ELECTRICAL INSTALLATION ENGINEER

NEWS LETTER

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EDITORIAL

Dear Members, Fellow Professionals and Friends,

Greetings To All!

Happy Christmas Greetings!

Advance Greetings for A Happy New Year 2021!

The year is coming to a close and we all seem to feel relieved as we can look forward to a New Year with hopes for return to normalcy and restart our journey for growth, betterment and economic prosperity. The whole year of 2020 was the year of CORONA which was a pandemic without sparing any part of the world, making all suffer, but at the same time teaching lot of lessons for all times to come. It is believed that the spread of CORONA is a proof interdependence and the connected world, which is going to spread the solutions too. Vaccines seem to be getting ready in many countries giving hope for a lasting solution to eliminate the problem. Our nation has always had the blessings to bounce back which has already started happening in both fronts of recovering from CORONA and reentering the economic growth path.

Both Green Revolution and White Revolution have helped us to stabilize ourselves and with good rains and continued efforts to improve irrigation and with good inputs of science and technology, the overall production from lands and villages have improved in a big way. There are frequent cases of farmers complaining about problems due to excess production, be it tomatoes or ladies fingers or many other crops. The solutions lie in preservation, distribution and better trade of all agricultural produce of the country, which is certainly feasible today with the help of technologies, communication and transportation. It is very unfortunate that there are ferocious agitations by farmers in some parts of the country opposing the efforts by the Government to offer better options and opportunities for better trade. We hope that proper understanding would evolve and we will march ahead. We are aware that the overall prosperity of our country and better all-round businesses depend on prosperous agriculture and sound and prospering rural economy. National 'Farmers Day' is celebrated on 23 December and let us hope and pray that all-round peace, satisfaction and prosperity will prevail.

Energy Conservation Day is on 14th December and both Energy and Energy Efficiencies are of great importance. Energy is the base for any activity but the sources have to ensure the safety and sustainability. Efficiencies of Energy determine the conservation of the resources as well as the competitiveness. Let us celebrate the Energy Conservation Day with resolve to devote our professional commitment and competencies to contribute to these causes.

We celebrated our Constitution Day recently and the Republic Day is coming on the 26th of next month. As it is expressed by eminent researchers and experts, our country has not been put together by any design, but it has evolved and survived for thousands of years due to its culture, values and tradition. It has undergone invasions and occupations for long periods but the idea of our land as one country with a binding culture and values, with all its diversities, make us proud. Our country started a new innings of building a strong and prosperous nation since the Independence in 1947 and adoption of the Constitution in 1950, with resolve to make it a successful democracy with rule of law based on our Constitution. There have been aberrations to this ideal from time to time, but let us resolve to continue to solve the problems and continue our march towards progress and betterment.

We thank all those members who have helped us by participating in the advertisement appearing for the issue November 2020 – E Power, Mahindra & Mahindra, Mersen, Supreme Power Equipment Pvt. Ltd.

Editor

ELECTRICAL INSTALLATION ENGINEER

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Energy conversion from "Start to End"

Part – 1

Every end user of the energy should have a minimum understanding of the "Energy Basics". This will help to avoid energy wastage / misuse. With this end in view, a few templates guidelines have been suggested here. It is believed that these measures will facilitate the end users to save all kinds of energy forms by finding / formulating / framing appropriate working policies / plan of actions. i.e. minimum consumption of Energy Sources with maximum beneficial usage. Three stages that exist for the energy form in transition prior and after its conversion are,

- Energy trail / movement prior to its conversion
- Energy trail during its conversion
- Energy trail after its conversion at the end use site.

Kindly note that all these processes are parts / components of the whole energy conversion process from start to end which "We", the energy users, normally perform as "Energy Converters"

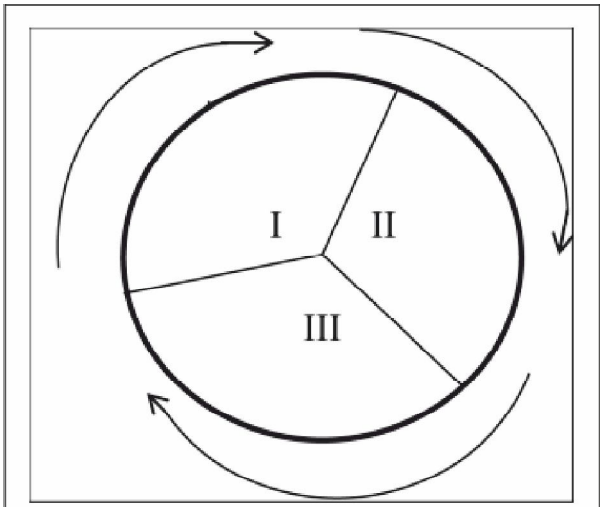


Fig 1

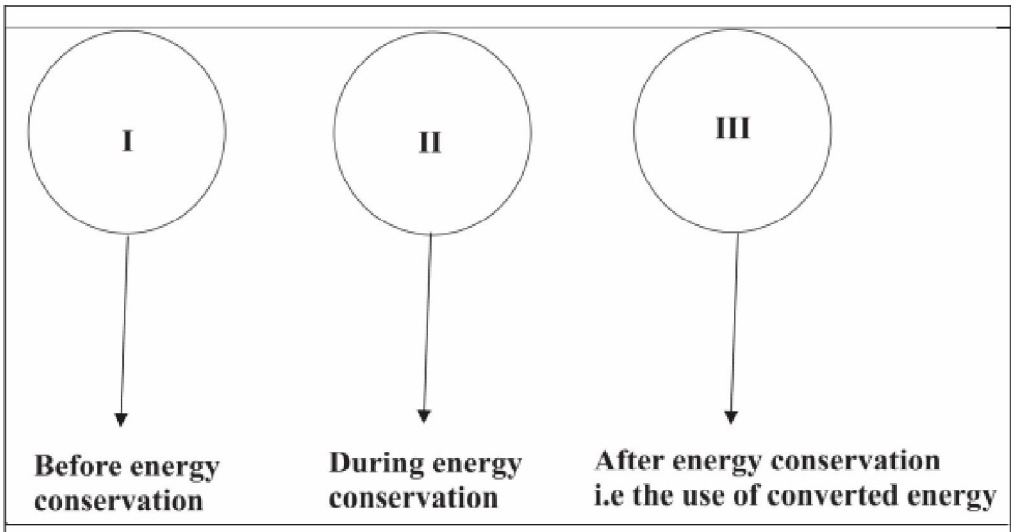


Fig 2 Three stages in Energy Conservation Process

In this conjecture, we should not overlook / side step the roles played by the "Energy Chakra" components in our energy saving strategies Viz. Energy Sources, Energy Converting Agent (Human Beings) the converting (tools, processes equipment, devices) adopted and finally the utilization of converted energy i.e How it is utilized (waste fully / beneficially with minimum losses)

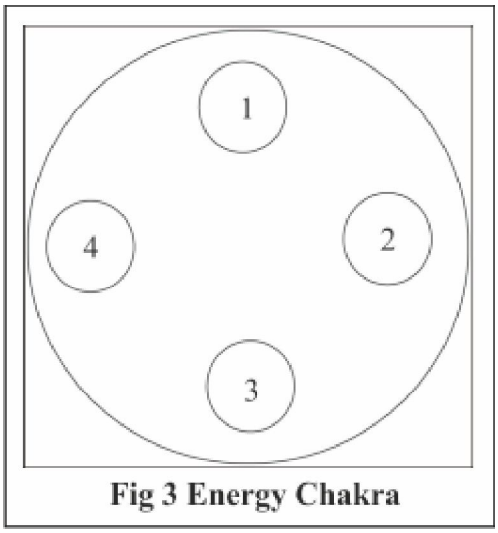


Fig 3 Energy Chakra

1. Energy Sources
2. Converting Agent
3. Converted Tool
4. Utilization of converted energy

They are the main players in our scheme of things. In this connection, let us understand the difference between "Strategy" and tactics (methods). A "Strategy" is a plan of action for achieving our "end objective" whereas "Tactics are the actions / methods adopted to implement the "Strategy"

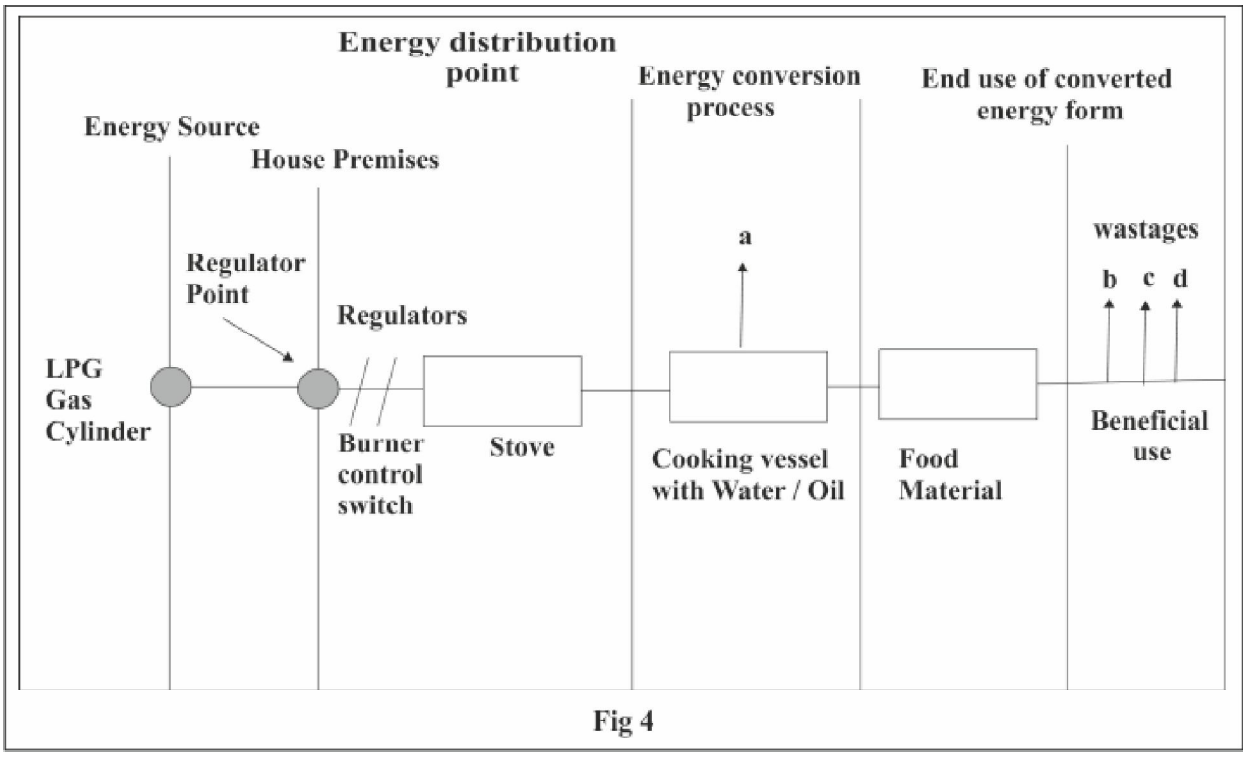


Fig 4

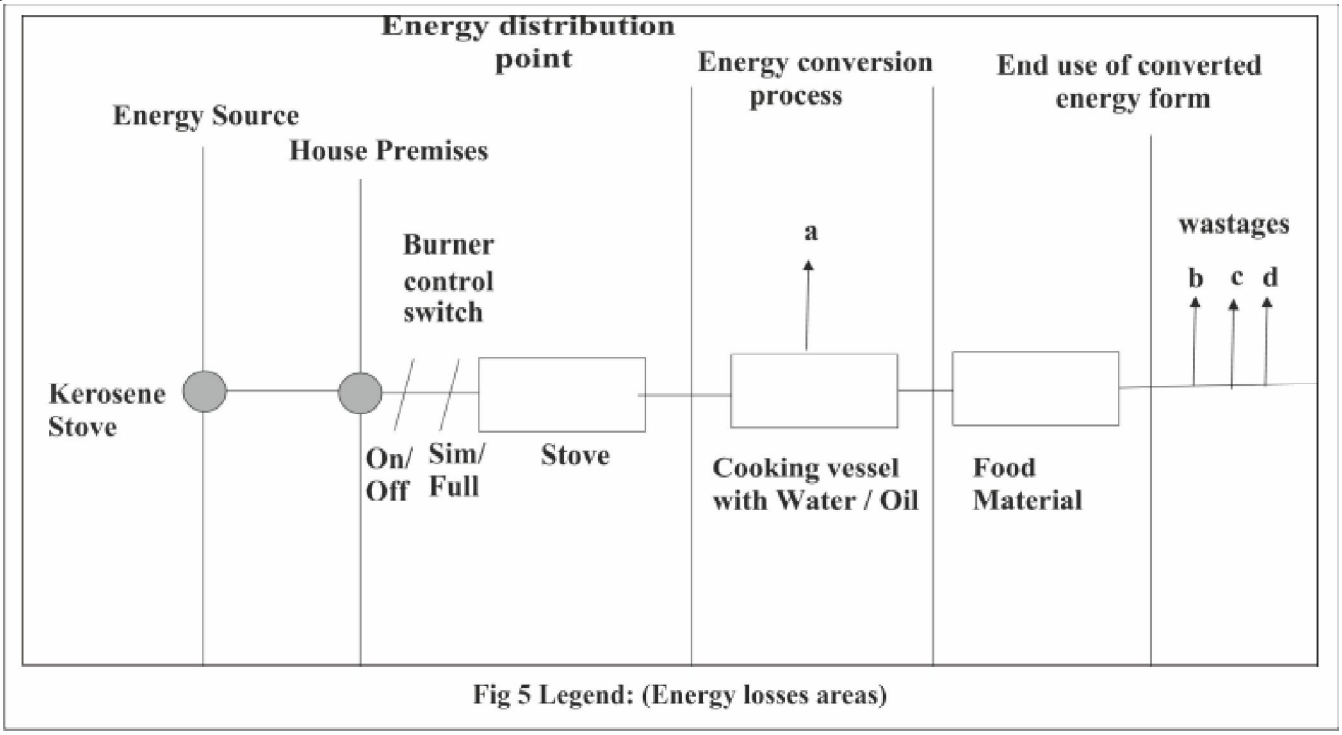
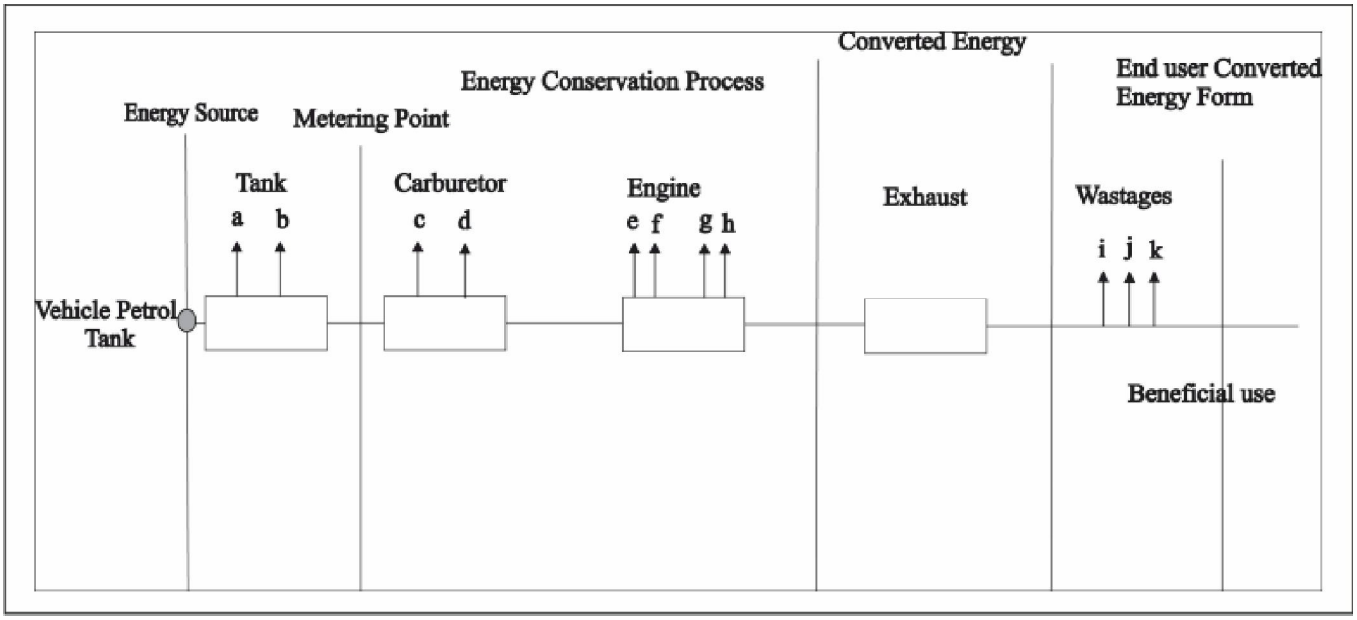


Fig 5 Legend: (Energy losses areas)

a. Improper selection of vessel
b. Frequent reheating of heat, beverages
c. Unused food thrown to dustbin
d. Other wastages

Fig 4 & 5 Flow of heat energy converted from LPG and Kerosene to end use.

Schematic diagrams exhibiting the areas / sectors where normally losses occur during the flow of energy from "fossil energy sources" like LPG, Kerosene, Petrol and coal are furnished (Fig 3, 4 & 5)



Legend

a. Leaded petrol
b. Moisture, dust
g. Lubrication problem
h. Improper tyre pressure

c. Presence of metal particles
d. Blockages
e. Improper firing
f. Spark plug problem
i. Idle running
j. Not running at proper speed
k. Other problems

Fig 6 Flow of heat energy converted from petrol in a vehicle to end use

After clearly understanding the issues involved by going through these basic diagrams, it will be a compelling priority for the end users of energy to understand who are the key players / factors that dictate the flow of varies energy forms. As an illustration, the flow of electrical energy from start to end has been depicted in fig 7 which will offer much help in this regard. This figure explains the concerned factors in a very simple form. However detailed explanations / elaboration will be provided in the forth coming paras.

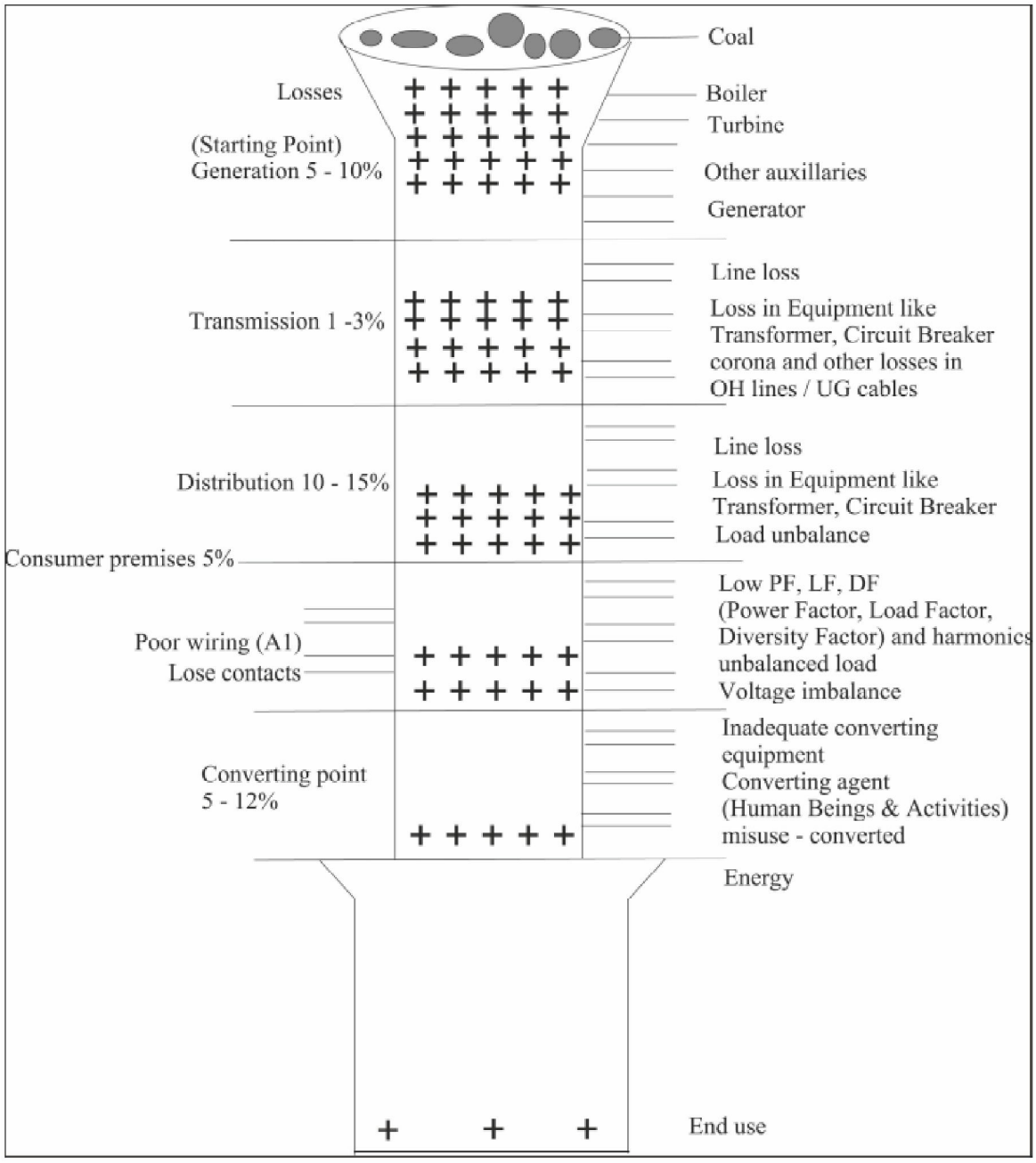


Fig 7 Flow of Electrical Energy – Generating station to end use (Coal to Plug)

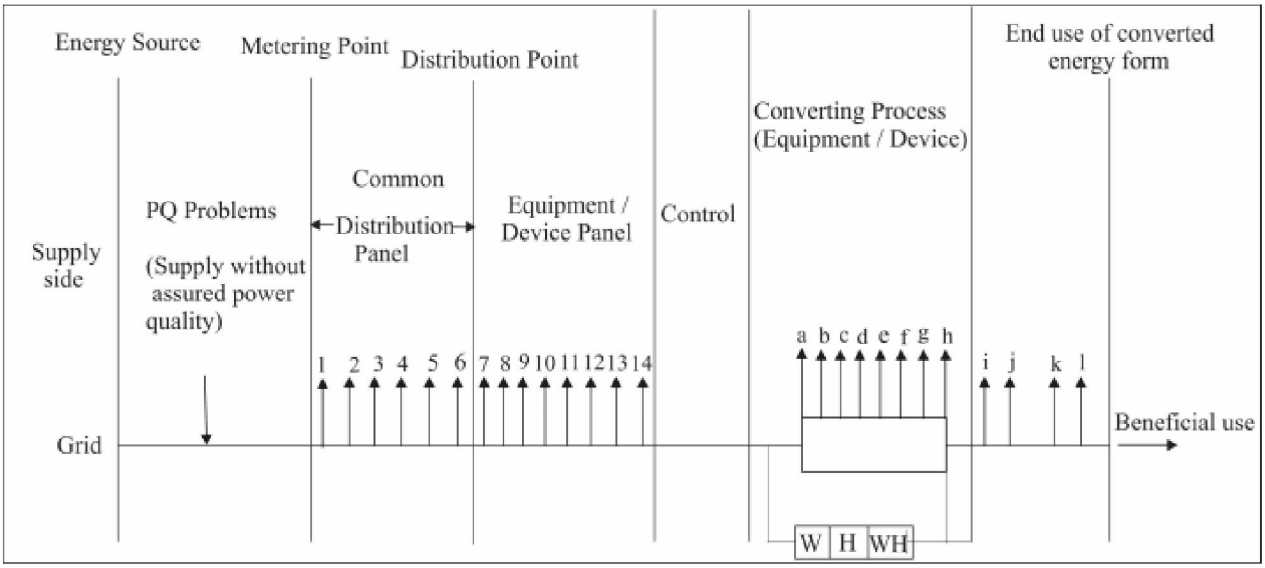


Fig 8 Losses in power delivery circuit / process Legend

Legend

1. Power Factor
2. Load Factor
3. Diversity Factor
4. Harmonics
5. Imbalance in Voltage
6. Unbalance in Load indicated by neutral current flow
7. Use of Al. Cables
8. Bimetallic Action (Due to Al + Copper Cable joints)
9. Loose connection + Improper crimping and overloading of Sockets
10. Improper running (Not Optimal running of Device)
11. Mishandling or improper selection of equipment / device
12. Higher voltage drop across connection
13. Incorrect maintenance
14. Applied voltage level is more than the required level.

This is applicable only for lighting loads, not for other loads like motive power loads and heating loads.

a. Manufacturing defects
b. Inadequate Design
c. Inefficient Equipment / device (not having energy star rating) or (unable to perform optimally in the existing / prevailing operating environment)
d. Poor maintenance
e. Improper handling of equipment / device
f. Mishandling of equipment / device
g. Improper selection of lighting (lighting pollution and its associated components)
h. Use of incandescent, zero watt bulbs for indication purpose
i. One light burning continuously as a safety measure in residential and commercial services
j. Running of fans, AC, lights in unoccupied room

k. Running of computer, TV with no purpose (Sleep mode running)

l. Continuous use of mobile charger, mosquito mat.

m. W-H-WH – During this energy converting process, we can adopt these steps (i) Keeping "H" – the hours of usage as constant but varying "watts" (ii) Keeping "W" as constant but varying hours (iii) Controlling "WH" (combined)

Control (Equipment & Devices)

A. Switch

B. Sensor

C. Remote

D. Lighting energy saver

E. Individual or parallel operation

F. Variable speed drive or Variable frequency drive

G. Soft starter

H. Idle running cutoff

I. Star-delta connection control

On loading operation cutoff (Employing sensors)

1. Temperature or inlet air control
2. Outlet air **control**

Before delving deep, let us learn the "Energy Saving Mantra". In use the main parts are

- Measure the flow
- Monitor the flow
- Focus on controlling devices like Regulators, Main switches, Remote switches
- Adopt energy saving devices and processes
- Monitor SEC (Specific Energy Consumption)

In the case of electrical energy, the key roles played by various factors are enumerated as follows

- Quality of incoming supply as provided by the supplier (Input)
- Abnormal conditions related to voltage and current in the supply network and in the consumer premises.
- Neutral current flow; voltage imbalance noticed in the three phase network (Demand or load side of consumer)
- Introduction of DSM methods (i.e implementation of energy management practices like maximum demand ammeter, demand controller, use of "Lighting Energy Saver", Energy Saving Capacitors (Power factor improvement capacitors – fixed / variable (Automatic PC controller)
- Optimum utilization of the equipment in use.
- Periodical maintenance / preventive maintenance of the equipment in use.
- Use of star rated (Energy Efficient) equipment / devices.
- Adoption of active energy efficient methods use of harmonic filters.
- Calculation of SEC and periodically shifting its goal posts

Let me sign off here.

(To be continued)

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ADDRESS BY THE PRESIDENT OF INDIA, SHRI RAM NATH KOVIND AT THE INAUGURAL FUNCTION OF 'CONSTITUTION DAY'

New Delhi : 26.11.2019

Honorable Members of Parliament,

1. I convey my warm greetings on the occasion of 70th anniversary of the adoption of the 'Constitution of India', to all of you, and to all our fellow citizens in India and abroad.

2. It was 70 years ago, on this very day, that in this Central Hall itself, through the members of the Constituent Assembly, we the people of India adopted, enacted and gave to ourselves this constitution.

3. It was in 2015, the 125th birth anniversary year of Babasaheb Dr. Bhimrao Ambedkar that the Government of India decided to celebrate November 26, as 'Constitution Day' every year. This is a commendable initiative to reiterate our gratitude to the chief architect of our Constitution. This is, for the first time that we are celebrating the 'Constitution Day' in the Central Hall, with the participation of members of both Houses of Parliament. It is a privilege for all of us to witness and participate in this historic event.

4. By their sheer wisdom, prudence, foresight and diligence, the makers of our Constitution, prepared a futuristic and vibrant document that reflects our ideals and aspirations on the one hand, and protects the future of all Indians on the other. The 'Constitution of India' lies at the foundation of the world's largest democracy. This is the supreme law in the country's democratic framework and it continuously guides us in our endeavors. The Constitution is also the fountainhead of our democratic system of governance and our guiding light.

5. We Indians have had a tradition of maintaining our Indian identity while also welcoming noble ideas emanating from all the sources. This cultural ethos also finds its reflection in the making of our Constitution. We have adopted the best practices from several other Constitutions of other countries. In addition, the imprint of our age-old values and the ideals from our freedom struggle can also be seen in our Constitution. Our Constitution is of the people of India, by the people of India, and for the people of India. It is a national document whose different facets also reflect the democratic systems prevalent in our ancient Assemblies and Sabhas, Lichchhavis and other ancient Indian republics and the Buddhist Sanghas.

6. Under the extraordinary chairmanship of Dr. Rajendra Prasad, the constituent assembly accomplished the exceptional feat of blending and balancing different ideas and ideologies. The drafting committee of the Constituent Assembly, under the chairmanship of Dr. Bhimrao Ambedkar, displayed unparalleled prudence, honesty, grit and diligence and gave final shape to the Constitution. Our democracy finds its resonance in our Constitution. To ensure that the Constitution remains relevant over time, the makers of the Constitution also incorporated provisions allowing future generations to make necessary amendments as may be deemed necessary.

7. Indian democracy is duly regarded and respected all over the world. This year, the people of India, participated in the 17th General Election and accomplished the largest democratic exercise in the world. Over 610 million people cast their vote in this election. The participation of women voters was almost equal to that of men. The election of 78 women members to 17th Lok Sabha, being the highest number of women members ever elected to this house, is a glorious achievement for our democracy. Today, all the members of the Standing Committee of Parliament on Empowerment of Women are women. This signifies an important social and political change reflective of a bright future.

8. The people of our country deserve to be complimented for the value and respect that the Indian Constitution has earned over the last 70 years. Likewise, the three organs of the Union and State Governments, i.e., the legislature, the executive and the judiciary deserve to be complimented for the same. Strengthening the relationship and synergy between the Union and States, our journey towards 'Co-operative Federalism' is a living example of the dynamism of our Constitution.

9. While delivering his last speech in the Constituent Assembly on November 25, 1949, Dr. Ambedkar had said that the success of the Constitution would depend upon the conduct of the people of India and the political parties. The illustrious makers of our Constitution had with complete devotion and honesty, envisioned to serve and work conscientiously while remaining free from fear or favour, affection or ill-will and bias. They would have been confident that their future generations, that is, all of us, will adopt these values with the same spontaneity and integrity, as they, themselves, did. I think, in the present times, we all need to introspect and reflect upon this.

10. In one of his speeches to the Constituent Assembly, Dr. Ambedkar while underlining the importance of 'Constitutional Morality' emphasised that the essence of 'Constitutional Morality' was to regard the Constitution as supreme and to follow the constitutionally mandated procedures regardless of any ideological differences. All the three organs of the State, persons gracing the constitutional posts, members of the civil society and common citizens of India are expected to abide by 'Constitutional Morality'.

11. According to our Constitution, it is the duty of every citizen to abide by the Constitution and respect its ideals and institutions; to cherish and follow the noble ideals of our freedom struggle; to renounce practices derogatory to the dignity of women; and to value and preserve the rich heritage of our culture. The Constitution also mentions other duties of citizens.

12. Mahatma Gandhi, while speaking about rights and duties of people, had said (AND I QUOTE) "The true source of rights is duty. If we all discharge our duties, right will not be far to seek. If leaving duties unperformed we run after rights, they escape us like a will-o'-the-wisp." (UNQUOTE)

13. By incorporating the provisions relating to Fundamental Duties into our Constitution, our Parliament has made it abundantly clear that while being alert about their rights, citizens should also be conscious of their duties. 'Fundamental duties' also remind the people of their moral responsibilities. It can be said that the soul of the Constitution lies in its Preamble, and in the parts pertaining to Fundamental Rights, Directive Principles and Fundamental Duties.

14. Rights and duties are two sides of the same coin. Our Constitution provides the fundamental right to 'freedom of speech and expression' and it also enjoins upon citizens the duty to safeguard public property and to abjure violence. Therefore, if someone misconstrues the meaning of the freedom of speech and expression and is about to damage some public property, then another, who prevents him from indulging in such an act of violence and anarchy will be seen as a dutiful citizen. Therefore, we need to perform our duties and thereby create circumstances which would ensure effective protection of rights.

15. Developing the spirit of humanism is also a fundamental duty of citizens. To serve with compassion towards all, is also inherent in this duty. I would like to mention one Smt. Muktaben Dagli of Gujarat, on whom I had the honour of conferring 'Padmashri' at Rashtrapati Bhavan, this very year. Despite losing her eyesight in her childhood, she devoted her whole life to the welfare of others. She has brightened the lives of many visually impaired girls. Through her organization, she has been instilling the light of hope in the lives of numerous blind women from many states of India. Citizens like her truly uphold the ideals of our Constitution. They deserve to be called nation-builders.

16. As Members of Parliament, you have taken an oath to bear true faith and allegiance to the Constitution of India as by law established and to uphold the sovereignty and integrity of India. As the President of India, I too have taken an oath to preserve, protect and defend the Constitution and the law to the best of my ability and devote myself to the service and well-being of the people of India. We all need to be always mindful of our oath and affirmation.

17. Citizens and voters of India expect their representatives to work to solve issues related to their welfare. Most people never get to meet their own Members of Parliament. But they regard you as the guardians of their hopes and aspirations. In deference to this trust and faith, serving the people should be our foremost priority. It is indeed a great fortune to enter this holy temple of democracy and get an opportunity to serve the people of India.

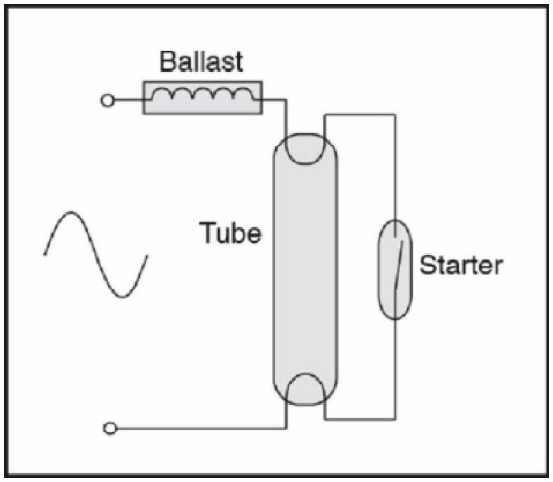
18. The most important objective and ideal presented to us by the Constitution is – to secure to all its citizens: JUSTICE, social, economic and political and EQUALITY of status and of opportunity. It is only because the Constitution makers ensured equality of opportunity that I have this opportunity to address this historic sitting of Parliament as the President of India.

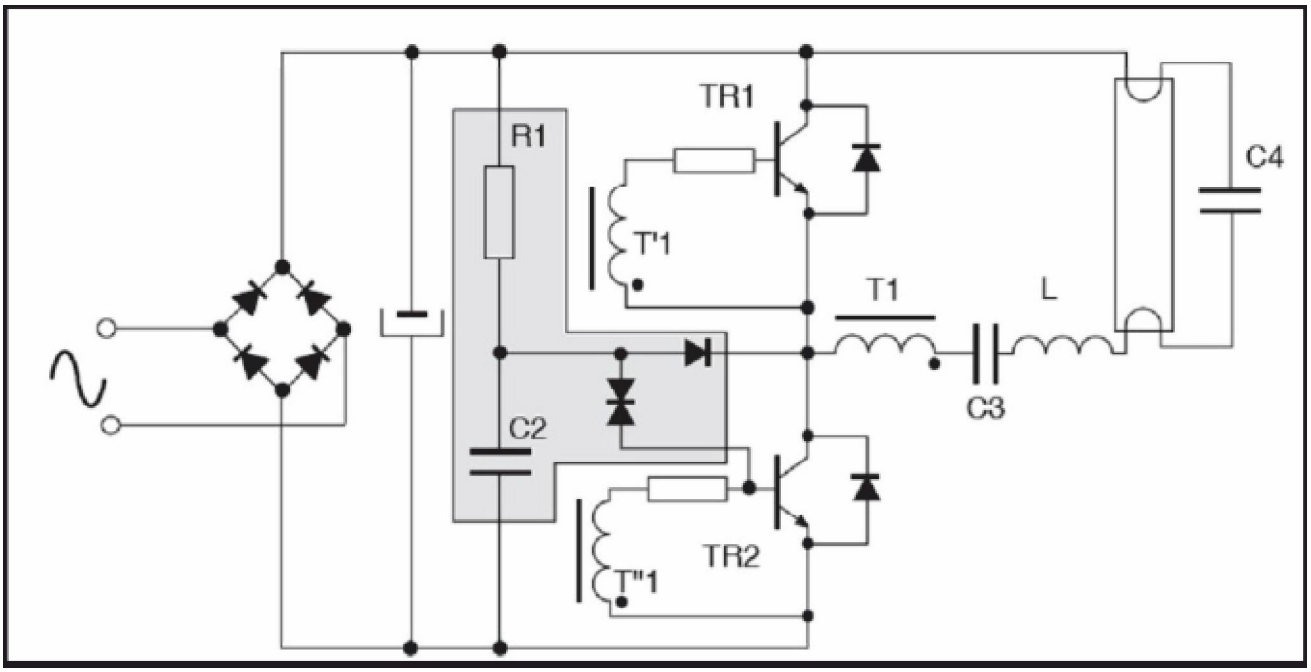
19. Our Constitution enshrines the ideal of building an inclusive society and also contains provisions for realizing it. Today is a great opportunity to convey our gratitude to the makers of our Constitution who gave us a system to bring about revolutionary changes peacefully by way of constitutional amendments. All Members of Parliament deserve appreciation for the several constitutional amendments passed during the last few years.

20. In our country, constitutional avenues are available to address all kinds of situations that we may face. Therefore, whatever we do, we must first ponder whether our action is in conformity with constitutional boundaries, dignity and morality? I am sure that, being mindful of this constitutional touchstone and consistent with our constitutional ideals, we will earn for India its rightful place in the world as an ideal democracy. Let us resolve that we, the people of India, will continuously strive to achieve the ideals of our Constitution and realize the dreams of millions of our fellow citizens.

INSTALL LIGHTING SYSTEM - 4

A current limiter, known as a ballast, must be added to prevent the current increasing to a level where the lamp is destroyed. The ballast controls the current and voltage flowing into the assembly and it may be attached directly to the lamp, or may be remotely connected.





Electronic ballasts replace the starting and inductive elements of the conventional system. The aim of using an electronic ballast is to increase the operating mains frequency of 50 Hz to over 20 kHz.

The two main effects when using an electronic ballast are:

(a) The gas in the tube does not have time to deionise between current cycles, which leads to lower power consumption (typically about 70% of that with conventional ballast), longer tube life and almost no flicker.

(b) The inductor required to generate a large enough overvoltage to ionise the tube is smaller, and so generates less resistive losses, and the weight of the system is reduced.

However, the electronic solution is more complex and has a higher initial cost although this will eventually be paid back by the savings in energy.

4.5 Explain the term stroboscopic effect.

When fluorescent lamps are operated on ac circuits, the light output creates cyclic pulsations as the current passes through zero.

This reduction in light output produces a flicker that is not usually noticeable at frequencies of 50 hertz, but may cause unpleasant stroboscopic effects when moving objects are viewed.

This cyclic flicker can be minimized by :

- Connecting fluorescent lamps to a three phase system in an industrial installation
- using a three-lamp fixture and connecting each lamp to a different phase of a three-phase system.

4.6 State the basic factors to be considered for designing a lighting installation.

The basic factors to be considered for designing a lighting installation are:

a) Architectural features of a building that can affect lighting.

b) Reflectance, diffusion and absorption of light by ceilings, walls, floor and furnishings.

c) Dimensions of space to be illuminated: ceiling heights and floor area.

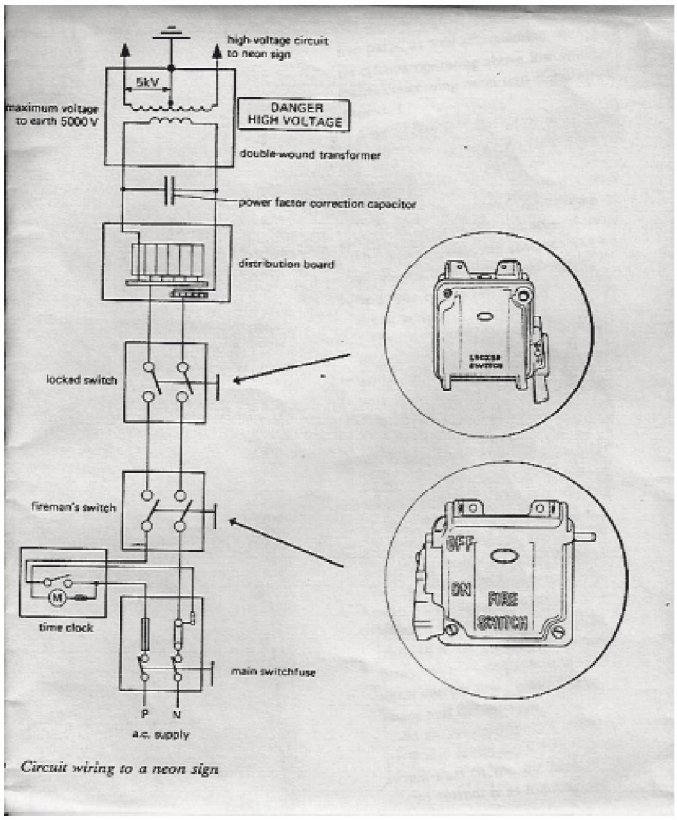
d) Proper selection of luminaries by evaluating their light distribution, efficiency, decorative value, elimination of glare and economy.

e) Height and spacing of luminaries within a room based on room function.

A well designed lighting installation is one that

- Provides adequate illumination for a particular set up
- Avoids glare and hard shadows
- Provides sufficiently uniform distribution of light all over the working plane.

4.7 Describe the operation of high-voltage signs and state the importance of firemen's switch.



Circuit wiring to a neon sign

The voltages at which H V signs operate are between 600 V and 5000 V. Thus, a 10 kV display unit could be used provided its supply transformer is centre-tapped to earth.

Where the input exceeds 500 W, means are to be provided for automatic supply disconnection in the event of a short –circuit or earth leakage current which exceeds 20 % of the normal steady current.

High-voltage discharge lamps are generally supplied by double-wound transformers and auto-transformers may be used on two – wire circuits which do not exceed 1.5 KV measured on open circuit.

All equipment are to be enclosed in an earthed metal or substantial container suitable for high voltage. A notice "**Danger – High Voltage**" is to be permanently fixed near the equipment.

Isolation of live conductors may be made by either one of the following methods:-

- An interlock on self-contained fitting to be provided in addition to the switch normally used for controlling the circuit.
- Local isolation by plug and socket or similar method in addition to normal control switch.
- Switch with removable handle.

Alternatively, a switch of a type that can be locked may be fitted if the keys are under the custody of authorised persons.

Importance of firemen's switch

A fireman's emergency switch is required for all exterior installations and unattended interior installations where they are used for window display lighting.

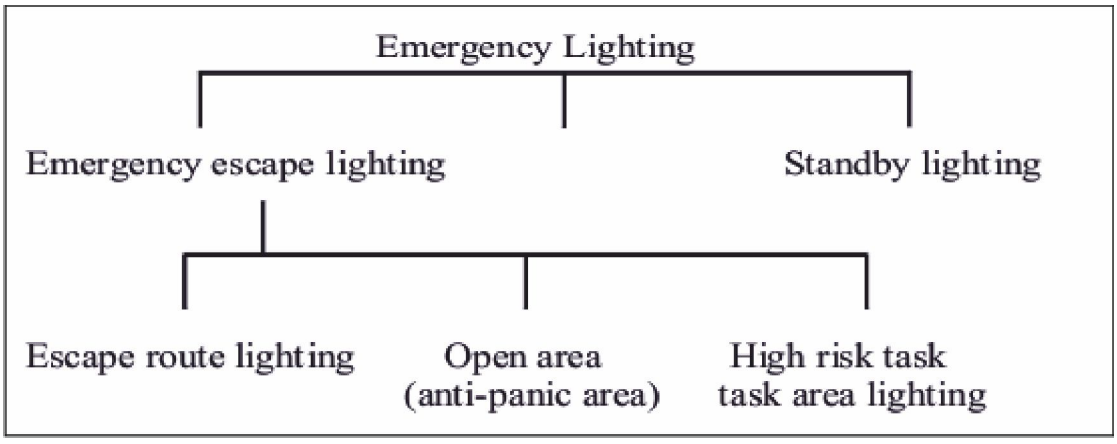
The switch must be:-

- Capable of isolating all live conductors
- Coloured red and marked FIREMAN'S SWITCH.
- Clearly marked ON and OFF with the off position at the top
- Installed in a conspicuous position
- Reasonably accessible to firemen.

4.8 State the importance of emergency lighting.

Emergency lighting is essential for the safety of building occupants. It is vital that the lighting comes on if the normal lighting fails.

It needs to be sufficiently bright, illuminated for a sufficient length of time and the light sources so positioned, that the building occupants can be evacuated safely in an emergency. Escape lighting is part of the emergency lighting which is provided to ensure that the means of escape can be safely and effectively used at all material times.



The function of escape lighting is to:

- Indicate clearly and unambiguously the escape routes.
- Provide illumination along such routes to allow safe movement towards and through the exits provided.
- Ensure that fire alarm call points and fire fighting equipment provided along escape routes can be readily located.

(To be continued)

Courtesy: Khemraz Ramduth

LIGHTING GLOSSARY - 4

RELAY:

A device that switches an electrical load on or off based on small changes in current or voltage. Examples: low voltage relay and solid state relay.

RETROFIT:

Refers to upgrading a fixture, room, or building by installing new parts or equipment.

SELF-LUMINOUS EXIT SIGN:

An illumination technology using phosphor-coated glass tubes filled with radioactive tritium gas. The exit sign uses no electricity and thus does not need to be hardwired.

SEMI-SPECULAR:

Term describing the light reflection characteristics of a material. Some light is reflected directionally, with some amount of scatter.

SHIELDING ANGLE:

The angle measured from the ceiling plane to the line of sight, where the bare lamp in a luminaire becomes visible. Higher shielding angles reduce direct glare. It is the complementary angle of the cut-off angle. (See CUTOFF ANGLE).

SPACING CRITERION:

A maximum distance that interior fixtures may be spaced that ensures uniform illumination on the work plane. The luminaire height above the work plane multiplied by the spacing criterion equals the centre-to-centre luminaire spacing.

SPECULAR:

Mirrored or polished surface. The angle of reflection is equal to the angle of incidence. This word describes the finish of the material used in some louvers and reflectors.

STARTER:

A device used with a ballast to start pre-heat fluorescent lamps.

STROBOSCOPIC EFFECT:

Condition where rotating machinery or other rapidly moving objects appear to be standing still due to the alternating current supplied to light sources. Sometimes called “strobe effect”.

T12 LAMP:

Industry standard for a fluorescent lamp that is 12 one-eighths (1 inches) in diameter. Other sizes are T10 (1 inches) and T8 (1 inch) lamps.

TANDEM WIRING:

A wiring option in which a ballast is shared by two or more luminaires. This reduces labour, materials, and energy costs. Also called “master-slave” wiring.

THERMAL FACTOR:

A factor used in lighting calculations that compensates for the change in light output of a fluorescent lamp due to a change in bulb wall temperature. It is applied when the lamp-ballast combination under consideration is different from that used in the photometric tests.

TRIGGER START:

Type of ballast commonly used with 15-watt and 20-watt straight fluorescent lamps.

TROFFER:

The term used to refer to a recessed fluorescent light fixture (combination of trough and coffer).

TUNGSTEN HALOGEN LAMP:

A gas-filled tungsten filament incandescent lamp with a lamp envelope made of quartz to withstand the high temperature. This lamp contains some halogens (namely iodine, chlorine, bromine, and fluorine), which slow the evaporation of the tungsten. Also, commonly called a quartz lamp.

TWIN-TUBE: (SEE COMPACT FLUORESCENT LAMP)

ULTRA VIOLET (UV):

Invisible radiation that is shorter in wavelength and higher in frequency than visible violet light (literally beyond the violet light).

UNDERWRITERS' LABORATORIES (UL):

An independent organization whose responsibilities include rigorous testing of electrical products. When products pass these tests, they can be labelled (and advertised) as "UL listed." UL tests for product safety only.

VANDAL-RESISTANT:

Fixtures with rugged housings, break-resistant type shielding, and tamper-proof screws.

VCP:

Abbreviation for visual comfort probability. A rating system for evaluating direct discomfort glare. This method is a subjective evaluation of visual comfort expressed as the percent of occupants of a space who will be bothered by direct glare. VCP allows for several factors: luminaire luminances at different angles of view, luminaire size, room size, luminaire mounting height, illuminance and room surface reflectivity. VCP tables are often provided as part of photometric reports.

VERY HIGH OUTPUT (VHO):

A fluorescent lamp that operates at a "very high" current (1500 mA), producing more light output than a "high output" lamp (800 mA) or standard output lamp (430 mA).

VOLT:

The standard unit of measurement for electrical potential. It defines the "force" or "pressure" of electricity.

VOLTAGE:

The difference in electrical potential between two points of an electrical circuit.

WALLWASHER:

Describes luminaires that illuminate vertical surfaces.

WATT (W):

The unit for measuring electrical power. It defines the rate of energy consumption by an electrical device when it is in operation. The energy cost of operating an electrical device is calculated as its wattage times the hours of use. In single phase circuits, it is related to volts and amps by the formula: Volts x Amps x PF = Watts. (Note: For AC circuits, PF must be included.)

WORK PLANE:

The level at which work is done and at which illuminance is specified and measured. For office applications, this is typically a horizontal plane 30 inches above the floor (desk height).

ZENITH:

The direction directly above the luminaire (180 angle)

LIGHTING FUNDAMENTALS – 1

CONTENTS

- Illumination
- Light Sources
- Ballasts
- Luminaires

A basic understanding of lighting fundamentals is essential for specifies and decision-makers who are evaluating lighting upgrades. This document provides a brief overview of design parameters, technologies, and terminology used in the lighting industry. For more detailed information about specific energy efficient lighting technologies, refer to the Lighting Upgrade Technologies document.

ILLUMINATION

- Quantity of Illumination
- Quality of Illumination

Quantity of Illumination

Light Output

The most common measure of light output (or luminous flux) is the lumen. Light sources are labeled with an output rating in lumens. For example, a T12 40watt fluorescent lamp may have a rating of 3050 lumens. Similarly, a light fixture's output can be expressed in lumens. As lamps and fixtures age and become dirty, their lumen output decreases (i.e., lumen depreciation occurs). Most lamp ratings are based on initial lumens (i.e., when the lamp is new).

Light Level

Light intensity measured on a plane at a specific location is called *illuminance*. Illuminance is measured in *foot-candles,* which are work-plane lumens per square foot. You can measure illuminance using a light meter located on the work surface where tasks are performed. Using simple arithmetic and manufacturers' photometric data, you can predict illuminance for a defined space. (Lux is the metric unit for illuminance, measured in lumens per square meter. To convert foot-candles to lux, multiply foot-candles by 10.76.)

Brightness

Another measurement of light is *luminance*, sometimes called brightness. This measures light "leaving" a surface in a particular direction, and considers the illuminance on the surface and the reflectance of the surface.

The human eye does not see illuminance~ it sees luminance. Therefore, the amount of light delivered into the space and the reflectance of the surfaces in the space affects your ability to see.

Quantity Measures

- Luminous flux is commonly called light output and is measured in lumens (lm).
- Illuminance is called light level and is measured in foot-candles (fc).
- Luminance is referred to as brightness and is measured in foot-lamberts (fL) or candelas/m^2 (cd/m^2).

Determining Target Light Levels

The Illuminating Engineering Society of North America has developed a procedure for determining the appropriate average light level for a particular space. This procedure (used extensively by designers and engineers (recommends a target light level by considering the following:

- the task(s) being performed (contrast, size, etc.)
- the ages of the occupants
- the importance of speed and accuracy

Then, the appropriate type and quantity of lamps and light fixtures may be selected based on the following: fixture efficiency

- lamp lumen output
- the reflectance of surrounding surfaces
- the effects of light losses from lamp lumen depreciation and dirt accumulation

- room size and shape
- availability of natural light (daylight)

When designing a new or upgraded lighting system, one must be careful to avoid over-lighting a space. In the past, spaces were designed for as much as 200 foot-candles in places where 50 foot-candles may not only be adequate, but superior. This was partly due to the misconception that the more light in a space, the higher the quality. Not only does over-lighting waste energy, but it can also reduce lighting quality. Refer to Exhibit 2 for light levels recommended by the Illuminating Engineering Society of North America. Within a listed range of illuminance, three factors dictate the proper level: age of the occupant(s), speed and accuracy requirements, and background contrast.

For example, to light a space that uses computers, the overhead light fixtures should provide up to 30 fc of ambient lighting. The task lights should provide the additional foot-candles needed to achieve a total illuminance of up to 50 fc for reading and writing. For illuminance recommendations for specific visual tasks, refer to the IES Lighting Handbook, 1993, or to the IES Recommended Practice No. 24 (for VDT lighting).

Quality Measures

- Visual comfort probability (VCP) indicates the percent of people who are comfortable with the glare from a fixture.
- Spacing criteria (SC) refers to the maximum recommended distance between fixtures to ensure uniformity.
- Color rendering index (CRI) indicates the color appearance of an object under a source as compared to a reference source.

Quality of Illumination

Improvements in lighting quality can yield high dividends for US businesses. Gains in worker productivity may result by providing corrected light levels with reduced glare. Although the cost of energy for lighting is substantial, it is small compared with the cost of labour. Therefore, these gains in productivity may be even more valuable than the energy savings associated with new lighting technologies. In retail spaces, attractive and comfortable lighting designs can attract clientele and enhance sales.

Three quality issues are addressed in this section.

- **glare**
- **uniformity of illuminance**
- **color rendition**

Glare

Perhaps the most important factor with respect to lighting quality is glare. Glare is a sensation caused by luminances in the visual field that are too bright. Discomfort, annoyance, or reduced productivity can result.

A bright object alone does not necessarily cause glare, but a bright object in front of a dark background, however, usually will cause glare. *Contrast* is the relationship between the luminance of an object and its background. Although the visual task generally becomes easier with increased contrast, too much contrast causes glare and makes the visual task much more difficult.

You can reduce glare or luminance ratios by not exceeding suggested light levels and by using lighting equipment designed to reduce glare. A louver or lens is commonly used to block direct viewing of a light source. Indirect lighting, or uplighting, can create a low glare environment by uniformly lighting the ceiling. Also, proper fixture placement can reduce **reflected glare** on work surfaces or computer screens. Standard data now provided with luminaire specifications include tables of its **visual comfort probability (VCP)** ratings for various room geometries. The VCP index provides an indication of the percentage of people in a given space that would find the glare from a fixture to be acceptable. A minimum VCP of 70 is recommended for commercial interiors, while luminaires with VCPs exceeding 80 are recommended in computer areas.

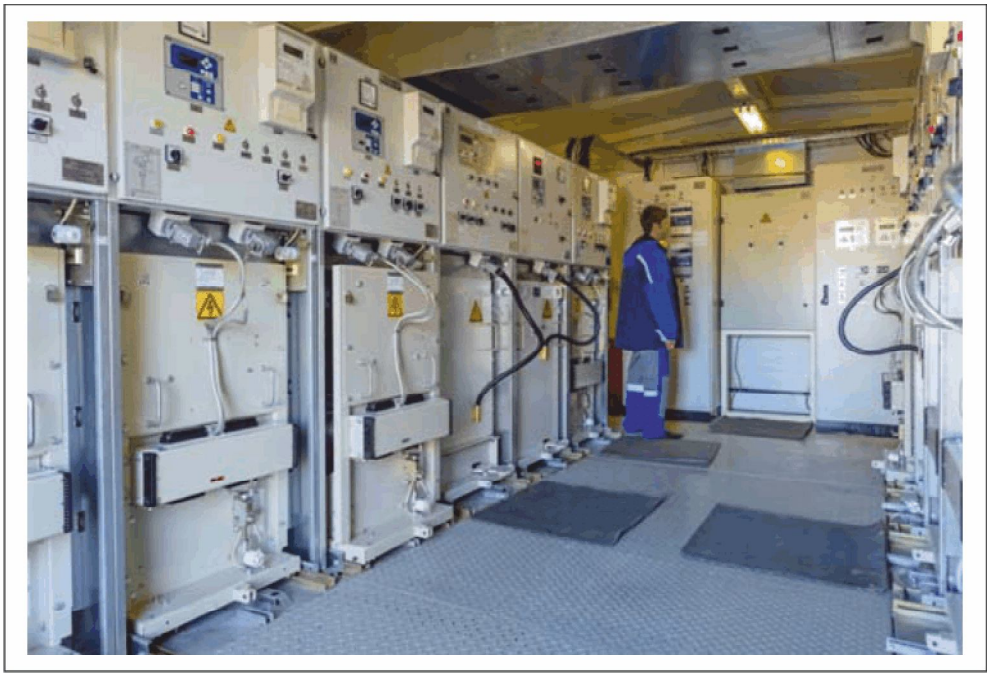
(To be continued)

Courtesy: U.S. EPA Green Lights

Democracy is "government of, by and for the people". – ABRAHAM LINCOLN

DIFFERENCE BETWEEN HIGH, MEDIUM AND LOW VOLTAGE CLASSIFICATIONS AND HOW THEY RELATE TO INDUSTRIAL GENERATORS

Voltages Divided into Classifications



High, medium, and low voltages are the terms we hear the most when talking about voltage classifications. From an international standpoint, these classifications and ranges change depending on where you live. In the United States, the National Electrical Code (NEC) and the National Electrical Manufacturer's Association (NEMA) have guidelines and standards that cover all voltage classifications. The American National Standards Institute (ANSI) oversees the creation, promulgation, and use of thousands of guidelines and standards that affect businesses. Each industry complies with applicable regulations.

Both the ANSI and the NEC code are publications that are purchased. The **Electrical Engineering Portal (EEP)** supplies a breakdown of ANSI standards C84.1-1989. This document divides voltages into five classifications. These classifications can be combined into the categories below:

- High (HV), Extra- High (EHV) & Ultra-High Voltages (UHV) - 115,000 to 1,100,000 VAC
- Medium Voltage (MV) - 2,400 to 69,000 VAC
- Low Voltage (LV) - 240 to 600 VAC

Generac issued a white paper titled **Medium Voltage On-Site Generation Overview.** The white paper compares NEC to ANSI Standards. It sites the following NEC voltage standards:

- High Distribution - 1000 to 4160 volts
- Medium Distribution - 50 to 1000 volts
- Low Distribution - 0 to 49 volts

The above lists illustrate the classification of voltage level changes depending on the governing authority. Generac states that generators less than and equal to 600 volts are medium-voltage and generators greater than 600 volts are considered high voltage. Generators producing 4160 volts are common in many industries for large motors that require high voltage. The backup generator supplies voltage to an individual grid.

Commonly stocked generator voltages are 4160 VAC, 480 VAC, 12,470 VAC, and 13,800 VAC, when power fails to an industrial facility, the backup generator supplies power to distribution and control panels for continued operations. The higher voltages from the generator are stepped down with transformers. The below content supplies information on each category of information.

NOTE:

The content in this document is for informational use only. Always consult with a certified professional when designing and working on electrical equipment. Never work on energized circuits or perform duties that you are not qualified for.

High, Extra-High and Ultra-High Voltages

High and extra-high voltages are associated with supply transmission from the power plant. The reason for transmitting power at high and extra-high voltage levels is to increase efficiency. The lower current accompanying the high voltage transmission allows for the use of thinner lighter-weight cables. This reduces the cost in the tower and electrical line construction. High voltages range from 115,000 to 230,000 VAC and Extra-High voltages range from 345,000 to 765,000

The United States transmits up to 500,000 volts on the high voltage grid. High voltages require specialized switching and distribution panels. The control rooms have redundant switching capabilities. They can be controlled remotely or placed in a manual for maintenance and testing of individual supply systems. Sub-stations provide stepped down voltage distributed to localized areas. Ultra-High voltages are voltages that are over 765,000 to 1,100,000 VAC. China is using the highest voltage transmission at 800,000 VAC. They are developing a 1,100,000 VAC system using cables rated at 1,200,000 VAC today.

Medium Voltages and Industry

Large industrial complexes and factories that require a substantial amount of power often utilize medium supply voltages. Electrical variational analysis dictates that the voltage is inversely proportional to amperage. This means that when the voltage is increased amperage is decreased to complete the operation.

Motors and electrical equipment designed to operate with higher voltages use less electricity and are more economical to operate. Most primary sub-stations do not receive more than 35,000 VAC from utility supply. The primary sub-station can supply stepped down power to secondary sub-station(s) or to a single building.

The secondary sub-station distributes power received from the primary sub-station. Secondary sub-stations can have step-down transformers to further step down the power for distribution to a control panel for distribution throughout the facility. The sub-stations are generally located in areas that can serve one or more buildings on the property.

Aluminum Company of America (ALCOA) Warrick Operations is an example of a large industry that consumes massive amounts of power. They are located in Southern Indiana and boast a self-contained power plant. They generate electricity by use of coal-fired power plant located on the Ohio River. They process aluminum ingots into rolled aluminum sheets to be used by factories that require aluminum can stock. The ingots are melted in large electric melting furnaces and then are processed through a series of operations to obtain the correct stock thickness.

Any factory that uses medium voltage supply to a sub-station requires emergency or backup power supply. It is not uncommon to see generators that supply 13,800 VAC. The voltage supply is perfect for small and medium voltage sub-stations and secondary sub-stations. With proper generator support, the complex can continue to operate during power outages. Offered in a variety of design styles including installed, sound attenuated enclosure and portable units. Portable units are enclosed in sound attenuated enclosures on a trailer pulled by a semi-tractor.

Low Voltage Supply and Controls

Low voltage has multiple meanings in the electric/electronic world. A common rule of thumb is that anything below 600 volts is considered low voltage. Factories that use automation can use multiple voltages, dividing the electrical use into supply and controls aids in understanding the usage. Each division performs a mission critical to the operation to the factory. Both must be working for production.

Supply

Factories that require medium or high voltage supply from the electric utility can have a dedicated sub-station. These substations step down voltages levels and distribute to buildings throughout the property.

There cannot be daily democracy without daily citizenship.
– RALPH NADER

However, not all factories require high or medium voltages. Some require low voltages of 240, 480, or 600 VAC from utilities. In this instance, power is routed directly the distribution system of the plant.

Controls

A system or machine that uses low voltage to operate higher voltage equipment are the basics for a control system. Programmable Logic Controller (PLC) is commonplace in these systems. The PLC receives inputs from sensors via the Input portion of the I/O. Outputs are calculated and sent out through the output section of the I/O. Both inputs and outputs are 12 or 12 VDC depending on system design.

The output can be routed to a relay with DC coil and AC contacts. When the relay receives the DC signal, its contacts close. This energizes the equipment or component until the trigger signal is removed by the I/O.

All factories require power. When utility power is lost, the industry is shut-down without the properly sized backup generator. We offer a wide range of styles of generators that can satisfy most needs. Our pre-owned generators pass a 31-point inspection prior to sales. Go to **Inventory** for a list of in stock generators. We can often ship a generator within 24-hours of purchase.

Courtesy: https://www.generatorsource.com/Articles/Generator-Info/High-Medium-and-Low-Voltage-Differences.aspx

HUMOUR

"For an optimist the glass is half full, for a pessimist it's half empty, and for an engineer is twice bigger than necessary."

"You can't spell Geek without EE."

"**Q**: What is the difference between Mechanical Engineers and Civil Engineers ?

A: Mechanical Engineers build weapons, Civil Engineers build targets."

"Some engineers are trying to measure the height of a high pole. They try building a contraption by piling up unstable ladders, but after one of them gets hurt falling off of it, a technician comes, removes the pole, lays it on the ground and measures it. One of the engineers sneers at him: '*what an idiot, he didn't measure the height, he measured the length*'..."

"Some engineer out there has solved P=NP and it's locked up in an electric eggbeater calibration routine."

What is said	**What it means**
A number of different approaches are being tried.	We don't know where we're going, but we're moving.
Developed after years of intensive research.	It was discovered by accident.
An extensive report is being prepared on a fresh approach to the problem.	We just hired three guys... We'll let them kick it around for a while.
Modifications are underway to correct certain minor difficulties.	We threw the whole thing out and are starting from scratch.
Preliminary operational tests were inconclusive.	The darn thing blew up when we threw the switch.
Test results were extremely gratifying.	It works, and boy are we surprised !
The design will be finalized in the next reporting period	We haven't started this job yet, but we've got to say something.
The entire concept is unworkable.	The only guy who understood the thing just quit.
We need close project coordination.	We should have asked someone else. *Alternate*: Let's spread the responsibility for this.

ELECTRICITY GENERATION - 1

Electricity Generation is the process of generating **electric power** from sources of **primary energy**. For **utilities** in the **electric power industry**, it is the stage prior to its **delivery** to end users (**transmission, distribution**, etc.) or its **storage** (using, for example, the **pumped-storage** method).

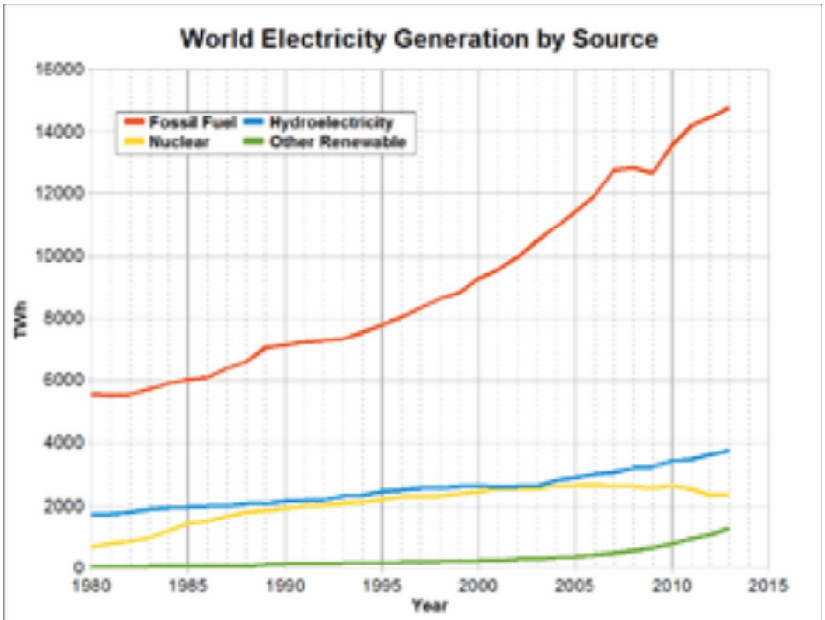


Figure 1: Electricity production in the World, 1980-2013

A characteristic of electricity is that it is not freely available in nature in large amounts, so it must be "produced" (that is, transforming other forms of energy to electricity). Production is carried out in **power stations** (also called "power plants"). Electricity is most often generated at a power plant by **electromechanical generators**, primarily driven by **heat engines** fueled by **combustion** or **nuclear fission** but also by other means such as the **kinetic energy** of flowing water and wind. Other energy sources include solar **photovoltaics** and **geothermal power.**

The fundamental principles of electricity generation were discovered in the 1820s and early 1830s by British scientist **Michael Faraday**. His method, still used today, is for electricity to be generated by the movement of a loop of wire, or **disc of copper** between the poles of a **magnet**. Central power stations became economically practical with the development of **alternating current** (AC) power transmission, using power **transformers** to transmit power at high voltage and with low loss.

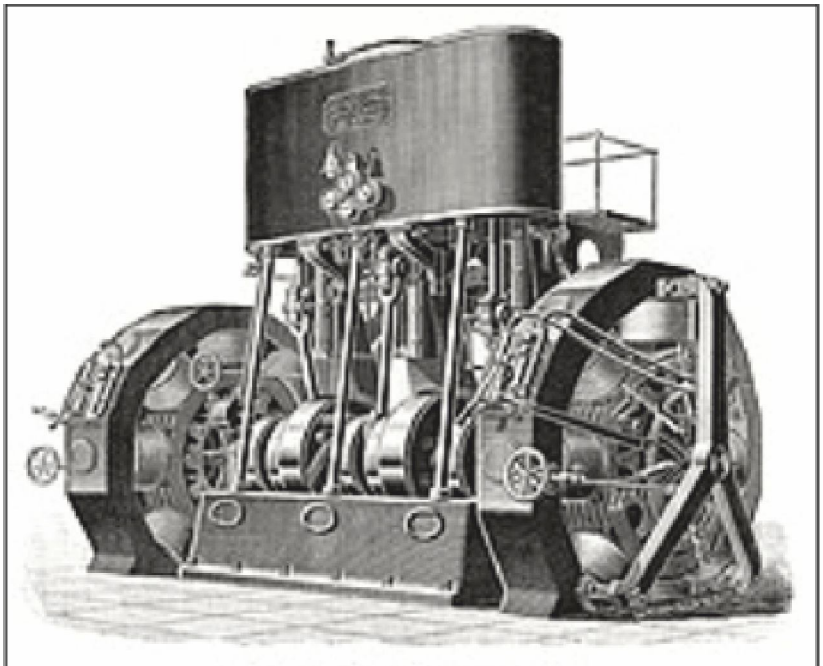


Figure 2: Dynamos and engine installed at Edison General Electric Company, New York 1895

In 1870, commercial electricity production started with the coupling of the dynamo to the hydraulic turbine. In 1870, the mechanical production of electric power began the **Second Industrial Revolution** and created inventions using the energy, whose major contributors were **Thomas Alva**

Edison and **Nikola Tesla**. Previously the only way to produce electricity was by chemical reactions or using battery cells, and the only practical use of electricity was for the **telegraph**.

Electricity generation at central power stations started in 1882, when a **steam engine** driving a dynamo at **Pearl Street Station** produced a **DC current** that powered public lighting on **Pearl Street**, **New York**. The new technology was quickly adopted by many cities around the world, which adapted their gas-fueled street lights to electric power, and soon after electric lights would be used in public buildings, in businesses, and to power public transport, such as trams and trains.

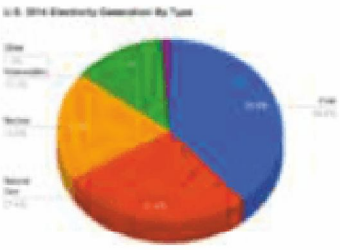


Figure 3: US 2014 electricity generation by type

The first power plants used water power or coal; and today a variety of energy sources are used, such as **coal**, **nuclear**, **natural gas**, **hydroelectric**, **wind**, and **oil**, as well as **solar energy**, **tidal power**, and **geothermal** sources. The use of power-lines and power-poles has been significantly important in the distribution of electricity.

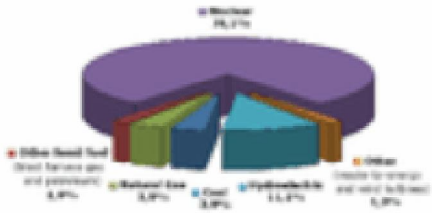


Figure 4: Sources of electricity in France in 2006.

Methods of Generation

2016 World [civil] power generation by source [IEA, 2018] (Percentages of 24.973 TWh)

Coal (38.4%)

Natural Gas (23.2%)

Hydro (16.3%)

Nuclear fission (10.4%)

Oil (3.7%)

Non hydro **renew** (8%)

Figure 5: Wind turbines usually provide electrical generation in conjunction with other methods of producing power.

Several fundamental methods exist to convert other forms of energy into electrical energy. The **triboelectric effect**, **piezoelectric effect**, and even direct capture of the energy of nuclear decay **Betavoltaics** are used in niche applications, as is a direct conversion of heat to electric power in the **thermoelectric effect**. Utility-scale generation is done by rotating electric generators or by photovoltaic systems. A very small proportion of electric power distributed by utilities is provided by batteries.

Generators

Electric generators transform **kinetic energy** into electricity. This is the most used form for generating electricity and is based on **Faraday's law**. It can be seen experimentally by rotating a magnet within closed loops of conducting material (e.g. copper wire). Almost all commercial electrical generation is done using electromagnetic induction, in which **mechanical energy** forces a generator to rotate:

A great democracy must be progressive or it will soon cease to be a great democracy. – THEODORE ROOSEVELT

LABORATORIES FOR THE 21ST CENTURY: BEST PRACTICE GUIDE EFFICIENT ELECTRIC LIGHTING IN LABORATORIES - 4

Strategy #13: Balance brightness of walls, ceiling, floor, and work-surfaces.

Balanced vertical illumination in the field of view reduces contrast, enhancing visual acuity. This can be achieved using wall-washing with down-lights on perimeter surfaces.

No other surface in a typical room will contribute more to the distribution of light than the ceiling. To aid in the proper distribution of light, a white or nearly white ceiling is recommended, with a minimum reflectance value between 0.80 and 0.85, as noted earlier. A matte finish is preferred over a semi-gloss or semi-specular finish because it eliminates the possibility of reflecting the images of bright light sources from within the indirect component of luminaires. Any colour or tint present in the ceiling material will also be contained in the light reflected off that surface, so care is needed in specifying any finish other than white or near white.

Floors have more to do with contrast reduction in the visual field than with contributing significantly to the ambient light level in a room. The reflectance value of a cream-coloured tile is 0.45, while a dark brown floor has a reflectance value of 0.1. These two colour choices will create significantly different impressions of brightness, even though the calculated illuminance levels will be almost identical.

Finally, dark bench tops and reagent shelves with miscellaneous items contribute to an impression of overall lower brightness even though the design meets the target luminance at the bench. Dark bench tops should therefore be avoided, if possible.

Figure 10: Balance of surface brightness in this lab is achieved with energy-efficient recessed lab lighting using T8 technology and compact fluorescent down lights with 4100-K lamp colour.
Photo courtesy of Pivotal Lighting Design/Affiliated Engineers

Strategy #14: Select lamps with high CRI and optimal colour temperature.

Improved colour rendition of the ambient lighting supports greater visual acuity, saving energy by allowing lower illuminance levels. Higher colour-rendering T8 and T5 light sources are also more compatible with daylight and with most compact fluorescent lamps. Specify fluorescent light sources with a minimum CRI of 82. Where colour rendition is very critical (e.g., analysis of blood specimens and organ tissues), consider the use of 5-phosphor or full spectrum lamps.

Typically, for laboratories, a colour temperature of 4100-5000K is recommended. It is important to coordinate the colour temperature of ambient and task lighting, since differences can be visually distracting.

Strategy #15: Balance uniformity and variation.

There should be a balance of light between benches, aisles and room perimeters. It is important that luminaires provide wall brightness at the tops of walls, to avoid the "cave" effect. This is especially important in labs,

because top shelves are often used for storage (even though code stipulates that nothing should be within 18 in. of the ceiling).

While a reasonable amount of uniformity is important, it is also important to have some visual variation and interest (e.g., accent lighting with wall sconces), otherwise the space will appear dull. Totally indirect lighting systems can often provide a virtually shadow-less visual environment. By flattening perspective within the evenness of surround-lighting, this lack of direct-light emphasis presents the three-dimensional lab and its accompanying apparatus to the eye as a mere two-dimensional visual task. Bench-mounted adjustable task lighting can help to enhance the visual environment significantly by adding sparkle and revealing 3D form. This adds variation and visual interest, which, in turn, support visual acuity.

Maintenance

Lighting system maintenance should be addressed beginning with the actual luminaire specification. Newer lamp technologies with reduced physical size have driven the design of sleeker, smaller luminaires. These have become correspondingly harder to physically maintain than larger versions simply because appropriate clearances between lamps, reflectors and luminaire housings are often forsaken for aesthetics. It is the lighting designer's responsibility to specify lighting fixtures that are clearly well-constructed and assembled with maintainability in mind. Accessories to avoid are those that require special tools to remove or that complicate routine maintenance procedures, such as clipped-on external baffles or louvers with sharp edges that snag dust cloths.

Codes and Standards

The IESNA Lighting Handbook is the primary reference for illumination criteria. Some of the energy efficiency requirements for laboratory lighting found in codes and standards include the following:

- ASHRAE Standard 90.1-2004 specifies lighting power densities for various space types. Laboratories are limited to 1.4 W/sf.
- California Title 24 (2005) limits lighting in high-precision work environments to 1.3 W/sf.
- The 2004 Seattle Energy Code limits lighting in laboratories to 1.8 W/sf.

Design Process Action Items

An integrated team-based approach requires involvement by all stakeholders from the very beginning of the conceptual and schematic stages. This is especially true because of the increasing complexity of most building systems, and the demand for better integration of sustainable construction techniques.

Pre-design

Define goals for daylight integration. Identify visual tasks and any special requirements (for example, RF shielding). Determine appropriate illuminance requirements, develop daylight integration strategies, and set a target for lighting installed W/sf.

Schematic Design

Conduct preliminary modeling to assess alternative fixture configurations in terms of visual performance, life cycle cost, implications for lab module design, ceiling height, maintenance, and potential for daylight integration.

Design Development

Conduct detailed modeling and mock-ups to evaluate alternative electrical lighting and control configurations. Evaluate installed W/sf, illuminance, brightness ratios, uniformity, colour rendition.

Determine zone size, switching requirements.

Construction Documents

Ensure that documents define the process for commissioning electrical lighting control systems, especially occupancy and daylight-based controls.

Conclusion

Lighting in laboratories impacts worker comfort, health and performance, and energy efficiency. Electrical lighting must always be designed as a supplement to effective daylighting. Some of the key best-practice strategies for electrical lighting include the use of direct-indirect luminaires for ambient lighting, the use of under-cabinet and/or articulated-arm task lights, and daylighting and occupancy-based controls that are properly commissioned. It is important to note that the effectiveness of lighting is a function of a wide range of performance parameters, not just task illuminance. Designers should take care to avoid overestimating required illuminance levels. An effective lighting design should achieve visual acuity by taking into account task illuminance levels in conjunction with other parameters such as surface brightness, colour rendition, and visual variation. This guide highlighted some examples of laboratories with lighting systems that meet high visual performance requirements while minimizing life-cycle energy use.

Figure 11: San Mateo County Forensic Laboratory incorporates integrated daylighting and lighting controls, contributing to anticipated energy consumption that is 50% less than mandated by California Title 24.
Source: HOK.

Courtesy: Lawrence Berkeley National Laboratory

TRANSFORMER BASICS - 1

Transformers are electrical devices consisting of two or more coils of wire used to transfer electrical energy by means of a changing magnetic field.

One of the main reasons that we use alternating AC voltages and currents in our homes and workplace's is that AC supplies can be easily generated at a convenient voltage, transformed (hence the name transformer) into much higher voltages and then distributed around the country using a national grid of pylons and cables over very long distances.

The reason for transforming the voltage to a much higher level is that higher distribution voltages implies lower currents for the same power and therefore lower I^2*R losses along the networked grid of cables. These higher AC transmission voltages and currents can then be reduced to a much lower, safer and usable voltage level where it can be used to supply electrical equipment in our homes and workplaces, and all this is possible thanks to the basic **Voltage Transformer**.

Fig 1. A Typical Voltage Transformer

The **Voltage Transformer** can be thought of as an electrical component rather than an electronic component. A transformer basically is very simple static (or stationary) electro-magnetic passive electrical device that works on the principle of Faraday's law of induction by converting electrical energy from one value to another.

The transformer does this by linking together two or more electrical circuits using a common oscillating magnetic circuit which is produced by the transformer itself. A transformer operates on the principals of "electromagnetic induction", in the form of Mutual Induction.

Mutual induction is the process by which a coil of wire magnetically induces a voltage into another coil located in close proximity to it. Then we can say that transformers work in the "magnetic domain", and transformers get their name from the fact that they "transform" one voltage or current level into another.

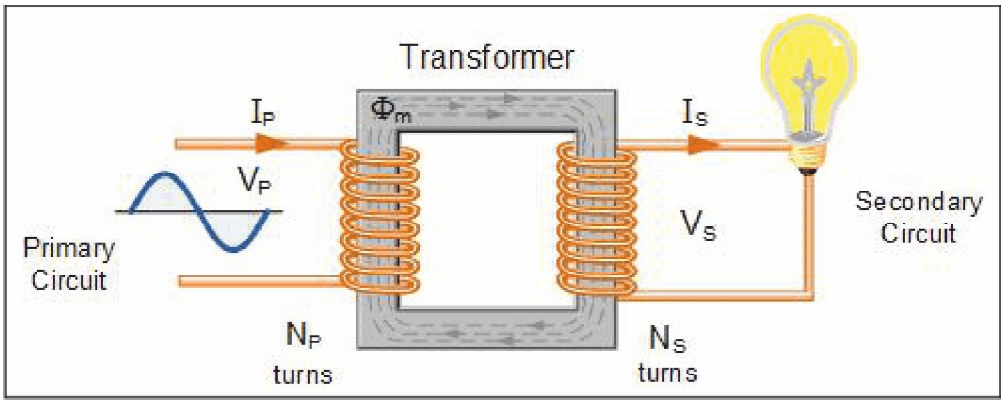
Transformers are capable of either increasing or decreasing the voltage and current levels of their supply, without modifying its frequency, or the amount of electrical power being transferred from one winding to another via the magnetic circuit.

A single phase voltage transformer basically consists of two electrical coils of wire, one called the "Primary Winding" and another called the "Secondary Winding". For this tutorial we will define the "primary" side of the transformer as the side that usually takes power, and the "secondary" as the side that usually delivers power. In a single-phase voltage transformer the primary is usually the side with the higher voltage.

These two coils are not in electrical contact with each other but are instead wrapped together around a common closed magnetic iron circuit called the "core". This soft iron core is not solid but made up of individual laminations connected together to help reduce the core's losses.

The two coil windings are electrically isolated from each other but are magnetically linked through the common core allowing electrical power to be transferred from one coil to the other. When an electric current passed through the primary winding, a magnetic field is developed which induces a voltage into the secondary winding as shown.

Single Phase Voltage Transformer



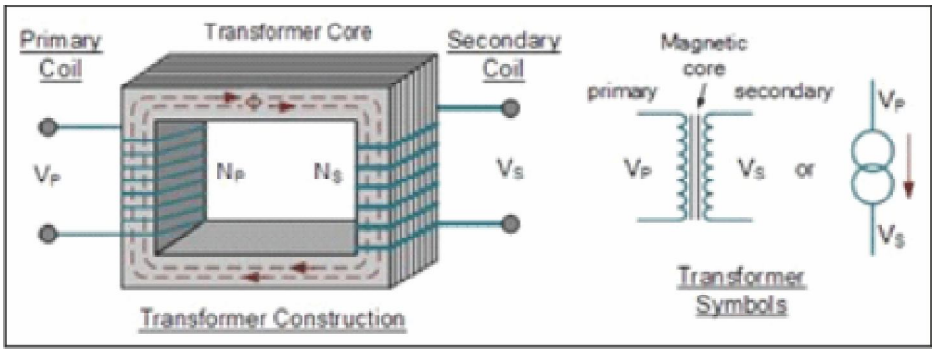
In other words, for a transformer there is no direct electrical connection between the two coil windings, thereby giving it the name also of an **Isolation Transformer**. Generally, the primary winding of a transformer is connected to the input voltage supply and converts or transforms the electrical power into a magnetic field. While the job of the secondary winding is to convert this alternating magnetic field into electrical power producing the required output voltage as shown.

Transformer Construction (single-phase)

Notice that the two coil windings are not electrically connected but are only linked magnetically. A single-phase transformer can operate to either increase or decrease the voltage applied to the primary winding. When a transformer is used to "increase" the voltage on its secondary winding with respect to the primary, it is called a **Step-up transformer**. When it is used to "decrease" the voltage on the secondary winding with respect to the primary it is called a **Step-down transformer**.

However, a third condition exists in which a transformer produces the same voltage on its secondary as is applied to its primary winding. In other words, its output is identical with respect to voltage, current and power

transferred. This type of transformer is called an "Impedance Transformer" and is mainly used for impedance matching or the isolation of adjoining electrical circuits.



Where:

- V_P – is the Primary Voltage
- V_S – is the Secondary Voltage
- N_P – is the Number of Primary Windings
- N_S – is the Number of Secondary Windings
- Φ (phi) – is the Flux Linkage

The difference in voltage between the primary and the secondary windings is achieved by changing the number of coil turns in the primary winding (N_P) compared to the number of coil turns on the secondary winding (N_S).

As the transformer is basically a linear device, a ratio now exists between the number of turns of the primary coil divided by the number of turns of the secondary coil. This ratio, called the ratio of transformation, more commonly known as a transformers "turns ratio", (TR). This turns ratio value dictates the operation of the transformer and the corresponding voltage available on the secondary winding.

It is necessary to know the ratio of the number of turns of wire on the primary winding compared to the secondary winding. The turns ratio, which has no units, compares the two windings in order and is written with a colon, such as 3:1 (3-to-1). This means in this example, that if there are 3 volts on the primary winding there will be 1 volt on the secondary winding, 3 volts-to-1 volt. Then we can see that if the ratio between the number of turns changes the resulting voltages must also change by the same ratio, and this is true.

Transformers are all about "ratios". The ratio of the primary to the secondary, the ratio of the input to the output, and the turns ratio of any given transformer will be the same as its voltage ratio. In other words for a transformer: "turns ratio = voltage ratio". The actual number of turns of wire on any winding is generally not important, just the turns ratio and this relationship is given as:

A Transformers Turns Ratio

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = n = \text{Turns Ratio}$$

Assuming an ideal transformer and the phase angles: Φ_P Φ_S

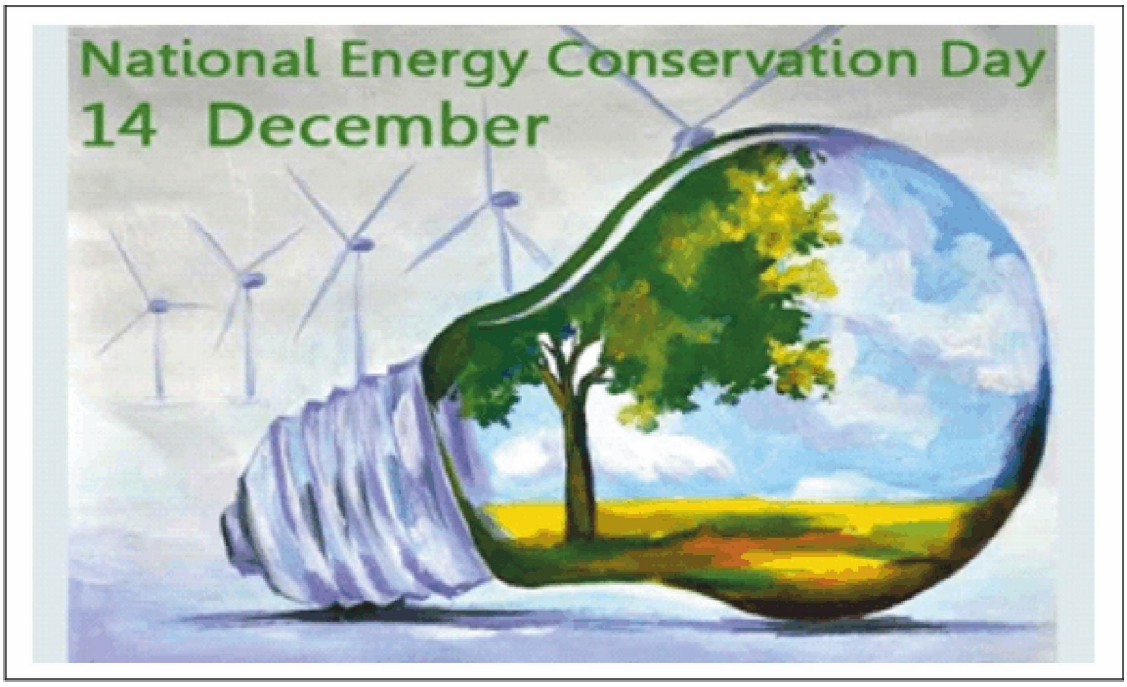
Note that the order of the numbers when expressing a transformers *turns ratio* value is very important as the turns ratio 3:1 expresses a very different transformer relationship and output voltage than one in which the turns ratio is given as: 1:3.

Courtesy: https://www.electronics-tutorials.ws/transformer/transformer-basics.html

Democracy is never a thing done.
Democracy is always something that a nation must be doing.
– ARCHIBALD MACLEISH

ENERGY INDEPENDENCE AND ENERGY SELF RELIANCE - 4

Sustainable Growth, Sustainable Energy and Renewable Energy



National Energy Conservation Day 2020

14TH December

The people all over the India on 14th of December celebrate National Energy Conservation Day every year. The Energy Conservation Act in India was executed by the Bureau of Energy Efficiency (BEE) in the year 2001. The Bureau of Energy Efficiency is a constitutional body, which comes under Government of India and helps in the development of policies and strategies in order to reduce the energy use.

What is the Energy Conservation?

National energy conservation day in India is celebrated to create awareness to people about the importance of energy as well as saving or conserving the more energy by using less energy. The exact means of energy conservation is using less energy by avoiding the unnecessary uses of energy. Using energy efficiently is very necessary to save it for the future usage. Energy conservation should be rooted in the behavior of every human being to get more effect towards the plan of energy conservation.

Objectives of National Energy Conservation Day

National energy conservation day is celebrated every year using particular theme of the year by keeping in mind some goals and objectives to make more effective all over the country among people. Some of the important goals are:

- It is celebrated to send the message of importance of conserving energy in the every walk of life among people.
- Promoting the way of process of energy conservation by organizing a lot of events such as discussions, conferences, debates, workshops, competitions and etc. all through the country.
- Promote people for less energy usage by neglecting the excessive and wasteful uses.

- Encourage people for efficient energy use in order to decrease the energy consumption and prevent the energy loss.

What are the measures for energy conservation?

- Every person can save energy by eliminating unnecessary use of fan, light, heater or other electrical instruments used in their daily life. It is the easiest and effective way to save the extra energy usage, which can be played a major role towards National Energy Conservation Campaign.
- Fossil fuels, crude oil, coal and natural gas etc. are generating enough energy to use in daily life, but their demand is increasing day by day, which creating fear of lack of natural resources in the future. Therefore, for energy conservation, we should use renewable energy resources instead of the non-renewable resources of energy.
- In many countries, government charges energy tax or carbon tax to make energy conservation effective. By this tax, imposed on high consumption of energy, use of energy has decreased and increased awareness among users about limited use of energy.

List of legislations on environment and ecology in India

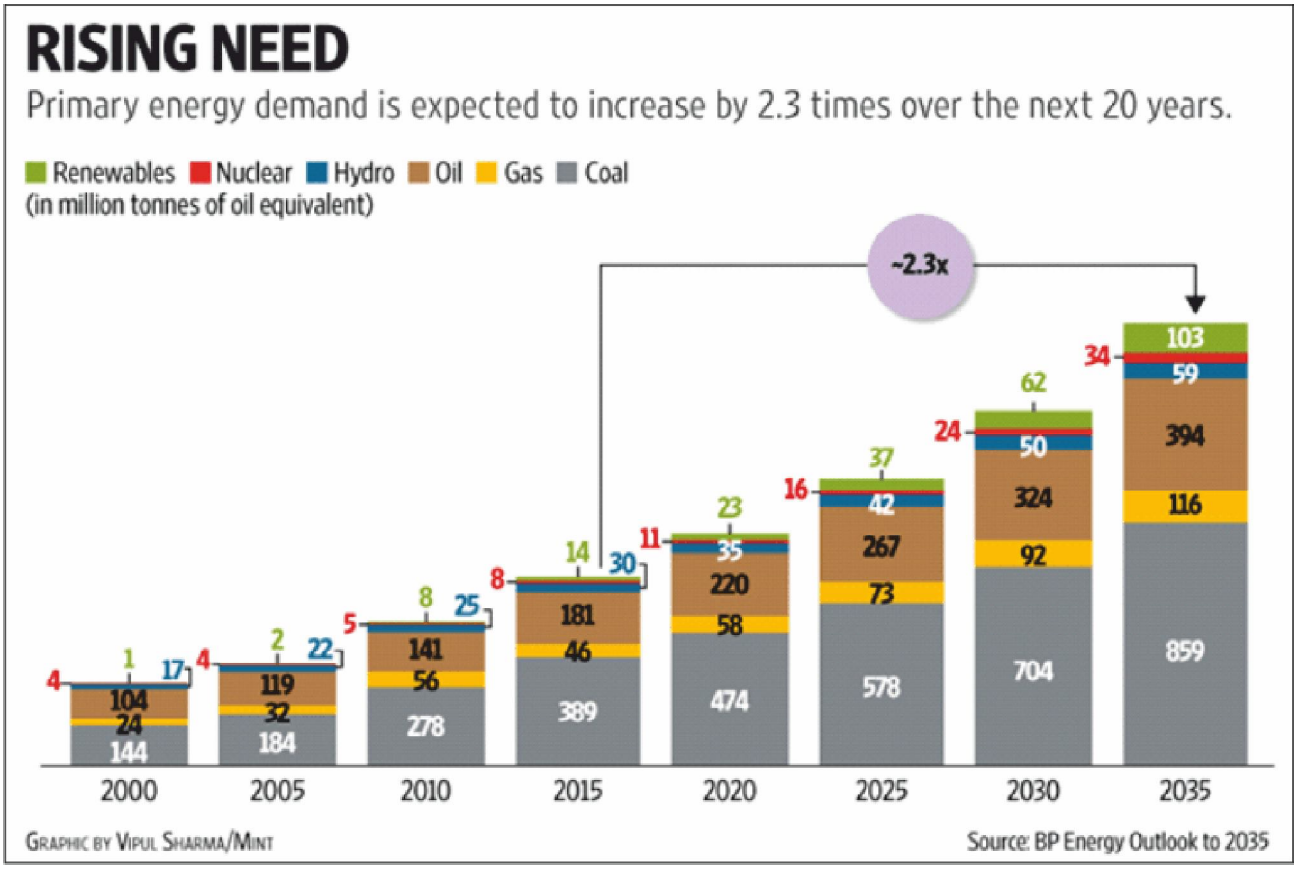
- People should be aware that more light bulbs on the workplace produces various problems like tension, headache, blood pressure, fatigue and decreases work efficiency of workers. However, in the natural light of day, level of work efficiency of workers increases and the energy consumption also decreases.
- In 1977, Petroleum Conservation Research Association (PCRA) was set up by the Indian government to promote energy conservation in the daily life of people. This is a very big step taken by the Government of India towards energy conservation. Apart from this, in 2001, the Government of India had set up another government organization named Energy Efficiency Bureau (BEE) for better energy efficiency and protection.

- Electric energy can be saved by preventing the wasteful expenditure of water by using a timer in the water tankers.
- Energy can be saved by using LED bulbs in place of 100-watt bulb or CFL.
- We should always use ISI marked electrical instruments.
- Social arrangements like marriage and religious activities should be held in daytime.
- Use maximum sunlight during the day time and keep closed unnecessary fan, light, AC.
- For street lights of residential complexes Photo Electric Control Switch should be used.
- After the construction of the buildings, we can protect buildings from being hit by covering the available part of the plot with trees / vines. As a result, those who live in the buildings will have to use fan, cooler, AC etc. at least.
- Use light colours on the inner surface of the room walls. By doing so, room can be lit up appropriately through low-energy lighting devices.
- Using a solar water heater instead of a geyser to heat water and solar cooker to cook food, we protect precious power energy and can become a partner in national interest. If you use geyser, then use it for a minimum period. For this, temperature setting of thermostat and timer should be taken care of.

Potentials and the important role of Bio Energy in Energy Self Reliance in India.

Rising Need and Rising challenges in changeover to Green Fuels

Expert projections of Primary Energy Demand are **given below** with 'Business as usual' kind of situation.



As detailed in the earlier presentation, sizable efforts, technology progress, Government support, and initiatives with regard to Bio CNG can help reduce the Petroleum and Natural Gas consumptions by renewables to some extent. The oil and gas (2020) demands are put at total of 278 Million Tons of Oil Equivalent and the plans for

Bio CNG are for 15 Million Tons of Oil Equivalent replacement. There is certainly a long way to go and development and adoption of new technologies particularly in the area of Bio oil/crude from Biomass can help substantially, given the potentials in our country.

Other important and potential areas are blending of Diesel and Petrol with Biofuels like Bio Diesel and Ethanol, in which lot of initiatives and work has been going on for quite some years now. Some of the reasons for the slow progress with suggested remedies are given below taken from some of the studies.

Biofuels – Flashes of successes and problems.

In August 2018, Spice Jet airline made history in the Indian transportation sector. A journey of about 285 kilometres from Dehradun (in Uttarakhand) to New Delhi was completed with a fuel, which had its origins in the farms of Chhattisgarh. A successful flight of about 45 minutes added India in the list of few nations (like the US and Australia) who have used biofuel for flying airplanes.

That flight did not only take 20 people to the sky but also inflated the hopes of the Indian biofuel sector.

Rapid urbanization and an increasing population compel India to accommodate more vehicles on the roads, which indirectly means more crude oil imports and carbon emissions. India's smart move to tackle this dual problem was to launch a policy, which could reduce the crude oil import along with handling the environmental crisis. Biofuel, which is a mixture of ethanol (sourced from plants and other wastes) with petrol or diesel is much cheaper than unblended fuel and emits less carbon.

The biofuel-propelled flight was not a sudden development. The history of ethanol production in India can be traced back to 1948, with the enactment of the Indian Power Alcohol Act. During the 1970s, research was conducted to find the feasibility of ethanol and in 2002; a notification mandated the blending of five percent ethanol with petrol by Oil Marketing Companies (OMCs) in nine states and four Union territories of the country. In 2008, the National Biofuel Policy (NBP) was adopted in an effective manner to regulate the market with standard legal guidelines. The NBP 2008 targeted to mix 20% ethanol in petrol and 20% biodiesel in diesel by 2017.

A few days before the Spice Jet plane took flight in 2018, Prime Minister Narendra Modi gave a speech on World Biofuel Day on August 10. He emphasized that biofuel is the link between India's economics and environment and mentioned that the government targets to save more than Rs 200 billion (Rs. 20,000 crore) in foreign exchange by biofuel blending. Apart from this, focus on employment generation, increasing farmer's income, rural development painted a very progressive image of biofuels.

Nevertheless, India's dream of carbonless growth and reduced imports of fossil fuel would have been easy to achieve — if biofuel blending was as convenient.

What is stopping the biofuel business?

In 2017, India was mixing only 2% and 0.1% of ethanol and biodiesel to petrol and diesel respectively. Underperformance from 2008 and futuristic hopes led India to set up a new target. The NBP 2018 promised 20% ethanol mixing in petrol and 5% biodiesel in diesel by 2030.

In a market where there are huge subsidies for fossil fuel, the entry of renewable energy is difficult, if not impossible. Fossil fuel has a history of over 200 years and subsidies as high as seven times compared to the renewable sector. It is difficult for any renewable energy to blossom without appropriate support and encouragement in such an environment.

Both the targets set in 2002 and 2008 failed, mainly due to the insufficiency of biomass. The 72-seater Bombardier Q400 aircraft of Spice Jet could reduce the carbon emission by 15% than usual by using 350 kilograms of biomass. India targets to reduce the carbon emission by 20,000 tons by blending 10 million (one crore) litres of ethanol in the fuel. However, the availability of biomass for ethanol production is far less than the demand.

The countries which are pioneers in biofuel blending (like US and Brazil) use biofuel sourced mainly from sugarcane, palm oil and other 1G, i.e. edible biomass sources. However, Jatropha and agricultural wastes (2G and 3G sources) are the mascots of India's biofuel plans. After close consideration and acute analysis, India promoted Jatropha on wastelands and other agricultural waste for biofuel production to save the debate of food versus fuel.

Jatropha was procured from about 500 farmers for the Spice Jet flight on August 27, 2018. However, even after the state and central government's support and incentives to promote crop production, the production of biomass has failed to meet the demands of the country. One of the reasons is the lack of research for the development of high-yielding, drought-tolerant Jatropha seeds.

Reports suggest that only 0.5 million hectares are currently under Jatropha cultivation. The Indian transportation sector is expected to consume about 117 million litres and 42 million litres of diesel and petrol, respectively in 2030. Considering those, to reach the targets by 2030, India would need to increase production by 22%.

The non-availability of the biomass is also accredited to the seasonal availability of biomass and unreliable biomass supply chain. Ajay Lahane has been associated with green energy production and biomass supply chain since 2011. Lahane, who runs a startup named EcoOpus Agri Ventures Private Limited (ECOOPUS) states that "the biomass supply chain has been totally ignored by the policy which makes the proper availability of the biomass difficult and hence the refineries would struggle to make the ethanol production economical and efficient."

Biomass refineries not only struggle with the procurement of the efficient biomass but also with making the whole process economically sound. India's focus on advanced biofuels demands expensive and advanced technology along with huge investments in research and development. The pace with which the biofuel industry

In a democracy the poor will have more power than the rich, because there are more of them, the will of the majority is supreme. – ARISTOTLE

is shaping up is very slow. Following India's targets of biofuel generation from waste and crop residues induce more uncertainties. India is lagging with respect to the necessary time to design and construct commercial-scale advanced bio refineries.

This business cannot be just usual

India's biofuel policy is a sunrise sectoral industrial policy, which focuses on supporting and encouraging the entry of newcomers in the green space. To save the industry from external and market shocks, import and export of biofuel is prohibited in the country and domestically produced biodiesel is exempt from taxes and duties however, there is a dearth of additional incentives for biofuel blenders and retailers. Though India's jump to advanced biofuel is laudable, the technology and efficiency of such bio refineries are still in the nascent stage.

Focusing on the private players, the government has also committed to viability gap funding of up to 40% for infrastructure development. The total amount committed is Rs. 50 billion (Rs. 5,000 crore). However, this level of funding is too small to support 2G/ 3G biofuel refineries, considering that development of one 100 kiloliters per day (klpd) bio-refinery will require around Rs.8 to 9 billion (Rs.800 – 900 crore) capital investment.

After bio refineries, comes the stage of retail marketing. The final blending of ethanol with fossil fuel is done by the public and private sector Oil Marketing Companies (OMCs). The six public sector OMCs – Indian Oil Corporation Ltd (IOCL), Hindustan Petroleum Corporation Ltd (HPCL), Bharat Petroleum Corporation Ltd (BPCL), Numaligarh Refinery Ltd (NRL), Mangalore Refinery & Petrochemicals Ltd (MRPL), Bharat Oman Refineries Ltd (BORL) – along with some private companies like Reliance, Essar and Shell are responsible for the retail marketing. It is estimated that the OMCs are in the process of setting up 12 2G bio refineries with an investment of around Rs. 100 billion (Rs.10,000 crore). However, this development would not translate into much progress without proper infrastructural investment in the rural areas, proper marketing of biofuels and supply chain management.

Mistakes are an inevitable and inescapable part of green industrial policies. In fact, too few mistakes are a sign of underperformance. Efficiency, effectiveness and legitimacy are the components required to make a green project successful. Missing any one of these interrelated components might fail the policy. What is needed is a set of mechanisms that recognizes errors and revises policies accordingly. The regulator bodies like the National Biofuel Committee have to guide the policy better.

Given the production capacity of biomass by the country, the available technology and the incentives and investment might not be able to push forward biofuel as part of the policy targets. Scholars have estimated with substantial policy support, India might reach the target of about 6% blending with petrol and about 4% blending with diesel by 2030 using advanced biofuels.

The 25% of ethanol blending for the Spice Jet flight was a onetime stunt, which India performed very well and gained global attention. However, to make the policy successful India needs to integrate the economic, environment and market aspects of biofuel production. Finance is always scarce for green industries and this is where the public sector has to jump in and uplift the renewable sector by attracting private investment.

(To be continued)

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Democracy is not just a question of having a vote.
It consists of strengthening each citizen's
possibility and capacity to participate in
the deliberations involved in life in society.
– FERNANDO CARDOSO

Section III

Installation of Solar Panel

3.1 Introduction

Solar modules are to be installed firmly and permanently on metallic structures. The structures depend on the application and size of the system. For smaller systems like solar home systems, simple module mounting structures are used. For systems like solar streetlights, solar powered signal lighting, solar pumps etc. pole mounting module frames are used. For bigger systems like Solar Power Plants and Solar Powered Railway Signaling Installations, bigger array mounting structures are used.

3.2 Testing before installation

Before installation the solar panels are tested at the manufacturing unit to check for the following parameters:

- Voc-Open circuit voltage
- Isc-Short circuit current
- Vmax- Maximum Voltage
- Imax- Maximum Current
- Pmax- Maximum power at Standard Test Conditions or Peak Power Output.

The following table shows typical user's specifications of different modules:

Table B

Peak Power Output (Pmax)	Nominal Voltage	Open Circuit Voltage (Voc)	Short circuit Current (Isc)	Max. Voltage (Vmax) at Pmax	Max Current (Imax) at Pmax
4W	6V	>11.5V	>0.63A	8.5V	0.47A
4W	12V	>21V	>0.3A	16.7V	0.23A
8W	12V	>21V	>0.56A	16.7V	0.47A
10W	12V	>21V	>0.70A	16.7V	0.59A
12W	12V	>21V	>0.84A	16.7V	0.71A
18W	12V	>21V	>1.26A	16.7V	1.07A
35W	12V	>21V	>2.4A	16.7V	2.09A
40W	12V	>21V	>2.7A	16.7V	2.39A
50W	12V	>21V	>3.3A	16.7V	2.99A
65W	12V	>21V	>4.0A	16.7V	3.89A
70W	12V	>21V	>4.5A	16.7V	4.19A
75W	12V	>21V	>5.0A	16.7V	4.49A
90W	12V	>21V	>6.0A	16.7V	5.38A

The above values are at standard testing conditions such as 25-degree cell temperature and 100-mW/Sq.cm solar radiation. The output will be reduced as temperature rises and intensity of sunlight reduces. Although accurate power is measured with the help of Module Tester at supplier's end, however to check working of module Voc and Isc can be measured at site as shown in Fig.7 (a) & (b) by simple multimeter in two different modes i.e. Current mode and Voltage mode when module is placed in sunlight. The solar panel is kept in such a position that it receives maximum sunlight.

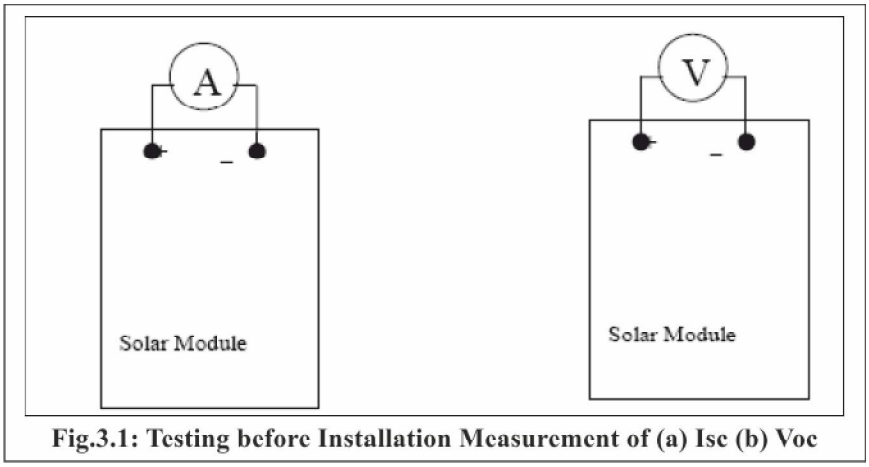


Fig.3.1: Testing before Installation Measurement of (a) Isc (b) Voc

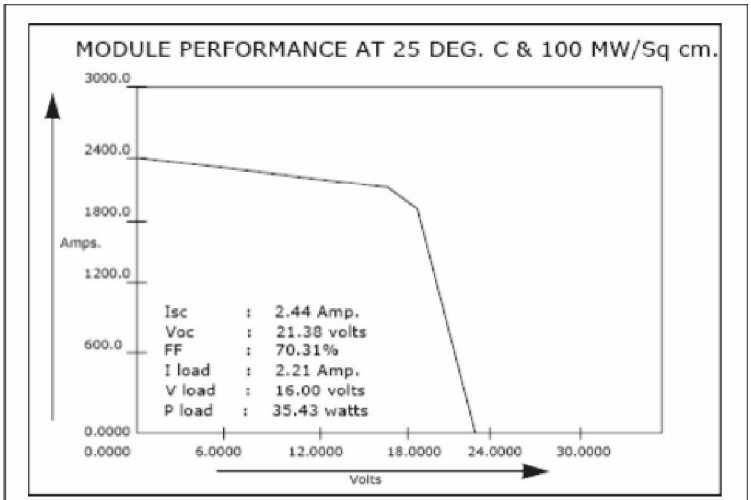


Fig.3.2: IV curve of a 35 Watt Solar Module

The typical I-V curve of a 35-Watt module with 36 series connected cells is illustrated in Fig 8.

3.3 Installation guidelines

The installation of Solar Power System involves the following major steps:

- Civil Foundation Job
- Assembly and fixing of support structure.
- Mounting of Solar Modules on the Support Structure.
- Installation of Battery Bank.
- Interconnection of SPV panel in series & parallel configuration, Charge Control Unit and FJB
- Connection of Battery Bank and Load
- Earthing of Lightning Protection Unit.

3.3.1 Mounting the Solar Modules

For mounting the solar panels first determine mounting method i.e. Roof mount or Ground mount.

While mounting the solar Modules, following points should be considered for getting maximum output from the solar modules:

- Modules should be oriented south facing to receive maximum sunlight.
- The Modules produce more power at low temperature and full sun.
- Tracking the Sun increases the amount of power from an array

The Solar panels are generally installed in such a way that they can receive maximum direct sunlight without shade from any building/trees nearby falling on them at any part of the day.

As we know that the Sun rises in the East and sets in the West as a result of Earth's rotation around its own axis. Also the Earth revolves around the Sun. Due to these two movements there is variation in the angle at which the Sun's rays fall on Earth's surface over a year. At any particular place on Earth this variation in angle in one year may be upto 45 degrees. Considering these facts the following guidelines are to be kept in mind while installing solar panels:

1. Solar panels should be installed at an angle of '(LATITUDE of the place + 10) degree' from horizontal. For example, New Delhi has a latitude of 26 degree, hence any solar panel in New Delhi is to be installed at an angle of 26 + 10 = 36 degree inclined to horizontal.
2. Solar panels should be installed South facing in the Northern hemisphere and North facing in the Southern hemisphere. Since India is in the Northern hemisphere, Solar panels will be installed always South facing in our country. The directions North- South may be found with the help of Magnetic Compass. The picture given in Fig 3.3 illustrates this.

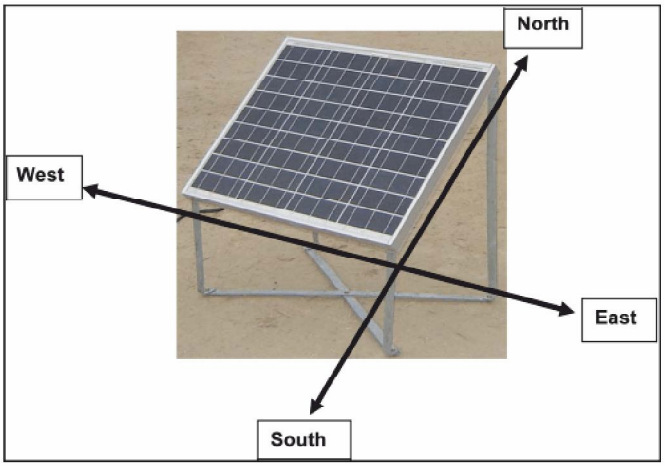


Fig.3.3: A Solar Panel installation

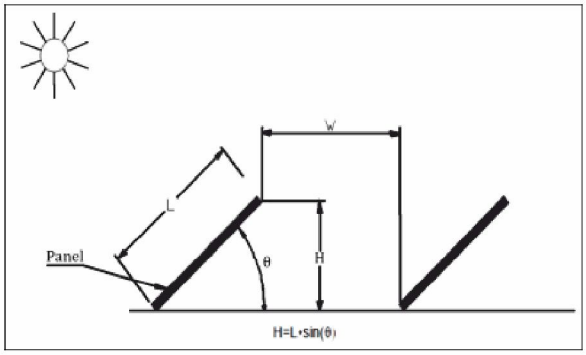


Fig.3.4: Sketch showing Panel Height, spacing between adjacent rows and angle of tilt

3. Any obstruction (such as tree or building) should be avoided in East, West or South of the place of installation. The following is the criteria:
   i. East or West: The distance between solar panel and obstruction should be more than double the height of obstruction.
   ii. South: The distance should be more than half the height of obstruction.

4. The support for the Solar panel need to be a robust one and should not be accessible to general public. It should be so installed that rainwater, bird dropping, leaves etc. do not accumulate and the top surface can be cleaned easily.
5. Calculate Tilt of Array
6. Calculate Space between Rows to avoid shadow.
   (i) Distance between adjacent rows of structures has to be maintained so that the shadow can be avoided.
   (ii) Calculate or measure panel height H.
   (iii) Locate the PV site Latitude.
   (iv) The minimum panel spacing W is given by the formula W = H X U
   (v) Where H is the vertical height of the panel from the base as shown in fig. below.
   (vi) U can be determined from the table C given below, corresponding to the latitude of PV site.

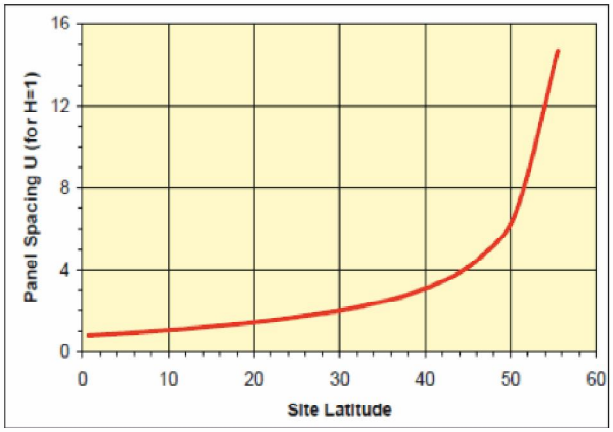


Fig.3.5: Panel spacing versus Site Latitude


Fig.3.6: A solar panel installation

Table C

Latitude	U	Latitude	U
0	0.614	39	2.818
10	0.885	40	2.972
20	1.259	41	3.166
28	1.699	42	3.359
30	1.842	44	3.844
32	2.001	46	4.499
34	2.195	50	6.547
36	2.404	55	14.520
38	2.667		

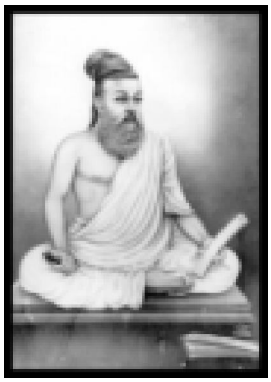
(To be continued)

Courtesy: CAMTECH Gwalior

The people who own the country ought to govern it.

– JOHN KAY

TENETS FROM TIRUKKURAL FOR EDUCATION, KNOWLEDGE AND UNDERSTANDING



Knowledge and Understanding are the topics dealt by Tiruvalluvar following closely after Tenets on Education. As we understand, Education is the foundation on which Knowledge, Wisdom and understanding (***Arivudaimai)*** are built for leading a successful and harmonious life. Under the heading of ***Arivudaimai,*** Tiruvalluvar gives his directions as to how we should understand and deal with the World at large. We are a large Nation with lot of diversity and with lot of languages,(22 languages are recognized as official languages of India, and our currencies print 14 languages) and our nation itself is a mini world and we deal with the world at large with great ease and need as interdependence is the order of the day.

Tiruvalluvar conveys two important points about dealing with the world, our mini world as well as the world at large. The first one is – understand and conform to the ways of the world and the second one is – learn to attach yourself with all persons and deal with the world with even temper. We can derive that the fundamental point that comes out is communication with ease, clarity and love, in the language they like and understand.

"Evvathu Uraivathu Ulagam Ulagaththodu Avvathu Uraivathu Arivu" Kural 426

எவ்வ துறைவது உலகம் உலகத்தோடு
அவ்வ துறைவ தறிவு. குறள் 426

"It is part of the wisdom to conform to the ways of the world"

"Ulagam Thazheeyathu Otpam; Malarthalum Koombalum Illathu Arivu" Kural 425

உலகம் தழீஇய தொட்பம் மலர்தலும்
கூம்பலும் இல்ல தறிவு. குறள் 425

"The wise men attacheth all men to **himself; and his temper is ever even, neither expanding nor contracting to excess"**

HOME FESTIVALS - 1

தை - Thai (Mid-January/Mid-February)

At left the Sun god, Surya, is being worshipped with the outdoor cooking of a large pot of rice from the recent harvest. The overflowing of the dish is called **"pongalo-pongal"**, and thus this festival is known as **Thai Pongal**. Other crops, like sugarcane, bananas and turmeric, are also offered. *Kolams* (hand-made rice flour patterns) are drawn in the form of the chariot, with the Sun and Moon in the centre. On this day cows and other animals are decorated and fed special foods, and their owners prostrate to them. Crows and other birds are offered food on leaves of turmeric. Sisters pray for the welfare of brothers, and elders bless the children. **Thai Pongal is celebrated by the poorest farmers and the wealthiest householders.**

(To be continued)

National
ENERGY
Conservation Day

14th December

It is a day for building up awareness regarding
**** Need for Energy Conservation ****
**** Energy Efficiency * Frugality in Energy use ****

TAMILNADU ELECTRICAL INSTALLATION ENGINEERS ASSOCIATION A GRADE

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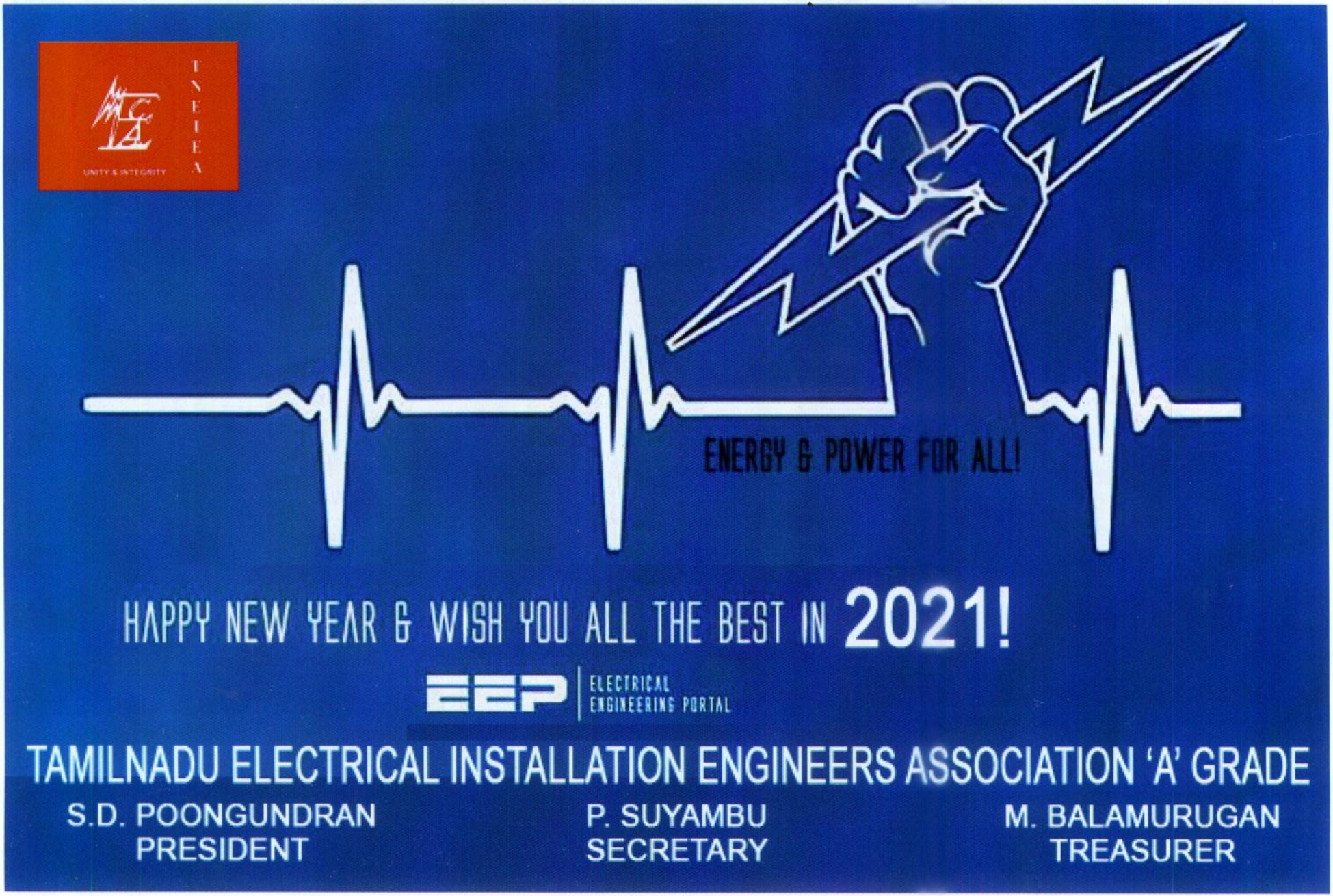
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