ELECTRICAL INSTALLATION ENGINEER

NEWS LETTER

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EDITORIAL

Dear Members, Fellow Professionals and Friends,

Greetings To All!

Greetings For A Happy Year 2022!

When we thought that we have slowly and steadily managed to come out of the pandemic, with very good signs of the economy picking up for the overall betterment in all fronts, we are facing fast spread of Corona again with old and new variants. While writing this, the spread was multiplying and the Governments were also initiating all necessary steps including vaccinations and booster doses and so on. As it is repeatedly conveyed at all levels of the community, it is only the full cooperation and commitment of all the people that can help come over the crisis. It is therefore the responsibility of every one of us to strictly follow the "Mask" and "Wash' and the "Social distancing" with care and without fail.

The New Year 2022 shows lot of positive hopes and signs in spite of all kinds of problems and added problems like very excessive rains in the past months and loss of crops and so on. Trade and commerce seem to be maintaining steady growth with high collections of GST and in the export front too, of both Goods and Services, there are reports of almost 50% growth in the April December period compared to corresponding period last year. With increasing FDI and Geo Political changes, it continues to appear that India stands to gain substantially helping our economy and growth and activities in all fronts.

In the Energy front, which is the main concern when it comes to achievement of Net "0" Emission, apart from addressing the efficiencies in all uses energy including the transport sector, the Buildings and homes with codes for Energy Efficiency are also coming into popular practice with certification and so on. Dependence of power sector on coal is an important concern, which is also being addressed with combination of "Firm and Infirm" Renewable Energy solutions with Bio Energy technologies beginning to play their important role.

Our Republic Day Celebrations reminds us, not only of our successful journey as a large Democracy with all round progress for 75 years, but also the building of a powerful armed forces to take on any threat from across the borders anywhere. We can certainly be proud of all our achievements in all areas, be it Nuclear or Technology or Communication or Space or Agriculture and we proudly march forward to become a leading economic power of the world. It is also interesting to see that our practices like "Yoga" and festivals like Deepavali are all getting international recognition with more to follow.

We thank all those members who have helped us by participating in the advertisement appearing for the issue December 2021 – 3SI Eco Power LLP, Asias Electricals, E Power Engineering, Galaxy Earthing Electrodes (P) Ltd., Pentagon Switchgear Pvt. Ltd., Power Cable Corporation, Shree Engineers, Supreme Power Equipment (P) Ltd.

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EDITOR DESK

Dear Friends

It all started casually during 2012 December. Not having a prior experience in editing, something made me to accept the post of Editor for our Newsletter. Barring a few months, I took the responsibility of being an Editor for the last 9 Years.

Now its time to say bye to my readers…

Thanks to all the Office Bearers who has been very supportive to my efforts in the last 9 Years..

I would like to take a moment and thank our Printer Mr. M. Venkataraman, for his outstanding support for this Newsletter. I feel lucky to travel with technical experts Mr. S. Mahadevan & Mr. V. Sankaranarayanan in this editorial journey.

My sincere thanks to Association office staffs Mrs. Anitha & Mrs. Vani for their cooperation.

Last but not least… I would like to thank each and every reader who has given me the encouragement to continue as an Editor, all these years.

I would like to extend my Best wishes to Mr. Murugan who shall be the New Editor for our Newsletter.

I would like to leave you with one of my favourite quotes from Ferris Bueller: "Life moves pretty fast. If you don't stop and look around once in a while, you could miss it."

Thank You

G. Venkatesh

Editor

Newsletter

LEARNING MANAGEMENT BACK FROM MACHINES – 2

A SURPRISE OF HOW WE CAN LEARN MANAGEMENT LESSONS FROM ELECTRICAL SAFETY SYSTEMS

In Part – I of the above said article published in our **News Letter Issue No. 181 Volume 16/2021**, we have seen how machines have been intertwined with our lives, just as much as sinews and bones with the skin above in our bodies.

We all know that the bonding of machines with us is because they are able to calculate more digits than us, carry us around effortlessly, make split-second decisions a million times and all such activities for which we are not infallible. Hence the machines have become an inevitable part of our lives.

We as engineers are progressing rapidly towards Machine learning / Deep Learning wherein we are teaching more processes and activities to machines.

On the other hand, the mechanisms, processes, safety principles adopted to operate current equipment are already so good that we are enjoying the fruits of our labour by getting excellent output, timely reminders to do our activities, prompting / alerting for correcting errors etc.

We will enjoy the fruits more by re-learning many fantastic Management Principles from such machine processes and procedures already conceived and incorporated by us. It is like an elderly person thrilled to learn something from his child while he is still paying for his child's school fees and also teaching him and reprimanding him for something else. Our new journey into "Learning Management Back from Machines" begins.

MANAGERIAL SOLUTION NO. 1

It is well known that any organization should be able to extract maximum productivity out of their employees and especially if the employee is paid fabulously or his work is very important. But many companies do not know how to do so and their productivity suffers. Can we see some examples from electrical systems, where costlier, important systems are taken well care of and thereby give a suggestion of how to sort out this management problem?

Lessons from an electric motor:

Electric motors are made with the sole purpose that they should give the best output for the power input given to them and should work durably for many years so that the investment made on them is recovered.

However, motors, like all equipment with steel parts can get corroded under high humidity. Higher kW motors or sophisticated motors more so are more costly and their maintenance and replacement costs are higher.

Hence engineers find ingenious methods to preserve the life of the motors and get the best output out of them. What do they do?

The technical solution to reduce corrosion and improve performance:

Engineers identified that corrosion of metallic parts due to condensation of water is a major factor and condensation would be reduced if the temperature inside the motor is always kept a few degrees above the ambient.

To enable the same, a space heater is provided within the motor which continues to draw a small amount of power even to keep a non-working motor at a higher temperature than surrounding ambient so that condensation could be reduced.

Generally small power rated motors, lesser important motors are not provided with space heaters and necessary controls and the "white elephant" effect of providing a space heater is limited to big powered motors like 75 kW and above.

The inference:

Similar to the above, organizations naturally expect higher performance from high-paid employees.

It is hence an important challenge to see that any impediments to the performance of these personnel is removed and they are always in productive roles. If not, such organizations will bleed monetarily and have an earlier demise.

Most managements track what a worker is doing for the organization but fail to concentrate on reviewing the availability and productivity of high-paid employees.

Taking a leaf from the electric heater provided for an electric motor, Personal Assistants could be given to high-paid employees so that the high paid employees do not spend their time on menial jobs, the psychology and interests of the high paid employees should be analysed and they should be kept motivated to perform well for many years.

MANAGERIAL SOLUTION NO. 2:

Performance of many organizations are ***affected by situations such as unproductive workforce, internal politics, leaking vital information of the organization to the outside world etc.***

Would there be any parallel to electrical and electronic systems and how do Electrical / Electronic Engineers manage such disturbances / fluctuating situations?

Such practical issues in Electrical Engg:

Electrical Power Engineers face many such situations in electrical systems like failure of inverter, inconsistencies in electric networks, circuit breaker reclosing, turn-off of heavy motors etc..

What do the Power Engineers do in such cases? They go to the root of the problem and find out the reasons like Waveform harmonic distortion, Frequency deviation, Sags, Swells, Commutation Notches, Frequency Deviations, Surges, Electrical Noise etc.

TYPICAL POWER DISTURBANCE IN ELECTRICAL AND ELECTRONIC SYSTEMS			***SIMILAR MANAGERIAL ISSUES***
TYPICAL SYSTEM PROBLEM	***TYPE OF DISTURBANCE IDENTIFIED***	***One of the solutions for the problem found by Engineers***	***Similar issues and solutions for Human Managerial problems***
Telephone transmission interference, degradation of electrical conductors etc.	*Identified as Harmonic Distortions* 	*Install harmonic filers to reduce the total harmonic distortion of current and voltage on the main input line to a acceptable percentage limit.*	*Similarly different people could be giving wrong inputs. Managements and Governments should put proper communication filers to distil such wrong inputs.*

Network problems	*Identified as frequency deviations due to probable generator instabilities* 	*Sort out the generator instability*	*Not all mistakes are with the employees. Employers or Managers could be giving too much load all of a sudden, suddenly thrusting new work etc. causing frequency of delivery of the employees to be affected!. Be more intelligent and have understanding of the work loads.*
Radar, radio signals are not clear	*Identified as electrical noises* 	*Identify whether any HV cable is going near the LV cable etc.*	*Avoid youtube, whattsapp etc. at office time.If you get distracted, speak aloud what you are doing.*

The inference:

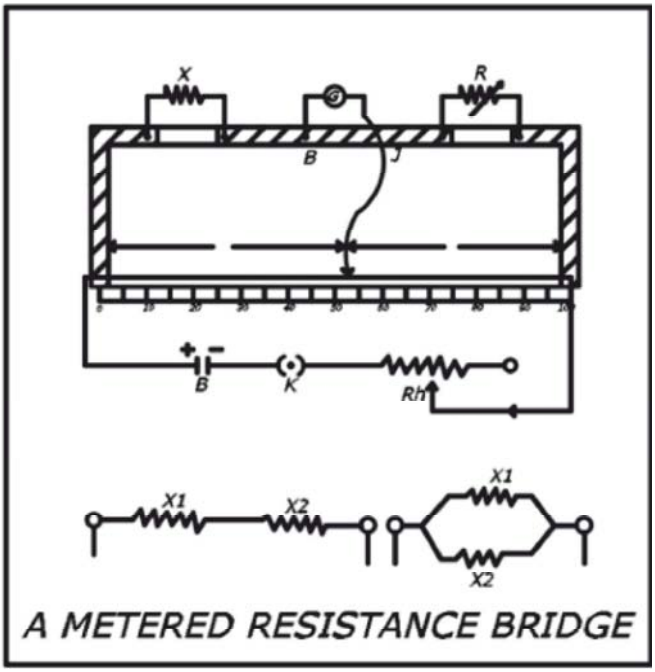
Hence, the electrical / electronic engineers understand the nature of the fault in the output and the reason why it would have happened. Easily, they remove the cause or add gadgets like Rectifiers, Voltage Stabilizers etc. and sort out the problem.

Similarly managerial problem could be reviewed and solutions found.

MANAGERIAL SOLUTION NO. 3: How to change resistance to executing a project?

Lessons from our school education:

We have done experiments in our school days. Our project book would have had a project something like this:



A METERED RESISTANCE BRIDGE

AIM: To determine unknown resistance and to verify the laws of combination of resistance using metered resistance bridges.

APPARATUS: A Metered Resistance Bridge, Resistance Box, two unknown resistance, a galvanometer, a battery cell, a plug key, a jockey, connecting wires, etc.

FORMULA

1. *X/R = Lx/Lr*
2. *When two resistances X1 and X2 are connected in series, the effective resistance of the combination is given by the formula - Xs = X1+ X2.*
3. *When two resistances X1 and X2 are connected in parallel,*

*The effective resistance of the combination is given by the formula - Xp = (X1 * X2)/(X1+X2)*

The inference:

Making two personnel who offer resistance to work on a job one after the other could increase the total resistance. On the other hand, giving them different portions of the same job at the same time or totally different jobs could increase competition / cooperation and output.

A bigger task could mean more resistance. Divide the task to smaller segments, feed inputs as required and get desired output.

MANAGERIAL SOLUTION No. 4:

Does your organization suffer because it does not have a proper hierarchy / work execution / succession plan? Does it have employees of multiple levels of skillsets at multiple locations and has difficulty in managing them and improve the overall performance?

In that case, which organization should one look at to follow their best practices?

The Organizational fall back

We should look to emulating the best institutions in our own respective fields – we should look at Organizational structuring of Financial Institutions / Technical / Medical like:

- *Institute of Electrical and Electronics Engineers*
- *International Standards Organization*
- *Bureau of Indian Standards*
- *National Fire Protection Association*
- *Oil Industry Safety Directorate*
- *Petroleum and Explosives Safety Organization, etc.*

The inference:

The above types of organizations:

- *Could be employing personnel with varying skillsets.*
- *Could be operating from various locations across the country and even across the world.*
- *Could be engaged in multifarious activities.*
- *Could have permanent as well as contractual employees, etc.*

The above types of organizations not only need to perform successful operation for several decades, they also need to be the trend-setters as well.

Hence reviewing their organizational strategies and implementing them suitably will be very beneficial.

The great going forward:

*So, our next generation of electrical, electronic and computer machines will be good at "**Modern Power Electronics, Drives & Control**", "**Electric Vehicles**", "**Big data and Cloud Computing**", "**5G Technology**", "**Robotics, UAV, and Unmanned Vehicle Technologies**", "**Wide Bandgap Semiconductors**" etc.*

We are however, bogged by lot of personal and managerial problems etc. It is like a comedian who makes everybody smile but heart of hearts has some personal problems which he does not know how to solve them as they could be too personal or too orthodox to be sorted by conventional style of management.

So, we now have a new and energetic mentor – the machines in our hands.

Wishing you all a very Happy, Prosperous Safe New Year.

K.Muthukrishnan

Fire safety consultant and author of the book "Learning Management Back From Machines"

M: 9930265069

9. Illustrations

These are based on then actual tests performed on ZnO Arrester Units or Arrester Models

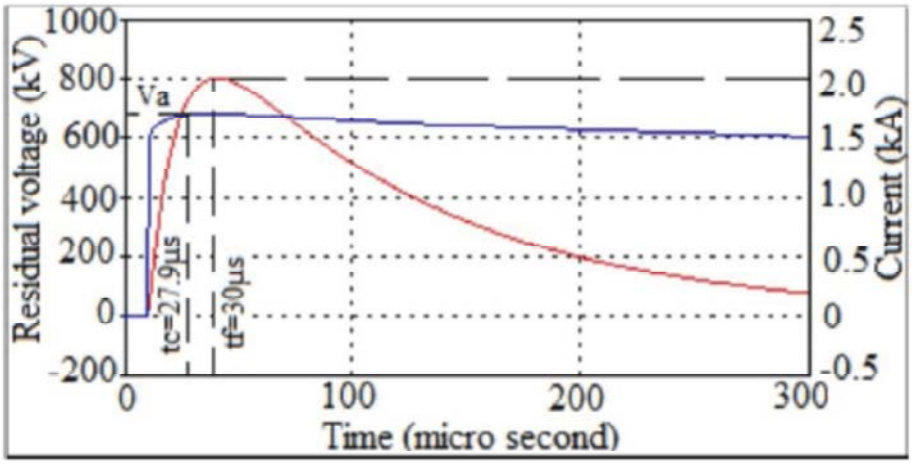


Fig 7. (i) Switching Surge Test 30/60 micro seconds 2KA wave

Switching Surge Test 30/60 micro seconds 2KA wave

(A) 330KV ZnO arrester

Peak residual voltage obtained = 680 KVP

Arrester conduction time = (T_c) = 27.90 micro seconds

Front time of current surge = 30 micro seconds

T_d = (27.90 – 30) micro seconds

In this case T_d = -2.10 (delay - micro seconds time)

(T_f lags behind T_c)

$T_d = (T_c - T_f)$

T_d = (Conduction time - front time of Current Surge) = Delay time.

Arrester "Turns on" successfully.

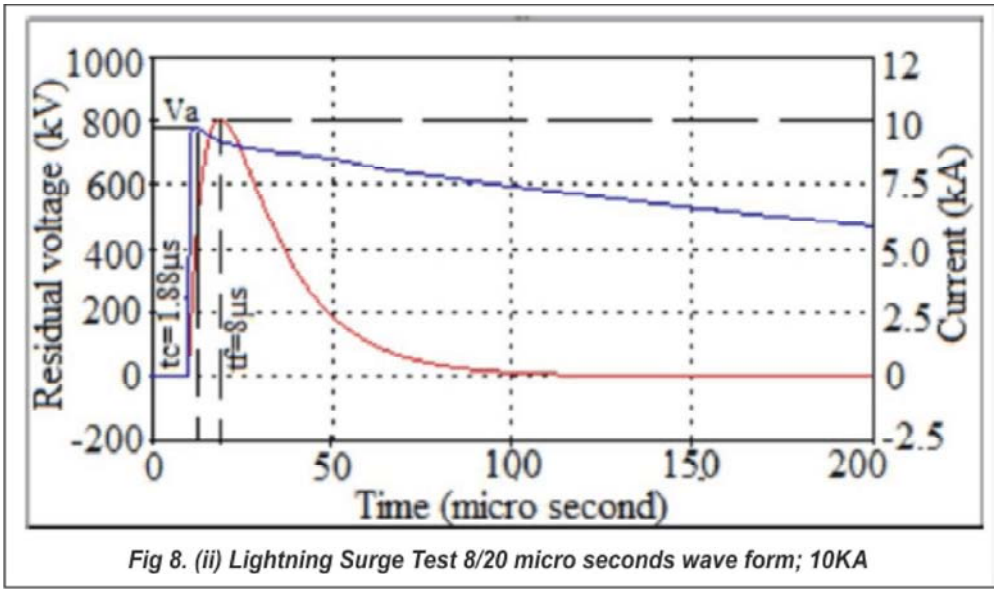


Fig 8. (ii) Lightning Surge Test 8/20 micro seconds wave form; 10KA

Lightning Surge Test 8/20 micro seconds wave form; 10KA

Peak Residual Voltage = 776 KVP

Conduction time (T_c) = 1.88 Micro seconds

Front time of current surge = T_f = 8 Micro seconds

T_d = -6.10 Micro seconds

(T_f lags behind t_c)

i.e. the current surge peak lags behind arrester conduction

Arrester "Turns On" successfully

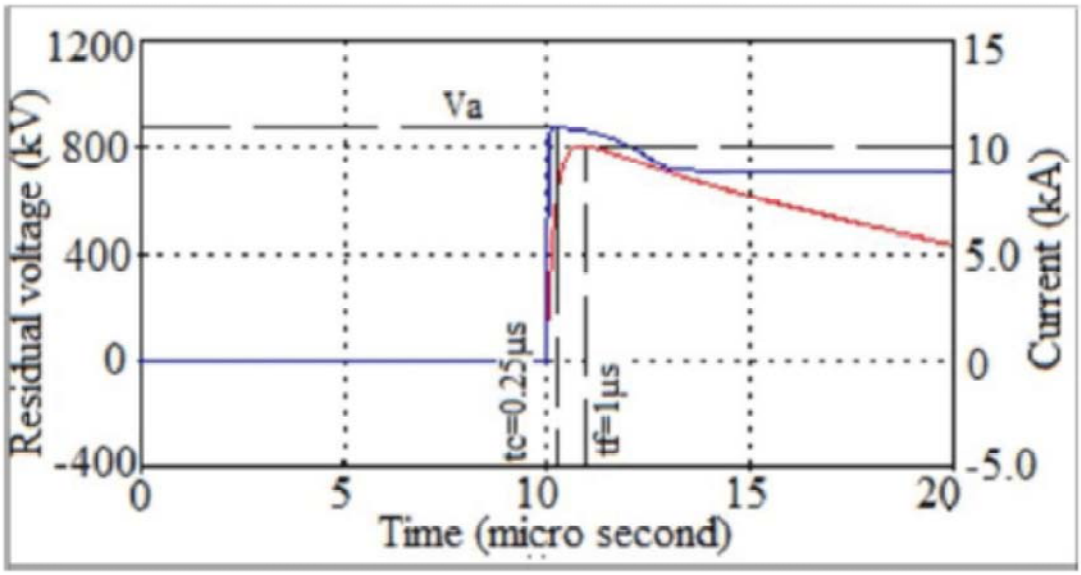


Fig 9. (iii) Steep Surge Test 1/10 Micro seconds; 10KA

Steep Surge Test 1/10 Micro seconds; 10KA

Peak Residual Voltage = 866 KVP

Conduction time – (T_c) = 0.25 Micro seconds

T_f = 1 Micro seconds

T_d = 0.25 – 1 = -0.75 Micro seconds

(T_f lags behind T_c)

Arrester "Turns On" successfully

In all these cases the "MOSA" "Turns On" well in time and seals its success or wins the game. It can be observed that it leads its rival almost from the start and crossed the furnishing line clear of its rival in a time of a few micro seconds.

Now let us view the test results indicating how MOSAS were out played by VFTOs. In the instant case, it was impressed with low magnitude, very steep current surges. (VFTOs)

"Humanity is battling a global pandemic right now, and this event is a timely reminder that the grave threat of climate change has not disappeared."
– NARENDRA MODI, Prime Minister of India

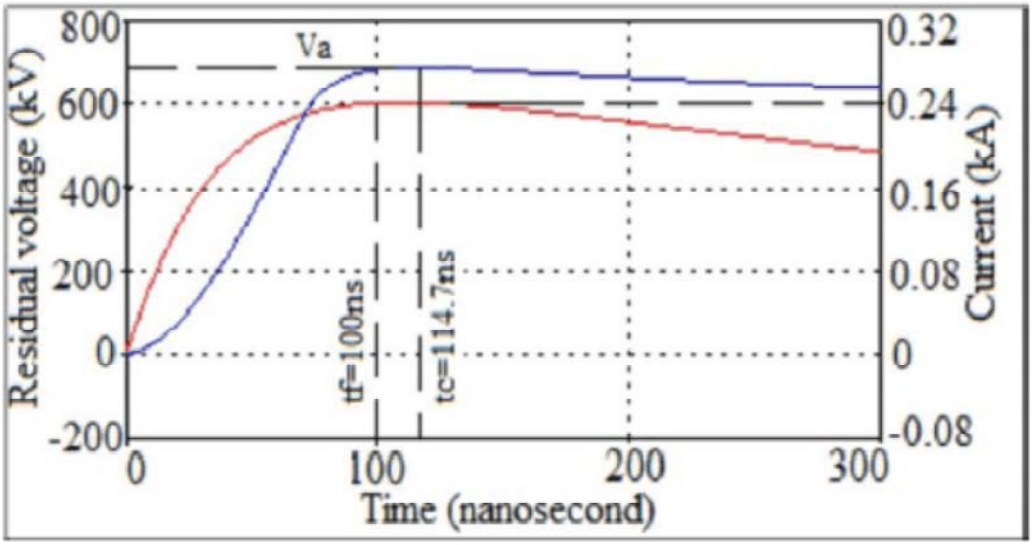


Fig 10. (iv) Arrester was impressed with 0.25 KA, 10 nano second VFTO

Arrester was impressed with 0.25 KA, 10 nano second VFTO

It shows flip flop in the run up to the conduction of the arrester.

Low magnitude very high steep waves tests

Results

Residual voltage =700 KVP

Surge current = 0.25 kA

T_f = 100 Nano seconds

T_c = 115 Nano seconds

T_d = +15 Nano seconds

Arrester fails to Turns On

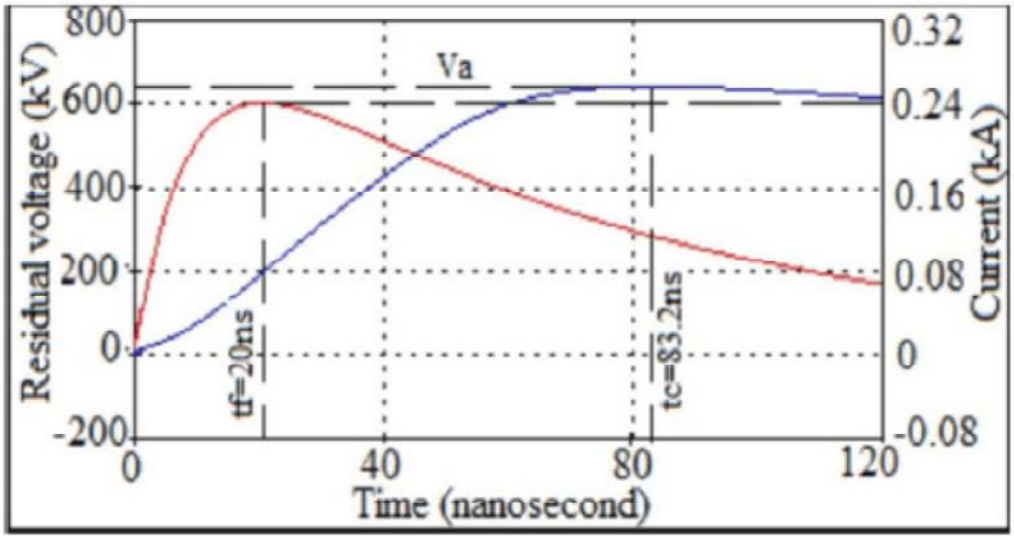


Fig 11. (v) Arrester was impressed with 0.25KA, 20 nano second VFTO

Arrester was impressed with 0.25KA, 20 nano second VFTO

Residual voltage = 610 KVP

Surge current = 0.25 kA

T_f = 20 Nano seconds

T_c = 83 Nano seconds

T_d = 83 – 20 = + 63 Nano seconds

Arrester fails to Turn On

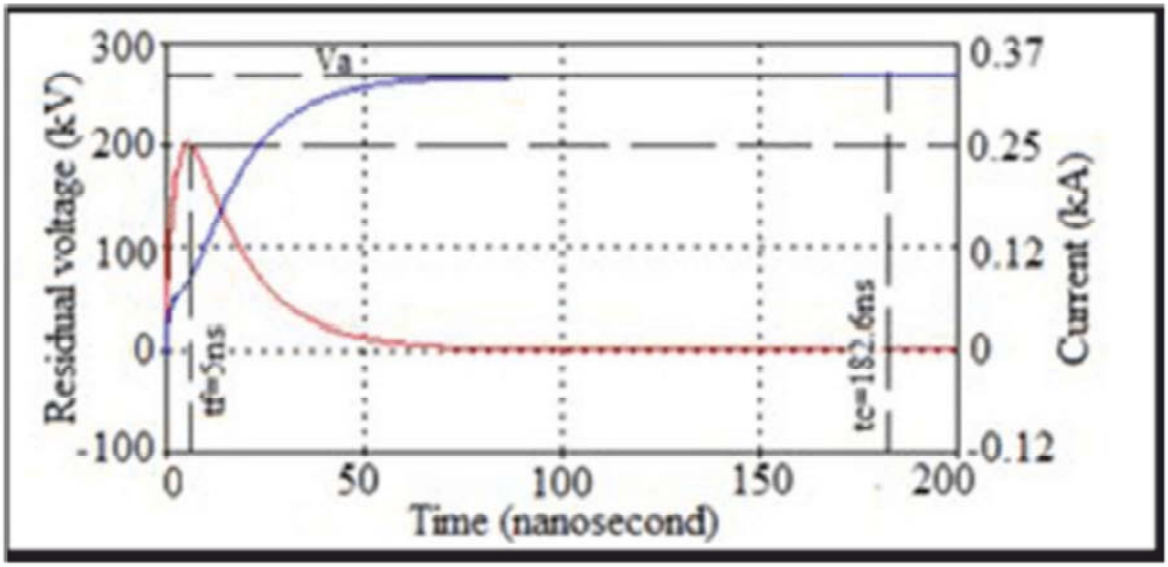


Fig 12. (vi) Arrester was impressed with 0.25KA, 5 nano second VFTO

Fig 10 – 12. Behaviour of 330kV arrester when impressed with low magnitude (0.25kA) and t_f: (d) 100ns (e) 20ns (f) 5ns steepness (VFTOs)

Arrester was impressed with 0.25KA, 5 nano second VFTO

Residual voltage = 280 KVP

Surge current = 0.25 kA

T_f = 5 Nano seconds

T_c = 183 Nano seconds

T_d = +178 Nano seconds = (T_c – T_f)

Arrester fails to Turn On

The recorded test values show that under VFTO conditions greater the magnitude of the applied current surges greater are the chances for the MOSAs to Turn On and vice versa.

10. What are the Health Checks adopted for MOSA? i.e. How the Health of the Security Guard of Power System Equipment is monitored?

HEALTH CHECKS ON SURGE ARRESTERS

I. Online Diagnosis of Surge Arresters (Health Monitoring)

Under normal operating voltage conditions (service conditions), the gapless arresters draw a small magnitude current called “leakage current”, which is in the order of a few micro amps. When deterioration sets in the

arrester components due to ageing or other factors, this leakage current gradually increases and hence it is taken as an indicator of the health status of the arrester. In the case of gapless arrester, the increased current increases the temperature of ZnO elements which in turn increases the leakage current further. Once this leakage current exceeds a critical level, the arrester turns on to a "thermal run away" condition resulting in its failure. The rate of change of leakage current (trend analysis), is therefore an important parameter to be studied while checking the operating status of both gapless are gapped surge arresters. Regular monitoring of arrester leakage amount would help to ascertain their health periodically.

The increase in leakage current may also be brought in by the contaminants on the insulator housing of the arrester. Hence, the arrester insulator housing should be periodically cleaned, especially before checking the arrester leakage current, when it is found to be touching the critical level on exceeding the tolerance limits.

Two kinds of devices are available to record arrester leakage currents.

- Permanently connected monitor – Surge monitor consisting of a counter and a leakage current indicator – (On line).
- Portable leakage current analyzer (Off line)

II. (a) Surge Monitor (On Line)

It contains two components – surge counter and a leakage current indicator. '*The primary function of the surge counter or discharge counter is to count the surges that pass through the arrester. The surge counter operates only at impulse currents above a certain amplitude (100 amps and above). A regular monitoring of this device will help to find out the frequency of surges faced by the system.*

The second component of the surge monitor viz. the leakage current indicator, shows the leakage current of the arrester on a regular basis. Milli Ammeters are normally employed for this purpose. These monitors normally have a *red band or red mark* at the higher scale regions. When the leakage current reaches this red marked zone, it indicates that the health of the arrester is not good and it is likely to attain the thermal run away condition or failure status. The qualitative information thus received are helpful the end user to take preventive measures before the arrester failure. In the case of Gapless arrester, the total current constitutes capacitive current, resistive current and surface leakage current of the arrester insulator housing.

Thus the data recorded in these devices require a careful study before taking a decision regarding the arrester.

In this context, it is important to note that the measured leakage current data obtained during arrester service needs to be compared with the data obtained during initial commissioning / the data supplied by the manufacturer. Further it is essential to record the operating voltage and ambient conditions during the measurement of the leakage current. In the case of ZnO arresters, *the resistive component of the total current plays a significant role in determining its health status. Another point to worth note is that the cleaning of arrester housing is necessary before taking the readings as the surge monitor reads the leakage current of the outer arrester housing as well as the inner active arrester components*. The on line surge monitor does not require for its operation any power source like batteries of D.C or A.C low voltage supplies from the station. An electromagnetic cyclomertic 5 digit non resetting type counter is provided for it. The voltage across the surge monitor does not exceed 10V rms during normal conditions. The surge monitor line terminal is solidly connected to the ground terminal of the surge monitor.

(b) Portable Leakage Current Analyser (Offline)

This device is generally used for checking the healthiness of ZnO arresters. The resistive component of the total current is extracted, measured and compared with a bench mark given by the arrester supplier or the reading recorded at the time of commissioning.

III. Diagnostic Tests on Gapless Arresters (ZnO)

(a) Gapless Arresters (ZnO)

The leakage current values at Maximum Continuous Over Voltage (MCOV) or any other reference voltage as recommended by the supplier should be measured periodically. The resistive component of the leakage current thus determined should not exceed the maximum level recommended by the supplier. *Under worst conditions*, *the maximum permissible current level is twice the reference value, measured at the time of commissioning the arrester.* In case facilities are not available for measuring the resistive component of the total leakage current, measure and record the leakage current at MCOV after a thorough cleaning of the arrester housing. This current should not exceed twice the value of the current recorded at the time of commissioning the arrester or the maximum set by the Arrester manufacturers.

11. What are the final thoughts on this topic viz. MOSA?

(Concluding Remarks / Final Thoughts)

Various facets of MOSA (Metal oxide or ZnO Surge Arrester) viz. its salient features, its core role in guarding the power system equipment, its weak spots while facing VFTOs are brought into focus. Many unknown facts about the operation of MOSA are also brought out. The roles played by arrester discharge voltage and the front time of invading current surge during its Turn on phase are also described. The key information or positives conveyed is that for the successful operation of ZnO arrester, while facing the over voltage spectrum, its conduction time (T_c) should be less than the front time of the intruding voltage waves (T_f). To achieve this, all the grains in the arrester discs must coordinate and work in tandem. If this condition is not met with, the arrester will not operate or "Turn on" and thereby endangers all the connected equipment in the Substation / Power station.

To get a clear view, it is stated that the peak of the arrester discharge voltage should always lead and establish its position well before onset of the peak of current surge concerned ($T_f > T_c$)

Front of incoming current surge = $T_f > T_c$ conduction time of Surge Arrester

T_d = Delay time = $T_c - T_f$ should be negative

(T_d; T_c; T_f are in Nano or Micro seconds)

MOSA suffers much under VFTOs because of the pulls exerted on it by stray and block capacitances and in the end it either fails or surrenders to the invading waves most of the time.

12. Behind the Bye-line (reference)

(i) Doctoral thesis titled "Possible approaches that facilitate Metal oxide Arresters to Turn On under VFTOs by Thiru R. Kannadasan of Anna University, Chennai

(To be continued)

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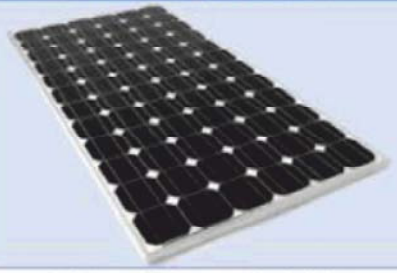
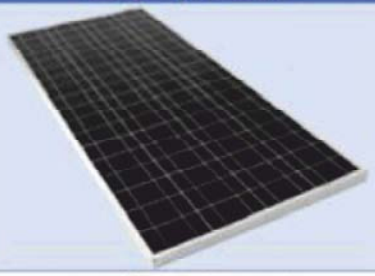
"The countries that take decisive action now to create the industries of the future will be the ones that reap the economic benefits of the clean energy boom that's coming."

– JOE BIDEN, US President

MONOCRYSTALLINE VS POLYCRYSTALLINE SOLAR PANELS

When it comes to solar panels, one of the most asked questions is which solar cell type is better: Monocrystalline or Polycrystalline?

In this article, we will do a full in-depth comparison between Monocrystalline and Polycrystalline solar panels including:

Characteristics	Monocrystalline	Polycrystalline
		
Physical Looks	Diamond pattern is visible	No diamond pattern
Power generation capacity per panel	400 Watt Peak (21% more)	330 Watt Peak
Works better in warm climate	After 43°C, 0.33% drop in power output per degree rise of temperature. (Suitable for warm climate)	After 40°C, 0.85% drop in power output per degree rise of temperature.
Efficiency	20.2%	17.5%
Price	25 to 30 taka per Watt Peak (20% more)	20 to 24 taka per Watt Peak
This comparison is based on the data available in August 2019.		

How are they made?

What do they look like?

How efficient are they?

How well do they react to heat?

What is their expected lifespan?

Are they recyclable?

How expensive are they?

But first, let's see how Solar PV works.

Solar Photovoltaics (PV) is the direct conversion to electric current at the junction of two substances exposed to solar energy. It occurs through a process known as the Photovoltaic Effect which cause photons to be absorbed and electron discharge. Solar energy is composed of photons which are small packets of electromagnetic energy. Materials that exhibit this photovoltaic effect are known as PV or Solar cells. Solar cells are composed of semiconductor materials, such as silicon, used in the microelectronics industry. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current — that is, electricity. This

electricity can then be used to power a load, such as a light or a tool. The first photovoltaic module was built by Bell Laboratories in 1954. So, without further ado, let's jump right into how solar panels are made.

A. Manufacture

How are Monocrystalline Solar Panels Made

In 1918, the Polish scientist Jan Czochralski discovered a brilliant method for monocrystalline silicon production and called it the Czochralski Process, and later in 1941, the first cell was constructed. The manufacture of monocrystalline solar cells contains 8 main steps and, in this section, we will quickly go through each one of them.

Make Metallurgical Silicon

The main ingredient that makes monocrystalline solar panels is silicon also known as Silica sand, Quartzite, or SiO2. The first step in manufacturing monocrystalline cells is to extract pure silicon from quartzite to make metallurgical silicon. To make metallurgical silicon, special ovens are used to melt SiO2 and Carbon at temperatures of over 2,552 degrees Fahrenheit leaving behind 98% to 99% pure silicon. Although the high purity of metallurgical silicon, it's not pure enough to be used in PV panels. Therefore, further purification needs to be done.

Purify Metallurgical Silicon

The next step is to purify this metallurgical silicon using the Siemens process.

First, we expose the powder of metallurgical silicon Si in a reactor with HCl at elevated temperatures resulting in SiHCl3 gas. The gas is then cooled and liquefied for distillation. Distillation is the process of evaporating then condensing the liquid to get rid of unwanted impurities. For instance, you can boil seawater (salted water), then condense the vapour to get pure water, as the salt will remain at the bottom of the pot. Using the same concept, the liquified SiHCl3 is heated then cooled to remove impurities with higher and lower boiling points such as Calcium and Aluminum. After distillation, the liquefied SiHCl3 is moved to a different insulated reactor with a hot rod, then mixed with Hydrogen gas and vaporized again at a temperature of up to 2732 degrees Fahrenheit. Due to the heat and the presence of H2 gas, the Cl atoms will dissolve leaving around 99.9999% pure silicon behind.

Creating Silicon Ingots

What differs monocrystalline cells from polycrystalline cells is that monocrystalline panels are made of a single pure silicon ingot. Making a single pure silicon ingot was really hard until Czochralski discovered this brilliant way. First, you dip a seed crystal, which is a small rod of pure single crystal silicon into the molten silicon.After dipping the rod, now it's time to slowly pull and rotate the seed crystal upward at the same time to minimize the effect of convection in the melt. As the seed crystal is pulled up, the liquid silicon will slowly solidify over 4 days creating a big homogeneous cylindrical single crystal silicon also known as silicon ingot. The size of the silicon ingot depends on 3 factors: temperature gradient, cooling rate, and rotation speed.

Creating Silicon Wafers

So far you have a huge single crystal silicon ingot, but how can you make solar panels of it?

Well, the answer is very simple, wire saw. The third step is to slice the silicon ingot into very thin slices using a very sharp wire saw creating 1 mm or 0.0393 inches silicon wafers. After cutting the wafers, it's about time to polish and wash the wafers to clean it from dust, dirt, and scratches.

Improving the Wafers

Because the wafer surface is very flat, many light rays are reflected away, and obviously, you don't want that, as it will decrease the efficiency of the solar panel. For this reason, manufacturers roughen and etch the wafers' surface, so the light can refract multiple times, which improves the panel's efficiency and prevents light reflection as much as possible.

Diffusion

Silicon wafers are positively charged. In other words, they act as a p-type material. To conduct electricity you need a p-n junction and in order to create a p-n junction, a negatively charged layer of phosphorous is added to each wafer, then wafers are moved to special 1652 degrees Fahrenheit ovens to inject the phosphorus with nitrogen. The mixture of nitrogen and phosphorus creates a powerful n-type layer resulting in a very effective p-n junction wafer, which of course will increase the efficiency of the panel. Improve Conductivity in order to decrease electricity loss, a highly-conductive silver alloy is pressed onto the wafer front, which ensures the power is perfectly transported and improves the monocrystalline cell conductivity even further.

Assembling

Finally, the last step in building monocrystalline panels is assembling. Each monocrystalline solar panel is made of 32 to 96 pure crystal wafers assembled in rows and columns. The number of cells in each panel determines the total power output of the cell.

How are Polycrystalline Solar Panels Made?

Polycrystalline also known as multi-crystalline or many-crystal solar panels are also made from pure silicon. However, unlike monocrystalline, they are made from many different silicon fragments instead of a single pure ingot. The difference between mono and poly solar cell production is that, after purifying the silicon, instead of pulling the ingot slowly to make a homogeneous cylindrical crystal (Czochralski Process), the molten silicon is left to cool and fragment. These fragments are then melted in ovens and poured into cubic-shaped growth crucibles. After the molten silicon solidifies, the ingots are cut into thin wafers, then polished, improved, diffused, and assembled just like monocrystalline panels.

B. Monocrystalline vs Polycrystalline Solar Panels Appearance

What Do Monocrystalline Panels Look Like?

Because the pure silicon ingot is round, slicing them will result in square wafers with rounded edges, which creates small gaps between the cells once assembled. And due to the fact that they are made of pure silicon, they appear with a uniform dark look because of how light interacts with pure silicon.Therefore, you can easily recognize the monocrystalline solar cells by their uniform dark appearance and the rounded edges squares with small spaces between each cell. Don't worry, although the monocrystalline solar cell is dark, there are plenty of colours and designs for the back sheets and frames that will meet your preferences.

What Do Polycrystalline Solar Panels Look Like?

Unlike the uniform dark look the monocrystalline solar cells have, polycrystalline cells tend to have a blue hue because of how sunlight interacts with the multi-crystalline. Moreover, because polycrystalline wafers aren't cut from cylinders like the monocrystalline ones, they won't have rounded edges. Thus, you can easily recognize them by the bluish hue and the absence of rounded edges. Polycrystalline cells also have plenty of colourful back sheets and frame designs that will definitely suit your roof.

C. Monocrystalline vs Polycrystalline Solar Panels Efficiency

The solar panel efficiency is an indicator of how good the cell is in converting sunlight into electricity. For example, if we brought 2 different solar panels, one with an efficiency of 10% and the other with 20% and we shine the same amount of light for the same duration. The latter will produce almost double the electricity generated by the first one.

How Efficient are Monocrystalline Solar Panels?

Among different solar panel types, monocrystalline cells have the highest efficiency typically in the 15-20% range and it's expected to get even higher. Fun fact: In 2019, the National Renewable Energy Laboratory managed to develop a six-junction solar cell with an efficiency of 47.1% setting 2 new world records.

How Efficient are Polycrystalline Solar Panels?

Because each polycrystalline cell is made of too many crystals, there is less room for electrons to move resulting in a lower electricity generation efficiency. Although monocrystalline have higher efficiency rates, the difference between mono and polycrystalline cells isn't that big. Most polycrystalline PV cells have efficiencies between 13% to 16%, which is still a very good ratio and it's expected to get only higher in the future.

D. Mono-Si vs Poly-Si Temperature Coefficient?

Another great factor that is greatly overlooked is the temperature coefficient. The temperature coefficient is a measurement of how well the solar cell functions when the temperature rises. In other words, it indicated the efficiency loss for every degree the temperature rises.

How Temperature Affects Monocrystalline Solar Panels Efficiency?

Most monocrystalline solar cells have a temperature coefficient of around -0.3% / C to -0.5% / C. So when the temperature rises 1 degree Celsius or 32 degrees Fahrenheit, the monocrystalline solar cell will temporarily lose 0.3% to 0.5% of its efficiency.

How Temperature Affects Polycrystalline Solar Panels Efficiency?

Polycrystalline PV cells have a higher temperature coefficient than the monocrystalline ones. This means that polycrystalline panels will lose more of their efficiency when the temperature rises making them not optimal to be used in hot areas.

E. Expected Lifespan

The lifespan of the solar cell is indicated by the degradation rate or the yearly energy production loss. Most solar panels have a degradation rate of 0.3% to 1%. Meaning that every year, the total power output of your system will decrease by 0.3% to 1%.

How Long Do Monocrystalline Solar Panels Last?

Most monocrystalline PV panels have a yearly efficiency loss of 0.3% to 0.8%. Let's assume we have a monocrystalline solar panel with a degradation rate of 0.5%. In 10 years, the system will operate at 95% efficiency, in 20 years, the system will operate at 90% efficiency, and so on till it loses a significant amount of its energy production capability that it becomes inefficient. Most monocrystalline solar panels come with 25 or 30 years warranties. However, you can expect your system to last for up to 40 years or more.

How Long Do Polycrystalline Solar Panels Last?

Polycrystalline PV cells have a slightly higher degradation rate than, which causes them to lose their efficiency a little faster than the monocrystalline ones. Don't get me wrong, they still have a lifespan of 20-35 years and sometimes even more.

F. Recyclability

Are Monocrystalline Solar Panels Recyclable?

The short answer is yes, monocrystalline solar cells can be recycled. Monocrystalline solar panels are made of 3 main components: Monocrystalline cells: Around 85% of the silicon wafers are recycled

Glass: Almost 95% of the glass can be reused , Metal: 100% of the metal parts are recyclable

2. Are Polycrystalline Solar Panels Recyclable?

Similar to monocrystalline, around 90% of all the material used to manufacture polycrystalline cells are recyclable. And by the year 2030, it's expected that almost 45 million new modules will be made using recycled materials, which is equivalent to 380 million USD.

G. Cost

How Expensive are Mono-Si Solar Panels?

Monocrystalline solar panels have numerous advantages but one of their main disadvantages is the high initial cost. Among all types of PV solar panels types, monocrystalline is definitely the most expensive one to produce.

This is due to the fact that the process of manufacturing monocrystalline solar cells is very energy-intensive and produces a big amount of silicon waste.

How Expensive are Polycrystalline Solar Panels?

Compared to their efficiency, polycrystalline solar panels have less cost per watt making them cheaper than the monocrystalline type.

The reason for this is that the manufacturing process creates less waste and uses less energy resulting in less production costs.

Fun fact: Sometimes poly-Si panels are made from the left-over pieces of mono-Si production, which reduces the amount of silicon waste. It's important to mention that although poly-Si cells are cheaper, they occupy more space than monocrystalline to generate the same amount of energy making them less space-efficient.

Factor	Monocrystalline Solar Panels	Polycrystalline Solar Panels
Silicone Arrangement	One pure silicon crystal	Many silicon fragments melded together
Cost	More expensive	Less expensive
Appearance	Panels have black hue	Panels have blue hue
Efficiency	More efficient	Less efficient
Lifespan	25-40 years	20-35 years
Temperature Coefficient	Lower temperature coefficient, making them more efficient in heat	Higher temperature coefficient,making them less efficient in heat

WIRELESS CHARGING - NEW TECH

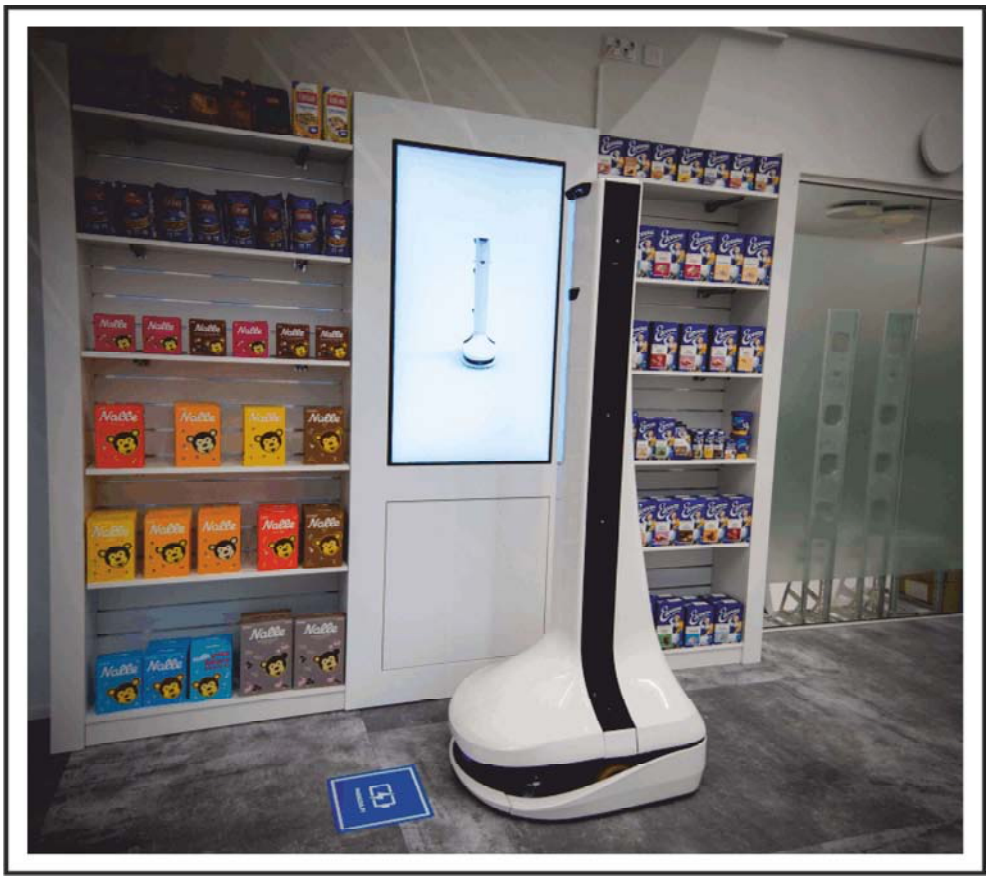
A new power transfer technology makes it possible to conveniently charge devices without using any wires or plugs. Warehouse robots, kitchen appliances, and even phones or laptops can receive power anywhere over the charging area, and because the power transfer continues even while the device is in motion, this technology could one day power electric vehicles while they're on the go.

The basics of wireless power transfer have been in place for some time, but existing systems are not able to charge devices placed anywhere within a large area. Using a single large transmitter to cover the entire area leads to unwanted electromagnetic exposure and means that the power flow to individual devices cannot be controlled. If many small transmitters are used, the receiving devices must be in a known position, and the transmitter and receiver have to be precisely aligned. This means the system either has to use fixed charging locations or incorporate position sensors, communication protocols, and processing to track the location of each receiver.

Researchers at Aalto University have tackled these problems, developing a power transfer technology that works regardless of the position and orientation of the transmitter and receiver. The key idea is to arrange the transmitters in a grid with the current in neighbouring transmitters running in opposite directions — for example, a clockwise loop in one transmitter and counter-clockwise loops in its neighbours. This creates a chessboard-like grid of 'positive' and 'negative' transmitting coils with a magnetic flux between them. A receiver above the grid of transmitters captures the magnetic flux between positive and negative transmitters, which generates an electric current to charge the device.

'The beauty of our method is that it's very simple yet quite sophisticated,' says Prasad Jayathurathnage, the postdoctoral researcher who led the project. 'We don't need a high-end processor or lots of computations to make the transmitters intelligent. At the end of the day, it's all an electromagnetic system, and our approach was to figure out how we could detect the receiver's presence and position electromagnetically.' Because the

presence of a receiver triggers the power transfer, the system can work without any positional tracking and communication between the receivers and transmitters. This also means that power is only transferred to the receiver, rather than the entire area being energised, and it makes it possible for several devices to be charged simultaneously.



Tiling transmitters together produces a charging area of the desired size and shape. A subset of the transmitters is then activated at lower power. 'That's basically a search — the transmitters are listening for a receiver,' explains Shamsul Al Mahmud, a doctoral student in the project. If power transfer to a receiver begins, the neighbouring transmitters switch from being off into an alert mode, primed to transfer power if the receiver appears over them.

The technology has been tested with commercial warehouse robots in cooperation with Finnish firm Solteq Robotics, and Jayathurathnage also leads the project Parkzia, a project funded by Business Finland. The project aims to commercialize this new technology for industry and transport. 'Taking this technology out of the lab and seeing it work in the warehouse was an exciting moment for me personally,' says Jayathurathnage. 'I was finally bringing the product of ten years of research out of the lab.'

More familiar applications can also improve our daily life. 'Take kitchen appliances, for example,' says Jayathurathnage. 'At the moment, you need to put a rice cooker or a blender at a particular spot for it to get energy. But with our technology we can make the whole kitchen counter a source of power for appliances or even phones, but the electromagnetic field is only generated under the devices.'

Although the technology is essentially ready for real-world applications, it still needs commercial packaging and certification. In the meantime, Jayathurathnage's team will continue to refine and improve this technology. One of their goals is to boost the power levels from about 1 kW to around 20 kW so that the technology could be used to charge electric vehicles. 'There are pilot projects on electrifying roads across the world,' says Jayathurathnage. 'Electric vehicles are a really great application of this technology.'

TANGEDCO TO INSPECT BUILDINGS FOR MULTIPLE SERVICE CONNECTIONS

Tamil Nadu Generation and Distribution Corporation (TANGEDCO) Chairman and Managing Director (CMD) Rajesh Lakhoni has directed all Deputy Finance Controllers (DFC) to increase revenue at the utility's 44 circles by ten per cent each.

CONSUMER-CONSUMPTION BREAK-UP

Category	Total no (in L)	%	Energy consumption in Mn units (during 2021)	%
HT Services	0.1 L (10,030 Nos)	0.03	27,917	29.91
LT Services				
Domestic	227.53	71.92	32,714	35.05
Commercial	35.37	11.18	6,738	7.22
Industries	7.38	2.33	8,384	8.98
Agriculture	21.81	6.89	13,956	14.95
Huts	9.89	3.13	393	0.42
Others	14.30	4.52	3,242	3.5
Total	316.38	-	-	93,344

This direction has been issued by the Chairman and Managing Director (CMD) Rajesh Lakhoni at a recent meeting of Deputy Finance Controllers in Chennai, a senior official told TNIE. He has also ordered them to have all Low Tension (LT) power connections inspected. The official said many LT consumers on the same localities obtained connections using different names and dodged paying additional charges, leading to revenue loss for TANGEDCO. According to Tamil Nadu Electricity Regulatory Commission (TNERC) norms, LT consumers exceeding their 150 Kilowatt (KW) limit should pay demand charges of Rs.350 /- per KW and the connection must be converted to High Tension (HT). Hence, all DFCs are instructed to merge such connections and to convert them to HT supply. . "Big shopping stores located in multi-storey buildings are taking separate low-tension commercial connections for each floor to avoid taking single high-tension connection for the whole building. If the total power demand exceeds 112 Kilowatt, they have to take HT connection for which they have to pay demand charges. To overcome it, they are taking separate connections for each floor," the official said.

This apart, the State-owned power company has trouble handling agriculture and hut services as well as a 100-unit free system. As per norms, hut services are allowed to utilize a single 60-watt bulb. This norm, however, is often violated, with consumers using fans, mixers, grinders, and other appliances using the hut connection. It has been found in many instances that even those staying in tiled-roof houses obtained power connections under the hut service scheme. No action has been taken against them.

The TNERC had strictly instructed, multiple times, that metering connections of all consumers is vital, but the utility is yet to meet the deadline, seeking extension after extension. To put an end to the revenue loss caused by consumers by availing multiple service connections, the Tamil Nadu Generation and Distribution Corporation has launched a drive to identify commercial/shopping complexes and residential premises having multiple connections in violation of norms.

The Accountant General (AG) audit team pointed out many irregular sanctions of more than one service connection under LT supply in the same premises for a total demand exceeding 112 Kilowatt. Now, the team has been asked to submit the inspection report for the apartment/flat/residential units having more than 50 numbers within the jurisdiction of all Distribution Circles in order to verify compliance to the TNERC order as well as instructions issued by the Tangedco," a memo issued by Tangedco's commercial wing stated.

It also pointed to Tangedco MD's instruction to conduct inspections of all flats irrespective of the number of dwelling units to confirm the number of services effected by a field official.

A senior official said that instructions were given to chief engineers of all distribution regions to conduct regular inspections of existing LTCT service connections and verify existence of multiple services in the same premisesIn residential premises, the official said that for one household only one service connection should be provided but they take two connections to separate the air conditioner and motor pump loads from others. "This is primarily done to avail subsidy benefits but it causes revenue loss for the utility. If a household consumes over 800 units they would be paying Rs 6.60 per unit after 500 units. If they have two meters, they will get 200 units free and they will pay less under the tariff slab, " the official noted.

NEW RECORD IN THE POWER CONVERSION EFFICIENCY OF SOLAR CELLS

A team of researchers from the National University of Singapore (NUS) has set a new record in the power conversion efficiency of solar cells made using perovskite and organic materials. This technological breakthrough paves the way for flexible, light-weight, low cost and ultra-thin photovoltaic cells which are ideal for powering vehicles, boats, blinds and other applications.

"Technologies for clean and renewable energy are extremely important for carbon reduction. Solar cells that directly convert solar energy into electricity are among the most promising clean energy technologies. High power conversion efficiency of solar cells is critical for generating more electrical power using a limited area and this, in turn, reduces the total cost of generating solar energy," explained lead researcher Presidential Young Professor Hou Yi, who is from the NUS Department of Chemical and Biomolecular Engineering and also leading a "Perovskite-based Multi-junction Solar Cells group" at the Solar Energy Research Institute of Singapore at NUS.

"The main motivation of this study is to improve the power conversion efficiency of perovskite/organic tandem solar cells. In our latest work, we have demonstrated a power conversion efficiency of 23.6% — this is the best performance for this type of solar cells to date," added Dr Chen Wei, Research Fellow at the NUS Department of Chemical and Biomolecular Engineering and the first author of this work.

This achievement is significant leap from the current power conversion rate of about 20% reported by other studies on perovskite/organic tandem solar cells, and is approaching the power conversion rate of 26.7% of silicon solar cells, which is the dominating solar technology in the current solar photovoltaic (PV) market.

This innovation was published in *Nature Energy* on 20 January 2022. The research was conducted in collaboration with scientists from the University of Hong Kong and Southern University of Science and Technology.

New trends in the solar world

Solar cell technology has achieved tremendous growth in recent years as a sustainable energy source. The reliability, efficiency, durability, and price of solar cells have a crucial impact on the commercial potential and large-scale implementation of solar energy projects around the world.

The conventional solar cells being used in solar power plants are based on a single-junction architecture. The practical power conversion efficiency of single-junction solar cells is limited to about 27% in industrial production. To push the frontiers of solar energy production will require novel solutions for solar cells to perform better in power conversion.

In order to raise the power conversion efficiency of solar cells to go beyond 30%, stacks of two or more absorber layers (multi-junction cells) are required. Tandem solar cells, which are made using two different types of photovoltaic materials, is a hot area of research.

In their latest project, Assistant Professor Hou and his team break new ground in the field of perovskite/organic tandem solar cells. Their discovery opens the door to thin-film tandem solar cells that are light and bendable, which could have wide-ranging applications such as for solar-powered blinds, vehicles, boats and other mobile devices.

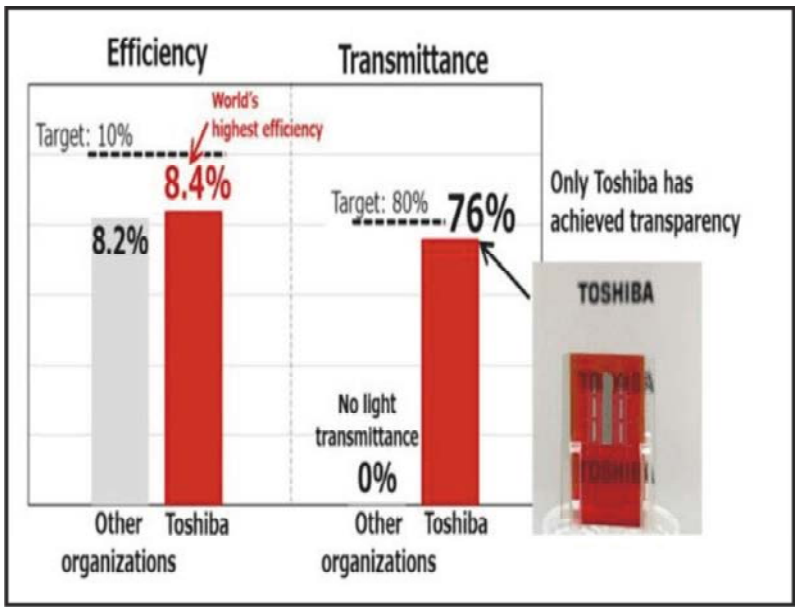
Breakthrough in power conversion efficiency

A tandem solar cell comprises two or more subcells electrically connected using interconnecting layers (ICLs). The ICL plays a critical role in determining the performance and reproducibility of a device. An effective ICL should be chemically inert, electrically conductive and optically transparent.

Although perovskite/organic tandem solar cells are attractive for next-generation thin-film photovoltaics, their efficiency lags behind other types of tandem solar cells. To address this technological challenge, Asst Prof Hou and his team developed a novel and effective ICL that reduces voltage, optical and electrical losses within the tandem solar cell. This innovation significantly improves the efficiency of the perovskite/organic tandem solar cells, achieving a power conversion rate of 23.6%.

TOSHIBA'S TRANSPARENT Cu2O TANDEM SOLAR TOP CELL ACHIEVES 8.4% EFFICIENCY

Toshiba Corporation has successfully raised the power conversion efficiency (PCE) of its transparent Cu2O solar cell to 8.4%, the world's highest level for a reported Cu2O solar cell.



With the cell positioned as the top cell over a 25% PCE silicon cell (Cu2O-Si tandem cell), Toshiba estimates that an overall PCE of 27.4% can be achieved, notably above the 26.7% highest PCE reported for any standard silicon cell.

Under the test criteria defined by Japan's New Energy and Industry Technology Development Organization (NEDO), Toshiba estimates that the Cu2O-Si tandem cell will carry an EV 35km without any need of recharging.

Looking ahead, Toshiba expects the new cell to boost the development of EVs with no need for plug-in charging, and to advance other mobility applications, such as the High Altitude Platform Station (HAPS), the telecom platform in the stratosphere.

The tandem solar cell offers the promise of more efficient solar modules by combining top and bottom cells that generate power at different wavelengths. Tandem cells that achieve an overall efficiency close to 30% have been reported, far higher than any conventional crystalline silicon cell, but they are fabricated with III-V materials, such as gallium arsenide, and their very high production costs%several hundred to several thousand times higher than for crystalline silicon solar cells%severely restrict application.

Toshiba has focused its R&D on transparent Cu2O cells. They are formed from naturally abundant materials, which lowers costs, and offer light transmittance that opens the way to excellent power generation efficiency. Toshiba developed the first transparent Cu2O solar cell in 2019, and demonstrated a Cu2O-Si tandem cell delivering 23.8% PCE in the same year, a time when the typical PCE of stand-alone silicon solar cells was 22%.

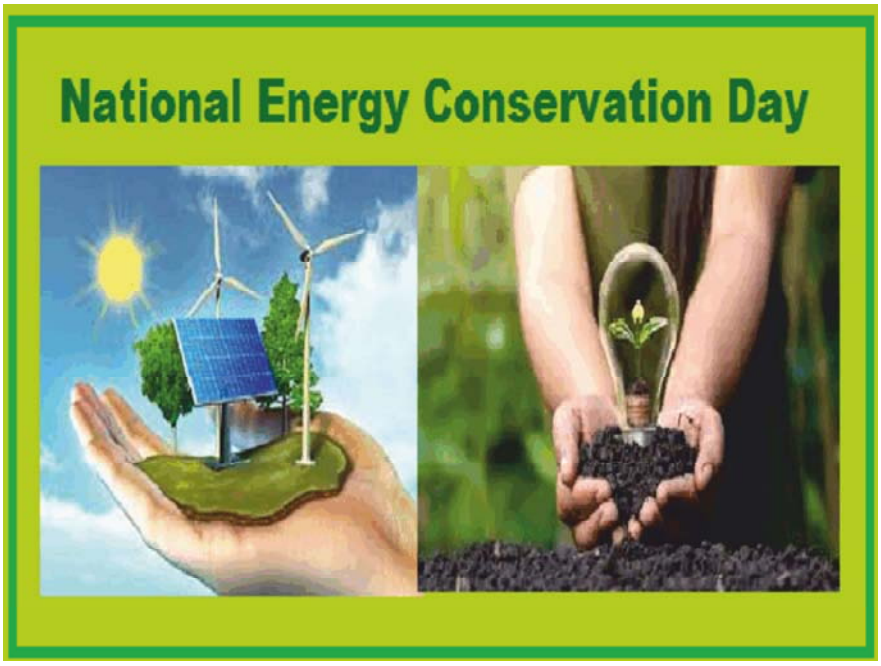
The company's latest advance in PCE is the result of precise control of CuO and Cu impurities during the fabrication of the cell's Cu2O layer. These impurities are generated in the current reactive sputtering deposition method due to the nature of the Cu2O, and they are the major cause of diminished PCE and transparency.

Commenting on the breakthrough, Kazushige Yamamoto, Fellow at Toshiba's Corporate Research & Development Center, said "X-ray diffraction analysis allows us to detect and quantify the degree of the CuO and Cu, giving us data that helps us to identify the best deposition method to control the impurities to the lowest level. Our targets are 10% PCE for the top Cu2O cell, and 80% of transmittance. This breakthrough brings us a step closer to those goals (Figure)."

With support from NEDO, Toshiba will continue research to achieve the 10% PCE target for top Cu2O cells. Toshiba is also cooperating with Toshiba Energy Systems & Solutions Corporation in the development of large-scale Cu2O solar cells that are the same size as mass-produced silicon solar cells. The two companies aim to supply samples for external evaluations by FY2023, with a roadmap to completing manufacturing technologies for commercial products by FY2025.

INDIA CELEBRATES ENERGY CONSERVATION DAY

To commemorate National Energy Conservation Day, states and agencies in India renewed their commitment to a sustainable and energy efficient future with awareness campaigns and new environmentally focused initiatives. Celebrated every year on the 14th of December, the day is a reminder of India's commitment to clean energy and combating climate change.



Minister of Power, Mr. R K Singh with delegates at the National Energy Conservation Day celebrations

At an event organized by Bureau of Energy Efficiency (BEE), India's Minister for Power, R K Singh, felicitated the 55 winners of the National Energy Conservation Awards. This year, a total of 408 applications from the industry were received by BEE for the awards, contributing to a total of 3,034 million kWh of electricity savings and 2.51 MTC02E emissions avoided. In addition, states came forward and announced new initiatives on building energy efficiency.

Energy efficiency in buildings, expected to become the largest consumer of electricity by 2030, is central to India's clean energy future. Electricity demand in both residential and commercial buildings sectors is projected to rise by 5 folds and 3 folds, respectively, by 2032. A major share of this electricity will be for space cooling in buildings, which is, in turn, being fuelled by rising climate induced heat stresses as well as rapid commercialization, economic activities, and urbanization.

BEE has led the country in achieving energy savings across sectors through its various plans and schemes. BEE estimates that its energy efficiency programmes have saved nearly 300 million tons of CO2 emissions. For the buildings sector, BEE launched the building energy efficiency codes programs, starting with the Energy Conservation Building Code (ECBC) which was geared towards commercial buildings and released in 2007, and more recently, with the Eco Niwas Samhita (ENS), the Energy Conservation Building Code for the Residential Sector, which was released in 2018.

States focus on building energy efficiency

States across the country conducted awareness building activities and announced new initiatives this week. Keeping their promise on energy efficiency, Andhra Pradesh and Telangana, the two southern states that have led efforts on energy efficiency in the country, are now setting new milestones.

In a big announcement, the state of Andhra Pradesh will break a new record with widespread implementation of energy efficient technology in the country's largest housing programme. It will build 2.8 million affordable houses under Prime Minister's Housing Scheme with modern technologies to improve energy efficiency and help to considerably reduce temperature, energy consumption and greenhouse gases, and enhance thermal comfort in residential buildings. Building energy consumption is more than 42% of the state's annual energy consumption. Andhra Pradesh recognizes that energy codes for new buildings are extremely important for ushering in energy efficiency in the building sector. Earlier in the year, the state notified ECBC-2017 so that new buildings in Andhra Pradesh require mandatory adoption of the code.

The state of Telangana is on the way to becoming the first state to make Eco Niwas Samhita mandatory in all new residential buildings. The state will also launch an extensive awareness building campaign on adoption of building energy codes and other passive cooling technologies including cool roofs. It will soon adopt an updated version of ECBC 2017. NRDC and the Administrative Staff College of India (ASCI) have been long standing partners of the states of Telangana and Andhra Pradesh in designing a system for ECBC implementation, and will continue to work towards new milestones for building energy efficiency in the residential buildings in the two states.

With progressive steps taken in the southern part of the country, we are working with other states to realize the energy savings potential of buildings as well. Two western states, Gujarat and Maharashtra, are key in India's transition to energy efficient buildings, and successful implementation of the code in these states will take India's efforts on building energy savings to the next level. NRDC and partners are working with stakeholders in both Gujarat and Maharashtra to develop a code implementation framework and bring real estate developers on board to implement building energy codes.

India has taken strong strides on its clean energy transition. While India's energy needs are expected to grow, energy efficiency can help meet them cost-effectively while leaving a better environment for the next generation.

Prima Madan is a climate change and cooling expert working as a consultant with NRDC's India team.

December 17, 2021 Sameer Kwatra

Guest Blog by Prima Madan

"This is a herculean task, because this is nothing short of complete transformation of the way we do business."

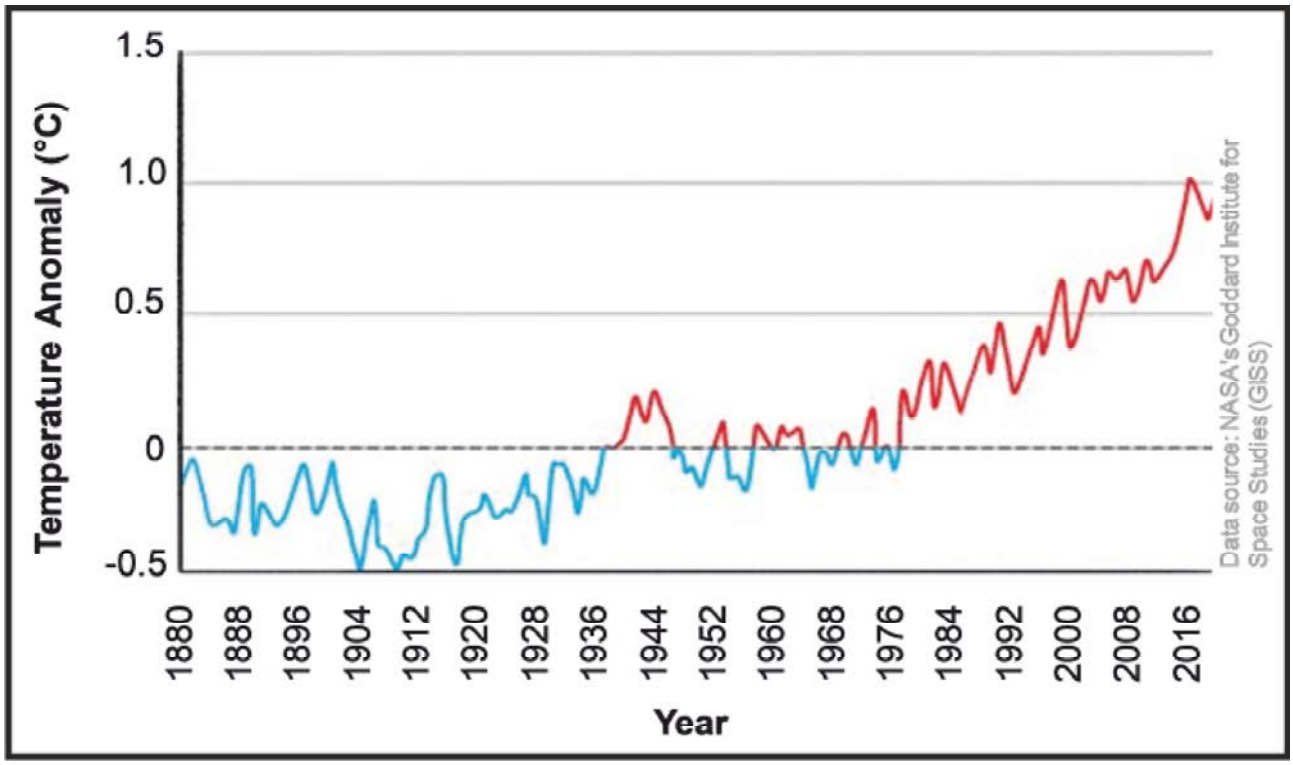
– ANGELA MERKEL, Chancellor of Germany

ENERGY – GLOBAL MISSION AND INITIATIVES INDIA'S COMMITMENTS AND STRATEGIES - 3

Sustainable Growth, Sustainable Energy and Renewable Energy.

CoP 26 is considered an important step forward towards commitment to take steps to reduce carbon emission and ultimately reach Net "0" Emission so that the 'Global Surface temperature' is reduced to safe levels.

Climate change is a change in the average temperature and cycles of weather over a long period of time.



The picture above shows the Global Surface temperatures recorded over the years. 2020 is considered one of the warmest years with temp. of 1.1Deg C.

Lot of scientific papers are published about the dangers associated with temperature increases and increase to 1.5 Deg is considered very serious. Therefore the combined efforts of all countries is to reduce emissions from all sources with particular focus on burning fossils as they contribute to major carbon emission. The goal is to bring down the temperature to, say 1980 level.

India has not only been committing about focus on renewable energy and emission reduction in sizable measure, there are lot of activities and investments, some of which are given below:

- ✓ Additions of large capacities of Wind and Solar
- ✓ Programmes of Solar Energy focused to Solar Pumps for agriculture
- ✓ Programme focused to 'Mini Hydels' in NE region - 6,000 MW and Investment of 70,000 Crores
- ✓ Programme for 15 Million Tons of Compressed Bio Gas CBG with ultimate goal of 60 Million Tons

What requires attention is large scale programmes focused to various Bio Energy Technologies to produce Bio Carbon, Bio Oil and Biomass Electricity, as India has sizable potential.

Some of the recent news given below are encouraging.

Biomass stakeholders launch Glasgow Declaration on Sustainable Bioenergy

Alan Sherrard

Pellets & Solid Fuels

November 10, 2021

A coalition of thirteen wood bioenergy companies and supply chain organizations from around the world have published the Glasgow Declaration on Sustainable Bioenergy. Using data from International Energy Agency (IEA) to highlight the indispensable role that sustainable bioenergy will play to help the world achieve global Net-Zero by mid-century, the Declaration sets out a vision for the sector's ambitious growth to support the push to global Net-Zero.

Launched on November 10, 2021, during COP26 in Glasgow, Scotland, the Glasgow Declaration on Sustainable Bioenergy sets out how wood-based bioenergy can help tackle climate change, with a worldwide industry standard for sustainability at its core. "Sustainable bioenergy is an essential tool for delivering on the ambitious goals of the Paris Agreement and helping to tackle climate change. The anticipated contribution of bioenergy to net-zero targets must go hand-in-hand with an unwavering focus on the highest standards of sustainability," said Dr Christian Rakos, President of the World Bioenergy Association (WBA) seen here addressing participants at the launch (photo courtesy WBA).

The Declaration has been signed by some of the world's largest wood pellet producers, users, and handlers – Associated British Ports (ABP), Drax Group, Eco2, Enviva, Fram Renewable Fuels, Graanul Invest, Great Resources Co. Ltd, Lynemouth Power Ltd, Pellet Мйxico Bioenergia, PD Ports, and Port of Tyne, as well as the Association of Renewable Energy and Clean Technology (REA), and the US Industrial Pellet Association (USIPA).

The IEA has distinguished sustainable bioenergy as one of seven 'key pillars' of decarbonization and technology that must scale exponentially to help meet global Net-Zero. The Glasgow Declaration serves as recognition

that as the industry grows, we must continue to lead in our sustainable sourcing, demonstrate transparency, and foster engagement with all stakeholders. Enviva is proud of the role it has played in enabling countries to reduce their carbon emissions and supports this initiative to ensure biomass delivers on its full potential, said John Keppler, Co-founder, Chairman, and CEO of Enviva.

Bioenergy is the world's leading form of renewable energy, supplying five times more energy than wind and solar combined across transport, heat, and power.

Sustainable wood bioenergy is recognized as essential for meeting climate goals by the leading authorities on climate change, including the UN's Intergovernmental Panel on Climate Change (IPCC), the UK's Climate Change Committee (CCC), and the IEA.

Meeting the commitments being made in Glasgow at COP26, and keeping the 1.5°C Paris Agreement alive, means recognizing the role that biomass has to play in helping to decarbonize the world's energy needs. Today, bioenergy is providing immediate carbon savings through its use in the production of power, heat, and renewable transport fuel. Internationally accepted global energy scenarios recognize that this role is going to grow, including the delivery of negative emissions through the deployment of bioenergy carbon capture and storage. However, the bioenergy industry fully recognizes that further growth must go hand in hand with a firm and transparent commitment to ensuring that biomass continues to be done right, said Dr Nina Skorupska, Chief Executive of the Association for Renewable Energy and Clean Technology (REA).

Sustainable wood bioenergy has already contributed significantly to decarbonizing the energy sector by providing a reliable, low-carbon, renewable alternative to fossil fuels.

The IEA's 'Net Zero Scenario' projects a threefold growth in the use of sustainable bioenergy by 2050 to help the world to meet the Paris Agreement's 1.5 °C target, and deliver 4 percent of the global energy supply by 2050.

This will reduce emissions by one billion tonnes of CO2e per year compared to 2020 – more than is currently emitted by the world's entire aviation industry.

These reductions will come from a combination of replacing fossil fuels with renewable energy and delivering negative emissions through bioenergy with carbon capture and storage (BECCS).

Woody biomass has directly replaced coal in some cases where coal power stations have been converted to run on sustainably sourced biomass. It also provides flexible energy, which supports a diverse low-carbon energy mix, including wind and solar power.

As an operating biomass power station, the first one in the UK to have fully converted from coal to biomass, Lynemouth Power is proud to have contributed to a significant reduction in greenhouse gases. But, if we are to meet the international commitments made during COP26, we can, and must, go further. The launch of the Glasgow Declaration is a landmark moment for the Sustainable Bioenergy sector and Lynemouth Power is proud to be one of the signatories, said Fiona Macleod, Managing Director, Lynemouth Power.

When sustainable wood bioenergy is combined with carbon capture and storage (BECCS), it provides negative emissions by capturing carbon at scale and burying it permanently underground, which helps to offset emissions from hard-to-decarbonize sectors such as aviation and agriculture.

The climate crisis is the greatest challenge the world faces and the world's leading climate scientists are very clear that biomass has a critical part to play in both reducing emissions as well as removing carbon dioxide from the atmosphere. Biomass is unique because it can be used to replace fossil fuels in the delivery of low carbon, flexible and renewable energy, and when combined with carbon capture and storage technology, it permanently removes carbon dioxide from the atmosphere. No other technology can do both. This declaration is the start of a process. We invite all stakeholders, especially fellow biomass producers, users, and NGOs, to discuss the principles and reach a consensus on what good biomass looks like, so the industry can sign up to the agreed principles and commit to only using biomass that meets them, said Will Gardiner, CEO, Drax Group.

The Glasgow Declaration on Sustainable Bioenergy has two main parts:

1) A vision for the sustainable growth of the global wood bioenergy sector over the next 10 to 30 years, based on pathways set out by the IEA and IPCC.

2) A framework of sustainability principles that are already helping to deliver sustainable wood bioenergy and must continue to underpin the entire industry as it grows. These principles outline a sustainable approach to wood bioenergy covering four key areas: managing natural resources responsibly; transparency and science-based carbon accounting; protecting biodiversity; and supporting and protecting communities. The principles are not intended as a replacement for detailed regulations and certification schemes, which are necessary to ensure sustainability.

The expansion of wood bioenergy could also support more than 200 000 additional jobs in the supply chain by 2030, and more than 450 000 additional jobs by 2050, providing employment and investment in under-resourced communities in both rural and industrial areas.

The Glasgow Declaration on Sustainable Bioenergy is an unambiguous statement, making clear that ensuring the sustainable use of natural biomass resources is at the centre of industry activities, both today and in the future. The principles reaffirmed within the Declaration go beyond a statement of intent, and form a foundation for how all bioenergy stakeholders can continue to review industry practices, ensuring that bioenergy delivers demonstrable carbon savings along with further environmental and social benefits, said Dr Nr Nina Skorupska, Chief Executive REA.

The group invites all participants in the broader bioenergy sector, including industry, civil society, academia, and governments, to join the signatories and help achieve the full potential of sustainable bioenergy to help deliver global Net-Zero.

As the global bioenergy industry continues to deliver decarbonization, innovation, and crucial green jobs throughout the supply chain, sustainability must remain at the very heart of business models. The Glasgow Declaration on Sustainable Bioenergy is an invitation to all participants in the broader bioenergy sector, including industry, civil society, academia, and governments, to join the existing signatories and help realize the full potential of sustainable bioenergy in delivering global Net-Zero, ended Dr Christian Rakos, President of the World Bioenergy Association (WBA).

Bloom Energy deploys Bar 20 Dairy Farms biogas power project

Bioenergy International

Heat & Power

November 9, 2021

US-headed fuel cell technology developer Bloom Energy Corporation (Bloom Energy) has announced the deployment of a 1 MW fuel cell at Bar 20 Dairy Farms LLC in Kerman, California (CA) to efficiently produce on-site, renewable electricity from dairy cow manure. The installation marks Bloom's first dairy farm biogas project. Bar 20 Dairy Farms combined a methane digester, gas clean-up skid, and Bloom Energy fuel cells for an end-to-end, waste-to-electricity solution.

The California BioEnergy (CalBio) digesters capture biogas, primarily consisting of methane, released from the anaerobic decomposition of dairy manure. After being cleaned in a separation skid, the biogas is then converted to renewable electricity through an electrochemical process, without combustion through Bloom Energy's fuel-flexible, solid oxide fuel cells (SOFC).

Dairy biogas contains up to 65 percent methane. The waste-to-electricity solution captures methane that would otherwise be released into the atmosphere while reducing carbon emissions in electricity generation and vehicle fuel. Bloom's Energy Servers generate enough electricity to operate the gas clean-up skid and to meet the energy needs of the dairy farm.

Bloom Energy Corporation (Bloom Energy) has announced the deployment of a 1 MW fuel cell at Bar 20 Dairy Farms in Kerman, California (CA) to efficiently produce on-site, renewable electricity from dairy cow manure. The installation marks Bloom's first dairy farm biogas project. Bar 20 Dairy Farms combined a methane digester, gas clean-up skid, and Bloom Energy fuel cells for an end-to-end, waste-to-electricity solution (photo courtesy Bloom Energy).

Excess power is deployed to electric vehicle (EV) charging stations across California. Dairy farms, like Bar 20 Dairy Farms, which provide renewable electricity to charge EVs in California, are able to participate in the California Air Resources Board's (CARB) Low Carbon Fuel Standard (LCFS) programme, providing a new income opportunity for farmers.

Finite resources don't mean finite energy, rather, it means doing smarter things with the resources we have. Bar 20 Dairy Farms has long understood that the actions they take today will have benefits for years to come for both their industry and for their communities. Methane is a potent greenhouse gas with a short lifespan in our atmosphere. This means that capturing and utilizing waste methane as a renewable fuel is a powerful way to positively and quickly impact climate change. Bloom Energy is proud to play a part in their journey and demonstrate that fuel cells are a strong part of the low-carbon solution, said Sharelynn Moore, EVP, and Chief Marketing Officer, Bloom Energy.

Vast potential in California

According to Bloom Energy, there are hundreds of megawatts of economically viable dairy biogas in California. With significant deployments of dairy digesters throughout the California dairy industry, there is a need for on-site power generation solutions that use the captured biogas to generate renewable electricity without combustion.

Bar 20 Dairy Farms' leadership in prioritizing climate-conscious energy solutions can serve as a catalyst for more California dairies to adopt technologies that support local environmental and global climate initiatives.

At Bar 20, we see ourselves as environmental stewards playing a substantive role in California's sustainability. Through this deployment we can further our efforts to use cost-effective and clean solutions that benefit our farms and our communities, supporting cleaner local air and mitigating the farm's overall greenhouse gas emissions.

We are demonstrating that realistic climate solutions are available and can be deployed today, said Steve Shehadey, Partner, Bar 20 Dairy Farms.

Reduce smog emissions

California's Central Valley, especially the San Joaquin Valley where many dairies are located, has some of the worst air quality in the United States, as well as the highest rates of childhood asthma in California. Using fuel cells to generate electricity from dairy biogas, instead of combustion engines, eliminates smog-forming emissions and provides improvements for local air quality and public health.

The Bloom Energy Server eliminates the majority of air pollution that is harmful to local communities and has far fewer carbon emissions than legacy technologies.

The Energy Servers are designed to generate power 24 x 7 x 365 and with a modular design can be configured to eliminate the need for traditional backup power equipment and scaled up as power demand grows.

Note: This has huge potential in India as we have already launched CBG Program and the Compressed Bio Gas can be used as fuel for Bloom Energy for Electricity Generation. The aspect of elimination of SMOG EMISSION could be of specific interest to Delhi.

(To be continued)

S. Mahadevan, *B.E., F.I.E., M.B.A.,*
Consultant, Energy and Energy Efficiency,
Mobile: 98401 55209

DECEMBER GOODS EXPORTS TOUCH $37.3-BILLION HIGH: GOYAL

Numbers show 37% growth; Minister says services sector to see 'good' tidings too

India's merchandise exports in December touched $ 37.29 billion, the highest-ever monthly figure, according to Commerce and Industry Minister Piyush Goyal.

Addressing a press conference here on Monday, Mr. Goyal highlighted the pursuit of export-oriented programmes by the Uttar Pradesh and Tripura governments.

"In every sector, there has been significant growth in exports," said Mr. Goyal. He claimed that every month's export data from April to December 2021 had displayed a "historic high".

Export figures for December, reflected a 37% increase from $27.22 billion a year earlier.

'48.9% rise in April-Dec.'

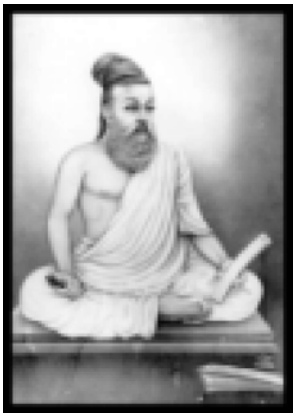
Merchandise exports grew 48.9% to $299.74 billion in the April-December 2021, from $201.37 billion seen in the same period of the previous year, Mr. Goyal said.

The Minister said the services side, especially the IT sector, had received special focus of the government. "We have seen $178 billion [services exports] in the first nine months and we are well on track to go up to about $230 billion or upwards of that, which will also be a historic high [for] services exports," he said, explaining that the sector had performed successfully despite the "big setback" experienced by the travel and tourism industry because of the ongoing pandemic.

He also said that credit should also go to India's diplomatic missions across the world, exporters, industry associations and export promotion councils for collectively working to explore newer global regions and to help expand the "export basket".

"If we're going to tackle climate change, we have to deal with the disaster of habitat loss and species loss across our planet."
– BORIS JOHNSON, Prime Minister of the UK

TIRUKKURAL ON DOCTORS AND THE TREATMENT



The pandemic is not getting over yet and the world is in the grip of severe wave still, call it with any number 3rd, 4th etc. India is also facing the numbers of afflicted increasing very fast frightening both the administration and the public. When it comes to such large scale health problems, which come periodically, it will be sensible to analyze and plan appropriate action and treatment. We seem to be doing it sensibly and seriously as our wisdom has also increased with the earlier waves. It is no wonder that Tirukkural deals with this subject too in all its dimensions. After advising how one can avoid getting affected with any disease and so on, he deals with such pandemic situation with clear analysis and advice which are worth following.

The comprehensive and valuable advice of Tiruvalluvar in the Kural referred can help understand the problems involved and tackling them by creation of a good set up with people and medicines and procedures for an effective treatment.

Utravan Theerppan Marunduzhaich Chelvanendru
Appal Narkkootre Marundu Kural 950

உற்றவன் தீர்ப்பான் மருந்துழைச் செல்வானென்று
அப்பால் நாற்கூற்றே மருந்து ***குறள் 950***

"The patient, the physician, the medicine and the apothecary, on these four doth all the cure depend: and four again are the attributes of each of them."

After listing the four important things that ultimately decide the cure, he also refers to the four attributes of each of the components and various commentators have attempted to get into the mind of Tiruvalluvar to list the attributes. Our best of understanding can detail some of the attributes as, cooperation of the patient, proficiency and the safety (of both the patient and the physician) of the doctors, proper medicines and the treatment and the preparation of medicines and admission after all necessary tests and trials.

HUMOUR

A small ATM room having two ACs and 4 tubelights, working 24 hours, is asking me not to print a receipt to save the environment

Q: How does President Bush plan on fighting record high temperatures? A: By switching from Fahrenheit to Celsius!

Why does a Time Magazine survey state only 85% of Americans think global warming is happening? A: The other 15 percent work for the oil industry!

I don't have a Carbon Footprint…

Because I drive everywhere.

I'm tired of people telling me to turn off my lights to save the environment.

I tried it once, and nearly killed some bloke on a bike.

My teacher wanted me to come up with a set of steps that we could use to save the environment…

So I created an Al Gore-ithm.

We all have to do our part for the environment. And there are many different ways one can save energy. I normally use the couch.

"We need a green planet but the world is on red alert. We are at the verge of the abyss. We must make sure the next step is in the right direction. Leaders everywhere must take action. First by building a global coalition for net zero emissions by 2050 in every country, every region, every city, every company, and every industry."
– ANTÓNIO GUTERRES, UN Secretary-General

HOME FESTIVALS - 2

மாசி - Masi (February/March)

Above, this is the month of **Mahasivaratri**, *Siva's great night*. In the above painting four stories associated with the festival are told. At lower left a hunter has been cornered in a tree-top by wild beasts, where he must spend the night. To avoid sleep he plucks leaves from the bilva tree, sacred to Lord Siva, and drops them upon a sivalinga below-a traditional for of worship. Many undertake fasts and stay awake the whole night, praying to Lord Siva both at home and in temples (lower right).

The home observance of Karadainombu (upper right) derives from the story of Savitri and her husband, Satyavan. They enter a forest, where he dies. When Lord Yama, the God of Death, comes to take his life, Savithri persuades Yama to let him live. The intent of the observance is that wives not be separated from their husbands.

Another explanation of this festival (upper left) is that on this day Lord Siva tied a thread to parvati's right hand after their marriage as a sign of protection and fidelity.

(To be continued)

HOME FESTIVALS - 3

பங்குனி - Panguni (March/April)

This month brings the popular nine-day festival of Ram Navami, celebrating the birthday of Lord Rama, an incarnation of Lord Vishnu. When the full moon rises, Vishnu in the form of Satyanarayana is worshiped before a decorated kumbha pot with a branch of mango leaves placed in its mouth and a coconut on top. Rice is spread on banana leaves and the sacred vessel is completed with a tray of fruits, flowers, betel leaves and nuts. This month is also known for Sita's marriage to Rama. King Janaka, Dasaratha and priests surround the sacred fire, as Sita garlands Rama in Janaka's royal palace.

(To be continued)

Energy Conservation Day Celebration

on 18th December 2021 at Hotel Fortune Pandian, Madurai

Respected dignitaries on the dias

Members at Registration Desk

Er. S. Umadevi, Chief Engineer,
TANGEDCO, Madurai
Lighting the Kuthuvilakhu

Er. S. Vennila, SE Metro,
TANGEDCO, Madurai
Lighting the Kuthuvilakhu

Er. S. Rethinavelu, Senior President,
TN Chamber of Commerce and Industry
Lighting the Kuthuvilakhu

Mr. K. Kannan, President, TNEIEA
Lighting the Kuthuvilakhu

Mr. A.A. Murali, VP-Madurai, TNEIEA
Lighting the Kuthuvilakhu

Welcome address by
Mr. K. Kannan, President, TNEIEA

Mr. K. Kannan, President, TNEIEA
honouring **Er. S. Umadevi,** Chief Engineer,
TANGEDCO, Madurai

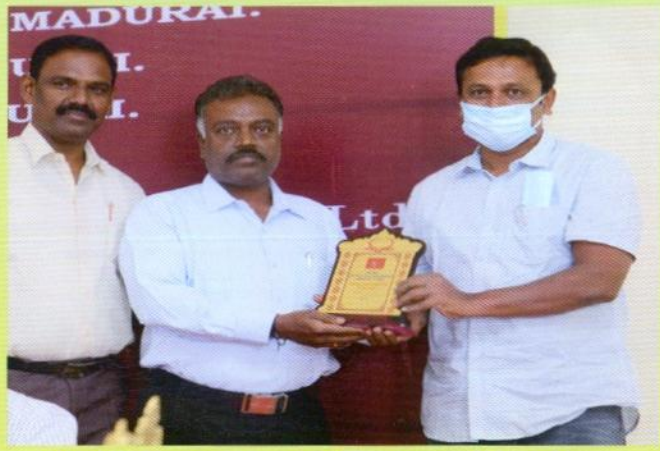
Mr. A.A. Murali, VP-Madurai, TNEIEA
honouring **Er. S. Vennila,** SE Metro,
TANGEDCO, Madurai

Mr. K. Kannan, President, TNEIEA
honouring **Er. S. Rethinavelu,** Senior President,
TN Chamber of Commerce and Industry

Mr. D. Chandran, Member, TNEIEA
honouring **Er. S. Mangalanathan,** SE MEDC,
TANGEDCO, Madurai

Mr.K. Ramesh, Joint Secretary, TNEIEA
honouring **Mr. Shanmuganathan,** Vice-Principal
TN Govt. Polytechnic, Madurai

Mr.V. Rengarajan, VP-Chennai, TNEIEA
honouring **Mr. Saravanan**, Professor
Thiagarajar College of Engineering, Madurai



Mr.P. Suyambu, Ex-Secretary, TNEIEA
honouring **Mr. D. Muthukumar**, EI, Madurai

Er. S. Umadevi, Chief Engineer,
TANGEDCO, Madurai
delivering the Inaugural speech

Er. S. Vennila, SE Metro,
TANGEDCO, Madurai
delivering the Technical speech

Er. S. Mangalanathan, SE MEDC,
TANGEDCO, Madurai
delivering the Technical speech

Er. S. Rethinavelu, Senior President,
TN Chamber of Commerce and Industry
delivering the Special address

Mr.M. Balamurugan, Ex-Treasurer TNEIEA
honouring **Mr. Harirajan,** CEO, M/s IPL Products
for Presenting Technical Papers

Mr. R. Muralidharan,VP-Cuddalore TNEIEA
honouring **Mr. Sathyaganesan,** M/s Megawin
for Presenting Technical Papers

TNEIEA honouring by **TN Govt. Polytechnic, Madurai** organisers and students
for performing a play on Energy Conservation

Mr.D. Santhanam, EC Member, TNEIEA honouring M/s Havells India Ltd. Team for Presenting Technical Papers

Mr. B. Kannan, Member, TNEIEA honouring **Mr. K. Kannan** President, TNEIEA

Mr. K. Vinoth Babu, EC-Member honouring **Mr. K. Ramesh,** Joint Secretary, TNEIEA

TNEIEA President & Members honouring **Mr. A.A. Murali** VP-Madurai, TNEIEA

Mr. K. Chinnathambi, EC-Member honouring **Mr. D. Chandran,** Senior Member, TNEIEA

Mr. B. Sasikumar, VP-Tirunelveli honouring
Mr. P. Suyambu, Ex-Secretary, TNEIEA

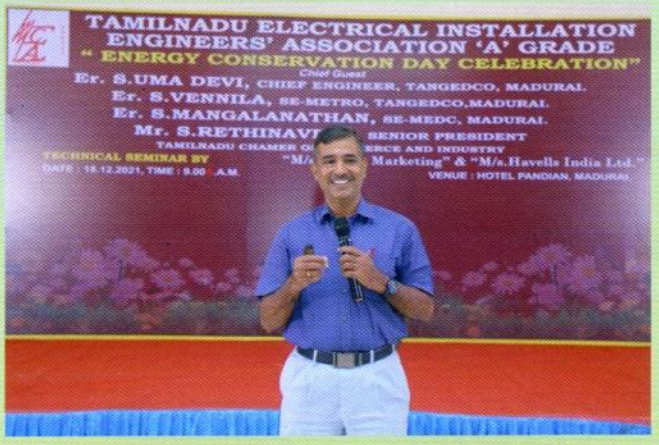
Mr. N. Senthikumar, EC-Member honouring
Mr.M. Balamurugan, Ex-Treasurer, TNEIEA

Mr. JRK. Anandaraman, EC-Member honouring
Mr.P. Thangaraj, Member, TNEIEA

Mr. G. Hariharan, EC-Member honouring
Mr.G. Ravindran, EC-Member, TNEIEA

Product display by M/s Megawin

Students of **Tamilnadu Govt. Polytechnic College,** Madurai performing a play for Energy Conservation Day Celebrations



Presenting Technical Papers by
Mr. Saravanan, Professor
Thiagarajar College of Engineering, Madurai

Vote of Thanks by
Mr. A.A. Murali VP-Madurai,TNEIEA

Participation of Members at the Energy Conservation Day Celebrations
Hotel Fortune Pandian, Madurai

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