ELECTRICAL INSTALLATION ENGINEER

NEWS LETTER

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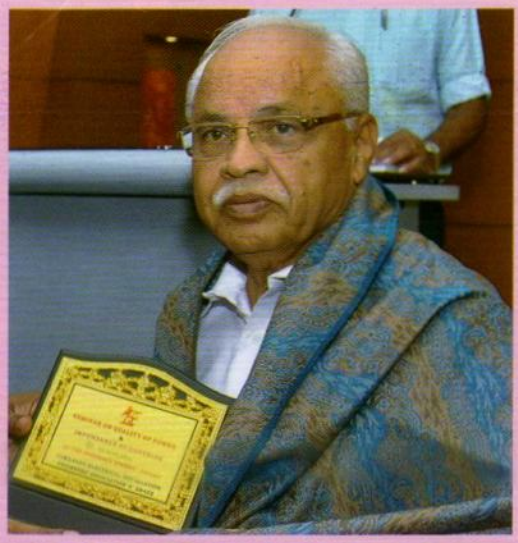
OBITUARY



Sri L.A. SRINIVASAN, Retd. CEIG
DOB: 15.11.1933
DOD: 27.07.2019

The Values and Standards you envisaged & believed in, are so deep rooted and shall remain with us forever.

In Reverence & Rememberence
Tamil Nadu Electrical Installation Engineers Association 'A' Grade, Chennai-16

A.K. Venkatasamy

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Condolence message on the demise of **Sri. L. A. Srinivasan, Retd. CEIG**

We are deeply saddened to hear about the loss of Shri. L A. Srinivasan, Retd., Chief Electrical Inspector, Government of Tamil Nadu.

He earned distinction and respect, as one of the most respected, efficient, hardworking, sincere and disciplined Officers, who represented the State of Tamil Nadu, in many forums and associated with various State level Committees and helped in the formulation of Rules and Standards at the National level.

He was a kind, caring, sympathetic wonderful person and cherished by everyone, who knew him.

With a heavy heart, we pray for the eternal repose of one, who was a man of distinguished humanity.

Condolences to the bereaved family.

May his soul rest in peace.

A.K.Venkatasamy

EDITORIAL

Dear Members, Fellow Professionals and Friends,

Seasons Greetings To One And All!

Happy Independence Day!!

The month of August spanning across the Tamil months of Aadi and Aavani is a very important month both for the history of our Nation and for the auspicious festivals across Tamilnadu and various states. Generally this is the month when fresh waters flood Cauvery and all areas are green with agricultural activities, but there are delays this year too due to delayed rains and the waters are just flowing into Mettur Dam and good days should follow soon.

Many important activities of Freedom Movement, be it Home Rule Movement or Swaraj Movement or Quit India Movement were all flagged off in the month of August in various years ultimately resulting in Freedom for our country on 15th of August 1947. We can feel proud that we are praised by the whole World as one of the largest and successful Democracies of the World. August 15th this year is the first Independence Day after the successful conduct of 17th General Elections in May '19. We have been celebrating Independence Day year after year and growing steadily in all areas of Economics, Social Welfare, Science, Engineering and Technology. Our achievements particularly in the areas of Space, Energy and Agriculture are remarkable with a huge potential yet remaining to be tapped. Our standards have improved in all aspects, but we still have a lot to do in terms of poverty alleviation, cleanliness and health etc. We should also be aware of the various ills that plague the county's progress like corruption, black money, political maneuvering with castes and religion and so on and support the strong measures that are initiated to curb them. There are 4 'P's, namely – **Power, Patriotism, Pride and Profit** - that are identified as important dimensions to analyze any situation or leaders or individuals. **Power** is very necessary to steer growth but misuse of Power and Power mongering should be curbed with strong measures. Similarly **Profit** or Economic surplus for individuals, enterprises and the Nation as whole is very important for stable growth and prosperity, but profiteering, evasion of taxes and hoarding of wealth should all be dealt with iron hands. **Patriotism** and **Pride** are on the wean since Independence, partly because of perverted and selfish political activities of a sizable section of people in the country and largely because of Education System failing to instill these qualities in the children and youth of this country. We, as a Nation, have lot of things to be proud of like our civilization, arts, literature, culture, heritage, natural resources, global economic superiority till about 150 years back which is being regained now and so on, which must be reinstilled in the youth of our country through proper education system.

Storage, distribution and appropriate and controlled usage of all waters of our country, increasing productivity both in Agriculture and Industries, working towards Energy Conservation, Energy Efficiency, Energy Security, Energy Freedom and to tap more of our renewable Energy sources are all some of the immediate challenges to be addressed and let us take a resolve to contribute our individual mite in all these activities and to support the measures initiated by Government through various 'Missions' addressing these.

We thank all those members who have helped us by participating in the advertisement appearing for the issue July 2019 – Elecxpo, Galaxy Earthing Electrodes Pvt. Ltd., Indo Swiss, Power Cable, Power Square Engineers (Indotech Transformers Ltd.), Supreme Power Equipment Pvt. Ltd., Visewham Electricals.

EDITOR

Thiru. K. Suresh Pandi
05.06.1981 – 25.07.2019

OBITUARY

On behalf of The Tamilnadu Electrical Installation Engineers Association 'A' Grade extends **Heartfelt Condolences** for the demise of Our Member **Thiru. K. Suresh Pandi, Proprietor, *I Engineering***, Madurai – 625 016**.**

We pray the almighty to rest his Soul in Peace.

ELECTRICAL INSTALLATION ENGINEER

President : S.D. POONGUNDRAN
Secretary : P. SUYAMBU
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CONTENTS

KNOW THY POWER NETWORK – 143

Having learnt Power Quality Issues, you may be interested to learn more about them, especially the one that related to "Harmonics". It is one of the severe stress components of electric power supply experienced by the equipment that invariably drive the electrical equipment and devices to their edges.

More on Harmonics

1) What is Harmonics?

Normal electric voltage/current wave form or the one generated at the power stations, is "Sinusoidal" i.e. its variations in amplitude with respect to time follow a "Sine Wave" form. In reality, the presence of higher frequency waves in the supply wave form disterts its sine wave form; the final wave form of supply thus received at the consumers's ends is totally different from the one generated at generating stations. This kind of wave form distortion, as a consequence of the unwanted entry of lower/higher frequency waves other than the fundamental, leads to this power pollution. i.e. it looses its purity. The presence of lower/higher frequency waves, other than the one at fundamental frequency (SOHz waves) is called "Harmonics". These external frequency waves that actually super impose and piggy ride on SOHz waves and brought its distortion/downfall.

Predominant among them are 150Hz, 250Hz and 350Hz waves (3rd, 5th and 7th Harmonics) and lower level intra Harmonics.

2) How this wave form distortion happens?

Put in other words, how this polluting waves ingress into fundamental/power frequency wave shape?

You may be surprised to note that this contamination is brought only by the consumers, to a greater extent. They are responsible for the down fall of their own equipment and devices. Kindly recall the aphorism, I have quoted in my last article – "give something and get something". In the instant case, the consumers need the smooth functioning of their Power electronic equipment like Light energy saver and Servo voltage stabiliser and consumer electronic devices like Televisions, Computers, Invertors and Electronic Chokes. So they pay the price for their usage. The use of modern day devices make our life smart but we have to pay heavily in terms of Harmonics and other adverse impacts. These modern power electronic equipment and devices function as "non-linear loads". i.e they demand non-sinusoidal currents with scattered or distorted waves. i.e. they cannot operate with normal SOHz current wave forms for their working. This results in the creation of Harmonics.

Thus this contamination intentionally or knowingly carried out for the survival or effective functioning of our electronic devices/equipment which have switch mode power supplies predominantly. In the creation of these undesirable harmonics, the suppliers also equally responsible i.e. their role is no less significant because they widely employ HT capacitors, Static VAR Compensators for Retiree Power Flow and voltage control, HVDC convertors for (seamless) HV and EHV transmission of power. The energization of EHV transmission lines and transformers also play a significant or marked role in this regard. Among the other Pollutors or Facilitators of Power Pollution (Harmonic Generators) are,

- Industries with wide use of Frequency Controlled Motors (Variable Speed Drives), Soft Motor Starters (In place of old Star Delta Starters).
- Railway Traction and Software Parks.
- Street Lights with LED Sodium Vapour and CFL lamps. This list is exhaustive; only few items are listed out as an illustration. In this context, you may pose the question that whether the presence of harmonics is a recent phenomenon or experienced earlier. To answer this, it may be stated that harmonics exist ever since the "Inception of Electric Generators" and grid 130 years ago but seldom

bring any major impact its presence and negative effects are very seriously experienced only recently i.e. after 1980. Now Harmonics producing agents grow phenomenally. It is because in earlier days, knowing its evil character its presence is very much limited and controlled; but now it crosses the tolerable limits where "Mitigation" becomes well nigh impossible; only moderation is possible i.e. we have to live with these Harmonics forever but we may try to restrict it to the maximum extent feasible.

One interesting point – Normally in Electrical Networks Power flows from upstream to downstream side only. In contrast to this in the case of Harmonics; it flows on both sides i.e. downstream to upstream side (reverse flow) and (normal flow) supply side (generation side) to demand side (load side). This flow of contaminants from load side to supply side impacts the supply side and power factor. The net quality of power received then becomes a "Variant"; it depends upon the quality of voltage and current at any location. One more intresting point. The voltage quality is amenable for monitoring and control but not the current quality. It is beyond any control. Another point that needs mention in this context is that in a power network, it is a must for the factors like reliability of supply, power quality and energy efficiency should work hand-in-hand. Then only the power network will work efficiently (with minimum loss) within its assigned parameters. In the present hostile working environment, all the electrical equipment and devices find it very difficult to survive and complete their assigned life spans. The harmonics, which causes deformed/distorted supply voltage/current wave form is injurious to all electrical equipment and devices, brings higher energy losses in the network and finally the premature failure/death of all connected equipment/devices. Presently there is a trend to apply widely Shunt Capacitors for Power Factor improvement. This is a wrong application when the working electrical atmosphere is polluted by harmonics. Then the PF improvement Capacitors will do more harms. They will not bring the desired PF improvement but lose their lives in the process. Further they will worsen the environment by causing amplified harmonics, higher flickers and fluctuations.

3) Ill Effects of Harmonics

- Over heating of all rotating machines (Motors, Generators and Capacitors), Transformers.
- Neutral over loading with consequential higher losses and neutral cut/break/burning.
- Creates more avenues for Electrical Fires.
- Reduce torque in Motors leading to its crawling-very low speed at low torque levels.
- Produces undesirable neutral-ground voltage; at times it may be high.
- Failure of capacitors and UG cables.
- Frequent/spurious operation of Protective devices like breakers and fuses.
- Improper/unreliable operation of electronic equipment and devices like electronic meters and relays. At times, it may result in their premature failure.
- Leads to higher energy losses and the power network; premature failure of all electrical equipment/ devices in the Power Network.

4) Possible Solutions

Among the Harmonics mitigation devices are,

i) Active Filters

- Reactor based filter
- IGBT based filter
- Harmonics compensation Transformers

ii) Passive Filters

Harmonics may be compared to a cancerous growth in the power network. It starts slowly but steadily and gradually ingrained and build up in the Power Systems and finally becomes a dangerous electrical pollution source. Once it sets in, it cannot be eradicated easily. At best, its further increase/development may be restricted; it effects may be slowly, steadily and continuously neutralised by adopting suitable remedial measures. No total solution to Harmonics is presently possible. To sum up, an electric delivery system with a poor quality Power Supply, infested with higher quantum of Harmonic Waves, constitutes a highly polluted, extremely hostile operating environment which is a high risk for all the connected electrical equipment and devices. An attempt has been made to present a whole Comprehensive View of power quality issues. Readers who are in need of further details so as to get a detailed view of Harmonics may kindly refer to the guide book titled "A Treatise on Power Quality with a focus on Harmonics" as brought by our association (Tamilnadu Electrical Installation Engineers Association "A" Grade).

Before signing off, I would like to outline the topics that will be brought out in the future issues of Newsletter.

1. Trade-off in the technical issues of a Power Network.
2. Electricity Grid-Looking back and ahead.
3. Power System Operation and Control-in brief.
4. Role of VAR Compensation equipment in Reactive Power Management.

Now I conclude here.

(To be continued…)

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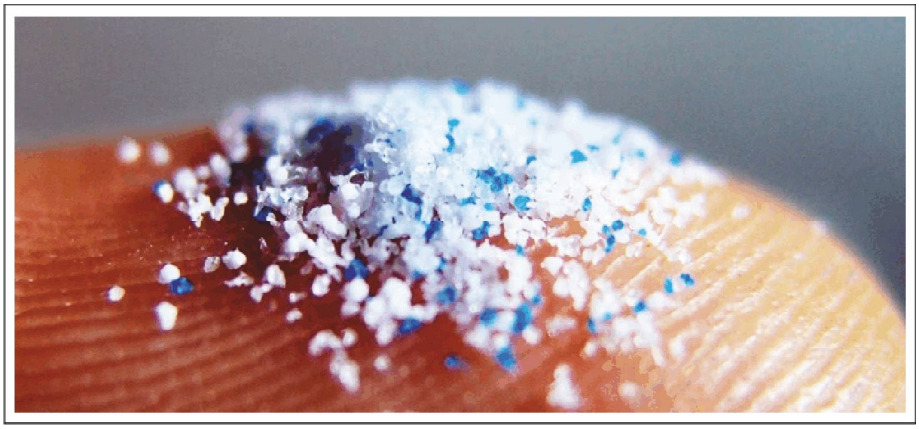
WHAT IS MATURITY OF MIND?

1. Correcting ourselves without trying to correct others.
2. Accepting others with their short comings.
3. Understanding the opinions of others from their perspectives.
4. Learning to leave what are to be avoided.
5. Leaving the expectations from others.
6. Doing whatever we do with peace of mind.
7. Avoiding to prove our intelligence on others.
8. Avoiding the status that others should accept our actions.
9. Avoiding the comparisons of ourselves with others.
10. Trying to keep our peace in our mind without worrying for anything.
11. Understanding the difference between the basic needs and what we want.
12. Reaching the status that happiness is not connected with material things

"A 'No' uttered from the deepest conviction is better than a 'Yes' merely uttered to please, or worse, to avoid trouble." – MAHATHMA GANDHI

WE ARE EATING A CREDIT CARD'S WORTH OF PLASTIC EVERY WEEK



A campaign by the WWF Singapore has revealed that the average person consumes approximately 5g of plastic every week. The NGO is calling on governments and businesses around the world to forge a global treaty to tackle plastic pollution.

People are eating approximately 5 grams of plastic every week, the equivalent weight of a credit card, according to a new global study by World Wide Fund for Nature (WWF) Singapore.

Drinking water is the leading source of plastic ingestion in humans, the study found. A 500 millilitre bottle of drinking water contains approximately 1,759 tiny plastic fibres. Other key sources of plastic ingestion include shellfish, beer and salt.

Invisible to the naked eye, microplastics do not biodegrade and persist in the marine environment. Microplastics are tiny particles that are directly released into the environment, through microbeads found in personal care products and the washing of polyester fabrics. In addition, they can also be derived from larger pieces of marine trash, such as plastic bags, that break down in the ocean.

At present, not much is understood about how ingesting plastic can affect human health. However, preliminary studies suggest that these substances cannot be broken down by the human body.

At the same time, 8 million tonnes more plastic waste enter the oceans every year, according to UN Environment. Increasing production of plastic materials, poor recycling infrastructure and waste mismanagement, particularly in developing Asia, are turning our oceans into plastic dumping grounds.

"In order to tackle the plastic crisis, we need urgent action at the government, business and consumer levels, and a global treaty with global targets to address plastic pollution," said Marco Lambertini, WWF International's director general.

A global petition, launched by WWF in February this year, to push for a legally binding treaty to address plastic pollution through international cooperation has garnered over 650,000 signatures. Proposed measures include setting quantifiable national targets to reduce and manage plastic waste, legislating extended producer responsibility to hold businesses accountable for the plastics they produce and supporting emerging research on the health effects of plastics and microplastics.

WWF's campaign website, yourplasticdiet.org, reveals how much microplastics is in your food and how you can participate in the fight against plastic pollution.

EVERY ENGINEER SHOULD READ THIS MESSAGE FROM DR. A P J ABDUL KALAM

Excerpts from the speech of our Former President Dr.A P J Abdul Kalam during the 14th Convocation of IIT Guwahati on 25th May 2012.

I am sure, you would like to do something different - out of box missions, what are they?

1 Will you be remembered for a visionary action for the nation, like Prof. Vikram Sarabhai or Homi Bhabha, Prof Satish Dhawan or Dr. DS Kothari in the field of space science, nuclear science and Defence Science?

2 Will you be remembered for introducing new industrial system product, which represents a convergence of technologies for low cost high efficiency products like bionic eye?

3 Will you be remembered for creating a company which finds a place in the top 100 of the Fortune 500 companies from India?

4 Will you be remembered for facilitating the creation of PURA complexes (Providing Urban Amenities in Rural Areas) in the neighbourhood of your work place?

5 Will you be remembered for working and creating a validated system for the production of 340 million tonnes of food grains and value addition through food processing by the year 2020?

6 Will you be remembered for modernization of SME's through application of new technology and innovation?

7 Will you be remembered as a discoverer or inventor of new phenomena in basic sciences?

8 Will you be remembered for promoting energy independence for the nation through the development of renewable energy system?

9 Will you be remembered for the action oriented – "Clean home, clean environment, clean state and clean nation."

10 Will you be remembered for evolving for smart waterway for the whole country, linking the major rivers?

Once again, let me congratulate all the graduating students. My best wishes to all the members of IIT Guwahati for success in the mission of developing quality technological human resource for the nation.

BEE TO SHARE ENERGY EFFICIENCY KNOW-HOW WITH ANDHRA PRADESH

With energy consumption at the household level in Andhra Pradesh headed to increase by over 200% , BEE will help the state design cheaper yet energy-efficient buildings.

The Bureau of Energy Efficiency will assist the Andhra Pradesh government with Indo-Swiss technology for affordable housing in the state. This follows an announcement by the state's energy minister B Srinivasa Reddy that electricity use per household is projected to increase from 650 KWh in 2012 to 2750 KWh by 2050.

According to the Bureau of Energy Efficiency Director-General Abhay Bhakre, the bureau will provide technological support to housing and financial support to hospitals, model schools and rural water supply for implementation of energy efficiency schemes. He said energy-efficient methods will save about 20% of energy compared to traditional housing methods.

Financial support for the efficiency programs is grant-in-aid nature which is 100% free. The BEE has agreed to provide technology for the state's flagship programme of 'affordable housing' for the poor, without any financial burden on the government, through Energy Conservation Building Code for Residential Buildings (Residential ECBC).

In a communication to N Srikanth, energy secretary and chairman-managing director of AP Transco, Bhakre said since AP is a proactive state in energy efficiency readiness, the BEE wants to promote the technology aggressively in key sectors. Additionally, a workshop will be conducted on residential ECBC in Vijayawada on August 26 and 27.

"While the Centre was planning to build above 2 crore houses in the entire country, the AP government itself has determined to build lakhs of houses to the poor, which is exemplary. The technology will directly impact heat loss, natural ventilation, daylight availability, reduction in electricity consumption and electricity bills" the letter says.

Srikanth said huge potential of the energy efficiency sector is untapped in the state.

The BEE has also agreed to support the implementation of energy efficiency measures in nine government teaching hospitals as a pilot project. As part of this, energy-efficient air conditioners, fans, and tube lights would be arranged in hospitals and the expected energy savings for the nine hospitals would be 1.81 MU.

ELECTRIC CAR SWITCH ON FOR HEALTH BENEFITS

Writing in the International Journal of Electric and Hybrid Vehicles, Mitchell House and David Wright of the University of Ottawa, Canada, suggest that the migration from polluting vehicles that burn fossil fuels to electric vehicles, ideally using electricity generated sustainably could significantly reduce the incidence of cardiopulmonary illness due to air pollution. This would lead not only to less employee absence from work through illness but also lead to broad improvements in quality and length of life.

The team's paper compares the financial costs of building electric vehicle charging infrastructure using empirical data with health costs to see if there is a net benefit. They have found that in the majority of plausible scenarios of balanced growth, when the number of vehicles rises and so does the number of charging stations, there is a positive net benefit to society.

"Since health benefits accrue to governments, businesses, and individuals, these results justify the use of government incentives for charging station deployment and this paper quantifies the impact of different levels of incentive," the team concludes.

The team explains that the Electric Vehicles Initiative (EVI) (an organization supported by 16 governments) has a target of 20 million electric vehicles by the year 2020. This was based on a notional growth rate of 75% per year defined in 2016. At that time, EV sales amounted to more than half a million (550000) worldwide in 2015, which represented growth of 70% on 2014. Electric vehicle sales have continued to grow, with 2017 and 2018 experiencing 61% and 64% year-over-year growth respectively.

Their results suggest that a 75% growth rate for electric vehicle uptake is not unrealistic. Moreover, in the face of anthropogenic climate change and the detrimental effects of health on pollution, some observers see the transition to electric vehicles as being a matter of serious urgency. This has to take into consideration the electricity generating mix from which the vehicles derive their power. If electricity is mostly supplied from power stations generating electricity by burning fossil fuels, including coal, gas, and oil, then many of the benefits are lost. This is particularly true in terms of climate impact at the global level but also in terms of sulfur oxide, nitrogen oxide, and particulate pollution. This has been witnessed in China, India, and Russia, as electricity demand has risen rapidly.

This latest study points out that governments have not been keen to support charging infrastructure due to a variety of industry players being involved and their responsibility to carry some of the cost. This would include electric utility companies who would profit directly from charging vehicles, out-of-town shopping centers that could attract more customers with charging points in their car parks, the manufacturers of vehicles and a new generation of "gas station" operators.

"The savings that can be achieved by 2021 are higher than the cost of installing charging station infrastructure over a wide range of scenarios," the team writes. "These net benefits apply both to balanced growth in charging stations (in which the number of charging stations is proportional to the number of EVs) and also to rapid build out (in which charging stations are built over 2-4 years in order to achieve government EV targets for 2020 and 2025)." Ultimately, it is the reduced financial burden of a healthier populace that offsets the costs.

THE IMPORTANCE OF ELECTRIC DRIVE

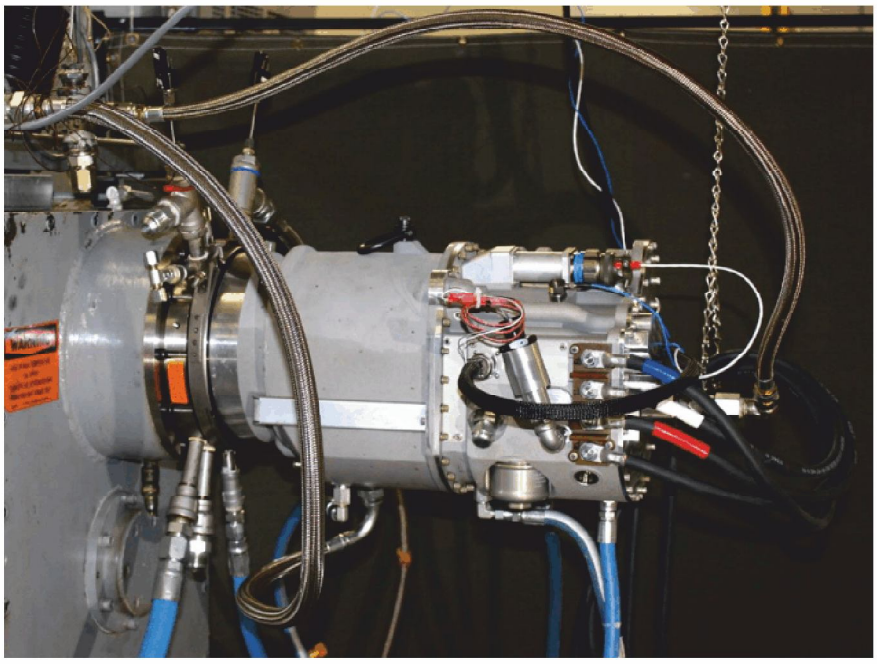
Health Benefits

- High air pollution levels negatively affect public health
- Vehicles that burn conventional fuels create emiisions that add to these levels
- EVs produce fewer emissions, some produce no emissions at all
- Lower emissions = improved air quality

The majority of the members of the Irish parliament are professional politicians, in the sense that otherwise they would not be given jobs minding mice at crossroads.

– FLANN O'BRIEN

GE AVIATION ELECTRIFIES AIRPLANE ENGINES TO MEET CARBON EMISSION GOALS



The aerospace industry is under intense pressure to reduce its impact on the environment. Between 2021 and 2035, the industry will have to offset a total of 2.6 billion metric tons of carbon dioxide under the Carbon Offsetting and Reduction Scheme for International Aviation, an emissions mitigation approach for the industry.

GE Aviation is one company that is working to meet the mandates by increasing the electrification of the aircraft it builds. The company produces 65 percent of all commercial airplane engines. It also has a large market share of components and integrated systems for commercial, business, and general aviation aircraft. Every two seconds, an aircraft powered by GE technology takes off somewhere in the world, the company says.

Its electrical power technology chief, IEEE Fellow Hao Huang, along with his colleagues, is developing hybrid electric propulsion systems and exploring additive manufacturing of airplane parts. He is the recipient of this year's IEEE Transportation Technologies Award for his "quest to develop 'more electric aircraft,' with electric systems in place of today's pneumatic and hydraulic ones for quieter, more fuel-efficient, and environmentally friendly flight."

AIRPLANE PRIMER

Conventional jetliners have engines or propellers that rotate to move the aircraft forward or take off. In addition to the engines, there are three other systems. The hydraulic system uses pressurized fluid to move and actuate landing gear, brakes, and flight control surfaces, which are aerodynamic devices allowing a pilot to adjust and control the aircraft's flight attitude. The pneumatic system bleeds air off the engines to power environmental control and protection from ice. The electrical system provides power to the engines as well as to equipment in the cabin.

The auxiliary power unit (APU), generally located at the rear of the aircraft, produces energy to power systems when the plane is on the ground as well as supplying energy needed to start the engines.

To make today's planes 'more electric' requires changing the systems, Huang says. For example, the engine needs to be more electrical, the aircraft's body more "actively" aerodynamic, and materials lighter to improve efficiency.

Huang points to the Boeing 787 Dreamliner, which uses electricity instead of pneumatics to power its environmental control system, to start its engine, and protect the wings from ice. The plane uses six generators to create more electricity. Two are located on each engine, and two are on the APU. The 787 also features a frame constructed primarily of composite materials.

Huang and his team are working on multiple electrification projects that have the potential to save fuel. One of its programs aims to eliminate the pneumatic bleed system and other parts to make planes lighter. Components

such as bleedless turbo fans, high-speed generators that operate at around 270 DC volts, and high-speed solid-state DC circuit breakers are expected to reduce a plane's weight by about 450 kilograms, Huang says.

GE has demonstrated engines that can more efficiently convert fuel to electricity. The company modified an F110 engine to generate 1 megawatt of electric power, for example. A megawatt of power is equivalent to 1,341 horsepower. The high-power-density device was tested at the company's US $51 million Electrical Power Integrated System Center—or EPISCenter—in Dayton, Ohio, followed by additional evaluation at its test site in Peebles, Ohio, where it was used to drive a 3.4-meter-diameter Dowty propeller from a Saab 340 turboprop aircraft.

Adding electrical components can make planes heavier. Lightening the load requires new technology, materials, and design approaches, Huang says. High-voltage materials, for example, are needed to make electrical cables thinner. Another solution is to reduce the weight of parts. GE is looking into manufacturing them using additive technology such as 3D printing.

The company is working on hybrid electric aircraft concepts. Huang referenced an report published last year in Aviation Week and Space Technology on GE developing gas turbines for emerging hybrid-electric propulsion architectures, which play a big part in so-called flying cars. The electric, self-piloted, vertical-takeoff and -landing passenger aircraft are expected to replace short-range urban transportation such as cars and trains. Flying cars are projected to cost less than helicopters and be quieter to boot.

Huang expects flying cars to be used in congested cities such as San Francisco, where it can take two hours to drive 40 kilometers. "People are busy and don't want to waste their time sitting in traffic," he says. "Flying cars can vertically take off and land, so you could arrive in 20 minutes. I predict we'll see these small aircraft in the next decade, but of course these planes will first need to undergo rigorous safety tests."

INDIA WILL EXCEED ITS PARIS AGREEMENT TARGETS BY 60%

Central Electricity Authority predicts renewables will provide 63% of installed capacity and 44% of India's power generation by 2029-30.

India is likely to obtain 63% of its installed power capacity from non-fossil fuel sources (including hydro) by 2029-30, according to the Central Electricity Authority (CEA). This would significantly exceed the country's Paris agreement target of a 40% share of installed power capacity from non-fossil fuel sources by 2030.

The CEA report estimates that growth in new installed power capacity will lead renewables to generate close to 44% of all electricity consumed in India in 2029-30.

In a briefing note released today, India Energy Transition Fuels Growth Path for Sustainable Development, IEEFA notes that CEA's analysis predicts moderate growth in increased coal capacity (from net end-of-life coal plant closures), while gas and biomass growth are expected to be negligible. The CEA makes a base forecast for thermal power capacity of 291GW by 2030, a clear expansion from the 225GW operating as of March 2019. But the CEA's bullish conclusion is that thermal capacity will drop from 64% to just 35% of total installed capacity in only 11 years.

The CEA models also take into account that India will need 34GW/136GWh of battery energy storage systems (BESS) by 2030 to balance the grid reliability and stability needs of 440GW of variable renewable energy capacity, supported by 73GW of hydro and 10GW of biomass. In view of the rate of technology change and cost deflation in batteries, this ambitious forecast could prove to be prescient.

The CEA's optimal capacity generation mix estimates are based on projected demand obtained through India's 19th Electricity Power Survey (EPS). The projections are adjusted to include estimated contributions from solar rooftop generation.

"India dominates the list of countries with the most polluted cities on earth. As per World Bank estimates, air pollution costs are equivalent to 8.5% of GDP. India is also facing extreme and growing water shortages in major cities. Transitioning to clean energy can help the country achieve its twin objectives of strong economic growth and sustainability," said Vibhuti Garg, the energy economist who wrote the IEEFA brief.

Garg notes that the momentum to build more renewable energy (RE) capacity should not only be reflected at the central planning level, but also integrated and co-ordinated with the plans of state governments. India is making huge strides, with 13GW of solar projects tendered in the month of June 2019 alone.

Gujarat is a front runner, with the state announcing plans to increase power generation capacity from renewable sources to 30GW in the next three years. However, IEEFA believes that in order to build energy security and incorporate an ever-increasing share of zero pollution and deflationary renewable energy, planners need to prioritise expansion of quality interstate grid transmission. This is a critical pre-requisite for India to meet its RE ambitions.

IEEFA notes that adoption of grid-scale energy storage technologies is critical for large-scale integration of renewable energy sources. With advances in technology, the cost of battery energy storage systems has been decreasing at a fast pace, down 30% in 2018 alone. India needs to invest its technical and financial resources to create energy storage capacity, that will enable it to absorb more RE into the power system into the foreseeable future.

"Renewable energy will further aid in addressing the issue of air pollution and water stress, as well as help mitigate India's chronic over-reliance on fossil fuel imports, which cause inflation and erode the value of the Rupee," said Garg.

"Manpoewr without Unity is not a strength unless it is harmonized and united properly, then it becomes a sprtual power."

– SARDAR VALLABAI PATEL

MANAGING AGING DISTRIBUTION AND POWER TRANSFORMERS

In terms of a company's bottom line, stoppage of this large piece of equipment, whose substitution is expensive and involves a lengthy process, is unacceptable. As such, emphasis is on reducing the costs associated with a transformer's life cycle in efforts to guarantee its reliability and durability. It is therefore essential to monitor its operating conditions, its insulation system and the working conditions of its accessories and other components in efforts to extend the 'life' and reduce the costs of transformers. Research and development of new technologies and advanced predictive maintenance techniques has greatly contributed to reduce supply stoppages, thereby ensuring improved reliability of energy supply. Several studies undertaken highlight the importance of optimising maintenance processes and diagnoses of substation equipment such as transformers. These studies are from various universities and engineers in Brazil and India who struggle with similar situations to those faced in sub-Saharan African countries. The prevailing question in each case is "Do we replace now or do we maintain the unit until failure?"

Addressing the solution

Stoppages can be properly managed through planning ahead and based on informative decisions. The aim is to prevent unplanned stoppages thereby supplying electricity uninterrupted to emergency facilities such as hospitals, infrastructure such as railways, intensive power users such as mines and domestic users. The term 'stoppage' indicates that the service of a piece of equipment was interrupted, specifically meaning that it was removed from operation due to a defect or fault. The situation becomes even more troubling when it comes to power transformers. Taking into account the age of electrical grids across the world, there are many countries in which these transformers are approaching their 'end of life'. This means that the transformers are urgently in need of being optimised through higher availability and reliability. However, due to ever increasing pressure to decrease costs, managers are continuously searching for alternatives to reduce the associated life cycle costs of installed assets and thereby improving the return on investment (ROI) of this equipment. This is normally achieved through the lowest possible cost and with a minimal environmental impact. With this in mind, ArmCoil developed the On Site Condition Analysis (OSCA) service to provide cost effective solutions for a complete range of solutions to meet the demand for optimising the performance of transformers through the asset's prolonged life cycle. OSCA is supported by the company through many years of experience in the repair and manufacturing of transformers across South Africa and into Africa. This enables ArmCoil's qualified employees to service transformers effectively and quickly on almost any installation.

Judge for yourself

Prolonging and optimising the extent of the transformer life cycle and performance through higher availability and reliability is achievable through the OSCA service as informed decisions produce the best results. This is why ArmCoil offers a cost-effective and unique solution for On Site Condition Analysis, which includes the following cases outlined below.

On Site Condition Analysis Phase 1

Using non-intrusive methods to conduct equipment assessment and registration, followed by a second process that involves visual inspections and oil sampling, with the aim of acquiring a general 'health status' of the asset/s. This also allows ArmCoil to map out all the locations for various substations and free standing transformers thereby ascertaining the priority status of each individual transformer. The analysis is carefully and thoroughly investigated based on the information retrieved from the assets. This places the client in an advantageous position in terms of being made aware of the risk of the immediate or imminent failure for critical assets in high and low populated locations. With this information, the client can make calculated and informed decisions based on factual evidence found and presented by the service provider. Once all the information is captured and compiled, a strategically prioritised schedule is presented for approval. Below is a basic summary of oil sampling types:

Dissolved gas analysis (DGA): This is the most sensitive and reliable technique used for evaluating the 'health' of the oil and indicates possible internal faults. The types of possible faults indicated are corona, arcing, sparking, overloading, overheating and possible paper breakdown.

Breakdown voltage test: This assesses the insulating properties of the oil – the lower the resulting breakdown voltage, the poorer the quality of the oil.

PCB (Polychlorinated Biphenyls) content: This is purely a health and environment issue, which has absolutely no impact on the asset's performance. PCBs can be compared to organ failure. This is a very serious problem in South Africa and must be treated with respect and importance. The only viable solution is to replace the contaminated oil, as purification will not reduce the PCB content.

Acidity content test: The acid content increases over time in any oil cooled transformer due to the interaction between moisture, temperature and oxygen. This reaction turns into sludge, which settles in between the windings and other internal parts.

Moisture content test: Contamination occurs during interaction between the air and the transformer oil through the breather. It is advisable to check the silica gel and change out regularly.

Furanic testing: This test determines the paper deterioration in the transformer through direct measurement of its tensile strength/ degree of polymerisation (DP). These are used to evaluate the 'end of life' of the paper insulation.

On Site Condition Analysis Phase 2

After prioritising the critical and non-critical assets according to their individual determined health status from Phase 1, the On Site Condition Analysis service costs are further reduced due to restriction of components or the entire asset. As an example, after determining that an aged transformer is rapidly approaching a catastrophic failure when no 'stoppage' options are available, ArmCoil would supply or manufacture an exact 'drop-in replacement' unit for the next maintenance shutdown to assist with minimum stoppage. The aged, or potentially failed asset, would be removed and discarded safely without any impact on the environment and minimum loss of income to the owner of the transformer. The OSCA services from ArmCoil are carried out in conjunction with the owner's specifications of the critical assets; and a variety of complete solutions will be implemented to extend the 'life cycle' of the identified aged transformers.

On Site Condition Analysis Phase 3

Upon reaching the Phase 3 level, the 'life cycle' of an aged transformer has been extended or improved, as shown through various reports obtained during the On Site Condition Analysis. This analysis is useful in that it may be used to reduced insurance premiums; and the reliability of the assets is also determined through the service events exclusive to ArmCoil's OSCA service. Of strategic importance are the quarterly or annual recommendations that are proposed for monitoring purposes, oil sampling and asset replacement for this phase. Undertaking these phases results in reducing expenditure on routine inspections through ArmCoil's mobile technicians.

PHYSICISTS USE NANOSTRUCTURES TO FREE PHOTONS FOR HIGHLY EFFICIENT WHITE OLEDS

Since the first development of white OLEDs in the 1990s, numerous efforts have been made to achieve a balanced white spectrum and high luminous efficacy at a practical luminance level. However, the external quantum efficiency (EQE) for white OLEDs without additional outcoupling techniques can only reach 20 to 40 percent today. About 20 percent of the generated light particles (photons) remain trapped in the glass layer of the device. The reason for this is the total internal reflection of the particles at the interface between glass and air.

Further photons are waveguided in the organic layers, while others get ultimately lost at the interface to the top metal electrode.

Numerous approaches have been investigated to extract the trapped photons from OLEDs. An international research team led by Dr. Simone Lenk and Prof. Sebastian Reineke from the TU Dresden has now presented a new method for freeing the light particles in the journal Nature Communications.

The physicists introduce a facile, scalable and especially lithography-free method for the generation of controllable nanostructures with directional randomness and dimensional order, significantly boosting the efficiency of white OLEDs. The nanostructures are produced by reactive ion etching. This has the advantage that the topography of the nanostructures can be specifically controlled by adjusting the process parameters.

In order to understand the results obtained, the scientists have developed an optical model that can be used to explain the increased efficiency of OLEDs. By integrating these nanostructures into white OLEDs, an external quantum efficiency of up to 76.3% can be achieved.

For Dr. Simone Lenk, the new method opens up numerous new avenues: “We had been looking for a way to specifically manipulate nanostructures for a long time already. With reactive ion etching, we have found a cost-effective process that can be used for large surfaces and is also suitable for industrial use. The advantage lies in the fact that the periodicity and height of the nanostructures can be completely adjusted via the process parameters and that thus an optimal outcoupling structure for white OLEDs could be found. These quasi-periodic nanostructures are not only suitable as outcoupling structures for OLEDs, but also have the potential for further applications in optics, biology and mechanics.”

“One individual may die for an idea; but the idea will, after his death, incarnate itself in a thousand lives.” – NETHAJI SUBASHCHANDRA BOSE

SNOW-POWERED NANOGENERATOR WORKS WHERE SOLAR PANELS DON'T

Snowy places aren't ideal for harvesting solar energy – panels can't do much if they're buried under blankets of snow, of course. Now a team from the University of California Los Angeles (UCLA) has developed a new device that can produce electricity from snow itself.

The team calls the new device a snow-based triboelectric nanogenerator, or Snow TENG. As the name suggests it works off the triboelectric effect, meaning it uses static electricity to generate a charge through the exchange of electrons. These kinds of devices have been used to make generators that pull energy from body movements, touchscreens, and even footsteps on floors.

Snow is positively charged, so rubbing it against a material with the opposite charge allows energy to be drawn out of it. After a comprehensive series of testing, the team settled on silicone as the most effective material.

The Snow TENG, which is 3D printable, is made with a layer of silicone attached to an electrode. The team says it could be integrated into solar panels, so they can continue generating electricity even when covered with snow, making it similar to an earlier hybrid solar cell that also harvested energy from the movement of raindrops on its surface.

The problem is that the Snow TENG produces a pretty tiny amount of electricity in its current form – it has a power density of 0.2 mW per square meter. That means you won't really be hooking that up to the grid like a solar panel, but it could make for small, self-powered weather sensors.

"The device can work in remote areas because it provides its own power and does not need batteries," says Richard Kaner, senior author of the study. "It's a very clever device — a weather station that can tell you how much snow is falling, the direction the snow is falling, and the direction and speed of the wind."

The researchers give other examples like a sensor that could be attached to the bottom of boots or skis and used to collect data for winter sports.

The research was published in the journal Nano Energy.

WINDOW FILM COULD EVEN OUT THE INDOOR TEMPERATURE USING SOLAR ENERGY

On sunny summer days it can be little short of unbearable to stay indoors or in cars. The heat radiates in and creates an unpleasantly high temperature for people, animals and plants. Using energy-intensive systems such as air conditioning and fans means combating the thermal energy with other forms of energy. Researchers at Chalmers University of Technology are proposing a method that utilises the heat and distributes it evenly over a longer period instead.

When their specially designed molecule is struck by the sun's rays it captures photons and simultaneously changes form — it is isomerised. When the sun stops shining on the window film the molecules release heat for up to eight hours after the sun has set.

"The aim is to create a pleasant indoor environment even when the sun is at its hottest, without consuming any energy or having to shut ourselves behind blinds. Why not make the most of the energy that we get free of charge instead of trying to fight it," says chemist Kasper Moth-Poulsen, who is leading the research.

At dawn when the film has not absorbed any solar energy it is yellow or orange, since these colours are the opposite of blue and green, which is the light spectrum that the researchers have chosen to capture from the sun. When the molecule captures solar energy and is isomerised, it loses its colour and then becomes entirely transparent. As long as the sun is shining on the film it captures energy, which means that not as much heat penetrates through the film and into the room. At dusk, when there is less sunlight, heat starts to be released from the film and it gradually returns to its yellow shade and is ready to capture sunlight again the following day.

"For example, airports and office complexes should be able to reduce their energy consumption while also creating a more pleasant climate with our film, since the current heating and cooling systems often do not keep up with rapid temperature fluctuations," says Moth-Poulsen.

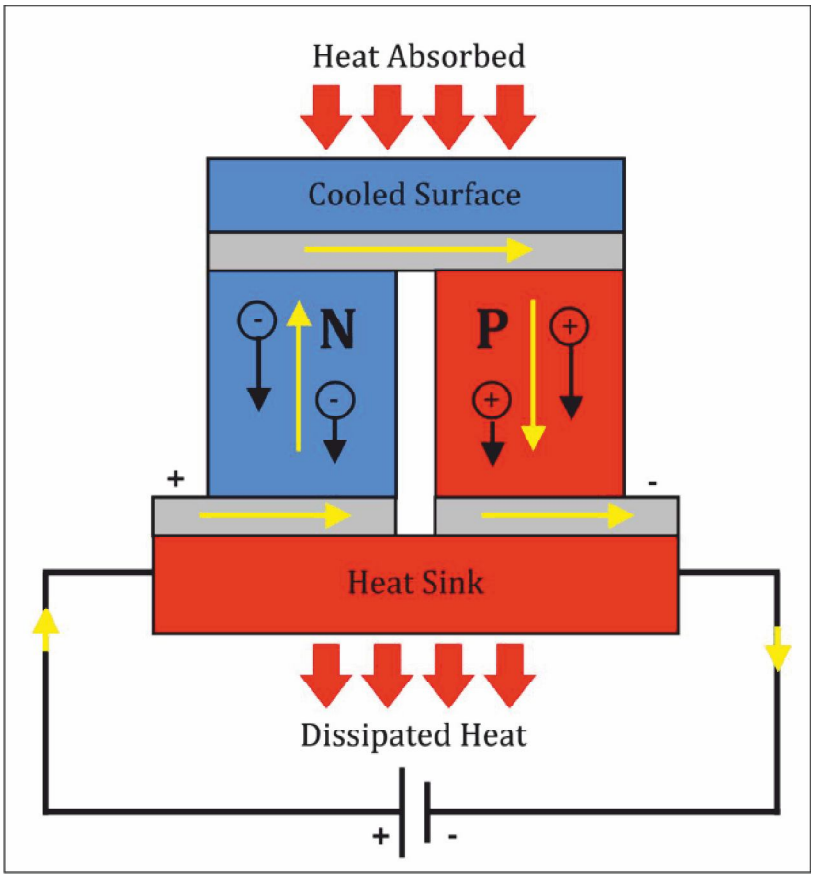
The molecule is part of a concept the research team calls MOST, which stands for 'Molecular Solar Thermal Storage'. Previously the team presented an energy system for houses based on the same molecule. In that case — after the solar energy had been captured by the molecule — it could be stored for an extended period, such as from summer to winter, and then used to heat an entire house. The researchers realised that they could shorten the step to application by optimising the molecule for a window film as well, which would also create better conditions for the slightly more complex energy system for houses.

What the researchers still have to do is to increase the concentration of the molecule in the film whilst also retaining the film's properties, and bring down the price of the molecule. But according to Moth-Poulsen they are very close to this innovation.

"The step to applying our film is so short that it could happen very soon. We are at a very exciting stage with MOST," he says.

NEW LOW-COST THERMOELECTRIC MATERIAL WORKS AT ROOM TEMPERATURE

Has your steering wheel been too hot to touch this summer? A new thermoelectric material reported in the journal Science could offer relief.



The widespread adoption of thermoelectric devices that can directly convert electricity into thermal energy for cooling and heating has been hindered, in part, by the lack of materials that are both inexpensive and highly efficient at room temperature. Now researchers from the University of Houston and the Massachusetts Institute of Technology have reported the discovery of a new material that works efficiently at room temperature while requiring almost no costly tellurium, a major component of the current state-of-the-art material.

The work, described in a paper published online by Science Thursday, July 18, has potential applications for keeping electronic devices, vehicles and other components from overheating, said Zhifeng Ren, corresponding author on the work and director of the Texas Center for Superconductivity at UH, where he is also M.D. Anderson Professor of Physics. "We have produced a new material, which is inexpensive but still performs almost as well as the traditional, more expensive material," Ren said. The researchers say future work could close the slight performance gap between their new material and the traditional material, a bismuth-tellurium based alloy.

Thermoelectric materials work by exploiting the flow of heat current from a warmer area to a cooler area, and thermoelectric cooling modules operate according to the Peltier effect, which describes the transfer of heat between two electrical junctions.

Thermoelectric materials can also be used to turn waste heat — from power plants, automobile tailpipes and other sources — into electricity, and a number of new materials have been reported for that application, which requires materials to perform at far higher temperatures.

Thermoelectric cooling modules have posed a great challenge because they have to work at cooler temperatures, where the thermoelectric figure-of-merit, or ZT, is low because it is dependent on temperature. The figure-of-merit is a metric used to determine how efficiently a thermoelectric material works.

Despite the challenge, thermoelectric cooling modules also, at least for now, offer more commercial potential, in part because they can operate for a long lifespan at cooler temperatures; thermoelectric power generation is complicated by issues related to the high temperatures at which it operates, including oxidation and thermal instability.

"Better remain silent, better not even think, if you are not prepared to act."

– ANNIE BESANT

The market for thermoelectric cooling is growing. "The global thermoelectric module market was worth ~0.6 billion US dollars in 2018 and it is anticipated to reach ~1.7 billion US dollars by 2027," the researchers wrote.

Bismuth-tellurium alloys have been considered the best-performing material for thermal cooling for decades, but the researchers said the high cost of tellurium has limited widespread use. Jun Mao, a post-doctoral researcher at UH and first author on the paper, said the cost has recently dropped but remains about $50/kilogram. That compares to about $6/kilogram for magnesium, a primary component of the new material.

In addition to Ren and Mao, additional authors on the paper include Hangtian Zhu, Zihang Liu and Geethal Amila Gamage, all of the UH Department of Physics and TcSUH, and Zhiwei Ding and Gang Chen of the Department of Mechanical Engineering at the Massachusetts Institute of Technology.

They reported that the new material, comprised of magnesium and bismuth and created in a form carrying a negative charge, known as n-type, was almost as efficient as the traditional bismuth-tellurium material. That, combined with the lower cost, should expand the use of thermoelectric modules for cooling, they said.

To produce a thermoelectric module using the new material, researchers combined it with a positive-charge carrying, or p-type, version of the traditional bismuth-tellurium alloy. Mao said that allowed them to use just half as much tellurium as most current modules.

Because the cost of materials accounts for about one-third of the cost of the device, that savings adds up, he said.

The new material also more successfully maintains electrical contact than most nanostructured materials, the researchers reported.

RENAULTS LAUNCHES K-ZE FOR CHINA WHILE INDIA AWAITS EV POLICY

Renault launches its affordable all-electric K-ZE for China, which is an electric version based on India's Kwid.

At Paris Motor show, Renault reaffirmed China's might by nudging India. It is launching its latest all-electric and affordable K-ZE car with a range of 250 kms in China. The vehicle will be manufactured locally by the e-GT New Energy Automotive Co, the Joint Venture with Dongfeng Motor Group and Nissan, created to develop and produce competitive electric vehicles specifically for the Chinese market.

The salt to the injury, Renault's first affordable electric vehicle, is designed out of its technical centre in Chennai and Indian engineers here have modified the all-electric K-ZE car to meet the environmental regulations put in place by the Chinese.

Driving home an important point, Carlos Ghosn, Chairman and CEO of Renault, spoke of the obvious gap between India and China at an event in Paris this week. Even though India's intent is at the right place, he added that carmakers are businessmen, and volumes drives their Businesses. "There are 27 million cars sold in China and 4 million in India," Ghosn pointed.

Renault had announced in its mid-term plans last year that it will launch an affordable electric car in India, but that promise is yet to fructify.

To pacify the Indian dream of 'Make In India', Renault is planning to make India the hub for emerging market products after the success of Kwid in South Africa and Latin America. This might soothe the sentiments a bit by creating jobs here but the in long run all these parts will go out for cars elsewhere, meaning that it may further delay selling better cars here and continue to sell somewhere else. According to the senior official at the Paris Motor Show, the company also plans to source 95 per cent of the parts for its future models from local parts suppliers.

This however does not take away the fact that car makers have been waiting for India to decide on an EV Policy. The delay and lack of clarity on EV Policymay have been a contributor here. The lack of ecosystem in India in comparison to China is evident in many aspects of the EV Market.

First the volumes sing the Chinese tune as mentioned earlier. Then comes the lack of Electric Vehicle charging infrastructure. Government sops have been placed in order to get things moving, but the glacial speed throws off the whole implementation process.

China, on the other hand, has been at the forefront in its electric mobility drive with over half a million cars produced last year and the number tipped to grow five times by the end of this decade. This also puts in perspective why companies like Renault are betting big on China to drive their electric agenda. Even Europe will have to wait till 2021 for models like the K-ZE where the overall market size will still be much smaller than China. It is logical to assume that India will also be part of this drive, going by what Renault has articulated in its five-year strategic plan ending 2022, but this will again be on a far lower scale.

China has gone the extra mile in defining a roadmap for itself as a global automotive giant. Chinese auto-makers are constantly on the prowl for opportunities to increase scale. Whether its Geely with acquisitions like Volvo Cars or Dongfeng who helped to bail out a once struggling Peugeot Citroen through infusion of equity. Likewise, General Motors got a lifeline from longtime Chinese ally, SAIC Motor, when it was nearly wiped out after the Lehman crisis.

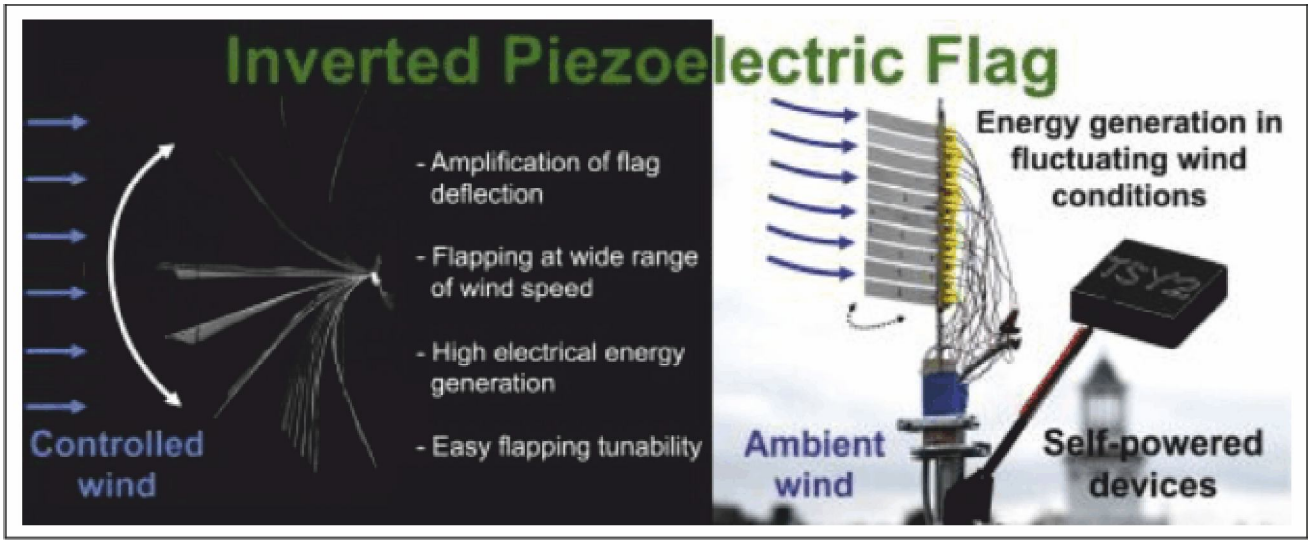
So Chinese have been working and improving their moves for quite sometime, while India has to start from scratch. First to develop its market, Invest in capacities, build its supply chains and create demand, all while keeping the electric vehicles attractively priced for its people to buy.

"Life is like a game of cards.
The hand you are dealt is determinism;
the way you play it is free will."

– JAWAHARLA NEHRU

SCIENTISTS HAVE CREATED FLAGS THAT CAN GENERATE ELECTRICAL ENERGY USING WIND AND SOLAR POWER

The novel wind and solar energy-harvesting flags have been developed using flexible piezoelectric strips and flexible photovoltaic cells.Piezoelectric strips allow the flag to generate power through movement, whilst the photovoltaics is the best known method of harnessing electric power by using solar cells. The study, conducted by researchers at The University of Manchester, is the most advanced of its kind to date and the first to simultaneously harvest wind and solar energies using inverted flags. The research has been published in the journal Applied Energy.



The newly developed energy harvesting flags are capable of powering remote sensors and small-scale portable electronics which can be used for environmental sensing such as to monitor pollution, sound levels and heat for example.

The aim of the study is to allow cheap and sustainable energy harvesting solutions which can be deployed and left to generate energy with little or no need for maintenance. The strategy is known as “deploy-and-forget” and this is the anticipated for model that so called smart cities will adopt when using remote sensors.

Jorge Silva-Leon, from Manchester’s School of Mechanical, Aerospace & Civil Engineering and lead-author of the study, says: “Under the action of the wind, the flags we built bend from side to side in a repetitive fashion, also known as Limit-Cycle Oscillations. This makes them perfectly suited for uniform power generation from the deformation of piezoelectric materials. Simultaneously, the solar panels bring a double benefit: they act as a destabilizing mass which triggers the onset of flapping motions at lower wind speeds, and of course are able to generate electricity from the ambient light.

Dr Andrea Cioncolini, co-author of the study, added: “Wind and solar energies typically have intermittencies that tend to compensate each other. The sun does not usually shine during stormy conditions, whereas calm days with little wind are usually associated with shiny sun. This makes wind and solar energies particularly well suited for simultaneous harvesting, with a view at compensating their intermittency.”

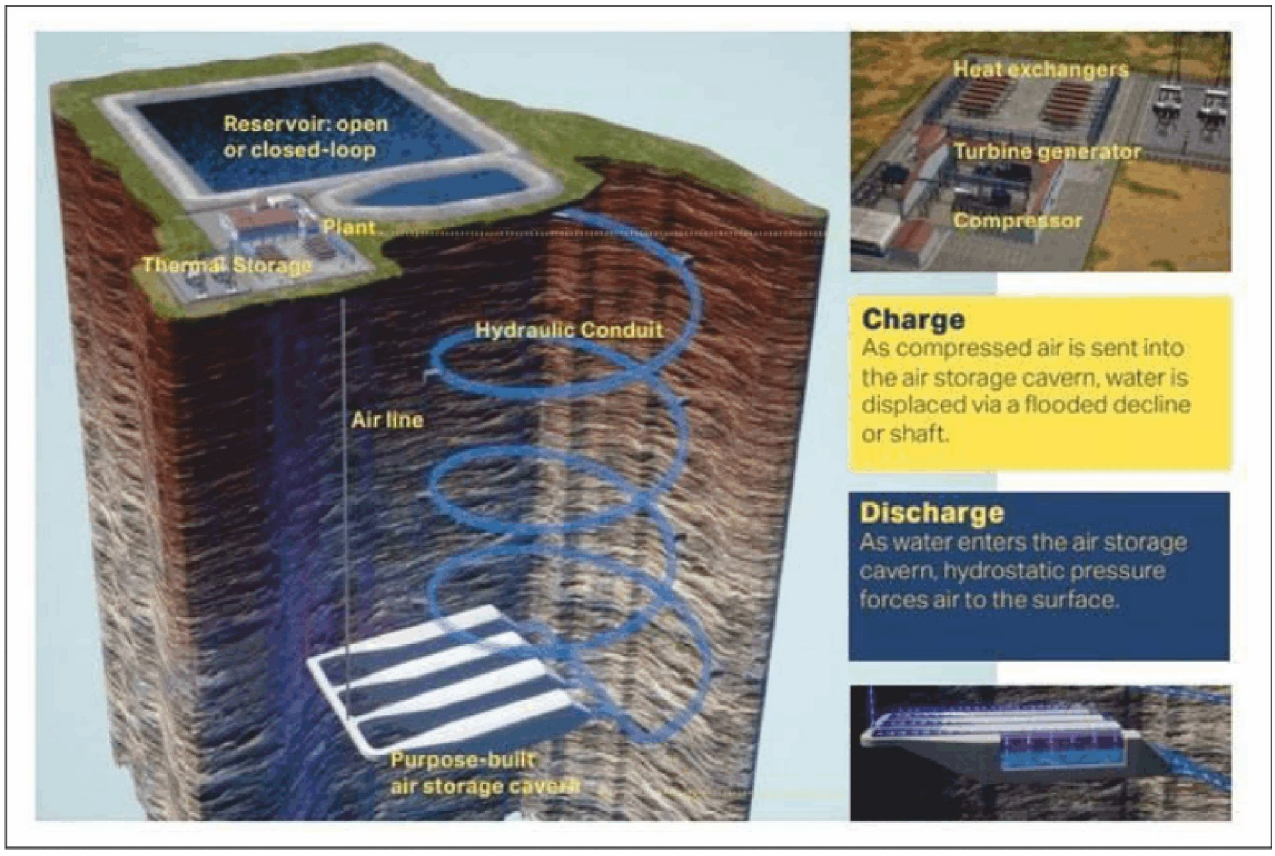
The team used and developed unique research techniques such as fast video-imaging and object tracking with advanced data-analysis to prove their flags worked. The developed harvesters were tested in wind speeds varying from 0 m/s (calm) to about 26 m/s (storm/whole gale) and 1.8 kLux constant light exposure, simulating a wide range of environmental conditions. Under these operation conditions, total power outputs of up to 3-4 milli-Watts were generated.

Dr Mostafa Nabawy, co-author of the study, says: "Our piezo/solar inverted flags were capable of generating sufficient power for a range of low power sensors and electronics that operate in the micro-Watt to milli-Watt power range within a number of potential practical applications in avionics, land and sea remote locations, and smart cities. We hope to develop the concept further in order to support more power-demanding applications such as an eco-energy generating charging-station for mobile devices."

Dr Alistair Revell, co-author of work, highlights current and future research directions saying: "We are currently making use of a novel computational framework for modelling and simulation developed at The University of Manchester, building on a long tradition of Computational Fluid Dynamics in the group. The use of computers to model fluid-structure interactions is increasingly referred to as virtual engineering, and plays a key part in device development by reducing the number of models which need to be physically manufactured and tested."

MINES AND POWER STATIONS USED AS CLEAN ENERGY STORAGE FACILITIES

Long-term energy storage has taken on greater importance as the world transitions away from fossil fuels toward renewable sources of clean energy. A Canadian startup, Hydrostor, has come up with a unique cost-effective, fuel-free, energy storage solution.Toronto, Canada-based Hydrostor was founded in 2010 and is a leader in Advanced Compressed Air Energy Storage (A-CAES), a technology uniquely suited to enable the transition to a cleaner, more reliable electricity grid.



Unlike utilizing lithium-ion energy storage batteries, compressed air energy storage (CAES) is a way to store energy generated at one time for use at another time using compressed air. Basically, Hydrostor's utility-scale storage systems pump large volumes of air into small underground shafts during off-peak hours and then releases it to run turbines when energy demand goes up.

Hydrostor's A-CAES system's performance is very similar to other rotating generation equipment such as the type used in natural gas facilities, however, compared to competing technologies, Hydrostor A-CAES has many distinct advantages that lower life-cycle costs.

Perhaps the biggest plus is that no fuel or chemicals are used in the technology and there are no emissions. And with a 50-plus year system life, the system has the lowest installed cost per kilowatt hour (kWh) for large-scale, long-duration energy storage (100+ MW). And we are talking about four to well over 24 hours worth of energy storage.

How the process works

Actually, the accompanying video is very easy to understand, but basically, off-peak or surplus electricity from the grid or a renewable source is used to operate a compressor that produces heated compressed air. In Hydrostor's patented fuel-free adiabatic process, the heat is extracted and stored in a proprietary thermal storage unit.

A specially-built storage cavern is also used to store air. Hydrostatic compensation is used to maintain the system at a constant pressure during operation. When electricity is needed, hydrostatic pressure forces the air to the surface where it is recombined with the heat and expanded through a turbine to produce electricity.

Now all this sounds simple enough. But what Hydrostor has done is figured out a way to repurpose coal-fired power plants and even old mines - turning them into utility-scale energy storage facilities. What's the huge plus to doing this? The old facilities already have the infrastructure in place to connect to the electric grid.

Hydrostor has signed an AUS$30-million deal in Australia to build a demonstration facility at a disused zinc mine near Adelaide. Hydrostor will construct the 5 MW / 10 MWh fuel-free Advanced Compressed Air Energy Storage (A-CAES) facility which will re-purpose the Angas Zinc Mine in Strathalbyn, 60 kilometers southeast of Adelaide.

"We bellieve in peace and peaceful development, not only for ourselves but for people all over the world." – LAL BAHADUR SASTRI

RINGLET

~ DIRECT CHANNEL PARTNER of :hager

Distribution boards

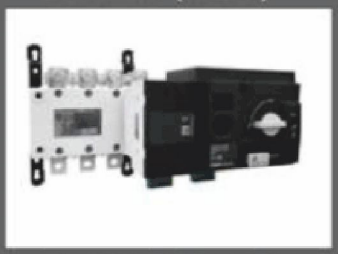
Miniature Circuit Breakers (MCB)

Moulded Case Circuit Breakers (MCCB)

Residual Current Circuit Breakers (RCCB)

RCBO ,RCD+MCB modules

Manual Changeover Switches



Automatic Transfer Switches

Time Switches

Digital Energy Meters

Contactors

Isolating Switches

Surge Protection Devices

LED Indicators

Plug & Socket Outlets

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ENERGY, ELECTRICAL ENERGY AND RENEWABLE ENERGY – 23

Sustainable Growth, Sustainable Electrical Energy and Renewable Energy

Review of Bio Energy and the Potentials

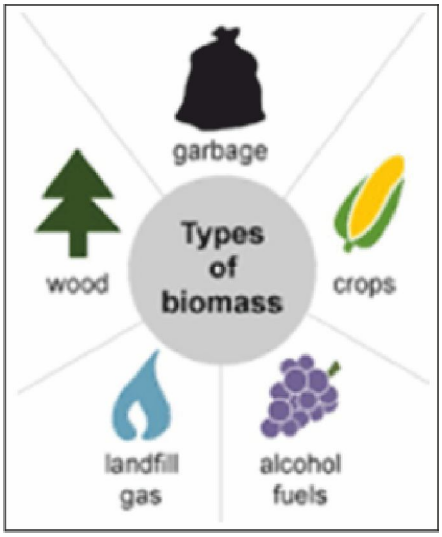
Solar Energy – Focus on Solar Thermal and Electricity.

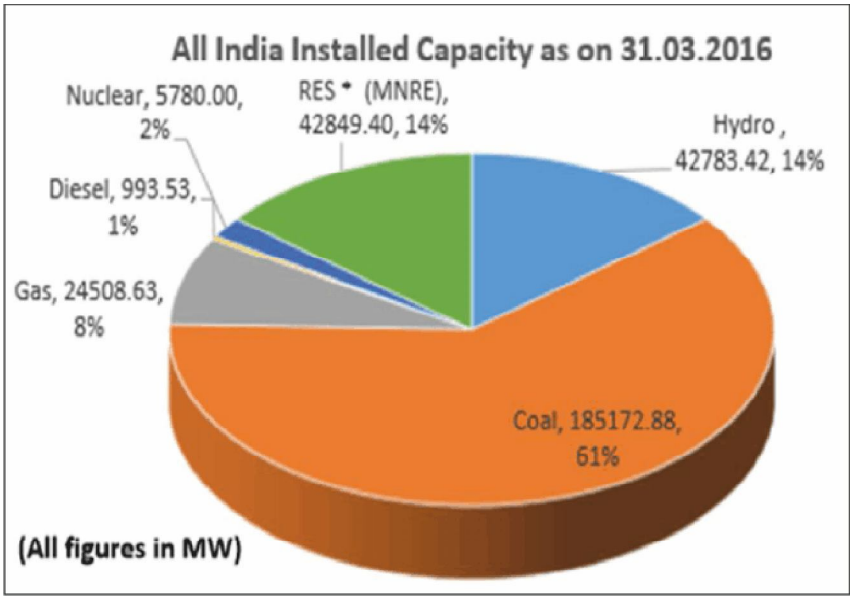
General Review:

As we all know, the important sources of renewable energy that are being tapped in sizable scale with economically feasible technologies in all parts of the world are Solar, Wind, Biomass and Hydel. Solar and wind and Hydel are playing sizable role elsewhere and in India too, and the technologies have all been established with commercial feasibility.

The total installed capacity picture of 2016 is shown below where the contribution of Renewable Energy is about 14%.

In 2019, the total installed capacity has increased to 3,50,000 MW and the breakup of RE are provided for information.





Installed grid interactive renewable power capacity in India as of 30 June 2019 (excluding large hydro)

- Wind Power: 36,368 MW (45.2%)
- Solar Power: 29,549 MW (36.7%)

- Biomass Power: 9,806 MW (12.2%)
- Small Hydro Power: 4,604 MW (5.7%)
- Waste-to-Power: 138 MW (0.2%)

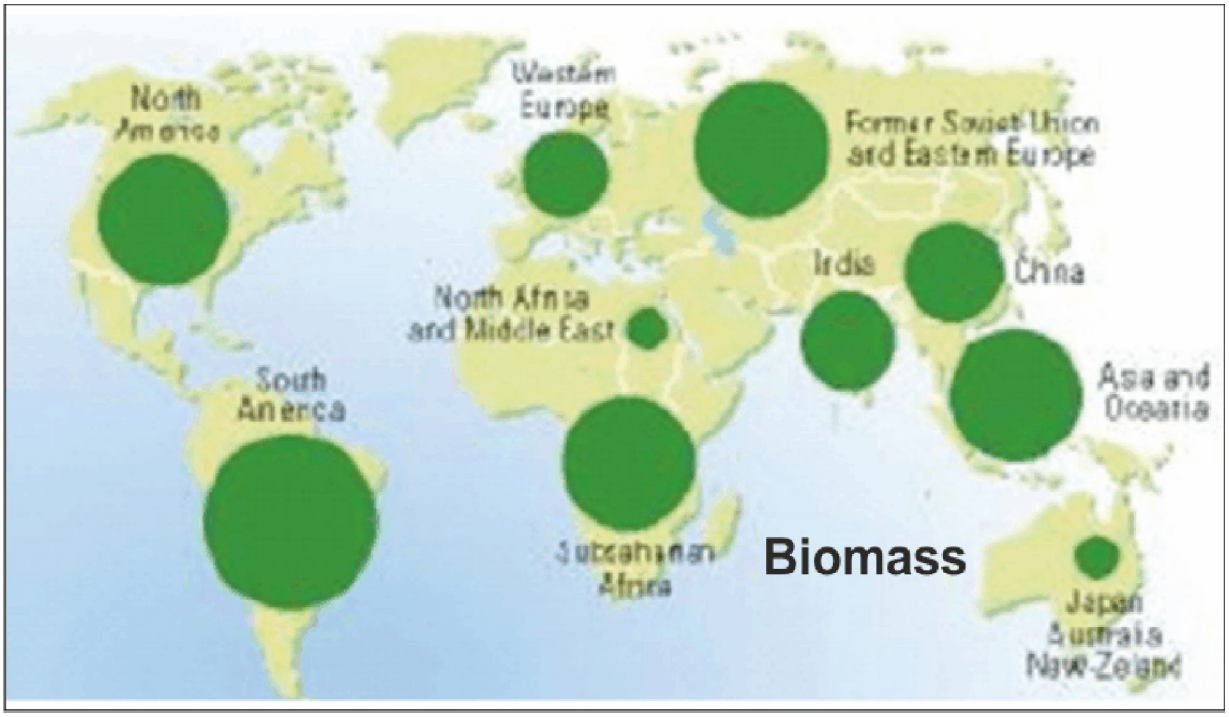
A study of Renewable Energy Potential estimates by the World bodies and India are interesting (with large variations) and requires deeper study by experts.

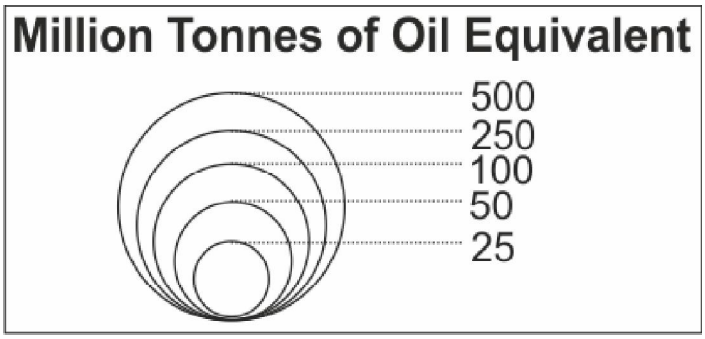
The Energy Statistics '18 provided by Central Board of Statistics, Govt. of India, estimates the Renewable Energy potential as 10 Lakh MW, with the breakup of 65% Solar, 30% Wind, 2% Small Hydro and 3% Biomass.

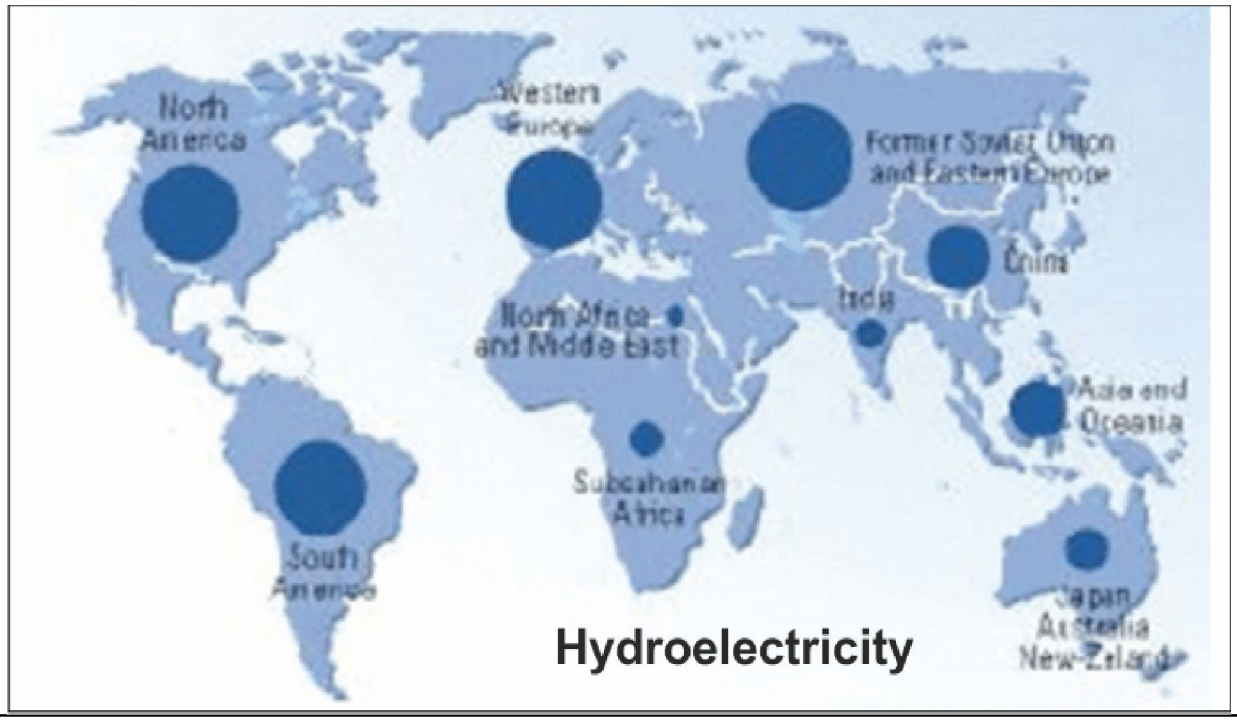
Global Renewable Energy Potentials (Source- Global Energy Network Institute) are shown below in the form of maps and circles depicting the potentials in different countries of the world. The sizes of the circles mark the potentials in terms of MTOE (Million Tons of Oil Equivalent) and the scale is also provided in the Maps.

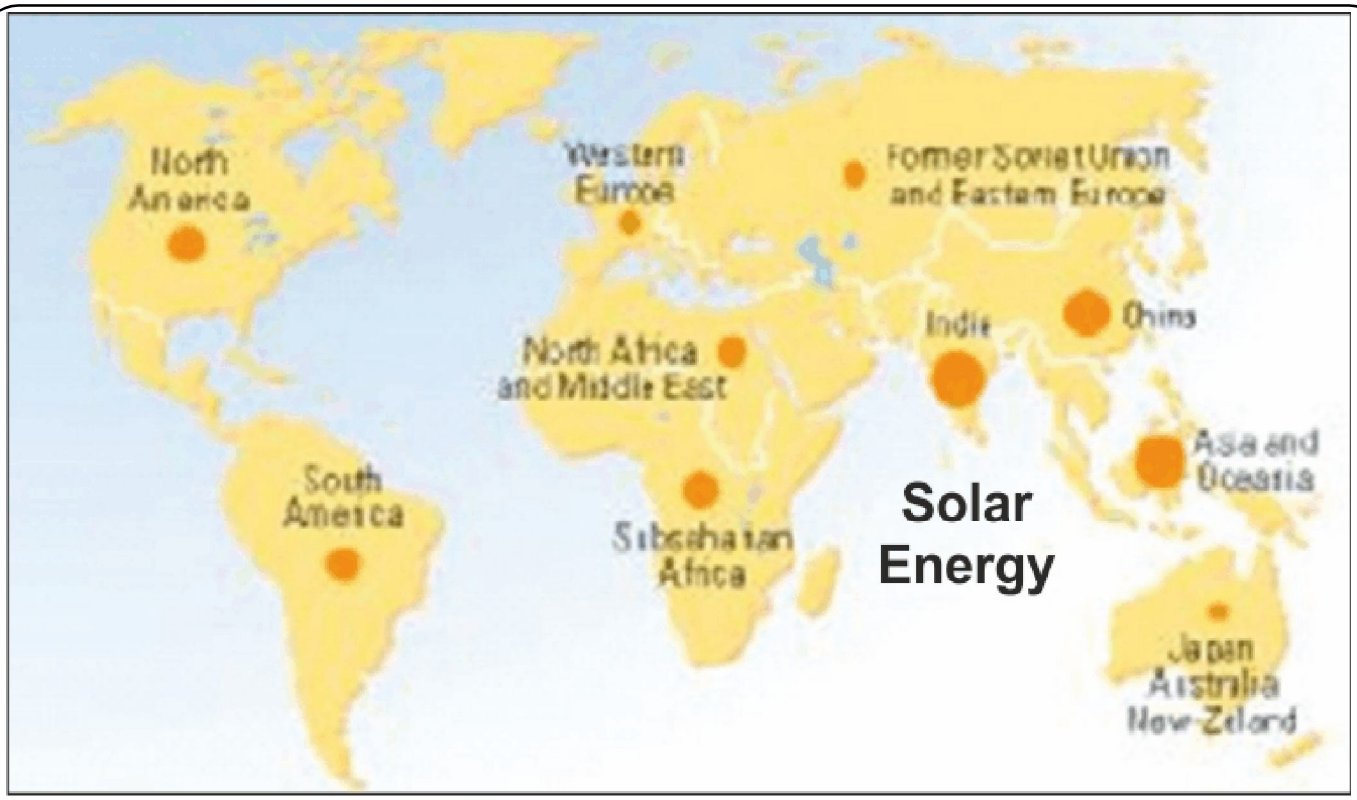
Closer study of the maps will show that the Biomass or Bio Energy potential of India is much higher than its Solar or Wind potentials. For example, studying co relating with the scale and diameters of circles, the Solar potential of India can be put at about 50 MTOE, whereas the Biomass potential can be put at about 200 MTOE, wind and Hydro potentials being about 10 and 15 MTOE respectively. These figures, particularly Biomass, may look unbelievable; but a deeper analysis taking into account of all kinds of wastes (lots of them are just burnt away today like the case of Punjab and Haryana where 20 Million tons per crop, of Rice straw and stubs are burnt every year) coming from Agriculture, Plantations, Farms, Forests, Animals and Poultry, Industries and Agro industries and solid and liquid wastes from all human habitations in all towns and villages can certainly establish the potentials. So, if have a relook at the RE Potentials given by Statistical Board detailed earlier, if the potential of solar is put at 6.5 Lakh MW (65% OF 10 Lakh), the potential of Biomass should be 4 x 6.5 = 26 Lakh MW. The multiplying factor of 4 has been arrived from 50 and 200 MTOE figs.

WIND POTENTIAL RENEWABLE ENERGY


North America
Western Europe
Former Soviet Union and Eastern Europe
India
China
North Africa and Middle East
South America
Asia and Oceania
Subsahanan Africa
Biomass
Japan
Australia
New-Zeland


Million Tonnes of Oil Equivalent
500
250
100
50
25


North America
Western Europe
Former Soviet Union and Eastern Europe
China
India
North Africa and Middle East
Asia and Oceania
Subsahanan Africa
South America
Japan
Australia
New-Zeland
Hydroelectricity



Closer study of the maps will show that the Biomass or Bio Energy potential of India is much higher than its Solar or Wind potentials. For example, studying co relating with the scale and diameters of circles, the Solar potential of India can be put at about 50 MTOE, whereas the Biomass potential can be put at about 200 MTOE, wind and Hydro potentials being about 10 and 15 MTOE respectively. These figures, particularly Biomass, may look unbelievable; but a deeper analysis taking into account of all kinds of wastes (lots of them are just burnt away today like the case of Punjab and Haryana where 20 Million tons per crop, of Rice straw and stubs are burnt every year) coming from Agriculture, Plantations, Farms, Forests, Animals and Poultry, Industries and Agro industries and solid and liquid wastes from all human habitations in all towns and villages can certainly establish the potentials. So, if have a relook at the RE Potentials given by Statistical Board detailed earlier, if the potential of solar is put at 6.5 Lakh MW (65% OF 10 Lakh), the potential of Biomass should be 4 x 6.5 = 26 Lakh MW. The multiplying factor of 4 has been arrived from 50 and 200 MTOE figs.

So where is the problem in assessing and converting all wastes into Energy? It is really the sustainable technologies and the sustained working with them. We have seen in earlier parts of this series of articles, about Bio Energy Technologies falling under Bio Chemical and Thermos Chemical Technologies groups, and developments in various parts of the world, particularly the US and Canada and the Europe.

In case of Bio Gas plants, the technology is quite simple, but it requires 24 x 365 days of continuous operations and monitoring and continuous use of the Gas. There are millions of Bio Gas plants installed in the past 4, 5 decades all over the country, assisted by Government and the KVIC etc., but a study may show that a majority of them are abandoned. There are also a number of success stories like the Bio Gas Plants of the CMWSSB, Salem Sago Plants, Namakkal Poultry litter Bio Gas plants, some large canteens and Dharam salas etc. Researches have resulted in advanced technologies for Bio Gas production and processing of them for value addition etc. which require assistance and popularization.

In case of Thermo Chemical Technologies and Power Generation with combustion and gasification technologies, the Indian experiences have been bad to worse. The reasons are many, but in simple terms they can be put as improper selection and application of technologies. Both in combustion and gasification the failures are mainly due to the "Tar" problems and the cost problems as the plants are designed to use only dry woody biomass

which have become very costly. Both Gasification and combustion technologies are now available (in these cases the initial cost may be high, but running cost and generation cost per unit will be low) which can take any kind of biomass and with varying degrees of moisture up to about 40% etc. (examples can be Municipal Solid Waste, Poultry litter and wastes, various kinds of straw and stems etc.) and run continuously requiring only annual maintenance. The tips for success in Biomass power plants are simple - the technology must be able to take any kind of biomass, should be able to run continuously for at least 300 days in a year and the cost of the biomass should be from Rs -500 (MSW) to Rs 1,000 (easily combustible with min moisture) per ton only and such biomass should be sourced.

(To be continued)

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HUMOUR

An engineer took a cruise to the South Pacific Islands. It was wonderful; the experience of his life. But, alas, a cyclone came up unexpectedly and the ship went down. He was swept onto the shore of an island. No people, no supplies, nothing.

He explored but found nothing other than some bananas and coconuts. He was desperate and forlorn, but what could he do? For the next four months he ate bananas, drank coconut juice and looked for a ship to come to his rescue.

One day, he spotted a rowboat coming from what looked like the other side of the island. In it was a gorgeous woman. She was tawny and tanned, and her hair flowing in the breeze gave her an ethereal quality. When she reached him, he asked excitedly, "Where did you come from? How did you get here?"

She said, "I rowed from the other side of the island. My cruise ship sank four months ago."

"Amazing," he said, "I didn't know anyone else had survived. How many of you are there? You are really lucky that a rowboat washed up with you."

"There is no one else—only me," she said, "and the rowboat didn't wash up. I built it out of raw material I found on the island. The oars I whittled from gum tree branches, I wove the bottom from palm branches, and the sides and stern came from a eucalyptus."

"But—but," asked the man, "What did you use for tools?" "Oh, no problem," replied the woman, "On the south side of the island there is a very unusual stratum of alluvial rock. I found that if I fired it to a certain temperature in my kiln, it melted into forgeable iron."

"But enough of that," she said. "Where do you live?" The man confessed he had been sleeping on the beach.

"Let's row over to my place," she said. So they got into the rowboat and left for her side of the island. The woman tied up the rowboat with a beautifully woven hemp rope. They walked up a stone walk to an exquisite bungalow. "It's not much," she said, "but I call it home. Would you like a drink?"

"No," he answered, "One more coconut juice and I will puke." "I have a still," said the woman, "How about a Pina Colada?" Trying to hide his amazement, the man accepted, and they sat down on her couch.

After a while, the woman asked, "Tell me, have you always had a beard?" "No," the man replied, "I was clean shaven all my life." "Well, if you would like to shave, there is a razor in the cabinet in the upstairs bathroom." The man, no longer questioning anything, went to the bathroom. In the cabinet was a razor made from a bone handle, two shells honed to an edge were fastened to its end inside of a swivel mechanism. The man shaved, showered and went back downstairs. "You look great," she said. "I think I will slip into something more comfortable."

After a short time, she returned wearing strategically positioned fig leaves and smelling faintly of gardenia. "Tell me," she asked, "We have both been out here for a very long time with no companionship. Have you been lonely? Is there anything that you miss? Something that all men and women crave? Something that would be really nice to have right now?" "Yes there is," the man replied, and moved closer to her. "Tell me, do you have an Internet connection?"

JAYARAM BANAN
Sagar Ratna

Sagar is a by word for quality; it is an Indian fast food at its finest, freshly made, reasonably priced and delicious.

With its outlets spread across Delhi and NCR, Sagar Ratna has become a by word for South Indian fast food. A price-friendly option for vegetarians, its chain ensures a high degree of standardisation, lightning-fast service and affordable quality food.

From a run away kid to a successful owner of restaurants chain Sagar, Jayaram Banan has indeed come a long way in life and is today fondly called the "**Dosa King of India".** He had introduced the first ever organized South Indian chain of restaurants in North India. Today he runs 28 branches and 42 franchisee outlets of Sagar Ratna in 66 cities. The daily turn over is rupees 20 lakhs. The outlets are frequented by a long list of customers including celebrities and many elite personalities.

Jayaram Banan celebrated the Silver Jubilee of his successful venture in 2012. He believes nothing comes easy in life. You really have to work hard for it. He says, *"Success has only been the results of systematic planning and hard work"*. He plans his restaurant to be more attractive and family styled and would fashion a better ambience and flaunt a wow factor.

We USP of Sagar Ratna was the passion to serve the best quality food at reasonable rates with a heart warming service. He has tried to ensure a personal touch to his restaurants by being present there as much as possible. Since 2001 Sagar Ratna has continuously and consecutively won the best South Indian Restaurant in India from HT and TOI-ever since they started giving such awards. Having achieved a stable growth pace, the aim now is to expand across the country and to fully saturate the Northern market.

In May 2010, Jayaram opened a Four Star 84 room hotel-Ocean Pearl-in Mangalore. Another extention is a chain of multi-cuisine fine dining restaurants with bar facility-Swagath-which was recognised as one of the top sea food restaurants across the Asian Continent by miele guide.

Famous slogans of Indian freedom fighters

"Inqlaab Zindanbad"- *Shaheed Bhagat Singh. ...*

"Tum Muje Khoon Do, Mai Tumhe Azadi Dunga" – *Subhash Chandra Bose. ...*

"Karo ya Maro" – *Mahatma Gandhi. ...*

"Sare Jahan Se Achha Hindustan Hamara" – *Muhammad Iqbal. ...*

"Vande Mataram" – *Bankim Chandra Chatterjee. ...*

"Satyameva Jayate" – *Pandit Madan Mohan Malviya*

FREEDOM FIGHTERS - BHAGAT SINGH

Bhagat Singh (September 27, 1907 – March 23, 1931) was an Indian revolutionary, considered to be one of the most famous martyrs of the Indian freedom struggle. For this reason, he is often referred to as Shaheed Bhagat Singh (the word shaheed means "martyr"). Bhagat Singh was born into a Sikh family to Sardar Kishan Singh and Vidyavati in the Khatkar Kalan village near Banga in the Jalandhar district of Punjab. His uncle, Sardar Ajit Singh, as well as his father, were great freedom fighters, so Bhagat Singh grew up in a patriotic atmosphere. Ajit Singh established the Indian Patriots' Association, along with Syed Haidar Raza, to organize the peasants against the Chenab Canal Colony Bill. He also established the secret organization, the Bharat Mata Society. At an early age, Bhagat Singh started dreaming of uprooting the British empire. Never afraid of fighting during his childhood, he thought of "growing guns in the fields," so that he could fight against the British. The Ghadar Movement left a deep imprint on his mind. Kartar Sing Sarabha, hanged at the age of 19, became his hero. The massacre at Jallianwala Bagh on April 13, 1919 drove him to go to Amritsar, where he kissed the earth sanctified by the martyrs' blood and brought back home a little of the soaked soil. He studied in the D.A.V. School in Lahore. At the age of 16, he used to wonder why so many Indians could not drive away these fistful of invaders. In search of revolutionary groups and ideas, he met Sukhdev and Rajguru. Bhagat Singh, along with the help of Chandrashekhar Azad, formed the Hindustan Socialist Republican Army (HSRA). The aim of this Indian revolutionary movement was now defined as not only to make India independent, but also to create "a socialist India." During the Simon Commission, Sher-e-Punjab Lala Lajpat Rai was wounded and died later. To avenge his death, Bhagat Singh and Rajguru killed Mr. Saunders (one of the deputy officers in connection with the Simon Commission).

When the British government promulgated the two bills "Trade Union Dispute Bill" and "Public Safety Bill" which Bhagat Singh and his party thought were Black Laws aimed at curbing citizens' freedom and civil liberties, they decided to oppose these bills by throwing a bomb in the Central Assembly Hall (which is now Lok Sabha). However, things changed, and the Britishers arrested Bhagat Singh and his friends on April 8, 1929. He and his friends wanted to be shot dead, since they were termed as prisoners of war. Their request was not fulfilled, and on March 23, 1931, Bhagat Singh, Shivram Rajguru, and Sukhdev were hanged to death. This man's only mission in life was to see his country free from British rule. He did his best and when he was being led to the gallows, he was satisfied that he had lived up to his principles, irrespective of the consequences. The only thing that made him sad was that he couldn't do more for his country.

Gandhiji & Jawaharlal Nehru's Discussing Bhagat Singh | The Legend Of Bhagat Singh Scene

Merciless criticism and independent thinking are the two necessary traits of revolutionary thinking. – Bhagat Singh

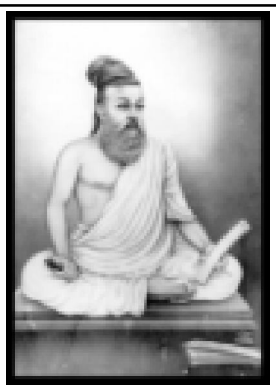
SOME VERY INTERESTING BUT ALSO SCARY PREDICTIONS..

1. Auto repair shops will disappear.
2. A petrol/diesel engine has 20,000 individual parts. An electrical motor has 20. Electric cars are sold with lifetime guarantees and are only repaired by dealers. It takes only 10 minutes to remove and replace an electric motor.
3. Faulty electric motors are not repaired in the dealership but are sent to a regional repair shop that repairs them with robots.
4. Your electric motor malfunction light goes on, so you drive up to what looks like a car wash, and your car is towed through while you have a cup of coffee and out comes your car with a new electric motor!
5. Petrol pumps will go away.
6. Street corners will have meters that dispense electricity. Companies will install electrical recharging stations; in fact, they've already started in the developed world.
7. Smart major auto manufacturers have already designated money to start building new plants that only build electric cars.
8. Coal industries will go away. Gasoline/oil companies will go away. Drilling for oil will stop. So say goodbye to OPEC! The middle-east is in trouble.
9. Homes will produce and store more electrical energy during the day and then they use and will sell it back to the grid. The grid stores it and dispenses it to industries that are high electricity users. Has anybody seen the Tesla roof?
10. A baby of today will only see personal cars in museums. The FUTURE is approaching faster than most of us can handle.
11. In 1998, Kodak had 170,000 employees and sold 85% of all photo paper worldwide. Within just a few years, their business model disappeared and they went bankrupt. Who would have thought of that ever happening?
12. What happened to Kodak and Polaroid will happen in a lot of industries in the next 5-10 years … and most people don't see it coming.
13. Did you think in 1998 that 3 years later, you would never take pictures on film again? With today's smart phones, who even has a camera these days?
14. Yet digital cameras were invented in 1975. The first ones only had 10,000 pixels, but followed Moore's law. So as with all exponential technologies, it was a disappointment for a time, before it became way superior and became mainstream in only a few short years.
15. It will now happen again (but much faster) with Artificial Intelligence, health, autonomous and electric cars, education, 3D printing, agriculture and jobs.
16. Forget the book, "Future Shock", welcome to the 4th Industrial Revolution.
17. Software has disrupted and will continue to disrupt most traditional industries in the next 5-10 years.
18. UBER is just a software tool, they don't own any cars, and are now the biggest taxi company in the world! Ask any taxi driver if they saw that coming.
19. Airbnb is now the biggest hotel company in the world, although they don't own any properties. Ask Hilton Hotels if they saw that coming.

20. Artificial Intelligence: Computers become exponentially better in understanding the world. This year, a computer beat the best Go-player in the world, 10 years earlier than expected.
21. In the USA, young lawyers already don't get jobs. Because of IBM's Watson, you can get legal advice (so far for right now, the basic stuff) within seconds, with 90% accuracy compared with 70% accuracy when done by humans. So, if you study law, stop immediately. There will be 90% fewer lawyers in the future, (what a thought!) only omniscient specialists will remain.
22. Watson already helps nurses diagnosing cancer, its 4 times more accurate than human nurses.
23. Facebook now has a pattern recognition software that can recognize faces better than humans. In 2030, computers will become more intelligent than humans.
24. Autonomous cars: In 2018 the first self-driving cars are already here. In the next 2 years, the entire industry will start to be disrupted. You won't want to own a car anymore as you will call a car with your phone, it will show up at your location and drive you to your destination.
25. You will not need to park it you will only pay for the driven distance and you can be productive while driving. The very young children of today will never get a driver's license and will never own a car.
26. This will change our cities, because we will need 90-95% fewer cars. We can transform former parking spaces into green parks.
27. About 1.2 million people die each year in car accidents worldwide including distracted or drunk driving. We now have one accident every 60,000 miles; with autonomous driving that will drop to 1 accident in 6 million miles. That will save a million lives plus worldwide each year.
28. Most traditional car companies will doubtless become bankrupt. They will try the evolutionary approach and just build a better car, while tech companies (Tesla, Apple, Google) will do the revolutionary approach and build a computer on wheels.
29. Look at what Volvo is doing right now; no more internal combustion engines in their vehicles starting this year with the 2019 models, using all electric or hybrid only, with the intent of phasing out hybrid models.
30. Many engineers from Volkswagen and Audi; are completely terrified of Tesla and they should be. Look at all the companies offering all electric vehicles. That was unheard of, only a few years ago.
31. Insurance companies will have massive trouble because, without accidents, the costs will become cheaper. Their car insurance business model will disappear.
32. Real estate will change. Because if you can work while you commute, people will abandon their towers to move far away to more beautiful affordable neighborhoods.
33. Electric cars will become mainstream about 2030. Cities will be less noisy because all new cars will run on electricity.
34. Cities will have much cleaner air as well.
35. Electricity will become incredibly cheap and clean.
36. Solar production has been on an exponential curve for 30 years, but you can now see the burgeoning impact. And it's just getting ramped up.
37. Fossil energy companies are desperately trying to limit access to the grid to prevent competition from home solar installations, but that simply cannot continue - technology will take care of that strategy.
38. Health: The Tricorder X price will be announced this year. There are companies who will build a medical device (called the "Tricorder" from Star Trek) that works with your phone, which takes your retina scan, your blood sample and you breath into it. It then analyses 54 bio-markers that will identify nearly any Disease. There are dozens of phone apps out there right now for health purposes.

WELCOME TO TOMORROW – *it actually arrived a few years ago*.

TIRUKKURAL AND FAIR AND ETHICAL MANAGEMENT - 7



Decision making is always considered as the important job of the Manager and the decision making process should normally be based on the following "Senses" namely,

- Historical Sense – Reviewing the historical background of the situation
- Socio, Political and Economic Sense – Reviewing SPE Background
- Commonsense – This is considered normally as the wisdom and experience of the individual based on his value system.

Analysing what could really make up the factor of commonsense, it is the ability of the person to take a clear decision taking into consideration all factors leading to the situation or the problem. It will be very good if it is built on sound value system, righteousness and selflessness and fairness.

Tirukkural, the work of Tiruvalluvar, can be considered as a total treatise to establish the 'Good Values' and their worth and importance and the perils if they are not followed, in all the activities and the whole life of individuals, society, rulers and the leadership. The buildup of 'Commonsense' should be based on **Aram, Dharma and Righteousness,** can be considered as an important message of Tirukkural. Sample of 2 Kurals are dealt below to illustrate the points and more will follow.

Aranarinthu Vekhka Arivudaiyarch Cherum
Thiran Arinthu Aange Thiru Kural 179

அறனறிந்து வெக்கா அறிவுடையார்ச் சேரும்
திறன்அறிந் தாங்கே திரு. குறள் 179

"Behold the wise man that understandeth justice and coveteth not. Success (Lakshmi) his worth and seeketh him"

Araththinangu Aakkamum Illai; Athanai
Maraththalin Oongillai Kedu Kural 32

அறத்தினூஉங்கு ஆக்கமும் இல்லை அதனை
மறத்தலின் ஊங்கில்லை கேடு. குறள் 32

"There is no great good than Righteousness, nor greater ill that the forgetting of it (results)"

HOME FESTIVALS - 9

புரட்டாசி - Purattasi (September/October)

Navaratri ("nine nights") is the principal festival this month. The Goddess is worshipped in Her many forms, and on the ninth day, Sarasvati (center of the painting) is invoked to bless musical instruments, account books, agricultural instruments and home tools(upper left). On Vijaya Dasami, the day following Navaratri, Goddess Durga is invoked as children are given their first instruction, worship their school books and honour their teacher. A decorated display of dolls is displayed through the nine days, then dismantled and stored on the tenth day. **Vijaya Dasami is also the birthday of Lord Venkateshwara**, presiding Deity of Tirupati temple in Andhra Pradesh, India's wealthiest temple. ***(To be continued)***

NEW CREO FAMILY OF E-BIKES

The e-bikes are coming and it's safe to say most will be a whole lot heavier than what cyclists are used to, especially those plying their trade on lightweight road frames. In no small way, Specialized is looking to close the gap with its new S-Works Turbo Creo SL Founders Edition, which packs 240 W of pedal assistance power into a beautifully (and very expensively) engineered full carbon frame.

At just 11.9 kg (26.2 lb), the Turbo Creo SL Founders Edition is going to be heavier than a typical road bike, but not overly so, and certainly falling at the ultra-light end of the scale when we're talking bikes with batteries stuffed into them.

In this case, Specialized has built a 380-Wh battery into the down tube, which it says packs enough juice for 80 miles (128 km) of assisted pedaling. Also, 160-Wh range extenders can be latched onto the bike to stretch that range out by 40 mi (64 km) apiece, with two thrown in as part of the Turbo Creo SL Founders Edition package.

The bike is powered by Specialized's own, in-house-built SL 1.1 motor, which outputs up to 240 watts in response to the rider's own torque curve and is claimed to create zero drag when riding without assistance.

A power meter is integrated into the top tube, while its distribution can be managed through the Mission Control smartphone app. Here, users can choose from Eco, Sport and Turbo assist modes and tweak where the power tops outs and how much support they want along the way.

Other features include hydraulic disc brakes, an 11-speed Shimano Dura-Ace groupset and a Custom Roval CLX 50 wheelset dressed in 28-mm tires. The Turbo Creo SL Founders Edition also comes with Specialized's latest bump-absorbing headset, the Future Shock 2.0, which offers 20 mm of vertical movement to help smooth out trips over uneven terrain.

The Turbo Creo SL Founders Edition is the range-topping model of Specialized's new Creo family of e-bikes, so less expensive versions are available but even these won't come cheap. They are a little heavier and use less sophisticated parts, with the Turbo Creo SL Expert carrying a price tag of $9,000 and the S-Works Turbo Creo SL priced at $13,500. The Turbo Creo SL Expert EVO, comes with 38-mm tires for off-road adventure and is priced at $9,000.

NEW CREO FAMILY OF E-BIKES

TECHNICAL SEMINAR PHOTOS - JULY 2019


TAMILNADU
ENGINEERS' ASSOCI
No. 1/61-10, Plot No.48, G
Ravi Colony, Near Kathipara, St. Th
"TECHNICAL SE
by
M/s Legrand
M/s B.L. Electric
M/s Sunbeam Generato


SUYAMBU


SUYAMBU


TAMILNADU ELECTRICAL INSTALLATION
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"TECHNICAL SEMINAR"


Mr. M. BALAMURUGAN


Complete power back-up solution
AMF as standard


Sunbeam Generator
Complete power back-up sol
AMF as standard offering
QR Code enabled genset
Remote monitoring
New attractive colour sche
Bolt-less canopy


CAL SEMINAR"
by
s Legrand
L. Electricals
Mr.K.KANNAN


by
M/s Legrand
B.L. El icals
M/s Si am Gen rs Pvt. Lta

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