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## No Plan B because there is no planet B

Hello and welcome once again to Electrical India, the leading publication on the power and electrical products industry in the country. So friends, if you recollect, just two months back in the April issue, I had asked a question, "where will this end" when US president Donald Trump went against his predecessor Obama's policy on global warming, which includes emission rules for power plants. Well the answer did not take long time to come. The US president has, after all, decided to exit the historic Paris Climate Accord signed by Obama and leaders from 196 countries in 2015.

What was the Paris pact after all? To keep the global temperatures rise below 2°C (compared to pre-industrial levels). Today, he is blaming countries like India and China, who according to him get billions of US dollars in foreign aid to participate in the Pact. You can say China - after all it's the world's largest polluter at 10.64 billion metric tonnes of carbon dioxide followed by US at 5.17, European Union at 3.47. Mind you, India with one-fifth of the world's population generates only 2.45 billion metric tonnes of CO<sub>2</sub>. India has, after signing the accord in 2015, received only US\$35 million for the project undertaken by NABARD for a solar micro irrigation project in a tribal area of Odissa. Even that amount was only about 20% of the project cost which was about US\$166 million. So the US president is wrong in his figures.

In any case, even though the US has withdrawn from the Pact, it doesn't destroy it as more than 145 countries have already ratified it. Nevertheless, it definitely leaves a hole in the global emission reduction targets. The US was supposed to cut emission by about 28% by 2025. It is difficult for any country to fill this gap of about 28% cut in emission which translates to around 1.7 billion tonnes of CO<sub>2</sub> equivalent. Second no country can match the ability to raise funds like the US. Smaller countries that need foreign fund to go green will be hit. India, with its largely domestically-funded plans, will manage it as Prime minister Modi rightly said, "Paris or no Paris, India committed to climate protection."

It reminds me of a speech in 2015 by Ban ki moon, then secretary general of UN and I quote, "we have to do what science tells us. Climate change is caused by human behavior. Nature does not negotiate with human beings. We have to adjust to nature. That's our only choice. We must all act and work as one." Trump's decision has only galvanised the world than weakened, and this vacuum will be filled by new broad committed leadership. Will Mr. Modi assume the mantle of global leadership on climate change initiatives? Time will tell. However, for the moment, the social media and the internet has a new mantra - "We have only one planet. There is no Plan B because there is no planet B."

Do send in your comments to me at [miyer@charypublications.in](mailto:miyer@charypublications.in)

*Mahadevan*

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## AiIB approves first loan to India for \$160 million to support Power Sector

The Board of Directors of the Asian Infrastructure Investment Bank (AIIB) approved a loan of US\$160 million in support of the Andhra Pradesh – 24x7 Power for All project in the Republic of India with the objective to strengthen the power transmission and distribution system in the State of Andhra Pradesh.

The Project is part of the Government of India's Power for All program that was launched in 2014 to provide an efficient, reliable and affordable electricity supply to all consumers across selected states within five years from the start of implementation of the program in each state. Andhra Pradesh is one of the first states selected for the rollout of the Power for All program.


The project aims to support the implementation of the 24x7 Power for All plan in the State of Andhra Pradesh by strengthening the transmission and distribution network, increasing network capacity, improving system



Jin Liqun

reliability and supporting operational reforms to improve the commercial performance of the state's distribution companies. It will directly contribute to the economic development of the State of Andhra Pradesh and India by increasing delivery of reliable, grid-based electricity to households, business and the agricultural sector. The project is co-financed with the World Bank.

Jin Liqun, President of AIIB, said, "AIIB supports its members in their transition towards a low-carbon energy mix by promoting the improvement of energy efficiency, such as upgrading the existing transmission and distribution networks.

I am delighted that AIIB is working closely with India, who is our second largest shareholder, in energy and other infrastructure sectors, and we expect the Andhra Pradesh – 24x7 Power for All project to be the first of many projects AIIB invests in India." 

## India overtakes US at top of renewable energy attractiveness index

India has surpassed the US at the top of the latest EY Renewable energy country attractiveness index (RECAI). The fall – the first for the US since 2015 – to third in the ranking of the top 40 countries follows a marked shift in US policy under the new administration.

The report identifies the US Government's executive orders to rollback many of the past administration's climate change policies, revive the US coal industry and review the US Clean Power Plan as key downward pressures on renewable investment attractiveness.


Ben Warren, EY Global Power & Utilities Corporate Finance Leader and RECAI, Chief Editor, said, "Movements in the index illustrate the influence of policy on renewable energy investment and development – both productive and detrimental. Supportive policy and a



Ben Warren

long-term vision are critical to achieving a clean energy future."

India continued its upward trend in the index to second position with the Government's program to build 175GW in renewable energy generation by 2022 and to have renewable energy account for 40% of installed capacity by 2040. The country has added more than 10GW of solar capacity in the last three years – starting from a low base of 2.6GW in 2014.

"The renewable energy industry is beginning to break free of the shackles that have stalled progress in the past. More refined technology, lower costs and advances in battery storage are enabling more widespread investment and adoption of clean energy," Warren further explained. 

## Remaining 4,141 villages to be electrified by 2018

While delivering the inaugural address at the two-day State Power Ministers' Conference, Minister of State (IC) for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal said that the objective of the conference is to review the work done in the sectors of power, coal, renewable energy and mining by State Governments/ Union Territories in last six months. Further, the conference intends to forge new policies for achieving the goal of providing 24x7 quality and affordable power for all in the stipulated time, upholding Prime Minister of India, Narendra Modi's vision of 'New India', Goyal added.


Addressing the august gathering, the Minister stressed that this conference is an 'Outcome focussed gathering' while reiterating the resolution taken in last State Power Ministers' conference in Vadodara to provide electricity to every household in the country by December 2018. He also noted that the challenges in achieving 24x7 Power for all are not over



Piyush Goyal

yet and in the next 3-4 months, a final push is needed to electrify remaining 4141 un-electrified villages in the country.

Talking about the transparency and accountability that a number of mobile apps and web portals have brought in the energy sector in India, Goyal said that transparency has been a hallmark of this government. The Minister encouraged the esteemed gathering to put forward a collective, collaborative and cooperative approach of State and Central Government which will help in creating a corruption free power sector in the country.

The conference was attended by Ministers and senior government officers from 23 State/UT governments. Also present on the occasion were P.K. Pujari, Secretary, Power, Arun Kumar, Secretary, Mines, Rajeev Kapoor, Secretary, New & renewable Energy along with senior officials of the Ministries and the CPSUs under them. 



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## 13,469 villages electrified up to 15th May 2017

Union Minister of State (IC) for Power, Coal, New and Renewable Energy and Mines, Piyush Goyal recently addressed the media on Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY). The Minister said, "Every state in the country has joined Power for All agreement". All the states have pledged to boost holistic development of entire village electrification process to provide 24x7 affordable and quality power to all which is planned under DDUGJY.

Talking about the impact of good governance in Rural Electrification, Goyal said, "The Government is working on the concept of 4S i.e. Skill, Speed,

Scale and now Sewa to improve the lives of the rural populace as the prime priority. We have changed the rules of this game. Instead of counting 10% households in the village to complete electrification process, now the Government is focusing on providing power connections to each and every household of village, thus providing meaning to the concept of 'Antyodaya'.

Goyal further added that, out of the 18,452 un-electrified census villages in the country, 13,469 villages have been electrified up to 15th May, 2017. A comparison of Achievements and the Physical & Financial Progress under rural electrification scheme in 2013-14 & 2016-17 is given as follows:

Parameters	2013-14	2016-17	2017-18 Target
Electrification of un-electrified villages	1,197	6,015 (5.02 times)	Balance un-electrified villages to be electrified by May 2018
Intensive electrification of villages	14,956	63,330 (4.2 times)	85,000
Free Electricity Connections to BPL households*	9.62	22.42 (2.3 times)	40 Lakh
Government of India Grant released to States**	Rs. 2938.52 Crores	Rs. 7965.87 Crores (2.7 times)	Rs. 4814 Crores

\*Free electricity connections to BPL Households provided to 256.81 Lakh BPL families up to 30th April 2017


\*\* Release of highest ever grant in any FY of Rs 7965.87 Crores to States

## REC sanctions Rs.10, 453 crores and signs MoUs worth Rs. 85,723 crores

Rural Electrification Corporation Limited (REC) signed Memorandum of Understanding's (MoUs) with Tamil Nadu Generation and Distribution Corporation (TANGEDCO) and Tamil Nadu Transmission Corporation (TANTRANSCO) for financial assistance of Rs. 60,063 crore and Rs. 25,660 crore. The MoUs were signed in the august presence of Thangamani, Hon'ble Minister of Electricity, Govt. of Tamil Nadu and Principal Secretary (Energy), Govt. of Tamil Nadu in Chennai.

The financial assistance is towards Implementation of various Generation, Transmission and Distribution projects in the State of Tamil Nadu during the next five years. Dr. P.V. Ramesh, IAS, CMD, REC also handed

over the Sanction letter for Rupee Term Loan (RTL) of Rs.10, 453 crore for implementation of 2x660 MW Udangudi Super Critical Thermal Power project during the ceremony.

CMD and Directors of TANGEDCO and TANTRANSCO lauded REC for their support in development of power sector in the state. They further stated that the huge loan assistance from REC as per the MoU will ensure timely implementation of these projects. CMD REC stated that such huge investment will not only improve the power infrastructure of state power utilities, but also improve their financial as well as operational performance. Officials of REC, TANGEDCO and TANTRANSCO were also present at the occasion. 

## India gets its largest vertical solar farm

Tata Power Solar, India's well known integrated solar company, and Dell International Services India have together built India's largest vertical solar farm of 120 kW. The first of its kind, 45-metre structure built on Dell's Bengaluru campus provides the dual benefit of producing sustainable green energy and insulation of the building, thus helping reduce power consumption.

The south facing vertical solar farm was a very complex project as it needed to be integrated on the façade of the building without compromising on the aesthetics. The project is a foray for Tata Power Solar into vertical solar structures which have the potential to transform urban energy management, utilising a fraction of the real estate which is at a premium in cities.


The solar farm, envisaged by Dell, produces enough energy to light-up its entire cafeteria and basement parking. While this significantly reduces the energy consumption of Dell, the panels itself act as solar insulation by



Ashish Khanna

blocking the south sun and thus reducing the power consumption of the air conditioning.

The project, by virtue of its unique design, needed significant innovation and customisation of the structures, load bearing characteristics and anchorage. To integrate the 480 modules, manufactured by Tata Power Solar, a specially designed, complex scaffolding was built. Safety was of utmost importance as the entire project was on a 11 storied building wall.

Ashish Khanna, ED & CEO, Tata Power Solar, said, "We thank Dell for choosing Tata Power Solar as its partner for this innovative project. We are very proud to have successfully executed this project which is unique and complex in so many different ways. We see tremendous opportunity, especially in urban regions, to deploy such vertical solar projects with multiple benefits. We hope more corporates follow Dell in implementing such pioneering and green initiatives." 



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## ABB India expands footprint with a global service centre for energy saving drives

The ABB remote service centre will provide 24x7 access to information and support on drives installed at customer facilities for predictive maintenance and condition monitoring for all industries including power, cement, oil and gas, metals, food & beverage and many other applications. The new centre is the third of its kind in the ABB global footprint and is now fully activated in India. It will support customer installations in India and around the world.

In India, 31% of total electrical energy is consumed by industrial motors. Drives control the speed of these motors and hence are a key component of enabling energy efficiency and improving productivity. Benefits of such a remote centre include faster identification of potential problems leading to increased uptime of customer assets and ultimately savings in operational costs.

The new production line manufactures digitally enabled low voltage



New production line for digitally enabled low voltage drives

drives (ACS560 and ACS580 series). The drive information in the cloud can be accessed securely with daily devices like smartphones. Drives are an environmentally friendly option to use energy efficiently while running motors based on their current load instead of running them on full speed continuously. These drives provide multiple energy optimisation features, are easily commissioned via smartphone, and include features for uninterrupted operations during power fluctuations.

Sanjeev Sharma, CEO and Managing Director, ABB India, said, "This is a reinforcement of our commitment to our nation and customers by establishing a world-class centre using our expertise in digitally enabled technology. We are also pleased to offer the benefits of our digital portfolio to our customers in India and partner them in the next level of their journey to develop a range of future services that will allow customer assets to become digital ready."

## BHEL's solar business gets on the fast track

Bharat Heavy Electricals Limited (BHEL) has ended the year 2016-17 with a significant Solar PV portfolio of 370 MW, comprising 360 MW ground-mounted power plants and 10 MW rooftop power plants, marking a significant contribution to the Nation's Green Initiatives.

Of this, 170 MW of BHEL-supplied ground-mounted and 2290 KW of rooftop power plants are already under operation in various locations in the country. During the year, the company secured orders for 131 MW of ground-mounted and about 8 MW of rooftop Solar PV plants. In addition, BHEL secured its first order for 240



Solar PV based pumping stations.

Leveraging its technical capability to offer new solutions for enhancement of energy generation, BHEL is actively exploring deployment of single axis solar trackers and battery-based energy storage for solar power plants. In addition, the company has prototyped floating solar power plant and solar PV based charging stations for charging electric vehicles. Backed up by a strong project management team, BHEL has enhanced its EPC capacity to address large size PV plants.

## NTPC NETRA installs India's highest temperature Drop Tube Reactor and Photogrammetry System

NTPC Energy Technology Research Alliance (NETRA) has installed India's first of its kind, indigenously developed, high temperature (designed for 1500 Deg C) Drop Tube Reactor (DTR) system recently. The DTR system is used for combustion characterisation of coal/biomass and is used for designing Advanced Ultra Super critical Technology and reducing carbon footprint from the fossil fuel plants.

Photogrammetry System of Solar Thermal Lab has also been installed and commissioned by M/s DLR, Germany at NETRA under Indo German R&D cooperation with the German grant. System installed for the first time in the country to measure 3D spatial coordinates of 'point cloud' of solar concentrators and



help in understanding its integrity.

NTPC is fully aligned to the needs of adapting to emerging technologies and upgrading the technologies through research and development as a leading player in the World Energy Sector. The company is particularly sensitive to Research & Development and the paradigm shift which it can make. NETRA set up in 2009 is the outcome of this vision. Climate change, waste management, carbon capture and Utilisation, new & renewable energy, efficiency

improvement and cost reduction are core areas of research at NETRA. It is also providing scientific support to NTPC and other power utilities for improving availability, reliability and efficiency.

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## CM of Uttarakhand inaugurates 78 MWp Solar PV project by Rays Power Infra

Following the successful commissioning of its 78 MWp Solar PV project recently, Rays Power Infra inaugurated the plant in the state of Uttarakhand. Hon'ble Chief Minister (CM) of Uttarakhand, Trivendra Singh Rawat honoured the inauguration of Rays Power Infra's plant in his state.

The project is one of the superior projects by Rays Power Infra, where local farmers have been made stakeholders by giving them a source of livelihood. Instead of forcing farmers to sell their land, Rays Power Infra has devised a unique model, where farmers can also become a part of the project. More than 1000 farmers will acquire direct and indirect benefits from this project by receiving a constant monthly source of income for more than 25 years. Furthermore, through this model, the company has created a land bank of



more than 2000 acres, where it can implement more than 500 MW. This has enabled them to single handedly accomplish 100% RPO of the state for the next five years.

Sanjay Garudapally, Co-founder & Director, Rays Power Infra, said, "This is yet another moment of great pride and honour for all of us here at Rays Power Infra. We started the project in

the last week of November 2016 and accomplished the same in record period of 90 days. That's not all; we not only inaugurated the plant, but also ready to appease major power necessities in the industrial areas of Bhagwanpur and Roorkee. Furthermore, what adds to our excitement is the fact that the vision and the mission of our organisation coincides so well with the bottom line of the MNRE."

## Suzlon's first S111 120m 2.1MW wind turbine generator achieves ~42% plant load factor

Suzlon Group, a well known global renewable energy solutions provider in the world, revealed that its revolutionary S111 120m 2.1 MW wind turbine generator has achieved a ~42% Plant Load Factor (PLF) in its first 12 months of operation- at the Jamanwada site in Kutch district of Gujarat. The prototype was commissioned in March 2016.

The 42% PLF demonstrated by S111 120m is 20 % higher than 35 % PLF achieved by S97 120m in its first 12 months performance at the same location.

The S111 wind turbine generator is the latest addition to the 2.1 MW platform and features the time tested Doubly Fed Induction Generator (DFIG) technology. With a swept area of 9,852 m<sup>2</sup> the S111 120m is designed to optimally harness wind resources at higher altitudes making low wind sites viable. It not only delivers superior energy yield, but also offers higher return on investment for customers. The new fleet of Suzlon

has garnered encouraging market response from customer segments across the board.

J.P. Chalasani, Group CEO, Suzlon Group, said, "The S111 120m 2.1MW wind turbine is a game changer in the industry. It has been our continuous effort to reduce the levelised cost of energy (LCoE) and we continue to invest in R&D with an aim to develop technologically advanced and innovative products. It is a proud moment for us to witness the prototype of S111 120m 2.1 MW turbine deliver ~42% PLF."



## Tata Power executes DFA for electricity distribution in Ajmer City

Tata Power, India's well known integrated power company, revealed the execution of Distribution Franchisee Agreement (DFA) for electricity distribution in Ajmer City. Subsequent to winning the bid for Distribution Franchisee of Ajmer Circle, Tata Power has formed a Special Purpose Company (SPC) 'TP Ajmer Distribution Limited'. The company signed the DFA with Ajmer Vidyut Vitran Nigam Limited (AVVNL) to cater to the power requirements of customers in Ajmer, for a period of 20 years.

The SPC, TP Ajmer Distribution Limited will be responsible for operating and maintaining the distribution network in Ajmer City, which includes City Division-I and City Division-II areas. It will also be responsible for managing the billing and collections in the said areas. TP Ajmer Distribution Limited will work closely with all the existing employees of AVVNL to facilitate



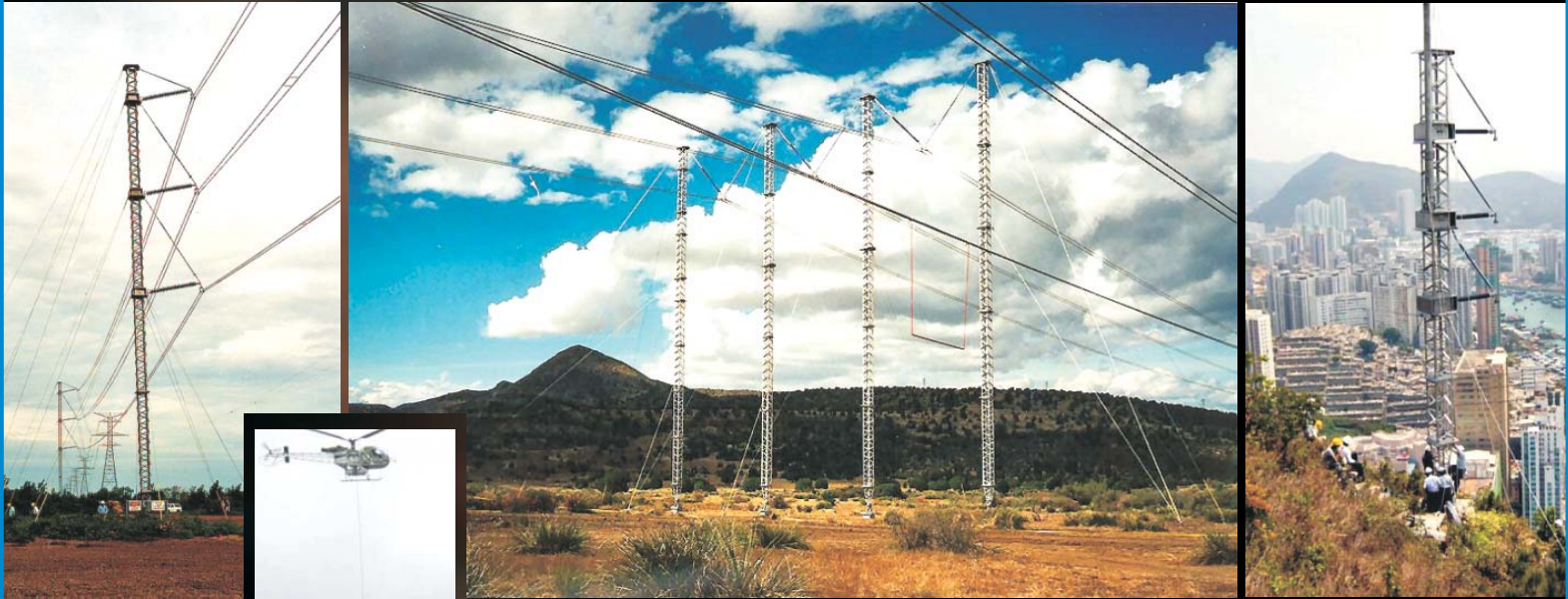
Anil Sardana

serving customers with efficiency and superior customer care that are synonymous with Tata Power.

Anil Sardana, CEO & Managing Director, Tata Power, said, "At Tata Power, we are committed to provide our customers with reliable and quality power, teamed with superior customer service. It is our endeavour to be the most preferred distribution company in the country, and work relentlessly towards achieving this objective. The success of our Delhi, Mumbai, and Jamshedpur Distribution businesses are testament to this fact. We

welcome all our customers in Ajmer to a world class reliable power experience that is backed by best-in-class customer service. We would also like to thank AVVNL for giving us the opportunity to serve the residents of Ajmer city. We look forward to support of all stake holders to make the new assignment a success."

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## Ameren unveils one of North America's most advanced distributed energy resource facilities


As part of its commitment to innovation and building a smarter, clean energy infrastructure, Ameren Corporation announced completion of one of the most technologically advanced utility-scale microgrids in North America. The \$5 million facility, located at Ameren's Technology Applications Centre (TAC) adjacent to the University of Illinois campus in Champaign, Illinois, is one of the only utility-scale microgrids in the nation capable of serving live (paying) customer loads on an actual utility distribution feeder.

As larger companies and high energy users seek to become more energy independent, Ameren built the microgrid facility to test monitoring and control methods for aggregating clean, renewable energy sources – wind, solar, and natural gas – with advanced automation and battery storage. The Ameren microgrid is one of the few in the world that operate at utility-scale



Warner Baxter

voltages, between 4-kilovolts and 34.5-kilovolts, with multiple levels of control. It is the only known microgrid in the nation capable of seamlessly transitioning the power source for an entire distribution circuit from exclusively distributed generation sources to the traditional grid. This concept, known as "islanding", enables Ameren to deliver more than 1-megawatt to live (paying) customers without experiencing an outage.


Warner Baxter, Chairman, President and CEO of Ameren Corporation, said, "Integrating microgrids onto our system can provide cleaner energy and a stronger, smarter grid capable of delivering the products and services to fit the needs of our future customers and the communities we serve. There is no better time than now to innovate and position Ameren for even better results in the years ahead." 

## Building Energy celebrates the operation of its first wind farm

Building Energy SpA, a multinational company operating as a global integrated IPP in the Renewable Energy Industry, through its subsidiary Building Energy Wind Iowa LLC, revealed the inauguration of its first wind farm in Iowa, which will add up to 30 MW of wind generation distribution capacity. The project, located north of Des Moines, in Story, Boone, Hardin and Poweshiek counties, will generate approximately 110 GWh per year. The beginning of operations has been celebrated on the occasion of the Wind of Life event in Ames, Iowa, in the presence of Andrea Braccialarghe, MD America of Building Energy, Alessandro Bragantini, Chief Operating Officer of Building Energy, Giuseppe Finocchiaro, Italian Consul General and George Revock, Managing Director and Head of Alternative Energy and Project Finance at Capital One Bank.

The overall investment in the construction of the Iowa distribution generation wind farms amounted to \$58 million and it sells its energy and related renewable credits under a bundled, long-term power purchase agreement with a local utility. Capital One Bank is committed to a tax equity contribution of approximately \$33 million to the project.

The wind facility, developed, financed, owned and operated by Building Energy, consists of ten 3.0 MW geared onshore wind turbines, each with a rotor diameter of 125 meters mounted on an 87.5 meter steel tower. The energy generated will satisfy the energy needs of 11,000 U.S. households every year while avoiding the emission of about 70,000 tons of CO2 emissions every year, according to US Environmental Protection Agency methodology, which is equivalent to taking 15,000 cars off the road each year.

Besides the environmental benefits, the wind farm also has advantages for the local communities, providing it with clean energy and creating jobs for local Iowans. The project involved more than a hundred of local skilled workers during the construction phase. Some of those jobs will be also permanent as necessary for the operation and maintenance activities as well as for additional services such as delivery, transportation, spare parts management, landscape mitigation, and further environmental monitoring studies. The developmental stage of the wind farm also required a vast number of studies, including environmental surveys, title surveys, engineering studies, and wind resource studies, that were carried out by local engineering firms, law firms, and various advisors such as a local university. 



### Letter to the Editor

Hello,

I am a Ph.D student and have gone through electricalindia.in recently for the purpose of learning, discussion and academic exchange, could you be so kind and please send me economic compare of **Resistive and Inductive SFCL (superconductive Fault current Limiters) in distribution network (voltage level: 20-33 kV)**.

I want a compare between Resistive and Inductive SFCL from point of view capital cost and maintenance cost according to impedance size and type of SFCL.

Your helping would be greatly appreciated.

Regards,

**Mostafa Hosseinpour**

Ferdowsi University of Mashhad, Iran

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## Eco Marine Power signs MOU for supply of Aquarius MAS + Solar


Eco Marine Power (EMP) has signed a Memorandum of Understanding (MOU) with a Singapore based shipping company to supply its Aquarius Management and Automation (MAS) + Solar solution. The solution will also include hardware and software that will allow ships to monitor fuel oil consumption in real time, automatically calculate NOx/SOx/CO2 emissions and interface with marine solar power systems. Initially one ship in the fleet will be installed with the Aquarius MAS + Solar solution and its performance jointly evaluated.

The Aquarius Management and Automation System or Aquarius MAS is a cost effective fuel oil consumption monitoring, alarm handling and data logging platform suitable for a wide range of ships. The system is based upon the reliable and robust KEI 3240 Data Logger which is already in use on



Marine grade solar panel and frame at Teramoto Iron Works, Onomichi, Japan

hundreds of vessels including tug boats, training ships, tankers and bulk ore carriers. A marine solar power solution from EMP is an integrated class-accepted system that may include a marine computer, battery chargers, batteries, marine-grade solar panels plus interfaces to other equipment and sensors. Each solution can be designed and scaled to suit a wide variety of ships including passenger ferries, cruise ships, tankers, bulk ore carriers, offshore support vessels and offshore platforms such as oil rigs and jack-up platforms.

For the first time marine grade solar panel mounting frames designed and manufactured by Teramoto Iron Works of Onomichi, Japan, will be used and supplied as a kit. This will simplify installation and enable the panels to be removed if necessary for deck maintenance. Teramoto Iron Works will also manufacture and supply the mounting frame for the battery pack. 

## ESCO reveals acquisition of renewable energy industry supplier

ESCO Technologies revealed that it has acquired NRG Systems (NRG), doing business as Renewable NRG Systems, located in Hinesburg, Vermont. NRG, founded in 1982, is the global market leader in the design and manufacture of decision support tools for the renewable energy industry, primarily wind.

The business, which will join Doble Engineering as part of ESCO's Utilities Solutions Group (USG) operating segment, has annualised sales of approximately \$45 million (with nearly half of its sales coming from international markets) and operating margins in the mid-teens. The terms of the transaction were not disclosed.


NRG's expertise spans both resource assessment products and wind plant optimisation equipment such as turbine control sensors, Lidar, and condition based monitoring systems. The products are used during both the



Justin Wheating

pre-development stage of a project and the operational stage when project owners need to optimise the performance of their assets.

Bryan Saylor, President of Doble, said, "The addition of NRG offers Doble the opportunity to access the growing renewable energy market, expand our geographic presence, and provide our existing customers with proven tools to optimise their renewable energy generation assets."

Justin Wheating, President of NRG, commented, "Becoming part of ESCO further strengthens our ability to grow through the continued investment in new products and the expansion of our existing technologies into new markets. We are excited about our future and pleased to join a company that shares our core values and demonstrates its strong focus on customers and employees." 

## Georgia Power unveils new 139-MW solar project at Robins Air Force Base


Georgia Power has revealed its plans to build a new 139 megawatt (MW) solar facility adjacent to Robins Air Force Base (AFB) in Warner Robins, Georgia, just south of Macon. The project was approved by the Georgia Public Service Commission (PSC) and will be the sixth large-scale solar project to be developed by Georgia Power working with the United States military and the Georgia PSC. The Warner Robins facility will be the largest single solar project to date to be constructed by Georgia Power.

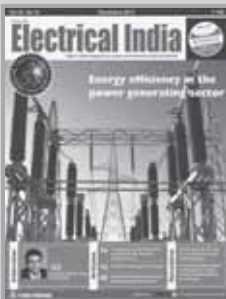
The new solar facility will be located on approximately 870 acres of land reserved to prevent encroachment near the base, and is expected to include more than 500,000 solar panels. As with the company's other military projects, power from the facility will be delivered



Georgia Power's Vice President of Renewable Development, Norrie McKenzie, announces the plan to build

to the state's electric grid at or below the company's avoided cost, the amount projected it would cost the company to generate comparable energy from other sources. The solar project at Robins AFB is estimated to represent a more than \$200 million investment and will help to enable the base to meet critical energy security and energy resiliency goals.

Georgia Power expects to conduct planning, engineering and design for the project, as well as a competitive bid process to select a construction contractor, throughout 2017 and 2018. Construction of the facility is expected to begin no earlier than 2018 and the project is expected to enter commercial operation before the end of 2019. 



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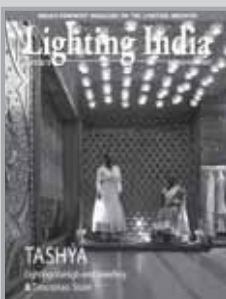
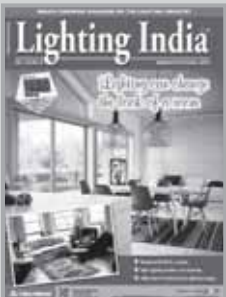
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## New Director (HR) takes charge at BEL

**R**N Bagdalkar has taken charge as the new Director -Human Resources (HR) at Navratna Defence PSU Bharat Electronics Ltd (BEL). He was working as Executive Director of BEL's Hyderabad Unit before the elevation.

Bagdalkar joined BEL-Bangalore in March 1984 after completing BE in Electronics and Communications from HKE Society's Engineering College (now known as PDA College of Engineering), Gulbarga, in May 1983. He was posted to BEL-EMD Hyderabad in May 1985 as part of the core team. He completed PG Diploma in Computer Systems in 1987 from the Institute of Public Enterprise, Hyderabad.

At Hyderabad Unit, he worked for 27 years, in D&E, Testing, System Integration and installation and Commissioning of Electronic Warfare (EW) systems. After working on various EW systems, he went on to



R N Bagdalkar

head the state-of-the-art Intelligence Electronic Warfare Project for the Indian Navy.

As Head of D&E at Hyderabad Unit, he led his team to successfully complete various projects for Navy, Army and Export. He also initiated a number of in-house technology development modules which will be basic building blocks for futuristic EW systems.

He has also built a strong software team; today, the complete software requirement of BEL-Hyderabad is met in-house.

He was elevated as General Manager (Technology Planning)/BEL-Corporate Office on July 1, 2012. He worked as General Manager (Technology Planning)/BEL-Corporate Office for a short period before taking over as General Manager, BEL-Hyderabad in November 2012. He was promoted as Executive Director on August 11, 2016.

## MYSUN names Ashit Maru as one of its founding members

**M**YSUN, the innovative rooftop solar solutions provider, has appointed Ashit Maru as one of its founding members. A Chartered Accountant by profession, Ashit brings with him over 25 years of rich and diverse experience across sectors such as FMCG, Renewable Energy and Food Services & Facilities management, working with companies such as Hindustan Unilever, Moser Baer Solar, Lanco Solar and Compass India.

On the Solar side, armed with entrepreneurial acumen, Ashit played an instrumental role in setting up the supply chain for Moser Baer's solar manufacturing business and



Ashit Maru

subsequently worked with Lanco Solar in the EPC domain.

At MYSUN, he would be focusing on operations, supply chain, vendor and partner development apart from leading some business diversifications.

Prior to joining MYSUN, he was with Compass Group India, managing procurement and supply chain for more than 80 client locations in food service and 250 client location in facilities management business. Before that, he was with Lanco Solar as the Senior Vice President, Supply Chain and Vice President, Procurement at Moser Baer Photovoltaic Limited.

## Siemens Gamesa names Markus Tacke as new CEO

**T**he Board of Directors of Siemens Gamesa Renewable Energy, at a meeting held recently, unanimously appointed Markus Tacke as the company's new Chief Executive Officer (CEO), following the recommendation of the Appointments and Remunerations Committee. The appointment takes effect immediately.

Markus Tacke has more than 20 years of experience in the energy and power generation sectors, and has held a number of senior executive positions in the industry. Before the merger, Markus Tacke served for four years as CEO of Siemens Wind Power. Under Tacke's leadership, the company's Offshore business grew into the dominant global market leader. He



Markus Tacke

helped transform Siemens Wind Power into a highly profitable and forward-looking global enterprise, leading the company's expansion into new markets including Latin America and North Africa.

Tacke also oversaw the expansion and modernisation of the company's production facilities, and led a number of company-wide initiatives to enhance efficiency and productivity. From 2014 to 2016 he served as Chairman of the European Wind Energy Association (EWEA)/Wind Europe, the industry association for Europe's wind power businesses. He holds a PhD in Mechanical Engineering from Darmstadt University (Germany), and a Master's Degree in Combustion and Fluid Dynamics from Cornell University (New York, USA).

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## Schneider Electric India bags the prestigious Aon Best Employers India 2017 award

**S**chneider Electric India – a well known specialist in energy management and automation was conferred Aon Best Employers Award for the year 2017. Aon Hewitt, is the global leaders in human resource solutions. The award comes as a recognition of the futuristic and impactful people practices of the company which have been instrumental in inspiring strong commitment, deeper engagement and superior performance from the workforce. The award was received by Anil Chaudhry, Country President and Managing Director, Schneider Electric India along with Rachna Mukherjee, CHRO, Schneider Electric India, at an award ceremony in Mumbai.

The recognition comes to Schneider Electric after a robust six-month long evaluation process. It is an outcome of a rigorous analysis to measure the alignment between 'Intent-Design-Experience',



Team Schneider Electric India receiving the award

people initiatives on talent, succession, well-being and diversity & inclusion that Schneider Electric has been undertaking over the years. The final analysis of the shortlisted organisations was conducted by an external panel of jury made up of corporates, academicians and industry leaders.

Anil Chaudhry, Country President and Managing Director, Schneider Electric, India, said, "I express my gratitude to all the employees on their engagement, commitment and hard work to make Schneider Electric a great company and a great place to work." E

## Gyanesh Chaudhary received commendations as the Emerging Leader

**G**yanesh Chaudhary, MD & CEO of Vikram Solar, was awarded with the title of 'Emerging Leader' by esteemed Calcutta Management Association (CMA).

Being an affiliate of All India Management Association (AIMA), which is the national apex body of the management profession in the country, CMA has always focused its efforts to create new platforms to encourage and recognise unique, innovative, and successful management practices that have instilled inspiration in others.

CMA Management Excellence Awards 2017, which honoured Gyanesh Chaudhary as the emerging leader, has been carefully



identifying exceptional practices in management since 2015. And being a promoter of ethical, smart, and innovative management choices, Gyanesh Chaudhary has made the perfect candidate for this year's recognition event.

Gyanesh Chaudhary said, "Inspiring the organisation through transparency, effective decision making, and communication has always been a leader's duty for me all along. And in pursuit of growth and recognition for the company and my talented team, I have always followed those ideals. And now, in this proud moment, I believe my win is actually a win for all the members of my team, the close knitted Vikram family". E

## Burns & McDonnell retains No. 1 Power Ranking on ENR 2017 List

**B**urns & McDonnell is a company made up of more than 5,700 engineers, architects, construction professionals, scientists, consultants and entrepreneurs with offices across the country and throughout the world. A continued surge of electric transmission and distribution projects to improve reliability and resiliency of the power grid has helped Burns & McDonnell stay as the No. 1 ranked firm in the Power category on the widely watched Engineering News-Record (ENR) Top 500 Design Firms rankings. Burns & McDonnell ranked No. 16 overall among the Top 500 firms on design revenue of \$1.3 billion.



Burns & McDonnell Chairman and CEO Ray Kowalik, said, "Burns & McDonnell has always been a broadly diversified firm but our power business has seen tremendous growth and momentum for several consecutive years. As projects in the power industry have grown larger and more complex, clients often need a program management specialist like Burns & McDonnell

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# Large Scale Energy Storage Future



R. P. Deshpande  
Fellow,

The Institution of Engineers  
(India)

Thermal energy generators are expected to be phased out and not replaced as they age out. However, the biggest issue to be resolved will be the erratic generation from renewable sources, which is not controllable on demand. Solar plants operate only when sun is shining, while wind mills operate only in windy conditions. Renewable energy will have to necessarily depend on devices and facilities which can store the energy when available and dispense to loads as per demand.



Energy storage is thus a basic requirement for deep penetration of renewable energy. Even at today's status, problems of energy management (both generation pattern and peak load) need serious attention. With installed capacity of 14%, total contribution from renewable energy generation in India is limited to just 5.6%. India's renewable energy target of 175 GW by 2022 target is not uniform state wise, but depends on local factors. This involves transmission of power over long distances. Issues needing consideration relate to storage, dispatch and distribution, peak loads and transient loads in order to target total dependence on renewable energy. With a mix of thermal, hydro, nuclear and renewable sources, load distribution and dispatching are not easy to manage.

Downward costs of PV and wind energy, and rising electricity prices are also contributing to

spread of renewable energy. Governments all over the world are encouraging these developments by way of incentives. Solar and wind power mix on an extended electricity grid has to match total demand and intermediate electricity storage throughout the year.

Today applications for energy storage include load following, renewable energy grid integration, and renewable energy time shifting. In future, time of use energy cost for commercial and industrial segments and conventional energy time shifting will also be part of management. Pike Research forecasts worldwide revenue growth for stationary energy storage systems for the electricity grid a strong pace, increasing from \$1.5 billion in 2010 to \$35.3 billion annually by 2020.

Traditional options for long duration energy storage include pumped hydroelectric storage, compressed air energy storage (CAES), and

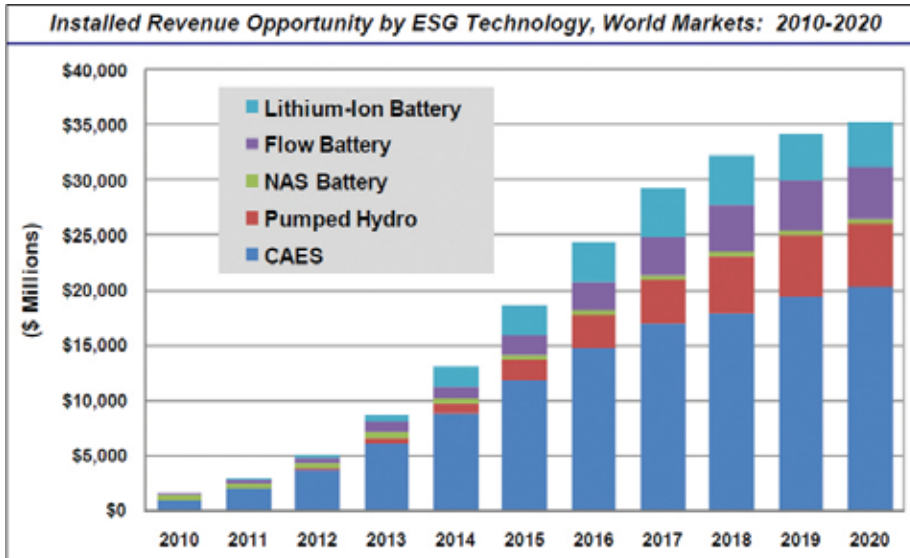


Figure 1: Trends in world energy markets 2010- 2020 (Source: Pike Research)

sodium sulfur (NAS) batteries. Other energy storage technologies are lithium ion batteries (energy density of 100-400 KWH/Kg), flow batteries, hydrogen generation and storage, and hydrogen based batteries like Ni-MH and Ni-Fe batteries with very long lifetimes. Ammonia based energy storage having energy density of 6.5 KW/Kg is also getting attention. Pike Research forecasts the most significant growth opportunities for CAES, Li-ion batteries, and flow batteries, although there are other prevalent technologies as well.

### A] Battery storage

Batteries convert electricity into chemical energy for storage and back into electrical energy, and perform different functions at various points along the electric grid. At solar PV or wind turbine sites, batteries can smooth out the variations in supply, store excess energy when demand is lean and release it when demand is high. Batteries can store energy when it exceeds a local substation's capacity and release the power when the flow is less; or store energy when prices are low, so it can be sold back

to the grid when prices rise. For households, batteries can store energy for use anytime and provide back-up power in case of blackouts.

Cost of battery energy storage (a major concern) is going down. Growing EV markets, benefitting from incentives and large scale manufacturing, are helping to bring down battery costs. For a reliable and steady supply and demand balancing, utilities today handle fluctuations in solar and wind power by adjusting their operations. As the amount of renewable energy grows, better battery storage is crucial. Batteries performance and safety issues limit their full integration in grid systems, along with regulatory barriers and costs, while researchers around the world are working towards better and cheaper batteries.

World over today major dependence is on battery storage- both lithium ion and lead acid types. However, presently there are practical limitations to their storage capacity. There have been persistent efforts to increase storage of battery systems, and the largest system installed today is 40MW.

World's largest battery storage system record is held by the State Grid Corporation of China with a 36MWh battery (less than 1/10 the size). This will be surpassed by 400MWH Li- ion battery-based energy storage facility near completion in South California capable of



Figure 2: 32 MW 8 MWH Li-ion Battery System by AES at Laurel Mountain, W. Virginia, as energy storage for 110 MW wind farm to maintain frequency. (Source: AES)

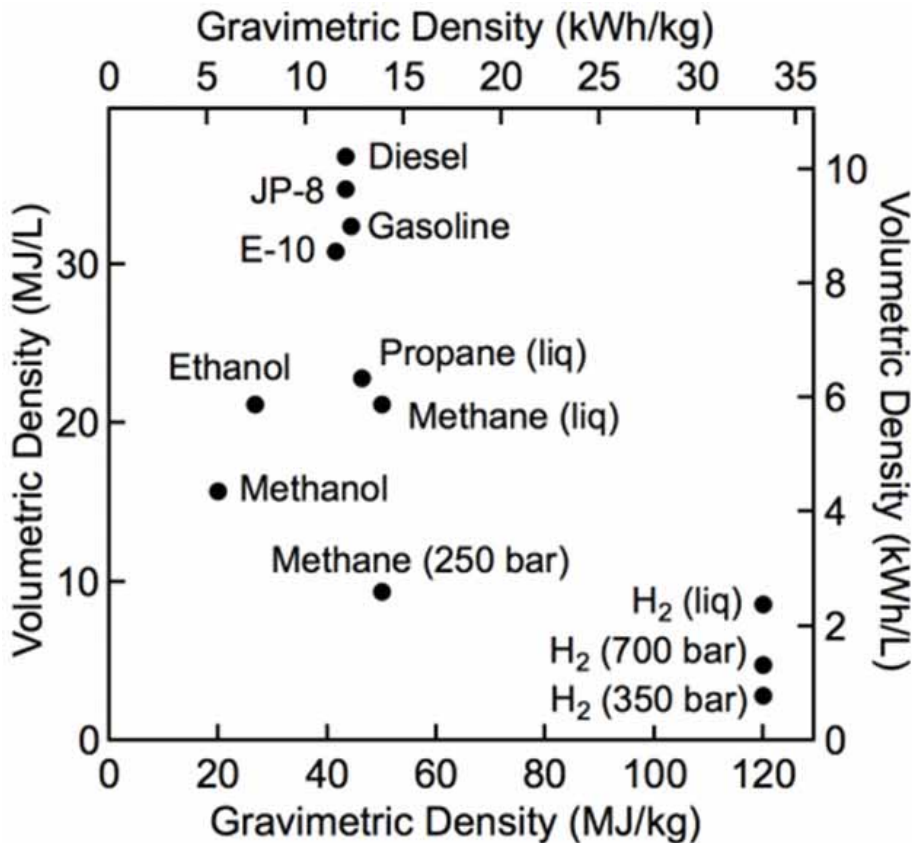


Fig. 3- Comparison of volumetric and gravimetric energy density for several fuels (Source: U. S. Department of Energy: energy.gov)

providing 100MW of power for up to four hours. Even this system is not enough for a large size distribution grid, but is sufficient to buffer conventional supplies at peak load and reduce operating costs.

International Renewable Energy Agency projects that by 2030, solar PV capacity will be grown nine times its size in 2013, while wind power could go five-fold. On the vehicle front, BEVs have range generally not exceeding 150 km, though one model of Tesla has a range of 240 miles (400 km). EV sales have increased 128% since 2012 and plug-in market is expected to grow at about 16% p.a. till 2024.

Tesla has embarked on one of the largest Lithium battery manufacturing units in order to bring down costs for their vehicles, as also to meet grid storage demand. Conventionally, battery storage cost lies anywhere between \$300-\$500/KWH. Tesla is aiming at \$100 per KWH at this Gigafactory in near future from its current price of \$150-\$200 / KWH with some design change and also due to bulk manufacture. Another company Bio Solar is working on a

breakthrough technology to bring it down substantially to a level target level of \$54/KWH. Battery costs are fast heading downwards- a healthy sign for energy storage.

Li-ion batteries start degrading typically after around 1,000 charge / discharge cycles. So, long term cost of ownership per KWH produced may be found by spreading the cost of battery over 1,000 cycles. Considering the efficiency of the battery, (Li-ion is around 90% efficient), this may be increased by 11% to get effective cost. Long term Levelized Cost of Energy (LCOE) of battery can be estimated as follows:

- \$300 / KWH battery: 33 cent / KWH electricity storage
- \$200 / KWH battery: 22 cent / KWH electricity storage
- \$150 / KWH battery: 17 cent / KWH electricity storage
- \$100 / KWH battery: 11 cent / KWH electricity storage

If carbon-free energy is to be cheaper than coal or natural gas, batteries should be extremely cheap in terms of cost per KWH produced. Battery

system costs are naturally the final purchase costs, including installation and maintenance. Wholesale grid electricity in the US at base load hours in night averages 6-7 cents / KWH, while retail rates average around 12 cents per KWH.

Battery storage can probably solve some issues faced by the penetration of solar and wind technology in the short term. Other technologies are emerging as potential long-term solutions, and proponents of these contend that they will be cost-competitive.

## B] Compressed Air Energy Storage

Compressed air energy storage, also known as CAES, is ideal for utility from 10 MW to 100 MW. It requires underground storage in natural or man-made caverns, and can work for storing wind or solar energy outputs. Adiabatic compressed air energy storage (CAES) uses tanks and compressors that are capable of 30 years or more of continuous use (over 10,000 cycles) with complete discharge capability (compared with 70% discharge for in Li-ion). Further, CAES can be used to store energy from a few weeks to years.

General Compression, New Zealand, is working on a model that will provide around 20-40 MWH of storage for each MW of peak power production. For a 100 MW wind project, the ideal would be a facility between 200 MWH and 400 MWH of storage. The company expects CAES would be able to deliver this at one fourth the price of battery technologies.

## C] Pumped Hydro

Pumped hydro conventionally supports coal and nuclear energy to meet short-term changes in demand. The system can also be used to absorb and manage changes in supply from renewable sources. Benefits include stabilizing and reducing wholesale electricity prices, increasing the spread of renewable energy and improving grid operations. A new approach locates pumped hydro storage away from natural watercourses using natural contours to situate two reservoirs at different elevations that could be used to store energy, thus obviating the need to curtail output from wind farms.

Pumped hydro storage is efficient, flexible, economical and commercially available on a vast scale and is the only large-scale storage technology currently available to the utility



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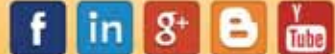
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industry. Competing storage techniques such as compressed air, high-temperature thermal storage in conjunction with concentrating solar thermal and advanced batteries are considerably costlier or less developed. There are only around 200 large pumped hydro systems in the world with a total capacity of around 130 GW.

## D] Flow Batteries

Flow batteries, a newcomer in the market, can theoretically operate for over 5,000 to 10,000 cycles or more. This technology, akin to both a fuel cell and a battery, uses liquid electrolytes to create electricity. The liquid that can be replaced fast and economically, and the spent liquid so removed can be recovered outside. It may also be recharged electrically. Fundamental difference between conventional batteries and flow cells is that energy is stored at the electrode material in conventional batteries but in the electrolyte in flow cells.

In redox flow batteries (RFB), "redox" refers to chemical reduction and oxidation reactions to store energy in liquid electrolyte solutions circulating in electrochemical cells during charge and discharge. Separation of power and energy is a key feature of RFB's. Energy is stored in the volume of electrolyte, which can range from a few KWH to tens of KWH, depending on the size of the storage tanks. Power capability is determined by the size of the stack of electrochemical cells in reaction chamber. Energy rating corresponds to discharge at rated power for two to eight hours. Flow can easily be stopped during fault conditions. This limits system vulnerability to uncontrolled energy release to a few percent of the total energy stored. This scores over integrated cell storage batteries (lead-acid, NAS, Li Ion), where full stored energy is always available for discharge in case of fault. The storage tanks can be located away from reaction chamber, and tanks can be huge to match required total energy storage. This permits considerable flexibility in design depending upon available space and geometry.

Redox flow electrolytes being very cheap (0.1\$/kg for aqueous types) can be a serious competitor of gasoline. Further, flow batteries are known for longevity, with companies already offering 20 years warranty. Nanoflowcell has been exhibiting a sports car using their flow



Figure 4: Bombardier's EnerGstor wayside energy storage system uses ultracapacitors to store 2KWH energy

batteries. Pure electric cars using the 48V batteries are said to have a range of 1,000 miles.

New York is planning a storage capacity of 100 MWH by 2020 along with an expanded solar target of 1,000 megawatts by 2030. Energy storage, with its capacity to integrate variable wind and solar power sources into the grid, is expected to play a critical role in meeting the city's plans by 2050. The planning includes a 400 KWH Vanadium redox flow battery system in Manhattan.

Today, the most advanced flow batteries are vanadium redox batteries (VRBs), which store charges in electrolytes that contain vanadium ions dissolved in a water-based solution. Vanadium's advantage is that its ions are stable and can be cycled through the battery over and over without undergoing unwanted side reactions. Since VRBs have a relatively low energy density, the external tanks have to be quite large to hold enough power. Other flow battery types include Iron- Chromium flow batteries and Zinc-Bromine flow batteries.

## E] Molten Salt Energy Storage

Molten salt is among the most flexible, efficient and cost-effective form of large scale

energy storage system deployed today. Molten salt energy storage, a mixture of 60% sodium nitrate and 40% potassium nitrate (which is the most commonly used salt), stores energy at over 55 °C in a hot molten salt storage tank until electricity is needed – day or night, during off-peak/normal hours or peak hours. When electricity is needed, the hot salt is pumped to a conventional steam generator to produce superheated steam for a turbine/generator as used in any conventional coal, oil or nuclear power plant. Typically, a 100 MW turbine would need a tank of about 9.1 meters tall and 24 meters in diameter to drive it for four hours.

Storage of energy in molten salt increases the reliability of solar systems, allows the plants to operate 24x7 providing base load power for both on-grid and off-grid applications, increasing the net annual output from a solar energy plant. It helps to avoid expensive fuel costs and provides cleaner power generation. Global molten salt energy storage capacity was about 1,290 MW in 2014 and is expected to reach 3,841.0 MW by 2018.

Molten salt storage enables solar thermal power plants to generate electricity when it is needed, as in conventional systems. Plants with such energy storage can operate 24x7 for both on-grid and off-grid applications. Molten salt



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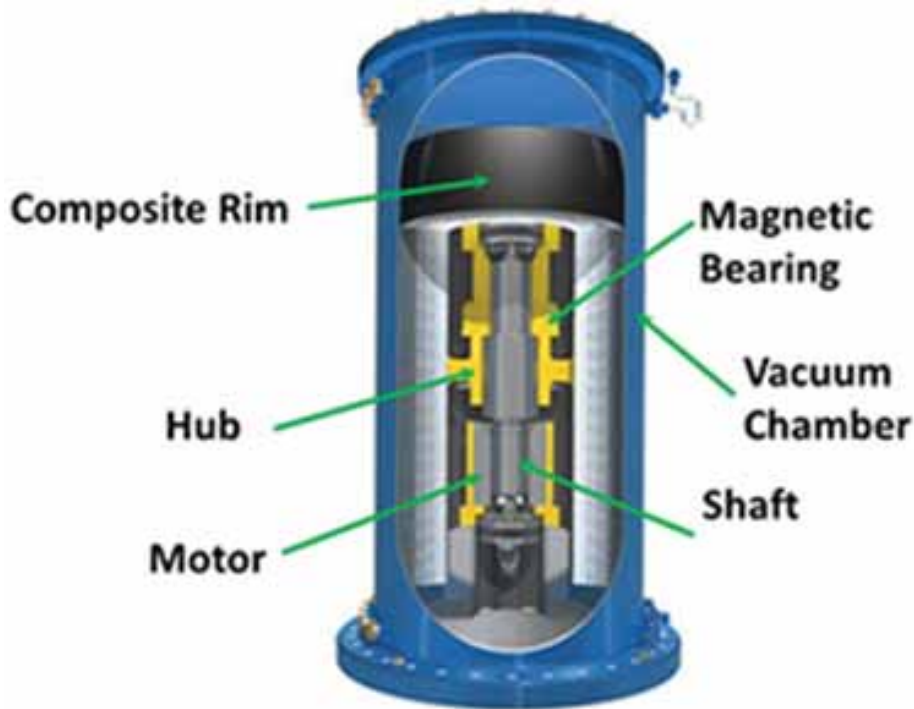


Figure 5: Flywheel construction (Source: Beacon Power, LLC)

thermal energy storage is the lowest capital cost energy storage system. It can prove as one of the most cost-effective solution for CSP thermal power generation.

## FJ Hydrogen Storage

Hydrogen is the most versatile material for storage. It can be produced and stored in both small and large scale. Small amounts of hydrogen (up to few MWH) can be stored in pressurized vessels at 100-300 bars or in liquefied state at low temperatures. Large quantities can be stored in underground caverns up to 50,000 cubic meters at 200 bars enough to produce 100 GWH of electrical energy.

As per Fraunhofer Institute for Solar Energy Systems in Freiburg, Germany, hydrogen and methane are the only options for large scale storage. According to them, pumped hydro and battery can at best provide storage capacity up to 50 GWH, but a tremendous amount of long-term storage up to 70 terawatt-hours can only be done with hydrogen and methane. They plan to use caverns to store hydrogen, which can be used for vehicles or in fuel cells. Alternatively, it can be converted into methane.

Electrical energy can be converted to hydrogen by electrolysis. Stored hydrogen can be

converted back to electricity by using various alternatives. Round trip efficiency today is as low as 30- 40%, and may increase to 50% if more efficient technologies are developed. Still, interest in hydrogen storage is growing due to much higher storage capacity at 120 MJ/Kg compared with 44 MJ/Kg for gasoline.

Reconversion to electrical energy can be done via fuel cells with efficiency of 50% or by burning in power plants at still higher efficiency of 60%. Hydrogen can additionally be used as feedstock for chemical or petroleum industry or in fuel cell vehicles.

While hydrogen storage is amenable to large scale grid systems, its use in fuel cell vehicles is a challenge to extend the range to over 450 km (comparable to gasoline vehicles). Though fuel cell vehicles of large size or luxury market have been developed, the real issue is its development for small car segment. This stems from the fact that due its low density, hydrogen storage space requirement is 8 MJ/l as against 32 MJ/l for gasoline.

Latest news from Delft University of Technology, Netherlands has come up with a new device called 'battolyser'. This integrated battery electrolysis system can not only store or supply electricity efficiently as a battery, but can also

electrolyze water into hydrogen and oxygen. The device is based on Ni-iron battery technology, whereby storage as well as hydrogen production are both efficient. It can store and supply electricity efficiently as a battery, and when the battery is fully charged, it automatically starts splitting water into hydrogen and oxygen. Combining the two technologies, efficiency as high as 90% is expected to be achieved, and it could be a new milestone in energy storage costs. The researchers hope to scale up their model for grid level storage in near future.

## Short time storage requirements:

The technologies above are gearing up for large scale energy storage needed for grid level and automobiles. In practice, transient loads at grid level cannot be met fast enough by batteries, and in automobiles there are problems leading to deep discharging of batteries. In both cases, battery life is adversely affected. In industry and grid supplies, if the transients are not met in the small time limits, it can lead to frequency and voltage fluctuations, and even the entire grid may collapse in extreme case. This battery limitation comes in because of the process of converting chemical energy into electricity and consequent time lag. Other modes of storage are also not capable to adjust within a few seconds or minutes.

Two technologies developed in recent years, viz ultracapacitors and high speed flywheel storage can take care of such transient and short time requirements. Both have very fast response time and can efficiently fill up this short time need ranging from a few milliseconds to a few minutes. While ultracapacitors have been more common, flywheel storage is making entry in grid or industrial applications.

Use of these systems can take care of small time requirements in case of power breakdown, when enough time is made available for an orderly shutdown of load, or to switch over to an alternative supply source like a DG set. They can smoothen out supply variations in solar or wind energy sources on account of inevitable natural factors like passing clouds, change in wind speeds etc. At the same time, they help absorb excess power fast and deliver it back equally fast whenever required.

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## G] Ultracapacitors (also called Supercapacitors)

Advent of ultracapacitors in recent years has enabled very high energy storage, comparable to battery storage (though most of these today store much less energy than battery). Energy is stored in ultracapacitors as electrical energy and is given off as such, without any time gap or energy conversion. As a result, the power an ultracapacitor system can discharge is several times that of battery, and the millisecond response takes care of all transients seen by grid systems or automobiles. Further, the round trip charge / discharge efficiency of the system is over 95-98% (lead acid battery efficiency is 65-70%).

Ultracapacitors can withstand tens of thousands or millions of charge/discharge cycles without losing their energy storage capacity. They outlast the lifetime of equipment or vehicles in which they are used. Ultracapacitors bridge the energy gap between traditional capacitors with high power output, and batteries with high energy storage capacity. When paired with battery, they extend battery life several folds by taking over all jerky loads.

Ultracapacitors perform various functions in automobiles like vehicle starting, jump start and cold start, power steering, window operation, regenerative braking and so on. Railways are benefiting by using them for recovery of kinetic energy from decelerating train and reusing the same for accelerating units. Huge energy saving up to 25% or more is being achieved by metros in Korea and elsewhere using ultracapacitor based trackside storage systems. Further, ultracapacitors act alongside batteries or standalone storage to take care of transients on grid supply systems. Inverters use them in place of batteries for fast and reliable response in case of power failure to allow industries an orderly shutdown or a switchover to another supply source, which is particularly important in continuous process industries.

Buses are running on ultracapacitors in China since 2014, and now in some European countries and the US. These are periodically charged en route at stops under 30 seconds. Even trams powered solely by ultracapacitors are now running in China. Trams in Europe use ultracapacitors for short distances or for tiding

over gaps without overhead catenaries. Ultracapacitors have been used by themselves or in hybrid vehicles for public transport, either along with IC engines or with batteries in many countries.

New developments in ultracapacitors are driving their energy density and/ or power density upwards with the additional benefits of minimum maintenance and durability. Ultracapacitors have made substantial inroads into motor-racing. The Toyota TS030 Hybrid uses a hybrid drive train with ultracapacitors (no battery) and IC engine and won three of the 8 races in the 2012 FIA World Endurance Championship season. Gasoline based hybrid cars are using ultracapacitors to get improved performance and efficiency.

Electric and hybrid electric vehicles using ultracapacitor/battery combinations are well known by now, and a reduction in fuel consumption ranging 20 to 60 % has been claimed by recovering brake energy. The short charging time, stable electrical properties, broad temperature range and longer lifetimes are obvious advantages. There is good scope for improvement in increasing energy and power density, and reducing weight, volume and cost.

## H] Flywheel Energy Storage

Flywheel energy storage systems (FESS) employ kinetic energy stored in a rotating mass with very low frictional losses. Electric energy input accelerates a flywheel to very high speeds of tens of thousands of RPM via an integrated

motor-generator. Energy is discharged by drawing kinetic energy using the same motor-generator. These modern flywheels are way different from conventional flywheels made of iron mass, rotating at not over 8000 rpm.

Advanced FESS offer unmatched energy density, high efficiency with miniscule losses, and are best suited for periods from few minutes to several hours. These high speed flywheels specially developed for high energy storage (FESS) rotate at speeds of 10,000 to 100,000 RPM. Special materials are needed to withstand tremendous centrifugal forces and stresses at these speeds, and tensile strength is more important than density of material. Main features include a high speed flywheel made of fiber glass resins or polymer materials with a high strength-to-weight ratio, operating in vacuum to eliminate aerodynamic drag. The flywheel spins is supported on frictionless magnetic bearings, and the whole assembly is enclosed inside a high vacuum chamber. Peripheral speeds are over 1000 m/s, and usual engineering materials are not capable of sustaining the resultant stresses.

Excess electric energy from supply via motor-generator accelerates flywheel to high speed and energy gets stored in it. When energy is drawn, the motor-generator reverses in direction. Flywheels are used in inverters and grid systems for large energy storage, with very fast charge / discharge times, not possible by any other storage source (except ultracapacitors). Energy density is as high as 100-130WH/Kg four times or more compared to lead acid battery. Even the

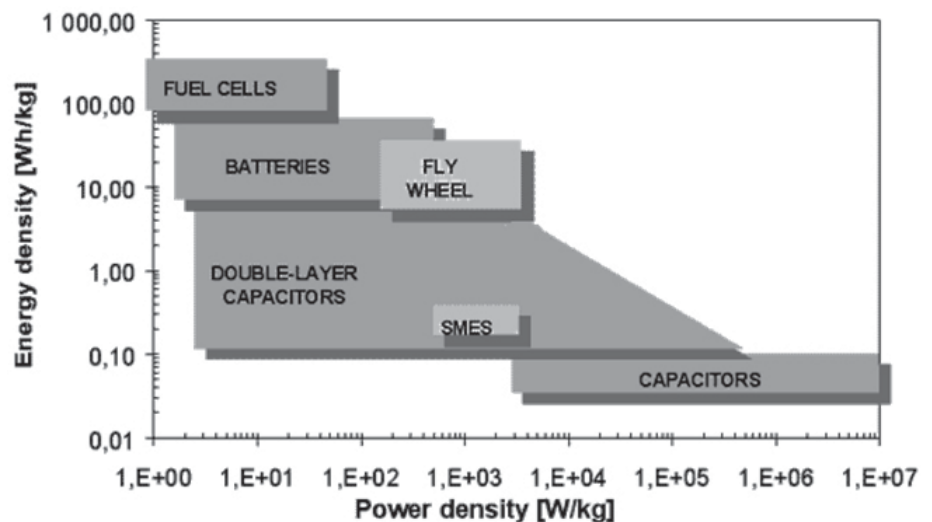


Figure 6: Comparison of Flywheel Vs. Battery (Source: Electropaedia)

volume energy density is much higher than lead acid battery. Rapid charging of a system occurs in less than 15 minutes. Round-trip efficiency can be as high as 90% or more, and capacities range from 3 KWH to 130KWH. Battery of flywheels can be used to scale up storage capacity.

Flywheels from Beacon Power spin up to 16 000 rpm, with a maximum storage capacity of 25 kWh that can be delivered back to the grid at maximum power rate of 100 kW (over 15 minutes). Number of these flywheels combine in a system to get desired storage capacity. Such flywheel farm is deployed primarily as an electricity frequency stabilizer, and to store cheap electricity available in the grid during the night.

Advanced flywheels are used for protecting against interruptions to national electricity grid. They provide power during period between any loss of utility power and its return, or the start of a back-up power system (e.g. a DG set). Flywheels


can discharge at 100 kW for 15 seconds and recharge immediately at similar speeds, providing 1-30 seconds of ride-through time. Back-up generators are typically online within 5-20 seconds.

A flywheel storage plant for grid power storage with a capacity of 5MWh, providing a power output of 20 MW for over 15 minutes has been installed at a Beacon Power plant in New York and other large installations are in the pipeline. Such installations on smaller scale can take care of industry needs. Already several manufacturers around the world are supplying flywheel systems.

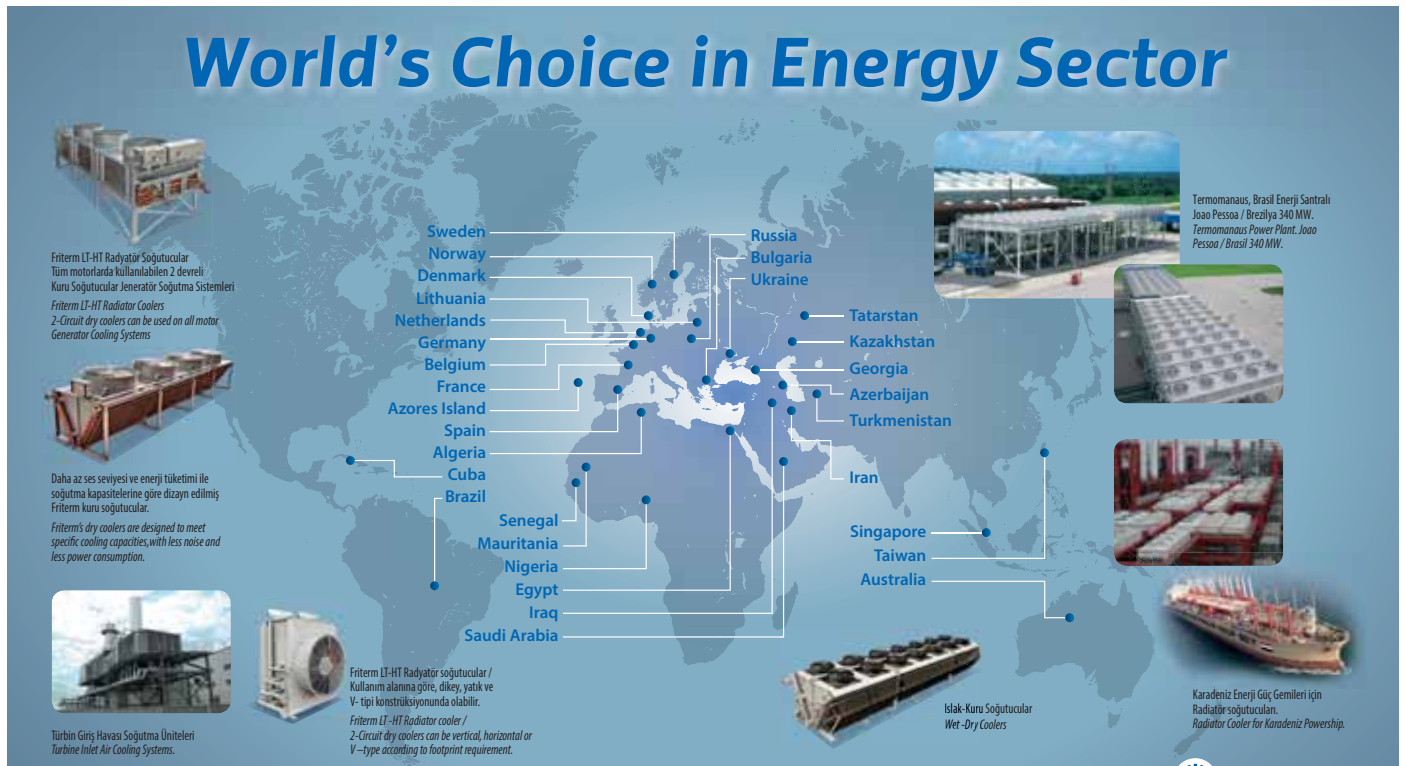
Volvo envisions hybrid vehicles with FESS systems to produce huge power for a few seconds to get a car to speed up, or accelerate fast when needed. They replace the battery pack and electric motor in hybrid vehicles. An experimental system on a turbocharged four-cylinder Volvo

S60 accelerates to 100 km/h in 5.5 seconds. Kinetic energy recovery system (KERS) adds up to 80 HP, with 25% better fuel economy than conventional system with two more cylinders. Volvo flywheel is a carbon fiber disc about 20 cm in diameter, weighing 6 kg, housed in vacuum.

### Conclusion

It is seen that a number of energy storage technologies – both existing and new developments will be available and at hand in sufficient measure worldwide in very near future. These will serve changing needs of electronic and auto industry, both short term and long term altering energy storage needs in supply grids, as well as renewable energies. With developments going on in renewable energies and energy storage (and both becoming economical), the world should be substantially free of dependence on fossil fuels in near future. 

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# Role of Smart Meters in Smart Grid



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The goal this article is to provide the knowledge on the role smart meter technology in the smart grid. The commissioning of smart grid pilot projects for research and supporting them by Government of India shows the interest of future development. Smart meter definitely has a great role in smart grid and is considered as most important for future energy management...

The Government of India's initiatives like 'Make in India' and 'Smart Cities' need the efficient, reliable and continuous power supply. India's power sector in the present day is facing a lot of problems like AT & C losses, inefficient distribution and transmission system because of age old infrastructure and power theft. The advanced energy management and increased use of renewable energy resources are the foremost areas to concentrate by governments for the development of country. The government cannot take initiatives for complete change of electrical equipment across the country but there is a need for changing the way of operation and control of the electrical equipment. For this Ministry of Power has initiated ISGF (Indian Smart Grid Forum) which works very closely with public, private and research organizations for developing standards and policies so as to deploy the 'Smart Grid' to assure efficient and cost effective power for all stakeholders. The smart meter is very important constituent for smart grid and is expected to provide cost-effective, social and ecological advantages for various stakeholders. The most significant key factors that determines the success of the smart meters is data analysis that deals with data acquisition, communication, processing and elucidation that benefits to consumer, utility company and government.

The idea of smart grid increases the efficiency of power usage by the introduction of bi-directional flow of information from utilities to consumer and vice-versa. This can be possible by the introduction of 'Advanced Metering

Infrastructure (AMI)'. The information about electrical consumption of a consumer is recorded in a timely manner and this data is aggregated and analyzed by 'smart meter' installed at consumer premises. The analyzed data is communicated to utilities using AMI. The AMI includes the advanced communication system including home area networks (HAN), neighborhood area networks (NAN) and wide area networks (WAN). Thus, AMI not only communicates the smart meter data to utilities but also transmits information to consumer from utilities about the peak demand, cost of energy consumption enabling the consumer to shift peak loads to some other time. Smart grid using smart metering and AMI technologies establishes the wide area monitoring, protection and control.

## Traditional Electricity Meters

In India, mostly electricity utilization of a consumer is recorded by traditional electromechanical meter or an electronic meter (with digital display). The bills are generated by utility personnel just by recording usage for a specific period of time (monthly or bimonthly). This traditional process has no relation with advanced monitoring or control. In general, the traditional meter has following architecture as shown in the figure1.

## Smart Meters

The smart meter is future for power industry and serves as an interface between consumer and the utility company. The smart meter records the power usage of consumer and communicates



Figure1: Traditional Electromechanical Meter Architecture

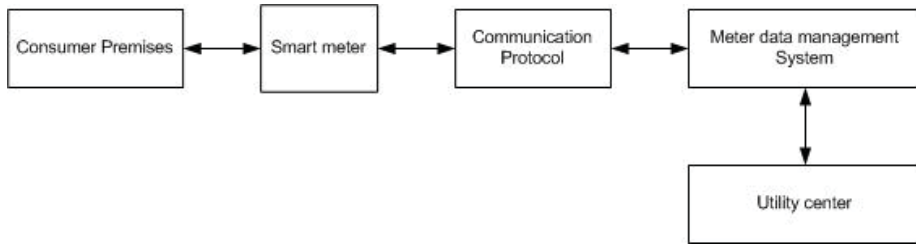


Figure 2: Smart Meter Architecture

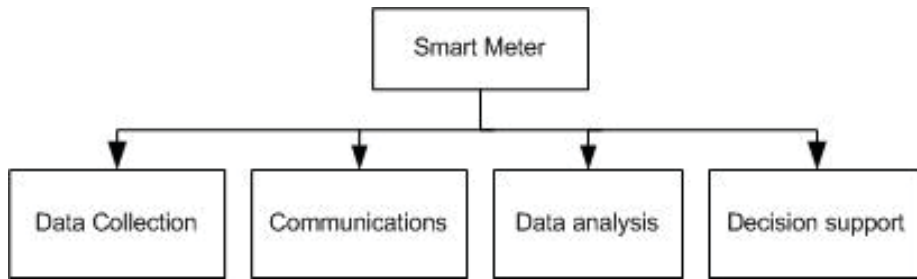


Figure 3: Important tasks carried by smart meter

this data in a timely manner to utility center. For smart meter, it is very essential to collect precise and appropriate data in a timely manner which includes gathering of data, its communication and storage. The smart meter allows the bi-directional flow of information, as shown in the figure 2, from consumer to utility and vice versa. The systematic analysis from the data acquired will lead to many prospective decisions by utility center that assures the efficiency and reliability of smart grid. This allows the utility center for better monitoring and control. The data communication in real time basis allows the utilities with advantages like real time pricing, outage detection, identification of power theft, avoids meter data tampering and provides better service. With the data received in timely manner utilities shall have a better opportunity to work better with increased stability.

Smart meters can definitely cut the domestic or commercial energy consumption by giving a lot of useful information to the consumer, but this information is useful only if consumer looks into it. Smart meter gives best home energy management solutions for smart homes using wireless technologies like (Zigbee or WiFi). Several sensor and actuators based appliances are commissioned in smart buildings to manage the connection of electrical load remotely based on the consumer choice or utility decisions envisaging the necessity of the smart meter.

### Smart Meter Functions and Advantages

The smart meter is expected to work in the following way. Data is collected from nodes, establishes the two-way communication, analyze the data and based on analysis it supports the controlling. The important tasks of smart meter is shown in figure 3. The data is collected from the individual appliances and is recorded at regular intervals of time. The data collected is stored in the memory and prioritization of the data is done for communicating to utility center. The command signals can be received from the utility center and the smart meter plans for load scheduling and controlling based on consumer choice. Automatic billing can also be done using smart meter. The figure 4 shows the important functions carried by smart meter.

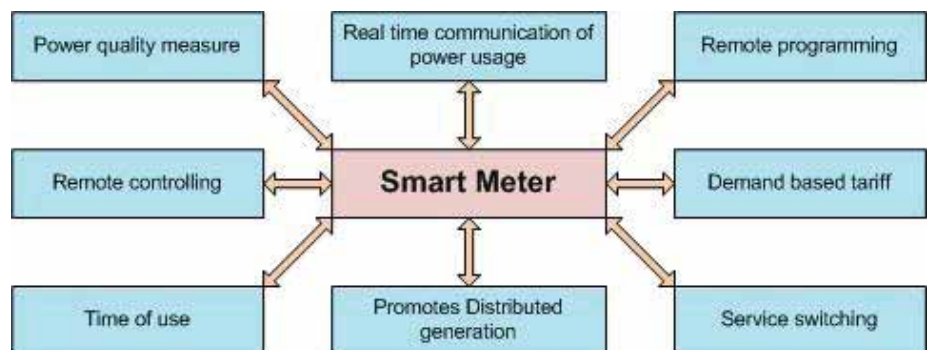


Figure 4: The important function carried by smart meter.

### Advantages of Smart Meters for Utilities

- With the advent of advanced monitoring technology the number of personnel required will be less.
- The increased ability for load management during peak load times.
- Makes more efficient use of grid resources.
- The system offers the latest tariff model for electricity market.

### Advantages of Smart Meters for Consumers

- Benefits the consumers in more accurate and timely electrical billing.
- Allows the consumer to schedule the electrical usage in the most optimal manner.
- Allows the user to think about the better plan for using the electrical equipment during the expensive hours.
- Allows the consumer to switch between conventional to renewable resources based on the tariff.

### Advantages of Smart Meters for Government

- The encouragement for smart meters will allow utilities to perform better in monitoring and controlling aspects of power systems.
- Encourages the renewable energy resources by consumers.
- An encouragement for environmental conditions with less CO<sub>2</sub> emissions.
- Prevents blackout by better monitoring and load forecasting for power grid.

### Smart Meter Technologies

Smart meter supports bidirectional flow of information. The smart meter is deployed at the end user premises to collect the information of



Figure 5: Smart meter used by EVB Energie AG in Germany

Similarly, utility center also can send some commands or signals or information to the smart meter at end user premises when required. The figure 5 shows a photo picture of Smart meter manufactured by EVB Energie AG in Germany.

The smart meter should communicate the data to utility center in a highly reliable and secured way. The system collects the data from local smart meters and communicates it to utilities using different wired and wireless technologies involving the HAN, NAN and WAN. The data communication in HAN is carried by using power line communication (PLC), radio frequency (RF), Zigbee, WiFi. The data communication in NAN involves, copper or optical fiber, WiFi, general packet radio service (GPRS) and WiMax. The data communication using WAN includes optical fibre, cellular, Satellite.

The smart meter system communication technologies at end user premises are PLC, RF, Zigbee and WiFi. These technologies are employed based on geographical conditions and business needs defined by utility center. Factors of selecting the technology include assessment of existing equipment, influence of new

technology to the existing appliances, functionality, should be economic to the end user and should be adaptable for long run based on present and future needs.

## PLC based Smart Meter Measurements:

The smart grid data communication challenges can be fulfilled by employing the PLC communication by using existing power lines i.e, by using simple electrical conductor lines converting them as hybrid power lines useful for transmission of electricity and bidirectional data communication.

The utility companies have adopted the following two types of PLC standards for smart metering networks. The data communication using narrowband (NB-PLC) using IEEE P1901.2 and ITU-G.9955/9956 can be used for low voltage (LV) electrical networks can be employed in large scale. Broadband-PLC (BB-PLC) defined by the coexistence standards ITU – T G.hn and IEEE-P1901 is actually an extension to HomePlug AV2 specification and is employable for medium voltage (MV) lines based data communication. The G3-PLC is developed for addressing the issues of rural or dense areas. G3-PLC uses OFDM

electrical usage from all the appliances at regular intervals using Local Area Network (LAN). The data from individual smart meter is collected by local data aggregators using NAN and then this information is passed to utility center using WAN.

Table 1. The features of wired technologies employed for smart metering systems

Wired	Data Rate	Frequency Bands	Distance	Advantages	Drawbacks	Deployments/Projects		
NB-PLC	up to 500 kbps	3–500 kHz	Several km	Medium already deployed devices do not depend on batteries.	Power cables are a harsh medium for communications.	<ul style="list-style-type: none"> <li>• Most rollouts in Europe and China Telegestore (IT)</li> <li>• Woodruff Electric Cooperative (USA) Pacific</li> <li>• Northwest Boulder SmartCityGrid (US) PRICE-GEN</li> <li>• (ES) Eandis and Infrac (BE) Linky (FR) Energy</li> </ul>		
BB-PLC	Up to several hundred of Mbps	1.8–250 MHz	Several km					
xDSL	ADSL	800 kbps upstream 8 Mbps downstream	From 25 KHz to 1MHz	Medium already deployed quite high data rates	High maintenance costs Efficiency decreases with distance	Demand Research Project, EDRP (UK) PRICE-GEN (ES) Eandis and Infrac (BE)		
	HDSL						2 Mbps	3.6 km
	VHDSL						15–100 Mbps	1.5 km
Euridis IEC 62056-31	9.6 kbps	80 MHz–1 GHz	Several meters	Low cost known technology	Low data rates	Wide rollout of SMs in France		
PON	155–2.5 Gbps	500 MHz	60 km	High data rates Noise immunity good performance over km	High cost	Boulder Smart City Grid (US) PRICE-GEN (ES) Austin (US)		





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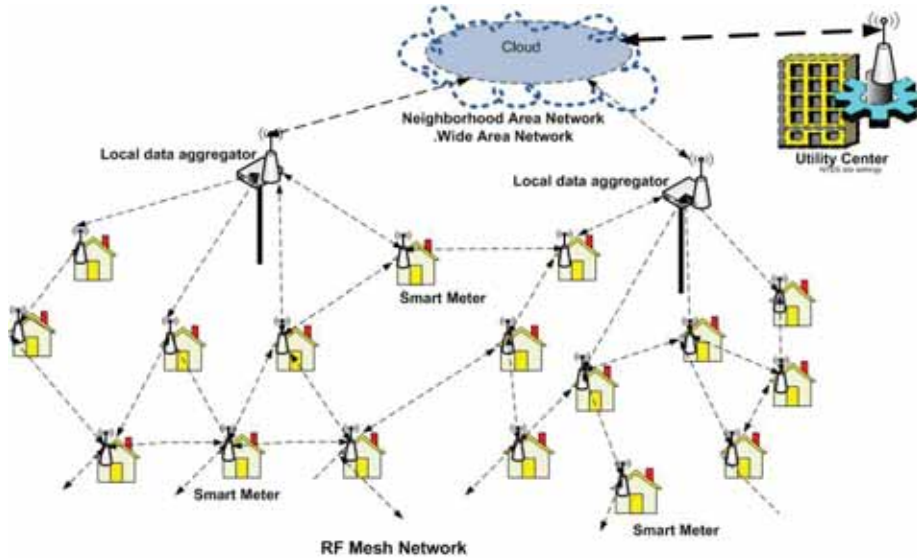


Figure 6: RF based Mesh network

technique in combination with OPSK and BPSK modulations and is adaptable for MV lines data communication. The table shows the technical specifications of NB-PLC, BB-PLC and G3- PLC.

The advantage of PLC include the employment of existing infrastructure like wires and poles make it cost effective for smart meter and AMI. With this PLC can communicate for long distances. The disadvantages include requires more latency (more data transmission time), less data rates and requires high installation cost in the urban areas. The table 1 shows the features of different wired technologies used for smart metering systems.

## RF based Smart Meter Measurements

The data is transmitted or received by a wireless radio from source (appliance or smart meter) to destination (Smart meter or local data aggregator) and vice-versa. This data processed and refined then sent to the utility center for different energy management operations and controlling. The smart meters uses RF operates at 915MHz frequency band.

## RF based Mesh Technology

The mesh network can be explained in two stages, firstly at home area the individual appliances uses wireless radio to communicate the data to smart meter. All the individual appliances in a home or building form a RF mesh based local area network(LAN) to communicate

the data in a timely manner to the local data aggregator (smart meter). Then the smart meters communicate to each other forming a mesh to reach the local data concentrator (distribution transformer) this is called as Neighborhood Area Networks (NAN). This data is processed and is communicated to utility center using Wide Area Networks (WAN). The figure 6 shows the pictorial representation of a RF based mesh network.

The advantages include the acceptable latency requirements and operate at required

bandwidth. There is need for research in standardizing this type of network for improving the topography issues and also to improve the long distance issues.

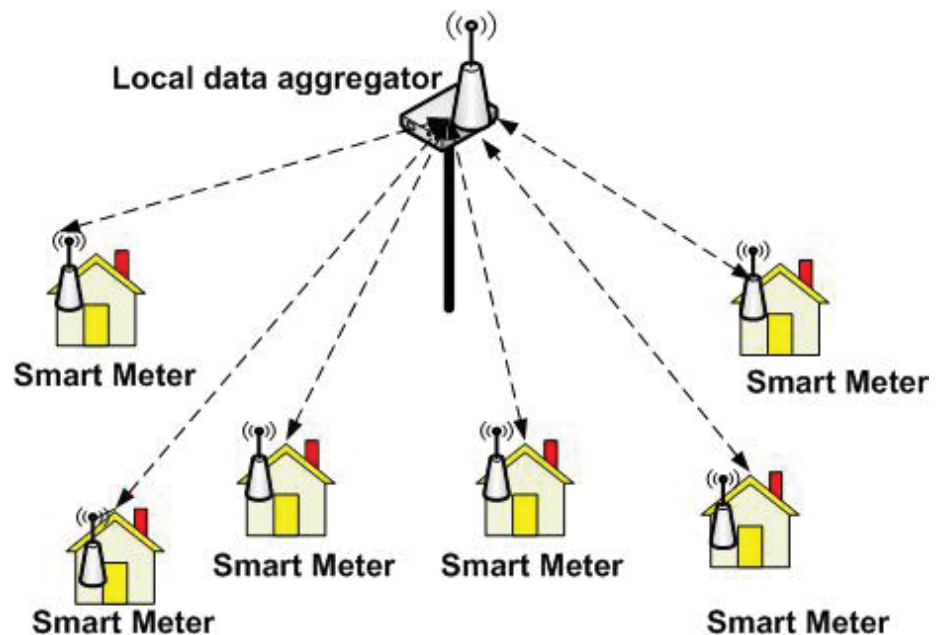
## RF based Point to point Technology

Every individual smart meter communicates directly to the local data collector (generally poles near home), the data collector communicates this data to utility center using various NAN and WAN technologies for processing the data. The figure 7 shows diagrammatical representation of RF based point to point network.

The advantages include very little latency, direct communication with two end points, good bandwidth, better throughput. The disadvantages include point to point RF are licensing, faces challenges like line of sight.

## IEEE 802.15.4:

In addition to the above RF communication the IEEE 802.15.4 based Zigbee is also used for smart metering communication. The amendments like IEEE 802.15.4g and IEEE 802.15.4e are based on the smart grid interoperability standards. This is more advantageous technology for AMI purpose is



RF Point to Point network

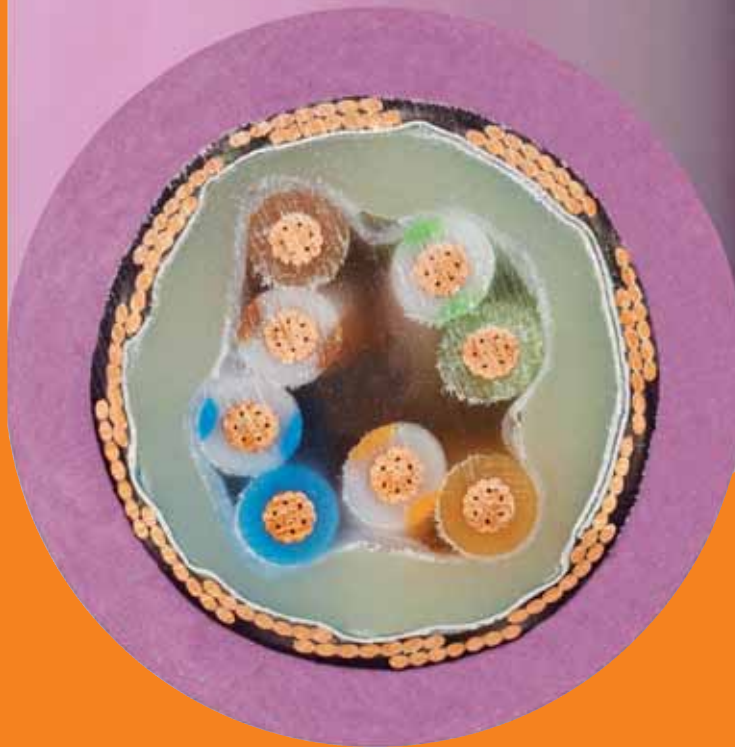
Figure 7: RF based point to point network

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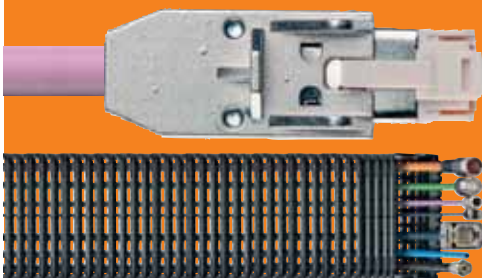
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**Table 2. The features of wireless technologies employed for smart metering systems**

Wireless		Data Rate	Frequency Bands	Distance	Advantages	Drawbacks	Deployments/Projects
RF		Up to 256 kbps	902-928MHz	Depends on hops	Coverage area can be increased	This is proprietary	Most of the Smart metering projects of USA.
IEEE 802.15.4	Zigbee	Up to 256Kbps	868MHz/ 915MHz/ 2.4GHz	10 to 1000 m	Low cost, Low power consumption	Low bit rates and Security issues	Energy Demand Research Project, EDRP (UK)
	6LoWPAN		2.4GHz	1-10m			National Smart Metering Programme, NSMP (IRL)
	Bluetooth	Up to 720Kbps	2.4GHz				
IEEE 802.11 Group	Wi-Fi	54 Mbps max.	2.4 GHz/ 5.8 GHz	Up to 100 m	High degree of reliability and availability	Affected by surrounding emitting devices	CMP AMI (US) National Smart Metering Programm, Enhanced NSMP (IRL)
	Enhanced Wi-Fi	54 Mbps max.	2.4GHz				
	IEEE 802.11n	600 Mbps max.	2.4GHz				
IEEE 802.16 WiMAX		70 Mbps	1.8–3.65 GHz	50 km	Good performance over larger distances Able to supply thousands of end-users	Higher costs than similar technologies	Victorian Smart Meter Rollout (AUS)
Cellular	3G–4G	60–240 kbps	824–894 MHz 1900 MHz	Up to 50 km	Wide-range coverage Low maintenance Low power consumption High flexibility	Individual connections are expensive. Moderate bit rates	China Southern Power Grid (CHN) Smart Grid Smart City (AUS) Essential Energy (AUS)
	GSM	14.4 kbps max.	900–1800 MHz	1–10 km			Telegestore (IT)
	GPRS	170 kbps max.	900–1800 MHz				PRICE-GEN (ES) Eandis and Infrac (BE) Linky (FR)

because of low cost, range and availability of number of channels for data communication are high.

Zigbee operates in the unlicensed frequency bands 868MHz (1 channel), 915MHz (10 channels) and 2.4GHz (16 channels). Operates with the data rates in between 40Kbps to 1Mbps. The maximum range up to 75m can be communicated. It can coexist with other technologies operating under 802.11, 802.15 and 802.16.

The interoperable technology 6LoWPAN also works under IEEE 802.15 and uses Internet protocol (IP) over WPAN (IPv6 over low power wireless personal area networks). The features of 6LoWPAN are almost similar to Zigbee. The main advantage of 6LoWPAN is, it identifies every

wireless node by means of an IP address and this increases adaptability and flexibility of the data communication system. The table 2 shows various features of different wireless technologies used for smart metering systems.

### Smart Meters in Indian Scenario

The government of India is very keen in the development of industrialization and world is recognizing India as one of the fastest growing economies. For the growth of industrialization, an adequate electricity resource has to be taken care by government keeping in the view of future needs. The Ministry of Power is very keen in taking initiatives for future energy demands and advocating the ideology of smart grid and has unveiled sixteen smart grid pilot projects that

employ the combination of smart metering and various technologies for increasing the efficiency and reliability of power systems. ISGF under the Ministry of power is very active in the development of smart grid technologies in the Indian power sector. Some remarkable smart metering pilots are the 'Puducherry Smart Grid Project,' with more than 1400 SMs equipped with different technologies; the 'Bangalore Pilot Project,' which will reach 2,000 residential and commercial customers and the deployment started in 2008 in New Delhi (with 500,000 SMs installed in 2011) where SMs include automated meter reading and a prepaid system utilizing PLC technology. Industry reports estimate that India will install 130 million SMs equipped with both PLC and wireless technologies by 2021. The table



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**Table.3 Smart grid pilot projects in India**


S. No.	Project Name	Project application	Benefits
1.	AVVNL, Ajmer, Rajasthan	AMI with the coexistence of smart meters	Coexistence of meters from different vendors, reduction in AT&C losses, better energy audit.
2.	APDCL, Assam	AMI, Peak Load Management, Outage Management, Distributed Generation	Increased available energy during peak time, Revenue increase through Power Quality measurements and power factor penalty , Reduction in AT&C Losses
3.	CESEC, Mysore	AMI, Peak Load Management, Outage Management, Distributed Generation, Micro Grid.	Reduced Distribution Losses, Reduced Peak load consumption, Reduced cost of billing.
4.	PED, Puducherry	AMI	Reduction in Distribution Losses, Reducing cost of bill, Increasing revenue collection efficiency.
5.	HPSEB, Himachal Pradesh	AMI, Peak Load Management, Outage Management, Power Quality Measurement	Shifting peak load, Reduction in penalties, Reduction in outages
6.	PSPCL, Punjab	AMI, Peak Load Management	Reduced AT&C Losses, Reduced Peak Load Consumption, Reduced Cost of Billing
7.	TSECL, Tripura	AMI, Peak Load Management	Reduced AT&C Losses, Reduced Peak Load Consumption
8.	TSSPDCL, Telangana	AMI, Peak Load Management, Outage Management, Power Quality Measurement	Reduced AT&C loss, Reduced purchase of high cost power at peak hours
9.	UHBVN, Haryana	AMI, Peak Load Management, Outage Management	Reduced AT&C Losses, Reduced Peak Load Consumption, Reduced Cost of Billing
10.	UGVCL, Gujarat	AMI, Peak Load Management, Outage Management	Reduction in AT&C losses, Reduction in Transformer failure rate, Reduction in number of outages, Reduction in Meter Reading cost, Cost of payment collection
11.	WBSEDCL, West Bengal	AMI, Peak Load Management	Reduced AT&C Losses, Reduced Peak Load Consumption
12.	IIT, Kanpur	AMI, Smart City Control Center, Smart Homes, Advanced IT Infrastructure, Renewable Integration	Smart City R&D Platform, Smart Home Management Systems, Substation Automation, Rooftop Solar PV Integration
13.	CED, Chandigarh	AMI, Substation Automation including SCADA, Integration of Rooftop Solar, Distribution Transformer Monitoring	Reduction in AT&C Losses, Improvement of availability, Reduced peak load, Improved billing and collection efficiency
14.	MSEDCL, Maharashtra (Amravati)	AMI, Outage Management, Demand Response	Reduction in AT&C Losses, Reduced peak load consumption, Reduced cost of billing and increase in collection efficiency
15.	MSEDCL, Maharashtra (Congress Nagar)	AMI, Outage Management System, Demand Response, SCADA	Reduction in AT&C Losses, Reduced peak load consumption, Reduces cost of billing.
16.	KESCO, Kanpur	AMI, Peak Load Management, Distribution Transformer Monitoring, Distributed Generation Integration	Reduction in AT&C Losses, Reduced peak load consumption, Reduced cost of billing, Reduction in outages

3 shows the smart grid projects commissioned in India whose main functionality is to assess the smart meter data for making important decisions.

## Summary

The main objective of smart meters is for assuring the systematic energy management with the active participation of end user by coordinating utility companies in making

intelligent decisions. The smart grid will enhance the stability and reliability of power systems using AMI technologies. The better outage management increased remote monitoring on power losses and controlling them and accurate billing are most important advantages of smart meters using AMI. The goal of this article was to provide the knowledge on the role of smart

meter technology in the smart grid. The commissioning of smart grid pilot projects for research and supporting them by Government of India shows the interest of future development. Smart meter definitely has a great role in smart grid and is considered as most important for future energy management. 

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### Can you please take us through the journey of Vikram Solar?

Vikram Solar was set up under the aegis of the Vikram Group in 2006 with an aim to carry forward its rich manufacturing legacy. Vikram Solar was born with the idea that solar energy is not just an option anymore; it is a necessity to protect our environment and satisfy the growing energy consumption rate. Back in 2006, when the flurry of Government support that the solar industry enjoys today, did not exist, the finest equipment and machinery were brought from USA, Germany, Switzerland, and Japan to establish world-class manufacturing & technological capabilities. Within just three years of inception, in 2009, we made our first mark in the international solar industry and established an office in Germany- Vikram Solar GmbH. In 2010, Vikram Solar stepped into international EPC business to deliver comprehensive energy solutions globally. Year 2011 saw us installing 3 MW of solar generation capacities in India. In 2013, we contributed to the solarisation of the world’s first fully solarized airport - the Cochin International Airport, in Kerala, India. In 2014, we offered India its very first floating solar panel in West Bengal, introducing the idea of utilizing water bodies to harvest solar energy in wake of ever-decreasing land availability. We successfully completed India’s largest

airport rooftop solar installation at Netaji Subhash Chandra Bose International Airport, Kolkata in 2015, and in the same year, we reached 0.5 GW annual PV module production capacities and announced a 2 GW by FY 2020 manufacturing capacity goal. The above achievements were recognised at multiple forums. In 2016, Vikram Solar bagged the National Excellence Awards from MNRE as a domestic solar module manufacturer of the year. Vikram Solar was further felicitated with the ET Bengal Corporate award for Fastest Growing Company that year. In 2017 we achieved an epic double award win at the 5<sup>th</sup> ET Bengal Corporate Awards, where we bagged the prestigious ‘Fastest Growing Company’ award for the second time in a row, along with the ‘Highest Job Creator’ award.

Today, Vikram Solar manufactures quality solar PV modules ranging from 10 Wp to 345 Wp. Our standard product range is divided in three tiers- 72 Poly cell module, 60 Poly cell modules, 36/18 Poly cell module. Our manufacturing capacity stands at 0.5 GW today, fast approaching the 2 GW mark by 2020, and we are a comprehensive solar EPC solutions provider, with an installed capacity of over 305 MW of solar plants. We have invested more than INR 100 million in Research & Development and product certifications till date.



Presently, Vikram Group has presence in five continents across the globe and has entered into technology and infrastructure collaborations with leading institutions like Fraunhofer ISE in Germany, Meyer Berger, Centrotherm, IEST, and teamtechnik and we are also a part of HDPV Alliance in USA. These collaborations will bring innovations in module manufacturing through research and knowledge sharing.

**The government has set the target of generating one lakh mw of solar power by 2022. What kind of opportunities will it generate for the Indian renewable energy sector?**

The 100 GW target by 2022 has created a sense of urgency within the Indian solar sector. Government support increased investor interest, rising energy demand, and global acceptance towards solar energy are opportunities for Indian solar sector to grow. Needless to say financial support through multi-billion dollar commitments, achieved through combined efforts of government and private sector are creating great opportunities for the Indian solar industry. With more than \$37 billion investment commitments, Indian solar manufacturing industry will obviously increase, but to make '100 GW energy generation capacity by 2022' a reality, domestic capacity enhancement is crucial. Government offering tax subsidies to manufacturing plants in Special Economic Zone (SEZs) is planning to bring quotas to increase demand for domestic manufacturers.

The shift towards solar sector can help India scale great heights, claiming a large portion in the global energy sector. But to reach these opportunities, the country needs to boost its efforts mainly on the domestic manufacturing front.

**What is the current capacity of manufacturing PV module? What are the challenges faced by Indian PV manufacturers?**

Our current annual capacity of manufacturing PV modules is 0.5 GW. It is true that Indian Government is taking some great initiatives

to make solar a mainstream energy option. Government backed policies, regulations, and initiatives are testament to India's commitment in developing solar sector. But we cannot deny that there are some challenges in the sector that Government needs to address first. Land scarcity, lack of closer industry-government cooperation, slow skill development, complexity of subsidy structures, delays in land acquiring processes, and lack of safe guards against solar equipment (module) dumping are few of these issues that are slowing down the growth of the solar sector in India.

During the FY 2016-17, 90% of the solar module demand has been met by imports from China and other countries. India has imported 161.5 million solar panels in FY 2014-15, incurring a cost of almost \$821 million. The import expenditure has jumped to \$1.3 billion in 2015-16. These countries are dumping the solar panels at much lower rates than that in their respective countries. Their local government is facilitating them by export subsidy to the tune of 15 – 17% depending upon their province apart from cheap finance. Besides, most imported modules are of sub-standard quality and cannot sustain solar power generation for the desired period (beyond five years). Low quality imported modules when implemented in energy grid, can damage the energy transmission and jeopardize sustainability. Hence, there is an urgent need for imposing anti-dumping duty on imported solar panels from countries like China. It will provide a level playing field for the domestic solar manufacturing industry, while providing a check on import and use of sub-standard material at the same time.

It is noteworthy in this context, that global markets like USA, Europe, have imposed anti-dumping duties to ensure quality and sustainability of their solar development. The USA's Department of Commerce, in 2012, determined that Chinese and Taiwanese solar imports were being dumped in their country at margins ranging from 18.32% to 249.96% with the help of subsidies ranging from 14.78%



Floating Solar power

to 15.97%. Based on this revelation, the USA imposed 44.18% duties on solar equipment imported from Taiwan. In 2015, the United States International Trade Commission investigated further on this issue and imposed 50% duties on Chinese imported solar equipment as well. The European Union too imposed anti-dumping and anti-subsidy duties on imports of solar cells and modules from China on 2<sup>nd</sup> December, 2013. These duties (to the range of 40 – 47%) were levied, for a period of two years, in order to create a level-playing field for European manufacturers also to compete on price. India needs to follow such international precedents to keep up pace with the global leaders.

To tackle the above challenges the government should invest in creating land banks, making it easier for the companies to build factories. Although, Government is welcoming suggestions from private companies to improve its solar development strategies, more active involvement from both parties is required. India needs more skill development campaigns like 'Suryamitra Skill Development Programme' to see Prime Minister Narendra Modi's dream of creating 50,000 skilled solar workers into fruition. A uniform policy structure for subsidies can also help domestic manufacturers and encourage new entrepreneurs to build solar companies.

### **What are the accomplished Solar EPC projects? While accomplishing these projects, what technological hurdles did you face? How did you overcome the same?**

We have an installed EPC capacity of 305 MW till date with a number of ongoing projects in the pipeline. Some of our milestone contributions in the solar EPC space are as follows:

In 2013, we gave world its first fully solarized airport at Cochin International Airport, Kerala. We also installed utility scale 40MW power plants in Rajasthan in 2013. In 2014, we offered India its very first floating solar power plant in West Bengal, introducing the idea of utilizing water bodies to harvest solar energy in wake of ever-

decreasing land. We successfully completed India's largest airport rooftop solar installation at Netaji Subhash Chandra Bose International Airport, Kolkata, in 2015. In 2017, we commissioned a 130 MW solar power plant in Bhadla, Rajasthan.

Installing a solar PV plant is less complex than most of the traditional energy generation and transmission structures. But, still there are issues like cost and time pressure that adds to the construction process and complicate things. Moreover, EPC construction within India requires continuous dealing with ministries, local bodies, clients, vendors, internal teams, sub-contractors, while managing operation profitability, which makes it hard for EPC contractors to formulate a simple plan and follow it astutely.

Besides these issues, primary challenges that EPC contractors face in India are:

- Land acquisition
- Logistics
- Engineering challenges due to geographic characteristics
- Power evacuation

Vikram Solar has successfully handled these problems by carefully planning each step and by utilizing an agile operation process powered by upgraded technology and expert manpower.

### **What is the target for this fiscal?**

Manufacturing expansion targets:

#### **Cumulative planned capacity**

- By end of FY 2017-18: 1.2 GW
- By end of FY 2018-19: 1.6 GW
- By end of FY 2019-20: 2 GW

#### **EPC growth targets (cumulative year-on-year)**

- FY 2017-18: 800 MW
- FY 2018-19: 1 GW

### **What is impact of WTO ruling against India's domestic content requirement (DCR) on the sector?**

Undoubtedly, the Indian market is showing an incredible growth rate, but we are still far from going toe-to-toe with countries (China, US) that already dominate huge parts of the solar product supply chain.

The key reason behind this is that the exponential shifts in India that have created a platform for record growth and improvement are only a few years old. And our industrial development is still at a stage of infancy while, countries like China and US are backed by decade long growth.

In hopes of helping domestic players to grow and to build industrial reliance, Indian Government opted to impose DCR. We believe it was a right decision. Because, Indian solar manufacturing industry is dealing with factors like competitive price declines due to



Rajasthan Solar Project

foreign oversupply, lack of scale, and under developed supply chain. Getting Domestic Content Requirement policy would have given domestic manufacturers a level playing field to compete with foreign players. Imported modules are still 8-10% cheaper than domestic modules today. So, the obvious way to compete with them would be to have better demand in the market, which DCR could have offered. Creating market demand (domestic and international) for domestically manufactured materials can mitigate these problems by pouring in investments and bringing back profits within the country. So, we believe, to develop India into a self-reliant manufacturing hub, Indian manufacturers need policies like DCR. And we are thankful to Indian Government to keep the DCR quota for Government sourced projects.

However, WTO's misplaced assessment of the policy, proved a logjam as WTO stalled India's appeal and ruled in favor of the US. But, India still has options to stabilize the situation. Presently, the Government of India is announcing Domestic Content Requirement (DCR) from time to time under the CPSUs scheme, because of the WTO ruling. To protect and nourish the dream of solar reliance, India needs to enhance domestic manufacturing capacities and award more projects within quotas (Last year, only 0.850 GW capacity projects were awarded, out of the 2.5 GW DCR category projects).

**The Government has up-scaled the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power. Going ahead, can India become a renewable energy hub?**

Yes, India can definitely become a green energy hub by championing solar. The announcement of a 100 GW solar target by 2022, has given the sector the much needed push, bringing in investments and encouraging private players to enter the industry. However, India's module and cell generation capacity is 5620 MW and 1212 MW respectively. Moreover, its current domestic manufacturing capacity lists 2,700 MW of module and 1,300 MW of solar cells every year. So, there is a clear deficit, which is currently being filled by using imported solar products.

Indian Government has announced policies and quotas for domestic manufacturers, creating demand for their product, and helping them grow. Although, the growth has been significant, rising from a minuscule energy generation capacity (200 MW) just a few years ago to a whopping 2,700 MW and growing, more needs to be done to fulfil India's dream of solar self-reliance.

Research reveals that focusing on domestic manufacturing can save India more than \$42 billion by 2030 in forex alone. Domestic solar growth has already created more than 416,000 new jobs (2015), indicating a potential solution for India's employment scarcity.

Taking a more aggressive initiative towards enhancing the domestic solar manufacturing capacity can help in meeting the solar energy implementation target (100GW) and prepare India for the mantle of solar super power.


**What are your expectations from the government for this sector?**

As a domestic manufacturer, Vikram Solar is focused on sustainability in Indian solar sector growth. However, we are worried that low bids might increase the access of low quality imported modules in the industry (as India does not have a uniform law against dumping). We believe that India should focus on long-term sustainability of solar energy generation (which low quality modules are unable to provide) and development of domestic manufacturing capacity, rather than spending on importing modules and reducing bid prices any lower. The Government of India needs to revisit and revive the investigation on imported solar modules from foreign countries. Normalization of import prices will help domestic manufacturers to gain significant advantages, while ensuring a fair playing field, and boosting the Make in India programme at the same time. To boost domestic manufacturing, the government also needs to revisit the SIPS/M-SIPS policy and release the capital subsidy as suggested in the policy.

Today there are skill development campaigns in India like 'Suryamitra Skill Development Programme', but we need more industrial training institutions to see the Prime Minister's dream of creating 50,000 skilled solar workers being realised.

A uniform policy structure for subsidies can also help domestic manufacturers and encourage new entrepreneurs to build solar companies. Nonetheless Vikram Solar is very optimistic about the government backed policies, regulations, and initiatives.

To promote the indigenous solar industry, the government can introduce incentive schemes. The 'Technology Up-gradation Fund' implemented in the textiles industry should be introduced in the solar sector as well. The Government should also provide interest subsidies for the solar industry. Incentives such as tax rebates to customers and end users can help increase solar uptake.

Awareness among customers can be a major way to push the uptake of solar power in the country. State Nodal Agencies need to be brought in the loop to assist independent consumers in understanding the benefits and the process of selecting solar energy. Schools, colleges, and education institutions can be imparted proper knowledge regarding the benefit of energy transition and role of solar. This will help increase demand for solar, providing impetus to the industry's growth in the long run. 

# Power Quality: A Growing Concern

The modern power distribution grid is changing rapidly and these changes can be expected to have an impact on power quality, which is the concept of powering sensitive equipment in a manner that is suitable to the operation of that equipment. In the short term at least, the impact is likely to be negative, with power quality problems becoming more rather than less troublesome.

The power grid is being forced to change as the result of not one but many simultaneous developments. These include the growing need to connect green energy sources, such as wind and solar power, and the steady reduction in the number of traditional bulk generation plants that rely on fossil fuels as their energy source. Loads on the grid are also changing, with new technologies like electric vehicles leading to an even greater demand for power and a shift in the hours of peak demand. To help address these changes, smart-grid technology, designed to make the grid more efficient and more flexible, is being introduced.

It might be tempting to think that the spread of smart-grid technology will alleviate power quality problems, with a consequent reduction in the need for power quality investigations. Unfortunately, this isn't the case.

A primary objective of the smart grid is to increase the reliability of power delivery – it is unlikely to have any significant impact on the quality of the power being delivered. In fact, the new types of loads and sources continually being added to the grid will inevitably create new power quality challenges.

Some of the most common power system fluctuations impacting power quality include under- and over-voltage, dips (sags) and swells, transients, unbalance, flicker, harmonics and rapid voltage changes. To help readers refresh their understanding of power quality and to stay up to date with the latest thinking, we are currently preparing a series of articles, starting with

the fundamentals of PQ and progressing to topics such as what is a Class A recording, transient and harmonic impacts on motors & transformers, energy fundamentals, and the truth about energy saving devices. The first of these timely and well informed series of articles will look at the foregoing types of power system fluctuations, explaining why and how they occur, examining the effects they have on the power distribution network and on loads, and discussing how they can be measured and evaluated.

Megger has been working extensively to address these concerns and with its latest





innovation – MPQ1000 and MPQ2000.

The MPQ1000 is in compliance with IEC61000-4-30 Class A and is rated CATIV at 600V. It can be used for a wide variety of applications including substation monitoring, equipment and breaker tripping, load studies and load balancing as well as for switchgear and component failure.

This highly intuitive unit delivers unmatched capability in a smart ergonomic platform. In both the scope and DVM

modes, the versatile MPQ1000 can record power, energy, RMS, sags, swells, transients down to one microsecond, harmonics, inter-harmonics, harmonic direction, THD, TDD, flicker, unbalance, rapid voltage change (RVC), mains signalling, phase angle deviation, as well as performs waveform analysis to the 128th harmonic in real time.

Data gathered during testing can be recorded with the MPQ1000 record verification by simply pushing a button. This feature automatically detects the current clamps, recognizes its range, identifies the nominal voltage and sets the triggers, as well as verifies that the unit is connected properly to

what it is testing.

The MPQ1000 unit also features flexible current clamps that have four selectable ranges from 0 to 6000A.


The MPQ2000 Megger Portable Power Quality Analyzer, with its latest software and enhanced capabilities, addresses the international IEC61000, IEEE1159, IEEE519 and EN50160 series of power quality and delivery standards used around the world. Powered off of either the phase A voltage input or an auxiliary input that operates off of 115 V 60 Hz or 230 V 50 Hz makes the unit highly versatile, allowing it to be used in any location. Additionally, the MPQ2000 measures ac and dc simultaneously up to 1000V.

The MPQ2000 is an easy-to-use advanced portable 3-phase power analyzer housed in a ruggedized weatherproof enclosure. It comes with a field-replaceable, rechargeable battery with backup/ride-through time up to 5 hours, making the MPQ2000 the ideal tool for outdoor use. The unit can be left at remote locations and data can be viewed from the user's locations at the convenience of the user.

The analyzer comes equipped with self-identifying, four range flexible current clamps which are powered by the unit. No batteries are required. Additionally, the analyzer comes equipped with real-time scope and DVM modes. View RMS data, waveforms, demand data, phase angles, vector diagrams, harmonics, inter-harmonics, unbalance, flicker, and more in real time.

When data needs to be recorded, the MPQ2000 record-verification feature automatically identifies the current clamps being used, recognizes the range they are in, and verifies the unit is connected properly. The analyzer verifies that all voltage and current connections are correct prior to the start of the recording. This eliminates the possibility of the recording of "bad" data.

From utilities, to commercial and industrial, to residential monitoring, the MPQ2000 is your comprehensive intuitive tool for analyzing and solving power quantity and power quality problems.

Megger is one of the world's leading manufacturers and suppliers of electrical test and measurement equipment. With research, engineering and manufacturing facilities in the USA, UK, Germany, and Sweden, combined with sales and technical support in most countries, Megger is uniquely placed to meet the needs of its customers worldwide. 



**Andrew Sagl**

Product Manager, Power Quality, Megger US

## Powering Dubai's Sustainable City

ABB string inverters deliver power for the residents of Dubai's first all-electric city...



Dubai's first city to be powered completely by solar energy relies on ABB string inverters to harness the power of the sun for residents. Inverters convert the direct current (DC) output from the panels in to the alternating current (AC) needed in homes.

ABB has supplied 400 string inverters to harvest solar energy for 400 villas in the Sustainable City, the region's first fully integrated sustainable community. "ABB is excited to be part of Dubai's first wholly sustainable city and help reliably harness the power of the sun. We share Dubai's vision of building a world-class smart city and we firmly believe for this to happen, it also needs to be energy-efficient. We are sure that Dubai's excellent initiatives coupled with innovative technologies from companies such as ABB will make this ambition a reality," said Mostafa AlGuezeri, Managing Director, ABB in the Middle East.

The inverters were installed by City Solar, one of the leading companies specializing in solar photovoltaic (PV) power generation in the United Arab Emirates and Dubai. "We are one of the pioneering engineering, procurement and construction (EPC) companies that supply grid connected PV solutions to this growing regional market," explains Anwar Abdel of City Solar. "This means we are responsible for procuring all equipment and materials necessary for the project and verify that it's functioning perfectly."

Conceived and built by Dubai based Diamond Developers, the Sustainable City will be home to some 2,000 people in an area of nearly 500,000 square meters. It will eventually generate 10 megawatt-peak (MWp) of power from solar panels on private and public buildings within the city.

As well as solar powered homes, the plan for the Sustainable City features solar powered chargers for electric cars, a hotel powered 100

percent by solar power and the Diamond Innovation Center, the first educational institute to use net zero energy over its lifetime.

The Sustainable City provides a complete suite of amenities and environmental features. With the initial phase completed in December 2016, the city comprises five residential clusters, a buffer zone, a green 'spine', an equestrian club and a multi-purpose development. The second stage, to be completed in 2018, will include the hotel, innovation center, school and country club.

Faris Saeed, engineer and CEO at Diamond Developers, says, "The Sustainable City is based on innovation, energy efficiency and a commitment to combat the effects of climate change. With its own commitment to innovative technology to make efficient use of renewable energy, ABB was the ideal partner to help us realize our vision of building the first net zero energy city in Dubai."

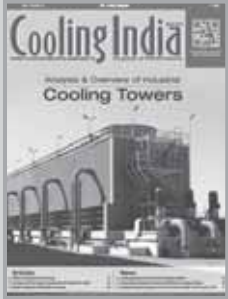
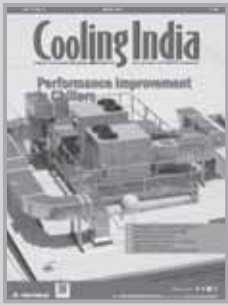
Working closely with the developers to design the solar power system for the villas, ABB supplied a string inverter demonstration unit at the start of the project to prove it could cope with the high outdoor temperatures experienced in Dubai. Models supplied under the contract were the PVI 5000, PVI 12.5, TRIO 7.5 and TRIO 8.5.

As well as supplying the inverters, ABB provides training, ensuring the client's own engineers can install and maintain the inverters. ABB is providing replacements in advance, delivering new inverters before collecting any faulty units.

ABB's Global Sales & Marketing Manager, Alireza Mehrdash, says, "ABB's innovation and wide ranging experience in solar power projects was clearly a major attraction to Diamond Developers when choosing a partner for the Sustainable City. We are glad to be involved with such a pioneering project that demonstrates how solar power solutions contribute to sustainably energy."

"The Sustainable City project is a benchmark and inspiration for other similar projects in the region." As well as the inverters for residential use in the Sustainable City, ABB also supplied inverters for a 1.4 megawatt (MW) parking lot solar roof project. This will charge the electric cars, which are the only powered vehicles allowed within the city limits.

ABB has one of the broadest portfolios of solar inverters in the industry, ranging from small single-phase and three-phase string inverters up to megawatt-sized central inverters. This extensive range of solar inverters is suitable for the smallest residential photovoltaic (PV) systems through to multi-megawatt PV power plants. ABB solutions are complemented by monitoring systems to ensure optimum performance of the PV installations, backed up by a global service network.



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## Govt Launches 'SEVA' App

Union Minister of State for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal launched the Saral Eindhyan Vitaran Application SEVA, developed in house by Coal India for power sector consumers; SEVA is aimed at increasing the Consumer Connect as well as the Transparency and Accountability in Coal dispatch.

Addressing the gathering, Goyal said that this app, along with other such apps of various Ministries of Government of India are in line with Prime Minister of India, Narendra Modi's vision of "Easy, Effective, Economical and Transparent Governance." Goyal further informed that for the benefit of all the citizens, the links for all mobile apps regarding Ministries of Power, Coal, NRE and Mines would be sent to the respective mobile number from which a missed call on the designated toll free number 1800 200 300 4 is given.

The minister added that this Government believes in dissemination of information of public interest and 'm-governance' would be the key to achieve this goal. These people-centric mobile apps would make the citizen empowered and hold the Government accountable for its decisions.

Talking about the SEVA app, the Minister said that there is a general perception that an app related to Coal dispatch would not be of importance for



the common man. Contrary to this view, Goyal said, by using this app the common man would be able to hold the Government accountable for the coal linkage allocations and would be able to check any pilferage or inefficiencies in coal consumption for power generation. This would, in turn, lead to rationalization of coal linkages and finally reduction in the power prices in the country. In near future, non-power sector mines would also be added in this app, the Minister added.

It was informed that the SEVA Dashboard provides summary of quantity of coal dispatched along with grades for the given day, month, and the latest yearly updates as well. It also provides information on rake movement including latest status of indents of rake, allotment and loading. This would help consumers making advance logistics planning. Further, the app has a dedicated backend team to monitor the status of specific grievances from consumers and take action on the feedback received on the app. While much of the information on the SEVA Dashboard is available in open access, consumer specific data would be password protected. The consumer friendly mobile app helps in tracking of coal dispatch to 118 power plants through Fuel Supply Agreement (FSA) of around 500 MT besides, dispatch through Special Forward e-auction and bridge linkage from more than 200 dispatch points spread over eight states of the country.



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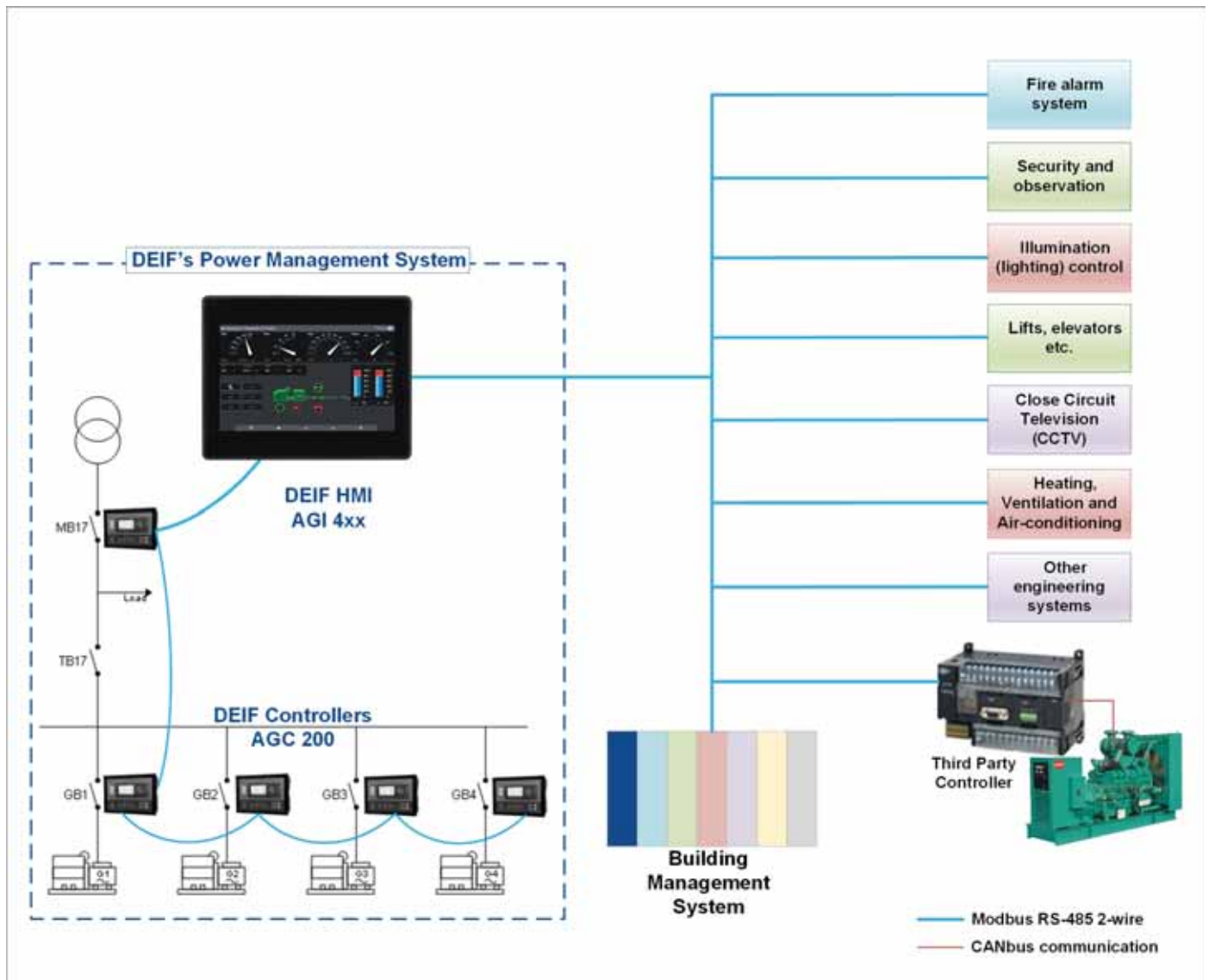
As a global supplier of green, safe and reliable energy control solutions, DEIF takes responsibility for design, supply, installation, commissioning and maintenance, offering end-to-end solutions, energy management and customer's comfort throughout the life-cycle of the project. DEIF solutions are designed for facilities to function smoothly and efficiently. Our revolutionary products and applications are the result of many years of research, development and craving for betterment.

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- Improved plant reliability and life
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AGI 400



AGC 200



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The advanced genset controller series integrates all necessary functions for superior genset protection, monitoring & control and stands out for its reliability & operator-friendliness.

### Other features of AGC 200

- Multiple operating modes in one software
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## “Smart meters will empower consumer to monitor power consumption”

The Government should support the industry for timely payment and encourage the deployment of latest technologies which will help utilities to bring down AT&C losses, states **Jitendra Agarwal, Chairman, IEEMA Meter Division** in an interaction with **Electrical India**.

### **What is the size of India Energy Meter industry? At what rate industry will grow in the medium term?**

The Ministry of Power is working towards providing reliable and quality power 24X7 to all. The electrical industry is fully committed to deliver meters as per the requirement of the utilities. Last year the meter industry's growth was down by 15-16% as the meters were not procured as per the anticipated rate. At present, size of the industry is Rs 3000 crore. However, it is not growing at the pace which we as an industry are looking. There are still a lot of unmetered consumers, faulty meters in the field, burnt meters, which need to be replaced on war footing scale. For any utility, meter is the Cash Box; it is the only equipment in entire power distribution, which measures energy flow from generation up to end consumer. The utilities should deploy meters at every point and conduct energy audit which will give them the clear picture about the losses and thus that pain area can be plugged. Looking at the present scenario, I am expecting that the industry will grow @5-6 % in near future.

### **What kind of potential do you envisage for this sector with the government's particular focus on upgrading overall infrastructure like roll out of 100 smart cities, commitment to provide 24\*7 electricity to all? So, what have been the recent technological innovations in the Indian energy meter industry?**

As far as, smart cities project is concerned, the implementing agencies have their own priorities and allocated the budget accordingly. There are different components of smart cities water management, waste management, power management, vehicle tracking etc and to the best of my knowledge not much has been allocated for smart cities power distribution.

The Power Ministry has initiated DDUGJY scheme for providing electricity to every house hold, under this scheme industry will supply meters directly to utilities or to turnkey contractors. We would urge that the same quality norms and approval process should be followed by utilities which they are

following for direct buying of meters by them. The Indian metering industry is most advanced in the world rather it has become R&D hub for metering and for providing products and solutions globally.

### **What are the bottlenecks that the Indian Energy meters industry is facing? What kind of support would you expect from the government?**

The Indian meter industry is totally dependent on the financial health of the utilities. The financial health of the utilities in India these days is not good barring few. We are not getting payment on time against supplied material which disturbs the entire cash flow cycle.

Secondly, the prices of the meters are going down with every tender. Entire buying pattern of the utilities needs to be revisited only low price criteria should be followed. Other parameters like field performance, R&D strength, systems and process followed by manufacturers etc needs to be carried out along with price. Vendor rating parameters to be followed by utilities so that they can get real benefit of the capex investment. We request that the government should look into it so reliable and quality meters can be procured by utilities.

### **Import of Chinese equipment is still a matter of concern for the industry. What is the scenario for Indian energy meters?**

Well it's a good question, if you look at any electronic products most of them are imported or manufacturing in India by MNC. I am proud to say Electronic Meter is truly Indian product. Indian R&D is providing metering technology around the globe. India has now become the R&D hub for metering. In the past, also Chinese meters entered Indian market those can be easily tampered in the field. Ultimately, utilities have to remove Chinese meters from the field.

### **India is close to implementing smart meters. What will be its implications on general consumers? How will this move benefit the Indian power sector?**

The Indian meter industry already has smart metering solution. Some of our members have started supplying smart meters to various utilities. In near future more and more utilities are coming up for implementation of smart metering solution.

Just like Smart Phone has empowered the consumers, similar smart meters will empower consumer to monitor and control electricity consumption, can participate in demand side management, can view his daily weekly, monthly electricity consumption, error free bills as the reading of meters is captured remotely so no chance of human error is involved.

Deployment of smart meters will make great impact on the demand side management. At present, government is installing the power generating stations to meet the peak demand. With the installation of smart meters peak demand can be managed effectively. Also with implementation of smart meters TOD (Time of Day) can be implemented by utilities.

**Deployment of smart meters will make great impact on the demand side management. At present government is installing the power generating stations to meet the peak demand. With the installation of smart meters peak demand can be managed effectively.**


### **What opportunities do you envisage with the Government scaling up the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power. ?**

Every power plant has to monitor electricity generation be it a Solar, Hydro, Wind Coal etc. With the installation of renewable power plant meters market will definitely grow of net meters. Industry is already supplying net meters to power producers.

### **What will be the impact of GST on Indian energy meters sector?**

It's too early to say about the impact of GST on industry, we will have to wait.

### **What is your outlook for the sector?**

Future seems to be very promising as well as challenging. The Government should support the industry for timely payment and encourage the deployment of latest technologies which will help utilities to bring down AT&C losses. Our industry is ready to provide full support to the government plans for roll out of smart meters in the country. 

## Retrofitting of Oil Circuit Breakers



**Paresh Shah**  
General Manager

Switchgear Division,  
Jyoti Limited, Vadodara



**N P Jhaveri**  
Deputy General  
Manager

Switchgear Division,  
Jyoti Limited, Vadodara

Retrofitting old medium voltage switchgear with newer technology is an efficient, cost effective and economical option for preserving existing assets, thus, saving cost and time.

In the race of implementation and adaptation of new technology we just destroy existing installation by scraping the products for want of alternate solutions and technologically sound and reliable supplier...

With Prime Minister's call for Make in India, there is need for development and change in all sectors of industries. Electricity is the prime over of all industrial and commercial activity and needs to meet increasing demand rapidly. As such efficient generation, distribution, utilization of electricity and preservation and management of asset is of utmost importance. Infrastructure for electricity generation and distribution is capital intensive and has long gestation time. The expected life of capital equipment is 15 to 20 years. After that there is obsolescence in terms of technology and maintenance. With more and more IT enabled equipment obsolescence becomes even faster.

Major components in medium voltage switchgear are breaker, bus bars, insulating components and control and protection equipment. Insulating components like CT, PT, Insulators, molded contact shrouds have

relatively less degradation and have long service life of around 30 years and over depending upon environment. Over the last three to four decades major technological changes have taken place in breaker and control and protection equipment. For breakers the technology has changed from MOCB to Vacuum Circuit Breaker and SF6 with SF6 fading out of switching applications in medium voltage. Control and protection equipment have undergone a sea change from electromechanical devices to IT enabled products.

Although it is not new concept retrofitting old medium voltage switchgear with newer technology is an efficient, cost effective and economical option for preserving existing assets, saving cost and time. In the race of implementation and adaptation of new technology, we just destroy existing installation by scraping the products for want of alternate solutions and technologically sound and reliable supplier.

We at Jyoti have supplied thousands of

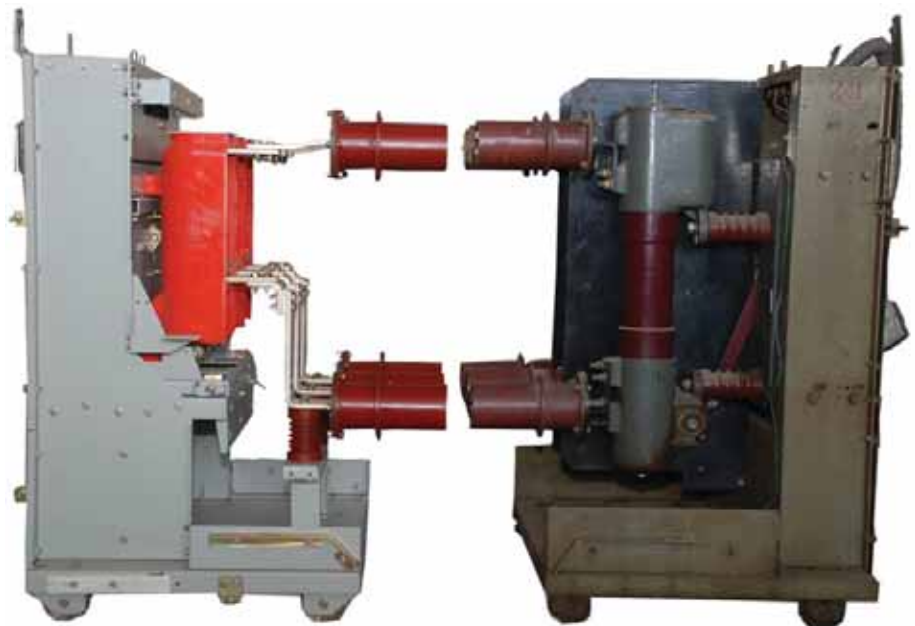


Figure 1: VCB MOCB



Figure 2: MOCB Truck



Figure 3: Refurbishment



Figure 4: Cassette Mounted VCB

Medium Voltage Switchgear Products starting from 3.3 kV to 33kV system voltage to all sectors in India e.g. power generation, transmission and distribution network, oil, petrochemical, fertilizer etc. The MV switchgears supplied (both MOCB and VCB) are still in service after 20 to 25 years and requests are received regularly for retrofitting these installations. Such retrofitting further extends the life of installation at least by 10 to 15 years.

Following up gradation can be carried out in existing installations panels:

1. Replacement / Retrofitting of old oil circuit breaker with latest Vacuum Technology. (Fig 1, 2 and 4)
2. Providing new feature in existing panel such as closed door operation for the safety compliance as per latest IEC 62271 requirement. (Fig 5)

3. Servicing and refurbishment of existing panel compartments like CT / Cable Compartment, Breaker Compartment, Bus bar Compartment and vermin proofing of panels. (Fig 3)
4. Upgrading the load capacity by increasing various bus bar sections of panels and change in rating of breaker which avoids requirement of new panel with higher rating. (Fig 3)
5. Replacement / Retrofitting of old electro-mechanical relay with latest Numerical Relay having IEC 61850 protocol protection system of nation's statutory requirement.

Utilities purchase medium voltage equipment for distribution network in large numbers. These MV switchgears are procured from different manufacturers by tendering. The MV switchgear of different manufacturers varies dimensionally and specially in bus bar configuration. This leads to a problem whenever new feeders or incoming sources are to be added to any sub station. The extension has to be done either by same make of switchgear or adapter panel is required to match bus bar of switchgear from two different vendors. The adapter panels usually is made by unqualified local vendors which may compromise safety. Further, it consumes precious floor space.

One of the most reputed utility of India had a



Figure 5: Retrofitted VCB

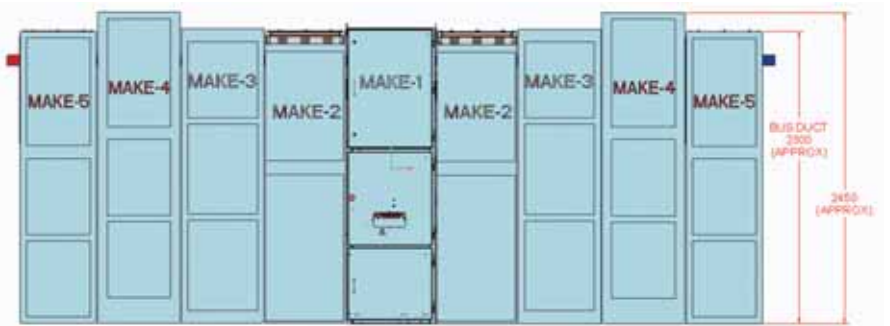
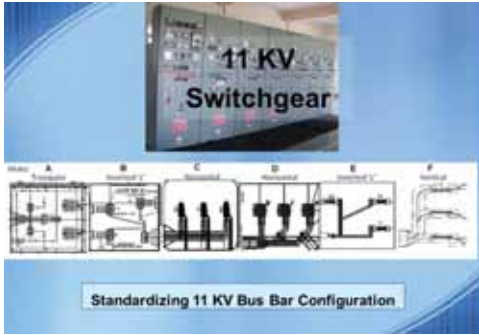


Figure 6

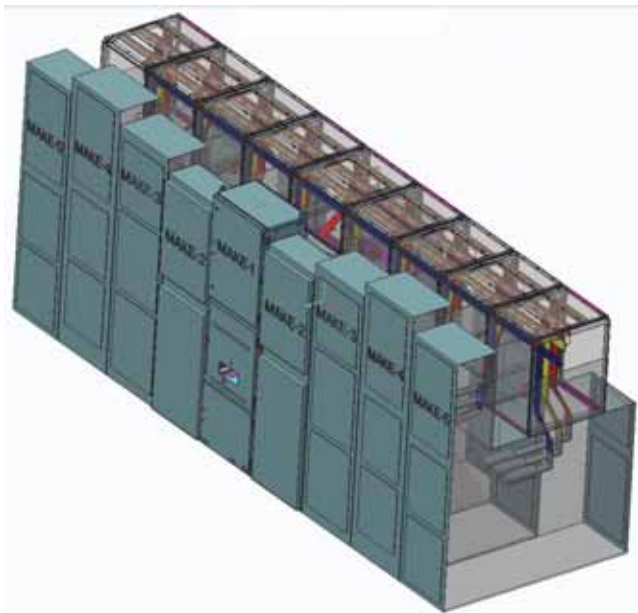


Figure 7a: Common Busbar Concept

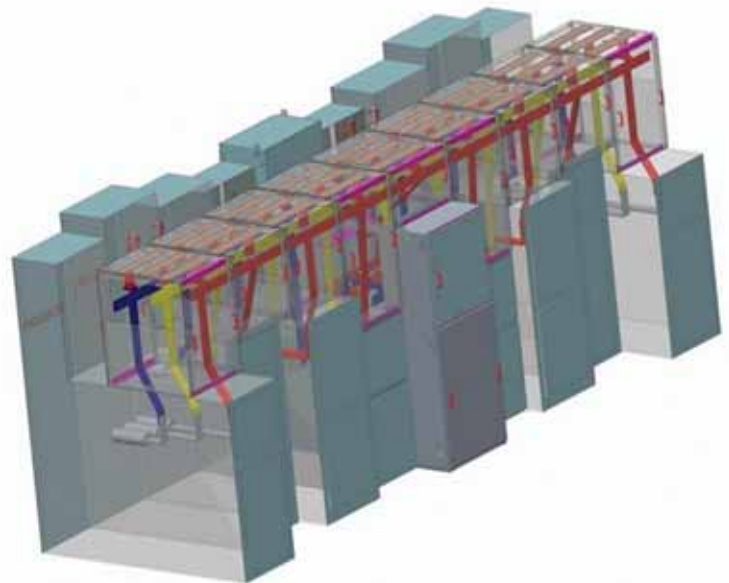



Figure 7b: Rear View of Common Busbar Concept

wish to have switchgear with common bus bar and so invited various manufacturers on this topic. Jyoti conceptualized, proposed and engineered a common bus bar concept which was accepted by utility and various vendors to the utility. Switchgear with this concept has already been supplied and installed. In future other utilities may also implement such concept. This is in a way advance planning against future

availability of a specific product from a particular vendor. The concept is illustrated above in Fig.6 and 7.

In many ways, retrofitting is just like a save energy drive. Every unit saved is unit generated. It reduces requirement of new installation, new cabling as there is no need for removal of old installation. Renewable energy has reduced the load on conventional power plants and thereby,

requirement of coal, gas, and oil. Similarly, retrofitting is conservation of national assets like steel, copper, resin, imported materials, items which can be employed more productively.

Government can encourage concept of retrofitting in private and public sector by giving incentive like for energy generation by renewable sources. Some examples of retrofitting are illustrated in the article. 

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# Smart Power Driving Energy Efficiency



Ashutosh Shukla  
Director

Equipment and Solutions  
Business, Schneider Electric India

Safety, reliability, energy efficiency and lower carbon trails are some of the key benefits of smart power in homes, buildings and industries

As economies look to grow in size and scale, the focus on efficiency is increasing with each passing day. This is most critical in case of power which is the fuel that drives industrial growth. Be it oil and gas, minerals, metals and mining, automobiles, hotels, hospitals, data-centers or any other industry, optimising energy usage is one of the most critical agenda for a robust growth. Continuity and quality of power, safety against fire hazards, high reliability, minimum downtime, ease of maintenance and cost of

energy are some of the major aspects to be kept in mind to achieve operational efficiency. At the same time, there is a need to ensure strict compliance of equipment or processes with predetermined standards and use clean energy sources to ensure reduction in carbon footprints.

## Making Power Distribution Smart

One of the safest and the most reliable option to address all these challenges is through smart power which involves use of smart



technologies. For example, power distribution can be made 'smart' through integrated solution offering that is combined with energy monitoring software. These software convert data into meaningful analysis and help customers improve the efficiency of their systems.

Asset management is another important facet of smart power, solutions like equipment, with local, remote and cloud based software ensure smooth management of the entire network. This includes safe electrical distribution, power monitoring and control system, power quality analysis, motor management and diagnostics, crisis management and recovery, and source management. Asset monitoring, asset use optimisation, maintenance management and critical asset management, are some other benefits.

Utilities across the world also set to gain through use of smart power solutions as it provides cost and efficiency management for energy saving and sustainability through cost allocation, energy use optimisation, green cost

optimisation and green standard compliance. These can be achieved through smart offerings for power monitoring and quality, energy management systems, security and surveillance, critical power, renewable energy and field services, amongst others.

### Range of Smart Power Offerings

Smart power offerings are used in various areas. In homes, their deployment assures safety, reliability, connected homes, sustainability and style. In buildings and cities, they ensure urban efficiency, smart mobility, smart grids, renewable power and intelligent, green buildings.

Even industries have great scope to use smart power technologies. In industries, the use of these solutions can speed up the pace of industrialisation, advance the Internet of Things, promote productivity and process automation, lead to faster modernisation of technology and augment sustainability as well as energy efficiency.

Similarly, usage of the Cloud offers benefits


such as digitisation, content on demand, Big Data aids predictive maintenance and improves asset life, while fostering a partner ecosystem.

### Smart Power for Homes and Buildings

In the case of buildings, major benefits and savings are assured using smart power offerings. Each building is unique in its design and operation, be it an office complex, hospital, hotel, airport or educational complex, since all have different functional requirements and occupancy patterns. Therefore, a smart energy management company such as Schneider Electric adopts an integrated approach to building management to reduce energy consumption by up to 30%, curb capital expenditures, lower operating expenses and boost overall business performance.

Home solutions are offered through automatic room control as well as HVAC (heating, ventilation and air-conditioning) and lighting solutions. It is imperative that plans are in place to maximise energy efficiency of all systems in the building even before construction, while other smart offerings are embedded during construction to benefit from these technologies. Engaging the energy efficiency experts during the planning stage itself is the right way to go about it to derive maximum benefits of these technologies. Further, automatic room controls, offer efficiencies to optimise room conditions pertaining to time, access, function and occupancy. Such systems could also provide comfort for occupants while keeping energy costs low.

Similarly, smart meters regulate energy flow throughout a house, minimising energy use and bills. With CCTVs, motion-sensitive/night-vision cameras and intruder alarms installed in homes, the safety and security of residents is fully assured. In the last case, smart homes equipped with voice command systems can be of immense benefit for bed and wheelchair-bound patients.

Smart power solutions have an important role to play to minimise daily-life stress in home and office environment by offering both comfort and convenience. This is also beneficial to the society at large as lower use of resources leads to lower carbon trails, thereby mitigating the impact of climate change and global warming. 



# Metering Systems & Policies for Roof-Top Solar



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Solar photovoltaic (PV) and wind two important renewable energy sources reached grid parity in 2010. This means that these renewables no longer need subsidies or government support for their growth. India is a tropical country that is blessed with ample solar power reception (6 lakh GW). This article has rectified the flaw and propose a metering and tariff policy that would foster widespread growth of solar roof-top in a diverse democratic country such as India.

**D**istributed Energy Resource systems (DER) are increasingly playing an important role in modern electric power distribution system. They refer to small grid connected decentralized energy generators that typically use renewable energy sources such as biomass, solar and wind power. In sharp contrast to the conventional centralized coal-fired, hydro or nuclear power plants, DER systems are located close to the load and use modular, flexible technologies. DER exploits small size for lower cost (it is now possible to mass produce small systems), reduced T&D losses (due to local generation / less site specific), low pollution, lower maintenance, lesser complexity and cost of regulatory oversight, tariff administration and metering and billing.

Since 2013 most of the DER systems have

reached grid parity – a point at which the DER can generate electricity at a Levelized Cost of Electricity (LCOE) that is less than or equal to the end consumer's retail price (see Figure 1). Reaching grid parity is essential for an energy source to be a contender for widespread development without subsidies or government support.

Solar photovoltaic (PV) and wind (see Table 1) reached grid parity even earlier (in 2010), and this has been a catalyst for growth of these two DER systems in a number of markets such as Europe, Australia, and US. Figure 2 shows the drop in LCOE for solar PV for the European markets.

Since grid parity dictates the success of DER systems, it is clear that the associated tariff policies, tariff mechanisms, compensation and

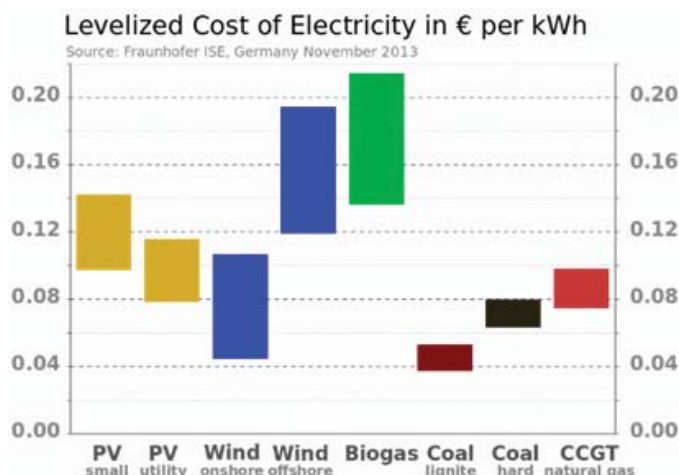


Figure 1. Levelized Cost of Electricity for DERs

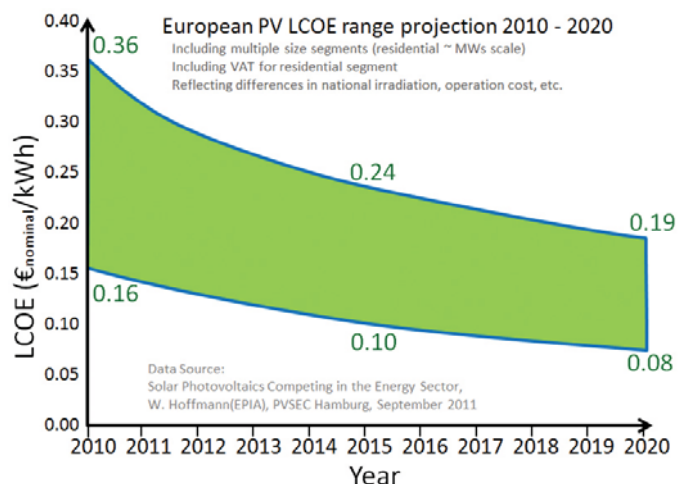


Figure 2. Drop in LCOE for Solar Photovoltaics

purchase arrangements play a vital role in sending clear signals to the public for their involvement. There are three compensation mechanisms that are designed to accelerate investments in DER systems:

1. **Power Purchase Agreement (PPA)**, also known as the 'Standard Offer Program' offers compensation that is generally below retail. It could be above retail, particularly, in case of solar where generation is close to peak demand.
2. **Feed-in Tariff (FiT)** which is usually set initially above retail and reduces down to retail as the percentage of DER adopters increase.
3. **Net Energy Metering (NM)** which is always at retail. Since the DER is mostly used for own consumption, technically, it cannot be termed as compensation, although it may be considered so if there is excess generation and if utility is allowed to make payments for the same.

In this paper, we will take a close look at each of the three tariff mechanisms and understand their pros and cons, in particular, for solar PV. We also consider the experiences of some of the countries where implemented, so that we can pick one that is best suited for our country.

### Compensation Mechanisms Power Purchase Agreement (PPA) based System

Onsite renewable Power Purchase Agreement (PPA) allow agencies to fund PV

projects with no up-front capital costs incurred. With the PPA, a developer installs a PV on agency property under an agreement that the agency will purchase the power generated by the system. The agency pays for the system through these power payments for the life of the contract, while the developer installs, owns, operates, and maintains the PV system over the same contract life.

Under the PPA mechanism, the energy generated and the consumed by the agency / consumer are metered separately using two meters, namely, the PPA meter and the standard consumer meter respectively (see Figure 3). Due

to this independence, under the PPA, neither the agency who pays for the power generated by the PV system, nor the developer who owns and operates the PV system, need to be a consumer of electricity. The PPA solely binds the agency and the developer, and therefore, is outside the scope, jurisdiction, and purview of the Electric Regulatory Commissions (ERCs). An exception to this is when the agency happens to be a local electric utility, in which case the tariffs would be under the purview of the ERCs.

PPAs feature a variety of benefits and considerations for utilities or government agencies.

Table 1: Estimated US Average Levelized Cost of Resources, 2010

Plant Type	Capacity Factor	Levelized Cost (USD/MWh)
Geothermal	92	47.9
NG*: Advanced Combined Cycle	87	64.4
NG: Conventional Combined Cycle	87	66.3
Wind	35	80.3
Hydro	53	84.5
NG: Advanced CC with CCS	87	91.3
Conventional Coal	85	95.6
Advanced Nuclear	90	96.1
Biomass	83	102.6
NG: Advanced Combustion Turbine	30	103.8
Integrated Coal-Gasification Combined Cycle (IGCC)	85	115.9
NG: Conventional Combustion Turbine	30	128.4
Solar Photo-Voltaic (PV)	25	130.0
IGCC with CCS	85	147.4
Wind – Offshore	37	204.1
Solar Thermal	20	243.1

\* NG = Natural Gas

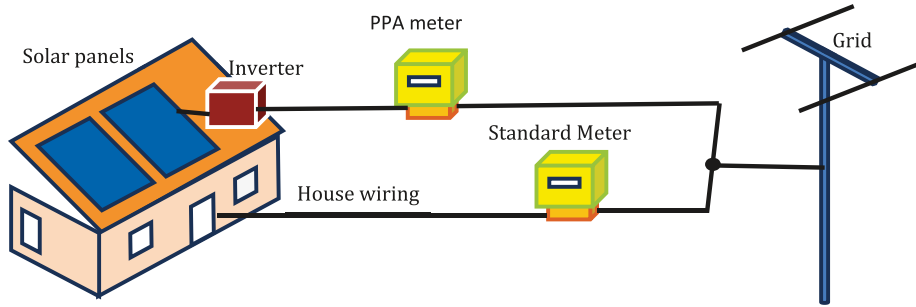


Figure 3: Parallel Connected Power Purchase Agreement (PPA) Meter

**Benefits to the utility/ agency**

- No up-front capital costs
- Typically, a known, long-term energy price
- Ability to monetize tax incentives
- No operations and maintenance responsibilities
- Minimal risk

**Considerations:**

- Utility/ government sector experience with PPAs is in its infancy/ still growing
- Challenges and concerns with site access contracts
- Contract term limitations
- Inherent transaction costs

However, as of 2009, many of the electric utilities have stopped accepting new PPA applications. For example in Ontario, Canada, the Renewable Energy Standard Offer Program (RESOP) has been replaced by the Feed-in Tariff (FiT) program.

The PPAs are individual contracts and are of lower significance in our current context. Hence, we will proceed to evaluate the remaining two, more interesting, compensation mechanisms.

**Feed-in Tariff (FiT) System**

Feed-in Tariff (FiT) schemes are typically based on a 15 – 20 year long contract where prices are pre-defined above retail with a tariff depression, which effectively reduces the

earnings over time. In the FiT, you get paid for every kWh you generate under an FiT contract.

The FiT system uses a separate meter called a FiT meter (see Figure 4) in order to measure the outflow of electricity generated from renewable energy on the consumer’s premises independently. The FiT meter is usually uni-directional, but if we are interested in knowing the consumption of small (usually insignificant) amounts of power by the PVs when they are themselves not generating, then we could consider it to be a bi-directional meter.

The electricity consumption is measured by the standard meter which is compulsorily a bi-directional meter (see Figure 4). The separation of electricity generation and consumption using two meters enables each to be priced separately.

Unlike the meter connections under the PPA scheme, in case of the FiT, it is possible to identify how much kWh units consumed by the consumer has been generated by his own PV system at any particular instant of time. Since only the surplus energy generated by the PV at any instant of time gets exported through the standard meter, it is possible to have a tariff rate applied to the surplus energy that is different from the rate applied to the total energy generated by the PV system.

The FiT systems are popular for solar generation in several European countries including Germany. In order to boost solar power,

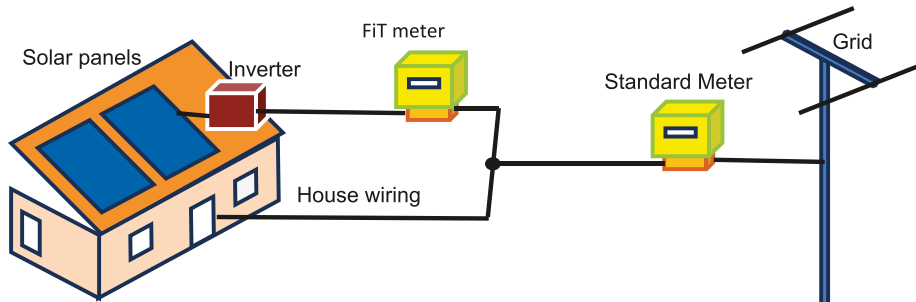


Figure 4: Series Connected Feed-in-Tariff (FiT) Meter Connections

German utilities once paid several times the retail rate for solar, but has successfully reduced the rates drastically while actual installation of solar has grown exponentially at the same time due to installed cost reductions. Since the German system pays what each source costs with a reasonable profit margin, wind energy, in sharp contrast, only receives around a half of the domestic retail rate. As a result of these measures, Germany has the highest PV installed capacity of 39 GW (as on 2015) of which 71% is in the rooftop segment. The PV Watt per Capita is also the highest in Germany at 491 (whereas it is only 4 in India).

However, long term contracts could have its risks. Malta is in the news, with a finding by its energy minister of irregularities in a €35 million FiT contract for the installation of photovoltaic panels on public buildings that binds the country for 35 years. While the contract provided a feed-in tariff of 23 cents per kWh for 25 years, it should actually have been 16 cents.

**Net Metering**

Net Energy Metering or simply Net Metering (NM) is a service offered by the local electric utility to an electric consumer under which electric energy generated by that consumer and delivered to the local distribution grid may be used to offset the electric energy provided by the electric utility to that consumer during the applicable billing period. Unlike FiT, the NM requires just a single bidirectional energy meter (see Figure 5).

Though the NM policy is designed to foster private investment in the renewable energy, it varies significantly by country and by state: if NM is available, if and how long you can keep your banked credits, and how much the credits are worth in retail or wholesale. In general, the NM policy involve a monthly roll over of energy (kWh) credits, a small monthly connection fee, monthly payment of the deficits which is the normal electric bill, and annual settlement of any residual credit.

In USA, net metering is popular in 43 States. The US Energy Policy Act 2005 mandates all public electric utilities to make net metering options available to all the customers. California has over 1 lakh net metering consumers with maximum solar capacity of 991 MWp. The NM

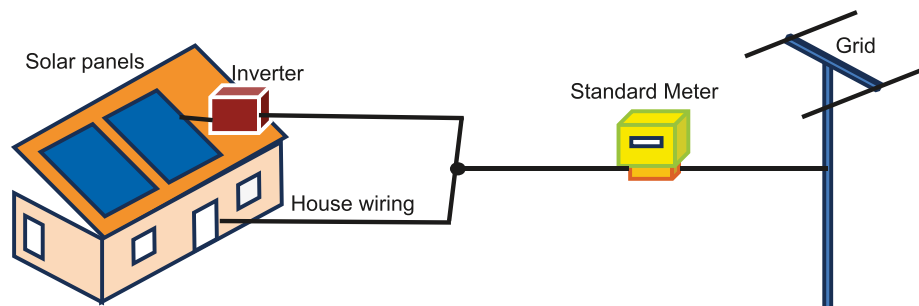


Figure 5: Net Energy Metering (NM) Meter Connections

policies are far more popular than the FiT policies in the US and in Japan.

### Comparison between FiT and NM Mechanisms

Table 2 highlights some of the differences between FiT and NM, their pros and cons.

#### Advantages of NM

We believe that any Indian consumer who is interested in generating energy using renewable means should be allowed to do so; moreover, encouraged to do so. NM needs no license. NM is about respecting and protecting the rights of individual home owners to generate their own power for their own use particularly from a renewable resource. This leads one to believe that NM is the most appropriate mechanism for a democratic country like India. However, we do not consider so due to the severe limitations that a single meter topology offers – this gets clarified in the following sections.

Instead of wasting the excess electricity, under NM it is provided to the local distributor

who will apply the credits for that excess towards the electricity bills. Grid-access has been the point of contention for NM. Electric utilities argue that under NM one may use an isolated PV to generate but not with a grid connection. To this, the counter argument would be – electricity is a perishable commodity that cannot be stored efficiently. It is in the best environmental interest to feed excess energy generated by PVs into the grid, and hence, local electric utilities should facilitate the same.

#### Advantages of FiT

Since NM protects the rights of consumers, it does not mean that the FiT model has no role to play. Two decades back, Western Europe's landmark FiTs were tremendously important in jump starting the solar industry. FiTs work well in places where the cost of retail electricity is low and the cost of electricity from solar systems is high. FiTs are also far more stable since they are contracts with a binding term on both parties. But today we have outgrown those infant days

when one needs to deliberately over-pay to get solar built.

Today, some say that there is contraction in the German market, turmoil in other European countries and in some states of US. The first and most famous US FiT – the Gainesville Regional Utilities program started in 2009 has been suspended in 2014. Over five years the utility has paid \$11.4 million at a solar generated electricity price of 0.29 cents per kWh. To account for this FiT, residential rates were raised by 0.3 cents per kWh. But, due to FiT, Gainesville has reached its solar targets. It is to be seen if Gainesville will be setting new targets for the forthcoming years, and if so, the model it would choose.

Though US favours NM, its residential consumers are not the major beneficiaries. Electric utilities also complain that NM takes the revenues away from the utilities base. A close study will reveal that it is solar leasing companies that derive their fees and maximum profit from NM. The utilities and consumers sell their rights to a leasing company to develop solar power.

On the other hand, community banks and credit unions prefer FiTs as they are more bankable. With a FiT, a community can take a loan from a bank and install renewable energy project on their own.

Germany has been the most successful with FiT after restructuring the Feed-in Law as the 'German Renewable Energy Act' in 2000. This Act has proved to be the world's most effective policy framework at accelerating renewable

Table 2: Comparison between FiT and NEM

	FEED IN TARIFF (FIT)	NET METERING (NEM)
Pros	<ul style="list-style-type: none"> <li>Guaranteed contract to sell electricity usually for a long period of 20-40 years.</li> <li>allows you to sell all your power if you're able to generate more than you use</li> <li>price is usually partly indexed to inflation</li> <li>fixed prices stabilize electricity rates, attract new investment</li> <li>guaranteed terms and low barriers to entry lead to job creation, economic growth</li> </ul>	<ul style="list-style-type: none"> <li>can offset your bill and you only pay for electricity used in excess of what you generate</li> <li>where it exists, there are laws that guarantee your right to net meter and offset your bill</li> <li>no license or contract needed, easy and simple to implement</li> <li>acts like a perfect hedge against rising electricity prices</li> </ul>
Cons	<ul style="list-style-type: none"> <li>more complex to implement because you need to get a contract and it may be a competitive process</li> <li>a separate generator account and a license is required</li> <li>usually rates paid by owners for electricity are higher than FIT contract prices therefore you may end up selling your electricity at one price and buying back the electricity you use at a higher price</li> <li>no hedge against rapidly rising electricity prices</li> </ul>	<ul style="list-style-type: none"> <li>rules can vary significantly as to how long you can bank your credits (i.e. only a month or up to a year) and how much your kwh's that you banked are worth (retail or wholesale value)</li> <li>if you produce more than you use, you generally don't get paid for these kwh's, they expire</li> </ul>

deployment. The German FiT policy (amended in 2004 and 2008) brought in important changes:

1. Purchase prices were based on generation cost. This led to different prices for wind power, solar power, biomass/biogas and geothermal and for projects of different sizes.
2. Purchase guarantees were extended to 20 years.
3. Utilities were allowed to participate.
4. Rates were designed to decline annually based on expected cost reductions, known as "tariff degression".

Under FiT, long-term contracts were offered in a non-discriminatory manner to all renewable energy producers. Purchase prices were based on costs. FiT policies typically target a 5–10% return. Efficiently operated projects yielded a reasonable rate of return. FiT resulted in growth of solar power in Spain, Germany, Ontario (Canada) while that of wind power in Denmark.

The success of photovoltaics in Germany resulted in an electricity price drop of up to 40% during peak output times. It resulted in savings between €520 million and

840 million for consumers. It also had a positive impact on job creation and economic growth.

However, savings for consumers have meant conversely reductions in the profit margin of the big electric power supply companies. Increase in the solar energy share in Germany also had the effect of closing gas- and coal-fired generation plants. The big electric power supply companies reacted by lobbying the German government, which reduced subsidies in 2012. Electric utilities also lobbied for the abolition, or against the introduction, of feed-in tariffs in other parts of the world, including Australia and California.

This leads one to believe that the NM suits residential scale PVs of capacities upto 100 kW, while the FiT is unparalleled at unleashing the commercial and community scale segments with larger PVs having capacities more than 100 kW.

## Regulatory Framework in Gujarat

Let us now change focus to India and, in particular, to the State of Gujarat. The policies that has been put in place to accelerate the growth of renewable energy in the energy mix are:

1. The National Action Plan on Climate Change (NAPCC) launched by the Government of India in June 2008 - a comprehensive plan that targets an increase in renewable energy purchase by 1% a year with a target to achieve 15% renewable by 2020.
2. Gujarat's Solar Power Policy-2015, launched on 13th August 2015, after the earlier policy (2009) resulted in a cumulative solar capacity in excess of 1000 MW.
3. The Jawaharlal Nehru National Solar Mission (JNNSM) launched in January 2010 that targets 22 GW of net installed solar generating capacity throughout India by 2022.
5. CEA has notified "Technical Standards for Connectivity of the Distributed Generation Resources-CEA Regulations 2013" in October 2013 which permits the grid connectivity of SPV rooftop also.
6. Ministry of Power approved CEA's draft - Installation and Operation of Meters-Regulation 2013" for metering arrangement for inter connection of SPV rooftop with grid.
7. CERC has brought out the draft guidelines for grid connectivity and metering arrangements for SPV rooftops.
8. MNRE has included Grid connected SPV rooftops in the "off grid and de centralized solar applications" scheme vide amend no.5/23/2009-P&C dated 30th October 2012 for SPV plants upto 100 kW capacity.
9. MNRE subsidy upto 30% on the following

### To achieve the targets put forth in the Gujarat's Solar Power Policy:

1. Gujarat ERC (GERC) passed its Solar Tariff Order No 3 of 2015, determining a levelized

**The success of photovoltaics in Germany resulted in an electricity price drop of up to 40% during peak output times. It resulted in savings between €520 million and 840 million for consumers. It also had a positive impact on job creation and economic growth.**

tariff for kilowatt scale power plant, for the period from 1<sup>st</sup> April 2016 to 31<sup>st</sup> March 2017, at ₹7.83 per kWh (without accelerated depreciation benefit) and at ₹7.11 per kWh (with accelerated depreciation benefit).

2. During the same period, GERC has determined a levelized tariff for large Megawatt scale power plant, at ₹6.30 per kWh (without accelerated depreciation benefit) and at ₹5.74 per kWh (with accelerated depreciation benefit).
3. GERC has further mandated a specific solar Renewable Purchase Obligation (RPO) at 1.75% for 2016-17. This represents the minimum quantum of purchase from solar for each distribution licensee and other captive and open access users consuming electricity generated from conventional captive plants in Gujarat.
4. GERC has been regularly initiating Suo-Motu proceedings to verify the RPO compliance each year with Gujarat Energy Development Agency (GEDA), a nodal agency for monitoring of RPO in the State of Gujarat, as a party
11. Gandhinagar city initiated a 5 MW (4 MW in government buildings and 1 MW in private homes) rooftop PV programme based on FIT/sale to utility.
12. Two project developers for 2.5 MW each selected through reverse bidding with GERC cap of ₹12.44/kwh.
13. Torrent Power to buy from Azur @ ₹ 11.21/kWh for 25 years and Azure will pass on ₹3.0/kWh to rooftop owner as roof rent.
14. Five more cities-Bhavnagar, Mehsana, Rajkot, Surat and Vadodara started installing pilot rooftop projects.

## Issues Hampering Proliferation of PVs in India

In the year 2016 many Indian states are still struggling with their roof-top programs while Germany has succeeded with it two decades back. The German FiT policy has resulted in a 40% drop in the price of electricity rates at peak times, and is considered to be most effective at accelerating renewable deployment.

One of the main reasons why India has not been successful with the proliferation of solar is



**Table 3: Energy Charges for Residential Consumers**

Sr. No.	For the Monthly Consumption	Rate: RGP (Rural) (₹/kWh)	Rate: RGP (Urban) (₹/kWh)
1. a	First 30 units (For BPL Consumers)	1.50	1.50
1. b	First 50 units (For other Consumers)	2.75	3.15
2.	Next 50 units	3.20	3.60
3.	Next 100 units	3.85	4.25
4.	Next 50 units	3.95	4.35
5.	Above 250 units	5.00	5.30

the discriminatory approach taken while offering contracts. In Germany, the long-term contracts were offered in a non-discriminatory manner to all the renewable energy producers on a cost plus basis with 5-10% return.

It is also important to note that all the programs initiated in India fall under the PPA category or more recently under the NM category. Though the NM policies have been implemented in US, we show below that it is not suitable for India. For the widespread proliferation of PVs in India we explain below why there is an urgent need to shift to the FiT policy and re-design the tariffs after linking them with the existing consumer tariffs.

**Problems Linking with Residential Consumer Tariffs**

For large scale proliferation of the Solar Roof-Top projects, it is important to involve the residential consumers. To understand the impact of the current residential consumption tariff, let us take a look at one such tariff, for the year 2014-15, set as per the directives of GERC for an electric utility in Gujarat, namely, MGVL. The tariff applicable to all residential premises located in the area serviced by MGVL are covered under Rate : RGP (Rural) and Rate : RGP (Urban), as shown in Table 3.

It can be observed from Table 3 that the energy charges for residential consumers vary considerably as per their monthly consumption: from ₹ 1.50 per kWh to ₹ 5.30 per kWh. This is because in India, unlike developed countries, it is believed that subsidy or concessions should be offered to low consumption households. Table 3 also shows extra concessions available for consumers located in rural areas, and for consumers categorized as 'Below the Poverty Line' (BPL).

As we have stated earlier, it is our firm belief that those interested in generating energy using

PV, should be encouraged to do so. In particular, the smaller consumers should not be discriminated with regards to benefits that accrue from solar generation. Only then can we consider the policies to be fair in a democratic regime.

**Discrimination under the NM Mechanism**

Since the NM mechanism has a single bidirectional energy meter it is not possible to measure the PV generation that is self-consumed. Only the surplus PV energy generated and exported to the grid is measured by the NM meter and hence purchased by the Distribution Company (DisCom) at a rate that is fixed by ERC. This rate is called the Average (pooled) Power Purchase Cost (APPC) rate, and is based on the levelized cost (LCOE) of solar energy generation (₹ 7.50 per kWh). As per the Gujarat Solar Power Policy-2015 and the GERC Order No. 3 of 2015,

the APPC rate for the year 2016-17 for kW scale PV power plant is ₹7.83. This rate is much higher than the subsidized or concessional tariff rates for consumption offered to a small consumer, say ₹ 2.75 per kWh for a rural consumer with consumption less than 50 units – (see Table 3). It is a pity that, under the current subsidized tariff regime, small consumers with roof-top solar generation units tend to lose their existing benefits when billed under the NM mechanism.

Though the large residential consumers in urban areas lose too, they would lose less from the solar generation, in comparison, since they can offset their own more expensive consumption units (exceeding 250 units costing a higher rate of ₹ 5.30 per kWh). Simultaneously, these large consumers can reap an additional benefit - as they would be consuming or drawing less energy from the grid, thereby falling into the smaller consumption slabs that attract a lower tariff rate and that were originally intended for small consumers.

Regardless of the category of the residential consumer, since the cost of energy consumed (see Table 3) is lower than the APPC rate of solar generation (₹7.83 per kWh), the payback period for the investment put by such consumers gets extended. This explains why residential consumers do not find solar generation attractive

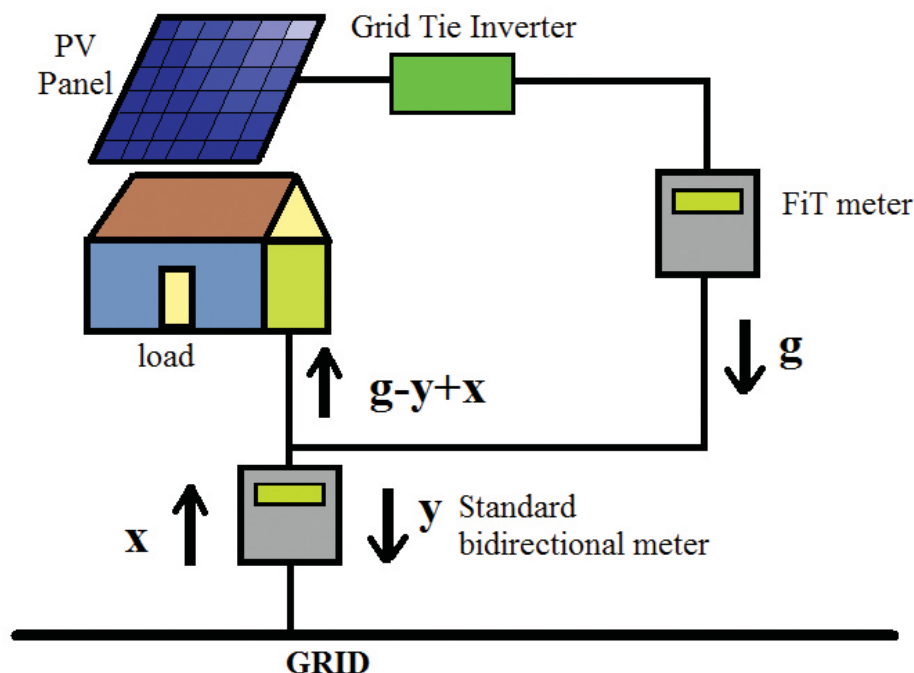


Figure 6: Energy recorded by FiT and standard meters

and why roof top solar policies have remained a miserable failure in India.

In spite of the simplicity of NM mechanism (single meter; no license requirement) making it ideal for a democratic country such as India, the disparity between APPC rate and subsidized residential tariff is powerful enough to reject this mechanism.

### Achieving Fairness with an FiT Mechanism

An FiT tariff can be designed in a fair manner unlike an NM policy. This is because to implement FiT we have two meters from which it is possible to take four readings, namely:

- g: Energy generated by the solar grid tie inverter (exported) and recorded by the FiT meter
- s: Energy consumed by the solar grid tie inverter (imported) and recorded by the FiT meter
- x: Energy drawn by consumer (imported) from utility grid as recorded by the Standard meter
- y: Net Energy (exported) to the utility grid as recorded by the Standard meter

For all practical purposes, we may neglect the energy consumed by the solar inverter, namely, s. Even if s is significantly high, it would not make too much difference as this consumption gets accounted in the Standard consumer meter reading, x. This strategy would help reduce the number of meter readings per consumer from four to three and also reduce the cost of the FiT meter which can now be unidirectional.

Part of solar generation consumed by the consumer = (g - y)  
 Total energy consumed by the consumer = (g - y) + x.

For the total energy consumed, namely (g - y) + x, the same tariff as given in Table 3 is still applicable and requires no change. The only difference in the billing process, in the case of a consumer with roof-top solar generation, would be felt by the meter reader who would now need to extract three readings from two meters instead of a single one. But, in the era of smart metering, with automatic meter reading infrastructure, this cannot be viewed as a major disadvantage.

The FiT achieves fairness in the compensation mechanism by giving the ability to disassociate

the consumer's own consumption from the solar generation. Accounting is done in two stages:

- a. For Consumption: The (g - y) + x formula supported under the FiT mechanism ensures that every consumer is entitled to the concessional tariff rate that is applicable to him depending on his category and consumption slab, regardless of whether he has roof top solar or not. There is no discrimination, to a consumer who is also a

One of the main reasons why India has not been successful with the proliferation of solar is the discriminatory approach taken while offering contracts.

- generator, in terms of his consumption bills.
- b. For Generation: The DisCom would pay the consumer for the total number of units generated by the solar PV, namely g, recorded on the FiT meter, as per the APPC rate fixed by the ERC for that year regardless of whether these units are self-consumed or not.

Table 4: Disassociating Consumption from Generation

Category	Formula	Tariff
Consumption	(g - y) + x	Rate : RGP (Rural/Urban)
Generation	g	APPC rate

The disassociation of generation from consumption under the FiT mechanism is summarized in Table 4. Thus, the above tariff scheme ensures a deterministic payback period that is independent of the consumer category and the consumption slab which was not the case under NM. Hence the implementation of the FiT policy would bring in a fair regime that will promote solar PV in the high volume, small consumption categories.

### Conclusions

In, GERC has estimated the typical cost per Kw of roof top grid connected PV power plant to be ₹80,000. It has also considered the O&M cost of a PV power plant to be ₹1090/kW/annum escalating annually at 5.72%. A residential consumer would be interested in a roof top project provided he is able to recover the cost from the solar generation. The presence of

subsidy in the residential consumer categories made solar generation less attractive since the payback period went up to 8-10 years. Moreover, since the subsidy differed slab wise, the payback period also differed accordingly. This explains why the solar has been a total failure in the residential roof top category and partial failure in commercial categories.

In this paper, we have not only identified the cause of failure but have also given an elegant proposal to bring in fairness in this categories. The FiT mechanism allows us to dissociate consumer's consumption from his generation so as to allow the entire generation to attract the higher APPC rate. This shortens the payback period to 4-5 years making the roof top project attractive to the consumers. Learning from the German experiment, which has 71% generation in roof top segment, we can confidently say that a simple shift in the compensation mechanism from NM to FiT would act as a great enabler to attract even the small residential consumers, and make solar roof top an overwhelming success in India too.



**Nivea Chauhan**



**Harsh Bhatt**



**Payal Bhadresa**




**Akash Senta**

# India Shows Way in Fight against Climate Change

Union Minister of State for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal presided over the launch of World's largest efficient lighting programme, UJALA – UK (UK Joins Affordable LEDs for All) by Energy Efficiency Services Ltd (EESL) in London. Talking about the philosophy of the Prime Minister of India, Narendra Modi about preventing wastage of all resources especially electricity, Goyal said that, “a sustainable lifestyle is important for the future of the planet and if the planet has to be saved for the future generations, it is I, you and we all who have to collectively make a difference and act today itself. We are running out of time.”



energy efficiency measures like the EESL LED programme, especially, looking at the climate change scenario in the present context. India's share in the Global LED market has increased from a mere 0.1% a few years back to around 16% today, it was informed.

Talking about the potential energy savings by implementing the LED programme in India, Goyal said that lighting alone consists of 15% of the total energy needs of the population across the country, especially, the lower middle class families, which is about 180 billion units of energy. As India moves towards becoming a 100% LED Nation, the potential savings would be around 112 billion units, in other terms reducing carbon dioxide emissions by nearly 79 million tonnes every year. Consequently, India's peak load will reduce by about 20 GW and our consumers will save around \$6.5 billion worth in electricity bills annually, the Minister added. Describing the strategy for scaling up the LED penetration in UK, Goyal said that India was able to significantly reduce the purchase price of the LED by increasing efficiency and not giving subsidies to the consumers. The scheme has sustained itself on the savings achieved by increasing energy efficiency in the whole lifecycle of the LED bulbs. 

Informing the august gathering about the scale at which the EESL LED programme is expanding, the Minister said that, “the EESL LED programme in India has grown 140 times in less than two years and I don't think we will find any parallel to that anywhere in the world. EESL would achieve the turnover target of USD 1.5 million by 2019, concomitant with the Government of India's target under the UDAY scheme and 100% rural household electrification.” Goyal further stated that even in the Developed countries like the US and Europe, there is a great potential for incorporating

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## Gensets Market in India 2016-2020

The genset market in India will record an impressive CAGR of close to 14% over the forecast period (2016-2020). The developing country such as India has been reeling under the problem of frequent power outages, triggering the demand for gensets...

According to Technavio market research analysts, the genset market in India will record an impressive CAGR of close to 14% over the forecast period (2016-2020). The developing country such as India has been reeling under the problem of frequent power outages triggering the demand for gensets. Apart from this, India, being the fastest development country, requires power for its industrial, commercial, transportation, infrastructural development consumption. Although the country is the third-largest producer and consumer of electricity in the world after the US and China, an estimated 27% of the energy generated in India gets lost during transmission or is stolen. Peak supply falls short of 9%, and frequent power outages last for an average of 10 hours in many regions of the country such as Meghalaya, Andhra Pradesh, Uttar Pradesh, Jammu and Kashmir, Andaman and Nicobar, Bihar, and Tamil Nadu. This has led to the augmented adoption of gensets, which are used to solve power outage issues in the country.

Hybrid genset that run on gas, diesel, solar and batteries is the new trend in the genset market. Soaring demand for these genset leads to several manufactures to introduce hybrid gensets and offer better cost and fuel efficiency than the conventional gensets. As compared to the conventional gensets, these gensets have less carbon footprint on the environment, emitting fewer harmful substances like NOx, CO, hydrocarbons, and particulates. They are cost-effective solutions for applications where the average running of the load is much below the size of installed gensets. A diesel genset paired with solar panels and dual fuel is another hybrid option that is expected to gain traction in the market over the next four years.

### Competitive landscape and key vendors

The gensets market in India is characterized by the presence of well-diversified international and regional vendors. With international players increasing their footprint in the market, regional vendors are finding it difficult to compete with them in terms of quality, technology, and pricing. Competition among these vendors is leading to the introduction of many innovative and advanced products. These vendors also provide innovative solutions as a part of their product portfolio. The competitive environment in this market will intensify further with the increase in technological innovations, M&A, and product or service extensions. International players will grow inorganically by acquiring regional or local players.

Key vendors in this market are Caterpillar, Cummins, Kirloskar, and Mahindra & Mahindra. Other prominent vendors in the market include Atlas Copco, Ashok Leyland, C&S Electric, Escorts Group, Eicher Motors, FG Wilson, Generac Power Systems, Greaves Cotton, Honda Siel Power, Kohler, International Tractors Ltd. (Sonalika), Sterling Generators, and TATA Motors.

### Segmentation by fuel type and analysis of the gensets market in India is Diesel genset, Gas genset.

Being one of the fastest growing segments in India, the gas genset segment is anticipated to post a growth at a CAGR of close to 20% over the forecast period. Natural gas is being increasingly used as a fuel source for gensets in many industries as it is an affordable option in terms of operations and maintenance. However, limited availability of high-power output capacity gas gensets and the difficulties in procuring a natural gas supply, especially, in emergency situations such as floods and earthquakes, are major challenges to the growth of this segment. However, the demand



for natural gas gensets will increase during the forecast period owing to the increasing use of eco-friendly fuels and the increased production and expansion of gas distribution network in the country.

### Segmentation by end user and analysis of the gensets market in India:

- Industrial sector
- Commercial sector
- Infrastructure sector
- Residential sector

During 2015, the industrial sector was one of the highest revenue generating segments in the market and is likely to grow at a CAGR of more 14% over the forecast period. Rapid industrialization in the country will boost the demand for electricity and because of the deficit in the power supply; it will lead to the increased adoption of gensets in the industrial sector in India.

### Global Scenario

According to MarketsandMarkets report, the generator sales market is expected to grow from an estimated USD 18.57 billion in 2016 to USD 24.45 Billion in 2021, at a CAGR of 5.7%. The market is set to witness growth, due to growing demand for uninterrupted and reliable power supply from all major end-users, such as industrial and commercial end-users.

The diesel generator sales segment is expected to hold the largest share of the generator sales market, by type, during the forecast period

The diesel generator sales segment led the generator sales market in 2015 and is expected to grow at a decent pace during the forecast period. A long running life, easy parts and fuel availability, and quick response have helped the diesel generator market grow worldwide.

This segment is primarily driven by increasing demand from data centres, IT facilities, and healthcare infrastructure in developing regions and is expected to create new revenue pockets for the generator sales market during the forecast period.

The generator sales market, in this report, has been analyzed with respect to five regions, namely, North America, Europe, Asia-Pacific, South America, and the Middle East & Africa. The Asia-Pacific market is expected to dominate the global generator sales market with the growth of the manufacturing sector in China, India, Indonesia, and Taiwan. Also, the growth of the IT industry and healthcare infrastructure in China, India, Australia, and Singapore has played a significant role in the growth of the generator sales market in the Asia-Pacific region.

To enable an in-depth understanding of the competitive landscape, the report includes profiles of some of the top players in the generator sales market. These players include Caterpillar, Inc. (US), Cummins, Inc. (US), Generac Holdings, Inc. (US), Kohler Co (US), and Mitsubishi Heavy Industries Ltd. (Japan). The leading players are trying to penetrate the markets in developing economies, and are adopting various strategies to increase their market share.



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## List of Selected Solar Cities under 'Development of Solar Cities Programme'

Sr. No.	State	Approved Solar Cities	Status of Master Plan	Status of Solar City Cell
1	Andhra Pradesh	1. Vijayawada*	Prepared	Yes
		2. Narsapur Town	—	—
		3. Kakinada	—	—
2	Assam	4. Guwahati	Prepared	No
		5. Jorhat	Prepared	Yes
3	Arunachal Pradesh	6. Itanagar	Prepared	Yes
4	Bihar	7. Gaya	—	—
5	Chandigarh	8. Chandigarh**	Prepared	Yes
6	Chhattisgarh	9. Bilaspur	Prepared	Yes
		10. Raipur	Prepared	Yes
7	Gujarat	11. Rajkot*	Prepared	Yes
		12. Gandhinagar**	Prepared	Yes
		13. Surat	Prepared	Yes
8	Goa	14. Panaji City	Prepared	No
9	Haryana	15. Gurgaon	Prepared	No
		16. Faridabad*	Prepared	Yes
10	Himachal Pradesh	17. Shimla*	Prepared	Yes
		18. Hamirpur	Prepared	Yes
11	Karnataka	19. Mysore**	Prepared	Yes
		20. Hubli-Dharwad	Prepared	No
12	Kerala	21. Thiruvananthapuram	Prepared	No.
		22. Kochi	Prepared	Yes
13	Maharashtra	23. Nagpur**	Prepared	Yes
		24. Thane*	Prepared	Yes
		25. Kalyan-Dombivli	Prepared	Yes
		26. Aurangabad	Prepared	No
		27. Nanded	Prepared	No
		28. Shirdi*	Prepared	Yes
		29. Pune	—	—
14	Madhya Pradesh	30. Indore	Prepared	
		31. Gwalior	Prepared	Yes
		32. Bhopal	Prepared	—
		33. Rewa*	Prepared	Yes
15	Manipur	34. Jabalpur	—	—
		35. Imphal	Prepared	Yes
16	Mizoram	36. Aizawl*	Prepared	Yes
17	Nagaland	37. Kohima	Prepared	Yes
		38. Dimapur	Prepared	No
18	Delhi	39. New Delhi (NDMC area)	Prepared	No
19	Orissa	40. Bhubaneswar**	Prepared	No

20	Punjab	41. Amritsar*	Prepared	No
		42. Ludhiana	Prepared	Yes
		43. SAS Nagar (Mohali)	—	No
21	Rajasthan	44. Ajmer	—	No
		45. Jaipur	—	—
		46. Jodhpur	Prepared	No
22	Tamil Nadu	47. Coimbatore*	Prepared	No
23	Telangana	48. Mahbubnagar	—	No
24	Tripura	49. Agartala*	Prepared	Yes
25	Uttarakhand	50. Dehradun	Prepared	Yes
		51. Haridwar & Rishikesh	Prepared	Yes
		52. Chamoli –Gopeshwar	Prepared	Yes
26	Uttar Pradesh	53. Agra	Prepared	No
		54. Moradabad	Prepared	Yes
		55. Allahabad	Prepared	No
27	West Bengal	56. Howrah	Under Preparation	Yes
		57. Madhyamgram	Prepared	No
		58. New Town Kolkata	Prepared	Yes
28	Jammu & Kashmir	59. Leh*	—	No
29	Puducherry	60. Puducherry*	Prepared	No

(\*\*Model Solar Cities, \* Pilot Solar Cities)

Source: Ministry of New & Renewable Energy

## SERVING LOW VOLTAGE SWITCHGEAR & CONTROLGEAR NEEDS SINCE 1990



### Contactors

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- ❖ Overload relays in 3 Sizes from 0.4 – 135A
- ❖ Oil immersed and airbreak motor starters
- ❖ Foot switches ❖ Rotary control switches



### Fully Automatic Star-Delta Starter

- ❖ Overall dimensions : W320 / H 340 / D 120 mm
- ❖ Contains 3 contactors, 1 overload relay
- ❖ Electronic timer for change over from star to delta
- ❖ Suitable for motors rated up to 200hp



### Oil Immersed Starters

- ❖ Contains a drum switch for star-delta change over and a contactor immersed in oil
- ❖ Suitable for all weather conditions and dusty places
- ❖ Two frame sizes: 20-30hp with 58mm dia glass epoxy drum, 3/10 copper contacts. 40-60hp with 70mm dia glass epoxy drum, 3/12 copper contacts
- ❖ 90 mm diameter glass epoxy drum, 3/15 copper contacts for motors rated 90hp

## SEVA SWITCHGEAR PVT. LTD.

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Ph : +91 80 4160 8100 E-mail: lvswitchgear@sevaspl.com www.sevaspl.com

## Forthcoming Events At A Glance

### National

#### Automation 2017

**Venue:** Bombay Convention & Exhibition Centre, Mumbai  
**Date:** 09-12 August, 2017  
**Website:** [www.automationindiaexpo.com](http://www.automationindiaexpo.com)

#### electronica India

**Venue:** Pragati Maidan, New Delhi  
**Date:** 14-16 September, 2017  
**Website:** [electronica-india.com](http://electronica-india.com)

#### Renewable Energy India Expo 2017

**Venue:** India Expo Centre, Greater Noida  
**Date:** 20-22 September, 2017  
**Website:** [www.renewableenergyindiaexpo.com](http://www.renewableenergyindiaexpo.com)

#### Intersolar India 2017

**Venue:** Bombay Exhibition Centre, Mumbai  
**Date:** 05-07 December, 2017  
**Website:** [www.intersolar.in](http://www.intersolar.in)

### International

#### 18<sup>th</sup> POWER Sri Lanka 2017

**Venue:** Sri Lanka Exhibition & Convention Centre (SLECC)  
**Date:** 14-16 July 2017  
**Website:** <http://cems-powerseries.com/powersri/>

#### Vietnam ETE 2017

**Venue:** SECC, Ho Chi Minh City  
**Date:** 19-22 July, 2017  
**Website:** [www.vietnam-ete.com](http://www.vietnam-ete.com)

#### ENERGETAB

**Venue:** Bielsko-Biala, Poland  
**Date:** 12-14 September, 2017  
**Website:** [www.energetab.pl](http://www.energetab.pl)

#### 12th International Wire & Cable Trade Fair for Southeast Asia

**Venue:** BITEC Bangkok, Thailand  
**Date:** 19-21 September 2017  
**Website:** <http://www.wire-southeastasia.com/>

<< Recognition

## ISRO Felicitates KBL for Hypersonic Wind Tunnel Project

Recognising Kirloskar Brothers Limited's capabilities to execute complex engineering projects amidst challenging environments, Indian Space Research Organisation (ISRO) felicitated the leading global fluid management company for successful completion of the project related to cooling piping system at its Vikram Sarabhai Space Centre (VSSC) at Trivandrum in Kerala. At a ceremony to recognise the prestigious vendors for their contribution to accomplish the task of national importance and pride, ISRO Chairman A S Kiran Kumar felicitated Vishnu K, KBL engineer associated with the project. ISRO recently commissioned a Hypersonic Wind Tunnel at the VSSC at Trivandrum. Notably, the Hypersonic Wind Tunnel at the VSSC facility at Trivandrum is the third largest wind tunnel in terms of size and simulation capability in the world. Kirloskar Brothers Limited (KBL) designed, supplied, erected and commissioned the cooling piping system for this facility through its engineering partner L&T.

According to ISRO Chairman Kiran Kumar, commissioning of such facilities would help in future space transportation systems and it will further strengthen our space venturing capabilities. Hypersonic Wind Tunnel can simulate flow speeds of Mach 6 to 12 with Reynolds Number up to 80 million per metre, while shock tunnel can simulate flight velocities up to 4.5 kilometres per second at a maximum stagnation pressure of 350 Bar. Hot



Shut-off Valves (HSVs) are the most critical valve components in the Hypersonic Wind Tunnel, operating at high pressures and temperatures as high as 1550° K. Other important components of this system include nozzle, test section and diffuser. Contoured nozzles are used to generate Mach 6, 8, 10 and 12 flows. The cooling system helps to keep the metal temperature within permissible limits (ambient temperature). The HSVs endure high temperature; hence, an elaborate cooling system is required independently for each valve element such as valve body, actuator stem and gate seat ring. The other system which requires cooling is the 'nozzle system'. The system requires three different ranges from minimum to maximum conditions for three interchangeable nozzle equipment. 15





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- Thermocouple Extension / Compensating Cable
- Importers of European branded PV Solar Cables for PV application, Rubber Cables & Special Cables
- SY (Steel Braided) Control Cables
- CY (Tinned Copper Braided) Control Cable

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Tel.: +91 80-26662172, 26860166, 26665344 • Fax: +91 80-26667339 • mail: [info@sbeecables.in](mailto:info@sbeecables.in)

## Power quality analyser gives Class A versatility

With the increased sophistication of electrical and electronic equipment, and new micro generation systems being added to the grid, there is now more than ever attention being paid to the quality of supply. Power quality surveys on electrical noise, lamp flicker, load balancing, power factor correction and motor in-rush studies can all be carried out with Megger power quality analysers.

The versatile MPQ1000 offers oscilloscope and DVM modes. In both modes it can monitor and record power, energy, RMS voltage and current, harmonics, inter-harmonics, harmonic direction, THD, TDD, flicker, unbalance, rapid voltage change (RVC), mains signalling and phase angle deviation as well as sags, swells and transients down to one microsecond. It also performs waveform analysis up to the 128th harmonic in real time.

Data gathered during testing can be recorded by simply pushing a button. The instrument automatically detects current clamps, recognises the range, identifies the nominal voltage and sets the triggers, after



which it verifies that the unit is properly connected before allowing a test to commence.

On-board data analysis is provided, and a removable SD card can be used to expand the instrument's memory capacity easily and inexpensively. All data recorded can be viewed on the integral VGA colour display and can also be transferred to Megger's power quality analysis software for more advanced analysis, reporting and archiving.

The PC-based software supplied at no extra cost with the analyser automatically creates custom configurations based on user requirements and facilitates tailored automatic data analysis. It also allows users to create their own analysis templates that can be loaded into the analyser.

To complement its versatile handheld MPQ1000 power quality analyser, Megger offers flexible current clamps that have four selectable ranges from 0 to 6000 A.

**For further information:** [en.megger.com](http://en.megger.com)

## FLIR provides professional thermal imaging cameras

The new FLIR T500-Series has the features professionals need to accurately troubleshoot hot spots and potential faults. With the 180° rotating lens platform and a bright 4" LCD, FLIR T530/T540 cameras are engineered to help users diagnose hard-to-reach components in any environment. Advanced on-camera measurement tools, laser-assisted autofocus, and FLIR's industry-leading image quality ensure you will find and diagnose problems quickly. FLIR T500-Series designed to support advanced thermographers and IR service consultants in the power generation, electrical distribution, and manufacturing industries by focusing on resolution, speed, and ergonomics.

The T500-Series offers inspectors the necessary support, comprehensive inspections in challenging conditions, especially when equipment is obstructed from view or difficult to access. Scan large areas from a safe distance, ensure crisp thermal imagery and spot-on temperature readings every time with laser assisted autofocus that maximises efficiency, safety and performance, helps to make critical decisions quickly, and designed to make your work easier.

### Key Features:

- 180° rotating optical block and vivid 4" capacitive touch screen
- Up to 464x348 pixel resolution
- Temperature range up to 1500 °C



- Fast and precise laser-assisted autofocus
- Laser distance and on-screen area measurement
- Customisable work folders
- Intelligent, interchangeable AutoCal lenses
- FLIR 2-10 warranty

**For further information:** [www.flir.com/t500Series](http://www.flir.com/t500Series)

Data cables from igus for the smallest bend radii in moving applications

The latest generation of chainflex data cables with a new alloy conductor and a halogen-free TPE outer jacket is ideally suited for the smallest bend radii down to 4xd with cycle numbers of over 40 million strokes. The new high-performance conductor alloy from igus is the solution for highly dynamic, fast applications with small radii from 15 millimetres. The new chainflex series CF298 and CF299 are a unique cable series for extremely heavy duty at the smallest radii, and can be delivered from stock.

Dynamic applications with very small bend radii can quickly allow the copper cores of conventional cables to meet their mechanical stress limits. For confined spaces, igus has now introduced the new data cable series in the product range. The CF298 (unshielded) and the CF299 (shielded) have been tested intensively in the largest test lab in the industry with a floor space of 2,750 square metres, and have qualified for small bend radii down to 4xd in continuous motion. This enables igus to offer on the market the smallest bending factor for moving data cables in e-chains. This is made possible mainly by the



combination of the new high-performance alloy conductor material and the highly flexible igus TPE outer jacket, which prevents cracks and breaks. The jacket material additionally offers the highest possible abrasion resistance in combination with energy chains from igus.

For extremely heavy duty and tough environments

The new generation of igus data cables is ideal for short, very quick movements, for example, in pick-and-place machines or other very fast handling applications. They are also suitable for both indoor and outdoor applications due to their resistance to UV, low temperature and oil. Since the cables are certified according to ISO Class 1, they can also be used in clean rooms. The new data cables are designed for up

to 40 million double strokes in e-chains. As a result, igus guarantees a life of 36 months here too, as for all chainflex cables. The CF298 and CF299 are now available from stock with various number of cores and conductor nominal cross-sections.

For further information: [www.igus.in](http://www.igus.in)

Rishabh unveils Rish Insu 5Dx

Considering the ever increasing demand of electricity, there is always a need of newer ways to satisfy the same with an increase in number of generating stations & to facilitate an uninterrupted power supply. The prior is a long term activity but the latter can be achieved by various ways that includes one of the major method - the periodic maintenance. In order to enable & empower government & private utilities, to have a complete diagnostic sculpture of all the constituents in the power system, Rishabh Instruments Pvt. Ltd. is here with a perfect solution – the Rish Insu 5Dx.

The Digital Insulation tester 'Rish Insu 5Dx' designed to perform professional insulation resistance measurements with test voltage programmable up to 5kVDC and wide measurement range up to 10Tohm which permits a large application for each industrial LV environment (test on electrical machines, power transformers, electrical cables, switchboard panels, generic devices, etc...). Three different function modes are available on meter: FIX mode (fixed test voltage), ADJUST mode (programmable test voltage) and RAMP mode (programmable test voltage and duration time with up to 3 kind of selectable ramps) which permits to reach correct results in each situation. The Polarization Index (P.I) and Dielectric Absorption Ratio (D.A.R) available features are duration tests which permits to define a good behaviour of the global insulation. The Insulation tester Rish Insu 5Dx is powered by a NiMH rechargeable battery with integrated adapter that permits to reach great performances during the measurements, it has an internal memory for saving results and a RS-232 interface for connection to PC and transfer saved measurements. All structure is fitted in a portable hard carrying case which assure safety typical of a 'on field' Digital Insulation Tester.

For further information: [www.rishabh.co.in](http://www.rishabh.co.in)

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## Briggs & Stratton unveils first inverter generator for home backup

At more than 60 % quieter (As tested per ISO3744 sound power standard when compared to standard generator 030607), 30 % lighter and 45 percent more compact than a standard generator (Versus a standard generator 030607), the new Briggs & Stratton Q6500 QuietPower Series inverter generator (Per ANSI/PGMA G300-2015) introduces category-changing innovations to the generator market. Its fully-enclosed, impact-resistant shell significantly reduces noise and its lightweight compact design answers unmet needs among generator owners.

The innovation behind the Q6500 was a collaborative effort between the Global Engines & Power Group and Global Turf & Consumer Product

Group at Briggs & Stratton. A recent study by the outdoor power equipment manufacturer uncovered quieter operation, improved fuel efficiency and lower weight were among the top six unmet needs of generator shoppers (Proprietary research conducted for Briggs & Stratton by Relevation Research). The Q6500's integrated engine and alternator configuration reduces overall weight and space, and simplifies airflow, allowing for complete enclosure which results in lower noise.

### Q6500 Details

- 306cc integrated engine/alternator allows for big power without the weight and bulk
- Up to 14 hour run time at 25 % load
- Impact-resistant shell encloses an all-steel frame for additional noise reduction and protection
- Lightweight design and telescoping handle for effortless storage and maneuverability
- Four GFCI 120V-20A outlets, one 120V-240V locking outlet and two USB outlets
- 6500 starting watts (Starting Watts is the maximum current that can momentarily be supplied when starting a motor, multiplied by the generator's rated voltage) delivers enough power to keep essential appliances and electronics up and running (If connecting a portable generator into your home electrical system, have a licensed electrician install an Emergency Manual Power Transfer System)
- Muffler and balancer minimises noise

**For further information:** [www.briggsandstratton.com](http://www.briggsandstratton.com)



## The first voltage tester that also measures current

Both instruments in the testo 755 current/voltage tester family are the first of their kind: voltage testers which meet the latest standard and which can also measure current. This means they are suitable for virtually all daily electrical measuring tasks. Each time

they are used they automatically select the right settings and therefore prevent dangerous incorrect settings. Both instruments have all the important functions for determining voltage/de-energization, for measuring current and resistance, as well as for continuity tests. In addition, the integrated torch enables dark spots to be illuminated.

The measuring tips can be changed easily, so that the whole instrument does not need to be replaced in the event of damage. The testo 755-2 model is differentiated by the larger current range of up to 1,000 V and special functions, such as the single pole phase testing and rotating magnetic field measurement.

- Automatic measurement parameter detection
- Certified according to voltage tester standard
- DIN EN 61243-3:2010
- Measurement result without any switching on or selection
- Measuring point illumination
- Exchangeable measuring tips

**For further information:** [www.testo.in](http://www.testo.in)



## Electrical Test & Measuring Solutions

**Turns Ratio Meter**

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**Digital Microhm Meter**

**Static Frequency Converter (EPS)**

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**Cast Resin Standard PT**

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**Regd. Office :** 279-D, Defence Colony, Jajmau, Kanpur -208010, U.P.

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## AEG Power Solutions unveils Protect Plus S500, flexible stand-alone UPS

**A**EG Power Solutions, a well known global provider of power electronic systems and solutions for industrial power supplies and renewable energy applications, unveiled Protect Plus S500, its new transformer-less UPS that combines high efficiency values with a compact footprint and flexible configurations. Reducing overall cost of ownership, this latest addition to AEG PS range is the system of choice to protect critical loads for small and medium applications where low power consumption, ease of maintenance and space are important considerations.



With Protect Plus S500 AEG Power Solutions is completing its transformer-less UPS range, protecting mission critical applications from 400 VA to 4 MVA, thus providing Data &IT or industrial players the solution of choice they need to secure power and ultimately data, infrastructure or people.

The Protect Plus S500 is a double conversion UPS (VFI SS 111). Its Eco mode allows secured operation up to 99%, thus reducing the utility costs associated with operating a device of this type. Moreover, it produces less heat waste resulting in minimised air conditioning costs. System AC/AC efficiency is up to 95.5 %.

Primarily designed for high availability ease of maintenance is an integrated design factor for the Protect Plus S500 which includes removal able internal modules contributing to low MTTR (mean time to repair). The hot connection and disconnection of parallel units and the CAN bus based distributed control systems, ensures optimum load sharing and allows the system to be easily expanded up to 6 units, both in power parallel or N+x redundancy. The wide range of options available makes this UPS ready for all the business critical applications.

**For further information:** [www.aegps.com](http://www.aegps.com)



# Ramakrishna Electrical Winding Works

Opp. Boat Club, Pithapuram Road, Kakinada - 533003. (A.P)

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Email: rkelecworks2003@yahoo.co.in Visit us : www.rkeww.com



- ❖ Complete Rewinding of 375 MVA, 17 KV, 3000 RPM Water Cooled Stator, Hydrogen cooled Generator with Hallow Conductors, trasposed coils (Robal bars) at Al-Zour South Power Generation & Water Distillation Plant, Kuwait.

An ISO 9001:2008 certified company

## Field of activities

- ❖ Repair, Rewinding, Overhauling & testing of rotating electrical machines (Steam/Gas/Hydro) Generators of lower, higher voltages & power ratings more than 250 MW & Power Transformers (220 KV)
- ❖ Manufacturing of Transposition coils and remaking the same.
- ❖ Commissioning of all electrical equipments.
- ❖ Dynamic balancing of Rotors, Fans & Impellers.
- ❖ Generators Redesigning & uprating of capacity of existing machines without disturbing the rotor winding.
- ❖ Redesigning of cooling systems like air cooled to water cooled and vice versa.
- ❖ Redesigning with change in voltage like 415V to 660 volts or 3.3KV to 6.6KV or 11KV to 15KV & vice versa.

## Profile

- ❖ RKEW is one of the premier and experienced service outfit in the field of electrical motors, generators and transformer repair in India.
- ❖ RKEW an exclusive expertise in executing Repair/Rewinding & Refurbishment of worst damaged industrial steam generators, motors & power transformers. It extends expert service to various locations of its large industrial clients spread across the globe.
- ❖ RKEW team that includes management, technical & skilled man power understands the urgent need of its clients and is well prepared to deliver faster services (with no limitations on size of the machine) to client's satisfaction.

Authorised Service Centre for





**Take the trouble out  
of troubleshooting.**

## **MPQ1000**

### **Handheld Power Quality Analyzer**

The Megger MPQ1000 Power Quality Analyzer is Class A compliant and rated CATIV at 600V. It can be used for a wide variety of applications including substation monitoring, equipment and breaker tripping, load studies and balancing as well as for switchgear and component failure.

Some of its features include:

- Automatic CT recognition
- Automatic connection verification
- On-board data analysis
- SD card and USB stick support
- 1000 V ac and dc range
- Scope and DMM modes
- CATIV @ 600 V
- IEC61000-4-30 Class A compliant

**Power on with Megger.**



**For a free product demonstration,  
register on [tiny.cc/MPQdemo](http://tiny.cc/MPQdemo)  
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- C, O, C-O with bounce time measurement
- Built-in Thermal Printer \*
- Internal memory for 100 records
- USB interface for data transfer & report \*
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For more information call us on 1800 209 1800

[siemens.com/sinamics-g120c](http://siemens.com/sinamics-g120c)