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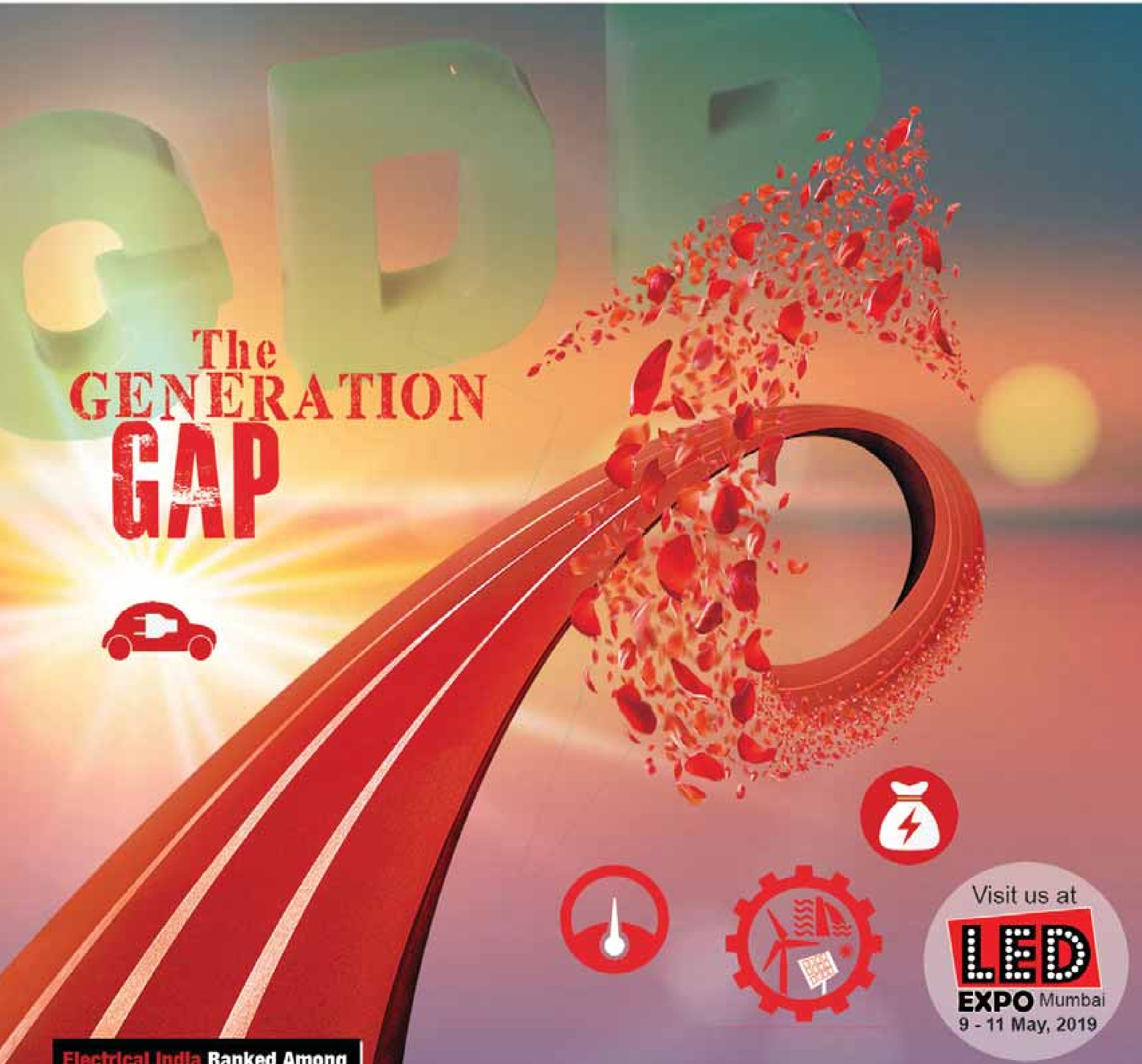
59th Year of Service to the Industry



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Publisher's letter

Access to electricity plays a key role in socio-economic growth of any economy. It is also essential for livelihoods and community services such as education and healthcare. In India, the demand for electricity has increased rapidly and is expected to rise further in the years to come. In order to meet the increasing demand for electricity in the country, massive addition to the installed generating capacity is essential. As per the 19th Electric Power Survey, the peak electricity demand is expected to touch 226 GW by 2021-22, 299 GW by 2026-27, 370 GW by 2031-32, and 448 GW by 2036-37. However, the new capacity addition especially in the thermal power sector has seen remarkable fall during the past one year.

In a recent move, the Supreme Court struck down the Reserve Bank of India's 'February 12 order' which stated a time-bound resolution of bank loans. The said RBI order mandated banks to take the defaulting companies to insolvency. "We found RBI's February 12 circular to be ultra vires (acting or done beyond one's legal power or authority)," the apex court ruled. Experts believe, the power companies will be immensely benefitted from the Supreme Court's order that had set strict norms for bad loan resolution, easing the concerns of some debt-laden companies and stringent bankruptcy process.

This time, we present to you an in-depth analysis on Indian power sector road map, with a focus on capacity addition. Hope you will enjoy reading this issue as always.

Do send me your comments at miyer@charypublications.in

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'ACHHE DIN' FOR POWER SECTOR?

India is going to witness the biggest election in world history – the Lok Sabha Elections 2019 commencing 11th April. The political parties, eyeing to sweep the polls, will go for 'high-voltage campaigning' by holding multiple rallies in their attempt to woo the voters in their favour. Generally, it is observed that the demand for electricity goes up whenever India approaches general elections primarily due to intensive audio-video campaigning, rallies, and lighting of signages etc.

Further, the 12th edition of annual cricket extravaganza Indian Premier League (IPL) is on! The matches mostly played at night result in consumption of huge volume of electricity by powering floodlights, giant screens and sound systems in stadiums across the country. Also, a large number of cricket-crazy fans watch the tournament live sitting in front of the television for long hours with air-conditioners on. This again increases power consumption.

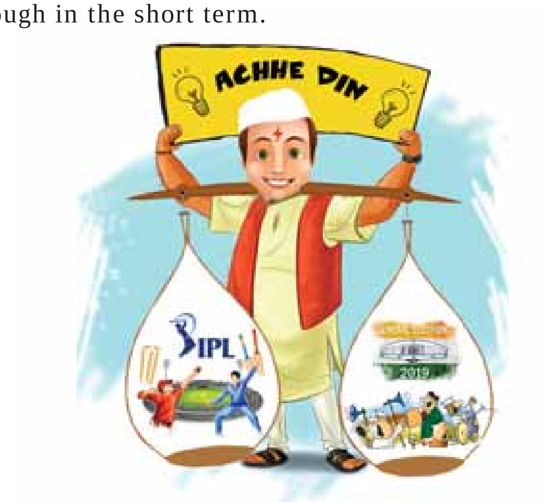
The above two mega 'events', even if short-term, signal good news for the power sector which is plagued by over-capacity and low demand.

Of late, the government has approved a slew of measures to provide the much-needed boost for the domestic power sector. It has cleared 3,760 MW projects worth Rs 31,560 crore to deal with stressed assets.

In order to revive the hydro power sector, especially to attract private participation in the sector, the Cabinet has approved renewable status for large hydro power projects of over 25 MW.

On the coal availability front, the Cabinet has approved coal linkages for short-term power purchase agreements (PPA) and allowed companies continue to have coal linkages even if PPAs are terminated due to payment default.

The above initiatives will provide a breather to the Indian power sector that is facing multiple headwinds. So, 'Acche Din' (good days) are here, though in the short term.



Subhajit Roy

Group Editor

Electrical India
April 2019

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Advanced testing and monitoring solutions

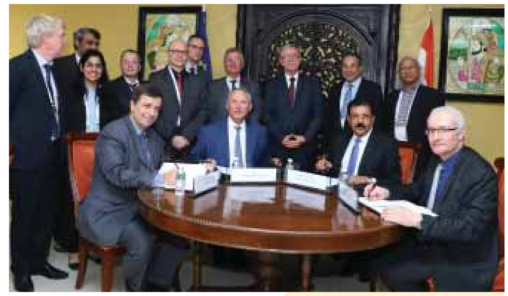
India Infrastructure Trust (InvIT) sponsored by Brookfield

Brookfield has filed the preliminary placement memorandum, in terms of which India Infrastructure Trust, an InvIT set up by Brookfield as sponsor and 90 per cent investor, will invest Rs. 13,000 crore to acquire the East-West pipeline. As a part of the transaction, the InvIT will acquire 100 per cent equity interest in Pipeline Infrastructure Private Limited (PIPL) which currently owns and operates the pipeline.

Pursuant to this acquisition by Brookfield, the existing pipeline usage agreement has been reworked as: 1. The reserved capacity reduced to 33 MMSCMD against the 56 MMSCMD. 2. Any unutilised capacity payment by RIL will be the difference between Rs. 500 crore a quarter and actual revenue earned by PIPL. 3. RIL will continue to be entitled to transport gas, either by itself or of any customers, free of cost against any outstanding unutilised capacity payments. At the current approved final tariff of Rs. 71.66/ MMBTU, if the average volume of gas transported is 22 MMSCMD, RIL will not be liable to make unutilised capacity payments.

Considering the new investments in the upstream sector in the KG basin, and the growing LNG imports, ability to swap gas, the average volume expected to be transported through the pipeline is expected to be significantly higher compared to the current levels.

Tata Power-DDL collaborates



Tata Power Delhi Distribution (Tata Power-DDL), has joined hands with Enedis, Schneider Electric, Odit-e and VaasaETT to implement a Smart Grid Demonstrator in India. The MoU for the same was signed between Sanjay Banga, CEO, Tata Power-DDL; Philippe Monloubou, Chairman of Management Board, Enedis; Luc Remont, Executive VP International Operations, Schneider Electric; Philippe Deschamps, CEO, Odit-E and Thomas N. Mikkelsen, Partner and Director of Consultancy, Vaasaett on the sidelines of India Smart Utility Week 2019 in the presence of Tomasz Kozlowski, H.E. EU Ambassador to India; Jean-Marc FENET, Minister-Counsellor for Economic Affairs, Head of the Regional Economic Department at the Embassy of France in India; Megan Richards, Director of DG Energy at the European Commission and Praveer Sinha, CEO & MD, Tata Power during the India Smart Utility Week 2019 at the Manekshaw Centre, New Delhi.

"The collaboration with Enedis, Schneider Electric, Odit-e and VaasaETT is one of the significant milestones in the Indian power sector," said Praveer Sinha, CEO and Managing Director of Tata Power.

GAIL India to equip its gas turbines with Siemens

Real-time data analysis from 29 Gas Turbines across multiple locations will increase availability, reduce forced outages and enable proactive, predictive maintenance. Digitalisation to improve availability, efficiency, productivity and flexibility.

Siemens Limited will install state-of-the-art Remote Diagnostic Services (RDS) for GAIL India Limited covering gas turbines installed across Hazira-Vijaipur-Jagdishpur (HVJ) pipeline and Vijaipur C2/C3 Plant. The scope includes supply of RDS hardware, site installation and commissioning including three years' remote Operational Service Desk (OSD) and Help-desk services. The 24/7, year-around accessible OSD will be equipped with machine learning tools and manned by technical experts to provide faster, higher quality troubleshooting and guidance for problem resolution.

Prashant Jain, Head, Power Generation Services, Siemens Limited, said, "Reliable and efficient operations, specially of critical assets, are key to a profitable and sustainable business for gas transmission utilities.

Siemens has an experience of monitoring over a thousand oil & gas and industrial rotating equipment across 80 countries through Remote Diagnostic Services. We take great pride in partnering GAIL in their quest for enhancing availability, reliability and efficiency."

IEEMA signs agreement with PSSC

In order to train budding electricians in the country, IEEMA under its CSR activities has partnered with Power Sector Skill Council(PSSC) to create maintenance technicians working in industrial plants and commercial buildings.

IEEMA has signed an MOU with PSSC for this initiative. The agreement was signed by Sunil Misra, Director General, IEEMA and Vinod Behari, CEO, PSSC as part of IEEMA's CSR activity. An amount of Rs 21 lakh will be invested in the skill development activities in 'Electrician Domestic Solutions' domain ensuring that more than 160 trainees will get trained.

Harish Agarwal, President, IEEMA said, "It is a great day for our industry. We have signed an MoU with PSSC for co-operation. Skill development is a gap which if filled up will have an extremely positive impact on the quality and reliability of industry's delivery."

Vinod Bihari, CEO, PSSC articulated, "This MoU with IEEMA constitutes a major milestone for PSSC. It would enable us raise the training and certification of Electricians to a significant level in response to their ever growing demand." EI

Railways could provide much greater benefits

The future of Rail is the latest in the IEA series shining a light on "blind spots" in the energy system, which are issues that deserve more attention from policymakers. It was released recently in New Delhi by IEA Executive Director, Dr Fatih Birol, at an event attended by India's Minister of Railways, Piyush Goyal.

The transport sector is responsible for almost one-third of final energy demand, nearly two-thirds of oil demand and nearly one-quarter of global carbon dioxide (CO_2) emissions from fuel combustion. Therefore, changes in transportation are fundamental to achieving energy transitions globally. While the rail sector carries 8 per cent of the world's passengers and 7 per cent of global freight transport, it represents only 2 per cent of total transport energy demand, highlighting its efficiency.

"The rail sector can provide substantial benefits for the energy sector as well as for the environment," said Dr Fatih Birol. "By diversifying energy sources and providing more efficient mobility, rail can lower transport energy use and reduce carbon dioxide and local pollutant emissions."

The Future of Rail includes a base scenario that projects the evolution of the railways sector to 2050 on the basis of announced policies, regulations and projects. EI

PM lays foundation stone of thermal power plants

Prime Minister Narendra Modi unveiled the foundation stones of Buxar and Khurja Thermal Power Plants digitally from Greater Noida. These plants, 1320-MW each are situated at Buxar (Bihar) and Bulandshahar (Uttar Pradesh) respectively.

The PM said that the thermal power plants launched at Buxar and Khurja will accelerate India's growth and will transform the power availability in Uttar Pradesh, Bihar and other neighbouring states. He spoke about the huge jump in power generation in the past four and half years.

Speaking about the Government's initiative towards improving the power sector in India, PM said his government focused on all four aspects of power generation, i.e. Production, Transmission, Distribution and Connection. He said, "Such an approach has completely transformed the power sector and One Nation - One Grid has now become a reality. The Government has also given right impetus to renewable energy sector also," PM said. He added that his dream is 'One World, One Sun, One Grid'.

RK Singh, Union Minister of State (IC) for Power and New & Renewable Energy graced the foundation stone laying ceremony at Chausa, Buxar in Bihar. Speaking on the occasion, he said, "The Project will bring many benefits to the region." EI

KEI expects to clock over 20% robust growth

KEI Industries aims to close this financial year ending March 31, 2019 with over 20 per cent growth, stimulated by robust export growth at 10 per cent with continued demand for its products in national and international market.

The company is bullish on expansion with over 1400 dealers pan India by this fiscal end, almost a jump of 9 per cent from 1284 dealers as on March 31, 2018. KEI's net profit also soared by 28.36 per cent to Rs 121.94 crore during nine-month period (April 1 2018 to December 31, 2018) from Rs 95 crore during the same period of 2018.

Elaborating on growth of Indian wire and cable industry, the Chairman cum Managing Director- KEI Industries Ltd, Anil Gupta said, "We have been able to expand and at the same time ensured our foothold across the market to which we cater. We do so with the help of strong financials and Capex, which has ensured our continuous growth. As our growth trajectory remains intact, we are very hopeful to clock 18 per cent to 20 per cent during the next fiscal." EI

Tata Power conferred with "Suraksha Puraskar"

Tata Power, India's largest integrated power utility has always prioritised the wellbeing of its employees and surrounding communities by simultaneously working towards improving their quality of life. Recognising this effort, the National Safety Council of India conferred Tata Power's Maithon plant with a "Suraksha Puraskar" and Haldia plant with a "Prashansa Patra" certificate at the recently held Safety Awards 2018 under the 'Manufacturing Sector' category. The award appreciated Tata Power's efforts to develop and implement effective management systems & procedures for Occupational Safety and Health (OSH) at its Maithon and Haldia plants.

With three distinct national level awards institutionalised in the Manufacturing, Construction and Micro, Small & Medium Enterprise sectors. The National Safety Council of India provides national recognition to companies for consistent and meritorious OSH performance and encourages them to further commit to it. EI

GE T&D India Limited to modernise Rajasthan's transmission grid

GE T&D India recently announced that it has been awarded a technology-driven grid modernisation project by Rajasthan Rajya Vidyut Prasaran Nigam Limited (RRVPL) as part of the utility's roadmap to implement grid initiatives and augmenting renewable energy in the state, which will benefit the Rajasthan's population.

Smart Transmission Network and Asset Management System (STNAMS), RRVPL's state-of-the-art power transmission roadmap, was designed to integrate large-scale renewable energy and support managing existing and future power structure.

A first by a state utility in India, the project investment totaling Rs 150 crore demonstrates the need for efficient, stable and secured operation of the grid.

The total installed power capacity of Rajasthan is around 21.6 GW, out of which 34 per cent comes from renewable sources. The state plans to further increase solar and wind generation capacity to 14.3 GW by 2022. To support this focus on renewable energy, the state requires remote monitoring and grid stability. EI

Vikram Solar commissions 200 MW solar project

Vikram Solar commissioned a 200MW solar power project for Andhra Pradesh Power Generation Corporation (APGENCO) that will power nearly 1,50,000 homes once connected to the grid. The plant situated in district Anatapuramu, Andhra Pradesh is segregated into two blocks of 100MW each for better management and higher efficiency.

The project is spread across 1000 acres (500 acres each for 100MW) of undulated rocky terrain, and power will be evacuated at 33KV level in two pooling substations of 33/220 KV capacity, which will further evacuate power to 220/400KV main substation.

In the project, a total of 8,48,680 modules, ranging from 320wp to 330wp were installed. The project is expected to produce 446 MU energy annually and will reduce 210 metric tonnes of CO_2 emissions in a year. Vikram Solar will also carry out Operation and Maintenance (O&M) of the plant for a period of 5 years from the date of commissioning.

L&T Construction awarded contracts

The Power T&D business of L&T Construction has bagged a number of Engineering, Procurement and Construction orders in India and abroad. In Andhra Pradesh, orders have been secured for design and construction of two 400kV substations and associated transmission lines. These substations and connected transmission systems form part of the 400kV ring network being implemented to ensure uninterrupted power supply for the state's new capital city, Amaravathi.

For the 2nd Phase of Bangalore Metro, an order to execute the receiving substations and the extra high voltage cables from grid stations has been received. Another order to execute the power supply system and SCADA works for Mumbai Metro Line 7 has been bagged.

Another order for the design and construction of a 15MW grid connected floating solar farm has been received to be executed as part of Visakhapatnam Smart City project. This is among the biggest floating solar projects in India. In Tamil Nadu, Engineering, Procurement and Construction orders have been secured from reputed developers for the implementation of solar power generating systems totaling 200MW. In the United Arab Emirates, an order has been bagged for the construction, supply, installation, testing and commissioning of a 132/11kV Substation and its associated works.

Samsung R&D Centre switches to solar energy

Samsung's R&D centre in Bengaluru has switched to solar power for its campus in the IT capital of India. The campus which houses over 3,000 R&D employees will draw 88 per cent of its power requirement from a solar farm in Kalburgi district in Karnataka, around 500 kilometres away from Bengaluru. In December 2018, Samsung R&D Institute, Bengaluru (SRI-B), which is Samsung's largest R&D centre outside Korea, adopted the green energy solution through a method called 'energy wheeling'.

The solar farm by Bagmane Green Power LLP based in Kalburgi has a tie-up with SRI-B. Through 'energy wheeling', the solar farm adds the required power to the state electricity grid and SRI-B in turn, receives an equal amount of power from the local electricity grid. This method reduces T&D losses, thereby making it more energy efficient.

"Our switch to solar power is an embodiment of Samsung values of being a socially and environmentally responsible citizen. Through this initiative we have not only reduced our dependency on conventional sources of energy but we will also have a positive impact on the environment by reducing our carbon footprint and passing on a greener planet to the next generation," said Dipesh Shah, Managing Director, SRI-B.

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Consortium named for UK offshore transmission asset

A consortium made up of Mitsubishi Corporation (MC), Chubu Electric Power Co., Inc. (Chubu) and HICL Infrastructure Company Limited has been selected as the preferred bidder for a new offshore electricity transmission link in the UK.

Valued at approximately GBP 500 million, the new offshore electricity transmission asset is comprised of subsea cables, land cables, offshore substations and an onshore substation that connect with the Walney Extension Offshore Windfarm (Generation Capacity: 660MW) situated approximately 30 km off the UK's western coast.

The consortium will operate this electricity transmission business for a 20-year period starting from fiscal year 2019, following successful acquisition of the asset and the granting of an Offshore Transmission Owner (OFTO) license by the UK's Office of Gas and Electricity Markets (Ofgem).

With the acquisition of the Walney Extension Offshore Windfarm transmission link, MC will now be operating, through its 100 per cent subsidiary Diamond Transmission Corporation Limited (DTC), eight out of twenty offshore transmission assets in the UK, giving it the largest share of the market. DTC will operate this electricity transmission business by leveraging its experience operating the neighboring Walney 1 and Walney 2 assets.

Ingeteam commissioned over 4GW of wind converters

Ingeteam Power Technology recently announced that it contracted over 4GW of wind energy converters globally in 2018. With a total of 45GW installed capacity to date, the company remains the unchallenged number one supplier of wind power converters in the world.

The Ingeteam Group closed the year with a 15 per cent increase in turnover compared to 2017. Ingeteam achieved these strong results despite price pressures on the wind supply chain due to an increasing competition among OEMs, as well as the recent industry slowdown in Brazil and India, two strategic markets for Ingeteam.

"The wind industry as a whole has weathered a challenging period in India and Brazil last year. That impacted our sales a little, but the slowdown has leveled off and we expect orders to rebound strongly this year," said Ana Goyen, Director of Ingeteam Wind Energy. Going forward, Ingeteam will benefit from the excellent growth outlook of the global wind sector, which becomes competitive with other energy sources in an increasing range of market conditions.

GE to co-develop plant in Bangladesh

Adhering to their commitment to provide reliable and affordable electricity in Bangladesh, Summit and GE Power announced they will proceed with the co-development of Summit Meghnaghat II, a 583-MW combined cycle gas power plant at Meghnaghat, near Dhaka, Bangladesh. The announcement follows the signing of a 22-year Power Purchase Agreement (PPA) between Summit Meghnaghat II Power Company Limited (SMIIPCL), a subsidiary of Summit Group, and the Bangladesh Power Development Board (BPDB). SMIIPCL also signed several other agreements, with the Government of Bangladesh, Power Grid Company of Bangladesh (PGCB), Bangladesh Petroleum Corporation (BPC) and Titas Gas Transmission and Distribution Company Limited. The power plant is expected to be operational by 2022 and will generate the equivalent electricity needed to supply up to 700,000 homes in Bangladesh. Summit and GE Power signed the equipment and engineering, procurement, and construction (EPC) scope of the project in 2017, while the services agreement was signed in 2018. Together, the two agreements are worth approximately $390 million.

"The phenomenal growth of Bangladesh in the last decade has established Bangladesh as a role model. Summit is proud to have played a role in it.

Siemens Gamesa awarded financing certificate

Siemens Gamesa Renewable Energy (SGRE) has been awarded the Brazilian Development Bank (BNDES) Special Agency for Industrial Financing (FINAME) Certificate for its SG 3.4-132 onshore wind turbine, which is produced in the factory located in Camaçari, Brazil.

This confirms that Siemens Gamesa produces a product that is compliant with BNDES' local content and manufacturing process regulations, allowing wind farm project developers to apply for special financing when acquiring the SG 3.4-132 wind turbine.

"This is a very important milestone in our strategy for local production of wind turbines," said Roberto Prida, Managing Director Onshore Brazil for Siemens Gamesa. "This certification will allow our customers to get competitive financing from BNDES for new wind projects, and we are very proud to deliver this added value as part of our products & solutions portfolio."

"Having completed four platform localisation processes in a period of only five years demonstrates Siemens Gamesa Supply Chain's outstanding local capabilities to adapt to our customers' needs and successfully deliver the solutions they need. We are grateful to the suppliers that have invested and are partnering with us, and to our team with its strong execution and innovation mindset," said Rodrigo Ugarte Ferreira, Procurement Director Onshore Brazil for Siemens Gamesa.

Building Energy inaugurates photovoltaic park

Building Energy, has inaugurated the Queule photovoltaic park, located in the Municipality of Las Cabras, in the region of O'Higgins. The plant, realised by Building Energy Andes SpA, a joint venture born from the collaboration with The Scotta Group, an Italian company specialised in the design, construction and installation of hydroelectric power plants and in industrial automation, has an installed capacity of 8,2 MWDC.

The start of the activities was celebrated recently with the inauguration of the solar park, in the presence of the MD Latin America of Building Energy, Daniele Moriconi, and the Ambassador of Italy in Chile, Mauro Battocchi.

The energy produced (16 GWh per year) will be used to meet the energy needs of more than 13,500 families living in the Municipality of Las Cabras, contributing every year to the reduction of 6,450 tonne of CO2 emissions for the benefit of citizens and the surrounding environment. The construction of the photovoltaic park, which began in February 2018 and ended in November 2018, required a total investment of 9.5 million dollars. For the development of the project, which also includes an environmental impact permit, Building Energy Andes has used the financing of the Chilean credit institute Banco Security.

Enel starts construction of 140 MW wind farm

Enel, through its renewable subsidiary Enel Green Power RSA (EGP RSA), has begun construction of its 140 MW Nxuba wind farm in the Amatole District, making it the Group's third wind project in South Africa's Eastern Cape province. The construction of Nxuba, which is expected to be completed by September 2020, will involve an overall investment of more than 200 million euros.

"Through the start of construction of the Nxuba wind farm, which is the first out of the five projects awarded to the company in South Africa's 2015 renewable tender to begin construction, Enel confirms its commitment to grow and strengthen its presence in the country," said Antonio Cammisecra, Head of Enel Green Power, the Global Renewable Energy business line of the Enel Group. "This new project reaffirms EGP RSA's contribution to further diversify South Africa's generation mix, while supplying sustainable energy to Eskom, and promoting the socio-economic growth of local communities."

Once fully up and running, Nxuba is expected to generate over 460 GWh per year, avoiding the emission of around 500,000 tons of CO2 into the atmosphere each year.

Ghanshyam Prasad Appointed as Govt Nominee Director of POWERGRID


Ghanshyam Prasad

Ministry of Power conveyed that the President has appointed Ghanshyam Prasad, Chief Engineer, Ministry of Power as Government Nominee Director on the Board of Directors of POWERGRID for a period of three years or till an officer is posted in the Ministry or till the date of superannuation or till further orders, whichever is earlier. Ghanshyam Prasad is BTech (Electrical) from IIT, BHU; M. Tech (Energy and Environment Management) from IIT, Delhi and MBA (Finance). He is presently working as Chief Engineer in Ministry of Power, Government of India looking after reforms and restructuring (R&R) in electricity sector and Operation and Monitoring (OM) of Electricity Grid. Earlier, he worked as Chief Engineer (Distribution) in Central Electricity Authority and Director (Transmission and OM) in Ministry of Power. He has also served for about six years in Haryana Electricity Regulatory Commission. He has varied and rich experience in the field of power system operation and electricity sector. He is not related to the Directors or Key Managerial Personnel of the Company and is also not debarred from holding the office of Director by virtue of any SEBI order or any other such authority.

Green Hippo appoints new sales and marketing head


David March

Green Hippo has announced the appointment of David March as Head of Sales and Marketing. Effective 25th February.

March's appointment comes at a time when the developer and manufacturer of Media Servers, renowned for its flagship Hippotizer product line, looks to continue to build on its 2018 acquisition by tvONE-owning Spitfire Creative Technologies, by growing further and faster. March will report directly to Green Hippo's Business Unit Director, Emma Marlow. He will take responsibility for Green Hippo's Sales and Marketing strategy in EMEA and Asia.

March comes to Green Hippo from VER where he most recently served as Head of VER Lighting Europe & Aurora Lighting. He began his career as a rental assistant at Vari-Lite Europe ultimately becoming General Manager at Vari-Lite Production Services. Since then he has held a number of leadership positions in the lighting and live events sector, including roles at Philips Entertainment, PRG Distribution and AED Distribution UK Limited.

Apollo-backed Lumileds appoints new CEO


Dr. Jonathan Rich

Lighting solutions company Lumileds, which is backed by Apollo Global Management, announced the appointment of Dr. Jonathan Rich as Chief Executive Officer. Dr Rich most recently served as Chairman and CEO of Berry Global, Inc., a Fortune 500 specialty materials and consumer packaging company, from 2010 to 2018. Dr. Rich succeeds Mark Adams, who is stepping down as CEO and from the board of directors but will remain in an advisory role to the company.

"I am very pleased to be joining Lumileds and am looking forward to building on the company's differentiated lighting technology foundation to increase the value we can deliver to customers across a broad set of industries," said Dr. Rich. "The opportunity for lighting innovation to make a positive impact on safety and sustainability is tremendous."

Before Dr. Rich held the position of Chairman and CEO of Berry Global, he was president and CEO at Momentive, a specialty chemical company headquartered in Albany, New York. Prior to that, he held positions with Goodyear Tire & Rubber Company, first as President of the Global Chemicals business and subsequently as President of Goodyear's North American Tire Division. Dr. Rich spent his formative years at General Electric, first as a research scientist at GE Global Research and then in a series of management positions with GE Plastics.

"Mark Adams has made significant contributions to Lumileds during his tenure, leading the transition to an independent company and cultivating a culture of innovation and customer focus," said Rob Seminara, a senior partner at Apollo and chairman of the board of Lumileds.

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Hanergy's products win multiple iF Design Awards

Hanergy Mobile Energy Holding Group, attended Germany's iF Design Award Night held in BMW Welt in Munich recently, with four of its cutting-edge products winning prestigious 2019 iF Design Awards, also known as the "Oscar Awards in designing".

Hanergy's four prize winners include one gold award: Single-Glass Triple-Arch HanTile, and another three Design Awards: Single-Glass Spool HanTile, Fold Backpack for Business Travel, and Solartank Thin-film Solar Power Backpack. HanTile is Hanergy's rooftop solar solution while the solar backpack is Hanergy's creation of integrating solar power generation with backpacks. Xie Tao, CEO of Hanergy's Global Application Product R&D Center received the awards on behalf of Hanergy.

The iF Design Award committee comments the gold-winning triple-arch HanTile as, "This product combines a traditional appearance with the latest energy breakthrough. These tiles represent the world's most advanced thin-film solar energy technology. Any house or building covered in these roof tiles has the chance to be energy-self-sufficient. The tiles have the look of glazed tiles and come in black or dark-green colors. This is the future of solar energy - integrated, efficient, attractive and unobtrusive." EI

ONGC bags Best Innovative Practices Award for Women

ONGC recently won the Best Innovative Practices Award for Women at Workplace at the 2nd Gender Equality Summit organised by Global Compact Network India on the theme "Preparing Women for the Future of Work", at New Delhi.

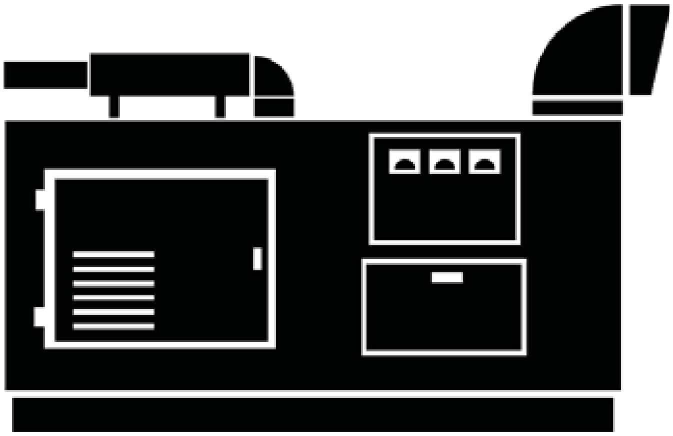
With 34 other organisations vying for the coveted award, both public and private sector, ONGC won the trophy after competing through two stages of evaluation – first, a written submission and second, case-study presentation before an eminent Jury. The evaluation of the case-studies was done on the basis of an evaluation matrix comprising of five parameters viz., 1) Enabling environment, 2) Safety & security, 3) Diversity, 4) Facilities and 5) Capacity development.

The Jury who evaluated the winners for the 'Case Study Competition' were very appreciative of the exemplary work done by ONGC in taking the idea of Gender Equality: Goal No. 5 of UN Sustainable Development Goals (SGDs) to commendable heights. EI

TDK in the world's 100 most innovative companies once again

TDK is once again among the world's 100 most innovative companies of the year in a ranking drawn up by Clarivate Analytics, formerly the intellectual property and science business unit of Thomson Reuters. This is the fifth time that TDK has appeared on the list.

A company's patents are crucial to their ranking. Both the number of patents and the ratio of patent applications to patents issued are assessed. Another factor is global patent protection for the portfolio, especially by Chinese, European, Japanese and US patent offices. The number of times patents are mentioned by other companies and institutions also serves as evidence of the influence of patents. TDK's latest innovations include axial-lead hybrid polymer aluminum electrolytic capacitors. These capacitors have already won the internal President's Award in the category "Technology". EI



Indian DG Market to Reach $1,518.1 mn by 2024

The market growth is expected to be driven by high-volume demand for these gensets in manufacturing, construction, and commercial projects.

According to Prescient & Strategic (P&S) Intelligence Market report, the Indian diesel genset market is projected to reach USD 1,518.1 million by 2024, registering a CAGR of 6.5 per cent during the forecast period.

The market growth is expected to be driven by high-volume demand for these gensets in manufacturing, construction, and commercial projects. Furthermore, growth in the construction industry is likely to translate into increasing demand for gensets to cater the compounded auxiliary and prime power requirements, thereby ascribing the growth of the market in the forthcoming period.

On the basis of power rating, the market is categorized into 5 kVA–75 kVA, 76 kVA–375 kVA, 376 kVA–750 kVA, and above 750 kVA. Among these, 5 kVA–75 kVA category accounted for the largest volume share during the historical period, owing to widespread demand for telecom towers, residential installations, small commercial complexes, hotels, and other low power requirement areas.

Based on end user, the Indian diesel genset market is classified into commercial, industrial, and residential. Of these, commercial category is estimated to account for the largest revenue share of over 60 per cent in the market in 2018. Furthermore, growth in the healthcare, telecommunications, hospitality, and retail industries is expected to boost the demand for these gensets in construction projects in the coming years. As diesel gensets are widely used at construction sites as a prime and backup power source, they are expected to remain in high demand in the near future, especially, those falling under the medium- and high-power categories.

On the basis of state, the Indian diesel genset market is categorised into Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Uttar Pradesh, Madhya Pradesh, Rajasthan, West Bengal, Gujarat, and Rest of India. In 2018, the major demand for these gensets is estimated to be generated from Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Uttar Pradesh, and Gujarat. The high-volume demand for diesel gensets in these states is attributable to the growth in commercial and residential real estate, installation and commissioning of telecom towers, and demand for gensets from commercial offices to serve power requirements.

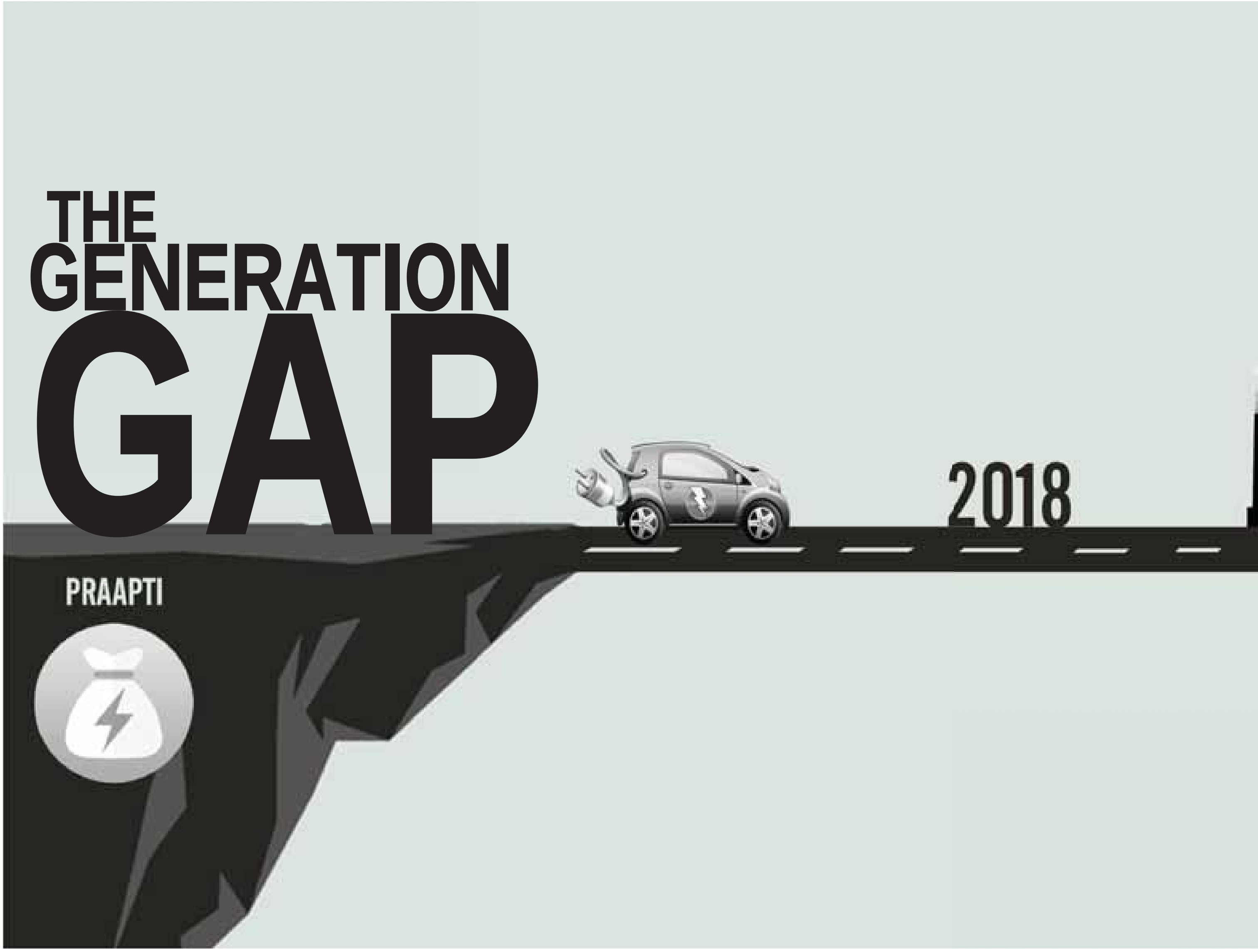
Telecom towers are expected to generate the highest demand for diesel gensets in the market

The demand for diesel gensets by telecom towers is estimated for a volume share of over 51 per cent in the Indian commercial diesel genset industry in 2018. This is attributable to high-volume demand for gensets to serve prime and auxiliary power requirements in telecom towers. Furthermore, the demand is likely to be driven by investments in the telecom sector, and growing installation of telecom towers to cater data and voice coverage requirements in remote locations across the country.

India Diesel Genset Market: Competitive Landscape

Some of the major players operating in the Indian diesel genset market are Kirloskar Oil Engines Limited, Ashok Leyland Limited, Greaves Cotton Limited, VE Commercial Vehicles Limited, Mahindra Powerol, Cummins India, and Caterpillar Inc. EI

THE GENERATION GAP



Is India on track to increasing capacity in the power sector?

– *Subhajit Roy, Group Editor*

Power is one of the most critical factors for the economic growth and welfare of a country. The sector has a pivotal stake in India, which is world's fastest growing economy. The demand for electricity in the country has increased rapidly over the last few years and is expected to only rise further in the years to come, as a result of growing industrialisation and urbanisation. In order to meet the burgeoning demand, massive addition to the installed generating capacity is required, leveraging both conventional and viable non-conventional sources of power generation, said Anil Kadam, Business Development, Solution Architect- Smart Grid/Smart Cities, Schneider Electric India.

The Government of India has identified the power sector as a key area of focus to promote sustained industrial growth with a vision to achieve 175 GW capacity in renewable energy by 2022. That said, the renewable energy sector in

India had a sobering year in 2018 with launch of new projects slowing down a bit. According to a Mercom India Research report, the safeguard duty and issues related to land, transmission and GST took a toll on large-scale installations in 2018.

Demand-Supply Status

Capacity additions in the power sector are dependent on the consumer demand of electricity, the main drivers of electricity consumption are rate of growth of economy i.e. GDP, energy demand has a positive correlation with the GDP. In India, electricity demand is primarily being driven by:

- Rural electrification – expected increase in consumer base by 33 per cent.
- Increased per capita consumption – currently at 1,200 kWh is bound to increase due to lifestyle changes, revival of economic growth etc.
- Make in India program which is expected to drive the manufacturing component of GDP from 16 per cent to 25 per cent which is expected to drive the electricity demand.
- Adaption of e-Mobility – The Electrical Vehicle sales is bound to pick up on the environmental concerns of the conventional vehicles and drive electricity demand.

The extent of increase in electricity demand to the growth in GDP depends on electricity intensity. The measure of the energy required to fuel each unit of GDP decreases over time, due to the improved efficiency of appliances, machinery etc. According to Sanjeev Seth, CEO, India Power Corporation Ltd, "Energy intensity would decline due to improvement in consumption efficiency, government initiatives on T&D loss

An opportunity exists in the renewables, storage solutions and electrical vehicles which needs to be tapped effectively for growth in the next decade, all in all it promises to be an exciting decade.

Sanjeev Seth
CEO, INDIA POWER CORPORATION LTD

reduction and schemes such as Perform, Achieve, Trade (PAT) and Unnati Jyoti by Affordable LEDs for All (UJALA). Electricity demand in the country is expected to grow to 1,627 BUs at a growth rate of 6.3 per cent by 2025."

On the supply side, Seth mentioned, the renewables are expected to dominate the capacity expansion due to the government promotion and thus it would form a large of the supply source wise, the supply would increase from current 350 GW to 586 GW in 2025. However renewable would have effect on grid balancing but with advancement in technology it should be resolved.

"The oversupply position is expected to remain in the near term. supply sources would be selectively dispatched to meet the demand based on several considerations – cost of supply and grid support being the most critical. There is an increased focus on optimising procurement cost by DISCOMs, to minimise the cost of power for consumers," Seth said.

Demand in India which will be around 144 GW in FY19 and with an expected generation of 142 GW (from 350 GW of installed capacity) in same period contributed mostly by thermal power by up to 85 per cent, and renewable energy up to 9 per cent in the mix, informed Sambitosh Mohapatra, Partner (Power) at PwC India. He adds, "Most of the willing households have been electrified under the $ 2.3 billion 'Saubhaya scheme' and with around 21.5 hours of average supply. For 24 hours supply and with no financial constraints, India needs additional supply of around 11 GW." According to the 19th Electric Power Survey, demand is expected to touch 183 GW by 2021-22, 228 GW by 2026-27 and 342 GW by 2036-37.

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Sambitosh Mohapatra
PARTNER (POWER), PWC INDIA

However, despite having an ambitious target, the new capacity addition in the thermal power sector has seen remarkable fall during the past one year. Only 44 per cent of the targeted 4,850 MW capacity addition is achieved during the fiscal year 2018-19. Most importantly, no capacity was added by Centre-owned utilities during the year 2018-19. On top of that, NTPC's 705 MW Badarpur is among the major plants shut down this fiscal.

Though renewable is being considered as the 'sunshine' sector, it is also witnessing a slowdown in terms of capacity growth. Only 6,500 MW of solar capacity has been added in the financial year 2018-19, as against a target of 10,000 MW for the year. Therefore, a massive growth of 25 per cent CAGR during FY17-22 is required to attain the target of having 175 GW of installed renewable power capacity by FY22.

Outstanding payments - A threat for gencos

Delay in payment is posing severe working capital issues at the

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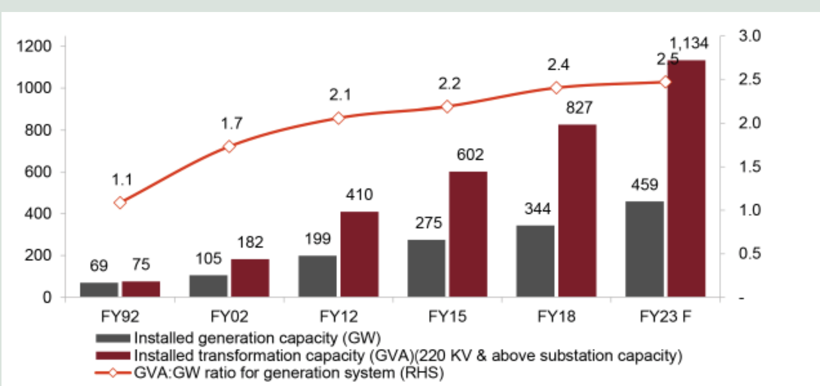

Outlook on transformation capacity by FY23 (Source: CRISIL)

Continued from page 30

private power plants. According to data available on the PRAAPTI portal of the Ministry of Power, 12 power generating companies have about Rs 40,846 crore outstanding from state distribution companies (DISCOMs) as of December 2018 whereas the overdue amount remained Rs 25,665 crore (Table 2). PRAAPTI stands for 'Payment ratification and analysis in power procurement for bringing transparency in involving of generators'.

Uttar Pradesh has the most outstanding dues of Rs 6,497 crore, followed by Maharashtra at Rs 6,179 crore and Tamil Nadu at Rs 4,107 crore. Other states not paying power generating companies on time include Karnataka (Rs 3,799 crore), Telangana (Rs 3,467 crore), Jammu and Kashmir (Rs 3,029 crore), Madhya Pradesh (Rs 1,984 crore), Rajasthan (Rs 1,972 crore) and Punjab (Rs 986 crore). In most of the cases, the payments are due for over 540 days.

Out of the Rs 25,665 crore overdue amount as on December 2018, Adani Group has to receive Rs 5,783.43 crore, GMR to get Rs 1,600.84 crore whereas Sembcorp to receive Rs 1,063.16 crore.

Experts observe that such delay in payments will risk projects being termed non-performing assets (NPAs) under the Reserve Bank of India's (RBI) new classification rules. Thus, uncertainty looms large over the power generating companies.

GenCo	Overdue Amount At End Of Dec 2018 (Rs.Cr)
ADNP [Adani Power]	5,783.43
BEL [Bajaj Energy Limited]	497.70
CLPI [CLP India Private Ltd.]	655.54
DBP [DB Power]	384.31
DHIL [Dhariwal Infrastructure Ltd.]	492.28
DVC [DVC]	1,272.90
GMR [GMR]	1,600.84
ITPCL [IL&FS Tamil Nadu Power Company Ltd]	396.07
JPAS [Jaypee Associates]	221.52
JSPL [Jindal Steel and Power Ltd]	597.02
LPGCL [Lalitpur Power Generation Company Limited]	1,883.57
NEEPCO [NEEPCO]	288.45
NHPC [National Hydroelectric Power Corporation]	1,387.53
NTPC [NTPC]	8,152.10
SEMB [Sembcorp]	1,063.16
SJVNL [SJVNL]	123.93
TPC [Tata Power]	879.92
TOTAL	**25,665**

Table 2: Genco-wise overdue payment break-up (Source: PRAAPTI)

Steps to be taken

According to Sambitosh Mohapatra of PwC India, with improving lifestyle of households, focus on promoting manufacturing industries, creation of new cities and targeted economic growth, India well poised to meet this challenge. He suggests the following measures to be taken by the year 2036-37:

- Enhance renewable generation to meet 90 GW of demand.
- Central and state sector PSUs have planned or under-construction capacities of around 40 GW.
- Revival of distressed coal and gas based thermal assets have the potential to add 41 GW and 11 GW respectively.
- Improvement of average plant load factors, which stands at 60.5 per cent for thermal power plants by 10 per cent can meet additional around 20 GW.

At present, 6.7 GW of nuclear capacities are under construction, and 8.4 GW additional capacities have been accorded financial and administrative approvals. India has further tied up with France, Russia and the US for nuclear plants, and a cumulative 29 GW have been accorded in principle approval.

"Energy conservation efficiency measures, adopted in large scale in the country, will also help in smoothening our demand curve up to 30 GW," Mohapatra adds.

Business opportunities

Even as India is working towards adding more capacity to meet future demand, a pressing challenge lies

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in addressing the AT&C losses and poor power quality which continues to be an impediment in the smooth functioning of the power transmission and distribution. Schneider Electric, the diversified energy management and automation major, believes, leveraging digital advancements in the power segment is an ideal way to control the prevailing issues to a large extent. Schneider Electric's EcoStruxure architecture is an open and interoperable system architecture for building, grid, industry, and data center customers. "Our gamut of connected products and solutions within the EcoStruxure Grid and Power architecture, strengthens power management capabilities and improves operational efficiency and reliability with state-of-the-art Power Monitoring and Control Software," said Anil Kadam.

Sanjeev Seth of India Power Corporation believes that the coming decade would be a VUCA (volatility, uncertainty, complexity, and ambiguity) decade – there will be challenges which need to be overcome by tactical decisions on a day-to-day basis therefore there would need to be short-term goals along with vision statements.

He said, "There may be a need to change the short-term goals based on the disruptions being caused by disruptive innovations to capture markets. Power would be no different, with renewable being the major contribution of disruption especially due to the grid balancing challenges and storage solutions innovations in progress."

Many of the storage solutions

In order to meet the burgeoning demand, massive addition to the installed generating capacity is required, leveraging both conventional and viable non-conventional sources of power generation.

Anil Kadam,
BD, SOLUTION ARCHITECT-SMART GRID/SMART CITIES, SCHNEIDER ELECTRIC INDIA

may become economically viable if environmental effects are considered therefore the effect of such solutions on the general business needs to be foreseen to overcome such challenges.

Moreover, the separation of carriage and content, smart metering penetration would result in grid to consumer automation wherein consumer will adjust his demand based on the rates, time availability etc. Growth of electrical vehicles would also add to the dynamics of the business and need to be resolved effectively.

Thus, in Seth's opinion, an opportunity exists in the renewables, storage solutions and electrical vehicles which needs to be tapped effectively for growth in the next decade, all in all it promises to be an exciting decade.

Conclusion

Though power demand is expected to escalate to a CAGR of 6.5-6.8 per cent between 2019 and 2023, the capacity additions to halve over this period on truant PPAs, erratic coal supplies, and rise in renewables. A report by ratings firm CRISIL predicts, thermal power capacity addition to diminish to 35 GW between FY19 and FY23, compared with 88 GW added in the previous five years.

The report adds: "A large number of projects that are at a nascent stage are likely to get postponed until the demand situation improves significantly. Moreover, fresh project announcements are limited as players are opting for the inorganic route for expansion, as a number of assets are available at reasonable valuations."

However, Mohapatra from PwC concludes by saying: "We should be able to meet the energy requirements, based on ability to sustain the additions of renewable to the system from both resource (funding, land, labour) perspective and ability of our grid to absorb the scale of renewables put online. We should also be able to create policies and reform upstream sectors to provide adequate fuel (coal and gas) at the reasonable prices, and wholesale and retail market reforms."

Need to revive stranded Gas-based Power Plant

Gas turbines are found to be more efficient than coal power plants at full load and at minimum complaint load. However, their efficiency range is broader and their minimum power load is higher than those of coal power plants.

Traditional methods of energy production produce greenhouse gases. Global warming and other environmental concerns are important issue when comparing energy sources. Coal-based energy generation 'Traditional' fuel for electricity production accounts for around 40 per cent of electricity production nationwide. Impacts of coal-based power generation, significant water uses to remove impurities, emission of CO2, SO2, NOX, mercury compounds, leaves behind ash requires disposal. Natural gas-based energy generation is newer technology with significant reduction of GHG emissions at the plant level. Natural gas can be transported in pipeline with lower energy requirement than coal.

However, the shortage of domestic natural gas has severely affected gas-based power generation in the country. As of December 2018, the country's most of the gas-based power capacity was operating at a suboptimal plant load factor (PLF) of 22 to 25 per cent. Meanwhile, ready-to-commission gas-based plants totaling 4340 MW are unable to commence operations due to gas shortage. Against a total domestic natural gas requirement of 87 million standard cubic meters per day (mmscmd), an average of only approximately 29 million standard cubic meters per day of gas supplied to power plants in FY 2015-16. In this scenario, the government's Scheme for Utilisation of stranded gas-based capacity, launched in March' 2015 for a period of two years gave a shot in the arm to power plants. While the scheme has not been extended for further years, the government is reportedly working towards a more sustainable long-term solution to revive gas-based power plants.

Gas-based power generation in the country received an impetus following the discovery of natural gas on the western coast by Oil and Natural Gas Corporation of

Image Courtesy: www.torrentpower.com

India Limited in the 1970s and the subsequent commissioning of GAIL India's Hazira-Vijaypur-Jagdishpur gas pipeline in 1987. In the following years, a large number of gas-based thermal power plants were set up along the pipeline, particularly in the northern and westerns parts of the country.

Basic Operations

Gas turbines basically provide a means of transferring energy from a pressurised fluid to mechanical energy in the form of a rotating shaft. The gas turbine compresses ambient air in a compressor and then channels the compressed air into a combustion chamber. The movement of the products of combustion through the turbine rotates the turbine shaft. Gas turbines are comprised of a compressor, combustor, and turbine. These components work together to produce power or thrust, depending on the application.

To begin the cycle, the compressor rotates and draws in ambient air. As it is taken in by the compressor, the air is pressurised, in some cases to 40 times atmospheric pressure. The pressurised air then moves into the combustion chamber where a fuel mixture is ignited, heating the pressurised air and causing it to expand into the turbine. As the heated air expands through the turbine it pushes against the turbine blades which then rotate the turbine shaft. The rotational energy is used to spin a generator and create electricity. Because they are attached to the same shaft, the rotation of the turbine also rotates the compressor, keeping the system operating. Of the power generated by the turbine, 55 per cent-65 per cent is used to drive the compressor and the remainder is used to drive a generator. This ratio of total turbine power to the power that was used to operate the compressor is called the back-work ratio.

While gas turbine power plants be operated with an open or closed cycle, open cycle plants are more common. The working fluid in an open cycle plant is atmospheric air, constantly drawn in to the compressor where it is typically compressed up to 18 times atmospheric pressure and then sent to a combustor. In the combustor, natural gas is burned to heat the air and expand it before it reaches the turbine. The exhaust further expands in the turbine, to approximately atmospheric pressure, and moves the turbine blades to create work. The exhaust is then released to the environment.

In a closed cycle, the working fluid is cycled through the compressor and then heated by an external source before it enters the turbine. Instead of being released to the atmosphere, the exhaust is sent through a heat exchanger that extracts heat from the exhaust before it is returned to the compressor. In both cycles, the turbine shaft is connected to a generator that converts the rotational power into electrical power.

Decline Gas Supply

With the discovery of natural gas in Reliance Industries Limited's, Krishna Godavari in 2002 and the subsequent commissioning of the East West pipeline, a greater volume of gas was brought into the system in early 2009. With projections of a further increase in gas production, a significant addition of gas-based capacity was planned by the developers. However, contrary to projections, gas production declined considerably due to sand and water ingress, thereby, affecting gas supply to the power sector. Meanwhile, in March 2012, the Central Electricity Authority issued an advisory to developers, asking them to not plan gas-based power plants till 2015-16 on account of the decline in natural gas production. Gas supply to power plants increased from about 38 mmscmd in 2007-08 to about 59 mmscmd in 2010-11. However, it declined gradually thereafter, to reach about 28 mmscmd in 2015-16. As a result, the gas deficit in the power sector increased significantly.

Lower Plant Load Factor

The Plant Load Factor (PLF) of gas-based power plants has also declined significantly over the years. It dropped from 66.9 per cent in 2010-11 to 22.5 percent in 2016-17. Of the gas-based capacity of 23,075 MW monitored by the CEA as of FY 2015-16, about 20210 MW is connected with major gas pipelines / the gas grid while the rest is connected with isolated gas fields. Of the capacity connected with the gas grid, almost 40 per cent is based on gas supplied under the administrated pricing mechanism, 34 per cent is based on gas from the KG-D6 block, while the remaining capacity of 5271 MW has been commissioned without any gas allocation. During 2015-16, the gas grid-connected capacity achieved an average PLF of 19.55 per cent after receiving 18.75 mmscmd of gas. Meanwhile, the capacity connected with isolated gas fields received 9.51 mmscmd of gas and achieved an average PLF of 50.57 percent. The average PLF of the entire gas-based capacity stood at 23 percent in 2015-16. Year-wise PLF trend of gas-based power capacity is as follows:

Financial Year	Plant Load Factor
FY 2007-08	55.18 %
FY 2008-09	55.44
FY 2009-10	66.97 %
FY 2010-11	66.94 %
FY 2011-12	62.06 %
FY 2012-13	37.25 %
FY 2013-14	24.28 %
FY 2014-15	20.93 %
FY 2015-16	23.40 %
FY 2016-17	22.50 %

Initiatives for Utilisation of Stranded Capacity

Taking note of the languishing gas-based power plants, the government launched the Scheme for Utilisation of Stranded Gas-based Generation Capacity in FY2015-16. Under the scheme, imported regasified liquefied natural gas (R-LNG) was supplied at a reduced price to stranded and partially stranded gas-based power plants, selected through a reverse bidding process. In the auction, the plants that sought the lowest per unit subsidy support for the sale of power to discom were selected, thereby, placing a premium on efficiency. The support from the Power System Development Fund (PSDF) was fixed at Rs 35 billion for FY 2015-16 and Rs 40 billion for FY 2016-17.

The scheme also provided for a waiver on taxes and levies on the R-LNG being imported for power plants in order to reduce the price of gas. Under the scheme, the procedure for availing of the customs duty waiver on imported LNG for power plants was streamlined. Also, exemptions were provided on value added tax, central sales tax, octroi and entry tax on R-LNG. In addition, the scheme had a provision for the waiver of service tax on the regasification and transportation of the e-bid R-LNG. Further, the pipeline tariff charges were reduced by 50 per cent and the marketing margin by 75 per cent on e-bid R-LNG. Meanwhile, power developers were asked to forgo the return on equity, and transmission charges and losses were exempted for stranded gas-based power projects. So far, four rounds of LNG auctions have been held wherein gas-based units of NTPC, Gujarat State Electricity Supply Company, CLP India, Torrent Power, and GMR Energy etc have benefited.

Efficiency of Gas Turbine

The simple cycle gas power plants in use currently are about 35 per cent efficient for two main reasons. First, the compressor uses a lot of energy to compress the air to the required pressure to run the air through the turbine. Because up to 2/3 of the turbine output is used to drive the compressor, only 1/3 of the rotational energy remains for conversion into electrical energy. Second, after the combustion gases pass through and exit the turbine they are still extremely hot (around 900–1200°F), so a significant amount of thermal energy is lost through the stack. In a simple cycle, this energy is wasted when the exhaust is released directly into the atmosphere. However, the energy can be recovered by using the exhaust to preheat the compressed air going into the combustor (which would reduce the fuel requirements), or by heating the air in the building or steam using a heat recovery steam generator. More than fifty per cent of the energy converted is used by the compressor. Only around 35 per cent of the energy input is available for electric power generation in the generator. The rest of the energy is lost as heat of the exhaust gases to the atmosphere. The power production of a gas turbine is greatly affected by weather conditions. Generally, the colder the inlet temperatures, the more power can be produced. It is for this reason that many gas turbine manufacturers install air cooling systems before the compressor. Hot weather, which prevents the coolers from lowering the air temperature sufficiently for the given application reduces the power output of the gas turbine. Because cold air is denser than hot air, the colder the air, the higher the mass flow rate of air is through the turbine, producing more power. When the weather is warmer, less steam is produced by a plant that is using its exhaust heat to produce steam to drive a steam turbine. At first glance, it might seem that less steam is produced because of the lower exhaust temperatures, but it is actually because there is less hot exhaust gas flowing out the exhaust because the warmer inlet temperatures of the gases have lower density.

After the air is compressed it travels into the combustion chamber; keeping the air as warm as possible reduces the energy needed for the combustion process. Preheating the air can be achieved without additional energy input by passing it through a heat exchanger, called a regenerator. A regenerator enables the considerable amounts of heat still contained in the exhaust exiting the gas turbine to be transferred from the exhaust

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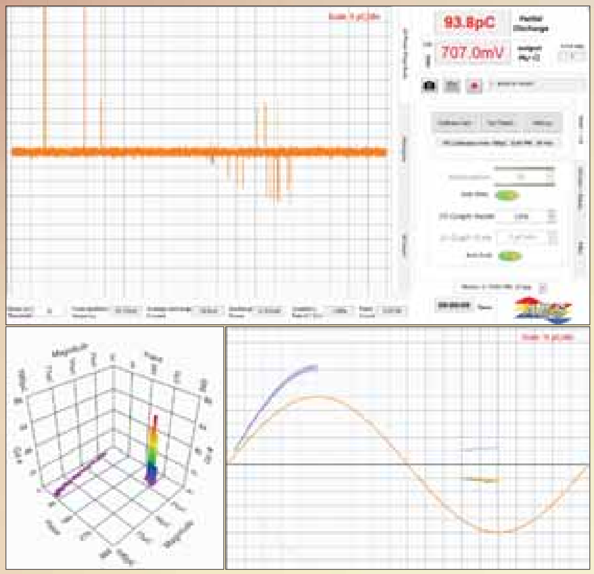
Partial Discharge Measurement System



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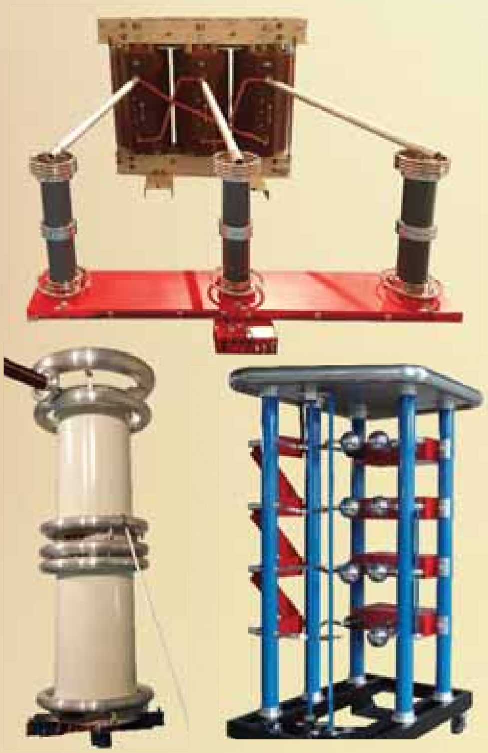

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Continued from page 38

to the air that is about to enter the combustor. This process increases the efficiency of the combustor, which then produces hotter exiting air that in turn generates more power from the gas turbine.

Advantages

Gas turbines have in the recent times become one of the most efficient and reliable energy conversion devices. Used in Combined Cycle Power plants they give the highest efficiency for converting fossil energy to electric power. Used in simple cycle mode they have the shortest gestation time. There are several advantages to using a gas power plant to generate electrical power as compared to other systems. Gas turbine power plants can be started up and run at full capacity in only 10 to 20 minutes, making them well suited as backup plants for utility companies that require additional electricity immediately. Because they are smaller than coal or nuclear plants, gas power plants can be built faster and at a lower cost. Gas turbine systems also require much less water than steam power plants, and they are easily converted into combined cycle power plants, which are much more efficient.

Natural gas has a high energy density (for a fossil fuel) and flexible applications, which make it a popular fuel. People advocating for natural gas often point to it as the cleanest burning fossil fuels. Natural gas power plants are cheap and quick to build. They also have very high thermodynamic efficiencies compared to other power plants. Burning of natural gas produces fewer pollutants like NOx, SOx and particulate matter than coal and oil.

Disadvantages

Gas turbine power plants have disadvantages as well. The power needed to drive the compressor reduces the net outputs, consuming more fuel to do the same amount of work. The operating temperature in gas turbines is higher than in other power plant systems and can shorten the lifespan of some of the system components. Furthermore, because the thermal energy is wasted when the exhaust is released, the efficiency levels of gas turbine plants are lower than those of other types of power plants. Natural gas plants have significantly higher emissions than a nuclear power plant.

Despite the improved air quality, natural gas plants significantly contribute to climate change, and that contribution is growing natural gas power plants produce considerable carbon dioxide, although less than coal plants do. On the other hand, the process of getting natural gas from where it's mined to the power plants leads to considerable release of methane (natural gas that leaks into the atmosphere). As long as natural gas plants are used to produce electricity their emissions will continue to warm the planet in dangerous ways. Even as a cleaner fossil fuel, natural gas is still made up of hydrocarbons and burning it releases CO_2 and other pollutants (NOx being a problem specifically). Natural gas use is often an improvement over coal, however, its combustion still contributes to air pollution and climate change.

Way Forward

As per the National Electricity Plan released by CEA in December' 2016, except the ready for commissioning / under construction gas based power plants totaling 4340 MW, no other plants are expected to be commissioned during the 13th Plan period FY 2017 to FY 2022, owing to the shortage of gas.

Given the benefits of gas-based power plants in efficiently balancing the grid and reducing emissions, the government needs to make strong efforts to revive domestic gas production and/or look at importing natural gas. Lack of concern initiatives in this regard may result in existing and under-construction gas based plants turning into non-performing assets. Thus, there is a need to incentivize exploration and production of domestic hydrocarbon resources. At present, the natural gas prices in the country are inadequate to cover the cost of production. Beside, given the natural gas glut in the international market and the decline in prices, long-term gas import contracts can be looked at as a viable option.

Conclusions

Gas turbines are found to be more efficient than coal power plants at full load and at minimum complaint load. However, their efficiency range is broader and their minimum power load is higher than those of coal power plants. Gas turbines are not only more efficient, but also faster than coal power plants. Start-up times in gas turbines range between 4–45 min in hot starts and 4–250 min in cold starts, which is quite lower than coal power plants. Similarly, full cycle times for gas turbines range between 45 and 280 min, while for coal power plants range between 350 and 800 min. Ramping rates are also generally higher in gas turbines than in coal power plants.

Ashok Upadhyay

Dy. Director (Generation)
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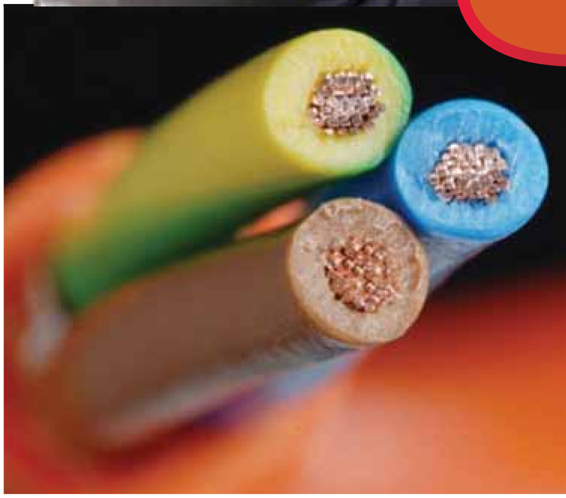
Regulatory Commission
Bhopal (M.P.)

Step Industries plans to triple turnover by 2020

Step is a cable and wire manufacturing company with specialisation in residential and commercial cables and EPC projects. The company's Co-Founder, Ankit Tayal is committed to redefine the Indian cable and wire industry. Talking about Step's immediate plans, he informs that the company plans to expand its manufacturing capacity by opening a new unit. Edited excerpts from his interview with Subhajit Roy:

Established in the year 2011 with only one full time employee, Step Industries has now achieved a turnover of Rs 300 crore and 1,000-plus workforce. Walk us through what has led to such achievement.

The entrepreneurial journey of our company started in the year 2011, when I in partnership with my uncle Sunil Tayal, co-founded Step Industries Pvt. Ltd. with a vision to become the best cable and wire manufacturing company in India.



As far as our immediate plans are concerned, we aim to expand further in next couple of years and triple our turnover to more than Rs 1,000 crore by 2020.

Ankit Tayal,
Co-Founder, Step Industries Pvt. Ltd.

Thanks to the guidance and vast experience of Sunil Tayal in the cable and wire industry, in a short span of 8 years, 'Step' has witnessed immense growth and has become one the leading cable and wire manufacturing company in India with a strong presence in over 150 cities of the northern and southern states of the country. The company has acquired the reputation of being one of the fastest growing company in the cable and wire manufacturing industry through constant innovation and upholding high standards of quality and services.

Apart from being cable and wire manufacturing company, we are also a leader in EPC (Engineering, Procurement, Construction) projects which has taken our growth journey to new heights in such a short period of time. We are currently playing an important role in fulfilling government's dream of providing electricity to every household, by being a major contributor in many central and state electrification schemes like 'Saubhagya Yojna', IPDS (Integrated Power Development Scheme), R-APDRP etc.

The use of new-age technology in manufacturing, and our focus on continual improvement in customer centricity by providing the best-rated products and services that surpass the expectations of our customers in terms of value, quality, promptness and reliability also gives Step Industries an edge over other available brands in the market.

Where do you see yourself in five years' time?

We have a vision to make 'Step' the best cables and wires manufacturing brand in India and also establish a strong global presence. We also aim to become a leading EPC contracts by further increasing our reach by grabbing more government-run electrification projects.

As far as our immediate plans are concerned, we aim to expand further in next couple of years and triple our turnover to more than Rs 1,000 crore by 2020. Also, soon we will be expanding its manufacturing capacity by opening a new unit to meet the rapidly growing demand.

What's your comment on the competition in the entire electrical cable and wire industry? Do you think competition will only intensify in this market?

With the advent of many global brands and slow but steady growth of the SME sector the competition in the cable and wire industry has definitely increased over past few years. Fortunately, thanks to the Government's focus and constant efforts towards the growth of infrastructure in the country, fast track implementation of many rural and urban electrification schemes, and development of smart cities, I also see a lot of growth opportunity for the sector in near future.

What are the USPs of your electrical cables and wires?

Step cables meet the requisite quality certifications together with adherence to the standard management system further strengthening the consumers trust and benchmarking the company as a reputed wire and cable manufacturer in India.

Step cables specialize in manufacturing wire and cable. It is renowned for its unique product range across India and overseas which includes electrical building wiring (house wiring), single-core or multi-core industrial cables, 3-core PVC insulated flat cable, 3-core XLPE insulated flat cable, elevator and escalator cables, PVC insulated power and control cables, XLPE insulated power and control cable.

What's your assessment on the potential of the B2B market?

With the growth of infrastructure and urbanisation the demand has increased exponentially over the last few years. Similarly, the B2B market of our industry has also witnessed growth and we see a great potential of growth in this direction in the coming time.

How would you like to enhance your market presence?

As of now our main focus is towards grabbing more EPC contracts and get involved with more government-run electrification projects. We are already working on a lot of government-run electrification schemes and hopefully will get more in the near future.

Are you in the export too?

Not as of now, however, establishing 'Step' as leading global brand has always been our vision. So, entering the global market is definitely on the cards, sooner or later. EI

Distribution System Reconfiguration for Reducing Losses

With the competitive electricity markets operation in electricity sector world-wide and renewable sources integration in distribution systems, there is a need to study the distribution system with reconfiguration for better placement of these sources.

Loss reduction in the distribution network is the most important priorities in the design and operation of electric power network. Significant percentage of the generated energy is wasted in the production to consumption. The losses in the distribution system are about 5-13 per cent of total power generated. There are many ways to reduce the losses as like capacitor placement, distributed generation placement, load management, network reconfiguration and so on. The combination of Distribution system Reconfiguration and optimal placement of DG units is the effective way to reduce the losses in distribution network. The network reconfiguration problem in a distribution system is to find a best configuration of radial network that gives minimum power loss while the imposed operating constraints are satisfied, which are voltage profile of the system, current capacity of the feeder, and radial structure of the distribution system. Network reconfiguration allows the system to serve the same load to users with less power losses. Network reconfiguration is an effective way to improve the power quality in the system and enhance the reliability of power and voltage on the user side.

A branch exchange-type heuristic algorithm has been suggested by S Civanlar, where a simple formula has been derived to determine how a branch exchange affects the losses. In D Shirmohammadi, the solution method starts with a meshed distribution system obtained by considering all switches closed and then opened one after another by determining the optimum flow pattern in the network. T E McDermott, proposed a Heuristic nonlinear constructive method. This method is fast but may trap into local minima and do not guarantee to find the optimum solution in finite running time. M E H Golshan, proposed a method based on Tabu search to solve more comprehensive distributed generation planning problem including simultaneous distributed generation sources and network configuration planning. M. Arun, proposed a new reconfiguration algorithm based on simple voltage stability index. The reconfiguration has been done by searching for an available better switching combination that further improves the voltage stability by considering a tie switch and its neighbouring sectionalised switches. An efficient heuristic algorithm for optimal reconfiguration of distribution systems was presented based on branch power flows direction. Ji-Yuan Fan, proposed single loop optimisation technique. The reconfiguration approach starts by determining the switch exchanges within the loop for minimum line losses and utilising the heuristic scheme to develop the optimal switch plan with minimum switch operations to achieve transition from the initial configuration to optimal configuration. S K Goswami reported a heuristic algorithm for reconfiguration of radial distribution system and the optimum configuration is achieved by closing a tie line and opening a branch through which the optimal flow is minimum in order to get the minimum power losses. A simple and efficient two-stage reconfiguration algorithm for minimisation of active power losses in both balanced and unbalanced distribution systems is proposed by G K Viswanadha Raju.

Wu YK proposed a reconfiguration methodology based on an Ant colony algorithm was presented to achieve the minimum power loss and increase the load balance factor of radial distribution networks with distributed generators. Also, the ant colony optimisation was used to solve reconfiguration problems using a multi-objective function with fuzzy variables considering both objectives of load balancing and loss reduction in the feeders. Sathish Kumar presented a method based on bacterial foraging optimization algorithm (BFOA) for distribution network reconfiguration with the objective of loss minimisation. Nelder-Mead algorithm combined with a bacterial foraging algorithm based on a fuzzy multi-objective function used to solve the reconfiguration problem. It deals with radial distribution network reconfiguration for loss and switching mitigation using genetic algorithm with two network encodings, capable of representing only radial connected solutions without demanding a planar topology or any specific genetic operator. An interactive fuzzy satisfying method, based on hybrid modified Shuffled Frog Leaping Algorithm, and Differential evolution algorithms was presented for the determination of the optimal placement and sizing of different kinds of DG units. W C Wu proposed an effective approach based on the particle swarm optimisation with enhanced integer coding to determine the switch operation schemes for feeder reconfiguration. LW de Oliveira proposed an optimal distribution network reconfiguration combined with optimal capacitor allocation to minimisation of energy loss on radial distribution systems. A heuristic harmony search algorithm was used to solve reconfiguration problem in presence of DGs. The genetic algorithm developed using the edge window decoder technique for network representation and building up spanning trees, as well as efficient genetic operators in order to explore the search space for power distribution system reconfiguration with minimal losses. Distribution feeder reconfiguration considering distribution generation based on particle swarm optimisation presented.

The penetration of DG may impact the operation of a distribution network in both beneficial and detrimental ways. Some of the positive impacts of DG are: voltage support, power loss reduction, support of ancillary services and improved reliability. To determine the optimal location of DG in radial distribution system based on bus admittance matrix, generation information and load distribution of the system to minimise the power loss of the system considering total power penetration from DG units presented. However, this method is not suitable for large systems. An analytical method, based on the exact loss formula, is proposed to determine optimal location and size of a DG, this method does not meet robustness requirements A methodology based on GA was presented by R K Singh to accommodate DG in distribution network by maximisation of profit, reduction of losses and improvement in voltage regulation. L.D. Arya described a technique for selection of buses in a sub transmission system for location of distributed generation (DG) and determination of their optimum capacities by minimising transmission losses. The buses have been selected based on incremental voltage (dV/dP) sensitivities. A multi-objective performance index-based determination of size and location of DG in distribution systems with different load models was presented by D Singh and implemented using GA. Based on voltage stability maximisation, Particle Swarm Optimisation (PSO) algorithm is used to find the optimal placement of DG and its size. K Nagaraju presented a novel methodology to find the optimal location and DG size based on real power loss at unity power factor. However, the DG can supply reactive power also. VVSN Mury proposed modified novel method to calculate the optimal location and DG sizes based on both real and reactive power losses at lagging power factor. Hybrid simulated annealing (SA) and mixed integer linear programming (MILP) approach used for static expansion planning of radial distribution networks with distributed generators (DGs). Authors presented the active power-sharing principles of multiple DGs by considering its control modes. The particle swarm optimisation with constriction factor approach is applied to determine the optimum size and location with multiple DGs and also the loading capacity of distribution system is enhanced through DG placement and its techno-economic benefits. An artificial neural network based optimal DG placement and size approach was proposed to minimise total power losses including uncertainties of the load. An analytical method computes the optimal location and size of multiple DGs, considering also different types of DGs. Loss sensitivity factors (LSF) are used to select the candidate locations for the multiple DG placements and Simulated Annealing (SA) is used to estimate the optimal size of DGs at the optimal locations.

This article proposed a method for finding optimal location for placing multiple DGs and their sizes to reduce the losses and to improve the voltage profiles. This paper is the extension of the previous work which was reported for single DG placement, however, the reconfiguration of the distribution system has not been considered. Also, the effect of multiple DGs allocation after reconfiguration of distribution has been studied in this paper. The reconfiguration of distribution system has been implemented based on the methodology. The data of IEEE 33 bus RDS is taken from M E Baran and S Sivanagaraju. The base MVA as100 and base KV as 12.66 are taken for both the systems.

Network Reconfiguration

The reconfiguration of 33 distribution systems have been considered to obtain the DG sizes and their impact on reduction of losses and improving the voltage profile. In the first stage, all candidate switches are closed to form mesh system. After performing power flow, switches are ranked based on increasing current magnitude. The top ranked switch is considered to be opened first by keeping all other switches closed. Power flow is performed with the new feasible configuration and various constraints are checked. The two switches in the neighborhood of the opened switch are stored in a list to use them in second stage. This procedure is repeated till the radial system is obtained. In the second stage, a series of branch exchange operation will be performed by using the neighborhood switch list to obtain the optimal configuration. For 33 bus RDS, the real and reactive power losses are 202.66kW and 135.13kVAr with s33, s34, s35, s36 and s37 switches opened. After obtaining optimal configuration, the real and reactive power losses are 139.55kW and 102.3kVAr with s7, s9, s14, s32 and s37 switches opened. The minimum voltage is increased from 0.9131p.u to 0.9378p.u.

Methodology

Optimal location and sizing of DGs using Modified Novel power loss sensitivity Method

Modified novel power loss sensitivity method was proposed for single DG allocation at unity and lagging power factor. In this paper, the method is extended for multiple DGs allocation and their optimal sizes are determined at unity and lagging power factors.

1) Single DG allocation

Loss reduction by a single DG allocation. Let us consider the following:

TLP = total active power loss

TLQ =total reactive power loss

I_i = branch current

R_i = branch resistance

I_{ai} = active component of branch current

I_{ri} = reactive component of branch current

TLP_a = loss associated with active component of branch current

TLP_r = loss associated with reactive component of branch current

$$TLP = \sum_{i=1}^{br} I_i^2 R_i \quad (1)$$

$$TLP = \sum_{i=1}^{br} I_a^2 R_i + \sum_{i=1}^{br} I_r^2 R_i \quad (2)$$

$$TLP = TLP_a + TLP_r \quad (3)$$

a) *DG at unity power factor placed at bus 'k'*

I_{adgk} = active component of current supplied by DG at node 'k'

The optimal DG current for maximum loss reduction is given by

$$I_{adgk} = -\frac{\sum_{i=1}^{k} I_{ai} R_i}{\sum_{i=1}^{k} R_i} \quad (4)$$

V_{dgk} = voltage magnitude of DG at node 'k'

Optimal size of DG at unity power factor is given as

$$P_{dgk} = I_{adgk} * V_{dgk} \quad (5)$$

b) *DG at lagging power factor placed at bus 'k'*

I_{adgk} = active component of the current to be supplied by DG for maximum loss reduction at bus 'k'

I_{rdgk} = reactive component of the current to be supplied by DG for maximum loss reduction at bus 'k'

$$I_{adgkp} = -\frac{\sum_{i=1}^{k} I_{ai} R_i}{\sum_{i=1}^{k} R_i} \quad (6)$$

$$I_{rdgkp} = -\frac{\sum_{i=1}^{k} I_{ri} R_i}{\sum_{i=1}^{k} R_i} \quad (7)$$

$$I_{adgkq} = -\frac{\sum_{i=1}^{k} I_{ai} X_i}{\sum_{i=1}^{k} X_i} \quad (8)$$

$$I_{rdgkq} = -\frac{\sum_{i=1}^{k} I_{ri} X_i}{\sum_{i=1}^{k} X_i} \quad (9)$$

$$I_{adgk} = \sqrt{I_{adgkp}{}^2 + I_{rdgkp}{}^2} \quad (10)$$

$$I_{rdgk} = \sqrt{I_{adgkq}{}^2 + I_{rdgkq}{}^2} \quad (11)$$

P_{dgk} = optimal real power supplied by DG at power factor cos Ø at bus 'k'

Q_{dgk} = optimal reactive power supplied by DG at power factor cos Ø at bus 'k'

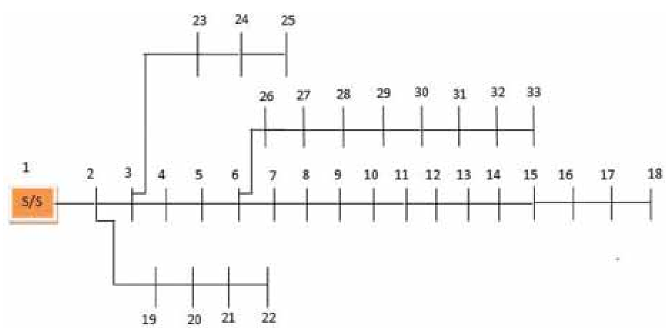


Figure 1: Single line diagram of 33-bus system

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$P_{dgk} = I_{adgk} * V_{dgk} * \cos Ø$ (12)

$Q_{dgk} = I_{rdgk} * V_{dgk} * \sin Ø$ (13)

The optimal size of DG can be calculated as

$$S_{dgk} = \sqrt{P_{dgk}^2 + Q_{dgk}^2} \quad (14)$$

Using eqns. (5), (12) and (13), optimal DG sizes can be obtained for unity and lagging power factor.

2) Multiple DGs allocation

The concept of loss reduction by a single DG allocation can be extended for multiple DGs allocation. Let us consider the following:

kdg = number of buses compensated by DG

Idg = kdg-dimensional vector consisting of DG currents

α_j = Set of branches from the source bus to the $_j{}^{th}$ DG bus (j=1, 2… k)

In Fig.1, if three DGs (k=3) are placed at buses 6, 15 and 30, the branch set

α_1 = [1 2 3 4 5],= [1 2 3 4 5 6 7 8 9 10 11 12 13 14],= [1 2 3 4 5 25 26 27 28 29]

a) DGs at unity power factor

The optimal DG currents for the maximum loss reduction is given by

[G][Iadg] = [B] 15

Where G is a kdg x kdg square matrix and B is a kdg-dimensional vector. The elements of G and B are given by

$$G_{jj} = \sum_{i\in\alpha_j} R_i \quad (16)$$

$$G_{jm} = \sum_{i\in(\alpha_j\cap\alpha_m)} R_i \quad (17)$$

$$B_j = \sum_{i\in\alpha_j} I_{ai} R_i \quad (18)$$

Only the branch resistances and real currents in the original system are required to find the elements of G and B. The DG currents at unity pf for the maximum loss reduction can be obtained from equation. (15)

$[I_{adg}] = [G]^{-1}[B]$ (19)

Once the DG currents are known, the optimal DG sizes can be written as

$[P_{dgk}] = [V_{dg}]\,[I_{adg}]$ (20)

Here V_{dg} is the voltage magnitude vector of DG buses.

b) *DGs at lagging power factor*

The optimal DG currents at lagging power factor for the loss reduction is given by

$[G][I_{pdg}] = [P]$ (21)

$[H][I_{qdg}] = [Q]$ (22)

Where G and H are kdg x kdg square matrix and B, C, D,E,P and Q are kdg-dimensional vector. The elements of G and H are given by

$$H_{jj} = \sum_{i\in\alpha_j} X_i \quad (23)$$

$$H_{jm} = \sum_{i\in(\alpha_j\cap\alpha_m)} X_i \quad (24)$$

$$C_j = \sum_{i\in\alpha_j} I_{ri} R_i \quad (25)$$

$$D_j = \sum_{i\in\alpha_j} I_{ai} X_i \quad (26)$$

$$E_j = \sum_{i\in\alpha_j} I_{ri} X_i \quad (27)$$

$$P = \sqrt{B^2 + C^2} \quad (28)$$

$$Q = \sqrt{D^2 + E^2} \quad (29)$$

$$I_{pdgk} = [G]^{-1}[P] \quad (30)$$

$$I_{qdgk} = [H]^{-1}[Q] \quad (31)$$

By calculating DG currents at lagging pf using equations.(30-31), real and reactive powers supplied by DG can be calculated as:

$P_{dg} = I_{pdg} * V_{dg} * \cos Ø$ (32)

$Q_{dg} = I_{qdg} * V_{dg} * \sin Ø$ (33)

The optimal DG sizes can be written as

$$S_{dg} = \sqrt{P_{dg}^2 + Q_{dg}^2} \quad (34)$$

Algorithm for Optimal DG Placement

The computational steps involved in finding the optimal DG size and location to minimise the loss in distribution system are summarised as:

1. Run the base case load flow and obtain the base case power losses. Find the DG sizes at each node using

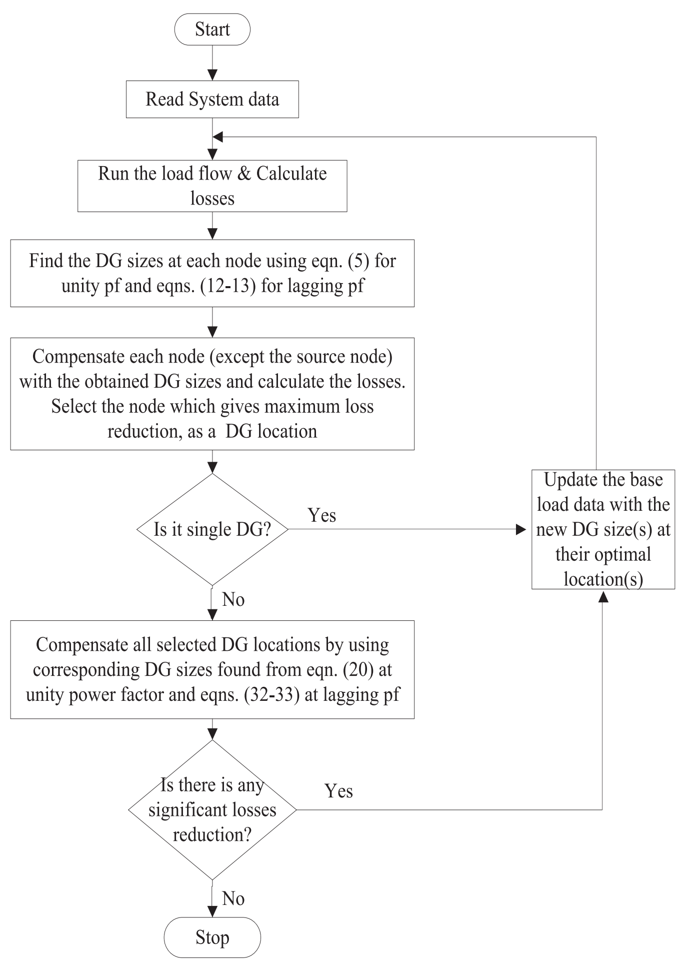

Figure 2: Flow chart of proposed method for multiple DG allocation

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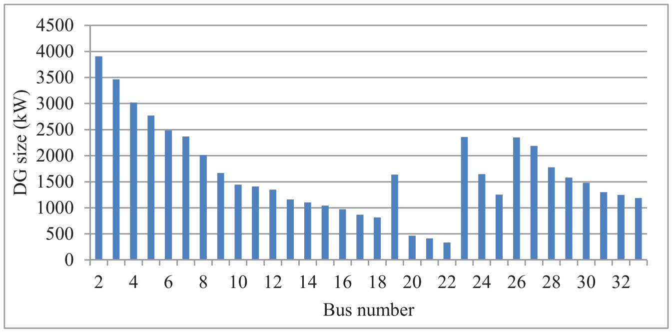

Figure 3: Optimal DG sizes for 33 bus system at UPF – before reconfiguration

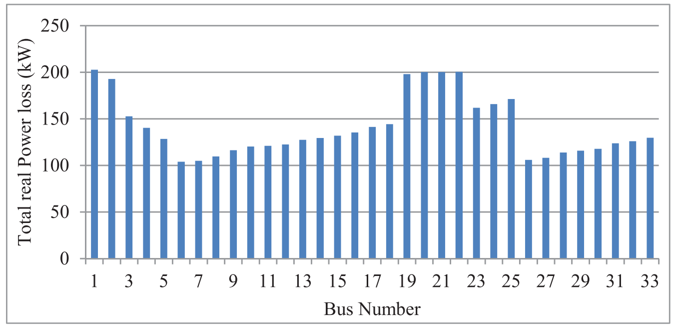

Figure 4: Variation of Total real power loss w.r.t DG size at UPF – before reconfiguration

equation (5) at unity pf and equations (12-13) at lagging pf.

2. Compensate each node (except the source node) with the DG sizes obtained in step 1 then select the node which gives maximum loss reduction, as a first DG location.
3. Update load data after placing the DG. Find the DG sizes at each node then identify the next compensating node at which maximum loss reduction is obtained.
4. Compensate all selected DG locations by using corresponding DG sizes found from equation (20) at unity power factor and equations (32-33) at lagging pf.
5. Repeat step 3-4 to determine next potential location for DG placement until it is found that there is no significant loss reduction that can be achieved by further DG placement.

Flow chart of proposed method for multiple DG allocation is shown in Figure 2.

Results and Discussions

Results for IEEE 33 bus distribution system: At Unity Power Factor

Before reconfiguration of 33 bus distribution system, the base case losses are 202.665kw and 135.133kVAr. Using Novel method, DG with optimal size will be placed at each and every node and then the bus at which total power loss is minimum will be considered as optimal location. It is observed from the figures 3 and 4, the optimal location for placement of single DG is bus 6. After placing the DG of size 2487.44 kW at bus 6, the real and reactive power losses are reduced by 48.649 per cent and 44.684 per cent from its base case respectively. The minimum voltage has been increased from 0.91309p.u to 0.9498p.u. By assuming single DG is connected at bus 6 of base system and then repeat the same procedure for the next optimal DG location and it is found that the bus 15 is next optimal location. Simultaneously placing two DG units at buses 6 and 15 with the sizes of 1902.4556kW and 564.926kW, the real and reactive power losses are reduced by 55.66 per cent and 53.427 per cent from its base case respectively.

The minimum voltage has been increased to 0.95319p.u. Similarly, by assuming two DG units are connected at buses 6 and 15 of base system, the same procedure has been repeated for finding next optimal location for placement of DG and it is found that bus 25 is next optimal location. By placing three DG units at buses 6, 15 and 25 with the sizes of 1696.669kW, 564.9261kW and 772.1976kW respectively, the real and reactive power losses are reduced by 60.95 per cent and 58.86 per cent from its base case respectively. The

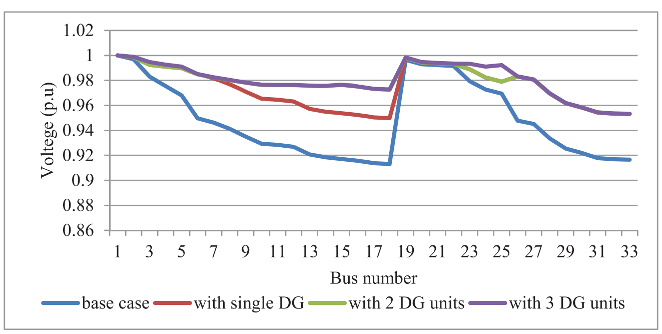

Figure 5: Voltage profile of 33 bus RDS without and with DGs at UPF– before reconfiguration

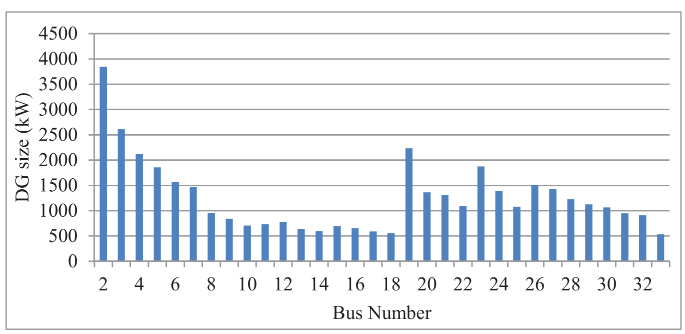

Figure 6: Optimal DG sizes for 33 bus system at UPF – after reconfiguration

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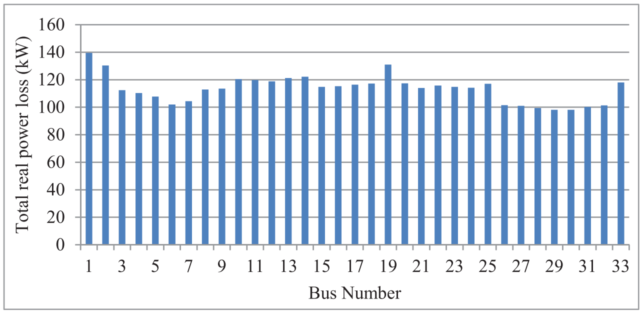

Figure 7: Variation of Total real power loss w.r.t DG size at UPF – after reconfiguration

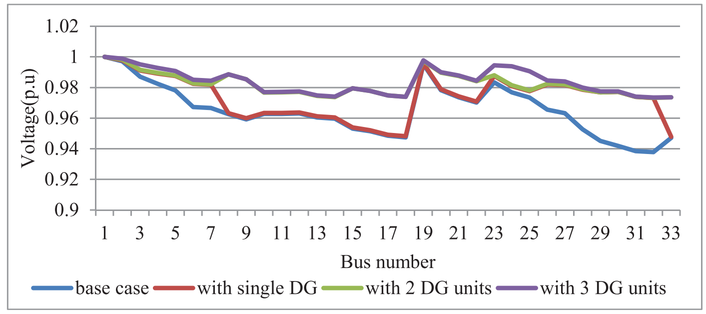

Figure 8: Voltage profile of 33 bus RDS without and with DGs at UPF– after reconfiguration

Table 1. Results for 33 bus system without and with DG units at UPF

	Before Reconfiguration upf							After Reconfiguration upf						
	Without DG	1 DG	2 DG		3 DG			Without DG	1 DG	2 DG		3 DG		
DG loc.	-	6	6	15	6	15	25	-	30	30	8	30	8	24
DG size in kW	-	2487.441	1902.4556	564.92613	1696.669	564.9261	772.1976	-	1065.797	1048.965	934.547	930.7651	914.2856	1052.4587
Tpl (kW)	202.665	104.07	89.856845		79.13762			139.549	98.092	72.72954		58.89953		
Tql (kW)	135.133	74.749	62.93498		55.59139			102.304	76.321	53.09944		44.25469		
Min V (p.u)	0.91309	0.9498	0.953199		0.953315			0.93782	0.9478	0.973237		0.973467		
bus	18	18	33		33			32	33	32		32		

minimum voltage has been increased to 0.95331p.u. The voltage profile obtained with and without DG units has been shown in Figure 5.

However, after reconfiguration the base case losses are 139.549kW and 102.304kVAr. The optimal location of for placement of single DG is bus 30 and its size is 1065.797 kW (figures 6&7). The real and reactive power losses are reduced by 29.707 per cent and 25.39 per cent from its base case. The minimum voltage has been increased from 0.93782p.u to 0.9478p.u. With the placement of two DG units of sizes 1048.965kW and 934.547kW at locations 30 and 8 buses, the real and reactive power losses are reduced by 47.88 per cent and 48.096 per cent from its base case and the minimum voltage is increased to 0.973237p.u. With placement of three DG units of sizes of sizes 930.76kW, 914.3285kW and 1052.458kW at buses 30, 8 and 24 respectively, the losses are reduced by 57.79 per cent and 56.74 per cent from its base case and the minimum voltage has been increased to 0.973467p.u. The voltage profile obtained with and without DG units has been shown in figure 8.

Thus, before reconfiguration by placing three DG units of total size 3033.7927kW, the losses are reduced to 79.1376kW and 55.5914kVAr. However, after reconfiguration by placing three DG units of total size 2897.7094kW, the real and reactive power losses are reduced to 58.899kW and 44. 255kVAr. It is observed that the minimisation of power loss is more with the DG placement after network reconfiguration (Table. 1).

Conclusions

In this article, novel and modified novel power loss sensitivity methods are presented which can be used to determine the optimal sizes and locations of multiple DG units. The results have been taken for two IEEE benchmark systems of 33 bus for both before reconfiguration and after reconfiguration of distribution systems. The result shows that the minimization of power loss is more and the improvement in voltage profile with the multi DG placement with network reconfiguration. Thus, it is essential to study renewable sources integration for better system operation considering the distribution system reconfiguration. EI

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ENERGY EFFICIENCY IN MOTORS AND INDIA'S STATUS

There is an urgent need to understand the challenges faced by the motor manufacturers especially the MSMEs and how they can contribute in adoption of IE3 motors quickly.

Abhishek Dhupar,
Manager–Motor & Motor Driven Systems, ICAI

Globally, 41 countries representing 76 per cent of energy consumed by motor systems have worked to transform their national markets towards high efficiency motors and motor systems through a combination of regulatory measures and supporting policies.

The majority of these countries have already adopted IE2 long back and few have progressed to make IE3 as MEPS. In India, upon IS 12615 mandatory certification, the bar has raised for improving efficiency standard for motors. However, there exist roadblocks too. In an interview with Subhajit Roy, Abhishek Dhupar, Manager–Motor & Motor Driven Systems, ICAI explains where does Indian motors industry stand in the road to energy efficiency. Excerpts:

ICAI is committed to encourage adoption of energy efficient motors. Could you discuss on the ways for improving efficiency standard for motors?

International Association of Copper India (ICAI) as an organisation through various initiatives work for improving energy efficiency in various domains like motors, transformers, wires and cables, air-conditioners. In industrial motors, specifically the LT motors which forms the major chunk in the motor family, it is important to improve its efficiency standard.

The most obvious method is by reducing its losses through upgrading a better and more efficient design. Here comes the improvement on efficiency levels viz. IE1, IE3, IE3 and IE4.

Upgrading the existing Indian standards for motors in line with the global standards and best practices can help in improving energy efficiency. In this regard, ICA is closely working with BIS and IEEMA technical committees.

Also, use of advanced technologies like diecast copper rotors enables achieving higher efficiencies in the same frame size.

In India, IS 12615 was brought under mandatory certification from 1st October 2017. Will standardisation alone help raising the efficiency bar for motors?

You are right when you say that IS 12615 has been made as mandatory MEPS in our country w.e.f. last year. Since then majority of the manufacturers have stopped manufacturing IE1 motors and now the minimum available efficiency class is IE2. But still the switchover has not been completely achieved. For this to happen along with standardisation lot of awareness regarding applicable motor standards and adoption of Higher Efficiency Motors (HEMs) by the end-users has to happen. Also, the support to MSME manufacturing sector needs to be extended in order to gear up for supplying HEMs in market. ICA has been working on capacity building by conducting various kinds of awareness workshops for end users, energy auditors and managers, consultants for adoption of HEMs.

How do you see the demand for IE2 and above motors?

The demand for IE2 and above motors has been increasing rapidly due to continuous various reasons. Firstly, by creating awareness regarding benefits of using HEMs in the industries for energy and cost savings. Secondly, efforts made by authorities responsible for driving standards and policy such as Bureau of Indian Standards (BIS) and Bureau of Energy Efficiency (BEE) for climate change mitigation and energy conservation. BEE's highly successful PAT scheme has pushed many energy intensive sectors to accelerate adoption of energy efficient technologies to reduce their energy consumption and carbon emission. Currently penetration of IE2 and above motors last year has been close to 65 per cent which was only 15 per cent in 2016.

What are the major challenges for adoption of HEMs?

Despite of knowledge of development of HEMs, the industry has been slow in replacing the existing motors with Premium Efficiency IE3 motors due to several barriers. These barriers exist at all stages in system, right from the buyer, consultant, operation and maintenance staff and also at supplier's end. Lot of efforts are required to educate buyer on energy and cost savings, payback period of investment and high reliability, low maintenance offered by IE3 motors. The mindset of user has to change, by spreading awareness on positive aspects of implementation of IE3 motors in existing industry. Biggest challenge is to spread awareness among users. Other barriers existing at different stages are: Higher initial purchase price of IE3 motors; Development of package solution for existing industrial users to facilitate switching over to IE3 motors; Availability of adequate testing facilities to meet testing requirements as per required testing standards; MSME manufacturers still not geared up to produce IE3 motors due to lack of R&D manpower and high investment in design and testing infrastructure; and users opt for multiple rewinding of old inefficient motors rather than replacing with the energy efficient motors.

What will it take to prohibit import of sub-standard motors?

We must complement the efforts of Dept of Industrial Policy & Promotion (DIPP) for issuing a Quality Control Order (QCO) in 2017 for motors to ban import of substandard motors in the country. But then total implementation or compliance of the same is still under question as imports haven't reduced significantly. It is quite possible these motors are being imported under some other codes which can easily bypass the customs duty. Hence, there is also a need to strengthen the compliance part and make the concerned authorities aware about how the traders can misuse the options available for other special motors HSN codes.

Is there any progress towards making of IE3 motors as far as Indian industry is concerned?

Still in India the supply of IE3 motors has not been very smooth not only due to lower demand but also investing in the test facilities and design involves significant investment along with skilled manpower which cannot be afforded by the MSME sector at least. Hence there is an urgent need to understand the challenges faced by the motor manufacturers especially the MSMEs and how they can contribute in adoption of IE3 motors quickly so that IE3 can be likely Minimum Energy Performance Standard (MEPS) in 2-3 years down the line. EI

FLIR T840: High performance thermal camera with viewfinder

The FLIR T840 infrared (IR) camera is designed to help electric utility and other thermography professionals comfortably survey equipment both indoors or outdoors and seek out signs of failure all day long. Thanks to an integrated eyepiece viewfinder and a bright 4-inch colour LCD display, the T840 makes it easy to conduct inspections outside in bright, challenging lighting conditions. The 180-degree rotating lens platform and thoughtful ergonomic design allow the T840 to help users diagnose hard-to-reach components in a variety of environments. With advanced on-camera measurement tools such as 1-touch level/span and laser-assisted autofocus, one can record accurate temperature measurements every time. Avoid costly power outages and plant shutdowns through regular predictive maintenance routines with this flexible and innovative IR camera.

Features

- Safely and comfortably assess equipment and prevent component failure from any vantage point, in any lighting condition.
- Advanced imaging technology and superior sensitivity help you make the right call – fast.
- Get the most out of your work day with rapid reporting features that help you organise findings in the field.
- Scan outdoor equipment from a safe distance using the integrated eyepiece viewfinder.
- Share lenses across your fleet of cameras thanks to AutoCal optics.
- Ensure crisp thermal imagery and spot-on temperature readings every time with laser assisted autofocus.
- Get industry-leading image clarity from FLIR Vision Processing, MSX, UltraMax, and proprietary adaptive filtering.
- IR Resolution 464 x 348 pixels.
- Accuracy (±) 2-degree C or (±) 2 per cent of reading.
- Object temperature range (-) 20-degree C to 120-degree C; 0-degree C to 650-degree C; 300-degree C to 1500-degree C.
- Thermal sensitivity <30 mK.
- 2-10 years warranty. EI

For more details, contact: flirindia@flir.com.hk

FGD Implementation in Thermal Power Plants

Flue Gas Desulphurisation (FGD) has gained pace with MoEFCC notification for compulsory installation of FGD system in the existing and upcoming thermal power plants to curb SOx emissions.

– Supriya A Oundhakar, Associate Editor

India satisfies most of her power requirement through thermal power. Thermal power generation constitutes about 56.5 per cent of the total installed capacity followed by renewable energy which is 21.2 per cent.

Going forward, around 30 GW of coal-based capacity is expected to be added over the next five years largely led by under-construction projects of state and central entities, informs Rahul Prithiani, Director, CRISIL Research.

Indian coal is high in ash, but is low in sulphur. Indian coal contains sulphur in the range of 0.25 per cent to 0.5 per cent. This range of sulphur content coal produces SO2 in the range of 1,500-2,000 microgram per cubic metre of flue gas (mg/Nm3). However, coal is also imported from Indonesia, Australia and South Africa for fuelling thermal power plants. This imported coal is high in sulphur content while being low in ash.

The government has focused on reduction of emissions from coal-based thermal power plants in accordance with the Intended Nationally Determined Contributions (INDCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) that has committed to curb emission intensity of its economy by 30-35 per cent from the 2005 level by 2030. Accordingly, the Ministry of Environment, Forest and Climate Change (MoEFCC), has issued notification no: S.O.3305(E) titled 'Environmental (Protection) Amendment rules, 2015 dated 7.12.2015 with the objective of reducing emissions of suspended particulate matter (SPM), SOx, NOx and mercury at thermal power plants (TPPs).

FGD Technology

Prior to MoEFCC order, there were no norms for emission control of SO2. The expected SO2 emission in the existing units of capacity below 500 MW is in the range of 700 to 800 mg/Nm3 and in the units of capacity above 500 MW 650 to 750 mg/Nm3.

According to the amendment the Thermal Power Plants has to comply the following norms specifically on Sulphur Dioxide (SO2) emission.

- Units with capacity less than 500 MW and installed till 31st December 2016 – 600 mg/Nm3
- Units with capacity equal to 500 MW and above and installed till 31st December 2016 – 200 mg/Nm3
- Units which are being installed after 1st January 2017 – 100 mg/Nm3

As per the implementation plan prepared by Central Electricity Authority (CEA), the existing TPPs are required to comply with the new emission standards by the year 2022, informs Rajkumar Nagarajan, Joint Director, CPRI.

With the MoEFCC order, it has become compulsory to install Flue Gas Desulphurisation (FGD) system in the existing and upcoming thermal power plants to curb SOx emissions. FGD is a system which reduces the SOx in flue gas through chemical treatment and converting the captured SOx into a by-product such as Gypsum or Calcium Sulphate or Sulphuric Acid depending upon the type of mechanism used.

Following are the type of FGD technologies available in the market

- Wet scrubbing
  - Wet lime process
  - Sea water process
  - Liquid ammonia process, and
- Dry scrubbing.

Globally around 80 per cent of the thermal power plants prefer wet scrubbing technology. Nagarajan, Joint Director, CPRI states, in a wet scrubber, a lime or limestone is used as sorbent which is sprayed in a tower where flue gas is passed and scrubbed to form Calcium Sulphite. This Calcium Sulphite is then oxidised to form Calcium Sulphate or Gypsum. This system involves usage large quantities of water. This water usage can be minimised by applying semi-dry scrubbers such as spray dry scrubbers (SDSs).

According to FICCI report, Central Electricity Authority (CEA), along with regional power committees has drafted a plan for the phased implementation of FGD systems at power plants, covering approximately 160 GW of power plant capacity. CEA has earmarked 414 units of aggregate capacity of 161.092 GW for non-compliance of emission norms. Of these, 30 units of about 12 GW capacity will install FGD systems till 2019.

FGD Phasing Plan

Year	Capacity (MW)	No of Units
2018	500	1
2019	11, 950	29
2020	24, 560	47
2021	61, 447.5	165
2022	61, 934.5	172
Total	160, 092	414

Source: CEA)

Status of FGD Implementation in Commissioned Units (MW)

Sector	FGD Planned	Feasibility Study completed	NIT issued	Bids awarded	FGD commissioned
Central	53,350	51,510	43,260	13,540	-
State	51,885	35,980	3,630	-	-
Private	61,737	42,220	19,750	1,820	1,820
Total	166,972	129,71	66,640	15,360	1,820

(Source: CEA)

As of September 2018, FGD systems have been planned for 166,972 MW of capacity. Of these, FGD has been successfully commissioned in power plant units of 1,820 MW. Bids are awarded for capacity of 15,360 MW. Apart from this feasibility studies are completed for 12,971 MW capacity units.

Recently, NTPC has awarded GE Power four orders for supply and installation of wet FGD systems for a combined value of Rs 1783 crore

The four power plant projects are:

- Solapur super thermal power project – 2x660 MW.
- Tanda Stage II super thermal power project – 2x660 MW.
- Feroze Gandhi Unchahar thermal power project – 1x500 MW.
- Meja thermal power project – 2x660 MW by Meja Urja Nigam Private Limited (a JV of NTPC & UPRVUNL).

As per the new reports, these new awards build on GE Power's expertise in Wet FGD systems with the recent completion of facilities and performance guarantee tests for wet FGD at NTPC's Vindhyachal Stage V/Unit 13 – 1 x 500 MW thermal power plant and awarded contract for wet FGD for NTPC's 2x800 MW Telangana thermal power project earlier this year.

Sembcorp Energy has also started bidding for setting up of two FGD units worth Rs 1000 crore in two power plants with a total capacity of 2,640 MW in Andhra Pradesh.

Cost Economics

The capital cost of FGD is additional in a new or existing thermal power plant. As per a recent Centre for Science, Technology and Policy (C-STEP) Report, the total cost of installing pollution control technology in thermal power plants is around Rs. 3.91 – 3.96 lakh crore till 2030. FGD in TPPs entails an approximate expenditure of Rs 50–60 lakh per MW. The C-STEP study has projected that, to meet the additional expenditure to meet the new emissions standards, the electricity tariffs may need to go up by 25-75 paise per kWh. In that direction, the government notified that investments for emission control technologies such as FGD wold be considered for pass through in tariffs.

According to Nagarajan, FGD systems are very reliable and proven commercial technologies are available with a byproduct of saleable gypsum production in many cases. As a commitment to comply with the stringent environmental regulations and emission control, these systems are essential. As a commitment from owner for improved environmental emissions from the plant these investments are inevitable and obviously the same has to be shared by the consumers (users) too.

Challenges in Implementation of FGD Technology

Though the implementation of the new pollution control norms is definitely necessary for reduction of carbon footprint, it has also its own constraints and challenges. Nagarajan sums up the major challenges in implementation of FGD as follows:

- **Time line for implementation**

  All the TPPs have to comply to the new emission norms by the year 2022. So, for retrofit the TPPs has to work on this stringent time line.

"Around 30 GW of coal-based capacity is expected to be added over the next five years largely led by under-construction projects of state and central entities."

Rahul Prithiani
DIRECTOR, CRISIL RESEARCH

> **"FGD is definitely the need of the hour to improve the environmental performance of the thermal power generating stations. This has led to creation of a new market in India for these technologies."**
>
> **Rajkumar Nagarajan**
> **JOINT DIRECTOR, CPRI.**

- **Shut down and related revenue loss**
  An overall project period of 30 to 36 months is required. During retrofit of the FGDs, shutdown of the unit for about 6 months is envisaged. These amounts for a revenue loss burden to the TPPs.
- **Additional auxiliary power**
  An additional auxiliary power of 1.5 to 2.0 per cent is envisaged on account of the additional FGD being installed.
- **Space constraint for installation of FGD as retrofit in the existing old plant.**
  In case of greenfield projects this is not a burden. However, in case of old plants, the layout is already in place and the available space will not be adequate to install the new FGD units. This need to be meticulously planned within the available space to accommodate for multiple units.
- **Increase in generation cost**
  The addition of new FGD will increase the capital cost and recurring O&M cost of the units. Thus, the generation cost will increase marginally. The envisaged capital expenditure on account of FGD will be about Rs 0.4 crore to 0.5 crore/MW.
- **Additional resource requirement**
  Depending upon the type of FGD, there will be an additional resource requirement such as water and limestone.

Further, the mobilisation of limestone for FGD in power plants creates its own environmental footprint, which needs to be studied and compared to the benefits of installation of FGDs.

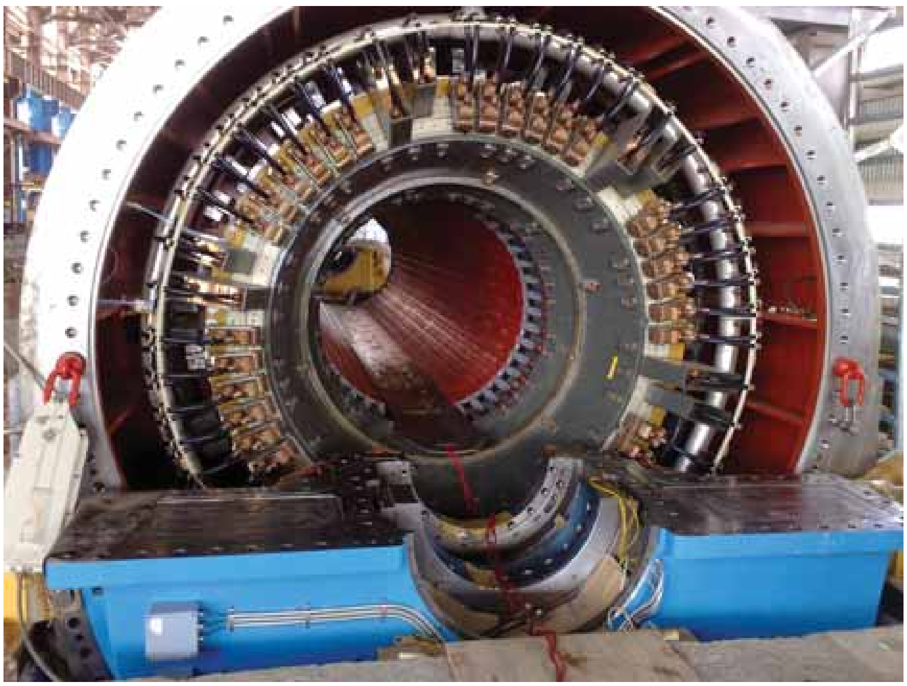
Way Forward

FGD is definitely the need of the hour to improve the environmental performance of the thermal power generating stations. This has led to creation of a new market in India for these technologies, concludes Nagarajan.

Moreover, the timeline committed by the CPCB for implementation of FGD is very challenging, and the government will have to be vigilant to ensure that targets are met by all stakeholders. EI

Stator Earth Fault Protection for Generators

The article reveals that 3rd Harmonic voltage generation is prime criterion to deploy the 100 per cent Stator Earth fault protection.



In today's power plant environment, utilities are much bothered about stator earth fault identification and protection implementation. This article will provide information regarding suitability of deploying stator earth fault protection on 3rd Harmonic voltage principle considering the operation philosophy and generator data of some type of machines supplied in past executed projects. However, the actual measurement during commissioning or post-commissioning has to be reviewed for implementing the said protection for any project.

It is evident that Earth faults in the final 5 per cent of the winding will result in such a low fault current or such a small imbalance in voltage that conventional protection cannot be relied on to detect the fault. In small sized generators (subject to acceptance by manufacturer) this limitation is accepted due to the low probability of a fault occurring in the 5 per cent of the stator winding closest to the star point, where the voltage to earth is lowest. However, for large generators, 100 per cent stator earth fault protection is commonly specified so as to cover the complete winding against any earth fault. Though such faults close to the star point is very rare and may occur due to small mechanical damage such as creepage of the conductors and loosening of bolts.

One proven method is to measure the internally generated third harmonic voltage that appears across the earthing impedance due to the flow of third harmonic currents through the shunt capacitance of the stator windings etc. When a fault occurs in the part of the stator winding nearest the neutral end, the third harmonic voltage drops to near zero, and hence a suitable relay capable of measuring third harmonic voltage with proper filtering technique can be used to detect the condition. Further as the fault location changes and away from the neutral end, the drop in third harmonic voltage from healthy conditions becomes less and it becomes difficult to discriminate between a healthy and a faulty winding. Hence, a conventional earth-fault scheme (known as 95 per cent Stator Earth fault protection) should be used in conjunction with a third harmonic scheme, to provide overlapping

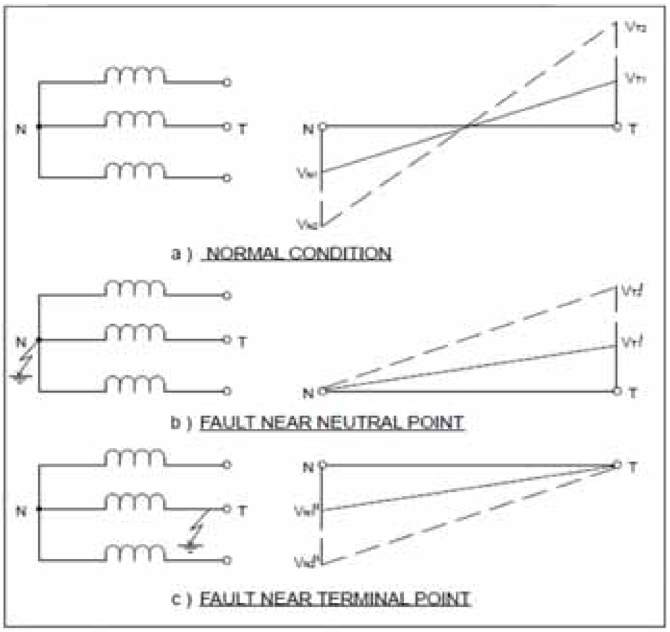


Figure 1

cover of the entire stator winding.

The measurement of third harmonic voltage can be taken either from a star-point VT/NGT or the generator line VT. If the third harmonic voltage is measured at the generator star point i.e secondary of star point PT or NGT, an under-voltage characteristic is used whereas an overvoltage characteristic is used if the measurement is taken from the generator line VT. For effective application of this form of protection, there should be third harmonic voltage of the order of 1 per cent across the generator neutral earthing impedance under all operating conditions.

In case the level of third harmonic voltage generated is low (i.e below the set value available in the relay) when generator output is low, the operation of relay can be inhibited using an overcurrent or power elements (kW, kVAr or kVA) and internal programmable logic.

Most generators will produce third harmonic voltage to some degree (of the order of 1 per cent of rated voltage at no load) due to non-linearities in the magnetic circuit of the generator design. Under normal operating conditions, the distribution of the third harmonic voltage along the stator windings corresponds to Figure 1a. The maxima occur at the star point N and the terminal

4x130.5 MW - Parbati-III HEP

Harmonic	Frequency (Hz)	(RMS) Line Voltage (Volts)	(RMS) Phas Voltage (Volts)	% Line Voltage (amplitude)	% Phase voltage (amplitude)
1	50	108.5	63.2	100	100
2	100	0.00	0.04	0.00	0.06
3	150	0.01	1.03	0.09	1.63
4	200	0.00	0.04	0.00	0.06
5	250	0.02	0.04	0.02	0.06
6	300	0.00	0.04	0.00	0.06
7	350	0.16	0.10	0.15	0.16
8	400	0.00	0.04	0.00	0.06
9	450	0.02	0.10	0.02	0.16
10	500	0.00	0.04	0.00	0.06
11	550	0.12	0.08	0.11	0.13
12	600	0.00	0.04	0.00	0.06
13	650	0.04	0.04	0.04	0.06
14	700	0.00	0.04	0.00	0.06
15	750	0.02	0.04	0.02	0.06
16	800	0.00	0.04	0.00	0.06
17	850	0.02	0.04	0.02	0.06
18	900	0.00	0.04	0.00	0.06
19	950	0.02	0.04	0.02	0.06
20	1000	0.00	0.04	0.00	0.06
21	1050	0.00	0.04	0.00	0.06
22	1100	0.00	0.04	0.00	0.06
23	1150	0.02	0.04	0.02	0.06
24	1200	0.00	0.04	0.00	0.06
25	1250	0.02	0.04	0.00	0.06

3x15 MW - Nimmobazgo HEP

Harmonic	Frequency (Hz)	(RMS) Line Voltage (Volts)	(RMS) Phas Voltage (Volts)	% Line Voltage (amplitude)	% Phase voltage (amplitude)
1	50	105.6	61.5	100	100
2	100	0.00	0.02	0.00	0.03
3	150	0.02	0.85	0.02	1.39
4	200	0.00	0.02	0.00	0.03
5	250	0.10	0.06	0.09	0.10
6	300	0.00	0.02	0.00	0.03
7	350	0.10	0.06	0.09	0.10
8	400	0.00	0.02	0.00	0.03
9	450	0.02	0.06	0.02	0.10
10	500	0.00	0.02	0.00	0.03
11	550	0.08	0.06	0.08	0.10
12	600	0.00	0.02	0.00	0.03
13	650	0.06	0.04	0.06	0.06
14	700	0.00	0.00	0.00	0.00
15	750	0.02	0.02	0.02	0.03
16	800	0.00	0.00	0.00	0.00
17	850	0.02	0.02	0.02	0.03
18	900	0.00	0.00	0.00	0.00
19	950	0.02	0.02	0.02	0.03
20	1000	0.00	0.02	0.00	0.03
21	1050	0.02	0.02	0.02	0.03
22	1100	0.00	0.00	0.00	0.00
23	1150	0.04	0.04	0.04	0.06
24	1200	0.00	0.00	0.00	0.00
25	1250	0.02	0.02	0.02	0.03

T. The value of 3rd Harmonic voltage increases with generator load.

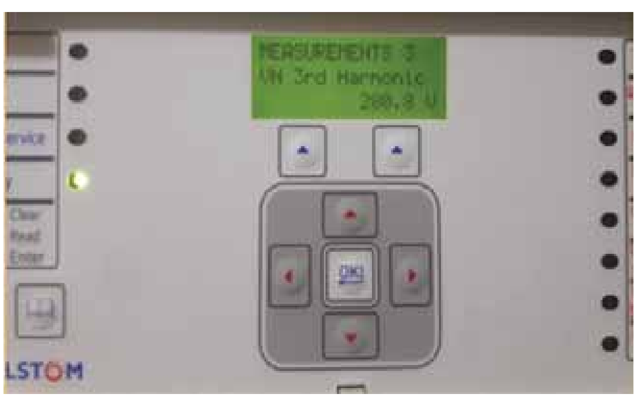
For a stator earth fault at the star point, Figure 1b, the amplitude of the third harmonic in the voltage at the terminals is approximately doubled or more both when the generator is off load prior to the fault (VT1') and when it is fully loaded (VT2'). Also, the third harmonic voltage is reduced to zero when measured at the star point of the generator at NGT secondary.

On the contrary when fault is at Generator terminal (refer Fig 1c) the third harmonic voltage at the terminal is reduced to zero and at neutral it will be measured approximately doubled or more.

To detect faults in the last 5 per cent of the generator winding, we should provide a third harmonic under voltage at neutral or a third harmonic overvoltage at phase side. We preferably opt to measure the reduction in third harmonic voltage at neutral by deploying under-voltage element which is capable of filtering the fundamental component and thus, providing the accurate and desired results.

Data captured during testing of generators of two past executed projects is shown below for ready reference. It is noted from the test results that the 3rd Harmonic voltage generated at no-load (independent Generator alone) is of the order of 1.63 per cent of rated voltage for 130.5MW Generator at Parbati-3 and 1.39 per cent of rated voltage for 15MW Generator at Nimmo Bazgo.

3 x 110 MW Kishanganga HEP



4*40 MW TEESTA HEP

As stated earlier that 3rd Harmonic currents being generated through the shunt capacitance of the winding is primarily responsible for the generated 3rd Harmonic voltages when machine is tested at no load. In practical the machine when placed in the system shall have more influencing parameters like capacitance of the busduct to ground, load at the consumer end, system parameters etc. Hence, in actual after considering all these practical aspects, the measured 3rd harmonic voltage will be more than what we measure during factory testing of generator at no-load.

To have more insight on the actual values of 3rd Harmonic voltage generated, we have obtained measurements from our running machines at 3*110MW Kishanganga HEP and 4*40 MW Teesta HEP and are shown below.

Above study reveals that 3rd Harmonic voltage generation is prime criterion to deploy the 100 per cent Stator Earth fault protection. Due to definite non-linearities in magnetic design of Generators, 3rd harmonic voltage will surely be generated and will increase with the loading of machine. Practically, our various machines at different site are already commissioned with the 100 per cent Stator Earth fault protection on 3rd Harmonic voltage measurement principle. Hence, 3rd Harmonic voltage measurement principle for 100 per cent Stator Earth Fault Protection can be relied upon and safely deployed.

On the other hand, if it is desired to have 100 per cent Stator Earth Fault protection when the machine is standstill, it is user's requirement to go for external injection principle which is having cost implication and supplier can give at extra cost, when asked by user. EI

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Uttam (Bharat) Electricals estimates 35% growth

Alok Agrawal, Director, Uttam (Bharat) Electricals Pvt Ltd gives sneak peek of transformers industry in an interaction with **Electrical India**.

We are focusing on developing aluminium wound transformers up to 10 MVA specially to attract the solar market.

What do you think the power sector, particularly the transformer segment, performed last year?

The electrical equipment industry in general, and distribution transformer segment in particular, performed very well last year in double digits due to huge demand of transformers in view of various schemes of the government like Deendayal Upadhyaya Gram Jyoti Yojana (Scheme of Govt of India for Rural Electrification), Integrated Power Development Scheme (IPDS), Saubhagya etc.

The transformer industry in India has gone through a challenging phase during the past few years. Is there a sign of revival?

The main challenges being faced by the transformer industry are delayed payments, lack of installation and maintenance practices, extended guarantee periods by utilities and use of secondary CRGO material by manufacturers. There are surely signs of revival as the payments are being streamlined by utilities due to Uday Scheme, the mandatory BIS guidelines on transformer and CRGO has helped improve the quality of transformers and curbed the use of defective CRGO. The utilities have agreed to reduce the guarantee periods and are now focusing on better installation and maintenance practices.

Could you give us an overview of Uttam (Bharat) Electricals Pvt Ltd Power & Distribution Transformers' scale of operations, manufacturing units in terms of capacity and the product line?

Uttam had a very humble beginning in 1983 over 35 years ago, and has spread itself to four manufacturing units with an annual capacity of more than 20,000 transformers or 1500 MVA with an annual group turnover of more than Rs 120 crore and a total population of over 2,15,000 transformers.

What were the significant business highlights for the company during the past year?

The company estimates a 30-35 per cent YoY increase in the topline. We constructed a new shed of 15,000 square feet thereby doubling the capacity of wound core transformers.

What are the new and promising technologies in the transformer segment? What are the company's growth plans and key focus areas? What are the key issues and concerns for the company?

We are focusing on developing aluminium wound transformers up to 10 MVA specially to attract the solar market. We also developed our first prototype of 315 KVA 11/0.433 kV EEL-2 transformers in amorphous core construction.

We understand that it is now mandatory for all global CRGO steel suppliers to get BIS certification. What is your overall view on the subject? Do you feel that the willful use of scrap CRGO by Indian companies has reduced?

The use of scrap CRGO is greatly reduced in organised sector due to mandatory CRGO certification and shifting to higher energy efficiency norms by BIS/ BEE. However, usage of the same by small players supplying only to home utilities cannot be ruled out.

These days, there is an effort to produce 'green' transformers using ester oil. Have you taken any steps in this direction?

We have secured an order for supply of 315 KVA transformers with ester oil for installation in city areas. The prototype is under type testing and the supplies will commence soon.

The failure rate of distribution transformer remains a major concern. How to address this issue?

The major area of failure of transformers is in rural areas and is mainly due to bad installation and maintenance, heavy over load, bye passing of protection equipment, theft of oil and live parts, insufficient earthing etc. The issue can only be addressed at the utilities level where they should improve the maintenance procedures and investigate the cause of each failure and take remedial measures instead of just shifting the blame on manufacturers and forcing them to repair the transformer under warranty period.

What do you think will be the key growth drivers for demand in the transformer segment in the coming years?

Due to penetration of electricity network in each village and household, the key growth drivers for demand in the transformer segment in the coming years will be due to increase in consumption of electricity in rural areas, urbanisation, industrialisation, electric vehicle charging stations, generation of solar and wind energy etc. EI

Range of transformers from 5 KVA to 15,000KVA up to 33KV class including –

- Power Transformers (up to 15 MVA)
- Three Phase Distribution Transformers
- Inverter or Converter Duty Step-up transformers having multiple winding for solar or wind and hydro generation application
- Transformers for compact sub stations or packaged sub stations
- Hermetically Sealed type transformers with corrugated radiator panels
- Furnace Duty Transformers up to 24 Pulse (with phase shift)
- Energy Efficient Transformers as per BEE Star Rating / BIS specifications.
- Single Phase Distribution Transformer

EVOLUTION of the SOCKET

The British Standard three-pin socket outlet is widely celebrated as one of the safest and most sophisticated in the world. One individual whose ideas helped to form the design we are familiar with today was Charles Arnold, electrical engineer and co-founder of MK Electric. As the company celebrates turning 100 years old, Emma Segelov, EMEA marketing operations manager for MK Electric by Honeywell, looks back at the socket's humble beginnings.

There is arguably no other breakthrough that has transformed society as much as the discovery of electricity. The ability to harness its power was the catalyst for the Second Industrial Revolution, which saw electricity replace steam as the main power source in industry.

In the 1800s, electricity revolutionised transport and communications and led to inventions such as the lightbulb, telegraph, and electric-powered trams, trains and underground systems, which were much faster than their steam- or horse-driven counterparts.

Today, it is hard to imagine a world without electricity, as we rely on it for nearly everything. Anyone who has ever desperately ransacked the house for candles or sat staring at a blank television screen during a power cut can attest to this.

When electricity was first introduced into domestic settings in the 1880s, it was primarily used for lighting. One common approach for other appliances (such as vacuum cleaners, electric fans, smoothing irons and curling tong heaters) was to connect to light bulb sockets using lampholder plugs. In Britain, there

Continued on page 70

Continued from page 68

were recognisable two pin plugs and wall sockets appearing on the market as early as 1885.

As electricity became a common method of operating labour-saving appliances, it was evident that a safer and better way of connecting to the electric system was required. This thought was shared by two electrical engineers: Charles Leonard Arnold and Charles Reginald Belling, who at the time were in business selling electrical fires under the name Belling & Company.

It was Belling who pointed the way forward, realising that his fires and other electrical equipment appearing on the market in ever-increasing volumes would require high quality and high-rated sockets and switches, and so The Heavy Current Electric Accessories Company was born.

The company was based on the Multy Kontact socket, patented by Charles Arnold. Before the Multy Kontact, most available sockets were split pin-style sockets that were primarily made from thick gauge slotted brass tubes, offering practically no flexibility. Plug pins were split to allow compression, but poorly made small pins would often produce a loose fit and poor contact. Large pins, on the other hand, needed too much force to insert and remove them.

According to the original patent filed in April 1919, the Multy Kontact socket was comprised of “numerous flexible spring tongues which actually grip the pin in much the same manner as the legs of two caterpillars on opposite sides of a flower stem.”

Flowery language aside, the Multy Kontact was safer and easier to use than anything else on the market at that time. As a result, the British Engineering Standards Association (BESA) revised its standards in line with the levels of self-adjustment and contact-making that the Multy Kontact established. Other manufacturers were forced to update their products to meet these new, stricter requirements.

In 1928, further safety advancements were made with the invention of the shuttered socket which concealed the live and neutral contacts when the plug was pulled out of the socket and eliminated the alarming ‘flash’ that invariably accompanied plug withdrawal from old fashioned sockets.

Despite this, shuttered sockets were not required by law until the post-war era, when the British Standard requirements were updated to include the stipulation that “The construction of the socket outlet shall be such that when the plug is withdrawn the current-carrying socket-contacts are automatically screened by shutters not operated solely by the current carrying plug-pins.”

The devastation of the Second World War encouraged progress in many areas of society, including the establishment of universal healthcare and the birth of the NHS. The massive programme of building required after the war also presented the opportunity to improve and standardise wiring and electrical outlets with updates to the British Standards.

The British ring final circuit system and BS 1363: 13 A plugs, socket-outlets, connection units and adaptors plug and socket-outlet system were introduced into the UK in 1947, following many years of debate by ‘The Electrical Installations Committee’ of the IEE, which was formed by the Minister of Works and Planning, Lord Reith.

Over the years there were ongoing efforts to improve electrical safety, catalysed by the introduction of the Plugs and Sockets etc. (Safety) Regulations in 1987. MK Electric evolved its shuttered socket design and developed Logic PlusTM - a range of wiring devices which are widely regarded as most advanced and safest on the market.

In 1947, nobody could have anticipated the impact that the technological revolution could have had on the electrical industry. The proliferation of the internet caused an influx of mobile devices, all with different plugs and charging requirements. This led to the inclusion of USB charging ports into socket outlets to provide a convenient, universal charging solution for all types of devices. USB sockets with Dynamic Device Recognition (DDR) technology are better and safer because DDR ensures that the device recognises the socket as it would its own charger and draws current in the way that best suits its design. This ensures optimal and efficient charging for any device.

The contemporary socket outlet may be worlds away from the original split pin design, but one thing remains true: electrical sockets are an essential part of modern life, enabling us to access the dozens of different electrical devices we use every day. EI

Emma Segelov,

EMEA Marketing Operations Manager, MK Electric by Honeywell

Electrifying Growth: Adoption of EV in Corporate Fleet

> "With a greater focus on R&D, India's transport can become all electric by 2030. There is a need for innovative alternative solutions for EV technology adoption with the application of the IoT to get the maximum out of batteries."
> **Prof. Ashok Jhunjhunwala,**
> IIT Madras

As vehicles get electrified, the conventionally followed fuelling option is to charge the batteries. Vehicle batteries are best slow-charged overnight in six to seven hours. Lower temperature and lower charging rates make the battery last longer. However, if a vehicle is driven in a day longer than the range provided by the battery (say 100 kms), the batteries are fast-charged.

This can be done in 45 minutes to an hour as long as battery is cooled during charging to keep battery temperature as close to 25-degree C, as possible. Waiting for 45 minutes to an hour for charging can be very often problematic. There are batteries which can be fully charged faster than this, but they are expensive. Of course, one can use larger batteries, which would give longer range (say for example, 300 kms), so that vehicle rarely requires more than one charge on a day. This, however, also significantly increases the cost of the batteries and therefore that of the vehicles. Also, higher weight of the battery implies lower energy-efficiency of the vehicles and therefore lower range.

An alternative, not considered in nations where affordability is not a serious issue, is to use smaller battery providing limited range. The vehicle weight is also reduced, enhancing the overall vehicle energy-efficiency. When the battery runs out, one does not go to a charging station; instead, one goes to a Swapping Outlet, which keeps an inventory of charged batteries and swaps the discharged battery with a charged one. This can be done in less than five minutes, time that a petrol/diesel vehicle takes to fill the tank. Further, the batteries may be no longer purchased with the electric vehicle, reducing the capital costs of the vehicle.

Instead, the battery is purchased by an "Energy Operator (EO)," which carries out charging and swapping and leases out the battery to the user. Once a discharged battery is swapped at Swapping Outlet, the discharged battery is taken to a conditioned environment, where the battery is cooled and charged in about two hours, ensuring that the life of the battery is maximised. The battery-lease charges depend upon the energy actually consumed and the battery-leasing rates are based on the depreciation and the interest-cost of the battery plus the charging-cum-swapping costs.

With Battery Swapping emerging as an option, a taxi-fleet may have two options:

EV with RE-battery

This option may be more meaningful for a private vehicle rather than a taxi. The vehicle is sold with a small fixed battery (say with a 100 km range). But the vehicle has a slot for a second battery, called Range-extension battery (RE-battery), which may be added or swapped at a swapping station, as and when needed. The fixed battery is slow-charged overnight and the vehicle can have 100 kms range in a day. Most private vehicles travel less than this range for 90 per cent to 95 per cent of days. On the days the vehicle needs to travel longer distance, it just drives to a Swapping Outlet and gets RE-battery mounted, doubling the range. This is just like getting petrol filled, as it happens only once in 10 to 15 days. If one needs even longer-range, the RE battery is swapped. The RE-battery is returned to any swapping outlet, once used. So, the vehicle does not require any fast charging; slow-charging of fixed battery during night-time is adequate, maximizing the life of the battery.

EV purchased without a battery

In this case, the taxi is purchased without a battery. The capital cost of the vehicle is even lower as compared to the vehicle with RE battery. Battery is just leased in, when required. Only a single battery would normally be used, but a taxi-driver, going on a long-route, where the Swapping Outlet is unlikely to be available, may choose to get both the batteries mounted. Only disadvantage is that a person may have to go to a swapping outlet every day, but for a taxi it may be a better option.

Comparisons between different approaches

Table 1 compares the two approaches discussed here and the conventional approach of charging a vehicle for a taxi. It is assumed that swappable battery has 100 kms range and costs about Rs 250,000 and has a cycle-life of 2,000. The vehicle without battery is assumed to cost about Rs 650,000 and that with RE-battery of 100 km range may cost about Rs 900,000. The conventional EV is assumed to have a large battery with 300 km range.

Table 1: Comparisons between different approaches

	Conventional EV (battery range 300km)	EV without battery	EV with RE-battery (battery range 100 km)
EV costs	Rs 1,400,000	Rs 650,000	Rs 900,000
Fast-charging / swapping time	60 minutes	5 minutes	5 minutes
Charging/ swapping Frequency for taxi	Rarely	2 to 3 times a day	1 or 2 times a day
Charging/ swapping Frequency for PV	Rarely	Every day	Rarely

From the table 1, one may conclude that EV with RE-battery may be the best for personal vehicles, EV without battery may be best for taxi-fleet.

Operation costs

In case of conventional EV, the battery is purchased by customer and the operating costs are electricity costs and overall maintenance of vehicle. When charged at home, the costs will be close to Rs 1.25 per km. This compares well with the operation costs of the petrol vehicle, which is closer to Rs 7 per km. When the EV is charged with a fast charger, the operator of charger will charge a premium over the electricity costs. The costs may be closer to Rs 2.25 per km.

When vehicle is purchased without battery, the leasing costs of battery plus vehicle maintenance may amount to Rs 4 per km. This is still much less than the operational cost for petrol vehicles.

For an EV with RE-battery, the costs per km is different based on whether fixed battery or RE-battery is used. Along with maintenance costs, the operation costs with fixed battery is Rs 1.25 per km, and with RE-battery is Rs 4 per km. Since RE-battery is used only in about once in 10 days, this will be highly acceptable.

Conclusion

Four-wheeler EVs in India need to be different from what is used in other countries, to match the affordability in India. Vehicles with large battery and fast-charging does not make economic sense. An option, as discussed here is to purchase EV without battery and lease battery as required, swapping batteries when needed. This approach implies that the capital costs of the vehicle is similar to that of petrol vehicle and operational costs are much lower than the petrol-vehicles. This is an excellent approach for taxi-fleets. For personal vehicle, one may use EV with RE batteries. Capital costs will be slightly higher as compared to petrol-vehicles as well as EVs without batteries, but the operational costs will be much lower. RE battery swapping ensures no range limitation. This may be ideal for personal vehicles. The capital as well as operation costs for petrol vehicles, EV without batteries and EV with RE-batteries is carried out here.

Comparing Capital and Operational costs in petrol vehicles, EV with only swappable batteries and in EVs with RE-battery

Assumptions for 5-seater, semi luxury vehicles

a) Petrol vehicles: Capital cost = Rs 700,000; Operation cost per km = Rs 7
b) EV with swappable battery: Capital cost = Rs 650,000; Operation cost per km = Rs 4
c) EV with range extension battery (100 km fixed with 100 km swappable): Capital cost = Rs 900,000; Operational cost per km = Rs 1.30 (operation cost per km 90 per cent of time at Rs 1 and 10 per cent time at Rs 4).

Comparing total cost of operation for 10000km, 20000km, 40000km per year

Here a total depreciation and interest cost to be 30 per cent of capital cost is assumed. Though depreciation of petrol vehicle should be higher than that of EV with fixed battery which should still be higher than EV with only swappable battery, however here we assume everything as same.

The total cost of operation for different km usage per year are illustrated in Table 2 and 3.

Table 2: Depreciation, interest and operational costs for different travel distance per year

	Depreciation and Interest costs in Rs	Operation costs (Rs per year)		
Travel distance (km/year)		10,000	20,000	40,000
Petrol	210,000	70,000	140,000	280,000
Swappable	195,000	40,000	80,000	160,000
Range Ext.	270,000	15,250	30,500	61,000

Table 3: Total cost per year for different travel distance

Total cost per year in '000 Rs			
Yearly travel (kms)	10,000	20,000	40,000
Petrol	280	350	490
Swappable	235	275	355
Range Ext.	285.25	300.5	331

Courtesy:
This article is based on a whitepaper titled 'Electrifying Growth - Adoption of Electric Vehicles in Corporate Fleets' that has been co-authored by Move-in-Sync Technology Solutions (MIS) and Prof. Ashok Jhunjhunwala. The paper was unveiled at the MIS hosted tech conclave 'TransporTech 2019.

Green Marine Transportation

Unlike the electric vehicles on road, solar boats derive more than 75% of its energy from sun and only rest is taken from grid.

In India, the idea of using alternative energy sources in transport sector is gaining more and more attention. The government is currently expecting 30 per cent of the electric vehicles on road by 2030 and has made plans and policies to attain this goal. Thrust to support electric vehicles on road is a positive sign, but in reality, the electric vehicles are not reducing pollution the way we think. In the case of electric vehicles pollution is shifted to power plants which is dominated by coal.

If this paradigm shift in plan is to reduce the pollution, the use of renewable energy to run vehicles should be encouraged. Water transportation always has advantages over road transportation as it is the cheapest mode. It can transport in large quantities as there is not much size restriction on water.

Renewable energy sources can be utilised to its maximum only in marine mode of transportation. Unlike the electric vehicles on road, solar boats derive more than 75 per cent of its energy from sun and only rest is taken from grid. This low dependency on grid means more eco-friendly.

A transformation is now happening in Indian maritime industry. In 2017, NavAlt Solar & Electric Boats based in Kerala successfully launched country's first solar ferry that can carry more than 75 passengers comfortably. "Aditya" its name simply denotes "Sun" what else it should be when its powered by sun's harnessed energy through its solar panels. Completing 2 long years of its successful voyage on January 2019, transported more than 600,000 people, saved 38,000 litres of diesel along with preventing 104 tonnes of CO2 emissions.

The operational cost of solar-powered vessels is less than US$ 3 for a day and has proven to be negligible in comparison to those powered by traditional fuel. Based on its success, the Kerala government has ordered three more solar ferries of 75 to 100 passenger capacity and have decided to phase out the old rickety boats over a period of next 5 years. Other States like Goa, Maharashtra, Uttar Pradesh and Telangana have similar plans for solar powered marine transit.

Fishing segment is facing an alarming situation which needs immediate attention. Skyrocketing

Benefits of solar ferry operations

Beneficiaries	Benefits
Passengers	– Enhanced and comfortable cruise (No sound, smell of diesel) – More safety during travel (More stable boats) – Convenient Transportation model – Higher trip frequency – Improved service reliability
Ferry Operators	– Comfortable operation (No sound, smell of diesel) – Better amenities – Remote monitoring facilities to ease the operations
Govt/Tourism Dept	– Improved business opportunity – Very ow operating & maintenance cost – 2nd state in India to introduce ferry (Mileage for Govt) – Overall development of tourism
Neighbourhood	– No pollution (Water, Air, Noise) – Employment Opportunities – Overall development of land

fuel price and CO2 emission points a question about the feasibility of existing fishing boats. About 1.13 tonnes of CO2 are released per tonne of live weight of marine fish netted. Energy conservation is now priority because of the increasing fuel price which is the major input for motorised fishing. Solar propulsion is the most advanced and efficient technology for this application. We are now researching on building new solar fishing boats understanding its significant potential and strategic importance in transforming the Indian fishing industry.

Solar-powered Ro-Ro (Roll on, Roll off) ferries is another interesting project on anvil. This vessel will operate fully on solar power or electricity, providing an emission-free urban transport solution. The electric Ro-Ro ferries will recharge their batteries during the unloading and loading of passengers and vehicles. The vessels will recharge their own batteries using an on-board diesel generator in case of any emergency requirements.

Solar-powered propulsion can be extended to marine transportation segments like harbour tugs pilot boats, coastal barges etc. The possibilities for clean eco-friendly public and personal marine transportation is very vast in country like India. As the industry is now considering going solar, it is now time for the government to take necessary initiatives in the marine industry for a faster adoption of solar propulsion.

Advantages of solar powered boats

Eco friendliness

Harmful emissions of gases like sulphur, carbon monoxide and carbon dioxide can be completely avoided with efficient and eco-friendly boats. Solar-powered boats are transforming the water transportation industry by reducing water pollution due to oil spills.

Cost effectiveness

With negligible operational cost due to absence of fuel, solar ferry break even period is as low as four years. The Total Cost of Ownership (TCO includes the initial cost, energy cost and the maintenance cost) is very low as they have a very low operating cost

Pleasure

All solar powered boats manufactured by NavAlt provide the passengers and crew a degree of pleasure which they expect during every travel. The boats have

The possibilities for clean eco-friendly public and personal marine transportation is very vast in country like India. As the industry is now considering going solar, it is now time for the government to take necessary initiatives in the marine industry for a faster adoption of solar propulsion.

well-designed spacious interiors, ergonomic cushioned seats to reduce tiredness and entertainments like TV, music system etc

Comfort

The passenger and crew have the basic right to expect to travel and work in a comfortable environment. The absence of the conventional IC engines provides the passengers and crew an absolute sound free ride along with the less vibration and no smell of fuel.

Safety standards in NavAlt's solar boats

Safety & stability

NavAlt follows higher standards in safety and stability. The ferries are designed and built as a catamaran for higher margin of stability. They are designed for overcrowding by 100 per cent meeting all stability conditions.

Marine grade Lithium batteries

NavAlt boats are equipped with efficient marine grade lithium-iron-phosphate batteries. Batteries conform to IEC 62133:2012 Standards and IP56 ingress protection. Battery ventilation is designed to ensure life cycle operation with temperature higher than 30 degrees by monitoring charge and air cooling by PLC.

Reliable electric motors

The boats are equipped with a rugged and reliable marine electric propulsion motors.

Redundancy

NavAlt's solar ferries are equipped with two independent motors and battery bank for 100 per cent redundancy. Under normal conditions the motors run at 50 per cent of load. During an emergency the boat can be navigated with only one motor on operation.

Light, efficient hull

The boats are lightweight due to the usage of lighter and stronger materials like GRP and aluminium. Efficient structure design and lightweight characteristics generates lesser drag in turn enable the boats to be completely propelled by solar power.

Dashboard monitoring

Despite the fuel gauge used to measure the fuel status in conventional boats, NavAlt introduced advanced Dashboard Monitoring System on board which provides an instant snapshot of vessel's key performance indicators like battery SoC, battery temperature, battery voltage which helps to monitor and identify the current status of boat for a safe voyage

Warning systems

All NavAlt boats have three levels of warning states displayed for critical components in terms of temperature, state of charge, voltage, current, sensor failure to protect the system. First level is usually information as precursor to second level. The next level forces a slowdown and the third level forces immediate shutdown of necessary equipment to protect it.

Remote monitoring

All the operating parameters of the boats are recorded and send to NavAlt's server from where the technical experts can gather data and monitor the performance of the boat. The latest software updates will be pushed remotely to optimise the performance and rectifies the existing digital flaws if any. Battery have the facilities for individual cell monitoring. EI

Sandith Thandasherry

Founder
NavAlt Solar and Electric Boats


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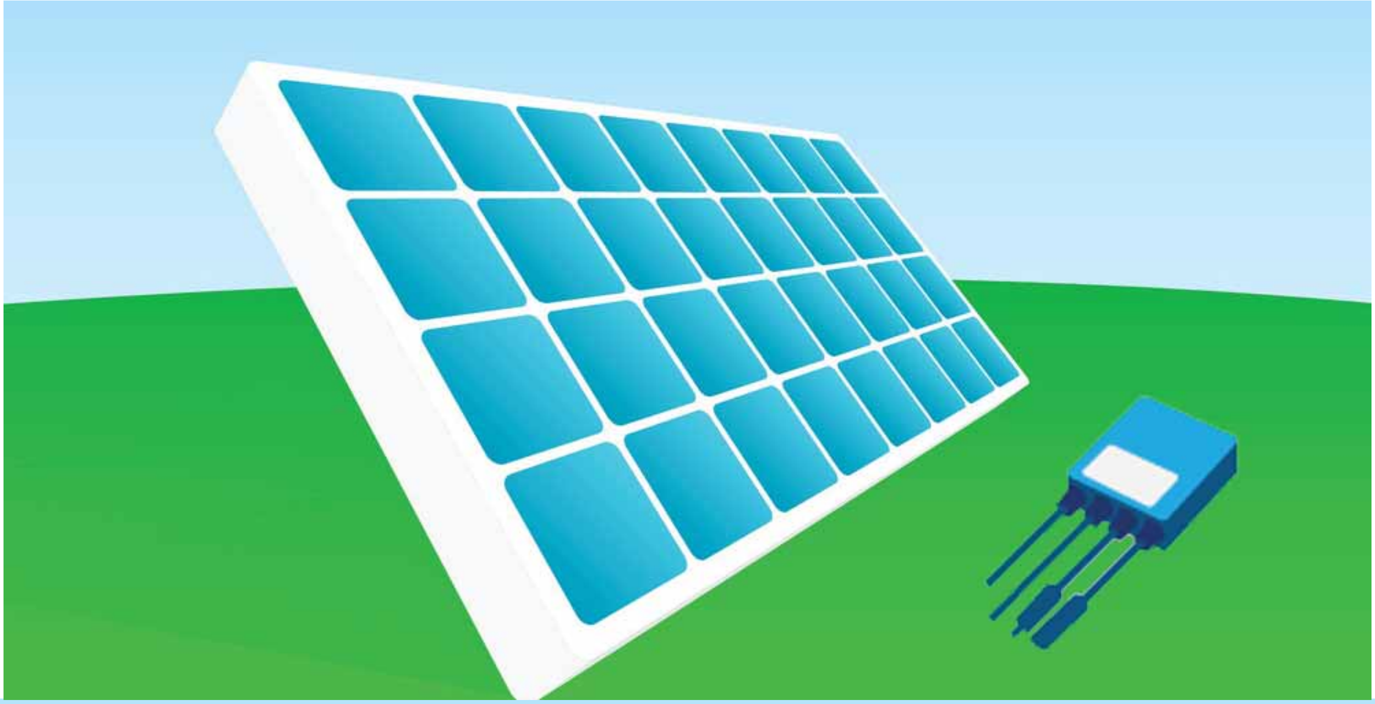


POWER OPTIMISER MARKET to reach 30mn units by 2025

The market from residential application, is predicted to witness an annual installation of over 10 million units until 2025.

The power optimiser market is set to grow from its current market value of more than $ 1 billion to over an annual installation of 30 million units by 2025, as reported in the latest study by Global Market Insights, Inc.

Growing environmental measures along with strict government schemes to curb emissions have aligned industrial focus toward the adoption of efficient energy conservation technologies. Operational and regulatory amendments across key power markets favoured by ongoing technological developments associated with product efficiency, flexibility, and operations have positively influenced the industry dynamics. Henceforth, significant upgrades and variations in manufacturing practices in line with cost-competitiveness will augment the overall power optimiser market scenario.

Stand-alone units in the current industrial regime, have primarily been influenced by the increase in demand for energy across regions observing complete isolation or limited grid access. The development of micro-grid infrastructure for large-scale renewable adoption has integrated a favourable industry scenario across the developed nations. Moreover, advanced distributed power generation technologies coupled with the ongoing development of sustainable electric infrastructure will further complement the power optimiser market size.

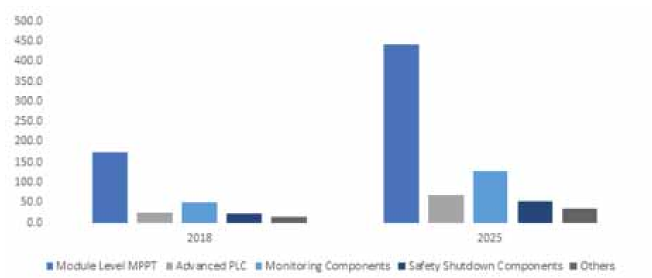
Stringent government measures subject to the capping of incentives and FiTs had obstructed solar installations across the European nations. However, regulators have continuously been focused towards distributed energy storage systems besides photovoltaic (PV) units through the provision of investment grants. The European Commission have imposed similar legislative schemes with an aim to favor the integration of sustainable technologies which will further drive the market growth.

Power Optimiser Market

Buck converters are anticipated to exceed $ 900 million by 2025. Buck units are DC-to-DC converters that step-down voltage levels from input to output. A switched-mode power supply technology containing one energy storage element, two semiconductors (transistor and diode, although new age converters usually replace diode with other transistor, for synchronous modification) and a capacitor, an inductor or the combination of two. Leading manufacturers with technological expertise and R&D capabilities have continuously been investing to upscale product performances which in turn will have the power optimiser market share.

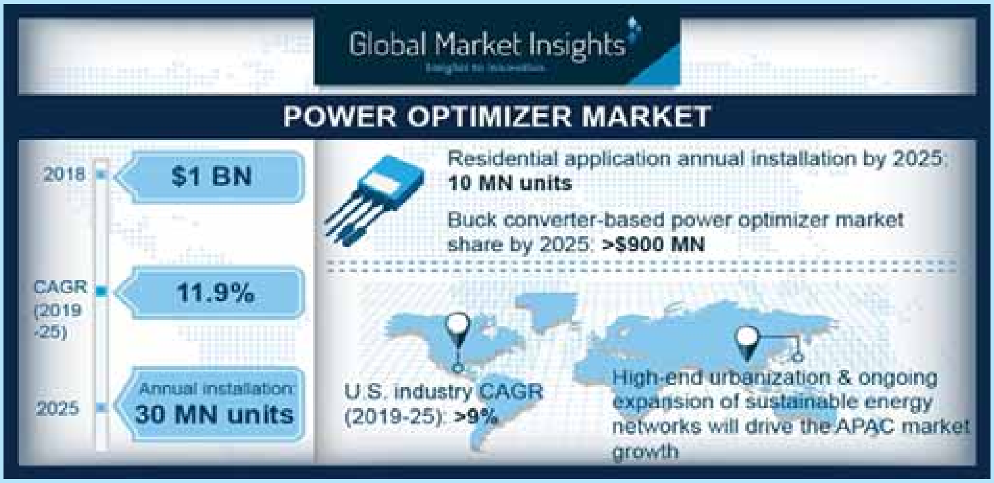
Optimisers have emerged in the power industry as a substitute for module level power monitoring and management, coagulating the benefits of MPPT with higher operational efficiencies of string inverters. In addition, features including module mismatch resonance, alleviation of module shading impact and over or under performing modules will strengthen the overall market potential.

Europe power optimiser market size, by end use, 2018 and 2025 ($ million)



Power optimiser market from residential application, is predicted to witness an annual installation of over 10 million units until 2025. Government subsidies, FiT's, and net metering positively influenced by the integration and manufacture of advance optimiser solutions will further stimulate the product penetration. Furthermore, government rollout plans and schemes including incremental energy efficiency grant to support residential rooftop installations will further complement the business outlook.

Eminent market participants include SMA Solar, SolarEdge, Altenergy, Tigo, Ampt, Huawei, igrenEnergi, Kuby Renewable Energy, Maxim Integrated, Darfon Electronics, GreenBrilliance, Texas Instruments, Mornsun, Xandex, Alencon, ABB, Ferroamp and Fronious.



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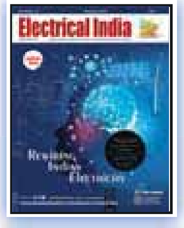

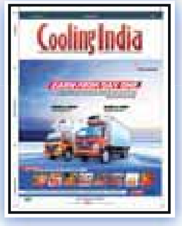

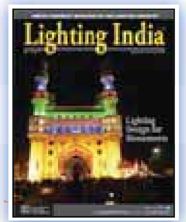

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Parallel Operation of Alternator

When the load on a system exceeds the amount of power that a single or existing number of generators can deliver, an additional generator is connected to the system to deliver required power. This method of adding an alternator in the existing system is called 'parallel operation of alternators'. It is essential to know that the incoming alternator must be paralleled such that each machine is supplying a proportionate amount of active and reactive power to the common load. For which certain rules are to be kept in mind.

Necessary conditions for parallel operation

It is never recommended to connect an alternator at standstill i.e. stationary alternator to bus-bar of a live system. An alternator at standstill generates no stator e.m.f which when connected with a rotating alternator would act as a load instead and cause internal circulating currents, which can lead to major faults.

There are certain requirements which must be fulfilled before an incoming alternator can be put in parallel with the existing alternator, this is called synchronising.

And the conditions to be taken into consideration while synchronising are as follows:

i. The voltage of the incoming alternator must be same as the bus-bar voltage.

ii. The frequency of the incoming alternator must be same as the frequency of bus-bar voltage.

iii. The phase of incoming alternator voltage must be identical to the phase angle of bus-bar voltage.

iv. The phase sequence must be identical, in case of a three-phase alternator.

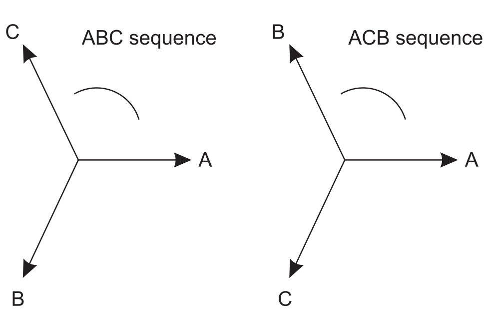

Figure 1: Incorrect phase sequence

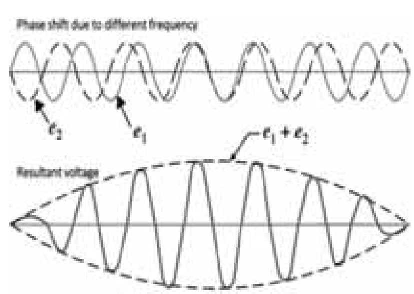

Figure 2: Effect of deviation in speed

What happens when the parameters are not matched?

Alternator voltage

The magnitude of internal voltages of both incoming and existing alternator must be identical else a potential difference will be created, causing circulation of currents amongst the two alternators and this is undesirable.

Voltage phase shift

When the zero crossing of both the voltage wave forms are not the same, a phase shift occurs resulting into voltage whose magnitude keeps on changing. This can be explained as a voltage which when given across a lamp will make it illuminate with different intensities.

Alternator speed

Suppose, the magnitude of alternator voltage of both the existing unit and incoming unit are same (depending upon the field excitation) and in-phase to external local circuit named e1 and e2. In this case even though the voltages are same but if speed of the alternator are not equal i.e. $Ns1 \neq Ns2$, the frequencies of both the alternators will not match

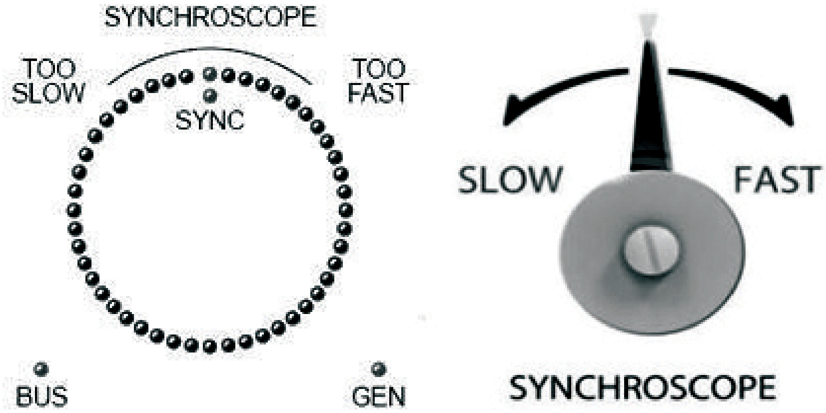

Figure 3: Synchroscope variants

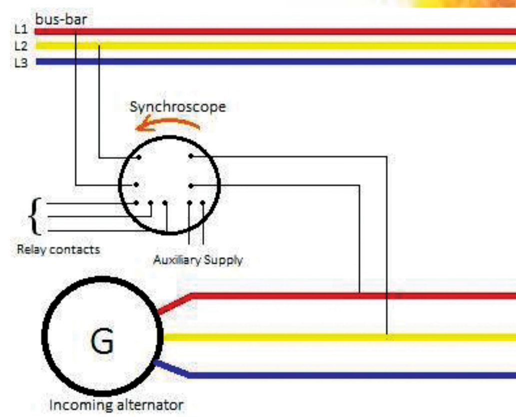

Figure 4: Synchroscope connection diagram

resulting into a phase shift between the two voltages. The waveform obtained is as shown below.

It would then be similar to the second case i.e. phase shift leading to constantly varying resultant voltage

Incorrect phase sequence

Incorrect phase sequence will cause damage, the bigger the phase difference the more electro-mechanical force is between the two out-of-phase alternators.

Synchronising

The method by which alternators are operated in parallel such that the above specified conditions are met is called synchronising. To ensure that the alternators are well synchronised, several methods are used and are listed as:

i. Three lamp dark method
ii. Two lamp bright method

Using Synchroscope.The first two methods use a combination of connections to ensure that the alternator voltage has similar magnitude, phase sequence, frequency and zero phase shift with the bus-bar voltage.

- The lamps illuminate with different intensities when there is a deviation in any of the quantity mentioned above.
- Lamps dark out and glow alternatively.
- In case of dark lamp method, when lamps go dark the alternators are synchronised as it indicated that the voltages e1 and e2 are in direct phase opposition leading to no circulating current.
- Whereas, in lamp bright method the connections are made such that lamps will glow with maximum intensity when the two voltages are in-phase and resultant voltage is twice the voltage of both alternators.
- But these methods using lamps in not quite accurate and require operator's expertise to switch alternator in at the right instant.

Hence, a device called synchroscope is used which indicates deviation in voltage (ΔV), frequency (Δf) and phase shift (Φ). As shown in figure 4, a synchroscope is connected to the system and accurate instant of time is achieved at which synchronisation is to be done.

Synchroscopes come in different variants, generally they are indicative type which show the speed and

phase shift of the alternator either by a pointer or LEDs arranged in a circular fashion.

Rishabh Instruments introduced a synchroscope which has the same functionalities as that of a basic synchroscope and comes with additional features of:

- Touchscreen display
- Consumes less power
- Highly accurate
- Aesthetically appealing
- ANSI housing.

EI

Neha Mistri

Application Engineer,
Rishabh Instruments
Pvt. Ltd

igus starts online shop for connectors

If cables are to be harnessed, then the matching connector can be found quickly, but often cannot be ordered in small quantities from the manufacturer. Here, igus now offers an additional service with its new online shop for plug-in connectors: the customer can order the right connector for his cable at a reasonable price from a wide selection of well-known suppliers such as Harting or Intercontec from stock and with no minimum order quantity.

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For more details, visit www.igus.in

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LPI uses the Leader Inception Theory (LIT) for designing lightning protection systems for HV power facilities. LIT is one of a number of design methodologies detailed in IEEE Std. 998.

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- Air terminals manufactured to a design achieving compliance with IEC 62651-2 & UL96
- Placement of Guardian Plus air terminals carried out in accordance with LIT as per IEEE Std. 998
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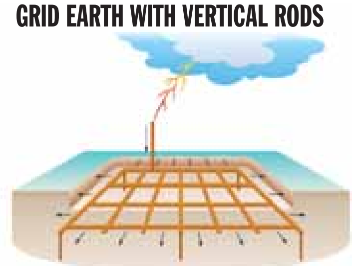

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Powerful 15 kV test solution for rotating machines

OMICRON's 15 kV testing solution for rotating machines includes the CPC 100 multifunctional testing device, the CP TD15 voltage booster and power/dissipation factor measurement module and the CP CR600 compensating reactor.

OMICRON's new CP TD15 testing accessory is used as part of a complete solution together with OMICRON's CP CR600 compensating reactor and CPC 100 multi-functional testing device for off-line insulation testing up to 15 kV on all types of rotating machines.

The CP TD15 combines a high-voltage booster and a high-precision power/dissipation factor measurement module and it generates test voltages of up to 15 kV. The CP CR600 compensating reactor allows users to test rotating machines with high capacitances of up to 1 μF at rated frequency.

Together with OMICRON's CPC 100 multifunctional testing device, the complete 15 kV testing solution can measure electrical parameters, such as insulation capacitance and power/dissipation factor, DC winding resistance and contact resistance. Additionally, the system can also be used for voltage withstand tests and as a high-voltage (HV) source for partial discharge measurements on rotating machines.

Easy to transport

All of the testing solution components – including the CP TD15, CP CR600 and CPC 100 – are lightweight, fit easily into a car and can be transported and used in the field by a single person. The solution's compact reactors and integrated HV source replace the need for large and heavy HV source equipment or test trailers. This significantly reduces the measurement setup time and makes the solution ideal for testing rotating machines in power plants and locations that are hard to access, such as crowded industrial environments, ships or wind turbines.

Intuitive and safe test setup

The 15 kV testing solution features an intuitive and easy connection concept that eliminates complex wiring to make testing faster. All modules can be placed in the working area, and a single shielded high-voltage cable safely connects the test system to the test object. This enables more streamlined connections in crowded testing environments, and provides the user with increased safety, flexibility and convenience during the measurement.

Automated control software

Additionally, the solution includes OMICRON's Primary Test Manager (PTM) software. It provides users with guidance throughout the entire test procedure as well as automated templates to speed up testing and reduce human errors. The software also enables instant measurement analysis with real-time result graphs as well as automated reporting. EI

For more information, visit www.omicronenergy.com/15kV

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