

Since 1961

Electrical India

ISSN 0972-3277

India's oldest magazine on power and electrical products industry



On tides of change

EXPLORING THE KGS IN INDIA

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



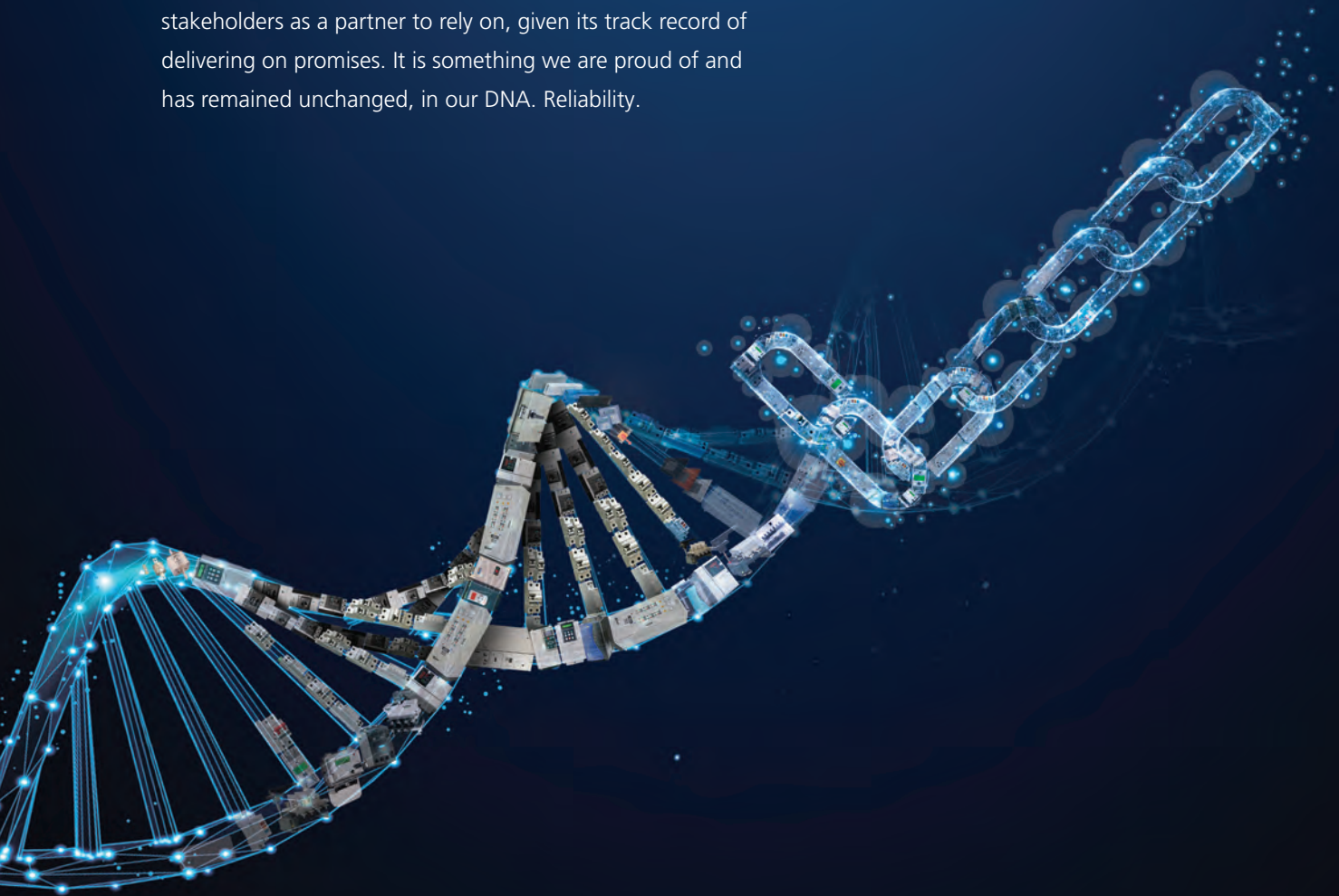
SUBSCRIBE/RENEW Online • Log on to www.electricalindia.in

WINNER OF
DEMING PRIZE
2019

RELIABILITY.

At E&A, it's in our DNA

L&T Electrical & Automation has been a pioneer in driving innovation and development in the electrical and automation industry. The organisation has earned the confidence of its stakeholders as a partner to rely on, given its track record of delivering on promises. It is something we are proud of and has remained unchanged, in our DNA. Reliability.



#DNAUnchanged

Customer Interaction Center (CIC)
BSNL / MTNL (toll free): 1800 233 5858
Reliance (toll free): 1800 200 5858 Tel: 022 6774 5858
Email: cic@Lntebg.com www.Lntebg.com



L&T Electrical & Automation

A brand of Larsen & Toubro Limited

START YOUR JOURNEY

WITH A SINGLE STEP - GO DIGITAL

WITH CHARY PUBLICATIONS

GROW YOUR BUSINESS WITH US



Contact us to know more:

smit@charypublications.in / abegail@charypublications.in



From the Editor's and Publisher's Desk

Looking forward: The Kite Generator System (KGS)

We are survivors. Yes! India has successfully reached 'Unlock 1,' and Mumbai is once again gearing up to fight COVID-19. That apart, we also see a more optimistic approach from the industry to move ahead and to strive towards progress. The June 2020 issue of the Electrical India magazine draws special focus to wind energy, with the Kite Generator System being the focal point of discussion. Representatives from the industry report that India presently has an installed wind energy capacity of approximately 37 GW, and has set the target of reaching 60 GW by the year 2022; this in addition to meeting an ambitious goal of 450 GW by the year 2030. The cover story talks about how the energy generated from renewable sources such as solar or wind can be converted into electricity. The story highlights the effectiveness of using the KGS in India, its limitations and the concerns following installation. It also talks about market value, growth, technologies and the measures that can be taken to improve the use of the technology in India.

Also, as utility-scale technology gains popularity, utility asset owners are now looking to store energy to smooth peak demand curves and provide back-up power. This month's issue also presents our readers with an interesting article on how gas turbines can contribute significantly to power generation.

We truly hope you have a wonderful read.

Do write to me, stay safe and stay connected!

Mahadevan

Publisher & Editor-In-Chief

Directors

Pravita Iyer
Mahadevan Iyer

Publisher & Editor-In-Chief

Mahadevan Iyer
miyer@charypublications.in

Commercial Director

Pravita Iyer
pravita@charypublications.in

Editor (Brand Positioning)

Ranjana Konatt
ranjana@charypublications.in

Editorial Assistant

Abegail D'mello
abegail@charypublications.in

Digital Marketing Executive

Smit Kubadia
smit@charypublications.in

Advertising Department

Head - Marketing

Yasmeen Kazi
yasmeen@electricalindia.in

Subscription & Marketing Department

Mariya Yenubari
sales@charypublications.in
sub@charypublications.in

Design

Sachin Parabkar
Jebas Thangadurai

Accounts Department

Dattakumar Barge
accounts@charypublications.in

Chary Publications Pvt. Ltd.

906, The Corporate Park, Plot 14 & 15,
Sector 18, Vashi, Navi Mumbai 400703
Phone: 022 2777 7170 / 71
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**



For more details contact:



iTvis Innovations Pvt Ltd
t: +91 22 66662600
info@itvisinnovations.com
www.itvisinnovations.com

FLAT IS **ESY**, BECAUSE IT REPRESENTS MAXIMUM PERFORMANCE WITH SLIM DESIGN

**RADIATION-FREE PIR SENSORS
WITHOUT ELECTROSMOG**

FLAT SERIES PRESENCE AND MOTION DETECTORS

The **FLAT** series achieves a new level in demand-driven automation in terms of both aesthetics and functionality: With a height of just 6 mm when surface-mounted on ceilings, a subtle look in white or black and an optional glass surface, FLAT blends seamlessly into any room design – guaranteeing a reliable 360° field of detection and a range of 8 m.



PERFORMANCE FOR SIMPLICITY

ESYLUX GmbH | www.esylux.com

Contents

Vol. 60 | No. 6 | June 2020

On tides of change: Exploring the KGS in India

- By the Electrical India content team

18



16

**Mechanical Energy
Storage: A Market
Overview**

24

**"HPL exports the finest
engineering goods," asserts Joint-
MD, HPL Electric & Power Ltd**

- Gautam Seth, Joint-Managing
Director, HPL Electric & Power Ltd.

26

**Gas Turbines:
The Heart of Power
Generation**

- Dr Iyad Al-Attar, Mechanical
Engineer and Business Innovator

30

**A Review of Battery Charger
Topologies and Infrastructure
for Plug-In Electric and Hybrid
Vehicles**

- Dr L Ashok Kumar, PSG College of
Technology, Coimbatore

36

**To what extent can MSMEs
turn its attention to
Renewables?**

- Sankalp Ved,
Ruchi Infrastructure Ltd.

REGULARS

4 Publisher's Note

8 News

44 Statistics

48 Events

49 Index to Advertisers

40

**Net - Metering Regulatory avenues of the solar supply chain
and business models**

- Vivek Soni, Bharatiya Vidya Bhavan's Institute of Management, New Delhi



ALTANOVA
GROUP

TECHMP

isa

intelliSAW

Global Monitoring for GIS

One System for Global GIS Condition Monitoring

- Partial Discharge Activity
- Open & Close Coil Currents: Profiles & Peaks
- I2T Sums & Maintenance Threshold
- Fault Currents
- Circuit Breaker Operation: Open/Close Time, Movement, Velocity
- Motor & Heater Currents
- SF6 Density & Leakage Monitoring
- Battery Voltage

ISA Advanced Instruments Pvt. Ltd. - ALTANOVA Group Company

www.altanova-group.com

info.asia@altanova-group.com

"PRIVATIZATION OF POWER DISTRIBUTION IN UTS AN EXCITING STEP," ASSERTS PWC INDIA

The move will help generate private sector appetite among Indian and international investors, says Sambitosh Mohapatra, Leader – Power and Utilities, PwC India

- The Electrical India Content team

The Union government's move to privatize electricity distribution companies (DISCOMs) in the eight Union Territories to ease economic adversity owing to the on-set of the novel Coronavirus disease (COVID-19) pandemic has been assessed by the industry. For the most, representatives believe that the move has brought out a great deal of improvement in the operational metrics of DISCOMS in the city-state.

Sambitosh Mohapatra, Leader – Power and Utilities, PwC India, said: "Power distribution in UTs to be privatized is an exciting step ahead. "Various PPP models will be tested; and quick demonstration of possible efficiency improvement and customer engagement models. It will provide confidence to larger states and utilities to undertake privatization based on improvements achieved here," Mohapatra added.

ET

DR SATYA GUPTA APPOINTED AS THE CHAIRMAN OF IESA FOR 2020 -2021

The new executive council at IESA is committed to the development of a vibrant Indian Electronics and Semiconductor ecosystem, the company said via a press release

- The Electrical India Content Team



On the 5th of May 2020, SEMI reported its Power & Compound Fab report for the year 2024, in which the Global fab equipment spending for power and compound devices is expected to rebound in the second half of the year 2020 to meet resurgent end-

product demand and jump 59% to a segment record US\$6.9 billion in 2021. The 2020 rally will help blunt a drop in annual spending, now projected at 8%, as fabs ride the COVID-19 recovery wave.

Power and compound devices are used to control electrical energy for devices across an array of industries such as computing, communications, energy and automotive.

ET

"VERY CONFIDENT OF KPTL'S GROWTH PROSPECTS AND MARKET OPPORTUNITY AVAILABLE," HIGHLIGHTS MD & CEO, KPTL

We believe there is considerable value in buying back KPTL shares, which are trading significantly below intrinsic value and will continue to focus on disciplined capital allocation strategy on driving profitable growth, he says

- The Electrical India Content Team

Kalpataru Power Transmission Limited (KPTL), a fast-growing EPC company in India, recently released its financial performance for the quarter & year end – 31st March 2020. Commenting on the results, Mr Ram Patodia, CFO, KPTL said: "The situation ahead seems to be very challenging and requires a focused approach for managing cash flow and cost. However, our strong balance sheet and order book position provides us the confidence that we will overcome the COVID-

19 challenge and emerge stronger. Further, we are progressing well on sale of our T&D assets and are confident to complete the process in FY 2021."

Commenting on the results, Mr. Manish Mohnot, MD & CEO, KPTL said: "In these unprecedented and challenging times, I am extremely proud of how KPTL and JMC has come worked relentlessly to ensure the safety and well-being of our workforce while continuing to serve our clients across the world.

ET

"THE 90,000-CRORE LIQUIDITY INJECTION IS A WELCOME RELIEF FOR FINANCIALLY STRESSED DISCOMS," SAYS CEO & MD, IEX

The measures like PFC and REC loans, rebates and reforms announced by the Central Government will go a long way in creating the much-needed fiscal space in the power sector value chain

- By Ranjana Konatt, Editor (Brand Positioning)



On Wednesday, May 13th 2020, Finance Minister Nirmala Sitharaman announced a special scheme for the power distribution sector wherein Rs 90,000-crore would be infused in distribution companies (DISCOMs). While giving details of the 20-lakh

crore relief package announced by the government to revive economic growth, she said: "DISCOMs are today facing unprecedented cash flow problems and desperately need help otherwise they are unable to pay power generating companies." Senior officials asserted that the amount made available by the Power Finance Corporation (PFC) and Rural Electrification Corporation (REC) will be used by DISCOMs to pay their dues to transmission and generation firms. PFC and REC are power sector non-banking financial companies (NBFCs).

Rajiv Srivastava, CEO & MD, Indian Energy Exchange, shared his views on the development. He said: "The most remunerative source of income for DISCOMs from industrial and commercial users has been deeply impacted by the COVID-19 lockdown." Adding, he said that the measures like PFC/ REC loans, rebates and reforms announced by the Central Government will go a long way in creating the much-needed fiscal space in the power sector value chain. "At IEX, we have been at the forefront to support DISCOMs in their dual role of ensuring 24x7 uninterrupted power availability as well as enabling optimization that improves financial liquidity during the crisis," Srivastava said. Elaborating, he said that they have met increased domestic demand as well as demand from the stressed healthcare and utilities sector and replaced costlier generation with low cost power available on the Exchange, thereby reducing power procurement costs leading to significant savings. EI

SCHNEIDER ELECTRIC AND AVEVA EXTEND PARTNERSHIP TO DELIVER END-TO-END SOLUTION FOR MULTI-SITE AND HYPERSCALE DATA CENTER

The partnership will deliver innovative solutions suited to the pace and scale of the evolving data-center market

- The Electrical India Content Team

Schneider Electric and AVEVA, announced their expanded partnership to deliver innovative solutions for the data center market, the companies announced via a press release. As hyperscale providers build data centers with an expanding fleet to meet worldwide demand, the complexities to operate and maintain these facilities are creating an unprecedented set of challenges. Operating at this scale requires a different approach for mission critical facilities

powering the globe's digital infrastructure. The combination of AVEVA Unified Operations Center, scalable industrial software with Schneider Electric's EcoStruxure for Data Centers control and monitoring capabilities enables both deep and expansive visibility to day-to-day operations.

The new joint solution provides a homogenous view of engineering, operations, and performance across a heterogeneous, legacy installed base. EI

SEVERE WEATHER CONDITIONS CAN THREATEN GRID OPERATIONS, SAY REPRESENTATIVES

Representatives from the utility industry say that severe weather conditions owed to climate change can threaten grid operations which increases the need for resilience, says Accenture

- The Electrical India Content Team

Digitally Enabled Grid, is a research carried out by Accenture, the research involved a survey of over 200 electric utility executives in 28 countries in five continents. The research showed that nearly three-quarters - (73%) of survey respondents said that extreme weather could present a challenge to network operations and safety, 88% said that maintaining network resilience to extreme weather conditions could result in significant increase in network prices for customers. And that only one-quarter (24%) believe that their businesses are well prepared to deal with extreme weather – one in 12 (8%) reporting as poorly prepared for such a circumstance.

Stephanie Jamison, Global Industry - Senior Managing Director, Accenture - Utilities Business, said: “With various parts of the world affected by drought, wildfires and flooding, in addition to the US hurricane season, climate change is increasing the frequency and the intensity of extreme weather conditions, and this can impact the electricity grid.” Greater system flexibility, he added, delivered through digital

and emerging technologies will be critical for grid optimization. For instance, an active management of available network redundancy, distributed generation and energy storage can help maintain power delivery during severe weather events and speed service restoration after network failures.

Providing a different perspective, Sanjeev Arora, Managing Director and Lead – Resources, Accenture in India, said: “Around the world, high-impact weather-related events are becoming more frequent and more severe. In 2018, India’s southern state of Kerala suffered its worst monsoon flooding in a century severely impacting the electricity distribution infrastructure in the flood-ravaged areas. Events like this and Cyclone Fani in 2019 in eastern India have shown us the impact of extreme weather conditions in disrupting network operations.” Adding, he said that utilities need a forward-looking, holistic and flexible grid resilience strategy, this paired with the right regulatory measures, proactive investments and maintenance so that we could bounce back quickly from major and even multiple events. 

REC LIMITED SUCCESSFULLY RAISES 3-YR USD 500 MN BONDS, FIRST USD CROSS BORDER ISSUANCE OUT OF INDIA SINCE COVID-19

REC Limited, a Government of India PSU and one of India’s largest power financiers, opened up the USD market for Indian issuers in the wake of COVID crisis...

- The Electrical India Content Team

REC Limited, a Government of India PSU and one of India’s power financiers, opened up the USD markets for Indian issuers in the wake of COVID crisis, the company stated via a press release. In the lead up to the issuance, REC was actively monitoring markets, waiting patiently for an opportune window. With the global lockdown fears receding somewhat and liquidity coming back to the Asian markets,

on 12th May 2020, REC pulled the trigger and tapped the offshore debt markets, making it the first issuer from India since 5th March 2020. The paper was strongly received by investors, with books rapidly crossing USD 2 Billion across Asia and Europe. US investors too came in strongly, with REC finally receiving subscription of more than 5-times of the actual issue size, through 175 investors. 

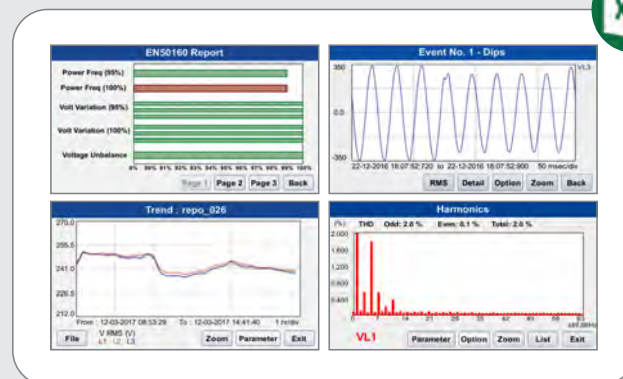


Rish PQA

Power Quality Analyzer

Features

- Per Phase Individual Harmonic Measurement as per IEC 61000-4-7 up to 63rd harmonics
- Thresholds as per EN50160 or user selectable thresholds
- Voltage Swell & Dip Detection & Voltage Variation
- Detection of Voltage Interruptions
- Report generation as per EN50160 in downloadable excel format



Measure



Control



Record



Analyze

RISHABH INSTRUMENTS PVT. LTD.

Head office: F-31, MIDC, Satpur, Nashik - 422007, India | Regd. office: A-54, MIDC, Andheri (E), Mumbai - 400 093, India
+91 253 2202028/99 | marketing@rishabh.co.in | www.rishabh.co.in

SEMI REPORTED ITS POWER & COMPOUND FAB REPORT TO 2024

Power and Compound Fab spending to rebound in the second half of 2020, set a new record in 2021, SEMI reports.

- The Electrical India Content Team

On the 5th of May 2020, SEMI reported its Power & Compound Fab report for the year 2024, in which the Global fab equipment spending for power and compound devices is expected to rebound in the second half of the year 2020 to meet resurgent end-product demand and jump 59% to a segment record US\$6.9 billion in 2021. The 2020 rally will help blunt a drop in annual spending, now projected at 8%, as fabs ride the COVID-19 recovery wave.

Power and compound devices are used to control electrical energy for devices across an array of industries such as computing, communications, energy and automotive. However due in order to curb the spread of COVID – 19, demand for servers, laptops and other electronics has surged.

The SEMI Power & Compound Fab Report to 2024 lists more than 800 power- and compound-related facilities and lines covering investments and capacities for the 12 years from 2013 through 2024. EI

ITC GETS NEW VICE PRESIDENT FOR TRANSMISSION PLANNING

Charles L. Marshall has been named as Vice President of Transmission Planning

- The Electrical India Content Team

On the 1st of May 2020, Thomas W. Vitez retired from ITC after which Charles L. Marshall has been named the Vice President of Transmission Planning for ITC Holdings Corp. Marshall's responsibilities have ranged from regulatory policy and stakeholder relations to project engineering and business unit planning. His experience and committee service with regional transmission organizations – the Midcontinent Independent System Operators (MISO) and Southwest Power Pool (SPP) offers a broad perspective of transmission needs and potential technical solutions.

Jon Jipping, Executive Vice President and Chief Operating Officer, ITC Holding Corp said: "Chuck has proven to be an incredible asset to the ITC team. His customer-centric approach will be a tremendous asset to ITC as we continue to plan, build and operate significant projects to improve electric transmission infrastructure across our footprint." EI

'ENERGY STORAGE TECHNOLOGY IS BECOMING AN ECONOMIC STAND-ALONE OR HYBRID SOLUTION FOR RENEWABLE ENERGY PROJECT DEVELOPERS,' SAYS CEO, ARCVERA

ArcVera Renewables – a provider of consulting and technical services for renewable energy projects with more than 40 years of global experience is now providing expert technical, financial, and independent engineering services for stand-alone energy storage or hybrid projects.

- The Electrical India Content Team

With over 100-gigawatts of operating renewable energy projects supported across 6 of 7 continents, ArcVera is recognized as one of the top technical consultants in the industry. Leaning on its expertise in both high-frequency time-series resource and energy storage, ArcVera will enable a reliable and durable integration of storage capacities into a renewable energy plant design. Its evaluations will also include assessments of the supply chain to assure the plant can be built and

performs as designed. Post-construction, ArcVera will evaluate and advise operations, asset management, software controls, and best-practice maintenance.

Gregory S. Poulos, CEO of ArcVera Renewables, said: "Energy storage technology is becoming an economic stand-alone or hybrid solution for renewable energy project developers. With our advanced technical expertise, we can deliver accurate and bankable insight needed to deploy storage capacities effectively with higher value." EI

SOLARMY DOES ITS BIT TO MAINTAIN LOW ELECTRICITY BILLS

Relief Program to ease out the financial burden on the South Florida homeowners, highlights the company...

- The Electrical India Content Team



Image by 272447 from Pixabay

SolArmy – a turn-key solutions operator and consultant based in South Florida have launched a COVID-19 relief program to maintain low electricity bills, the company said via a press release. Offering a \$1,000 activation bonus, three months of electric bills paid, and no upfront costs and payments for up to a year; this has brought home-owners the much-needed financial relief and reassurance during these unpredictable times with solar power technology.

Nizar Dalbani, CEO & Founder, SolArmy said: “SolArmy’s mission is to promote sustainable living at the most affordable price possible. Most of the Americans’ electricity bills have increased due to the time spent at home.”

13

NEW PARTNERSHIPS: PORTLAND GENERAL ELECTRIC AND DOUGLAS COUNTRY PUD

Portland General Electric and Douglas County PUD partner to advance the Northwest’s clean energy goals

- The Electrical India Content Team

On the 13th of May 2020, Portland General Electric Company and the Douglas County Public Utility District have partnered to optimize the region’s resource to supply clean energy to customers. They have signed a five-year power purchase agreement to supply Portland General Electric (PGE) customers with up to 160 megawatts of additional capacity from the Wells Hydroelectric Project on the Columbia River north of Wenatchee, Wash. It also provides Douglas County PUD with PGE load management and wholesale market sales services.

Maria Pope, President and CEO, Portland General Electric said: “This partnership demonstrates the value of utilities collaborating to deliver clean energy solutions for customers and our region. We can provide our portfolio management expertise as a fully integrated utility to Douglas County PUD while they are providing us access to additional emissions-free hydroelectric power.”

13

THE COVID-19 CRISIS IS HURTING BUT NOT HALTING GLOBAL GROWTH IN RENEWABLE POWER CAPACITY

After a dip this year, new renewable capacity additions are expected to rebound in 2021, but policy certainty is critical to ensure investor confidence

- This Electrical India Content Team

The world is set to build fewer wind turbines, solar plants and other installations that produce renewable electricity this year because of the impact of the Covid-19 crisis, marking the first annual decline in new additions in 20 years, according to the International Energy Agency. But their growth is expected to resume next year as most of the delayed projects come online and assuming a continuation of supportive government policies. Renewable power sources have so far showed impressive resilience despite the disruptions and changes caused by the coronavirus pandemic, with

their share of the electricity mix increasing in many markets. But the world is set to add 167 gigawatts (GW) of renewable power capacity this year, 13% less than in 2019, according to the IEA’s Renewable Market Update report, which was released today.

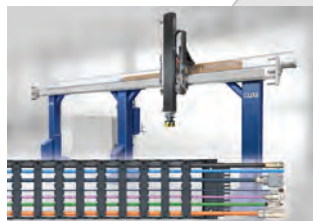
The decline reflects possible delays in construction activity due to supply chain disruptions, lockdown measures and social distancing guidelines, as well as emerging financing challenges. But despite the slowdown in new additions, overall global renewable power capacity still grows by 6% in 2020, surpassing the total power capacity of North America and Europe.

13

SAFETY AT HIGH SPEED WITH THE IGUS E-CHAIN SYSTEM IN THE LINEAR MOTOR ROBOT

Side-mounted energy chain from igus, ensures reliable energy supply in high-speed lightweight linear robots, says the company via a press release

- By the Electrical India Content Team



A side-mounted igus energy chain system, ensures safe cable guiding of the x-axis of the linear motor robot from Fibro Lapple Technology.

Twice as fast and half as heavy: this is what makes the linear motor robot from FIBRO LÄPPLE TECHNOLOGY (FLT) different from other solutions. For the linear robot to be able to get production up and running quickly and

reliably, a compact, durable and quiet energy supply was required. A side-mounted igus energy chain system with pre-harnessed chainflex cables proved to be the optimal solution.

Linear robots are the automation tool of choice for machine or press loading, order picking and high-bay warehouse loading or even for transport and handling tasks. Due to the demands of production for faster, more intelligent and economically profitable solutions, Fibro Lapple Technology has developed a linear robot which fulfils the desire to maximise production performance. In a new carbon design, the linear motor robot saves up to 50 per cent in weight compared to conventional solutions. The weight reduction enables twice the speed, accelerations of up to

26m/s² and twice the positioning accuracy. Instead of a rack and pinion drive, the designers chose a linear motor because it allows very high dynamics. An unsupported energy chain of the E4.1 series from igus ensures a secure energy supply for the z-axis. The integration of a suitable energy chain solution in the compact installation space of the x-axis was a challenge, because a classic gliding or unsupported solution was out of the question due to the high forces. "Together with igus, we therefore decided on a side-mounted energy chain", explains Boris Bind, Head of Mechanical Design and Development at Fibro Lapple Technology.

Complete energy supply system directly from a single source

An E4.1 series energy chain is used with additional sliding elements that further reduce wear. The designers also used the igus range for the cables. They chose pre-harnessed chainflex cables - so-called readycables - that are specifically designed for use in the energy chain and, thanks to many tests in the company's own 3,800 square metre test laboratory, are given a guarantee for 36 months. The complete system is housed in a special guide trough, which further minimises noise and increases the reliability of the system. **BI**

P2P ELECTRIC VEHICLE CHARGING ESTIMATED MARKET SIZE BY 2027

Governments emphasize on providing funds for developments of P2P network by adapting new features and enabling EV charging stations at commercial, parking space and residential areas.

- The Electrical India Content Team

On the 13th of May 2020, a new report by Grand view Research Inc. indicated the global peer-to-peer (P2P) electric vehicle charging market size that is expected to reach USD 351.7 million by the year 2027, while registering a CAGR of 21.8% from the years 2020 to 2027. There was emphasis on the provisions of funds for the development of peer-to-peer networks. For instance – the US governments established the Northeast Corridor Regional Strategy under which it provides support to enhance the Electric Vehicle (EV) charging infrastructure, it also encourages public charging stations and charging networks.

The increasing approach of various governments,

Original Equipment Manufacturers (OEMs), and automobile companies towards improving the performance of charging solutions by adapting features such as Vehicle-to-grid (V2G) and blockchain payments, promises and expeditious market growth.

For instance, in the year 2016, the Government of Netherlands provided funding worth USD 180.3 billion for enhancing electric vehicle supply equipment, including peer-to-peer networks to companies including BMWAG and Eaton Corporation. Several OEMs and EV manufacturers are looking to strengthen the interoperability of charging infrastructure and electric vehicles, which is expected to enhance the P2P networks. **BI**

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

igus® (India) Pvt. Ltd.
36/1, Sy. No. 17/3, Euro School Road,
Dodda Nekkundi Industrial Area - 2nd Stage
Mahadevapura Post Bangalore - 560048
Phone +91-80-68127800 Fax +91-80-68127802

igus®.in
info@igus.in plastics for longer life®

MECHANICAL ENERGY STORAGE:

A MARKET OVERVIEW

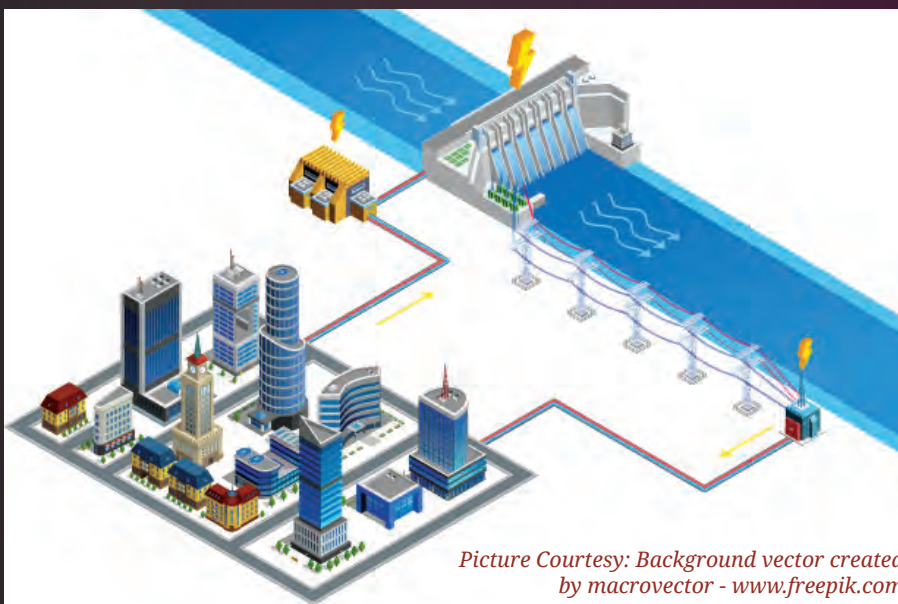
As utility-scale solar technology maintains and gains popularity, utility asset owners are now looking to store energy to smooth peak demand curves and provide back-up power, highlights report

- Presented to you by the - Electrical India Content Team

A report presented by the Prescient and Strategic (P&S) Intelligence observed that the global mechanical energy storage market is the utility application of energy storage and associated grid technologies. As utility-scale solar technology maintains and gains popularity, utility asset owners are now looking to store energy to smooth peak demand curves and provide back-up power. Further, as per the World Energy Council report in January 2016, a significant drop will be observed in the costs of majority of energy storage technologies during 2015–2030. This will also pave the way for high adoption of mechanical energy storage solutions in the utility sector.

Mechanical energy storage systems take advantage of kinetic and gravitational forces to store inputted energy. While the physics of mechanical systems are often quite simple (e.g. spin a flywheel or lift weights up a hill), the technologies that enable the efficient and effective use of these forces are particularly advanced. High-tech materials, cutting-edge computer control systems, and innovative design make these systems feasible in real-world applications. Pumped hydro, compressed air, and flywheel energy storage techniques are the best known. The mechanical energy storage market is segmented based on type, application, and region.

The mechanical energy storage market is categorized into PHS, CAES, and FES, based on type. Among these, the PHS category holds the largest share in the market, as PHS technology is well established, while other megawatt-scale technologies are being developed. For instance, as



Picture Courtesy: Background vector created by macrovector - www.freepik.com

per the World Energy Council, more than 95% of global energy storage is met by PHS technology and for years, it has offered a cost-effective way to provide large-scale storage solution and support grid balancing services. The mechanical energy storage market is categorized into residential, commercial, industrial, and utility, on the basis of application. Among these, the utility application constitutes a wide application area of mechanical energy storage systems, holding a significant share in the market. This is due to a large number of services required by utility projects, such as bulk energy services, ancillary services, grid support services, and renewable energy integration to reduce the network congestion during peak hours, which have helped extend the life of assets and improve the systems' resilience, and as a result increase system energy generation efficiency, which will boost the demand for energy storage systems.

Geographically, APAC accounts for substantial share in the mechanical energy storage market, on account of government investment in

energy storage solutions, mainly in economies like China and India. For instance, the India Energy Storage Alliance (IESA) estimates that the market for energy storage will grow to over 300 GWh in 2025 and will need an investment of \$3 billion. Whereas, North America also plays a vital role in the growth of the market, owing to the increasing demand for electricity storage systems. For instance, as per the environmental and energy study institute, the U.S. generated 4 billion megawatt-hours (MWh) of electricity, but only had 431 MWh of electricity storage available in 2017.

Mechanical Energy Storage Market Dynamics Drivers

The energy installation cost per kilo watt hour (kWh) of mechanical energy storage systems is low relatively to other types of energy storage method. For instance, installation costs of PHS and CAES types of mechanical energy storage are \$21/kWh and \$53/kWh, respectively; whereas, other types of energy storage cost in the range of \$100–\$1000/kWh. Further, rising

concern about environmental impacts of fossil fuels is also driving the mechanical energy storage market growth. For instance, the International Energy Association (IEA) estimated that, in order to keep global warming below 2°C, the world is expected to require 266 GW of energy storage by 2030, up from 176.5 GW in 2017.

Restraints

To some extent, the growth of the mechanical energy storage market is being hindered by the availability of substitutes of energy storage systems, such as Li-ion battery, lead-acid battery, and molten salt energy storage, as these systems have higher efficiency. Further, continuous development in Li-ion battery technology may also hinder the market growth.

Mechanical Energy Storage Market Competitive Landscape

Some of the major companies operating in the global mechanical energy storage market, are: Siemens AG, Hydrostor Inc., Apex Compressed Air Energy Storage LLC, Ridge Energy Storage and Grid Services LP, LightSail Energy, SustainX Inc., Airlight Energy, Storelectric Ltd., Pacific Gas and Electric Company, Magnum Development LLC., ABB Group, Beacon Power LLC, STORNETIC GmbH, VYCON Inc., Active Power Inc., Rotonix USA Inc., POWERTHRU, Teraloop, Williams Grand Prix Engineering Limited, Amber Kinetics Inc., Voith GmbH, Sulzer Ltd., and Hitachi Ltd. 

Information and report courtesy: Prescient and Strategic Intelligence

ON TIDES OF CHANGE: EXPLORING THE KGS IN INDIA

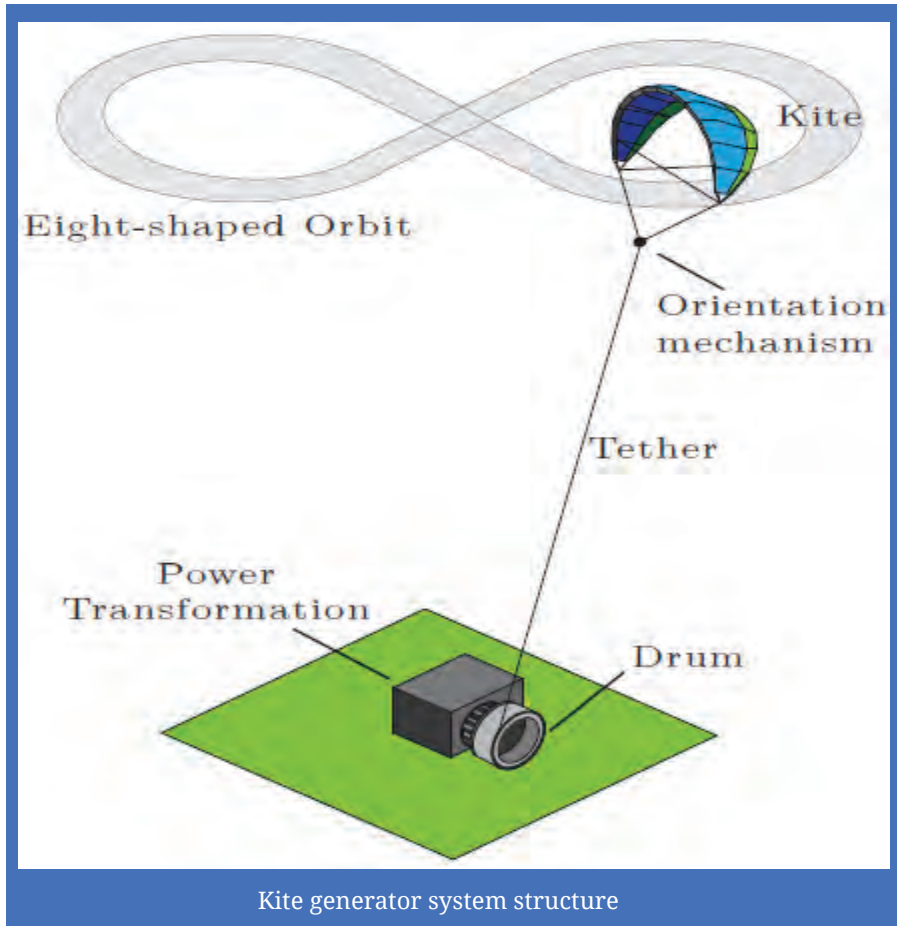
The story attempts to understand the installed wind energy capacity in India, the limitations to adopting the KGS system, market trends and more...

- By the Electrical India content team

India presently has an installed wind energy capacity of approximately 37 GW. Also, it has a target of reaching 60 GW by the year 2022; and an ambitious goal of 450 GW by the year 2030. In terms of potential, it is 695 GW at a hub-height of 120 meters. To date, only on-shore wind potential is being tapped into, but industry representatives' assert that the market is huge.

Ajay Devaraj, Secretary-General, Indian Wind Power Association, while highlighting the stressors and inconsistencies in the regulatory framework, says: "The availability of infrastructure to evacuate the power generated and the tariffs must all be factored in." India, he says, is looking at comprehensive amendments to the Electricity Act, 2003 - setting up green-corridors and making huge investments in the power sector. "The renewable market is certainly open to turbines and has always been so.

However, turbine manufacturers would also need to step in to understand the changed scenario, that machines are capable of operating at heights up to 120 meters, competitively priced and comprehensive



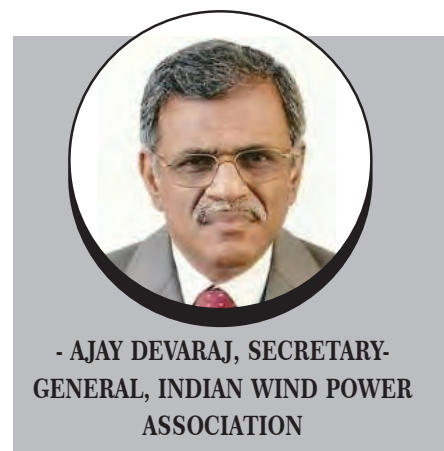
Get acquainted with the KGS system

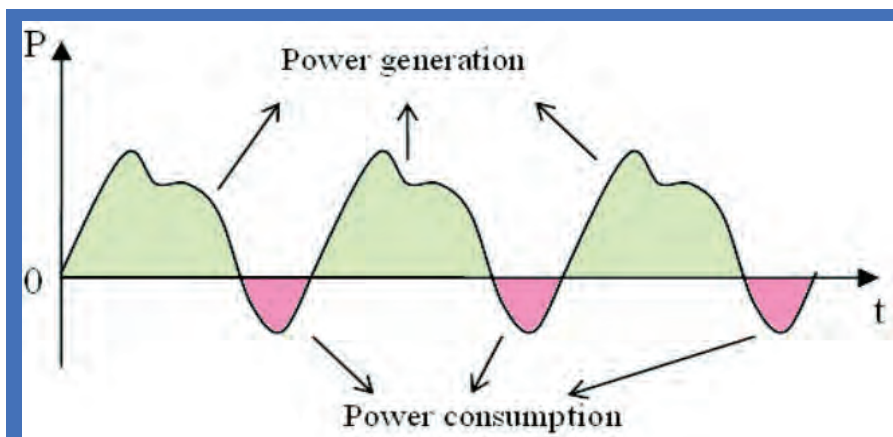
In the May 2020 issue of the Electrical India magazine, Singh stated that KGS is the future of the renewable energy market. There is already a heavy demand as well as a tough competition in the international market for KGS technology. While further explaining the basic elements of the KGS system, he says: “On the top is the kite in the shape of a parachute. The natural path followed by this kite is upward with the wind in an eight-shaped orbit. The tether is a cheap rope made of fibre having good mechanical strength. The one end of the tether is connected to the kite and the other end is wound on a drum. The drum rotates to unroll the tether and the kite goes upwards. An electromechanical energy conversion (EMEC) device is connected on the same shaft as the drum through a gearbox. Hence, the linear kinetic motion of the kite is converted in rotational motion of the drum and is used to generate electricity using an EMEC device.” Also, he says that the KGS is a Relaxation Cycle System; it is composed of a traction phase. In the traction phase, the kite goes up following an eight shaped orbit, hence drum unrolls and the EMEC

O&M, availability of spares throughout the entire useful life of the machine, etc.”

Siddharth Singh, Data Analyst & Machine Learning Engineer, IBM, speaks about the market for wind energy in India while also pointing at the competition in the market. He says: “Many companies in Europe, Northern America and China have generated significant value in its intellectual property (IP) related to the Kite Generator System (KGS) in the form of patents, prototypes, design reports, simulations, technical results, market reports and more.” These IPs, he adds, were acquired from various research institutes initially, and have been enhanced to achieve its final form as a product. “To be honest, I believe, only the

biggest private players in India can afford the cost of borrowing the technology. Further, there is an urgent requirement in the country to improve its infrastructure and education system. This will accelerate research and innovation as well as it will provide the Indian market with competent manpower,” he adds. Speaking of the emerging trends concerning the KGS system, Singh says: “The advancement in technology has led to the decrease in the cost and the size of communication devices. Today, the equipment can be mounted on power kites and they can be used as boosters, repeaters and antennas. Hence this will improve the accessibility to various communication networks in the remote areas.”





Example of power profile of a relaxation (limit) cycle system

device acts as Generator. “In the recovery phase, the electrical energy is consumed to bring the kite back down, the EMEC device acts as a motor to deliver the power to the shaft and the drum rolls back the tether,” he adds.

The need to operate the Kite in a specific range of height (generally 350 to 500m) is explained in fig. 3. The figure shows the different kite power region which is in the shape of a quarter sphere, considering the direction of wind going into the page. There is a lower limit under which the kite is having the risk of falling. Little above comes the maximum power region where we get a peak in power curve then comes the medium power region where power output is almost constant with increase in height. The efficiency above a certain height is low. Hence as soon as kite reaches minimum power region, a relaxation cycle is initiated to bring the kite back in the maximum power region of operation.

Can the KGS system be enhanced and modified via IoT?

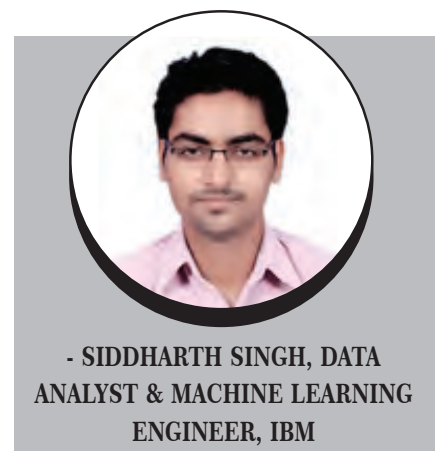
Singh asserts that there is no doubt that IoT can be used to implement the control scheme. He says: “Various

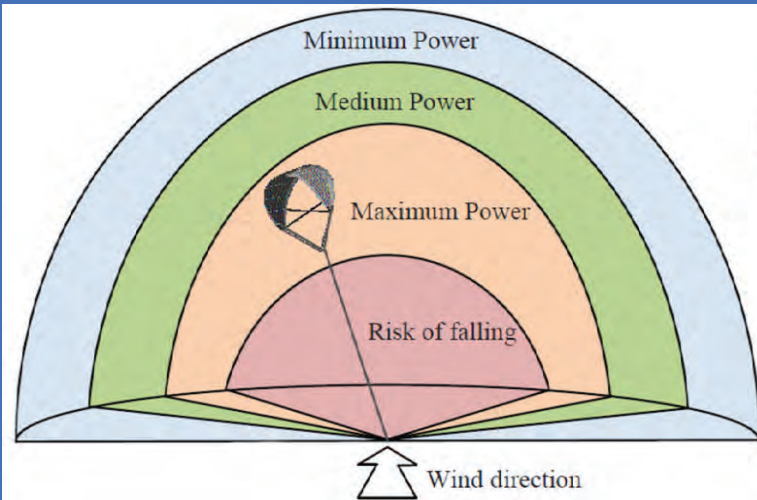
sensors will be required to identify the trajectory, orientation and curvature of the kite. Wireless communication is required to transmit the signals received from these sensors to the controller module.” He adds and says that the data collected at higher altitudes can be sent to data centres for research and analysis, to predict the weather and generation and to predict time-varying price of the wind power by various electricity aggregators. He says that companies such as Makani Power, Kitepower, Kitegen, Kitemill, Magenn, Swiss Kite power, Sky Wind Power, Skysails, Joby Energy etc. have already launched such out-performing models in form of market-ready finished products. “The National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy publishes an annual report which could be found at www.nrel.gov/publications” Singh adds. Singh says that presently the system is still being developed and we are looking at funding for the next stage. We are open to investment from India as the country is a primary market for the solution. Our solution, in particular, can be used as an ‘energize platform,’ serving multiple purposes. Hence, we are not limiting ourselves to energy production.

HAWC technology and the limitations to its adoption

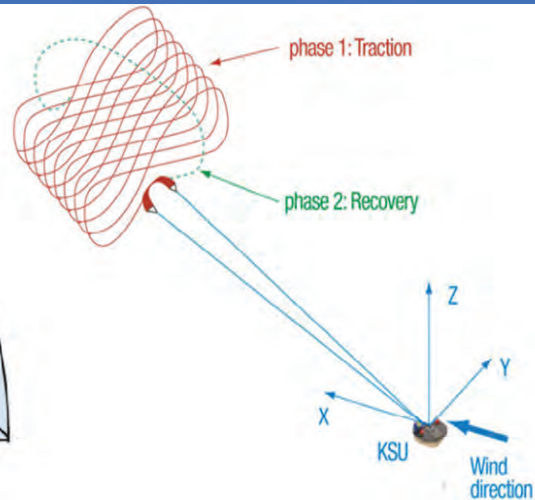
Michael Perlberger, Founder, Brainwhere GmbH, speaks on High Altitude Wind Energy Systems (HAWC). He says: “With the growing population and energy need on the one hand and the availability of enormous amounts of high altitude wind energy, India is a country that will explore with new technology.” While highlighting the limitations to the KGS system, he says that the industry is doing enough to research, experiment and find solutions concerning performance. He says: “The winds across the Himalayas are pretty constant in speed and direction (from west to east). The KGS system operates above the clouds therefore snow or rainfall is not so much of an issue. Air traffic is handled using classical Traffic Avoiding Collision Systems. The power electronic circuitry to act as an intermediate between the grid and the generator is easily available.”

Singh is also in agreement with Perlberger. He says: “Even if the product gets market-ready, approval from Aviation Authorities and other concerned government bodies is another challenge. The proposal of UAV and drones has already been





The kite power region



Working of a Kite Generator System

rejected in the past due to security concerns. Still, I believe approval will be granted since the kite will cover only a specific area.” Perlberger adds and highlights that another limitation is that it is difficult to design a power electronic circuitry which will act as an intermediate between the generator and the Tethered airfoil (kite) because of the variations in speed.

Sighting another limitation, Singh points to the power electronic circuitry that acts as an intermediate between the grid and the generator; this he says, is easily available. He adds: “It is difficult to design a power electronic circuitry which acts as an intermediate between the generator and the Tethered airfoil (Kite) because of the variations in wind speed and due to complex control algorithm required to optimize the power output of a relaxation cycle-based generation like KGS.” Further, it is difficult to design a control mechanism for the orientation, the curvature of the Kite and the gearbox. Finally, he says that the ultimate task is to control and optimize the trajectory of the kite since

the control algorithm is integrated to achieve synchronization between the control mechanism and the power electronic circuit. Instead of viewing the situation as a reluctance to adopt the technology, Singh says that there are only a hand-full of engineers talking about the technology. Further, major businesses dealing with wind energy have manufactured turbines. This means that they would have to bear losses if the finished products are not sold in the market. “Apart from infrastructure, the companies have invested a lot in conventional wind turbine technology in terms of intellectual property, R&D, human resource development etc,” he said. So, it is justified that established business in wind power sector will not invest in KGS technology because that will mean a huge loss to them. However, start-ups may utilize this opportunity to bring a breakthrough and capture the market in India.

Improving control and optimising trajectory: The adoption of KGS system

Singh says that researchers around



the world have already utilized Fuzzy and PID control to solve the problem in the past. A better control strategy was proposed by Mariam Ahmed, Ahmad Hably and Seddik Bacha in 2012. The control strategy proposed is divided into two parts. The first aims at generating an optimal reference orbit with an optimal tether radial velocity. In the second part, a nonlinear Model Predictive Control (MPC) strategy that allows an optimal tracking under constraints of the generated orbit is implemented.

ET

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

Trust...

25 Years of Excellent
Customer Satisfaction

Strength...

12,500 Sq. Mts.
Well Equipped Unit

Assurance...

ISO 9001:2015
Certified

Global Footprint

Covering entire globe
including SAARC Nations
& Middle East



Manufacturer of Wire & Wire Products

- Cable Armour Wire & GI Strip
- Barbed & Weldmesh
- Binding Wire
- ACSR Core Wire
- Cable Tape
- Earth Wire
- Hot dip GI Farming wire
- Hard Drawn Steel Wire
- PC Wire
- Spring Steel/ Shutter Wire
- Stranded Steel Wire
- Welding Electrode



H.D. WIRES
PVT. LTD.

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

Ph.: 91-731-4211199 Mob.: 98269 28878, 99935 29185

Telefax: 91-731-4211111 • Email : sales@hdwires.com

“HPL EXPORTS THE FINEST ENGINEERING GOODS,” ASSERTS JOINT-MD, HPL ELECTRIC & POWER LTD

*Gautam Seth, Joint-Managing Director,
HPL Electric & Power Ltd.*

*speaks to the Electrical India content
team on HPLs route to improving the
reliability and efficiency of its products
and technology...*

- The Electrical India Content Team



Tell us about your international business. Talk about the challenges?

HPL has managed to route its presence abroad by constantly improving the reliability and efficiency of its products and technology, without any challenges. This includes the export of the finest engineering goods to 42 countries in regions of Asia, Africa, Europe, UK and Indian Sub-continent through the overseas logistic partners.

What's latest with HPL Electric & Power Ltd? Tell us about the company's range of meters?

HPL caters to a wide variety of meter solutions across the industrial, domestic and commercial sector. For instance - Digital panel & Energy Meters, Multi-function meters, Din Rail Meter, Power Factor Control, 1Ph Direct Connection Counter/LCD Meters, 3P Direct Connection Counter/LCD

Meters, Trivector Meters, Dual Source Projection Meters, Long Range Integrated Meter and Import Export - Net Meter. However, there are no major differences among these, except some commercial meters may use demand meters and the billing is the kW hr. usage plus the max kW dem based on a 15-minute interval over the billing period. Also, a commercial meter may have a greater capacity

than a domestic meter regardless of which utility it is considering.

Tell us about your modular switches - Elmo Switches, Smart Modular Switches, Smarter Accessories and TUFF – Solo Switches

HPL manufactures various modular switches - the sockets have similar features such as user- friendly shutters, consists a gold plate, convenient removal and installation, and are made of polycarbonate material. HPL also provides a range of smarter accessories which includes cordless chimes, extension cords, holders & ceiling rose, international adapters, spike guards, wire doorbells, video door phone & multi plugs for the efficient functioning of smart switches.

HPL also has various types of TUFF solo switches as per their amplitudes, for instance, 6A one way & two-way switches and 16A one way & two-way switches.

The Elmo switches include Switches, Socket, Communication Socket, Regulator & Dimmers, Support Modules, Plates and boxes. Further, in the communication socket, HPL manufacturers TV sockets, RJ112 line socket and RJ45 cat6 socket & neon indicators. All the sockets have similar features such as user-friendly shutters, have a gold plate, are easy to remove and install and are made of polycarbonate material. In the smart modular switches category, the company has a wide range in Switches, Socket, Communication Socket, Regulators & Dimmers, Support Modules, Hotel & Hospitality Range, Specialty Product, Plates and Boxes.

Elaborate on the use of Switchgears in industrial and domestic products...

Switchgear is a combination of devices designed to control, regulate, meter and protect electric generation, transmission and distribution equipment, and electric motor control systems. These days switch gears are being used even in industrial works & projects, domestic and commercial buildings. Switchgear is commonly termed as a circuit breaker; switch the disconnecter or an isolator. Depending on the voltage of the power line for which they are designed, the equipment is called high, medium or low voltage switch gears. For the industrial sector, HPL has Intelliprotect

& Intellismart products in air circuit breaker category. Furthermore, our range of products are manufactured in MCCB, changeover switches, control gear, fuse gear & isolators categories. For the domestic sector, the company manufactures a variety of products such as MCBs, RCCBs, Isolators, Distribution Boards, MCB changeover and O Protect. Also, HPL caters to a four-dimensional product range of wires and cables - such as domestic and industrial wire, data networking transmission wire, special control and instrumentation wire and speciality cable. Furthermore, there are different products in each category. Domestic and Industrial wire includes flame insulated cables, zero halogen, multi-core & submersible cables. There are three product ranges in data networking transmission wire, such as Telephone cable, networking cable and coaxial cable. Specialty cables include fire alarm cable which is armored/unarmored cable and has PVC insulated speaker cables which are fire retardant and consists of two more electrical conductors individually insulated by plastic and DC solar cable which is a flexible tinned, annealed electrolytic grade copper conductor. Besides these subcategories, specialty cable also includes Fire survival cables, flat elevator cables and CCTV cables.

Tell us about your wire and cable product range. Please elaborate on each in detail.

HPL caters 4 types of wire and cable product range such as Domestic and Industrial wire, data networking transmission wire, special control and instrumentation wire and speciality cable. Furthermore, there are different products in each category. Domestic and Industrial wire includes flame insulated cables, zero halogens, multi-core & submersible cables. There are three product ranges in data networking transmission wire, such as Telephone cable, networking cable and coaxial cable. Specialty cables include fire alarm cable which is armored/unarmored cable and has PVC insulated Speaker cables which are fire retardant and consists of two more electrical conductors individually insulated by plastic and DC solar cable which is a flexible tinned, annealed electrolytic grade copper conductor. Besides these subcategories, specialty cable also includes Fire survival cables, flat elevator cables and CCTV cables.

15



Expert Insight

GAS TURBINES

THE HEART OF POWER GENERATION

- The
article is
authored by
Dr Iyad Al-Attar

Dr Iyad Al-Attar is a Mechanical Engineer, and business innovator. He is also a Visiting Academic Fellow at the School of Aerospace, Transport and Manufacturing at Cranfield University. He received his mechanical engineering degree from the University of Toronto and his Masters from Kuwait University. His PhD, from Loughborough University United Kingdom, is concerned with the performance of pleated filters for HVAC and Gas Turbine applications with special emphasis on the chemical and physical characterization of suspended particles.

Our Stark Reliance on Power

For all the generations that were born to find wall sockets for their phone chargers, televisions, and many electrical appliances, have you ever wondered how long could we survive without power? In fact, we get very irritated if our air conditioning and/or heating systems are off for even short periods.

Today, we feel isolated if the batteries of our smartphones and laptops are not charged. Our patience could dissolve in seconds if we missed our favourite television show or if there was no power to run our home appliances. We even demand that aircraft seats to be equipped with power sockets to charge our devices, in order to stay connected. Nevertheless, how did power make it to our homes and offices? How did our daily lives become so extremely reliant on power and at the mercy of its availability?

Centuries of development

Although the theory of gas turbines and their anticipated functions were established over the past four centuries, the manufacturing of a gas turbine was faced with great challenges. The earlier unavailability of required materials

impeded the full implementation of the theory into practice. The gas turbine operation requires components capable of sustaining excessive temperatures for an extended period. Further, additional challenges, such as the growing power demand and fuel price, have highlighted the importance of efficient gas turbine performance.

The definition of gas turbine

The term “gas turbine” describes an engine consisting of at least a compressor, a combustion chamber, and a turbine. It can convert natural gas or other liquid fuels to mechanical energy. In the land-based application, the generated power then drives a generator that produces electricity. Land-based gas turbines are of two types: (1) heavy frame engines and (2) aeroderivative engines.

Working Principles

The working principles of a gas turbine is based on the thermodynamic principles of the

Brayton cycle. The objective of operating a gas turbine is to have efficient compression and expansion processes to produce useable power output.

Atmospheric air is drawn through a filter housing installed at an elevated level and then passed through the filtration stages prior to entering the compressor via the bell mouth. Filtered air is compressed to high pressure and temperature before entering the combustion chamber where fuel is injected and combusted at constant pressure. The gases that leave the combustor at high temperatures contain large amounts of energy. Energy is then extracted from the hot pressurized gas, thus reducing pressure and temperature. 50 to 60 % of converted energy is used to drive the compressor and the rest drive a generator or shaft to produce power or the mechanical equipment of interest.

The challenges ahead

Gas turbines operate in different

environments such as tropical, coastal, and desert. They confront a wide array of atmospheric contaminants with various concentrations and particle size distributions. This could lead to performance degradation and components deterioration. Gas turbine engines are challenged by fouling, erosion, corrosion, abrasion, and foreign object damage. The compressor fouling (Figure 2) caused by the deposition of airborne particulate matter, smoke, oil vapour, carbon, sand, and sea salt is responsible for a 70–85% of gas turbine performance degradation [5]. It is described as the deposition of airborne contaminants on the aerofoils and annulus surfaces at the inlet of the gas turbine engine, particularly the compressor section. The presence of pollutants in the atmosphere may cause a compressor performance to degrade due to changes in aerofoil geometry and surface roughness.

Recoverable and Irrecoverable degradation

When compressor fouling can be removed by cleaning, performance losses are regarded as recoverable. The recovery takes place through offline or online compressor cleaning. However, extensive exposure of contaminant deposition can lead to non-recoverable degradation. Non-recoverable degradation in performance due to physical impacts causing permanent defects to gas turbine components during operation. Wear and tear of the profile of the blade profile is a great example of the aerodynamic alternation because of a permanent change

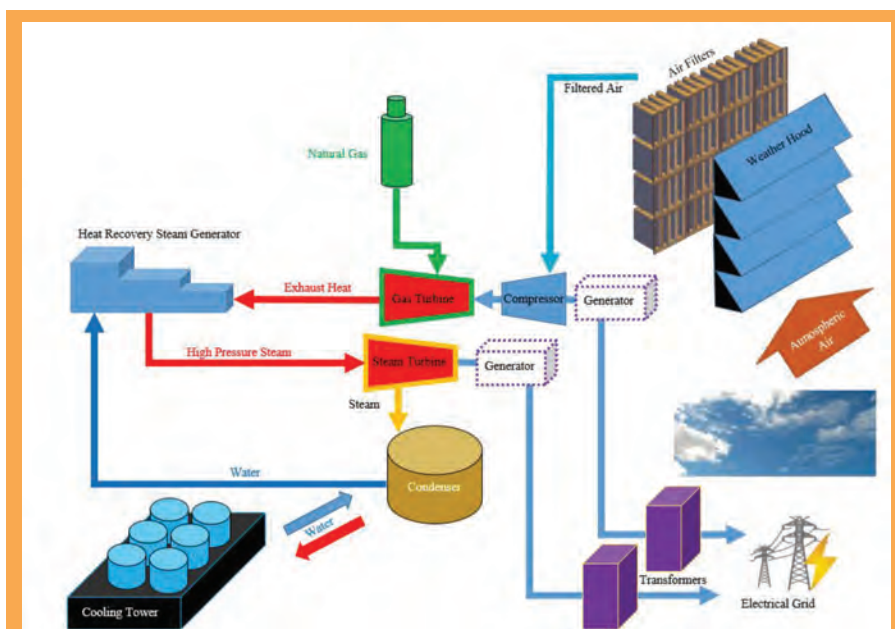


Figure 1: Schematic of a combined cycle power plant.



Figure 2: Fouling on the compressor assembly of a gas turbine engine.

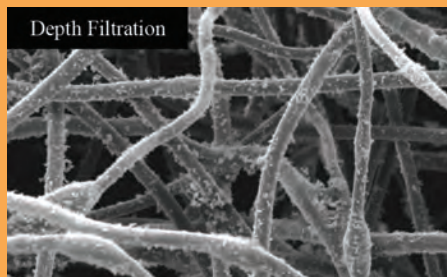


Figure 3: Scanning electron microscopic images of depth (left) and surface (right) filter media

in its shape, which affects the integrity of the component.

Air filtration

Air filtration emerges as a critical (separation and retention) process to capture pollutants prior to introducing the air to the gas turbine engine. Different filtration techniques such as static (Depth) and pulse (Surface) filters shown in Figure 3 are employed to protect the compressor assembly from suspended contaminants. Therefore, accurate filter performance prediction facilitates their appropriate selection in order to avoid premature clogging. This can be facilitated by virtue of capitalizing on multi-stage filtration selected after professional aerosol monitoring has been conducted. This would allow the engineer in charge to recognize the contaminants the gas turbine engine is up against and make appropriate filtration plans and compressor washing techniques to combat them. Furthermore, the detailed account of filter media must be investigated since it is the building block of air filter cartridges.

Compressor washing

Compressor washing is another maintenance measure where an engineered injection of demineralized water droplets and

cleaning fluids is delivered to the compressor assembly (Figure 4). Compressor washing is widely used to bring compressor blades to their design point and allow the compressor assembly to realize its fullest potential. The three methods of compressor washing are: online, offline, and/or hand-wash. They can be used at different times and are usually implemented alongside various filtration techniques to achieve optimum results.

The balanced approach

Increasing the number of filter stages and/or upgrading their efficiency leads to pressure drop increase of the entire filter section. On the other hand, reducing the number of filter stages and/or their efficiencies provides greater volume of less unfiltered air to reach the gas turbine engine. However, this would subject the compressor assembly to various

types and concentration of airborne pollutants deposition to be washed when required.

It is also important to realize that flow rate used in land-based gas turbine is higher than that used in HVAC applications. Therefore, installed air filters are exposed to greater concentrations of contaminants with various size distribution and chemical composition throughout their lifetime. Ultimately, the limitations of air filters and the wide spectrum of suspended pollutant make it difficult to rely on air filtration as a sole technique to maintain gas turbine performance. Therefore, compressor-washing techniques come in handy in rendering the compressor assembly back to its design point. Perhaps, a techno-economic study can reveal the current design limits of both technologies prior to holding any them responsible for engine performance degradation. Particularly, since an efficiency gain as low as one percent is significant to gas turbine operators.

Sustained gas turbine performance translates into maintaining the designed power output, reducing fuel consumption, emission, and the number of outages. Therefore, implementing a balanced approach between



Figure 4: Compressor washing nozzles in operation

professional air filter installation and compressor washing techniques can prove invaluable in designing maintenance measures. Clearly, the objective is to utilize available tools to maintain optimum efficiency of the compressor. However, one must address the inability of air filters to remove all suspended contaminants with various concentrations, size distribution and chemical composition.

Air pollution and sandstorms

Air pollution and sandstorms add to the complexity of filter performance prediction. Research has proven that polluted air and sandstorms expose the installed filters to high particle concentration causing them to bridge with one another leading to dust-cake formation whereby particles begin to agglomerate. Furthermore, high particle concentration alters filter porosity and occupies the interstitial spaces of the filter medium causing a significant rise in the filter's pressure. Unfortunately, early surface deposition on a depth filter does not warrant the full utilization of filter depth/thickness as shown in Figure 5. It could also reduce permeability of the filter triggering premature clogging and more frequent filter replacements



Figure 5: Particle cake formation on the surface of fibrous filter media due to high particle concentration.

because of the accelerated rise in pressure drop.

A tactic to tweak!

Abiding by international filtration standards alone cannot get the job done. In fact, actual performance of air filters installed in hot and humid climates tends to deviate from the performance predicted by laboratory results. This is particularly true in regions sustaining frequent sandstorms and known to have atmospheric dust (Figure 6) with characteristics deviating from that of commercially available synthetic standard dusts (Figures 7&8). Therefore, it is recommended that any filter enhancement to consider the following three-element plan:

1. **Conduct** chemical and physical characterization of atmospheric dust in the concerned region.
2. **Investigate** the possible impact of those characteristics on the filter selection and performance.

3. **Revisit** existing air filter designs to enhance the gas turbine performance via efficient, economic, and appropriate filtration solutions for the corresponding climate conditions.

There is an opportunity for operators to employ the concepts of the balanced approach detailed in this article to capitalize on the gas turbine performance and environmental impact. 

References

1. Claire Soares, 2011. "Gas Turbine" A Handbook of Air, and Sea Applications. Elsevier.
2. William W. Bathie, 1996. "Fundamentals of gas turbines". Second Edition, John Wiley & Son Inc.
3. David Gordon Wilson, Theodosios Korakianitis, 2014. "The Design of High-Efficiency Turbomachinery and Gas Turbines". MIT Press.
4. Klaus Hunecke, 2013. "Jet Engines: Fundamentals of Theory, Design and Operation". Airline, England.
5. Meher-Homji CB. Gas turbine axial compressor fouling – a unified treatment of its effects, detection and control. Int J Turbo Jet Engines 1992;9(4):99–111.

The images presented in the article are copyright of the author



Figure 6



Figure 7

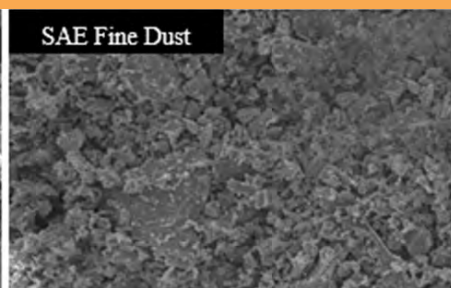
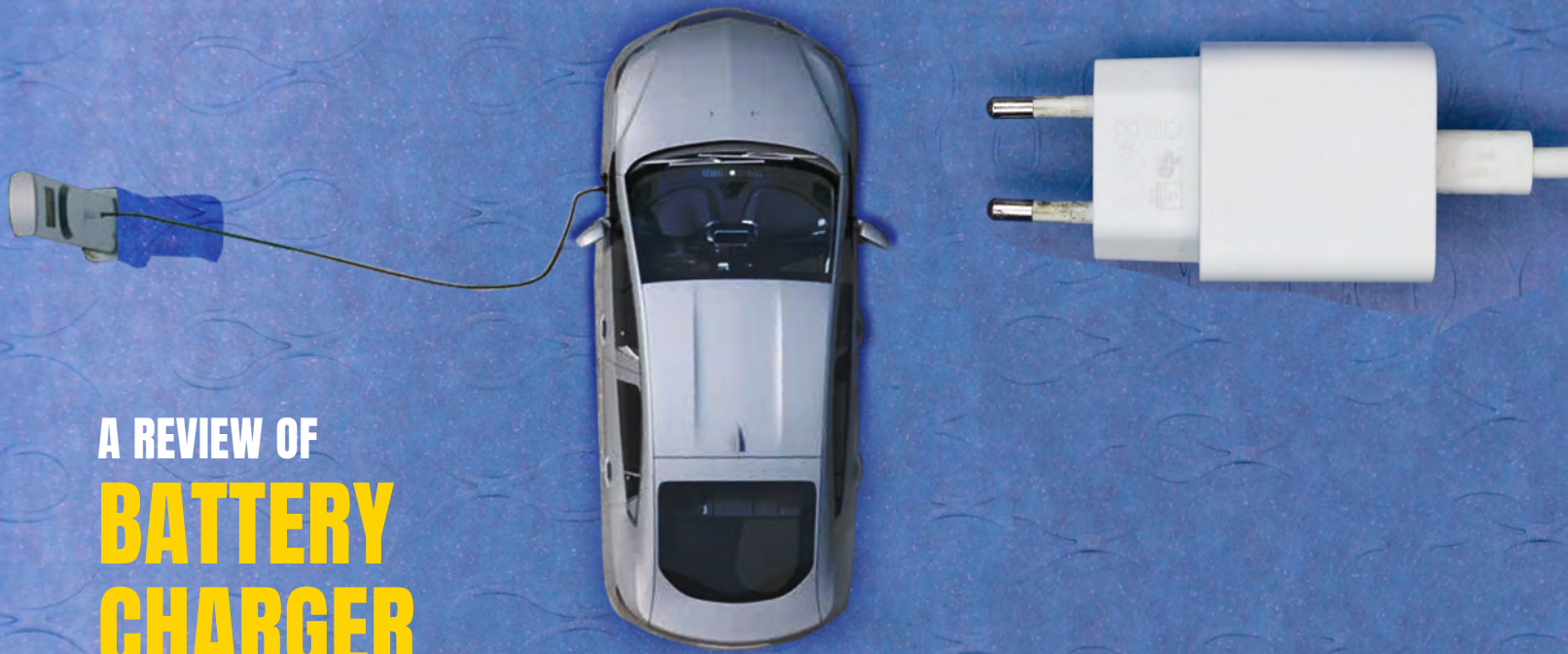


Figure 8



A REVIEW OF BATTERY CHARGER TOPOLOGIES AND INFRASTRUCTURE FOR PLUG-IN ELECTRIC AND HYBRID VEHICLES - PART 1

*The article is authored by
Dr L Ashok Kumar,
Professor, Department of
Electrical & Electronics
Engineering, PSG College
of Technology, Coimbatore*

This paper reviews the current status and implementation of battery chargers, charging power levels, and infrastructure for plug-in electric vehicles and hybrids. Charger systems are categorized into off-board and on-board types with unidirectional or bi-directional power flow. Unidirectional charging limits hardware requirements and simplifies interconnection issues. Bidirectional charging supports battery energy injection back to the grid. Typical onboard chargers restrict power because of weight, space, and cost constraints. They can be integrated with the electric drive to avoid these problems. The availability of charging infrastructure reduces onboard energy storage requirements and costs. On-board charger systems can be conductive or inductive. An off-board charger can be designed for high charging rates and is less constrained by size and weight. Level 1 (convenience), Level 2 (primary), and Level 3 (fast) power levels are discussed. Future aspects such as roadbed charging are presented. Various power level chargers and infrastructure configurations are presented, compared, and evaluated based on the amount of power, charging time and location, cost, equipment, and other factors.

An Introduction:

There is growing interest in Electric Vehicle (EV) and Plug-in Hybrid Electric Vehicle (PHEV) technologies because of their reduced fuel usage and greenhouse emissions. PHEVs have the advantage of a long driving range since fuel provides a secondary resource. Connection to the electric power grid allows opportunities such as ancillary services, reactive power support, tracking the output of renewable energy sources, and load balance. For purposes of this paper, plug-in vehicles will be lumped together with EVs. Several organizations, such as IEEE, the Society of Automotive Engineers (SAE), etc., are preparing standards and codes concerning the utility/customer interface. EVs have yet to gain wide acceptance. Three important barriers include the high cost and cycle life of batteries, complications of chargers, and the lack of charging infrastructure. Another drawback is that battery chargers can produce deleterious harmonic effects on electric utility distribution systems although chargers with an active rectifier front end can mitigate this impact.

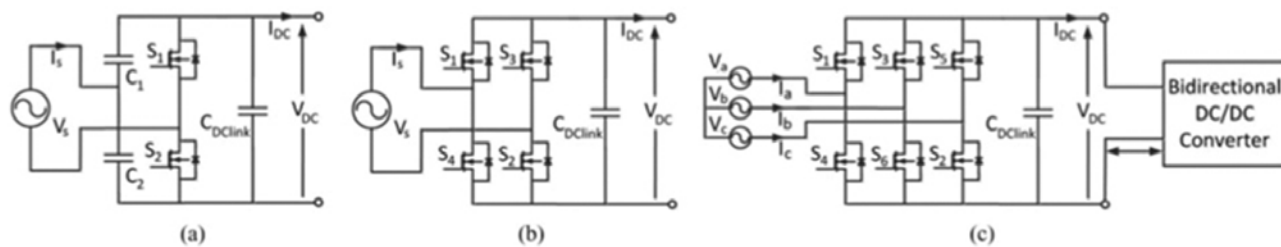
Most EV charging can take place at home overnight in a garage where the EV can be plugged into a convenience outlet for Level 1 (slow) charging. Level 2 charging is typically described as the primary method for both private and public facilities and requires a 240 V outlet. Future developments focus on Level 2; semi-fast charging provides sample power and can be implemented in most environments. Usually single-phase solutions are used for Levels 1 and 2. Level 3 and dc fast charging are intended for commercial and public applications, operating like a filling station, and three-phase solutions normally apply.

EV battery chargers can be classified as on-board and off-board with unidirectional or bidirectional power flow. Unidirectional charging is a logical first step

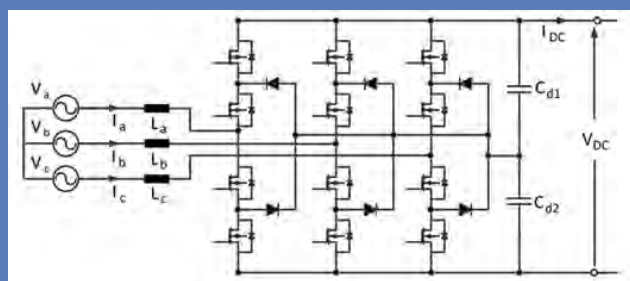
because it limits hardware requirements, simplifies interconnection issues, and tends to reduce battery degradation. A bidirectional charging system supports charge from the grid, battery energy injection back to the grid, and power stabilization with adequate power conversion. Typical onboard chargers limit high power because of weight, space, and cost constraints. They can be integrated with the electric drive to avoid these problems. On-board charger systems can be conductive or inductive. Conductive charging systems use direct contact between the connector and the charge inlet. An inductive charger transfers power magnetically. This type of charger has been explored for Levels 1 and 2 and maybe stationary or moving. An off-board battery charger is less constrained by size and weight. This paper reviews the current status and implementation of EV battery chargers, power levels, and charging infrastructure.

Battery Chargers for plug-in electric and hybrid vehicles

Battery chargers play a critical role in the development of EVs. Charging time and battery life are linked to the characteristics of the battery charger. A battery charger must be efficient and reliable, with high power density, low cost, and low volume and weight. Its operation depends on components, control, and switching strategies. Charger control algorithms are implemented through analogue controllers, microcontrollers, digital signal processors, and specific integrated circuits depending upon the rating, cost, and types of converters. An EV charger must ensure that the utility current is drawn with low distortion to minimize power quality impact and at high power factor to maximize the real power available from a utility outlet. IEEE-1547, SAE-J2894, IEC1000-3-2, and the U.S National Electric Code (NEC) 690 standards are limit the allowable harmonic and DC injection into the grid, and EV chargers are usually designed to comply.



Bidirectional chargers: (a) single-phase half-bridge, (b) single-phase full-bridge, and (c) three-phase full-bridge



Three-level diode-clamped bidirectional charger circuit, as in

Modern EV battery chargers contain a boost converter for active power factor correction (PFC). In the fast diodes in the bridgeless interleaved PFC have slightly lower power losses, since the boost diode average current is lower in these topologies. Overall the MOSFETs have increased current stress in the bridgeless topologies. It uses a dedicated diode bridge to rectify the ac input voltage to dc, which is followed by the boost section. The bridgeless boost PFC topology avoids the need for the rectifier input bridge yet maintains this boost topology. The rectifier fewer PFC-stages, converter solves the problem of heat management in the input rectifier diode bridge inherent to the conventional boost PFC but increases electromagnetic interference (EMI). Interleaving has been proposed to reduce battery charging current ripple and inductor size a unidirectional configuration presented in bridgeless interleaved PFC is illustrated in Fig. 1. It consists of two boost converters in parallel operating 180° out of phase. The interleaved boost converter has the advantage of paralleled semiconductors. With ripple cancellation at the output, it also reduces stress on output capacitors. However, similar to the boost, this topology must provide heat management for the input bridge rectifier; therefore, it is limited to power levels up to approximately 3.5 kW. A bridgeless interleaved topology was proposed for power levels above 3.5 kW in.

Multilevel converters can reduce the size, switching frequency, and stress on devices and are suitable for Level



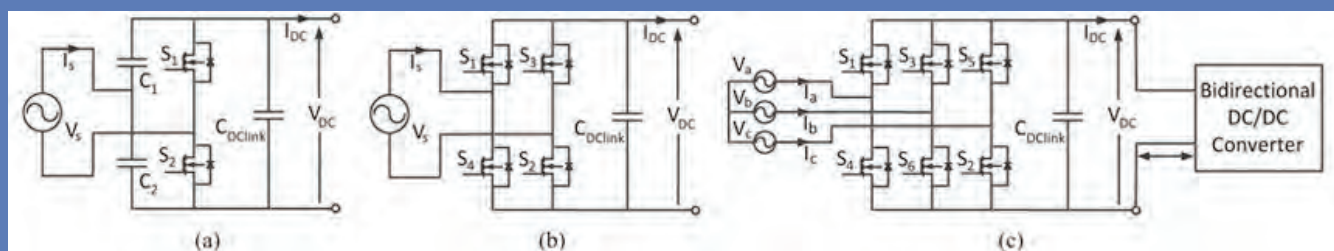
SAE's J1772 combo connector for ac or dc Level 1 and Level 2 charging

3 EV chargers. They allow for a smaller and less expensive filter, most PEVs use a single-phase on-board charger to recharge their batteries, and many circuit configurations are reported in the literature. In Fig. 2, the topology of a single-phase unidirectional multilevel charger is suitable and is a common multilevel charger topology for low-power Levels 1 and 2 charging. Three-phase bidirectional multilevel converters are recommended for high-power Level 3 charger systems. These converters provide a high level of power quality at input mains with reduced THD, high power factor and reduced EMI noise and boost, and ripple-free, regulated dc output voltage insensitive to load and supply disturbances. Three-level bidirectional dc-dc converters have been investigated for charge station application, as shown in Fig. 3. These converters are characterized by low switch voltage stress and used in smaller energy-storage devices such as inductors and capacitors.

This topology requires more pulse-width modulation (PWM) inputs that add to the complexity and cost of control circuitry. Fig. 4(a)–(c) shows basic bidirectional circuits. Fig. 4(a) shows a single-phase half-bridge bidirectional charger. Fig. 4(b) shows a single-phase full-bridge charger and Fig. 4(c) shows a three-phase full-bridge bidirectional unit that interfaces to a dc-dc converter.

Charger Power Levels and Infrastructure

Charger power levels reflect power, charging time

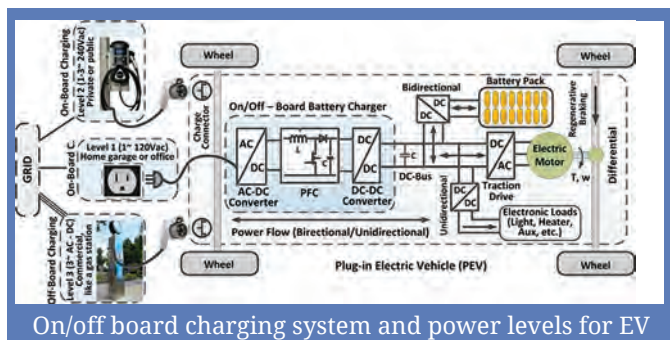


Bidirectional chargers: (a) single-phase half-bridge, (b) single-phase full-bridge, and (c) three-phase full-bridge.

and location, cost, equipment, and effect on the grid. Deployment of charging infrastructure and electric vehicle supply equipment (EVSE) is an important consideration because of many issues that need to be addressed: charging time, distribution, extent, demand policies, standardization of charging stations, and regulatory procedures. Charging infrastructure availability can be used to reduce onboard energy storage requirements and costs.

EV charge cords, charge stands (residential or public), attachment plugs, power outlets, vehicle connectors, and protection are major components of EVSE. They are generally found in two configurations: a specialized cord set and a wall or pedestal mounted box. For this reason, Level 1 and Level 2 charging equipment will be the primary options.

- **Level 1 Charging:** Level 1 charging is the slowest method. In the U.S., Level 1 uses a standard 120 V/15 A single-phase grounded outlet, such as the NEMA 5-15R. The connection may use a standard J1772 connector into the EV ac port. The many existing installed cost of a residential Level 1 charger infrastructure although in general it would be expected that this level will be integrated into the vehicle.
- **Level 2 Charging:** Level 2 charging is the primary method for dedicated private and public facilities. This charging infrastructure can also be on-board to avoid redundant power electronics. Existing Level 2 equipment offers charging from 208 V or 240 V (at up to 80 A, 19.2 kW). It may require dedicated equipment and a connection installation for home or public units, although vehicles such as the Tesla have the power electronics on board and need only the outlet. The new standard has an SAE J1772 ac charge connector on top and a two-pin dc connector below and is intended to enable either ac or dc fast charging via a single connection, as shown in Fig. 5.
- **Level 3 Charging:** Level 3 commercial fast charging



offers the possibility of charging in less than 1 h. It can be installed in highway rest areas and city refuelling points, analogous to gas stations. It typically operates with a 480 V or higher three-phase circuit and requires an off-board charger to provide regulated ac-dc conversion. The connection to the vehicle may be direct dc. Level 3 charging is rarely feasible for residential areas. Standards for dc plugs and infrastructure requirements are being set, as shown in Fig. 5. A Japanese protocol known as CHAdeMO is gaining international recognition. Cost of installation is a potential issue.

The SAE J1772 connector for (PHEV and EV) standard prescribes that Level 1 and Level 2 EVSE should be located on the vehicle, while Level 3 is located outside the vehicle. General public stations are expected to use Levels 2 or 3 to enable fast charging in public places. Lower charge power is an advantage for utilities seeking to minimize the on-peak impact. High- power rapid charging can increase demand and has the potential to quickly overload local distribution equipment at peak times. Level 2 and 3 charging can increase distribution transformer losses, voltage deviations, harmonic distortion, peak demand, and thermal loading on the distribution system. Degradation of typical distribution equipment can be mitigated by using a controlled smart- charging scheme. A reliable communication network and control of public charging is needed to enable the successful integration of a large number of EVs.

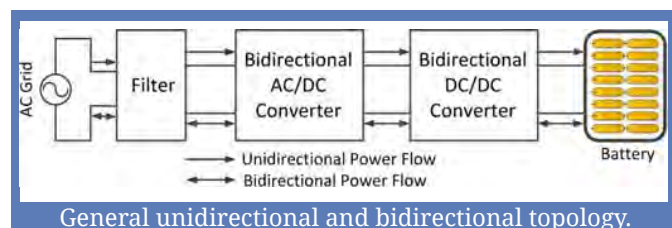
International Charging Codes and Standards for EVs

The successful deployment of EVs over the next decade is linked to the introduction of international standards and codes, a universal infrastructure, and associated peripherals and user- friendly software on public and private property, as implied in Fig. 6. Safety codes and standards address a wide range of issues relating to EVs. Costs associated with the charging infrastructure correlate with hardware standards. Certain standards are making EV charge infrastructure more complicated and expensive than conventional electrical infrastructure. Article 625-18 of the National Electrical Code, for example, requires that connectors and cables for Levels 2 and 3 be de-energized unless connected to a vehicle. This adds cost to the EVSE. (Vehicle manufacturers generally add an interlock that prevents a vehicle from being driven while on a charge, although this vital feature is not uniform in standards).

Some currently available PEVs that are equipped to accept dc fast charging (such as the Nissan Leaf and Mitsubishi i-MiEV) are using the CHAdeMO connector, developed in coordination with Tokyo Electric Power Company. SAE is also working on a “hybrid connector” standard for fast charging that adds high-voltage dc power contact pins to the J1772 connector, enabling the use of the same receptacle for all charging levels. The new standard is expected to be available on EVs in 2013.

Unidirectional Chargers

Two types of power flow are possible between EVs and the electric grid, as shown in Fig. 7. EVs with unidirectional chargers can charge but not inject energy into the power grid. These chargers typically use a diode bridge in conjunction with a filter and dc-dc converters. Today, these converters are implemented in a single stage to limit cost, weight, volume, and losses. High-frequency isolation transformers can be employed and Fig. 8 shows a unidirectional full-bridge series resonant converter for a Level 1 charging system.



Simplicity in the control of unidirectional chargers makes it relatively easy for a utility to manage heavily loaded feeders due to multiple EVs. Those with active front ends can provide local reactive power support utilizing current phase angle control without having to discharge a battery. Research on unidirectional charging seeks optimal charging strategies that maximize benefits and explore the impact on distribution networks. With a high penetration of EVs and active control of charging current, unidirectional chargers can meet most utility

objectives while avoiding cost, performance, and safety concerns associated with bidirectional chargers.

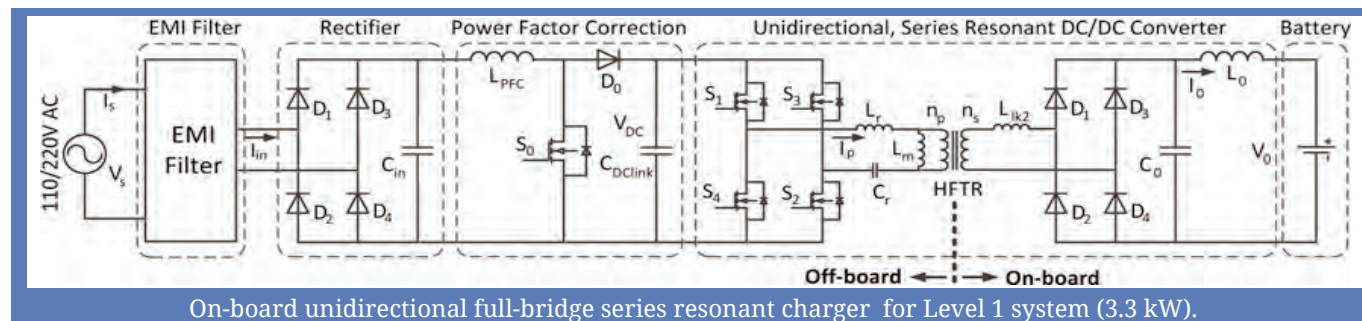
Bidirectional Chargers

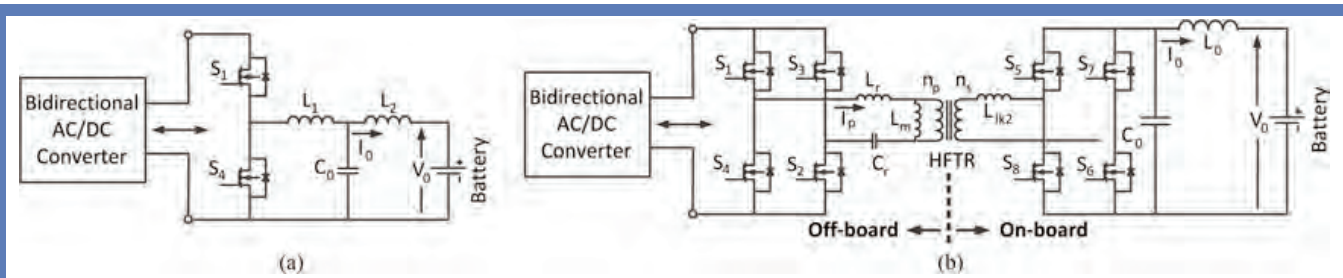
A typical bidirectional charger has two stages: an active grid-connected bidirectional ac-dc converter that enforces power factor and a bidirectional dc-dc converter to regulate battery current. These chargers can use non-isolated or isolated circuit configurations. When operating in charge mode, they should draw a sinusoidal current with a defined phase angle to control power and reactive power. In discharge mode, the charger should return current in a similar sinusoidal form. A bidirectional charger supports charge from the grid, battery energy injection back to the grid, referred to as vehicle-to-grid (V2G) operation mode, and power stabilization. The topology shown in Fig. 9(a) is a non-isolated bidirectional two-quadrant charger. This circuit has two switches, which greatly simplifies the control circuitry. However, two high-current inductors tend to be bulky and expensive, and it can only buck in one direction and boost in the other. The topology in Fig. 9(b) is an isolated bi-directional dual-active bridge charger. While this circuit provides high power density and fast control, the large number of components can add to cost.

While most studies have focused on bidirectional power flow, there are serious challenges for adoption. Bidirectional power flow must overcome battery degradation due to frequent cycling, the premium cost of a charger with bidirectional power flow capability, metering issues, and necessary distribution system upgrades. Levels 1, 2, and 3 chargers can be unidirectional. Bidirectional chargers are expected only for Level 2 infrastructures because Level 1 power limits and cost targets are low, and it is vital to maximizing flexibility. In Level 3 fast charging, reverse power flow conflicts with the basic purpose and premise of minimizing connection time and delivering substantial energy as quickly as possible.

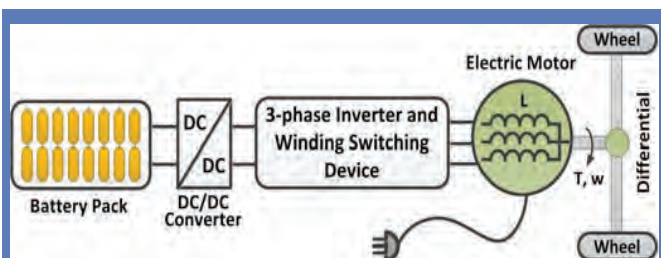
On-Board and Off-Board Chargers

A charger located inside the vehicle allows EV owners to





(a) Nonisolated bidirectional two-quadrant charger. (b) Isolated bidirectional dual active bridge charger.



Typical structure of integrated PEV charger.

Level 1 because of weight, space, and cost constraints. Resonant circuits can be helpful. The unidirectional full-bridge series resonant on-board Level 1 charger shown in Fig. 8 is an example. Given that typical power electronics ratings in an EV are at least 30 kW, off-board charging involves redundant power electronics and the associated extra costs. Other disadvantages include the risk of vandalism and added clutter in an urban environment.

charge their vehicles wherever a suitable power source is available. Typical on-board chargers limit the power to

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






empowering the power industry since 1988

We are the India's Leading manufacturer of Cables & Conductors. For over 30 Years, we are continuously expanding our presence in Indian and Overseas market to Electricity Boards, Government and Private Power Utilities, Private Contractors & Various EPC Companies. Our Organizational Philosophy is backed by Product Excellence, Customer delight technological advancements and an environmentally friendly approach.

Manufacturer & Exporters of:

- 66 KV XLPE Power Cables
- HT & LT Aerial Bunched Cables
- HT & LT XLPE UG Power Cables
- LT PVC Power & Control Cables
- FR/FRLS/LSZH Cables
- Solar Power Cables

- Airdac, Communication and Concentric Cables
- Bare & Insulated Copper Conductors
- ACSR, AAA, AA, AL59 & HTLS Conductors
- Railway Signaling, Power & Quad Cables
- Medium Voltage Covered Conductor





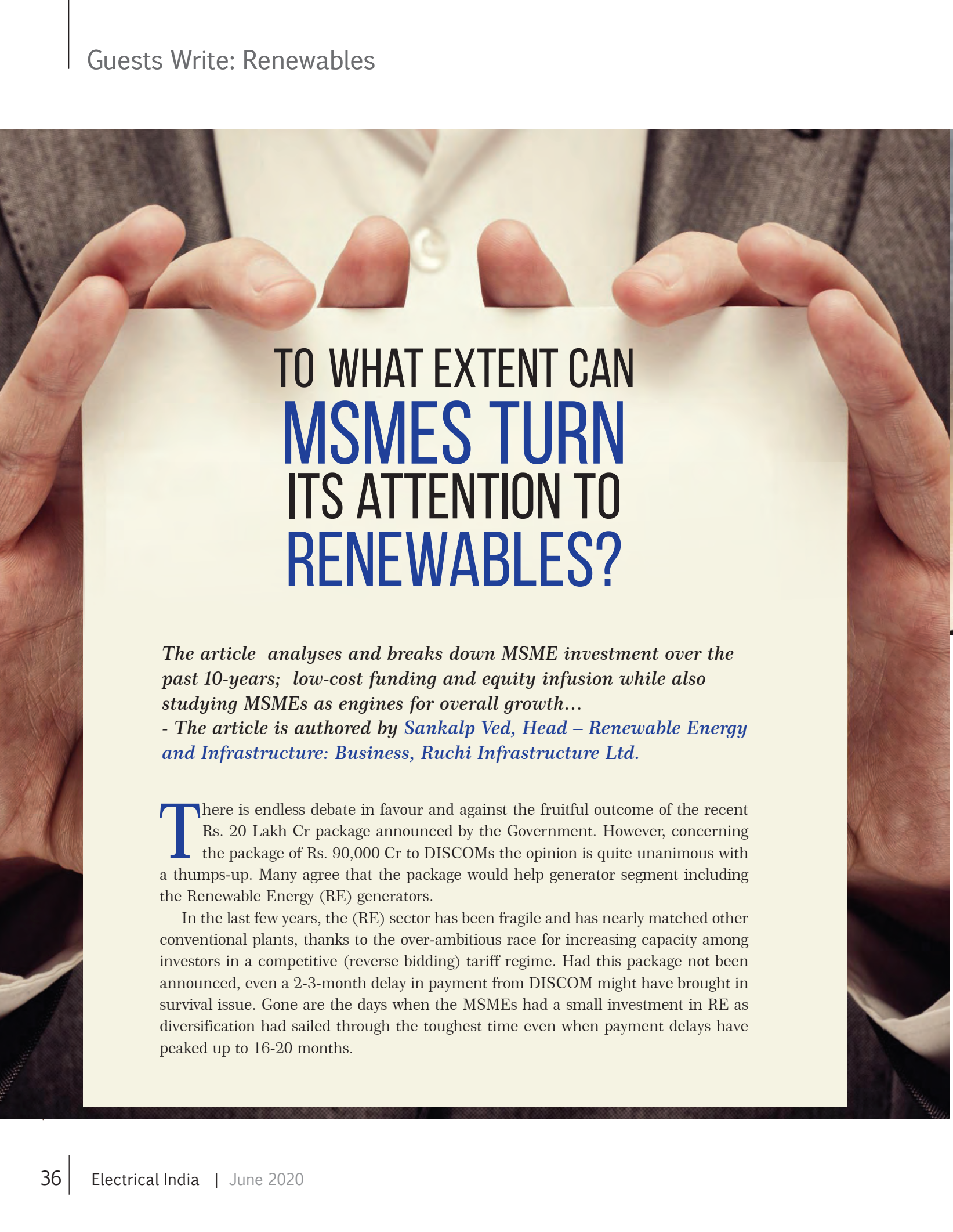
Dynamic Cables Ltd.

(A Govt. Recognised Star Export House) AN ISO 9001:2015 & OHSAS 18001:2007 Certified Company

Registered Office: F-260, Road No.13, V.K.I.Area, Jaipur- 302013, Rajasthan, India Ph: +91-141-2332388, 2262589, 4042005 | Fax: +91-141-2330182 E-mail: info@dynamiccables.co.in | Website: www.dynamiccables.co.in

— Supporting —





TO WHAT EXTENT CAN MSMES TURN ITS ATTENTION TO RENEWABLES?

The article analyses and breaks down MSME investment over the past 10-years; low-cost funding and equity infusion while also studying MSMEs as engines for overall growth...

- The article is authored by [Sankalp Ved](#), Head – Renewable Energy and Infrastructure: Business, Ruchi Infrastructure Ltd.

There is endless debate in favour and against the fruitful outcome of the recent Rs. 20 Lakh Cr package announced by the Government. However, concerning the package of Rs. 90,000 Cr to DISCOMs the opinion is quite unanimous with a thumbs-up. Many agree that the package would help generator segment including the Renewable Energy (RE) generators.

In the last few years, the (RE) sector has been fragile and has nearly matched other conventional plants, thanks to the over-ambitious race for increasing capacity among investors in a competitive (reverse bidding) tariff regime. Had this package not been announced, even a 2-3-month delay in payment from DISCOM might have brought in survival issue. Gone are the days when the MSMEs had a small investment in RE as diversification had sailed through the toughest time even when payment delays have peaked up to 16-20 months.



There is fund allocation for MSMEs also by way of funding and other reliefs. This is a change to bring back the golden era of MSME investment in RE like in the decade of 2000-10. The last financial year ended on the 31st of March 2020 and the sector clocked approximately 2.1 GW of wind energy and about 5.7 GW of solar energy installations in the country. However, in the last 5-7 years, MSMEs share in the RE installation has been moving to the negligible category especially about Wind energy investment. A new trend which has been evolved with a lesser share of MSMEs, which are called 'Retail investors' by Industry Jargons is now not a trend but a concluding reality.

The share of retail investors in wind projects this year came down to below 5% which was as high as up to 90% from 2005 to 2010. In the same way, solar also started with 60%+ share of MSME investors which now is below around less than 15% today.

Who are the retail investors?

MSMEs and small companies typically invest with 0.5 MW to 5 MW renewable energy project and avail of the various incentives available inclusive of accelerated depreciation, tax-free income, and preferential tariff especially if they sell power to a local utility or use the power for the captive purpose for their factory while paying wheeling charges

for the same. These companies typically take the project in their books and term loan is also availed by strength in the parent's balance sheet.

What happened to MSME investment in the last 10 years?

Small renewable investors moved out from the market slowly, especially from the wind sector for several reasons, such as the increase in the average size of wind turbines or the unavailability of the generic standard feed-in tariff with long term PPA. This year, the average turbine size installed has crossed 2-2.5 MW. During 2005-2012 the average turbine size was below or near 1MW. A typical retailer has an option to invest in small WTG of 0.6 or 0.8 MW with 3-5 Cr. investment and prudently do his planning, and now if an investor has to go for a bigger size the minimum investment required is gone up from Rs. 3 Cr. to Rs. 11 Cr. Further, in the present scenario neither any supplier offers a single turbine nor any state signs PPA for a single turbine. Thus, the availability is restricted to a very narrow band of the captive user and that too is limited to few states as a feasible option.

Although the problem of minimum Rs. 10-11 Cr. investment is not there in case someone is opting for a solar project. Even a small 0.25 MW solar project (ground-mounted or roof-

MSME share reducing	FY 2014-15		FY 2019-20	
	MSME	IPP	MSME	IPP
Wind	25%	75%	<5%	98%
Solar (Ground Mounted)	41%	39%	<10-15%	85-90%+
<i>*Source: Public web sites, media reports, Average approximate numbers are taken</i>				

top) is also possible. Still, there is no generic long-term feed-in tariff available for a small investor to make bankable investments with predictable cash flow. Investors have to wait for government tender /RFP, then apply for it, and hence it fulfils so many terms and condition & then he may win (or lose) a PPA. These are big-ticket investments and the process also requires so many deadlines and gives a very small window for anyone to make financial planning.

Another challenge is funding. Several IPPs which emerged as multi MW investor in Indian RE market have engineered the new equity and debt funding model which allows them to leverage more, and pump in less equity for a large project, get longer repayment schedule, ECB funding at a lower rate and even bridge funding for equity in some cases. On the contrary, a small retail investor has to go with conventional 30:70 term loan at a coupon rate of not less than 11.5%-12%. Now

in reverse bidding kind of tender (typically ground-mounted Solar and Wind) a Large IPP can aggressively bid a tariff which a small investor can never match (even while considering depreciation benefit which IPPs cannot use and neither have they bothered for it!).

Big size IPPs with penetration of foreign equity fund into their books, get more importance and access to detailed information from the supplier/project developer due the size of their contract and the 'carrot' they show for the future multi-billion contract. On the contrary, a 0.5 MW investor has to settle only with the 'leftover.'

How can these MSMEs ride the wave?

With all challenges listed above coupled with the COVID-19 triggered



slowdown, there is still a new window of opportunity for MSMEs and small investors to again turn their face to renewables and relive the glorious past. The requirement is to prudently plan the investment and scout for innovative funding ideas. Few new policy decision and package announcements are going to support re-entry of the MSMEs in the sector:

Low-cost funding and equity infusion:

One can always argue that if the general business sentiment is as such negative and the working capital is drying up how can an MSME think of diversification into renewables. The fact is, not all MSMEs are in trouble. As per the public data available for India's largest bank, only 20% of the accounts have opted for a moratorium so there must be many MSMEs in 80% who have not opted. Though, it is just one indicator. As per the announcement, banks and NBFCs will offer up to 20 per cent of entire outstanding credit as on February 29, 2020, to MSMEs. Units with up to Rs 25 Cr. outstanding in credit and Rs 100 Cr. turnover are eligible for taking these loans that will have four-year tenor with a moratorium of 12 months on principal payment. Also, Rs. 20,000 Cr. is announced for subordinate debt and Rs. 50,000 Cr. for equity infusion. Overall, for a good

company which follows corporate governance funding should not be a challenge.

Captive Project opportunity:

Even with access to funding, some challenges are to be seen ahead as explained above. However, there are opportunities available only with MSMEs having small-small plants and factories. By tying-up wind/solar power for the captive purpose, the power cost of the factory/production is frozen for 25-years. Renewable projects become an integral part of the production process and it safeguards plants from the annual increment in the tariff to the tune of total generation. Further, new tariff policy 2020 which is expected to be announced anytime from now the challenges for open access transmission and permissions etc. will be removed.

- **Solar Rooftop:** Here, the dominance still rests with MSMEs as such. Roof-top solar is expected to complement & not supplement the captive market as both are very different from the application point of view. With the cost of solar modules going down and the access to funds at its high time small factory setups to explore this viable option as prudently make a growth plan. New Ideas like 'integrator' approach should

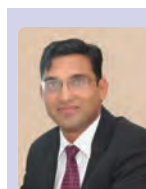
have experimented wherein a company make various tie-ups for using the roof and sell the power to another company (at a discounted rate) which has provided roof. MNRE also recently announced some policy amendments which will go in favour of MSMEs.

- **Solar Pumps:** Agriculture is largely unaffected by COVID-19 and with a bumper crop and a favourable monsoon; solar pumps are going to get a big boost. Further, along with the package announced in favour of DISCOMs, there is a condition of gradually reducing cross-subsidy surcharge. This means there might be some increment in the agriculture power tariff. In that case, solar pumps make all the more sense. Many small companies can play a role from supplier to dealer to the integrator to cash-in on this low hanging fruit.

MSMEs are growth Engines:

The country has seen a debacle of UMPPs, and it has also witnessed the absolute disappearance of all big investors (especially backed by foreign fund) from the market during the 2008 meltdown. Even during those days, these MSMEs continued small-small invest & the ball kept rolling. When double-digit growth is being targeted, Govt. should also take some more sector-specific initiatives so that these MSMEs remain in the game. 

Sankalp Ved, B.E. – Electrical, PGDFM. He is a Certified Energy Manager with 17+ years' experience in the Energy sector especially Renewable Energy. He is presently heading the renewable energy and infrastructure, business vertical at Ruchi Infrastructure Ltd. – a company devoted to the wind and solar power projects and other infrastructure assets. He was also instrumental in the execution of the country's most diversified Captive Wind Power Portfolio at 10 Locations in 4 states and Execution big size solar Project in 2010 as the first mover. He was part of the team which achieved the country's first Carbon Credit project.



Sankalp Ved,

Head – Renewable Energy and Infrastructure – Business, Ruchi Infrastructure Ltd.

NET - METERING

Regulatory avenues of the solar supply chain and business models - Part 1



India is ranked third, globally concerning power generation, accounting for 5.86% of the world's total annual energy generation after China and the US. Concerning the regulatory regime, net-metering plays a vital role in maintaining such a position where the country's energy sector regulates via the amended Electricity Act 2003. The Act is the parent legislation that governs all kinds of energy resource, except for nuclear energy. Fundamentally, the concept of net-metering allows residential and commercial customers who generate their electricity from solar power to sell the electricity they aren't using back into the grid. Based on the lesson learnt from the international net-metering demonstrations worldwide, several regulatory changes and initiative have been taken by various state regulators in the past year. For instance - Support incentive arrangements have been implemented for the promotion of the

metering arrangements, fiscal incentives such as capital subsidy, tax credits etc.

Looking forward, several states have passed net-metering laws. In other states, utilities may offer net metering programs voluntarily or as a result of regulatory decisions. The differences between state legislation, regulatory decisions and the implementation of policies mean that the mechanism for compensating solar customers varies widely across the country. As of today, only a few (Indian) States have such policies, discouraging users elsewhere. Consequently, with the increased use of renewable, the role of regulators is also intensified as the challenges to 'One Nation One Grid Scheme' is escalated high to tackle bidding guidelines for wind power projects and safeguards duty on solar panels and indirectly to assess monetary benefits from net-metering. Therefore, as a qualitative discussion, the article deliberates on



net-metering as a concept, its types, the context of developing regulations, more important discusses the type of business models and its future impact on the Indian Energy Regulations and consumer's base and arriving at feasible solutions for sustainable energy generation in India.

Net –Metering as a concept

Net-metering is a concept for utility billing that provides credit to customers (both residential and business) who make excess electricity with their solar panel systems. The net-metering system electricity also sends it back to the grid. The concept of net-metering suits well in renewable energy generation like rooftop solar systems that generate electricity near the point where they will be used, and this reduces the strain on the grid's distribution and transmission infrastructure, and this also minimizes energy-loss from sending voltage many miles from the nearest power plants. For instance, in residential areas a customer has a Photovoltaic (PV) system installed on their roof, it may generate more electricity than the home uses during daylight timings. If the home is net-metered, the electricity meter will run backwards to provide a credit against what electricity is consumed at night or other periods when the home's electricity use exceeds the system's output. Based on this, customers are only billed for their "net" energy usage, which can save money on their utility bills every year. On average, it has been estimated that only 20-40% of a solar energy system's output ever goes into the grid, and this exported solar electricity serves nearby customers' loads.

Net-metering: Consumer perspective definition

The definition of an eligible consumer for a net-metered project is important from the perspective of permitting third-party ownership of rooftop solar systems. Globally, the net-metering system is permitted for both self-owned and third-party ownerships, and accordingly regulatory frameworks have been developed to address the same. The third-party ownership is also being facilitated through legislative or regulatory measures.

In India, the third-party-owned power projects supplying electricity to consumers would amount

to third party sale of electricity unless addressed otherwise. These consumers would subsequently be liable to pay wheeling charges, cross-subsidy surcharge and additional surcharge (if applicable). Rooftop solar projects under net-metering are expected to be of small size and will act as on-site generation cum consumption for the consumer. The connectivity with the grid will act as a support facility to the consumer to bank the electricity in the grid for a defined period. There is merit in allowing both self-owned as well as third-party-owned systems under the net metering arrangements where the primary purpose is to meet the internal electricity consumption requirement of the consumer.

It is proposed that consumer's eligibility for net-metering be defined in such a way that it allows, both self-owned as well as third-party-owned systems, to be installed for meeting consumer's self-consumption. The regulations could then exempt only such eligible consumers from wheeling, banking and cross-subsidy related charges.

Types of Net –Metering

There are two different types of metering arrangements, Gross and Net metering. Surveys say that globally, both net metering and gross metering concepts have been implemented. In a gross metering arrangement, the entire energy generated by the rooftop solar PV system is fed directly into the electrical grid and the system owner is benefited by feed-in-tariff based on the sale of power to the utility. However, little differently, in a net-metering arrangement, the focus is primarily on self-consumption of electricity generation by the consumer. The surplus energy is either sold to or banked with the local utility. In the sense, the Net metering arrangements, thus, combine elements of captive consumption and exchange of power with the utility.

The Feature (s) of Net-Metering

Giving Customers Control Over Their Electricity Bills: On prima facie is that net metering allows utility customers to generate their electricity efficiently. During the day time, most solar customers produce more electricity than they consume and net metering allows them to export that power to the grid and reduce their future electric bills.

Creating Jobs & Encouraging Private Investment

Net metering also provides substantial economic benefit in terms of socio-economic sense such as jobs, income and investment. It is seen that due to the increase in awareness of net-metering, the demand for solar energy has increased in the market, and this in turn creates jobs for installers, electricians, and manufacturers who work in the solar supply chain. Today, in India, the solar industry employs thousands of workers in large part-transmission and distribution due to strong state net-metering policies which have allowed the solar industry to thrive. Andhra Pradesh, Tamil Nadu, Rajasthan, Madhya Pradesh, Maharashtra are few of them.

Protecting the Electric Grid

Sometimes, net-metering policies lose opportunities. They create a smoother demand curve for electricity and allow utilities to better manage their peak electricity loads. By encouraging generation near the point of consumption, net metering also reduces the strain on distribution systems and prevents losses in long-distance electricity transmission and distribution. Many studies are found in the context of that demonstrate the value of the solar system to local economies and the electricity system as a whole.

International Status

As per reports by the European PV Industrial Association, and the research carried out by Indian leading MNCs such as Deloitte - it provides an overview of the metering arrangements, ownership pattern and incentive structure for the rooftop solar PV projects which is being followed by various geographies across the world. In countries such as Germany, the Netherlands and Denmark, consumers can benefit from net metering arrangements. In these countries, consumers with small solar or wind energy generators can supply excess energy to their local distribution facility in exchange for vouchers to offset electric energy provided to them at other times when required. In particular, Germany is a well-known example of the successful propagation of the gross-metering concept. Japan was found on a similar pattern and several states in the United States, on the other hand, have implemented the concept where the energy is self-consumed before the surplus is sold to the grid. The recent trend in Japan has been to progressively move towards a gross metering model with FiT mechanism.

This concept of net-metering is quite famous in developed nations but not in developing countries.

Among developing countries, Thailand is observed as the first country to initiate net-metering. In India, the concept is not very old, and some states such as Andhra Pradesh, Tamil Nadu, Uttarakhand, Maharashtra and also Delhi have come up with their policies of net metering. However, there are several issues around the same. Firstly, both the DISCOMS and end-consumers in India are reluctant about Net Metering. From the consumer end, the reluctance stems from tariff structure and grid reliability. Tariff structure so far does not offer many motivating incentives. Concerning grid reliability, India suffers from excessive load shedding, which may result in a waste of power from solar PV during outages. There needs to be anti-islanding protection in grids which enables the invertors to it shut off and stop feeding the power into the grid when there is a power outage.

International experience in the energy sector in the evolution of rooftop solar segment highlights that there is a very high relevance of policy and regulatory framework. Such policies found seen as a support to the development and propagation of various lucrative business models. Therefore, having learned from the various lessons at International cases, in India also both the types of Gross and Net metering models necessitate distinct and modified policy support from the Government for various benefits, incentives and subsidy instruments. Similarly, the ownership patterns, intermediaries and financing mechanisms get shaped to a large extent by the regulatory mechanism in place across various countries and India has made a very good effort and has been successful in planning and designing such policies to the extent.

Context of developing net metering regulations in India

Energy regulations in India are complex and have been framed perhaps for simpler and easier operations to support metering systems through all kinds of energy resources. Often, gross-metering based renewable projects (including solar) are seen evolving since many times. In tune with the National Solar Mission that is an initiative of the Government of India and State Governments, regulatory commissions to promote solar power, many states have seen developed the regulatory framework for the solar sector. Over time, in search for more share to the optimal energy mix, this resulted in enhanced capacity addition from the large capacity solar power projects. However, as an emollient remedy, as such there was no feasible way to use such projects,

thus, many states started implemented other than under gross-metering arrangement.

As an inestimable case, states like Gujarat have initiated the implementation of small capacity rooftop solar projects under the gross-metering arrangement, with a defined commercial arrangement and interconnection requirements. Technical and commercial requirements for net-metering arrangement have however not been addressed adequately and this constrains the propagation of this segment of rooftop projects. It is well recognized that a grid-connected net-metering arrangement requires a well-defined regulatory and commercial framework to address issues related to third-party owned systems, provisions under the open access regulations, and banking of energy, etc. Further, exhilarating the need for a business model, key business models and parameters important from the perspective of developing draft model net-metering based rooftop solar regulation have been identified as follows.

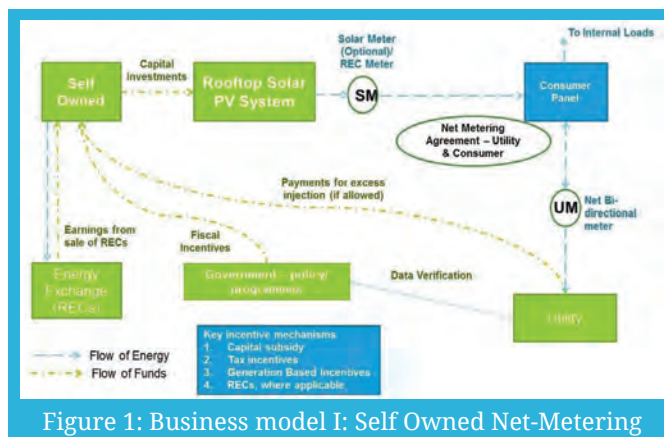
Net-metering business models

The net-metering based rooftop solar projects facilitate the self-consumption of electricity generated as well as feeding the surplus into the network of the distribution licensee. The type of ownership structure for installation, classify as an important criterion for defining the different rooftop solar-based business models. The models that gain the attention of customers on monetary terms as well as on the sustainability part of using solar as resources. In this reference, many models are seen developed worldwide internationally; and the rooftop solar projects have found two explicit distinct ownership arrangements.

Self-owned arrangement wherein rooftop owner also owns the PV system and Third-party ownership in which a developer owns the PV system and also enters into a lease/commercial arrangement with the rooftop owner. Both these models are also found very much relevant in the Indian context and have been discussed in the section below.

Self-owned arrangement metering model

In a self-owned, net-metering based rooftop PV model, the rooftop owner who is also the electricity consumption for the utility installs the rooftop solar system, either on its own or with the help of a system supplier and installer. The electricity generated by the system is first used to service the consumer's captive load within the rooftop owner's premises. The solar power generated more than the



owner's electricity consumption is fed into the grid through a net meter, which is a bi-directional energy meter capable of registering both import and export of electricity.

So, technically, net-metering enables customers to use their generation from on-site renewable energy systems to offset their consumption over a billing period by allowing their electric meters to turn back when they generate electricity over the demand, enabling customers to receive retail prices for the excess electricity they generate. Net-generation highlighted here is credited to the owner's account and adjusted subsequently against imports from the grid. For this model to work and to interconnect with the distribution utility, necessary provisions permitting net-metering through rooftop solar systems have to be adopted. In the interim, there are several policy instruments like the Generation Based Incentive (GBI) or capital subsidy which can be adopted to bridge the difference between the higher cost of solar generation and applicable retail tariff for the consumer categories. There are several other forms of this model which have been implemented in Japan. The net – metering concept in Japan is seen as relatively higher retail tariffs combined with capital subsidy make such systems attractive for rooftop owners, while in the case of the United States, tax rebates are the primary concerns for incentives.

15

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



Vivek Soni,

Chartered Engineer, PhD IIT Delhi Faculty, Bharatiya Vidya Bhavan's Institute of Management New Delhi

ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS (As on 30.04.2020)

Region	Ownership/ Sector	Mode wise breakup								Grand Total
		Thermal					Nuclear	Hydro	RES * NRE)	
		Coal	Lignite	Gas	Diesel	Total				
Northern Region	State	16659.00	250.00	2879.20	0.00	19788.20	0.00	5777.25	701.01	26266.46
	Private	22425.83	1080.00	558.00	0.00	24063.83	0.00	2817.00	15790.10	42670.93
	Central	14354.96	250.00	2344.06	0.00	16949.02	1620.00	11491.52	379.00	30439.54
	Sub Total	53439.79	1580.00	5781.26	0.00	60801.05	1620.00	20085.77	16870.11	99376.93
Western Region	State	21740.00	1040.00	2849.82	0.00	25629.82	0.00	5446.50	555.54	31631.86
	Private	32847.17	500.00	4676.00	0.00	38023.17	0.00	481.00	24821.29	63325.46
	Central	18347.95	0.00	3280.67	0.00	21628.62	1840.00	1695.00	666.30	25829.92
	Sub Total	72935.12	1540.00	10806.49	0.00	85281.61	1840.00	7622.50	26043.13	120787.24
Southern Region	State	19512.50	0.00	791.98	159.96	20464.44	0.00	11774.83	586.88	32826.15
	Private	12747.00	250.00	5340.24	273.70	18610.95	0.00	0.00	41344.74	59955.69
	Central	11835.02	3240.00	359.58	0.00	15434.60	3320.00	0.00	541.90	19296.50
	Sub Total	44094.52	3490.00	6491.80	433.66	54509.99	3320.00	11774.83	42473.52	112078.34
Eastern Region	State	7450.00	0.00	100.00	0.00	7550.00	0.00	3537.92	275.11	11363.03
	Private	6153.00	0.00	0.00	0.00	6153.00	0.00	96.00	1214.05	7463.05
	Central	13682.05	0.00	0.00	0.00	13682.05	0.00	1005.20	10.00	14697.25
	Sub Total	27285.05	0.00	100.00	0.00	27385.05	0.00	4639.12	1499.16	33523.32
North Eastern Region	State	0.00	0.00	497.71	36.00	533.71	0.00	422.00	233.25	1188.95
	Private	0.00	0.00	24.50	0.00	24.50	0.00	0.00	101.39	125.89
	Central	770.02	0.00	1253.60	0.00	2023.62	0.00	1155.00	30.00	3208.62
	Sub Total	770.02	0.00	1775.81	36.00	2581.83	0.00	1577.00	364.64	4523.46
Islands	State	0.00	0.00	0.00	40.05	40.05	0.00	0.00	5.25	45.30
	Private	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.84	7.84
	Central	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10	5.10
	Sub Total	0.00	0.00	0.00	40.05	40.05	0.00	0.00	18.19	58.24
ALL INDIA	State	65361.50	1290.00	7118.71	236.01	74006.21	0.00	26958.50	26958.50	103321.74
	Private	74173.00	1830.00	10598.74	273.70	86875.45	0.00	3394.00	3394.00	173548.85
	Central	58990.00	3490.00	7237.91	0.00	69717.91	6780.00	15346.72	15346.72	93476.93
	Total	198524.50	6610.00	24955.36	509.71	230599.57	6780.00	45699.22	45699.22	370347.52

Figures at decimal may not tally due to rounding off

Source: CEA

Energy Power Supply Position (Provisional)

Figures in MU net

States	April, 2020			
	Energy Requirement	Energy Supplied	Energy not Supplied	
	(MU)	(MU)	(MU)	%
Chandigarh	76	76	0	0.0
Delhi	1,665	1,665	0	0.0
Haryana	2,513	2,513	0	0.0
Himachal Pradesh	403	402	0	0.1
UT of J&K and Ladakh	1,568	1,272	296	18.9
Punjab	2,397	2,397	0	0.0
Rajasthan	4,872	4,871	1	0.0
Uttar Pradesh	8,142	8,065	77	0.9
Uttarakhand	626	626	0	0.0
Northern Region	22,262	21,888	375	1.7
Chhattisgarh	2,229	2,229	0	0.0
Gujarat	7,784	7,784	0	0.0
Madhya Pradesh	5,317	5,317	0	0.0
Maharashtra	11,752	11,752	0	0.0
Daman & Diu	68	68	0	0.0
DNH	85	85	0	0.0
Goa	241	241	0	0.0
Western Region	27,476	27,476	0	0.0
Andhra Pradesh	4,785	4,785	0	0.0
Telangana	4,799	4,799	0	0.0
Karnataka	6,122	6,122	0	0.0
Kerala	2,050	2,048	2	0.1
Tamil Nadu	7,181	7,181	0	0.0
Puducherry	149	149	0	0.0
Lakshadweep #	4	4	0	0.0
Southern Region	25,088	25,086	2	0.0
Bihar	2,201	2,201	0	0.0
DVC	897	897	0	0.0
Jharkhand	674	674	0	0.0
Odisha	2,057	2,057	0	0.0
West Bengal	3,870	3,870	0	0.0
Sikkim	36	36	0	0.0
Andaman-Nicobar #	29	27	2	6.7
Eastern Region	9,735	9,735	0	0.0
Arunachal Pradesh	47	46	1	2.8
Assam	604	546	58	9.7
Manipur	67	66	1	1.9
Meghalaya	118	114	4	3.4
Mizoram	47	46	1	2.3
Nagaland	61	60	1	1.4
Tripura*	104	102	2	1.5
North-Eastern	1,048	979	69	6.5
All India	85,608	85,164	445	0.5

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

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

Source: CEA



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



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 : Cash Credit
Account Number : 000930110000085	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: Mariya +91 8286000950 • Website: www.charypublications.in

THE DIARY

MIDWEST SOLAR EXPO

Date: 15 - 17 June 2020
Location: Online
Time: 09:00 AM-06:00 PM (expected)

SOLAR EXPO BANGLADESH

Date: 02 - 04 July 2020
Location: Bangladesh



RENEWABLE ENERGY

Date: 08 - 10 July 2020
Location: Japan

SOLAREX ISTANBUL

Date: 09 - 11 July 2020
Location: Turkey
Contact: info@voli.com.tr



ELECTRIC POWER EQUIPMENT AND TECHNOLOGY

Date: 13 - 15 July 2020
Location: Philippines

WORLD RENEWABLE ENERGY TECHNOLOGY CONGRESS & EXPO (WRETC & EXPO)

Date: 21 - 23 August 2020
Location: Convention Centre-NDCC, New Delhi

WEBINAR

Company Name: ABB

Time: 2PM EDT

Date: 11th June'20

Webinar Name: Decarbonization and the role of transportation electrification

Sponsor: TPC Training

Time: 2PM EDT

Date: 22nd July'20

Webinar Name: Fall and Electrical Hazards: The Double Dangers of Maintenance

Company Name: ABB

Time: 2PM ET/11AM PT

Date: 17th June'20

Webinar Name: Electrical Contractors and BIM: What It Can Do For

Company Name: ABB

Time: 11:30 AM EST

Date: 25th June'20

Webinar Name: Wireless communication fundamentals for electric utility applications



IN THE JULY 2020 ISSUE

**POWER DISTRIBUTION
SPECIAL**

**Distribution Transformers &
Allied Industries**

**Smart Grid, Transmission Lines,
Power Cables**

Company Name	Page No.
Allied Power Solutions	50
Dynamic Cables Ltd	35
ESYLUX Asia Ltd	5
H.D Wires Pvt Ltd	23
igus India Pvt Ltd	15
ISA Advance Instruments (I) Pvt Ltd	7
Jindal Electric & Machinery Corporation	49
Kloekner Desma Machinery Pvt Ltd	BC
Larsen & Toubro Ltd	IFC
Rishabh Instruments Pvt Ltd	11

REDUCE FAILURE RATE OF ELECTRICAL EQUIPMENTS

& SAVE ENERGY

by installing

JINDAL'S INDUSTRIAL ROBOT AUTOMATIC VOLTAGE CONTROLLER

A breakthrough in energy conservation



CAPACITY : 30 TO 100 KVA



CAPACITY : 150 TO 3000 KVA

5 Years Guarantee

GENERAL TREND OF VOLTAGE DURING DAY TIME

340V-400V 09:00 HRS - 12:00 HRS	400V-440V 12:00 HRS - 14:00 HRS Lunch Hours	340V-400V 14:00 HRS - 18:00 HRS	400V-430V 18:00 HRS - 22:00 HRS	400V-470V 22:00 HRS - 05:00 HRS Peak Hours Restriction	400V-450V 05:00 HRS - 09:00 HRS
------------------------------------	---	------------------------------------	------------------------------------	--	------------------------------------

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 : jmc@jindalelectric.com Website : www.jindalelectric.com

Discover the Power Quality Analyzer

RISH PQA is a compact state-of-the-art power quality analyzer designed for utilities, as well as for industrial & commercial customers. The meter is equipped with a 5" TFT color display for easy graphical representation of harmonics, Phasors and Waveforms. RISH PQA can continuously monitor power quality in-keeping with EN50160, also the built-in flexibility allows the user to set the customized setting to do power quality analysis. This EN50160 report can be downloaded in excel format. The meter is capable of measuring harmonics as per IEC 61000-4-7, inter-harmonics, dips, swells, interruptions.



Intelligent algorithm allows user to monitor multiple parameters at a glance on a single screen, which helps in analyzing power quality issues very easily. The Power Quality Analyzer also monitors demand and measures energy with an accuracy of class 0.2S as per IEC62053-22. The meter supports memory card (micro SD, up to 8GB) for the recording of events and power quality parameters as per EN50160. Communication can be done via modbus over RS485. Rish PQA is supported with Power configuration application software for configuring and displaying data via RS 485. USB should be used to download data on PC and for the firmware upgrade process.

COMPLETE ELECTRICAL SOLUTIONS UNDER ONE ROOF



**Insulation Monitoring
Device**



**Surge Protection
Device**



**Surge Arrester
TYPE 2 / CLASS II**

**Lightning Current & Surge Arrester
TYPE 1+2 / CLASS I+II**



Certifications



ALLIED POWER SOLUTIONS

T - 4, 5 & 6, Third Floor
Pankaj Plaza - 3, I.P. Extn.,
Patparganj, Delhi - 110 092 (INDIA)
t: +91 11 2224 7322 m: +91 96500 44992
e: info@alliedpowersolutions.com
w: www.alliedpowersolutions.co

LPI®

LIGHTNING PROTECTION INTERNATIONAL PTY LTD

Guardian Plus

Protection Solutions for HV Power Facilities



IEEE Standard 998

IEEE Standard 998 is the only international standard dealing with shielding of substations against direct lightning strikes.

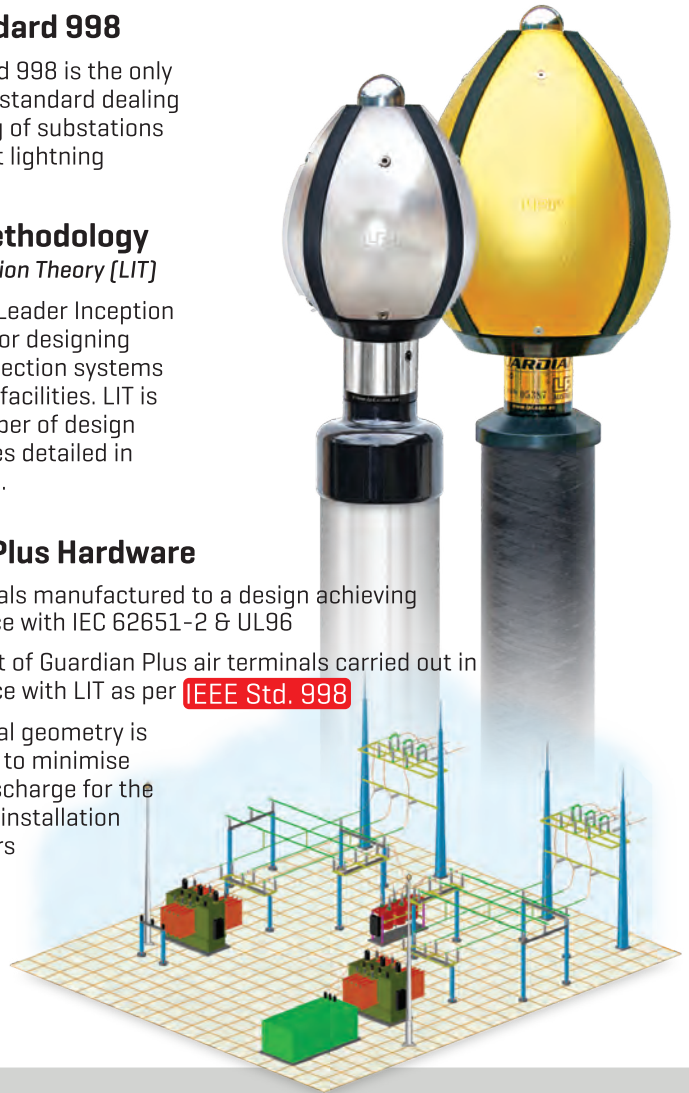
Design Methodology

Leader Inception Theory (LIT)

LPI uses the Leader Inception Theory (LIT) for designing lightning protection systems for HV power facilities. LIT is one of a number of design methodologies detailed in IEEE Std. 998.

Guardian Plus Hardware

- Air terminals manufactured to a design achieving compliance with IEC 62651-2 & UL96
- Placement of Guardian Plus air terminals carried out in accordance with LIT as per **IEEE Std. 998**
- Air terminal geometry is optimised to minimise corona discharge for the particular installation parameters



Comprehensive Lightning, Surge Protection

GRID EARTH

Specially Design for substation based on IEEE standard.



GRID EARTH WITH VERTICAL RODS



JOIN US FOR POWER TALK @5

ON THE BELOW ID

www.instagram.com/electricalindia1961



CHALLENGING

APPROACHES TO WITNESS

AN EVOLUTION

Contact us to know more: ranjana@charypublications.in/ smit@charypublications.in

*Your experts in rubber and
silicone injection moulding.*

24/7

DESMA

Silicone Injection Moulding



DESMA SIGMA SE Series Silicone Rubber Injection Machines, Moulds & Cold Runner Blocks

Everything for the profitable production of composite insulators, arrestors & cable accessories

No.1 in India and Exporting to 21 Countries

11 to 33 kV Insulators

- Sigma 250 SE Machine
- 16 cavity 11 kV/8 cavity 33 kV/22 kV combo mould + 8 nozzle Single Block CRB
- Process optimised for less than 5% wastage
- Also suitable for 25 kV Railway insulators

Long Rod Insulators

- Top clamping and bottom clamping design
- SIGMA 450 SE and 630 SE machines are suitable
- Modular concept two cavity mould for Step Moulding
- Hydraulic ejectors and rod support mechanism to avoid rod bending and shed damage

Arrestors & Hollow Core Insulators

- SIGMA 250 SE to 630 SE machines suitable for production of 9-132 kVA arresters (with multi cavity moulds)
- Special sealing feature to prevent silicon leakage in the oxide blocks during moulding

Cable Accessories

- Turnkey project solution for efficient production of Cable Joints, Elbow Connectors and Terminations
- Machines and Cold Runner Blocks designed for LSR/HTV/EPDM materials



Strategies for Success in Rubber and Silicone Injection Moulding



ISO 9001:2015
ISO 14001:2015
ISO 45001:2018

Kloeckner DESMA Machinery Pvt Ltd

Plot No.10, Road No.1, G.I.D.C., Kathwada,
AHMEDABAD 382430, India

Phone +91 79 6619 0000

Mail sales@desmaindia.com

Web www.desma.biz

Sales & Service : DELHI • HYDERABAD • PUNE • NASIK • CHENNAI