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## Cable Construction & Cable Selection

- ▮ Cable Construction & Cable Selection
- ▮ Self Regulating Heat Tracing Cable
- ▮ Ancillary services through Microgrid for Grid Security & Reliability
- ▮ Stay Protected from Electrical Fires
- ▮ Digital Earth Resistance Measurement System
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Hello and welcome once again to *Electrical India*. The much-awaited cabinet reshuffle of the Modi government was done today and as was expected Piyush Goyal has been shunted out of the power ministry and he has been succeeded by former bureaucrat R K Singh. I must add word of appreciation for the former power minister before we tell him good bye and get used to writing power minister R K Singh. Piyush Goyal, who has been elevated to cabinet rank and named as the new minister of railways, will also retain the ministry of coal.

No doubt, there is still power shortage and no electricity in many thousands of villages throughout the country, but Piyush Goyal, who was considered the harbinger of change in the power sector, has in the past three years completely transformed the power and energy scenario in the country. In my career as a journalist in the power industry for over 20 years, I can emphatically say that Piyush is one such power minister, who has not only made electricity accessible and affordable but has also made the country's position in the world bank's electricity accessibility index up from 99 when he took over to 26 when he was promoted today. Strangely, another former power minister who was dynamic in the power ministry was also from the BJP - in the erstwhile Vajpayee government. He was Rangarajan Kumaramangalam, who propelled mega power projects forward and delivered on his promises and whom I had interviewed for *Electrical India* a few months before he passed away at a very young age of 48 in August of 2000.

Goyal's game changer has been his own scripted Ujwal Discom Assurance Yojana (UDAY), which is the first comprehensive power sector reform seen in India as it covers the entire value chain in the power sector from fuel to generation, transmission, renewable, distribution and consumers. Many of our highly indebted state power distribution companies, which are the weakest link in the electricity value chain has turned around.

The target of UDAY and the power ministry has not yet been met. A lot is still to be done. Hopefully, his successor R K Singh, whose first statement after taking charge was complimenting Piyush Goyal for finishing bulk of the work he had started and for making his challenge easier, will be taking it to the finishing line before the next general election. Going by his track record as a bureaucrat, ministry of power will be the ministry to watch for, for action and surprises. After all, this entire exercise of cabinet reshuffle was also done keeping in mind the next general election. Please send in your comments to me at [miyer@charypublications.in](mailto:miyer@charypublications.in)

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## BHEL consolidates its global footprint, forays into two new countries

**B**harat Heavy Electricals Limited (BHEL) has achieved yet another milestone in expanding and consolidating its footprint in the international market by securing export orders from Chile and Estonia.

With maiden orders for transformer bushing from Niquel Electric Ltda., Chile and Electronic cards from SCANFIL OY Vana Sauga, Estonia, BHEL has now expanded its global footprint to 82 countries across all the six inhabited continents. The company is continuously aligning its export strategy in line with global dynamics. Persistent efforts towards globalisation have led to BHEL securing the highest ever export orders of over Rs.10,000 Crore from 23 countries in FY 2016-17. Significantly, the company secured its largest

ever export order for setting up the 1,320 MW (2x660 MW) Maitree Super Thermal Power Project in Bangladesh. Significantly, won against stiff international competitive bidding, this is BHEL's largest power project order in the international market. Recently, it also forayed into two other countries in Africa, Togo and Benin.

BHEL is making concerted efforts to tap available opportunities in the overseas market. Currently, the company is focusing on expanding its global presence through market expansion and market penetration. The company is favourably placed in opportunities in Africa including a Combined Cycle Power Plant in Tanzania and a Hydro Power Plant in Zimbabwe. 

## Decentralised Distributed Generation for Electrification of Remote/Backward Areas

**T**he Minister of State (IC) For Power, Coal, New & Renewable Energy and Mines, Piyush Goyal, in a written reply to a question in Lok Sabha, informed the House about the steps taken by the Government for electrification of villages situated in backward and remote areas of the country through new and renewable energy sources.

The Minister stated that under the Decentralized Distributed Generation (DDG) of Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), electricity access is provided to all the villages/habitations where grid connectivity is either not feasible or not cost effective including those situated in backward and remote areas of the country. This includes mini grids and standalone systems.

Goyal informed that as on 30.6.2017, 4,220 projects have been sanctioned with the project cost of Rs.1354.60 crore, in various States across the country under the DDG scheme. All the remaining un-electrified villages are targeted to be electrified by May, 2018.

Further, the Minister stated that a subsidy of Rs.246.84 crore was

disbursed under DDG during the last three years. The State-wise details of capital subsidy released under DDG during the last three years 2014-15, 2015-16 and 2016-17 are as follows:

Sr. No.	Name of the State	Subsidy amount (Rs. in crore)
1	Andhra Pradesh	14.4025
2	Assam	81.6966
3	Chhattisgarh	96.1373
4	Karnataka	5.2974
5	Kerala	1.2439
6	Madhya Pradesh	10.5729
7	Rajasthan	24.6835
8	Uttarakhand	1.4834
9	Uttar Pradesh	11.3187
	<b>Grand Total</b>	<b>246.8363</b>

## NHPC scheduled to generate 4458.69 MUs additional power


**M**inister of State (IC) for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal, in a written reply to a question in Rajya Sabha, informed that NHPC is scheduled to generate 4458.69 Million Units (MUs) additional power (based on design energy) from two of its present under construction hydro projects, viz., Parbati-II H.E.P (800 MW) in Himachal Pradesh, scheduled to be commissioned in October, 2018 and Kishanganga H.E.P (330 MW) in Jammu & Kashmir scheduled to be commissioned in January, 2018.



Informing about the status of progress of hydro-electric projects in the country, Goyal stated that presently 41 H.E.P. (above 25 MW), aggregating to 11792.5 MW, are under construction in the country. All the above projects are running behind schedule due to various reasons including natural

calamities, geological factors, delays in forest clearances & land acquisition and law & order problems, the Minister added.

Goyal informed the House about the steps taken by the Government for expeditious commissioning of pending projects, which are as follows:

- Central Electricity Authority (CEA) is monitoring the under construction hydro power projects (above 25 MW) in pursuance of Section 73 (f) of Electricity Act, 2003. The progress of each project is monitored continuously through site visits, interaction with the developers & other stake holders. Chairperson, CEA holds review meetings with the Power Projects Monitoring Panel (PPMP) and monitoring divisions of CEA.
- Power Project Monitoring Panel (PPMP), set up by the Ministry of Power, independently monitors the progress of the hydro projects.
- Ministry of Power also reviews the progress of ongoing hydroelectric projects regularly with the concerned officers of CEA, equipment manufacturers, State Utilities / CPSUs / Project developers, etc. 



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## Government takes steps to ease stress in Stalled Thermal Power Projects: Piyush Goyal

The Minister of State (IC) for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal, while giving a written reply to a question in Lok Sabha, informed the House that Government has reviewed the status of 34 stressed Thermal Power Projects, as per the list provided by Department of Financial Services (DFS), with an estimated debt of about Rs. 1.77 lakh crore. The Minister also informed that as per DFS data, the total advances towards electricity generation sector reported by Scheduled Commercial Banks (SCBs) is about Rs. 4.71 lakh crore and most of them are stranded assets.

Goyal stated that Neyveli Lignite Corporation of India Limited (NLCIL) has identified Ragunathpur Thermal Power Station- Phase-I (2x660 MW), a stressed asset of Damodar Valley Corporation (DVC) for acquisition. NLC has also shortlisted two suitable stressed power assets for possible acquisition to augment its power generation capacity. Currently, NTPC has no proposal to acquire stressed power projects or enable their lenders to operate on contract basis, the Minister added.

Government has identified the major reasons for stress in the Power Sector, which are as follows:

- Non-availability of regular fuel supply arrangements
- Lack of Power Purchase Agreement (PPA) tie-ups
- Inability of the Promoter to infuse the equity and service debt
- Regulatory and Contractual issues

**Goyal informed that the Government has also taken a number of steps to ease stress in the sector. These include:**

- For grant of regular coal linkages, Govt. of India has approved New Coal

Allocation Policy, 2017, for Power sector, on 17.05.2017 viz. SHAKTI (Scheme for Harnessing and Allocating Koyala Transparently in India) under which coal is made available to Public Sector Undertakings of Central and State Government, and Independent Power Producers (IPPs) against already concluded long-term Power Purchase Agreements (PPAs) and long-term & medium-term PPAs, to be concluded in future.

**To encourage increased purchase of Power, following measures have been taken:**

- Ujwal DISCOM Assurance Yojana (UDAY) scheme for Financial and Operational Turnaround of power distribution utilities (DISCOMs) of the country.
- Power For All (PFA) initiative with States and UTs for bringing uninterrupted quality of power to each household, industry, commercial business, small & medium enterprise and establishment.
- Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) for Rural Electrification; strengthening of sub-transmission and distribution networks in the rural areas; separation of agriculture and non-agriculture feeders and metering of distribution transformers/ feeders/ consumers in the rural areas.
- Integrated Power Development Scheme (IPDS) for strengthening of sub-transmission and distribution networks in the urban areas; Metering of distribution transformers / feeders / consumers in the urban areas and IT enablement of distribution sector.
- Augmenting Transmission capacity to remove transmission constraints.
- Flexibility in utilisation of domestic coal for reducing the cost of power generation.

## Turning Indian villages into solar power stations

Villages in India will benefit from Swansea University expertise in creating buildings that work as power stations, generating, storing and releasing their own power, thanks to £7 million of UK government funding. The money was awarded to a Swansea-led consortium of 12 UK and Indian universities, including Oxford, Cambridge, Brunel, and Imperial College London.

The award illustrates Swansea University's leading role in research in areas such as solar energy and steel, and the pioneering work on "buildings as power stations" carried out by the University-led SPECIFIC project, which recently opened the UK's first energy-positive classroom.

The new solar project, called SUNRISE, will develop printed photovoltaic cells and new manufacturing processes, which can be used to construct solar energy products in India. These will then be integrated into buildings in five villages, allowing them to harness solar power to provide their own energy and run off grid.

One of the key aims is to provide a real-life example which proves that this technology works, and that it is appropriate in these communities. The plan is that it will encourage local industries to manufacture affordable

prefabricated buildings, adapted for their environment, that can generate, store and release their own power.

The project is in line with Indian government plans, announced by Prime Minister Narendra Modi, to turn the country into a solar energy leader, leap-frogging fossil fuels, and to boost the Indian manufacturing sector.

The concept of a building as a power station has already been proven to work, with the opening of the energy-positive classroom on the



Swansea University Bay campus.

Designed and built by the SPECIFIC project, the classroom can run off grid. Electricity is generated by a steel roof with integrated solar cells, supplied by SPECIFIC spin out company BIPVco. It is connected to two saltwater batteries, which are being used in the UK for the first time and are capable of storing enough energy to power the building for two days.

The building also uses Tata Steel's perforated steel cladding for generation of solar heat energy, which can be stored in a water-based system, and an electrically-heated floor coating that has been developed by SPECIFIC researchers.



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## India's largest battery based Solar Project – UP Sabzi Mandi project


Consul Neowatt, the global Indian UPS company shared that it has received the approvals for execution of one of the largest battery based hybrid solar power projects in India totalling over 3MW. The project will be powered by Consul Neowatt's much acclaimed Sunbird range of hybrid solar inverters, which has strong performance credentials and is today the No 1 preferred choice of solar system integrators in India for any solar power plant with energy storage.

The Sabzi Mandi project initiated by the Government of Uttar Pradesh is a full-fledged market facility for farmers well equipped with cold storage facilities, shops, drainage systems, and warehouses.

The project will cover 16 locations in the state and locations will be fitted with multiple units of 150kw to 400kW Sunbird solar Power Conditioning Units (PCUs) to be self-sufficient for uninterrupted power supply. The solar power in these sites will



serve a mix load of pump motors, lighting, cool storage fans and other infrastructural needs of the Mandi's.

Sriram Ramakrishnan, CEO & MD, Consul Neowatt Power Solutions, said, "Our Sunbird range of solar inverters has proven its ruggedness and ability to handle a variety of loads over the last couple of years and was the natural choice for a project that required solar power to not only power up the traditional lighting loads but also pump motors and cold storage fans. This project demonstrates the feasibility of high power solar power plants with energy storage as a viable option for DG Sets and is enabled by the industry leading technology in-built in our Sunbird hybrid solar PCUS." 

## MYSUN launches India's most advanced and easy to use Rooftop Solar Calculator

Buoyed by the overwhelming success of the MYSUN Solar Calculator, which has been used by more than 200,000 energy consumers across India in less than 9 months since its launch, MYSUN, the innovative technology backed solar rooftop platform recently revealed the launch of an advanced version of the tool. Called the 'MYSUN Advanced Rooftop Solar Calculator, the solar system sizing and savings calculator allows users to estimate an accurate solar system size, costing estimates, financial returns, impact of subsidies and offers a simulation of different financing options tailor made for each and every individual user. The best part is that running the Advanced Calculator is just as easy as the Basic Calculator and requires just the three basic inputs: your location, electricity bill amount and the consumer category.

Recognising the requirement of builders and homeowners who are constructing a new house or a new building, the company has also launched a separate calculator, specifically designed to cater to their needs. This would allow consumers/ builders/ real estate companies to not just design their buildings solar ready, it would also allow them to estimate their energy savings while the construction is being planned so that they can go solar from Day 1. MYSUN believes that with free tools such as the MYSUN Solar



Calculator for Under Construction Building and MYSUN Advanced Rooftop Solar Calculator, the consumers will be able to visualise and therefore maximise their energy savings through optimum use of solar systems. This would eventually help in the adoption of solar reducing the decision making time, propelling India to reach the set target of 100GW by 2022 faster.

The Advanced MYSUN Solar Calculator also has a Net Metering feature, which helps buyers to gauge as to how their savings and returns would be impacted when they opt for Net Metering and whether they should go for it or not. The tool also informs about the solar policies as well as the Net Metering policies across different states in the country.


Through the calculator, consumers can also determine the impact of using a battery-backed solar system (off-grid solar or hybrid solar) versus a grid connected system and can decide which system type is more suitable for them. This usually depends on specific energy requirements, grid downtime and savings expectations. Commercial and industrial establishments can also test the impact of availing Accelerated Depreciation, if they wish to.

In short, the MYSUN Advanced Solar Calculator is the most comprehensive tool for those who are serious about going with Rooftop Solar. 

## Vikram Solar concludes MoU with Israel's Water-Gen

Vikram Solar had signed a Memorandum of Understanding (MoU) with Israel's Water-Gen, an air-to-water technology provider in March 2017, to understand and develop options to meet water solutions in the country. The plan was to co-operate and jointly study and examine the water needs across India and use the know-how and technology

of Water-Gen to establish local manufacturing facilities in India.

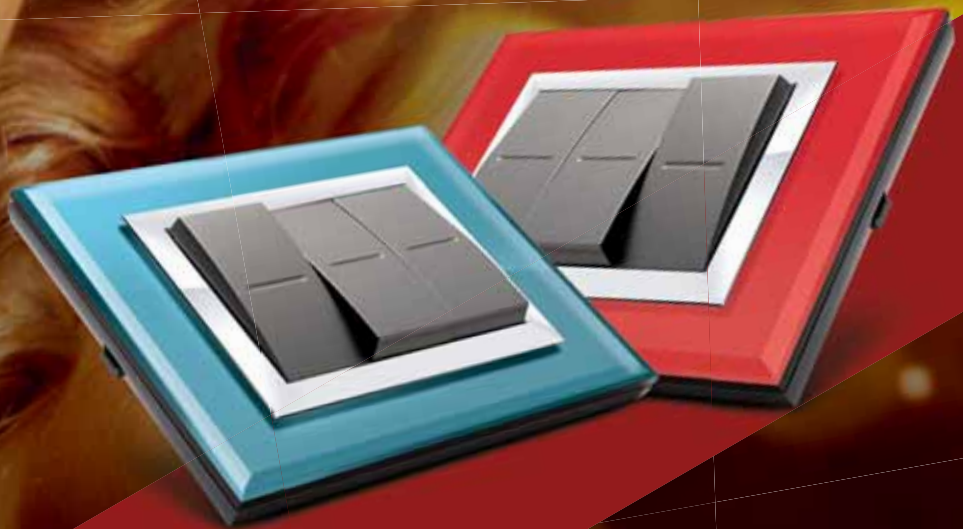
Although the journey brought light to new technology and the opportunities to provide clean water solutions in various areas of India, the Memorandum of Understanding (MoU) with Israel's Water-Gen expired on 27th May 2017 and will not be extended any further. 



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## Alfanar Group of Saudi Arabia collaborates with Suzlon

Suzlon Group, a well known global renewable energy solutions provider in the world, has won an order of 50.40 MW wind power project from Riyadh based Alfanar Group. This is a maiden order from Alfanar, for 24 units of S111-90m wind turbine generator, each with a rated capacity of 2.1 MW. The project will be completed by March 2018.

Alfanar Energy is a fully owned subsidiary of the Alfanar Group and has set ambitious targets for the Indian market as an independent power producer (IPP) and developer. The group has allocated resources for setting up 2.2 GWs of renewable energy projects in the next five years and will focus on wind, solar (PV and CSP) and biomass primarily in MENA, India and Southern Africa.



J.P. Chalasani

Suzlon will execute the entire project on a turnkey basis and will also provide operation and maintenance services. The project has the potential to provide power to over 27,000 households and reduce 0.10 million tonnes of CO2 emissions per annum.

J.P. Chalasani, Group CEO, Suzlon Group, said, "We welcome Alfanar Energy to India and into our customer family. Renewable energy market is growing at a robust pace in India. With our two decades of experience, proven technologies, comprehensive product portfolio, and end-to-end solutions along with integrated maintenance and services, Suzlon is best positioned to serve Alfanar's ambition to capitalise on the growing market opportunities in India."

## Tata Power becomes the first power utility to introduce QR code for bill payments in India

Tata Power, India's well known integrated power company is a pioneer in the application of innovation and technology for value added benefits to its customers. In line with this commitment, Tata Power has become the first power utility to introduce QR code service for bill payments in Mumbai.

The QR code linked to Unified Payments Interface (UPI) will be printed on the electricity bills. Customers can scan the QR code with BHIM app or any other UPI linked bank apps and pay their bills without any hassle. The bill details will be displayed on the app, post which the customer can authorise the payment within a few seconds and his bill will be paid instantaneously.

Though this functionality of bill payments through a QR code has been introduced in other service industries, it will be launched in the power industry for the first time in India by Tata Power.

### Some of the advantages of QR code service are:

- Consumer need not visit any Tata Power Bill Collection/

Customer Relation Centre or any other payment avenues and can make the payment from the comfort of his home/office or on-the-go.

- All bill details will be auto captured while scanning the QR code and the consumer has to pay using a single tap on his smartphone. The consumer need not remember his debit / credit or net banking A/c & IFSC code details.

Ashok Sethi, COO & ED, Tata Power, said, "We, at Tata Power are constantly working to harness the use of technology to improve our overall customer service and experience. With this, Tata Power will revolutionise electricity bill payments in the city.

The service will provide safer payment options to the consumers and contribute to the financial inclusion in the country. Tata Power is confident that it will prove to be a great addition to their overall stakeholder experience and we will remain committed to providing quality and uninterrupted power to our consumers."



Ashok Sethi

## Siemens to install state-of-the-art IGBT technology for Indian Railways

Indian Railways contributes to the enduring success of the nation's growth story through its pivotal role in ensuring reliable, safe and secure transportation of people, goods and services. With a focus on modernisation, expansion of rail networks and energy efficiency, Siemens has been a trusted partner of the Indian Railways for the last six decades.

Siemens Limited will be designing, supplying and installing Alternating Current (AC) Traction systems for Dual Cab High Horsepower Diesel Engine locomotive for Diesel Locomotive Works (DLW), Indian Railways. The systems have been developed based on the state-of-the-art Insulated Gate Bipolar Transistors (IGBT) technology. The AC Traction systems will be produced at the Nashik Factory of Siemens Limited.



Tilak Raj Sethi

IGBTs are state-of-the-art power electronics for the traction system of electric and diesel-electric rail vehicles. The main benefit of IGBT is that it reduces the requirement for current, minimising heat and traction noise while also making the acceleration process efficient.

Tilak Raj Sethi, Executive Vice-President and Head, Mobility, Siemens Limited, said, "The advent of IGBTs has yielded strong efficiency gains in electric drive technology. The project showcases Siemens' partnership with the Indian Railways as it combines innovation with responsibility to bring together the combined expertise of its teams that is committed to deliver reliable, safe and efficient technologies."


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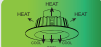
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## ABB wins \$30 million order to strengthen power infrastructure in Iraq

ABB has won an order to supply and install a substation at the 3,000 megawatt (MW) Rumaila power plant, located in the Basra region of southern Iraq. The completed power plant will be operated by Shamara Holding Group (SHG), one of Iraq's largest private industrial conglomerates and an independent power producer. The Rumaila power plant is expected to increase power generation capacity by about 20 percent and address acute shortages of electricity, hampering economic growth in the country. The order was booked in the second quarter of 2017.



generating plants will increase electricity supply, and support economic growth.

ABB will design, engineer, supply and install the 400 kilovolt (kV) air insulated switchgear (AIS) substation, which will be equipped with technology and instrument transformers from ABB. The substation will also be equipped with advanced digital control, protection and telecommunication

systems.

Claudio Facchin, President of ABB's Power Grids division, said, "Our advanced substation solution will help bring much needed electricity to the region by expanding capacity and strengthening Iraq's power infrastructure, bringing much needed power to consumers. This project adds to our extensive installed base in the region and supports our Next Level strategic thrust on growing markets."



## Duke Energy seeking wind power to serve customers in the Carolinas

As part of building a smarter energy future and generating cleaner energy for its customers, Duke Energy Carolinas (DEC) issued a request for proposals (RFP) for up to 500 megawatts (MW) of wind capacity that would be delivered to its transmission system.

Results from the RFP could bring clean wind energy to the Carolinas and help DEC meet North Carolina's 2007 Renewable Energy and Energy Efficiency Portfolio Standard (REPS) that mandates the company generate 12.5 percent of its retail sales in the state by renewable energy or energy efficiency programs by 2021, and continuing afterward.

Rob Caldwell, President, Duke Energy Renewables and Distributed Energy Technology, said, "As costs in the wind sector decline and capacity factors increase, now is an excellent time to pursue wind energy for the Carolinas. Our experience in wind energy spans more than a decade, so we are excited to evaluate this resource for the benefit of our customers."

Wind energy will be a strong complement to the company's already extensive solar energy portfolio here in the Carolinas, providing energy during times that solar is not typically available, and it will further diversify



the company's fuel mix.

The RFP is open to existing or new wind generation facilities – from 100 to 500 MW of delivered capacity – that can be transported into DEC's transmission system by the end of 2022. Although Duke Energy owns and operates more than 35 solar facilities in the Carolinas, it does not currently purchase any wind capacity for customers in the region.



## Energy Recovery awarded \$2.5 Million for Desalination Projects in Saudi Arabia

Energy Recovery, the leader in pressure energy technology for industrial fluid flows, today announced total award of \$2.5 million to supply its PX Pressure Exchanger technology for desalination projects in Saudi Arabia. The orders began shipping in the second quarter of 2017, with expected completion by the third quarter of 2017.

Energy Recovery will supply its PX-Q300 and PX-220 Pressure Exchanger devices for the plants, which will produce a total of up to 103,000 cubic meters of water per day. Energy Recovery estimates the PX devices will reduce the total power consumption for all projects by 14.4 MW, saving a total of over 124.4 GWh of energy per



Joel Gay

year and avoiding 74,378 tons of CO2 emissions per year.

Energy Recovery's President and CEO Joel Gay, stated, "We remain bullish on the outlook of the desalination market through the balance of 2017 and into 2018. These orders further solidify our position as a market leader in the Middle East desalination market, more specifically in Saudi Arabia, which remains a bellwether for mega project activity.

As mentioned on our previous 2nd quarter 2017 earnings call, we remain laser-focused on our water business and will continue to guard our position as market leader and attack new opportunities to provide our Pressure Exchanger technology to customers seeking to optimise plant savings and operations."





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## IKEA introduces new Solar Battery Storage

Home furnishings expert IKEA has teamed up with leading solar firm Solarcentury to launch a new Solar Battery Storage solution to help homeowners make huge savings on their electricity bills, as well as increasing the rate at which they can reap the benefits from their solar investment.

Designed to work alongside existing Solar Panels or as part of a brand new combined home Solar Panel and Battery Storage system, the new offering will make it much easier for homeowners to save on their electricity bills by enabling them to use more of the



making further cost savings.

electricity that is generated by their solar panels.

Solar Battery Storage allows users who have solar panels installed on their homes to store the electricity generated by the sun and use it whenever they like. An average solar home in the UK will typically consume around 40% of all the solar electricity generated, or even less if they are regularly out during the day. The remaining 60% of unused solar electricity is sent back to the National Grid, at a loss compared to its value. This means that homeowners currently lose out on

15

## Siemens Gamesa successfully installs Asia's tallest wind turbines in Thailand

Siemens Gamesa has set a new record in Asia by installing this year the tallest wind turbines on the continent. The turbines are equipped with 153-metre tall towers, and with the 56-metre blades, they reach a total height of 210 metres.

The project - owned by Thai engineering company Gunkul and being built by developer PowerChina ZhongNan- has total capacity of 67.5 MW; i.e. 33 units of the G114-2.0 and G114-2.1 MW models.

Siemens Gamesa has already installed these 33 turbines in the Sarahnlom wind farm in the Nakhon Ratchasima province in central Thailand, while commissioning is scheduled for this year. The company will also be in charge of the plant's operation and maintenance for the next 10 years.



"This milestone showcases the company's R&D prowess", said Álvaro Bilbao, CEO of Siemens Gamesa for Asia-Pacific. "We are demonstrating once again our ability to respond to what the market needs and the versatility of our turbines", he further added.

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## Power to the People: How the Sharing Economy will Transform the Electricity Industry

A new report released by the World Economic Forum, *The Future of Electricity: New Technologies Transforming the Grid Edge*, finds that adoption of new 'grid-edge' technologies in OECD countries could bring more than \$2.4 trillion of value creation for society and the industry over the next 10 years.

The report outlines the major transformations facing the electricity industry, as technology and innovation disrupt traditional models from power generation to beyond-the-meter energy management. Its findings point to three trends in particular that are converging to produce game-changing disruptions: electrification, decentralisation and digitalisation. These trends are presently at the 'grid edge' – smart and connected technologies at the end of the electric power grid. They encompass all of the major technologies – such as distributed storage, distributed generation,

smart meters, smart appliances and electric vehicles – that are impacting the electricity system.

The \$2.4 trillion of value would come from new jobs and reduction of carbon emissions derived from increasing the efficiency of the overall system, optimising capital allocation and creating new services for customers.

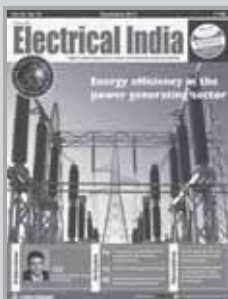
Rapidly falling costs of smart meters, connected devices and grid sensors will increase the efficiency of network management and, more importantly, allow customers to have real-time information about energy supply and demand across the system. The expected surge in adoption of electric vehicles could provide great flexibility to the grid in the shape of storage, but could also pose site congestion challenges, for example if a large number of electric vehicles wanted to recharge in a given geography at the same time.

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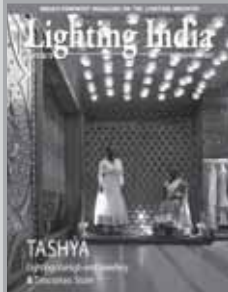
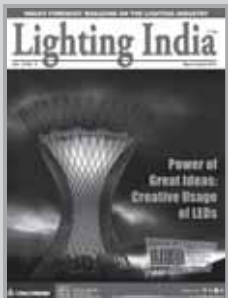
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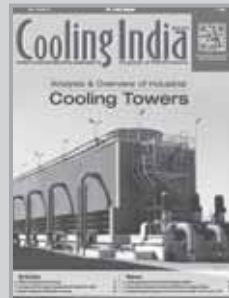
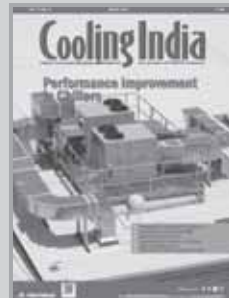
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## Schneider Electric India appoints Meenu Singhal as Head of Industry business

Schneider Electric revealed the appointment of Meenu Singhal as the Vice President of its Industry business. In his new role, Meenu will be responsible for accelerating Schneider Electric's growth of the business with a focus on automation of industries and will drive the push for Industrial Internet of Things (IIoT) platform across businesses for building greater efficiencies.


Meenu's joining comes at an exciting time in industrial automation, with the IIoT offering unprecedented possibilities of building efficiencies across an entire system of an industrial operation. Schneider Electric is at the forefront of this technology wave with its cutting-edge solutions and Innovation at Every Level—which is being delivered through EcoStruxure, an IIoT-enabled, open and interoperable system architecture and platform



Meenu Singhal

for plants and machines.

Meenu Singhal brings with him a rich experience of over 26 years in the field of automation. Following his graduation as an Electrical Engineer he took a post graduate degree in Marketing Management from IMT, Ghaziabad.

Sharing his views on joining the Industry business at Schneider Electric, he said, "I am excited to take over as a leader of Industry and Automation at a time when businesses are looking at leveraging technology to automate and drive serious efficiencies in business. Schneider Electric is uniquely positioned as a global leader in automation industry and our focus as a team is to ensure business continuity and value creation through innovative offerings. I look forward to bringing in my experience on board at Schneider Electric to take the business forward." 

## Wärtsilä India appoints Neeraj Sharma as President & Managing Director

Wärtsilä India, a subsidiary of the technology company Wärtsilä Corporation, has appointed Neeraj Sharma as the new President & Managing Director.


Sharma comes with over 30 years of experience in the Energy and Industrial sectors. He has significant experience in leading and developing emerging markets. Prior to this appointment, he was Executive Vice President, Asia Pacific and Member of the Executive Board for KONE Corporation, Finland. Earlier to this, he was Managing Director, KONE India. Sharma has also held management positions with global organisations like General Electric and Alstom.

Kari Hietanen, Chairman, Wärtsilä India, said, "Neeraj has an outstanding career spanning over 30 years in the industry, and has shown



Neeraj Sharma

strong results in the demanding posts he has held in India and globally. We are confident that his experience, deep understanding of the market dynamics, analytical management style and ability to identify potential areas of expansion will further facilitate profitable growth for Wärtsilä in India. We look forward to utilising his expertise and experience in taking the company's goal and vision forward."

"I would like to thank Kari and the local management team for steering Wärtsilä India through challenging times during the last two years. Wärtsilä India has a competitive edge in the country, and I am convinced that we will have a big role to play in implementation of solutions for the Energy and Marine sectors in India in the coming years", said Neeraj on his appointment. 

## Siemens extends appointment of CEO Joe Kaeser


The Supervisory Board of Siemens AG has extended Joe Kaeser's appointment as President and Chief Executive Officer ahead of schedule. His term of office will now extend until the Annual Shareholders' Meeting in 2021. This move is intended to ensure the continuity and stability needed for sustainable and successful implementation of the company's Vision 2020 strategy program. "Over the past few years, Kaeser has driven Siemens' realignment with great dedication and entrepreneurial spirit," said Supervisory Board Chairman Gerhard Cromme. "He's not only a guarantor of success, but also of stability in increasingly turbulent times. From the perspective of the Supervisory Board, it's all the more gratifying that we'll be continuing the extremely successful collaboration with Kaeser, which is based on the highest levels of trust."



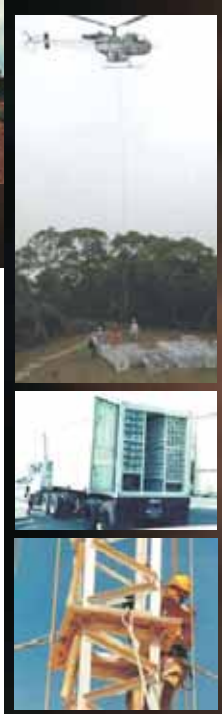
Joe Kaeser

"We've accomplished a great deal together over the past four years. Vision 2020 has given Siemens a clear direction, and we've significantly increased our company's value," said CEO Joe Kaeser. "But we still have a long way to go. Together with our global leadership team, we at Siemens want to shape the digital transformation of industry and ensure that our company is well prepared for the next generation."

Implementation of the Vision 2020 strategic realignment was initiated at the start of the fiscal year that began on October 1, 2014.

The core elements are the alignment of the company with the growth fields of electrification, automation and digitalisation, the sharpening of the focus of the company's portfolio and the implementation of concrete, sustainable measures for enhancing its functional efficiency. 

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Lindsey ERS are designed to be user-friendly especially during mission-critical situations and can be deployed swiftly - a complete tower can be erected within a matter of hours. All ERS tools and accessories such as insulators, hardware, anchors and gin poles, can be safely stored and transported in standard 20 foot containers. PCI can also provide the necessary orientation and training of your technical disaster management personnel.

These highly reliable and quick-to-deploy ERS have played a significant role in the restoration of normalcy of power supply in the aftermath of various natural calamities in India such as the 1998 cyclone in Gujarat, the 1999 Orissa cyclone and the severe floods that had paralyzed vast districts in Bihar and Assam during 2010.

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## BHEL wins ICAI National Award for Excellence in Cost Management

**A**mong a host of public and private sector companies, Maharatna engineering and manufacturing enterprise, Bharat Heavy Electricals Limited (BHEL) has been conferred the 'ICAI National Award for Excellence in Cost Management 2016'. The award was presented by Piyush Goyal, Hon'ble Union Minister of State (I/C) for Power, Coal and New & Renewable Energy to Atul Sobti, Chairman & Managing Director, BHEL and T. Chockalingam, Director (Finance), BHEL, in the presence of Arjun Ram Meghwal, Hon'ble Union Minister of State for Finance and Corporate Affairs, at a function in New Delhi.

Significantly, this is the tenth time BHEL has won this prestigious recognition. An independent jury unanimously selected BHEL for the



First Award in the PSU Manufacturing Organisation - Large category, for the Award for 2016. 

## BMU's Vice Chancellor Dr. Satyanarayana wins Best VC Award


**B**ML Munjal University's Vice Chancellor Prof. B. S. Satyanarayana was awarded the 'Best Vice-Chancellor Terna Mathworks Award'. The award was conferred by the Indian Engineering Educators and Administrators Conference (IEEAC-2017) in recognition of his key role towards research and innovation and hands-on and cross-disciplinary learning. Prof. Satya is also playing an instrumental role in helping set BMU up as a Green campus, teaching his students how to ensure a sustainability model on campus.

Prof Satyanarayana has two patents to his name. He has initiated and implemented many projects, with funding to the tune of over \$ 50 million, published over 120 papers in journals & conf. proceedings, and delivered over 200 invited and contributed presentations in conferences and workshops.

Prof. B. S. Satyanarayana holds a Ph.D in Electrical Engineering from Cambridge University UK. He has over 30 years of experience working in Industry, R&D institutions, Academics and Government Policy in India, UK and Japan and with other international partners. This includes establishing new entrepreneurial ventures, setting up new labs in Academic, R&D & industrial environment, change management,



Dr. Satyanarayana receives the award

defining new government policies and defining new pedagogy in academic environment. At all the places of work he has entered new domains, created new facility, trained new teams, demonstrated new technologies bringing in frugal innovation and creating an environment for Make in India in his Indian activities. 

## Paras Prasad receives honorary doctorate in Brazil

**U**niversity at Buffalo researcher Paras Prasad, an internationally recognised expert in optics and photonics, has been awarded an honorary doctorate from the Federal University of Pernambuco (UFPE) in Brazil.

Prasad, PhD, who serves as the executive director of UB's Institute for Lasers, Photonics and Biophotonics (ILPB), received the award on July 6.


The honor stems from a 19-year ongoing partnership that Prasad — a SUNY Distinguished Professor in UB's departments of chemistry, physics, medicine and electrical engineering — formed



Paras Prasad holds the honorary doctorate he received from the Federal University of Pernambuco (UFPE) in Brazil. To his left is Anisio Brasileiro, rector of UFPE.

with the Brazilian university.

Since 1999, Prasad has co-authored 19 scientific papers and received grants with UFPE collaborators, given numerous lectures and helped organised conferences at the Brazilian university, hosted UFPE students at UB, and connected UFPE researchers with counterparts in China, France and elsewhere.

"Working with UFPE has been one of the most gratifying experiences in my career. I am humbled to receive such an honour," said Prasad, who was an early pioneer in nanomedicine, which uses super-small particles, materials and devices to treat and diagnose disease. 





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# High Voltage Cables Market worth USD 41.27 Bn by 2021

Major factors, such as grid interconnections, offshore wind farm connections, connections of islands with mainland, power from shore links to offshore oil & gas installations, and projects integrating renewable generation with the power transmission grid are driving the market across the globe...

The high voltage cables & accessories market is expected to grow from an estimated USD 30.83 billion in 2016 to USD 41.27 billion by 2021, at a CAGR of 6.0%. Major factors such as grid interconnections, offshore wind farm connections, and connections of islands with mainland, power from shore links to offshore oil & gas installations, and projects integrating renewable generation with the power transmission grid are driving the market across the globe.

### XLPE cables is the biggest underground products market

XLPE (cross-linked polyethylene) cables are the most commonly used cables in undergrounding systems. The cable technology has advanced significantly, which has enabled the use of XLPE cables over the fluid-filled cable technology. XLPE provides insulation to cables to make it withstand the electric field under rated and transient operating conditions. XLPE cable was the largest segment in the underground cable systems market in 2015.

### Asia-Pacific is the dominant market for high voltage cables & accessories

Asia-Pacific is the largest market for high voltage cables & accessories among other regions. This region will continue to dominate the high voltage cables & accessories market, seeking high voltage transmission projects in the region. China is leading the regional high voltage cables & accessories market, whereas other global key markets include the US, India, Germany, UK, Brazil, and Egypt. The manufacturers and service providers are focusing

and creating huge prospects in this service industry. Also, governments, private producers & service providers, and cables & accessories manufacturers are continuously trying to integrate their existing technologies and develop new ones extensively to increase the capacity of high voltage transmission and reduce the impact of high voltage transmission near residential areas.

### Cable and Accessories Market worth 202.07 Billion USD by 2021

The global cable and accessories market is projected to grow from an estimated USD 147.53 billion in 2016 to USD 202.07 Billion by 2021, registering a CAGR of 6.5%. Factors such as increase in renewable energy generation, rapid industrialization & urbanization, and government initiatives undertaken to expand transmission & distribution systems would drive the LV & MV cable and accessories market.

### Infrastructure segment to dominate the LV cables & accessories market

The cable and accessories market has been categorized, by installation, into three segments, namely, industrial, infrastructure, and renewables. The infrastructure sector held more than half of the LV cables & accessories market share in 2015. This growth can be attributed to increasing urbanization and continuing demand from commercial users, especially in the emerging economies. The industrial sector held around half of the MV cable and accessories market share in 2015. Growth in construction



would eventually increase the number of MV cables & accessories being used in the construction process. These factors drive the cable and accessories market.

On the basis of installation, the LV cable and accessories market has been segmented into underground and overhead. The overhead sector dominated the market, followed by underground in 2015. Further, the MV cable and accessories market, based on installation, has been segmented into underground, overhead, and submarine. In 2015, the underground sector dominated the market, followed by overhead. Continuous refurbishment of LV & MV voltage cables & accessories is essential in the underground segment. They have to be replaced in order to maintain the cables according to the soil condition. Therefore, the market for LV & MV cables & accessories in the underground segment is expected to grow at the highest CAGR during the forecast period.

The Asia-Pacific region is expected to witness a high-growth rate for cables & accessories from 2016 to 2021. Moreover, increase in renewable power generation would drive the LV & MV cable and accessories market.





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## Cable Construction & Cable Selection



**Jignesh Parmar**  
M. Tech (Electrical)

Technical Writer,  
Technical Blogger

It is also an important factor for selecting the type of cable. It is to be kept in mind that the cost of the cable should not be such large that it causes loss and another cable may fetch the same results in low cost and loss...

### Cable Construction

#### Parts of Cable:

1. Conductor (For LV/MV/HT Cables)
2. Conductor Screen (For MV/HT Cables)
3. Filler & Binding Tapes (For LV/MV/HT Cables)
4. Insulation (For LV/MV/HT Cables)
5. Insulation Screen (For MV/HT Cables)
6. Separation Tape (For MV/HT Cables)
7. Bedding (Inner Sheath)
8. Metallic Sheen (For MV/HT Cables)
9. Armor (For LV/MV/HT Cables)
10. Outer Sheath (For LV/MV/HT Cables)
11. Water Blocking Tapes –Optional (For MV/HT Cables)
12. Insulation Tapes–Optional (For MV/HT Cables)

### 1. Conductors

**Code:** IS: 8130 / IEC 60228/ BS 6360

**Material:** Class 2 - Annealed Plain / Tinned Copper / Aluminum.

**Used for:** LV, MV & HV Cables

#### Purpose:

- Usually stranded copper (Cu) or Aluminum (Al) is used.
- Copper is denser and heavier, but more conductive than aluminum.
- Electrically equivalent aluminum conductors have a cross-sectional area approximately 1.6 times larger than copper, but half the weight.
- The size of the copper / Aluminum conductor forming one of the cores of a cable is



expressed in square millimeters (mm<sup>2</sup>), and the current rating of the cable is dependent upon the cross-sectional area of each core.

- Multi-core Aluminum or copper conductor are produced by two shapes

**Circular Conductor:** Multi-layers of stranded wires are assembled together to make circular shape.

- To achieve a circular conductor, the number of strands follows a particular progression: 3, 7, 19, 37, 61, and 127 etc, the diameter of each strand being chosen to achieve the desired cross-sectional area of whole conductor.
- Circular shape conductor is normally available used up to 200mm.2

**Segmental Conductor:** Five segments of compacted conductor in triangle shape of 72 degree are assembled together with separation of non-metallic tapes to reduce the skin effect which reduce the AC conductor resistance.

- Larger sizes have conductors with the strands laid up in a segmental formation; this cable achieves a better space factor and reduces the overall diameter of the cable. It also reduces the inductance of the cable due to decreased spacing between phases
- Segmental conductor is normally available from 1000 mm<sup>2</sup> and above.

## 2. Conductor Screen (Semi Conductor Screen):

**Code:** IS: 7098/IEC: 60502/ BS: 6622/BS: 7835

**Material:** Extruded thermo set semi-conducting



compound, carbon paper and carbon loaded polymer.

**Used for:** Cable from 6 to 30kV (MV & HV Cables)

**Purpose:**

- This screen consists of a lapped copper tape or metallic foil usually less than 1.0mm in thickness, which is the interface between the conductor and the insulation (PVC, XLPE).
- The main purpose of conductor screen is to maintain a uniformly divergent electric field, and to contain the electric field within the cable core.
- Conductor screen is semi-conducting material because semi-conducting materials do not conduct electricity well enough to be a conductor but will not hold back voltage. It

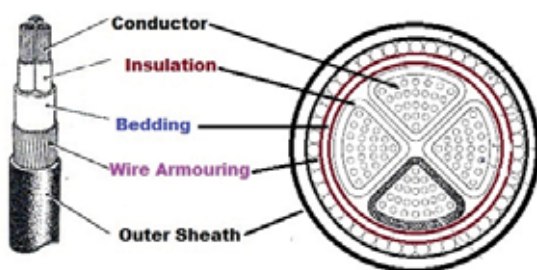
smoothes out the surface irregularities of the conductor. The conductor shield makes the voltage on the inside of the insulation the same.

- Semiconducting screening materials are based on carbon black that is dispersed within a polymer matrix. The concentration of carbon black needs to be sufficiently high to ensure an adequate and consistent conductivity.
- The incorporation must be optimized to provide a smooth interface between the conducting and insulating portions of the cable.
- The smooth surface is important as it decreases the occurrence of regions of high electrical stress.

**Control Electrical Field:** Conductor screen is control the electric field within the insulation and thus the same voltage gradient across it. It also avoids any interaction of the electric stresses due to the voltages on different phase conductors within the same cable.

**Reduce Voltage Stress:** Conductor Screen helps to reduce voltage stress at the interface between the conducting and insulating components.

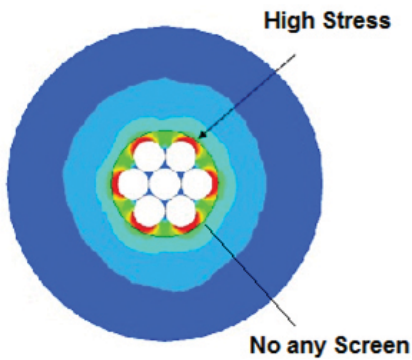
- A typical construction for a medium voltage cable consists of an aluminum conductor covered by a screening layer, then by a polyethylene or ethylene propylene rubber



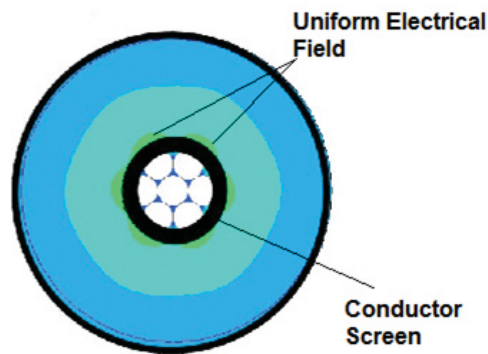
**MV / HT Cable**



Cable without Conductor Screen



Cable with Conductor Screen



insulation followed by a further screening layer. The coefficient of expansion of the insulation layer is typically ten times greater than that of the aluminum and when the cable is at its maximum operating temperature of 90°C, a large enough gap can be formed to allow electrical discharges to occur. The semi-conducting layer then serves to even out the stresses associated with these discharges, which would otherwise attack the insulation at specific points.

**Uniform Electrical Field:** A black semi-conducting tape is used to maintain a uniform electric field and minimize electrostatic stresses in MV/HV power cables.

- The external surfaces of the conductor may not be smooth, particularly for stranded conductors, so this layer provides a smooth surface at the same potential as the conductor to keep the electric field consistent all the way around the surface. Without this layer, any small peaks or troughs could cause concentrations of electrical energy which could create small arcs, and over time could erode the insulation layer and cause failure of the cable.

**Reduce Electrical Flux line around the each core:** It provide a cylindrical, smooth surface between the conductor and insulation

- Semi-conducting compounds also have the effect of filling in the interstices of the conductor giving a smooth surface for the insulation. This reduces the electrical flux lines around each individual wire that make up the conductor, which can reduce the stress by 10-15%.

### 3. Filler & Binding Tap (Laying-Up):

**Material:** Non-Hygroscopic PVC / Poly propylene Fiber to maintain roundness of cable.

**Used for:** LV, MV & HV Cables

#### Purpose

- In case of three core cables, the three cores are laid up with polymer compound or non-hygroscopic fillers like polypropylene (PP) fillers and a binder tape is applied with an overlap to provide a circular shape to the cable.
- These binder tapes can be of PVC or foamed Polyethylene.
- Inner Sheath (Bedding) for Armored Cables. Extruded layer of PVC or PE is applied over the laid up cores for armored cables.

### 4. Insulation

**Code:** IS: 7098, 8130, 14494 / IEC: 60502 / BS: 6622/BS: 7835.

**Material:** PVC, XLPE, Rubber, Elastomer, EPR.

**Used for:** LV, MV & HV Cables

#### Purpose:

- Insulation main Purpose is to withstand the electrical field applied to the cable for its design life in its intended installed environment.
- This will be an extruded layer of XLPE, Elastomer, Rubber or PVC applied over conductor screen under triple extrusion process along with conductor screen and insulation screen.
- There are different Type of Insulation Material used for cable but widely used are

#### (A) Cross-linked polyethylene: (XLPE)

- They are known as PEX or XLPE Cable. It is form of polyethylene with cross links.

- XLPE creates by direct links or bonds between the carbon backbones of individual polyethylene chains forms the cross linked polyethylene structure.
- The result of this linkage is to restrict movement of the polyethylene chains relative to each other, so that when heat or other forms of energy are applied to the basic network structure cannot deform and the excellent properties that polyethylene has at room temperature are retained at higher temperatures.
- The cross linking of the molecules also has the effect of enhancing room temperature properties.
- The useful properties of XLPE are temperature resistance, pressure resistance (stress rupture resistance), environmental stress crack resistance (esc), and resistance to UV light, chemical resistance, oxidation resistance, room temperature and low temperature properties.
- XLPE cables work for the working voltage of 240 V to 500 KV.
- The jacketing material can be of PVC / Flame Retardant / Flame Retardant Low Smoke / Zero Halogen (LSOH).

**Applications:** Fire Survival, Under Water Cables, Underground burial, installation on trays and ducts.

#### (B) Polyvinyl Chloride (PVC)

- They are known as PVC insulated cables are widely used in various fields.
- PVC's relatively low cost, biological and chemical resistance and workability have resulted in it being used for a wide variety of applications.
- For electric cables the PVC is mixed up with plasticizers. PVC has high tensile strength, superior conductivity, better flexibility and ease of jointing.
- PVC is a thermoplastic material, therefore, care must be taken not to overheat it; it is suitable for conductor temperatures upto 70°C. PVC insulated cables should not be laid when the temperature is less than 0°C, because it becomes brittle and is liable to crack.

**Applications:** Low voltage copper conductor PVC cables are extensively used for domestic home appliances wiring, house wiring





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- Polyethylene Cables
- HT & LT Aerial Bunched Cables
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- VLF partial discharge measurement

and internal wiring for lighting circuits in factories, power supply for office automation, in control, instrumentation, submarine, mining, ship wiring applications etc.

## (C) Elastomer insulated cable

- These cables are suitable for use where the combination of ambient temperature and temperature-rise due to load results in conductor temperature not exceeding 90°C under normal operation and 250°C under short-circuit conditions.
- This insulation shall be so applied that it fits closely on the conductor (with or without either separator or screen) but shall not adhere to it. The insulation, unless applied by extrusion, shall be applied in two or more layers and it is applicable to cables with a rated voltage up to 1 100 volts.

**Applications:** Welding Cables, Ship wiring cables, Pressure Tight Cables and cables for submerged connection, Railways locomotives and coach wiring cables, mining cables.

## (D) Polyvinyl chloride (EPR).

- For high-voltage cables, the insulation is ethylene propylene rubber (EPR) and for low-voltage cables it is polyvinyl chloride (PVC).
- EPR has good electrical properties and is resistant to heat and chemicals; it is suitable for a conductor temperature up to 85 °C.

## (E) Rubber insulated cable

- These are used in electric utilities such as the generation and transmission of electricity. Long service life under normal environment in nuclear and conventionally powered generating stations plus safety considerations are the significant factors of these electric appliances.
- When exposed to fire, Silicon offers circuit integrity, low smoke evolution, and freedom from halogen acids.

## 5. Insulation Screen

**Code:** IS: 7098/IEC: 60502/ BS: 6622/BS: 7835

**Material:** Extruded thermo set semi-conducting compound, Carbon paper and carbon loaded polymer.

**Used for:** Cable from 6 to 30kV (MV & HV Cables)

### Purpose

- An extruded layer of semi conducting is applied over the insulation layer to insure that the electric stress is homogenous

around the insulated core. The semi conducting layer shall be firmly bonded to the outer layer of the insulation layer.

- The purpose of insulation screen is same as conductor screen.
- The purpose of insulation screen is to reduce voltage stress at the interface between the conducting and insulating component.
- A cylindrical, smooth surface between the insulation and metallic shield.
- Insulation screen is a layer of black cross linked semi conductive compound of approx 1mm thickness and is either fully bonded to the insulation layer, or can be "cold strippable" by hand.
- When terminating or jointing the cables, it is necessary to remove a part of the insulation screen.

## 6. Bedding (Inner Sheath)

**Code:** IS: 7098, 1554 / IEC: 60502 / BS: 6622 / BS: 7835.

**Material:** Thermoplastic material i.e. PVC, Polyethylene, thermosetting (CSP) compound

**Used for:** LV, MV & HV Cables

### Purpose

- It could be also called inner sheath or inner jacket, which serves as a bedding under cable armoring to protect the laid up cores and as a separation sheath.
- Inner sheath is over laid up of cores.
- It gives circular shape of the cable and it also provides Bedding for the armoring.
- IS: 1554 permits following two methods of applying the Inner Sheath of thermoplastic material i.e. PVC, Polyethylene etc., which is not harder than insulation.
- Inner sheath is provided by extrusion of thermoplastic over the laid up of cores.
- Inner sheath is provided by wrapping at thermoplastic tape.
- All multi-core cables have either extruded PVC inner sheath or thermoplastic wrapped inner sheath, which is compatible with insulation material and removable without any damage to insulation. Single core cables have no inner sheath.

## 7. Water blocking Tapes

- Water blocking is used to prevent moisture migration.
- Water blocking tapes or Swelling powder should be applied between the conductor

strands to block the ingress of water inside the cable conductor (if required).

- Water blocking methods to be considered are as follows:
- **Powders:** Swell able powders are used as longitudinal water blocks in cables to prevent longitudinal water penetration. These powders swell and expand sufficiently upon contact with water to form a gel-like material to block the flow of water.
- **Water-Blocking Tapes:** A water-blocking tape is usually a non-woven synthetic textile tape impregnated with, or otherwise containing, a swell able powder.
- **Sealed Overlap:** To ensure a seal of the overlap, hot-melt adhesives can be used. These adhesives can be extruded or pumped into the overlap seam of a longitudinally formed metallic tape before the seam is closed during cable manufacture.

## 8. Metallic Screen

**Code:** IS: 7098 /IEC: 60502 / BS: 6622/ BS: 7835.

**Material:** Non-magnetic metallic materials Copper Wire / Tape or Aluminum Wire / Strip

**Used for:** MV & HV Cables

### Purpose:

- Medium Voltage & High voltage cables have an earthed metallic screen over the insulation of each core.
- This screen consists one or multi layers of a lapped conductive copper wires, copper tape or metallic foil, lead, aluminum helically with overlap over insulation screen.
- The metallic shield needs to be electrically continuous over a cable length to adequately perform its functions of electrostatic protection, electromagnetic protection, and protection from transients, such as lightning and surge or fault currents.
- (1) **Shield Electromagnetic radiation:** A metallic sheath is used as a shield to keep electromagnetic radiation in the cable.
- The main function of the metallic screen is to nullify the electric field outside of the cable – it acts as a second electrode of the capacitor formed by the cable. The screen needs to connect to earth at least at one point along the route.
- The capacitive charging current and induced circulating currents which are generated

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under normal operating conditions will be drained away through the screen.

(2) **Earth Path:** It also provides a path for fault and leakage currents (sheaths are earthed at one cable end).

- The screen also drains the zero-sequence short circuit currents under fault conditions; this function is used to determine the required size of the metallic screen.

- Lead sheaths are heavier and potentially more difficult to terminate than copper tape, but generally, provide better earth fault capacity.

(3) **Water Blocking:** The other function of metallic sheaths is to water block and form a radial barrier to prevent humidity from penetrating the cable insulation system.

(4) **Mechanical Protection:** It also provides some degree of mechanical protection to cable.

- Cable shields are non-magnetic metallic materials. The two materials typically used for metallic shields are aluminum and copper. Aluminum requires a larger diameter as a wire or a thicker cross section as tape to carry the same current as copper. At equivalent current-carrying capacity, an aluminum shield will be lighter in weight but about 40% larger in dimensions

## Different Types of Metallic Screen

### (A) Concentric Copper Wire screens /Tapes

#### Advantages

- Lightweight and cost-effective design.
- High short-circuit capacity.
- Easy to terminate.

#### Drawbacks

- Low resistance of screen may necessitate need for special screen connections to limit the circulating current losses.
- Does not form a complete moisture barrier unless water swell able tapes are used under and/or over the copper wires.

### (B) Aluminum foil laminate

#### Advantages

- Lightweight and cost effective design.
- Moisture proof radial barrier.

#### Drawbacks

- Low short circuit capacity.
- More difficult to terminate – requires special

screen connections.

### (C) Extruded lead alloy sheath

#### Advantages

- Waterproofing guaranteed by the manufacturing process.
- Excellent resistance to corrosion and hydrocarbons (suitable for oil and gas plants).

#### Drawbacks:

- Heavy and expensive.
- Lead is a toxic metal whose use is being restricted in some countries.
- Limited capacity for short circuits.

## 9. Armoring:

**Code:** IS: 7098 / IS: 3975 / IEC: 60502 / BS: 6622/ BS: 7835.

**Material:** metallic or non-magnetic Aluminum, Steel wire/strip.

**Used for:** LV, MV & HV Cables

- The armor provides mechanical protection against crushing forces.
- Armor also can serve as an Earth Continuity Conductor (ECC).

- The armoring type could be:

Mechanical protection of the cable is provided by a single layer of wire / strip strands laid over the bedding. Steel wire or strip is used for 3-core or 4-core cables, but single-core cables have aluminum wire armoring.

- When an electric current passes through a cable, it produces a magnetic field (the higher the voltage the bigger the field). The magnetic field will induce an electric current in steel armor (eddy currents), which can cause overheating in AC systems. The non-magnetic aluminum armor prevents this from happening.

- **Magnetic Material's armoring for 3Ph System:** With 3-core or 4-core cables the vector sum of the currents in the conductors is zero, and there is virtually no resultant magnetic flux. In multi-core, armored cables have either single layer of Galvanized Steel wire Armor or Galvanized steel strip applied over inner sheath with left hand lay.

- **Non-Magnetic Material's armoring for 1Ph System:** This is not so, however, for a single-core cable, where eddy-current heating would occur if a magnetic material was used for the armoring. The material has

to be non-magnetic for armoring as in this case of return current is not passing through the same cable. Hence, it will not cancel the magnetic lines produced by current. These magnetic lines which are oscillating in case of AC systems will give rise to eddy currents in magnetic armoring and hence, armoring will become hot, and this may lead to failure of the cable. Hence, single core cables for use on AC systems are armored with single layer of non-magnetic (aluminum) material.

#### Armoring is mostly of following type:

- SWA - Steel wire armor, used in multi-core cables (magnetic),
- AWA - Aluminum wire armor, used in single-core cables (non-magnetic).
- Tinning or galvanizing is used for rust prevention. Phosphor bronze or tinned copper braid is also used when steel armor is not allowed.
- As strip construction is economical, the manufacture always provides steel strip armoring unless wire armoring is specified.
- As per IS: 1554 Round Wire armoring is provided in cable where calculated diameter under amour is upto13mm. Above this the amour is either steel wire or steel strip of size 4.00X0.80mm.

## 10. Over Sheath (Outer Jacket):

**Code:** IS: 7098 / IEC: 60502 / BS: 6622/BS: 7835.

**Material:** PVC Flame Retardant / Flame Retardant Low Smoke / Zero Halogen (LSOH), High density Polyethylene HDPE, Halogen Free Flame Retardant (HFFR)

**Used for:** LV, MV & HV Cables

#### Purpose:

- It is the outer protection part of the cable against the surrounding environment.
- Protected against water ingress, protection against termite, protection against UV and protection against differing soil compositions.
- It is applied over armoring in case of armored cable and over inner sheath in case of unarmored cable called as 'Outer Sheath'.
- The standard sheath color is Black other colors such as Red, Light Blue can also be provided.
- High-voltage cables are identified by outer sheaths colored red; a black sheath indicates a low-voltage cable

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The following are the electrical property may be considered while selecting an outer Sheath Materials

- **Dielectric Strength:** Cable Sheath may be semiconducting or insulating.
- **Discharge and Tracking Resistance:** When a non shielded cable rests upon or comes into contact with a ground plane, the ground plane acts as the outer plate of the capacitor, made up of the conductor, insulation and the ground plane. Discharges and tracking may cause erosion of the outer sheath material.
- **Material:** A major consideration in selecting outer sheath may be a thermoplastic or thermosetting material. Mostly, a thermoplastic jacket is less expensive. However, thermoplastics will melt at some elevated temperature and, thus, could run or drip from the cable under extreme conditions.
- Thermoset materials will not melt and run or drip at elevated temperatures.

## Comparison of Cable

### PVC Insulated Cable

- PVC insulation becomes stiff making it difficult to fold and the soft PVC loosens its softening agent over years, making it brittle and prone to rip.
- Even at the time of disposing, burning PVC emits toxic dioxin, which is responsible for causing cancer and does, when dumped scantily dissolve.
- PVC is thin insulation mainly used in LT side cables and XLPE is thick insulation used in MV & HT cables.

### XLPE Insulated Cable

- **Higher Current Capacity:** XLPE has higher current carrying capacity.
- **Higher Temperature Withstand Capacity:** It can withstand higher temperature compared to PVC cable.
- **Higher Overload Capacity:** XLPE have high overload capacity.
- **Low Dielectric Constant:** XLPE has lower dielectric and constant power factor.
- **Light weight & Small Bending Radius:** XLPE cables are lighter in weight, has smaller bend radius, and hence lesser installation cost.
- **Higher Short Circuit Capacity:** XLPE has

higher short circuit rating. XLPE can withstand higher & lower temperatures insulation is usually thinner but the resistance is higher.

- **Higher Moisture Resistance:** XLPE also has a higher moisture & chemical resistance.
- Cable installation job for XLPE is easier than PVC insulated cables because of less weight, less diameter and less bending radius.
- The volume resistivity (ohm-cm) for XLPE is way higher than the PVC cables which are of the order of XLPE cable has insulation resistance of 1000 times compared to PVC cables.

### Elastomer Insulated Cable

- Elastomer cables are preferred for flexible application and in congested locations, where the bending radius are very small. Elastomer cables are available from low voltage up to 33 kV grade.
- Elastomer cables are also available with rigid copper conductors and having properties like fire survival, zero halogen and low toxicity FS properties.

### Rubber Insulated Cable

- Rubber insulation remains in the best condition after a long span of time, say 25-30 years and remain soft and pliable even when the temperature is low.
- Rubber Cables are predominantly used in special applications like, mining, ship wiring, transportation sector and defense applications & earth moving machines.
- These materials have the potential to be recyclable since they can be molded, extruded and reused like plastics, but they have typical elastic properties of rubbers which are not recyclable owing to their thermosetting characteristics

## Cable Selection Parameters

### Voltage of Cable

- The Nominal voltage is to be expressed with two values of alternative current  $U_0/U$  in V (volt).
- $U_0/U$  : Phase to earth voltage
- $U_0$  : Voltage between conductor and earth
- $U$  : Voltage between phases (conductors)
- (i) Low-tension (LT) cables — upto 1000 V
- (ii) High-tension (HT) cables — upto 11,000 V

- (iii) Super-tension (ST) cables — from 22 kV to 33 kV
- (iv) Extra high-tension (EHT) cables — from 33 kV to 66 kV
- (v) Extra super voltage cables — beyond 132 kV
- A low-voltage system usually has a solidly earthed neutral so that the line to earth voltage cannot rise higher than (line volts)  $\div \sqrt{3}$ . Cables for low-voltage use are insulated for 600V rms score to earth and 1000V rms core to core.
- High-voltage cables used in Shell installations are rated 19000/3300V or 3810/6600V or 6600/11000V, Phase/Phase.
- In selecting the voltage grade of cable, the highest voltage to earth must be allowed for. For example, on a normal 6.6kV unearthed system, a line conductor can achieve almost 6.6kV to earth under earth-fault conditions, to withstand this, a cable insulated for 6600/11000V must, therefore, be used.

### Current Carrying Capacity

- The current carrying capacity of a cable is called Ampacity. Ampacity is defined as the maximum amount of electrical current a conductor or device can carry before sustaining immediate or progressive deterioration and is the rms electric current which a device or conductor can continuously carry while remaining within its temperature rating.

### Short Circuit Values

- The “short-circuit current rating” is the maximum short-circuit current that a component can withstand. Failure to provide adequate protection may result in component destruction under short circuit conditions.
- Short circuits and their effects must be considered in selecting cables. These cables should have a short circuit rating which is the highest temperature the cable can withstand during an electrical short circuit lasting up to about half a second.

### Type of Conductor

- Type of Conductor Material Copper or Aluminum is main criteria for selection of Cable

### No of Core



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- Multi Core cables up to 400 mm<sup>2</sup>
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- No of core selection is depends upon power system.
- For Single Phase Power Supply, we can use 2 core cable for three phase supply we can use 3.5 core or 4 core cable for HV supply. We may be use single core cable.

## Voltage drop

- It is a primary concern when installing lengths of cables is voltage drop. The amount of voltage lost between the originating power supply and the device being powered can be significant. All cables have resistance, and when current flows in them, this results in a volt drop.

## Type of Insulations

- Type of Cable Insulation Material like, PVC, XLPE, Rubber
- PVC Cable is cheaper than XLPE Cable

## Method of Installation

- If we lay cable in ground armor cable is required. But if we lay cable in cable tray, we may be used an armor cable to reduce cost of cable.
- If we lay cable on cable tray, then shielded cable is required.
- Mutual heating effect due to cable group laying is also considered while selecting a cable. When multiple cables are in close proximity, each contributes heat to the others and diminishes the amount of external cooling affecting the individual cable conductors. Therefore, cable de rating is necessary consideration for multiple cables in close proximity.

## Shielded Cable or unshielded Cable

The choice of a shielded cable or non-shielded cable depends upon some criteria.

- An area such as a production/factory floor where heavy equipment being used is a prime example of a place where we might consider a shielded cable.
- Grounding can also be a concern in some installations. If shielded cable is used to connect equipment from two different circuits, a ground loop can occur, causing noise on a network line. If the ground voltage difference is great enough, it may even cause damage.
- Terminations of the shielded cable must also

be made with care to provide for a smooth dielectric transition from the shielded condition to the unshielded condition.

- The substantial space required if shielded cables were used. Shielded cables require a significant amount of space at each end of the cable for installation of the stress cone kit. Also, the minimum bending radius for shielded cables is twelve times cable outside diameter, whereas the minimum bending radius for unshielded cables is only eight times outside diameter (and even less with extra-flexible appliance connection cables used in controllers).
- The two factors, high cost and large space requirements, preclude use of shielded cable in switchgear.

## Economics

- It is also an important factor for selecting the type of cable.
- It is to be kept in mind that the cost of cable should not be such large that it causes loss and another cable may fetch the same results in low cost and loss.

## Environmental Conditions

- Cable operates at its best when it is installed in its optimum environmental conditions.
- For example, Elastomeric Cable is applied in trailing, coal cutter, wind mill, panel wiring, battery cable and such other areas. XLPE cables work good in areas where moisture content is good. Thus, proper cable should be selected so that the system becomes more efficient.

## Applications

- Low voltage cables with both PVC and XLPE insulation are suitable for indoor and outdoor applications.
- Armored cables are not recommended for tray applications, as they are heavy in weight and extra loads are exerted on the tray.
- Unarmored cables are not recommended for direct buried applications, except if the quoted cables are designed and produced to pass direct burial test requirements (example, direct burial tests described in UL 1277 and UL 1581).
- A PVC jacket is a very stable material against a wide range of chemicals, while HDPE jacketed cables can serve better in wet

locations.

## Cable Core Colors Identification

- Single core - Natural
- Two core - Red, Black
- Three core - Red, Yellow and Blue
- Four core - Red, Yellow and Blue and Black
- Five core - Red, Yellow and Blue and Black and Green

## Abbreviation for PVC & XLPE Cable

- A = Aluminum Conductor.
- Y = PVC Insulation or PVC Sheath
- 2X = Cross-linked Polyethylene Insulation
- W = Round Steel Wire Armoring
- WW = Double Round Steel Wire Armoring
- F = Formed Steel Wire (Strip) Armoring
- FF = Double Formed Steel Wire (Strip) Armoring
- C = Metallic Screening (Usually of Copper)
- CE = Metallic Screening (Usually of Copper) over each individual core.
- Gb = Holding Helix Tape (of Steel)
- Wa = Aluminum Round Wire & Aluminum Formed Wire (Strip) Fa Armoring.

## Example:

- **AYY:** Aluminum Conductor, PVC Insulated, PVC Outer Sheathed Heavy Duty Cables.
- **AYWY:** Aluminum Conductor, PVC Insulated, Round Steel Wire Armored and PVC Outer Sheathed
- **AYFY:** Aluminum Conductor, PVC Insulated, Flat Steel Wire (Strip) Armored and PVC Outer Sheathed
- **AYCY:** Aluminum Conductor, PVC Insulated, Metallic Screened and PVC Outer Sheathed
- **A2XCY:** Aluminum Conductor, XLPE Insulated, Metallic Screened and PVC Outer Sheathed

## Cable Application Standard

- IEC 60502 (Part 1) "PVC/ XLPE insulated cables" single core /multi-core
- BS 5467 for XLPE insulated armored cables
- BS 7889 for XLPE insulated single core unarmored cables



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# Self Regulating Heat Tracing Cable

Self-regulating trace heater cables on roofs or gutters are used to melt ice during winter months. When used in gutters the cable is not meant to keep the gutters free of ice or snow,

but only to provide to free path for the melted water to get off the roof and down the downspout or drain piping. Similarly, hot water service piping can be traced, so that a circulating system is not needed to provide hot water at outlets. The combination of trace heating and the correct thermal balance where the heat output from the trace heating matches the heat loss from the pipe. Self-limiting or regulating tapes have been developed and are very useful in this application. In this paper authors like to discuss about development, uses and product classification approach to measure the temperature class of thermopads make self-regulating type trace heater model STF 15 J.



Every pipe or vessel is subjected to heat loss when its temperature is greater than ambient temperature. Thermal insulation reduces the rate of heat loss but does not eliminate it. Self-regulating heat tracing tape is used for pipe freeze protection application. Its resistance varies with temperature. When the cable temperature reaches the set point, the resistance goes high and then no more heat is supplied. This means heat is supplied only where needed along the length of the cable.

A trace heating system shall be designated so that the sheath temperature of the trace heater is limited to a temperature class or ignition temperature, minus 50K for temperature

less than or equal to 200°C or minus 100K for temperatures greater than 200°C. Maximum sheath temperatures of trace heaters shall be determined for proper application of the heater.

## Development

Electrical trace heating began in the 1930s. Mineral insulated cables ran at high current densities to produce heat and control equipment was adapted from other applications. Mineral insulated resistance heating cable was introduced in the 1950s, and parallel type heating cables that could be cut to length in the field became available. Self-limiting thermoplastic cables were marketed in 1971.





Figure 1: Self-regulating trace heater cable STF15J for freeze protection in pipes.

Control systems for trace heating systems developed from capillary filled bulb thermostats and contractors in the 1970s to network computerized control in the 1990s, in large system that require centralized control and monitoring.

### Uses

The most common pipe trace heating applications include:

- Freeze protection
- Temperature maintenance
- Snow melting on driveways

Other uses of trace heating cables include

- Ramp and stair snow / ice protection
- Gulley and roof snow / ice protection
- Under floor heating
- Door / frame interface ice protection
- Window de-misting
- Anti-condensation
- Pond freeze protection
- Soil warming
- Anti-cavitation purpose
- Reducing condensation on windows.

### Self-regulating

Self-regulating heat tracing tapes are cable whose resistance varies with temperature – low resistance for temperatures below the cable set point and high resistance for temperatures above the cable set point. These cables used two parallel bus wires which carry electricity but do not create significant heat. They are encased in a semi-conductive polymer. This polymer is loaded with carbon as the polymer element heats, it allows less current to flow. The cables are manufactured and then irradiated and by varying both the carbon content and the dosage then different tape with different output characteristics can be produced. There is then an inner jacket which separates the bus wires from the grounding braid. In commercial and industrial cables, an additional outer jacket of rubber or teflon is applied. The benefits of this cable are the ability to cut to length in the field. It is more rugged but

not necessarily more reliable than series or zone heaters, it cannot over-heat itself so in theory it can be crossed, but it is bad practice to install tape in this way. Self-regulating heating cables have a specific maximum exposure temperature based on the type of polymer which is used to make the heating core which means that if they are subject to high temperatures then the tape can be damaged beyond repair. Also self-limiting tapes are subject to high inrush currents on starting up similar to ‘induction’ motor so a higher rated contactor is required.

### Thermo trace Self Regulating Trace Heater Cable

STF15J is a self-limiting heating tape for applications for freeze protection applications in pipe lines. It comprises of the inner insulation of TPE material and outer jacket of fluoropolymer. As the cable self regulates its heat output, it limit the maximum sheath temperature. Thus, making it burnout proof. Table 1 shows the technical specifications of STF15J.

### Construction

- 1) 1.2 sq. mm coated copper bus wires
- 2) Semi conductive heating core extruded over bus wires
- 3) TPE jacket providing electrical insulation, mechanical strength and moisture resistance
- 4) Aluminum mylar with drainwire / coated copper braid to give a continuous ground path

- 5) Outer jacket of UV Resistant Fluoropolymer (J)/TPE(JT) to enable use in corrosive area.

### Determination of maximum sheath temperature

At least one of the following two methods shall be used for verifying a trace heater’s sheath temperature or temperature class.

- a) Product classification approach in which the maximum sheath temperature is determined in an artificial environment simulating adverse conditions.
- b) Systems method in which the manufacturer demonstrates the ability to design and predict sheath temperatures of trace heaters by conducting tests on representative installations representing adverse design and operating conditions when installed according to the manufacturers installation instructions.

We are adopting product classification approach for verifying trace heater sheath temperature or temperature class in which the maximum sheath temperature is determined in an artificial environment simulating adverse conditions. A detailed test procedure is described in the following section.

### Determination of Sheath temperature as per Product Classification Approach

A sample of trace heater at least 1500 mm in length is placed loosely coiled in a forced air

Table 1: Technical Specifications of STF15J

Catalogue Reference	STF15J
Heating Power W/m (230V AC) at 100C	15
Voltage Supply	230V AC, 50 Hz., 110/120V AC
Min. Installation Temperature	-400C
Max. Installation Temperature Power on	650C
Max. Exposure Temperature Power Off	850C
Insulation Material Max. Exposure Temperature	1500C(J)/1050C(JT)
Minimum Bending Radius	25mm

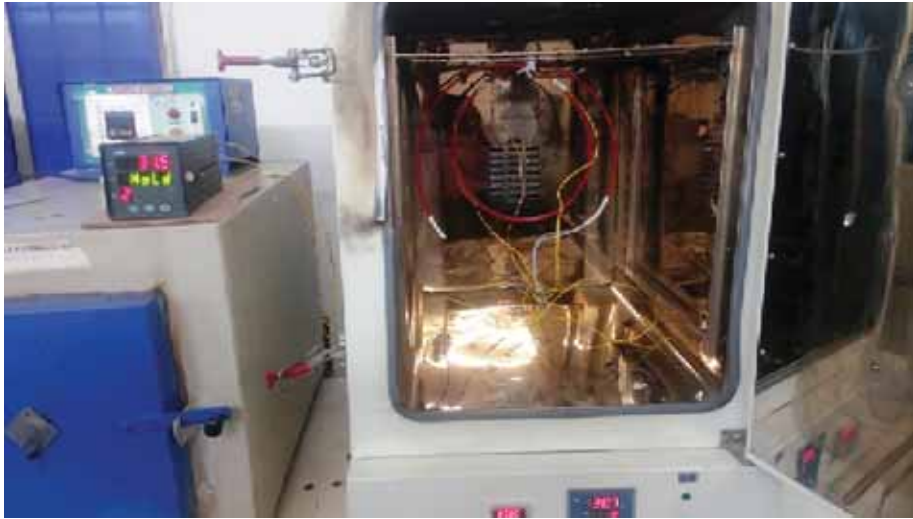


Figure 2: Set up for measuring the sheath temperature of trace heater Cable, STF15J

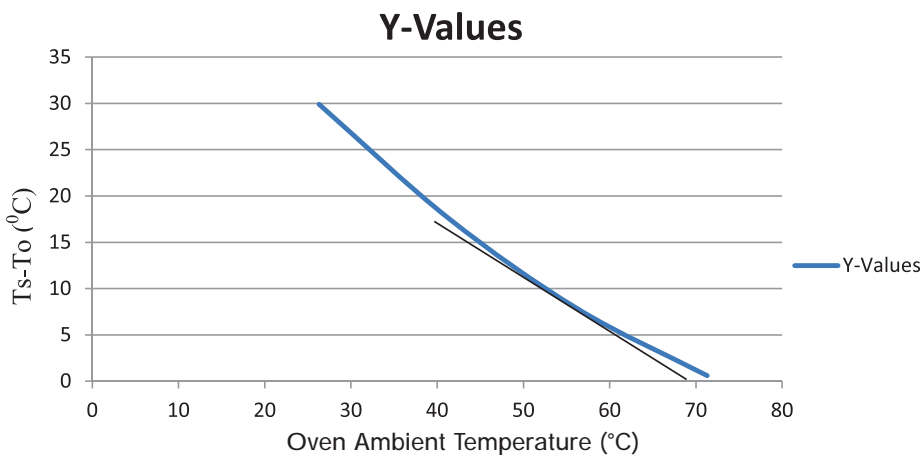


Figure 3: The variation between tracer heater sheath (Ts-To) and oven ambient temperature (To)

circulation oven. For a trace heater pad or panel, a representative sample is placed horizontally in the oven. The sample shall be within the upper half of the trace heater's thermal output tolerance. Representative thermocouples are used to monitor sample sheath temperatures and are placed approximately 500 mm from each end. One additional thermocouple is used to monitor oven ambient temperature. The trace heater shall be powered at 110% of rated voltage. Table 2 shows the measured data of Thermopads make tracer type STF15J.

The oven ambient temperature is incrementally raised from room ambient in approximately 15 oK increments. Sufficient time is permitted at each temperature for the oven ambient and heater sheath temperatures to stabilize and attain thermal equilibrium. Oven ambient and heater sheath temperatures are

recorded at each successive level until the difference ( $\Delta T$ ) between the two approaches 5oK or less. Figure 3 shows the variation between, difference between tracer heater sheath and

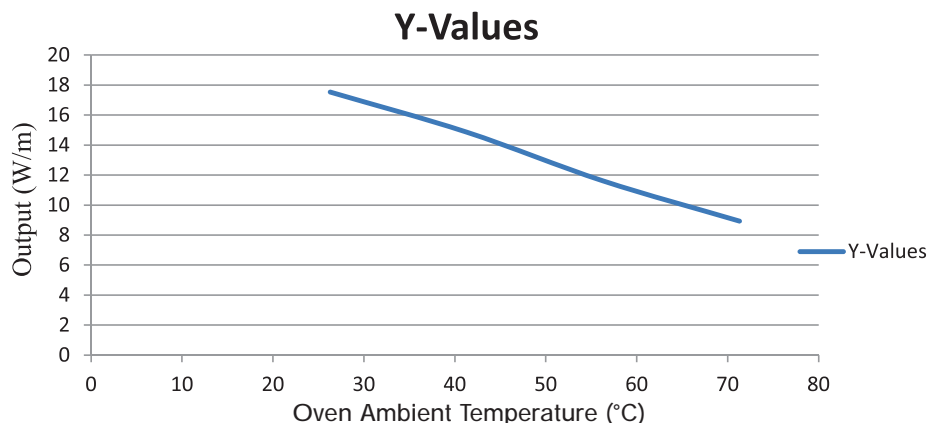


Figure 4: The variation between tracer (STF 15J) output (W/m) and oven ambient temperature °C

oven ambient temperature. A straight line is also drawn tangent to the curve at 5oK temperature difference point and extended to the X axis (oven temperature). The temperature read at this intercept is taken as the maximum sheath temperature which can be verified from the test results and curves obtained. Figure 4 shows the variation between tracer (STF15J) output (W/m) and maintain oven temperature °C.

It is cleared from Table 2 and Figure 4 that tracer STF15J output (W/m) decreases as oven temperature increases.

## Instruments Used to Measure Data

- 1) Digital Ampere Meter 0-10A
- 2) Digital Voltmeter 0-500V
- 3) Digital Voltmeter 0-300V
- 4) Digital Watt Meter 0-200W
- 5) Digital Watt Meter 15-1000W
- 6) Digital Temperature Controller 0-400 Deg.C
- 7) Digital Temperature Controller 0-300 Deg.C
- 8) Data Logger (8 Channels) 0-1370 Deg. C
- 9) Ageing Oven 0-300Deg.C with 3 Nos. K-type thermocouple Sensors
- 10) Ageing Oven 0-400Deg.C with 3 Nos. K-type thermocouple Sensors.

This is an effective means of slowly heating an object to measure thermodynamic properties such as thermal.

## Conclusions

- 1) Thermo trace self-regulating is used for freeze protection of pipeline.
- 2) Tracer maintains the temperature above freezing by balancing heat loss within heat supplied.

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# Application

**Table 2: The Measured Data Of Thermopads Make Tracer Type Stf15j**

Trace Type	: STF 15J							
Wattage (w)	: 15W @ 10 deg. C							
Rated Voltage (v)	: 230							
Total length 9m)	: 1.5							
Measured Temperature in Deg. C.								
Voltage (v) (110% of rated voltage)	Current I (A)	Total wattage VxI (W)	Wattage (W/m)	Sensor-reading (OC)-Placed on tracer heater sample at 500mm away from power connection side)	Sensor-reading (OC)-Placed on trace heater sample at 500mm away from opposite side of power connection )	Max. Sheath Temp (OC) for sensor-1 & sensor-2 reading Ts	Oven Ambient Temp. (OC) To	Difference between tracer heater sheath and Oven ambient temp (Ts-To)OC
254.0	0.10	26.3	17.53	56.2	55.9	56.2	26.3	29.9
254.0	0.09	22.3	14.86	58.9	58.1	58.9	41.3	17.6
253.0	0.07	17.4	11.61	63.9	64.1	64.1	56.3	7.8
254.0	0.05	13.4	8.93	71.9	71.5	71.9	71.3	0.6

- Tracers are cable whose resistance varies with temperature – low resistance for temperature below the cable set point and high resistance for temperature above the cable set point heat.
- As the cable self regulates its heat output, it limits the maximum sheath temperature, thus making it burnout proof.
- The maximum sheath temperature of thermo pads make tracer type STF15J was measured

72°C which comes under temperature class T6 (i.e. less than 85°C).

- The output of tracer STF15J (W/m) decreases as oven temperature increases.



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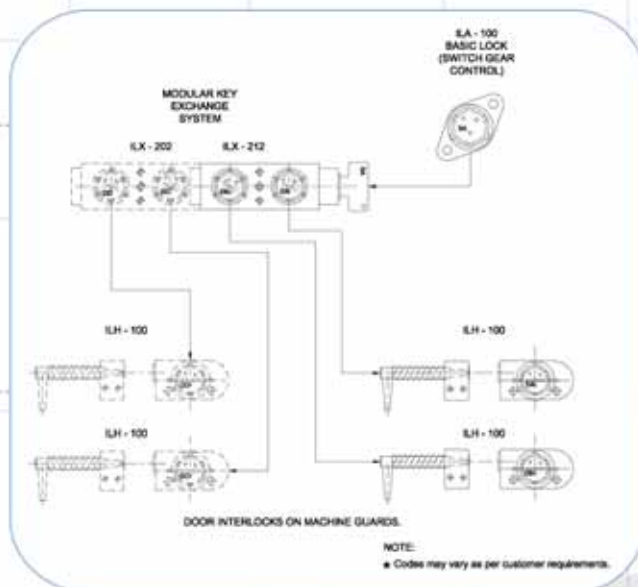
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While designing safety systems for machines, movable guards like doors, panels, gates or other physical barriers are frequently used. Each and every one of these guards should be interlocked with the machine control system so that the hazards covered by the guards will be effectively controlled even when the guard is opened.

This Scheme shows a single control, Multiple Access System. Options of Multiple control systems are also available.

The drawing shows Door interlock suitable for Hinged doors. Contact **PSPC** for suitable locks for sliding and bolted doors.

The **Unique Modular** key exchange system from PSPC allows addition of more guard interlocks to the system at will. For more complex systems use PSPC Rotary switch interlocks, Time Delay interlocks and Remote controlled interlocks with Solenoids, for controlling isolation.



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## “Renewable integration will change generation footprint”

**Sterlite Power** is India’s leading solution provider of energy delivery. It has become a pioneer in introducing some of the best global practices in the Indian power transmission sector. The transmission sector will see investments worth Rs 2,60,000 crore over the next five years to ensure that government’s vision of power for all is met. Private sector will have a huge role to play in this and we are confident of winning a fair share of this market, informs **Ved Mani Tiwari, COO, Sterlite Power** in an interaction with **Electrical India...**

### What are the key market trends of Indian Transmission sector? What are the growth drivers of this sector?

Some key trends the sector has witnessed over the last couple of years are:

**Power Surplus Status:** We as a nation have moved from an era of power deficit to surplus power. Currently, our installed capacity exceeds that of our demand. This is a huge achievement for the sector, where government, public as well as private sector has joined hands to deliver this.

**Lowering T&D losses:** Transmission and Distribution (T&D) losses, also referred to as Aggregate Technical & Commercial (AT&C) losses, while still high, have come down significantly. At an all-India level, the T&D losses have come down from 26.63% in 2011-12 to 21.81% in 2015-16. Government is targeting to bring it down to 15 %

by 2019 through use of smart metering, better detection of theft, and more efficient transmission and distribution network.

**One Nation One Grid:** The power market in the country operates in five different grids and with the integration of the southern grid with the national grid, the country has the One Nation One Grid One Price is closer to reality. This means a seamless interconnected grid network across the country capable of transferring a watt of energy from a surplus zone to a deficit one.

**Private participation:** The opening of the transmission sector to private participation has been one important policy intervention. From there moving to a Tariff Based Competitive Bidding (TBCB) has not just laid a level playing field for all players but also reduced the project cost and timelines. Success of BOOM projects is a good testimony of healthy private participation in the sector.



**Rise of renewables:** Our renewables capacity, which includes solar and wind, are galloping at a very healthy clip. Of the 330 MW installed capacity as on June 2017, 58 GW comes from renewables. This was 44GW last year. Comparatively, thermal capacity rose by just 6GW during the same period. This gap will only rise in the years to come.

**Technology for transparency:** Government is using technology to enhance transparency in the sector. Each power mission now has an app (e.g. URJA, UDAY, DEEP, TARANG etc.) which could be tracked by anybody. This is very helpful for all stakeholders.

The Growth drivers of transmission sector are:

- Govt scheme like UDAY to improve health of DISCOM
- IPDS, rural electrification programme, DDUGJY
- Allotment of funds into Clean energy fund, PSDF.
- Improvement in per capita consumption
- MVA/MW ratio
- Inter-regional transmission capacity
- Improvement in the last mile connectivity.

**Sterlite Power is the first power sector company and the second infrastructure player to launch the initial public offering of its infrastructure investment trust (InvIT). How much funds did you raise through this IPO? What are the transmission projects in pipeline for which the company will utilize these funds?**

We are happy and proud that the first transmission sector InvIT done by us. We raised Rs 2,250 crore through the listing of India Grid Trust (IndiGrid). The issue was subscribed 1.3 times.

IndiGrid currently has two revenue earning projects in its portfolio and it plans to acquire its sponsor's, which is Sterlite Power, four additional inter-state power transmission projects. These four projects have a topline of Rs 300 crore and would add around 50-60% growth in topline post acquisition. The acquisition will add 3-5% growth in distribution per unit.

**What kind of opportunities would you envisage for your company with the government's reforms such as 'Power for all' and plans to add 88.5 GW of capacity by 2017 and 93 GW by 2022?**

Indian power grid will see massive changes on both ends – demand will see a phenomenal growth due to Power for All and UDAY. Renewable integration will change generation footprint and profile. Transmission sector will have to make both ends meet – large scale new capacity will be needed.

With renewables taking centre stage in new capacity addition,

inadequate transmission will act as the biggest bottleneck as renewable capacity addition takes just months to come up against years for the supporting power evacuation infrastructure. Hence, those transmission players with a strong focus on ahead-of-time delivery will be able to meet this challenge.

As per the CEA estimate, India would need 100,000 circuit km (ckm) of transmission lines and 2,00,000 MVA transformer capacity of substations at 220 kv and above voltage in the 13th plan. The transmission sector will see investments worth Rs 2,60,000 crore over the next five years to ensure that government's vision of power for all is met. Private sector will have a huge role to play in this and we are confident of winning a fair share of this market.

**Indian power grid will see massive changes on both ends – demand will see a phenomenal growth due to Power for All and UDAY. Renewable integration will change generation footprint and profile. Transmission sector will have to make both ends meet – large scale new capacity will be needed.**

**What are the hurdles the company face while executing the projects? So, what kind of support would you expect from the government?**

While the Ministry of Power has introduced policy for incentivizing early commissioning projects, issues related to revised SCOD (Scheduled Commercial Operational Date), upstream/downstream readiness are yet to be resolved. Deliberation on early commissioning policy and emulation of international best practices will make the standard bid document more effective. Developers like us who invest a lot in technology and project management to deliver projects ahead of schedule will be greatly encouraged if early commissioning is rewarded.

While in principal the states have agreed to move to TBCB, a push is required for its implementing. Competitive bidding will benefit consumers through reduced tariffs. Defining threshold limit for competitive bidding is also required at this stage. One of the key issues faced by infrastructure developers are those related to ROW and Forest clearances. Simplifying these clearances process will reduce the timelines involved and speed up the execution of the project.

Players from nations which don't allow Indian developers to participate in their market should face similar restrictions. While FDI is important for the overall growth of power transmission sector, government should keep in mind the reciprocity given by other countries to us.

# Ancillary services through Microgrid for Grid Security & Reliability



**Prof. Mrs. Kalyani M. Kurundkar**  
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PVG's College of Engineering and Technology, Pune



**Dr. Mrs. G. A. Vaidya**  
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Microgrids can provide potential Ancillary services to the power system for maintaining its voltage profile and frequency. These services also improve stability, security of system and reduce congestion. These will be source of revenue generation for microgrid owner's in near future and will be of great importance to the power market players...

India's sustained growth has led to supply demand imbalance with the peak deficit of 12.7%, which could further increase. Large fraction of population depends on fossil fuels for their energy needs, which increase the green house gas emissions. The government has recognized the importance of renewable energy and it is seen as the environment friendly solution to the problem of increase in energy demand. According to the strategic plan of MNRE for the period of 2011-2017, 20 million solar lights are estimated to avoid the use 1 billion liters of kerosene per annum in 2020 and 5 million sq.m. thermal collectors are expected to save fuel oil of about 350 million liters per annum in 2020. The government is also working towards installation of 10,000 Renewable energy based microgrids in the next five years which will provide access to electricity to 237 million Indians. Government of India has planned for renewable energy (RE) capacity addition of 175 GW by 2022. With technological advances, market shifts, and policy changes that support increasing levels of distributed generation based

on renewable energy sources the Indian electricity system is evolving rapidly. Without a proper integration into network operation, Distributed Generation (DGs) based on intermittent energy might jeopardise the stability of the network at higher penetration levels. The possible impacts on power system operation specifically at distribution level due to high penetration of renewable energy sources are discussed below.

### Bidirectional Power Flows

While distribution feeders were initially designed for unidirectional power flow, integration of DG units at low voltage levels can cause reverse power flows and lead to complications in protection coordination, undesirable power flow patterns, fault current distribution, and voltage control.

### Power Quality Issues

Two main aspects are usually considered under power quality issues: transient voltage variations and voltage harmonic distortion. Depending on several issues such as capacity,

type of prime mover, interface, location, etc. the effect of DG on network voltage can be either positive or negative. In practice, meeting the required standards either from the energy converter side or from the grid side causes no problems to grid operation.

### Stability Issues

The presence of DG may have a considerable impact on the stability of the electric power system since the networks are no longer passive.

### Congestion Problems

In some scenarios, DG may alter branch flows significantly, which may pose additional problems in terms of managing energy flows. This may ultimately cause branch overload, especially, in the case of high levels of renewable-based DG integration, which may inject large amounts of energy into the distribution system.

### Protection issues

Protection of the generation equipment from internal faults; protection of the faulted distribution network from fault currents supplied

by DG; loss-of-mains protection and impact of DG on existing distribution system protection.

### Low inertia

Unlike bulk power systems where high number of synchronous generators ensures a relatively large inertia, DG system might show a low-inertia characteristic, especially, if there is a significant share of power electronic-interfaced DG units.

### Uncertainty

The economical and reliable operation of DG system requires a certain level of coordination among different sources. This coordination becomes more challenging when taking into account the uncertainty of parameters such as load profile and weather forecast.

This impact of distributed generation penetration in the grid can be reduced without compromising the quality of supply and reliability by **ancillary services** for grid support. Reliability of supply with best power quality has become the highest priority of consumers. Ancillary Services in

power system (or grid) operation are support services necessary to support the power system (or grid) operation for maintaining power quality, reliability and security of the grid, e.g. active power support for load following, reactive power support, black start, etc. For secure and reliable operation of power system in restructured environment, there is a need for ancillary services more at distribution level than at transmission level.

Ancillary Services consist of services required for:

- a) Maintaining load – generation balance (frequency control)
- b) Maintaining voltage and reactive power support
- c) Maintaining generation and transmission reserves

Traditionally, ancillary services were provided by the supply authority itself, in a re-regulated regime, where customers are energy producers too, these may be provided by both supply authorities and microgrid owners. 'Microgrid' fundamentally consist of controlled Distributed Energy Resources (DER's) which include a master



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**Table 1: Microgrid components and the corresponding ancillary services**

Microgrid Components	Ancillary services to main grid
All DER systems, WTGs, PV systems and hydro power plants, loads with storage system units but not thermal-driven combined cooling, heat and power (CCHP)	Frequency regulation
Inverter and SG-coupled DG/storage units and Loads but not IG coupled DG	Voltage Control, Congestion Management, Optimization of Grid losses
WT's Coupled with Inverters, SGs, PV with Inverter, Micro-Hydro with Inverter/ SG and Storage	Black Start
WT's With DFIG/ Inverter, PV with Inverter, Micro-Hydro with inverter, CCHP with Inverter, Storage	Fault Ride through Capability

controller with its control system, microsource controller, microsource or distributed generation, storage units and loads. Microgrids can be operated interconnected to the main power grid or in an autonomous mode (standalone or Islanded Mode). The major Ancillary services that are provided by Microgrid to the power system are:

- 1. Frequency regulation:** This service is based on active power control which can be done by controlling the output of DER. Adjusting generation to load minute by minute to maintain specified system frequency within the control area, is known as 'regulation'. This service can be provided efficiently by the microsources (DG's) of Microgrid, which are connected to the grid and at the same time located close to the load pockets. Load following takes place over longer periods. Load following is the capability of on-line generation equipment to track customer load variations and control the load as per the requirement.
- 2. Voltage Control, congestion management and optimization of grid losses:** Ancillary service of voltage control, Congestion Management and Optimisation

of Grid Losses can be provided by controlling the reactive power which not only depends on control capability of the grid-coupling technology but also on the active power control capability of the DER unit. Reactive power and voltage control are needed for regulating distribution voltage within specified limits. Microgrid can perform smooth voltage regulation locally in response to controller settings. Moreover, local supply of real and reactive power from microsources of Microgrid significantly reduces feeder losses and is useful for congestion reduction. For power utilities, reactive power and voltage control is generally accomplished at the cost of generating capacity. If Microgrids provide this service, it would help the utility generators to generate at their maximum capacities, thus enhancing overall generation. The Improvement of Voltage Quality depends on the grid-coupling technology.

- 3. Supply of reserves:** Microgrids can sell three ancillary services, viz. (i) frequency responsive spinning reserve, (ii) supplemental reserve and (iii) backup supply in open competitive market. These services

are aimed at restoring the real-time energy balance between generators and loads in case of any sudden contingency.

- 4. Network Restoration / Black Start:** Black start is defined as the capability of a power system to restart its generation after a total system collapse, without importing any external power. Microgrids can easily sell power for system black start.
- 5. The Fault-Ride-Through Capability** depends on the grid-coupling technology which has to balance the power flow on the grid-side and the DC-side in case of voltage disturbances.
- 6. Islanded Operation:** Islanded Operation requires the capability to control active power, reactive power, voltage and frequency. Active power control can be done by control of the distributed generation. The reactive power control is possible by proper grid coupling technology. Distributed storage is mostly designed for islanded operation for uninterruptible power supplies.
- 7. Network Stability:** Microgrids are capable of sensing the low-frequency oscillations and providing adequate damping. This may

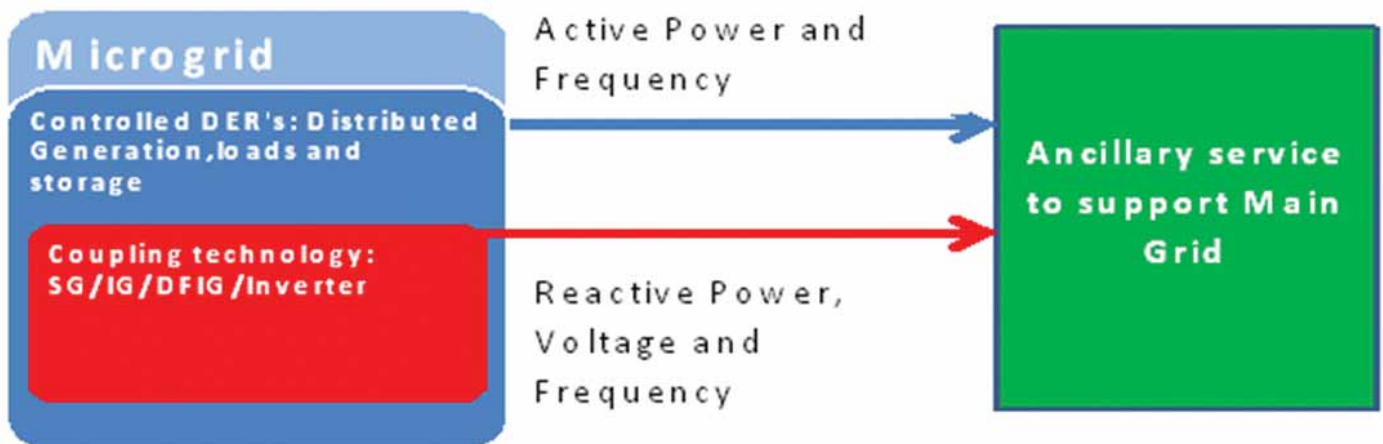


Figure 1: Technological Framework For Ancillary Services through Microgrid

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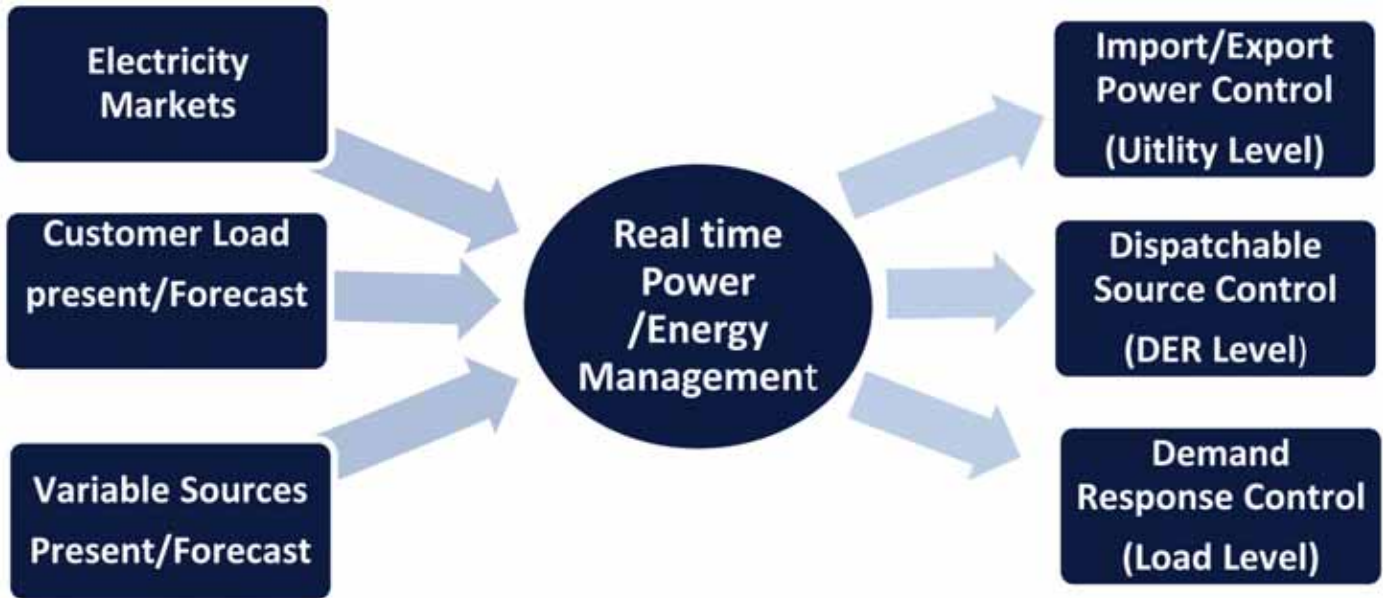


Figure 2: Functions of Energy Management System for Microgrid

be accomplished by making the microsource supply power at 180 degree out of phase from the oscillation.

Harmonic compensation and peak shaving are some of the other ancillary services that can be provided by microgrid.

The Table no 1 shows the Microgrid components and the corresponding ancillary services provided by them. The cost reduction in Information and Communication technology has given the boost to increase the capability of the microgrid master controller (MC) to control the output of DER in Standalone and grid-connected mode. The capability of the microgrid as a whole to provide the ancillary service depends on the grid coupling technologies used to couple DER with the main Grid and also the Controlled DER in the Microgrid. There are different types of grid coupling technologies used like Doubly Fed Induction generators(DFIG),directly coupled Synchronous Generators(SG), directly coupled Induction generators(IG), Inverters (Including Inverter coupled IG or SG). The grid coupling technologies transform the available power input into a power output of a different characteristic.

Fig 1. shows the technological framework, for providing ancillary services through microgrid to main grid. In order to analyze the technological capability of a microgrid to provide the ancillary service, firstly the Grid coupling technology is to

be analyzed and then the controlled DER as a whole. Economic Framework of Provision of ancillary services through microgrid depends upon decision making capacity of Energy Management System (EMS) that will suggest most promising technologies for the provision of ancillary services and most feasible service which will result in incremental revenue for community microgrid owners, providing security of supply to the customers. Microgrid's Master controller has Energy Management System (EMS).

The energy management system as shown in figure 2 controls the power flows in the microgrid by adjusting the power imported/exported from/ to the main grid, controls the dispatchable DERs, the controllable loads based on the present and forecasted information of the market, the generations, and the loads in order to meet certain operational objectives (e.g., minimizing costs) and maximizing the financial gains. For many ancillary services, the EMS would make a decision in a day-ahead market as to whether it would be profitable to supply the service, and at what price. The EMS would then bid into the market and find out if the bid was successful. If successful, the EMS would plan to supply the service the next day. Thus, ancillary service market can be a large source of revenue generation to Microgrid owners. In many parts of the world the microgrid owners are presently making profits from energy markets.

## Market Perspective

The success of any technology depends upon its commercial acceptance and use. Similar, Microgrid technology will be completely successful only if its participation in the energy and ancillary services market will bring profit to its market players without compromising on its assets. For successful implementation of microgrids, in India, the energy and ancillary services market must come forward with strong financial incentives for both i.e. microgrid owners and power utilities. The independent system operators, aggregators and market players will play a very important role in this context. In this case, it is the Microgrids EMS which responds to the pricing signal and act accordingly. Thus, in an Indian Power system with significantly increased levels of renewable energy sources penetration in distribution networks, the opportunities for microgrids to provide ancillary services at distribution level may increase. Ancillary services provision at distribution level has manifold advantages to utility as well as customers. With ancillary services from microgrids, the utility generators can be used to their full capacity for generating electricity. If utility and microgrid owners are able to participate in the ancillary services market, it will bring a lot of benefit to all the stakeholders, improving resource utilization, security, power quality and increasing overall system reliability. ⓑ

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# 50 lakh Smart Meters for Reducing AT&C Losses

The meters are being procured for implementation of smart grid projects in the states of Haryana and Uttar Pradesh. These meters will help these states in not only significantly reducing their AT&C losses way of increased billing efficiency, but will completely change the way in which electrical energy is presently being consumed and paid for by the ordinary consumers...



EESL will be making the entire upfront investment as well as maintain the whole infrastructure for the next ten years. This approach has made the project feasible as most of the state utilities are not in a position for such rollouts due to their financial constraints. EESL will recover its investment from the savings accruing to the DISCOMs in subsequent years.

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Installation of these smart meters along with its associated communication and IT infrastructure will enable the DISCOMs to obtain real time energy consumption data of each consumer for subsequent analysis and will pave the way for initiating various smart measures by DISCOMs like Time of Day (TOD)/Time Of Use (ToU) billing, prediction and management of peak demand, providing real time energy consumption data to consumer, prepaid billing facility, remote connection and disconnection of load, accurate billing, etc. Installation of these meters will also obviate the need for the meter reader's visit to each and every consumer. In order to make the entire project feasible and affordable, EESL has unbundled the Advanced Metering Infrastructure (AMI) project into two parts viz. procurement of smart meter and arranging the system integrator. EESL is also planning to issue the tender for selection of system integrator early next month, as second part of the AMI project.

Senior officials of Haryana and Uttar Pradesh DISCOMs were present in the pre-bid meeting along with representatives from DISCOMs of Bihar, Jharkhand and Odisha, as well as senior officials from CEA, NSGM etc.

**E**nergy Efficiency Services Ltd (EESL), under the Ministry of Power, Government of India had put out a mega tender for procurement of 50 lakh smart meters in July, which would help in reducing AT&C losses, power theft and also help in monitoring of round the clock power supply eventually leading to greater efficiency and 24X7 power for all.

A pre-bid meeting was held by EESL recently for procurement of 50 lakh smart meters, which elicited a stellar response from the smart meter manufacturers, system integrators and has also excited various other stakeholders including World Bank and telecom operators etc. The interest shown by the smart meter fraternity is also evident from the participation of about 100 companies in the pre-bid meeting and is a measure of the potential which smart projects have in India.





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## MV Covered Conductors: Safety Solution for Wildlife

Using Bare Conductors on the overhead distribution lines in forest and wild life sanctuaries resulting fatal accidental death of several wildlife animals and big birds due to electrocution



Presently, we are witnessing several incidents where wild life has been fatally electrocuted in India. 400 flamingos have died in 10 days due to electrocution by high tension cables near their breeding grounds in Gujarat (2014). As many as 139 greater flamingos were electrocuted in Kutch desert wildlife sanctuary. On January 25, a female elephant died due to electrocution in the forests of Odisha's Rourkela district. On the night of 4 September 15, a large tusker was electrocuted by a sagging high tension electric cable in Kaziranga National Park, Assam.

Two leopards, one tigress and two sambar deer were also electrocuted between January 11 and 14(2011) in different forest divisions of Maharashtra's Nagpur district. As per Tito Joseph of the Wildlife Protection Society of India (WPSI), every year at least 20 elephants, 11 leopards die due to electrocution.

According to CEA (Central Electricity Authority) mandatory guidelines, Medium Voltage Covered conductors should be used to reduce the ROW (right of way) of HT lines which are passing through the forest area for the safety of wild life.

Apar has taken the lead from the MAKE IN INDIA initiative to develop Medium Voltage

Covered conductors (MVCC) which is currently imported from overseas manufactures.

### Challenges Faced by Indian Utilities

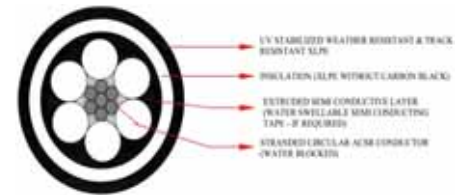
- Outages due to temporary tree contact
- Conductor slashing due to corrosion
- Wide Right of Way (ROW)
- Electromagnetic field effect on electronic Surveillance
- Safety (Road /Rail/River crossings/Slums/ Congested residential areas etc.)

### Technology



Covered conductors consist of a conductor insulated by a covering made of insulating material(s) as protection against accidental contacts with other covered conductors and with grounded parts such as tree branches, etc. In comparison with insulated conductors, this covering has reduced thickness, but is sufficient

to withstand the phase-to-earth voltage temporarily"



### Construction of MVCC

**Conductor:** Longitudinally water tight Stranded All Aluminium Alloy (AAAC) or Aluminium Conductor Steel Reinforced (ACSR)



- Conductor Screen:** Water swellable semi-conducting tape (if required) and extruded semi-conducting compound
- Inner Insulation:** XLPE
- Outer Insulation:** UV protected and anti-tracking black coloured XLPE / HDPE

### Anti-Tracking Properties

Anti tracking property is must for MVCC Outer XLPE/HDPE. As per the experience of several international utilities, in the absence of anti-tracking, XLPE /HDPE, MVCC fails within a short time period of 5-6 months. Anti -tracking jacketing has been specially designed to meet the outdoor conditions & performance requirements of 13.8KV to 34.5KV distribution networks. The material has an excellent resistance to arc, corrosion inhibitor, fungicide activity, oil resistance, and weather conditions like humidity, pollution, presence of salt in atmosphere etc. There is a special test method for carrying out the tests for the anti-tracking in SS EN 50397-1.

## Applicable Standards

SS EN 50397-1, BS EN 50182, IS 398-2, IS 398-4, IEC 61089

## Salient Features of MVCC Technology

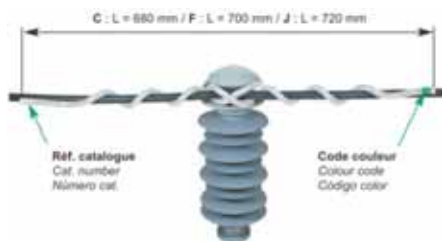
1. Rare Interruptions on transient faults (contact of tree branches or creepers etc.) that contribute the majority of total faults occurred in overhead distribution lines.
2. Less Power shut downs for clearing of the lane from growing trees e.g. Branches or trees can be cut and moved away under live working conditions.
3. No faults due to momentary clashing of phase conductors during wind and stormy conditions.
4. Reduced tower related cost due to reduced Phase to Phase conductor distance.
5. Ideal and safer solution for installations over river / lake/ railway / road slums / congested residential areas and in polluted areas

## Accessories used by MVCC

Tension clamps



Cables ties



Connectors



Compression Joints



Suspension Clamps



Moreover, lighting protection, earthing and arc protection accessories are available.

## Easy Installation


Covered Conductors can be installed in an easy and fast manner; Normal pole to pole spacing can be between 50-70 meters, standard poles of bare conductor can be used for covered conductors as the weight of covered conductors is only about 10-12% higher than bare conductor due to insulation. For fast installation, even existing poles of bare conductors can be used without changing the cross arms and other fitting with covered conductor and its accessories.



## Benefits of MVCC

- No interruptions by contact of tree branches.
- No faults with short duration touching of phase conductors during wind conditions.
- Phase to Phase conductor distance can be reduced (reduce the Tower costs)
- Ideal and safer solution for installations for river/lake/ railway/ road crossings and in populated areas.
- Can protect big birds like peacocks, flamingos etc. Ideal for installations in forest areas and in bird sanctuaries.
- Covered conductors are a cheaper alternative to underground cable and also to ABC cables, especially, in difficult terrain and in densely populated areas.
- Lines nearby areas where the public visits are not so dangerous because of accidental touching.
- Overcomes costly Right of Way issues and line can be commissioned faster.

## Conclusions

Covered conductors are the best economical solutions where ever the safety of human and wildlife has been challenged or compromised by bare conductors. It gives maintenance free overhead line reliability. Service calls will drastically reduced which means an uninterrupted power supply adding more revenues to the utility. It is a safe, economical, environmental friendly, reliable solution for utility to protect the wildlife from being electrocuted. 



**Manish Patel**  
Apar Industries Ltd.

## A. Lalitha, the first Indian woman engineer: Love of Electrical Engineering was in her blood

By reading true life stories like that of A. Lalitha, many girls will be inspired to study engineering and more importantly once entering the work force find a way to stay and contribute to technical fields...



Attendees First International Conference of Women Engineers and Scientists (WES). Lalitha on the far left. Image courtesy of Society of Women Engineers National Records, Walter P. Reuther Library and Archives of Labor and Urban Affairs, Wayne State University

In 1940, Lalitha Rao made history as the first woman engineer of India, and the first woman to graduate from one of the oldest Indian technical institutions, my alma mater, College of Engineering, Guindy (CEG), University of Madras.

Lalitha was born on August 27, 1919 in Chennai (then Madras). She had a middle class upbringing in a Telugu speaking family (Chennai is predominantly a Tamil speaking city). She had four older and two younger siblings. Lalitha was married in 1934, when she was fifteen. Her studies continued even after marriage, but came to a stop after receiving the Secondary School Leaving Certificate (SSLC or Class X). Her daughter Syamala was born in 1937 and was only four months old when Lalitha's husband passed away. As a young widow with a baby, Lalitha wanted to go back to college and get a professional degree that would allow her to be self-sufficient.

Lalitha joined Queen Mary's College in Chennai and completed her intermediate exam

with first class. Lalitha thought about medicine as a career, but the rigors of being a doctor, while taking care of a young child didn't appeal to her. The other option was to become an engineer, and follow in the footsteps of her father and brothers, but even though Lalitha was a brilliant student and getting into CEG today would have been a breeze, this seemed impossible in an age where technical education was considered a male prerogative. Luckily her father, a professor of electrical engineering at CEG, took up her daughter's cause and spoke to the then principal of the college, Dr. K.C. Chacko and also got the approval from Director for Public Instruction.

Lalitha entered CEG in 1940 as a student of the four year electrical engineering program. Two more women Leelamma George and P.K. Thressia joined CEG to study civil engineering in 1940. All of them graduated in 1943, the first batch of women to do so from CEG. Lalitha's Honors degree in Electrical Engineering was awarded in February of 1944.

After completing her qualifying examinations for Bachelor of Engineering degree in Electrical Engineering in 1943, Lalitha completed her one year apprenticeship in Jamalpur Railway Workshop, which was a major repair and overhaul facility.

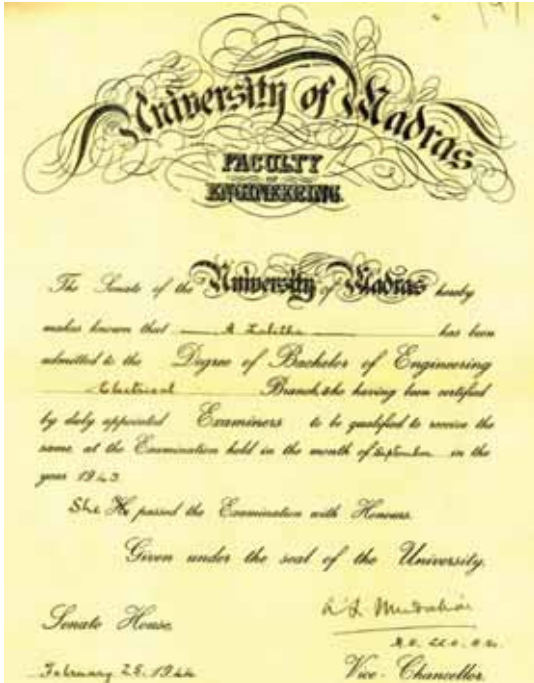
In 1944 Lalitha joined the Central Standards Organisation of India, Simla, as an engineering assistant. She stayed in the job until December 1946. She also took the Graduateship Exam of the Institution of Electrical Engineers, London, UK.

In 1946 Lalitha left her job in order to help him with his research. She couldn't continue this beyond 1948 due to financial reasons, and joined the Associated Electrical Industries (AEI). The post was to be in Calcutta, and Lalitha's second brother lived there, which was fortunate, since living by herself would have been problematic as a widow in those days. In AEI, Lalitha worked in the engineering department, and sales division, Calcutta branch.

She had a very satisfying job there as a design engineer designing transmission lines. Her work also spanned solving problems of protective gear, substation layouts, and execution of contracts. A notable project was the Bhakra Nangal dam. Lalitha moved on to contract engineering, serving as an intermediary between the equipment manufacturers in England and the local installation and servicing engineers. Being a widow with a child, Lalitha's work was confined to providing the expertise and assistance to those who were above her in seniority and she did this with great efficiency and satisfaction.

In 1953, the Council of the Institution of Electrical Engineers (IEE), London, elected her to be an associate member and in 1966 she became a full member.

One of the highlights of Lalitha's career was



Note: They had to strike out 'He' and write in 'She'

being invited to the First International Conference of Women Engineers and Scientists (WES) in New York which took place in June 1964.

On her way back to India, Lalitha spent three weeks touring UK, visiting AEI factories including Trafford Park (Manchester) and Rugby works.

Lalitha became a full member of the Women's Engineering Society of London in 1965, and acted as their representative in India for the Second International Conference of Women Engineers & Scientists, held in Cambridge, England in July 1967.

Lalitha's accomplishments at the time she achieved them are awe inspiring. They would not have been possible without the extensive support structure she had.

She retired from working in 1977.

In 1979, when she was only 60 years old, she was struck with a brain aneurism and passed away after a couple of weeks on October 12.

Lalitha once said, "Electrical Engineering runs in my blood. My father, four brothers, nephew and son-in-law are all electrical engineers". Today, many girls get a STEM education – both in India, and elsewhere. For any number of reasons many of them decide to drop out of their fields. It takes grit and interest in the field to stay the course. Lalitha's life is a beacon for all the women who came after her in the 50's but also today.



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## Rishabh CTs – A Technological Excellence

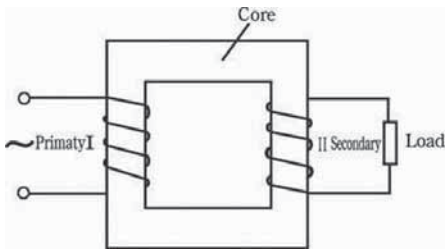
### CT Basics

Measurement of energy flow is extremely important to monitor and protect the power system. Current Transformer is widely used for this purpose.

It becomes practically impossible for any measuring instrument to handle the high current values and hence Current Transformer comes as a handy solution. Current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer isolates the measuring instruments from very high voltage in the monitored circuit.

Engineers often tend to think of a current transformer as an ideal device. Hence let's have a look at ideal CT.

### Ideal Current Transformer



$$a = \frac{n_1}{n_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

- where: a = turns ratio of transformer  
 $n_1$  = number of turns on primary  
 $n_2$  = number of turns on secondary  
 $V_1$  = primary voltage  
 $V_2$  = secondary voltage  
 $I_1$  = primary current  
 $I_2$  = secondary current

An ideal current transformer would proportionally scale down the value of the power system current to a useable known value. Second, the scale-down output should faithfully reproduce the power system current waveform. An ideal current transformer should perform these two tasks over the range of a few amps up

through ten thousands amps. The ideal current transformer should be able to meet these requirements. In reality, a current transformer has limitations.

Today's current transformer hasn't changed since it was developed. A current transformer consists of the following components:

- A laminated steel core
- A secondary winding around the core
- Insulating material

When current travels through a current carrying device, such as a cable or bus duct it develops a magnetic field at right angles to the flow of current. The strength of the magnetic field varies as the current magnitude changes during all operating conditions. As learnt in transformer theory, when a magnetic field strikes a wire, it will cause a current to flow in the wire. By using the strength of the magnetic field and knowing the turns ratio, we can obtain a value of current that is useable for meters, relays and other current sensing devices.

In order to scale a value of high current flowing in a conductor, the engineer needs to introduce a specific number of uniformly distributed turns of wire around the core to scale down the system current. This will ensure that the output current is always proportional to the current flowing in the conductor.

The current carrying conductor is referred to as a primary or P1 and the ends of the wire surrounding the core are referred to as a secondary or S1 and S2 for single winding current transformer.

In the past, there were two main values of secondary current typically used in measuring current. In India and most of Asian countries and also in the United States, engineers typically use a 5-amp output. Other countries have adopted a 1-amp output.

### Application

Rishabh Current Transformers are manufactured to meet indoor or internal devices for switchgear, distribution systems, generator

sets and control panels. Rishabh CTs are intended for supplying measuring instruments and protection circuits of electrical power devices with a maximum operating voltage of 0.72KV and frequency of 50Hz or 60Hz. These current transformers are supplied in ring/rectangular/split core type in a wide range of ratios and accuracies with primary current ranging from 1A up to 7500A and with secondary current of 5A and 1A.

### CT Assembly



Accuracy of CT depends on the magnetic performance of the steel core. Hence, we can call it as a heart of CT. Torridly wound cores with high permeability and low loss are used to optimize performance and physical size of the transformers. High grade insulation is used to insulate between the windings and the core and between winding layers.

Maximum mechanical and electrical performance is achieved by distributing all windings evenly around periphery of core.

The casing of the CTs is made with UL 94 V-0 approved 10% glass filled Polycarbonate material having self-extinguishing and non-drip feature that provides an excellent mechanical / fire protective body & look and long term dielectric performance.

### CT Selection

Factors to be considered while selection of the current transformer.

1. **Primary Current:** The nominal value of the primary current ( $I_{pn}$ ) should be selected from the offered series range of available

Accuracy Class +/- Percentage Current (ratio) error at Percentage of Rated Current Shown Below						+/- Phase Displacements at percentage of rated current Shown below									
						In Minutes					In centiradian				
	1	5	20	100	120	1	5	20	100	120	1	5	20	100	120
0.1	NA	0.4	0.2	0.1	0.1	NA	15	8	5	5	NA	0.45	0.24	0.15	0.15
0.2S	0.75	0.35	0.2	0.2	0.2	30	15	10	10	10	0.9	0.45	0.3	0.3	0.3
0.2	NA	0.75	0.35	0.2	0.2	NA	30	15	10	10	NA	0.9	0.45	0.3	0.3
0.5S	1.5	0.75	0.5	0.5	0.5	90	45	30	30	30	2.7	1.35	0.9	0.9	0.9
0.5	NA	1.5	0.75	0.5	0.5	NA	90	45	30	30	NA	2.7	1.35	0.9	0.9
1	NA	3	1.5	1	1	NA	180	90	60	60	NA	5.4	2.7	1.8	1.8
3	NA	NA	NA	3	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	NA	NA	NA	5	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

- types to provide the closest match with the expected primary current of the system. All low voltage transformers manufactured by Rishabh have an extended rating of 120% which makes conversion possible within a range 20% higher than the rated value.
- Secondary Current:** Secondary current ( $I_{sn}$ ) is to adapt to the system found on the secondary side of the transformer. 5A and 1A are the standardized secondary current values. Primary current/secondary current ( $I_{pn}/I_{sn}$ ) is the standard transformation ratio.
  - Power – the transformer load:** The total load (VA) that will be connected to the secondary side of the transformer should be considered, including the load from the connected device as well as losses on connection leads and terminals. According to standard IEC 60044-1 the current and phase errors of the transformer should not exceed values specified in below given table at any secondary load in the range from 25% to 100% of the rated load.

- Dimensions:** Internal and external dimensions of the transformer should be specified to ensure the possibility to install the transformer on the current circuit and that it can be accommodated in the planned locations.
- Accuracy class to obtain satisfactory measurement accuracy:** In case of metering CTs with accuracy class 0.2, 0.5, 1 or 3, CT has to be accurate from 5% to 120% of the rated primary current and CTs with accuracy class 0.2S and 0.5S, it has to be accurate from 1% to 120% of the rated primary current at 25% and 100% of the rated burden at specified power factor.

### Factors affecting CT prices

Selection CT VA burden and accuracy class should be according to the actual requirement of the application wherein the CT is going to be installed. Selecting higher VA or Class than necessary usually results in a higher cost. The cost generally increases as the CT internal diameter increases. 1A secondary CTs are usually more expensive than 5A CTs.

### Instrument Security Factor (FS)

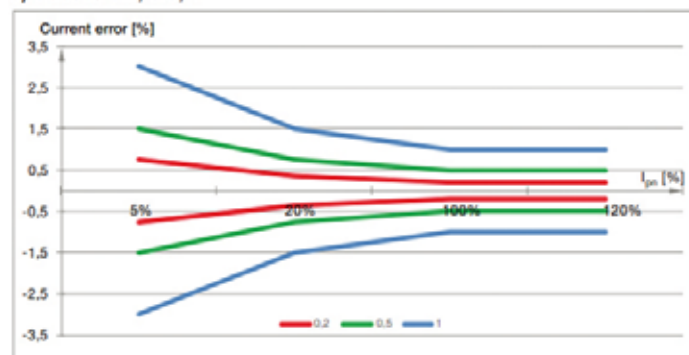
In order to protect the instruments and meters from being damaged by high currents during fault conditions, a metering core must be saturated typically between 5 and 20 times the rated currents. The rated instrument security factor (FS) indicates the over current as a multiple of the rated current at which the metering core will saturate. It is, thus, limiting the secondary current to FS times the rated current. ISF for Rishabh CTs are designed to 5 or less than 5. The safety of the metering equipment is greatest when Rishabh CTs are used.

### CT Testing

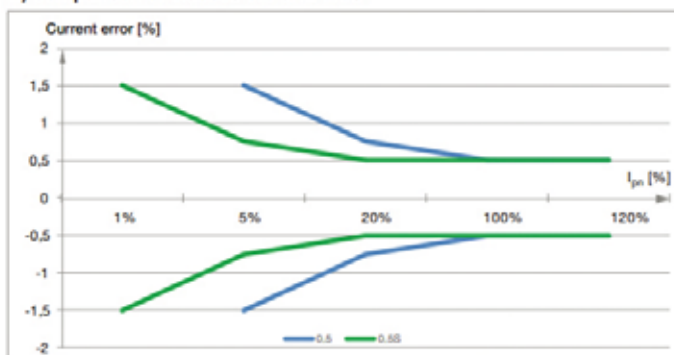
Each and every CT is tested in accordance with IEC 60044-1 or IS-2705 for ratio errors and phase angle errors with microprocessor based automatic transformer test set (Omicron make CT Analyzer) with facilities for automatic printout of test results. Test comparisons are made with standard traceable NPL to validate ratio accuracy performance for all CTs. For protection class CT the performance is verified by excitation measurements.

### Accuracy class characteristics

a) classes 0.2; 0.5; 1



b) comparison of classes 0.5 and 0.5S







## GE Continues to Modernise Generator Units of Paks Nuclear Power Plant

GE is a global recognised company in services for the global nuclear power industry. It has completed retrofits on 257 steam turbines installed at 103 nuclear power plant units...



Paks Nuclear Power Plant - Nuclear Hall

GE's Power Services has successfully modernised the fifth generator at the 2,000-megawatt (MW) Paks Nuclear Power Plant, located 100 kilometers (62 miles) from Budapest, Hungary. The generator refurbishment of the nation's only nuclear power station is expected to extend the asset's life and help increase the reliability of the plant. It also demonstrates GE's capabilities to service cross-fleet power generation equipment across more than 90 brands. This generator refurbishment is part of GE's agreement to service eight generators—one per year through 2021.

Pascal Schweitzer, General Manager, GE's Power Services, Europe, said, "We are very excited to complete the fifth generator modernisation and extend its life 20 years helping to support Hungary's growing electricity needs."

"The project showcases our ability to service other OEM generators in existing nuclear power plants as well as our readiness to support modernising Paks' station generators," he further added.

As part of the agreement, which began in 2013 and runs through 2021, GE will service the station's eight, 250-MW, Ganz-supplied generators in the station's four nuclear reactor units (Paks units 1-4), plus one spare generator. The generators were commissioned between 1982 and 1987.

GE performed the work at its generator services facility in Budapest, utilising the skills and expertise of both the GE Hungary teams as well as several local subcontractors. High-speed balancing of the generators is

performed at GE's services facility in Wroclaw, Poland, underscoring the company's regional supply chain capabilities and expertise.

GE is well known in services for the global nuclear power industry. It has completed retrofits on 257 steam turbines installed at 103 nuclear power plant units. While GE Hitachi Nuclear Energy, the nuclear joint venture of GE and Hitachi, is one of the world's leading technology and services providers for boiling water reactor stations, the Paks generator projects showcase GE's enhanced ability to service steam turbine-generators and other equipment for pressurised water reactor (PWR) units, the nuclear industry's largest reactor segment.

Source: [www.ge.com](http://www.ge.com)

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# Stay Protected from Electrical Fires



**Vimal Kumar Chopra**  
Associate V.P.  
(Wires and Cables)  
BCH Electric Limited

The BIS authorities, in order to keep pace with the changes in the International specification, applications and usage conditions in India, have been revising the IS 694 Standard from time to time to keep the industry and consumers abreast with these changes. The last (4th) revision of IS 694 took place in the year 2010, and this revision though long overdue, sets norms which are in tune with international specifications. The IS 694: Revision 4: 2010 forms a major basis of our analysis in this article.

The low voltage wires and cables market in India comprises both organized and unorganized players. Recent changes in the governing regulatory and technical standards for insulated electrical cable and cords used in homes and offices are meant to ensure better quality and higher flame withstand parameters of these wires and cables. For the buyer or user, knowledge of these changes and their implications on the quality and safe life of cables, would, make them well informed of the precautions to take while deciding their purchase or use, thereby, mitigating the risks and ensuring their safety from electrical fires which occur due to usage of low quality wires.

## Evolving BIS Standards & Effects on Markets

In the Indian electric power distribution

segment, where low voltage flexible cables and cords are used, IS 694 is the most prevalent specification. This is applicable for industries, in house wirings as well as in appliances, as cords. The IS 694 standard is in alignment with the IEC and BS (British) standards, in specific IEC 60227 and BS 6500 and was first brought out in the year 1955. The BIS authorities, in order to keep pace with the changes in the International specification, applications and usage conditions in India, have been revising the IS 694 Standard from time to time to keep the industry and consumers abreast with these changes. The last (4th) revision of IS 694 took place in the year 2010, and this revision though long overdue, sets norms which are in tune with international specifications. The IS 694: Revision 4: 2010 forms a major basis of our analysis in this article. This



**Table 1: Additional Tests Conducted for FR & FRLS Wires & Cables**

Test	Function	Test Method Specification	Specified Values
Acid Gas generation (Only for FRLS)	To ascertain the amount of Hydrochloric acid gas evolved from insulation of wire under fire	IS 10810 Part 59	Less than 20%
Critical Oxygen Index (For FR & FRLS)	To determine percentage of Oxygen required for supporting combustion of insulating material at room temperature.	IS 10810 Part 58	More than 29%
Temperature Index (For FR & FRLS)	To determine at what temperature, normal Oxygen content of 21% in air will support combustion of insulating material.	IS 10810 (Part 64)	More than 250° C

revision, after due deliberations, was implemented with effect from September 2016.

The latest revision of IS 694 specification includes four new categories:

HR PVC (Heat Resistant PVC), FR (Flame Retardant) and FRLS (Flame Retardant Low Smoke and Halogen) cables and lastly, Type 'D' insulation for general use.

Here, we would take up FR & FRLS categories: categories generally referred to as 'House Wires'. In the 2010 revision of IS 694, both Flame Retardant (FR) & Flame Retardant Low Smoke &

Halogen categories have been added. This inclusion of FR & FRLS by BIS is highly appreciable, and a step in the right direction. It is in alignment with the practise prevalent in developed countries, as in European and US markets.

In the Indian scenario, data shows that the majority of industrial disasters and commercial or household fires are a result of electrical short circuits. These electrical short circuits cause fires in the electrical appliances or electrical fittings, which rapidly spread through flames via the connecting electrical wires to the surrounding

rooms or halls and combustible furniture, etc. Apart from igniting the combustible furniture, other connected electrical equipment, these 'under fire' cables emit thick smoke from the burning insulating compounds in the wires, which cause asphyxia in humans, if exposed to such hazardous environments for prolonged periods lead to their falling into coma or their death if unattended or untreated. The Uphar Cinema tragedy happened almost two decades back, in that perspective this revision of BIS was long, long overdue! Considering the safety of

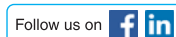


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users and public and a safer environment, it is felt by the author that the FR and FRLS categories' inclusion should have come much earlier. As a matter of fact, FR and FRLS insulated cables had become the compulsory in the Nineteen eighties, in Europe and the US in all LV applications.

In the case of electrical short circuit conditions, wherever good quality and genuine FR and FRLS cables are in use, the cables when exposed to the flames, self-extinguish the flames in a short time and emit much lesser toxic smoke. This is the primary reason why FR and FRLS cables should be the singular specification for LV applications used in densely populated areas like commercial complexes, houses, hospitals, office buildings, theatres, and in industries.

It would be interesting to know the Tests conducted on FR and FRLS cables:

Despite the fact that regulatory standards are in place, it is felt by the author that compliance to the standards should be tightened. Unfair trade practices and lower quality manufacturing of wires by the unorganised cable manufacturers makes the competition unhealthy and the consumers unsafe.

## Challenges in Indian Market

In India, the harsh environmental conditions of ambient temperatures (up to 55° C) and high humidity (>90%), which are common in summers and monsoons, mandate unambiguous and strict standards for the conductors and insulation. The basic purpose of the insulation is to provide a safe and non-deteriorating jacket over the conductor for the life of the cables. In

addition, the FR and FRLS insulations have flame retardant and reduced smoke emission properties which protect human lives and property in case of fires arising from electrical faults or short circuits. (Refer Table 1 above)

## CAVEAT EMPTOR! (Let Buyer Beware)


For the average Indian consumer or specifier, it is pertinent to know that:

By merely confirming their cables are FR or FRLS compliant is not the assurance that the cables would perform their roles in times of such hazards or calamities!

In the Indian Wire and Cable industry, it is well known that the unorganized sector cable- wire manufacturers use cheap and inferior PVC FR insulation, which would not genuinely pass the Critical Oxygen Index and Temperature Index Tests. In case of FRLS cables, their cables are seen to fail in the Acid Gas Generation tests. Further, an industry knowledge that the unorganised sector manufacturers get their cable samples passed at the threshold limits or at the time of Inspection by BIS or by their customers. The buyers need to understand that the latest BIS revision although mandatory for FR and FRLS cables, is not fully sufficient to ensure that the FR and FRLS cables would maintain their integrity over their lives. There are plenty of avenues available for the manufacturers to thwart the specifications or testing criteria as explained above. Moreover, the additives like antimony are quite expensive, which are absolutely essential to enhance the flame retarding and smoke inhibiting properties of PVC, these are substituted

by cheaper varieties. The life of the FR / FRLS cables and their enhanced Flame Retarding or Smoke Inhibiting properties to remain intact throughout their lives are, thus, severely compromised.

One way the specifier or user can protect himself or herself is by restricting his choice to only the organised sector players. Secondly, they must insist on a valid IS license number (It would be as CM/L number of the manufacturer) along with the FR / FRLS ( as the case may be) printed legibly on the cables at every one metre length. Thirdly, at least the bulk buyers must demand and get an FR or FRLS Test report (recent) from the suppliers.

These measures, will go a long way in educating the buyers or decision makers or specifiers on the recent changes in the BIS standards and the regulations, as well as taking the necessary safeguards while deciding on the purchase or use. They can have the assurance about the cable quality for which they are paying are good value -for-their money. If they follow the guidelines, they can be 100% sure that these cables are genuinely going to provide the safety of lives and properties in case of electrical fires under electrical short circuit or other fire hazards in the vicinity of such electrical wires. Otherwise, as has been happening time and again in the Indian scenario, use of sub-standard FR / FRLS wires, which is the norm in the unorganized sector in India, or normal ( Non FR / non FRLS ) PVC wires, would regularly appear as news headlines, and pose far more losses to lives and property, and valuable GDP. 

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## New Chip-Repellent e-tubes from igus

The R2.1 series product range expanded again – Easy filling thanks to lids that are openable from both sides...

At EMO 2017, igus is presenting its R2.1 series energy-tubes, which are available immediately in new sizes and with even more accessories. In a test in the igus laboratory, it was shown that the tubes of the R2.1 series are among the best sealed energy-tubes for use in moving applications – In permanent movement with continuous exposure to metal chips weighing 2 kilograms in total, only 0.5 grams penetrated into the tubes after 100,000 cycles. In spite of being sealed, the tubes of the R2.1 series can be opened very easily, which makes assembly work even easier.

Doubly easy – This is the slogan for the R2.1 series energy-tubes from the motion plastics specialist igus. Easy because the tubes, which keep chips out, only consist of two parts: a link and a crossbar that functions as a form-fit lid. Easy because these lids can be opened very easily from both sides – now, this can be done along either the inner or outer radius. Users can choose the type that is best for their needs, which makes assembly and maintenance work even easier.

"The chip-proof e-tubes from igus are primarily of interest in the area of machine tool making as a reliable energy supply in an environment where chips are often present", explains Lukas Czaja, Head of Industry Management Machine Tools at igus. "This industry is faced with the enormous challenge of mastering the increasing pressure of prices combined with rapidly growing technical requirements. The R2.1 series provides outstanding chip protection, can be assembled efficiently and stands out due to its very good price/performance ratio." During the chip test in the 2,750 square metre igus test laboratory, it was shown that the tubes of the R2.1 series are among the tightest sealed energy-tubes on the

market. During this laboratory test, the tube is moved continuously in a chip drum filled with two kilograms of metal chips of very different sizes and shapes. After 100,000 cycles, the size 40 e-tube R2.1 only let 0.5 grams of chips accumulate inside.

### Expansion of Product Range for Fast, Individual Assembly

At EMO 2017, igus is presenting the R2.1 in new sizes. A completely new size with an inner height of 48 millimetres is available as a version with lids that can be opened along the inner radius. The sizes with an inner height of 26 millimetres or 40 millimetres are also available as versions that can be opened along the outer radius. Due to this expansion of the igus product range, users can always determine the filling method that is the best for them. Assembly or later filling can, therefore, be carried out very quickly.

### Technical Features for Cable-Friendly Energy Supply

The lids of all the versions of the R2.1 series are openable and do not have to be removed completely in order to fill the tube. Their contours



At EMO 2017, igus is presenting its R2.1 series energy-tubes, which are available immediately in new sizes. (Source: igus GmbH)

are smooth and the curvature and tight manufacturing tolerances guarantee that chips do not accumulate between the stops. In addition, the smooth inner contours of the R2.1 and the rounded latching separators made of identical material ensure that the cables on the inside are not damaged or abraded. The integrated grid design also ensures a firm hold of the interior separation, even in side-mounted applications. Due to a brake in the stop-dogs of the individual chain links, operation of the chain is considerably quieter. Less vibration means more precise work on the workpiece. And due to the double stop-dogs, the energy-tube can absorb high fill weights and can even master long unsupported lengths. With the universal connecting elements of the R2.1, the strain on the cables can be relieved either inside or outside the chain cross-section.

## ***Digital Earth Resistance Measurement System***

Earth faults are dangerous that's why it requires proper earthing to prevent undesired current from passing through body of personnel, nearby metallic object and other critical equipment. In this paper, we present the impact of soil resistivity on earth electrode grounding by carrying out extensive measurement of resistance of earth electrode, using the Fall-of-Potential method. Thus, the study revealed that the values of earth electrode resistance should be within range of 1 to 10 Ohms and the results also confirmed that earth electrode resistance has great impact on types of soil in which the earth rod was grounded and hence efforts should be made to improve soil resistivity for effective earthing of the system.

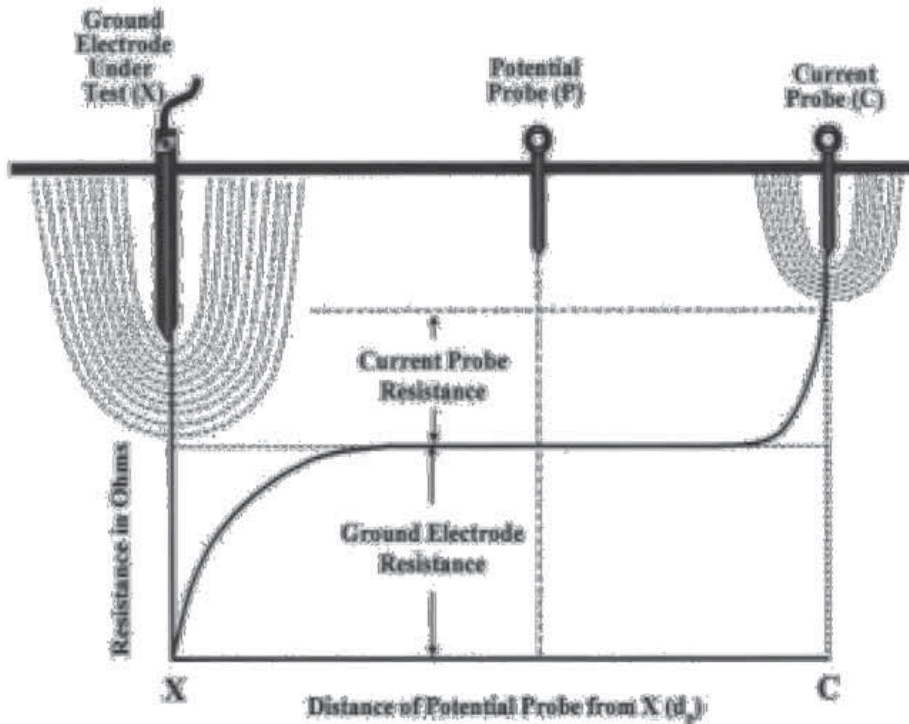


**E**arthing is very important, since a large number of faults involve earth are caused due to thunderstorm or lightning strokes. The term earthing and grounding have the similar meaning and it means of making a connection between the equipment under protection and the general mass of the earth. The main purpose of grounding is to minimize the effect of transient overvoltage occurred due to lightning stroke, in accordance with the standards for personnel safety and for assisting the rapid detection and isolation of the fault areas. Earthing connections are accomplished by driving earth electrode into several different-different places of the earth. Earth electrode is of a metal plate, metal pipe or metal conductors electrically connected to the earth and the equipment to be earthed. The material used for earth electrodes is made up of copper, aluminum, mild steel and galvanized iron. The factors that affect the earth resistance of an electrode or group of electrodes includes the composition of

the soil in the immediate neighborhood, the temperature of the soil, the moisture content of the soil and the depth of the electrode. Thus, the composition of a soil gives an indication about good soil resistivity. Soil resistivity measurement is normally carried out for determining the actual value of the soil resistivity under the changing weather conditions in which an electrode is installed.

We know that the resistance of an earth electrode depends upon the resistivity of the soil in which the electrode is inserted and hence, soil resistivity measurement is an important parameter when designing earthing installations. In this paper, fall-of-potential method is used for the measurement of effective resistance of earth terminals.

Resistance is that property of a conductor which opposes the flow of electric current when a potential difference is applied across the two ends of that conductor. Resistance is the ratio of the applied voltage (V) to the flow of electric



of the electrode and the depth to which it is buried into the ground. The most commonly used method for measuring the earth resistance of an earth electrode is the fall-of-Potential method. It is the most recognized method for measuring the resistance of the earth of an earthing system. This method is based on IEEE standards. It is suitable for use in circumstances such as transmission line structure.

### Components & Methods

Fall-of-Potential method is used to determine the earth resistance. The following listed equipment are used for the measurements of resistance of earth electrode.

In this method, three points of ground contacts are considered that consist of the earth electrode under test, a current probe which is inserted at adequate distance from the earth electrode which is under test and voltage probe which is inserted at some distance between the probe under test and the current probe. With this method, the Digital Earth Tester is used to inject current into the tower footing earth electrode under test. The current then flows through the earth to the remote current probe and returns to the tester. As the current flows through the earth a voltage drop is created. This voltage drop is

current (I) as defined by Ohm's Law i.e.,  
 $V = I \times R$  .... (1)

V is the Potential Difference across the conductor (Volts)

I is Current flowing through the conductor in (Amperes)

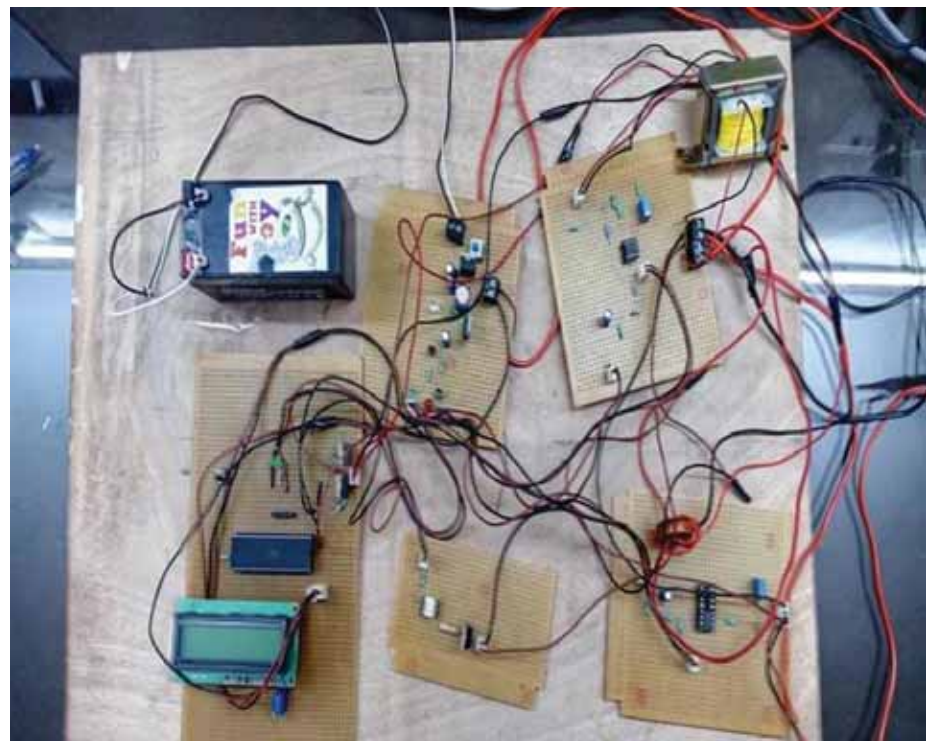
R is Resistance of the conductor in (Ohms)

The resistivity of the soil varies widely throughout the world and changes throughout the year. Soil resistivity is determined by the content of its electrolyte which consists of moisture, minerals, and the dissolved salt in it. It impacts on the overall sub- station resistance and how much earth electrode is required to achieve the desired values of earth resistance. The lower the resistivity the shorter electrode is required to achieve the desired earth resistance value. It is an advantage to know the resistivity at the planning stage as it gives an indication for how much electrode is required. When selecting the test technique for soil resistivity, factors such as probe depth, lengths of cable required, efficiency of the measuring technique, cost and ease of interpretation of the data need to be considered.

Resistance of the earth of any earth electrode is influenced by the resistivity of the surrounding soil. This depends to a large extent on the nature of the soil with its moisture content. Since soil

exhibits a resistance to the flow of electrical current and is not an ideal conductor. There is always some resistance between the earth electrode and "true Earth". This resistance is called earth resistance of an electrode and it depends on the soil resistivity, the type and size

### Setup



# Earthing

proportional to the amount of current flow and the resistance of the earth electrode to earth. The voltage probe was used to measure this voltage drop and the meter then displays both the amount of current flow and the resulting voltage drop. The resistance measured at several locations moving the voltage probe at regular intervals, each of them equal 10% distance of probe under test and current probe. The resistance value then displayed by display of Digital Earth Tester.

During measurement, the position of the current probe was moved far enough away from the earth electrode under test so that the voltage probe can lie outside the effective resistance areas of both the earth electrode and the other test electrode. This is because there may be overlapping of the resistance areas which can cause a steep variation in the measured resistance.

## Procedure of Testing


- Three rods are inserted into the ground as per norms of IEEE.
- One rod is reference rod and other two rods are for current and voltage measurement respectively.
- The circuit is connected with the rods through the clamps.

- After this switch on the device and take readings.
- After one reading, move the voltage rod and observe the change.
- Take at least four readings for accuracy purpose.
- Thus readings are taken and the device is switched off.

## Results

Depth of the ground electrode (in meter)	Distance to the inner stake (in meter)	Distance to the outer stake (in meter)
2	15	25
3	20	30
6	25	40
10	30	50

## Conclusion

The Earth Resistance measurement could be carried out at selected points along its route. The Earth Resistance profile varies between 10 Ohms and 20 Ohms. Soil identifications as well as programmed intensive field measurements of soil resistivity and earthing system at selected sites proves that soil resistivity values' depend on the type of soil. In rocky areas, the resistance could be lowered by a buried network of well-designed earth mat or by a network of buried counterpoise earth wire in order to reduce the effect of lightning stroke. For better earthing of electrical systems the soil resistivity should be improved for effective earthing of system. 



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# Rural Electrification: Energising Villages

“It is home where he has opportunities to grow physically, mentally, intellectually and spiritually. Right to shelter, therefore, includes adequate living space, safe and decent structure, clean and decent surroundings, sufficient light, pure air and water, electricity, sanitation and other civic amenities like roads etc. ....”

— Chameli Singh Vs State of UP (1996)-2 SCC 549



Aqeel Ahmad

Solar, Substation, T&D Expert  
Working with US, MNC on Govt  
of India's project DDUGJY



India is agriculture based country; more than 70% of India lives in villages, and therefore, 'Rural Electrification' is an important step in the direction to uplift the quality of life of common man apart from ensuring rapid economic development by providing electricity as an input for productive uses in agriculture, rural industries, etc. It will also reduce the mass migration to our metros or urban areas.

Electricity is termed as the fundamental 'Right' to life and liberty of every Indian citizen as per Article-21 of Constitution of India ...!

Access to electricity is necessary for modern economic & overall social development of the country. Electricity opens the new avenues of technologies that promote education, public health and mass communication. Without electricity, communities are unable to participate in the benefits of modern advances and may left isolate, literally in the dark. Electricity is a neat and clean, superior form of energy than heat and easy to transport and storage with comparatively lesser losses. It may generate heat, turn a motor and may produce efficient lighting. India is agriculture based country, more than 70% of India lives in villages, and therefore, 'Rural Electrification' is a key step in the direction to uplift the quality of life of common man:

– To ensure rapid economic development by providing electricity as an input for productive uses in agriculture, rural industries, etc. It will also reduce the mass

migration to our metros or urban areas.

– To improve the quality of life of the rural people by supplying electricity for lighting of rural areas etc.

Common man expectations are as follows from electricity providing agency i.e. DISCOM:

- Easy accessibility
- Round the clock availability
- Reliability without frequent black-outs
- Affordability- reasonable within common man's reach or budget
- Quality without brown-outs and fluctuations

According to our Prime Minister on August 15, 2015 from Red Fort, "It is now the solemn pledge of 'Team India' of 125 crore countrymen that the target of providing electric poles, electric wires and electricity to these 18,500 villages would be achieved within next 1000 days".

Young India is one of the strongest emerging economies of the world today. Emerging economy means 'unquenchable' thirst for electricity of approximately 1,337,332,348 people of India, right now, with a population growth of 1.2% (2016). India is the fifth largest

country in the world as far as power production is concerned as shown in the chart below.



(Source: CIA World Fact Book website, 2014)

According to Ministry of Power (MoP), at present, all India installed capacity is 314642.32 MW of power stations including thermal, hydroelectric, nuclear and renewable energy sources (RES), whereas RES covers small hydro power(<25KW), wind power, Bio-mass and Solar Power (PV).

### Renewable Energy Production in 2016-17

Sector	Production in MW
Small Hydropower	4333.86
Wind Power	28700.44
Bio-mass Power	7971.02
Solar Power	9012.69
Total	50018.01

(Source: Ministry of Power)

The most significant year was 2015-16, so far 23,976 MW highest ever power capacity addition, 28,115 CKM highest ever increase Transmission line, 1,28,403 MVA highest ever increase in Power Sub Station (PSS), 7108 villages electrified in 2015 out of 18,500 un-electrified villages (UEV) with 2.1% lowest ever energy deficit, according to MOP, India. Now, let us see the other side during the Five-Year planning i.e. year 2012-17, the gap between supply and demand was 46.9%, so approximately, every year we need to add much more than what we are doing, still more than one third of our population remains under dark every day during peak hours.

### Comparison of World's Per Capita Power Consumption

Rank	Country	Power Consumption (KWh)
1	Iceland	51,142.11
3	Norway	23,485.8
4	Kuwait	17,030.6
6	United Arab Emirates	15,131.1
7	Canada	14,350.58
8	Sweden	13,986.29
10	United States	12,185.94
153	India	565.21



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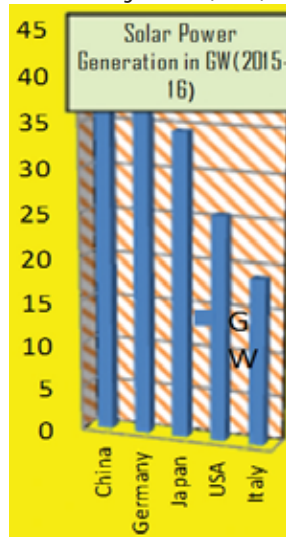
Rank	Country	Power Consumption (KWh)
162	Sri Lanka	408.25
165	Pakistan	357.34
168	Bangladesh	233.88

(Source: CIA World Fact Book, 2014)

In last two years, India's per capita consumption got almost doubled i.e. 1007 KWh, due to improvements in middle class power consumption but still we are nowhere on global ranking as shown above; might be little better than our Indian sub-continent neighbours like Sri Lanka, Pakistan or Bangladesh. India suffers from chronic energy poverty. More than 300 million people have no access to electricity, yet. If we consider the hard fact that 75% rural population, so far, connected to grid, get less than 5-6 hours of electricity every day, then more than 750 million people are still 'Power Poor'. We use electricity for practically for all applications. Apart from lighting, cooling & heating, electricity is now being used for cooking as well i.e. induction & microwave cooking range. In transport sector also, there is shift towards electricity from conventional fossil fuels in form of electric car, auto and two wheelers to reduce pollution level.

## Genesis of Rural Electrification in India

1. Stage I: Early Fifties 45,000 villages were covered.
2. Stage II: More than 2 lacs villages were covered and more than 1 crore pump sets were energised in sixtees.
3. Stage III: During Eighties 2.20 lacs villages covered, 43 lacs pump sets were energised
4. Stage-IV: During Nineties 41000 villages were covered only due to serious financial constraints in SEBs
5. Stage-V: Minimum Needs Program- Started in Vth plan but discontinued in 2004-05 due to lack of response from states
6. Stage-VI: Kutir Jyoti Program-Initiated in 1988-89 71.7 lacs BPL were given connection, later merged with AREP in 2004 later in RGGVY
  - a. Pradhan Mantri Gramoday Yojna- Launched in 2000-01, discontinued in 2005.
  - b. Accelerated Rural Electrification Programme (AREP) – Launched in 2002
7. Stage-VII: Rajiv Gandhi Gramin Vidyut Yojna (RGGVY): Major objectives were
  - a. Electrifying all villages and habitations.
  - b. Providing access to electricity to all rural households.
  - c. Giving Electricity Connection to Below Poverty Line (BPL) families free of charge
  - d. Decentralized Distributed Generations- Electrification of villages which are not connected to grid are taken in this project by



utilizing renewable energy, major features are as follows

- Projects can be based on conventional or renewable sources
  - REC to be the Nodal Agency
  - Ownership with State Governments
  - Implementing agencies would be SREDAs / Depts dealing with renewable / state utilities / CPSUs
  - Projects will be approved and monitored by Monitoring Committee of MoP
  - With 'Stand Alone- for single house' and 'Micro Grid- for group of houses in villages' where normal grid access is not available
8. Stage-VIII: Deen Dayal Upadhaye Gram Jyoti Yojna (DDUGJY)- It is extension of RGGVY with following additions like
    1. Separation of Agriculture and Non-Agriculture feeders.
    2. Strengthening of ST&D infrastructure
    3. Provide power to BPL connections.

It will not only facilitate the judicious rostering of power supply to agriculture & non-agriculture consumers but will also be in line with Government of India policy to provide 24x7x365 power supply to all along with fixed hours of supply to agriculture. This will be of great help in bringing down the cost of agriculture operations to the farmers and saving in foreign exchange due to decreased diesel consumption.

## Power Generation Problems

Total electricity generated (314642.32MW) in India, in the year 2016-17 as follows:

1. Hydroelectric Power (44189.43 MW)-14.04%
2. Thermal Power (214654.89 MW) -68.22%
3. Nuclear Power (5780.00 MW)-1.83%
4. Renewable Energy (50018.00MW)-15.8%

**Hydroelectric Power (14.04%):** Hydro takes a back seat, it was 40% during eighties, though it is cheapest to produce but day by day its production is falling due to unpredictable weather conditions. Besides, its initial cost is high and it takes 5-10 years to complete a project. It is common in hilly regions of the country but the catastrophe of 2013 in the Uttarakhand is still alive in the minds of people. Political interference in rehabilitation of masses due to the construction of dams is also a serious problem apart from several clearances like forest, environment and pollution control department.

**Thermal Power:** Thermal power generation is highest (68.22%) in the country from fossil fuels. Among the fossil fuels coal and gas are two major components. Coal available in India is not sufficient enough to feed the existing thermal power plants, in addition to the poor quality due to low calorific value and high ash contents. That's why, we need to import quality coal from Australia. On the other hand, gas available is also not sufficient to meet the future demand.

**Nuclear Power (1.83%):** It is also not suitable for us. Its raw material and technology are imported. There are serious dangers in handling "left-over" of nuclear fuel after processing. We did not forget the Chernobyl, Russia and Japan's recent nuclear power house cases. Chernobyl caused the death of more than 200,000 persons, according to a report. Such incidents in densely populated India may cause havoc.

**Renewable Power (15%):** Its production increased dramatically in

recent years in India too from few MW in 2009-10 to 9,000 MW in 2016-17. Inspite of that, China (43.5GW) and Germany (39.7GW) are far-far ahead than us (9.02GW), as far as renewable energy is concerned. Germany has almost 50% of its requirements from solar while China is now number one country in the world as far solar power production is concerned. The Govt has set a prestigious target for solar power i.e.100 GW by 2022 (60 GW Utility scale and 40 GW Roof top) in July 2015, it is a herculean task to achieve. Adani power has planned to establish a 1 GW solar plant in Tamil Nadu, out of which 765 MW already commissioned and connected to grid, it is a 'true' engineering marvel, in spite of unprecedented rainy season and flood in Tamil Nadu. The 150MW Andrasol Solar power station is a commercial concentrated power plant located in Spain. The power plant uses molten salt to store solar power energy. Solar power storage is the biggest challenge now. A technical breakthrough in the problem will provide the giant leap to this emerging technology and a viable solution of neat and clean energy.

### Major Challenges of Rural Electrification

- Infrastructure projects need huge initial investments with slow returns, that's why PPP model was difficult to implement.
  - High cost per unit and difficult recovery of cost of operations
  - Sub-optimal and risky investment
  - Sustainability
  - Lack of clear vision for rural electrification upto the beginning of 21st century. Major push for rural electrification was in National Electric Policy 2005 onwards.
  - Initially, rural electrification was assigned to state electricity boards (SEB), which were in mess and bad financial health.
  - Lack of co-ordination of fund management between central and state governments due to socio-political and geographical reasons.
  - Installation, erection, commissioning to operation and maintenance were under SEBs, which were suffering acute man-power shortage.
  - Impact of environmental regulations
- Ministry of Power developed a mobile app 'Garv' to monitor the development of rural electrification by us, as a step to enhance transparency in the administration.

### Possible Remedies & Solutions

**Energy Conserved, Energy Produced:** The potential for energy saving during peak hours was 9,240 MW as estimated in the year 2000-01. The need for efficient use of resources, energy conservation assume significance and must be an integral part of the policy tools, consequently, Energy Conservation Act 2001 passed on October 1,2001 with following key features as-

Specify the norms for processes and energy consumption standards for any equipment, appliances which consume, generate, transmits or supplies energy. Later some amendments were introduced to it. It was the solid foundation for Electricity act 2003, 2005 and later on.

**Mix of Renewable & Conventional Energy:** Power For All (PFA) i.e. supply of power 24x7x365 program is running in the country since 2006-07. Therefore, average power availability improved all over the country, as it is obvious from the per capita power consumption just got almost double in a span of less than five years in India. We have to focus more on renewable

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energy production but we can't afford to ignore other conventional sources like hydro, thermal and nuclear due to the vast gap between supply and demand.

Land availability for power substations (PSS), transmission & distribution lines at a reasonable price is very important in the power sector. The bench of Honourable Justice A K Sikri & Justice R. Banumathi of Supreme Court gave a vital verdict on Dec14, 2016 in a case between the Power Grid Corporation of India Ltd V/s Century Textile & Industries Ltd & other i.e. "No Prior Consent, from the owner of the land, is necessary before laying Electricity transmission line."

**Electricity sector – Introduction of Universal Service Obligation (USO) era:** As we have seen above, 'Electricity' is no more a luxury but a fundamental need of every Indian citizen, so Universal Service Obligation (USO), which is now a legal mandate as supported by honourable court's decision mentioned above. USO may be defined as "Minimum set of services with well-defined quality to which all consumers have easy access at a reasonable cost without hurting competitions between the "service providers" for better quality and more competitive rates". It is already a well-established concept in western world in power sector. In India, we have seen it telecom sectors in the last two decades.

**Exploring New Avenues (R&D):** Our eastern world except Japan spends very little on R&D, most of the time we have to rely on western world and they provide us their obsolete technologies at the price of their own choice along with arm-twisting as and when required. We need to break it up as early as possible. Need to thrust more on quality of education to produce world class scientists and engineers and give them due regard in terms of salaries and perks and conducive working environment free from nepotism and favouritism like Infosys and TCS in India. As we know, more than 40% engineers of NASA are Indian, the economies of GCC and few western countries are rolling due to Indian engineers. Now, Indian engineers are a 'force to reckon with' globally.

### Power Management Redefined

**Demand Management (DSM):** It is the management of consumer's demand of electricity through various methods such as financial incentives and consumer education i.e. energy efficiency & bill payments etc. Usually the goal of DSM is to encourage the bulk consumers to use less energy during peak hours or to move the time of energy use to the off-peak hour viz. night. For the purpose, a different scheme such as Time of Day (TOD) tariff was introduced to offer the monetary incentive to consumer to shift the load during off-peak hours for example Ferro Alloy producers are advised to

shift the load of their submerged arc furnaces to night shift.


**Aggregate Technical & Commercial (AT&C) Losses:** India is the fifth largest country as far as electricity production is concerned as mentioned above but probably we are at the top in the world on sustained AT&C losses i.e. with average of 27% in 2013-14, while world average is merely 9% and western world is maintaining it to 4-5%. Actually, at some places in India, it was found up to 50%. It means whatever power we produces, only half of it reaches to consumers or billed. It incurs huge losses to DISCOMS.

Ministry of Power (MoP) launched Ujjawal DISCOM Assurance Yojna (UDAY) to resolve it by feeder & DTR metering for energy audit, rural feeder segregation, more field vigilance, proper meter readings and improved bill collections.

**Efficient Billing:** As mentioned earlier, billing is very important for the financial health of our DISCOMS. Billing methods must be consumer oriented like payments through mobile, bank or door to door collection and other apps. Severe penalties for non-payments for all. Our power policies need to be implemented on ground religiously to yield results within a specific timeframe.

**Deferred Payment:** If consumer can't pay entire bill, he must be entitled to enter into "Deferred Payment option", if the utility has not issued more than one 'disconnection' notices in the past 12 months or so, and the consumer has deposited all his previous bills on time. One should contact the utility before due date of the bill, if he needs a deferred payment option and his services will not be disconnected. Likewise, there must be incentives from utility for the regular payments customers. 'Illegal connections' must be recognized as serious or non-bailable offence through fast track courts.

– Reactive Power Management: Among huge T&D losses, power factor is major contributor. So far, we have imposed restrictions on industrial sector only to maintain higher power factor (>0.95) for improved voltage regulation, more MVA utilization and less current in our lines. It has to be implemented in domestic power distribution network too by providing capacitors at load ends and capacitor banks at distribution sub-stations.

Electricity is our 'fundamental' right, according to Constitution of India but vis-a-vis responsibilities assigned should also be fulfilled by us before demanding for right. Government make policies and plans; its successful implementation is our responsibility as an engineer, planner, manager, administrator or consumer. 

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# Forthcoming Events At A Glance

## National

### electronica India

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

### Renewable Energy India Expo 2017

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

### SOx NOx 2017 - Misson Energy Foundation

**Venue:** Taj Vivanta, New Delhi  
**Date:** 21-22 September, 2017  
**Website:** <http://soxnox2017.missionenergy.org/>

### Intersolar India 2017

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

## International

### Power Nigeria

**Venue:** Landmark Centre, Lagos  
**Date:** 5-7 September 2017  
**Website:** [www.power-nigeria.com](http://www.power-nigeria.com)

### ENERGETAB

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

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

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

### 14th SOLAR Bangladesh 2017 International Expo

**Venue:** International Convention City, Bashundhara, Dhaka, Bangladesh  
**Date:** 26-28 October 2017  
**Website:** <http://cems-solarexpo.com/>

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## Executive Summary of Target & Achievement of Sub-Stations During 2016-17

As on 30.09.2016

(All figs. In MVA)

Programme / Achievement	HVDC						765 kV				400 kV					220 kV					Total Central, State & JV/ Private Sector					Grand Total		
	± 800 kV			± 500 kV							Central Sector			State/ Private Sector		Total	Central Sector			State/ Private Sector		Total	Central Sector				State/ Private Sector	
	Central Sector	State Sector	Total	Central Sector	State Sector	JV/Private Sector	PGCIL	DVC	Total CS	State Sector	JV/Private Sector	PGCIL	DVC	Total CS	State Sector		JV/Private Sector	PGCIL	DVC	Total CS	State Sector		JV/Private Sector					
Programme 2016-17	1500	0	1500	0	0	0	10500	1500	2000	14000	9890	0	9890	13015	2000	24905	0	0	0	4783	0	4783	21890	0	21890	19298	4000	45188
Sept, 2016 Programme	0	0	0	0	0	0	0	0	0	0	630	0	630	1145	0	1775	0	0	0	420	0	420	630	0	630	1565	0	2195
Achievement	0	0	0	0	0	0	3000	1500	0	4500	2425	0	2425	2160	0	4585	0	0	0	940	0	940	5425	0	5425	4600	0	10025
Upto Sept, 2016 Programme	1500	0	1500	0	0	0	9000	1500	2000	12500	4630	0	4630	6925	2000	13555	0	0	0	2800	0	2800	15130	0	15130	11225	4000	30355
Achievement	1500	0	1500	0	0	0	9000	3000	1500	13500	7740	0	7740	5680	2000	15420	0	0	0	7040	0	7040	18240	0	18240	15720	3500	37460

## Executive Summary of Target & Achievement of Transmission Lines During 2016-17

As on 30.09.2016

(All figures in circuit 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		Total	Central Sector			State/ Private Sector		Total	Central Sector			State/ Private Sector		
	Central Sector	State Sector	Total	Central Sector	State Sector	JV/Private Sector	PGCIL	DVC	Total CS	State Sector	JV/Private Sector	PGCIL	DVC	Total CS	State Sector		JV/Private Sector	PGCIL	DVC	Total CS	State Sector		JV/Private Sector					
Programme 2016-17	2597	0	2597	0	0	0	3123	750	1313	5186	3642	311	3953	5799	762	10514	78	0	78	5009	0	5009	9440	311	9751	11558	2075	23384
Sept, 2016 Programme	24	0	24	0	0	0	0	0	0	0	13	0	13	114	576	703	0	0	0	587	0	587	37	0	37	701	576	1314
Achievement	2574	0	2574	0	0	0	945	337	758	2040	581	0	581	457	0	1038	0	0	0	248	0	248	4100	0	4100	1042	758	5900
Upto Sept, 2016 Programme	2597	0	2597	0	0	0	3123	750	1133	5006	1993	0	1993	3090	942	6025	0	0	0	2597	0	2597	7713	0	7713	6437	2075	16225
Achievement	2574	0	2574	0	0	0	2336	337	950	3623	2262	0	2262	1754	1362	5378	28	0	28	3538	0	3538	7200	0	7200	5629	2312	15141

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## The voltage tester with the best display on the market

The three models in the testo 750 voltage tester family are the first instruments with an all-round LED display. The display can be seen from any position and guarantees an ideal voltage indication thanks to its unique fibre optics. All three models meet the latest voltage tester standard EN 61243-



3:2010 and have a safety specification according to CAT IV.

They have the most important functions for voltage testing, continuity testing and rotating magnetic field measurement. The testo 750-2 is also suitable for single pole voltage testing and has a torch along with an RC trigger function. Vibrating load buttons ensure that the trigger test cannot be carried out accidentally. In addition, the testo 750-3 is fitted with an LC display to show the current reading.

- Clear, patented all-round LED display
- Fibre-optic technology for optimum voltage indication
- Anti-slip ring for secure grip
- Ergonomic handle shape
- Measuring point illumination

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

## Gas Leak Detector reduces potential utility equipment damage due to gas leaks

Identifying leaks of sulfur hexafluoride (SF<sub>6</sub>), used as an electrical insulator in extremely high-voltage utilities applications, generally requires the purchase or rental of an expensive gas detector or hiring an outside consultant. The alternatives are shutting down equipment and using a sniffer, which after some time, can determine only the approximate area of the leak, or coating the entire equipment in soapy water and inspect, which is extremely time consuming and requires the equipment to be powered down.

The new Fluke® Ti450 SF<sub>6</sub> Gas Leak Detector combines a high-quality infrared camera with an SF<sub>6</sub> leak detector that visually pinpoints the location of SF<sub>6</sub> leaks without shutting equipment down. The Ti450 SF<sub>6</sub> allows utility crews to include it as a normal part of their maintenance routine, allowing them to conduct both infrared and gas inspections whenever and wherever necessary. It eliminates the need to wait for special annual or bi-annual leak inspections — and the corresponding expensive equipment rentals or contractors — so maintenance work can be done as required, reducing potential equipment damage.

“Leak detection in utility equipment has always been a disruptive operation that requires expensive equipment and equipment downtime,” said Brian Knight, Fluke Thermography Business Unit Manager. “The Fluke Ti450 SF<sub>6</sub> makes it incredibly convenient to make leak detection part of regular maintenance identifying the problems so leak corrections can be performed during a scheduled maintenance period.”

The pistol-grip Ti450 SF<sub>6</sub> makes diagnoses of issues point-and-shoot



convenient, even in hard to reach or high overhead locations. With the Ti450 SF<sub>6</sub>, technicians can monitor leaks more frequently allowing maintenance scheduled at a convenient time without unplanned downtime. The leak detector can also be used to quickly verify that the repair was fixed.

The infrared camera includes the award-winning LaserSharp® Auto Focus that delivers instant focus on a single target using a built-in laser distance meter to calculate and display the distance to the designated target with pinpoint accuracy. LaserSharp Auto Focus enables technicians to precisely target up to 100 feet away for infrared readings and SF<sub>6</sub> gas detection no matter how awkward the position of the target. This makes it safe to measure around high voltage areas and potentially dangerous areas. It also features Fluke IR-Fusion®

technology, which combines both digital and infrared images in one for better clarity. By adjusting the blending of the image, technicians can easily detect then pinpoint the exact location of the SF<sub>6</sub> gas leak.

The Ti450 SF<sub>6</sub> comes complete with 2x telephoto smart lens, tripod holder for mounting to any industry standard tripod, eyepiece, cable, viewer, batteries and chargers, all in a hard shell carrying case. SF<sub>6</sub> gas detection training tools, including a systematic instructional video, are also available on the Fluke website.

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

# Hi - Tech, Light Weight, Portable Crimping for T & D Overhead Line.



PK1000C



AHP 700-L

### Features :

- Suitable for all ACSR conductor (moose, panther zebra, squirrel etc.)
- Single acting 100 ton crimping head for connection with hydraulic drive units.
- Robust and compact design.
- Interchangeable dies
- Nickel plated version.
- Quick coupling.
- For connecting to hydraulic drive units with 700 bar operating pressure for best possible crimping results.

**3 in 1**

**Crimping**

**Cutting**

**Punching**

### Features :

- Rated Pressure of Power Pack - 700 bar or 10,000 PSI.
- Single drive for crimping, cutting and punching.
- Lightweight for mobile application with single port for inlet and outlet.
- Works on both battery and AC.
- "On the GO" charge option at your 4 wheeler.
- Advanced features like ARS, MRS and Auto retraction controlled by Micro Processor.
- 2 stage advanced hydraulic system.

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## Ultrasonic Thickness Gauge

**M**odel Km-8041, is a new device introduced by "Kusam-Meco" an ISO 9001-2008 certified company. This ultrasonic device is used to measure the thickness of various materials like metals, glass or plastics pottery & many more.

It has an adjustable ultrasonic velocity adjustment. It is used to measure velocity function. The thickness



unit is in mm/inch which is convertible. It has a coupling indication. It is built in a metal piece for calibration. It has a low battery voltage indication with auto power off. This ultrasonic thickness gauge is designed according to European Unions CE Safety Norms. It has an ultrasonic frequency of 5MHz. It has a digital display of 4 digits.

Its measuring range is between 1.2mm to 225mm & its Pipe has a minimum diameter of 20\*3mm. Its velocity range is between 1000 to 9999m/s. It has a resolution of 0.1mm & Accuracy of +-1%H + 0.1mm. Its response time is 0.5S. It can be operated to an operating temperature of 0 to 40°C & operating Humidity of 10 to 90%RH.

**For further information:** [www.kusam-meco.co.in](http://www.kusam-meco.co.in)

## Kyoritsu Range of Insulation Testers

**K**yoritsu range of Insulation Testers features more than 20 diverse models, with test voltages ranging from 15V to 12KV, and analogue or digital indicators. Battery-powered, compact and user-friendly, each and every product is an industry standard today.

Kyoritsu's 3125 is Defacto Standard in 5KV insulation testing in this part of the world. In our endeavour to provide the best we have an improved 3125A now with key differences between old & new being:

- Additional function of Dielectric Absorption Ratio (DAR)
- Increased Short Circuit Current to 1.5mA
- Additional open circuit voltage range of 250V
- Higher safety rating of CAT IV 300V / CAT III 600V
- New Form Factor to enable ease of Use

**Other Features of 3125A are:**

- Insulation resistance up to 1TΩ

- Short-circuit current up to 1.5mA
- Wide test voltage from 250V to 5000V
- Diagnosis function of PI and DAR
- Newly-designed alligator clip (27mm Jaw)
- It comes standard with a tough hard case
- Filter function reduces noise interference for obtaining stable measurement
- Large display with bar graph indication and backlight
- Live voltage warning
- Safety standard IEC61010-1 CAT IV 300V / CAT III 600V



**For further information:** [www.kew-ltd.co.in](http://www.kew-ltd.co.in)

## MG320 CAT IV Insulation Tester/ True RMS MultiMeter

**C**ombines a portable 20GΩ/1000V Insulation Tester with a True RMS MultiMeter. Insulation tester includes PI/DAR modes, programmable timer, and a comparator for custom test configurations and quick results.

Multimeter functions include AC/DC Voltage, Resistance, and Continuity Test. Manually store/recall up to 99 readings. Designed with rugged housing and large backlit 6,000 count LCD display with analog bargraph. CAT IV-600V safety category. Complete with test leads, alligator clip, 6 x AA batteries, and soft case.



### Key Features

- Measure Insulation Resistance to 20GΩ
- 5 Test Voltage ranges
- Polarization Index (PI) and Dielectric Absorption Ratio measurements (DAR)
- Low Resistance measurement with Zero function
- Programmable Timer feature sets the duration of test
- Comparison Mode allows user to set the Pass/Fail values for insulation measurements
- Step Voltage (10% steps at 50% to 120% of range)
- Auto-discharge of voltage test signal
- Lock Power On Function for hands-free operation
- High voltage and overload indication
- Data Hold to freeze displayed reading
- Auto Power Off and Low battery indication

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

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## Electrical Test & Measuring Solutions



Contact Resistance Meter 200A



Turns Ratio Meter



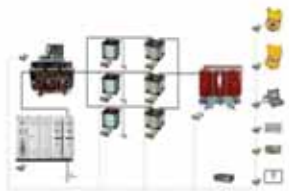
Winding Resistance Meter



Digital Micro Ohm Meter



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Automatic Transformer Test System



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Automatic Portable HV Tester



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Standard CT



Battery Analyzer

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