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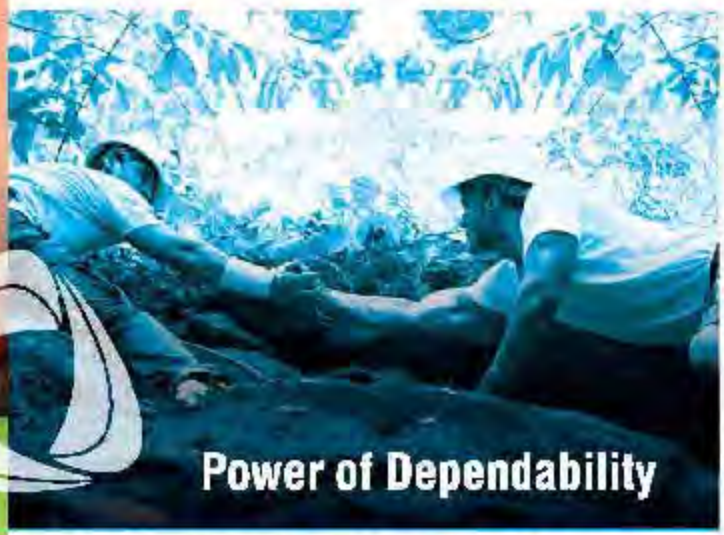

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> **Raising high capacity power transmission lines**

Electrical power is obviously prime necessity for any country for economic development. Electricity consumption is, though lowest in India, yet inspite of increased generation capacity, huge gaps between generation and demand still persist, drastically slowing down the economic growth of the country. It is time to evaluate Indian power sector reforms, transmission lines and restructuring. Country needs to focus on ultra high voltage transmission for long distances. Power Grid Corporation is exploring research into superconducting transmission systems. It is getting ready in raising higher capacity power transmission lines to 1,200 kV. Nowhere in the world does a 1,200 kV line exist. Currently, China has a 1,100 kV line in commercial operation.

For transmission lines the international standards fire safety requirements are based on exigencies of the fire behaviour of individual materials. A write-up, 'Polymeric cables and Materials' highlights on polymeric materials being widely used in electrical industry and CPRI, Bangalore has several test facilities to evaluate polymeric materials for flammability & smoke characteristics.

Country has seen one of the power reforms towards transition from a monopoly market structure to wholesale and retail structure with existence of power exchanges, to enable power trading for efficient and reliable power at competitive price. The article, 'Electricity Price Forecasting Model – Defining the Need and Approach for India Market' talks about forecasting model tool that is based on the various research and case studies. Among other revealing articles, there is an article on simple stand alone solar-DC system, which does not need the inverter; another write up devolves on smart grid for power supply, which is one of the important issues in modern energy economy.

Do visit us at **Elecrama 2014 (Hall 3A/Stall H3A97).** This issue contains topics relevant to the current trends in power sector. We cherish the feedback from our readers, support of our advertisers & subscribers. At the outset, I wish you all a happy and prosperous year for your business adventures.

Do send in your comments to us at
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High-Tech Integration in Power Transmission lines

> "HVDC transmission scheme has lower costs and lower losses"

Demand for power is growing exponentially and the scope of growth of electrification and electricity services sector is immense. As far as investment is concerned, estimated total fund requirement for transmission by 12th Plan i.e. 2016-17 has been assessed as US$ 42 Billion and Inter-State Sector US$ 21 Billion, whereas for State sector, it is assessed US$ 21 Billion. In power T&D sector, High-voltage direct-current link technology is now being used for greater efficiency, which is also used to stabilize control problems in large power distribution networks.

Electrical power Transmission as distinct from electrical power distribution involves transmission lines from generation spot to substations. And distribution network which includes lines from high-voltage substations to end-user, together with transmission network constitutes power grid is a well know terminology. Some percentage of the units of electric energy generated by power station is lost in the distribution network and this difference in the generated & distributed units is the T&D loss, remaining unpaid. And, it is estimated, though technical or non technical transmission loss is 17%, distribution loss is around 50%. This is a serious issue in managing electrical power.

For long distances, HVDC transmission scheme has lower costs and lower losses than an AC transmission link. India is working to set up an HVDC power transmission line with Nepal and Bhutan as part of its energy security plans. Also, to have power transmission connectivity with ASEAN and SAARC countries, including Pakistan, Afghanistan and Myanmar, as addressed by country's External Affairs Minister during World Energy Policy Summit 2013.

Spurred by the continued rising deficits, the Planning Commission of India has adopted a target of 88,500 MW to meet energy requirement of 1,043 billion units by the end of 12th plan. Investor-owned electric utilities and stand-alone transmission companies invested a record $34.9 billion in transmission and distribution infrastructure in 2012 according to new survey results released by the Edison Electric Institute. Industry's capital expenditures on transmission totaled $14.8 billion in 2012 depicting an increase of over $11.9 billion over previous year.

Based on the National Electricity Plan, Central Transmission Utility and State Transmission Utility have key responsibility of network planning and development as provided in the Eelctricity Act. In country, transmission line length has been growing at a CAGR of 7-8% between 2007-2012. 'Inspite of bottlenecks, it was possible to add 17,107 ckm of transmission lines during the year 2012-13 and it is proposed to lay 18,674 ckm of transmission lines during 2013-14, out of which 7,620 ckm is already achieved till November 2013'. The quality of electricity infrastructure in Indian villages needs to be improved. UHV is an evolving technology. Efforts are on to move towards higher voltage including 765 kv, 800 kv HVDC and 1200 kv. An unique effort made by POWERGRID through collaborative research between POWERGRID and Indian manufacturers to establish a 1200kV UHVAC Test Station is a positive step.

Research by Power Grid Corporation into superconducting transmission systems is based on superconducting system's physics that keeps the cable under extremely low temperatures, so low that making it possible at temperatures of -135 °c is known as 'high temperature super conductivity'. The challenge is, to keep the cable so cold that, there will be practically no transmission losses. And of course, with respect to entire gamut of power sector, there is a need for cutting edge technologies for power transmission, and if country has acumen to put satellite onto Mars orbit indigenously, then ours scientific talent and capabilities can bring mammoth transformation in power sector.

Gopal Krishna Anand

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Gamesa India inaugurates its state-of-the-art integrated Service and Monitoring Centre

Gamesa Wind Turbines Pvt Ltd, a global technological leader in the wind industry inaugurated its new Integrated Service and Monitoring Centre at Red Hills, near Chennai, to help its valued customers. Speaking on the occasion, Chairman and Managing Director, Gamesa Wind Turbines Private Limited, Ramesh Kymal, said, "We are extremely proud to have this new state-of-the-art facility inaugurated keeping in line with the aggressive growth plan of Gamesa India. This Centre would give us tremendous possibilities to serve our customers better and manage their assets in a more efficient and sustainable way". This composite facility is equipped to handle all the functions of its service portfolios under one roof viz. operations management, technical back-up office, spares and logistics management, Control and Training Centre and Repair Circuit Outlet. Around 902 wind turbines which have been installed in India and the neighboring island Nation, Sri Lanka, by Gamesa India will be monitored and controlled round-the-clock – all round the year. Also, as and when new installations gets added up the same would be hooked up to this control Centre. Gamesa India is exploring the feasibility of covering geographical areas beyond India and set up an advanced monitoring prognosis Centre. The vital data collected through Supervisory Control and Data Acquisition (SCADA) network would facilitate this mission. As more and more wind farms across the countries are being developed at very remote locations often far away from the urban hubs and conditions being unfavorable to work during nights, this control Centre will help monitor and operate the wind turbines remotely with very less human interventions. This will improve the availability of turbines for power production at the installation besides helping in predictive maintenance. ■

India offers all assistance in Renewable Energy to Nepal

India has offered all possible assistance to Nepal in developing its renewable energy resources. This offer was made by Minister for New and Renewable Energy when he called on the President of Nepal, Dr. Ram Baran Yadav at Kathmandu. He also called on Khil Raj Regmi, Chairman of the Council of Ministers of the Interim Election Government and briefed him on the energy situation in India and the rapid growth of the renewable energy sector in India. He spoke of India's plans to add significant amounts of renewable energy to its energy mix in the next 5 years. He also highlighted India's conducive and investor friendly policy framework for promoting renewable energy in a big way. Dr. Abdullah suggested that Nepal had great potential for enhancing its use of renewable energy resources, particularly, hydro, solar and biomass and offered to provide all possible assistance for the purpose. ■

Highest power transmission line in Maharashtra

In the power transmission segment, 400 km distance cables connecting Wardha and Aurangabad in Maharashtra will, in coming years, have the distinction of being the world's highest capacity power transmission line. At present, it is "charged to 400 kV" but when the Power Grid Corporation of India is ready, the capacity of the line will be raised to 1,200 kV. Nowhere in the world does a 1,200-kV line exist. The Wardha-Aurangabad transmission system takes off from a 2 km-long pilot line that the public sector PGCIL has been experimenting in Bina, Madhya Pradesh. The pilot was to study how electrical systems behave when a current of 1,200 volt zips through them. Crompton Greaves recently announced the setting up of a Rs 40-crore UHV lab to test if various transmission equipment can withstand electrical stress when current of very high voltage, up to 1,600 kV, passes through it. ■

Trend of lucrative prices in IEX spot market in power continues

Power market at IEX continued to remain buyer friendly in the month of November. The seasonal variations across the country did lead to a slight reduction in the quantum of electricity traded in the spot market. The average market clearing price (MCP) in November increased to Rs 2.78 per unit, up from Rs 2.71 per unit last month, highlighting a marginal increase of 2%. The month of November saw a total of 2481 MU's (Million kWh) traded in the market, marking a decrease of around 6% from the 2645 MUs traded in October'13. With winter season setting in northern India, the constituent states in the region traded almost 25% less power as compared to the previous month. In the eastern region too, the demand reduced owing to heavy rainfall caused by cyclonic activities. Congestion in the transmission network also restricts inter-regional flow of electricity. The month of November saw around 497 MUs of electricity in the day ahead spot market being lost on account of congestion. The volumes traded at the exchange could have been higher had it not been for severe transmission congestion, especially in the Southern corridor - between rest of India and the Southern region as well as in the Southern bid areas of S1 (Andhra Pradesh and Karnataka) and S2 (Tamil Nadu and Kerala). On an average, 1521 participants traded in the day ahead spot market at IEX in the month of November. On an overall basis, the eastern region, north eastern region, S1 bid area (Andhra Pradesh and Karnataka) and W2 bid areas (Chhattisgarh) witnessed a drop in area prices - the average prices fell to Rs. 2.41, Rs. 2.41, Rs. 3.50 and Rs. 2.30 per unit. The day-ahead power market at IEX continued to remain buyer friendly in the month of November, following the same trend as observed in the last few months. ■

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ICPCI with the support of BIS organized National Awareness campaign in 6 cities on revised 'National Electrical Code India 2011'

International Copper Promotion Council India (ICPCI) in support with Bureau of Indian Standards (BIS) and in association with The Institution of Engineers, Hyderabad organized a special session on the Revised National Electrical Code India. The awareness campaign was run in 6 cities starting September 2013 in Hyderabad, Bangalore, Ahmedabad, Pune, Chandigarh and Kolkata. The seminar was addressed by a panel of dignitaries like, N Krishna Reddy, Chief Electrical Engineer, R&B Department, Andhra Pradesh, D. H. Basavaraju- Chief Electrical Inspector, Karnataka, I.M. Bhavsar, Chairman - Gujarat Energy Development Agency (GEDA), Sandeep A. Patil Chief Engineer (Electrical) PWD & Chief Electrical Inspector, Maharashtra, Er. S.K. Chadha, Chief Engineer, Chandigarh Administration, R K Trehan, Scientist-F & Head, Bureau of Indian Standards (BIS) and many more. The objective was to enhance Electrical Safety amongst key constituents of building industry and industry stakeholders, through nationwide awareness campaign about key provisions in revised National Electrical code of India 2011.The campaign was supported by agencies like Bureau of Indian Standards (BIS), The Confederation of Indian Industry (CII), Fire and Security Association of India (FSAI), Electrical Contractors Association of India (ELCA), Institute of Engineers, and National Institute of Construction Management and Research (NICMAR). It was attended by Electrical Engineers of all key government depts. and sponsored by organizations like - Chola MS Risk Services, OBO Bettermann, L.L. Hager, Luminous, Jeff Technology Solutions. The seminar witnessed participation of over 800 delegates. ■

National Institute of Solar Energy

Government has set up an autonomous Institute namely 'National Institute of Solar Energy (NISE)' under the administrative control of Ministry of New & Renewable Energy (MNRE) by converting the existing Solar Energy Centre (SEC) with its headquarters and research facilities at Gwalpahari Village, Distt. Gurgaon (Haryana). The NISE has been registered under the Haryana Societies Registration Act on 24th October, 2013. The main objective of setting up the National Institute would be to assist the Ministry and function as the apex National Centre for research and technology development and related activities in the area of solar energy technologies in the country. The institute would also perform all related tasks to achieve this objective to coordinate various S&T related tasks under the Mission and other activities as decided by the Government from time to time. ■

Electricity Generation from Solar and Other Renewable Projects

Per capita consumption of electricity in country has increased from 566.69 kWh in 2002-03 to 883.63 kWh in 2011-12. The Government is encouraging generation of electricity from various renewable energy sources by giving various fiscal & financial incentives. Thus apart, the state governments are procuring electricity from renewable energy projects at preferential tariff. So far 29,535 MW of renewable power capacity have been installed in the country, which includes 19,933 MW from wind, 2079 MW from solar, 3746 MW from small hydro and 3776 MW from bio energy. Ministry of New and Renewable Energy is providing various renewable energy systems for decentralized generation of electricity. So far, 10,752 villages have been electrified using various renewable energy systems. ■

Schneider Electric India Foundation launches its first Renewable Energy Training Centre (RETC) in India

Schneider Electric India Foundation inaugurated its first Renewable Energy Training Centre at the Art of Living Headquarter in Kanakpura - Bangalore Ashram during December in association with Art of Living Foundation. The event was attended by Sri Ravi Shankar, Dr. Shalini Sarin - VP and HR Country Partner and Nagarajan, VP Partner business, Schneider Electric India Pvt. Ltd. The Renewable Energy Training Centre has been setup to support new entrepreneurs from the "Bottom of the Pyramid" to start their own business in renewable electrical market along the lines of Schneider Electrics' flagship Corporate Social Responsibility (CSR) program BipBop, that is based on 'Business, Innovation, and People at the Base of the Pyramid' and aims to provide access to reliable, affordable and clean energy for people with limited or no access to electricity. The Renewable Energy Training Centre RETC will play a vital role in training youth to sustainably distribute and manage electricity in rural India. This RETC in Bangalore alone will create 150 livelihood opportunities per year on small scale business and promotion and subjects relevant to Energy Needs of India (Category wise), Solar based home lighting system installations, Micro grid installation and maintenance, Solar water pumping installation and maintenance, Battery management, Entrepreneurship – how to run a small business as well as engineering aspects. Schneider Electric India Foundation commits itself by helping the planet and society through its unique 4E interventions as Education, Employment, Electrification and Entrepreneurship. ■

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BHEL's First Supercritical Thermal Unit at Barh adds 660 MW to India's Power Generating Capacity

BHEL has achieved yet another milestone with its first supercritical set of Barh Thermal Power Project (TPP) Stage II Unit 4 in Bihar attaining full load of 660 MW on 30th November 2013. This is a significant event in India's power generating capacity addition programme. The commissioning of the unit has not only demonstrated BHEL's preparedness in setting up supercritical thermal power projects but has also reinforced the company's leadership status in supercritical thermal units involving supply of state-of-the-art equipment, suited to Indian coal and Indian conditions. Notably, the supercritical steam parameters for this project viz. efficiency and heat rate are better than those of comparable supercritical projects presently under installation by others. BHEL had bagged its maiden order for 660 MW sets with supercritical parameters from NTPC through International Competitive Bidding (ICB) for this 1320 MW project, located about 75 km from Patna. The order is a testimony to the customer's confidence in the company's capabilities and proven technological excellence. For the project, the key equipments have been manufactured by BHEL at its Haridwar, Trichy, Hyderabad and Bangalore works, while the construction of the plant was undertaken by the company's Power Sector – Eastern Region, Kolkata. In addition to Barh, the other major supercritical sets presently under execution by BHEL include 2x660 MW Mouda Stage II & 2x800 MW Gadarwara of NTPC, 3x660 MW Nabinagar of NPGCL (Joint Venture of NTPC and Bihar State Electricity Board), 2x660 MW Bara TPP of the Jaypee Group, 2x800 MW Yeramarus of Raichur Power Corporation Limited etc. ■

Installed Solar power generation

As per reports available the installed Solar power generation capacity in countries like China, USA, Japan and Spain is in the range of 3,000-8,500 MW, while it is over 16,000 MW in Italy and over 32,000 MW in Germany. In comparison, the installed solar power generation capacity in India has reached around 3,100 MW as on October 2013, most of which has been set up during the last three years after the Jawaharlal Nehru National Solar Mission was launched and is on the increase. A target for deployment of 20 million sqm of solar thermal collectors area and 2,000 MW off-grid & 20,000 MW grid connected solar power generation capacity by 2022 in the country has been set under the JNNSM. focus is also being laid on creation of favourable conditions for developing solar manufacturing capability and increased R&D. ■

National Energy Conservation Awards Function 2013

Inaugurating the Annual National Energy Conservation Awards Function, President of India, Pranab Mukherjee, handed over the prizes to several industrial units and other establishments for their innovative efforts in enhancing their Energy Performance. The awardees represented Industries, Thermal Power Stations, Office Buildings, BPO Buildings, Hotels, Hospitals, Shopping Malls, Zonal Railways, Railway Workshops, Municipalities, State Designated Agencies and manufacturers of BEE Star Labelled appliances/equipment. The President also presented the prizes to the 1st, 2nd and 3rd prizes for the National Energy Conservation Painting Competition undertaken by the Ministry of Power and BEE. The competition is held every year at the School, State and National Levels. This year, the competition witnessed a record participation of 45 lakh students from 98,000 schools across the country. Commenting on the importance of Energy Efficiency, Pranab Mukherjee said, "Our future progress is determined largely by the level of technology that will drive our economy. Innovation and technology intervention provides the competitive edge that our industrial sector should not be deprived of. Therefore, there is a need to ensure a conducive environment to innovation so that technologies are available that addresses both energy efficiency & climate change". A National Target of increasing the efficiency of energy use to bring about a 20 to 25 percent reduction in the energy intensity of our GDP by 2020, he added. ■

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Alstom T&D India wins major 400 kV gas-insulated substation orders for Himachal Pradesh

Alstom T&D India has been awarded two contracts with a total value of INR 2983 million (€38 million) to supply two 400/220/66 kV gas-insulated substations (GIS) at Wangtoo and Gumma in Himachal Pradesh. The projects respectively received from Larsen & Toubro (L&T) and HP Power Transmission Corporation Limited (HPPTCL), respectively, aim to improve the transmission capacity of HPPTCL for the transport of electricity generated by hydropower sources across the state. The scope of the Wangtoo project, worth approximately INR 1520 million (€ 8 million), covers the design, engineering, manufacture, supply, testing, and commissioning of 400 kV, 220 kV and 66 kV gas-insulated switchgear, power transformers, instrument transformers and substation automation system. The Gumma project, worth INR 1463 million (€20 million), includes design, engineering, manufacture, supply, erection, testing, commissioning and covers civil works of 400 kV and 220 kV GIS substation on a turnkey basis. All key equipment for both the projects will be produced by Alstom's state of the art manufacturing facilities across India. Kathin Basu, Managing Director, Alstom T&D India says, "With these dual contract wins for HPPTCL, Alstom is pleased to earn the confidence of its customer for the provision of advanced GIS solutions at the Wangtoo and Gumma substations. Alstom is the leader in India's GIS activity and has so far supplied over 300 GIS bays in India, covering a range of voltages from 66kV to 400kV. Over 50% of the supplied solutions are produced in India." Alstom has been the pioneer in localizing GIS manufacturing activity in India since 2009 at its facility in Padappai, near Chennai. GIS is the preferred technology for hydropower plants and coastal areas; its compact and enclosed design makes it ideal for smaller footprint and low maintenance application. ■

Welspun commissions 8.02 (DC) MW capacity Solar Project in Karnataka

Solar developer Welspun Energy Limited (WEL) has commissioned its first solar project in Karnataka of 8.02 (DC) MW capacity, four months ahead of schedule. The project, located in Chitradurga was developed by WEL's step down subsidiary Welspun Solar Kannada Pvt Ltd under the Karnataka State Policy. As per the PPA signed with Mangalore Electric Supply Company, the power plant was scheduled to begin commercial operations only by March 2014. WEL has commissioned this project well before the timeline. This project is one of the many solar and wind projects of WEL being developed in Karnataka and will contribute to the state's energy needs. This project will address Karnataka's annual peak deficit of 27.4% by generating 13,264 Mn kWh annually, enough to power 33,600 households. The solar project will mitigate 11,651 tons of carbon emissions annually. ■

GAIL DBPL project receives Platts Premier Project Construction Award for 2013

GAIL's 1000 Kms Dabhol-Bengaluru Pipeline Project has been awarded as Premier Project in large construction category at Platts Global Energy Awards 2013 held in New York City. Jayanta Sinha, President, GAIL Global (USA) Inc. Houston, a wholly owned subsidiary of GAIL (India) Limited received the award on behalf of the Company. Nominations were received from more than 25 countries including Brazil, India, Puerto Rico, Saudi Arabia, South Africa, Spain, Russia, Switzerland, Argentina, China, Pakistan, Bangladesh, Thailand, UK and the United States. Finalists were chosen from a list of over 200 nominations, based on their performance for each category's criteria within the designated time frame. The Dabhol-Bengaluru pipeline was recently dedicated to the nation by the Prime Minister of India during the 5th Asia Gas Partnership Summit 2013. ■

Suzlon Group wins orders of 266 MW for community windfarms in Germany

Orders for 103 turbines totaling over 266 MW capacity. Turbines will go to 24 community wind farm projects in Schleswig Holstein. Pune/ Hamburg: REpower Systems SE, a wholly owned subsidiary of the Suzlon Group, the world's fifth largest* manufacturer of wind turbines has signed contracts to deliver 103 wind turbines with a total capacity of over 266 megawatts (MW) for 24 community wind farm projects in the Schleswig Holstein region of Germany. The contracts were concluded with different contractors who were previously represented by a purchasing association. REpower signed a primary memorandum with the purchasing association, "Schleswig Holstein GmbH Wind", in December 2012. This memorandum assured the participants from 52 projects in Schleswig - Holstein binding conditions in a model contract. REpower has won 55 percent of all potential wind turbines for itself in this process. The projects will employ various types of turbines from the MM82 with 59 metres hub height, to the 3.2M114 with a hub height of 92 metres. 11 wind turbines of the signed projects are already in the implementation phase and are to be commissioned quickly. The other projects will be completed by 2015. Andreas Nauen, CEO of REpower Systems SE, "With these contracts, we are significantly expanding our position in Northern Germany. This is only possible because we have a suitable turbine for each individual site in our product portfolio from Lübke - Koog in the far north, to near Fehrnarn in the east of Schleswig-Holstein, and also because we have the ability to implement the interests of customers optimally with our staff on site." ■

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Crestron Delivers the Future of AV Distribution

Crestron Asia Limited ("Crestron Asia"), the Asia headquarters of Crestron Electronics, Inc. ("Crestron"), the world's leading manufacturer of advanced control and automation systems, released its DMCO 7-Series output cards, providing streaming H.264 video transmission capabilities from Crestron DigitalMedia™ card-based matrix switchers. DM switchers can accept analog or digital input signals and transmit those signals over HDMI, HDBaseT, multimode fiber, single mode fiber and now streaming over the network via RTSP (Real-Time Streaming Protocol). Streaming video eliminates the distance limitations, enabling signals to be sent around the building, around the campus, or around the world. DigitalMedia switchers now support a very high bandwidth video stream (up to 25 Mbps) to both unicast (one-to-one) and multicast (one-to-many) protocols. The DM® series can now stream HD 1080p content directly to computers and Crestron touch screens, as well as to in-house servers or open source media sites, or even to any display and mobile device anywhere in the world. By using the new DMCO 7-Series cards, Crestron DigitalMedia offers a total integrated AV distribution solution that includes HD streaming. The 7-Series cards can combine two signals over the same stream to enable Picture-in-Picture and Picture-by-Picture display. Exclusive Crestron Instant Switching™ provides instantaneous, glitch-free signal switching between sources. Crestron understands that streaming is the future of AV, streaming output is essential to form a complete DM network. The modular, card-based architecture DMCO 7 Series output cards make it easy to add streaming to a DM system. Crestron is the pioneer and standard-bearer for digital AV distribution where leading organizations around the world rely on Crestron DigitalMedia for presentations and communications. ■

CG Opens Fourth Office in UK, in Stafford

Avantha Group Company CG, one of the world's leading engineering companies, has opened its fourth office in the U.K. at Stafford, complementing its existing offices in Hazel Grove Stockport, Barrow-Tyne and Wear and Inchinnan-Renfrewshire. Avantha Group Company CG's regional VP, EMEA, Mark Weston said,"We have chosen Stafford for our new UK office because it has a long-established and successful engineering tradition in High Voltage Power, Transmission and Distribution Grid Systems. This aligns very well with our growth plans for the UK. The UK is a significant opportunity for CG considering the large investments announced in the National Grid transmission and distribution infrastructure, power generation from renewable sources and the country's rail network. I believe that the Stafford office will help us better meet the needs of our UK customers, while enabling us to accelerate our growth plans here." ■

NTPC and KfW (Germany) ink agreement for research cooperation

NTPC tied up a fixed interest term loan facility for EUR 52 million with KfW, the German government developmental financial institution to part finance the capital expenditure on Electro Static Precipitators and other selected packages of its Mouda Stage II power project. An agreement to this effect was signed by G.K. Sadhu, Executive Director (Finance) on behalf of NTPC. The loan is on a standalone basis without sovereign guarantee reflecting the trust and confidence reposed by the German financial institution in NTPC's strong credit quality and professional management. KfW has in the past provided financial support to the company's renovation and modernization and emission reduction schemes. ■

HARTING wins "Manufacturing Excellence (MX) Award" again

The HARTING Technology Group has once again been presented with the "Manufacturing Excellence (MX) Award". On this occasion the HARTING local subsidiary HARTING Electric won the award in the "sustainability" category. The local subsidiary HARTING Electronics climbed the winners' podium last year in the "information technology" category. This time HARTING Electric has impressed the jury with its highly effective deployment of sustainable and eco-friendly production processes. "I am delighted that HARTING has once again received this prestigious award. This illustrates that not only are we highly successful on the market with our HARTING products and solutions but our contribution to environmental protection and sustainability is also being recognized by experts," remarked TorstenBalzmann, Senior Vice President Production and Logistics at the HARTING Technology Group. The Harting family, which owns the company, focused heavily on the economic, environmental and social aspects of its business activities at an early stage. These key elements of its corporate vision had already been established by 1996. Over the years HARTING has received numerous independent certifications verifying its commitment to corporate social responsibility (CSR), such as ISO 26000. "The issue of sustainable production will remain high on our agenda in future. We regard sustainability as implementing green projects while keeping the figures in the black," summed up Balzmann. "The MX Award has honored best-practice companies in the manufacturing sector since 2005 under the maxim "identifying strengths – setting standards." The objective is to recognize and promote innovative solutions and to make them generally accessible. ■

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ABB wins $75 million HVDC order in North America

ABB, the leading power and automation technology group, has won orders worth around $75 million from Hydro-Québec, the utility in eastern Canada, and National Grid, the utility in New England, USA, to refurbish three high-voltage direct current (HVDC) converter stations. The multi-terminal HVDC link between Québec and New England was the world's first such link to be put into service between 1990 and 1992. ABB will now replace the 20-year-old control and protection systems with the newest modular advanced control systems (MACH) for HVDC equipment. The link has a total transfer capacity of 2,000 megawatts of power and spans a distance of 1,500 kilometers from the La Grande II hydroelectric generating complex near James Bay in eastern Canada, via Nicolet, a substation located on the south shore of the St Lawrence river, down to Sandy Pond, near Boston, Massachusetts in the US. "ABB pioneered HVDC technology and we continue to lead the way through innovation," said ABB CEO Ulrich Spiesshofer. "This project reinforces ABB's focus and commitment to supporting customers throughout the lifecycle of the products and systems it delivers. It also underlines the company's emphasis on growing its service business." The project scope also includes refurbishment of two cable transition stations and a control and protection system replica for a test center in Canada. The stations are scheduled to go in operation in stages and will be completed by 2016. The MACH system is the world's most extensively deployed control solution for HVDC and Flexible Alternating Current Transmission Systems (FACTS) installations, with over 1,100 such systems in operation throughout the world. "The upgrade of the converter stations will enhance the efficiency and reliability of this important HVDC link," said Claudio Facchin, head of ABB's Power Systems division. ■

Promotion: FLIR i3 thermography camera

FLIR Systems offers its FLIR i3 handheld thermal imaging camera at the very affordable price of Rs 54,000. This promotion will be valid in India from 1 December 2013 to 31 March 2014. The FLIR i3 is the smallest, lightest and most affordable true thermal imaging camera on the market. It is incredibly easy to use and requires no former experience. It really is a matter of "point-shoot-detect" to obtain high-quality thermal images that will immediately give you the thermal information you need. A thermal imaging camera is a reliable non-contact instrument which is able to scan and visualize the temperature distribution of entire surfaces of machinery and electrical equipment quickly and accurately. Thermography programs have contributed to substantial cost savings for our customers around the world. ■

Malaysia to host annual gathering of global power industry professionals at POWER-GEN Asia 2014

POWER-GEN Asia and Renewable Energy World Asia, the region's premier conference and exhibition for all aspects of the power generation industry, will return to Kuala Lumpur, Malaysia on 10-12 September 2014, at the KLCC. POWER-GEN Asia, co-located with Renewable Energy World Asia, is the leading force in delivering a platform for the power industry to meet, share information on the challenges facing the power industry and discuss solutions for advancing Asia's energy future, and will return to Malaysia for the first time since 2011. Attracting over 7,800 delegates and attendees from over 70 countries across South East Asia and around the world, Event Director, Glenn Enser, remarked, we are delighted that POWER-GEN Asia will be returning to Malaysia. ■

Honeywell's Film For Solar Panels named one of the Top 10 Most Innovative Material in China

Honeywell announced that its laminate film designed to keep solar panels cooler and more efficient has been named one of the top 10 most innovative materials in a competition held in China. PowerShield™ Cool Black, a backsheet film that helps reduce solar panel operating temperature by reflecting solar radiation, was honored at PVTOP50, a competition organized by Modern Photovoltaics magazine and the Website solarpvsources.cn. The competition, first held in 2007, encourages innovation, initiative and creativity among companies to accelerate scientific achievements. Honeywell's material was chosen by a combination of public and consumer votes and through an assessment by a judging panel consisting of managers from the National Development and Reform Commission of China and experts from China's photovoltaic industry associations. China is the world's largest producer of solar panels. "The technology behind PowerShield Cool Black is based on more than three decades of Honeywell innovation in high-barrier films for food packaging, industrial and healthcare applications," said Xu Huang, Asia general manager for Honeywell Specialty Products. "Collaborative testing by local Chinese component manufacturers and other global leaders has proven the effectiveness of this technology to meet the demanding needs of solar manufacturers. Honeywell is committed to an active and global research and development program for photovoltaic backsheets, with laboratories in the U.S. and Shanghai." PowerShield Cool Black is a black laminate film designed to help make black solar panels cooler and more efficient. ■

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Power Demand in Mena Region set to Grow by Seven Per Cent Annually Until 2020

Demand for electric power in the MENA region is accelerating rapidly, and is set to continue to grow by seven per cent annually in the coming decade, according to a report published by the Economist Intelligence Unit (EIU). The report, titled MENA's electric power supplies to 2020, states that population growth, economic development and industrialization driven by rising oil prices, are significant factors propelling demand for electricity, with some countries diversifying fuel sources and investing in renewable energies, especially solar power, as part of their efforts to expand power supply. The report, which was published ahead of Middle East Electricity, one of the world's largest and longest running energy events, added that the Gulf Cooperation Council (GCC) interconnection grid, due for completion by the end of 2013, will enable power surpluses to be traded across the region. Taking place from 11-13 February 2014 at the Dubai International Convention and Exhibition Centre, Middle East Electricity focuses on the power, lighting, renewable and nuclear sectors, featuring more than 1,200 exhibitors from 100 countries. The three-day event is strategically located in Dubai, a hub of regional economic activity, providing exhibitors the ideal platform to showcase their latest energy related products and services to more than 18,000 decision makers from around the world. "One of the key drivers of the surging power demand in the MENA region is due to rapid population growth," said Anita Mathews, Director of Informa Energy Group, organizers of Middle East Electricity. "Others include increasing urbanisation and lifestyle improvements that come with growing economic prosperity, further enhanced by the resurgent construction boom that has now returned to the region. ■

Appalachian Power seeks SCC Approval to Update Southwest Virginia Transmission Line

Appalachian Power filed an application with Virginia State Corporation Commission requesting permission to make improvements to the company's 35-mile portion of the Cloverdale-Lexington 500 kilovolt (kV) transmission line. The proposed work will replace all existing conductors—the wires that carry electricity—and replace or add approximately 12 towers. Appalachian Power shares the 47-year-old line with Dominion Virginia Power. Appalachian's portion is located in Botetourt and Rockbridge Counties beginning near its Cloverdale Substation and running 26 miles northeastward to its interconnection with the line section owned by Dominion, approximately three miles west of the City of Lexington. Project is needed to ensure adequate and reliable electric service by addressing North American Electric Reliability Corporation reliability criteria violations projected to occur in 2014. ■

Japan and U.S Island Grid Project

In Hitachi's vision, smart cities seek to deliver quality of life (QOL) while also satisfying the demands of society (such as making extensive use of renewable energy), based around solutions that fuse information and control technologies. Hitachi is actively involved in the deployment of these smart city solutions outside Japan, including being entrusted by Japan's New Energy and Industrial Technology Development Organization (NEDO) to participate in the Japan-U.S. Island Grid Project. This demonstration project runs up until the end of FY2014 and is being conducted in collaboration with partners which include the State of Hawaii, the County of Maui, Hawaiian Electric Company, Inc., Maui Electric Company, Ltd., the Hawaii Natural Energy Institute of the University of Hawaii, and other partners. ■

ESI: 1st International Conference and Exhibition on Energy Storage and Microgrids

Energy Storage India (ESI) Conference and Exhibition in Mumbai that came to close on December 6, 2013 attracted 306 delegates from 12 countries worldwide. Jointly organized by Messe Düsseldorf India, Customized Energy Solutions and powered by the India Energy Storage Alliance (IESA), ESI 2013 is the first energy storage conference and exhibition in India to focus exclusively on applications, customers and deal making. The event provided important impetus for the Indian energy and power industry. The 14 exhibitors at the Energy Storage India Exhibition showcased innovative technologies and applications in the energy storage sector. The exhibitors included Panasonic, Dresser-Rand, EEI Italy, FIAMM Sonick, Ecoult, Eaton Technologies, Aartech Solonics, Inergy Energy (Erstwhile Dodya Energy), Local Grid Technologies, India Energy Exchange, India Smart Grid Forum, Alliance for Energy Efficient Economy (AEEE) and Customized Energy Solutions. The event started with three workshops providing delegates with a broad overview of various energy storage technologies as well as opportunities for solar and wind storage integration. The technologies addressed in the workshops and conference spanned the complete range including electrochemical batteries such as advanced lead acid, Li-Ion, flow batteries, ultra capacitors, flywheels, sodium nickel chloride, sodium sulfur, nickel iron as well as other forms of energy storage technologies such as pumped hydro, compressed air energy storage, thermal and hydrogen storage. ■

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International Renewable Energy Agency concludes 6th Council Meeting in Abu Dhabi

The International Renewable Energy Agency concluded its 6th Council meeting in Abu Dhabi. Delegates and representatives of 21 IRENA Members deliberated over two days the Agency's Work Programme for 2014-2015. This included flagship initiatives to strengthen renewable energy worldwide by addressing key challenges such as costs and grid infrastructure, as well as the global potential of renewables. "IRENA's mission is to support countries in their transition to a secure and clean energy future, and to help them identify a path to accelerate the deployment of renewable energy sources," Adnan Z. Amin, IRENA's Director General said at the Council meeting. "With our expert and independent advice, IRENA is making an impact in the world of renewable energy by providing a range of reliable and well-understood services that create fresh momentum." Amin added. Initiatives discussed at the Council meeting included a first-of-its-kind web portal dedicated to renewable energy cost analysis www.irena.org/costs, which is free for all users; and a user's guide on how to make optimal use of smart grid technologies for the integration of renewables into the grid, "Smart Grids & Renewables – A Guide for Effective Deployment." The consultations furthermore centred on two major publications that will be published at IRENA's 4th Assembly in January, the Agency's institutional publication, REthinking Energy, and a roadmap to double the share of renewables in the energy mix by the end of the next decade, REMAP 2030. Approximately 230 representatives from over 80 countries attended the two-day Council meeting. They finalized the agenda for IRENA's 4th Assembly meeting, which will be held in Abu Dhabi on January 18 and 19, 2014. ■

TechNavio announces Publication of its Research Report -Power Cables Market in China 2014-2018

TechNavio recognizes the following companies as the key players in the Power Cables Market in China: Far East Cable Co. Ltd., Nexans S.A., Prysmian S.p.A., and Shandong Wanda Cable Co. Ltd. Commenting on the report, an analyst from TechNavio's team said: "The Power Cables market in China is currently growing at a rapid pace. Moreover, a number of mergers and acquisitions and other strategic alliances are taking place in the market, with many large players and emerging vendors considering this lucrative strategy to acquire a larger share in the market. For instance, Italian high technology cables manufacturer Prysmian SpA acquired Dutch cable manufacturer Draka Holding in 2011. This approach also enhances the vendors' distribution channels and improves their market reach. ■

MECASOLAR supplies 1 MW in solar trackers to PV solar plant in Jordan

The 1,028MWp solar farm, located in Ma'an, southern Jordan, is set to be connected at the beginning of 2014. The supply deal adds to other agreements recently reached by the multinational, which expects to sign new contracts in Morocco and Saudi Arabia soon. MECASOLAR has signed an important contract under which it will supply fixed structures to be installed in a PV solar park in Jordan. The new 1,028MWp solar park will be installed in Ma'an, southern Jordan, 218km from Amman, the capital of the country. The installation will be connected to the grid in the early months of next year. MECASOLAR, a multinational firm specializing in the design and manufacture of solar trackers, fixed structures for ground- and roof-mounted installations, and foundation screws for PV solar farms. ■

2014: Three Major Trends of PV Energy – High-Efficiency Cell, Energy-Storage System, and Acquisition

Demand from China, Japan, and USA will represent about 50% of the total worldwide market share in 2014. Due to the recovery of the European market and the rise of the emerging markets, supply and demand in the PV industry will be able to achieve equilibrium. EnergyTrend research manager, Jason Huang, points out the three major trends within the PV industry, which are high-efficiency products, energy-storage systems, and merge and acquisitions. High-efficiency products become the mainstream; target efficiency for multi-si cell is 18% by the end of 2014. Although many manufacturers have started to come up with new PV technology, crystalline silicon products remain the mainstream in the overall market. Among all, multi-si products are the most popular ones because they have excellent quality, reasonable price, and simpler power plant design and inverter specifications. Since 2013, module wattage has increased from 240 to 250. Multi-si cells with efficiency of 17.2%~17.6% are cells that are mostly used. Following the increased use of high-efficiency cells, downstream developers hope to acquire modules with higher wattage. It's projected that cell efficiency will rise to 17.6%~17.8% in the first half of 2014. While 60 pieces of cells' module is equivalent to 250/255W, 72 pieces of cells' module is equivalent to 300/305W. By the end of 2014, mainstream will be products above 255/305W with efficiency of 17.8%~18%. With energy-storage product demand burning stronger, selling it with PV system as a set will be critical to the next market development. Most of the countries switch their PV development focus to self-consumption or peak-electricity usage adjustment because subsidies have been cut or even cancelled in different regions. ■

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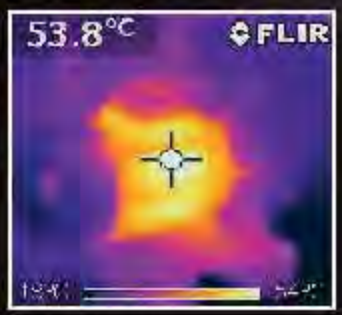

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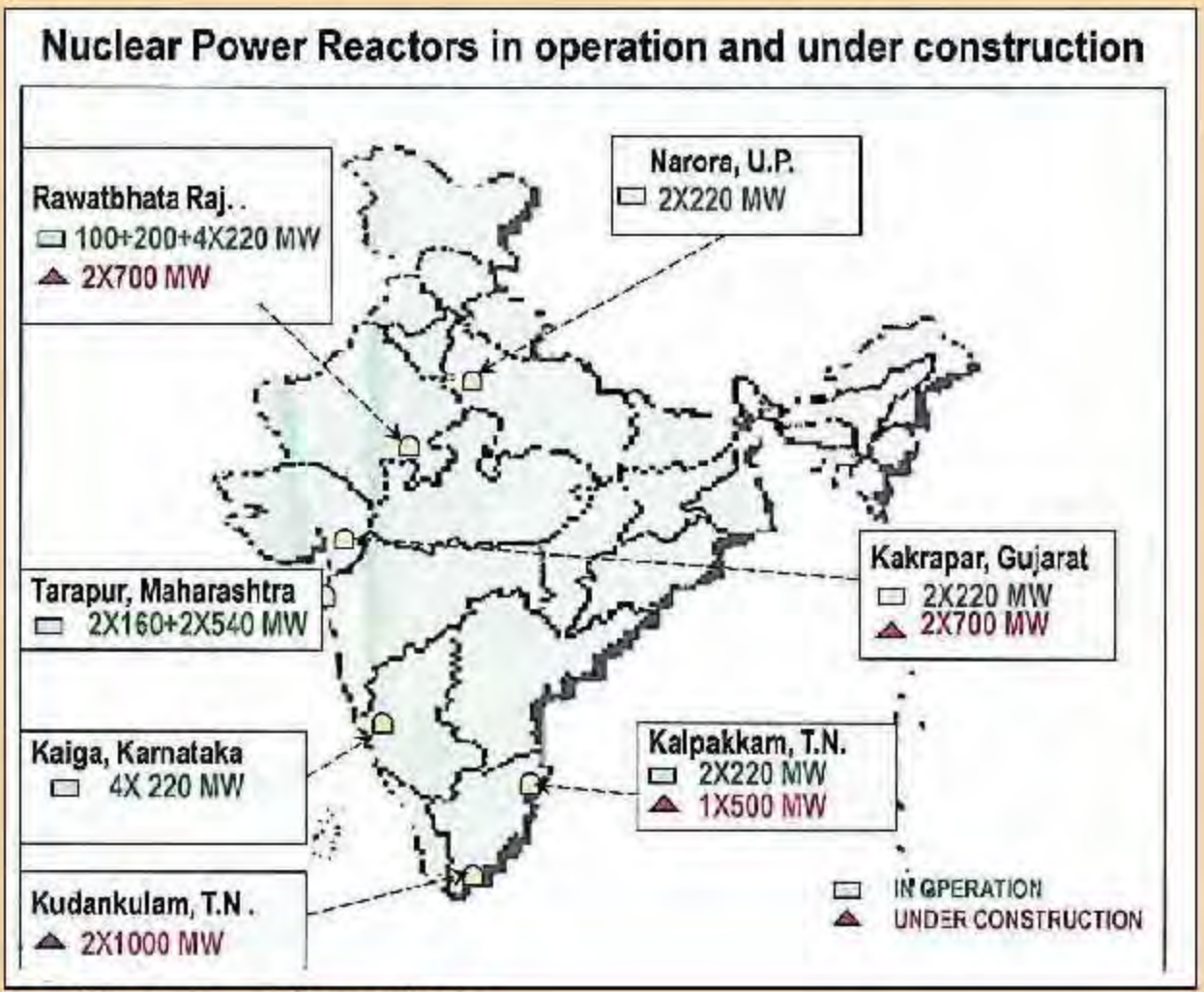
Power Statistics

Nuclear Power Plants in the Country

Region	Rajasthan Atomic Power Station			Indigenous Reactors Project	Location and Type	Capacity (MW)	Reactors with International Co-operation	
	Unit	Capacity (MW)	Date of Commercial operation				Type	Capacity (MW)
1.	RAPS-1	100	16-Dec-1973	GHAVP 1&2	Gorakhpur, Haryana PHWR	2 x 700	KKNPP 3&4 Kudankulam, Tamilnadu	2 x 1000
2.	RAPS-2	200	01-Apr-1981	CVAPP 1&2	Chutka, Madhya Pradesh PHWR	2 x 700		
3.	RAPS-3	220	01-Jun-2000	MahiBanswara, 1&2	MahiBanswara, Rajasthan PHWR	2 x 700	JNPP 1&2 Jaitapur, Maharashtra	2 x 1650
4	RAPS-4	220	23-Dec-2000	Kaiga 5&6	Kaiga, Karnataka PHWR	2 x 700		
5.	RAPS-5	220	01-Feb-2010	FBR 1&2	Kalpakkam, Tamilnadu; FBR	2 x 500	Kovvada, 1&2 Kovvada, Andhra Pradesh	2 x 1500
6.	RAPS-6	220	31-Mar-2011	AHWR	Location to be decided AHWR	300	ChhayaMithiVirdi, 1&2 ChhayaMithiVirdi, Gujarat	2 x 1100
Total Capacity		**1180**						

Source: CEA

Nuclear Power Reactors in operation and under construction



Source: Nuclear Power Corporation of India Limited (NPCIL)

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Power Sector Reforms

- An Overview

It was felt that Indian Power sector needed some reforms and restructuring. Accordingly some State Power Boards/ State Power sectors, took up this task and Odisha (Orissa) was the pioneer in this activity. Some doubts arose on the successful implementation of these reform activities. It is time for evaluation of these reforms Visa-vis the aims and objectives of such reforms. For success of any activity relating to any sector in the Country is through committed approach with honesty and nobility. To stand strong as a noble nation such qualities are essential.

- Er. Y G Krishna Swamy, Er. Y S S Ramesh

Two Decades back after detailed deliberations at different levels, need was felt for Power sector reforms considering the Power supply position prevailing then in the country. Orissa (Odisha) took the lead in initiating the Power sector reforms in the State. This reforms process started way back in 1994 with main aims and objectives of improving in quality and quantity of services, improvements in revenue realization and reduce the receivables, reduce the non-technical losses, improvement in plant and system performance, tariff reforms , increased efficiency, efficient use of Energy, attracting investment and such other related matters--- Also World Bank who were in the Power sector activities both in Centre and State sectors showed greater interest and enthusiasm for participating in the power sector activities in the country as a whole. This sort of attitude by the World Bank perhaps encouraged some States and Odisha for different reasons took the lead to undertake some structural changes in the power sector in the name of Reforms and restructuring. These reforms were aimed at restructuring the existing unified and composite Power sector by separating Generation, Transmission and Distribution (T & D) activities into different entities. Mostly State Power Boards were carrying these activities/responsibilities as a composite and unified sector with both plus and minus points. When the problems on managements of these systems have increased in some States, a thought came up that unbundling the sector (restructuring) may be an appropriate option which may improve the management efficiency with more focused attention to each entity, with gradual withdrawal of Government involvement in these sectors. It was also felt private sector participation in the Generation would be some advantage in capacity addition. But some impression was created sooner or later in some quarters that all was not that well in the process of unbundling. In this article some attempts are made to provide some views/impressions on the power sector in general and with a reference to Odisha experience, as the author was associated with the Odisha Power sector for a long time.

General

After the restructuring(or unbundling) of the Power sector in the state and as things stand, Odisha Hydro Power Corporation Ltd.(OHPC) , Grid Corporation of Odisha Ltd.(GRIDCO) (with not much of activity) Odisha Power Transmission corporation Ltd.(OPTCL) and four distribution companies operating under the four zones, are in position with the respective responsibilities. And of course Odisha Regulatory Commission as an autonomous three member body. In general, broadly this is the structure after the reforms and restructuring in different State power sectors where these activities were undertaken, with some adjustments here and there. In Andhra Pradesh the broad structure is APTRANSCO, APGENCO and zonal wise distribution companies and of course the AP Regulatory commission. Unlike in Odisha, APGENCO looks after both Hydro and Thermal generations. In Odisha thermal Generation is with different Organizations/ players including the private operators. Private sector participation in capacity addition both Thermal and Hydro generations is there in many States.

It is worth noting that some of the Views/opinions that came out in the past on the power sector reforms and restructuring. Some of such were- that no fruitful results were achieved from the Power sector reforms in the State, the experiments of bifurcation or trifurcation of State Electricity Boards (SEBs) and handing over to the private sector proved to be a disaster, power sector reforms triggered by Government' bankruptcy, power reforms in the State was a total failure-. The above observations were suggestive in totality that everything did not go well with the reforms. Reforms means, to make things better, to achieve improvements, to transform in to a better environment and such positive aspects. It was felt that only unbundling took place and the needed and aimed reforms could not be achieved suitably.

In some aspects, particularly on service matters and personnel matters there were some discouraging trends and the promised service conditions which would not be inferior to those before reforms perhaps did not take place. This is an area where failure was more prominent is some cases. In other words structural changes and unbundling was only effected and not the overall reformations as aimed and envisaged.

Doubts arise as to whether we came to a better situations from that of Pre reform era or otherwise. Also some views existed that existing system could have been reformed instead of going through the process of Reforms and Restructuring. Reinforcement and empowering the existing system with full Government support on positive lines could have achieved better results. Unfortunately that was not to be and no meaning the Post-morteming that aspects. But certainly one thing can be done with the political and administrative will is that to evaluate the results Visa-via, the aims and objective of Power sector

reforms envisaged then. This will provide whether we are in the right path or to contemplate an alternative better model or to revert to the existing pre reforms scenario. Such exercise and recommendations that would come out should be able to bring beneficial results to the system as a whole.

A brief mention on Indian Power sector. Indian Power sector grew in leaps and bounds. With more than 2 Lakh MWs of installed capacity from conventional energy sources, very large H.T, EHT, UHT transmission networks with the associated sub stations, transmission outlet, sub-transmission lines, unlimited number of distribution networks and associated distribution transformers, and the entire sector poses number of Challenges with again huge manpower at different levels. Yet Indian Power sector is doing well though much more to do even to meet the present power demand and what to talk on the future demands.

Demand of Power is galloping and supply demand gap is widening. Construction of new power projects associated transmission networks, inter-regional and inter-state power transfers, tariff and its regulation all are going to be a tough task for the present and future power sector. Andhra Pradesh suffered badly during 2012-13 on account of Power shortage almost throughout the year. There was mostly unreliable power supply where villages suffered with power cuts even beyond 12 hours a day.

Even in the urban and semi-urban areas power cuts ranged from 4 to 8 hours in a day for some days. These were not good symptoms in a developing environment. It was not simply due to the failure of monsoon, but also other reasons contributed to this situation. For any State to maintain round the clock power supply is a big challenge and is almost impossible in many States. I wonder if there could be any respite or relief from such situations.

Conclusion

In this article some attempts are made to discuss on the reforms in the Power sector. This attempt is only a small component on the pre and post power sector reform scenario, viewing from some angles. There could be different angles from which this aspect can be viewed and to present proper platform for suitable discussion and debate. Power sector is so vast that number of presentations can be made on different aspects relating to the sector. As envisaged in the aims of the reforms and restructuring, certain questions need to be answered and addressed. Could we improve the system efficiency? Could we able to reduce the Transmission & distribution losses at least by one percent? (Even one percent reduction in T & D losses is not less).Could we able to reduce the non technical losses in the system? Could we able to provide appropriate tariff for development of Industries? Could we able to satisfy the customers-with improved services and absolutely reasonable tariff without undue burden? (The argument that cost of every commodity is raising steeply, what not Electricity tariff, could not be ignored altogether, yet the interests of common man and middle class need to be protected). Evolution on such aspects along with other related factors would be helpful for evolving new models/methods as per the need.

In every aspect of life and living discipline is a must. The word discipline covers every good aspect of life and living. Discipline is a must for every democracy. Unfortunately India lacks that needed discipline leading to inefficiency and ineffectiveness in many aspects. The present Indian political environment has become a matter of concern and leading to frustration among the disciplined citizens, who are in absolute minority. Morality and moral values taken a back seat. Restoration of these values even to a reasonable level has become an unaddressable task.

I wonder how to address this sort of situations and who will address. Way back in 1961 our Professor in our Engineering college mentioned "Honesty is the noblest creation of God. "What a powerful and noble message was it? At least 50 % of the educated persons follow this in letter and spirit, the nation is going to be a strongest and noblest one in the coming periods. Can we be optimistic? May God Bless us to achieve this. ■

Er. YG Krishna Swamy, Graduated in Electrical Engineering in 1962 from the then Govt. College of Engineering, Kakinada (A.P). He joined Orissa Govt. and served in the Electricity wing between 1963 and 1998. He was associated with all the Hydro Power stations of State mainly in Operation and maintenance activities and closely associated with system operation control and Management aspects and with Power sector reforms project. Retired as C.E (Elec.) his last assignment being the Director (Operations), Orissa Hydro Power Corporation Ltd. He published number of papers mostly relating to Orissa Power sector.

Er. Y.S.S. Ramesh, B.Technology (Electrical) from College Of Engineering and Technology, Bhubaneswar. Presently Employed with The Andhra Pradesh Paper Mills Ltd. His interests are Power systems and operation & maintenance of Power Plants.

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Smart Grid Technology in India

The development and execution of a smart grid for power supply is one of the important issues in modern energy economy, given high national priority and huge investments, although the entire subject is still in its initial stage. Smart grid delivers energy from producers to the consumers in a bi-directional way. Bidirectional technology allows the utilities to take over the control of appliances in the consumer's houses and industries to save energy and to increase the overall efficiency of the electrical grid. A smart grid includes an intelligent monitoring system that keeps track of all the electricity that flows in the system.

- Dr N Kumarappan, Vigneysh T and Arulraj R

In India, the present day power system is the integration of generation, transmission and distribution system with centralized control. Due to their old infrastructure, the losses associated with the current system are very high. As the investment on the grid is less and due to manual operations, the reliability and continuity of the supply is reduced. So, it is essential to improve the reliability of the supply and to modify the infrastructure of the present day power system. It can be achieved by modifying the old grid into a smart

grid. The Smart Grid is an idea of a better electricity delivery infrastructure. Smart Grid implementations will certainly increase the quality and use of information available from advanced sensing, computing and communication system. As a result, they help utilities to address important issues such as global warming, unrelenting increases in electricity demand and an upturn in the trend in unit costs of electricity.

Effective use of Smart Grid technologies helps utilities in:

- Improved grid usage, grid efficiency, reliability and security.
- Better match of demand with supply of energy and grid congestion.
- Enable distributed generation.
- Allows customer to manage their consumption level and to take benefit of pricing and supply options.

Smart Grid Background

What are Smart Grids?

A smart grid is an electrical grid that uses information and communication technology together to improve how the electricity travels from power plants to consumers. Smart grid is collection of hardware and software that works together to make the grid smarter. When electrical infrastructure combines with information infrastructure there will be bidirectional flow of information in the grid and it makes the grid smarter. Smart grid integrates new and improved technologies, advanced sensing and measuring elements, integrated communication and security for the effective operation of the grid and so the reliability of the entire system is improved. Smart grid also includes the integration of renewable energy based power generation and on-site power generation (distributed generation) and so the environmental effects caused by the conventional power generation system is reduced. Main attributes of the smart grid include: automated operation, self-healing, intelligence, information based, bidirectional information flow, decentralized decision-making, monitoring the equipment in real time, reliability and its flexibility.

Potential benefits of the smart grid:

The smart grid presents a wide range of potential benefits, including:

- Optimizing the value of existing production and transmission capacity
- Incorporating more renewable energy
- Enabling step-function improvements in energy efficiency
- Enabling broader penetration and use of energy storage options
- Reducing carbon emissions and delivery efficiencies
- Improving power quality
- Improving a utility's power reliability, operational performance, asset management and overall productivity
- Enabling informed participation by consumers by empowering them to manage their energy usage
- Promoting energy independence.

Key drivers of smart grid

Today, the electricity supply industry is struggling with an unmatched array of challenges, ranging from a supply-demand gap to increasing costs and environmental impacts. These and other forces are driving the need to reinvent the

business. That, in turn, is driving the need for a smart grid.

India has limited experience with smart grid deployments and advanced metering, especially for small consumers. The factors that will drive India's adoption of smart grids include the need to reduce technical and commercial losses, resolve its chronic supply demand gap, and find a way to "leapfrog" into a more advanced electricity supply solution to satisfy its sustainable, low-carbon, high-growth economic development goals.

Drivers in India

In India, six factors drive the adoption of the Smart grid. They are as follows.

Renewable energy: India has supported the implementation of renewable energy. Historically, much of its support was for wind power, but the newly announced National Solar Mission and its goal to add 20,000 MW of solar energy by 2020 should be an accelerant. Spurred by environmental concerns and the desire to tap into all available sources of power, this move can also be a smart grid driver.

Peak load management: India's supply shortfalls are expected to persist for many years. A smart grid would allow more "intelligent" load control, either through direct control or through economic pricing incentives that are communicated to customers in a dynamic way. Such measures would help mitigate the supply-demand gap.

Loss reduction: India's aggregate technical and commercial losses are thought to be about 25-30%, but could be higher given the substantial fraction of the population that is not metered and the lack of transparency. While a smart grid is not the only means of reducing losses, it could make a substantial contribution.

Supply shortfalls: Demand, especially peak demand, continues to outpace India's power supply. The increasing affordability of household appliances is adding to the burden on the grid. Official estimates of India's demand shortfall are 12% for total energy and 16% for peak demand. Managing growth and ensuring supply is a major driver for all programs of the Indian power sector.

Managing the human element in system operations: Labor savings are not a prime driver for the smart grid in India, as contracts for outsourcing are inexpensive. However, automated meter reading would lower recording and other errors — including what are known elsewhere as "curb stone readings" or "shade tree" readings — or even deliberate errors, which are thought to be significant reasons for losses.

Technological leapfrogging: Perhaps the most intriguing driver for India is the potential to "leapfrog" into a new future for electricity, as it did with telecommunications. Also, the "smart" in a smart grid is ICT (Information and Communication Technology) and area of unique capability in India.

Need for Smart grid in India

Utility operations

Smart Grids can assist the utilities, as the principal focus of the utilities is to improve business processes. Many utilities have an extensive list of projects that they would like to fund in order to improve the customer service or to ease workforce's burden of repetitive work. Calculating Smart Grid benefits by the cost/benefit analysis it puts emphasis in favour of the change and can also significantly decrease settlement/payback periods. Mobile workforce group and asset management group work collectively to organize assets and then maintain, renovate, and replace them. Thus results in increased productivity and fuel saving from superior methods. Similarly, Smart Grid provides customers with real time information and encourages them to do on-line payments, thus lowering billing costs. Utilities can include these cost and service improvement in the list of Smart Grid benefits.

Costs

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and customers. And Smart Grids will not reduce funds expansion, of course; therefore huge investments are required in order to setup a link between the customers and the Smart Grid. Further with the aid of Smart Grids less generating units would be required in order to fulfil the energy demand of the growing population and cost of setting up more and more plants can be deferred. At that point of time, more emphasis will be on overall development of T&D efficiency based on demand response, load control, and many other Smart Grid technologies. Energy efficiency would be the second priority in order to save cost with reference to the customers. With timely and detailed information provided by Smart Grids, customers would be encouraged to limit waste, adopt energy efficient building standards, and invest more and more in energy efficient appliances.

Environmental impact

Smart Grid development is happening at a very fast pace because of the broad interest of policy makers and utilities in decreasing the adverse effect that energy usage has on the environment. Smart Grids uses technology to drive efficiencies in transmission, distribution, and consumption. As a result, fewer generating plants, fewer transmission and distribution assets are required in order to cater the growing demand of electricity. With the possible expectation of wind farm sprawl, landscape preservation is one of the evident benefits. Since maximum generation today results in emission of greenhouse gas, Smart Grids reduce air pollution and play a significant role in combating global climate change issue. Smart Grids has the capability to accommodate technical difficulties of integrating renewable resources like wind and solar to the grid and providing further reduction in greenhouse gas emissions.

Theft control

This is not an issue in developed countries like US, but in developing countries like India, where people have a little insight of the grid and higher poverty rate, power theft is quite common. With development of Smart Grid, power theft can be controlled to a greater extent, thereby improving the efficiency of our distribution system. Thus grids will provide high quality and reliable power supply and there will be fewer blackouts.

Economic Issues in Smart Grid

Smart Grid system enables bidirectional communication between consumers and electric power companies. In this system, electric power companies receive consumer's information in order to provide the most efficient electric network operations. At the same time, consumers get better access to data to help them make intelligent decisions about their consumption. Thus, project economics will need to reflect the benefits to both consumers and utilities.

A top-down review of smart grid projects reveals that a large capital outlay will usually be required to fund the various aspects of implementation. The primary costs will include automated metering infrastructure, customer systems such as in-home displays and digitally controlled appliances, and electric distribution and transmission system grid automation.

The primary benefits includes:

- lower operating and maintenance costs
- lower peak demand
- increased reliability & power quality
- reduction in carbon emissions
- expansion of access to electricity
- lower energy costs from fuel switching and home automation.

Cost-Benefit Analysis

The cost benefit analysis of smart grid includes following objectives.

- Develop a common cost-benefit methodology that can be applied across all smart grid demonstrations (approved by financing sources and regulators).
- Ensure that the methodology can easily accommodate changes and expansion.

In order to analyze the economics of the smart grid projects, one needs to consider various scenarios with selected elements being implemented in a phased manner. This section presents a high-level framework for identifying the typical costs attached to the various elements of smart grid and the potential benefits associated with its projects.

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Smart substations – include the monitoring and control of critical and non-critical operational data such as power factor performance, security, and breaker, transformer and battery status.

Smart distribution - is self-healing, self-balancing and self-optimizing, including superconducting cables for long-distance transmission, and automated monitoring and analysis tools capable of detecting or even predicting cable and other failures based on real-time data on weather, outage history, etc.

Smart generation - capable of "learning" the unique behavior of power generation resources to optimize energy production, and to automatically maintain voltage, frequency and power factor standards based on feedback from multiple points in the grid.

Intelligent appliances - capable of deciding when to use power based on pre-set customer preferences. This can go a long way toward reducing peak loads, which has a major impact on electricity generation costs by alleviating the need for new power plants and cutting down on damaging greenhouse gas emissions. Early tests with smart grids show that consumers can save up to 25% on their energy usage by simply providing them with information on that usage and the tools to manage it.

Economic benefits – Five types of economic benefits can be derived from the smart grid.

- Reduced industrial consumer costs
- Reduced operations and maintenance costs
- Cost savings from peak load reduction
- Reductions in capacity costs

Service benefits – Smart Grid will bring benefits to residential, commercial and industrial customers like:

- Improved reliability
- Increased efficiency of power delivery
- Consumption management
- Improved system security
- Enhanced business and residential consumer service

Barriers in Implementation of Smart Grid

High capital and operating costs: Capital and operating costs include large fixed costs linked to the chronic communications network. Hardware costs do not cause in significant growths in economies of scale and software integration possess a significant delivery and integration risks.

Technical challenges: Technology is one of the essential constituents of Smart Grid which include a broad range of hardware, software, and communication technologies. In some cases, the technology is well developed; however, in many areas the technologies are still at a very initial stage of development and are yet to be developed to a significant level. As the technologies advances, it will reduce the delivery risk; but till then risk factor have to be included in the business situation.

On the hardware side, speedy evolution of technology is seen from vendors all over the world. Many recently evolved companies have become more sceptical to the communications solutions and have focused on operating within a suite of hardware and software solutions. Moreover the policy makers, regulators, and utilities look upon well established hardware providers for Smart Grid implementation. And this trend is expected to continue with increasing competition from Asian manufacturers and, as a consequence, standards will naturally form and equipment costs will drop as economies of scale arises and competition increases.

On the software and data management side, the major challenge is to overcome the integration of the entire hardware system and to manage high volume of data. With multiple software providers come multiple data formats and the need for complex data models. In addition, the proliferation of data puts stresses on the data management architecture that are much similar to the telecommunications industry than the utilities industry. Many of these issues are currently being addressed in pilots such as Smart Grid task force and, as a consequence, the delivery risk will reduce as standards will be set up.

Lack of awareness: Consumer's level of understanding about how power is delivered to their homes is often low. So before going forward and implementing Smart Grid concepts, they should be made aware about what Smart Grids are? How Smart Grids can contribute to low carbon economy? What benefits they can drive from Smart Grids? Therefore, consumers should be made aware about their energy

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consumption pattern at home, offices etc. Policy makers and regulators must be very clear about the future prospects of Smart Grids. Utilities need to focus on the overall capabilities of Smart Grids rather than mere implementation of smart meters. They need to consider a more holistic view.

How to Overcome the Barriers in Implementation?

Despite the challenges mentioned above, there are many number of step that can be taken to speed up the implementation of smart grid technologies. Foremost step that is required to be taken is that policy-makers and regulators need to restructure the economic incentives and align risk and reward across the value chain. By building the right economic environment for the private sector investment and focusing more broadly about the way that social value cases are created and then the presented implementation would become much easier. By analyzing these solutions in bigger environments i.e. in cities, the entire industry will learn what it takes to implement smart grids successfully and will result in developing an industry that is set to boom in the coming periods.

Increasing awareness on smart grids

There is an imperative need to make the society and the policy makers aware about the capabilities of a Smart Grid. The main step is to form perfect, universal description on the common principles of a smart grid. Beyond agreement on a characterization, the matter also needs to be debated more holistically as a true enabler to the low-carbon economy, rather than as an investment decision to be taken within the meeting room of distinct utilities. The importance of consumer education is not to be under estimated. The formation of user-friendly and state-of-the-art products and services will play a significant role in convincing the society about Smart Grids. Also the utilities are required to scrutinize the major challenges in implementation of Smart Grid and their impact on their business model and operations.

Creating a fresh pool of skills and knowledge

Successful implementation of the smart grid will require a large number of highly skilled engineers and managers mainly those who are trained to work on transmission and distribution networks. As a result to on-job training and employees development will be vital across the industry. Simultaneously, there is a requirement for investment in the development of relevant undergraduate, postgraduate and vocational training to make sure the availability of a suitable workforce for the future. The investment in T&D should not be limited and neither in research and knowledge development, which would be essential for the development of this sector.

Enabling distributed generation and storage

Smart grids will change where, when and how energy is produced. Each household and business will be empowered to become a micro-generator. Onsite photovoltaic panels and small-scale wind turbines are the predominant examples; developing resources consist of geothermal, biomass, hydrogen fuel cells, plug-in hybrid electric vehicles and batteries. As the cost of traditional energy sources continues to rise and the cost of distributed generation technologies falls, the economic situation for this evolution will build.

Achieving greater efficiency in energy delivery

Smart Grid Technology should consider building greater efficiency into the energy system which would result in reduction of losses, peak load demand and thereby decreasing generation as well as consumption of energy. New regulatory framework which incentivizes utilities for reducing the technical losses would help utilities to perform more efficiently.

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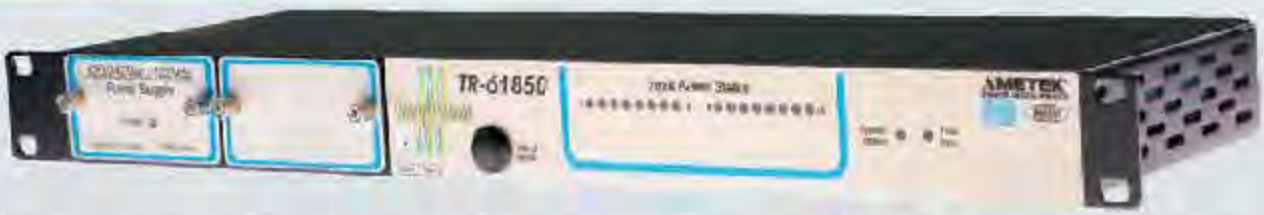

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Smart Grid Vision and Roadmap for India

Customers:

- Expand access to electricity "Power for All"
- Improve reliability of supply to all customers – no power cuts, no more DG sets and inverters
- Improve quality of supply – no more voltage stabilizers
- User friendly and transparent interface with utilities

Utilities:

- Reduction of T&D losses in all utilities to 15% or below
- Peak load management – multiple options
- Reduction in power purchase cost
- Better asset management
- Increased grid visibility
- Self-healing grid
- Renewable integration

Government & Regulators:

- Satisfied customers
- Financially sound utilities
- Tariff neutral system upgrade and modernization
- Reduction in emission intensity

Smart grid priorities for India:

- No power cuts, "Prosumer" enablement
- Reduce Transmission and Distribution losses, Improve quality of supply; and revenue cycle optimization
- Manage peak power, Demand Response
- Integrate Renewables/ Distributed generation efficiently

Smart grid vision for India:

"Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem by 2027 that provides reliable and quality energy for all with active participation of stakeholders"

Smart Grid Pilots in India

- ISGTF (India Smart Grid Task Force) mooted the idea of promoting 8 smart grid pilots in the country in different distribution utilities
- ISGTF issued model specifications and guidelines to utilities for choosing the pilots and technology partners
- 50% of the project cost will be funded by Govt. of India (under Restructured Accelerated Power Development and Reforms Programme); rest to be borne by the utility fully or shared between the utility and the technology partner
- 17 utilities submitted DPRs in Dec 2011 /January 2012. 14 Projects allocated in July/August 2012
- Average size of these pilots is USD 10 million

NSGM Roadmap – Targets

12th Plan (2012-2017)	13th Plan (2017-2022)	14th Plan (2022-2027)
• Access to "Electricity for All" • Reduction of transmission losses (>66 kV) to below 3% • Reduction of AT&C losses in all Distribution Utilities to below 15% • Reduction in Power Cuts; Life line supply to all by 2015; grid connection of all consumer end generation facilities where ever feasible • Renewable integration of 30 GW; and EV trials • Improvement in Power Quality and Reliability • ToU (Time of Use) Tariff • Energy Efficiency Programs • Standards Development for Smart Grids including EVs • Strengthening of EHV System • Efficient Power Exchanges • Research & Development, Training & Capacity Building • Customer Outreach & Participation • Sustainability Initiatives • SG Pilots, SG roll out in major cities	• Reduction of transmission losses (>66 kV) to below 2% • Reduction of AT&C losses to below 12% in all Utilities • Improvement in Power Quality • End of Power Cuts; Peaking power plants; Electrification of all households by 2020 • Nationwide smart meter roll out • Renewable integration of 70 GW; • Standards Development for Smart Infrastructure (Buildings, Roads/Bridges, Parking lots, Malls) and Smart Cities • UHV and EHV Strengthening • Research & Developments; Training & Capacity Building • Export of SG products, solutions and services to overseas • Customer Outreach & Participation • Sustainability Initiatives & Public Safety	• Reduction of AT&C (Aggregate Technical and Commercial) losses to below 10% in all Utilities • Financially viable utilities • Stable 24x7 power supply to all consumers across the country • Renewable integration of 120 GW; 10% EV penetration • Smart Cities and Smarter Infrastructures • Export of Smart Grid products, solutions and services to overseas • Research & Development; Training & Capacity Building • Active Participation of "Prosumers" • Sustainability Initiatives & Public Safety


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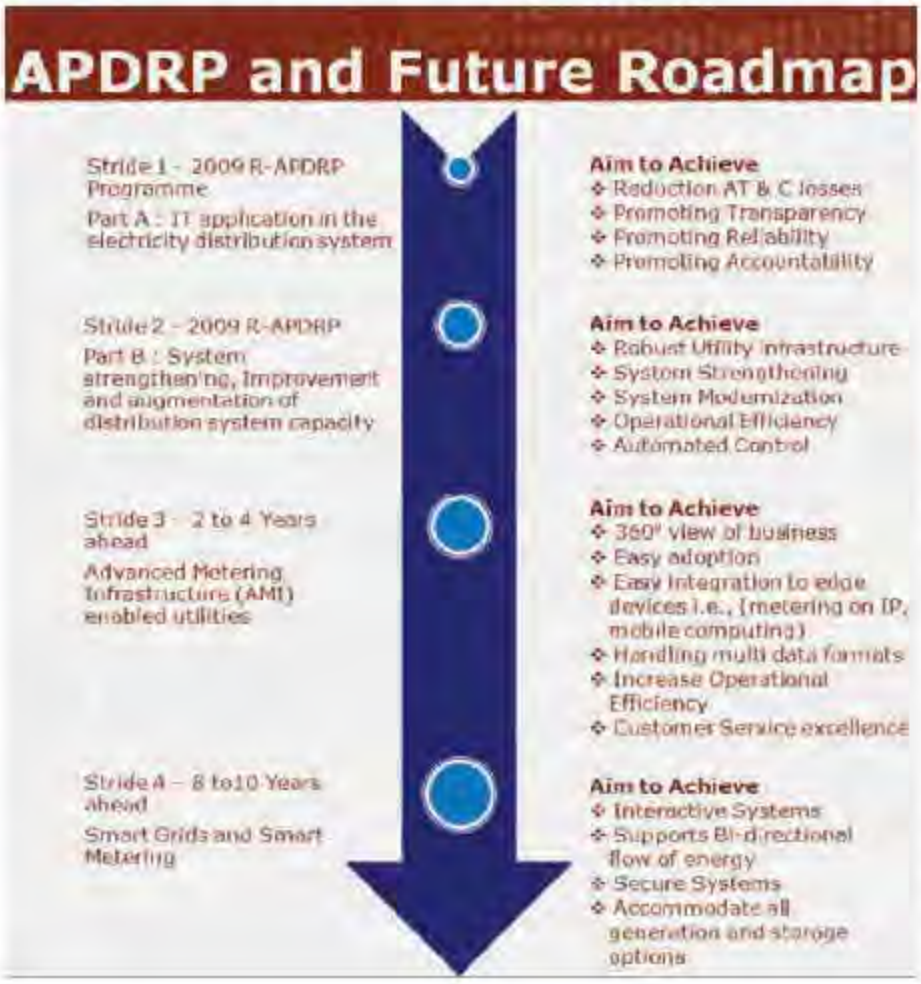
The following functionalities have been proposed in the 8 pilot projects:

S.No.	Functionality	Objective
1	Residential AMI (Advanced Metering Infrastructure)	Demand Response, Reduced AT&C
2	Industrial AMI	Demand Side Management, Reduced AT&C
3	Outage Management	Improving availability and reliability, Proactive maintenance
4	Peak Load Management	Optimal resource utilization, Distribution capacity enhancement, Load curtailment
5	Power Quality Management	Voltage Control, Reduced losses and failures, Decrease in reactive power and harmonics
6	Micro Grid	Improved Power Access in rural areas, Renewable Integration, Reduced carbon emissions
7	Distributed Generation	Distributed Generation
8	Combined Functionality as at 1,2,4,5 above	Improved Power Access in rural areas, Sustainable Growth, New technology implementation

Smart Grid Activities in India

- APDRP, R-APDRP initiative for distribution reform (AT&C focus)
- DRUM India: Distribution Reform Upgrade, Management
- Four pilot sites (North Delhi, Bangalore, Gujarat, Maharashtra)
- Smart Grid Vision for India
- Smart Grid Task Force: Headed by Sam Pitroda
- BESCOM project, Bangalore: Integration of renewable & distributed energy resources into the grid
- KEPCO project in Kerala: $10 Billion initiative for Smart Grid
- L&T and Telvent project, Maharashtra: Distribution Management System roll-out
- Distributed generation via roof-top solar for 40% in a micro-grid



Conclusion

In this article, we have seen what smart grid is and about various key challenges in implementing the concept of smart grid in India. In most of the advanced countries Utilities have made major achievements in terms of productivity, reliability, and efficiency through the use of Smart Grid technology. Indian utilities are still lagging far behind when compared to other countries. Today their main focus is on providing energy at reasonable price but soon the day will come when the utilities will be focusing on encompassing

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sustainable use and environmental improvement into their agendas. Smart Grids will play a vital role to help utilities in accomplishing this mission. So, the utilities will need to invest heavily in new hardware, software, business process development, and staff training.

Further there would be high investment in home area networks and smart appliances by the customers. Achieving the broader view of Smart Grid will require complex task prioritization and right set of policies and regulations to be in place. Justifying its implementation however requires a full understanding of the long-term benefits it would bring to the customers, utilities, societies in terms of minimizing the cost and improved customer service. In addition to these benefits it would play important role in addressing global issues like energy security and climate change. ■

Dr N Kumarappan, presently Professor in Annamalai University graduated from Madurai Kamaraj University, post graduated from Annamalai University and PhD at CEG Anna University under QIP fellowship, AICTE. He has published more than 90 international papers. His research interests include power system operation and control; power system reliability and artificial intelligence techniques. He is a Life Fellow of the Institution of Engineer's (India) and a Life Member of the Indian Society of Technical Education. He is an IEEE Madras Section Education Activity Chair and a Coordinator for more than 20 IEEE Madras Section organized FDP, SSDP, Workshop and TISP programs. He was the recipient of the IEEE Madras Section Motivation Award in 2010 and the Certificate of Appreciation. He is a Reviewer and Session Chair for IEEE/IET-U.K., international conferences & other international journals. He was the recipient of the IEEE-NNS Outstanding Paper Travel Grant Award and the IEEE PES Student Program Award.

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"Indian market for wire and cable is projected to grow at 1.5 to 2 times that of GDP growth in the long run"

Horace CC Tan
Commercial Director, Asia Pacific Region
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Dow combines the power of science and technology to innovate what is essential to human progress. The Company connects chemistry and innovation with the principles of sustainability to help address many of the world's most challenging problems such as the need for clean water, renewable energy generation and conservation etc. Dow's diversified industry-leading portfolio delivers a broad range of technology-based products and solutions to customers in approximately 160 countries and in high-growth sectors such as electronics, water, energy, coatings and agriculture. The Company's more than 5,000 products are manufactured at 188 sites in 36 countries across the globe. In an exclusive interview with **Electrical India, Horace CC Tan** says, we are partnering with various parties to elevate the quality standards for power cables.

You are heading the commercial organization for Electrical & Telecommunications Region, Asia Pacific. How much lucrative you find the Indian market?

With a $1.8 Trillion USD economy and an annual growth rate of 5.5%, India offers significant potential. Secondly, the per capita consumption of electricity in India is approximately 900KWh which is far below China with an approximate consumption of 3300 Kilo Watt hour per capita.

There is strong correlation between the GDP growth and electricity demand. Electricity is a core industry and is an essential element for the development of infrastructure and agriculture. The Ministry of Power is pushing for an increased spending in R&D, providing a boost for the industry. In the short-term, we see some stagnation, but in the long run, India remains a region for growth.

In the last couple of years, while the demand for Dow's materials in India (XLPE, Semiconductive shields) has been stable and growth is as per our expectation, we remain very much focused in the country and will continue to be a driver and contributor to India's growth.

Currently, we are the only company in India with dedicated resources in sales, technical and marketing support to serve our customers.

What is your perspective about the wire and cable for power sector in India vs Asia-pacific region?

For the wire and cable market for power cables, Dow has products ranging from Low voltage, Medium voltage (MV), High voltage (HV) to extra high voltage (EHV). In the telecommunications cables industry, we have insulation materials for copper and radio frequency cables and polyethylene (LDPE, MDPE, HDPE) jacketing. The Indian market for wire and cable is projected to grow at 1.5 to 2 times that of GDP growth in the long run. We have seen an increase in the number of customers compared to previous years, as well as an increase in capacity building – mainly in MV, HV and EHV.

The power cables are the backbone for the reliable power distribution. The end consumers' requirements and expectations are increasing and power cuts are not tolerated. The quality standards and specification for power cables in India are not modernized. The first step to create reliable power cables is to establish the standards for the cables to be in line with best practices in developed markets. For example, in China, they have already taken steps towards improving the conditions with state run tests and the establishment of research houses in line with industry standards, and are inclusive of the wet aging test to differentiate the good, better and best to elevate the overall quality of the cables. The first wet aging study conducted by Wuhan High Voltage Research Institute from China showed that cables made with poor quality local XLPE material could not pass the 360 day test and failed within 160 days. It goes to show that the quality of the material matters.

How essential it is to expand the wire and cable infrastructure for India? What future do you see for the same?

One of the major concerns for India are the high losses incurred, sometimes up to 30%, because of proliferation, theft, subsidies, etc. The use of power cables instead of bare overhead conductors could be one way to reduce the amount of loss due to theft. In India, there are many examples of how losses can be reduced by using underground cables. Utilities such as Reliance Energy, BSES, Tata Power Delhi Distribution Limited have shown dramatic reduction in losses through various measures including use of power cables.

The cost of right-of-way and aesthetics are other important reasons that the distribution companies prefer power cables. There are challenges faced by the industry even in the use of underground cables for trenching and installation and newer ways of installation are needed. Horizontal drilling should make the process easier and expedite the installation of the power cables.

The underground power cable system can help to reduce the losses while beautifying the surroundings, hence the demand for the cables is expected to grow at faster rate.

What new standards have been evolved for safety and sustainability of power?

In today's competitive world, conserving limited resources and stretching the product life are important factors for sustainability. Dow is committed to using resources more efficiently, providing value to our customers and stakeholders, delivering solutions for customer needs and enhancing the quality of life of current and future generations. DOW Endurance category of products are focused on reliability and longer lifespan, ensuring the most effective use of the natural resources, while at the same time lowering the total cost for the utilities. At Dow Electrical & Telecommunications (E&T), we understand that one of the greatest challenges in the cable industry today is to adopt green, sustainable solutions while also maintaining quality, safety and performance. With our newly developed DOW ECOLIBRIUM bio-based Plasticizers, it provides a renewable alternative that is free of phthalate and lead, with the same performance excellence and feel of standard plasticizers - and at a competitive price. DOW ECOLIBRIUM bio-based Plasticizers meet all regulatory requirements for flame resistance, while increasing customer's potential for LEED and other carbon credits. As they are made from renewable content, Dow ECOLIBRIUM Plasticizers will reduce greenhouse gas emissions by 40% compared with existing PVC compounds, minimizing the carbon footprint of the product and the dependence on crude oil.

What solutions does the company provide for cable applications in the Indian Market?

Dow E&T offers a comprehensive portfolio of materials and technologies that set new standards for performance and reliability in power and telecommunications applications.

The materials from Dow E&T are backed by more than 60 years of industry expertise, global technical support and reliable supply.

We have the complete solution offerings for power cables, from the semi-conductive shield, XLPE insulation (up to the 400KV rated cables) to the jacketing compound for both telecommunication and power cables. All products are backed by strong proven track record

of quality and reliability. We are the only integrated facility with a manufacturing base in different parts of the geography, allowing us to optimize our customer service.

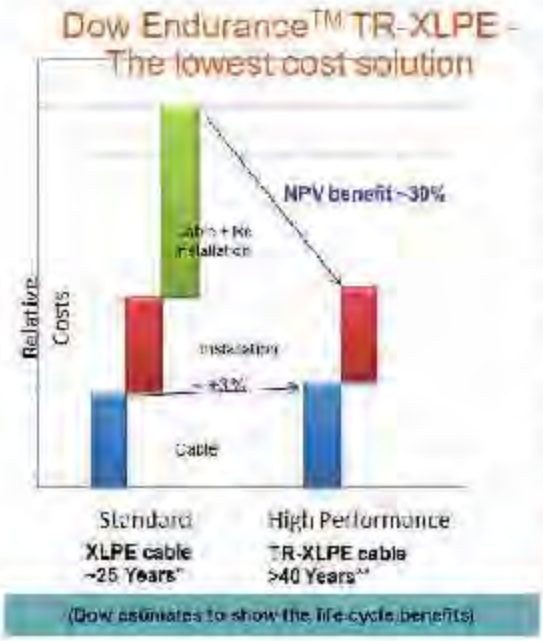
What is the product range offered by Dow Electrical & Telecommunications for Power industry? Could you state its cutting edge strategy over other similar products?

The range offered by Dow for the power industry is the DOW ENDURANCE MV/HV/EHV Insulation. It is a family of semiconductive and insulation materials for medium voltage (MV), high voltage (HV) and extra-high voltage (EHV) cable constructions developed to last. MV cables made with DOW ENDURANCE 4202 tree retardant crosslinked with polyethylene (TR-XLPE) insulation show little wear after more than 25 years of use and have an expected life span of over 40 years.

DOW ENDURANCE HV/EHV materials have been used globally for cables ranging from 69 kV to 500 kV for more than 10 years. Dow Electrical & Telecommunications' (E&T) clean manufacturing, packaging and logistics practices help assure cable manufacturers and utilities of years of durable and reliable underground cable function without the fear of contaminants that can lead to cable failure. DOW ENDURANCE 7708 jacketing compound used in MV, HV and EHV cables has excellent extrusion properties to allow for thin gauge extrusion.

DOW ENDURANCE TR XLPE is an example of Dow E&T continuing its commitment to bring higher-value products to the industry, by demanding ongoing product development in order to consistently deliver higher-quality, reliable cable with longer-life and improved ease of installation. Over time, Dow has demonstrated that proper material selection and high-quality cable manufacturing are critical to the performance of the cable in field applications. As part of the Dow Inside program, Dow E&T has worked with selected wire and cable manufacturers for their considerable manufacturing experience and expertise.

The cables made with DOW ENDURANCE TR-XLPE provide the lowest life cycle cost option. The initial material price for DOW ENDURANCE TR-XLPE 4202 will have premium of approximately 10% over DOW ENDURANCE 4201HC, which may have a marginal, incremental (1-5%) premium for the cables. However, there will be an approximate 30% cost benefit on NPV basis over a life cycle of the cables.



(Dow estimates to show the life-cycle benefits)

What initiatives are taken by you towards the power industry that benefits cable industry?

DOW ENDURANCE MV category of products are developed to assure the life span of more than 40 years. Dow E&T has the dedicated resources to engage the entire value chain, from utilities and industrial users to research and testing organizations to create the right awareness while the team works continuously to upgrade the standards and specifications for the MV power cables in India and globally. Some of the Indian utilities and other end users have since adopted DOW ENDURANCE TR-XLPE.

We are partnering with various parties to elevate the quality standards for power cables in the region to help ensure peace of mind throughout the value chain.

What strategies would you suggest for overall development and expansion of wire and cable industry domestically and globally?

Through strong collaborations and a drive towards sustainability it will raise the standards for more innovative solutions, geared towards a more developed India.

What is your vision for the next two years?

Being an established global company with years of manufacturing experience, Dow is well positioned to further strengthen our position in Asia, especially India. The completion of the Sadara joint venture with Saudi Aramco, Sadara in mid-2015, will mark the largest petrochemical facility ever built in a single phase. Sadara and the adjoining PlasChem Park will establish a world-scale manufacturing footprint that will deliver a full range of value-added, performance products destined for the emerging markets of Asia Pacific, the Middle East, Eastern Europe and Africa. ■

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Shinji Yamabe
Managing Director
Mitsubishi Electric India

Mitsubishi Electric India Private Limited (MEI) was established in 2010 as a comprehensive sales company of Mitsubishi Electric Corporation and Yamabe was assigned as the first Managing Director of this company. Businesses including Factory automation and industrial products, Air-conditioners for both residential and commercial applications, Visual & imaging products, Railway systems, Power devices such as IGBT are being promoted under the leadership of Yamabe. Mitsubishi Electric India's sales & service network covers widely across India with 17 offices to facilitate the access to the customers and satisfy the customers' needs. In an exclusive interview with **Electrical India, Shinji Yamabe** says, MEI is now fully geared-up to provide the Japanese Technology Products specifically designed for India.

You have been associated with Mitsubishi Electric Corporation for over three decades. Could you share your journey experience till becoming first managing director of MEI.

I started my career with Mitsubishi Electric Corporation in 1982, in charge of satellite communications earth station projects. After 25 years of experience in telecommunications sector including 12 years in France and UK, was assigned as leader of "India Project" to strengthen the Mitsubishi Electric's business in India. It was then in 2010, that Mitsubishi Electric India Private Limited (MEI) was established as a comprehensive sales company of Mitsubishi Electric Corporation and I was assigned as the first Managing Director of this company.

What is your perception about automation in the power sector in India?

Automation has huge scope in power sector be it at the generation level or transmission & distribution and the last mile connectivity level.

Automation plays a vital role in terms of power generation plant, Scada system & making whole process highly automated to make the overall plant efficient and cost effective. Similarly automation can also be used in transmission & distribution for decreasing the loses and making the T&D system efficient. Automation can be highly adopted by utility companies for the last mile coverage. There is a huge scope of automation in India in power sector.

Would you share your experience as to how challenging the task was when you were assigned for 'India Project' to grow Mitsubishi Electric's business in India?

It was very challenging task to set up business in India. Although we did business in India since 1950's, we worked through distributors and agents. When MEI was set up in 2010, we had to change our pattern of operations, set up the infrastructure, and get a hold of the market. This journey started as branch office at two locations, today we can boost of a Pan India presence with Sales Office, Satellite offices & a PAN India network of Dealers & System Houses; manufacturing Unit, R&D, Exclusive brand outlet, etc we have come a long way, yet long way to go. The journey has been challenging and therefore exciting. We established our network and registered our company with various regulatory bodies e.g. VAT, Excise, Import/Export, Import license for importing air conditioners etc for direct business and presence.

Could you share with us the product range that are suited to Indian Market and also detail us on the sales & service network across India?

We have different product range for Indian market under all the business units. We operate through dealers, System Integrators & distributors. For Air conditioner segment we have Residential Air-Conditioner range, VRF for industrial and commercial purpose. For Factory automation segment, PLCs, VFD (inverters), Servo, Robotics, LV8 and CNC products to suit the Indian Industrial sector. For Visual Imaging, We have Video wall and Medical & Photo printer.

We are catering to different segments e.g. Government Bodies, Educational Institutes, Shopping Malls, Commercial Building etc. for data wall and Hospitals, pathological labs for CT Scan, MRI Scan & other investigating tools by Medical Printers and Photo studios with Photo Printers. For Power Semiconductor, we have distributors & specifiers.

We are the preferred vendor for power devices for traction, renewable energy, induction heating and UPS solutions. We operate through Mitsubishi Electric India's sales & service network and cover widely across India with 19 offices to facilitate the access to the customers and satisfy the customers' needs.

What have been your priorities in Indian market? Do you have plans to launch more new product for the India Market?

We are focusing on Factory Automation & Industrial Div, Air-conditioners Dept., Transportation and Power Semiconductor. For industrial market we are focusing on automation product for energy saving product line and VRF for Air conditioner.

We have introduced Jet Towel (Hand dryers) to Indian market. We have also launched new Air conditioner models for residential segment as well. As a part of the growth plan for Factory Automation and Industrial Division (FAID), we are planning for many more products which are energy efficient and suitable for Indian Market. Mitsubishi Electric launched a new range of Final Distribution products namely; Miniature circuit breaker (MCB), Residual current circuit breaker (RCCB), and Isolating switch and Distribution boards (DB), L-series Compact PLCs, the FX 3GE and FX 3S range of Micro PLCs, the futuristic and energy efficient J4 & JE Servo Motor and Amplifiers and Industrial robots keeping in mind the needs of Indian Market to supply products better suited to the Indian market.

We established R&D centre in Pune for the factory automation and industrial business along with the product marketing teams. Transportation department is also our area of focus. We have got good success and securing maximum railway projects in India with various Metro Rail projects. We have a good market share in Delhi Metro, Bangalore Metro, Mumbai Metro, Chennai Metro, Hyderabad Metro, Kolkata Metro & Jaipur Metro.

Can you mention your company's prominent products specifically suited for India? And what response are you receiving from the same?

We have different product range under all the business vertical for Indian Market, We are getting a very good response for all our products. We have seen good amount of growth as being a new sales company in India.

In terms of Transportation, metro rail project among the transportation segment is the major contributor. Our rolling stock products of metro railways projects are governing biggest

market share in India. In FAII, we have 8 to 10% market share and we are partnering with top companies in Manufacturing sector for their automation needs.

We have got good response from various verticals like Automotive, Pharma, Textile, MTBs, F&B, Water, Oil & Gas, etc.Similar in our Power semiconductor business, we are the preferred vendor for power devices for traction, renewable energy, induction heating and UPS solutions. We are securing decent market share in Power Devices segment.

Could you share details about power devices solution for efficient control?

Mitsubishi Electric power modules are at the forefront of the latest energy innovations that seek to solve global environmental issues while creating a more affluent and comfortable society for all. Some of these innovations are photovoltaic (PV) and wind power generation from renewable energy sources, smart grids realizing efficient supply of power, hybrid/electric vehicles (HVs/EVs) that take the next step in reducing carbon emissions and fuel consumption, and home appliances that achieve ground-breaking energy savings. Whether in appliances, railcars, EVs or industrial systems, our power modules are key elements in changing the way energy is used.

What has been the contribution of Mitsubishi Electric towards Indian Market and what strategies do you have for cutting edge over competitors in the same line of solutions?

The main strategy of MEI is the constant Research and Development that we do to ensure that the best technology is made available to the consumer.

Also, MEI markets and distributes environmentally well-considered consumer and industrial products and devices, and also supports the infrastructure-related systems business in the rapidly-growing country.

Where do you envision the company in the next two years?

MEI is now fully geared-up to provide the Japanese Technology Products specifically designed for India as it has size to match customer's needs, strength to create innovation and support to render personalized services and to ensure the best comfort for all customers. We hope to claim a greater share of the market in the coming years. ■

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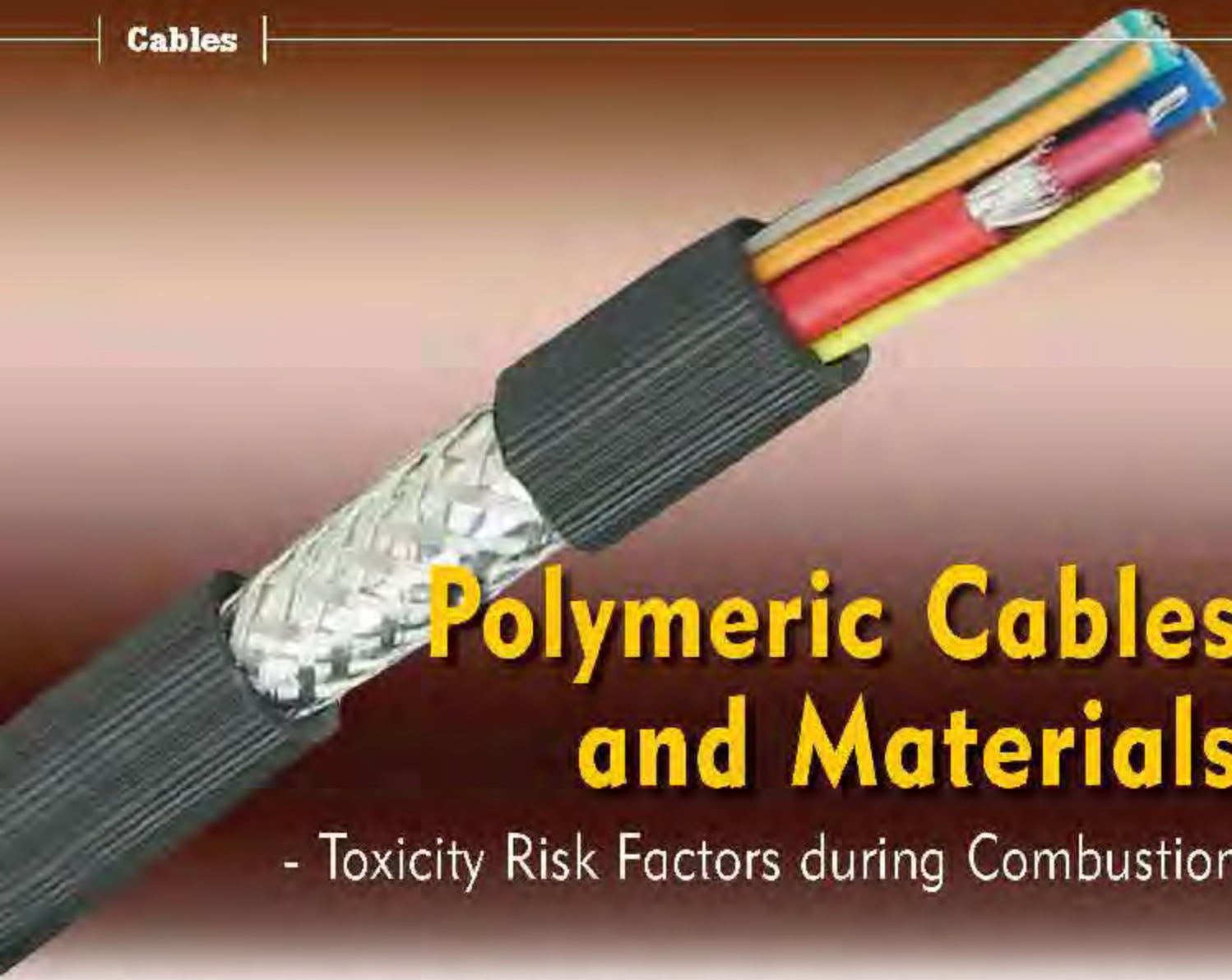

Polymeric Cables and Materials

- Toxicity Risk Factors during Combustion

The generation of lethal combustion products is of primary importance in the assessment of "fire hazard" materials used in any industry. Polymeric materials are widely used for various applications such as in the manufacture of electrical & electronic equipments, machines and components, construction and furnishings, consumer items, buildings, aircrafts, automobiles trains, buses etc.

- B Nageshwar Rao, Ms. R Arunjothi and A R Srinivasan

In electrical industry polymeric materials are extensively used in the manufacture of transformers, HV equipments, Cables, Bushings, Cable trays, Channels, Feeder pillar boxes, Energy meter covers, terminal blocks, Supporting insulators, PVC conduit pipes etc. These materials are susceptible to burn when subjected to heat. Fires involving in these polymeric materials may cause the loss of life as well as damage to the facilities and equipment. They also spread flames and produce smoke, toxic and corrosive fumes.

The toxic products can cause both acute and delayed toxicological effects. Hazards associated with fires have been of great concern. Therefore interest has centered around in the development of polymers which evolve less smoke and toxic gases.

Central Power Research Institute (CPRI), Bangalore, India which has got test facilities for HRR measurements using cone calorimeter

(ASTM 1354/ ISO 5660), Wire/ cable bunch flame propagation (IEC 332-3/IS 10810(P-62), Smoke density of wire/cable (IEC 61034 (1,2)/IS 10810(P-63), ASTM E 662 for optical smoke density, ASTM 2843 for smoke density from the burning or decomposition of plastics, Limiting oxygen index (LOI) test as per ASTM 2863 / IS 10810 (P-58), Toxicity index test as per NES 713/NCD 1409 / IEC 754 part 1 & 2, UL 94 for flammability of plastics, IS 7888 tests for flexible polyurethane foam, Fire survival test (IEC 331/ BS 6387 category B, W & Z) etc. to carry out various fire reaction tests and has been assisting various manufacturers in developing polymeric materials with less smoke and toxic gases and improved low flammability materials.

Toxic Products of Combustible Polymers

Polymeric materials are generally composed of hydrocarbons and are specifically made of small units bonded into long chains. Carbon makes up the backbone of the molecule and hydrogen atoms are bonded along the backbone. There are polymers that contain only carbon and hydrogen like Polypropylene, polybutylene, polystyrene and polymethylpentene. Even though the basic makeup of many polymers is carbon and hydrogen, other elements can also be involved. Oxygen, Chlorine, Fluorine, Nitrogen, Silicon, Phosphorous and Sulfur are other elements that are found in the molecular makeup of polymers. Polyvinyl chloride (PVC) contains chlorine. Nylon contains nitrogen. Teflon contains fluorine. Polyester and polycarbonates contain oxygen. Some inorganic polymers have a silicon or phosphorous backbone instead of having a carbon backbone.

Polymeric Cables

Electric cables are designed to carry power and communications for long distances and can act as pathway along which fire can travel and spread. They also act as an area of significant fire hazard because of the medium of high fuel loading represented by the insulating and sheathing materials. There are cable installations where large number of cables are installed vertically. Vertical orientation of cables also permits preheating action, upto the installation by developing flames. For decades PVC compounds are being used as insulation material in cable manufacturing due to its excellent mechanical and chemical properties. Halogen acids, which are generally produced from these materials during combustion, are highly suffocating and can cause problems of corrosion to electrical apparatus and metallic structures even months after the fire.

In recent years with more stringent legislation throughout the world, there is an increasing number of applications requiring halogen-free products. PVC materials are replaced with LSOH materials which are free of Chlorine, Fluorine, Bromine and Iodine. They are being extensively deployed in numerous types of safe and environmental friendly products all over the world.

Factors influencing fire and smoke characteristics

The generation of heat, smoke, toxic and corrosive fire products depends on several factors.

- The generic nature of the materials and presence or absence of additives such as fire retardants
- The shape, size and arrangement of the materials
- The presence or absence of the combustibles & heat sources
- The availability of air and the movement of fire products with air and the presence or absence of fire suppression/ extinguishing agents.

Corrosive gas emissions

Polymeric cables containing halogens, sulphur and phosphorous all form corrosive acid gases and liquids. Emissions of hazardous and corrosive gaseous substances are quantified by the Acid gas tests and Toxicity tests. Widespread recognition of the potential hazards of acidic gas emissions from burning materials has not been accompanied by a corresponding effort on assessment methods or on the consequences of exposure. Test methods to evaluate corrosivity involve direct measurement of the amount of acid gas produced during pyrolysis or measurement of pH and electrical conductivities of solutions.

Toxic gas emissions

The toxic gases evolved during combustion of materials are very dangerous and harmful to human life and equipment. Though not much attention was focused on this subject earlier, considerable progress is being made in "fire hazard assessment" techniques. In recent times there are large number of possible assessment methods being formulated, but there is no single test or procedure has emerged which can be confidently used to assess the human toxicity risk presented by a burning material. In most fires the nature and concentration of gaseous products change as fire develops. Several gas species are involved and the biological influences singly and synergistically are very difficult to interpret.

Material Evaluation Techniques

The fire and smoke characteristics of various materials are evaluated

by several test methods in the industrial countries of the world and more are being published every year.

The fire safety requirements in the international standards are based on exigencies of the fire behaviour of individual materials that are made up of. In United States the fire safety is addressed through small scale flammability and smoke emission tests and performance criteria based on guidelines by Federal Railroad administration (FRA) and National Fire Protection Association (NFPA) etc.

The FRA test methods include measures of material flammability and smoke in terms of downward flame spread (ASTM E 162, D 3675 and E 648). FAR 25.853 (a) and ASTM C-542 are small burner tests which measure a materials resistance to ignition and burning for a small sample of the material.

ASTM E 662 measures the smoke generation from small, solid specimens exposed in (i) a flaming mode to a radiant heat flux of 35 kW/m2 and (ii) a non-flaming mode to only a radiant heat flux of 25 kW/m2. The European National standard (BS 6853) German standard DIN 5510, French standard NF F 16101/2 are generally adopted for evaluation of materials. However these standards are likely to be withdrawn and replaced by one standard EN45545: Railway applications fire protection of railway vehicles part 2.

This standard covers the requirements of fire behaviour of materials and components for cables; Vertical flame spread (EN 50266-2-4) IEC 332 part 3, Specific optical density (EN -50268-2) IEC 1034. Smoke optical density and toxicity (ISO-5659-2), Ignitability of curtains, sunblind and air filter materials, lateral flame spread (ISO 5658-2). Seat assemblies are tested using furniture calorimeter or cone calorimeter.

Heat Release Rate (HRR) test methods are used to predict the real-scale burning behaviour of materials and assemblies as it quantifies fire size, rate of fire growth and consequently the release of associated smoke and toxic gases.

HRR is considered to be a key indicator of fire performance and is defined as the amount of energy that a material produces while burning. MARHE the maximum average rate of heat emission is another parameter which is used to assess the fire behaviour of materials. In fire situation as the HRR of materials increase, the air temperature increases and thus the people could be injured from high temperatures, heat fluxes and toxic gases emitted by materials involved in fire.

Evaluation of Corrosive gas Emission

To assess acid gas yield under 'representative' fire conditions of cable insulating and sheathing materials, a chemical titration method as per the guidelines discussed in IEC 754 1 standard can be followed. Fig 1 shows the test set up.

For materials with halogen content less than 5% and for zero halogen compounds this method is not suitable. For Zero halogen materials an IEC standard 754-2

Fig. 1: Test set-up for determining Halogen Acid by titration (IEC 754 -1)

Fig. 2: Test set-up for determining Acid Gases by pH & Conductivity (IEC 754 - 2)

Sl. No	Type of Cable	Amount of Halogen acid (%)
1.	PVC Insulated & PVC Sheathed cable	Sheath : 7.4 Filler : 0.5 Insulation : 10
2.	EPR Insulated & Thermo Polyolefin Sheathed cable	Sheath : < 0.1 Filler : < 0.1 Insulation : < 0.1

Table 1: Percentage of halogens present in different types of cable

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method (Figure 2) is adopted for the determination of degree of acidity of gases evolved during the combustion of compounds by determining pH value and conductivity. Table 1 show the typical values obtained on different cable materials.

The amount of halogen acid is calculated in mg of HCl/gm of the sample. The safe limit value is 200 mg/g.

Evaluation of Toxic index of combustible gases

The toxicity Index is defined as the numerical summation of the toxicity factors of selected gases produced by complete combustion of the material in air. The evaluation of the toxicity is made through the determination of the following gases: Carbon oxides (CO, CO2), Halogen acids (HCl, HBr, HF), Hydrogen cyanide (HCN), Nitric oxides (NOx), Acrylonitrile (CH2CHCN).

Fig. 3: Toxicity index apparatus

Toxicity (NES 713/ NCD 1409)

This test explores the toxicity of the products of combustion in terms of small molecular species arising when a small sample of a material is completely burnt in excess air under specified conditions. Fig 3. shows the test chamber used for determining the toxicity of a material.

The chamber consists of an airtight enclosure of at least 0.7 m3 volume lined with opaque plastic sheeting material having a sliding door fitted with a transparent plastic panel. This test explores the toxicity of the products of combustion in terms of small molecular species arising when a small sample of a material is completely burnt in excess air under specified conditions. Typical gas concentration by polyolefin cables are given in Table 2 [1]. To exemplify

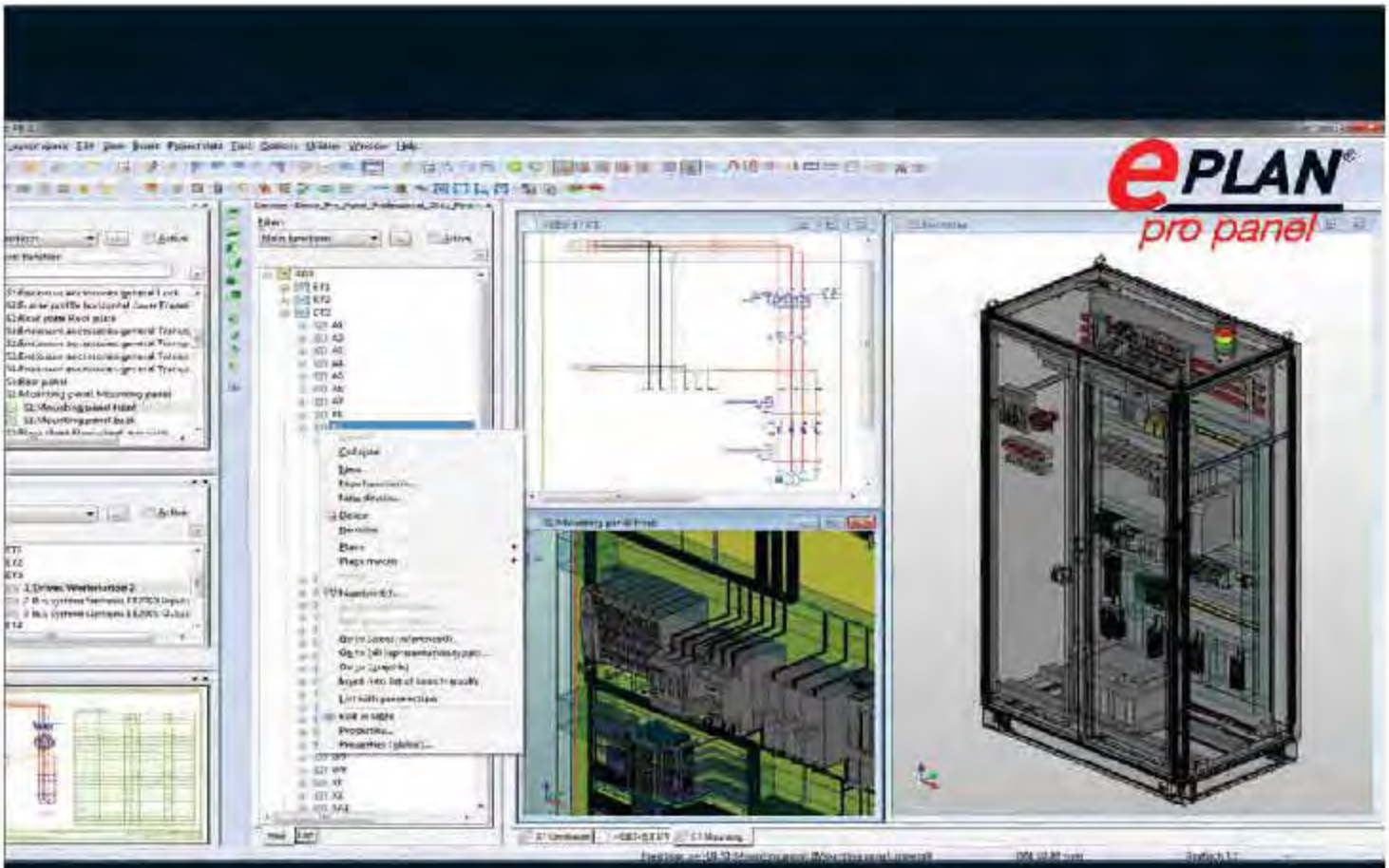
Sl. No.	Gases	Measuring sensitivity (ppm)	Insulation	Filler	Sheath	Ref NES 713
1.	Carbon Monoxide	1	3000	2200	4000	4000
2.	Carbon Dioxide	5	26000	26000	18000	100000
3.	Hydrogen Sulfide	1	< 1	< 1	< 1	750
4.	Ammonia	2	3	4	6	550
5.	Formaldehyde	1	4	7	5	200
6.	Hydrogen chloride	5	< 5	< 5	< 5	400
7.	Acrylonitrile	0.1	< 0.1	< 0.1	< 0.1	400
8.	Sulphur Dioxide	10	< 10	< 10	< 10	400
9.	Nitrogen Oxides	1	5	14	5	250
10.	Hydrogen cyanide	2	< 2	< 2	< 2	150
11.	Hydrogen bromide	1	< 1	< 1	< 1	150
12.	Hydrogen fluoride	3	< 3	< 3	< 3	100
	Toxicity Index		1.37	0.98	1.34	□ 2*

Table 2: Typical Gas Concentration values (ppm) of Polyolefin cable
*Average weighted mean

Sl. No	Type of Cable	Amount of Halogen acid (%)
1.	PVC Insulated & PVC Sheathed cable	Sheath : 13.25 Filler : 1.35 Insulation: 14.85
2.	EPR Insulated & Thermo Polyolefin Sheathed cable	Sheath : 1.34 Filler : 0.96 Insulation : 1.37

Table 3: Typical values of toxicity index of cable materials

Fig 4: Cone Calorimeter



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Description of the material	Sample numbers	Gases detected	Total Toxicity Index
Laminated densified wood	A, B, C	CO2, CO, Acrylonitrile	0.9987, 0.9481, 0.9551
FRP Board	MF, MMF, PP	CO2, CO, NOx, HCHO, Acrylonitrile	1.7891, 1.8257 0.3378
FRP/GRP phenolic material	A, B	CO2, CO, Acrylonitrile	0.7923, 0.7843
Polycarbonate material	A	CO2	1.0521
Fire Retardant Curtain Cloth	A	CO2, CO, HCHO, phenol	0.3875
	B	CO2, NOx	0.8849
PVC Coated Nylon Fabric	A	CO2, CO, NOx, HCl	2.8871
Solid layered PVC Coated Upholstery Cloth	A	CO2, CO, HCl	0.719
	B, C	CO2, CO, NOx, HCl	2.5366, 3.8739
Rubber sample	A	CO2, Acrylonitrile, HCHO	0.7482
Densified thermal bonded polyester blocks	A, B, C, D, E	CO2, CO	0.4939, 0.6364, 0.4377, 0.4728, 0.4174
Flexible PVC vinyl flooring	A, B, C	CO2, HCl	2.6297, 3.2200, 1.3319
Graphite Polyurethane foam	A, B	CO2, CO, NOx, HCHO, Acrylonitrile	1.9082, 2.7038
Polyurethane foam (Slab stock)	A, B, C, D, E, G, F	CO2, CO, NOx, HCl HCHO, Acrylonitrile	3.2846, 5.299, 3.850, 5.2427, 3.7998, 6.3002, 4.6306
High density moulded polyurethane foam	A, B	CO2, CO, NOx, Acrylonitrile,	6.1599, 6.2064
	C, D E, F,G	CO2, CO, NOx, HCHO, Acrylonitrile	3.6968, 2.7742, 4.7426, 3.022, 3.6475
	H, I	CO2, NOx, HCHO, Acrylonitrile	2.6909, 4.4305
PVC Insulated & PVC Sheathed cable	Sheath, Filler, Insulation	CO2, CO, NOx, HCHO, HCl, Sulphur dioxide, H2S Ammonia, Acrylonitrile	13.25, 1.35, 14.0
EPR Insulated & Thermo Polyolefin Sheathed cable	Sheath, Filler Insulation		1.35, 0.87, 1.2

Table 4: Typical values of toxicity index of materials

the improvements reached with halogen free cables Vs the PVC ones, a comparison between two Low voltage cables are given in Table 3. It is noticed from Table 3 that the Toxicity Index value of a new generation cable is one order of magnitude lower than that of PVC cable which represents remarkable improvement in safety.

Table 4 presents the toxicity index values of different polymeric materials that were evaluated in the laboratories of CPRI. The end user requirement of toxicity index is less than one. However from the table 4 it is seen that only certain materials like densified wood, FR boards, fire retardant curtain fabrics, thermal bonded polyester cushioning materials meet the requirement.

The cushioning materials polyurethane foams: rigid, slab stock have toxicity index values ranging from 3 to 6. Attempts are being made by several manufacturers to develop materials whose toxicity levels are below the specified limits of < 1.

Advanced Techniques

The cone calorimeter (Figure 4) is a small-scale instrument that measures rate of heat release of materials under a wide range of conditions, using the oxygen consumption technique. Subsequent to its standardization, instrumentation developments on the Cone Calorimeter have focused on some advanced research needs. These include extensive gas measurement facilities and controlled atmosphere Calorimeters. Because the burning environment

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ASTM D229 - Method 1 - Burning rate, Method 2 - flame resistance
ASTM D635/IS 11731(P-1,2) - Burning rate in vertical position
ASTM D1929 - Self and flash ignition temperatures
ASTM D2584 - Ignition loss of cured reinforced resins
ASTM D2843 - Smoke density from the burning or decomposition of plastics
ASTM D2859 - Flammability of finished textile floor covering materials (methenamine pill)
ASTM D2863/IS 10810(part-58) - Limiting oxygen index (LOI)
ASTM D3014 - Flame height, burning time, loss of weight for plastics
ASTM D3065 - Flammability of aerosol products
ASTM D3675 - Surface flammability of flexible cellular materials
ASTM D3801 - Comparative extinguishing characteristics of solid plastics in a vertical position
ASTM D3874 - Ignition of materials by hot wire sources
ASTM D4804 - Flammability characteristics of non-rigid solid plastics (Methods A and B)
ASTM E84 - Surface flammability characteristics of building materials
ASTM E136 - Behavior of materials in a vertical tube furnace
ASTM E162 - Flame spread using a radiant panel
ASTM E603 - Full scale room burn test
ASTM E648 - Critical heat flux of floor coverings using a radiant panel
ASTM E659 - Auto ignition temperature of liquid chemicals (AIT)
ASTM E662 - Optical smoke density
ASTM E681 - Flammability (explosion) limits of chemicals (UEL, LEL)
ASTM E800 - HCN, Hydrogen Cyanide measurement using the colorimetric method
ASTM E906 - Heat and visible smoke release rates
ASTM E1317 - LIFT - Lateral flame spread
ASTM E1321 - Material ignition and flame spread properties
ASTM E1354 - Cone Calorimeter
ASTM E2058 (FM 4910) Screening Test- Screening test for clean room test
ASTM F814 - Smoke density for aerospace applications
AITM 2.0005 (7.1.6) 60 degree flammability
AITM 2.0008 (7.3.3) Optical smoke density
AITM 3.0005 (7.4) Toxicity
ATS 1000.001 - Flammability, smoke, toxicity, and heat release
BELLCORE GR-63-CORE - Telecommunications equipment fire resistance
BIFMA X5.7 - Furniture flammability
BMS 13-48 - Smoke and toxicity
BSS 7230 Flammability testing of aircraft materials to FAR Part 25, Appx F, Part 1
BSS 7322 - Determination of heat release using OSU
BSS 7324 - 60 degree flammability, smoke, and toxicity
BSS 7238 - Optical smoke density
BSS 7239 - Toxic gas generation
CAL 106 - Resistance of a mattress or mattress pad to combustion from smoldering cigarettes
CAL 116 - Cigarette test of upholstered furniture
CAL 117, Sect A, Part I - Flame retardance of resilient filling materials used in upholstered furniture

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CAL 121 - Flammability test procedure for mattresses in high risk occupancies
CAL 129 - Flammability test procedure for mattresses for use in public buildings
CAL 133 - Flammability test procedure for seating furniture for use in public occupancies
CFR vol. 16, 1610 - Std. for the flammability of clothing textiles (45 deg. angle test)
CFR vol. 16, 1632.4 - Mattress flammability
CPAI 84 - Tent fabric flammability
DIN 4102, Part 1, Class A1 - Ignition (only)
DOT 173.338-18(b)(7) - Flammability using a red hot platinum wire
FAA/FAR 25.853 - Flammability tests
FAA/FAR 25.855 - Flammability tests
FED STD 191A, Method 5903.1 - Flammability of cloth in a vertical direction
FED STD 191A, Method 5903.2 - Flammability of cloth in a vertical direction
FMVSS302 - Automotive interior flammability
HALOGEN CONTENT - Determination of the halogen content level
IEC 331 - Fire characteristics of electrical cables
IEC 332-1 - Single wire/cable flame propagation
IEC 332-3/ IS 10810(P-62) - Wire/cable bunch flame propagation
IEC 695-2-2 - Fire hazard testing; needle flame test
IEC 754-1 - Evolved combustion gases of wire/cable
IEC 754-2 - Acid gas
IEC 1034 (1,2)/ IS 10810 (P-63) - Smoke density of wire/cable
IEEE 383 - Cable tray flame spread
IEEE 45 - Cable tray flame spread
IMO A.652(16) - Upholstered furniture flammability test
IMO A.653(16) - LIFT - Flammability of marine surface finishes
ISO 4589-2 - Determination of burning behavior by oxygen index
ISO 5660 - Cone Calorimeter
ISO 9705 - Room burn facility and modified (1/2 scale and 1/4 scale) room burn
MIL 2031 Fire/Toxicity tests for composites used in submarines
MIL C-24643 - Acid gas
Mobil 45 deg - Flammability test calculating weight loss for rigid urethane foams
MSC.41(64) - Smoke and toxicity products of combustion
NES 711 - Smoke
NES 713 - Toxicity
NES 715 - Temperature Index
NFPA 225 - Surface flammability characteristics of building materials
NFPA 258 - Optical smoke density
NFPA 264A - Cone calorimeter
NFPA 701 - Flame resistant textiles and fibers
NFPA 1971 - Flame resistance of cloth in a vertical direction (Fed. Std. 191A, Method 5903.1)
Room Flammability Tests - 12'x12'x12' (adjustable ceiling height)
SMP 800-C (Modified) - Combustion toxicity
UL 94 V Series - Vertical flammability
UL 94 HF Series - Horizontal flammability
UL 214 - Flame propagation of fabrics and films
UL 723 - Surface flammability characteristics of building materials
UBC 8-2 - Full scale room burn test

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Facts to Remember

Exposure by Inhalation

- Respiratory system is most potentially hazardous route of intake of poisoning - asphyxiants reduce or eliminate oxygen uptake - irritants mucus, nasal, skin - anesthetics – loss of consciousness - lacrymators cause tearing, gagging
- Small volumes within the aveoli and bronchi tend to trap aerosol particles in the micron size range
- Tidal volume of lungs is small compared to stagnant volume – a long time is required to fully exchange
- Strong irritants can cause swelling which closes passageways and products asphyxiation.

of the Cone Calorimeter is considered to be a good representation of the majority of actual fire conditions, chemical sampling is often done as a supplement to the standard test procedures. Some gases (CO, CO2, H2O, total unburned hydrocarbons) can readily be monitored with dedicated real-time gas analyzers. Other gases (HCN, HCl, HBr, SO2, NOx, TDI) can be batch sampled, then analyzed by ion chromatography.

Alternatively, by Fourier Transform Infrared (FTIR) spectrometers have been explored for real-time analysis of numerous gas species simultaneously. The Cone Calorimeter produces large amounts of data: curves of heat release, smoke, and mass loss, also often of CO, CO2, and other gas yields.

Measures of Toxicity

Carbon Monoxide, CO

Gases	TLV
Carbon Monoxide(CO)	TLV = 100 ppm
Carbon di-oxide(CO2)	TLV = 5000 ppm
Hydrogen Cyanide(HCN)	TLV = 10 ppm
Hydrogen Sulfide (H2S)	TLV = 10 ppm
Sulfur Dioxide(SO2)	TLV = 5 ppm
Nitrous Oxide(N2ONitric Oxide (NO)	TLV = 25 ppm
Nitrogen Dioxide (NO2)	TLV = 5 ppm
Ammonia (NH3)	TLV= 50 ppm

Toxic Gases and their Threshold Limiting Values

- Hemo toxin; combines with hemoglobin 300 times more readily than Oxygen.
- TLV is 100 ppm. Our body can tolerate 0.01% in air.
- @ 1000 ppm (0.1%) causes headache and nausea
- @ 10,000 ppm (1%) results fatal to adults in 1 min.

Carbon Dioxide, CO2

- TLV is 5000 ppm (0.5%) ; present atmosphere is 320 ppm.

Hydrogen Cyanide, HCN

- TLV = 10 ppm; 0.2-5.0 ppm is the odour threshold (almond smell).
- @ 100 ppm, causes death in 1 hour,
- @ 180 ppm, causes death in 10 minutes
- @ 280 ppm, immediately fatal.

Conclusion

Central Power Research Institute, Bangalore has several test facilities to evaluate polymeric materials for flammability & smoke characteristics. Facilities have been augmented for determination of corrosive gases and toxicity index of the products of combustion from small specimens of materials.

Acknowledgement

The authors thank the management of CPRI for the permission to present this article. ■

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"Manufacturing testing equipment catering to both Primary and Secondary side of power system"

Imteyaz Siddiqui
Regional Manager,
South Asia & Middle East
ISA Advance Instruments India Pvt Ltd

ISA Advance Instruments India Private Limited, a subsidiary company of ISA s.r.l., Italy, has been specializing in electrical test equipment for the power industry for over 70 years, providing leading edge technology with innovative and reliable products. ISA is a leading worldwide provider of Advanced Test and Measurement System to diversified industries such as electrical utilities, power equipment manufacturers, petrochemical & chemical Industry, and electrical testing service companies. ISA maintains global operations in 80 countries across 5 continents. Their test instruments are developed, designed and constructed to comply with the most used international standards. In an exclusive interview with **Electrical India, Imteyaz Siddiqui** remarks, our products comply with all the relevant IEC, IEEE, ANSI standards.

What is your perception about testing and measurement systems under your region of control? And how do you see their scope in India market?

South Asia and Middle East are, at the moment, among the few markets that have a tremendous growth potential. South Asia, particularly, has a lot of potential because it consists of developing countries. Middle East, as always, is doing quite well; especially Qatar and Abu Dhabi are leading the show. We Indians are trying to fulfil the gap between the power demand and supply, and we are expecting to bridge this gap substantially in the next few years. Test and measurement equipment play an important role in maintaining the robustness of our electrical system. Although in the last few months we have seen some slow down, but I am confident that the scenario will be positive in 2014 onwards.

Besides India, Bangladesh and Sri Lanka have a tremendous potential. I am expecting Nepal also to open up, as the political stability is returning there.

Could you share with us the wide range of Testing Devices and the demand of the same in the Indian Market?

The Indian market is really interesting. It has a wide range of customers, of which some are quality conscious and others are price conscious. Hence, the competition becomes really tough.

At ISA, we are manufacturing testing equipment catering to both the Primary and the Secondary side of power system. On the one hand we have equipment that are worthwhile for the utilities and on the other we also have instruments that are good for the manufacturing sector. As the power sector is growing at a regular pace, the demands for testing devices are ever-growing. Our instruments are also very helpful in estimating the Residual Life Assessment (RLA) of the electrical devices that are in service for a long time.

Online monitoring of electrical assets is going to be another important opportunity in the near future. Many customers are now looking forward to continuous monitoring of their important (and costlier) assets, which undoubtedly will create an important market for us. In this scenario, the market demand will encompass not only hardware and software supports but also an expert advice for the analysis of data obtained from the continuous monitoring. We, at ISA, are gearing up to cater to this requirement from this emerging market.

What is the overall market scenario in South Asia and Middle East? What policies do you adhere to enhance the business and customer relationship?

In any business scenario, where the competition is cut throat, the customer relationship becomes very important. Timely response to a customer's problem creates a niche market for us. Ours is very small world, and the word-of-mouth publicity makes a huge difference, both in favour and against. One satisfied customer will make way for many new customers and one dissatisfied customer will ensure you lose the business consistently.

Our policy is quite simple and time tested. We are providing proactive support to all our customers. Our engineers are accessible to our customers whenever they need us. We put our customers first and leave no stone unturned to cater to their requirements.

I have seen that many companies at times neglect their existing customers, by not taking their calls or not attending to their complaints. In the longer run, these companies lose their customers' trust and confidence, allowing them to move to their competitors. Hence, we encourage our engineers to take customers' calls even if they are in meetings and seek time to respond back on the basis of their urgency.

What marketing strategies are you planning to boost the sales of company's products in the South Asia and Middle East?

Here also, our strategy is very simple. We are ensuring that we are reachable and accessible to all our existing customers/prospective customers, irrespective of the physical distance between us.

We are not only enhancing our brand name by spending lots of money on the advertisements, but also building our customers' confidence by providing them good-quality equipment at a reasonable price. We do not go out to sell our equipment aggressively. In fact, we spend time with our prospective customers to understand their present requirement, then we assess their future requirements, and then only we suggest them one of our products. These extra efforts are now recognized by our customers, and they consider us different from other run-of-the-mill suppliers.

How challenging it is for you to encounter and overcome major competitors in South Asia and Middle East?

It might sound naïve but we do not consider our competitors as our rivals. In fact, we consider them as stake holders. Because of them we are always on our toes and cannot get complacent. In South Asia, we have three levels of competition: first is from International (European/American) suppliers like us, second is from Chinese manufacturers who are also very active nowadays, and third is from local manufacturers.

In the Middle East, the competition is mainly among the International suppliers like us.

Could you update us on the development of a state-of-art technical resource centre in NOIDA that you are working with?

Our focus is to develop a technical resource centre in NOIDA as a world-class centre – not only as a repair or after-sales support centre but also as a technical resource hub. We plan to build a team of good professionals and competent engineers who can provide application support to the entire South East Asia and Middle East from here.

Could you highlight various standards that your products comply with and what strategies do you adhere to promote the ISA brands?

Our products comply with all the relevant IEC, IEEE, ANSI standards.

They are also CE marked. All the instruments are rigorously tested in our factory during the manufacturing process and before the final shipment to customers all over the world. I would like to pin point four different market scenarios in which an equipment manufacturer is measured by their prospective clients. First, if both their product quality and service support are not up to the mark. In this scenario, they are doomed. Second, if their product quality is not good but their service support is good. Customers initially try their products but eventually get fed up with the regular breakdown of their products. Third, if their product quality is very good but their service support is not so good. In this case the customers still buy their products until one day when they get frustrated with their lack of commitment and support. In fourth category, however, are the suppliers whose both, product quality and service support, are excellent, they are the champion and the ultimate winner in the longer run. Our consistent endeavour is to be amongst the fourth category by incorporating the feedback from our customer spread over the whole world.

What is your vision for the region in the next two years?

Our vision is to become the supplier of first choice to all our customers. This is not easy but we are determined. We are changing market dynamics with our pro-active support to all customers. We are constantly striving to fulfil our commitments to all the stakeholders of power system set up. Only the time will tell us how much we succeed in our endeavour. ■

Need for Adoption of Solar Water Heater Systems Awards Given in the Solar Water Heater and Concentrating Solar Technologies

Minister of New and Renewable Energy Dr. Farooq Abdullah has highlighted the need for greater propagation about the solar water heating system. Speaking on the occasion of the Award distribution function on Solar Thermal Systems in the Capital, he said that solar water heating can save tremendous amount of energy. He emphasized on the need for having more number of sale and service professionals/ entrepreneur in this area so that people have access to renewable sources of energy. He exuded confidence that the target of generating 20,000 Megawatts through the Jawaharlal Nehru Solar Mission by the year 2022 would be achieved. The awards were given in the category of Solar Water Heating Systems and Concentrated Solar Thermal Systems. A total of 28 awards were distributed which include awards to State Nodal Agencies, beneficiaries and Channel Partners of the Ministry. The award for the First Position among State Nodal Agencies for Solar Water Heating Systems was given to Gujarat Energy Development Agency, Gandhinagar. The award for the First Position among State Nodal Agencies for Solar Water Heating Systems relating to percentage increase in SWHS installation was given to Ladakh Renewable Energy Development Agency, Ladakh. Best Website on Solar Water Heating System Award was given to National Informatics Centre (NIC), Ministry of Communication and Information Technology. Best State Nodal Agency for use of Dish Solar Cookers and the award for highest number of SWHS installations in special category states was given to Uttarakhand Renewable Energy Development Agency, Dehradun.

Kargil Renewable Energy Development Agency(KREDA), Kargil-Ladakh (J&K) was awarded Best State Nodal Agency for largest installation of domestic Green Houses for the purpose of growing vegetables in extreme climatic conditions for the year 2012-13. Earlier, the Minister also released two Knowledge documents developed by the Ministry in partnership with UNDP-GEF that includes success stories and video films on installations, fliers on Concentrating Solar Technologies and a Compendium of such technologies available. ■

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Solar Power: the Bridge to Future Rural Electrification

The world has stepped into 21st century. In this era of technological revolutions and instantaneous communications, significant parts of India cannot get 24X7 electric power supply. Electrical power has become a prime necessity for any country for economic development. Power shortage is a dominant problem, being faced by the most of the developing countries today. On the top of this, the conventional fuel sources for power generation i.e. coal & oil deposits are fast getting depleted. The obvious way out, is to shift focus to renewable sources of energy.

- P M Menghal, Dr. A Jaya Laxmi & Dr. Uma Rao K

In a country like India our villages which are remotely located, always suffer from power cuts or grid failure although they have enough potential and resources to generate their own power. But due to lake of technology know-how, they are unable to tap their resources to generate power in a distributed manner. To provide some solution to this problem we can develop distributed generation, which is a component of smart grid, to suit Indian requirements. The article entails the detailed economic analysis of using a solar kit with DC loads, in remote off-grid villages of India. The villagers use kerosene, petromax or candles for their lighting. These energy sources deplete natural fossil fuels. Further, the villagers are forced to trek long distances to get

the fuel and also to charge their mobile phones. A simple 40W solar panel, with a charge controller and a lead-acid battery for energy storage is studied in detail as a viable option. Details of the cost comparison are presented, along with possible business models for implementation.

"Imagination has brought mankind through the dark ages to its present state of civilization. Imagination led Columbus to discover America. Imagination led Franklin to discover electricity" L. Frank Baum.

The genesis of rural electrification lies in India's need for food security. India learnt through the bitter experience of the drought of the late 1960s that it must be self-sufficient in food to enjoy political freedom in the international arena. Water was a must for the rain-fed agriculture sector but canal based irrigation systems could not be developed in the short-term. The only immediate solution was to have ground water-based irrigation using electrical pumps. For that, village electrification meant grid extension to farms and not to village habitations. Over the past sixty years as economic growth has accelerated from a rate of 3 per cent to 7 per cent, the objective of village electrification has changed from energizing water pumps to providing electricity to village households living below the poverty line. It would not be out of place to re-emphasize that the scaled up objective of rural electrification at the household level is the cornerstone of India's economic growth as it enables basic minimum facilities of lighting and communication. Viable and reliable electricity services result in increased productivity in agriculture and labour, improvement in the delivery of health and education, access to communications (radio, telephone, television, mobile telephone), improved lighting after sunset, the use of time and energy-saving mills, motors and pumps, and increased public safety through outdoor lighting. Thus, providing electricity to village households is a means to help meet the aspirations of the rural population. Rural households spend around 10% of their monthly income on basic fuel and energy services, which are used primarily for cooking and heating activities- Fig 1. Their willingness to pay depends upon income, existing energy mix and costs thereof, availability of electricity, quality of supply and appliance ownership.

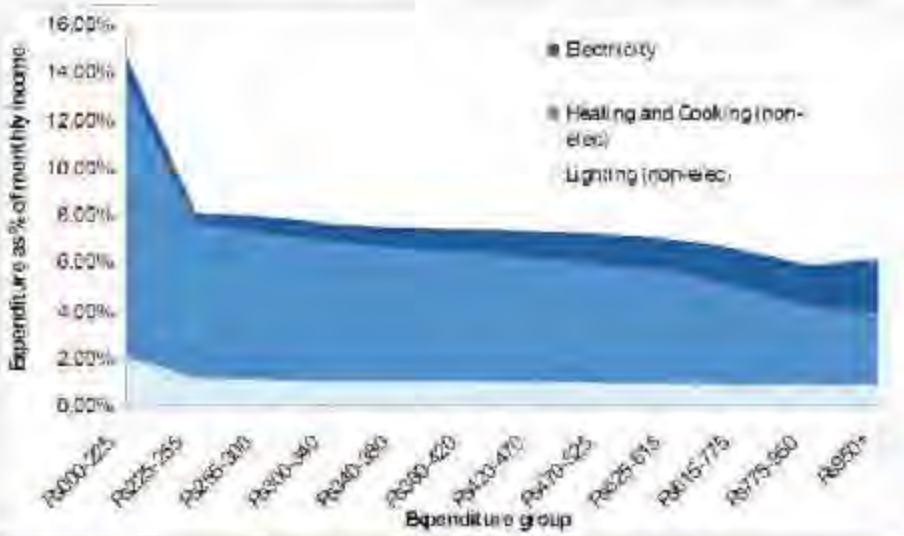

Fig. 1: Rural household spending on energy as % of monthly consumption

One of the biggest problems in connecting remote rural areas to the national grid is the lack of infrastructure. Many of these villages are not connected to the grid. Even if the government goes ahead with the electrification of these areas, the most obvious source would be coal-based power plants since coal is the cheapest power resource. Renewable energy (RE) sources such as solar, wind, bio and hydro are considered attractive in this venture both for grid fed and off grid systems. A 20% penetration of RE in electricity generation globally is considered necessary in the coming decade (by 2020). RE by very nature is dispersed and distributed and random too. Bulk of the global population is also distributed, making concentrated generation at times to be undesirable or infeasible. Man needs energy to meet desired quality of life in the form of heat, light and motion. In developing economies with large dispersed population, electricity is also a promoter of good education, healthcare, agriculture and population control. Electricity is considered to be the best vehicle to carry energy from source to the load. Challenge of today is not only to produce electricity without upsetting nature but to efficiently transmit and utilize the same. Despite massive rural electrification plans, India has nearly 54000 un electrified villages. In most of the electrified villages not only the connected households are a fraction of the total but power is available on an average of 4 hours per day. This is not acceptable if 'electricity to all' is the motto with all ensured 24x7 power.

Fig. 2: Rural Electrification

Fig. 3 : Use of Candle

Fig. 4 : Use of Kerosene lamp

Fig. 5: Use of Petromax

Power Scenario in Rural India

The electricity consumption is amongst the lowest in India. Inspite of increased generation capacity, huge gaps between generation and demand still persist, drastically slowing down the economic growth of the country. Distribution is one of the weakest links in the power supply chain due to severe overloading of transformers and conductors, low metering efficiency and large scale power theft. Lack of transmission and distribution facilities to remote areas, is the main reason for failure of complete rural electrification.

The need of the hour is to supply at least minimal power to these households. There have been many initiatives like providing individual solar lanterns, community solar cookers, solar refrigerators etc. Yet the sad truth is that a vast majority of this rural population literally goes to sleep at 6.30 pm, for sheer lack of power. Distributed energy is slowly making inroads in India, with solar energy emerging as a leader. A number of solar parks have been set up in many parts of the country.

To name a few, 100 MW park near Jaiselmer, Rajasthan; 605 MW solar generation started in Gujarat; 2 MW plant planned at Chennai. Most of these ventures are by enthusiastic entrepreneurs, local and global, who wish to capitalize on the situation and capture a business opportunity. The Power Purchase Agreement tariff with the government is generally more expensive than the tariff for power generated by government held plants.

While, costs are expected to come down in the next couple of years, solar plants are expected to increase many fold. The goal of Indian government is to install 20GW of solar power by 2022. But at the current pace of progress, this is far from a realistic goal. Considering that the country has almost 300 days of sun in a year, the focus on solar power has to be improved. It is a matter of great concern that even today solar power is viewed as a futuristic idea in India. Rural electrification has been identified as top priority by government of India. About 200 million households do not have access to grid power and around 2,50,000 villages connected to the grid have regular power shut down for around 10-12 hours or sometimes even 20 hours in a day. Contrast this with the fact that mobile phone penetration is highest in India, where people prefer mobile phones to toilets in rural India ! A strange paradox!

Rural Electrification

In rural India , where there is no grid power the residents use one of the following as an energy source: Kerosene, petromax, candle or wood, as shown Fig 2 – Fig 5. None of the above are renewable source of energy and most of them are far more expensive than solar power. A detailed cost analysis is presented.

A detailed survey has been conducted in sample villages which do not have grid power at all and use other energy sources. We have made a very modest computation, by considering just enough energy required for lighting a household for three hours daily, say from 6.30 pm to 9.30 pm. This would vastly improve the quality of their lives, by extending the daily active life by three hours and

Kerosene		
1	No. of Kerosene lamps required for sufficient lighting	3 Nos.
2	Average no. of lumens produced by a kerosene lamp	37.5 Lumens
3	Total no. of lumens produced by 3 lamps(37.5x3)	112.5 Lumens
4	Rate of fuel consumption of a kerosene lamp	23.5 ml/hour
5	Amount of kerosene required for 3 hours in a day (23.5x3x3)	211.5ml
6	Amount of kerosene consumed per Month (211.5x30)	6.345 litres
7	Average (subsidized) rate of kerosene per litre @ Rs.14.75(6 litres per month)	Rs 14.75
8	Average (non-subsidized) rate of kerosene per month	Rs. 75
9	Cost of 6 litre kerosene @ Rs. 14.75 per litre (14.75x6)	Rs. 88.5
10	Cost of 0.345 litre kerosene @Rs. 75 per litre (30x0.345) =	Rs. 17.25

Petromax		
1	No. of lamps required for sufficient lighting	1 Nos.
2	Average no. of lumens produced by a petromax lamp	3000 Lumens
3	Rate of fuel consumption of a petromax lamp	62 Gram/hour
4	Amount of LPG required for 3 hours (62x3)	186 Grams
5	Amount of LPG consumed per day	186 Grams
6	Amount of LPG consumed per month(186x30)	5580 Grams
7	Average (subsidized) rate of LPG (for 14.2kg)	Rs. 415
8	Cost of 5580 grams of LPG @ subsidised rate	Rs.163

Candles		
1	No. of candles required for sufficient lighting	9 Nos.
2	Average no. of lumens produced by a candle	12.57 Lumens
3	Total no. of lumens produced by 9 candles(12.57x9)	113.13 Lumens
4	Burn time of a standard candle	1 Hour/Inch
5	Average height of a standard candle	6 Inch
6	Cost of 1 standard candle	Rs. 5
7	Amount spent on candles per day (9x5)/2	Rs. 22.5
8	Amount spent on candles per month(22.5x30)	Rs. 675

also permit the children to continue their studies in the nights. We consider four sources of energy : Kerosene, candles, petromax and solar with battery.

Total cost of kerosene is Rs 105.75. This cost for consumption assumes that the kerosene is used only for lighting. Whereas, in reality, kerosene is also used for cooking and heating water. If, we assume that the kerosene is bought in the non-subsidized category, then the cost would be a around Rs 330. This is an exorbitant price to pay for a household whose per capita income is around Rs 1000 a month. That's a whooping 33% expenditure on energy!!! In the above calculation, we have to add the cost of wicks which is around Rs 10 a month, and the cost of the glass case which cracks over prolonged heating. The cost can be around Rs 30 a month. Therefore, even at the lowest cost, the consumer spends approximately Rs 145 per month on lighting three kerosene lamps.

Thus, the total amount of money spend on petromax is around Rs 163 a month. Of course, the light output of the petromax is far greater than that of three kerosene lamps and hence more activities can be taken up. Or, the petromax can be shared between two neighboring houses.

The option of the candle is the most expensive at Rs 675 per month. In all above calculations we have not considered the carbon footprint of the energy sources as all of them are non renewable sources. Further none of them can be used to charge the mobiles. So villagers have to shell out additional money to pay for mobile charging service.

40 MW stand alone solar DC system

We now consider the setting up of a simple 40W solar system. The inverter is done away with and the system is used with DC. We calculate the cost of the system as follows:

- Storage device is a 12V, 10 Ah, Lead acid battery. With 60% efficiency, this can deliver 72 Wh. Cost of the battery is Rs 1500, and with 3 hour usage the life of the battery can be expected to be around 4 years. Cost per year works out to Rs 375.
- We use 40 W solar panel costing Rs. 1540 with a 20A solar charge controller costing Rs 1000, to efficiently charge the battery. The life of these components can be taken to be around 10 years. Therefore the annual cost would be, Rs 254.
- Load: With this set solar panel and battery, delivering 72W-hr, we can connect two 10W LEDs, giving 2000 Lumens, for three hours, and also charge two

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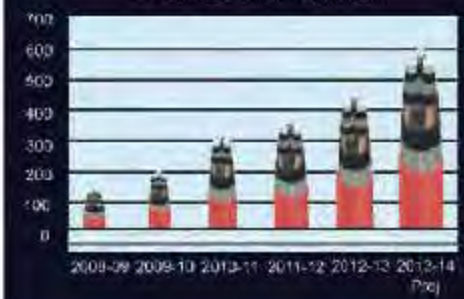

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Specifications	Kerosene Lamp	Petromax Lamp	Candle	Solar stand alone
No. of units sufficient To light a 10x10 room	3 Nos	1 Nos	9 Nos	40W solar panel, charge controller, 12V, 10Ah lead acid battery
Lumens Output	112.5 Lumens	3000 Lumens	113.13 Lumens	2000 Lumens
Fuel Consumption/ Burn Time	23.5 ml/hour	62 Gram/hour	1 Hour/inch	-
Fuel consumption per day (Assuming 3 hours of burn time per day)	211.5 ml	186 Gram	4.5 Candles	-
Fuel Consumption per month	6.345 Litres	5.580 Kg	135 Candles	1 Unit
Cost Equivalent(*) (per year)	Rs 145x12 =Rs 1740	Rs.163x12 = Rs1956	Rs.675x12 =Rs 8100	Rs 675
Pay back period	4.65 Months	4.14 Months	1 Month	Basis for comparison

Table 1: Comparison between different Energy Sources

mobile phones. Cost of the two LEDs is Rs 450. The life expectancy of LED is very high and can easily be taken to be 10 years.

Thus the annual cost of the solar panel, charge controller, battery and two LEDS is approximately Rs 675. We can now tabulate the above results as shown in Table 1.

Food for Thought

In this article, we have presented the case study of a simple stand alone solar-DC system, which does not need the inverter. The option is primarily meant for off-grid remote villages with no access to grid power. The analysis shows that the option is very economical and the consumers would be spending lesser than what they are doing for alternatives like kerosene, petromax, candle etc. Even as a business venture it is very attractive as the payback period is as less as 6-7 months, at the worst. The payback period can be even lesser. One of the biggest barriers to the clean energy economy is people not understanding how possible it is and what potential we have to create it.

In India, we have millions of people who need electricity and now we have the opportunity to leapfrog the mistakes we made in the past like over usage of fossil fuels and help them out. The key is to decentralize and localize the community system by using smaller systems for solar, do away with DC-AC converters wherever possible and offer greater community growth, economic growth and jobs for people for a better quality of life. ■

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"Company is moving towards Digitization in a big way"

S Nagarajan
Vice President - Power Business
Schneider Electric India

As a global specialist in energy management with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in Utilities & Infrastructure, Industries & Machines Manufacturers, Non-residential Building, Data Centres & Networks and in Residential. Focused on making energy safe, reliable, efficient, productive and green, the Group achieved sales of 24 billion euros in 2012, through an active commitment to help individuals and organizations make the most of their energy. Sharing his views about Xperience Efficiency Yatra, in an exclusive interview with **Electrical India, S Nagarajan** said, it is a unique initiative wherein we visited 50 cities and showcased the entire gamut of offers from Schneider Electric India.

Could you describe your journey and share with us the vast exposure you had till assuming role as Vice President Power BU at Schneider Electric India?

I started my career as a Contracts Engineer in the mid-eighties with English Electric (Erstwhile Areva). After a stint of eight years executing contracts of companies like NTPC, BHEL, State Electricity Boards etc, I moved to a subsidiary of India Cements Group (Indchem Instrumentation) to Head Southern Sales. After 5 years with them, I moved to Tyco Electronics Group in Bangalore as Country Manager in-charge of 4 Verticals (Power Tech, Railways, Industrial Machinery and Instrumentation). After a successful stint of 3 years, I moved to Schneider Electric, Gulf to head their High Voltage Group. Then, after a couple of brief assignments in France, I moved to India in 2005 to head the newly formed Services Business Division. I was in-charge of Energy & Infra Business Units and SGBD, handling Strategic Global National Accounts and moved to the role of Country President of Srilanka and Bangladesh in 2010. Then, in April 2013, I moved back to India as Vice President, Power Business Unit. So my journey in 30 years of work experience was not only diverse but challenging and exciting as well.

What are your activities and roles as Vice-President at Schneider Electric India?

Power business of Schneider Electric offers electrical low voltage products and solutions to our customers. Our offers include Air Circuit Breakers, MCCBs, Busways, Capacitors, Contactors, Meters, LV panels, full electrical distribution solution etc. As Vice President of this

business, my role is to grow this business by focusing on 3 things:

- Customer satisfaction: Ensure high level of customer satisfaction by delivering high quality offers
- Partner ecosystem development: Build the partner base and enable partners to grow faster
- Employee Satisfaction: Have a committed team by focusing on Schneider Electric's value system of 4C's of Care, Connect, Challenge, Commit.

Schneider Electric celebrated 50 years of operations in India. How has been the response to initiative on Xperience Efficiency Yatra, 2013 as part of 50 city road show?

Xperience Efficiency Yatra is a unique initiative wherein we visited 50 cities and showcased the entire gamut of offers from Schneider Electric India under the theme of Xperience Efficiency from plant to plug. This initiative received an overwhelming response. Our customers were delighted to know in depth about the capabilities of Schneider Electric to assist them in their energy efficiency journey. This initiative has resulted in a tremendous boost to our positioning and awareness in Tier 2 and 3 cities.

During road show what range of products, solutions & technology had been showcased?

We had an interactive marketplace showcasing our entire range under Xperience Efficiency from plant to plug theme in one Schneider Electric Smart City. Solutions across business segments of Schneider Electric i.e. Power, Lifespace, Buildings, Industry, Energy and IT were showcased. The SmartGrid model was a focal point of interest and showcased Schneider Electric's solutions for cities' immediate challenges. The model showcased how hardware, software and process expertise within operating systems can come together to build a smarter grid and a smart city to make it efficient, sustainable and liveable. Various concepts like Demand Response management; Peak load management, Renewables integration etc were demonstrated.

From LV distribution specifically we displayed our entire range right from Sandwich type busbars, Air circuit breakers with integrated metering and advanced protections, MCCBs with embedded energy metering suitable for distribution and motor applications, MCBs, RCCBs, MPCBs, Contactors, advanced relays, single device universal starter solutions and large range of conventional and high end meters. All these products were integrated on a common platform, via Modbus and/or Ethernet TCP/IP on Power Monitoring Expert Software enabling local and remote monitoring and control of the entire LV system showcasing the digitization in electrical distribution networks. The Acti 9 range of low voltage modular devices with its Smartlink enabled communication module was another key offering from us. Other offerings such as efficient drives and motion controllers along with intelligent building management control systems and datacentre lifecycle services were also on clear display. Our solar solutions ranging from grid to residential and our new solar pump offering was a source of great interest to our customers.

All these solutions basically led into one common Ecostruxure platform. Ecostruxure architecture enables the convergence of five key domains of our expertise; management of Power, Process & Machines, IT rooms, Buildings & Security. It acts as a solution ecosystem delivering the guaranteed compatibility across key application areas. Ecostruxure takes multiple siloed systems and adapts them to an integrated solution, reducing redundancy in equipment, software and personnel. It is the only comprehensive and integrated approach designed for the reality of digital economy.

Does emphasis on rural infrastructure a must? Detail us on recent Rural Project?

Rural infrastructure creation is a social commitment of Schneider Electric. The mission of SE India foundation is "To help people change their life through Access to Energy". Strategic focus areas of our foundation are Education, Employment and Entrepreneurship for people at Bottom of the Pyramid and we have a host of initiatives around this. We have already set-up 140 plus electrician training centers across the country and 1100 plus households in remote villages are illuminated by solar home lighting systems. Further we are also taking Solar powered drives for pumping water application.

How do you perceive energy efficiency in the context of India and what measures would you advocate with focus on it?

Energy Efficiency is considered the cheapest, fastest, and cleanest way to reduce carbon emissions. It will also help to reduce the dependence on imported oil and coal. For our country both objectives are very important and energy efficiency is a key focus for government, industry and nodal authorities in this space. Robust automation, control and monitoring of energy usage can deliver upto 30% energy savings. Techniques such as energy modeling, integration with BMS, etc. are already available in India. Then there are smart grids, demand response systems and remote facility management systems too. Similarly, Schneider Electric's Remote Energy Management is a solution that measures, monitors and manages the

energy consumption of WAGES (water, air, gas, energy and steam) and can complement requirements of facilities very effectively. Lately, we are witnessing a convergence between IT and energy management. Taking cognizance, Schneider Electric has developed new energy management solutions such as EcoStruxure. EcoStruxure enables the user to see, measure, and manage energy use across the entire enterprise, with compatibility between the management of power, IT, process and machines, building control, and security, delivering up to 30% energy savings.

What scenario do you visualize when we you cannot generate enough electricity? Besides T&D losses what are the constraints and challenges to meet its need?

Energy Dilemma: By 2030, the demand for energy in India will have quadrupled. The carbon emission needs to be reduced by ½. So the energy dilemma is here to stay. By using fossil fuels, etc for conventional sources we have already seen the damage it has created to the eco system – the recent flash floods in Uttaranchal is a grim reminder of this. Hence, we need to switch to renewable sources of energy and in my opinion, whatever we do now, we might not be able to bridge the gap in increasing energy requirements. So the best way is to save energy by following efficient energy management techniques which is at the core of Schneider Electric Strategy. Our aim to make energy safe, reliable, efficient, productive and green. We feel this is the best way to tackle the energy dilemma.

Besides educating children, what are the strategies adopted for creating awareness in saving energy? It is mega issue as you say, if we do not have electricity, what will we do?

As the Global Energy Management Specialist, we believe that it is our responsibility to promote awareness regarding energy efficiency. We have launched Conserve My Planet program for schoolchildren- the program has been running successfully in Bangalore and Hyderabad for the past few years and about 100,000 school children have received training on ways to conserve electricity. We will be rolling this program in Mumbai and National Capital Region in the future. We have the My Energy University, a website where users can register and receive training on different energy efficiency measures for free. These programs are to cater to the needs of different users, ranging from professionals to technicians, and students to the common person. Further, this year, on the occasion of our 50th year in India, we have launched our corporate campaign in which the key message is save energy. As part of the campaign, we invited ideas to save 50 million kWh of energy. Top 50 ideas would be recognized as well. Ideas can come in from our customers, public in general as well as within the organization. From the ideas that we received till now, many are sustainable and involve a mix of everything – our own products and solutions, existing energy-saving practices or bringing new solutions to the marketplace.

It is a fact that we will never be able to produce enough energy. What is your perception about renewable energy?

The demand for power will be quadrupled by 2030 and carbon emission will need to be reduced by half. These objectives can be achieved through a focus on renewable energy and energy efficiency measures. While significant capacity is installed in the wind and hydro sectors in the past few years, solar has taken a lead since 2012, owing to the JNNSM initiative, and support from the central and state governments. Also, the cost of solar power has come down significantly. Solar power is going to grow faster than planned, and India should achieve the target of 10GW solar power by 2017. Also the rooftop and off-grid segments have huge potential in India, given the country's vast geography and power-deficit situation with grid power either not available or only intermittently available at several places.

Schneider Electric supplies products and solutions in the wind, hydro and solar sectors. We are a leading player in Solar market and offer a complete product basket of balance of equipment (BOS) which includes inverters, transformers, MV equipment, SCADA, grid substation and up to 220kV evacuation substation. Lately we have introduced 'solar inverter substation' which is a containerized plug-and-play power conversion system adapted to customer requirements and local standards. We have also launched a complete range of products for residential, small commercial and off-grid solar and backup power in the Indian market.

What further awareness do you want and what further technical progress would you like to see for the company in near future?

The company is moving towards "Digitization" in a big way. We need to be focusing on a few key verticals in future and bring in total specialization by our wide range of Software Services & Solutions ensuring that at the heart of this is 'Energy Efficiency'. ■

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Statistical Analysis of Transformer Failure

All power utilities are much worried these days due to high rate of failure of distribution transformers and service. The failure rate of transformers in India is in the order of 12-15% as against less than 1% in developed countries. No one wants to share responsibility of failure. Manufacture offend blame to users for running the transformers in overload for single phasing or unbalancing. Users are of the opinion that the cause of failures is due to faulty design or bad materials or poor workmanship. But the fact is responsibility should be shared equally by both.

- Prof. Manish N Sinha, Palak Patel, Parth Shah, Maulik Doshi, Nishith Bhalodiya

The manufacturer should accept the feedback from the utilities without any prejudice and take remedial measures, while the users, on their part, should ensure that the equipment is not abused and correct feedback on the product's performance, is passed to manufacturers. Collection of failure data is the first major task. In free repair service or in repair contract very little effort is being made by utilities to find out root cause of failure, which could be one of the reasons why a damaged transformer is replaced by a new one with-out removing the cause of damage, leading to failure immediately or within a very short period.

Company Details

The projects has been done at Royal Electricals Pvt Ltd, Plot No. 1405, phase 5, GIDC Estate,Vitthal Udhyognagar 388121, Dist. Anand,Under the IDP Scheme Gujarat technological University.

Age wise transformer failure

The curve showing failure rate vs. time is called bathtub because of its cross-section shape. It comprises three parts, The first part is a decreasing failure rate, known as early failures. The second part is a constant failure rate, known as random failures. The third part is an increasing failure rate, known as wear-out failures.

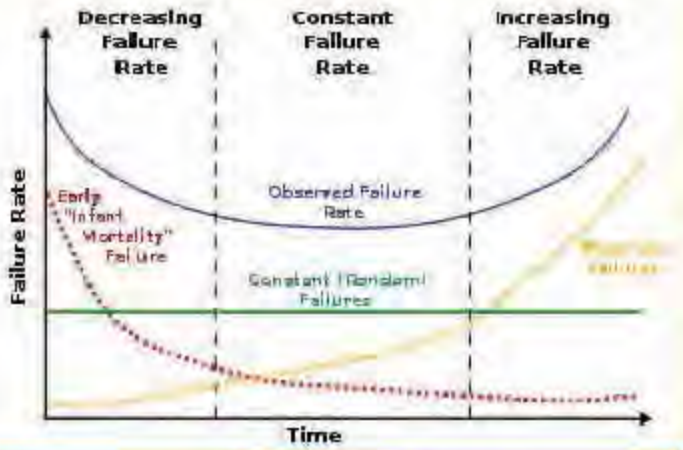


Fig. 1: Bathtub curve

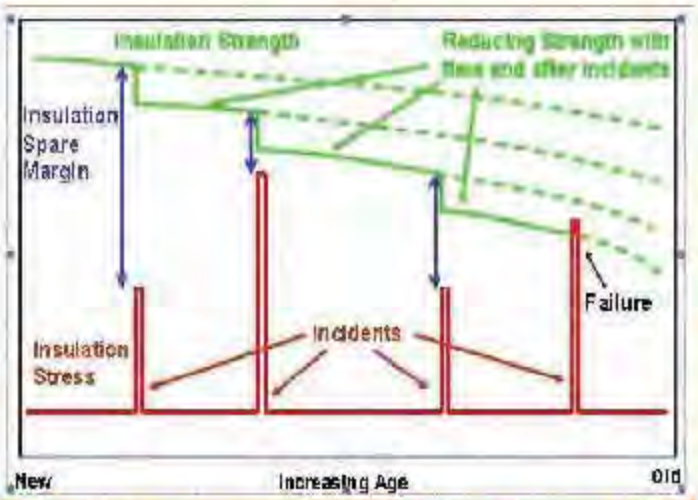


Fig. 2: Failure due to decrease in insulation strength with age (CIGRE)

Results and Discussions

Thus we conclude that in the early life of a product adhering to the bathtub curve, the failure rate is high but rapidly decreasing as defective products are identified and discarded, and early sources of potential failure such as handling and installation error are surmounted.

In the mid-life of a product generally, once it reaches consumers, the failure rate is low and constant. In the late life of the product, the failure rate increases, as age and wear take their toll on the product.

Voltage wise transformer failure

The following data was collected from Gujarat Energy Transmission Corporation Limited (GETCO).

This shows that majority of low voltage transformer fails (i.e. distribution transformers) compare to high voltage transformer (i.e. power transformer). The reason for this is in India importance is not given for protection of distribution transformer.

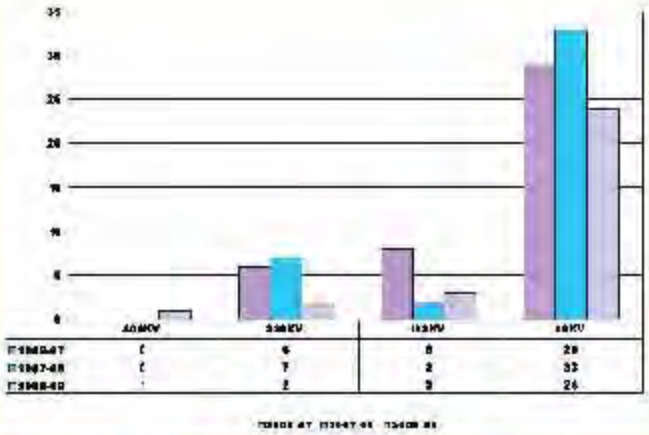


Fig. 3: Voltage ratings wise transformer failure

Year wise transformer failure

The following data from GETCO was collected:

Year	No of transformer failure
2006-07	43
2007-08	42
2008-09	30

Table 1: Year wise transformer failure

Number of transformer failure is decreasing year wise. This shows that with years there is improvement in transformer manufacturing and protection.

Cause wise transformer failure

The following data was collected from GETCO: (2009-10).

Voltage Rating	Age	External Faults	PRQ	PMQ
400 KV	0	0	0	0
220 KV	0	0	0	0
132 KV	3	2	2	0
66 KV	11	10	8	5

Table 2: Cause wise transformer failure

Majority of failure of transformer occurs in distribution transformer due to aging and external faults like long time overloading, short circuits etc. Now days it is found that many power transformers fails due to OLTC.

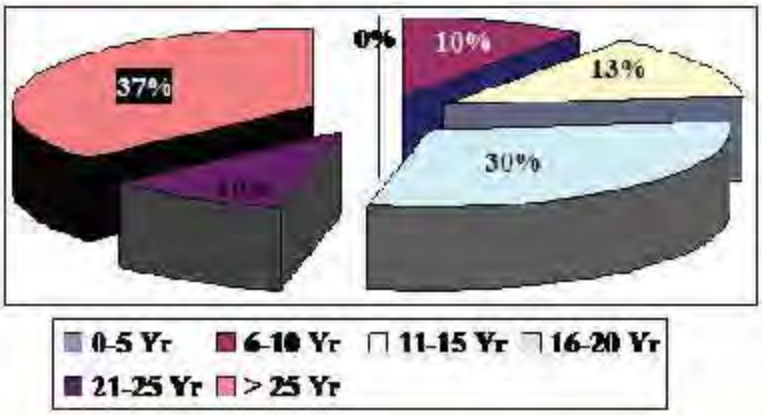
Numbers of new transformer failure is decreasing with years as improvement in design and manufacturing process.

Conclusion

From case studies of Royal Transformers Pvt. Ltd. on transformers, we conclude that major failures

Life Span Comparision

2006-07:



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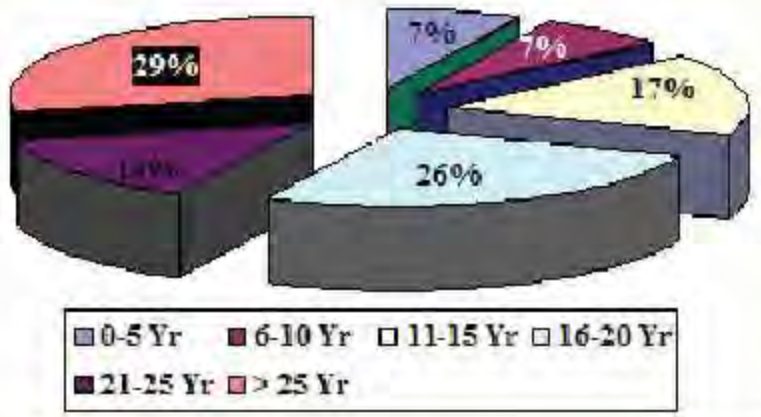

2008-09:

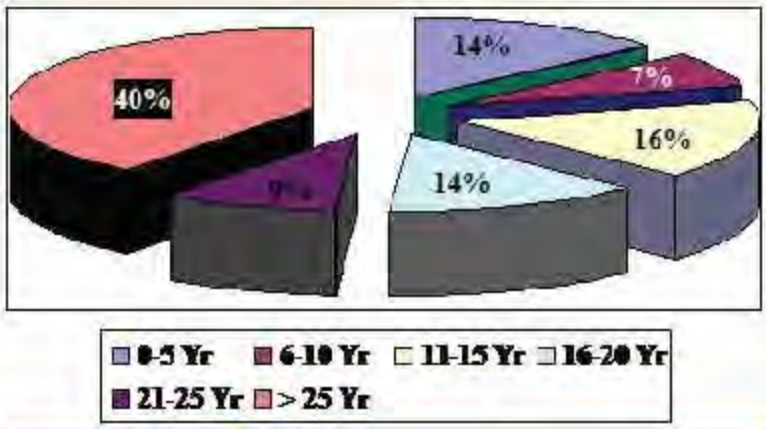

Fig. 4: Life span comparison

which occur are mainly on distribution transformer of rating 11kV/433V.

The major causes of failure on this range of transformers are unbalanced loading, single phasing, overloading and some user attributed reasons. The major failures on power transformers are due to insulation damage, deterioration of oil, leakage oil and also due to bushing failures.

Acknowledgement

We express our heartfelt gratitude to Royal Electricals Pvt Ltd, V.U.Nagar, Anand and a number of people who extended their full support and cooperation in analyzing this project.

We sincerely thank Pinakin A Patel and Ashok Prajapati of Royal Electricals Pvt Ltd. for granting permission for project and providing all the necessary resources to develop a project.

We would like to take this opportunity to thank our college, "Birla Vishvakarma Mahavidyalaya, V.V.Nagar" for giving us this tremendous opportunity to work in the Industry for the project. ■

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E-WASTE RECYCLING :

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The Electrical & Electronics Waste often abbreviated as E-waste is used to describe old, obsolete and discarded appliances that operate with either a power source or battery source. The common items that flow in the waste stream includes Information Technology equipments like computers, printers, fax machines, Communication Equipments like televisions, mobile phones and white goods like refrigerator, washing machine, etc.

-S Durairaj, Revathy Subbiah Rajaram

As a developing nation, India shows an increasing growth in Information & Communication Technology which also results in the growth of the waste generated by the industry. According to the Central Pollution Control Board (CPCB) the nation generated 0.15 million tons of e-waste in the year 2005 and the waste production has grown to 0.8 million tons in 2012 and is expected to rise up to 2.15 million tons by 2018.

A recent report from CPCB states that the following 10 states contribute up to 70 % of total e-waste generated in the country: Maharashtra, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab. Apart from the waste generated by the nation, we also import around 50,000 tons of e-waste in the name of charity and donation. The increase in the e-waste is not balanced by proper recycling or refurbishing technology which gives room for the most crucial question 'Is e-waste an opportunity or burden? '

Factors Contributing to Electronic Waste Generation

The e-waste industry in India is influenced by several factors, but it can be broadly classified into two categories: E-waste Generated & E-waste imported.

The centre for Science and Environment reports that the E-waste generated in the country ranges from 330,000 tons to 400,000 tones, whereas 50,000 tons of e-waste is illegally imported into the country every year.

Courtesy: Department of Information Technology

The growth of e-waste in the country is influenced by low end of life of electronic products due to frequent release of new models, reasonable & attractive prices, low awareness on recycling & refurbishing and most importantly lack of recycling infrastructure in the country. This is also due to the lack of balance between the wastes generated and recycled (252,868 MTA).

In addition to that India also imports 50,000 tons of e-waste annually under the label of charity, donation, free trade agreements and illegal imports. Moreover, exporting e-waste is more profitable for the exporter country than recycling or disposing it within the country.

For example, waste traders in Europe or USA have to pay US $20 to recycle a computer safely in their countries while they can sell it at half the cost to the informal traders in developing countries like India. It costs Rs. 12,000 to recycle a ton of rubbish after segregation in the U.K., whereas shipping the rubbish to India costs just about Rs. 2,800/- The Indian government is in full swing to contain this situation through the implementation of the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules.

E-waste Recycle Market in India

The global e-waste recovery market in the year 2009 is $6.9 Billion and it is anticipated to grow up to $21 billion by 2020 says a report published by GBI Research. According to the CPCB, the e-waste recycling revenue potential in India is estimated around US$ 1.5 Billion in 2013 which is further expected to double by 2018. The concept of recycling has gained more importance and awareness since the ministry of Environment & Forests published "Guidelines for environmentally sound management of E-waste" in 2008 followed by which the "E-Waste Management and Handling Rules in 2011. As of today there are 97 dismantling / recycling units registered with the Central Pollution Control Board from 12 states.

E-parisaraa, Ultrust Solutions, Earth sense Recycle, Sims Recycling India and E-Recon Recycling are among the registered units, who form a competitive landscape in the realm of Indian E-waste recycling.

The state wise break down in given in the chart below.

The Ministry of Environment & Forests, framed e-waste management rules (2010) based on the concept of extended producer responsibility. The Extended Producer Responsibility (EPR) is an environment protection strategy that makes the producer responsible for the entire life cycle of the product, especially for take back, recycle and final disposal of the product. This was included in the legislative framework making EPR a mandatory activity associated with the production of electronic and electrical equipment over a period of time and it came to enforcement since 1st may 2012.

A MAIT-GTZ study on "E-waste Assessment in India - a Quantitative assessment on the generation, disposal & recycling of Electronic Waste in India" conducted in 2007, states that, 95% of e-waste is recycled in the informal sector and

Source: Central Pollution Control Board

Source: Central Pollution Control Board

only about 5% reach authorized recyclers. The e-waste is either processed by the unauthorized recyclers (informal sector) or being resold, or refurbished and resold, or recycled in an unhygienic and unsafe manner at many remote parts of our country.

The process of informal recycling includes, open burning of plastic wastes and printed circuit boards (PCBs), use of acid bath for extracting precious metals, pulverization of cathode ray tubes (CRTs) and so on. E-waste recycling in the unauthorized units has been found to be seriously polluting the environment and causing adverse effects to the health of the workers. The impact of informal recycling is much worse than the impacts caused due to stored e-waste.

The probability of risk due to hazardous waste when they are exposed in to the atmosphere in an uncontrolled manner is very high. The informal recycling has the following problems.

Environmental problems: The emission of heavy metals and liquid crystals pollutes air, water and soil making them unusable.

Health problems: Health hazards includes, injuries from cuts and acids, respiratory problems, neurological, cardiovascular and gastrointestinal diseases; malfunctioning of kidneys and respiratory system and possibly cancer. Some of the diseases acquired, causes genetic problems and poor fertility rates.

Economic Problems: Since the informal recyclers are unaware of the actual recoverable contents and the methods, they extract what they find economically valuable and throw the rest into waste dumps or water bodies or in worst case, burn them in open places. This leads to the loss of precious metals due to the lack of knowledge.

E-Waste Recycling: Growing Opportunities

E-waste rather than being a reputational risk can be seen as an excellent business opportunity. India being one of the largest producers of e-waste is a suitable ground for the recycling business. Recovery of ferrous & non ferrous metals from e-waste is much cheaper than mining it out of ores.

The US Environmental Protection Agency estimates that about 24 kg (50 lb) of gold, 250 kg (550 lb) of silver, 9 kg (20 lb) of palladium, and more than 9,000 kg (20,000lb) of copper can be extracted through recycling 1 million cell phones.

Zero Waste SA, a South Australian State Government E-waste recycling firm testifies that 95 % of glass can be recycled from CRT Tube Monitor and 90 % to 98 % of plastic can be recycled and reused from monitor case, base, mouse, cables and keyboard.

The government also encourages e-waste recycling by supporting the set up of Integrated E-waste Recycling and treatment facilities in and around the country.

In addition to that the CPCB is planning to establish e-waste collection centers throughout the country. It is strongly believed that this initiative will help divert the waste flow from informal market to formal recycling market thereby ensuring safety & sustainability. ■

S Durairaj, currently working as a Professor in the Department of Electrical and Electronics Engineering, Kings College of Engineering, Tanjore, TamilNadu has PhD from Madurai Kamaraj University and Boyscast Fellowship from DST, Govt. of India for doing post-doctoral research at Queens University Belfast, UK. He also received Young Scientist Fellowship (YSF) from Tamilnadu State Council for Science and Technology (TNSCST). He worked as Professor in the Department of Electrical and electronics Engineering, Kalasalingam University, Srivilliputtur, TamilNadu. His research interests include Reactive Power Management, Distribution Automation, and Energy Management Systems

Revathy Subbiah Rajaram was an Assistant Professor at Kalasalingam University, previously Tutor at Edith Cowan University. She has Masters degree in Computer & Network Security from Edith Cowan University, Australia and Bachelors in Electronics and Communication Engineering from PSR Engineering College (Affiliated to Anna University). Her area of interest includes Internetworking (CISCO), Computer Forensics, Green Computing and E-waste Management. She has participated and organized several seminars, workshops and conferences at both National and International level. She is keen in guiding both BTech and MTech projects in the fields of Computer Networking, RFID and Wireless communication.

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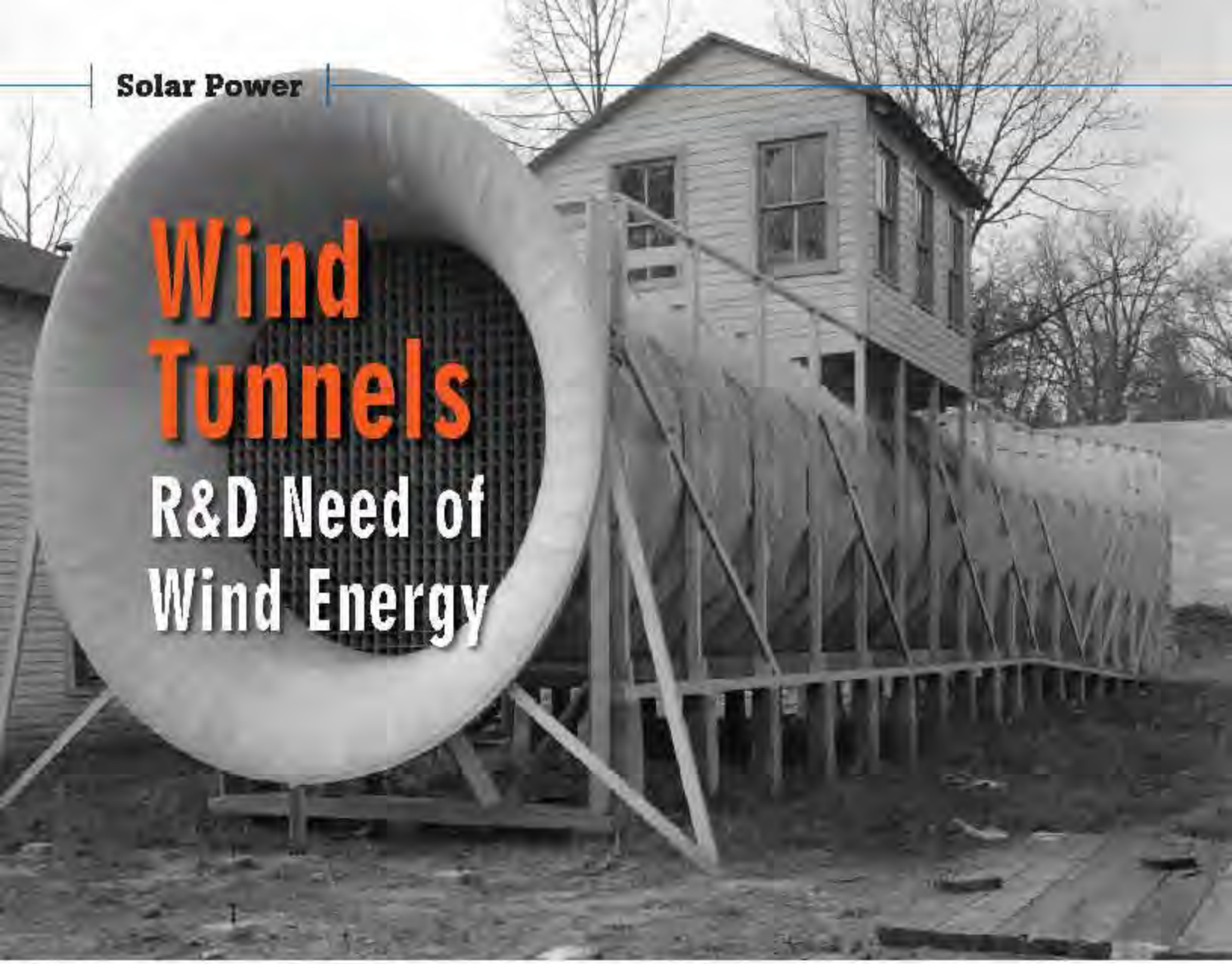


Wind Tunnels
R&D Need of Wind Energy

In design and development of various man made moving objects in any outdoor product/system; aerodynamic studies plays important role. Effect of speed, density, directional issues of air and other system issues associated with air needs to be studied before commercialization of the product/ system. Various computer software and mathematical models can be used for this. However, actual field test is necessary for highest level of reliability. Aerodynamic studies of aircraft, automobiles, wind turbines, civil engineering components related to buildings and mechanical structures are playing very important role in development of these products/ systems or subsystems associated with them.

- Datta S Chavan, V L Kokate and Dr. P B Karandikar

Wind tunnel is the best way to study the aerodynamic parameters of these products/ systems. Wind tunnel is costly system but most effective for this purpose. Testing such product/system in wind tunnel gives guarantee of its performance under variety of aerodynamic conditions. Wind tunnels were first proposed as a means of studying aircraft in free flight. The wind tunnel was projected as a means of reversing the usual paradigm: instead of the air's standing still and the aircraft moving at speed through it, the same effect would be obtained if the aircraft stood still and the air moved at speed past it. In that way a stationary observer could study the

aircraft in action, and could measure the aerodynamic forces being imposed on the aircraft. Later on, wind tunnel study came into its own: the effects of wind on civil and mechanical engineering structures or objects needed to be studied for high rise buildings which becomes high enough to present large surfaces to the wind, and the resulting forces affects the internal structure. Subsequently, the wind tunnel testing was applied to vehicles not to determine aerodynamic forces but more to determine ways to decrease the power required to move the vehicle on roadways at a given speed to improve mileage of vehicle. In an actual situation the roadway is moving relative to the vehicle but the air is stationary relative to the roadway, but in the wind tunnel the air is moving relative to the roadway, while the roadway is stationary relative to the test vehicle.

In recent past, wind tunnels are used for wind turbine testing. Typically, there are many wind parameters which affects the electrical power quality in wind turbines. Wind turbine parameters also degrade the output power quality. There are various generators available, which also decides the power quality. Wind turbines are also of various types,varieties of towers are employed for mounting these wind turbines which affects the power quality. Thus large numbers of wind parameters, site related issues, turbine parameters affects the performance of wind turbines. Wind parameters are very multifaceted, which affect power quality of the system. Thus, in analysis, it becomes multi-input multi-output system. To study parameters like effect of blade shape, hub mechanism and blade material testing against various wind parameters, wind tunnel is required. Most effective method of testing the wind turbine output against variation of these parameters is wind tunnel of bigger size. In this article various issues related to wind tunnels useful for wind turbine are presented. The article discourses copious wind tunnel parameters such as its applications, types and development etc, in brief. Study of wind tunnel parameters will bestow sustenance to impending researchers to pick the correct wind parameters to enhance the overall quality of the product/ system such as wind turbine.

Classification of wind tunnel

Various types of wind tunnels are used in aerodynamic studies. Typically, wind tunnels are of classified as follows,

Based on air circuit - The air circuit can be either closed circuit and open circuit. In an open circuit wind tunnel, the air is taken from outside environment and discharged to outside environment again. The air generally follows a straight path from the entrance to the exit of the wind tunnel. In closed circuit wind tunnels, the air is circulated by the help of a power unit continuously. Sometimes, a small amount of air is exchanged with the environment to increase the air quality and have some temperature control. Open circuit and closed circuit wind tunnels have some major advantages and disadvantages. Hence the comparison of these two is presented in Table 1.

Based on structure: tunnel shaped or normal type, horizontal or vertical axis wind tunnel, long, short or medium length

Based on structure material: Metallic structure or concrete type or composite structure

Based on shape of inlet section: Semicircular, circular, square, semi-elliptical or other cross sections of various shapes

Based on location: outdoor or indoor

Based on speed of air velocity: low speed, medium speed, high speed

Based on anemometer placement: push in type, windows for anemometer, anemometer frame type.

Construction of wind tunnel

Open circuit wind tunnel consists of three parts as shown in Fig 1. Inlet section has exhaust fan of suitable size. It may have multiple exhaust fans of required speed and

Sr. No.	Open circuit wind tunnels	Amount of Halogen acid (%)
1	Less construction cost	More construction cost and hence initial investment is higher
2	Flow quality is easily affected from wind or room size	The quality of the flow can be well controlled and independent of atmosphere
3	No purging problem in flow visualization	Precautions must be taken if used for flow visualization
4	The tunnel requires more energy (for a given size and speed)	The tunnel requires less energy (for a given size and speed)
5	The open circuit tunnels are more noisy	Less noisy. Needs cooling if used extensively

Table 1: Comparison of open circuit and closed circuit wind tunnels

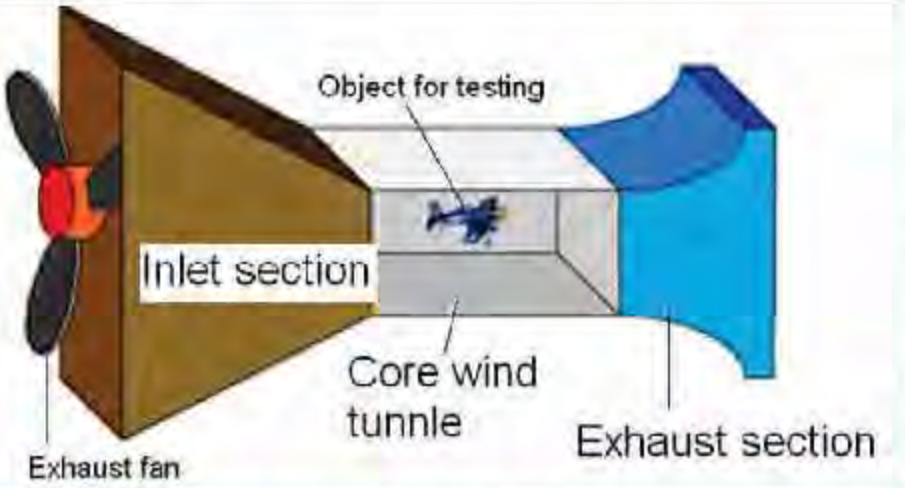


Fig. 1: Simple wind tunnel construction

air delivery. Its shape is such that air gets compressed as it passes through it. This causes the increase in velocity of air entering in tunnel. At the end of this section cooling of air may be required. The central part is the core wind tunnel, where products/ systems under study are kept. This section has facility to do measurement of air parameters and other output parameters. The third part of this tunnel is exhaust section. Sufficient empty space is required to be left at the exit as high velocity wind can affect the objects next to it. Close circuit wind tunnel uses this high velocity air at exit and recirculates it, back to in let, thereby requiring less amount of energy compare to open circuit wind tunnel described here.

Basic calculations for wind tunnel

Power requirements for development of wind tunnel can be estimated by using basic calculations pertaining to fan specifications. These calculations have been explained by using example of wind tunnel of 25 square meter inlet area and depth of 5m. It is assumed that the inlet section, core wind tunnel and outlet section are having uniform cross section. Inlet area of

Let,

wind tunnel = 25 m2

Total volume 25 m2 area X 5 m length = 125 m3

Each fan is of @1 kW rating with discharge rate = 3 m3 /s

Air delivery of N fans is 3 m3/s X N fans =3N m3/s

Let, max air speed required = 30m/s

Total fans required N = 30m/s X 25m2/3m3/s =250

Power required by fans= 250 X @1kw = @250kw(max)

To reduce the effect of exhaust air, the outlet can be turned upward. Alternately air obstacles can be put at some distance from exit of the high speed air. Multiplying factor of 1.2 may be considered for power calculations to account for effects of surface unevenness in wind tunnel. Speed control methods for fan used can be rheostatic or autotransformer based or series- parallel control or power electronic based.

Design parameters and applications of wind tunnel

Wind tunnel design and development requires consideration of variety of parameters. Some of the important parameters areas follows,

- Type of anemometers used
- Inlet-outlet air velocities

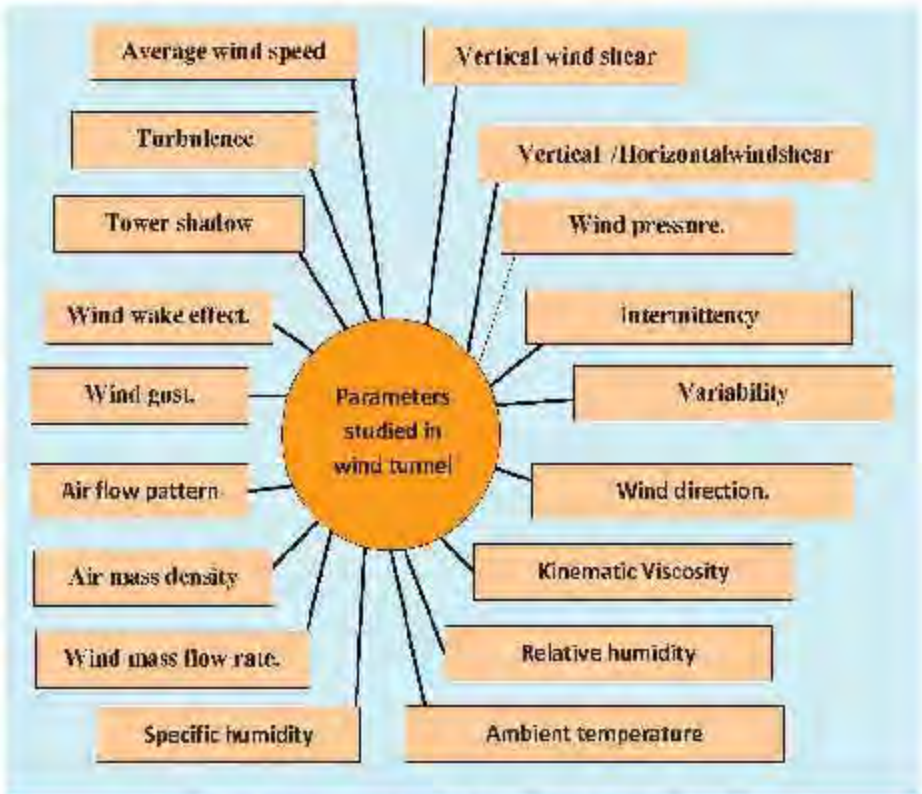
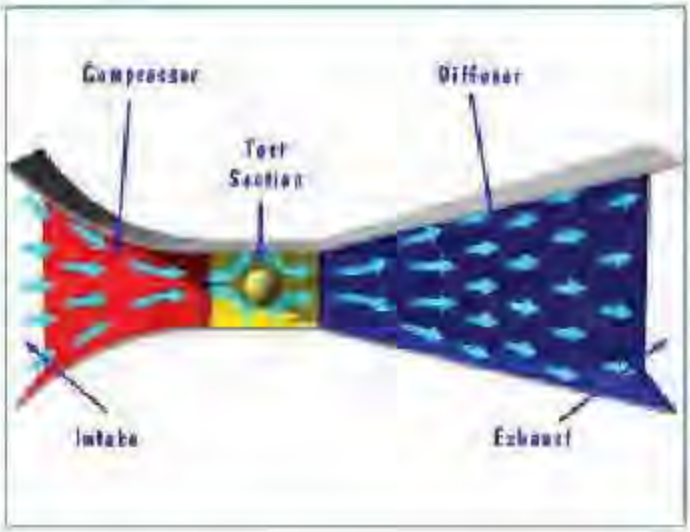


Fig. 2: Various wind parameters which can be studied with the wind tunnel



- Tunnel vibration
- Safety issues
- Sound pollution
- Strength of structure
- Types of fans used
- Power of fans used
- Power factor
- Diameter of tunnel
- Weight, volume and shape
- Material of the walls and base
- Duty cycle
- Placement of fans and its specifications
- Cooling of air
- Air delivery and speed of fans used
- Moisture and dust effect
- Data logger facility
- Proposed applications of wind tunnel
- Size and shape
- Site suitability
- Fins or air directors.

Fig. 2 shows the diverse parameters pertaining to the wind related products/ systems, which can be studied using wind tunnel. Wind turbulence, air flow pattern, wind shear effect, tower shadow effect and wind gust are particularly important in study of wind turbines.

Need of wind tunnels in India

In India, there are very few wind tunnels. By and large, they are of smaller/medium size and hence not suitable for automobile /energy sector trials i.e. automobiles aerodynamic studies and wind energy related testing. This is the main hurdle in research and development of these sectors. Research in this area cannot be done at college level as such facilities are not available with educational institutes. UG/PG level projects in this area cannot be taken by students. Thus entire research work in these areas is done by the industry. If more wind tunnels of medium and high capacity are constructed at university and college levels then young engineers can work on some innovative areas such as development of low speed wind turbines, efficiency improvement of vehicle by modifying it shape etc.

Thus article presents the classification and basic calculations of wind tunnel. Need of wind tunnel, its construction, applications and design parameters have been presented. It is well known that lack of this facility is the main hurdle in research and development activities in wind energy sector in India. ■

Datta S Chavan, is pursuing PhD in Electrical Engineering. He is BE(Electrical) and ME (Power systems) from University of Pune. He is presently an Associate Professor, in Bharati Vidyapeeth Deemed University, College of Engineering, Pune. He has total 22 years of industrial and teaching experience. He guided 20 Bachelor's and 10 Master's projects. He published total 36 papers out of which 20 are conference papers and 16 are international journal papers. He is a member of many professional bodies like IEEE, Institution of Engineers, India etc.

V L Kokate, is pursuing MTech in the area of wind energy. He is working in Gurow Wadia Institute of Technology, Pune. He is BE Electrical from University of Pune and has total 25 years of experience. He has worked on around UG level 20 projects. His area of interest is energy and power sector.

Dr. P B Karandikar, is PhD in Electrical Engineering and ME Electrical from COEP, Pune. He is working as an associate professor in Army Institute of Technology, Pune, India, since last 19 years. He is associated with Bharati Vidyapeeth Deemed University, College of Engineering, Pune as an adjunct professor in electrical engineering department. He published total 30 papers out of which 25 are conference papers including 7 IEEE papers and 5 are international journal papers. He published one text book. He acquired three Indian patents in his credit.

"To help various utilities in executing RGVVY and RAPDRP"

Gunjan Tripathi
Director (Operations & Business Development & COO)
Medhaj Techno Concepts Pvt Ltd

Medhaj Techno Concept Pvt Ltd, an ISO 9001:2008 & 14001:2004 company incorporated in 2007 is one of the fastest growing infrastructure consultancy firms in India. Medhaj has stood as top consulting company in regulatory area in power sector across India. It is now building its strong position in upcoming technologies like Smart Grid and also expanding its consulting practice in other Infrastructure sector like Water and Roads & bridges by providing similar types of services as what it is providing in power sector. In all, Medhaj is repositioning itself as a top service provider in Consulting, IT and BPO lines of business. Gunjan's dream for Medhaj is to build an enterprise which is most trusted brand in world amongst its clients and its employees. In an exclusive interview with **Electrical India, Gunjan Tripathi** remarks, we are now venturing into other sectors like highways, IT, water etc, wherein we can leverage our project execution skills to newer heights.

What are main roles and responsibilities you are engaged in the company? Share with us your vast global experience and challenges that you have faced while handling various roles in USA, Europe and Asia pacific?

As Director (Operations & Business development), I am responsible for running service delivery of all projects at Medhaj, winning new orders to feed the future, building new capabilities to stay market relevant and ensure the employee satisfaction by giving them exciting career options within the company. I feel fortunate to have travelled across the world, lived in some the best destinations of world and made friends everywhere. More than the challenges I faced, I felt there were opportunities to leverage. Recipe for success is same for all the places. You need to build trust by being credible, authentic and reliable and an intimacy gets developed in relationship once you develop sensitivity to specific cultural nuances of the region. Every

individual has different strengths in his/her personality.
One needs to leverage different strengths to mix up well in different culture. For example the straightforwardness and transparency of my personality helped me in settling down faster in US but what helped me in Philippines was my basic nature of respecting every individual.. I had to trigger my analytical strengths more than anything else to win over my European clients. Once you gets accepted by people, that automatically starts culminating into professional success.

What is your perception about regulatory regime prevalent in India today with respect to power sector?

Electricity being a concurrent subject in the Indian constitution, India has a unique regulatory regime in the country with centre and state regulators in place. The concept of independent regulations in States was introduced to save the financial collapse of the sector due to political influence on tariff setting. The enactment of the Electricity Act, 2003 has provided larger canvass for the regulators to function.
As a result, we have seen large investment from the private sector, enhanced grid stability and greater competition. However, these initiatives have been largely driven by policy and regulatory initiatives at the centre. The regulatory functions at State are still dominated by tariff setting which is still a challenge for the regulators considering the complexities arising out rising costs, financial conditions of the end consumers and other socio-political factors.
In the current economic scenario, the regulators have to play active role to address the challenges arising out of fuel shortage, competitive bidding, and implementation of open access, grid security and better utilization of resources through introduction of new products in power market. The State regulators also have to ensure that they do not lag behind Central regulator in developing a more competitive market, capacity building for resolution of dispute and facilitate competition at end consume level.

How far your contribution to government electrification projects has been successful, could you elaborate on that?

In the last six years we have worked extensively for the government funded schemes like RGGVY, R-APDRP etc. in the power sector. We have worked on schemes which have been rolled out by the government for the larger benefit of society and as a consultant it was our responsibility to appraise the various stakeholders on the progress of the schemes, and to effectively monitor the scheme in a cost effective and time bound manner.
We have being assisting DISCOM's of Uttar Pradesh, Bihar, Madhya Pradesh and other states in the project monitoring consultancy of various projects to look into the timely completion of the projects. As we monitor all the crucial aspects of the scheme ranging from technical to financial, it gives me immense pleasure that we see to it that the funds of the government are being channeled into the right areas.
We have also been involved in the regulatory assignments like preparation of the Multi Year Tariff (MYT) regulations for the state of Chhattisgarh. The power tariff of any state is determined by following the MYT regulations, therefore the regulations were framed keeping in view the interests of all the stakeholders involved.
As a Director, I get immense pleasure when I look back at the time when we had intense discussions with the officials of the Chhattisgarh State Electricity Regulatory Commission (CSERC) on critical aspects of the regulations and now those very regulations will be determining the tariff of the generation, transmission and distribution companies of Chhattisgarh for the next three years.
We have done projects not only at the execution level but also to access whether the objectives envisaged at the initial level have been met or not. For example, the state of Madhya Pradesh undertook the Feeder Separation Programme to separate the domestic and agriculture feeder in the rural areas of the state where we were appointed as the project management consultant for the project, to monitor the progress of the scheme and also to check the quality of the work and the material being used by the contractors. On the other hand, looking at our experience in conducting impact study of various financial and technical projects, we were appointed by the Rural Electrification Corporation to study how the Feeder Separation Programme was implemented and whether there has been any socio economic change in the lives of the rural people post its implementation.

Could you share with us some of the strong brands that Medhaj had work for government's electrification schemes like RGGVY and RAPDRP?

We have rich experience in successfully completing projects

under RGGVY & RAPDRP schemes of Government of India. The spectrum of major clients we have served under the flagship of RGGVY & R-APDRP scheme includes Ministry of Power, Rural Electrification Corporation, MoP-UNDP Access to Energy, Power Finance Corporation, Consultancy Development Centre, Distribution utilities of the state of Uttar Pradesh, Madhya Pradesh, Assam, Rajasthan, Chhattisgarh, Jammu & Kashmir, Haryana, Himachal Pradesh, Gujarat and Bihar. Medhaj has executed projects under RGGVY Xth, XIth & XIIth plan till date which includes preparation of detailed project report of 72 districts in the state of Uttar Pradesh, Madhya Pradesh & Assam in the FY 2013-14.

We have been appointed as National Quality Moniter for Tier-III inspection under RGGVY scheme by Ministry of Power. Under R-APDRP scheme, we have prepared Detailed Project Report of Part B i.e. distribution strengthening project and covers system improvement, strengthening and augmentation etc. of more than 100 towns, the same have been approved by the funding agency i.e. Power Finance Corporation.

Could you share the details of Honours and Rewards bagged by Medhaj?

At Medhaj we set high performance targets for ourselves and we believe it is critical to report on our progress. We are proud of the recognition we have earned by important organizations for our contribution in development of the power sector in India, over the past few years since inception.

We are proud to be recognized for, "Indian Leadership Award for Industrial Development" award in 2012 by IBN 7 for our contribution in development of infrastructure in the country. Further, in 2010 Medhaj has received the "Award of Excellence 2010" by the Institute of Economic Studies (IES), India. Our Chairperson cum Managing Director, Samir Tripathi was honored with the "Udyog Ratan Award 2010" and "Business Leadership Award 2011" by IES in recognition of his outstanding contribution in the field of engineering in India.

Further, International Biographical Center (IBC), Cambridge, England has recently honored our CMD as one of their "IBC Leading Engineers of the World 2011". These achievements are the manifestation of our thrust on delivering cutting edge consultancy solutions to the clients.

Could you share highlights of some important projects and your major clients?

A close and synergistic relationship with Government and Corporations in India and Abroad is our complementary strength. We continue to grow, and exhibit strong performance amidst challenging markets and circumstances.

Medhaj is the only private consulting company in India working on live Smart Grid Project Management Consultancy for assisting APDCL in Implementation of Smart Grid pilot project in Guwahati under APDCL. We are also an integral part of the highly prestigious India Smart Grid Forum (ISGF), an initiative of Ministry of Power. Our other important and prestigious assignments for Central Government Ministries, Agencies and State/UT Level Utilities include:

- Preparation of DPR and periodic monitoring of supply of electricity to rural areas under RGGVY in Chhattisgarh, for UNDP-Access to Energy.
- National Quality Monitoring for quality inspection of RGGVY XI plan for Ministry of Power.
- Impact Study of "Implementation of Feeder Separation Scheme" in the state of Madhya Pradesh for Rural Electrification Corporation.
- Consultancy Services for Study on assessment of component with AT&C losses for Tamil Nadu, Uttar Pradesh, Rajasthan for Power Finance Corporation.
- Survey and Preparation of Report for 765 kV Transmission line for "System Strengthening Common for WR for Power Finance Corporation Consulting Limited.
- WR & NR region and Selection of sites for development of Ultra Mega Power Projects in Gujarat and Jharkhand for Power Finance Corporation Consulting Limited.
- Monitoring and Evaluation of Solar Photovoltaic Systems installed in the fields during the years 2007-08, 2008-09, 2009-10, Mizoram & Goa and Monitoring and evaluation of SPV systems and stand-alone power plants installed during :2007-08, 2008-09, 2009-10 and 2010-2011 in Haryana Uttarakhand, Haryana, Mizoram, Jharkhand, Punjab, Sikkim and Uttar Pradesh for Ministry of New and Renewable Energy.
- Consultancy services for supervision, quality control and monitoring of 11 KV feeder separation work in villages under the jurisdiction of Madhya Pradesh Madhya Kshetra Vidyut Vitran Co Ltd, Bhopal.
- Approval of Business Plan for

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MEDHAJ—AN OVERVIEW

Medhaj Techno Concept Pvt. Ltd. an ISO 9001:2008 & 14001:2004 company incorporated in 2007 is one of the fastest growing infrastructure consultancy firms in India. Our success is built upon an environment that leaves a significant space for nurturing innovative ideas in the field of consulting. We offer a wide range of consultancy services, particularly in the areas of pre-project advisory, design engineering, project management, third party quality inspection, construction supervision, energy efficiency, policy & regulatory advisory and public private partnership.

OUR VISION

"Conquering the marketplace – Being the most trusted and topmost brand name in consulting."

BREADTH & DEPTH:

Medhaj has a pan India presence with offices and team in more than 22+ states in India for its 75+ clients. Medhaj has 750+ employees on its payroll. Medhaj is known in marketplace as one of the best employers for Women employees. Medhaj is the leading consultant in Smart Grid and other high-end IT enablement projects in infrastructure sector. Smart Grid is the futuristic top notch technology for Grid automation in power transmission and distribution sector.

GROWTH STORY

– Medhaj' growth from 3 employee to 750+ in 6 years since inception

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second control period, work of Truing up of FY 2010-11, approval of ARR for each year of the second control period & approval of Tariff for the FY 2011-12 & FY 2012-13 for various utilities of Gujarat for Gujarat Electricity Regulatory Commission, Ahmedabad.

What are the energy efficiency projects being taken up by Medhaj? As a director of the company how do you look forward to the overall growth of the company's business?

We have executed energy efficiency projects for Ministry of New and Renewable Energy (MNRE), United Nations Development Program (UNDP) and Energy Efficiency Services Limited (EESL).

We have assisted Ministry of Power- UNDP in year 2010 in the preparation of DPR and periodic Monitoring of review of supply of electricity to rural areas covered under the RGGVY scheme in Chhattisgarh.

Our scope of work was also to compute the energy saving and the reduction of AT&C losses after the implementation of this scheme in the pilot areas selected for the study.

Recently, we are assisting EESL in the energy audit of 5 district buildings of Public Health Department, Govt. of Maharashtra.

As we have worked extensively in the transmission and distribution fields, we look forward to undertake consulting mandates in the conventional as well as renewable areas of generation. In the recent past, we have done assignments in the renewable segment of generation and provided services to MNRE and DISCOM's in preparation of DPR, FPR and monitoring and evaluation of RE projects. In the existing scenario, energy efficiency has attracted global attention from the policy makers.

In India, the Central/State governments are also coming up with a number of projects in this area and providing subsidy/grants in these projects and therefore we are also aggressively venturing into the energy efficiency segments. We have already been empanelled by the Energy Efficiency Services Limited (EESL), Delhi. Also, we have a separate team of experts who are focusing in this segment.

It has been seen that the client in the power sector has hired multiple consultants to provide domain specific services ranging technical to financial services for a single project. But, now we have witnessed that considering the complex nature of assignments, the client prefer to hire a single consultant who can provide end-to-end advisory services required in that project like in the PPP and the distribution franchisee projects. The Ministry of Power (MoP) has taken initiatives in the field of distribution franchisee and we are sure that substantial business will come in the next five years in these segments.

Given our skill set ranging from expertise in the technical as well as the commercial areas, we are in a position to handle these types of assignments by providing end-to-end solutions to the clients. There are few consultants in India, who can provide such end-to-end solutions to the power sector clients and Medhaj is one them.

Having spread our footprints across all the major segments in the power sector value chain and being aware of the demographies of almost all the states in India, we are now venturing into other sectors like highways, IT, water etc, wherein we can leverage our project execution skills to newer heights.

Where do you envision your company in the next two years?

Our Project management services in power sector are maturing well. I expect to help various utilities in executing RGVVY and RAPDRP with best project management practices like Six Sigma.

Also, we expect our services in other sectors like road, water to grow and mature at same pace. I expect to increase the number of clients in our newer capabilities namely Smart Grid Project management capability, our Information Technology (IT) products developed to manage projects and processes better.

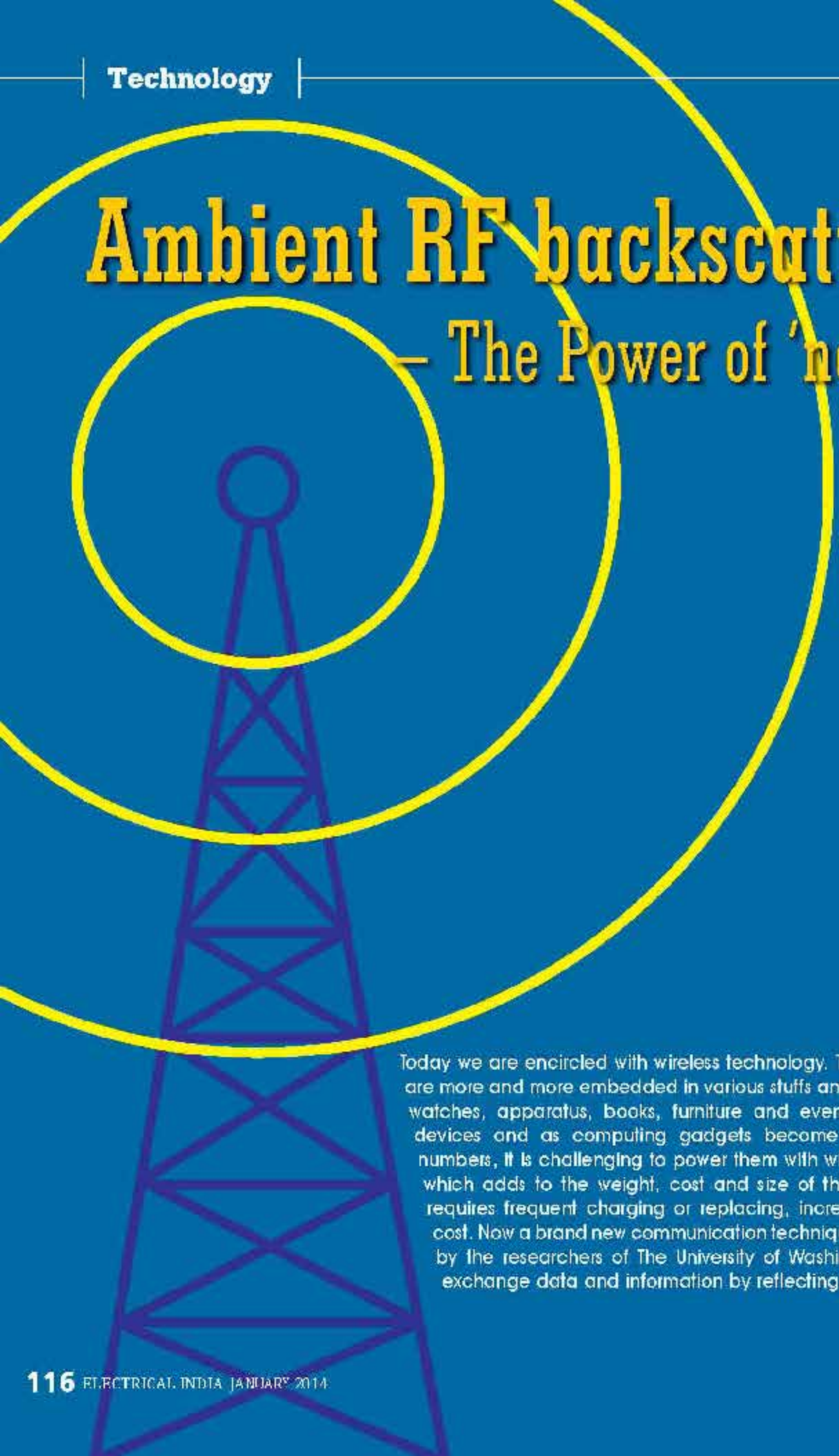
Could you elaborate on things which need improvement from your perspective in Indian Power sector?

There is a lack of maturity in clients in their ability to leverage services of consultants. Consultants need to be seen as an extended team of client's organization so that best is achieved from contractors, but I see that lacking in many of our clients.

Also, government departments are very sluggish in releasing payments in time to consultants.

Only 4 percent of new enterprises survive for more than 10 years and single top-most reason for remaining 96% to fail is their inability to manage their outstandings. Government needs to help consultants in infrastructure sector survive by ensuring timely payments of their outstandings. States like UP, Bihar need to learn from states like MP where thing are managed better on this front. ■

Ambient RF backscattering
– The Power of 'no power'



Today we are encircled with wireless technology. Tiny computing devices are more and more embedded in various stuffs and environments such as watches, apparatus, books, furniture and even implantable medical devices and as computing gadgets become smaller and in more numbers, it is challenging to power them with wires and bulky batteries which adds to the weight, cost and size of the devices. Moreover it requires frequent charging or replacing, increases the maintenance cost. Now a brand new communication technique has been developed by the researchers of The University of Washington which is able to exchange data and information by reflecting ambient RF signals.

- Linoy A Tharakan

We are moving towards a new-found paradigm of computer and information technology, the Internet of Things (IoT). The Internet of Intelligent Things and systems with immense potential of communication among Machine to machine, machine to environment, machine to infrastructure.

To make the internet of things (IoT) a reality, devices in and around need to be able to communicate with the internet and with each other. All of them need to be powered by battery or any other sources of energy that would be difficult at least in some applications. "Ambient backscatter" has become so imperative and crucial in this scenario.

Backscatter

"In physics, backscatter (or backscattering) is the reflection of waves, particles, or signals back to the direction from which they came. It is a diffuse reflection due to scattering, as opposed to specular reflection like a mirror."

According to Wikipedia, Ambient backscatter is a technology that exploits ambient signals of TV and mobile phone transmission by which the devices can communicate one another. In this info-communication world the Ambient RF signals from Television and cellular towers are widely available indoors and outdoors, round the clock. These signals can power up, according to researchers, wireless devices with hundreds of microwatts.

These devices can exchange information and interact with users and also with other devices without using batteries but by reflecting pre existing radio signals. Yes, scientists have already built up a battery less small device with antennas to capture and reflect a RF signal.

Developments

A credit card sized prototype has been developed by researchers of Washington University to test the Ambient Backscatter technology. Each test device has an onboard LED light which flashes as it is placed within a considerable distance. The device was tested by setting them up half a mile away from the TV tower. It was tested across Seattle inside and outside of the apartments and garages too.

RF back scattering vs RFID

RF Backscattering requires no special power infrastructure like RFID as it harvests energy from existing RF signal. This eliminates installation and maintenance cost to an extent. RF backscattering consumes no additional energy beyond which is already in the air so it has a negligible environmental footprint.

Moreover RF Ambient backscatter gives a device to device communication in contrast with RFID. RFID tags only supports a one way communication from Tags to RFID reader and not able to exchange information between tags to tags. Moreover, like RFID reader, ambient backscatter has no centralized mechanisms for overall monitoring and control. Thus it must follow multiple access protocol and develop functionalities like carrier sense that are not available in traditional back scattering devices.

Applications

Researchers of Washington University created the prototype design to evaluate Smart Card applications. Here passive battery less cards can communicate with each other. Now a day's customers swipe the credit cards on the machine to pay the bills. But with this technology cards can simply be placed in close proximity of the e-bills and transfer the fund. Imagine you could transfer funds to your friends account as you just place two cards one over the other. Yes, Such an application has very high value in various real time circumstances like money transfer between credit cards, and lots of futuristic applications in digital paper technology.

In future the Ambient backscatter will become the spinal code of ubiquitous and pervasive computing with zero maintenance. ■

Linoy A Tharakan, Associate Professor, Mar Thoma Institute of Information Technology, Department of Computer Applications, (University of Kerala), Kerala.

How Concerned are we about Energy which is going to be Exhausted One Day!

Since energy can be transformed from one form to another, there can only be two kinds of energy utilization and that is either useful utilization or wastage of energy, which is mostly rejected as heat. Energy is prerequisite for any form of activity and that is why it has prompted some economists to place energy at par with other basic factors of production such as land, labor, capital and enterprise. As energy is a limited resource therefore it is essential to optimize its use, i.e. to use it in the most efficient manner. Optimization of utilization of energy in scientific and non-scientific manner is conservation of energy in a simple language.

- Shaikh Shamser Ali

Sources of energy are from Mother Nature and it is limited which will ultimately run out of its reservoir one day. Electricity, which is generated from natural resources, is the lifeline of today's modern and highly mechanized lifestyle. Every nation whether developed or under-developed is very much concerned about optimal utilization of electrical power. India can certainly be a role model to the rest of the world in energy conservation as we have manpower and brainpower, which is key to this application. Saving energy is not only having monitory gain but also having excess capacity to meet the ever-growing demands of energy. Energy conservation is applicable to every walks of life, be it industrial or non-industrial applications. To conserve energy we need to understand the basic elements of energy conservation. Broadly speaking energy conservation has four main elements that are the key factors in it. These are Energy audit; Identification of appropriate measures to save the energy and funding; Implementation of the energy saving measures; and measurement and verification to monitor the expected savings.

Energy audit is a scientific diagnostic process to evaluate the operational efficiency of any electrical, mechanical, hydraulic, pneumatic, electro-mechanical, electro-hydraulic, electro-pneumatic or any such systems and thereby identify the areas in the process / system where energy utilization is inappropriate. Therefore an energy audit can be an application specific or for the whole system /

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process. A detailed energy audit is done in stages. At first the basic data such as machines details, drawings, operational requirements, process layouts and energy bill details are collected to study and understand the functioning of the establishment. Once a fair amount of idea is gained about the premise that is to be audited then a walk around audit is conducted to come up with an audit plan, which will be acceptable to the occupants of the premises if it is a commercial building or the production department if it is a manufacturing facility. Data collection is the final activity that is done at the site and the various data at different locations are to be monitored and recorded while the equipment / machine is actually working at maximum loading condition. Most suitable and calibrated test equipment is only to be used for data collection. Once all the data are collected then it is the time to interpret / evaluate / analyze the collected data scientifically to ascertain the operational efficiency of the system and the energy index of the premises. One should have the best-practiced data related to the application from the industry to compare the collected data in order to make the findings more practical. The final audit report is made based on a comparison of the actual consumption of the energy against that of what is the best practiced in the industry / scientifically calculated values. Based on the findings of the audit once the possible areas / applications are identified with an expected energy saving potential then it is time to identify the most appropriate energy saving measure/s that can be implemented.

An energy saving measure can be a more efficient machine / equipment, an energy saving product that will help optimization of energy usage, change in technology, fine tuning the system, corrective administrative actions, good housekeeping or behavioral change of the people living / working in the premises. Based on the selection of measure one-can categories these as no cost savings, low cost savings, and high cost saving and very high cost savings. First two categories can be implemented without much difficulty but for the next two categories one must take into consideration the economic viability of the project. Economics of scale is very important, as everything is so uncertain in to-days competitive market. Energy conservation is in its infancy in developing countries where as it is state sponsored campaign to conserve the energy in developed countries. If the real savings in energy has to come then one needs to spend huge amount of money to implement the project. Past experience in developed countries show that the government's involvement and government's clear cut policies to grant incentives to energy conservation program is a must for the success of the energy conservation campaign. In fact energy conservation is a tripartite: The client; Energy Saving Company (ESCO) and Funding agency activity in developed countries where they all enter into an agreements for a certain period of time by which the project will be implemented successfully and the total cost of the project will be recovered. The modus operandi of the system is "PAY AS YOU SAVE" and it does not put any budgetary constraint to the client or the ESCO, which can be most of the time very difficult for them to accept. Time taken to recover the total cost of the project is called payback period. Roughly speaking 3 – 4 years payback period will be good enough for successful implementation of a high cost energy saving project if only the direct benefits of the energy saving is taken into consideration for the purpose of calculating the payback period. Energy conservation has mainly two benefits, direct benefit and indirect benefit. Direct benefit is the monthly reduction in energy bill that comes from the successful implementation of the energy conservation project. Indirect benefits are little cumbersome to quantify as these are the cumulative effects of improvement in efficiency, less breakdowns, reduction in maintenance cost, increase in productivity, excess capacity of energy, reduction in maximum demand charges, tax and other monitory incentives that the local government / authority may be providing to encourage the energy conservation program.

Implementation of the energy saving measures is a key factor of energy conservation activity. To begin with one must first try and get as much savings as possible from corrective administrative actions, good housekeeping and behavioral changes because many of the energy savings products are tailored made to suit the requirements and therefore costly. Installation and commissioning must only be done by the qualified and trained engineers / technicians so that the unnecessary risks and possible consequential damages to men and equipment is avoided.

After the energy saving project is implemented then it is the time to monitor and verify the savings in energy that was estimated after a detailed and scientific energy audit. There are internationally accepted Measurement and Verification (M & V) procedures, which can be followed as per the requirements of the project. Guidelines for these M & V procedures are very clear and elaborate.

It should be the duty of every Indian living in India to contribute in his / her own way to save the precious energy as much as possible. After having done over fifty energy audits I would like to share my experience

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with the readers about some of the simple ways that can help us saving energy in our day to day life.

- Open the window curtain or relocate your furniture to use the natural light as much as you can.
- Keep the toilet / bathroom lights OFF when not in use.
- Switch OFF the lights in unoccupied areas like corridors, store, garage, laboratories and meeting / conference room.
- Keep the bedroom lights OFF when you are actually sitting in your drawing room with your family and guests.
- Keep the ceiling fan running when the AC is ON and set the room temperature in your AC two degrees more than the temperature you want to maintain.
- Switch OFF your bedroom AC after 3 A.M. and keep the ceiling fan running if you happen to get up from your sleep.
- Switch OFF the AC in your office half an hour before you leave the office for the day.
- Close leaking taps of water or fuel.
- Close leaking valves of air or steam.
- Do not leave the tap running when not in use, no matter how small the time might be.
- Select appropriate water level when using automatic washing machine.
- Keep the exhaust fan in your kitchen OFF when not in use.
- Try to use public transport as much as possible.
- Share the private vehicle with colleagues or friends when you reside at the same locality and go to office at the nearby places.
- Follow the traffic rules and drive your vehicle at cruising speed.

I am sure these are not very difficult at all and can be done at no cost to personal comfort. It will not be an uphill task for any one living in India to save 0.1 KWH of electrical power every day and 25 ML of fuel per vehicle per day that plies on Indian roads. Quantities might sound very little but if we calculate the same amount taking into consideration the population of India and the number of vehicle that are plying on the Indian roads daily then the savings will come in millions of rupees per day. Today when the top executives of the private companies and the government organizations spend many hours thinking about the Total Quality Management (TQM) and Value Engineering in order to minimize the operational expenditures I feel it is the time for all of us to think very seriously about the energy conservation in India. If simple activities like good housekeeping and behavioral changes can save millions of rupees daily then successful implementation of energy conservation projects can give a boost to the much needed development programs of India towards its journey to become a successful developed nation. Here are few facts which we usually overlook thinking these are of no significance.

- A commonly used 4 feet fluorescent fixture with electromagnetic ballast and 40 watts T12 tube actually consumes 50 watts.
- A compact fluorescent light (CFL) bulb uses 25% of the energy of a standard incandescent light bulb (ordinary bulb) while providing an equal amount of illumination – the majority of the electrical energy that the incandescent light bulbs use is lost as waste heat which results in additional load on your AC system.
- Oil leakage @ one drop per second accumulates over 2000 liters of oil loss a year.
- Raising AC setting by one degree Fahrenheit can cut roughly 5% off cooling energy use.
- Replacement of aluminum or steel blades of fan with FRP blades with aerofoil design can results in savings in the range of 20 to 40 %.
- A successful energy conservation program can generate a savings in the range of 15 to 40% of the total power consumed.
- Efficiency of poorly maintained worn out pump drops by 10 to 15%.
- Properly installed ceiling fans (those placed no more than 8 to 9 feet above the floor) can save up to 40% of summer cooling cost by creating a wind chill effect within the room because of evaporative cooling.
- Desktop computers still draws approximately 30 watts in stand by mode.
- Approximately 500 grams of carbon dioxide (causes global warming) per KVA of power generation is released into the atmosphere by the power generating station using fossil fuel.
- Approximately 500 grams of carbon dioxide (causes global warming) per KVA of power generation is released into the atmosphere by the power generating station using fossil fuel.
- At present rate of consumption, global supply of fossil fuel energy will be exhausted, for all practical purposes within the next few centuries.

I am thinking seriously about the energy conservation. Are you? Let's talk about energy conservation with others then. Let's work together to conserve energy as much as we can. Let's get started and take the first step towards energy conservation. ■

Shaikh Shamser Ali, ex Indian Naval Marine Electrical Engineer with 30 years of varied experience. He has worked in India, UK & Middle East. He is certified Energy Auditor and Energy Manager by BEE, Govt. of India and PMP by PMI, USA. He has worked with 3 ESCOs for over 10 years in India and abroad. He is having over 10 years of projects execution experience. He has presented many technical papers in CII, FICCI & International ESCO forum in the past.

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Chairman & Managing Director
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Rishabh Instruments Pvt Ltd manufactures industrial control products and test & measuring instruments. Rishabh Instruments closed financial year 2013 with consolidated revenue of about Rs 225 crore. Over 50% of its revenues come from exports, mainly from Western Europe and North America. In Year 2011, under able leadership of Narendra Goliya an Indian Institute of Technology and Stanford educated entrepreneur, Nashik-based Rishabh Instruments Pvt Ltd acquired 85% stake in Poland-based Lumel S.A.I t manufactures industrial automation equipment and aluminium pressure castings. The acquisition helped Rishabh to expand its presence into the European markets and also got them access to Lumel's technology and R&D capabilities, while Lumel benefited from Rishabh Instruments expertise in electrical and electronic instruments. In an exclusive interview with **Electrical India, Narendra Goliya** remarks. We will soon be introducing power quality clamp meter & advanced multimeters offering unique value propositions to our customers.

Could you share the roles and responsibility serving as the Chairman at LUMEL S.A., besides being the Chairman and Managing Director at Rishabh Instruments Pvt. Ltd?

LUMEL S.A. is a subsidiary of Rishabh Instruments and was acquired in 2011 to serve our global customers. My foremost responsibilities include synergizing the two businesses and directing their growth plans. It's my top priority that both the units are properly manned with appropriate talent and be developed as effective organisations. I am responsible for ensuring that the group gets the planned synergies: let it be R&D, Marketing or global sourcing. We have drawn plans & currently in process of splitting the R&D responsibilities between the two team-units to ensure that we can increase the speed of development along with localizing the products within the respective markets. Majority of my responsibilities with regard to routine operations of Finance Department has been delegated but I am actively involved in arranging funds for the growth of the group. Essentially, I am responsible for giving Strategic Directions and ensuring good governance in LUMEL S.A. and Rishabh Instruments.

What according to you is the status and scope of electrical test and measuring instruments?

Electrical Test and Measuring Instruments (TMI) is a growing area in India albeit at slower pace. Nonetheless, lots of technological innovations are coming in terms of measuring power quality and to do preventive health check of the new installations or existing electrical systems.

In India, a big proportion of test and measuring instruments are being imported and majority of them comes from China, Taiwan and Korea; whereas we as a company have taken a conscious decision of indigenously designing and domestic manufacturing it. TMI are getting smarter, added compactness and multi-functionality in their features for e.g. Multimeters with built in frequency and capacity measurement, Min - Max measurements and simultaneous display of multiple parameters.

Similarly, insulation testing is merged with multimeters; parameters are now available in clamp meters also. Multifunction meters are merging with transducers and all instruments have communication either RS485 or Ethernet or Profibus. So instruments along with indications are also becoming intelligent to control and monitor electrical parameter. The growth is slow within the Electrical Industries in general because lots of Test & Measurement Instruments are still used by the Government Organisations like the Utilities and Railways which are not modernizing as far as other industries are. However, it is quite obvious that the utilities have to be updated to industry standards in the coming years and we will see the market jump in instruments which can predict failures along with control and measurement functions.

What policies have you executed for the overall activities of the company including the development of strategies for future growth?

Rishabh is a R&D focused organization and its 1st exclusive R&D Center approved by the Government of India came up in 2004. In 2010 we built a modern 100 seater R&D Center in Nasik which is the foundation of our future growth. Other than modernizing and improving our present basket of products, we have internal goals to add one new product basket each year to the existing range.

Hence we are mixing traditional products with modern products/ technologies such as instruments to measure Solar Parameters or improve power quality where we will see a big growth in Domestic market. We have strategies to increase customer satisfaction and therefore all activities to ensure this are measured. Other than customer complaints, communications and feedback are given importance to enable us to improve our customer service.

We have sessions to get strategic feedback from our Executives and Managers which help us to plan growth. HR activities both recruitment and training are given a lot of importance to ensure that we have a right quality of people which can ensure that we can lead this growth.

After LUMEL S.A. we bought the SIFAM & TINSLEY brands which have a very high reputation in UK and help us to increase products in that segment. We make five year rolling plans to give our growth a particular direction proposed on the basis of market requirement.

Can you share with us the latest technology that the Domestic and Global facilities are equipped with?

As you know the electronic products today are built with SMT (Surface Mounting Technology) and a mix of SMT & THD. However, the components are getting smaller and the power consumption is considerably reduced & going down further to ensure higher processing capability and battery life. Along with availability of dedicated chips and micro controllers, the price performance ratio is going up. However, this needs the latest standards in calibration and testing not only of basic parameters but also EMI & EMC Testing.

Reliability test includes extreme temperature, humidity, vibration, shock and EMI - EMC test which are Mandatory in Global Markets like EU& US Markets. Other than ISO standards one has to follow TS (Standards) and equip the people with modern tools such as Six Sigma, SPC, Kaizan & JIT. Moreover along with meeting the national standards, one has to comply with International Standards such as IEC, DIN, ANSI and JIS. Products have to be approved for safety by UL, CSA, CE, GOST (Russian authorities) and ASTA.

Besides having ISO certifications the calibration labs have to be accredited/recognized by NABL for testing and Calibration of Electro Technical and process parameters. One has to follow the international norms like WEEE and ROHS.

Could you share the activities and interests as Technical Director of Nashik Engineering Cluster?

Nashik Engineering Cluster (NEC) is registered under section 25 (Non Profit Organisation) formed under Industrial Infrastructure Up-gradation Scheme (IIUS), Ministry of Commerce & Industry.

Government of India. Its mission is to enhance international competitiveness of the domestic industries by providing quality infrastructure through Public - Private Partnership. 75% of which was funded by the Central Government and 25% from the Municipal Corporation and NICE, a body of industrialists from Nasik.

We have the latest set of equipment to enable industries to compete globally eg. CNC Machines, Plastic Proto Typing Machine, Metal Proto Typing Machine, CAD, CAM, Unigraphics to do all kinds of simulation and analysis for moulding, casting, stress analysis to enable the industries to reduce process time for new product development. NEC has all latest instruments of testing and calibration for Physical and Electro Technical quantities besides laboratory to do all kind of mechanical and electrical test. My job as Technical Director is to ensure that these services are offered to the industries at competitive rates and the machineries are fully exploited.

Besides, we ensure that the cluster has the talent to ensure that machines are properly used. NEC prides itself in creating Engineering Workers which are to be absorbed by the industries and groom our future Managers to handle the growing responsibilities. In this respect regular trainings are held on advanced tools and software to coach managers in these areas.

What product range you have for Test and Measuring instruments? Do you have future plans to diversify and launch further products?

We have a strong presence in Test and Measuring instruments in India. Over the years, we have introduced many quality products in Indian markets which are known for their robustness, precision and safety features like automatic blocking system. Our wide range of T&M products include digital multimeters, digital clamp meters, and insulation testers. We hold international patents for our innovative design of Clamp Meters which gives its users unique advantage in terms of operability and safety.

We have recently launched next generation multimeters which have received very good response from the market. Our ambitious and aggressive plan to increase our market share in the T&M sphere will be fuelled by expansion of our current line of products and diversification into new product ranges.

We will soon be introducing power quality clamp meter & advanced multimeters offering unique value propositions to our customers. We have envisioned achieving leadership position in Test and Measuring instruments by providing world class yet affordable solutions to our customers including safety and building installation testing.

What scope do you see you see for the manufacturers of Electrical Measuring Instruments in India?

India is among the developing countries, which has a huge requirement for Energy and Infrastructure. It is expecting GDP growth of 6 to 7 % every year, year -on-year which should go to double digit in the next 3-4 years. We believe that with swift economic and industrial growth is set to increase the energy consumption.

- Energy-intensive industries, such as oil and gas, petrochemical, steel, and cement have been rapidly growing for the last three to five years and this trend is likely to continue. Power generation is still lagging the demand but should catch up to fulfil the shortage that we presently have.
- With industrial development on the rise, demand for Electrical Measuring Instruments is likely to increase.
- Various end-user segments are witnessing increased awareness of energy efficiency and energy conservation & power quality. This is likely to drive the market for energy management systems with electronic meters being no exception.
- With extensive plans of improving the rail and road infrastructure of the tier I and tier II cities, there have been equally-high investments in new shopping malls, commercial buildings, and residential complexes.

As a manufacturer, we see more & more emerging technologies, new R&D breakthroughs, economics booming & market potential in coming years. In nutshell, a lot more market opportunities for both existing & new players.

What all activities are under your control and what strategy do you follow when facing the challenges in marketing the products available in the similar range in the market?

Our marketing strategy has always been customer centricity with end to end solution. The ease of customization that is built into our products allows us to provide our customers with a specific quality solution coupled with economy pricing, quality & delivery commitment. Adopting philosophy "Prices are negotiable, but Quality and features are not"

- Having established domestic marketing offices, sales and

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- Diversification of the products and services.
- Market situation analysis and developing products based on market needs.
- Providing world class products at competitive prices through distributors locally in each geography we are in.

At the end, the best marketing for us is to have a growing number of satisfied customers who recommend us and a lot of successful stories of co operation between our business partners & Rishabh Instruments through repeat orders.

We have challenges in terms of Imports as well as Domestic manufacturing. The imported Chinese products do not have features or reliability and therefore are not difficult to address. But European and American Markets/products poses a challenge. Of-course, designing and manufacturing within India makes it much more competitive in terms of raw resources availability but we have to build features, reliability like German and American products. Our acquisitions in Poland and UK are helping us do this exclusively.

What do you envision for the next two years?

We are going big way to increase our presence in the Global marketplace with added manpower & technology integration, mainly to concentrate on Eastern European & Domestic Indian Market.

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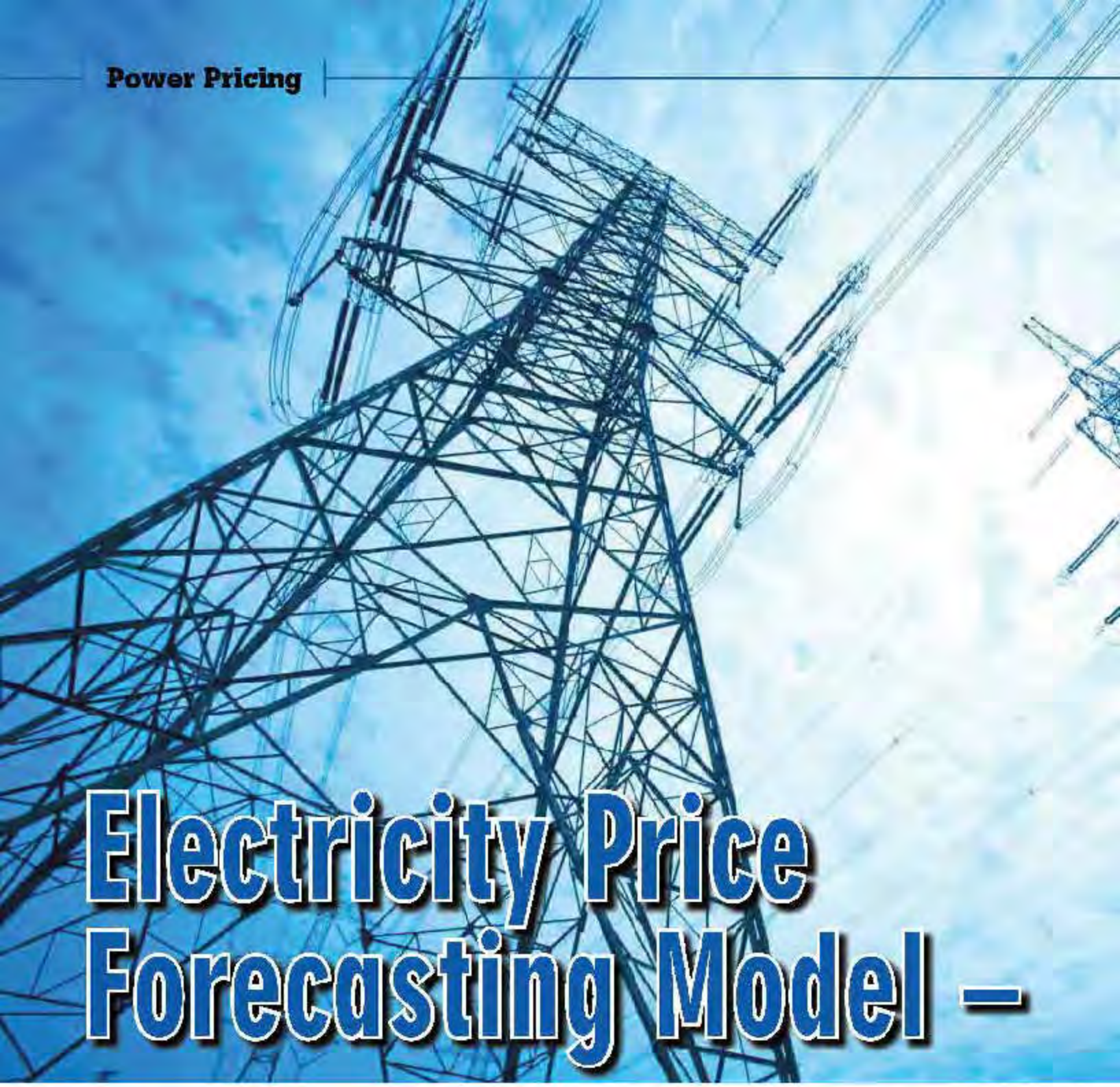

Electricity Price Forecasting Model –

Defining the Need and Approach for India Market

Like the reforms in other sectors there has been tremendous transformation in the Power sector too wherein there has been transition from a public monopoly market structure to one of competitive wholesale and retail structure with the unbundling and existence of power exchanges to enable power trading for efficient and reliable power at competitive price.

- Jasdev Singh Soni

The need for price forecasting model is driven out of the typical characteristic of the power sector which involves long term capital investment with highly specific nature of assets and distinct characteristic of electricity compared to other commodities. The electricity plays a vital role with its high strategic importance in the development of any country due to economic significance and also the political sensitivities. The Customer needs protection in terms price variations and the investors wants confidence. Thus the objective of Price Forecasting model is to visualize the future electricity market dynamics to assist in present decision making process. The load forecasting and demand forecasting tools have been widely developed and deployed in the power sector for better planning but there is very little emphasis seen on the price forecasting in India so far, maybe as the power sector has just transformed and the electricity market is evolving. It is not that the need or the requirement of price forecasting is missing but it is complex requirement of data and the combination of various tools that make a price forecasting model a unique product and the dynamics of India Power sector demands Price Forecasting Solution and not a Product or a standard model.

The Power sector has transformed in the complete value chain be it the Generation, Transmission & Distribution and the new Power Trading functions which is being widely adopted by states with new participant entering the existing power exchanges. Today India has the installed capacity of 186624 MW which has increased from 1362 MW since independence and there are plans to add additional capacity of every year. If we see the annual per capita consumption which is still low at 770 units' approx. compared to other countries. The India Power sector is still facing acute problems of Power cuts scheduled and outages and there are issues pertaining to power theft and Tariff fixation. There are problems related with the transmission network unavailability and congestion and inadequate power generation capacity. Then there are issues with the lack of optimum utilisation of the existing generation capacity. There are lot of plans and blue prints being constituted to counter these problems. But there is still lot of potential in the power sector for adding additional capacity and improvements but then there are risks associated discussed in the next section.

The complete global electricity industry has undergone transition towards deregulation with the ultimate objective to benefit the end-use customer with a reliable but yet cheaper electricity supply. The objective was to promote competition among different market players and to make the electricity market more efficient.

Electricity is traded in the power exchange markets with wholesale buyers and sellers take part in an auction and submit their bids in terms of prices and quantities for the 24 hours or the pre-defined of the next day. The market clearing price is determined by the intersection between the aggregated supply and demand curves.

The past practice of setting the tariff based on their aggregate cost is being replaced with a new structure and functioning with leading generation, transmission and distribution to be independent activities. The Indian power market is also gradually moving towards a customer driven market.

As commonly stated electricity is like a commodity in the form of electrical energy- generated, transmitted, supplied or traded for any purpose. But then there is a difference electricity cannot be stored economically and requires to be delivered immediately, and there

is large fluctuation in the demand depending on the various factors specifically the weather and variation in the supply too which could be affected by the power plant outages or transmission grid congestion/ failure. Thus good price forecasting model is a critical part of the whole process since any player with in adequate knowledge of the market could end up losing financially. The losses could be to any player in the market "buyer" "seller" or the "trader" and even the Investor.

In this article effort has been made to highlight the need for good price forecasting solution and it has been tried to emphasize on the fact that there is no standard model or scheme which can adopted off the shelf for the price forecasting as followed for commodities price prediction as this might result in the high errors. But the right approach is to have different models combined together and used alternatively for different forecast period. For example there are different approaches to modelling and forecasting spot electricity price and for short term price forecasting. One such methodology and approach has been present without getting into detail of algorithms. This paper also discusses the need and importance of electricity price forecasting in the today's market and significance of price forecasting for different players and how they can use it.

Need for Electricity Price Forecasting Model

Like the reforms in other sectors there has been tremendous transformation in the Power sector too wherein there has been transition from a public monopoly market structure to one of competitive wholesale and retail structure with the unbundling and existence of power exchanges to enable power trading for efficient and reliable power at competitive price. The need for price forecasting model is driven out of the typical characteristic of the power sector which involves long term capital investment with highly specific nature of assets and distinct characteristic of electricity compared to other commodities. The electricity plays a vital role with its high strategic importance in the development of any country due to economic significance and also the political sensitivities. The Customer needs protection in terms price variations and the investors wants confidence. Thus the objective of Price Forecasting model is to visualize the future electricity market dynamics to assist in present decision making process. The load forecasting and demand forecasting tools have been widely developed and deployed in the power sector for better planning but there is very little emphasis seen on the price forecasting in India so far, maybe as the power sector has just transformed and the electricity market is evolving. It is not that the need or the requirement of price forecasting is missing but it is complex requirement of data and the combination of various tools that make a price forecasting model a unique product and the dynamics of India Power sector demands Price Forecasting Solution and not a Product or a standard model.

Electricity Price Forecasting Beneficiaries

The benefits of Electricity Price Forecasting can be realized across the power sector value chain as detailed below.

Generators and Investors/Financial Institutions: Profitability and Confidence: There are huge investments being carried out in expanding the Power generation capacity in the country with the active participation from the private players with ample support from investors. There is no doubt that these are good Investment opportunities in the electric power generation as there is still huge gap between the Demand and supply enabling the state utilities adding capacity in line with central planning and regulation. It is also seen that now pre-dominantly the investments in the power plant is being made by independent companies or the developers.

Largely the responsibility of financing the power generation projects has been passed on to these private investors. Thus there is no direct pass through arrangement of costs to consumers, and with uncertainty in the prices of electricity in future, these investor's decisions for investment carry a lot of risk component in terms of price volatility this is apart from the other risk factors pertaining regulatory decisions etc.

The Long term Electricity price forecast could be a trigger for the Investors to set up new power plants and then it will help in identifying the appropriate location or region which would yield maximum benefits considering the transmission and other constraints.

Thus there are various decisions involved in the initial stage during the feasibility study of the power generation project. A Long term Price Forecasting tool can be instrumental in the decision making process and mitigate the investment risks. At times there are major slippages in meeting targets of capacity addition and this factor also influencing the prices in the market. While the Generators have objective to maximize their profits by scheduling their dispatch and have appropriate bidding strategy in place. The scheduling needs to be done in such a manner that the cost of power generation for each unit is taken into

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consideration while preparing a schedule to ensure that maximum advantage is taken by delivering power at lowest cost of generation. It is important to know the unit generating costs and the impact of increasing the Generation on the overall cost. Thus the Application of Price Forecasting is not limited to Long term forecasting but Medium and Short term forecasting is also required by the Generators for effective scheduling of the dispatch between various plants and units within a power plant.

Transmission Organization and System Operators - Demand on the Transmission Network: The transmission network has expanded on the basis of demand based planning models but with the changing scenario of the power sector which has various players influencing the demand and loads, and the tariff structures like Availability based Tariff (ABT) in place for Grid discipline combined with the new technologies and the initiatives coming up in the Smart Grid area with the smart consumer pricing.

Hence it has become important to ensure that the price factor is also well accounted into the model used for the power network expansion decision making process. Since the transmission expansion is a long term planning, so proper methods needs to be considered for price-based demand response to predict the future prices accurately.

At present the consumers like domestic residential and commercial are not active player in the power market thus their consumption pattern is almost unaffected by the price variations in the power market but then it is not too far when the consumer shall be taking decisions on their consumption pattern on hourly or daily basis which would be possible by the use of Smart meters. The transmission network being the backbone to ensure reliable power supply, usually the transmission expansion plans are driven based on the Network congestion towards the supply point while the consumer demand being considered static and not affected by the price signals from the energy market in the medium and short term market. The price forecasting thus plays significant role in predicting the prices in various nodes or zones as applicable which goes a long way in long term planning and also short term congestion management. Thus a good price forecast model can be instrumental for Central Transmission utility for effective Network Planning and expansion.

Regional and State Load Dispatch Centers (RLDCs/SLDCs): The Regional and State Load Despatch centre whose primary responsibility is to ensure Grid discipline and facilitate Load scheduling & dispatch functions effectively along with Energy Accounting & Settlement Mechanism. This price prediction tool can help them in understanding the behavior of market by understanding the price sensitivities so that they can plan the resources in advance and ensure smooth operations. They can provide inputs for National Grid planning to the Authority and the Central Transmission Utility.

Power Traders /Load serving entities– Long term and Short term contracts: For the load serving entities it is beneficial to use price forecasts to develop strategies and negotiation positions for entering into long term and short term contracts with customers, also this shall enable to exercise call and put options and hedge their risk in the power exchanges or by entering into bilateral agreement or financial ones. This could be a tool for decision making in terms of trading the forward contracts in the future markets. The knowledge of market clearing prices of the previous day and also historic data on the MCP of the past months/year along with good forecast of the next day's price is a crucial input in formulating bidding strategies.

Distribution Utility – Planning and Scheduling Power Purchase and Trading: The Unbundling of State Electricity boards into separate entities for transmission, generation, distribution and trading functions has provided thrust to the power sector to move towards highly efficient and self-sustainable model. Now the responsibility to procure power at a best price resides on these utilities and they need to do better planning and scheduling to ensure that they do not get into position wherein they have to procure power at very high rates during the peak demand periods.

Hence not just the load forecasting but it also important for them to know the market prices in the future so that they can take calculated risk and also enter into bilateral agreements in advance. There are instances where the decision needs to be taken whether to run own generating units to meet captive requirements or to buy power from grid, these situation arises while the cheap power is available in the grid and there are situations when there is surplus power available but the crucial decision needs to be taken whether to sell surplus power in the spot market in the power exchange or shut down high cost generating units.

Hence the price forecasting and generation cost forecasting tools will be useful and help in strategic decisions thereby improving the profitability. On one hand it shall help the Discoms to reduce the power purchase cost with efficient power purchase strategy and on the

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other hand it shall help to manage the monthly peak and energy demand.

Large industrial Open Access (OA) customers & CPP - Hedge their risks through long-term, fixed price contracts: As per the Electricity act 2003 the mechanism of "open Access" has been introduced and which has been adopted across few states and others states may eventually follow, this provides option to the consumers to choose its supplier. The Price forecasting has found its relevance among these consumers as it is instrumental in the decision making process for spot markets and long-term contracts, price forecasts are necessary to develop bidding strategies or negotiation skills in order to maximize benefit.

When the price forecast for the next day or the future period six months, one year is available it helps the consumer plan his production and also the utility of power in much efficient manner in case of Captive Power Plants too who may take call as per the price forecast whether to run their machines or procure power from the grid.

Unscheduled Interchange (UI) charges which is mechanism to maintain Grid discipline by CERC carries significance for the need to do the proper planning in the power trading functions since there are charges payable/receivable depending on the Grid frequency for under/Overdrawal by the buyer or the beneficiary and under/over supply by the generating station or the seller.

Regulators – Policy and Tariff Fixation: Regulators one of the primary responsibility is the fixation of Tariff in accordance to the provision of Electricity act for the

- For the Generating company for supply of power
- Wheeling charges for Transmission of electricity
- Tariff for Distribution Licensee to be charged from Retail consumers.

This is new dimension to the use of price forecasting tools, regulatory bodies play very important role in fixation policy and tariff across the value chain. Hence these price forecast tools could prove to be a tool for assisting them on the decision making for Tariff fixation. The different models can be created for this process and virtually they can simulate different conditions and see the overall impact.

The policy makers can evaluate the option of using the price Forecasting models for power trading in the global market wherein different countries can have an option to strategies and pool its reserve capacity thereby reducing cost for extra power stations and limiting requirement of spinning reserve.

Electricity Price Forecasting Model – Applications

For all the beneficiaries the price forecasting can be applicable in various time frames based on their specific requirements but then the accuracy of the forecast is low in the short term forecast due to the incomplete information or uncertain bidding strategy of the market participants but the accuracy is more reasonable with the time frame enlarged. The purpose of classifying the forecasting in different time frames is due to the fact that there is a different forecasting methods and approach which is applicable for each of the time frames. It is not advisable to use the methods applicable for short term forecast for long term forecast as short term forecast will be have quantitative analysis while on the other hand the long term forecast which are strategic in nature and used in business decisions.

Different methods in Forecasting are categorized as mentioned below:

- Qualitative methods - where there is no formal mathematical model (long term forecasting)
- Regression methods –Here a variable is thought to be linearly related to a number of other independent variables
- Multiple equation methods – There are no of dependent variables that interact with each other through a series of equations (as in economic models)
- Time series methods There is a single variable that changes with time and whose future values are related in some way to its past values. These techniques are mostly used for short and medium

Long Term Above 2 years	Medium term (1Year to 2 Year)	Short Term (Within 1 Year)
Transmission Expansion and augmentation	Negotiations of Bilateral contracts	Opportunity cost (Reserves and capacity)
Setting up New Generating Stations and Generation Augmentation	Congestion Management	Risk Assessment
Distribution Planning	Portfolio Allocation	Trading Scenarios
Regional Energy Exchanges		
Bidding Strategies		
Usually required for Strategic Decisions	***Can be used for Tactical decisions***	***Mainly the Operating decisions***

Table 1: Price Forecasting Application

term forecasts.

Electricity Price Forecasting Model – Influencing Factors

To do accurate Electricity price forecast it is important to detail the influencing factors on the electricity prices and these are mainly categorized into segments as mentioned in the Table 2.

There are a number of parameters that affect the bidding strategy of the generating companies. There are technical constraints on unit operation; load and weather forecast and hydro energy availability are some of the factors.

The variables would vary with regard to the forecasting dimensions, with different input variables for Long and medium term forecast which would not vary considerably in shorter time frame while on the other hand the short term forecast or Day ahead, hour ahead prices forecast the input variables would vary as per the market characteristics. In long term forecasting hydro factor is crucial as the water level in the reservoir is high would help to moderate the electricity prices in the market. The long term Power purchase agreements (PPAs) are also required to be taken into consideration as this would have implication of prices. The volatility in the prices can be largely attributed to the nature of electricity which is different from a normal commodity as it cannot be stored and there is need to maintain balance between demand and supply, also the inelastic nature of demand over short period of time. These factors needs to be categorized into input variable and these variables could be as many 50 no's put across different buckets to understand the impact of the each variable on the final price output by studying the past behavior.

Practical Approach for Price Forecasting Model Development

There are various initial activities to be performed before the actual forecast is initiated. Basic activities to be performed are:

- Data Management Large Volume of real time and Historic data from various sources which could be the CEA websites, SLDC, RLDCs, Power exchanges, Traders and State utilities need to be collected and stored in a common database.
- Data Preparation– Processing Configuration Validation Analysis and Estimation of data
- Build Data Model
- Forecasting and Optimization Model

A first step to price forecasting is to identify all the crucial factors and variables which set the future price trend in the market. The initial step is the data preparation and doing data analysis thereby clearly identifying the outliers so that the forecasting result is not biased based on them. The historic models and its results need to be studied to select the most efficient model. A basic model is developed initially which can be clearly understood by the power market players and then a comparison between the actual and forecast results is done to do the required optimization of model. There are various method used for electricity price forecasting and it becomes difficult to identify the appropriate method for forecasting. To understand the price forecasting methods better it is important to understand the influencing factors and forecast these influencing factors using the existing and proven methodologies like in the case of weather forecasting or be the load and demand forecasting tools. It is common presumption that these tools can be applied for price forecasting but then it is not very effective and the errors would vary for example Artificial Intelligence (AI) approaches such as neural network, and support vector machine (SVM), which have been successfully applied in load forecast whereas Support Vector Regression (SVR) model which is developed in terms of the particularity of the price forecast in electricity market.

It is also important that the input variables used for the Electricity price forecasting are also predicted using proven methodologies and required modelling is done for them. Figure 3 illustrates one of such approach whereby different input variables are predicted such as the weather input parameters like temperature humidity etc. is

Power System	Fuel Factor	Weather	Hydro-Factors	Spot market	Financial market
Consumption Generation (Nuclear, Thermal etc) Unit-Planned Outages Historical load, data on imports / exports Capacity (Excess/shortfall) Transmission congestion index Transmission Corridor Availability	Coal Prices Crude Oil Prices	Precipitation Temperature Wind	Hydro balance Water inflow for reservoirs Ground water level	Prices Turnovers Power exchange (Market clearing price)	Futures contracts Forward contracts

Table 2: Price Forecasting Influencing factors

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predicted using the weather forecast module and on the other Load forecasting module is utilized for the prediction of load parameters.

For the purpose of Long and medium term forecasting it would be required to setup basic database on the installed capacity and the additional projects in the pipeline for power generation which would be input for Supply forecast. The next step is to input the required data along with historical data's for all the influencing factors also the historic price data. The availability of accurate historic data is a key factor for accurate forecast. The screening of data for accuracy and also in case of some data is missing that needs to be estimated. The data analysis is to be carried which shall be followed by selection of an appropriate model. The next step is to do the application development which shall integrate various models and also do the required reporting. The process is to be repeated with different models to arrive at the optimized state wherein the right model combination is selected for each module and this requires various permutation and combinations to be carried out with due consideration to time factor. This is an iterative process, for an investor who would like to know the Return on Investment (ROI) for his investment and the best method is to calculate the net present value of additions in resources or withdrawals for each year of the forecast period is considered. It is predicted to see of the future prices of electricity can be sufficient to cover the resource, development, operation, maintenance costs this includes his profit margin.

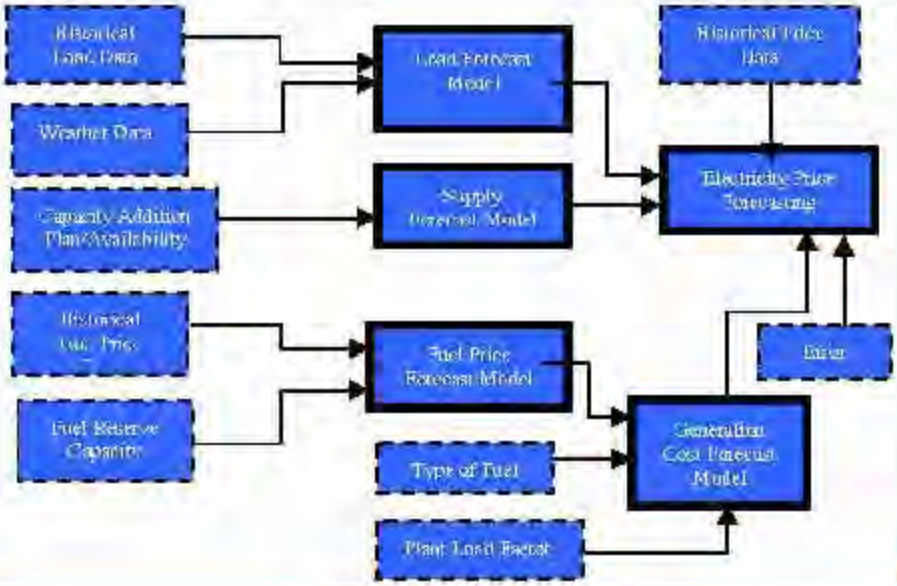

Fig. 3: Price Forecasting Modules

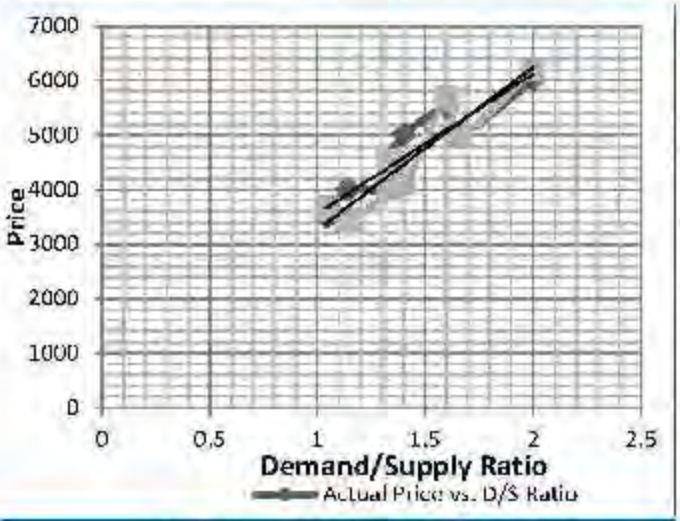

Fig. 4: Demand Supply ratio Vs. Prices

There is another approach for short and medium term forecasting which is detailed market simulation approach in which lot of data pertaining to power exchange market is required. This is preferred by the Power utilities and market operaters. In this method the actual market condition is simulated by assuming the demand and supply data based on the historic trend and also factor for system operating constraints.

This method can be used as supporting tool over and above the statistical and intelligent models. These approaches forecast future prices using historical operation data. The need for different modules is to accurately predict the Demand Supply ratio as it is observed that the electricity prices follow the demand supply curve and hence the demand supply ratio is major contributor as variable input for the price prediction model.

Time series models are among the proposed approaches with reasonably good results. ARIMA models, for instance, are reported to predict market prices with a reported MWE forecast error of up to only 5% in Californian market while TF and DF models give a result with an average weekly error of only 3% for the same market. On the other hand, a MAPE of about 9% is reported using ANN for the England-Wales market.

Electricity Price Forecasting Model Application

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forecasting methodologies, it is important to understand different type of models, time frame for prediction, input variables required, output variables, data points and analysis. Model needs to be developed using selected methodology and the system needs to be revisited from time to time.

There is still lot of research and case studies being developed on the performance of various methodologies and models developed for electricity price and demand forecasting. The task is to identify right tools and integrate them together as there is no standard product which can be applied to meet the universal requirements. On the contrary the load forecasting tools and methods have matured enough and the errors have within 3 to 4% while the price forecasting is still in the infant stages.

It can be really confusing by seeing the available models on the electricity forecasting as published by Electric Power Research Centre (EPRC). It is thus suggested to go for a hybrid approach with ARIMA and ANN models providing more flexibility for price prediction. Auto Regressive Integrated Moving Average (ARIMA) models which is combination of two models mainly Auto Regression and Moving Average while this has been applied to forecast commodity prices like oil or natural gas and also in successfully in load forecasting but due to its accuracy and past experience of results in mainland Spain and Californian markets make them a preferred model.

The approach for application development is to calculate the error between the forecast data and the actual outcome and this error which is basically Mean Absolute Error (Average of absolute error of last two forecasted values is fed back into the system as input variable. As discussed in earlier section that important aspect in the price forecasting is the Demand supply ratio and it is observed that the Demand supply ratio follows the price pattern. Hence it is necessary to forecast the demand and supply data through the respective modules and this is applied to the price forecast model.

The above figure 5 shows one such approach for Electricity price forecasting with the use of combination of statistical Time series model Auto –Regression Integrated Moving Average (ARIMA) and intelligent system Artificial Neural Networks (ANN). The additional use of the thorough Market

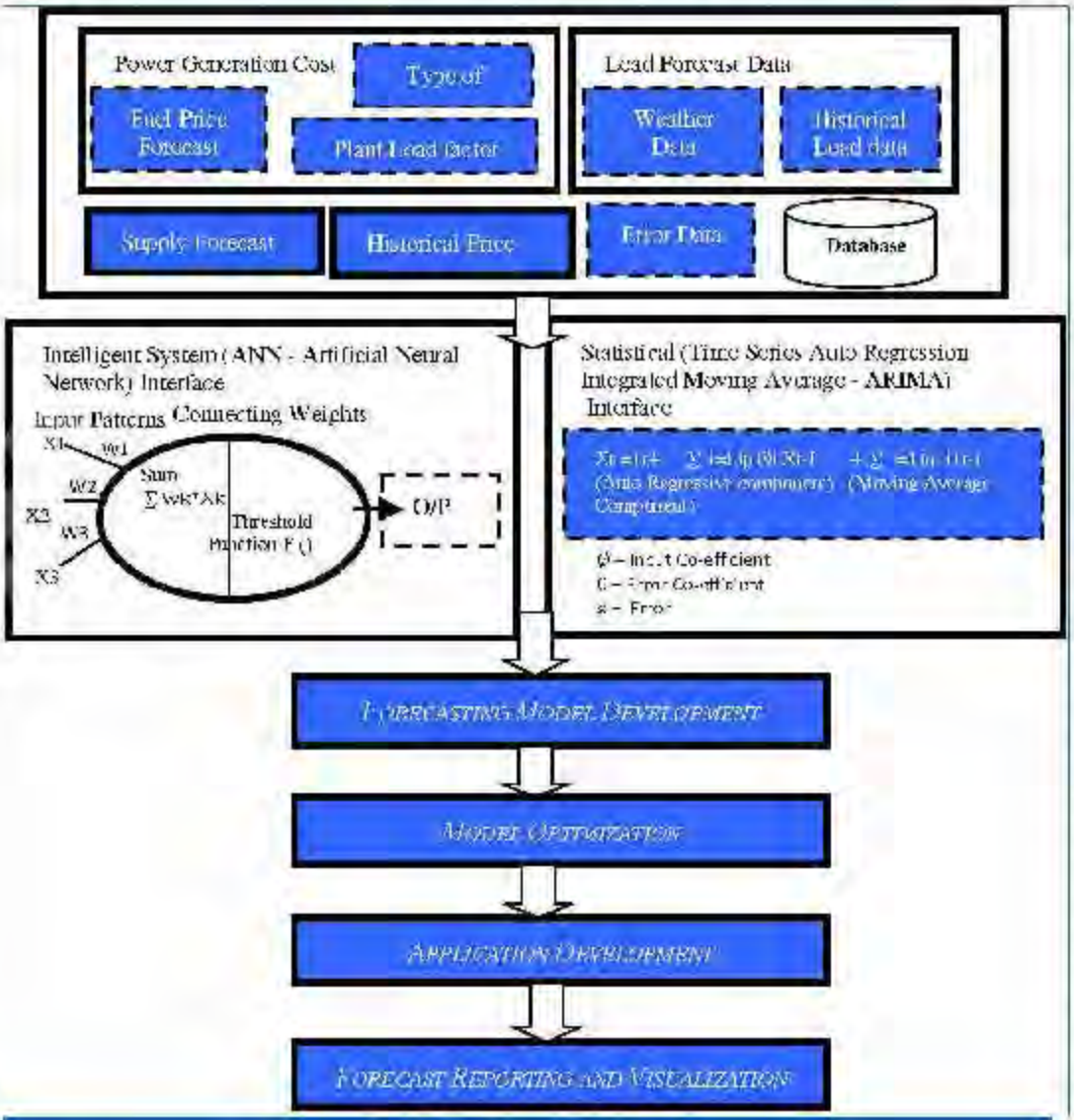

Fig. 5: Price Forecasting Approach

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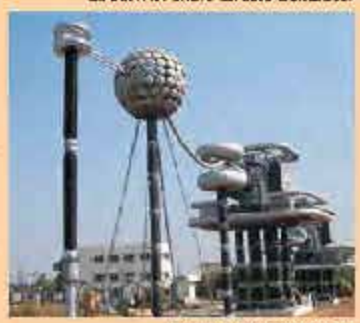

1200kV CVT under test

1200kV Insulator String testing

Erection of Tower for Testing

Cable Testing

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Simulation techniques could be a best approach for short term or spot prices prediction. The disadvantage of the ARIMA is that it cannot capture nonlinear patterns of complex time series if nonlinearity exists. Hence it is important to use a combination model approach with ANN which eliminates the drawback of ARIMA.

It is observed that there is continues need to revisit the coefficients and also the structure of models depending upon the forecast periods or time frame. The objective here is to develop simple price forecast model which allows the use by various entities to predict electricity prices based on their needs.

There is no need to re invent new methods for forecasting rather advisable to use the existing developed models and use the errors to customize the model so that the favourable results can be achieved.

Conclusion

The Electricity price forecasting is complex but based on the various research and case studies it is essential tool which needs to be applied with thorough analysis as there is no standard model or scheme which can adopted off the shelf but approach is to have a different models combined together come out with an expert model and can used alternatively for different forecast period.

The various past research and understanding the requirement of various players and influencing factors, it is observed that forecast methodology varies depending on the forecast requirements in terms of Short term Medium term and Long term forecast and similar is the case of errors which would vary depending on the methods used for the forecasting. In the global market Electricity price forecasting have been developed and deployed. The exchange markets which have very recently come into existence in India and also with lot of development happening in the power sector, this could be the right time when the price forecasting model can be developed and put into use so that the learning curve can be established and as the power exchange market grows the tool shall also get matured enough and can be utilized by the power market players effectively for their benefits. ■

Jasdev Singh Soni, is BE (E&E), PG in Power Plant Engineering and PGDBA in Operations Management.

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Prashant Shah
Director
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Vardhman stampings, celebrating Silver Jubilee with dedicated 25 years in the Transformer Lamination Industry is enjoying substantial market share in domestic & overseas market. The group is enjoying accreditation of export house by Govt. of India. The company is one of the top most growing and Indian transformer industry and having vast experience in their field. In an exclusive interview with **Electrical india, Prashant Shah** says, quality of the products and production process is their primary concern.

You are manufactures of distribution & power transformer lamination. What is the scope and status of transformer market in India?

Of course, India has good demand for power and distribution transformers as we are lagging behind in meeting XIth plan but because of political & economical uncertainties there is slow down in overall market. Utilities and projects are delaying takeoff of transformers because of financial crunch. We foresee that after elections and by 2015 market will improve and demand for transformer will gear up.

Could you share details about the product range of the company?

Our group is involved in various industries since 1965. In 1989, group set one more milestone by establishing VSPL in transformer industry. As of now, we manufacture transformer lamination up-to 1000mm width and 5500mm long. Radiators for power and distribution transformers. Wound gap cores, Toroidal cores for CT's and PT's, and assembled cores. In 2013 we have added our product list by manufacturing Bushing type current transformers, Tank Shunts, Shunt Reactors & Paper wound Copper Strips.

You are one of the major importers of Cold Rolled Grain Oriented (CRGO) Steel. Does the Indian market also produces CRGO steel and meets your standards?

In domestic market there is availability of CRGO but they are not producing various grades of material. Even in projects of NTPC and PGCIL no mil. in India is approved for all grades. Looking to present scenario consumption of Hi-B grade is increasing to fulfill demand of star rating

transformer from Utility. Also there is huge gap in demand and supply for CRGO manufactured in India and therefore we are dependent on overseas mills.

What is the competitive edge you command against competitors in the same line of products in the market?

Competition is part and partial of each and every industry. Competitors always inspire us to give best quality products at competitive price to customer. We at VSPL have started to adopt latest technologies since 2003. We always keep on adding our product range; today VSPL offers entire range of transformer lamination form 5 Kva to 1200Kv class, with the rich experience of 25 years in this field and with the help of latest technology at VSPL we are able to offer consistent quality material at competitive rate and in time delivery, what else more a customer expect?

Could you share details about various accreditations and certifications your company enjoys?

We are ISO 9001 and OSHAS 18001 certified company, VSPL is one and only company in Indian Transformer lamination industry having OHSAS certification. Our company is also enjoying export house facility. Apart from that we are approved vendors of all leading transformer manufacturers in India and around the globe.

What various tests are being subjected to raw material to ensure quality standards?

Quality of our products and production process is our primary concern, which has been the driving force behind our rapid growth. We conduct numerous quality checking procedures and audits right from material acquisition to packing. We are maintaining standards of TQM since 2005, where we plan the quality improvement on continual basis.

It is our endeavor to create a culture of Total Quality where continuous improvement of our people, our processes and our products become a way of life. We had done heavy investment in setting up in-house laboratory equipped with latest equipments from world's best Dr. Brockhaus, Germany having facility of Single Sheet Tester, Ring Core Tester, Epstein Tester and Franklin Tester, equivalent to the laboratory of reputed CRGO Steel Mills and ERDA.

You had been participating and sponsoring many exhibitions. Could you share details about the same?

We regularly participate in domestic as well as international exhibitions, which had helped us to increase our market share and global presence. Today we are proud to celebrate 25 years of success with our presence in Africa, Europe, Asia and Latin America.

What is your vision in the next two years?

We are geared to increase our production facilities to boost our penetration in global market and to serve Indian industry at its best. Also we have started to manufacture major products pertaining to transformer industry viz, Shunt reactors, tank shunts and Paper wound Copper Strips. ■

Projected Demand and Installed Capacity Requirement

Electricity sector in India has present Peak Demand of about 1,15,000 MW & Installed Capacity is 1,52,380 MW with generation mix is thermal (63%), hydro (25%), Nuclear (9%) and renewables (9%). Projected Peak Demand in 2012 is about 150 GW and in 2017 is more than 200 GW. The corresponding Installed capacity requirement in 2012 is about 220 GW and in 2017 is more than 300 GW. The projected Peak Demand and the Installed Capacity Requirement in next 15 years is shown herein.

Fig. 1: Projected peak demand in India

Fig. 2: Projected Installed Capacity Requirement

Source: POWERGRID

Necessity of EHV in Urban Transmission

Energy market has changed dramatically over the last years as a consequence of deregulation,privatisation and unbundling of generation and transmission. The new network owners mainly focus on the cost-effectiveness of their assets. This applies to new network investments but,certainly, also includes the optimisation of usage of the existing underground network. The design of a High Voltage underground system is extremely important and requires an in-depth knowledge of cables, accessories, methods of installation,the fault current of the system and impact on the electrical network. In the world of today, the EHV systems are basically EPC contracted, and need to specialize in providing total management of major projects and offer a complete turnkey approach, from system planning to final testing and post-sale services. Installation design and methods, co-ordination and scheduling of installation activities, are as crucial as the manufacture of cables and accessories to achieve a reliable and satisfactory connection. It is necessary to operate to the highest accreditation and safety standards to meet the demands of the most complex project environments. Turnkey approach, worldwide experience,top class customers references and strong focus on innovation represent the winning recipe that makes Ravin the world leader in HV systems.The effective management of the existing networks requires different knowledge and experience,as they are often of hybrid nature (fluid filled, gas insulated and XLPE extruded cables).

- Vijay Karia

As India marches towards the 21st Century, power becomes an essential ingredient for infra-structural development. With rapid urbanisation around the corner to sustain the industrial growth, the necessity of transmitting large blocks of power to load centres assumes significance. Over they ears, there has been a marked increase in the voltage level for transmission of bulk power, due to the distinct advantages offered by the use of high voltage.

Necessity for EHV Transmission:
With increase in transmission voltage, for the same amount of power to be transmitted the current in the line decreases which reduces I2R losses. This will lead to increase in transmission efficiency. With decrease in transmission current, size of conductor required reduces which decreases the size of conductor. The transmission capacity is proportional to square of operating voltages. Thus the transmission capacity of line increases with increase in voltage. With increase in level of transmission voltage, the installation cost of the transmission per km decreases. It is economical with EHV transmission to interconnect the power systems on a large scale. The number of circuits and the land requirement for transmission decreases with the use of higher transmission voltages. Over the years, there has been a marked increase in the voltage level for transmission of bulk power, due to the distinct advantages offered by the use of high voltage. This had ushered in the generation of Extra High Voltage (EHV) power transmission systems with voltage grades of 66 kV & above. This is something which we will call the Power of "Urban Transmission".

Underground EHV cables are also used for evacuating bulk power generated in pumped storage hydroelectric power generating stations, situated at a lower altitude, at outdoor switchyard located at a higher altitude. Similarly, underground cable systems are the appropriate means of power transmission over short distances where erection of overhead tower lines would be infeasible considering the space constraints.

It is in this context that Cross-linked Polyethylene (XLPE) insulated cables offer significant advantages. As an insulating material, XLPE combines the advantages of improved mechanical and thermal properties with excellent electrical characteristics of high dielectric strength, low relative permittivity and low di-electric losses. These advantages have rendered what XLPE cables can achieve today carrying large currents at voltages upto 500 kV, with an inherent higher short circuit withstand capacity of 250°C. Additional benefits that accrue are simple construction, easy installation and trouble-free operation.

EHV cables come in different combinations as per the features mentioned in chart below:

Conductor	Aluminium/Copper	Outer Sheath	Optional DTS System
Aluminium/ Copper	Aluminium Laminated Foil	PVC/HDPE	FibreOptic Cable embedded in main cable/ FOC laid separately
	Copper Laminated Foil		
	Corrugated Aluminium		
	Lead Sheath		
	Lead Sheath + Copper Wire +/ Aluminium wire		

EHV Cable Design

The 3 fundamental components of an EHV cable:

- Conductor
- Insulation System (Conductor screen, Insulation and insulation screen)
- Metallic Screen/Sheath Complex.

Design of the Conductor
The 2 basic Design drivers for designing the conductor are:

- Current Rating (continuous operation and short circuit)
- Mechanical Behaviour (flexibility, pulling strength)

Current Rating depends on
DC resistance: choice of metal and cross section area (CSA)
CSA = depends on maximum DC resistance (IEC 60228) or minimum weight (US standards)
AC resistance: depends on choice of construction (stranded/segmented) and wire surface treatment (bare/ oxidised/enamelled).

Additional features

- Longitudinal water blocking system
- Semi-conducting binder.

Design of the Insulation System
The 2 basic Design drivers for designing the insulation system are:

- Electrical Gradients
- Thermo-Mechanical & Thermo-Electrical Properties.

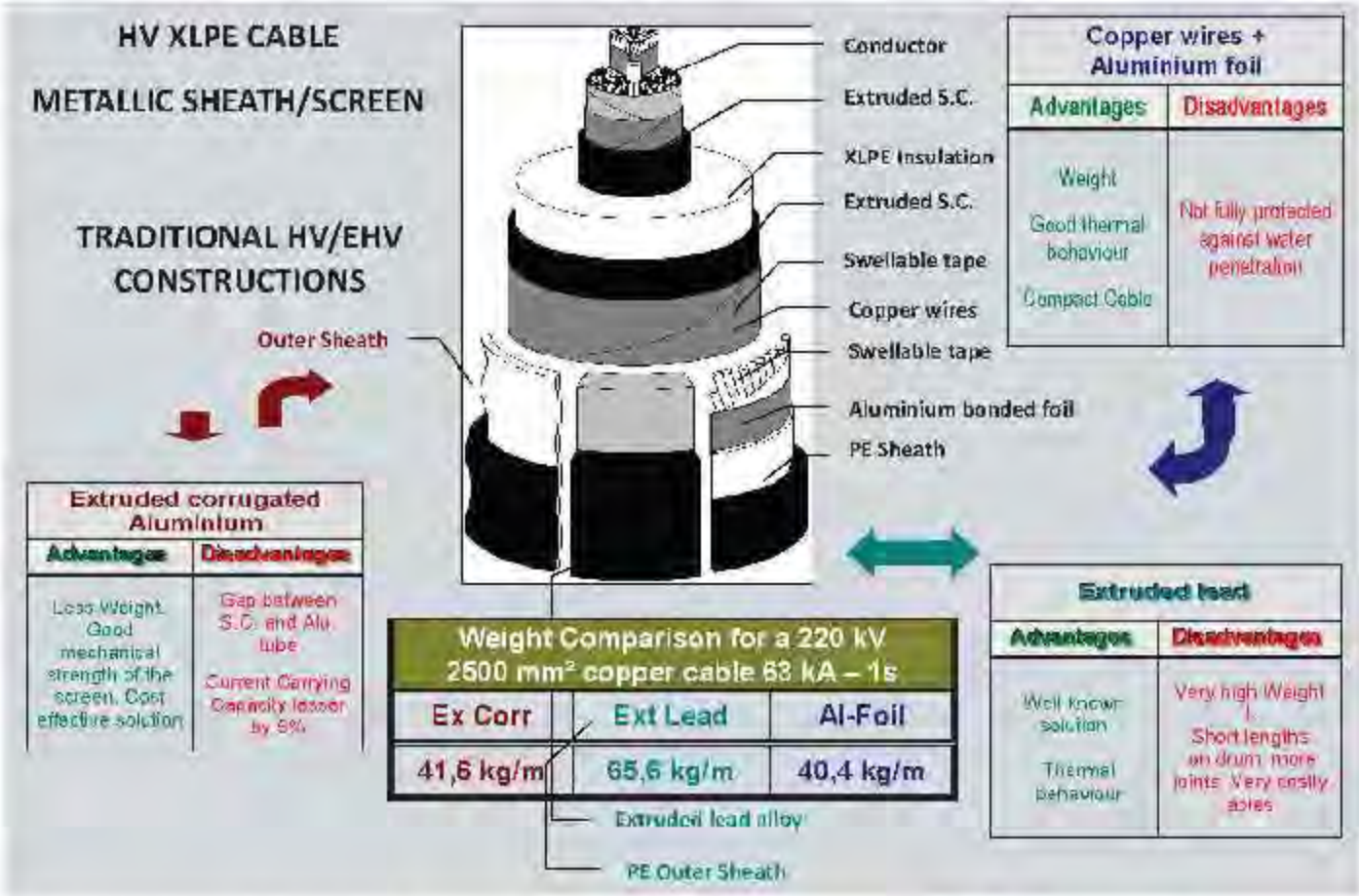
Electrical Gradients depend on

- Intrinsic reliability - Life curve and reliability derivation
- Qualification coverage - Type test and pre-qualification coverage (IEC 60840, IEC62067, Cigre Technical Brochure 303)

Thermo-Mechanical & Thermo-Electrical Properties

- Dissipative Power Factor (tg δ)
- Dielectrical losses = f(U²)
- Relative permittivity (ε)

Reactive power (power flows); charging current (off load current, setting of protections)



- Temperature withstand In continuous operation, in overload and short circuit.

Design of Screen / Sheath Complex

The 2 basic Design drivers are:

- Mechanical Properties
- Thermo-Electrical Properties.

Mechanical Properties

- Bending capability (laying behaviour)
- Core protection (shocks, punctures, radial water tightness)
- Fatigue (thermal cyclic loading).

Thermo-Electrical Properties

- Short circuit capability (IEC 60949, IEC 61443, Cigré TB 272)
- Screen losses (generated in AC systems).

Additional features

- Longitudinal water blocking system
- Outer sheath
  - Anti-corrosion protection
  - Safety of personnel (induced voltages)
  - Mechanical strength (abrasion during laying, deformation in cleats)
  - Special properties:
- Flame retardancy& LSOH
- Anti-termite / anti-rodent properties
- UV protection
- Resistance to hydrocarbons and solvents.

Anatomy of an EHV Cable

Normally, high voltage cables are characterised by the presence of the following components:

- Conductor
- Semi-conducting conductor screen
- Insulation (also called "dielectric")
- Semi-conducting insulation screen
- Metallic sheath or screen
- Protective outer covering.

Each of these components is described in the following paragraphs:

Cable Components

Conductors

Conductors are made from copper or aluminium, using wires or segments. Copper conductors are mainly used when a high current carrying requirement is needed (typically >1000 A) in addition to higher fault current. In case of lower requirements, aluminium conductors are frequently preferred due to the lower cost impact. Another important parameter that has to be taken into account is the resistance with alternating current. Because of the skin effect, the "AC resistance" of a conductor tends to be more significant as the cross section increases. The skin effect forces the current to flow along the peripheral areas, so the central section of the conductor becomes less efficient. For this reason, a special conductor construction, called "segmental

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Milliken", is used with big cross sections (from 1000 up to 2500 mm2). The conductor is typically divided in 5 or 6 segments that are slightly insulated from each other, so the current is "constrained" to flow inside the segments.

Fig. 1: A 400 kV cable with a Milliken conductor

Moreover, in order to obtain a further reduction of the skin effect, it's possible to oxidise or enamel a certain percentage of the wires inside the segments. The 400 kV cable shown in Figure 1 has a Milliken conductor.

Water blocking of the conductor is generally recommended in order to limit the water propagation along the conductor in case of damage to the cable.

Insulation and semi-conducting screens

The main materials used for high voltage extruded cables are detailed below:

- High Density Polyethylene (HDPE) is a thermoplastic material that was used for a limited period. Due to its limitations with regard to its working and short circuit temperatures (respectively 80°C and 150°C), HDPE insulation has been replaced by other extruded materials. HDPE has also been observed to have some difficulties in handling the cables at low temperatures.
- Ethylene Propylene Rubber (EPR) is a thermosetting compound and it is made from a blend of components, which formulation can be modified in order to obtain specific characteristics. It is manufactured and offers good performance in terms of "water treeing" resistance, as well as good elasticity characteristics. EPR has high dielectric losses compared to XLPE and this has limited its use to the maximum voltage level of 150 kV. EPR has a rated maximum conductor temperature of 90°C, an emergency rating of approx. 130°C and a conductor short-circuit rating of 250°C.
- Cross Linked Polyethylene (XLPE) is a thermosetting material. It offers a degree of purity higher than that offered by the EPR and this makes this insulation a suitable material for applications up to 500 kV. Contrary to EPR insulation, XLPE is very sensitive to moisture which would lead to its degradation. For this reason, it's necessary to prevent water penetration into the insulated core. This is achieved by applying a radial water barrier. XLPE cables have rated maximum conductor temperature of 90°C and an emergency rating of up to approx 105°C (depending on emergency time). The conductor short-circuit rating is 250°C.

Fig. 3: A Closeup of an extruded XLPE cable

Figure 3 shows a close-up of an XLPE cable and the black semi-conducting screens can be seen on each side of the XLPE insulation. Semi-conducting screens are used on all high voltage cables from 6.6 kV onwards to ensure a smooth electrical interface between conducting and insulating regions. The stranded profile of the conductor would initiate localised field concentration (i.e. high stress areas) if interfaced directly with the insulation and a consequent risk of ionisation and ultimately electrical breakdown. Hence, provision of semi-conducting screens removes these high stress areas and provides uniform stressing at the interface with the insulation.

To ensure a good interface, all three layers (i.e.conductor screen, insulation and insulation screen) are extruded in one process (triple extrusion). The electrical properties for the various extruded type insulations are detailed below:

Tan Delta	Electrical Permittivity	
PE	0.001	2.3
EPR	0.005	3
XLPE	0.001	2.5

Metallic Sheath

Fig. 4: A lead sheathed XLPE cable

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While EPR cables up to 150 kV may be used without any metallic barrier, it is recommended that all XLPE cables with rated voltages higher than 60 kV are provided with a radial moisture barrier comprising one of the following metallic sheaths:

- Extruded lead sheath
- Extruded corrugated aluminium sheath (CAS)
- Smooth longitudinally welded aluminium sheath (WAS)
- Aluminium or copper laminated and glued foil

The main functions of the metallic sheaths are:

- Protection against the ingress of moisture
- To give mechanical protection, thus preventing damages against external actions
- To withstand the single-phase fault current
- To carry the charging current
- To provide the earth or near-earth potential reference for the cable insulation.

Sometimes the above designs may be used in combination with copper wires or aluminium wires in order to increase the short circuit carrying capability.

All the above sheathing methods have advantages and disadvantages when compared towards the following topics:

- Thermal performance
- Electrical performance
- Corrosion resistance
- Water resistance
- Mechanical fatigue
- Weight
- Environmental impact.

Consideration of the optimum sheathing system will usually depend on the specific application and maybe also any specific country requirements.

Outer Sheath

Generally PE (polyethylene) is used as the sheathing material for


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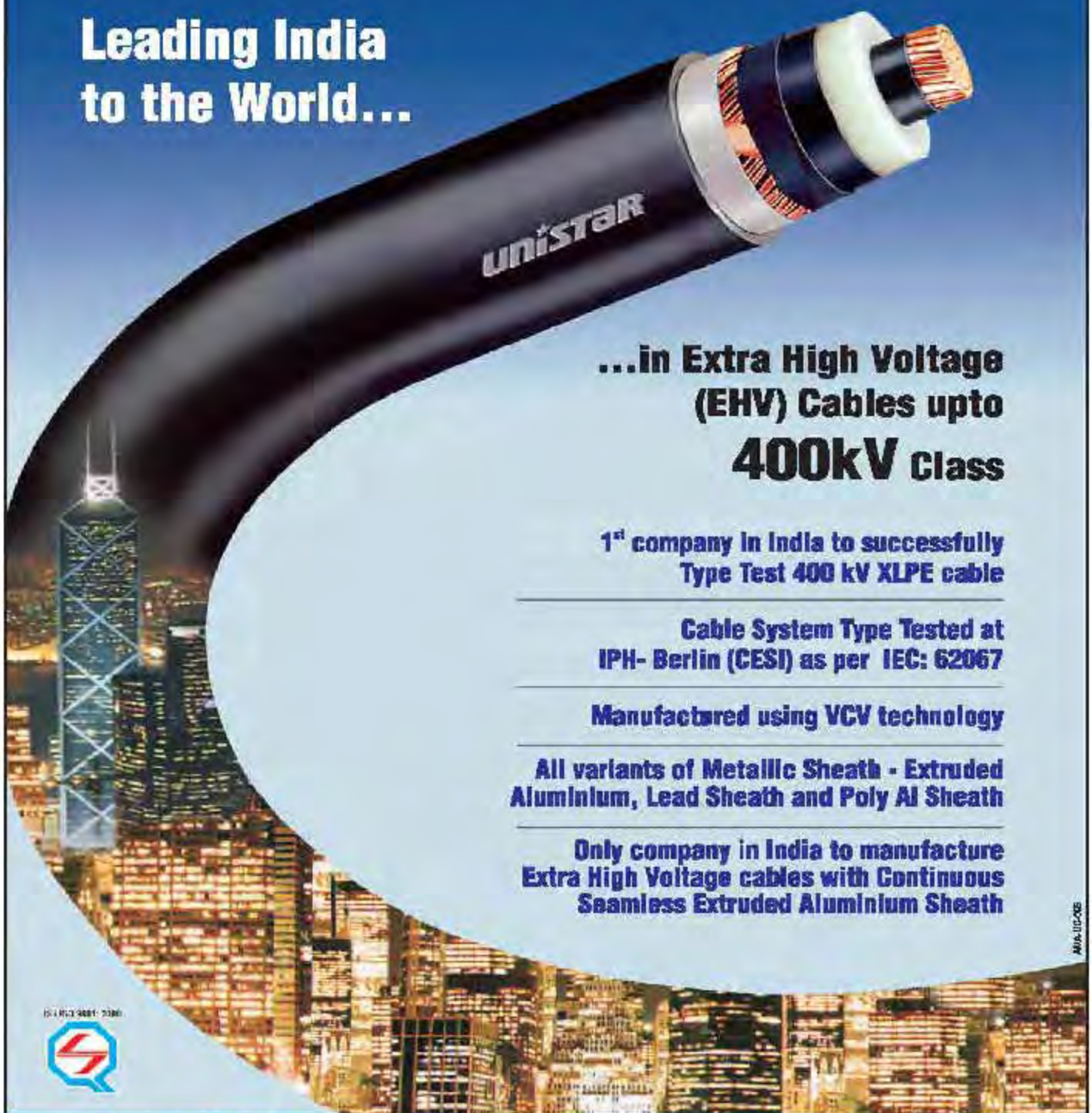

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Rated Voltage of Cables Uo/U	Highest Voltagefor equipment between Conductors Um	30min Voltage test 2.5Uo	Partial Discharge test 1.5Uo	Tandelta measurement Uo	Heating Cycle test 2Uo	Impulse Withstand test	15min power frequency voltage test after impulse test 2.5Uo
kV	kV	kV	kV	kV	kV	kV	kV
38/66	72.5	90	57	38	76	325	90
64/110	123	160	96	64	128	550	160
76/132	145	190	114	76	152	650	190
127/220*	245	315	190	122	254	1050	315

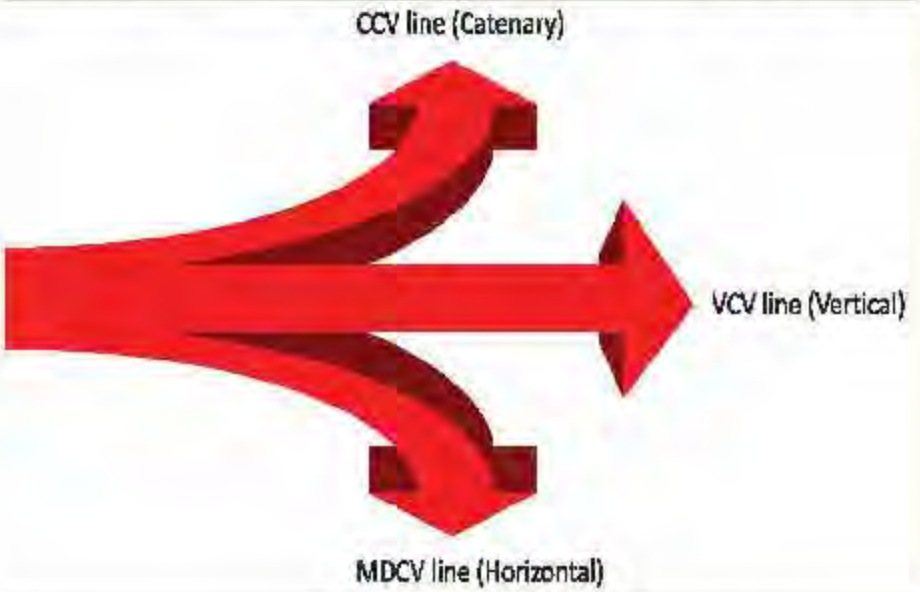
Table No. 1: Reference Test Voltages for EHV Cables

buried cables. This is normally medium-density polyethylene (MDPE) or alternatively high density polyethylene (HDPE), both of which provide good mechanical protection, good corrosion protection and good resistance to abrasion.

PVC (polyvinyl chloride) may also be used for buried cables. Cables laid in air (gallery, shaft, tunnel, etc.) normally have either a flame retardant PE or a PVC sheath. Both systems are widely used.

Manufacturing process of HV XLPE Cable

There are 3 types of Extrusion Technologies



EHV Cable Accessories

Installation of EHV Cables and Accessories

Ravin Group supplies and instals high voltage cables and systems on turnkey packages. We provide our customers with a comprehensive cable service package which encompasses system design, design and selection of cables and compatible accessories, supply of quality materials, installation, testing, commissioning and finally ensuring full safety and reliability of the installation.

Our installation team consists of a highly qualified and experienced team of engineers, who work with clients and manufacturers to identify the quickest and most cost effective power solutions. Our team has been trained and experienced in various countries around the world, and they carry with them over 250 years of cumulative experience in specialty jobs. We have an experience of installation of more than 150 kms of EHV cables and 1500 joints and terminations above 66 kv and 300 joints and terminations at voltages greater than or equal to 220 kV. ■

Vijay Karia, Chairman and Managing Director, Ravin Group of Companies. He is part of various committees and has been panelist and guest speaker on various TV occasions. He has held various posts as Chairman of IEEMA cable Division; Executive Council Member, IEEMA and has also been on the Organizing Committee of Elecrama 2010 and Elecrama 2012, organized by IEEMA. He was the Chairman of Cablewire 2009 and Cable wire 2011, the largest technical conference of the cable industry in India and Chairman of the Cable Conclave 2010. He is the Chairman of the Safety Conclave 2012. He has been member of Indian Merchants Chamber Delegation to UK in 2005. He has been invited as distinguished guest, panelist and speaker in various programmes. As CMD of Ravin Cables Limited, he has been instrumental in leading the electrical cable segment in many ways by launching new and improved products from time to time, which have been beneficial in reducing the overall T&D losses of the utilities; has been at forefront of advocating quality systems and transparency in the industry, and launching training programmes for utilities across India, etc.

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Shailendra Goyal
Managing Director
Zera India Pvt Ltd

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Which activities are you involved, heading South Asian regional operation of Zera GmbH?

We, ZERA India Pvt. Ltd, are working as a subsidiary of the ZERA GmbH. ZERA GmbH is a renowned international company associated with the testing and certification of Energy Meters. We are pioneer in the field of Hi-Tech & Fully automatic Testing System for Energy Meters and Instrumen. Transformers to be used in the field and laboratory. ZERA was founded in the year 1920 and operates in Europe, the Middle & Far East, South Africa and South America in 60 countries.

ZERA India has grown rapidly to gain market leadership. India is one of the important markets for ZERA GmbH because of the vast opportunities present here in the Power & Energy sector. The Indian operation of the ZERA is responsible for serving the India & its neighboring countries.

With increasing advancement in technology and automation, the Indian Operation of ZERA helps utilities to measure & maintain at par with world class technology in niche area and it also helps them to lower costs without compromising on the quality. In our company we bring together the entire expert knowledge of Research and Development, Sales and Marketing, Repairing and After Sales Support under one roof. The resulting synergies are an ideal basis for the development of high – quality precision products. Our creative development team creates individual solutions as well as universally adaptable standard products. Our core competency is the

development of innovative testing & calibration solutions which has helped us to maintain our market leader position. One can find out our state of art customized testing solutions everywhere around the world.

We are continuously working to facilitate & to meet the expectations of our esteemed customers in a much better way as we keep on innovating. We have a team of dedicated and trained engineers having the sufficient know how and expertise for providing the after sales support for such Hi Tech equipments. Office in India has a calibration laboratory fully equipped with the facilities for testing, calibration, diagnosis and repair of equipment. In fact we pride ourselves that we are only the company who has a calibration laboratory fully equipped with the facilities for not only testing but also in house calibration and adjustment facilities.

Our aim is to serve customers in a competent and efficient manner in the areas related to application, calibration and technical services. The mission of the company is to provide a reliable and hi-tech test and measurement solutions for Energy Meters to the Manufacturers, Laboratories and Power Utilities.

We at Zera think from customer's perspective, take their test problem as a challenge and provide them a reliable and workable solution based on our knowledge, expertise, experience & competence and by using modern state of art technologies in our design.

How do you look forward to the electrical engineering sector in India as the global trends are getting influenced rapidly with latest technology?

Electrical engineering is often considered to be a mysterious science, because electricity cannot be seen. However, at the same time we all are aware of its existence and usefulness in our daily lives. We aim to take the mystery out of electrical engineering on the basis of our good understanding of the fundamental principles of electricity gained through decades of existence in this field and our relentless attitude to learn & innovate. The rapid technological developments, instrumentation accompanied with high measurement accuracies and low uncertainties, now a days play a major role in cost optimization in major projects in almost all engineering sectors. But in the Electrical Engineering Sector, measurement is a very important activity for the optimum utilization of the resources, cost effectiveness and for actual performance evaluation. The calibration of the instruments with traceability is an important requirement to get confidence of the measurements performed before concluding the final decision.

In view of this, in India and abroad all the manufacturers, utilities and policy makers are keen on building the labs with state of art technologies globally. As it is rightly said that "Essence of the time is continuous improvement by employing new technologies and innovations". The world is facing serious challenges in the field of Power Sector. The global economy is set to grow fourfold in the next 40 years, which promises economic benefits. But it also implies a much greater use of energy. Energy Meter is the most important equipment to know about the energy consumption; and also helps in spreading awareness towards energy conservation and is helpful in proper utilization of resources. Smart metering and its associated technical innovations are key factors in the area of meters and meter testing.

What quality standards or certifications are suitable for meter testing equipment and which technicals and standards have been advantageous?

Indian Energy & Power Sector, crucial for overall economic growth, continues to grapple with multiple complex issues. Government and various Regulatory bodies have been making efforts to address the issues related to the electricity including the Energy saving and Power Requirement. As we know lot of efforts are being made to introduce reliable and smart metering solutions with the help of different type of Energy Meters & also enough Guidelines and quality Standards are available for the monitoring of such projects but unfortunately such type of guidelines and quality standards are not available for the Meter Testing equipment's which are to be used for the verifying these Energy Meters and its associate equipment's. Economic viability and sustained growth of the entire power sector depends on reliable, smart & efficient metering of electricity. As per our view for this the Regulatory Bodies should develop the standards and guidelines for the Testing Equipment's, this will help them in maintaining the existing system properly, which they have developed by financing millions of rupees.

In view of this, I would like to add that Zera is not only delivering the high quality and reliable products but also working in the field of drafting the national and international standard which will help users to define and select right product as per their application which is in regular demand. Zera is also a member of IEC committee and working for IEC standards for such equipment to be used in the field and laboratories.

Energy Meter Testing equipment's are capital equipments and are used

for years and years therefore selection of these equipments should be proper and exactly satisfying the required application. These equipments are being used for testing and verification of revenue generation machine i.e. energy meter of utility. These are only equipment's which are playing a major role in resolving the conflicts between utilities and customer. I hope that these regulatory & governing bodies will soon come out with the detailed guidelines for the Meter Testing equipment's which will help utilities to select and use universal product as per International Standards.

Could you detail about the product range available for Indian market? Also, share something about transformer testing system?

Our product range covers Portable and Stationary Test Equipments for testing of Energy Meters and Instrument Transformers. These products are been widely used by the calibration Laboratories and Power Utilities. ZERA is preferred because it is known to appreciate and understand the issues related to measurement and testing of power / energy. It is preferred choice of the NPL; NABL accredited Laboratories, leading Independent test-Houses as well as utilities' laboratories in India and around the world. These equipments are being used by uppermost & trusted laboratories as their primary measuring standards. Customers are benefitted from the services of our expert sales professionals who provide them unique & customized solutions, with the underlining objective of offering only the best product and service. We have seen that there are an increasing number of different instrument transformer types. This is a trend that will continue rather than stop. So what is needed in the future is the possibility to cut down the amount of money and time spent due to this diversity. What could be more desirable than to have one test system that is capable to test all types of instrument transformers - one test system that would be able to handle all different types of inputs coming from the transformers under test? ZERA has developed such an instrument transformer test system, the new WM3000U for voltage transformer, and WM3000I for current transformer. As usual, for a measuring bridge it compares the signals coming from the transformer under test with a reference signal from a standard. But as is clear the graphic, the largest benefit of the new instrument transformer test system is to test conventional, electronic and digital instrument transformers as well. One no longer needs separate devices to fulfill testing according to IEC60044-1/2, IEC60044-7/8 and IEC61850-9-2. ZERA configures instrument transformer testing systems for Current Transformers (CT) or Voltage Transformers (VT) testing as well as combined testing systems for CT and VT testing. ZERA's testing systems can be designed for testing instrument transformer manual or automatic. If it is about Energy Meter and Instrument Transformer Testing: Simply Trust on ZERA.

Launching of information and communication technologies in modern energy supply networks has many advantages. Could you detail features of smart metering system of Zera for communication infrastructure to integrate smart metering, smart grid etc?

Smart metering and its associated technical innovations are a key topic in the area of meters and meter testing. Up to now, meter testing was only testing of the metrology. But with the introduction of smart meters, the aspect of data communication has come more and more into the focus of testing. It is no longer sufficient for a meter only to register the correct values. The correct transmission of data and its accuracy and consistency is equally important. As it is a well-known fact that cooperation always helps to combine competences and quickly achieves well instituted results. So it was only consequent that VDE, Germany and ZERA developed a concept for a new test system in a joint project work. Unlike all currently at the market available test systems, this one can test functionality of electronical meters as well as data communication. ZERA has developed in cooperation with partners a test system for metrology and data communication named as SML Protocol – A Smart Message Language Protocol. The Smart Message Language protocol serves for transmitting data between the meter and the remote meter reading system. The SML protocol for remote meter reading possesses an optimized structure for use in both classical communication routes (PSTN, GSM, etc.) and in package-oriented network operation.

The SML protocol enables modern-day communication technologies to be integrated for remote meter reading and facilitates near-real-time transmission of energy consumption metering data. Just as in the measuring of consumption values, there can be cases of occurrence of errors in the data communication with the meter. These can be caused by the meter itself or by an incompatibility of meter and data transmission unit (e. g. MUC controller). To assure that the meter transmits and receives data correctly, the communication rules - the spelling of the meter in a way – have to be tested. In the case of summation meters like EDL and

Metrology meets communication

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"We express our sincere thanks to NPL, New Delhi & IDEMI, Mumbai for giving us the opportunity to supply for establishing Primary Standard – Precision Power Calibration System for Energy / Power Measurement with uncertainty of < 10 PPM."

SyM' meters, the SML protocol plays a major role.

What are the products you are going to display at ELECRAMA 2014 and what expectations do you have from the expo at Bangalore this time?

As it is a well-known fact that ELECRAMA 2014 is one of the important exhibitions for power sector by which OEM's and utilities are definitely benefited by adopting advance automated equipment and state of the art technologies in their processes and power network. We are displaying our specially developed product Single Phase Energy Meter Test System, a handheld working standard based on the state of the art technology in power measurement with unique features like:

- Capable to test the household meters on entire range even on lower load without disconnecting the supply.
- Ergonomic & compact design and can store more than 1000 test results.

The above mentioned features combined with user friendly operational concepts are providing the greatest possible flexibility for a comprehensive testing of metering installations in the field itself. Its excellent measurement stability reflects the high quality of the system. In developing this product, we have used our concentrated know how to offer our customers the products that are particularly productive and economic. I believe that this product will help utilities to verify their domestic consumers even on minimum load without disconnecting the supply which is not available in the equipment widely used by the utilities.

We are also displaying Three Phase Hi-Tech Fully Automatic Meter Test System used for the testing of the Energy Meters which are essential for recording the value of electricity consumption for utility billing, load survey analysis and energy audit purposes and therefore they are rightfully termed as the "Cash Box" of the utility. The equipment displayed has facilities to verify metrological properties as well Data communication facilities with various interface. The System is capable to generate and simulate assorted field conditions in the laboratory itself to check the reliability of "Cash Box". It has unique feature of logging and recording various environmental conditions automatically and cut off the supply in case of any emergency as a safety measure.

I would like to summarize the major challenges which we are facing in the Energy and Power Distribution segment i.e. financial health of state electricity boards, high aggregate technical and commercial losses and SEBs resorting to load shedding during peak hours.

We believe that the design of this product will further strengthen our commitment to provide solutions specially designed to delight our local or regional customers. As it is a great saying that "Progress always involves risks. We can't steal second base and keep our foot on first."

Could you highlight features and benefits of Portable Meter Test System? Which of your products have higher production level in the market?

ZERA's business builds on the combination of specific know-how, state of the art technology and years of experience. On this basis, we have been developing and producing test systems for many years – systems that deliver reliable and reproducible results of highest precision.

ZERA is committed to the quality seal 'Made in Germany' and our customers appreciate this. This is why our products have been able to prevail worldwide for a long time.

The MT310 is a portable working standard based on newest technology in power and energy measurement. Various measuring features combined with its easy operation concept provide the greatest possible flexibility for a comprehensive testing of metering installations on site which makes it most popular Field Calibrator in India.

Using MT310 many Indian utilites are certainly enhancing the Revenue Protection and Power Quality Improvement curriculum. In addition, MT310 provide the type of data that can be leveraged by back-office analytics and software techniques to detect erroneous

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- Unique long-term and temperature stability of the measuring module.
- Internal memory to store measurement results and customer data.
- Windows based data management software is for evaluation of the test results.
- External system control via PC with windows based control software.
- No additional error for reactive measurement.
- The facility to check, total and fundamental energy separately measured by tariff meters.
- Measurement and analysis of effect of Harmonics on Metering.

Keeping in view the large number of complaints that were being received regarding the electronic meters which have been installed in the NCT of Delhi, the Delhi Electricity Regulatory Commission (DERC) decided to undertake a limited meter testing drive in order to allay the fears in the minds of the public regarding electronic meters. A total of 536 meters were tested during the drive. For testing of meters, a standard reference meter of ZERA make MT310 of 0.1 Class accuracy owned by the Central Power Research Institute (CPRI), Bangalore.

Due to above mentioned configurability and features; this equipment played a major role successfully for adjudication of disputes between the stack holders in Delhi and Mumbai. To have a fair decision, in connection with the disputes and differences arising, DERC and MSREC decided to release an order and gave responsibilities to Central Power Research Institute, Bangalore and Institute for Design of Electrical Measuring Instruments, Mumbai to carry out sample testing of the Energy Meter and to produce a test report independently to find out the facts.

Could you share with us advantages of training programs that Zera conducts at the German training center?

Our aim is to serve customers in a competent and efficient manner related to application, calibration and technical services. In view of this we provide training to the customers on equipment specific issues. Our mission is to help customers to make the best use of our supplied products i.e. Stationary and Portable Meter Test system through effective and responsive support, active advocacy, and a broad and flexible range of self-help resources. Our technical team is always available with the answers to the questions raise by the customers about specific details of procedures, such as discussing available features, options, and limitations of the equipment. We also provide direction to the customer at their site by guiding them about the various standards and certifications available for the Meter and Instrument Transformer Testing. We also provide a specific know how about the installation practices followed by renowned utilities internationally. Customers are also made aware how to Isolate, document and find circumventions for reported software defects.

What do you envision for the overall growth of Zera India in the next two years?

ZERA India has made its mark in the Power & Energy Sector by working closely with power utilities, regulatory bodies and recognized Calibration laboratories. We look forward to extend the great work done by the team and continue to help our regional customers. We continue to strive to upgrade and customize to meet specific requirements of our customers, to have edge on competitions and to deliver quality products, and endlessly endeavor for our customer's satisfaction. We invest in upgrading our equipment and technology and add new equipment from time to time. It is really a matter of pride to announce that the Primary Standard –PPCS for the measurement of Power & Energy is from Zera and It has been recently installed at NPL, New Delhi and IDEMI, Mumbai which will facilitate other laboratories to calibrate their Standard equipment's in India itself to maintain the traceability.

ZERA is envisaged to be an experience beyond compare from its previous years. ZERA's philosophy of evolution based on continuous innovation, improvisation based on customer feedback has led to this radical transformation in services and amenities to the highest quality on par with international standards. With our own development department we drive forward the refinement and the optimization of test engineering. We will try to maintain the ideals of our company's philosophy: quality, reliability and closeness to the customer. We do not mean closeness in just a spatial way sense, as we know our customer's business environment, their requirements and their problems. We always believe in viewing the customer's needs as is we are looking through their eyes and we believe in developing the perfectly appropriate solutions for their application. We are thoroughly independent and work exclusively in our customer's interest. ■

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- AC filters (for UPS, frequency drives, converters, and more)
- Wind turbines and solar energy

AC Capacitors Range

- Self-healing MKP up to 1 $kVAC_{RMS}$
- 1-phase and 3-phase

Recommendations: IEC 60831, IS 13340, and customer specifications

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HVAC Power Capacitors

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- Fixed compensation for T&D networks
- Tuned and detuned harmonic filters
- AC filters for Static VAR compensators
- DC filters up to 800 kV for HVDC lines
- Surge protection
- MF/NF furnace capacitors

AC Capacitors Range

- 1-phase and 3-phase
- All-film low-loss technology
- Internally fused or fuseless

Recommendations: IEC 60871, IS 13925, and customer specifications

Power Electronic Capacitors

Applications

- Industrial variable-speed drives and traction devices
- UPS
- Puncture welding and magnetizing
- Wind turbines and solar energy
- Test equipment
- Power quality
- Industrial and medical lasers

DC Capacitors Range

- Self-healing MKP up to 10 kV/40 kJ
- Non self-healing film/foil up to 100 kV/20 kJ

AC Capacitors Range

- Self-healing MKP up to 3 kVAC
- Non self-healing film/foil up to 24 kVAC

Recommendations: IEC 61071 and IEC 61881, and customer specifications

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Power Factor Controller detects the total kVAr requirement based on that phase current in which CT is connected, and switches on a higher value kVAr capacitor, assuming the same load condition exists in the remaining two phases also. This causes correct amount of compensation at the (first) phase in which CT is connected and overcompensation in the other two phases, for majority of the time and causes the monthly average PF to be "leading PF" which is undesirable. A custom made APFC is proposed here for highly unbalanced 3-f loads, to improve the PF near to unity. An Indian Electric supply system with 440 V, 50 Hz is considered for this study. The authors have developed and implemented a real time model of a 45 kVAr APFC panel, compensating about 100 A of inductive current, at 230 V in each phase of 3-f, 50 Hz power supply. This model is working in 23 places and compensating the reactive power and improving the PF near to Unity.

The Power Factor in a 1-f supply, is the angle (f) difference between the load voltage vector V_L and the load current I_L, as shown in Fig. 1.

The value of PF (cosf) will be between zero and unity. The PF of a load with inductive in nature (say a tube light) is represented as lagging PF and that with capacitive in nature is represented as leading PF. Hence, with reference to Fig. 1 the PF of a tube-light load is 0.55 lagging as depicted in Fig.2.

Fig. 2 Analog PF meter dial having both lagging zone and leading zone and a single

Design & Implementation of Low Cost Automatic Power Factor Controller for Highly Unbalanced Three Phase System

The 3-f Automatic Power Factor Controller (APFC) available in the market is suitable only for balanced 3-f loads. This Power Factor Controller (PFC) use only one Current Transformer (CT) at one particular line of the 3-f system, assuming that all the connected loads are 3-f balanced loads. The balanced 3-f supply voltage is assumed here at all the load conditions and 3-f, Δ-connected, Power Factor (PF) compensating capacitors rated in kVAr at 440V are used, in commercially available PFC.

- S Ponnavira Sundaravel and S Kannan

pointer showing the PF of a tube-light as 0.55 lagging.

The lagging PF of any value between +0.00 to Unity PF (UPF) can be improved towards UPF by simply connecting appropriate value of capacitor (passive component) across the load. This basic principle is adapted throughout this paper.

In 3-f unbalanced applications such as educational institutions where majority of the loads are 1-f Air-conditioners, group of personal computers powered from 1-f uninterrupted power supplies (UPS), or stabilizers, process industries where 1-f induction motors etc., the injection of capacitive VAr to improve the PF becomes very essential. An outline for the necessity of Automatic Power Factor Controller (APFC) for unbalanced 3-f system is explained in. The proposed APFC will be suitable for a 3-f system which has highly unbalanced loads, i.e., number of 3-f balanced loads are less & 1-f loads at different phases are more in a system, where majority of the 1-f loads are switched "ON" & "OFF" randomly to cause highly unequal kVAr demand in each phase, such that, it is not possible to use the 3-f balanced Δ-connected capacitors to compensate the unbalanced kVAr demanded by the 3-f load.

The controller shown in the Fig. 3 is a complete setup for controlling the Power Factor (PF) of a balanced 3-f system such as textile mills etc, where majority of the loads are 3-f induction motors which always draw balanced current in all the three phases, at all loading conditions, if balanced supply voltage is assumed.

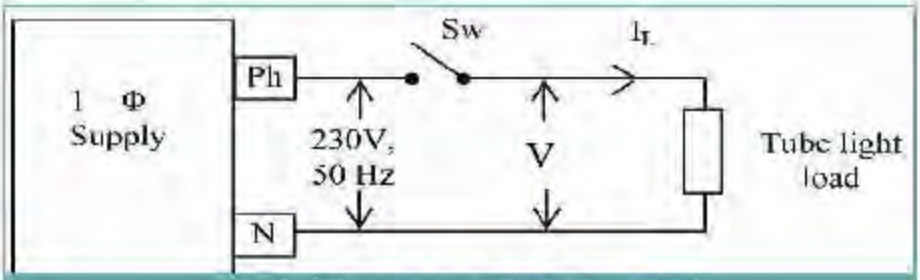

Fig. 1(a): Circuit diagram of a tube-light load

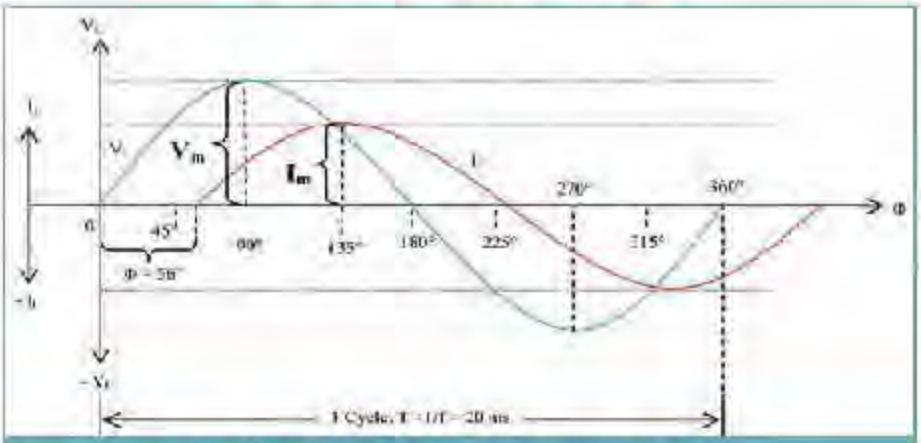

Fig. 1(b): The VL and IL measurement using CRO

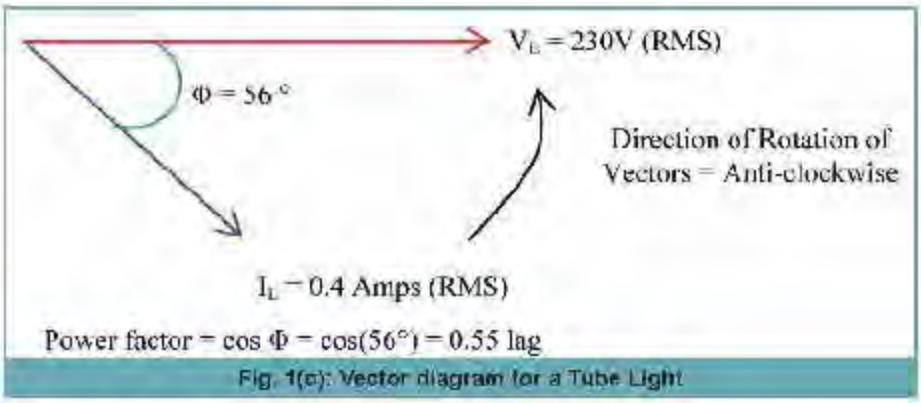

Fig. 1(c): Vector diagram for a Tube Light

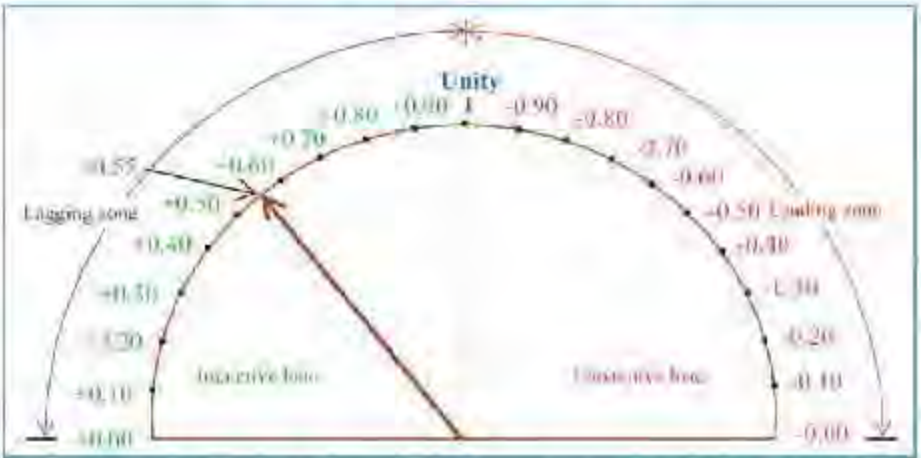

Fig. 2: Analog PF meter-dial, needle showing lagging PF 0.55 of a Tube light

The above PF compensation system consists of a (microcontroller based) Electronic PFC module, one Current Transformer (CT) at one particular phase (say phase 1), one potential transformer (PT) inside the module connected across phase 2 & 3, few 3 pole electro-mechanical power contactors to connect or disconnect the 3-f capacitors depending on the command received from the Electronic module corresponding to the kVAr requirement by the whole 3-f load.

The existing Electronic PFC module, which has been designed for balanced loads, cannot be used to a 3-f system which has more number of 1-f loads connected & switched "ON" & "OFF" randomly to form highly unbalanced load current in the 3-f system.

If the current in the phase 1, where CT is connected, is heavier than the current in other two phases, then the controller will assume that same heavy current is flowing in phase 2 & 3, & switch "ON" more number of 3-f, Δ-connected, power capacitors, as if to improve the PF of 3-f system.

This will cause correct compensation (unity PF) at phase 1 & over compensation (leading PF) in phase 2 & 3 which leads to the present/instantaneous PF as leading PF causing reduced (poor) resultant PF over a month.

So the available total unbalanced 3-f load system is considered and virtually divided as 3 numbers of 1-f loads connected in star. And the 1-f approach with 1-f power capacitors for each phase is proposed here for PF compensation.

In this article, section 2 discusses about the proposed 1-f approach to improve PF of an unbalanced 3-f system. Section 3 discusses about installation of APFC and section 4 concludes.

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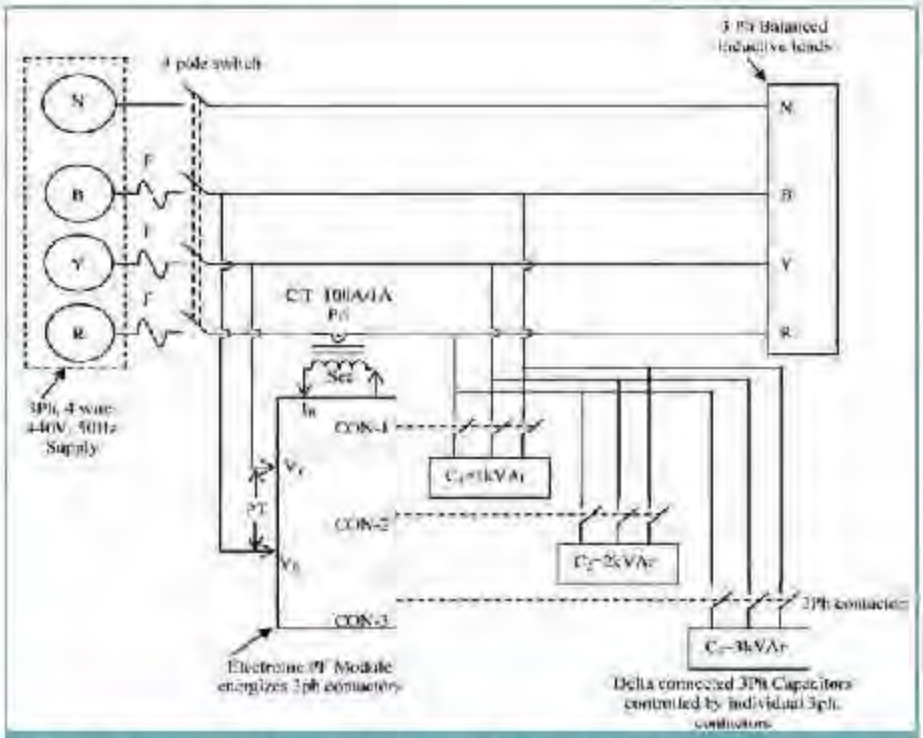

Fig. 3: Power factor controller available in the market for balanced 3-ϕ system

90°. The cosine value of the angle ϕ is known as the PF of the 1-f system (combination of all types of load with different PF for each type of load).

The ultimate job/function of this 1-f kVAr transducer is to measure the total kVAr demanded by all the loads in the particular 1-f.

Having measured the phase angle between load current & load voltage, the kVAr transducer will also find out the value of apparent power S=V×I VA, where S is the product of the amplitude of the rms value of the load voltage & the load current derived from the sample voltage and current signals through the PT and CT respectively.

The calculated value of apparent power VA is multiplied by the cos ϕ to obtain the value of real power.

Single phase approach to improve the PF of an unbalanced 3-f system

The 1-f system shown in Fig. 4, consists of a kVAr transducer, a CT, a PT (available inside the kVAr transducer), an analog to digital converter, few optically isolated power electronic semiconductor switches, few 1-f power contactors & few 1-f power capacitors.

The 1-f PFC with more details is shown in Fig. 6. The electronic module block in Fig. 4 is explained further in section 2.D, Design steps of APFC panel, with details in Fig. 7 and Fig. 8.

The approximate cost of manufacturing the complete 3-f APFC (three numbers of 1-f controllers of each 15 kVAr capacity in one cabinet panel) will be approximately 75,000 (Indian Rupees) or 1500 US $.

Measurement of reactive power by kVAr transducer

By receiving current signal (Fig. 6) corresponding to load current & voltage signal corresponding to load voltage from the CT & PT respectively, the kVAr transducer measures the phase angle of the current signal with reference to the phase angle of the voltage signal.

The angle difference between these two signals is known as the PF angle ϕ, lies between 0° and

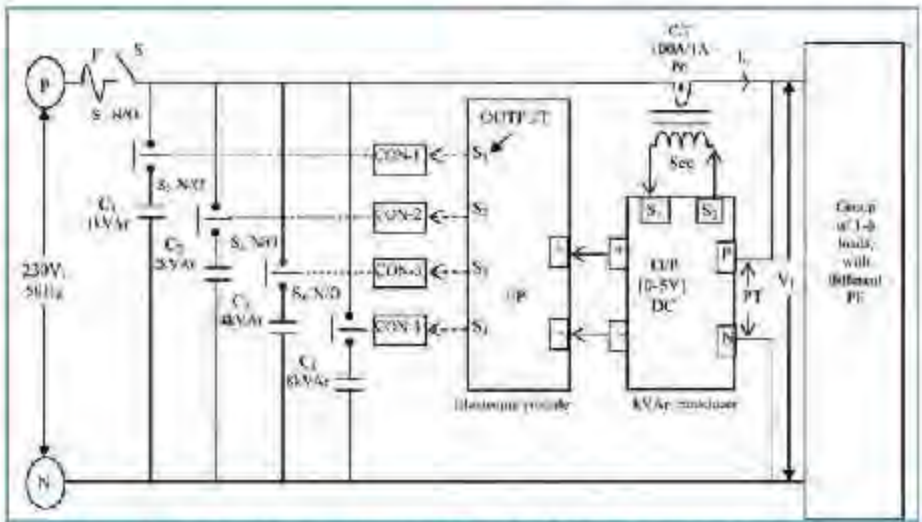

Fig. 4: A part of the proposed APFC suitable for PF compensation of one particular phase of a 3-f system

Real Power = [Apparent power] × [Power Factor] (2)

P = VIcosϕ (3)

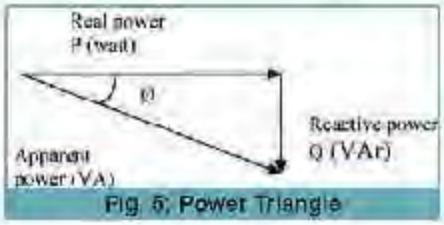

Fig. 5: Power Triangle

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Jyoti Ring ™

Jyoti Ltd. introduces **'Jyoti Ring ™'** a SF6 gas insulated Ring Main Unit. This product has been type tested at CESI, Italy, one of the most reputed European Laboratories. The total International certification has been done as per IEC 62271-100/200/103/102.

Design of the Jyoti Ring is modular & any combination is possible as per customer's requirement. There are three basic modules :

- Load Break Switch (Type L) 15.5kV, 21kA, 630A
- Vacuum Circuit Breaker (Type 'V') - 15.5kV, 21kA, 630A
- Direct Link (Type - D) - 15.5kV, 21kA, 630A


CESI

TEST REPORT

The Type tested ratings of the Jyoti Ring are as follow

Rated Voltage	15.5kV
Power Frequency Withstand Voltage	38/45kV
Impulse Withstand Voltage	75/85kV
Rated Frequency	50Hz
Operating temperature range	-5°C to +55°C
Rated continuous current	630A
Rated Short-time withstand Current	21kA rms, 3sec
Rated peak withstand current	52.5kA
Rated symmetrical interrupting current for VCB	21kA
Rated asymmetrical making current	52.5kA
Rated operating sequence of Circuit Breaker	O-3min-CO-3min-CO
Rated cable charging interrupting current	25A
Mechanical operating sequence CB(C-O) M2	10000
Mechanical operating sequence LBS(C-O) M2	5000
Minimum operating Gas Pressure	0.3 bar G

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The kVAr transducer also calculates the value of total VAr demanded by all the loads in a phase, by using the Pythagoras theorem (Fig. 5).

$$VAr = \sqrt{(VA)^2 - (W)^2} \qquad (3)$$

The calculated value of VAr is communicated out by the kVAr transducer in the form of an analog voltage signal, say 0-5 V- DC, in order to energize 1-f power capacitors through an electronic module and 1-f power contactors.

The electronic module consists of an analog to digital converter, which converts the analog DC voltage signal received from the kVAr transducer (0-5V, DC corresponding to the kVAr demand) into a four-bit digital signal. The least significant bit (LSB) of the digital signal will energize the lowest value (less weightage) of 1-f capacitor, 60mF. And the most significant bit (MSB) of the digital signal will energize the highest value of 1-f capacitor 480mF, through the respective power contactors which are energized by the optically isolated semi conductor switches (TRIACs) as shown in Fig. 6.

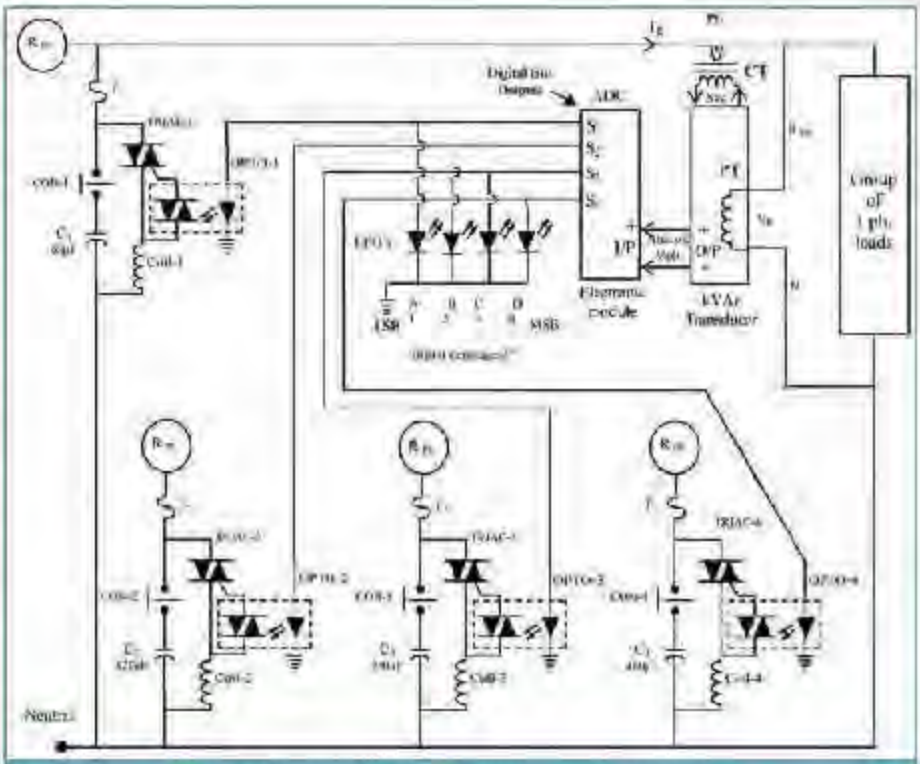

Fig. 6: Proposed 1-f PF controller with more details

Power Electronic Switches to Energize Contactors

These TRIACs are correspondingly triggered by the active output bits of the Analog to Digital Converter (ADC). OPTO couplers (Optically isolated current buffers) are incorporated in between the ADC section & the TRIACs, in order to isolate & protect the sensitive low voltage (5V DC) ADC section from the high voltage (230V-AC) power section of semiconductor switches (TRIACs).

The Opto-coupler will have a Light Emitting Diode (LED) & a slave TRIAC housed in a tiny Integrated Circuit. The built-in LED of the Opto-coupler receives the triggering pulses (electrical command) from the active output bits of the ADC section and transform them into optical pulses to trigger the photo TRIACs (slave TRIACs) integrated in the same Opto-coupler. Each triggered slave photo TRIAC in turn triggers the power TRIAC (master TRIAC), of its stage which, as explained above, will energize the corresponding 1-f power contactor, which will include an fixed kVAr value (having its position weightage) into the power system to inject correct (predetermined) amount of reactive power, eventually to obtain the instantaneous PF of the concerned phase to be very close to the Unity PF.

Specification of components

The specifications of important components are given in Table 1.

Design steps of APFC panel

The APFC is realized with easily available components with following control and supervisory circuits:

- Digitized switching of 1- f capacitors stepped in a binary (2n, n = 0 to 3) ratio with the help of zero voltage opto couplers & electromechanical contactors,
- Development of simple circuit for the quick measurement of the inductive or capacitive reactive power (–ve / +ve kVAr) with the help of a reactive power transducer,
- Independent control of reactive power in each phase,
- Development of a controller/ driver printed circuit board (PCB), which is fail-safe in operation with regulator IC.

All the above mentioned features can be very well implemented with the use of a kVAr transducer, an Analog to Digital converter (ADC) and Opto-coupler based zero voltage switching. The use of micro-controller is not necessary/ compulsory here, because the overall control circuit is very handy, smart and reliable.

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  11kV, 11.5kV, 12kV, 12.5kV, 13kV, 13.5kV, 14kV, 14.5kV, 15kV.
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Sl.No	Name of the component	Specifications
1	Reactive power (kVAr) Transducer, Model:RPT 11; Make: MECO	Input: (0-300) V.a.c, (0-1) A.a.c. (single phase) and (0-300) VAr – lag. Auxiliary power supply: 230V a.c. Operating frequency: 50Hz. Output: (0-5) V.d.c. analog signal
2	Power contactors and capacitors	2 pole, 16 A, for C1 = 60µF / 440V a.c. 2 pole, 25 A, for C2 = 120µF / 440V a.c, 2 pole,25A,for C3 = 240µF / 440V a.c, 2pole, 40 A, for C4 = 480µF / 440V a.c., Note: 60µF will offer 1 kVAr when 230V ac, 50 Hz is applied across it.
3.	Current transformer	100 A / 1A; bar primary (hole dia 30 mm); 660V a.c. rated; accuracy 1%; burden=15 VA.

Table 1: Specification of components for APFC

The first step to improve the PF is to calculate kVAr demand with the help of measured real power and PF from the electronic energy meter.

To measure the real power of the service connection on which the PF is to be improved.

This can be obtained from the energy meter readings (electronic tri-vector meter) itself or from the electricity bills of previous months. The maximum demand readings (MD in kW) for the past 6 months are considered and the highest kW value of MD is considered as the real power of the service connection.

If electricity bills of previous months are not available or for new service connection, consider the sanctioned load (SL in kW), available in the electricity consumption bill or energy meter service panel, as real power of that service connection. Here 60 kW is considered as the real power drawn by the 3-f loads from the LT, non CT service connection.

To find the resultant PF of the total 3-f loads

This can also be obtained from the energy meter (tri-vector meter) or from the electricity consumption bill of previous months, represented as "resultant PF" or "monthly average PF". The value of resultant PF will be within the range of PF=0.00 to PF=1.00, lead or lag. Normally it will be 0 to 1 lag, since most of the loads are combination of resistive and inductive in nature. Here cos f = 0.8 is considered as the resultant PF for model calculation purpose. This could be as low as 0.3 lag with intermittent loads such as welding machines. We have identified two key parameters of the power triangle, as shown in Fig. 5.

$\cos\phi$ kW/kVA 0.8;

$kVA = kW/\cos\phi = 60kW/0.8 = 75kVA;$

$kVAr \quad \sqrt{(kVA)^2 - (kW)^2} \quad \sqrt{(75)^2 - (60)^2}$

45kVr fr 3 ϕ

This total requirement of 45 kVAr may be divided into 3 to get 15 kVAr of maximum reactive power demand per phase, connected in star. This 15 kVAr demand per phase is taken as input parameter to calculate the number of capacitors required per switching step. Here we have finalized 16 steps of variation in capacitor in a phase (i.e from 0 kVAr to 15 kVAr).

For this we must have 15 numbers of 1 kVAr capacitor and 15 numbers of electro-magnetic contactors to switch ON/OFF the individual capacitor for one particular phase alone, and for total 3-f, a 45 numbers of 1kVAr capacitors and contactors are needed.

By using an Analog to Digital Convertor (ADC) at the output of the kVAr transducer, we can reduce number of capacitors and contractors to 4 only per phase. The ADC receives the analog DC voltage from the kVAr transducer corresponding to the kVAr requirement measured by the transducer. The ADC converts the analog signal [say (0-5) volts, DC] into a 4bit digital word, from 0000 through 1111. Fig. 7 & Fig. 8 are a part of Fig. 4.

kVAr transducer which outputs (0-5) V-dc-analog signal corresponding to the kVAr input, derived from the load voltage and load current through PT and CT.

For example if the 1-f kVAr input (in the form of load V and load I) given to the transducer is 15 kVAr

MSB			LSB
D_3	D_2	D_1	D_0
8 kVAr	4 kVAr	2 kVAr	1 kVAr

Table 2: Weightage of digital bits

Sl. No	kVAr input	Analog DC output	Digital output
1	15 kVAr	5 V	1-1-1-1
2	0 kVAr	0 V	0-0-0-0
3	1 kVAr	0.333 V	0-0-0-1
4	2 kVAr	0.366 V	0-0-1-0
5	3 kVAr	0.999 V	0-0-1-1

Table 3: kVAr input vs Analog/Digital output

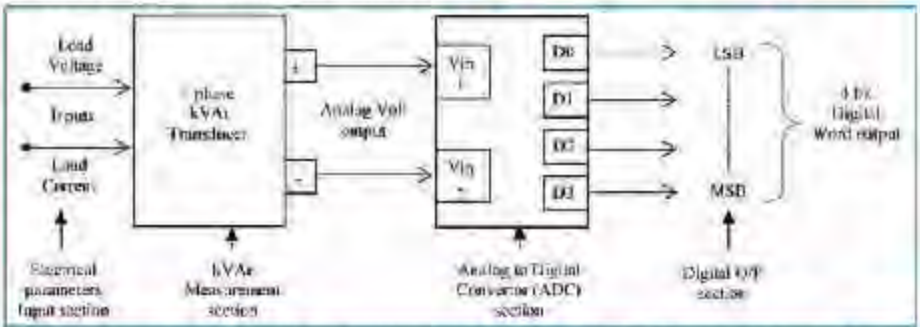

Fig. 7: Measurement of kVAr (Reactive power) through CT & PT and obtaining of the digital signal corresponding to kVAr measured using an ADC section

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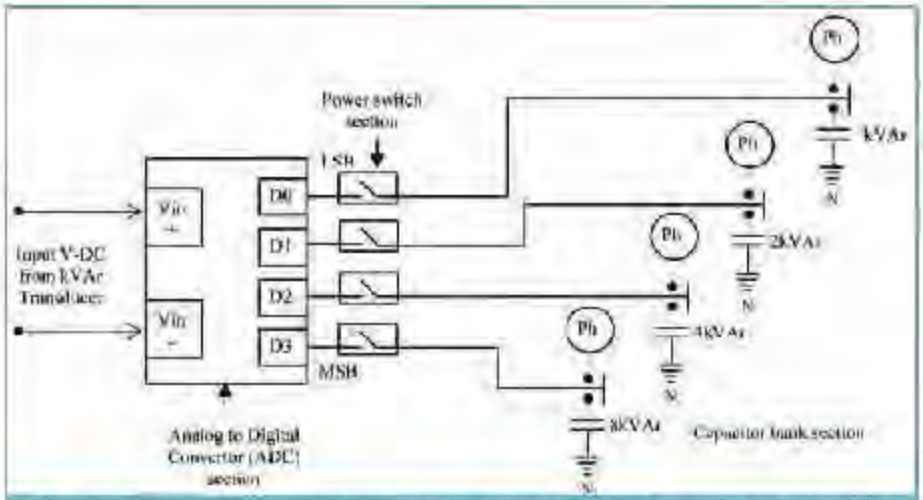

Fig. 8: Energizing required power capacitors through power switches by an ADC section and kVAr Transducer (section 2.2)

then the corresponding analog DC voltage output signal from the transducer will be 5V DC. This analog voltage is given as input to the ADC section, and the corresponding output will be a 4 bit digital word output signal will be 1111 (D_3 D_2 D_1 D_0). The first digital bit D0 (LSB) of the digital signal energizes the 1 kVAr capacitor (60mF) through an electronic power switch (TRIAC) with necessary isolation provided by OPTO-coupler. This corresponds to 4 bit digital word 0001. The second digital bit D_1 (next higher bit to LSB) of the 4 bit digital signal energizes the 2 kVAr capacitor. Similarly the 3rd and the 4th (MSB) digital bits D_2 & D_3 of the ADC section energize the 4 kVAr & 8 kVAr capacitors respectively as shown in Table 4.

With the combination of 4 numbers of capacitors (1, 2, 4 and 8kVAr), any value of kVAr from 0 to 15 kVAr (in steps of 1 kVAr) can be obtained. For example if 5 kVAr is given as input to the kVAr transducer, which will produce a corresponding analog DC voltage (1.665 V DC) which will be converted into digital word as 0101(D_3 D_2 D_1 D_0) where D_0 is LSB and D_3 is MSB. Since D_0 & D_2 are having weightage as 1 kVAr and 4 kVAr respectively the 0101 digital word will energize both 1kVAr & 4kVAr capacitors at a time to cause 4+1=5 kVAr of reactive power to be injected into the system to compensate the 5kVAr demand of the load instantaneously.

Output port of ADC	Realization of weightage	Remarks
D_0	1 kVAr	$2^0 = 1$
D_1	2 kVAr	$2^1 = 2$
D_2	4 kVAr	$2^2 = 4$
D_3	8 kVAr	$2^3 = 8$

Table 4: Output port of ADC - Realization of weightage

As another example if the reactive power demand by the load is, say, 5.5 kVAr, then either the 1+4=5kVAr or 4+2=6kVAr capacitors will be energized depending on the decision taken by the ADC-section. Thus it is possible to generate 0-15 steps to switch ON/OFF any value between 0 kVAr and 15 kVAr in step of 1 kVAr just with the 4 numbers of 1-f power capacitors.

For example if the Sanctioned Load is 110kW (LT, CT Service) & the 3-f kVAr demand is 90 kVAr then the per phase maximum kVAr demand will be 90/3=30 kVAr. The injection of 30 kVAr per phase can be implemented by using same set up described in this article with very slight modifications in the value of capacitors (kVAr), breaking capacity of power contactors and the ratio of CT. Instead of 1, 2, 4 & 8 kVAr weightage used for 60kW service connection the doubled value of kVAr such as 2, 4, 8 and 16 kVAr capacitors bank can be introduced to handle a reactive power compensation of 30 kVAr per phase (in steps of 2 kVAr) for a 110 kW LT, CT service connection. The electro-magnetic power contactors are also to be replaced with higher rating-double breaking capacity power contactors or two, 8kVAr capacitors & two contactors may be used in parallel to have single, 16 kVAr capacitors in the MSB stage. In this case, the step size is 2 kVAr.

Installation details of 3-f APFC panel

The Fig. 9 shows three, 1-f controller panels connected in star connection. The 1-f loads in each phase and 3-f, Δ-connected loads together can be assumed as star connected three numbers of 1-f loads. Compensation is given for independent phases using 1 f capacitors to make it suitable for highly unbalanced load currents to obtain optimum PF towards unity.

Fig. 6, shows the complete schematic of a 1-f PFC with a capacity of 0 to 15 kVAr with 16 stages. That is, we can obtain any value of kVAr from 0 to 15 kVAr with a step of 1 kVAr. These 16 steps per phase are really good in number to handle a real power of 60 kW, 3-f system (3-f low tension, non- CT service connection).

For a service connection of 3-f low tension CT services (110 kW), the number of steps/phase can be increased by replacing the four bit ADC converter by an eight bit ADC converter, which will facilitate to have 8 contactors & 8 capacitors per phase to handle a reactive power of up to 90 kVAr in a 3-f system, with a real power of 110 kW.


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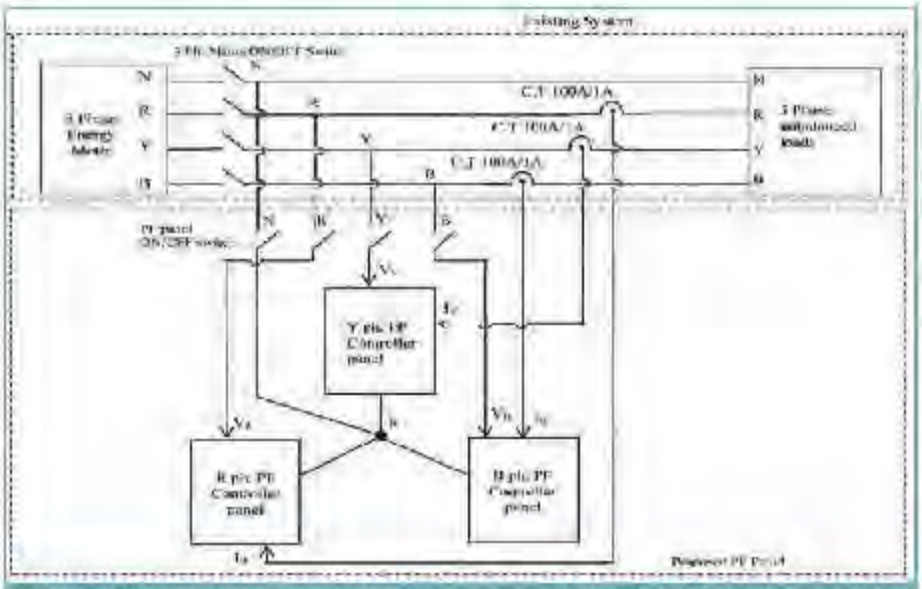

Fig. 9: Installation of the proposed APFC panel in the existing 3-f service connection (upto 80 kW) which caters power to an unbalanced 3-f load system

The above 1-f PFC (Fig. 6) can be repeated for 2nd and 3rd phases and grouped to act as a single controller for the 3-f system to ensure fool proof compensation as shown in Fig 9.

Manual method of improving PF

If the kVAr requirement of one group/pattern of load is constant/ fixed over a day/shift, then a fixed capacitor with required kVAr value can be connected exactly across the consumer service connection point, after the energy meter. The energy meter will record the improved PF and hence the monthly low PF penalty can be avoided. On the other hand if the required kVAr value is connected before the energy meter by some means, which is not advisable, then also the PF will be improved, which is noticed and recorded by the common energy meter located at the secondary of the distribution transformer before the premises of user's service location, but not noticed and recorded by the energy meter at the consumer's premises, and it will be considered as penalty to the consumer for low PF.

Automatic VAr injection

Next, if the kVAr demand required by the consumer's total load is varying with time due to random switching of some of loads, then a timely varying capacitor is required to inject variable kVAr into the loads at different timings to compensate the reactive power requirement. For this, the APFC panel, which is basically a variable VAr injector into the loads, is proposed as in Fig. 9.

The reactive power management overview is given in Appendix and also Fig. 10 & Fig. 11. Thus the proposed PFC panel will contribute to reactive power management, because now the sub-station transformer does not need to deliver reactive power to the consumer load and the feeder cable carries only real current, since reactive current is locally supplied by the variable capacitor (PFC panel), so the conductor of lesser diameter for feeder line from substation to distribution transformer is enough. Since, feeder line current is reduced the line voltage drop is also reduced. So the tail end voltage is improved (since reactive current flow is avoided in the line). Now the line conductor is relaxed from excess current & may be utilized to carry and cater maximum possible amount of real power (say for the neighboring consumer to share the load current through the same conductor). And the maximum transfer of real power is also ensured between substations to end users, with existing feeder conductor size and substation transformer.

Summarily, a) the reactive power management (reduction of unnecessary transport of reactive power) b) the maximum transfer of real power c) tail end voltage improvement and d) feeder line loss (wattage loss= I^2R) reduction are taken care of by simply improving the PF from lagging to unity PF by just installing an APFC panel of appropriate capacity. It can be understood that the observation of any low PF at substation is the indication of poor power quality management at the consumer end. By creating sincere awareness to the consumers about PF, the overall power quality of the system can be improved.

Those who are paying penalties to electricity provider can assemble this controller on their own, from the details provided in this article and be beneficial to both the consumer-self and the nation. This PFC panel is to be connected immediately after the energy meter such that all the load currents in the factory must flow through the three CTs of the controller panel to have complete compensation, as shown in Fig 9. Later if the load current of any particular equipment newly connected after installation of APFC panel (1 or 3-f) is not flowing through CT (i.e., if the load is powered from a point of source before the CT location), then the PF of that particular equipment will not be improved by the PFC panel. But it will be observed by the energy meter as a reduced, poor instantaneous PF and hence reduction of monthly average PF & causing penalty.

Performance details of APFC

The authors have developed a real

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And 23 such schemes are in working condition since 2006 without any major failure except replacement of Power Capacitors due to ageing, that too after satisfactory service. Each unit is successfully compensating about 100 A of inductive current at 230 V in each phase of a 3-f, 50 Hz supply and avoiding the penalties of low PF from Tamilnadu Electricity Board by always maintaining the PF 0.95 and above.

Reactive power management

The generator produces both real and reactive power and the common load at consumer end also requires both real and reactive power. So, both real and reactive current flow in the feeder line from the sub-station transformer (Fig. 10) to the load at consumer point. So obviously the feeder line conductor/cable must be higher in diameter to carry both real and reactive current.

If the exact requirement of reactive power (kVAr) demanded by total loads of the service connection (Fig. 11) with a sanctioned capacity of 60 kW is measured by using a kVAr transducer, then it is enough to connect and inject only that amount of reactive power by 3-f Delta-connected capacitors, rated in kVAr at the point of consumption of real and reactive power at load/tail end, to avoid the flow of reactive power through the feeder line cable. The substation feeds only the Real power required by the loads and the variable capacitor bank (local-kVAr injection) feeds the Reactive power required by the loads. Thus, the transport of Reactive power is avoided between substation and load.

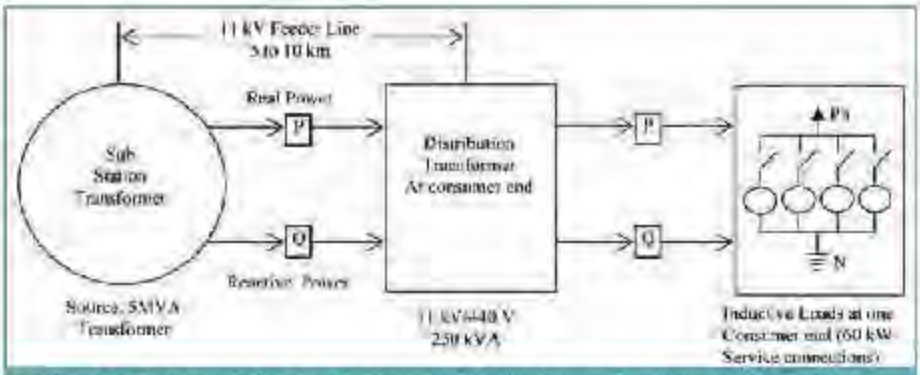

Fig. 10: The substation feeds both real & reactive power required by loads at different consumer points after the Distribution Transformers

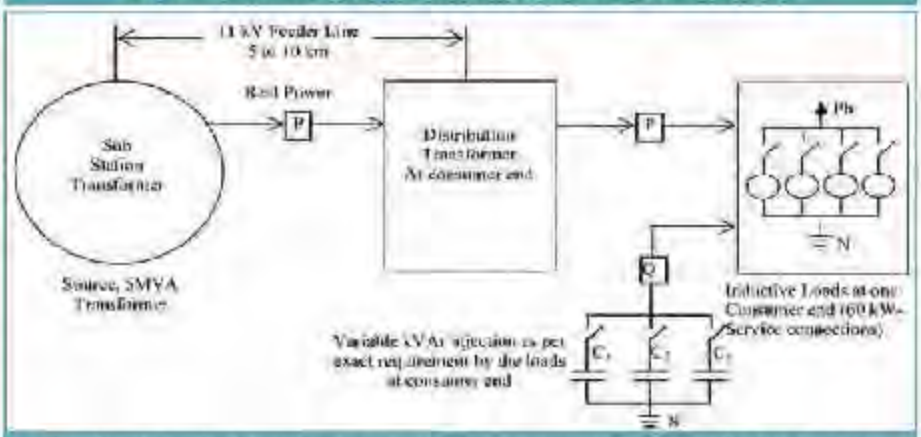

Fig. 11: The substation feeds only the Real power required by the loads & the variable capacitor bank (local-kVAr injection) feeds the Reactive power required by the loads

Conclusion

The purpose of this article is to provide true & deep information on the topics of reactive power management, maximum transfer of real power, tail end voltage stability & transmission line-loss reduction by simply improving the PF from lagging to unity for an Indian (Tamil Nadu state) Electric utility system. Sufficient discussion has been made about the measurement of poor PF by using the kVAr transducer which is due to the inductive reactive power drawn by the group of 1-f & 3-f loads & the remediation to improve the poor PF to unity by designing and manufacturing the 3-f APFC suitable even for un-balance load currents. This APFC will function to improve the PF of the system even when one or two phases are failed. This is possible since it combines three numbers of independent 1-f PF controllers, to function as a versatile controller panel for both un-balanced as well as balanced 3-f loads. ■

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"To start manufacturing cables for Renewable Energy & Railway markets"

Pushpendra Singh
Managing Director
LEONI Cable Solutions (India) Private Ltd

LEONI is a global supplier of wires, optical fibers, cables and cable systems as well as related development services for applications in the automotive business and other industries. It has two subsidiaries in India: LEONI Wiring Systems (Pune) Private Limited which is into automotive harnesses and LEONI Cable Solutions (India) Private Ltd which is into manufacture of cables and cable systems. The LEONI cable plant has been setup to manufacture cables of four business units Automotive Standard cables, Industrial Projects, Traffic and Solar & Windpower. In an exclusive interview with **Electrical India**, **Pushpendra Singh** states, we are currently working on several solar projects through EPC contractors.

What is the status and scope of cable industry in India? How much market share does industrial cables of your company, command in India?

Cable industry being a part of electrical industry is linked to the overall growth of the manufacturing sector and country's economy. The rate of Indian Economic Growth has dropped to less than 5%. During Apr Oct 2013, as per IIP release by GoI, manufacturing sector had almost no growth. However, within the broad category there are areas where growth is still taking place. This is true of cables for special applications. We are new to the Indian market and have just started business, hence it not appropriate to calculate our market share at this juncture of the company.

What are the activities of LEONI Cable Solutions (India) Pvt Ltd? And, what is scope of your responsibility as managing Director of Leoni in India?

LEONI Cable Solutions (India) Pvt. Ltd, is into the manufacturing of cables for industrial applications like automotive, oil & gas and industrial projects. We import cables for railway and renewable energy applications which we plan to manufacture soon. We have also started exporting cables from our factory. I am responsible for the company's establishment in India and achieving its plans decided by the Board of Directors.

What product range is available for Indian market? Could you share some information on

solar cable with a reduced diameter?

We manufacture cables for automotive applications and various process industries like Oil & Gas, Petrochemicals, Pharmaceuticals, Fertilizers and Power Sector etc. We also provide cables for renewable energy, railway and other special applications. These are currently imported but will be manufactured locally in due course.

Mention some of the Industrial Projects that have been implemented so far and what are your future plans?

We are currently working on several solar projects through EPC contractors like Juwi, Tata Solar, and BHEL etc. We are currently supplying products to Reliance Industries for their Oil & Gas projects. In automotive we are already approved by leading OEM's like Volkswagen, Ford, and GM etc.

Can you share with us something on green field project at Pune? How beneficial will it be from the manufacturing point of view?

In the past LEONI companies have been exporting products to Indian customers. We had felt the need to start local production. This would enable us to feed our existing customers and also tap new customers. Indian and other Asian customers will benefit by getting International quality products available easily. In due course we would be able to develop or customize products for new applications in the Indian market. In addition we have the possibility of exporting products from the Indian facility.

The new plant at Pune has a production area of 15,000 sq mm and is located at Chakan which is about 35 km from Pune. The machinery and test equipment is imported from the same sources as the other group companies of LEONI.

The employees have all been trained at our European plants and also team of experts from Europe visit frequently to ensure quality standards are maintained.

What certifications and standards do you follow as cable manufacturer that enhances the quality of your products?

We manufacture products as per latest EN 50288-7 for instrumentation and control, ISO 6722 & JASO D 609-90 for automotive applications. We have already obtained ISO 9001 for our automotive plant.

What are your plans for the growth of the company in next two years?

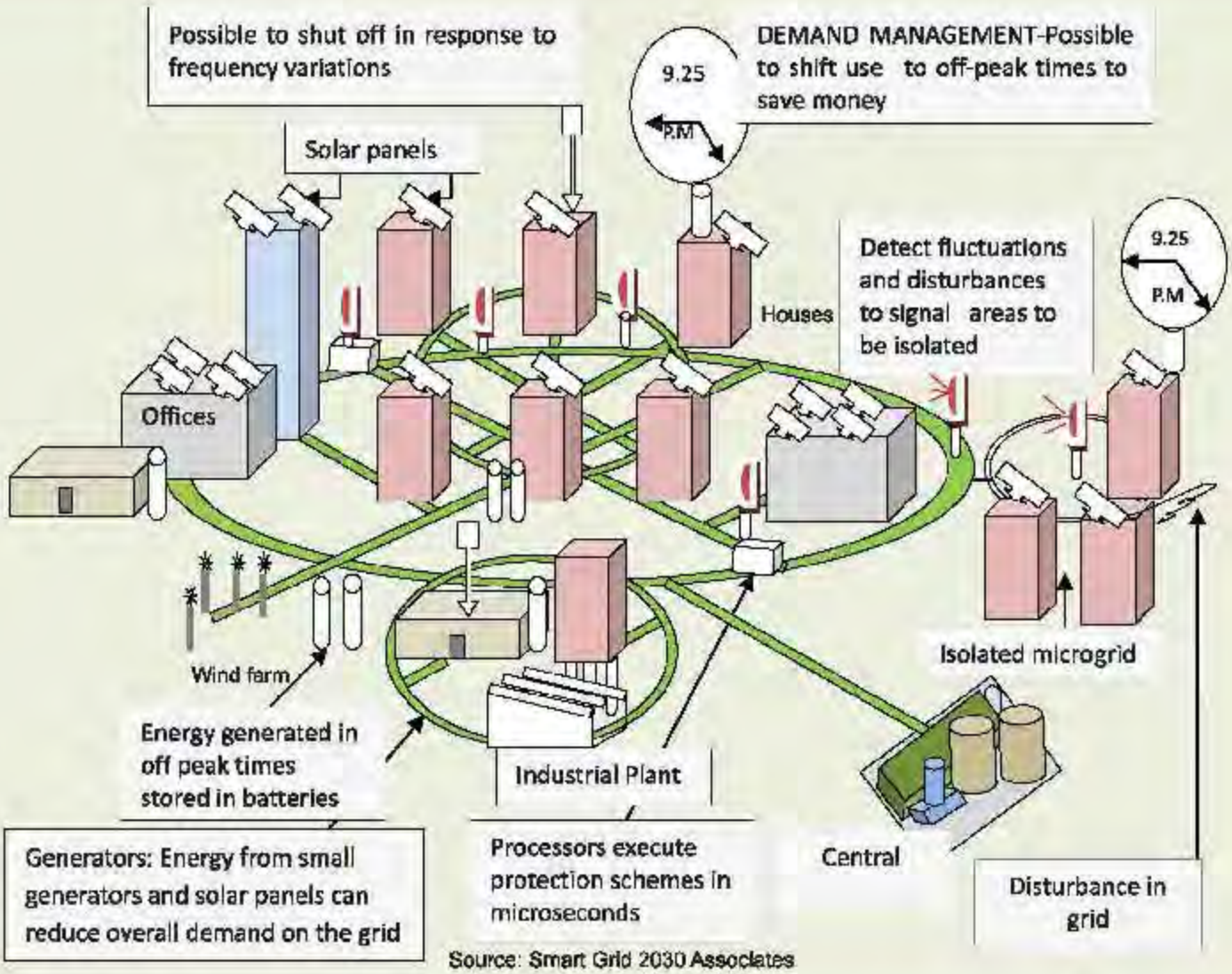
We plan to start manufacturing the cables for Renewable Energy and Railway markets by installing electron beam curing equipment. ■

Transmission Works (220 kV and above) for Transmission Lines Commissioned/Ready for commissioning as on November 2013

Voltage Level (kV)	Name of the Transmission Line	Type	Executing Agency	Line Length (CKM)
PVT Sector:				
400	Parli (PG) - Pune (PG)	MC+D/C	RPTL	668
STATE Sector:				
400	Malwa TPP - Pithampur	D/C	MPPTCL	272
230	LILO of K.R. Thoppur - Gobi at Pallakkapalayam	D/C	TANTRANSCO	10
220	Dalkhola(PG)- Dalkhola	D/C	WBSETCL	2
220	Jeerat-Rishra	D/C	WBSETCL	140
220	LILO of Dausa -Anta at Lalsot	D/C	RVPNL	21
220	LILO of Itarsi - Narsinghpur at Chichali	D/C	MPPTCL	4
220	LILO of Khara - Saharanpur at Behat	D/C	UPPTCL	5
220	LILO of Nagdha - Neemuch at Daloda	D/C	MPPTCL	9
220	LILO of Bahadurgarh- Rohtak at Kabulpur	D/C	HVPNL	47
220	Parichha-Jhansi	D/C	UPPTCL	28
220	Xeldem-Cuncolim	D/C	ED- GOA	20

Source: CEA

Smart Grids for Modern Energy Systems



Source: Smart Grid 2030 Associates

Implementation of smart grids for a low-carbon economy can change both the way power is produced and the way it is consumed. Smart grids can help reduce transmission and distribution losses, optimise the use of existing infrastructure to regulate power flows and meet peak demand, accommodate decentralized and renewable energy into the grid, and improve energy efficiency by managing the consumption patterns of new and existing users connected to the grid.

- C S Indulkar

Smart grids can benefit both energy consumers and producers, by using advanced sensors and computer-based remote controls designed to limit outages and network losses. These devices are linked to integrated communications networks to enable consumer participation and to manage the integration of distributed energy sources (renewables, energy storage, combined heat and power) through intelligent advanced systems and operations management. Power companies need a real-time wide-area security monitoring, protection and control system. Synchronized measurement technology (SMT) is the backbone of this system. Phasor measurement units (PMUs) are the most widely used SMT-based device for power system applications.

With the introduction of the smart grid,

- it is possible to control energy consumption centrally or remotely in households (web portals and in-home displays allow consumers to proactively monitor their energy consumption),
- offices can adjust cooling and lighting depending on real-time costs and needs,
- smart meters relay energy usage and pricing information between consumers and energy providers,
- wireless technologies and power lines are used for "real time" communications,
- electric vehicles can be recharged from green sources or when energy is cheapest, supporting zero- tail-pipe emissions,
- overall demand on the grid can be reduced by using intermittent energy sources, e.g. solar panels,
- energy storage systems can store electricity generated off-peak hours for later use, and
- central management system gathers information from smart meters and regulates the flow of power so that supply and demand is always in balance.

Smart Grid is defined as a future power delivery grid that:

- enables new products, services and markets,
- provides power quality for the range of needs in a digital economy,
- optimizes asset utilization and operating efficiency,
- anticipates and responds to system disturbances in a self-healing manner, and
- operates resiliently against physical and cyber attacks, and natural disasters

To fully capitalize on the potential benefits of smart grids, the energy sector will need to overcome the following main challenges:

- Issues of standardization and certification, operation, system testing, and consumer participation.
- Large amounts of funding are needed throughout the lifecycle of smart grid development. Innovative mechanisms to finance these investments are needed if a full smart grid vision is to be a reality.

The development of smart grids is a long-term process that requires capital over many years, and a strong commitment from all stakeholders. Therefore, policymakers, industry (including IT companies), and network operators have to work closely together. Further, the public should be made aware about the benefits of smart grids.

Financing mechanisms

Several financing mechanisms for developing smart grid technologies and incentivizing private sector investment have been established in various countries as shown in Table 1.

It is necessary to involve national regulatory authorities in the early stage of smart grid development, as this allows them to better understand the benefits of the technologies and provide appropriate regulatory mechanisms to support their full deployment. In the United States, alongside federal financing, smart grid technologies and developments are financed by private investments. Significant progress in smart grid development has been made in the US by funding (2010 Smart Grid System Report: Department of Energy, February 2012):

- to establish 30 manufacturing facilities for electric vehicle batteries and components,
- the use of 877 PMUs which provide phasor information in real time (Effective utilization of PMUs is very handy in mitigating blackouts and learning the real-time behaviour of power systems), and
- the use of advanced metering infrastructure and expanding broadband access and adoption.

In emerging countries, the cost of financing the development of smart grid technologies is for the most part borne by government finances or external grants. For example, the State Grid Chinese Corporation has been carrying out pilot projects by means of independent investment and public tendering. Similarly, smart grid projects in India are being implemented on a pilot basis and are mostly funded by government finances or external grants. Among these, Distribution Reform, Upgrades and Management (DRUM) is a USD 30 million.

Bilateral project developed by the U.S. Agency for International Development (USAID) and the Indian Ministry of Power, with USAID training Indian utility personnel in the commercial, technical, safety, communication,

Public Funding	External Grants	Private Funding	Regulatory Incentives
European Union: EU funding programs for RD&D projects (FP7, IEE, NER300, Connecting EU facilities) **USA:** over USD4 billion from DOE Public	**USTDA:** USD 686,447 grant for smart grid implementation **DRUM training program:** USD30 million by the USAID and the **Indian Ministry of Power** for Smart Grid development	**USA:** partnership GE and venture capital firms **Korea (Republic):** government and private funds (USD0.5 billion and USD18.1 billion)	**New tailored mechanisms:** AEEG (Italy) Del 39/10 OFGEM (UK); RIIO, LCNF, IFI, RPZ **R-APDRP (India)** ANEEL (Brazil) Law No 9991

Table 1: Available financing mechanisms
Smart grids: Best practice fundamentals for a modern energy system -World Energy Council, 2012

and management aspects of electricity distribution. The project is aligned with the R-APDRP, a financial incentive scheme (~ USD 9 billion) where the Indian government initially provides loans to the utilities to strengthen and upgrade sub-transmission and distribution networks through the adoption of IT and the implementation of smart grid technologies. If the utilities are able to implement the project within a stipulated period and bring down network losses to stipulated levels, the loan is partly or fully converted into grants.

To fully utilize the benefits of smart grids, technological as well as financial challenges have to be overcome and it is of uttermost importance that policymakers and industry work closely together and include the wider public in their efforts. The development of smart grids is a long-term process that binds capital over many years and therefore requires strong commitment from all stakeholders with a positive business model.

Fig.1 shows the expected electricity consumption growth of different countries during 2007-2050. Fig.2 shows that non-technical losses in the power sector are small in advanced economies. For example, Japan's electricity grid is among the most efficient and reliable in the world with average distribution losses of less than 5% (2000–2010). In contrast, India's T&D losses are among the highest in the world, averaging 26% of total electricity production. Adding non-technical losses, such as energy theft, which typically occurs through illegal connections to the grid, total losses are as high as 50%. A similar situation exists in Brazil with an over strained and ageing electricity network, where T&D power losses were as high as 15.3% in 2006-12, which was nearly twice the global average. Therefore the priorities for India and Brazil are to build a grid able to carry enough capacity for the rising demand of electricity, as well as reduce the high levels of electricity losses. Smart grids help control and expand these grids by optimizing the operation and improving the network efficiency through enhanced automation, more monitoring devices, protection and real time operation, as well as faster fault identification. The Indian Electricity Act of 2003 and the National Electricity Policy of 2005 have set clear objectives on the reliability and quality of power, as well as the availability of electricity. Additionally, the Government of India launched the Restructured Accelerated Power Development and Reforms Program (R-APDRP) in 2008, an incentive scheme for strengthening and upgrading the sub-transmission and distribution network through the adoption of IT and the implementation of smart grid technologies.

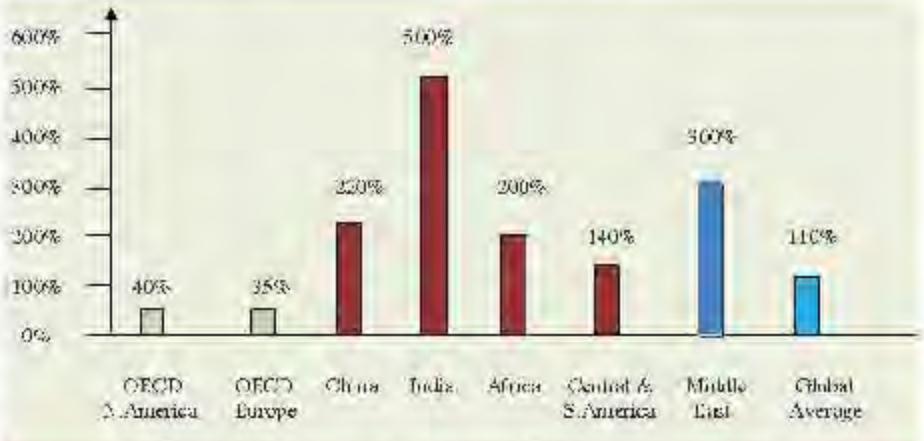


Fig. 1: Electricity Consumption growth (2007-2050), approximate percentages.
OECD (Organization for Economic co-operation & development)
Source: IEA, 2011, Technology Road Maps Smart Grids

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Requirements

There is a need for more public funds and tariff incentives for all stages of smart grid development:

- Research and development (R&D),
- Large demonstration projects (which show the impact on the system), and full deployment, in both advanced and emerging countries.

deployment of smart grid technologies. Low recovery of revenues is common in India, pushing most distribution companies into appalling losses, and leaving the states' utility companies with hardly any funds to upgrade distribution networks. Hence in general, the states look to the central government to provide funding and technical direction to strengthen the distribution system.

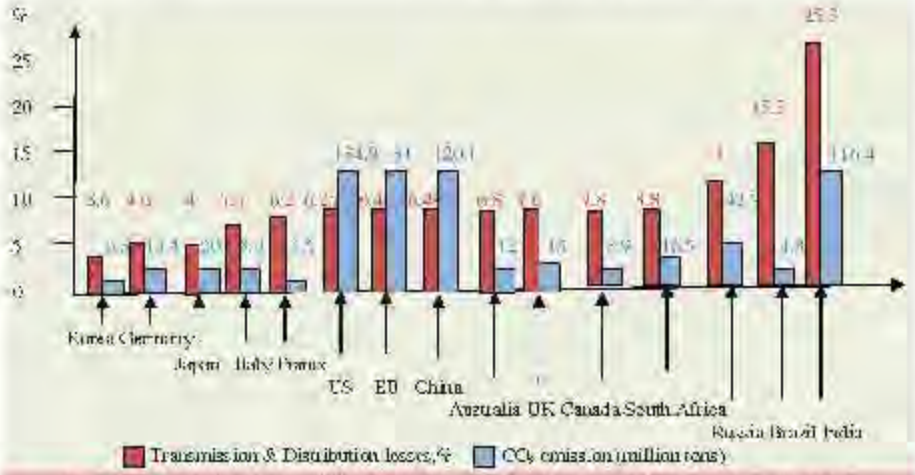

Fig. 2: T&D losses at the grid and resulting CO2emissions of MEF countries in 2006. MEF (Major Economies Forum on Energy & Climate, December 2009, Technology Action Plan: Smart Grids)

All countries, regardless of whether they are developed or emerging, face a number of challenges and government intervention should demonstrate and accelerate the

Regulations

In Europe, full deployment and the replication of smart grid technologies present themselves as a major challenge. One key issue is the definition of clear technology standards for smart grid technologies that would allow for a massive deployment.

The standardization of solutions and interoperability of technologies helps reduce deployment costs, which is essential to establish a positive business environment. Furthermore, for large-scale demonstration projects, defining clear regulatory frameworks that support the full scale deployment of smart grids requires strong actions by each national and European regulatory authority, as shown in Table 2.

In India, where both the central and state governments have specific, sometimes overlapping powers leading to complicated technical and investment-related decisions. As most distribution companies in India are state-owned, the political pressure is high to keep tariffs down and distribute electricity at low rates to certain sectors like agriculture and small industries. Although the central government has addressed the matter, support for implementation levels is unsatisfactory. The primary reasons for failing to implement smart grids are the lack of:

Germany Mix of PLC (power line communication) and GPRS (general packet radio service) in pilot projects will continue into full roll-outs. **PLC preferred due to lower cost** but bandwidth is a concern	France **PLC currently being tested in pilot projects, but other solutions being analyzed for full roll-outs**
Netherlands **Prefer PLC for cost, reliability and control**	Spain **Major players have identified PLC as the preferred technology;** unclear level of sophistication OFDM(orthogonal frequency-division multiplexing) vs. traditional spread spectrum
Sweden, Denmark, Finland **Mix of PLC/GPRS with PLC preferred due to lower cost,** however, pressure to improve PLC outage management features	UK GPRS used during pilot projects (and interest for PLC). **For full roll-outs, technology will be either GPRS or RF**(radio frequency)

Table 2: Technology standards for smart meters in key EU countries
Source: McKinney & Co.2010

- incentives for participating companies,
- adequate number of skilled workers, and
- transparency of the systems.

R-APDRP (the newly structured Accelerated Power Development Reforms Program under the 10th Five-Year Plan) has tried to look into solutions into many of these implementation lacunas.

China, with the same need to build a new infrastructure to respond to the increasing demand for electricity, has introduced smart grid technologies in the transmission infrastructure from the outset. This is because China's enormous state-owned transmission companies and streamlined regulatory processes enable rapid construction with few barriers. The majority of countries do recognize the importance of regulations for the implementation of smart grids. In a country like China with a central government, a standard set of regulations can easily be implemented; in other countries, agreeing on clear technology standards as well as defining a set of regulations and their consequent implementation impose a huge challenge.

Public awareness

The benefits provided by smart grids need to be clearly communicated in order to raise public awareness. The lack of customer interest, especially in developed countries, not only stems from a generally low level of awareness of the electricity bill amounts, but also from a limited understanding of smart grids and how their implementation can create value. Therefore, it is necessary to explain to the customers in simple terms what a smart grid is, and more importantly, the direct benefits they will incur with a massive deployment of all the necessary technologies.

In California, for example, some customers of the Pacific Gas & Electric utility have been opposed to smart meters being installed in their homes due to privacy, health, and safety concerns. The same issue has surfaced in the states of Maine and Illinois, where customers have opposed smart meter rollouts. All this opposition has led the respective states' public utility commissions to consider smart meter opt-out options, where consumers pay an initial fee and monthly charge for choosing to opt out.

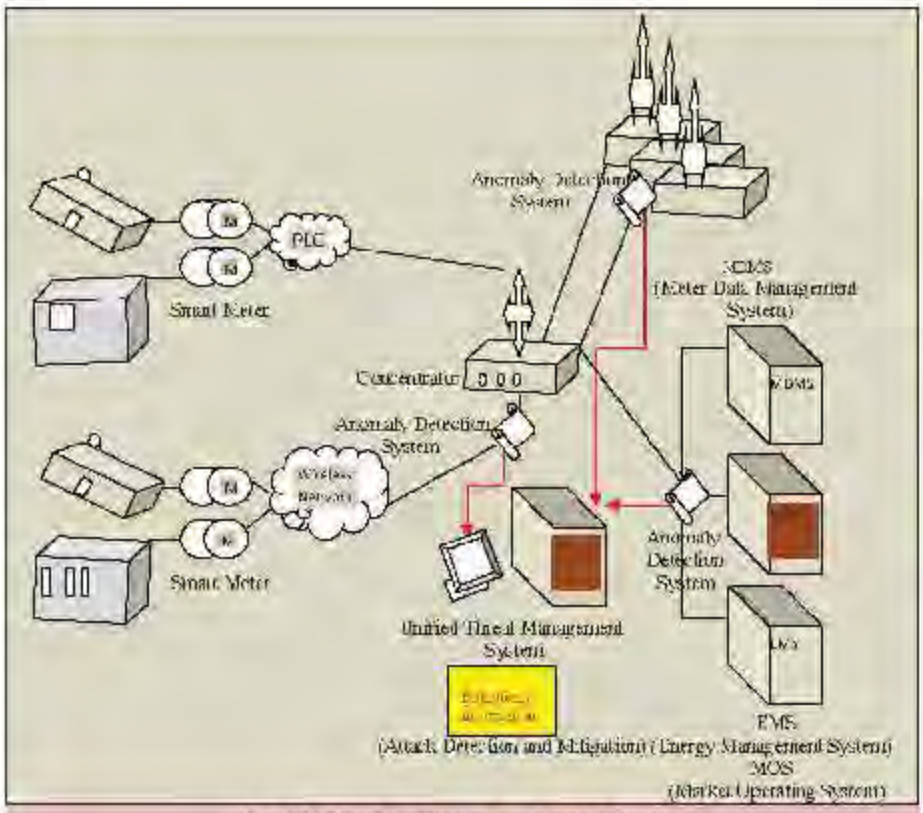

Fig. 3: Security monitoring and control system

Distributed Security Monitoring and Control

To ensure efficient operation there are many systems in a smart grid. An EMS is employed to handle a power plant properly based on electricity usage. A SCADA system is installed to manage the devices that measure the status of the power grid. A metering data management system is used to provide valuable customer services. All these systems are composed of servers, databases, and desktops. In additions, each micro grid has its own EMS and SCADA system. All these devices are spread out over a wide area. Each of these systems could be potential victim of cyber-attack. Therefore in case of a triumphant attack, it must be detected and handled as soon as possible. For this purpose, a system could be employed to monitor the system behaviours, identify abnormal ones, decide whether they are cyber-attacks, and properly mitigate the attack/s. Fig.3 shows a security monitoring and control system for the smart grid.

Synchronized Measurement Technology

Power companies need a real-time wide-area monitoring, protection and control system. Synchronized measurement technology (SMT) is the backbone of this system. Phasor measurement

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units (PMUs) are the most widely used SMT-based device for power system applications. A PMU when placed at a bus can provide a highly accurate measurement of the voltage phasor at that bus, as well as the current phasors through the incident transmission lines. Modern PSUs have other features, like frequency measurement, measurement of derived quantities (e.g., power components, power-quality related indicators), and monitoring of the status of substation apparatus. PMUs are increasingly being used in different parts of the world as shown in Table 3.

PMU Applications	N. America	Europe	China	India	Brazil	Russia
Post disturbance analysis Stability monitoring				P P	T P	
Thermal overload monitoring				P	P	
Power system restoration				P	P	P
Model validation				P	T	
State estimation	P	P	P	P	P	P
Real-time control	T	T	T	P	P	P
Adaptive protection	P	P	P	P	P	P
Wide area stabilizer	T	T	T	P	P	P

T=Testing phase; P=Planning stage

Table 3: PMU deployment in various countries

In India, Powergrid is planning to install 20-25 PMUs at critical buses in different regional grids. The synchronized measurements from these PMUs will be used for model validations and the development of a common state estimator combining the regional state estimators.

Based on the success of this stage, more PMUs will be installed to explore different advantages of SMT, and develop remedial action schemes. Some important areas where significant improvement can be achieved by utilizing SMT are:

- Design of an advanced warning system
- Causes of total or partial blackout
- Fine-tuning of system models
- Real-time congestion management
- Real-time angular and voltage stability analysis and enhancement

Automated metering infrastructure (AMI) framework

Smart Grid technology, driven by governments and industry, is transforming how electricity is generated, stored, distributed, and consumed. It provides real-time monitoring of transformers and line voltage, data collection and remote control of system elements such as substations, intelligent devices, smart meters, power lines, capacitor banks, feeder switches, fault analyzers and other physical facilities. The smart Grid framework also provides consumer participation in Demand Side Management (DSM).

AMI framework lays down the foundation for a two way communication between a meter and a central Head End System (HES). AMI system supports:

- Automated meter reading of the energy, load survey data, instantaneous parameters and event data from meter to Head End System (HES)
- Demand Response Facility to disconnect load on predefined variable load settings
- Remote configuration as well as remote firmware upgrade without affecting the meter metrology.
- the consumer to read energy consumption, real time energy prices and control of load on an in-home display and on other Home Area Network (HAN) devices.

Two way communications between meter and Head End System is achieved in two ways:

- Meter to HES directly over GSM (Global System for Mobile Communications)/GPRS etc
- Meter to Data Concentrator Unit (DCU) over RF mesh/PLCC and from DCU to HES over GSM/GPRS etc

AMI Communication Infrastructure can be broadly divided into following:

- Local Area Network(LAN) / Neighborhood Area Network(NAN)/ Wide Area Network(WAN)
- Home Area Network(HAN)

Communication Technologies generally adopted are RF mesh/PLCC/GPRS/WIMAX (Worldwide Interoperability for Microwave access) etc.

AMI model consists of the following major components:

- Smart Meter
- LAN/WAN communication over RF mesh/PLCC/GPRS, Network Management System (NMS)
- Home area network supporting in Home Display over Zigbee/PLC

(ZigBee is a technology of data transfer in wireless networks. It has low energy consumption and is designed for multi-channel control systems, alarm systems, and lighting control. It also has various other home and industry applications.)

The reading frequency proposed is once in 24 hours automatically. Alarms are to be communicated on their occurrences. On demand meter reading facility can also be made available.

Requirements

There is a need for more public funds and tariff incentives for all stages of smart grid development:

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- Large demonstration projects (which show the impact on the system), and full deployment, in both advanced and emerging countries.

deployment of smart grid technologies. Low recovery of revenues is common in India, pushing most distribution companies into appalling losses, and leaving the states' utility companies with hardly any funds to upgrade distribution networks. Hence in general, the states look to the central government to provide funding and technical direction to strengthen the distribution system.

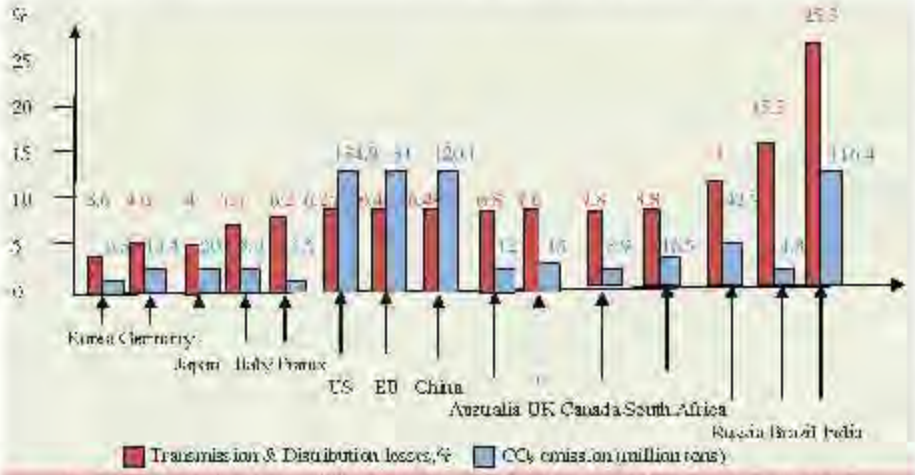


Fig. 2: T&D losses at the grid and resulting CO2emissions of MEF countries in 2006. MEF (Major Economies Forum on Energy & Climate, December 2009, Technology Action Plan: Smart Grids)

All countries, regardless of whether they are developed or emerging, face a number of challenges and government intervention should demonstrate and accelerate the

Regulations

In Europe, full deployment and the replication of smart grid technologies present themselves as a major challenge. One key issue is the definition of clear technology standards for smart grid technologies that would allow for a massive deployment.

The standardization of solutions and interoperability of technologies helps reduce deployment costs, which is essential to establish a positive business environment. Furthermore, for large-scale demonstration projects, defining clear regulatory frameworks that support the full scale deployment of smart grids requires strong actions by each national and European regulatory authority, as shown in Table 2.

In India, where both the central and state governments have specific, sometimes overlapping powers leading to complicated technical and investment-related decisions. As most distribution companies in India are state-owned, the political pressure is high to keep tariffs down and distribute electricity at low rates to certain sectors like agriculture and small industries. Although the central government has addressed the matter, support for implementation levels is unsatisfactory. The primary reasons for failing to implement smart grids are the lack of:

Germany Mix of PLC (power line communication) and GPRS (general packet radio service) in pilot projects will continue into full roll-outs. **PLC preferred due to lower cost** but bandwidth is a concern	France **PLC currently being tested in pilot projects, but other solutions being analyzed for full roll-outs**
Netherlands **Prefer PLC for cost, reliability and control**	Spain **Major players have identified PLC as the preferred technology;** unclear level of sophistication OFDM(orthogonal frequency-division multiplexing) vs. traditional spread spectrum
Sweden, Denmark, Finland **Mix of PLC/GPRS with PLC preferred due to lower cost,** however, pressure to improve PLC outage management features	UK GPRS used during pilot projects (and interest for PLC). **For full roll-outs, technology will be either GPRS or RF**(radio frequency)

Table 2: Technology standards for smart meters in key EU countries
Source: McKinney & Co.2010

- incentives for participating companies,
- adequate number of skilled workers, and
- transparency of the systems.

R-APDRP (the newly structured Accelerated Power Development Reforms Program under the 10th Five-Year Plan) has tried to look into solutions into many of these implementation lacunas.

China, with the same need to build a new infrastructure to respond to the increasing demand for electricity, has introduced smart grid technologies in the transmission infrastructure from the outset. This is because China's enormous state-owned transmission companies and streamlined regulatory processes enable rapid construction with few barriers. The majority of countries do recognize the importance of regulations for the implementation of smart grids. In a country like China with a central government, a standard set of regulations can easily be implemented; in other countries, agreeing on clear technology standards as well as defining a set of regulations and their consequent implementation impose a huge challenge.

Public awareness

The benefits provided by smart grids need to be clearly communicated in order to raise public awareness. The lack of customer interest, especially in developed countries, not only stems from a generally low level of awareness of the electricity bill amounts, but also from a limited understanding of smart grids and how their implementation can create value. Therefore, it is necessary to explain to the customers in simple terms what a smart grid is, and more importantly, the direct benefits they will incur with a massive deployment of all the necessary technologies.

In California, for example, some customers of the Pacific Gas & Electric utility have been opposed to smart meters being installed in their homes due to privacy, health, and safety concerns. The same issue has surfaced in the states of Maine and Illinois, where customers have opposed smart meter rollouts. All this opposition has led the respective states' public utility commissions to consider smart meter opt-out options, where consumers pay an initial fee and monthly charge for choosing to opt out.

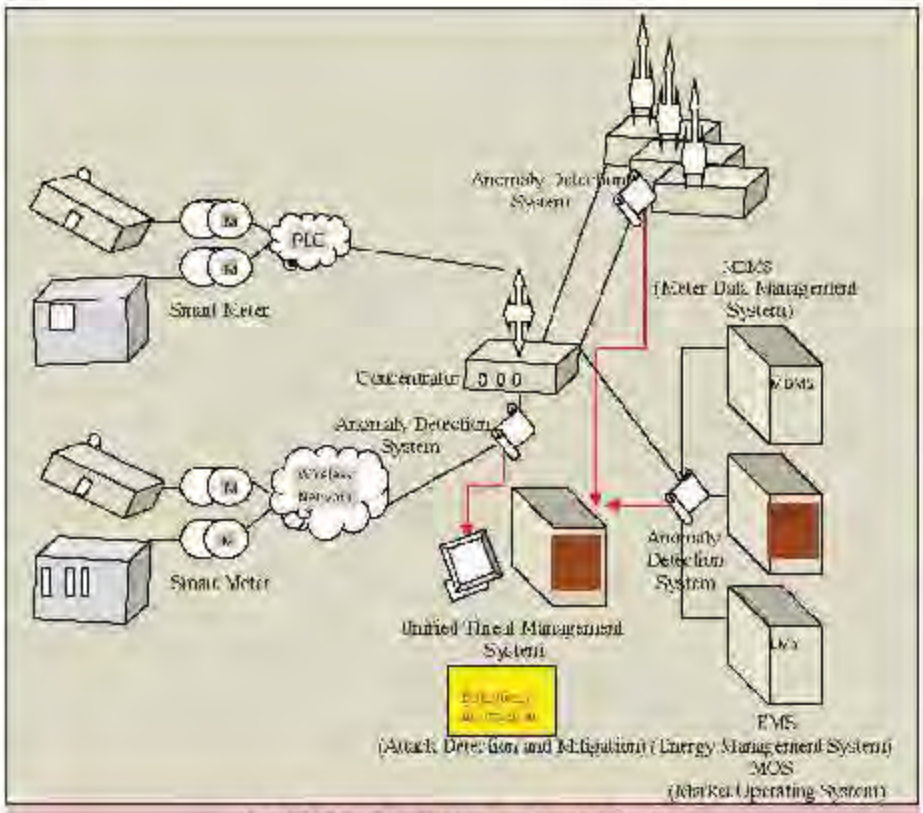


Fig. 3: Security monitoring and control system

Distributed Security Monitoring and Control

To ensure efficient operation there are many systems in a smart grid. An EMS is employed to handle a power plant properly based on electricity usage. A SCADA system is installed to manage the devices that measure the status of the power grid. A metering data management system is used to provide valuable customer services. All these systems are composed of servers, databases, and desktops. In additions, each micro grid has its own EMS and SCADA system. All these devices are spread out over a wide area. Each of these systems could be potential victim of cyber-attack. Therefore in case of a triumphant attack, it must be detected and handled as soon as possible. For this purpose, a system could be employed to monitor the system behaviours, identify abnormal ones, decide whether they are cyber-attacks, and properly mitigate the attack/s. Fig.3 shows a security monitoring and control system for the smart grid.

Synchronized Measurement Technology

Power companies need a real-time wide-area monitoring, protection and control system. Synchronized measurement technology (SMT) is the backbone of this system. Phasor measurement

units (PMUs) are the most widely used SMT-based device for power system applications. A PMU when placed at a bus can provide a highly accurate measurement of the voltage phasor at that bus, as well as the current phasors through the incident transmission lines. Modern PSUs have other features, like frequency measurement, measurement of derived quantities (e.g., power components, power-quality related indicators), and monitoring of the status of substation apparatus. PMUs are increasingly being used in different parts of the world as shown in Table 3.

PMU Applications	N. America	Europe	China	India	Brazil	Russia
Post disturbance analysis Stability monitoring				P P	T P	
Thermal overload monitoring				P	P	
Power system restoration				P	P	P
Model validation				P	T	
State estimation	P	P	P	P	P	P
Real-time control	T	T	T	P	P	P
Adaptive protection	P	P	P	P	P	P
Wide area stabilizer	T	T	T	P	P	P

T=Testing phase; P=Planning stage

Table 3: PMU deployment in various countries

In India, Powergrid is planning to install 20-25 PMUs at critical buses in different regional grids. The synchronized measurements from these PMUs will be used for model validations and the development of a common state estimator combining the regional state estimators.

Based on the success of this stage, more PMUs will be installed to explore different advantages of SMT, and develop remedial action schemes. Some important areas where significant improvement can be achieved by utilizing SMT are:

- Design of an advanced warning system
- Causes of total or partial blackout
- Fine-tuning of system models
- Real-time congestion management
- Real-time angular and voltage stability analysis and enhancement

Automated metering infrastructure (AMI) framework

Smart Grid technology, driven by governments and industry, is transforming how electricity is generated, stored, distributed, and consumed. It provides real-time monitoring of transformers and line voltage, data collection and remote control of system elements such as substations, intelligent devices, smart meters, power lines, capacitor banks, feeder switches, fault analyzers and other physical facilities. The smart Grid framework also provides consumer participation in Demand Side Management (DSM).

AMI framework lays down the foundation for a two way communication between a meter and a central Head End System (HES). AMI system supports:

- Automated meter reading of the energy, load survey data, instantaneous parameters and event data from meter to Head End System (HES)
- Demand Response Facility to disconnect load on predefined variable load settings
- Remote configuration as well as remote firmware upgrade without affecting the meter metrology.
- the consumer to read energy consumption, real time energy prices and control of load on an in-home display and on other Home Area Network (HAN) devices.

Two way communications between meter and Head End System is achieved in two ways:

- Meter to HES directly over GSM (Global System for Mobile Communications)/GPRS etc
- Meter to Data Concentrator Unit (DCU) over RF mesh/PLCC and from DCU to HES over GSM/GPRS etc

AMI Communication Infrastructure can be broadly divided into following:

- Local Area Network(LAN) / Neighborhood Area Network(NAN)/ Wide Area Network(WAN)
- Home Area Network(HAN)

Communication Technologies generally adopted are RF mesh/PLCC/GPRS/WIMAX (Worldwide Interoperability for Microwave access) etc.

AMI model consists of the following major components:

- Smart Meter
- LAN/WAN communication over RF mesh/PLCC/GPRS, Network Management System (NMS)
- Home area network supporting in Home Display over Zigbee/PLC

(ZigBee is a technology of data transfer in wireless networks. It has low energy consumption and is designed for multi-channel control systems, alarm systems, and lighting control. It also has various other home and industry applications.)

The reading frequency proposed is once in 24 hours automatically. Alarms are to be communicated on their occurrences. On demand meter reading facility can also be made available.

Meter to DCU over RF mesh/PLCC and from DCU to HES over GSM / GPRS etc

Fig. 4 shows the AMI Solution Framework based on RF mesh/ PLCC and GPRS.

RF mesh/PLCC type of network, especially in areas where the meter population density is high, is a preferred choice. A LAN/NAN is formed using the RF mesh/PLCC that feeds data from multiple meters to a data concentrator unit (DCU) located on poles/Distribution Transformers, as the case may be. Data from DCU can be sent to HES using the WAN technology such as GPRS. It causes the system to be scalable and accommodates large numbers of meters in an AMI system. 865-867 MHz is the license free band as the power allowed is 1W in that frequency band and gives better coverage.

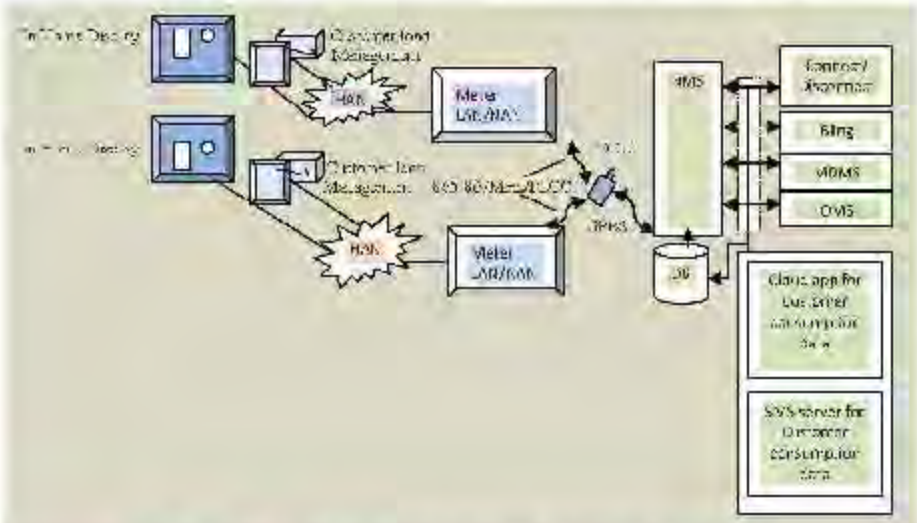


Fig. 4: AMI Solution Framework based on RF mesh/PLCC and GPRS

A 20 MHz band will be required to make the system futuristic. Any other de-licensed band which suits the application can also be utilized. RF mesh/PLCC can also be used for Home energy management depending upon the compatibility of devices. RF mesh has following advantages:

- Obviates the difficulty of providing each meter an IP address.

- Any meter can be added or removed in the existing network.
- Dynamic Communication
- Auto-Registration
- Self configuring / Self-Healing

PLCC is envisaged to be used in high rise buildings. Areas where the meter population density is low directly use WAN technology such as GPRS at meter end to directly send data to HES if economically feasible. Home area network (HAN) refers to the devices that a meter can communicate to in user's premises if compatible with the RF Mesh that is implemented in the meter.

There are basically two technologies used on the HAN side i.e. Zigbee communication or PLC communication. RF is a wireless technology while PLCC is wired technology. In today's world of IT communication and requirement of better power quality level, wireless technology is a better choice.

Functional requirement of cost effective Single Phase Meter

Smart meter for an AMI solution would support the regular features of a standard static meter. In addition it will support communication interface for data exchange between DCU /HES as the case may be, as also interface for Home energy management including display.

The meter can have a GPRS modem in case when it connects to the NMS directly for spread out locations. In case of dense locations, meter shall have a RF mesh module working in the frequency band of 865-867 MHz that would communicate to a Data Concentrator Unit before the data is sent on WAN using cost effective meter. The reading frequency proposed is once in 24 hours automatically. Alarms are to be communicated on their occurrences. On demand meter reading facility shall also be available.

Cost effective solution is used to meet the following objectives:

- Automatic Meter reading for energy accounting and auditing, billing and collection
- Demand response including above functions.

Demand response in urban areas is implemented in following manner:

- By informing consumer about the increase in tariff due to grid constraint or increase of load in excess of predefined conditions,
- By disconnection of load within stipulated time in case of exceeding load/maximum demand, and
- By disconnecting consumer appliances such as washing machines/air conditioners etc.

The bi-directional communication shall be used for:

- Communication to utility regarding actual load at the time of partial or full load disconnection.
- Disconnection of load based on advance agreement between utility and consumer.

Group Metering

A group of meters can be housed and can be mounted on electric pole or any convenient location. In that case:

- All meters are mounted on pole and in house display device (IHDD) can be provided on consumer request.
- All these meters are connected to Data Concentrator through RS-485 with upward link to HHS via GPRS.
- Meter is provided with tamper detection and notification.
- Power outage detection/ restoration with information notification is in the meter.
- Load profiling, Demand & Time of Use (TOU) is provided in the meter.
- Facility may be provided for remote meter configuration changes/ remote firmware upgrade without affecting meter metrology.
- When RF mesh/PLCC radio communication is available, HAN services can be built up to enable the consumer to read energy consumption, real time energy prices and control of load in customer premises.

The in-house display device (IHDD) plays a vital role in a smart meter. It is needed for consumer involvement, demand/ response and for interfacing with appliances. IHDD is not part of meter and may be kept as an option. Utility can provide the facility of furnishing bill related information on mobile phones as well.

Cloud application for energy consumption data over GPRS/Internet:

Like an SMS server, a web based application can be implemented that can display energy consumption. The user logs in to the application using his username and password and can view the energy consumption information.

Functional Requirement Specification for Single Phase Smart Meter-Applicable Standards

(Central Electricity Authority, Distribution Planning & Development Division, www.cea.nic.in)

The meters shall comply with IS 13779 for all requirements except for those parameters which have been specifically mentioned to be otherwise in the following specification:

- Reference Voltage: 240 V (-40% to +20%) Single Phase, Current Rating 5-30 A, 10-60A, Operating Temperature range: 10 deg C to 55 deg C, Humidity <= 95%, Frequency 50 Hz +/- 5%.
- Meter Display: Min 6 digit LCD Display with legends to identify parameters on meter.
- Parameters to be measured: Instantaneous-V, I, kW, Power

factor, Cumulative Active Energy, Apparent Energy, Average power factor.
- Previous Month's parameters: MD in kW, kWh, Average PF
- Power Quality Information: Logging of quality of supply events like power on/off, over/ under voltage, over current (50 events)
- Settings of Under/Over Voltage and Over current to be decided by utility.
- Maximum Demand: Should have Maximum Demand register kW with integration period of 30 minutes. Resets should be auto-monthly or through communication command.
- Load Survey/Interval Data- 35 days' data to be recorded with 30 minutes integration period for Active Energy, Average Voltage, and Average Current. In addition cumulative mid-night kWh (00.00 Hrs) shall also be recorded for 35 days.
- LED / LCD Indicators: LED indicator for pulse/kWh. LED / LCD Indicator for Tamper, Disconnection, Earth leakage.
- Tamper/Event recording: A total of past 50 events considering all tampers defined must be detected and logged as tamper events on first in -first out basis along with date & time of occurrence and restoration, total tamper counts with tamper identification. Snapshot of kWh, V and I to be recorded along with the following tamper events:
  - Cover open detection First instance. Neutral disturbance. Magnetic Interference
  - Alarm -for power on/off, Under Voltage, Over Voltage, Over Current, and Mal-functioning of relay.
- Malfunctioning of diagnostic events shall be generated and communicated to the HES immediately.
- Meter should have two measuring elements - one in phase and other in neutral path.

Load Control Relay for connection/ disconnection

Phase and Neutral Disconnection works on the following conditions:
- Over current
- Load Control Limit (Load Control limits shall be programmable).
- Pre-programmed Tamper conditions
- Disconnect signal from Utility Control Centre such as balance unavailable in case pre-paid facility is availed by consumer.

The disconnection mechanism is as follows:
- The switch re-connection shall be decided by meter locally. It will try to re-connect the load up to 3 times, with 5 minutes interval.
- if the consumption is still more than the programmed limits, it will lock out and wait for 30 minutes (lock out period).
- if the consumption is still above the limit, the above two procedures shall be repeated.

Reconnection shall normally be done from HES. In case of failure of communication/HES, reconnection shall be possible through HHU locally and the same shall be password protected. Indication of status of relay i.e. connected / disconnected will be available on display as well as through communication.

It should be possible to program the limits / values of parameters from remote ends through sufficiently adequate security mechanism. Once programmed it will be possible for the programmed parameters to come into effect from a certain date & time.

Meteorology under such condition must remain intact and shall not be upgradable from remote.

Summary

One of the overall goals of the smart grid is the development of a more automated and flexible distribution system. The smart grid is very efficient due to the extensive monitoring system whereby each and every aspect of the grid is constantly monitored. With the development of the smart grid resulting in competition in power generation through electricity market operations, the average efficiency in power plants can be improved considerably.

Recent increases in energy consumption, production costs, and environmental concerns have triggered the efforts to develop smart grids for power systems. Control, information and communications technologies are at the core of the smart grid vision. These will empower today's power grid with the capability of supporting two-way energy and information flow, isolating and restoring power outages more quickly, facilitating the integration of renewable energy sources into the grid and empowering the consumer with tools for optimizing their energy consumption. ■

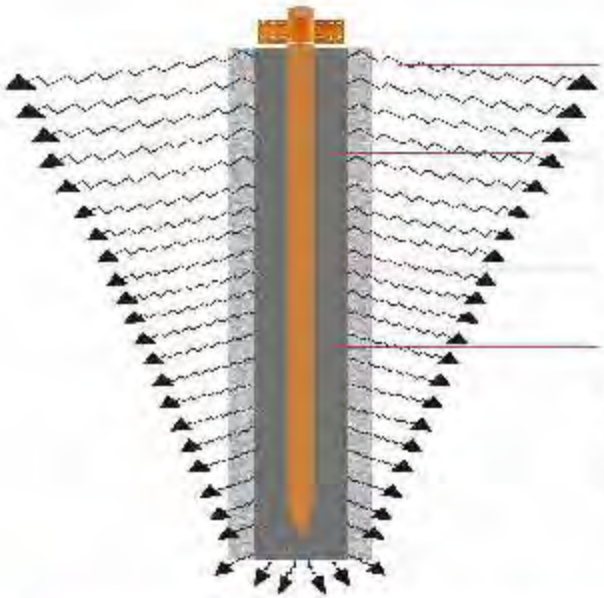
C S Indulkar, worked previously at the Chambal Hydroelectric Scheme, and the M P Electricity Board Bhopal before joining IIT Delhi. He retired from IIT Delhi as Professor and Head of Electrical Engineering Department. Professor Indulkar has authored a number of technical papers in various refereed journals, including IEEE Transactions and IET Proceedings. He has also been a reviewer of papers for the above journals and for several other International Journals of Electrical Engineering, and also for the Electrical Engineering Division Journal of the Institution of Engineers (India). He was the Chairman of the IEEE Delhi Section during 1991-92. He is a Life Fellow of the Institution of Engineers (India), and Life Senior Member of the IEEE.

Maintenance Free Earthing

Lightning Protection

Surge Protection Devices

A TYPICAL ILLUSTRATION OF JEF ECOSAFE GROUNDING SYSTEM

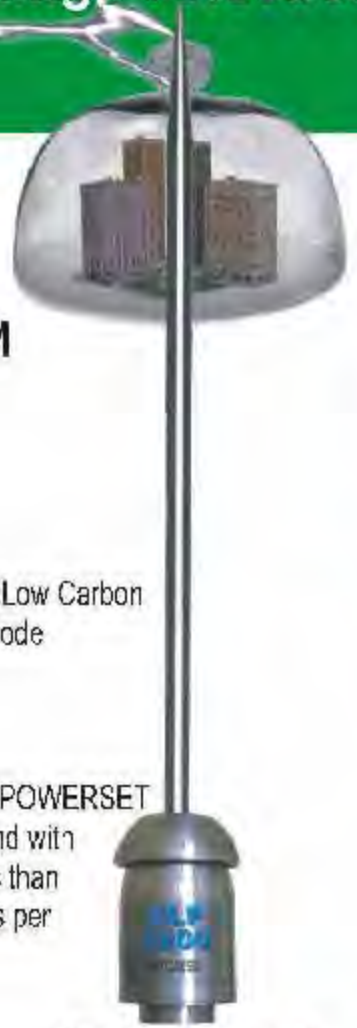


Back Filled Soil

Copper Bonded Low Carbon Steel Rod Electrode

Bore

POWERFILL or POWERSET backfill compound with resistivity of less than 0.12 Ohm mtr as per IEEE : 80.



ESE Lightning Rod

- Combined (Class B&C) protection
- Status Indication
- Potential free contacts for remote indication

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"Investing around US$ 5 million to set up a corporate Innovation center at Halol"

Amit Bhatia
Sr. VP & Profit Centre Head of Power Business
Raychem RPG

Raychem RPG (P) Ltd. incorporated in 1989 is a 50: 50 Joint Venture between TE Connectivity (formerly Tyco Electronics, U.S.A) and RPG Enterprises, India. Raychem RPG is contributing to the strengthening of infrastructure segments of the country, such as energy transmission and distribution, transformer, telecommunication, oil, water & gas as well as export activities. It is first company to develop drive transformers from 500 kva to 6000 kva. Speaking to Gopal K Anand about company's future prospects, during telephonic interview to **Electrical India, Amit Bhatia** said, we intend to double our revenues in the next four years' time.

Mr. Amit, you have worked in various positions how do you prioritize your role as vice president and head of profit centre power business at Raychem?

There are three areas to focus upon, the Profitability, Business Development and Organisation development. All three get equal attention.

How do you see the business development of the Raychem since you have joined?

Raychem's approach has been providing a satisfying experience to its customers. We partner with our customers and own up their goals as well as issues. The end to end solutions approach has ensured that we are the preferred partner to our customers and revenues have gone up ten times in last decade.

Could you brief us about the product range that your company is having?

We offer solutions to our customers in three specific areas:

- Reliable Connection Systems
- Asset & Personnel protection
- Electrical loss & Theft reduction.

The connection systems include the Wedge connector system, Insulation Piercing Connectors, Mechanical Shear Bolt Connectors and Bolted connector systems. The Voltage range covered is 1.1kV to 1200kV. Recently, we participated in PGCIL's 1200kV Test station wherein we supplied the 1200kV Connectors. We have on offer Cable accessories from 1.1kV to 245kV.

Under Asset protection, we offer tailor made solutions for Insulation Enhancement up to 400kV.

Our range of Polymeric surge arresters is used for Equipment & Transmission line protection up to 765kV.

The unique Series parallel design has been used all over the world for easy and compact installations. The Safety range of PPE specifically focuses on Electrical Applications and we have Cable spiking tools, Arc flash clothing, Insulating Helmets, Gloves and use up to 33kV.

Loss and Theft reduction is major challenge being faced by the Power sector, specifically in the Low Voltage distribution. We have been able to assist our Utility customers with customized designs and technologies which have helped them to reduce their Losses. For example, with our wedge connector technology, the IsquareR losses are reduced to almost one sixth of conventional connector technologies.

Do you manufacture the products in India itself? Tell us something about the manufacturing facility?

We have three manufacturing facilities located at

- Vasai
- Chakan
- Halol.

The Vasai plant produces Heat Shrink and Cold applied components for worldwide consumption, whereas the Pune plant produces Dry and Oil filled transformers. We have extended or range up to 132kV 20 MVA recently. Halol plant is the hub for Energy products and 80% of our Energy products are shipped from this location. We are further investing around US$ 5 million to set up a corporate Innovation center at Halol.

Do you say Halol is the Hub central for Raychem?

Halol plant is the hub for Energy products and 80% of our Energy products are shipped from this location.

Share us something about the company's energy product division?

The Energy division is over 300 Crs at Raychem RPG. Both Halol and Chakan plants put together account for 50% of Company revenue and deploy 500 plus Team members. Our focus is on Niche Solutions for our customers in Utilities, Industry, OEM's, Railways & Generation segments.

Can you tell me whether these technological solutions you have implemented or you have come out how much loss reduction could have been achieved ?

Tata Power uses wedge connector technology and have benefitted from the same as the contact resistance is lower and losses reduced to less than 1/6th as compared to conventional connection systems used in LV Distribution.

How do you see the power business scope in India?

Power Business is all set to grow. It definitely needs some government interventions in terms of quicker decisions on the reforms. The plans are very well laid, up to the year 2032 there. It is the implementation part where in the government has to work especially fuel linkages and Environmental clearances which are the two major bottlenecks. Thirdly, I clearly see a scope to improve technical specifications to adopt the low loss modern technologies, which are compact and energy efficient as compared to conventional designs in use.

You are participating in 2014 Elecrama what are your expectation from the same?

Yes, we are participating in Elecrama. It is a major exhibition in India and it is frequented by industries and utilities and Industry Experts who come to have a look at the newest technologies. So we are looking forward to have a good interaction not only from the customers' point of view, but also towards the latest technologies being showcased by the Industry.

What products are you displaying at the expo?

We will be displaying power and connection systems, cables and accessories up to 245 KV , connector systems up to 1200 KV as well as we will be looking for showcasing some of the components which we are have for loss reduction.

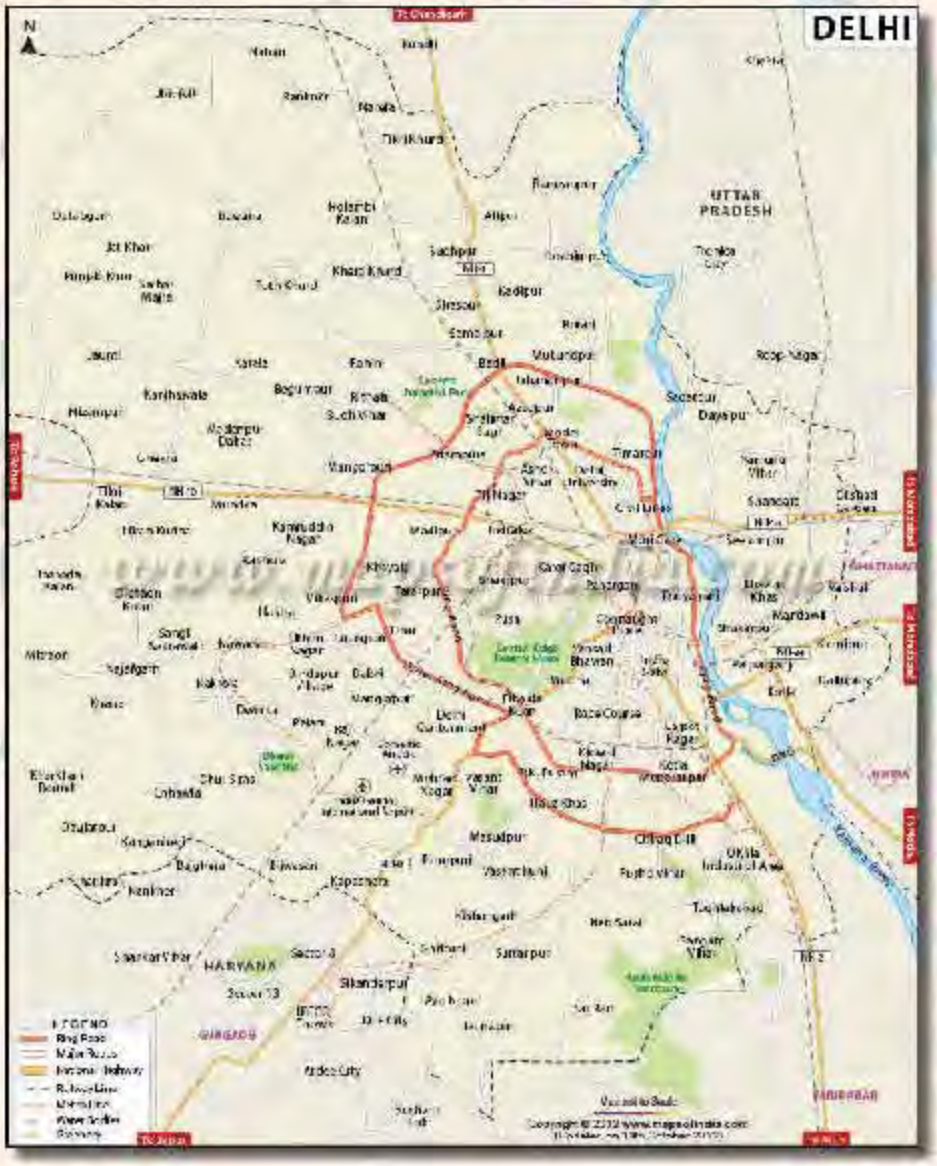
Where do you envision the company in the next two years?

The company's vision is to maintain & reach to the leadership position in all the chosen lines of business through Best of solutions and services. We intend to double our revenues in the next four years' time. ■

Power Scenario in Delhi

The combination of generating stations, transmission network, and distribution along with load is known as power system. As the electricity demand grows there is need of proper planning to cater the need of customers. Due different types of loads, reliability and protection are important aspects of power system. Moreover, deregulation is required to enhance the system capability. This article shows the power scenario in Delhi under deregulated environment.

- Dheeraj Joshi, Sidhant Chabra, Vijaya Sharma



Delhi Vidyut Board (DVB) had been divided into six successor companies on July 2002. These are as follows:

- Delhi Power Supply Company Limited (DPCL)- Holding Company
- Delhi Transco Limited (DTL) TRANSCO
- Indraprastha Power Generation Company Limited (IPGCL) GENCO
- BSES Rajdhani Power Limited (BRPL) - DISCOM
- BSES Yamuna Power Limited (BYPL) DISCOM and
- North Delhi Power Limited (NDPL) - DISCOM.

Further, government handed over the management of the business of electricity distribution to three private companies BRPL, BYPL and NDPL with 51% equity of the private sector. Out of these companies, the last three are joint ventures between the Delhi Government and the private sector which handle the power distribution sector in Delhi. BRPL is responsible for distribution of power in Central, South and West Delhi. BYPL handles power distribution in East Delhi (Trans-Yamuna). NDPL distributes power in North and North-West Delhi. The remaining two companies, DTL and IPGCL, are wholly owned by the Delhi Government.

Power Generation in Delhi

Delhi Government Owned Indraprastha Power Generation Company Limited Details has four power plants. Details of them are as follows.

The Central Sector Power Generation Plant is owned by NTPC at Badarpur.

a 'State Transmission Utility of the National Capital of Delhi', whereas IPGCL is responsible for power generation. DTL, has been responsibly playing its role in establishing, upgrading, operating and maintaining the EHV (Extra High Voltage) network. DTL has also been assigned the responsibility

spread all over the city. Information of Transmission Network of DTL is given in Table 2.

Table 3 and Table 4 shows the list of 400kV and 220kV existing and in progress substations.

Power Distribution in Delhi

Mainly, the power distribution in

Station	Indraprastha Power Station	Rajghat Power Station	Gas Turbine Power Station	Pragati Power Station	NTPC Badarpur
Generation Sector	State	State	State	State	Central
Station Capacity	247.5 MW	135 MW	282 MW	330 MW (Total 994.5 MW)	720 MW (Derated 705 MW)
Units Size	3x62.5 MW 60 MW	2x67.5 MW	6x30 MW (GT) 3x34 MW (WHRU)	2x104 MW (GT) 1x122 MW (WHRU)	3X95 MW 2X210 MW
Year of Commissioning	1967-71	1989-90	1986 & 1996	2002 -03	Unit I- 95 MW - July 1973 Unit II- 95 MW August 1974 Unit III- 95 MW March 1975 Unit IV - 210 MW December 1978 Unit V - 210 MW - December 1981
Coal Fields/Gas	NCL, BINA	NCL, BINA	GAIL HBJ Pipeline	GAIL HBJ Pipeline	Jharia Coal Fields
Water Sources	River Yamuna	River Yamuna	River Yamuna	Treated water from Sen Nursing Home and Delhi Gate Sewage Treatment Plants	Agra Canal
Beneficiary Areas	VIP- South & Central Delhi	Central & North Delhi	NDMC-VVIP, DMRC	NDMC, South Delhi	Delhi

Table 1: Power generation in Delhi

It is seen from Table 1 that the station capacity by state generation sector is MW while central owned plant generate 720 MW.

Transmission Network in Delhi

Delhi Transco Limited (DTL) is

of running the State Load Dispatch Centre which is an apex body to ensure integrated operations of power systems in Delhi. The existing network of DTL consists of a 400kV ring around the periphery of Delhi interlinked with the 220kV network

Delhi is handled by three companies BRPL, BYPL and NDPL. The area covered by each of this company can be seen from Fig. 1.

After the privatisation of Delhi's power sector and unbundling of the Delhi Vidyut Board in July 2002.

Parameters	400 kV Level	220 kV Level
No. of Substations	3	29
Transmission Capacity (in MVA)	3465	7970
Transmission Lines (length in Ckt. km.)	227	577.06 + 40.254 (under ground)

Table 2: Transmission Network in Delhi

400kV Existing Substations	400kV In Progress Substations
Bawana, Mundka, Bamnauli	East of Loni (Harsh Vihar)

Table 3: 400kV Substations

220kV Existing Substations	220kV In Prgress Substations
Narela, Rohini, Subzi Mandi, Ridge Valley	Electric Lane
Najafgarh, Sarita Vihar, Geeta Colony, DIAL	Peeragarhi
Mehrauli, Vasant Kunj, Pappankalan -I, Pragati	Wazirpur
IP Estate, Gazipur, Lodhi Road, Maharani Bagh	Rohini-II
Patparganj, South of Wazirabad, Kashmere Gate, AIIMS	
Okhla, Naraina, DSIDC Bawana	
Gopalpur, Pappankalan -II, Parkstreet	
Shalimar Bagh, Kanjhwala	

Table 4: 220kV Substations

the business of power distribution was transferred to BSES Yamuna Power Limited (BYPL) and BSES Rajdhani Power Limited (BRPL).

These two of the three successor entities distribute electricity to 32 lakh customers in two thirds of Delhi. The Company acquired assets, liabilities, proceedings and personnel of the Delhi Vidyut Board as per the terms and conditions contained in the Transfer Scheme.

BSES Yamuna Power Limited (BYPL)

BYPL distributes power to an area spread over 200 sq kms with a population density of 6750 per sq km. It's 13.5 lakh customers are spread over 14 districts across Central and East areas.

The power distribution of the following areas are served by the BSES Yamuna Power Ltd.

- Pahargani
- Patel Nagar
- Daryaganj
- Yamuna Vihar
- Karawal Naga
- Laxmi Nagar
- G T Road
- Nand Nagri
- Krishna Nagar
- Shankar Road
- Mayur Vihar
- Chandni Chowk
- Karkardooma.

BSES Rajdhani Power Limited (BRPL)

BRPL distributes power to an area spread over 750 sq. km with a population density of 2465 per sq km. It's over 18.5 lakh customers are spread in 19 districts across South and West areas. The areas that are catered to by the BRPL include-

- Vasant Kunj
- Nizamuddin
- Hauz Khas
- Alaknanda
- Saket Nehru Palace
- Janakpuri
- Khanpur
- Vikas Puri
- Dwarka
- Tagore Garden
- Palam
- Sarita Vihar
- Punjabi Bagh
- RK Puram
- Mundka
- Nangloi
- Najafgarh.

Table 5 herein shows the operational statistics that gives an overall view of the strength of BSES distribution network as of Dec 2012.

Tata Power Delhi Distribution Limited (NDPL)

Tata Power Delhi Distribution Limited (TPDDL) is a joint venture between Tata Power and the Government of NCT of Delhi with the majority stake being held by Tata Power (51%).

TPDDL distributes electricity in North & North West parts of Delhi and serves a populace of 6 million. With a registered consumer base of 1.35 million and a peak load of around 1573 MW, the company's operations span across an area of 510 sq kms.

The areas that are catered to by the NDPL include-

- Motinagar
- Model Town
- Shakti Nagar
- Civil Line
- Pitam Pura
- Keshav Puram

Sr. No.	ITEMS	2002-03			As on Dec'12		
		BRPL	BYPL	BSES	BRPL	BYPL	BSES
1	No. of Grids	63	40	103	74	50	124
2	No. of Power Transformers	146	98	244	204	137	341
3	EHV Capacity (MVA)	3036	1863	4899	4570	2884	7454
4	EHV Cable Length/Line Length Laid (Kms)	674	363	1037	1038.6	745	1834
5	No. of 66 & 33 kV Feeders	132	89	221	195	144	339
6	Shunt Capacitors (MVAr)	810	573	1383	1427	965	2392
7	No. of Distribution Transformer	4852	2657	7509	6958	3282	10240
8	Distribution Transformers Capacity (MVA)	2587	1704	4291	4176.3	2344	6520
9	No. of 11 kV Feeders	733	476	1209	1145	732	1877
10	11 KV Cables laid (Kms)	1595	1303	2898	2132.9	1770	3903
11	11 KV Lines laid (Kms)	1565.81	145	1710.81	1755.1	249.3	2004
12	Total No. of LT Feeders	15219	10193	25412	21740	13294	35034
13	LT Lines laid (Kms)	5382.33	4589	9971.33	10284.1	5589	15873

Table 5: Operational Statistics

Fig. 1: Power Distribution in Delhi

- Rohini
- Badli
- Mangolpuri
- Narela
- Bawana
- Shalimar Bagh.

Conclusion

Due to the growing demand of electricity, deregulated power system is must for reliability and safety point of view. This article specifically shows the power scenario of Delhi under deregulated environment. It is a big step by Government to have a joint venture with private companies such as Tata Power and in near future it may also be possible that in power generation private sector plays a key role. ■

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EP Shanghai attracts over 25,000 Trade Buyers Worldwide

Special Highlights of Fair: Smart Grid Zone

The 9th International Exhibition on Electric Power Equipment and Technology (EP Shanghai 2013) and 2013 International Exhibition on Electric Power Automation Equipment and Technology (EPA 2013) during Oct. 31-Nov. 1, drew its curtain in Shanghai, P. R. China. Jointly organized by China Electricity Council and Adsale Exhibition Services Ltd. EP Shanghai and EPA 2013 attracted over 25,000 visitors from all over the world, among which 7.6% were overseas visitors, and well attended by more than 800 exhibitors from 20 countries and regions.

World-class leading suppliers of the electric power industry showcased the latest technologies and equipment at EP Shanghai 2013. From advanced equipment and materials to state-of-the-art technologies, the trade fair created boundless business opportunities to not only power groups and power grid corporations, power plants, but also power construction companies, research and design institutes and industrial end-users, and provided an informative and interactive hub for professionals to share their expertise and the most updated market news.

Smart Grid and Electric Power Automation in the Spotlight

This year, EP Shanghai 2013 had an unprecedented show-scale breakthrough of over 35,000 square meters. World-renowned exhibitors included ABB, Schneider, General Cable, Siemens, Hyundai, Delixi, Chint, Hitachi, Huaming, KGE, S&C Electric, Emerson, Pentair, Rittal, AEG, Linbo, Minghan, Senyuan Electric, Multi-Contact, Ormazabal, WIKA, Comking, Baer Power, NARI, Pinggao Group, DECA, GEA, Zhuhai Copower, AKSON, Legrand, Rothenberger, Deba and etc, as well as the overseas pavilions from Germany and U.S.A. To cope with the increasing demand for smart grid equipment and accessories, EP Shanghai 2013 joined hands with the well-known suppliers to foster the theme zones on Smart Grid and Electric Power Automation. Exhibitors include NARI, Linbo, Huaming, Emerson, and etc, displayed a series of smart grid equipment and technology, grid safety and information system and applications.

EP Shanghai 2013 was highly recognized by exhibitors, over 80% of the exhibitors found their participation satisfactory and would like to join the next event again. Mr. Lu, Sales Manager of Qualitrol, commented that the exhibition had broadened his horizon through exchanging information with industry experts, and that he met potential business partners and made friends at the fair. Feng from Comking was very satisfied with the exhibition this year, and expressed that the overall services had been continuously improving to perfection. Inoforges indicated that the exhibition was very helpful to the company, and they had successfully achieved deals at the show. On top of these, the first-time world-class exhibitors General Cable and Delixi were also very much impressed by the exhibition and said that the results were commendable.

Tremendous Groups of Delegations Visit EP Shanghai

Being China's largest and Asia's leading electric power expo, EP Shanghai 2013 attracted over 20 professional buyer delegations. They were from power groups and power grid corporations, trade associations, engineering companies and design institutes from Shanghai, Jiangsu, Zhejiang, Beijing, Guangdong, Shanxi, Tianjin, as well as overseas trade visitors from Russia, India, South-east Asia and over 60 countries/

regions. On the other hand, the Organizer invited delegations from mining, metallurgical, petrochemical and railway industries, and they were well matched with the exhibitors who offered related electric power equipment and services catered for them. The fair served as the business platform for suppliers and buyers worldwide across different industries. Mai of Zhuhai New Energy & Smart Grid Industry Association deemed that the exhibition setting was well arranged, and the fair covered a rich scope of exhibits for the industry chain in addition to the traditional products. Zhao of State Grid Nantong Electric Power Supply Company affirmed that his visit at EP Shanghai was very fruitful. The information acquired gave him a better understanding of his interested products, and was very useful for his work as well. EP's loyal visitor Xu of East China Electric Power Design Institute commented that the exhibition was comprehensive and well organized, which successfully showcased the development of the electric power industry in both domestic and foreign markets. Ms. Jia of Haian Electric Power Supply Company said that their company organized delegation to visit EP China/ EP Shanghai every year, because the show was the industry trendsetter and they were inspired by the intelligence elements acquired from the exhibition. It was a good indicator to source the most advanced products.

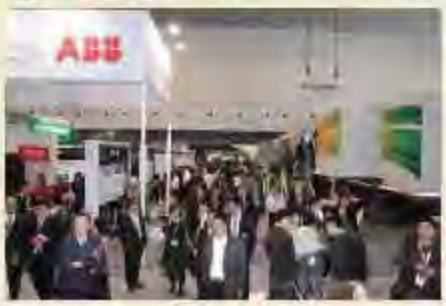
In addition, Yang of Guangdong Electric Power Material Corporation was impressed by the scale of EP Shanghai 2013, and complimented that the exhibition was influential to the industry. Lots of equipment for electric power system could be sourced at the fair, thus offering them great convenience. Shen of Puyuan Power mentioned that the insulating materials, switchgear and sets of equipment that his company needed could all be found at the fair, and intended to visit EP China in Beijing next year.

Concurrent Forums and Symposia Gathered the Top Industry Professionals

Over 10 forums and symposia were held concurrently with EP Shanghai 2013. Government representatives, industry leaders, trade professionals and company directors expressed their insightful views on the trend and future development of the industry, creating a comprehensive and interactive exchange platform for the industry specialists. Organized by China Electricity Council, "2013 Smart Grid Conference" covered topics on distributed energy, wind power development and set up, new technologies on substation automation, smart micro grids and energy storage. Presented by professionals from China Electric Power Research Institute, China Southern Power Grid, State Grid Zhejiang Electric Power Company and etc., this high-level conference was highly recognized and concluded in a full house with rounds of applauses.

"Smart Grid and Energy Conservation" be Sustained in EP China 2014

In response to China's rapid development of smart grids, new energy and energy conservation, the next edition EP China 2014 will continue its theme on "Smart Grid and Energy Conservation". The exhibition will be staged at China International Exhibition Center in Beijing, China during October 22-24, 2014. The Organizer will expand the exhibition scale to 8 halls, and draw in worldwide advanced technologies and equipment to the fair. With the goal of enhancing the effectiveness and reliability of smart grids in China, EP China will continue to serve as an effective business platform for the electric power industry around the globe. ■

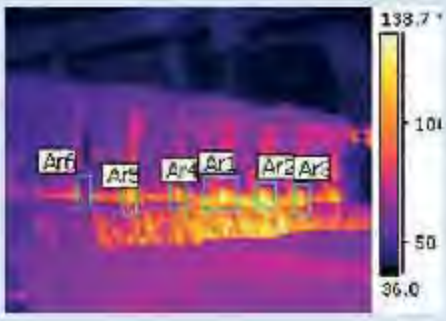


JNARDDC Institute helps Indian aluminum industry save energy and optimize production process with thermal cameras

Thermal imaging cameras are a very welcome technology in the aluminum production industry. In India, Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC) institute is using thermal imagers to help aluminum production companies across the country save energy and find faults in a very early stage. Aluminum is the second most abundant metallic element in the earth's crust after silicon and has been produced in commercial quantities since 1886. It is the world's second most used metal. Aluminums' many properties and qualities explain the magic surrounding this metal and the reason why its popularity continues to grow among new product designers who are constantly adding to its already wide range of applications.

Monitoring aluminum production

Aluminum production is an energy intensive process and saving energy at each step of the production process is the primary aim of process engineers and designers. Infrared thermography has played an important role in precictive maintenance of these processes in terms of time and money. The precictive maintenance by means of thermal imaging has also helped to perform timely interventions of fault detection and to schedule equipment maintenance. Monitoring a production process can of course be performed best when processes are running. And it is with this so-called 'online monitoring' that thermal imaging can really show its value. Slight temperature variations across a surface will indicate failing components, such as degrading electrical contacts. But thermography can also be used successfully to inspect furnace ducts, bus isolator jumpers, casings, heating chambers or tanks.



Early fault detection

Infrared thermography has proven to be an effective and beneficial tool to the industry, because it allows production managers to schedule their maintenance routines well before anything critical happens. This saves valuable time and significantly reduces the production downtime. Predictive maintenance schedules help the industry to arrange tools and spares for repair in time. Whether it is switch yard joints, current transformers, insulation of turbines, pumps, motors, hot patches in kiln, furnaces etc., all of the them can be surveyed with thermal cameras for early detections of faults. By means of thermal cameras and other heat measuring devices like heat flux meters, it is also possible to discover scaling, the unwanted deposits in pipelines, storage and processing units. With thermal cameras you can estimate the thickness of scales and take corrective action when needed.

Indian center of excellence

The Indian JNARDDC has been using thermal imaging cameras for years. The institute is located in Nagpur, India, was set up in 1989 and is fully functional since 1996. JNARDDC is an established center of excellence in the Indian aluminum industry. Next to the conduct of research, the center also offers a variety of R&D, testing and training services to the aluminum industry. In order to better support its aluminum production customers with high-quality services, JNARDDC decided to purchase FLIR thermal cameras in 2002. The institute was supported by FLIR's local distributor PCI Limited, situated in Mumbai, who recommended JNARDDC to use the FLIR P660 professional thermal imaging camera for predictive maintenance purposes.

Inspection frequency

In India, aluminum production companies usually carry out thermography inspections only when the need arises. Others will perform inspections on a yearly or half-yearly basis. The advent of thermal imaging in predictive maintenance programs has resulted in willingness to perform these maintenance routines more frequently, because inspection with thermal cameras no longer requires shutting down production.

The FLIR P660 thermal camera is now frequently used by the team of Anupam Agnihotri, Head and Scientist at JNARDDC, and consisting of S K Thokal (Electrical Engineer) and N Warhadpande (Electronics Engineer).. Although the institute is enthusiastic about the use of FLIR's technology, customers were a little hesitant at first. "The operations people were little hesitant at the initial period of inspection, because they conceived infrared to be some kind of X-ray, which would allow them to see inside the equipment," comments Agnihotri.

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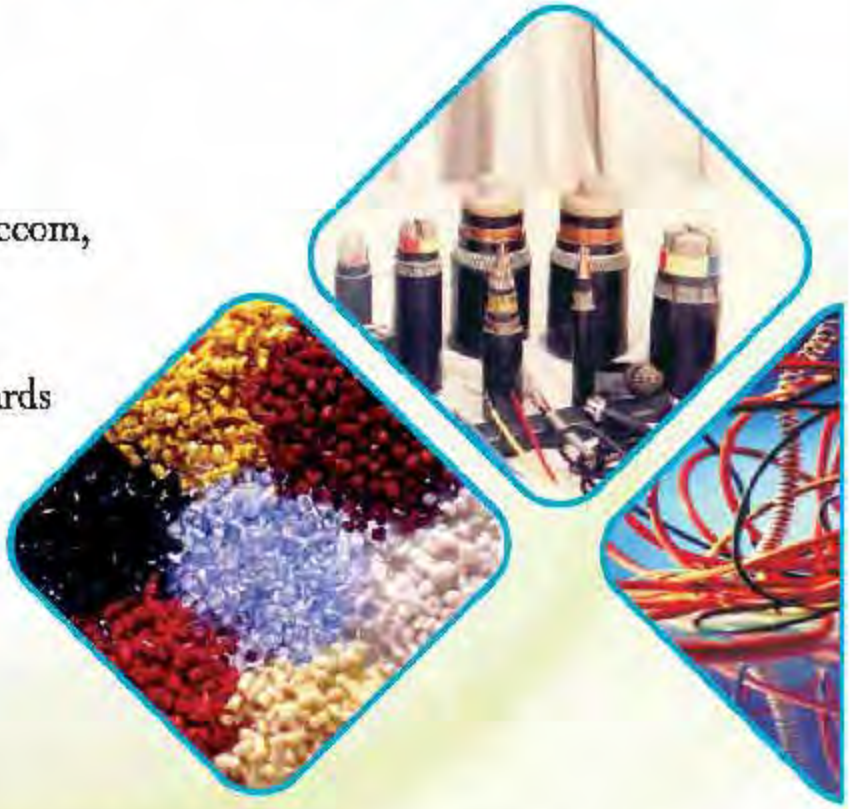

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"Others thought of infrared as being emitted by the camera and thought that it might harm their equipment" Concept ons like these are indicative and typical for the low awareness of thermal imaging technology. Fortunately, it was an easy task for FLIR Systems and its Indian distributor PCI Limited to explain the many benefits and background of thermal imaging. After a short training program, JNARDDC customers were convinced and understood the importance of online condition monitoring with thermal imaging. "Now operations managers demand to cover the problematic area more frequently than other areas," comments Agnihotri. "JNARDDC is now assisting with the design of predictive programs for a breakdown-free plant environment with the help of plant people and their management".

High-performance P660 camera

The FLIR P660 camera is the highest performing infrared inspection system available. With its state of the art technology, including 640x480 detector resolution and unique ergonomic design, it is the natural choice for professionals that want the most efficient instrument producing professional results. The FLIR P660 is an affordable, easy-to- operate and high-performance infrared camera that delivers accurate temperature measurements at productive and safe distances. This makes the P660 camera an ideal solution for cost-effective and efficient predictive maintenance programs. The P660

includes an integrated 3.2 megapixel camera to aid in reporting. Infrared and visual images taken with the P660 can be stored in standard JPEG formats. The P660 visual camera includes matching Field Of View lenses, so IR and visual images are shown at similar long distances using the same Field Of View. ■

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A Novel Open Circuit Fault Detector
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In India, the detection of open circuit faults of distribution lines is done manually and only after people realize that something is wrong. The device- Open Circuit Fault Detector can detect open circuit faults in distributors fed at one end instantaneously and reports it to the concerned sub-station and to the people nearby by glowing a bulb or by raising an alarm, or both (according to the requirement). Circuit of the device has been developed and simulated on Matlab.

- Nimish Rastogi

India being a developing country faces power shortage as one of the major problems, consequently leading to power cuts. As a result, the load which could have been distributed over a period of time gets concentrated as people are left with no other option than to finish off their work in the time when power is available. Un-sanctioned load, which officially is unaccounted is also contributed from nearly each household in India. These factors sum up to result in open circuit faults in distribution lines which occur quite frequently. The problem doesn't come to an end here. The timely detection of such faults is also necessary. These days, most people have inverters at their homes and hence it becomes difficult to realize merely by looking around that whether it is an open circuit fault or a power cut, since in the event of such a fault the power supply in the houses would be resumed by the inverters. The problem of fault detection becomes even more grim during the day time as the lights in the houses as well as the street lamps are switched off and thus making it nearly impossible to realize whether the nearby houses are getting the power supply or not, unless one goes to someone's house to inquire it, which doesn't usually happen. More often than not, people come to know about the fault when their inverter batteries get exhausted and they start calling to their respective power sub-stations, so as to know when would the power supply be restored, only to find that there hasn't been a power cut.

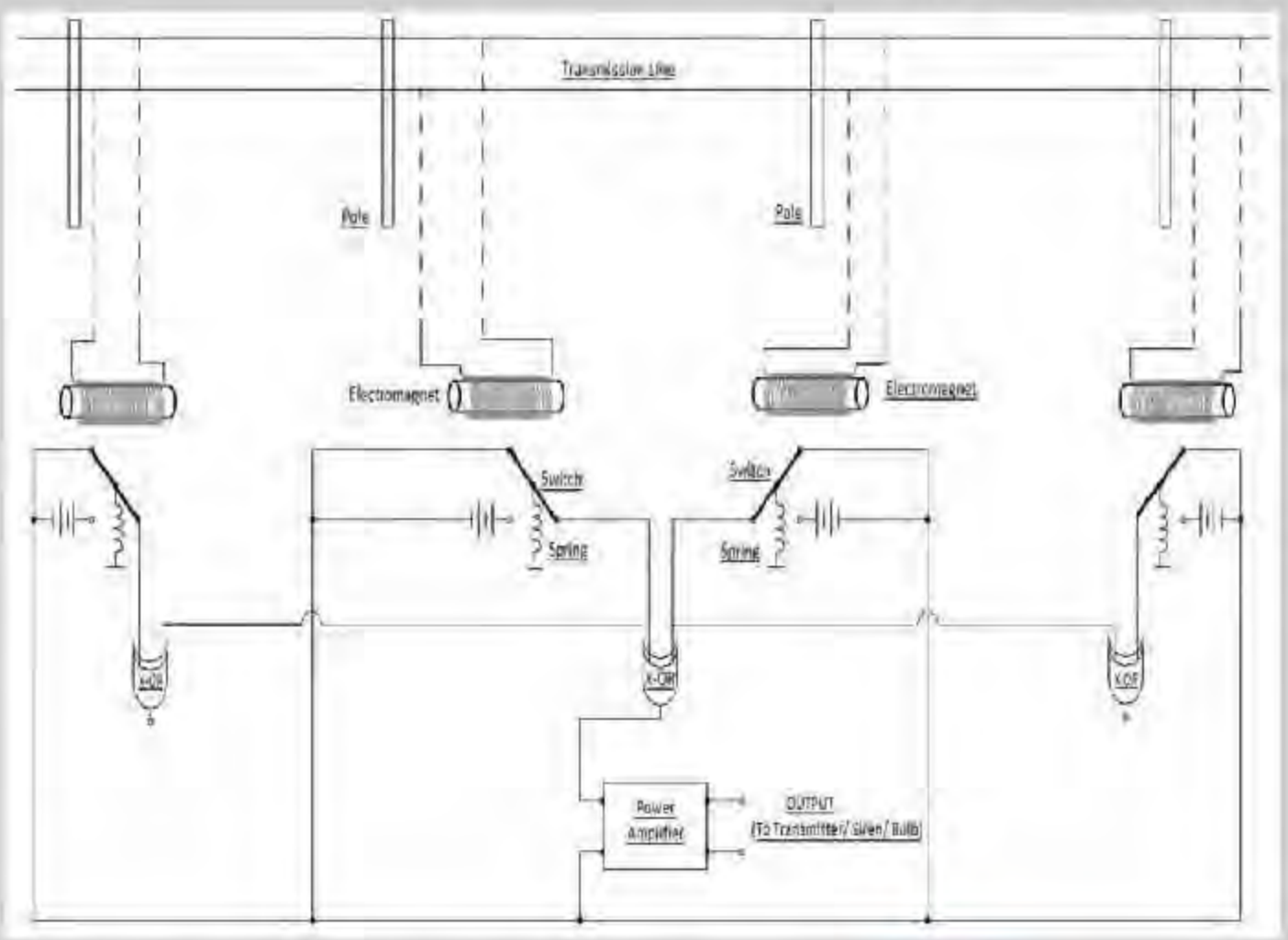
Modelling of the device

One solenoid is connected near each pole, on the distribution line. Switches made of magnetic material are connected near each solenoid. When the solenoid is in a magnetized state, i.e., the line is working, the switches would be pulled up by the solenoid and the switches would come in contact with the negative terminal of the battery. When the solenoid would be demagnetised, springs connected to the switches would pull them down and now the contact with positive terminal of the battery would be closed. The other end of the switch is connected as an input to a XOR gate. Hence one gate would be used between two poles. It gives an output of logic 1 when one of its inputs is 1 while the other is 0 whereas it is 0 when both the inputs are either 1 or 0. The output from the XOR gate is weak signal, incapable of running the required devices such as an alarm or a bulb and hence a power amplifier is used to amplify the output signal.

Working Principle

Three cases arise:

- When the supply is off: In this case all the solenoids will be demagnetised, and as a result all the switches will be closing the contacts with positive terminal of the batteries and hence both inputs to each XOR gate will be 1. And thus the output will be 0.
- When supply is on with no open circuit fault: Here, all the solenoids would be magnetised attracting corresponding switches and as a result switches will close contacts with



negative terminals of the batteries. Hence both the inputs to the each XOR gate would be **0** and hence the output will be 0.

- When the supply is on with an open circuit fault: In this situation, the fault detector comes into picture. Now consider an open circuit fault occurs between pole A and pole B. All solenoids connected from the supply line before the point of open circuit will be in magnetised state. And those connected after the point of open circuit will become de-magnetised. Now solenoid S1 is magnetised while S2 is demagnetised and hence the corresponding XOR gate will receive 0 and 1 as input respectively Hence, in this case it will give an output 1 which will be fed into a power amplifier. The amplified signal is powerful enough to drive an alarm or a bulb, and hence giving an alert for the fault. This signal is also fed to a transmitter (one for each X-OR gate and power amplifier configuration) whose corresponding receiver giving supply to that transmission line. Each of these transmitter is set to send a unique signal thus making it clear that from which transmitter the signal has been received, subsequently making it clear to the receiver at sub-station that where the fault has occurred. The other XOR gates will give 0 as an output as described in a) and b) above.

Conclusion

The above described device can hence be effectively used for open circuit fault detection where manual detection of the fault becomes too cumbersome. The circuit is quite simple and is made using easily available devices such as a solenoid, XOR gate, power amplifier etc. ■

Nimish Rastogi, B Tech Electrical Engineering, 4th Semester, Jamia Millia Islamia Maulana Mohammad Ali Jauhar Marg, New Delhi

Influence of Cross Linking on ageing of cables

Cables for industrial applications where the equipment is expected to provide service under harsh conditions in excess of 20 years are usually cross-linked. Such applications are rolling stock (trains, trams, locomotives and high speed trains), power generation (solar, nuclear and traditional gas or coal) and power transmission medium voltage and high voltage. Particularly severe for cables are the combined effects of a warm environment, and the unpredictable high additional loads expected in these applications.

Cross-linking confers mechanical stability, and ensures that in the case of short circuits or fire, the insulation maintains integrity for a period of time. In the market there are cables with different cross-linking systems available. These are electron beam, a physical cross-linking system, and two chemical cross-linking systems, peroxide based, or silane based. Each system has its strengths and weaknesses, but under identically harsh conditions, the higher thermal stability of the e-Beam cross-linked cables (typically offered with 120°C to 125°C temperature ratings) usually results in longer useful service life. Typically chemically cross-linked cables are offered for use at 90°C utilising insulation with 100°C-110°C ratings. Using lower temperature rating cables results in having to use larger cross-section cables for the same application, increasing both initial cost and the cost of running.

Particularly in countries with warmer climates than Europe, such as India or the Middle East, where the ambient temperature is 10-15°C higher, 120°C rated e-Beam cross-linked cables provide an important additional safety margin together with a significant reduction of the Total Cost of Ownership. The use of the Arrhenius rule to predict lifetime, allowing extrapolation of short term ageing data to generate long term life time predictions. Originally based on studies of the ageing kinetics of polyethylene, the principal is today applied to many other families of polymers with the concepts and limits being described in IEC 60216ii. This allows the definition of a thermal index or rating, which may be applied to specifying components in industrial equipment, such as cable, to allow the required lifetime to be designed in at the expected working temperature. The lifetime of materials to which the Arrhenius rule applies is halved by each 10 degrees higher service temperature or doubled by each 10 degrees lower service temperature. Small differences in real temperature ratings can therefore have a large effect on actual service life. However it is generally true to say, that a cable with a rating of 120°C/20000h will survive twice as long as an equivalent cable with a rating of 110°C/20000h in the same application. In this publication, we will give indications as to how cables with higher temperature ratings can actually be a more sound investment, both commercially and environmentally.

Temperature Ratings / Continuous use Temperature: These two terms are often confused

The Temperature Rating or Index is determined according to the method described in IEC 60216, in which samples are aged at several temperatures usually significantly higher than the intended temperature of use, which according to Arrhenius accelerates the ageing process, resulting in failure in a shorter period of time. Plotting these times to failure using the method described, allows the extrapolation of the point of failure

to different (lower) temperatures enabling a prediction of the lifetime under service conditions. Temperature Index should always be stated with a time i.e. 120°C/20000h and should include the end point which was used in determining the Index. Usually for the Solar industry or rolling stock the end point is stated at 20,000h with 50% remaining extension at break.

The Continuous Use Temperature is the temperature at which the cable can be used safely during continuous operation. There is no statement of how long the cable can be used for at this temperature, or how long it will survive. It is often therefore assumed by non-specialists, that the cables can be run permanently over the lifetime they require at this temperature. This is a very dangerous assumption. For example, many cables rated 90°C are made with materials with 100-110°C temperature Index, i.e. they would reach the end point stated after 20,000h at 100-110°C.

What does this imply in real applications!

Assuming the cable is used at 90°C continuously, how long will it last?

The 120°C rated cable would give 18.4 years of continuous use, which may be sufficient to achieve a service life 25 years of for rolling stock with intermittent use. For applications such as Solar, rolling stock, where 25-30 years is the target life a design temperature of 85°C with a 120°C rated cable would give 210,000h or approx. 28 years continuous service. This allows an appropriate safety margin, to allow for sub optimum installation and service conditions. ■

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P2Power Solutions, an ISO 9001:2008 company, established to 'Power You' Power' through innovative engineering solutions and with a specific focus on Energy efficiency and Power quality enhancement, s promoted by a group of IIT alumni and offers a wide range of nnovative CE certified products in the field of advanced power electronics.

Power Quality

IEEE defines Power Quality as, "The concept of powering & grounding sensitive electronic equipment in a manner suitable for the equipment"; Power Quality can also be defined as, "the impact of electricity on our electrical equipment". The concept of Power Quality involves many other things. Equipment may get damaged, fail pre-maturely, deteriorate, function mproperly etc. when supplied with power of poor qua ity. Power Quality ssues, since Electricity's inception, nave been a major source of concern and in the last decade they have become more prevalent. Substantial ncrease in the use of converter circuits, var able frequency drives, sem -conductor devices such as PLCs, nformation technology equipment, and non-l near devices have made 'Power Quality' a major concern for ndustries, commercial sectors etc. Astronomica use of non-linear loads n the industrialized sectors has resulted in Power Qua ity's downfall. Continu ty of service, ority of sinusoidal nature of e ectrical quantities, and maxim um optimization of electrical equipment are the parameters which can completely rate quality of electrical power. Any variation in the electrical quantities from their prescr bed values results in unwarted situat ons for the system. These variat ons result in inevitable problems such as voltage sag/swell, changes in frequency, harmonics causing waveform distortions, transients in current values etc, lasting for short as well as long durations. The causes and impacts of the changes in Power Quality depend upon the type of industry they occur i.e. type of loads in the industry, and their sensitivity towards these changes. In addition to the continuously increasing demand for reactive power, harmonics have left the ndustries in a state of worry. The most prevalent PQ problems, a ising mainly due to reactive requirement of load and harmonic distortions, are:

- Nuisance tripping of electrical switchgears
- Flickering screens and lights
- Overheating of transformers at moderate load
- Heating up of induction motors
- Over-heating of conductors/ cables due to skin effect
- Data network congestion
- Failure of Power Factor correction equ pments
- Overloaded neutrals
- Utility claims resulting from harmonics affecting supply
- Electromagnetic Interference due to Harmonics.

Harmonic distortions may come from the utility, but they are usually generated from within the facil ty. They not only cause impurity in supply, but also reduce overall eff ciency of the electrical infrastructure. Along with causing a decline in the functioning of the electrical system of the utilities, harmonic distortions lead to lowe production levels, high maintenance costs, monetary osses, etc, ultimately reflecting in the profit margins. Poor Power Quality is an environmental concern as well. Low power factor and ha monic disto tions result in under-utilization of power from the utility. Hence, to meet consumer's demand additional coal/diese are to be burnt, which adds up to the existing env ronmental pollution. The excess power drawn from the utility, as a result of high reactive requirement of the load and harmon c d stortions, eliminates the scope of maximum utilization of generated electrical power.

P2Power Active Filter: A universal solution to all Power Quality issues

In many industries, such as IT, crane, welding, etc, the system demands a solution, which is more versatile and adjustable to wo st situations. P2 Power Active filte helps comprehensively to tackle Power Quality issues involving Harmonics, reactive currents, load balancing and neutral compensation. The increased population of electronic equipments/ loads causing ha monic pollution is an inevitable concern. The need of the hour is to find an appropriate solution to the harmonic problems, contributing majorly to the issues related to Power Quality, which, obviously, is 'P2Power Active Filter'. Active filter, an innovative engineering technology, is electronically driven equipment which generates current of a specific wave-shape. The term 'Active' is derived from the fact, that they utilize active components such as

Active Filters Advantages

Sr	Feature	APFC	RTPFC	Active Filter
1	Purpose	Reactive compensation / Harmonic filtration	Reactive compensation / Harmonic filtration	Harmonic mitigation / reactive compensation / load balancing / neutral compensation
2	Response time	>50 ms	20-40 ms (1-2 cycles)	<200 µsec
3	Effectiveness	Preferably, for constant loads	Effective with kinds of loads	Effective with kinds of load
4	Current Injection	Stepped compensation	Stepped KVAR compensation	Step-less current compensation
5	PF Compensation	Only Lagging	Only Lagging	Both Leading & Lagging
6	DG Compatibility	"Not compatible with DG" (Reduce DG Efficiency, Incur DG Hunting etc.)	"Not compatible with DG" (Reduce DG Efficiency, Incur DG Hunting etc.)	"Compatible with DG" (Maintain PF, Mitigate Harmonics, Increase DG Efficiency etc.)
7	Size & weight	Large Footprint	Large Footprint	Small Footprint
8	Maintenance	Recurring cost of capacitors / contactors	Recurring cost of capacitors / contactors	Virtually maintenance free

GBTs, diodes, etc for the generation of current of desired wave-shape. DSP, the controlling component of the Active Filter, analyze the current from the source continuously and feed the current, other than the fundamental current, at the load terminals accordingly. Widespread availability of DSPs, power switches such as IGBT, MOSFET, BJT, etc, have made Active Filter a practical solution. The major features of P2Power Active Filter are: Power Factor correction, Harmonic Filtering, Load Balancing and Neutral Protection. Table shows comparative analysis between different solutions implemented to rectify harmonic distortion/reactive compensation issues. Installation of Active Filter increase overall system reliability and efficiency; also, problems related to frequent tripping, single point of failure, equipment deterioration, etc are significantly reduced. P2 Power Active Filters are customer-oriented solutions, advantageous technologically as well as monetarily. High filtering efficiency and individual harmonic selection capability makes Active Filter a solution to all Power Quality problems. Although, the investment done for Active filter is higher, but ROI is quick & its high reliability makes it profitable. P2 Power Active Filters are completely programmable as per user requirements and are virtually maintenance free. Active Filter achieve savings in electricity bills. Harmonic mitigation reduces stress on equipments increasing life expectancy and reducing their maintenance cost. Active filter is simply applied solution to complex problems. The advantages of Active filter lies in the fact that it can be utilized for more than a particular purpose at any instant. Adding an Active Filter into the system reduces the total harmonic distortion levels approximately less than 10% which adhere to IEEE 509 Standards. ■

For further details contact:
contact@p2power.com

Woodward India Pvt. Ltd.

Woodward's provide systems and components that increase reliability and performance of engine, turbine, and switchgear equipment throughout the power, transportation, and process markets. Major power equipment OEMs worldwide rely on Woodward control Systems to keep their equipment operating dependably and efficiently. Woodward has track record in providing reliable power generation and distribution controls for applications such as standby power in data centres, hospitals, airports and other locations that have critical need for reliable power. Woodward controls detect the loss of the primary utility source, start the gensets, provide automatic synchronisation, and share loads in standby power generations systems. These controls communicate over a separate peer-to-peer CAN network for synchronisation and isochronous load sharing. For synchronisaton and load sharing issues, Woodward has a solution. Its HighPROTEC protection relays have flexibility to meet up coming new requirements and help keep generator online when under-voltage faults occur. MCDGV4 generator differential protection relay, part of HighPROTEC family, is highly adaptable to these renewebles interconnections requirements. ■

For further details contact:
www.woodward.com

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The future of circuit breaker testing

The new **CIBANO 500** is the first 3-in-1 test system worldwide to combine a micro-ohmmeter, a timing analyzer, and a circuit breaker supply in one device. This helps users to carry out all kinds of tests on all types of circuit breakers, quickly and with little wiring. Even better, it weighs only 20 kg / 44 lbs.

The unique wiring concept makes circuit breaker testing safer and easier. All tests can be carried out with both sides of the circuit breaker grounded and you don't need to rewire between the single tests. And now that measured data can be transmitted digitally, interference is history. The Primary Test Manager® (PTM) software gives you one overall report of all results.

Circuit breaker testing has never been so easy. Check it out for yourself!

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Precision Automation & Robotics India Ltd.

Precision Automation & Robotics India Ltd, is a global automation solution provider of robotic products and technologies. With over 850 employees and 6 facilities worldwide, PARI provides a complete range of automation solutions including conceptualizing, designing, manufacturing, implementing and supporting of advanced factory automation systems. The company began its operations in 1990, and has since grown at an amazing rate of 50% each year. Serving global customers in 4 continents, and with operations and markets in over 12 countries, PARI serves various market segments including Automotive, Industrials, Transportation, Infrastructure, Farm Equipment, Energy, Food & Beverage, Pharmaceuticals and Life Sciences. PARI operates in three business verticals - Automated Manufacturing & Robotic Solutions, Automated Car Parking & Automated Logistics, serving these sectors. The company operates through deploying well-engineered automation solutions through mass customized technologies and system to achieve the global needs of its customers. PARI's success lies in the fact that the company strives to provide excellence in every step of the process from sales to commissioning and ensuring that this excellence is reflected in its products, people and solutions. With a wide range of innovative solutions and focus on complete customer satisfaction combined with a fast growing global presence, PARI aims to be among the top 10 global automation companies.

PARI switched to EPLAN in 2004 and since then has never looked back. With a large market base in India, Europe and the US, PARI felt the need for an error-free design system to help cater to the high standards of quality expected. However, the software that was being used by PARI required that the work be done manually, which held a potential risk for errors at every step. "EPLAN is a well-designed user friendly software. It has reduced the engineering time by at least 40%.

Transition brings desired results

PARI experienced a smooth transition from the existing software to the use of the present solution. Before the launch of EPLAN, all engineers at PARI were trained to work on EPLAN through a series of training workshops that were conducted.

Execution of a typical project at PARI

PARI uses EPLAN in its design phase. In a typical project, PARI designs schematics in-house for the panels along with the field wiring. The production team at PARI use terminal/wire/cable reports and the wiring schematics during the production phase of the project, to wire up the panels/ boxes and the field wiring. After the design phase, the clients of PARI continue to use EPLAN schematics for maintenance purposes.

Impact on PARI's engineering productivity

Although PARI's primary reason to change its design software was to generate impressive and error free drawings of international level, EPLAN has in turn provided a positive impact on PARI's overall engineering productivity.

PARI succeeds in eliminating errors

The successful launch of the engineering solution has encouraged best practices in PARI in four different areas, namely through the provision of standardization of recurrent content, through faster and more reliable generation of documentation, through the reduction or elimination of errors and easier error-checking and through faster integration of data corrections and customer-specified changes.

PARI is extremely satisfied with EPLAN

PARI's extreme satisfaction has resulted in them rating the service and support at a high 4, on a scale of 1 to 5. This stems from the fact that the product has not only made it possible to increase production even further, but has also provided a full range of services to fall back upon. For example, thanks to Unicode, the integration of their international locations was made easy for PARI. Extremely satisfied with the current engineering solutions, PARI also recently purchased EPLAN Fluid to aid in other areas of design and production. Overall, PARI found EPLAN as a reliable tool, especially since it contributed towards significant improvements in areas such as project documentation, error reduction, content standardization and document generation. ■

For further details contact:
info@eplan.de

Prime Electric Limited: Passion for Technology and Excellence

As a leading EHV power transformer manufacturer, Prime Electric Limited (PEL) continues to exhibit stellar commitment to setting new standards of excellence, be it in terms of technology for manufacturing or be it in terms of commitment to customer satisfaction. Striving for excellence is not new for PEL which is part of Prime Group, a highly diversified group of companies operating, for nearly three decades, on an international plane and providing innovative technology solutions in five business verticals, namely Power & Energy, Aerospace & Defence, Engineering Products, Manufacturing & Services, Infrastructure, and Information Technology. The Group was founded by its Chairman and Managing Director Surinder Mehta. Prime Electric Limited surges ahead under Managing Director Rohan Mehta.

Power Transformers Par Excellence

PEL's ultra modern and fully integrated state-of-the-art manufacturing facility is located in the SEZ (Special Economic Zone) at Naidupeta in the district of Nellore in Andhra Pradesh. Sprawling over 100 acres, the facility is equipped to manufacture of extra high voltage power transformers. PEL plans to further expand this capacity to become India's largest power transformer manufacturer at a single location. The plant is located in close proximity to three major sea ports Krishnapatnam, Ennore and Chennai; and has an excellent connectivity by road as well.

Infrastructure that compares to the Best in the World

PEL offers a comprehensive array of some of the most globally advanced facilities in- house that compare with some of the best in the world. The facility has state-of-the-art equipment.

In-House Facility for Advanced Testing

Being part of Prime Group, PEL has knowledge of the importance of performance and nature of exacting requirements imposed on EHV power transformers under various applications. PEL adopts the finest available testing technologies from across the globe. The Testing Bay/ Section at the PEL manufacturing plant is completely supplied and commissioned by High Volt of Germany who are globally renowned as pioneers and undisputed leaders in the field of testing.

Technological Collaboration in R&D

Furthermore technology and training accorded by the world renowned 'VIT', which is part of Electrozavod, one of the largest power transformer manufactuers in the world. An array of software programs are employed to arrive at the optimum design and calculate the expected behavior of the transformer at test and in service from all aspects. The advanced 3-D CAD engineering system allows the engineers to review the complete internal and external design of a transformer even before assembly so as to eliminate possible errors and defects during production.

A Wide Product Range

The wide range of power transformers up 1000 MVA /765 101 offered by Prime Electric Limited includes: Generator Transformers; Auto-transformers; System Transformers; Power plant auxiliary and standby transformers; Transformers for distribution networks; Transformers for industrial enterprises. The range also includes Special Transformers such as: Transformers for metallurgical companies; Transformers for railways substations; Furnace transformers; Testing transformers; and more.

Excellent after Sales Service

PEL provides the full range of services during warranty and after the warranty period such as commissioning, maintenance, diagnostics and modernization.

Quality Consciousness

The ubiquitous ethos of quality at PEL is evident and on ample display in all spheres of the company's activity. The stringent management system ensures a consistent high level of product quality manifesting itself in higher customer satisfaction reinforcing PEL's reputation as a reliable and committed transformer manufacturer. The process of implementing the quality management system corresponding to international ISO 9001 standards has already started.

Projects Division

A Prime Electric, in addition to meeting its direct sales commitments, has a dedicated Projects Division. It is a front runner in the execution of extra high voltage transmission lines, sub-station erection and rural electrification on turnkey basis.

As an EPC contractor, PEL's scope of work includes design, testing, fabrication, support, erection and commissioning for various applications including substations up to 400 101 and EPC for transmission line towers up to 800KV. ■

For further details contact:
sales@primeelectricltd.com

A DESIGN MARVEL: Emko Elektronik provides cost-effective power monitoring & control for Gen-sets

Trans-AMF Automatic Genset Controller with Transfer Switching controllers constantly monitors the state of the mains supply. If the mains supply is interrupted, the voltage of the mains supply drops under a pre-determined level or surges above pre-determined parameters. The electronic control unit will immediately disconnect the mains supply and start the generator set. Once the generator is operating and producing a stable supply, it will transfer the load to the generator supply by energizing the motorized transfer switch. When the mains supply returns to a healthy state, it will carry out the reverse operation. The electronic control unit will then shutdown the generator set and resume its monitoring function, ready for the next event. This entire procedure is carried out automatically, with out the need for operator to interfere. TRANS-AMF offers "the best cost controller "for standard on-site gensets; besices easily putting together the modules to realize project basis business through the sales channels and agents and partners of genset producers. This module system shall offer an opportunity for more flexibility to realize specific projects. Check also TRANS-Mini series will create added value in the highly competitive market with its genuine design, small size and economical prices.

TRANS-AMF Technical Details:

Can Bus: J1939 ECU Communication; event logs: Last 50 events with measured values; inputs: 6x configurable digital, 4x Analogue senders, 1x cabinet temperature, magnetic pickup, charge alternator D+(W.) inputs; outputs: configurable 2x relays, 4x transistors, MBR and GBR outputs; current measurement: 3 phases CT inputs for load current, 1x CT input for earth current; voltage measurement: 3 phases for mains, 3 phases for alternator; power factor measurement: for 3 phases. ■

For further details contact:
www.emkoelektronik.co.in

Parker Hannifin offers New AC10 series of VFD to machine builders

Parker Hannifin India launched their new series of AC variable frequency drive, the AC10Micro Drive. AC10 is a simple, reliable and extremely versatile drive providing economical solution to every-day motor control applications requiring speed or torque control and are available in the power range of 0.2 kW to 15 kW. Offering extremely compact dimensions and features normally only associated with higher specification drives, AC10 provides an optimised solution for OEM machine builders and process industry users, seeking a simple cost-effective drive without any compromise in performance. The many functional benefits such as auto-tuning sensor less vector mode, built-in PLC functionality, multiple V/f etc are available as standard which makes the device beyond simple V/f motor control. Some of the features are that the product is built- in PID controller and also is built in brake chopper; it has advanced fault diagnostics along with automatic voltage regulation; it is available in compact size. Some of the benefits are that it is quick and easy set - up for process; no extra cost, panel space is saved; it has better and precise dynamic torque control; it is also easy to set-up for most applications; safe to work in very harsh environment. The new AC10 Drive will be available from the state of the art Parker India modern manufacturing facility at mahindra world city near chennai and will also be available through nationwide network of sales offices, ATCs (system integrators) and Parker Stores.

Applications

The typical applications for AC10 include conveyors, centrifuges, fans, mixers, packaging machines and textile machines etc. ■

For further details contact:
sales.augindia@parker.com

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Venture's LeafNut System

Venture's LeafNut™ system is an advanced intelligent wireless control system for area or street lighting. The LeafNut "nodes" are housed in each light fixture and communicate via radio, satellite and cellular systems to deliver control and status messages to your secure web page accessed from any computer on the web. One can control, adjust, monitor and receive maintenance messages from each light fixture. With their upgrade kit of energy efficient pulse start ballasts and Uniform® lamps plus the power of the LeafNut system, you can drastically reduce energy consumption expenses while improving with bright, white site lighting.

Benefits

Venture's LeafNut system with Venture's EISA compliant ballasts offers many benefits. These benefits are apparent from the first day the system is in place and continue to enhance your lighting over time. Benefits include: energy savings through dimming ; web based control; 24/7 Control and Programming; no software; no WiFi needed ; energy reporting per fixture; unlimited number of nodes; secure web site access control; no dedicated computer to maintain; 24/7 real-time monitoring; lamp/Ballast condition reporting • Lamp aging report by fixture; control lights as individuals, groups or by sites; no panels to install. ■

For further details contact:
marketing@vlindia.com

Automatic Voltage Controller by Jindal

Automatic Voltage Controller is an industrial robot which continuously monitors the voltage variation around the clock and stabilizes the output Voltage in few seconds irrespective of the voltage fluctuations on the Input side. The basic purpose of AVC is to maintain the desired voltage and to reduce the breakdown of electrical equipments due to low/high voltage. Power saving, reduction in MDI and improvement of Power factor are the added advantages at high voltage. The capital & interest cost of AVC is just 1.5% per month and with this cost one can have saving 4-8 times of capital & interest cost per month of AVC due to reduction in breakdown of electrical equipment and energy saving. Voltage variation is a common phenomenon. The input voltage is generally low during daytime and high during the night hours. Apart from above few months in a year /few days in a month /few hours in a day the voltage is either very low or very high due to the following reasons: Holidays; peak hours; rainy days; agriculture load; weather conditions etc. In India all electrical equipments are designed for 230 / 400 Volts single / three phase and operate with optimum efficiency at its rated voltage. Therefore for smooth functioning of electrical equipments and to reduce failure rate of electrical equipments one should install Automatic Voltage Controller (AVC) with ± 15% input voltage variation range i.e. 340-460V/400Volts and output voltage 400V model. Intall Data Logger to analyze voltage variation. If there is higher breakdown of electrical equipments, this could be due to high voltage. ■

For further details contact:
jemc@jindalelectric.com

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The measurement of electric power and energy at high voltages and currents at low power factors is becoming increasingly important economically as a way to reduce costs in an ever-growing industrial economy. Today the transformer purchaser subjects the transformer manufacturer to an economic penalty for losses that occur in load and no-load conditions. To keep these penalties as low as possible, it is important that the manufacturer accurately measure these losses.

Our Product Range:

Calibration Test Benches, Winding Resistance Ohmmeters, Micro Ohmmeters, Transformer Turns Ratio Meter, Insulation Testers, Capacitance & Tan Delta Test Kit, Strain Measurement Systems, High Voltage Standard Capacitors, Power Loss Measurement System for Power Transformers & Shunt Reactors, HV Testing Equipments, CT / PT Test Set, AC Power Standard, Temperature Calibrator, Pressure Calibrator, Multifunction Calibrator, Process Calibrators, Reference Temperature Probes, Precision Thermometry Bridges, DC Metrology Standard, Standard Resistors, Calibration software.

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Metrology is Our Science, Accuracy is Our Business

Transformer Insulating Oil Tester

The UDEY OTSA series oil testers are fully automatic micro controller based system, completely self contained, compact and portable with test voltages of 0 to 60, 75, 80,90, 100 kv. The tester is designed to test the dielectric strength of insulating oil in filed, floor shop or laboratory. The tests can be done as per various international standards like IEC 156/ IS 6792/ASTM D 1816/ASTM D877 /UNE 21 which are pre programmed. A User definition mode makes it easy for the user to programme as per one's settings. The entire test cycle is done automatically erasing human error. The operation is automatic as well as manual mode. The UDEY OTSA is user friendly, storage up to 100 test results, built in plain paper printer, day, date calendar, large LCD display for ease of reading, RS-232 Interface and gives accurate performance regularly. The tester weighs 34 kgs only. ■

For further details contact:
info@udeyraj.com

Lacing Machine

Trimfit 100 is a coil binding machine used in the production of motor manufacturing lines. The machine is equipped with servo in combination with PLC, enhances the adaptability of the machine to cover wide range of motors and alternators. Change over from 2 pole to 4 pole or alternate coil to continuous coil binding is just a choice of program. The small foot print of the machine enables the flexible production line configuration and efficient utilization of production floor. The product is a creation of the organizations experience and technological strength and is strongly supported by superior engineering resources and services to re-enforce the motor and alternator manufacturing in Indian industry. ■

For further details contact:
electromech@dataone.in

ISA offers STS 5000 & TD 5000

ISA has been specialising in electrical test equipment for the power industry providing excellent and leading edge technology to its customers. All ISA Test Instruments have three characteristics, recognised world-wide: innovative, rugged,user friendly. All ISA test and measurement systems have been designed to be used in severe environmental conditions such as high voltage substations and heavy industry plants. ISA maintains global operations with support resources and sales representatives in more than 100 countries. ISA is glad to present to ELECRAMA attendees a smart, new and breakthrough technolog cally advanced test system STS 5000, especially designed to test al current, voltage and power transformers. STS 5000 becomes an excellent and accurate Capacitance/Tan Delta measurement test set with TD 5000 module. ISA is confident that ELECRAMA is the best opportunity to introduce this new complete test system to the Indian market as STS 5000 & TD 5000 is the best tool for commissioning and maintaining activities in MV and HV substations. STS 5000 & TD 5000 main features are that it is fully automatic; primary injection testing capabilities: up to 800 A or up to 3000 A, with the optional module BUX 3000; variable output frequency: 15 - 500 Hz; power dissipation factor test with the optional module TD 5000 (voltage up to 12 kV); 2000 V AC high-pot test: large graphic display; advanced test & data management software for test set control, results storage and analysis; USB Interface and Ethernet interface for PC connection; compact and lightweight. ■

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info.asia@isatest.com

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Digital Insulation Resistance Tester by Kusam-Meco

Model KM 7010 is a new Digital Insulation Resistance Tester introduced by "KUSAM-MECO". This Digital Insulation Resistance Tester can be used to measure High Insulation Resistance, with a test voltage of 500V to 15000V & the max Insulation Resistance range of 2TΩ. Short-circuit current is up to 5mA suitable for high power transformers in switch yards. It has EMC/EMI approvals. It has an Auto-Hold function, Auto-ranging on all insulation ranges, Optical USB to RS-232 data transmission, Auto Power off & Backlight function, Internal memory for data storage. The display is 2 Linesx16 characters large intelligent LCD display & calendar display. 2 optical LEDs are built-in for data transfer with Bar graph indication for test voltage. It has indication of testing time & adjustment time 1 to 30 minutes. It has a high insulation resistance measuring capacity. The instrument has a AC measuring Voltage range of 0V to 700V & DC measuring 0V to 700V. It is useful for measuring Insulation resistance of transformers, motors, electrical installations etc. It can measure PI (Polarization Index) indication, DAR (Dielectric Absorption Ratio) indication. ■

For further details contact:
sales@kusam-meco.co.in

Motwane brings Motor Winding Resistance Meter LR2045-S

Based on its rich experience of many years in developing and manufacturing of low resistance meters and with mature engineering techniques, Motwane has designed and developed Motor Winding Resistance Meter LR2045-S after extensive research on the challenges and requirements of motor winding testing. This gives fast, stable readings of winding resistance measurement for any rating and any type of Motors, Generators, Alternators and Distribution Transformers. The Motwane make LR2045-S comes with complete solution for low resistance measurement with 4½ digit LED display. It is a fully portable micro-ohmmeter capable of measuring low resistance from 20mΩ to 2KΩ having resolution of 1μΩ with 0.05% Accuracy. The instrument works on the 4 wire measurement principle where it eliminates the lead resistance which occurs in 2 wire measurement method. A constant DC current is applied to DUT and voltage drop across the DUT is measured and corresponding resistance reading is displayed. The instrument has auto select current range of 100μA to 1A for the various resistance ranges. It comes with pulse mode operation where the instrument can be used for temperature sensitive test objects. LR2045-S is well protected against Back EMF which occurs in rotating test objects. The instrument comes with industrial ABS casing which allows the instrument to be used in harsh industrial conditions. Data Management application software is designed for users to control LR2045-S meter through a PC. The software connects to the device through the USB port of any personal computer where the application is installed and following features of the software: Operating LR2045-S through application software; Viewing saved readings (logs); Calculator for Specific Resistivity, Length and Area; Calculator for "Temperature Rise"; Facility for printing and export to excel or text file; LR2045-S application is based on the familiar Microsoft Windows standard. ■

For further details contact:
sales@motwane.com

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Executive summary of Target and Achievement of Transmission Lines during 2013-14

As on 30.11.2013

(All figures in ckt. kms)

Programme / Achievement		HVDC						765 kV			400 kV						220 kV						Total Central, State & JV/ Private Sector					
		± 800 kV			± 500 kV						Central Sector			State/ Private Sector			Central Sector			State/ Private Sector			Central Sector			State/ Private Sector		Grand Total
		Central Sector	State Sector	Total	Central Sector	JV/Private Sector	Total	Central Sector	State Sector	Total	PGCIL	JVC	Total CS	State Sector	JV/Private Sector	Total	PGCIL	JVC	Total CS	State Sector	JV/Private Sector	Total	PGCIL	JVC	Total CS	State Sector	JV/Private Sector	
Programme 2013-14		0	0	0	0	0	0	2585	426	3011	3892	311	4203	4756	2436	11445	56	406	462	3756	0	4218	6533	717	7250	8938	2486	18674
Nov, 2013	Programme	0	0	0	0	0	0	0	0	0	865	0	865	696	0	1561	0	0	0	484	0	484	865	0	865	1180	0	2045
	Achievement	0	0	0	0	0	0	0	0	0	0	0	0	272	668	940	0	0	0	286	0	286	0	0	0	558	668	1226
Upto Nov, 2013	Programme	0	0	0	0	0	0	2025	429	2454	3009	0	3009	2925	1616	7550	56	0	56	2773	0	2829	5093	0	5093	6124	1616	12833
	Achievement	0	0	0	0	0	0	549	0	1549	999	38	1036	275	142	3453	0	0	0	2618	0	2618	2447	38	2585	3893	1142	7620

Transmission Addition Programme in 12th Plan

Tr. Lines, Voltage level	End of 10th plan (Ckm)	End of 11th Plan (Ckm)	Estimated additions in 12th Plan (Ckm)
765 KV	2,184	7,612	25000-30000
HVDC Bi-pole	5,872	11,078	4000 - 6000
400 KV	75,722	1,25,000	50000
220 KV	1,14,629	1,50,000	40000
Total Tr. Lines	1,98,539	2,93,852	119,000 – 126,000

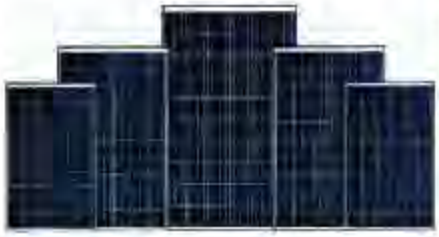
Source: CEA/ Powergrid

Transmission addition Programme by POWERGRID in 12th Plan

Sl. No.	Sector	Capacity(MW) addition envisaged	Transmission System planned for corresponding capacity (MW)	
			Under construction	DPR under preparation
1	Central	28,600	4,240	17,394
2	Private	57,000	14,740	33,676
	Total	85,600	18,880	51,070

Source: CEA/ Powergrid

SPV Modules Range by Surana Venture Ltd



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Most competitive price-performance ratio and a positive power tolerance; SVL Solar PV modules confirm to International Standard IEC 61215 Ed-2, IEC 61730, and IEC 61701; MNRE Channel Partner: 200Wp, 225Wp, 230Wp, 240Wp, 250Wp & 290Wp are some of the range. ■

For further details contact:
www.suranaventures.com

Megger BITE 3

The Megger BITE 3 Battery Impedance Test Equipment determines the health of lead-acid cells up to 2000 Ah bytaking measurements of the most important battery parameters. The BITE 3 measures cell impedance, aninternal ohmic test, cell voltage, and intercell connectionresistance. And, for the first time in a battery instrument, the BITE 3 measures float current and ripple current. There is even a built-in spectrum analyzer to show the harmonic content of the ripple current. It has firmware that can be upgraded through the Internet and supports multiple languages. It works by measuring the internal impedance of cells, the intercell connection resistance, cell voltage, float and ripple current. These along with temperature, specific gravity and other battery data, can provide the best basis for evaluating the overall health of batteries from terminal plate to terminal plate and to a lesser extent, even the charger (from ripple current and its harmonic content.) Megger recommends that the BITE 3 be made part of a comprehensive battery maintenance program with reading taken and recorded semi-annually for flooded, lead-acidcells and quarterly for VRLA. Unlike load-cycle testing which is expensive, nonpredictive and time-consuming (but does provide actualcapacity data), the BITE 3 is quick, reliable and easy to use. With a rapid test time, one person can easily, quickly and precisely measure cell and string parameters without taking the system off line. The processor of the BITE 3 uses a Windows® CE OperatingSystem and can store more than 4000 sets of data in morethan 1000 tests. It is menu-driven that is easy to navigate. Its unique data analysis screens provide immediate feedback on the status of cel impedance.

It also supports Proactiv Database Management Software

The first of its kind, ProActiv is a powerful software package that organizes and analyzes battery data in an MS access database. Used in conjunction with the BITE 3,ProActiv manages the transferred test data from the BITE 3 by organizing it according to ones need and providing it in an extremely useful manner. Once

the database is configured to ones liking and test data are transferred from the BITE 3, it provides red, yellow and green bands that coincide with user entered pass, warning and failure limits. ProActiv allows the user to organize and manage battery data such as voltages, impedance, intercell connection resistance, ripple current, and specific gravity. ■

For further details contact:
india.sales@megger.com

Chauvin Arnoux: A Clamp unlike any other

The rugged C.A 6416 and C.A 6417 clamps are designed for day-to-day use. Their weight has been limited by using high-performance magnetic materials. To ensure more comfortable use, the clamp's jaw benefits from a new feature: a force compensation system installed on the trigger. Minimal effort is required to keep the clamp open in order to optimize handling of the productwhile reducing user fatigue. As an additional safety feature, a protective guard prevents the hand slipping during measurements. The moulded-silicone rotary switch is easy to operate even when wearing safety gloves. The large function keys on the front of the clamp give direct access to the various functions. The measuring head is the key component of the ground clamp which guarantees the performance of the product. These Chauvin Arnoux® ground clamps comprise two independent, shielded magnetic circuits which ensure excellent rejection of measurement noise. The smooth finish of the surfaces in contact prevents the accumulation of particles which might affect the measurements. The centring system ensures optimum alignment of the 2 parts of the head in order to offer measurements that remain accurate over time. With the Launch of this innovative Earth Clamps, Chauvin Arnoux re-affirms its un-paralled leadership in earth testing & measurement. Chauvin Arnoux based in France is a world leader in measurement since the last 115 years. ■

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