

Since 1961

# Electrical India

ISSN 0972-3277

India's oldest magazine on power and electrical products industry



## WHERE DOES OUR POWER SECTOR STAND

**Electrical India** Ranked Among  
World's Top 100 Publications  
in "The Future of Energy"

 **A Chary Publication®**



Scan the QR Code  
to know more  
about EI Website

Follow us on



SUBSCRIBE/RENEW Online • Log on to [www.electricalindia.in](http://www.electricalindia.in)



# Pioneering Digital Transformation in Industry & Infrastructure

Digitalization, decarbonization, and decentralization are increasingly shaping the energy system. Siemens has created an integrated digitalization concept for the entire low-voltage electricity infrastructure. The concept is based on real time exchange of information between products, software, systems, and solutions. Thanks to intelligent SIVACON switchboards, busbar trunking systems, communication-capable components, and professional planning tools that makes all this possible while continuously improving the operational processes and maintenance. SIMOCODE pro is a flexible and modular motor management device with cloud connectivity for low-voltage motors that improves their efficiency. SENTRON Low Voltage components ensure a fail-safe power supply and can be integrated seamlessly into holistic energy efficiency concepts and into building and industrial automation. For starting, protecting, switching, commanding, signaling, monitoring, and responding, we have the SIRIUS portfolio covering every possible industrial control application. The 3RW5 soft starters are ready for a digital future with large volumes of data available whenever and wherever needed, even to our IOT solution – MindSphere.

[siemens.co.in](https://www.siemens.co.in) | 1800 209 1800

**SIEMENS**

# AMC 300

Advanced Programmable Controller



The robust and flexible AMC 300 controller allows you to build resilient solutions for marine and offshore applications. Designed by marine engineers for marine engineers, the Linux-based PLC platform includes industry-proven technologies like EtherCAT and is easy to specify, install, and maintain. The modular architecture ensures maximum design flexibility, and the rugged design and cutting-edge cyber security features ensure years of resilient and trouble-free operation.



**DEIF India Pvt. Ltd.**

602, 6th Floor Town Center – II, Andheri Kurla Road, Andheri (East), Mumbai – 400 059  
www.deif.com - india@deif.in - Ph.: +91 22 42452000

Read more about  
DEIF AMC 300



[www.deif.com/products/amc-300](http://www.deif.com/products/amc-300)



## From the Publisher's Desk

### Indian Power Sector: A Role-model for the Developing World

Sometimes I feel astonished to think of the gradual yet steady transformation of our power sector that has changed our country's status. In today's world, a country's power production & consumption status indicates its industrial capability. Thus, we have a lot to be proud of our power sector, which is the rarest one among all the developing countries. Just with a quick glance, we see: that – in this year only, the International Energy Agency (IEA) has made a forecast that by 2030 India will overtake the European Union as the world's third largest energy consumer.

Also, a recent study by Research And Markets shows that India appeared to be the third-largest power generating country in the world. The total installed capacity in India increased at a remarkable pace of 7.96% during the FY 2010 - FY 2020 period. As of 31<sup>st</sup> December 2020, our country had a total installed capacity of 375.32 GW, transitioning from a power-deficit country to a country with surplus power.

Although, thermal power was the predominant type of installed capacity in India, accounting for a 62.31% share of the total installed capacity in FY 2020, we are gradually and steadily amassing our Renewable Energy (RE) sector. As per the study, RE was the second-leading energy source in India, capturing 23.51% of the total installed capacity in India in FY 2020. The Indian government's ambitious target of installing 175 GW of renewable energy, capacity coupled with the establishment of solar parks and the solar city program has propelled the growth of clean energy in India.

Then, don't you think that as far as the power sector is concerned, our country's clear energy vision and consistent conversion of planning into action have truly worked, and today we are a role-model for the entire developing world?

*Mahadevan*

**Publisher & Editor-In-Chief**

#### Directors

Pravita Iyer  
Mahadevan Iyer

#### Publisher & Editor-In-Chief

Mahadevan Iyer  
[miyer@charypublications.in](mailto:miyer@charypublications.in)

#### Director Commercial

Pravita Iyer  
[pravita@charypublications.in](mailto:pravita@charypublications.in)

#### Editorial Department

P. K. Chatterjee (PK)  
[pkchatterjee@charypublications.in](mailto:pkchatterjee@charypublications.in)

#### Design

Sachin Parabkar  
Jebas Thangadurai

#### Subscription Department

Nafisa Khan  
[sub@charypublications.in](mailto:sub@charypublications.in)

#### Accounts Department

Dattakumar Barge  
[accounts@charypublications.in](mailto:accounts@charypublications.in)

#### Follow us on:

electricalindiamagazine

electricalindia

ElectricalIndia

electricalindia1961

#### Chary Publications Pvt. Ltd.

906, The Corporate Park, Plot 14 & 15,  
Sector 18, Vashi, Navi Mumbai 400703

Phone: 022 4961 2499

[www.electricalindia.in](http://www.electricalindia.in)

Single Issue: ₹ 100 / Annual Subscription: ₹ 1000

#### Disclaimer

Electrical India does not take responsibility for claims made by advertisers relating to ownership, patents, and use of trademarks, copyrights and such other rights. While all efforts have been made to ensure the accuracy of the information in this magazine, opinions expressed and images are those of the authors, and do not necessarily reflect the views/ collection of the owner, publisher, editor or the editorial team. Electrical India shall not be held responsible/ liable for any consequences; in the event, such claims are found - not to be true. All objections, disputes, differences, claims & proceedings are subject to Mumbai jurisdiction only.

Printed, Published and owned by Mahadevan Iyer from 906, The Corporate Park, Plot 14 & 15, Sector 18, Vashi, Navi Mumbai 400703 and Printed at Print Tech., C-18, Royal Indl Estate, Naigaum Cross Road, Wadala, Mumbai - 400 031. **Editor: Mahadevan Iyer**





# Switch to Smart. Secure. Sustainable Solutions

AV ATS The Advance Automatic Transfer Switch



Controllers

CM 335

CM 331



AV Onload  
Changeover Switch



AV Load Break  
Switch



AV By Pass Switch



AV Switch Fuse  
Changeover

## Automatic Transfer Switch **AV ATS** Motor Operated Changeover Switch

Switch with Exceptionally High Thermal Withstand capacity | Neutral - 2N  
Only Switch for Green Building Concept | Power Terminals for Aluminum & Copper Bus Bar & Thimble  
No Extension required for Power Terminals.



Self Fire Extinguishing,  
High thermal resistance



Load Line  
Reversibility



Total Safety



Shrouded



Arch Chute



RoHS  
Compliant



[hpl@hplindia.com](mailto:hpl@hplindia.com),  
For query, contact: +91-120-4656300  
Customer Care No.1800 419 0198

Follow us:    

[www.hplindia.com](http://www.hplindia.com)

# Electrical India

## Contents

Vol. 61 | No. 10 | October 2021

### Electrical Maintenance

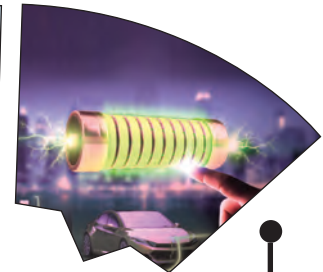
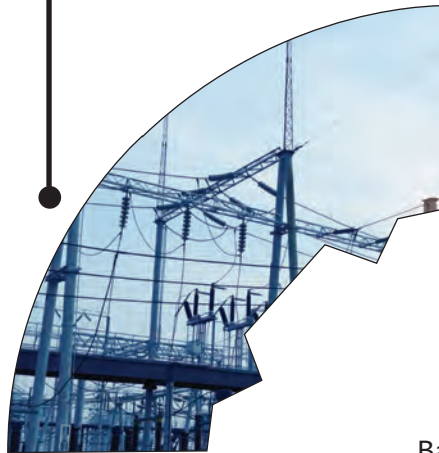
Five things to consider before choosing a thermal imager for electrical facility maintenance, according to Thermographers Co., Ltd.

40

### Cover Story

Where does our power sector stand?

20



42

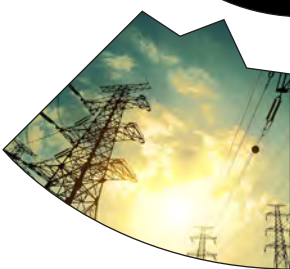
### Energy Storage

The "War of the Battery" for Future EVs - Part 1

34

### Power Supply

Demand Response Program with Different Elasticities - Part 1



26

### Transmission & Distribution

Role of Marconite in T&D Field



30

### Biomass Utilisation

Understanding the Techno-economics - Part 2

## REGULARS

- 4 Publisher's Letter
- 8 News
- 19 Apointments
- 39 Test & Measurement
- 48 Product Avenue
- 45 Statistics
- 49 Index of Advertisers
- 50 Events



M/s. Madhav Engineers Pvt Ltd  
Corporate Off.: B-403,  
Western Edge II, C.C.I. Compound,  
Borivali (East), Mumbai: 400 066,  
India  
Tel.: +91 22 8080434954  
Fax: +91 22 2870 6652  
siddharth@madhavengineers.com  
www.madhavengineers.com

# PFT-SERIES

## AC High Voltage Dielectric Test Set

The **PFT-503CM(F) AC Hipot** hipot test set provides continuously adjustable output voltages for overvoltage withstand testing of switchgear, circuit breakers, reclosers, vacuum bottles, hot sticks, and other high voltage insulation requiring AC tests.

This **PFT** series offers a convenient one-piece field portable design offering a 0 to 50 kV AC output, a 6 meter, 20 feet Shielded HV Output Cable, a Guard Ground Circuit for accurate leakage current measurements, and Transit protected meters to prevent meter damage between test sites.

*For more information on these and other high voltage test products, contact High Voltage, Inc.*

ISO 9001 : 2015



**HIGH VOLTAGE, INC.**

31 County Rt. 7A • Copake, NY 12516  
p. 518.329.3275 • f. 518.329.3271  
sales@hvinc.com • hvinc.com

## INDIA RECEIVES COMPLIMENTS FROM THE UNITED STATES OF AMERICA

Recently in New Delhi, R.K. Singh, the Union Power Minister, met a delegation led by John Kerry, the U.S. Special Presidential Envoy for Climate (SPEC). The purpose of the meeting was to discuss further collaboration on climate change issues and to work towards a genuine partnership between the two countries to pave the way for the rest of the world on Energy Transition.

The Power Minister informed the US side about GoI's intent to move towards clean energy transition. He further stated that the biggest challenge for infusion of Renewable Energy (RE) was 'Storage', which needs to be addressed immediately to make power accessible to the masses. He mentioned that huge bids for Green Hydrogen and Electrolyzers are



(L to R) R.K. Singh and John Kerry during the recent bilateral meeting...

planned in the upcoming months. Singh requested the US side to send their companies to participate in the bids. He also highlighted India's upcoming projects in Ladakh on Green Hydrogen and Green Energy Corridors.

SPEC communicated that the USA is willing to enter into a genuine collaboration with India to enable us realise the ambitious target of reaching 450 GW Renewable Energy by 2030, which would pave

the way to India achieving sub 2°C level, much more than what has been committed under Paris Climate Agreement.

Both sides agreed that Indian labs could work with the US labs with the objective of reducing costs and finding alternative chemistry for making energy transition economically viable. EI

## POWERGRID WINS THE PRESTIGIOUS GLOBAL ATD BEST AWARD

**POWERGRID is one of the largest Transmission Utility in the world...**

Power Grid Corporation of India Limited (POWERGRID) has been awarded the coveted 'Association for Talent Development (ATD) 2021 BEST Award' securing eighth rank among the 71 organizations from around the globe, thus becoming the only PSU to win this award and one of the only two companies of India in Top 20.

The Association for Talent Development (ATD, formerly ASTD) is the world's largest association dedicated to those who develop talent in organizations and ATD's BEST Award is the talent development industry's most rigorous and coveted recognition. The global program recognizes organizations that demonstrate enterprise-wide success through talent development.

POWERGRID has won this International recognition for its diligent efforts in talent development practices and programmes. The talent development initiative in

POWERGRID is driven by POWERGRID Academy of Leadership (PAL).

PAL is POWERGRID's state-of-the-art Institute of Learning in Management and Technology catering to both domestic and international clients. At PAL, trainings and initiatives are organized for enhancing employee performance, boosting employee productivity, improving and strengthening company culture.

POWERGRID is a schedule 'A', 'Maharatna' Public Sector Enterprise of Govt. of India, which was incorporated on 23<sup>rd</sup> October 1989 under the Companies Act, 1956. This is a listed company, with 51.34% holding of Government of India and the balance is held by Institutional Investors and public. It is engaged in the core business of bulk Power Transmission through its Inter-State Transmission system. EI

## QUALITY DRIVES EVERYTHING WE DO



Glands



Cable Connectors



Insulated Terminals



Bimetallic Lugs



Non-insulated Terminals



Crimping Tools

The name Dowells has been synonymous with quality since its inception in 1961. A **pioneer of terminal technology** products in India, it has led the industry with top-grade products that assured dependable service for decades. Now, Dowells and Polycab have joined forces to bring you the most advanced cable termination solutions. Rest assured that you'll get the same exceptional quality in every product you buy.

### Cable Connectors, Terminals, Glands, Crimping Tools and Accessories

**Highlights:** • High Conductivity • Better Performance • Perfect Connection Fit  
• Type Tested as per IEC • Wide Product Range & Customisation

**Ideal for:** Cable Connection and Termination for Industrial, Renewable, Automotive, Aerospace, Telecommunication, Commercial, Utilities, Railways and Metros.

Please buy from our authorized channel partners only.

enquiry@polycab.com | <https://dowellscableaccessories.com> | Toll Free No.: 1800 267 0008

## NTPC STARTS WEEKLY 'SAFETY AWARENESS & SKILL DEVELOPMENT' TRAINING

Recently, NTPC has started a chain of Safety programmes – at least one in every week; as a part of the safety awareness and skill development initiative under 'Azadi Ka Amrit Mahotsav'. This reinforces the commitment of Team Coal Mining towards Mine Safety. The objective of such technical training sessions is to disseminate information and to share knowledge among in-house executives stationed at various coal mining projects to create a strong safety culture through awareness and implementation of the best safety practices at coal mining projects of NTPC to secure 'Zero Incidents'.

Sessions by internal as well as external faculties including OEMs are being organized as a part of the ongoing training conducted on variant topics related



to 'Mine Safety & Best Practices', 'Use of Information Technology or Digital Initiatives in Mines', 'Sustainable Mining' etc.

Technical sessions on 'use of Terrestrial Laser Scanner for dump slope monitoring', 'e-SMP', 'Safety Management Plan implementation', 'Monsoon Preparation in Mines', 'Electrical Safety', 'Safety features of HEMM'

have been organised as part of the training program schedule that has been appreciated by the participants.

To go forward in this direction & to improve the Safety in NTPC's coal mines, forthcoming sessions will be focusing on Mine Planning, Environmental Social Governance, Mining and Environmental Aspects of the Industry, Design & Optimization of Blasting in Opencast Mines, Fleet Management System & Haul Road Management, Preparatory training for appearing to First class certificate of competency examinations. **ET**

## SAUBHAGYA COMPLETES FOUR YEARS OF SUCCESSFUL IMPLEMENTATION

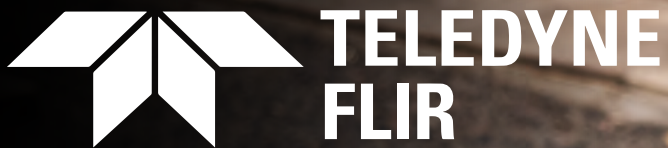
**SAUBHAGYA is one of the largest household electrification drives in the world...**

Up to March 31 this year, 2.82 crore households have been electrified since the launch of SAUBHAGYA. As of March 2019, 2.63 crore willing un-electrified households in rural and urban areas of the country were provided electricity connections in a record time of 18 months. Subsequently seven states- Assam, Chhattisgarh, Jharkhand, Karnataka, Manipur, Rajasthan and Uttar Pradesh reported that around 18.85 lakh un-electrified households, identified before 31.03.2019, which were unwilling earlier, but later expressed their willingness to get electricity connections, were also covered under the scheme.

SAUBHAGYA was announced by the Prime Minister Narendra Modi on September 25, 2017. The objective of the scheme was achieving Universal

Household Electrification in the country, through last mile connectivity and providing access to electricity to all un-electrified households in rural areas and poor households in urban areas. While launching the scheme, the Prime Minister pledged to provide access to electricity and work towards equity, efficiency and sustainability in the New Age India.

The total financial implications of the project was Rs. 16,320 crore, while the Gross Budgetary Support (GBS) was Rs. 12,320 crore. The outlay for the rural households was Rs. 14,025 crore while the GBS was Rs. 10,587.50 crore. For the urban households, the outlay stood at Rs. 2,295 crore while GBS was Rs. 1,732.50 crore. The Government of India largely provided funds for the Scheme to all States/UTs. **ET**



# EFFICIENT CONDITION MONITORING

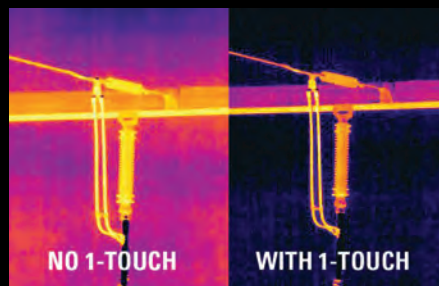
Run camera-guided inspections  
with the **FLIR T800-Series**



IMPROVE WORKFLOW  
EFFICIENCIES



WORK SAFELY AND  
COMFORTABLY



MAKE CRITICAL DECISIONS  
QUICKLY

Discover more: **[flir.in/T800-series](https://flir.in/T800-series)**

For more information, please call us at +91-11-4560 3555  
or write to us at [flirindia@flir.com.hk](mailto:flirindia@flir.com.hk)

## ESSAR POWER COMMISSIONS ITS FIRST FLUE GAS SCRUBBER

**E**ssar Power, one of Essar Global Fund's key investments in the Energy portfolio, has commissioned its first flue gas scrubber at the Essar Power Hazira (EPHL) facility. The scrubber is designed to bring down the sulphur dioxide in flue gas by 25%, going a long way in checking emissions and helping the environment.

Essar takes excessive care to ensure that there is a balance between business operations and environment. With an aim to further its Environment, Social and Governance (ESG) goals, Essar has been encouraging its businesses to transition to green operations and invest in technologies that reduce their carbon footprint.

Commenting on the milestone Kush Singh, CEO – Essar Power, said, "Essar Power believes in running its



operations with minimal environmental impact. The commissioning of scrubber has been accomplished despite the challenges we faced due to the pandemic. With the first one completed, we shall surely look at replicating it at other facilities of ours in future. Such eco-initiatives are part of Essar Power's strategic plan to transition to green operations."

The team involved with the project has put in place an innovative approach, wherein the scrubber was optimised as per the coal quality being supplied, and the emission norms targeted. In fact, the project was fast-tracked while maintaining all safety precautions, and executed without a single reportable incident. Essar Power has overcome all challenges that came up from the Covid-19 situation both in terms of supply of material, as well as manpower. **ET**

## TATA POWER DEPLOYS THE 'MOBILE-GIS' BASED TRACKING SYSTEM

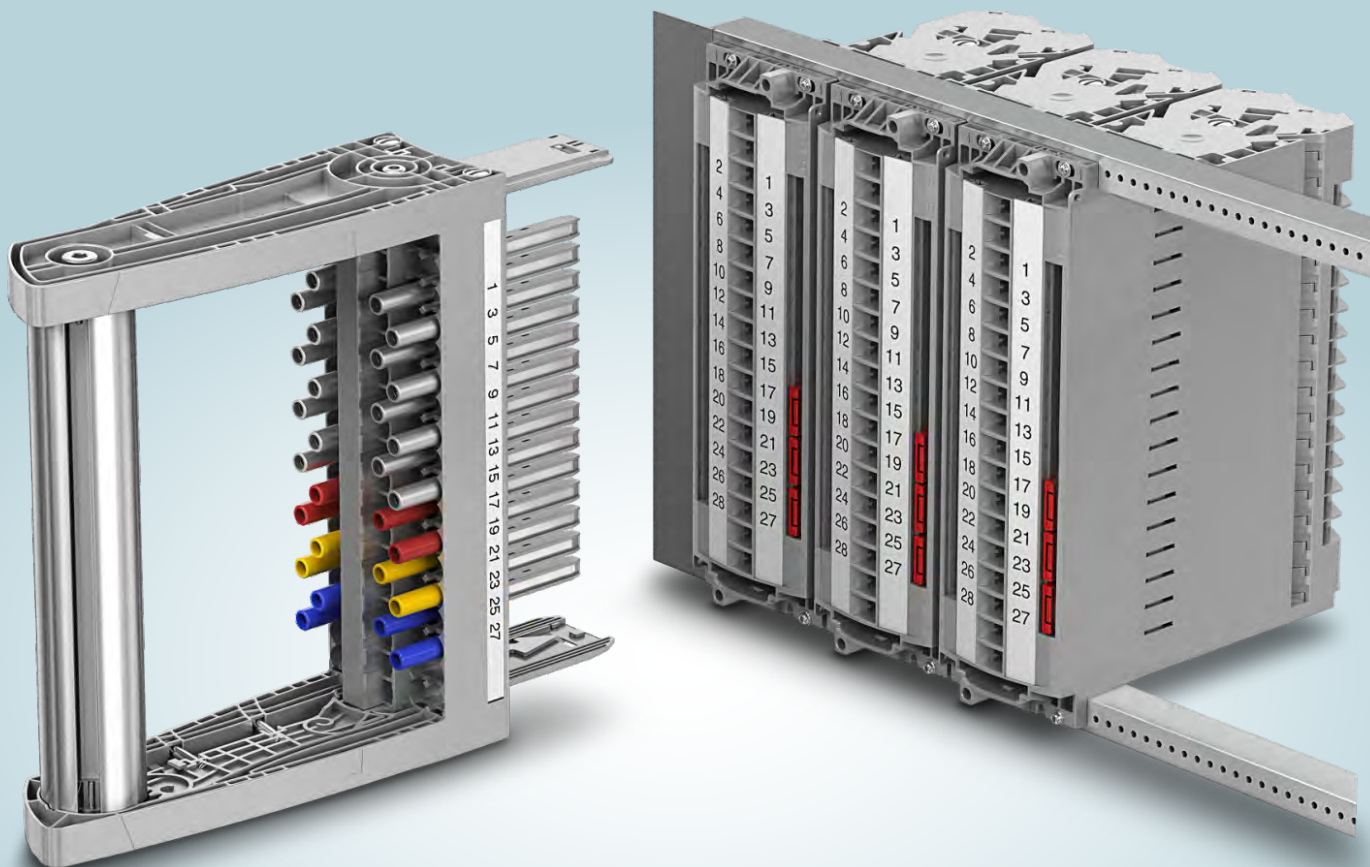
*It is a digitally automated and cost effective system for customers to register complaints...*

**P**ower cuts or other power supply related issues are one of the key areas of concern for any utility. In line with its focus on 'Customer Centricity', Tata Power has recently deployed a unique feature called 'Mobile-GIS assisted system for Restoration and Care' (maRC) for its Mumbai customers. It is a digitally automated and cost effective system for the complete 'customer trouble call management' including quality and effective tracking related to power cut or outage complaints.

The system sends a message to the customer on their mobile number upon registration of technical complaint with the link for 'maRC', which gives details pertaining to ETA (Expected Time of Arrival) of the technician assigned to attend to the fault.

The application also enables easy tracking of the technician's location in real time on a Map. This offers ease and assurance to the customers that Tata Power has registered the complaint and is in the process of priority resolution.

The 'maRC' system apart from engaging with the customer during a technical complaint also acts as an efficient complaint resolution tool. Once the technical complaint is resolved, the system gains immediate first-hand feedback on experience, which can be done with just a few clicks on mobile. This experience connect through customer feedback serves as a measure for the company to further enhance its customer service in technical complaint resolution and ensure customer delight. **ET**



## FAME RACK – The plug-in test system for 19 inches racks

FAME RACK is the latest addition to the FAME (Fast And Modular Energy) plug-in test system – a test interface between the field installation and the measurement or safety equipment in high and medium-voltage switching devices. The new plug-in test sockets can be installed directly in the commonly used 19" racks in accordance with IEC 60297-3. Functionally, FAME RACK is based on FAME 3 technology. The plug-in test socket and the test plug have been newly developed especially for use in the compact 19" technology. The system is modular in design and makes consistent use of the CLIPLINE complete system accessories, e.g. the simple realization of star-point bridges. This makes FAME a unique test system that can be used throughout the world.



### HEAD OFFICE

**Phoenix Contact (India) Pvt. Ltd.**  
F-26/2, Okhla Industrial Area, Phase-II  
New Delhi - 110 020 INDIA  
Tel.: +91-11-71810700/800  
Fax: +91-11-41611071  
E-mail: [response@phoenixcontact.co.in](mailto:response@phoenixcontact.co.in)  
Website: [www.phoenixcontact.co.in](http://www.phoenixcontact.co.in)

### SOUTHERN INDIA OFFICE

No. 10/7 - 8, 2<sup>nd</sup> Floor  
Umiya Landmark, Lavelle Road,  
Bangalore - 560001  
Tel.: +91-80-33235400

### WESTERN INDIA OFFICES

30, Shaswat Bungalow, 1<sup>st</sup> Floor  
Ceaser Road, Amboli  
Andheri [W], Mumbai - 400 058  
Tel.: +91-8377004752 / 4753

5<sup>th</sup> Floor, Devi House  
37, Shivaji Nagar  
Pune - 411005  
Tel.: +91-20-71395000-031

## CESL LAUNCHES SCHEME FOR SALE OF ELECTRIC TWO-WHEELERS

State-owned Convergence Energy Services Limited (CESL), a wholly-owned subsidiary of Energy Efficiency Services Limited (EESL) - an entity under the Ministry of Power, Government of India, has launched an electric two-wheeler programme in Kerala. The programme is custom-designed for employees of the Government of Kerala, and vehicles are made available by CESL through its relationship with vehicle manufacturers.

All vehicles will benefit from the Central Government's subsidy programme FAME II, which allows customers to access a significant subsidy that brings electric vehicles closer to the cost of their fossil fuel equivalents.

This programme is carried out in collaboration with the Energy Management Centre (EMC), Government of Kerala. The Scheme was inaugurated by the Minister for Electricity, K. Krishnankutty, in the presence of MLA,



*A view of the inauguration of the scheme...*

V. K. Prasanth, Mayor of Thiruvananthapuram Corporation and Arya Rajendran amongst other dignitaries.

The Government of Kerala has undertaken several initiatives to increase electric mobility penetration in the state. This is the first state in the CESL portfolio to move ahead and ordering

two-wheelers. The launch of this scheme, therefore, makes Kerala the first user of the digital marketplace – MyEV – which will enable easy access to consumers for booking and buying electric two-wheelers. Special design features have enabled a virtual experience to come as close to being at a showroom – designed to reduce physical visits to retail outlets with the COVID pandemic still looming in the country. Interested consumers can visit [www.MyEV.org.in](http://www.MyEV.org.in) or download Mobile App: MyEV via playstore on their handsets.

ET

## BHEL COMMISSIONS INDIA'S LARGEST FLOATING SOLAR PV PLANT

**BHEL is the leading EPC player in the solar industry in India with an overall EPC portfolio of more than 1.2 GW...**

Bharat Heavy Electricals Limited (BHEL) has successfully commissioned India's largest floating Solar PV plant. Located at NTPC Simhadri in Andhra Pradesh, the 25 MW floating SPV project covers an area of 100 acres, leading to saving of valuable land resource and conserving water by reducing evaporation.

Notably, with its unique state-of-the-art design, the project is an engineering marvel, created by BHEL. Besides producing clean power, the project will also reduce water evaporation by providing shade to the covered area. It will also have a higher yield as compared to conventional ground-mounted projects due to the cooling effect.

BHEL has designed an innovative floating array to meet the unique requirement of anchoring the

support structures without touching or loading, either the reservoir floor or the bund structure. This complex module array has been designed - for the first time in India - to withstand gusts of wind up to 180 km/hr. In view of the coastal location of the project site that leads to severe corrosion, all the platform structures and other equipment have been made corrosion resistant.

The company's scope of work in the project included design, engineering, procurement and construction of the solar project and has been executed by the recently formed Solar Business Division. Contextually, today BHEL's portfolio of floating SPV projects is the largest in the country with more than 45 MW projects commissioned and around 107 MW under execution.

ET

# Assuring Strength Across the Globe

*We just don't draw wires,  
We draw customer satisfaction.*

## Trust...

27 Years of Customer Satisfaction  
Through Service Excellence

## Strength...

13,260 Sq. Mts.  
Well Equipped Unit

## Assurance...

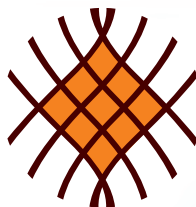
ISO 9001:2015  
Certified

## Global Footprint

Covering Entire Globe  
Including SAARC Nations  
African Countries &  
Middle East

## Manufacturer of Wire & Wire Products

- ACSR Core Wire & Strands
- Barbed Wire & Binding Wire
- Cable Armour Wire & Strip
- Cable Tape
- Crimping Wire
- Earth Wire & Stay Wire
- Farming GI Wire
- Genral Engineering Purpose GI Wire
- Hard Drawn Steel Wire
- Music Spring Wire
- PC Wire
- Rope Wire - Black & Galvanized
- RQ/FQ Black & Galvanized
- Shutter Wire
- Sprint Steel Wire
- Welded Wire Mesh



# HD WIRE (P) LTD

17-20, Sanwer Road, Sector E, Industrial Area, Indore - 452 015

Ph.: 91-731-4211199, Mob.: +91 98936 06199, +91 97520 90210

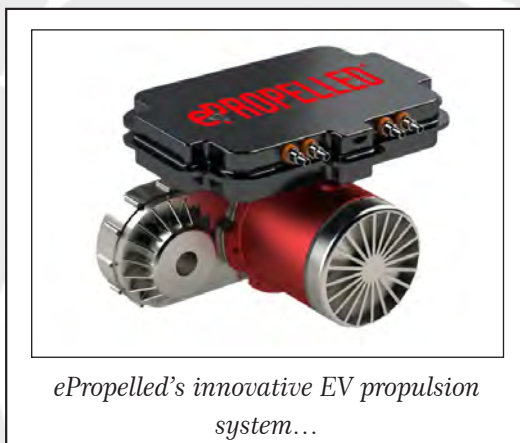
Email: sales@hdwires.com, salesonline@hdwires.com

## EPROPELLED ROLLS OUT NEW EV MOTOR SYSTEM AT CENEX-LCV

**e**Propelled, the Massachusetts-based technology company that offers leading-edge electric propulsion systems, has launched a groundbreaking new Electric Vehicle (EV) propulsion system. This new system increases power efficiency by at least 15%, which will allow manufacturers to reduce the size and cost of their battery packs.

Battery packs can account for as much as 30% of the cost of vehicles, which can make smaller EVs uneconomical. Reducing this cost will improve profitability of EVs while facilitating adoption by consumers.

ePropelled's Dynamic Torque Switching (eDTS) uses an innovative software-controlled reconfigurable propulsion motor that is the foundation of a complete EV propulsion system. eDTS allows the electric motor to



*ePropelled's innovative EV propulsion system...*

provide high torque at low speeds without drawing high current from the batteries. It also provides high speeds at low torque levels without using field weakening, thereby increasing the efficiencies throughout. eDTS is a scalable design that can be used in a variety of electric vehicles ranging from light EVs, such as scooters and three wheelers used in last mile delivery, to cars and trucks.

This patented technology is a drive system concept that allows a single electric machine to dynamically change between several modes to provide a much broader range of high efficiencies for low power consumption. The control system is designed to allow the transition between the modes to take place seamlessly to deliver optimum torque, speed, and efficiency characteristics in real time. The system has been designed to be scalable. E1

## WIND POWER LINE SUEDLINK TO BE EQUIPPED WITH SIEMENS ENERGY'S HVDC TECHNOLOGY

*The power grids of the future will face a wide range of challenges that require a rapid expansion of the infrastructure...*

**A** total of 7,500 kilometres will have to be optimized, strengthened, or newly built in the German transmission network over the next few years. High-Voltage Direct Current (HVDC) transmission links are playing a key role here, such as SuedLink, the new wind power line, which will enable low-loss energy transport over long distances – and the integration of wind power from the North and solar power from the South of Germany into the transmission grid.

The contract for the necessary converter technology for the section between the grid interconnection points of Brunsbüttel in Schleswig-Holstein and Leingarten/Großgartach in Baden-Württemberg was signed recently. Siemens Energy will supply the converters and carry out the detailed and site-specific planning of the facilities in the coming months

together with the project owners, the transmission grid operators TenneT and TransnetBW, and further project members.

Describing the importance of the project, Tim Meyerjürgens, MD, TenneT, said, “The construction of SuedLink, the largest grid expansion project in Germany, is crucial to the success of the energy transition.”

Commenting on the contract, Dr. Werner Götz, Managing Director of Transnet BW, said, “With the award of the contract, we have taken a decisive step closer to realizing SuedLink. Now the planning can be further worked out in concrete terms at two starting and end points, and the preparatory construction measures already underway at the southern end point in Leingarten, Baden-Württemberg, can be driven forward.” E1

# Nurturing Passion for **ENGINEERING & TECHNOLOGY**



Titan Engineering & Automation Limited (TEAL), is a wholly owned subsidiary of TITAN COMPANY LIMITED. We are in the business of Providing world class Turnkey assembly and testing solutions



We cater to various industry segments like:

- **Transportation**
- **Energy**
- **Electronics**
- **Life sciences**
- **Engineering**
- **Consumer packaged goods (CPG)**

WE  
OFFER



Linear Transfer  
Assembly Line



Rotary  
Assembly Line



Lean  
Assembly Line



Robotic  
Assembly Line



Vision Inspection  
System

## Our Capabilities

- **Assembly Technology**
- **Testing & Measurement**
- **Controls & Software**
- **Industry 4.0 Enabled Solutions**

## For Enquiries Contact

### Head Office

Mr. Hari.E  
☎ +91 – 94422 67678  
✉ harie@titan.co.in

### Northern and Southern Region

Mr. Praveen Kumar  
☎ +91 – 73977 01444  
✉ praveenk1@titan.co.in

### Western Region

Mr. Issac Kuttisseril  
☎ +91 – 73974 84425  
✉ issac@titan.co.in

### Global

Mr. Anto Jauspher  
☎ +91 – 94425 05271  
✉ antoj@titan.co.in

Reach us at:

**TITAN ENGINEERING & AUTOMATION LIMITED (TEAL),**

UNIT 1 :- Automation Solutions, No. 27 & 28, SIPCOT Industrial Complex, Hosur - 635126, Tamil Nadu, India

Tel :- +91- 4344 664 876 / 891 / 840

Email:- infotas@titan.co.in , Website :- www.titanautomation.in

## CHUBU TO INVEST IN VIETNAM'S LEADING PRIVATE RENEWABLE POWER COMPANY

**C**hubu Electric Power Co., Inc. (Chubu) has recently participated in a bid for a partial share acquisition of Bitexco Power Corporation (BPC). BPC is a subsidiary of the Bitexco Group of Companies, which develops real estate, energy, commercial services and infrastructure, telecommunication, oil and gas exploration businesses in Vietnam. BPC owns and operates 21 hydropower plants and one solar power plant in Vietnam, with a total gross generation capacity of about 1,038 MW (as of February 2021). This capacity makes BPC a leading renewable energy company focused on hydroelectric and solar PV generation in the Vietnam private sector.



*Nho Que 1 Hydropower Plant  
(32MW)...*



*Nhi Ha 1 Solar Power Plant  
(50MW)...*

Chubu has successfully entered into a Share Purchase Agreement (SPA) with certain existing shareholders, who are selling their shares in BPC and a Share Subscription Agreement with BPC. Furthermore, upon

completion of the SPA, Chubu will enter a Shareholders' Agreement with BPC and Bitexco Investment Corporation (the majority shareholder of BPC). Subject to certain regulatory approvals, Chubu will become a 20% shareholder of BPC. For Chubu, this is the first investment in Vietnam as well as abroad in a hydropower company.

Vietnam, where approx. 2,000 Japanese companies have positioned their business activities in as of December 2020, is experiencing remarkable population growth and economic development, and electricity demand is expected to continue to grow. While electricity demand reached 216.8 TWh in 2020, according to the draft Power Development Master Plan (PDP8) for 2021-2030 released by the Ministry of Industry and Trade of Vietnam – it is expected to increase to 491.3 TWh (annual average growth rate of 8.5%) in 2030.

❶

## GE, NAREVA TO BUILD 200 MW AFTISSAT ONSHORE WIND FARM EXTENSION

*GE Renewable Energy is selected to supply 40 of its Cypress onshore wind turbines...*

**G**E Renewable Energy has been selected by Energie Eolienne du Maroc (EEM), a leading developer of wind projects and a wholly-owned subsidiary of Nareva Holding, to supply 40 onshore wind turbines for the 200 MW Aftissat onshore wind farm extension in Morocco. EEM will operate the Cypress turbines at 5.0 MW, with a rotor diameter of 158m. GE's scope of work also includes a 20-year full-service contract.

The project is expected to start operations in 2023, and is intended to support industrial companies under power purchase agreements, in line with Morocco's goal to install 52% of renewable energy capacity by 2030.

This marks the first order in Morocco for GE's Cypress onshore wind platform, the company's

largest onshore wind turbine in the field, and GE's largest Cypress wind farm in the Middle East & Africa region. This also adds up to GE Renewable Energy's 287 MW of installed base and backlog in Morocco, which includes the 200 MW Akhfenir wind farm that Nareva and GE have built together in 2016.

Gilan Sabatier, Onshore Wind International Chief Commercial Officer, GE Renewable Energy, said, "Morocco has a great potential for wind energy and has been an early mover in the journey toward renewable energy integration, achieving great progress in its renewable energy targets. We are thrilled to be partnering with Nareva to implement our Cypress technology in Morocco, confirming our commitment to the country's wind energy development."

❶

## S. SHARMA HAS BEEN APPOINTED AS THE MD OF SECI



*As MD of SECI, she is enjoying the Chief Executive status of the corporation...*

**S**uman Sharma, who had been working as the Additional Director General of Foreign Trade, has been appointed as the new Managing Director (MD) of the Solar Energy Corporation of India Ltd. (SECI) under the Ministry of New & Renewable Energy, with effect from 29<sup>th</sup> August 2021.

Sharma is an M.Sc in Organic Chemistry from the Meerut University. She also possesses an MBA from the University of Hull, United Kingdom. She belongs to the Indian Revenue Service

(IRS) batch of 1990. She has replaced the previous Chairman & Managing Director (C&MD) of SECI, Jatindra Nath Swain (IAS).

After assuming the new charge, Sharma has been accountable to SECI Board of Directors, GoI and other shareholders of the corporation. She will have to take care of the efficient functioning of the corporation, and lead the entity towards achieving its corporate objectives and performance parameters. **BI**

## A. ROSLING JOINS AS THE CHAIRMAN OF THE BOARD OF AZURE POWER



*In 2014, he was awarded Commander of the British Empire (CBE)...*

**A**lan Rosling has been appointed as a non-executive and nominee Director of Azure by Caisse de dépôt et placement du Québec (CDPQ). He will also assume the role of Chairman of the Board of Azure Power India Private Limited, a subsidiary of Azure Power Global Limited.

Rosling is a Co-founder & Director of ECube, a specialist in ESG advisory and climate finance in India. He was earlier Co-founder of Kiran Energy Solar Power and previously an Executive

Director of Tata Sons Limited, where he was in charge of the Tata Group's internationalization drive. Rosling was educated at Cambridge University and the Harvard Business School.

Commenting on the appointment, Ranjit Gupta, MD and CEO, Azure Power, said, "We are pleased to have Rosling join our Board as the new Chairman. His long history of leadership and connect with India, coupled with his hands on experience in the clean energy space makes him an ideal person for this role." **BI**

## R. W. LEWIS JOINS THE BOARD OF CENTER POINT ENERGY AS A MEMBER



*She is a member of several community and civic organizations...*

**C**enter Point Energy, Inc. has appointed Raquelle W. Lewis, an accomplished communications and community outreach leader with extensive experience in the transportation and infrastructure industries, to its Board of Directors, effective from September 29.

With more than 25 years of experience in communications, strategic project development, business operations, community outreach, and risk and crisis management in the transportation and infrastructure industries, Lewis has held positions of increasing responsibility over

the course of her career. She currently serves as Director, Southeast Texas Communications and Public Information Offices for the Texas Department of Transportation (TxDOT), a state government organization that constructs and maintains highway, aviation, rail, and public transportation systems.

Prior to her role at TxDOT, Lewis was with Parsons Brinckerhoff, a global engineering and design firm that specializes in engineering, construction management, energy, infrastructure, and community planning. **BI**



# WHERE DOES OUR POWER SECTOR STAND

*The recently published BRICS Energy Report 2021 has drawn a detailed picture of the Indian power sector. Before COP 26, this report is a basis for evaluating India's progress towards the path of global climate conservation. Let us see where we do stand at this moment...*

*- P. K. Chatterjee (PK)*

India is the world's third largest power consumer country. Of late, it has been certified by several agencies. Many of its states have by now achieved 100% household electrification too. As on date, the picture of our power sector is represented in the Table 1.

The forthcoming 26<sup>th</sup> session of the Conference of the Parties (COP 26) will be held between 1<sup>st</sup> to 12<sup>th</sup> November 2021, in Glasgow, UK. On the eve of that, it is high time that we look at our progress towards our commitment.

## Indian Power Sector at a Glance

### Installed GENERATION CAPACITY (FUEL-WISE) AS ON 31.08.2021

| Catagory                                                                | Installed Generation Capacity(MW) | % Of Share In Total |
|-------------------------------------------------------------------------|-----------------------------------|---------------------|
| Fossil Fuel                                                             | 2,34,858                          | 60.9%               |
| Coal                                                                    | 2,02,805                          | 52.6%               |
| Lignite                                                                 | 6,620                             | 1.7%                |
| Gas                                                                     | 24,924                            | 6.5%                |
| Diesel                                                                  | 510                               | 0.1%                |
| <b>Total Fossil Fuel</b>                                                | <b>2,34,258</b>                   | <b>60.4%</b>        |
| Non-Fossil Fuel RES (Incl. Hydro)                                       | 1,47,096                          | 37.9%               |
| Hydro                                                                   | 46,412                            | 12.0 %              |
| Wind, Solar & Other RE                                                  | 1,00,683                          | 25.9 %              |
| Nuclear                                                                 | 6,780                             | 1.7%                |
| <b>Total Non-Fossil Fuel</b>                                            | <b>1,53,876</b>                   | <b>39.6%</b>        |
| <b>Total Installed Capacity<br/>(Fossil Fuel &amp; Non-Fossil Fuel)</b> | <b>3,88,134</b>                   | <b>100%</b>         |

Source: Central Electricity Authority (CEA)

On September 02, Union Minister of State for Power and Heavy Industries, Krishan Pal Gurjar has officially launched the BRICS Energy Report 2021, BRICS Energy Technology Report 2021 and the BRICS Energy Research Directory 2021, in a virtual meeting of the BRICS Ministers of Energy.

In this 6<sup>th</sup> meeting of BRICS Energy Ministers, Gurjar underlined that India is committed to improving the quality of life of its citizens by ensuring adequacy of electricity availability. He said, “The ‘Power for All’ by 2022 program is a major step in this direction. We have achieved universal access. We added 28 million consumers in just about 18 months, which was the fastest expansion access anywhere in the world, and much of it is due to the fact that we went in for renewables in a major way.”

## BRICS Energy Report 2021

This report is an important document that highlights the Indian power sector’s progress towards its climate

deterioration mitigation plan. Let us see an overview of our progress from this report, which will help us in asserting our power sector’s steady and noteworthy action to mitigate the climate change – consequently to provide a best-practice-guideline to the rest of the world.

According to the report, India is a major force in the global energy economy. In the last decade, starting from 2010-11, India’s energy consumption has increased with a CAGR of 4.11%. The continuous rise in energy consumption is supported by a growing population and increased per capita income. Energy demand has steadily increased across all sectors, including agriculture, industry, commercial and residential, and is expected to continue to grow. In 2010-11, the total energy consumption was 540.26 Mtoe, which has increased to 776.58 Mtoe in 2019-20(P). Figure 1 graphically presents the year-wise growth in energy consumption.

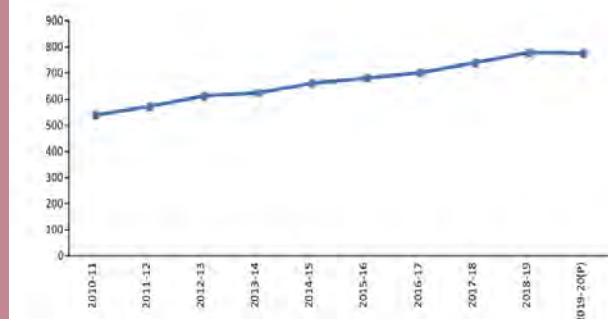


Figure 1: Year-wise energy consumption in India...  
Source: Energy Statistics 2021, Central Statistics Office  
Ministry of Statistics and Programme Implementation, Government of India

Due to the increase in industrialization and government endeavours to provide uninterrupted

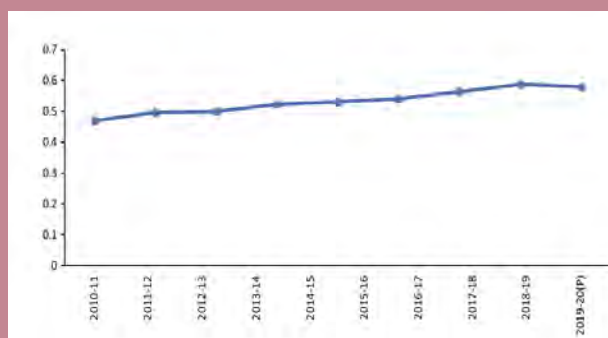


Figure 2: The energy use per person in tonne(s) of oil equivalent (toe)...  
Source: Energy Statistics 2021, Central Statistics Office  
Ministry of Statistics and Programme Implementation, Government of India

power supply to all, per capita energy consumption increased with a CAGR 2.65% from 2010-11 to 2019-20 (P). Although the per capita energy consumption is increasing it is still much lower than the world average of 2.58 toe per person (IEA World Energy Balance 2020). The energy use per person in tonne(s) of oil equivalent starting from the year 2010-11 is shown in Figure 2.

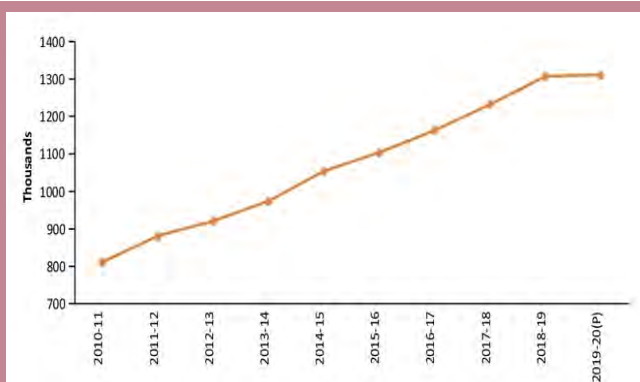


Figure 3: Year-wise net availability of electricity in India...

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

The total electricity generation increased yearly with a CAGR of 5.63% from the year 2010-11 to 2019-20. In 2010-11, total electricity generation was 844.74 TWh, which increases to 1383.41 TWh in 2019-20(P).

Of the total consumption of electricity in 2019-20, the industry sector accounted for the largest share (42.69%),

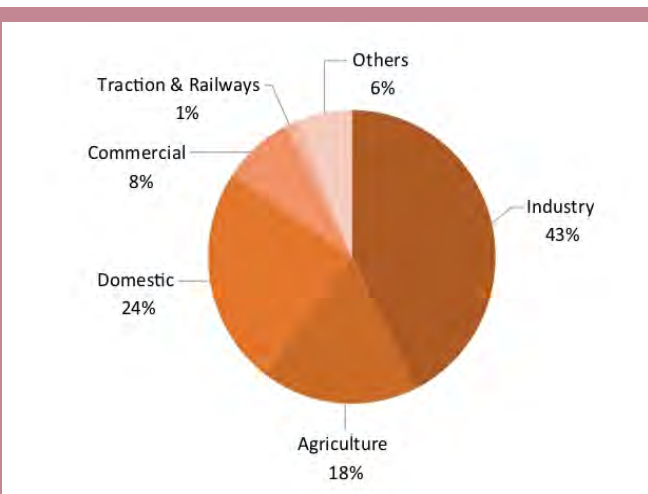


Figure 4: Consumption of electricity by sector in 2019-20 in India...

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

followed by domestic (24.01%), agriculture (17.67%), and commercial sectors (8.04%). Of the total consumption of electricity in 2019-20, the industry sector accounted for the largest share (42.69%), followed by domestic (24.01%), agriculture (17.67%), and commercial sectors (8.04%). Refer Figure 4.

## Energy Mix in our country

The report clearly shows our maximum dependence on fossil fuel. India's energy system is primarily based on coal for power generation. India is the world's second-largest producer of coal, next to the People's Republic of China. The share of coal in both the energy mix and the power mix in India is predominantly high, and in 2020 fossil fuel provided around 74% of the total electricity generation.

Due to the impact of government policies to promote renewable energy sources, the share of electricity from low carbon sources is increasing continuously since 2016 (Figure 5). This is well captured by the fact that while the installed capacity of renewable sources of electricity generation excluding hydro from utilities grew at 12% in the previous year (2020 over 2019), that of thermal sources grew only at 1.91%. Table 2 presents the share of electricity production by source in 2020.



Figure 5: Source-wise installed capacity of electricity generation in India...

Source: Energy Statistics 2021, Central Statistics Office Ministry of Statistics and Programme Implementation, Government of India

## Measures to improve the status quo

As per the BRIC Energy Report, India's energy transition is characterized by its ambitious targets. By the year 2022, India seeks to provide all households in the country

**Table 2: Share of electricity production by source in 2020 in India...**

|                                     | Coal   | Gas   | Oil  | Nuclear | hydropower | Wind  | Solar | Other Renewables |
|-------------------------------------|--------|-------|------|---------|------------|-------|-------|------------------|
| Electricity Production TWh          | 946.93 | 52.11 | 0.13 | 44.55   | 163.51     | 60.41 | 58.73 | 15.58            |
| Share of Electricity Production (%) | 70.56  | 3.88  | 0.01 | 3.32    | 12.18      | 4.50  | 4.38  | 1.16             |

**Source: BP Statistical Review of World Energy**

24×7 power. By 2022, India also seeks to install 175 GW of Renewable Energy (RE) capacity. These national targets are aligned with India's climate commitments made at the 21<sup>st</sup> Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC), also known as the Paris Agreement, which came into force in November 2016.

In its Nationally Determined Contributions (NDCs), India committed to three targets to be achieved by the year 2030. It includes the following main elements:

- To reduce the emissions intensity of GDP by 33%–35% by 2030 below 2005 levels;
- To increase the share of non-fossil-based energy

resources to 40% of installed electric power capacity by 2030, with the help of the transfer of technology and low-cost international finance, including from Green Climate Fund (GCF); and

- To create an additional (cumulative) carbon sink of 2.5–3 Giga tonne CO<sub>2</sub>e through additional forest and tree cover by 2030.

As per, UN Environment Emission Gap Report 2019, developed countries like the USA, Republic of Korea, EU, Canada, Japan, and Australia needs additional policy initiatives to meet their NDC commitments requirement whereas developing nations like India, China, Argentina; with their stated policies are already on the track of meeting their NDC targets.

India's NDC is currently rated '2°C compatible' by the Climate Action Tracker (CAT). An updated NDC reflecting India's current policy projections would be rated '1.5°C Paris Agreement compatible'. At the Secretary General's summit in New York, India announced its intention to reach a target of 450 GW of renewables by 2030. The ramp-up of renewables in India can provide access to affordable power to all. For three consecutive years, renewable energy investment topped fossil fuel-related power investments, and in 2018, solar investments exceeded those in coal.

### Significant points to be noted

The report categorically states that India adopted Sustainable Development Goal 7 (SDG-7) to ensure access to affordable, reliable, sustainable, and modern energy to all. The goal stresses more focused attention to improve access to clean and safe cooking fuels and technologies, improve energy efficiency, increase renewable sources, and promote sustainable and modern energy for all. The targets adopted as a part of the Goal 7 of SDGs 2030 Agenda are as follows:

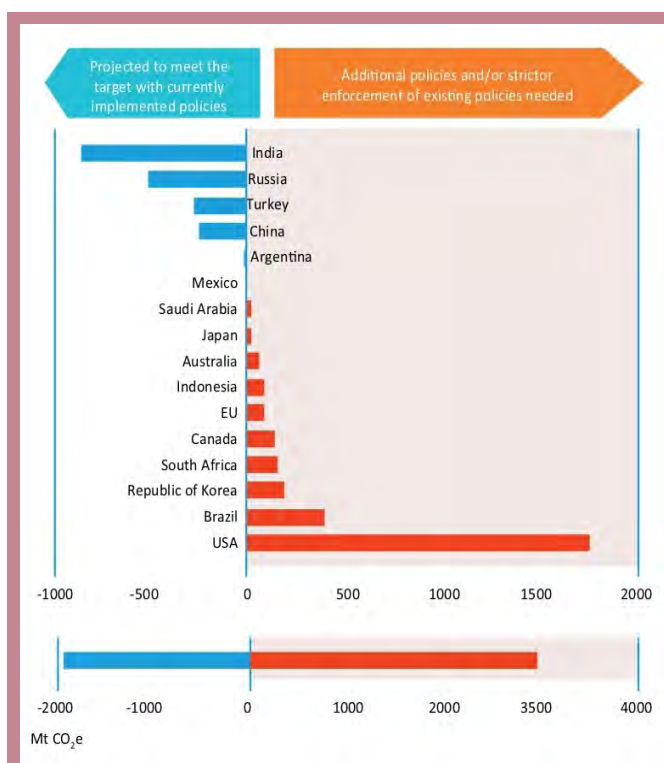


**Figure 6: Countries status to meet NDC...**

- Ensure universal access to affordable, reliable, and modern energy services.
- Increase the share of renewable energy in the national energy mix substantially.
- Double the national rate of improvement in energy efficiency.

Providing secure, affordable, and sustainable energy to all is an important policy priority in India, and significant progress has been made towards the United Nations Sustainable Development Goals (SDGs), notably SDG7 on energy. In April 2018, the Government of India (GoI) announced that India had achieved its goal of providing electricity to every village in India. Indian experiences can be taken up as a case study for Universal Access to Energy as we have taken some landmark initiatives towards electrification of all households. Under Pradhan Mantri Sahaj Bijli Har Ghar Yojana – ‘Saubhagya’ free electricity connections to all households were provided. There were around 3 Crore un-electrified households in the country as of October 2017 and as on March 2019, almost 100% electrification of households have been achieved.

To increase the share of renewable energy capacity (SDG 7.2), the Government set a renewable capacity goal of 175 GW by 2022, targeting 60 GW of utility-scale solar photovoltaic (PV), 40 GW of rooftop solar PV, 60 GW of wind power, 5 GW of small hydro and 10 GW of bioenergy.

### A few recent fruitful initiatives noted in the report

In the last six years, India's installed Renewable Energy (RE) capacity has increased by over two and a half times and stands at more than 141 Giga Watts (including large Hydro).

The installed solar energy capacity has increased by over 15 times and stands at 41.09 GW.

India's RE capacity is the 4<sup>th</sup> largest in the world. Its annual RE addition has been exceeding that of coal-based thermal power since 2017.

During the last 7 years, over USD 70 billion investment has been made in RE in India.

India has a very liberal foreign investment policy for renewables allowing 100% Foreign Direct Investment (FDI) through the automatic route in the sector.

Established dedicated Project Development Cells (PDC) and FDI cells in all Ministries for handholding and facilitating domestic and foreign investors. PDCs

have been established to develop investible projects in coordination between the Central Government and State Governments and thereby grow the pipeline of investible projects in India and increase FDI inflows.

Developed Renewable Energy Investment Promotion and Facilitation Board (REIPFB) Portal to provide one-stop assistance and facilitation to the Industry and Investors to develop projects and bring new investment to the RE sector in India.

Several members from the industry have voluntarily declared RE goals and committed to the Carbon Disclosure Project (CDP), Renewable 100% (RE100), and Science-based targets (SBTs) to reduce greenhouse gas emissions.

Rules are being framed for a ‘Green Tariff’ policy that will help electricity distribution companies supply electricity generated from clean energy projects at a cheaper rate than power from conventional fuel sources.

The Government of India is also promoting Green Hydrogen with obligations for Fertilizers and Refining industries (Green Hydrogen Purchase obligations).

Viability Gap Funding options for Offshore Wind Energy.

Green Term Ahead Market and Green Day Ahead Market.

Rules for facilitating renewable energy through Open Access.

Renewable energy procurement through exchanges will also be notified to promote non-conventional resources of energy.

Strategy Plan towards Developing an Energy Efficient Nation (2017-2031).

Potential to reduce 438 Million ton CO<sub>2</sub> to 623 Million ton CO<sub>2</sub> by 2030 by adoption of energy efficiency measures.

### Conclusion

As a developing nation, under the supervision of our captain prime minister Narendra Modi, what India has done to prevent global climate deterioration that is truly commendable and copiable for many nations. Through this progress, India has proved that good planning, strong determination and consistent work can create excellence. The BRICS energy report clearly indicates that as far as the NDC target is concerned, India's progress is praiseworthy – and definitely in the coming days our country will be a role-model for many other countries.

# Directly to the most cost-effective drive cable ...

readycable® Productfinder

the most cost-effective drive

Easy searching

Service life



## ... that is guaranteed to do its job!

More than 4,000 drive cables ... 24 drive manufacturers ...

Enter the original manufacturer number to choose online from up to 7 cables of different qualities to find the best possible price for your application. Including service life calculation. With a 36 month guarantee. Delivery time from 24 hours.  
[igus.in/readycable-finder](http://igus.in/readycable-finder)



igus® (India) Pvt. Ltd.  
36/1, Sy. No. 17/3, Euro School Road,  
Dodda Nekkundi Industrial Area - 2nd Stage  
Mahadevapura Post Bangalore - 560048  
Phone +91-80-69116900 Fax +91-80-68127802

**igus®.in**  
plastics for longer life®

# Role of Marconite in T&D Field



*This article presents a Case Study on the impact of high soil resistivity in lightning prone areas and mitigation measures being adopted in 400 kV D/C Silchar (Assam) - Byrnihat (Meghalaya) interstate transmission line of NETC by application of Bentonite & Marconite...*

The earthing system has an important role in safe operation of Transmission Lines. In the hilly terrain / terrain of high soil resistivity or lightning prone areas, lightning over voltage causes flashovers and subsequent tripping in transmission lines. Reduction of grounding resistance is one of the efficient ways to prevent occurrence of such flashovers. The primary object of safe earthing design of a transmission line is to provide low resistance path to lightning current. 400 kV transmission lines of NETC traverses through areas having high soil resistivity (10–10,000  $\Omega\text{m}$ ) and high isokeraunic levels. In North Eastern Region, soil is very acidic in nature in addition to other severe environmental conditions.

## Background

North East Transmission Company Limited (NETC) is

a Joint Venture Company of POWERGRID, OTPC and Six states of North Eastern region. The main objective of the company is to evacuate 726.6 MW power from Gas Based Combined Cycle Power Project (GBCCPP) of OTPC at Palatana in Tripura. NETC is operating 400kV D/C Palatana-Silchar-Bongaigaon transmission line of 662.8km traversing through the states of Tripura, Meghalaya and Assam. One circuit of 400kV Silchar–Bongaigaon double circuit interstate line is looped-in looped-out at Byrnihat substation in Meghalaya and another circuit is looped-in looped-out at Azara substation in Assam.

### The condition

Major constraints in operation and maintenance of transmission line in north eastern region have been described hereafter. The operation and maintenance of transmission line in North Eastern Region is a big challenge due to the following major constraints:

- Dense forest, Hilly terrain, fast growing vegetation, agricultural cultivation fire.
- Frequent land sliding & road blockage due to heavy rainfall. The rain fall in NER is about 7-10 times more than all India average rainfall.
- The acute ROW issues and theft prone area in some parts of Assam, river scoring.
- Severe lightning in some portion of the line.

To minimize the impact of lightning effect, following options were analyzed.

- Providing additional earthing of towers through PG clamp with separate earth pit.
- Providing spike on tower top to capture lightning strikes.
- Providing one more additional insulator disc to protect against Back flashover.
- Installation of Transmission Line Arrestors (TLA) in locations where TFR value is more than 50 ohms.
- If the value of the soil resistivity is more than 1500 ohms metre – then need for use of counter poise earthing up to 70 metres.
- The use of Morolite (Mixture of Bentonite with 7.5% salt) with 40 mm dia Galvanized pipe type electrode.
- Addition of Salt & Charcoal with Rod earthing.
- Carbon earthing.

Lightning is a massive electrostatic discharge caused by electric charges in the atmosphere and resulting in a strike from cloud to ground. Lightning is a very

high frequency signal and high voltage /current, the impedance of the line changes with the frequency of lightning. Whenever lightning strikes the top of a transmission tower or earth wire, a lightning current flows towards bottom of the tower and causes voltage rise to a tower that results in back flashover across the insulators of transmission line or causes phase to ground fault. The probability of flashovers can be minimized if the lightning current gets the least resistance path to ground, which can be achieved by reducing TFR.

### Types of chemical earthing

Following types of chemical earthing compounds are commonly used for reducing the soil resistivity:

- Bentonite
- Marconite.

Bentonite and Marconite have certain similarities and both are used as Ground Improvement Materials (GIMs) to reduce earth resistance. NETC considered Bentonite due to its cost effectiveness over Marconite for improvement of lightning performance of transmission lines.

Types of Bentonite: Two types of Bentonite are commonly available –

- Sodium Bentonite.
- Calcium Bentonite

Sodium Bentonite is having properties of swelling while calcium Bentonite is non-swelling in nature. NETC has used the sodium Bentonite as it can absorb water up to 5 times of its original weight and swells up to 13 times of its dry volume in 139 tower locations.

### Characteristics of Bentonite

Bentonite usually forms from weathering of volcanic ash with high content of silica. It is well-known for its swelling properties and moisture retaining properties.

Bentonite clay is a natural earth soil (clay) containing the mineral montmorillonite. Due to its high moisture characteristics, resistivity of soil decreases.

### Marconite's characteristic and advantage over the Bentonite

- NETC has explored the alternative option to Bentonite earthing in some of the locations by using the conductive concrete earthing (cement by using the Ground Enhancement Material as a Marconite). After application, we obtained good result.
- The Marconite is Corrosion & Maintenance free product.

## Transmission & Distribution

- The life of the Marconite is 50 years as compared to the life of bentonite, which is 4 to 5 years.
- It has very low resistivity, it dissipates the fault current very fast.
- It does not leach away by ground water as a conductive concrete. It is chemically inert.
- Marconite does not require the water to flow of the electricity, as bentonite. It conducts the electricity through the movement of the electrons. It's a pollution free green product used by NETC as an innovative measure in T/L first time in India for transmission lines.
- The soil pollution has been reduced by the application of the Marconite. It doesn't require water at regular interval – so there is saving in the water resources.

The various power utilities /railways/companies are using Marconite in their substations and proved to be very effective. For earth pit doesn't require water periodically, it is saving of water resources.

Three types of earthing in T/L

- Pipe earthing
- Counter poise earthing.
- Pipe Type Earthing.

Bentonite treatment is done in counter poise earthing of transmission line of NETC.

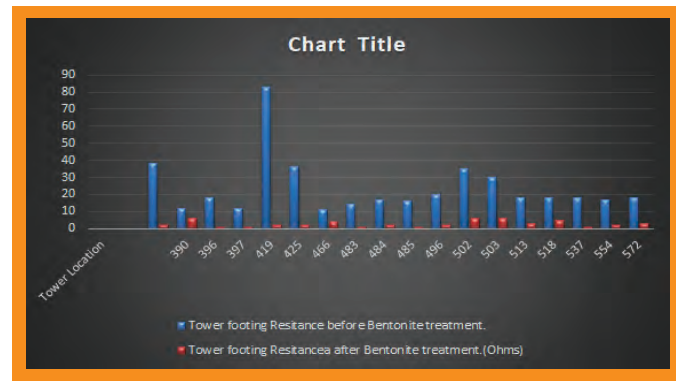
While implementing chemical earthing, sodium bentonite was laid at a depth of 900 mm using new galvanized steel stranded wires (10.97mm) with proper compaction by means of ramming of soil after every 400 mm back filling. In each leg approximately 500Kg Sodium bentonite has been used – length of galvanized steel wire was kept up to 40 metres depending upon soil characteristics.



Bentonite application work...

The Graph showing the improvement of TFR before and after Bentonite Treatment.

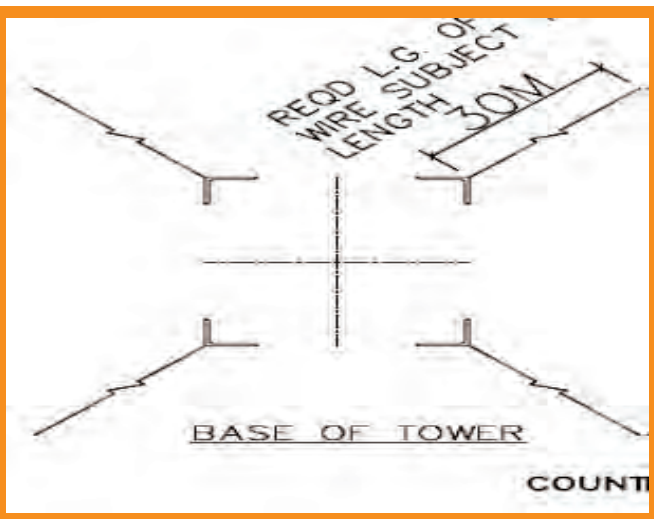
(X- axis indicates tower locations & Y-axis indicates Resistance in OHMs)



### Marcionite conductive concrete implementation

**Marconite earthing execution:** The Marconite contains the fixed carbon (98.5%), by product of coal, very low resistivity of 0.001 ohms, after adding with water & cement, it will be 0.19 ohms. The standard mixture ratio is 75 kg marconite, 25 kg cement and 25 kg/liter water. Marconite is available in premix form also. It is a very challenging job of earthing maintainance in existing system line, various ROW can be encountered during excavation work , but requires no outage. The Marconite has to comply with the test and follow the IEC62561-7 standard.

**Procedure for Marconite application:** Excavation of trench Length: 30 metres. Depth: 90 cms. Width: 30 cms. by manual means, removal of existing counterpoise earth wire, cleaning and rubbing (if any rusting found) of counterpoise earth wire, application of bituminous paint



on the surface of counterpoise earth wire. (anti corrosive paint), setting of form box for putting of counterpoise earth wire and mixture, back filling of the trench with excavated soil (without stone mixed soil) and ramming of soil after every 40 cms back filling.

### Application of Marconite

Mix Marconite with cement & water so as to form a mortar (Ratio of Marconite: cement is 2:1). Pour the mixture inside the form box say 25 to 50 mm (1-2 inch) thick. Lay the counterpoise earth wire on top of the mixture inside the form box. Apply another layer of the mixture say 25 to 50 mm (1-2 inch) thick. Ensure



Marconite earthing execution work...

that the counterpoise wire is fully covered. Wait till the mixture gets set. Carefully remove the form box and backfill the trench with the excavated soil. Rammed the soil after every 40 cm to ensure that the soil is compact.

NETC successfully implemented the Pilot Project of the Marconite earthing, where the tower footing value improved. In locations, where the TFR value did not improve, the value is more than 50 ohms the idea of installation of Transmission Line Arrestors (TLA)

| Improved results after application of the Marconite |                |                                                                                                   |                                                         |                |
|-----------------------------------------------------|----------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------|----------------|
| S. N.                                               | Tower Location | TFR average Value before application of Marconite. (Ohms)                                         | TFR average Value after application of Marconite (Ohms) | Remark.        |
| 1                                                   | 318            | Infinity (Beyond the range of meter)much more value & Lightening mark observed in this locations. | 6.08                                                    | Value Improved |
| 2                                                   | 319            |                                                                                                   | 5.18                                                    | Value Improved |

will be the better option. TLAs are installed on the conductors, electrically in parallel to insulator strings. In the event of lightning, instead of back flash over across insulator string, TLA conducts and provides path to the lightning current towards phase conductors. It not only avoids flashover but prevents tripping in the transmission line. It is worth mentioning that application of TLA nullifies any impact of higher tower footing resistance.

### Conclusion and lessons learnt

Performance of transmission line depends on the performance of the earthing. It is essential to reduce the tower footing resistance to minimise the tripping of line during fault condition & lightning stroke on transmission line. This article mainly aimed to discuss various measures to improve the Tower Footing Resistance by using Sodium Bentonite as a Ground Enhancement Material (GIM) & Marconite in 400 kV in Transmission lines for improving the Tower Footing Resistance (TFR) However, Marconite is better ground enhancement material than Bentonite.

In lightning prone areas, where reduction of tower footing resistance does not improve performance of transmission line, application of TLA may be a better option to reduce the tripping.



**Harshal Radheshaym Malewar** is a graduate in Electrical Engineering from the Govt. College of Engineering Chandrapur, Maharashtra. He also possesses an MBA degree in Power & Operation Management. He has diversified experience of more than 14 years in the Power Transmission & Distribution with various power sectors' companies – such as RECTPCL, MSETCL, Sunflag Steel & Power, Jyoti Structures Ltd. and North East Transmission Company Ltd.

*In this article, the conversion process of agricultural residue to bio fuels and methanisation have been discussed in detail, and the issues with the use of these fuels are taken up and finally an economic analysis is taken up as a comparative study...*

# UNDERSTANDING THE TECHNO-ECONOMICS

## PART II

### Bio-methanisation

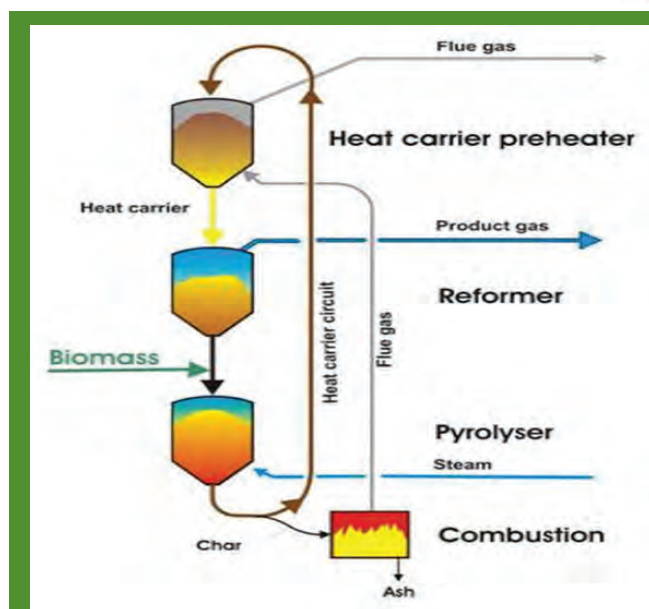
Biomethanation is a process by which organic material is microbiologically converted under anaerobic conditions to biogas. Three main physiological groups of microorganisms are involved: fermenting bacteria, organic acid oxidizing bacteria, and methanogenic archaea.

Microorganisms degrade organic matter via cascades of biochemical conversions to methane and carbon dioxide. Syntrophic relationships between hydrogen producers (acetogens) and hydrogen scavengers (homoacetogens, hydrogenotrophic methanogens, etc.) are critical to the process. Determination of practical and theoretical methane potential is very important for design for optimal process design, configuration, and effective evaluation of economic feasibility.

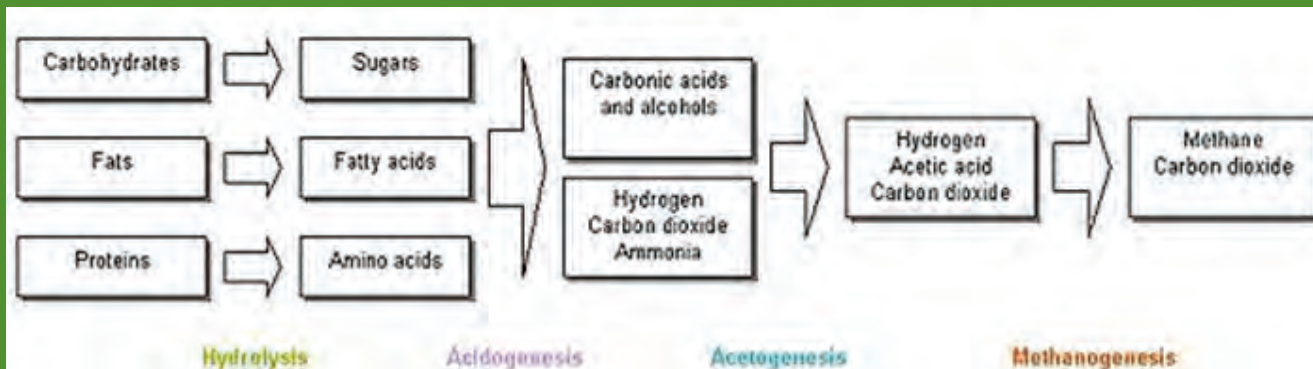
## Satat scheme

Satat is an innovative initiative with PSU Oil Marketing Companies (OMCs, that is, IOC, BPC and HPC) inviting Expression of Interest (EoI) from potential entrepreneurs to set up Compressed Bio-Gas (CBG) production plants – and make available CBG in the market for use in automotive fuels, which have the capability to boost availability of more affordable transport fuels, better use of agricultural residue, cattle dung and municipal solid waste as well as to provide an additional revenue source to farmers.

Bio-gas is produced naturally (through a process of anaerobic decomposition) from waste / bio-mass sources like agriculture residue, cattle dung, sugarcane press mud, municipal solid waste, sewage treatment plant waste, etc. After purification, it is compressed and called CBG, which has high methane content.



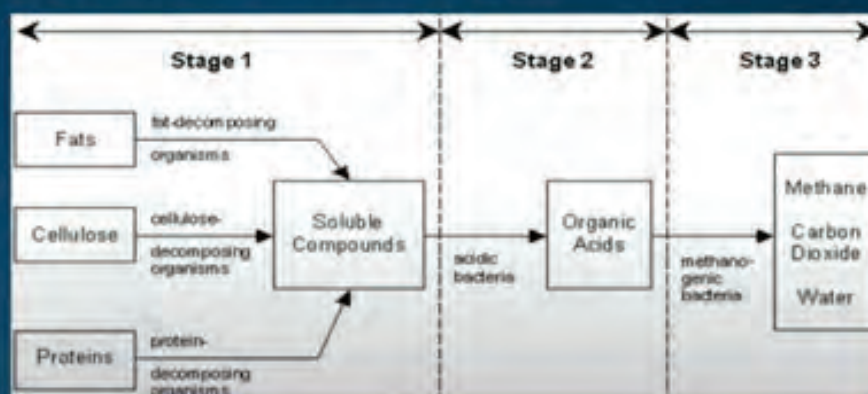
Agricultural residues are bailed by the bailers...

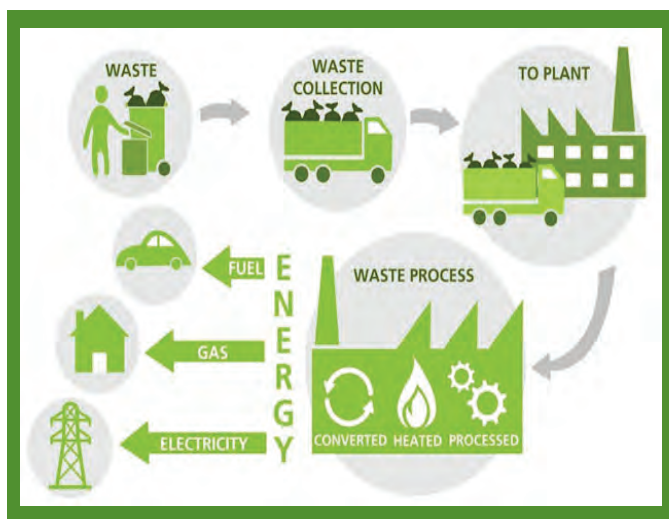
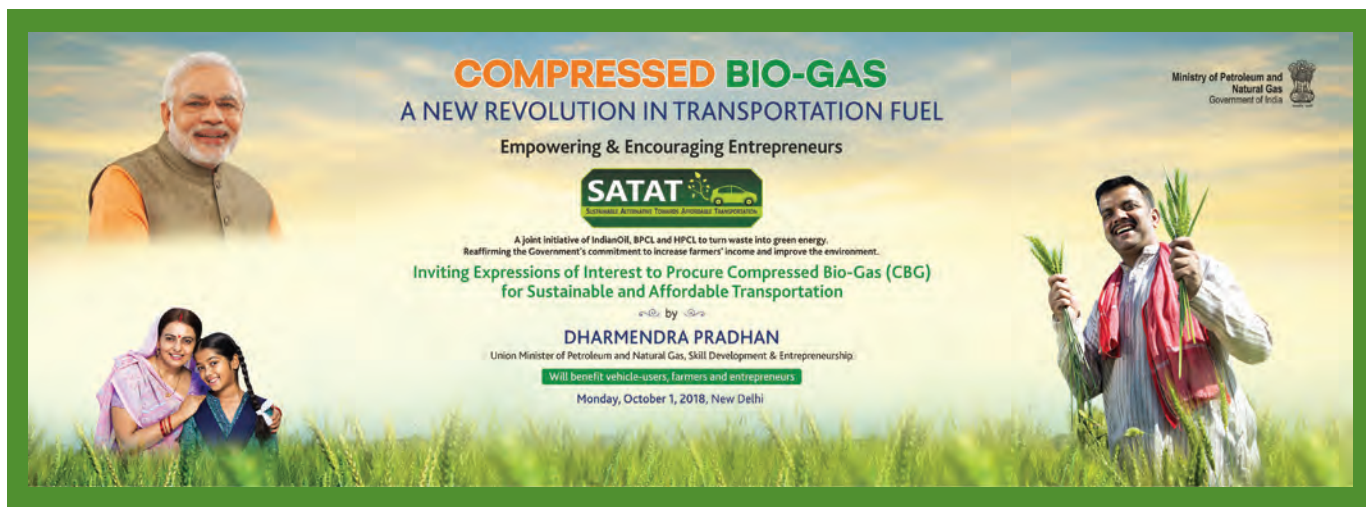


## Stages of Biogas Production

Anaerobic Digestion is accomplished by three stages

- Solubilization
- Acidogenesis
- Methanogenesis.





Further, Compressed Bio-Gas is exactly similar to the commercially available natural gas in its composition and energy potential. With similar calorific value and other properties similar to CNG, Compressed Bio-Gas can be used as an alternative, renewable automotive fuel. Given the abundance of biomass in the country, Compressed Bio-Gas has the potential to replace CNG in automotive, industrial and commercial uses in the coming years.

## Production & marketing plan

Compressed Bio-Gas plants are proposed to be set up mainly through independent entrepreneurs. CBG produced at these plants will be transported through cascades or through pipelines to the fuel station networks of Oil Marketing Companies (OMCs) for marketing as a green transport fuel alternative. The 1,500-strong CNG stations network in the country currently serves about 32 lakh gas-based vehicles.

The entrepreneurs would be able to separately market the other by-products from these plants, including bio-manure, carbon-dioxide etc., to enhance returns on investment. The National Policy on Biofuels 2018 emphasises active promotion of advanced bio-fuels, including CBG. The Government of India had launched the GOBAR-DHAN (Galvanising Organic Bio-Agro Resources) scheme earlier this year to convert cattle dung and solid waste in farms to CBG and compost. In addition to Govt. of India's efforts, Individual states have also come forward to promote CBG initiatives, in this direction several states such as Haryana, Punjab, Uttar Pradesh and several other States have formed State Level Committee for implementation and monitoring of SATAT Scheme.

As we know, Methane as natural gas has got four-fold use, it is PNG in our kitchen, CNG on the road, Fuel for Power-Plants based on combined cycle and raw-material for fertilizer. While transportation of briquettes could add significantly to its lended costs, natural gas can be utilized in the vicinity of its production. Let us now see the gas prices in different forms.

## CNG prices

Below are the prices of Compressed Natural Gas (methane is the major constituent)

- NCT of Delhi – Rs. 43.40/- per Kg
- Noida, Greater Noida & Ghaziabad– Rs.49.08/- per Kg
- Muzzaffarnagar & Shamli – Rs.57.25/- per Kg
- Gurugram – Rs.53.40/- per Kg
- Rewari – Rs.54.10/- per Kg
- Karnal – Rs.51.38/- per Kg

| Rice husk<br>in kg | Yield Methane in<br>Cube | Methane Density in<br>Kg/Cub M | Yield Methane<br>in Kg | @46/kg as per satar<br>Scheme |
|--------------------|--------------------------|--------------------------------|------------------------|-------------------------------|
| 1                  | 0.5                      | 0.68                           | 0.34                   | 15.64                         |

- Kaithal – Rs.51.38/- per Kg
- Kanpur, Hamirpur & Fatehpur – Rs. 60.50/- per Kg

### PNG prices

- NCT of Delhi – Rs.28.41/- per SCM (Including VAT)
- Noida, Greater Noida & Ghaziabad – Rs.28.36/- per SCM
- Karnal & Rewari – Rs.28.46/- per SCM
- Muzaffarnagar, Meerut & Shamli – Rs. 32.67/- per SCM (including VAT)

On further analysis, we find that: By Briquettes, we are able to make around Rs 7/KG and for gas we make Rs. 15 approximately.

### Now, let's add the transportation cost

Here are the Operating Cost and Fixed Cost of each truck (could vary from company to company by 10%) based on 8,000 Kms., monthly running.

- Fuel : Rs. 14.00 per Km
- NH Toll : Rs. 5.00 per Km
- Tyre : Rs. 2.00 per Km
- EMI : Rs. 6.00 per Km
- Maintenance : Rs.1.00 per Km
- Double Drivers : Rs.4.00 per Km
- National permit, Insurance, Fitness, Road Tax, goods Tax : Rs.1.00 per Km
- Police / RTO / Border / Accidents : Rs. 1.00 per Km
- Company Management Expenses : Rs. 1.00 per Km

On Adding all the prices, we get a Total Cost / Km : Rs. 35.00 per Km.

Let's assume, a truck can carry a standard of 10 Ton of briquettes.

So, Rs.35 per Km will be the cost of transporting the briquettes by trucks with a capacity of 10 tons.

Let's assume an average distance of 300 Km, So  $300 \times 0.0035 = 10500 = \text{Rs. } 1.05$

So, we need to add the cost of transport to the cost of briquettes as landed cost.

Here, we have not taken into account the further benefit of liquid fertilizer from methanization, which can also be sold.

### Conclusion

What was traditionally considered as waste is being

increasingly transformed into energy. Every bit of biomass can be used to produce bio-gas and bio-coal. This will go a long way in making India energy self-reliant, help combat global warming and mitigate climate change.

If we look for the price of pellets, it's competitive if we go for mass production and transport in bulk through Railways. With average distance of 200-300 Km, the transportation cost is reduced in comparison to coal received from mines 1,000 Kms from the power plants. Environment being the first priority, biopellets can be substituted for coal, at least 5 to 10%, at Rs 7 to 8 per Kg as against Rs 4 per Kg of landed cost of coal.

However, when methanised the same, 1 Kg agricultural residue can yield approximately Rs 15/- @ Rs 46/ Kg of CBG under the Satat scheme. CBG can be utilised in the vicinity of its production without additional transportation cost unlike bio pellets that would require Rs 1/Kg over an average distance of 300 Kms, also liquid fertiliser as a byproduct of bio methanisation has a huge economic value. Thus, bio methanisation of agricultural residue is preferable – as it yields more value besides reducing petroleum and natural gas import for the country. 

**...concluded**



**Sowjanya Rath** is currently working as a Business Analyst in ESSPL, Bhubaneswar, Odisha. He is a Graduate (B. Tech.) in Electrical And Electronics Engineering from Silicon Institute of Technology. He has done internship at NTPC Corporate Engg., Noida.



**Dr. Bibhu Prasad Rath** is a graduate in Mechanical Engineering. He has worked in various functions in NTPC including Operation & Design. He is presently Additional General Manager in Project Engineering Division. He has also completed ICWA (Inter - 1995), and M.Tech (IIT Delhi - 2002) and PhD (in Business Administration - 2015) from Aligarh Muslim University.

# DEMAND RESPONSE PROGRAM WITH DIFFERENT ELASTICITIES

## PART - 1



*This article presents an overview of new flexible resources for operating a reliable system. It starts with defining the Demand Response (DR) and shows how electricity consumers can be responsive...*

For many reasons, electric utilities and power network companies have been forced to restructure their operations from vertically integrated mechanisms to open market systems. With the restructuring and deregulation of the electricity supply industry, the philosophy of operating the system was also changed. The traditional approach was to supply all power demands whenever they occurred, however, the new philosophy states that the system will be most efficient if fluctuations in demand are kept as small as possible. Electricity markets have arisen as a result of the power sector restructuring and power systems' deregulation. The players participating in the competitive electricity markets must define strategies and take decisions using all the available information and business opportunities to accomplish their goals.

Reliable operation of the electricity system necessitates a perfect balance between supply and demand in real time. This balance is not easy to achieve given that both supply and demand levels can change rapidly and unexpectedly due to many reasons, such as generation unit forced outages, transmission and distribution line outages, and sudden load changes. The electricity system infrastructure is highly capital intensive; demand side (load) response is one of the cheaper resources available for operating the system according to the new philosophy. DR has proved to be a good opportunity for loads to participate in this environment, gaining competitive advantage, and represents significant benefits for the whole electricity market performance. DR programs may produce an increase in power consumption efficiency through active consumer participation, making evident the value that each consumer attributes to his individualized additional demands.

Recent efforts are aiming at improving wholesale markets with more intensive use of DR. This includes, for example, the acceptance of demand bids/offers for ancillary services; the specification by the DR resources of the frequency, duration and the amount of their participation in consumption reduction; and the existence of aggregators that bid into the market on behalf of customers.

This article presents an overview of new flexible resources for operating a reliable system. It starts with defining the Demand Response (DR) and how electricity consumers can be responsive. Highlighting different DR programs follows, including classical, new market-based and dynamic pricing scenarios. Potential cost savings and benefits related to different market components are also discussed.

## **Demand Response (DR) concepts**

DR is a class of demand-side management programs in which utilities offer customers incentives to reduce their demand for electricity during periods of critical system conditions or periods of high market power costs. Interest in DR has increased during the past decade, although these programs have existed for nearly 25 years. Many utilities and independent system operators in deregulated markets have long recognized the benefits of DR. Utilities can purchase load demand from their customers for lower rates than they would pay to provide it, lowering the utility system's peak demand and help reduce peak wholesale

power market prices. In addition, customers can also be asked to reduce load during non-peak periods to help maintain grid reliability, defer or eliminate generation capacity expansion, or defer or eliminate transmission/distribution capacity expansion.

Demand response can be defined as the changes in electricity usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time. Further, DR can be also defined as the incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized. DR includes all intentional electricity consumption pattern modifications by end-use customers that are intended to alter the timing, level of instantaneous demand, or total electricity consumption.

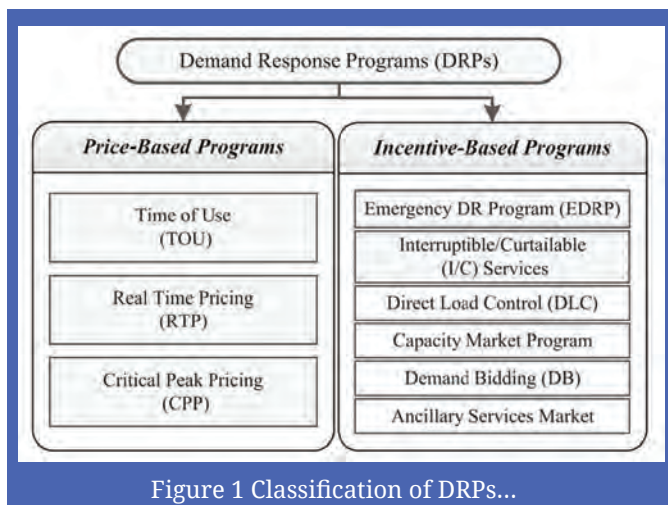
An important advantage of demand response implementation is the postponement of investments in generation resources and transmission/distribution lines. This is highly important when the generation is near its maximum capacity with exponentially increasing generation costs. In these conditions, a small reduction in load will cause a big reduction in generation costs and, therefore, a significant reduction in the price of electricity.

### **Customer response**

Customer response can be achieved by three actions. The first action is reducing electricity consumption of customers by themselves at peak time when prices are high without altering their usage pattern on normal time. This action involves loss of comfort for a small period temporarily. Temporary change of thermostat settings of heaters or air conditioners is an example. The second action is changing the consumption time of some peak demand operations from peak period to off-peak periods. Changing some household activities to off-peak periods is an example. In this action, there is no loss for residential consumer but losses will be incurred for industrial consumers. The third action of customer response is done by customers who are using onsite generation—customer owned distributed generation. The consumption pattern of these type of customers will not be changed.

### **Classification**

Demand response programs can be divided in two wide groups: price-based programs and incentive-based programs.



Price-based demand response program is related with the changes in energy consumption by customers in response to variation in the prices they pay. This group includes Time-Of-Use (TOU), Real Time Pricing (RTP), and Critical-Peak Pricing (CPP) rates. For different hours or time periods, if the price varies significantly, customers can respond with changes in energy use. Response to price-based demand response programs is entirely voluntary. TOU is a rate that includes different prices for usage during different periods, usually defined for periods of 24 hours. This rate reflects the average cost of generating and delivering power during each period. RTP is a rate in which the price of electricity is defined for shorter periods of time, usually one hour, reflecting changes in wholesale price of electricity. Customers usually have the information of prices on a day-ahead or hour-ahead basis.

CPP is a hybrid of the TOU and RTP programs. The base program is TOU and a much higher peak pricing is used under specified conditions (e.g., when system reliability is compromised or supply costs are very high).

Incentive-based demand response includes programs that give customers incentives which may be fixed or time varying and that are complementary to their electricity rate. These can be established by utilities, load-serving entities, or a regional grid operator. Some of these programs penalize customers that fail the contractual response when a priority specified events are declared. This group includes programs such as Direct Load Control (DLC), Interruptible/Curtailable Service (ICS), Demand Bidding/Buyback (DBB), Emergency Demand Response Program (EDRP), Capacity Market (CM), and Ancillary Services Market

(ASM) Programs. As with Direct Load Control programs, customers participating in Interruptible/Curtailable Programs receive upfront incentive payments or rate discounts. Participants are asked to reduce their load to predefined values. Participants who do not respond can face penalties, depending on the program terms and conditions. Demand Bidding (also called Buyback) programs are programs in which consumers bid on specific load reductions in the electricity wholesale market. A bid is accepted if it is less than the market price. When a bid is accepted, the customer must curtail his load by the amount specified in the bid or face penalties. On the other hand, in Emergency DR Programs, participating customers are paid incentives for measured load reductions during emergency conditions.

Furthermore, Capacity Market Programs are offered to customers who can commit to providing pre-specified load reductions when system contingencies arise. Participants usually receive a day-ahead notice of events and are penalized if they do not respond to calls for load reduction. Ancillary services market programs allow customers to bid on load curtailment in the spot market as operating reserve. When bids are accepted, participants are paid the spot market price for committing to be on standby and are paid spot market energy price if load curtailment is required.

## DR Measurement and Simulation

### DR Measurement

Several studies have proved that loads are not rigid, exhibiting elasticity that can be used for mutual benefits of power systems and consumers. Changes in electricity price over time and incentive payments give place to increased demand flexibility as end-use customers intentionally modify their electricity consumption patterns as a response to exterior stimulus. DR can be contracted over longer or shorter periods either as result of its inclusion in capacity markets or directly through bilateral contracts.

Price elasticity is a measure used in economics to evaluate the responsiveness of the demanded quantity of a good or service to a change in its price, or the percentage change in quantity demanded on response to a one per cent change in price. In what concerns electric loads, price elasticity is a normalized measure of the intensity of how usage of electricity changes when its price changes by one per cent. In the opposite way, demand elasticity is a measure of how price changes when usage of electricity changes.

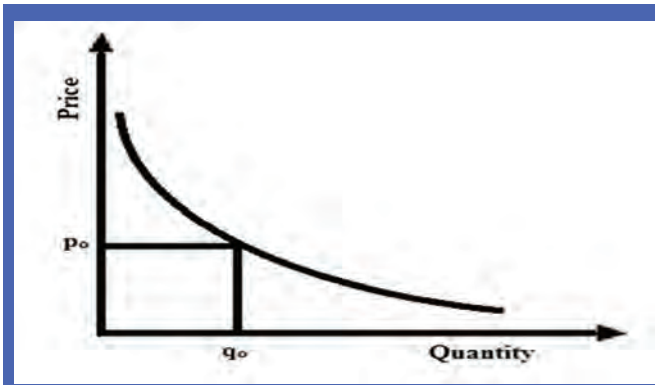


Figure. 2 Price elasticity...

In order to ensure the effective participation of the customers in the DR program, a suitable economic load model needs to be developed based on the change of customers' power consumption with the change of electricity prices, benefits, and penalties applied to the customers. In general, the load demand of customers who participate in the DR programs is inversely proportional with the electricity price as shown in Figure 2.

Demand-price elasticity is defined as the ratio of rate of change of demand to the rate of change of price as follows.

$$\epsilon = \frac{\Delta \text{Demand} / \text{Demand}}{\Delta \text{Price} / \text{Price}}$$

where  $\epsilon$  is the elasticity,  $q_0$  is the demand at price  $p_0$  for a given equilibrium point, and  $\Delta \text{Demand}$  is the change of demand due to the change of price of  $\Delta \text{Price}$ .

The elasticity of a substitution measures the rate at which the customer substitutes off-peak electricity consumption for peak usage in response to a change in the ratio of peak to off-peak prices. This kind of elasticity is important in TOU and CPP pricing programs. The elasticity is divided into self-elasticity and cross-elasticity. Self-elasticity measures the demand reduction in a certain time interval due to the price of that interval. Cross elasticity measures the effect of the price of a certain time interval on electricity consumption during another interval.

As Figure 3. suggests, elasticity is used in conjunction with expected price to modify expected demand;

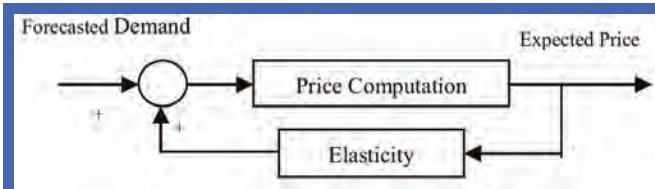


Figure 3: Effect of price elasticity in price computation...

consequently, demand and prices will be reduced if prices are above the equilibrium point ( $p_0, q_0$ ); see Figure 2. The equilibrium point is defined as price and demand of the normal case. In this analysis, one equilibrium point is assumed for each period.

## Market simulation

In this article, a single-sided uniform market price is considered in which the supply-side submits bids for supplying power to the market operator when the market operator has a forecast of demand. These bids reflect generator cost functions. The operator announces the expected prices for the next 24 hours. These prices act as guidelines for customers to respond to that in real time, depending on their elasticity and expected prices.

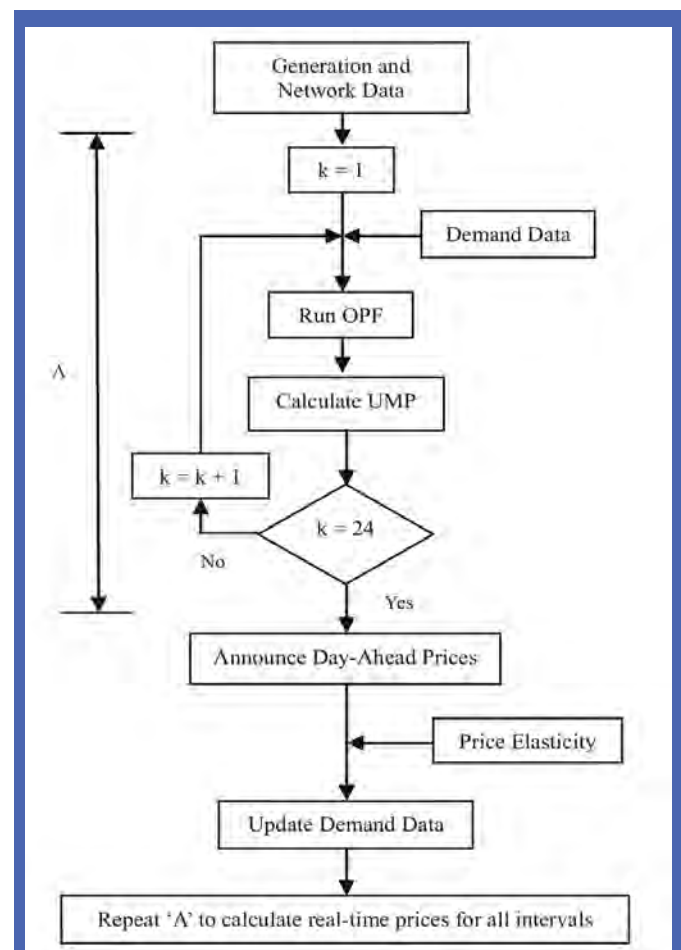


Figure 4: DR flowchart...

This DR is very beneficial as it can reduce market prices as well as costs. The process used for simulating DR is shown in Figure 4.

## Optimal Power Flow formulation

In OPF, the values of some or all of the control variables

need to be found to optimise (minimise or maximize) a predefined objective. It is important that the proper problem definition with clearly stated objectives be given at the onset. The quality of the solution depends on the accuracy of the model studied. Objectives must be modelled with its practicality with possible solutions. Objective function takes various forms such as fuel cost, transmission losses and reactive source allocation. Usually the objective function of interest is the minimisation of total production cost of scheduled generating units. This is mostly used as it reflects current economic dispatch practice and importantly cost related aspect is always ranked high among operational requirements in Power Systems. OPF aims to optimise a certain objective, subject to the network power flow equations and system and equipment operating limits.

For Optimal Power Flow (OPF) simulations, we use MATPOWER a MATLAB Power System Simulation Package. A common objective function used in OPF studies is the minimization of generation costs.

The objective function based on generation operating cost can be expressed as,

$$\text{Min } J = \sum_{i=1}^{NG} C_i(P_i)$$

$$C_i(P_i) = aP_i^2 + bP_i + c_i$$

where J is the total generation costs;  $C_i(P_i)$  is the cost function of generator i;  $P_i$  is the power output of generator i, and NG is the set of all generating units including the generator on the slack bus. Generators are assumed to be bidding their true cost of generation.

$$P_i - PD_i = \sum_j |V_i||V_j|Y_{ij} \cos(\theta_{i,j} + \delta_j - \delta_i) \quad \forall \quad i = 1, \dots, N; i \neq \text{slack}$$

$$Q_i - QD_i = - \sum_j |V_i||V_j|Y_{ij} \sin(\theta_{i,j} + \delta_j - \delta_i) \quad \forall \quad i = 1, \dots, NL$$

The minimization objective function has the following constraints: Network equations –

where  $V_i$  is the voltage at bus i;  $\delta$  is the angle associated with the voltage at relevant buses;  $Y_{i,j}$  is the element of the bus admittance matrix;  $\theta_{(i,j)}$  is the angle associated with  $Y_{i,j}$ ;  $P_i$  and  $Q_i$  are real and reactive power generation at bus i, respectively.  $PD_i$  and  $QD_i$  are real and reactive power demand at bus i, respectively. NL is the number of load buses.

## Generation Limits

$P_i^{\text{Min}}$  and  $P_i^{\text{Max}}$  are the lower and upper limits on real power generation and  $Q_i^{\text{Min}}$  and  $Q_i^{\text{Max}}$  are the lower and

$$P_i^{\text{Min}} \leq P_i \leq P_i^{\text{Max}} \quad \forall \quad i \in NG$$

$$Q_i^{\text{Min}} \leq Q_i \leq Q_i^{\text{Max}} \quad \forall \quad i \in NG$$

upper limits on reactive generation from bus i.

## Bus Voltage Limits

This constraint ensures that the voltages at different buses in the system are maintained at specified levels.

$$|V_i| = \text{constant}, \quad \forall \quad i = 1, \dots, NG$$

$$V_i^{\text{Min}} \leq |V_i| \leq V_i^{\text{Max}} \quad \forall \quad i = 1, \dots, NL$$

The generator bus voltages are maintained at a fixed level. Voltage level at a load bus is maintained within a specified upper limit  $V_i^{\text{Max}}$  and a lower limit  $V_i^{\text{Min}}$ .

There are two types of market price formulations: the Locational Marginal Prices (LMP) and the Uniform Market Price (UMP). The Locational Marginal Pricing (LMP) mechanism is one of the most commonly employed tools for market settlement in the deregulated power system environment. The LMP at a bus signifies the cost of supplying the next increment of load at that bus. It is the sum of supplying energy marginal cost, cost of losses due to the increment and transmission congestion cost, if any, arising from the increment. The market price at each bus is represented by the Lagrangian multiplier  $\lambda_i$  of the real power balance constraint at that bus.

In an UMP formulation, the market price is the highest value of the bus incremental cost obtained by solving the above model:

$$\rho \leq \lambda_i \quad \forall \quad i = 1, \dots, N$$

where  $\rho$  represents the uniform electricity market price;  $\lambda_i$  is the incremental cost of generation at bus i, and N is the number of buses in the system. E

*...to be continued*



**I. Arul Doss Adaikalam** is from T.J.S Engineering College, Chennai, Tamil Nadu, India



**C. K. Babulal** is from Thiagarajar College of Engineering, Madurai, Tamil Nadu, India

# Megger, IPS Group form strategic partnership

*Megger Group is a leader in electrical test and measurement globally and IPS Group is a global software company with specialized solutions for power utilities...*

**M**egger Group (Megger) and IPS Group (IPS) have reached a definitive agreement to work together as strategic partners combining their exclusive experience and product lines to create new value for the electrical supply industry. The agreement includes Megger taking an equity stake in IPS.

IPS is one of the leading providers of Enterprise Asset Management (EAM), Asset Performance Management (APM), Network Model Management (NMM), Outage Management (OMS), Enterprise Protection Information (EPIS) and Mobile Software Solutions (WFM) for the electrical supply industry. Gartner ranked IPS as 'the world's highest-performing Niche Player for the execution of the Enterprise Asset Management.

IPS was founded by Dr Zeljko Schreiner in 2004. Since then, it has grown to be a leading provider of APM data analytics to the electrical power industry, enabling electrical utilities to increase network reliability while reducing both maintenance costs and customer minutes lost, as well as providing insight to Asset Investment Planning.

The partnership with Megger extends the reach of IPS's technical excellence and brings improved market access as well as new opportunities in commercial and strategic

innovation. Megger will benefit from IPS's data analytics capability, cyber security and digitalization expertise.

Commenting on the partnership, Jim Fairbairn, CEO of Megger, stated "We are thrilled to announce our partnership with IPS and are excited about the opportunities of working together on a global basis. The Megger team has been very impressed with IPS and in particular the quality of the team at IPS. This move is aligned to the Megger strategy of extending our leadership in electrical test & measurement to include online condition monitoring equipment and services and enabling Asset Performance Management critical data flow and related prescriptive insights to electrical power systems through advanced analytic capabilities."

Expressing his satisfaction on the development, Dr Zeljko Schreiner, Founder and CEO of IPS, commented, "I'm very happy to have Megger as our strategic partner who will help us take the business to the next level. We have already identified many opportunities to work together to increase the value for our customers. The IPS Team is looking forward to co-operating with Megger over the coming years."

For further information:

E-mail: [milind.thakkar@megger.com](mailto:milind.thakkar@megger.com)

*Social Media keeps Changing, but Networking is Constant*

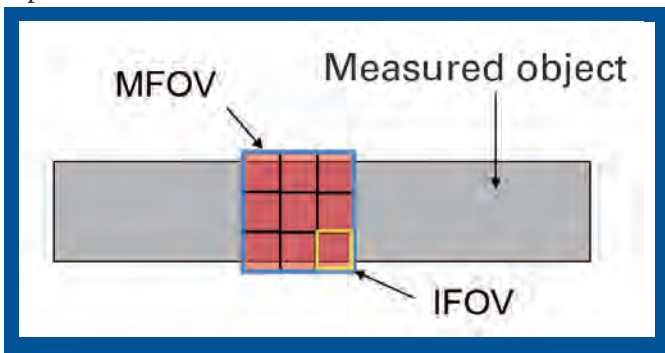


**Paid Services: Coverage on our Electrical India digital profiles and print magazine**  
 contact us: [pravita@charypublications.in](mailto:pravita@charypublications.in)

# Five things to consider before choosing a thermal imager for electrical facility maintenance, according to Thermographers Co., Ltd.

**L**arge-scale electrical fires were a common occurrence in electric utility power plants and factories in Japan in the early 2000s. Due to poor economic conditions at the time, facilities poured less money into necessary maintenance and repairs. It was around this time that thermal imaging cameras began drawing attention as an electrical inspection and diagnostics tool. Previously, thermal imaging cameras were more commonly used for research and development because of their cost and large size. But as thermal imagers have become smaller and more affordable, they have been gradually introduced into electrical facilities for condition monitoring to identify problems without the need to shut down equipment.

Shutdowns and equipment repairs can be costly. That's why electrical facilities all over the world are switching to condition-based maintenance and routine inspections of equipment using thermal imaging. This technology has enabled facilities to routinely inspect equipment and make repairs as needed – before a failure occurs.



Thermographers Co., Ltd. is a team of specialists in Japan that offers thermography inspection services and seminars on gaining qualification as engineers in condition monitoring and diagnostics of machines (under the ISO 1826-7 international standard). Hirofumi Yamada, the company's president and a thermography expert, offers the following five things to



consider before choosing a thermal imager for electrical facility maintenance:

## Emissivity

An understanding of the infrared properties of a material is important in determining whether you are observing a true or a false hot spot. Electrical connections and contacts are made of or plated with metal to prevent radiation heat; the emissivity of the metal parts tend to be low. Emissivity varies between 0 and 1.0. The lower levels reflect, while the higher levels emit infrared energy. Depending on the thermal camera used, the emissivity must be correctly set to get an accurate temperature reading.

## Temperature Under No Load

It is also important to know how much load the facility operates. For example, if there is an increase in temperature but it is unclear whether the increase is caused by the properties of the facility or by a failure, then it is impossible to make a diagnosis. It is necessary to understand the relationship between degradation failure temperature and heat generation, including whether the temperature increase is adequate for the load.

## Measurement Field of View (MFOV)

MFOV is the spatial resolution necessary for measurement. In the camera specifications, the instantaneous field of view (IFOV) is often specified. This corresponds to the angular projection of a single pixel. For accurate measurement,

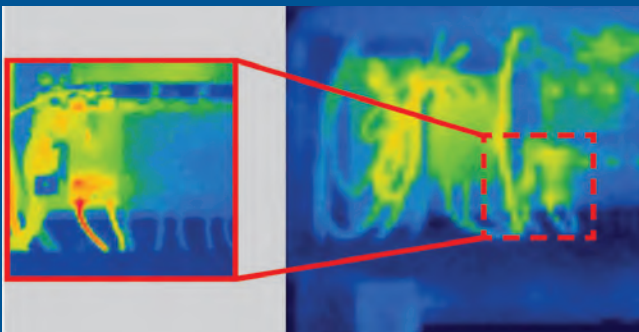
we need to cover a larger area (approximately  $4 \times 4$  pixels), which is called the MFOV. Premium cameras have a high detector resolution and good optics, which help with IFOV and MFOV, allowing you to accurately measure small targets at a larger distance than you can with lower resolution cameras.

## Degradation

Using thermal imaging cameras in electrical facility maintenance requires the knowledge of degradation



Power distribution panel with loosened screws (digital camera)



Low-pixel camera ( $160 \times 120$  pixels) If the heat-generating point is unclear with the entire panel displayed, shorten the distance from the panel to carry out the measurement.

failures, including what kinds of degradation failures or losses may occur. Electrical facilities are often located outdoors, exposed to outside air, so they degrade naturally. Their degradation varies, depending on their operating environment, materials, design, and how they are used and put under load. According to Yamada, the occurrence of an accidental failure or disaster makes predictions more difficult. “You should keep in mind that the average service life of electrical facilities is not necessarily as specified by their manufacturer,” he says. According to Yamada, using a thermal imager for inspection is more complex than users expect. “Many think they can discover



High-pixel camera ( $640 \times 480$  pixels) Even when the entire panel is displayed, the heat-generating point is clearly shown due to the high resolution.

high-temperature locations and degradation failures by simply using a camera. But to measure, you need a certain level of experience and knowledge to carry out the diagnosis,” Yamada says. “Temperatures may increase or decrease depending on the degradation, as described in examples in the ISO textbook. It is necessary for the user to understand, to a certain extent, the relationship between degradation failures and temperatures, and infrared theory including relevant physical laws.” Without general knowledge of degradation failures, it is impossible to make a diagnosis using a thermal imaging camera.

## Don't Fixate On

‘PRICE’ Typical users tend to care most about price when purchasing their first thermal camera. However, Yamada says, “Less expensive cameras are more suited for experienced users, and beginner users should purchase a premium camera.” Low-priced cameras have limited functions, so their effective use requires experience and skill, while premium cameras have functions that compensate for the measurers’ inexperience, including the ability to shoot high-precision images of wide areas. Focus on choosing the right camera with the right functions, so problems can be accurately diagnosed. With these five things in mind, every electrical facility can successfully incorporate a thermal imager into an inspection routine. Through regular condition monitoring using FLIR thermal imaging technology, electrical facilities can reduce equipment failure, expand life cycle, and lower overall costs. <sup>(5)</sup>

*Imagery for illustration purposes only.*

For further information, Email: [flirindia@flir.com.hk](mailto:flirindia@flir.com.hk),  
Website: [www.teledyneflir.in/electrical](http://www.teledyneflir.in/electrical)

# The “War of the Battery” *FOR FUTURE EVs*

Part - 1



*In the “War of The Batteries”, many technology would fall and many underdogs would rise in coming times before few winners take their righteous place. Here is a description of the development of the Batteries and the present day status with the future potential...*

The “War of the Currents” is a well-documented technology war of the 1880s, with “Edison” & “Westinghouse” on either side of the fence. It is said to be the very first technology war to set standards of power distribution and, involved a series of events. Its end came with the construction of a 3.70 MW powerhouse at Niagara Fall by Westinghouse Electric in 1895 and within the next few years, the DC power system was completely replaced by an AC power system. All of the then-existing ~15 electric companies merged into two; General Electric and Westinghouse Electric. The world of electricity had changed then. Later, we saw many more such technology wars e.g. Videotape format

war (1978~80), Apple IBM war (~the 1980s) & first Browser war (~the 1990s), PC Operating System (1988), HD optical disc format war (2006~2008) to name which changed the course of technology and world for the better. In EVs market, one such war is already on, for EV charging system amongst four types of charging system – first one known as Tesla’s own Supercharger system, second one is CCS (known as Combined Charging System and is favoured by Europe, BMW, Mercedes-Benz maker Daimler, Ford and the Volkswagen, Audi and Porsche), third one CHAdeMO (Charge de Move and developed by Japanese firms including carmakers Nissan and Mitsubishi) and lastly GB/T in China, the world’s biggest electric car market.

In the coming few years, with the rise of EVs, we are probably going to witness a similar War which might later be studied as the “War of The Batteries”. With the meteoric rise of Tesla in the area of EV, This unsaid “war of the batteries” has already begun.

However, it is interesting to recall that despite multiple fuel options available for ICEVs (e.g. Hydrogen, Natural gas, Conventional gasoline, Conventional diesel, Ethanol, LPG, LNG, CNG, Butane, or Propane), ICEVs had only two known & established technologies to harness the energy from these fuels- spark plug ignition (SI technology for a petrol engine) & Compression Ignition (CI for Diesel engine) and being complementary, they both grew in tandem during the last century depending upon the application and need, supplementing each other. There was no fight for supremacy.

The situation is not the same in the current EVs market, which is still evolving. While the main drive technology may remain more or less the same for all EVs, there are multiple options of onboard energy storage & generation for these EVs. While these technologies may have performed well till now in western countries with a limited number of EVs, in diverse & complex Indian mobility market, which has extreme weather conditions (with rains, temperature, dust, humidity, etc.), as well as other complexities e.g. highly unregulated traffic, typical driving habits & conditions, poses a different level of challenge for these EVs and their batteries, affecting the travel range, performance & reliability.

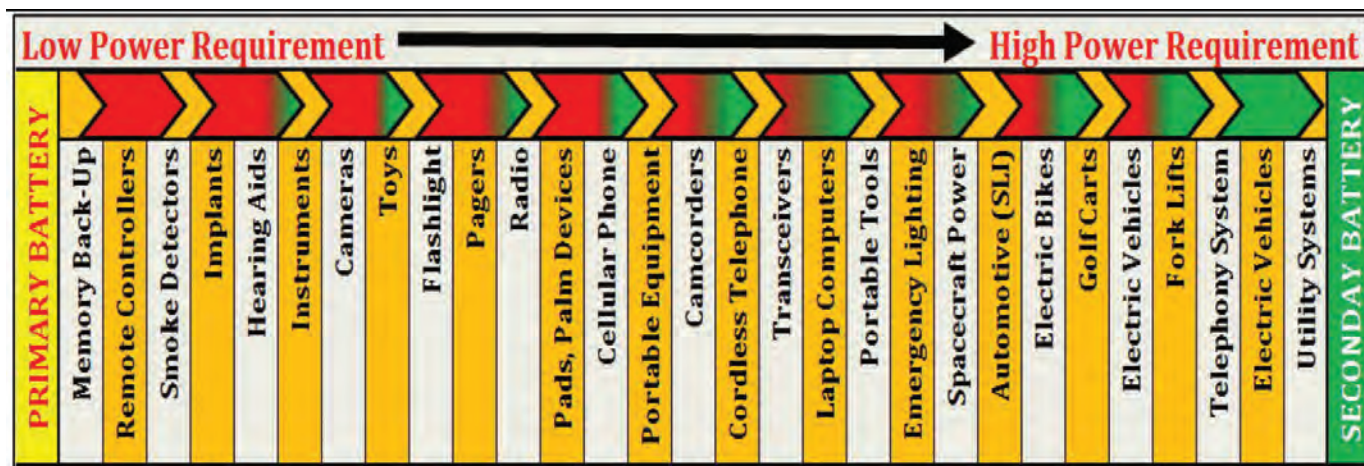
While many of the infrastructure related challenges like reliability & functionality of charging stations [where power is a political tool & power theft is a normal thing (25~27% of total generation)], the EV manufacturers, as well as energy source manufacturers for these EVs, need to look into many such contradictions of Indian mobility world before deciding about the kind of energy source their EVs would be using for Indian roads.

In the “War of The Batteries”, many technology would fall and many underdogs would rise in coming times before few winners take their righteous place, however, till the time that happens let’s try to understand the current scenario, starting from the beginning.

## The beginning

An about 2,200 years old clay pot discovered near Baghdad, Iraq, currently known as “Baghdad Battery”

| Historical Development |                         |                   |              |                                     |                                       |                              |                                      |                      |                           |                                 |
|------------------------|-------------------------|-------------------|--------------|-------------------------------------|---------------------------------------|------------------------------|--------------------------------------|----------------------|---------------------------|---------------------------------|
|                        |                         |                   |              |                                     |                                       |                              |                                      |                      |                           |                                 |
| Baghdad Battery        | Linked Glass Capacitors | Voltaic Pile      | Daniell Cell | First Crude Fuel Cell               | Nitric Acid Battery                   | Poggendorff cell             | Planté Cell (Lead Acid Storage Cell) | Gravity Cell         | Georges Leclanché Cell    | Zinc-Carbon Battery (Dry Cells) |
| ~1000 BCE              | 1749                    | 1782              | 1836         | 1838                                | 1839                                  | 1842                         | 1859                                 | 1860                 | 1866                      | 1886                            |
| Unknown                | Benjamin Franklin       | Allesandro Volta  | John Daniell | Physicist Welsh & Sir William Grove | William Grove                         | Johann Christian Poggendorff | Gaston Planté                        | Callaud              | Georges Leclanché         | Karl Gassner                    |
|                        |                         |                   |              |                                     |                                       |                              |                                      |                      |                           |                                 |
| Nickel-Cadmium Battery | Nickel-Iron cell        | Alkaline Dry cell | Button Cell  | New Age Fuel Cell                   | Idea/ Development Of Primitive of LIB | Lithium Polymer Battery      | Nickel-Metal Hydride                 | LIB (Multiple Types) | Modern Age Al-Air Battery |                                 |
| 1899                   | 1905                    | 1949              | 1950         | 1959                                | 1970                                  | 1980                         | 1989                                 | 1991                 | 2001                      |                                 |
| Waldemar Jungner       | Thomas Edison           | Lew Urry          | Samuel Ruben | Francis Bacon                       | M. Stanley Whittingham                |                              | Dr. Masahiko Oshitani                | Sony                 | Trevor Jackson            |                                 |



is probably the oldest electricity generation device by chemical reactions (generating 1.1V) indicating the age-old human need to produce, store & use electricity at will. Fast forward to the current time, today these portable energy storage devices have become an integrated part of our daily life and have almost become an extension of every individual himself. Batteries (both rechargeable/ non-rechargeable) are now redefining our lifestyles. From the TV remote to mobile phone to invertors of the house's batteries have come a long way.

the required operating voltage and or current". However, for general discussion and as well this article, they are considered at par and mean the same.

Depending upon their ability to get recharged, these electrochemical cells/batteries are further classified as primary (non-rechargeable) or secondary (rechargeable) cells or batteries. These batteries have one biggest advantage over IC engines - unlike IC engines, they are NOT subject to the limitations of the Carnot cycle dictated by the second law of thermodynamics and hence they can convert chemical energy into electrical energy, with higher energy conversion efficiencies.

## Application of Primary & Secondary Batteries

The chart below shows the application range of primary and secondary batteries. As the power requirement of the application increases the size of the battery also increases leading to a rise in replacement cost, hence the battery choice also shifts from the "primary battery" to the "secondary battery" as instead of replacement, they could be recharged and used multiple times.

With this background this article tries to explore the current and future possibility of present energy sources, which are being successfully deployed in many of modern EVs in Indian perspective.

*...To be continued*



**Prabhat Khare** possesses a BE (Electrical) degree from IIT Roorkee (Gold Medalist). Now, he is the Director of KK Consultants. He is also a BEE Certified Energy Manager and a Lead Assessor for ISO 9K, 14K, 45K & 50K.

**ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS**  
(As on 31.08.2021)

| Region                     | Ownership/<br>Sector | Mode wise breakup |         |          |        |           |         |          |               | Grand<br>Total |
|----------------------------|----------------------|-------------------|---------|----------|--------|-----------|---------|----------|---------------|----------------|
|                            |                      | Thermal           |         |          |        |           | Nuclear | Hydro    | RES *<br>NRE) |                |
|                            |                      | Coal              | Lignite | Gas      | Diesel | Total     |         |          |               |                |
| Northern<br>Region         | State                | 16659.00          | 250.00  | 2879.20  | 0.00   | 19788.20  | 0.00    | 5888.25  | 725.51        | 26401.96       |
|                            | Private              | 22425.83          | 1080.00 | 558.00   | 0.00   | 24063.83  | 0.00    | 2961.00  | 20475.26      | 47500.09       |
|                            | Central              | 15662.48          | 250.00  | 2344.06  | 0.00   | 18256.54  | 1620.00 | 11484.52 | 379.00        | 31740.06       |
|                            | Sub Total            | 54747.31          | 1580.00 | 5781.26  | 0.00   | 62108.57  | 1620.00 | 20333.77 | 21579.77      | 105642.11      |
|                            |                      |                   |         |          |        |           |         |          |               |                |
| Western<br>Region          | State                | 21500.00          | 900.00  | 2849.82  | 0.00   | 25249.82  | 0.00    | 5446.50  | 569.28        | 31265.60       |
|                            | Private              | 32847.17          | 500.00  | 4676.00  | 0.00   | 38023.17  | 0.00    | 481.00   | 30263.68      | 68767.85       |
|                            | Central              | 20144.92          | 0.00    | 3280.67  | 0.00   | 23425.59  | 1840.00 | 1635.00  | 666.30        | 27566.89       |
|                            | Sub Total            | 74492.09          | 1400.00 | 10806.49 | 0.00   | 86698.58  | 1840.00 | 7562.50  | 31499.26      | 127600.34      |
|                            |                      |                   |         |          |        |           |         |          |               |                |
| Southern<br>Region         | State                | 20322.50          | 0.00    | 791.98   | 159.96 | 21274.44  | 0.00    | 11819.83 | 592.88        | 33687.15       |
|                            | Private              | 12747.00          | 250.00  | 5340.24  | 273.70 | 18610.95  | 0.00    | 0.00     | 44321.24      | 62932.19       |
|                            | Central              | 11835.02          | 3390.00 | 359.58   | 0.00   | 15584.60  | 3320.00 | 0.00     | 541.90        | 19446.50       |
|                            | Sub Total            | 44904.52          | 3640.00 | 6491.80  | 433.66 | 55469.99  | 3320.00 | 11819.83 | 45456.02      | 116065.84      |
|                            |                      |                   |         |          |        |           |         |          |               |                |
| Eastern<br>Region          | State                | 7450.00           | 0.00    | 100.00   | 0.00   | 7550.00   | 0.00    | 3537.92  | 275.11        | 11363.03       |
|                            | Private              | 5553.00           | 0.00    | 0.00     | 0.00   | 5553.00   | 0.00    | 209.00   | 1401.70       | 7163.70        |
|                            | Central              | 14287.56          | 0.00    | 0.00     | 0.00   | 14287.56  | 0.00    | 1005.20  | 10.00         | 15302.76       |
|                            | Sub Total            | 27290.56          | 0.00    | 100.00   | 0.00   | 27390.56  | 0.00    | 4752.12  | 1686.81       | 33829.49       |
|                            |                      |                   |         |          |        |           |         |          |               |                |
| North<br>Eastern<br>Region | State                | 0.00              | 0.00    | 466.36   | 36.00  | 502.36    | 0.00    | 422.00   | 233.25        | 1157.60        |
|                            | Private              | 0.00              | 0.00    | 24.50    | 0.00   | 24.50     | 0.00    | 0.00     | 160.20        | 184.70         |
|                            | Central              | 770.02            | 0.00    | 1253.60  | 0.00   | 2023.62   | 0.00    | 1522.00  | 30.00         | 3575.62        |
|                            | Sub Total            | 770.02            | 0.00    | 1744.46  | 36.00  | 2550.48   | 0.00    | 1944.00  | 423.45        | 4917.92        |
|                            |                      |                   |         |          |        |           |         |          |               |                |
| Islands                    | State                | 0.00              | 0.00    | 0.00     | 40.05  | 40.05     | 0.00    | 0.00     | 5.25          | 45.30          |
|                            | Private              | 0.00              | 0.00    | 0.00     | 0.00   | 0.00      | 0.00    | 0.00     | 27.66         | 27.66          |
|                            | 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     | 38.01         | 78.06          |
|                            |                      |                   |         |          |        |           |         |          |               |                |
| ALL<br>INDIA               | State                | 65931.50          | 1150.00 | 7087.36  | 236.01 | 74404.86  | 0.00    | 27114.50 | 2401.27       | 103920.64      |
|                            | Private              | 73573.00          | 1830.00 | 10598.74 | 273.70 | 86275.45  | 0.00    | 3651.00  | 96649.74      | 186576.19      |
|                            | Central              | 62700.00          | 3640.00 | 7237.91  | 0.00   | 73577.91  | 6780.00 | 15646.72 | 1632.30       | 97636.93       |
|                            | Total                | 202204.50         | 6620.00 | 24924.01 | 509.71 | 234258.22 | 6780.00 | 46412.22 | 100683.32     | 388133.75      |

Figures at decimal may not tally due to rounding off

Source: CEA



# RIGHT INFORMATION FOR INDUSTRY

## SUBSCRIPTION RATES

| PERIOD                         | No. of Issues | Print          |                      |            | Digital   | Print+Digital        |            |
|--------------------------------|---------------|----------------|----------------------|------------|-----------|----------------------|------------|
|                                |               | By Normal Post | By Registered Parcel | By Courier | By E-mail | By Registered Parcel | By Courier |
| ELECTRICAL INDIA               |               |                |                      |            |           |                      |            |
| 1 YEAR                         | 12            | 1000.00        | 1600.00              | 1800.00    | 1000.00   | 2100.00              | 2300.00    |
| 2 YEARS                        | 24            | 1750.00        | 2950.00              | 3350.00    | 1750.00   | 3825.00              | 4225.00    |
| 3 YEARS                        | 36            | 2500.00        | 4300.00              | 4900.00    | 2500.00   | 5550.00              | 6150.00    |
| 5 YEARS                        | 60            | 4000.00        | 7000.00              | 8000.00    | 4000.00   | 9000.00              | 10000.00   |
| COOLING INDIA                  |               |                |                      |            |           |                      |            |
| 1 YEAR                         | 12            | 1000.00        | 1600.00              | 1800.00    | 1000.00   | 2100.00              | 2300.00    |
| 2 YEARS                        | 24            | 1750.00        | 2950.00              | 3350.00    | 1750.00   | 3825.00              | 4225.00    |
| 3 YEARS                        | 36            | 2500.00        | 4300.00              | 4900.00    | 2500.00   | 5550.00              | 6150.00    |
| 5 YEARS                        | 60            | 4000.00        | 7000.00              | 8000.00    | 4000.00   | 9000.00              | 10000.00   |
| LIGHTING INDIA                 |               |                |                      |            |           |                      |            |
| 1 YEAR                         | 6             | 750.00         | 1050.00              | 1250.00    | 750.00    | 1425.00              | 1625.00    |
| 2 YEARS                        | 12            | 1350.00        | 1950.00              | 2350.00    | 1350.00   | 2625.00              | 3025.00    |
| 3 YEARS                        | 18            | 2000.00        | 2900.00              | 3500.00    | 2000.00   | 3900.00              | 4500.00    |
| 5 YEARS                        | 30            | 3000.00        | 4500.00              | 5500.00    | 3000.00   | 6000.00              | 7000.00    |
| MEDICAL EQUIPMENT & AUTOMATION |               |                |                      |            |           |                      |            |
| 1 YEAR                         | 6             | 750.00         | 1050.00              | 1250.00    | 750.00    | 1425.00              | 1625.00    |
| 2 YEARS                        | 12            | 1350.00        | 1950.00              | 2350.00    | 1350.00   | 2625.00              | 3025.00    |
| 3 YEARS                        | 18            | 2000.00        | 2900.00              | 3500.00    | 2000.00   | 3900.00              | 4500.00    |
| 5 YEARS                        | 30            | 3000.00        | 4500.00              | 5500.00    | 3000.00   | 6000.00              | 7000.00    |
| AUTOMATION & ROBOTICS WORLD    |               |                |                      |            |           |                      |            |
| 1 YEAR                         | 6             | 1200.00        | 1500.00              | 1700.00    | 1200.00   | 1875.00              | 2075.00    |
| 2 YEARS                        | 12            | 2160.00        | 2760.00              | 3160.00    | 2160.00   | 3435.00              | 3835.00    |
| 3 YEARS                        | 18            | 3200.00        | 4100.00              | 4700.00    | 3200.00   | 5100.00              | 5700.00    |
| 5 YEARS                        | 30            | 4800.00        | 6300.00              | 7300.00    | 4800.00   | 7800.00              | 8800.00    |



Chary Publications Pvt. Ltd.

To Subscribe, visit: [www.charypublications.in](http://www.charypublications.in)

# Indulge in Unlimited Digital Reading

**Attention Subscribers!** We have launched new digital offer just for you.  
Enjoy **unlimited reading** now with our exclusive offers.

**Offer**  
Valid till  
31<sup>st</sup> October  
2021



- Buy 1 year digital subscription of Electrical India and get 1 year subscription of Lighting India FREE
- Buy 1 year digital subscription of Cooling India and get 1 year subscription of Medical Equipment & Automation FREE

**WHAT ARE YOU WAITING FOR?  
HURRY UP NOW!**

**\*OFFER VALID FOR LIMITED  
PERIOD ONLY.**

## SUBSCRIPTION FORM

Yes, I would like to subscribe ELECTRICAL INDIA / COOLING INDIA / LIGHTING INDIA / MEDICAL EQUIPMENT & AUTOMATION / AUTOMATION & ROBOTICS WORLD for \_\_\_\_\_ years at Rs. \_\_\_\_\_. Payment needs to be in favour of "CHARY PUBLICATIONS PVT LTD"

| Cheque/DD.No | Dated | Drawn On |
|--------------|-------|----------|
|--------------|-------|----------|

Preferred mode will be NEFT/RTGS for which the details are as under :-

|                                            |                                  |
|--------------------------------------------|----------------------------------|
| Account Name: Chary Publications Pvt. Ltd. | Account Type : Current Account   |
| Account Number: 000920110000322            | IFSC Code: BKID0000009           |
| Bank: Bank of India                        | Branch: Chembur, Mumbai - 400071 |

Name: \_\_\_\_\_ Designation: \_\_\_\_\_

Company: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ Pin Code: \_\_\_\_\_

Email : \_\_\_\_\_ Tel.No. \_\_\_\_\_ Mob.No. \_\_\_\_\_

Signature : \_\_\_\_\_ Stamp : \_\_\_\_\_



## Chary Publications Pvt. Ltd.

905-906, The Corporate Park, Plot No. 14 & 15, Sector 18, Opp. Sanpada Railway Station, Vashi, Navi Mumbai - 400 703.  
Email: sub@charypublications.in | Contact: 022 4961 2499 | Website: www.charypublications.in

## FAME RACK – The plug-in test system for 19 inches racks by Phoenix Contact

**F**AME RACK is the latest addition to the FAME (Fast And Modular Energy) plug-in test system – a test interface between the field installation and the measurement or safety equipment in high and medium-voltage switching devices. The new plug-in test sockets can be installed directly in



the commonly used 19" racks in accordance with IEC 60297-3. Functionally, FAME RACK is based on FAME 3 technology. The plug-in test socket and the test plug have been newly developed especially for use in the compact 19" technology. The system is modular in design and makes consistent use of the CLIPLINE complete system accessories, e.g. the simple realization of star-point bridges. This makes FAME a unique test system that can be used throughout the world. 

For further information: E-mail: [adverts@phoenixcontact.co.in](mailto:adverts@phoenixcontact.co.in), Website: [www.phoenixcontact.co.in](http://www.phoenixcontact.co.in)

## Gliding, rolling, saving: igus expands E4.1 energy chain modular system for long travels

*New rollers and glide pads for upgrading reduce costs and increase the service life of E4.1 e-chains...*

**O**n long travels, the energy supply systems from igus are favourites for safely guiding cables and hoses. In most applications, customers rely on the strong E4.1 universal energy chain modular system. igus has now expanded the successful system with glide pads and roller chain links for quick retrofitting. This allows users in abrasive environments as well as in applications with very high speeds or extreme travel lengths to increase the service life of their systems quickly and cost-effectively.

More than 25,000 igus energy chains move over long distances every year, whether in STS cranes, storage and retrieval units or linear robots. In all these areas of application, customers worldwide rely on the tough and modular E4.1 energy chain system from igus. The energy supply system has an undercut design and thus a high torsional rigidity. It is quiet and variable in heights and widths. In 90% of gliding applications, the E4.1 is the universal solution. To extend the service life of the energy chain, especially in abrasive environments, igus has now introduced glide pads with which the chain can be easily upgraded. The wear-optimised sliding elements



can be easily placed on the chain links in the inner radius. They are made of a highly abrasion-resistant igumid polymer, which can double the service life of the energy supply system at travel speeds of 1-3m/s.

### Safely rolled at high speeds

igus has had energy chain links with rollers in its product range for over 20

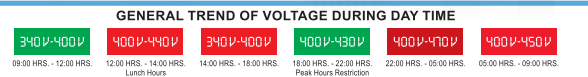
years. They reduce the pull/push forces on long travels and ensure a significantly longer service life of the energy supply system. Therefore, igus has now developed new optimised roller chain links in two sizes especially for its E4.1 modular system. Their use is particularly worthwhile at high speeds of up to 10m/s or very long travels. The rollers reduce the drive power by up to 37%, which significantly saves energy. The new roller chain links and glide pads provide a customised energy supply system for every special application from 12m to 500m travel. "In order to find the best technical and economical solution for the customer, we advise them individually", says Jörg Ottersbach, Head of the e-chains Business Unit at igus. 

For further information: E-mail: [kramanujachar@igus.net](mailto:kramanujachar@igus.net), Website: [www.igus.in](http://www.igus.in)

| Company Name                            | Page No. |
|-----------------------------------------|----------|
| DEIF India Pvt Ltd                      | 3        |
| FLIR Systems India Pvt Ltd              | 11       |
| H.D. Wire Pvt Ltd                       | 15       |
| Hammond Power Solutions                 | 49       |
| High Voltage, Inc.                      | 7        |
| HPL Electric & Power Ltd                | 5        |
| igus India Pvt Ltd                      | 25       |
| Jindal Electric & Machinery Corporation | 49       |
| Phoenix Contact (India) Pvt Ltd         | 13       |
| Polycab India Ltd                       | 9        |
| Siemens Ltd                             | IFC      |
| Titan Engineering & Automation Ltd      | 17       |
| Vertiv                                  | BC       |

## REDUCE FAILURE RATE OF ELECTRICAL EQUIPMENTS

&  
**SAVE ENERGY**  
 by installing  
**JINDAL'S INDUSTRIAL ROBOT**  
**AUTOMATIC VOLTAGE CONTROLLER**  
 A breakthrough in energy conservation



NOTE: We can provide you the computerized printout of voltage variation at your premises by installing the Data Loggers

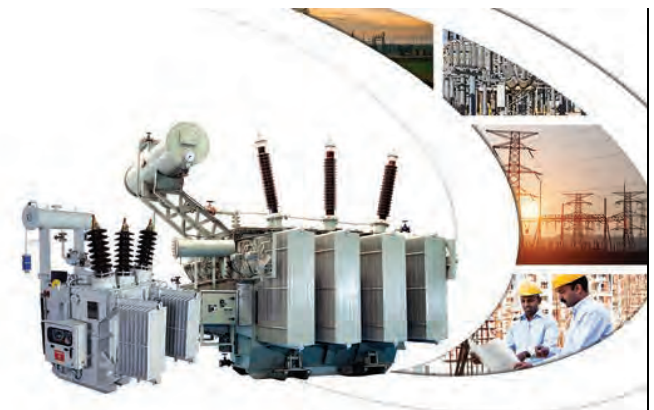


**JINDAL ELECTRIC & MACHINERY CORPORATION**  
 C-57, Focal Point, Ludhiana (India) Tel: +91-161-2670250, 2676890, 2676968 Mobile: 98140 84948, 98142 28100  
 E-mail: jems@jindalelectric.com Website: www.jindalelectric.com

# LET YOU MESSAGE ECHO

EXPAND YOUR DIGITAL REACH VIA OUR SOCIAL MEDIA PLATFORMS AT AN ECONOMICAL COST

For more details, contact us at:  
 pravita@charypublications.in



## Work with a strong Global Player in the Transformer Industry

Hammond Power Solutions (HPS) excels at designing and manufacturing a broad range of standard products and engineered-to-order solutions to meet your distribution substation needs.

Distribution transformers are available from 250-2500 kVA up to 33kV class (as per BIS, IS 1180 standard with Star rated losses).

HPS power transformers incorporate cost effective and energy efficient designs with ratings up to 60MVA (ONAN), 138kV Class.

Our product designs meet a wide range of global standards and regulatory compliance including IEC, BIS and IEEE.



www.hammondpowersolutions.com



# THE DIARY

## LED EXPO 2021

**Date:** 18 - 20 November 2021  
**Location:** Greater Noida, India  
**Contact:** +91 22 6144 5914  
**Mail:** ruhi.shaikh@india.messefrankfurt.com

**LED expo**  
 NEW DELHI

## WIRE & CABLE INDIA 2021

**Date:** 23 - 25 November 2021  
**Location:** India  
**Contact:** +91 22 667 89933  
**Email:** ContractorM@md-india.com



## ELASIA 2021

**Date:** 27 - 29 November 2021  
**Location:** Bangalore, India  
**Contact:** +91-80-43307474  
**Mail:** info@elasiaexpo.com



## LASER WORLD OF PHOTONICS INDIA 2021

**Date:** 16 - 18 December 2021  
**Location:** Bengaluru, India  
**Contact:** +91 22 4255-4700  
**Email:** info@world-of-photonics-india.com



## THE SMARTER E INDIA

**Date:** 02 - 04 December 2021  
**Location:** Gandhinagar, Gujarat  
**Contact:** +91 22 4255-4707  
**Email:** info@mm-india.in



## ELECTRICAL ENERGY STORAGE EXHIBITION 2021

**Date:** 14 - 16 December 2021  
**Location:** Mumbai, India  
**Contact:** +91 22 4255-4700  
**Mail:** info@mm-india.in



## IN THE NOVEMBER 2021 ISSUE

POWER TRANSMISSION

Electric Vehicles

Energy Management

# THINK 'OUT-OF-THE-BOX'

## BE A STEP AHEAD !

**BRAND  
WITH US**



Work with us  
to leverage both  
**PRINT + DIGITAL**  
Brand presence

We help you lead-generate via  
our robust brand models



Contact us to know more: [pravita@charypublications.in](mailto:pravita@charypublications.in)



# Scalability

Because your IT management needs  
are always changing.



Introducing

## **VERTIV™ AVOCENT® ADX ECOSYSTEM.**

Welcome to Vertiv™ Avocent® ADX Ecosystem. A vendor-neutral ecosystem that enables you to access and manage all your data center and edge devices – including servers, service processors, virtual machines, routers, switches, firewalls, storage devices, and flexible and scalable deployments.

- Automate configuration processes
- Ensure infrastructure resilience
- Enhance IT infrastructure security
- Improve scalability of solutions
- Enable virtual machine sessions
- Deliver exceptional video performance
- Gain high availability of your management appliance
- Use open-source management tools
- Consolidate IP addresses
- Use modern connectors
- Meet customer demand for firmware access

Call Tollfree : 1-800-2096070  
E-mail : [marketing.india@vertiv.com](mailto:marketing.india@vertiv.com)

Corporate Office : Plot C-20, Rd No.19,  
Wagle Ind Estate, Thane (W), 400604. India



Scan code  
to know more