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From the Publisher's Desk

Timely Completion of Solar Energy Projects is Essential

Six years back, under the leadership of our respected Prime Minister Narendra Modi, India realised the efficacy of Solar Energy as the growth accelerator of the sustainable future. When the international pressure was mounting for phasing out fossil fuels by 2050 globally, India was not at all near the periphery of the era of fossil-fuel-free power generation. That time, in an interview, the ex-Environment Minister of India Jairam Ramesh said, "India is certainly under the international gaze because its coal consumption is expected to go up three times at a very minimum over the next 15 years, and this has understandably caused a lot of concern." However in February this year, an analysis by energy think tank Ember revealed that India's coal-fired electricity generation fell 5% last year due to significantly reduced annual electricity demand as a result of the COVID-19 lockdown. Ember's study also noted that the coal generation in India – the third-largest emitting country – was down by 8% in 2020 compared to 2018. But still the highly polluting fossil fuel remains the dominant source of electricity, generating 71% of the nation's power throughout last year. Ember's Senior Analyst Aditya Lolla noted: it seems increasingly likely that coal power will plateau in the 2020s in India, But he warned there is still a risk the country could be 'knocked off the course'. As per Lolla, "As India recovers from the COVID-19 pandemic shock, the choices it makes in the next decade will make or break its coal-to-clean electricity transition."

I completely agree with him. I feel, now, the authorities need to be much more vigilant on timely completion of the solar projects. Although, at present onshore wind and solar are the cheapest sources of energy, owing to our huge landmass and an average of 300 sunny days a year, harnessing maximum solar energy is easier and cost-effective for India.

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Frontec Heat Shrink

Some of Our Productlines:

- LT Jointing Kits
- 11 and 33 KV Terminations
- 11 and 33 KV Straight Joints

- Tap Off Connectors for AB Cables
- AB Accessories

- Anti-Track Tubing
- HS Components

- Jointing Services
- Consultancy & Troubleshooting

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In the past 30 years, Frontec has serviced several prestigious customers (both SEB's as well as large Private Contractors) in India. Frontec has the capability to customize and develop specialized shapes/sizes of Heat Shrinkable Products for and **exports several proprietary Heat Shrinkable Components** to key customers across the globe.

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- Fully Insulated Porcelain (MVT)
- Fully Insulated Silicon (SMVT)
- Shrouded Type (STOC)



Photographs (in clockwise order from top right)
1. Frontec STOC Typical installation
2. Frontec SMVT
3. Frontec Porcelain MVT
4. Frontec STOC
5. Installed MVD, Kandighat
6. Typical installation use for Tap Off Connectors



KEY FEATURES

MVT and SMVT connectors offer a safe and fully insulated method for loop in/loop out from AB cable networks.
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CABLE JOINTING KITS

KEY COMPONENTS
Frontec manufactures all major HS components inhouse :

Anti-track Red Tubing
Good Insulation Thickness
Rain Skirts for Creepage
3 Finger Breakouts



Photographs (in clockwise order from top right)
1. Frontec Outdoor Termination Kit - 2019
2. Frontec Indoor Termination Kit - 2018
3. Frontec Straight Joint during installation
4. Frontec Indoor Termination - 2005
5. PILCA Straight Joint Installation - 1993
6. 33KV Termination being installed under supervision of Mr. Ashok Sengupta - 1979
7. Frontec Termination Kit at DLF Gateway tower - 2003



- Cable End Termination Kits
 - Straight Through Joints
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POWERGRID DEPLOYS SEVERAL CSR INITIATIVES IN THE LADAKH REGION

Power Grid Corporation of India Limited (POWERGRID), a Maharatna CPSU under Ministry of Power handed over one Vaccine Delivery van, twelve ice lined refrigerators and nine deep freezers to district administration of Kargil recently. On this occasion, Mohsin Ali, Executive Counsellor (Kargil) flagged-off the Vaccine Delivery van.

The items costing ₹29 lakhs have been handed over by POWERGRID under its CSR initiative. The vaccine delivery van shall benefit residents of far-flung areas of the UT and help in achieving greater vaccination drive. With the help of freezers, COVID-19 related and other vaccines, can be stored, preserved and transported easily. It will support to tackle logistic challenges of vaccine distribution in Kargil.



A view of the vaccine delivery van flagging-off ceremony...

POWERGRID is also supporting Ladakh region in rural electrification infrastructure in far flung villages under various schemes of Government of India like PMDP, DDUGJY where, in the Drass Tehsil of Kargil district one 66/11 kV Sub-station is being established, which will feed various adjoining villages and shall improve power availability. Under these schemes, POWERGRID is electrifying 23 villages costing ₹57 crore in Kargil district. Further, under PMDP scheme 66 kV power line network

will also be strengthened at a cost of about ₹30 crore.

In order to boost up the employment opportunity for local youth, POWERGRID has also planned special recruitment drive of junior engineers specifically from Ladakh region. It has also built a state-of-the-art 220/66 kV Gas Insulated sub-station at Kargil, which connects the region to the national grid. ❶

CABINET APPROVES REVAMPED DISTRIBUTION SECTOR SCHEME

The scheme aims to improve operational efficiencies and financial sustainability, by providing result-linked financial assistance to DISCOMs...

The Union Cabinet, chaired by the Prime Minister, Narendra Modi has approved a Reforms-based and Results-linked, Revamped Distribution Sector Scheme. The scheme seeks to improve the operational efficiencies and financial sustainability of all DISCOMs/ Power Departments excluding Private Sector DISCOMs by providing conditional financial assistance to DISCOMs for strengthening of supply infrastructure.

The assistance will be based on meeting pre-qualifying criteria as well as upon achievement of basic minimum benchmarks by the DISCOM evaluated on the basis of agreed evaluation framework tied to financial improvements. Implementation of the scheme would be based on the action plan worked out for each state rather than a 'one-size-fits-all' approach.

The scheme will have an outlay of Rs.3,03,758 crore with an estimated GBS from Central Government of Rs.97,631 crore. It is proposed that the currently ongoing approved projects under the Schemes of IPDS, DDUGJY along with PMDP-2015 for the Union Territories of Jammu & Kashmir (J&K) and Ladakh would be subsumed in this scheme, and the savings of their GBS (approx. Rs. 17,000 crore) would be part of the total outlay of the Revamped Distribution Sector Scheme under the existing terms and conditions till their sunset on 31" March, 2022.

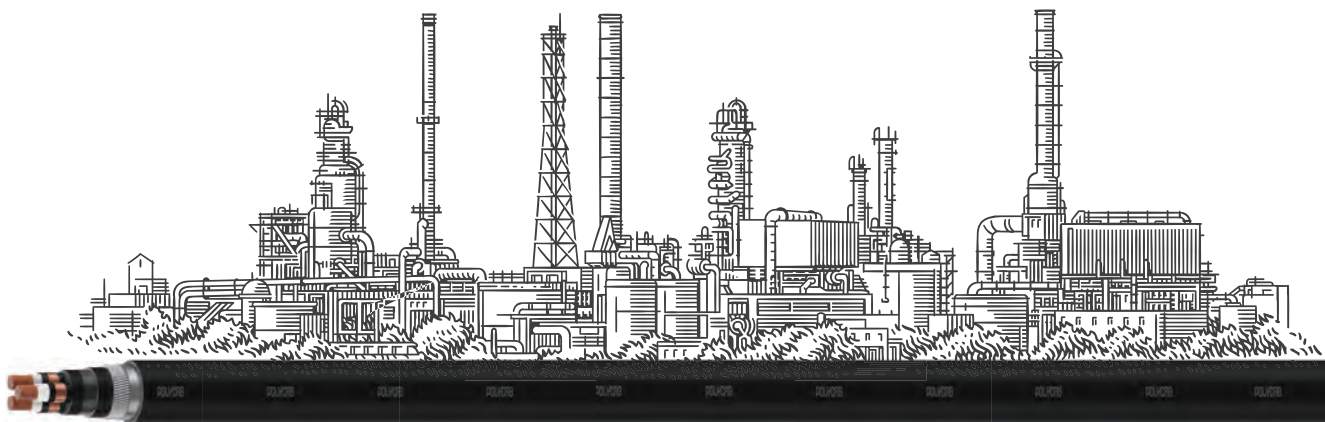
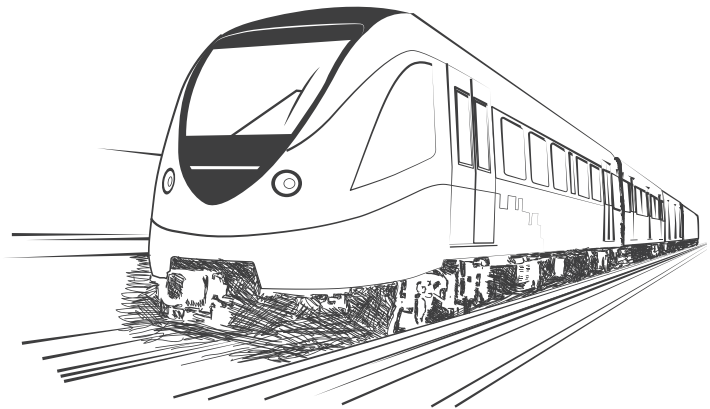
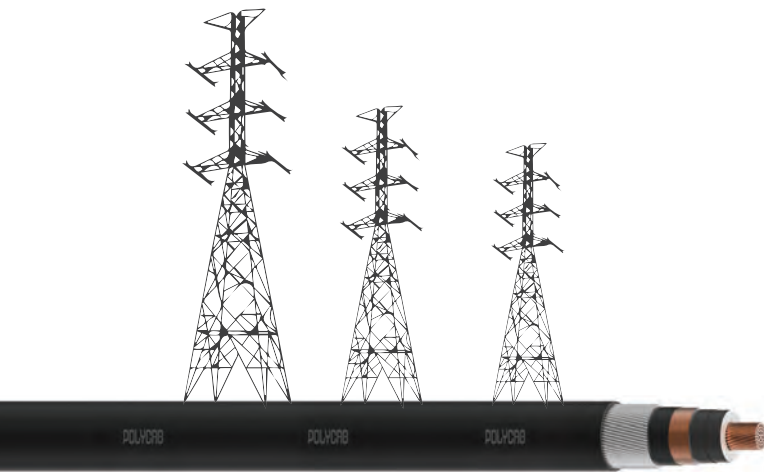
The funds under these schemes would be available for the identified projects under IPDS and for the approved ongoing projects under Prime Minister's Development Program (PMDP) for the Union Territories of J&K and Ladakh under IPDS and DDUGJY till 31 March, 2023. ❷



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CMPDI, CCL INK MOA FOR DEVELOPMENT OF SOLAR POWER PROJECTS

Recently, Central Mine Planning & Design Institute (CMPDI) and Central Coalfields Ltd (CCL), Ranchi have signed in an MoA (Memorandum of Association) for development of Solar Power Projects.

This MoA will open a new path for CIL in becoming a Net Zero Energy company. The MoA was signed by A. K. Singh, General Manager (E&M), CMPDI and V. K. Singh, General Manager (E&M), CCL. Also, this occasion was graced with the presence of S. K. Gomasta, Director (T/CRD/ES), CMPDI and Manoj Kumar, Regional Director, RI-III, CMPDI.

CMPDI is a Government of India enterprise having its corporate headquarters at Ranchi in India. The company is a fully owned subsidiary of Coal India Limited (CIL) and a Schedule-B company. It is a Mini Ratna (Category I) company since 2019. CMPDI and



A view of the MoA signing ceremony...

all its seven Regional Institutes have been granted the right and licence to be listed in the Bureau of Indian Standards' Register of Licencees of Quality Management System, in accordance with IS/ISO 9001:2015. Licence No: QM/L-5003433 dated 29th March 2017.

CCL (formerly National Coal Development Corporation Ltd) was one of the five subsidiaries of Coal India Ltd. Now, CCL has 62

Operative Mines (22 Underground & 40 Opencast Mines), 7 Washeries, 5 Coking Coal Washeries (Kathara, Rajrappa, Kedla & Sawang, Kargali) and 2 Non-Coking Coal Washeries (Piparwar & Giddi). The company also holds 1 Central Workshop (ISO 9001) at Barkakana, 5 Regional Repair/Workshops (3 w/s are ISO 9001) at Jarandih, Tapin North, Dakra, Giridih and Bhurkunda.

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NTPC DECLARES ITS ENERGY COMPACT GOALS TOWARDS SUSTAINABILITY

The largest power producer of India is also aiming at 10% reduction in net energy intensity by 2032...

NTPC Limited, India's largest power generating company under Ministry of Power has become the first energy company in energy domain in India to declare its Energy Compact goals as part of UN High-level Dialogue on Energy (HLDE). NTPC has set a target to install 60 GW of renewable energy capacity by 2032.

NTPC is among the few organisations globally to declare its Energy Compact goals. Further, NTPC has declared that it will form at least two international alliances or groups to facilitate clean energy research and promote sustainability in energy value chain by 2025.

The targets were unveiled in the recently held 'Ministerial Thematic Forums for the HDLE' event.

The commitment from NTPC has been made public on UN's website as well. United Nations is set to convene a high-level dialogue in September, this year to promote the implementation of the energy-related goals and targets of the 2030 Agenda for Sustainable Development.

NTPC has been taking various steps for increasing its green energy portfolio by adding significant capacities of Renewable Energy (RE) Sources. The company had earlier planned to have a minimum of 32 GW capacity through RE sources constituting nearly 25% of its overall power generation capacity by 2032. This development will prove to be huge boost for nation's largest energy producer that will catapult its position in the green energy map of the country.

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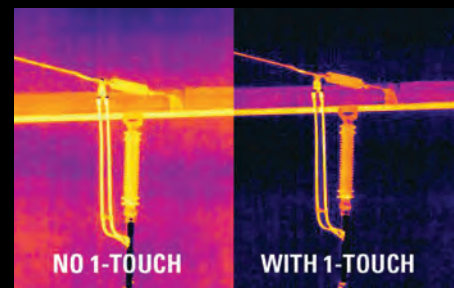
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HPL TO INSTALL SMART METERS IN PARTS OF DELHI

HPL Electric & Power Ltd., has received approval and production clearance from a leading Private Distribution Company for the implementation of NB-IoT based Smart Meters in parts of National Capital, Delhi. India's smart meter programme aims to replace 250 million conventional meters to help raise annual revenues of debt-laden electricity distribution companies. This project comes at the backdrop of world's largest electricity smart metering programme underway in India, aimed at cutting distribution losses.

HPL's new range of smart meters with Narrow Band-Internet of Things (NB-IoT) communications technology smart meters are both 4G and 5G compatible offering a dedicated channel for the smart metering and avoiding any reduction in performance from interference or



Gautam Seth, Joint MD, HPL Electric & Power

obstruction due to congestion on the public network. The new range of NB-IoT smart meters have been developed in-house at HPL's new R&D facility at Gurugram.

Detailing on the advanced technology being installed, Gautam Seth, Joint MD, HPL Electric & Power added, "NB-IoT is a new and cost-effective technology in 4G and 5G spectrum with fast deployment quality. With this technology, the interference and problems arising due to public network congestion will not hamper the performance of smart meter anymore as data will smoothly flow through a dedicated

channel. It will also enable more number of remote meter readings possible thereby ensuring the safety of the consumers during pandemic times. This new launch will further strengthen our position as a leading smart meter manufacturer in the country." 

RENEW POWER STEPS FORWARD FOR NEW ENERGY STORAGE SYSTEM TECHNOLOGY DEVELOPMENT

ReNew will benefit from its association with StorageX as the initiative will leverage the resources of partners to overcome barriers in energy storage...

ReNew Power (ReNew), one of India's leading renewable energy companies, has recently collaborated with the Precourt Institute for Energy at Stanford University and its StorageX Initiative (StorageX). StorageX is an academic-industry-government initiative that aims to solve the most pressing real-world challenges in battery storage. ReNew's collaboration with StorageX will focus initially on challenges surrounding grid level battery usage and performance in India, with an eye toward optimizing the performance of storage assets, and ultimately driving stable and firm power delivery to the grid.

ReNew will participate in StorageX through the Stanford Energy Corporate Affiliate (SECA) program, which facilitates interactions between organizations and Stanford faculty and graduate students across

the full range of energy-related topics. Through its membership in the SECA program, the company will have access to world-class research and opportunities for collaboration on research, education and training.

Speaking about the affiliation, Founder, Chairman and CEO of ReNew Power, Sumant Sinha said, "The collaboration with Stanford's StorageX Initiative will broaden ReNew's field of vision and help us in recognizing promising new technologies quickly.

Reliable renewable power generation in India is critical to meeting the government's goal of putting 450 gigawatts of renewable power online by 2030. ReNew is proud to work with Stanford's Precourt Institute for Energy in ensuring that economical and efficient energy storage technologies become critical in reducing the intermittency of renewable power in countries around the world." 

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INDIA'S LARGEST SOLAR CARPORT INAUGURATED AT TATA MOTORS' CAR PLANT

Tata Motors and Tata Power have jointly inaugurated India's largest grid-synchronized, behind-the-meter solar carport at the Tata Motors car plant in Chikhali, Pune. The 6.2 MWp solar carport deployed by Tata Power will generate 86.4 lakh kWh of electricity per year and is estimated to reduce 7,000 tons of carbon emissions annually and 1.6 lakh tons over its lifecycle. Spanning over 30,000 square meters, this carport will not only generate green power, but will also provide covered parking for finished cars in the plant.

Envisioned as part of its net zero carbon goal for 2039, Tata Motors had entered into a Power Purchase Agreement (PPA) with Tata Power on August 31, 2020. Despite the challenges of COVID-19, both companies successfully managed to develop this massive carport



A view of the carport inaugural function...

infrastructure in a record time of 9.5 months.

Speaking on the occasion, Shailesh Chandra, President, Passenger Vehicle Business Unit, Tata Motors said, "We have always been conscious of the need to conserve energy and are committed towards achieving 100% renewable energy source for all our operations."

Commenting on the partnership, Dr. Praveer Sinha, CEO & MD, Tata Power, said, "As One Tata initiative, we are proud to partner with Tata Motors and inaugurate India's largest solar carport. Our partnership is a testament to our collective efforts to lower the carbon footprint and provide innovative and future-focused green energy solutions. We will continue to explore new ways to harness clean resources and offer them to our partners and customers."

SUZLON'S NEW 252 MW WIND POWER PROJECT TO COME UP IN GUJARAT

The S120-140m WTGs feature the Doubly Fed Induction Generator (DFIG) technology that efficiently integrates wind turbines into the utility network...

Suzlon Group has received a new order for the development of a 252 MW wind power project from CLP India. Suzlon will install 120 units of S120-140m Wind Turbine Generators (WTGs) with a Hybrid Lattice Tubular (HLT) tower, with rated capacity of 2.1 MW each. The project is located in Sidhpur, Gujarat and is expected to be commissioned in 2022. The company will execute the project with a scope of supply, foundation, erection and commissioning. It will also provide comprehensive operation and maintenance services post commissioning.

Commenting on the project, Rajiv Ranjan Mishra, Managing Director, CLP India said, "Our Wind Energy Project in Sidhpur, Gujarat is our largest renewable project at a single site. It is a testimony

of our commitment towards India's renewable goals. We are pleased to partner with Suzlon, given their technologically advanced products, EPC capabilities, operations and maintenance services."

Speaking on the order win, Ashwani Kumar, CEO, Suzlon Group, said, "This is the first big order that we have announced post our debt restructuring closure in line with our plans to restart business operations and lead the Indian Wind Energy market from the front. We are seeing an increased interest from all our stakeholders and customer segments to invest in renewable energy. Suzlon's expertise in the Indian Wind Energy Market over the last 25 years offers convenience and reliability to customers for setting up wind power projects in India's varied wind regimes."

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CS WIND TO ACQUIRE VESTAS' PUEBLO TOWER FACTORY

Vestas has signed an agreement with CS Wind for the acquisition of Vestas' tower manufacturing facility in Pueblo, Colorado. The aim of the agreement is to allow the factory to be run by a company specialised in tower manufacturing and hereby enable increased volume as well as sustained local job creation by extending tower production to multiple wind turbine manufacturers, including Vestas.

As a part of the agreement, Vestas will secure an agreed upon volume of the tower factory's output to secure domestic supply for the North American market. In addition, CS Wind will expand offerings to include manufacturing of towers for other wind turbine manufacturers through a multi-brand strategy, as well as continue the ongoing Vestas investments and initiatives to reduce CO₂-emissions.



Tommy Rahbek Nielsen

"Across our global supply chain footprint, we are involving more partners to build on the foundations we have established for wind energy. This includes honing our own resources to where they can be most effective and transferring parts of our operational setup to be run by other industry leaders who can create more value and secure additional long-term jobs. I'm

therefore very excited about the agreement with our long-term partner CS Wind to expand our cooperation further, which can help grow and mature the supply chain in Colorado," says Executive Vice President and COO Tommy Rahbek Nielsen.

Established in 2009 as the world's largest tower manufacturing facility, the Pueblo factory today employs more than 500 people and manufactures over 3,000 tower segments a year. E1

TWO COMPANIES WORKING TOGETHER ON DEVELOPING NEW TYPE OF GIS

The establishment of a system for mass production and commercialization of the product will follow by the end of March 2023...

Toshiba Energy Systems & Solutions Corporation (Toshiba ESS) and Meidensha Corporation (Meidensha) have been collaborating since 2020 on the joint development of Gas Insulated Switchgear (GIS) for 72kV/84kV using a natural origin gas that contains no sulphur hexafluoride (SF₆) at all, and have now decided to accelerate the development and commercialization of this GIS due to higher demand for environmentally friendly products in the market. Specifically, the two companies plan to complete type tests to confirm performance in line with international standards by March 2022.

The GIS under joint development uses a Vacuum Circuit Breaker (VCB) for high-current interruption and dry air for the main circuit insulation of the

equipment and for the current switching parts of the disconnect and earthing switches to ensure insulation performance and high-current interruption capability. Toshiba ESS will be responsible for the entire GIS, while Meidensha will be in charge of the development of the main component, the VCB.

Commenting on the combined work, Koji Saito, Director, Vice President of the Grid Aggregation Division of Toshiba ESS said, "We are very proud of this joint development with Meidensha. We have a great deal of expertise in the development of GIS products as a whole, including the 72 kV GIS launched into a commercial operation firstly in Japan in 1969. On the other hand, Toshiba ESS has been developing SF₆ alternative technologies for more than 15 years." E1



Integrated Transformer Testing Solutions

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Transformers Loss Measuring System

Step-Up Transformers

Capacitor Bank

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**HIGH VOLTAGE
TEST & MEASURING
SOLUTIONS**



HV PD Test System

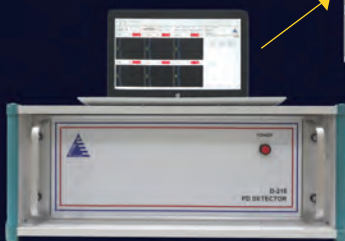


Impulse Voltage Test System



58.73 kV	49.8 Hz	99.9 pF	0.00021
4.74 mA	1.03 mA	0.2 mV	1.7 kV

**C, L & Tan Delta
Test Set**



58.73 kV	49.8 Hz	99.9 pF	0.00021
4.74 mA	1.03 mA	0.2 mV	1.7 kV

**Multi-channel Partial
Discharge Detector**

APPLICATIONS

Routine and Type Test Equipment for the testing of:

- ❖ Power Transformers
- ❖ Instrument Transformers
- ❖ HT Cables
- ❖ HT Switchgear
- ❖ Motors & Generators
- ❖ Epoxy Components

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GE'S TECHNOLOGY TO ACCELERATE ENERGY TRANSITION IN AUSTRALIA

GE's latest customer pilot project utilizing its gas turbine technology will power Australia's first dual-fuel capable natural gas/hydrogen power plant at the Tallawarra B Power Station in New South Wales (NSW). The project aims to accelerate the energy transition in Australia using gas that can be further decarbonized by using hydrogen and hydrogen-blended fuels.

Energy Australia has ordered one of GE's 9F.05 gas turbines to power the Tallawarra B Power Station to enhance the reliability of the energy grid and help ensure NSW energy consumers have continued access to affordable, reliable, and sustainable power prior to the closure of the Liddell coal-fired 1,680-megawatt plant located in the Hunter Valley region in 2023. The power



The proposed Tallawarra expansion...
Image Courtesy: Energy Australia

plant will operate with high operational flexibility as a 'peaker' plant – firing up rapidly when needed to stabilize the power grid during demand peaks – and it will utilize partial loads of hydrogen to decrease its carbon emissions footprint.

The 316-megawatt (MW) Tallawarra B Power Station will be built by a consortium with the Engineering, Procurement

and Construction (EPC) company Clough and will be adjacent to EnergyAustralia's existing Tallawarra A 435 MW gas plant, located in Yallah on the western shore of Lake Illawarra in the state of NSW – approximately eight miles southwest of the city of Wollongong. The NSW State Government and Australian Federal Government contributed AU\$83 million to support the financial close and support the use of hydrogen. **ET**

MAN ENERGY IS BECOMING THE MAIN OWNER OF H-TEC SYSTEMS

H-TEC SYSTEMS was founded in 1997 and has over 20 years of experience in hydrogen development and research...

MAN Energy Solutions is increasing its share in H-TEC SYSTEMS to almost 99%. The acquisition of the shares, which will remain held in free float, has been agreed. The company already gained a 40% stake in H-TEC SYSTEMS in 2019. The now-completed acquisition of the shares from the previous majority shareholder, GP JOULE, was already agreed in the past year. The parties have agreed not to disclose the price of the acquisition. The now-complete transaction was, until now, subject to approval by the competition authorities.

GP JOULE, the Schleswig-Holstein-based group that operates in the renewable energies sector, acquired H-TEC SYSTEMS in 2010. Frank Zimmermann, spokesman for the board of management at H-TEC

SYSTEMS, thanked them for their successful collaboration in recent years. He said, "GP JOULE recognized the potential of H-TEC SYSTEMS at an early stage, and placed their trust in green hydrogen for a future with renewable energies. This leading edge can be seen in our leading electrolyzers."

With the acquisition, MAN Energy Solutions is completing its range across the hydrogen value chain – and is further aligning its business towards a range of solutions for decarbonisation. Dr. Uwe Lauber, Chief Executive Officer at MAN Energy Solutions, said, "Starting with extraction and transport, right through to the use of climate-neutral energy, we offer our customers solutions for using green hydrogen, and are therefore strongly positioned in one of the most important future markets." **ET**

S. SADHUKARAN BECOMES THE NEW ADDITIONAL DIRECTOR, MD & CEO OF SEIL



He has 25 years of experience in multiple industries and cultural environments...

The Board of Directors of Schneider Electric Infrastructure Ltd. (SEIL), a company engaged in the business of manufacturing, designing, building and servicing technologically advanced products and systems for electricity network, has appointed Sanjay Sudhakaran as Additional Director, Managing Director and Chief Executive Officer (CEO) for five years from May 1 this year. He was functioning as the Vice President of Schneider Electric's Digital Energy Division.

Sudhakaran is associated with

the Schneider Group since 2019, and holds a vision stemming from a deeply embedded belief that 'what is right for the environment is right for all stakeholders'. Throughout his career, he has aimed at contributing to building a sustainable and efficient ecosystem.

Prior to joining Schneider Electric, he worked in positions like: Regional Director for ASEAN, Managing Director India & APAC Marketing Director in other global corporations that are into buildings solutions, automation and efficiency. 

J. GAY TO BE THE CHIEF EXECUTIVE OFFICER OF VANGUARD



Under his leadership, Energy Recovery more than quadrupled its equity value...

Vanguard Renewables, the U.S. leader in organics to renewable energy, has recently appointed Joel Gay as its Chief Executive Officer. Prior to joining Vanguard Renewables, Gay was President and CEO of Energy Recovery, a global manufacturing and technology company serving multiple industrial markets.

Commenting on Gay's appointment, George Polk, Chairman of Vanguard Renewables, said, "Vanguard is in the midst of an aggressive expansion

plan to deploy more than 100 new anaerobic digester projects across 30 states, representing nearly \$2.5 billion of digester facilities. As the scale of the business grows, our team is expanding to include some of the most talented project developers and operators in the industry. Joel is an accomplished, results-driven leader, with the proven ability to inspire growing teams and businesses to reach new heights. I am very excited for Joel to lead Vanguard Renewables forward." 

A. CLAYTON TAKES OVER AS NON-EXECUTIVE DIRECTOR OF NXP SEMICONDUCTORS N.V.



She also led Dell Inc.'s supply chain transformation...

NXP Semiconductors N.V. has recently declared that Annette Clayton has been appointed as a Non-executive Director of their Board of Directors, effective from May 26, 2021. Her appointment was overwhelmingly approved in the latest Annual General Meeting of Shareholders of the company.

Clayton is the Chief Executive Officer and President of Schneider Electric North America, the largest operating region of Schneider Electric, a multinational firm specializing in energy management and

industrial automation solutions. Prior to Schneider Electric, she served in executive leadership roles at Dell and General Motors. Clayton also chairs the National Electrical Manufacturers Association (NEMA, USA) and is in the Board of Director for the National Association of Manufacturers.

NXP Semiconductors N.V. enables secure connections for a smarter world, advancing solutions that make lives easier, better and safer. The company secures connectivity solutions for embedded applications. 

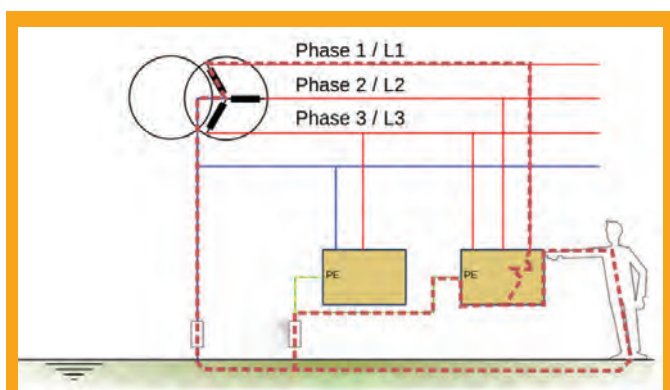


GROWING DEMAND FOR EARTHING EQUIPMENT

Owing to several positive changes in India, the demand for earthing equipment is bound to grow in our country in the near future. However, as the big projects and the new electrical product development works are going slow because of the COVID pandemic, it may be delayed...
- P. K. Chatterjee (PK)

When a live wire is joined with a properly grounded, deep & wide enough metal piece, the brunt of the high voltage directly reaches the ground without causing any damage to the people and property around. Thus, earthing plays perhaps the most important role to ensure electrical safety both inside and outside the premises.

Traditionally earthing is done in two ways. It may be a Metal Plate type earthing or a Metal Pipe type earthing. Although it is the most essential system as far as the electrical safety is concerned, especially in the residential sector it is often given less priority, which causes many small or big (avoidable) accidents.



Description of the phenomenon of electrocution...

Any electrical equipment or system or circuit needs proper earthing that will provide a low resistance path for dissipation of current into the earth. In the power generation, transmission and distribution segments also, where safety is the topmost priority, special attention is paid on proper earthing. If the leakage or excess current does not get an easier way to reach the earth, ultimately it makes its own way through the human body and one or more persons are electrocuted. Thus, improper earthing or grounding is always harmful. However, the awareness is growing in this field and the earthing equipment market is showing a positive growth trend.

The future of the earthing equipment market

According to a recent study published by Market Research Future (MRF), a part of WantStats Research And Media Pvt. Ltd., “Earthing system is a process of connecting through a metal link between the body of any electrical appliance, or neutral point to the deeper ground soil. It transfers the electricity directly to the earth plate by low resistance electrical cables. The metal link is normally of MS earthing flat, CI earthing flat, GI earthing flat which should be penetrated to the ground earth grid. Earthing equipment are devices that include fuses and residual current devices, low voltage earthing kits that aid in reducing the risk of electric shock from uninsulated metal parts of electrical devices and others.

The global earthing equipment market is anticipated to witness sustainable growth in the upcoming years which is attributed to the rise in demand for alternative energy sources, and rapid growth of the construction industry in emerging economies such as China, India and other

South Asian countries. Moreover, the earthing equipment is also expected to experience rapid growth which is attributed to rise in the consumer electronics industries, across the globe. The growth in the demand for earthing equipment in the developing economies of Asia-Pacific and Latin America has pushed manufacturers to expand their distribution network. The consumer electronics industry has witnessed improved sales volume in India, which is largely driven by increasing population, coupled with rising disposable income levels.

Factors such as growing construction activities coupled with increasing government investment in infrastructure development; especially in emerging economies, has led to the tremendous growth of the earthing equipment market.

Hence, the global earthing equipment market is expected to witness a CAGR of around 5.5% over the forecast period. However, fluctuating cost of raw materials hampers the growth of earthing equipment market.”

Growth boosters

As per the MRFR report, there are several factors that are fuelling the global earthing equipment market share. Some of these entail the growing need for alternative energy sources, rapid growth of the construction industry in emerging economies including India, China, & other South Asian countries, growing construction activities, rising government investments in infrastructure development in emerging economies, rapid industrialization, growth in the construction industry, and increasing construction of residential and commercial buildings, railway tracks, manufacturing plants, tunnels, and roads in developing nations.

The additional factors adding to the global earthing equipment market value include the growing need for efficient earthing equipment, increasing use of smart devices like refrigerators and televisions that need constant earthing, the increasing product demand from automobile manufacturers and reconstruction of existing power grids. Besides, several technological advances like integration of consumer electronics with Internet of Things (IoT) and artificial intelligence are the latest earthing equipment market trends.

Global earthing equipment market: regional analysis

The report (MRFR), “Earthing Equipment Market

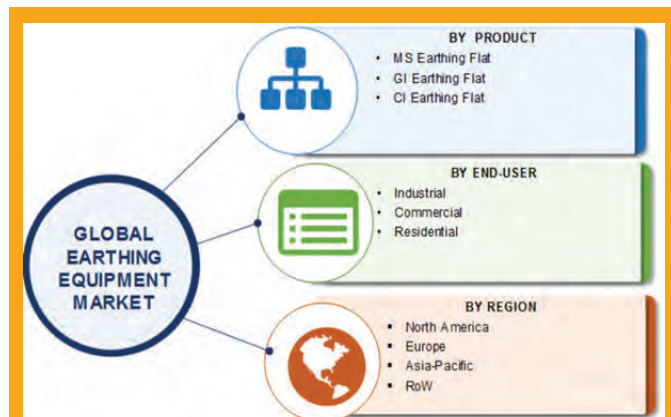
Research Report, By Product (MS Earthing Flat, GI Earthing Flat, and CI Earthing Flat), End-User (Industrial, Commercial, and Residential) and Region — Global Forecast till 2027” also states, “Geographically, the global earthing equipment market is segmented on the basis of region into North America, Europe, Asia-Pacific, and Rest of the world (RoW). North America held the largest share in the earthing equipment market. The market in this region is majorly driven by technological advancements in the electrical equipment industry. US is projected to be the largest consumer of earthing equipment and accounted for the largest market share in terms of value and volume among all countries in the North American region. Leading earthing equipment manufacturing companies such as Emerson Electric, GE, and Harger Lightning & Grounding are based in this region.

However, Asia-Pacific is anticipated to witness maximum growth rate over the forecast period. While majority of the companies are based in the US, the Asia-Pacific region has witnessed an overwhelming increase in the demand for earthing equipment market. Companies based out of the US are now setting up operations in countries such as India and China, which offer tax benefits and reduced manufacturing costs.”

Global earthing equipment market: segmentation

As MRFR notes, “By product, the global earthing equipment market is segmented into CI earthing flat, GI earthing flat, and MS earthing flat. Of these, the CI earthing flat will lead the market over the forecast period for the rise in industrial construction projects.

By end user, the global earthing equipment market is segmented into residential, commercial, and industrial.



Source: MRFR Analysis

Of these, the industrial segment will dominate the market over the forecast period for the expansion of the industrial sector in India and China. These countries have expanded their manufacturing capabilities in the last decades to cater to the growing need for electronic goods and services.”

The flip side

On the flip side, as MRFR points out, “Fluctuating prices of raw materials, high price and changes & absence of standards for product design may limit the global earthing equipment market revenue over the forecast period.

Also, the global earthing equipment market has faced the brunt of the COVID-19 outbreak. This is owing to several factors such as supply chain disruptions, demand share fluctuations, the economic outcomes of the pandemic, and the instant as well as future impact of the global crisis due to physical distancing trends and lockdowns imposed by the government all across the world have all affected the market growth negatively. However following relaxation of the lockdown in some parts the market is likely to return to normalcy soon.

The global earthing equipment market is fragmented and competitive due to the presence of different international as well as domestic industry players. They have incorporated an array of strategies to remain at the vanguard and also cater to the burgeoning requirements of the customers, including collaborations, contracts, partnerships, new product launches, geographic expansions, joint ventures and more. Additionally, these players are also making huge investments in various research and development activities for strengthening their portfolios as well as creating a hold in the market.

Conclusion

As the impressive report by Market Research Future indicates – the Indian market for earthing equipment is bound to grow. With the country’s pledge for ‘Make in India’ indigenous production of different kinds of electrical equipment are to be started here soon. Also, because of our achievement of cent per cent electrification, and drive for renewable power generation (in many cases decentralised) the use of electrically operated equipment will grow to a large extent in the coming days. Naturally, the demand for earthing equipment in India will also grow manifold.

TOWARDS WORLD'S FIRST AMMONIA-FIRED TURBINE SYSTEM

Mitsubishi Power is working to reduce environmental impact through the development of high-efficiency power generation technologies...

Mitsubishi Power, a subsidiary of Mitsubishi Heavy Industries (MHI) Group, has commenced development of a 40-megawatt (MW) class gas turbine that is fueled by 100% ammonia (NH_3).

The project was started in response to the increasing global focus on decarbonization. As firing of ammonia produces no carbon dioxide (CO_2), carbon-free power generation is achieved. Going forward, after combustion and other testing, Mitsubishi Power is targeting commercialization in or around 2025.

When achieved, it will mark the world's first commercialized gas turbine to make exclusive use of ammonia as fuel in a system of this scale, and will aid in the promotion of decarbonization of small to medium-scale power stations for industrial applications, on remote islands, etc.

The status quo

Until now, Mitsubishi Power has pursued technological developments enabling a transition from natural gas fuel used in Gas Turbine Combined Cycle (GTCC) systems, which currently emit the lowest amount of CO_2 among thermal power generation systems, to hydrogen, which emits no CO_2 . In tandem with pursuing active use of ammonia, the company has also been developing a system in which the waste heat from a gas turbine reconverts ammonia into hydrogen and nitrogen for use in hydrogen gas turbines.

Developing a method for directly combusting ammonia will further expand Mitsubishi Power's lineup of carbon-free power generation systems. A challenge needing



H-25 Series gas turbine...

to be addressed with direct combustion of ammonia is the production of nitrogen oxide (NO_x) caused by oxidation resulting from the combustion of the nitrogen component of the fuel. Mitsubishi Power is aiming to resolve this issue through commercialization of a gas turbine system that combines Selective Catalytic Reduction (SCR) with a newly developed combustor that

reduces NO_x emissions, for installation in the company's H-25 Series gas turbines (output: 40MW class), which has a rich operational track record spanning the globe.

Why ammonia?

Ammonia, which is a compound consisting of hydrogen and nitrogen, is a highly efficient hydrogen carrier, and it can also be directly combusted as fuel. In recent years, attention has begun to focus on ammonia from two perspectives: achieving carbon neutrality through transition to a hydrogen society, and minimizing environmental impact caused by existing energy modes. Expectations are held that early introduction of ammonia-based power generation equipment at power companies and Independent Power Providers (IPPs) will promote ammonia's future use as a carbon-free fuel.

The future plan

Going forward, Mitsubishi Power will work to advance the energy transition as a member of MHI Group. By prioritizing its resources into expanding its gas turbine power generation and other efficient, environmentally friendly generation technologies, the company will contribute to the stable supply of power, indispensable to global economic development, and the protection of the environment through the promotion of decarbonization. 

DESIGNING A SOLAR POWERED BOAT

This article attempts to draw attention on using solar energy for boats. It has systematically given the methods to design a solar-propelled and managed boat...

The aim of this article is to design a Solar Powered Boat for transport or tourists along the coast, in rivers, in the lakes to promote clean energy. In order to do this, a boat solely powered by electricity captured through solar energy will be designed for tourists or transport – and we'll explore solar energy applications for marine vehicles rather than using traditional combustion engines.



The fuel crisis nowadays really brings anxiety to people who are using fuel engines like cars, boats and motorcycles. This crisis cannot be taken lightly because many people are affected with the current fuel depletion and unstable price. Many innovations made were made for overcoming this problem – such as hydrogen, electric car, Natural Gas Vehicle (NGV). Most of them focus on automobiles like cars. What about boats? Is there any innovation on this? The answer is ‘yes’, currently many innovations for this transportation are based on solar power and this innovation has started a long time ago. A solar power boat consists of solar

panel, battery and electric motor. Based on this idea that leads to this article, it might give an answer to boat users on how they can reduce fuel dependency. A solar powered boat is an electrical boat with clean engine that uses either AC or DC motor. On the seas and inland waters as well as along their banks there are only a few connections to public electricity mains.

Literature Review

Yirebong S. Apkaba et al.: The author wrote that over the past few decades, the need for environment preservation consciousness and awareness has been developed worldwide, so he stated that, solar energy

is prodigious renewable energy source, which has enormous energy existing as heat and light, convertible into electricity.

The authors research project is based on modeled Solar Power Tour Boat, code named 'JJUYS01'. The boat is powered by energy processed from solar by minimizing environmental pollution and fuel cost. However, adverse weather conditions, backup power system integrated with the photovoltaic cell drives the boat to make the system more self-sustaining and reliable.

In lieu of the global demand of green technology, it is clear that solar electric boat propulsion is an effective solution, which reduces CO₂, NO₂ and SO₂ emission etc. The overall output of the project is to present a model for zero pollution system.

Shinde D. Tukaram et al.: In this paper, research directed towards importance of availability of uses of solar energy with an example. He found alternative to save conventional energy using solar energy. Author explored the solar application as an example of electric boat and solar boat.

The ordinary boat uses diesel fuel to run the generator of the boat, so found the use of new alternative energy to substitute the requirement of fuel. The solar electric boat is one of the alternatives that can possibly solve this problem. The solar electric boat cannot be used at night because of lack of sun light. However, this problem can be solved using rechargeable batteries that can supply power to electric motor of the solar boat during night.

Ahmad Nasirudin at el.: This paper presents a methodology to design a solar boat with the aim to determine the size of photovoltaic system with minimum cost.

Two stage optimization procedures have been proposed. First stage is simplified ship size optimization based on the existing ship design for obtaining minimum propulsion power by using golden search section algorithm. Second stage is optimization of PV system size for obtaining the no of photovoltaic (PV) module and battery with minimum cost by using simplex algorithm.

Comparing the existing ship, the optimum ship gives higher PV power and smaller battery capacity, which means that the optimum ship utilizes the more solar energy that and reduces the dependency to grid energy.

Eyad Al Samadi et al.: This paper describes solar energy systems for boat, encompassing novel Water Piston Engine Propulsion.

The primary source of power is solar energy that powers an air compressor whose compressed air is used in the novel engine. The propulsion system is based on the novel engine called Water Piston Engine.

George J. Tsekouras et al.: The author explored "simplified method for the assessment of ship electric power systems' operation cost reduction from energy storage and renewable energy sources integration."

Worldwide concern about air quality and green house emission has led to stricter regulations in ship building industry. The large variety of plant components enables conformity with ship energy efficiency directives, not attainable from each component alone.

Design Specifications of Solar Boat

The design specifications of solar boat is segregated such as; a) Mechanical System Design b) Electrical System Design.

Mechanical System Design

- Area of boat = 5.20 m x 2.30 m = 11.96 = 12 m².
- Area of Solar Panel = 12 m * 0.70 m = 8.4 m².
- No. Persons = 20 = 2000kg
- Weight of Each Panel = 18kg
- Weight of Each Battery = 20kg
- Weight of Empty Boat = 500kg including weight of the and allied structures.
- Weight of Seating Arrangement = 3kg x 20 = 60kg
- Steel Structure / Miscellaneous = 500kg
- Inverter Weight = 50 kg

Total Weight of the Boat = 4874Kg or 5 tonne

Electrical System Design

The electrical system is shown Fig.1. to drive the

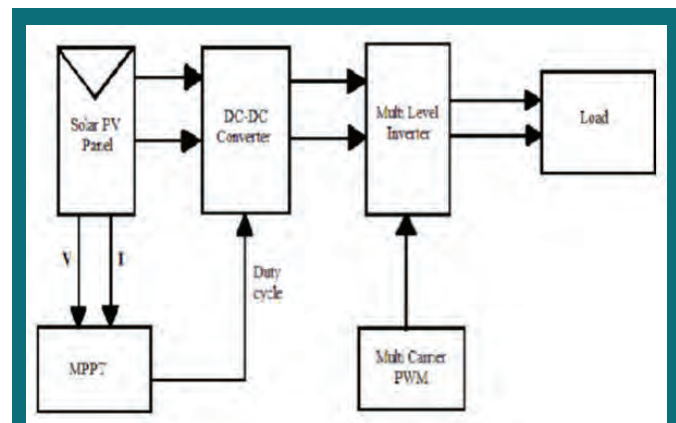


Fig 1.Block Diagram of Solar System...

electrical load i.e. motor and lighting load, solar panel has to supply the required power for load. The electrical DC power supplied to inverter through charge controller and Maximum Power Point Tracking (MPPT) module.

The electrical system is designed as per specifications initiated from load side i.e. electrical load to solar panel.

Electrical Load

- A motor Load -20000W = 20kw = 26HP
 - Lighting Load – 2000W = 2kW
 - Miscellaneous Load – 1000W = 1kW
- Total Electrical Load = 23000W = 23kW
- Working Hour of Ship 6 Hrs / Day
- Energy Required for Ship = Power x Hrs/day
= 23kW x 6Hrs/Day
= 138 kWh / Day

Inverter Sizing

Assume Losses = 20% = 0.2

- Inverter Loss = 138*0.2 = 27.6 kWh / Day
 - Input to Inverter = 27.6 + 138
= 165.6 kWh / Day
 - Inverter Sizing = Total Load Power = 23 kW
- Inverter = 25 kW 25 kVA Selected
- Battery Output = Inverter Input
 - Input To Inverter = 138 + 27.6 = 165.6 kWh / Day

Assume –Depth of Discharge (DOD)

Battery Specifications Selected:

12V, 240Ah

DOD = 0.5 for -----Lead Acid

DOD = 0.9 for -----Li-ion

Battery Storage = 165.6 / 0.5 = 331.2 kWh/Day

Battery Storage = 165.6 / 0.9 = 184 kWh/Day

Li-ion Battery is selected for Marine Applications.

- No. of Batteries Required = Battery Storage / 2.4 = 184 / 2.4 = 76.66

No. of Batteries Required 77

For One Day Storage 77 batteries are required

Assume Battery Losses -15%

- Input To Battery = 165.6 x 0.15 + 165.6
= 190.44 kWh/Day

Miscellaneous Sizing

Assume Losses in Electrical Circuits - 4%

Losses Electrical Circuits = 190.44 * 0.04 = 7.61 kWh/Day

Panel Sizing -

- Panel Output = 190.44 + 7.61 = 198.05 kWh/Day
- Assume Panel Losses – 25% (Dust & Temperature)
- Losses in Panel = 198.05 * 0.25 = 49.51 kWh/Day
- Energy Generated by Solar Panel = 198.05 + 49.51

= 514.08

~ 247.56 kWh/Day

- Assume Solar Radiation = kWh / Day = 5.5 kWh/m² / Day
 - Power of Solar Panel = 247.56 / 5.5 = 45.01 kW
 - Suppose We take 250W Panel –Standard from Market
- No. of Panels = Power of Solar Panel / 250
i.e. 4500/250 = 18

Motor Selection

Brushless DC motor or BLDC motor or PMDC motor (the permanent magnet DC motor), it can provide much more efficiency than the other traditional DC motor. For marine applications PMDC motor is selected by taken into consideration of its numerous advantages.

Applications

- For Tourist Transport
- For Light Weight Material Transportation.

Advantages

- They are Environmentally-friendly.
- They are Cost-efficient.
- They Eliminate Sound Pollution.
- They Continue Charging.
- They eliminate the emission of hazardous gases.
- They have a Relatively Less Environmental Impact.
- They are Highly Reliable.

Conclusion

Over the past few decades, the need for environment preservation consciousness and awareness has been felt worldwide. Solar energy is a prodigious renewable energy source, which has enormous energy existing as heat and light, convertible into electricity.

This article has presented the practical aspects of mechanical design as well electrical design more accurately and precisely.

©



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“ALUMINIUM IS THE METAL OF THE FUTURE FOR THE ELECTRICAL SECTOR...”



*Vedanta Ltd. is the largest aluminium producer in India with a capacity of 2.3 MTPA. The company holds 40% market share in India's aluminium industry. It is also the largest manufacturer of wire rods globally. In an exclusive e-interview, **Ajay Kapur, CEO – Aluminium & Power Business and MD – Commercial** reveals several facts on the advantages of using aluminium in power sector to **P. K. Chatterjee (PK)** from **Electrical India**. Excerpts...*

How is the demand of aluminium growing in the (electric) power industry?

Affordable, reliable, and clean energy will be a key enabler in realization of India's vision of a USD 5 trillion economy. According to the International Energy Agency, India is the world's third-largest energy consuming country, due to rising population, rising incomes, and improving standards of living. From sustainably leveraging large-scale coal reserves for power generation, to ensuring energy

access to all corners of the country, institutionalizing quality controls for energy efficient machines and consumer goods, and investing in and harnessing substantial solar or other forms of renewable energy, India's post-COVID recovery phase is going to be a very dynamic period in its energy development.

High structural strength, light weight, good conductivity, high ductility, and non-magnetic properties have made aluminium and its alloys indispensable for the power industry. The major areas of application include cables, busbars, overhead transmission lines, motors, foil windings, electrolytic capacitors, heating elements, heat sinks, and many more. India is currently the largest consumer of aluminium based wires and cables, excluding China, with an annual consumption of 1.2 million tonnes of aluminium wire rods. India's per capita consumption of aluminium in the electrical sector is at 0.9 kgs, while the world average is about 1.3 kgs. Vedanta's Aluminium Business is the world's largest producer of aluminium wire rods, ex-China, catering almost exclusively to the power industry.

What are the major causes behind such uptake?

The three pillars of economy, population, urbanization, and industrialization shall keep India at the heart of global energy system. Key factors that shall drive the electrical sector, and consequently the consumption of aluminium in the sector, are:

- Increased migration into cities and urbanization, which will require increased construction and infrastructure to ensure availability of essential utilities to people.
- Procurement of electrical appliances, air conditioning

units and other white goods, as necessities of modern life.

- Between 2021-26, the Indian government has planned an investment of USD 2.15 billion to electrify rural households, bolstering the country's power transmission network.
- The Government also plans to double the share of installed electricity generation capacity of renewable energy to 40% by 2030.
- The Electric Vehicle (EV) segment is to significantly drive demand for electricity (and consequently, electrical infrastructure) in the next 5-10 years, with declining cost of EV technology, tightening emission norms and the central government's push for EV adoption.
- Upcoming large-scale industrial projects, like Vedanta's proposed aluminium park at Jharsuguda in Odisha, and the government's visionary projects like 100% electrification of Indian Railways and Smart Cities are also expected to boost the demand for electricity.
- With an opportunity to sell surplus power, international projects like Cross Border Grid Interconnection to link the national grids of neighbouring countries can also drive electricity demand.

Although aluminium is a cheaper and lighter option, how can the 'conductivity' aspect be compensated?

Aluminium is versatile, by virtue of its exceptional design flexibility as well as superb conductivity. Among base metals, only copper has a higher conductivity than aluminium. An aluminium wire will need ~1.5 times



Wire rods are being stored in Vedanta Ltd...



Manufactured wire rods in Vedanta Ltd...



Jharsuguda Power Plant of Vedanta Ltd...



Jharsuguda thermal power plant's switch yard...

larger cross section to pass the same current, but it is two times lighter and non-corrosive in the face of weather elements, which is why aluminium wire rods are used for transmission lines. The light weight of aluminium wire rods lends itself very well to non-sagging of transmission lines, which is of vital importance while ensuring power distribution over long distances.

Vedanta produces High Strength Low Sag special grade wire rods from primary aluminium, with purity levels as high as 99.99% and an appreciable lifecycle. This enables us to deliver high quality products with superior conductivity over conventional electric grade conductors, for various applications in the power industry.

How can aluminium be used safely for long distance power transmission lines?

After conductivity, and its non-sag characteristic, weight is the second most important parameter for high-voltage power lines that transmit power over long distances. Aluminium wires reduce the load onto grid pylons and increases the distance of spans between them, thus reducing expenses and shortening construction time. Therefore, only aluminium wires are used in main overhead power lines. This is further bolstered by the fact that aluminium has good ductility and formability, and it easily sustains significant static loads.

Another special property of aluminium is that it is non-corrosive, which lends itself to significantly longer service life (almost 40 years) with low maintenance needs. So, on a cost-benefit analysis, aluminium ranks significantly high compared to traditional metals. And

at the end of life, aluminium can be 100% recycled with barely any loss in properties to find usage across diverse sectors. In our quest for a circular economy, aluminium is the metal of the future for the electrical sector.

Then, what are Vedanta's contributions to the power sector?

At Vedanta's Aluminium Business, we are marrying sustainable and efficient manufacturing processes with our technology leadership, to produce a broad range of best-in-class value-added aluminium products. As India's largest producer of aluminium, Vedanta has been catering to the raw material needs of the power sector with its superior quality wire rods, produced using global best technologies. In this regard, we are also a key enabler and proponent of indigenously developed products, domestic manufacturing, value-addition, and supply of quality products to the downstream industries.

Besides supplying electric grade wire rod to the domestic players, we have also focused on development of customized variants for niche applications. With our engineering prowess, deep R&D capabilities, a vibrant Innovation Cell, Centre of Quality Excellence and Customer Technical Service (CTS) function, we are well resourced to meet the current and evolving needs of the domestic and global customers.

Are you developing any exclusive grades of aluminium for the power industry?

We are developing application-centric customizations of our wire rods portfolio for the power industry, like

power transmission in coastal belts, which have specific requirements due to their climactic conditions. We are also adding some more special and premium grades of conductors for the power industry.

What is the cost implication of replacement of copper with aluminium?

Aluminium wire conductors and cables can be produced to offer the same capabilities with negligible cost implication.

What is your recommendation to the decision makers of the Indian power industry?

Despite a production capacity of 4.1 MTPA, 60% of the domestic demand of 3.7 MTPA is being met through imports, majorly in the form of scrap. The absence of any quality standards and regulations for scrap has serious implications on the domestic industry, from manufacturing of sub-standard products (which bring in serious safety and health concerns) to India becoming the world's dumping ground in an industry sector –

where it has all of the natural advantages – from rich coal and bauxite reserves to skilled manpower, a strong primary and downstream processing capability and an evolved manufacturing base.

The power industry should ensure that it uses only high-quality primary aluminium for all kinds of cables and conductors to ensure the highest levels of quality and eliminate any electricity and conductivity losses which cost the nation's economy very dearly when sub-standard materials are used.

To boost domestic manufacturing of cables and conductors supporting domestic power industries, Production Linked Incentive schemes (PLIs) may also be extended.

There is also the threat of subsidised imports of wire rods into India in the 7mm and above diameter segment that find usage in electrical industry. This is also impacting the competitiveness of the domestic producers. Hence, the domestic power industry should encourage preferential usage of domestically produced aluminium products for the self-reliance of the country. (B)

Solutions For A Wired World



Ring Main Unit

Bimetallic terminals for connecting power cables with aluminium conductors to copper terminals and bus bars on equipments are made by STI. A bimetallic terminal consists of copper palm integrated to an aluminium barrel by process of friction welding. Aluminium conductors of a power cable is connected to bimetallic terminal inside the aluminium barrel and secured by compression (crimping) tools. Bimetallic terminals eliminate burn out of copper terminals crimped to aluminium conductors. To bushing of Ring Main Units (RMUs) and to copper bus bars.

Ask For **Calter Bimetals** & Compliment With Range Of **Calter Tools** For A **Secure Connection**



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In today's rapidly advancing world of technology, development in one field boosts another.

Exactly in the same way, advancement in the Information Technology field has enormously eased the monitoring challenges in the field of Solar Energy.

Read on...

SMART SOLAR ENERGY MONITORING SYSTEM

Renewable energy has started playing an increasingly important role for augmentation of grid power, providing energy access, reducing consumption of fossil fuels and helping India pursue its low carbon development path. Ahead of COP 21, India submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC, outlining the country's post-2020 climate actions. India's INDC builds on its goal of installing 175 Giga Watts (GW) of renewable power capacity by 2022. India has set a target to increase the country's share of non-fossil-based installed electric capacity to 40% by 2030. The INDC also commits to reduce India's GHG emissions intensity per unit GDP by 33 to 35% below 2005 levels by 2030, and to create an additional carbon sink of 2.5 to 3 billion tonnes of carbon dioxide through additional tree cover.



Solar energy has become one of the major clean energy sources around the world in the recent years. Launched in January 2010, the National Solar Mission (NSM) was the first mission to be operationalized under the National Action Plan on Climate Change (NAPCC). Using a three-phase approach, the mission's objective is to establish India as a global leader in solar energy, by creating the policy conditions for solar technology diffusion across the country as quickly as possible. The initial target of the mission of installing 20 GW grid-connected solar power plants by the year 2022 was enhanced to 100 GW to be achieved by the same target year. The Solar energy scenario in India and the world has been shown in the figures below.

Renewable energy sources play a vital role in the energy sector due to depletion of fossil fuel in the world, to fulfil ever increased demand of consumers and need for more reliable and low-cost energy supply. There is a need for PV storage as part of the

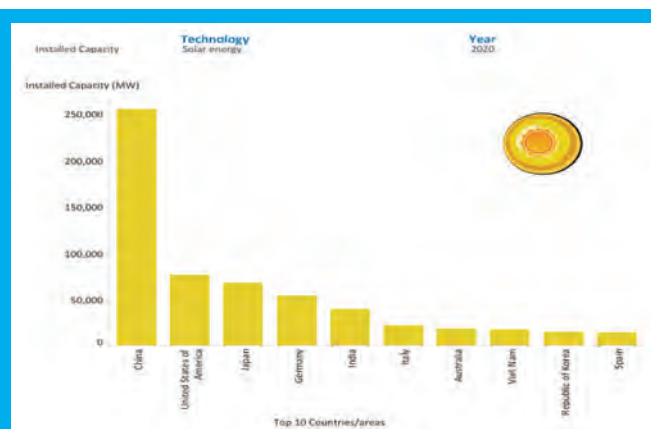


Figure 1. Comparison of Solar power generation capacities installed in different countries in the world...
Source: The International Renewable Energy Agency (IRENA)

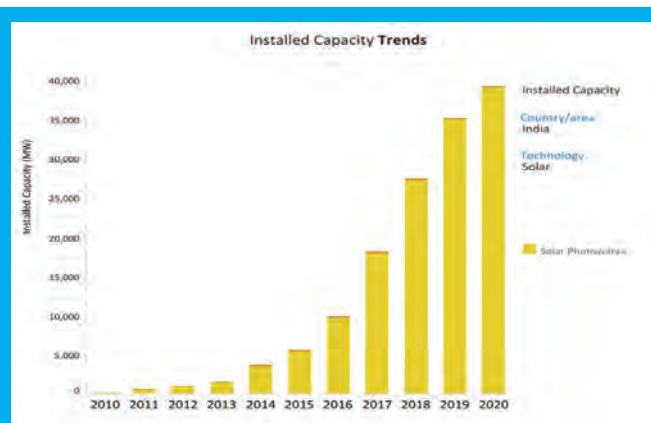


Figure 2. Solar power generation capacity installed in India...
Source: The International Renewable Energy Agency (IRENA)

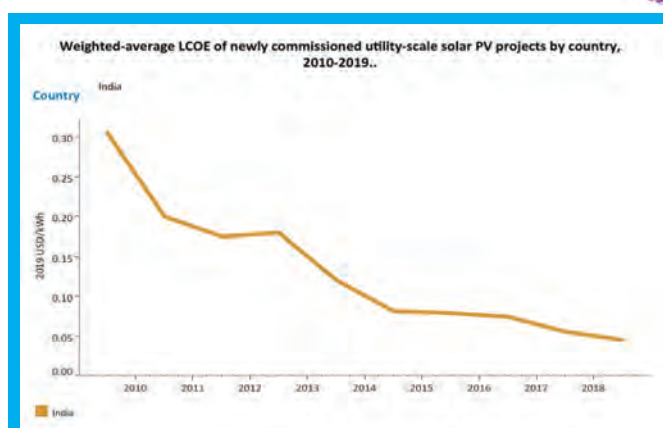


Figure 3. Solar power generation costs in India...
Source: The International Renewable Energy Agency (IRENA)

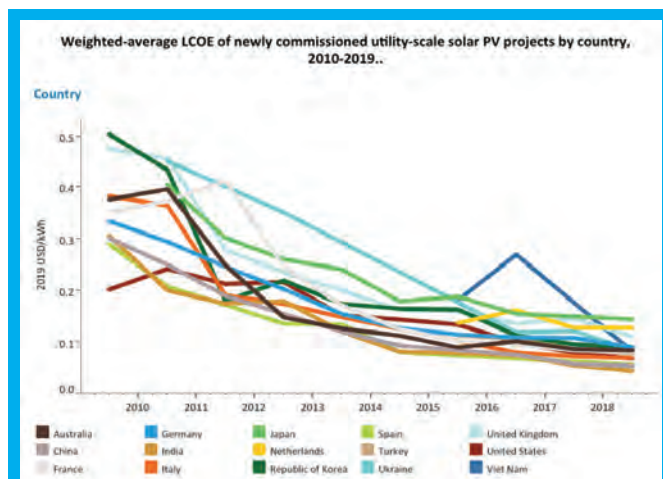


Figure 4. Comparison of Solar power generation costs in the world...
Source: The International Renewable Energy Agency (IRENA)

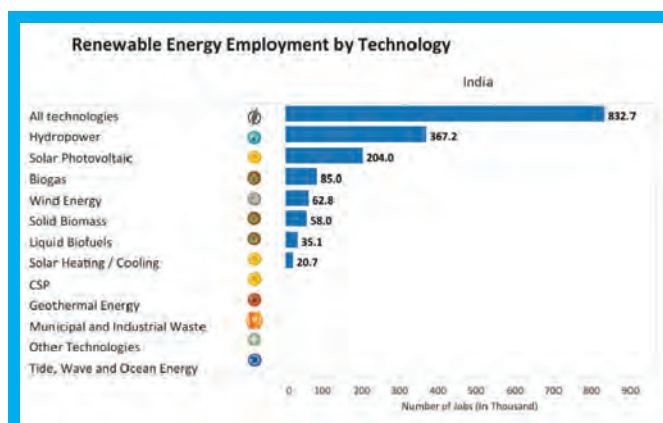


Figure 5. Renewable energy employment status in India...
Source: The International Renewable Energy Agency (IRENA)

modern grid-connected system. On the other hand, the potential benefits of including renewable energy sources in a grid are often difficult to realize due to their intermittent and highly unpredictable nature, the challenge in demand side energy management lays

focus on the efficient utilization of renewable sources without limiting the power consumption. To deal with the above issue, it seeks for design and development of an intelligent system with day-ahead planning and accurate forecasting of energy availability.

In this work, an Intelligent Smart Energy Management Systems (ISEMS) is proposed to handle energy demand in a smart grid environment with deep penetration of renewable. Intelligent Smart Energy Management Systems (ISEMS) architecture is for demand-side energy management considering Renewable source. ISEMS has three stages, which are PV generation and data collection, smart energy management system based on prediction and IoT environment for the user to access the energy details and management.

Design of IoT based Smart Solar Energy Monitoring System

The monitoring systems mainly include manual investigation and remote wired monitoring. These methods have some disadvantages such as time-

consuming and wiring complexity. The emerging technique of communication technology called Internet of Things (IoT) offers a new solution to overcome these problems. The IoT is the network of physical objects embedded with electronics, software, sensors and network connectivity. It allows objects to be sensed and controlled remotely across the existing network infrastructure resulting in improved efficiency, accuracy and economic welfare.

The IoT is reported to enable quick and easy interactions with everyday objects like personal computer, smart-phones, sensors and actuators through the Internet with the help of devices like microcontrollers, transceivers and information and network protocols. Hence, the communication network with IoT can provide a better monitoring and controlling of a PV system in a remote and large field compared to human inspection.

Working of PV monitoring system using IoT

The system described in this article is capable of measuring the values of voltage, current and temperature

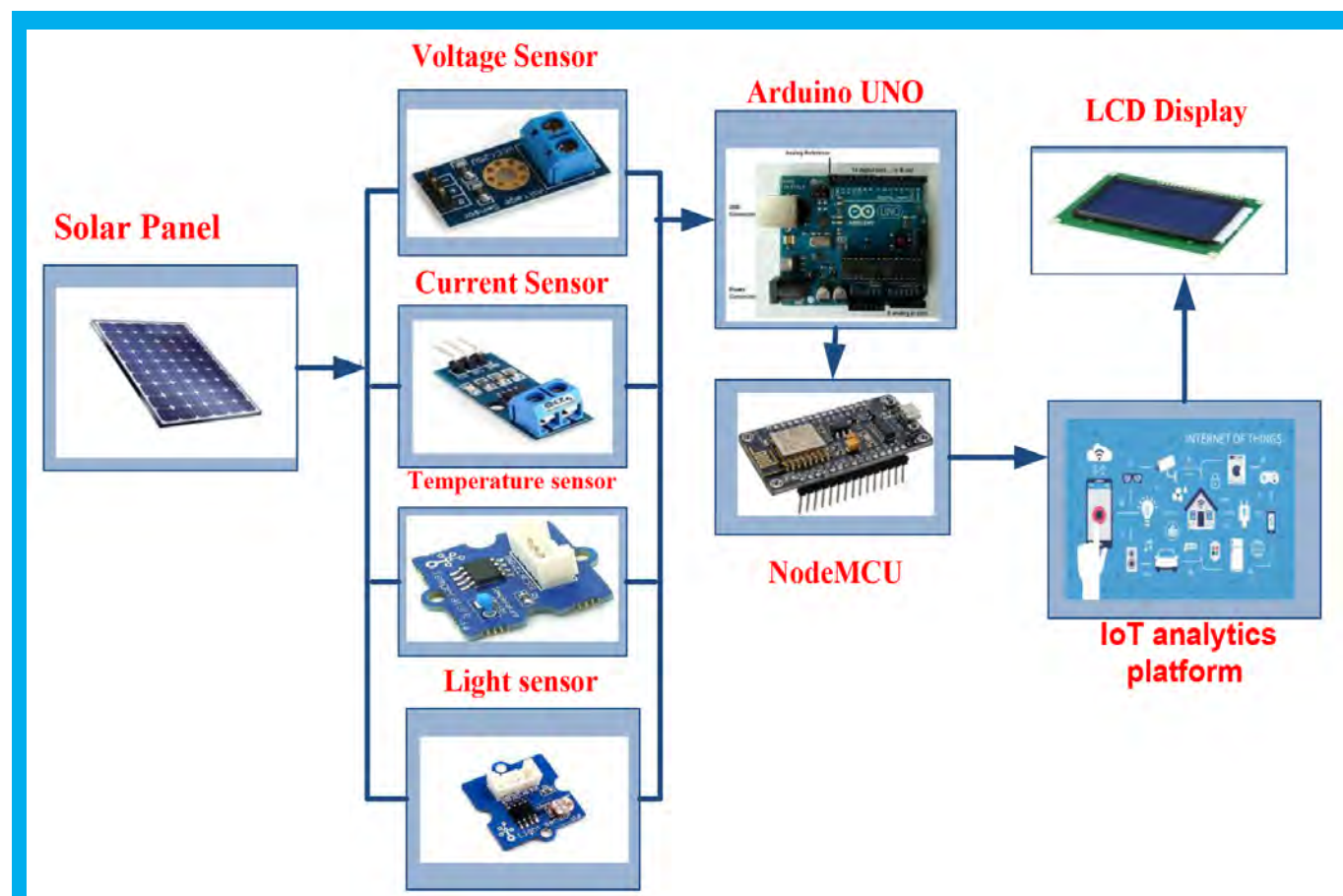


Figure 6. IOT based PV monitoring system...

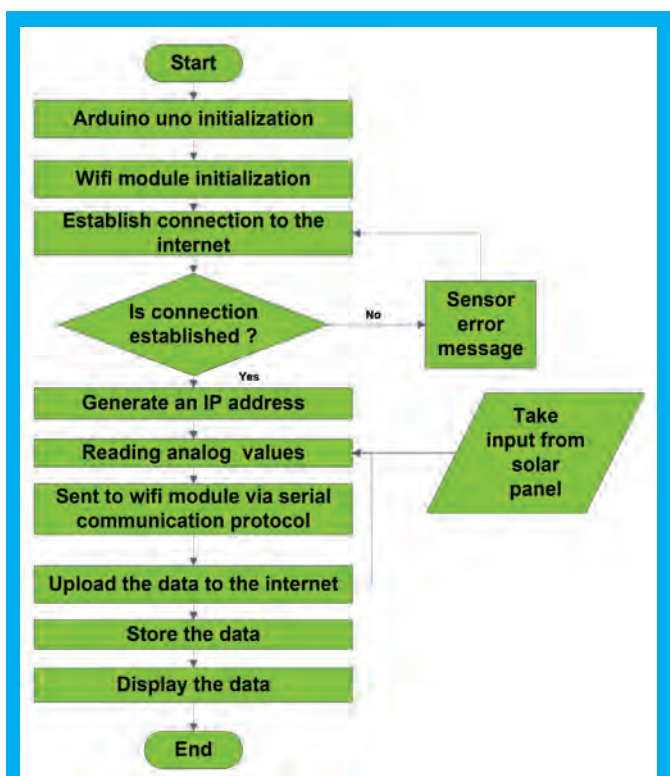


Figure 7. Flowchart of PV monitoring system using IoT...

of the solar PV panel – and also the intensity of the sunlight received by the panel. All the data were recorded by a microcontroller Arduino ATmega2560 and uploaded to the Internet by a wireless transceiver NodeMCU ESP8266. An open source of IoT cloud platform namely Thingspeak is used to store all the data from the sensor and visualize it in the graphical representation, so the user can monitor the data remotely as long as the Internet connection is available. The monitoring can be done via Thingspeak website and also via Smartphone application that were designed using MIT App Inventor. The block diagram of the system is shown in figure 6.

An open source of IoT cloud platform application namely Thingspeak has been used in this study. This application can retrieve and store the data from the sensor through Internet that uses Hypertext Transfer Protocol (HTTP). The data from the sensor was uploaded from the Arduino board connected to a WiFi module to the cloud. It updates all the data logs received from the sensors and giving the status application to the users.

To use these features, the user needs to create an account or specific IP address, which contains different channels for monitoring the different parameters in the system. The flowchart diagram of the data gateway system is shown in figure 7.

This platform enables the user to visualize the data in graphical representation. With Internet-based monitoring, the data would be easily accessible through an online interface (via computer or smartphone). The major advantage of this system is that the solar PV panel output information can be easily monitored anywhere with an available Internet connection. Table 1 shows the various applications of IoT use in PV systems.

Table 1. IoT applications in solar PV system...

Application in PV system	Microcontroller	Transceiver	Transceiver
Monitoring of dust accumulation in PV System	Arduino Uno	ESP8266	Thingspeak
Monitoring of PV power and sunlight intensity	Arduino Uno	ESP8266	Thingspeak
PV array inspection	N/A	Raspberry Pi	Zigbee
PV tracking system	N/A	Raspberry Pi	Thingspeak
PV cleaning system	Particle Photon	N/A	Ubidots
PV fault and control	Arduino Uno	Xbee	Zigbee

Conclusion

An implementation of Internet of Things (IoT) in the monitoring of solar PV system consists of data acquisition, data gateway and Smartphone application display was proposed. The data acquisition was successfully collecting the data with accuracy. The data gateway was able to send the graphical representation of the data to the Smartphone application with a mean transmission time of a few seconds. The results demonstrate that the proposed monitoring system can be a promising solution for intelligent remote and real-time monitoring of a solar PV system. 



Challa Krishna Rao is an Associate Professor at the Department of Electrical and Electronics Engineering in Aditya Institute of Technology and Management, Tekkali, Andhra Pradesh, India.



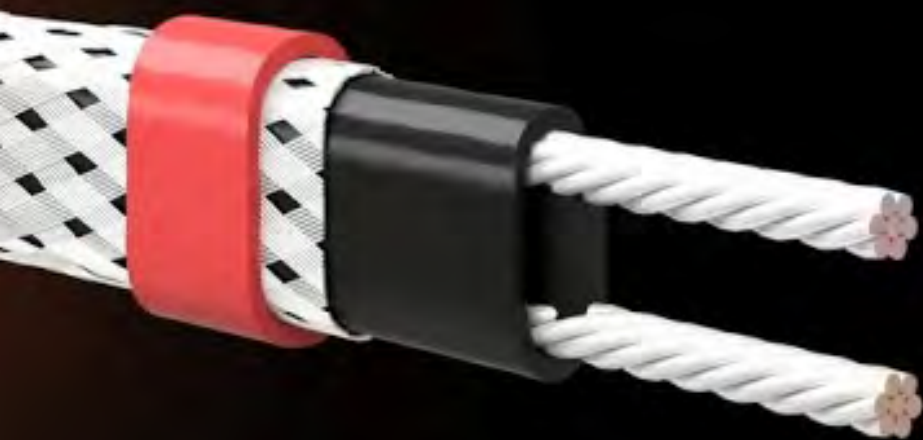
Dr. Sarat Kumar Sahoo is a Professor/HOD at the Department of Electrical Engineering, in Parala Maharaja Engineering College, Berhampur, Odisha, India.



HIGH POWER RETENTION TECHNOLOGY

The nVent RAYCHEM HTV heating cable is internationally certified for use in hazardous areas, it comes with a 10-year product warranty and is now globally available...

nVent Electric plc (nVent), a global leader in electrical connection and protection solutions, has launched its newest nVent RAYCHEM self-regulating heating cable, the nVent RAYCHEM HTV. The new heating cable will be used in critical industrial applications with high exposure or maintenance temperatures. Offering superior levels of High Power Retention (HPR) during its designed life of more than three decades, the brand new self-regulating heating cable, nVent RAYCHEM HTV, meets stringent demands for maximum process integrity while protecting people, processes and infrastructures.



Increased performance, extended design life

nVent RAYCHEM HTV surpasses previous self-regulating heating cables in performance and design life. Specifically designed for high temperature environments, the cable can operate under high continuous operating temperatures of 205°C/400°F and withstand temperatures up to 260°C/500°F. Its power retention levels are unparalleled: after 10 years of performance at 205°C/400°F, the HTV cable retains 95% of its power output. This not only reduces downtime risk and maintenance costs for decades, it also increases plant safety and productivity.

“We understand how important day-to-day operational integrity is,” said Marty Lee, nVent Vice President of Product Management. “While long-term design life is important, the power retention profile over time is equally important. With 95% power retention for 10 years and a more than 30-year design life, our customers can be confident of improved process integrity and lower contingencies for decades to come. In an increasingly electrified world, the HTV heating cable will save our customers money and increase their overall operational efficiencies.”

New materials and groundbreaking research and development

To create such a high-performance heating cable, nVent turned to new materials, as well as new developments in nanotechnology and thermal structuring of the materials.

“The nVent RAYCHEM name has long been synonymous with innovative science; true R&D. nVent still operates that way today,” said Linda Kiss, nVent Vice President of Engineering. “We have almost 75 years of expertise in polymer materials science and have gained new knowledge about how best to construct the highest temperature composites. We created a ground-breaking, new semi-conductive polymer nanocomposite material with increased thermal stability, which provides superior power retention at high temperatures.”

nVent RAYCHEM heat tracing cables are already well known for their exceptional freeze protection capabilities and the maintenance of critical process temperatures, in many industrial facilities around the world. From critical chemicals to power plants, from oil & gas to pharmaceutical and renewable industries, nVent RAYCHEM products and solutions are associated with reliability, high-caliber performance and long operational life. The new nVent RAYCHEM HTV self-regulating heating cable will build upon this reputation by offering industrial plant owners the opportunity to advance their process integrity and operational efficiency for decades to come.

EI

TRANSPORTING THE TITANIC TRANSFORMER

On June 6, this year, a very big electric transformer has been transported from Ipswich Docks to a National Grid substation at Burwell in Cambridgeshire, England. The unusual size of the transformer needed special arrangements...

www.electricalindia.in

Transformers play a vital role to help in ensuring that the UK continues to enjoy safe and reliable electricity supplies. Thus, the country needs to make sure that the old transformers that have reached the end of their lives must be replaced ASAP. This real-life report is one such initiative where transporting a mammoth size transformer was nicely planned before the actual logistical



work was performed. As far as India is concerned, the roads are highly congested where transporting large sized materials is too difficult, thus, the information conveyed through this report is a knowledge bank for us.

It was decided that the transformer, which was more than eight metres long, four metres tall and five metres wide, would be delivered on a specialist vehicle. The vehicle would travel at approximately 12 miles per hour and would have a police escort for the journey to make the process as smooth and safe as possible. The transformer was decided to leave Ipswich Docks at 8 am on Sunday 6th June and was expected to arrive at Burwell Substation the same day, between 6 pm – 9 pm.

The transformer, which is more than eight metres long, four metres tall and five metres wide, was

Ipswich to Burwell was made through consultation and co-ordination.

Due to the size of the transport load, the authority was asking the local people to avoid parking on the street or pavement between 6 pm and 9 pm on 6th June, so the transformer could safely access the substation.

Focusing on their responsibility, National Grid Project Manager, David Oglesby, said, “Millions of people rely on us to supply their electricity without interruption, day in, day out so it’s important that we keep our substations and the equipment in them working efficiently. The delivery of this transformer to our Burwell site will ensure we are able to continue to deliver power reliably to the local area.”

Highlighting their preparation to maintain safety during the transport of the transformer, Rachel Sheridan, Highways England Project Manager, said, “It’s not



A photograph of transportation of the huge transformer through Rochdale...

planned to be delivered on a specialist vehicle.

Due to the exceptional size of the load and its speed of travel there might be some delays on the route, which was also taken into account. National Grid, its delivery partner, police and Highways England had spent months carefully planning the route and the delivery to keep disruption to traffic and people who live, work and are travelling in the area, to a minimum. A realistic roadmap between

every day that you see an 184-tonne transformer being transported on the Highways England road network, but we’ve been working closely with the National Grid and police for the last few months to ensure this abnormal load is delivered to the substation in Cambridgeshire as safely and smoothly as possible. Throughout its journey we will look to keep disruption to drivers and people who live, work and are travelling in the area, to a minimum but recommend people plan ahead if they’re looking to use a similar route.”

15

BUSDUCT

SYSTEM DESIGN

PART-4

In order to have low losses and enhanced reliability in the distribution system, bus-ducts are preferred over cables for higher current ratings and shorter lengths at different voltage levels. Though Sandwich Bustrunking System with rated operational voltage (U_e) 1000 Volt are easily available, when it comes to economics–Air insulated bus ducts have an edge. This article focuses on the types of air insulated busducts and their selection guidelines, design requirements, de-rating factors and sizing requirement...

Busbar enclosure

The proximity effect can also be minimized by using a non-magnetic enclosure of aluminium or stainless steel. In magnetic materials the field in the enclosure is produced in the form of small magnetic loops. Its effect cannot be alleviated by breaking the electrical path alone, as illustrated in Figure-13. Its effect can be reduced only by replacing a few parts of the magnetic enclosure itself, such as its top or bottom covers or both, with a non-magnetic material. It is possible to achieve an economical and low-loss enclosure by replacing only

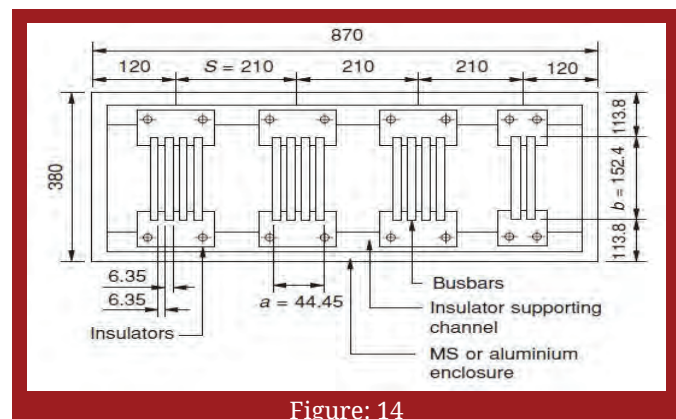


Figure: 14

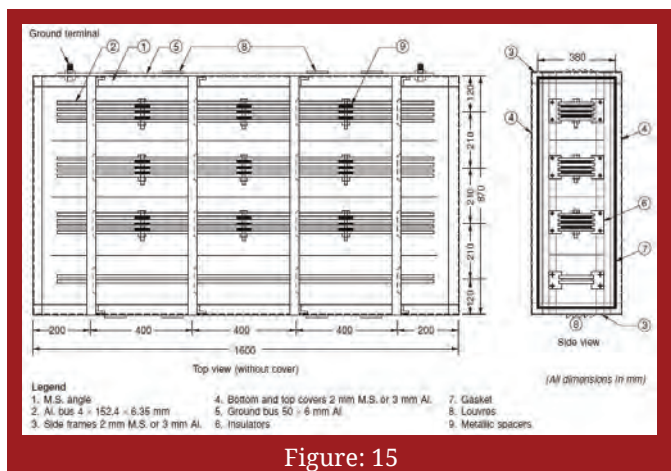


Figure: 15

its top and bottom covers with a non-magnetic material. The covers constitute the larger part of the surface area of the enclosure.

By equipping adequate louvers in the enclosure or by using a forced-air draught through the length of the enclosure.

Designing A 2500A Aluminium Busbar System

Example-6: For a three phase four wire 415V $\pm 10\%$, 50Hz $\pm 3\%$ Fault level - 50kA, Duration of fault - 1sec, Continuous current rating - 2500A,

Ambient temperature - 50deg.C, with maximum permissible operating temperature - 85deg.C Permissible final temperature at the end of the fault - 185deg.C, sizing of busduct of different types are detailed below

Case-1: Non segregated phase busbar without phase interleaving

Minimum size of busbars for short circuit conditions:

$$\theta_f = \frac{k}{100} \cdot \left(\frac{I_{sc}}{A} \right)^2 \cdot (1 + \alpha_{20} \theta_f) \cdot t$$

$$185 - 85 = (1.166/100) \cdot (50000/A)^2 \cdot (1 + 0.00403 \cdot 85) \cdot 1$$

$$A = 625 \text{ mm}^2$$

Assume rectangular flats of electrolytic grade E-91E or its equivalent. Busbars chosen for each phase – four (152.4 mm x 6.35 mm) – which are more than the minimum size required to account for the thermal effects during a shortcircuit condition and for neutral – two (152.4 x 6.35 mm) Size of busbar enclosure – 870 mm x 380 mm (Figure-15) Material of enclosure – Aluminium Busbar configuration – as in Figure 14.

Deratings:

- Due to ambient temperature, from table-1
 $K_1 = 0.815$

- Due to size of enclosure

$$\text{Heat dissipation factor} = \frac{\text{Cross sectional area of active Aluminium}}{\text{Area of enclosure}} = 0.041 \text{ (4\%)}$$

$$\frac{(3 \times 4 \times 152.4 \times 6.35) + (2 \times 152.4 \times 6.35)}{380 \times 870}$$

From table-3, $K_2 = 0.77$

- Due to proximity effect, as $S < 2b$, derating is approximately 20%

$$K_3 = 0.8$$

$$\text{Total derating } K = 0.815 \cdot 0.77 \cdot 0.8 = 0.5$$

Busbar current rating of 4x152.4mmx6.35mm Aluminium busbars per phase as in table-11 = 4240A. Effective rating after considering all de-ratings = 4240*0.5 = 2120A

These sections of busbars are not adequate for the required current rating of 2500A. The rating of the bus system can however be enhanced by almost 20% and make it suitable for the required rating by providing the busbars and inside of the enclosure with a non-metallic, matt finish black paint.

Voltage drop: Skin effect:

Rdc for E-91E grade of conductor from table-13 = 32.38 x 10⁻⁶ ohm per conductor at 20°C

Rdc at an operating temperature of 85°C

$$= R_{dc_{20}} (1 + \alpha_{20} (\theta_2 - \theta_1))$$

$$= 32.38 (1 + 0.00363 (85 - 20))$$

$$= 40.02 \times 10^{-6} \text{ ohm per conductor and for the phase} = 40.02 / 4 = 10.005 \times 10^{-3} \text{ ohm/1000m}$$

Area of cross section per phase = 4x152.4x6.35 = 38.71cm². For this area of cross section, the skin effect ratio Rac/Rdc from fig-4 for Aluminium grade E-91E at 85°C having b/a = 152.4/44.45 ≈ 4 measures almost 1.425 approx.

$$\text{So } R_{dc}/R_{ac} = 1.425$$

$$\rightarrow R_{ac} = 10.005 \times 10^{-3} \times 1.425 = 14.257 \times 10^{-3} \text{ ohm/1000m per phase}$$

Proximity effect:

Measure reactance Xa from fig-9 for 1.26 x S/(a+b) = 1.26*210/(44.45+152.4)

$$= 1.344 \text{ corresponding to } a/b = 44.45/152.4 = 0.29$$

$$X_a = 110 \times 10^{-6} \text{ ohm per meter per phase}$$

$$\text{Impedance } Z = \sqrt{14.257^2 + 110^2 \times 10^{-3}} = 0.111 \text{ ohm per 1000m per phase}$$

For 20m length of busduct this impedance will cause a voltage drop of 2500x0.111x20/1000 = 5.5V which is 1.3% of rated voltage and is therefore acceptable.

Conductor

Calculation of short circuit effects:

Electrodynamic forces:

$$I_{sc} = 50,000A$$

$$F_m = k \cdot \frac{16 \cdot I_{sc}^2}{S} \times 10^{-4} N/m$$

K corresponding to (S-a)/(a+b) i.e. (210-44.45)/(44.45+152.4) = 0.84 from curve for a/b = 0.25 is 0.93 approx.

$$\Rightarrow F_m = 0.93 \times \frac{16 \times 50,000^2}{210} \times 10^{-4} N/m$$

= 17,714.6 N/m = 1806.1 kg/m (1N/m = 1/9.807 kg/m) Since the busbar support are assumed to be at a distance of 400mm Force on each section of busbars, insulators and the mounting fasteners

$$= 1806.1 \times 0.4 = 722.51kg$$

Mechanical suitability of busbars and their supporting system: Bending stress on the busbars Bending stress at section x-x = $\frac{F_m \times I}{12 \times M \times N} kg/cm^2$

Where F_m = maximum electrodynamic forces acting on each support in the event of fault

I = Centre distance between two busbar supports

N = Number of busbars per phase

M = Sectional modulus at section

$$x-x = (1/6) \times a \times b^2 cm$$

$$F_m = 722.51 kg$$

$$I = 40cm$$

$$a = 6.35 mm = 0.635cm$$

$$b = 152.4 mm = 15.24 cm$$

$$N = 4$$

$$M = 0.635 \times 15.24 \times 15.24 / 6 = 24.58cm^3$$

$$\text{Bending stress} = \frac{722.51 \times 40}{12 \times 24.58 \times 4} = 24.49kg/cm^2$$

From Table-13, Busbar support can be SMC or DMC

Case-2: Non segregated phase busbar with phase interleaving

Busbar current rating of 2x152.4mmx6.35mm

Aluminium busbars per phase as in table-11 = 2860A

Total current = 2*2860 = 5720A Figure-16:

With derating = 0.5*5720 = 2860A

Voltage drop: Skin effect:

Rdc for E-91E grade of conductor from table-13 = 32.38 x 10-6 ohm per conductor at 20°C

Rdc at an operating temperature of 85°C

$$= Rdc20 (1 + \alpha20(85-20))$$

$$= 32.38 (1 + 0.00363 (85-20))$$

$$= 40.02 \times 10^{-6} ohm per conductor and for the phase = 40.02 / 4 = 10.005 \times 10^{-3} ohm/1000m$$

Area of cross section per phase = 4x152.4x6.35 = 38.71cm² For this area of cross section, the skin effect ratio Rac/Rdc from fig-4 for Aluminium grade E-91E at 85 deg,C having b/a = 152.4/19.05 ≈ 8

$$\rightarrow Rac = 10.005 \times 10^{-3} \times 1.18 = 11.81 \times 10^{-3} ohm/1000m per phase$$

Comparison:		
Description	Busduct without Interleaving	Busduct with Interleaving
Basic current rating without derating	4240A	5720A
Effective rating	4240*0.5 = 2120A	5720*0.5 = 2860A
Proximity Effect		
Xa	110 x 10-6 ohm per meter	37 x 10-6 ohm per meter
Skin Effect		
Rac/Rdc	1.425	1.18
Rac	14.257x10-6 ohm per meter	11.81x10-6 ohm per meter
Impedance Z	111 x 10-6 ohm per meter	38.84x10-6ohm per meter
Voltage drop		
% of system voltage	1.3%	0.45%
Electrodynamic forces		
Fm	1806 kg/m	1585.3 kg/m
Forces on each set of busbar insulators and mounting fasteners when 400m apart	722.51kg	634.2kg
Busbar support	SMC or DMC	SMC or DMC

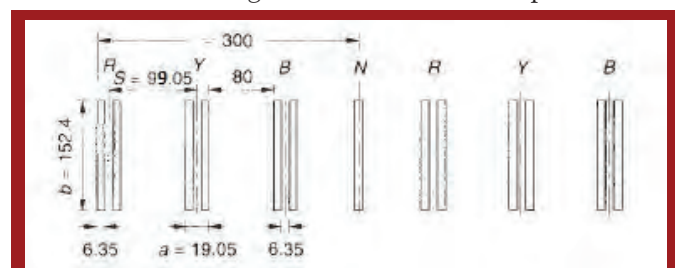
Proximity effect:

Measure reactance Xa from fig-9 for 1.26 x S/(a+b) = 1.26*99.05/(19.05+152.4) = 0.73 corresponding to a/b = 19.05/152.4 = 0.125

$$Xa = 74 \times 10^{-6} ohm per meter per circuit$$

$$\text{Combined } Xa = 37 \times 10^{-6} ohm per meter$$

Impedance Z = 0.0388 ohm per 1000m per phase For 20m length of busduct this impedance will cause a voltage drop of 2500x0.038x20/1000 = 1.9V which is 0.45% of rated voltage and is therefore acceptable.



Calculation of short circuit effects:

Electrodynamical forces:

$$F_m = k \cdot \frac{16 \cdot I_{sc}^2}{S} \times 10^{-4} \text{ N/m}$$

$I_{sc} = 50,000 \text{ A}$

K corresponding to (S-a)/(a+b) i.e. (99.05-19.05)/(19.05+152.4) = 0.47 from curve for a/b = 0.125 is 0.77 approx.

$$\Rightarrow F_m = 0.77 \times \frac{16 \times 2 \times \left(\frac{50,000}{2}\right)^2}{99.05} \times 10^{-4} \text{ N/m}$$

= 15,547 N/m = 1585.3 kg/m (1N/m = 1/9.807 kg/m)

Since the busbar support are assumed to be at a distance of 400mm. Force on each section of busbars, insulators and the mounting fasteners

$$= 1585.3 \times 0.4 = 634.2 \text{ kg}$$

Table-7: Properties of copper and Aluminium at 20°C

Parameters	Standard copper	Commercial purity aluminum (for electrical use)		
		1	2	3
Relevant standards	IEC 60028	IEC 60105 ISO 209-1.2		
Standard grades				
(a) As in BS	100% IACS	E1E - M ¹	HE9 - W ¹	E - 91E ¹
(b) As in BS 2898 (ISO-1)	-	1350	6063 A	6101A
(c) Equivalent (xxx) grades	-	CIS - M ¹	SOS - W ¹	D SOS - W ¹
Physical properties				
(a) Chemical composition				
Copper (Cu)		Cu, Si, Fe - not more than 0.5%	0.1	0.05
Magnesium (Mg)	99.9% pure		0.6-0.9	0.4-0.9
Silicon (Si)		Mg, Cr, Sn, Zn and Mn = 0.01	0.3-0.6	0.3-0.7
Iron (Fe)	-		0.15-0.35	0.4
Cr, Ti, Zn, and Mn			0.6	0.1
Aluminum		99.5%	Rest is all aluminum	
Specific heat	gm. Cal/°C	0.092	0.220	
Density	(gm/cm ³)	8.89	2.71	2.71
Melting point	(°C)	1083	660	
Mechanical properties				
Ultimate tensile strength	kgf/mm ²	22 to 26	6.5/7.0	15.5/23.5
Ultimate shearing strength	kgf/mm ²	16 to 19	5.5	16.5
Modulus of elasticity E	kgf/mm ²	12000	7000	6700
0.2% tensile proof strength	kgf/mm ²	60-60% of the tensile strength	11/19.5	16.5/22
Electrical properties				
Volume resistivity or specific resistance (ρ)				
(a) In μ Ω cm	1.7241	2.873	3.1/3.6	3.133
(b) In $\frac{\mu \Omega \cdot \text{cm}}{10^3}$	(1.7241 x 10 ⁻³)	2.873 x 10 ⁻³	3.1 x 10 ⁻³ /3.6 x 10 ⁻³	3.133 x 10 ⁻³
Volume conductivity	m/Ω mm ³	58	34.80	32.26/27.8
Conductivity	% IACS	100	61/60	50/48
Temperature coefficient of electrical resistance Per °C α ₂₀ (applicable over a working range of 100-200°C)	3.93 x 10 ⁻³	(4.03 x 10 ⁻³ / 3.96 x 10 ⁻³)	(3.3 x 10 ⁻³ / 3.168 x 10 ⁻³)	3.63 x 10 ⁻³
α ₂₀ at a particular conductivity = α ₂₀ at 100% conductivity x actual conductivity of the metal				
Coefficient of linear expansion (thermal), (mm/°C) (applicable over a working range of 20-200°C)	1.73 x 10 ⁻⁵	2.3 x 10 ⁻⁵	2.3 x 10 ⁻⁵	2.3 x 10 ⁻⁵
Mass resistivity = volume resistivity x density (μ Ω gm/cm ³)	15.328	7.786	8.37/9.72	8.49

Source: Industrial Power Engineering and Applications Handbook – K.C. Agrawal

Table-8: Current ratings of single rectangular copper

Conductor size (mm)	Area of cross-section (mm ²)	Approximate rating Amp (a.c.)
2.5 x 12.5	31.25	159
16.0	40.0	195
20.0	50.0	235
25.0	62.5	287
31.5	78.75	347
40.0	100.0	426
50.0	125.0	516
63.0	157.5	630
4.0 x 16.0	64	254
20.0	80	305
25.0	100	367
31.5	125	445
40.0	160	542
50.0	200	660
63.0	252	802
80.0	320	900
100.0	400	1185
6.3 x 25.0	157.50	473
31.5	198.45	569
40.0	252.0	696
50.0	315.0	832
63.0	396.9	1010
80.0	504.0	1220
100.0	630.0	1465
125.0	787.5	1755
160.0	1008.0	2145
10 x 50.0	500	1060
63.0	630	1260
80.0	800	1525
100.0	1000	1800
125.0	1250	2150
160.0	1600	2620
200.0	2000	3140
250.0	2500	3710
16 x 100.0	1600	2220
125.0	2000	2640
160.0	2560	3180
200.0	3200	3760
250.0	4000	4500
315.0	5040	5370

Source: Industrial Power Engineering and Applications Handbook - K.C. Agrawal

Table-9: Multiplying factors for copper sections

Total area of cross-section (mm ²)	Multiplying factors		
	2 bars	3 bars	4 bars
500	1.78	2.45	3.13
1000	1.72	2.36	3.00
1500	1.65	2.24	2.84
2000	1.60	2.16	2.70
2500	1.55	2.10	2.60
3000	1.52	2.02	2.52
3500	1.48	1.98	2.48
4000	1.44	1.96	2.45

Source: Industrial Power Engineering and Applications Handbook - K.C. Agrawal

Table-10: Current ratings for rectangular Aluminium sections, grade E-91E (6101 A)

Size (mm)	1 bar			2 bars		3 bars		4 bars	
	D.C	50 Hz A.C	D.C	50 Hz A.C	D.C	50 Hz A.C	D.C	50 Hz A.C	
Approximate ratings									
25.4 x 6.35	355	355	710	705	980	970	1120	1100	
38.1 x 6.35	520	520	1030	1020	1380	1350	1585	1535	
50.8 x 6.35	670	670	1315	1290	1765	1705	2050	1940	
63.5 x 6.35	820	810	1550	1510	2100	2000	2430	2260	
76.2 x 6.35	970	960	1805	1740	2440	2310	2860	2620	
101.6 x 6.35	1260	1235	2260	2140	3060	2800	3640	3200	
127.0 x 6.35	1545	1505	2700	2510	3660	3240	4410	3700	
152.4 x 6.35	1840	1780	3130	2860	4290	3680	5250	4240	
50.8 x 9.53	840	830	1560	1500	2090	1970	2460	2260	
76.2 x 9.53	1210	1180	2180	2050	2940	2660	3510	3030	

Conductor

101.6 x 9.53	1550	1495	2710	2480	3660	3150	4400	3560
127.0 x 9.53	1940	1860	3290	2930	4450	3660	5400	4200
152.4 x 9.53	2260	2120	3770	3340	5140	4080	6300	4680
203.2 x 9.53	2940	2750	4800	4150	6500	4900	8060	5740
76.2 x 12.7	1405	1355	2450	2240	3290	2830	4000	3240
101.6 x 12.7	1830	1740	3100	2720	4170	3360	5100	3900
127.0 x 12.7	2230	2080	3720	3120	5040	3900	6170	4550
152.4 x 12.7	2620	2420	4300	3500	5850	4400	7200	5100
203.2 x 12.7	3380	3060	5450	4450	7420	5300	9110	6150
254.0 x 12.7	4080	3640	6500	5000	8860	6000	10900	6850

Source : Industrial Power Engineering and Applications Handbook - K.C. Agrawal

Table-11: Current ratings for rectangular Aluminium sections, grade EIE-M (1350)

Conductor Size (mm)	Cross sectional area (mm ²)	1 bar	2 bars	3 bars	4 bars	5 bars	6 bars
2.5 x 12	30	118	210	285	360	425	480
16	40	151	275	395	490	580	655
20	50	183	320	450	575	675	770
25	62.5	223	390	540	685	800	910
30	75	263	480	660	840	990	1115
40	100	342	610	860	1080	1260	1425
04 x 12	48	156	290	420	536	620	700
16	64	198	340	470	600	710	815
20	80	238	410	570	720	850	955
25	100	290	530	755	950	1110	1250
30	120	339	600	845	1060	1245	1400
40	160	434	750	1050	1320	1550	1750
50	200	532	905	1260	1575	1825	2035
06 x 12	72	200	350	480	610	720	825
16	96	252	450	640	805	960	1075
20	1420	301	550	790	1000	1170	1320
25	150	364	640	900	1120	1315	1485
30	180	424	730	1025	1290	1520	1720
40	240	545	935	1310	1630	1900	2130
50	300	660	1130	1580	1950	2255	2505
60	360	782	1350	1870	2200	2630	2885
80	480	995	1700	2310	2745	3070	3330
100	600	1215	2090	2770	3190	3490	3745
120	720	1415	2415	3180	3640	3985	4270
160	960	1830	3100	4050	4600	5025	5340
10 x 40	400	720	1230	1710	2110	2425	2670
50	500	870	1500	2060	2505	2850	3100
60	600	1015	1750	2350	2795	3120	3380
80	800	1250	2215	2940	3355	3675	3950
100	1000	1565	2650	3465	3940	4315	4635
120	1200	1810	3050	4010	4560	4980	5290
160	1600	2310	3940	5170	5870	6300	6620
200	2000	2795	4750	6160	-	-	-
250	2500	3365	5720	-	-	-	-
16 x 100	1600	1950	3260	4250	4890	5340	5660
120	1920	2255	3850	5030	5700	6130	6450
160	2560	2840	4830	6260	-	-	-
200	3200	3395	5780	-	-	-	-
250	4000	4095	6500	-	-	-	-

Source : Industrial Power Engineering and Applications Handbook - K.C. Agrawal

Table-12: Indal CIS-M (EIE-M) and D 50 S-WP rectangular busbars mechanical and electrical data

Size	Cross Sectional Area	Weight	CIS-M d.s. Resistance (max.) At 20°C	D 50 S-WP d.s. Resistance (max.) At 20°C	Reaction force X _a at 305 mm spacing At 50 Hz	Moment of inertia I _{xx}	I _{yy}	Section modulus Z _{xx}	Z _{yy}	Radius of gyration r _{xx}	r _{yy}
mm	mm ²	Kg/m	μΩ/m	μΩ/m	μN/m	cm ⁴	cm ⁴	cm ³	cm ³	cm	cm
25.4 x 6.35	161.29	0.435	178.15	194.35	236.22	0.874	0.012	0.688	0.191	0.734	0.183
38.1 x 6.35	241.30	0.652	118.76	129.56	215.22	2.914	0.033	1.540	0.262	1.102	0.183
50.8 x 6.35	322.58	0.871	89.07	97.18	199.14	6.951	0.125	2.737	0.393	1.468	0.183
63.5 x 6.35	403.23	1.089	71.26	77.82	186.35	13.569	0.125	4.261	0.426	1.836	0.183
76.2 x 6.35	483.87	1.306	59.38	64.80	175.85	23.434	0.166	6.145	0.508	2.202	0.183
101.6 x 6.35	645.16	1.742	44.55	48.59	159.45	55.484	0.208	10.930	0.688	2.936	0.183
127.0 x 6.35	806.45	2.177	35.63	38.88	146.00	108.387	0.291	17.075	0.852	3.670	0.183
152.4 x 6.35	967.74	2.613	29.69	32.38	134.51	187.304	0.333	24.581	1.032	4.404	0.183
50.8 x 9.53	484.12	1.307	59.38	64.80	195.86	10.406	0.374	4.097	0.787	1.466	0.274
76.2 x 9.53	726.19	1.961	39.60	43.18	174.21	35.130	0.441	9.226	1.147	2.202	0.274
101.6 x 9.53	968.25	2.614	29.69	32.38	157.48	83.246	0.749	16.387	1.540	2.936	0.274
127.0 x 9.53	1210.3	3.268	23.75	26.21	144.36	162.580	0.916	25.613	1.917	3.670	0.274
152.4 x 9.53	1452.7	3.921	19.82	21.59	134.18	280.956	1.082	36.871	2.311	4.404	0.274
203.2 x 9.53	1936.5	5.228	14.83	16.21	117.45	665.970	1.457	65.548	3.064	5.872	0.274
76.2 x 12.7	967.74	2.613	29.69	32.38	170.93	46.826	1.290	12.290	2.048	2.202	0.368
101.6 x 12.7	1290.3	3.848	22.28	24.28	155.84	111.009	1.748	21.844	2.737	2.936	0.368
127.0 x 12.7	1612.9	4.355	17.81	19.42	143.04	216.773	2.164	34.134	3.409	3.670	0.368
152.4 x 12.7	1935.4	5.226	14.83	16.21	132.54	374.608	2.622	49.161	4.097	4.404	0.368
203.2 x 12.7	2580.6	6.968	11.12	12.14	115.81	887.822	3.455	87.376	5.441	5.872	0.368
254.0 x 12.7	3225.8	8.710	8.89	9.71	96.78	1734.43	4.329	136.57	6.817	7.341	0.368

Source : Industrial Power Engineering and Applications Handbook - K.C. Agrawal

Table-13: Properties of thermosetting plastics

Properties	Unit	DMC	SMC	Relevant standards for test methods
• Physical properties				
1 Specific gravity	gm/cc	1.85 – 1.95	1.8	
2 Shrinkage	mm/mm	0.002-0.003	0.0015	
3 Water absorption	%	0.2-0.3	0.15	
4 Operating temperature	°C	0.2 (m)	0.15 (m)	BS:2782
• Mechanical properties				
1 Minimum tensile strength	Kgf/cm ²	250 – 500	500 -900	BS:2782
2 Minimum compressive strength	Kgf/cm ²	1200 – 1800	1600 -2000	BS:2782
3 Minimum cross-breaking strength or Flexural strength (bending strength)	Kgf/cm ²	700 – 1200	1400-1800	BS:2782
4 Impact strength	Kgf/cm ²	30 – 40	60	BS:2782
• Electrical properties				
1 Dielectric strength (min)	Kv/mm	10 – 14	10 – 14	BS:2782
2 Tracking index	V	1000	1000	BS:5901

Source : Industrial Power Engineering and Applications Handbook - K.C. Agrawal

Table-14: Typical fault levels for an integrated transmission and distribution network

Nominal system voltage kV (r.m.s)	Highest system voltage kV (r.m.s)	Symmetrical interrupting current rating kA (r.m.s)	Minimum momentary current peak for dynamic rating kV (peak)
765	800	40	100
400	420	40	100
220	245	31.5/40	79/100
132	145	25/31	62.5/77.5
15/24	-	25	62.5
11	12	-	-
6.6	7.2	40	100
3.3	3.6	40	100
0.415	0.44	43/50	90.6/105

Source : Industrial Power Engineering and Applications Handbook – K.C.Agrawal

Table-15: Insulation levels, power frequency and impulse withstand voltages for metal enclosed switchgear assemblies

Nominal system voltage Vrms (kV)	Rated maximum system voltage kV r.m.s	Standard one minute power frequency withstand voltage kV r.m.s	Standard lightning impulse withstand voltage phase to ground kV peak
3.3	3.6	10	20
6.6	7.2	20	40
11	12	28	60
15	17.5	38	75
22	24	50	95
33	36	70	145
44	52	95	250
66	72.5	140	325
110	123	185	450
132	145	230	550
154	170	275	650
220	245	360	850

Source : Industrial Power Engineering and Applications Handbook – K.C.Agrawal

Conclusion:

This article gave a comprehensive insight on air insulated busduct design and selection guidelines. Bus-duct design must be based on electromagnetic, thermal and mechanical considerations and all dominant factors upon these analyses were briefed in this paper.



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ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS (As on 31.05.2021)

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	5888.25	725.51	26401.96
	Private	22425.83	1080.00	558.00	0.00	24063.83	0.00	2916.00	17942.46	44922.29
	Central	15662.48	250.00	2344.06	0.00	18256.54	1620.00	11484.52	379.00	31740.06
	Sub Total	54747.31	1580.00	5781.26	0.00	62108.57	1620.00	20288.77	19046.97	103064.31
Western Region	State	21500.00	900.00	2849.82	0.00	25249.82	0.00	5446.50	569.28	31265.60
	Private	32847.17	500.00	4676.00	0.00	38023.17	0.00	481.00	28671.58	67175.75
	Central	20133.00	0.00	3280.67	0.00	23413.67	1840.00	1635.00	666.30	27554.97
	Sub Total	74480.17	1400.00	10806.49	0.00	86686.66	1840.00	7562.50	29907.16	125996.32
Southern Region	State	20322.50	0.00	791.98	159.96	21274.44	0.00	11774.83	586.88	33636.15
	Private	12747.00	250.00	5340.24	273.70	18610.95	0.00	0.00	43557.49	62168.44
	Central	11835.02	3390.00	359.58	0.00	15584.60	3320.00	0.00	541.90	19446.50
	Sub Total	44904.52	3640.00	6491.80	433.66	55469.99	3320.00	11774.83	44686.27	115251.09
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	1310.19	7559.19
	Central	14169.48	0.00	0.00	0.00	14169.48	0.00	1005.20	10.00	15184.68
	Sub Total	27772.48	0.00	100.00	0.00	27872.48	0.00	4639.12	1595.30	34106.90
North Eastern Region	State	0.00	0.00	466.36	36.00	502.36	0.00	422.00	233.25	1157.60
	Private	0.00	0.00	24.50	0.00	24.50	0.00	0.00	122.08	146.58
	Central	770.02	0.00	1253.60	0.00	2023.62	0.00	1522.00	30.00	3575.62
	Sub Total	770.02	0.00	1744.46	36.00	2550.48	0.00	1944.00	385.33	4879.80
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	24.87	24.87
	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	35.22	75.27
ALL INDIA	State	65931.50	1150.00	7087.36	236.01	74404.86	0.00	27069.50	2395.27	103869.64
	Private	74173.00	1830.00	10598.74	273.70	86875.45	0.00	3493.00	91628.67	181997.12
	Central	62570.00	3640.00	7237.91	0.00	73447.91	6780.00	15646.72	1632.30	97506.93
	Total	202674.50	6620.00	24924.01	509.71	234728.22	6780.00	46209.22	95656.25	383373.68

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Source: CEA

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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



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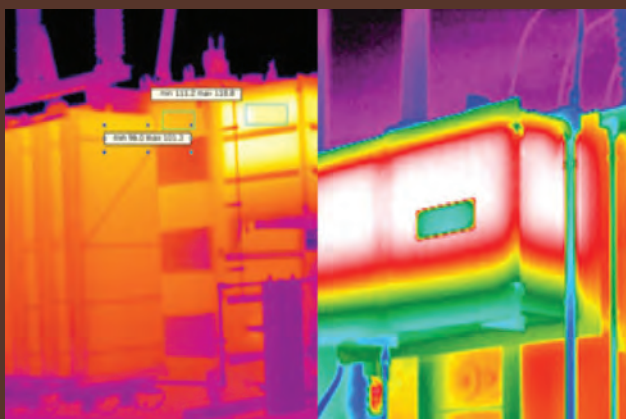
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If an LTC fails, the entire transformer will shut down. Transformer failures can cost your utility millions of dollars, adding overtime pay for workers and additional expenses to expedite repair. This outage will adversely affect numerous distribution circuits and the remaining power grid due to the need to reroute the load to supply the affected circuits. Regularly assessing the health of LTCs and catching problems before a failure occurs is important to prevent downtime and minimize the cost of repairs.



An LTC plays a critical part in a transformer's operation...



Fixed thermal sensors can provide constant 24/7 temperature trending...



A Solution

A thermal imager is a valuable tool for recording or monitoring temperatures in realtime to assess the health of an LTC, as well as ensure that LTCs meet EPRI guidelines. A tap changer should not be hotter than the main tank of the transformer, and it should not be more than 5°C different from the top to bottom – any temperature rise may be an indication of a problem. Fixed thermal sensors, such as the FLIR AX8, can provide constant, 24/7 temperature trending of critical components including LTCs. You can even send data via local network or a cloud-based solution.

The Results

Using fixed thermal sensors for regular condition monitoring can help you understand the temperature trends of an LTC and make critical decisions on the health of the transformer before it fails. You'll get real-time, accurate data for a more efficient inspection. Inspect from outside the fence line and still get real-time, accurate data to work safely and more efficiently.

For more information about FLIR in substations/ transmission, or to schedule a product demonstration visit: www.flir.in/substation-transmission





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From a garage to a global market leader: the couple who founded igus celebrate their 90th birthdays

Together, Günter and Margret Blase laid the foundation for a motion plastics breakthrough in industry in 1964

In 1964, they founded igus in their back yard garage in Cologne-Mülheim. In 2021, the internationally active company supplies customers all over the world with its lubrication-free and maintenance-free motion plastics. On the occasion of the founders' 90th birthday, igus is bringing that garage back to life.



When Günter Blase drives to igus on his 90th birthday, as he does on many days of the year, the company founder can currently see the construction progress of the new company building on the B8. The new building is being erected next to the headquarters in Cologne Porz-Lind and can be identified from a long ways off by its signature yellow pylons. This is where igus GmbH develops and produces motion plastics – high-performance plastics for moving applications. The tribo-polymers are being used all over the world to make moving parts lubrication-free, quiet and lightweight – on theatre stages and in mountain bikes and office furniture,

in offshore drilling rigs, crane systems, ships and space rockets. In 1965, a year after the founding, none of this was imaginable when the first motion plastics were developed in a 55-square-metre garage in Cologne-Mülheim. Blase had recognised the potential of plastic early on and realised that injection moulding could be the key to rationalisation in

industry. So, after eight years of a steady job at a company in the plastics industry, he decided to strike out on his own. His wife, Margret, who also celebrated her 90th birthday this April, supported his decision. As an independent tax advisory agent, she also assumed responsibility for the new company's accounting and finances while her husband focused on production. For six years, igus manufactured motion plastics from the garage as a simple contract manufacturer for a few industrial customers. 

For further information: E-mail: sgeorge@igus.in,
Website: www.igus.in

THE DIARY

GADGETS & ELECTRONIC APPLIANCES 2021

Date: 26 - 28 August 2021
Location: Mumbai, India
Contact: +91 22 67716614

WIRE & CABLE INDIA 2021

Date: 8 - 10 September 2021
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Contact: +91 22 667 89933
Email: ContractorM@md-india.com



LASER WORLD OF PHOTONICS INDIA 2021

Date: 22 - 24 September 2021
Location: Bengaluru, India
Contact: +44 (0)1273 286362
Email: info@world-of-photonics-india.com
Contact: +49 89 949-20325

ELECTRICAL ENERGY STORAGE EXHIBITION 2021

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



POWER2DRIVE INDIA 2021

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



WEBINAR

Electric Vehicles: Types, Batteries, Infrastructure

Date: 12 July 2021
Time: 03:00 PM
Organizer: www.npcindia.gov.in

Adaptive EMC Design for Wide Bandgap Power Converters in Aviation Applications

Date: 21 July 2021
Time: 9:00 AM ET
Organizer: IEEE Power Electronics

Systematic Relationships of Power Converter Topologies through Graph Theory

Date: 3 August 2021
Time: 11:00 AM ET
Organizer: IEEE Power Electronics



IN THE AUGUST 2021 ISSUE

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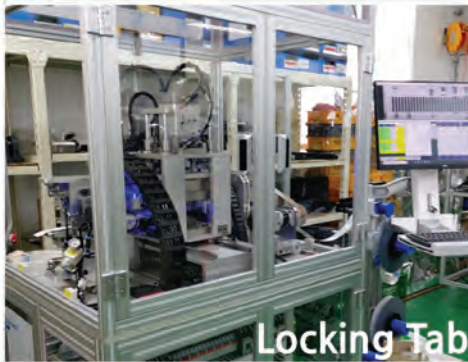


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