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DECEMBER **2015**

# PTC Chronicle

*Quarterly Journal from PTC India Limited*

## MISSION: RENEWABLE ENERGY

# Energizing Future

PTC Energy

## Asset Based Business in Renewable Energy Sector

# PTC Energy Ltd.

Subsidiary of PTC India Ltd.

2nd Floor, NBCC Tower, 15 Bhikaji Cama Place, New Delhi - 110066

**Chief Editor**
Harish Saran

**Editorial Team**
Sneh Daheriya
Shashank Gupta
Saurabh Kaura
Raghuram C. Soragavi
Parvesh Sharma
Lavjit Singh
Shruti Rai
Surinder Sharma

**Editorial Address:**
PTC India Ltd., 2nd Floor, NBCC Tower, 15, Bhikaji Cama Place, New Delhi 110066



**Design & Printing by:**
Colour Bar Communications, New Delhi

# From the Chairman's Desk

With India's aim to achieve energy security and need to manage economic growth with pragmatic consideration of climate change, renewable energy offers a critical solution to India's burgeoning energy demand challenges.

Govt. of India has set up an ambitious target of addition of 175 GW of renewable capacity by 2022. The high tariffs of renewable energy have been a concern. Economies of scale, various incentives coupled with innovative financing have brought down the tariffs close to and in some cases at grid parity. The recent tariff bid of Rs 4.63/unit by Sun Edison for 500 MW solar project is one such milestone.

Govt. initiatives such as bringing back accelerated depreciation, facilities at the solar parks, green corridor, bundling with thermal power, foreign currency denominated tariffs etc. are playing major role in attracting investors to participate in this sector. The technological advancement in forecasting, scheduling of energy shall go long to make renewable resources as important constituent of energy basket.

However, there are certain concerns in the renewable energy development such as, viability of the aggressive pricing, slow pace of development of rooftop solar which has target of 40 GW in the overall solar targets, marketability of renewable energy particularly in the present time when the distribution utilities are facing financial distress and lack of ancillary services such as gas based projects, pumped storage hydro projects etc. The resolution of these issues will require collective efforts from all stakeholders viz. policy makers, regulatory bodies, transmission & distribution companies, investors and financial institutions.

The specific coverage for Renewable Energy in this edition makes an endeavor to discuss the various aspects of development of renewable energy such as discussion on various technological options for the renewable energy and their suitability, various schemes for renewable energy development and discussion on small hydro power projects.

We would like to thank all our readers and acknowledge their feedbacks and continued support. We hope to continue receiving your support and valuable feedbacks. We wish our readers a valuable read.

**Deepak Amitabh**
Chairman & Managing Director
PTC India Ltd.

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PTC India Financial Services Limited
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Corporate Office: 7th Floor, Telephone Exchange Building, 8 Bhikaji Cama Place,
New Delhi - 110 066, India
Board: +91 11 26737300 | Fax: +91 11 26737341, 26737373, 26737374
E-mail: info@ptcfinancial.com Website : www.ptcfinancial.com

# Editorial

India is a growing economy and its energy requirements are also growing. Through various reforms, the power supply situation has improved and at present, we have around 2-3% of energy and peak deficit, which is much improved situation as compared to last year's 4-5% range. However, depleting fossil fuel reserves and its environmental impact has made the larger society to think of alternative solutions. In this scenario, deployment of renewable energy has come up as a long term solution and has got attention of international community. Further, renewable energy technologies are normally more labour-intensive than more mechanized fossil fuel technologies and hence, can provide a tremendous opportunity to create domestic jobs with appropriate skill set development. In India, Govt. has made ambitious target for installing 175 GWs of renewable energy by 2022 and has come up with various schemes to achieve the target.

In this edition, we have covered various aspects of renewable energy deployment such as installation, technology solutions, cost trends and financing. We have also collated India's submission to COP21 in Paris for our readers' reference. Discoms' financial and operation performance is critical for development of power sector. This edition covers highlights of Govt's initiative: Ujwal Discom Assurance Yojana (UDAY) for turnaround of the distribution sector.

Besides the deployment of renewable energy, energy efficiency measures will play an important role in achieving environment conservation goals. We have made an endeavor to cover initiatives taken in the energy efficiency front in this edition.

We have also introduced a new section - PTC Analytics wherein we have made an endeavor to analyze the short term market trends of various States using various statistical methods to understand the sale, purchase and UI patterns.

PTC organized the first Stakeholders Meet in collaboration with the Brearley Economics and CBIP for preparing the Indian power market for carriage and content separation (introduced in draft Amendment to Electricity Act, 2003). PTC also conducted a capacity building programme in the area of power trading for Nepalese Delegation considering the expanded India-Nepal interconnection in collaboration with USEA and NPTI. The highlights of these two events have also been covered in this edition.

We thank you for your continued support and solicit your suggestions to make PTChronicle more enriched with each edition.

**Harish Saran**
Executive Director (Marketing)
PTC India Ltd.

# CONTENT



PTChronicle

Your feedback is valuable to us. Kindly share them at editor.ptchronicle@ptcindia.com

# RENEWABLE ENERGY
## FOR CLEAN AND GREEN INDIA

**Deepak Amitabh**
Chairman & Managing Director,
PTC India Ltd.

The world economy is facing volatility due to weak demand in most markets including weaknesses in the European Market. Crude oil prices and major currencies of the world have been witnessing lows. The developing countries too are facing tough challenges such as high borrowing costs and demand contraction. The global financial institutions expect the world economy to grow at less than 3% in 2015 and a moderate improvement of over 3% in 2016 and 2017. Changes that may seem to be steady in the long run due to the impression of benefitting the global economy may actually cause strain and even a slowdown owing to the sudden transition and associated challenges.

We believe that stable economies and progressive countries would be those investing in people's education and health. The above stated factors will help general business environment and thereby creating jobs through steady upgrades in infrastructure. This is likely to place economies better in years to come.

In India, the momentum in economic activities has been encouraging with gradual implementation of reforms. The investor confidence has encouraged capital inflows and investments have started picking up. The lower crude oil prices have incidentally helped in containing fiscal deficit and inflationary trends. India is expected to continue on its path of recovery, with expected growth projections of 7.5% in 2015-16.

Further, India has made impressive progress in power generation witnessing substantial improvements in the power supply situation. With an addition of 25, 679 MW in last one year, we have an installed capacity of 280,328 MW as on 31st Oct, 2015 as compared to 254,649 MW by Oct, 2014. The energy deficit situation improved to 2.4% in the first half of FY15 from 4.1% in the first half of FY14. Similarly peak deficit situation improved to 3.2% in the first half of FY15 as compared to 4.7% in the first half of FY14. The growth can be attributed to an improved business environment where statutory clearances and other constraints are being addressed. Fuel availability through assurance of coal linkages and coal block auctions has restored capability of power generation units. Transmission capacity addition of 17,156 ckt KM lines has taken place during Apr-Oct'15 and is expected to improve the power flow situation facing restrictions due to congestion.

India has made an exceptional commitment to Renewable Energy by raising its 2022 target to 175 GW (Solar:100 GW, Wind:60 GW, Biomass:10

Besides capacity addition, it is also important to create a market place for renewable energy which has liquidity, reasonable returns, strong payment security mechanisms and flexibility to switch to different buyers in case of default events, including to the open access customers.

GW and Small Hydro:5 GW). The share of renewable sources in the total generation is expected to be ~18% with this addition. The Government has announced an unprecedented policy push and States are providing necessary infrastructure. Annual investments in solar could surpass investment in coal by 2019-20, with USD 35 bn committed by global players. For domestic IPPs, solar has to be an inherent part of their expansion strategy, as RE obligations become strictly enforceable and cost of power from conventional sources are witnessing an increase.

In the long run, India plans to reduce the emissions intensity of its GDP by 33-35% by 2030 from 2005 levels and achieve 40% of its cumulative electric power of around 350 GW installed capacity from non-fossil fuel-based energy resources, mainly renewable power. It is estimated that ~$2.5 trillion (at 2014-15 prices) will be required for meeting India's climate change actions by 2030. The achievement of targets requires transfer of technology and low-cost international finance, including from the Green Climate Fund.

As on 31st Oct, 2015, India has renewable installed capacity of 39,325 MW consisting of 38,096 MW of grid connected and 1,229 MW of off-grid/captive power. Renewable sources contributed to ~7% of the total energy generation. Private sector interest is shifting towards RE segment as the sector has numerous investment opportunities. The Reserve Bank of India has included RE projects under Priority Sector Lending for which bank loans up to Rs 15 Cr to borrowers will be available for RE projects. Innovative financing mechanisms such as tax-free green bonds, foreign currency denominated tariff etc. are also expected to bring down the financing cost and in turn the RE tariff in future.

Among the various renewable energy resources, solar energy potential is the highest in the country. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. Solar energy, therefore, has great potential as future energy source. It also has the advantage of permitting the decentralized distribution of energy. The National Tariff Policy was amended in January 2011 to prescribe solar-specific RPO be increased from a minimum of 0.25% in 2012 to 3% by 2022. As of now, total Solar installations are 4,860 MW (Grid connected: 4579 MW, Off-grid: 281 MW) and also have a strong pipeline of projects. In last few years, there has been unprecedented growth in solar capacity addition with a CAGR of 38% between FY'12 to FY'15. The reduction in the cost of solar panels and economies of scale have resulted in electricity tariff for solar decreasing continuously, falling from Rs 17.51/unit in 2010 to Rs 4.63/unit as quoted by SunEdision for 500 MW solar project in Andhra Pradesh. It is expected that, by 2020, annual solar power capacity additions and investments could surpass those in coal based power projects.

Out of the 100 GW solar target, 40 GW is proposed to come from the roof-top projects. The pace of roof-top

solar is slower as compared to ground mounted projects as it is capital intensive and there is lack of funds & limited standardized solutions available with the roof-top owners and further delay in implementation of the subsidies. The government is now focusing into this area and taking steps for its revival involving the State Governments. As of now, 15 States have come out with Solar Policy supporting solar power including grid-connected roof-top systems. SERCs of 21 States/UTs have notified regulations for net metering/ gross metering mechanism. For providing finance, Department of Financial Services has advised all Public Sector Banks to provide loans for grid connected roof-top solar systems as home loan/home improvement loan.

The massive capacity addition plans require associated infrastructure support such as land and connectivity to transmission system and also flexibility in the entire power system. Renewable power is intermittent in nature which effectively increases per unit cost of transmission. At the same time, more flexible peaking and ramping capabilities are needed. Higher wind and solar capacity also affects the machine efficiency of the base load plants in case they are needed to back down. All these factors directly or indirectly add up to the overall costs of RE deployment. However, in our country, wherein we have growing demand situation, these costs should not be as high as compared to countries with stagnant power demand. For providing integration of RE into the grid, Green Corridor project with expected investment of ~Rs 40,000 Cr has been proposed. There are also plans to integrate the solar cities with the Smart cities.

A general perception prevails about the Grid's instability due to high RE share. We have experiences from other countries which have high RE deployment, where the RE generation went up as high as 70-80%, however no reliability issues occurred and the systems remained stable.

Wind, having the highest share of RE (~62.7% with an installed capacity of 24.68 GW), remains an important RE resource besides Solar. Government has brought back the Accelerated Depreciation and GBI for promoting wind power. Off-shore wind projects have been proposed by the MNRE with JV of various companies mainly the CPSUs for implementing pilot projects along the coastline. The Government has approved the National Offshore Wind Energy Policy which aims to harness wind power along India's 7,600 km coastline. Under the policy, wind energy mapping of the country and locations with high potential will be identified. Government will get required approvals for these areas from various departments such as defense, shipping and space and offer the projects under competitive bidding.

Besides capacity addition, it is also important to create a market place for renewable energy which has liquidity, reasonable returns, strong payment security mechanisms and flexibility to switch to different buyers in case of default events, including to the open access customers. Discoms play critical role in providing the market for the renewable power. Most of the RE projects are connected with the State Grid system and have Power Purchase Agreements with the State Discoms. Despite the improvements in the power sector, distribution companies remain a weak link because of the expenditure and revenue realization mismatch and resultant mounting losses. Due to stressful financial conditions, there have been slippages in the RPO implementation in States. The same also poses risk of delayed payments causing cash flow issues to the RE generators.

To resolve distribution sector issues, the government has launched - UDAY (Ujwal Discom Assurance Yojana) with an aim to improve financial and operational efficiencies of power distribution companies.

To resolve distribution sector issues, the government has launched - UDAY (Ujwal Discom Assurance Yojana) with an aim to improve financial and operational efficiencies of power distribution companies (Discoms). It envisages reducing interest burden, cost of power and AT&C losses. The scheme provides that States would take over 75% debt of Discoms, as on 30th September, 2015 in two years. UDAY has inbuilt incentives encouraging State Governments to voluntarily restructure their debts. These incentives include taking over of Discom debt by the States outside the fiscal deficit limits; reduction in the cost of power through various measures such as coal linkage rationalization, liberal coal swaps, coal price rationalization, correction in coal grade slippage, allocation of coal linkages at notified prices and priority/additional funding. UDAY is considered different from earlier restructuring schemes in several ways including flexibility of keeping debt taken over outside fiscal deficit limit, reduction in cost of power and a series of time bound interventions for improving operational efficiency.

## GOVERNMENT TO PUMP IN RS 70,000 CRORE IN REPLACING OLD THERMAL POWER PLANTS

The Union government has firmed up plans to shut down ~11,000 MW of thermal power generation capacities that are at least 25 years old and build bigger plants with total capacity of at least 20,000 MW on the same tract of land for estimated investments of Rs 70,000 crore.

The roadmap for shuttering at least 100 old units with capacities ranging from 60 to 220 MW was given a preliminary shape at a meeting between the CEA and State utilities. In their place, ~30 super critical units ranging between 660 and 800 MW will come up. This will lead to a savings of about Rs 40,000 crore on land acquisition as well as infrastructure cost like rail and water linkages along with facilities like ash pond and power evacuation lines. Coal supplied to the old plants would be fed into the units that would replace them.

It is estimated that a total capacity of ~36,000 MW is more than 25 years old and these units could be replaced in phased manner. Some of these plants are in good running conditions and have just undergone renovation and maintenance, allowing them to run for a few more years. However, all such plants will have to be eventually shut down and be replaced by new super critical units.

Ministry of coal had already issued guidelines for automatic transfer of coal linkage from old and inefficient units to new super critical units.

During the 13th plan period, generation capacity of ~86,400 MW is likely to be added primarily through super critical units. Land being scarce, utilities are exploring possible options to utilize the existing land and other facilities in most effective manner.

## THIRTEEN GAS-BASED POWER PLANTS TO BE REVIVED AFTER LNG E-AUCTION

Thirteen stranded gas-fired power plants with a capacity of 8,260 MW will be revived following the e-auction of imported LNG. The government will support the initiative with Rs 1,590 crore from the Power System Development Fund. These plants would generate 11.03 BUs of electricity which will be supplied at or below Rs 4.70 /unit to the purchaser Discoms during the period from 1st Oct, 2015 to 31st Mar, 2016.

Of the 24,150 MW of gas-fired power generation capacity, 14,305 MW has no fuel supply. This includes 29 plants that were eligible to participate in the reverse auction of 13.5 MMSCMD. The successful bidders include power plants in Southern region. The generation from these plants would improve the power availability in the Southern grid.

## MAHARASHTRA GOVERNMENT NOD, FINANCIAL SOPS TO RESTART DABHOL POWER PLANT

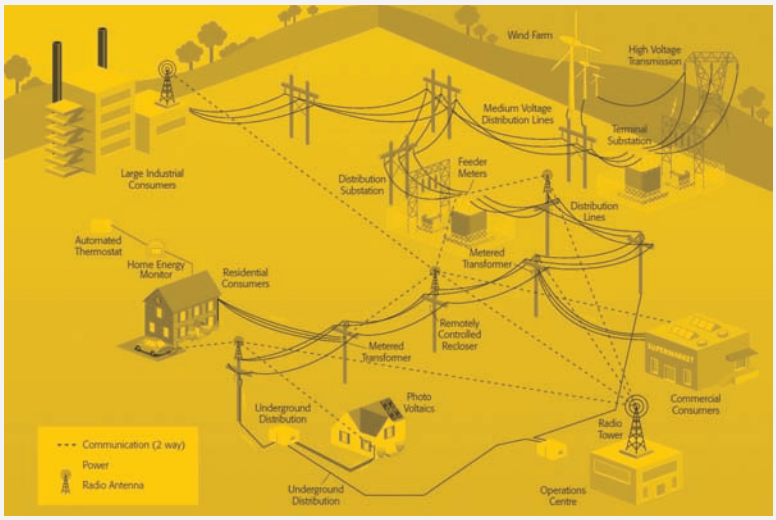
The Maharashtra government gave in-principle approval to restart the Dabhol power plant to start producing 500 MW and supply electricity to the Indian Railways. The Union and State governments will offer financial sop for the revival of the stalled power project through subsidies for the first two years.

The 1,967 MW plant located at Anjanwel in Maharashtra's Ratnagiri district has been dysfunctional since 2013. According to the revival plan, the Union and State governments will help the Ratnagiri Gas Power Project Limited (RGPPL), the company formed earlier to revive the plant, with financial support for the first two years to produce energy using Regasified Liquified Natural Gas (RLNG). RGPPL will now have a separate facility for LNG.

According to the plan, RGPPL will supply power to the railways at Rs 4.70 per unit for the first two years, even as the actual power purchase cost would come to Rs 6.15 per unit. The remaining Rs 1.45 per unit is proposed to be bridged through support from the Union government's Power System Development Fund.

The proposal is also beneficial for the railways since the cost of energy for railways in Maharashtra is currently Rs 8.63 per unit.

## CESC SIGNS PACT WITH US FIRM FOR SMART GRID BUSINESS




CESC Ltd. entered into an MOU with US-based Silver Spring for exploring business opportunities in India in the smart grid space. Silver Spring is a US-based Company and a market leader in Smart Grid space across the globe. As part of its ongoing drive for modernizing its transmission and distribution network, as a pilot project CESC will work with Silver Spring on smart grid distribution models in parts of South Kolkata under CESC's licensed area. CESC is a fully-integrated electrical utility company and has been generating and distributing power in Kolkata and Howrah. The company has private participation in generation, transmission and distribution of electrical power. It owns and operates three thermal power plants generating 1125 MW of power.

What makes a Grid…Smart Grid?: The digital technology that allows for two-way communication between the utility and its customers and the sensing along the transmission lines is what makes a grid, smart grid. Like the Internet, the Smart Grid will consist of controls, computers, automation and new technologies and equipment working together, but in this case, these technologies will work with the electrical grid to respond digitally to our quickly changing electric demand.

The Smart Grid represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability and efficiency that will contribute to economic and environmental health. During the transition period, it is critical to carry out testing, technology improvements, consumer education, development of standards and regulations and information sharing between projects to ensure that the benefits we envision from the Smart Grid become a reality.

## PFS LAUNCHES LENDING SCHEME FOR INFRA PROJECTS

PTC India Financial Services Limited (PFS) introduced credit enhancement scheme to step up lending to "quality" infrastructure projects.

"PTC India Financial Services Limited (PFS), announced introduction of its Credit Enhancement Scheme as part of its efforts to step up lending to quality infrastructure projects in the country.

As part of the scheme, PFS will offer credit guarantee after detailed appraisal to eligible projects along with other financial institutions for providing partial guarantees for projects and the same shall be backed by adequate security. Credit Enhancement Scheme will help the viable infrastructure projects within eligible category, to enhance their credit rating for their borrowing programmes.

"At a time, when credits worthy projects seek to optimize their cost of funds, this is expected to provide PFS with newer opportunities in infrastructure space." said Dr. Ashok Haldia, Managing Director & CEO, PFS in the statement.

The company offers an array of financial products to infrastructure companies in the energy value chain. PFS also provides fee based services such as loan syndication and underwriting.

## INDIAN SOLAR POWER TARIFFS : ON THE WAY TO ACHIEVE GRID PARITY

Solar power tariffs in India have hit a new low with the tender for 500 MW of capacity offered under the NSM in Andhra Pradesh receiving huge investor interest. In response to tenders for setting up 10 projects of 50 MW each, bids totalling around 5,500 MW were received. The lowest bid is from SunEdison which quoted Rs 4.63/kWh for 500 MW capacity.

The development assumes significance given the comparison with conventional sources of electricity such as coal. In the last financial year, the average rate of electricity sold by NTPC's coal-fuelled projects was Rs.3.25 per unit, while the tariff of power from its other projects ranged between Rs. 2 and Rs.4.50 a unit.

NTPC has already articulated its intent to supply electricity from 10,000 MW of solar power capacity that it is setting up on its own at Rs.3.20 per unit by bundling it with unallocated power to bring tariffs down. In addition, it plans to sell electricity at around Rs. 5 per unit for 15,000 MW that it is buying on behalf of the MNRE and earn 7 paise per unit in return. Recent bidding in Punjab, a State with relatively lower irradiation and higher cost of land, also saw tariffs in the range of Rs.5.09-5.98 per kWh.

The government's target of achieving 100,000 MW by 2022 would require an investment of around Rs.6.5 trillion over five years. Of the total targeted capacity, 20,000 MW will come from solar parks and 40,000 MW each from roof-top and distributed generation projects. The government plans to set up 25 solar power parks.

The solar space has already seen a significant decline in tariffs. Solar tariffs declined to Rs.7.49-9.44 per kWh in JNNSM Phase I, Batch II during FY12 from Rs.10.95-12.76 per kWh during FY11. In phase II, Batch I, the concept of VGF was introduced and the tariffs declined to Rs.5.45 per kWh. However, the current tariffs are even lower than those offered through VGF. The recent coal-based bids for the purchase of thermal power by Andhra Pradesh saw tariffs in the range of Rs.4.27-4.98 per kWh, which are in the similar range of Rs 4.63 per kWh it received for solar projects.

Government has planned to award contracts for the supply of 15,000 MW this year. In India, the world's biggest greenhouse gas emitter after the US and China, renewable energy currently accounts for only 13.5%, or 38,096 MW, of the total installed power capacity of 280,328 MW.

Bids were submitted for 10x50 MW of solar PV projects under the new phase of NSM. This is also the first time that bids have been called for projects to be set up in solar parks being developed under the new Solar Parks Policy. A total of 30 developers had submitted valid bids totalling 5.5 GW.

The solar power tariffs have come down due to the decline in the cost of capital and equipment (modules, inverters, BOP—balance of plant costs have come down by 15-20% over past 1.5-2 years and 40-50% over the past 3-4 years) and return (equity IRRs) thresholds may have probably come down versus usual target of 13-15% for international utilities, 18-20% for PE backed IPPs and 20% for Indian corporates.

A number of utilities and PE firms are trying to get a slice of India's growing green energy pie. These include Brookfield Asset Management, Partners Group AG, I Squared Capital, Abraaj Group and Nebras Power QSC. A subsidiary of Singapore-based Sembcorp Industries Ltd acquired a 60% stake in Green Infra Ltd for USD227 Mn. Actis Capital committed USD 230 Mn to create an Indian RE platform called Ostro Energy Pvt. Ltd. SunEdison recently agreed to acquire Continuum Wind Energy Ltd.

There has been growing interest from overseas investors in the Indian RE space. Russia's OAO Rosneft, the world's largest publicly traded oil company, US-based First Solar and China's Trina Solar are among the firms looking for opportunities to participate in India's solar energy sector. SoftBank, along with Bharti Enterprises Ltd and Taiwan's Foxconn Technology, proposed to invest at least $20 billion in solar energy projects in India through joint venture SB Cleantech Ltd.

India has a $250 billion investment opportunity in the renewable energy space. The investor interest in the current round can be gauged from the fact that six developers including SunEdison, Adani, Rattan India, Reliance, SoftBank and Energon have bid for the entire 500 MW capacity. Also, prominent new entrants include Trina Solar, Enel, Energon, Solar Arise, Suzlon and Greenko. However, concerns remain about the payment for solar power by the SEBs, which are weighed down by Rs. 3 trillion in accumulated losses.

## INDIA AND GERMANY TEAM UP FOR MOBILITY SOLUTIONS, SOLAR POWER

India and Germany signed agreements on hastening German investments into India.

The European country, which leads in renewable energy, will invest €1 billion (around Rs.7,300 crore) to help India's green energy corridor project and another €1 billion to develop solar projects. These were part of 18 pacts signed between the two nations.

The green energy corridor will facilitate transmission of renewable energy from points of generation to load centres, helping in transmission of clean energy from the States which are rich in renewable energy to those which have high electricity demand.

Five agreements were signed between Indian and German companies on urban mobility solutions, solar power generation and skill development. Gujarat International Finance Tec-City inked a pact with Siemens to build smart urban mobility solutions, while Tata Power entered into a pact with Rohde & Schwarz to collaborate on software defined radios.

OPG Power Ventures and IBC Solar AG signed a deal to generate 1,000 megawatts of solar power in the next seven years, while Hindustan Machine Tools and Fraunhofer will collaborate on improving design on machine tools. National Skill Development Corporation signed an agreement with Infineon Technologies for skill development in semiconductor production.

Most of the agreements were in line with India's initiative on smart cities, renewable energy and employment generation.

## OFF-SHORE WIND: FLOATING A NEW ENERGY SOURCE

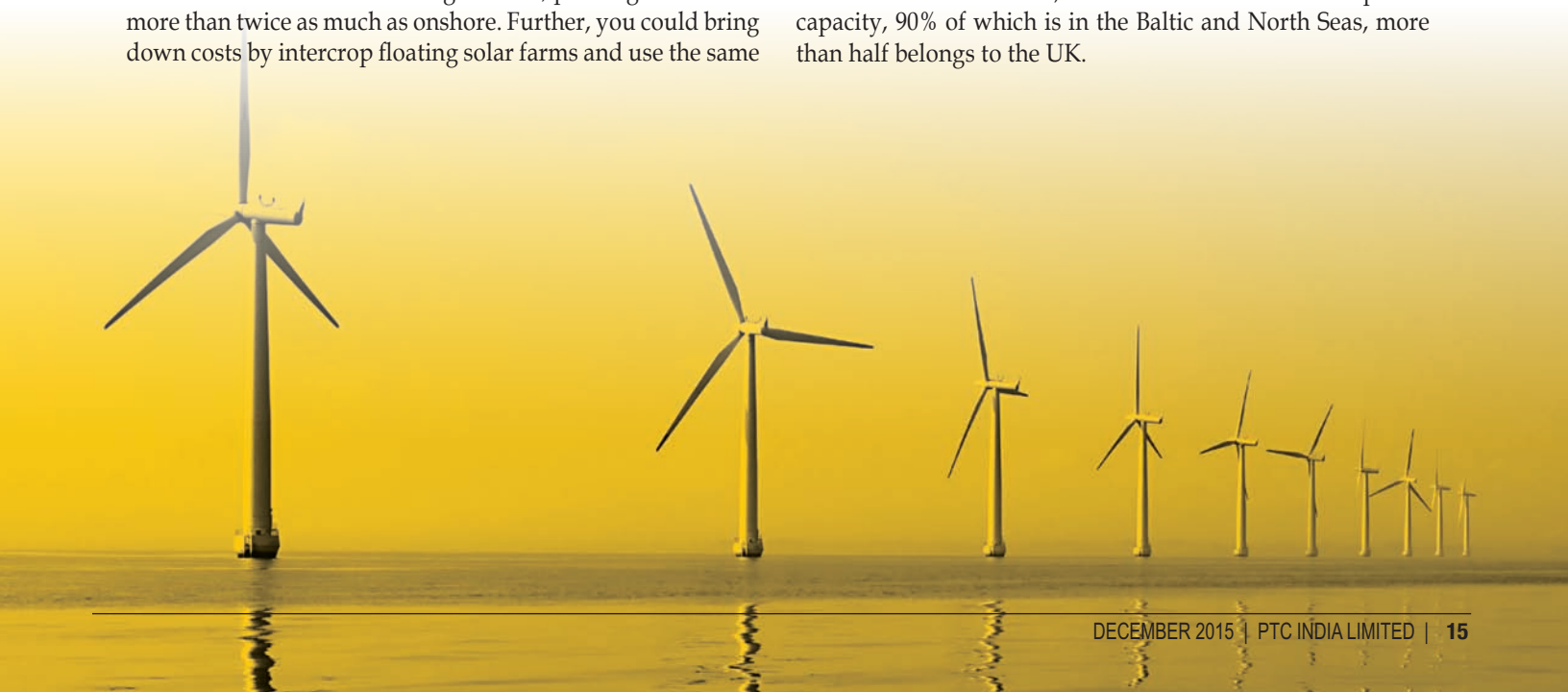
The Cabinet approved the National Offshore Wind Energy Policy. India has exclusive economic zone of 2.3 million sq km. All of it belongs to the Government of India. With today's technologies, a wind turbine can be put on a floating platform and can be towed around. So an offshore wind farm can come up anywhere, though the first ones will come up in the not-so-deep near shore regions. The southern coasts of the peninsula and Gujarat are the most promising.

There are many advantages in the Off-shore wind. The machines can be very big—6 MW is becoming the norm and bigger machines are in the works—mainly because the long blades can be made on the coast and shipped to site. The machines, however, cost a lot more — ₹20 crore/MW, compared with ₹6.5 crore for an onshore machine—but since winds blow harder and for longer hours, power generation is more than twice as much as onshore. Further, you could bring down costs by intercrop floating solar farms and use the same cables to transmit power.

Still, offshore farms produce costly power today—around ₹12/unit, according to Greenshore Energy's calculations, off Tamil Nadu coast and ₹17 off Gujarat's—roughly where solar was in 2012. Cost reductions should be visible in 5-6 years. While in 10 years offshore wind energy will become "absolutely affordable". With indigenisation, scale and perhaps hybriding with solar, costs will come down.

NTPC, through an MoU last year, has formed a consortium with other public sector power companies (PGCIL, PTC, PFC, IREDA) to put up the first offshore projects. Shipping Corporation of India is also interested in the pilot programme of 100 MW, coming up off the Gujarat coast.

The world has about 9,000 MW of offshore wind power capacity, 90% of which is in the Baltic and North Seas, more than half belongs to the UK.



## SOLAR ENERGY CORPORATION AND PTC INDIA SIGN MOU FOR SALE OF SOLAR POWER

Solar Energy Corporation of India (SECI) has signed an MoU with the leading power trading company, PTC India Limited (PTC), for sale and purchase of power generated from 3000 MW solar projects for onward sale on long term basis, for full term of 25 years from Commercial Operation Date of each of the Project/ Facility to State Utilities.

Under the said arrangement, SECI will facilitate development of 3000 MW solar projects at various locations in India on behalf of CPSUs or any other government/private agency. PTC will purchase solar power offered by SECI/project developers for onward sale to State Utilities at tariff to be determined by SECI through reverse auction process or any other competitive route.

**MOU Signing Ceremony**

**From Left:** Mr. Pankaj Goel, Sr. Vice President, PTC, Mr. Rakesh Kumar, Director, SECI, Dr. Rajib Kumar Mishra, Director, PTC, Mr. Deepak Amitabh, CMD, PTC, Dr. Upendra Tripathy, Secretary, MNRE, Mr. Piyush Goyal, Hon'ble Minister of Power, Coal, New and Renewable Energy, Dr. Ashvini Kumar, Managing Director, SECI, Mr. Rajiv Bhardwaj, Director, SECI and Mr. Harish Saran, Executive Director, PTC

## INDIA PLANS TO PROVIDE SOLAR POWER AT NEW LOW OF Rs 4.75 PER UNIT TO STATES

India's strategy of a foreign currency-denominated tariff plan for solar energy is aimed at providing solar power at a new low of Rs. 4.75 per unit to the States.

Firms such as State-owned NTPC Ltd will call for bids from solar project developers for buying 15,000 MW on behalf of the MNRE that will then be sold to the States. NTPC will run a reverse bidding process for procuring solar-powered electricity in foreign currency-denominated tariff to reduce risk. It will provide a purchase guarantee, making such projects bankable and help solar power eventually cost the same as that purchased from the grid.

With the developers expected to quote bids in the range of Rs.3.50 per unit, NTPC will sell the power to the States at Rs.4.75 per unit, with the balance going to a hedge fund. This hedge fund will be used for payment to cover the foreign exchange risk.

This foreign currency denominated tariff plan may involve bundling with unallocated thermal power as a backstop arrangement, in the event of the rupee depreciating beyond a particular level. The move is aimed at attracting foreign investors to India's solar energy sector by reducing the foreign exchange risk involved.

India may include yen along with dollar, euro in the basket of currencies it is considering for a foreign currency-denominated tariff plan for solar energy. Both State-owned NTPC and PTC India Limited plan to implement the scheme for foreign currency equivalent tariff on a pilot basis for 1,000 MW each.

## BIDS FOR UMPP: DEVELOPERS' CONCERNS OVER LAND ACQUISITION

While the Power Ministry wants to revive Cheyyur (in Tamil Nadu) and Bedabahal (in Odisha) Ultra Mega Power Projects (UMPP), power developers are worried that the provisions on land acquisition in the proposed changes to bidding mechanism will lead to increase risks for them. The Power Ministry is proposing to divide land for power plants into 'critical' and 'non-critical'. While the 'critical' land defined for the use of achieving commercial operations is to be acquired by the State distribution utilities and handed over to the developer, the 'non-critical' land will be acquired by the developer after the project is completed and ready to run. The entire cost of land (both critical and non-critical) will be part of the PPA.

The potential bidders want the entire land requirement to be treated as one. The risk in such a model is that the developer will have no say on what is 'critical' land requirement. Also, the additional cost on acquiring the 'non-critical' land has been capped at 10% over the declared cost of the entire land mentioned in the PPA. The industry's other concern is to do with the social impact assessment (SIA) and environment impact assessment (EIA) which is required under the Land Acquisition, Rehabilitation and Resettlement Act. Under current provisions, the SIA and EIA have to be initiated for the entire project.

There is also concern about the manner in which land is proposed to be acquired for the captive coal block. It has been proposed that the captive coal block land required by the power station for five years from commercial operations will be acquired prior to the project being handed over to the developer. The remaining land will have to be acquired by the developer and leased to an infrastructure SPV which will be under the State distribution utility.

## WELSPUN RENEWABLES GETS $617-MN FUNDING, INKS PACT WITH GERMANY'S IPLON

Welspun Renewables has received another round of funding of $617 mn, two-third of which was in the form of debt. The company has generated $405 mn debt and got $165 mn as equity. Another $47 mn is in the form of line of credit. The investment has been through a combination of debt and equity infusion by the promoters, existing and new investors. Last year the Asian Development Bank and General Electric had made significant investments in the company.

The company is targeting to set up 5 GW capacity, of which 1 GW will be commissioned this fiscal. At present, its solar and wind projects are spread across eight States.

Welspun Renewables today also signed an agreement with Germany-based iPLON for supplying equipment required for its 550 MW upcoming solar power capacity in India. iPLON will offer its power plant automation system, plant analysis tools, telemetry systems and central monitoring systems required by Welspun Renewables to manage their large portfolio of projects. The MoU was signed on the sidelines of Hannover Messe, one of the largest engineering exhibitions in the world, held annually in Germany.

## ODISHA TO INVEST RS 887 CR FOR RENOVATING THREE HYDRO POWER PROJECTS

To increase production of green electricity in the State, the Odisha Government decided to renovate three major hydro-power stations with an investment of about Rs 887 crore. A decision to this effect was taken at a high level review meeting presided over by Chief Minister Shri Naveen Patnaik.

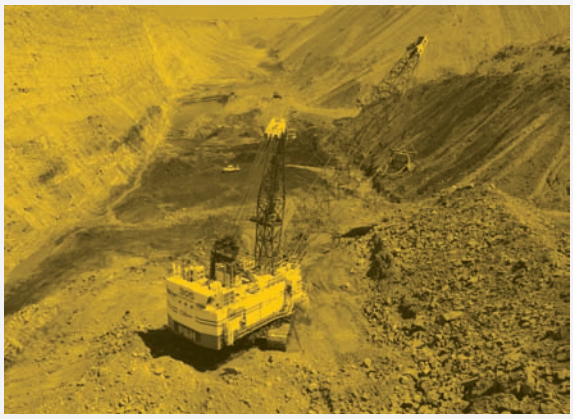
The hydel-power stations at Hirakud, Chipilima and Balimela would be renovated in phases. The State has six hydro-power stations with installed capacity of 2,008 MW. Hirakud power station was set up way back in 1961, the Government would renovate two of its units (37.5 X 2) by investing Rs 158 crore. The capacity of Hirakud station would increase from 75 MW to 86 MW after renovation. Orders for the renovation have been issued and it would require about 30 months to complete the work.

The 34-MW power station at Chipilima, set up in 1964, will be renovated at an estimated amount of Rs 65.67 crore and the work would complete in 20 months. The Balimela Hydel Project, which has an installed capacity of 510 MW, would be renovated at an investment of Rs 664 crore.

## GOVT. PLANS TO AUCTION LARGE COAL RESERVES FOR COMMERCIAL MINING

The Centre plans to auction a few large coal reserves to commercial miners in an effort to introduce competition in the sector. The Ministry is yet to finalize the fine prints of the process but some blocks with proven reserves upwards of 500 million tonnes could be offered, Joint Secretary SK Shahi said while addressing the Indian Coal Conference.

Large mines would allow commercial miners to achieve economies of scale, thus allowing them to compete with the only commercial producer, State-run Coal India. However, blocks would first be offered to State Government-owned entities so that they could commercially mine the dry fuel and sell it in the open market. Private miners will be given the next chance.



## ADB TO FINANCE INDIA-BANGLADESH ELECTRICITY LINK UP-GRADATION

Asian Development Bank (ADB) will help finance increased transmission capacity of a cross-border electricity link between India and Bangladesh which will allow Bangladesh to better meet sharply rising power demand and support increased power exchanges across South Asia.

ADB's loan of $120 million to Bangladesh will double the capacity of the existing interconnection system which links the power grid of western Bangladesh at Bheramara and the grid of eastern India at Bharampur.

The two networks were first interconnected in 2013, under a previous project financed by ADB. New transmission capacity will rise from 500 MW to 1,000 MW.

Bangladesh's fast-growing economy has soaring energy needs but domestic natural gas supplies cannot keep up with demand, resulting in an increasing dependence on oil and diesel-based plants. To meet its goal of providing electricity for all by 2021, the government is working to increase generating capacity and to source additional supply. The initial linking of the two national grids helped India deliver over 2,000 MUs of electricity across the border in 2014.

The inter-connection project is part of efforts under the South Asia Sub-regional Economic Cooperation (SASEC) Program to promote regional prosperity and improve economic opportunities through strengthened cross-border links in trade, power, road and rail networks. Its members are India, Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka.

## INDIA ON WAY TO BECOMING WORLD'S ENERGY EFFICIENCY HUB

India is on its way to becoming the energy efficiency hub of the world and it constitutes a critical part of the country's goal of delivering "just" climate action, the key Indian negotiator said at the UN climate conference. "India is on its way to becoming the energy efficiency hub of the world. The programmes launched by the government are world-beating. People are now looking at India for best practices in energy efficiency and demand-side management," said India's key negotiator Mr Ajay Mathur at COP21.An official statement said that India has proved to be a model State in terms of introducing sustained efforts to reduce energy intensity through policy intervention. Under the National Mission for Enhanced Energy Efficiency, India has undertaken the world's largest LED-based lighting programme, which aims to replace 770 million incandescent bulbs and 35 million streetlights over a three-year period. "These schemes have been largely successful, recording energy savings of 109,000 GWh while reducing 85 million tonnes of CO2," the statement said.

Noting that India has evolved a successful business model for energy efficiency products and services that can be replicated globally, the statement said that the three crore LED bulbs distributed by Energy Efficiency Services Ltd(EESL) will result in an annual energy savings of 4 billion KWh, capacity addition avoidance of over 900 MW and cost savings of Rs 3.04 billion and has impacted over 10 million consumers. This has also led to a reduction in CO2 emissions of over 3.2 million tonnes per annum, it said.

Further, it was informed that, The main goal of the Perform, Achieve and Trade initiative of India's Energy Efficiency Certificates Trading Scheme, is to make plants efficient. Because of the demand growth that is happening in India, new plants are coming up. Any plant that comes up, has to be more efficient than the rest.

# FIRST STAKEHOLDERS MEET ON CARRIAGE AND CONTENT SEPARATION

The first Stakeholders Meet was organized by PTC on 26th August' 2015 for launching the initiative to prepare the Indian power market for carriage and content separation in collaboration with the consortium partner Brearley Economics and channel partner Central Board of Irrigation and Power. The Conference attracted large participation and a lively interaction. The experts and the participants were appreciative of the opportunity provided to everyone present to take active part in the deliberations, thereby enhancing the effectiveness of the bidirectional information flow.

The proposed amendments to the Electricity Act have clearly implied that the main beneficiaries of our electricity supply business should be the consumers. Splitting of carriage and content envisages a competitive market for 'content' business, i.e. electricity supply; while 'carriage' i.e. local distribution networks continue to remain as regulated assets. This new market design will allow market players to obtain a license for supplying electricity to a local area.

Before any change in market structure, or transfer of roles and responsibilities, it is necessary to realize the reason for such change. The experience of segregation of wire and supply business in UK has demonstrated efficiency gains followed by cost reductions and has benefitted consumers through price reductions and improvements in quality of service. The Indian States need to learn and simulate similar competitive frameworks for delivering real value to consumers and other stakeholders.

British High Commission has partnered with PTC India for facilitating knowledge exchange with key UK players on the subject of carriage and content separation in India amongst the Indian policy makers, regulators and the State Electricity Boards.

The objective of the stakeholder meet was to understand the UK supply license model and assess the similarities and gaps vis-à-vis its implementation in India, consequent delivery risks and issues.

Based on feedback and market acceptability, we will be identifying potential pilot States, conducting multiple workshops and knowledge exchange, both in India & UK and prepare a roll out plan for implementing the proposed reforms.

The benefits expected out of the carriage and content separation are as follows:

- By separating carriage and content, the distribution companies could improve and channelize their focus on technical and operational efficiencies.
- Competition in retail supply will create downward pressures on costs and prices and ensure that the consumers come first.
- Supply licensees will introduce a larger skill set in the sector with objective functions of cost effective and quality customer delivery, supported by private sector incentives.
- An improved quality of regulatory framework allows for reduction in Government interventions and associated costs.

However, the variability in results expected out of segregation of carriage and content will depend on the implementation strategy, State commitments and change in regulatory frameworks of power distribution and supply. The amended to Act proposes that transfer scheme is to be made by State Governments for achieving the objectives of such segregation.

There is an imperative to clarify the roles and responsibilities of new entities, Standards of Performance, transfer of PPAs, change in consumer interface, tariff determination, allocation of financial and technical losses, reduction of cross subsidies, etc. under the new market design.

We hope this initiative by PTC India supported by British High Commission and CBIP, impart the foundation and learning on implementing segregation of carriage and content and help all stakeholders meet the uncertainties and challenges in effectuating the objectives proposed under this amendment to Electricity Act.

# ENERGY EFFICIENCY - WAY FORWARD

**Dr Rajib K Mishra,**
Director,
Marketing & Business Development,
PTC India Ltd.

In India, energy efficiency targets should be directly linked to reduction in cost of energy import which is almost 30% of total energy import. This reduction will not only reduce foreign exchange burden but will also strengthen economy through suitable currency.

With the release of INDC, India has laid down a clear intent to act on climate change. 'Intended Nationally Determined Contribution' (INDC) addresses reduction in emission intensity of GDP target of about 35% by 2030 from 2005 levels, achieving 40% cumulative electricity installed capacity from non-fossil fuel based energy sources by 2030, creation of carbon sinks of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030 and better adaptation with climate resilient agriculture and water conservation. The Government has calculated that it will require approximately $2.5 trillion at current prices to meet these targets besides access to new technologies. The present Indian government has up scaled its renewable energy target to 175 GW in the next seven years.

Honorable Prime Minister on 5th January, 2015 has launched "National Programme for LED-based Home and Street Lighting" across the country. The entire project aiming to install LED bulbs for domestic and street-lighting in 100 cities is targeted for completion by March 2016. As estimated, this programme will result in conservation of nearly 8 billion units every year that accounts for a saving of Rs. 4,000 crores. EESL has been nominated as nodal agency for implementing this program on turnkey basis. The Union government has raised its equity in EESL from Rs. 90 crore to Rs.500 crore.

Domestic Efficient Lighting Project (DELP) is an EESL initiative for replacing the incandescent lamps used by households with LEDs at a nominal cost. This would also reduce power consumption of households and their electricity bill, estimated at Rs.800-1000 per household per year. This also helps to enhance awareness about use of energy efficient products amongst households and have a cascading effect for other products. EESL is likely to invest about Rs. 1800 crores in this program over the next 3 years.

In last decade EE programs such as Star Labeling have raised sufficient awareness, however, there is a need for more Energy Efficiency initiatives in developing countries. Developed countries like USA, Korea and Japan have achieved substantial reduction of energy consumption. This was achieved through incessant innovation and R&D. Incentive schemes and setting up MEPS (Minimum Energy Performance Standard) has resulted in reduction in power consumption to the extent of 60%. There has been significant market transformation with higher efficiency limit and to an energy efficiency shift.

India also requires implementation of MEPS so that less efficient and cheap induction motors are out of market, the second sector where developed nations like USA, Japan and China have strictly enforced economy of fuel and CGGS emission standards. Fuel economy in USA has achieved higher efficiency to the extent of 50%, Japan by 12% and China by 40% over last 5 years. There is immense scope for imposing sanctions to low efficiency vehicles and even penalty for violators in India.

The next major area is buildings, where pilot projects need to be identified specifically for smooth transition

Few major things which are yet to be taken up in India but must be kept on priority are building certification program, building codes, target management and energy saving in public building.

to mandatory registration program. Buildings must be imposed for energy saving targets, both for consumers and suppliers and provide them with incentives. To achieve higher performance standards, some of the developed nations have targeted zero energy building by 2025. The three step target for highly energy efficient building can be step reduction by reducing 50% of heat and air- conditioner energy which can be achieved through high insulation, triple window and heat exchanging ventilation. The second step should be to achieve passive window by reducing 90% of the heat and air-conditioner energy with 250 mm heat insulation and LED lighting. Third step is zero energy building with vacuum insulation, LED lighting and solar generation at the rooftop.

Large industrial sectors can keep green house gas energy reduction target. Some of the developed nations have set up long term goals of energy saving such as improvements of national energy efficiency by staggering 50% until 2030. Some of these nations have adopted continuous decrease of oil dependency by diversifying sources since last 30 years. A good example is Korea consumption pattern which has reduction of oil consumption from 61% to 42% in 30 years. Similarly nuclear is contributing to double its installed capacity. The installed consumption with better energy efficient equipment has come down from 57 to 36%.

In India, energy efficiency targets should be directly linked to reduction in cost of energy import which is almost 30% of total energy import. This reduction will not only reduce foreign exchange burden but will also strengthen economy through suitable currency. These smaller drives such as optimal heating in winter times, proper tyre pressure, eco driving and reduction in emission standards by power and green friendly complex in electronics must be achieved.

Few major things which are yet to be taken up in India but must be kept on priority are building certification program, building codes, target management and energy saving in public building. There is urgent need for creation of carbon market and green house gas management. The registration and certification of GHG management and certificate of CDM projects are to be envisaged. Although EESL is doing commendable job by executing some of the major energy efficiency projects such as LED lighting, replacement of low efficiency pumps etc. There is need for Public Private Partnership with participation from large industrial houses for bringing the reduction in energy consumption and efficiency achievement as achieved by developed nations like USA and Japan.

The spurious and ill devises available in grey market which do not adhere to IS standard and energy efficiency leveling program must be targeted through penalty mechanism and seizure be carried by enforcement agency. There can be means of imposing higher excise duty for less efficient industrial and commercial equipment to discourage production and sale in market.






# TECHNOLOGY OPTIONS FOR RENEWABLE ENERGY

**Ajit Kumar**
**Managing Director,**
PTC Energy Ltd.
**Director (Commercial & Operations),**
PTC India Ltd.

**Abstract**

Both IEA forecast and WEC's world energy scenarios of 2050 show that fossil fuels will still play a crucial role for both power generation and transport. Coal is going to play an important role in the long run especially for power generation in China and India. India is entering an era of unprecedented change in the way we produce and use energy. The conventional thinking about how energy is extracted, converted and consumed is being challenged by growing concerns about the environmental impacts of power generation on land, water, air quality and climate. In the Symphony scenario, the WEC anticipates a huge increase of non-CO2 technologies globally, including hydro and other renewables such as solar, wind, nuclear and carbon capture and storage (CCS). Further, thrust has to be given to Solar PV and CSP technologies to tap the renewables to a greater extent.

**Key words:** *fossil fuel, power generation, environment impact, carbon capture and storage (CCS), solar PV and CSP, geo-thermal*

## 1.0 Introduction

Modern energy services are crucial to human well-being and to a country's economic development; and yet globally over 1.3 billion people are without access to electricity and 2.6 billion people are without clean cooking facilities. More than 95% of these people are either in sub-Saharan African or developing Asia and 84% are in rural areas. Commercial energy at affordable price with sustainable means is required to uplift this huge population.

The world is not on course for a sustainable energy future. World needs energy, both for power and non-power applications like building, industry and transport rely heavily on fossil fuels. CO2 emissions have increased by more than 20% over the last decade. Indeed, if the future is in line with present trends, CO2 emissions and oil demand will continue to grow rapidly over the next 25 years. This is after taking account of energy efficiency gains and technological progress that can be expected under existing policies. Extrapolating this beyond 2030 shows that these trends are likely to get worse. In the Baseline Scenario of IEA, CO2 emissions will be almost two and a half times the current level by 2050. Surging transport demand will continue to put pressure on oil supply. The carbon intensity of the world's economy will increase due to greater reliance on coal for power generation – especially




in rapidly developing countries like India and China with huge domestic coal reserves.

Both IEA forecast and the WEC's World Energy Scenarios to 2050 show that, in 2050, fossil fuels will still play a crucial role for both power generation and transport. Coal is going to play an important role in the long run, especially for power generation in China and India, the two most rapidly growing demand centres up to 2050. Natural gas, especially from unconventional sources, will play an increasing role and gain more importance in the energy share. An example is the transport sector where heavy transport will depend on fossil fuels for decades to come. Oil will continue to remain dominant for transport, an increase in importance of unconventional sources – in particular oil sands and oil shale – is expected. No renaissance of nuclear energy is anticipated in the next decade. In the Symphony scenario, the WEC anticipates a large increase of non-CO2 technologies globally, including hydro, other renewables such as solar PV and wind, nuclear and carbon capture and storage (CCS).

Of the 1.4 billion people of the world who have no access to electricity in the world, India accounts for over 300 million. The IEA estimates India will add between 600 GW to 1,200 GW of additional new power generation capacity before 2050. As per WEC projections, primary energy supply needs to be increased four to five times and electricity generation supply by six to seven times up to 2030/31 (as compared to 2003/04). The technologies and fuel sources India adopts, as it adds this electricity generation capacity, may make significant impact to global resource usage and environmental issues

As per many estimates, India is expected to become world's largest economy by 2050 overcoming China and USA. It is anticipated that this will lead to a widening gap between domestic energy resources and demand, especially for coal , oil and natural gas. This scenario requires that India shall harness and deploy renewable energy heavily.

India is one of the lowest GHG emitters in the world on a per capita basis. The country is vulnerable to climate change and has a strong interest in having a fair and equitable global agreement for minimising the risk of climate change. India has announced its intention to reduce the emissions intensity of its GDP by 20–25% over the 2005 levels by the year 2020.

India is entering an era of unprecedented change in the way we produce and use energy. The conventional thinking about how energy is extracted, converted and consumed is being challenged by growing concerns about the environmental impacts of power generation on land, water, air quality and climate. Although the long-term opportunity to reshape our energy infrastructure is promising, the current reality is that fossil energy remains the backbone of the Nation's energy economy.

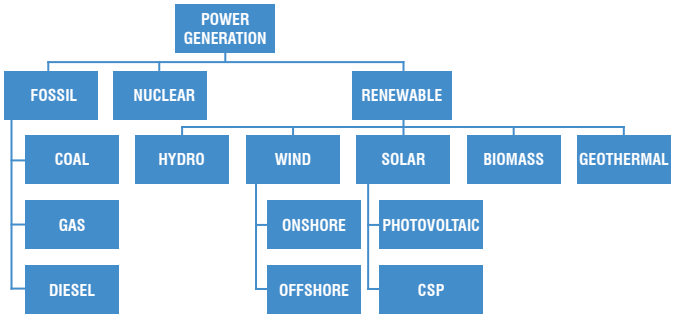
Currently, about eighty two percent of our electricity is generated by fossil-fired plants (Thermal), comprising about seventy percent of our installed capacity (CEA report April to Dec 2014). These fossil fired power plants are responsible for almost all of the carbon emissions from the power sector. There is a growing concern to address ways to reduce emissions through a change in the fundamental energy supply structure. These concerns are driving the thrust for solar and other renewable power generating options.

In view of above GOI has set an ambitious target of adding 175GW of renewable power by 2022. Out of this target, it is proposed to add 100 GW through Solar ( utility scale, distributed, off-grid/ mini grid), 60 GW through Wind ( utility scale),5 GW through Small hydro and 10 GW through Bioenergy. Various technology options available for these sources have to be deployed to achieve this target.

Considering these targets, renewables will account for approx. 40 % of total installed capacity and 19 5 of total generation by 2022.

### 2.0 Present power generation options

Power generating options can be classified in following categories:



### 3.0 Renewables

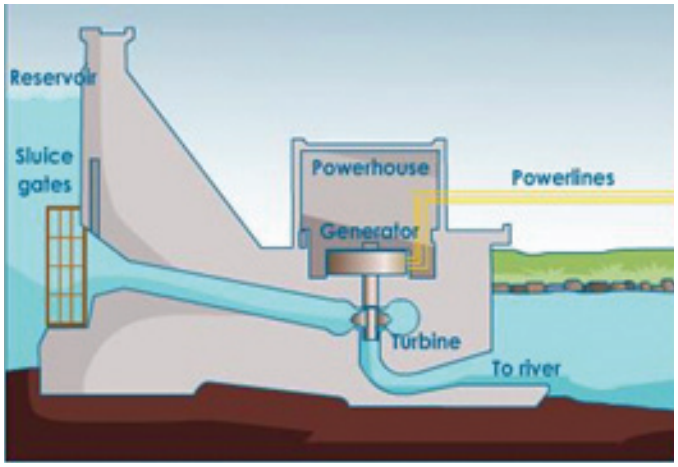
Various sources of renewable power are Hydro ,Wind onshore and offshore, Solar PV, Solar CSP, Biomass and Geothermal which have been tapped commercially and are discussed below:

### 3.1 Hydro

India is endowed with economically exploitable and viable hydro potential assessed to be about 84,000 MW at 60% load factor. In addition, 6740 MW in terms of installed capacity from Small, Mini and Micro Hydel schemes have been assessed. Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified. It is the most widely used form of renewable energy. India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario.

The present installed capacity as of 31 March 2015 is approximately 41267 MW which is 15.18% of total electricity generation in India. The public sector has a predominant share of about 97% in this sector.

Pumped storage plants are perfect peaking power solution for the load management in the electricity grid. Pumped storage schemes would be in high demand for meeting peak load demand and storing the surplus electricity as the share of renewable, which is of intermittent nature grows and India graduates from electricity deficit to electricity surplus. Pump storage stations also produce secondary /seasonal power at no additional cost when rivers are flooding with excess water. Other alternatives to store electricity such as batteries, compressed air storage systems, etc. are costlier than pump storage system. India has already established nearly 6800 MW pumped storage capacity which is part of its installed hydro power plants.




A schematic view of a hydro power plant

### Cost

As per report circulated by MNRE, hydro project cost is of the order of Rs 10.5 crores and 9 crores per MW for small and large scale respectively and predicted cost for the year 2020 based on analysis of available data is Rs 13.5 crores and 11.3 crores per MW for large and small scale respectively.

### 3.2 Wind

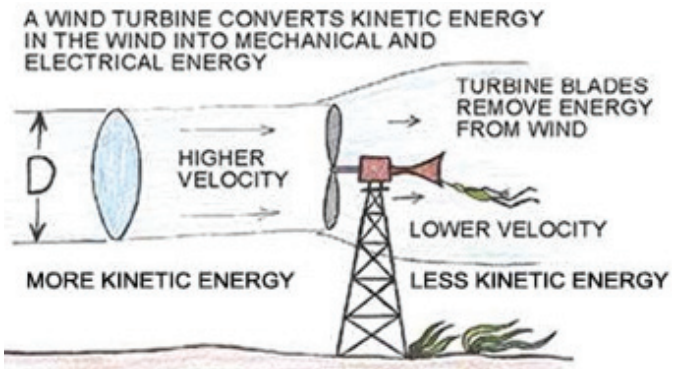
Another cheap renewable source, wind energy has already been exploited to a great extent and may continue to find greater deployment at remaining potential onshore and offshore sites.

It is estimated that with the current level of technology, the 'on-shore' potential for utilization of wind energy for electricity generation is of the order of 65,000 MW. India also is blessed with 7517km of coastline and its territorial waters extend up to 12 nautical miles into the sea. A total of about 23444 MW of commercial projects have been established until March 31, 2015. The unexploited resource availability has the potential to sustain the growth of wind energy sector in India in the years to come. The potential is far from exhausted.

A noteworthy feature of the Indian program has been the interest among private investors/developers in setting up of commercial wind power projects. Several companies have established themselves in wind technology manufacturing. In the years ahead, the prospects of wind electricity generation are bright due to its maturity, cost competitiveness and policy enablers in India.

As of 31 March 2015 the installed capacity of wind power in India was 23,444 MW, mainly spread across Tamil Nadu (7,253 MW), Gujarat (3,093 MW), Maharashtra (2,976 MW), Karnataka (2,113 MW), Rajasthan (2,355 MW), Madhya Pradesh (386 MW), Andhra Pradesh (916 MW), Kerala (35.1 MW),etc. East and North east regions have no grid connected wind power plant as of March, 2015 end.

No offshore wind power farm utilizing traditional fixed-bottom wind turbine technologies in shallow sea areas or floating wind turbine technologies in deep sea areas is under implementation. However, India is looking at the potential of offshore wind power plants, with a 100 MW demonstration plant being planned off the coast of Gujarat (2014).



**Cost**

The capital cost for wind power ranges between 5.0 crores to 7.5 crores per MW, depending up on the type of turbine, technology, size and location.

### 3.3 Solar

With about 300 clear, sunny days in a year, India's theoretical solar power reception, on only its land area, is about 5,000 trillion kilowatt-hours (kWh) per year (or 5 EWh/yr) The daily average solar energy incident over India varies from 4 to 7 kWh/m2 with about 1,500–2,000 sunshine hours per year (depending upon location), which is far more than current total energy consumption. For example, assuming the efficiency of PV modules were as low as 15%, this would still be a thousand times greater than the domestic electricity demand projected for 2015

#### 3.3.1 Solar photovoltaic

Utility scale solar plants require huge land. Land is a scarce resource in India and per capita land availability is low. Dedication of land area for exclusive installation of solar arrays might have to compete with other necessities that require land. The amount of land required for utility-scale solar power plants — currently approximately 4-5 acre per MW — could pose a strain on India's available land resource.

The architecture more suitable for most of India would be a highly distributed set of individual rooftop power generation systems, all connected via a local grid. However, erecting such an infrastructure, which does not enjoy the economies of scale possible in mass, utility-scale, solar panel deployment, needs the market price of solar technology deployment to substantially decline, so that it attracts the individual and average family size household consumer. That might be possible in the future, because PV is projected to continue its current cost reductions for the next decade and be able to compete with fossil fuel. Right government policies such as differential tariff can also encourage roof top deployment. Government may provide subsidies for the production of PV panels and this can lead to more usage of solar power in India.

Operating silently and without any moving parts or environmental emissions, PV systems have developed from being niche market applications into a mature technology used for mainstream electricity generation. A roof-top system recoups the invested energy for its manufacturing and installation within 0.7 to 2 years and produces about 95 percent of net clean renewable energy over a 30-year service lifetime.

India is currently pursuing aggressive solar capacity addition program. Present solar capacity of 3743 MW is hardly 1.37% of total installed capacity as on 31 March 2015. Total renewable share is just about 13% of total generation. Intermittent nature of renewable generation is therefore not a big problem right now. However, the pace at which the solar generations is being added to the grid, we may reach the point very soon where the problems of huge intermittent renewable capacity will pose serious threat to stable grid operation and economical operation of conventional fossil fuel plants.

India is facing a perfect storm of factors that will drive solar photovoltaic (PV) adoption at a "furious pace over the next five years and beyond". The falling prices of PV panels, mostly from China but also from the U.S., has coincided with the growing cost of grid power in India. This coupled with Government support for 100 GW solar capacity by 2022 and ample solar resources have also helped to increase solar adoption.

**Cost:**

Due to the exponential growth of solar photovoltaics, prices for PV systems have rapidly declined in recent years. However, they vary by market and the size of the system. Given the smaller system size, home installations are more costly than commercial or utility installations. However, by the end of 2014, residential rooftop PV system installed prices averaged $3.48 per watt, down from $3.83 per watt in the first three months of 2014, the sharpest absolute decline in recent times. Solar PV prices in India for roof top solar ranges from INR 30-60 per watt (approx. $ 0.5 to $1 per watt). Nowadays, solar PV modules account for less than half of the system's overall cost leaving the rest to the remaining BOS-components and to soft costs, which include customer acquisition, permitting, inspection and interconnection, installation labor and financing costs. The average cost of generation from grid connected solar plant is now in the range of Rs 5 to 5.50 per unit.

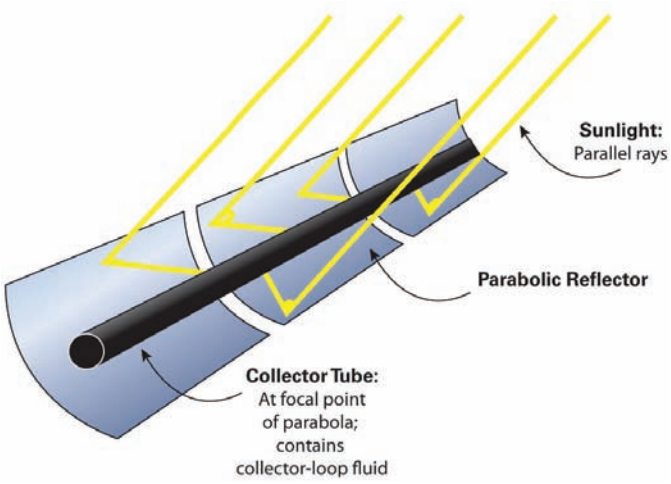
#### 3.3.2 Concentrated Solar Power (CSP)

Concentrating solar plants (CSP) generate solar thermal electricity while producing no greenhouse gas emissions, so it could be a key technology for mitigating climate change. In addition, the flexibility of CSP plants enhances energy security. Unlike solar photovoltaic (PV) technologies, CSP plants use steam turbines and thus can provide most needed ancillary services. Moreover, they

can store thermal energy for later conversion to electricity. CSP plants can also be equipped with backup from fossil fuels delivering additional heat to the system. When combined with thermal storage capacity of several hours of full-capacity generation, CSP plants can continue to produce electricity even when clouds block the sun, or after sundown or in early morning when power demand steps up. Supplementing solar PV with storage technologies in an attempt to solve these challenges may disrupt the cost economics of solar PV in long run and the balance may shift towards CSP technology which is more suited to thermal storage and can provide cheaper alternative to Solar PV with storage.

Hybridization of solar thermal with conventional coal or gas based system is another alternative to reduce cost and to handle the problem of intermittency. NTPC has recently taken up a project at Dadri to integrate solar thermal with one of the conventional coal based unit.

**Parabolic Trough Reflector**




**Cost:**

It is expected that cost of CSP will drop drastically due to improvement in efficiency and also due mass production of equipment. Several experts believe that in 2-3 years the cost of CSP may drop below the cost of fossil based electric power.

### 3.4 Biomass

India has 4533 MW of Installed capacity of biomass based power plants. In this system biomass, bagasse, forestry and agro residue & agricultural wastes are used as fuel to produce electricity. Nearly 750 million tons of non-edible (by cattle) biomass is available annually in India which can be put to use for higher value addition. India has been promoting biomass gasifier technologies in its rural areas, to use surplus biomass resources such as rice husk, crop stalks, small wood chips and other agro-residues. The Largest Biomass based power plant in India is at Sirohi, Rajasthan having the capacity of 20 MW, i.e., Sambhav Energy Limited. In addition, gasifier systems are being installed at 60 rice mills in India.

### 3.5 Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. India's geothermal energy installed capacity is experimental. Commercial use is insignificant. According to some ambitious estimates, India has 10,600 MW of potential in the geothermal provinces but it still needs to be exploited. Feasibility studies are being carried out for a 20 MW commercially viable power plant at Tattapani in Chattisgarh by NTPC .

### 5.0 Conclusion

Thus we can see that in future thrust for power generation will be on renewable technologies like solar ,wind and nuclear although Ultra Super Critical technologies will be deployed in large proportion as coal is going to be main stay for power generation. Thrust on renewable technologies will help to maintain environment issues to some extent.

**References:**


1. Updated Capital cost estimates for utility scale Electricity Generating Plants; US Energy Information Administration Report.
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3. Eurelectric Full Report: Power choices: Pathways to carbon neutral electricity in Europe by 2050.
4. The Wealth Report 2012; Knight Frank and Citi Private Bank by Think Publishing
5. http://www.worldenergyoutlook.org/
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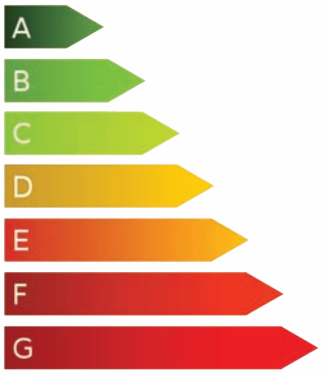
10. http://www.mnre.nic.in

# Energy Efficiency Services

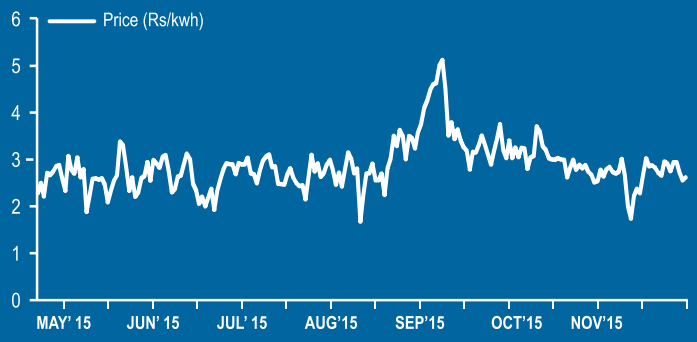



PTC has been continuously making strides in the direction of Energy Efficiency Management. PTC's engagement with Bureau of Energy Efficiency (BEE) under Ministry of Power has been extended for a further period of 5 years to undertake Energy efficiency projects and also to seize emerging opportunities such as perform, achieve and trade (PAT).

- Prestigious Projects undertaken :
  - Presidential Estate
  - AIIMS
  - Safdarjung Hospital
  - IGESIC (Rohini)
  - Dr. Ram Manohar Lohia Hospital
  - ESIC Hospital (Jhilmil)
  - National Archives
- MoU with Bureau of Energy Efficiency & EESL
- Conducting Investment Grade Energy Audits & preparing DPRs
- Implementing Energy Efficiency solutions through ESCO model

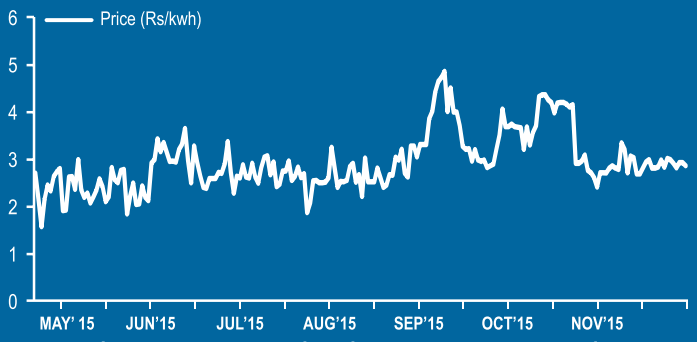
PTC India
PTC India Limited
2nd Floor, NBCC Tower, 15 Bhikaji Cama Place,
New Delhi - 110066

# MARKET WATCH



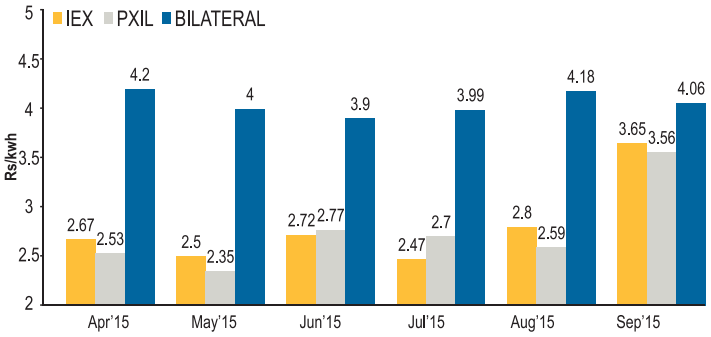

**Max. Price : 5.11** **Min. Price : 1.68** **Avg. Price : 2.87**

**Daily Prices - Indian Energy Exchange (IEX)**

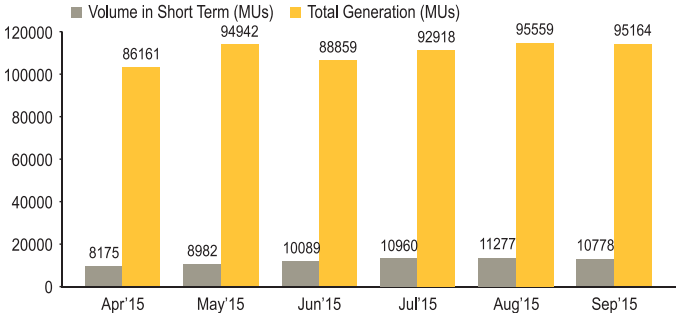



**Max. Price : 4.85** **Min. Price : 1.56** **Avg. Price : 2.93**

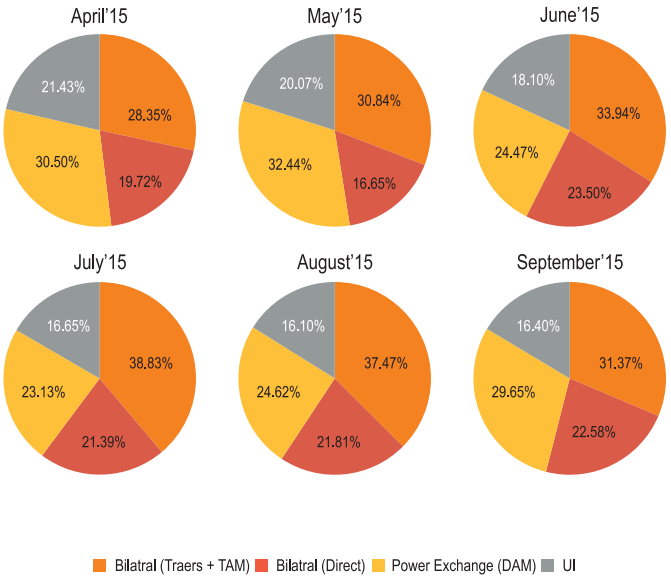
**Daily Prices - Power Exchange India Limited (PXIL)**



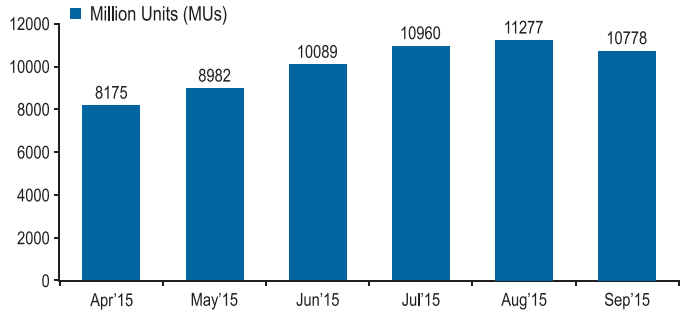

**Weighted Average Prices (Apr 2015 - Sep 2015)**




**Total Volume Traded in Short Term vs Total Generation (Apr 2015 - Sep 2015)**




**Total Short Term Contract Volume (Apr 2015 - Sep 2015)**

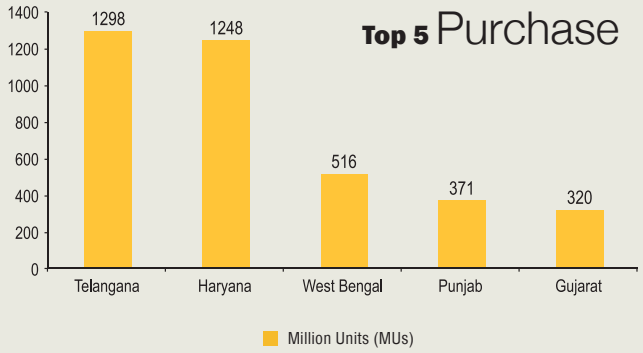


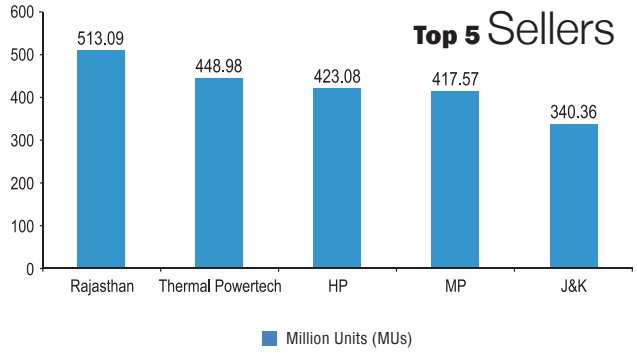

**Total Short Term Contract Volume (Apr 2015 - Sep 2015)**

**Source:**
*CERC Market Monitoring Report • Indian Energy Exchange • Power Exchange India Ltd.*

PTC India
PTC India Limited

## BILATERAL MARKET

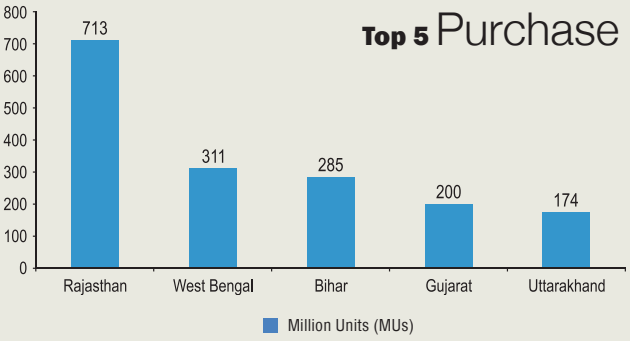


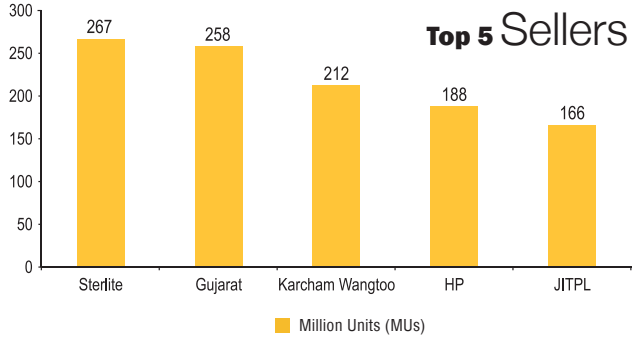




# MARKET TRADE

The trading data corresponds to purchase and sale made in the month of Sep, 2015

## SPOT MARKET




# POWER TRADING MARKET SIZE

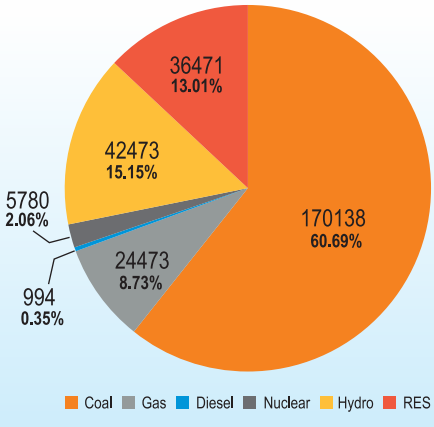
## Bilateral Trade And Power Exchange Market

| Year | Electricity Transacted through Traders (BU) | Price of Electricity Transacted through Traders (Rs/ kWh) | Size of bilateral Trader Market (Rs Crore) | Electricity Transacted through Power Exchanges (BU) | Price of Electricity Transacted through Power Exchanges (Rs/ kWh) | Size of Power Exchange Market (Rs Crore) | Total Size of the bilateral trader + Power Exchange Market (Rs Crore) |
|---|---|---|---|---|---|---|---|
| 2009-10 | 26.72 | 5.26 | 14055 | 7.19 | 4.96 | 3563 | 17617 |
| 2010-11 | 27.70 | 4.79 | 13268 | 15.52 | 3.47 | 5389 | 18657 |
| 2011-12 | 35.84 | 4.18 | 14979 | 15.54 | 3.57 | 5553 | 20532 |
| 2012-13 | 36.12 | 4.33 | 15624 | 23.54 | 3.67 | 8648 | 24272 |
| 2013-14 | 35.11 | 4.29 | 15061 | 30.67 | 2.90 | 8891 | 23952 |
| 2014-15 | 34.56 | 4.28 | 14801 | 29.40 | 3.50 | 10288 | 25089 |

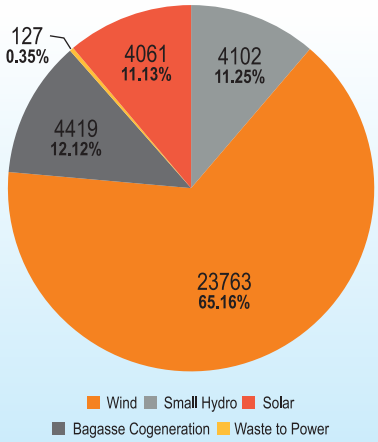
# POWER SUP

## All India Installed Capacity as on 31st Oct, 2015 (in MW)

| Ownership/ Sector | Modewise Breakup | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Thermal | | | | | | | |
| | Coal | Gas | Diesel | Total | Nuclear | Hydro | RES (MNRE) | Grand Total |
| State | 59,451 | 6,975 | 439 | 66,864 | 0 | 27,862 | 1,919 | **96,646** |
| Private | 61,307 | 9,978 | 555 | 71,840 | 0 | 3,120 | 34,551 | **109,512** |
| Central | 49,380 | 7,520 | 0 | 56,900 | 5,780 | 11,491 | 0 | **74,171** |
| Total | **170,138** | **24,473** | **994** | **195,604** | **5,780** | **42,473** | **36,471** | **280,329** |




Installed Capacity (Oct 2015)




Renewable Grid Connected Installed Capacity (Oct 2015)

# PLY POSITION

## State Wise Power Supply Situation (Apr to Oct 2015)

| Region | State/UT | Energy Req. MUs | Energy Availability, MUs | Surplus/ Deficit (-)% | Peak Demand MWs | Peak Met, MWs | Surplus/ Deficit (-)% |
|---|---|---|---|---|---|---|---|
| **Northern** | Chandigarh | 1,081 | 1,081 | 0.0% | 342 | 342 | 0.0% |
| | Delhi | 20,246 | 20,219 | -0.1% | 5,846 | 5,846 | 0.0% |
| | Haryana | 30,533 | 30,464 | -0.2% | 9,113 | 9,113 | 0.0% |
| | Himachal Pradesh | 5,146 | 5,101 | -0.9% | 1,379 | 1,379 | 0.0% |
| | Jammu & Kashmir | 9,123 | 7,700 | -15.6% | 2,437 | 2,026 | -16.9% |
| | Punjab | 34,871 | 34,859 | 0.0% | 10,852 | 10,852 | 0.0% |
| | Rajasthan | 37,202 | 37,115 | -0.2% | 10,961 | 10,961 | 0.0% |
| | Uttar Pradesh | 65,987 | 57,094 | -13.5% | 16,988 | 13,521 | -20.4% |
| | Uttarakhand | 7,715 | 7,572 | -1.9% | 1,986 | 1,948 | -1.9% |
| **Western** | Chhattisgarh | 14,780 | 14,534 | -1.7% | 3,929 | 3,757 | -4.4% |
| | Gujarat | 61,195 | 61,190 | 0.0% | 14,495 | 14,448 | -0.3% |
| | Madhya Pradesh | 31,473 | 31,473 | 0.0% | 9,971 | 9,971 | 0.0% |
| | Maharashtra | 82,722 | 82,329 | -0.5% | 20,973 | 20,594 | -1.8% |
| | Daman & Diu | 1,359 | 1,359 | 0.0% | 307 | 307 | 0.0% |
| | DNH | 3,446 | 3,446 | 0.0% | 740 | 740 | 0.0% |
| | Goa | 2,989 | 2,988 | 0.0% | 583 | 552 | -5.3% |
| **Southern** | Andhra Pradesh | 29,560 | 29,497 | -0.2% | 7,032 | 6,913 | -1.7% |
| | Telangana | 29,433 | 29,133 | -1.0% | 6,837 | 6,837 | 0.0% |
| | Karnataka | 36,518 | 34,259 | -6.2% | 9,463 | 9,335 | -1.4% |
| | Kerala | 13,271 | 13,166 | -0.8% | 3,762 | 3,632 | -3.5% |
| | Tamil Nadu | 58,345 | 57,668 | -1.2% | 13,580 | 13,505 | -0.6% |
| | Puducherry | 1,478 | 1,471 | -0.5% | 368 | 350 | -4.9% |
| | Lakshadweep | 28 | 28 | 0.0% | 8 | 8 | 0.0% |
| **Eastern Region** | Bihar | 13,811 | 13,595 | -1.6% | 3,756 | 3,456 | -8.0% |
| | DVC | 10,918 | 10,831 | -0.8% | 2,814 | 2,794 | -0.7% |
| | Jharkhand | 4,396 | 4,348 | -1.1% | 1,122 | 1,122 | 0.0% |
| | Odisha | 15,945 | 15,789 | -1.0% | 4,153 | 4,153 | 0.0% |
| | West Bengal | 29,747 | 29,630 | -0.4% | 7,905 | 7,885 | -0.3% |
| | Sikkim | 215 | 215 | 0.0% | 95 | 95 | 0.0% |
| | Andaman- Nicobar | 140 | 105 | -25.0% | 40 | 32 | -20.0% |
| **North- Eastern Region** | Arunachal Pradesh | 329 | 300 | -8.8% | 138 | 125 | -9.4% |
| | Assam | 5,421 | 5,013 | -7.5% | 1,566 | 1,491 | -4.8% |
| | Manipur | 472 | 450 | -4.7% | 160 | 153 | -4.4% |
| | Meghalaya | 1,030 | 955 | -7.3% | 400 | 322 | -19.5% |
| | Mizoram | 258 | 247 | -4.3% | 90 | 89 | -1.1% |
| | Nagaland | 441 | 432 | -2.0% | 140 | 138 | -1.4% |
| | Tripura | 750 | 703 | -6.3% | 300 | 269 | -10.3% |
| **All India** | | 662204 | 646223 | -2.4% | 153366 | 148463 | -3.2% |

# PTC ANALYTICS

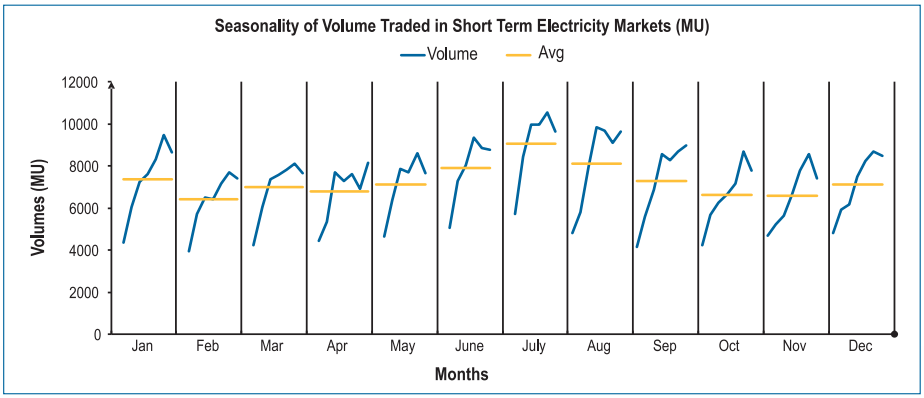
**Shivank Kapur**
Manager – Analytics
PTC India Ltd.

## TRENDS OF ELECTRICITY DEMAND IN SHORT TERM MARKETS

PTC Analytics was created to provide actionable intelligence and identify business opportunities in the Indian electricity markets. From collection of data from all stakeholders in the electricity supply chain, creating usable data sets and time series for future analysis to identifying business opportunities driven by data mining of big data, the analytics team seeks to collect, collate, compile and critically analyze the operating environment of PTC India Ltd.

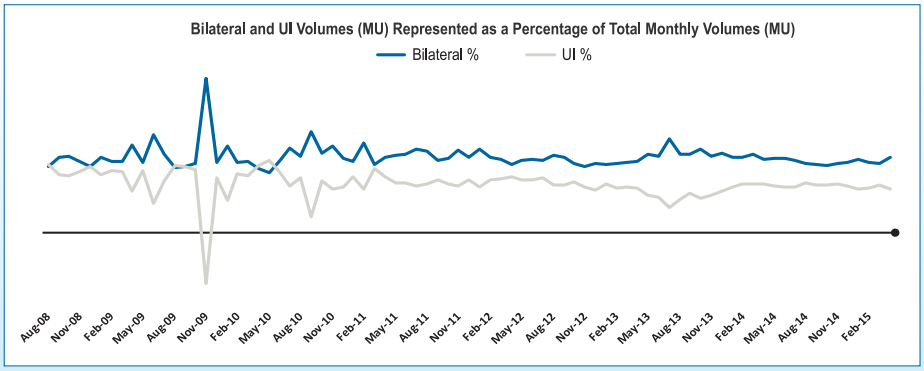
Using CERC monthly report data, the PTC analytics team was able to analyze the demand structure of the States and the short term markets.

1. **Seasonality:** The volumes (MU) traded showed distinct patterns of seasonality. The short term markets show peak demand in high summer – monsoon season from June through August:




The chart above shows the volumes (MU) traded since 2008 in every January, in every February etc and their respective averages.

2. **Correlation & Regression:** Monthly volumes (MU) of Bilateral and UI trades were represented as percentages of total monthly volumes. The resultant graphical depiction is given below:

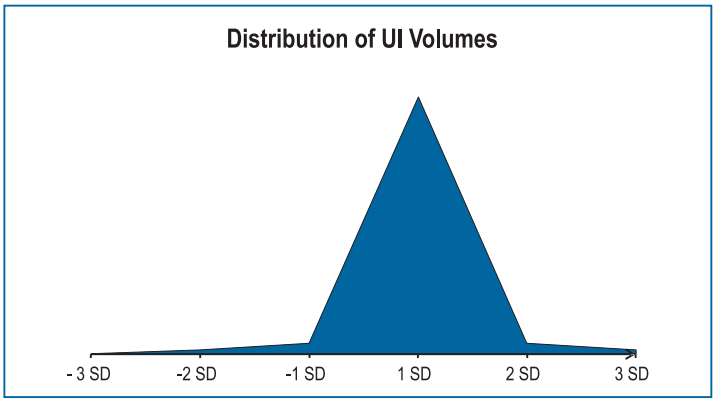



Visually, an intriguing representation was seen, which suggested that there was an inverse correlation between Bilateral and UI volumes for any given month. Further investigations yielded the following results:

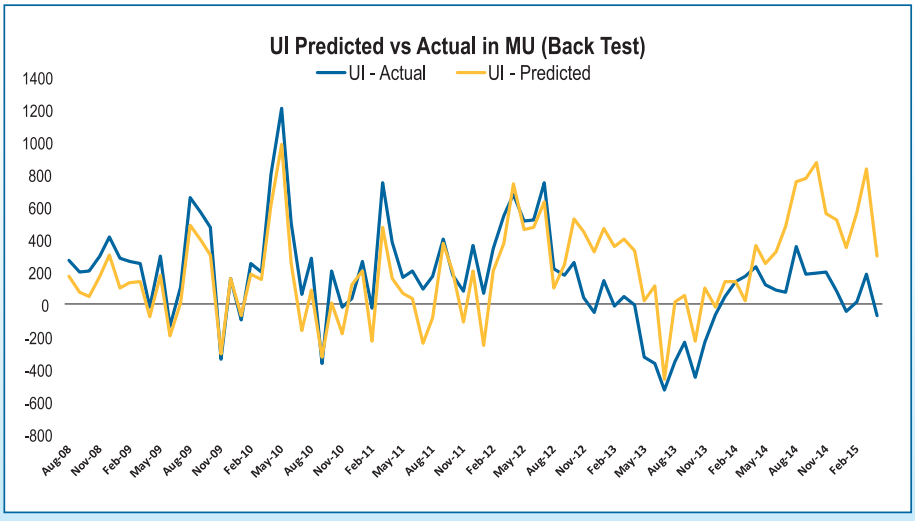

| Covariance | |
|---|---|
| | **Bilateral** |
| **UI** | -0.076714325 |
| **Correlation** | |
| | **Bilateral** |
| **UI** | -0.885922518 |

The high degree of goodness of fit as suggested by the covariance output, the high inverse correlation suggested there was causality at play between Bilateral and UI volumes. This was further strengthened by regression analysis run on the same. Our analysis yielded the following:

a. The strength of the linear relationship between Bilateral and UI volumes as indicated by Multiple R is very high
b. Approximately 80 % of the movement in UI volumes is explained by Bilateral Volumes
c. The chance that this is a random pattern or that this result can be recreated by a random distribution is very low
d. The distribution of UI demand, which is normal. 99% of UI volumes were within 3 standard deviations.




Deriving a demand equation where UI Volumes are dependent upon Bilateral volumes, we back tested on historical data to see the deviation between actual and predicted UI Volumes in the short term markets. Following is the graphical representation of the same:




The findings on seasonality, correlation and regression were cross verified by analyzing State level demand and hold true for all individual States as well. In conclusion, a seasonally adjusted probability distribution for UI volumes can be constructed for the short term market in general and for individual States (with a somewhat wider error margin), given a specified level of Bilateral volumes. These results throw up the possibility that the probability of a given level UI demand can be predicted with a fair degree of accuracy given specific levels of Bilateral volume.

# CAPACITY BUILDING IN POWER TRADING

The expanded Nepal-India interconnection will represent a substantial step for Nepal in terms of the energy scenario in the country. Given this development, Nepal is in need of significant capacity building and technical assistance to ensure that negotiations related to the increased energy transactions, consequent to increased interconnectivity, continue to progress smoothly and successfully and beget the socio-economic benefits which they entail.

To help in this cause and in line with their continued involvement in the region, USAID SARI/EI had assigned United States Energy Association (USEA) with the task of implementing a program focused on capacity building for the Nepalese. USEA had approached PTC to collaborate and design a detailed plan to conduct a series of activities that will bolster Nepal's readiness in the area of power trading. PTC has taken National Power Training Institute (NPTI) on-board as its execution partner in the designing and conducting of the Training Activities, in view of the vast experience of NPTI in this field and the ease of conducting the classroom training activities at NPTI's Campus in Faridabad. The Activities are designed to be conducted in 3 modules of a week's duration each and would cover topics ranging from the regulatory and policy environment and evolution to the specific topics related to the power trading activities in India.

The first of the modules was conducted by PTC and hosted by NPTI during 14th to 18th September, 2015. The inauguration of the Module was done by Ambassador Jonathan Addleton (USAID Mission Director to India) & Mr. Deepak Amitabh (Chairman & Managing Director, PTC India). Senior representatives from PTC, NPTI, USEA & USAID were also present on the occasion. During his welcome address, Amb. Addleton highlighted the need for increasing the harmonious energy cooperation between the South Asian countries which would enable them to realize their enormous potential. During his Inaugural Address, CMD-PTC noted the progress and evolution of PTC hand-in-hand with the advancements in the power markets in India. CMD-PTC also explained about the role played by PTC in the conceptualization of the practices in the power sector, which has been well received by all quarters. CMD-PTC highlighted the various transactions which are being undertaken by PTC with its neighboring countries of Bhutan, Nepal and Bangladesh for the past many years. Lastly, CMD-PTC expressed his pleasure regarding the conceptualization and conducting of such programs between the South Asian Countries and reiterated the commitment of PTC of helping other countries evolve their own structures for intra-country and inter-country energy transactions.

The participants included 12 members from Nepal, 2 members from Bangladesh and 1 member each from Bhutan and Afghanistan. Dr. Frank Felder, Director Rutgers University was also present for the module as Discussion Facilitator. The Module got underway with the participants being informed about the journey of the Indian Power Sector during the past century. The Participants were also exposed to the various rules, regulations and governing policies which shape its operating environment in the Indian Power Sector. The Faculties invited were Senior Officers from different government/private organizations of the Power sector and the insights along with the personal experiences which they brought to the lecture sessions made them very informative and interactive for the participants.

After 5 rigorous but equally enriching days of lectures, feedback received from the participants regarding the subject areas covered and overall training experience vindicated the initial targets set before the module by PTC and successfully achieved its purpose for making the participants accustomed and aware of the prevalent practices in the Indian Power Sector as a whole and the power markets.

Program ended with Vote of Thanks by Mr. Harish Saran (ED-Marketing, PTC), Mr. J. S. S. Rao (Principal Director, NPTI) & Mr. R. K. Mishra (Director, NPTI).

# INDIAN POWER SECTOR: GROWTH AND CHALLENGES

**Dr. Hiranmoy Roy,**
Assistant Professor (SG),
Department Of Economics and International Business,
University of Petroleum and Energy Studies, Dehradun

**Sahej Mahajan,**
College of Legal Studies,
University of Petroleum and Energy Studies, Dehradun

Sustained growth of the power sector is the key to drive economic development. Over the years, installed generating capacity in India has increased from a meagre 1713 MW in 1950 to 280,329 MW as on 31st October 2015. Electricity generation has also increased from 5.1 billion kWh in 1950 to 1048 billion kWh in 2014-15. However, percapita consumption of electricity in India is only 957 kWh in 2014, which is abysmally low compared to world average. The industrial, domestic and agricultural categories are the major consumers of electricity, constituting about 44.87%, 21.79% and 17.95% respectively of the total consumption including non-utilities. As per International Energy Agency (IEA) report (2009), per-capita energy consumption was 15467 kWh for Canada, 8012 kWh for OECD countries, the world average was also 2729 kWh. The 12th Five Year Plan projections made by the Planning Commission indicate that for a sustained Gross Domestic Product (GDP) growth rate of 9 percent per year, energy supply has to grow at around 6.5 percent per year. As per IEA projection, per-capita energy consumption in India will be 1895 kWh by 2030. Hence, the installed capacity should be more than 5,00,000 MW by 2030 along with associated transmission and distribution network. In order to achieve the projected capacity addition of around 1,00,000 MW and build commensurate transmission & distribution capacity, investment of more than INR 11,00,000 Crore would be required in the 12th Five Year Plan. Moreover, for proper functioning of the power system, investments in Generation Vs Transmission Vs Distribution should be in the ratio of 2:1:2.

Important challenges faced by the sector are thermal capacity addition are plagued by the growing fuel availability concerns faced by the Industry. While a significant gas based capacity of more than 20,000 MW is idle due to non-availability of gas. Coal supplies by CIL is restricted to around 65% of actual coal requirement by coal based thermal plants, leading to increased dependence on imported coal with the cascading result of high power generation costs.

Years of populist tariff schemes, mounting AT&C losses and operational inefficiencies have adversely affected the financial health of State Discoms which are currently plagued with humongous out-standing debts.

Increasing power generation costs due to limited fuel availability, poor financial health of State Discoms, high AT&C losses have contributed in suppressed demand projections by State Discoms.

Over the last 4-5 years, the leading rates have increased significantly from the time of project appraisal resulting in project cost overrun and hence higher end tariffs.

The micro level policies governing the fuel cost pass-through, mega power policy; competitive bidding guidelines are not in consonance with the macro framework like The Electricity Act 2003 and the National Electricity Policy (Puri R., 2014).

The solutions to the above problems are various aspects like ramping up coal production by both public and private sector in a time-bound manner, increased participation of private sector in coal production and easing of regulatory framework, clearances and approvals for allocation and development of coal blocks & gas infrastructure need to be addressed while formulating such reforms.

There is a dire need to develop both conventional and non-conventional forms of energy, wherein, three key factors must be kept in view for developing an energy mix: (i) the pattern of energy demand seen in the country (ii) the availability of fuels and (iii)fuel production and import costs. It would be effective to adopt coal thermal as a fundamental component of the fuel mix for the next 20-30 years, with solar occupying 5-8 percent of the total mix.

Regulators need to be sensitized to the challenges faced by the sector and policy framework needs to be crafted and enforced to ensure a win-win situation for all the stakeholders. They must pro-actively intervene to resolve the immediate issues ailing the power sector.

A robust and sustainable credit enhancement mechanism for funding in Energy Sector needs to be put in place through increased participation by global funding agencies like The World Bank, ADB etc. in the entire value chain.

There is a strong need to push for wider-scale implementation of public private partnership models. The private sector has been playing a key role in generating power; a more supportive environment will help in bridging the energy deficit of the country.

This is the foundation of a functioning energy market and the sustainable, green growth economy that India should pursue (Puri R., 2014).

It is evident that power shortage is a significant impediment to India's ambitious plan to be a global super power having third largest GDP by 2030 and also to have a sustained economic growth of 8-10 percent for at least another decade (Pal Animesh, 2013). Adequate availability of energy would be a fundamental requirement for this objective to materialize. Substantial expansion of coal and gas production as well as exploration of new fossil fuel reserves needs to be expedited. Moreover, large projects in the domain of generation, transmission and distribution are to be executed more efficiently to meet the project schedules.


# INDIA's Submission

1 India plans to reduce the emissions intensity of its GDP by 33-35% by 2030 from 2005 levels and achieve 40% of its cumulative electric power of around 350GW installed capacity from non-fossil fuel-based energy resources, mainly renewable power.

2 It also estimates that at least $2.5 trillion (at 2014-15 prices) will be required for meeting India's climate change actions between now and 2030.

3 Targets to be achieved with help of transfer of technology and low-cost international finance, including from the Green Climate Fund.

4 India plans to create an additional carbon sink of 2.5 to 3 billion tonnes of CO2-equivalent through additional forest and tree cover by 2030

5 Explaining its plan for tackling climate change, India plans to adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, the Himalayan region, the coastal regions, health and disaster management.

6 introduction of new, more efficient and cleaner technologies in thermal power generation; promotion of renewable energy generation and increasing the share of alternative fuels in the overall fuel mix; reducing emissions from the transportation sector and waste; promotion of energy efficiency in the economy, notably in industry, transportation, buildings and appliances; development of climate-resilient infrastructure; and full implementation of the Green India Mission and other afforestation schemes, are other plans envisaged by government.

7 India plans to expand the National Mission for Enhanced Energy Efficiency and to cover new large industry sectors like railways as well as enhance targets

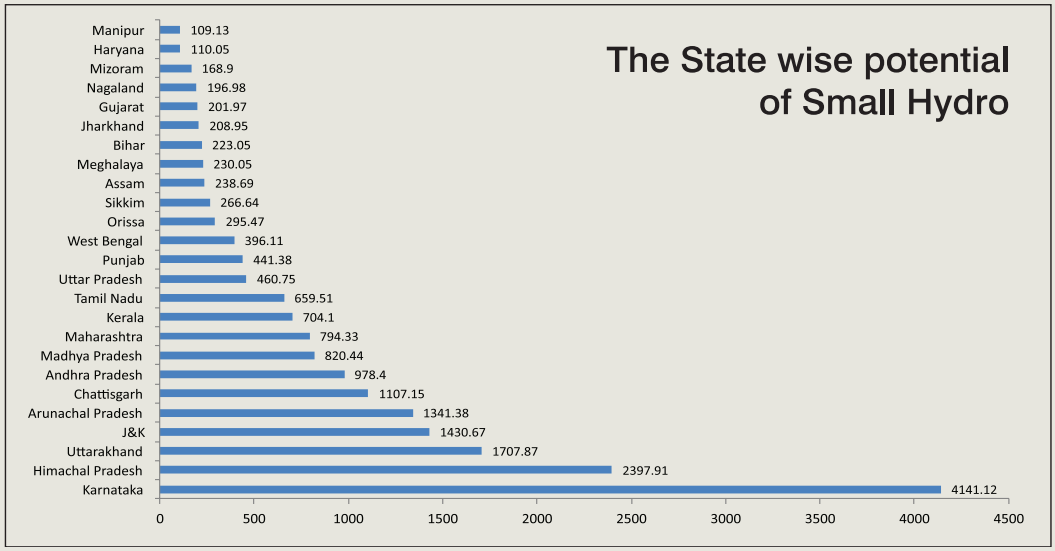
8 India will be widening the scope of its Perform, Achieve and Trade (PAT) scheme, which is a market-based energy efficiency trading mechanism that at present covers 478 plants in eight energy-intensive industrial sectors, accounting for one-third of the total energy consumption in the country.

9 Government has revisited its National Missions under the NAPCC (National Action Plan for Climate Change) and identified new missions and programmes on wind energy, health, waste to energy and coastal areas, while redesigning the National Water Mission and National Mission on Sustainable Agriculture

# FOSTERING GROWTH IN SMALL HYDRO

**Harish Saran**
Executive Director (Marketing),
PTC India Ltd.

After setting ambitious targets for solar energy development, the government also turned its focus to harness small hydro projects, aiming and planning to set up 5000 MW of small hydro projects in the next five years. Small hydro is the classification used for hydropower projects below 25 MW capacity, their distinguishing attribute being that these are mostly run-of-the-river type and do not require construction of dams. Thus, apart from the fact that electricity is generated from a renewable source, small hydro projects have far lesser environmental impacts as well.




It has the potential to benefit local people/authority where grid connectivity is not economical and even neglected many times. With respect to social impacts, these facilities have no significant geological or environmental impacts and will have a guaranteed discharge (and production rate) throughout the year. There is no land acquisition required and these projects could be maintained and run by local bodies which can latter take the ownership of the project in future. Small hydro projects have no major Rehabilitation & Resettlement (R&R) issues as compared to large hydro or coal based power plant where relocation and settlement of the relocated people is a major concern.

In the 12th plan, capacity addition of 2100MW is envisaged from small hydro renewable sources, only 10% of the total potential (~19749MW, of which 3600MW is already installed) in the country.

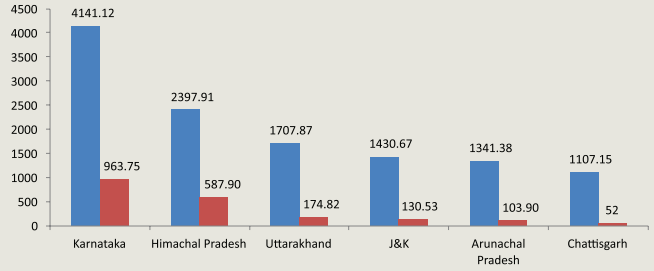
On analyzing top 5 States having maximum potential of small hydro and installed capacity in these States, less than 20% of potential capacity has been utilized.

It is to be noted, that despite small hydro projects positing various implementation advantages, however, only 20% of the potential has been somewhat utilized. This is because the potential small hydro project sites (total 6474 potential sites identified) are located at remote places, far from demand centers. Also, evacuating power from these remote locations to the nearest grid requires investments in transmission lines, over undulated and difficult geographies, increasing the cost for investments in transmitting such power.

Also, as these are remote locations, with limited facilities around project sites, they are inaccessible for regular operations and maintenance related activities, thereby further increasing costs for O&M.

Further, obtaining statutory clearances is a time consuming process. Techno-economic clearance (based on detailed project report to be prepared) by State Electricity Board or power department, allotment of land by State revenue department, water rights by State irrigation department and the most time consuming – forest and environmental clearances from concerned authorities. Apart from

**INSTALLED VS POTENTIAL**




these clearances, few States also demand no objection certificates from fisheries department and, ironically, State pollution control board.

Considering these challenges, the Ministry of New and Renewable Energy has been providing financial support/ subsidy on the activities like resource assessment, detailed survey and investigation, detailed project report preparation and perspective plan for States. Financial support is also being provided for research and development, human resource development, strengthening of technical institutions, capacity building and setting up turbine laboratory. Prima facie, the government support is towards pre-project development activities and less towards implementation.

Construction & commissioning period of such projects are claimed to be less as compared to other non-renewable or even large hydro projects. However, pre-project development activities include surveys and investigations, feasibility studies and DPRs, designs and drawings, financial closure and finalization of contracts, itself take a time period of 15-18 months to complete, almost two years from conceptualization.

Also, as there is less civil works required for these projects, such projects claim to have lesser initial investment cost compared to other sources, thereby reducing pay-back periods. The capital costs calculated and expected at Rs. 5-6Cr/MW, only today remain to be a perception, as costs have increased to Rs. 10 Cr/MW with still variation in capex based on scales up to 20%.

Apart from construction costs, there are other hard costs that are to be understood in case of development of small hydro projects. These include project cost for local area development fund, environmental monitoring plan, catchment area treatment plant, free energy (some percentage) to States, forest fee and charges (compensatory afforestation and reclamation plan), cost of transportation uphill and downhill, all add to the capex of small hydro projects.

Considering high capex, the levelised tariff expected from small hydro projects operating at PLFs of 45% still hover between Rs. 4.5/KWh to Rs. 5/KWh. Investments are expected to grow in small hydro at a steady CAGR of 9-11% till 2020.

All said, small hydro projects have the advantage of providing economically sustainable power production and 80% of total potential is still unexploited. The small hydro projects should be favored by States owing to its ability to provide power to remote areas. The State Governments need to immediately pick the low hanging fruits of identified sites and identify projects that could be developed at economical costs, streamlining and expediting statutory clearances. This shall provide a quick impetus to utilize balance small hydro potential.

Land acquisition and R&R issues (though minimal in this case) are State specific and State policies need to be reviewed to promote development of small hydro projects. Incentives and sops for small sized projects and local area development could be provided to encourage investments in the sector (after all, tariffs are very lucrative). States, for a start, could adopt State Policy of Himachal Pradesh with respect to hydro power development, which is one of the best in the country.

The government should also work toward reducing the time period for undertaking pre-project development activities. Techno-economic clearance may be fastened, either by developing a mechanism wherein studies are monitored by approving agency, or allowing multiple agencies to provide techno-economic clearance.

Private public partnerships, of joint ventures, with State Governments may be encouraged and promoted for faster clearances and execution of small hydro projects.

To avoid geological surprises and facilitating quicker implementation of projects, detailed route survey and feasibility studies for assessing transmission connectivity may be conducted for all identified project sites to assess project costs and identify low hanging fruits.

All measures above have the potential to encourage and boost investments in the small hydro sector. Further, there is an imperative for all stakeholders to foster growth in this sector by complying with environmental matters, optimizing project incentivization and benefit sharing and strong knowledge & information sharing between various stakeholders.

# UJWAL DISCOM ASSURANCE YOJANA (UDAY)

In a bid to rescue financially distressed State Electricity Utilities, the Union Cabinet approved a scheme for rejig of Rs 4.3 lakh crore debt of the utilities besides measures to cut power thefts and align consumer tariff with cost of generating electricity.

**Key points in Ujwal Discom Assurance Yojana (UDAY)**

- **Eligibility:** State owned Discoms including combined Generation, Transmission and Distribution Undertakings
- Participating Discoms / entities to undertake improved operational efficiency measures in line with the scheme timelines:

| Activity | Targeted Benefit | Expected Date of Completion |
|---|---|---|
| Compulsory feeder and Distribution Transformer (DT) metering by States | Ability to track losses at the feeder and DT level for corrective action | Feeders – 30th Jun 2016<br>DTs – 30th Jun 2017 |
| Consumer Indexing & GIS mapping of losses | Identification of loss making areas for corrective actions | 30th Sep 2018 |
| Upgrade or change transformer, meters etc | Reduce technical losses and minimizes outages | 31st Dec 2017 |
| Smart Metering of all consumers consuming above 200 Units per month | Smart Meters will be tamper proof and allow remote reading thus helping reduce theft, implementation of DSM activities and consumer engagements | Consumption above 500 Units per month – Dec 2017<br><br>Others – Dec 2019 |
| Demand Side Management and efficient industrial equipment through PAT (Perform, Achieve, Trade) | Reduce peak load and energy consumption; LED alone has annual saving potential of Rs 40000 Crore | 31st Mar 2019 |
| Quarterly Tariff revision, Particularly to offset fuel price increase, to be permitted | Periodic Tariff Revision | Necessary changes in tariff policy by 31st Dec 2015 |
| Comprehensive IEC campaign to check power theft | Enhance public participation | Awareness Program jointly with States up to 31st Dec 2016 |
| Assure increased power supply in areas of reduced AT & C Losses | Encourage local participation to reduce losses | 31st Mar 2018 |

- **Indicative Parameters:**
  - ❖ Reduction in AT &C loss to 15% in 2018-19
  - ❖ Reduction in gap between Average cost of supply (ACS) and Average Realised Revenue (ARR) to Zero by 2018-19.
- **Efforts to reduce cost of generation:**
  - ❖ **GoI initiatives:**
    - **a.** Increased supply of domestic coal
    - **b.** Coal linkage rationalisation
    - **c.** Coal swaps from inefficient plants to efficient plants and from plants away from mines to pithead plants (minimize cost of transportation)
    - **d.** Coal price rationalisation based on GCV
    - **e.** Correction in coal grade slippage
    - **f.** Coal India to supply 100% washed coal for G -10 and above by 1st Oct 2018
    - **g.** Coal India to Supply of 100% crushed coal by 1st Apr 2016

**h.** Faster implementation of Transmission lines and creation of adequate transmission facility by 31st Mar 2019

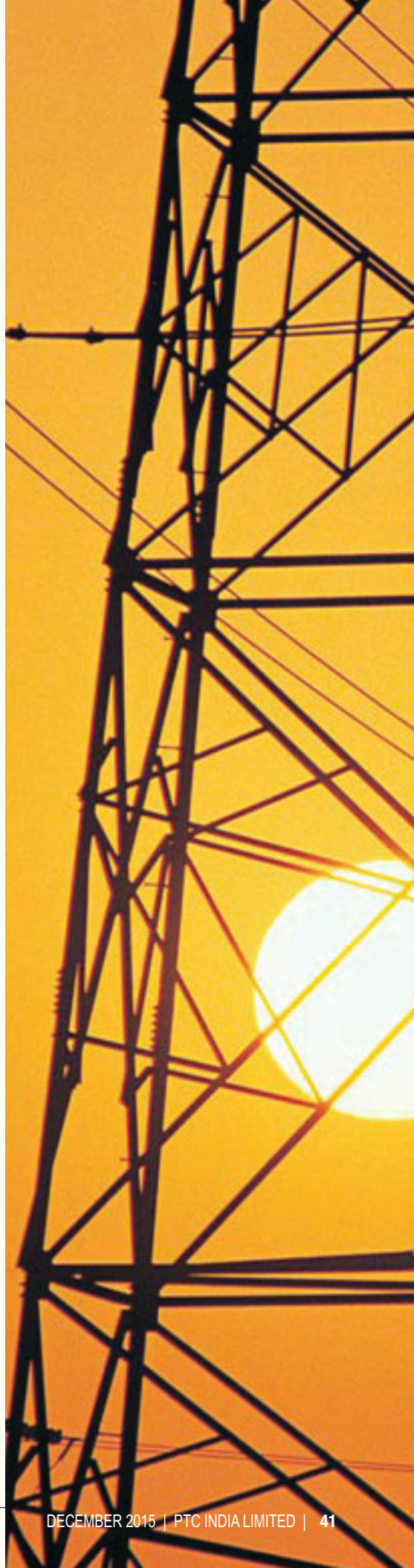
**i.** Allocation of coal to States on notified price, based on the same States may go for tariff based bidding

❖ **States' Initiatives:**

**a.** Prospective power purchase through transparent competitive bidding by DISCOMs

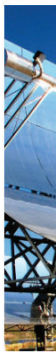
**b.** Improving efficiency of State generating units

- **Scheme for Financial Turnaround:**
  - ❖ States shall take over 75% of DISCOM debt as on 30th Sep 2015 over two years – 50% of DISCOM debts shall be taken over in 2015 -16 and 25% in 2016-17
  - ❖ States to issue Non – SLR bond (increase liquidity) to the respective banks / FIs holding the DISCOM, debt to appropriate extent. Proceeds from Bond shall be entirely transferred to DISCOMs, which in turn shall discharge corresponding amount to Banks / FIs debt
  - ❖ Bond shall have a maturity of 10 -15 years with a moratorium on repayment of principal up to 5 years
  - ❖ Coupon Rate: 10 Year G – Sec + 0.5% (State Bond) + 0.25% (for non SLR status) on semi-annual compounding basis or market determined rate whichever is lower. In case of monthly payment the interest / coupon rate may be suitably appropriated
  - ❖ Banks / FIs not to levy any pre-payment penalty on DISCOM debts
  - ❖ The transfer to the DISCOM by the State in 2015-16 and 2016 -17 will be as a grant. In case of States' inability to take on interest burden, the grant can be spread over 3 years and States with very high DISCOM debt, this period can be further relaxed for 2 years in consultation with MoP
  - ❖ States can give not more than 25% of the grant as equity to DISCOMs
  - ❖ DISCOM debt to be taken over by the State shall include DISCOM bonds which are part of FRP – 2012
  - ❖ DISCOMs loan shall carry interest rate not more than the Bank's base rate + 0.1%. States shall guarantee repayment of principal and interest payment for the balance debt (i.e. 25%) is remaining with the DISCOM / bonds issued by DISCOM through an appropriate mechanism being developed by MoP in consultation with MoF
  - ❖ Bonds shall be offered for subscription by Market including pension and insurance companies and balance if any shall be taken over by banks in proportion to their current lending to DISCOMs
  - ❖ Special incentives to Jharkhand and J&K to clear the provisional outstanding dues and it shall not be counted against the fiscal deficit of respective State
- **Financing of future losses & working capital**
  - ❖ States shall take over the future losses of DISCOMs in graded manner and shall fund the loss to an extent of 50% of previous year's loss by 2020 -21
  - ❖ Banks / FIs shall not advance short term loan to DISCOMs for financing losses
  - ❖ Working capital to an extent of 25% of previous years' annual revenue or as per prudential norms can be financed by Banks / FIs
  - ❖ DISCOMs to comply with RPO guidelines since 1st Apr 2012
  - ❖ Participating States may get additional benefits from other schemes of MoP and MNRE, if they meet the operational milestones outlined in this scheme



# Renewables in India: Translating Ambitions in to Reality

**Prof. Amit Kumar,**
Dean, TERI University



Ever since the change of guard at the Centre, renewable energy is in news and all for the right reasons. Indeed, over past few months, goals set for the renewables by the Union Government have increasingly become more and more ambitious. Renewables based electricity alone has now a goal of adding up 175 GW by 2022 – an audacious target by any standard, so to say. In a way it is good that country's aspirations for clean energy are set high because that would set tone for all the subsequent actions. Achieving these targets does require a well-balanced orchestration of a variety of actions, not only at the Centre but more importantly at the States' level, electricity being a concurrent subject. Otherwise also, success of the implementation and delivery of these programmes ultimately depends greatly on the efficacy of the field-level institutional arrangements. Let us also look at some other key areas that would need to be fine-tuned if we were to move in the right direction with a speed that fits in the given time frame.

For any programme to succeed, that too of this magnitude, it is crucial that it is backed by an enabling policy framework. Here this dimension becomes even more critical because most of the investment is envisaged to be private one. And for that to happen, investors certainly look up to a policy environment that is consistent and has a long-term visibility, thereby providing them a level of comfort. The related aspect pertains to regulations. As has been seen in the past, generation of RE power alone is not sufficient unless there is concomitant uptake of that electricity by the utilities, which also brings in to picture the whole issue of compliance. But that in a sense is also linked to the vexed subject of the financial health of the utilities in the Country. That, therefore, clearly indicates toward the need for tackling renewables not in a piecemeal basis but in much more holistic fashion. Given the intermittency of wind and solar energy and the reluctance of the utilities arising out of it, perhaps it is time to start looking the power sector de novo where the whole planning, balancing requirements and the electricity markets are designed keeping renewables at the centre rather than on the fringes as is being done presently. This is also important because with innumerous small capacity solar rooftop systems getting connected to grid will bring in its own set of challenges. That also underlines the need for much greater attention on R&D, especially on storage and grid-interconnection but also on collaboration to gain from the global best practices.

Financing is the other key area on account of two reasons. The banking community in the country is already wary of power sector lending because of a variety of reasons. In fact the bidders that got the mining lease in recent coal mines auction are finding it difficult to raise debt for their projects. In such an environment, raising such an enormous amount of financing for RE projects too would be an Herculean task. Secondly, the cost of capital being

the major factor influencing not only the project viability but also the cost of electricity, it is necessary that low-cost financing is made available for such projects. Then only scaling-up of this magnitude would be possible in such a short span. For both of these, proactive role of the Union Government is essential.

Renewable energy has been one of the identified sectors under National Programme on `Make in India'. Make in India lists out vast potential of renewable energy resources in the country, its facilitative measures and its import dependency as some of the drivers for this sector and rightly so. In fact the federal Government's ambitious goals of having 100,000 MW of solar energy and 50,000 MW of wind energy by 2020 - not to speak of biomass and small hydro etc.- are indicative of large domestic demand being created that can benefit from indigenous manufacturing besides providing the manufacturing industry a ready-to-tap market. India being strategically located thereby having access to the emerging renewable energy markets, renewable energy manufacturing sector is certainly poised for greater heights if some key fundamentals are kept in mind during planning and execution.

India, while as a result of efforts made during the past over two decades in promoting renewable energy, does have a certain level of manufacturing capabilities. It lacks, however, a strong and vibrant manufacturing ecosystem. It lacks scale at which economies of scale kicks in. The other fundamental that needs to be set right is integrated manufacturing along the complete value-chain (the only exception being the wind sector). In today's globalized scenario, it is imperative for any industry to be competitive. For renewable manufacturing to be truly competitive, the industry as well as Government must start doing things differently. For this to happen, country needs to graduate from likes of `domestic content requirement' to policies that facilitate and incentivize industry to acquire latest technologies, State-of-the-art manufacturing setup and economic scales of operation. The large-scale adoption of locally produced products would then be a natural – and sustained – progression rather than an artificially created one. And it is not that this will lead to only big manufacturing plants. Far from it, automobile industry is a good example where large manufacturing plants are linked to so many ancillary units that are actually small and medium enterprises. The key is to focus on the complete value-chain, on components, balance of systems and products as well.

Now `Make in India' would not be a sustainable phenomenon in a long run if simultaneous attention is also not paid to indigenous R&D and technology development, which depending upon the requirements, may very well be collaborative. The maximization of value addition is possible with self-developed technologies and products. For brand `Make in India' to make its mark, assuring highest levels of quality cannot be overemphasized. And towards that, the Government will have to invest heavily in creating enough testing and certification facilities of global standards that can cater to sharply increased demand arising out of this campaign. Now, the biggest challenge in tackling all of these will be to have right kind of human resources for given tasks, that too in large numbers. Thus, gearing up our education and skill development systems will hold the key if such potentials are to be unlocked.

Considering the fact that one is talking of manufacturing of clean energy technologies and products, it may not be out of place to suggest that the equal attention is paid to `greening' of these manufacturing lines so that the energy intensity as well as wastage of resources is minimized to the fullest extent possible. The collateral benefit would be ultimately the reduced cost of production and therefore, increased competitiveness. Massive amounts of investments would be required for setting up the plants, for modernization of the existing production lines and towards the working capital etc. While some of these could come from the existing schemes, there will still be a need for mobilization of funds on a large scale. The Government, therefore, will have to create an environment that encourages `people-public-private- partnerships', thereby leveraging public resources many times over.

The deliberations in the fifteenth edition of Delhi Sustainable Development Summit (DSDS) would be around `Sustainable Development Goals and Dealing with Climate Change'. The role of renewables in this whole discourse is central and so is their local production in order to achieve the scale most cost-efficiently.

During his recently concluded India visit, President Obama pledged USD 2 billion of leveraged financing for renewable energy investment and USD 1 billion in loans for small and medium businesses. Both of these put together could help not only in pushing US-India collaboration in the field of renewable energy to the next level, but also in giving concrete shape to some essential contours of `Make in India' vision.

A well designed `Make RE in India' programme would not only help bring down the costs of renewable energy systems through economies of scale and encourage introduction of the latest technologies/processes; it generates millions of jobs at various levels. And that is how India's demographic dividend can be used in a `green' manner.

**Atanu Dasgupta**
Consultant
PTC India Ltd.

# WINDOWS OF OPPORTUNITY IN THE ERA OF SOLID STATE LIGHTING

## Introduction

Many of us have already seen three basic generations of electrical lighting: tungsten incandescent lamps, fluorescent tubes and CFL. In fact all three generations co-existed happily for quite some time until the arrival of Solid State Lighting. Solid State Lighting is a mechanism of extracting visible light energy from a solid object - a semiconductor p-n junction popularly known as Light Emitting Diode (LED). It can be a fair guess that based on trends supported by scientific and technological advancement; all the aforesaid three generations of lights will vanish into thin air in another 20 years maximum. Hail the era of Solid State Lighting!

## Solid State Lighting

Solid-State Lighting (SSL) is a technology in which light-emitting diodes (LEDs) replace conventional incandescent and fluorescent lamps for general lighting purposes. It is also deployed now-a-days for a variety of applications like street lighting, building lighting, automobile lighting and perhaps everywhere the conventional systems are still operational and for a host of new areas and applications unthinkable hitherto. An SSL device produces visible light by means of electroluminescence, a phenomenon in which electric current passing through a specially fabricated semiconductor diode causes the semiconductor material to glow.

Traditionally, LEDs are being used as indicator lamps in professional and household electrical and electronic devices. In fact this practice is likely to continue for ever perhaps. As brighter LEDs were developed, SSL devices found applications in traffic lighting, electronic billboards and headlamps for motor vehicles. Today, we find them in flashlights, searchlights, cameras, projectors, indoor and outdoor lighting arrangements and numerous other applications.

## Benefits

Superior energy conversion efficiency is the principal advantage of SSL lamps over incandescent and fluorescent lights and CFLs. A typical incandescent bulb, intended for home use, converts about 10 percent of the supplied electrical energy into visible light; the rest comes off as infrared (IR) radiation ("heat"), which is invisible. Whereas, an SSL device, in contrast, converts about 90 percent of the supplied energy into visible light and only 10 percent into IR.

The other most significant advantage of SSL technology lies in the long lifespans of SSL devices. A properly designed and manufactured SSL lamp lasts about 35,000 to 50,000 hours, more than 20 times the average life of an incandescent bulb and about six times the life of a CFL. The long lifespan and associated energy saving help reducing environmental pollution and carbon foot-print.

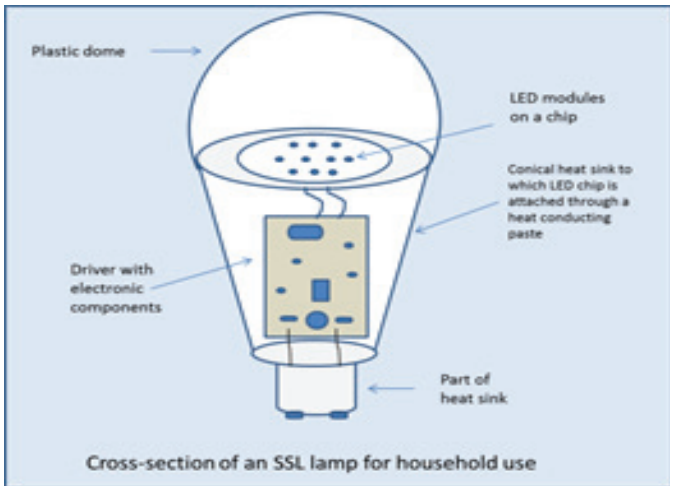

Apart from aspects like energy savings, longer lifespan and improved quality of light that SSL devices offer, the easy controllability of this deployment through intelligent networking solutions can usher in real revolution in the way discoms and ULBs are likely to utilize their street lighting infrastructure in order to deliver a cost-effective, sustainable and safer living space.

In the area of green initiatives too, SSL technology scores over the conventional ones. Solid-State lamps are bereft of hazardous substances (unlike CFLs) and they do not cause shattering when dropped like their predecessors.

A typical SSL lamp can be deployed as dimmable like an incandescent bulb, whereas a fluorescent lamp or CFL is not. This feature is useful for energy saving and optimization of illumination and running cost.

Optics in SSL luminaire can be optimized adequately for the maximum benefit of the users in terms of even more distribution of light and reduction of lumen losses in unwanted directions. This feature reduces light pollution and wastage.

Further, SSL lamps do not radiate ultraviolet (UV) rays that



Cross-section of an SSL lamp for household use

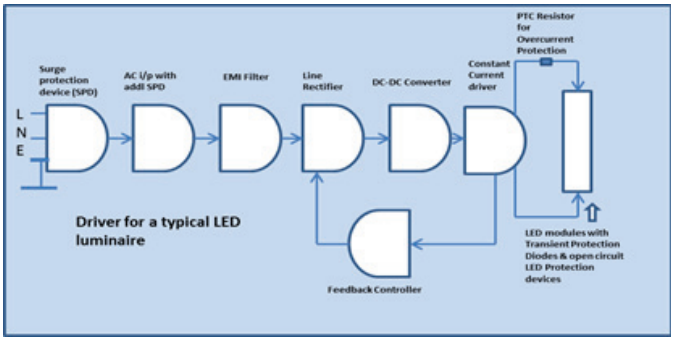
can attract insects and cause fading of wall papers, artwork, clothing etc over a period of time.

The SSL system offers better natural color rendering characteristics that can help improve safety and security in the areas where it is deployed. With a high color rendering index (CRI) the SSL device makes it easier for all kinds of users whether at homes, community buildings, market places or on streets. The easy availability of cool, neutral and warm white LEDs add the option to adjust the color temperature to the specific lighting applications. It is needless to say that with conventional lighting technologies such alternatives are unthinkable.

Although the illuminance (Lux/watt) available from High Pressure Sodium Lamps (HPSL) is equivalent to that of solid state lamps, the former produces undesirable hot spots that improves the lux rating but brings in undesirable visibility, safety and glare issues.

An SSL device functions at a lower temperature than a typical CFL. The electromagnetic interference (EMI) from SSL is better controllable than that from CFLs. The SSL lamps are also better poised in connection with its vulnerability to electromagnetic compatibility (EMC) aspects.

In order to satisfy users' preferences and actual needs, the SSL lamps can be manufactured with color shades ranging from "cool blue" to "warm yellow".




Presently, the principal disadvantage of SSL lamps is that it costs considerably higher than incandescent lamps and somewhat more than CFLs. However, accounting for the long lifespan that the SSL lamp offers and long-term cumulative reduction in energy consumption and accompanying reduction in carbon footprint, consumers may actually save money by using SSL lamps in most of the situations.

The other disadvantage in connection with outdoor installation of SSL lamps (eg. LED lamps for street lighting) is its vulnerability to lightning strikes and surges from the electrical supply system that necessitates suitable protective devices and efficient earthing system.

The encapsulation of SSL lamps for outdoor illumination needs high degree of accuracy and workmanship so that the luminaire is least vulnerable to environment.

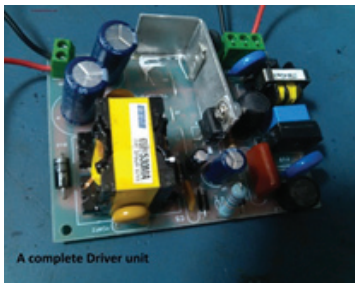
### Important design parameters

There are a number of technical aspects that need to be checked for the SSL luminaire design as a whole with whole lot of complex electronics inside plus mechanical, thermal and photometric properties including the aspects of photo-biological factors, built-in power factor correction capabilities and EMI/EMC issues. The LED modules are most important in respect to quality of luminescence. The next is the design and choice of the LED driver that needs careful selection of electronic components – both active and passive that include a microprocessor plus Switch Mode power Supply (SMPS). The performance of the driver including surge and transient protection capabilities at various stages in the driver contribute to effective long life of the SSL luminaire. Encapsulation of the LED modules, Driver board and other mechanical and thermal management components like sizing of the heat sink including choice of material, heat sink compound for thermal conduction, sealing of the bottom metal collar with glass etc. are very important to offer a quality product as per international standards. The figures provided show the construction of a typical SSL luminaire as used at homes and also the general internal disposition of a Driver. There is a strong possibility that at the time of mass production many of the aforesaid factors are bypassed or ignored for the sake of simplicity and cost-cutting that demean the quality of the end product delivered.

### Detrimental effects in case design parameters are not followed during manufacture

In the event, substandard SSL lamps are allowed to flourish in the market the following detrimental effects will have to be encountered:

a. The domestic lighting industry will be severely restricted to grow and multinational companies with quality products will shy away. Thus the 'Make in India' concept will suffer enormously.


A complete Driver unit

b. Light emanated from the cheap SSL lamps shall be of inferior quality with unacceptable colour rendering and photo-biological factors that is bound to affect public health in the long run.

c. Light output (lumens) from such SSL devices shall be low against the electric power that they will consume. But an ordinary user may take a long time to understand such drawbacks and take corrective actions.

d. The cheap SSL fixtures, while deployed in bulk, shall present undesirable power factor to the electrical grid that will result in overheating of distribution transformers – thus creating havoc in the system and financial loss to the suppliers. The cost of purification of the grid will be enormous.

e. The life of such LED lamps shall be much lower as compared to properly standardized, designed and manufactured SSL lamps that EESL has been promoting.

### PTC's role and future

It is a matter of great pride that PTC India Ltd has been actively associated with several projects in the areas of SSL initiatives for street lighting projects spearheaded by EESL on behalf of the government. PTC has also been involved in EESL's Demand side management-based Efficient Lighting Programme (DELP) through which highest quality of SSL products are being distributed to the citizens at a great subsidy. By involving in the aforesaid initiatives, PTC has gained valuable experience in project handling in an all India scenario and difficult site conditions besides interacting with end-users, manufacturers and standardization organizations, CII and other related fora on design, engineering, quality and implementation issues related to SSL technologies. Thus PTC has already proved its mettle in offering quality products and projects for the benefit of citizens and ensuring energy efficiency in a well-coordinated and structured manner. Based on this experience, PTC is now poised to open further windows of opportunity in various areas related to energy efficiency, renewable energy and beyond. Some of the ensuing projects may include further SSL street lighting projects in a wide area concept and DELPs in other cities and ULBs and also similar projects in connection with Smart City implementation, renewable energy projects, building automation projects and other associated infrastructure projects. PTC is also looking forward to its involvement in other energy efficiency projects like distribution of energy efficient fans, agricultural pumps, air-conditioners etc. in near future.

### Challenges in field implementation

Adequate sensitization is necessary for manufacturers, users and implementers of SSL projects whether for domestic use, outdoor or industrial deployment. The mechanical fittings, electrical connections and aesthetics are pre-requisites for a long life and trouble-free SSL system. Since surge suppression is important particularly for outdoor installation such as street lighting, adequate surge arrestors must be provided as an integral part of SSL luminaires. In the event surge arrestors are not installed, the life of the SSL lamps are bound to be reduced and then the effect of long term saving in maintenance will be lost and higher cost of implementation cannot be compensated quickly as return of investment will take longer time. The surge arrestors, on the other hand, will require good grounding system so that the energy associated with incoming surges due to lightning and electrical distribution system faults can be grounded effectively and immediately after occurrence. The electromagnetic interference (EMI) from SSL system is also needed to be controlled as per international standards otherwise this may create havoc in the radio frequency spectrum and may cause mal-operation in systems that use radio frequencies, eg. broadcast receivers, Wi-Fi based data acquisition, monitoring and control systems, electro-medical equipment etc. In order to control the EMI caused by the pervasive SSL systems in near future, it requires adequate design considerations in the driver circuit and also an effective grounding system.

### Future trend

Next-generation SSL system is expected to deliver unprecedented power savings and product reliability and they will probably be deployed in areas that is unimaginable today. For example, SSL system shall be used for artificial light for nurturing plant growth. The dedicated system for agriculture will offer low power, high-efficiency, uniform light pattern, homogenous light distribution at precise wavelengths and color ratios that are needed for superior photosynthetic process.

SSL devices are all set to be used for water-purification purpose for providing safe drinking water for human consumption, medical devices and all other areas where water is used with various limits of purity and minerals. For this purpose specially designed LEDs shall be used in water-treatment plants shunning the deployment of chemicals or mercury-based UV lamps.

Some of the broad areas where SSL system is going to mark its powerful presence include food processing industry, printing processes, LED drying for industrial and domestic usage etc.

In future, SSL system can be used to power wireless communications networks as well using LI-Fi technology that uses light instead of radio waves for exchanging data traffic.

It is also understood that the future will be full of lasers. Laser diodes, which are already being used as car headlights, are expected to gradually replace LEDs and will dominate the lighting industry for its improved efficacy.

Laser diodes can also be used for "intelligent lighting" like smartphone-controlled projectors that display imagery or data on walls or floors. It is predicted that laser diodes will be used extensively for wireless communications. In future, laser-based Li-Fi may replace LED-based Li-Fi, as a laser diode-based version would be faster than LED-based Li-Fi.

### Summary comments

When buying an LED lamp, one will hear the term 'lumens per watt', that quantifies luminous efficacy. The higher the lumens per watt, the better the LED lamp is because it consumes lesser energy to emit the same, or a greater amount of light. The luminous efficacy of LEDs range from 80Lm/W to 160Lm/W. The energy efficiency, thus achieved, makes it cost-effective and it amounts to less money spent on electricity bills.

Modern LED lamps have high luminous efficacy along with long life expectancy of up to 50,000 hours, which makes it truly energy-efficient. The savings accrued from the reduced power consumption combined with the lower maintenance costs make LEDs a smart investment. However, the life of the SSL luminaire is truly a function of the efficient driver and protection system it is provided with rather than the LED modules in it. So it is the lifetime of the electronics associated with the SSL luminaire that really creates value.

PTC is committed to work truly long term in the areas of energy efficiencies and beyond piggyback on its experience in complete project management in street lighting and DELP projects.

# PTChronicle

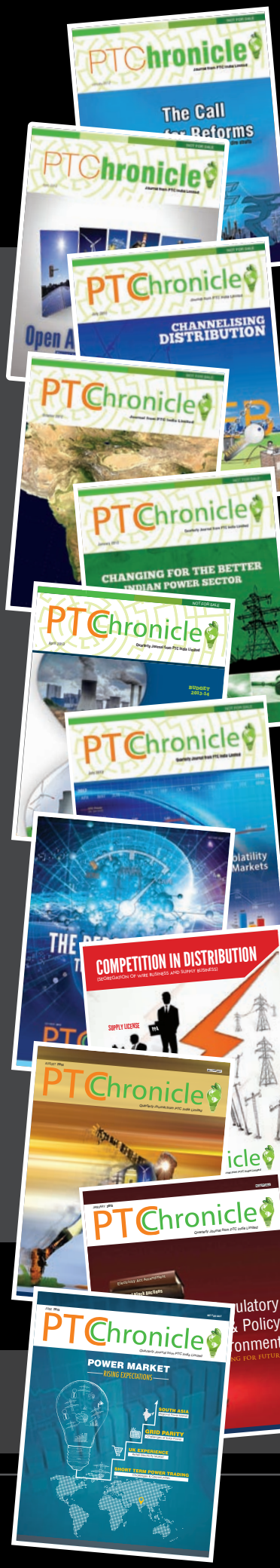
PTC India Limited was incorporated in 1999 as a Government of India initiative by the Ministry of Power. The major objective of PTC was to introduce power trading in India and encourage investments by facilitating market based transactions.

With an experience of more than 14 years, PTC India has spearheaded the industry introducing products and services for the development of the sector.

PTChronicle, the quarterly journal from PTC India Limited, aims to draw the Indian Power Sector closer to the people by discussing answers to questions relevant to the power sector today.

We request the readers to send their valuable feedback and suggest any issue, that we may be able to address in the forthcoming editions of PTChronicle.

For suggestions and subscriptions, you may mail us at editor.ptchronicle@ptcindia.com




Dear Readers,

Thank you for the kind response. We hope we continue receiving your valuable feedback at editor.ptchronicle@ptcindia.com

PTC India

**PTC India Limited**

2nd Floor, NBCC Tower, 15 Bhikaji Cama Place, New Delhi - 110066

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New Delhi - 110066 Tel.: 011-41659500, Fax: 011-41659126
E-mail: marketing@ptcindia.com Website: www.ptcindia.com