TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

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EDITORIAL

Positivity is a state of mind characterized by optimism, cheerfulness, and an overall positive outlook on life. It is a powerful tool that can transform the way we experience the world and how we interact with others.

Being positive means focusing on the good aspects of situations and people, rather than dwelling on the negatives. It is about finding silver linings in difficult circumstances and believing that things will work out for the best. Positivity is not ignoring or denying the challenges we face; it is about facing them head-on with hope and resilience.

A positive mind-set can make us more resilient in the face of adversity. It helps us bounce back from setbacks, turning them into opportunities for growth and learning. By embracing a positive attitude, we become more solution-oriented, finding creative ways to overcome obstacles rather than giving up.

Positivity also radiates to those around us. When we have an optimistic outlook, we inspire and uplift others. Our positive energy can create a ripple effect, spreading happiness, and building stronger connections with people. It can improve our relationships, enhance our communication skills, and foster a supportive environment.

Furthermore, positivity is closely linked to physical and mental well-being. Numerous studies have shown that a positive mind-set can reduce stress, enhance immune function, and improve overall health. It can also elevate mood and increase self-confidence, paving the way for personal growth and success.

To cultivate positivity, it is important to practice gratitude, challenge negative thoughts, and surround ourselves with positive influences. Engaging in activities that bring joy and happiness, such as exercise, spending time in nature, or pursuing hobbies, can also contribute to a more positive mind-set.

In conclusion, embracing positivity is a choice that can significantly impact our lives and the lives of those around us. It can transform challenges into opportunities, strengthen relationships, and improve overall well-being. By adopting a positive outlook, we can navigate life's ups and downs with resilience, hope, and an unwavering belief in the power of optimism.

We thank all those members who have helped us by participating in the advertisement appearing for the issue December 2023 – Sinewaves Solutions India Pvt Ltd., Power Cable Corporation Screened Separable Connection, 3SI Eco Power LLP., Velan Infra Projects Pvt Ltd., Value Engineers, Sastinadha EPC Solutions India Pvt Ltd., VSP Power Solutions, E Power Engineering, Sri Bhoomidurga Marketing (P) Ltd., Gravin Earthing & Lightning Protection System (P) Ltd., Power Cable Corporation (Cable Network Solution), Sakthi Transformers, Global EPC IndiaPvt Ltd., MV Power Consultants & Engineers (P) Ltd., Galaxy Earthing Electrodes (P) Ltd., Supreme Power Equipment Ltd., Pentagon Switchgear (P) Ltd., Kelcon.

EDITOR

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TAMILNADU ELECTRICAL INSTALLATION ENGINEERS' ASSOCIATION 'A' GRADE

NEWSLETTER

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CONTENTS

THE BACK OF THE HAND MATHEMATICS FOR ESTIMATING ELECTRICAL POWER REQUIREMENTS FOR FIRE FIGHTING PUMPSETS IN RESIDENTIAL BUILDINGS – PART – 4

OUR JOURNEY IN THE LAST THREE PARTS COVERED IN EARLIER ISSUES OF OUR JOURNAL:

Whether it is an architect or any other specialist involved in constructing an residential building, we all know that the ultimate responsibility of designing and finalizing the power requirements for the electrical systems rests on the electrical engineer.

As discussed earlier, the power requirement for the fire-fighting pumpset is not only a major connected and demand load of a building, it is also an priority power requirement (power cannot be drawn from downstream feeders), it is an emergency power requirement hence DG Sets need to be sized also to cater to this requirement.

In the acute situation of water flooding faced by residents, some resourceful residents have tapped their dedicated power supply to fire pumps to run drainage pumpsets!

We have covered the following aspects in the earlier issues of the Journal:

Part – 1: We have reviewed the type of water based fire protection requirements as per the National Building Code 2016 Table 7

Part – 2: We have reviewed the pumping capacity and water tank capacity required for fire protection pumpsets as per the National Building Code 2016 Table 7

Part – 3: We have made calculation to make a rule of thumb estimation for a eight storey building as per the National Building Code 2016 Table 7

In this part, we will make a calculation for a Multistage pumpset for a 30 storey building.

Please note that other alternatives like having intermediary stage pumpsets is possible, having the fire pumps in the terrace with water tank also is possible.

Hence the calculation below is a suggestion to take forward.

Hence, we are furnishing the back-of-hand mathematics to this important requirement of estimating roughly the power requirement for fire pumpsets.

BUILDING HEIGHT, M				
APPROXIMATE CALCULATION - 1				
Inputs				
Number of				
Residential Floors	30			
Podium floor	1			
Power estimation for main pump				
Number of		Qty.	App. Height, m	Water head, mwc required
		(1)	(2)	(3)=(1)*(2)
Residential Floors	(a)	30	3.5	105

Podium floor	(b)	1	5	5
Pressure reqd. at hydrant, mwc	(c)			35
App. Pressure drop due to frictional loss, mwc	(d)			20
Total pressure drop, mwc	(e)=(a)+(b)+(c)+(d)			165
Pump head minimum required, mwc (pm), say	=(e)			165
Next higher head selected, mwc	(f)			**170**
Pump capacity required, min. as per NBC, LPM(for building ht. upto 45 m as per NBC, sub. Clause 10) (qm)	(g)			**2280**
Main pump kW reqd	(h) = 16.3766*qm* pm/10000/ħ* 1.15(factor of safety)			**90.67**
Immediate next size of motor available, say	(i)			**110**
Power estimation for jockey pump				
Pump head required, mwc (pm)(calculation done for main pump adopted here)	(j)			170
Pump capacity required, min. as per NBC, LPM(for building ht. upto 45 m as per NBC, sub. Clause 10) (qm)	(k)			180
Jockey pump kW reqd = 16.3766*qm*pm/ 10000/ħ	(l)			**4**
Immediate next size of motor available, say	(n)			**7.15**
Total minimum kW required	(o)=(i)+(n)			**97.83**

Closing Note: From the above calculations, we can understand the approximate kW of power required for the fire pumps.

In addition, for Booster pumps also, additionally about 10 kW can be added.

This will help our knowledgeable fellow electrical engineers to take more informed decision on the power requirements.

Thanks once again for this opportunity to explain the crucial calculation of estimating approximately the power requirement for fire pumpsets in residential buildings. Please feel free to contact me for any further information.

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ACHIEVING 24X7 ELECTRICITY SUPPLY FOR ALL IN 2024: INDIA'S FOCUS ON COAL AND RENEWABLES

Synopsis

India plans to enhance its power infrastructure, aiming for uninterrupted 24x7 electricity by 2024. The Union power ministry proposed a substantial 91 GW addition to coal-based thermal power, investing Rs 7.28 lakh crore. Minister R K Singh emphasised energy security amidst geopolitical uncertainties, citing the impact of the Russia-Ukraine war on Europe.

NEW DELHI: India will focus on setting up more coal-fired power projects as well as keep adding renewable generation capacity to achieve 24x7 electricity supply for all in 2024 amid economic expansion and the need to ensure energy security in these times of rising geopolitical uncertainties. In a reflection of ambitious plans, the Union power ministry has planned a whooping 91 GW of coal-based thermal power generation capacity entailing an investment of Rs 7.28 lakh crore over the next few years.

Talking to PTI, Union Power and New & Renewable Energy Minister R K Singh said, "24X7 supply of power is right of the consumer. Similarly, energy security is of paramount importance for us. You have seen what happened in Europe due to the Russia-Ukraine war."

At present, average power supply across India is 23.50 hours in urban areas and 22 hours in rural areas, he said.

Singh also said that the coal-based thermal power capacity will insulate the country from any geopolitical disruption and ensure energy security for the country at a time when our economy is expanding rapidly.

The coal-based capacity addition is also important in view of rising demand of electricity in the country as peak power demand was at an all-time high of 243.27 GW in September 2023.

India has installed power generation capacity of about 426 GW, including more than 213 GW of coal and lignite-based projects.

Earlier this month, President Droupadi Murmu said the dependence on fossil fuels is definitely decreasing but fossil fuel-based energy is also essential for the country.

India has always worked as a responsible country in the field of clean energy. India is promoting clean coal technologies so that the processes of coal extraction and use become more efficient and environment friendly, she had said at an event.

According to the 20th Electric Power Survey (EPS) report published in November 2022, peak power demand in the country will touch 366.39 GW in 2031-32, 465.53 GW in 2036-37 and 574.68 GW in 2041-42.

Explaining why renewable energy alone cannot be sufficient for round the clock power supply, Singh said that solar is available in the day and wind blows at different times.

Thus, renewables can provide round-the-clock power with energy storage only, which is expensive presently, he said.

Singh said the ministry has planned 91 GW of new coal-based thermal power generation capacity, which includes 27 GW under construction.

Around 31 GW of coal-based thermal capacity which is at an advanced stage of implementation.

Out of the total, construction would begin on 17 GW in 2024, the minister said, adding that another 33 GW thermal power capacity has also been planned.

The 17 GW thermal capacity addition entails an investment of about Rs 1.36 lakh crore at an average cost of implementation of Rs 8 crore per MW at the current prices. It works out to be USD 16.4 billion dollar at the foreign exchange rate of 83 against the dollar, as per back of the envelope calculations.

Anil Sardana, Adani Power Managing Director and Chairman of industry body CII's National Committee on Power, said that while renewable sources will continue to play a central role in the energy mix, meeting high base load demand growth will require additional thermal power capacity.

He noted that as per the Central Electricity Authority, the peak power demand is expected to soar above 256 GW in 2024.

Further, he said that the power sector, particularly in India, faces a complex set of challenges as it stands at the intersection of multi-decadal growth and transition towards becoming a developed nation.

India's ambitious growth trajectory implies a substantial increase in power demand in the coming years. Meeting the soaring demand and providing reliable electricity while adhering to renewable energy targets and a stable grid is a significant challenge, he pointed out.

Apart from round-the-clock power supply, consumers can also look forward to a new policy regime which will end monopoly in electricity distribution.

A Tata Power Delhi Distribution spokesperson said it is possible that customers may have the option to choose their electricity provider in the future, but it is uncertain whether this will happen in the near future.

"Giving a choice to select a service provider was introduced in the Electricity Amendment Bill and has been awaiting consensus since. If it does happen, it will undoubtedly be advantageous for customers," the spokesperson said.

About integrating electricity markets across states, PTC India Chairman and Managing Director Rajib K Mishra said 2024 could see significant progress in this direction, with the implementation of the proposed 'Market Coupling Mechanism'.

It will allow for real-time power trading across regional grids, optimising resource allocation and potentially bringing down costs for consumers, he added.

Further, he said introduction of electricity derivatives such as futures and options could provide much-needed risk management tools.

According to him, 2024 could see the development of a regulatory framework and pilot programs for these instruments, paving the way for a more mature and resilient electricity market, he added.

Courtesy: The Economic Times

Electricity can transform people's lives, not just economically but also socially. – PIYUSH GOYAL

ELECTRICAL MAINTENANCE UNIT (QUESTION & ANSWERS) - 21

Nuclear reactor theory

1. State the law of conservation of mass and energy.

   Mass and energy are interchangeable. When mass is lost there is a substantial gain in energy and when energy is lost there is an increase in mass.

   Energy = mass*C^2

   $E = MC^2$

   Where C is the conversion factor = $3*10^{10}$ (velocity of light)

   $C^2 = 9*10^{20}$

2. Which of the following material is good moderator? Why?

   a. H_2 b. D_2 c. H_2O d. D_2O e. Beryllium f. Graphite.

   The functions of a good moderator are

   a. It has to thermalise neutrons effectively.

   b. There should be only a minimum absorption of neutrons.

   c. It should not be toxic.

   d. It should not be inflammable.

   In case of Hydrogen (H_2) though it is an effective sheatherer it cannot be used as a moderator because it is a gas and there is a lot of distance between atoms. A neutron cannot meet the nucleus in a definite manner.

   For D_2 also the same problem as this is also gas and it cannot be used as a moderator. In case of H_2O it is a good scatterer but is absorbs neutrons. Its moderation ratio is 72. So it cannot be used as a moderator.

   In case of D_2O though it is not as effective scatterer as that of H_2O it has minimum absorption of neutrons. It has a moderating ratio of 21000. This is an ideal moderator.

   In case of Beryllium it is a toxic material. Therefore, cannot be used. Graphite absorbs neutrons and is inflammable and therefore cannot be used. So from the above statements the D_2O is the good moderator material.

3. The activity of an Iodine – 131 is 10 curies. After how many half-lives will it come down to 625 millicuries?

   Activity of an Iodine – 131 = 10 curies

   To find number of half-lives for coming it to 625 millicuries,

   10 * 1st | = 5 (1^{st} half-life)

   5* | = 2.5 (2^{nd} half-life)

   2.5 * | = 1.25 (3^{rd} half-life)

   1.25 * | = 0.625 (4^{th} half-life)

   So during 4th half-life the Iodine – 131 reduces to 625 millicuries.

4. What do Atomic number and mixture mean?

   Atomic number: The atomic number of an atom is the number of protons in that atom.

Example – Hydrogen has one proton and its atomic number is one (1).

– Uranium has 92 protons and its atomic number is 92.

Mixture: It is a substance formed by different elements and these elements can be separated by physical methods.

Example – Air is a mixture of oxygen and nitrogen and these can be separated by physical methods.

5. What is the weight of a proton?

   1.00759 amu (atomic mass unit)

6. What is the energy of a thermal neutron?

   0.025 eV (energy volt)

7. What is the charge of an alpha particle?

   2+.

Nuclear system

1. What is the purpose of moderator D_2O?

The purposes of moderator D_2O are,

a. To thermalise neutrons to maintain criticality.

b. Emergency core cooling when PHT fails.

c. Structural cooling.

2. What is the cooling water used in moderator heat exchanger during normal operation? And during class IV failure?

   During normal operation process LP water is used in moderator heat exchangers, which transfers heat to seawater. During class IV failure firewater is used for the moderator heat exchanger.

3. During loca how the cooling of fuel bundle is achieved?

   During loca there is provision for taking D_2O from the moderator system, which is connected to PHT system for fuel cooling and there is one more option for the cooling of the fuel from the fire water system.

4. How coolant flow is maintained in the event of loss of power to the PHT system?

   When the PHT power fails, it takes two minutes for DG to come to full power. The circulation is maintained by flywheel, which increases the de-acceleration and maintains the flow for two minutes.

   If there is a station blackout the flow is maintained by thermo-symphoning by which more denser cold water comes down and less denser hot water goes up by convection method.

5. What are the materials in contact with PHT system?

   Piping – carbon steel.

   Pressure tubes – zircalloy-2

   Fuel cladding – zircalloy-2

   End shield – stainless steel. Etc.

6. What are the main futures of PHT system?

a. Impeller – To reduce the water flow.

b. Self-injection Hx – Cools the water in case of leakage.

c. Gland supply – Cools the seals.

d. Primary and secondary seals – sealing the pump.

e. Thrust bearing – To take the axial thrust.

7. What are the purposes of bleed condenser?

The purposes of bleed condenser are,

a. To cool the bleed water, which goes to bleed cooler.

b. To provide cool hot water to the PHT purification system.

8. What is header level control?

For the purpose of maintenance of PHT pipe valves, boiler inlet valve the level of the coolant should be below the valve to prevent the coolant coming out of the system. This is called the header level control and achieved by means of manual operation of valves and shutdown cooling pump.

9. In MAPS Unit # 1 end-shield cooling system has got heaters. Why?

Unit # 1 end-shield is made of nickel steel, which had a nil ductility temperature of –100°C while commissioning. After 30 years of operation this will rise to +32°C, because of radiation exposure. To avoid the failure of end shield of MAPS Unit # 1 the temperature of the end-shield should be maintained at 68°C always. MAPS 1 end-shield cooling system is operating at elevated temperature. But in MAPS Unit #2 this problem is not existed because in this unit end-shields are made up of stainless steel.

Reactor general

1. What are V1 and V2? How they are connected? What is the harm in opening F/M vault door during reactor operation?

The reactor building is divided into two areas. They are V1 and V2.

V1 – Dry volume area.

V2 – Wet volume area.

V1 area includes F/M vault, boiler room, and entire dome area. Rest of the areas in the reactor building is V2 area. V1 and V2 are connected by vent shaft through suppression pool.

F/M vault is a V1 area and F/M maintenance bay is a V2 area. Usually when there is an accident in F/M vault the pressure is relieved through boiler room through suppression pool and the uncondensed gases to V2 area. When the reactor is in operation and if we open the F/M vault door, suppose of there is an accident in F/M vault the pressure released directly goes to F/M maintenance area, which is a V2 area. Thus pressurizing the entire building.

2. What is the purpose of inlet manifold inside calandria? What is the material used for that?

The purpose of inlet manifold is to introduce heavy water to the calandria with low velocity to avoid mixing. That is stratified flow of D2O is obtained b inlet manifold. Thus the temperature is kept minimum. It is made of zircalloy.

3. Why bi-directional flow is chosen for PHT system?

Bi-directional flow is chosen for PHT system because,

a. Uniform temperature gradient is facilitated so there will be no differential thermal expansion.

b. It facilitates fueling even when the reactor is working, which facilitates uniform neutron flux and this intern gives rise to maximum fuel burns up.

4. What is the purpose of end-shield?

The purposes of end-shield are,

a. To permit access to F/M vault during shut down.

b. To provide tight clamping for fueling machines.

c. To support the calandria tubes and also system.

Station grounding

1. What is grounding?

   It is an electrical connection with the general mass of earth through an earth electrode.

2. What is difference between earthing and grounding?

   Both have same meaning. The term earthing is used in U.K. and grounding in U.S.A. ground means earth.

3. What are types of grounding?

   There are two types

   a. System grounding.

   b. Equipment grounding.

4. What does mean by system?

   Grounding of neutral point of equipment is called system grounding. For instance grounding of generator neutral, transformer neutral etc.

5. What does mean by equipment grounding?

   Grounding of non-current carrying metallic parts is called equipment grounding. For instance, no-current carrying parts include the following:

   a. Motor body, switchgear metal enclosure, transformer tank, conduits of wiring etc.

   b. Support structures, tower, poles etc. in the neighborhood of electrical circuits.

   c. Sheath of cables.

   d. Body of portable equipment such as iron, oven, etc.

6. What is the important of system grounding?

   It is important because:

   a. Earth fault protection is based on the method of neutral earthing.

   b. System voltage during earth fault depends on neutral earthing.

   c. It is a protection against arcing grounds, unbalanced voltages with respect to earth and lighting.

7. What is the important of equipment grounding?

   Equipment earthing ensures safety.

8. How safety could be ensured by equipment grounding?

   In order to enumerate this, let us first find out the effects of current and voltage developed during fault condition.

9. What is the permissible body current limit?

   The magnitude and duration of current conducted through a human body at 50 Hz should be less than those did that cause ventricular fibrillation.

   (Ventricular fibrillation is considered to be the main cause of death due to electrical shock).

These below given data are also applicable for current limits to human body.

Current magnitude	Physiological effect	Description
1 mA	Threshold of perception	A current at which a person is just able to detect a slight tingling in his hand or finger
1 – 6 mA	Unpleasant to sustain	This is often termed as let go currents. Do not impair the ability of a person holding an energised object to control his muscles and release it.
6 – 9 mA	Threshold of muscular contraction.	These are threshold values, since 10.5 mA current and 16 mA current are the let go values for women and man respectively.
9 – 25 mA	Muscular contraction	May be painful and can make it hard or impossible to release energised objects grasped by the hand.
25 – 60 mA	Muscular contraction	Make breathing difficult.
60 – 100 mA	Ventricular fibrillation	Ventricular fibrillation, stoppage of heart or inhibition of respiration might occur and cause injury or death if time is more than 1 sec.

Hence the grounding equipment shock current can be kept below the value sufficient to cause injury or death by lowering the step and touch potential.

10. How fibrillation current functions?

Fibrillation current is actually function of individual body weight.

For 50 kgs body weight: fibrillation current (IB) = $0.116/\sqrt{}$ ts (Limited to 0.03 – 3 sec. Range)

Where ts = duration of current exposure in sec.

Note = Above equation results = 116 mA for 1 sec. and 367 mA for 100 sec.

For 70 kgs body weight: fibrillation current (IB) = $0.157/\sqrt{}$ ts

Note = Above equation results = 157 mA for 1 sec. and 496 mA for 100 sec.

Above times are very - very important from the point view of clearing the fault. Above limit dictates that grounding should be such that current magnitude through human body should not increase the specified values.

In order to ensure above following have been done.

1. Current conductor has been buried in ground
   a. At the depth of 600 mm in switchyard. Depth 600 mm is normally selected because of freezing or drying out, the Resistivity of upper layers could vary with seasons, while the Resistivity of lower soil layers remains nearly constant.
   b. Horizontal grid conductors are more effective in reducing the danger of high step and touch voltages on the earth surface by creating equipotential surface during fault conditions.
   c. At the depth of 800 mm elsewhere. Here depth is kept more because to care for under grounding services. Example laying of power cables, drainage etc.
2. 25-mm dia copper rod electrodes have been driven in soil.
   a. Upto 5 meters depth in 220 kV switchyard.
   b. Upto 3 meters elsewhere.

Why only 5 meters and 3 meters depths have been selected is that the resistance is diminishes rapidly with the first few feet of driving, but less so at depths greater than 2 to 3 meters in soil of uniform resistivity.

These lengths are adopted in selecting the ground electrodes.

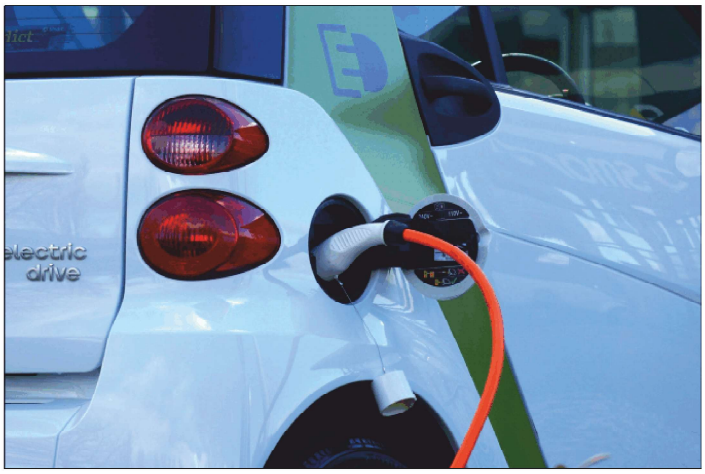
3. 4-inch layer of gravel in 220 kV switchyard has been used. Purpose of using gravel is by doing steps 1, 2 above tough and step potential are computed and compared with tolerable potential and found as given below.

Potential	Computed value	Tolerable value
Tough	550 V	665 V
Step 2.a switchyard with crushed rock surface	230 V	2165 V
Step 2.b elsewhere with natural soil	166 V	168.5 V

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

GOVT MULLS EASING POLICY REGULATIONS FOR EV MAKERS IN INDIA, SAY SOURCES

Officials will also consider tweaks to various incentive schemes like production linked incentive, advanced cell chemistry to make them wider in their scope of support for the EV sector



The central government is working on easing policy regulations for electric vehicle manufacturing in India, government sources have told Business Today TV.

"Various ministries like Finance, Heavy Industries, Road Transport Ministry and commerce ministry are discussing possible sops for foreign car manufacturers wanting to make in India for the world," the sources said.

It is also learnt that the Prime Minister's Office held a meeting for expediting policy decisions on the matter.

A reduction in the import duty and faster approvals are among the proposals that will be discussed by the officials. At present, all car imports attract 70 per cent import duty for vehicles upto $40,000, while cars above $40,000 attract a 100 per cent import duty.

Officials will also consider tweaks to various incentive schemes like production linked incentive, advanced cell chemistry to make them wider in their scope of support for the EV sector.

"We are in touch with executives of Tesla on its make in India plans", the sources said. Business Today TV was the first to report this July on Tesla's localisation plans including the construction of a gigafactory with a capacity to produce 500,000 cars initially.

Tesla CEO Elon Musk and Prime Minister Narendra Modi met during the latter's state visit to the US in June. India has also invited US President Joe Biden to be the chief guest for the Republic Day celebrations on January 26, 2024.

Courtesy: Chetan Bhutani

HARMONICS IN POWER SYSTEM & MITIGATION - 4

How Capacitors Effect Harmonics

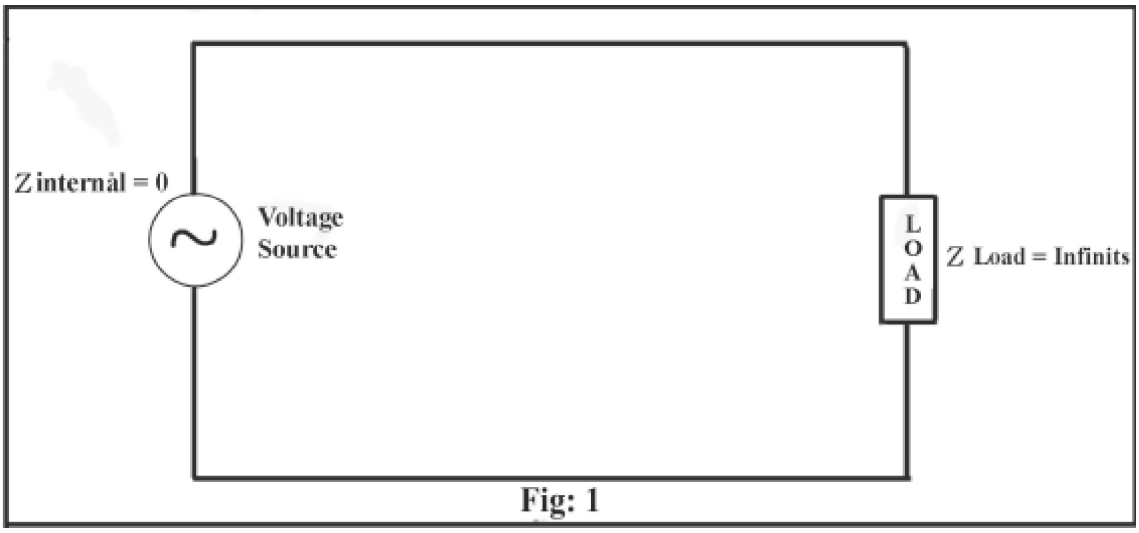


Fig: 1

The load impedance for the voltage source should be much higher than the individual winding impedance. Ideally internal winding impedance should be zero. But practically it is as much as 5 to 7% of the full load impedance because of inductance and parasitic resistance.

When the load impedance is linear the current waveform will follow the voltage waveform. If the load impedance is changing periodically the current waveform may be different from voltage sine wave which is HARMONICS

Harmonics are created by non-linear loads and initially are current waves. The magnitude of current wave depends exclusively on the nature of the load. Since the harmonics exist in the current drawn, the source is treated as a CURRENT SOURCE

Unlike the voltage source the ideal current source has infinity internal impedance and prefers zero load impedance to maintain the current

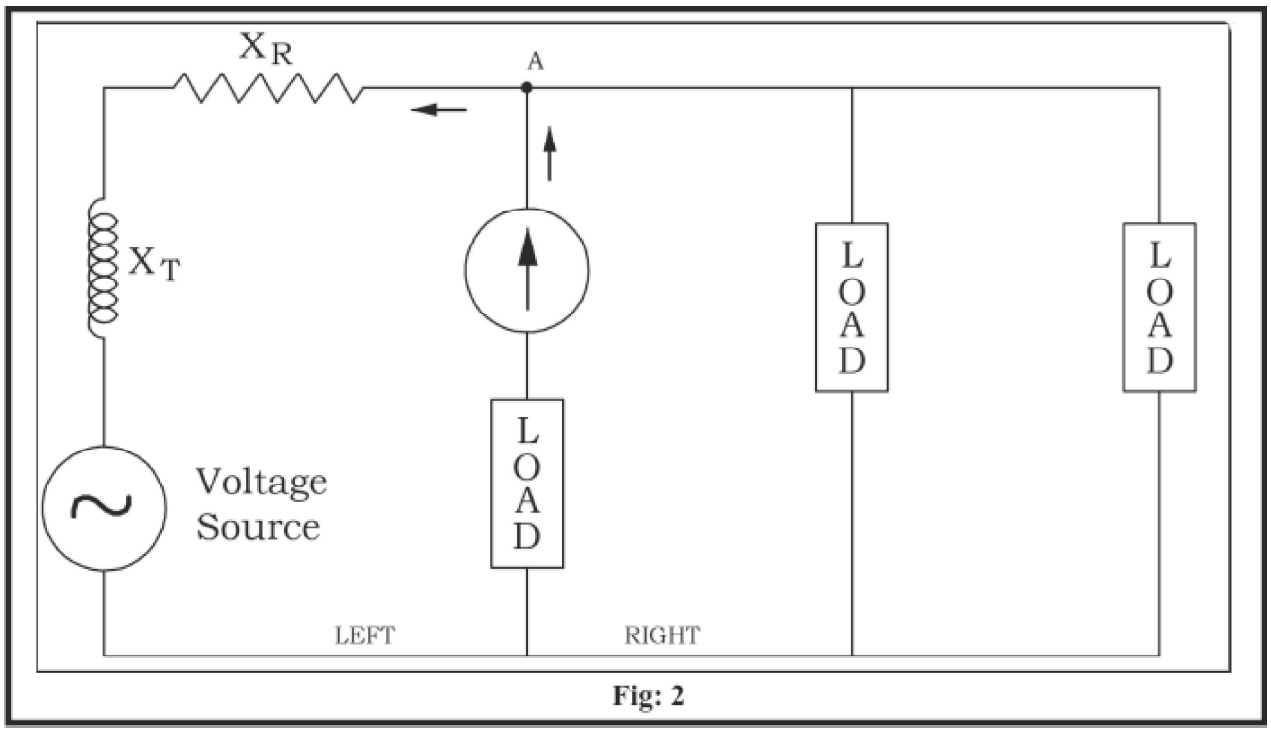


Fig: 2

The LEFT SIDE impedance is the internal impedance of Transformer in addition to source impedance. As such the total impedance of LEFT SIDE is very much lower than the fully loaded RIGHT SIDE. Most of the harmonic current will flow towards the POWER TRANSFORMER.

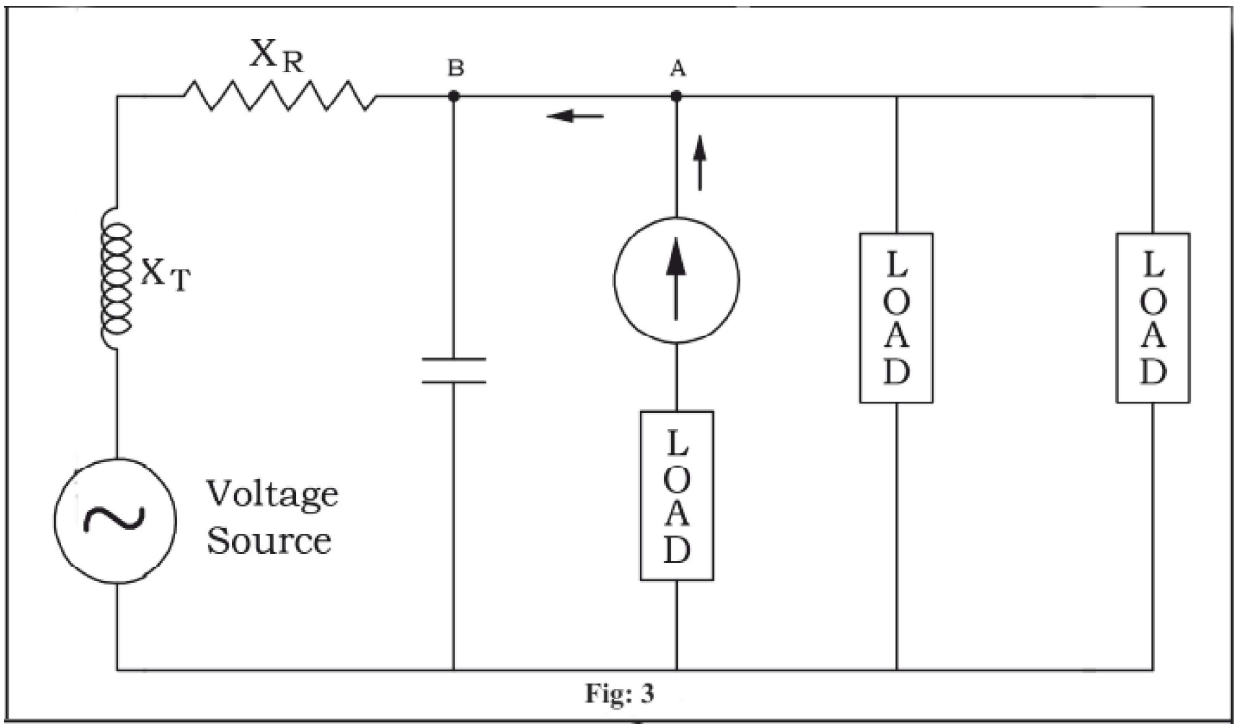


Fig: 3

Now the power factor correction capacitor is added as shown in the above figure to improve the Power Factor. The harmonic current coming to the junction B will encounter the capacitor and connected in parallel to resistance & reactance,

At some particular harmonic frequency XL and XC will be equal and parallel resonance takes place. Parallel resonance raises the circuit impedance and the current circulates between the capacitor & inductance without being passed to the ground

Due to interaction of the Capacitance with Inductive reactance there is always the risk of resonance with capacitor bank application. Harmonic currents at or near resonant frequency can create high harmonic voltage across the high parallel impedance and capacitor may not be able to withstand resonance voltage

Resonant Frequency Fr = root of (system fault level in MVA/Cap bank MVA)

Thump Rule to avoid resonant frequency

Fr – Fc > 0.2 wherein Fr is resonant frequency & Fc is dominant harmonic frequency

(To be continued)

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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

AIR CIRCUIT BREAKERS MARKET IS ON GROWTH WHEEL

A recent research report by Markets and Markets predicts that the air circuit breaker market is poised for substantial expansion, with the global market size projected to grow from an estimated USD 3.2 billion in 2023 to USD 4.1 billion by 2028. This anticipated growth is expected to occur at a steady Compound Annual Growth Rate (CAGR) of 5.0% throughout the forecast period…

As per the report; titled "Air Circuit Breaker Market by Voltage (Low-Voltage and Medium-Voltage), Type (Air Blast Circuit Breaker and Plain Air Circuit Breaker), Application (Industrial, Commercial, and Residential) and Region – Global forecast to 2028;" the key growth catalysts for the air circuit breaker market include rising investments in smart grid technologies aimed at safeguarding and managing power equipment, along with the replacement of aging infrastructure.

Furthermore, the increasing demand for dependable Transmission and Distribution (T&D) networks offers lucrative growth prospects for the air circuit breaker market.

The largest contributor by application

The industrial segment often leads the air circuit breaker market because industrial facilities have notably higher energy demands compared to residential or commercial sectors.

This necessitates more robust electrical infrastructure capable of handling power distribution, making air circuit breakers the preferred choice due to their capacity to manage higher currents and provide essential short-circuit protection.

Furthermore, air circuit breakers are versatile, effectively safeguarding critical assets from electrical faults and overloads, ensuring uninterrupted industrial operations. Moreover, stringent safety regulations in industrial settings mandate high breaking capacity and reliability in interrupting fault currents, qualities for which air circuit breakers are well-known, enabling industries to comply with safety standards effectively.

The air blast circuit breaker segment is expected to grow at the fastest rate

The air blast circuit breaker segment is witnessing robust growth within the air circuit breaker market due to its advanced technology, which efficiently handles high fault currents by employing compressed air to extinguish electrical arcs during faults, ensuring rapid and reliable interruption of high-power circuits.

Particularly well-suited for high voltage applications like substations and transmission networks, air blast circuit breakers are in high demand as electricity needs continue to surge, especially in urban and industrial areas. Their integration into smart grid systems is increasingly crucial, as these circuit breakers can be enhanced with sensors and monitoring devices, enabling real-time data collection and remote control. This integration is pivotal for optimizing grid performance, enhancing reliability, and minimizing downtime.

By voltage, the low voltage segment is expected to be the largest contributor

The dominance of the low-voltage segment in the air circuit breaker market can be attributed to its extensive applicability across residential, commercial, and industrial sectors. Low-voltage air circuit breakers play a crucial role in safeguarding electrical systems from overloads and short circuits in buildings, especially as the construction industry experiences growth.

Moreover, their usage in industrial machinery ensures the protection of vital equipment and aligns with the expanding industrial sector's automation needs.

Additionally, these circuit breakers are integral to maintaining electrical safety and reliability in growing infrastructure development projects, including transportation systems, commercial complexes, and data centers, solidifying their position as a cornerstone of electrical protection across diverse settings.

Asia Pacific is expected to be the largest and fastest-growing market

Asia Pacific's status as the largest market for air circuit breakers is driven by a confluence of factors. The region is witnessing significant urbanization and industrialization, spurring a heightened demand for electricity.

To meet this demand, robust electrical infrastructure is essential, and air circuit breakers are pivotal in ensuring reliable power distribution and protection.

Additionally, the diverse industrial landscape in Asia Pacific relies heavily on electricity, particularly in sectors like manufacturing and heavy machinery, making air circuit breakers a preferred choice due to their capacity to handle high currents.

Governments across the region are investing substantially in infrastructure development, including modernizing electrical grids with advanced circuit protection devices like air circuit breakers.

Energy efficiency is also a focal point, with air circuit breakers offering high breaking capacity to reduce energy losses during faults.

Furthermore, the rising adoption of smart grids in Asia Pacific underscores the importance of air circuit breakers, which can be equipped with sensors and remote monitoring capabilities to enhance grid reliability and efficiency, aligning with the region's progressive initiatives.

Courtesy: Electrical India

UPDATED CENTRAL ELECTRICITY AUTHORITY (MEASURES RELATING TO SAFETY AND ELECTRIC SUPPLY) REGULATIONS, 2023 – 3 – CHAPTER III

General Safety Requirements

14. General safety requirements pertaining to construction, installation, protection, operation and maintenance of electric supply lines and apparatus.

(1) All electric supply lines and apparatus shall be of sufficient rating for power, insulation and estimated fault current and of sufficient mechanical strength, for the duty cycle which they may be required to perform under the environmental conditions of installation, and shall be constructed, installed, protected, worked and maintained in such a manner as to ensure safety of human beings, animals and property.

(2) Save as otherwise provided in these regulations, the relevant standards including National Electrical Code and National Building Code shall be followed to carry out the purpose of these regulations and where relevant Indian standards are not available, International standards shall be followed and in the event of any inconsistency, the provisions of these regulations shall prevail.

(3) The material and apparatus used shall conform to the relevant standards.

(4) All electrical equipment shall be installed above the Highest Flood Level and where such equipment is not possible to be installed above Highest Flood Level, it shall be ensured that there is no seepage or leakage or logging of water.

15. Service lines and apparatus on consumer's premises

(1) The supplier shall ensure that all electric supply lines, wires, fittings and apparatus belonging to him or under his control, up to the point of commencement of supply, which are on a consumer premises, are in a safe-condition and in all respects fit for supplying electricity and the supplier shall take precautions to avoid danger arising on such premises from such supply lines,wires, fittings and apparatus.

(2) The service lines placed by the supplier on the premises of a consumer which are underground or which are accessible shall be so insulated and protected by the supplier as to be secured under all ordinary conditions against electrical, mechanical, chemical or other injury to the insulation.

(3) The consumer shall, as far as circumstances permit, take precautions for the safe custody of the equipment on his premises belonging to the supplier.

(4) The consumer shall also ensure that the installation of the licensee under his control is kept in a safe condition.

16. Switchgear on consumer's premises.

(1) The supplier shall provide a suitable switchgear in each conductor of every service line other than an earthed or earthed neutral conductor or the earthed external conductor of a concentric cable within a consumer's premises, in an accessible position and such switchgear shall be contained within an adequately enclosed fireproof receptacle:

Provided that where more than one consumer is supplied through a common service line, each such consumer shall be provided with an independent switchgear at the point of rigid junction to the common service.

(2) Every electric supply line other than the earthed or earthed neutral conductor of any system or the earthed external conductor of a concentric cable shall be protected by a suitable switchgear by its owner.

17. Identification of earthed and earthed neutral conductors and position of switches and switchgear therein.

Where the conductors include an earthed conductor of a two-wire system or an earthed neutral conductor of a multi-wire system or a conductor which is to be connected thereto, the following conditions shall be complied with,

(i) an indication of a permanent nature shall be provided by the owner of the earthed or earthed neutral conductor or the conductor which is to be connected thereto, to enable such conductor to be distinguished from any live conductor and such indication shall be provided as per relevant standards, namely: –

(a) where the earthed or earthed neutral conductor is the property of the supplier, at or near the point of commencement of supply;

(b) where a conductor forming part of a consumer's system is to be connected to the supplier's earthed or earthed neutral conductor, at the point where such connection is to be made; and

(c) in all other cases, at a point corresponding to the point of commencement of supply.

(ii) no cut-out, link, switch or circuit breaker other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and live conductors shall be inserted or remain inserted in any earthed or earthed neutral conductor of a two wire-system or in any earthed or earthed neutral conductor of a multi-wire system or in any conductor connected thereto:

Provided that the above requirement shall not apply in case of a link for testing purposes, or aswitch for controlling generator or transformer.

18. Earthed terminal on consumer's premises

(1) The supplier shall provide and maintain on the consumer's premises for the consumer's use, a suitable earthed terminal in an accessible position at or near the point of commencement of supply as per relevant standards:

Provided that in the case of installation of voltage exceeding 250 V the consumer shall, in addition to the aforementioned earthing arrangement, provide his own earthing system with an independent electrode and the same shall be interlinked with the earthed terminal mentioned in sub-regulation (1) through a suitable link.

(2) The consumer shall take all reasonable precautions to prevent mechanical damage to the earthed terminal and its lead belonging to the supplier.

19. Accessibility to bare conductors

Where bare conductors are used in a building, the owner of such conductors shall,

(a) ensure that they are inaccessible to general public;

(b) provide in readily accessible position switches for rendering them dead whenever necessary; and

(c) take such other safety measures as are specified in the relevant standards

20. Danger Notices

The owner of every installation of voltage exceeding 250V shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the district, with a sign of skull and bones of a design as per relevant standards on,

(a) every motor, generator, transformer and other electrical plant and equipment together with apparatus used for controlling or regulating the same;

(b) all supports of overhead lines of voltage exceeding 650 V which can be easily climbed upon without the aid of ladder or special appliances; and

(c) luminous tube sign requiring supply, X-ray and similar high frequency installations of voltage exceeding 650 V but not exceeding 33 kV:

Provided that where it is not possible to affix such notices on any generator, motor, transformer or other apparatus, they shall be affixed as near as possible thereto, or the word "danger" and the voltage of the apparatus concerned shall be permanently painted on it:

Provided further that where the generator, motor, transformer or other apparatus is within an enclosure one notice affixed to the said enclosure shall be sufficient for the purposes of this regulation.

Explanation – For the purposes of clause (b) rails, tubular poles, wooden supports, reinforced cement concrete poles and pre stressed cement concrete poles without steps, I-sections and channels, shall be deemed as supports which cannot be easily climbed upon.

21. Handling of electric supply lines and apparatus

(1) Before any conductor or apparatus is handled, adequate precautions shall be taken, by earthing or other suitable means, to discharge electrically such conductor or apparatus, and any adjacent conductor or apparatus if there is danger therefrom, and to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon shall be followed as per the relevant standards.

(2) Every person who is working on an electric supply line or apparatus or both shall be provided with,

(a) personal protective equipment, tools and devices such as rubber gloves and safety footwear suitable for working voltage, safety belts for working at height, nonconductive ladder, earthing devices of appropriate class, helmet, line tester, hand lines, voltage detector and hand tools as per the relevant standards; and

(b) any other device for protecting him from mechanical and electrical injury due to arc flash and such personal protective equipment, tools and devices shall conform to the relevant standards and shall always be maintained in sound working condition.

(3) No person shall operate and undertake maintenance work on any part or whole of an electrical plant or electric supply line or apparatus and no person shall assist such person on such work, unless he is designated in that behalf and observes the safety precautions given in Part-I, Part-II, Part-III and Part-IV, as the case may be, of Schedule I.

(4) Every telecommunication line on supports carrying an overhead line of voltage exceeding 650 V but not exceeding 33 kV shall, for the purpose of working thereon, be deemed to be a line of voltage exceeding 650 V:

Provided that prior permission shall be taken from the concerned licensee before laying telecommunication lines on electric supports.

(5) For the safety of operating personnel, all non-current carrying metal parts of switchgear and control panels shall be properly earthed and insulating floors or mat conforming to the relevant standards, of appropriate voltage level shall be provided in front and rear of the panels where such personnel are required to carry out operation, maintenance or testing work.

(6) All panels shall be painted with the description of their identification at front and at the rear.

22. Supply to vehicles and cranes

Every person owning a vehicle, travelling crane, or the like to which electricity is supplied from an external source shall ensure that it is efficiently controlled by a suitable switch enabling all voltage to be cut off in one

operation and, where such vehicle, travelling crane or the like runs on metal rails, the owner shall ensure that the rails are electrically continuous and earthed at multiple points to ensure equipotential.

23. Cables for portable or transportable apparatus

(1) Flexible cables shall not be used for portable or transportable motors, generators, transformers, rectifiers, electric drills, electric sprayers, welding sets or any other portable or transportable apparatus unless they are insulated for required voltage as per the relevant standards and adequately protected from mechanical damage.

(2) Where the protection is by means of metallic covering, the covering shall be in metallic connection with the frame of any such apparatus and earthed.

(3) The cables shall be three core type and four core type for portable and transportable apparatus working on single phase and three phase supply, respectively and the core meant to be used for earth connection shall be easily identifiable.

24. Cables protected by bituminous materials

(1) Where the supplier or the owner has brought into use an electric supply line, other than an overhead line, which is not completely enclosed in a continuous metallic covering connected with earth and is insulated or protected in situ by composition or material of a bituminous character, –

(i) any pipe, conduit, or the like into which such electric supply line may have been drawn or placed shall, unless other arrangements are approved by the Electrical Inspector in any particular case, be effectively sealed at its point of entry into any street box so as to prevent any flow of gas to or from the street box; and

(ii) such electric supply line shall be periodically inspected and tested where accessible, and the result of each such inspection and test shall be duly recorded by the supplier or the owner.

(2) The supplier or the owner shall not bring into use any further electric supply line as aforesaid which is insulated or protected in situ by any composition or material known to be liable to produce noxious or explosive gases on excessive heating.

25. Street boxes

(1) Street boxes shall not contain gas pipes, and precautions shall be taken to prevent, any influx of water or gas.

(2) Where electric supply lines forming part of different systems pass through the same street box, they shall be readily distinguishable from one another and all electric supply lines at or in street boxes shall be adequately supported and protected so as to prevent risk of damage to or danger from adjacent electric supply lines.

(3) All street boxes shall be regularly inspected for the purpose of detecting the presence of gas and if any influx or accumulation is discovered, the owner shall give immediate notice to the agency or company owning gas pipeline in the neighborhood of the street box and in cases where a street box is large enough to admit the entrance of a person therein have been placed in position, provision shall be made,

(i) to ensure that any gas which may by accident have obtained access to the box shall escape before a person is allowed to enter and the box shall have provision for sufficient cross ventilation; and

(ii) for the prevention of danger from sparking.

(4) The owners of all street boxes or pillar boxes containing circuits or apparatus shall ensure that their covers and doors are kept closed and locked and are so provided that they can be opened only by means of a key or a special appliance.

(5) The street or pillar boxes shall be erected with the live parts at least 0.6 metre above the ground level or above the flood level of the local site condition, whichever is higher.

Courtesy: https://cea.nic.in/

INDIA'S RACE TOWARDS 1,000 TWH GREEN ENERGY

This article highlights the plethora of opportunities available in India in the field of Renewable Energies (REs). It also indicates the steps required to accelerate adoption of REs.

Renewable energy procurements have strengthened in India with the launch of the target of 500GW (280GW of solar and 140GW of wind) of renewable energy by 2030 – and plans to reduce the emission intensity of its GDP by 45% from 2005 levels by 2030. Of which already ~130GW was achieved as of July 2023, which is just ~26% of the target. As of date, India has installed a maximum utility-scale PV capacity of 16GWs in one year in year 2022 – and we need to increase our annual capacity deployment by 4.5X. Additionally, the generation planning expansion report by CEA estimates reaching 64% of renewables by 2030. Apart from Net Zero Targets (NZT), energy security and revenue growth prospects are the key drivers to accelerate this race towards 1000TWh in India.

Recently, it has been witnessed that India's power demand has surged by ~8% when compared to last year and recorded its peak power demand at 234 GW on August 17, 2023. With increasing, distributed energy resources in the grid, electrification of industries and electric vehicles are creating complexities in the grid, leading to demand-supply imbalances, acute power cuts or shortages, and stressed grids in many states of India. With this, it has become crucial to revisit the past decade and understand the key imperatives that are necessary for future-proofing India's energy transition along with stable operations of the transmission and distribution grids.

Looking Back: Roadblocks in Green Race

A decade down the line, sustainability and digitization will be mainstream as there will be a new revenue stream for key stakeholders. India is already making huge progress towards decarbonization, and has taken various measures for renewable purchase obligations, ultra- mega projects or solar parks, CPSU scheme, PLI scheme, waiver of transmission system charges for inter-state solar and wind power sales, green energy trading platforms such as Green-Term Ahead Market (G-TAM), etc. However, quality and integration are areas that are still nebulous and there is a need to take learnings from past developments and new ones with strong institutional support and adequate competencies.

- **Investments:** The energy transition requires substantial investments of $12.7 trillion for India's transition to a net-zero economy by 2050 presents an investment opportunity. Of these, 30% will be required for

EV sales, 16% in grid upgrades, 6% in CCS, 3% in hydrogen, and the rest in other low-carbon initiatives. Investments in energy flexibility pilots are crucial for flexibility management to manage underutilized grids efficiently with increasing renewables assets (utility-scale and behind the meter-BTM). Additionally, investments in CCS and hydrogen would also be important for the industrial sector (steel, aluminium, petrochemical, and cement) decarbonization to tackle hard-to-abate emissions.

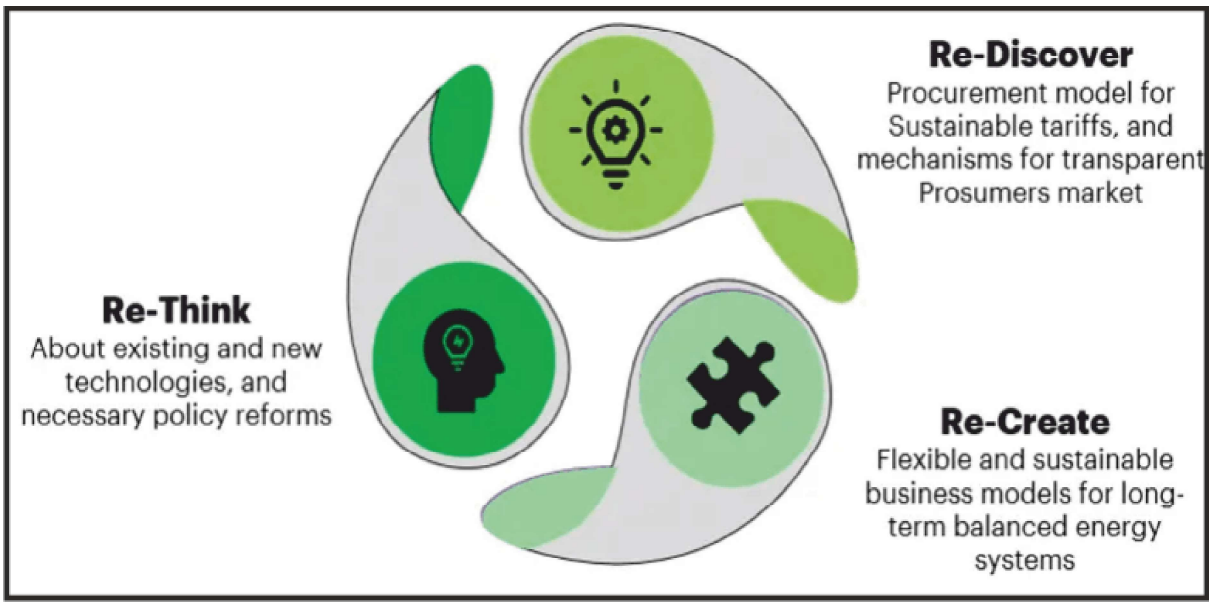

Exhibit 1 – Key Themes for Future Readiness for Energy Transition…

- **Policies & programs:** Central and State Governments need to re-design policy mechanisms and programs that support current issues such as the market mechanism for prosumers, demand-side flexibility programs, and policy, upscaling of energy storage (BTM) for peak load management and balancing price signals, RE curtailment issues, and other schemes. Furthermore, there are a handful of policies released by govt, the National Electricity Plan 2023, the National Green Hydrogen Mission 2023, the Carbon Credit Trading Scheme, and the draft Green Credit Programme, in recent months that need appropriate execution.
- **Capacity of DISCOMs to absorb RE:** Many DISCOMs hold on from signing contracts because of the expectation of tariffs falling even further. Tariffs are already hovering between INR 2.2 to INR 2.7. Lower tariffs affect investor returns and make projects unviable. Furthermore, to manage RE intermittency and limited availability, discoms must invest in battery storage, energy efficiency, and demand-side management programs. But these require investments, piloting, and capacity which the DISCOMs lack because of their financial situation.
- **Under development of new and frontier technologies:** Technologies like floating solar, offshore wind, and distributed renewables are still emerging in the Indian market, and due to land constraints, these technologies need to be on a fast track to meet RE targets.
- Floating PV solar had a target of 10 GW by 2022, of which ~2GW were installed. With a potential of more than 100 GW, only ~4 GW tenders are out, and some got cancelled due to limited float/pontoon suppliers or undeveloped markets.
- Similarly, the offshore wind policy was launched in 2016 by MNRE & NIWE, and a potential of 100 GW in coastal areas was evaluated 5 years ago. NIWE has released guidelines and facilitation schemes, and an EOI of 1 GW was released. Since the industry faces supply-chain barriers, and policy and offtake uncertainties, no installations have happened so far but revived the plan in 2023 where bids will be issued for the first 3 years of 4GW annually.

Forward Approach: Turn Challenges into Opportunities

Past experiences necessitate India reinventing itself around Renewable Energy and Digital transformation for energy sector transformation by taking certain strategic moves. The need is to balance the new complexity in India's energy systems, and turn these challenges into opportunities brought about by below key levers:

- **Digitization:** Digital twin combined with AI/IoT for demand/supply, price forecast, predictive analytics, AR/VR for optimizing operations, productivity, and intelligent automation will help manage demand-supply balances. Data management and asset health diagnostic of renewable assets will become more dispatchable and transparent with digitization. With growing installation, efficient integration, and performance monitoring become essential. AI/IoT-enabled systems play a vital role in big data analytics, forecasting/prediction, and monitoring of data gathered from these operational plants; fault and defect diagnostics of the operational plant would be another vertical to minimize plant downtime. Enable transparency between OEMs, IPPs, and grids/DISOMs.
- **Demand aggregation:** Aggregation of demand from various consumers (CI, residential, remote areas, and areas at higher altitudes) will help in managing various grid applications such as voltage/ frequency regulation, ancillary services, arbitrage, and flexibility/congestion management. Innovative aggregated DERs model will ease transparent and flexible trade-offs of electricity for consumers and DISCOMs. The retail market transformation will be carried out by new players such as aggregators and third party storage providers. These resources are primarily used for self-consumption for consumers and demand-side management to grid operators and will accelerate the pace of revolution.
- **Platform & services:** Explore end-to-end energy value chain and associated process to develop collaborative platform services for seamless one-stop-shop solutions for energy flexibility, sustainability as service, green data centers, EV charging services roaming platform, etc. The proposition is to bring all stakeholders to one platform to improve transparency and efficiency for renewable energy, integrated platforms for grid/discoms, and aggregation platforms for DISCOMs/retailers/market operators.
- **Decentralize:** Reduce the industry's dependence on the grid and transmission network and save on costs of procuring high-cost energy fuels and power from the grid. Peer-to-peer trading through block chain (which happens at the local distribution level) can reduce peak demand grid congestion. This transformative technology facilitates optimized utilization of renewable resources, empowers localized and distributed energy markets, and nurtures community-driven renewable energy DERs with storage systems that can dispatch excess electricity produced to the grid which can, in turn, help defer additional expenditure on increasing generation capacity and transmission infrastructure to meet peak demand.
- **Diversify:** Identify the most appropriate mix/hybrid of various RE technologies for electric and non-electric applications or use cases. More focus needs to be on Technology such as BESS, Green hydrogen, and CCUS will act as a catalyst in this transition that will play a dominant role in flexible energy dispatch.

Battery energy storage/Green hydrogen system will complement intermittent power supply. Embracing these technological improvements with grid integration not only unlocks new prospects but also enables cost reduction and cultivates a cleaner, more resilient, and orchestrated energy ecosystem in India.

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Courtesy: Electrical India

SUBSTATION DESIGN APPLICATION GUIDE – 14

8. Flexible A.C. System

8.1 FACTS- is an acronym for Flexible AC Transmission System. The philosophy of FACTS is to use reactive power compensation devices to control power flows in a transmission network, thereby allowing transmission line plant to be loaded to its full capability.

All FACTS devices can be fitted to existing AC transmission routes thus providing an economic solution. FACTS technology, however, allows greater throughput over existing routes, thus meeting consumer demand without the construction of new transmission lines.

AREVA Transmission & Distribution has been providing FACTS devices such as Mechanically Switched Capacitors (MSCs), Mechanically Switched Capacitor Damping Networks (MSCDNs), Static VAr Compensators (SVCs) and Short Circuit Limiting Couplings (SLCs) all over the world to be used in transmission networks for many years. MSCs and MSCDNs have generally been connected to the grid system at 132kV, 275kV and 400kV and SVCs have been connected either at 275kV or 400kV via dedicated stepdown transformer.

In England and Wales, the National Grid Company plc (NGC) has identified the need for reactive power plant that can be relocated at short notice, and AREVA T&D Substation Project HV system has been commissioned to design and install relocatable Static VAr Compensators, Mechanically Switched Capacitors and Mechanically Switched Capacitor Damping Networks as an ongoing programme.

Disturbance to the System

The voltage drop in a power supply system, caused by loads which are large compared with the short-circuit level of the system, is mainly due to the reactive component of current, I_q, flowing through the system reactance X_o.i.e.

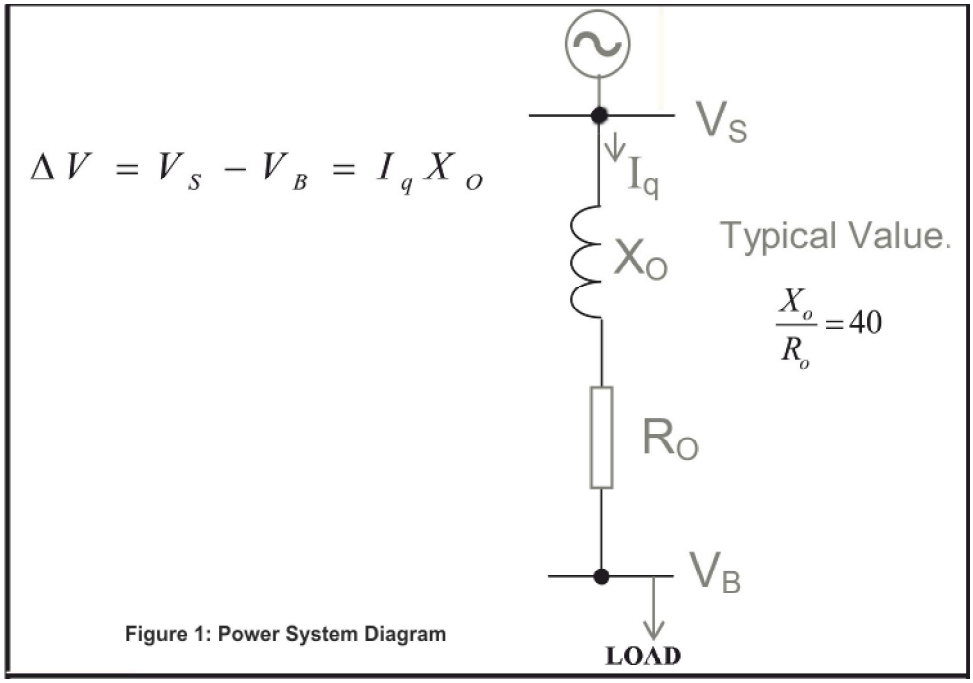


Figure 1: Power System Diagram

Transmission Line

Imaginary Power/reactive Power/Useless Power

The 'concept of real' power, which is unidirectional and 'reactive' power, which alternates but does not produce power in a load, has lead to the concept of 'real' and imaginary power. Because reactive power leads or lags

'real power by 90°, it soon became known as 'imaginary' power. Because reactive has no effect on the power in the load, it may be thought that it has no significance in power networks.

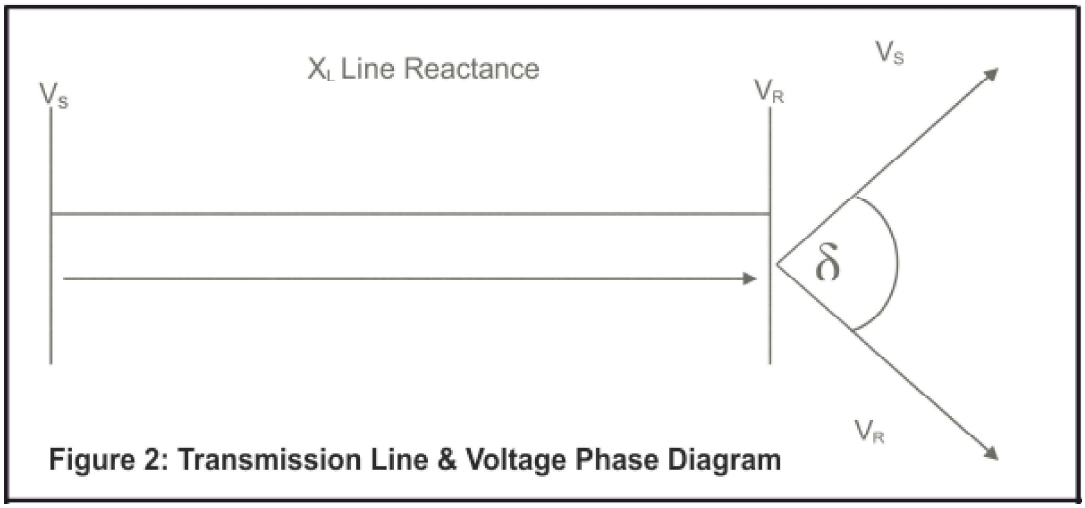


Figure 2: Transmission Line & Voltage Phase Diagram

In a very large transmission system such as the 400kV, 500kV and 750kV system used in America, China and in continental Europe for transmission over very long distances, charging currents due to shunt capacitance can result in a pronounced Ferranti effect, even under local conditions. Such effects can be offset by installing either reactors in shunt at intervals along the line or alternatively, large capacitors in series.

Real power flow along a transmission line is a function of the sending end voltage (V_S) and receiving end voltage (V_R) transmission line reactance X_L and phase angle δ.

$$P = \frac{V_S V_R \, Sin\delta}{X_L}$$

Assuming that busbar magnitudes are maintained at fixed levels, in order to increase power flow, the angle δ between V_S and V_R must increase. However, increasing angle δ increases the risk of transient and voltage stability problems if a fault were to occur along the line.

By increasing the sending end voltage V_S to 220kV, 400kV, 500kV or even to 800kV, more real power can be pushed through a transmission line. However, the insulations of the electrical equipment must be increased, which are more expensive.

By increasing phase angle δ up to 90° (Sin 90 = 1) by means of phase shifting transformer i.e. either Quad Booster or phase shifting generator, more real power P can be transmitted along the transmission line. Real power P through the transmission line can be increased by decreasing the transmission line reactance X_L by adding a series capacitor in series with the transmission line as series compensation.

Real power flow P through the transmission lines

$$P = \frac{V_S V_R \, Sin\delta}{X_L}$$

Reactive Power: (Imaginary Power)

$$Q_L = \frac{V^2 SR}{X_L} \text{ (Absorption)}$$

This equation is a load dependent

V_{SR} equal to the difference line end voltages, thus the line will absorb Reactive Power.

The line shunt capacitance will generate reactive power (imaginary or useless power).

$$X_{SC} = \frac{l}{j\omega c} = \frac{-j}{\omega c}$$

$$Q_C = \frac{V^2}{x_{sc}} = -v^2\omega c(\text{Generation})$$

Thus we see that lightly loaded lines generate reactive power GENERATION > ABSORPTION

$Q_C > Q_L$

$\therefore V_R > V_S$

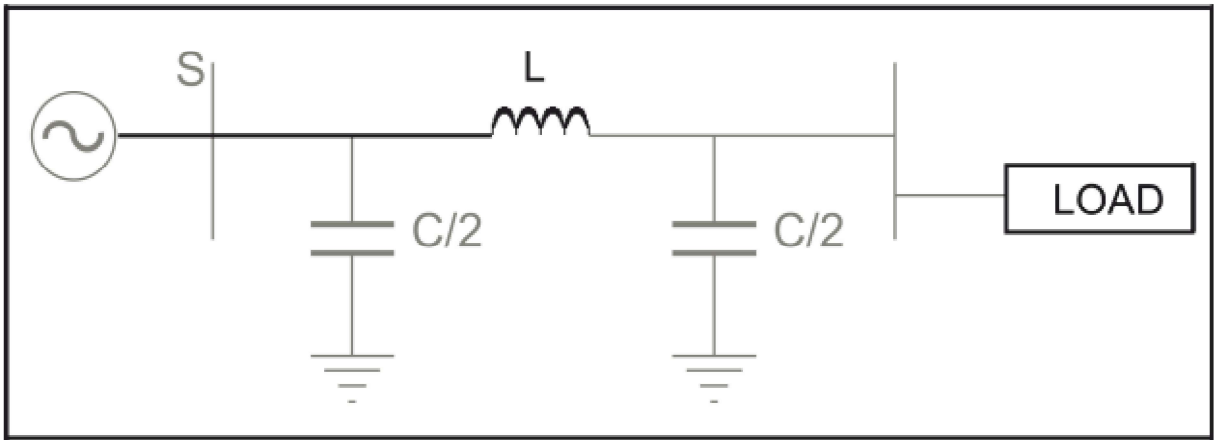


Figure 3: Transmission Line with Line Parameters

Greater line loading leads to greater reactive power absorption. The reactive power must be supplied from the network or some form of reactive power compensation of generation.

For long transmission line we also have to consider the effect of shunt capacitance in the line. If there is no load on the line, then the busbar voltages are in phase and no reactive power is absorbed by the load.

Heavy loading conditions, the reactive power absorbed by the line reactance will be greater than the reactive power generated by the shunt capacitance in the line.

$Q_L > Q_C$

$\therefore V_S > V_R$

Shunt Compensation

Power is being exported along the transmission line from sending busbar (V_S) towards the receiving end busbar (V_R). Under light load condition the receiving end voltage will rise higher than the sending end voltage due to the effect of the line capacitance (Ferranti effect).

The voltage profile of the uncompensated transmission line is a maximum at the line ends, V, and minimum at the mid-point, V_M. If the line is naturally loaded (this means shunt capacitance should be considered), the voltage profile would be flat i.e. the voltage magnitude would be equal at all points along the line. If the shunt capacitance available in the line is good enough to provide voltage magnitude equal at all points along the line, then no compensation is required.

However, the shunt capacitance of the transmission line is not big enough to support the flat voltage profile during heavy load condition. Thus the application of line compensations can be seen as a means of approximating a flat voltage profile. This, however, implies that the compensation is distributed along the transmission line, which is clearly impractical. However, the next best approach is to provide compensation at the mid-point. It can be seen that the line is divided into two sections.

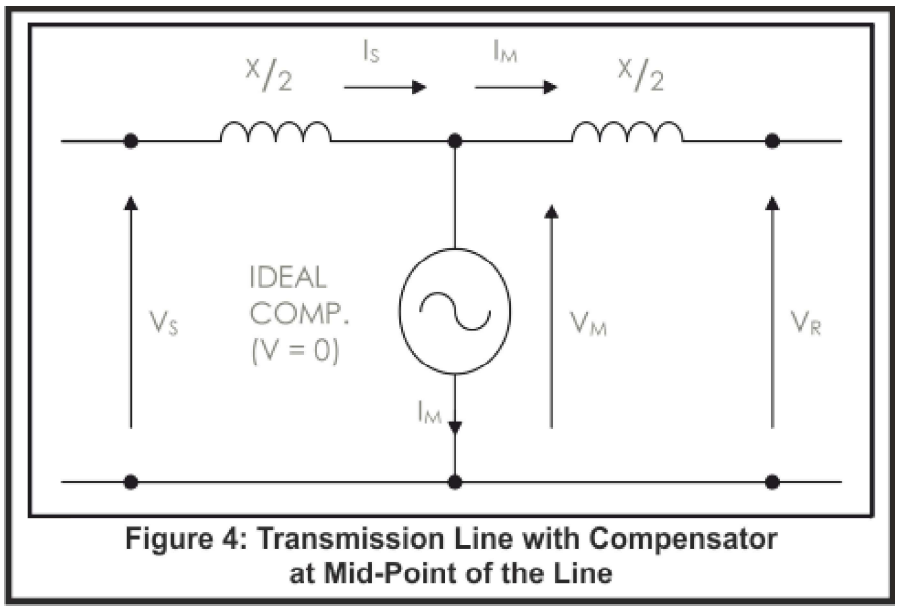


Figure 4: Transmission Line with Compensator at Mid-Point of the Line

The above figure shows the arrangement of an ideal mid-point shunt compensator which maintains a voltage V_M.

Uncompensated Line

The real power exported along the line is given as:

$$P = \frac{V^2}{X} Sin\delta$$

Compensated Line

The ideal mid-point shunt compensator i.e. MSC, MSCDN, SVC which maintains voltage Vm equal to the busbar voltage such that

$|V_S| = |V_R| = |V_M| = |V|$

Power transferred from S to the mid-point is equal to the power transferred from the mid-point to R, and is given by:

$$P = \frac{2V^2}{X} Sin\frac{\delta}{2}$$

Note: It can be seen that the compensator does not consume real power since the compensator voltage V_M and its current I_M are in quadrature. The reactive power generated by the compensator, $Q_p = I_M V_M = I_M V$.

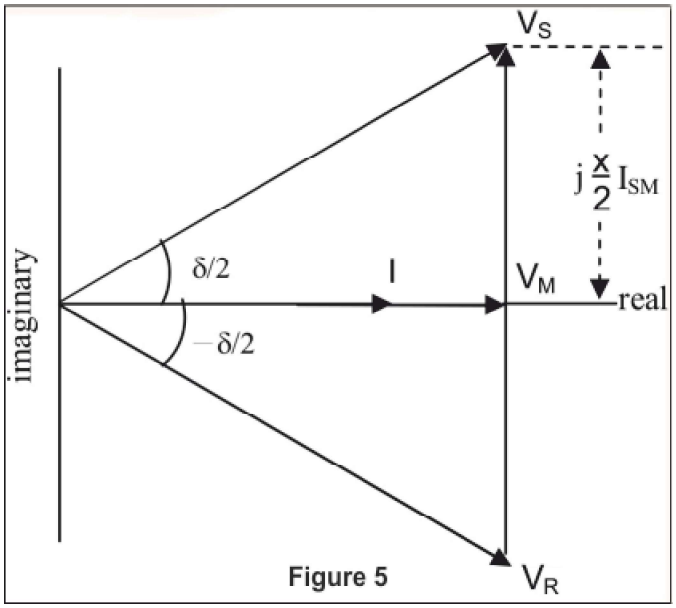


Figure 5

Reactive Power Q Absorbed by the Line

$$Sin\frac{\delta}{2} = \frac{1X}{2V}$$

$$I = \frac{2V}{X} Sin\frac{\delta}{2}$$

The line absorbs reactive power Q as a function of the line current I

$$\therefore Q = I^2X = \frac{4V^2}{X} Sin\frac{\delta}{2} = \frac{2V^2}{X}(1 - Cos\,\delta)$$

With long transmission lines a single mid-point compensator may not be adequate to support the line voltage and several shunt compensators (i.e. MSC, MSCDNs or SVCs) connected at intervals down the line may be needed. The line will then be a closer approximation to the fully distributed solution.

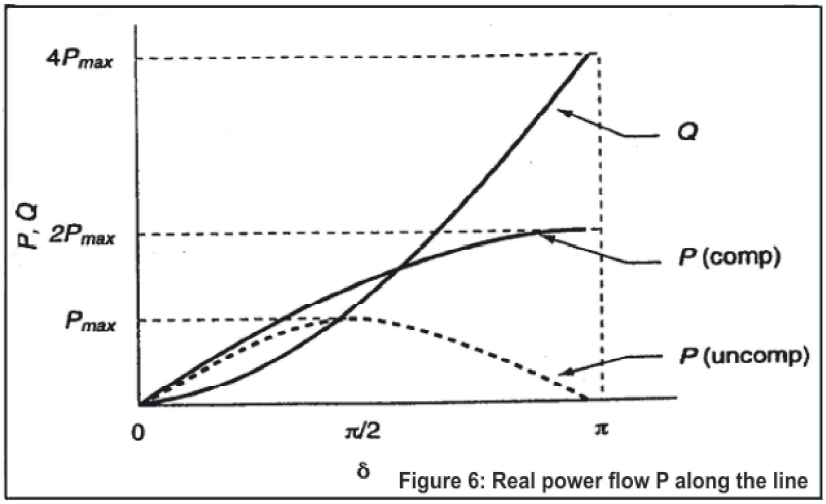


Figure 6: Real power flow P along the line

(To be Continued)

Courtesy: V. AyaduraiBsc, C.Eng, FIEE
Engineering Expert

BUDGET 2024 : GOVERNMENT MAY EXTEND FAME II INCENTIVE SCHEME FOR MANUFACTURING ELECTRIC VEHICLES

According to ET, because the finance ministry hasn't approved FAME III, there's a suggestion to extend the current edition until a new framework is in place. If accepted, this extension would streamline the process, as it wouldn't need multiple approvals like launching a new scheme.

Budget 2024: The government is thinking about extending its main electric vehicle incentive program, FAME II, into the fiscal year 2025. It's looking into getting more funds in the interim budget to support the scheme. According to ET, because the finance ministry hasn't approved FAME III, there's a suggestion to extend the current edition until a new framework is in place.

If accepted, this extension would streamline the process, as it wouldn't need multiple approvals like launching a new scheme. The goal is to maintain momentum in the electric vehicle market, particularly since Budget 2024 on February 1 will be a vote on account due to the upcoming general elections in April-May.

FAME III approval hesitation: Budget concerns and shift in EV support

The finance ministry seems cautious about approving FAME III, projecting a budget of over Rs. 30,000 crore for the next five years to encourage the use of electric two-wheelers, buses, tractors and other vehicles. Insiders say that prominent electric two-wheeler manufacturers, who benefited from FAME I and II, may not need government support anymore. The general view is that resources are limited, and if used to promote electric mobility, they should focus on developing the eco system rather than providing benefits to individuals who can afford electric vehicles.

Drive for cleaner air: 30% EV sales target by 2030

India, facing pollution challenges with three cities among the world's top 10 polluted, is actively encouraging electric mobility to reduce vehicle emissions. The government targets electric vehicles to make up 30% of all new vehicle sales in the country by 2030. Currently, the market share of electric vehicles is relatively small, ranging from about 2% in cars to 5% in two-wheelers, even though India is projected to become the third-largest global automobile market by the end of the decade.

FAME II: Subsidies for EVs and fast-charging stations

Through FAME II, The Ministry of Heavy Industries MHI) has provided Rs. 5,228 crores in subsidies for approximately 1.15 million electric vehicles sold up to December 1, 2023. Furthermore, the government has earmarked Rs. 800 crore under FAME II for public sector oil marketing companies (OMCs) like IOCL, BPCL, and HPCL to set up 7,500 fast-charging stations across the country. This effort seeks to address range anxiety and promote the broader acceptance of electric vehicles.

Courtesy: The times of India, dt. 10.01.2024

WHAT HAPPENS TO SOLAR PANELS WHEN IT'S CLOUDY OR RAINING?

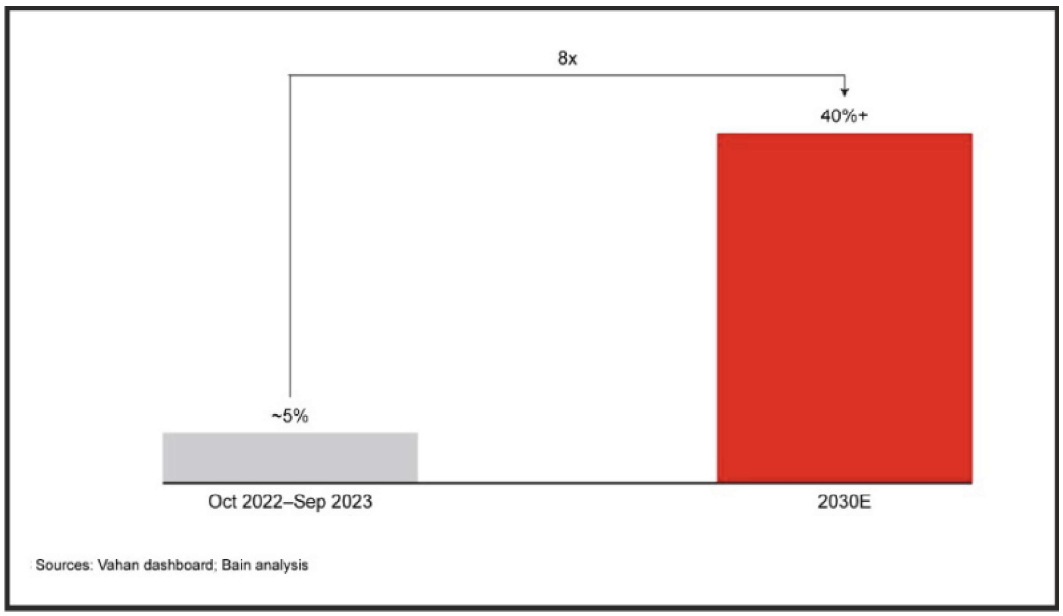
Photovoltaic panels can use direct or indirect sunlight to generate power, though they are most effective in direct sunlight. Solar panels will still work even when the light is reflected or partially blocked by clouds. Rain actually helps to keep your panels operating efficiently by washing away any dust or dirt. If you live in an area with a strong net metering policy, excess energy generated by your panels during sunny hours will offset energy that you use at night and other times when your system isn't operating at full capacity.

Courtesy: https://www.seia.org.initiatives>what-happen-solar

INDIA ELECTRIC VEHICLE REPORT 2023 AT A GLANCE

- Electric vehicles (EVs) could account for more than 40% of India's automotive market and generate over $100 billion of revenue by 2030.
- Achieving this will require concerted strategies across five areas: new product development, go-to-market/distribution, customer segment prioritization, software development, and charging infrastructure.
- Several of these interventions will require category-specific stakeholder action.

India's electric vehicle (EV) market is at an inflection point. EVs accounted for about 5% of total vehicle sales between October 2022 and September 2023—and could reach more than 40% penetration by 2030 (see Figure), driven by strong adoption (45%+) in both two-wheeler (2W) and three-wheeler (3W) categories.



However, several structural challenges need to be addressed to spur increased EV adoption. For example, EVs are currently priced higher than internal combustion engine (ICE) vehicles. There's also anxiety over range, limitations in charging infrastructure, and friction in customer financing.

2W EVs form the majority of EV sales today, accounting for 85%–90% of all EV units sold in India, followed by 4W EVs (7%–9% of sales) and 3W EVs (5%–7% of sales). While Phase II of the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme was recently revised, 2W EV penetration has remained stable at around 5% in line with Jan–Mar 2023 levels (and only a marginal decline in Jun–Jul 2023). 3W EV and 4W EV penetration levels experienced an upswing, with volumes more than doubling over the past 12 months, driven by low total cost of ownership (TCO).

To realize its $100 billion revenue potential, India's EV market needs to grow more than tenfold in volume over the next 6–7 years. This is achievable, but only with focused interventions across five key areas: new product development, GTM/distribution optimization, B2B focus, software development, and scale-up of charging infrastructure.

These interventions are above and beyond the macro elements that also need to be addressed, such as policy support, safety improvements, and battery price

Five focus areas for interventions

1. Develop "customer-back" products to optimize capital expenditure.

EV penetration is significantly higher in the premium segments than the mass market, as EV manufacturers aim to balance pricing with range and performance. Most EV categories are already TCO-positive at threshold

range, which makes them attractive as fleet and B2B vehicles. However, mass adoption requires pricing parity with comparable ICE models (e.g., Honda Activa among 2Ws and Bajaj RE among 3Ws), even if that entails compromises in range and performance.

OEMs will need a deep understanding of customer segments to build EVs that meet their needs, especially with respect to range and performance. In addition, for better economics, OEMs may need to reduce "nice to have" features from existing premium models when subsidies expire.

2. Reimagine distribution models to grow beyond metro and Tier 1 cities.

Metro and Tier 1 cities currently drive the majority of EV sales. For example, metro/Tier 1 cities account for 80%–90% of 3W EV sales, compared to only 55%–65% of comparable 3W ICE sales. This is driven by lower EV distribution footprint in Tier 2 cities, limited customer understanding of EVs' TCO benefits, and high range anxiety among Tier 2 customers.

Replicating ICE dealership models is unlikely to work in Tier 2 cities since EV dealerships generate less service revenue. EV models have lower service requirements, with a lower number of components, hence service revenues only comprise 10%–15% of EV dealer revenues (compared to 30% or more for ICE dealers). As a result, OEMs have to operate with higher margins, lower cost structures (via "lean" dealer operations, lower headcounts, or direct-to-consumer sales), or a combination of both over time.

3. Prioritize B2B/fleet customer segments to generate near-term momentum.

OEMs can accelerate EV adoption by targeting B2B customers and fleets, such as food/grocery delivery platforms, logistics firms, and cab fleet operators. EVs offer a superior value proposition for these segments based on positive TCO, which is reflected in their ambitious electrification plans. For example, Amazon plans to add 10,000 EVs to its India logistics fleet by 2025, Zomato aims to electrify 100% of its delivery fleet by 2030, and Uber plans to add 25,000 EVs by 2026 as part of its "Uber Green" initiative.

4. Use software as a differentiator and profitability driver.

Profitability and cost optimization are significant challenges for OEMs, especially as they try to drive adoption and scale, and must be addressed to ensure long-term business viability. Software can help OEMs materially improve their economics by adding new revenue streams and simultaneously improving vehicle performance. For example, OEMs can leverage software to enhance power delivery, optimize battery management based on vehicle usage to increase battery life, etc.

Global EV OEMs like Tesla extensively use software to enable superior safety, battery management and improve the overall customer driving experience. Some of Tesla's software-driven functionalities include auto-pilot functions, software-controlled all-wheel drive, live traffic visualization, etc.

OEMs need to understand customer needs across segments, and then develop native software capabilities to extract better, differentiated performance from their hardware.

5. Scale charging infrastructure.

India significantly lags other geographies on charging infrastructure, with roughly 200+ EVs per commercial charging point in India, as compared to ~20 in the US and less than 10 in China. India needs both slow- and fast-charging infrastructure, through establishing more charging points in existing EV areas, as well as widening pin-code coverage to reduce range anxiety.

Battery swapping (offered by companies like Sun Mobility and Battery Smart) can also potentially solve the infrastructure gap in select commercial use cases, such as passenger 3W EVs and 2W EVs for last-mile deliveries etc., while simultaneously lowering upfront costs, increasing earnings potential (due to low down-time), and improving flexibility for customers. OEMs need to prioritize the right use cases, optimize product designs, and partner with battery-swapping players to address a wider range of customer segments.

Source: By Mahadevan Seetharaman, MihirSampat, Prabhav Kashyap, Prithviraj Sagi, Arpit Agarwal, and Venkatesh Modi

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 form 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)

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