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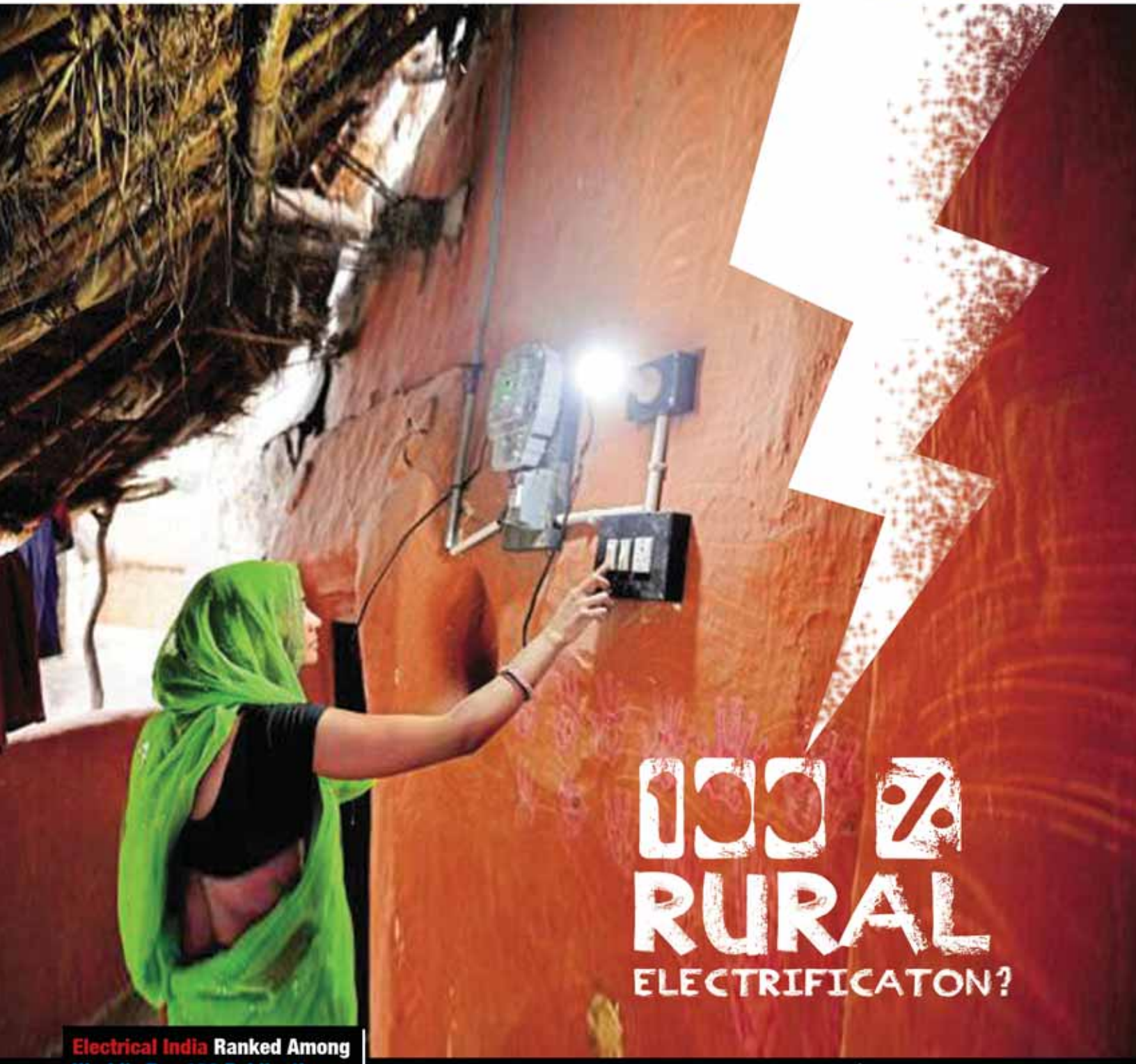

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- 36 GIS terminations
- 30 Outdoor terminations
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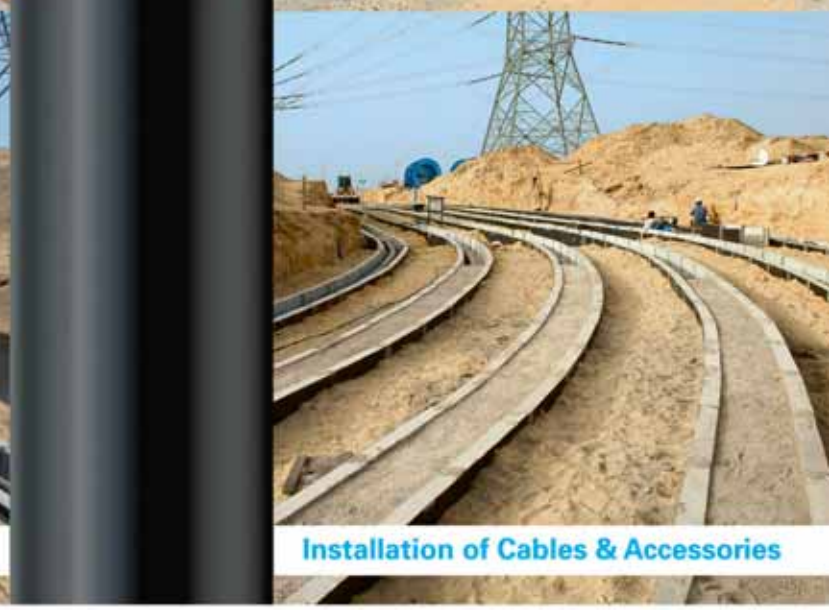
Production & Engineering

Transportation

Cable Pulling



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Publisher's letter

Delivering electricity to every village in India was at the top of the agenda for the successive governments at centre. Subsequently, on 28 April 2018, Indian Prime Minister Narendra Modi announced that the country had achieved its goal of providing electricity to every village in India which is being considered as "one of the greatest achievements in the history of energy".

However, it does not reflect the right image of 'electricity for all' as a village is considered electrified if 10 per cent of its homes and public buildings are connected to the grid. Therefore, despite successful implementation of rural electrification schemes, about 3.21 crore households in India remained without electricity until May 2018. Thus, the present government expressed its commitment to energise every household in the country. In this context, the Saubhagya Scheme or Pradhan Mantri Sahaj Bijli Har Ghar Yojana was launched in September 2017 that envisaged complete the electrification process by December 2018.

So far, the government has made significant progress in this move. Data available on the Saubhagya dashboard showed that out of total 21,34,53,076 rural households, 21,34,30,385 are already electrified and 22,691 homes which constitutes to 0.01 per cent are yet to be electrified.

This time, we are presenting a reality check of India's 100% rural electrification. Hope you will enjoy reading the issue as always.

Do send me your comments at miyer@charypublications.in

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e-gallery

CAPTURING more of the SUN'S ENERGY

Solar power sector in India is witnessing exponential growth primarily driven by the government's favourable policies. For the first time in India, solar power made over 50 per cent power capacity addition in 2018. According to data compiled by the Central Electricity Authority (CEA), solar power generation in the fourth quarter (Q4) of CY 2018 increased by 48 per cent year-over-year (YoY) to 9,672 million units (MUs) compared to 6,523 MUs during Q4 2017. Rooftop solar also had an impressive year in 2018 as it has witnessed 66 per cent YoY growth, thanks to the policies which include subsidies and net metering. Further, solar installation is expected to rise 360 per cent by 2020 as the country is committed to achieve 100 GW of solar energy capacity by 2022.

Solar energy's overall contribution to the power grid is increasing like never before. Total power capacity additions in India stood at 16.3 GW in 2018 from all sources. Of this, solar representing 50.7 per cent whereas new addition of coal-based capacity is accounted for 27.5 per cent. This shows the country's commitments towards green and clean energy.

However, the safeguard duty and issues related to land, transmission and GST created major roadblocks in large-scale installations in 2018. According to a report by Mercom India Research, solar capacity addition in India last year came down by 15.5 per cent to 8,263 MW as compared to 2017 due to safeguard duty and issues related to GST and transmission.

Against this backdrop, coming April, Mumbai will open its doors for Intersolar India 2019 – one of the largest shows on solar energy business. Taking place during 4-5 April, the show will bring together the key players in the solar and allied industries from across the globe to showcase their latest technologies and innovations. Electrical India, being the media partner, will be present at this event.

We look forward to see you there. Till then, happy reading.

Subhajit Roy

Group Editor

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Electrical India
March 2019

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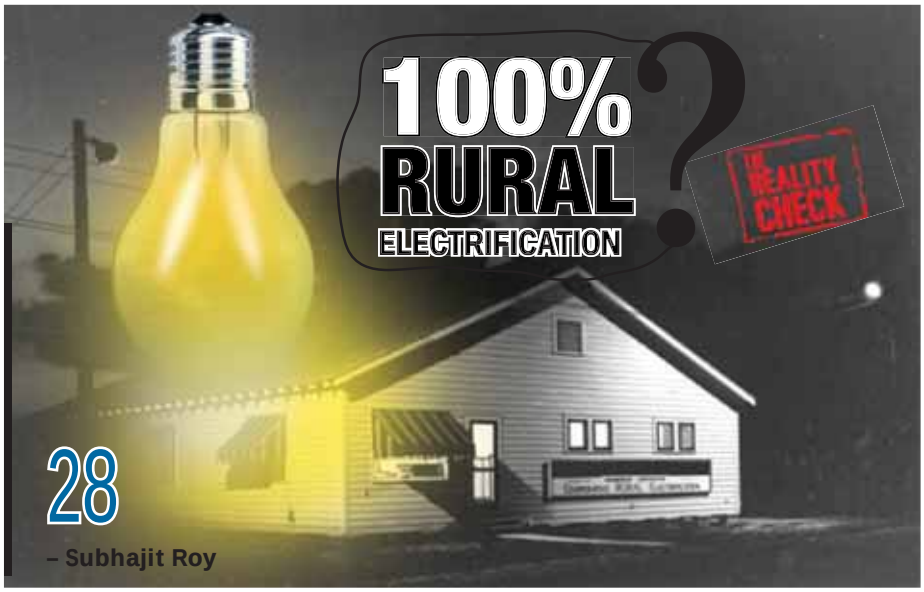

In brief

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ICA India Seminar on Energy Efficient Motor Standards

International Copper Association India (ICA India) hosted the national seminar on 'Energy Efficient Motor Standards & Emerging Challenges' in New Delhi. The guests of honour for the event were Ravinder, Secretary DIPP and R K Bajaj, DDG - BIS who delivered keynote address. Ravinder cited that the import of sub-standard motors should be controlled and customs can help by keeping a check and barring them from entering India eventually helping in the adoption of IS across the country.

Sanjeev Ranjan, Managing Director, ICA India said, "We hope that our seminar on energy efficient motor standards would have provided all the stakeholders the ground to come up with solutions for the challenges related to adoption of Higher Efficiency Motors (HEMs) and finding new solutions for transforming the markets towards high efficiency motors and motor systems." Abhishek Dhupar, Manager–Motor & Motor Driven Systems, ICA India said, "Since IS 12615 was brought under mandatory certification for improving efficiency standard for motors in India, the demand and usage of IE2 & above motors has increased and hence this seminar was an effort to address the issues related to mandatory certification." The seminar had experts from DIPP, BIS, Siemens, KBL, ERDA & ICA India.

IEEMA officially launches ELECRAMA 2020

With the grand launch on February 4 in Mumbai, IEEMA kicked off its preparation for the upcoming 14th edition of ELECRAMA scheduled from 18th-22nd January, 2020 at the India Expo Mart, Greater Noida.

Anil Saboo, Chairman ELECRAMA 2020 and Chairman said that the Vision of ELECRAMA 2020 is to make it Global platform by getting exhibitors from more than 50 countries and visitors from more than 100 countries to share new Technologies & Innovations. The Launch event witnessed the presence of who's who of the power equipment industry. Over 400 delegates at the launch ceremony itself proves the importance of ELECRAMA for the power sector. Furthermore, the year 2020 will also mark the completion of 30 years of ELECRAMA.

Saboo further informed that the ELECRAMA flagship event of IEEMA in the last edition recorded more than 220000 footfalls and over 1,200 exhibitors showcased their products and services at the biggest showcase of electrical and electronics manufacturers. Business queries or more than 1 billion USD were estimated and visitors from various countries experienced transformational developments taking place in India and globally.

The electrical industry will showcase solutions on Artificial Intelligence, Machine Learning, blockchain and a combination of innovation in manufacturing of electrical gadgets, equipment, machineries and energy efficiency programmes at ELECRAMA 2020.

ABB CEO Discusses AI, e-mobility with Maharashtra CM

ABB CEO Ulrich Spiesshofer held talks with the Chief Minister of Maharashtra Devendra Fadnavis on the sidelines of the NASSCOM Technology and Leadership Forum 2019. The discussion focused on how a partnership with ABB could be created to deploy artificial intelligence (AI) and digitalisation technologies to meet the state's requirements, including using AI to take skills development to the next level.

The two leaders also discussed the state's focus on becoming an export hub and how ABB could help enhance India's role in the global value chain. "Maharashtra has been a forerunner in AI technology in India and ABB, as a pioneering technology leader in digital industries, is ready to support it in developing its digital economy," said ABB CEO Ulrich Spiesshofer. "By rapidly adopting advanced technologies, Maharashtra can expand its role as an export hub and strengthen India's competitive position in global markets." Enhancing the state's presence as a robotics hub was factored in the talks.

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GAIL Fast-tracks Bokaro-Durgapur Pipeline Project

In a swift move to safeguard project schedule of the Pradhan Mantri Urja Ganga natural gas pipeline to eastern India states, GAIL India as the owner and operator of the project under execution has offloaded the pipe laying contract from M/s IL&FS due to poor project progress driven on account of acute financial crisis. The Bokaro-Durgapur section (124 kms) is now re-tendered and awarded to three different contractors to expedite construction efforts for hooking up supply network to the fertiliser, city gas distribution. The project consultant, M/s Engineers India Limited was replaced by M/s MECON for overseeing the project activities under this crucial stretch.

Post commencing supplies at Varanasi, the final leg of Phase-I (Phulpur-Patna section of approximately 585 km length) of the 2660 km pipeline project is now closer to readiness and natural gas supply to Patna is expected to commence soon. B C Tripathi, Chairman and Managing Director, GAIL re-affirmed company's commitment to ensure completion of Pradhan Mantri Urja Ganga project, strictly within envisaged project schedule. Accordingly, Phase 2 of this project beyond Dobhi (Gaya) towards Durgapur-Haldia and Bokaro- Ranchi-Angul- Dhamra (1900 Km) is slated for progressive completion by December 2020 .

DistribuELEC showcases breakthrough technologies for smart distribution

DistribuELEC 2019, the 3-day exhibition on power distribution, held between 4 -6 February in Mumbai. Organised by Indian Electrical and Electronics Manufacturers' Association (IEEMA), the expo brings utility, consumer, electrical operational technology (OT) and Information Technology (IT) on the same platform.

Simultaneously with DistribuELEC IEEMA organised its first edition of buildELEC and a technical conference Intelect 2019.

Sunil Singhvi, Chairman, distribuELEC 2019, said, "DistribuELEC 2019 and BuildELEC 2019 provide the energy and construction industry an unrivalled environment to meet suppliers, all in one place. Participants had the chance to meet with exhibitors and explore new developments. In addition, leading industry experts have shared their knowledge experience in energy sector during 2-day interactive conference."

Exicom Wins Manufacturing Excellence (EV Infrastructure) Award

Exicom wins 'Manufacturing Excellence (EV Infrastructure) at '3rd ASSOCHAM Auto Forum & Awards' with the theme 'Moving towards a Greener Transportation' recently in New Delhi.

These ASSOCHAM Awards are supported by the Department of Industrial Policy and Promotion (DIPP), Ministry of Heavy Industries & Public Enterprises, Ministry of Road Transport & Highways, Ministry of Environment, Forest and Climate Change, Government of India and the NITI Aayog. The other award winners are Maruti Suzuki, Toyota Kirloskar, Tata Motors, Ather, NDS, Mahindra Electric, Minda, Motherson Auto and Krishna Maruti under various categories.

Dr Arbinda Mitra, Scientific Secretary, Office of the Principal Scientific Advisor to Government of India said, "We are now very soon going to launch the second phase of Faster Adoption and Manufacturing of Hybrid & Electric Vehicles), this is a consortia approach that we are putting along with the Department of Heavy Industries and Department of Science and Technology,".

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Sterlite Power Forays into Grid Connected Battery Storage

Sterlite Power has submitted bids for two storage projects in the auction of Salt River Project utility. This marks the first foray of Sterlite Power into grid connected battery energy storage systems (BESS). Grid connected BESS are rapidly achieving commercially viability for utilities around the world as total system costs have dropped approximately 60 per cent over the last five years. As grids integrate a greater share of renewables in their footprints, BESS solutions are needed for a seamless and reliable transition. These systems provide critical services like peak load shaving, energy and ancillary services that will be increasingly needed in a renewable-heavy grid.

Pratik Agarwal, Group CEO, Sterlite Power, said, "BESS are critical to realise the renewable revolution, underway across the world, in a reliable manner. Our foray into grid connected battery storage will allow us to stay ahead of this technology's adoption."

In addition to operational flexibility, the net negative emission of BESS system is a huge factor, aiding its adoption. Sterlite Power is in commissioning and operating transmission grids, the company understands that BESS solutions are inevitable for grids across the world.

National Salt Memorial goes Solar with Waaree Energies

Prime Minister Narendra Modi inaugurated the National Salt Memorial on the 150th death anniversary of Mahatma Gandhi. The memorial was built to honour the famous Dandi March by Mahatma Gandhi. With a unique combination of history and innovative technology going hand in hand, the memorial houses various artefacts and souvenirs of the famous freedom fighter along with 41 solar trees. Waaree Energies was the partner in supplying solar panels for these trees. With a highly efficient 370 Wp mono crystalline panels, the solar trees have the capacity to generate 182 kWp and are installed in such a way that they are capable of meeting the energy demand of the entire memorial thus, making it a net zero energy building.

Waaree Energies takes immense pride in supplying solar panels to a memorial of this stature. Waaree Energies has made their mark in the industry with their consistent supply of high quality and reliable modules and services, through state-of-the-art technology and service delivery.

ERDA inaugurates site testing laboratory at PVVNL Muradnagar, UP

Electrical Research and Development Association (ERDA) signed a MoU with Pashchimanchal Vidyut Vitran Nigam Limited (PVVNL) on 1st February 2019 for setting up of a testing laboratory at PVVNL Muradnagar, Uttar Pradesh. This site testing laboratory shall be equipped with routine and acceptance testing facility of major electrical distribution equipment e.g. Distribution Transformer, Instrument Transformer, Energy Meter, Insulator, Cable etc. PVVNL and other UP DISCOMS shall be using this facility for acceptance testing of equipment purchased by them to ensure quality assurance of the equipment purchased by them. In future, other state government distribution companies may also avail this facility. Inauguration of this site laboratory was performed by Shrikant Sharma, Minister of Energy Government of Uttar Pradesh in the presence of Ashutosh Niranjan, Managing Director, PVVNL and Hitesh Karandikar, Director, ERDA at an official function at PVVNL headquarter at Meerut on 1st February 2019.

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KEC Announces Successful Sale of Stake in KECBSTPL

KEC International Ltd (KEC), has announced the successful sale of its 99.99 per cent stake in KEC Bikaner Sikar Transmission Private Limited (KECBSTPL) to Adani Transmission Ltd (ATL) at an Enterprise Value of around Rs 227.5 crore.

The sale was previously announced on November 3, 2018, and has completed effective. KECBSTPL is having an operational transmission line of 344 ckt. kms in the state of Rajasthan from Bikaner to Sikar. KEC Bikaner Sikar Transmission Private Limited holds a minimum 25 years concession license to operate and maintain a 400 kV D/C Bikaner- Sikar Line of 344 Ckt kms in Rajasthan. The project was awarded through competitive bidding process, the project was physically completed almost four months ahead of schedule by KEC International Ltd.

The line was commissioned in December, 2017 and since then has been in successful operation. Vimal Kejriwal, MD & CEO, KEC International commented, "We are happy to successfully complete the sale transaction of our entire stake in KEC Bikaner Sikar Transmission Pvt. Ltd. to ATL. Our decision to sell our stake in KECBSTPL is in line with our asset light model of operations and our strategy to focus on the core EPC business."

Eaton Introduces 9E & DX-RT UPS Systems

Eaton introduced 9E and DX-RTUPS systems to the Indian market. The three new products – Eaton DX-RT 06-10 kW, Eaton 9E-IN 1/2/3 kVA and Eaton 9E-IN 06-10 kW, provide customers and end users with an energy-efficient, highly reliable and compact power solution. The Eaton 9E & DX-RT are highly advanced UPS systems that are designed to provide protection to critical applications in healthcare, IT and SME sectors.

Syed Sajjadh Ali, Managing Director – India, Electrical Sector, Eaton said, "These UPS systems provide significantly stronger protection on inrush current and improve adaptability to grid power condition."

Eaton DX-RT 06-10 kW is a true online double conversion rack and tower convertible UPS system. It has a power rating of 06-10 kW @ Unity PF with rack and tower configuration and voltage at 230 Vac..

Eaton 9E-IN 1/2/3 kVA delivers more power in a limit space and saves energy cost due to its highly efficient design and offers efficiency > 91 per cent in online mode. Eaton 9E-IN 06-10 kW delivers more power in a limit space and saves energy cost due to its highly efficiency design and offers efficiency up to 95 per cent in online mode.

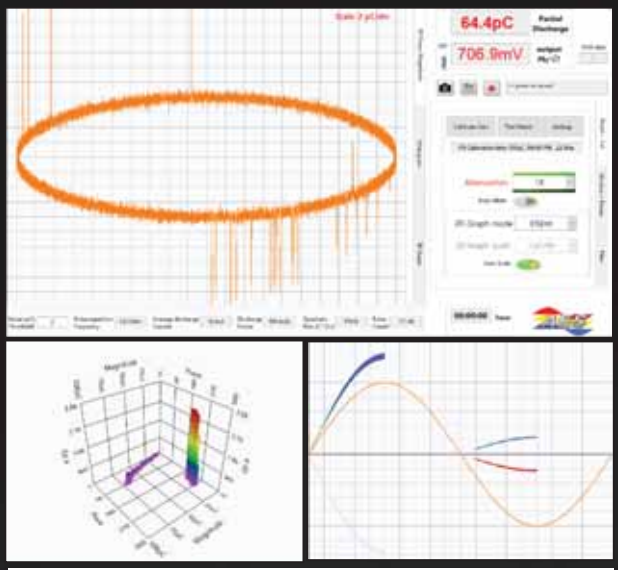
India Gets its First Grid-Scale Battery-Based Energy Storage System in Delhi

Tata Power, The AES Corporation and Mitsubishi Corporation inaugurated India's first grid-scale battery-based energy storage system in Rohini, Delhi. The 10-megawatt grid-connected system, owned by AES and Mitsubishi Corporation will pave the path for wider adoption of grid-scale energy storage technology across India. Fluence, a supplier of energy storage technology jointly owned by Siemens and AES, supplied its state-of-the-art Advancion Technology for the project.

Battery-based energy storage enables electricity to be stored and then delivered within milliseconds, reducing instability of the electric grid and enabling more energy to be captured and delivered on demand.

India has the ambitious vision of installing 225 GW of renewable energy generation by 2022. Battery-based energy storage provides the flexibility and agility to better integrate intermittent solar and wind energy resources into India's electric grid and ensure high-quality power for consumers. This 10 MW project is located at Tata Power Delhi Distribution sub-station in Delhi and will provide grid stabilisation, better peak load management, add system flexibility, and enhance reliability.

Partial Discharge Measurement System



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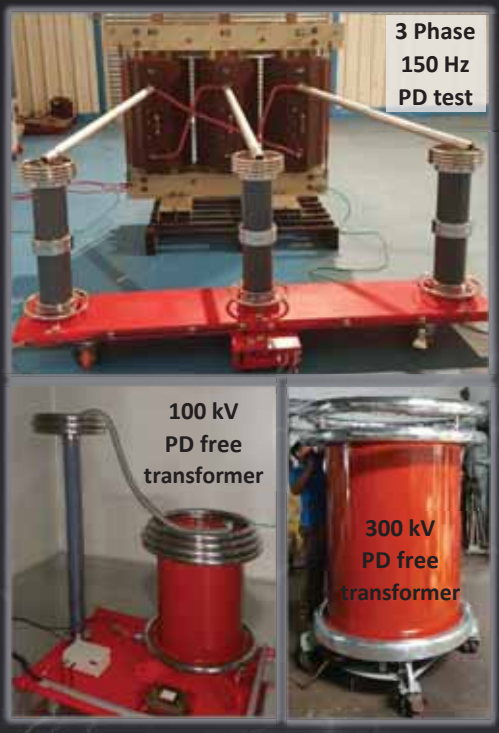

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Essar Oil UK Group Acquires BP Strategic Assets

The Essar Oil UK Group of companies unveiled the latest phase of its strategic business development after announcing the acquisition of a number of assets from BP to further strengthen the company's logistics infrastructure network which will fuel growth ambitions in the UK. This latest expansion of its UK interests means Essar has now invested nearly USD 1 billion in building a profitable and sustainable UK business since first acquiring the Stanlow Manufacturing Complex in July 2011.

Under the agreement, Essar will acquire an equity stake in the UKOP pipeline, a share of the contractual joint venture (with Shell) which runs the Kingsbury Terminal and a 100 per cent interest in the Northampton Terminal. Essar Oil UK Chief Executive Officer, S Thangapandian, commented, "The acquisition of these BP assets further demonstrates the company's ongoing commitment to investing in and growing their businesses within the UK. It currently supplies over 16 per cent of the UK's road transport fuel demand and this agreement will enable us to improve our competitiveness.

"The acquisition will allow Essar to maintain its presence in a very competitive UK Midlands region and grow that current footprint," he further adds.

Schneider Electric Launches Masterpact MTZ in India

Schneider Electric announced the launch of Masterpact MTZ, the next generation of high-power low voltage circuit breakers, combining the company's legendary performance and reliability with new digital capabilities. Assembled in India, for India, and for the world, Masterpact MTZ is a first-of-its-kind air circuit breaker in the market that provides the customer with multiple benefits of enhanced performance, increased reliability and safety. It is a future ready product that seamlessly integrates within the Smart Panel architecture, and can be remotely monitored and controlled with any supervision system.

Shrinivas Chebbi, President Buildings Business, Schneider Electric India said, "Masterpact's connectivity, digital capabilities and ability to be seamlessly integrate into our EcoStruxure Power architecture will deliver significant benefits for end users, specifiers, panel builders and contractors requiring high power breakers as part of low-voltage solutions for industrial sites and buildings." Anil Chaudhry, Zone President and Managing Director, Schneider Electric India said, "Masterpact MTZ represents for us a next step in our effort towards digitisation of power distribution, adding to our commitment to a sustainable circular economy."

ZX Lidars Achieves World-First Wind Lidar Measurements from Drone

Wind Lidar developer ZX Lidars has successfully demonstrated the use of Drone Wind Lidar to accurately measure the wind in what is believed to be a world-first. ZX Lidars provides vertical and horizontal profiling wind Lidars to accurately measure wind conditions remotely and above or ahead of their installed position. The company has now achieved accurate wind Lidar measurements from a commercially-available drone for demonstration purposes, and trialed the system successfully during summer 2018 with excellent data rates and sensitivity.

Managing Director, Ian Locker. ZX Lidars said, "This and other trials conducted since 2015 only stand to further confirm that our core technology is accurate, reliable and robust lending itself perfectly to a range of applications such as Drone Wind Lidar." Dr Michael Harris, Director of Science at ZX Lidars, has pioneered wind Lidar for the wind energy industry for nearly 20 years .

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ReNew Power Secures Additional OPIC Debt Funding of $350 mn

ReNew Power announced that it has secured fresh debt financing of up to USD 350 million from the Overseas Private Investment Corporation (OPIC), the US Government's development finance institution. This follows an earlier round of financing when OPIC had granted a loan of USD 250 million to ReNew Power in March 2016.

The funds will be utilised by ReNew Power to support construction of new wind and solar power plants in India. This will strengthen ReNew's contribution to the goal of diversifying India's power generation mix with an increasing proportion of energy being generated from renewable sources. Sumant Sinha, Chairman & Managing Director, ReNew Power said, "I reiterate our commitment to develop innovative and sustainable energy solutions and invest in high quality projects to generate maximum returns for our stakeholders.'

OPIC President and CEO Ray W Washburne said, "Investment in new and reliable energy will help India diversify its power generation, which is critical in order to meet growing energy demand and sustain economic growth," said Washburne. "OPIC looks forward to continuing its partnership with ReNew Power and supporting its commitment to advancing economic development throughout the Indo-Pacific."

Legrand India Rolls Out ELIOT IoT Program

Legrand India provides a new dimension for connecting lives with its roll out of IoT programme- ELIOT. ELIOT which stands for Electricity and Internet of Things is a programme that aims to inject the power of communications, advances in connectivity and intelligence in the building environment and enhances value of the connected products to improve user experiences. Eliot also supports the development of suitable digital infrastructures for buildings and provides interoperability. In India, the Eliot product offerings are – Residential: Arteor With Netatmo, My Home Up, Classe 300 IP Door Phones, Nuvo for Audio Systems; Hospitality: Neat for Integrated Assisted Living, Flex Commercial: Power Distribution Unit, Energy Distribution.

ELIOT, a combination of electricity and IoT, will work to transform built environments through a purpose-built cloud, with gateways for installed legacy offerings, an array of natively connected new products, and solutions comprising connected, intelligent technologies and services.

Legrand India through their IoT Eliot programmes aims to deliver additional benefits for all private and professional users, whether they are end users or installers. The products are interconnected in such a manner that they are able to talk to each other and interact when the user wishes too.

Bentley Systems Announces OpenUtilities Solutions for Grid Modernisation

Bentley Systems announces the availability of OpenUtilities DER Planning and Design Assessment Solutions, the latest of Bentley's electric utility software offerings that provide decision support and cost-based models and simulations for Distributed Energy Resources (DER) integration. In partnership with Siemens' Digital Grid business unit, OpenUtilities Solutions for DER empowers electric utilities, electricity suppliers, and distribution network operators (DSO) with software applications to analyse, design, and evaluate DER interconnection requests through desktop and cloud-based services . OpenUtilities Solutions for DER create automatic network analysis models for Siemens' PSS SINCAL with the integration of GIS-based network data including ESRI, GE, and Smallworld. The solutions generate an electrical digital twin for utilities. Some of the major challenges utilities encounter with DER integration are system complexity, increased regulatory requirements, high customer demand, and cost management. Digital twins can provide huge efficiencies in grid operations by streamlining DER interconnection applications with optimised workflows to better assess operational impacts, long-term strategic scenarios and investment decisions.

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iRAM Technologies Appoints Sameer Koul


Sameer Koul

iRAM Technologies, a homegrown product development and technology company with most advanced solutions based on Internet of Things (IoT), announced the appointment of Sameer Koul, Regional Director - Sales and Alliances, Western Region, India. In his role, Sameer will strategise growth and expansion of iRAM Technologies across western and central India. He will be responsible for developing relationship with municipal corporation and state government and with onboarding partners or dealers.

A seasoned sales professional, Sameer has an experience of over 20 years in customer acquisition, sales management, business development, P&L management across various industries. He has worked with MNCs like Honeywell, Bosch, Oracle etc in senior capacities.

iRAM has recently won key projects to implement smart parking solutions in smart cities in Maharashtra. Sameer's appointment is in line with iRAM's commitment to offer IoT enabled solutions to smart cities in West and Central India. On the appointment, Vishal Mehra, Director & VP, iRAM Technologies said, "We are delighted to have Sameer on board to share his insights and expertise to help grow our business. His diverse background and extensive experience will enable him to inject a fresh perspective and further bolster our expansion drive. We are confident that he will play an integral role in sustaining our growth momentum in western and central India."

Sameer Koul, Regional Director - Sales and Alliances, Western Region, India, said, "I am excited for this opportunity and to be part of the dynamic iRAM Technologies team. Bringing my varied experience on a platform of a brand like iRAM, I look forward to working with the them and taking their expansion growth to the next level."

Sameer is a graduate (Engineering) from Dayalbagh Educational Institute, Agra. Prior to his role at iRAM Technologies, Sameer was a Senior Business Manager – Global Utilities Business (JAPEC Region) at Oracle and has supported in establishment of new business verticals and strategic partnerships.

Endurance International Group Appoints Manish Dalal as MD of Asia-Pacific


Manish Dalal

Endurance International Group announced the appointment of Manish Dalal as Managing Director of Asia-Pacific (APAC). Manish will be responsible for overseeing the existing APAC business and designing and executing a growth strategy through new markets, products and business opportunities.

"We are excited to welcome Manish to lead the growth and development of our APAC strategy," said Christine Timmins Barry, Chief Services Officer of Endurance International Group.

"His expertise in the region coupled with his strong industry expertise in domains, web hosting, and online presence make him an ideal leader and instrumental to Endurance's future growth." Manish brings over 20 years of corporate experience to his role at Endurance. He has worked for leading technology companies such as Motorola, Yahoo! and Verisign with roles that spanned engineering, product management, global partnerships and general management. Most recently, he was Vice President and General Manager for Verisign APAC where for the last eight years, Manish grew the company's online presence business across regions such as India, China, Japan, South Korea, and Southeast Asia.

"I'm impressed with Endurance's breadth of brands that support small business owners and am excited to foster new opportunities for the company in APAC," said Dalal. "Small and medium businesses play a vital role in economic development of every country with their rapid innovation and expansion. According to the Ministry of Micro and Small Medium Enterprise (MSME), there are around 51 million MSMEs in India that contribute over 37 per cent of India's GDP. Out of these 51 million MSMEs, around 16 million are actively connected to the Internet with more coming online every day. With India's digital consumers coming of age, MSME owners are increasingly reimaging their business with an online mind set. Therein lies the opportunity to partner with small businesses in their online journey as they fast-track their path to business success," added Manish.

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Tata Power Bestowed with Two Awards at The India Risk Management Awards

Tata Power was bestowed with two awards - the 'Best Risk Management Framework & Systems – Power' and 'Business Continuity' at the 5th Edition of The India Risk Management Awards. Tata Power has constantly worked towards creating a robust regulatory compliant business by building a highly efficient risk management team.

Kenneth Rogoff, an American economist, the Thomas D. Cabot Professor of Public Policy and Professor of Economics at Harvard University, presided over the ICICI Lombard & CNBC-TV18 India Risk Management awards function and felicitated the winners. The jury was led by Arundhati Bhattacharya ex CMD – State Bank of India Group. The event was attended by Parshuram Date, CRO and the Risk Management Team.

Praveer Sinha, CEO and Managing Director, Tata Power, said, "We are ecstatic to receive this prestigious award and feel honoured to be felicitated for our efforts by an esteemed American economist. This award will encourage us to continue managing risk and ensuring safety thereby, creating a secure working environment."

ABB CEO Gets India's NASSCOM Global CEO Award

ABB Chief Executive Officer Ulrich Spiesshofer received the NASSCOM Global CEO Award at the NASSCOM Technology & Leadership Forum 2019 in Mumbai, India. The award, presented by the main trade organisation of Indian IT-BPM companies, recognises Spiesshofer's exemplary business leadership in shaping ABB as a pioneering technology leader in digital industries.

"It is a great honor to receive this award in the presence of so many distinguished innovators and leaders at the NASSCOM Technology & Leadership Forum 2019," Spiesshofer said. "At ABB, we believe digital technologies hold the key to solving global challenges like climate change and to drive growth, productivity and prosperity around the world. Accordingly, we have been transforming our company to become a leader in digital industries. Today, with our leading ABB Ability offering of digital solutions and services, we help our customers to drive efficiency and productivity and to digitalise their operations."

TMEIC Wins 5 Star Rating Award for Excellence in EHS Practices

TMEIC Industrial Systems India (hereinafter, TMEIC India), a group company of Toshiba Mitsubishi-Electric Industrial Systems Corporation (hereinafter, TMEIC President & CEO Masahiko Yamawaki), announced that the company has won the 5 Star Rating Award for Excellence in Environment, Health and Safety (EHS) practices and the first place award in the category of Manufacturing-Engineering or Electrical Appliances during the Confederation of Indian Industry – Southern Region (CII-SR) EHS Excellence Awards 2018. The winners were selected by 35 EHS experts and four jury members from among 154 participating companies across South India, after assessing factory sites and benchmarking the EHS practices with others in respective sectors.

"The EHS certificate with a 5-star rating is an assurance of TMEIC's commitment to the environment, our people and product reliability and quality," said Hemant Joshi, Managing Director, TMEIC India.

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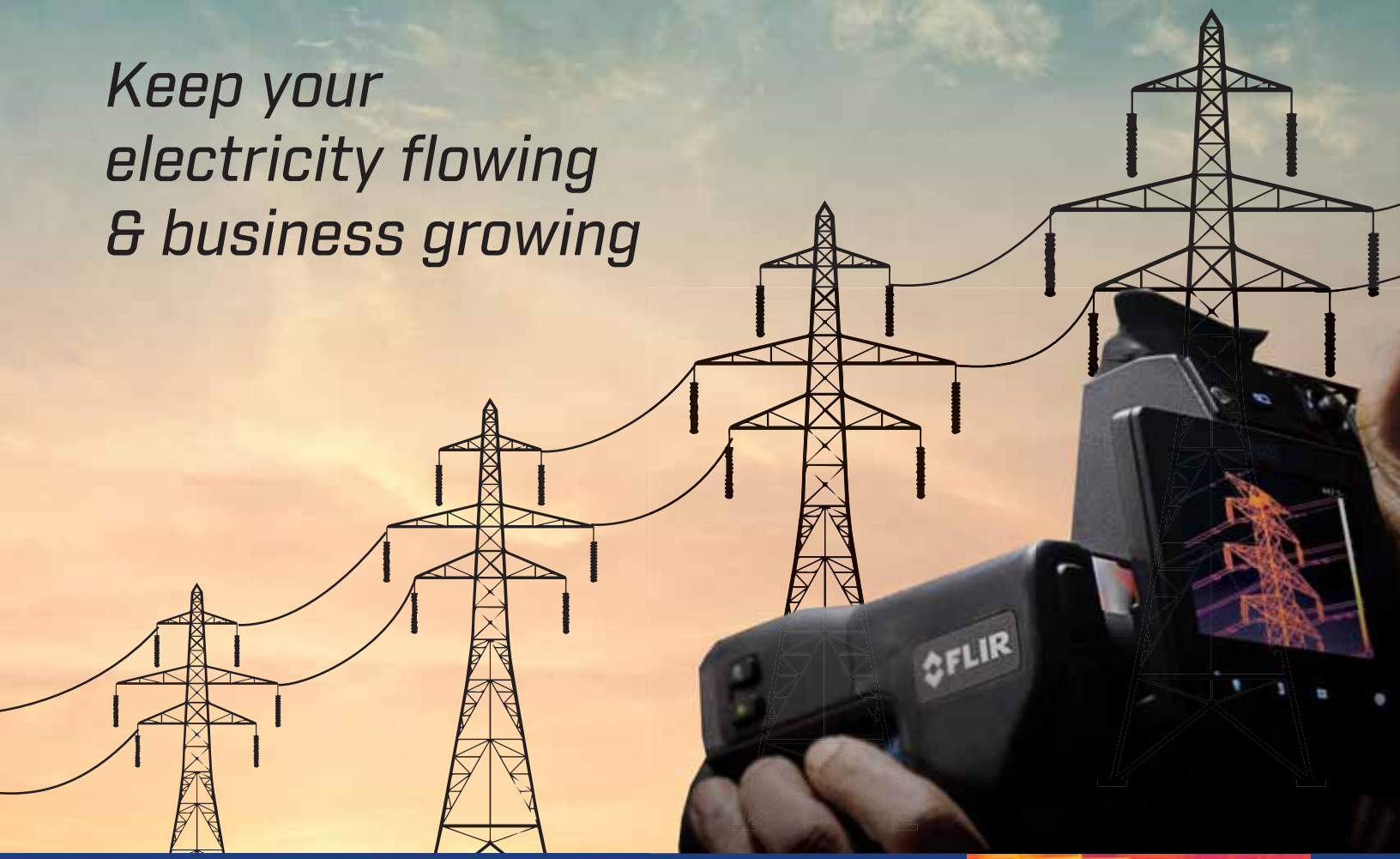

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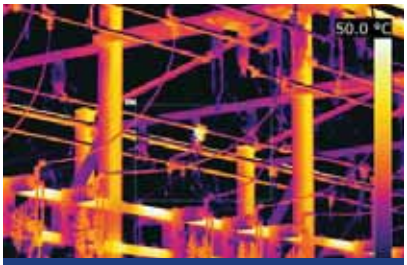

Substation Thermal Image

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Wireless EV Charging Market to be $ 407 mn by 2025

The demand for luxury EVs, increased EV sales, government regulations to curb emissions, and fast developing EV infrastructure are driving the overall demand of the wireless EV charging market.

According to Marketsandmarkets report, 'Wireless EV Charging Market', the wireless Electric Vehicle (EV) charging market is projected to grow at a CAGR of 117.56 per cent to reach USD 407 million by 2025 from an estimated USD 8 million in 2020.

The demand for luxury EVs, increased EV sales, government regulations to curb emissions, and fast developing EV infrastructure are driving the overall demand of the wireless EV charging market. OEMs in collaboration with wireless charging technology manufacturers have also begun developing their own charging infrastructure for the convenience of EV owners, which is expected to drive the growth of the wireless EV charging market.

Government initiatives to promote zero or low emission vehicles are contributing to the high growth of Battery Electric Vehicles (BEVs). The governments of some countries have begun providing subsidies for environment-friendly cars, thereby, encouraging the use of BEVs. For instance, the Chinese Government provides subsidies of RMB 55,000 on the purchase of passenger BEV and RMB 30,000 for Plug-In Hybrid Electric Vehicles (PHEVs).

The Dynamic Charging segment is estimated to be the fastest growing wireless EV charging market. The dynamic wireless charging technology for EVs is the most preferred and attractive future technology in the EV industry. Wireless charging system manufacturers such as Qualcomm Technologies, Inc. (US) have demonstrated the dynamic wireless charging technology by constructing 100 meters of test roads embedded with the wireless charging system. Dynamic charging technology has a great future once EVs are launched in the mass market. The future roads or highways are expected to be equipped with this technology, and the drivers would have to pay a tax for entering the lane to charge their EVs while on the move.

Asia Pacific is expected to be the largest market for wireless EV charging system in 2025.

Asia Pacific is projected to be the largest market for wireless EV charging system from 2020 to 2025. A rise in the penetration of EVs in the developed markets may boost the demand for wireless charging systems. Increasing R&D investments, coupled with the growing number of partnerships and joint ventures between major OEMs and domestic players, have created growth opportunities for wireless charging system manufacturers in Asia Pacific. Moreover, the region comprises the emerging economies, such as China and India, along with the developed nations, such as Japan, and is the largest market for automobiles. Thus, technological advancements have led major OEMs to incorporate advanced and convenience features such as wireless charging system in their EVs. The wireless EV charging market is dominated by globally established players such as WiTricity Corporation, Evatran Group, Mojo Mobility, ChargePoint, Bosch, Momentum Dynamics Corporation, Qualcomm Technologies, and Bombardier. EI

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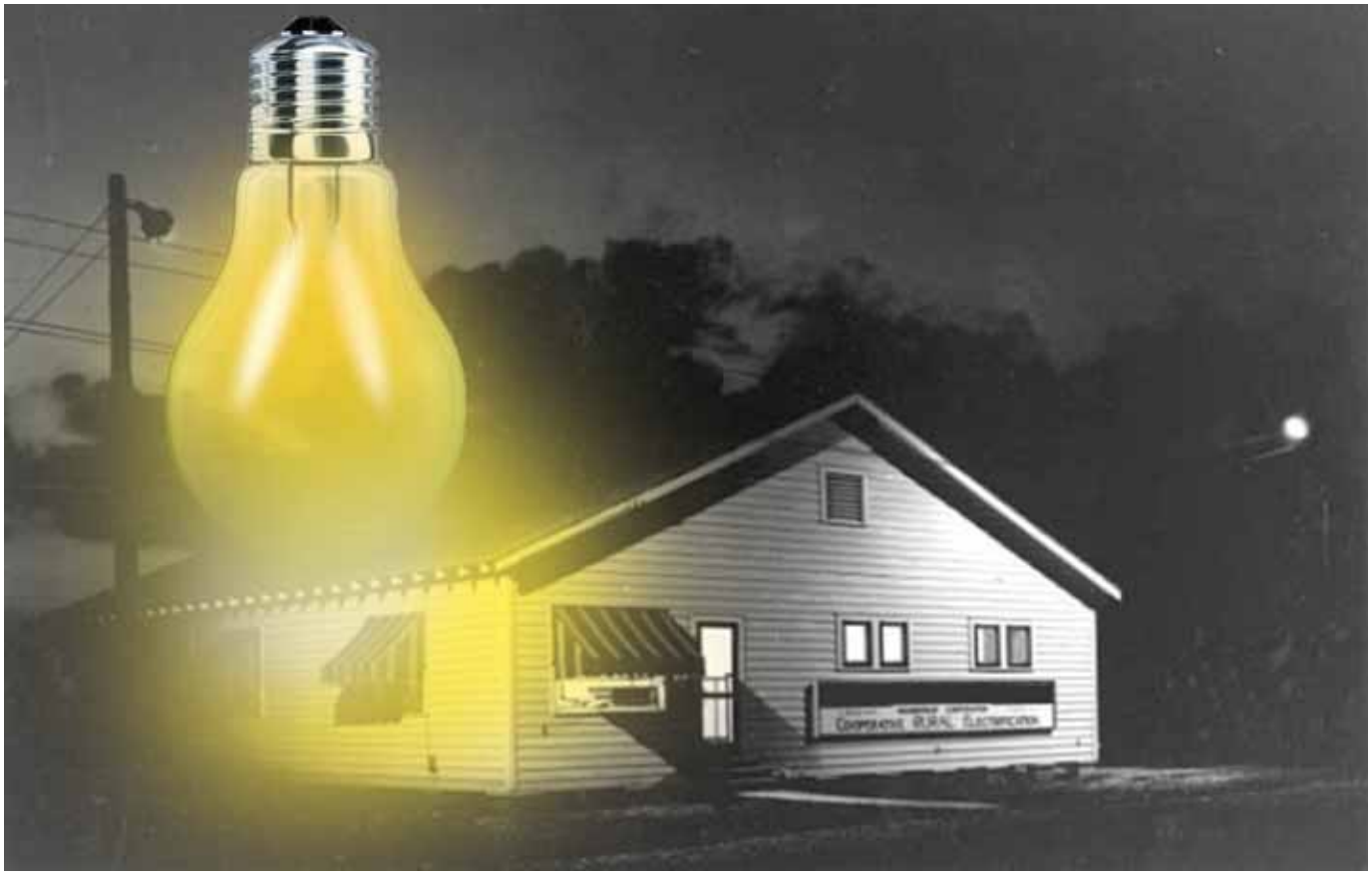

100% RURAL ELECTRIFICATION?

THE REALITY CHECK

– *Subhajit Roy*, *Group Editor*

Electricity is a key constituent for the economic growth of the country and is directly linked to GDP of the country. Rural electrification is required to meet surge in demand for power in India due to increase in capacity utilisation, industrialisation, urbanisation and population.

Rural electrification enhances the demand of transmission and distribution (T&D) equipment which shall help to electrical industries to utilise their production capacity.

Energising every village in the country with electricity is on the top agenda for the successive governments in India. Since 2000 around half a billion people have gained access to electricity in India, with political effort over the last five years significantly accelerating progress. However, this initiative got momentum with the present government's thrust on providing 24x7 electricity to all households by 2019.

The International Energy Agency (IEA) recently termed India's move to electrify every village as "one of the greatest success stories in access to energy in 2018". Earlier, in IEA's Energy Access Outlook 2017, India was considered as "a bright spot for energy access".

IEA, the global energy watchdog for the developed world, said, the Deen Dayal Upadhyaya Gram Jyoti Yojana scheme is a prime example of coordinated government action. This scheme focused on strengthening distribution networks and increasing village and household connections by co-funding network upgrades and extensions. Over 99 per cent of people who have gained access in India since 2000 have done so as a result of grid extension – the focus of government measures. The government has more recently been targeting mini-grid and stand-alone solar home systems to deliver access to some of the hardest-to-reach homes.

"Electricity can increase productive hours in a household leading to positive outcomes on education and economic wellbeing. It can also spur innovation and lead to entrepreneurial micro businesses ventures, and in time lead to greater agricultural yields. Benefits also flow to the likes of schools, banking and medical services," experts at the agency said.

Power Minister RK Singh said, "The country is on path to achieve 100 per cent household electrification by 31st March, 2019 and our next goal is 24x7 power for all households." He informed that 2.5 crore households are electrified under Saubhagya in a record time of 17 months.

Data available on the power ministry's Saubhagya dashboard showed that out of total 21,34,53,076 rural households, 21,34,30,385 are already electrified and 22,691 homes which constitutes to 0.01 per cent are yet to be electrified. Experts claim that the present government is doing progressive and excellent work in electrification sector. Last year, in World Bank Electricity accessibility list, India moved to 73rd positions from 99th position. India is also now the 3rd biggest power producer country in the world.

However, explaining the ground reality of '100 per cent household electrification', Anil Saboo, Chairman of CII Rajasthan, said, "More than 30 million households still don't have access to electricity. According to the government, a village will be called as electrified if 10 per cent of the total number of households in that village has access to power. So, even if in a village, 90 per cent of the population don't have power connection, it will still be considered as electrified village." Mr Saboo is the CMD of Jaipur-based Elektrolites (Power) Pvt Ltd. Also, he is presently the Chairman of ELECRAMA 2020.

A survey states that only 71 per cent of households in India have access to power connection. This is quite obvious that urban areas have more connections than rural areas. Only around 60 per cent of rural households have access to electricity. People wish for reliable energy which they can use when and where they need it.

According to Mr Saboo, "While it is true that we have achieved 100 per cent electric coverage in India but still around 60 per cent of rural households have access to electricity. Government claiming is simply means that basic infrastructure like

The country is on path to achieve 100 per cent household electrification by 31st March, 2019 and our next goal is 24x7 power for all households.

Power Minister RK Singh

transmission lines and distribution transformer has reached in all villages of India and they are now connected to power grid."

Preparedness of Utilities and DISCOMs

India has made rapid progress in rural electrification over the past decade. To improve generation capacity or purchasing power, the state's electricity sector must be in good shape.

However, according to Mr Saboo, power distribution companies (DISCOMs) continue to struggle with their financial turnaround plans despite implementation of the centre's mega loan recast scheme called UDAY. "Unable to charge cost reflective tariffs, DISCOMs have been resorting to widespread load-shedding to check their operational losses," he observed. Many state electricity DISCOMs have to sell electricity at prices well below the cost of generation, transmission and distribution. The distribution infrastructure is overburdened, as the demand has grown, causing a high level of technical losses and frequent breakdowns. The distribution network capacity in several states is inadequate to carry available electricity.

"While the performance of DISCOMs is improving, they are still not at the performance level to supply electricity 24x7. The only hope of the utilities is continued assistance from the state governments," Mr Saboo observed.

Both policies and politics need to shift focus from universal connections to upgradation of quality of supply and services.

Anil Saboo,
Chairman, CII Rajasthan

On their own, the many of the DISCOMs right now are not ready to provide 24x7 powers. The first and foremost is their financial health. Most of them are not financially capable to do this. Also, only some of the DISCOMs have the infrastructure to supply good quality power on a sustained basis. But, in Mr Saboo's opinion, if the respective state governments continue to give financial support and assurances to the DISCOMs, then this could definitely improve.

The state's electricity DISCOMs' financials must be improved for the development of country in both case growth as well as economic development.

Quality of power supply

It is very important that connected households receive adequate level of services because the size of the benefits of electrification depends on the reliability of electricity supply. Despite all the stories of progress and success on household electrification, availability of "quality power" remains the biggest concern.

The reliability of electricity is still low compared with the international standard Global Competitiveness Report ranks India 80th among 137 economies in the reliability of its electricity supply in 2018. Both policies and politics need to shift focus from universal connections to upgradation of quality of supply and services, opines Mr Saboo.

Today, DISCOMs have been resorting to load shedding while their contracted generation capacities are underutilised. Adding new load to the existing fragile distribution network will only compromise the quality and reliability of supply. It could result in continued blackouts for the rural poor during peak hours. DISCOMs should emphasis on building Smart Grids and IoT based equipment to deliver quality power, he suggests.

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CLEAN ENERGY MINI-GRIDS:

POWERING THE INDIAN RURAL ECONOMY

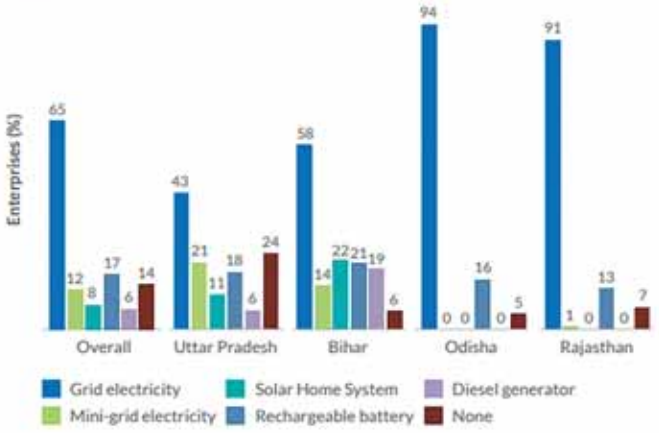
Based on REEEP calculations, clean energy mini-grids could serve at least 36,5 million people and mitigate greenhouse gas emissions of up to 122 million tonnes of CO2 between 2020 and 2035 in Bihar and Uttar Pradesh alone.

The energy landscape in India is rapidly transforming. The SAUBHAGYA scheme of the Government of India focusing on expansion of centralised grid infrastructure has brought electricity to more than 25 million households since 2017 – a huge leap forward in the universal mission to provide energy to access to all.

Yet connections in many rural areas continue to struggle with poor quality of electricity services and many hours of brownouts. According to a recent study on "Customer Behaviour and Demand for Rural Electrification in India" by the Smart Power Initiative of the Rockefeller Foundation: Almost 40 per cent off-grid electricity users do not express satisfaction with grid-electricity services. The report draws upon results from more than 10,000 surveyed households in Bihar, Uttar Pradesh, Odisha, and Rajasthan.

The same report shows a wide gap in reliability of grid-connections to rural micro-enterprises with only 65 per cent of 2,000 rural enterprises surveyed reporting grid-connections. In the most remote areas of India productive loads to power the rural economy are hence the exception, not the rule.

Figure 3.7: Electricity sources used by rural enterprises, by state



Thanks to their proven ability to provide power at high quality in a cost-efficient way, decentralised renewable energy solutions (DRE), such as clean energy mini-grids provide a reliable solution to the above challenges in the short term.

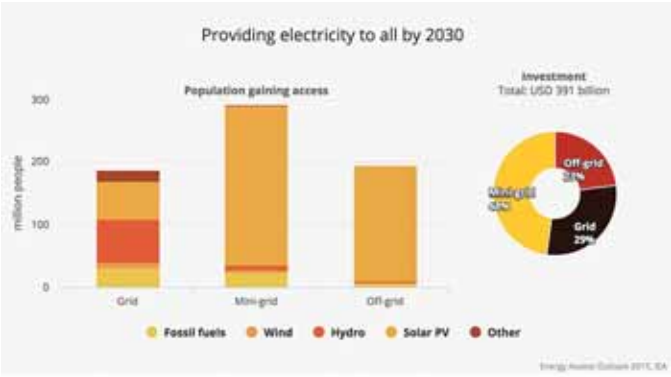
Clean energy mini-grids can provide 24x7 reliable, locally managed power with local ubiquitously available resources such as biomass, hydro, wind and solar (combined with storage, diesel backup or both). Additionally, mini-grids are quickly deployed, cost-competitive and, if done in the right way, able to integrate with the main grid. Lastly, via the use of productive renewable energy (PURE) they can also bring socio-economic development in rural areas.

In a similar vein, an impact assessment of mini-grids in Karnataka's Uttar Kannada district, showed a preference for clean energy mini-grids vis-à-vis the national grid. The customers preferred mini-grids for two reasons: Firstly, mini-grids showed higher reliability and quality of power than the national grid, which was cited as being unreliable. Secondly, interviewees referred to the benefits of a locally managed service as compared to one perceived as distant and unaccountable. A study from ISEP in Uttar Pradesh equally showed increasing demand and willingness to pay for mini-grid solutions.

An apt example of the use case for clean energy mini-grids in rural India is Mlinda, a Member of the Alliance for Rural Electrification (ARE). Through an ARE-managed grant from the OPEC Fund for International Development (OFID), Mlinda Association received funding to build three hybrid mini-grids in Narotoli, Shahitoli and Pasanga (Jharkhand). The successful project connected 358 households, 57 productive uses and 61 commercial outlets and was implemented one year ahead of schedule (after just 12 months instead of 24 months). Building on this success, Mlinda plans to replicate the model and to commission a total of 50 mini-grids by June 2020. The business model of Mlinda builds on agriculture as the anchor load as well as working with existing social capital in the local communities such as entrepreneurs, existing women groups, farmers clubs and local governance structures.

(Photo credits: Mlinda Association)

Based on REEEP calculations, clean energy mini-grids could serve at least 36,5 million people and mitigate greenhouse gas emissions of up to 122 million tonnes of CO2 between 2020 and 2035 in Bihar and Uttar Pradesh alone. Globally, IEA estimates that mini-grids and off-grid installations are the lowest-cost options for over 70 per cent of the new electricity connections. To meet this demand, investment capital in mini-grids alone would be about USD 190 billion between now and 2030.



(Source: IEA Energy Access Outlook 2017)


(Photo Credits: Studer-Innotec)

With the above in mind, it is not surprising to see that corporate giants such as ARE Members General Electric, Sterling & Wilson, Schneider Electric and ENGIE, as well a large number of SMEs and start-ups are increasingly engaged in the Indian DRE market. Backing up this trend, the National Solar Energy Federation of India (NSEFI) recently announced that decentralisation is one the key pillars in achieving the 100 GW national solar target without straining grid infrastructure.

This begs the question - what is needed for the DRE market to reach its potential?

1. **Coordination between private sector and government on DRE and mini-grid policy:**
   Energy policy in India is highly politicised and discussed on the highest echelons of politics in India. A takeaway from numerous discussions ARE has engaged in, is that additional public-private dialogue and cooperation is crucial to support more streamlined regulations and more awareness among policy makers of mini-grids as a viable and reliable solution for rural electrification. This is where an alliance of like-minded companies and stakeholders, such as the ARE, can play a key role as a mediator.

   Specifically pertaining to regulations for mini-grids, more engagement is needed to define the interplay between different policies on the national and state level (in states where regulations exist that is), the interoperability between the main grid and mini-grids as well the relation between mini-grid Distributed Energy Service Companies (DESCOs) and state-owned Distribution Companies (DISCOMs).

   Ultimately, the sector will require long-term cooperation between the public and private sectors in order to render mini-grid deployments viable at scale and attract sufficient amounts of domestic and international investor confidence and hence investments. Together with other relevant DRE actors, ARE is ready to engage in these dialogues with Indian policy makers.

2. **Lack of data about performance, market size and demand/customer profiles for mini-grids:**
   While a number of mini-grid initiatives, such as CES-MICRO by ARE Member CES India have been successful in collecting mini-grid performance data in India (e.g. on battery performance), and others have successfully collected data on demand and market size in certain Indian states (e.g. Smart Power India Programme supporting DESCOs in Uttar Pradesh), additional work is still needed to better understand the full market size and customer base for mini-grids in most parts of rural India.

   Moreover, it is of utmost important that lessons learnt from mini-grid projects all over India are collected and analysed to ensure that past mistakes are not repeated. Going hand-in-hand with its efforts to collect global mini-grid data, based on positive experiences in other parts of the world ARE can also here play an important role as a central knowledge platform to collect and to share best practices (from India and the rest of the world) and hence ultimately to increase investor confidence and de-risk DRE investments.

3. **Industry Quality Standards**
   In a competitive DRE market, led by private sector companies, it is fundamental to ensure that rural customers receive adequate services. In the Indian context, it is important that the DRE sector aligns with the Bureau of Standards (BIS) to ensure that service levels for rural customers meet nationally defined standards by the BIS. ARE will continue to work with and to support knowledgeable actors in this field such as IRENA and IEC.

4. **Embracing innovations to increase the efficiency of DRE solutions**
   As in the past years, new technologies will continue to improve the efficiency and cost-effectiveness of mini-grids in the near future. Emerging innovations in generation, storage, payment systems as well as end-use equipment will increase efficiency, decrease costs and provide better energy services to end users. Examples include more efficient PV panels, remote monitoring and control systems, AI, blockchain, smart meters, swarm technology and online payment

systems, such as pay-as-you-go, which has been used with great success for off-grid solar in Eastern Africa.

To promote innovative companies, it is essential to increase support for disruptive ideas and entrepreneurship, to reduce FOREX risks and to provide technical assistance provision through start-up or SME accelerators, incubators and traditional advisory and grant financing for market entry activities (both for local Indian and foreign private sector companies).

5. Capacity building to develop human capital in the DRE sector

Being a relatively new sector, there is a shortage of job-ready talent to develop, to install, to operate, and to manage DRE solutions such as mini-grids on the-ground. The human capital gap is most pronounced in remote rural areas.

Through appropriate training programs, it is also the belief of ARE to fill this gap and build a sustainable mini-grid industry for the 21st Century, empowering activating markets for affordable energy services, and creating local jobs and inclusive economies.

As an example, ARE Member, Schneider Electric via its 'Access to Energy' Programme has provided vocational training to over 190,000 people across 150 projects in around 40 countries with more than 250 partners and why, ARE Member LED-Safari specialises in online trainings for off-grid solar. Likewise, the Skill Council for Green Jobs in India has made impressive progress in providing training to support the Indian renewable energy sector. In this context, ARE has become a global partner of the #PoweringJobs, a global campaign led by PowerforAll to create employment-ready workforce to scale distributed renewable energy solutions in emerging economies in Asia and Africa.

ARE as an association also offers on-demand specialised trainings for utilities, government and private sector to help bridge the capacity gap in the sector. As a next activity, ARE offers a one-and-a-half-day rural electrification training for policy makers and officials at Intersolar Europe on 16-17 May 2019.

Jens Jaeger

Policy & Business Development Officer
Alliance for Rural Electrification (ARE), Belgium

HD Wires Envisages 10,000 TPM in Next 2 Years

HD Wires Private Limited was incubated as well as incorporated in the year 1988. The commercial production began in July 1994 and the company is celebrating its 25th anniversary of operations in 2019.

Indore-based HD Wires started its operations with manufacturing of binding wires for the construction industry; and HB hard drawn wires that are raw material for other wire products like nails and fasteners. During its journey of 25 years, the company has integrated into manufacturing of:

- Black and galvanized wires ranging from low to high carbon chemistry for general engineering purposes as well as agriculture.
- Cable armour, Stay and ACSR wires to cater to the expanding power sector in India.
- Fencing solutions i.e. solar fencing, barbed and chainlink mesh.
- Concrete reinforcement using weldmesh for irrigation pipelines and RCC slabs in low cost housing.
- Hardware products focusing B2B - Stitching wire, fasteners and welding electrodes.

The company started production with an achievable capacity of 300 TPM. "The journey has been long and rewarding to the current level of 165 tonnes per day. The key to this has been ongoing investment in technology, and by May 2019, with two new products, Cable armour tape and PC Wire, our monthly production will cross 6,500 tonnes," informs Dilip Dev, Director, HD Wires.

Markets for products

The major market share of HD Wires comes from Maharashtra, Gujarat, Jharkhand, West Bengal, Odisha, Uttar Pradesh, Rajasthan and Madhya Pradesh. While all states have its product presence due to the diversified product portfolio. HD Wires has been exporting to Nepal for the past 10 years, and since last 2 years, we have made inroads in to the middle east and south Asian markets. The company exports around 5-6 per cent of its total production. "We don't wish to increase our export percentage any further in near future as there is no export viability for the Indian steel goods manufacturers, especially, when raw material availability is under stress in India and China and Turkey are able to offer export at competitive prices. Moreover, imposition of MIP, and subsequently anti-dumping duty (AD), on various steel products has further put stress on raw material availability," says Dev.

Infrastructure

The company has a spacious workspace that is equipped with a series of machines and tools that are based on modern and cutting-edge technology. Managed by a team of experts, HD Wires' infrastructure is one of the major reasons that it is capable of catering to the bulk requirements of its prestigious patrons

For 1,500 TPM expansion in capacity, the capacity expansion is under progress at the same location and facility, where greenfield development is in progress for the same. "Our vision for wire division was to have a single point facility. We have about 1,40,000 sq ft constructed area at the facility at present. Around 22,000 sq ft area has been constructed more for the new shed under the expansion plan," states Dev.

Growth Trends & Demand Scenario

HD Wires expects a huge demand growth for the next two years. The growth in power, infrastructure, and other sectors will generate a surge in demand for steel wire, thus giving a fillip to the industry. "I believe that as there will be growth in economy and infrastructure, the steel industry market will also widen more. Major producers know that the consumption of steel is increasing and they are well-equipped to meet the soaring demand. The per capita steel consumption of India is one-third (69 kg) of the world's average (214 kg), and the country has yet to reach its optimum potential in terms of steel consumption," informs Dev.

HD Wires envisages to double the capacity in less than two years. At present, the company is producing 5,000 TPM, and in near future, it expects to touch 6,500 TPM within six months. "In less than one and a half years, we will hopefully touch 10,000 TPM target. We will be working with all those sectors that will have a demand for steel wire products. HD Wires has also acquired 35-40 acres of new land, which will be constructed within 1-2 years," states Dev. EI

For more details, visit www.hdwires.com

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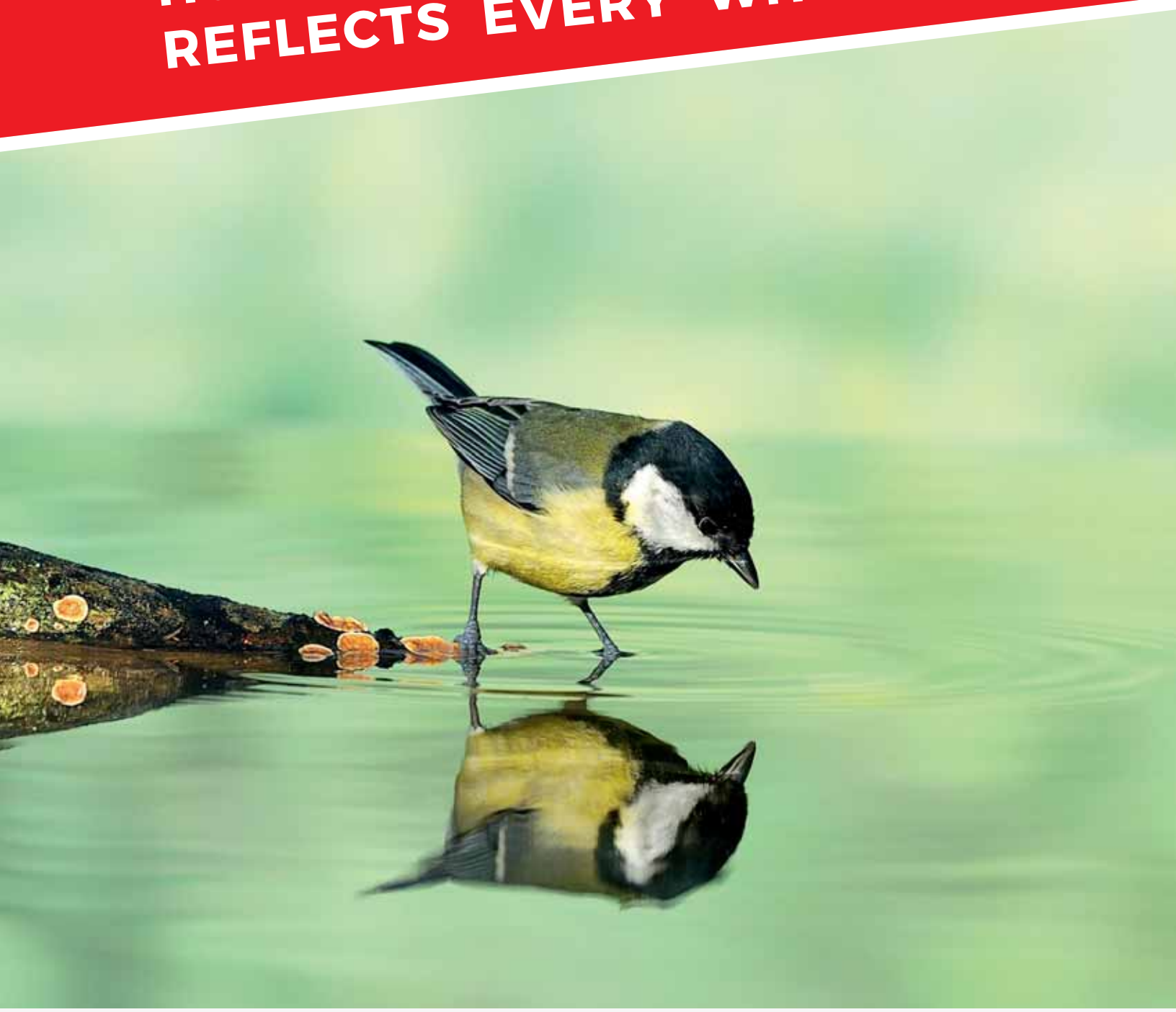

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Which factors affect the power supply quality?

The harmonious and uniform standards should be specified by the State Regulatory Commissions to serve the best interest of the utilities and consumers connected to the national grid.

The objective of the power quality Standards is to ensure reliable and quality power to the electricity consumers. The Electricity Act 2003 has enshrined the basic need of consumers to be provided with continuous, reliable and quality supply by the distribution utilities. Meanwhile the accelerated growth of renewable energy along with meteoric rise of non-linear loads, are posing serious challenges for quality of conventional unidirectional power flow from generation to consumption points. India is the 4th largest consumer of electricity in the world but in spite of being one of the leaders both in electricity generation and consumption, it is facing major

issues related to power quality. The issue of power quality remained largely ignored in the electricity supply industry of India. There are many reasons like huge gap between demand and supply just a decade back, lack of awareness and capacity to understand issues and challenges associated with quality of power, restricted availability of technology in detecting and overcoming such challenges.

Power quality is drawing increasing attention due to the heavy penetration of power electronics-based loads in every walk of our lives. Power quality parameters like frequency, voltage quality (interruptions, variations, unbalances, flicker, sags, and swells), harmonics and power factor are key matrices/indicators for defining a good power quality environment. Poor quality of power lead to premature failure or reduced/ degraded performance of equipment. It also caused increased system losses. Discerning consumers are looking for clean and quality power to drive their sensitive equipment at all levels. In this context, issues pertaining to power quality need for greater regulatory intervention in ensuring quality of power supply.

At present, a few parameters related to power quality are covered under the Central Electricity Authority (CEA) and SERCs Regulations. The Grid Code, Supply Code and Standard of Performance laid by various SERCs do mandate the quality of power to be maintained. The State Regulations, when dealing with the aspect of power quality through Supply Code/Grid Code or Standards of performance are not harmonious across different States and does not cover all aspects of power quality. Even there are lot of variations in similar power quality parameters specified by different SERCs. Therefore, there is a strong need to introduce a harmonised regulation on power quality across all states. SERCs are also required to put emphasis on measurement and introducing incentive/dis-incentive mechanism to ensure compliance to power quality parameters within certain limits.

Business and the economy in digital era also depend upon reliable and quality power supply. So far, the focus of the sector was limited to providing uninterrupted power supply to consumers. This was understandable at the time of deficit when the limited supply of power was available to meet peak demand and the expectation of end consumers was availability of power supply. But now the India has become one of the purples power country, thus, the quality power supply becomes the priority.

What is Power Quality

The reliability and quality are two important aspects of any electrical power supply system. Power Reliability means availability of power supply 24x7 basis which constitutes adequacy of electrical system at all levels from generation, transmission to distribution. However, power quality refers to both the extent of deviation or distortion in pure supply waveform and the continuity of supply. Any significant deviation in the magnitude, frequency, waveform or symmetry of line voltages is a potential power quality problem. Ideally, a wave form should be smooth and free from disturbances. But even the best power systems are subject to fluctuations and all electrical equipment are susceptible to damages caused by these fluctuations. When quality of the power supplied is deficient, it results in performance degradation and reduced life expectancy of equipment. Therefore, we may understand poor power quality as any power problem manifested in voltage, current, or frequency deviations that result in failure, increased energy loss or malfunctioning of equipment, thus causing economic loss.

Poor power quality can also result in problems with electromagnetic compatibility and noise. It can affect sophisticated protection systems and/or malfunctioning/ failure of vital control and signal systems. Typical electrical loads, such as lighting, heating, and motor, are less sensitive to variations in the supply voltage, and more sensitive to availability (free from interruptions) of supply. However, electronic/digital equipment are more sensitive to variations in supply voltages. Characteristics that affect power quality are voltage fluctuation, harmonic distortion, voltage unbalance, flicker, supply interruptions, voltage sags, voltage swells and transients etc.

Need of Quality Power

In the emerging surplus power scenario, the characteristics of loads and the requirements of electrical systems have changed significantly. The devices and equipment used presently in industrial, commercial and domestic facilities are more sensitive to supply variations than equipment used in the past. It is due to increased use of power

electronics and microprocessor-based technologies in equipment and appliances. The increasing penetration of Renewable sources of energy, semiconductor based electronic equipment, non-linear loads, data centres, industries running on adjustable speed drives and arc furnaces, etc. distort voltage/current waveforms in non-conformity to their desired form. This brings challenges to maintain the quality of power to ideal one and ensuring efficacy.

In India, various sectors are prone to both generation of higher power quality pollution as well as susceptible to power quality disturbances. The losses due to power quality issues are economic as well as technical. Both utilities as well as consumers are heavily impacted due to the techno-economic losses arising out of poor power quality. Poor power quality not only causes performance degradation and premature failure of electrical equipment but also results in increased system losses, financial loss etc. Therefore, apart from the reliability i.e. continuous supply, the preference of the electricity consumers is shifting towards quality power supply from the distribution licensees. Optimum power quality can enhance productivity and reduce losses.

Power Quality Parameters

The standards for voltage and other technical criteria are there which can be used to measure power quality. Parameters affecting power quality can be divided into two categories, i.e. Steady-state (or continuous) and Disturbances. Steady-state power quality parameters include Harmonics (waveform distortion), frequency deviation, voltage unbalance, voltage fluctuations and flicker. Disturbances include outages, momentary interruptions, momentary or transient overvoltage or surges, voltage dips and voltage swell. The important parameters are defined below with their probable causes and effects on the electrical equipment or supply system:

Frequency

Any variation of the power system fundamental frequency from its specified nominal value (e.g. 50 Hz in India) is defined as a frequency deviation. Frequency variations that go outside of the accepted limits for a normal steady-state operation of the power system can be caused by faults on the bulk power transmission system, a large block of load being disconnected, or a large source of generation going offline. Large frequency variations result in long-term damage to both generator and end use rotating electrical equipment whose rated output may suffer in low frequency regime. It may affect system stability and also leads to blackout of the grid. In interconnected power systems, significant frequency variations are rare.

Voltage

Voltage is a most important parameter in power system which affects the quality power in several ways like supply voltage interruptions, voltage fluctuations, voltage unbalance, voltage sag, voltage swell, voltage transients and voltage harmonics etc. as given below:

- **Supply Voltage Interruptions:** It is a condition in which the voltage at the supply terminals is lower than 10 per cent of the nominal voltage. It may be long or sustained interruption if duration is longer than 1 min. and short interruption if duration is up to and including 1 min. Voltage interruptions longer than 1 min. are often permanent and require human intervention to repair the system for restoration. For poly-phase systems, an interruption occurs when the voltage falls below 10 per cent of the nominal voltage on all the phases otherwise, it is considered to be a voltage dip. Long power interruptions are a problem for all users, but many operations e.g. continuous process operations, multi-stage batch operations, digital data processing semiconductor fabrication etc. are very sensitive to even very short interruptions.
- **Voltage Fluctuations:** It is defined as a cyclic variation of the voltage envelope or series of random voltage changes, the magnitude of which does not normally exceed the specified voltage ranges. They are relatively small (less than +5 or +10 percent) variations in the rms line-voltage. These variations can be caused by static frequency converters, cyclo-converters, arc furnaces, rolling mill drives, main winders and large motors during starting, etc. Voltage fluctuations may cause nuisance tripping due to mal-operation of relays and contactors and unwanted triggering of UPS units to switch to battery mode. It may stress electrical and electronic equipment toward detrimental effects that may

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disrupt production processes with considerable financial loss.

- **Voltage Unbalance:** It is a condition in a poly-phase system in which the root mean square values of the line-to-line voltages, or the phase angles between consecutive line voltages, are not equal. The sources of unbalanced voltages are due to malfunctioning of equipment, mismatched transformer taps and impedances, blown capacitor fuses, open-delta regulators, or open-delta transformers. It can also be caused by uneven single-phase load distribution among the three phases. Unbalanced systems indicate the existence of a negative sequence component of supply voltage, which is harmful to all poly-phase loads, especially three-phase induction machines. It can cause an over-load on induction machines and malfunctioning of frequency converters. Voltage unbalance can create a current unbalance which can be 6 to 10 times the magnitude of voltage unbalance. In turn, current unbalance produces heat in the motor windings which degrades motor insulation causing progressive performance deterioration and permanent damage to the motor.
- **Voltage Sag (dip):** It is a condition in which the voltage reduces at the supply terminals ranges for a duration of about half a cycle to several seconds. Common sources of sag are the starting of large induction motors and system faults. Sags can happen due to an overloaded circuit, malfunction of a transformers tap changer, breakers connecting a large inductive load to the grid or a disconnected capacitor bank. Also, arc furnaces initially take large amperes to produce high temperatures causing voltage sag. Voltage sag results in malfunction of equipment/ relays and contactors, under voltage tripping, loss of efficiency of motors and intermittent reduction of light illumination etc. In case voltage is too low, accelerated aging may take place in components and eventually causing faults in the network.
- **Voltage Swell (rise):** It is a condition in which the voltage rises at the supply terminals for a duration of about half a cycle to several seconds. Over-voltage could be the result of connecting a capacitor bank or disconnecting a large inductive load. Other sources of voltage swells are line faults and incorrect transformer tap changer settings in the sub-stations. It also occurs due to transfer of loads from one source to another. Voltage swells results in malfunction of an equipment, insulation failure, intermittent increase in light illumination, tripping of relays and contactors etc. In case of very high voltage, damage to electrical appliances may occur.
- **Voltage Transients**: Transients are momentary changes in voltage or current which occur over a short period of time usually for microseconds. It is divided into two categories. Impulse transient, which is a brief, unidirectional variation in voltage, current, or both on a power line and Oscillatory transient, which is a brief, bidirectional variation in voltage, current, or both on a power line. The most common causes of impulsive transients are lightning strikes, switching of inductive loads, opening and closing of energised lines and tap changing on transformers. Oscillatory transient can occur due to the switching of power factor correction capacitors, or transformer ferro-resonance. Poor or loose connections in the distribution system can also generate transients.

  Due to transients, electronic devices may operate erratically. Motor winding insulation is degraded and resulting in eventual failure. The electrical distribution system is also affected by transient activity. Voltage Transients degrade the contacting surfaces of switches, isolators, and circuit breakers. Intense transient activity can produce nuisance tripping of breakers. Transformers may get saturated if exposed to high voltage transients. In such cases hysteresis losses will increase thus causing transformers to run hotter than normal.
- **Voltage Harmonics:** It is a sinusoidal component of a periodic voltage waveform having a frequency that is an integral multiple of the fundamental frequency. It is the deviation from the original or pure voltage sine waveform. Generally, at the source point, the Voltage harmonics is absent. As the power flow progresses towards load end, voltage harmonic creeps in due to the effect of current characteristics of non-linear loads reflecting on network

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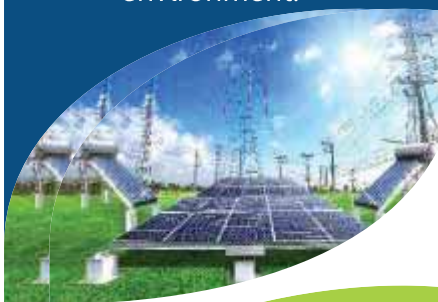

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impedances. Voltage harmonics is generally expected to be managed by the utility service provider.

Flicker

It is the impression of uncomfortable visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates rapidly with time. It is caused under certain conditions by voltage fluctuations resulting in change of the luminance of lamps. Quantitatively, it may be expressed as the change in voltage over nominal voltage expressed as a percent. The main cause of these effects is fast switching operations of industrial processes and electrical appliances connected to the supply system. Flicker is considered the most significant effect of rapid voltage fluctuations because it can affect the production environment by causing personnel fatigue and lower work concentration levels.

Current Harmonics

It is sinusoidal component of a periodic current waveform having a frequency that is an integral multiple of the fundamental frequency. It is the deviation from the original or pure current sine wave. Voltage and Current Harmonic pollution can be quantified by Total Harmonic Distortion. Current harmonics in the system are produced by non-linear loads and causes power pollution akin to air pollution caused by automobile emission. Examples of such non-linear loads are power electronic equipment including variable speed drives, fan regulators, CFLs, LEDs, Televisions, Switched Mode Power Supplies, Data Processing equipment, high efficiency lighting, electrical machines working under magnetic saturation, arc furnaces, welding machines, rectifiers, DC brush motors, etc. These harmonics have serious effects on various electrical equipment such as overheating of cables and equipment. Further Harmonic causes increased system losses, interference with communication lines, errors while indicating electrical parameters, probability to produce resonant conditions, etc.

Power Factor

Power factor is a key indicator for an efficient energy delivery in AC electrical system. It is a measure of how effectively a specific load consumes electricity to produce work. Power factor may be categorised into displacement power factor and true power factor. Displacement power factor is the cosine of the angle between the fundamental voltage and current waveforms. However, presence of harmonics introduces additional phase shift between voltage and the current. True power factor is calculated as the ratio between the total active power used in a circuit (including harmonics) and the total apparent power (including harmonics) supplied from the source. True power factor is always less than displacement power factor if harmonics are present in the system.

Poor power factor results into requirement of higher apparent power and thus higher current flow at nominal voltage to do the same work against a higher power factor. To cope with these higher currents due to a poor power factor one has to increase conductor sizes or capacities of electrical equipment like generators or transformers thus resulting in blocked capital expenditure (capex) and increased operating cost of the system. The large current at low lagging power factor causes greater voltage drops in alternators, motors, transformers and transmission cum distribution lines. This leads to decrease in voltage at the driving end and forces the use of extra equipment like voltage stabilisers to counteract the voltage drop, or FACTS devices. Improving the power factor can maximise current-carrying capacity, improve voltage to equipment, reduce power losses, and lower electric bills. The simplest way to improve power factor is to add power factor correction capacitors preferably at load ends of the electrical system but ensuring network resonance due to harmonics is not magnified.

Recommendations

The prevailing legal and policy framework with respect to power quality, provides that State Regulators are entrusted with the responsibility to specify or enforce standards with respect to quality, continuity and reliability of services by licensees to the consumers through Regulations. It was observed that main focus of the State Regulators is on management of power factor, frequency and reliability indices of power supply to the consumers. The other important power quality parameters such as voltage sags/ swells, voltage fluctuations, voltage unbalance, harmonic distortion and voltage transients etc. are not covered comprehensively in the Regulations. These power quality parameters are not considered for assessing the health of DISCOMs and their obligation to provide

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quality supply as of now. Further, it is observed that power quality problems in distribution system are not yet studied extensively by the utilities. Some of the recommendations for quality power are as follows:

- Regulations on power quality are need to be issued which define the power quality indices, roles and responsibilities of various entities, Standards/limits to be followed, incentive/disincentive mechanism to be deployed and procedure for monitoring, management and control of all aspects of power quality.
- Since reliability and quality go hand in hand, the reliability indices should be included in the regulations.
- For power quality parameters at transmission and sub-transmission system level, regulators should introduce appropriate reporting and incentive/dis-incentive mechanism in their grid/ supply code or in standards of performance regulations for regular monitoring and implementation of the specified limits. incentive/dis-incentive mechanism may be structured and implemented in a phased manner.
- Limits for some of power quality parameters like harmonic distortion, voltage variation and flicker, voltage unbalance, voltage sags/swells and supply interruptions have been specified in the regulations and code on power quality keeping in view the international or national standards. The limits for other power quality parameters may also be included in power quality regulations by the SERCs based on their experience and specific system requirements.
- There is need of continuous monitoring and reporting of power quality parameters at identified locations by the distribution licensees.
- Power quality measurements may be integrated with the smart grid applications for a reliable smart grid.
- SERCs may prescribe power quality reporting format and fix the responsibility to maintain the power quality database by the distribution licensees or bulk consumers, as the case may be, for a sufficiently long period.
- Regulatory framework may specify the training requirements for effective implementations of the power quality standards.
- Regulatory framework should introduce the compliance audit of power quality parameters by Independent agencies.
- Power quality may also be integrated with the smart grid application for a more reliable smart grid and promote adoption of technologies such as advanced power quality meters, wide-area power quality measurement, power quality enhancement devices for system component and sensitive loads that can provide fast diagnosis and correction of power quality disturbances.
- State regulators have specified reliability indices such as SAIFI, SAIDI, CAIDI and MAIFI etc. in Grid/Supply Code or in Standards of Performance Regulations for reporting. However, there is a need that these reliability indices be also strictly monitored and implemented.

Conclusion

The existing regulations cover the power factor, frequency, reliability of supply and voltage regulations as power quality parameters. While there is a strong system of frequency regulation, enforcement of the standards specified for reliability parameters are required to be strictly monitored and implemented. Issues of voltage regulations, transients, and harmonics are not given the attention they deserve.

With increasing penetration of renewable energy, electronic equipment, non-linear loads, data centres and industries running on adjustable speed drives etc., there is a need of emphasising separate regulations covering exhaustively all parameters of power quality with a clear incentive/disincentive mechanism to ensure compliance of specified parameters.

The Act and the Tariff Policy emphasises the need for supply of reliable and quality power of specified standards at reasonable rates. It is desired that the harmonious and uniform standards should be specified by the State Regulatory Commissions to serve the best interest of the utilities and consumers connected to the national grid.

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DIGITALISATION HEADED IN THE RIGHT DIRECTION

Digitalisation holds great promise for the power generation industry, especially in developing economies such as India, where increasing productivity, improving efficiency of processes and reducing cost of operations, as well as energy consumption and emissions, is critical.

- Rajeev Kishore,
Digital Lead, Hub Asia Pacific, ABB

ABB is a pioneering technology leader in power grids, electrification products, industrial automation and robotics and motion, serving customers in utilities, industry and transport and infrastructure globally. Continuing a history of innovation spanning more than 130 years, ABB today is writing the future of industrial digitalisation with two clear value propositions: bringing electricity from any power plant to any plug and automating industries from natural resources to finished products. As title partner in ABB Formula E, the fully electric international FIA motorsport class, ABB is pushing

the boundaries of e-mobility to contribute to a sustainable future. **Rajeev Kishore, Digital Lead, Hub Asia Pacific, ABB**, says, "In Asia, digitalisation within the power industry is definitely going in the right direction." Excerpts from his interview with **Subhajit Roy:**

The energy and grid transformation are driving changes in how electricity is being generated, transported and consumed. What is ABB's response to these changes?

The Fourth Industrial Revolution is transforming businesses worldwide, adding sensing and communication technologies to turn machines and equipment into smart assets. Through secure connectivity, smart assets and systems can communicate and cooperate not only with each other but also with humans in real time, improving performance through the entire value chain. This revolution is making profound changes to the power industry. Renewables, distributed generation and smart grids require entirely new capabilities and are reshaping the way that the energy market works. Even for oil and gas companies, as we see more and more enter the energy space, slowly moving away from fossil fuels and diversifying into other forms of power generation, power trading and retail, battery storage and electric vehicle recharging.

For all those users with control of grid-connected assets, such as vertically integrated utilities, cities and aggregators, coordinating control of networked generation assets is vital. In doing so, the operation of each connected unit and the delivery of grid services are economically optimised in real time.

For industrial and commercial companies that actively manage their own power consumption and resources, digital solutions can give them the opportunity to trade more efficiently with the grid while optimising their own power consumption and resources, reducing energy costs, and minimising environmental impact. Tackling these issues on both levels, ABB has developed and launched OPTIMAX (for Virtual Power Plants and for Commercial and Industry) which, as part of ABB Ability, enables integrated planning, trading, operating, monitoring, and reporting of power plants, generation units, energy storages and controllable loads.

What's your take on the recent trends of power plant digitisation?

From conventional power generation, including coal, gas, combined cycle,

nuclear, hydro and waste-to-energy, to renewables like biomass, solar, tidal and wave, each sector and business has its own priorities and challenges. These include heavy investment in improving the performance of legacy equipment, gaining greater access to expertise in remote geographies and automating compliance reporting.

Power generators need digital solutions to solve specific business challenges in a scalable way – e.g. that can be extended across fleets or assets – to deliver real and measurable benefits, sustainable over both the short and long term. There is no 'one size fits all' approach to implementing digital solutions. It takes significant industry expertise, a deep knowledge of the market context and understanding of the power generation process. Sustainable progress for the power generation industry can only be achieved through a close, collaborative relationship between technology partners and decision-makers. In Asia, digitalisation within the power industry is definitely going in the right direction.

How do you see the need of power plant digitisation in developing economies like India?

Digitalisation holds great promise for the power generation industry, especially in developing economies such as India, where increasing productivity, improving efficiency of processes and reducing cost of operations, as well as energy consumption & emissions, is critical.

However, a range of internal and market challenges can constrain its effective uptake and implementation for those in the early stages of their digital journey. Innovative companies that approach digitalisation strategically, balancing the short and longer-term objectives of the business, will gain a significant competitive advantage, improving their ability to adapt and thrive.

In India, the power industry is thankfully fully aligned with the government's initiative to digitalise the economy. As the country chases ambitious plans to be among the world's top three growth economies by 2020, the government is taking bold steps towards building an alternative which promises a greener and cleaner energy generation.

India's Prime Minister Narendra Modi has set clear goals to generate 40 per cent of the installed energy capacity from renewable sources by 2030 and 175 GW of renewable generation by 2022, enough to power 60 million homes by the sun.

With renewable energy, which is intermittent in nature, digitalisation can cope with the load fluctuation issue, allowing more flexibility for conventional plants. ABB has been able to support India's clean energy vision and push for solar power through a number of solar projects. One such project is Adani's solar power plant in Kamuthi, located 90 km from Madurai city in southern India. Here, we have provided the electrification and automation systems for the entire Adani solar project. The project is the world's largest solar plant in a single location and has positioned India third in the world's solar market, behind China and the US.

Digitalisation can also offer a significant range of immediate operational and financial benefits. Sensors, devices and software can enable operators to utilise a wide range of data in real time and improve decision-making; control systems enable improved performance and maintenance of vital infrastructure and equipment either on-site or remotely; advanced analytics enables predictive maintenance and simulation to optimise asset performance; remote monitoring and external support can address key human resource and knowledge retention issues.

The longer-term promise of digitalisation is also starting to be realised. New, more agile operational and business models are now possible based on connectivity, optimised decision-making and automated processes. Cloud technology and secured remote services also enable a closer relationship with partners. They allow expertise to be accessed securely from outside the plant and they free up company personnel to focus on strategic areas, such as the adoption of new business models.

ABB has launched OPTIMAX for virtual power plants. How does it help in optimising power plant performance?

OPTIMAX provides day-ahead optimisation based on weather and load forecasts. It then coordinates your energy assets and resources — in real time — to balance supply and demand using dynamic load shedding.

With optimised supply and demand, vertically integrated utilities, industrial sites and microgrids can readily add newer, low-cost but intermittent renewables without risk to grid reliability or stability. And when favourable pricing or production conditions exist, the sites and microgrids can even sell surplus energy production and capacity, enabling the operator to benefit from the available flexibility and increase

the revenues. The system allows for bundled planning, trading, operating, monitoring, and reporting of power plants, generation units, energy storages and controllable loads.

Are solutions like OPTIMAX can be of help for existing power plant/s?

OPTIMAX helps existing power plants thrive given new opportunities presented by the bi-directional flow of energy and information. OPTIMAX for Virtual Power Plants aggregates and optimises decentralised energy resources into a virtual power plant. You can then advantageously buy or sell in wholesale energy markets or provide energy as a subscription service. Decentralised energy resources can range from dozens to many thousands of units, from microsites (kW) to utility scale (MW), and be spread over a large geographic area

Finally, digitisation of a power plant also involves a whole lot of data handling and is thereby prone to cyberattack. How do you ensure security of such data?

Cyber security is not a destination but an evolving target. It is about finding the right balance by taking a defence in depth approach to ensure operations are protected and secure. ABB has helped many utilities assess the security position of their critical assets, identify vulnerabilities and potential threats, develop a plan to protect the assets and comply with international standards, national regulations and corporate policies. With a more networked architecture, cyber security is a paramount design requirement for digital solutions, that must encompass both the life cycle of systems and data. As cyber-attacks increase and digitalisation expands, close collaboration between IT and OT is essential. ABB understands both departments and their roles and responsibilities. We help them come together, communicate with each other and understand one another. We can explain to OT why the new measures are needed, but we can also explain why OT is concerned about the disruptions those measures may cause.

Intersolar India comes to Mumbai

The event focusses on the areas of photovoltaics, PV production and solar thermal technologies.

– Supriya A Oundhakar, Associate Editor

The Indian solar sector stands at fifth position globally in terms of installed solar capacity. The sector has witnessed nine-fold capacity addition from 2.63 GW in 2014 to 24.58 GW in December 2018. Further, the solar sector received a boost during the recent Interim Budget; wherein it was recognised as a key dimension, as part of renewable energy in the government's vision for the coming decade. India has been at the forefront of solar conversations globally.

"This has made us positive that 2019 will be the year of transformation, which will propel solar on fast track towards becoming the leading resource to answer the country's energy needs," Sunil Rathi, Director, Waaree Energies.

"We believe that the sector will soon gain traction with the government focusing on innovative approaches like floating solar and wind solar hybrid. The government is also weaving a 'rent a roof' policy that is likely to give conspicuous impetus to the rooftop solar capacity, we are inclined to believe," informs Anmol Singh Jaggi, Founder - Gensol Group.

However, the solar power sector has experienced many fluctuations in the past year, and went through significant changes. After a record addition of 9,780 megawatt (MW) in 2017, Mercom India Research projects solar capacity additions to slow to 8,000MW in 2019. The sector has been witnessing a slowdown due to cap on tariffs, imposition of duties on solar panels, infrastructure constraints, execution and operating challenges. Due to these, the investors are wary about the viability of projects. So much so that some of auctions were withdrawn due to paucity of participants.

"This year's story, so far, however, does not seem to be that inspiring, keeping in mind that out of the current

File Photo: Intersolar India 2018
(Courtesy: Solar Promotion International GmbH)

We believe that the sector will soon gain traction with the government focusing on innovative approaches like floating solar and wind solar hybrid.

Anmol Singh Jaggi, Founder, Gensol Group

fiscal target of 11 GW both ground and roof, only over 4 GW has been achieved as on December 2018," says Jaggi from Gensol Group.

"While there were initiatives that helped develop the sector, it was not without its challenges, especially for manufacturers. For example, the request to consider Bureau of Indian Standards (BIS) certification as a selection criterion was welcomed by all stakeholders, however the implementation of safeguard duty has had little effect on market dynamics," states Rathi from Waaree Energies.

The cancellation of bids in the sector has led to sluggishness. The increasing cases of cancellations of solar auctions, along with delay in tenders, has hurt the sentiments of investors. The SECI tender for 10 GW can be one of the prime examples.

"But we are likely to see more activity given that the Government has declared the trajectory of bidding 60 GW capacity of solar energy till March 2020 and it seems to quite upbeat on tendering our 30 GW each in the year 2018-19 and 2019-20," hopes Rathi. Further, the India solar market will gain traction with new market opportunities in combination with the energy storage and electric mobility sector.

In order to tap this opportunity, Intersolar India 2019 is being held in Mumbai, Maharashtra on April 4-5, 2019. With rapid developments in India's key western solar markets, Maharashtra is the leading solar rooftop market and its capital city Mumbai is India's financial hub. The event takes place at the Bombay Exhibition Centre (BEC) and has a focus on the areas of photovoltaics, PV production and solar thermal technologies.

It brings together the entire gamut of solar sector on one platform with the aim of increasing the share of solar power in energy supply. Since being founded in 1991, Intersolar has become the most important industry platform for manufacturers, suppliers, distributors, service providers and partners of the solar industry

Concurrent Intersolar conferences generate platforms for deliberations for the solar and energy industry. The Intersolar India Conference focuses on the areas of photovoltaics, PV production technologies and solar thermal technologies.

Intersolar India is good platform for users and developers for molding business strategy, future business scope etc. It is a one stop solution for solar systems products.

Brijesh Prajapati, Managing Director, Sofarsolar

"Intersolar India is good platform for users and developers for molding business strategy, future business scope etc. It is a one stop solution for solar systems products," informs Brijesh Prajapati, Managing Director, Sofarsolar. Gensol has been actively participating in the Intersolar event since last seven years. "We have been active speakers and sharing thoughts, have displayed our services multiple times and enjoyed with the solar community during the networking sessions," states Jaggi from Gensol Group.

Apart from being a launch pad for new products, services and solution, Intersolar India 2019 will bring entire universe of the solar segment to Mumbai. So, block your dates!

While there were initiatives that helped develop the sector, it was not without its challenges, especially for manufacturers.

Sunil Rathi, Director, Waaree Energies

BATTERY ENERGY STORAGE SYSTEM FOR RENEWABLE ENERGY INTEGRATION

This article presents an overview on the battery energy storage technologies and its integration with renewable energy, selection criteria and its key design considerations.

In India generation of electricity from renewable energy sources is growing at a very high rate. The total installed capacity of renewable energy in India as on December 2018 was around 21 per cent (72 GW) of total energy. Indian government has set an ambitious target of 227 GW of renewable power generation by 2022. This increase is largely due to combination of various factors such as falling price of renewable generation, deficit in the availability of fossil fuels and strict environmental norms. This increasing dependency on renewable generation in turn is posing challenges to utilities and system operators. One of the key issues with renewable generation like PV solar, wind is that their generation is of intermittent in nature. Energy Storage System (ESS) can provide support in balancing the variable generation of renewable energy. When ESS is properly deployed it can help to improve the grid reliability and asset utilisation.

ESS is classified on the basis of the form of energy stored such as Pumped storage, Batteries, Fly wheel, Compressed air, Super capacitors etc. Battery Energy

Storage System (BESS) is a type of ESS where energy is stored electrochemically. This paper discusses various application aspects of BESS that enables large scale renewable energy integration.

BESS Definition

A BESS comprises of series and parallel combination of electrochemical cells which converts electrical energy into chemical energy and utilises this stored chemical energy by converting back into electrical energy as per the application demand. Each cell consists of an anode and a cathode separated by an electrolyte which can be solid, liquid or viscous states. Other major components of battery energy storage system include:

- Power Converter/ Inverter with controller
- Battery management system (BMS)
- SCADA
- Transformer and switchgear.

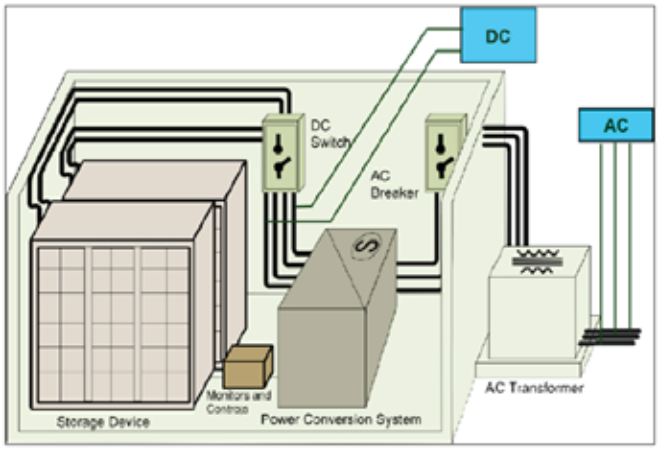

Figure 1: Schematic of Battery Energy Storage System

Battery Technologies

There are several types of battery technologies. Battery technologies which are popular are depicted in Figure 2. One significant observation can be made on the physical state of electrolyte. Electrolytes present in the secondary batteries are either in solid or viscous state. However, in flow batteries, it is in liquid state due to which it flows between anode to cathode or vice-versa during charge-discharge cycle.

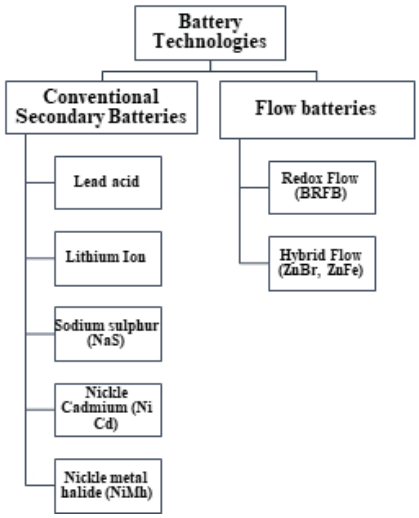

Figure 2: Classification of battery technologies

Lithium-Ion (Li-Ion) batteries have gained the popularity in the last few years due to their high energy density, high voltage, better cycle life and higher efficiency. Thus Li-Ion leads the battery energy storage market with significantly large number of demonstrated grid applications, particularly in conjunction with renewables across globe. Li-Ion includes many sub types

based on the chemistries. Some common available sub types are:

- Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2) - NMC
- Lithium Nickel Cobalt Aluminium Oxide (LiNiCoAlO2) - NCA
- Lithium Titanate (Li4Ti5O12) - LTO
- Lithium Iron Phosphate (LiFePO4) - LFP
- Lithium Manganese Oxide (LiMn2O4) - LMO
- Lithium Cobalt Oxide (LiCoO2) - LCO.

Lithium Nickel Manganese Cobalt Oxide (NMC) is the most widely used in grid-scale energy systems for its balanced performance characteristics in terms of energy, power, cycle life, and cost.

Sodium Sulphur: Sodium Sulphur (NaS) is a molten salt battery which is termed as high temperature battery as the operating temperatures of these batteries are in the range of 300-degree to 360-degree C. It has higher energy density, negligible self-discharge, easily recyclable and higher depth of discharge. However, high operating temperature and requirement of auxiliary system to maintain its operating temperature poses safety threat. Sodium Sulphur batteries have been proved in many grid and renewable applications, majority in Japan.

Flow Batteries: Flow batteries are unique in their design when compared to both Li-Ion and high temperature batteries because of the cell construction. In this battery, the electrolyte is stored in tanks external to the battery cell. During discharge and charge cycles, electrolyte is pumped from the tank into the cell stack to interact with the electrodes. Highest cycle time and calendar life, suitability for long duration, and negligible self-discharge are some of its merits. However, low energy density, low efficiency, large space requirement and complicated control system have put the technology a step backward.

Advanced Lead Acid Battery: It is a hybrid energy storage device that combines the characteristics of a super capacitor and conventional lead acid battery at the material level within the cell. Due to its low energy density, low depth of discharge and short cycle life, this technology has not gained its popularity and market share.

Nickle based batteries are not suitable for large grid-based applications.

Renewable Energy Applications

Renewable energy is intermittent in nature. They are affected by the geographical location, time duration, climatic condition, hence output power generated by these energy sources are unpredictable. This unpredictability causes fluctuation in frequency and voltage which could cause instability of grid. One of the main objectives to be addressed in renewable energy connected grid is to improve the reliability and provide stability to the grid, thus making it energy efficient. Battery energy storage helps in smoothening renewable generation output thereby improving power quality. Thus, reducing the need for grid regulation services, and making better use of network infrastructure. Renewable energy applications of BESS are ramp support, energy time shift and capacity firming.

RAMP Support: RAMP Support reduces large fluctuation in renewable energy. Its main purpose is for improving the economy of operation rather than peak demand. When there is a sudden change in wind speed or passing cloud, it causes a rapid change in the output of a PV array or wind generation leading to significant drop in MW output (by 70 to 80 per cent) in about a minute's time. Battery can discharge quickly to ensure that the net facility output is smoothened with respect to demand (see figure 3).

Figure 3: Ramp rate control

Energy Time Shift: Energy time shift involves storing energy during periods of low tariff and discharging during high tariff periods. This is customarily accomplished by storing energy during off-peak period (during night) and then using it during peak demand.

Energy time shift is predominantly best suited for wind energy as the energy from wind generation can be stored at night and during early morning. Stored energy can be discharged during high demand i.e. during weekday afternoons.

Figure 4 depicts an example for wind energy time shift for a storage capacity of 1 MW. Batteries are charged during off peak hours (0-5 hrs) i.e. when the demand is low and energy tariff is also low. Stored

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energy is discharged during peak demand hours (13-18 hrs). From the graph it is apparent that with integration of battery energy storage the generation output gets doubled during times when both demand and the tariff of electric supply are highest.

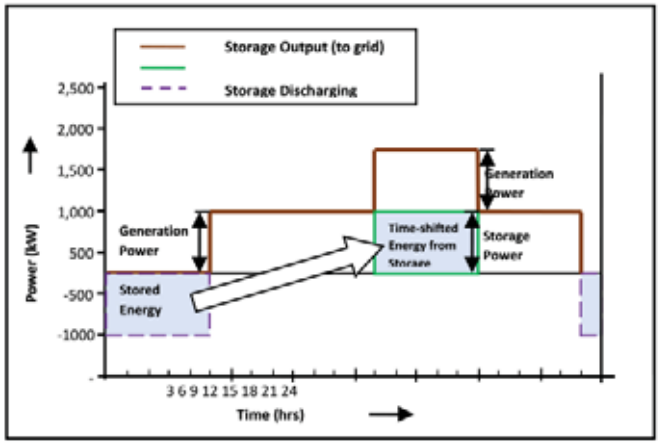

Figure 4: Renewable energy time shift

Renewable Capacity Firming: Capacity firming refers to the 'Firm' generation capacity in which constant power generation is guaranteed. This defers the need to upgrade existing generation or transmission infrastructure. Storage not only helps in fulfilling the loss of generation but also keep the output generation stable.

From the point of capacity firming, renewable energy intermittency can be of 'short-duration' or for a 'diurnal'.

Short-duration occurs randomly over time scales ranging from seconds to minutes. It is caused by location specific terrestrial obstructions such as trees and tall buildings. However, the most undeniable and uncontrollable cause of short-duration intermittency is due to clouds in case of solar generation and variations of wind speed in case of wind generation.

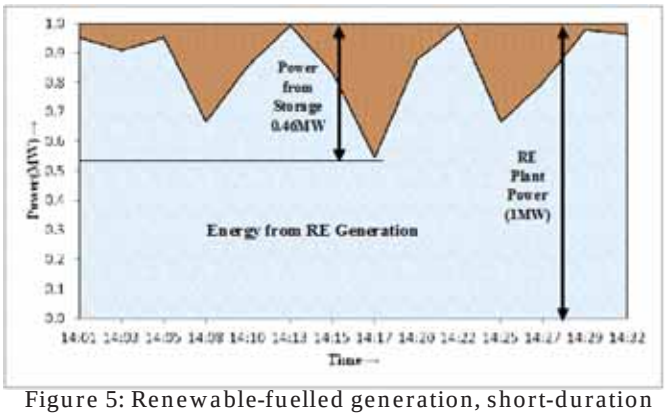

Figure 5: Renewable-fuelled generation, short-duration intermittency

Diurnal intermittency occurs in a regular or predictable way over a 24-hr period. Diurnal intermittency of solar generation depends on the solar insolation (solar radiation received on the earth surface/ sqm in a day (Watts/m2/day)) which varies throughout the day based on the position& angle of the sun, altitude, atmospheric conditions and the geographical location. In case of wind generation, wind speed tends to vary over a day, sometimes it is higher in evening while relatively lower in the morning (refer Figure 6).

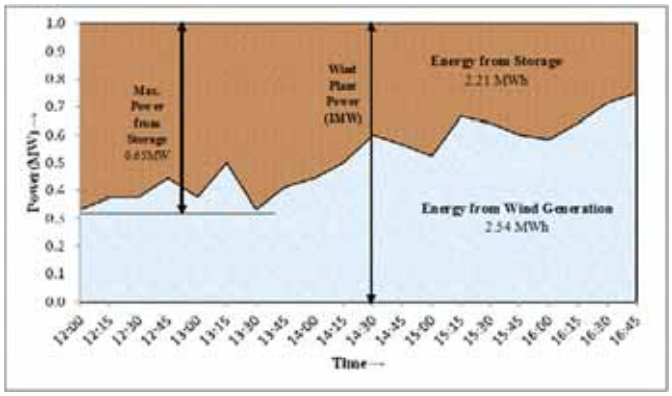

Figure 6: PV generation output variability during peak demand hours

Battery Selection

Selection of battery energy storage for the renewable energy grid application depends upon the specific application need and the way it competes the strength of different battery technology options. Hence, no single battery technology solution is the best in many cases.

The key factors which govern the selection of battery technology for a particular application are:

- Performance parameter of the battery
- Duration of the application and capability of the battery to meet the discharge duration.
- Cost economics.

Performance Parameter

The key technical performance parameters which are important in selection analysis are:

- Energy density.
- Depth of discharge (DOD) or State of Charge
- Response time.
- Round Trip Efficiency
- Life cycle.

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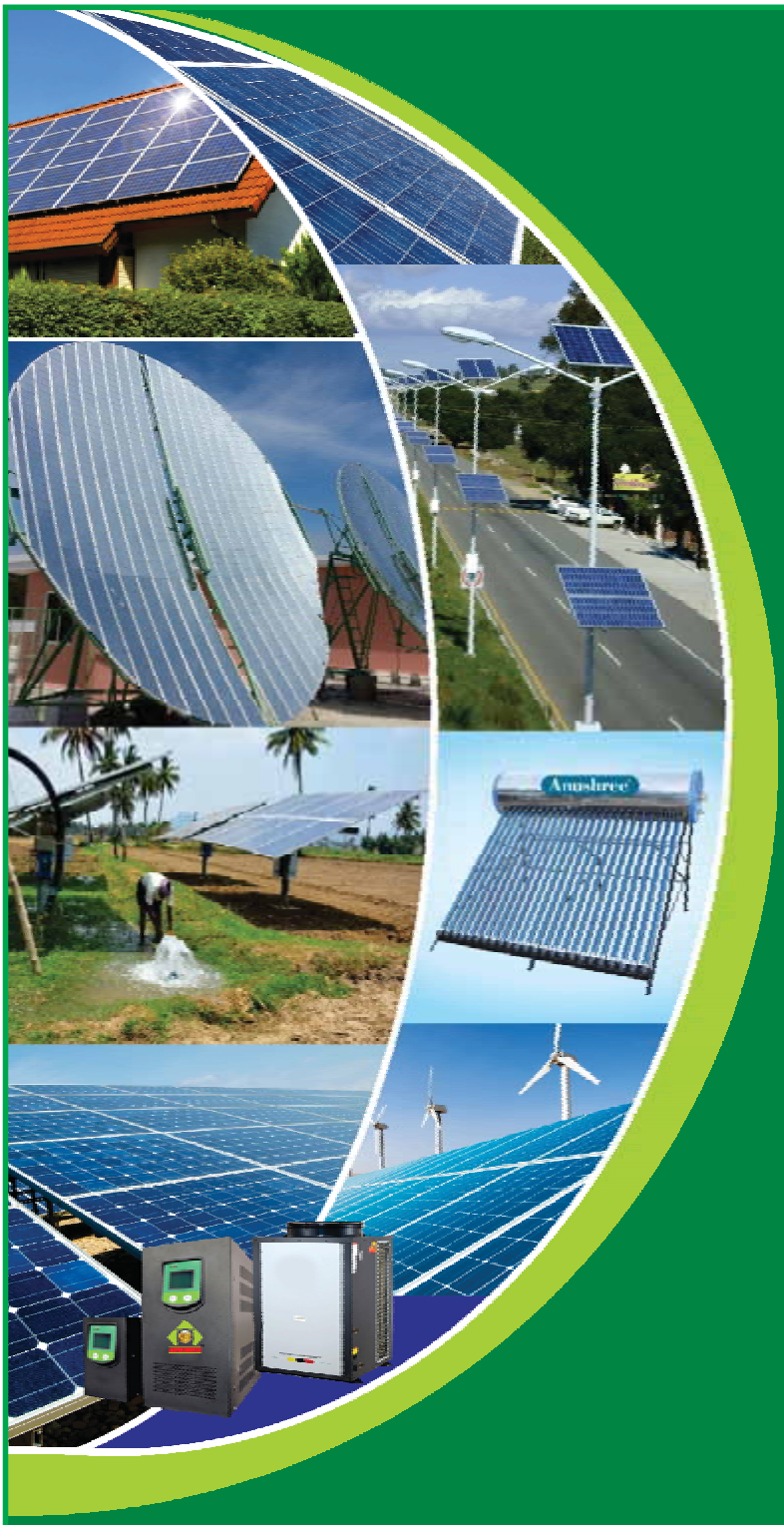

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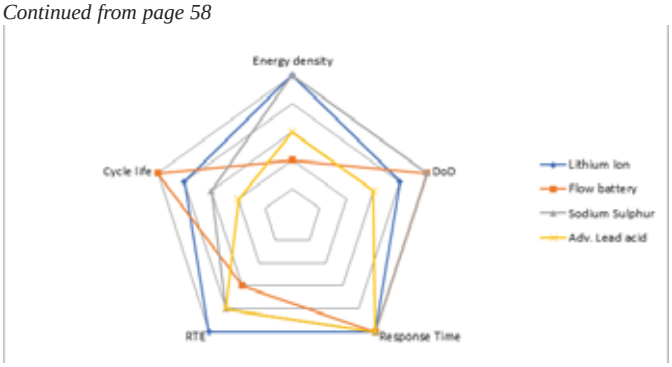

Figure 7 depicts the comparison of the performance parameters of four technologies

Discharge Duration

Discharge duration measures how long a storage device maintains its output before reaching its cut-off voltage. Discharge duration may range from few minutes to few hours. Long duration applications demand large storage capacity in order to provide prolonged discharges (which may last for one or more hours). Contrary to long duration application, short duration applications require a fast and short charge and discharge capability (generally ranging between few minutes up to 1 hour).

Design Considerations

Based on discharge duration criteria, the design considerations for various renewable energy applications are:

Ramp Support: Renewable resource variability is fast and occurs frequently and thus battery storage with ramping capability is one of the key factors. Ramping support falls under frequent short duration application. So, storage systems with response time in a minute, high power output and long-life cycle are best suited for this application. The discharge duration for this application is few minutes to 1 hour.

Energy Time Shift: Discharge duration depends mostly on the duration of the region's off-peak and on-peak periods and the on- peak versus off-peak energy tariffs. This application falls under frequent and long duration discharge application. Storage system with long discharge capability, high efficiency for economical operation, long life cycle will be best suited for this application. The discharge duration for this application is around 3 to 5 hrs.

Renewable Capacity Firming: As its primary use is to provide constant power, the storage used for capacity firming should be more dependable with long discharge capability as this falls under long duration discharge application. Discharge duration varies from 2 to 4 hrs.

Cost Considerations

The cost economics of battery energy storage plays a vital role in selection of battery technology as the cost of batteries is significantly high at present. The capital cost of energy storage system comprises of following components:

- Energy Storage Equipment
- Power Conversion Equipment
- Power Control System
- Balance of System
- Installation.

At present Li-Ion technology has high market share and competitive cost when compared with other technologies.

Conclusion

There is a persistent need to integrate more renewable energy sources into future grid. Renewable energy sources, when coupled with energy storage, can immensely benefit the grid by smoothing renewable generation output, improving power quality and making the renewable grid more reliable.

Some major challenges in the deployment of battery energy storage systems such as cost competitiveness of battery technology, limited engineering standards, availability of evaluation tools, and mitigation of safety risks associated with fire and explosion needs attention while planning BESS. However, with increase in demand and usage, battery prices are expected to fall. All these aspects will make battery storage more viable for wide deployment of BESS across globe.

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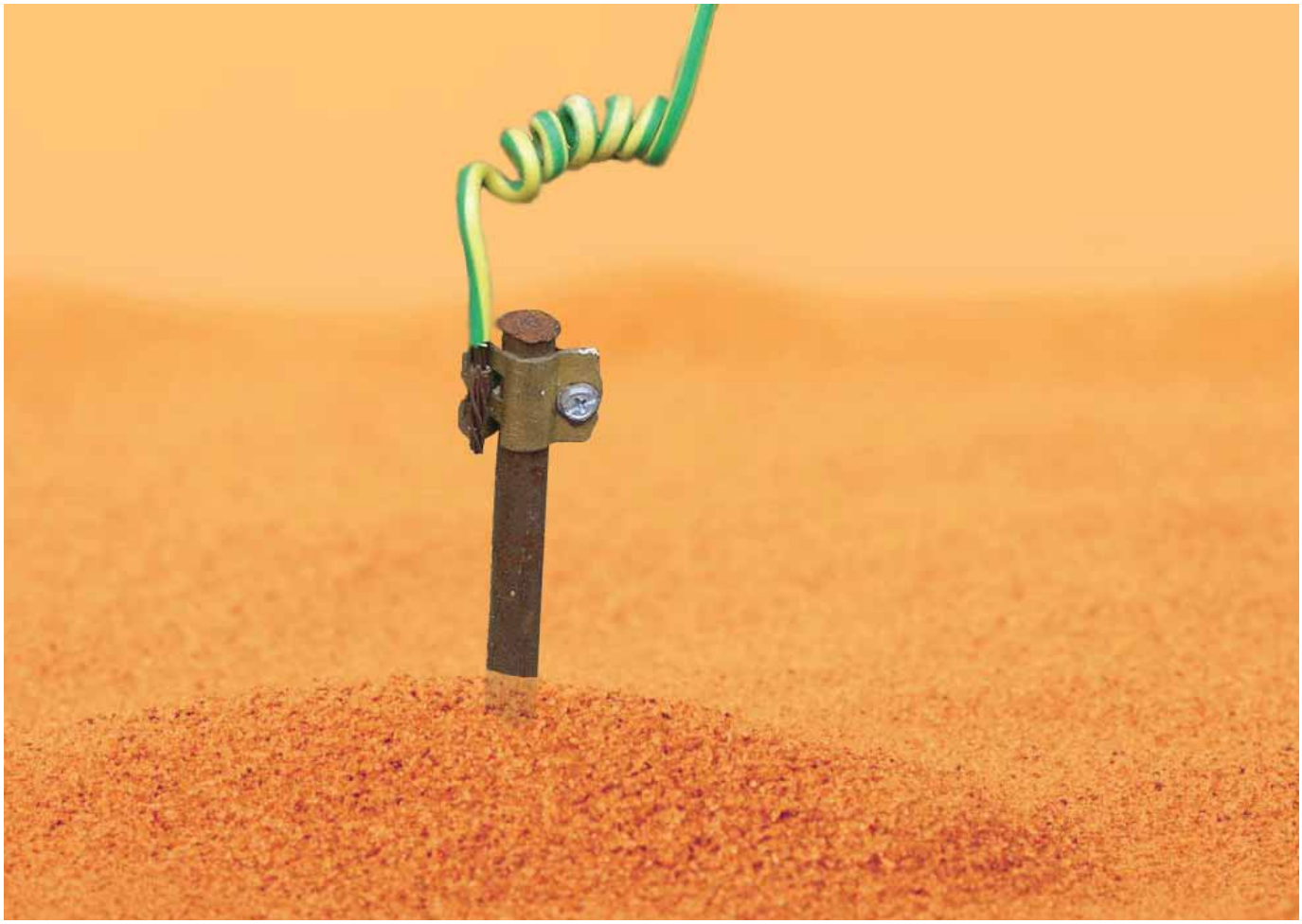

Need of Interdisciplinary Research for Earthing

The article sheds light on the multidisciplinary aspects for earthing and its need in current scenario.

The electrical earthing is the most important element for safe and reliable operation of power system. Earthing is vital to achieve equipment and personnel protection. It is of two types i.e. system earthing and equipment earthing. In system earthing current carrying conductor is connected to earth for protection of system and in equipment earthing noncurrent carrying parts or body of apparatus is connected to earth for protection of human life and equipment. Moreover, the stability of any electrical or electronic system is greatly affected by the condition of earthing. Earthing is not a new concept. It has started in a way back at end of 19th century. It has been

studied and standardised since then. Earthing has been studied by various researchers in mainly four aspects viz.:

- Earthing pertaining to substations, industrial plants
- Earthing requirement and standardisation related to it
- Safety aspects of earthing
- Earthing methodology.

Out of these, earthing methodology is the most neglected aspect in recent past. Earthing is considered as matured field of electrical engineering. However, the natural and manmade changes are influencing earthing design and associated parameters. Urbanisation and new life style has changed soil contents over the years. Rain fall, seasons' patterns have changed over the last few decades. It changed moisture contents in soil. The natural soil layer is depleted because of crowding over places. Population has increased at such a rate that available land is almost occupied. Dense localities leave a very little space for earthing. Soil pollution is bringing lot of changes in earthing methodology. Electrical generation capacities have grown up rapidly. With increase in non-linear load and uncertain renewable energy sources feeding grid, lot of harmonics are added in system. Harmonics and neutral earthing affect quality of power. Advances in digital electronics and automation lead to use of sensitive instruments. For such instruments earthing is must. Due to all these changes there is a need to reinvestigate earthing methodology and various aspects of earthing right from design to commissioning of earthing.

Major objective in designing earthing system is to achieve lowest possible earth resistance value. Factors which affect earth resistance are earthing electrode and soil conditions around earth electrode are shown in Fig.1. The earth resistance is reduced by varying depth, diameter and material of earth electrode. Deep driven electrodes give less earth resistance. As the diameter of earth electrode increases, contact area with soil increases which lowers earth resistance. The most preferred option between these two is deep driven electrode from practical concerns. The parallel connection lowers resistance so multiple electrodes connected in parallel can be an option but should not have overlapping zone. Composition, moisture and temperature of soil affect the earth resistance value. More salts in soil around electrode helps in easy passage of current. Earth resistance is less in presence of moisture. Increase in temperature results in rise in soil resistance. The resistance of earth electrodes itself do not have major contribution to

overall earth resistance. The significant factor of earth resistance is resistivity of soil around electrode.

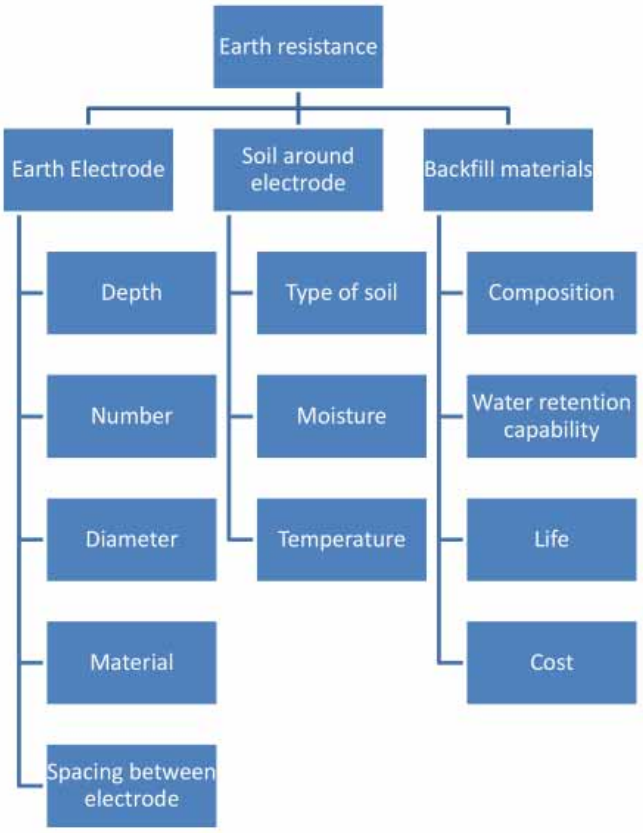

Fig. 1: Important Factors affecting Earth Resistance

Various factors and their effects have been studied over a time witnessing all revolutionary technology developments. These factors have been investigated since 19th century. Now, to know how much earthing is enough, effects of all above parameters need to be considered while designing earthing system. This is done through modelling of earth system. It has started with simple practical based equation technique which is now turned into multifaceted technique.

Determination of adequacy of earthing system:

The need of accurate modelling of earthing system is of great importance as they are tool to define adequacy of earthing system. Fault conditions can be simulated and system behaviour can be studied. The modelling can be categorised in three families of methods viz;

1. Circuit Theory based methods
2. Electromagnetic model-based methods
3. Hybrid methods

1. Circuit Theory based methods:

In these models earthing electrodes or rods are modelled with lumped or distributed passive components. Early models were only of resistances and hence frequency independent. Later developments included frequency dependence of segments' self and mutual inductance, capacitance, conductance and internal resistance. A circuit simulator is then used to calculate the voltages and currents on the electrodes. These methods provide an easy model for earthing systems. They work directly in time domain. The main drawback is that they cannot predict surge propagation delay. These models can be extended to transmission line models. This technique cannot accurately model other than straight conductors.

2. Electromagnetic theory-based methods:

This is the most rigorous method for modelling of earthing system, because it solves full Maxwell's equations with minimum approximations. The physical phenomena that underline the fault current dissipation into the ground can be studied by means of Maxwell's Electromagnetic Theory. The realistic prediction of the currents distributed in the aerial parts and in the parts embedded in the soil is of basic importance. The methods employ numerical techniques such as the Finite Element Method, the Method of Moments or other numerical methods. It is believed to be very accurate. However, this

Parameters	Circuit Theory based	Electromagnetic model based	Hybrid methods
Mathematical Expression	Simple	Complicated	Complicated
Domain consideration	Time	Frequency	Both
Solution Characteristics	Simple, can include soil ionisation, cannot predict wave propagation delay	Complicated, can predict wave propagation delay, cannot include soil ionisation,	Slightly Complicated, can predict wave propagation delay can include soil ionisation
Accuracy	Reasonably accurate	Most accurate	Reasonably accurate
Computation Time	Large	Small	Small

Table1: Comparison of Earthing design modelling

Continued on page 66

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model is too complex to be implemented. Computation time is more for large structure. Another disadvantage of electromagnetic field approach is that, because of its frequency domain solution procedure, it cannot be easily modified to include non-linearity due to soil ionisation, and combine other non- linear devices that have time domain models.

3. Hybrid methods:

There exist hybrid methods which try to combine the circuit theory methods and the electromagnetic methods in order to profit from the advantages of both. The goal of the hybrid method is to obtain a frequency-dependent equivalent electric circuit for the earthing system where all the inductive, capacitive and conductive couplings among different conductor elements are accounted for and their analysis can be carried out in the frequency domain. These models are summarised in following Table1.

Advent of computers and their development can solve complex mathematical expression and hence more realistic earthing design model can be made. Modelling has evolved with technology from simple electric circuits to complex electromagnetic circuits to give more accurate real scenario. The accurate, realistic model can be obtained when all aspects of earthing stemming from various disciplines like soil science, metallurgy, chemistry, civil, mechanical, computer and electrical are considered. All sciences, right from nanotechnology that dealing materials at nano level to geology dealing with earth and whole have evolved over period of time. This development readdresses need of finding innovative practices in earthing system design by carrying out multidisciplinary research. The influence of various disciplines on earthing system design and their progression is explained in following section.

Interdisciplinary Relevance:

Complex and real-world problems are driving forces for interdisciplinary research. Innovations are result of integration of knowledge from various research areas. Different perspectives from various fields are studied to chalk out best solution. Earthing is related to many various fields like soil science, chemistry, and metallurgy, mechanical, civil and electrical. Optimal solution for earthing design can be found out by amalgam of research from these fields. Fig.2 depicts prominent fields influencing earthing.

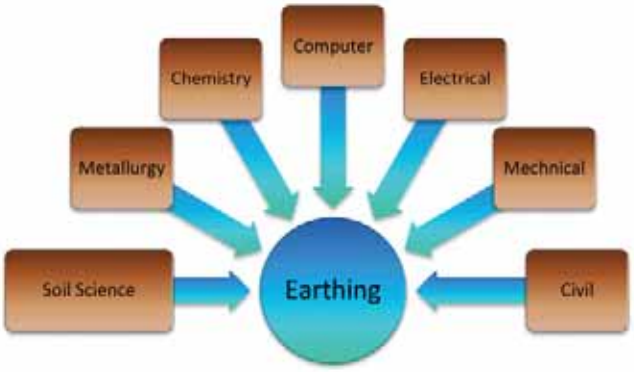

Fig.2 Disciplines influencing earthing

Soil around earth electrode is decisive in earth resistance. The effective earth resistance depends on the soil resistivity. The determination of its value is often a complicated task for two main reasons: 1) the soil does not have a homogenous structure. It is formed by layers of various materials making it multi-layered in nature. Layers can be horizontal, vertical or mix of both.2) The electrical resistivity of a given type of soil varies widely. It is affected by parameters like the nature of the solid constituents, particle size distribution, arrangement of voids, porosity, degree of water saturation, electrical resistivity of the fluid and temperature. Change of seasons, temperature and moisture has effect on soil resistance. Thus, soil science plays an important role. Soil properties are changing due to natural and manmade changes. Their effects need to be investigated.

Various chemicals are used as additives in soil to reduce earth resistance. Soil improvers such as salts, charcoal powder and bentonite powder are mixed with soil. Lack of proper understanding and application of additives usually lead to poor performance of earthing systems. Nature friendly additives are required to reduce cost of earthing. Chemical soil conditioners are costly and have prolonged secondary effect on soil causing soil pollution. They might lead to contamination of water table nearby. There is a need for maintenance free, cost effective and nature friendly option for soil improvers to reduce the earth resistance over long periods of time and in order to avoid the expensive cost of elements and their secondary effects. Thus, chemical engineering plays vital role to find out such options. Nanotechnology opens up doors to unexplored world of material, their undiscovered potentials to be utilised to earthing practices. Newer materials can be invented as soil improver by changing

Continued on page 68

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properties using nanotechnology. Ball milling operation can be used to change particle size of soil additives and their effects needs to be investigated.

Earth electrodes are main bridge between system and ground. Electrodes must have low electrical resistance as per soil, strong, reliable, long life, less maintenance. Various plate sizes, shapes, pipe structures of conductors, various joint types and their mechanical strength are fields to be investigated related to mechanical engineering. The grid is welded at various joints which make welding process important to decide strength, durability of joints under fault condition and their effect on resistance.

Metallurgy plays an important role as electrodes' composition will play significant role in earthing. Electrodes are buried in soil. Various chemical reactions take place like oxidation, reduction. Even some buried metals in soil near to earthing are deciding factors. With advent of new technologies new materials can be used as electrodes. Various materials for coating can be thought of to prevent corrosion and increase life of earthing system.

Excavation of soil to commissioning of earthing system, civil engineering aspects needs to be considered. Pits construction needs to be relooked in terms of its design and material used. Funnel placement around pits can be investigated. Multiple water entries in each pit needs to be designed. Conductive cement can be used as soil improver. Due to concretisation original soil has almost replaced so concrete itself can help in earthing is to be investigated. Thus there are many civil engineering aspects in earthing system.

Computers are influencing every aspect of our day today life and so is true in earthing. Various simulations of practical scenarios need to be considered to get most accurate results so various computational techniques and advanced algorithms are used with computers. Computer software packages can be used to assist in earthing grid design by modelling and simulation of various earthing grid configurations.

Electrical engineering is involved as major contribution for safety to personnel and equipment. Load types and patterns have changed over the years. Lot of harmonics are added in system affecting power quality due to nonlinear load. Providing earthing for various conditions of load and fault types is an important task. Simple design and complexity of power system has to be matched by electrical engineer in current situation.

Earthing is complex because of inclusion of earlier discussed factors from various disciplines. It's much more than a rod or plate buried in soil and connected to electrical system. All disciplines' involvement from earthing point of view underlines the necessity of multidisciplinary research in current scenario.

Conclusion

Earthing has been in practice from many years. The natural and manmade changes are influencing earthing. Due to various developments in sciences and technology, lot of design and practical approaches has been changed in earthing system. All fields of sciences and technology should work together to get best earthing practice in current situation. Effective yet simple solution for earthing system is the need of time.

A lot of research is carried out to lower earthing resistance either by improving earth electrode properties or by soil conditioning. There is further scope to reduce earth resistance by use of advances in material sciences. Complex design process in earthing can still be improved by taking best of both conventional and computational techniques. Advances in material science and improvement of computation techniques will surely give optimised and cost-effective earthing system. Multidisciplinary research needs more time, efforts, finance than single discipline research but the results are substantial.

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IMP AIMS TOP SPOT in transformer manufacturing

IMP Powers Ltd., a flagship company of the $ 120 million IMP-Mangalam group, is a name to be reckoned with in the manufacturing of quality EHV, power, distribution, and special purpose transformers. In an interview with Subhajit Roy, the company's MD Aaditya Dhoot reveals IMP's future roadmap. Excerpts:

Started business with energy meter manufacturing in 1961, today IMP Power is one of the top players in transformer manufacturing. How has the journey been so far?

We started our journey in 1961 as Industrial Meters Pvt Ltd. During this time, we were one of the largest manufacturers of analog meters, amp meters, power factor meters, energy power meters,

We would aim to become the No. 1 transformer manufacturing company in 132 and 220 kV class in the country.

Aaditya Dhoot,
Managing Director,
IMP Powers Ltd.

test terminal blocks and various sets of testing equipment. The journey so far has been invigorating as we have learnt a lot through the process and have grown from strength to strength.

After being present in the power industry for almost 58 years, today IMP is a brand name! Its goodwill and brand recall value are amongst the best in the industry.

What is the market size for power and distribution transformers?

The market size in terms of power and distribution transformers would be 2.2 lacs and 1.1 lacs respectively in terms of MVA. The total market value is about Rs 14,500 crore.

What is your market share?

We are amongst the top 3 transformer manufacturers in the country in 132 and 220 kV class and upto 315 MVA.

What are the new products in pipeline?

We have recently launched Hydro Kinetic Energy Turbine, which is a breakthrough technology with a licensing agreement from SHP, Germany. This product works on the principle of kinetic energy, which is also called zero-head turbine. This is a plug-and-play model where all we need for installation is flowing water at a particular speed. We are quite thrilled about this diversification and know that it will be extremely crucial in the areas with smaller spaces.

In 2012, we launched our subsidiary IMP Energy Ltd., which is an end-to-end solution provider in EPC to provide clean and green power by setting up small and mini hydro power plants in the country.

We are the first company to successfully commission three SHP projects of KREDA (Kargil Renewable Energy Development Agency) in the tough terrains of Kargil, Ladakh, region of Jammu & Kashmir.

IMP is proud to inform that even at (-) 30-degree C, our workers are constantly working in remotest areas of the country. Also, in the

IMP's plant is working in (-) 28-degree C and generating 400kW output

last 2 years we are able to provide power to the Indian Army and the habitants of J&K.

As the renewable energy is gaining prevalence, how do you look at the scope for transformers business?

I feel, there is a huge scope for transformers businesses in 132/220 kV segment as renewables are getting integrated within the grid at 220 kV class. We are at the tip of iceberg in terms of transformers because the IPDS, SAUBHAGYA, and APDRP Scheme have started and feeder separation is extrapolated in the country then there is lot of electrification that needs to be done. Our per capita consumption is still around 1,100 kWh units whereas the world average is 7,000 kWh – so we are way too behind. Railways, metros and exports are other areas for growth. Replacement demand would be huge as the transformers installed in the 80's would need to replaced.

Briefly tell us about your manufacturing facility and capacity.

IMP's ultra-modern state-of-the-art transformer facility is located in Silvassa, around 168 km away from Mumbai, with an overall manufacturing capacity of 16,000 MVA per annum. The plant is ISO 9001:2008 and ISO 14000:2004 certified and includes facilities like air-conditioned winding shop, air-conditioned core building and CCA, vapour-phase drying oven and an in-house NABL accredited testing laboratory. IMP is one of the leading HV and EHV transformer manufacturers in India. All type tests as per Indian (IS) and International Standards (IEC,

BS, ANSI etc.) for transformers up to 315 MVA, 400 KV class including impulse test, partial discharge and temperature rise tests are carried out within the factory premises.

How do you see the Indian transformer manufacturers gaining foothold in global markets?

The Indian transformer manufacturing industry has matured significantly in the last decade – more so in last 7 years. I believe there are some companies who have gained significant market share globally and simultaneously there have been world leaders who have expanded in India like Siemens, ABB, GE and TBEA. They have set up units and have doubled their capacity to cater to world market from India, making India a manufacturing hub.

As far as IMP is concerned, besides exporting regularly to Nepal, SAARC regions and Africa, we are now going to significantly look at exporting to Latin America in next 2-3 years.

What are some of your key recent achievements?

As I mentioned earlier, apart from transformers, we have diversified and created a separate vertical to provide electricity in the rural areas of Kargil. We only specialise in less than 5MW.

Our key achievement is that we are the only company in the country to successfully commission three SHP projects in the Kargil region under the Prime Minister's Ladakh Renewable Energy Initiative.

Another accomplishment is that we are the first company in India to install Smart Hydro Kinetic Energy Turbines. Our pilot project in Neyveli lignite thermal power plants cooling canals is giving a PLF of 65-75 per cent with 1.30 lac units generated.

We are also the only company in India who have successfully short-circuit tested seven 160 and 100 MVA in 220 kV in a span of 24 months. We have received the most valued customer award for the year 2016-17 and 2017-18 from CPRI.

Where do you see IMP Power in five years?

We would aim to become the No.1 transformer manufacturing company in 132 and 220 kV class in the country. I personally aim to expand our global footprint and take IMP Powers all over the world with its significant revenue coming from exports.

Are you looking at any kind of merger and acquisition?

We are always open for an inorganic growth and if there is an opportunity we would definitely explore.

Why is water killing power transformer insulation?

Dielectric frequency response analysis is a powerful tool used to determine the water content in power transformers and to assess their condition and remaining lifetime. By using improved algorithms like PDC+, the measurement time can be drastically reduced. Further automation of the whole measurement and assessment process makes the technique easy and reliable for all users.

Water in power transformers

Water is the foundation for life on our planet. It is essential for every living plant or creature. But there is one place where water greatly reduces life: The oil-paper insulation of power transformers.

This insulation consists of paper and pressboard elements which provide the mechanical stability of the insulation. The main component of paper and pressboard is cellulose. It consists of glucose molecules which are linked and form a chain (Figure 1). The average number of glucose molecules in a cellulose chain (which is also called "degree of polymerisation" or "DP" in short) is about 1,200 for new paper. These large chains give the paper the mechanical strength it requires to fix the windings, even in rough conditions such as when a short circuit has occurred.

Unfortunately, these chains can be split by water molecules which reduces the mechanical force they can withstand. A small amount of moisture is always present in the paper of a power transformer, even if it is dried perfectly. At elevated temperatures, the water molecules split the cellulose chains, causing shorter chain lengths and – as a by-product – even more water. So, a self-accelerating process is taking place which increasingly

Figure 1: Part of a cellulose molecule showing 12 glucose molecules (schematic)

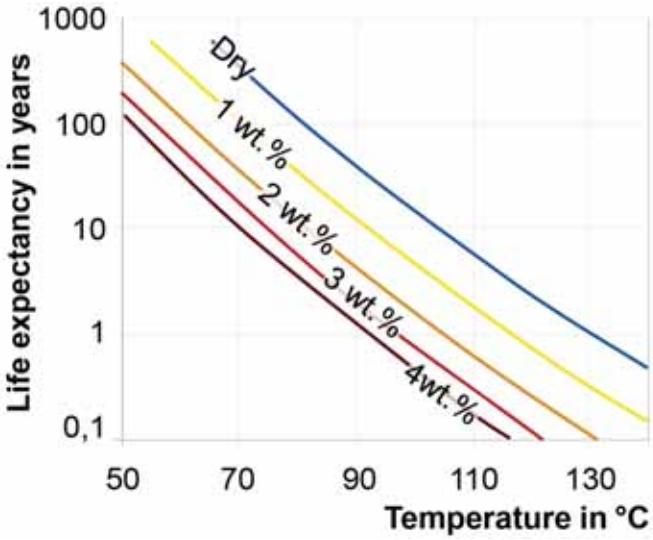

Figure 2: Dependency of life expectance on moisture content and temperature

reduces the mechanical stability of the transformer insulation. The speed of this process is highly dependent on the temperature but also on the moisture content (Figure 2). Although the higher temperatures displayed in the chart are unlikely to be reached by the average temperature of the transformer, local hot spots have to be considered.

When the average length of a cellulose chain in paper is 200 or below, it is usually considered at the end of its life because the mechanical strength is then so heavily reduced that it can't withstand higher stresses.

As aging produces more water molecules, the water content of a power transformer is a very good indicator for the age of the transformer insulation. It allows not only an assessment of the remaining lifetime but also correct condition-based maintenance: A moderately wet power transformer might be dried which reduces the water content and thereby slows down the aging. If a power transformer is very wet, the paper is usually in a very aged state and drying wouldn't help as it can't un-age the paper. If it was dry, drying would be a waste of time and money.

In a mineral oil filled power transformer, the amount of oil is about 10 times larger than the amount of cellulose insulation. However, as water is barely soluble in oil, the vast majority (> 99 %) of water is located in the cellulose insulation and not in the oil. Oil samples of power transformers contain water only in the lower ppm (parts per million) range whereas the range for water in the cellulose is usually in the area of 0.3 % to 6 %. The water content of the oil is highly dependent on temperature, oil condition and impurities. Small errors in sampling and handling result in high deviations of the final result. The water content in the cellulose provides a much more reliable value for condition assessment, as it is barely

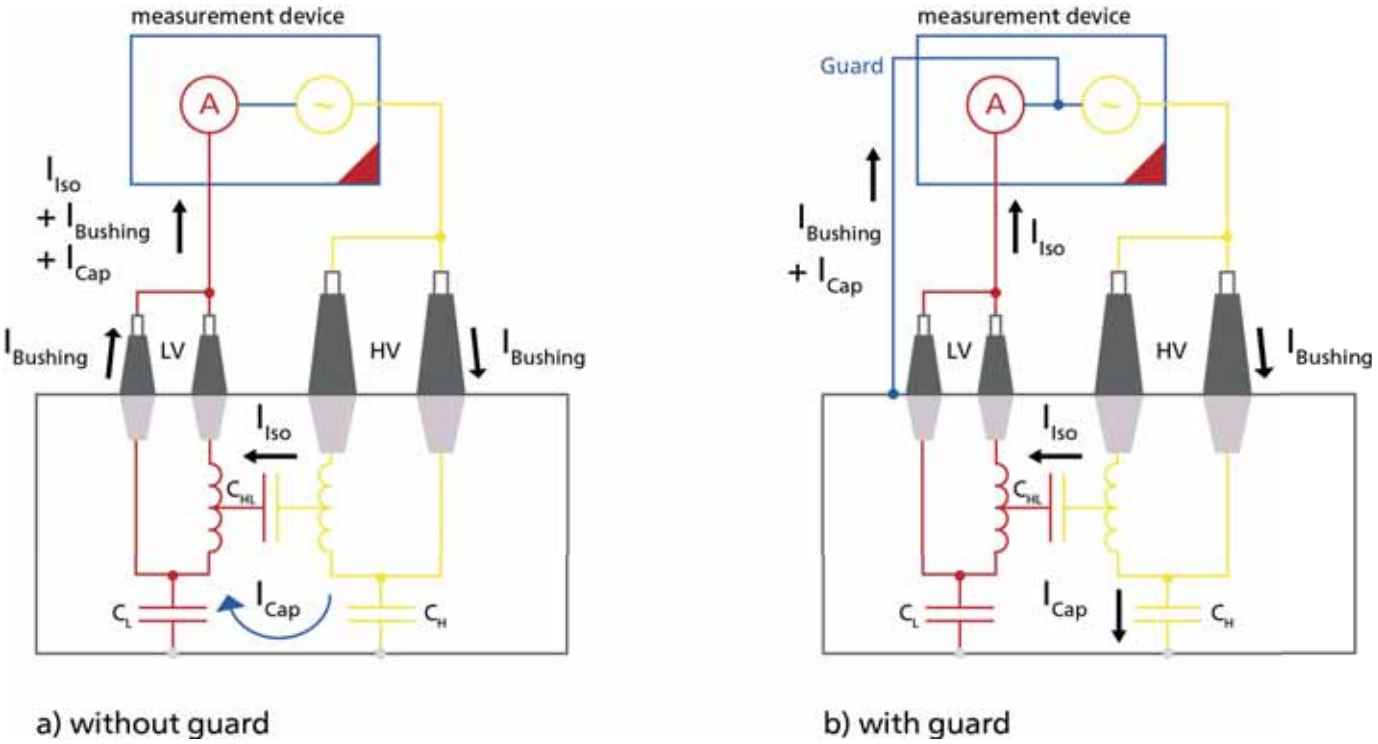

Figure 3: CHL measurement on a 2-winding transformer without and with guard

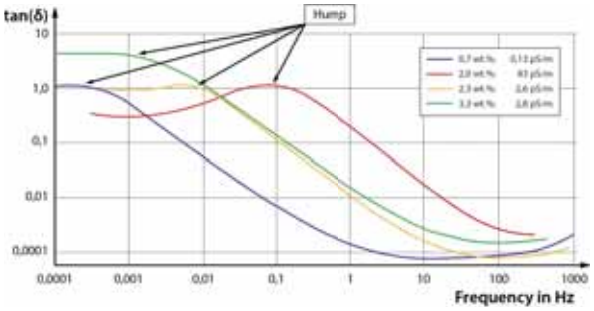

Figure 4: Broadband dielectric response of four different power transformers at 20-degree C

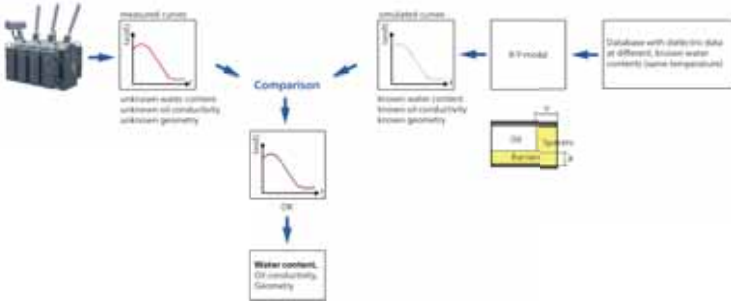

Figure 5: Principle of the water content assessment of power transformers

influenced by those parameters. Unfortunately, sampling of cellulose for moisture analysis is a very difficult task as the solid insulation of a power transformer isn't easily accessible.

Moisture determination via dielectric frequency response analysis

A simple and reliable way to determine the amount of moisture in a power transformer is dielectric frequency response analysis (DFR). When a material absorbs water, it changes its dielectric properties, such as conductivity, capacity and dielectric losses. This principle is used, for example, in humidity sensors. Cellulose also shows such a dependency of dielectric values at different water contents.

Measurement principle

In dielectric moisture analysis of power transformers, the whole main transformer insulation is used as a humidity sensor. The measurement device is connected to the bushings and determines the dielectric properties of the insulation. The connection is very simple, like in a normal power factor/tan(δ) measurement. Only one insulation has to be measured. Typically, the main insulation from the high voltage to the low voltage side (CHL) is used as it contains most cellulose. For analog to power factor/tan(δ) measurements, a guard is used to bypass unwanted influences (Figure 3).

As moisture influences the dielectric properties of cellulose, especially at very low frequencies, the measurement is performed down to the μHz region. Figure 4 shows the dielectric losses of four power transformers in a frequency range from the μHz region up to some hundred Hz. Each curve has a characteristic shape which includes a more or less pronounced "hump" at lower frequencies. The region below the "hump", around 1 - 2 decades from the "hump" peak, is highly influenced by the water in the paper insulation. Determining this frequency region is essential.

Result assessment

The assessment of the curves is a complex process as many parameters are influencing the dielectric properties. However, modern measurement software,

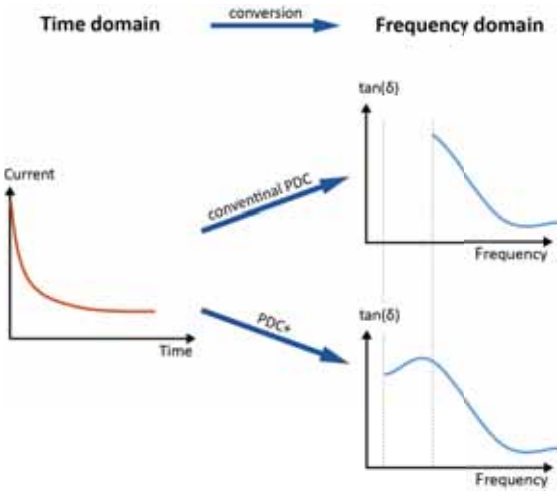

Figure 6: Conversion from time to frequency domain for conventional PDC and PDC+

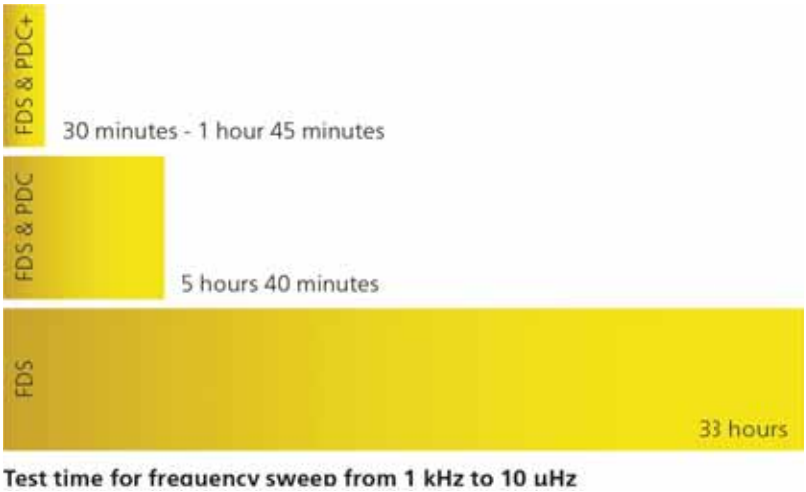

Figure 7: Test time for a frequency sweep from 1 kHz to 10 μHz

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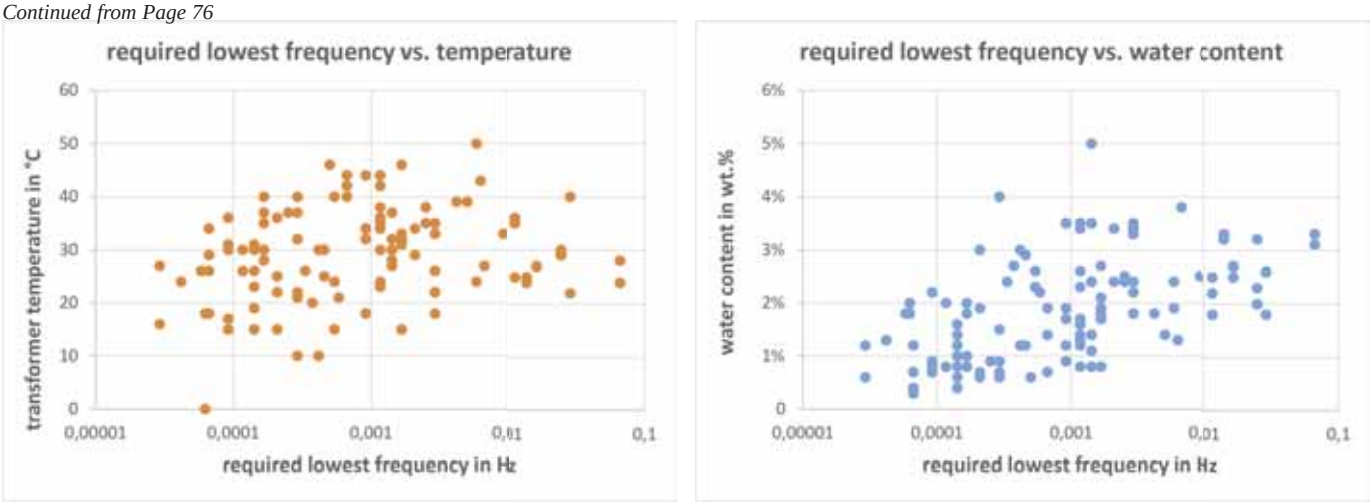

Figure 8: Correlation of transformer temperature and water content to the required lowest frequency which has to be measured. The evaluation is based on 115 dielectric measurements on power transformers.

which include a database of dielectric properties of pressboard at various water contents and temperatures, help users to automate this process.

The principle of the assessment is to simulate a transformer insulation using the database and to model barriers and spacers with the so-called X-Y-model. This way, no "fingerprint" or previous measurement is required and all kinds of transformers (and also other oil-paper insulated assets) can be simulated (Figure 5). The parameters of the simulated curve are adapted until the simulated curve fits the measured curve. When this is the case, all parameters (moisture, oil conductivity, etc.) of the "fitting" simulated curve are identical to the parameters of the measured transformer. The whole procedure involves a high number of calculations but is performed within seconds by the measurement software.

The DFR method has been described by CIGRÉ, and an IEEE guide is currently under development. There are no other non-invasive ways to assess moisture in a transformer that can provide comparable accuracy.

Reduce the time for DFR measurements

Traditional FDS measurement method

Traditionally, dielectric parameters are measured in frequency domain by applying different frequencies and measuring the response. This technique is called frequency domain spectroscopy (FDS) and is applicable for all frequencies, from the μHz area to the GHz area and above. It is quite simple in handling, but takes a lot of time to measure low frequencies as the duration of sine waves at, for example, 10 μHz, takes about 27 hours, not taking into consideration all the other frequencies which also have to be measured.

Conventional PDC measurement method

Another method to measure the dielectric properties is to apply a voltage step to the tested asset and to measure the resulting polarization current for some time. This time-dependent information can be transferred to frequency-dependent dielectric properties. It is called polarisation depolarisation current measurement (PDC) as traditionally not only the polarisation, but also the depolarisation current, was measured and compared. Modern algorithms only require the polarisation current which halves the measurement time. By using PDC instead of FDS, the measurement time can be significantly reduced as one single PDC measurement provides the information for all frequencies which should be measured.

This principle provides a way to save measurement time: Conventional conversion from time domain to frequency domain uses a static correlation between the

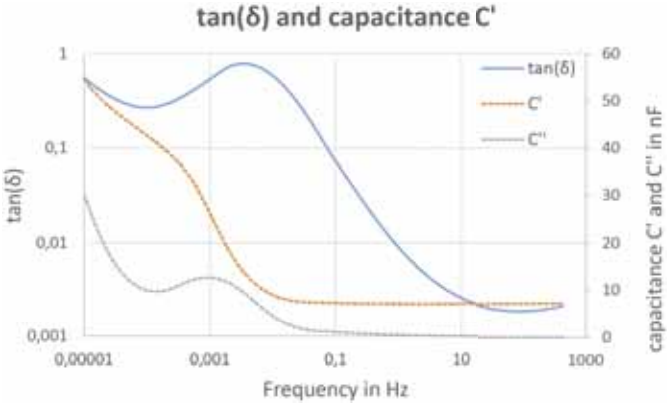

Figure 9: Correlation of the "hump" in tan(δ), the real part C' and the imaginary part C'' of the capacitance for a power transformer

measurement time and the calculated frequency range. If, for example, the time domain measurement was performed for 1,000 seconds, the frequency response was always calculated down to the inverse frequency of 0.001 Hz.

Time-improved PDC+ measurement method

A new algorithm called PDC+ uses a dynamic approach and calculates up to 20 times more data in frequency domain from the same time domain information (Figure 6).

Thus, the PDC+ technique allows much shorter measurements for the same frequency range than FDS or conventional PDC techniques (Figure 7). Modern measurement devices combine FDS for high frequencies and PDC+ for low frequencies. Where conventional FDS measurements take more than a day to measure from 1 kHz to 10 μHz, modern FDS&PDC+ devices can achieve this in 30 minutes to 1 hour 45 minutes.

There is also yet another way to reduce the test time. In many cases, it is not necessary to measure the whole frequency range down to 10 μHz. If the test can be stopped earlier, more time can be saved. However, shortening the measurement time too much can be critical as the important frequency range below the hump has to be measured. If the test is stopped too soon, the results would be worthless and the whole measurement would have to be repeated.

The required lowest frequency, which has to be measured in order to achieve valid results, is not showing any good correlation to the transformer temperature, so this can't be used to determine the required frequency range (Figure 8). The required frequency range is also not directly related to the water content of the sample (Figure 8).

There is a parameter which is directly related to the hump and which is measured directly: The real part of the complex capacitance, known as C' or mostly referred to simply as "capacitance". At high frequencies, it is stable but at the beginning of the hump it starts to increase (Figure 9). As the tan(δ) is the quotient of imaginary part C'' (namely, the losses) and the real part of the capacitance C', it is obvious that a larger increase of C' than of C'' leads to a lower tan(δ). The increase of C' can be used to detect the position of the hump. As

the part of 1-2 decades left of the hump is dominated by the influence of moisture, this frequency range has to be measured. Lower frequencies are not required, so the measurement can be stopped once this frequency range has been determined.

The advantage of using C' is that its value is rarely influenced by disturbances. Also, for certain assets, for example, power transformers with good oil but increased moisture content, the tan(δ) curve does not show a pronounced hump but the evaluation of the C' increase provides correct information.

The effect is not only proved empirically but can also be derived from the dielectric behaviour: An increase of C' in this low frequency area corresponds to space charge polarisation which happens in the cellulose insulation. Therefore, the frequency area where C' increases (compared to high frequencies) is influenced by the cellulose.

With the information of the required frequency range, which is available during the measurement, the frequency range can be limited to the minimum required range. This helps to reduce the test time drastically in most cases and avoids inaccurate measurements with too short frequency ranges.

Modern DFR measurement devices

One of the big problems of dielectric moisture determination in the past was – besides the measurement time – the high complexity of the measurement. Although the test setup itself is very easy, the determination of the correct frequency range and the assessment of the curve required background knowledge.

Modern DFR measurement software is able to automatically and individually set the frequency range for each power transformer. At first, the maximum frequency range is set and when the software has determined the increase of C', it can calculate and adjust the required remaining frequency range and the corresponding measurement time.

The increase of C' not only helps to reduce the time, but also allows a more accurate moisture assessment as the part of the curve which is dominated by moisture is reliably identified. Modern measurement software is able to perform the curve fitting and assessment of water content and oil conductivity fully automatically once the required data has been measured. It also normally includes an automated assessment function, which compensates for influences such as insulation geometry, oil conductivity and aging by-products. The testing device should be able to conduct the automatic evaluation according to national, international or user-defined standards.

Conclusion

Water is a danger to the insulation of oil-paper insulated power transformer as it ages and decreases the mechanical strength of the insulation. If the water content is increased, counter-measures, such as drying, have to be applied before the insulation is severely aged. Dielectric measurements enable a reliable assessment of the water content without the drawbacks of other methods.

The new PDC+ method combined with modern software allows much shorter measurement time and easier applicability.

With the automation of the whole test, which is possible in modern software, the tester only has to set up the test set and press the start button. The only parameter which has to be entered manually is the asset temperature. Therefore, even inexperienced users can reliably assess the water content of power transformers. This information allows the user to determine if life extending actions have to be taken or if the asset is still in good shape. EI

Martin Anglhuber

Product Manager
OMICRON electronics GmbH
6833 Klaus, Austria

Highly flexible Ethernet igus cables for e-chains with CC-Link IE Field certificate

New chainflex CAT5e and CAT6 cables with guaranteed service life and certification for CC-Link IE protocols

CAT5e or CAT6 cables are generally vital to meet the goals of Industry 4.0 for automation. igus has now developed two highly flexible Ethernet cables, CFBUS.045 and CFBUS.049, for use in energy chains. The new cables have now been tested by independent institutes and received the certificate for CC-Link IE protocols for the Asiatic region as well as UL certification, increased to 600 volts, for the American market.

Industrial Ethernet is the future step for the digitised factory of tomorrow. Many studies show that the world of fieldbus is stagnating, and the number of Ethernet nodes is increasing, with high double-digit growth rates. This is true in Asia but increasingly in Europe as well, and users are choosing CC-Link IE (Industrial Ethernet) technologies. These systems offer seamless data exchange on all levels of a production facility, from the highest control level to the manufacturing levels. The CC-Link IE controller network has been designed for the rapid exchange of large amounts of data in a factory or production plant, whereas the CC-Link IE field network has been optimised for connection of a wide range of devices and their connection to other existing networks such as the standard CC-Link. These increasing requirements for industrial Ethernet communication nodes call for a secure and long-lasting connection between the components to meet the continuously growing amounts of data being transferred. The CAT5e and CAT6 chainflex Ethernet cables are exactly the right choice to ensure this communication. This is because igus has been developing and testing cables for more than 30 years in the industry's largest laboratory, these cables being specially designed for use in energy chains. With more than 2 billion test cycles and over 1.4 million electrical tests per year, igus is regarded as the number one for moving cables in energy chains.

Chainflex cables for secure and reliable data transfer

A big challenge in industrial environments is the limited life of data flows due to ageing of the moving cables. With this in mind, igus is the only supplier to offer the CFBUS.045 CFBUS.PUR.045, CFBUS.PVC.045 (CAT5e) and CFBUS.049, CFBUS.PUR.049 and CFBUS.PVC.049 (CAT6) series of bus cables, this being the most extensive range of cables on the market that have been specially developed for use in energy chains. With over 76 million strokes and a bend radius of 9.5 x d, they have been able Test 3089 to clearly demonstrate their exceptionally long service life in the in-house igus test laboratory. A further proof of quality is provided by their certifications: All new BUS cables have been certified by the CLPA CC-Link Partner Association after extensive electrical tests, whereby the cables also have the increased 600-volt UL certification.

Ethernet cables with 36 months guarantee for industrial communication

igus supplies 1,350 types of cable, the widest range of energy chain cables is the market with the world's most extensive selection of international certifications such as the CC-Link certificate. The motion cable specialist has also been supplying UL-certified chainflex cables for mechanical and plant engineering for more than 25 years. For exporting companies, this means simple customs clearance for easy entry into the United States. Due to the constant testing of all chainflex cables in the in-house 2,750 square metre test laboratory, igus is the only manufacturer in the world to offer a 36-month guarantee on its complete cable range, including the new Ethernet cables for CAT5e and CAT6. EI

For more details, visit www.igus.in

New chainflex Ethernet cables with a guaranteed service life and certificate for CC-Link IE protocols ensure fast data transfer and easy trading in the Asiatic area.

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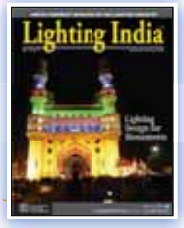

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PC-based control optimises logistics applications

Open control technology for warehouse and distribution logistics

TwinCAT bundles all machine control functions that are essential in logistics and offers flexible support for horizontal communication from machine to machine as well as vertical communication with higher-level control and warehouse management systems.

Beckhoff will present its expertise as a long-standing automation partner for the logistics industry at LogiMat, international trade fair for intralogistics solutions and process management. Open PC and EtherCAT-based control technology is ideally suited for optimising logistics processes and responding to quickly changing market trends. With open interfaces, modularity and scalable performance, it is the perfect fit for intralogistics solutions that are custom-tailored to individual requirements, while delivering technological and economic competitive advantages at the same time. Components for system-integrated connection to the cloud make it easier to implement IoT and Industry 4.0 concepts in smart warehouses.

Due to its openness, PC-based control technology from Beckhoff fulfils the requirements for end-to-end networking of intralogistics, production and distribution to perfection – one of the key challenges in the sector. PC-based control is based on a comprehensive portfolio of advanced Industrial PCs, TwinCAT automation software, EtherCAT as a fast communication system, decentralised I/O components and highly dynamic drive solutions. Integrated, cost-effective and flexible system planning is assured by the performance-driven scalability of the control platform, the flexible support for different fieldbus systems and the same programming and configuration software across all performance classes.

The TwinCAT automation software suite bundles all necessary machine functionalities: from PLC to motion control, robotics, HMI, safety and measurement technology through to integration of vision systems and cloud solutions. Open interfaces allow effortless integration of control functions into existing system and database structures.

With support for standardised protocols, such as OPC UA, Beckhoff provides the prerequisites for implementing secure cloud communication in the smart warehouse. Users benefit from the openness of the control architecture also in this respect, for example through the unrestricted choice of cloud solution. All systems concerned – from I/O level to warehouse management and eCommerce software – can be fully connected.

For more details, visit www.beckhoff.com

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Citizen Metalloys have developed customised components which provides a speedy, convenient and economical solutions for electrical power, distribution and automation industries using many processes like cutting, punching, bending, plating, coating, sleeving, turning, tapping, twisting, milling, drilling, stud fixing, forging, forming, ultra-sonic wielding and specialised in cold forming.

The company has an ISO 9001:2015 (Quality Management System), ISO 14001:2015 (Environment Management System) and BS OHSAS 18001:2007 (Occupational Health & Safety Management) and Government Recognised Star Export House. Today the company exports to more than 40 countries. They have been honoured with the highest export award for last five consecutive years through EEPC-Engineering Export Promotion Council of India and also awarded as best Export Performance (Emerging Company) World Non-Ferrous in 2017.

The company has recently been rated by Dun & Bradstreet as SMERA MSE 1 for highest creditworthiness, financial strength and operating performance.

Quality and Citizen Metalloys goes hand in hand. The company has very stringent policies to ensure strict adherence to quality maintenance. Identifying and "eliminating" quality deviations and failure causes at early stages, and extensive use of data feedback are the suggested tools to accomplish continuous improvements and to assure high-quality products. They follow the Kaizen and 5S methodology of total quality management to organise and manage the workspace and work flow with the intent to improve efficiency by eliminating waste, improving flow and process unreasonableness.

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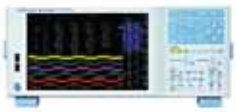

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Kyoritsu 3128 12KV Insulation Testers

Kyoritsu, Japan has a frontline global presence in electrical test and measurement equipment since 1940, with specialised expertise in low voltage test and measurement.

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Kyoritsu products are readily available in India and have complete service- and calibration- support set-up too.

For more details, contact: info.ei@kew-india.co.in

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HF3 is a heavy-duty chassis-mounting relay available in a strong transparent enclosure. It is a 40A relay with a 3CO, 3NO or 3NC configuration. These configurations further reduce useless expenditure. Relay mounting is insulated.

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For more details, contact at bd@tararelays.com

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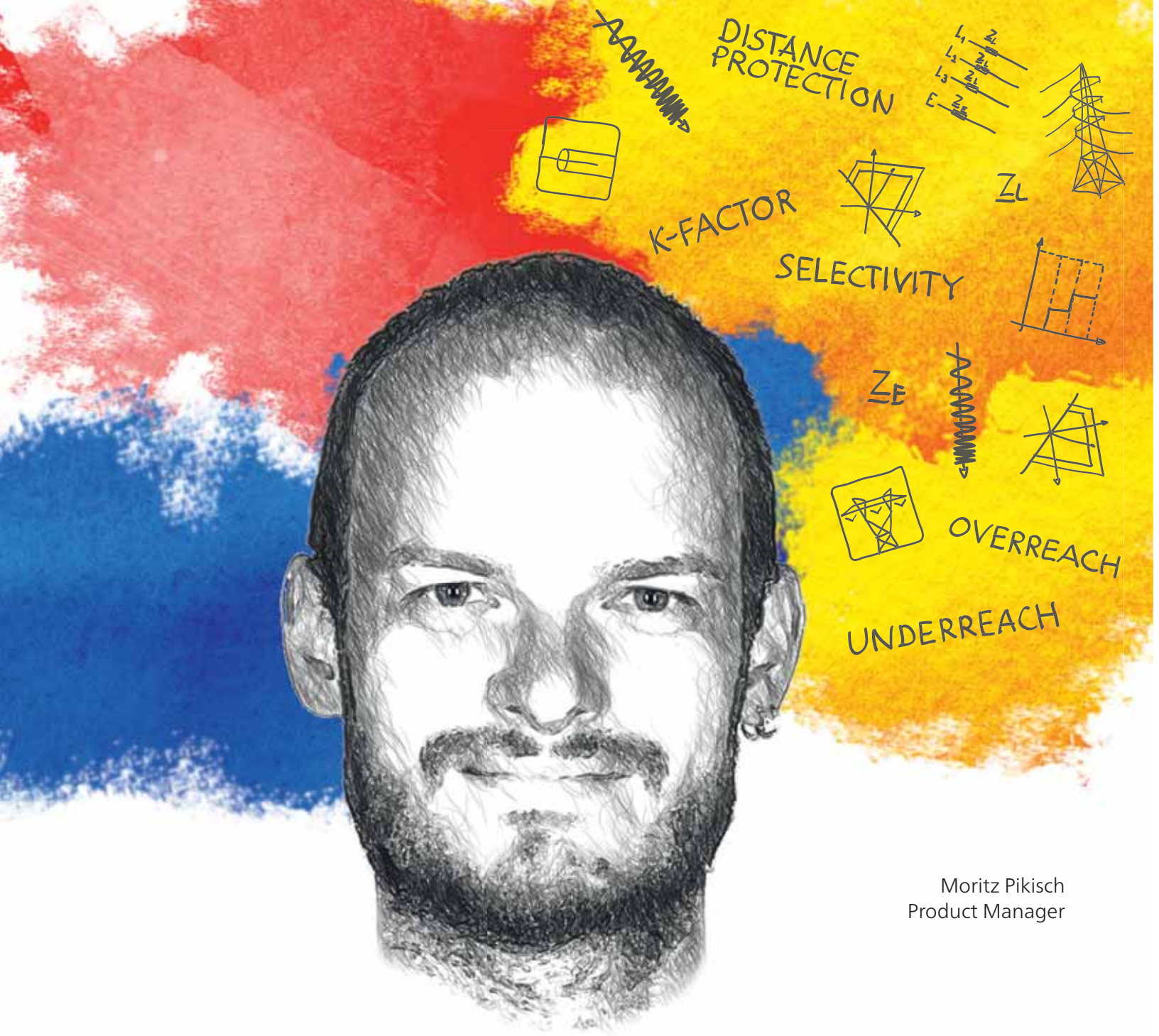

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- Rated current: 50A-750A
- Rated voltage class: 380V/480V/690V
- Modular Design, Easy For Capacity Expansion
- Active Filter, Automatic Resonance Avoiding, Automatic Current Limiting Without Overload

Active Harmonic Filters

IGBT NPC topology, DSP control

- Reactive Compensation Range: -1~1 (Adjustable)
- Power Factor: 0.99
- Rated Capacity Of Cabinet: 30kVar-600kVar
- Rated Voltage Class: 380V/480V/690V
- Modular Design

BERGEN

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