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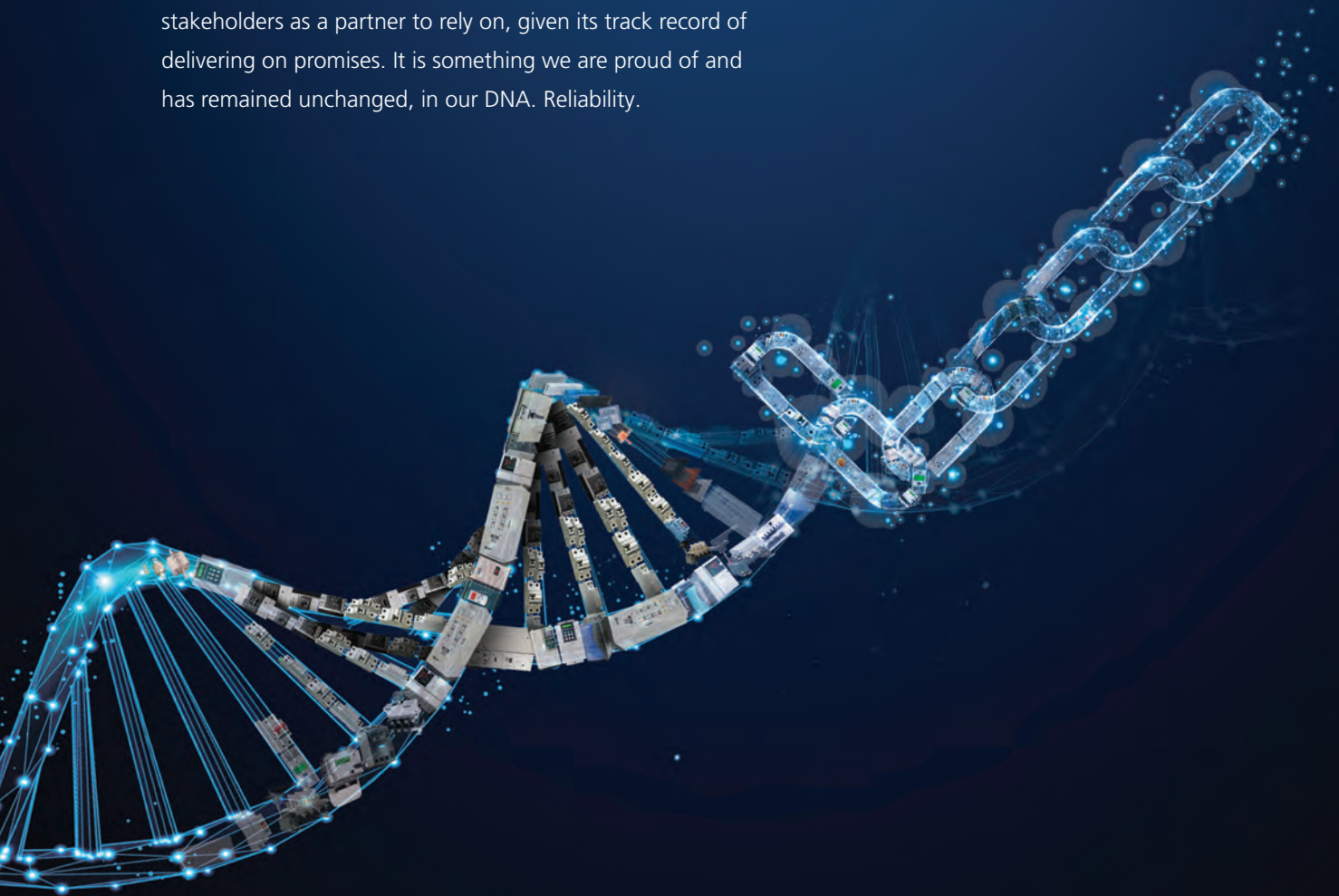
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From the Editor's and Publisher's Desk

ARE WE READY TO COMBAT CYBER ATTACKS ON OUR GRIDS?

In power management, there were lots of challenges when the things were completely manual, they started transforming with the advent of advanced automation, and now in the era of digitalisation most of the challenges are predictable, yet vulnerability is not a matter to take leniently. In other words, grid reliability has improved manifold and resilient systems have been in place almost everywhere, still what a planned cyber-attack can do that all of us can easily imagine. Thus, in one hand managing the power control systems have become very easy today, on the other hand keeping the control system healthy has stood as a big challenge in front of our power engineers.

Around one year back, in May 2019, Central Electricity Regulatory Commission constituted an expert committee, to look into this aspect in depth and suggest a revamp of the decades-old guidelines that our grids still follow blindly. The expert committee has already submitted its report in January this year. In that they have devoted one complete chapter on cyber issues or vulnerability of our grids to attack. Although, the committee has categorically stated the urgent need for installation of firewalls and taking other measures, so far no progress is visible in that direction. Also, we urgently need to set our post attack back up plan.

It is a proved and globally known news that China has been trying to hack the cyber systems of different big organisations globally, and I think I need not remind anyone about the ongoing bitterness in Sino-Indian relationship. So, we urgently need action to secure and strengthen our grids.

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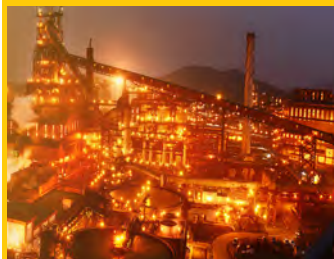
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BBMB POWER HOUSES & SUB-STATIONS ARE REMOTELY OPERABLE NOW

Power minister, R. K. Singh recently inaugurated the Remote Control Room built at SLDC Complex for machines of Bhakra Left Bank Power House...

Recently, R K Singh, Hon'ble Minister of State for Power (I/C), Govt. of India, has e-inaugurated from New Delhi the BBMB (Bhakra Beas Management Board) Power Houses & Sub-Stations' Remote Control Room at SLDC Complex, BBMB, Chandigarh.

During the occasion, Singh lauded the BBMB's team for achieving this technological advancement, which is at par with rest of the world. This assumes greater importance keeping in view its completion by BBMB during these unprecedented pandemic times.

S.N. Sahai, IAS, Secretary (Power), Govt. of India, was the distinguished guest in the event who also joined from New Delhi. Sahai too congratulated BBMB for achieving automation of one of the oldest power houses in the country.



R K Singh is inaugurating the Remote Control Room built at SLDC complex, Chandigarh, sitting in New Delhi.

Machines of Bhakra Left Bank Power House can now be operated and monitored from Remote Control Room at SLDC, Chandigarh. It will increase reliability, improve customer satisfaction, reduce manpower, improve utilization and reduce the operational and maintenance expenses. It will also lead to a better coordination with Northern Regional Load Despatch

Centre (NRLDC) for meeting Grid requirements etc.

D.K. Sharma, Chairman, BBMB delivered a brief presentation on remote operation of Power Houses & Sub Stations system. He also congratulated BBMB engineers and employees for their perseverance and dedication to complete this work during the testing CORONA times. Vote of thanks was delivered by Harinder Singh, Member (Power), BBMB.

VIKRAM SOLAR TO PRODUCE SOLAR EQUIPMENT IN TAMILNADU

The company earlier announced its plan to set its own manufacturing plant over a period of five years...

On 20th July, Vikram Solar Ltd, a leading solar energy solutions provider specializing in efficient PV module manufacturing and comprehensive EPC solutions, has signed a Memorandum of Understanding (MoU) with the Government of Tamil Nadu to set up a 3 GW of solar manufacturing facility in the state. In line with the vision of 'Aatma Nirbhar Bharat', earlier the company announced wafer, cell and module manufacturing set up over a period of five years.

With an international presence in six continents, the company is an active contributor in



Photo by @pexels.com

shaping the solar revolution across continents.

Carrying forward the extensive manufacturing experience of the Vikram Group, Vikram Solar, since 2006, has been building on a four-decade-old success story.

The company's annual PV module production capacity now stands at 1.2 GW. The company's products comply with the international standards of quality, reliability, and performance. As a fully forward- integrated Solar EPC solutions provider, Vikram Solar deploys world-class technology to design, install and commission solar projects worldwide.

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INDIA'S FIRST 700 MWE PHW REACTOR ATTAINS CRITICALITY

Prime Minister, Narendra Modi, said, "This indigenously designed 700 MWe KAPP-3 reactor is a shining example of Make in India."

At a time when the country's media is continuously busy with debating on unprecedented spread of COVID 19 virus and designing the appropriate action against China, Indian nuclear scientists have created yet another milestone. Kakrapar Atomic Power Plant, Unit-3 (KAPP-3), India's first 700 MWe (megawatt electric) Pressurized Heavy Water Reactor (PHWR) with innovative features has attained criticality at around 0936 Hrs on 22 July 2020.

A nuclear reactor attains criticality when every nuclear fission event releases a sufficient number of neutrons to sustain an ongoing series of reactions or a self-sustaining chain reaction. Atomic Energy Regulatory Board (AERB) has carried out exhaustive safety review of various safety aspects to ensure satisfactory compliances to regulatory requirements and granted permission for First Approach to Criticality of KAPP-3 on 17 July, 2020.



Photo by Markus Distelrath@pexels.com

Due to prevailing COVID-19 situation, the safety review was carried out by working from home, partial working from office and through discussions and meetings over video conferencing. The criticality has been witnessed by the AERB Observer Team posted at Kakrapar Site and by AERB experts at Headquarters through live streaming from KAPP-3 Control Room.

Prime Minister, Narendra Modi has congratulated the achievement of Indian nuclear scientists, in a tweet. He has said, "Congratulations to our nuclear scientists for achieving criticality of Kakrapar Atomic Power Plant-3. This indigenously designed 700 MWe KAPP-3 reactor is a shining example of Make in India, and a trailblazer for many such future achievements!" KAPP-3 is located at Kakrapar Site, Gujarat, where already two 220 MWe PHWRs (KAPS-1 & KAPS-2) are in operation and another 700 MWe PHWR (KAPP-4) is under advanced stage of construction. 

TPGEL TO DEVELOP 225 MW HYBRID RENEWABLE POWER PROJECT

The proposed plant is expected to generate about 700 MUs of energy per year and will annually offset approximately 700 Million Kg of CO₂...

As per a recent report from India's largest integrated power company Tata Power, its wholly owned subsidiary Tata Power Green Energy Limited (TPGEL) has received a Letter of Award (LoA) from Tata Power Mumbai Distribution on 13th July 2020 to develop a 225 MW hybrid renewable project.

The energy will be supplied to Tata Power Mumbai Distribution under a Power Purchase Agreement (PPA), valid for a period of 25 years from its scheduled commercial operation date. The company has won this capacity in



Photo by @pexels.com

a bid finalised recently by Tata Power Mumbai Distribution. The project is required to be commissioned within 18 months from the date of execution of the PPA.

The new plant is expected to generate about 700 MUs of energy per year and will annually offset approximately 700 Million Kg of CO₂. Tata Power's renewable capacity will increase to 3,782 MW, out of which 2,637 MW is operational and 1,145 MW is under implementation including 225 MW won under this LOA. 

FIRST PUBLIC DC FAST CHARGER FOR NEW DELHI INSTALLED

The Terra54 is a cloud-connected charger that will be linked through Open Charge Point Protocol (OCPP) 1.6 to EV Motors' backend office...

Although the sudden outbreak of the coronavirus pandemic has affected the rhythm of growth of our country, the pre-planned projects are still continuing. With a view to supporting India's dream for faster transformation to the electric transportation era, ABB India limited has recently installed its first Public DC fast charger in New Delhi with EV Motors India, the major charge point operator for BSES Yamuna Power Limited. The Deputy Chief Minister of New Delhi, Manish Sisodia inaugurated the Terra54 CJG charging station, which caters to multiple charging protocols of CCS2, CHaDeMO and AC Type 2.

During the inauguration ceremony, Prem R Kumar, CEO, BSES Yamuna Power Limited and Amit B Gupta, Head - Delhi NCR and Rajasthan cluster, ABB India were also present. This ABB charging station is also the first public installation of a DC fast charger for BSES Yamuna Power Limited (BYPL), a joint venture between the Government of Delhi and Reliance Infrastructure Limited.

The Terra54 is a cloud-connected charger that will



be linked through Open Charge Point Protocol (OCPP) 1.6 to EV Motors' backend office. Passengers will be able to charge their cars in about 40-50 minutes from 0 to 80%. All ABB chargers come with connected services, which help customers easily connect their chargers to different software systems like back-offices, payment platforms, Energy Management Online Solutions and smart remote diagnostics that ensures significant uptime value.

Commenting on the development, CP Vyas, President, Electrification Business, ABB India, said, "We are privileged to be a partner in India's quest for sustainable mobility with clean energy and smart solutions. This installation with BYPL and EV Motors India, our first Public DC fast charger in Delhi, will provide further impetus to the adoption of clean electric transportation in India. Being at the forefront of this innovative technology, our advanced chargers reflect not just the latest in technology but are also user-friendly, providing high customer value. This is in line with our global vision of Mission to Zero."

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NTPC ACHIEVES HIGHEST DAILY GROSS GENERATION

The PSU's total power generation includes those from its 25 subsidiary and JV companies too.

India's largest power generation company, NTPC Ltd., has recently issued a notification stating that it has achieved the highest daily gross generation of 977.07 Million Unit (MU) on 28th July, 2020. NTPC is a Public Sector Undertaking (PSU) under the Ministry of Power, and its total generation includes those from its subsidiary and JV companies too.



Photo by @pexels.com

According to the NTPC's statement, five of its power stations Korba, Sipat and Lara in Chhattisgarh; Talcher Kaniha in Odisha

and Koldam hydro in Himachal Pradesh exhibited exceptional performance – and achieved 100% Plant Load Factor (PLF) on the day. NTPC's previous best daily generation was 935.46 MU achieved on 12th March 2019.

With a total installed capacity of 62910 MW, NTPC Group has 70 Power stations comprising 24 Coal, 7 combined cycle Gas/Liquid Fuel, 1 Hydro, 13 Renewables along with 25 Subsidiary & JV Power Stations.

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ABB STEPS AHEAD WITH ITS POWER GRIDS BUSINESS DIVESTMENT PLAN

With a view to achieving its goal to become a decentralized global technology company, recently ABB has disinvested 80.1 per cent of its Power Grids business to its long-term partner Hitachi. This will allow ABB to concentrate on key market trends and customer needs like the electrification of transport and industry, automated manufacturing, digital solutions and increased sustainable productivity. However, ABB will initially retain a 19.9 per cent equity stake in the joint venture that will operate as Hitachi ABB Power Grids and be headquartered in Switzerland. The company has a pre-defined option to exit the retained 19.9 per cent shareholding three years after closing.

Elaborating on the action, Peter Voser, Chairman of the Board of Directors of ABB, said, "Since announcing our intention to divest Power Grids to Hitachi, ABB has made significant progress in becoming a more customer-focused and simplified organization. We



believe Hitachi is the best owner for Power Grids and its next stage of development, building on the solid foundation achieved under ABB's previous ownership. ABB remains committed to using net cash proceeds from the transaction for a share buyback program. Our goal is to execute this in an efficient

and responsible way, taking account of the prevailing circumstances."

Focusing more deeply on the ABB's latest target, Björn Rosengren, CEO of ABB, said, "With the divestment, ABB is well positioned for the future with a strong focus on industrial customers. Leveraging our technology leadership and passion for innovation, we will now focus on creating superior value for our customers, employees and shareholders. We will do this by evolving our decentralized business model, strengthening our performance management culture and driving active portfolio management."

HYDROGEN-BASED MICROGRIDS HAVE MORE POTENTIAL

With resilience of the economy in the spotlight post-covid, the new figures lend support to clean energy systems of the future. Diesel's reputation of being cheaper no longer stands.

In the recent past, the award-winning manufacturer of highly efficient, modular hydrogen generators, Enapter has published a very interesting report, which states that 100% renewable microgrids are more resilient and economic than diesel supported ones. The company has been researching the feasibility of using hydrogen within microgrids in a bid to replace fossil fuels with carbon free alternatives.

According to Enapter's latest briefing, diesel generators can be replaced with green hydrogen in both existing and future built microgrids. Instead of curtailing and effectively wasting excess solar and wind, the valuable resource can be turned into green hydrogen to achieve

seasonal storage needs in a 100% renewable microgrid setup.

The new statistics indicates that the cost of operation, fuel and logistics is what makes diesel expensive. Meanwhile, prices of hydrogen and equipment are dropping and will continue to do so, further strengthening the economics.

Visait Hansaward, the Managing Director of Blue Solar Co. Ltd is co-developing the first green hydrogen powered microgrid on Koh Jik island in Thailand. Hansaward said, "Seeing the economics work out positively and can enable the transition to a completely carbon free setup on Koh Jik. Breaking the cost barrier associated with hydrogen is what we needed to replace diesel and fulfil a 100% green solution."

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17 Position Coarse Fine (11/22/33kV, 200A max.)

Overall Dimension : 1124 (l) x 852 (h) x 503 (w)

Weight without oil : 268 kgs

Oil Quantity : 135 litres

Oil quantity in Kgs : 115 kgs



17 Position Linear (11/22/33kV, 200A max.)

Overall Dimension : 1124 (l) x 837 (h) x 700 (w)

Weight without oil : 280 kgs

Oil Quantity : 200 litres

Oil quantity in Kgs : 170 kgs



9 Position Linear (11/22/33kV, 200A max.)

Overall Dimension : 1083 (l) x 700 (h) x 600(w)

Weight without oil : 230 kgs

Oil Quantity : 110 litres

Oil quantity in Kgs : 94 kgs

Started Supplies

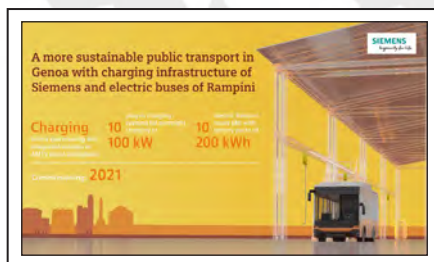
SIEMENS PIONEERS ELECTRIFICATION OF ITALY'S PUBLIC TRANSPORT PROJECTS

Innovative space management approach in design will maximize the number of buses that can be charged in a single depot.

Siemens Smart Infrastructure has secured the order to set up the charging infrastructure for 10 Rampini E80 electric buses (e-buses) in Genoa, Italy. The buses will be used by AMT Genova (AMT), the city's public transport operator. It is scheduled to be commissioned by the summer of 2021.

Initially, Siemens will supply 10 innovative plug-in charging systems for AMT's Cornigliano depot. Those will enable e-bus recharging overnight or during other operational breaks planned by the operator. The space-saving design makes it possible to subsequently deploy up to 60 charging units in the bus depot for as many electric buses – a future-proof modular approach.

Based on the Siemens Sicharge UC 100 overnight plug-in charging systems, which are compliant with the latest international standards and have a charging capacity of up to 100 kilowatts (kW), the depot will be able to charge the buses using power cables that can be pulled out from the top. That space-saving design concept



maximizes the number of buses that can be charged in a single depot. Combined with Siemens smart charging software, all the charging operations will be intelligently optimized in order to minimize the overall energy consumption and peak loads of the depot.

Equipped with 200 kWh battery packs, the ten E80 electric buses by Rampini have a width of 2.2 metres and a capacity of 43 passengers. With these structural dimensions, they are the only e-buses in Europe that guarantee the highest levels of maneuverability in historic city centers.

Commenting on the plan, Marco Rastelli, Head of the Distribution Systems business unit at Siemens Italy, said, "This first public transport electrification project in Italy proves the potential of our flexible and compact solution, which can be adapted and integrated even in this small historic facility. We are proud to offer our technology to make Genoa's urban mobility even more efficient and sustainable."

US DOE ACTS TO BOOST BIOECONOMY

The projects will ensure the United States' leadership across all segments of the growing global bioeconomy.

The U.S. Department of Energy (DOE) is all set to fund more than \$97 million for 33 projects that will support high-impact technology research and development (R&D) to accelerate the bioeconomy. These projects will improve the performance and lower the cost and risk of technologies that can be used to produce biofuels, biopower and bioproducts from biomass and waste resources.

Detailing on the proposal, Under Secretary of Energy, Mark W. Menezes, said, "Advancements made in bioenergy technologies will help expand America's energy supply, grow our economy and enhance our energy security. These projects will ensure the United States' leadership across all segments of the growing global bioeconomy, and allow us to provide U.S. consumers and businesses more homegrown energy choices for their fuels and products."

The selected projects will address a variety of R&D areas, including: Scale-up of bench applications to reduce scale-up risks for biofuel and bioproduct processes; Waste to energy strategies including strategies for municipal solid waste, wet wastes, like food and manures, and municipal waste water treatment; Cost reduction of algal biofuels by improving carbon efficiency and by employing direct air capture technologies; Quantification of the economic and environmental benefits associated with growing energy crops, focusing on restoring water quality and soil health; Development and testing of low-emission, high-efficiency residential wood heaters; Innovative technologies to manage major forms of urban and suburban waste, with a focus on using plastic waste to make recycled products and using wastes to produce low-cost biopower.

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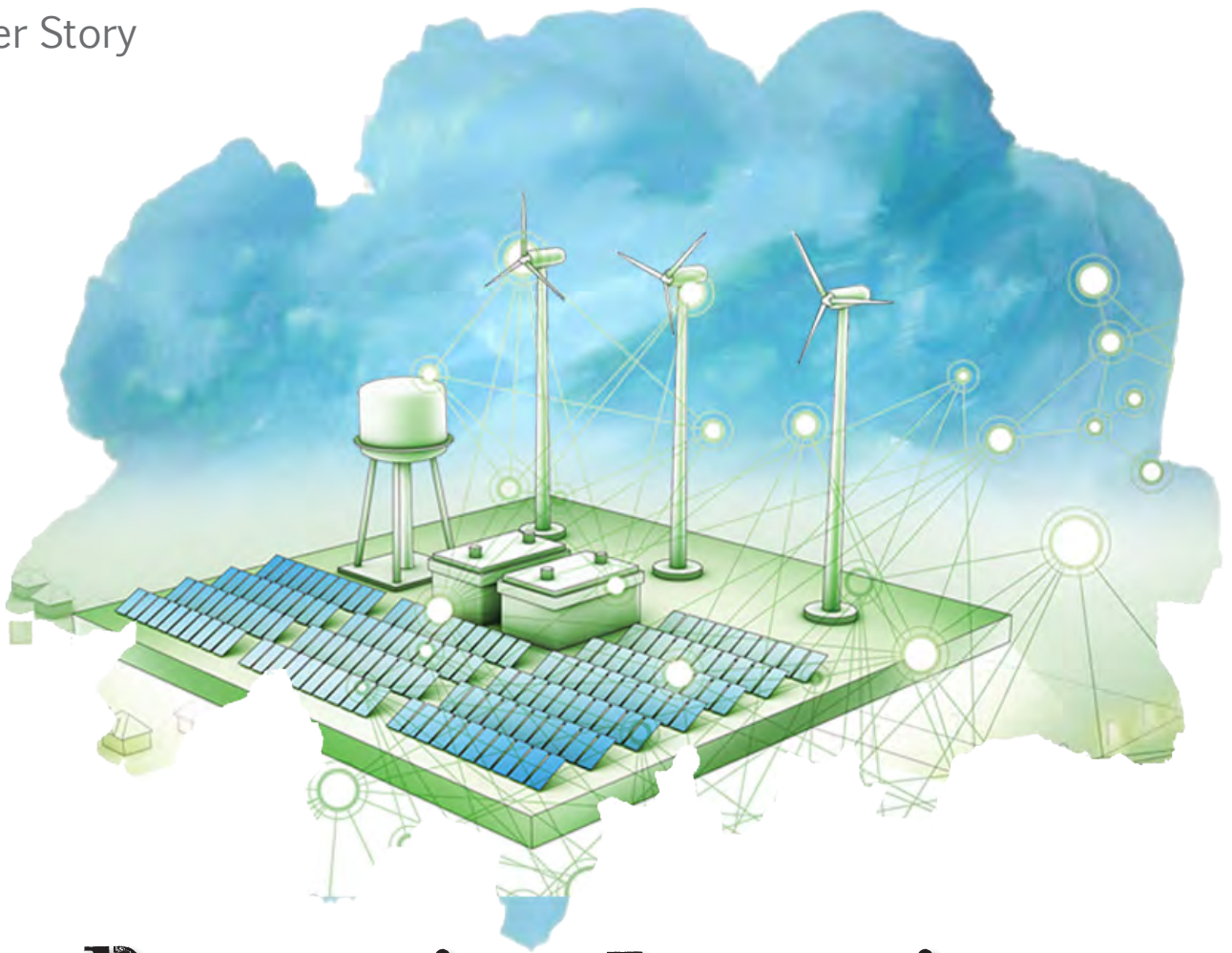
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Protection Issues in MICROGRID

- A Synthetic View

The independent power systems - Microgrids are the most important solution to overcome the power blackout due to overloading of main electrical grid. As a localized power grid, microgrid has its own generation sources, and definable load systems. It also works with renewable energy sources for power generation which tends to the usage of storage resources according to the requirement. Microgrid can operate in line with the traditional grid as well it can be disconnected from the grid to operate autonomously. It tends to provide reliable, quality and efficient energy supply to customers. Apart from the major issues like power flow control, power quality, and stability still the implementation of microgrids pose some technical challenges at the protection level of microgrid. This study mainly focuses on the protection issues faced by microgrid and some possible remedies to overcome the technical challenges at the microgrid protection phase.

In recent days, the generation of electrical energy locally at distribution voltage level is emerging as Distributed Generation (DG). Usage of renewable energy sources such as photovoltaic system, wind power, hydro turbine, tidal and biogas in Distributed Generation (DG) become a vital solution to overrule the problems like energy efficiency and environmental concerns with the traditional electrical grids. The increase of DGs in distribution end leads to the formation of Microgrid. The microgrids can be defined as a subsystem or local distribution system inclusive of microsources for generation, power electronic convertors, storage resources like flywheels, energy capacitors and batteries and associated controllable and uncontrollable loads. Microgrids have the tendency to operate in line with the utility grid (grid mode) or isolated from the utility grid (island mode). Through point of common coupling (PCC) the microgrids have inline connection with utility grid. Microgrids enable an improved energy management systems (EMS) to optimize the power flow within the network when connected with utility grid. As well focus has made to minimize the energy price and improve the power factor at PCC. When microgrids are in island mode the stabilization of voltage and frequency enables the system stability.

Microgrids serve various consumers like residential buildings, commercial entities and industrial parks. They tend to provide various advantages such as improving energy efficiency, minimizing overall energy consumption and improves the quality and reliability of power supply. Apart

from these advantages microgrids have three major challenges while connecting with distribution grid. They are as follows:

- Technical challenges associated with control and protection system
- Regulation challenges
- Customer participation challenges

The technical issues with microgrid in grid connected mode are existence of multiple energy resources for power generation, location of PCC and level of penetration of microgrid with main grid. The increased penetration of DG in micro grid system poses several technical problems in the operation of the grid such as steady state and transient over & under voltages at point of connection, protection malfunctions, increase in short circuit levels and power quality issues. The regulation challenges involves with the regulation policies, microgrid legality and engagement between microgrid firms and customers. The major challenge in microgrid is with the protection system. The response of protection system should be for both microgrid and main grid faults. The quick operation of protection system have to maintain the synchronism after transition to islanded operation of microgrid, to maintain the stability of the main grid. This study have main focus on issues with the protection system in microgrid and possible solutions for the issues in both grid connected mode and island mode.

Protection Issues

The main goal of microgrid is to provide quality and reliable supply to the customers. Hence, it is necessary to isolate the microgrid if fault occurs in main grid and to isolate the

minimum faulty part if fault occurs inside microgrid.

Faults during Grid Connected Mode

During the occurrence of fault in Microgrid the protection devices in distributed energy resources (DER) must respond only after the activation of protective devices provided at PCC. With the fault ride through capability (FRT), DER should continue its work. For fault within the microgrid, the designed protection strategy should disconnect the faulty portion from the rest of system. The conventional OC protection scheme is set at fault current of 10-50 times of the full load current. Some non-fault cases result in voltage unbalance at PCC, which are difficult to identify. Hence, there is a need for much effective protection schemes to avoid such unwanted situations.

Faults during Island Mode– In this mode, the nature of issue is different from the previous one. The fault current of an islanded microgrid is of 5 times of the load current. Here, the OC protection scheme is set to get activated at 2-10 times of the full load current. This can be reduced to 2-3 times of the full load current for converter based DERs in microgrid. This difference makes the usage of fuses rather than OC protection devices in microgrid.

Changes in Fault current magnitude

The fault current level is high in grid connected mode rather than island mode. According to types of DG the fault current contribution also varies. Fault current of synchronous type DG is 5 times of the rated current and inverter fed DG is 1.5 times of the rated current. Hence, prediction of fault current is difficult because the magnitude of fault current depends

upon many parameters including the mode of operation, type of DGs and number of DGs.

Reduction in reach of impedance relay – The occurrence of fault in downstream of the bus DG connected to utility grid, impedance measured by relay located in upstream is higher than real fault impedance. This affects grading of relays and causes delay in operation or sometimes relay does not operate at all.

Bi-directional Power flows – Unidirectional power flow (Substation to load) takes place in conventional distribution system. The interconnection of DGs in distribution end makes the power flow reverse and leads to power quality issues, voltage variation and protection issues.

False Tripping – It occurs when a DG is located near to the substation in a feeder and if fault current in a healthy feeder is supplemented by the DG connected in neighboring feeder then the protection device in the healthy feeder may isolate the circuit unnecessarily.

Blinding of Protection – When DG is connected to a network and if fault occurs in that feeder, the impedance of the grid is much higher than the DG impedance. This makes the short circuit current less than the pickup current of the feeder relay which leads to the failure in detection of fault.

Re-Synchronisation – After islanding, the process of re-synchronization taking place to reconnect the microgrid with main grid through the re-synchronization equipment at PCC. This can be done either in manual mode or automatic mode. The microgrid synchronization schemes are of three types:

- Active synchronisation
- Passive synchronisation

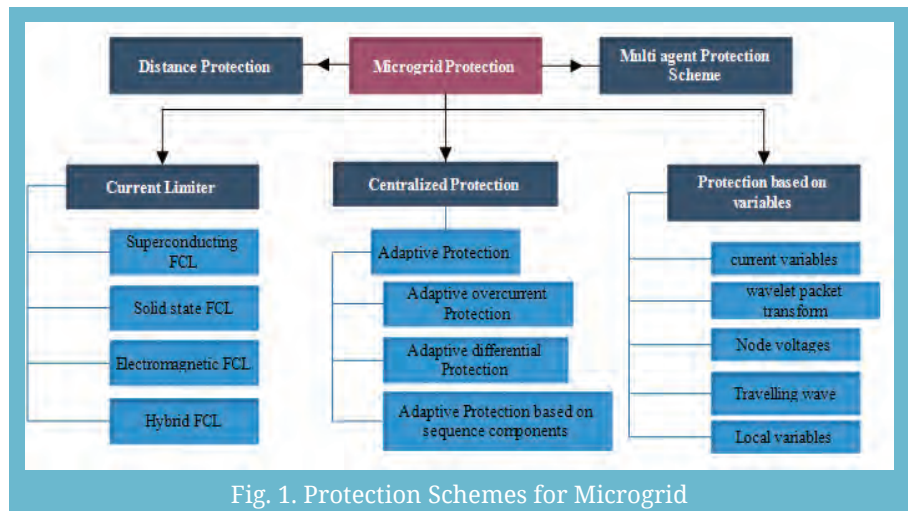


Fig. 1. Protection Schemes for Microgrid

- Open-transition transfer synchronisation

Solutions for Protection Issues

The combination of primary and backup protective schemes should be available in a microgrid protection scheme, so that the unhealthy portions can be isolated from the rest of the system. The introduction of DGs in main grid makes the system more complicated. Hence, usage of fuse and overcurrent relays for protection makes the system very simple. Therefore, an efficient protection scheme must be developed to cope up with the above said issues.

Current Limiter – The placement of Fault Current Limiters near PCC is to limit the fault current supplied by the utility grid to microgrid and vice versa. During normal operating condition the FCL is kept in minimum position to neglect unnecessary losses and in maximum position under faulty condition.

Centralized Protection – In centralized protection, Microgrid Management System is used to supervise the status of microgrid and to set rating of the respective protection equipment. Here the communication of protective devices is based on

standards IEC61850. Based on the status of the microgrid (grid connected or island) received through MMS, the protecting devices make comparison between the measured parameter and the operating curves set then provides trip signal.

Adaptive Protection – The introduction of DG units in the utility grid pose changes in fault current magnitude. Hence, the revision of power rating of protecting equipment should be done. Also the mode of operation of microgrid and other network changes must be updated periodically in adaptive protection. This can be effectively done with the help of Transmission Control Protocol/ Internet Protocol(TCP/IP)based Ethernet network.

Protection Based on Variables – The protection of microgrid is also possible with the help of various parameters like samples of current, voltage, angles, travelling wave, wavelet packet transform (WPT) - as well as some local variables such as rms current, rms voltage, voltage THD (Total Harmonic Distortion), current THD and symmetrical components of current and voltage.

Distance Protection - The impedance (Z_m) from the measured

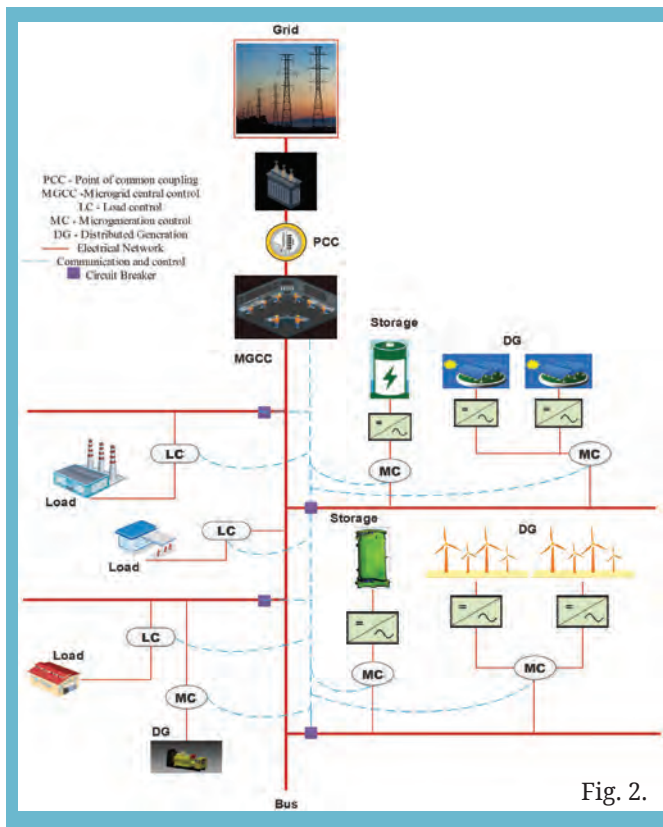


Fig. 2.

voltage (V_m) and current (I_m) at each relay point is used here. At normal condition the measured impedance is higher as it includes load impedance. During fault, the measured impedance is low as it is equal to the line impedance. By comparing the Z_m with the preset value the protection is getting activated.

Multi Agent Protection – Distribution of intelligent hardware and software agent in the network promise to achieve an efficient protection of microgrid. This protection scheme is inclusive of three layers such as equipment layer, substation layer and system layer. Through the agents, substation layer communicates with the equipment layer and transmit the information to the system layer and corresponding agents to make microgrid adaptive protection more efficient.

Change in Device Settings – The placement of DG units in main grid impose some impacts on traditional protection scheme hence there is a need to change the device settings to get desirable protection. In this way, the bidirectional power flow due to introduction of DG unit replaces the OC relay to directional OC relay by changing the protective settings.

Smart Transformers – In microgrid protection smart transformers play an important role. While going for wide area protection, synchronization of measured values can

be effectively done with smart transformers rather than the protection plan of using local measurement with Solid State Transformer (SST).

From the wide review made on several protection strategies represented for microgrid (Fig.1.), adaptive protection is the best one as it includes all the dynamic changes of DG and relay settings. As well, it works for all working conditions of microgrid. Since the implementation cost of the adaptive protection scheme is high with digital equipments, it should be compromised with the energy price for long planning.

Concluding Remarks

The key factor for the incorporation and enlargement of microgrid is to face the increase in energy demand and the limitations of the unsustainable energy resources. The introduction of microgrid in the utility grid makes the traditional protection schemes ineffective. In this context, the protection issues and the key factors for designing a proper protection schemes to overcome the protection issues with microgrid have been overviewed in this study. Hence, several protection scheme with various parameters are suggested for efficient protection. But, a substantial research is still required for the microgrid protection for the stability of the system and for the reliable power supply.

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SCENARIO OF ELECTRICAL ENGINEERING

DURING AND POST COVID-19

In electrical engineering sector, the cash flow at all levels is getting hampered, which is one of the major concerns for all stakeholders.

The development of various branches of Economy, right from industry to agriculture, depends greatly on the accessibility and usage of electricity. The pandemic, COVID-19 has not only affected the people's well-being and the country's economy but also has affected the electrical engineering sector. The generation, transmission and distribution of electricity are the vital jobs for the industrial sector and also for the groups of people reliant on the safe and reliable power supply. These groups include people in hospitals, people staying at home, people working from home, kids studying online, etc.

As people are staying at home, the usage of electricity by businesses and industries is declining while it is rising in residential and a few commercial areas. Reduction in load is to the tune of 10 to 20%. On account of this, the electric grid is experiencing variations in the load patterns. These variations are very well taken care of and an uninterrupted power supply is provided to all by the electric utility companies, which is

worth appreciating. However, there are a few more challenges ahead in the electrical engineering sector. Importantly, the cash flow at all levels is getting hampered, which is one of the major concerns for all stakeholders. Other concerns and challenges are listed below.

Reliable and Resilient Power Supply:

Due to the guidelines of the local authorities, almost all the offices and schools are closed. Thousands of professionals are working from home and students are attending classes online. Along with this, the health care systems are operating at their full capacity whether a city or a village, making the role of electrical infrastructure more critical. This has underlined the prominence of delivering reliable and resilient electric services to various parts of society. Preventive and pre-monsoon maintenance activities carried out by utilities during the lock-down period has been affected and hence will have a greater impact on supply reliability and voltage quality.

Supply Chain Issues: As most of the electrical allied industries are temporarily closed worldwide, there is a limited production of the electrical parts, components, equipment, and related materials. Consequently, there can be shortage of these, during an emergency. Shortage can also be due to the non-availability of the transport facilities within the cities, states and countries. This will further delay the completion of on-going projects and postpone the implementation of proposed projects of national interest.

Reduction in the Peak Demand: There has been a substantial reduction in power consumption of industrial,

commercial sectors due to lower demand, supply chain, and labour issues. Railway's power demand has reduced extensively. The decrease in load demand has effectively increased the renewable resource percentage share of some electric power plants. This has simultaneously, led to an increase in the curtailment of non-renewable generation. Industries with the reduced power demand and having captive solar photo-voltaic (PV) generation are facing challenges related to surplus generation during the production period and holidays. As they are not allowed to inject surplus generation into the grid, the part of the SPV system is required to be switched OFF. Under-capacity utilization of installed solar rooftop, installation is affecting the return on interest (ROI). If the situation of lock-down and lower demand get prolonged, future rooftop solar PV installations will be affected to a major extent. To overcome this situation it is necessary to accelerate battery charging installation infrastructure to promote electric vehicles (EVs). Further, the distribution companies are finding difficulties in recovering funds from consumers and facing acute fund crises.

kVAh Billing: In the state of Maharashtra, kVAh billing was introduced in April 2020 for adequate reactive power compensation and to avail maximum system benefits. Many industrial customers were using fixed and switched shunt capacitor schemes, as per the previous tariff to avail benefits of power factor incentives. During the lock-down, fix compensation resulted in higher leading RkVAh and higher kVAh bills. The contribution of RkVAh in total kVAh was in the range of 50

to 80% for many consumers. This resulted in higher energy monthly bills even though active power consumption was lower. During Unlock-1, industrial consumers will be required to focus on adequate reactive power compensation to minimize the difference between kVAh and kWh by the use of a hybrid reactive power compensation scheme. Sizing of hybrid reactive power compensation cost-effectively by the study of base-load reactive power and fluctuating reactive power is going to be obligatory. Step-less reactive power compensation sizing shall be done only to meet highly fluctuating requirements. While designing a new reactive power compensation scheme, a holistic approach is required at the design stage to avail maximum benefits of adequate reactive power compensation. This includes reduction in branch circuit losses, branch circuit loading that will help reduce maintenance requirement, breakdown and minimize RkVAh generation, so that kVAh closer to kWh can be achieved.

Low Power Consuming Devices: Revolutionary developments such as industrial internet of things (IIoT), data science, machine learning, and artificial intelligence will make more than 3500 crore devices operational by 2022. These include devices at our houses and offices, buildings and infrastructures, vehicles and even on human bodies to monitor health, our environment etc. The current devices and systems consume too much power and all these cannot be battery powered. Hence, there is a need to develop new types of devices and integration tools that consume very little power.

Need for Data-driven Systems:

Every instant data is generated by the IoT, from a variety of sources such as healthcare, genomics, advanced metering, economics and social networking. This data poses a challenge for storage and processing. This inspires the need of developing new data-driven applications that will require the creation of drastically new designs that simulate the functionality of human behaviour. All the mentioned equipment and developments are highly sensitive to voltage quality in terms of short and long term root-mean-square (RMS) voltage variation. For the satisfactory operation of the mentioned system, the required voltage quality is higher. In that case, more emphasis is desirable to improve voltage quality and impose current quality limits. There is an urgent need to work on National standards related to immunity and emission requirements, and voltage and current quality.

Global Challenge: Grand Engineering Challenges for 21st-century announced by the National Academy of Engineering (NAE) in the areas of healthcare, energy, environment and urbanization necessitate deeper partnerships with other fields that stretch the definition of electrical engineering and engage experts in these areas to develop realistic solutions for the pressing problems of the society.

Prototyping: Strengthening the culture of prototyping and model making is required to be encouraged to a large scale, in which students, researchers, and faculties comprehend and demonstrate their inventions from idea to market.

Power Quality: By 2050, it is predicted that almost all the sectors will be electrified. In doing this, stress will be given for good power quality as it is crucial for the efficiency of the equipment. As a result, it will be increasingly important to develop technologies to improve power quality. As electricity plays an increasingly important role across sectors, the impact of failure becomes even more significant. Breakdowns are very costly for industrial and domestic consumers and they are targeting to achieve zero breakdowns. Power quality and grounding are the main cause of the failure/malfunction of pieces of equipment. All new technological developments in the next decade demand highly reliable and quality power. There is a need to work on a national level voltage quality standard which will address short duration and long duration voltage quality aspects. As said earlier, equipment level immunity, emission, and energy efficiency standards, and their enforcement will help meet changing electrical environment requirements of sensitive equipment. Power quality contracts to meet specific power quality requirements of specific customers will be need of an hour. More research and development is required to develop highly cost-effective power quality conditioners to address power quality problems faced by customers using highly sensitive equipment. The holistic approach will help address the mentioned issues in an economical and eco-friendly manner.

Central Level Energy Storage: Rate of the addition of installed capacity of the solar PV system in India will result in surplus generation during some parts of the day.

The addition of more renewable generation capacity, if not matched with vehicle battery charging station and use of the electric vehicle, may result in surplus generation during some part of the day. Even during COVID-19, many industries having captive solar plants are required to switch off their PV generation during the production period due to lower demand, and major SPV generation is switched OFF during holidays. To establish a balance of production and generation it is required to emphasize the development and use of small, medium and grid-level energy storage devices. This will help keep the pace of the addition of more renewable energy sources to the grid.

Despite multiple challenges posed by COVID-19, it is required to explore new avenues and opportunities to address mentioned issues to rise and take the economy to a healthy state. 



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MOVING TOWARDS

BETTER INDIAN ELECTRICITY GRID DISCIPLINE - PART 1

The Indian power sector has gone through many innovative reforms for improving the grid discipline. The implementation of the Availability Based Tariff (ABT) was the most economical approach to stabilize the varying grid frequency. This article is to appraise the major changes in the permissible operable frequency range by certain amendments in Indian Electricity Grid Code (IEGC) and it encompasses all the changes in the ABT. This article seeks to investigate the efficiency of the implementation of the availability based tariff by reviewing the frequency profile of the grid. The article also highlights one scenario where Indian power system exhibited excellent discipline when suddenly load fell by 31 GW in just 4-5 minute on 5th April, 2020.

Maintaining the discipline of electric grid is essential for its secure, economic and stable operation. During the last decade in India, there is a noticeable surge in the installed capacity and it has grown to 369427.97 MW as on 29-02-2020. The increased capacity of grid further sets challenges of varying frequency, stability, mismatch in demand & supply, etc. The grid frequency of a power system network changes continuously and it can be controlled by minimizing the mismatch in demand and supply. When generation is more than the demand, the frequency of the grid rises while if the generation is less than the demand, the frequency falls. By either changing the demand or by changing generation the frequency of grid can be maintained at the constant level. The prior problem of the Indian



power system was not only shortage of power; there was very big difficulty in grid operation caused by indiscipline in the prevailing system. As a solution to this problem, the Central Electricity Regulatory Commission issued a detailed order on 4th January, 2000 and for the first time introduced the term ‘Availability Based Tariff (ABT)’ into the Indian power sector. In the context of the Indian power sector, the literal concept that the term ‘Availability Based Tariff’ had introduced is Unscheduled Interchange (UI) i.e, the amount of deviation from the scheduled value. The introduction of the Electricity Act, 2003 brought many changes to power sector like open access in transmission, increased generation capacity, Independent Power Producer (IPP) etc. Our Indian Power System operates synchronously with five regional electricity regions named Eastern, Western, Southern, Northern, and North-Eastern regional load dispatch centres. Despite the commission’s detailed order dated 04.01.2000 many review petitions were received that caused the delay in the implementation of ABT in all the regions. Table 1 shows the date of implementation of ABT in respective regions, though there were some delays upon its implementation but it showed excellent improvement in grid discipline.

In this article, ABT’s implementation has been analyzed by analytical research upon various data sources published by CERC, NLDC, and regional load dispatch centres. This will also identify any

Table 1. Date-Wise Implementations of ABT in all regions.

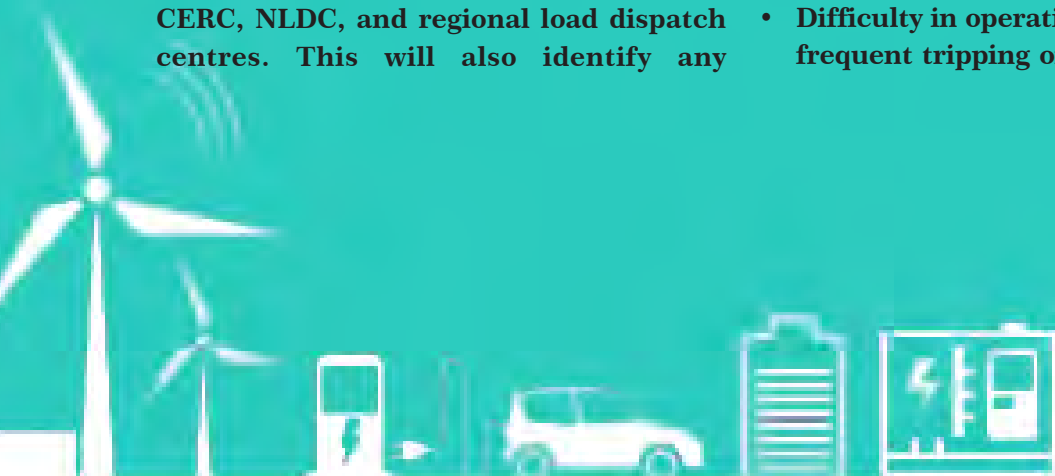
Region	Date of Implementation (w.e.f.)
Western	1st July, 2002
Northern	1st December, 2002
Southern	1st January, 2003
Eastern	1st April, 2003
North-Eastern	1st November, 2003

foreboding regulation in order to kill the functionality of ABT from the tariff structure and all the major changes in permissible frequency range and rates are plotted. A section in this article describes an event when all the lights were switched off at 9:00 p.m. on 5th April, 2020 for 9 mins as a tribute to all the COVID-19 warriors. This study is organized as follows; Section II is the case study of Availability Based Tariff. Section III discusses various ABT related changes. Section IV discusses an example of discipline in the Indian power system.

Availability Based Tariff

Intending to analyze the need of ABT, the past problems associated with grid are discussed as:

- Low frequency at peak load periods, with frequency falling to 48.0- 48.5 Hz for several hours per day.
- Grid frequency shows irrelevant rise during off peak hours and needless burning of fuel.
- Difficulty in operation of generators i.e, frequent tripping of generators.



The most commendable aspect of ABT is its approach of splitting the tariff calculation into three parts – (i) Capacity charge, linked to MWs capability of generating station (ii) Energy charge, variable costs like fuel cost etc. (iii) UI charges, cost for deviation from the schedule (can be incentive/disincentive)

Capacity Charge: The beneficiary has to bear this capacity charge in proportion to their scheduled allocation irrespective of their actual drawl. Also known by the term, ‘Fixed charge’ is related to the generating station’s availability and ‘Availability’ means the readiness of the generating station to deliver ex-bus output.

Energy Charge: This charge is calculated by the scheduled ex-bus energy per kWh rate that is supposed to be delivered by generating station. It should be noted explicitly that the energy charge (at the specified plant-specific rate) is not based on actual generation and plant production, but on scheduled generation. For an instance, a generating station injects 800MW power into the grid while it was scheduled to deliver 600MW then the generating station would be paid only for the pre-committed scheduled amount i.e, for 600MW and the tariff for the mismatch would be dealt according to the UI rates of the prevailing time.

Unscheduled Interchange: For synchronized operation of the Indian power system, the operators are supposed to maintain the frequency of Indian power grid at its nominal value of 50Hz. The mismatched amount in generation and demand is either incentivized or disincentivized by using UI charges. In this tariff scheme, the generating station is entitled to receive the incentive payment according to the frequency

Table 2. Proposed UI rates in the ABT-Order of the year 2000.

Average Frequency	UI Rate (paise per kWh)
50.5 Hz and above	0
Below 50.50 Hz and up to 50.48 Hz	4.8
Below 49.4 Hz and 49.02 Hz	355.2
Below 49.02 Hz	360.0
Between 50.5 Hz and 49.02 Hz	linear in 0.02 Hz step

Table 3. UI rates for the year 2002-03 to 2005-06 [8].

Average Frequency of time block (in Hz)		UI Rate (paise per kWh)	Rate of change
Above	Below		Rise in 6 paise per kWh for each 0.02 Hz step fall in frequency.
50.5	-----	0	
50.48	50.50	6	
50.46	50.48	12	
-----		---ctd.	
49.80	49.82	210	Rise is 9 per kWh paise for each 0.02 Hz step fall in frequency.
49.78	49.80	219	
49.76	49.78	228	
----		---ctd.	
49.0	49.02	570	
---	49.0	570 (Ceiling Rate)	

driven rate for the surplus amount of generation when the actual supplied energy is more than that of pre-committed scheduled value. Similarly, the stations are imposed with monetary fine if the actual supplied power is less than that of scheduled value. For calculation of UI charge, the energy is metered in 15 mins time block and this accounted energy value is then compared with the scheduled value for that 15 min block. After this, the corresponding UI rate is determined by using the average frequency of the grid during the same 15 min interval.

Availability Based Tariff: A Timeline Review

In year 2000, after accounting all the encountered problems in the grid the commission issued a detailed order for the compliance of ABT based tariff mechanism in the Indian power sector. Due to some misapprehending, soon after its order, the commission received many review petitions for this order but commission retorted every relevant petitioner who were stakeholders, generation companies etc. Table 2 shows the proposed UI rate to the corresponding average frequency and these rates are subject to change through a separate notification from time to time.

ABT in 2002-03 to 2005-06

Finally in the annual report of 2002-03 of CERC, the commission obsoleted the old tariff structure and the new tariff structure was regulated. After its successful implementation in all the regions, the ABT showed a remarkable improvement in the grid discipline and

Table 4. UI rates for the year 2006-07.

Average Frequency of time block (in Hz)		UI Rate (paise per kWh)	Rate of change
Above	Below		
50.5	-----	0	Rise in 6 paise per kWh for each 0.02 Hz step fall in frequency.
50.48	50.50	6	
50.46	50.48	12	
-----		---ctd.	
49.80	49.82	210	The rise is 9 paise per kWh for each 0.02 Hz step fall in frequency.
49.78	49.80	219	
49.76	49.78	228	
----		---ctd.	
49.50	49.52	345	The rise is 16 paise per kWh for each 0.02 Hz step fall in frequency.
49.48	49.50	361	
49.46	49.48	377	
---	---	---ctd.	
49.0	49.02	745	
	49.0	745(Ceiling Rate)	

frequency profile. The implemented UI rates are discussed below:

For UI rate of 49.80 Hz to 49.82 Hz:

$$\text{Total number of steps} = (50.50 - 49.80) / 0.02 = 35 \text{ steps of } 0.02 \text{ Hz each} \quad (1)$$

Now, the rate for this range is 6 paise/kWh rise for each 0.02 Hz step fall then,

$$\text{UI rate} = 35 \times 6 = 210 \text{ paise} \quad (2)$$

Table 5. UI rates for the year 2007-08.

Average Frequency of time block (in Hz)		UI Rate (paise per kWh)	Rate of change
Above	Below		
50.5	-----	0	Rise in 8 paise per kWh for each 0.02 Hz step fall in frequency.
50.48	50.50	8	
50.46	50.48	16	
-----		---ctd.	
49.80	49.82	280	The rise is 18 paise per kWh for each 0.02 Hz step fall in frequency.
49.78	49.80	298	
49.76	49.78	316	
----		---ctd.	
49.0	49.02	1000	
	49.0	1000(Ceiling Rate)	

For UI rate of 49.0 Hz to 49.02 Hz i.e. Ceiling rate:

$$\text{Total number of steps} = (49.80 - 49.0) / 0.02 = 40 \text{ steps of } 0.02 \text{ Hz each} \quad (3)$$

Now, the rate for this range is 9 paise/kWh rise for each 0.02 Hz step fall then,

$$\text{For Ceiling rate} = (40 \times 9) + 210 = 570 \text{ paise} \quad (4)$$

While these UI rates were performing well, the commission kept on receiving petitions/suggestions to maintain the ceiling rate above the cost of diesel based generation.

ABT in 2006-07

In response to these suggestions, the CERC further amended the UI price vector in 2006-07 and increased the ceiling rate from 570 paise/kWh to 735 paise/kWh. The following table shows the new UI price vector to its corresponding average frequency w.e.f. the year 2006-07.

Table 4 shows the UI rate variance, corresponding to the average grid frequency. The implementation of ABT was continuously improving the frequency regime, meanwhile the commission again started receiving the petitions to reconsider the UI rates.

ABT in 2007-08

Finally, in the 2007-08, the commission further proclaimed it by enhancing the UI ceiling rate from 745 paise/kWh to Rs 10 per kWh in its annual report. The new UI rates are given in Table 5. 

This article will be continued in the next issue as Part 2



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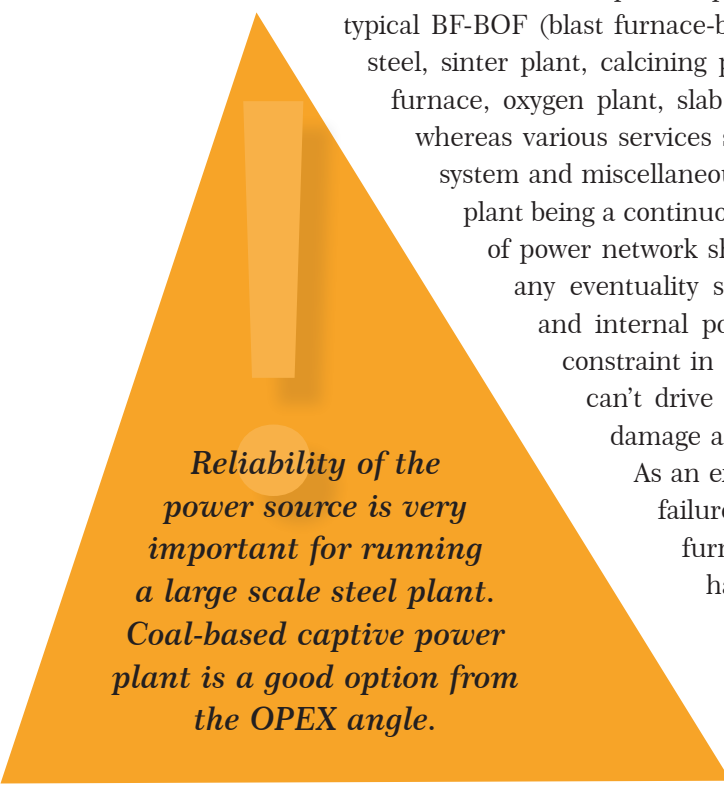


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Vice-Chancellor, Madan Mohan Malviya University of Technology, Gorakhpur



CRITICALITY OF POWER DISTRIBUTION SYSTEM IN A STEEL PLANT



Power distribution system in a steel plant is different from any other industrial plants due to the nature of load and its magnitude. An integrated steel plant of large scale consists of various process plants, non process plants, services and utilities. For a typical BF-BOF (blast furnace-basic oxygen furnace) route manufacturing process of steel, sinter plant, calcining plant, coke oven, blast furnace blowers, basic oxygen furnace, oxygen plant, slab casters, rolling mills constitute major process loads, whereas various services such as raw material handling, water, compressed air system and miscellaneous auxiliary system constitute non process loads. Steel plant being a continuous process plant with high capital expenditure, design of power network should be realised from criticality point of view so that any eventuality such as grid power failure, power equipment failure and internal power system disturbances due to poor power quality, constraint in the selection and sizing of equipment and accessories can't drive the processes into jeopardy resulting in huge capital damage associated with financial loss due to loss of production.

As an example, interruption of power supply to BF blowers or failure of BF blowers may cause capital damage to the blast furnace putting the steel plant operation into complete halt. Recovery time also is quite high as manufacturing and refractory work of capital equipment demand long delivery time. Hence if electrical power driven blowers are envisaged, 3 x 50% configuration is more beneficial from reliability point of view.

Critical aspects of reliability and flexibility

Reliability of the power source is very important for running a large scale steel plant. Coal-based captive power plant is a good option from the OPEX angle.



of power distribution network along with power sourcing necessitate formation of robust power system that will enhance safety of capital equipment. From the feasibility of CAPEX, optimisation of power network needs to be looked into as well. In a large scale integrated steel plant generally the philosophy of construction is phase wise in which plant loads come up in multiple phases along with power generation to ease out cash burden. Scaling of plant power distribution system capacity is also applicable to match with the enhancement of plant capacity along with all other services and utilities. Along with the load growth power source capacity and reliability should be enhanced. Options are available to select the power sources from utility grid, co-generation plant and diesel generator plant. To provide

stability and reliability of the in-plant power system, power sources should be reliable along with the power distribution system. Sourcing of power should be looked into critically and possibility of sourcing from multiple sources should be explored. Power sourcing from utility grid is mandatory as high fluctuating loads particularly in the rolling mill area can be absorbed by grid without causing voltage fluctuation at rolling mill bus and other plant load buses beyond permissible limit. The irritation level of flicker and voltage variations at upstream high voltage buses as well as at the point of common coupling also remain well within permissible limit. In plant power generation is another reliable source of power which can be utilised for production of steel. In a large scale integrated steel plant there is availability of by product gases

from blast furnace, coke oven and LD plant. Although calorific value of by product gases is low, but these gases can be utilised to generate electrical power and process steam which can be used by different process plants such as reheating furnace in mill. Co-generation plant run by by-product gas and waste gas form captive power plant which provide reliable power source at cheaper rate than grid power. Steam and power generation from available by product gases from steel plant is routed through proven and established HRSG (heat recovery steam generator) and STG (steam turbine generator) route instead of gas turbine route. The reasons are – (1) low calorific value of by product gas will result in higher power consumption in the fuel gas compressor, (2) the available by product gas is not clean which

requires elaborate gas cleaning plant, (3) available gas is fluctuating in nature, and (4) adequacy of steam generation to meet the demand of steel plant process steam is uncertain. From the availability of waste gas power can be generated through top recovery turbine (TRT) and coke dry quenching (CDQ) plant. Capacity of power and steam generation depends on the volume of gases produced in the steel production process. When steel plant is in operation with full capacity power import from grid will be low due to full power generation by captive power plants with higher amount of gas availability. Dependency on grid power import can be reduced with installation of coal based power plant with added advantage of reliability, accessibility for control of power generation and availability of start-up power in case of major grid failure. Coal based captive power plant is better option than centralised diesel generator power plant from OPEX point of view. The consideration as stated above needs study and in-depth techno-commercial analysis of different alternative configurations of power system with different connectivity of

power sources in each alternative. This analysis will be the stepping stone for selection of most feasible alternative of power network in terms of reliability, flexibility and cost optimisation.

Power System Configuration

The criteria for selection of power distribution configuration is based on reliability, adequacy of redundancy, optimum loading of equipment, system fault current, optimum utilization of layout, reliable and instantaneous islanding operation of captive power plant generators from grid in case of grid disturbances, provision for expansion of power system for allowing future capacity enhancement and cost optimisation. System voltage variation should not cause the tripping of critical motors or/and drives, or of generators due to the operation of under voltage and over voltage relays. Similarly frequency variation should not trip the generator due to the operation of under frequency and over frequency protections. While sourcing grid power, quality of power is also to be explored with respect to frequency and duration of grid interruptions,

current and voltage harmonics among other things. Power network should be configured considering 2x100% redundancy such that outage of one transformer or feeder does not cause power interruption and jeopardise the operation of process plant connected to the distribution network. Steel plant is a continuous process plant where loads are categorised as critical, non critical and emergency based on the criticality of power supply. Quantum of critical and non critical loads has to be assessed after discussion with process and operation group. For a typical BF-BOF route of steel making process, critical loads are comprised of electrical power driven BF blowers along with its auxiliaries, part load of BF process, coke plant, oxygen plant, steel melt shop, services and utilities. Under any contingency condition continuity of power supply has to be maintained for critical loads. With reduction in cost gas insulated switchgears (GIS) are better option than air insulated switchgears (AIS) as it can save 60-70% of foot print space with added advantage of higher reliability, safety, least maintenance

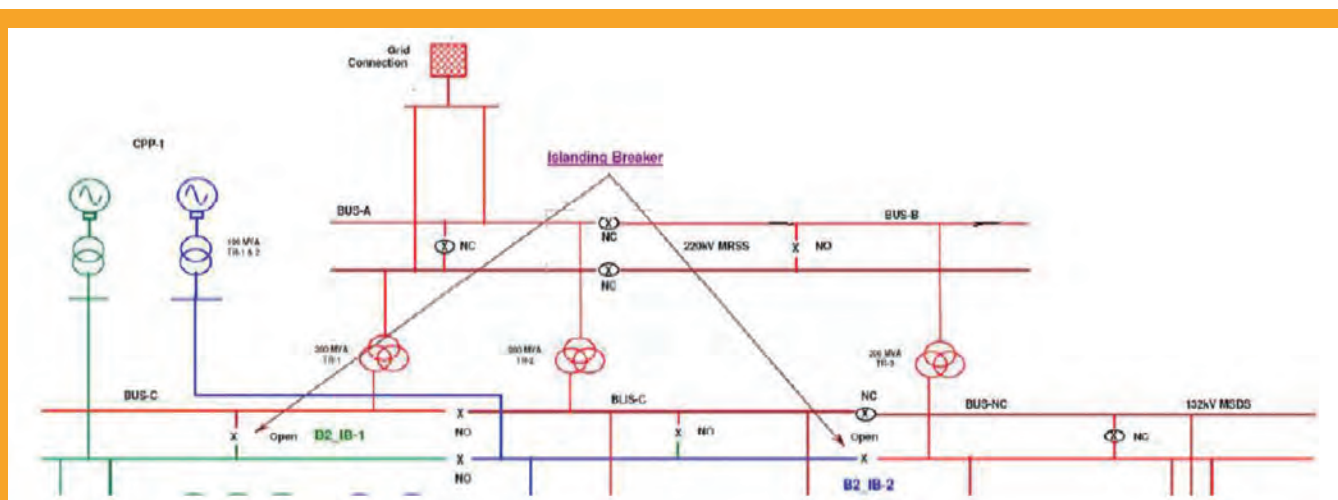


Figure-1: Part power network showing connectivity of utility grid and CPP generators

and interference caused by external factors such as environmental pollution. GIS can be used at different voltage level up to 33 kV with double bus bar configuration and bus sectionalizers. The primary power distribution system should be arranged such that critical and non critical loads can be operated in different islands with captive power generation and utility grid supply. In other words, power supply to critical loads are made from a bus section where grid and captive power generation are connected. Furthermore, utility grid and captive power generation sources are connected at different voltage level to ensure less voltage variation in case of any grid disturbances. A typical part power distribution scheme showing the connectivity of utility grid and CPP (captive power plant) generators is shown in Figure-1. From the figure it is observed that grid power and captive power are connected at 220 kV and 132 kV bus respectively. Under normal operation of power system grid and captive power generators will be running in parallel at 132 kV bus with bus coupler breaker (B2_IB-1) and bus section breaker (B2_IB-2) closed condition. Captive power generation is operated to match the demand of steel plant loads such that import from grid is minimised. In case of grid disturbance, grid system is isolated from the plant power system with tripping of both the breakers (B2_IB-1 and B2_IB-2) so that total power failure to the plant loads particularly critical loads can be avoided with availability of generation from captive power plant.

It is desirable to deploy automatic load shedding system for a critical

process plant. The operation of the islanding scheme triggers the dynamic load shedding scheme whose operation will restore balance between availability of power and load demand within frequency stability limit of the in-plant generators. When one or more in-plant generation facilities are shut down and power demand is expected to exceed power generation, load management system (LMS) is activated to initiate dynamic load shedding of non-critical loads to ensure balancing of power demand and supply of in-plant generation. In the event of failure of the dynamic load shedding scheme, the under frequency-based back-up scheme (with time delay) comes into play and sheds sufficient load to arrest the fall in frequency to sustainable level. Emergency power generators are installed at certain manufacturing processes to ensure protection of equipment and emergency evacuation under total power failure condition. Priority loads are identified according to the nature of the criticality to ensure that LMS carries out load shedding with least priority loads in stages to maintain balance between power supply and demand. Entire load shedding process has to be completed within certain time as obtained from power system analysis to ensure that captive power plant generators do not cross stability limit.

Conclusion

After various alternative studies based on the criteria as discussed in previous sections the selected power distribution scheme has to undergo power system analysis comprising of load flow, short circuit, motor starting, transient stability, islanding & load shedding, insulation coordination

and flicker studies to revalidate the scheme, finalise equipment rating, critical fault clearing time, time to shed non critical loads within stability limit and flicker limit. Critical and non critical loads and its magnitude have to be assessed correctly and taken into account while developing power distribution scheme. Sourcing of power from multiple sources including captive power generation, connectivity with the power network, islanded operation of the power system to ensure continuity of power supply under any contingency are significant requirement to bring reliability in the power distribution system for integrated steel plant. Deployment of LMS also is a prime requirement to match between power supply and demand in case of outage of grid and planned shutdown or outage of 1 or 2 generating units of captive power plant. As the extent of damage of capital equipment, cost, loss of revenue and recovery time of a steel plant is quite high, extreme care has to be taken while finalising power distribution system such that in the event of failure of grid power supply and plant equipment, operation of steel plant can continue or safe shutdown can take place depending on the availability of power and plant equipment. Reliability, redundancy and cost optimisation shall be blended and balanced during the planning of power distribution system for a large scale integrated steel plant project. 



- This article has been authored by

Anupam Roy

Discipline Head- Electrical,
Tata Consulting Engineers
Limited

“ERDA TO SET UP A CENTRE OF EXCELLENCE...”



Background Photo
by Alexandru Boicu
on Unsplash

Electrical Research and Development Association (ERDA) is a not-for-profit professional Organisation. The organisation's services are provided under three business verticals namely “Testing & Evaluation”, “Field Services” and “R&D and Expert Services”. In an exclusive e-interview with **Electrical India (EI)**, **Hitesh Karandikar, Director, ERDA**, replies the questions sent by P. K. Chatterjee, Editor, EI. Excerpts...

What do you feel about the journey of the Indian power sector?

It is indeed a remarkable journey for India from being a “Power deficit” country to emerging as a “Power surplus” country. The peak demand deficit was about 12,159 MW (9.0%) and the average energy shortage in the country was about

87 Billion kWh (8.7%) during the 1st year of 12th plan i.e. 2012-13. Presently for all practical purposes, we meet our peak power demand of 133 GW easily.

The growth of Renewable energy installed capacity is also astounding. The installed capacity as on 31st March 2016 from renewable energy sources was 42,849 MW, whereas the same as on 30th April 2020 is 87,268 MW.

Difficulty in the acquisition of land for construction of a substation and obtaining Right of Way for laying transmission lines are changing the transmission sector drastically. In the transmission sector, 765kV AC Transmission lines and +/- 800KV HVDC lines are new normal now instead of 400kV Transmission lines as during the beginning of the 12th Plan. GIS substations, even up to 765kV, are coming up in equal proportion to the AIS substations nowadays. ACSR & AAAC conductors are being replaced by HTLS conductors. Polymer insulators have replaced traditional porcelain insulators. One Nation One Grid has been successfully implemented.

In the distribution sector, 100% of villages are powered with electricity with a focus on improving the metering efficiency through smart meters. Even the power generation and distribution of the remote and isolated localities have been solved through Decentralized Distributed Generation and Smart Grid. However, the financial health of public utilities is still a cause of concern due to varied reasons.

How is ERDA transforming itself to cater to the emerging needs of the Indian electrical industry?

ERDA has always maintained pace with the changing electrical industrial scenario. ERDA is the first Indian laboratory to get BIS accreditation for Smart Meter testing as per IS 16444: 2015 way back in April 2016. We have also got accreditation for DLMS COSEM communication protocol testing facility for smart meters. Today, we test more than 50% of India's Smart Meters.

Similarly, we have set up a communication protocol testing facility as per IEC 61850 for communicable IEDs. This facility has become helpful for indigenous manufacturers of communicable protection relays in India.

We have also set up India's first High Temperature Low Sag (HTLS) conductor testing facilities, for which Indian manufacturers earlier travelled to foreign countries. This facility will give a great fillip to Indian manufacturers and utilities for HTLS conductor. In our state of the art High Voltage Partial Discharge laboratory, we have started testing GIS and HV Cables up to 245 kV. In our 10 meters semi-anechoic chamber EMI / EMC testing is done as per commercial and MIL standards so that local manufacturers can develop global standard products and export them to the

global market or use them for our indigenous defence manufacturing sector.

When quality control order on Distribution Transformer as per IS:1180 was promulgated, we were inundated with a deluge of distribution transformer type test requirement. ERDA stood up to this challenge and increased its testing capacity by manifolds. Today we are happy to inform you that ERDA conducts more than 75% of Distribution Transformer type tests of India.

How is ERDA serving the LED and their control gear manufacturers?

ERDA is having state of the art type 'C' Goniophotometry & Sphere photometry facilities in its photometry testing laboratory for testing of all types of LED lamps and luminaries along with facilities of LED control gear, EMI/ EMC & IP testing laboratory under one roof at Vadodara. These facilities are accredited by NABL (Govt. of India).

ERDA conducts Certification testing for BIS Compulsory Registration Scheme (CRS) scheme notified by Ministry of Electronics and Information Technology (MeitY). Certification testing for white LED (W-LED) based solar lighting system as per MNRE Specifications approved by MNRE (Govt. of India.) is also conducted at ERDA. Moreover, ERDA is empanelled with EESL & BEE for energy-efficient LED lighting testing as per EESL & BEE test protocol.

ERDA supports LED lamp and luminaries manufacturers, including small scale sector manufacturers, by providing Developmental / Verification tests before submission of the product for a final type test, to verify the important design parameters.

What is ERDA's contribution to support motor development and diagnostic?

ERDA offers expert services related to Motor Diagnostic and Motor development/upgradation of design to meet the energy efficiency challenges.

During our expert services on Motor through integrated Condition Monitoring, we conduct MCSA, Vibration Analysis and Acoustic Emission Analysis. We have found out that the majority of issues at the site were related to the Misalignment of the rotor shaft with the load shaft. These issues were diagnosed with our integrated condition monitoring expert services and due to this early detection, the consequential damage to motor bearings and downtime was reduced. These

services are regularly offered to power plants, process plants and cement industries.

ERDA also offers expert services for the design upgradation to meet the energy efficiency challenges and new application challenges like Textiles and e-vehicles. ERDA has offered various designs to small scale industries in Ahmedabad and Surat region to meet these specific application challenges including the energy efficiency. ERDA has offered their expert services to various small scale industries to develop their own motors for e-vehicle applications. ERDA has also developed high-efficiency IE3 & IE4 Induction Motors and these technologies are available for commercialization.

Is ERDA taking any initiative to address onsite condition monitoring needs of transformers?

ERDA through its Research & Development vertical continuously develops new technologies as per the emerging need of the electrical industry. ERDA has thus developed a new technology of "Online Fault Sensor for Distribution Transformers". A sensor for the transformer has been designed that senses hydrogen gas emitted as a result of fault inside the transformer. This sensor is to be installed in addition to Buchholz relay. It has two components 1) Sensor Head and 2) Display cum Control Unit. It operates on the principle that during a fault when evolved hydrogen gas reaches sensing element positioned in the sensor head, it gets detected and an equivalent electrical signal is produced, which is transferred to control unit for further action depending on the severity of the fault. This patented economically suitable technology is available for commercialization.

Is ERDA organising any training programme?

ERDA conducts workshops on various evaluation and other technical topics with both theoretical and practical sessions from time immemorial. These workshops are widely popular among manufacturers, utilities, industries and laboratory personnel. This year due to COVID-19 pandemic, there is a restriction of movement among our customers. Hence, ERDA conducted various online webinars and workshops, even during the initial lockdown periods, for the benefit of our customers. We have received tremendous response and participation for these webinars and workshops. This positive response has encouraged us to plan more webinars and workshops than last year. The latest calendar of these workshops is available on our website www.erda.org.

How is ERDA offering its service to the regional countries?

ERDA is well known and widely accepted for its authentic test reports in the SAARC countries, Middle East, Far East and African countries. Even the world's best-known certification agencies e.g., Intertek (ASTA), UL, KEMA, CSA, TUV etc., have accredited ERDA as their evaluation partner. Middle East countries like Dubai, Sharjah, Abu Dhabi, Oman and Far East countries like Malaysia accept ERDA's test reports. Among our neighbours, Nepal, Bhutan and Sri Lanka accept ERDA Test reports. Moreover, ERDA engineers regularly visit Middle East countries to conduct onsite testing and calibration jobs. ERDA is thriving to expand its horizon to other countries across the world.

What are the future plans of ERDA in brief?

In the field of testing and evaluation, ERDA has set-up a state-of-the-art High Temperature Low Sag (HTLS) conductor testing facility at Vadodara. Presently India is having no HTLS conductor testing facility and manufacturers have to travel abroad for testing of such conductors. This facility is expected to be operational by August 2020.

ERDA is also setting up complete type testing facility of Solar PV Panels as per IS 14286 and IS / IEC 61730 at Vadodara. This project is expected to be completed by December 2020.

ERDA will be upgrading its existing 600kV Partial Discharge Test Facility to 900kV and has planned to set up a Climatic Test facility for Dry Type Transformer, Fully Automatic Transformer Test System. ERDA is also planning to upgrade its Conducted immunity and Radiated immunity test facility under EMI/EMC Testing facility. ERDA is also acquiring Portable Accurate Transformer Loss measuring system for onsite testing of Power Transformers.

However, the dream project of ERDA is to set up Centre of Excellence for Medium Voltage Short Circuit Laboratory for testing of Medium Voltage Switchgear equipment and Power Transformers up to 50 MVA, 132kV. ERDA believes it to be a project of national importance. This project is having an outlay of around Rs. 600 Cr. Financial closure of this project is awaited from the Government of India and Government of Gujarat.





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- The article is authored by Dr L Ashok Kumar, Professor, Department of Electrical & Electronics Engineering, PSG College of Technology, Coimbatore. The article is a continuation of the Part 2 carried in the Electrical India July 2020 issue.

Part 3: A Review Of Battery Charger Topologies and Infrastructure

For Plug-In Electric and Hybrid Vehicles



Image by (Joenomias) Menno de Jong from Pixabay

Inductive Charging

An inductive charger transfers power magnetically. This type of charger has been explored for Levels 1 and 2 devices. A recommended practice for EV inductive charging was published by the SAE in 1995. The clear advantage of contactless charging is its convenience for the user. Instead of deep-cycling the battery, the vehicle battery can be topped off frequently while parked at home or at work, when shopping and even at traffic lights. Cables and cords are eliminated. Advantages include convenience and galvanic isolation. It is also possible to build charging strips into highways which enables charging while driving. Therefore, inductive charging

could strongly reduce the need for a fast-charging infrastructure. Disadvantages include relatively low efficiency and power density, manufacturing complexity, size, and cost. Given that energy savings is an important motivator for EVs, the extra power loss is an important consideration. Basic principles of inductive power transfer (IPT) are similar to transformers, although most versions have poor magnetic coupling and high leakage flux. The secondary side may be stationary, or moving (roadbed charging). Typical stationary and roadbed IPT charging systems are represented in Figs. 16 and 17.

- **Stationary Inductive Charging:** Stationary inductive charging employs primary and secondary

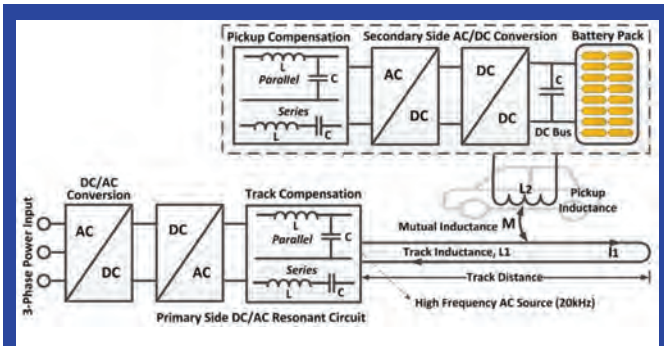


Fig.17. Inductively coupling road bed EV battery charging system.

transducers. In the version originally developed for the EV1 (see Fig. 16 in previous issue of EI) the primary transducer is a paddle and the secondary transducer is a vehicle charge port. When the paddle is inserted into the charge port, a magnetic circuit forms and power is transferred through a high-frequency link converter. Power transfer levels of typical systems vary from 0.5 W to 50 kW with air gaps of 1–150 mm. One of the first commercially available inductive couplers was developed by Delco Electronics and applied to the General Motor EV1 system. The main advantage of that approach was the fact that a higher number of turns could be used to maximize the magnetizing inductance of the transformer and hence minimize requirements on the medium power converter to supply magnetizing current. Stationary inductive charging methods have better coupling, tuning, lateral alignment, and higher efficiency than contactless moving-roadbed EV charging methods. Single-stage high-power-factor converter can be used for inductive Level 1 charging. An alternative is to use a two-stage power converter that can be any one of a number of different types of resonant and PWM converters. Due to high peak currents, two-stage approaches dominate for inductive Level 2 charging. Other topologies with a high-frequency resonant current link have been used for both the power transmitter and receiver to compensate coils and support efficient power transmission. To meet distortion standards, an active front end is likely for Levels 2 and 3 inductive charging.

- **Contactless Roadbed EV Charging:** Inductive charging systems have been considered for roadway contactless power transfer. The vehicle can be moving or stationary. Contact- less moving-roadbed

EV charging can be used for battery weight and size reduction. Constraints on vehicle energy storage can be relaxed with roadbed charging systems since a portion of the operational power is delivered from the roadbed and, this type of system transfers power from a stationary primary source (track or loop) embedded below the pavement surface to one or more secondary loops (pickup) installed in a moving vehicle as shown in Fig. 17. The powering EVs while in motion to address the inherent compromise that on-board energy storage imposes on EV range and availability. High power can be transferred with perfect alignment and tuning. There have been several proposed methods for increasing the tolerance of IPT to lateral movement or other position errors, as well as to the inherent large air -gap. Configurations that include a long wire loop, sectional loops, and spaced loops have been presented in the literature. The spaced-loop geometry improves the coupling coefficient and overall system efficiency, while minimizing the magnetization current, supply voltage ratings, and stray fields. Challenges of roadbed charging include high power ratings, poor coupling high supply-voltage requirements, loop losses, high magnetization current due to loose coupling, lateral misalignment, the large air gap, and stray field coupling.

By using slim primary ferrite core bars, efficiency can be improved, but cost must be taken into consideration when magnetic components are built into the primary track. A sectional track IPT system for moving vehicles is proposed and studied for increasing power efficiency. Much higher efficiencies have been reported for inductive chargers in stationary applications and it is described a design process to select the parameters of a coreless inductively coupled power transfer (ICPT) device with

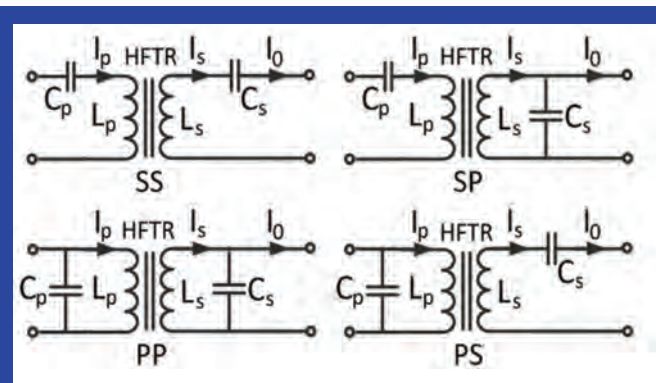


Fig. 18. Basic compensation topologies (SS, SP, PS, PP).

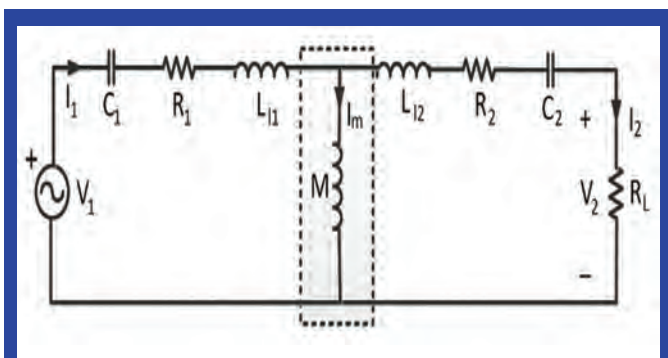


Fig. 19. Circuit model of transformer with SS compensation.

a large air gap that delivers high power efficiently. A polarized coupler called a double-D-quadrature (DDQ) is introduced and optimized for EVs. The DDQ produces a flux-path height twice that of a circular pad along a single-sided flux path. It has the potential to support cost-effective ICPT designs.

A novel approach implemented for contactless power interface, which is based on IPT technology and suitable for bidirectional power transfer between a common DC bus and multiple electric or hybrid vehicles. The proposed bi-directional contactless power-transfer concept is viable and can be used in applications such as V2G systems to charge and discharge electric or hybrid vehicles to the power grid.

- **Resonant and Compensation Circuit Topologies:**

Resonant circuits are normally employed in inductive charging networks to maximize power transfer capability while minimizing power-supply voltage and current ratings. To deliver the required power

with small devices, it is necessary to operate at high frequency. To supply the necessary real power efficiently, series or parallel reactive compensation is required for both the primary and secondary sides of an inductive charger as shown in Fig. 18. Conventional compensation circuit topologies are not suitable for application to EVs because of the high power level, long air gap, and need for low sensitivity to misalignment.

- For inductive charging, among the most critical parameters are the frequency range, the low magnetizing inductance, the high leakage inductance, and any capacitance needed to set up resonance and support reactive power requirement. The series-series (SS) high-frequency resonant topology has been established as a good solution because its resonant circuit can be designed independently of the coupling.

An electric circuit model of the SS system is shown in Fig. 19. Both primary and secondary windings are series-compensated to keep the efficiency high. Parallel-parallel (PP) topologies for both the transmitter and receiver have higher impedance and can be driven more easily than SS topologies. A novel receiver circuit topology for a cordless EV charger is developed for Parallel-parallel (PP) topologies. Compared to a PP circuit, the parallel-parallel-series (PPS) circuit improves the power factor. A PPS circuit allows a larger gap between the transmitter and receiver coils and the objective of a design of the primary resonant circuit that mitigates effects of phase or frequency shifts.

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NEW RENEWABLE SOURCE DEVELOPMENTS - PART 2

Solid-Oxide fuel cells (SOFC)

According to developers, solid oxide fuel cell technology would be among the most in demand. Researchers at Harvard School of Engineering and Applied Sciences, headed by Sriram Ramanathan are working on solid oxide fuel cells to replace fossil fuels with pollution-free fuel cells. They use abundant natural resources at low cost to create small devices working at lower temperatures.

One major hurdle in current all-ceramic thin-film SOFC fuel cell technology has been use of very expensive platinum electrodes. Harvard team developed platinum-free low cost and more reliable SOFC. Conventional technology needed very high temperatures between 800-1000°C. New technology SOFC works at 500°C and efforts are on to reduce the temperature near 300°C.

These fuel cells will run on methane, abundantly available at low cost, and useable at low temperatures. Hydrogen was found to be costlier than methane for fuel cells. These SOFC may be usable both for stationary as well as transport applications if temperatures are on lower side, and present target of 300°C may make it possible.

Downside of SOFC is their water emission as waste, which may not be good in a number of applications. Since low temperature operation is a long way, there no immediate possibility of their use in computers and mobile phones. The drawbacks are expected to be overcome and SOFC technology is likely to be in extensive use in near future.

Portable fusion reactors

Lockheed Martin has been trying to create portable compact fusion reactor (CFR) since past five years. They aim to create a reactor to power a small city. Researchers created a small cylindrical reactor in a

space of 1m × 2m and created a confined plasma, heating Deuterium gas with RF energy (a form of non-ionizing electromagnetic radiation). Plasma is kept stable using magnetic field. In May 2016, there were good number of investment proposals, and they expect projects as large as 100 MW in ten years.

Other developments

Recently China has reported creating artificial sun, using fusion reaction and reaching temperatures six times that at the core of the sun. When fully developed, they expect to get energy and light from this high temperature plasma source in earth orbit on continuous basis to cover huge requirements for the country.

Algae is looked upon as a viable perennial source of fuel. Algae are mega oil producers, capable of producing 1000-5000 gallons oil per acre, not possible by any crop. Oil from algae is similar to vegetable oil and can be converted to oil using existing technology. Algae do not compete with food sources for land, can be grown even in salty conditions and they also treat polluted waters. There is still some way to go, but researchers feel this can be promising fuel source of future. If and when the systems are in place, there will be good energy available from algae, which at the same time, will help remove water pollution.

A German firm Rawlemon has created a spherical sun power prototype, called Beta-ray. The yield is expected twice that of solar panel in a much smaller surface area. Design is fully rotational, and is suitable for inclined surface, walls of buildings, or anywhere where it is open to sky. This can also be used for car charging stations.

There are other developments also going on, and we can expect new exciting technologies in near future forming a part of renewable energies.

ET

Please Note: The article is a continuation of the Part 1 carried in the Electrical India July 2020 issue.



- This article has been authored by

R. P. Deshpande

B.Tech. Hon. (Elec.), IIT(Bom); F.I.E.

igus offers low-cost customised robot design

For industrial use, robots are finding several ways into the retail trade ensuring rapid automation processes. Users place high demands on design and reliability at a cost-effective price. Due to which, igus is now offering its low-cost robot - robolink DP - consisting of high-performance polymers, in custom design.

Features of robolink DP robot arm:

- The customer has the option to design the robot arm as he/she wants, with four or five axes.
- The user can freely use the RAL colour palette either for the corporate design of the company or as a barista robot in an elegant white look.



• The compact, lightweight robolink DP makes comprehensive use of the advantages of igus motion plastics in production: light, lubrication-free and maintenance-free, quiet, durable and cost-effective.

• The new articulated arm can be configured individually via the platform [RBTX.com](https://www.igus.in) and, depending on the type of application, can be equipped with grippers, cameras or sensors from a wide range of manufacturers.

See the robolink DP for yourself: <https://www.youtube.com/watch?v=46XPjsUBZbk>

For more details, visit www.igus.in

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— Supporting —



Elmeasure launches EL-CLEAiR

Elmeasure, whose business domain is energy management, has now joined the COVID fight to serve the society. EL-CLEAiR, a path-breaking UV sanitizer developed jointly with Rockforest.

Feature:

- EL-CLEAiR acts as an air purifier by eliminating dust, odour, germs, bacteria, and viruses including COVID-19 in few hours.
- It sanitizes personal belongings like wallet, currency, mobile, masks, etc., in about 10 minutes.
- It is tested and certified by NABL Accredited Laboratory and recognized by IAPMO R&T, USA.



- It is 100% safe even for kids & pets.
- It can be used in homes, schools, hospitals, clinics, offices, shops, hotels, saloons, etc.

For more details write to info@elmeasure.com

Influence of high voltage on Electrical Equipment

In India, all electrical equipments are designed for 230 / 400 volts single / three-phase. Voltage variation is a common phenomenon all over the country. Normally voltage variation 300 - 480 Volts, 3 - Phase (170 - 275 Volts, 1 - Phase)

Power Consumers running 24 hours face problems of low & high voltage. Generally, voltage is low during the daytime and high during the night hours. Moreover on holidays, peak hours, rainy days and when the agricultural / factory load is switched off, the voltage rises quite sharply - which is more dangerous.

High Voltage: At high voltage, the no-load current of electrical/electronic equipment increases sharply.

The high current increases the losses of equipment resulting overheating, and weakens the insulation of electrical/electronic equipment & pre-mature failure of equipment as explained in the chart hereafter:

Sr. No	% Higher Voltage	Voltage Variation	Normal Life of Electrical Equipment	Remarks/ Pay-Back (6-2 months)
1	5%	400 V - 420 V	Life is 100%	Depending upon the duration of high voltage, Working hours of plants, Type of electrical / electronic equipments (Some equipments are more sensitive like Electronic cards, Bulbs, LED, Tubes, Chokes) and motors below 5 Hp.
2	10%	400 V - 440 V	Life is 80%	
3	15%	400 V - 460 V	Life is 50%	
4	20%	400 V - 480 V	Life is 20%	

The power consumers having a high failure rate of electrical equipment, low power factor, higher MDI can reduce the failure rate of equipment & reduce power consumption bills, MDI according to the high voltage range. This can be saved by maintaining the rated voltage at 400/415V by installing AVC as per their requirement.

Low Voltage: - At low voltage, no-load current of electric equipment does not increase and does not affect the life of the equipment. In case of very low voltage (i.e. 370V), the customer needs to run the unit on DG set which is very costlier (approx. double than the normal electricity charges).

So, the Payback period (in both cases i.e. very low/high voltage) of the AVC is 6 - 24 months, depending upon input voltage variation and working hours of the plant.

For more details, contact at jemc@jindalelectric.com

MODERNIZING POWER GRID INFRASTRUCTURE

CoMPAS is the first of many leveraged collaboration projects in LF Energy's DSAS initiative.



Image by Th G from Pixabay

Recently, LF Energy; in partnership with GE Renewable Energy, Schneider Electric, RTE, Alliander and other leading organisations in the energy sector; has launched the first project under DSAS. The project is known as CoMPAS or Configuration Modules for Power industry Automation Systems. The goal of the initiative is 100% decarbonization a reality by transforming power grid infrastructure. The Digital Substation Automation Systems (DSAS) initiative was launched to enhance the power grid's modularity, interoperability and scalability to accelerate the effort toward carbon neutrality by 2050.

Digital Substations

The transition from fossil-based fuels to clean energy sources has given rise to variable conditions that cause fluctuations in power supply and demand, like renewable energy and electrical vehicles. Because of this, power grid operators now face

greater challenges in ensuring the grid is stable and optimizes power supply and demand.

LF Energy's DSAS initiative seeks to alleviate these challenges by optimizing electrical substations through open-source technology. These substations form crossroads of the grids, connecting grid users and grid voltage levels. By deploying modern, open-source technology, digital substations can more efficiently adjust to changes in power supply and demand through expanded dynamic protection settings, better data management capabilities, and increased adaptive automation functions.

According to LF Energy, "a more efficient power grid of the future will increasingly integrate more solutions on the edge of the power grid, such as decentralized physical infrastructure assets, network or control, applications and analytics. Transforming our power grid represents one of the

great opportunities for mitigating the climate crisis."

CoMPAS

CoMPAS is the first of many leveraged collaboration projects in LF Energy's DSAS initiative. This is the first time in the power industry that organizations have come together to build open-source solutions for energy systems from start to finish, as most open-source projects are formed using existing technology. CoMPAS specifically seeks to build standardized and broadly-applicable software components that optimize protection, automation and control (PAC) systems, as deploying modern PAC technologies is a pivotal first step to update substations.

One hurdle to achieving industry-wide modernization of electrical substations is the lack of interoperability between PAC components from different vendors. To ensure standardization and encourage broad adoption, CoMPAS's software components will be developed according to IEC 61850, an open, international standard that provides the framework to integrate a substation's PAC functions, regardless of the vendor or end-user. IEC 61850 can be complex to comply with, which may discourage independent companies from developing technology that abides by it. CoMPAS seeks to provide the standardized open-source software building blocks for PAC components vendors to use to create interoperable digital substation solutions. 

ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS
(As on 30.06.2020)

Region	Ownership/ Sector	Mode wise breakup								Grand Total
		Thermal					Nuclear	Hydro	RES * NRE)	
		Coal	Lignite	Gas	Diesel	Total				
Northern Region	State	16659.00	250.00	2879.20	0.00	19788.20	0.00	5777.25	701.01	26266.46
	Private	22425.83	1080.00	558.00	0.00	24063.83	0.00	2817.00	15969.04	42849.87
	Central	14354.96	250.00	2344.06	0.00	16949.02	1620.00	11491.52	379.00	30439.54
	Sub Total	53439.79	1580.00	5781.26	0.00	60801.05	1620.00	20085.77	17049.05	99555.87
Western Region	State	21740.00	1040.00	2849.82	0.00	25629.82	0.00	5446.50	555.54	31631.86
	Private	32847.17	500.00	4676.00	0.00	38023.17	0.00	481.00	25010.48	63514.65
	Central	18347.95	0.00	3280.67	0.00	21628.62	1840.00	1695.00	666.30	25829.92
	Sub Total	72935.12	1540.00	10806.49	0.00	85281.61	1840.00	7622.50	26232.32	120976.43
Southern Region	State	19782.50	0.00	791.98	159.96	20734.44	0.00	11774.83	586.88	33096.15
	Private	12747.00	250.00	5340.24	273.70	18610.95	0.00	0.00	41372.38	59983.33
	Central	11835.02	3240.00	359.58	0.00	15434.60	3320.00	0.00	541.90	19296.50
	Sub Total	44364.52	3490.00	6491.80	433.66	54779.99	3320.00	11774.83	42501.16	112375.98
Eastern Region	State	7450.00	0.00	100.00	0.00	7550.00	0.00	3537.92	275.11	11363.03
	Private	6153.00	0.00	0.00	0.00	6153.00	0.00	96.00	1217.98	7466.98
	Central	13682.05	0.00	0.00	0.00	13682.05	0.00	1005.20	10.00	14697.25
	Sub Total	27285.05	0.00	100.00	0.00	27385.05	0.00	4639.12	1503.09	33527.25
North Eastern Region	State	0.00	0.00	533.86	36.00	569.86	0.00	422.00	233.25	1225.10
	Private	0.00	0.00	24.50	0.00	24.50	0.00	0.00	102.14	126.64
	Central	770.02	0.00	1253.60	0.00	2023.62	0.00	1155.00	30.00	3208.62
	Sub Total	770.02	0.00	1811.96	36.00	2617.98	0.00	1577.00	365.39	4560.36
Islands	State	0.00	0.00	0.00	40.05	40.05	0.00	0.00	5.25	45.30
	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.84	7.84
	Central	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10	5.10
	Sub Total	0.00	0.00	0.00	40.05	40.05	0.00	0.00	18.19	58.24
ALL INDIA	State	65631.50	1290.00	7154.86	236.01	74042.36	0.00	26958.50	2357.03	103627.89
	Private	74173.00	1830.00	10598.74	273.70	86875.45	0.00	3394.00	83679.86	173949.30
	Central	58990.00	3490.00	7237.91	0.00	69717.91	6780.00	15346.72	1632.30	93476.93
	Total	198794.50	6610.00	24991.51	509.71	230905.72	6780.00	45699.22	87669.19	371054.12

Figures at decimal may not tally due to rounding off

Source: CEA

Energy Power Supply Position (Provisional)

Figures in MU net

States	June,2020				April,2020 to June,2020			
	Energy Requirement	Energy Supplied	Energy not Supplied		Energy Requirement	Energy Supplied	Energy not Supplied	
	(MU)	(MU)	(MU)	%	(MU)	(MU)	(MU)	%
Chandigarh	161	161	0	0.0	352	352	0	0.0
Delhi	3,109	3,109	0	0.0	7,302	7,302	0	0.0
Haryana	5,158	5,158	0	0.0	11,570	11,570	0	0.0
Himachal Pradesh	806	806	0	0.0	1,927	1,925	3	0.1
UT of J&K and Ladakh	1,564	1,263	301	19.3	4,753	3,844	908	19.1
Punjab	6,733	6,733	0	0.0	13,052	13,052	0	0.0
Rajasthan	7,199	7,185	14	0.2	18,774	18,754	20	0.1
Uttar Pradesh	11,872	11,770	102	0.9	30,418	30,130	288	0.9
Uttarakhand	1,147	1,147	0	0.0	2,795	2,795	0	0.0
Northern Region	37,749	37,331	418	1.1	90,944	89,725	1,219	1.3
Chhattisgarh	2,318	2,318	0	0.0	6,763	6,763	0	0.0
Gujarat	8,953	8,953	0	0.0	25,628	25,628	0	0.0
Madhya Pradesh	2,318	5,253	0	0.0	16,839	16,839	0	0.0
Maharashtra	8,953	11,124	0	0.0	35,550	35,550	0	0.0
Daman & Diu	5,253	149	0	0.0	349	349	0	0.0
DNH	347	347	0	0.0	678	678	0	0.0
Goa	265	265	0	0.0	923	923	0	0.0
Western Region	28,408	28,408	0	0.0	86,732	86,732	0	0.0
Andhra Pradesh	5,102	5,102	0	0	15,496	15,496	0	0.0
Telangana	4,611	4,611	0	0	14,178	14,178	0	0.0
Karnataka	5,315	5,315	0	0	17,803	17,803	0	0.0
Kerala	1,920	1,920	0	0	6,155	6,152	2	0.0
Tamil Nadu	8,798	8,798	0	0	24,862	24,862	0	0.0
Puducherry	232	232	0	0	613	613	0	0.0
Lakshadweep #	5	5	0	0	15	15	0	0
Southern Region	25,978	25,978	0	0	79,106	79,104	2	0.0
Bihar	2,977	2,977	0	0	8,047	8,040	8	0.1
DVC	1,581	1,581	0	0	3,862	3,862	0	0.0
Jharkhand	744	744	0	0	2,200	2,155	45	2.0
Odisha	2,391	2,391	0	0	6,846	6,846	0	0.0
West Bengal	4,273	4,273	0	0	11,672	11,609	63	0.5
Sikkim	39	39	0	0	122	122	0	0.0
Andaman-Nicobar #	29	27	0	2	87	81	6	6.7
Eastern Region	12,005	12,005	2	0	32,749	32,634	115	0.4
Arunachal Pradesh	60	60	0	0.4	139	138	2	1.3
Assam	896	873	23	2.5	2,254	2,123	131	5.8
Manipur	78	77	0	0.5	214	212	2	0.9
Meghalaya	176	176	0	0.0	438	430	7	1.6
Mizoram	55	55	0	0.7	160	159	2	1.1
Nagaland	68	68	0	0.5	191	189	1	0.8
Tripura*	133	132	0	0.0	360	358	2	0.6
North-Eastern	1,466	1,442	24	1.6	3,756	3,609	147	3.9
All India	105,606	105,164	442	0.4	293,287	291,803	1,484	0.5

Lakshadweep and Andaman & Nicobar Islands are stand- alone systems, power supply position of these,does not form part of regional requirement and energy supplied. * Excludes energy exported to Bangladesh.

Note: Power Supply Position Report has been compiled based on the data furnished by StateUtilities/ Electricity Departments.

Source: CEA



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Organizer: IEEE Power Electronics Society

Webinar Name: Advancing Layout Tools to Support High Performance/High-Frequency Electronic Design Competition and Regulation for Ipps
Date: 24 September 2020
Time: 11:00 AM ET
Organizer: IEEE Power Electronics Society

Webinar Name: Utility of the future: The impact of renewables, DERs and prosumers
Date: 21st August 2020
Time: 2:00 PM EDT
Organizer: ABB Power Grids

Webinar Name: High-Density Medium-Voltage SiC-based Modular Power Converters for Naval Applications — Challenges and Solutions
Date: 6th October 2020
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Organizer: IEEE Power Electronics Society

IN THE September 2020 ISSUE

POWER ELECTRONICS

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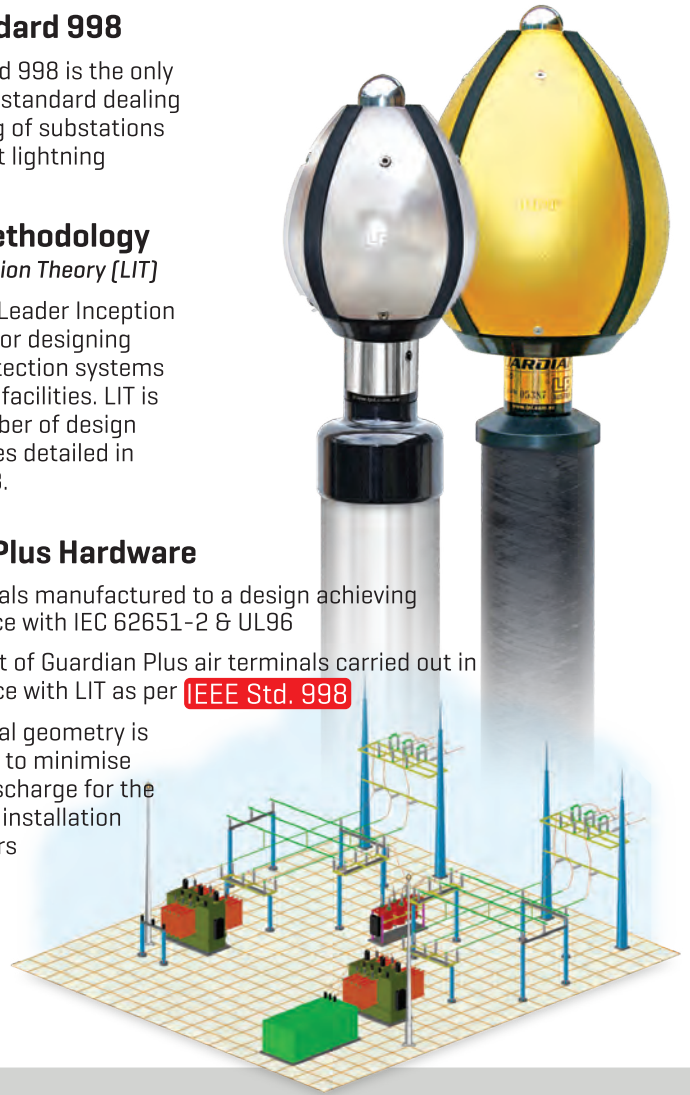
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