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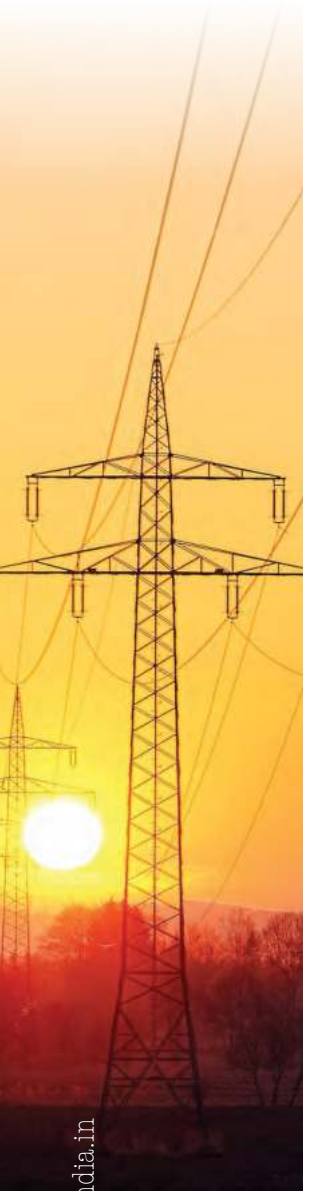

GTAM - A Great Step

With a view to encouraging the renewable energy developers, a mechanism called Renewable Purchase Obligation or RPO was designed under Section 86(1) (e) of the Electricity Act 2003 ("EA 2003") and retained under the National Tariff Policy 2006. Under this mechanism, the obligated entities are obliged to purchase certain percentage of electricity from Renewable Energy sources, as a percentage of their total consumption of electricity.

With the amendment of Tariff Policy in January, 2016, the State Electricity Regulatory Commissions (SERCs) were required to reserve a minimum percentage for purchase of solar energy, which should be such that it reaches 8% of total consumption of energy, excluding Hydro Power, by March 2022 or as notified by the Central Government from time to time. The Government of India in July, 2018 notified the Long Term growth trajectory of RPOs for Solar as well as Non-solar, uniformly for all States or Union Territories, reaching 21% of RPO by 2022 with 10.5% for solar based electricity.

However, still something more was required, to attract, involve and incentivise the country-wide RE-generators to make them increase their stake in the Green Energy generation beyond their respective state's aggregated purchase obligation. Now, with the launch of Green Term Ahead Market (GTAM) for electricity, the RE-generators will have much wider sales potential.

Obviously, through GTAM contracts, now the RE-generators will get access to a much wider market to sell their generated renewable energy. The obligated entities will be able to procure renewable energy at competitive prices. It will also create an effective platform for the environmentally conscious open access consumers and utilities to buy green power.

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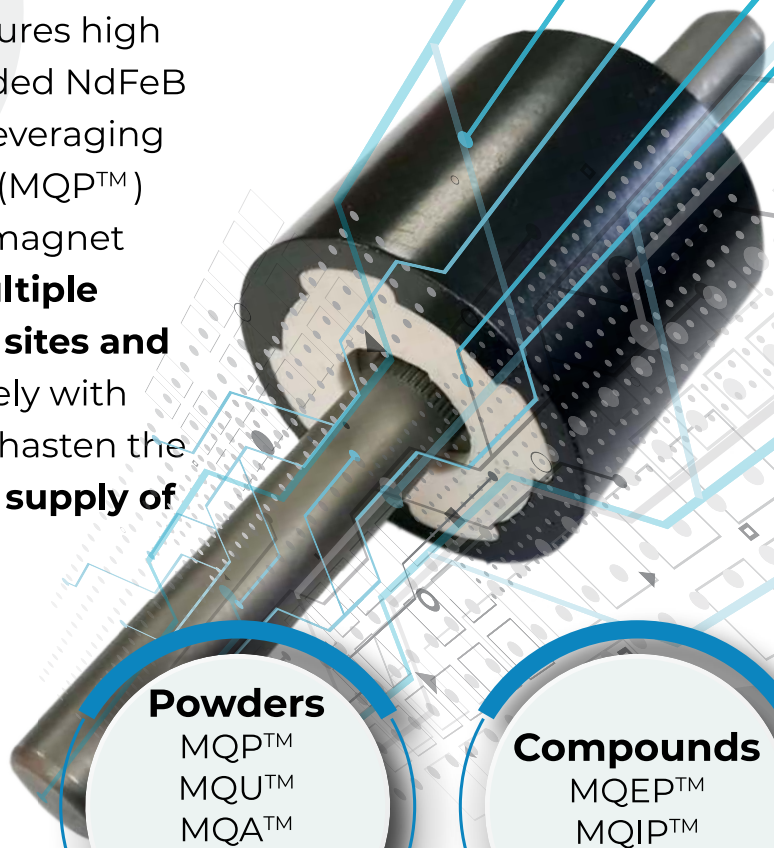

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TIME EXTENSION IN SCHEDULED COMMISSIONING

Through a memorandum issued on 13 08 2020, the Ministry of New & Renewable Energy (MNRE) under the present union government has asked all concerned to treat the delay on account of disruption of the supply chains due to spread of corona virus in China or any other country, as Force Majeure and that they may grant suitable extension of time for projects, on account of corona virus, based on evidences or documents produced by developers in support of their respective claims of such disruption of the supply chains due to spread of corona virus in China or any other country.

The memorandum has also stated that all RE projects under implementation as on the date of lockdown, i.e., 25th March 2020, through RE Implementing Agencies designated by the MNRE or under various schemes of the MNRE, shall be given a time extension of five months from 25th March 2020 to 24th August 2020. This blanket extension, if invoked by the RE developers, will be given without case to case examination and no documents or evidence will be asked for such extension.

This decision has literally revitalised the morale of the industry. However, some stakeholders are still worried about the government's future plans of imposing more taxation on the RE segment.

Revealing the sign of temporary relief, Ritu Lal, Head of Institutional Relations, Amplus Solar, said, "Developers had been making several representations to the MNRE on the matter for the last few months. We thank the Ministry for taking note of our concerns on this issue and allowing us this much required extension."

However, considering the present situation, Pinaki Bhattacharyya, Co - Founder and CEO at Amp Energy India, said, "This is a positive move by MNRE and showcases their intent of helping the sector tide over these tough times by providing the developers sufficient extension timelines. Having said that, the government should not impose more trade barriers after extending SGD such as Basic Customs Duty. The power costs have already gone up, any additional duty will further increase the cost of power for consumers and this would not a great move given the current situation." It's evident that Bhattacharyya's concern has a strong ground. ■

Electrical India

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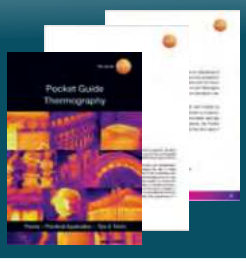

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IEX ELECTRICITY MARKET TRADES 5467 MU IN AUGUST 2020

The electricity market at the Indian Energy Exchange trades 5467 MU in August'20 witnessing a 1% increase over volume traded in August'19. The national peak demand in the same period sees a 6% YoY decline while the energy consumption declines 2% in August 20 according to the data issued by the NLDC.

Image by Gerd Altmann from Pixabay

The day-ahead market traded 4484 MU during the month with average market clearing price at Rs. 2.43 per unit. The price saw a significant 27% YoY decline over Rs 3.32 in August'19. The attractive prices made electricity procurement from the exchange an attractive proposition for both the distribution utilities and industries yielding significant savings.

The day-ahead market sees adequate availability of power with high sell side liquidity. The total sell bids at 10,123 MU were twice of the buy bids at 5081 MU.

The distribution utilities from states such as Southern, Western and Northern states continued to leverage the exchange market to meet their short-term electricity requirements. Moreover, as the COVID restrictions ease, industries have been procuring power at attractive prices that has been facilitating revival of industrial growth.

One Nation One Price prevailed during all 31 days during the month.

The trade in the term-ahead market at 115 MU increased 97% MoM basis indicating continued acceptance of TAM contracts by the distribution utilities for meeting their short-term power requirements.

GREEN MARKET WAS LAUNCHED ON 1ST SEPTEMBER 2020

Markets to enable trade in renewable energy on pan India basis in transparent, flexible, competitive, and efficient manner.

In an event organized by Ministry of Power on 1st September 2020 R.K. Singh, Minister of State, Independent Charge for Power, New & Renewable Energy and Skill Development and Entrepreneurship launched the 'Green Markets'.

Minister Singh said: "The commencement of green markets has positioned India of the league countries with the developed electricity market. The markets are aligned with the Honorable Prime Minister's vision to build India as a sustainable Energy Economy. Going forward, we expect the introduction of several new and innovative market products to deepen the green markets as well as work on the integration of storage and other new technologies towards assuring round the clock and firm renewable energy. The government is pro-actively working with the stakeholders in this direction."

Sanjeev Nandan Sahai, Secretary (Power) said: "The launch of green markets is a significant development for the energy ecosystem. The markets offering payment assurance for renewable energy generators will be a good indicator to guide much-needed investments in the renewable sector."

S.N. Goel, MD & CEO, IEX stated: "Introduction of green markets will facilitate to build a vibrant pan India market in renewable energy. The generators will now be able to commit part capacity under PPA as well as sell the energy in the market. The recently launched real-time electricity market coupled with the green term-ahead market will offer distribution utilities to integrate renewable energy efficiently."

EESL TO PROCURE 250 ELECTRIC VEHICLES

Energy Efficiency Services Limited (EESL) will procure 250 electric vehicles from Tata Motors and Hyundai Motor India. The companies were selected through an international competitive bidding process, which was aimed at increased participation. Tata Motors Limited (TML) and Hyundai Motor India Limited (HMIL) won the tender and now will supply 150 Nexon electric compact SUVs & 100 Kona electric premium SUVs respectively for government's use. The letter of award for the procurement was presented to the two companies, in the presence of Guenter Butschek, CEO & MD, Tata Motors, Shailesh Chandra, President, Passenger Vehicle Business Unit, Tata Motors and Tarun Garg, Director – Sales, Marketing & Service, Hyundai Motor India Ltd. This procurement will utilize 5 Million from the recent grant provided by the Asian Development Bank (ADB). EESL has received financing from ADB towards the cost of scaling up and financing high priority areas like Demand Side Energy Efficiency Sector Projects. Commenting on the decision, Saurabh Kumar, Executive Vice Chairperson, EESL said, "A shift to EVs, facilitated by our e-mobility programme will reduce dependence on oil imports and promote power capacity addition in India. This will greatly enhance the energy security of the country and will also lead to reduction in GHG emissions from the transport sector. Furthermore, we're also working on rapid establishment of EV charging stations, which will give a fillip to the electric vehicle sales, going forward."

EESL procures 150 Tata Nexon electric vehicles...

SCHNEIDER ELECTRIC INDIA PRIVATE LIMITED TO SUPPORT MAKE IN INDIA

The combined business of Larsen & Toubro's Electrical & Automation business and Schneider Electric India's Low Voltage and Industrial Automation Product business – Schneider Electric India Private Limited (SEIPL), owned 65% by Schneider Electric, and global investment company Temasek owns the remaining stake. In the mission of boosting India's economic growth and supporting the government's vision of an Atmanirbhar Bharat, SEIPL will provide a wide range of products and technologically superior solutions with pan India geographical reach.

Jean-Pascal Tricoire, Chairman & CEO, Schneider Electric said: "The coming together of Schneider Electric and L&T's Electrical & Automation business combines two great teams highly professional and specialised in the space of energy management, automation, and passionate about technology, innovation, quality, safety, sustainability, and social responsibility. This newly merged company will serve the priorities of India: Make in India for India and the rest of the world, Digital India, Skill India, Sustainable Energy, Smart Cities & Infrastructure for self-reliance, to bring tremendous value to our customers and stakeholders, employees, partners, suppliers, and community in which the company develops. We are also proud to partner with Temasek, who bring along their deep knowledge of India, and their coaching to help to develop the export of the company. This major strategic move will make India, Schneider Electric's third-largest business in the world, and one of the four major global Schneider hubs for global R&D, global manufacturing."

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BLOOM ENERGY PARTNER WITH SK E&C

Bloom Energy and SK Engineering and Construction (SK E&C) have announced that they have powered on two new clean energy facilities with fuel cell technology in the Gyeonggi province of South Korea. Located respectively in the cities of Hwasung and Paju, these new installations use Bloom Energy's non-combustion, electrochemical process to produce electricity with low and predictable energy costs, enhancing reliability and reduction in carbon emissions.

Image by Adam Radosavljevic from Pixabay

The first power plant, located in the historic city of Hwasung, boasts a 19.8-megawatt fuel cell deployment of Bloom Energy Servers – the largest Bloom Energy project in South Korea to date and the company's second-largest in the world. The second plant located in the city of Paju consists of an 8.1-megawatt fuel cell deployment of Bloom Energy Servers designed to power nearly 18,000 homes in the area.

KR Sridhar, Founder, Chairman and CEO, Bloom Energy said: "South Korea is clearly on the leading-edge of our world's energy future, this utility-scale deployment of fuel cells is a powerful proof point of its ambitious energy plan. Bloom Energy is proud to support this visionary effort to make clean, reliable, resilient and adaptable power generation."

Jason Ahn, President and CEO, SK E&C explained: "We must all be thinking about how to provide the energy needed today while also contributing to the betterment of our air and environment. Embracing technology advancements like those from Bloom Energy, address energy needs and benefits to the environment and society."

In July 2020, Bloom announced plans to enter the commercial hydrogen market by introducing hydrogen-powered fuel cells and electrolyzers that produce renewable hydrogen. These products will be first introduced to the South Korean market in 2021 through an expanded partnership with SK E&C.

MULTITECH LTD. TRANSFERS OWNERSHIP

ENGIE decided to sell MultiTech Ltd. to a company that could refocus the business on profitable growth opportunities in the Toronto market...

ENGIE that acquired MultiTech Ltd. has transferred the ownership on 1st September'20 to an affiliate of Beswick Corporation, part of a group of companies owned by David and Kevin Beswick, investors in the greater Toronto area in Canada.

Image by Michal Jarmoluk from Pixabay

Gwenaelle Avice-Huet, Executive Vice-President, ENGIE Renewable business line and CEO, ENGIE North America stated: "Appreciate the dedication of both the local MultiTech team and the ENGIE professionals that allowed for the best option for both parties and a successful transfer of ownership to the Beswick Corporation."

David Beswick & Kevin Beswick said: "On behalf of Beswick Corp Management, our current employees and families, we look forward to welcoming our new team in servicing and growing our local areas. As a tier-one, locally family owned multi-trade organization, we are committed to growing MultiTech and remaining at the forefront of the industry."

IGUS INITIATES IGUS GREEN CHAINGE RECYCLING PROGRAM

With 'igus green chainge recycling program', the motion plastics specialist igus is now doing something completely new: users can send their plastic chains to igus for recycling – completely irrespective of the manufacturer. The igus green chainge recycling program will start in Germany and then be implemented locally in many other markets such as China, the USA, Japan, Taiwan and Korea.

Clean the chains...

The program aims to recycle plastic from energy chains and reuse them for new products. To this end, users can send their old out-of-use plastic energy chains to igus after cleaning them – completely irrespective of the chain's actual manufacturer. The plastics are then sorted, cleaned, shredded and packed. After this, they can be reused by igus or other companies to produce high-quality technical products. In return, the customer receives a voucher amounting to 0.78 euros per kilogram.

Frank Blase, CEO, igus GmbH said: "With igus chainge recycling program, ingus aims to contribute to a reduction of plastic waste and improvement the recycling process. As the world's biggest manufacturer of plastic energy chains, we already recycle 99% of the plastic waste that occurs in production to reuse it as re-granulate. The chainge program is now the next important step in the direction of sustainable business operations."

ORIGIS ENERGY'S SOLAR PROJECT FUELS CLEAN ENERGY

The solar industry's role in rebuilding the American economy battling the COVID-19 crisis is being announced by leading corporations, congressional leaders, 650 companies within the industry and clean energy-related organizations.

Image by skeeze from Pixabay

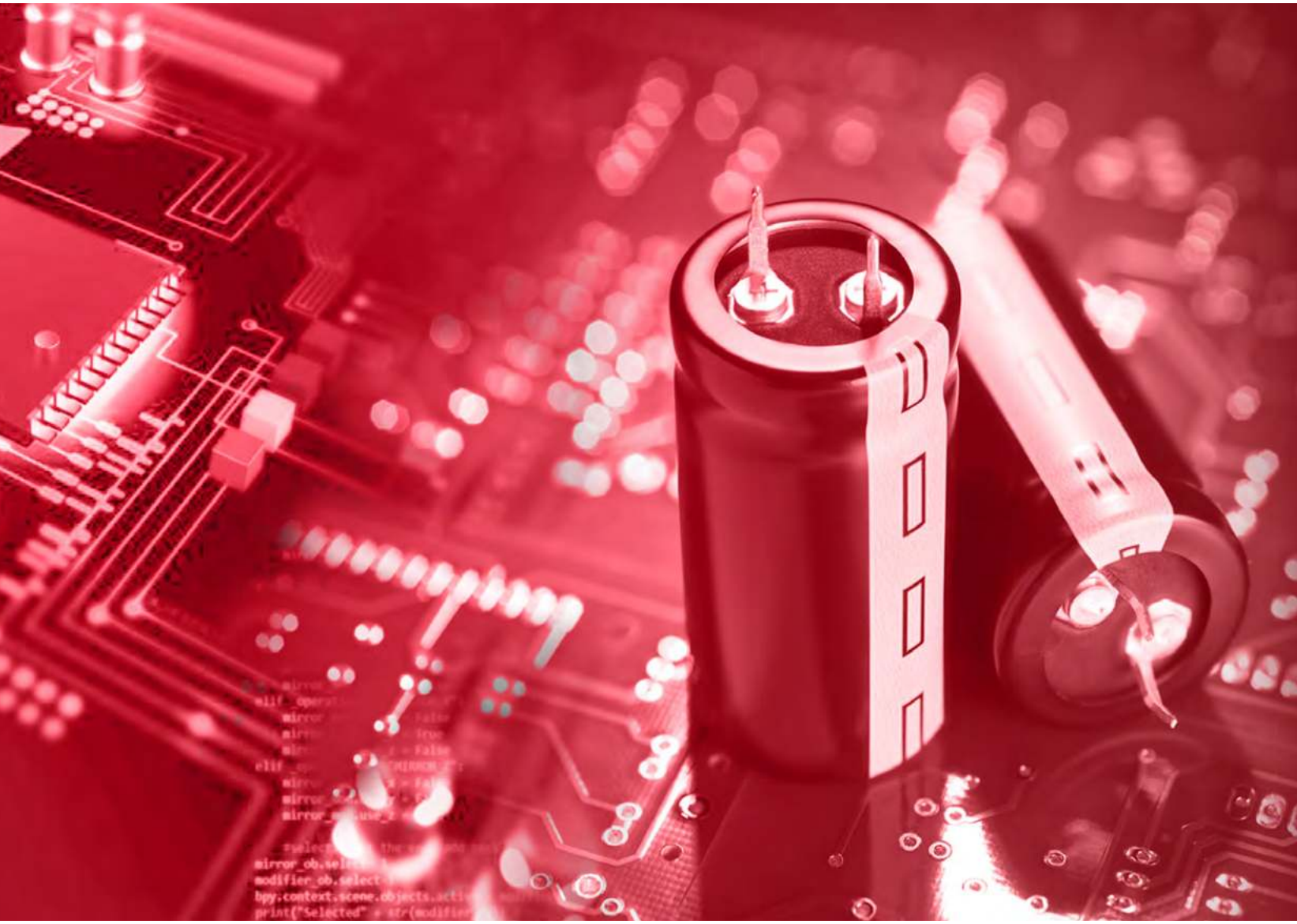
Guy Vanderhaegen, Chief Executive Officer & President, Origis Energy said: "With over one gigawatt (GW) of operational solar projects and nearly three GW in contracted projects to be completed by the end of 2023, Origis Energy is delivering the economic benefits of clean energy to communities across the country. There is more to come as we develop a 15 GW pipeline putting clean energy, and the economic benefits it creates, within reach of more Americans." He added: "The timing of these efforts could not be better as the contributions of large scale solar and energy storage are more likely localized in rural regions where the rebuilding effort is vital."

Johan Vanhee, Chief Commercial Officer & Chief Procurement Officer, Origis Energy said: "Economic development not only was a sound basis for our team reaching these significant milestones, they increasingly drive our future growth. Without the trust and support of so many customers, utilities and large Fortune 500 companies, underwriting the importance of our local communities, Origis Energy would not have become a leader in the new economy of renewable energy in America."

PEEPING INTO THE PE COMPONENTS

Developments in the field of Power Electronics (PE) are directly being influenced by the socio-economic, environmental and political forces. In fact, in the twenty-first century, the growth of the PE segment is complementary to the advancement of the societies and/or economies…
- P. K. Chatterjee (P. K.)

Power Electronics has been so ubiquitous today that attempting to define the subject in a few words is next to impossible. Broadly speaking, this is the field of engineering science that deals with conversion of electric power from one form to another. According to a very simple definition from Wikipedia, "Power electronics is the application of solid-state electronics to the control and conversion of electric power." It is quite astonishing to note that



around 80% of the total power generated globally is reprocessed through some form of power electronic systems. Quite naturally, the subject attracts high degree of importance as it deals with power conversion efficiency that is related to almost every electrical machine or plant design.

Background of the development

Literally the history of the application of power electronics goes back to 1902, when Peter Cooper Hewitt, an American electrical engineer and inventor of mercury-vapour lamp, invented the mercury arc rectifier, the first rectifier or the forefather of the modern rectifiers that convert AC (Alternating Current) to DC (Direct Current) without using any mechanical means.

The real breakthrough came in 1959 with the development of MOSFET (Metal Oxide Semiconductor Field Effect Transistor) by Mohamed Atalla and Dawon Kahng at Bell Labs. They started gaining huge popularity due to some salient advantages including low gate drive power, fast switching speed, easy advanced paralleling capability, wide bandwidth, ruggedness, easy drive, simple biasing, ease of application and ease of repair.

Yet another device called IGBT (Insulated Gate Bipolar Transistor) came to the market in 1982. This is a three-terminal semiconductor switching device

Nenad Grujic on Unsplash.com

capable of fast switching with high efficiency. It has the power handling capability of the bipolar transistor and the advantages of the isolated gate drive of the power MOSFET. IGBT finds wide application in amplifiers for switching or processing complex wave patters with Pulse Width Modulation (PWM).

Applications of MOSFET & IGBT

MOSFETs and IGBTs are nowadays selectively used in power electronics according to the required I/O characteristics. In the low-current region, the MOSFET exhibits a lower on-state voltage than the IGBT. However, in the high-current region, the IGBT exhibits lower on-state voltage than the MOSFET, particularly at high temperature. IGBTs are commonly used at a switching frequency lower than 20 kHz because they exhibit higher switching loss than unipolar MOSFETs.

The market driving forces

Today, the power electronics technology has reached a remarkably mature stage after several years of dynamic evolution of semiconductor devices, converters, PWM techniques, electrical machines, motor drives, advanced control and simulation techniques. The day is not far when today's flow of 80% of total (globally) generated power through power electronic systems will become 100%.

The major driving forces are: speeding up of global industrialization, upgradation of general energy systems, meticulously undertaking the energy saving drives, rapid development in renewable energy harnessing and strategic deployment of electric or hybrid vehicles.

Whether it is conversion from AC to AC, AC to DC, DC to DC or DC to AC, everywhere we need application of power electronics. A little consideration will show that tackling challenges of climate change is directly related to the development of power electronics – as it has a lot to

deliver in the emerging and growing fields of energy saving, renewable energy harnessing, bulk energy storage development, and plying electric or hybrid vehicles.

MOSFET & IGBT Gate Drivers Market 2020

According to a recent market survey by Expresswire (Published by MarketWatch), the "Global 'MOSFET and IGBT Gate Drivers Market' is expected to grow at a CAGR of roughly 5.2% over the next five years, and will reach 1750 million USD in 2024, from 1290 million USD in 2020."

The report also states, the"United States had the largest global export quantity and manufacturers in MOSFET and IGBT Gate Drivers market, while the Europe was the second sales volume market for MOSFET and IGBT Gate Drivers in 2017.

In the industry, Infineon Technologies profited most in 2017 and in the recent years, ON Semiconductor and STMicroelectronics ranked 2 and 3. The market shares of them were 18.27%, 13.48% and 9.42% respectively in 2017."

Highlighting the market operation and potential, the report states, "The gap of market share is being enlarged due to different strategies. Nowadays, there are five main types of MOSFET and IGBT Gate Drivers, including Single Channel Gate Drivers, Half-bridge Gate Drivers, Full Bridge Gate Drivers, Three Phase Gate Drivers and Others. Half-bridge Gate Drivers is the main type for MOSFET and IGBT Gate Drivers, and the Half-bridge Gate Drivers reached a sales volume of approximately 232.77 M Units in 2017, with 41.94% of global sales volume."

Pointing at the business pie and the opportunity for the new entrants, the report categorically communicates, "MOSFET and IGBT Gate Drivers technology is much mature now, and new enterprises cannot surpass existing famous brands on reputation or design in the short term. So, the study group recommends the new entrants need to be careful before they decide to enter into this field.

Some of the prominent PE giants

As per Reportlinker, "While global megatrends sweeping through the market influence the primary direction of growth, regional markets are swayed by more granular locally unique business drivers. Several macroeconomic factors and internal market forces will shape growth and development of demand patterns in emerging countries in Asia-Pacific, Latin America and the Middle East."

The report also reveals, "Competitors identified in this market include, among others, ABB Group (Switzerland); Analog Devices, Inc. (USA); Danfoss A/S (Denmark); Fuji Electric Co., Ltd. (Japan); Hitachi Ltd. (Japan); Infineon Technologies AG (Germany); Littelfuse, Inc. (USA); Maxim Integrated Products, Inc. (USA); Microchip Technology, Inc. (USA); Microsemi Corporation (USA); Mitsubishi Electric Corporation (Japan); NXP Semiconductors NV (The Netherlands); ON Semiconductor Corporation (USA); Renesas Electronics Corporation (Japan); ROHM Co., Ltd. (Japan); SEMIKRON Elektronik GmbH & Co. KG (Germany); STMicroelectronics NV (Switzerland); Texas Instruments, Inc. (USA); Toshiba Corporation (Japan); and Vishay Intertechnology, Inc. (USA)."

Some of the prominent Indian players working in this field are: Analog Devices India Pvt. Ltd., Atmel R&D India Pvt. Ltd., AVX Corporation Infineon Technologies India Pvt. Ltd., EPCOS India Pvt. Ltd., Infineon Technologies India Pvt. Ltd., Insel Rectifiers Pvt. Ltd., Microchip Technology Inc., RECOM Asia Pte. Ltd., Rohm Semiconductor India Pvt. Ltd., STMicroelectronics Pvt. Ltd., Texas Instruments India Pvt. Ltd., TOSHIBA Semiconductor & Storage Products, Vicor Power and Vishay Components India Pvt. Ltd.

Looking at the future

MarketsAndMarkets recently reported, "APAC has been the fastest-growing region in terms of consumption of power electronic products and solutions compared to other regions in the world, owing to the increasing adoption of power electronics in consumer, industrial and automotive applications across various countries such as China, Japan, India and South Korea, among others." So, the growth chart indicates a good positive trend.

Further developments in the field of power electronics will mostly centre around the software development. In India beside others, we are specially focused on development of renewable energy and deployment of electric vehicles. In both of these areas, there is tremendous potential of power electronics. In fact, in another few years we may run short of power electronics experts. So, our universities must develop more courses and take up renewed R&D initiatives in this field.

SMART ASSET ANALYTICS IN POWER DISTRIBUTION SYSTEMS

This paper presents an overview of industry trends and practices in the deployment of technologies needed to support the implementation of smart asset analytics in electricity distribution systems. The paper discusses the strategic opportunities and benefits in pursuing specific applications of smart asset analytics e.g., failure prediction, asset optimization and power distribution efficiency improvements, and the role of modern innovative practices in achieving them...

Power Distribution is one of the most critical elements of the power supply value chain. It is a regulated activity and a customer inter-facing operation. A Power Distribution Company (DISCOM) has to ensure electricity supply availability, reliability and quality at all times, in compliance with the established regulatory framework and Standard Operational Practice (SOP). An efficient network asset management programme through asset planning, failure analysis and distribution efficiency improvements is essential to manage cost of operations, by reducing network breakdowns and costly asset replacements. The paper aims to evaluate and substantiate the value proposition in adopting advanced asset analytics for failure prediction, asset optimization and efficiency improvements, using modern tools such as big data, Artificial Intelligence (AI) and Machine Learning (ML).

Asset management in Power Distribution

Asset management is an important activity in power distribution system planning, operation and maintenance. It has a direct impact on a DISCOM's revenue. The maintenance of network infrastructure comprising assets across the distribution chain from the substation to the consumer premises has to reflect current best practices to meet the stress of fluctuating electricity demands. To this end, DISCOMs need to introduce asset data analytics as part of

their strategy for predicting and analyzing faults, reducing downtime and rapid system restoration.

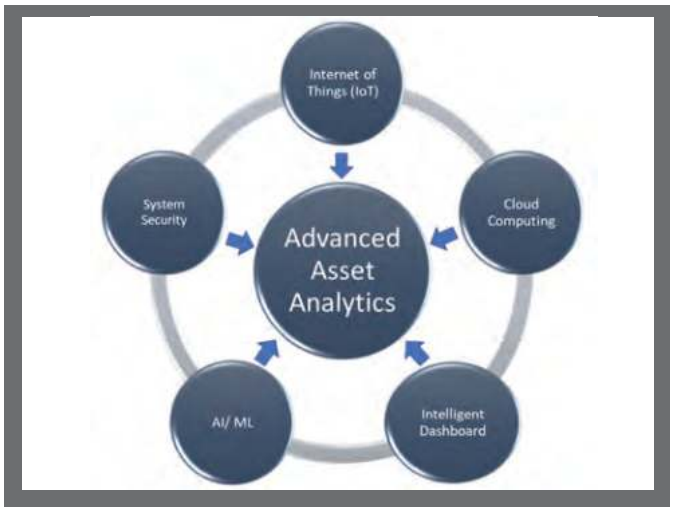
Asset data analytics uses risk-based analysis to manage performance, predict failures and control costs. It benchmarks asset performance and predicts how it is going to perform in the future. Apart from an analysis of the financial aspects of network asset performance, such as cost of downtime, there are technical, regulatory and socio-environmental aspects such as power quality, reliability and carbon footprint.

Innovations in Power Distribution automation and smart grid have resulted in the growth of intelligent devices communicating with the electrical network assets in real time and collecting vast amount of network data in the process. This data after analysis provide vital clues on the health of the electrical assets and operating conditions. A robust asset management helps plan power distribution network for profitable and sustainable operations. Efficient asset management maximizes asset value over its entire life cycle, maximizes ROI and optimizes network operations.

Advanced Asset Analytics in Power Distribution

Advanced asset analytics makes use of modern technologies for remote monitoring of network assets and enables advance warning systems for proactive network management. Recent innovations in Internet of Things (IoT), Cloud computing and AI/ ML now offer cost-effective platform for intelligent asset analytics.

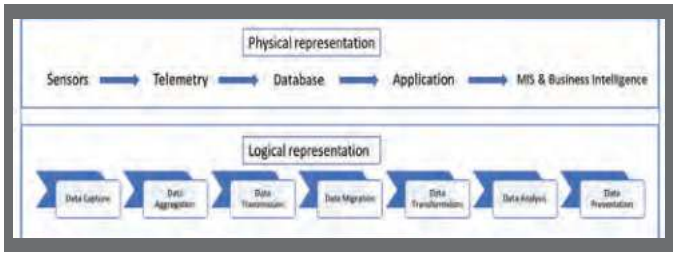
Maintenance of physical systems and associated strategies form an important part of network asset management. This includes corrective maintenance, preventive maintenance, condition-based (predictive) maintenance and proactive maintenance. Advanced asset analytics helps in planning maintenance strategy for various power system components, such as power transformers, distribution transformers, switchgears, overhead lines, underground cables and protection devices.



Accurate, timely and reliable asset information results in better decisions, leading to balancing cost, performance and risks associated with power distribution operations. Advanced asset analytics promises network efficiency improvement, asset optimization, loss minimization and carbon footprint reduction.

Technologies for Advanced Asset Analytics

Advanced asset analytics uses automated data-driven technologies to collect, migrate, process, analyze and present data to aid decision-making and improve asset performance. It involves cyber-physical implementation of asset management using sensors, telemetry, computerized data processing and business intelligence to measure and analyze asset performance data across the life cycle. Ageing infrastructure is a common problem affecting the Power DISCOMs.



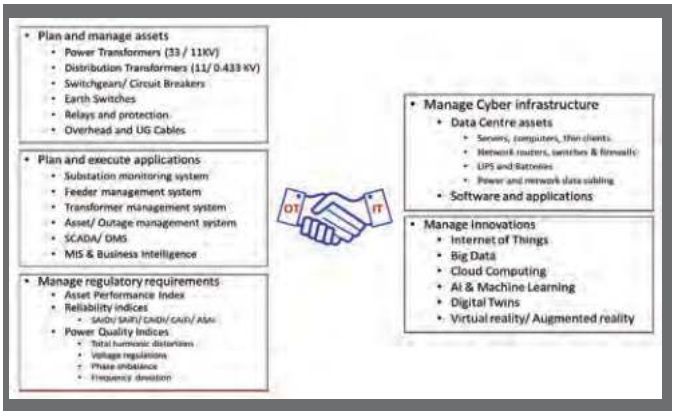
IT and OT Integration in Asset Analytics

The operation of substations, feeders, transformers, switchgears and other electrical systems responsible for the supply of electricity, as per regulatory norms and standards, comes under the domain of operational technology. Operational Technology refers to industry-specific business operations responsible for monitoring events, processes and devices, making adjustments and applying controls to run the DISCOM business operations. Information Technology provides the backend computing hardware, system software and software applications, which support the power distribution business operations. Advanced asset analytics requires integration of both Information Technology (IT) and operational technology (OT) systems.

Use Cases in Advanced Asset Analytics

Use case: Substation Feeder Monitoring System

Substation feeders are the arteries of the distribution network. Failure of substation assets directly impacts

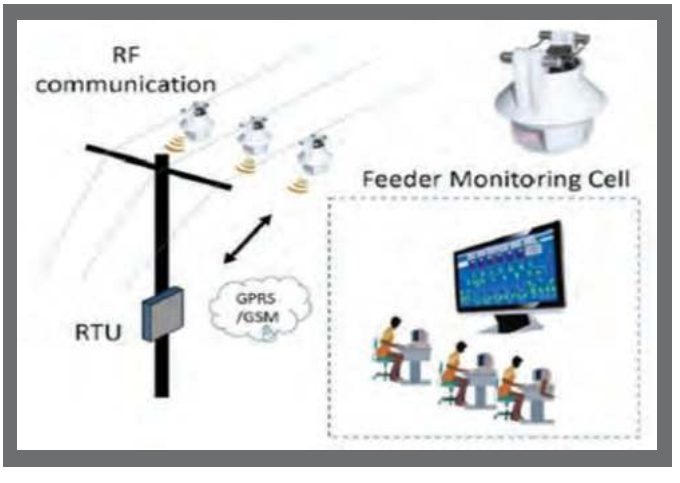


the revenues of the DISCOM, due to cost of system restoration and billing disruption.

Substation asset analytics uses information collected from Fault passage current sensors installed on LT feeders, in real time, and monitors any sign of overloading, short circuit or earth fault. The current and load signals are graphically displayed on a remote Digital Fault Recorder (DFR) and the information is utilized to ascertain possible fault conditions and location of impending fault. Early detection of an emerging fault provides operators with a better understanding of the vulnerable sections of the network and help them take preventive measures before major fault could occur.

Fault passage sensors communicate the status of the network to the Remote Terminal Unit (RTU) using RF communication, and the RTUs relay the network condition data using GSM/ GPRS communication to the Feeder Monitoring Cell, where the data is processed and analyzed by advanced asset analytics program.

By effective condition monitoring of LT distribution systems, the number and duration of the outages can be reduced drastically, thus saving the cost of maintenance and system restoration. This enables DISCOM improve network reliability, operate the network within acceptable limits and avoid regulatory penalties.



Substation feeder data analytics can yield the following tangible benefits:

- Quicker detection of a fault condition
- Determination of the location of fault
- Isolating of the faulty section of the LV network
- Re-energizing heathy sections, outside the faulty isolated section

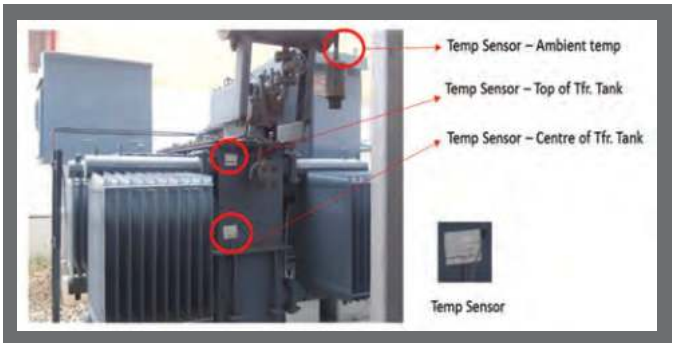
Use Case: Transformer Monitoring System

Distribution Transformer (DT) is the heart of the LV distribution networks. The health of DT needs to be monitored at all times to ensure continuous and reliable electricity supply. Failure of DT due to overloading, overheating, voltage sags and swells, harmonics and transients adversely impacts the distribution assets, asset life expectancy and network performance.

On line monitoring and analytics of DTs make use of sensors to capture the critical parameters of the transformer, analyze data and apply proactive corrections, which prevent overloading, reduce the risk of transformer failure and enhance the life of the transformer. The data is monitored remotely on a smart dashboard application, using GSM/ GPRS, Ethernet, RF or ZigBee communication. The failure of transformer in service could be due to temperature rise, low oil levels, over loading, poor quality of connections or improper installation. These abnormalities can be detected early and major faults can be averted by taking timely action, based on intelligence provided by advanced asset data analytics. As a result, DT breakdowns is drastically reduced, thus enhancing the life of the network asset.

Use Case: Power Quality Monitoring of the Network

The quality of electricity supply is an issue of growing concern among the DISCOMs. The power quality of an electricity distribution network is affected by power line disturbance such as waveform faults, overloading, capacitor switching transients, impulse transients and total harmonic distortions (THD). The proliferation of energy efficient



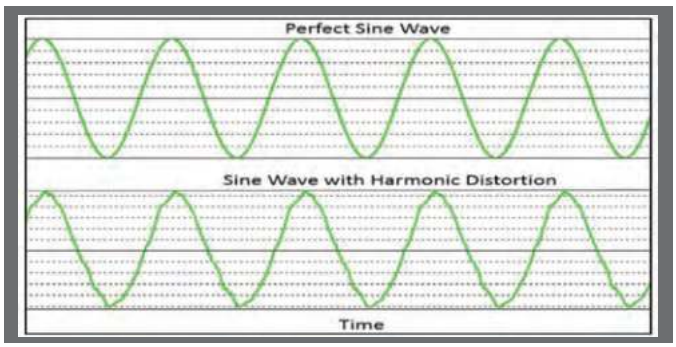
equipment, renewable energy sources and power electronics results in electrical distortions beyond regulatory limits of harmonics, as specified by IEEE 519: 2014 standard, and voltage quality index, as specified by EN 50160 standard. This can be potentially damaging to the network assets – circuits, relays, protection switches and other equipment, by causing overheating, cable faults and tripping.

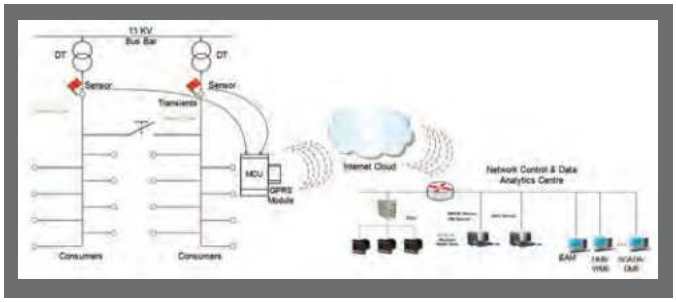
Ideally, the best electrical supply is pure, sinusoidal waveform of a constant magnitude and frequency. However, many loads are not purely resistive or linear. The presence of magnetizing current, effect of rectification and inherent impedance of certain loads may result in creation of harmonic distortions and electrical imbalance, which may degrade the power quality leading to technical losses and asset deterioration.

Various measurement instruments are used for monitoring power quality in LT distribution systems, e.g., smart meters, protection relays and fault recorders. Nowadays, IoT and Cloud-based technology are used to monitor and analyze power quality of the distribution network and its impact on asset condition. The asset condition data is collected at regular intervals and analyzed to take timely corrective measures and safeguard network assets.

IoT and Cloud-based asset condition monitoring and analytics ensure efficient and trouble-free operation of the distribution network. IoT sensors and telemetry system allow DISCOMs to record vital information regarding power quality of supply, in compliance with the power regulations. They provide real-time information for asset condition monitoring and asset analytics. The sensor records harmonics, inter-harmonic frequencies, voltage, current, active/ reactive power, power factor and frequency usually at the Point of Common Coupling (PCC) of the electricity distribution network. The asset condition data is transmitted over wireless or wired communications to Network Control and Data Analytics Centre.

The solution provides network asset visualization including THD and voltage quality parameter, allowing





early fault detection in the LT distribution network. The electrical (V, I, P, Q, PF, THD) and physical parameters (Transformer casing and winding temperature) of the network assets can be measured at user-selectable intervals. The asset parameters are aggregated in a Master Control Unit (MCU) connected to a communication gateway to transmit data to a remote intelligent dashboard. The dashboard is powered by advanced asset analytics application, which performs graphical analysis, and sends out alarms and notifications, allowing DISCOM operators to take proactive control actions. This method eliminates the use of expensive diagnostic instrumentation, such as Power Quality Analyzers and Digital Fault Recorders.

Conclusion

Advanced asset analytics is being increasingly adopted in electrical utilities across the globe for remote monitoring and real-time visualization of vital network assets of DISCOMs. The business case is justified in terms of cost reduction, asset life increase and revenue gains that it can bring, as explained in the use cases above. It can be a useful tool for the DISCOMs to manage their assets more productively with the following benefits:

- Improving cost efficiency in network operations
- Increasing life expectancy of network assets
- Compliance with regulatory standards
- Improving reliability and quality of power supply
- Minimizing technical losses and improving efficiency
- Reducing carbon footprint in asset maintenance

Advanced asset analytics can add significant value to any smart grid implementation, and therefore deserves to be given its due merit in enabling cost-efficiency, process improvement, reliability and quality in power distribution.

Jayant Sinha

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Spectrum Infra Ventures Pvt. Ltd.
Asia Power Quality Initiative (APQI) NSN Partner

Image by Ashraf Chemban from Pixabay

MOVING TOWARDS

BETTER INDIAN ELECTRICITY GRID DISCIPLINE - PART 2

The implementation of ABT was proving to be a successful tool for enforcing better grid discipline, also, as a way forward the commission and government was continuously taking various initiatives regarding better grid infrastructure. The ceiling rate has increased from 570 paise per kWh in 2002-03 to 745 paise per kWh in 2006-07 and finally to Rs. 10 per kWh in 2007-08 for the frequencies below 49.0 Hz or more precisely below 49.02 Hz. It is noted that the commission continued to raise the ceiling rate till 2007-08 while the permissible frequency range remained untouched. Figure 1 shows the UI rate variance with corresponding average grid frequency of three different years and it shows the year-wise changed picture of UI price vector.

ABT in 2008-09

Until 2007-08 the commission's amendments regarding ABT hovered around changing the UI rates only while the permissible frequency range remained untouched. In the annual report of 2008-09, the commission reduced operable permissible frequency range to 49.2 – 50.3 Hz as against the 49 – 50.5 Hz earlier. Also, the ceiling UI rate was reduced to 735 paise per kWh at grid frequency of 49.2 Hz and below against the earlier UI rate 1000 paise per kWh at 49.0 Hz and below.

Table 6 shows the new UI rates and operable frequency band which replaced the old UI rates w.e.f. 1.04.2009, this year the commission released a separate UI regulation and showed that the sole objective of UI is to maintain grid discipline. Also, CERC's tariff regulation exempted customers from the pressure of paying income tax on the amount of money received by UI charges.

ABT in 2010-11 to 2018-19

In the year 2010-11, the commission further reduced the operable frequency range from earlier 49.2 – 50.3 Hz to 49.5 to 50.2 Hz. Correspondingly, the payments for deviation from the schedule were also raised with a further penalty in the form of additional 40 percent UI charges for deviation when the frequency is below 49.5 Hz and an additional 100 percent UI charge when the frequency is below 49.2 Hz. In order to uphold stronger

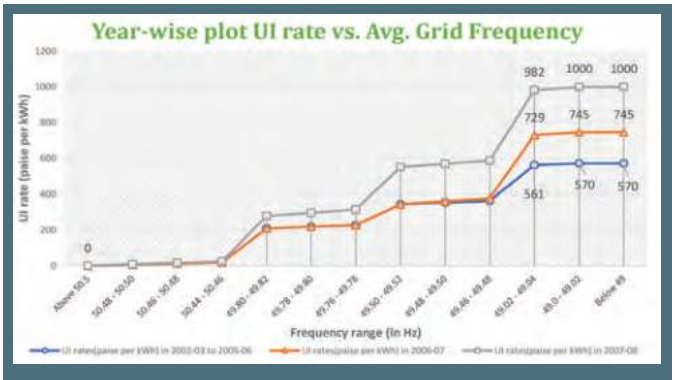


Fig.1. UI rate vs. Grid Frequency for the year 2005-06, 2006-07.

Table 6. UI rates for the year 2008-09 to 2010-11.

Average Frequency of time block (in Hz)		UI Rate (paise per kWh)	Rate of change
Above	Below		Rise in 12 paise per kWh for each 0.02 Hz step fall in frequency.
50.5	-----	0	
50.48	50.50	12	
50.46	50.48	24	
-----		---ctd.	
49.50	49.52	480	
49.48	49.50	497	The rise is 17 paise per kWh for each 0.02 Hz step fall in frequency.
49.46	49.48	514	
---	---	---ctd.	
49.20	49.22	735	
	49.20	735(Ceiling Rate)	

grid discipline, the new IEGC regulations of 2009 also prohibited the over-drawl of electricity from the grid when the frequency drops below 49.2 Hz.

The commission again stiffened the permissible operating frequency range from 49.5 – 50.2 Hz to 49.7 – 50.2 Hz w.e.f. 17-09-2012 with a view of improving grid frequency. The IEGC regulations were amended on 5 March 2012 and the revised UI charges are given in Table 7.

The commission also launched the provision of additional UI charges payable when the frequency is below 49.7 Hz, with additional UI charges ranging from 20 percent of UI charges to 49.5 Hz and rising up to 100 percent of UI charges for frequencies below 49.2 Hz for over drawing.

Frequency band has been further tightened from 49.7-50.2 Hz to 49.90 to 50.05 Hz w.e.f. 17.02.2014 by the CERC and the commission took a strict measure that any purchaser's over-drawl / under-drawl of electricity during the time period shall not surpass 12% of its schedule draw or 150 MW, whichever is lower, whether the grid frequency is '49.70 Hz and above and below 50.10 Hz' also, provided that no over-drawl of electricity is permitted by any purchaser when the grid frequency is "below 49.70 Hz" and

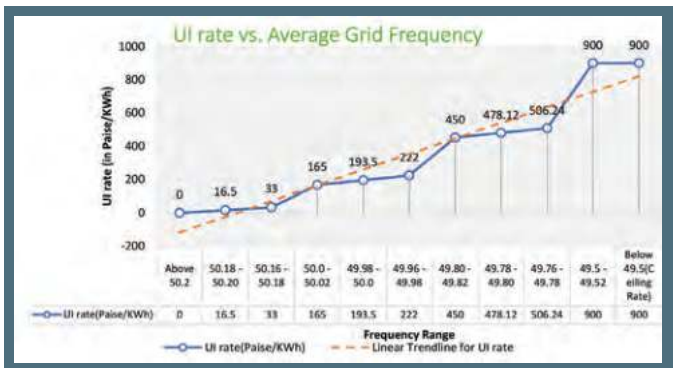


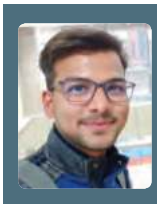
Fig.2. UI rate vs. Grid Frequency for the year 2011-12.

Table 7. UI rates w.e.f. 17-09-2012.

Average Frequency of time block (in Hz)		UI Rate (paise per kWh)	Rate of change
Above	Below		Rise in 16.5 paise per kWh for each 0.02 Hz step fall in frequency.
50.2	-----	0	
50.18	50.20	16.5	
50.16	50.18	33	
-----	----	---ctd.	
50.0	50.02	165	
49.98	50.0	193.5	The rise is 28.5 paise per kWh for each 0.02 Hz step fall in frequency.
49.96	49.98	222	
---	---	---ctd.	
49.80	49.82	450	
49.78	49.80	478.12	The rise is 28.12 paise per kWh for each 0.02 Hz step fall in frequency.
49.76	49.78	506.24	
---	---	---ctd.	
49.50	49.52	900	
---	49.50	900(Cap Rate)	---

no under-drawl of electricity by any purchaser is permitted when the grid frequency is "50.10 Hz and above". This step can be suspected somewhere as an attempt to weaken the ABT from the tariff structure as the commission banned the over-drawl / under-drawl completely except for the limit given above and this step the obscured the presence of UI charges. Figure 2 is for the UI rate variation with average grid frequency as per the new amendments published in the 2011-12 annual report of CERC.

This article will be continued in the next issue as Part 3



Aniket Raj

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"A prominent position in the T&M industry..."

Established in 2006, Testo India Pvt. Ltd. is a 100% subsidiary of Testo SE & Co. KGaA. In an exclusive interview with Electrical India, Parag Yelegaonkar, General Manager – Govt. Business, from the company fields questions from Abegail D'mello. Excerpts...

Tell us in brief about your company. Assess the electrical sector from your perspective–distribution transformers, smart grid applications, transmission lines, power cables, storage, motors, and cables? Could you provide an estimate regarding market worth for the above?

Testo India Pvt. Ltd. is a 100% subsidiary of Testo SE & Co KGaA, which is a world leader in design, development and manufacturing of electronic portable test and measuring instruments and is backed by more than 60 years of measurement engineering experience. Testo India has shown phenomenal growth over the last 14 years with new products and innovations getting added to the basket year after year, extending our reach throughout the nation, increasing our support and services in every aspect. With its head office in Pune, & a PAN India sales and channel partner network, Testo India now enjoys a prominent position in Test & Measurement industry. We also have an established state-of-the-art, NABL accredited service & calibration lab located at Pune.

Regarding the electrical sector, transformers, smart grid operations, transmission lines, etc, if you look at India's next five-year power plan, the focus will slightly shift from generation to supply i.e., distribution of power. This is in view of the surplus from thermal power generation capacities that our country has built over the years, coupled with moderate demand and rising share of renewable energy, India will now witness a marked shift towards efficient supply and optimum generation classification mix, which mainly is thermal, hydro and nuclear power. Hence, the market for electrical assets like transformers, transmission lines, switch yards, storage, motors and cables continue to rise linearly. From Testo standpoint, we play a major role in helping power utility to enhance the efficiencies by keeping the asset availability to maximum and reduce the losses. Our instruments like thermo-vision cameras, electrical instruments & data loggers are used in predictive & preventive maintenance, condition and health monitoring of the major electrical equipment that are mentioned above & also climate monitoring respectively.

Do you see an upward trend regarding the market demand for these solutions? What are the factors influencing the uptake for such solutions?

As the industry grows power demand rises and we also witness the sharp increase in distribution network

capacity building and hence the demand for the Test & Measuring T&M Instruments will also grow in the same proportion due to the increase in the application areas. Also these measuring instruments are smart & intuitive, which gives you higher efficiency & helps in reducing the down time of any facility. Being said that, there definitely are several factors that play an important role in the inclusion of such solutions in the day to day operation of the electrical & power sector. The more people & users get to know about these solutions the better, along with proper trainings. Then there are government policies, operation of the plant and project execution pace, which are also vital aspects influencing the uptake for such solutions in government and private utilities

How has the electrical industry evolved in India? What is the wide range of opportunities for the sector across the value chain?

Energy, today, is considered crucial to achieve India's development ambitions, to support an expanding economy, to bring electricity to rural areas, to fulfill the demand and to develop the infrastructure needed to meet the demands. India's energy consumption has almost doubled since 2000 and the potential for further rapid growth is enormous. From potential of installed generation capacity to the limitations in distribution of power, the present and the future aspiration of this sector is worth analyzing. Which ultimately confirms that there is a lot of opportunities along with some areas of improvement in this sector across the value chain.

Could you highlight the impact of the following on the electrical sector: the growing demand for energy in India, network extension, upgradation, a reduction in energy intensity, the unbundling of supply services, and the growth of cross-border trade that presents opportunities in the industry? How is the Indian industry fairing in these?

Given the huge opportunity for growth in the power sector, an overall huge investment could potentially come in over the next decade. The paradigm shifts in the Indian energy sector will increasingly influence and shape the Indian and global energy economy. This includes power generation, renewable energy, oil and gas and electric mobility. It is quite evident that, the network must grow and expand. Up gradation and retrofits will be required in each value chain elements. India has already taken a leap in CBT and it will continue moving forward as the global energy economy is also showing upward trend.

Do we need to emphasize on Research and Development to obtain global quality standards? Can India's domestic market and industry add to its prospects of emerging as a prime producer of energy?

Of course, there is need of continual efforts in R&D to meet global quality standard, which will help in raising our standards and quality. Looking at the domestic market, Total prime energy consumption in India is amongst the highest in the world. Due to high energy & power demands, there is a continuous increase in the energy production, transmission and distribution as well. Several schemes implemented by the government regarding electrification and power distribution also contribute to the growth of the segment. Not only that, increased demand for renewable energy usage has boosted the solar & wind power plants in the nation. Very evident that energy sector is pivotal in India and in the coming days the growth will be exponential, which could turn out to be crucial in emerging as a prime producer of energy in each classification.

Tell us about your company's recent projects, any case studies you would like to share with us? Statistical/ market related data?

Recently we have executed several important projects in T&M for Power Grid, State Generation and Transmission utilities and NTPC. In fact, Power Utilities is one of the largest sectors that we cater to in the market. We have also provided our solutions in several solar plants like the Karnataka Solar Power having 1000 MW + installations and also to Sterling and Wilsons, Renew Power, AP-GENCO, MSEDCL Dhule - Sakri 125MW Solar Power Plant.

Talking specifically about our products, our Thermal Imagers are already operational at various power plants. Right from the beginning i.e., installation phase thermal imagers can be used for setting up benchmark parameters & for all kinds of troubleshooting jobs. Consider the power generation phase of the power plant–where a small lapse in preventive and predictive maintenance can lead to highly unsafe conditions. Most importantly, in power T&D segment like, the electrical connection points and insulators for overhead power

lines in substations or the overhead power lines in high-voltage systems, switch yards and transmission lines must be regularly checked for routine maintenance for thermal anomalies detection purposes. For inaccessible locations testing & checking can be done by thermal inspection as a predictive maintenance tool from a safe distance, without endangering the user or without needing a shut down the entire power transmission network. Testo India provides testo 885 and testo 890 high end thermal imagers that, can be used to conduct thermal inspections in transmission lines up to 765KV voltage level, using a super telephoto lens with correspondingly high resolution, conveniently from the ground.

What in your opinion has the influence been of the COVID-19 pandemic on the electrical industry sector regarding output and utilitie?

We cannot deny the fact that the industry is affected to a considerable extent due to Covid-19 epidemic and we might even witness the prolonged effects & slowdown for next one year or so. Many important projects in renewable energy and transmission network capacity building have suffered due to unavailability of manpower, potential threat of viral spread & an overall slowdown in manufacturing too. Utilities have also felt the heat of this pandemic equally, resulting in lower growth rate. We expect that soon things get back on track & we start working on the progress plan.

How are government policies influencing the energy sector? What are the policies that would be an enabler to the industry if adopted on a government and national level?

Government policies plays very important role in growth and pace of the electrical industry and energy sector. There is a broad portfolio of policies and provisions led by the government in regards to the energy sector & efficiency management like regulation, market transformation, monetary policies, awareness program etc, including both national and sub-national policies and program. With favourable policies as regards to implying the higher duties on imports, giving concessions in GST and local taxes on electrical equipment for conventional and renewable power industry the expected growth and pace can be achieved. Hence, the policies not only at national level but at state level also need to be effectively implemented for the growth in the domain across value chain of the energy sector.

On the technical side, in what direction are we headed? What are we seeing with regard to technological innovation? What are the trends?

In terms of technology, we have been on a progressive path & things look in proper shape. Also, the latest advancements are coming in the forms of smart operation, which is also the current trend accompanied by the digitization of the working system along with the increasing in critical application areas. So there is a need and a larger scope to adopt the latest technologies in generation, transmission, and distribution network. We need to adopt the advanced methods in each sector right from the product development to manufacturing of electrical goods and services. Awareness, proper trainings, reducing losses must be a matter of concern for the stakeholders in the process of adoption of new techniques. Similarly, SMART grids and digitization needs to be addressed at management level for respective verticals in the energy sector.

Any company-side developments you would like to comment on?

Yes, we at Testo are emphasizing on developing more SMART solution for the Industry to improve efficiency and availability that allows the industry to monitor the health of the equipment or an electrical asset. Consider our latest and most advanced solutions for instance, our Electrical Instruments are very distinct and unique in their features. They are excellent instruments to inspect the electrical components and circuit failure threats. Along with that they ensure longevity and efficiency of various power electronic components that control and regulate the flow of electrical energy. The unique Clamp meters and Multi meters are intuitive, can measure several parameters in a single component. Testo clamp meter can even be connected to thermal imagers via Bluetooth, which can instantly display electrical parameters along with thermal profiles. Our new range of Thermal Imagers with smart phone integration designed to deliver networked thermography are mostly used for predictive and preventive maintenance in electric and power sector. These electrical instruments & thermal imagers are the best solution for trouble shooting in power sector.

Cybersecurity Concerns for the Smart Grid in the Age of the Pandemic

Modern communication technologies like fibre optic lines, satellite communication etc,. have come forward to address the long-existing communication challenges between the substations...

Two-thirds of the total world population is confined to their homes in this era of the pandemic, yet we require electricity. So, power plants and distribution networks have to be up and running all the time, since no one can imagine a life without electricity.

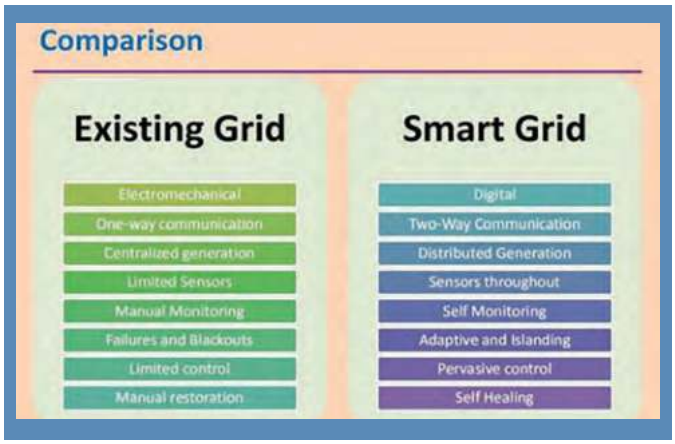
Many people assume the Smart Grid is a revolutionary change to the operation of the electric grid. In reality, it is an incremental step in the long evolution of adding automation to the electric grid.

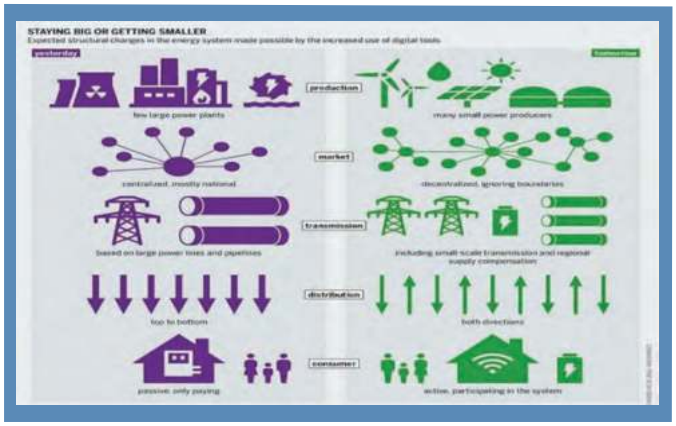
Demand for the smart-grid would be increasing in the post covid scenario. In this article, we explore cyber-security concerns for the smart-grid in India.

Why smart grid?

The smart grid connects commercial power plants to distributed generation systems, batteries, and various kinds of industrial and private equipment installed at the sites of power consumers through communication networks. It is a solution that is an attractive proposition as a key technology with the following benefits :-

- Improving the efficiency and stability of power supplies and solving environmental problems.
- Quicker restoration of electricity after power disturbances.
- Reduced management power costs for consumers.
- Enables new energy-saving functions not available from the conventional power networks, such as meticulous adjustment of power demand and supply.
- Promotes the implementation of various renewable energy systems.
- Enables the visualization of power consumption.





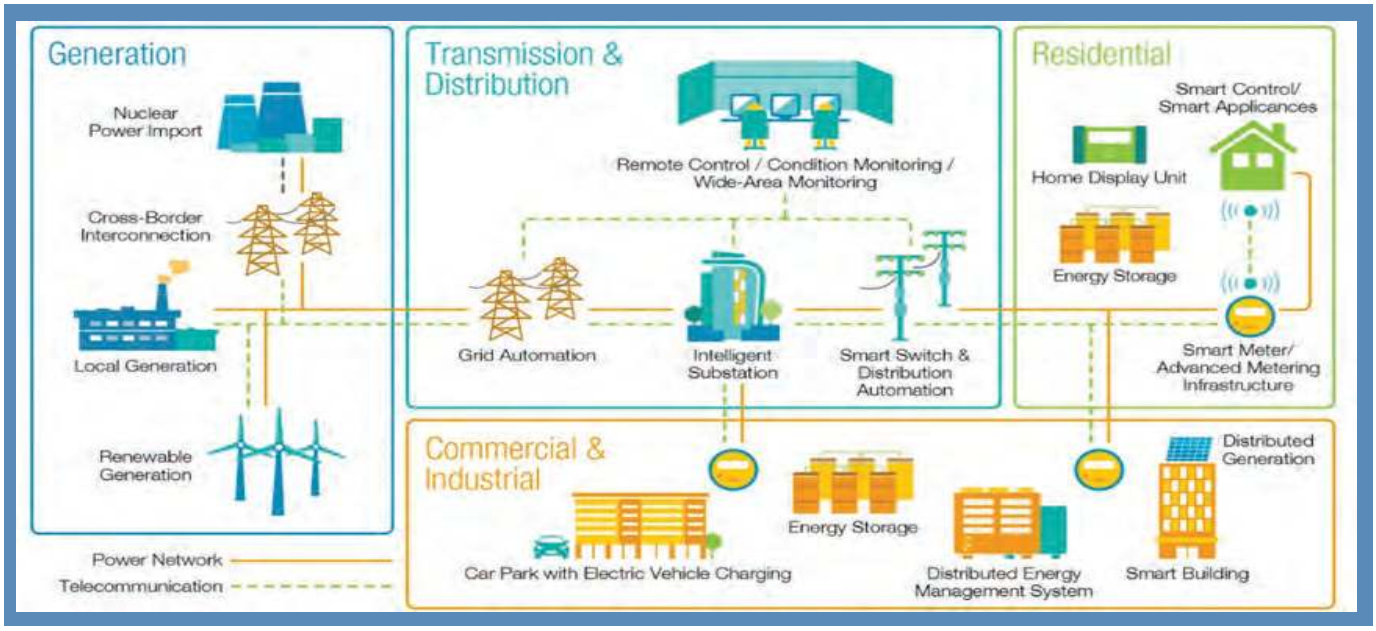
- There are expectations from the smart grid to run power networks stably by suppressing peak power demand.
- To strengthen power networks and utilize conventional utilities efficiently in India.

Requirements for a smart grid

Smart grid requires improved intelligence of grid system's inter-operation by the provision of multi-directional information flow between any two or more units in the system to achieve a revolutionized power industry.

The intelligence is achieved by incorporating powerful processors in each component of the power system. This enables it to access its own operating conditions and report to its neighbouring agents via the communications paths, circuit breakers and communication ports for the processors.

The conventional power systems are being upgraded worldwide to deliver advantages including:



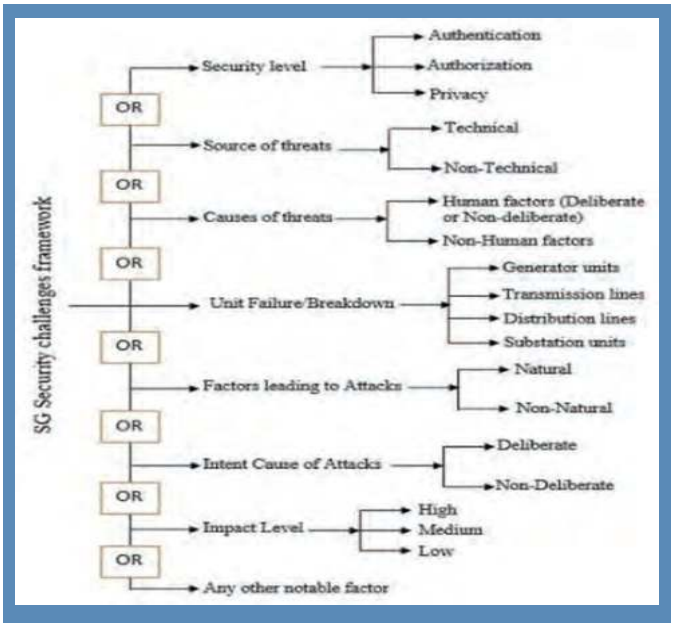
- Increased reliability
- Security
- Flexibility in energy distribution
- Power consumption monitoring
- Demand Side Management (DSM)
- Enhanced optimized network traffic
- Shorter downtimes, minimized failures

With the increased availability of sophisticated computing, communication and measurement technologies, the system's emergency response will be greatly improved. These also provide protections, which are not provided by the central control systems or the protection schemes for the power infrastructure from the utility end and for smart homes.

Smart Grids (SG) security threats and challenges

Smart Grid architecture and infrastructure are faced with myriads of security threats and challenges ranging from thefts, cyber-attacks, terrorism, natural disasters, etc. In the event of SG's failure due to any of the threats, possible consequences include power system blackouts (small and large outages), SG IT infrastructure failures, false visualization of the actual system's condition, cascade failures, damaged consumer devices, energy market chaos, endangered human safety, etc., which may include :-

- Risk of breach of high volume of sensitive customer information by adversaries.
- Thefts, physical components damage, malware propagation in the cyber systems, instantaneous system malfunctioning.



- Distributed control devices vulnerability; lack of physical protection against natural or environmental disasters such as floods, earthquakes, fire outbreaks, tsunamis, explosions, landslides, dangerous radiation leaks, pollutions, dust and corrosion.
- Ageing infrastructure especially that most of the installations were made several decades ago stand as a major threat against newer and more technically advanced systems.

Solutions

- Power Grids and Communication networks should be monitored continuously.
- Frequent maintenance schedules should be done for power system devices to ensure they are in operational condition.
- All devices with battery backup systems must be automatically tested to ensure the battery's capability to support the device.
- System operators must be included in the design of the automation logic, so they can understand the work-flow and also understand that it is not a replacement for them, but a support tool.

India should should take major desperate measures to improve the efficiency and quality of the service by adopting certain proposed security frameworks through research:-

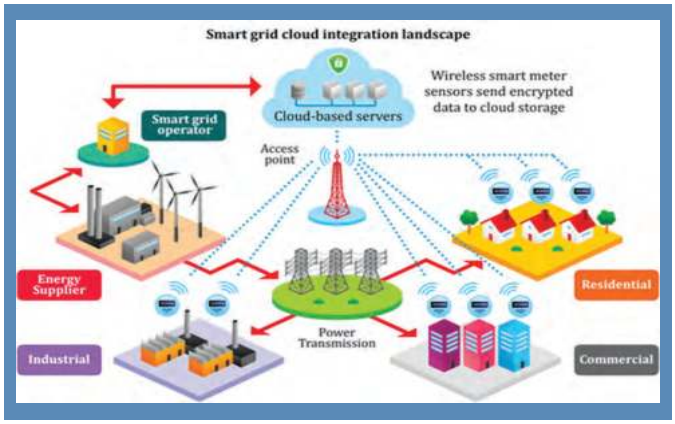
- ZigBee
- Wireless Mesh Networks
- WiMax
- 3G
- 4G
- WiFi
- Bluetooth.
- Also, new emergent technologies such as micro-grids, Virtual Power Plants (VPPs)

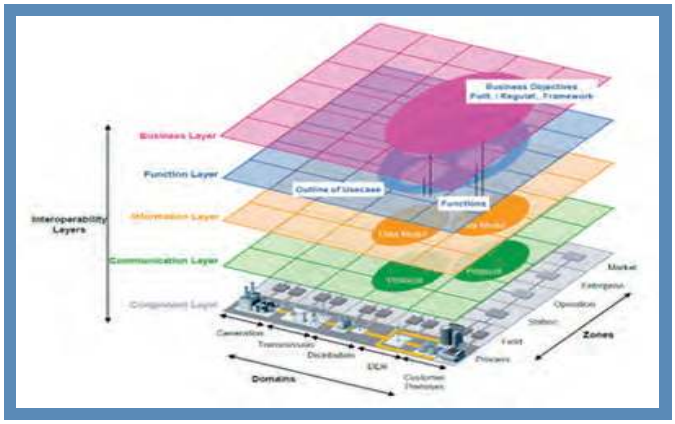
Smart meters and power theft

Smart Meters (SMs) are advanced energy meters employed as replacements for the conventional analogue meters to measure a customer's energy consumption by providing additional information to the utility company and the customers themselves unlike in the case of conventional energy meters.

Enhanced functions of SMs are:-

- Failure and outage notification
- Remote command operations
- Load control for demand response purposes
- Power quality monitoring





- Energy theft detection
- Effective implementation of "Internet of Things" (IoT) with various intelligent devices.

Although, SMs have however changed the nature of SM data frauds or attacks, compromising the meter by remote penetration and control of recorded and stored data may be a source of very sophisticated attacks capable of allowing indistinct changes to customer's usage and falsely indict targeted victims or depending on their intention, launch large-scale attacks on the main grid.

Currently there are tens of thousands, feeder Intelligent Electronic Devices (IEDs) in operation that are regularly polled by the Supervisory Control and Data Acquition (SCADA) master for updated analog and status data. While these remote IEDs provide monitoring and control capabilities to the system operator, there is little or no automation. Adding intelligence and automation to the distribution feeders is a vital next step leading to the Smart Grid.

Communications systems

Early on, utilities faced the problem of communicating to very remote hydroelectric power plants, and installed power-line carrier systems between high voltage substations to solve the problem. These systems carried both voice and data, which solved the problem as long as there was a direct link between the two substations. Most of these systems have probably been replaced with microwave. Utilities with large geographic areas have private microwave systems to handle large volumes of information over long distance communication links.

A few utilities have implemented satellite communications for sparsely populated large geographic areas. Fiber optic cable is being used both within substations and as Wide Area Networks (WANs). With the recent concerns about security this is becoming a more attractive and cost effective solution.

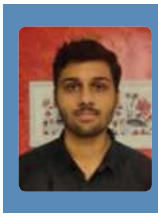
Starting in the 1980s, licensed 900 Megahertz point-to-multipoint radio systems became very popular, especially for small substations. These systems provided a substantial cost savings over leased phone lines and were under the complete control of the utility company.

Conclusion

Though India has a long way to go, the need for an SG has been felt for a long time now, but it would be demanded more than ever. Imagine people taking meter readings, in far flung areas moving from door to door with the Covid-19 pandemic spreading far and wide. On the other hand, the advanced countries with SGs face increasing cyber-security threats. The spyware in power systems machinery may communicate sensitive data to unscrupulous elements or a hostile country eager to exploit. We need to secure ourselves through firewalls, upgrade our systems and train our people to meet cyber-security challenges to the Smart Grid.

Sowjanya Rath

Graduate in B.tech Electrical And Electronics Engineering from Silicon Institute Of Technology, has done internship in NTPC Noida under electrical department on study of electrical machines in Thermal Power Plants.



Suraj Prasad

Bachelor Of Technology in Media Technology from Manipal Institute Of Technology final year student with work experience in multiple clubs registered under Manipal Institute Of Technology.

Dr. Bibhu Prasad Rath

Graduate in Mechanical Engg has worked in various functions in NTPC including Operation & Design, he is presently Additional General Manager in Project Engineering division.

"We are channelizing and have strategized the business development activities..."

***Mitsubishi Electric India Pvt. Ltd.**, was incorporated in 2010, since then the company has been consistently providing solutions in products, technology and services at its best to its Indian customers. In an exclusive interview with **Electrical India, Hitesh Bhardwaj, General Manager, Semiconductors & Devices** division of the company briefs on the status quo of their company to **P. K. Chatterjee**. Excerpts…*

Could you please brief me on the current presence of Mitsubishi Electric in the Indian market, especially on its penetration in the Indian semiconductor industry?

The Indian semiconductor industry offers high growth potential areas as the industries, which source semiconductors as inputs are themselves witnessing high demand. Mitsubishi Electric is receiving a strong support from its customers in the areas of traction and utility solar locally in India. We are consistently working upon the opportunity to ensure a better experience for our customers in the India market. We are channelizing and have strategized the business development activities in three phases i.e. Immediate, mid-term and long-term phase in India. In Immediate Business opportunity we will continue to focus on traction, utility solar, solar power and consumer durables. For mid-term phase, we are channelizing our best efforts in getting the Design for emerging segments of EV Charger, EV Traction, Medical and for long term along with the Growth of above mentioned segment we are looking forward

in contributing in High Voltage Direct Current (HVDC) and Space for High Frequency (HF) & Optical Devices (OPTO). On the Product side our regular checks and development will be on Dual in line packaged intelligent power module (DIPIPM), Industrial Insulated Gate Bipolar Transistor (IGBT) and most importantly, X Series HVIGBT for various Applications.

What are the emerging areas where power control devices will find much wider applications?

As stated above, Electric Vehicle Traction & its infrastructure is one of the new emerging areas for power devices, which is opening globally & so in India. Apart from basic power conversion applications, energy efficiency is another key aspect where the conventional systems such as consumer appliances are implementing power devices for energy saving functions & thus opening a new opportunity and market for power devices.

What do you feel, the corona pandemic has affected the market of Mitsubishi Electric or it is an opportunity in disguise?

The pandemic has definitely affected the market and brought sales to a standstill for a certain period - but we believe that our customers are loyal and they trust the products we have to offer them, therefore in the coming months we hope to recover and get back in track and achieve what we set out to do during this commercial year.

What kind of potential are you finding at this juncture from the healthcare industry in India and abroad as far as deployment of power control and other semiconductor devices are concerned?

Mitsubishi Electric Semiconductors and devices are consistently supporting healthcare industry. Many of the devices used in healthcare are in-built with semiconductors. Semiconductor-enabled equipment includes Magnetic Resonance Imaging (MRI) systems, radiography, blood pressure monitors, pacemakers, etc. A pioneer in the industry, Mitsubishi Electric India has a range of semiconductors and devices designed with cutting edge technology that provides energy-saving solutions for various devices.

What is your role in the great Electric Vehicle (EV) movement in India?

Mitsubishi Electric has already taken a step towards making the idea of mass scale shifting to electric vehicles a reality. The company launched a new J-Series transfer molded power semiconductor module (T-PM) mainly for motor drive applications in electric and hybrid vehicles. It is known that automotive components must especially meet stringent safety standards, which creates demands for power semiconductor modules that provide greater reliability than modules for industrial equipment.

The company's new module is expected to contribute to further compactness, weight reduction and reduced power consumption in inverters for electric and hybrid vehicles. It has some cutting-edge features like reduced inverter size and weight achieved through the extra compact package with high integration. The compact power semiconductor module features a highly integrated sixth generation IGBT with a carrier-stored trench-gate bipolar transistor (CSTBTTM) structure and high-thermal conductivity isolation sheet in a transfer molded package. It realises compact EV/HEV inverter designs by achieving 36% smaller footprint and 42% lighter weight compared to the existing J-Series CT300DJH060 automotive power semiconductor module. Another important feature is inverter power-loss reduction supported by low-loss power semiconductor chips. It realises low power-loss EV/HEV inverter designs through the utilization of sixth generation IGBT achieving 12% lower collector-emitter saturation voltage compared with the existing J-Series.

What's your message to the Indian users of Power Control devices?

Mitsubishi Electric is one of the leaders in Power devices globally & known for its product quality, solutions & services. We have been supporting power electronics customers in India for more than last two decades, directly or through our partners, with state-of-the-art power device technology available globally with best services.

Pandemic Shockwaves to create major pitfalls for grid stability concomitant to EV CHARGING

Electric Vehicle (EV) and Hybrid Electric Vehicle (HEV) configurations have been historically proposed as a more sustainable alternative to the conventional fossil-fuel powered internal combustion (IC) engines for the global automotive and transportation industries. The COVID-19 pandemic has resulted in tectonic shifts in such foundational concepts and compelled several industries to adopt a philosophical bend of mind to accept the new norm, the automotive industry being no exception. While the pandemic aftershocks have led to external factors that typically impact the automotive value chain as well as the global energy economy as a whole, such as sharp decline in crude prices, it has also created new opportunities in the technology layer. The pandemic era can be looked upon as an opportunity for the stakeholders to resurrect the energy and associated verticals, unlocking new business models and identifying innovation sweet spots. The electric power economy, overarching application areas such as smart grids and its components such as the charging infrastructure and grid storage, is all set to adopt to these paradigm change.

Some of the major trends of the grid connected EV landscape and the associated technologies are as follows:

Fluidizing the power exchange: Deploying EVs at scale would have a cascading effect on the energy grid, one of them being the increase in grid load during the charging operation i.e., transfer of energy from the grid to the vehicle (G2V) to charge the battery. To fortify the grid stability, the

Image by Andreas160578 from Pixabay

EV ecosystem players are reinforcing the EV with vehicle to grid (V2G) technologies. V2G depicts the set of technologies used for the management and control of electric vehicle loads through the local electrical utility. The V2G nomenclature represents a robust two-way communication channel with the smart grid as well as the vehicles and initiates the transfer of unused or excess power back to the grid. The components included usually consists of vehicle to grid chargers, grid aggregators, power loads, power transmission systems and communication systems. The typical advantages of V2G revolve around harmonic filtering, resulting in improved quality of power and efficient failure recovery from an outage. The active power support manifests load-leveling services along with peak load shaving. Also, control of the grid voltage becomes more precise with control switching and appropriate sizing of the DC link charger capacitor. The EV owners are economically benefited with respect to the amount of energy transferred back to the grid.

Enhancing grid stability with bidirectional power flow: The smart grid leverages an integrated communication system to manage and control power flow associated with the EV battery. In a conventional system, this flow is often unidirectional which consists of a basic control system for controlling the charging rate. The concept is, however, effective enough to provide power grid support with spinning reserves and grid control. This energy exchange can be made more fluidic with a flexible policy between electrical utility and EV users. In order to unleash the true potential of the power flow with several grid support activities such as reactive power support, peak load shaving, frequency regulation and voltage regulation, bidirectional flow can be activated i.e., V2G and G2V. A bidirectional EV battery charger consists of DC/DC converter and AC/DC converter (rectifier). During EV charging, the rectifier converts the AC power from the grid to DC power, which is again converted back to AC with an inverter while discharging, sending the power back to the grid. The DC/DC converter, on the other hand, acts as a flyback or a buck-boost converter that uses current control methods to regulate the bidirectional flow i.e., a boost converter and a buck converter during discharging and charging respectively.

Dedicated grid stabilization initiatives: The rapid growth in the numbers of electric vehicles on Britain's roads will mean more demand on local electricity networks, if EVs are all plugged in at the same time, such as during the peak between 5pm and 7pm in the evening. Recently, UK's Western Power Distribution (WPD), in collaboration with CrowdCharge has triggered a new V2G trial across parts of the UK, as a part of the next phase of the Electric Nation program. The program is directed towards enabling EVs to stabilize the grid, powering domestic houses.

Technological advancements come with its share of challenges and bidirectional power flow is no exception. The technological development and its market attributes have several nuances, some of which should be strategically upholstered to drive commercialization

So What?

Stabilizing the grid has been a major challenge for utilities as well as technology developers for decades and a long-term solution would not be viable without active involvement in the initiatives by the EV users. The policies should be incentivized, such as it is rewarding for the EV owners to not to charge their vehicles during peak time resulting in the prevention of the peak hour overloading. Developing and commercializing the ideal energy storage technology has been one of the major challenges plaguing the energy industry. Continuous charging and discharging associated with bidirectional flow would lead to quicker degradation of the EV battery due to the irreversible internal chemical reactions. To support such operations, the ideal balance between energy density, specific energy, and cost should be found, else the battery stands vulnerable to the deterioration

of the battery's usable power and increase its internal resistance.

Battling the cost resistance: While the utilities have been drumming up government support to sanction the capital-intensive up-gradation of the existing power system with respect to the software and hardware infrastructure of smart grids, the impact will trickle down to the EV users as well. To fulfill the V2G requirements, the EV participant would require a sophisticated (and hence, cost-intensive) bidirectional battery charger. Furthermore, the charging and discharging would increase chances of energy losses over smart grids.

Absence of targeted promotion campaigns: The understanding of the criticality of grid stability is often myopic on the end-user side. Thus, without a short-term, tangible benefit, it would be challenging for the utilities to convince EV users to participate in V2G schemes. Furthermore, the automotive industry, which was profusely bleeding cash since the pre-COVID times, has been compelled to edict the normalized EV pricing propositions into obscurity. With high prices and lower subsidies, the potential EV owners are often discouraged to rule out the counterpart IC engine powered options. There is, thus, need for interlocution between the government, the automotive OEMs and utilities to segment the pricing propositions for various cross-section of EV buyers and subscribers such as schemes for buyers with smart homes, buyers with installed solar panels at home, buyer with limited accessibility to the grid and so on. A well-defined scheme highlighting realizable value can overturn a user towards opting for an EV or participating in energy sharing propositions.

Hydrogen economy can be a looming threat: Despite the technology development slowdown, the much-awaited hydrogen economy is a promising alternative to grid-connected EV, HEV and other options of sustainable mobility. The hydrogen-powered propulsion indirectly challenges the market of V2Gand G2V technologies. The development and commercialization of fuel cell powered vehicles in certain regions (the US and few countries in Europe) is one of the major drivers for the adoption of hydrogen as an environment-friendly, emission-free fuel. The fuel cell can be fed on any hydrocarbon compound, which is disintegrated into carbon and hydrogen within the cell. The hydrogen is used to produce electricity and water is generated as end-product. With the addressal of shortcomings related to efficient way of hydrogen storage and upscaled production, this technology can completely neutralize the demand for the grid energy exchange infrastructure associated with the EV.

In spite of the challenges, it may be expected that too futuristic technology alternatives would be discarded in these inadvertent times. R&D budgets of OEMs are likely to be slashed, discouraging such enterprises to be pushed below the substitutional technologies at this juncture.

Key Takeaway

Even with undisputable advantages of reactive and active power support, renewable energy support, grid overloading prevention, failure recovery, and power factor regulation, bidirectional power flow remains a convoluted impasse. The COVID era exposes the environmental hardliners and electric mobility evangelists to an even more belligerent situation as compared to the fossil-fuel driven value chain participants. With plummeting crude prices, surfacing of hybrid configurations of CNG and LPG with petrol from auto majors to minimize operating cost, the thriving EV market is suffering a pernicious setback. The complementing market of zero-power homes (which can produce its own electricity consumption through rainwater harvesting and solar panels), which were expected to be one of the biggest contributors to V2G options, are withdrawing to an inadvertent plan of sustenance. This is due to increased solar panel prices because of the import restrictions of Chinese products and rippling effect on the overall operational value chain, driving the total ownership cost higher.

Overall, it would be challenging to convert potential EV buyers to actual buyers without a discrete, short-term monetary benefit or by imposing draconian penalties for carbon emissions. Absence of a structured blueprint of either would make the wide scale adoption of bidirectional power flow technologies and the associated stability of the smart grid a distant and overtly ambitious aspiration.

Disclaimer: The views expressed in the article belong solely to the author, and not necessarily to the author's employer, organization, committee or any other group or individual.

Avimanyu Basu
Lead Analyst with Information Services Group (ISG)

"India will chart its own course of energy transition..."

*Recently, in a free-wheeling interaction with **Electrical India (EI)** team, **Dr Vivek Soni, Faculty of Management, PhD & MTech (IIT Delhi)**, and a **Certified Independent Director -MoCA, Govt of India**, revealed his observations and expectations from the ongoing developments in the Indian Power Sector. Here is the Part 1 of the interaction; remaining parts will appear in the next issues of EI...*

Image by S. Hermann & F. Richter from Pixabay

What are the most prominent trends in the Indian power sector today?

Indian power sector has been a significant contributor to the national economy. The last decade, the sector shown in trends on broad parameters of macroeconomics, supply security, generation infrastructure, and transmission infrastructure, degree of competition, regulatory scenario, and assessment of future potential.

During the recent years, the sector operations have been scaled up due to changes in structure of energy sector, consumer behaviour, load profile, new policy and climate change. To this effect, a significant change in energy prices is also seen. Select trends also include dropping prices for renewable and more and more need for energy storage, the finalization of the nation's first carbon regulations, and the proliferation of distributed energy resources, changes are taking hold faster than many expected.

The power sector also saw major milestones achieved in some of challenging areas even as uncertainty held back others. It was not an easy time to plan demand and supply to remain on safer side. There are good indications that 2019 could be different and represent a period of rebalancing and revival.

In a nutshell, the power sector has witnessed various issues, which include changes in power market regulatory structure, decline in conventional coal power, use of natural gas, renewable parity, load defection problems of

utilities, a new paradigm sees as solar energy game. Not only these, impact on electricity tariff, debates over rate design reforms and value of distributed energy recourses, modernization of grids, customers focused utilities buying into shortage; changing business models are also seen. It is also evident that — the traditional electric utility model would be upended, and utilities would need to adjust their business models to operate in a new energy future.

For many power companies and politicians, the single most noticeable trend in the utility industry is the steady retirement of coal-fired power plants. In this regards, coal-based thermal power generation is set to make a return as DISCOM are bound to call for bids to contract fresh capacity to serve a growing base-load demand.

Keeping the future demand in mind, coal production has been scaled up and that continued to improve (doubling over the past decade to over 600 million tons). Such target of Coal ministry and central PSE could maintain stock levels at power plants, with increase in capacity utilization (plant load factor) from 59 per cent to 62 per cent. The market valuation of operating thermal power plants looks certain to improve, with better performance and with lesser competition as fewer new plants are getting commissioned. In the renewable energy segment, in contrast, there was level of high competition seen between the companies. These companies may see their valuation getting moderated as the outlook for capacity growth in the near-term is soft and competition for fewer bids continues to be fierce. Here, the drop in tender flow reflects the buyer's concerns of pricing and seller's challenges in terms of availability of land, substation capacity and financing.

This was also evident in the part that the current government and power sector regulators took steps to deal with the effects of a rising share of renewable energy, up from 8.9 per cent last year to 10.9 per cent. The generation, spread unevenly across the day, is backed-up by coal-fired power plants unsuited for such a role, using up more coal and causing wear and tear. This makes a case for developing renewable energy projects with storage, which can absorb the variability and provide a 'clean peak' when needed. State governments could take this next evolutionary step in 2019 and tender for projects that combine the best of renewable energy and base-load power plants.

The battle to retain big consumers will come into focus this year. Over the years, high tariffs have caused many large-energy users to switch to alternate suppliers by signing corporate Power Purchase Agreements (PPAs). The loss of revenue and cross-subsidy has reached serious proportions, and utilities are starting to act. This year's tariff reviews may see utilities settle for a lower rate hike to keep customers and, instead, seek a levy on the corporate PPAs as a compensation for being the supplier of the last resort.

The losses on supply to smaller consumers, that were a persisting drag on the sector, are being seen with a different perspective. The utilities are now helping smaller users aggregate so that private developers are attracted to set up local generation, either at an individual level (e.g., smaller solar rooftop) or at the community level (e.g., mid-sized rural wind-solar hybrid projects). This helps utilities leverage long-term development capital through Renewable Energy Service Company (RESCO) tenders to save on their current fuel costs and operational losses.

The business operations of utilities are getting more complex and overextended with their rapid growth. In the past year, utilities connected 23 million new households and will experience similar growth spurts as distributed generation, behind-the-meter storage, and charging points for electric vehicles take off. The power companies will look to invest in digital technologies and outsource work to private operators to manage this growth efficiently.

India turned a net electricity exporter for the first time in 2017 but, the market opportunity remained very regulated and tepid (exports constitute just 0.5 per cent of the output). A major change in mindset is evident in the new guidelines for cross-border power trade issued last month, which could lead to development of a regional power market. The stage is now set for companies to develop integrated power generation (based on imported fuels) and transmission projects, pursue multi-country PPAs, and export cheaper renewable energy to other South Asian nations.

The state and central government power agencies, too, are keen to go beyond borders to popularize their successful programmes such as with solar parks and Energy Service Company and RESCO models. This could speed up the pace of adoption and innovation in the sector, expanding the market opportunity for power companies in 2019 and beyond.

What are we doing to utilise the full capacities of our existing power plants, which mostly operate at low capacity?

Capacity is the amount of electricity a generator (a company) can produce energy when it's running at full blast. Achieving high capacity is an issue as power plant operations are affected by many challenges, that include raw material arrangement and handling, distribution cost, skilled manpower, material handling skilled, technical expertise to handle to plant operations etc. It is seen that the capacity utilization in Indian coal based power plants hovered between 60% and 62% in 2018-19 because of large capacity additions in the past five years.

Power generators also face an important issue to service loans when PLFs, the industry term for utilization level, many times falls below a certain level of 60%. It is fact that PLF of coal power plants, many of which are already distressed due to lack of adequate demand and coal supply issues, has been low amid tepid power demand.

Capacity utilization of coal-based thermal power plants sometimes is seen fallen below 60% during the financial year 2019. For an optimal energy mix supply, even under a blue-sky scenario in which solar addition increases to 18GW, annually while new coal-based capacity of 8GW is added. It is also expected that coal-based thermal power plants operating at few lower values of plant load factor (PLFs) would continue to face challenges in many aspects.

There has been contribution of capacity addition from side, government as well as the private one. It however says that central government-owned utilities are given relatively more preference than private developers given their ability to better manage counter-party, resource utilization in terms of fuels and off-take risks. In this regards, it can be said that investing in new energies poses challenges around risk-return trade-offs and agility in decision making, which can be addressed through" operations of power plant's realignment, culture shifts and a strategy at power plant level which focuses on leveraging strengths but redefining protocols".

Renewable energy-based plants, equipped with the Central government's "must-run" status, are already preventing thermal power stations from improving their PLFs by supplying much of the incremental electricity requirement. The operations of thermal plants are critical and complex and generally will have to go online and offline (ramp rate) much faster with the advent of renewable energy. For example, a typical 500 MW unit coal fired power plant, the ramp rate is around 5 MW per minute. To make these plants more flexible, retrofitting equipment (that depends on mini and large electronics circuits, current and safety requirements), of course which involves additional investments.

Not only this, the low PLF condition has prompted the sector at stable-to-negative in the last few years despite visible improvements in the financial health of select distribution companies and lower dependence of generating companies on imported coal. The other reasons behind the improvement in the financial health of certain discoms is attributed to lower transmission and distribution losses, tariff hikes and cost rationalization.

Consequently, DISCOMs made strategy to marginal tariff hikes, increasing proportion of single-part tariff power purchases, installation of prepaid or smart meters to improve collection efficiency and lower billing errors, softer merchant tariff rates, continued usage of higher domestic coal than imported coal, and stable or marginally higher PLFs, leading to lower per unit cost as fixed cost gets absorbed over larger volumes.

Indian power sector positively look forward to stable outlook on most of its rated power plant as the operations would continue to manage fuel and counter-party risks due to a favorable tariff mechanism, a comfortable liquidity position and support from central and state governments.

In a country like India, in spite of huge operational and resource challenges to coal, gas and hydro power plants, we are finding ways to achieve the twin objectives of more energy and less carbon through a healthy mix of all commercially-viable energy sources, adding that India will chart its own course of energy transition in a responsible manner.

What is necessary to ensure smooth power evacuation from all our power plants?

We must know what are the issues related to smooth power evacuations. There are large or small operations that depend upon size of the power plants and sometimes resource type sued for energy generation. To understand this, operations and power evacuation in hydro power plants are the best. Unlike the generators in large hydro power stations, which operate in voltage control mode, the generators in small hydro power stations (SHPs) are forced to operate in power factor control mode due to their limited reactive power support. In fixed power factor operation, smaller variations of voltage at the evacuation bus are managed by on load tap changing at the generator transformers. However, during large and frequent variations in voltage, such SHPs face difficulty in evacuating the power due to delayed response by the operators and inadequate tap settings of the generator transformers.

Therefore, it is necessary to ensure such technical issues related with power evacuation and, to overcome such practical limitations faced by SHPs use of Static VAR compensators (SVCs) seems feasible options to ensure smooth evacuation of every unit of real power generated. The power generated from such plants goes to neighbouring grid in a grid connected power system for the purpose of consuming energy. Many tests those compliances IEEE 30-bus test system by way of connecting the SHP units to the most critical system bus of the test system with SVC control at the local bus are performed. To ensure the operations, testing have been fruitful and validated with the support of power flow tools such as Matlab.

Next part of the interaction will appear in the next issue of EI...

ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS
(As on 31.07.2020)

Region	Ownership/ Sector	Mode wise breakup								Grand Total
		Thermal					Nuclear	Hydro	RES * NRE)	
		Coal	Lignite	Gas	Diesel	Total				
Northern Region	State	16659.00	250.00	2879.20	0.00	19788.20	0.00	5777.25	725.01	26290.46
	Private	22425.83	1080.00	558.00	0.00	24063.83	0.00	2817.00	16044.35	42925.18
	Central	22425.83	1080.00	558.00	0.00	24063.83	0.00	2817.00	16044.35	42925.18
	Sub Total	53439.79	1580.00	5781.26	0.00	60801.05	1620.00	20085.77	17148.36	99655.18
Western Region	State	21740.00	1040.00	2849.82	0.00	25629.82	0.00	5446.50	555.54	31631.86
	Private	32847.17	500.00	4676.00	0.00	38023.17	0.00	481.00	25189.62	63693.79
	Central	19147.95	0.00	3280.67	0.00	22428.62	1840.00	1695.00	666.30	26629.92
	Sub Total	73735.12	1540.00	10806.49	0.00	86081.61	1840.00	7622.50	26411.46	121955.57
Southern Region	State	19782.50	0.00	791.98	159.96	20734.44	0.00	11774.83	586.88	33096.15
	Private	12747.00	250.00	5340.24	273.70	18610.95	0.00	0.00	41460.62	60071.57
	Central	11835.02	2990.00	359.58	0.00	15184.60	3320.00	0.00	541.90	19046.50
	Sub Total	44364.52	3240.00	6491.80	433.66	54529.99	3320.00	11774.83	42589.40	112214.22
Eastern Region	State	7450.00	0.00	100.00	0.00	7550.00	0.00	3537.92	275.11	11363.03
	Private	6153.00	0.00	0.00	0.00	6153.00	0.00	96.00	1222.00	7471.00
	Central	13682.05	0.00	0.00	0.00	13682.05	0.00	1005.20	10.00	14697.25
	Sub Total	27285.05	0.00	100.00	0.00	27385.05	0.00	4639.12	1507.11	33531.28
North Eastern Region	State	0.00	0.00	533.86	36.00	569.86	0.00	422.00	233.25	1225.10
	Private	0.00	0.00	24.50	0.00	24.50	0.00	0.00	104.14	128.64
	Central	770.02	0.00	1253.60	0.00	2023.62	0.00	1155.00	30.00	3208.62
	Sub Total	770.02	0.00	1811.96	36.00	2617.98	0.00	1577.00	367.39	4562.36
Islands	State	0.00	0.00	0.00	40.05	40.05	0.00	0.00	5.25	45.30
	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.84	7.84
	Central	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10	5.10
	Sub Total	0.00	0.00	0.00	40.05	40.05	0.00	0.00	18.19	58.24
ALL INDIA	State	65631.50	1290.00	7154.86	236.01	74312.36	0.00	26958.50	2381.03	103651.90
	Private	74173.00	1830.00	10598.74	273.70	86875.45	0.00	3394.00	84028.57	174298.02
	Central	59790.00	3240.00	7237.91	0.00	70267.91	6780.00	15346.72	1632.30	94026.93
	Total	199594.50	6360.00	24991.51	509.71	231455.72	6780.00	45699.22	88041.91	371976.84

Figures at decimal may not tally due to rounding off

Source: CEA

Energy Power Supply Position (Revised)

Figures in MU net

States	July, 2020				April, 2020 to July, 2020			
	Energy Requirement	Energy Supplied	Energy not Supplied		Energy Requirement	Energy Supplied	Energy not Supplied	
	(MU)	(MU)	(MU)	%	(MU)	(MU)	(MU)	%
Chandigarh	185	185	0	0.0	537	537	0	0.0
Delhi	3,314	3,313	1	0.0	10,617	10,615	2	0.0
Haryana	5,898	5,898	0	0.0	17,469	17,469	0	0.0
Himachal Pradesh	857	855	2	0.2	2,786	2,780	7	0.2
UT of J&K and Ladakh	1,418	1,418	0	0.0	6,171	5,262	908	14.7
Punjab	7,390	7,390	0	0.0	20,385	20,385	0	0.0
Rajasthan	7,783	7,777	6	0.1	26,545	26,519	26	0.1
Uttar Pradesh	13,115	13,007	109	0.8	43,527	43,130	397	0.9
Uttarakhand	1,350	1,350	**0**	0.0	4,250	4,250	0	0.0
Northern Region	**41,309**	41,192	117	**0.3**	**132,286**	**130,946**	**1,339**	1.0
Chhattisgarh	2,822	2,822	0	0.0	9,592	9,592	0	0.0
Gujarat	8,750	8,750	0	0.0	34,020	34,020	0	0.0
Madhya Pradesh	6,510	6,510	0	0.0	23,380	23,380	0	0.0
Maharashtra	11,146	11,146	0	0.0	46,395	46,395	0	0.0
Daman & Diu	164	164	0	0.0	517	517	0	0.0
DNH	428	428	0	0.0	1,108	1,108	0	0.0
Goa	314	314	0	0.0	1,282	1,282	0	0.0
Western Region	**30,134**	**30,134**	**0**	**0.0**	**116,294**	**116,294**	**0**	**0.0**
Andhra Pradesh	4,751	4,750	1	0.0	20,221	20,220	1	0.0
Telangana	5,576	5,575	1	0.0	19,721	19,720	1	0.0
Karnataka	4,835	4,834	1	0.0	22,493	22,492	1	0.0
Kerala	1,941	1,940	0	0.0	8,098	8,095	3	0.0
Tamil Nadu	8,202	8,200	1	0.0	33,094	33,092	1	0.0
Puducherry	231	231	0	0.0	846	846	0	0.0
Lakshadweep #	4	4	0	0	19	19	0	0
Southern Region	**25,536**	**25,531**	**5**	**0.0**	**104,473**	**104,466**	**7**	**0.0**
Bihar	3,295	3,275	20	0.6	11,364	11,329	35	0.3
DVC	1,892	1,892	0	0.0	5,926	5,926	0	0.0
Jharkhand	830	827	3	0.3	3,056	3,003	53	1.7
Odisha	2,718	2,718	0	0.0	9,653	9,653	0	0.0
West Bengal	5,017	5,014	3	0.1	17,054	16,974	79	0.5
Sikkim	40	40	0	0.0	164	164	0	0.0
Andaman-Nicobar #	29	27	2	7	115	108	8	6.7
Eastern Region	**13,792**	**13,766**	**26**	**0.2**	**47,218**	**47,051**	**167**	**0.4**
Arunachal Pradesh	53	52	0	0.6	188	186	2	1.1
Assam	996	951	45	4.5	3,265	3,089	176	5.4
Manipur	77	77	0	0.5	285	283	2	0.8
Meghalaya	163	163	0	0.0	582	575	7	1.2
Mizoram	62	62	0	0.4	217	215	2	0.9
Nagaland	77	76	0	0.4	268	267	2	0.6
Tripura*	143	143	0	0.0	504	502	2	0.4
North-Eastern	1,570	1,524	46	3.0	5,308	5,115	193	3.6
All India	**112,341**	**112,147**	**194**	**0.2**	**405,578**	**403,872**	**1,707**	**0.4**

Lakshadweep and Andaman & Nicobar Islands are stand- alone systems, power supply position of these,does not form part of regional requirement and energy supplied. * Excludes energy exported to Bangladesh.
Note: Power Supply Position Report has been compiled based on the data furnished by StateUtilities/ Electricity Departments.

Source: CEA

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Smart and well-networked Thermal imager - testo 868

Smart-thermal camera - testo 868

In the range of thermal imagers, testo 868 is one of the best considering its quality, measuring performance and impressive smart functions. Its integrated digital camera ensures high-resolution image quality. With this portable device, users can generate error-free, objectively comparable infrared images and execute on-site reporting via testo Thermography App. Since it is Wi-Fi enabled and equipped with smart technology, one can even use a smartphone or tablet as an alternative display or for remote control. The testo 868 can identify leaks, overheated connections, overloaded machine parts, electrical anomalies, structural defects, etc.

Mechanical and Electrical maintenance

In the industry where machines and equipment are continuously operating to fetch the desired output, early identification of imminent malfunctions, defects on plants, electrical components and connections are critical.

Thermal imagers & testo 868 is used for:

- Identify wear on machines, motors, bearings, shafts etc.
- Fast detection of Hot Spots during continuing operation
- Avoid expensive damage, downtimes and fire risks on plants and machines
- Test switching cabinets, electrical conditions or circuit boards
- Evaluate heat status in low, medium and high voltage plants

Building Thermography

The health of a building is necessary due to various aspects and testo 868 can easily address:

- Test air-tightness of windows and doors
- Locate insulation errors and cold bridges in a building shell
- Detect and visualize mould-risk areas

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Facility managers are obligated to ensure healthy systems & testo 868 can assist them in various ways:

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- Thermal profiling of other air regulating components

Thermal Inspection

Solar plants are great sources of power and electricity furthermore some serious threats can jeopardize the power output of these systems. Also, as there are so many crucial components in the PV plants like solar modules, cells, array box, diode junction box, invertors, LT panels, cables etc, it makes the maintenance of the plants compulsory and what better way than conducting a thermal inspection to detect

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- Open/Short circuit in the modules & cells
- Overheating of panels or joints
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- Corrosion & loose connections

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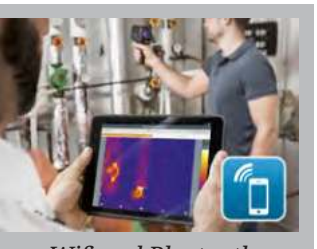

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