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From the Publisher's Desk

Good News on the Last Day of 2020

In the Indian Power Sector, one of the most significant developments of 2020 has come forward on the last day of the year. The Asian Development Bank (ADB) and the Government of India on 31st December 2020 have signed a \$100 million loan to modernise and upgrade the power distribution system to enhance the quality and reliability of electricity supply in Bengaluru city in the state of Karnataka. Bengaluru city accommodates the third largest crowd of people after Mumbai and Delhi. Thus, the city's power distribution system is definitely supposed to be of global standard.

As per Dr. C. S. Mohapatra, Additional Secretary, Department of Economic Affairs in the Ministry of Finance, who signed the loan agreement on behalf of the GoI, with this loan, conversion of overhead distribution lines into underground cables will help build an energy-efficient distribution network in Bengaluru, reduce technical and commercial losses and minimize electricity outage resulting from natural hazards.

Also, in parallel to underground distribution cables, over 2,800 km of fibre optical cables will be installed to strengthen communication network. Moving about 7,200 km of distribution lines underground will help reduce technical and commercial losses by about 30%. The fibre optical cables will be used for smart metering systems, Distribution Automation System (DAS) in the distribution grid, and other communication networks. The project will install 1,700 automated ring main units adapted with a DAS to monitor and control the distribution line switchgears from the control centre.

Thus, it is a boon for the city from all angles, consumers will enjoy better power supply and Bangalore Electricity Supply Company Limited (BESCOM) will see enhanced profitability.

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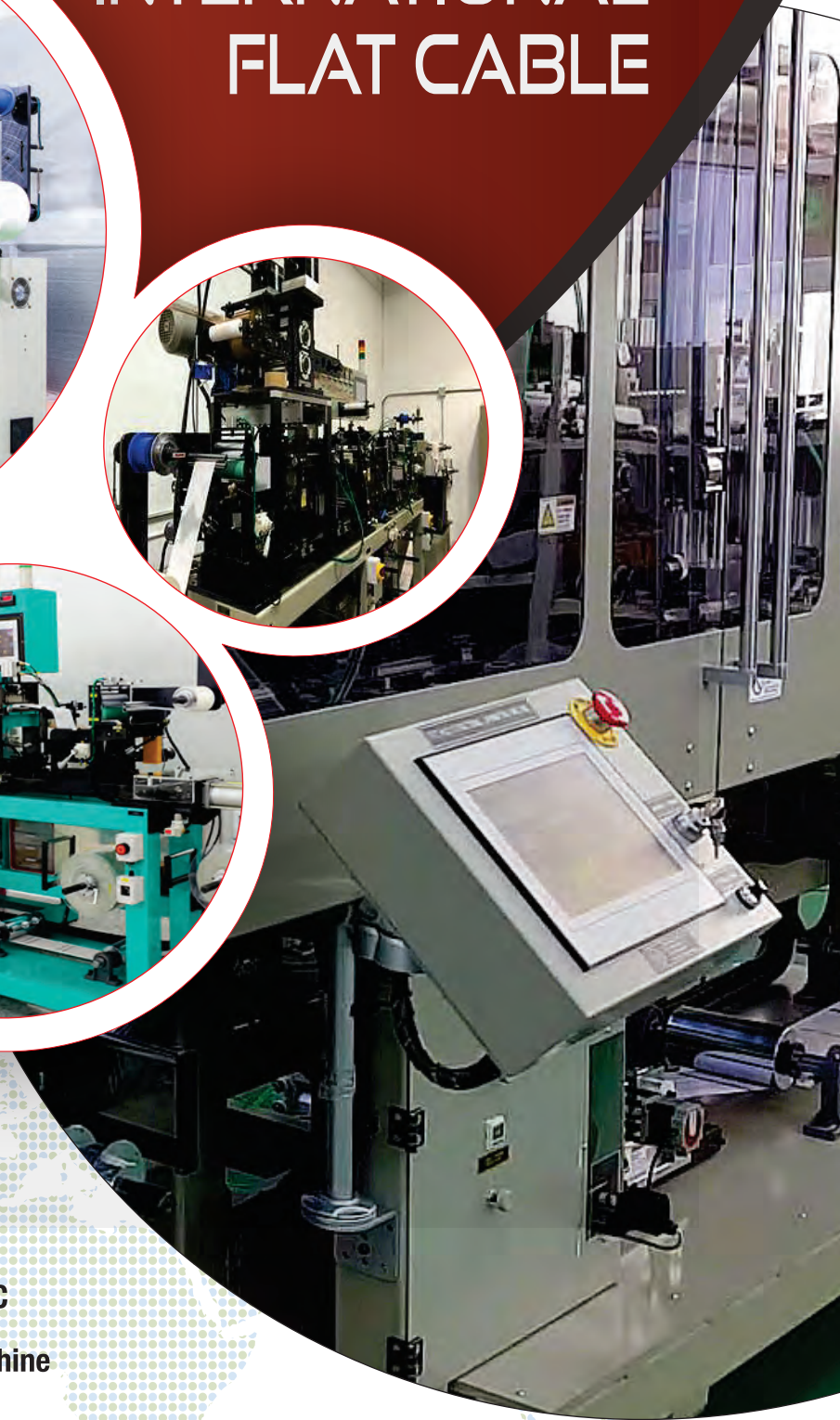
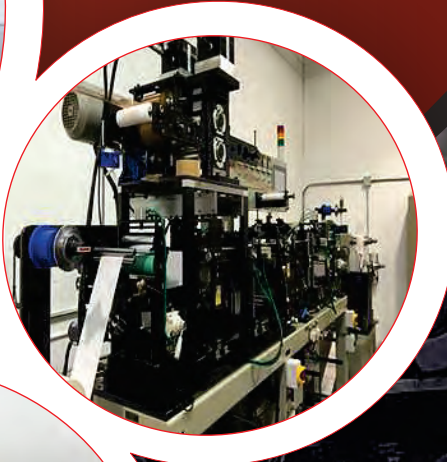
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Contents

Vol. 61 | No. 01 | January 2021

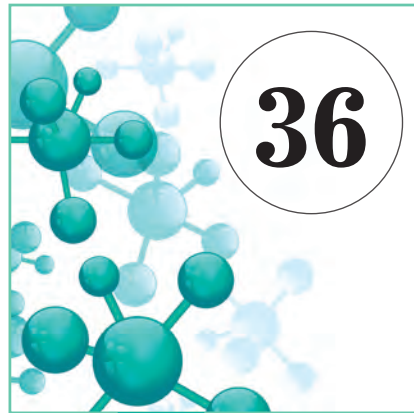
Cover Story

Artificial Intelligence
in T&M Devices



Review

Single Phase Matrix
Converter Applications -
(Part I)

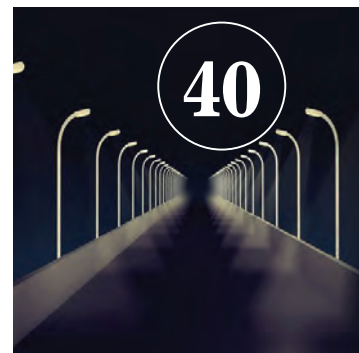


Innovation

Advanced Polyamide
Compounds for
Connectors

Performance Analysis

Photovoltaic-Fed
Multilevel Inverter



Case Study

Energy Efficient LED
Street Lighting

REGULARS

- 4 Publisher's Letter
- 8 News
- 44 Statistics
- 49 Product Avenue
- 45 Special Feature
- 49 Index of Advertisers
- 50 Events



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Transformers Under Test

Transformers Loss Measuring System

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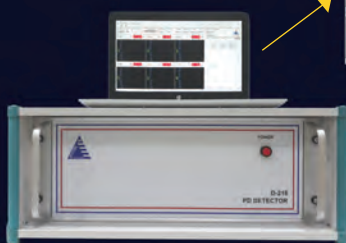
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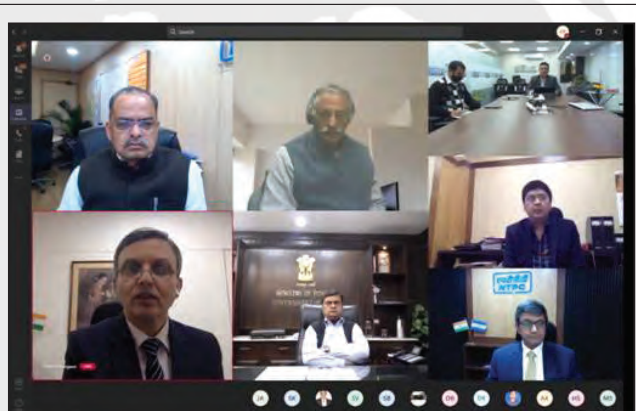
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NVNN WORKS TOWARDS FINDING GREENER SOLUTIONS

Recently, R. K. Singh, the Union Minister of State (I/C) for Power and New & RE, launched the Green Charcoal Hackathon organised by NVVN (NTPC Vidyut Vyapar Nigam), a wholly-owned subsidiary company of NTPC Ltd.

With a view to fast-tracking the technology development, NVVN, in partnership with EESL organises technology challenge aptly named as Green Charcoal Hackathon. The purpose of the event is to leverage the innovative Indian mind to bridge the technology gap, with the prime objective to clean the air by eliminating farm fire, producing renewable energy out of the agro residue, to promote local entrepreneurship and to increase the income of the farmers.



R. K. Singh and other officials during the inauguration of Green Charcoal Hackathon...

Speaking on the occasion, Singh said, “The Hackathon displays the spirit of innovation, which pervades NTPC. Any organisation has to have this spirit of innovation to grow and prosper or otherwise, it would fade away. I am sure that the NTPC management has told all young engineers that innovation and new ideas are encouraged.”

The minister further added, “This (Hackathon) is also innovation in the pursuit

of reducing our carbon footprint. From that point of view, all competitors in the Hackathon should keep in mind that the process of converting this (agro residue) to charcoal should not lead to emissions. Another key thing is the commercial model, which will depend on the cost of both the machine and charcoal production. I am sure we will come out with a machine, which is economical.”

SJVN, IREDA SIGN MOU FOR GREEN ENERGY PROJECTS

The partnership of SJVN and IREDA is expected to be long lasting and fruitful for both...

Recently, SJVN Limited, a PSU under Ministry of Power has entered in an MoU with Indian Renewable Energy Development Agency Ltd. (IREDA), a PSU under Ministry of New & Renewable Energy. According to the MoU signed, IREDA will provide its services to SJVN for Green Energy projects. The MoU was signed by Nand Lal Sharma, CMD, SJVN; and Pradip Kumar Das, CMD, IREDA in the presence of Akhileshwar Singh, Director (Finance), SJVN; Surinder Pal Bansal, Director (Civil), SJVN; Chintan Shah, Director (Technical), IREDA; and other senior officials through virtual mode.

On the occasion, Sharma said that as per the MoU, IREDA will undertake Techno-Financial due diligence of Renewable Energy, Energy Efficiency & Conservation Projects for SJVN. Under the MoU,

IREDA will also assist SJVN in developing an action plan to create and acquire Renewable Energy projects for the next five years. He also added that SJVN is committed to contribute in realizing the renewable energy target of 175 GW by 2022 set by the Prime Minister. The steps in this direction have already been taken – and presently SJVN is developing 100 MW Dholera Solar Power Project & 100 MW Raghanseda Solar Power Project in Gujarat.

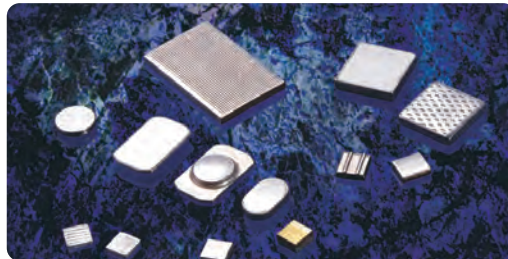
Das said, “The MoU highlights IREDA’s continuous efforts for the development of Renewable Energy sector in line with the Prime Minister’s vision of Aatmanirbhar Bharat. This is a transformational opportunity for IREDA and SJVN to work together forming a perfect synergy between both the organisation.”

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POWER SECRETARY VISITS CHANGLANG IN ARUNACHAL PRADESH

Power Secretary, Government of India, Sanjiv Nandan Sahai recently visited Changlang district of Arunachal Pradesh on 3rd December 2020. During the visit the Secretary was accompanied by Tanmay Kumar, Joint Secretary (Hydro), A.K. Singh, CMD, NHPC and K. Sreekant, CMD, PGCIL.

On his arrival at Changlang helipad, the Secretary (Power)

was accorded a hearty welcome by Tesam Pongte, Dy. Speaker, Arunachal Pradesh Legislative Assembly and Phosum Khimhum, MLA, Changlang (South) alongwith Deputy Commissioner (I/C), Superintendent of Police, Changlang district and Senior Officials from NHPC and PGCIL.

At the Circuit House, Changlang, Secretary (Power) was given a warm traditional welcome by the local residents. It may be recalled that the visiting Secretary (Power), Govt.



The visitor group with local officials at Changlang...

of India served the people of Changlang as Deputy Commissioner during the year 1991-94. The local residents recalled the immense developmental works undertaken at Changlang during the tenure of Sanjiv Nandan Sahai.

Sahai took a review meeting on the development of mini

and micro-hydro projects of Changlang district. The meeting was chaired by Phosum Khimhum, Hon'ble MLA, Changlang (South) wherein the Arunachal Pradesh State Hydro Power Department briefed about the various issues associated with mini and micro-hydro projects in the district. The issues related to erection of transmission lines by PGCIL were also discussed at length – and the visiting Secretary (Power) assured all necessary help and support from the Ministry. **BT**

NTPC SIGNS MoU WITH IIFM, BHOPAL

Narmada Landscape Restoration Project will greatly benefit the city of Indore, which draws over 60% of its municipal water supply from River Narmada...

NTPC Ltd. has recently signed a Memorandum of Understanding (MoU) with Indian Institute of Forest Management (IIFM), Bhopal, to implement the Narmada Landscape Restoration Project. The program is in partnership with a grant in aid from NTPC Ltd., and United States Agency for International Development (USAID) in equal proportions.

The 4-year project will be implemented in Khargone District of Madhya Pradesh, in the catchments of selected tributaries of the River Narmada between Omkareshwar and Maheshwar dams. IIFM, Bhopal, an autonomous Institute under the Ministry of Environment, Forest and Climate Change (MoEF&CC), GoI with the grant-in-aid from NTPC, Ltd. will be jointly implementing this project with Global Green Growth Institute (GGGI), an intergovernmental organization

that promotes sustainable and inclusive economic growth in emerging economies. GGGI will participate in this project with funding support from USAID, the international development arm of the US Government.

NLRP's collaborative and participatory approach will demonstrate the interdependency of the upstream sustainably managed forest and farm practices on downstream water resources. The project aims to establish an incentivisation mechanism that can continue to support the riparian forest and farm communities of the Narmada basin to maintain sustainable landscape practices. This is expected to positively impact the water quality and quantity in the Narmada tributaries. Through NLRP, NTPC Ltd. is extending its support to demonstrate nature-based solutions for enhancing ecosystem services, primarily water. **BT**



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AMP ENERGY INDIA UNVEILS NEW RE PROJECT IN EASTERN INDIA

Tata Hitachi; a joint venture company between India's Tata Motors and Hitachi Construction Machinery of Japan; partnered with Amp Energy to set up an onsite solar power unit at their facility in Kharagpur, West Bengal. The solar plant has been commissioned on 11th November, 2020. This project was a repeat order to Amp Energy India from Tata Hitachi. Amp has an operational 5 MW solar project supplying power to Tata Hitachi at their factory premises in Kharagpur since 2018.

With this project, Amp has expanded the capacity to 10.5MW making it the largest behind-the-meter project in Eastern India. The Power Purchase Agreement (PPA) with Amp for procurement of solar power is for 25 years and will generate 7,150 MWh of green energy



The onsite solar power unit at Tata Hitachi's plant...

in a year, equivalent to reducing 5,055 MT of carbon emissions annually. The project execution was done following all compliances placed to manage the COVID-19 situation.

“Tata Hitachi is the best demonstration project of Amp's Programmatic Approach of building sustainable partnerships through project types and

geographies. We are supplying solar power to them through open access in Karnataka and behind-the-meter in West Bengal. This repeat order from them is a testimonial to our service quality and deliverability. This partnership will ensure that the growth in the construction sector is on the back of solid ecosystem of solar power generation and demand in India,” said Pinaki Bhattacharyya, MD and CEO, Amp Energy India. E1

TP RENEWABLE MICROGRID INAUGURATES ITS FIRST BIO-GAS GENERATING PLANT

The 5 kW plant commenced operations on 'National Energy Conservation Day,' i.e., 14th December 2020...

TP Renewable Microgrid (TPRMG), a wholly subsidiary of Tata Power, has inaugurated its first 5kW Bio-gas generating plant at Kamalpura (Basaitha) village in Muzaffarpur district of Bihar. TPRMG constructed this plant in association with Grassroots Energy. The plant consumes cow dung, which is procured from nearby villages and then it is processed through a Bio-digester to generate methane gas. This gas is then used to drive a specially designed 5kW generator to generate electricity, which is fed to the adjoining 30kW microgrid generating station. It is interesting to note that the residue of the Bio-gas plant is processed to create organic manure for the farmers.

Commenting on the project, Praveer Sinha, CEO & MD, Tata Power, said, “It is a proud moment for us,

we are constructively moving ahead with our agenda to be the foremost Renewable Energy Company of India and continue to support the nation to achieve its green energy goals. We would like to congratulate our team to complete this project in a record time – and be able to commence the operation of this plant on National Energy Conservation Day.”

Focusing on the potential of this success, Manoj Gupta, CEO, TP Renewable Microgrid, said, “It's a major achievement for us. We are proud to collaborate with Grassroot Energy for our first Bio-gas plant. With this low-cost energy-efficient technology to produce purified biogas in a cost-effective manner, we will address diverse market segments currently using conventional energy sources.” E1

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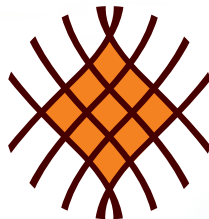
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VIKRAM SOLAR INSTALLS SOLAR PLANT IN ITS MANUFACTURING UNIT

Vikram Solar has commissioned a rooftop solar project on its manufacturing facility in Falta, Kolkata. This rooftop plant is of 987.2 kW capacity – and consists of 2584 solar panels, covering an area of 6500 sq. meter.

The plant consists of 2584 solar panels ranging from 325Wp – 400Wp. The panels used are Vikram Solar's SOMERA Monocrystalline & Half-Cut & full cell that will generate an annual yield of 1409.58 MWh. To store the energy generated from the plant they have installed 14 Solar grid connected inverters from Sungrow, Huawei & Solis.

This is a unique project of its type – as it uses 12 different types of modules and a mix of half-cut & full-cut cells in the modules manufactured by Vikram Solar.



Solar plant in Vikram Solar's Falta plant...

Constructing the project with the difference in module size was the main challenge faced – and due to which the module mounting structures had to be adjusted as per requirement for each row and the module to module looping as there were mixing of half-cut and full-cut module.

Commenting on the development, Saibaba Vutukuri, CEO, Vikram Solar, said, "We at Vikram Solar are in constant efforts to bring out innovation and modification in everything we do and thus lead by the example and this project proves the phrase "Talk the Talk and Walk the Walk". This project not only caters to the captive energy requirement of the manufacturing unit but also contributes towards making it a green energy unit."

ADANI ELECTRICITY RELAUNCHES ITS CEILING FAN PROGRAM

Consumers saved over 7.5 MU cumulatively from the past ceiling fans program. AEML is now looking forward to the increased savings...

Post the success of last year's energy saving, ceiling fan program, Adani Electricity Mumbai Limited (AEML) has relaunched the same for all its residential customers in December 2020. These fans will enable the customers to have maximum savings in terms of their electricity bills, as the ceiling fans utilize 60% less electricity than average. During the past three similar programs, AEML had distributed 25 thousand energy efficient 5 star ceiling fans and 6500 refrigerators at subsidised cost to its residential consumers. This year, the company is relaunched the initiative at a larger scale with over 50 thousand ceiling fans.

In a bid to reduce carbon emissions, promote energy saving and boost sustainable consumption, the utility company is furthering this initiative.

Since energy saving appliances cost more in the market, AEML has made it more accessible by providing rebates of 25-30% on the purchase. This program will be made available to all Adani Electricity residential consumers in its distribution areas.

According to an AEML spokesperson, "Consumer satisfaction is the primary focus at AEML and we undertake all efforts to ensure that all possible benefits are provided to them. This program has a huge potential for energy saving, as ceiling fans are used up to 10-12 hours a day on an average, in each household. By buying these appliances, the customers would not only avail monetary benefits but also contribute towards lowering carbon emissions."

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

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

Weight without oil : 268 kgs

Oil Quantity : 135 litres

Oil quantity in Kgs : 115 kgs



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

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

Weight without oil : 280 kgs

Oil Quantity : 200 litres

Oil quantity in Kgs : 170 kgs



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

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

Weight without oil : 230 kgs

Oil Quantity : 110 litres

Oil quantity in Kgs : 94 kgs

Started Supplies

IBERDROLA ENTERS THE POLISH MARKET

Iberdrola has reached an agreement to acquire a 50% stake in developer Sea Wind, which has seven-project pipeline in early stages of development, with a potential capacity up to 7.3 GW. The deal allows Iberdrola to further enhance its strategy of geographical diversification in markets with favourable investment conditions, such as the A-credit-rated Poland. The move also allows the company to position itself in the initial stage of development of the country's offshore wind market, with great growth potential in the coming decades.

With this transaction Iberdrola is also promoting the creation of an offshore wind hub in the Baltic Sea, which would act as the epicentre of offshore services and local content for the company's projects in Germany, Poland and Sweden.



Ignacio Galán in West of Duddon Sands...

The agreement between Iberdrola and Sea Wind creates a solid alliance, which is also open to the incorporation of Polish partners in the future. Poland has implemented a strategy to decarbonise its energy mix while boosting energy independence and has plans to install up to 8 GW of offshore wind capacity by 2030.

Sea Wind has an experienced team in offshore wind development and in-depth knowledge of the Polish market. Both companies previously worked together in the development of the Baltic Eagle project off the German coast.

The size of the Polish offshore wind market and its geographical location in the Baltic Sea allows Iberdrola to commit technical and financial capacities to a long-term vision, aligned with the country's energy plans. **BI**

GOGORO TO RECEIVE F&S AWARD

In a typical usage scenario, a customer rides up to a Gogoro GoStation, places used batteries in the two open slots, and six seconds later, receives pre-charged batteries in exchange...

Based on its recent analysis of the global swappable battery electric scooter market, Frost & Sullivan (F&S) has recognizing Taiwan-based Gogoro with the 2020 Global Company of the Year Award for its Gogoro Network. Gogoro Network is an intelligent energy platform that combines the power of connectivity, artificial intelligence and machine learning to create a new generation of swappable refueling that is smart, scalable and continually optimizing itself.

Gogoro has grown from 70 GoStations in 2015 to nearly 2,000 stations in 2020, accessed by nearly 360,000 customers every month. The company strategically places these stations every 500 meters in places such as malls, convenience stores, parking structures, and coffee shops. It has

established consumer battery swapping on a mass scale, performing 265,000 battery swaps each day (135 million to date). It demonstrates that its business model is viable and practical.

"The company expects to build the service out in several cities outside of Taiwan. As a testament to its success with GoStations, its vehicles, and the overall Gogoro Network, the company's ridership developed their own community, forming multiple forums and networks and becoming ambassadors for climate change and clean energy transportation. All this comes together via the innovative Gogoro Network, which utilizes cloud computing to connect to GoStations, battery swapping stations designed to exchange used batteries for charged ones," said Vishwas Shankar, Research Director at Frost & Sullivan. **BI**

MASDAR, PT PJBI FORM JOINT VENTURE

Masdar, one of the world's leading renewable energy companies and PT PJBI, a subsidiary of Indonesia's state electricity company PT PLN (Persero) – have formed a joint venture to drive the development

of the Cirata Floating Photovoltaic Power Plant – Indonesia's first floating PV project.

The new company, PT. Pembangkitan Jawa Bali Masdar Solar Energi (PMSE), was formally announced at a ceremony at the Cirata reservoir in West Java, where the project will be located. The event was held as part of UAE-Indonesia Week, taking place throughout this week to mark the close ties between the two nations.

“This partnership will help to strengthen the already-powerful ties of friendship and bilateral collaboration between the UAE and Indonesia. The UAE has



Cirata at a glance... (Source: PR Newswire)

committed to not only diversifying its energy mix but to extending its expertise outside its own borders. The Cirata project marks the UAE's first investment in Indonesia's renewable energy sector, and will contribute to the nation's sustainable

development,” said His Excellency Abdulla Salem Al Dhaheri, the UAE Ambassador to Indonesia and the ASEAN region.

Upon completion, the Cirata Floating Photovoltaic Power Plant, which will be located on a 250-hectare plot on the 6200-hectare reservoir, will power 50,000 homes, offset 214,000 tons of carbon dioxide emissions and contribute to the creation of up to 800 jobs. It is the largest of its kind in Southeast Asia and one of the largest in the world, and is scheduled to start construction in the first part of 2021. 

AMARENCO GROUP ENTERS THE SPANISH SOLAR PV MARKET

Amarenco has an ambitious Solar PV plan for both Portugal and Spain...

Amarenco Group has signed the acquisition of a 49.94MWp Solar PV plant from Hanwha Energy. This is the first expansion by the Irish based Solar IPP into the Spanish market. ‘Las Naranjillas’ project is located in Carmona, Seville with an area of 137 hectares covered by 121,800 photovoltaic modules. The plant will produce enough energy to meet the electricity demand of 13,997 homes. In addition, 51,977 tonnes of CO₂ will be removed from the atmosphere, which is equivalent to the consumption of 10,192 vehicles. Spain and Portugal have some of the best irradiation levels in Europe and the projects can operate without State subsidy. Notably, 180 jobs were created during construction of the photovoltaic plant.

Alain Desvigne, of Amarenco Group said, “Las Naranjillas sets up the first milestone on our relationship with Hanwha Energy and we look forward to repeating deals such as this with Hanwha Energy in the future.

Iberia is now a key market focus for Amarenco going forward and we expect this market to be a significant part of the balance sheet going forward.”

Ik Pyo Kim, of Hanwha Energy said, “Starting with the current project pipeline of over 1GW in Spain, we will actively proceed more than 6 GW of solar projects in total in the European market including Spain to build further meaningful achievements in the solar PV area and also across diverse renewable energy areas as a part of 10-year strategic plan.”

Amarenco Group is a leading Solar IPP operating in Europe, overseas departments and territories, Middle East and Asia. The group develops, finances, builds and operates commercial and utility-scale solar PV projects. It has successfully delivered over 2,000 solar photovoltaic infrastructure projects working in close collaboration with farmers, local authorities real estate owners and businesses for more than a decade. 

R. GERA BECOMES THE DIRECTOR (IND. SYSTEMS & PRODUCTS), BHEL



Renuka Gera has an across-the-board experience in many engineering fields...

Renuka Gera, 57, has recently assumed the charge as Director (Industrial Systems & Products) of the Public Sector Engineering and Manufacturing Enterprise. BHEL Significantly, she is the first woman employee of BHEL to reach the level of Director.

Prior to this, Gera was heading BHEL's Industry Sector business segment as Executive Director. She is an Electronics and Communication engineering graduate from Delhi College of Engineering. Gera started her career

with BHEL as an Engineer Trainee in the company's Transmission Business Group, in 1984. She has over 36 years of holistic and hands-on experience in various verticals of the Industry Sector including, driving business development and diversification initiatives in Energy Storage Systems, Electric Mobility, Railway Electrification, Transportation, Defence, Transmission Systems including High Voltage Direct Current Transmission (HVDC), Renewable Energy and Water Management Systems. **ET**

M. SAXENA ASSUMES THE CHARGE OF (CVO) OF IREDA



Manisha Saxena has vast experience in Indirect Taxes and GST...

Manisha Saxena, IRS 2000 (C&CE), has been appointed as Chief Vigilance Officer (CVO) of IREDA on 14th December, 2020. Saxena is an Indian Revenue Service (IRS – Customs & Central Excise) Officer of 2000-batch. Before joining IREDA, she was posted as Commissioner in Goods & Service Tax Commissionerate, Vadodara under the Central Board of Indirect Taxes and Customs.

Saxena did her Master's in Public Administration after graduating in

Commerce from the University of Rajasthan. She has also done a Diploma in Human Resource Management from the same university. She is also an avid reader who has special interest in music and movies.

Speaking on the occasion, CMD IREDA, Pradip Kumar Das said, "CVOs play a consistent role in bringing transparency and compliance in the system. All IREDA employees should leverage from the new CVO's experience in Indirect Taxes and GST." **ET**

B. BASU TAKES OVER AS THE DIRECTOR (PROJECTS), NHPC



Biswajit Basu has worked in various projects during construction and O&M stages...

Biswajit Basu has been given the charge of Director (Projects), NHPC Limited on 1st January 2021. Prior to his appointment as Director (Projects), he held the position of Chief General Manager, Project Monitoring and Support Group Division, NHPC.

Born on 30th December, 1963, Basu is an electrical engineering graduate from Tripura Engineering College (Now NIT, Agartala). He joined NHPC in year 1987 as a Trainee Engineer (Electrical) at Loktak Power Station, Manipur and steadily has risen to the professional ladder in NHPC.

During his career spanning around 33 years in NHPC, Basu has worked in various projects during construction and O&M stages. The projects where he was posted during their Construction Stage were Kurichu (60 MW, Bhutan), Chamara-II (300 MW, Himachal Pradesh), Subansiri Lower (2000 MW, Arunachal Pradesh and Assam), Sippi (4 MW, Arunachal Pradesh), Loktak Down Stream (66 MW, Manipur), Dibang (2880 MW, Arunachal Pradesh). He was also posted in O&M Projects such as Loktak (105 MW, Manipur), Rangit (60 MW, Sikkim). **ET**



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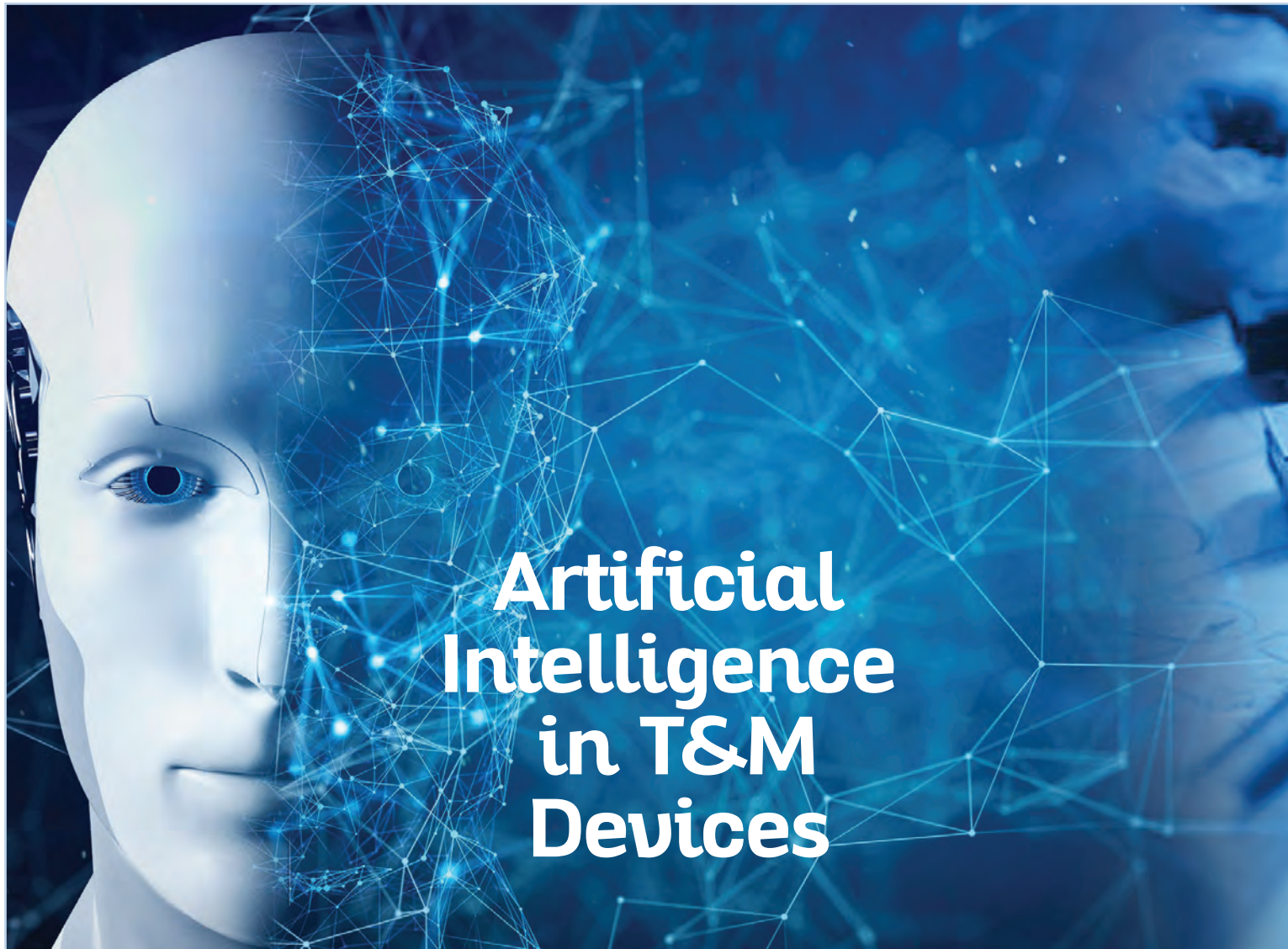
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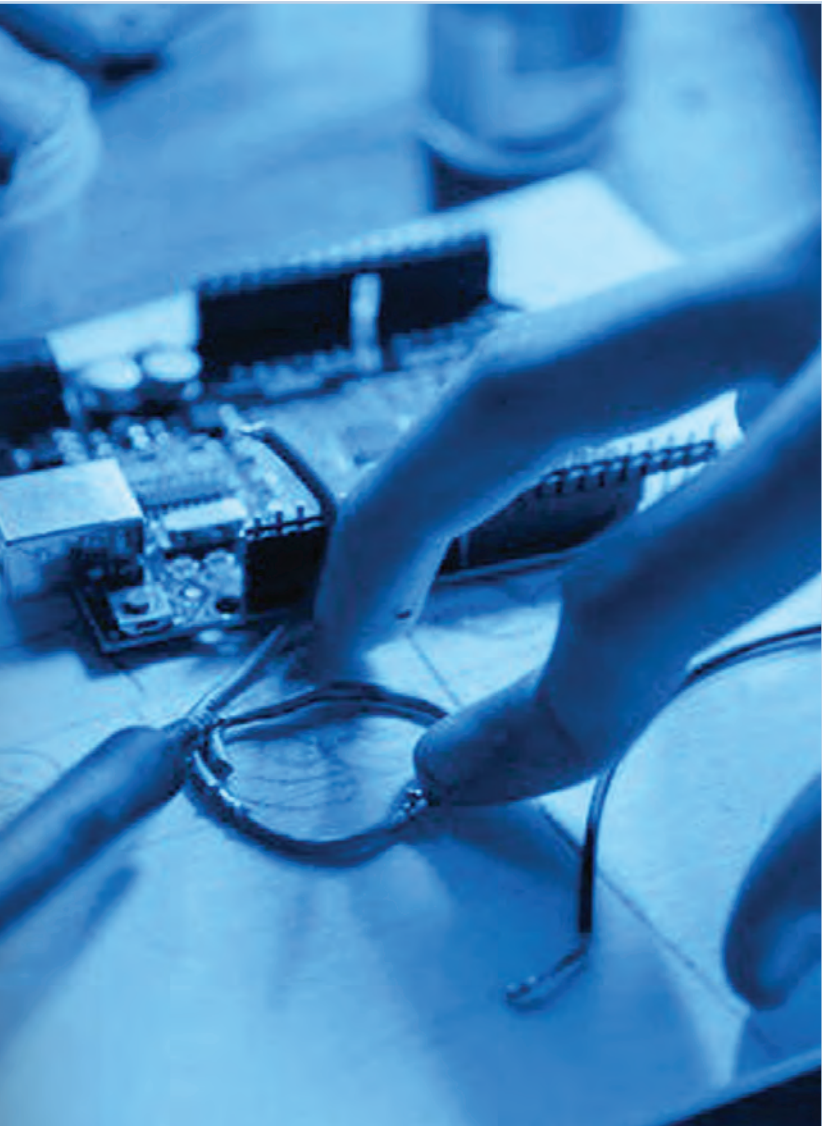


Artificial Intelligence in T&M Devices

Many new technologies for testing and measuring are waiting to enter the market in 2021, which will monitor and predict the chance of breakdown automatically. The new Artificial Intelligence (AI) based Test & Measurement devices will not only ease the job of maintenance but also drastically reduce the downtime...

Although 2020 was a gloomy year as far as the progress of the overall human civilization is concerned, there are plenty of innovations that will ease the future course of progress. The field of Electrical Engineering has evolved further – though a fairly good amount of time has been lost due to repeatedly declared lockdown to control the spread of COVID – 19 at all parts of the world.

In 2020, globally, inclusion of Artificial Intelligence (AI) in Electrical T&M instruments has boosted up the capability, reliability and functionality of many T&M devices. Several research works too have been conducted in



this field. Let us have a look at a few of the interesting developments in this area.

PCB testing

Today's versatile use of Printed Circuit Boards (PCBs) and the increasing need to reduce their form factors are leading to more and more stringent requirements with regard to design and quality assurance. In good PCB design, it is very important to avoid any kind of electrical interference and ensure electromagnetic compatibility. The Fraunhofer Institute for Applied Information Technology FIT has developed a modular AI platform to optimize the design and testing of PCBs, thereby reducing the requisite outlay by as much as 20 per cent.

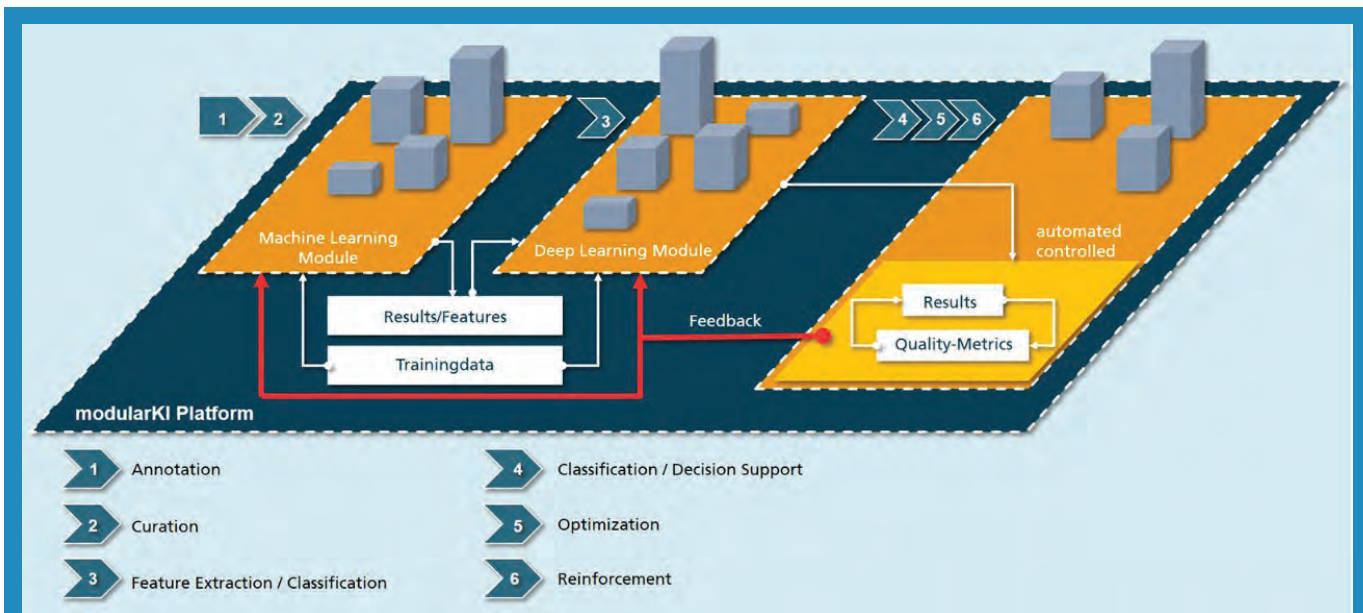
According to a communiqué from the Institute, "When designing a PCB for a new application, every care is taken to make best possible use of the available space and to position components as close together as possible without risking a failure. At present, this process relies largely on the experience of engineers, whose designs must then be tested in real trials. A further complication is that results are not stringently documented, meaning that error-prone designs undergo repeat testing, which leads to increased costs."

Drawback of the current system: As per the communiqué, given their complex design, PCBs must be manufactured to extremely exacting specifications. For this reason, each completed PCB undergoes, at the very least, Automated Optical Inspection (AOI). This uses image analysis techniques in order to determine that the PCB has been produced as per design and therefore does not have any technical defects. At present, however, this method generates a high false negative rate, i.e., a lot of fully functional PCBs are incorrectly classified as defective.

These supposedly defective PCBs must then be inspected once again by hand, either visually or by means of measuring equipment. In other words, an unacceptably high false negative rate means that non-defective PCBs are being rejected and then require re-inspection, which in turn results in higher costs. On the other hand, if this rate is too low, the follow-up costs are high as a result of defective components entering the supply chain. It is difficult to achieve an ideal true positive or false negative rate based on human inspection, since human errors also enter into the equation.

The development: The work at Fraunhofer FIT shows what a future inspection process can look like. As in conventional Automated Optical Inspection (AOI), a camera records images of the PCB. This improves the quality of the decisions made by the algorithms. Here, it is vital that the modules are provided with high-quality training data. Initially, the modules for machine learning and deep learning are fed with a good selection of data.

"The modular design means we can harness several algorithms, which continually enhance their own performance. Data generated by ongoing automated inspection of components flows back to the algorithm. This then provides the basis for a process of self-learning by the artificial intelligence module. This permanent feedback enhances the database and optimizes the true negative rate. Early estimates from industry indicate this



The modular platform comprises modules for machine learning, deep learning and artificial intelligence. In turn, each module features algorithms trained to undertake different tasks. For example, an algorithm from the first type of module (left) not only classifies input data but also extracts features from that data, which then provides the input for further modules...

Source: Fraunhofer FIT

could reduce the use of production resources by around 20 per cent,” explained Timo Brune, Project manager at Fraunhofer FIT.

One of the appreciable advantages of these modules is – user can train the modules themselves, on the basis of their own process and production data. This means that companies retain control of their own data and are not required to send it to an external server, for example. This toolkit of algorithms can be combined at will for application to specific problems.

Once trained, the algorithms can also be used to design new PCBs. This ends the lengthy and costly procedure of trial and error – whereby components are arranged on the board until the optimal configuration is found. Instead, an algorithm helps to predict which configuration, from a host of options, offers the best functionality.

The PCB application is merely one instance of where a modular, self-enhancing algorithm platform can enhance design and quality assurance. In fact, this approach from Fraunhofer FIT can be applied to many other electrical systems. Here, too, processes can be optimized in order to achieve significant savings in time and production costs.

Data logging and recording

Yokogawa is a leading manufacturer of recorders, and

also holds a solid track record in the consulting industry with the use of machine learning to predict and analyze both equipment anomalies and product quality for manufacturers. The company’s Artificial Intelligence (AI)-enabled versions of the GX series panel-mount type paperless recorders, GP series portable paperless recorders, and GA10 data logging software, which are components of the highly operable and expandable SMARTDAC+ data acquisition and control system. These can be used for monitoring and recording of voltage, current and many other process variables; evaluation of performance in equipment management, production, and product development; safety and reliability evaluation during product quality inspection processes.

According to the company, there is a rising interest in the manufacturing sector in the use of AI to prevent equipment malfunctions and maximize productivity. At the same time, AI technologies have a steep learning curve, and the introduction of existing AI-enabled products and the analysis of their data is typically beyond the expertise of novices to this field.

Recorders are used in manufacturing and R&D to acquire, display, and record data on voltage, current, temperature, flow rate, pressure, and other process variables. In order to improve productivity and product quality, Yokogawa is now building user-friendly AI-related



functions into its recorders, data logging software and controllers. Just to cite an example, these functions now enable GX/GP series recorders to draw waveforms on screen that are predicted based on the real-time analysis of collected data – so that users can anticipate and correct problems early on, before they have a chance to escalate. Also, the company’s e-RT3 Plus edge computing platform has been enhanced with the addition of support for Python, a programming language that is widely used in AI R&D.

A new approach to support maintenance

Senzoro has developed a novel approach to predictive maintenance combining ultrasound with artificial intelligence. Ultrasound has been used by NASA for many years and Senzoro has combined this as a world first with artificial intelligence for the broad mass market.

As per the company, there is a lot of generic knowledge available, but the actual competitive advantage is achieved with specific data from your own systems and machines. To do this, combine the specific data with the publicly available knowledge, whereby the forecast of the Remaining Service Life (RUL) becomes more and more accurate. The earlier you start to ‘digitize’ the health of

your assets, the greater is your advantage. It’s difficult or impossible to accelerate real data over time. There are test stands and ‘synthetic data’, but these can never be compared with real data from factories.

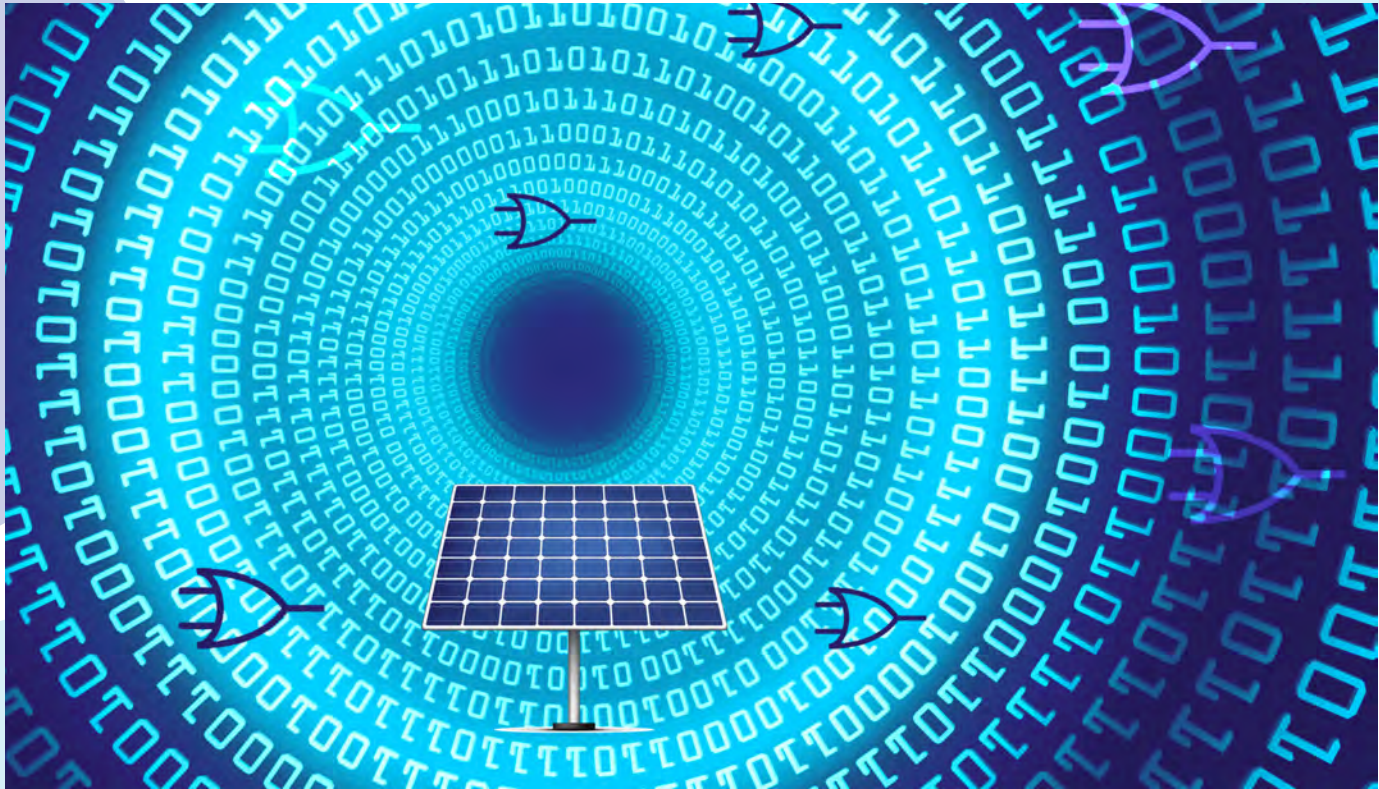
They say ‘PF (Potential Failure) curve’ describes how early you can recognize a potential failure. It is well known that ultrasound is the earliest technology to detect potential failures. The human senses are more in the ‘late stage’ (for example, if you already hear the “rattling noise”, the failure is not far away). Modern technologies give you a time buffer to carry out the exchange as efficiently and cost-effectively as possible. The technology has a high potential to detect the chance of failure of the bearings and other components in motors, generators and other electrical equipment.

Conclusion

The year (2020) of lost-productivity has created an avenue for better productivity in the year 2021 and henceforth. In the small span of this article, all the developments could not be included, thus there are many other technologies available now, which will help in improving productivity of electrically operated machinery. May the new technologies find the widest applications!

19

PHOTOVOLTAIIC-FED MULTILEVEL INVERTER



The quality of power is most significant in the field of the power system. Many techniques are used for improving the same. In this article, the quality of the Power and THD values for different switching pulses are to be analyzed. Here, the existing system comprises a Solar Photovoltaic array, boost converter, Multilevel inverter with normal switching pulse, and RLC Load. The proposed system comprises a solar photovoltaic array fed multilevel inverter with Pseudorandom Binary Switching (PRBS) pulse, buck-boost converter, and three-phase induction motor. The Pseudo-Random Binary Sequence generator consists of shift register and logic gates...

Power quality is an important aspect of the power sector. There are different types of methods and techniques, which are used to solve the power quality issues or threats. In recent years, the renewable energy has played a vital role in the power market. The solar panel is used for different types of applications. The solar panels are operated based on solar radiation and solar temperature. Solar is the best and most efficient energy – when compared with all other renewable energy sources. In the converter circuits, the switching devices decide the efficiency of the motor because it causes losses and harmonics.

This article consists of normal switching pulses in the existing system and pseudo-random switching pulses in the proposed system. The existing system consists of a Photovoltaic panel, Boost converter, Multilevel inverter with normal Switching pulse, and RLE load. The proposed system consists of a solar

photovoltaic panel, Boost converter, Multilevel inverter with Pseudorandom binary switching pulse, and three-phase induction motor.

The solar panel acts as an input source for the proposed system. Figure 1 depicts the block diagram of the proposed system. The solar photovoltaic panel generates the input voltage and that voltage is given to boost converter. The boost converter boosts up the voltage in the 1:2 ratio. The multilevel inverter with PRBS switching pulse converts DC voltage to AC voltage and the three-phase induction motor is acted as load.

The main contribution of the article is 1) The third harmonics in the existing and proposed system is analyzed. 2) The voltage and current Total harmonics distortion values are measured. 3) In the proposed system the Pseudorandom sequence gating pulse was used and efficiency was improved.

The proposed system is designed with a solar panel for an input voltage of 75 VDC and a disturbance voltage of 8VDC for simulating the system. The converter operates with 150 VDC and it boosts the voltage to 290 VDC with a 1:2 ratio. The inverter converter the 290 VDC DC supply to 290 VAC for a single-phase AC supply. The three-phase induction motor acts as a load and the motor is operated with a 460 VAC three-phase supply.

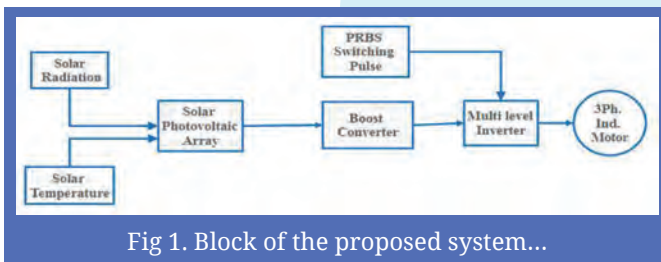


Fig 1. Block of the proposed system...

Photovoltaic Panel

The Photovoltaic panel is a solar array module that generates the power from the Sunlight. The PV panel is made up of a PN junction. The number of panels connected in parallel and form a PV array. When the sun rays fall on the panel due to the irradiance and temperature the voltage is generated.

The simulink model is built for both existing and proposed system with following parameters such as short circuit current $I_{sc}=5.45$ A, open circuit voltage $V_{oc}=75$ V, Maximum current $I_{max}=4.95$ A, Maximum voltage $V_{max}=75$, $P_{pv}=369.5$, $V_{pv}=76.25$ V, I_{pv} current = 4.85 A, disturbance voltage $V=8$ V and the parameter of the ideal switch is $R_{on}=0.001\Omega$, $R_s=1e5$, $C_s=inf$.

Buck-Boost Converter

The output of the PV panel is connected to the buck-boost converter. The buck-boost converter boosts both voltage and current. The converter or chopper is operated based on a 1:2 ratio. The input voltage is doubled. Due to the three-phase induction motor, the buck-boost converter is used in the proposed system. The best power system must ensure high quality and stable power supply.

The converter or chopper operates based on the duty cycle of the chopper. The buck-boost converter are designed with the following specification such as $L=2e^{-3}$, $C=100e^{-3}$, $R=0.001\Omega$, $C=50e^{-6}$, the MOSFET have FET $R_{on}=0.001\Omega$, Internal diode Inductance = $1e^{-6}$, Internal diode resistance= 0.001 , snubber resistance $R_s=2000\Omega$ and Diode have $R_{on}=0.001$, $V_f=0.8$ Snubber $R_s=1500$. The power electronics converters are used in numerous applications in various fields and effective control in the emerging technology.

Seven Level Multilevel Inverter

The inverter played an important role in the power electronics section. The inverter converts the DC supply to the AC supply. The Battery, capacitor, fuel cell may be acting as an input source for the inverter. In the proposed system, the solar panel acts as an input source. The grid-tied inverter is used for the stability analysis by using a generalized Nyquist stability criterion.

The multilevel inverter is used for conversion purposes. The different multilevel inverter is cascaded H bridge MLI, diode clamped MLI, and hybrid MLI. The cascaded Multilevel inverter is used in the hybrid electric vehicle, FACTS devices, and motor drives. When the number of levels of inverter increases, the quality of the sine wave is also increased. The grid impedance information can be used to enhance the operation of the grid-tied inverter.

In the proposed system, a seven-level multilevel inverter is used. For seven-level multilevel inverter, the seven steps are produced in the output AC waveform. The multilevel inverter is designed with Resistance $R=0.5\Omega$, $V=290$ V, MOSFET have FET $R_{on}=0.1$, $R_d=0.01$, $R_s=1e^{-5}$, $C_s=inf$

Gate Pulse Switching by a Pulse Generator

The inverter operation is based on the switching or gating pulse. The PWM gate pulse is also applied to the inverter. From this pulse, the output voltage can be controlled and harmonics are reduced. Normally the pulse generator performs the switching operation. In the existing system, the normal switching pulse is used by the pulse generator.

Performance Analysis

In the existing system, each MOSFET is operated for a 60° phase shift operation. The basic pulse generator is operated based on the sampling voltage and sampling time. The pulse generator has the parameter such as amplitude =1 A, Period=0.02, Pulse width=30, and phase delay =0.002. Each pulse generator is operated for a 600 phase shift.

Pseudo-Random Binary Sequence (PRBS) Switching for MLI

The pseudo-random binary sequence generator generates the random pulse of different values as a gating signal. The most commonly used input stimuli for correlation analysis is Pseudo random binary sequence (PRBS) with a maximum length sequence. The PRBS sequence is used for analyzing the parameters of the electrochemical cell. By the appropriate duty cycle (D), the output of the inverter can be controlled.

$$\text{The duty cycle, } D = \frac{t_{on}}{T}$$

Where t_{on} = On time, t_{off} = Off time

$$T = t_{on} + t_{off}$$

The pseudo-random binary sequence generator is made of shift register and logic gates. Figures 2 and 3 show the PRBS comparison diagram and logic gate configuration. The main advantage of the PRBS method, sine sweep because it can be generated by using time delay. The PRBSs are deterministic bitstream of '0' or '1' runs randomly for a length after it will be repeated.

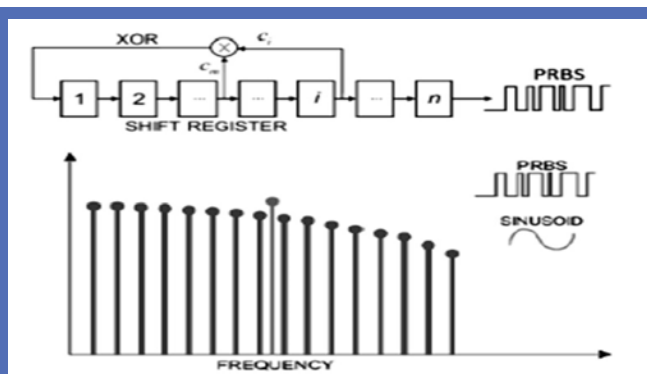


Fig 2. PRBS comparison diagram...

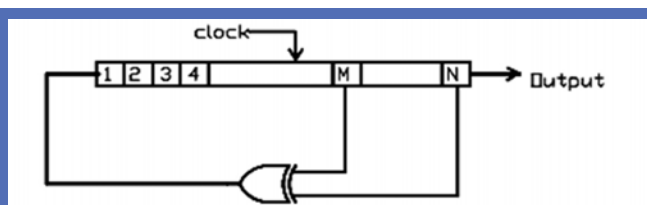


Fig 3. Logic gate configuration...

In this PRBS generator for specific maximum length (MLS), a polynomial length L will generate the deterministic sequence of '0' and '1' of $2^L - 1$. Figure 4 shows the PRBS bits. The PRBS gate pulse injection does not introduce an excessive amount of noise to the proposed system.

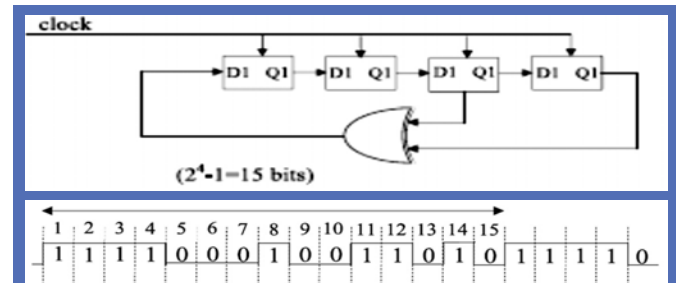


Fig 4. PRBS bits...

The gating signal initiates the operation of the inverter. The gating signal comprises Pseudo random binary signal and sinusoidal signal. In the proposed system, the multilevel inverter with pseudo-random gate pulse is used. In the existing system, the RLE load is used but in the proposed system the three-phase induction motor acts as a load. The spectrum of PRBS is discrete but it is optimized between maximum length, sampling frequency, and PRBS bit frequency. For the online measurement method, the PRBS injection is used. The online measurement methods consist of active and passive system identification.

The PRBS gating pulse module is designed with the following parameters such as Vector of output is [0 1 0 1 0 1 0 1 0 0] and sampling time is 0.0001. the vector of time value is [0.001 0.002 0.004 0.006 0.008 0.009 0.012 0.013 0.017 0.018 0.020]. The constant value is 01 and sampling time = inf. The Figure 5 demonstrates the model of seven level multilevel inverter.

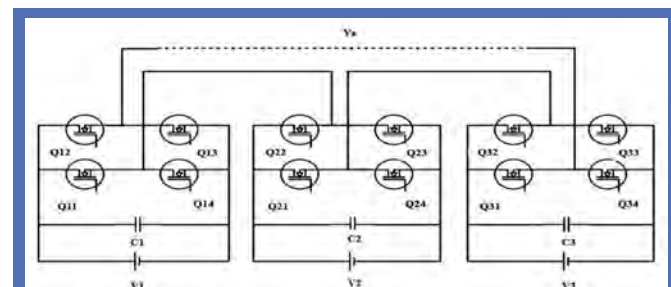


Fig 3. Logic gate configuration...

Simulation Result

This section discusses the simulation result for both

the existing and proposed systems. The existing system is designed with a pulse generator gated inverter and a proposed system gated with PRBS injected pulse Multilevel inverter.

Existing system simulation diagram

Figure 6 -14 depicts the construction and operation of the existing system.

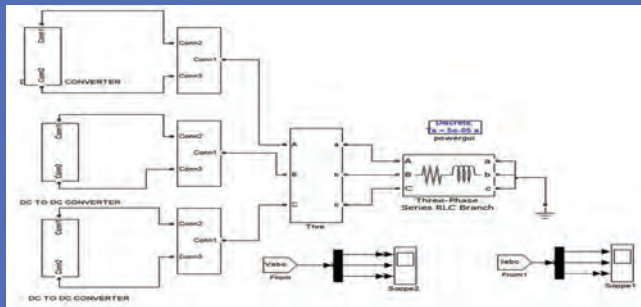


Fig 6. Circuit diagram of a multilevel inverter with RL –load (Normal Switching pulse)...



Fig 7.Voltage across PV...

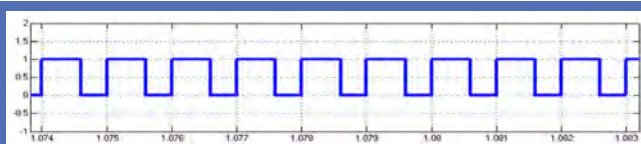


Fig 8. Switching pulse of Buck-boost converter...

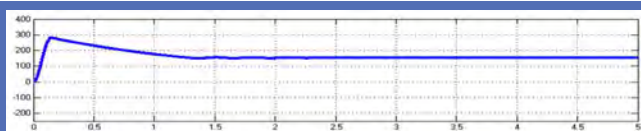


Fig 9. Voltage across the buck-boost converter...

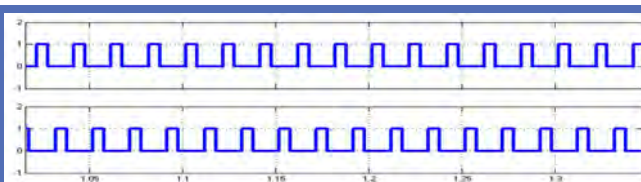


Fig 10. Normal Switching pulse of inverter...

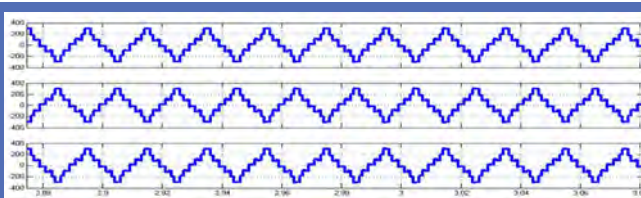


Fig 11. Voltage across RL-load...

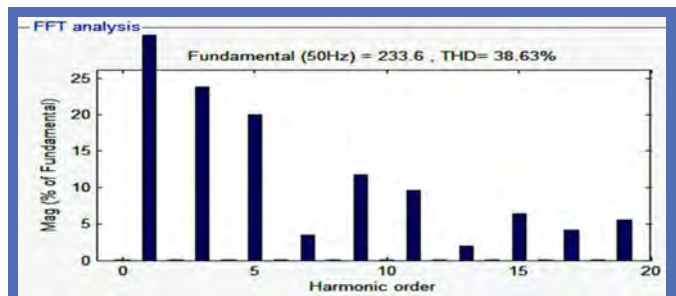


Fig 12. Voltage THD...

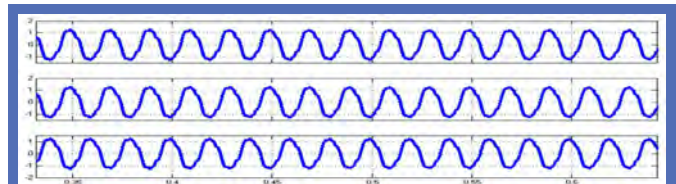


Fig 13. Current through RL load...

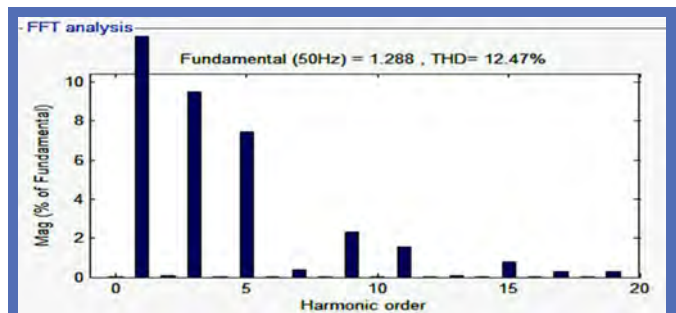


Fig 14. Current THD..

Proposed system simulation diagram

This section discusses the proposed system initiated with PRBS injected gated inverter. Figure 15-23 represent the process of the proposed system.

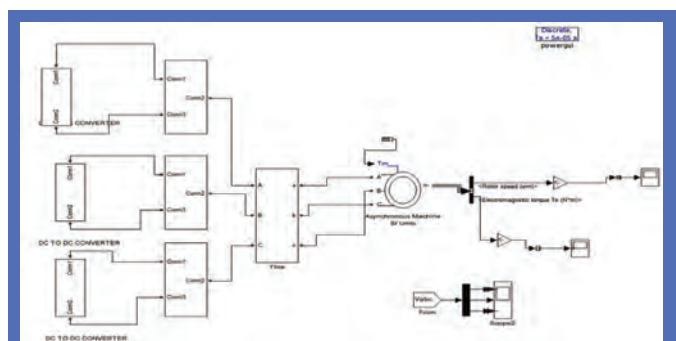


Fig 15. Circuit diagram of the multilevel inverter with Motor load(Pseudorandom)...

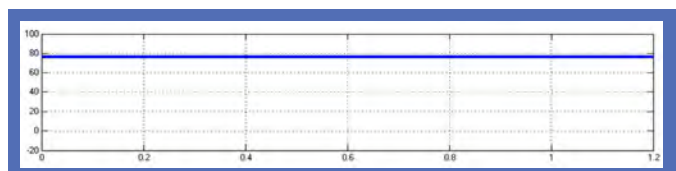


Fig 16.Voltage across PV...

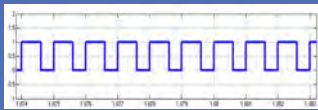


Fig 17. Switching pulse of the buck-boost converter with PRBS...

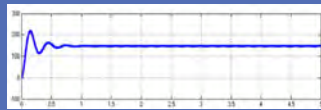


Fig 18. The voltage across the buck-boost converter with PRBS...

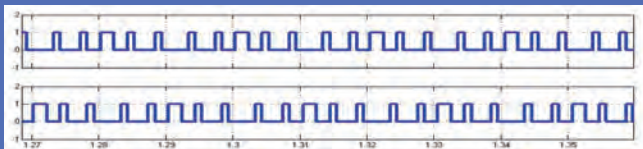


Fig 19. Pseudorandom Binary Sequence Switching pulse of inverter...



Fig 20. The voltage across Motor load...

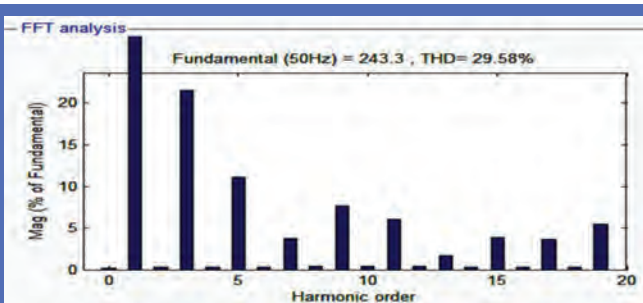


Fig 21. Voltage THD...

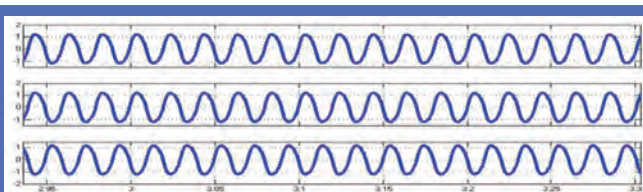


Fig 22. Current through Motor load...

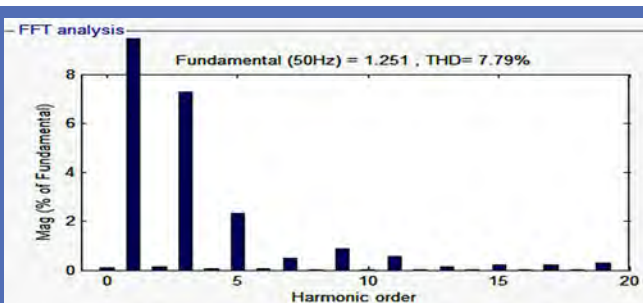


Fig 23. Current THD...

Harmonics Comparision

Harmonics are one of the major threats in the field of power systems. In this article, the third harmonics are analyzed and THD values are noted. In the existing system, the multilevel inverter fed by normal switching pulse with RLE load is used but in the proposed system the multilevel inverter fed by PRBS gating pulse with a three-phase induction motor is used. Table 1 depicts the comparison of voltage and current THD. The voltage and current harmonics THD values of normal switching pulse is higher than that of Pseudorandom switching pulse gated inverter system. Table 1. Shows the comparison of harmonics values.

Table 1. Comparison of Voltage and Current THD

MLI	Voltage THD	Current THD
Normal switching Pulse	38.63%	12.47%
Pseudorandom Pulse	29.58%	7.79%

Conclusion And Future Work

This article examined the response and performance of inverter fed RLE load for pulse generator gated pulse injection and Multilevel inverter pseudo-random binary sequence injection. The gating pulse influencing the value of the harmonic in the system. The third harmonics are analyzed in both systems and results are tabulated. In the existing system, the voltage and current THD values are high. But in the proposed system the voltage and current THD value are low when compared with the existing system. The existing system is verified with RLE load and the proposed system is checked and verified with 460 VAC three-phase induction motor. So, as per the results the proposed system produced more efficient output with lesser THD value when compared with the existing system.



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SINGLE PHASE MATRIX CONVERTER APPLICATIONS (PART I)

A study of applications of Matrix Converter in single phase is presented. Single Phase Matrix Converter topology (SPMC) has many advantages. It is flexible and can replace many converter topologies by its wide applications as universal converter...

Matrix converter is an advanced topology that offers possible “all silicon” elucidation for power conversion, eliminating the necessity for reactive energy storage components used in usual rectifier-inverter based system. The topology was first proposed by Gyugyi in 1976. Three phase circuit topologies were mainly dealt in previous studies whilst the single phase Matrix Converter had modest interest though offering a very wide application. Single phase matrix converter was first released by Zuckerberger in 1997 as the direct single phase AC-AC converter though having possibilities of phase conversion in Matrix Converters. The Matrix Converter is capable of rectifying, inverting. The Single phase Matrix Converter can even perform the function of generalized single phase power electronics converter – such as acting as frequency changers (cyclo-converter, cyclo-inverter). Generally, the operation of converters and maintenance needs proficiency and skilled manpower. This generalized functionality of Matrix Converter eases the need for new converter hardware. The use of a Matrix Converter in the future will reduce the necessity for learning several varying converter topologies. The Single phase Matrix Converter can perform all the functions of a generalized single phase power electronics converter only by changing the

input parameters. The input is based on either an AC or DC supply, synthesizing both in the form of AC or a DC output using a Carrier based Pulse Width Modulation technique called Sinusoidal Pulse Width Modulation (SPWM).

So, no matter what the application of Matrix Converter as a particular converter topology is, it depends mainly on the input supply we give and also the switching pattern, though all the functionalities could not be met at one fell swoop. The birds' eye view of Matrix Converter applications with the topology is presented in Figure 1, such that it can be effectively used as required in individual or in combinations. As a whole, the Matrix Converter could be utilized effectively as a revolutionized power electronic converter system for generalized applications. It can be used as a rectifier-inverter system along with solar for battery charging (rectifier) and to deliver the AC load (inverter) either from battery (critical loads) or directly from solar power conversion system, which could be incorporated with MPPT technologies to drive AC motor. The excess inverted AC could possibly be fed to the utility system through single phase three wire system.

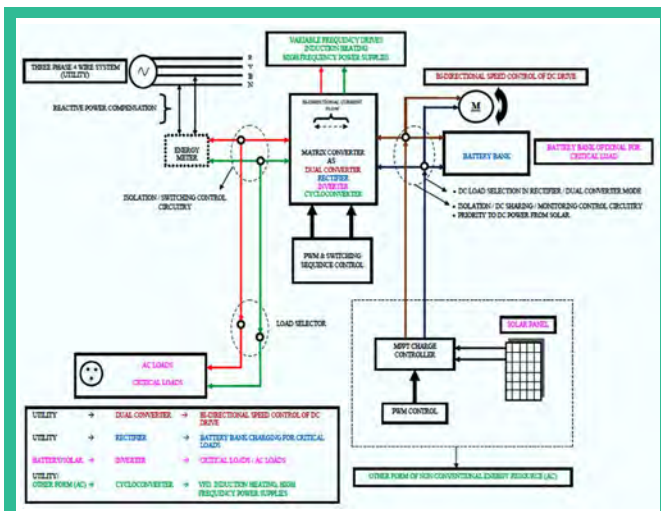


Fig. 1. Birds' Eye View of Matrix Converter Applications...

The unchanged system could also be implemented as Dual Converter only by changing the switching algorithm to drive DC motor in both the directions. This must be ensured with necessary isolation between the battery load and the motor load when implementing as a system on whole for every function (rectifier or dual converter).

Matrix Converter Topology

The Matrix Converter topology in a single phase consists of four bidirectional switches as matrix relating the supply input to the load output at the intersections as shown in Figure 2.

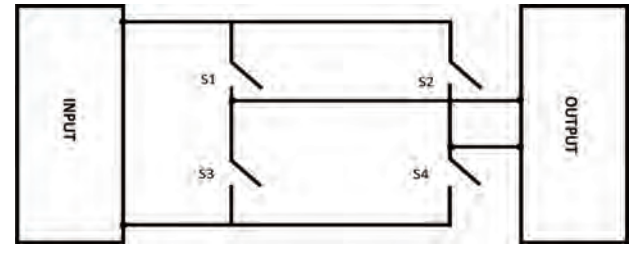


Fig. 2. Matrix Converter Topology...

The bidirectional switches (Figure 3) are capable of conducting the current in both directions while at the same time blocking voltage. The Matrix Converter topology comprising the bidirectional switch is presented in Figure, in which S1 is mentioned as S1a & S1b, S2 as S2a & S2b, respectively. The input to the Matrix Converter may be AC or DC depending upon the make use of the Matrix Converter as particular power electronic converter.

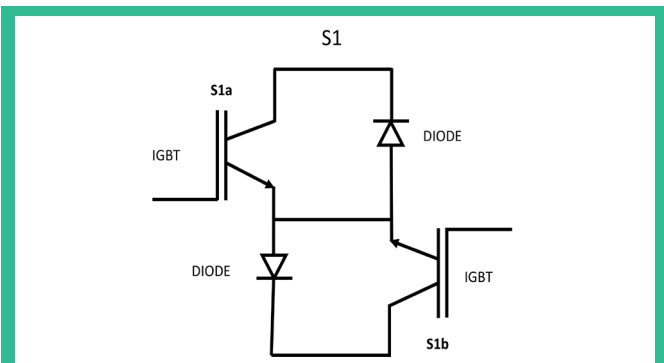


Fig. 3. Bidirectional Switch of Matrix Converter...

Functional Possibilities with Operational Sequence

Table 1. Matrix Converter Functionality...

S.No	Input Supply	Switching sequence	Converter Function
1	AC	1a, 4a 2b, 3b	Rectifier
2	AC	1a, 4a 2b, 3b 2a, 3a 1b, 4b	Dual Converter
3	DC	1a, 4a 2a, 3a	Inverter
4	AC	1a, 4a, 2b, 3b 2a, 3a, 1b, 4b	Cyclo-converter
5	AC	1a, 4a 2a, 3a 2b, 3b 1b, 4b	Cyclo-inverter

Matrix Converter as Rectifier

The Matrix Converter is functional as Rectifier-Inverter system along with solar, with priority given to solar power conversion system for charging the battery as well as to meet out the load and compensation via utility. Based on the requirements, both the applications could be incorporated in a single Matrix Converter system with proper load isolation between the load and Battery.

Let the supply input to the Matrix Converter as shown in Figure 2 is AC. For the positive half cycle of the AC input the switches 1a and 4a are triggered as given in Table 1. Then for the negative half cycle of the input, the other two pairs 2b and 3b are triggered such that the output from the Matrix Converter is DC. This is clearly presented by the simulation results of MATLAB/Simulink.

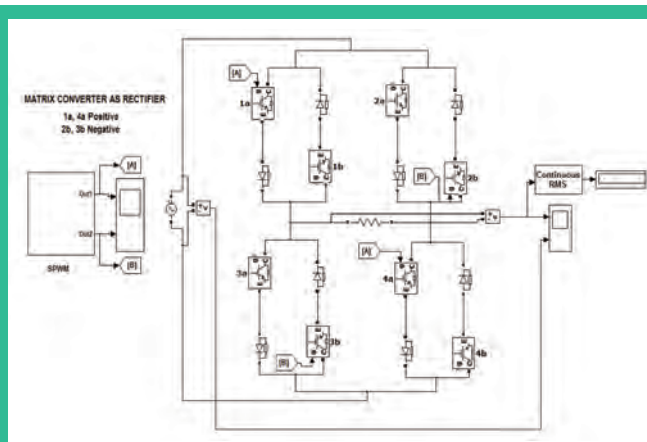


Fig. 4. Simulation Circuit of Matrix Converter as Rectifier...

The Figure 4 shows the simulation circuit of Matrix Converter working as rectifier with input AC supply of 230Vrms and the output is DC of the same value (Figure 5). The analysis is carried out for resistive load. The gate pulses are developed by SPWM technique and are given

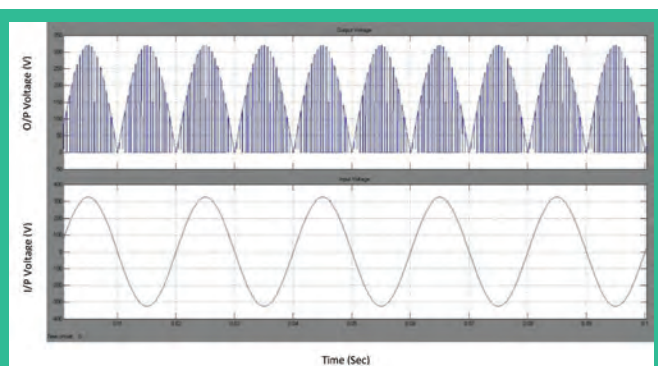


Fig. 5. Input Voltage vs Output Voltage for Matrix Converter as Rectifier...

to the switches 1a, 4a and 2b, 3b as per the sequence shown in Table 1.

Matrix Converter as Dual Converter

Here the supply input to the Matrix Converter as shown in Figure 1 is AC. The Matrix Converter is made to function as dual converter for bidirectional speed control of DC drives. For the positive half cycle of the AC input, the switches 1a and 4a are triggered. Then for the negative half cycle of the input, the other two switches of the pair 2b and 3b are triggered such that the output from the Matrix Converter is positive DC voltage. For the same positive half cycle of the AC input, if the switches 2a, 3a are triggered and for the negative half cycle of the input, the switches 1b, 4b are triggered, then the output from the Matrix Converter is negative DC voltage. This is also clearly presented by the simulation results of MATLAB/Simulink.

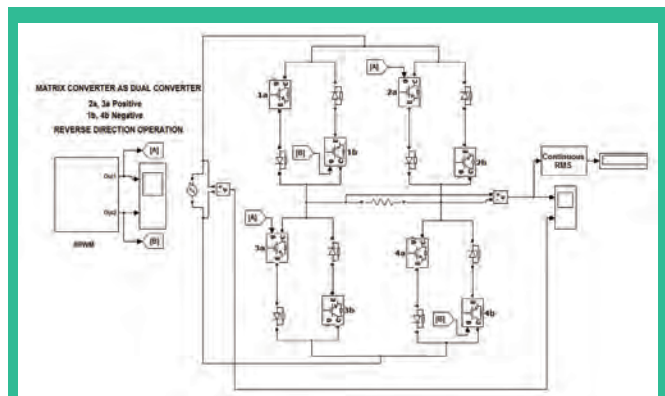


Fig. 6. Simulation Circuit of Matrix Converter Operating as dual Converter...

The circuit of Matrix Converter in Matlab simulation is shown in Figure 6 for its operation as dual converter in which the switching sequences are noticeably given in Table 1. The positive and negative output DC voltage with respect to input is given in Figure 7 and 8.

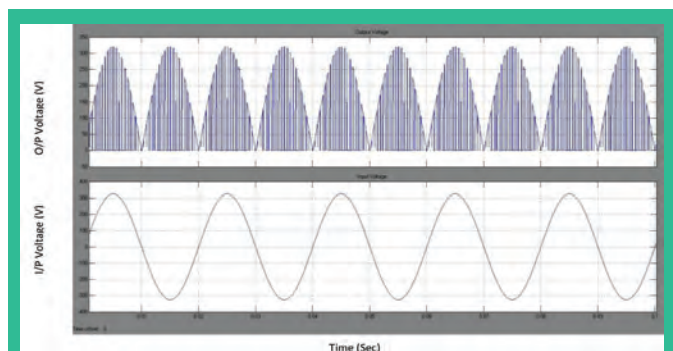


Fig. 7. Positive DC Output Voltage vs Input Voltage...

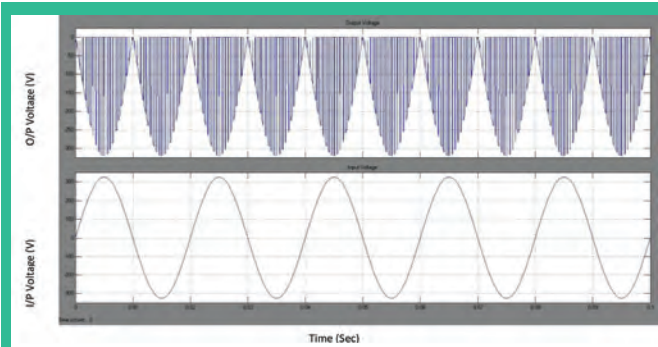


Fig. 8. Negative DC Output Voltage vs Input Voltage...

Matrix Converter as Inverter

The Matrix Converter as inverter could possibly be made to drive AC motor with its variable frequency inverted AC output as speed control of AC drive via changing the frequency. For the circuit shown in Figure 2, if the input to the Matrix Converter is DC and the switching sequence are given as 1a, 4a and 2a, 3a then the Matrix Converter will function as inverter giving AC output of the frequency as that of the PWM frequency. The simulation circuit as well as the result is shown below in Figure 9 and Figure 10.

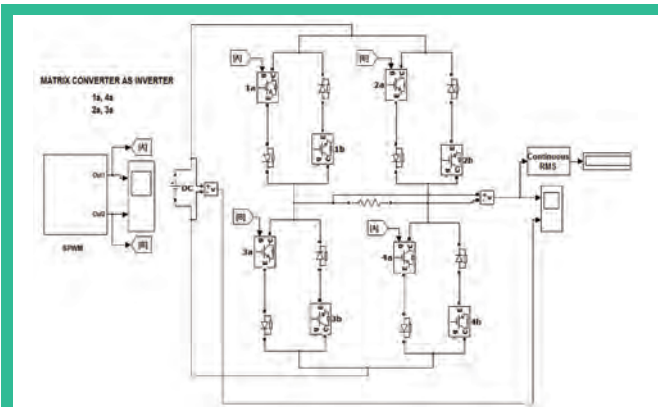


Fig. 9. Simulation Circuit of Matrix Converter as Inverter...

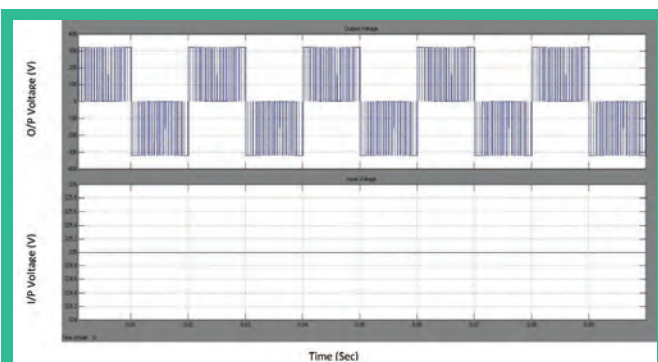


Fig. 10. Simulation Circuit of Matrix Converter as Cyclo-Converter...

The inverter operation of Matrix Converter could be applied to get the AC output voltage of the required frequency by varying the frequency of the PWM with that of the reference cycles. This operation could be implemented for speed control of AC drives via the frequency control of the output AC voltage. The input DC to the Matrix Converter may optionally be from the solar power conversion system, so that the battery is utilized only in case of emergency/ critical loads.

Matrix Converter as Cyclo-converter

The operation of the Matrix Converter as Cyclo-converter for positive output load voltage is obtained by the conduction of the switches 1a, 4a for the positive half cycle of the AC input, and 2b & 3b for the negative half cycle of the input and similarly 2a, 3a, & 1b, 4b for the negative output load voltage. For Cyclo-converter mode of operation, the output frequency obtained is given by, $f_o = f_{in}/N_r$, Where, f_o = Output frequency, f_{in} = Input frequency and N_r = Real number. The operation of Matrix Converter as Cyclo-converter could be easily understandable from the following simulation circuit and output.

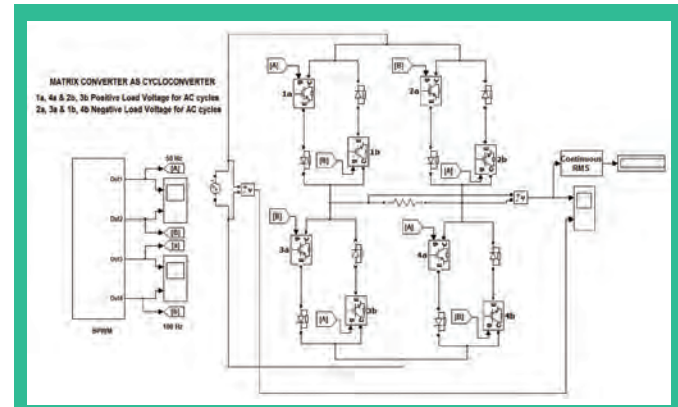


Fig.11. Simulation Circuit of Matrix Converter as Cyclo-Converter...

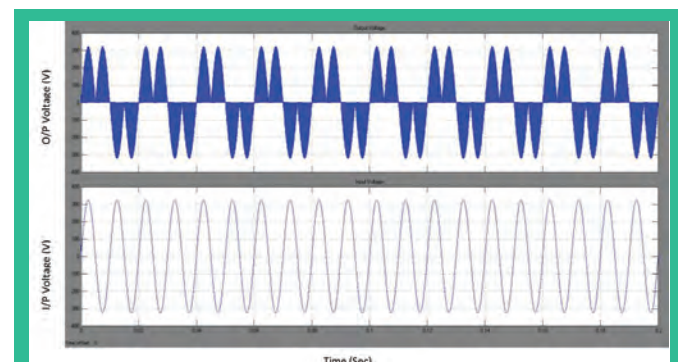


Fig. 12. Simulation Output of Cyclo-Converter (100Hz Input Voltage vs 50Hz Output Voltage)...

Here, the output frequency is given by, $f_o = f_{in} / N_r$, $50 = 100/2$, in which the desired output is achieved by the SPWM pulses of the reference frequency of 50Hz. Figure.12 shows the AC output voltage of 50Hz waveform from the 100Hz AC input waveform.

Matrix Converter as Cyclo-inverter

Similarly the operation as Cyclo-inverter is obtained by the conduction of switches 1a, 4a, 2a, & 3a for the positive half cycle of the input and 2b, 3b, 1b and 4b for the negative half cycle of the input in which the output frequency f_o will be $f_o = f_{in} \times N_r$, Where, f_o = Output frequency, f_{in} = Input frequency and N_r = Real number. The output frequency of the Matrix Converter when working as Cyclo-inverter will be of the necessary value depending on the developed SPWM cycle frequency.

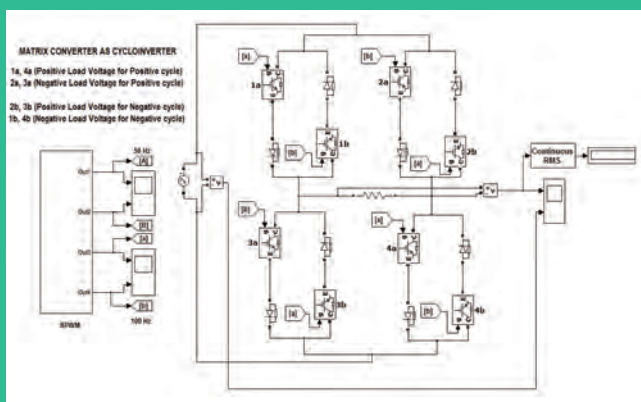


Fig. 13. Simulation Circuit of Matrix Converter as Cyclo-Inverter...

Figure 13 shows the simulation circuit of the Matrix Converter and followed by is the simulation result (Figure 14) in which the output frequency is 100Hz for an input of 50Hz AC supply.

Thus, the Matrix Converter could be implemented as Cyclo-inverter for developing the output of desired

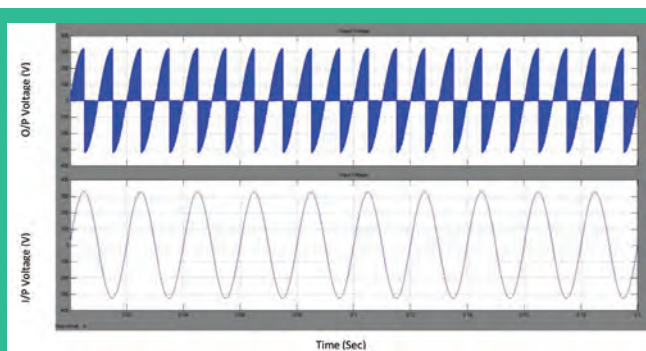


Fig. 14. Simulation Output of Cyclo-inverter (100 Hz Output Frequency vs 50 Hz Input Supply)...

frequency with that of the input via SPWM technique. For cyclo-converter and cyclo-inverter process the input AC source could necessarily be either from utility or other non-conventional form of AC source like wind, etc. The possibility of combinational functionalities of Matrix Converter could enhance the power to weight ratio. The change of sequence from Rectifier to Inverter should start only if the utility power fails (offline) and a necessary monitoring / control circuit for that should be provided and vice versa for the change-over from Inverter to Rectifier operation. Generation of switching sequence can be implemented through SPWM as it is immune to noise and less susceptible to voltage changes. A Microcontroller or advanced controller like FPGA can play an effective role in generation of PWM pulses, changing over the sequence and for monitoring the controllability over it. Necessary protection (back from Matrix Converter to line) / isolation can also be implemented with proper isolation control circuitry employing digital controllers.

Matrix Converter as a Z-source Buck-Boost Converter

Minh-Khai Nguyen et al represent Single Phase Matrix Converter as a Converter that can buck and boost with step-changed frequency and both the frequency and voltage can be stepped up or stepped down. The Converter is employed with a safe-commutation strategy to conduct along a continuous current path eliminating voltage spikes on the switches, thus avoiding snubber circuit. The authors describe the construction of the circuit with an LC input filter, a Z-source network, bidirectional switches and an RL load. The sequence of switching control is in two states, where state 1 includes active mode and commutation mode and state 2 with shoot-through mode, free-wheeling mode and commutation mode. Here the output voltage can be produced at three different frequencies 120, 60 and 30 Hz in the buck-boost amplitude mode. This application of Single Phase Matrix Converter as a Z-source Buck-Boost Converter is suitable for controlling the speed of a fan or a pump without the use of an inverter as in conventional AC-DC-AC systems.

Matrix Converter as a Four Quadrant DC Chopper

The Matrix Converter in single phase can also be implemented as a Four Quadrant DC Chopper. A four Quadrant DC Chopper (FQDC) converts a fixed DC into a variable DC output statically. Here, the

magnitude of the output voltage of the converter is controlled by PWM and quadrant operation is due to the bidirectional control of current in switches of the Matrix Converter. A dead time is introduced in the switching transitions to allow the dissipation of energy in the load inductance. Mohammad Noor S. Z. et al have studied the principles of four quadrant DC-DC Chopper and the switching sequence has been realized in the FPGA for the implementation of DC chopper using Single Phase Matrix Converter.

Matrix Converter as a Quasi-Z-source AC-AC Converter

Minh-Khai Nguyen et al. had represented single phase Matrix Converter as quasi-Z-source ac-ac converter. This converter consists of all the possibilities of traditional single-phase Z-source ac-ac converter like buck-boost, reversing, or maintaining the phase angle, and more specially sharing the same ground and operating in continuous current mode. The author had reported the converter with high efficiency, lower input current harmonic distortion and higher input power factor. Further as the converter employs duty-ratio control, it can also be implemented as DVR to compensate for voltage sags and swells in the ac-ac line conditioning. The authors represent the quasi-Z-source ac-ac converter as a modified one with the following features as the output voltage bucked or boosted and be both in-phase and out-of-phase with the input voltage sharing the same ground.

Matrix Converter as an Off-grid solar photovoltaic power system

T. R Sumithira et al represent the implementation of single phase Matrix Converter for an off-grid solar photovoltaic power system as it would be a feasible solution for medium power applications at remote locations without electricity connection in the state of Tamil Nadu. The authors claim a THD of less than 7% with the implantation of Matrix Converter. Here the matrix Converter in single phase is implemented as an

inverter with Modified Pulse Width Modulation MPWM. FPGA is used here to realize the modulation strategy and commutation technique for SPMC.

Matrix Converter for Wind Energy Conversion System

Navdeep Singh et al had explored an alternative to multistage AC-DC-AC power conversion. Matrix Converter is used as a single stage AC-AC power converter for interfacing the wind energy conversion system (WECS) to a grid as a distributed load system. In this, a control mechanism and time switching pattern are employed to convert variable frequency input power which is proportional to wind speed into a constant frequency output power for a distributed load system in a single unit. The authors justify that this system is suitable for interfacing a wind turbine to a distributed load system technically with adaptive active and reactive power injection control.

(To be continued in the next issue...)



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ADVANCED POLYAMIDE COMPOUNDS FOR CONNECTORS

Owing to some shortcomings of thermoplastics, a need was felt to make thermoplastics behave like thermosets. This led to the development of a material, which is easily processable like a thermoplastic and should have higher thermal properties like thermosets in application...

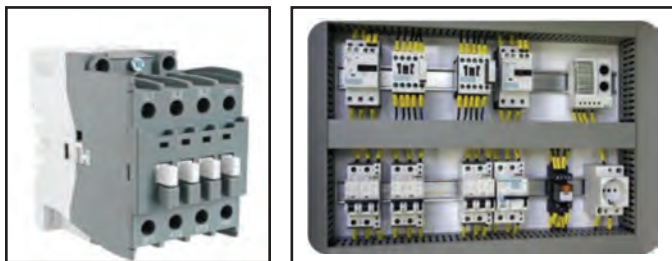
The highly competitive and growing market for connectors used in Electrical and Electronics (E&Es) applications is driving a trend toward smaller designs with tighter tolerances that can take higher operating temperatures and lower wall thickness. The wall thicknesses are dropping dramatically and creating demand for high performance Polyamides. Simultaneously, the OEMs are demanding lower costs, which is requiring molders to find ways to enhance both performance and productivity

Improved Polyamide 6 and Polyamide 66 (PA66) compounds have been developed recently and ramped up using new technology for the connector market that provides significant improvements by addressing the challenges, particularly in lower thickness performance, reduced plate-out, improved melt flow and enhanced part-to-part consistency. The new Formpoly and Starflam compounds that have been undergoing significant customer testing in the past few years are now widely available commercially. Results of those tests and the growing challenges in the E/E connector market are reviewed in this article.

Introduction

Thermoset plastics have been successful in Electrical & Electronic applications where they display performance at a lower cost. However, the biggest disadvantage of thermoset is their brittleness and difficulty in thin walled moldings. "To do maximum with minimum" is the main objective of Electrical and Electronics industries, which has led to miniaturization. The challenge for the industry is that with every new development, the size shrinks in geometric proportion resulting in high heat generation. With thinner and thinner wall thickness, applications of thermoset are limited due to their inherent nature of ductility, even though they can meet the thermal requirement.

Thermoplastic is a good option for thin walled applications, but they have limitation to meet the stringent 'in use' fluctuations like short duration temperature shoot up and elevated high temperature due to miniaturization. There are very few thermoplastics with higher melting point of 400+ °C and they are equally expensive. Hence, there was a need to make thermoplastics to behave like thermoset. This resulted



in the development of a specialized material, which is easily processable as a thermoplastic and after radiation crosslinking develops higher thermal properties of thermoset in actual application during usage.

Connector Background

Plastics resins are used to provide physical structure and to hold contact points in precise position and insulate the contacts from one another.

Polyamides (nylons) widely replaced thermoset plastics that were originally used for connectors and remain the dominant plastic used in the market. Now, many plastics are used for connectors, including Polyesters (PBT), Liquid-Crystal Polymers (LCP), Polyphenylene Sulfide (PPS), Polycarbonate and other high-end engineering plastics, as well as thermoset plastics such as Phenolic and unsaturated Polyester. Resin choices are based on a combination of requirements, including cost, melt flow, moulding performance and physical properties.

Polymer compounds are often reinforced with glass fibre, to improve stiffness, tensile strength, and dimensional stability. Growing demands for high-heat performance have led to comparatively higher loadings of flame retardants at lower thickness, which is also creating greater potential for plate-out issues. Leading markets include computers, telecommunications and automotive etc.

Connector Design Issues

Many connector tools are rather complex in design to ensure the functional requirements such as contact spacing, insulation properties and physical connection style are met. There may be latches and/ or hinges designed for various connection purposes. These tools typically have side action to create specific design detail, resulting in sophisticated cavity design. The complexity can lead to mold filling and venting related issues, resulting in excessive downtime and increased molded-part cost. Designers are challenged to design the parts for functionality, and molders are challenged to produce the parts at minimal cost.

Key Performance Requirements for Connectors

- **Strength:** High strength is required to maintain the connection in all types of environments. Latches and hinges need to maintain strength for the part's life cycle. Pin retention and pull-out strength are critical to connector performance.
- **Electrical:** A connector material must have excellent insulating properties and resist creation of a tracking path in various environments.
- **Flammability:** Many connectors require UL V-2 flammability, while others require V-0 and still others require 5VA ratings of Flammability along with superior electrical properties to take care of sudden temperature spikes.
- **Flow:** Complex connector designs and sometimes delicate mating cores and pins make flow critically important. The thinner wall sections, thin core pins and need for venting all require a material that flows well with less pressure.
- **Product Hygiene:** Clean products are required to reduce mold deposit formation that result in downtime for mold cleaning. This will significantly increase molded-part cost..

Performance Characteristics that Make Polyamides the Material of Choice

PA6 & PA66 have many key attributes that make it a desirable material for electrical connectors:

- High strength and rigidity
- Excellent chemical resistance
- Inherent flame resistance
- Excellent resistance to tracking an electrical path
- Excellent dielectric strength and volume/surface resistivity make it an ideal insulating material
- Excellent thermal endurance (UL RTI) for use in higher-temperature applications

Innovative Developments in Polyamide Resin Performance

The goal of meeting the processing and design challenges in several important Polyamide markets, including connectors used for electrical and electronic applications was taken by Formulated Polymers Material and Eurostar Engineering Plastics France with the development of a new technology resulting in significant performance improvements in key areas.

Reduced Plate-Out

Plate-out, defined as the release of compounds that

foul the tool, is generally a major problem for injection moulders. At typical PA66 processing temperatures (280 to 320 °C), there is a gradual build-up of volatiles that precipitate out of the polymer melt and condense on the relatively cold mold surface. The volatiles include monomers and oligomers in material inherent in PA66, residual material from glass sizing, lubricants and other additives. They can plug vents, reduce the speed of air evacuation from the mould cavity and impede the moulding process. Cycle times and part quality are affected. Excessive plate-out leads to operational inefficiencies including vent plugging, burning, increased mould maintenance and even increased cycle times.

One expert in mould design and maintenance says that more labour-hours are spent cleaning mould plates and tooling than any other tooling repair stage. It is necessary to keep mould plates and tooling clean to maintain product quality and extend tool life. Most moulds are cleaned manually, adding to the expense. Downtime, however, is the biggest expense, particularly for high-cavitation, expensive tools. In some moulding shops, tools are removed and staged for cleaning, often creating a backlog of maintenance work. Formulated Polymers Material targeted this problem with development of a proprietary compound and process.

Improved Melt Flow

Polyamide grades have been optimized grades for improved flow using proprietary compounding technology during processing while maintaining high flammability performance in final component. Improved flow offers advantages in processing (including reduced pressures) and increased design flexibility, including increased length over thickness (L/t) flow ratio. L/t is an experimental index that indicates the distance the leading edge of the plastic melt flow can reach in a fixed thickness and at a fixed pressure.

Advantages of Formpoly Cross-linkable Grades

No Penetration of Pin at 90 °C i.e., above melting point showed that it has become thermoset by total cross link, which ensures performance compliance during sudden temperature surges/variatioins.

- No more melting of the part. It only chars at higher temperature
- Improvement in properties-mechanical (tensile, flexural), thermal (HDT), chemical (reduction in solubility & hydrolysis) , electrical (CTI)
- Increased resistance to stress cracking, reduced crack propagation
- Greater resistance to frictional heat damage
- Higher dimensional stability
- Improvement in fiber-to-matrix adhesion and strength in glass reinforced
- Reduction of cold flow (creep), Improvement in tensile set and compression set
- Improved heat resistance- Higher limit values for working temperatures
- Higher hot wire resistance
- Higher ageing resistance

Need for the Innovation

Thermoset plastics have been successful in Electrical & Electronic applications where they display performance at a lower cost. However, the biggest disadvantage of thermoset is their brittleness and difficult in thin walled moulding. “To do maximum with minimum” is the main objective of Electrical and Electronics industries that leads to miniaturization.

The challenge for the industry is with every new development, the size shrinks in geometric proportion resulting in high heat generation. With thinner and thinner wall thickness, applications of thermoset are limited due to their inherent nature of ductility, even though they can meet the thermal requirement.

Ready to use compound: reinforced flame retardant colored with additives	Parts Molding: standard molding conditions Possible use of regrind	E-beam Irradiation. normal sec ops possible, e.g. lasermarking, assembly

Thermoplastic is a good option for thin walled applications, but they have limitation to meet the short duration temperature shoot up and elevated high temperature due to miniaturization. Of course there are very few thermoplastics with higher melting point of 400+ °C equally they are very expensive. Hence need was felt to make thermoplastics behave like thermoset. It creates the need to develop a material which can be easily processable as a thermoplastics and should have higher thermal properties as thermoset in application.

Starflam RX12414 PA66 X-linkable Flame retardant survives the lead-free soldering process and has snap fit and hinge effect capability. The compounds are available in any colour including laser markable with both Improved resistance to creep under heat (fixings ...) and improved resistance to over-heating (seals, connections ...). These Polyamide grades are used to replace more expensive materials (LCP)and over-designed materials (selected for the high heat capabilities – whereas only a short term high heat behaviour is required).

	Min Thk	Flame			RTI	RTI	RTI
Color	(mm)	Class	HWI	HAI	Elec	Imp	Str
BK	0.38	V-1	1	0	130	65	65
	0.60	V-1	1	0	130	65	65
	0.8	V-1	1	0	130	65	65
	1.6	V-1	1	0	130	65	65
	3.0	V-0	0	0	130	65	65

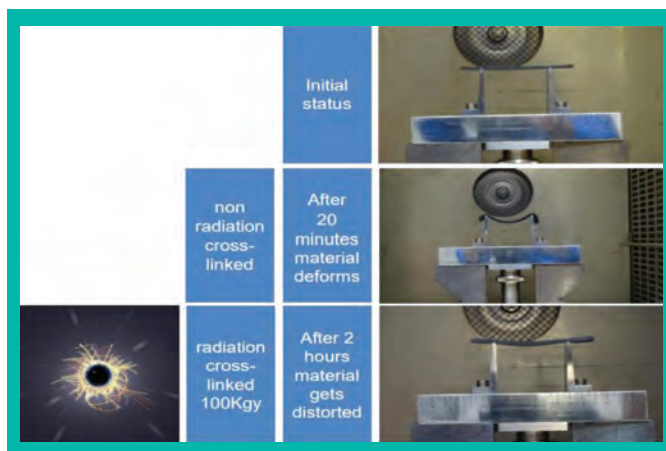
Polyamide Grade

	Min Thk	Flame			RTI	RTI	RTI
Color	(mm)	Class	HWI	HAI	Elec	Imp	Str
ALL	0.8	V-0	0	0	140	110	140
	1.6	V-0	0	0	140	110	140
	3.0	V-0	0	0	140	110	140

Polyamide Grade

Reduced Shot-to-Shot Variability

Compounds with improved melt rheology and tighter viscosity specifications than current industry standards provide a larger processing window that leaves the moulder with more options to fine-tune the moulding process and reduce cycle time. This will translate into improved shot-to- shot control and consistent cavity pressure. Robust process control is critical to producing connectors with uniform physical properties. The end result is more consistent part weight and physical properties from shot to shot. The lower injection pressures required to mould these special grades will



reduce fatigue of mould components, particularly small core pins.

Evaluations in Lab at 295°C in air ventilated oven

- without crosslinked polyamide deformation in 20 min
 - with crosslinked Polyamide the distortion is after 2hrs
- Radiated component can withstand high temperature for more than one & a half hour.

Summary

High performance Polyamides PA6, PA66 grades having flame retardant additives and glass fibre have been converted to thermoset after injection moulding by radiation. Significant increase in physical properties can be achieved. Beta or gamma radiation of 50 -100kGy for the cross-linking of polyamide is highly effective in this two-step process – where polyamide is injection moulded into desired shape and then the component is exposed to radiation.

This innovation in Polyamide has been patented and is a good alternative for thermoset material, where thin walled mouldings and high productivity is required and can be a cost-effective alternate for high-cost, high-performance thermoplastics.

This innovation is first of its kind in India and Asia – and a significant increase in physical properties can be achieved through it. FPL has these speciality PA6 & PA66 grades, which are readily available.



Dr. Rashmi Bhardwaj

The author is the Vice President (Development) at Formulated Polymers Limited, India. He holds a PhD degree in Polymer Technology as well as he is an MBA.

energy efficient led street lighting

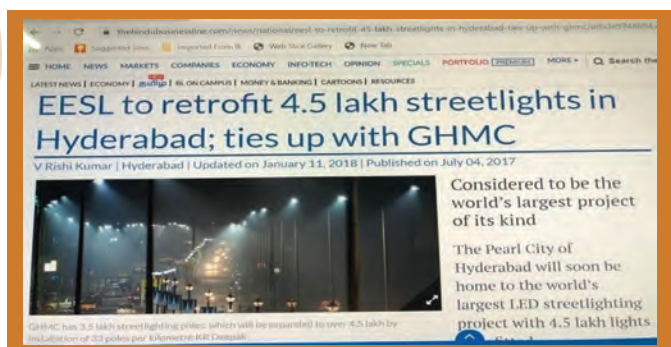
This is a success story of Urban Local Bodies (ULB), where energy savings achieved was 48 MW (61%) in demand, and realisation of savings was worth ~ Rs.85 crores/year on the actual bills. It was also world's largest single street lighting LED project of its kind...

Greater Hyderabad Municipal Corporation (GHMC) had about 4.209 Lakhs of street lights, consisting of 40W (R-25W) tube lights, 70W (R-35W), 150W (R-75W) & 250W HPSV, 250W (R-110W) & 400W (R-200W) MH and LED lights of various wattages. The total connected load is about 77.5 MW. As a part of energy efficient street lighting program, GHMC has replaced old conventional fixtures with LED lamps under Energy Service Company (ESCO) model through Energy Efficiency Services Limited (EESL). It is a Shared Savings Model type venture, to replace the outdated High Pressure Sodium Vapour (HPSV) lights, Fluorescent Tube lights, Metal Halide lights with new LED lights.

Siri Exergy carried out the Baseline Energy Audit and Post Implementation Study of Greater Hyderabad Municipal Corporation (GHMC) during year 2018-19. The investment of Rs. 270 Crores was done by Energy Efficiency Services Ltd. (EESL) under ESCO model. The total number of Street lights were about 4.2 Lakh conventional lights with annual Energy consumption of 240.7 MU and Energy Bill of Rs.180 Crores (2016-17).

Siri Exergy carried out the Base line energy audit of 2500 switching points, by measuring Energy, Lux levels, Number of lights glowing etc. In the post implementation also the same measurements were carried out for the same locations and the savings were quantified.

This is the success story of ULB, where there is energy savings of 48 MW (61%) in demand, about Rs. 85 Crores/ year worth saving on the Actual Bills. It was also the world's largest single street lighting LED project of its kind.



This project was Implemented by EESL under ESCO Model by investing about Rs.270 Crores. Siri Exergy has done the 3rd party baseline Energy audit and Post Implementation Monitoring & Verification Audit

Pre Implementation Status

Energy Base Line:

The following table gives the population of conventional Street lights of different types such as Tube lights and HPSV. The total connected load of 4.209 lakhs lights worked out to be 67.84 MW.

Wattage	No. of Existing fittings	Connected Load MW
40 W	14365	0.57
70 W	84718	5.93
120 W - LED	937	0.11
150 W	216797	32.52
250 W	86257	21.56
400 W	17853	7.14
Total	420927	67.84

Projected Load with 100% Glowing:

The connected load was 67.84 MW, where the measured

Pre Implementation Status			
No	Parameter	Unit	Total Services
1	Services	No's	23399
2	Total Lights	No's	420927
3	Connected Load	kW	67842
4	Connected Load of only Glowing	kW	47480
5	Measured Load	kW	61021
6	Non Glowing %	%	21.30%
7	Projected Load (21.3% non Glowing)	kW	61021
8	Projected Load with 100% Glowing	kW	77591

load at 100% glowing is 77.591 MW. The measured load is higher than the connected load due to power consumption by the ballasts and also due to the leakage current etc.

Guaranteed Savings under ESCO Model

The total investment cost is about Rs. 270 Crores to replace 4.2 lakhs odd street lights. Since, GHMC was not having the money, they wanted to implement this project, under ESCO model through Energy Efficiency Services Ltd (EESL), without any initial investment. EESL offered guaranteed savings of 55%, and wanted to recover their investment in 7 years period.

The following table gives the Guaranteed savings in Electrical Energy along with expected reduction in Energy cost and GHG emission reduction.

No.	Parameters	Units	Baseline Before Implementation	Post Implementation	Difference	% Expected Reduction
1	Electrical Energy	kWh/Year	240777822	108350020	132427802	55.00
2	Energy Cost	Rs. Lacs/Year	17911.9	8060.355	9851.545	55.00
3	Overall Energy Cons	MTOE/Year	20706.893	9318.102	11388.791	55.00
4	Overall CO ₂ Emission	tCO ₂ /Year	214292.262	96431.518	117860.744	55.00

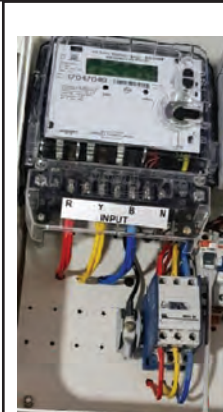
Project Implementation

The conventional lights were replaced, to get equivalent light. In addition to replacing lights, the switching points are also replaced with Computer Controlled Monitoring Systems (CCMS) and also Dash Board is developed.

Existing	Replaced with
40 W Tube Lights	18 W LED
70 W HPSV	35 W LED
150 W HPSV	70 W LED
250 W HPSV/HPMV	110 W LED
400 W HPSV (High Masts)	200 W LED

The main features of CCMS are:

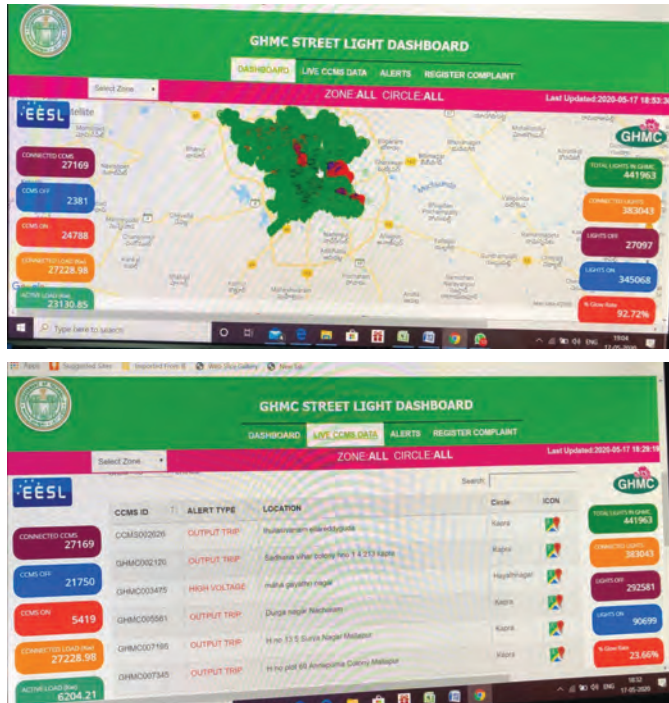
- GPS
- Fault Monitoring
- Remote Control and Scheduling
- Alert Notification
- Flexible Dimming Controls
- Power Metering
- Burn Hours Monitoring & Reporting
- Local Intelligence for faster response times and better performance
- Local Data Storage in case of communications link failure



Case Study

Dashboard:

GHMC developed Dashboard, and the Dashboard gives, the online data of actual number of lights on/off, the actual load and the number of lights off and also alerts about any maintenance related data.



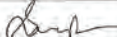
Field Measurements:

Siri Exergy has carried out measurements during night time, the actual power consumption and also the lux levels for about 2500 switching points.

Same measurements repeated for the same switching points after project implementation and energy savings, lux level improvement & glowing % etc monitored and extrapolated the savings for entire GHMC.



The following table gives the energy savings for one of the street in Secunderabad. The actual savings are 63.56%, against the guaranteed savings of 55%.

Pre & Post Energy Audit Report								
General Information								
Zone	N91th.	Circle Name	Secunderabad	Circle No.	29			
Switching point location details			H.No. 10-4-7/2/3, Madhav Nagar					
GPS Coordinates of switch point								
TSSPDCL Energy Meter No./ Type (1Ph/ 3Ph)			TS 6602 04					
Type of distribution (Single/ Median etc.) and no. of lights per pole			S.S. 20					
Mode of Operation (Timer/ Manual)			TIMER					
A. Details of lights connected to the switch point and measurement of energy parameters (existing/ pre scenario):								
Type of lights	40W FTL	70W HPSV/ MH	150W HPSV/ MH	250W HPSV/ MH	400W HPSV/ MH	Total		
No. of lights			6	25		8		
No. of glowing lights			6	25		31		
Existing/ Conventional streetlight scenario (Pre audit)								
Parameters	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total energy consumption (KWH)
Connected load (KW)	8.2	8.2	8.2	8.2	8.2	8.2	8.2	626.4
Voltage (V)	245	243	243	243	243	245	243	
Current (A)	14.28	14.25	14.25	14.25	14.25	14.28	14.25	
Power Factor								
KWH reading	19089	19134	19218	19402	19566	19611	19754	
Operational hours (hrs.)	12	12	12	12	12	12	12	
B. Details of lights connected to the switch point and measurement of energy parameters (LED/ post scenario):								
Type of lights	18W LED	35W LED	70W LED	110W LED	190W LED	Total		
No. of lights			6	25		31		
No. of glowing lights			6	25		31		
LED streetlight scenario (Post audit)								
Parameters	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total energy consumption (KWH)
Connected load (KW)	3.12	3.12	3.12	3.12	3.12	3.12	3.12	228.24
Voltage (V)	235	233	230	232	233	235	230	
Current (A)	14.99	15.12	15.31	15.18	15.18	14.99	15.23	
Power Factor	0.97	0.98	0.97	0.98	0.98	0.97	0.98	
KWH reading	25353	25311	25294	25267	25255	25243	25238	
Operational hours (hrs.)	12	12	12	12	12	12	12	
Energy savings report:								
Total Energy consumption of existing streetlights (KWH)		Total Energy consumption of LED streetlights (KWH)		Total energy savings (KWH)		Percentage energy savings (%)		
626.4		228.24		398.16		63.56%		
GHMC's representative			FMC's representative			EESL's representative		
Name: SWAPNA			Name: V. GIREESH			Name:		
Designation: A-E			Designation: Project Engineer			Designation:		
Signature: 			Signature: V. Gireesh			Signature:		

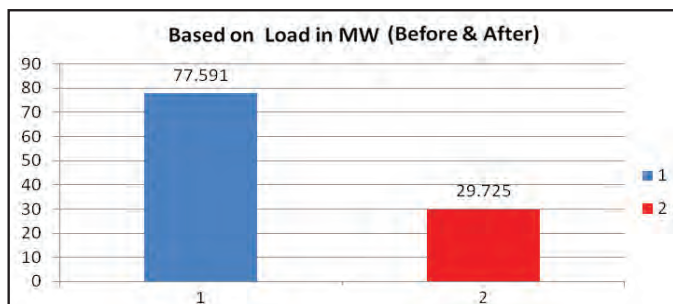
Overall Results of the project

The total project took almost one year to complete and the following table gives the overall summary of the project after implementation.

It can be seen that the load has reduced from 77.59 MW to 29.72 MW, a savings of 47.86 MW, which is 61% reduction, against the guaranteed savings of 55%.

No.	Parameters	Value	Units
1	Total Number of Street Lights replaced	425128	no's
2	Initial electrical Load - with 100% glowing	77.591	MW
3	Load after Replacement with LED	29.725	MW
4	Reduction in Load	47.866	MW
5	% Reduction in Load	61.690	%
6	Units consumption Before Project - Actual	24.08	Crore kwh
7	Units consumption After Project implementation - Actual	11.77	Crore kwh
8	Electricity Bill before Implementation - Actual Bills	179.32	Rs Crore
9	Electricity Bill After Implementation - Actual Bills	94.06	Rs Crore
10	Annual Energy Savings - Actual	85.26	Rs Crore
11	Investment	270	Rs Crore
12	Payback Period	3.167	Years
13	Reduction in GHG	1,00,889	TCO2

The Actual electricity bill savings of Rs.85.26 Crores/year and additionally maintenance cost reduction of another Rs.30 Crores/year. The total savings are more than Rs. 100 Crores/year. Thus this is very successful Energy Efficiency project, without any initial investment.



Here we enumerated multi benefits by different stakeholders of this unique project.

Benefit to GHMC

- No Initial Investment
- Bill has reduced by Rs 85 crores/year. In addition Maintenance cost has been reduced by Rs.30 Crores
- Street Lights Glowing percentage has increased from 78% to 98%
- Lux level has been improved by 60%, when compared to HPSV lamps
- Street light related complaints have reduced
- Total monitoring system is automated through CCMS and online Dash Board created.

EESL

- Investment of Rs 270 crores will be recovered in 7 years.
- Yearly EMI x 7. So, EESL will receive almost double their investment.

LED street light manufactures

- About 22 vendors have supplied 4.209 lakh LED lights.
- Vendors such as Phillips, Crompton, Bajaj have been hugely benefitted.

Government

- Due to the huge energy savings, the saved energy can

be supplied to other sectors like Industry at higher tariff.

- There is avoided investment towards new power plants.

Public

- People are getting good lighting (visibility has improved)
- Less number of complaints
- Lesser Power Breakdowns

Consultant / M & V Auditors / Energy Auditors

- Project consultancy fees
- More business opportunities in future

Global (Benefits to Environment)

- Due to reduction in energy consumption GHG emissions have been reduced.
- These can be sold in an international market through Carbon Credits under Clean Development Mechanism (CDM)

Uniqueness of the project & Conclusion

- This is the World's single largest LED Street Lighting Project
- Load Reduction of 77.6 MW to 29.7 MW (49 MW) – 61%
- Energy Bill Reduction of Rs. 85 Crore/year
- In addition, Rs.30 Crores Savings in Annual Maintenance
- Lux Level improvement of 60%
- Glowing % improvement from 77% to 97%
- GHG Emission Reduction of 1,00,889 T CO2
- Complaints have reduced drastically form Public
- Above all Benefits without Initial Investment of Rs.270 Crore's under ESCO model
- This is a proven case study that can be replicated not only in India, but also worldwide

In this project, 4.2 Lakh old street lights have been replaced with LED lamps. The total investment of about Rs. 270 Crores was invested by EESL under Energy Service Company (ESCO) model. Under this ESCO model, the project is implemented, based on Shared Energy Savings Model to recover the initial investment made by the ESCO company over a period of 7 years. For Monitoring and Verification (M&V) of the savings by this project, Central Control and Monitoring System (CCMS) have been installed. For automatic online monitoring and also for switch off and switch on, the systems are based on real time clock.



G. Subramanyam

The author is the Director of Siri Exergy & Carbon Advisory Services (P) Ltd., Hyderabad, India

ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS (As on 30.11.2020)

Region	Ownership/ Sector	Mode wise breakup								Grand Total
		Thermal					Nuclear	Hydro	RES * NRE)	
		Coal	Lignite	Gas	Diesel	Total				
Northern Region	State	16659.00	250.00	2879.20	0.00	19788.20	0.00	5777.25	725.51	26290.96
	Private	22425.83	1080.00	558.00	0.00	24063.83	0.00	2817.00	16390.32	43271.15
	Central	14352.96	250.00	2344.06	0.00	16947.02	1620.00	11450.52	379.00	30396.54
	Sub Total	53437.79	1580.00	5781.26	0.00	60799.05	1620.00	20044.77	17494.83	99958.65
Western Region	State	21740.00	1040.00	2849.82	0.00	25629.82	0.00	5446.50	555.54	31631.86
	Private	32847.17	500.00	4676.00	0.00	38023.17	0.00	481.00	26262.86	64767.03
	Central	19147.95	0.00	3280.67	0.00	22428.62	1840.00	1627.50	666.30	26562.42
	Sub Total	73735.12	1540.00	10806.49	0.00	86081.61	1840.00	7555.00	27484.70	122961.31
Southern Region	State	19782.50	0.00	791.98	159.96	20734.44	0.00	11774.83	586.88	33096.15
	Private	12747.00	250.00	5340.24	273.70	18610.95	0.00	0.00	42322.78	60933.73
	Central	11835.02	2890.00	359.58	0.00	15084.60	3320.00	0.00	541.90	18946.50
	Sub Total	44364.52	3140.00	6491.80	433.66	54429.99	3320.00	11774.83	43451.56	112976.38
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	1278.78	7527.78
	Central	13684.05	0.00	0.00	0.00	13684.05	0.00	1005.20	10.00	14699.25
	Sub Total	27287.05	0.00	100.00	0.00	27387.05	0.00	4639.12	1563.89	33590.06
North Eastern Region	State	0.00	0.00	498.86	36.00	534.86	0.00	422.00	233.25	1190.10
	Private	0.00	0.00	24.50	0.00	24.50	0.00	0.00	105.66	130.16
	Central	770.02	0.00	1253.60	0.00	2023.62	0.00	1263.50	30.00	3317.12
	Sub Total	770.02	0.00	1776.96	36.00	2582.98	0.00	1685.50	368.91	4637.38
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	65631.50	1290.00	7119.86	236.01	74277.36	0.00	26958.50	2381.53	103617.40
	Private	74173.00	1830.00	10598.74	273.70	86875.45	0.00	3394.00	86385.27	176654.72
	Central	59790.00	3140.00	7237.91	0.00	70167.91	6780.00	15346.72	1632.30	93926.93
	Total	199594.50	6260.00	24956.51	509.71	231320.72	6780.00	45699.22	90399.11	374199.04

Figures at decimal may not tally due to rounding off

Source: CEA

Managing the Menace of High Voltage

In India, often the productivity is lost or reduced because of the voltage fluctuations in the power supply. However, now there is a reliable solution available to easily overcome this challenge...

Voltage variation is a common phenomenon. In India, all electrical equipment are designed for 230 / 400 volts single / three phase. If the voltage maintained $\pm 5\%$ then that is tolerable & does not effect on performance/ life of the equipment. The Input voltage is generally low during the day time and high during the night hours. Apart from this, a few months in a year or a few days in a month or a few hours in a day – the voltage is either low or high due to the following reasons:

- Holidays
- Weather Conditions
- Agricultural Load
- Rainy days
- Peak Hours

Effects of High Voltage: The high Voltage no load current of electrical or electronic equipment increases sharply. This high current increases the losses of equipment resulting overheating, weakens the insulation of electrical or electronic equipment and becomes the cause of pre-mature failure of electrical or electronic equipment as explained in the next table:

Effects of Low Voltage: The low voltage does not increase the no load current. In case of very low voltage, the equipment does not work or operate, which results in production loss or uneven quality products. To run the unit in case of low voltage, it needs an alternative source of power, i.e., DG power supply which is very costly and not reliable.

Earlier no reliable technology or manufacturer were available in India – due to that customers installed the A VC on every individual machine, which has lot of deficiencies like higher power consumption, non-availability of servicing in case of any problem – and ultimately became scrap for the company.

In the year I 990, we developed the linear voltage regulator contact assembly up to 3000 kVA, which is quite reliable or dependable with lesser losses. This has a working life of I 0-15 years and recovers the invested money within 6 to 18 months, i.e., depending on their voltage variations. Where the voltage is higher its payback is too short, i.e., 6 to 12 months.

Post Sales Service: It is the most important part after the sale of any equipment; we have more than 10000 installations in pan-India with service structure, i.e., located in every major cities of every state of India. To maintain service structure throughout India for prompt service after sales costs to company on an average 25-30% of the equipment.

Bypass: A VC is an electro-mechanical machine and is having lot of moving mechanical parts. There may be fault any time, which may be 1 out of 100 products, to avoid any production loss or run trouble-free – you can bypass the Automatic Voltage Controller till the time the service engineer reaches the site and rectifies the problem. It is only 20 to 25% cost of the equipment.

So, the power consumers having high failure rate of electrical equipment, higher MDI, can reduce the failure rate of equipment & MDI by maintaining their voltage at 400/415 V.

Conclusion: If they find voltage fluctuations, then they check their voltage hourly in a day for a week, accordingly they should rectify the problem through installed Automatic Voltage Controllers. 

Input Voltage Variation	% Increase In Breakdown		% Increase In Power Consumption	
	Motor Load below 10 hp	Lighting Load	Motor Load below 10 hp	Lighting Load
380-400 V	NIL	NIL	NIL	NIL
400-420 V	5%	10%	3%	5%
420-440 V	10%	20%	5%	10%
440- 460 V	15%	3%	7%	20%
460-480 V	30%	60%	10%	30%



B. B. Jindal
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3 YEARS	36	2500.00	4300.00	4900.00	2500.00	5550.00	6150.00
5 YEARS	60	4000.00	7000.00	8000.00	4000.00	9000.00	10000.00
COOLING INDIA							
1 YEAR	12	1000.00	1600.00	1800.00	1000.00	2100.00	2300.00
2 YEARS	24	1750.00	2950.00	3350.00	1750.00	3825.00	4225.00
3 YEARS	36	2500.00	4300.00	4900.00	2500.00	5550.00	6150.00
5 YEARS	60	4000.00	7000.00	8000.00	4000.00	9000.00	10000.00
LIGHTING INDIA							
1 YEAR	6	750.00	1050.00	1250.00	750.00	1425.00	1625.00
2 YEARS	12	1350.00	1950.00	2350.00	1350.00	2625.00	3025.00
3 YEARS	18	2000.00	2900.00	3500.00	2000.00	3900.00	4500.00
5 YEARS	30	3000.00	4500.00	5500.00	3000.00	6000.00	7000.00
MEDICAL EQUIPMENT & AUTOMATION							
1 YEAR	6	750.00	1050.00	1250.00	750.00	1425.00	1625.00
2 YEARS	12	1350.00	1950.00	2350.00	1350.00	2625.00	3025.00
3 YEARS	18	2000.00	2900.00	3500.00	2000.00	3900.00	4500.00
5 YEARS	30	3000.00	4500.00	5500.00	3000.00	6000.00	7000.00
AUTOMATION & ROBOTICS WORLD							
1 YEAR	6	1200.00	1500.00	1700.00	1200.00	1875.00	2075.00
2 YEARS	12	2160.00	2760.00	3160.00	2160.00	3435.00	3835.00
3 YEARS	18	3200.00	4100.00	4700.00	3200.00	5100.00	5700.00
5 YEARS	30	4800.00	6300.00	7300.00	4800.00	7800.00	8800.00



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THE DIARY

INDIA POWER EXPO

Date: 20 - 21 January 2021
Location: India
Contact: support@xpobuzz.com



POWERGEN INDIA

Date: 27 - 30 January 2021
Location: Virtual Expo
Contact: network@itenmedia.in

WIND EXPO TOKYO

Date: 03 - 05 March 2021
Location: Tokyo
Email: info@reedexpo.co.jp



SOLARTECH 2021

Date: 30 March - 1 April 2021
Location: Indonesia
Email: +622154358118

ELEKTROTEC 2021

Date: 12 - 15 August 2021
Location: India
Contact: elektrotec@codissia.com



CONFERENCE

Power Week Asia 2021

Date: 15 - 18 March 2021
Location: Virtual Conference
Organizer: Infocus International

Power Week Africa 2021

Date: 20 - 23 April 2021
Location: Virtual Conference
Organizer: Infocus International

WEBINAR

Control and Estimation Techniques for the Safe Operation of Critical DC Microgrids

Date: 14 January 2021
Time: 11:00 AM ET
Organizer: IEEE Power Electronics Society

All SiC High Power Converters for Combined Integration of Solar PV and Energy Storage

Date: 27 January 2021
Time: 11:00 AM ET
Organizer: IEEE Power Electronics Society



IN THE FEBRUARY 2021 ISSUE

POWER GENERATION

Thermal Power, Nuclear Power, Boilers,
Turbines And Generator (BTG)

Engines, Heavy Equipment Logistics
Motors & Drives, Pumps & Valves

Company Name	Page No.
Fluke Technologies Pvt Ltd	3
Dynamic Cables Ltd	29
Electracon Paradise Ltd	9
H.D Wires Pvt Ltd	13
HPL Electric & Power Ltd	11
igus India Pvt Ltd	19
International Flat Cable	5
Jindal Electric & Machinery Corporation	49
KVTEK Power Systems Pvt Ltd	7
Larsen & Toubro Ltd	IFC
Pla Components	29
Sturdy Volt (P) Ltd	15
Universal Cables Ltd	IBC
Vishay Components Pvt Ltd	50

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Polymer lead screw nut for lubrication-free adjustment

Igus' injection-moulded dryspin JGRM polymer nut offers a cost-effective alternative to ball screw nuts. The new lubrication-free and wear-resistant design can move heavy loads. For higher axial loads, the new lead screw nut is also available with a stainless steel plate as a "Heavy Duty version".

"The new JGRM series is a robust alternative to ball screw nuts. The new design of the nut, distributes the radial and axial loads in such a way, that we can absorb higher forces in contrast to conventional flanged lead screw nuts," says Thorben Hendricks, Division Manager of Screw Technology at igus GmbH."

The new type is based on the connection sizes and pitches of ball screws and therefore can be easily replaced. The nut offers a variety of installation



methods: it can be screwed on or off or installed in a hole. The thread centring spigot, the anti-rotation feature by means of spanner flats, and the use of four M6 cap head screws helps in the installation. The nut is manufactured by igus using injection moulding in Cologne, so it is very light and cost-effective.

Compared to ball screw systems, the polymer lead screw nuts cost only half as much. Due to the use of iglidur J high-performance polymers, the nut has a very low coefficient of friction. The rounded thread flanks and the absence of balls make the lead screw very smooth running. In addition, due to the use of dry lubricants, the lead screw nut does not require external lubrication that has to be released into the environment.

For further information: E-mail: vinayak@igus.net



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