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Given its target of achieving 175 GW of renewable power generation capacity by 2022 along with strong push for electric mobility, India presents huge opportunity in the energy storage front. In 2018, India's total energy storage market from stationary applications was around 24 GWh. India Energy Storage Alliance (IESA) estimated that the cumulative potential of energy storage will be between 270 to 365 GWh during 2019-2025. To meet such huge demand, India is on the cusp of creating a manufacturing ecosystem for advanced energy storage technologies. Looking at the potential, IESA's Debi Prasad Dash anticipates, India has to create a 10 GWh capacity by 2020 which will attract investments of around \$3 billion within next 3-4 years.

Thermal imaging technology is used to improve the visibility and clarity of objects in a dark environment by detecting them using infrared radiation. According to a research report by Market Research Future (MRFR), the global thermal imaging market is expected to worth US \$ 3.96 billion by 2023, growing at 7 per cent CAGR between 2018 and 2023. Thermal imaging is a proven way of proactive maintenance in the electrical industry as it provides insights on heat map of critical electrical assets. This time, we present to you an in-depth analysis on why thermal imaging is becoming important in electrical industry.

The issue also touched upon important topics like energy monitoring, power grid automation, grid modernisation, and control and management in power systems operations. Hope you'll enjoy reading this issue as always.

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Publisher & Editor-In-Chief

Directors Pravita lyer Mahadevan lyer

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

Group Editor Subhajit Roy subhajit@charypublications.in

#### **Editorial Department**

Associate Editor Supriya Oundhakar editorial@charypublications.in

Editorial Co-ordinator Nafisa Kaisar nafisa@charypublications.in

#### Advertising Department

Director Advertisement Pravita lyer pravita@charypublications.in

Advertising Manager Yasmeen Kazi yasmeen@electricalindia.in

Advertising Executive Mariya Yenubari sales@charypublications.in Nafisa Khan advt@electricalindia.in

#### Design

Nilesh Nimkar Jebas Thangadurai charydesign@charypublications.in

Subscription Department Priyanka Alugade sub@charypublications.in

Accounts Department Dattakumar Barge Bhakti Thakkar accounts@charypublications.in

Digital Department Ronak Parekh dgmarketing@charypublications.in

Chary Publications Pvt. Ltd. 906, The Corporate Park, Plot 14 & 15, Sector 18, Vashi, Navi Mumbai 400703 Phone: 022 2777 7170 / 71

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# <u>Editor's</u> etter

# Sabka Power | Sabka Vikas |

ndia's socio-economic growth is closely linked to the growth of its power sector. After the BJP-led National Democratic Alliance (NDA) storms back to power for the consecutive second term, the government's big job now is to recharge a struggling power sector.

Increasing losses and piling debt of state-owned power distribution companies (DISCOMs) remains a worry for the power sector. The previous NDA regime had introduced the Ujwal DISCOM Assurance Yojana (UDAY) in November 2015 for the operational and financial turnaround of DISCOMs. The scheme aims to reduce interest burden, cost of power and power losses in distribution sector, besides improving operational efficiency of DISCOMs by reducing the country's aggregate technical and commercial (AT&C) losses from around 22 per cent to 15 per cent by 2018-19.

UDAY has received a very lukewarm response from DISCOMs and so far, only 15 states have been able to bring AT&C losses below 15 per cent. Also, according to a CRISIL report, aggregate external debt of DISCOMs is expected to increase to pre-UDAY levels of Rs 2.6 lakh crore by the end of the current fiscal, which is alarming. So, the new government has to revive the second leg of power sector reforms under the planned UDAY 2.0.

The Modi 1.0 had envisaged 24x7 Power for All from April 1, 2019 and a giant stride was taken in that direction. According to the government data, out of the 26.30 million households targeted under the scheme, 26.28 million, or 99.93 per cent households have already got electricity connections under the flagship Pradhan Mantri Sahaj Bijli Har Ghar Yojana or Saubhagya. Now, for Modi 2.0, the challenge will be to make reliable power available 24X7 at affordable cost. Expressing his government's commitment, the Power Minister RK Singh said, "As we begin our second innings, our focus will be on 24x7 Power For All. We want to provide reliable and sustainable Power For All."





Group Editor





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#### **Registered Office**

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#### Works

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# In brief

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## IWTMA submits recommendations to MNRE

Indian Wind Turbine Manufacturers Association (IWTMA) participated in the brainstorming session organised by Ministry of New & Renewable Energy (MNRE) and submitted their recommendations to the Ministry.

Chairman of IWTMA said, "The wind energy sector has been reeling under tremendous pressure and struggling with the transition from FiT to reverse bidding with tariff cap regime resulting into very low tariff. The tariff discovered is so low that it is neither bankable nor sustainable. Due to this, irrespective of bidding of 17 GW, actual installation is around 700 MW. Also, in last two years, against country's annual installed manufacturing capacity of 10 GW, only 15 per cent capacity is utilised. This low capacity utilisation is not sustainable by the sector and has severely affected 4,000 SMEs and 2 million jobs. At this rate, achieving national target of 175 GW by 2022 will be a big challenge." IWTMA suggested the following:

- Implement FiT & 5 years firm policy framework to develop 50 GW
- Under open access, waiver of ISTS charges for captive consumers
- Uniform Wheeling & Banking policy for captive power consumers in the states
- FiT policy for <25 MW for small domestic investors.

# Ratan Tata invests in Ola Electric Mobility



Ola Electric Mobility announced that Ratan Tata, Chairman Emeritus of Tata Sons, has invested in the company as part of its Series A round of funding. Tata is also an early investor in ANI Technologies, Ola's parent company.

Tata has been a driving force in the automotive industry, with a handson contribution to the innovation, growth, and international reach of Tata Motors. His investment in Ola Electric will bring his deep experience and mentorship to the company's ambitions to make electric mobility viable at scale.

Tata's investment in Ola Electric is a significant endorsement of the company's approach to developing an electric mobility ecosystem, including innovations in charging infrastructure, swapping models, and market-appropriate products. Ola Electric is currently running several pilots involving charging solutions, battery swapping stations, and deploying vehicles across two, three and four-wheeler segments.

Ratan Tata, said, "The electric vehicle ecosystem is evolving dramatically every day, and I believe Ola Electric will play a key role in its growth and development. I have always admired the vision of Bhavish Aggarwal and I'm confident that this will be part of yet another important strategic move into this new business area."

Bhavish Aggarwal, Co-founder & CEO, Ola said, "Tata has been an inspiration and a mentor to me personally in shaping Ola's journey over the years. I'm very excited to welcome him on board Ola Electric as an investor and a mentor in our mission of building sustainable mobility for everyone on our planet as we work towards our goal of a million electric vehicles in India by 2021."

# IEEMA committed to restoration of power in cyclone-hit Odisha

IEEMA has expressed anguish and pain caused by Fani cyclone hitting the coastal areas of Odisha and stands in solidarity with the people of affected areas. IEEMA membership stands committed towards meeting the needs of the state pertaining to restoration of electrical and power infrastructure on a priority basis.

IEEMA has also committed to Odisha Chief Minister Naveen Patnaik and its utilities about the offer given by one of its member Supreme & Co to re-erect any transmission tower pro bono for rapid restoration of power supply. According to the initial reports, cyclone Fani has caused extensive damage to the power infrastructure in the coastal region of the state.

IEEMA has also appointed a nodal officer in Bhubaneshwar to address the emergency needs of power infrastructure restoration work.

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# NTPC wins 100 MW solar project

NTPC participated in the tender floated by Solar Energy Corporation of India (SECI) for 250 MW grid connected solar projects at Dondaicha Solar Park, in Dhule, Maharashtra. NTPC has won 100 MW of solar capacities at a tariff of Rs 2.91 per unit in the reverse auction held.

This 100 MW of solar project shall be set up by NTPC under EPC mode and add to the installed capacity of NTPC. With this NTPC's total capacity won under tariff based competitive bidding goes to 345 MW.

# MNRE discusses issues related to RE sector

Ministry of New & Renewable Energy (MNRE) held a 'Chintan Baithak' with the stakeholders of renewable energy sector recently. The meet was chaired by Secretary, MNRE, Anand Kumar and saw good participation from the sector including the representatives of major RE developers, equipment manufacturers, financers, regulators, think-tanks, industry bodies and skill developers. The meet deliberated upon various issues pertaining to the RE sector viz solar, wind, bio-energy, smallhydro, regulatory issues, bidding and pricing, demand forecasting, financing of RE projects, energy storage, Make in India, skilling India's RE work force etc. Praveen Kumar, Additional Secretary, MNRE and other senior officials of the Ministry were also present.

# GAIL expedites Jagdishpur-Haldia pipeline

Stepping up the momentum for construction of the Jagdishpur-Haldia & Bokaro-Dhamra Natural Gas Pipeline (JHBDPL) and Barauni – Guwahati Pipeline (BGPL) pipeline, GAIL India has completed awards for all major contracts worth Rs 10,500 crore for pipe supply and laying for the integrated 3,400 km. long project.

GAIL has placed an order worth Rs 475 crore for steel line pipes of approximately 280 km to provide pipeline connectivity from Durgapur to Haldia including spur line to Kolkata in West Bengal. Till date, the company has committed over Rs 12,500 crore for the project.

The pipeline has already reached Barauni and GAIL is ready for supplying gas to refinery and upcoming fertilizer plant. The



pipeline also supplies Natural Gas for Patna City Gas Distribution network (CGD). This is a major milestone towards providing green fuel to eastern part of the country. The work for balance portion is going on in full swing and is scheduled to be completed by December 2021 in a phased manner. The construction work of Dobhi–Durgapur Pipeline section is likely to be completed by December 2019 for supplying gas to Matix Fertilizers, Durgapur, West Bengal.

# IndiGrid to acquire transmissions assets



India Grid Trust (IndiGrid), India's infrastructure investment trust, announced the closing of a preference unit issuance worth Rs 2,514 crore (USD 363 million). As part of the transaction, KKR and GIC have invested Rs 1,084 crore (USD 157 million) and Rs 980 crore (USD 142 million), respectively, to collectively own 42 per cent of IndiGrid's outstanding units. KKR has also applied to become a sponsor of IndiGrid and plans to acquire an additional 15 per cent of IndiGrid's total units from Sterlite Power. KKR and GIC will collectively own approximately 57 per cent of IndiGrid's outstanding units.

In a separate transaction, KKR will additionally acquire a majority share holding in Sterlite Investment Managers. With the capital infusion provided by the new unit issuance, IndiGrid will purchase five electricity transmission assets worth Rs 11,500 crore (US\$1.66 billion) from Sterlite Power. A share purchase agreement for the two operational transmission assets — NRSS XXIX and OGPTL — has been signed, while three additional assets will be purchased once they become operational.



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# Schneider Electric launches smart switches in India

Schneider Electric launched three new wiring devices range - Clipsal X, UNICA Pure and Avatar ON. With products that are digitally advanced, with alluring designs, Schneider Electric aims to address the growing consumer market that demands style, strength, efficiency as well as digitisation. The products are being introduced with the unique proposition of customisation and IoT enablement. Available in varied price ranges, the products are one-of-its kind in the Indian home distribution segment.

In India, the Home Automation industry is rapidly growing and evolving more to a converged offering with integration of lighting controls and switchboards, safety security sensors, voice enabled system etc.

One critical aspect of smart homes today are smart savvy lighting alongside immaculately designed switchboards to go along with the aesthetics of the house. Srinivas Shanbhogue, VP Retail Business, said, "Smart home devices are rapidly catching up in India. Today, people are beginning to make sustainable choices at every step of their life starting from their homes, and our new range of wiring devices and switches cater to this market. At Schneider Electric, we believe in delivering the best technology and our teams have been working hard to create market offerings that are ready to disrupt the Indian wiring devices market." ٦

# ERDA organises Customer Meet at Jaipur

Rajasthan and particularly Jaipur, has evolved as a major hub of small and medium scale distribution transformer manufacturing in India. As per latest BIS data, there are more than 60 nos.

BIS accredited DT manufacturers at Jaipur whereas there are more than 90 BIS licensees in the state of Rajasthan.

In order to have a face to face interaction with these customers, ERDA organised a customer meet for DT manufacturers located at Jaipur on 10th May. Around 25 DT manufacturers attended this programme including Alok Agrawal, Chairman of IEEMA DT division and Director of Uttam Bharat Transformers Ltd. The programme was also attended by Anil Saboo, CMD of Electrolite (Power) Private Ltd and



Chairman of ELECRAMA 2020.

The customers were addressed by Hitesh Karandikar, Director ERDA. H. K. Mishra, Addl. Director ERDA made a presentation on ERDA's experience on DT Testing as per IS:1180 – 2014. Rajib Chattopadhyay, Head - BD & CRM, ERDA presented the corporate video and corporate presentation. Finally, an interactive session took place with the customers which espoused lot of enthusiasm among the customers. The programme finally concluded with a vote of thanks from Amol Sharma, BD Engineer posted at Jaipur. . 0

## Surge in Bajaj Electricals' income

During the fourth quarter, the company achieved sales or income from operations of Rs 1,772.94 crore as against Rs 1,606.27 crore registering a growth of 10.4 per cent over the fourth quarter of the previous year. Profit before tax and profit after tax for the quarter were at Rs 43.86 crore and Rs 28.54 crore as against Rs 43.85 crore and Rs 7.31 crore in the corresponding quarter of the previous year, respectively.

For the year ended 31st March, 2019, the company achieved sales or income from operations of Rs 6,673.14 crore as against Rs 4,716.39 crore, registering a growth of 41.5 per cent over the previous year. Profit before tax and Profit after tax

for the year were at Rs 259.44 crore and Rs 167.07 crore as against Rs 164.47 crore and Rs 83.62 crore for the previous year, respectively.

Shekhar Bajaj, Chairman and Managing Director, Bajaj Electricals Limited, said, "Consumer products segment continued to reap the benefits of Range & Reach Expansion Programme (RREP), registering a good growth with improvement in margins, RREP has now been fully rolled out pan-India, which helps the company to reach out to end consumers through more than 2,05,000 retail outlets across the country. This has given the company an edge over the competition in terms of product availability and reach."

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## ABB provides safety to highest altitude substations in India



Braving the ice-break test and subzero temperatures, ABB provides safety to substations 3,500 meters above sea level. Leh - Ladakh is a fabled, mystical land. Surrounded by the Himalayas and the Kunluns - the harshest mountain ranges in the world, power equipment here gets coated with layers of ice, and maintaining and servicing often becomes perilous. To this challenge, ABB's solution is its double-break disconnectors that operate as shields that isolate power equipment from the network and ensure safety and reliability of the substation.

The 66 and 145 kilovolt (kV) disconnectors with ice-breaking capacity have been deployed at the Leh, Khalsti, Drass and Kargil substations owned by the Power Grid Corporation of India. The substations were installed as part of the Indian government's '24x7 power for all' initiative in 2014 that has brought electricity to many far-flung corners of the country. Yet in Leh - Ladakh there are hurdles galore. Geographical remoteness and extreme weather, frequent blizzards and wide-ranging temperatures - between -20 and 40 C in the summer – make managing a power station a herculean task.

# Signify acquires animal-centric lighting experts Once Inc and iLox

Signify expands its business for agricultural lighting as it acquires Once Inc., based in Plymouth, Minnesota, and iLox, based in Vechta, Germany. Once and iLox are market leaders in the design and manufacturing of animalcentric lighting. These tailor-made lighting systems improve the quality of life for livestock, which leads to healthier and enhanced production for the farmer.

"With this acquisition, we add know-how, technology and expertise in animal lighting that complements ours in horticulture lighting. We are very pleased to partner with the teams of Once and iLox to combine our innovations to capture growth," said Bill Bien, Business Leader Agriculture at Signify. "This



next step in the development of our agriculture business addresses the global need for feeding the world's growing population, further unlocking the potential of light for brighter lives and a better world."

"We are excited to become part of Signify. The potential market is young and growing and we look forward to working together to further improve animal welfare and farmers' production," said Zdenko Grajcar, CEO and Founder of Once.

## Crompton unveils anti-bacteria LED bulb

Crompton Greaves Consumer Electricals Ltd. (CGCEL) announced the launch of 'Crompton Anti-Bac LED Bulb' that helps provide dual benefits to consumers, delivering regular LED light and also killing germs.

This first-of-its-kind launch is all set to position Crompton as a pioneer in the industry or country within the LED segment, the company claims. Now, with the flip of a switch, homes can be disinfected and protected thereby killing germs and visibly reducing the dreadful build-up of mold in kitchens, laundry rooms, kids' playrooms, bedrooms and other family living spaces. This innovation comes with advanced Envirosafe technology and is recommended by



the Indian Medical Association.

Present at the occasion, Bollywood actor Soha Ali Khan said, "Given that we are exposed to a lot of household and ambient germs indoors itself in today's day and age, we now have an LED bulb that actually kills germs."

Mathew Job, CEO, CGCEL said, "Anti-Bac LED bulb that kills up to 85 per cent of germs while the light is on and makes the living environment of consumers healthy and safe. "



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#### TI enables system reliability in hybrid and EV

Texas Instruments (TI) introduced fully tested reference designs for battery management and traction inverter systems along with new analog circuits with advanced monitoring and protection features to help reduce carbon dioxide emissions and enable hybrid electric vehicles and electric vehicles (HEV/EVs) to drive farther and longer.

Scalable across six to 96-series cell supervision circuits, TI's new battery management system (BMS) reference design features the advanced BQ79606A-Q1 precision battery monitor and balancer. Engineers can get their automotive designs to market quickly using the reference design, which implements the battery monitor in a daisy chain configuration to create a highly accurate and reliable system design for three- to 378-series, 12-V up to 1.5 kV lithium-ion battery packs.

The highly integrated BQ79606A-Q1 accurately monitors temperature and voltage levels and helps maximise battery life and time on the road. Additionally, the BQ79606A-Q1 battery monitor features safe-state communication that helps system designers meet requirements up to Automotive Safety Integrity Level D (ASIL D), which is the highest functional safety goal defined by the ISO 26262 road vehicles standard. Ø

# Sterlite Power delivers its first project in Brazil ahead of schedule

Sterlite Power celebrates the kickoff of operations in the Arcoverde project May 9th, in Pernambuco. This is the first of 10 projects assigned to the company in Brazil. Arcoverde Project covers 139 km of power lines and three substations to boost wind energy power transmission in the Pernambuco region.

After the company won the project through transmission and began construction works in May 2018, the Arcoverde project, which boasts 400 MVA in power. The group of assets within the Arcoverde project expand coverage in the Pernambuco outback region, reinforces the system and covers the growing power demand in the region. According to Rui Chammas, CEO of Sterlite Power in Brazil, "We're confident about our operations in Brazil and for delivering the first project 28 months ahead of the schedule set by ANEEL, thanks to the hard work of our highly qualified team and our operational engineering excellence, as well as the commitment of our partners. This project showcases how infrastructure can help the National Integrated System – in this case supplying the Northeast region with wind power."

Pratik Agarwal, Group CEO, Sterlite Power, said, "It is a proud moment for us to deliver our first project in Brazil in record time, and this is possible because of immense hard work and support from our employees. Delivering Arcoverde only two years after Sterlite Power came to Brazil showcases our solid standing in the country."

# Unit of Novovoronezh Nuclear Power Plant-2 generates power in Russia

Russia's Rosatom State Atomic Energy Corporation, the technical consultants and main equipment suppliers for Kudankulam Nuclear Power Plant in Tamil Nadu, announced that 'innovative unit-2 of the Novovoronezh Nuclear Power Plant-2' for the first-time supplied electricity to the national grid.

The VVER-1200 reactor was brought to the minimum controlled power level on 22 March. On May 1, 2019 it reached a capacity of 240 MW. It is located in southwest Russia. it reached a capacity of 240 MW. It is located in southwest Russia. Novovoronezh Nuclear Power Plant-2 Unit 2 will be the third VVER-1200 to be commissioned, following



Novovoronezh NPP-2 Unit 1 and Leningrad NPP-2 Unit 1.

VVER-1200 is a flagship nuclear reactor and core product of Rosatom State Atomic Energy Corporation. Being an evolution of VVER-1000 reactors that were built in Iran (Bushehr), India (Kudankulam) and China (Tianwan), the new design features improved performance across all parameters.

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#### Atos delivers world's highest-performing quantum simulator to Total

Atos, a leader in digital transformation, has delivered its Atos Quantum Learning Machine, the world's highest-performing commercially available quantum simulator, to French multinational energy company Total. Total group intends to use the Atos QLM to support all of its businesses.

Combining a high-powered, ultra-compact machine with a universal programming language, the Atos Quantum Learning Machine enables researchers and engineers to develop and experiment with quantum software. It simulates the laws of physics to compute the exact execution of a quantum program with double-digit precision. Quantum simulation will find concrete applications within the Total group such as molecular and materials chemistry, the optimisation of energy networks, vehicle fleets or industrial tools and seismic imaging and fluid mechanics. "We will develop a quantum approach to different research issues covering all our businesses to explore new ways of solving problems and improve performance and efficiency," said Marie-Noëlle Semeria, R&D Director at Total. "Atos is working closely with researchers and engineers around the globe, such as Total, to support them with tools to drive significant technological advances," said Sophie Proust, Atos CTO. ▣

# Vestas brings in Sulzer Schmid and WKA Blade Service

Sulzer Schmid, a Swiss company pioneering UAV technology for rotor blade inspections, and WKA, the leading blade inspection and repair service provider, have been enlisted by Vestas to conduct a massive and challenging drone-based blade inspection campaign in Scandinavia, on a staggering 1,250 wind turbines in less than 12 weeks.

For this important campaign, time is of the essence. The blades of the 1,250 Vestas turbines located across Sweden and Finland must be inspected by the end of June, just in time for the beginning of the repair work season that traditionally takes place during the less windy summer months. To deal with that challenge, Vestas has opted for a drone-based solution, which is the only approach that can meet its high-quality standards within such a demanding time-frame.

WKA & Sulzer Schmid's have joined forces to offer the complete service needed by Vestas. Within their partnership, Sulzer Schmid's cutting-edge drone-based inspection technology will be combined to WKA's qualified field personnel and rotor blade expertise to offer a stateof-the-art turnkey solution. WKA will deploy drones equipped with cameras and sensors to capture and record blade defects and ensure smooth operations in the field. The project management will be supported by ROBUR company TEC GmbH, an industrial services specialist. The offering of Sulzer Schmid and WKA covers the entire workflow up until the defects are made available on the customer portal of Vestas.

# GE Renewable Energy repowers more than 4 GW of wind turbines in US

**GE** Renewable Energy announced at the AWEA Wind power Conference that the company has completed over 2,500 repowering upgrades, covering 4 GWs of capacity at 36 different wind farms across the US since 2017. The company said it expects to repower an additional 3 GW of units for 11 customers at over 25 new wind farms by the end of 2020, reflecting robust demand for the service. The company highlighted its capability to repower non-GE wind turbines, noting that two of the projects are for equipment originally supplied by other equipment manufacturers. Customers who have taken advantage of GE Renewable Energy's repowering services include NextEra, E.On, and Mid American Energy amongst other leading players.

Repowering involves replacing older units with new, higher capacity turbines or retrofitting them with more efficient components - in both cases, significantly increasing wind farm production. Vikas Anand, GE Renewable Energy's CEO, Americas Onshore Wind, said, "Repowering existing wind turbine technology is a complex endeavour, requiring the ability to blend new technology and equipment with aging machines." The National Renewable Energy Laboratory has estimated that annual US wind repowering investment could grow to USD 25 billion by 2030.

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#### Appointments

## R STAHL AG appoints Thomas Wittek as Managing Director



R STAHL AG has appointed Thomas Wittek as Managing D i r e c t o r and board member of R STAHL Private L i m i t e d.

India, effective from 1st March, 2019. Thomas Wittek succeeds Joerg Fitzek, who will continue his association with R STAHL India in the capacity as Regional Sales Director. In his new role, Thomas Wittek will be responsible for leading several strategic growth initiatives in India and the APAC region. He will directly report to Dr Mathias Hallmann, CEO of R STAHL AG.

Thomas Wittek has held several leadership roles for more than 20 years and has a proven track record of establishing sustainable and profitable businesses. Before joining R STAHL, he has worked with several privately-owned companies and large multi-national business conglomerates across Europe, Far-East Asia and the Indian subcontinent. His most recent role was with a major tier-II automotive supplier in India as their CEO. 0

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#### R K Singh becomes Power Minister in New Modi Government



**Raj Kumar Singh** 

Bureaucrat-turned politician and second time Lok Sabha member from Arrah in Bihar, Raj Kumar Singh is India's Minister for Power and Renewable Energy.

Singh was instrumental in the launch of household electrification scheme Saubhagya. According to the Power Ministry data, around 2.63 crore families were provided electricity connections under the scheme.

The minister of state with independent charge, Singh has been continued in the critical infrastructure

ministry where earlier he was responsible for implementing the NDA Government's politically important Rs 16,320 crore Saubhagya scheme to provide all Indian households with electricity. He also oversaw rapid progress in India's green economy with the country running the world's largest renewable energy programme.

The former home secretary and a 1975 batch Bihar cadre Indian Administrative Service officer is a tough task master and is not shy of taking on challenges.

A second time Lok Sabha MP from Arrah, Singh is well regarded within the bureaucracy and has been seized of the problems in the power sector.

#### Prashant Jain leads GE Steam Power in India



GE appointed Prashant Jain to lead GE Steam Power for the South Asia region. Prashant has assumed the role of Regional General Manager GE Steam Power South Asia and Managing Director GE Power India on April 17, 2019. He joined GE from Siemens where he was most recently the CEO of Power Generation Services. Prashant succeeds Andrew H DeLeone, who was previously the Managing Director of GE Power India. Vishal Wanchoo, President & CEO of GE South

Prashant Jain

Asia, said, "Prashant brings deep knowledge and vast experience which will further strengthen GE's Steam Power business in the region."

Prashant Jain said, "This is indeed an exciting opportunity for me. I look forward to leading and growing the GE Steam Power business in South Asia."

Prashant has been with Siemens for 17 years, and prior to that he was with Schneider Electric. Over his career, Prashant has held roles of increasing responsibility across the energy and industrial sector, including power generation and renewable energy. GE Steam Power is one of the leaders in clean power generation from coal with a portfolio of air quality control systems that can help further lower emissions. In India, GE Steam Power has approximately 2,000 employees, one engineering center and two key manufacturing facilities, in Durgapur and Sanand. GE Steam Power recently commissioned India's first limestone-based desulphurisation system with 100 per cent gas flow and won more than 10 orders for air quality control systems for NTPC, helping to ensure a cleaner future for India.



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Awards

# TDK in one of the world's 100 top innovators



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

A company's patents are crucial to their ranking. Both the number of patents and the ratio of patent applications to patents issued are assessed. Another factor is global patent protection for the portfolio, especially by Chinese, European, Japanese and US patent offices. The number of times patents are mentioned by other companies and institutions also serves as evidence of the influence of patents. TDK's latest innovations in electronic components include CeraCharge, the world's first rechargeable solidstate SMD battery, and PowerHap piezo actuators with haptic feedback, which deliver unrivalled performance in terms of acceleration, force and response time. •

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## CGPL bags 'Gold' at APEX India Occupational Health & Safety Excellence Award 2018

Coastal Gujarat Power Ltd (CGPL), a fully owned subsidiary of Tata Power was bestowed with the APEX India Occupational Health & Safety Excellence Award – 2018



under the 'Gold' category for outstanding achievement in Occupational Health & Safety (OH&S) Management in Thermal Power Sector at a recently held award function. The award was conferred to CGPL by Major General (Retd) P K Sehgal, Defence Expert in the presence of Manoj Tiwari, Member of Parliament and other senior dignitaries and was received by Bhaskar Bhattacharjee, Chief - O&M (Services), CGPL on behalf of the company.

Commenting on this win, Kumar Ghate, CEO, CGPL, said, "Health and safety is not only a high priority area for us but also an integral part of our business. We constantly strive to put in place the best occupational health and safety systems at our work place. This award will encourage us to continue managing risk and ensuring safety thereby creating a secure working environment."

Apex India Foundation, a non-profit organisation honours individuals and organisations for their contribution towards the society every year while maintaining a thorough selection process.

## Sobti honoured with Manav Rachna Excellence Award 2019

Atul Sobti, CMD, Bharat Heavy Electricals Limited (BHEL) has been bestowed with the Manav Rachna Excellence Award 2019 for Nation Building. Sobti is a changemaker with a track record of innovation and achievement.

The award, recognising Sobti for his visionary leadership, was presented by Prof D P Singh, Chairman, University Grants Commission at a glittering ceremony. These awards are conferred on outstanding luminaries and accomplished leaders in various categories. They recognise those



pushing the bounds of leadership excellence across a diverse spectrum, therein making a positive difference.

Bharat Heavy Electricals Limited (BHEL), is owned and founded by the Government of India, is an engineering and manufacturing company based in New Delhi, India. Established in 1964, BHEL is India's largest power generation equipment manufacturer.

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#### FLIR's wide range of products for predictive and preventive maintenance

These products help in detecting hot spots from a safe distance, avoiding unwanted shutdowns, identifying hazardous SF6 gas leakage, monitoring high voltage electrical substations continuously from remote location, etc.

#### For more information, call us at +91-11-4560 3555 or write to us at flirindia@flir.com.hk

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#### Transformer Thermal Image



# Human Centric Lighting Market worth \$3,655 mn by 2024



ccording to the marketsandmarkets research report, the 'Human Centric Lighting Market' is projected to grow from USD 810 million in 2019 to USD 3,655 million by 2024—growing a CAGR of 35.2 per cent. The growth of the human centric lighting market is driven by the high adoption of LED lighting solutions; initiatives toward establishing smart cities; and the rise in the demand for energy-efficient lighting solutions. Implementation of wireless technology for LED lighting is expected to provide substantial growth opportunities to market players.

'Lighting controllers to witness highest CAGR in human centric lighting market during 2019–2024'

The market for lighting controllers is expected to grow at the highest CAGR from 2019 to 2024. The human centric lighting market for lighting controllers has been further segmented into sensors, switches and dimmers, LED drivers, microcontrollers and microprocessors, and transmitters and receivers. The control and communications components include LED drivers and ballasts, sensors, dimmers and switches, and wireless receivers and transmitters. These lighting controls enable the implementation of intelligent lighting solutions and connect human centric lighting in various spaces. The growth of the human centric lighting market is driven by the high adoption of LED lighting solutions; initiatives toward establishing smart cities; and the rise in the demand for energy-efficient lighting solutions.

# 'Residential applications are expected to witness highest growth rate during forecast period'

The human centric lighting market for the residential application is expected to grow at the highest CAGR from 2019 to 2024. Factors such as ongoing technological advancements, increasing consumer preferences for better interior designing, and rising need for energyefficient lighting are driving the growth of the market for decorative as well as smart lighting. Also, in residential settings, i.e., at home or in elderly care, human centric lighting can reduce sleep disorders, thereby, limiting the need for cost-intensive medication and reducing nursing efforts. The growing implementation of smart lighting will lead to the increase in the demand for human centric lighting solutions in the residential sector.

#### 'Growing infrastructure and urbanisation will boost demand for human centric lighting solutions in APAC during forecast period'

The human centric lighting market in APAC is expected to grow at the highest CAGR during the forecast period. Factors driving the growth of the market in this region include the rise in industrialisation and commercialisation and high demand for energy-efficient solutions in developing countries. In a few countries such as South Korea and Malaysia, the success of the market for energy-efficient products such as LED products depends on the ability of light source manufacturers to form a rapport with local partners.

Key players in the market include Signify Lighting NV (Netherlands), OSRAM Licht AG (Germany), Acuity Brands (US), Cree (US), Legrand SA (France), Hubbell (US), Zumtobel Group AG (Austria), Wipro India, Glamox AS (Norway), and Lutron Electronics (US). These players are increasingly undertaking product launches and developments, mergers and acquisitions, contracts, partnerships, and agreements to develop and introduce new solutions in the market.



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# THERMAL IMAGING AND ELECTRICAL INDUSTRY

Thermal Imaging Cameras were once common in utility and industrial plants. Here's an in-depth analysis on why thermal imaging is becoming important in electrical industry. ne of the most common uses for thermal imaging Camera is the regular thermal surveys as part of electrical equipment maintenance. As uninterrupted, quality electricity supply remains at the core of today's industrial activities, it becomes essential to make the required electrical equipment available all the time, thereby helps in eliminating the factory downtime. Thermal imaging cameras, also known as infrared (IR) cameras, play an important role in such critical application areas.

Thermal imaging cameras work by converting emitted radiation levels into a two-dimensional picture that highlights contrasting energy levels. Electricity generates heat while passing through resistant components. So, in case of any electrical fault, a thermal imaging camera displays a rise in temperature which serves as the basis for identifying most electrical faults.

The prime advantage of thermal imaging camera is that it enables accurate inspection of electrical equipment without interrupting the machine operation. This allows a user carryout preventive maintenance without causing any downtime.

Importance of thermal imaging in electrical industry Most of the industries are adopting to



# The Technology Behind

Infrared thermography is an important sensing technology. In this image, infrared energy (A) coming from an object is focused by the optics (B) onto an infrared detector (C). The detector sends the information to sensor electronics (D) for image processing. The electronics translate the data coming from the detector into an image (E) that can be viewed in the viewfinder or on a standard video monitor or LCD screen.

Infrared thermography is the art of transforming an infrared image into a radiometric one; every pixel in a radiometric image is actually a temperature measurement.

Final product is a Thermal Image which can tell exact temperature of an object, if right product has been selected for desired application. This makes the Thermal Imaging Camera a perfect tool for predictive maintenance. (Source: FLIR Systems)

proactive way of doing maintenance rather than reactive maintenance. Thermal imaging is one of the proven ways of proactive maintenance as it provides insights on heat map of critical electrical assets. No machine goes to fail overnight and the machine always takes a journey from potential failure to actual failure over a period of time. Proactive maintenance is all about finding this journey of the machine towards failure and avoid such failure. According to P. Sridharan, Product Manager, Fluke Technologies (India) Pvt Ltd, thermal imaging is an easy and effective way to understand this journey of the machine by monitoring the thermal image of the machine. He said, "Many electrical problems like single phasing, high resistance contacts, issues related to insulation damage, winding failure of the motor can be identified using thermal imaging in less than a minute. These problems can lead to costly

downtime, machine failure and in many instances, safety hazards."

Discussing the importance of thermal imaging in electrical industry, TP Singh, Sales Director -Emerging Markets-Ins (India, Middle East, CIS, Turkey, SS Africa), FLIR Systems, said, "Globally, including India, electrical utilities are amongst the major users of thermal imaging Whether cameras. generation, transmission or distribution – all use and need accurate thermal cameras as electrical utilities face frequent problem of critical installations getting heated up. The moment this phenomenon heating starts. temperature starts rising and FLIR Thermal imaging cameras play a very important role there. Without touching or taking shut down, these Thermal Cameras FLIR can accurately measure the temperature of these installations from a safe distance." He further claims, from

nut/bolt on a transmission tower to transformers to many other critical installations, FLIR products meet and exceed all expectations.

to the Indust

### Types of electrical equipment Thermal Imaging Cameras can survey

The applications of thermal imaging cameras are limitless, said P. Sridharan of Fluke Technologies (India) Pvt Ltd. He adds, "Since thermal imaging cameras help to understand heat map of electrical assets, it is important to include all assets in the thermal imaging survey. The commonly inspected equipment include but not limited to are: (3-phase) Power distribution, fuse boxes, cables and connections, relays/switches, insulators. capacitors, substations, circuit breakers, controllers, transformers, motors and battery banks."

## Cover Story

The inspection is critical during installation and whenever a fault is repaired. Apart, a periodical survey helps. The success also of thermography lies in the ability to compare or trend to arrive at conclusion of the risk of prematurely failing assets. "There is a need to develop a baseline when the equipment is in perfectly healthy condition and compare the thermal image taken at different timeframe with this baseline. The change in the thermal pattern will then reveal a potential problem the asset may undergo," Sridharan suggests.



Many electrical problems like single phasing, high resistance contacts, issues related to insulation damage, winding failure of the motor can be identified using thermal imaging in less than a minute. These problems can lead to costly downtime, machine failure and in many instances, safety hazards.

P. Sridharan, Product Manager, Fluke Technologies (India) Pvt Ltd TP Singh of FLIR Systems sums up a list of electrical applications that can be surveyed by thermal imaging cameras:

- Checking transformer health which is critical equipment in any substation.
- Predictive maintenance of other critical installations including:
  - Inspection of connectors (which are everywhere)
  - Inspection of cables and joints
  - Inspection of exposed cables.
- Visualisation of SF6 leakage.

### A few advanced Thermal Imaging Cameras

Fluke offers wide range of thermal imaging camera that suits different needs and different budgets. Their solutions include a cost-effective pocket size thermal imager to a highend HD thermal imager. The pocket size thermal imager helps the user to quickly scan the electrical system where he is working for a potential heat map to understand the condition of the machine. The asset tagging feature helps the user to tag the thermal image automatically to the corresponding asset using a barcode. The high-end HD thermal imager has an infrared resolution of 1024 X 768 pixel. With super resolution feature this resolution can be enhanced to 4 times (2048 X 1536 pixel). The product also provides 32x digital zoom.

Fluke also provides a thermal imaging camera with SF6 gas leak detection option. This helps the user to use it in the normal mode for his day to day thermography and in SF6 mode to detect SF6 leak from the circuit breakers, informs Sridharan. He adds, "We also have thermal multimeter that combines a digital multimeter, 2500A clamp meter and a thermal imager in a single tool."



Whether generation, transmission or distribution – all use and need accurate thermal cameras as electrical utilities face frequent problem of critical installations getting heated up.

TP Singh, Sales Director -Emerging Markets-Ins (India, Middle East, CIS, Turkey, SS Africa), FLIR Systems

FLIR has many products being accepted by Indian electrical Utilities but T series has been very successful due to its very useful design, claims TP Singh. It has rotatable optics. T6xx and T1 K has 120-degree rotation and new T5xx has 180-degree rotation of optical block. Since many electrical installations which need to be scanned for temperature are above eye level, this design is very useful. Benefit of this design is, operator does not get stress on wrist, shoulder, neck and eyes while using this range even if this is used frequently. "The ease of use of this great design can be felt only with experience," assures Singh. Ð





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# **Energy Monitoring**

# Energy Monitoring Need in Buildings

The article shows how the safety of the utility equipment as a system is ensured against the breakdown related deviations by prompt monitoring of their energy consumption.

The building needs electricity and energy monitoring now to ensure equipment in a building are working safely, rationally and optimised for the sustained energy and health of buildings. The lights, fans, pumps and the AC equipment, DG set, water heaters etc need to be metered first in terms of KWH and run hours so that the cumulative run hours and the accumulated KWH of the utility will show the healthiness of the equipment that are running for many years. This article shows how the safety of the utility equipment as a system is ensured against the breakdown related deviations by prompt monitoring of their energy consumption.

#### Electrical Incoming Parameters

The case study building is a residential gated community multistoreyed apartment of say 100 flats which has a transformer of 250 KVA capacity. (These case studies can be applied to any commercial building as well). Here, are the steps to be taken during installation and maintenance. The steps towards energy monitoring need based on safety aspects are:

- In the EB incoming MV panel, install a high voltage or low voltage relay which will give audio visual alarm whenever the 415 volts side Voltage is going High or Low below 400 and above 415 volts setting done in the relay.
- The transformer is having OLTC, mostly Off Load Tap Change over function in the old buildings (in the latest building only, On-Load-

Tap-Changer Transformer has come). We have to monitor the 415 Volt side and set the tapping correctly such that it is around 400 to 410 volts band that is equal to 230 to 235 volts single phase. The lights sustain longer at 200 volts.

d **Le** 

Many gadgets in the building will consume more power and break down prematurely when the individual flats are receiving more than 250 volts, so Transformer Off-Load Tap Changer to be set optimally and that the electrical breakdowns can be minimised and power consumption of the



Pump System Parameters



individual flat is getting reduced as well.

- If the building transformer does not have the Tap-Change-Over provision, the individual flats to install the suitably rated KVA Automatic Voltage Stabiliser except for AC, and water heater circuits inside the flat. The AC, fridge and TV stabilisers definitely must have On-Delay timer, so as to avoid heavy voltage surges to these gadgets. In many instances, we find these gadgets fail simultaneously when there is power interruption from EB grid. This can be avoided.
- Building to have only maintenance free earthing electrodes so that earth protection is steadily ensured for decades.
- Install surge protection device (to

guard against the switching surges from outside the building) at the Secondary of the Transformer or at the Incoming of the LT service and especially at the Lighting Switch Boards.

• Very often due to electricity leakage in lighting in un-occupied areas, fire mishaps happen. This is one of the silently ignored factors that need to be taken care of. Also, never over-squeeze cables inside the concealed electrical conduits.

Open well Sub pump Single Phase 1.5 HP consumes 12 Amps, Single Phase 2 HP pump consumes 28 Amps.

• The bore well sub pump, open well sub pump in the Sump etc are to be electronically monitored against overloading, underloading of current (happening due to pump Dry Run), single phasing protection upto the pump end, apart from the current unbalance between the phases. This is fool-proof and reliable compared to thermal relay protections. The pump control panels to be fitted with KWH meter and run hour meter for each pump. This will show the relative water consumption, referring its power consumption and pump's name plate.

• Any pump motor, if fitted with the above two meters, will show the pump healthy running parameters like the loading with reference to its name plate, this can be generalised not only for the buildings but also for the industry. Further, the flow

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# **Energy Monitoring**







**Diesel Generator DG Working Parameters** 

of water delivered per hour approximately is calculatable now, with reference to the pump's name plate LPM, water in liters per minute and running KW.

- Take the case study of 2 HP and 1.5 HP single phase Open well sub pumps used for each block of flats to pump water from sump to overhead tank. The sub pump rated 1.5 HP of block I consumed 12 Amps, and this is normal, whereas the Block II sub pump rated 2 HP Single Phase consumed 28 Amps, and its overload relay was bypassed too. This is abnormal. The capacitors inside the pump panel were failing frequently and the electrician used to replace routinely after few days of operation and kept it running, since no failures from pump end noticed.
- The pressure gauge at each

pump delivery was showing around 3 Kgsc pressure. So, it was assumed the pumps were running normal, but 2 HP pump's power consumption was more than twice the normal pump's power consumption, and increase in month's EB bills.

On diagnosing the pump circuit, the flat 3 core cable was run in a GI pipe conduit for 15-meter distance from EB room to sump pump, and the whole length of GI pipe conduit was full of water inside, that got entered in the pipe due to seasonal rains from inspection pit. On visually inspecting the cable by pulling out, near to the sump pump location, the cable was found damaged and the inside bare copper strands of the cable were touching the water and GI pipe inner wall. Having identified the

earth leakage, the Electrician immediately cut that damaged portion of cable and re-jointed the cable back.

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QUARTZ

HOURS

- Now, after rectifying that fault, the 2 HP pump was run and found the current dropped to 12 amps from 28 amps. So, the pump had consumed twice the power consumption per hour, and this pump runs daily around eight hours. So, the Earth Leakage in that damaged cable when goes un-noticed is an unsafe condition, hazardous, waste power consuming and needs to be attended on war footing.
- If this earth leakage can happen here to one domestic pump and does not come to notice. then visualise thousands of motors driven machines or pumps etc in the industries, need to be



Air Conditioner Healthy Working Symptoms - Freon Pressure Band Outputs For The Given Power Input To The Ac. As A Consumer, Do We Know Freon Pressure Range I

As A consumer, bo we know he contressure hange.				
Low Side	High Side	Duct Temp	Possible Cause	
Low	Low	Warm	Low refrigerant charge	
High	High	Warm	Overcharge of refrigerant	
High	High	Some Cool	Air in the system or Overcharge	
Normal	Normal	Warm	Moisture in the system	
Low	Low	Warm	Expansion valve stuck closed	
Low	Low	Warm	Orfice tube plugged	
Low	Low	Warm	High side restriction	
High	Low	Warm	Compressor or control valve failed	

Air Conditioner Parameters

Continued on page 36



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# Energy Monitoring

#### Continued from page 34

ampere monitored routinely from safety angle. When safety fails, conservation fails and pollution (breakdown hazard) starts.

- While talking about the input electric power consumption in terms of KW, the same has to be multiplied by the actual running hours daily or weekly or monthly or yearly as KWH - the energy consumed by the machine over the period of time. So, this run hour meter is mandatory measure the cumulative to energy now and also to know the machine output for the given averaged power input in units per hour for the given period of time. For DG, UPL, units per liter of diesel is the key parameter. KW, KWH, Run hour meters are mandatory now for buildings.
- Consumers are used to low cost subsidised electricity from the EB national and state grid till now. And today due to power cuts, they are forced to run DG set to meet statutory demands, but at high cost of electricity. After generating the electricity KWH from their own DG set, one is aware of the high cost of precious KWH.
- It is wise to rightly undersize the DG KVA rating (and not to oversize) during procurement and in operation, the DG to load at an optimum of 50 per cent loading above and operate the DG set so as to get at 400 – 405 volts instead of 420-430 volts. This gives instant savings in diesel. The DG's UPL in buildings to maintain around 2.5 in practice.
- Though consumer wants DG set as an emergency standby in case of power cuts, it is practically

seen, in many places the DG is operated at 10 to 20 per cent loading, and the user can get only 1 KWH unit per liter of diesel ie 1 KWH cost is equal to Rs 60, a huge waste. DG when runs at 35 per cent efficiency, and at NO load at output, the DG consumes tare load diesel, say a 62.5 KVA DG set consumes 6 liters of diesel per hour at zero output, this is idling consumption.

- It should be ensured that the single-phase loads are distributed evenly across the three phases so that the unbalance between 3 phases is not more than 10 per cent of total DG set capacity. More the unbalance, this will lead to less UPL.
- Since the running cost of DG is so high, plan the use of DG rationally when required only and load the same optimally. Make the DG as standby for emergency indispensable services, like the Lift and use the ACCL Automatic Current Circuit Limiter to limit the Wattage during DG run in each flat, and in common utilities.

AC's Freon charging and running pressures matter most now. This can be monitored using IN-Situ Pressure Gauge inside. An undercharged AC runs for more hours for the given room's cooling requirements. An overcharged AC consumes more power for the same room's given cooling requirements.

• This KWH meter is fitted to the AC power circuit to measure ACs cumulative KWH over a period. And the Run hour meter is wired from the AC compressor cutin cut-out circuit to know the AC compressor Run hours. Both meters will show AC's running health and efforts towards energy savings done or not.

- Now Split AC erectors install the AC stabilizer near to the Outdoor unit, so as to reduce the line drop voltages from the Stabilizer to the AC compressor. But it is always better to assess AC health by knowing both the parameters like AC compressor Run Hours, AC machine Run Hours, and AC KWH in its Run hours to condition monitor AC efficiency.
- During AC installation, add a KWH meter (priced from Rs 500 onwards) along with the runhour meter costing Rs 300/- now consumer can analyse whether he or she is running equipment uselessly as a liability or he or she is fully utilising the equipment to its optimum efficiency?
- So, for steady-Watt loads like tube light, fridge, storage water heater, room heater etc, consumer can think of simple retrofit of hour meter and for the varying KW loads and can plan to add 3 phase 4 wire KWH meter with CT or direct connect type.

#### Lighting System Parameters

- Here, the lighting circuit also needs to be checked for its loop parameters and against earth leakage. One Lighting OEM supplied lakhs of LED tube lights to the group of textile mills few years back, on condition that, to extend the warranty clause, OEM insisted that each LSB must have maintenance free earthing protection and SPD device to protect tube lights against the switching surges from the heavy motor loads surrounding to the soft lighting loads.
- As and when the light or row of *Continued on page 38*
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### Energy Monitoring

Continued from page 36



STP plant blowers to run intermittently cyclically. Each blower to be fixed with KWH and run hour meters

lights is installed and switched on, consumer has to check and confirm with the plug-in Power Guard PG meter, the power consumption in watts, VA, PF, KVAR are okay at that instant, as they are constant watt loads only.

On the LED tube light installation, the light is steady only when earthing is correct. In one case study, the electrician by mistake hammered a nail on the concealed electrical conduit by mistake. And the LED tube light started flickering after that for some time and failed instantly. After any LED tube light replacement in place of existing old tube lights, we have to confirm the basic power parameters are all okay, to complete the LED tube lights replacement program.

#### Sewage Treatment Plant Workings

The blowers in STP plants are more in number in these multi-blocked apartments, and run for more hours of the day to maintain the oxygen demanded by the STP plant. Practically, this area is neglected by the building users. And they don't replace the paper filter in time, at suction of blower for years. Instead, they need to retrofit on top now, a cubicle mesh box doubles the volume

of the actual paper filter. Daily take out the pre-filter Fine Netlon mesh box and swipe clean with brush to ensure steady air intake volume.

Provide an ordinary U tube Manometer to show the air intake suction filter choke condition. The blower runs for more hours in achieve the BOD/COD function, if its air intake filter is choked. Also, if the twin-lobe blower's internals are poorly maintained, this leads to higher blower-discharge temperature, and this leads to poor running efficiency of blowers. Here, we can install a temperature gauge with alarm function to alert against falling efficiency.

#### Conclusion

In Energy Management, buying energy efficient equipment is only half done. How efficiently user load and run the equipment is the vital half of energy day-to-day management by the users in buildings and industries now.

Energy measurement is the first step towards the energy management, whether daily or weekly or monthly logging of consumption depends on the usage and how the individual responds proactively. User must know what is the utility machine's daily consumption as compared to the total consumption per day either

in domestic or commercial segment.

Also, if more than one machine is there in premises, relative condition monitoring of daily KWH of two or more machine will prompt or provoke the consumer why the daily KWH difference between two or more machine in premises? The difference in KWH daily readings will prompt and motivate the energy conscious consumer to conserve energy, promptly.

So, Bureau of Energy Efficiency (BEE) can also give thrust and enforce the utility OEM to incorporate the energy monitoring of the 5-star rated equipment performance at the consumer end like retrofitting the KWH & Run hour meter on the same. Monitoring of the gadgets or appliances will prompt the user to adapt to energy conservation mode naturally and this makes both the ends meet in the National Mission of Enhanced Energy Efficiency in the Energy Monitoring and Control Aspects. Ø



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#### Analysis



# India's Energy Storage Market & Opportunities

Advanced energy storage technologies can play an important role in renewable integration, energy access, electric mobility and the smart cities initiatives of the Indian government.

#### Why Energy Storage?

Ever since the existence of an electrical grid, grid operators have been looking for ways to safely and efficiently store energy so that it can be supplied and consumed on demand. Over 170 grid scale energy storage technologies (excluding PHES) are either commercially available or are under development across different regions worldwide. The energy storage technologies landscape is distributed across a variety of systems to ensure we meet our everyday energy needs. This includes mechanical storage like pumped hydro storage, flywheels, compressed air and electrochemical storage such as lead acid, advanced lead acid, lithium ion chemistries, sodium-based batteries, nickel-based batteries and flow batteries. Advancements in fuel cells and traditional thermal storage are also relevant to various emerging applications.

It is also worth noting that energy storage is resource neutral i.e. it allows us to use electricity more efficiently, regardless of the power source. Whether the energy production is from a thermal power plant or wind power from a field of



turbines, energy storage technologies can capture the energy and make it available when it is needed most. It also provides quality and reliable power to the end consumers.

## Government's target of 175 GW by 2022

The Government of India has come up with an ambitious plan to deliver 175 GW of renewables by 2022 and 24x7 power for all by 2019 by creating an efficient, resilient and financially sustainable power sector. Furthermore, India in COP 21 has committed to generate 40 per cent power from clean energy sources by 2032. This objective, along with clean energy access, has become the center of all plans around economic development and environment.

High deployment of renewable energy and its use requires technical as well as commercial solutions and a variety of policy decisions around minimising the impact of intermittency and enabling grid integration of renewable energy. The falling costs and rising efficiencies of the supporting technologies, such as energy storage, are already making the generation of renewable power compete with conventional thermal power. Such technological advancement and cost reduction in both the renewable energy and energy storage options will facilitate the exploitation of the abundant renewable resources.

Energy storage technologies can provide an array of services

to modern grid such as peak load management, grid balancing and renewable energy integration. Historically, storage systems such as pumped hydro were deployed for energy arbitrage; however, emerging distributed energy storage technologies are currently used in many other areas such as grid balancing and renewable energy integration in addition to energy arbitrage.

Globally, renewable energy along with energy storage is being increasingly seen as an alternative to building peaking power plants. Energy storage integrated with renewable energy generates a smooth and firm output that is controllable, which subsequently



optimises transmission investments. A key application for energy storage in transmission is to defer the investments on upgrade for new capacity projects required to reduce renewable energy curtailments.

#### India's Energy Storage Market

Most of the batteries currently consumed in India comes from China, Korea, US, Japan and Europe. Manufacturing of new technology batteries is still not happening in India. There are no Li-ion cell manufactures in India but few companies have established Li-ion assembly in India. In the consumer electronics space, importing and assembling has been feasible so far for India and if tax benefits are provided by the government, indigenous manufacturing can pick up.

In 2018, India's total energy storage market from stationary applications was around 24 GWh. During 2019-2025, the cumulative potential of energy storage is estimated to be between 270 to 365 GWh on a business-as-usual and best-case scenario respectively. Several policies supporting the growth of energy storage in grid scale application are in the draft or proposal stage which is likely to get approved in the short term and expected to drive the market. Demand for energy storage in Behind the Meter (BTM) applications will account for ~70 per cent of the cumulative market during 2018-2026. Inverters and telecom towers have a major share of the BTM market. SLDCs or RLDCs or DISCOMs would need to be mandated or incentivised to procure a minimum percentage of their reserves needed for frequency regulation through electric storage. 2018-19 witnessed several renewable

plus storage projects being floated by NTPC, SECI, State utilities/ agencies such as AP Transco, Himachal renewables Ltd for peak management, DSM settlement, energy shifting, voltage support. Large ESS tenders such as the 3.2 GWh AP Transco and 3.6GWh SECI project announcements indicate the positive growth of the market during the forecast period. Besides, Central Electricity Authority (CEA) advocates storage systems for the capacity to accommodate 2.5 per cent of RE generated in a day in all projects to curtail 1 per cent of RE generation so as to maintain a Minimum Thermal Load (MTL) on Thermal power plants.

The overall projection of Energy Storage System in India for behind the meter (BTM) sector is 22 GWh during the period 2018-2026 on the base case scenario. The increasing grid availability will reduce the market growth for traditional inverter-backup markets however the capacity installed will continue to rise owing to increase per capita energy consumption, and growing demand from the rural and suburban commercial and residential sector. The inverter battery market was the largest contributor towards the BTM market installations in 2018, and continues to be so till 2026. Telecom sector contributed nearly 24 per cent towards the BTM market in 2018. The sector has a significant penetration of Li-ion batteries due to its adoption by one of the fastest growing players (Reliance Jio) in their telecom towers. Rooftop PV Policy subsidies, dropping battery prices and increasing electricity tariffs, energy storage with rooftop solar is expected to pick up in the

short term. The rural electrification sector majorly constitutes the solar home lighting systems under Saubhagya scheme, solar street lights under AJAY scheme, and microgrids. 2018 market was driven by Saubhagya SHLS deployment; however, the sector looks unattractive due to lack of policies existing in the market to drive it beyond 2020.

#### **Policy Support**

In March 2018, Minister for Power and New and Renewable Energy, R K Singh chaired a meeting with batterybased energy storage manufacturers to set up manufacturing units in India. The meeting not only focused on the government's push on electric vehicles (EVs) and its expected surge in the coming years, but also on future tenders that cover hybrid solar and wind projects to be coupled with energy storage.

Under the proposed National Energy Storage Mission (NESM), the government will soon release a policy with a focus on 'Make in India' and the government is planning to take all possible measures to incentivise advanced energy storage manufacturing in India. NESM also addresses the issues related to the raw materials available for manufacturing and the government had already started discussions with resource rich countries such as Bolivia and Australia.

India signed a Memorandum of Understanding (MoU) with Bolivia for development and industrial use of lithium—a prime component used in batteries for electric vehicles. The recently launched the National Mission for Transformative Mobility with Phased Manufacturing Program for li-ion battery manufacturing by NITI Aayog. Ministry of Heavy Industries has launched FAME -2 (Faster Adoption and Manufacturing of Electric Vehicles) incentives with a budget of Rs 10,000 crore. India is also focusing on domestic manufacturing for all types of energy storage technologies including advanced lead acid, thermal storage and ultra-capacitors apart from Li-ion batteries. Ministry of Science and Technology is also keen to accelerate domestic R&D capabilities to support this growing industry through Mission Innovation.

#### Conclusion

Advanced energy storage technologies can play an important role in renewable integration, energy access, electric mobility and the smart cities initiatives of the Indian government. We are at a critical stage for building a manufacturing ecosystem for advanced energy storage technologies in India. Around the globe, 200 over GWh of advanced energy storage manufacturing capacity is already built and another 200 GWh of new capacity will be built within the next three to five years. IESA is very closely working with both state and central government bodies like NITI Aayog, MNRE, MoP, DST, MEITY, DIPP, DHI and other intergovernmental departments. Due to global competition and economies of scale, it is recommended that minimum capacity for a Li-Ion cell manufacturing is 1 GWH production per year. As per estimates, for cell manufacturing, 1 GWh capacity would need an investment of up

to \$300 million. Looking at the potential, India has to create a 10 GWh capacity by 2020, India could attract investments to the tune of \$3 billion with in next 3-4 years. And as this happens, ancillary development including module development, containers, transformers, inverters could need an equal amount of investment, taking the total potential to \$6 billion. With appropriate government support, industry participation, India will be one of the top markets for energy storage adoption and manufacturing. A

he Industri



**Debi Prasad Dash** 





The article gives a glimpse of smart grid technology that represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency.

smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. This system allows for monitoring, analysis, control and communication within the supply chain to help improve efficiency, reduce energy consumption and cost, and maximise the transparency and reliability of the energy supply chain. The smart grid was introduced with the aim of overcoming the weaknesses of conventional electrical grids by using smart net meters.

The smart grid represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency that will contribute to economic and environmental health. During the transition period, it will be critical to carry out testing, technology improvements, consumer education, development of standards and regulations, and information sharing between projects to ensure that the benefits we envision from the Smart Grid become a reality.

#### Four features of smart grids

- **Flexible**: They make it easier to manage variations in generation and consumption better.
- **Reliable**: Thanks to the information sent in real time and the remote management of the grid, the risk of power failures and incidents is reduced.
- Accessible: All the different sources of energy can be integrated into the grid and, thanks to interconnections between grids, consumers can also take advantage of renewable energy generated in large quantities in neighbouring countries when there isn't enough in Belgium.
- Savings: Better management leads to reduced costs.

#### Smart Grid Components

To achieve a modernised smart grid, a wide range of technologies should be developed and must be implemented. These technologies generally grouped into following key technology areas as discussed below.

Intelligent Appliances: Intelligent appliances are capable of deciding

when to consume energy based on customer pre-set preferences. This can lead to going away along toward reducing peak loads which have an impact on electricity generation costs. For example, smart sensors, like temperature sensor which is used in thermal stations to control the boiler temperature based on predefined temperature levels.

Smart Power Meters: The smart meters provide twoway communication between power providers and the end user consumers to automate billing data collections, detect device failures and dispatch repair crews to the exact location much faster.

Smart Substations: Substations are included monitoring and control non-critical and critical operational data such as power status, power factor performance, breaker, security, transformer status, etc. Substations are used to transform voltage at several times in many locations, that providing safe and reliable delivery of energy. Smart substations are also necessary for splitting the path of electricity flow into many directions. Substations require large and very expensive equipment to operate, including transformers, switches, capacitor banks, circuit breakers, a network protected relays and several others.

#### Need for Smart Grids in India

According to the Ministry of Power, India's transmission and distribution losses are amongst the highest in the world, averaging 26 per cent of total electricity production, and as high as 62 per cent in some states. These losses do not include non-technical losses like theft etc.; if such losses are included, the average losses are as high as 50 per cent. India losses money for every unit of electricity sold, since India has one of the weakest electric grids in the world. Some of the technical flaws in the Indian power grid are - it is a poorly planned distribution network, there is overloading of the system components, there is lack of reactive power support and regulation services, there is low metering efficiency and bill collection, etc.

A lacuna of renewable resources is that their supply can be intermittent i.e. the supply can only be harnessed during a particular part of the day, like day time for solar energy and windy conditions for harnessing wind energy, also these conditions cannot be controlled. With such unpredictable energy sources feeding the grid, it is necessary to have a grid that is highly adaptive (in terms of supply and demand). Hence, the opportunities





Smart Grid

for building smart grids in India are immense, as a good electric supply is one of the key infrastructure requirements to support overall development.

#### Benefits of Smart Grid

The benefits associated with the Smart Grid include:

- More efficient transmission of electricity
- Quicker restoration of electricity after power disturbances
- Reduced operations and management costs for utilities, and ultimately lower power costs for consumers
- Reduced peak demand, which will also help lower electricity rates
- Increased integration of largescale renewable energy systems
- Better integration of customerowner power generation systems, including renewable energy systems
- Improved security
- Reduction in cost ultimately help keeping the prices of goods and services lower than they would be otherwise
- Virtual elimination of blackouts
- Improved infrastructure boosts economic development
- A more robust transmission grid will accommodate larger increases in wind and solar generation i.e. green energy.
- Downward pressure on prices through improved operating and market efficiencies
- Creation of new electricity markets — enabling society to offer its electricity resources to the market and creating the opportunity to earn a revenue stream on such investments as demand response, distributed

generation, and storage

- Deferral of capital investments as future peak loads are reduced and more accurately forecasted through the combined efforts of consumers and delivery companies
- Reduced consumption of KWh's through conservation, demand response, and reduced transmission and distribution (T&D) losses
- Reduced CO2 emissions
- Improved public health.

#### Disadvantages of Smart Grid

Following are the drawbacks or disadvantages of Smart Grid:

- Continuous communication network should be available.
- During emergency situation, network congestion or performance are big challenges in smart grid system.
- Cellular network providers do not provide guaranteed service in abnormal situations such as wind storm, heavy rain and lightning conditions.
- Some smart meters can be hacked which can be used to increase or decrease the demand for power.
- It is expensive to install smart meter as compared to traditional old electricity meter.

#### Challenges faced by Smart Grid Technology in India

Even though this would be a good system for India, there are several challenges facing the implementation of this system. The main challenges that policy makers faced are:

• High operating costs and benefit constraints by the regulatory framework. Since

there is a necessity for a large communications network, it escalates the capital and hardware cost to a great extent. This might prove dear to the exchequer. The smart grid may be a profitable option in the short run but in due course of time misaligned policy and regulatory incentives might make the investment less attractive.

- The successful operation of the smart grid requires seamless connectivity of technology. In India, communication technology is at par with many developed nations in the world. But in many areas related to communication the extent of which is required for a smart grid, the technology is at the initial stages of development. This will reduce the positive impact during delivery of services.
- Even if the technological developments are aligned there is the issue of integration of the entire hardware system to manage high volumes of data. It requires complex data models to manage the various data formats that flow into the system. As of now, there is no such system in India and it needs to be developed.
- Lack of awareness among the customers is yet another issue that policy makers will face. Since the system needs to be adopted by customers, they need to be made aware of what a smart grid is and how it could make their life better.



#### Dr. Lata Gidwani

Associate Professor, Rajasthan Technical University, Kota, Rajasthan

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#### Interview



center will help customers to explore, purchase and experience Crabtree's most intuitive and advanced range of products.

# to Customers

#### Vivek Yadav, Senior Vice President, Havells India Ltd.

In order to offer holistic experience to the customers and a peak into future technologies, Crabtree – a well-known brand of Havells India Limited, plans to set up 100 Futuristic Smart Experience Centres across the country in the next 2-3 years. In an interview with Subhajit Roy, Vivek Yadav, Senior Vice President, Havells India Ltd. talks about the business strategy and future plans for Crabtree brand.

Havells acquired the India brand rights of Crabtree way back in 2006. What's your strategies to take this brand to the next level? Crabtree, a 100-year old British legacy brand for premium range

of switches and home automation. is synonymous with aesthetically designed products and maintaining highest levels of engineering excellence which has helped the brand to retain its leadership position since its launch in 2002. Way back in 2006, when we acquired the brand, the focus was primarily on switches and domestic switchgears. However, as the brand has evolved, we are focusing more and more on electronics i.e. home automation and IoT based products which are aimed at making the life of consumers more convenient and smarter.

Our target audience is premium and high-end users i.e. HNIs and we are also looking at addressing architects, interior designers, designer community at large through our own teams. We are also looking at using our existing channel partners who are addressing high-end customers through our premium products to create experience center in their own shops and also sell Crabtree range of high-end products to their existing customers. As the technology is becoming simpler to use, easy to install, easier to manage, it is now possible reaching to wider customer base.

Secondly, we are not just looking at targeting the absolute top-end premium segment but today's aspirational customer-base as well. Since every homeowner has an



aspiration of upgrading himself and using certain products to upgrade his lifestyle. So, we are looking at different budget levels where we can address those needs of consumers through aspirational products.

## Are you looking at expansion of Crabtree's product range?

India is an aspirational country and at Havells, we are committed to launch products that cater to the changing preferences and rising sophistication among our valuable customers. Therefore, we would be launching products which are innovative and future-ready i.e. IoT or Internet-enabled. So, from this perspective, there is a lot of work which is going on in creating Crabtree platform where all the devices in a house whether it is kitchen, AC, TV, sockets and switches everything can be controlled through the Internet. Going with this philosophy, we are set to launch Smart Socket, a first of its kind Wi-Fi-enabled socket which fits in the existing socket of the home and any non-intelligent device such as microwave, geyser or air-conditioner can be controlled through your mobile.

In our existing range of home automation "Smart Wirefree", we offer plethora of products to our customers.

#### Electric switch technologies have evolved over the years. What's next for Crabtree?

We have recently launched SmartH switch, a first of its kind modular

glass finish touch switch which is a blend of beauty with intelligence and fits in the existing switch box. These switches can be operated by connecting with Internet and may be operated via smartphones as well. These smart switches offer unique benefits such as easy installation, various control options (fans, curtains etc.), mood setting or dimming lights, voice control as compared to any other products available currently in the market today.

# Why smart cities are a golden opportunity for Indian electrical industry?

The government's "Smart Cities" is widely expected to push demand for quality electrical equipment



G-17, Bharat Industrial Estate, T. J. Road, Sewree (W), Mumbai - 400 015. India. Tel. : 022-27754546, 24156638, 24124540, 27750292 / 0662 E-mail :sales@kusam-meco.co.in

#### Interview

and thus, opens up massive growth opportunities for electrical equipment manufacturers. Since there will surge in construction activity, the demand for high quality switchgears is bound to see a quantum jump.

Apart from smart cities project, the government's various other schemes such as Make in India, Digital India, Integrated Power Development Scheme (IPDS) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) are committed towards development of new infrastructure and revamping of the existing infrastructure in the country thereby improving India's standing on the global arena.

# Discuss on Havells's most significant offering in the smart city domain.

Havells is fully geared up to tap the growth potential in the government's ambitious Smart City project and has developed new technologydriven lighting products and home appliances to cater to the demand of innovative and quality electrical consumer products in the country.

The company has developed innovative LED solutions for street lighting that offer a centrallycontrolled monitoring system enabling remote-controlled operations of street lights, energy analysis and fault monitoring. In regards to this, Havells is providing an end-to-end solution, right from conceptualising, design, in-house production to installation, testing and commissioning including maintenance. Havells is also offering a centrally controlled monitoring System (CCMS), which enables remote-controlled and scheduled operations of the lights, energy analysis, fault monitoring, etc. Also, exhaustive smart street lighting solutions for smart cities with in-house developed technology is ready in the stable.

Apart from this, in order to tap the growth potential in the power sector in India, we have already enhanced our manufacturing capabilities from 5 lakh lamps to 25 lakh lamps per month, so that it assists the government's plans for increased efficiencies in the power sector.

With a dedicated state-of-the-art in-house huge production facility for fixture manufacturing, we at Havells are all set to support the government's initiatives. We are now only focussing on the manufacturing of LED lights which have huge growth potential and currently contribute 75 per cent to our lighting division's turnover.

#### What's your strategy behind launching the Experience Centre in Jalandhar? How many such stores are in pipeline?

Today's consumers are aspirational, are ready to uplift their lifestyle and want to make a statement by embracing intuitive products. The Internet-based smart technologies are adapted by consumers for convenience and in order to cater to this demand in a unique way, we have introduced our first Crabtree Smart Experience Center in Jalandhar which will provide holistic experience to the customers i.e. live experience of the smart products under one roof offering instant solutions for specific needs related to modern homes.

Our smart experience center will help customers to explore, purchase and experience Crabtree's most intuitive and advanced range of products such as smart range of switches, switchgears, security systems and home automation products based on IoT and other futuristic technologies

We are planning to launch 100 such experience centers across India in the next 2-3 years.

#### Finally, what is your view on how things are likely to shape up post 2019 General Election?

We are hopeful that the new government will continue to work towards the improvement of the sector and revamping power of the existing infrastructure through schemes such as Smart Cities Mission, Make in India, Digital India, Integrated Power Development Scheme and Atal Mission for Rejuvenation and Urban Transformation. We would wish the government to take continued efforts towards the augmentation of power sector and also strengthen power distribution. 0

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## Surge Protection reinvented – Safe Energy Control Technology

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# Protecting Power Grid Automation Systems

The article gives a glimpse of functionalities of power grid, its automation and control system, communications. Potential cyberattacks and their adverse impacts on power grid operation are discussed, a general SCADA cyberattack process is presented. The article also discusses the major challenges and strategies to protect smart grid against cyberattacks.



Picture Courtesy: Steag / VGB Power Tech GmbH; www.commons.wikimedia.org

he recent discovery that hackers have inserted software into the US electrical grid, which would allow the grid to be disrupted at a later date from a remote location, clearly demonstrates the fact that the utility infrastructure is quite vulnerable and that its overall mission of serving the population could be severely compromised as a result of unexpected man-made or natural disasters. As other industry sectors are already experienced with arming automation systems with modern

information technology (IT), the power grid is also facing the trend of integrating the electrical infrastructure with information infrastructure, and it is experiencing a profound change towards the smart grid. This change not only moves power automation systems from outdated, proprietary technology to using common technologies—personal computers, Microsoft Windows, and TCP/IP/ Ethernet, but also brings the isolated and closed network of power control systems into the public network. The integration of different systems, originally without consideration of security protection and mechanism, results in tremendous cost and performance benefit to the power industry, as well as arduous challenges of protecting the automation systems from security threats, especially when the public network is used. It is misleading to suggest that IT people should take the full responsibility for power grid network security including automation and control networks. Compared with regular IT systems, power automation systems have different goals, objectives, and assumptions on what needs to be protected. It is important to understand what 'real time performance' and 'continuous operation' of a power automation system really means and to recognise that power automation systems and applications were not originally designed for the general IT environment. Therefore, it is necessary to embrace and use existing IT security solutions where they fit, such as communication

within a control center, and develop new solutions to fill the gaps where IT solutions do not work or apply. This article discusses conceptual layered framework for protecting power grid automation systems against cyberattacks.

# Scope and Functions of the Power Grid

From the power flow viewpoint, the input to the power grid is high voltage (100 kV or above) power, stepped up by the power plant transformer from the low voltage power produced by the generators. The output of the power grid is electricity at medium or low voltage (less than 100 kV), stepped down by transformers in substations, and delivered to commercial, industrial, and residential consumers.

The major functions of power grid are performed in three different levels: corporate, control center, and substation. At the corporate level, the following major functions of both business management and operation management are performed:

- Planning—plan of equipment and line upgrades based on forecast of load and generation sources, market conditions, and system utilisation;
- Accounting—management of contracts and bids with other market participants;
- Engineering—system design and engineering for transmission and distribution lines and automation systems;
- Asset management monitoring, replacement, and maintenance plan of equipment and lines;
- Historical information system an online historical database is commonly used to retain all telemetry data, operator actions, alarm summaries, etc., for a periodic of time that ranges typically from 3 to 24 months. At the control center level, the



Figure 1: Power grid automation system

#### Automation



Figure 2: Gateway security solution

following major real-time and nonreal-time functions are performed:

- Forecast short-term forecasting of load and power generation sources;
- Monitoring—monitoring of system state, activity, load, equipment conditions;
- Operation switching operation, changing setups, starting emergency procedure, performing system restorations, etc.;
- System analysis—model update, state estimation, contingency, and stability analysis, power flow analysis;
- R e c o m m e n d a t i o n recommendation of preventive, corrective, and optimised operations;
- Fault or alarm processing locating fault and intelligent processing of alarms;
- Training—operator training;
- Logging—archiving logs and reports;
- Data exchange—exchanging data with ISO (independent system operator) or RTOs

(regional transmission organisation), power plants, consumers, and peer transmission and distribution system operators.

At the substation level, the following major real-time and non-real-time functions are performed:

- Normal operation—collecting data and alarms and sending them to control center, executing commands issued by control center;
- Exchange of protection data between the RTU and IEDs within the substation. Relay devices perform protection, control and indication gathering functions;
- Emergency operation—power system protection, load shedding, recovery from load shedding, shunt control, compensation control, etc.;
- Engineering—protection engineering, automation engineering, line engineering;
- Logging—archiving logs;
- Maintenance—equipment and line maintenance.

#### Power Grid Automation Systems

A typical grid automation system, as shown in Fig. 1, is an integration of one or more control centers, with each center supervising multiple substations. The power grid automation system is a layered structure and performs data collection and control of electricity delivery. At corporate level, some functionalities are related to the automation system. For example, planning plans for the amount of electricity that must be generated for the next day. A control center typically includes devices such as an energy management system (EMS), human-machine interfaces (HMIs), and a front-end processor (FEP) translates which different communication protocols—for instance some legacy RTUs in substation use DNP 3 and new ones use IEC 61850. Substations contain remote terminal units (RTUs), programmable logical controllers global (PLCs), positioning system (GPS) sync timers, HMIs, communication devices (switch, hub, and router), log servers, data concentrators, and a protocol gateway. Other intelligent electronic devices (IEDs) include field devices, such as instrument transducers, meters, tap changers, circuit reclosers, phase measuring units, and protection relays.

#### Power Grid Communications Systems

In order to deliver electrical power from power producers to consumers economically, power grid system operators have to *Continued on page 56* 

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#### Automation

Continued from page 54



Figure 3: Proposed three-layer architecture

Figure 4: Security service proxy solution

exchange data with power producers, ISOs, RTOs, consumers, and peer system operators. As shown in Fig. 1, at control or operation center level, dedicated lines are widely used and Inter Control Center Protocol (ICCP) is deployed as the communication protocol. Local area network (LAN) and Internet Protocol (IP)-based protocols are usually used for the communication link between corporate and control center; IP-based protocols, such as DNP3.0 over TCP, are widely used for the communication link between control center and substations. Wireless technology is also deployed for this communication link. The current SCADA systems provide HTTP(S), Secure Shell (SSH) ports for remote connections.

#### Current Security Solution

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A gateway security solution, as shown in Figure 2, is currently widely used to protect power automation system from external cyberattacks. All incoming data packets to a substation are inspected by the security gateway.

#### Major Challenges and Strategies of Security Solutions for the Smart Grid

To address security issues of the smart grid, it is necessary to identify those unique challenges. There are four major challenges when developing new network security solutions for power grid automation systems.

- Many automation components (such as RTU) use proprietary operating systems, which are designed for control functionality and performances, but not security.
- Automation systems use heterogeneous network technologies, such as ProfiBus, ModBus, ModBus Plus, ICCP, DNP. Most technologies and protocols were designed for connectivity, without consideration of cybersecurity.
- 3) Most automation systems are combinations of new and legacy components with many systems expected to run up to 20 or 30 years, perhaps even longer.
- 4) Since power grid is experiencing

a profound change and moving to smart grid, there are new applications (such as using phasor measuring units and smart meters) and corresponding new requirements for data communication in terms of bandwidth, delay, and new communication protocols.

The strategies to design a security solution for smart grid are as follows:

- Scalability is the system's ability to increase or decrease its capacity to protect larger or smaller size of power grid automation systems in a graceful manner.
- Extensibility—which refers to a system designed to include hooks and mechanisms for expanding and enhancing the system without having to make major changes to the system infrastructure.
- Interoperability—a property referring to the ability of diverse systems to work together. Since power grid automation systems use various technologies with *Continued on page 58*





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Continued from page 56

#### **Multi Level Security**



Figre 5: Multilayered integrated security framework

respect to hardware, operating systems, and communications protocols, the security framework and components must be able to work together regardless of the technology on which they are executed or developed.

- Non-intrusiveness—which refers to the system's ability to be subjected to security activities without compromising its control functionalities and performance.
- Flexibility—which is the ability to adapt to various needs in the development and at runtime.

# The Integrated Security System

To meet the challenges discussed in the previous section, we propose

an integrated security framework with three layers (power, automation and control, and security), also called common security platform, as shown in Figure 3. The automation and control system layer monitors and controls power grid processes, while the security layer provides security features. Since the security layer provides clear demarcation responsibilities, of control functionalities and security functionalities can be decoupled during design stage. Data related to security management flows on this layer. Another important idea is that the proposed security solution replaces the gateway security solution by a security service proxy solution, which is shown in Figure 4. There are three key security subsystems: Security Agent, Security Switch, and Security Manager. Security Agents and Security Switches, which are security enforcement devices, run as security service proxies; and Security Manager runs as a security management device either in the control center or in a substation. The proposed integrated security framework operates on three hierarchical levels, as shown in Figure 5. Each of these levels is protected by a component of our security system listed below:

- Device level, in which electronic devices, such as RTU and IED, are protected by the Security Agent;
- Network level, in which communication bandwidth is protected and delay is guaranteed by the managed security switch;
- Operation level, in which security policies are orchestrated and managed by the security manager.

#### Security Agent

The security agents bring security to the edges of the system by providing protection at the device level—it applies to both wired and wireless devices. These agents are firmware or software agents depending on the layer of the control hierarchy. At the field device layer (e.g., IEDs), these agents will be less intelligentcontaining simple rules and decision-making capabilities-and whose primary responsibilities consist of event logging and reporting. At the substation level (eg, RTUs), these software agents will be more intelligent with more



complex rules for identification and detection of intrusive events and activities within the controllers. In particular, a security agent will be commissioned to accomplish the following functions:

- To translate between different protocols;
- To acquire and run the latest vulnerability patches from its security manager;
- To collect data traffic patterns, system log data and report to the security manager;
- To analyse traffic and access patterns with varying complexity depending on the hierarchical layer;
- To run host-based intrusion detection;
- To detect and send alarm messages to the security manager and designated devices, such as HMI;
- To acquire access control policies from the security manager and enforce them;
- To encrypt and decrypt exchanged data (end-toend security).

#### **Managed Security Switch**

Managed switches are used across the automation network to protect bandwidth and prioritise data packets. These switches, working as network devices, will connect controllers, RTUs, HMIs, and servers in the substation and control center. Managed security switches possess the following functionalities:

- To separate external and internal networks, trusted and non-trusted domains;
- To run as a dynamic host configuration protocol (DHCP) server;
- To run network address translation and network port address translation (NAT/NPAT) and to hide the internal networks;
- To acquire bandwidth allocation patterns and data prioritisation patterns from the security manager;
- To separate data according to prioritisation patterns, including operation data, log data, trace data, and engineering data;
- To ensure qos for important data flow, such as operation data, guaranteeing its bandwidth, delay, etc.;
- To manage multiple virtual local area networks (VLANS);
- To run simple network-based intrusion detection.

#### **Security Manager**

Security managers, with a graphical user interface (GUI), reside in the automation network and directly or indirectly connect to the managed switches across

the automation networks. They can be protected by existing IT security solutions and will be able to connect to a vendor's server and managed switches via VPN. The security manager will possess the following functionalities:

- To collect security agent information;
- To acquire vulnerability patches from a vendor's server and download them to the corresponding agents;
- To manage keys for VPN;
- To work as an authentication, authorisation, and accounting (AAA) server, validating user identifications and passwords, authorising user access rights (monitor, modify data), and recoding user changes to controllers;
- To collect data traffic pattern and performance matrix from agents;
- To collect alarms and events;
- To generate access control policies based on collected data (using data mining techniques) and download them to agents;

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### Automation



Figre 6. Different implementations of security agents

- To run complex intrusion detection algorithms at control network levels;
- То generate bandwidth allocation patterns and data prioritization patterns (possibly through data mining techniques) and download them to managed switches.

#### Security Engineering System

Security engineering system is used to create, configure, manage, monitor, and troubleshoot the integrated security system project. The project navigator is the common view for all tools of the engineering system. It offers a common list of all controls and data and generates the runtime configuration data. The engineering system acts as a centralised data and program administration. In this project, the security engineering

system was not developed. Some functions of the security engineering system will be implemented in the security manager.

#### Intrusion Detection

Traditionally, automation systems are subjected to more constrained behaviour as compared to enterprise networks. Automation networks possess:

- relatively static topology;
- regular communication patterns;
- limited number of protocols;
- simple communications protocols.

#### Implementations of Security Agents

It would be very costly if one standalone security agent protects each electronic device. To make it more cost-effective, security agents are implemented in four different ways, as shown in Figure 6:

- individual 1. An two-port module-the internal is connected to the protected device (such as RTU and HMI), the external port connected to a network device (such as switch, router);
- 2. An individual two-port module—the internal is connected to a group of electronic devices (such as meters or protection relays), the external port connected to a network device (such as switch, router);
- 3. Agent resides in a managed security switch—a virtual security agent runs on an internal port connected to the protected device;
- 4. Agent resides in all newly developed devices (such as log server, PLC, RTU) — runs independently of control firmware.

#### Conclusion

This article first introduces functionalities of power grid, its automation and control system, communications. Potential cyberattacks and their adverse impacts on power grid operation are discussed, a general SCADA cyberattack process is presented. Further, it discusses the major challenges and strategies to protect smart grid against cyberattacks.



#### Dr L Ashok Kumar

Professor, Dept. of **Electrical & Electronics** Engineering, PSG College of Technology, Coimbatore

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# Control & Management in Power Operations

The tasks involved in the control and management of an interconnected electric power system are grouped. The first group covers the direct operational control of the system as a daily routine. The second group involves short-term scheduling, including the near future



he problems that arise in system control and management are solved on models, using programming. A model is an intermediate process which is used for analysis of the prototype process. In economics, a model is a set of equations based on certain assumptions that describe the national economy as a whole or a part thereof. Among the problems facing the control and management of large power systems, the most important is the search for a better method of power system optimisation:



# Tasks in control and management

The tasks involved in control and management of an interconnected power system are divided into three groups:

Group I - (from seconds to hours)

This group includes the direct operational control of the power system. The control engineer does this as a matter of daily routine. The tasks include involving normal steady-state, normal transient state, abnormal state, post-fault or restorative (transient and steady) state.

#### Group II- Short-term

## **management cycle** (from days to weeks to months)

The tasks in this group involve short-term scheduling, including the near future.

#### Group III- Long-term

**management cycle** (from one to several years)

This group involves long-term cycles, that is, long-term planning and forecasting. This group may include planning the level of operation for a day, or forecasting loads for the next month. However, in most cases forecasting refers to longer and planning to shorter periods of time.

The details of tasks involved in the three groups are given below:

#### Tasks involved in Group 1 - (from seconds to hours)

Normal steady state:

- Optimal system regulation on hourly basis, including active and reactive power dispatch at power stations and substations equipped with reactive power sources
- Frequency and power

interchange control over tie lines (including limits of interchange)

#### Normal transient state:

- Routine system switching operations
- Frequency and active power interchange control over tie lines (including limits of interchange)
- Optimum system scheduling on hourly basis
- Optimum economic and var dispatch at stations and substations with reactive power sources
- Voltage control at system centres
- Load limiting and load shedding (scheduled outages)- order to lower control levels

#### Abnormal state:

- Integrated operation of automatic failure clearing means, including:
  - switching in networks (system sectionalizing and area isolation)
  - automatically connecting to inter-system and trunk lines
  - Emergency load shedding
  - Control of mechanical and electrical braking for generators
  - Emergency regulation of generator excitation and voltage at system centres
  - Limiting active power at stations.
- Regulation of frequency and active power flow over transmission line in emergency. Post-fault or restorative (transient and steady state)
- Integrated operation of automatic state-restoration means including:
  - Switching in network,

re-synchronisation of isolated system parts, restoration of disrupted connections (including loads)

- change-over to hot and cold stand-by sources
- Frequency and active power control
- System dispatch including
  - Economic and var dispatch for stations and substations with reactive power sources
  - Voltage regulation at system centres.

#### Tasks involved in Group 2 (from days and weeks to months)

Short-term management cycle

- Forecasts on active and reactive loads at system centres (on daily and monthly basis)
- Forecasts on river runoff
- Calculation of static operating states of the system
- Calculation of short-circuit currents
- Calculation of protective relay settings, and creating a selectivity chart
- Selection of gains of regulators for excitation, speed, transformers etc.
- Selection of failure-preventive control settings
- Analysis of steady-state stability, and determination of maximum power interchange over power transmission line
- Transient analysis and determination of maximum power interchange over transmission lines under dynamic stability
- System reserve dispatch (monthly, weekly, daily), including:

## Energy Optimisation

- Selection of plant mix
- Selection of plant for cold standby
- Maintenance scheduling on monthly basis.
- Determination of interoperation logic for automatic controls and regulators in case of emergency
- Determination of logic for restorative conditions
- Inflow, usage and spillage for hydro reservoirs and cascaded stations (on weekly and monthly basis)
- Outage scheduling
- Monthly power balance and power generation for system areas.

#### Tasks involved in Group 3 (from one to several years)

Long-term management cycle

- Forecasts on active and reactive loads at system centres
- Forecasts on reserve run-off
- Forecasts on steady-state load characteristics for system centres
- Processing of emergency and failure statistics
- Calculation of static operating states for the system
- Calculation of short circuit currents
- Selection of gains for regulators(excitation speed ,transformers etc.)
- Selection of settings for automatic failure-clearing means
- Steady-state stability analysis

and determination of maximum power flow over transmission line under steady-state conditions

- Transient analysis and determination of maximum power flow under dynamic stability conditions
- Reserve dispatch ( on yearly basis) including:
  - Selection of plant mix in operation
  - Selection of plant for coldstandby
  - Scheduling of mail plant.
- Determination of interoperation logic for automatic controllers and regulators in emergency conditions
- Determination of logic for postfault (restorative ) system state
- Calculation of automatic frequency regulation on semiannual basis
- Calculation of over-voltages (internal and atmospheric)
- Inflow, usage and spillage scheduling for hydro reservoirs and cascaded stations on annual and quarterly basis
- Calculation of maximum and optimal levels of operation
- Scheduled load outage
- Annual power balance and power generation for system areas.

#### Conclusions

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Among the problems that face the control and management of large power systems, the most important

is the search for better and novel methods of power system optimization. It is necessary to work out newer mathematical models that could reflect the actual hierarchical structure of very large systems. It is necessary to look for reliable methods for building such models.

It is also necessary to set up a system which would gather, process and present data, evaluate the effects of data corruption, and advance both theoretical and experimental work on data transmission.

The problems that need solution before а reliable management information system can be set up for the power industry are interrelationships between large power systems and the national economy and the biosphere, which the is environment, in the broad sense of the word.

It is essential to study the principal directions in which the power system in the country may develop in the next few years, and evaluate the prospects of using more renewable energy sources and the converting means in the existing power system.



#### C. S. Indulkar

Rtd. Professor Head of Electrical Engineering Department, IIT Delhi

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# Future Solar Panel would use tricks of LIGHT HARVESTING ALGAE

Researchers claim that light-harvesting algae could increase solar panel efficiency to 95 per cent.

ight emitting microalgae have been surviving in all sorts of environment for billions of years and in the process, it picked up a few tricks for harvesting light as efficiently as possible. Little light reaches algae that resides at a depth of one meter or more in seawater, as light is absorbed by seawater. These fluorescent algae are able to capture up to 95 per cent of available light using a novel method, a way much better than our most efficient solar panels are able to do. Researchers are finally getting an idea of how they do it and how we potentially can do the same. The technique these light emitting microalgae use, could help us develop the next generation of solar panels.

Using advanced mass spectrometry methods. where ionisation is used to analyse chemical and structural properties the organisms, scientists of could get more insightful look at two types of microalgae namely cyanobacteria and red algae. So how are they such efficient solar converters? The surfaces of these microorganisms are anchored with a mass of light harvesting antenna called phycobilisomes which are protein complexes. The geometrical arrangement of a phycobilisome is very elegant and results in 95 per cent efficiency of energy transfer. Each phycobilisome consists of a central core of one type of protein

(types of protein). The triangular core is assembled from three stacks of disc (size - 12 nm diameter and about 6-7 nm thick) shaped subunits. Radiating from the triangular core are several rods of about 12 nm in diameter. Each outwardly rod consists of stacks of about 6 discs, each disc of about 6 nm thick. They act as the bridging pigment between phycobilisome and photosynthetic lamella. This increases the surface area of the absorbing section and helps focus and concentrate light energy down to the reaction centre to the chlorophyll lamella in less than 100 ps time. With these phycobilisomes or antennae, the microalgae are able to capture 95 per cent of the light that reaches them. Absorption of a photon by a molecule lead to electronic excitation when the energy of the captured photon matches that of an electronic is called resonance energy transfer and the rate depends strongly on the distance between the energy donor and energy acceptor molecules. Light harvesting complexes have their pigments specifically positioned to optimise these rates and they are located around the reaction centre.

to the Industry

One factor that makes photosynthesis so efficient is that it occurs at incredibly high speeds. During the process, sunlight hits a light trapping pigment 'chlorophyll lamella' that energises an electron, causing it to fly across the cell's membrane in billionths of a second. The electrons make its journey via a series of specially located pigments referred above, which, evolution has finely tuned to create what is essentially a one-way path. In contrast, in case of conventional solar cells, the electron can easily bounce back across the membrane,



incu uigu

called allophycocyanin which sits

above a photosynthetic reaction

centre (RC), from which several

outwardly rods made of stacked

discs of three other types of proteins

branch out. The central triangular

core is composed of allophycocyanin

and that the peripheral rods contain

phycocyanin and phycoerythrin

transition. The fate of such excitation can be a return to the ground state or another electronic state of the same molecule. When the excited molecule has a nearby neighbouring molecule, the excitation energy may also be transferred, through electromagnetic interactions, from one molecule to another. This process losing its energy and rendering the whole process very inefficient.

If we are able to use the same technique, then the potential boost for renewable energy would be huge, considering the majority of mainstream photovoltaic cells we have at the moment operate in 10 - 20 per cent efficiency range. The

#### Solar



Attachment of biomolecular complex to substrate

ingenious control panel that algae use to convert sunlight into energy is more complicated than a swiss watch. Armed with the knowledge of how light harvesting algae and other plants harness power from sun, a team of researchers from Vanderbilt University started work to make a solar cell mimicking its mechanism. More than 40 years ago, scientists discovered that one of the proteins involved in photosynthesis, called photosystem 1 (PS1), continued to function when it was extracted from plants like spinach. Then they determined PS1 converts sunlight into nearly 100 per cent efficiency. When a PS1 protein is exposed to sunlight, it absorbs the energy in the photons and uses it to free electrons and transport them to one side of the protein. That creates regions of positive charge, called holes, which moves to the opposite side of the protein.

To make the prototype, Vanderbilt team extracted PS1 from spinach or microalgae into an aqueous solution and poured the mixture on the surface of a p-doped silicon wafer. Then they put the wafer in a vacuum chamber in order to evaporate water away leaving a film of protein. They found

that the optimum thickness was about one micron, about 100 PS1 molecule thick. Protein alignment is very important. In a plant, all the PS1 are perfectly aligned. In earlier prototypes made by the researchers, PS1 were oriented randomly and that was a major problem. Those PS1 that are oriented in one direction provide electrons, while those that are oriented in opposite direction pull electrons out of the matrix. As a result, both positive and negative currents are produced that cancel each other out to leave a very small net current flow. The secret to overcome this problem is doping silicon wafer. The p-doped silicon overcomes this problem to a great extent, because it allows electrons to flow into PS1 but will not accept them from proteins. In this manner, the electrons flow through the circuit in a common direction. It is reported that the prototype PS1/p-doped combination silicon solar cell produces about one milliamp of current per square centimetre at 0.3 volts. The reason the combo works well is because the electrical properties of the silicon substrate have been tailored to fit those of the PS1 molecule. This is done by implanting electrically

charge atoms in the silicon matrix to alter its electrical properties: a process known as "doping". In this case, the protein worked extremely well with silicon doped with positive charges and worked poorly with negatively doped silicon. A prototype of size 1,800 mm x 1,800 mm solar panel with about 1,000 numbers of this centimetre sized cells connected in series has been made.

Studies on photosynthetic protein based solar cells and quite a number of such cells have been made, show that initially they achieved high photocurrents, but they are shortlived and they can hardly produce any photocurrent after a week which is indicative of some kind of degradation with time. As the major photovoltaic components in these solar cells are biomolecular complexes, it is vital to understand their vulnerability in a foreign environment. The biomolecular components often lack a protective environment in the solar cells which deteriorates their functionalities, ensuing short-lived solar cells. The in-vitro stability of reaction centres (RC) needs to be improved. As RCs are isolated from their native environment, they are prone to conformational changes as the stabilizing effect offered by the membrane lipids is lost. Lipids play an important role in affecting the biophysical and electron transfer properties and promote structural stability and flexibility. Further much work will have to be done to make this route commercially viable. 0



Rathindra Nath Biswas,

Head (Retired), MECON, Durgapur, West Bengal



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#### Renewable Energy

# Hybrid Renewable Energy Technologies for Rural India

Hybrid energy systems can be potential solutions for the electricity problems in the rural region. However, vast research is needed in this aspect to make it technically feasible to be deployed at these areas.

Reliable access to electricity is a basic precondition for improving people's lives in rural areas, for enhanced healthcare, education, and for growth within local economies as well as to meet millennium development goal in 2018. At present, more than 70 per cent people in India do not have access to electricity in their homes. Almost all of these people live in rural areas; most have scanted prospects of gaining access to electricity in the near future.

Energy is a key component of any poverty eradication and sustainable development strategy and is critical to the achievement of the millennium development goals. Better access to sustainable energy service for rural people in India is prerequisite for the sufficient supply of lighting, communication systems, and the development of income generating activities as well as the improvement of the public health situation. Today, it is widely accepted that renewable energy system (RES) have a large potential to contribute to the strengthening and development of national sustainable energy infrastructure in many countries in the world by securing better energy independence through the mobilisation of domestic renewable energy resources especially in rural areas.

The Indian Government tried to connect this rural location by using national grid extension for the last two decades. However, still the current electricity access is below 50 per cent and the real connection is less than 14 per cent. In this scenario, the rural people who have very low load demand with dispersed settlement will not get electricity in the near future. India being rapidly growing economy with an average GDP growth rate projected around six per cent over the past two decades; still the development aspect of rural areas is yet alarming. Though country have got a vast hydro electric potential but due to major river water distribution





Figure 1: Recycling Energy from Fuel Cell



Figure 2: Hybrid system of biomass gasification and array Wind Turbine

conflicts these cannot be harnessed.

Thus, in order to promote the development in remote areas there is a requirement to develop a sustainable and efficient energy system to deal with the persistent electricity problems in these areas. With cutting edge growth in renewable energy sector, these can be viewed as a potential solution for current situation, infact hybrid systems could be look forth as a prior solution to such kind of issues. The present generation capacity and estimated potential has been estimated in the table 1.

Tenewable energy sources in mula	
Source	Total Installed
	Capacity (MW)
Wind Power	34,046
Solar Power	21,651
Biomass Power	8,701
Waste – to – Power	138
Small Hydropower	4,486

Table 1: Installed capacity of ranawahla anargy sources in India

Presently, scientists and engineers around the globe have been supporting the utilisation of renewable energy resources. Since these are abundant, though dilute and variable, locally available, almost and don't contaminate the

environment, simplicity in onsite generation. Since, it is dilute and variable in nature, many complexities exist in conversion, condition, control, coordination etc. They are utilised as a standalone system serves many applications i.e. lighting system, water pumping for irrigation, traffic control etc. But it is costly, unreliable, and requires individual conditioning and controlling units. In this challenging atmosphere, hybrid energy system (HES) is one of the feasible solutions to harvest energy from renewable energy resources.



Figure 3: PV/wind hybrid energy system



Figure 4: Laboratory material for Solar-induced hybrid fuel cell from biomass

#### Renewable Energy



Figure 5: Solar-induced direct biomass-to-electricity hybrid fuel cell

#### Overview of Hybrid Renewable Energy Systems

Hybrid energy system usually comprises of two or more renewable energy sources combined in such a way to provide an efficient system (Figure. 1). In other words, it can be said that hybrid energy system is a combination several (two or more) energy sources with appropriate energy conversion technology connected together to feed power to



Figure 6: Hybrid power – integrated solutions with renewable power generation

local load or grid.

Since, it is categorised as a distributed generation system, there is no unified standard or structure. It is beneficial in terms of reduced line and transformer losses, reduced environmental impacts, relived and distribution transmission congestion, increased system reliability, improved power quality, and increased overall efficiency.



#### Types of Hybrid Renewable Energy Systems Biomass-wind-fuel cell

Consider a load of 100 per cent power supply and there is no renewable system to fulfil this need, so two or more renewable energy system can be combined. For example, 60 per cent from a biomass system, 20 per cent from a wind energy system and the remainder from fuel cells (Figure 2). Thus, combining all these renewable energy systems may provide 100 per cent of the power and energy requirements for the load, such as a home or business.

#### Photovoltaic-wind

Another example of a hybrid energy system is a photovoltaic array coupled with a wind turbine (Figure 3). This would create more output from the wind turbine during the winter, whereas during the summer, the solar panels would produce their peak output. Hybrid energy systems often yield greater economic and environmental returns than wind, solar, geothermal or trigeneration stand-alone systems by themselves. **Solar-Induced Hybrid Fuel** 

#### Cell from Biomass

Researchers have developed a new type of low-temperature fuel cell that directly converts biomass to electricity with assistance from a


Geographical feature	Type of HRES applicable	Recommendations
High Altitude	Biomass-wind-fuel cell, photovoltaic-wind, photovoltaic-biomass	Photovoltaic-biomass
Mountain	Biomass-wind-fuel cell, photovoltaic-wind, photovoltaic-biomass	Photovoltaic-biomass
Plain	Photovoltaic-biomass, hydro wind, solarflower, combined HRES plant, biomass-wind, photovoltaic-wind	Combined HRES plant
Semi Desert	Wind-fuel cell, wind-photovoltaic, wind-biomass, photovoltaic- biomass, photovoltaic-wind-biomass	Photovoltaic-Wind- Biomass
Desert	Wind-fuel cell, wind-photovoltaic, wind-biomass, photovoltaic- biomass, photovoltaic-wind-biomass	Photovoltaic-Wind- Biomass

Table 2: Suitability of different HRE system on basis of geographical terrain

catalyst activated by solar or thermal energy. The hybrid fuel cell can use a wide variety of biomass sources, including starch, cellulose, lignin — and even switchgrass, powdered wood, algae and waste from poultry processing.

A new solar-induced direct biomass-to-electricity hybrid fuel cell can operate on a variety of fuels. The fuel cell, shown on the right (Figure 4), relies on a polyoxometalate (POM) catalyst (shown in the vials) which changes colour as it reacts with light.

Electrons in the biomass (Figure 5) can be transferred to polyoxometalate (POM) under sunlight irradiation, and reduced POM can deliver the charges to the anode. These electrons are then captured by oxygen in the cathode.

#### Completely Renewable Hybrid Power Plant

Completely Renewable Hybrid Power Plant (solar, wind, biomass, hydrogen) a hybrid power plant consisting of these four renewable energy sources can be made into operation by proper utilisation of these resources in a completely controlled manner (Figure 6). **Hydro-wind** 

One of the fastest expanding sources of renewable energy is the

wind energy. The stand-alone wind energy systems may not be able to cater the demands of specific loads owing to the low wind speeds and high unpredictability concerns. A wind-hybrid energy system comprises of the wind energy system combined with one or more other renewable energy systems and a suitable backup system in the form of batteries bank or diesel generator. Combined operation in the form of hybrid system (Figure 7) enhances the reliability and compensates for the drawbacks perceived in standalone systems.

Rural areas in India amounts to about total land area of country and about 75 per cent of population of country reside in these areas. The living condition here are very unhealthy and people lack here basic facilities like electricity, water supply, education, roads etc. In order to bring people living in these areas in mainstream and to prevent large scale migration from these areas to metropolitan cities, we need to develop some sources that can fulfil their basic needs amongst them vital classification to be electricity. And in this case hybrid renewable energy systems can prove to be a major cutting-edge solution for these problems.

The classification of suitability of various techniques in hybrid renewable energy sources (HRE) given in table 2 could prove to a solution and in what type of region on the basis of geographical pattern and location of that particular region. The suitability of different systems on basis of the geographical features is mentioned in table 2.

#### Conclusion

Though hybrid energy systems could be potential solutions for the electricity problems in the rural region yet vast research is needed in this aspect to make it technically feasible to be employed at these areas. The prime focus of study should be the cost of the system and its output.





**Dr. Sujit Kumar** Department of Electrical and Electronics Engineering, NIET, Greater Noida

## RE Technology

# New Renewable Source Developments

The article gives a glimpse of new technologies being used in renewable energy systems for improving efficiency and output. Solar and wind energy farms are becoming common, but current energy systems by themselves will not be able to meet entire requirements of the world, considering the limitations of these

sources as also those energy storage of systems. These may not be sufficient to reach goal of pollution free energy, and there is scope for some new additional technologies, if the goal to make fossil fuels extinct has to be achieved in good time. There have been efforts by a number of researchers and organisations to develop newer sources and methods

Tidal Turbine Sea Level

of energy generation and storage.

New technologies are being used in heat pumps, electronic equipment as also in solar and wind systems to improve their efficiencies and output. Following technologies

> are being added to the cart in energy development systems:

#### **Tidal energy**

Tidal energy is one of the major renewable sources in the world, but as yet in infant stages. Motion of natural water currents and rivers can be used to run mechanical devices to produce power. This can be done in number of ways.

i. Tidal stream





generators use kinetic energy of running water to power tidal turbines, similar to wind turbines. This method is preferred due to its lower cost and least ecological impact. Dynamic tidal power uses both the kinetic and potential energy of moving water. This is done by creating very long dams across coasts right into the sea, without specifically enclosing an area. This method has a downside in that it can have adverse effects on natural habitat and ecology.

- ii. Tidal barrages are built across full width at mouth of an estuary. Water is stored in barrages on high tide. Difference in levels during low tides is used for generating electricity similar to hydropower plants. This method has limitations due to lack of enough available sites worldwide, and may also affect the ecology of river system.
- iii. Oscillating water column uses waves to compress air in a closed chamber to generate wind and run turbine. Wind is created when water enters and recedes from chamber. Turbine is designed so that its direction does not depend on wind direction. One such plant of 500 KW capacity is in operation since 2000 in Scotland at Islay island.
- iv. Tapered channel (TAPCHAN) devices use waves to pump seawater to an elevated reservoir. By energy conservation principle, as the wave width decreases, the amplitude increases, enabling the wave travel up a ramp and pour into the reservoir. Trapped water is then released back to run a turbine for generating electricity.

#### Benefits of tidal energy

- Tidal power is not much vulnerable to weather and season, and power is uniform all the year (since tides are predictable), with only minor variations.
- ii. No fuel needed to operate, and no waste products.
- iii. Long term and operating costs are low compared with conventional energy sources.



## RE Technology



Gestation periods for these plants are quite long, and no power can be generated till they are complete. Payback periods are therefore longer. Batteries cannot be placed near them in sea. Though a new technology, it has high potential. UK is looking forward to 200-300 MW tidal wave generation capacity by 2020, and see a potential of up to 27 GW by 2050. This will be enough to meet 12% of current UK demand.

Blue Shark Power System, France has signed an MoU with the Republic of Djibouti for supply of 495 of River Tidal Turbines, with a capacity of 240 kW each, making a total capacity of 120 MW. They have planned to test one turbine in the first half of 2019. First 80 machines are scheduled for the first half of 2020. The country will become energy independent once the project is completed.

Credit for the largest tidal project in the world goes to South Korea at the Sihwa Lake Tidal Power Station, with an installed capacity of 254MW. Built in 2011, this also used a 12.5 km long seawall built in 1994 to protect the coast against flooding and to support agricultural irrigation.

Orbital Marine Power, UK, is

developing a tidal turbine system, which is claimed to be the most powerful tidal generating platform in the world. They plan to deploy their 2MW Orbital O2 turbine at the European Marine Energy Centre, in Orkney, in 2020. This will be 73 m long floating structure having two turbines of 1 MW each, with 20 m rotor diameter. The capacity is rated for wave speed of 2.5 m per second, and adds up to generation of 48,000 KWH per day at full load.

#### Geothermal Energy

Geothermal energy from hot springs and geysers has been historically used for cooking, bathing and heat. Civilizations have used it throughout past 10,000 years, as is known from history. Number of places on earth use it today, mainly for heating and cooking purpose. At many places, hot water comes naturally to surface, and its use is easy. Sources for geothermal energy can be from shallow hot water springs and rocks, to few kilometers down the earth surface as extremely hot molten rock.

Efforts are on to pump water deep into rocks in dry land areas, and circulate the water to get heat to surface. Direct use of geothermal energy applications give heat at 50 -150°C, and can be used for room or space heating, and some low temperature applications. In Iceland and New Zealand, among others, buildings are heated by this hot water, and about 50 per cent energy approximately gets trapped this way. This system has problems of salts and impurities, which need to be returned to earth.

Geothermal heat pumps at shallow depths can be used to heat buildings or houses. At these depths of under 6 meters, temperatures are more or less stable all the time, and direct heat exchangers can be used to cool or warm the rooms depending upon season and location, and also by circulating air from house through underground pipe system. This takes all the load of air conditioning.



Another method collects rising steam from depths by pumping water in, and use it to run turbines in power generation plant. Pressurized high temperature water is drawn from deep under the earth, and subject it to sudden decrease in pressure to vaporise it. Steam is then used for power plant. It is also possible to circulate heat exchanger fluids to these depths to heat water into high pressure steam for use in power plants.

Geothermal power plants have been in operation in New Zealand, California since 1960s. and today over 80 countries are using geothermal energy. Leaders in the field are China, Turkey. Hungary, U.S.A. and Iceland. Worldwide installed geothermal electrical power plant capacity in 2017 was about 14,000 MW, producing about 84.8 TWh. Waste heat from these plants can be used for low temperature applications before recirculating the heat exchanger fluids through earth. Largest power plant complex is operating at Geysers, USA, consisting of 22 plants, with 1.5 GW capacity.

Geothermal plants can be normally used for 20-30 years, and energy output may decrease with time. Environmental effect of geothermal heat extraction is minimum.

#### **Artificial Photosynthesis**

Artificial photosynthesis is a chemical process mimicking natural photosynthesis process to use CO2, water and sunlight to generate carbohydrates and oxygen. Plants use sunlight and perform huge conversion of over 1000 billion tons of CO2 into organic matter and oxygen every year. They do this using only 3 per cent of sunlight reaching



the earth. Artificial photosynthesis system or photo-electrochemical cells mimicking the plants can create endless source of inexpensive neverending source of gas and electricity, that too, in storable form.

Joint Center for Artificial Photosynthesis, US, came up with an artificial leaf, which uses sunlight to convert energy from sunlight to isolate hydrogen from water. They made prototypes with 3D printers, and in 2015 created system to separate CO2 before it is released into atmosphere, and convert to fuels and other products. Efficiency is claimed at 3 per cent, and they feel it will be viable when the efficiency goes up to 10 per cent.

Most water-splitting devices are made of a stack of light-absorbing materials. Each layer absorbs different wavelengths of full solar spectrum from infrared light to visible or ultraviolet light and generates voltage. These individual voltages together give enough one voltage to split water into oxygen and hydrogen fuel. The problem with this is performance potential of silicon cells that is compromised in this system.

## Converting seawater into jet fuel

US is the largest consumer of fuel in the world, with jet fuel accounting for over 70 per cent of petroleum products. Though submarines can run on nuclear power, jet fuel for aircraft is still needed in large quantities. They were looking for development a process for synthesizing fuel on board, so that dependence on oil tankers to fuel jets could be eliminated. Material science and technology division of Naval Research Laboratory, US has reported developing a way to separate CO2 and hydrogen from seawater and convert these into liquid fuel.

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NRL has filed a patent for a process to produce fuel from sea water. They claimed success with 92 per cent efficiency in CO2 removal, and used the fuel to power a remote-controlled sustained flight. The process involves conversion of carbonates and bicarbonates to CO2, with simultaneous production of hydrogen using metal catalyst in reactor and convert the gases into liquid hydrocarbons. Sea contains over 140 times the concentration of CO2 compared to air.

Sea water is first acidified through ion exchange reaction to pH of 6.5 or lower by exchanging H+ ions for Na+ ions. It is then degassed to obtain CO2, and fed to a reactor to produce jet hydrocarbons. The carbon dioxide obtained by degassing is fed to a reactor with hydrogen to produce hydrocarbons, such as jet fuels. Hydrogen for reactor is also produced from sea water. Cost of jet fuel with this process is claimed to be \$3-6 per gallon.

#### Flying wind farms

A large number of entrepreneurs are targeting the sky to harvest high amounts of energy in winds there. High up in the sky, ground resistance decreases, and winds blow at very high speeds, exceeding

## **RE** Technology



150 Kmph. NASA is reserving funds of USD 100,000 for research for exploring high altitude wind farms. Idea is to have air borne turbines at 30,000 ft above ground level. At these heights, wind has more power and velocity, can be predictable, and power generated can be 8 to 27 times that produced at ground level. Researchers estimate potential of such high-altitude wind turbines to be over 100 times that needed for the entire planet.

One benefit naturally is it will not take any ground space. Turbines may be housed using kites, or can be kept floating using helium filled balloons. NASA is trying with kite designs. The M.A.R.S. (Magenn Power Air Rotor System, in picture) is a helium filled device capable of harnessing wind energy and transporting it down via 330-meter rope. This 4 KW unit is likely to start production soon, and they expect to have 7 more models in coming years.

One major limitation is airspace

restrictions in place so that they do not obstruct or interfere with air traffic. Currently, these limit the heights of turbines to 2000 ft and below. Winds at 2000 feet are 20 times stronger than for landbased turbines at 350 feet high. Theoretically, wind energy grows exponentially with speed.

Sky Windpower, a San Diego is developing a Flying Electric Generator (FEG), a kite-like 1,100pound air-borne wind turbine expecting to build stable flying wind farms in future. This technology will act like vehicles in air space conforming to strict air traffic monitoring so that it does not become hazardous to other flying objects. There is also a challenge in transporting energy harnessed in skies above the oceans towards landbased power plants.

#### 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 pollutionfree 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 in 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 is 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  $1m \times 2m$  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 time 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, helps remover water pollution as well. A German firm Rawlemom 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.

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





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# INNOVA I DNDAY 2019

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## Siemens opens start-up incubator Next47 in India

Sieme

iemens is launching its start-up incubator, solutions that create sustainable value for businesses and societies. The company announced the opening of a Mobility, Future of Energy and Artificial Intelligence. Next47 office in Bangalore.

role in our global digitalisation strategy. Research based in Pune, Noida and Gurgaon where software and software development in India coupled with the sharpened focus on start-up innovations through Next47 with Siemens customers to develop digital innovations will actively drive the implementation of cutting-edge for data analysis and machine learning. technologies. With our unique IoT platform, comprising an inclusive innovation ecosystem, Siemens is well of Siemens AG at Siemens Innovation Day 2019.

"In the digital age, new business models driven by IoT are successful in creating customer value through speed and scale. Dr. Roland Busch, COO CTO and Managing Board Member, Siemens AG

www.electricalindia.in

Around 4,000 IoT and software experts will collaborate Next47, in India with an aim to accelerate with teams around the world to conceptualise, develop, efforts to develop and bring to market innovative test and bring-to-market applications in the areas of Smart Urban Infrastructure, Digital Enterprise, Connected The IoT solutions developed in India will complement "India is a key focus market and plays an important the work done at the MindSphere Application Centers, developers, data specialists and engineers work together

SIEMENS

Sunil Mathur, Managing Director and Chief Executive an advanced technology stack, domain know-how and Officer, Siemens Limited, said, "India needs to harness digitalisation to optimise manufacturing growth. We are prepared to support India into the digital age," said Dr. seeing an acceleration in interest and demand from Roland Busch, COO, CTO and Managing Board Member customers for our digitalisation portfolio. IoT enabled applications are the need of the hour and will focus on contributing to customers' efforts to maximise the potential with digitalisation through data insights."

> Siemens Innovation Day 2019 showcased innovative solutions that create sustainable value for businesses and societies. It was a platform for dialogue around outputdriven, market-oriented technological and business innovations. Siemens experts from Digital Industries, Smart Infrastructure, Gas and Power, Mobility, Corporate Technology and Next47 also shared the latest innovations, industry trends, and demonstrated how Siemens solutions create value for customers and society. 0

## Waaree Energies launches Next Gen Solar module in India

aaree Energies has launched India's first 400 Wp cut cell module series called Super 400 which is touted to be the future of rooftop solar. The Super 400 series is a Mono PERC Module, with a 400Wp output and the Super 400 Pro Module, which is a Bifacial module, with up to 30



per cent higher output. In case of partial shadow, the Super 400 series provides enhanced power output, i.e. over 50 per cent higher than regular best-in-class modules. Manufactured at Waaree's 1.5 GW module manufacturing plants in Gujarat, the module has a life of minimum 25 years, and comes with Waaree Energies' acclaimed maintenance and service.

With product innovation at its core, it has been indigenously developed to give impetus to the growth of the rooftop solar segment. These modules can be deployed with the lowest inter row spacing within a power plant, and hence, the area required for the installation of Super 400 Series modules is less by five per cent to 20 per cent than that required by other modules. Despite the lower requirement of space, the modules provide 8 per cent higher output as compared to some of the bestin-class modules available in the market today. Based on the potential of their new offerings, Waaree is looking at an exponential growth trajectory with significant contribution towards their order book. The Super 400 Series alone is expected to contribute significantly in FY 2019-20.

Sunil Rathi, Director, Waaree Energies, said, "Waaree believes that the best way for India's transition towards a solar reliant country is to promote rooftop solar adoption and maximise output in rooftop projects. Super 400 is a one-of-a-kind doublet module with 400Wp capacity that is aimed at providing higher energy output in such projects. The module is apt for both commercial and residential projects, especially when space allocation is a challenge."

"Moreover, through our expansive network of 270+ franchise units across the country, Waaree is providing customised modules according to the requirements of the project. Our exceptional post-sales service is an added advantage to our partners, and is the reason why we are on the top of the industry's consideration," he added.

he Industri

According to a Bridge to India report, India is likely to add 80 GW in the next 5 years, wherein the contribution of the rooftop segment will be closest to 10 per cent with 8 GW. Rooftop installations have

observed a year-on-year growth of 66 per cent in 2018, but still only make up 12 per cent of the total solar installations in the country. Due to land limitations, extracting the maximum energy out of such rooftop projects is vital to meet the 175GW renewable energy goal by 2022. With this focus on the rooftop market, Waaree expects the entire market to eventually shift to 400Wp modules, owing to their higher output and efficiency, as well as lower space utilisation.

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## Industry Speaks

# HALS 2.0

India's prudence in picking a stable government reflects its biggest strength, our democratic fundamentals. Going forward, infrastructure growth, reskilling of the workforce and deeper tech penetration needs strategic focus.

Gautam Adani, Chairman, Adani Group

www.electricalindia.in

Keeping pace with the growing demand, India's power sector adopted a highly diversified power generation system ranging from hydro to nuclear. In May 2018, out of 25 nations that were measured for power availability ratio, India ranked 4th in the Indo-Pacific region. In fact, during the run up to the 2019 elections availability of power had become an important election issue.

The present Minister for Power RK Singh and other National Democratic Alliance (NDA) candidates had drawn huge crowds only because the government under its Pradhan Mantri Sahaj Bijli Har Ghar Yojana or Saubhagya got electricity connections to 26.28 million households out of 26.30 million households targeted under the Rs 16,320-crore scheme, that is 99.93 per cent success rate.

With such a huge market size and a total installed capacity of 350.16 GW (as on February 2019), India's power sector has been naturally attracting huge investments. The power industry in India attracted **US\$ 14.18 billion in Foreign Direct Investment (FDI) between April 2000** and December 2018, accounting for 3.48 per cent of total FDI inflows. The reappointed Power Minister RK Singh, former Union Home Secretary and a 1975 batch Bihar cadre IAS officer, is known to be a performer and 'difficult to please officer' as far as targets are concerned. But his main challenge will come from service providers who are known to trip on performance and run into huge losses.

> Seshadri Chari, Member, BJP's National Executive Committee





Over the last five years, the Prime Minister has brought in innovative mega missions that have changed the lives of hundreds of millions of citizens, driving a new template for development. With the mandate for another five years under his visionary and strong leadership, the transformation of India is on the fast track.

#### Vikram S Kirloskar, President, Confederation of Indian Industry (CII)

The incumbent government led by the Prime Minister defying antiincumbency returned to power with enhanced mandate not only in terms of number of seats and vote share but also substantially augmented footprint in the states where they were conspicuous by their absence. The PM after the election made a point which can redefine India's political and social spheres as also the economic. He classified Indians into "poor" and those "who can make them come out of poverty". As

somebody blessed with limited ability to read between the lines, would like to think that the latter category would comprise of wealth creating organs of the society. For wealth to be redistributed it needs to be created. It can be created at scale which can double India's GDP in six years only if there is trust in such organ of the society and effective steps are taken to make doing business far easier than what it is today.

> Harish Agarwal, President, IEEMA



## Industry Speaks



This is a massive mandate from the people of India and it's good to have continued stability for the next five years. There is a lot of work to be done and hopefully the new government under the leadership of Narendra Modi will get right to it.

Sumant Sinha, Chairman & CEO, ReNew Power

In the first term NDA government has demonstrated its intent to carry out important structural reforms such as IBC, GST and UDAY Scheme for power sector which are transformational. We expect that 2nd term mandate to NDA will give required emphasis to further ease private sector participation in the power sector by amending the Electricity Act and reforms in DISCOMs. We also need national level policy to harness immense potential of rooftop solar in India. We believe such measures will attract additional capital in the sector and help the government achieve its ambitious renewable energy target which will accelerate India's adoption of decarbonised electricity in fight against global warming.

> Nikunj Ghodawat, Chief Financial Officer, CleanMax Solar





A clear mandate to BJP by the people of India will provide continuity to policies and development agenda. I think all the unfulfilled dreams of the government will now get delivered.

> Hemant Kanoria, Chairman, Srei Infrastructure Finance Ltd

The government will now re-ignite its reforms agenda to push growth, tackle critical issues like creating more jobs, usher in more tax-friendly laws, strengthen India's position in global trade while protecting domestic industry from dumping and create more conducive environment to attract FDI in critical segments like mining and oil & gas. **Anil Agarwal, Chairman, Vedanta Resources** 











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## **Statistics**

Tune	Achievement	Targets	Achievement	% Change of Achievement
туре	Apr-18	Apr-19	Apr-19	w.r.t. Apr-2018
Thermal	93.00	98.96	94.42	1.52
Nuclear	3.31	3.673	3.18	-3.90
Hydro	7.56	9.539	11.09	46.80
Bhutan Import	0.02	0.18	0.24	946.49
All India	103.89	112.35	109.93	4.85





## All India Installed Capacity (MW) Region-wise as on 30-04-19

			Thermal		Nuclear	Hydro	Res**	Grand Total	
Region	Coal	Lignite	Gas	Diesel	Total				
Northern	50360.20	1580.00	5781.26	0.00	57721.46	1620.00	19707.77	14199.02	93248.25
Western	72808.62	1540.00	10806.49	0.00	85155.11	1840.00	7547.50	23078.94	117621.55
Southern	43042.02	3140.00	6473.66	561.58	53217.26	3320.00	11774.83	38620.18	106932.27
Eastern	27463.64	0.00	100.00	0.00	27563.64	0.00	4942.12	1401.48	33907.24
North-East	770.02	0.00	1775.81	36.00	2581.83	0.00	1427.00	324.29	4333.11
Islands	0.00	0.00	0.00	40.05	40.05	0.00	0.00	17.73	57.78
ALL INDIA	194444.50	6260.00	24937.22	637.63	226279.34	6780.00	45399.22	77641.63	356100.19





## All India Installed Capacity (MW) Sector-wise as on 30-04-19

Costor			Thermal		Nuclear	Undro	DEC	Crand Total		
Sector	Coal	Lignite	Gas	Diesel	Total	Nuclear	nyaro	KED	Granu rotai	
State	64076.50	1290.00	7118.71	363.93	72849.13	0.00	29878.80	2347.93	105075.86	
Private	74688.00	1830.00	10580.60	273.70	87372.30	0.00	3394.00	73661.40	164427.70	
Central	55680.00	3140.00	7237.91	0.00	66057.91	6780.00	12126.42	1632.30	86596.63	
All India	194444.50	6260.00	24937.22	637.63	226279.34	6780.00	45399.22	77641.63	356100.19	

RES as on 31.03.2019

#### ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS (As on 30.04.2019)

AS ON 30.04.20 (UTILITIES)

		Mode wise breakup									
Region	Ownership/			Thermal			Undur	RES *	Grand		
	Sector	Coal	Lignite	Gas	Diesel	Total	Nuclear	Hyaro	(MNRE)	Total	
	State	16344.00	250.00	2879.20	0.00	19473.20	0.00	8697.55	699.56	28870.31	
Northern	Private	21680.83	1080.00	558.00	0.00	23318.83	0.00	2514.00	13120.46	38953.29	
Region	Central	12335.37	250.00	2344.06	0.00	14929.43	1620.00	8496.22	379.00	25424.65	
	Sub Total	50360.20	1580.00	5781.26	0.00	57721.46	1620.00	19707.77	14199.02	93248.25	
	State	21560.00	1040.00	2849.82	0.00	25449.82	0.00	5446.50	547.89	31444.21	
Western	Private	34745.67	500.00	4676.00	0.00	39921.67	0.00	481.00	21864.76	62267.43	
Region	Central	16502.95	0.00	3280.67	0.00	19783.62	1840.00	1620.00	666.30	23909.92	
	Sub Total	72808.62	1540.00	10806.49	0.00	85155.11	1840.00	7547.50	23078.94	117621.55	
	State	19932.50	0.00	791.98	287.88	21012.36	0.00	11774.83	586.88	33374.07	
Southern	Private	11874.50	250.00	5322.10	273.70	17720.30	0.00	0.00	37491.40	55211.70	
Region	Central	11235.02	2890.00	359.58	0.00	14484.60	3320.00	0.00	541.90	18346.50	
	Sub Total	43042.02	3140.00	6473.66	561.58	53217.26	3320.00	11774.83	38620.18	106932.27	
	State	6240.00	0.00	100.00	0.00	6340.00	0.00	3537.92	275.11	10153.03	
Eastern	Private	6387.00	0.00	0.00	0.00	6387.00	0.00	399.00	1116.37	7902.37	
Region	Central	14836.64	0.00	0.00	0.00	14836.64	0.00	1005.20	10.00	15851.84	
	Sub Total	27463.64	0.00	100.00	0.00	27563.64	0.00	4942.12	1401.48	33907.24	
	State	0.00	0.00	497.71	36.00	533.71	0.00	422.00	233.25	1188.95	
North	Private	0.00	0.00	24.50	0.00	24.50	0.00	0.00	61.04	85.54	
Region	Central	770.02	0.00	1253.60	0.00	2023.62	0.00	1005.00	30.00	3058.62	
	Sub Total	770.02	0.00	1775.81	36.00	2581.83	0.00	1427.00	324.29	4333.11	
	State	0.00	0.00	0.00	40.05	40.05	0.00	0.00	5.25	45.30	
Islands	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.38	7.38	
Islands	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	17.73	57.78	
	State	64076.50	1290.00	7118.71	363.93	72849.13	0.00	29878.80	2347.93	105075.86	
	Private	74688.00	1830.00	10580.60	273.70	87372.30	0.00	3394.00	73661.40	164427.70	
ALL INDIA	Central	55680.00	3140.00	7237.91	0.00	66057.91	6780.00	12126.42	1632.30	86596.63	
	Total	194444.50	6260.00	24937.22	637.63	226279.34	6780.00	45399.22	77641.63	356100.19	

Figures at decimal may not tally due to rounding off

Source: CEA

## Product Avenue



## Guide data, energy, fluids & air in a very tight space with igus

Fast and smart: the micro flizz safely guides energy, data and media in a confined installation space even at high speeds. For predictive maintenance, users can now integrate the CF.D into the energy chain system.

With the smart micro flizz energy supply system, cables and hoses move reliably at high speeds

G high speeds is a major challenge for many users, for example in intralogistics. With the micro flizz, igus offers a compact energy supply system which travels up to 100 metres. It consists of an energy chain, flexible chainflex cables for tight bend radii and an aluminium guide channel. The micro flizz can now also be used with the new smart CF.D system. This monitors the data transmission characteristics of the cable in advance and promptly warns of a failure.

Narrow compact spaces and fast movement in lanes, such as in storage and retrieval units, are common usage scenarios for busbar systems. Their big disadvantage: they can normally only be used for energy transmission. In order to be able to supply not only energy but also data, fluids and air simultaneously in the horizontal and vertical directions, igus has developed the micro flizz energy supply system. With this, travel speeds up to 6 m/s and accelerations up to 4 m/s2 are possible. The micro flizz consists of a plastic energy chain that travels in an aluminium channel. In addition to highly flexible chainflex control, data and motor cables for tight bend radii, the energy chain can also guide hoses as well as fibre optic cable with data rates of up to 10 GBit/s. Thanks to extensive testing in the in-house 2,750 square metre test laboratory, igus provides a guaranteed

service life of 36 months on all chainflex cables. If the user wants to monitor the transmission characteristics of his used bus cable, igus now offers the option of using the intelligent CF.D system in the micro flizz. The smart plastics innovation detects changes to the transmission characteristics of the cable in advance and provides timely information about an essential replacement. Therefore, maintenance is planned in advance and an unexpected shutdown is avoided.

#### Modular and easy to clean system

The main advantage of the micro flizz, in addition to the optional intelligent monitoring, is its special construction. Integrated "side wings" hold the chain firmly in the stretched condition at all times in a special groove in the upper and lower part of the channel. Together with plastic springs on the crossbars of the e-chain, they provide a soft and quiet rolling. This means the friction, wear, energy consumption and noise development are reduced significantly. Another advantage: Thanks to its modular design, the system is easily accessible and therefore easy to clean. Therefore, the use of the micro flizz is also ideal in the field of pharmacy and food production. The energy chain system is available in three different sizes depending on the diameter of the cables. 0

For more details, visit on www.igus.in

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to the Industry

SEC technology represents an easy-to-install product range for power supply which combines maximum performance, superior durability and space-saving. These surge protective devices provide compact and consistent plug-in design with floating remote indication contact and optical, mechanical status indicator.





## Indian Diesel Genset Market Overview

P&S Intelligence Market Research report estimates that Indian diesel genset market to achieve USD 1,518 mn by 2024 due to high demand and adoption of medium and high horsepower diesel gensets across the country.

The Indian diesel genset market estimated to value USD 1,039.7 million in 2018 is projected to reach USD 1,518.1 million by 2024, demonstrating a CAGR of 6.5 per cent during the forecast period, according to P&S Intelligence Market Research report. This growth is expected to be driven by the high demand and adoption of medium and high horsepower diesel gensets across the country. Furthermore, macroeconomic growth coupled with revival in infrastructure, growth in manufacturing, and increase in commercial construction projects, is expected to boost the demand for these gensets for meeting prime and auxiliary power requirements in several facilities and plants in the coming years.

A diesel genset or a diesel generator set is an integrated system comprising a diesel engine and an electric generator that work in conjunction to produce electricity. The electricity produced by the genset is used for meeting power requirements.

On the basis of power rating, the market is classified into 5 kVA-75 kVA, 76 kVA-375 kVA, 376 kVA-750 kVA, and above 750 kVA diesel gensets. In terms of volume, the category of 5 kVA-75 kVA gensets is estimated to hold the largest share in the Indian diesel genset market in 2018. These gensets are employed in high volumes at residential and small commercial installations, construction projects, and telecom towers. Besides, since these generators are manufactured by a large number of market players in both organised and unorganised sectors, they are generally competitively priced.

Besides, factors such as investments in the telecom





sector and growing installation of tower towers for connectivity in remote locations, coupled with improvements in current network capabilities, are expected to support the demand for these gensets in the Indian diesel genset market.

The Indian diesel genset market is also categorised into commercial, industrial, and residential applications. Of these, gensets for commercial application are estimated to contribute the largest revenue to the market in 2018. This can be mainly attributed to the high demand for diesel generators in telecom towers, commercial offices, hospitals, and hotels. Additionally, growing cloud adoption by public and public players, increasing focus of telecom companies toward high-speed services, and construction of captive and colocation data centers are expected to drive the demand for these gensets during the forecast period.

In terms of volume, nearly half of the demand in the Indian diesel genset market is estimated to be generated by Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, and Uttar Pradesh in 2018. This can be mainly attributed to the high regional demand for these gensets in various application areas, including telecom towers, residential facilities, construction projects, and manufacturing plants, for meeting prime and auxiliary power requirements.

#### India Diesel Genset Market Dynamics Trend

The implementation of Bharat Stage VI (BS-VI) emission standards for internal combustion engines in 2016 and their nationwide rollout expected by 2020 can be viewed as a major trend observed in the Indian diesel genset market.

Under the proposed guidelines, diesel gensets of different power ratings are expected to comply with the smoke limit and other criteria laid out for particulate matter (PM) and gaseous emissions. From a manufacturing standpoint, this is expected to lead to structural reforms and significant technological overhaul in manufacturing and final product configurations. However, the transition is expected to be smooth due to the pre-existing production of standard-compliant products for export markets.

#### Drivers

Growth in end-use industries such as manufacturing and construction is expected to result in the generation of a high-volume demand for diesel generators for commercial applications, thereby, driving the Indian diesel genset market.

The Indian manufacturing industry is poised for growth on account of private and public investments, government schemes, development of special economic zones, and improvement in transportation and logistics network. Diesel generators are widely employed in manufacturing facilities owing to uncertainty, powerintensive production lines, and the need for a reliable backup power source. Thus, growth in the manufacturing industry during the forecast period is expected to drive the demand for diesel generators in the country.

Besides, growth in the residential and commercial real estate market of India has picked up in recent years, on account of increased transparency, rapid urbanisation, and development in the IT/ITeS sector. Increased customer confidence in residential real estate, in coherence with growth in commercial construction projects such as commercial offices, hotels, metros, and telecom towers, is expected to translate into the widespread adoption of diesel generators to meet prime and backup power requirements in the country. Furthermore, construction and localisation of data centers is anticipated to act as an inflection point for the generation of a high demand for these generators, thereby, positively impacting the Indian diesel genset market.

#### Restraints

Increasing penetration of electricity grids and growing implementation of laws and regulations aimed at curbing environmental emissions are expected to hinder the growth of the Indian diesel genset market in the near future.

In recent years, the regulatory agencies in India have adopted stringent regulations for diesel generators owing to the detrimental environmental impact and carcinogenic nature of these gensets. Additionally, the country has made significant progress in energy



Indian diesel genset market for commercial application, by user, units (2024)

generation, with its grid capacity increasing from 199.9 GW in 2012 to 344.0 GW in 2018, complemented by electrification of over 16.7 million areas during the same period. This shift toward power generation through electricity grids has lowered the traditional dependency on diesel gensets across several regions in the country, thus, hampering the growth of the Indian diesel genset market.

## India Diesel Genset Market Competitive Landscape

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

The Indian diesel genset market is characterised by the presence of several organised and unorganised players. The organised sector of the market is highly concentrated, with Cummins India Ltd., Kirloskar Oil Engines Limited, Mahindra Powerol Ltd., and Caterpillar Inc. operating as key players. These players have strong in-house R&D capabilities and offer differentiated portfolios of diesel generator sets.

Besides, the Indian diesel genset industry has witnessed a number of product launches in recent years. For instance, in September 2018, Perkins, a subsidiary of Caterpillar, announced the launch of its six-cylinder, 23-liter 4006 electronic engine. The genset is electronically controlled, is compatible with Perkins EST diagnostic tool, and generates 750 kVA of prime power. The product is manufactured at the company's Aurangabad facility in Maharashtra and is expected to serve a vast customer base in the country in the coming years.

## Advertorial



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#### Using thermal imager with Vane anemometer SMART probe – testo 410i

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Kyoritsu, Japan has a frontline global presence in electrical test and measurement equipment since 1940, with specialised expertise in low voltage test and measurement.

In India, the company has been present for many decades already, offering world-class products optimised for Indian needs at 'just right prices'. Many of these products have for long been the choice equipment of every Indian electrical installation professionals.

Explore new Mixed Signal Power Analyser DEWE3-PA8

DEWETRON is an Austrian manufacturer of precision test and measurement systems designed to help customers make the world more predictable, efficient and

safe. The strengths lie in customized solutions that are immediately ready for use while also being quickly adaptable to the changing needs of the test environment and sophisticated technology of the energy, automotive, transportation and aerospace industries. DEWE3-PA8 is the next generation of mixed signal power analyser from DEWETRON. It meets and exceeds today's demands for reliable and precision analysis of electrical motors, inverters, complete electric/hybrid electric drive trains and other electrical components.

## Precision multi power analyzer for polyphase measurements

- The DEWE3-PA8 Mixed Signal and Multi Power Analyser is the solution for high performance power analysis.
- Gap Lesly record any signal with only one instrument.
- PXI Express Bus Technology ensures high speed throughput.
- Overall power accuracy 0.04 per cent guaranteed.

#### Typical DEWETRON solution

- The precision of the DC and AC voltage inputs (DC ± (0.02% of reading + 0.02% of range).
- AC  $\pm$  (0.03% of reading)) and current inputs DC  $\pm$  (0.02% of reading + 0.02% of range). AC  $\pm$  (0.03% of reading)) is unrivalled in the industry.
- 10 MS/s and 18-bit A/D conversion, as well as the best

linearity of the signal conditioning offers the highest dynamic performance in the whole input range. Because of the low range error, the DEWE3-PA8 achieves the highest accuracy available in the market, even with low range utilization. Precision accuracy is guaranteed throughout the whole analysis, without range switching or gaps in recorded data.

#### One system for all inputs

Modular and Mixed Signal inputs, Isolated high

voltage & current inputs

- High performance auxiliary inputs (e.g. torque, speed, vibration)
- CAN interface with input and output function, Ether CAT and XCP, SCPI over Ethernet
- High number of mid speed inputs for low dynamic

signals (e.g. temperature)

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For more information, contact: info.ei@kew-india.co.in

## **Rish CT with Transducer**

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For more details, visit www.rishabh.co.in



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#### **Book Review**



"Data is the new oil – whoever controls data, controls everything!" — It is truly an alarming statement. It is also said that in the future, wars will be fought over claims to large database.

India is becoming a substantial data consumption market with digital data consumption expected to increase twice as fast as the global rate – from around 0.6 zettabytes in 2013 to 6 zettabytes in 2020. The key drivers for this growth are sectors like insurance, banking, telecommunications, IT, digital commerce, social media, and the government sector. In 2018, the Indian data centre infrastructure market was valued at US\$27 billion, which by 2020 is expected to be

## **'Data Sovereignty'** by Vinit Goenka highlights Data Possibilities

	Title:	Data Sovereignty - The Pursuit of Supremacy
	Authors:	Vinit Goenka along with Lt. Gen V. M. Patil (Retd),
		Lt. Gen Dr. D. B. Shekatkar (Retd),
		Lt. Gen Vinod Khandare (Retd), Lt. Gen Vinod Bhatia
		(Retd), Jayadeva Ranade, and Bharat Panchal
	Foreword by:	A. S. Kiran Kumar, Former Chairman, ISRO
	Publisher:	Penman Books
	Publication date:	Tuesday, May 21, 2019
	Time:	5 to 7 p.m.
	Venue:	BSE Convention Hall, Bombay Stock Exchange
	Price:	Hardcover - Rs 599 or US\$ 14.99
	ISBN:	978-93-89024-02-9
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the second largest market within the Asia-Pacific region.

While India presents а tremendous business opportunity, risks and significant obstacles also exist. Key factors such as regulatory policies, energy, water resource, network bandwidth, and the risk and management of natural disasters are areas identified as preventing market forces playing its due role. The book titled "Data Sovereignty: The Pursuit of Supremacy" identifies the risks and gaps in these areas and attempts to set a clear objective for

regulators to formulate a businessfriendly, unambiguous, and strict policy environment for the data centre business in India.

The book also focuses in-depth on the steps and concrete actions required to build highly capable data centres ensuring data security, and implementation of well-thought-out policies, procedures, and laws on data sovereignty to ensure that India allays all fear of 'Data Colonisation' well in time. According to the author of the book, Vinit Goenka, Secretary, Centre for Knowledge Sovereignty (CKS), the impact of these steps, as presented in the book, would be a radical breakthrough in the ease of doing data centre business in India.

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