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Power has to wait for another Budget

Hello everybody and welcome once again to another issue of Electrical India. I on a holiday to Canada, one of the coldest places on earth. As I write this from Montreal where the temperature right now is minus 10 degree and amid growing tension just across the border where about hundred thousand people have been turned back from various airports across the US after the newly-elected Trump government imposed a ban on entry of people from seven countries to their country.

Incidentally, there is growing concern back home in India after US president Donald Trump announced restriction on H1B visa. It could result in a major setback to our IT sector, which is the largest foreign exchange generator for the country.

This week also saw for the first time in the Indian history budget presented in January against the traditional colonial era procedure of presenting the budget in February. Ever since Mr Modi came to power in 2014, he has shown keen interest in developing the Indian solar power industry as also electrifying the entire length and breadth of the country. However, finance minister Arun Jaitley has in this year's budget, which was overshadowed by the currency demonetisation imposed by his government in November 2016, has given less importance to the power sector. This was expected as the entire focus of Budget 2017 was how much relief would he give after the "*note ban*".

It is a known fact that private power companies have always struggled to stay put in the industry, which has been dominated by public sector enterprises. With more push on renewable energy since last couple of years, the government has increased the outlay for the renewable sector by about 10% from the previous year's Rs. 5036 crore to Rs. 5473 crore this year. What has to be seen is how the GST, which hopefully will be implemented this year, will impact the renewable industry. Since the government has concentrated more on solar power, it has to be seen how the solar components would be categorised after GST.

I for one thought Jaitley should have pumped in more money into hydro power sector, which has been languishing for more than a decade now. Same goes for the nuclear energy, especially after Rs 400 per tonne clean cess was imposed on coal last year. The fanfare with which Manmohan Singh and Obama signed the deal a decade back, has not been carried forward thereafter. If the government wants the world to come to India to manufacture, we need power not in few hundred mega watts but in thousands. This would be possible only and only if huge amount is allocated for the power sector and certainly not possible with a piecemeal approach.

Do send in your comments at miyer@charypublications.in

Mahadevan.

Publisher & Editor-In-Chief

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Directors
Pravita Iyer
Mahadevan Iyer

Publisher & Editor-In-Chief
Mahadevan Iyer
miyer@charypublications.in

Editorial Co-ordinator
Nafisa Kaisar
nafisa@charypublications.in

Advertising Department

Director Advertisement
Pravita Iyer
pravita@charypublications.in

Advertising Manager
Yasmeen Kazi
yasmeen@electricalindia.in

Design
Nilesh Nimkar
charydesign@charypublications.in

Sub-Editor
Dhanya Nagasundaram
edit@charypublications.in

Subscription Department
Nafisa Khan
sub@charypublications.in

Accounts
Dattakumar Barge
accounts@charypublications.in

Customer Care
Sonali Pugaonkar
mktg@*charypublications.in*

Electrical India is also available online on www.electricalindia.in. For online enquiries contact at: *dgmarketing@charypublications.in*

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India supplies additional 80 MW to Nepal

Janardan Sharma, Minister of Energy, Government of Nepal, in a recent visit to India, held discussions with Piyush Goyal, Minister of State (IC) for Power, Coal, New & Renewable Energy and Mines, Government of India. Besides reviewing cooperation and expanding ties between the two countries in the power/energy sector, Minister of Energy of Nepal requested for an additional supply of 80 MW from India to alleviate power shortage in Nepal due to seasonal reduction in supply from domestic hydro projects in winter months.

In a swift response to this request, within a period of 20 days, the Power Grid Corporation of India Limited (PGCIL) installed an additional 220/132kV, 100MVA transformer at Muzaffarpur substation in India. This transformer will facilitate additional power supply up to 80 MW to Nepal through the Muzaffarpur (India) - Dhalkebar (Nepal) transmission line. With this augmentation, a total of 160 MW can now be supplied to Nepal through this transmission line.

Hence, India has started supplying additional power transfer of 80 MW to Nepal since 1st January, 2017. With this, the total supply of electricity to Nepal from India will be about 400 MW.

The electrical grids of India and Nepal are connected through various radial lines at 132kV, 33kV and 11kV voltage levels. Prior to February 2016, as per the request received from Nepal from time to time, various short-term augmentation schemes were carried out which resulted in enhancement of power flow to Nepal from 50 MW to about 240 MW.

Tamil Nadu becomes 21st state to join UDAY

Union Minister of State (IC) for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal presided over the signing of the Memorandum of Understanding (MOU) under the Ujwal DISCOM Assurance Yojana (UDAY) Scheme with the Government of Tamil Nadu- and its Discom TANGEDCO, for operational and financial turnaround of the DISCOM, in New Delhi. The signing ceremony was held in the august presence of the P. Thangamani, Minister for Electricity, Prohibition & Excise, Government of Tamil Nadu.

Tamil Nadu would derive an overall net benefit of approximately Rs. 11,000 crores through UDAY, by way of savings in interest cost, reduction in AT&C and transmission losses, interventions in energy efficiency, coal reforms etc. The state also signed 24X7 Power for all document on the occasion. With Tamil Nadu joining the cause, 92% of country's Discom debt has been covered under UDAY.

By signing the MOU under UDAY, the State Government is taking over 75% of debt of Rs. 30,420 crores of TANGEDCO. The scheme also provides for the balance debt to be re-priced or issued as State guaranteed Discom bonds, at coupon rates around 3-4% less than the average existing interest rate. The State would have savings of about Rs.950 crores in annual interest cost through reduction of debt and through reduced interest rates on the balance debt.

India, Japan collaborate for a sustainable energy future for both nations

Union Minister of State (IC) for Power, Coal, New & Renewable Energy and Mines, Piyush Goyal presided over a bilateral meeting with the Japanese delegation led by H.E. Hiroshige Seko, Minister for Economy, Trade and Industry, Government of Japan.

During the long sessions in the Energy Forum, there were technical discussion sessions on critical subjects of mutual cooperation in the energy sector, which included Enhancing Renewable Energy and Grid Stability, Promoting Technological Cooperation in Energy Efficiency in Industrial and Commercial Sectors and Technological Options and Energy Efficiency Improvement in Transport Sector.

Speaking on the scope of India-Japan cooperation, Goyal said that this forum is a platform to engage with Japan for mutual benefit in the energy sector by working towards bringing Japanese strengths in cutting edge engineering and technology to India. This would help India in enhancing Grid stability, bringing Electric Mobility at affordable prices to the country etc., which the Government is vigorously pursuing, he added.

The Minister also informed that during the bilateral meet with his Japanese counterpart, it was put across that India's power demand is going to expand four fold in the next 15 years to become one of the largest energy markets globally and it would open immense business opportunities for Japan in the sector in India, hence making this bilateral engagement mutually beneficial for both countries.

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POWERGRID Rajarhat 400/220kv Sub-Station to supply power in Kolkata

Rajarhat 400/220kV substation, being established by Power Grid Corporation of India Limited (POWERGRID) with 1000MVA capacity, is critical to supply of power in Kolkata and surrounding areas. This substation is being connected to Farakka and Purnea so that it not only receives the power from Thermal Generating Power Stations in Farakka and Sagardighi but also hydro power from North Eastern Hydro Stations.

This substation is created with a state-of-the-art Gas Insulated Switchgear (GIS) Technology, which requires about 1/4th of the land as compared to conventional substation. GIS technology is safe, reliable and requires less maintenance. This technology is a proven technology with more than 5000 High Voltage GIS Installations world-wide already in use; including in developed countries like Japan, UK, China, Russia, USA etc. Even in India, more than 30 High Voltage GIS Installations are working as on date.

The construction works of Rajarhat 400/220 kV Substation are undergoing for the last 2-3 years and is on the verge of completion. Government of West Bengal is all along supporting POWERGRID in the early completion of this important project. Considering the advantages of the project as mentioned above, POWERGRID solicits cooperation from all stakeholders.

NTPC signs MoU with RVUN and RUVNL

National Thermal Power Corporation (NTPC) has signed a Memorandum of Understanding (MoU) with Rajasthan Rajya Vidyut Utpadan Nigam Limited (RVUNL) and Rajasthan Urja Vikas Nigam Limited (RUVNL) for take-over of Chhabra Thermal Power Plant Stage-I (4x 250 MW) and Stage-II (2x660 MW) of RVUNL by NTPC, in the presence of Vasundhara Raje, Chief Minister of Rajasthan in Jaipur.

Officials during the signing of MoU

The organisations shall execute binding agreements based on the detailed due diligence being underway.

A. K. Gupta, Executive Director (Commercial) NTPC, N.K. Kothari CMD, RVUN and MD, Bannalal from RUVNL signed the MoU on behalf of their respective organisations. Best practices of NTPC in efficiency and systems will benefit and improve performance of Chhabra Project, benefiting the consumers of the state.

Pushpendra Singh, Energy Minister of Rajasthan; Sanjay Malhotra, Principal Secretary Energy; Shreemat Pandey, Chairman DISCOMS, A. K. Verma, Joint Secretary Power Ministry (GoI); Gurdeep Singh, CMD, NTPC; R. G. Gupta, Advisor Energy Dept. were present during the occasion.

GoI and World Bank sign US$ 470 million loan agreement

The Government of India (GoI), POWERGRID, the six north eastern states of Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura and the World Bank signed a US$ 470 million loan agreement- to support these six states to augment their Transmission and Distribution (T&D) networks and strengthen the capacity of the state-level power utilities/ departments in extending last mile electricity connections to households.

Officials after signing the agreement...

The loan agreement for the North Eastern Region Power System Improvement Project (NERSIP) was signed by Raj Kumar, Joint Secretary, Department of Economic Affairs, Ministry of Finance, on behalf of the GoI; and Hisham Abdo, Operations Manager and Acting Country Director, World Bank India, on behalf of the World Bank. The project agreement for the subject loan was signed by T C Sarmah, Executive Director (Business Development Department, Joint Venture & Private Investment), on behalf of POWERGRID and supplementary project agreement(s) were signed by Rajiv Bora, Additional Chief Secretary, Power (Electricity) Department, on behalf of the state of Assam; Vineet Joshi, Commissioner (Power), on behalf of the state of Manipur; E P Kharbhih, Commissioner and Secretary (Power Department), on behalf of the state of Meghalaya; S.K. Rakesh,Principal Secretary, Power Department, on behalf of the state of Tripura and Khose Sale, Additional Chief Engineer, Power Department on behalf of the state of Nagaland.

The NERSIP will be implemented through POWERGRID, which has been appointed as the implementing agency by the GoI and it will provide technical and managerial support for improving intra-state transmission and distribution systems in these states. After commissioning, the assets created under the project will be owned, operated and maintained by the respective state power utilities and departments. POWERGRID will also help build the capacity of the state departments and utilities to continue managing the refurbished networks in an optimum and efficient manner.

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ABB, POWERGRID get together for a mega project

ABB has teamed up with India's national electricity grid operator Power Grid Corporation of India Limited (POWERGRID) in a mega project worth over INR 4,350 crore for ABB to deliver a transmission link that will have the capacity to bring reliable electricity to more than 80 million people. The Raigarh-Pugalur 800 kilovolt (kV) Ultrahigh-Voltage Direct Current (UHVDC) system will connect Raigarh in Central India to Pugalur in the southern state of Tamil Nadu.

HVDC transmission lines help to conserve land as they occupy only one third of the space compared to the alternative – saving around one third the area of Bangalore.

The 1,830 kilometer (km) link will be among the longest in the world. With a capacity of 6,000 megawatts – the equivalent of more than six large power plants – it will be enough to meet the electricity needs of over 80 million people in India. The two-way link will integrate thermal and wind energy for transmission of power to high consumption centres located thousands of kilometers away, supporting electricity demands in the south, when wind strength is low, and transmitting clean energy to the north, when there is excess wind power.

Ulrich Spiesshofer, CEO, ABB, said, "ABB is honoured to partner with POWERGRID for this smart long distance transmission project. Delivering reliable electricity to India's energy demand centres is a top priority for the Indian government to support the country's impressive growth momentum. ABB is strongly committed to India for more than a century and with this new long distance transmission link, we are delivering the benefits from the Energy Revolution to the country building on the strength of our strong local manufacturing footprint. With our state-of-the-art UHVDC technology, we enable the balancing of renewable and conventional electricity supply over long distances in a smart and reliable way."

Adani Group unveils 100 MW solar plant in Bathinda, Punjab

Adani Enterprises, part of the Adani Group, a globally integrated infrastructure player, inaugurated Punjab's largest solar power plant of 100 Megawatts (MW) at Sardargarh and Chughe Kalan, Bhatinda, with an investment of around Rs 640 crore, set by its subsidiary Adani Green Energy.

Jayant Parimal

The ceremony was attended by Hon'ble Deputy Chief Minister of Punjab, Sukhbir Singh Badal, amongst other senior officials from the state.

The company is using top notch technology to set up the entire 100 MW solar plant project which has started commissioning almost six months ahead of schedule. Indirect and direct employment opportunities were created for a total of around 300-400 personnel, who worked diligently to achieve this feat ahead of its time.

The solar plant is not only the largest project in Punjab but will also prove to be the largest tracker-based solar project in the country. The technology used for setting up this plant includes Poly Crystalline Silicon PV Modules and Horizontal Single Axis Tracker (HSAT). This plant will be India's biggest HSAT plant at a single location. The plant spreads over approximately 641 acres of land with the evacuation of 132 kV Balluana Substation through Double circuit 132 KV transmission line. The annual energy yield is expected to be approximately 88,000 Mwh/ annum.

Jayant Parimal, CEO, Renewable Energy Business, Adani Group, said, "We are delighted to have added yet another feather in our cap with the setting up of this plant, helping us prove our dedicated efforts towards nation building. We are moving closer to our aim of revolutionising the renewable energy sector in India. I would like to take this opportunity to express my gratitude to the Hon'ble Deputy Chief Minister and the government of Punjab, present here today, for their endless support and playing a huge role in helping us achieve this enormous feat."

BHEL to build EHV substations to evacuate power

Significantly, this is yet another landmark order for BHEL, further establishing its leadership presence in the domain of Green Energy linked Transmission Corridor.

The substations to be augmented include 400/220kV substation at Tumkur (Pavagada), 400kV at Mysore and 400/220kV at Tumkur (Vasantnarsapur). The augmentation of 400/220kV substation facilities is linked with the transmission system being set up for evacuation of solar power and shall play a key role for transfer of Renewable Energy (RE) power from India's largest Ultra Mega Solar Power Park (2000 MW) Phase-II (Part-A) to be set-up at Tumkur (Pavagada) district on 10,000 acres of land.

The key EHV equipment for these substations, like 125 MVAr and 80 MVAr reactors including other substation equipment, will be supplied from BHEL's manufacturing Units at Bhopal and Bangalore. The substations are slated for commissioning in a schedule of 18 months.

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Hartek Power's solar grid EPC portfolio surpasses 500 MW

Hartek Power, one of India's fastest growing Engineering, Procurement and Construction (EPC) companies, has successfully connected 270-MW solar projects spread across Punjab, Uttar Pradesh and Karnataka to the grid. With the commissioning of these projects, the power systems EPC portfolio of Hartek Power has surpassed 500 MW in solar power projects.


Mr. Hartek Singh, CMD, Hartek Group

The company has registered a phenomenal twofold growth in its power systems EPC business catering to solar plants in a span of nine months. From just 258 MW, as on March 31, 2016, the solar power system EPC projects executed by Hartek Power have now gone up to 528 MW.

Involving 11 substations of up to 132 KV, the 270-MW projects executed by Hartek Power included a 150-MW project in Muktsar district of Punjab, a 70-MW project in Mahoba district of Uttar Pradesh and a 50-MW project in Ittagi district of Karnataka. The scope of work of these projects, which were completed in just five months, included complete turnkey solutions of post-inverter works covering the design, engineering, supply, installation, automation and commissioning of the power plant electrification.

Hartek Singh, Hartek Group, Chairman and Managing Director (CMD), said, "The power systems business unit of the Hartek Group has done incredibly well. We owe our success to our unflinching commitment to quality and timely execution of projects. We have won the trust of key developers by creating immense value for them in terms of unmatched expertise and services. These are the factors that have enabled us to emerge as one of the fastest growing EPC companies in the Indian solar space."

HPL Electric & Power receives orders over Rs. 100 crore

HPL Electric & Power, an established electric equipment manufacturing company in India, has received orders of over Rs. 100 crore, which include Rs. 70 crores for Bhopal Smart City Lighting project and Rs. 33 crores for Energy Meters from Southern Power Distribution.


Gautam Seth

Gautam Seth, Joint Managing Director, HPL Electric & Power, said, "We are pleased to receive the order for Bhopal Smart City Lighting and would like to acknowledge our R&D team's promising efforts which made it possible. At HPL, we have fully dedicated teams working on the advancement of street lighting system that help in energy efficiency. This order is a reward for our exceptional technology in the field of lighting which gave us a cutting edge over others. Adding to our order book, we have also received a Rs. 33 crores order for Energy Meters from Southern Power Distribution."

Suzlon obtains 105 MW maiden order from Axis Energy Group

Suzlon Group, one of the leading global renewable energy solutions provider in the world, revealed its maiden order win of 105 MW wind power project from Hyderabad based Axis Energy Group. Axis Energy Ventures India Private Limited is the flag ship company of the Axis Energy Group and the project is being undertaken by a Special Purpose Vehicle - Axis Wind Farms (Anantapur) Pvt Ltd. The project consists of 50 units of S111 90m tubular tower with rated capacity of 2.1 MW. Located in Anantapur district of Andhra Pradesh, the project is scheduled for completion in two phases; first phase will be completed in March 2017 and the second phase will be completed in June 2017.


J P Chalasani

Suzlon has entered into an exclusive Supply and Installation Agreement (SIA). The company will also be responsible for operation and maintenance services with dedicated life cycle asset management services for an initial period of 10 years. The project has the potential to provide power to over 50,000 households and reduce 0.22 million tonnes of CO_2 emissions per annum.

J.P. Chalasani, Group CEO, Suzlon Group said, "We welcome Axis Energy Group in our customer profile and would be delighted to forge a solid partnership with our maiden venture with them. The order adds to our backlog for the next financial year and also reaffirms the traction for S111 platform. Our continuous endeavour is on bringing down the cost of energy by investing in technologically advanced products and thereby enables renewable energy to transition from alternative to mainstream energy source."

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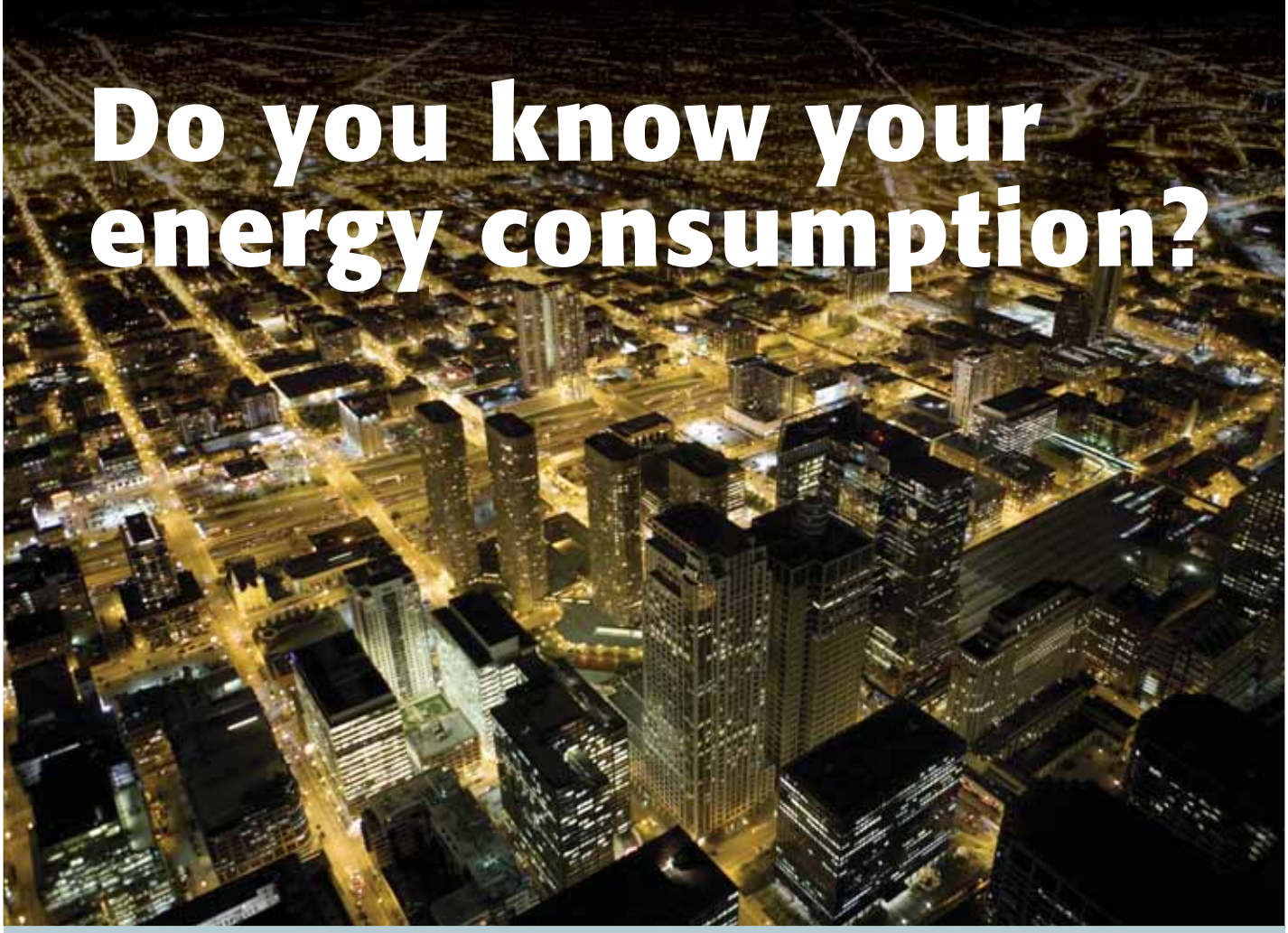

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ABB wins multiple orders from US utilities

ABB has won orders from three major US utilities for its innovative AssetShield solution to deliver hardened and bullet resistant transformers, and facilitate the protection of critical grid assets, minimising potential outages and enhancing the reliability of power networks.


Markus Heimbach

AssetShield-protected transformers are designed to help utilities meet new security and resiliency standards for critical substations in the US. This solution is an integral part of ABB's Transformer Resilience initiative which includes five strategic elements – assessment, hardening, monitoring, rapid repair and rapid replacement – designed to help utilities protect assets and restore power quickly in the event of physical damage to a substation.

ABB's scope of supply for the orders received includes a 700 Megavolt-Ampere (MVA), 345 kilovolt (kV) power transformer, two 100 MVA, 141 kV power transformers and three 500 kV single phase units. The UL-752 standard compliant transformers feature Asset Shield tanks, dry bushings, impact sensors and automated cooling valves.

Markus Heimbach, Managing Director of ABB's Transformers business unit, a part of the company's Power Grids division, said, "We are pleased to provide this innovative solution to support increased grid resiliency and reliability. ABB is collaborating with customers to address rising physical security concerns through solutions like AssetShield and other protective measures to mitigate risk and restore power faster."

APR Energy, GE renews strategic alliance in Fast-Track Power

APR Energy, well known for fast-track power solutions, and GE revealed that they have renewed their strategic alliance to provide mobile turbine technology into the fast-track power rental market.


John Campion

The strategic alliance grants APR Energy exclusivity around the globe as the rental provider of GE mobile gas turbines under 50 MW. As part of the agreement, APR Energy will acquire new Generation 8, GE TM2500+ mobile turbines in connection with its initiative to upgrade and standardise its fleet. In addition, GE and APR Energy will collaborate on leads for customers looking for interim or rental power solutions as a bridge to more permanent power solutions.

The acquisition of the new mobile turbines further strengthens APR Energy's position as the world's leading provider of mobile gas turbine power, expanding its total fleet capacity to more than 2GW – enough to power the equivalent of two million U.S. homes.

John Campion, Chairman of APR Energy, said, "We are very excited about the mutual benefits our renewed alliance brings, and appreciate the increased collaboration between our two companies. Our partnership will provide APR Energy access to new leads and opportunities throughout the GE global network, helping to support our business growth and thereby increasing demand for GE equipment. The alliance also provides us with the latest generation of TM2500+ units, giving us the newest fleet in the industry, while benefiting customers with the latest advancements in fuel efficiency and emissions controls."

FirstEnergy rebuilds transmission line in Wood County

FirstEnergy is a company dedicated towards safety, reliability and operational excellence. Its 10 electric distribution companies form one of US largest investor-owned electric systems, serving customers in Ohio, Pennsylvania, New Jersey, West Virginia, Maryland and New York. The company's transmission subsidiaries operate more than 24,000 miles of transmission lines that connect the Midwest and Mid-Atlantic regions.


Transmission Line Rebuild Completed in Wood County

It has rebuilt a transmission line connecting substations in Bowling Green and Pemberville to help enhance service reliability for about 38,000 customers in Wood County in the Toledo Edison service area.

The $6.3-million project included replacing 220 poles in the existing transmission right-of-way and installing a second 69-kilovolt circuit. Overall, more than 16 miles of wire was installed along the route. In addition, remote control switching devices were installed on the new sections, which allow grid operators to assess operational conditions more quickly, reducing the length and frequency if service disruptions occur.

The rebuilt line went into service in mid-December. As part of the project, work also was done to upgrade the Pemberville substation, with additional enhancements scheduled to be done at the Bowling Green substation next year.

The project is one of numerous distribution and transmission infrastructure projects totalling approximately $115 million that FirstEnergy completed in 2016 in Toledo Edison's service area.

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Wärtsilä to supply 150 MW power plant to Bangladesh

Wärtsilä will supply a 150 MW Smart Power Generation plant to Ace Alliance Power Limited, a special purpose company owned by the Summit Group of Companies in Bangladesh. The order comprises eight Wärtsilä 50 and one Wärtsilä 32 engines. The contract includes the Engineering and Equipment (EEQ) with additional advisory services for the plant's installation, testing and commissioning, as well as on-site staff training. The equipment is scheduled to be delivered during the second half of 2017, and the plant is scheduled to be operational in early 2018. The order is booked in the first quarter of 2017.

Both the population and economy are growing in Bangladesh, and a need for additional reliable power generation is evident. The new power plant will be built in Kodda in the Gazipur district, and will feed power into the national grid. Internal combustion engine-based power plants already play a key role in the country's energy system. The Summit Group of Companies is the largest independent power producer in Bangladesh and has a long-established relationship in power plant construction with Wärtsilä. During the past 20 years Wärtsilä's installed capacity with Summit Group has grown to 750 MW. With this recently signed contract, Wärtsilä's installed capacity with Summit Group will reach 900 MW.

With this project, Wärtsilä provides roughly 25 % of the grid capacity in Bangladesh with an installed base capacity of close to 3000 MW.

Canadian Solar and Wirsol commissions power plant in Netherlands

Dr. Shawn Qu

Canadian Solar, a well known solar power company, revealed that Wirsol has started the commercial operation of a 30MWp solar photovoltaic (PV) power plant in Delfzijl, Netherlands, for which Canadian solar has supplied the panels.

The Solarpark Delfzijl was commissioned on January 19th, 2017. Built with 116,335 Canadian Solar CS6P-265P modules, the solar power plant is expected to generate approximately 27,634 MWh/p.a. and save up to 17,962 tons of CO2.

Dr. Shawn Qu, Chairman and Chief Executive Officer of Canadian Solar, said, "I am delighted to see the Delfzijl solar power plant come online. We look forward to building more solar projects together with Wirsol in the BENELUX."

ENEL brings green energy to Italian embassy in Abu Dhabi

Francesco Starace

Enel has completed the installation of two solar PV power plants at the Italian Embassy in Abu Dhabi, as part of the Green Embassy project promoted by the Group's renewables division Enel Green Power in cooperation with the Italian Ministry of Foreign Affairs and International Cooperation, as well as the Embassy of Italy in Abu Dhabi.

Two plants with a respective capacity of 17 kWp and 10 kWp have been installed on the roofs and in the car park at the Embassy. The solar facilities are able to produce around 48,000 kWh per year, and can cover approximately one fifth of the Embassy's annual energy needs while avoiding the emission of around 35,000 tonnes of CO2 each year.

The two plants rely on 216 thin-film photovoltaic modules provided by 3Sun, the Group's solar panel manufacturing facility based in the Sicilian city of Catania. In the future, excess power output could be supplied to the city of Abu Dhabi, as the two facilities have also been connected to the city's distribution grid.

Francesco Starace, CEO of Enel, said, "We are very pleased to give our continued contribution to the Italian Foreign Affairs and International Cooperation Ministry's Green Embassy initiative, which shares with our company the commitment to promote clean energy technologies for a more sustainable future. Green Embassy projects also give us the opportunity to showcase our technology leadership in the renewables sector and open up our energy to the world, in line with our Open Power strategy."

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Subrata Mukhopadhyay
Mob.: +91 9836691112
Customer Care : 9595000200
Email Id: s.mukhopadhyay@oem-systems.com

Mahesh Gaikwad
Mob.: +91 9921829011
Customer Care : 9595000200
Email Id: m.gaikwad@oem-systems.com

Sarad Gairola
Mob.: +91 9820094621
Customer Care : 9595000200
Email Id: s.gairola@oem-systems.com

Sudhakar Poul
Mob.: +91 9860638920
Custom Care : 9595000200
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Gamesa secures its first order in Spain

Gamesa is exhibiting its strategic commitment to the Spanish market, having secured its first order since the latest energy sector reforms: the company will build a 20-MW wind farm for Villar Mir Energía, the Villar Mir Group's energy division.

Under the terms of the agreement, Gamesa will supply 10 of its G114-2.0 MW turbines at the Valiente wind farm located in the province of Huesca over the course of next year. It will also carry out the related construction work, including the civil engineering and electric infrastructure works, and operate and maintain the facility. The facility is expected to be commissioned during the first quarter of 2018.

The wind farm will be financed by Triodos Bank, an institution that specialises in financing renewable energy projects.

With a market share of over 50%, Gamesa is Spain's number-one Original Equipment Manufacturer (OEM), having installed more than 12,000 MW nationwide to date. In addition, the company services nearly 9,000 MW of turbines.

Spain, where close to 4,000 people work for the company, is also home to the company's main Research & Development (R&D) centre, as well as constituting one of its global production and supply hubs, manufacturing the full range of turbines included in the company's portfolio.

JinkoSolar donates 14 kW to RE-volv for two East Coast Non-Profits

JinkoSolar, a well known company in Photovoltaic (PV) industry, revealed that its wholly owned subsidiary, JinkoSolar (U.S.), donated 14 kW to RE-volv, a solar non-profit and member of the White House National Community Solar Partnership. This donation will provide two local charities with solar power.

JinkoSolar's donation significantly reduced RE-volv's crowdfunding goal, allowing both the Serenity House in Philadelphia, PA, and the Riverwest Co-op, in Milwaukee, WI to enjoy the benefits of solar sooner than anticipated.

5.6 kW of high-efficiency JinkoSolar modules have been installed on the Serenity House, an outreach ministry of the Arch Street United Methodist Church. It serves as a safe space in the heart of North Philadelphia, a community beset with poverty, homelessness, and substance abuse. The roof-top system is expected to interconnect this month, saving the Serenity House over 15% on its monthly electricity costs. Arch Street United Methodist Church will reinvest the savings into its community services.

The remaining 8.4 kW will be installed on the Riverwest Co-op, a natural food store and cafe located in Milwaukee's vibrant and diverse Riverwest neighbourhood. With the help of Jinko's module donation, Riverwest Co-op will save $40,000 in electricity costs over the lifetime of the system and keep 61 tons of burned coal from the atmosphere. Through its revolving Solar Seed Fund, RE-volv will use the ongoing lease payments from these two projects to finance four more solar projects for other community-serving nonprofits and co-ops.

Montana-Dakota Utilities Co. signs agreement to purchase power

Montana-Dakota Utilities Co., a division of MDU Resources Group, Inc., has signed a 25-year agreement with a subsidiary of ALLETE Clean Energy (ACE) to purchase power from a wind farm expansion in southwest North Dakota. The agreement also includes an option for Montana-Dakota to buy the project at the close of construction.

The expansion of Thunder Spirit Wind, located near Hettinger, ND, will boost the combined production at the wind farm to approximately 150 megawatts of renewable energy and will increase Montana-Dakota's generation portfolio from approximately 20 % renewables to 25 %. The original 107.5-megawatt Thunder Spirit Wind project was constructed by ACE and included 43 turbines; it was purchased by Montana-Dakota in December 2015. The expansion includes 13 to 16 turbines, depending on the turbine size selected, and will be constructed by ACE. It is expected to be online in December 2018.

Nicole Kivisto, President and CEO, said, "Our relationship with ACE on the first phase of Thunder Spirit Wind proved to be a winning formula. We are in need of additional energy to meet our growing demands, and with the easements, interconnection to the grid and permits already in place from the first phase of Thunder Spirit Wind, it makes this a great project for Montana-Dakota."

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Honeywell President and COO elected to company's Board

Honeywell revealed that it's President and Chief Operating Officer (COO) Darius Adamczyk has been elected to the company's Board of Directors.

Earlier in 2016, the company proclaimed that Adamczyk would be the successor to current Chief Executive Officer (CEO) Dave Cote beginning on March 31, 2017. Cote will continue as Executive Chairman of Honeywell until the company's Annual Shareowners meeting in April 2018.

Darius Adamczyk

Adamczyk said, "I am honoured to have been elected to the Board. Dave and the Board have been incredibly supportive of me throughout this transition and I am grateful for their willingness to provide guidance during this process. The opportunity to join the Board at this time will help accelerate my transition and ensure alignment with Dave and the Board as I work to ensure the continuation of Honeywell's outstanding performance over the past 15 years."

Mentor Graphics appoints VP for Integrated Electrical Systems

Mentor Graphics revealed the appointment of Martin O'Brien as Vice President (VP) of the company's Integrated Electrical Systems Division. The division primarily supports the automotive and aerospace industries, which are already challenged by the density and variety of electronic content and must now tackle emerging connectivity, electrification and security of the overall system. The division creates software for architecting, designing, manufacturing and maintaining electrical and electronic content for both original equipment manufacturers and their supply chain.

Martin O'Brien

O'Brien, formerly general manager of the division, was recruited in 2001 from Tyco Electronics where he was the global sales director. Prior to that O'Brien worked for Raychem Corporation managing multiple product developments, before moving into product management and then product marketing as director for Asia. O'Brien is based in the UK where he earned a master's degree in Materials Science from Brunel University.

Scott D. Drury begins his new role as President

The New Year brings new leadership to San Diego Gas & Electric (SDG&E) as Scott D. Drury becomes president of the energy company. Drury succeeds Jeff Martin, who has become Executive Vice President and Chief Financial Officer at Sempra Energy, the parent company of SDG&E.

As he steps into the role of President, Drury is focused on advancing SDG&E's efforts in clean, safe and reliable energy.

Scott D. Drury

Drury has held various leadership roles within the company, most recently, he served as the company's chief energy supply officer, overseeing all aspects of acquiring energy and capacity, electric transmission and substation operations, enterprise engineering, strategic planning, and generation and resource planning. He has held positions in human resources, diversity and inclusion, construction operations, safety, supply management and other areas.

Drury said, "It's an exciting time to be in the energy business. At SDG&E, we're inspired by the opportunity to improve the lives of our customers, and the communities where we live and work, by building the cleanest, safest, most reliable energy company in America."

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BHEL awarded for its contribution in equipment manufacturing

Bharat Heavy Electricals Limited (BHEL), an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing company of its kind in India has been awarded the CBIP Award 2017 for 'Best Power Equipment Manufacturing Organisation'. The award was received by Akhil Joshi, Director (Power), BHEL, from Sanjeev Kumar Balyan, Hon'ble Union Minister of State for Water Resources, River Development and Ganga Rejuvenation on CBIP Day 2017. The company has been conferred with the award for its outstanding contribution in manufacturing a wide range of equipment for the core sectors of the economy including power generation, transmission and renewable energy.

NTPC NETRA gets recognised

NTPC, a leading player in the world energy sector, recognised the potential of cutting edge technology in further improving its services and efficiency. The company is fully aligned to the needs of adapting to emerging technologies and upgrading the technologies through Research and Development (R&D). The company is particularly sensitive to R&D and the paradigm shift which it can make. NTPC Energy Technology Research Alliance (NETRA) is an outcome of this vision, which was set up in 2009.

Its core areas of research are: climate change, waste management, new and renewable energy, efficiency improvement and cost reduction besides providing scientific support to NTPC and external utilities for improving availability, reliability and efficiency.

NETRA is a member of IEA GHG R&D Program France, IERE Japan and CSLF France. It is a National Boiler Board Certified RLA Agency.

NTPC NETRA was awarded for Institutional Research, Training and Excellence in Academia at the 10th Enertia Awards held in New Delhi.

Sterlite Power bags CBIP Award

Sterlite Power, India's well known power transmission company, has been honoured by the Central Board of Irrigation and Power (CBIP) for setting new benchmarks in India's power transmission sector and bringing advanced and innovative technologies to speed up energy delivery.

CBIP is a premier central government backed Institution rendering dedicated services to professional organisations, engineers and individuals resulting in accelerated development in water resources, energy and allied fields, including renewable energy. It is a recognised international platform for knowledge sharing, training, consultancy, and research. Minister of State for Water Resources, River Development and Ganga Rejuvenation, Dr Sanjeev Kumar Balyan, presented the coveted CBIP Award for 'Best Performing Power Transmission (System) Utility' to Sterlite Power.

Pratik Agarwal, CEO, Sterlite Power, said, "Today, our projects use global technologies like sky crane, heli-stringing and LiDAR surveys and these have helped us speed up projects, especially in difficult terrains, and in many cases complete them ahead of schedule. We will continue to meet our commitments to make sure no home is without electricity. We thank CBIP for bestowing this honour on Sterlite Power and validating our efforts to bring state-of-the-art technologies to the Indian transmission sector."

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The Winner of The Future

P K Chatterjee

One of the major causes behind slow deployment or adoption of solar energy is – not having the right information on the falling cost of the solar modules. Many of us still feel: though environment-friendly and sustainable, going solar is a costly affair...

According to the available information from the Central Electricity Authority (CEA), 5791.54 MU of electricity has been generated by cumulative solar installations in India between April 2016 to September 2016. Table 1 indicates the change from the previous year 2015 – 2016.

Table 1: Electricity Produced By Cumulative Solar Installations In India

Year	Energy generation (MU)
2015-16	7447.92
2016-17 *	5791.54

* from April-2016 to September, 2016. Source: CEA

Also, let us look at the comparative percentage of solar energy produced during the last three years and the current year out of all renewable energy generation during the period (Table 2).

Obviously, both Table 1 and Table 2 show a positive trend as far as the growth of solar energy is concerned. But considering that our country has an ambitious plan for ramping up solar power generation to 100 GW by 2022, obviously we will have to work much harder from today's 8.63 GW capacity (level).

Although the Indian government is trying hard to popularise adoption of solar power, we are still to achieve a lot. There are several reasons behind that, however, one of the major causes behind slow deployment or adoption of solar energy is – not having the right information on the falling cost of the solar modules. Many of us still feel: though environment-friendly and sustainable, going solar is a costly affair. How far is that true? What is happening globally?

The scenario in the USA

The USA is still considered as the country leading the area of high technology globally. Let

Table 2: Comparative Percentage Of Solar Energy

Year	Solar Energy generation (MU)	Total Renewable Energy generation (MU)	% of Solar energy produced
2013-14	3353.80	53224.50	6.3%
2014-15	4599.02	61784.93	7.4%
2015-16	7447.92	65780.85	11.3%
2016-17*	5791.54	47627.29	12.2%

* from April-2016 to September, 2016. (Tentative data received from CEA)

us have a look at the status quo there. A recent report from the National Renewable Energy Laboratory (NREL) states that the modeled costs to install solar Photovoltaic (PV) systems continued to decline in the first quarter of 2016 in the U.S. residential, commercial and utility-scale sectors. Driving the cost reductions were lower module and inverter prices, increased competition, lower installer and developer overheads, improved labour productivity and optimised system configurations.


Ran Fu

"The continuing total cost decline of solar PV systems demonstrates the sustained economic competitiveness of solar PV for the industry across all three sectors," says NREL Senior Analyst and Project Lead Ran Fu.

The modeled costs for the first quarter of 2016 were down from the fourth quarter of 2015 by 6%, 4%, and 20% in the residential, commercial and utility-scale sectors, respectively. The costs fell to $2.93 per watt of direct current for residential systems, $2.13 per watt of direct current (Wdc) for commercial systems and $1.42 Wdc for utility-scale systems for fixed-tilt utility-scale systems, and $1.49 Wdc for one-axis-tracking utility-scale systems.

"Such accurate cost benchmarks are critical for tracking the progress of PV systems toward cost-reduction goals. Because our cost model categorises hardware and non-hardware costs with a high degree of resolution, the results can also be used to identify specific cost-reduction investment opportunities and assess regional levelised costs of energy," adds Fu.

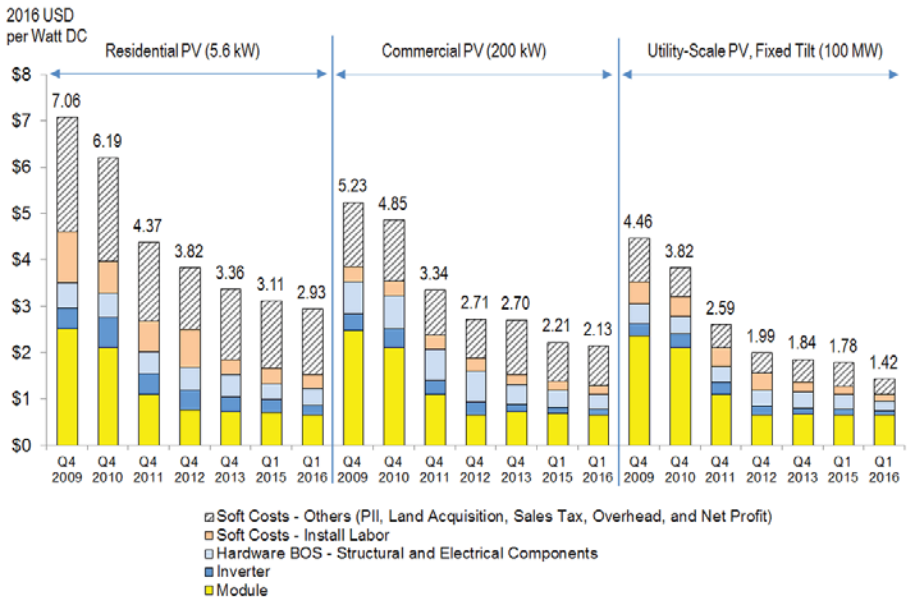
The new results also highlight the importance of non-hardware, or 'soft,' costs. As the pace of cost reductions for modules and inverters has slowed in recent years, the proportion from soft costs – such as labour, overhead and permitting costs – have grown. In the first quarter of 2016, soft costs accounted for 58% of residential system costs, 49% of commercial system costs and 34% of utility-scale system costs.

NREL uses a 'bottom-up' modeling method to construct total capital costs by quantifying the typical cost of each individual system, and project-development component, largely through dialogues and interviews with solar industry collaborators. The results represent total installed system costs from the perspective of the PV project developer or installer, including net profit in the cost of the hardware. The benchmarks are national averages weighted by state installed PV capacities.

Solar PV to boom in Africa


Adnan Z Amin

According to Adnan Z Amin, Director-General of International Renewable Energy Agency (IRENA), "In recent years, solar PV costs have dropped dramatically and will continue to do so with further declines of up to 59% possibly in the next ten years. These cost reductions, coupled with vast solar potential on the continent, present a huge opportunity for Africa. Both grid-

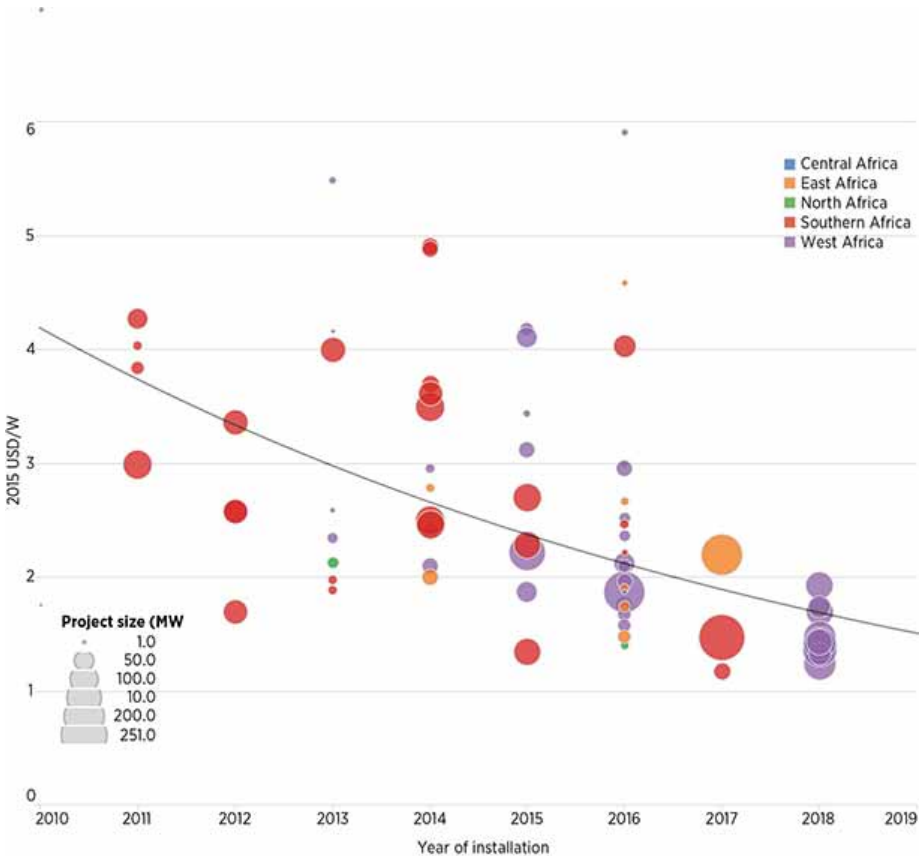


NREL U.S. PV system cost benchmarks, from the fourth quarter of 2009 to the first quarter of 2016...

connected and off-grid solar PV now offer a cost-competitive means to meet rising energy needs and bring electricity to the 600 million Africans who currently lack access."

According to IRENA's recent report titled, 'Solar PV in Africa: Costs and Markets,' the installed costs for power generated by utility-scale solar PV projects in Africa have decreased as much as 61% since 2012. Today, installed costs for these projects are as low as USD 1.30 per watt in Africa, compared to the global average of USD 1.80 per watt.

Mini-grids utilising solar PV and off-grid solar home systems in Africa also provide higher quality energy services at the same or lower costs than the alternatives, finds the IRENA report. Stand-alone solar PV mini-grids have installed costs in Africa as low as USD 1.90 per watt for systems larger than 200 kW. Solar home systems – which have tripled in Africa between 2010 and 2014 – provide the annual electricity needs of off-grid households for as little as USD 56 per year, less than what they currently pay for poor quality energy services.



Utility scale solar PV project costs in Africa...

Europe and Asia striding forward

Oliver Schafer

SolarPower Europe, the new EPIA (European Photovoltaic Industry Association), is a member-led association representing organisations active along the whole value chain. "Solar is booming and continues to break records in many parts of the world, which gives us reasons to believe 700 GW globally installed solar power is possible by 2020," says Oliver Schafer, President SolarPower Europe.

As per their market report, called the 'Global Market Outlook for Solar Power 2016-2020,' a total of 229 GW of solar power was installed in the world by the end of 2015 – an over 45-fold market increase in only 10 years.

China, Japan and the US led the world's solar market in 2015, with China and Japan alone responsible for 50% of newly installed capacity. 2015 also marked a growth year for the European solar market with 8.2 GW of grid-connected solar power, the market grew by 15% year-on-year.

In the first quarter of 2016, China alone installed over 7 GW of solar power. Europe became the first region in the world to pass the 100 GW mark of installed PV capacity. "Solar is booming and continues to break records in many parts of the world, which gives us reasons to believe 700 GW globally installed solar power is possible by 2020" says Oliver Schafer, President of SolarPower Europe.

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The Indian scenario

In India, in the last two years, solar power generation segment has seen good growth. However, as pointed earlier, it is mostly government's effort. Of course several private enterprises also have extended their hands to embrace solar power generation. But one of the high potential areas, that is the rooftop segment is still available offering a huge opportunity.

As far as the grid-connected photovoltaics is concerned, the change scenario of the last three years and a half can be seen in the Table 3.

Table 3: Grid Connected Solar Power Installation Capacity Increase In Last 3.5 Years

Year	Solar Capacity Installed in MW
2013-14	947.46
2014-15	1112.07
2015-16	3018.88
2016-17	1965 (as on 31.10.2016)

Source: Press Information Bureau, India

Realising the less-taped wide potential and to encourage the nation, on 09 12 2016, the Director of the Solar Energy Group under the Ministry of New & Renewable Energy (MNRE), Dr G Prasad has issued an office memorandum. It coveys, "Ministry is implementing the program for installation of grid connected Roof Top Solar (RTS) power systems/projects in buildings/ vacant areas belonging to various Ministries/ Departments. In order to expedite the implementation, PSUs have been empanelled by MNRE to assist the Ministries/Departments through Project Management Consultancy (PMC)."

Obviously, the good steps which are starting from the ministries now, will take quite some time to be followed by the common citizens. Also, delay in grid connection is one of the main challenges affecting fast acceptance of the Rooftop solar projects. The current policy of MNRE of financing such projects will definitely enhance the adoption of the new rooftop solar projects. One of the recent analyses of Bridge to India points out that effective grid connection and net-metering policies can increase customer adoption rates by up to 50%.

What do the experts say?

"Solar power is becoming increasingly cost-competitive with fossil fuels and distributed solar is cheaper than retail electricity in many countries. In 2016, solar also became cheaper than on-shore wind power in parts of the globe," says Michael Schmela, Executive Advisor of SolarPower Europe and Lead Author of the SolarPower's report.

"India's economy is growing rapidly, and the country has ambitious plans for widespread electrification. Renewable energy resources and technologies have an important role to play in these plans. By reaching out and sharing knowledge between government ministries and mini grid developers, financiers and suppliers, we have been able to offer solutions that make solar power a practical and profitable option to electrify India's rural regions," says John Harvey, Project Manager, Ricardo Energy & Environment.

Last year, while approving the $625 million loan to support the Government of India's program to generate electricity from widespread installation of rooftop solar Photo-Voltaic (PV), and co-financing loan of $120 million on concessional terms and a $5 million grant from Climate Investment Fund's (CIF) Clean Technology Fund, Onno Ruhl, World Bank Country Director in India, said "India is endowed with huge solar energy potential, and the World Bank is strongly supportive of the government's plans to harness this potential and increase India's solar PV capacity to 100 GW. Solar PV will not only improve access to electricity, but it will do so in a manner that avoids the environmental impacts of other traditional electricity sources."

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Sample Based Fault Classification

Dr Ashok Kumar Pradhan
Professor
Electrical Engineering
Department, IIT Kharagpur

Dr Bibhuti Bhusan Pati
Professor
Electrical Engineering Deptt.
VSSUT, Odisha

Dr (Mrs) Monalisa Biswal
Assistant Professor
Electrical Engineering Deptt.
NIT Raipur

In order to classify the faulty phase and distinguish clearly between line-to-ground and double-line to ground fault a superimposed phase current component based approach is present in this article for fixed series compensated line....

In recent years, the large growth in power demand and area constrains encouraging the wide application of series compensation on long transmission systems. But protection challenges associated with such lines with Metal Oxide Varistor (MOV) sought better algorithms to improve relay performance. To improve the stability, Single-Pole Tripping (SPT) and Auto Reclosing (AR) schemes are applied to high voltage transmission system. Proper phase selection is more important for such scheme for fast closing followed by tripping in line-to-ground fault case. On the other side fault type indicator has a greater importance on the distance relay operation so as to quickly identify and isolate the abnormality and restore the rest as soon as possible.

With the inception of fault in a system, it can be detected within quarter of cycle. But fault classifier may take several times or fail to classify due to instrument error, incorrect setting, classification algorithm, insufficient signal etc. So, the overall process will lead to unanticipated operation of distance relay. For different types of fault, the signals may appear differently, so considering that change, fault classification algorithms are set.

Several fault classification algorithms have been mentioned in the literature for series compensated and long transmission systems.

Discrete wavelet transformation and fuzzy can be applied to series compensated line to classify the fault type. For advanced series compensated line, a Support Vector Machine (SVM) based fault classification algorithm is used. As voltage-based classifiers have main drawback when strong source is connected with long line, the classifier operate incorrectly. So, only superimposed phase current based technique is suggested. Both superimposed phase voltage and current based techniques are also proposed by some experts.

Fault type can be easily detected by using sequence components i.e., whether there is a ground fault, phase-to-phase fault or three phase fault. Considering the sequence, components of current and voltage, a fault classification method is also proposed.

Also, fault type can be classified using the fault impedance. In the literature several integrated approach based methods are proposed to accurately discriminate the fault type. Another approach using sequence components applied to fuzzy integration is used to discriminate different fault types.

Another fuzzy based method is also proposed by some authors. Correlation analysis can be applied to achieve fast fault classification. Instead of using complicated logic, simple soft-processing based techniques can be used to accurately classify the type of fault. Simple max and min logical operators are applied to different rules to perform the task. Moving sum approach based fault detection is prescribed in some books. It is a very strong approach and it is not sensitive to frequency deviation, CT saturation, noise, transients etc.

In this article, a superimposed current sample based moving sum approach is presented for finding the accurate fault type in a series compensated, connected at middle of the line. Ground current is considered to distinguish between ground fault and phase fault. Based on rules, logical operators like max and min fault discrimination is done. The proposed method is very effective for changing system conditions, high resistance faults, CT saturation, different level of compensation, fault inception angle etc. The method is tested for a 400 kV series compensated line simulated using EMTDC/PSCAD.

Fault Classification Problems with Series Compensated Line

Most of the fault classification algorithms for long transmission lines are either based on sequence components or phase quantity may provide correct results for wide system variations, if designed properly. But the available methods may mal-operate when applied to series compensated lines because of several reasons.

With the initiation of fault decaying, DC is always present in the current signal during the transient period as shown in Fig.1. More than two cycles are required to damp out these components.

Further any disturbance in a series compensated line can give rise to sub-synchronous frequency components in the fault current.

Digital filters like least square, reiterative DFT can able to provide fundamental components but the overall process will take much time.

High current fault in a series compensated line is not an issue. But as the MOV is self extinguishing in nature, transients are generated with its

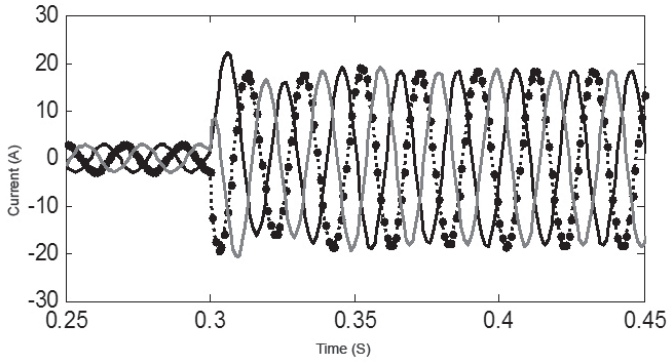

Fig. 1. Current waveform for three phase fault

reinsertion, which can influence the relaying decision.

With low current faults voltage and current inversion problems may arise in a series compensated lines. This is not at all a problem with series capacitors placed at the middle of the line. Generally, line end capacitor creates more problems than the capacitor placed at the middle.

For fault at different positions (before and after capacitor), the current level may be of the same order in a line with series capacitor placed at central location.

Hence, the overall performance of fault classification algorithm depends on position of series capacitor, MOV operation, phasor estimation, fault location, fault resistance, type of fault etc.

So, within half a cycle discriminating the type of fault holding these challenges is a crucial task for the relaying algorithm.

Moreover, simplicity of the method is also an important factor to avoid large mathematical calculations.

Hence, a fault classification technique is proposed in this article, which will enable to look out the above mentioned issues.

Proposed Superimposed Current Based Moving Sum Approach

Fault detection using superimposed current phasors is a very strong approach.

But classification of different fault types is very difficult mainly between line-to-ground fault and double-line-to-ground fault at different positions for a series compensated line as shown in Fig. 2.

The system data are provided in the Appendix. The current data is collected from the output of CT having ratio 1600/5.

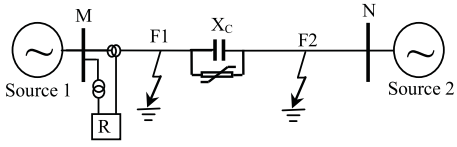

Fig. 2: The three phase power system model...

For an AB-G fault occurred at 0.3 sec after 149 km with 80 ohm fault resistance from the capacitor, the superimposed current based method provides almost same output for AB-G and Ag fault, which is cleared from Fig.3 (a) and (b).

So, there is a chance of mal-operation of the relay.

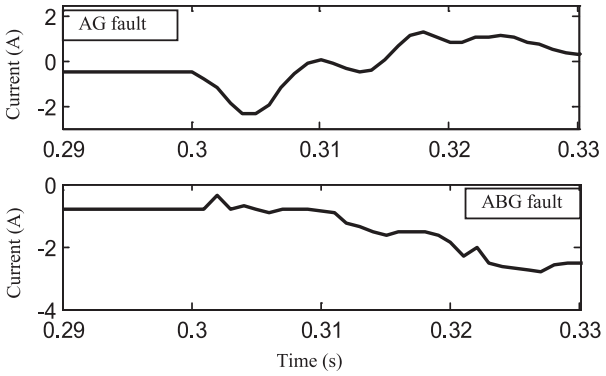

Fig. 3. Current waveforms for (a) ab-g fault... (b) ab fault...

For a wide range of system variation, it is very difficult for any method to offer correct result. Selecting the threshold value is also very difficult. Instead of using very complicated mathematical calculations or any integrated approach, a simple rule based fault classification approach is provided as described below.

A: Description of Proposed Method

After the detection of fault superimposed current sample value for each phase A, B, C are calculated.

$$i_{SUP\_A} = i_{A\_F} - i_{A\_PRE}$$
$$i_{SUP\_B} = i_{B\_F} - i_{B\_PRE}$$
$$i_{SUP\_C} = i_{C\_F} - i_{C\_PRE} \qquad (1)$$

A short window is considered for calculating the moving sum of each phase superimposed current data.

$$\Delta i_{SUM\_A} = \sum_{k=1}^{N/2} i_{SUP\_A}(k)$$
$$\Delta i_{SUM\_B} = \sum_{k=1}^{N/2} i_{SUP\_B}(k)$$

$$\Delta i_{SUM\_C} = \sum_{k=1}^{N/2} i_{SUP\_C}(k) \qquad (2)$$
$$i_g = i_{A\_F} + i_{B\_F} + i_{C\_F} \qquad (3)$$

Where N = no. of samples per cycle. i_g is the ground current.

To obtained accurate fault type within half-a-cycle separate rules are framed for each fault case. As transients in the current signals are present during initial period, any logic will not provide consistent result. So, the logical operators max and min are used. After the detection of fault, the moving sum of three phases superimposed currents are calculated. From the calculated values half cycle samples are considered.

Then based on the rules their maximum vales are calculated. If the maximum value is minimum of the compared values then based on rules the fault type is declared. i_g is considered to distinguish between ground fault and phase-to-phase fault. After going for several cases and system

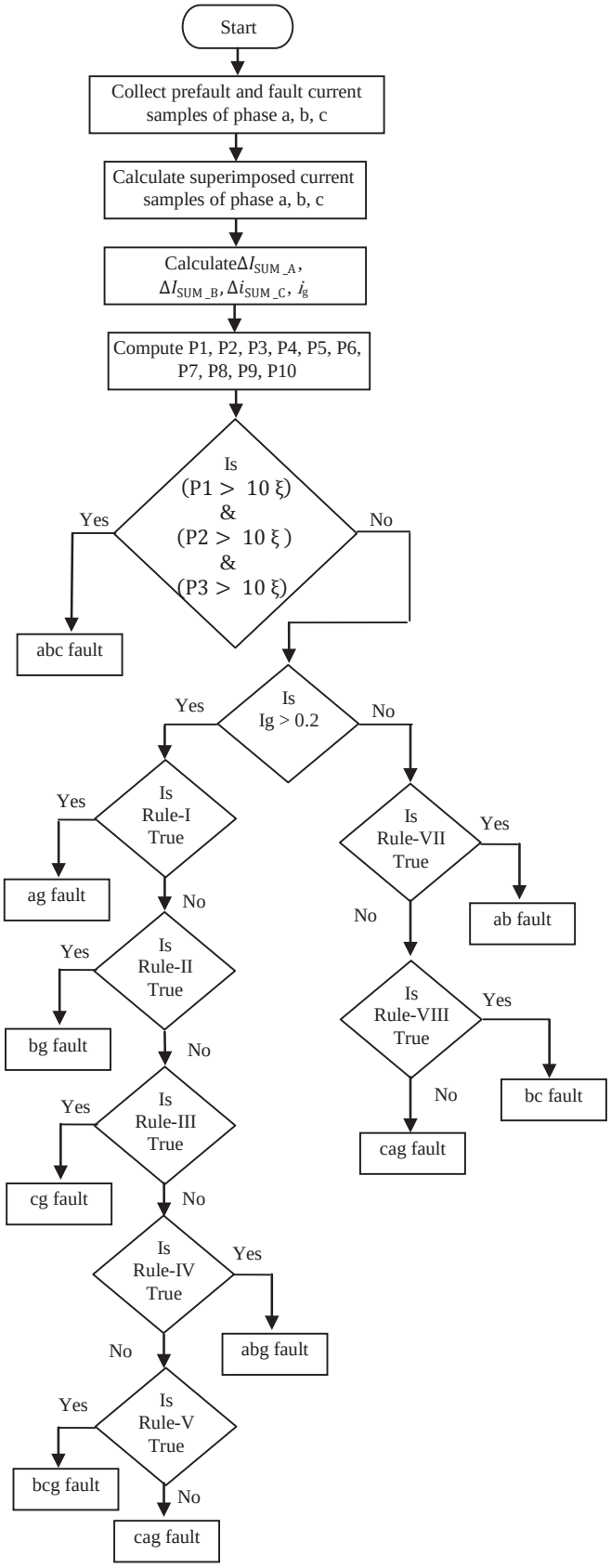

Fig. 4: Flow diagram of proposed fault classification method...

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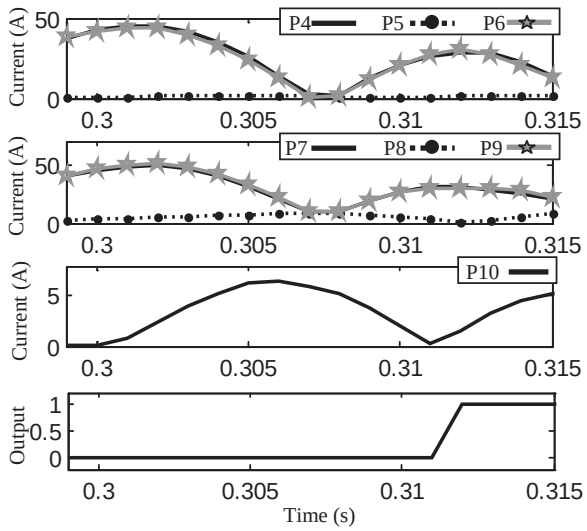

Fig. 5: Plots for a-g fault at 90 km from relay with Rf = 100 ohms...

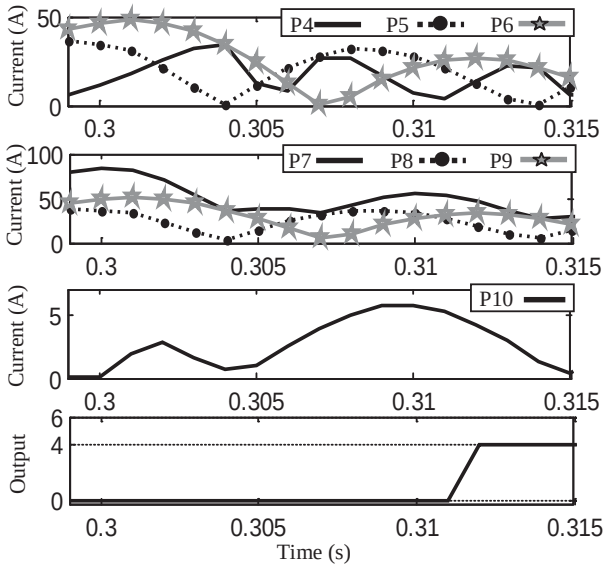

Fig. 6: Plots for ab-g fault at 90 km from relay with Rf = 100 ohms...

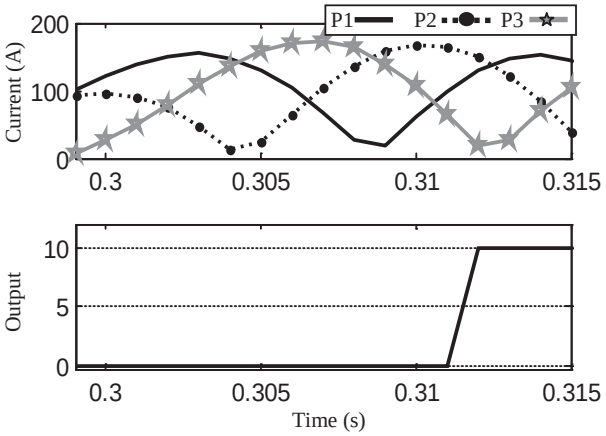

Fig. 7: Plots for abc fault at 1 km from capacitor...

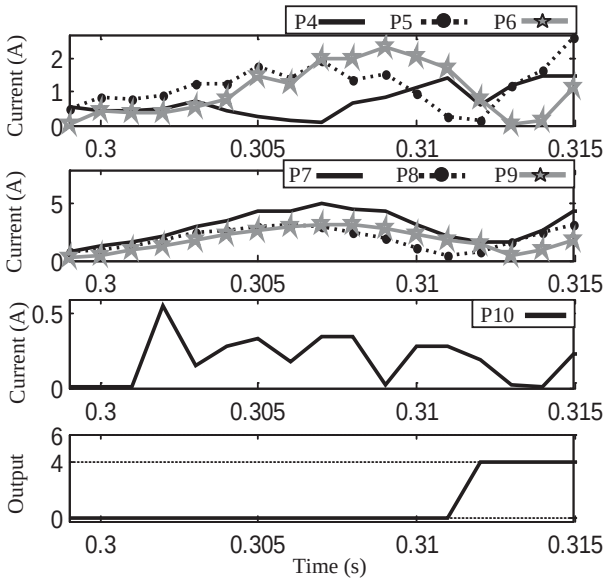

Fig. 8: Plots for ab-g fault at 297 km with Rf = 200 ohms...

conditions it is observed that a minimum value of current flowing through the ground during balance fault and phase-to phase fault. So, a threshold limit α of 0.2 amps in the ground is considered to distinguish between ground and ungrounded fault. Similarly, to distinguish the different types of fault, a minimum limit value is fixed i.e., ξ which can be considered as CT secondary current. The algorithm first checks after the fault detection, whether it is a three phase fault or not. If not, then the neutral current is calculated to detect other fault type.

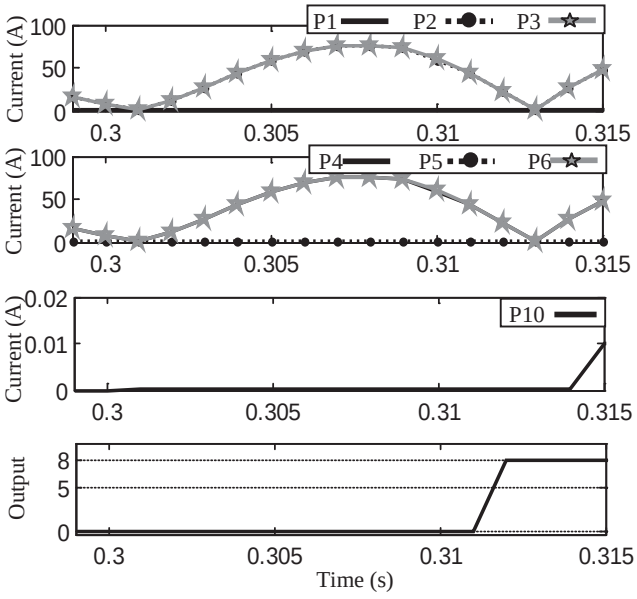

Fig. 9: Plots for bc fault at 295 km with Rf = 1 ohms...

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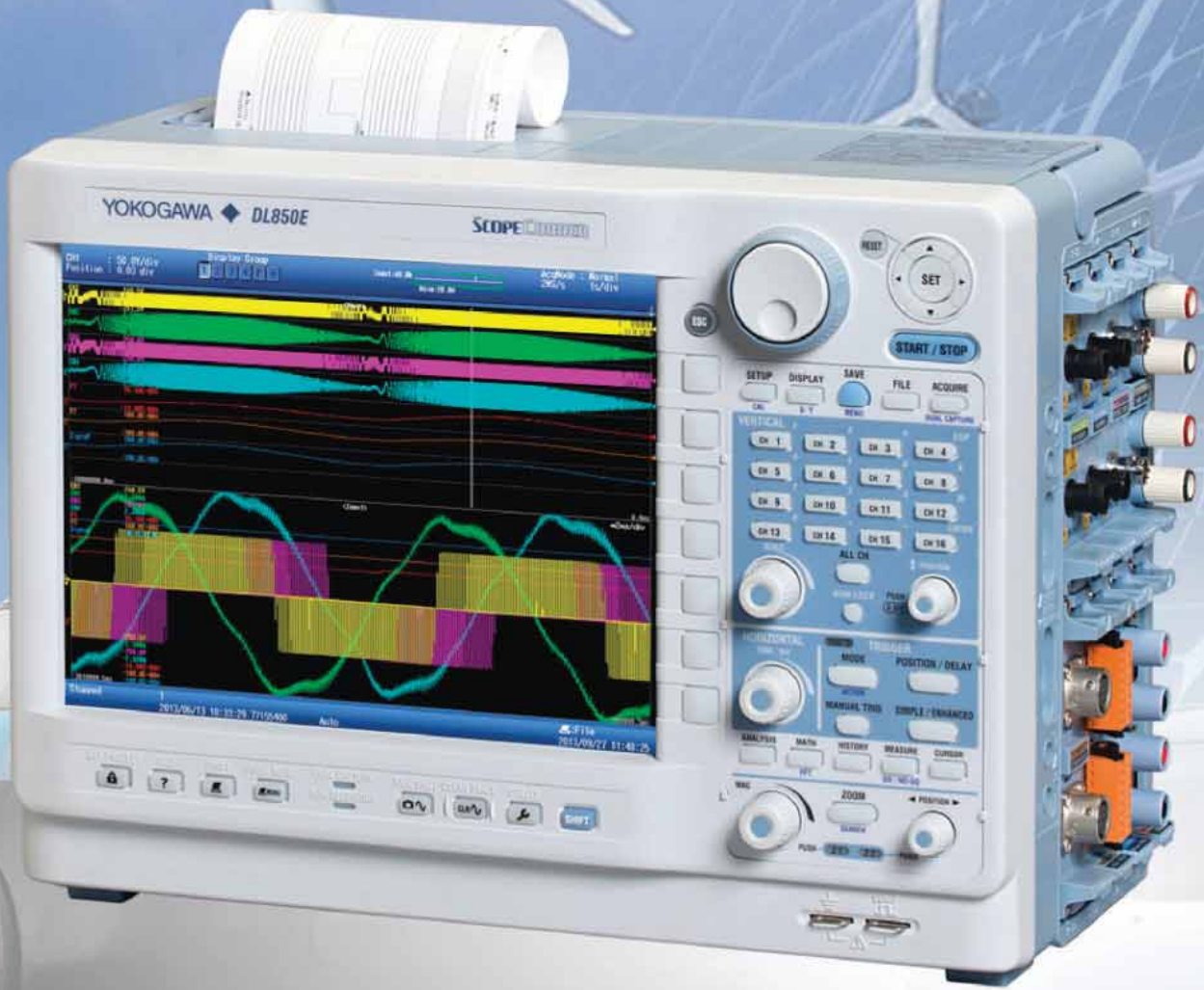

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Table I - Fault Classification Output for h =1, δ=10°, and R_f = 1 ohm

Fault Type	Fault Location (km)	P1 (A)	P2 (A)	P3 (A)	P4 (A)	P5 (A)	P6 (A)	P7 (A)	P8 (A)	P9 (A)	P10 (A)	Output
bc	1	1.021	1029.1	1029.6	1028.3	1.021	1028.9	-	-	-	0.00	8
abc	1	2108.1	1382.0	1772.4	-	-	-	-	-	-	-	10
bg	140	14.84	104.5	14.94	98.39	97.51	0.87	111.61	112.48	29.79	14.26	2
bcg	140	7.95	123.1	159.9	121.2	89.94	152.3	125.5	272.2	167.4	11.91	5
bc	140	2.03	135.3	139.7	133.3	4.51	137.8	-	-	-	0.158	8
abc	140	299.9	201.1	234.4	-	-	-	-	-	-	-	10
cg	151	8.78	9.60	83.78	0.86	79.76	79.76	18.38	88.49	87.79	11.55	3
cag	151	137.4	4.74	124.28	133.4	120.7	42.18	141.40	127.79	257.4	6.94	6
ca	151	128.5	0.93	127.1	127.6	126.2	1.56	-	-	-	0.10	9
abc	151	159.0	165.8	176.8	-	-	-	-	-	-	-	10
ag	299	45.8	12.07	12.28	43.66	0.93	44.47	48.89	24.35	48.25	5.78	1
abg	299	59.5	90.9	4.4	36.4	88.0	57.5	150.4	93.9	62.4	2.63	4
ab	299	64.1	67.7	1.7	3.6	66.0	63.4	-	-	-	0.05	7
abc	299	90.3	97.0	99.4	-	-	-	-	--	-	-	10

Table II - Fault Classification Output for h =1, δ =10°, and Rf = 100 ohm

Fault Type	Fault Location (km)	P1 (A)	P2 (A)	P3 (A)	P4 (A)	P5 (A)	P6 (A)	P7 (A)	P8 (A)	P9 (A)	P10 (A)	Output
ag	250	5.25	0.70	0.71	4.55	0.32	4.79	5.94	1.35	5.71	0.52	1
cg	250	1.93	2.00	10.04	0.32	9.28	9.59	3.94	10.81	10.49	2.12	3
abg	250	17.22	20.14	1.65	9.73	19.20	15.56	35.63	21.09	18.88	1.72	4
bcg	250	2.30	13.85	13.47	11.63	11.26	11.73	16.06	24.55	15.21	1.55	5

Table III - Fault Classification Output for h = 0.98, δ =2°, and R_f = 2 ohm

Fault Type	Fault Location (km)	P1 (A)	P2 (A)	P3 (A)	P4 (A)	P5 (A)	P6 (A)	P7 (A)	P8 (A)	P9 (A)	P10 A)	Output
ag	120	166.0	16.96	16.96	156.3	0.003	156.3	177.5	33.92	177.5	19.10	1
abg	180	117.82	153.5	4.57	50.62	148.9	113.2	271.3	158.0	122.4	6.63	4
ab	210	116.3	116.4	0.21	0.47	116.3	116.1	232.8	116.6	116.5	0.048	7
abc	240	107.03	133.9	122.3	-	-	-	-	-	-		10

Table IV - Fault Classification Output for h =1.02, δ =20°, and R_f = 50 ohm

Fault Type	Fault Location (km)	P1 (A)	P2 (A)	P3 (A)	P4 (A)	P5 (A)	P6 (A)	P7 (A)	P8 (A)	P9 (A)	P10 (A)	Output
ag	120	69.44	9.56	9.59	65.27	0.02	65.27	74.83	19.16	74.84	8.76	1
cg	180	6.42	6.41	31.25	0.02	29.86	29.86	12.84	32.63	32.63	6.10	3
bcg	210	5.11	37.65	39.98	32.56	22.87	35.49	42.73	75.33	44.83	3.54	5
cag	240	47.84	3.39	27.33	47.32	26.80	24.77	48.37	27.86	75.18	2.67	6

Table V - Fault Classification Output for Considering Change in Source Impedance - h =1, δ =10°, and R_f = 150 ohm

Fault Type	Fault Location (km)	P1 (A)	P2 (A)	P3 (A)	P4 (A)	P5 (A)	P6 (A)	P7 (A)	P8 (A)	P9 (A)	P10 (A)	Output
ag	30	38.74	1.45	1.46	38.25	0.019	38.25	39.23	2.92	39.24	5.85	1
bg	60	1.82	28.46	1.81	27.87	27.86	0.012	29.05	3.63	5.63	5.63	2
cg	90	3.12	3.12	29.14	0.007	28.42	28.43	6.24	29.85	29.84	4.56	3
abg	120	30.73	22.41	3.43	21.64	22.36	30.71	51.84	22.46	30.76	3.44	4
bcg	180	3.74	19.73	19.21	16.10	13.77	16.64	23.37	35.45	22.10	2.21	5
cag	210	26.01	2.25	18.72	25.39	16.46	15.95	26.63	20.98	42.14	2.35	6

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B: Operators used in proposed fault classification rules:

$$P1: \max\left(|\Delta i_{SUM\_A}|\right)$$
$$P2: \max\left(|\Delta i_{SUM\_B}|\right)$$
$$P3: \max\left(|\Delta i_{SUM\_C}|\right)$$
$$P4: \max\left(|P1 - P2|\right)$$
$$P5: \max\left(|P2 - P3|\right)$$
$$P6: \max\left(|P3 - P1|\right)$$
$$P7: \max\left(|P1 + P2|\right)$$
$$P8: \max\left(|P2 + P3|\right)$$
$$P9: \max\left(|P3 + P1|\right)$$
$$P10: \max\left(|i_g|\right)$$

C: Rules for different fault types:

Rule - I:
If (P10 > α) &
(min (P4, P5, P6) = P5) & (min (P7, P8, P9) = P8)
Then AG fault.
Output: 1

Rule - II:
If (P10> α) &
(min (P4, P5, P6) = P6) & (min (P7, P8, P9) = P9)
Then BG fault.
Output: 2

Rule - III:
If (P10> α) &
(min (P4, P5, P6) = P4) & (min (P7, P8, P9) = P7)
Then CG fault.
Output: 3

Rule - IV:
If (P10>α) & (min (P4, P5, P6) = P4) & (max (P7, P8, P9) = P7)
Then ABG fault.
Output: 4

Rule - V:
If (P10 > α) & (min (P4, P5, P6) = P5) & (max (P7, P8, P9) = P8)
Then BCG fault.
Output: 5

Rule - VI:
If (P10 > α)
(min (P4, P5, P6) = P6) & (max (P7, P8, P9) = P9)
Then CAG fault.
Output: 6

Rule - VII:
If (P10 < α) &
(min (P1, P2, P3) = P3) & (min (P4, P5, P6) = P4)
Then AB fault.
Output: 7

Rule - VIII:
If (P10 < α) &
(min (P1, P2, P3) = P1) & (min (P4, P5, P6) = P5)
Then BC fault.
Output: 8

Rule - IX:
If (P10 < α) &
(min (P1, P2, P3) = P2) & (min (P4, P5, P6) = P6)
Then CA fault.
Output: 9

Rule - X:
If (P1 > 10 ξ) & (P2 > 10 ξ) & (P3 > 10 ξ)
Then ABC fault.
Output: 10

The flow diagram of the proposed method is shown in Fig.4.

Procedure Evaluation

To observe the performance of proposed algorithm for various fault types and system conditions, data are generated by EMTDC/PSCAD software and input to MATLAB. The voltage magnitude ratio (h) and load angle (δ) are considered as 1, 10°. Sampling rate of 1 kHz is selected for the system. Using three phases superimposed moving sum current and ground current based on rules fault class is declared.

A: Results for fault before series compensation:

An A-G and AB-G fault cases are simulated from 90 km from relay end with fault resistance (R_f) is considered as 100 ohms. Fault initiation occurs at 0.3 sec. Fig. 5 illustrates the plots for A-G fault. From the figure, it is clear that P_5 and P_8 have minimum values with P_{10} greater than α, so the output comes out as 1 indicates A-G fault by the proposed method.

This implies that even for normal line also, this will provide correct result. Similarly in Fig. 6, an AB-G fault case is shown. As all the conditions satisfied, the output comes out at 4.

It is clear from the two results that as the same operators are used to distinguish between single-line-to-ground fault and double-line-to-ground fault, and because of the distinct signals there is not at all a chance of mal-operation of the proposed algorithm. To test the accuracy of the proposed method, several other cases are also simulated below.

B: Results for fault close to series compensation:

A fault case is simulated for three phase fault 1 km after the series compensation. From Fig. 7, it is clearly understood that as the P_1, P_2, and P_3 are simultaneously greater than 10 ξ which indicates there is a balance fault and the output comes out as 10 i.e., ABC fault.

C: Results for far end high resistance fault:

Generally, far end faults are difficult to detect and classify if going through high resistance as the level of fault current is very less. To check the performance of proposed method, a case is simulated for AB-G fault at 297 km from relay end with R_f of 200 ohm.

In Fig.8, the output is shown, which indicates the accuracy of the proposed method. To observe the performance of the proposed method, wide variation in fault resistance and fault locations are considered and the simulation results are provided in Table I and II.

D: Results for faults during changing system condition:

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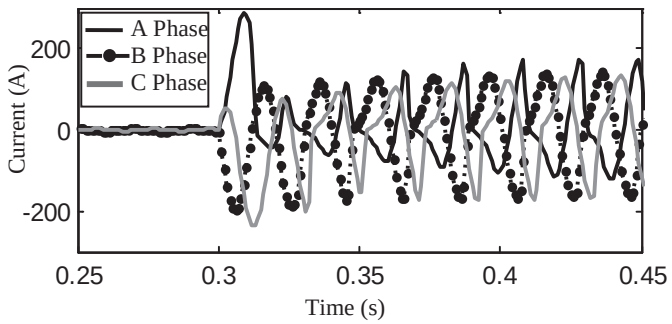

Fig. 10: CT saturation waveform.

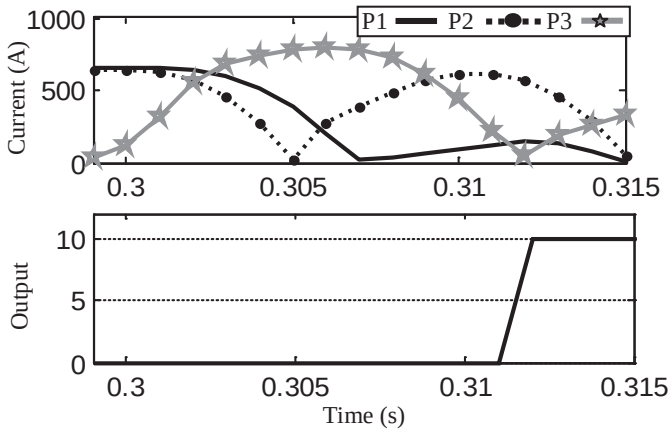

Fig. 11: Response of proposed method during CT saturation...

System conditions such as loading level, voltage level, source impedances change frequently. Protective algorithm should be of adaptive nature or designed considering the most expected variations so as to avoid mal-operation. A fault case is simulated considering load angle (δ) as 2° and voltage magnitude ratio (h) as 0.98. An bc fault is simulated at 295 km from relay with a fault resistance of 1 ohm.

The current in the ground is very less. So it is detected as a phase-to-phase fault. According to rules for ab fault P3 and P4 should have minimum value which is true as shown in Fig.9. So the output is 7.

Different fault cases with fault resistances and large change in system conditions are simulated and result of each shown in Table III and IV.

To observe the effect of source impedance variation on the proposed method different fault cases are simulated by increasing the source to twice of its original value. From Table V it is cleared that the influence of source impedance variation is negligible on the proposed algorithm.

Effect of CT Saturation

A short circuit fault very near to relay may cause CT saturation. During saturation, secondary current of CT is severely distorted which results in phase shift between unsaturated and saturated current waveform.

Also, the presence of large decaying dc component creates error in phasor estimation. The current waveform for CT saturation period is shown in Fig.10.

The response of proposed method for such a condition is tested by creating a three fault at 1km from relay end.

The burden resistance of CT is taken as 30 ohms. From Fig. 11, it is understood that even for CT saturation also the method holds the accuracy.

Conclusion

A methodology to classify the ten fault types within half-a cycle without using any phasor estimation process considering only moving sum of superimposed data for a series compensated line has been presented in this article. The proposed method is able to discriminate between line-to ground and double-line-to ground faults irrespective of their position, fault resistance and position of series compensation.

Also, influence of change-in source impedance and loading level have less impact on the proposed method. The classification of different fault types is also possible during CT saturation, which is evident from the results.

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"Success lies in the success of our valued customers, strategic partners, business associates & employees..."

Hitachi Hi-Rel Power Electronics Pvt. Ltd., is a 100% Hitachi group company. It is recognised as a pioneer in power electronics. They offer world class power electronics products, value added services & customised solutions.In an exclusive interview with **Electrical India**, the company's **Managing Director (India), Dr. Kazuhiro Imaie** is describing various aspects of their business to **PK Chatterjee**. Excerpts…

Please describe in brief about yourself and association with Hitachi.

I have taken over the responsibility of Managing Director of Hitachi Hi-Rel Power Electronics, India in April 2016. Having strong Power Electronics background (Ph.D. in Power Electronics), I have been associated with Hitachi Japan for more than 26 years and worked in different roles, be in Technology or Business.

I am happy to be at the helm of Hitachi Hi-Rel Power Electronics (HHPE), which is now a 100% Hitachi Group Company and is recognised as a Pioneer in Power Electronics, and is on its way to the next level of success.

Please share how Hitachi made Hitachi Hi-Rel in India a Wholly-Owned Subsidiary of Hitachi.

The demand for power electronics products is expected to increase in keeping with the development of various industries in India and Southeast Asia as well as the recent rapid growth of renewable energy market worldwide.

In this market background, Hitachi has decided to take direct control of Hitachi Hi-Rel operations by acquiring 100% stake in Oct 2015, after having major stake in way back in 2011. This was done mainly to reinforce power electronics business through increasing product competitiveness and expanding application fields by enhancing Hitachi Hi-Rel's R&D, design, and manufacturing structures with making full use of the Hitachi Group's sales/service network.

By further expanding power electronics business, Hitachi will contribute to the development of industry in India and throughout the world.

Please describe in brief about your company, its vision and product range.

Having more than 3 decades of experience as Hi-Rel Electronics Pvt. Ltd, we have garnered a significant level of trust in our market segment and now with direct control of Hitachi management, we continue to offer world class power electronics products, value added services & customised solutions at Hitachi Quality.

Our vision is to be recognised as the most trusted power electronics company by supplying superior products and services.

We target to lead all our current market segment be it grid tied solar inverters, UPS for industrial (non-IT) and enterprise (IT & commercial) applications, medium & low voltage variable frequency drives and other product domain.

Please describe your Establishments in India.

I am particularly pleased with the fact that we are contributing to the 'Make in India' initiative of the Govt. of India since 2011, much before its launch. I am proud to note that HHPE has been a strong contender in the market for the last 33 years with state-of-the-art manufacturing facilities, both at Sanand & Gandhinagar, to manufacture power electronics products conforming to global standards to cater to the Indian and global market.

> I proud to inform you that we have been chosen as Inverter partner for world largest Solar power plant in India (648 MW) by leading business group and we have supplied 360 MW worth of Inverters in record time of 3 months.

Our ultra-modern Sanand Manufacturing Works Spread over 26,000 sq mtr. is modelled on Hitachi's Omika Works in Japan and is one of the most modern power electronics manufacturing facilities in India.

This Company is a key hub, for both 'Manufacturing' as well as 'Research & Development', within the Power Electronics division of Hitachi Group and we will leverage it to drive Innovation and Growth. This geographical advantage, value added solutions and technological leadership help us in serving the customers in India and across the globe – USA, Africa, Middle East, South East Asia and Australia.

For solar, presently, we are operating on our maximum manufacturing capacity (150 MW / month). We have expansion plan in place and our production capacity for both Centre Inverters and Variable Drives would be double in next year.

Kindly brief about your offerings in Solar Industry.

We are offering highly optimised energy solutions based on Hitachi technology. For solar, we offer grid tied solar inverters (HIVERTER NP 201i) which is available from 250 kW to 1.25 MW capacities. With 3 level IGBT technology and wider MPPT range, HHPE inverters are delivering considerably high reliability and maximum power generation.

Hitachi 1.25 MW Solar Inverter is among the most popular grid tied solar inverters currently in India for its various technical advantages and major saving in EBOP.

We offer highly reliable after sale support from dedicated & decentralised after-sales-service centres located at strategic locations across the country.

Kindly enlighten our readers on the performance of your Inverters in India in various geographic locations, customer feedback.

Performance of our Inverters is definitely good….giving excellent generation. We have installations base of more than a 1 GW in India and installed around 962 Inverters units at different sites (65 locations) at all terrains.

Yes, we did experience some challenges initially in terms of Inverters breakdown due to differences in Installation practice followed in India. We have overcome to this challenge and introduced some minor changes in new systems.

Present some noteworthy projects, case studies of solar plants built using your solar Inverters

I am proud to inform you that we have been chosen as Inverter partner for world largest Solar power plant in India (648 MW) by leading business group and we have supplied 360 MW worth of Inverters in record time of three months.

In last financial year, we have worked on one more mile stone project in country and supplied Inverters for 150 MW NTPC Ananthpur project through EPCs & successfully commissioned within time frame. This was the first solar plant of NTPC under UMPP scheme.

What are your plans for India, your view on the Indian Government aggressive target of 1000 GW Solar Power by 2022

Looking ahead, we are expecting a historically strong year in Indian solar market be a State Policies, UMPP or SECI projects. I am confident that, with our leading technology, strong brand name and superior products, we will further solidify our market leading position. HHPE experienced truly unique achievement – a much deserved entry into 1000 MW Club. We are poised to achieve even bigger targets (1.5 GW) leveraging the experience gained in past. We are confident to meet industry demands looking forward to consolidate and fortify our brand for promising future in coming years.

What is your vision and future plans for Hitachi Hi-Rel Power Electronics?

As the Managing Director of Hitachi Hi-Rel Power Electronics, my vision is to take Hitachi Hi-Rel to a new height, to position our organisation as one of the most admired company in the world, number one power electronics company in India, and as one of the top performing of Hitachi group companies with power electronics

business at the centre contributing significant growth in revenue and profit.

With expertise, experience and an efficient product line, we will always try to be a leader in power electronics sector. One of our values – Customer Delight, encourages us to realise our customer's expectations and to serve them better - All Time, Every Time.

Any message to Indian Industry?

I firmly believe that our success lies in the success of our valued customers, strategic partners, business associates and employees.

This we can achieve by working together in a cohesive and vibrant environment. I have a vision to not only lead from the front, but also lead by setting examples – be it by offering state-of-the-art products, well-timed services and through happy and content employees

We appreciate the constant and valuable support extended by our business partners in the past and hope to receive the same in our future endeavours too.

I promise to deliver the best to Industry from Hitachi Hi-Rel. Wishing all readers a successful year 2016-17.

A Study on Nanotechnology

Research by scientists at Swansea University is helping to meet the challenge of incorporating nanoscale structures into future semiconductor devices that will create new technologies and impact on all aspects of everyday life...

Dr Alex Lord and Professor Steve Wilks from the Centre for Nanohealth led the collaborative research published in Nano Letters. The research team looked at ways to engineer electrical contact technology on minute scales with simple and effective modifications to nanowires that can be used to develop enhanced devices based on the nanomaterials. Well-defined electrical contacts are essential for any electrical circuit and electronic device because they control the flow of electricity that is fundamental to the operational capability.

Everday materials that are being scaled down to the size of nanometres (one million times smaller than a millimetre on a standard ruler) by scientists on a global scale are seen as the future of electronic devices. The scientific and engineering advances are leading to new technologies such as energy producing clothing to power our personal gadgets and sensors to monitor our health and the surrounding environment.

Over the coming years this will make a massive contribution to the explosion that is the Internet of Things (IoT) connecting everything from our homes to our cars into a web of communication. All of these new technologies require similar advances in electrical circuits and especially electrical contacts that allow the devices to work correctly with electricity.

Professor Steve Wilks said, "Nanotechnology has delivered new materials and new technologies and the applications of nanotechnology will continue to expand over the coming decades with much of its usefulness stemming from effects that occur at the atomic- or nano-scale. With the advent of nanotechnology, new technologies have emerged such as chemical and biological sensors, quantum computing, energy harvesting, lasers, and environmental and photon-detectors, but there is a pressing need to develop new electrical contact preparation techniques to ensure these devices become an everyday reality."

"Traditional methods of engineering electrical contacts have been applied to nanomaterials but often neglect the nanoscale effects that nanoscientists have worked so hard to uncover. Currently, there isn't a design toolbox to make electrical contacts of chosen properties to nanomaterials and in some respects the research is lagging behind our potential application of the enhanced materials," he further explained.

The Swansea research team[1] used specialist experimental equipment and collaborated with Professor Quentin Ramasse of the SuperSTEM Laboratory, Science and Facilities Technology Council. The scientists were able to physically interact with the nanostructures and measure how the nanoscale modifications affected the electrical performance.[2]

Their experiments found for the first time, that simple changes to the catalyst edge can turn-on or turn-off the dominant electrical conduction and most importantly reveal a powerful technique that will allow nanoengineers to select the properties of manufacturable nanowire devices.

Dr Lord said, "The experiments had a simple premise but were challenging to optimise and allow atomic-scale imaging of the interfaces. However, it was essential to this study and will allow many more materials to be investigated in a similar way. This research now gives us an understanding of these new effects and will allow engineers in the future to reliably produce electrical contacts to these nanomaterials which is essential for the materials to be used in the technologies of tomorrow."

"In the near future this work can help enhance current nanotechnology devices such as biosensors and also lead to new technologies such as Transient Electronics that are devices that diminish and vanish without a trace which is an essential property when they are applied as diagnostic tools inside the human body," he further added.

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Web: www.pamas.in

PAMAS GmbH Head Office:

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  20 ft. **(400KV)**.
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  16 sq.mm; 8mtr. long **(66-132KV)**; 25 sq.mm; 10mtr. long **(132-220KV)**
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RS Components sets up a new Electronic Centre in Bangalore

RS Components, a well known distributor of electronics and maintenance products proclaimed the opening of their innovation hub, a new 'Electronic Centre' in Bangalore. The high service level supplier of electronic components and tools plans to invest close to $ 15 million over the next two to five years at the Bangalore centre.

The new 2000 sq feet office in the heart of Bangalore has been set up to support electronic design engineers and manufacturers in the region. The company also plans to set up a warehouse, which will enable RS Components to undertake 'next day delivery' to its customers.

The Bangalore centre will have technical marketing and support teams, specialised sales force that will focus on specific industry verticals like IoT, Medical Electronics, Aeronautics, Automotive and R&D sector.

Speaking at the launch of the Electronic Centre, Keith Rice, Head of Emerging Markets, RS Components Worldwide, said, "Our Electronic Centre at Bangalore is a great opportunity to bespeak RS' strong value proposition in the light of our technical expertise and tailor made solutions that create a huge difference in the day-to-day life of a design engineer."

Talking about the potential of the Indian market and RS India's growth Keith Rice added, "RS envisages India as one of the most promising and high potential markets. The pace at which the RS India story is accelerating will soon turn out to be a significant advantage for them on a global landscape."

Shiv Bhambri, CEO RS Components India, further added, "The Bangalore Electronic Centre is a reflection of the strong Indian ESDM market, as well as the continued growth of the Indian operations of RS Components, which has been a part of the electronics design and manufacturing story in India for the past 20 years."

Explaining the reason for setting up such a large operation in the city Shiv Bhambri said, "Bangalore has emerged as a major global EDSM hub and recognised as the R&D capital of India. Most of the Global Industries and PSUs in strategic electronics have their manufacturing facilities and R&D centres in Karnataka. Therefore it was important for RS Components in India to further expand it's Electronics focused set-up in Bangalore."

On the role of the Bangalore office in supporting the local ESDM community, Shiv Bhambri said, "The Electronic Centre at Bangalore will be key to RS Components goal of providing technical training and assistance to Design engineers and students. The engagements with design engineers will influence and drive our electronics business which is targeted for high double digit growth in near future."

RS will offer value added services to the design community in and around Bangalore including:

- Organising workshops on new technologies and solutions
- Running training programs for EDE & Academia
- Holding engineer meet ups
- New product launches in collaboration with suppliers, among others

The team at the Bangalore office will also be actively involved in building up the design engineering community through DesignSpark.com. DesignSpark provides its community of over five lakh engineers with free access to design tools like DesignSparkPCB, DesignSparkMechanical and DesignSparkElectrical.

RS In India

Elaborating on RS Components unique value proposition to Indian manufacturers Shiv Bhambri said, "The key to our strategy is that we are a high-service level distributor. No order is too small, as we believe in supporting every aspect of the business from concept to preproduction. He further added, "We offer our customers a choice over 500,000 products from 2500 leading brands along with technical datasheets to help them make an informed buying decision."

With e-commerce at the heart of its business strategy, RS India has one of the most advanced transactional website offering benefits like parametric search and around 5000 new product introductions every month.

"We offer the broadest range of semis, passives, electromechanical components, test & measurement equipment and quintessential tools to support every design engineers' job. We are committed to provide value add solutions to electronic design engineers at every stage of design life cycle from concept to pre-production," said Shiv Bhambri.

About RS Components

RS Components and Allied Electronics are the trading brands of Electrocomponents plc, the global distributor for engineers. With operations in 32 countries, we offer more than 500,000 products through the internet, catalogues and at trade counters to over one million customers, shipping more than 44,000 parcels a day. Our products, sourced from 2,500 leading suppliers, include electronic components, electrical, automation and control, and test and measurement equipment, and engineering tools and consumables.

Electrocomponents is listed on the London Stock Exchange and in the last financial year ended 31 March 2016 had revenues of £1.29bn.

RS Components is focused on meeting the needs of engineers from concept, design, and prototyping to procurement for final manufacture. Customers can count on RS Components to deliver products on time and on budget. RS has become the number one high service distributor of electronics and maintenance products across Europe and Asia Pacific due to RS components' skill in inventory management and the ability to ensure quick and on-time product delivery. We have gained a reputation for delivering large orders within just 24 hours, predominantly facilitated by a large and well-stocked inventory. For more information on RS Componenets, please visit the website: http://in.rsdelivers.com

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How Power Industry reacted....

Union Budget 2017 presented by Finance Minister, Arun Jaitley brings in mixed reviews...

Finance minister, Arun Jaitley indicated a number of measures in 2017-18 in order to elevate clean energy, access to power and energy security- that will result in 20 Gigawatts (GW) of solar capacity addition, higher spending on rural electrification, two new planned oil reserves and lower import duty on Liquified Natural Gas (LNG).

In his budget speech, he said by 1 March 2018 the full electrification of 18,452 villages identified in 2015 will be accomplished. He disclosed that an extra Rs 4,814 crore will be spent in the next financial year for this purpose. Further, he also stated that around 12,000 villages have been currently electrified.

He further explained that there will be major momentum to the shift to clean energy by making provision for 20 GW of solar power capacity and providing 7,000 railway stations with solar power. Past couple of years, the contribution of solar power in the nation's energy mix has been progressively increasing, while that of thermal power has been decreasing.

As compared to budget approximation of Rs 8,500 crore for the current fiscal, the allocations under the Integrated Power Development Scheme (IPDS) and Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) has been increased by over 25 % to Rs 10,635 crore in 2017-18. Nevertheless, the budget document stated that the revised estimate of these two schemes together was Rs 7,874 crore for this fiscal.

Jaitley's budget for the year has evoked varied reactions from experts from various industries.

Sunil Misra, Director General, IEEMA ,said, "Given that this is an election year, the budget doesn't seems to be populist, on the contrary bold decisions on electoral funding and tax compliance are a welcome step. However, individual salary relief which was expected has only come as a small relief."

The increase in allocation to the rural sector such as MNERGA, providing 1 crore housing for poor, thrust in Pradhan Mantri Gram Sadak Yojna and government's commitment to electrify all villages by May 2018, will result in an increase in domestic demand.

The increased expenditure in the rural and infrastructure sector will result in higher disposable income within the economy leading to long term stable growth of the country.

Total outlay of 3.96 lakh crore in infrastructure sector is a positive news. Further, the government's target of putting up 3500 kms of railway lines, modernization of railway stations through private partnership and new metro rail policy will benefit the domestic electrical industry.

The Finance Minister also announced, 20 GW of solar capacity to be installed, giving impetus to the renewable sector.

Anil Chaudhry, Country President and Managing Director, Schneider Electric India, said, "With India being the fifth largest energy consumer in the world, the country needs to make a concerted effort in promoting energy efficiency by reducing its dependence on fossil fuels and curtailing carbon footprints.

While access to energy is a basic human right, we need to make it sustainable. Today's budget gave a clear indication of the government's focus to achieve 'sustainable energy for all', with two of its critical steps; firstly, by providing a boost to rural electrification with a 25% increase in the outlay for key power schemes like Integrated Power Development Scheme and Deen Dayal Upadhyaya Gram Jyoti Yojna. This is expected to fast track the rural electrification drive of the Government, which is now planned to be completed by May 1, 2018. Secondly, by strengthening its focus on renewable energy forms with the inflow of another 20 GW in the next fiscal.

This however, will require investments in grid management and digitisation of the grid to ensure supply of quality reliable and safe power. It is important to stress that along with rural electrification, it is equally important to provide reliable and quality power which requires investments towards modernisation of the country's transmission and distribution power networks and use of digitisation in grid management."

Sanjeev Sardana, IEEMA President, Sanjeev Sardana, said, "Increased allocation to Deen Dayal Upadhaya Gram Jyoti Yojna and Integrated Power Development Scheme will provide a much needed impetus to the sector. Tax relief of 5% for companies below Rs. 50 Crore turnover is welcome. This will encourage the morale of the industry as 80% of electrical equipment industry is under MSME".

The budget is focused on the long term growth of the economy, which will have a corresponding impact on the Indian Electrical equipment industry.

Ashish Khanna, ED &CEO, Tata Power Solar, said, "The budget does focus on a few areas for the solar sector and demonstrates the Government's commitment to being a frontrunner in renewables. The proposed solarisation of railway stations is a positive step and will boost the demand for infrastructure going green. The announcement of 20 GW for the second phase of solar mission and focus on pushing for the solar projects is very heartening. However, we need more clarity in the coming days on its roll out.

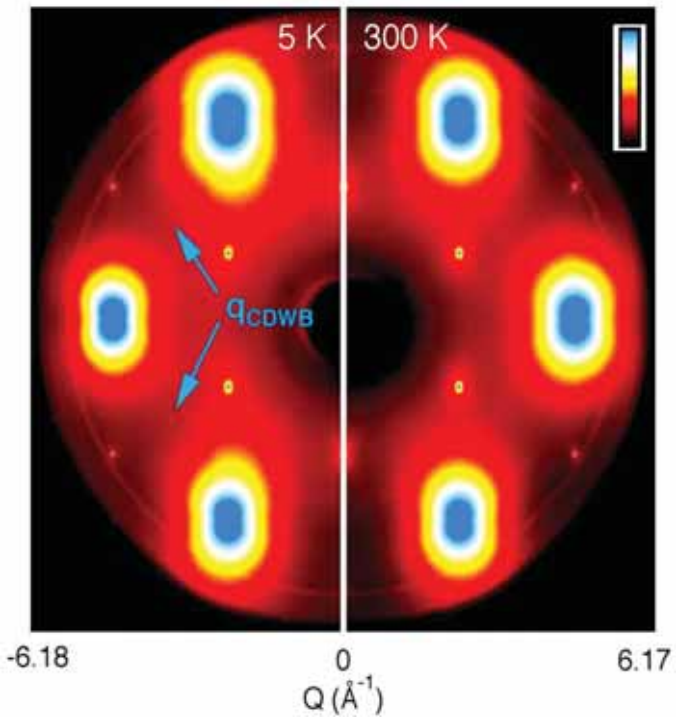
We also anticipate some indirect impact for solar with the Government's ambition of 100% electrification of villages, and we hope this to have a solar component. A set timeline for rolling out GST is a welcome move, however requires further clarity on its implementation and how much it will impact the solar sector."

Pratik Agarwal, CEO, Sterlite Power, said, "The Union Budget 2017-18 is in sync with government's progressive agenda to energise Indian economy. We appreciate government's enthusiasm to promote clean energy and reliable energy access to every citizen of our nation by adding 20 GW of solar power generation capacity and allocating higher resources for rural electrification. This will require robust and timely power transmission networks that can deal with unpredictable renewable energy. With rapidly expanding renewable energy capacity, execution of transmission networks is the need of the hour."

Shivramkrishnan Hariharan, Director (Commercial), Essar Steel India Ltd, said, "The policy initiatives in this Budget will have a catalytic effect on the economy. These include the abolition of FIPB that will encourage more FDI investment, increased allocation to the infrastructure sector that will enhance public spending, the 100% rural electrification programme, the move to have additional 20,000 MW of solar power plants, the creation of two more strategic crude reserves and increased support to affordable housing."

Researchers have found an unusual amount of charge density on the surface of a molybdenum oxide, which may lead to further development of superconductive materials...

A Potential Discovery



A Charge Density Wave (CDW) is a state of matter where electrons bunch together in a repeating pattern, like a standing wave of surface of water. Superconductivity and charge density waves share a common origin, often co-exist, and can compete for dominance in certain materials.

Conventional CDWs and superconductivity both arise from electron-phonon interactions, the interaction of electrons with the vibrations of the crystal lattice. Electron-electron interactions are the likely origin of unconventional, high-temperature superconductivity such as found in copper- and iron-based compounds.

Researchers at the U.S. Department of Energy's (DOE's) Ames Laboratory have discovered an unusual property of purple bronze that may point to new ways to achieve high temperature superconductivity. While studying purple bronze, a molybdenum oxide, researchers discovered an unconventional charge density wave on its surface.

Unconventional, electron-electron driven CDWs are extremely rare and its discovery here is important, because the material showed an 'extraordinary' increase of CDW transition temperature from 130K (-143°C) to 220K (-53 °C) and a huge increase of energy gap at the surface.

Both are properties essential for CDW and high-temperature superconductivity, explained Adam Kaminski, Scientist & Professor, Ames Laboratory, Department of Physics and Astronomy at Iowa State University. He said, "This was an accidental but very exciting discovery. We were studying this material because its one-dimensional structure makes it quite interesting. We saw strange things happening to the electronic band structure, but when we looked at the surface we were stunned by extraordinary enhancement of transition temperature and energy gap."

The research used resources of the Advanced Photon Source, a DOE Office of Science User Facility at Argonne National Laboratory.

Smart Grids

Jayesh G Priolkar
Assistant Professor
E&E Department,
Goa College of
Engineering

The electric power industry needs to be transformed in order to cope with the needs of modern digital society. Customers demand higher energy quality, reliability and a wider choice of extra services, at the same time they want energy prices to be lower.

As a consequence, a structural change in traditional electricity supply systems is demanded, which provides alternative solutions of grid integration as well as daily electricity system operation at minimal cost for society. The vision for Smart Grid is due to growing recognition for electricity grid modernisation to integrate, enable new electricity generation sources and consumption schemes. Modern power grid needs to be smarter in order to provide an affordable, reliable and sustainable supply of electricity.

The physical implementation of the smart grid communication faces tough challenges to ensure the network connectivity. The diversity in the physical characteristics of the grid, reliability, scalability and security aspects necessitates the need for applying various communication technologies to implement the network in the smart grid. The implementation of smart grid is not going to be an easy task in India – as the Indian power sector poses a number of issues such as minimising T&D losses, power theft, inadequate grid infrastructure, low metering efficiency and lack of awareness.

Smart Grid

Smart Grid is a broad collection of technologies that delivers an electricity network that is flexible, accessible, reliable and economic. Smart Grid facilitates the desired action of its users and these may include distributed generation, deployment of demand management and energy storage systems or optimal expansion and management of grid assets. In general, the 'Smart Grid' can be defined as 'a system of systems'. It is a platform that enables functioning of different technologies and systems.

From the Information Technology point of view, the Smart Grid technology will significantly increase the amount, quality, and use of data received from various sensors and meters.

Smart energy grid indicates an energy network that allows a two-way communication between suppliers and consumers, while monitoring the network condition in real time i.e., electricity production, consumption and distribution...

Power Infrastructure

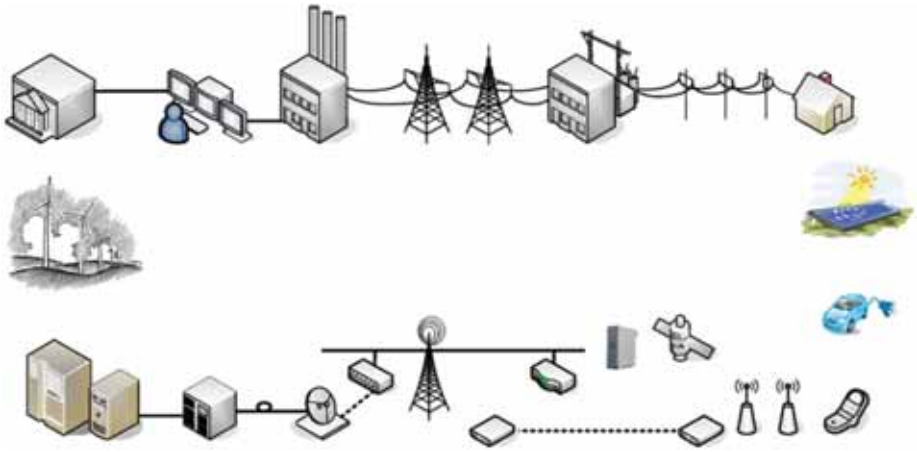


Figure 1: Smart Grid structure…

Introduction of Smart Grid will increase both security and efficiency of the power supply.

Another driving factor of Smart Grid is the new 'smart' way of energy use. It implies energy resource optimisation (e.g., own generation or distribution grid), as well as optimisation of time of use (e.g., avoiding peak hours usage). In smart grid, network flow of electricity from utility to consumer becomes a two way conversation, saving consumers money, energy, delivering more transparency in terms of end-user use, and reducing carbon emissions. Smart Grid Technology can be grouped into five key areas, Sensing and measurement, Smart meters, Phasor measuring units and Integrated communications with Advanced control. Figure 1 shows visual representation of Smart Grid concept.

The characteristics of Smart Grids are

1. Optimised for best resource and equipment utilisation, open for all types and size of generation
2. Interactive (customers, retailers, markets)
3. Adaptive and scalable (for changing situations)
4. Proactive rather than reactive (to prevent emergencies)
5. Reliable and secure (from threats and external disturbance)
6. Efficient
7. Environmental friendly (using renewable energy resources)

Smart Grid from Energy Industry Point of View

The real-time two-way communications available in a Smart Grid will allow customers to be compensated for their efforts to save energy and to sell energy back into the grid through advanced metering technologies. After spreading distributed generation sources such as residential solar PV panels, small wind turbines, Fuel Cells, the Smart Grid will improve the efficiency of energy industry by providing green energy recourses and reducing peak loads. It will allow small domestic customers and businesses to sell power to their neighbours or even back into the distribution grid.

The same concept can be applied to larger commercial organisations that have renewable power systems that can give the excess power back into the grid during peak demand hours. Smart Grid platform is viewed as a core component of the solution to modern challenges such as growing electricity demand, aging utility infrastructure, and the environmental impact of the greenhouse gases produced by conventional electric generation.

Integrated Smart Grid solutions combine advanced metering technology, two-way high-speed data and power transfer, constant monitoring and analysis software, along with other related services aimed to provide location-specific real-time data as well as home energy management solutions. When combined, these

Traditional Grid	
• One way limited communication • One way power flow • Centralised generation • No electric vehicles	• Few sensors and analog control • Little to no consumer choice • Limited usage transparency • Limited grid accessibility for new producers
Future Grid	
• Bidirectional communication & metering • Bidirectional power flow • Electric vehicles • Loads follow generation	• Pervasive monitoring and digital control • Self monitoring and high visibility • Many consumer choices • Extended grid accessibility

solutions will significantly increase the efficiency and reliability of the electric grids.

Technology Development

Some of the technologies that enable Smart Grids are available on the market today. Smart Grids will move the utility industry into the information age as the information about energy consumption, generation, distribution and storage will become available in the real-time. Until today, the electric utility industry has lagged behind other industries in taking advantage of the modern communication and networking technologies. Therefore, first steps towards introducing Smart Grids will not be 'creating new technologies', but introduce and synergise the technologies of today.

Applications of Smart Grid

Demand response

Demand Response (DR) has recently gained a lot of interest among regulators, utility, consumers and government. It is a relatively simple concept, the benefits of which are mostly experienced by end-customers. It encourages consumers to reduce their electricity consumption during peak price hours. Demand response solutions vary from simple advanced metering systems to fully automatic home systems. The demand response system consists of at least two interconnected devices, installed at customer's premises: a smart load controlling device and a smart meter. DR is a faster, cleaner, cheaper and more reliable solution compared to adding a new power plant during peak hours. Both end-customers and utilities will benefit from the introduction of this solution. The fact that both parties will save money will be a huge driver for adoption of demand response technique.

Energy storage

Energy storage across the distribution grid can provide dispatchable power that can be used during peak hours. Therefore, this solution will decrease (and consequentially eliminate) the use of expensive power plants that are introduced by system operators as a 'last hour' resort during peak demand hours. Also, it will make distribution network less volatile as it will smooth the load and may help to avoid consuming electricity high-price tariffs. Energy storage solution will be crucial for storing energy from renewable generators (wind and solar power are only produced at certain times, which are not necessarily coincide with the times when the electricity is needed; therefore it is important to utilise energy storage technologies to conserve electricity for times when direct generation is not possible).

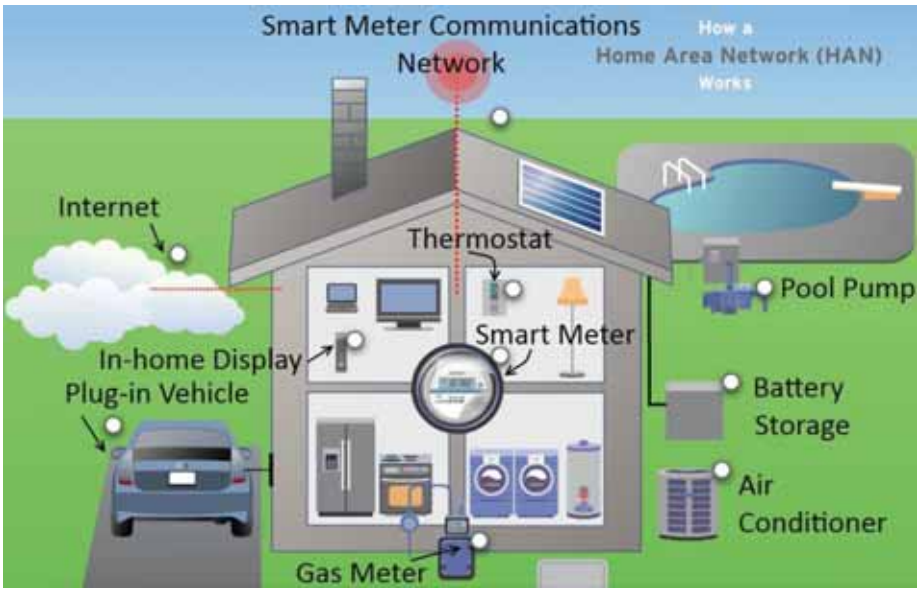


Figure 2: Future home area network...

Home Area networks (HAN)

It allows Smart Grid applications to communicate with various home appliances. HAN are an extension of Advanced Metering Infrastructure, which makes possible two-way communication between devices, users, and utility. The customer can manage intelligent home appliances using real-time monitoring system according to the time-of-use tariff system. The utility will automatically determine the tariff rates according to generation/ consumption data received from Smart Meters.

Advanced Metering Infrastructure (AMI)

The AMI includes hardware, software, communications and customer systems and meter data management software. The application layer is responsible for data collection and analysis, operational control, and real-time monitoring. The transport layer is responsible for a two-way information transfer between utility and customer.

Integration of Distributed Generation

The goal is to achieve 'plug-and-play' integration of renewable energy sources into Distributed Generation. In order to reach mass penetration of renewable energy sources, they must be able to deliver energy directly to end-users. Microgrid is an independent, small and self-reliant grid that generates and stores the power for the consumers within it. The microgrid can be connected to the conventional distribution grid during normal operations, but in case of any

faults on the DG side the microgrid can be isolated. While being isolated or 'islanded' it will be able to continue to meet the electric requirements independent of the DG. The same can work in the opposite directions: the owners of renewable energy sources inside the microgrids can sell the energy back into the distribution grid.

Advanced Utility Control Systems

Advanced Utility Controls Systems (AUCS) aim to integrate different control systems and technologies, in order to support control and optimisation of a distribution grid. It consists of the following components:

- Meter Data Management (MDM)
- SCADA Systems
- Distribution Management Systems (DMS)
- Energy Management System (EMS)
- Customer Information Systems (CIS)
- Geographic Information Systems (GIS)

Bringing together such systems will dramatically improve consumption, load forecasting, reliability, protection and performance of the grid.

Smart Grid Initiatives in India

India Smart Grid Forum (ISGF), which is a non-profit voluntary consortium of public and private stakeholders, was launched on 26th May 2010. India Smart Grid Task Force (SGTF) has been formed, which is an Inter-Ministerial Group – and will serve as a focal point for activities related to the smart grid technology. Powergrid corporation of India ltd. is coming up with Smartgrid project in Pondichery. Uttar Gujarat Vij Company limited (UGVCL) has commissioned the first smart grid at Naroda in North Gujarat. Smart-grids must help India move away from coal and oil to renewable resources as its economy grows.

Smart Grid in India can be used to: 1) Reduce distribution losses, 2) Enable decentralised power-generation and optimise usage, 3) Explore alternate methods of storage, including storage of heat (cool), 4) Handle peak-demand better, 5) Manage demand and supply to meet activities at all points of time, by using storage and high-cost instantaneous power-sources at different levels, 6) Intelligently decide where to do load shedding if no other options and 7) Enable time of day metering with remote monitoring.

Conclusion

Smart Grid platform promises to transform the way power is delivered, consumed, and accounted for. This can also facilitate network planning and construction, operation management, market trading and service in power sector. Introduction of smart grid in India will improve security, reliability, safety and efficiency of the power supply.

As simple as a *Smartphone*

A paradigm shift to test technology

TRAX is not just another multi-functional test instrument, but rather many intelligent instruments built into one box. The software includes a number of apps, making it fast and easy to perform a large range of different tests. The hardware offers unmatched flexibility and the range of cables and accessories adding even more flexibility, making the TRAX an efficient and time saving system for any user in the world...

New test technologies respond to increasing demands

Reduce costs, switch to renewable energy sources, create de-centrally supplied grids, maintain high grid quality – we know that the demands made on energy supply companies and the accompanying efficiency pressures are increasing all the time. The result: human resources must be utilised extremely rationally and flexibly. This also applies for measurement and control technology, where many companies now employ all-rounders instead of specialised test engineers.

This new type of measurement technician, who can for example be found in medium-voltage substations, looks after all the important assets such as transformers, power converters, voltage converters, circuit breakers, protection equipment, primary and secondary feeds, all ground connections etc. The market offers a whole arsenal of highly developed products for each of these areas. Each one on its own is tailored for the specialised test engineer and is of a highly complex construction.

They are, however, often too complicated for universally acting measurement technicians. This is where a new product from measurement and test technology manufacturer, Megger, comes in: the multi-function test unit for power transformers and substations – TRAX – is easy to understand and to control using apps. When the app is called up for a specific test, the unit is pre-set to a suitable configuration and the test sequence is then self-explanatory. There is also a great number of measures to guarantee safety during testing (emergency stop, key switch, incorporation into external safety circuits or ground monitoring), and the recording of measurements with the TRAX unit has also been made easy for the user. If required, a specialised test engineer also has access to an expert mode with "manual controls" within the app, and therefore, has complete control over any desired test construction or any generator setting, for selecting measuring channels or for illustrating measurement results. It is not only the specialist user who will appreciate the fact that the multi-functional test unit now only requires one operating software instead of having to learn many different operating philosophies for different units. Software updates will, therefore, also be much simpler, as only one system will have to be updated in the future.

> Megger is introducing a paradigm shift to test technology with its multi-function test unit for power transformers and substations

Working with TRAX

The tester selects their measuring

instrument, such as the transformer ratio measurement via the app. All necessary channels become active immediately and light up in red.

Once the tester has entered the vector group of the transformer and the details of the tap-changer, the tester can then call up a connections diagram, if desired, which will tell them exactly how they should connect the TRAX unit with this particular transformer type. One press of the START button and the test will commence and, as the tap-changer has also been set up, the entire test can be carried out automatically by the TRAX unit. A winding resistance measurement can then be carried out as the next test, for example. For this, the relevant app is opened. Data already provided for the ratio measurement will be used for this test. After the test, the transformer is demagnetised, which prepares the transformer for the next test and prevents problems when the transformer is re-connected to the network.

> The multi-function test unit for power transformers and substations – TRAX – is easy to understand and to control using apps.

Further tests can be initiated and carried out at the same time as those already running. Upon completion, the TRAX unit will generate a summary record from the individual measurements, which can be automatically stored and saved, if required.

Basic equipment data

The unit will in principle offer all options required by a manufacturer's or energy supplier's measurement technician for the correct testing of power transformers and all other components in a transformer station. The basic unit generates an alternating current of up to 800 A, a direct current of up to 100 A, an alternating voltage of up to 2.2 kV and a direct voltage of up to 300 V. With the relevant accessories, the AC output capacity of the TRAX unit can be extended to 2,000 A and 12 kV. The voltages and currents generated can be controlled and measured in a highly precise way. Two pairs of relay contacts allow the tap changer or circuit breaker to be controlled remotely. The TRAX unit also offers safe measuring processes with dual ground, a three-phase analysis of circuit breakers, current and voltage converter testing and a protection relay test capability.

Monitoring & maintenance

The intelligent interaction between software, cables and accessories ensures added flexibility. No single part of the system weighs more than 32 kg – a fact that will come as a pleasant surprise to international maintenance or service engineers in particular, as the unit does not need to be transported by air freight when working abroad. The system also offers a Multilanguage option, so that commissioning or test protocols can be generated directly in the client's language.

Flexible configuration

Megger has also geared itself to current software solution for updates and configurations. You no longer need to purchase all available functions, as the TRAX unit can be tailored to the individual needs of the user in a flexible way. If add-ons are required at a later date, it can be updated online or by means of hardware options.

Functions

- **Winding resistance and tap-changer testing**
  - checks at 50 V with 100 A real DC
  - adaptive demagnetisation
  - tap-changer control
  - dynamic resistance measurements for tap-changer diagnosis
- **High voltage ratio measurement**
  - (250 V and 2,200 V output)
- **Switch box for 3 pH/6-coil measurements (option)**
- **12 kV Tan Delta (loss factor) and capacitance test (option)**
  - individual temperature control (ITC)
  - automatic voltage dependency detection (VDD)
- **Power and voltage converter testing**
- **3 pH circuit breaker analyser**

> One press of the START button will initiate the test and, as the tap-changer has also been set up, the entire test can be carried out automatically by the TRAX unit

  - main and resistor contacts
  - automatic substation measurements
  - battery voltage and coil current
  - stroke measurement with a transducer
- **Time measurement for circuit breakers**
- **Relay testing**
- **Time measurement applications**
- **Phase angle measuring unit**
- **Ground impedance test**
- **4-channel power multimeter**
- **4-channel oscilloscope**

For more information, please visit megger.com/TRAX

Energy Technology and Education

C S Indulkar
Life Fellow of the Institution of Engineers (India), and Life Senior Member of the IEEE

This paper deals with the present state of energy technology and the prospects for its growth. The general aspects of this subject need to be known. To achieve this goal, it is important that the engineer studies the pertinent literature that gives him a new horizon and understanding of diversified connections between power engineering and different branches of economy, the biosphere, and a great variety of activities aimed at promoting technological progress.

Energy technology is a subsystem of the global complex of human activity; its other subsystems are the environment and various branches of economy. Energy technology is the system of energy supply which is the aggregate of large and artificial, man-made, systems intended to recover, transform, and distribute all kinds of energy resources to be used in the economy. Fig.1 shows the aggregate of systems and the direct and feedback (shown by the dashed lines) effects they produce on one another. The figure emphasizes the systems approach to energy technology by treating it as a large-scale system that comprises subsystems, which are parts of other large-scale systems. The science of energy technology implies a systematic knowledge of the features and interaction of energy flows, their effect on human society as viewed in the social, economic, and technological aspects, and their influence on the environment.

Energy technology is concerned with the regulations, processes, and phenomena directly or indirectly related to the recovery of energy resources essential to the economy, building of generating plants, and converting and using different forms of energy.

The science of energy technology develops in the following directions:

- Studying the proportions of the most favourable energy technology with the object of improving the methods of prediction, planning, and operation as applied to power systems. This direction is closely related with the social processes and the economics in the country.
- Improving the methods of power generation, conversion, transmission, and consumption as related to different forms of energy.
- Increasing the efficiency of all power plants, and decreasing their ecological effects, i.e. their adverse actions on the biosphere.
- Devising new ways and means of generating power, converting different forms of energy into electricity, developing new methods of power transmission, and utilisation of electricity in stationary and movable plants.

Energy technology depends for its development and efficiency on social and

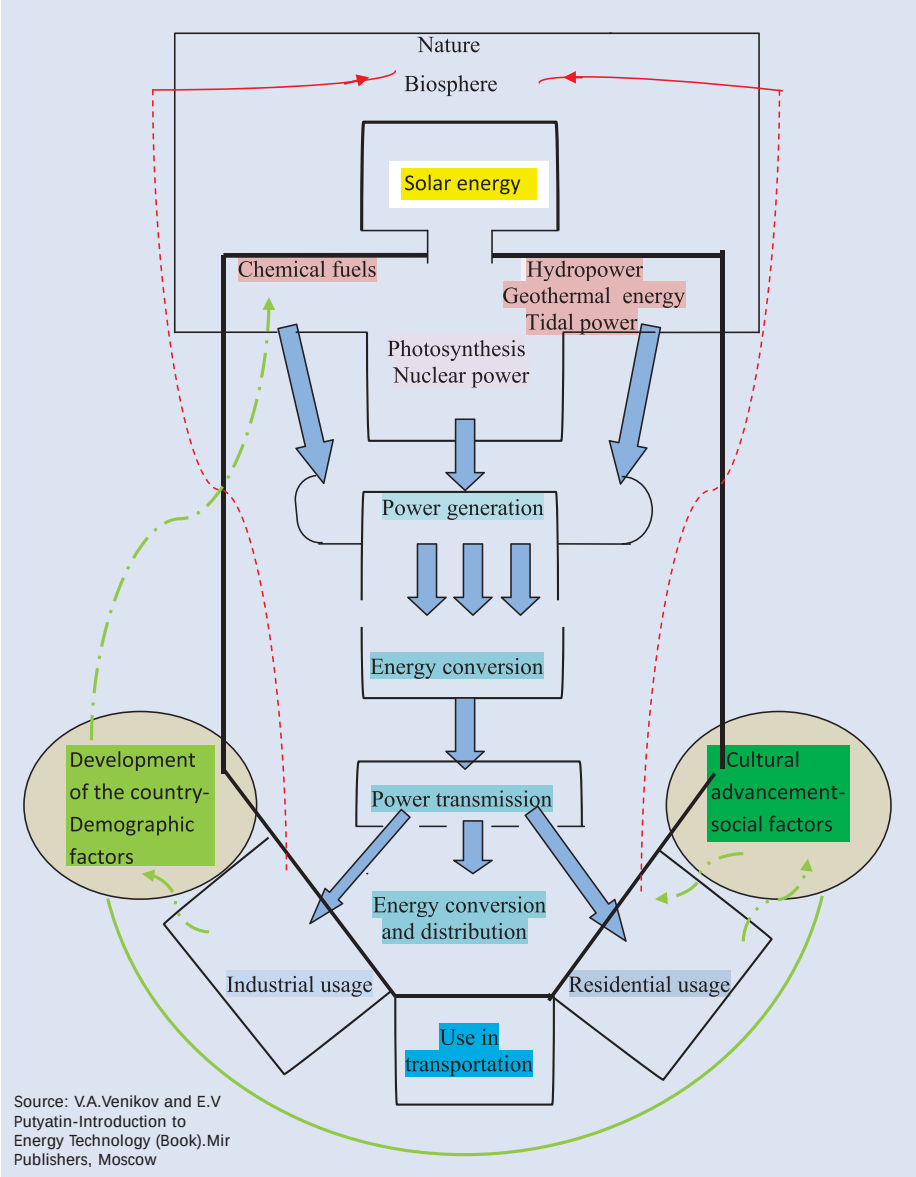


Figure 1: Energy Technology and associated subsystems

demographic factors, i. e. the political and economic situation in the country, manpower availability, population distribution, and location of energy sources. Energy technology is related to power engineering, power system control, electric, hydraulics, heat and nuclear power engineering. It also covers the field of fuel supply, provision of fossil fuels (coal, peat, gas, oil, nuclear fuels).The course "An Introduction to Energy Technology" should be delivered at the first stage during the training of an engineer. The role of engineer in modern society is enormous and will be still greater in future. The word "engineer "is of French origin and implies a person capable of creating something new, having an inventive mind. The notion of "technology" is also associated with creative work. It is derived from the word 'techne" applied in ancient Greece to artisans most distinguished for their craftsmanship. These days plain mental work is done by computers, which offers the engineer wider scope for creative scientific activities. Engineers can and should make science a socially productive force by taking advantage of scientific achievements to raise the efficiency of labour and improve the quality of manufacture in the sphere of materials production.

More emphasis should be placed on the features of energy technology that make the output of future power plants commensurate with those of natural geophysical processes that affect the universe. The supply of and demand for energy should play an increasingly important part just as demographic, social and also political factors that influence inter-state relations and largely determine the policy of our country.

In this paper, the front page image shows the first of its kind solar–biomass hybrid 256 kW demonstration plant at Village Shive in Khed Taluka of Pune district under the Public-Private-Community Partnership (PPCP) mode, in association with M/s Thermax Ltd., which has been commissioned. The plant uses solar energy and biomass, reducing cost of solar-biomass hybrid option. Attempts are being made to provide enabling conditions for running the plant continuously through interaction with the utility.

Importance of Energy Technology in Technological Progress

Technological and social progress necessitates increased energy usage and development of new and more efficient energy sources. Today, solar energy, chemical energy from chemical fuels, hydropower from rivers, seas, and oceans, nuclear energy from fissionable heavy isotopes is already being used. The utilisation of thermonuclear power released by the fusion of light elements holds much promise and, if realised, will solve the problem of world energy supply that is caused by the depletion of chemical fuel reserves. Cybernetics, computer technology, and space system engineering could not have been developed without electricity. The main distinguishing characteristics of electric energy are that it can readily be transmitted over long distances, and simply converted into different forms of energy with little loss of power.

A power system producing electric and thermal energy is directly connected with the fuel-supply system, i.e. the one providing primary energy sources, as shown in Fig.2. The power system depends largely for its construction and operation on natural factors as the availability of water basins and the location of energy resources and users. The power system must be controlled considering its impact on the biosphere and also the social functions of the fuel supply system, energy requirements of industry and transport. Control is exercised not only by

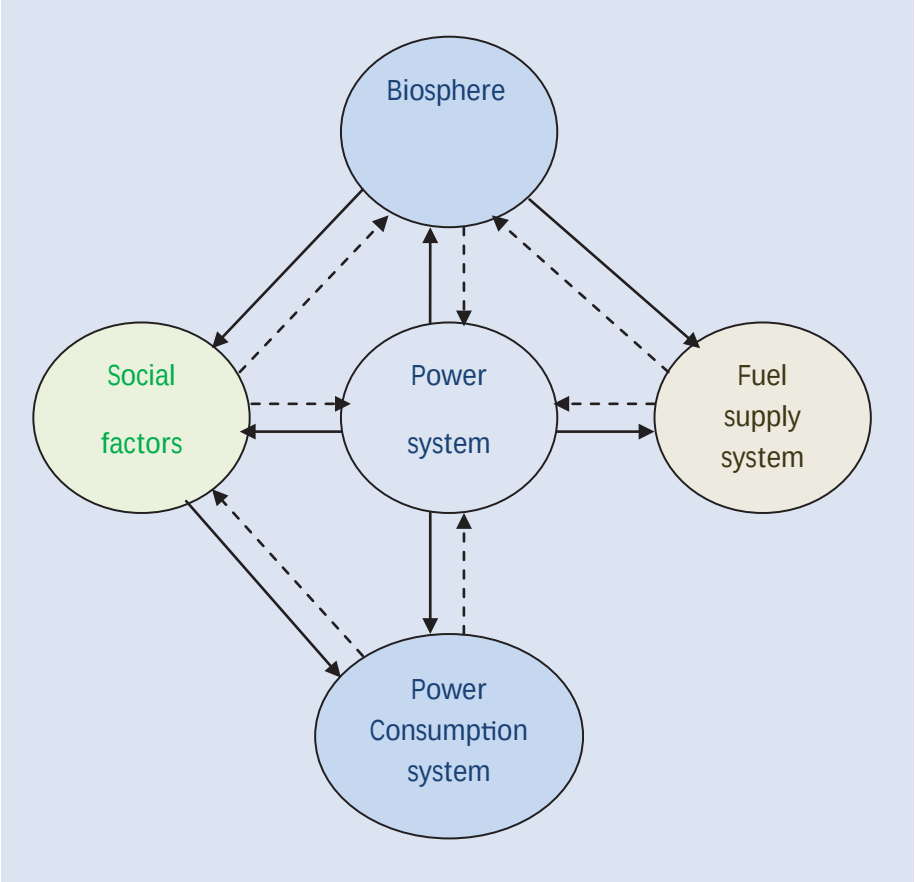


Figure 2: Effect of various factors on power system performance

producing energy but also by consuming it in various branches of the economy. All this requires is that the power engineer be trained on a very wide scale.

Training for Power Engineering

The present requirements of the power engineer imposed by the rapid technological and social progress are that he needs to be quick in adapting himself to the changing conditions, assimilate new scientific and technological achievements in his own and different fields, and put these achievements to practical use. Hence, the power engineer must develop and improve his ability to assimilate and systematise the acquired knowledge. The professions directly involved with power engineering are subdivided into electrical, thermal, and hydropower engineering. There is also a group of professions dealing with fuel technology. Specialists in these professions are trained for development of mineral resources, design and operation of oil and gas lines. The group of civil engineering includes professions such as the construction of thermal power and hydroelectric generating plants. The specialists in mining electrical engineering are employed to maintain the electrical equipment used in the construction and operation of mines. Electrical power engineering also includes the electrification of agricultural production. The direct relation between power engineering and economics is accounted for by such professions as mining engineering, petroleum and gas engineering, and economics of power engineering.

Power engineering education

Education and training of engineers, technologists and technicians require the development of engineers with broad, holistic backgrounds with capabilities to respond technological changes in a global environment. Today's engineers have to develop new processes and products, and create and manage new systems for manufacturing, information management, and computer based communications etc. In general, they have to put knowledge to work for society. The total educational experience of the power engineer must emphasize not only on the basics of engineering and associated technologies, but also remain responsive to the rapid changes in technology. Co-operative internship programs between institutes, industry, and government need to be encouraged. The engineering profession requires that engineers continually strengthen and refresh their talents to remain creative and innovative. Employers should release working personnel to complete their Bachelors or Masters programs on a full-time basis so that their education is current and is at the appropriate working depth of knowledge and skills. Since engineers have to work in a world of intense economic competition and since the global economy requires diverse communication skills, the working knowledge of a foreign language is desirable.

The three integral parts of the process of study are perception, knowledge, and ability. Each of these requires specific approach and is essential for the specialist working without assistance. Understanding, for instance, a phenomenon, one may be unable to design and build a particular component for lack of required aptitude. Perception, in turn, is an independent approach to the solution of problems arising in the course of study. Higher education is said to be a skilful guidance of students plus their unassisted studies. The students should learn to grasp the basic logic of the lecture and the groundwork of a mathematical proof without getting confused by details. The manner of presentation and intonation serve the lecturer as a means to direct the students' attention to the main, principal points of the lecture.

The lecturer should not confine himself to the subject-matter as it is, e.g. proving a theorem, but also illustrate the general principles of scientific reasoning and show the approach to technological problems of similar kind. The student is faced with a number of difficulties on his way to knowledge. First, the knowledge gained at the institute may become out-of-date in the course of time so that the graduate will encounter an entirely new technology in his practical activities. It is therefore essential that fundamental principles of development be

learned, basic knowledge acquired, and research techniques mastered during the years of study to enable the graduate to become afterwards involved in the technological progress without delay.

The lecture is one of the most critical elements of educational process. It is the lecture that must show the logic of reasoning, give a digest of scientific thought accumulated over decades and centuries, and usher the students not only into the workshop of technology but also into the sanctuary of modern sciences.

It is necessary to introduce the students, who have sought to learn the present state of the science of energy technology, to the history of energy technology, the problems it encounters, and the prospects for its growth. To achieve this goal, it is important that the would-be power engineer be strongly recommended to study the pertinent literature that gives him a new horizon and an understanding of diversified connections between power engineering and different branches of the economy, the biosphere, and the great variety of human activities aimed at promoting technological progress.

The present requirement of the specialist imposed by the rapid technological and social progress are that one be quick in adapting himself to the changing conditions, digest new scientific and technological achievements in his own and different fields, and put these achievements to practical use.

Conclusions

The paper will aid in forming a view of power engineering as a vocation, of the science of energy technology, and the associated problems that need to be solved. For the students who are aspiring to study power engineering, the paper is of educational value because it provides a progressive world outlook characteristic of the engineer who makes decisions not only on the specific technical factors concerned, but also on the most general approach to the problems of country-wide economic importance that require the social aspects of human activities and their effect on the environment.

Smart metering solutions

Smart metering solutions

Operational costs are on a steep rise due to the escalating power tariffs and power shortages. Any reduction in these day to day expenses would help you to improve your operation and at the same time improve your profits and efficiency. Energy conservation through effective energy management is hence gaining increasing attention in recent times. DEIF's metering solutions can benefit you in your efforts to reduce the operational expenses.

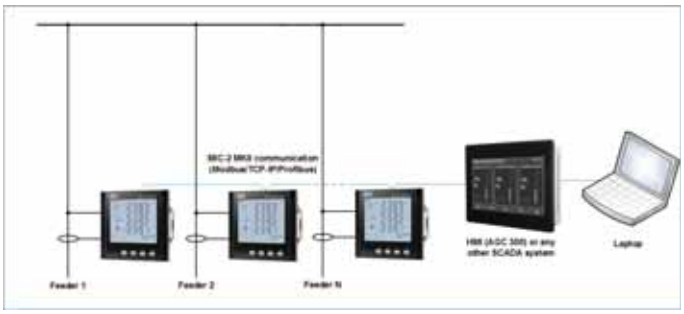
DEIF, Danish Electro Instruments Factory, has the experience of making meters for over seven decades and providing metering solutions for simple applications to most rugged applications with focus on precision and robustness. DEIF offers wide range of meter program for absolute energy measurement as well as for energy and power quality measurement. Come to us for a comprehensive solution that will empower you with accurate measurement and analysis for cutting your energy bills.

Smart meters

DEIF's superior quality products are designed with flexible functionality to comply with relevant standards and manufactured under stringent quality control procedures with testing under the harshest conditions. DEIF's products employ the state-of-the-art technologies and up gradation of the products through continuous R&D initiative. Customers know and prefer us for our 24/7 service and support, customised applications as well as training programs.

Identify your energy consumption

To reduce your energy costs you need to measure and monitor by analysing your actual energy consumption. Based upon this information you can then take necessary evasive action. Take the right path to take your decision making to a higher level through factual information, about where you can optimise your energy consumption.



Metering Application

Smart meters

DEIF offers a complete range of modular energy and power meters with communication ports. Our advanced metering solutions connected to a centralised place, which could be our HMI (AGI 300) or any other SCADA, allow remote monitoring of parameters giving you instant access wherever you are.

MIC-2 MKII (Multi-Instrument Communication)

Versatile and intuitive, DEIF's multi-instrument MIC-2 MKII is perfectly suited for monitoring and analysis of all types of power systems. The MIC-2 MKII helps you optimise your energy system. Capable of logging all applications from single low voltage to multiple high voltage applications, the sturdy unit offers a complete overview of your SCADA system.

A microprocessor-based measuring unit for most electrical quantities on 2-phase or 3-phase electric energy distribution networks, readings are displayed on a large built-in LCD screen. Fitted with the Ethernet TCP/IP module, the unit offers direct access to Modbus data and is easy to access remotely via standard browsers.

KWh counter reset and change of settings can be password-protected, and using DEIF's free utility software it is a simple and fast job to configure and adapt the unit to fit most applications.

MIB (Multi-Instrument Basic)

For economical solutions we also have basic multi-instrument with limited functionality, depending upon your need. A large number of standard analogue instruments can be replaced by the MIB in all electrical measuring applications. The MIB contains all necessary measuring circuits and presents all values on a display with white backlight.

The MIB can be used in almost all 3-phase network topologies with/ without neutral and with both balanced and unbalanced load.

Continued savings

DEIF is your best partner for selecting measurement solutions that deliver maximum return on your investment. The average customer finds that DEIF meters pay for themselves through savings in less than a year. When investing in DEIF's measurement products and solutions you are receiving the best technology, reliability and service in the business.

For more information, visit: www.deif.com

NREL Scientist Maria Ghirardi named AAAS Fellow

Maria Ghirardi, a scientist at the Energy Department's National Renewable Energy Laboratory (NREL), has been named a fellow of the American Association for the Advancement of Science (AAAS). AAAS cited Ghirardi for 'distinguished contributions to the understanding of photobiological hydrogen production in photosynthetic organisms.'

At NREL, Ghirardi is involved in both basic and applied research, primarily in the area of biohydrogen and photosynthesis. She has extensive experience working with organisms that convert light into chemical energy and examining the methods by which these organisms can be used to produce economic, sustainable fuels.

Ghirardi earned her Ph.D. at the University of California at Berkeley, where she studied the ability of plants to extract energy from sunlight. After three years at the Department of Agriculture, working on the turnover of proteins involved in photosynthesis, she came to NREL in 1991. Currently she is a principal scientist, an NREL Fellow, and a Renewable and Sustainable Energy Institute (RASEI) Fellow. She has authored more than 118 publications, holds four U.S. patents, and has been featured as an invited speaker in many national and international conferences.

Ghirardi's past research involved the use of algae to photosynthetically generate hydrogen from water, a potentially efficient source of clean, renewable energy. Practical implementation has been hampered by the extreme sensitivity of the hydrogenase enzyme to oxygen, one of the byproducts of photosynthesis. Ghirardi and her team investigated a way around this roadblock by replacing the algal hydrogenase with a bacterial one that is more tolerant to oxygen, thereby attempting to make the process more commercially viable. Her current research is focused on understanding the role of alternative electron transport pathways in photosynthesis, and in deconvoluting the metabolic partners of a crucial redox enzyme-ferredoxin-in algal metabolism.

A Software Key

Simmi Sharma
Assistant Professor
B.P.I.T, Delhi

Renewable energy is obtained from naturally repetitive and persistent flows of energy occurring in the environment. Electricity demand is rising over the years around the globe. So, use of renewable energy based methods like photovoltaic systems is being driven by the need for lower carbon emissions, decreasing capital investment.

Due to the concerns about the levels of greenhouse gas emission and over exploitation of fossil fuel, solar energy is emerging as a clear, free, alternative power source, and attracting a growing amount of political and commercial interest.

Power obtained from solar array depends upon solar insulation, climate etc. Researches conducted on photovoltaic systems face major issues related to high expenditures required for purchasing photovoltaic panels and applying validation test conditions.

A PV emulator, which is an electronic device that simulates VI characteristics of actual PV arrays under different temperatures and solar irradiance conditions is the best suited alternative to such problems. PV emulator was initiated for the testing of PV application such as inverters, MPPT charge controller. The time and money of researchers can be reduced by using a PV emulator since it can replicate different types of panels and in different environmental conditions. The terminal characteristics of a PV cell are non-linear in nature.

The time and money of solar researchers can be reduced by using a PV emulator, since it can replicate different types of panels and in different environmental conditions...

Key features of solar emulator

1. It should predict nearly same static IV characteristics of real solar array and panel under various weather conditions and local conditions.
2. It should give satisfactory results under partial shading conditions with more than one Peak and Step.
3. Output current and voltage should follow the diode equivalent model as closely as possible.

A DC-DC converter has property of variable resistance, which plays an important role to emulate solar IV characteristics and its respective PV curve of PV array.

Various control schemes for Buck converter based PV emulator

1. Hysteresis control.
2. Voltage mode control.
3. Current mode control.
4. Fuzzy Logic control.

The soft computing techniques like Fuzzy Logic, Genetic Algorithm, Artificial Neural Network are frequently used artificial intelligence schemes.

Fuzzy Logic Control stages includes

a. **Input stage** that senses voltage.
b. **Intermediate stage** where Fuzzy Logic operations take place and generate output for every input
c. **Output stage** transforms the whole result to respective control output value.

The role of controller is to get full IV characteristics accurately i.e., having very less percentage of deviation from its actual characteristics.

Advantages of using Fuzzy Logic Control in PV applications

1. It mimics human control logic.
2. It is inherently robust.
3. It can be modified easily.
4. It uses imprecise language.

However the limitation of Fuzzy Logic control includes:

1. Requirement of skilled operator with experience.
2. Complexity in system.
3. Generalised results are not available, so they are programmed for specified application.

For solar power, the output power at a given condition is maximum at a particular operating condition, and the point is known as the Maximum Power Point (MPP). Now-a-days many MPPT control methods are available. The most widely used is the perturbation and observation, P&O method also known as hill-climbing method. This method searches the MPP by checking the differential coefficient of the power, P with respect to the voltage,V or current, I $\left(\frac{dP}{dV} \text{ or } \frac{dP}{dI}\right)$. The main drawback of this method is the oscillations that happen around the optimum voltage point. This results in loss of energy capture that increases with the step size of the perturbation. But by reducing the step size width, the response time to track the MPP would be longer.

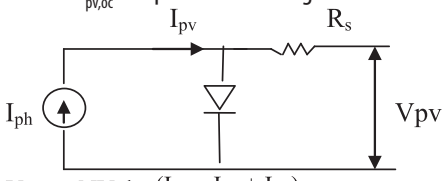
MPPT control can also be done by incremental conductance method, which avoids the oscillation appearing in previous P&O method. This is based on comparing the values of conductance increment $\left(\frac{dP}{dV}\right)$ with the conductance $\left(\frac{I}{V}\right)$. It removes the effect of the oscillations but performance is not satisfactory enough in lower irradiation regions as only a small range of voltage is covered. Short-current method requires the optimum output current, calculated by multiplying the short circuit current by proportionality constant. This technique although solves the oscillation problem, the step size problem is not eliminated. So, research on computing techniques like Partial Swarm Optimisation (PSO), biogeography-based Optimisation (BBO) are also at a good pace to get MPP.

The Fig a. presents an equivalent electrical model of a PV panel. The characteristic equation for the model is given in Eq. 1

where V_{pv} = Output voltage of the panel
N = Number of cells
V_t = Thermal voltage
I_{ph} = Photocurrent
I_{pv} = Output current of the panel
I_{sat} = Diode saturation current
A = Ideality factor
k = Boltzman's constant
q = Charge of an electron
T = Temperature

I_{sc} = Short-circuit current

$V_{pv,oc}$ = Open-circuit voltage



$$V_{pv} = NV_t \ln \frac{(I_{ph} - I_{pv} + I_{sat})}{I_{sat}} \quad (1)$$

$$V_t = \frac{AkT}{q} \quad (2)$$

The output power of a PV panel depends on the irradiance incident on the panel and the temperature. Eq. 3 and Eq. 4 present the relationship with irradiance (R_a) and temperature (T). ΔV_{oc} and ΔI_{sc} gives the temperature coefficient of open-circuit voltage and short-circuit current.

$$I_{sc} = \frac{R_a}{R_{as}} [I_{scs} + \Delta I_{sc} (T - T_s)] \quad (3)$$

$$V_{pv,oc} = V_{pv,ocs} + \Delta V_{oc} (T - T_s) + V_t \ln \frac{(I_{sc})}{I_{scs}} \quad (4)$$

$$I_{sat} = \frac{I_{ph}}{\exp\left(\frac{V_{pv,oc} - 1}{V_t}\right)}$$

Photocurrent (I) can be approximated to short-circuit current when considering the short-circuited PV panel. Considering the open-circuit condition of the panel, the diode saturation current of the model can be found from Eq. 5. These equations (1 to 5) are used to develop

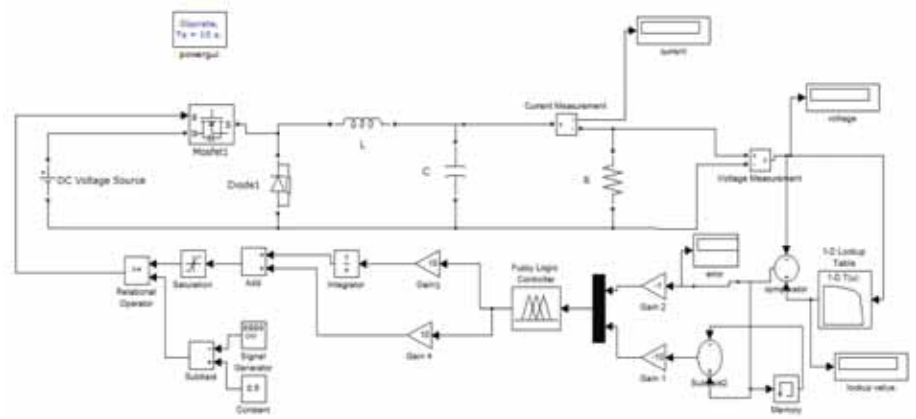


Figure 1: PV Emulator using Power electronic components and Fuzzy Logic Controller

general photovoltaic emulator. Power converters-based photovoltaic emulator can be used for reproducing the PV module's output curve. Designing of PV emulator can be done in different ways. The emulator output I-V characteristics are obtained from a lookup table stored in a memory or using a mathematical exponential model or by amplifying the output of a solar cell in order to produce the I-V curve of a solar panel. Power electronic components can be easily employed for obtaining a solar emulator that closely follows a real solar panel characteristics. One such model utilising this is shown in Fig 1.

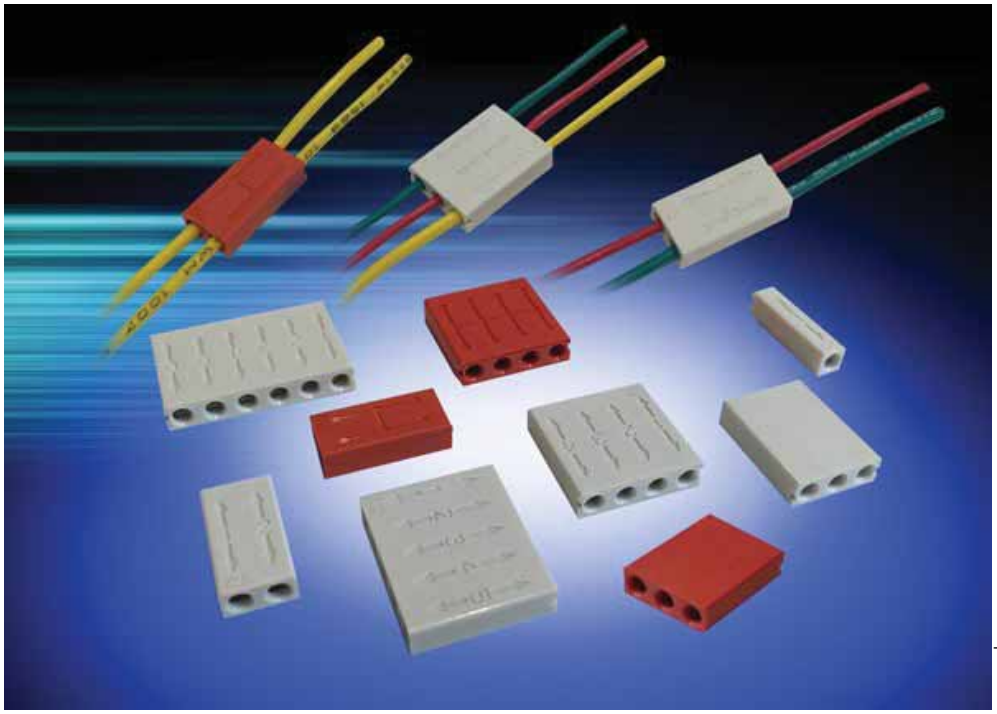
The circuit gives best results by varying the load resistance. The Fuzzy Logic controller can be replaced by PID to get parameters like maximum overshoot, transient time, settling time corresponding to the PV panel under study.

Further, Bode and Nyquist Plots can be obtained by calculating transfer function. Thus, the circuit can be utilised to get control parameters using power electronics components. Thus, the modern software approach is the key to fast, efficient, economic and reliable research to provide a common platform to the new researchers without being in direct contact to the field. The new optimisation techniques can be treated as the key to success for our new researchers.

Wire-to-Board Connector market to soar high by 2022

Automotive application is expected to lead the market during the forecast period...

According to a recent MarketsandMarkets report, the wire-to-board connector market that valued at USD 3.55 Billion in 2015 is expected to reach USD 4.73 Billion by 2022, at a CAGR of 4.18% between 2016 and 2022. The most significant factor driving the wire-to-board connector market is the increasing penetration of consumer electronics and automotive infotainment systems. Growing demand for smartphones and other connecting devices as well as adoption of automation in industrial instrumentation are also the factors driving the growth of the wire-to-board connector market.



Source: AVX Corporation

AVX026 9286 WTW Connectors

Connectors with receptacle style to hold the largest share of the wire-to-board connector market

The receptacle style connector, though expected to grow at a low rate compared to few other connector styles, is expected to account for the largest share of the wire-to-board connector market in 2016. This is mainly because these connectors are perfect for major applications such as mobiles, scanners, bar code readers, portable music equipment, mobile computing, navigation and GPS equipment, handheld printers, handheld medical equipment, self-diagnostic equipment, consumer payment and transaction terminals, automotive diagnostic equipment and other handheld devices. These connectors also have its application in major industries such as food and beverages, chemical, transportation, and water treatment plant.

Automotive application is expected to lead the market during the forecast period

On the basis of applications, the market is segmented into computer and peripherals, medical, industrial and instrumentation, data/ telecom, automotive, and aerospace and defence. The wire-to-board connector market for the automotive sector is expected to hold the leading position by 2022, owing to increasing application in intelligent transportation systems, automotive electronics, safety systems, and infotainment systems. The market for data/telecom sector is expected to grow at the second-highest growth rate, owing to the increasing usage in handheld communication devices in consumer electronics and industrial measurement.

Asia-Pacific is the major consumer of the wire-to-board connector market

APAC is expected to account for the largest share of the global wire-to-board connector market in 2016. The demand for industrial Internet of Thing is high in the APAC region with special focus on process automation. In countries such as Japan and China where the automobile market has opportunities supported by electric vehicles, the consumption of connectors is high. The APAC region is a huge hub for consumer electronics market, which in turn increases the demand for connectors in this region.

Power Quality

Ankush N Bahale
Deputy Executive Engineer
Maharashtra State Power Generation Company Ltd. (MAHAGENCO)

Power quality monitoring programs are often driven by the demand for improving the system wide power quality performance. Many industrial and commercial customers have equipment that is sensitive to power disturbances, and therefore, it is more important to understand the quality of power being provided...

Power quality determines electrical supply of constant magnitude and frequency – sinusoidal voltage waveform to consumer devices. Synchronisation of the voltage, frequency and phase allows electrical systems to function in their intended manner without significant loss of performance or life of consumer devices. The Power Quality of a system expresses to which degree a practical supply system resembles the ideal supply system. The term is used to describe electric power that drives an electrical load and the load's ability to function properly.

What is power quality?

Power Quality = Voltage Quality

P = V I

V-Voltage-consistent controlled by power supply system

I- Current-varied by particular load

Therefore, the standards on the power quality are maintaining the supply voltage within certain limits. Any power problem manifested in voltage, current or frequency deviations results in failure or misoperation of customer equipment. However, it is actually the quality of the voltage that is being addressed in most cases.

Technically, in engineering terms, power is the rate of energy delivery and is proportional to the product of the voltage and current. It would be difficult to define the quality of this quantity in any meaningful manner. The power supply system can only control the quality of the voltage; it has no control over the currents that particular loads might draw. Therefore, the standards in the power quality area are devoted to maintaining the supply voltage within certain limits. AC power systems are designed to operate at a sinusoidal voltage of a given frequency (typically 50 or 60 Hz) and magnitude. Any significant deviation in the waveform magnitude, frequency, or purity is a potential power quality problem. Of course, there is always a close relationship between voltage and current in any practical power system. Although, the generators may provide a near-perfect sine-wave voltage, the current passing through the impedance of the system can cause a variety of disturbances to the voltage. For example:

1. The current resulting from a short circuit causes the voltage to sag or disappear completely, as the case may be.
2. Currents from lightning strokes passing through the power system cause high-impulse voltages that frequently flash over insulation and lead to other phenomena, such as short circuits.
3. Distorted currents from harmonic-producing loads also distort the voltage as they pass through the system impedance. Thus, a distorted voltage is presented to other end users.

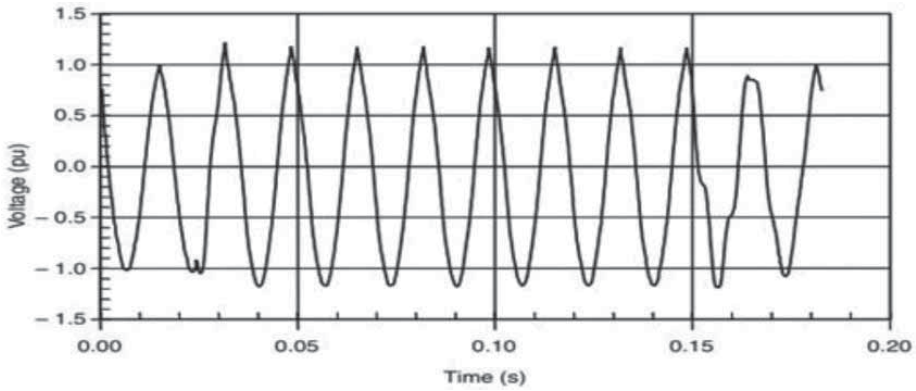


Figure 1: Instantaneous voltage swell caused by an SLG fault

Therefore, while it is the voltage with which we are ultimately concerned, we must also address phenomena in the current to understand the basis of many power quality problems.

Why are we concerned about power quality?

The ultimate reason that we are interested in power quality is economic value. There are economic impacts on utilities, their customers, and suppliers of load equipment. The quality of power can have a direct economic impact on many industrial consumers. Thus, like the blinking clock in residences, industrial customers are now more acutely aware of minor disturbances in the power system. There is big money associated with these disturbances.

Causes of poor power quality:

1. **Variations** in the peak or RMS voltage.
2. **Swell**: When the RMS voltage exceeds the nominal voltage by 10 to 80% for 0.5 cycle to 1 minute, the event is called a 'swell.' Refer Figure 1.
3. **Dip/Sag**: The RMS voltage is below the nominal voltage by 10 to 90% for 0.5 cycle to 1 minute. Refer Figure 2.
4. **Flicker**: Random or repetitive variations in the RMS voltage between 90 and 110% of nominal can produce a phenomenon known as 'flicker' in lighting equipment. Flicker is rapidly visible changes of light level.
5. **Spikes/Impulses/Surges**: Abrupt, very brief increases in voltage, called 'spikes', 'impulses', or 'surges', generally caused by large inductive loads being turned off, or more severely by lightning.
6. **Undervoltage**: An undervoltage is a decrease in the RMS AC voltage to less than 90% at the power frequency for a duration longer than 1 min. The term 'brownout' is an apt description for voltage drops somewhere between full power (bright lights) and a blackout (no power – no light). A load switching on or a capacitor bank switching off can cause an undervoltage until voltage regulation equipment on the system can bring the voltage back to within tolerances.
7. **Overvoltage**: An overvoltage is an increase in the Rms AC voltage greater than 110% at the power frequency for a duration longer than 1 min. Overvoltages are usually the result of load switching (e.g., switching off a large load or energising a capacitor bank). The overvoltages result because either the system is too weak for the desired voltage regulation or voltage controls are inadequate. Incorrect tap settings on transformers can also result in system overvoltages.
8. **Power Frequency Variations**: Power frequency variations are defined as the deviation of the power system fundamental frequency from its specified nominal value (e.g., 50 Hz).The power system frequency is directly related to the rotational speed of the generators supplying the system. There are slight variations in frequency as the dynamic balance between load and generation changes. The size of the frequency shift and its duration depends on the load characteristics and the response of the generation control system to load changes.
9. **Waveform Distortion**: Waveform distortion is defined as a steady-state deviation from an ideal sine wave of power frequency principally characterised by the spectral content of the deviation. It is usually described as harmonics at lower frequencies (usually less than 3 kHz) and described as Common Mode Distortion or Interharmonics at higher frequencies. All this phenomena potentially lead to inefficient running of installations, system down time and reduced equipment life and consequently high installation running costs. If due to poor power quality the production is stopped, major costs are incurred.

Possible consequences of poor power quality

1. Equipment failure or malfunctioning.
2. Unexpected power supply failures (breakers tripping, fuses blowing).
3. Equipment overheating (transformers, induction motors etc.) leading to their lifetime reduction.
4. Increase of system losses.
5. Damage to sensitive equipment (Computers, control systems equipments etc).
6. Communication Interference in case of electronics devices.
7. Increases the need of oversize installations to cope with additional electrical stress, which leads to consequential increase of installation and running costs.
8. Poor power factor that leads to penalty or increases need and cost of installation of power factor correction equipments.

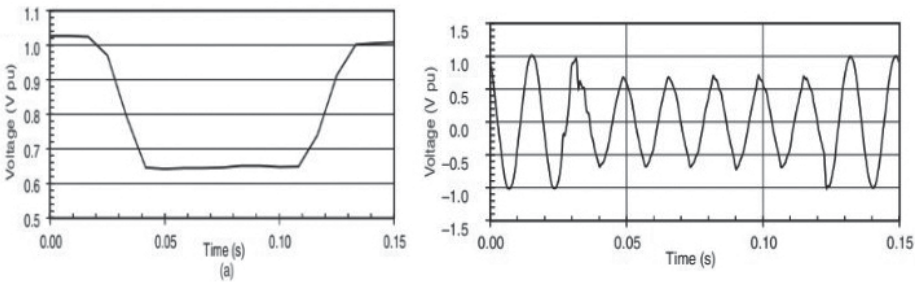
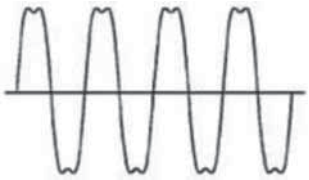
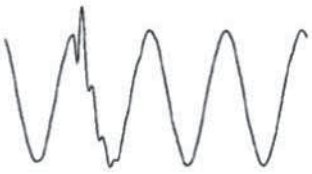


Figure 2

Table 1: Monitoring of different types of power quality parameters

Type of Power quality variation		Requirements for monitoring	Analysis and display requirements
Voltage regulation and unbalance		• Three-phase voltages • RMS Magnitudes • Continuous monitoring with periodic maximum minimum, and average samples • Currents for response of equipment	• Trending • Statistical evaluation of voltage levels and unbalance levels
Harmonic (distortion harmonics)		• Three-phase voltages and currents • Waveform characteristics • 128 samples per cycle minimum • Synchronized sampling of all voltages and currents • Configurable sampling characteristics	• Individual waveforms and FFTs • Trends of harmonic levels (THD and individual) • Statistical characteristics of harmonic levels • Evaluation of neutral conductor loading issues • Evaluation with respect to standards (e.g., IEEE 519, EN 50160) • Evaluation of trends to indicate equipment problems
Voltage sags, swells and short-duration interruptions		• Three-phase voltage and currents for each event that is captured • Configurable thresholds for triggering events • Characteristics of events with actual voltage and current waveforms, as well as rms vs. time plots • RMS resolution of 1 cycle or better during the rms vs. time events and for triggering	• Waveform plots and rms vs. time plots with pre- and post event information included • Evaluation of cause of each event (fault upline or downline from the monitoring) • Voltages and current to evaluate load interaction issues • Magnitude duration plots superimposed with equipment ride-through characteristics (e.g., ITI curve or SEMI curve) • Statistical summary of performance (e.g., bar charts) for benchmarking • Evaluation of power conditioning equipment performance during events
Transients		• Three-phase voltages and currents with complete waveforms • Minimum of 128 samples per cycle for events from the power supply system (e.g., capacitor switching) • Configurable thresholds for triggering • Triggering based on waveform variations, not just peak voltage	• Waveform plots • Evaluation of event causes (e.g., capacitor switching upline or downline from monitor) • Correlation of events with switching operations • Statistical summaries of transient performance for benchmarking

Power Quality Monitoring

Power quality monitoring is the process of gathering, analysing, and interpreting raw measurement data into useful information. The process of gathering data is usually carried out by continuous measurement of voltage and current over an extended period. The process of analysis and interpretation has been traditionally performed manually, but recent advances in signal processing and artificial intelligence fields have made it possible to design and implement intelligent systems to automatically analyse and interpret raw data into useful information with minimum human intervention.

Power quality monitoring programs are often driven by the demand for improving the system wide power quality performance. Many industrial and commercial customers have equipment that is sensitive to power disturbances, and therefore, it is more important to understand the quality of power being provided.

Different types of instruments are used to monitor the power quality parameters like CT, VT, Transducers, digital meters, modern system called 'smart grid' etc. Modern systems use sensors called Phasor Measurement Units (PMU) distributed throughout their network to monitor power quality and in some cases respond automatically to them.

Using such smart grid features of rapid sensing and automated self healing of anomalies in the network promises to bring higher quality power and less downtime while simultaneously supporting power from intermittent power sources and distributed generation, which would if unchecked degrade the power quality.

Different types of power quality parameters that should be monitored are given in Table 1.

Methods for power quality problems correction

1. Proper designing of the load equipment.
2. Application of passive, active and hybrid harmonic filters.
3. Proper designing of the power supply system.
4. Application of voltage compensators.
5. Use of Uninterruptible Power Supplies (UPSs).
6. Reliability on standby power.

Conclusion

This article has reviewed the importance of good power quality. It has presented power quality costs and solutions to poor power quality. A basic description of power quality has been given together with its quantification through different parameters.

The information from power quality monitoring systems can help improve the efficiency of operating the system and the reliability of customer operations. These are benefits that cannot be ignored. The capabilities and applications for power quality monitors are continually evolving.

Automate your power distribution with Elmeasure's Intelligent ACCL

Frequent power failure in a day is exhausting due to repeated manual switching of the DG Set. This over usage causes wear and tear and leads to switch failure in the expensive equipment.

Elmeasure's Intelligent Automatic source Change over with Current Limiter (iACCL) gives freedom from such maintenance problems. Built with high precision microcontroller that offers automatic changeover between main supply and generator supply, iACCL replaces dedicated manpower and also grants protection against overload/over voltage from the DG Set.

iACCL allows supply from mains as long as the load current is below the programmed current. When the mains supply fails and stand by generator supply is on, it connects the DG power to each consumer in sequence & starts monitoring its load.

Whenever the load current exceeds the allotment, power is automatically switched off for 10 seconds, and automatically restored. This cycle repeats for 5 times each time with double the time (20, 40, 80 & 160) and then enters into lockout mode until it is 'Reset' manually. This helps to protect against over voltage from DG.

Its current limiting capabilities are ideally suited to the efficient utilisation of the standby generators frequently used in multi-storied apartments, commercial complexes, etc.

Features:

- Microcontroller based automatic source changeover with neutral isolation.
- DIN Rail/surface mountable for single phase and Surface mountable for 3 phase.
- SMPS based design for low power consumption.
- Intelligent re-connection once trip has occurred due to either over voltage or over load.
- Manual Reset provision when in sleep mode for restoring power supply.
- Energy, Current, Voltage measurement for DG & Current measurement for EB.
- Programmable threshold setting for both sources independently.
- Over voltage protection for DG.

For further information, email: marketing@elmeasure.com

FLIR E60 Thermal Imaging System for Electrical & Mechanical Inspection

The delivery of reliable electrical power and other utility services is essential in our demanding technological world. Considering the growing demand consumption, the most successful utility companies take every precaution to prevent sudden outages, and that is why thermal imaging has become a core predictive maintenance tool in ongoing inspection programs. Thermal imaging camera helps in intensive regular substation surveys as well as quick safety checks of energised equipment before beginning maintenance work – anything that will help them avoid costly service interruptions and exorbitant equipment losses.

FLIR E60 advanced Thermal Imaging Camera continues to revolutionise thermal inspection efficiency with more onboard tools for faster imaging, analysis and sharing. It helps troubleshoot electrical problems more efficiently and accurately. Find hotspot and overheated connection and cable, an easy-to-use handheld device available with PC software (FLIR Tools) to document your work. Inspection of transformers, substation, transmission lines, electrical panel, solar plant, pump, motors etc. are the ideal applications.

FLIR E60 featuring MSX technology with 320 × 240 pixels IR resolution, < 0.05°C Thermal Sensitivity, 25°x19° Field of view and temperature range up to 650°C and offer ±2°C of reading accuracy. FLIR exclusively offers 2-10-year product warranty (2 years on hardware and 10 years on IR detector).

For further information, email: flirindia@flir.com.hk

Metrel presents its new Digital Transformer Analyser

Metrel MI 3280 Digital Transformer Analyser which further simplifies the procedure, even when testing transformers with less usual winding configurations. The instrument supports winding resistance measurements and turn ratio measurement of single and three phase power (up to 1,6 MVA), voltage and current transformers and is encased, like our other instruments, intended for serious field use, in a sturdy plastic carrying case with a high degree of protection (IP 65 with closed lid). With a 3.4" colour touch screen and Bluetooth connectivity with PCs, Android tablets and smart phones and built-in charger for extended autonomy, it offers great user friendliness which is significantly augmented with built-in help screens and colour-coded test leads.

When a user starts testing a transformer and enters configuration data, the instrument offers help in a form of self-explanatory pictures with detailed, colour schematics that show how to connect the leads to the transformer and to instrument terminals, prepared for each specific winding configuration. Colour coding of both the test leads and terminals minimises the possibility of an error even more. In that manner even less experienced users can perform the necessary measurements quickly and, most importantly, safely. Obtained results can then be downloaded to a computer, analysed with our Metrel ES Manager software and printed out in report form.

Key Features

- A 3.4'' colour LCD display with touch screen offers easy-to-read results and all associated parameters.
- The operation is straightforward and clear to enable the user to operate the instrument without the need for special training.
- Test results can be stored on the instrument. PC software that is supplied as a part of standard set enables transfer of measured results to PC where they can be analysed or printed.
- Built-in help screens for referencing on site.
- Autotest sequences.
- Built-in charger and rechargeable batteries as standard accessory.
- BT communication with PC, Android tablets and smart phones via built-in BT.
- PC SW Metrel ES Manager for creation of test structures and uploading, downloading of test results, autotest editor and report creation.

- High degree of protection IP 65 (case closed), IP 54 (case open).

Measuring Functions

- Turn ratio measurement of single phase transformer
- Phase deviation between high voltage and low voltage winding
- Excitation current when measuring turn ratio
- Turn ratio measurement of three phase transformer
- Phase deviation between high voltage and low voltage winding
- Excitation current when measuring turn ratio
- Winding resistance measurement of single phase & three phase transformer

For further information, email: sales@nsmtechnologies.co.in

KUSAM-MECO High Voltage Detector

KUSAM-MECO has introduced the advanced High Voltage Detector Model 230 HD, which detects high & extra high voltage in AC lines. An extendable insulation rod permits checking of high tension circuits at safe distance for voltage.

Also it is telescopic, compact, light, weight, easy to use and handy. The intermittent lighting in red of a high intensity light emitting diode and intermittent audible sound of an electronic buzzer greater than 50 dB are easy recognisable at full daylight & noisy locations, from 3 m apart. The detecting head, being

tightly enclosed, is free from any trouble due to dust & water. The retracted overall length is 893 mm & extracted length is 1520 mm. The 485gm weighing model can be operated in - 10°C to 50°C temp. The electrical specifications are as follows.

Measuring Voltage range : 3KV to 36.5KV, Operating Start Voltage (to ground) - 1.35 KV, Freq - 50/60Hz , With Stand Voltage - 100kV / 300mm, Insulation Resistance - 2000MΩ , Leakage Current - less than 100µ A. It is most suitable for use in switch yards of Electricity Beards & also H.T. Corporate Customers. Model 230HD is suitable for use upto 36.5KV. & Model 290HD is suitable for use upto 81.5KV.

For further information: www.kusam-meco.co.in

Sterlite Power project to supply over 1,200 MW electricity to Ranchi & Purulia

Sterlite Power, India's leading private developer of independent power transmission systems, has set another benchmark by commissioning the Purulia-Kharagpur Transmission Project. The project consists of two 400-kV Double Circuit lines with a total length of 273 Km including the 112-km long Purulia-Ranchi and 161-Km long Kharagpur-Chaibasa lines. Sterlite Power will operate and maintain the project, traversing through the states of Jharkhand and West Bengal, for 35 years.

With the commissioning of its fifth project, the company is now managing a portfolio of 4,063 circuit Km of operational transmission lines and two substations spread across 11 states.

Sterlite Power bagged the Purulia-Kharagpur Transmission Project through a Tariff-Based Competitive Bidding under the Build, Own, Operate and Maintain model. The line will contribute to the growing generation capacity in eastern India and strengthen the interconnection between state grids and regional grids to facilitate the exchange of additional power. Both the transmission lines under the project have been planned under the System Strengthening Scheme for exchange of power between West Bengal grid and Inter-State Transmission System.

"The Purulia-Kharagpur Transmission Project is a new milestone in providing uninterrupted power supply to the energy-deficient villages in West Bengal and Jharkhand. Adverse working conditions did not deter our team from addressing the toughest challenges faced during project execution. Sterlite Power is committed to achieving the nation's ambitious goal to ensure quality power to all," said Sterlite Power COO Ved Mani Tiwari.

The Purulia-Ranchi line connects Purulia Pumped Storage Power Project (PSPP) in West Bengal and the 765/400-kV sub-station of Power Grid Corporation in Jharkhand. The Kharagpur-Chaibasa line that connects sub-stations of Power Grid and West Bengal utility in Chaibasa and Kharagpur respectively was commissioned in mid-2016.

For further information: www.sterlitepower.com

Siemens Ltd launches the most energy efficient low voltage motors in India

Siemens Ltd announces the launch of its new range of energy efficient motor SIMOTICS 1LE7. The new SIMOTICS 1LE7 range of motors is the newest entrant in the existing range of motors offered by Siemens in India. These motors offer efficiency values higher than the IE3 standards - which is currently the highest efficiency class as recognised by Indian Standards.

Siemens SIMOTICS 1LE7 motors are capable of offering an average monetary savings of up to 8 – 20% depending on the frame size. Apart from generating savings, the SIMOTICS 1LE7 range of motors will assist customers to reduce lifecycle costs, and meet environmental regulations.

Bhaskar Mandal, Executive Vice President and Country Division Lead, Process Industries & Drives Division, Siemens India, said "Siemens began the manufacturing of motors in India since 1966 and has been recognised as a pioneer in manufacturing state of the art motors for diverse sectors, applications and power classes. Taking this legacy forward, SIMOTICS 1LE7 will prove to be a reliable and efficient innovation which will boost the performance of energy intensive industries like cement, metals, mining, power, textiles, pulp and paper to achieve significant reduction in energy consumption and thus reduce costs of operation and their carbon footprint."

Siemens Ltd was also the first company in India to launch the locally – manufactured IE2 and IE3 efficiency class industrial motors. Today, one out of two energy efficient low voltages IE motor sold in India is from Siemens.

For further information: http://www.siemens.co.in/

CBS ArcSafe launches RSA-73B for General Electric Type HPC Switch

CBS ArcSafe, a well known manufacturer of remote racking and switching solutions for low- and medium-voltage switchgear, introduces its Remote Switch Actuator (RSA) for the General Electric Type High Pressure Contact (HPC) switch. The lightweight, portable CBS ArcSafe RSA-73B allows technicians to remotely close or trip the GE HPC switch from a safe distance of up to 300 feet while remaining stationed outside the arc-flash boundary.

Installation and operation do not require any modifications to the existing electrical equipment, due to CBS ArcSafe's magnetic latching system. The RSA-73B is compatible with Type HPC switches with ratings of 800-1600 A, with manual or electric trip with top feed (inverted style). Typical applications include high available fault current systems such as main service disconnects, feeder disconnects, or branch circuit disconnects. When compared to other arc-flash mitigation alternatives, the RSA-73B is a cost-effective solution for keeping operators safe.

Optional features include radio remote with range of up to 300 feet, 24 V DC LED light, wireless video camera system with LCD monitor, and rugged protective case assembly. All RSA units are portable, fast, and easy to set up; offer mechanical and/or electrical safety protection; are adjustable to fit unique electrical equipment configurations; reduce the requirements for personal protection equipment; and help customers with NFPA 70E arc-flash safety compliance.

Website: www.cbsarcsafe.com

Complete solutions for welding robots

For the quick replacement of energy chain systems on welding robots, the motion plastics specialist igus now offers fully assembled dress-packs. Easily adapted to the customer standard, these complete solutions can be connected quickly and easily to the robot and therefore minimise production downtime. Customers can rely on reliable "all-in-one solutions" from igus.

Time plays a very important role in automated plants, such as for automotive production. If production stops, every minute counts. Pre-assembled systems help to keep maintenance and assembly work as low as possible. For this reason, the motion plastics specialist igus now offers ready-to-install standard dress-packs for welding robots. These packs consist of a three-dimensional triflex R energy chain from igus, completely filled with chainflex cables and hoses for supplying energy, data and media. "Due to to the large number of enquiries for retrofit in existing plants, we decided to develop this standard dress-pack for welding robots," explains Jörg Ottersbach, head of the robotics industry at igus. "They can be adapted to the customer's individual requirements, for example, you can choose between different bus systems as well as different hose manufacturers or cable cross sections." It is also possible to have the cables harnessed directly by igus according to 24 manufacturer standards with original plug connectors.

Complete carefree packages for industrial robots

The new dress-packs from igus guarantee a quick replacement of the energy supply. For further applications for industrial robots, igus offers both customer-specific advice and an easy-to-use online configurator. With the "QuickRobot" (http://www.igus.de/quickrobot-online) the right solution from over 2,000 options can be selected and ordered with just a few clicks by specifying the robot manufacturer and the model series. On request, igus supplies suitable retraction systems to guide the energy chains with constant tension to the end of the robot arm, and also offers the installation at the customer's site on request. Since igus produces all components of the energy chain system from a single source, its reliability can be guaranteed. The company igus is the only supplier on the market capable of providing a 36-month guarantee on all chainflex cables from igus due to the ideal coordination of chains and cables.

For further information: www.igus.de/quickrobot-online

GE expands its Medium-Voltage solution Portfolio

GE has recently launched its IEEE MV portfolio. Specifically, GE added three new solutions to its Seco MV product family – SecoBloc, modules designed for original equipment manufacturers (OEMS); SecoVac R, a retrofit vacuum circuit breaker (VCB); and SecoGear, metal-clad switchgear. As part of its MV portfolio expansion, three new IEEE solutions are now available:

SecoBloc modules are designed to house GE's IEEE-rated SecoVac VCBs and are ideally suited for OEMs serving industry-focused applications. Designed for easy, reliable use with features such as reduced weight, an integrated door and a front-accessible modular operating mechanism, it brings simpler and faster installation and reduced maintenance time to MV OEMs and their customers. Along SecoBloc, GE also offers additional OEM construction options as an L-frame or cell kit to be integrated into their design based on their level of need.

SecoVac is designed to easily replace VCBs in existing GE switchgear. SecoVac R is a streamlined solution to update legacy vacuum circuit breakers with smart design features such as simplified mechanism, bringing shorter maintenance times and simple installation to customers.

SecoGear is designed to distribute power from the substation to the electrical room for efficient facility operations in industrial and commercial applications. With features such as embedded poles, reduced weight and a front-accessible modular operating mechanism, SecoGear with SecoVac VCBs delivers simpler, faster installation and reduced maintenance time.

For further information: www.geindustrial.com

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Testo 770 – Clamp Meter - The first clamp meter with revolutionary clamp mechanism

The three instruments in the testo 770 clamp meter family are ideally suited for current measurement in switching cabinets. One of the two pincer arms can be fully retracted into the instrument. This unique grab mechanism means that cables in tight switching cabinets can be easily grabbed. The automatic measurement parameter detection also ensures reliable work: in the current and voltage area, all three instruments detect direct and alternating current and select other parameters such as resistance, continuity, diode and capacitance automatically. The testo 770-1 model is the standard version for daily measuring tasks, including starting current measurement.

In addition, the testo 770-2 contains both a µA area as well as a temperature measurement by means of an optional thermocouple adapter type K. The testo 770-3 also calculates all output ratings, has a Bluetooth interface and the possibility of connecting to the testo Smart Probes App to show the measuring profile as a graph or to document it directly in a report.

- Unique grab mechanism makes it easier to work at tight measuring points
- Auto AC/DC for current and voltage
- Large two-line display
- True root mean square measurement - TRMS
- With additional functions, such as starting current, power and µA measurement
- Bluetooth and testo Smart Probes App

For further information: For more info: Write to info@testoindia.com or visit www.testo.in

Schneider Electric introduces new solar home systems for off-grid households

Schneider Electric, the global specialist in energy management and automation, at COP22 Marrakech, unveiled Homaya Solar Home Systems, portable electrification solutions designed to improve lives in off-grid households in Africa and Asia. These complete solutions comprise solar panels, an in-built battery and 3-4 lamps. In addition to powering the lamps, the battery can be used for Direct-Current (DC) electrical devices such as radios, fans, televisions. This robust system offers access to sustainable energy in suitable conditions for African and Asian homes for an up-front investment of around US$100. The product has been designed to meet three key specifications: robustness, quality and affordability.

For further information: www.schneider-electric.com

Yokogawa unveils ISA100 Wireless-based field wireless vibration sensor

Yokogawa Electric Corporation introduces its ISA100 Wireless -based field wireless vibration sensor with the ability to quickly update data and a long battery life. By providing real-time updates on vibration levels in plant facilities, this sensor helps users quickly detect equipment anomalies and enables predictive maintenance.

Product Features

The principal components of this field wireless vibration sensor are the FN510 field wireless multifunction module, the LN01 piezoelectric type acceleration sensor, and the FN110 field wireless communication module. Via a gateway device, the FN510 uses the ISA100 Wireless communications protocol to exchange data with a host-level system such as a DCS. The data collected with this vibration sensor enables plant operators and maintenance staff to monitor vibration levels in real time. Both explosion proof and non-explosion proof types are available. Key features of this sensor are as follows:

1. **Fast data updates**
   The sensor can be set to update data as quickly as every 10 seconds. This update time is ideal for monitoring vibration levels in plant facilities.
2. **Long battery life and easy maintenance**
   When the vibration sensor is set to update data once per minute, it can operate on a single set of batteries for up to 10 years. In addition to eliminating the cost of providing replacement batteries, this reduces maintenance workload.
3. **Highly reliable and versatile system**
   Thanks to the features of ISA100 Wireless and our technical know-how, we have achieved a highly reliable wireless network with fully redundant communications that is capable of sending and receiving different types of sensor signals over long distances.

For further information: www.yokogawa.com

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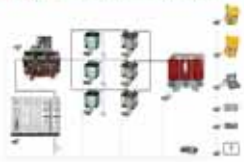

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Website: www.ngepl.com

Harmonic Filtering Solutions

The increasing use of modern power electronic apparatus (drives, uninterruptible power supplies, etc.) produces nonlinear current and thus loads the network with harmonics. The capacitance of the power capacitor forms a resonant circuit in conjunction with the feeding transformer. Experience shows that the self-resonant frequency of this circuit is typically between 250 and 500 Hz, i.e. in the region of the 5th and 7th harmonics. Typical loads requiring harmonic filtering include 6 pulse drives (AC / DC), 3 phase UPS, frequency converters

For further information: www.larsentoubro.com

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Field of activities

- Repair, Rewinding, Overhauling & testing of rotating electrical machines (Steam/Gas/Hydro) Generators of lower, higher voltages & power ratings more than 250 MW & Power Transformers (220 KV)
- Manufacturing of Transposition coils and remaking the same.
- Commissioning of all electrical equipments.
- Dynamic balancing of Rotors, Fans & Impellers.
- Generators Redesigning & uprating of capacity of existing machines without disturbing the rotor winding.
- Redesigning of cooling systems like air cooled to water cooled and vice versa.
- Redesigning with change in voltage like 415V to 660 volts or 3.3KV to 6.6KV or 11KV to 15KV & vice versa.

Profile

- RKEW is one of the premier and experienced service outfit in the field of electrical motors, generators and transformer repair in India.
- RKEW an exclusive expertise in executing Repair/Rewinding & Refurbishment of worst damaged industrial steam generators, motors & power transformers. It extends expert service to various locations of its large industrial clients spread across the globe.
- RKEW team that includes management, technical & skilled man power understands the urgent need of its clients and is well prepared to deliver faster services (with no limitations on size of the machine) to client's satisfaction.

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