



ELECTRICAL INSTALLATION ENGINEER

NEWS LETTER

TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE (Regn. No. 211/1992)

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ISSUE NO.183

VOL : No. 17/2022

MONTHLY ISSUE NO.2

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EDITORIAL

Dear Members, Fellow Professionals and Friends,

Greetings To All!

Greetings For A Happy New Year "Subhakrith"!!!

Greetings For A Prosperous Financial Year 2022 – 23!!!

We are stepping into the New Year "Subhakrith", which means 'Good things' in simple translation, and into the New Financial Year 2022 – 23 with full of hopes and expectations as the normalcy is returning fast and the economy shows encouraging performance. The GST collections and the increasing exports and the improved performances in many sectors illustrate this point and the GDP growths are also projected to gallop from the current period onwards.

We are celebrating "Amrut Mahotsav", 75 years of Independence this year with all pride. There have been lot of debates for long, in particular in the past 3, 4 decades about our history and background. More and more historical evidences prove that we were a Great Nation and a Great Civilization and a Great Economy for thousands of years till about 700. 800 years back. It is the invaders and colonial rulers who have destroyed our preeminent position in the globe, be it skills or technologies or trading or warfare. The writers of history commissioned by vested interests have portrayed us as a poverty ridden loosing nation skipping our glorious past. One simple example can be the 'Cholas Dynasty' who have excelled all over the present boundaries known as India and a number of neighboring countries particularly in the east. The monumental constructions, more than thousand years old, left behind by them speak volumes. There have been a large number of glorious dynasties who have all enriched the knowledge, civilization and standards of living. It is a true history that Vasco da Gama, when he was sailing to find the sea route to India, he was guided and shown the route to India, somewhere near the southern tip of Africa, by a fleet of Merchant ships from India, who were all sailing for trade across countries. Can we believe that the books and manuscripts burnt at Nalanda, after destroying the university, by the invaders, was burning for a full year? It is clear that we are on our way to regain our economic power in the coming 3 decades.

At the time of penning this page, bloody war was on between Russia and Ukraine disturbing India and the entire world with fears in every one's mind that it should not become a nuclear war. We hope that the global pressures and good senses would have prevailed and ended the war, when the Newsletter is in your hands.

Global Warming and Climate Changes are threatening the world. Most of the countries, including India, are committed to take adequate steps to 'Decarbonize' so that the world carbon emission becomes "Net'0'" by 2050 or 2070. This decade and the coming decades and the stage by stage reductions are important to achieve the goal and save the planet earth. Role of Engineering and Innovation are important in every sphere of human activity and we celebrated 'World Engineer's Day in the first week of March with the theme of "Engineering for a Healthy Planet".

We thank all those members who have helped us by participating in the advertisement appearing for the issue February 2022 – 3SI Eco Power LLP, Arrow Marketing, Asias Electricals, E-Focus, E Power Engineering, Pentagon Switchgear Pvt. Ltd., Power Cable Corporation, Power Links, Supreme Power Equipment (P) Ltd.

Editor

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EDITOR DESK

Dear Friends,

Thank You All for the opportunity given to me to serve as the Editor of Newsletter, since March 2022.

There is a famous quote of the Motivational Speaker Zig Zigler - "You don't have to be great to start, but you have start to be great"

I have taken my first step in this new Responsibility as an Editor. I hope with all your support and Support of Mr. V. Sankara Narayanan, Mr. S. Mahadevan and Mr. K. Muthu Krishnan, I will be able to do justice to this role.

I thank Mr. G. Venkatesh for his valuable stint as an Editor for almost a decade.

I assure you that I will put my best efforts to fulfill the expectations as an Editor along with my team - Our office staff, Sponsors & Printer.

Starting from the current edition, valuable articles about Energy Management & Other Technical topics shall follow.

Regards

M. Murugan

Editor

LEARNING MANAGEMENT BACK FROM MACHINES PART – 3

MAKING MACHINES A PART OF OUR MENTAL, PHYSICAL AND SOCIAL GROWTH PARTNER

ARE YOU AN 'EMT' PERSON??

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.

In Part – II of the above said article published in our **News Letter Issue No. 182 Volume 17/2022**, we have seen how **Electrical Engineering can be the elixir for all our managerial problems**.

It happens now that we are all engrossed with machines. For every activity, we have started to depend on machines, literally hanging on to them and in the process losing our physical and mental capabilities. We need to relearn our physical and mental capabilities and learn to coexist with machines rather than becoming overly dependent on them.

I remember and would like to recollect two events in my life, the first – a humorous, ego-slapping incident that happened to me when I was about nineteen years old and second one – a recent one related to me by a Chief Neuro Doctor in Bengaluru who reflected how humankind is losing their core capabilities by becoming over-dependent on machines and why we all should become a “EMT” person. I recollect both the incidents below:

Incident No. 1: When I was around 19 years old, I one day proclaimed proudly to my father that I had driven the car by myself from Tiruvannamalai to Chennai about a distance of 175 km. He kept quiet. I expected better response from him and was upset, but I repeated my proclamation again. He was again quiet. The third time when I repeated, he calmly said that his elder brother used to cycle from Tiruvannamalai to Chennai and back at least once or twice a month to carry on his errands. I became speechless.

Incident No. 2: A Chief Doctor from one of the top most medical institutions in Bengaluru on knowing that I am writing the book ‘Learning Management Back from Machines’ called me and said she would like to meet me. I went to meet her and during the course of the discussions on diminishing human capabilities in this fast age, she said her grandmother used to make sweaters for her, her brother etc. Her grandmother knew which thread to pull, which not to pull, whether she was doing the sweater for her grandson or granddaughter, her grandmother did not take measurements 1000 times and while she was knitting the sweater also, she was also concentrating in what is happening in the kitchen, who is coming outside the house etc. and also telling her prayers – an automatic multi-tasker.

The Doctor felt bad that nowadays even fellow doctors are losing the hand-eye coordination and are not having unwavering concentration required to do delicate surgeries. The Doctor warned that once a person starts using lesser and lesser faculties of his brain, he then becomes an ideal candidate to diseases like dementia.

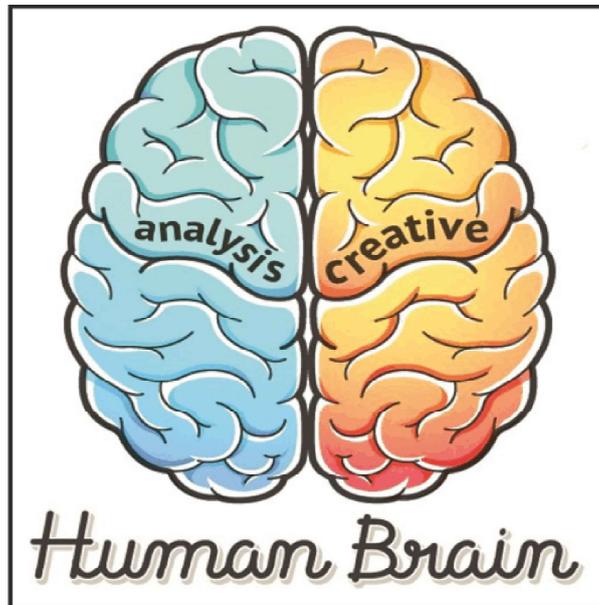
The Doctor prayed that there should be a coalescence of the trades and intellects of Doctors and Engineers. She opined that a Doctors will need to understand the machines to improve his trade and an engineer should know about the brain functions so that the engineers do not lose the purpose of their existence.

She hence advised me that I should write in my book on why people should become not just Technically savvy but **‘EMOTIONALLY, MEDICALLY, TECHNICALLY SAVVY’ and I should compare brain and machines**.

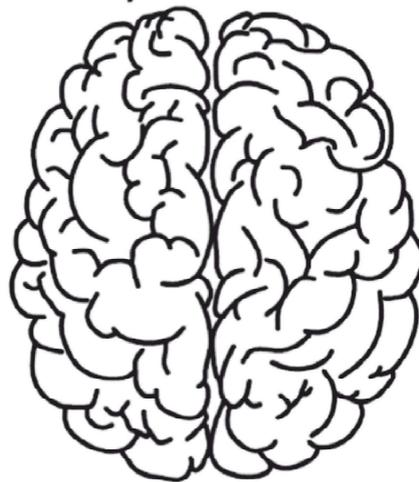
Accordingly in this brief article I give a small writeup of which part of the brain does which activity and which machine does that activity now, replacing or complementing our skillsets.

BEFORE YOU READ FURTHER, PLEASE PAUSE FOR A MOMENT, CLOSE YOUR EYES AND THINK WHETHER YOU CAN REMEMBER THE DIFFERENT PARTS OF THE BRAIN AND THEIR FUNCTIONS FROM YOUR SCHOOL EDUCATION..... NOW CONTINUE FURTHER.

(Please note that there are very many medical terms, descriptions etc. - Hence relax if you cannot identify some portions of brain etc. Just be fascinated with how many activities the brain does consciously and subconsciously and you will find yourself improving).



<u>LEFT SIDE BRAIN FUNCTIONS</u>	<u>RIGHT SIDE BRAIN FUNCTIONS</u>
<i>Controls right-side of the body</i>	<i>Controls left-side of the body</i>
<i>Analytical</i>	<i>Creativity</i>
<i>Logic</i>	<i>Emotion</i>
<i>Math/Scientific skills</i>	<i>Face recognition</i>
<i>Number skills</i>	<i>Imagination</i>
<i>Objectivity</i>	<i>Intuition</i>
<i>Reasoning</i>	<i>Music/Art awareness</i>
<i>Spoken language</i>	<i>Shapes</i>
<i>Written language</i>	<i>Subjective planning</i>



Once you got a solar panel on a roof, energy is free. Once we convert our entire electricity grid to green and renewable energy, cost of living goes down. – ELIZABETH MAY

Major Portions of the Human Brain and their vital functions

PORTION OF THE BRAIN AND ITS MEDICAL NAME	ACTION CARRIED OUT BY THAT PORTION OF THE BRAIN
PORTION-A FOREBRAIN (Cerebral Cortex, Cerebrum, Neo-Cortex)	<ul style="list-style-type: none"> ✓ Motion ✓ Cognition ✓ Sensory Processing ✓ Memory ✓ Language ✓ Planning
PORTION —B MIDBRAIN (MESENCEPHALON) (Tectum, Tegmentum)	<ul style="list-style-type: none"> ✓ Vision ✓ Hearing ✓ Motor Controls
PORTION—C HINDBRAIN (RHOMBENCEPHALON) (Metencephalon, Myelencephalon)	<ul style="list-style-type: none"> ✓ Homeostasis (keeping in equilibrium) ✓ Respiratory rhythm, ✓ Motor activity ✓ Sleep

PORTION—A—Fore Brain

Activity of this specific portion of the brain	Which machine has this feature?	What should humans do, to activate this portion of the brain?
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Motion

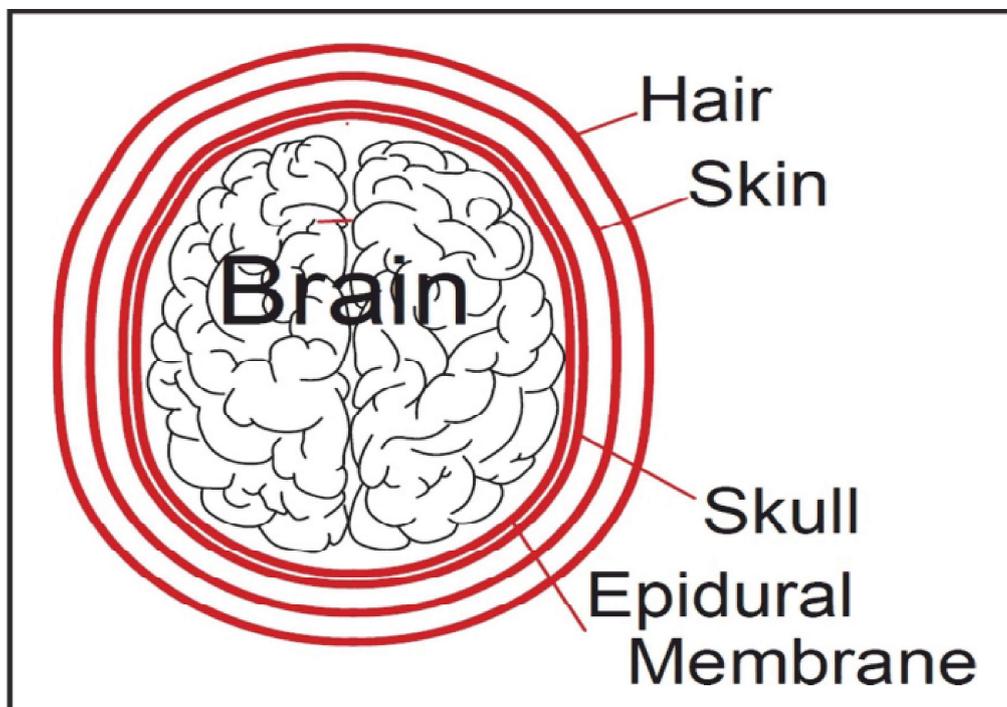
Various types of movements like Angular motion, Gliding, opposition, abduction, protraction, retraction, rotation, opposition etc. are possible	They come embedded with some information (similar to a child of a particular race having some inborn instincts of that race embedded) Further, the robots also auto-learn just like a child. For example - If a room size is changed and an object is moved to a longer distance, the robot auto learns to move the extra distance to reach that object.	<p align="center">Exercise systematically developing each and every muscle.</p> <p align="center">Get some sunlight everyday</p>
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Cognition

(Defined as the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses.)	<p>Almost yes through artificial intelligence.</p> <p>Present day washing machines and so on!!</p>	<p>For eg. – Before going through any document, first, reminiscence about what you know about the document contents already. After reminiscing about the subject then, read through the contents of the latest document in hand. You will then be astonished as to how much your memory retention power is improving.</p>
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<i>Sensory Processing</i>		
<i>Sensory Perception</i> is the process of performing the neurophysiological process through the senses organs including hearing, vision, taste, smell and so on	Machines are developed very well in this aspect. Laptop keypads, finger print readers etc.	We are slowly losing in this cognitive skill. Learn to improve all your sensory perceptions, observe more keenly. As you are walking down the road, try to concentrate whether your ears are picking up a sound of a vehicle approaching fast behind you... your safety will improve.
<i>Memory</i>	Integrated Chips.	Develop, develop, develop.
<i>Language</i>	It almost means nothing to the machines but they can be programmed easily to decipher any language. Example includes Voice Synthesizers etc.	Learn to become closer to each other through mutually speaking each other's languages.
<i>Planning</i>	No planning is done by machines. Just execution. This right now is a strength of human beings yet to be replicated by machines!!	Work your plan and plan your work.
<i>PORTION—B—Mid Brain</i>		
Activity of this specific portion of the brain	Which machine has this feature?	What should humans do, to activate this portion of the brain?
<i>Vision</i>	CCTV cameras	Visualize the situation before seeing. Go beyond just seeing.
<i>Hearing</i>	Microphones	Listen without. Today there is a fantastic technology called WSPR – ‘Weak Signal Propagation Report’. Learn to catch weak signals also.
<i>Motor Control</i>	Robots	Develop your weak hand like the strong
<i>PORTION—C—Hind Brain</i>		
Activity of this specific portion of the brain	Which machine has this feature?	What should humans do, to activate this portion of the brain?
<i>Homeostasis</i> (keeping in equilibrium)	Gyroscope	Do Yogasan and other exercises.
<i>Respiratory Rhythm</i> Motor activity, sleep and wakefulness	Not required actually but available for power conservation etc. Electrical, electronic, hydraulic machines etc.	Develop voluntarily and involuntary breathing, plan sleep and wakefulness.

AND importantly, if one is asked to mention the parts of one's head, he would say 'Cerebrum, Cerebellum, Medulla Oblongata' etc. He fails to recognize a thin layer of skin called epidural membrane which cushions the brain from shock and has multiple functions, and outside of epidural membrane there is the skull which takes the hard knock and protects the internal organs and also provides the shape form, and outside of the skull there is a skin protecting everything within and outside of the skin we have the hair.



In real world also, similar to the above analogy, it is true that we think we ourselves are only contributing to our own lives. We tend to forget the contributions of our parents, teachers, security staff, municipality worker, bus driver etc. in our lives. We shouldn't forget their contribution to our lives but appreciate them as well.

The inference:

1. Give credit to each and every part of your body. Appreciate them, they will not let you down.
2. We live for our body, mind and soul – not for external possessions (common persons have understood this, most politicians have not).
3. Make meditation a part of your life. It will help you in fore-thinking.
4. Commit for good activities. Do not commit for bad activities.
5. Before you take out your calculator and calculate something, do a mental calculation – if you wanted to do calculation '19 x 21', your calculator can immediately give you the result, but think atleast, what are the nearby numbers to 19 and 21? It is 20, Therefore $20 \times 20 = 400$. 19 x 21 is coming as 399. So the answer indicated by the calculator is correct. Your brain will start improving.
6. Think of kW calculation – $16.3766 \times Q_m \times P_m / 10000 / \text{efficiency}$ before looking up at the google (my father knew more than half the values of logarithmic tables by heart, so would have been your parents and you as well please in your young age, but current exam pass-outs seem not to hold too much in their brains due to over-dependance on machines and poor memorization techniques and limited use of the brain).

7. Understand and complement the use of machines with your physical and mental work. (There is gym in the first floor of my office building and people wishing to go to the gym wait for the lift and push their way inside when the lift door opens).
8. Let all of us standup, stretch our right hand forward with palm facing down and take the oath below:



- We all will not dissuade ourselves and children from using mobiles and other gadgets, but only use them limitedly and for constructive purposes.
- We all will not avoid using mechanized transport, but also will relearn to enjoy walking, cycling and swimming because that is what will enable us to prove to ourselves when the need for physical strength arises.
- We will not dissuade ourselves and our children from eating fast-food and drinking aerated drinks, but do so in moderation and also enjoy the nutritious food items cooked in the house, even if the food may not be as tasty.
- We all will try to become socially healthy beings so that the next generation can live better than us – we all will try to become emotionally, medically, technically interconnected.

The definition of 'health' as per World Health Organization is very instructive. It defines health as a "complete state of physical, mental and social wellbeing and not just the absence of diseases or infirmity". The word social wellbeing needs to be underlined as many of the prominent personnel in our society who seem to be physically and mentally well may not fit into the category of being healthy, due to their poor social wellbeing.

Let all of being engineers with a dignity of our own to behold in this community strive to improve and sustain our physical and intellectual capability and becoming emotionally and socially a great individual and contribute to this society as we go along.

Wishing all the best to my fellow Engineers and their family and friends and to our Bharat.



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*Author of the Engineering Cum Management Book –
"Learning Management Back from Machines"*

Replacing traditional sources of energy completely with renewable energy is going to be a challenging task. However, by adding renewable energy to the grid and gradually increasing its contribution, we can realistically expect a future that is powered completely by green energy. – Tulsi Tanti

KNOW THY POWER NETWORK - 164

(Preventive Maintenance – A Tool for Energy Savings)

(This paper describes the role played by Predictive Engineering Techniques in Preventive Maintenance Schemes in a plant)

I. A General View

(1) What is the need for maintenance of both Mechanical and Electrical Equipment?

To find out the health status of any equipment, which includes all kinds of defects, faults and malfunctions that exist in the equipment, either due to poor design manufacturing, mishandling or to oppressive operating environment and pollution, some kind of maintenance is always required. It may be one of the types of maintenance programs like Preventive, (Predictive) Planned, Periodical, Regular and Reliability based maintenance and condition based maintenance schemes. All these maintenance programs are essentially based on various health monitoring parameters / health checks.

Such maintenance programs are necessary to avoid premature failure of power system equipment like the rotating machines. (Such as motors, generators), static / stationary machines like transformers and circuit breakers which are part of power generation and industrial application and enhance their assigned operating life span. Any premature failure of the equipment invariably leads to unexpected power outages with the consequential economic losses, in addition to the damages caused to the asset itself. Simply put, an effective maintenance planning is essential to have accurate component health information that facilitates the correct process of repair or replacement. All these point to the need for the knowledge of the components that form the power system apparatus and the knowledge of the methods of measurement and diagnosis that helps the effective detection of problem areas. In short, it may be treated on par with the periodical whole body checkup of Human beings. Simply put, real time assessment of equipment health is always required to predict failures its remaining life span.

In this context, following points are also worthy of consideration.

- (a) All equipment both Mechanical and Electrical and its protective devices will function properly only when they are regularly examined, checked and maintained.
- (b) It is impossible to predict the abnormal behavior of any electrical and mechanical equipment. So we should be ready to make these equipment to function / operate properly at all times. Here comes the role of maintenance planning programs. Admittedly such planned programs always lead to huge monetary savings.
- (c) We all know most of the power system outages with the consequential fires losses of equipment and personal are mainly attributed to inadequate condition monitoring, testing and maintenance programs
- (d) Do not forget to give the power system applications the care and attention due to it.

(2) Briefly explain the types of Maintenance Programs

Among the types of Maintenance Programs are (i) Preventive Maintenance, (ii) Periodic Maintenance, (iii) Proactive Maintenance (Condition based / Reliability based maintenance) (iv) Prescriptive Maintenance.

The issues related to the mechanical aspect of the equipment are given wide focus in this article. It applies to all kinds of drives and driver equipment

(3) Explain the main features of Predictive Maintenance techniques that fall under the category of Preventive Maintenance Program

To start with, it must be noted that the Predictive Engineering Techniques (PET) are part of the preventive Maintenance Program and gained importance or popularity in the last 15 years or so. The technologies tools adopted to mechanical part of the equipment and building play key roles in this PE Techniques.

Among them are,

- (i) Infrared Thermograph
- (ii) Vibration Analysis
- (iii) Building pressure testing to establish its footprint on the condition of building fabric.
- (iv) Heating / Cooling plant operations
- (v) Lubricating oil Analysis
- (vi) Vibration Analysis
- (vii) Power consumption in the plant studies

(4) Let us understand where and how these techniques are used?

(i) Thermographics (Thermal Imaging Camera / Infrared Thermograph)

It is based on infrared technology. It helps to assess the integrity of a building electrical system some rotating equipment, Electric Panels, Hot Fuse Holders, Heat Exchangers, the Critical Pumps in a Heat and generates systems and also the fabric of a building for heat and cooling losses. The variations in the temperature of the parts concerned plays an important role in this diagnostics.

(ii) Vibration Analysis

This technique mainly applies to rotating plant and machinery. The vibration readings taken help indicate whether the machines are working at their normal level or it needs attention to find out its suspect parts. It is preferable to confirm the vibration recordings by ultra sound waves. This technique also helps to find out whether the equipment are being employed to their full potential and predictive failure levels. The vibrations with the attendant noise and the visible vibration routes are helpful in identifying the problem areas.

(iii) Ultra Sound Guns

To test UG cable system, Electric Panels, Rope Strength, Bearing Condition, Chains, Pipes Blowers and motors. This technique is adopted.

(iv) Lubrication Oil Analysis

This method is generally applied for mechanical equipment / devices like gear boxes where 10 micrometer oil films are used for its functioning. 10 micrometer film of oil is more or less equal to the diameter of a blood cell. Loss or contamination of this film, presence of unwanted metal particles in the lubrication oil system are pointers to the inevitable equipment failure increased oil levels in the oil samples taken from a baked extruder gear box can be cited as an illustration. So to ensure the smooth running of the machinery concerned, it is essential that the oil concerned should be kept clean and dry.

(v) Control Systems

In many high rise commercial / residential building prime controllers are generally used. These systems can be considered as “Energy Implementation Systems”. The mal functioning of any of these systems is a source of energy loss.

(vi) Building Pressure Systems

The next item in line for our attention is the air tightness of the buildings. It helps to maintain appropriate levels of air exchangers to maintain good breath ability.

(vii) Cost - Benefit Analysis

From this view point, PETs are less expensive, faster less time consuming and there by cheaper. Hence it is preferable.

(5) Issues that need attention in a building

(i) Air Leaks

It relates to the functioning of air conditioning plants in a building. The common areas of leaks,

- Gaps along the edge of doors and flooring
- Windows and its frames
- Through electrical outlets, switch plates and base boards, weather stripping around the doors.

(ii) Insulation

If the insulation levels used are less than the required minimum, heat gain through ceilings and walls will occur. All these point to the periodic inspection of AC equipment, the filtration of its refrigerant gases by various techniques and better cooling methods

(6) Base Line Breachers / Problem Areas

The predictive maintenance techniques discussed so far are generally applied to detect the problem areas in the following equipment / system

(a) Belt – Pulley System – Looseness

- Misalignment, Belt Resonance, Vibrations and Sub Harmonic Natural frequencies

(b) Rotor problems in electric motors like eccentricity, unbalance, angular mis alignment, shaft bends looseness of mechanical couplings, links

(c)

- Generator rotors –do-
- Commutators in DC motors and DC generating units, looseness of brushes
- Higher capacity pumps – bearing heating, looseness
- Generator Turbines – Thrust Bearings – problems in the continuous flow of lubricating oil through the bearings
- Cooling water system and pumps in a thermal power station
- Condensers in thermal power stations
- Cooling towers in air conditioning plants
- Mechanical equipment that are used as any auxiliary to boilers.
- Heat Exchangers
- Heavy Duty Boilers
- High rise building in information technology parks.

(7) In this connection, it is to be stated that the basic steps that need to be followed are,

- Monitor and Record the performance indicators, conditions of the equipment during its normal operation.
- Find out how its present performance parameters / indicators compare with that of the normally permitted ones and find out whether they are any deviations / conditions exceeding the prescribed tolerances
- Put your ears on the equipment and listen to its stress – related signals.
- Identify the presence of unbalanced conditions if any
- If abnormal vibrations are witnessed identify the source of vibrations (Mechanical or Electrical) and also figure out its signatures.

Then measure the vibrations, analyse it with data and see whether it indicates, signals any alarm conditions or immediate repairs. In simple terms, measure and understand

- The sources and causes of vibrations
- Its size
- Amplitude
- Frequency
- Velocity / speed
- Acceleration
- Displacements / damages brought by it and
- Plot time vs wave forms of vibrations

(8) Final Remarks

The predictive engineering techniques described play significant roles in Energy Audit Process and in the reduction of consumption of electricity and lubrication materials like grease and oil. The related expenditures (payback period) are paid within 6-12 months. It is beneficial to small medium industries and the plants who are not afford to undertake costly techniques to get energy savings.

Let me sign off.

Kindly stay tuned for the next article.

(To be continued)



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ELECTRICAL MAINTENANCE UNIT (QUESTION & ANSWERS) - 12

216. What is the material used in florescent tube?

The fluorescent tube is filled with argon gas at low pressure and some mercury after evacuating the tube. This argon gas gives initial starting at quick manner. Initially the mercury is in the form of globules on the inside of the tube surface. As the temperature increases the liquid takes globules mercury changes into vapour form and takes over the conduction of the current.

217. What are the importances of conversion of AC into DC?

- a. For traction purpose a DC series motor is most important. Examples in railways, in electrical lifts etc.
- b. For electrolytic and electro chemical processes such as electro plating, electrolysis, electro refining only DC is essential.
- c. DC is essential for battery charging, running arc lamp torch, cinema projector and for arc welding.
- d. It is required for operating relays, timer, telephone, circuit breakers etc.

218. What is rectifier? Write few types of rectifiers.

Rectifier is a device which converts AC supply into DC. Following are the types of rectifiers generally used.

- a. Copper oxide rectifier.

- b. Selenium rectifier.
- c. Electrolytic rectifier.
- d. Mercury arc rectifier.
- e. Tungar rectifier.

219. What are the parts of paper insulated lead covered cable?

- a. Core.
- b. Insulation of cable.
- c. Metallic sheath.
- d. Bedding.
- e. Armouring.
- f. Serving.

220. What are the factors considered for selecting a cable?

Following factors considered for the selection of the cable.

- a. System voltage.
- b. Condition of installation.
- c. Continuous current to be carried.
- d. Maximum operating conductor temperature (70°).
- e. Ambient air temperature (40°).
- f. Thermal resistivity of soil.
- g. Depth of laying.
- h. Short circuit current. $I_{sh} = Ka / (t/2)$. Where 'K' is constant ($K = 109$ for copper cables), 'a' is area and 't' is time duration of short circuit in seconds.

221. What are the advantages of high voltage transmission?

- a. Saving in conductor materials.
- b. Low power loss (I^2R) of transmission lines due to decrease in current.
- c. Better efficiency of line due to fewer losses.
- d. Better voltage regulation due to less voltage drop in line due to less transmission current.
- e. Due to the less cross section of conductor distance between the poles increases and the cost decreases and the labour cost also decreases.

222. What are the types of distribution system?

- a. Radial distribution system.
- b. Ring distribution system.
- c. Grid distribution system.

223. What are the types of distribution of supply?

- a. Over head distribution system.
- b. Under ground distribution system.

224. What are the main items used in over head distribution system?

- a. Conductor material.
- b. Pole.
- c. Cross arm.

- d. Insulators.
- e. Strain insulator.
- f. Post insulator.
- g. Stay wire.
- h. Support with insulator and stay lightning.

225. Write types of lightning arrestor.

- a. Horn gap lightning arrestor.
- b. Oxide film lightning arrestor.
- c. Pellet lightning arrestor.
- d. Thyrite lightning arrestor.

Motor, Generator and Exciter

1. What are the main classifications of alternator?

- a. Salient pole.
- b. Non – salient pole.

2. What is the emf equation of alternator?

Flux cut per second by each conductor = $2 \phi_m f$

Average emf generated in each conductor = $2 \phi_m f Z$

Average emf generated per phase = $k_d k_c 2 \phi_m f Z$

r.m.s emf generated per phase = $k_f k_d k_c 2 \phi_m f Z$

For sinusoidal waveform when k_f is 1.11 then emf generated

$$= 1.11 * 2 k_d k_c \phi_m f Z$$

$$= 2.22 k_d k_c \phi_m f Z$$

k_f → form factor

f → Frequency

ϕ_m → Flux maximum

Z → Turns per phase

k_d → Breadth factor or distribution factor

k_c → Coil span

3. Why conductors in alternator are transposed?

To reduce eddy current losses.

4. What is the effect of frequency and high voltage at the start of motor?

For a constant load if frequency decreases motor current will increase and at the start if voltage is more motor current also increases.

5. What is the minimum voltage required for starting of 6.6 kV motors?

Minimum 80% of rated voltage

6. What are the limits of vibration measurement for motors?

50 microns for displacement and 5 mm/second for velocity

7. What you mean by SPDP?

Screen protected drip proof.

8. What is the current in single phasing?

2 times of rated current

9. What is the impedance per phase of delta connected motor?

1.5 times the total impedance.

10. What is the slip of an induction motor during normal running?

More than zero.

11. What is the effect of increased load on power factor of induction motor?

Power factor of an induction motor increases with loading.

12. Explain the behavior of generator when operating alone and operating parallel with grid.

Generator operating alone

- The power factor of generator depends on load power factor.
- The terminal voltage decreases when generator is loaded.
- Governor decides the frequency of generator.
- Increase in excitation increases the terminal voltage of the generator.

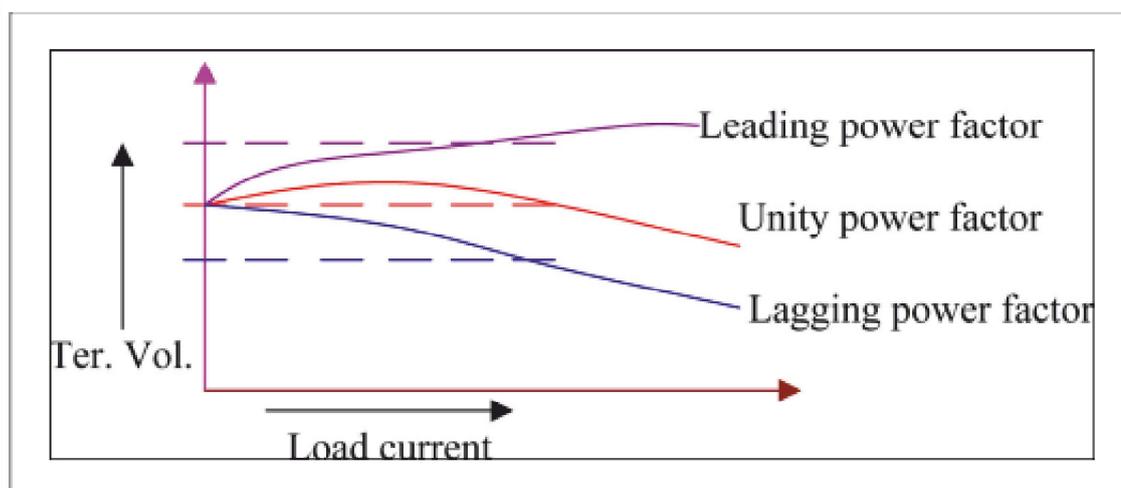
Generator parallel with grid

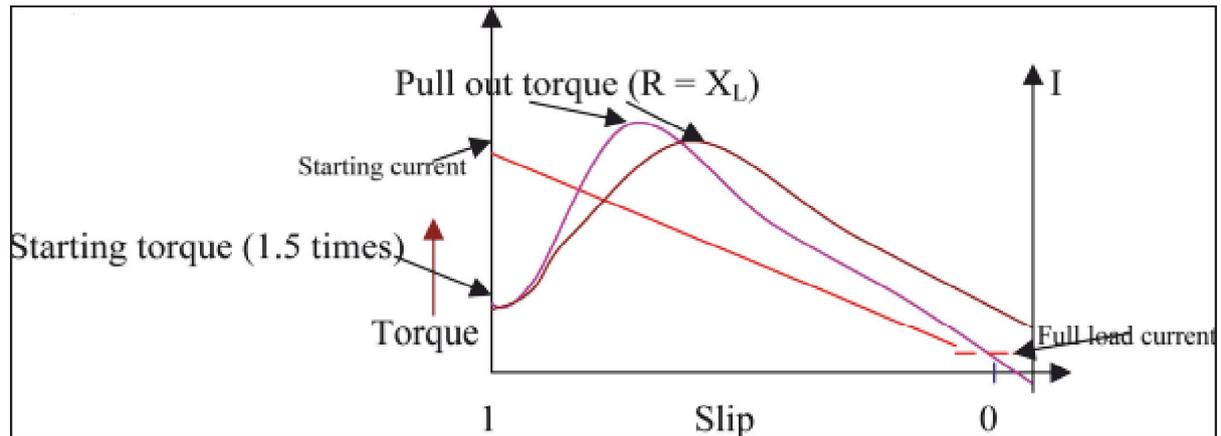
- If we increase the steam input to the generator the frequency of the generator will not change. It will remain practically constant as same as grid frequency. That is grid decides the frequency of the generator.
- Increase in the excitation will not increase the terminal voltage. Instead the reactive power output of the generator increases. This reactive power supplies for the magnetizing current of motors, transformers and etc.
- Increase in the steam input increases the active power of the generator.
- If generator is under excited it will draw leading reactive current from the grid.

13. Draw and explain following.

a) Load current Vs terminal voltage at different power factors.

- At leading power factor as the load current increases the terminal voltage also increases.
- At lagging power factor as the load current increases the terminal voltage drops.
- At unity power factor as the load current increases there is slight drop in terminal voltage.





When motor is started from rest the slip is 1 (one) at the time of starting and starting torque is 1.5 times of rated torque. As the motor accelerates slip reduces and torque increases. Because the power factor of rotor is improving due to the decrease in rotor frequency and at certain slip the rotor reactance is equal to rotor resistance. At that time torque is maximum (pull out torque). When the motor accelerates to the rated speed the torque comes to the rated value, which is less than the starting torque. Torque is zero when slip is zero, because there will be no relative motion between stator magnetic field and rotor.

c) Generator capability curve

This curve gives the operating limits of the turbine generator at different power factor what should the power output of the generator to avoid the heating of generator stator winding, rotor parts and end parts.

14. What is the cooling medium for different parts of the turbo generator?

Stator – DM water.

Rotor – Hydrogen.

Bearing – Oil.

15. What are the effects of unbalanced voltage on induction motor?

There will be negative sequence current, which will heat up the stator winding and weakens the insulation. These currents will induce emf in rotor and heat up the rotor bars and cause breakage in them. Also due to high leakage fluxes due to negative phase sequence current the end parts heating will be more.

16. What are the types of bearings are adopted for small motors and large motors?

Small motors (LT motors)

Horizontal mounted – deep groove ball bearing at both ends.

Medium motors

Roller bearing at DE and deep groove bearing at NDE.

Large motors (HT motors above 750 kW)

Horizontal mounted – sleeve bearing (pedestal) cooled by lub oil.

Vertical mounted – face to face angular contact ball bearing at NDE and roller or ball bearing at DE.

(To be continued)

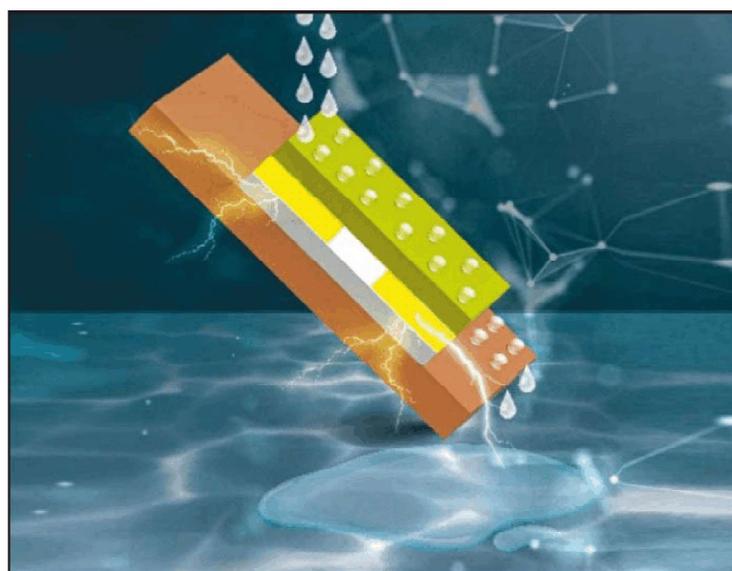
Courtesy: <https://www.scribd.com/document/244623258/Question-and-Answers-Electrical-Maintenance-Unit>

ELECTRICITY FROM RAINDROPS

While the entire world is worried about managing the battery wastes that will create a big challenge by 2050, Indian researchers have created an excellent device that will literally use water to generate electricity to support small electronic devices...

Liquid-solid Interface Triboelectric Nanogenerator

Researchers from IIT Delhi have designed and fabricated a device that can generate electricity from water drops, raindrops, water streams, and even from ocean waves using 'Triboelectric Effect' and 'Electrostatic Induction'. The device is called 'Liquid-solid Interface Triboelectric Nanogenerator'. The generated electricity can be stored in batteries for further use.



The device has a very simple structure consisting of specially designed nanocomposite polymers and contact electrodes and can generate a few Milliwatt (mW) power, which is sufficient to power small electronic devices like watches, digital thermometers, radio frequency transmitters, healthcare sensors, pedometers. When compared to conventional methods, such as the use of the piezoelectric effect, the present device can generate significantly more electricity.

Construction of the device

The researchers have successfully incorporated nanostructures into a polymer matrix, which has enhanced the film's surface roughness, polarizability, and hydrophobicity, among other characteristics, as a result. Due to the enhancement in the above property, the flexible film is used to fabricate the device where raindrops have just to slide down and can generate electricity. The artificially created rough surface allows to generate more charge and superhydrophobic properties of the solid surface help to roll the water drop without getting stick to the surface.

The IIT Delhi research team also explored the underlying mechanism of the electricity generated when the water drop comes in contact with the solid surface and it is shown that saline water drops generate more electricity.

Background of the development

Prof. Neeraj Khare from the Department of Physics and his group at the Nanoscale Research Facility (NRF), IIT Delhi, have been working on harvesting electrical energy from to-be-wasted mechanical vibrations using the triboelectric effect. The group has filed an Indian patent on the various aspects of the use of ferroelectric polymer for harvesting mechanical energy including the present device.

Commenting on the high-potential development, Prof. Khare said, "Triboelectric effect is a known phenomenon for a long time, and in this effect, charges are generated when two surfaces are in friction. The best example we see are sparkling lights when we move the blankets/jackets. It is only lately that it has been extensively investigated as a practical alternative for energy harvesting".

Supporting organisations

The Ministry of Electronics and Information Technology (MeitY) and the Department of Science and Technology (DST), Government of India, have supported the research work under NNetRA project.



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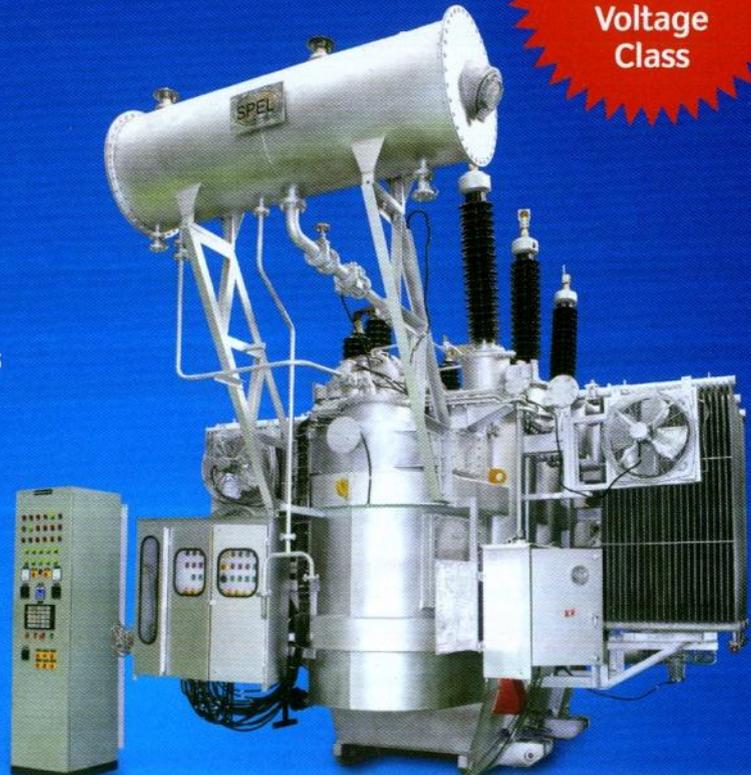
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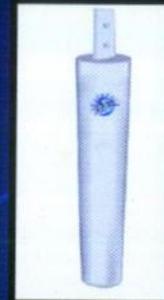
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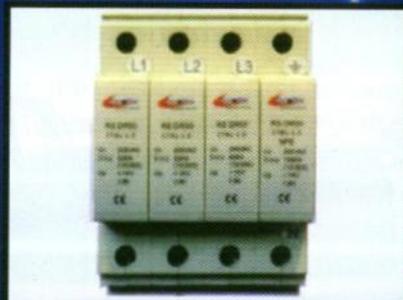
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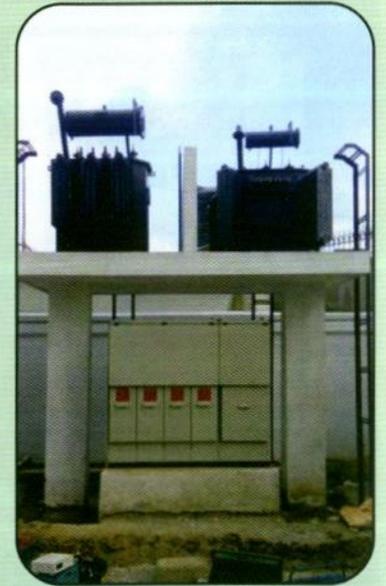
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SUBSTATION DESIGN / APPLICATION GUIDE – 5

3.4.10 Mesh

This arrangement is applicable to four or more circuits with rarely more than six. In practice the physical design of the substation provides for an ultimate even number of circuits, though the initial installation may be for an odd number of circuits.

Note that there can be physical problems in extending a mesh substation if the possibility of future extension was not considered in the initial design stage.

The mesh arrangement permits a circuit breaker to be taken out of service without interrupting the supply to a circuit and therefore gives a good continuity of supply. This is only applicable for one circuit breaker. When the mesh has already been broken, the opening of another circuit breaker could cause serious problems in the continuity of supply. Hence the limitation on the number of circuits connected in a mesh arrangement.

Bus zone protection is not applicable to mesh arrangements. If current transformers are provided on each side of the circuit breaker, these would provide discriminative protection for the elements of the mesh as well as protection for the outgoing circuits .

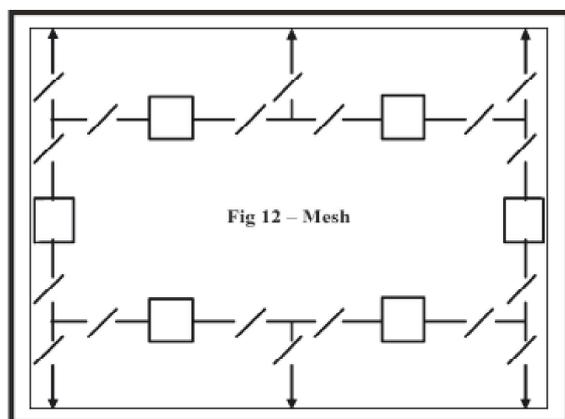


Fig 12 – Mesh

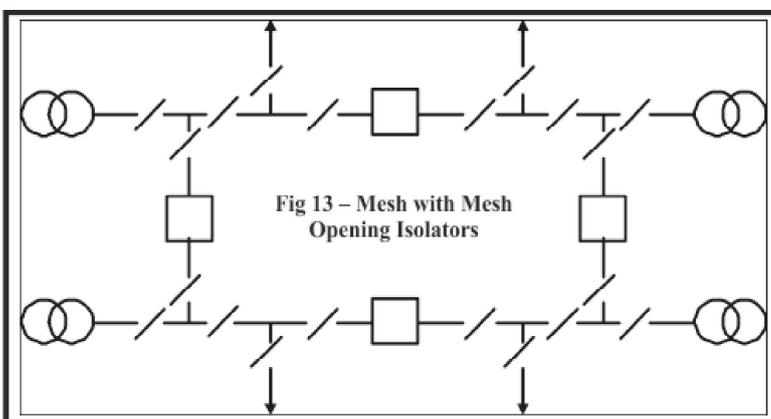


Fig 13 – Mesh with Mesh Opening Isolators

A more economical variation of the mesh arrangement sometimes used by the CEGB incorporates mesh-opening isolators and is shown in *Figure 13*. Normally this is applied to a four-switch mesh and a transformer is paired with an overhead line. It is not essential that all sides of the mesh have mesh-opening isolators.

When it is required to switch a circuit, the mesh must first be complete before the mesh-opening isolator adjacent to the circuit being switched is opened. The circuit can then be switched by the circuit breaker, the circuit isolated, and the mesh then completed.

Under fault conditions both line and transformer are disconnected, the faulty circuit isolated, and the mesh again completed.

3.4.11 Breaker-and-a-Half

This arrangement of three circuit breakers in series to give a “diameter” between a pair of busbars gives good service continuity since a circuit breaker can be taken out of service without interrupting the supply to a circuit. It also has better operational facilities than a mesh arrangement.

As in a mesh arrangement, the diameters must be run solid to achieve the best service continuity and operational facilities.

This arrangement with the additional circuit breakers, isolators and current transformers is more costly than the mesh and double bus arrangements.

To obtain discriminative protection for faults on a diameter, current transformers are required each side of the circuit breaker. These current transformers can also be used for the circuit protection.

3.4.12 Breaker-and-a-Third

This is a lower cost variation of the breaker-and-a-half arrangement. Whilst in the “solid” condition it gives equal service continuity but less operational facilities. When not “solid”, the service continuity is less than that for a breaker-and-a-half arrangement.

3.4.13 Four Switch Substation

This arrangement was introduced into the British Grid system to provide small substations on a ring network.

This arrangement gives good service continuity but negligible operational facilities. The latter can be improved by replacing one of the bus section isolators by a load breaking switch isolator.

3.4.14 Three Switch Substation

This developed from the four switch substation and provides almost the same facilities but at a much lower cost. The two normally open isolators connected between the transformers are provided to allow continuity of supply with a circuit breaker out of service.

Note that because they are off-load devices they can only be operated when all the circuit breakers are closed. Note also that it is possible to have an arrangement with the transformers and feeders interchanged.

3.4.15 Single Switch Substation

This arrangement is used in place of the three-switch substation at the less important substations. There is a slight reduction in the continuity of supply.

Note that there must be provision for the tripping of the remote circuit breaker on the feeder with transformer faults.

3.4.16 Shunt Circuit Breaker

This was invented by Electricité de France and patented in 1956.

On occurrence of a fault, the shunt circuit breaker closes to clear transient faults with no operation of the circuit isolator and to clear permanent faults with operation of the circuit isolator whilst the circuit breaker is closed, the operation of the isolator is automatic.

The variation in Figure 20 operates in the same manner under fault conditions but the shunt breaker can be used for operational switching by opening the “earthing” isolator, closing the circuit shunt isolator, closing the shunt circuit breaker, opening the circuit bus-bar isolator, then opening the shunt circuit breaker. The circuit shunt isolator must then be opened and finally the “earthing” isolator closed ready for fault operation.

3.4.17 Gas Insulated Switchgear (GIS)

Gas insulated switchgear substations need reduced ground area. These substations can be extended easily. They are environmentally more acceptable. They need reduced civil works & cabling.

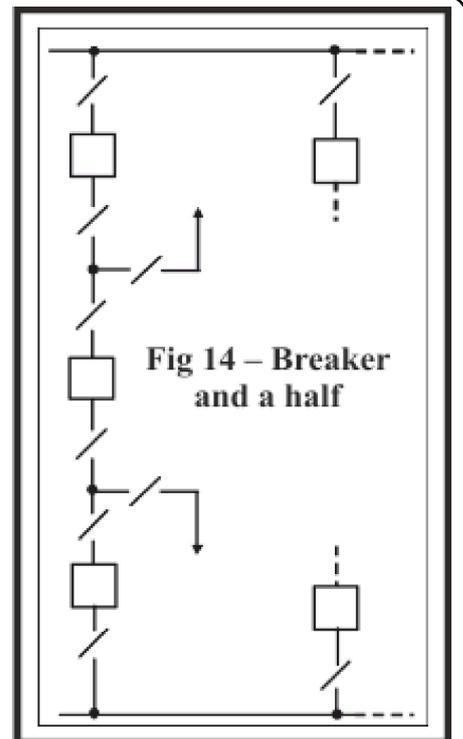


Fig 14 – Breaker and a half

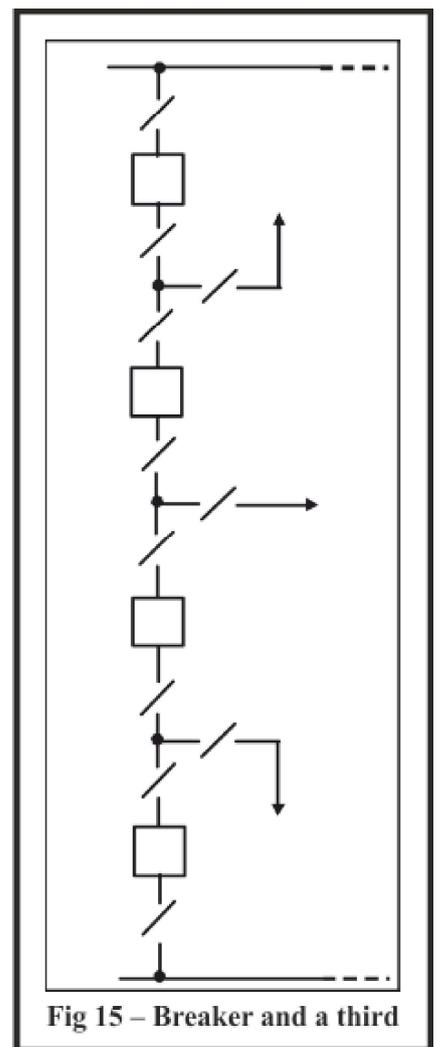
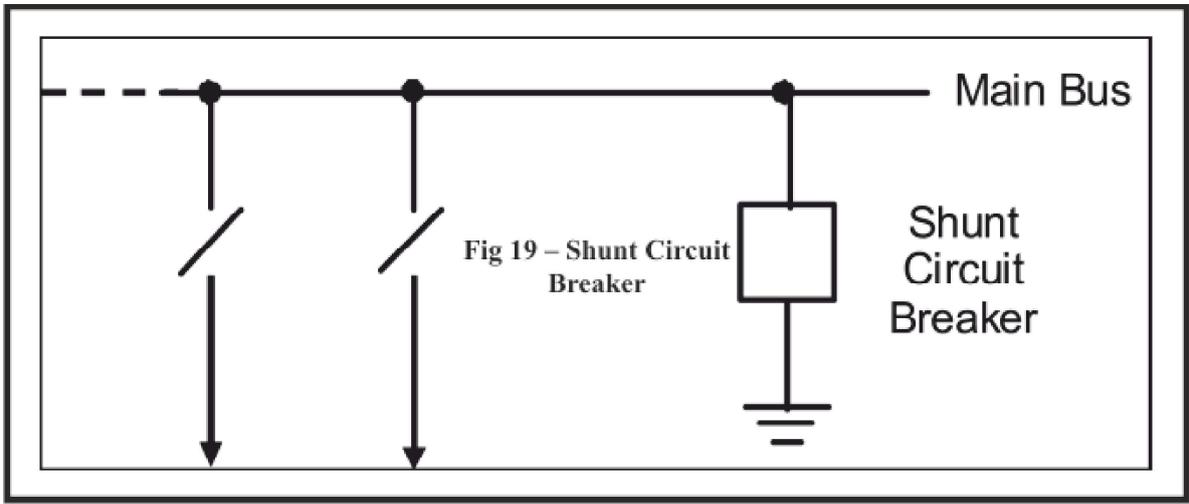
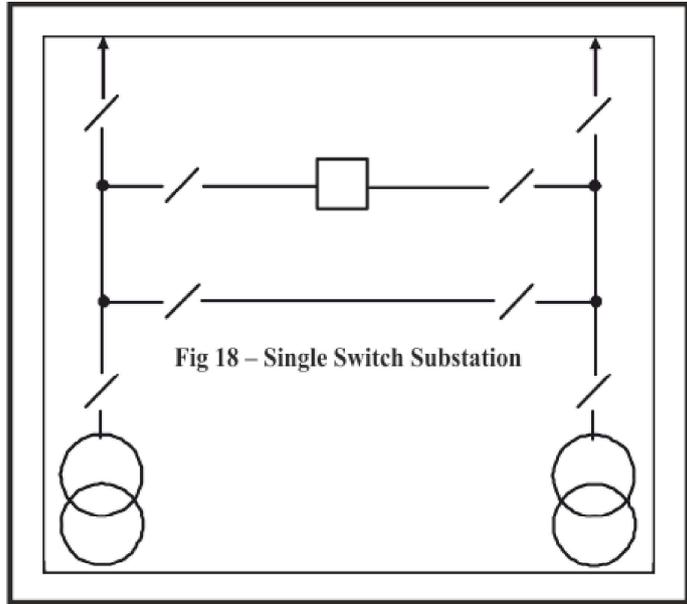
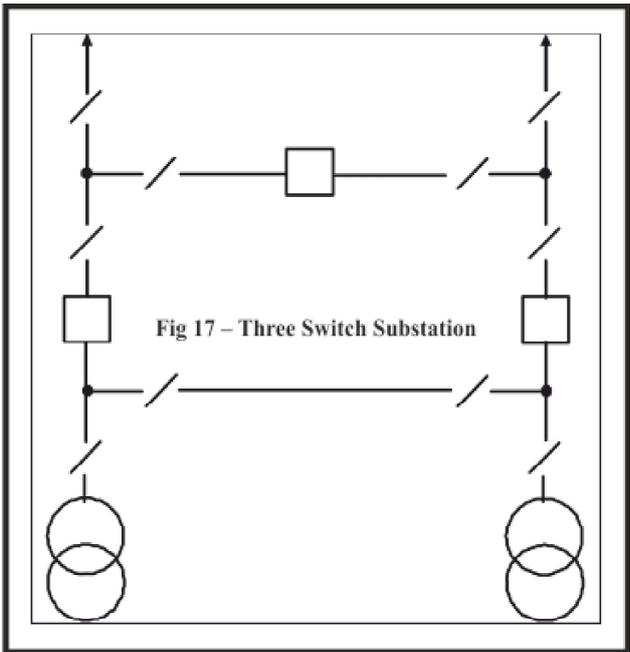
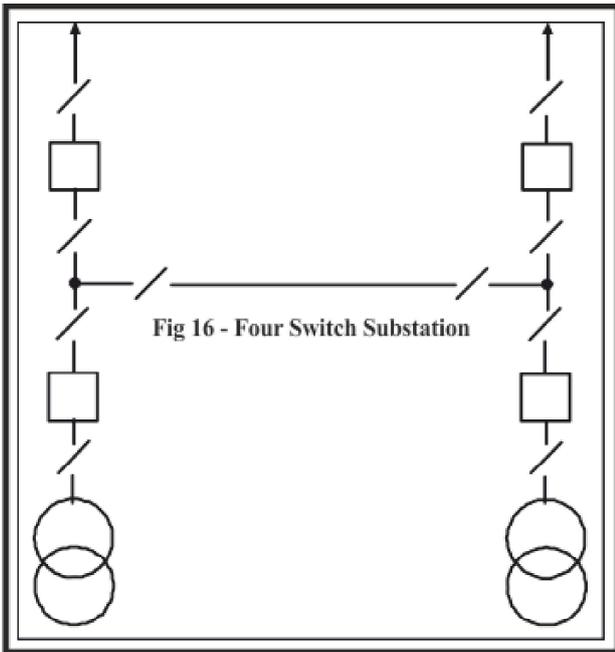
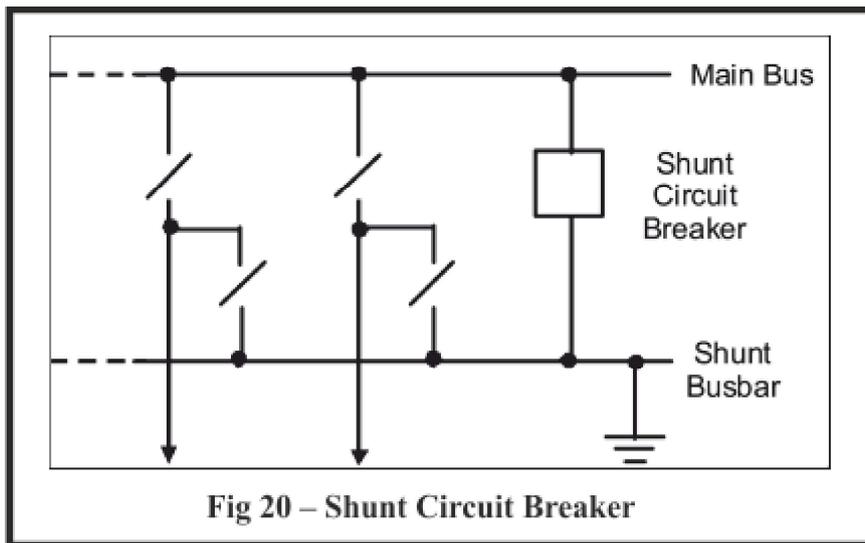
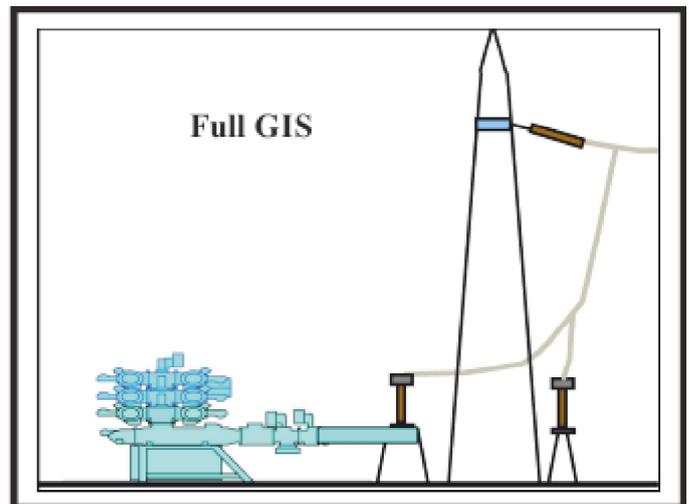
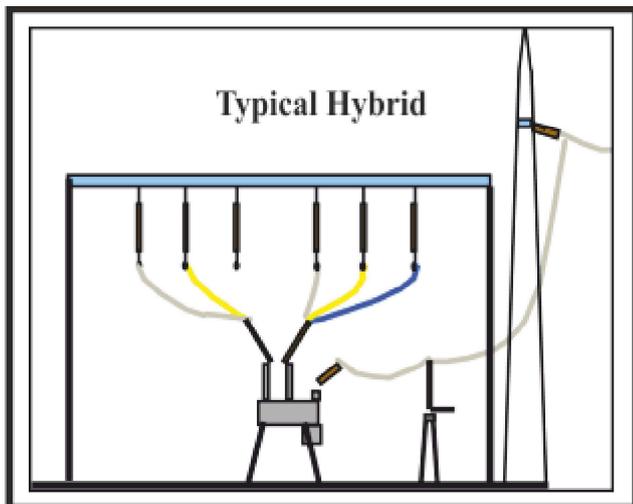
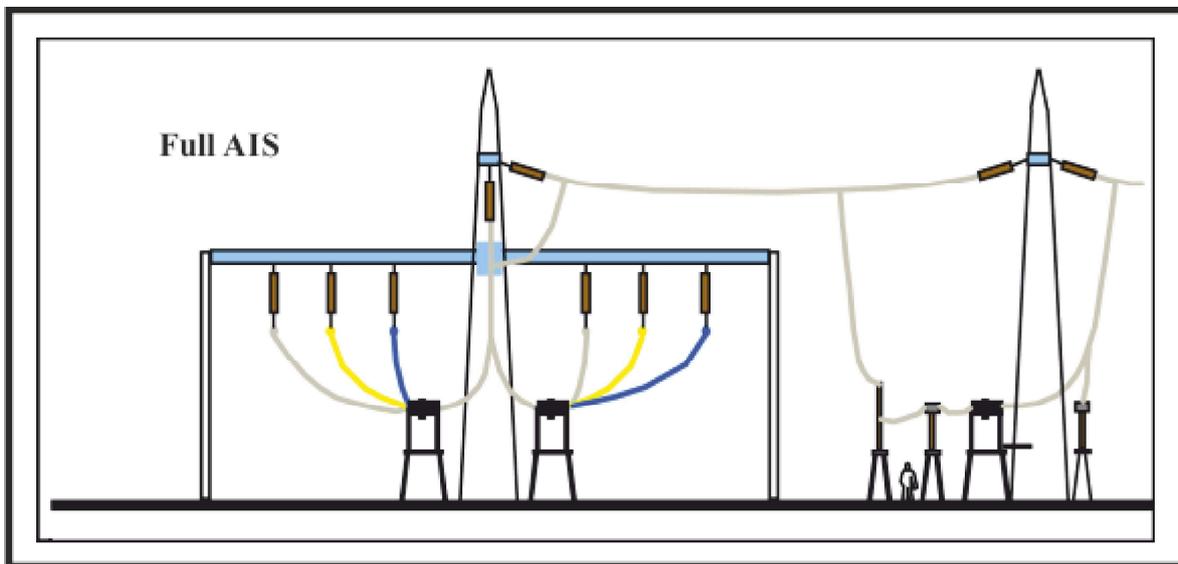


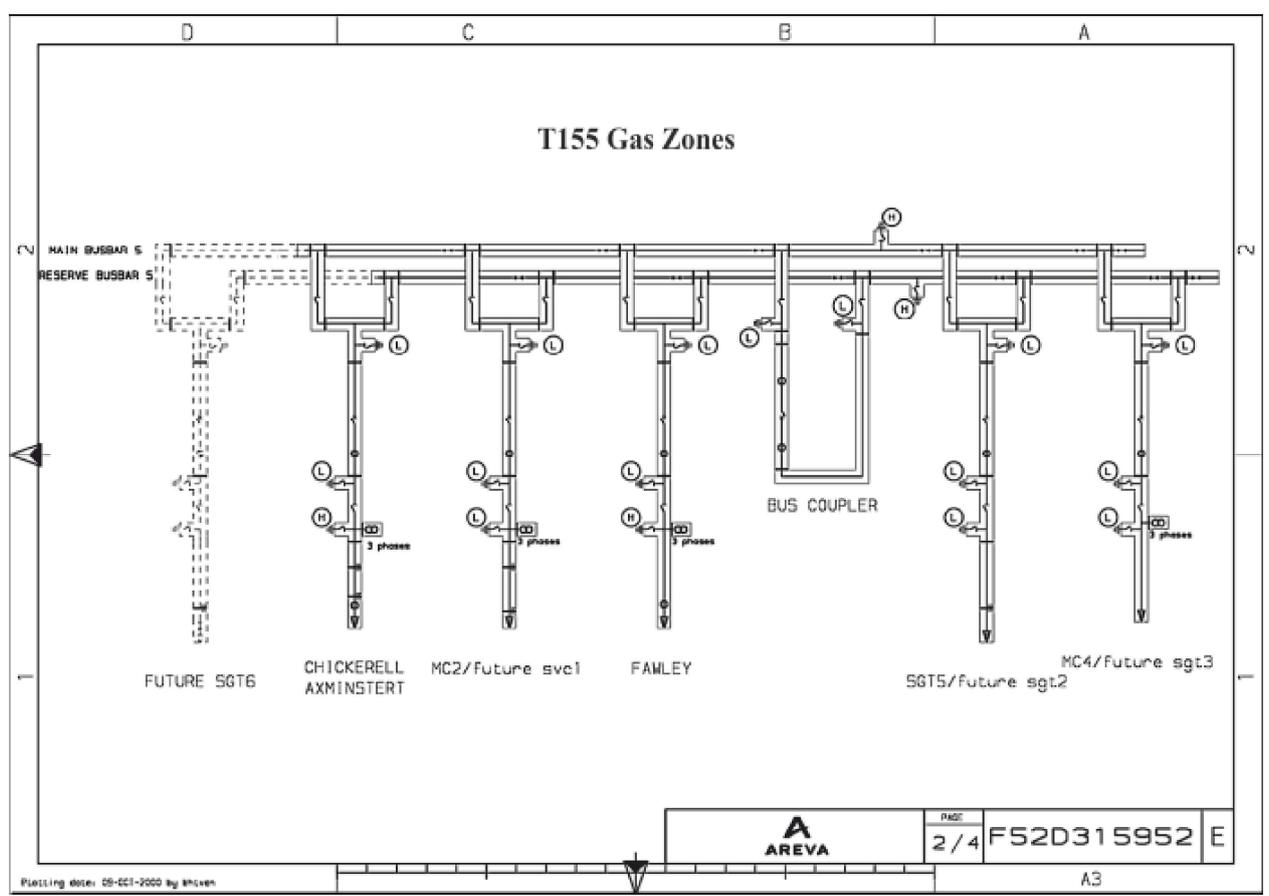
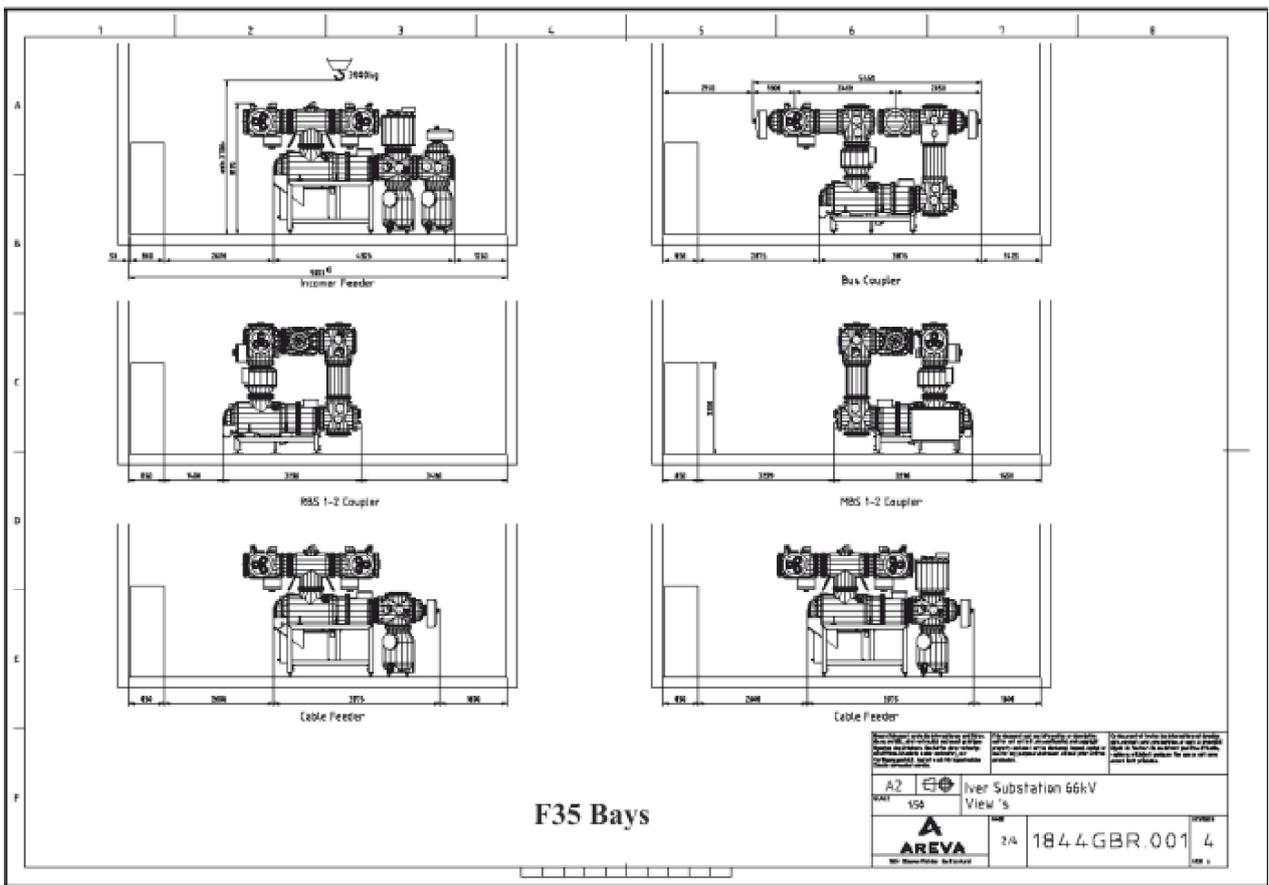
Fig 15 – Breaker and a third

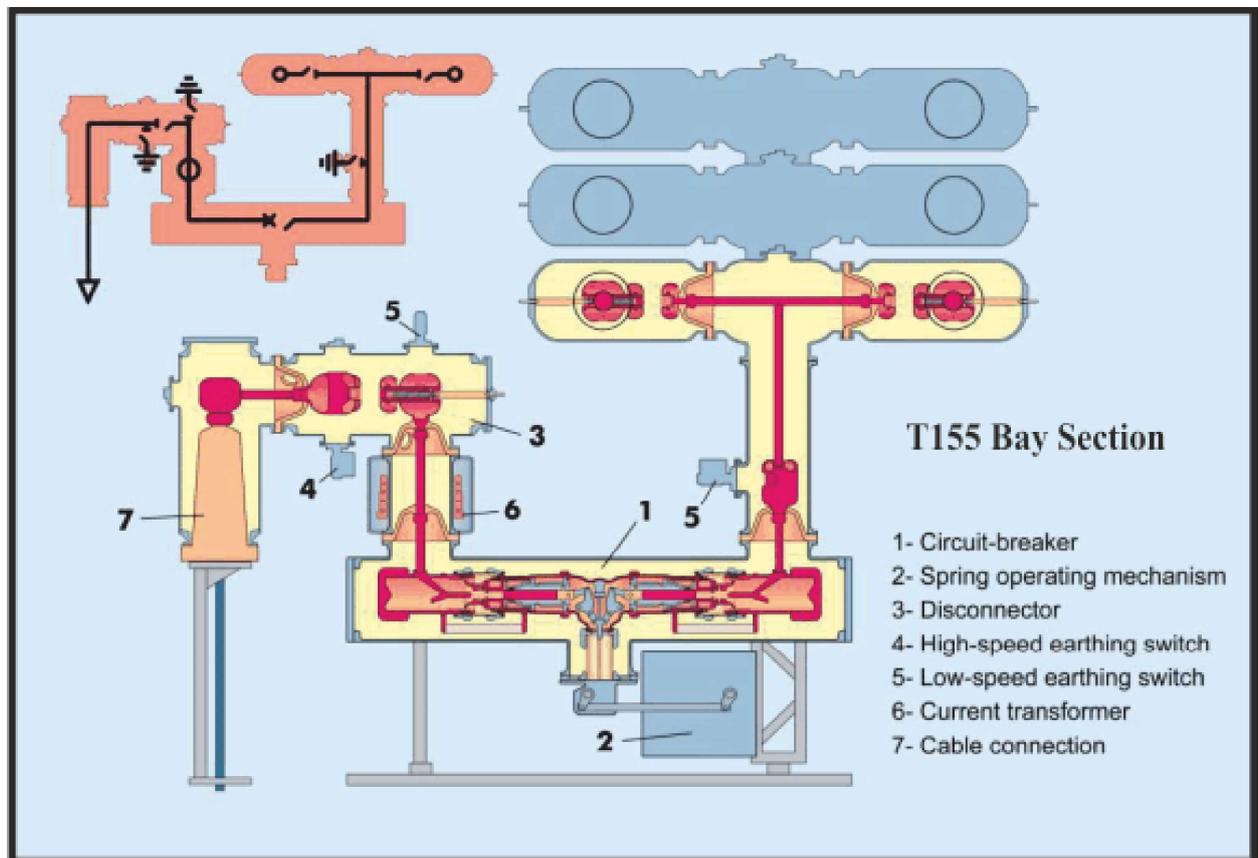
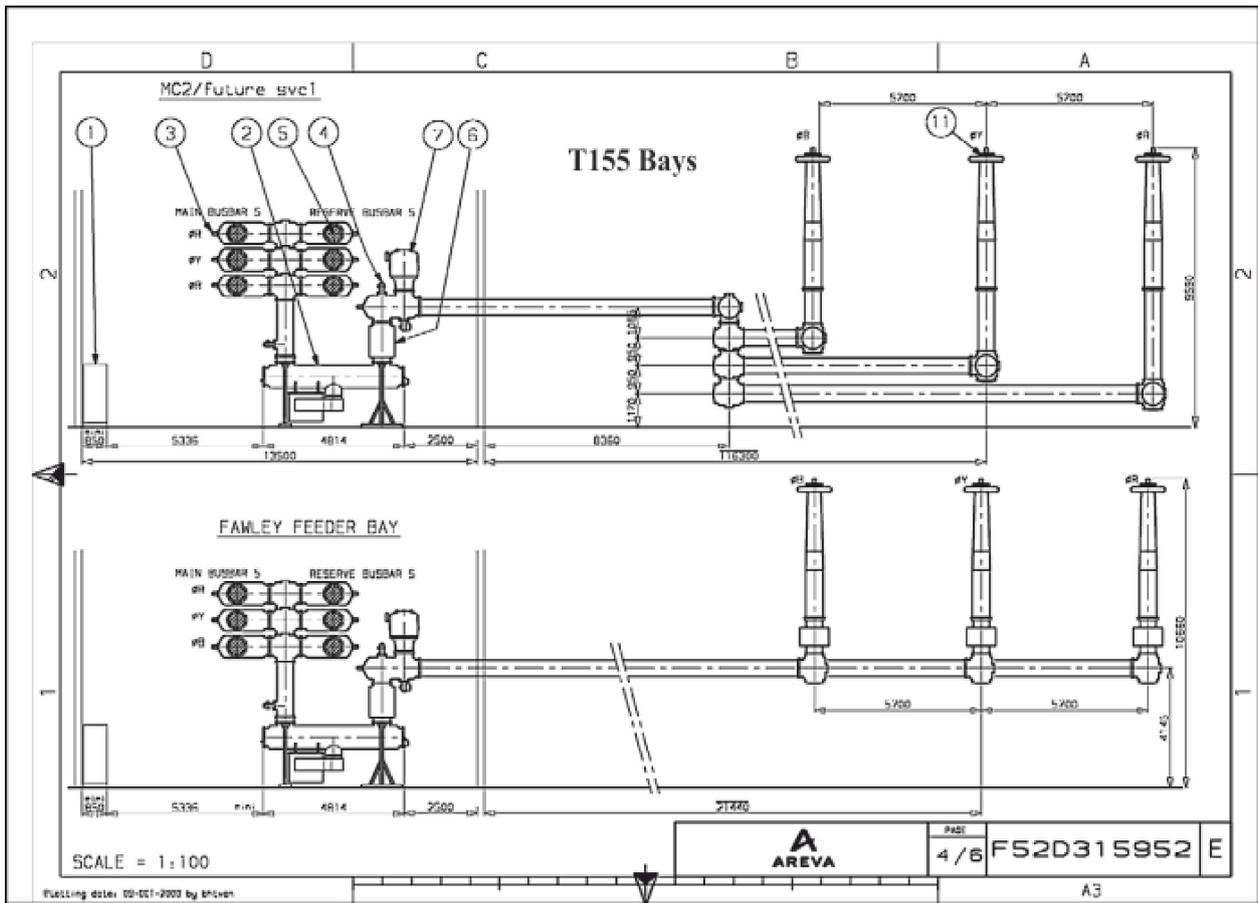




Comparison of AIS, Hybrid and GIS Substations









T155 Hybrid substation

Hybrid switchgears are ideal equipments to refurbish existing AIS or GIS substations. Engineering application time, civil works and outage time are reduced. All innovative substation layouts are possible with hybrid switchgears.

(To be Continued)

*Courtesy: V Ayadurai Bsc, C.Eng, FIEE
Engineering Expert*

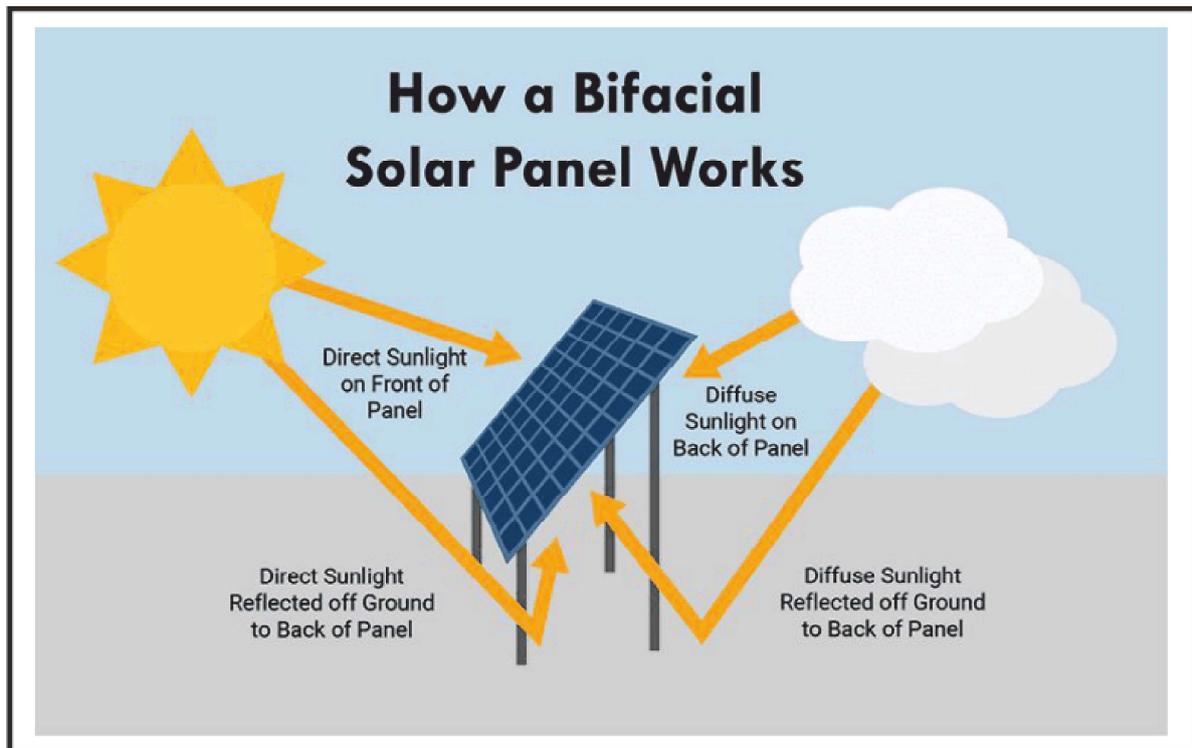
An increased push for energy efficiency, renewable energy technology, electric mobility - along with the growing digitalization movement and a universal carbon pricing structure - would speed up the carbon-free future and the rise of a global middle class we desperately need. We can and must all do our part.

- JOE KAESER

BIFACIAL SOLAR MODULE PERFORMANCE – AN INSIGHT

Background

As with any emerging commercialized technology, the solar industry is just beginning to grapple with how to value the project impact of bifacial solar module technology. What is a bifacial module? Bifacial simply means that the solar module is receiving irradiance and generating power from both sides of the module, whereas a traditional monofacial module only accepts irradiance incoming on one side, with an opaque back side. Bifacial technology is not necessarily new – designs were presented as early as 1960, and installed systems have been tested since the 1990s (Guerrero-Lemus et al. 2016). However, with advances in module manufacturing, cell efficiencies, and the overall rapid growth of the global solar photovoltaic industry, bifacial technology has recently emerged with the potential to capture a significant portion of the module market.



Bifacial photovoltaic module technology has seen strong growth in recent years, with significant interest throughout the industry and many more product offerings available. Several Tier 1 module manufacturers, including Trina, ongi, Jinko, Canadian Solar and others currently offer bifacial products, and racking manufacturers have also developed designs to optimize gains and minimize racking costs specifically for bifacial systems. Solar resource assessment campaigns are more commonly incorporating albedo measurements to better quantify the potential bifacial gains, and solar energy modeling software such as NREL’s System Advisor Model (SAM) and PVsyst have incorporated algorithms to simulate bifacial energy output.

Based on rapid developer adoption, ArcVera Renewables expects bifacial designs to eventually dominate the utility-scale module market.

Bifacial Energy Production Considerations

The benefit of bifacial modules is in the additional solar irradiance captured and resulting gains in energy output for a given site and solar plant design. Module manufacturers may advertise gains “up to 25%” or more, and while this may be technically achievable, in practice the gains are highly variable and depend on many project

site and design characteristics (Romero et al., 2018). Based on ArcVera's modeling of bifacial systems and our review of third-party models and test systems, typical groundmount tracking systems in North America more likely exhibit annual energy gains in the range of 3% to 10%, with some opportunity for further optimization.

The primary drivers of bifacial energy production gains are:

- **Module “Bifaciality”:** This aspect denotes the efficiency of the “bottom” side, relative to that of the “top”. Current bifacial modules have bifaciality factors of 60% to 95%. On the higher end of that range are higher-cost modules more typical of smaller/niche applications. Typical utility-scale bifacial modules are currently in the range of 60% to 70%. Multiplying the bifaciality fraction by the percent of back side solar radiation to front side irradiation gives the bifacial percent gain.
- **Surface Albedo:** The primary variable associated with bifacial gains is surface albedo, or the amount of solar radiation reflected by the ground (Stull, 1988). Surface albedo exhibits significant differences throughout regions and groundcovers, across the different seasons, and even throughout the day. The albedo factor is quantified as a number between 0 and 1 (0.0 indicating 0% reflection and 1.0 indicating 100% reflection). The reflected irradiance and resulting bifacial energy gains are directly proportional to this value. Light coloured surfaces have higher albedo, and dark colored surfaces have lower albedo. Snow, for example, is more reflective and may have an albedo factor between 0.4 and 0.9, whereas grass may have an albedo factor between 0.1 and 0.2. Quantifying time-varying albedo is of primary importance when estimating bifacial gains.
- **Ground Cover Ratio (GCR):** GCR is the ratio of the module array footprint to the total project land area. This number depends on the module size and racking orientation (i.e. two modules in portrait, one in landscape, etc.), and the spacing between rows. A lower GCR causes less shading as a percentage of the project area, leaving more ground area to reflect solar irradiance to the module's back side, whereas a higher GCR would imply less exposed ground surface (more shading), and less irradiance available to the back side.
- **Array Height:** The array height will influence how much reflected light makes its way to the module's back side. A higher rack will allow more of the light reflected by the surrounding ground surface to reach the back side, increasing the potential gains.
- **DC: AC Ratio:** The DC:AC ratio is an important design choice to be optimized at any site, and bifacial module gains need to be considered in this optimization. For example, during peak sunshine hours, additional bifacial gains may not be realized if the system is already clipping power, perhaps allowing for a lower DC:AC ratio at the site.

There are several technical considerations which can complicate the accurate estimation of bifacial gains. Albedo alone has fairly high uncertainty and variability, and until recently has not been measured by on-site albedometers. An albedometer is typically comprised of one up-looking and one downward facing pyranometer. Satellite-based (e.g. NASA Clouds and the Earth's Radiant Energy System, or CERES, satellite measurements) or other methods of estimating albedo without ground-based measurements are sufficiently coarse (Stephens et al. 2012, Rutan et al., 2009) or approximate with respect to solar plant footprint, so as to introduce questions regarding applicability and adequacy for analysis.

Other more nuanced impacts, though perhaps of second order, include bottom-side soil accumulation, snow accumulation on the ground (increasing albedo but reducing effective array height), site footprint variance of albedo, bifacial array mismatch losses, module degradation, under-side racking and wiring obstructions, and other factors.

These specific considerations are the focus of those pushing bifacial design and energy modeling forward. Several field tests have shown significant performance gains under a range of conditions, and in some cases have validated modeled results. Bifacial modules are opening up very interesting opportunities, including model improvements like incorporation of time-series albedo and more detailed racking specifications, optimization of ground cover such as genetically engineered reflective plant species or ground-surface modification, vertical

fixed-tilt applications, new racking and wire management design solutions, and new optimization of tracking algorithms.

Bifacial Project Economics

Energy gains from bifacial modules should be considered with due respect to the associated change in cost of implementation. Therefore, design optimization should be thoroughly evaluated with respect to determining the cost of energy in financial models.

The bifacial module market is evolving, and pricing has fluctuated with the larger module market and more recently with changing trade tariffs. Manufacturers may quote costs in the range of 6% to 10% increase from their equivalent monofacial modules. Given that modules are only a fraction of the overall installed cost (albeit a significant fraction), a fairly modest increase in energy output can provide substantial economic benefit and justify the implementation of bifacial modules (aside from other considerations like product availability, warranty, and other project- or developer-specific factors). In general pricing terms, the increased cost of the bifacial panel adds an estimated five cents per watt. In a project where debt financing is utilized, an increase in the production value of a project will generally increase the amount of debt the project can support. Depending on the lender's evaluation of the risks associated with bifacial technology, the increased production value may not be answered by the same increase in debt. However, under a typical project model using debt financing, an increase of 3-4% in energy production value is generally found to result in a more valuable project, with lower cost per installed watt.

Additional Considerations

In terms of technological risk, the electrical components of a bifacial panel are not much different than a monofacial panel (Siason and Kedir, 2018). The challenge is how to accurately model and estimate the production value of bifacial panels to help stakeholders in their acceptance and adoption of the technology. With its potential for significant energy yield benefit, the methodology to technically assess and accurately estimate bifacial value panel technology is rapidly converging to a best practice.

A key consideration to financially valuing bifacial technology is determined by how well the project developer designs the project and measures the albedo, given that different modules and project designs will respond differently to the same albedo. To understand its value risks and optimize potential gains, ArcVera Renewables recommends deployment of met stations including albedometers to gather site-based albedo. This, along with design certainty, is a key strategy to underwrite the technical value of a prospective project considering the use of bifacial panel technology.

Deployment of a met station to understand albedo is relatively low-cost when compared to the value they deliver and provide actual GHI and DNI measurements which 'true up' the long-term, satellite TMY3 datasets. Met stations also provide other important data that reduces associated resource uncertainties, such as measuring the rate of panel soiling and site design loads. Importantly, without on-site albedo measurements it is possible that the calculated energy production gain will be offset significantly by the uncertainty of those calculations, reducing debt value depending on the P-Value utilized by a given financial institution. More than one albedometer measurement site may be advisable if ground conditions (and therefore albedo) vary significantly across the site footprint.

Conclusions

Bifacial technology and energy estimation are evolving, and with them the level of comfort from financial institutions. To realize the expected project value increase associated with 3-10% in bifacial solar project energy production, ArcVera Renewables recommends diligent and accurate measurement and modeling of site conditions, equipment specification, and project design. Ultimately any estimated gains in energy output and offtake, changes to system costs, and associated changes to project economics would be subject to review for project finance.

PM INAUGURATES GOBAR-DHAN PLANT: ASIA'S BIGGEST BIO-CNG UNIT IN INDORE

PM Modi inaugurated (17/02/2022) a solid waste-based Gobar Dhan plant in Indore. It is said to be Asia's biggest Bio-CNG plant. Here is everything you need to know about the unit.



The plant is based on zero-landfill models, whereby no rejects would be generated.

HIGHLIGHTS

Here's all you need to know about Indore's Gobar-Dhan plant:

1. Situated on the Devguradia trenching ground, the plant has the capacity to treat 550 tonnes per day of segregated wet organic waste. It is expected to produce around 17,000 kg per day of CNG and 100 tonnes per day of organic compost, the PMO informed.
2. The plant is based on zero-landfill models, whereby no rejects would be generated. Additionally, the project is expected to yield multiple environmental benefits- reduction in greenhouse gas emissions, providing green energy along with organic compost as fertilizer.
3. Gobar Dhan plant will enable operation for 400 city buses and 1,500 small vehicles on CNG. During the inauguration, the Prime Minister said that this campaign will help a lot towards making India's cities clean, pollution-free, clean energy.
4. PM Modi said that the government is working on introducing 75 more Bio-CNG plants in 75 other districts and villages to benefit farmers in the animal husbandry sector. He further said that whether it is the wet waste that comes out of the houses in the city, the garbage from the livestock and farms in the village, all this is in a way cow dung.
5. The project is expected to yield multiple environmental benefits- reduction in greenhouse gas emissions, providing green energy along with organic compost as fertilizer.

The future is green energy, sustainability, renewable energy.

– ARNOLD SCHWARZENEGGER

ENERGY – GLOBAL MISSION AND INITIATIVES INDIA’S COMMITMENTS AND STRATEGIES - 4

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. The danger surface level temperature rise is 1.5 Deg. C and as of 2021 we have recorded a rise of 1.1 Deg. C. If the situation continues as usual, may be within a decade or two, the danger levels could be reached. Alarming carbon emission levels and the dangers can be summed in the following 2 statements extracted from the various reports:

“Despite the decline in 2020, global energy-related CO₂ emissions remained at **31.5 Gt**, which contributed to CO₂ reaching its highest ever average annual concentration in the atmosphere of 412.5 parts per million in 2020 — around 50 per cent higher than when the industrial revolution began,” said the report. - 29-Apr-2021

“India’s current CO₂ emissions (2021) are **2.88 Gt**. According to the Centre for Science and Environment (CSE)’s projections based on the median annual rate of change in the past decade 2010-2019, India’s generation in a business-as-usual scenario will be 4.48 Gt in 2030.” - 02-Nov-2021

It is an important fact that the Energy Sector plays a key role in the Net‘0’ efforts, as energies are provided largely utilizing the “Fossils” namely Coal, Oil and Natural Gas. For India too the challenge is how to replace almost 200 Million Tons of Petroleum and about 1000 Million Tons of Coal from the Energy Sector in stages. The important thing to remember is that net zero targets mean little without a concrete plan to cut emissions this decade. The lion’s share of emissions cuts need to occur this decade if we are to avoid catastrophic climate change. A net zero target is also fundamentally incompatible with new coal or oil or gas. All gas, oil and coal expansion must stop.

Before, during and after CoP 26, many countries of the world came forward to commit to take steps to cut emissions to achieve Net 0 by 2050 and India committed to achieve the same by 2070. It is important that each country must plan its Net 0 strategy taking into consideration its own specialties in terms of its resources, costs and priorities etc. and this is particularly important to India with its substantial Bio Energy potentials, apart from its substantial potentials in Solar, Wind and Water.



What is detailed below is extracts from the IEA reports with suggested plans, covering different areas like energy efficiency, renewable energies and so on, for achieving Net 0 by 2050, which can be helpful for formulation of strategies by different countries. India is proceeding ahead with plans to achieve Net 0 by 2070 with combinations of Solar, Wind, Hydro and Bio Energies along with serious commitment to energy efficiency.

The Net Zero Emissions by 2050 Scenario (NZE).

This is a normative IEA scenario that shows a narrow but achievable pathway for the global energy sector to achieve net zero CO₂ emissions by 2050, with advanced economies reaching net zero emissions in advance of others. This scenario also meets key energy-related United Nations Sustainable Development Goals (SDGs), in particular by achieving universal energy access by 2030 and major improvements in air quality. This is consistent with limiting the global temperature rise to 1.5 °C without a temperature overshoot (with a 50% probability), in line with reductions assessed in the IPCC in its Special Report on Global Warming of 1.5 °C.

A Roadmap for the Global Energy Sector

- ✓ As the major source of global emission, the ENERGY SECTOR holds the key to responding to the world's climate change
- ✓ Despite many pledges and efforts by governments to tackle the causes of global warming, CO₂ emissions from energy and industry have increased by 60% since the United Nations Framework Convention on Climate Change was signed in 1992.
- ✓ Global commitments and actions are growing but they still fall well short of what is needed to limit the rise in global temperature to 1.5 Degrees C and avert the worst effects of climate change.
- ✓ Net '0' by 2050 roadmap provides a pathway to reach this formidable and critical goal, setting out more than 400 milestones for what needs to be done, and when, to decarbonize the global economy in just three decades.
- ✓ Net '0' by 2050 or 2070, if the implementation is commenced by all countries, starting from the immediate decade, the emissions will start coming down.

The path to net zero emissions is narrow

Staying on it requires the massive deployment of all available clean energy technologies – such as renewables, EVs and energy efficient building retrofits – between now and 2030. For solar power, it is equivalent to installing the world's current largest solar park roughly every day.

By 2030

A surge in clean energy investment can bring jobs and growth

To reach net zero emissions by 2050, annual clean energy investment worldwide will need to more than triple by 2030 to around \$4 trillion. This will create millions of new jobs, significantly lift global economic growth, and achieve universal access to electricity and clean cooking worldwide by the end of the decade.

We need to drive huge leaps in clean energy innovation

Most of the reductions in CO₂ emissions through 2030 come from technologies already on the market today. But in 2050, almost half the reductions come from technologies that are currently at the demonstration or prototype phase. Major innovation efforts must take place this decade in order to bring these new technologies to market in time.

By 2035

A rapid shift away from fossil fuels

Net zero means huge declines in the use of coal, oil and gas. This requires steps such as halting sales of new internal combustion engine passenger cars by 2035, and phasing out all unabated coal and oil power plants by 2040.

By 2040

Electricity becomes the core of the energy system

It will play a key role across all sectors, from transport and buildings to industry. Electricity generation will need to reach net zero emissions globally in 2040 and be well on its way to supplying almost half of total energy consumption. This will require huge increases in electricity system flexibility – such as batteries, demand response, hydrogen-based fuels, hydropower and more – to ensure reliable supplies.

By 2045

New low-emissions industries flourish

By 2045, new energy technologies will be widespread. The vast majority of cars on the roads will be running on electricity or fuel cells, planes will be relying largely on advanced biofuels and synthetic fuels, and hundreds of industrial plants will be using carbon capture or hydrogen around the world.

2050

A clean energy world – with Net “0” in time

The global energy sector in 2050 is based largely on renewables, with solar the single largest source of supply. Achieving this cleaner, healthier future will rely on a singular, unwavering focus from all governments, working closely with businesses, investors and citizens. It will also require greater international cooperation among countries, notably to ensure that developing economies have the financing and technologies they need to reach net zero in time.

Key solutions

Energy efficiency

Many energy efficient solutions for buildings, vehicles, home appliances and industry are available today and can be scaled up quickly, creating lots of jobs in the process. Our pathway rapidly puts all of them to use on a massive scale in order to push the average rate of energy efficiency improvements in the 2020s to about three times the average of the last two decades.

Electrification

As electricity generation becomes progressively cleaner, electrification of areas previously dominated by fossil fuels emerges as a crucial economy-wide tool for reducing emissions. This takes place through technologies like electric cars, buses and trucks on the roads, heat pumps in buildings, and electric furnaces for steel production.

Renewables

Renewable energy technologies like solar and wind are the key to reducing emissions in the electricity sector, which is today the single largest source of CO₂ emissions. In our pathway to net zero, almost 90% of global electricity generation in 2050 comes from renewable sources, with solar PV and wind together accounting for nearly 70%.

Bioenergy

Sustainable bioenergy delivers emissions reductions across a wide range of areas, including low-emissions fuels for planes, ships and other forms of transport, and the replacement of natural gas with bio methane to provide heating and electricity. Sustainable bioenergy is also essential for bringing clean cooking solutions to the 2.6 billion people who currently lack them.



CCUS

Carbon capture, utilization and storage (CCUS) contributes to the transition to net zero in multiple ways. These include tackling emissions from existing energy assets, providing solutions in some of the sectors where emissions are hardest to reduce like cement, supporting the rapid scaling up of low emissions hydrogen production, and enabling some CO₂ to be removed from the atmosphere.

Hydrogen and hydrogen based fuels

Hydrogen and hydrogen-based fuels will need to fill the gaps where electricity cannot easily or economically replace fossil fuels and where limited sustainable bioenergy supplies cannot cope with demand. This includes using hydrogen-based fuels for ships and planes, as well as hydrogen in heavy industries like steel and chemicals.

Behavioral changes

Achieving net zero by 2050 cannot be achieved without the sustained support and participation from citizens. Behavioral changes, particularly in advanced economies – such as replacing car trips with walking, cycling or public transport, or foregoing a long-haul flight – provide around 4% of the cumulative emissions reductions in our pathway.



(To be continued)

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MORE ENERGY FROM DEEP INSIDE THE EARTH TO BE USED ON ITS SURFACE

Global Geothermal Power Market is expected to witness growth at a CAGR of 5.0% by 2032...

Recently, Visiongain, one of the fastest growing and most innovative, independent, market intelligence company, has published its report – titled ‘Geothermal Power Market Report 2022-2032’. As per the report, COVID-19 pandemic has wreaked havoc on people all across the world. Meanwhile, electrical grids with substantial renewable energy content continue to function well. The energy transition, when incorporated into stimulus and recovery measures, can be a long-term investment. The crisis has exposed more flaws in the current system, such as its dependency on fossil fuels and significant energy access gaps, which have an impact on healthcare, water supply, information and communication technologies, and other critical services. An investment package centred on the energy transition can assist to lift the economy out of its funk and create much-needed jobs in the near and long term.



Due to disruptions in the worldwide supply chain and a reduction in investment for prospective projects, the breakout of COVID-19 is projected to have a substantial impact on the global geothermal energy sector. Although annual additions are in line with the driven market, COVID-19-related lockdown measures are projected to cause certain projects to be postponed. The growth of the geothermal energy market is being driven by rising electrical security concerns as a result of clean and environmentally beneficial supplies. Furthermore, rising demand for heating and cooling systems, such as ground source heat pumps and district heating, is expected to propel the geothermal energy industry forward. However, during the projected period, the lucrative market for alternative clean energy sources such as solar and wind is likely to stifle market expansion. Production and supply chains have been disrupted, demand for goods and services has diminished, commodity prices have fallen, and there has been a significant economic recession around the world as a result of the

response measures, which include widespread lockdowns. Hundreds of millions of people have lost their employment or had their livelihoods jeopardised as a result of the health crisis. Renewable energy has proven to be more resilient than other sections of the sector, despite suffering along with the rest of the world's economy. Fossil fuels have taken a beating as energy demand for transportation and industry falls. Even as fossil fuels continue to show signs of revival, at least in the short term, oil prices have plummeted, increasing concerns about volatility and long-term viability.

The Binary Cycle Power Plants Segment

The water or steam beneath the soil never comes into direct contact with the turbines in binary cycle power plants. Instead, geothermal water is pushed via a heat exchanger, where it warms a second liquid-like isobutene (which boils at a lower temperature than water). This second liquid is converted into steam, which drives the generator's turbines. The first liquid is recycled through the turbine and back into the heat exchanger, where it can be utilised again, while the second liquid is recycled into the soil through the injection well.

Investing in the Energy Transition

Investment in the energy transition can help the economy recover in the years 2021-2023 and create a variety of jobs. Stimulus measures can hasten the progression of beneficial trends. Renewables and other transition-related technologies generated USD 824 billion in investments in 2019. During the recovery phase, such investments should roughly treble to about USD 2 trillion, and then expand at a rate of USD 4.5 trillion per year over the next decade. Government funds can multiply private investments by a factor of three to four, and they should be widely deployed to drive investment and finance decisions in the right direction.

To properly comprehend the implications of the transition and guarantee that it is timely and just, the energy sector must be understood as an important element of the broader economy.

Increasing Technological Advancements

The benefits of geothermal energy are driving the market. Furthermore, the expanding technical advancements in the geothermal energy industry are expected to drive the geothermal power market's growth. Geothermal energy is quickly becoming one of the most dependable renewable energy sources. Because of its eco-friendly nature and consistent availability, it is gaining traction over traditional and non-renewable energy sources. Geothermal reservoirs are refilled naturally and have enormous power generation potential, with the ability to supply world baseload demand by generating up to 2 terawatts of power. Because of their high efficiency and low maintenance requirements, geothermal resources will continue to be used in the generation of power. As a result, geothermal energy's benefits are likely to drive market expansion over the projection period.

The Expansion of the Geothermal Power Market

Increasing investments in geothermal energy in various nations would further boost the geothermal power market forward throughout the forecast period. Breakthrough Energy Ventures announced in March 2019 that it would invest \$12.5 million in Baseload Capital, a geothermal project development company. It is a project investment firm that provides funding for the development of geothermal power facilities using technology developed by Climeon, the company's Swedish parent. EnergiMiinas, a Philippine-based geothermal firm, aims to put two geothermal power plants in Peru into operation by 2026 or 2027, with each project costing \$1 billion. Thrive Renewables has also announced intentions to invest roughly 6.5 million in the UK's first geothermal power plant, with the goal of supplying approximately 3 MW of electricity to the National Grid and up to 12 MW for local consumption.

Competitive Landscape

The major players operating in the geothermal power market are Atlas Copco, Ansaldo Energia S.P.A, BHE, Calpine Corporation, Chevron Corporation, ElectraTherm Inc., ENEL SPA, Fuji Electric Co. Ltd., General Electric, Halliburton, Innergex Renewable Energy Inc., KenGen, Mitsubishi Corporation, Ormat Technologies Inc, Pertamina, Terra-Gen, and Toshiba Corporation. These major players operating in this market have adopted various strategies comprising M&A, investment in R&D, collaborations, partnerships, regional business expansion, and new product launch.

TIRUKKURAL ON CITIZENS



The words Citizen and Citizenship are being used world over in the right and wrong contexts with good and bad intentions. While the human race belonging to various countries and territories of the world are trying to divide the people and tighten the boundaries, the nature and the technologies are doing everything to remind that the world is one. The recent pandemic and the threats of 'Global Warming' are demonstrations by the nature and the Internet and communication revolution are examples of technologies, both trying to show that the world is one. It is relevant at this point to think of Tirukkural

which is clearly defining how a citizen should be, irrespective of which part of the world he lives and contributes.

The following Kurals proceed to list out the attributes and characteristics which can only define a 'Good Citizen' worthy of emulation by all, to create a 'Good World' around.

*Ozhukkamum Vaaymeyum Naanum
Immoondrum*

Izhukkar Kudipirandar *Kural 952*

ஒழுக்கமும் வாய்மையும் நாணும்இம் மூன்றும்
இழுக்கார் குடிப்பிறந் தார். குறள் 952

“Citizens of gentle birth fall not from three things, namely, correct conduct, truth and delicacy.”

*Nagai Eegai Insol Igazhamai Naangum
Vagai Enba Vaaymaikkudikku* *Kural 953*

நகைசகை இன்சொல் இகழாமை நான்கும்
வகையென்ப வாய்மைக் குடிக்கு குறள் 953

“Four are the attributes of the true citizen; a smiling face, a liberal hand, sweetness of speech and condescension.”

HUMOUR ON ENERGY

What do wind turbines think of renewable energy?

They're big fans.

What's a solar panel's favourite type of exercise?

Circuits.

How does the kitchen say hello?

It microwaves.

What bank account does an LED lightbulb have?

An energy saver.

What do you call it when an electron cheats?

A Current Affair.

Why didn't the LED lightbulb get top student?

The halogen was brighter.

Why do fridges make good illusionists?

They don't move, but they're always running.

How is the fish and chip shop owner good at saving energy?

She makes things battery.

Why are wireless appliances bad at music?

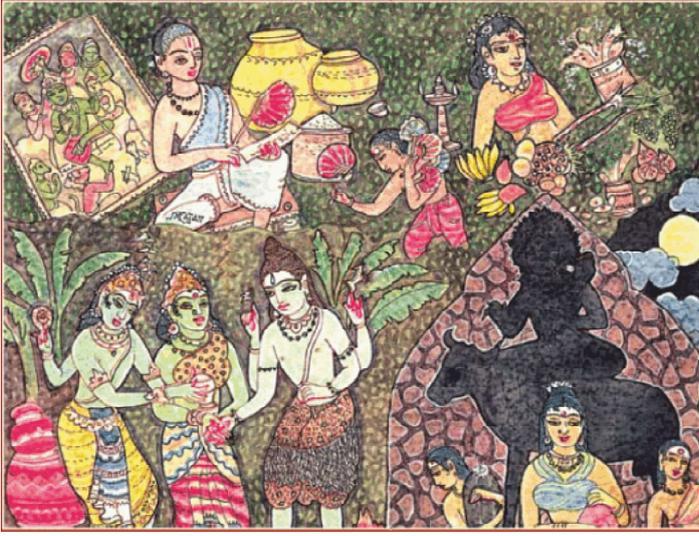
They don't know any cords.

There is no justifiable reason why our electricity, heating and cooling and transportation needs aren't powered by 100 percent renewable energy.

– DEB HAALAND

HOME FESTIVALS - 4

சித்திரை - Chitrai (April/May)

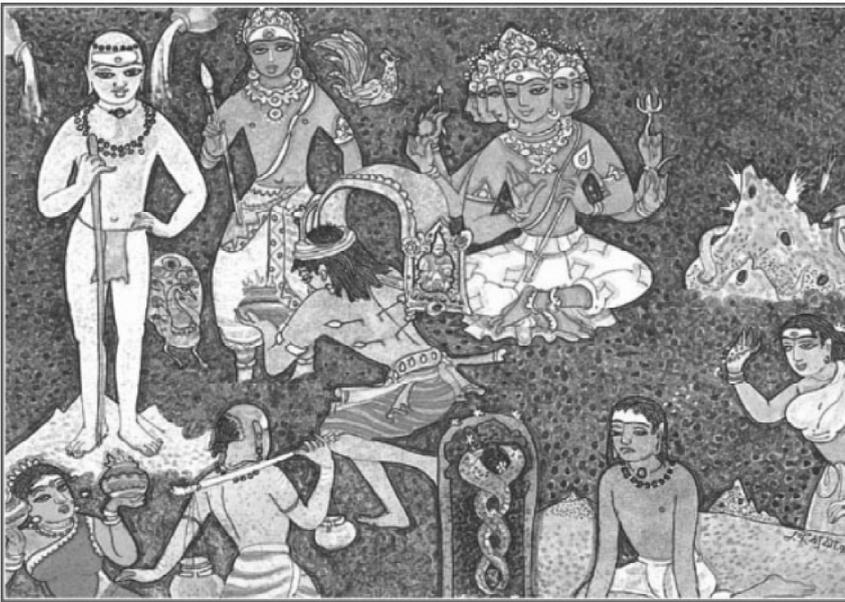


This month begins with the completion of Ram Navami, the nine days of celebration of Lord Rama's birth ages ago, which started in the previous month. At the upper left we see a decorated picture of Lord Rama's coronation. Next (Proceeding clock wise) comes a Vaisnava priest telling the stories of Lord Rama's birth and life; behind him are great parts of *paanagan*, a delicious drink of sugar and ginger, and a basket of *sundal*, spiced chickpeas, served

to the storyteller's guests, who also receive palm fans, as this is the hot season. Tamil New Year often falls on April 14 (as does the New Year of several other communities). The lady at upper right is shown with the new clothes and jewellery which are part of the celebration, as well as bananas, mangoes and the ingredients for *vepon pu pachadi*, a combination of bitter neem blossoms, sugar and mango – a reminder to face the unpleasant in life with a sweet smile. At lower left is the marriage of Siva and Parvati, Meenakshi Kalyanam, with brother Vishnu pouring the sacred ganga water on the earth joined hands. At lower right is the dark form of Yama, Lord of Death, who figures in three stories associated with this month; that of Savitri, who won her husband back from Yama in a battle of wits; Nachiketas, the boy who extracted three boons from Him and Markandeya, who won eternal youth from Lord Yama through the worship of the Sivalinga.

HOME FESTIVALS - 5

வைகாசி - Vaikasi (May/June)



This month is devoted to the worship of Lord Murugan, who is honoured on Vaikasi Vishakham (above). He is shown at far left as Palani, the

renunciate, dressed in loincloth, wearing a necklace of rudraksha beads, sacred ash covering His body and holding the sannyasin's staff. To the right He is shown as a prince, with His peacock, and farther to the right as the six-headed Arumugam. Devotees approach Him doing penance by piercing their bodies with small spears and carrying various offerings, including pots of milk and a *kavadi*, a kind of portable arched shrine. At lower right is depicted Naga Chaturthi, celebrating an ancient story in which a young boy bit by a cobra was saved from death when his sister's prayers caused the sands of the cobra's anthill to counteract the poison.

(To be continued)

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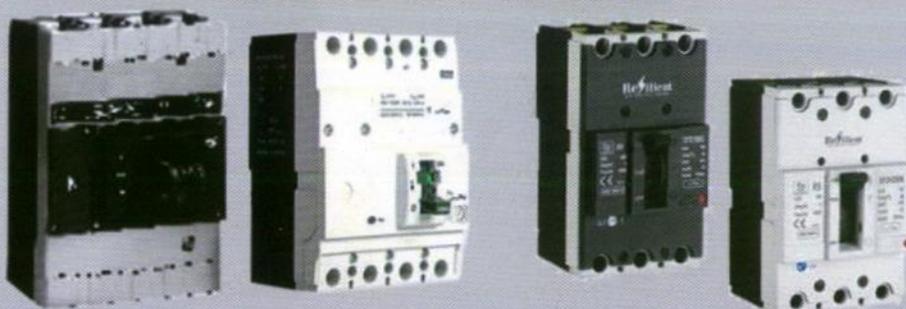
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Printed and Published by 'Tamilnadu Electrical Installation Engineers' Association
"A" Grade, Chennai - 16. Editor : M. Murugan Advisor : S. Mahadevan