback compact car
Horsepower	125kW/170hp (25kW/34hp using the Range Extender)
Range	180 km (manufacturer's specification); 140 km (new energy test drive)
Max. torque	250 Nm
Top speed	150 km/h
Acceleration (1–100 km/h)	7.2 seconds
Consumption	12.9 kWh/100 km (manufacturer's specification) or 0.61/100km using the Range Extender
CO_2 emissions	0g CO_2; 13g CO_2/km using the Range Extender
Battery	22 kWh Lithium-ion battery
Charging time	From eight hours (household socket) to around 30 minutes (80 per cent charge at a 50 kW rapid charging station)
Length	3.999 m
Width	1.775 m (with mirrors folded)
Height	1.597 m
Wheelbase	2.570 m
Weight	1,195 kg
Price	EUR 34,950
Availability	Since November 2013
Seating capacity	4

the air-conditioning and charging processes via the i3's iPhone app.

In conclusion, the BMW i3 was the 2013 car of the year, thanks to its clever combination, of an electric drive, lightweight construction, and innovative design. There is no sign yet that any other model to be launched this year will have a more convincing innovative concept. If the i3 is not able to make e-cars mainstream as status symbols, it will be difficult to achieve the aims that have been loudly proclaimed by politicians and industry. EF

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The Growing Role of RE Technologies in the Oil and Gas Sector

Dr Suneel Deambi

Some say matchmaking is a thing of past in today's fast-changing modern world. However, it may still be subservient as to which geographical location is under active consideration. Simply put, rural areas are still wedded to such causes unlike the urban centres throwing off new choices by the day. Almost same is the case with oil and gas sector pairing up with the renewable energy especially in the rural areas. This matchmaking choice seems to be a misplaced one at the first go but it is a growing reality. It is an amazing distinction of sorts as oil and gas formation in the earth's/ocean bed owes its origin to some naturally occurring processes and phenomena. Solar and wind energy are the moving manifestations of nature in a free-flowing manner. These two sources in particular are now the new favourites of energy generation scenario across the world.

A large number of end-use applications, such as lighting, water pumping, battery charging (for multiple uses), and power generation (both off- and on-grid) are making wider outreaches via solar energy-based systems. There are few selective applications in the oil and gas sectors which make use of clean, safe, noiseless, smokeless, and reliable energy sources. This article takes a close look at the synergy between the renewable energy sources on one hand and the vast expanse of oil and gas sector on the other hand from several key considerations.

The Early Global Perspective

The sheer fact is that oil and gas companies worldwide have been experimenting with the use of renewable energy (RE) sources or even RE business since a long time now. In the wake of oil crisis of 1970s, the Organisation for Economic Cooperation and Development (OECD) put in place a range of incentives and subsidies for energy independence. OECD represents a group of 30

countries having a strong belief in the free market system. This sparked a first wave of stand alone RE business ventures, focusing on solar, wind, and geothermal energy, for example, Chevron, which happens to be the world's largest producer of geothermal energy. The government led hand-holding did not last for long as the public incentives for RE technologies were withdrawn in the 1980s. The sad outcome was that most companies bid goodbye to the RE-based investment and turned their attention yet again on their core petroleum business. A second wave of oil and gas companies entered the RE arena in the late 1990s and early 2000. The pivotal consideration was the coming in of a global climate agreement. However, due to the global economic downturn the industrialized countries failed to match rhetoric with practical action. This led to a silent burial of sorts for the ventures in solar and wind notably by two industrial giants, i.e., Shell and BP amongst others.

The New Beginning

The United States based oil and gas companies kick started a major investment drive in RE sector between 2000 and 2010. A massive investment of around $9 billion was made in solar, wind, and bio-fuel technology segments. Pertinent to mention here that in several places, the economic tide is steadily but surely moving in favour of renewables over the polluting fossil fuels. A glaring example is that of Australia, where the wind power recently edged out new coal. Likewise, in Texas, wind is now becoming increasingly competitive with natural gas. Following few points merit consideration in the backdrop of RE relationship with the oil and gas sector:

- Developing renewable energy reinforces the strengths of oil and gas sector.
- Sound inclusions are those of energy market foresight, technology know-how, etc.
- RE offers a means for diversification in the face of volatile energy input costs and also a hedge against the peaking oil demand in key markets.

Importantly enough, the renewable energy specific investments can also mean accrual of favourable political capital for the oil and gas companies. This is keeping in view the climate conscious community members and decision-makers.

The Crying Need for Carbon Management

Today there is a heightened impetus on an aggressive carbon management from key financial partners of the oil and gas sector. The underlying consideration is to showcase cost-effective options for abatement of greenhouse gas emissions. It is also being made as one of the conditions for project finance. In totality, the oil and gas companies are saddled with enough opportunities to make judicious investments in renewable energy. A striking case is that of ethanol blending mandates in the United Sates, European Union, and Canada. The Shell Company is currently the world's leading vendor of bio-fuels. However, there is more to it than what meets the eye as large-scale use of biomass resources for fuel is facing flak from several quarters.

Barriers Impeding Free Flow of Renewables

- The prices of natural gas are lower than the high capital cost of renewable energy.
- Subdued levels of awareness on renewable energy technologies/ programmes amongst the oil and gas companies.
- Not so determined focus on increasing market penetration of RE technologies.

The fact remains that RE technologies happen to be cost competitive for oil and gas in several cases. This is true when it comes to competing against the expensive diesel or even propane-based power in off-grid applications.

Justification for Solar Energy Utilization for Oil/Gas Activities

The wireless supply of energy has been a well-suited solution for the oil and gas activities in remote locations since many years now. Solar PV technology-based systems are seemed to be quite efficient in this sector because of their very high field performance reliability even in high risk locations. They can be conveniently used for the following purposes:

- To supply energy for oil and gas installation functions. These mainly include pipeline control systems, beaconing, and nocturnal lighting for onshore and offshore oil platforms.
- To help in diesel displacement for major oil and gas companies.

It may be noted that the fuel carrying pipelines need to have the requisite changeover and monitoring stations located at every 30 kms. These stations need a certain amount of power to run the System Control and Data Acquisition (SCADA) system for monitoring pressure, flow, operations, etc., of all the control devices, besides valves and other electrical equipment. These remotely located stations are using the diesel gen-sets and other different kinds of energy producing devices.

Prominent PV Applications in Oil/Gas

Solar and wind energy can energize a number of applications related to the oil and gas sector. One of the earliest known applications powered by solar PV technology has been the cathodic protection of pipelines. Several more such uses are listed below for our ready glance:

- Enhanced oil recovery
- Remote telemetry units
- SCADA
- Flow measurement and monitoring telemetry
- Drilling meters
- Natural gas automation
- Process control equipment
- Lighting/water heating
- Enhanced oil recovery

Two prominent applications are highlighted below at some length:

Cathodic Protection

Photovoltaic technology can be put to several uses in this high value sector. Cathodic protection is one such use. Any underground metal storage tank holding non-toxic materials or petrochemicals need cathodic protection. Additionally, there are thousands of miles of pipelines and well casings that are corrosion protected via cathodic protection. Solar PV systems are used successfully in places where the current needs are small and there is no access to grid power lines. Expectedly the use of PV for this application will increase as the effectiveness of metal coatings decrease the current demand. Estimating the amount of current needed to protect a metal structure is not a straight forward solution and offers challenge for even the experienced corrosion engineers.

Case specific example of cathodic protection

This is an interesting example of solar PV technology use for a cathodic protection of a gas pipeline in a desert environment. The challenge is to offer a renewable power-based solution so as to replace the existing diesel powered engine generator. The system must be able to operate in extreme desert heat, high humidity, and in a high dust environment with a minimal need for user maintenance. These conditions were not being met by the diesel generator. Accordingly, a solar power system was installed for the specified purpose of cathodic protection. Table 1 summarizes the key features of this system.

A unique attribute of the customized solar power system can be seen in terms of just two cycles of annual maintenance as against the bi-weekly engine refuelling done previously. This resulted in an estimated annual fuel usage saving of around $ 30,000. This transformed into a project payback period of one year or so.

Enhanced oil recovery via solar energy utilization

Today renewable energy applications are being introduced into the oil industry across many countries. Its larger purpose is to conserve energy and maximize efficiency besides optimizing the production cost. Oman presents one of the suitable case specific examples of possible solar energy use in different applications within its oil industry.

Solar assisted enhanced oil recovery

Some geographical locations, like Oman, may have a significant amount of highly viscous oil, such as bitumen from oil sand. This may well be recovered using a special method of enhanced oil recovery technology better known as steam-assisted gravity drainage. Steam can be produced by burning of natural gas, but natural gas is needed for several other applications as well. Thus, solar energy based enhanced oil recovery (EOR) is likely to play a key role in the mix of EOR technologies. In this case, Concentrated Solar Power (CSP) technology is used for steam

Table 1: Key features of Cathodic Protection

System design voltage	24 V
PV array capacity	1920 Wp
Battery capacity	2400 Ah, 24 V
Mounting structure	MS hot dip galvanized structure
System autonomy	More than 5 days (depending on the soil conditions)
Battery box	Customized stainless steel enclosures with separate controls
Cathodic protection regulation	Stainless steel enclosure
Varying load requirement	40–250 W

production. The receivers collect the solar energy and then convert it into heat. The heat thus obtained is then used to produce steam from water.

It is pertinent to note here that Solar EOR can generate the same quality and temperature of steam as normally available via natural gas. The use of solar EOR has the potential to reduce demand for natural gas required in enhanced oil recovery. Natural gas, hence saved, can well be used in other economic activities, such as in water desalination, power generation, and as a vital feedstock and energy source for industrial processes. A pilot scale project of 7 MW dealing with solar EOR was initiated by Petroleum Development Oman and the contract was awarded in August 2011 to California-based GlassPoint Solar inc.

Early Indian Experiences of RE Use in Oil Sector

India embarked on an ambitious programme of offshore oil and gas exploration, production, and laying of pipelines for the transportation of oil and gas. Solar PV systems were considered suitable for providing power for telemetry and communication requirements of unmanned offshore oil/gas production platforms along the onshore pipelines. According to the estimations made by the Department of Electronics, the annual requirement for such applications was pegged at around 200 kWp by 1990. It is to be noted here that SPV systems for offshore applications call for a high degree of sophistication in design and performance due to the extremely unfavourable environment of flammable gases and vapours, and also to the remoteness of the site. The solar modules have to pass severe environmental and safety tests. In 1990, a total of 36 such systems had been supplied to the Oil and Natural Gas Commission (ONGC) by the two premier public sector solar companies of that time, viz., Bharat Heavy Electricals Limited (BHEL) and Central Electronics Limited (CEL).

The Indian Oil and Gas Sector

The all India installed power capacity of ONGC stood at 245,393.54 MW as on April 30, 2014. Out of which, gas and oil based power generation accounted for 21,781.85 MW and 1,199.75 MW, respectively. Renewable energy sources together contribute to around 31,692.14 MW. Importantly, gas and oil find so many diverse uses other than power generation. Table 2 presents the ten major oil and gas companies in India.

As per the industry experts, most of the easy oil has been discovered. The future potential lies in the logistically difficult areas and in the deep waters. It is equally true that no major oil reserves have been found in the recent times. The indigenous production is at a plateau stage and renewable energy seems to be need of the hour. The hard

Table 2: Major oil and gas companies in India

Company	Location (Corporate)	Business products	Estimated turnover	Website (for detailed information)
Indian Oil Corporation (IOC)	New Delhi	Oil, Gas, and Petroleum products	$ 28 bn	www.iocl.com
Oil and Natural Gas Commission (ONGC)	Dehradun, Uttranchal	Oil, Gas, and Petroleum products	$ 6.50 bn	www.ongcindia.com
Bharat Petroleum Corporation Ltd (BPCL)	Bengaluru, Karnataka	Oil, Gas and Petroleum products	$ 40 bn	www.bharatpetroleum.com
Reliance Petroleum Ltd	Ahmedabad, Gujarat	Oil, Gas, and Petroleum products	$ 670 mn	www.reliancepetroleum.com
Essar Oil World	Noida, Uttar Pradesh	Oil, Gas, and Petroleum products	$ 9bn	www.essar.com
Cairn India Ltd	Gurgaon, Haryana	Oil, Gas, and Petroleum products	$3400 mn	www.cairnindia.com
Gas Authority of India Ltd	New Delhi	Oil, Gas and Petroleum products	$ 8bn	www.gail.nic.in
Hindustan Petroleum Corporation Ltd	Mumbai, Maharashtra	Oil, Gas, and Petroleum products	$8bn	www.hindustanpetroleum.com
Oil India Ltd	Mumbai, Maharashtra	Oil, Gas, and Petroleum products	$35 bn	www.oil-india.com
Tata Petrodyne	Mumbai, Maharashtra	Oil, Gas, and Petroleum products	$100 bn (Tata Group)	www.tatapetrodyne.in

fact is that oil prices are maintaining an upward trend and energy demand is going up too. Thus, it has become absolutely necessary for rather one and all to search for viable alternative to oil, preferably from renewable energy sources.

The following section takes a close look at some of the renewable energy initiatives of few oil/gas majors, such as ONGC, IOCL, and GAIL.

ONGC

The Oil and Natural Gas Commission is the largest E&P company in the country, which is engaged in oil exploration and production in India and abroad. Exploration, drilling, production, and processing of oil are energy-intensive activities. With this in view, ONGC marched on a path of setting up a 50 MW wind power project in Gujarat state. The clear enough objective is to meet its internal demand at various oil producing installations. The reason for choosing wind energy is that Gujarat has a good wind potential besides a large number of oil installations as well. ONGC buys power from the state electricity board, thus it decided to go for wind power to replace the SEB power. Salient features of this wind power project are:

- Location: Adjacent to Bhuj, Gujarat
- Wind speed: 8–10 m per second
- 34 numbers of 1.5 MW machines chosen for the purpose
- Steel tower height equivalent to 78 m
- Wheeling power to ONGC installations
- Plant load factor: 24 per cent
- Evaluation based on cost of generation (Rs per kWh) including operation and maintenance (O&M) cost for a period of 10 years

As per the available reports, the work has been completed and 10 out of 34 machines are currently producing power. The remaining machines are awaiting the desired grid connection. According to ONGC, the major concern is related to less generation of energy mainly due to presence of less wind at times. Surplus generation may also occur, however, Gujarat state does not allow banking of the power beyond one month. Further, the availability/reliability of grid is of a paramount importance. There is a growing unanimity on the fact that wind energy happens to be one of the best, economical, technologies tested, and environment-friendly clean source of energy. It is now being seen as a good alternative option for the medium-term requirement. ONGC sees the path of renewable energy as an ominous one from several key considerations.

Mumbai ONGC society installs solar and wind power systems

It is a true novelty of sorts not so much for the use of solar PV in a housing society, but in terms of collective use of solar and wind power systems at one place. It has a twin objective of bringing down the expensive electricity bill along with reducing the carbon footprint. The location under consideration is a residential complex in Bandra West, Mumbai. Here ONGC has installed a miniature version of windmills atop its three buildings. These wind turbines are often seen in remote and open countryside locations, but this time they have found an urban home. The underlying purpose is to showcase the objective of generating clean and reliable energy.

The three turbines put up in the society are collectively capable of producing around 9 kW of electricity in a day. The power thus generated is enough to run the lights in the common areas of society, i.e., in corridors, parking, and stairwells for about 12 hours. The three buildings within the society have 54 flats. Further, the turbines are a part of the hybrid system that also includes solar modules. Is this not a shining example of sun and wind teaming up together for a powerful cause? The total system cost of Rs 20 lakhs was fully funded by the ONGC, which hopes to replicate this wonderful experience at its other locations across the country.

Gas Authority of India Limited

The Gas Authority of India Limited (GAIL) began in late eighties essentially as a natural gas transmission company and eventually transformed into an integrated energy company along the natural gas value chain with global footprints. As of now, GAIL has a network of natural gas pipelines covering a length of more than 10,500 kms with interests in the business of natural gas, LPG, liquid hydrocarbons,

petrochemicals, exploration, and production besides city gas distribution and telecom.

The gas company has started taking a strong preference towards a steady use of both wind and solar power. A total wind power capacity of 117.95 MW is already in place for meeting certain end-use applications. Additionally, GAIL has recently commissioned a solar power plant of 5 MW capacity in Rajasthan.

Indian Oil Corporation Limited

Indian Oil Corporation (IOC) began its operations in 1964 via the merger of Indian Refining Ltd and Indian Oil Company Ltd so as to become an integrated refining and marketing company in the PSU domain. IOC has a strong R&D taskforce of about 438 scientists and support staff who undertake research activities in the diverse areas of lubricant technology, biotechnology, nanotechnology, and alternate energy. The concentrated solar power technology is of special relevance for the centre due to a synergy of sorts in process flows at few selective levels.

IOC has so far set up a 5 MW solar PV power plant in Rajasthan in addition to a wind power based capacity addition of about 21 MW. That is not all, as the company has marketed around 30,000 solar lanterns through its countrywide dealer-distribution retailer network, IOCL has also installed a few centralized solar power charging stations on a pilot basis for immediate benefit to the rural poor. Building integrated solar PV system of a few kilowatts at Noida (UP) happens to be one of its early adoption setups in solar technology.

This is just a snapshot of the efforts going on at these big oil companies towards an enhanced market penetration of RE technologies more so solar and wind energy.

The Indian Oil Majors Painting a Big RE Canvas

As per the available reports, oil majors like ONGC and Indian Oil Corporation are planning to form new companies specifically to set up large capacity solar and wind power projects both within India and abroad. In fact, ONGC along with Oil India Ltd (OIL), GAIL, Engineers India Ltd (EIL), Solar Energy Corporation of India (SECI), and Indian Renewable Energy Development Agency (IREDA) are expected to set up a special purpose vehicle. The larger purpose is to carry out big size RE grid connected projects. There is an interest to set up off-grid projects (incorporating advanced technologies) too, for the realization of which OIL is planning to piece together a second Special Purpose Vehicle (SPV). This SPV will include Bharat Petroleum Corporation (BPCL), Hindustan Petroleum Corporation in addition to SECI and IREDA. An MoU has already been signed up and the collaboration is aimed at leveraging the financial and managerial capabilities of the oil companies to scale up the RE projects. There is a determined plan to set up ultra-mega power projects of 500 MW capacity at a per MW capital cost of Rs 6–7 crore per MW. EIL has been entrusted with the responsibility to undertake the techno-economic feasibility studies. India does not have any installations of offshore wind farm projects till date and there is a broad consensus to develop such projects in 15 nautical miles.

Key Operational Attributes

Two SPVs are likely to be incorporated by August 2014.

- Specific objective of these SPVs is to promote the deployment of RE technologies so as to supplement the conventional fossil fuel-based power generation.
- Expected boost to the development of large-scale grid connected RE projects in addition to implementation of off-grid applications.
- SPVs are likely to act independently akin to the commercial organizations while utilizing various promotional schemes of MNRE and state governments.
- The first SPV is to be headed by ONGC and likely to get involved in installation of large-scale grid connected projects.
- The second SPV is to be led from the front by Indian Oil Corporation and likely to get involved in setting up of off-grid RE projects via an effective mix of advanced technologies and market-based solutions for promoting energy access to the energy deficient population.

The Oily Path Forward

There is no denying the fact that renewable energy technologies are steadily but surely expanding their frontiers of use in more ways than one. Expectedly, the oil/gas majors may bask under the glory of sunshine and fast blowing breeze by setting up large-scale RE power capacities for meeting its captive power needs both in the on-grid and off-grid segments of use. The die has already been cast on this front with growing expectations of taking RE power to new heights. As per the industry sources, ONGC is keen to play a major role in the off-shore wind power arena in near future. Quite clearly, oil/gas companies are not entirely new to the alternate energy domain. Likewise, wind power can lead to sweeping changes as far as meeting the power requirements within the oil/gas majors is concerned. Together, solar and wind power are going to be the two big favourites of the oil sector for sure in the time ahead. EF

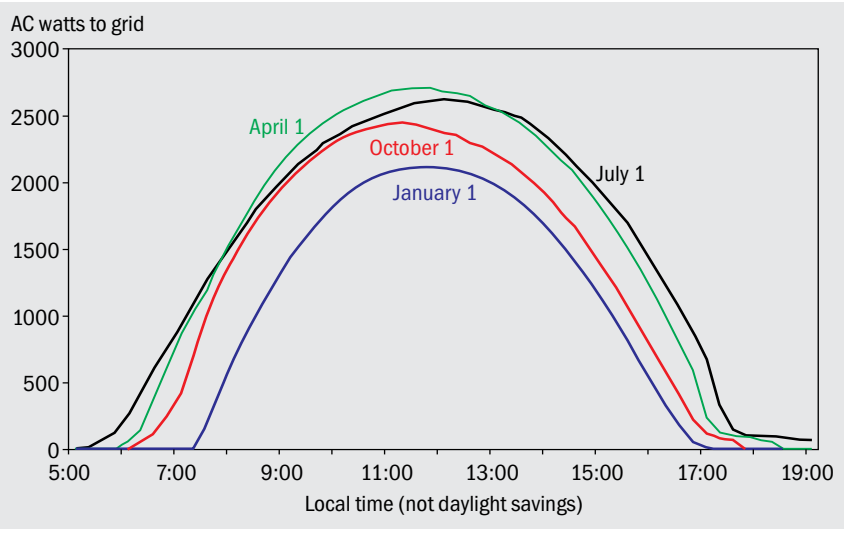
Dr Suneel Deambi, Consultant, TERI

From Intermittency to Dependency

Energy Storage Solutions for Grid Integration of Renewables

Sapan Thapar

With over 140 GW of solar photovoltaic and 320 GW of wind-based power generation capacity in operation (out of the total installed renewable capacity of 560 GW), renewables are on their way to contribute increasingly towards meeting the energy needs of the world. India has also set up its targets and aims to have more than 50 GW from renewables (mostly solar and wind-based projects) by the end of current plan period. It is further contemplating to replace its conventional fossil-based systems by renewable technologies as a measure to contain climate change and enhance its energy security.



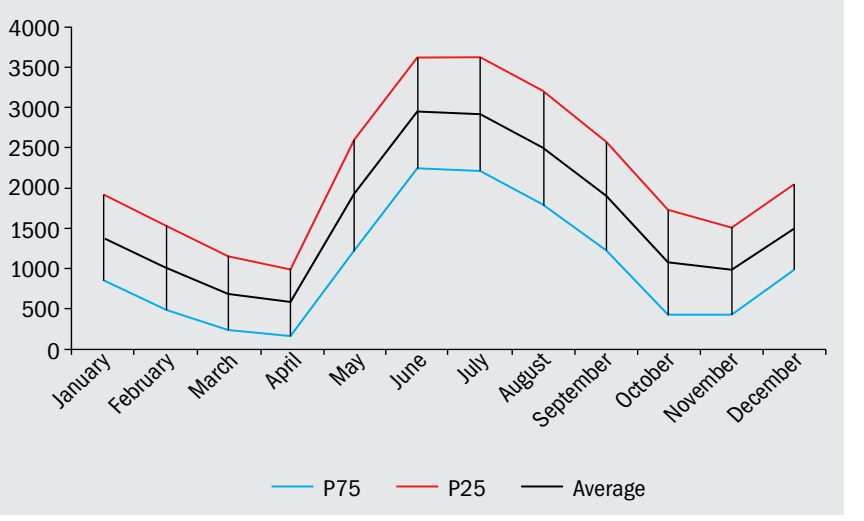
Graph 1: Typical annual generation from solar-based plants

Issues at Large

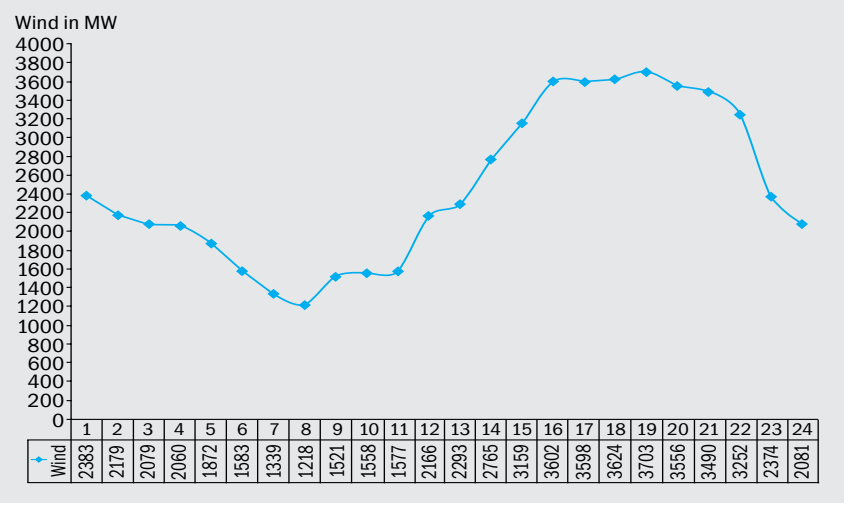
However, being dependent upon the vagaries of nature, the energy generation from renewable technologies, especially from wind and solar, is erratic, commonly referred to as intermittency. Graphs 1, 2, and 3 show a wide variation in power generation both on a diurnal basis as well as on seasonal basis. This has been often cited as the main cause of concern by the grid managers to accommodate higher percentages of renewable power in the power system.

Even in India, renewable surplus states, such as Tamil Nadu and Gujarat, are finding it difficult to accommodate more quantity of renewables. They have to many times back-down their fossil-based (coal/gas) plants. This impacts the revenue inflows of these plants (many of which have been set up under IPP mode by private sector entrepreneurs). Further, there are issues with respect to time required to ramp up-and-down the coal-based plants, thereby impacting their efficiency and longevity. This is a kind of interim solution and a permanent measure needs to be evolved.

There is also a talk of putting up solar thermal projects (CSP) with storage



Graph 2: Variations in wind power availability over a year



Graph 3: Typical daily generation curve from wind turbines

facilities. However, the miniscule CSP-based capacity may not be sufficient to support large quantities of installed wind and solar PV capacities.

Possible Solution—Energy Storage Technologies

An old adage—'Save for the rainy day'—is well suited for the renewables. As such, the use of energy storage solutions is paramount to complement renewable-based power systems to meet the energy needs of the end-users and contribute towards grid stability. Electricity can be stored only in the form of potential, chemical, mechanical, thermal, or magnetic formats. As such, different kinds of storage systems are being developed (which are under various stages of development) to be used in conjunction with the renewable power projects.

Energy Storage Technologies

The details of some of the prominent storage technologies/systems, which can support large-scale deployment of renewable energy capacity, are discussed in the following paragraphs.

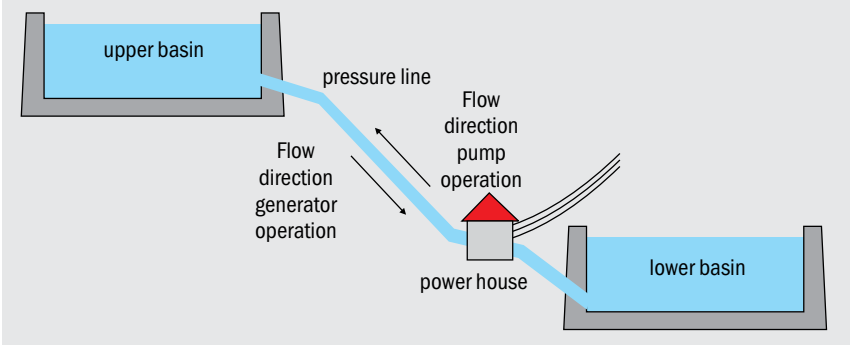
Pumped Storage Plants (PSP)

It is a kind of hydro-energy system, wherein two reservoirs are located at different heights/elevations with a reversible pump-turbine device. In the normal course, water flows

downstream from reservoir located at higher elevation to the lower elevation reservoir converting its potential energy to kinetic energy. This energy is then converted into mechanical energy and finally to electric power. A part of the water going downstream is tapped below and pumped back to the upstream reservoir (say by utilizing the excess wind/solar power), whose potential energy can be again converted to kinetic format as and when the need arises (say in case of reduced power generation from solar/wind plants to meet the peaking load).

Pumped storage has been the most widely used technology in the world and offers high amount of energy storage capacity, with over 70–80 per cent conversion efficiency and with a lifespan similar to hydro-power plants (around 30–35 years). However, these projects are site specific and dependent upon water flow. Further, in case of energy deficit countries/regions, they offer limited use as there shall not be many occasions of surplus power to be deployed back to pump the water back to upstream reservoir.

Globally, PSP accounts for more than 90 per cent of energy storage capacity as it is the cheapest amongst the commercially mature storage technologies. In India, the total potential of pumped storage was assessed as more than 95 GW (CEA survey). Nine plants of 4,785 MW capacity have been installed, out of which only five plants of 2,600 MW capacity are working. Two plants, i.e., Tehri-II (100 MW) and Koyna LB (80 MW) are under construction. Three plants, viz., Malshej Ghat (Maharashtra 700 MW), Humbarli (Maharashtra, 400 MW), and Turga (West Bengal, 1,000 MW) are undergoing survey and investigation.



Graph 4: Pumped Storage Plant (PSP)

Compressed Air Energy Storage (CAES)

These systems compress, inject, and store air in underground cavities

(including porous rock foundations and mining sites) using electric motor-driven compressor. This compressed air, stored at pressure of 45–70 bars, can be used in a gas turbine for driving the generator, thus saving upto 40 per cent of its fuel. During the compression process, the air is heated to around 150 °C, which is then utilized for expanding the turbine. The commonly used cycle is diabatic, with an associated efficiency of 40–70 per cent.

Globally, there are only two operational plants—one each in Germany and the United States, both of which are adjunct to the existing gas-based power plants.

Incidentally, many of the probable CAES sites coincides with remotely located wind sites, with space available for injecting compressed air in the underground caverns. With respect to India, CAES can be experimented in the Kutch area of Gujarat having large capacity of salt plants (offering ideal conditions for construction of large-sized underground caverns), which can use the power generated from the ubiquitous wind turbines located in the area.

Flywheel Energy Storage System (FESS)

These flywheel systems use electric energy to spin the rotor of a giant cylinder/wheel, mostly in a vacuum frictionless enclosure (to minimize friction losses). When energy is needed, the flywheel is slowed and the kinetic energy is converted back to electrical energy within a small time by reducing the rotational speed of the flywheel. The amount of energy that can be stored in a flywheel is directly proportional to its mass, the square of the spinning speed, and its radius.

The flywheel is connected to a combination of motor-generator. They are associated witth high efficiencies (over 80 per cent), low ramp-up time, low maintenance, high energy density, and a long lifespan.

With respect to current usage, flywheels have been used in a wind farm in the United States as energy storage systems to counter the constrained transmission facilities in the region. In India, the use has been limited to supporting the Uninterrupted Power Supply (UPS) in small size formats.

Batteries

Rechargeable Lead Acid Batteries have been in use for over a century as low cost storage systems with lead as anode, lead oxide as cathode, and sulphuric acid as an electrolyte. They have been extensively used in small-sized solar systems to run solar lanterns and lights. They are also used in transport vehicles and as storage devices for UPS and inverter systems. They are widely available in ready-to-use sealed maintenance free enclosures. However, their energy density is low, they are bulkier in size, and contaminate the environment due to the use of lead. They are slowly giving space to other forms of rechargeable battery systems.

Rechargeable Lithium-Ion Battery is a form of rechargeable battery, which is ubiquitous as high energy density storage for smaller electronic applications, cellular phones, and notebook computers. These batteries have electrodes of lithium and carbon, which are light in weight and can operate in a range of temperatures. However, they are prone to overheating and costs higher than other available storage systems. In the United States, a Wind Energy Storage project involves use of a 32 MW-hour lithium-ion battery bank, which stores about 15 minutes of peak energy from the 98 MW farm.

Sodium–Sulphur Battery (NaS) is based on sodium sulphur reaction and operates under high temperature. These batteries are used for large-sized applications and have high energy density. The world's largest battery system for energy storage (6 MW) is operational at Hitachi's Automotive Systems Factory in Japan.

The various advantages of rechargeable battery systems are their small size, placement (can be sited outdoors and indoors), minimal noise, compatibility, and portability (not site specific). However, long-term availability of chemicals (anode and cathode) at competitive prices and their impact on environment (discharge of chemicals) are some of the issues confronting this sector.

Techno-commercial Comparison

Each of the energy storage system has got its own characteristic and fitment. Pumped storage is commercially mature, conversion efficient, cheap, and is site specific. With respect to energy delivered per rupee, flywheels are high in energy density and conversion efficiency, but they are noisy and require specific vacuum chambers. Batteries are compatible, but are not environment-friendly and have a short lifespan. The storage projects currently in operation/being implemented shall provide necessary lessons to plan for future, wherein, large quantities of renewable power are going to be integrated into the grid. The fine print in selecting any technology includes the cost per kWh, availability of input materials, ease of implementation and use, efficiency, operation and maintenance, and the right fitment with the existing renewable technologies.

Summary of Energy Storage Technologies

The Table below shows a comparison among different storage systems.

Comparison among different storage systems

Storage technology	Advantages	Challenges
Pumped Hydro	Mature technology Low cost and long life Large capacity	Site specific Long lead time Environmental concerns
CAES	Established technology Better ramp-up rates Long life	Site specific Low efficiency Slow response time
Flywheel	Modular nature Long cycle life High efficiency	Frictional loses Special materials for rotor Short-term storage
Lead Acid Battery	Mature technology Low cost Modular nature	Low energy density Electrode corrosion
Li-Ion Battery	High energy density High efficiency	High cost Temperature sensitive
NaS Battery	High energy density Fast response Long life Scaling potential	High operating temperature Liquid containment issues

Advantages of Energy Storage Technologies

As we have observed that the use of storage systems at different scales enables large-scale integration of renewables into the grid. These storage technologies provide numerous benefits to the sector stakeholders, utilities, grid managers, project developers, and the end-user. The benefits include:

- Meeting scheduled power delivery commitments as per grid code.
- Meeting peaking load requirements.
- Utilizing all renewable power generated (in case when generation is higher than demand).
- Maintaining the voltage and frequency profile of the grid for power system stability.
- Providing start-up/back-up power for energizing the system/grid.
- Complementing smart grids towards grid management as part of demand-response mechanism and supporting electric transportation.
- Supporting a 100 per cent RE scenario. EF

The author is a professional engineer and a certified energy manager with over a decade of experience in the field of energy including renewable technologies. All the views expressed above are personal.

“Evacuation is the most important issue today”

At the recently concluded RENERGY 2014 in Chennai, **Madhusudan Khemka**, Chairman of the Indian Wind Turbine Manufacturers Association, shared his thoughts on the prevalent trends in the wind energy sector, both in India and Tamil Nadu. He also spoke extensively on how it could be bettered. Ms Sapna in conversation with Mr Madhusudan Khemka for *Energy Future*.*

What has been the progress of the wind energy sector this year, in India and in Tamil Nadu?

Compared to 2,100 MW last year, the wind energy industry in the country will see an addition of around 3,000 MW of capacity during the year. If the Accelerated Depreciation (AD) is there, this will increase to another 1,500 MW or more. India is capable of producing 10,000 MW of wind every year, more than what we need. As for Tamil Nadu (TN), the total installed capacity of wind energy in the state is 7,248 MW. This is almost 40 per cent of the total installed wind energy capacity in the country, according to Tamil Nadu Energy Development Agency (TEDA). Recently, the state government announced the removal of restrictions, and control on wind power evacuation, and withdrawal of all load shedding in the state. This has come as a breather to the industry, which had been suffering various issues in TN. During 2011–12, the industry added around 1,000 MW of wind energy in TN and we hope to repeat the same kind of installation in the next two years.

Also recently, S Akshayakumar took over as Chairman of the Tamil Nadu Electricity Regulatory Commission (TNERC). The post should be handled

*This interview was done before Accelerated Depreciation (AD) was formally announced by Union Finance minister Arun Jaitley in Parliament.

by a technocrat and he knows the subject very well too. In the RE sector and generation, we need technically competent people who take decisions. This is where we welcome the move.

While GBI has been reinstated, there is still some uncertainty with regards to AD. What are your thoughts on this?

We have huge potential in the country when it comes to wind energy. While infrastructure is only a mindset, the management of grid plays a major role. In 2012, the figure came down from 3.2 GW to 1.7 GW and in 2013–2014, it was 2 GW, whereas the country has a potential of closer to 70 to 80 GW, (assessed potential).

There have to be two life streams to add to the growth of the sector. Generation Based Incentive (GBI) is most welcome, that is where the interest of IPPs is taken care of, but at the same time, why wind energy alone is left over, when it comes to AD. There are a lot of small players and captive investors, who are keen on investing in the sector, but they are not able to do that because without AD it is not viable and GBI is not available to everybody. We should have a target of 5,000 MW per year and for that AD is very important. So, in the budget proposal we are focusing on AD.

According to you, is the evacuation of wind power improving?

Evacuation is really the most important issue today. We have our own state, Tamil Nadu, which is blessed with a lot of wind and we have many other states which do not have wind, but they have a need for energy, a need for power. I would like to congratulate the Tamil Nadu Government because there is a huge amount of focus in sorting out evacuation issues in TN. Chief Minister J Jayalalithaa herself made a statement some time back, giving a lot of thrust on the evacuation of wind power in the state. The entire wind energy sector is appreciative of this initiative. Also, evacuation is something we need to focus on because the industry cannot work in isolation, we cannot keep on adding RE projects. It is improving, but, we have wind in one part of the country and we have evacuation. National grid is one solution, so wherever there is wind, we use the energy and we evacuate power in various parts of the country. Secondly, there has to be a lot of thrust on smart grid and on wind forecasting. When we come across all the challenges, we know that there are solutions in some other parts of the world. We need to bring the latest technologies and solutions for the country. It is happening but slowly, because it needs huge amount of funding. As far as the transmission is concerned, a lot of credit goes to the TN State Electricity Board where a new 400 kW sub-station is being installed. A new sub-station will be commissioned in the next couple of months, followed by some more sub-stations. So, with these, I am sure that we will be able to sort out evacuation challenges

But without doubt, there are huge evacuation challenges in the country. There is a willingness to install more RE, but we need to sort out evacuation challenges.

What about energy storage? What are your views on this?

We have been talking about storage of power. For such a huge volume, this cannot happen using batteries. In many parts of the world, they have been using hydro stations as stations of power. I think we need to have large-scale use of wind hydro to handle the issue. A countrywide plan on evacuation for RE through green corridor is the only solution. That has to be absolutely high tech. I'm happy that Central Electrical Authority and Power Grid Corporation are involved as well. Also, now we have a common Ministry and they are all working in co-ordination.

In TN, we have nearly 7,000 MW of wind energy installed. There, the small vision of storage may not solve the problem and we need to have a bigger vision, maybe 1,000 MW equivalent, hydel balancing, maybe hybrid. I fully agree that decentralized energy storage is another very big solution. When we talk about smart cities, if our energy requirements are planned very well from the beginning, decentralized power stations can play a big role, which can have a good combination of hybrid, solar, wind, maybe even diesel and storage. As of now, storage is expensive, when we look at storage through battery systems. Storage battery technologies are now similar to what solar technology was say 10 years ago. But, they are really improving now and going forward. In five to seven years we will see a revolution getting into the RE sector, where the storage cost will come down. When the government is planning smart cities, it will take five to seven years. By that time, we will have a much better solution and storage has to be looked at differently, decentralized and on a smaller scale. For a country like India with huge power requirement, we should look at big storage solutions like hydel and wind solar.

What is the contribution of renewable energy to the grid?

If say a particular state has a five per cent mix, next years, it should become six per cent to eight per cent, so that ultimately, we achieve an optimum level of contribution of RE into our main grid. It depends from state to state. In Tamil Nadu it is the highest, closer to 12 per cent, thanks to huge wind installations. Whereas, there are many states which have almost nil contribution of RE. For that there is a good mechanism, which is not implemented well. That is where REC mechanism comes into place. REC is for the states, which do not have scope for big RE. Instead, they can buy REC certificates from the states which have it. Overall, country wide, we can have a much more balanced inclusion and distribution of RE in our grid system. This is what needs to be strengthened and it can be done by more amendments or implementing the Electricity Act strictly.

Could you tell us about the IWTMA's plans for the future?

The IWTMA expects to forge an alliance with the Wind Independent Power Producers' Association, an organization of IPPs, to raise common issues with the government. Also, the IWTMA is seeing more investments in states, like Rajasthan, Madhya Pradesh, and Maharashtra on wind power and this should be considered a positive sign. However, in Gujarat, where there is an installed capacity of around 3,000 MW of wind power, the industry is awaiting some policy changes related to AD. We are also trying to urge the Tamil Nadu Government to have stricter implementation of RPO.

There have been plans to initiate a National Wind Energy Mission. What are your thoughts?

The Wind Energy Mission is absolutely important. We feel that stable, a focused, qualitative, and uniform policy will help the wind sector a great deal. EF

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Consensus on Renewables

In its third year, RENERGY 2014 drew around 2,000 delegates, 250 exhibitors, and 20,000 visitors, international experts and regulatory bodies from across the globe. Organized by the Tamil Nadu Energy Development Agency (TEDA) and supported by the Government of Tamil Nadu, the three-day international conference and expo in Chennai focused on the need to steer the renewable energy sector ahead.

Thiru Natham R Viswanathan, Minister for Electricity and Prohibition, and Excise, Government of Tamil Nadu, who inaugurated the event, was quoted as saying, "With immense technology learning in recent years, tapping renewable energy sources like solar and wind is not a problem and it is becoming increasingly affordable."

He added that with growing energy needs, the Government of Tamil Nadu has announced many schemes and recently incentivized rooftop solar system of up to Rs 20,000 per kW above the capital support that central schemes offer.

The need to set goals was also stressed by officials at the event. As Sudeep Jain, CMD, TEDA, put it, "We need to set our targets clearly. We need maybe 1,000 GW of energy and 200 to 300 GW has to come from renewable energy by 2040. Once we are able to set targets clearly, once we have a determination to achieve that, we will surely be able to do it."

Looking ahead, a session by the Planning Commission as to how India will meet its targets also featured in the discussions. One of the main issues centered on how the country would meet its energy needs by 2047.

Also, the need for better investment prospects and enhance energy levels were some of the issues that were deliberated at the event. Energy storage was a topic of discussion and Toine Van Megen, co-founder, Auroville Consulting summed it up when he aptly suggested, "We hardly use 2.7 per cent of the solar energy available, so the issue is one of storage. We have to be able to store it."

Apart from policy-makers, industry experts, and delegates, one of the

major highlights of RENERGY 2014 was the presence of a number of students. The zealous youngsters got an impetus when winners of the "Renewable Renergise Redesign", a national level student competition on renewable energy, collected their trophies from the minister. Around 967 students constituting 295 teams from 95 institutions and 13 states participated in the first round. In the final round, held at IIT Madras Research Park on March 22, 2014, 73 teams constituting 236 students from 44 colleges across 7 states participated. Their projects were judged by a panel comprising industry, technical and research experts, and senior officials from TEDA. The winners included:

- 1st prize–Vijay Prithiv B R, R Prabhakaran, R Sukumar from Sri Sairam Engineering College, Chennai.
- 2nd prize–Aman Goel and Dheeraj B from IIT Madras, Chennai.
- 3rd prize – A Raghunath, R Manikanda Krishnan, and S Neegha of Sri Eshwar Engineering College, Coimbatore.

Later, Daniele Maucini, Ambassador of Italy in India, told reporters, "I am very pleased to see the enthralling response from the young participants, which shows they are well informed and interested in adopting renewable energy. It is a good sign for a country like India with its increasing energy needs".

The minister launches RENERGY Games at the event.

It was also interesting to see an interplay of technology and renewable energy at the event. While questions from the audience could also be SMSed to the speaker concerned, another interesting move was the introduction of "RENERGY Games". Accessible on phones and tablets, this initiative by TEDA is a collection of six games, developed in an animated style and aimed at creating an awareness on various RE sources, like solar, wind, biomass, and tidal energy.

A parallel event to the conference was a one-day solar training programme for businesses and companies conducted by leading renewable energy companies, such as SunEdison, L&T, SWELECT, and EAI. EF

Thiru Natham R Viswanathan, Minister for Electricity and Prohibition and Excise, Government of Tamil Nadu, with winners of "Renewable Renergize Redesign".

CURRENT R&D SOLAR

Has India's Solar Mission increased the deployment of domestically produced solar modules?

Energy Policy, Volume 69, June 2014, Pages 501–509

Gireesh Shrimali, Anshuman Sahoo

The Jawaharlal Nehru National Solar Mission (JNNSM), India's flagship policy for solar energy deployment, includes an increasingly strict Domestic Content Requirement (DCR) intended to promote the domestic crystalline photovoltaic solar industry. We examine the impact of the JNNSM DCR on the utilization of domestic and domestic crystalline silicon modules. Using a plant-level database of approximately 250 plants, we show that the policy accomplished its intention of promoting domestic crystalline silicon modules. However, the second and stricter version of the policy has not been as effective. It appears to have promoted the use of foreign thin film modules instead. This analysis shows that the tightening of the DCR was associated with leakage or foreign thin film modules. This suggests that DCR policies need to be comprehensive in scope to ensure that they achieve a goal of using only domestic content; however, policy-makers should appropriately assess the welfare impacts of such restrictions.

Hybrid solar–biomass power plant without energy storage

Case Studies in Thermal Engineering, Volume 2, March 2014, Pages 75–81

T Srinivas, B V Reddy

Non-uniformity and high initial investment are the problems associated with solar energy technologies. Biomass power plant demands a huge amount of fuel feed which may not be available readily at all places and at all times. A feed control in biomass fuel with variable solar radiation avoids the need for solar energy storage and thereby saves storage cost. In this work, solar parabolic collectors and biomass combustion have been arranged in parallel to produce steam for power generation. Solar energy is limited to a maximum share of 50 per cent to avoid the operation of biomass combustion at low-fuel feed rate in daytime. The performance characteristics of a hybrid power plant have been developed with turbine inlet condition (pressure and temperature) and variation in solar energy sharing. The focused results are cycle thermal efficiency, hybrid plant thermal efficiency, plant fuel efficiency, and specific power. The mass, energy, and performance variations are studied under variable solar radiation. A case study has been carried out to validate the thermodynamic cycle results. The results show that the plant fuel energy efficiency increases from 16 per cent to 29 per cent with an increase in solar participation from 10 per cent to 50 per cent at the boiler pressure of 20 bar.

Energy generation from grey water in high raised buildings: The case of India

Renewable Energy, Volume 69, September 2014, Pages 284–289

Prabir Sarkar, Bhaanuj Sharma, Ural Malik

Energy consumption in developed as well as developing countries is high, especially in residential and commercial building sectors. Researchers have been working on several technologies for the reduction of energy consumption in buildings. Among them, energy-harvesting techniques are quite promising. In this paper, we explore a possibility

of harnessing energy from grey water, while it flows down through high-raised buildings. We propose the usage of a micro/pico hydro turbine installed at the ground floor of a high-rise building that utilizes the energy of grey water falling from floors above, to generate electricity. The electrical energy generated from the turbine can be utilized further in numerous ways. Scaled prototype of the same has been developed and tested. The proposed design of a gravity-energized wastewater system in high-rise buildings for generation of hydroelectricity is being checked for its feasibility in Indian markets. Calculations show that the proposed system is commercially promising for most of the major cities in India. The paper also undertakes a cost–benefit analysis of the proposed system to support claims for possible commercialization of this technology.

Performance analysis and comparison of two silicon material based photovoltaic technologies under actual climatic conditions in western India

Energy Conversion and Management, Volume 80, April 2014, Pages 97–102

Brijesh Tripathi, Pankaj Yadav, Siddharth Rathod, Manoj Kumar

A study is conducted for solar PV energy generation from two grid-connected installations (mc-Si and a-Si power plants) located at the same place in Gujarat, Western India. Datasets on electricity production were collected over an entire year and compared under actual climatic conditions. The final yield of the mc-Si power plant varied from a lower value of 2.79 h/d in the month of August to a maximum value of 5.14 h/d in the month of March. Final yield for amorphous silicon power plant varied from a lower value of 2.62 h/d in the month of August to a maximum value of 4.84 h/d in the month of March. The performance ratio (PR) of the mc-Si power plant ranges from 57.1 to 93.14, and for a-Si power plant PR ranges from 53.72 to 87.64. The a-Si solar PV power plant found to have high capture losses as compared to the mc-Si solar PV power plant.

Modelling renewable energy impact on the electricity market in India

Renewable and Sustainable Energy Reviews, Volume 31, March 2014, Pages 9–22

Deb Chattopadhyay

Renewable power generation development, most notably for wind and solar, has taken off at a rapid pace in India especially over the last four years. While these developments have many positive aspects, a rapid shift in the balance of baseload and intermittent generation must be assessed carefully to ensure the share of renewable power generation increases without compromising system security and economics. Seasonal and spatial variability of wind, and to a lesser extent that of solar, can render these resources to have low availability for a significant part of the year, leading to an increase in unserved energy, i.e., deteriorate system reliability. The intermittency of generation also impacts inter-state power flows and lead to higher congestion in the grid. Climate model results provide a rich set of information on the nature of solar/wind variability that can be embedded in an electricity market simulation tool to assess these impacts on prices, generation dispatch and power flows. We have developed a modelling analysis for the Indian national electricity market informed by CSIRO climate model results. We have assessed the added costs arising from intermittency to put in perspective the true costs and benefits of renewable power. We have focused on the near-term developments in 2017 to show how some of the high renewable growth scenarios included in the Indian National Electricity Plan may imply significant pressure on inter-state/region transfer capability, and lead to a significant worsening of system reliability. The outcome of our modelling analysis suggests that a more orderly and balanced development of renewable and conventional power generation capacity is needed with a strong focus on system economics and security.

Examining the regional pattern of renewable energy CDM power projects in India

Energy Economics, Volume 42, March 2014, Pages 240–247

Aparna Sawhney, M Rahul

India is one of the leading host countries of Clean Development Mechanism (CDM) projects, but these projects have been concentrated within 10 states of the country. While the skewed distribution of CDM projects across countries is well recognized, little attention has been given to the skewed distribution of CDM projects within a country, such as India. We examine the different factors that account for the regional distribution of renewable energy-based CDM power projects in India using state-specific and renewable form-specific explanatory variables including natural potential, economic conditions, and government policies. We find that state implementation of fiscal incentive measures and CDM benefit-sharing were the most significant factors in locating these projects within the states apart from natural renewable potential. In the top

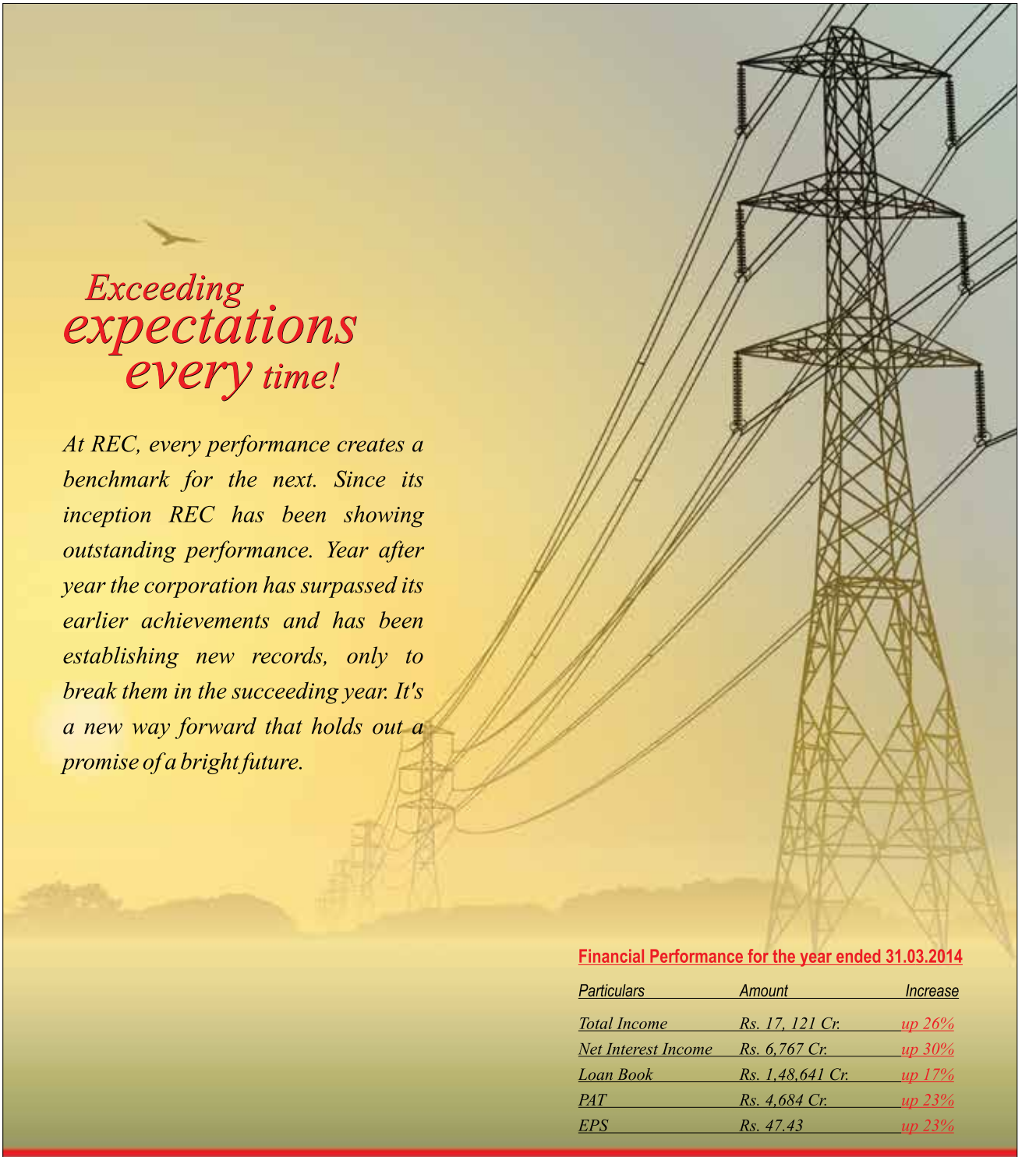
10 states, controlling for the government incentives and subsidies, the pre-installed renewable power capacity was also a significant factor. State financial incentives and CDM benefit clause were also found to be the most significant factor in the generation of certified emission reductions from CDM projects. Unfortunately, states with relatively higher natural potential lost out on the additional product gains through CERs and an important aspect of the CDM approach seems to have been missed in India — that of promoting development in other regions of the country which had natural potential.

Renewable energy education: A global status review

Renewable and Sustainable Energy Reviews, Volume 34, June 2014, Pages 300–324

Tara C Kandpal, Lars Broman

The need for renewable energy education and training at all levels is globally recognized. During the last three decades, a large number of countries across the globe have initiated academic programmes on renewable energy technologies and related aspects. A review of published literature on renewable energy education initiatives across the globe, challenges faced, and potential approaches towards efficient and effective solutions are presented in the paper. EF



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Lighting through Solar

Currently, a number of solar powered devices are available in the market, which are not only energy efficient, but non-polluting too. One of the latest to hit the stands is the innovative Maple Solar System, which has been designed to provide reliable lighting and a power charging solution in places which have access to plenty of sunshine, but limited access to electricity.

Essentially, the Maple Solar Power System is a new generation of DC solar power products with a power distributer. The system includes energy-efficient LED lights with lithium batteries. These batteries get charged when the power distributor is connected to the solar modules.

Once the batteries are charged, the individual LED light can be moved around without an electric wire. The system can also be expanded by adding more solar modules and LED lights as and when required. Furthermore, the lithium batteries and controller are housed inside each light, thus there is no need for a separate battery and controller.

With a 4,400 mAh Li-ion battery, it provides better lighting with energy-efficient LED and energy saving mode. Moreover, it is pollution and fire hazard free with no kerosene burning. Apart from providing cost-effective and convenient lighting, it can also be used as a charger for small electronic devices. Introduced by Canadian Solar, the device consists of the following components:

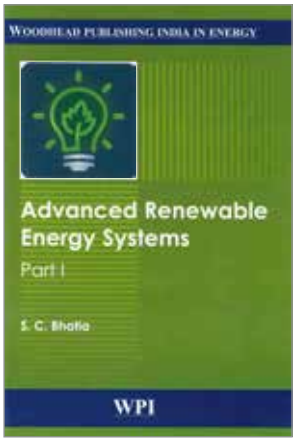
- *Solar module*: This converts sunlight into electricity.
- *Li-ion battery*: This stores the energy generated by the solar module.
- *LED lamps*: The intensity of the lamp is adjustable, with two power modes.
- *System controller*: It protects the battery from over charge and over discharge, USB output from over-load and short circuit, solar module and battery from reverse polarity.
- *Charging indicator*: It indicates the charging status of the Maple system.
- *USB port*: This helps to charge a cell phone and other small electronic devices.
- *Battery and USB status indicator*: It indicates battery over discharge or low voltage, USB output overload or short circuit.

Priced at Rs 4,300, it is available in four attractive colours, yellow, crimson, blue, and green. Yet another feature of this hanging light is that it has three lighting variants, dim, bright, and brighter, to suit individual needs. EF

Contact: Soltech Equipments, Solar Power Solutions, Chennai, at +91 97910 94980.

Advanced Renewable Energy Systems (2 Vol. Set)

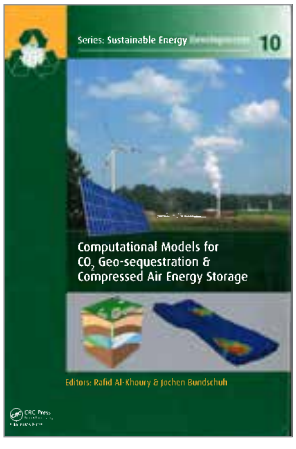
Renewable energy is a natural energy which does not have a limited supply. Renewable energy can be used again and again and will never run out. It is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun or from heat generated deep within the earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and bio-fuels and hydrogen derived from renewable resources. This book is a complete treatise on renewable energy sources and also includes issues relating to bio-fuels. It aims to serve as a text for undergraduate and postgraduate students in relevant disciplines and a reference book for all professionals in related fields. EF



Author: S C Bhatia
Publisher: Woodhead Publishing 2014
775 pages

Computational Models for CO_2 Geo-sequestration and Compressed Air Energy Storage

Energy and environment are two interrelated issues of great concern to modern civilizations. As the world population will soon reach eight billion, the demand for energy will dramatically increase, intensifying the use of fossil fuels. Utilization of fossil fuels is by far the largest anthropogenic source of CO_2 emission into the earth's atmosphere. This unavoidable reality necessitates efforts to mitigate CO_2 from being indefinitely emitted in the atmosphere. CO_2 geo-sequestration is currently considered to be a vital technology for this purpose. Meanwhile, as fossil fuels will sooner or later be depleted, utilization of renewable energy resources is inevitable. Nowadays, wind and solar energy, being clean and sustainable, are gaining momentum. However, their availability is intermittent. This intermittent nature of solar and wind energy necessitates storing the produced energy at off-peak times for later use. Compressed air energy storage in subterranean caverns, aquifers, and coal seams is currently considered to be a plausible technology for this purpose. CO_2 geo-sequestration and compressed air energy storage are thus vital technologies for current and future energy strategy development. These technologies can be made safe and cost-effective by utilizing computational tools capable of simulating the involved multi-physical phenomena and processes. Computational modelling of such systems is challenging and resource-consuming. Meeting such a challenge constitutes the focal point of this book. This book addresses comprehensive theoretical and computational modelling aspects of CO_2 geo-sequestration and compressed air energy storage. It consists of 16 chapters authored by prominent researchers in these two fields. EF

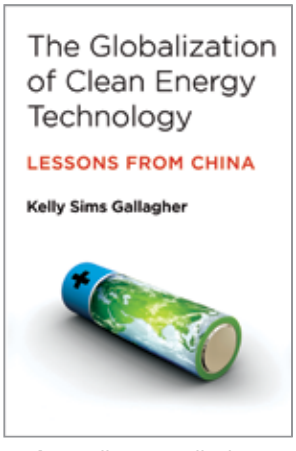


Editors: Rafid Al-Khoury, Jochen Bundschuh
Publisher: CRC Press 2014
574 Pages

The Globalization of Clean Energy Technology: Lessons from China

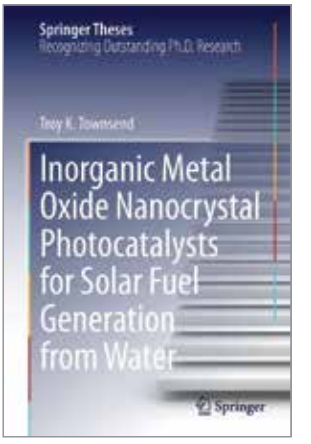
The development and deployment of cleaner energy technologies have become globalized phenomena. Yet, despite the fact that energy-related goods account for more than 10 per cent of international trade, policy-makers and academics as well as the business community perceive barriers to the global diffusion of these emerging technologies. Experts point to problems including intellectual property concerns, trade barriers, and developing countries' limited access to technology and funding. In this book, Kelly Gallagher uses analysis and case studies from China's solar photovoltaic, gas turbine, advanced battery, and coal gasification industries to examine both barriers and incentives in clean energy technology transfer.

Gallagher finds that the barriers are not as daunting as many assume; these technologies already cross borders through foreign direct investment, licensing, joint R&D, and other channels. She shows that intellectual property infringement is not as widespread as business leaders fear, and can be managed. She finds that firms in developing countries show considerable resourcefulness in acquiring technology legally. She finds that financing does present an obstacle, especially when new cleaner technologies compete with entrenched, polluting, and often government-subsidized traditional technologies. But, the biggest single barrier, she finds, is the failure of government to provide sensible policy incentives. The case studies show how government, through market-formation policy, can unleash global market forces. Gallagher's findings have theoretical significance as well. She proposes a new model of global technology diffusion that casts doubt on aspects of technology transfer theory. EF



Author: Kelly Sims Gallagher
Publisher: The MIT Press 2014
280 Pages

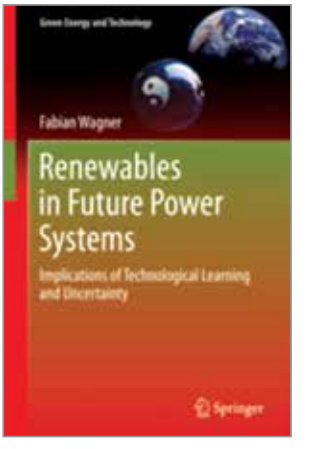
Inorganic Metal Oxide Nanocrystal Photocatalysts for Solar Fuel Generation from Water



Series: Springer Theses
Troy K Townsend
2014, XVI, 71 p. 44 illus.,
17 illus. in color.

Nominated as an outstanding PhD thesis by the University of California, USA, this thesis gives a detailed introduction to photocatalysis. It includes over 40 illustrations and provides detailed experimental protocols. Townsend's thesis explores the structure, energetics, and activity of three inorganic nanocrystal photocatalysts. The goal of this work is to investigate the potential of metal oxide nanocrystals for application in photocatalytic water splitting, which could one day provide us with clean hydrogen fuel derived from water and solar energy. Specifically, Townsend's work addresses the effects of co-catalyst addition to niobium oxide nanotubes for photocatalytic water reduction to hydrogen, and the first use of iron oxide 'rust' in nanocrystal suspensions for oxygen production. In addition, Townsend studies a nickel/oxide-strontium titanate nanocomposite which can be described as one of only four nano-scale water splitting photocatalysts. He also examines the charge transport for this system. Overall, this collection of studies brings relevance to the design of inorganic nanomaterials for photocatalytic water splitting while introducing new directions for solar energy conversion. EF

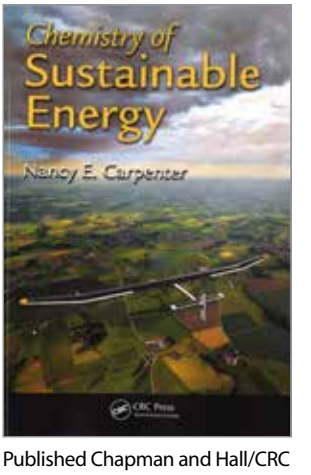
Renewables in Future Power Systems: Implications of Technological Learning and Uncertainty



Series: Green Energy and Technology, Fabian Wagner
2014, XVI, 291 p. 70 illus.,
14 illus. in color.

The book examines the future deployment of renewable power from a normative point of view. It identifies properties characterizing the cost-optimal transition towards a renewable power system and analyses the key drivers behind this transition. Among those drivers, particular attention is paid to technological cost reductions and the implications of uncertainty. From a methodological perspective, the main contributions of this book relate to the field of endogenous learning and uncertainty in optimizing energy system models. The primary objective here is closing the gap between the strand of literature covering renewable potential analyses on the one side and energy system modelling with endogenous technological change on the other side. The models applied in this book demonstrate that fundamental changes must occur to transform today's power sector into a more sustainable one over the course of this century. Apart from its methodological contributions, this work is also intended to provide practically relevant insights regarding the long-term competitiveness of renewable power generation. EF

Chemistry of Sustainable Energy



Published Chapman and Hall/CRC
Nancy E Carpenter
2014, 446 Pages, 308 illus.

Understanding the chemistry underlying sustainable energy is central to any long-term solution to meeting our future energy needs. Chemistry of Sustainable Energy presents chemistry through the lens of several sustainable energy options, demonstrating the breadth and depth of research being carried out to address issues of sustainability and the global energy demand. Authored by an organic chemist, this book reinforces fundamental principles of chemistry as they relate to renewable or sustainable energy generation throughout the book. Written with a qualitative, structural bias, this survey text illustrates the increasingly interdisciplinary nature of chemistry research with examples from the literature to provide relevant snapshots of how solutions are developed, providing a broad foundation for further exploration. It examines those areas of energy conversion that show the most promise of achieving sustainability at this point, namely, wind power, fuel cells, solar photovoltaics, and biomass conversion processes. Next-generation nuclear power is addressed as well. This book also covers topics related to energy and energy generation that are closely tied to understanding the chemistry of sustainable energy, including fossil fuels, thermodynamics, polymers, hydrogen generation and storage, and carbon capture. It offers readers a broad understanding of relevant fundamental chemical principles and in-depth exposure to creative and promising approaches to sustainable energy development. EF

RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT

Outdoor lighting using wind–solar hybrid renewable energy sources

As an outcome from the continuous hybrid renewable energy research, an innovative outdoor lighting system powered by a shroud-augmented wind turbine and a solar panel was installed in the KL campus of the University of Malaya. This hybrid green energy system has a compact design that harmoniously integrates a vertical-axis-wind-turbine (VAWT) with the novel omni-direction-guide-vane (ODGV), solar panel, and LED lighting system. Comprising several guide vanes, the ODGV is carefully designed and placed to surround the VAWT for wind power augmentation where the oncoming wind is guided through the ODGV. This will create a venturi effect that increases the wind speed before the wind-stream interacts with the turbine blades. Furthermore, the unique design of the ODGV that shrouds the wind turbine rotor provides a safer and more secure environment for maintenance workers and the public.

Ultimately, the ODGV overcomes the low-wind speed challenge in the tropics by guiding and increasing the speed of the wind from all directions radially through the guide-vanes before entering the VAWT at the centre portion. To harness power from the sun, a photovoltaic panel is mounted on the top surface of the ODGV for solar energy generation. The green energy generated from this wind–solar hybrid system is utilized to power the outdoor lighting system.

http://www.sciencedaily.com/releases/2014/05/140525204734.htm

Buried fossil soils found to be awash in carbon

In the journal *Nature Geoscience*, it was reported that deep soils can contain long-buried stocks of organic carbon which could, through erosion, agriculture, deforestation, mining, and other human activities, contribute to global climate change. It was assumed that there was little carbon in deeper soils. Most studies are done till top 30 centimetres. The soil studied by Marin-Spiotta and her colleagues, known as the *Brady soil*, formed between 15,000 and 13,500 years ago in what is now Nebraska, Kansas, and other parts of the Great Plains. It lies up to 6.5 metres below the present-day surface and was buried by a vast accumulation of wind-borne dust known as loess about 10,000 years ago, when the glaciers covering much of North America began to retreat.

The team led by Marin-Spiotta also found organic matter from ancient plants that, thanks to the thick blanket of loess, had not fully decomposed. Rapid burial helped isolate the soil from biological processes that would ordinarily break down carbon in the soil.

The work suggests that fossil organic carbon in buried soils is widespread and, as humans increasingly disturb landscapes through a variety of activities, a potential contributor to climate change as carbon that had been locked away for thousands of years in arid and semi-arid environments is reintroduced to the environment.

The element carbon comes in many forms and cycles through the environment — land, sea, and atmosphere — just as water in various forms cycles through the ground, oceans, and air. Scientists have long known about the carbon storage capacity of soils, the potential for carbon sequestration, and that carbon in soil can be released to the atmosphere through microbial decomposition.

The deeply buried soil studied by Marin-Spiotta, Mason, and their colleagues, a one-metre-thick ribbon of dark soil far below the modern surface, is a time capsule of a past environment, the researchers explain. It provides a snapshot of an environment undergoing significant change due to a shifting climate. The retreat of the glaciers signalled a warming world, and likely contributed to a changing environment by setting the stage for an increased regime of wildfire.

The retreat of the glaciers also set in motion an era when loess began to cover large swaths of the ancient landscape.

Loess deposits can be thick — more than 50 metres deep in parts of the Midwestern United States and areas of China. It blankets large areas, covering hundreds of square kilometres in metres of sediment.

http://www.sciencedaily.com/releases/2014/05/140525154724.htm

Innovation required if biomass is to meet tough targets

A fresh approach to managing biomass feedstock supply chains is required if the UK biomass sector is to continue to grow, while meeting stringent new criteria, according to the Director of Savills Energy.

Stuart Campbell, Director of Savills Energy and a biomass and waste-to-energy expert, has put forward the case for a new approach to management of feedstock supply chains. Mr Campbell argued that understanding the implications and security of the widening supply chain will be fundamental to the continued development of viable biomass projects in the UK going forward, especially in the wake of a perceived government U-turn over subsidies. The biomass sector needs to meet stringent new sustainability and reporting criteria introduced by the government. "All generating plants with an output of 1 MW and above using solid biomass now have to submit an annual independent audit report which assesses compliance against strict sustainability criteria", Mr Campbell explained. "The Greenhouse Gas (GHG) lifestyle criteria ensures that biomass delivers savings against fossil fuel while the land use criteria specify that forests are managed sustainably. However, with greater emphasis on the sustainability of feedstock, the supply chain is coming under increasing scrutiny. The study found that the UK power sector will need 23 million tonnes of feedstock by 2020. However, despite significant investment in recent years, the supply chain remains challenging, with costly financial implications in the case of failure.

Pre-empting and managing the financial implications of feedstock supply chain failure better and more proactively will act as a catalyst to unlock the potential in new and existing bio-energy projects, Mr Campbell maintains. This will in turn support the UK's obligations under the Renewable Energy Directive and open up opportunities for job creation and economic growth.

http://www.renewableenergymagazine.com/article/innovation-required-if-biomass-is-to-meet-20140522

Cleantech India launches in 2014 to make way for deployment of renewable energy solutions

There has been exponential growth in the renewable technology market. It is the perfect time to raise the subject of depleting natural resources and bring in technological advancements and clean business practices to the forefront of the Indian market. The launch of Cleantech India will be an ideal platform for a clean energy revolution. The show aims to boost the development and deployment of renewable energy technologies among Indian Industries. Messe Frankfurt has a successful history of hosting global trade fairs, such as the Water Expo China, Canadian Waste and Recycling Expo, Eco Expo Asia, and Building Solar China. The introduction of Cleantech India 2014 will further cement its position as the leading exhibition organizer for 'Green Industry' professionals.

India needs green solutions and energy renewable technologies to break the dependence on natural resources. Cleantech India's focus on alternative energy resources through solar power, hydro power, and wind power, will provide technologies and solutions that can maximize use of resources and minimize environmental impact.

Currently estimated at Rs 102,000 crore (USD 17 billion), India's renewable energy market is growing at an annual average of 15 per cent, indicating enormous opportunities and the untapped potential of the sector. Clean energy technologies that improve operational performance and optimize efficiency while reducing costs, energy consumption, waste, or environmental pollution is the need of the hour and engineers, manufacturers, and authorities are aware of the competitive edge it can provide to their businesses and more importantly to the economy. With the UN declaring 2014 to 2024 as the decade for 'Sustainable Energy for All', it is time for India to prove its leadership by making way for renewable energy resources.

http://www.moneylife.in/business-wire-news/cleantech-india-launches-in-2014-to-make-way-for-deployment-of-renewable-energy-solutions/39285.html

India power giant to develop 130-acre PV power plant

Leading India energy firm Tata Power has announced plans to build a 130 acre solar power plant in the BRIC country. The 28 MW facility will be built in the Satara district of Maharashtra. It will be one of the largest PV power plants owned by Tata to date. Tata Power said that the latest state-of-the-art technology in PV solar generation will be utilized for the plant. The company has signed a power purchase agreement to run the plant for 25 years. The plant will further build up Tata's 30 MW+ portfolio of solar power, making it one of the largest solar energy generators in India. The company has committed to building solar projects across India over the last few years. This includes commissioning a 25 MW solar power plant in Gujarat in February 2012. The Gujarat plant has helped to reduce an annual average of 37,696 tonnes of carbon dioxide, by producing 39,597 MWh of clean energy per year.

http://www.renewable-energy-technology.net/solar-energy-news/india-power-giant-develop-130-acre-pv-power-plant

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NATIONAL AND INTERNATIONAL EVENTS

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

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

2014 2nd International Conference on Control, Robotics, and Cybernetics — ICCRC 2014

August 8th–10th, 2014
Singapore
Website: http://www.iccrc.org/

2014 International Conference on Energy (ICOE)

August 12th–13th August, 2014
Colombo, Sri Lanka
Website:
http://www.energyconference.co

2014 International Conference on Mechatronics, Electronics, and Automation Engineering (ICMEAE 2014)

August 15th–17th, 2014
Lijiang, China
Website: http://www.icmeae.net/

Conference on SPIE Optics + Photonics 2014

August 17th–21st, 2014
San Diego, California,
United States of America
Website: http://spie.org/optics-photonics.xml?WT.mc_id=RCal-OPW

5th World Renewable Energy Technology Congress & Expo 2014

August 21st–23rd, 2014
New Delhi, India
Website: http://www.energetica-india.net/events/5th-world-renewable-energy-technology-congress--expo-2014-

World Renewable Energy Technology Congress & Expo 2014

August 26th–28th, 2014
New Delhi, India
Website: http://wretc.in/

The 5th IASTED African Conference on Power and Energy Systems

September 1st–3rd, 2014
Gaborone, Botswana
Website: http://www.iasted.org/conferences/home-814.html

Conference on 2nd Frontiers in Computational Physics: Energy Sciences

September 8th –11th, 2014
Zurich, Switzerland
Website: http://www.frontiersincomputationalphysics.com

Cleantech India & Pollutech India 2014

September 10th–12th, 2014
New Delhi, India
Website: http://www.conferencealerts.com/s

BIEE 10th Academic Conference Balancing Competing Energy Policy Goals

September 17th–18th, 2014
Oxford, United Kingdom
Website: http://www.watertechindia.com/

ENVIRO'14 Conference

September 17th–19th, 2014
Adelaide, Australia
Website: http://www.enviroconvention.com.au

Sustainable City 2014

September 23rd–25th, 2014
Siena, Italy
Website: http://www.wessex.ac.uk/city2014

The 2nd International Conference on Sustainable Development— ICSD2014

September 26th–27th, 2014
Rome, Italy
Website: http://www.ecsdev.org/index.php/conference

Indian Renewable Energy Summit 2014

October 9th–10th, 2014
Gujarat, India
Website: http://www.indianrenewableenergysummit.com/

AVTECH '14 / Automotive and Vehicle Technologies Conference

October 16th–18th, 2014
Istanbul, Turkey
Website: http://www.avtechconference.org

2nd International Renewable and Sustainable Energy Conference

October 17th–19th, 2014
Ouarzazate, Morocco
Website: http://med-space.org/irsec

Local Renewables Conference 2014

October 22nd–24th, 2014
Freiburg, Lörrach,
Baden-Württemberg, Germany
Website: http://www.local-renewables-conference.org/freiburg2014/home/

International Conference on Computational and Experimental Science and Engineering (ICCESEN)

October 25th–29th, 2014
Kemer-Antalya, Turkey
Website: http://www.iccesen.org

4th Kazakhstan International Exhibition — Renewable Energy Sources, Energy Saving, Energy Efficiency, and Resource Saving

October 28th–30th, 2014
Almaty, Kazakhstan
Website: http://www.enfsolar.com/event/profile/exhibition/1327

Renewable Energy at a Glance

Physical Progress (Achievements)

Sector	Target		Achievements during the month of May		Achievements during the month of May		Cumulative Achievements	
	2013-14	2014-15	2013-14	2014-15	2013-14 (% of Target)	2014-15 (% of Target)	(as on 31.05.2013)	as on 31.05.2014)
I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)								
Wind Power	2500.00	2000.00	114.30	53.05	264.10 (10.56)	130.15 (6.51)	19317.05	21262.23
Small Hydro Power	300.00	250.00	24.00	-	39.00 (13.0)	- (-)	3671.25	3803.65
Biomass Power & Gasification	105.00	100.00	-	-	- (-)	- (-)	1264.80	1365.20
Bagasse Cogeneration	300.00	300.00	-	-	- (-)	- (-)	2337.43	2648.35
Waste to Power	20.00	20.00	-	-	- (-)	- (-)	96.08	106.58
Solar Power	1100.00	1100.00	73.0	-	73.00 (-)	- (-)	1759.44	2647.00
Total	4325.00	3770.00	211.30	53.05	376.10 (8.7)	130.15 (3.45)	28446.05	31833.01
II. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN MWEQ)								
Waste to Energy	10.00	10.00	-	-	- (-)	- (-)	115.57	132.73
Biomass(non-bagasse) Cogeneration	80.00	80.00	2.80	-	2.8 (3.5)	- (-)	473.95	531.82
Biomass Gasifiers *Rural*	1.00	0.80	-	-	- (-)	- (-)	16.79	17.48
Industrial	9.00	8.00	0.5	-	0.5 (5.6)	- (-)	142.08	147.20
Aero-Genrators/Hybrid Systems	1.00	0.05	-	-	- (-)	- (-)	2.11	2.25
SPV Systems	40.00	60.00	-	-	- (-)	- (-)	124.67	174.35
Water Mills/Micro Hydel	2.00 (500 nos)	4.00 (500 nos)	-	-	- (-)	- (-)	10.65 (2131 nos)	13.21 (2643 nos)
Biogas-based Energy System	2.00	-	-	-	- (-)	- (-)	-	3.77
Total	143.00	158.85.00	3.30	0.00	3.30 (9.06)	- (-)	885.82	1022.81
III. OTHER RENEWABLE ENERGY SYSTEMS								
Family Biogas Plants (numbers in lakh)	1.10	1.10	-	-	- (-)	- (-)	46.55	47.40
Solar Water Heating – Coll. Areas(million m2)	0.60	0.50	-	-	- (-)	0.05 (10)	6.98	8.15

Source: www.mnre.gov.in

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General information

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- All colour
- Matte paper
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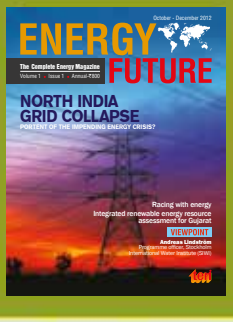

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