ELECTRICAL INSTALLATION ENGINEER

NEWS LETTER

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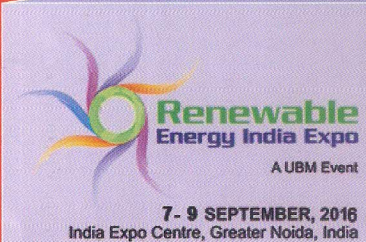
EVENTS

L&T Training Programme

Selection of LV Switchgear and Applications	1st – 5th August 2016
Introduction to Industrial Electrical Systems	8th – 10th & 22nd – 24th August 2016
Selection, Protection & Maintenance of Transformer	9th – 10th August 2016
Introduction to Medium Voltage Switchgear	11th – 12th August 2016
Selection & Application of Drives	17th – 19th August 2016
Industrial Electrician Training Programme	22nd – 23rd August 2016
Electrician Training Programme for Residential Buildings	24th August 2016
Electrical Safety	29th August 2016

Venue: L & T Ltd., Switchgear Training Centre, Nilgiris
Contact Tel.: 0423-2517107 **Fax:** 0423-2517158 **Email:** stc_coonoor@lntebg.com



Events Profile: Expo intends to accelerate the growth of India's Renewable Energy sector and contribute to the country's sustainable economic development. The show aims to upscale and mainstream the applications of renewable energy resources, showcase innovations, and enrich deliberations by providing the industry with an international exhibition and conference platform.
Date: 7th – 9th September 2016
Venue: India Expo Centre, Greater Noida, India
Website: http://www.renewableenergyindiaexpo.com/

Events Profile: Elektrotec 2016 is one of the largest electrical and industrial electronics sector trade events in India.
Date: 15th – 18th September 2016
Timings - 10.30 AM to 06.00 PM
Venue: CODISSIA TRADE FAIR COMPLEX, Avinashi Road, Coimbatore
Website: http://elektrotec.codissia.com/

ELECTRICIAN 2016 Trade Fair

Events Profile: Tamilnadu Electricians Welfare Association is working for the welfare & development of Electrical Workers working in the Non-formal Sector, with more than 20,000 members in 10 districts of Tamilnadu. The trade fair is open both to professional People and Public. The Visitor's Profile includes Members of our Association, Students from Engineering Colleges, Polytechnics and Industrial Training Institutes in Chennai City, Electrical Contractors in Chennai, Builders and Electrical Engineers in Chennai.
Date: 17th & 18th September 2016 **Venue:** Valluvar Kottam, Nungambakkam, Chennai
Website: http://www.tnewa.org/

EDITORIAL

125th Issue of the News Letter!

Dear Members, Fellow Professionals, Friends and Well wishers,

SEASONS GREETINGS TO ONE AND ALL!

It is indeed a proud moment for the Association and the Team involved in bringing out the issues of **"ELECTRICAL INSTALLATION ENGINEER'** month after month and the **125th Issue** is in your hands. Our continuous efforts have been to provide, apart from 'News and Views', information and details about Technologies, Safety Practices, Energy and Energy Efficiency Matters and general materials for Life, Culture and Ethical practices. We look for more inputs from Members and our readers for more improvements. We greatly appreciate and are thankful to all the Members and Fellow Professionals and Friends who have guided and continuously supported this effort.

We are all aware that India is on an Economic Growth Trajectory for over 2 decades now and with all kinds of Global and Local problems and challenges, we have been marching ahead and are expected to become one of the top 3 economies of the world in another 2 decades or so. There is no doubt about the fact that Electrical Energy in all its dimensions of steady capacity additions, and steady supplies of adequate and quality supplies of Electricity, be it Agriculture or Commerce or Services or Manufacturing, decides the performance levels and Growth. In fact the 'Per Capita Consumption of Electricity' is a measure of Growth and Prosperity of a Society. There has been lot of Growth in these areas in our Country in the past 60 years and further Growth is also very much on the cards as we continue to be an attractive country for the world to do Business, Investments and Manufacture.

The Governments have also been doing their role to increase the pace of Growth. Though there are views that the Growth could have been much faster, we cannot forget the fact that we continue to be one of the World's largest Democracies with almost one sixth of the population of the World, which throws its dimensions of challenges. Another interesting feature is also that we are one of the oldest and the most diverse civilizations of the World, but we continue to be bonded together, helped by our Culture and Heritage. *Global recognition of "Yoga" now is a testimony for our Glorious Culture.*

A critical look at our Country and our selves at this point can probably go a long way to push us all to become better and contribute better towards the 'Nation Building Efforts'. We are one of the few countries of the World abundantly blessed by nature, be it Sun Shine or Waters or Rivers, Mountains and Minerals or many such, but we have turned to be a mass of people with Selfishness, Greed, Envy and all such ills, which is reflected in all our Individual, Collective and Political activities. It is also a fact, however, that we have been able to prove ourselves, facing the Global pressures, in many areas, be it Agriculture or IT or Space or Atomic Power or Manufacturing. Even a modicum of improvement in the Nature, Attitudes, Values and Behaviour of People, individually and collectively, can go a long way in ensuring our faster Growth towards Better Economy and Better Standards and Better Living for everyone.

We thank all those members who have helped us by participating in the advertisements appearing for the issue June 2016 - Abirami Electricals, FLIR Systems India Pvt. Ltd., Ashlok Safe Earthing Electrode Ltd., Elektrotec 2016, Galaxy Earthing Electrodes Pvt. Ltd., Sun Sine Solution Pvt. Ltd., Faith Power Solutions, Dehn India Pvt. Ltd., Wilson Power and Distribution Technologies Pvt. Ltd., Fomra & Fomra, JL Seagull Power Products, Universal Earthing Systems Pvt. Ltd., Anchor Electricals Pvt Ltd., Supreme Power Equipment Pvt. Ltd., OBO Bettermann India Pvt. Ltd.

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KNOW THY POWER NETWORK - 106

II Rotating Machinery

Assessing the state of the life or residual life of rotating machine insulation is always a high priority industry subject because the unscheduled outages of key machineries will lead to costly down time and monetary losses. So there lies a big demand / need for the presentation of machine failures due to insulation damages. One part of this preventive work is the assessment of the remaining life of the equipment. The need of the hour is how to assess the state of insulation after a few years of service (Partial Ageing) and how to use this information to get reliable predictions about the service life of its insulation. In other words, we have to make use of the currently available methods to assess age induced changes that took place in the insulation and with that information to reliably estimate remaining life of the rotating equipment.

Before delving further deep into this topic, let us find answers for the key question viz. "*What is the definition of the remaining life?" From the perspective of utility engineers, it may be defined as the period or time, the equipment may be expected to operate or give service without (a) The need for major maintenance or repair or (b) The possible development of a minor fault into a major fault.*

From the view point of researchers, it is defined as the time remaining before insulation properties become so poor that the insulation can no longer withstand the applied multiple stress. Our test methods should cover these two perspectives. In addition, the required study data should be obtained without shutting down the equipment. Presently the required diagnostic information are collected during the planned outages. Further we have to consider the fact that the many factors that influence ageing are quite complex and the methods presently adopted to assess the state of ageing of the equipment insulation are empirical in nature. i.e. it has limited practical values.

We all know that among the stresses of concern that contribute to the ageing and loss of life of the equipment are,

- Partial Discharge induced deterioration

- In the absence of these discharges, there is another source that can cause degradation viz. Presence of chemicals. i.e. chemically induced degradation of organic components of the insulation
- Mechanical stresses that lead to the movement of equipment parts or components. It may be due to thermal cycling or electromagnetic forces. The movement of parts can facilitate electrical discharges.
- Local environmental influences (moisture or contaminants)

The main point to be noted in this regard is that the changes induced by the ageing phenomena always lead to the changes in the electrical properties or parameters, often on a localised scale. These changes gradually affect the other parts of the insulation and finally alter the integrity of the equipment as a whole.

The degradation brought by Partial Discharge, the chemical, thermal, mechanical and environmental stresses always reflect in the electrical parameters of the equipment insulation i.e. they bring measurable changes in the electrical properties of the rotating machinery insulation and thus becomes the crystal ball / viewing mirror / prism to show the existing condition of the equipment insulation and resultant estimation of the remaining life of equipment.

- Thus the tests that provide the data on the changes experienced by the insulation as a result of the stresses as outlined above will be the "first step" in the assessment of residual life of the equipment. Other test methods are also available notable amongst them are
- DC Insulation Resistance and Polarization Index
- DC hipot test
- 0.1 Hz hipot test
- Capacitance, dissipation factor and tan delta that changes with AC voltage

Before concluding this topic, it is once again stressed that the ageing process in large rotating machines and hence its remaining life are brought by the mechanical and electrical stresses faced by it while the life of small machines is influenced by its operating environment and operating temperature.

III Underground Cables

At present XLPE cables and PE cables find wider application in transmission and distribution networks. The cables used in distribution circuit suffer degradation due to the entry of water / electro chemical treeing / moisture and voids. This water treeing degradation is mostly noticed in polypropylene type of cables and treated as an ageing-induced degradation HVDC testing, which is used for finding out the health status, maintenance testing of a cable or fault tracing and fault location shortens the service life of a cable. Environmental stresses, voltage stresses, moisture, higher temperature, presence of trapped changes due to HVAC / HVDC testing, presence of switching and lightning surges, injuries suffered during installation / digging by other agencies and poor quality of its heat sinks play an important role in the ageing induced degradation of UG cable insulation.

We have seen that the application of higher DC voltages across cables, as a part of non destructive test, often leads to its premature loss of life. Further various diagnostic tests indicate its present level of resistance to oxidation, thermal status of semi crystalline insulation, chemical degradation of its insulation and presence of foreign ions. Yet there is no fool proof, conclusive and quantitative relationship exists between the results of these diagnostic tests and the residual life of the cable. Hence the accurate residual life estimation of an UG cable is always difficult and at best it can only be approximate.

IV HT Circuit Breakers

Several types of monitors are used to assess the remaining life of circuit breakers. One type of circuit breaker monitor gives the cumulative interrupted current and the number of operations carried out by the breaker. It measures the actual service undergone by the breaker. In another type of monitor utilizes the signature analysis of the circuit breaker operations to assess the service life conditions of a breaker. It analyzes the vibration signatures of the breaker to find out its actual and remaining service lives. This kind of monitor can detect in vibrations which in turn signify / reflect the changes that took place in the breaker operating mechanism. The topic on hand viz. Residual life assessment of equipment ends here. In forth coming article, a model format will be given for assessing the Happiness Index of electrical equipment.

With this, I would like to sign off. Kindly stay tuned.

(To be continued…)

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DATA CENTER POWER SYSTEM HARMONICS: AN OVERVIEW OF EFFECTS ON DATA CENTER EFFICIENCY AND RELIABILITY – 1

Executive Summary

People familiar with the fundamental concerns of electricity in data centers may specifically be aware of the power quality issues associated with alternating current (AC) power line harmonics. Harmonic currents can distort the voltage that is being consumed by the information technology (IT) equipment, thereby disrupting the operation of the equipment. Ironically, these harmonic currents are usually caused by the power supply units (PSUs) within the IT equipment itself, but there can be other causes as well, such as variable frequency drives in cooling and ventilation equipment. Some devices meant to improve power quality, such as uninterruptible power supply (UPS) systems, can actually create harmonic currents that could interfere with equipment further upstream. Such power quality issues have been well documented and are generally understood within the technical community.

Less appreciated is the effect of harmonic currents on the overall efficiency of a data center. Harmonic currents are wasted energy that appears as heat. Not only can the heat have a detrimental effect on the performance and life expectancy of various pieces of equipment, but the harmonic currents also reduce the overall efficiency of the entire data center by increasing the amount of heat that must be removed.

It is possible to mitigate the effects of harmonic currents to some degree. Devices such as isolation transformers can trap harmonic currents and prevent their detrimental effects. But these devices themselves consume energy. Efforts to improve data center operating efficiency by removing transformers might actually be counter productive if there are significant harmonic currents being generated by the IT equipment. A better solution is to identify the equipment that could be potential sources of harmonic currents (generally referred to as "nonlinear loads") before such devices are put into service in a data center. This may not always be practical or even possible. An assessment may be necessary to determine the level of harmonic currents that can be tolerated within a data center, in terms of both power quality and efficiency loss, before deciding to add or remove mitigation equipment.

Instrumentation to locate harmonic currents can be fixed or portable. Instruments commonly found in data centers that measure volts and amperes, or calculate watts and watt-hours, can give false information if they are not designed for nonlinear loads. Therefore, consideration must be given to the accuracy of power and energy metering devices before calculating the power usage effectiveness (PUE™) of a data center.

I. Introduction

Data center power system harmonic currents and voltages contribute to issues that often arise in the data center electrical infrastructure, such as losses to the efficiency of a system, power component overheating, negative impacts on neutral conductors (where present), and safety concerns. The causes and effects of these issues are often complex. Developed by The Green Grid Association—a non-profit, open industry consortium working to improve the resource efficiency of information technology (IT) and data centers worldwide—this white paper presents a brief overview of harmonics, including what they are, the difference between harmonic voltage and current, what causes harmonics, and what problems harmonics can cause. The paper then discusses what levels of harmonics can be tolerated and under what conditions, along with some suggested diagnostic and mitigation methods, as well as how harmonic voltages and currents can affect data center power distribution system efficiency.

This paper does not try to address the broader utility-level or campus-level causes and effects of harmonics. Instead it looks primarily at the impact of harmonics within an uninterruptible power supply (UPS) and distribution to equipment further downstream in the data center, including transformers and IT equipment PSUs.

II. Definition of Harmonics

A harmonic is a higher-order integer multiple frequency current and/or voltage distortion of fundamental waveform. If the fundamental frequency is 60 hertz (Hz), which is typical in the United States, then 120 Hz, 180 Hz, 240 Hz, and 300 Hz are the 2nd-, 3rd-, 4th-, and 5th-order harmonics, respectively. Figure 1 shows an

example of a fundamental waveform and some lower-order frequencies (i.e., those that are typically of the 15th order or less). Adding those frequencies results in the distorted waveform called out in Figure 1. Even-order harmonics, such as 2nd, 4th, and so on, are less prevalent, while odd-order harmonics (3rd, 5th, etc.) more typically exist in a system. Harmonics are typically integral multiples of the fundamental, but they can also be non-integral (fractional) multiples, called interharmonics.

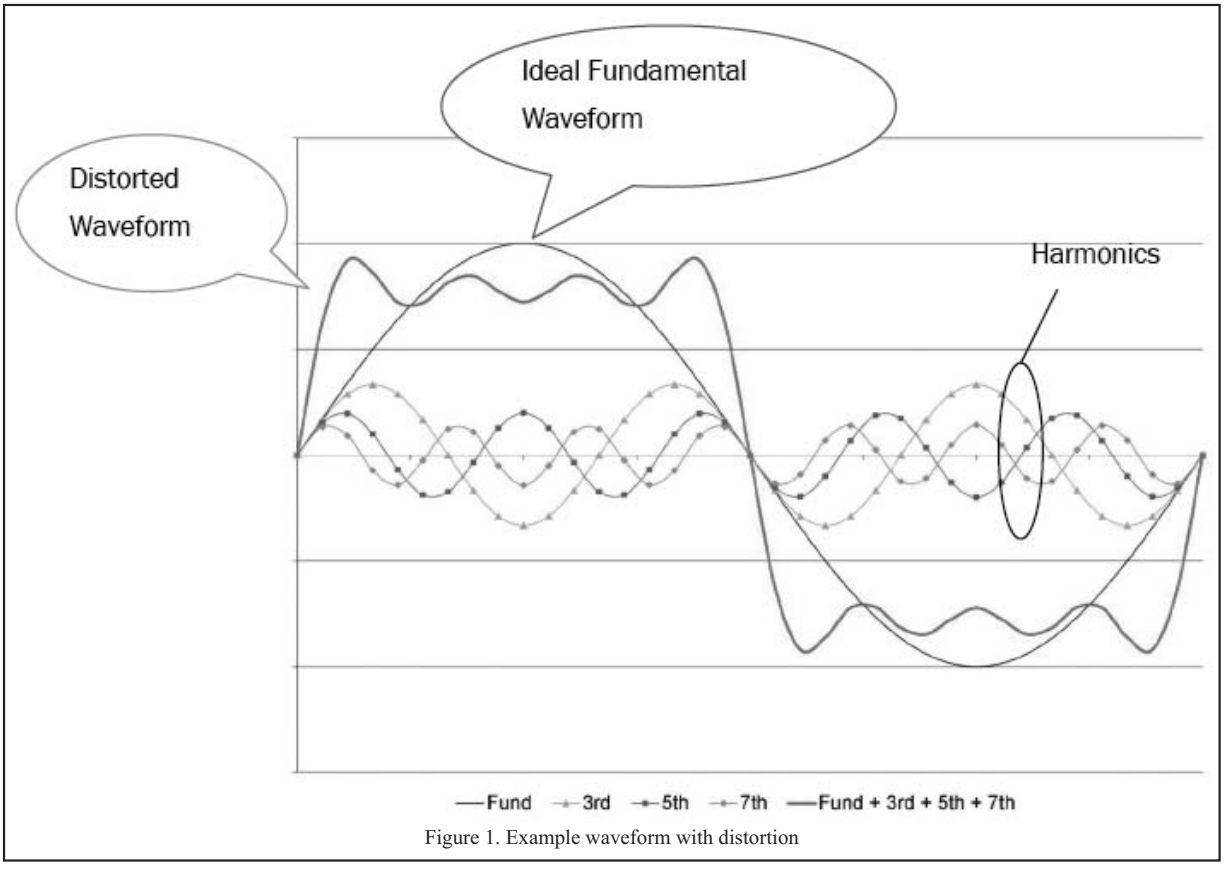

Figure 1. Example waveform with distortion

Harmonics may exist both in voltage and current. For any electrical system to be operated with good efficiency and performance, the goal is to have voltage and current waveforms primarily consist of the fundamental frequency, with minimal higher-order frequencies (i.e., frequencies that are higher than the fundamental frequency). Low-order harmonics (those that are typically of the 15th order or less) also create higher-order harmonics (those that are typically of the 25th order or higher) due to ferroelectromagnetic resonance in the power system. These higher-order harmonics may also be referred to as high-frequency noise.

The International Electrotechnical Commission (IEC) standard IEC 61000-3-2 defines the upper limit of harmonics as the 40th harmonic of the power frequency (2.4 kilohertz [kHz] for a 60 Hz distribution system), which is the primary focus of this white paper. It should be noted that there is emerging evidence that higher-frequency harmonics cause more issues than previously assumed.

III. Causes of Harmonics

HARMONICS CAUSED BY DATA CENTER LOADS

To fully understand harmonics and their causes, the load type on the data center's electrical infrastructure needs to be understood. A linear load draws current that is instantaneously proportional to the voltage, such as in Figure 2 and Figure 3. One example of a linear load is a resistive load, such as an incandescent light bulb. A nonlinear load either draws a current waveform that is not instantaneously proportional to the voltage or is a load that causes current to distort its sinusoidal shape. The current waveform also leads or lags voltage or phase. Example components that cause nonlinear load currents include rectifiers, switch mode power supplies (SMPSs), UPSs, electronic ballasts, and variable-speed drives. Many of these components are frequently found in IT power supplies. Nonlinear loads use a switching mechanism, which generates harmonics on the current and hence the voltage. (See Figure 4.)

Examples of nonlinear load sources that can inject harmonics back into a system include variable frequency drives (VFDs), pumps (with and without motor drives), transformers, lighting (electronic and magnetic ballasts), DC-to-AC converters, and rectifiers. Even DC-to-DC converters can inject harmonics into a DC system, more commonly known as ripple and/or noise. Older, line-switched, three-phase rectifier loads (e.g., motor drives) can create higher harmonics than typical IT supplies. The behaviour of current IT PSUs at light loads depends on how they are optimized around efficiency. At light loads, some more efficient supplies generate higher amounts of harmonics, although this trend is changing as the focus on low power behaviour is sharpened.

Figure 1 shows a graphical representation of harmonics generated on a fundamental waveform by a nonlinear load. The pink waveform indicates the nonlinear waveform resulting from the impact of 3rd- and 5th-order harmonics on the fundamental waveform. This is a typical current waveform for a nonlinear load such as that from a VFD.

Harmonics involve two undesirable and directly interrelated conditions: current distortion and voltage distortion.

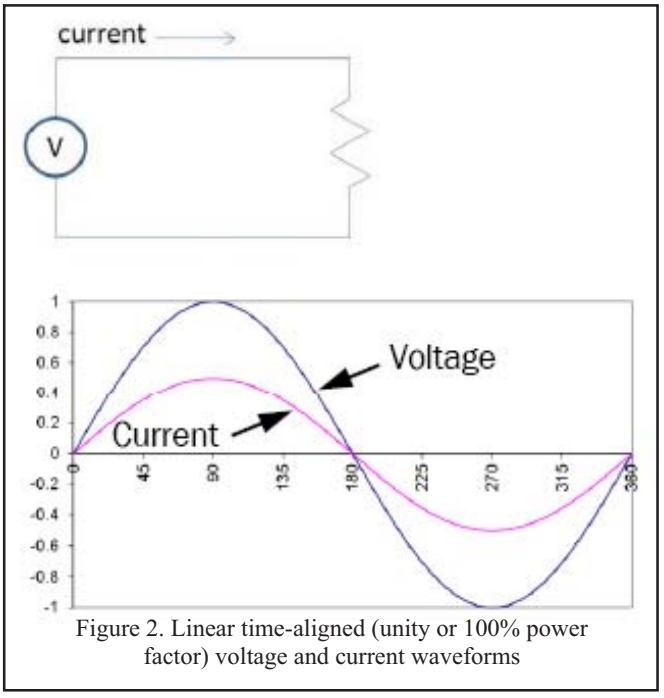

Figure 2. Linear time-aligned (unity or 100% power factor) voltage and current waveforms

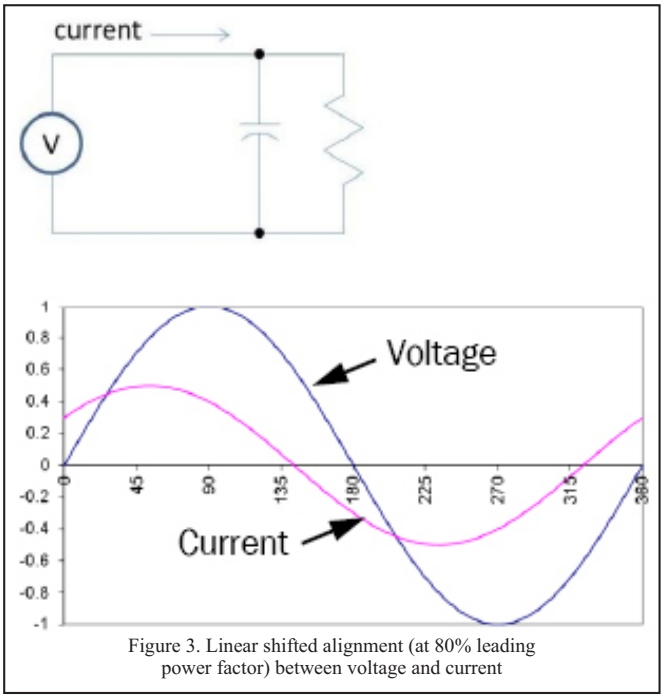

Figure 3. Linear shifted alignment (at 80% leading power factor) between voltage and current

Magnetic Devices

Devices that contain magnetic structures, such as transformers, inductors, motors, and ballasts, can exacerbate a harmonic problem, depending upon the impedance of the magnetic structure. When these magnetic structures are operated at or above their rated capacity, problems from harmonic currents can result in overheating and/or a potential fire hazard.

To fix the problem, magnetic devices are typically oversized to handle the additional currents. This can decrease the efficiency of a system, because conventional wisdom says to maximize efficiency and minimize capital cost by operating devices near their rated capacities. The result is a tradeoff: for example, operating a transformer or an inverter duty motor near its rated kilovolt-ampere (kVA) capacity may lower the capital cost, but full-load operation may not be best when load-generated harmonic currents are present.

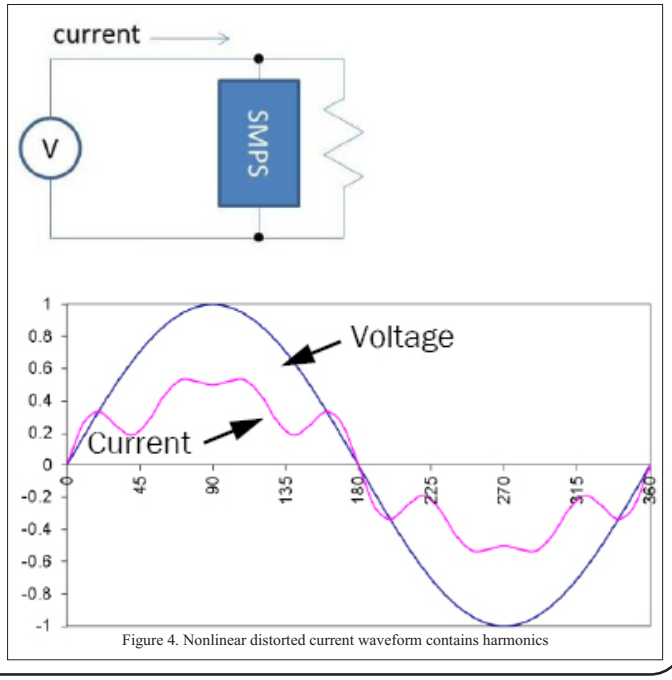

Figure 4. Nonlinear distorted current waveform contains harmonics

Using transformers that are designed specifically to handle harmonic loads can assist in alleviating the problem. (See the *Mitigating Harmonics* section for more information). Harmonics also cause increases in a transformer's no-load losses.

IT Power Supply Units

In a category all their own, IT PSUs, both individually and in combination, have been and continue to be a known source of harmonic currents. PSUs can interact as a group, creating high harmonic currents that cause instability at the system level. The problem is primarily found in single-phase IT equipment that incorporates switch mode power supplies (SMPSs), resulting in an abundance of triplen harmonics (the 3rd and odd multiples of the 3rd). Whereas other harmonic orders have a tendency to cancel each other out, triplen harmonics are additive, thereby creating equipment heating and high levels of voltage distortion and current on neutral conductors. In the early 1990s, triplen harmonic currents that summed in the neutral were a big problem. Underrated neutral conductors provide a high impedance path that produces a higher voltage distortion. These underrated neutrals would overheat and cause fires. The solution at the time was to double the rated neutral conductor cross-sectional area or use multiple conductors to limit the individual cross-sectional area. However, modern PSUs, now connected phase-to-phase rather than phase-to-neutral, have made triplen harmonics less of a problem, as discussed below. In addition, three-phase power supplies inherently do not produce triplen harmonics.

Most modern IT PSUs contain active power factor correction (PFC). This added active variable impedance can have a mitigating effect on harmonic currents. However, it should be noted that PFC power supplies at partial load create a higher percentage of harmonics than PFC power supplies at full load. Therefore, simply because a power supply has PFC built in does not mean it will have a good harmonics profile. The power factor measurement is at the fundamental frequency, so it is possible to have a power factor of 1.0 (termed "unity power factor") while still having a poor harmonics profile with high 3rd- or 5th-order and higher current harmonics in the current waveform. Power factor–corrected circuits use input voltage waveforms to shape the current. If the voltage waveform is ideal, then the current waveform is also good; but, if the voltage waveform is not ideal, the current waveform will not be ideal either. When the source or line impedance is high, the IT PSU tries to correct the waveform that may have been distorted by external causes.

PSUs from two vendors with similar input and output specifications may behave very differently in the same facility due to their respective control loop characteristics. In a data center that contains thousands of IT power supplies, each experiencing different system-loading conditions, their input currents sum together. The total accumulation at the point of common coupling (e.g., at a circuit breaker panel board) may show many random-order harmonics even though any one specific power supply may not exhibit any of them.

Power supply unit design has changed throughout the years, as evidenced by the information in Table 1, which comes from 80Plus. Efficiency has increased over the past eight years; however, power factor and current harmonics (total current harmonic distortion [THDi]) have varied.

Table 1. Snapshots of PSU efficiency and total current harmonic distortion from 2005, 2010 and 2013

At Light (20-25%) Load	Typical 2005 PSU	Typical 2010 PSU	Typical New PSU
Power Factor	0.95 leading	0.9 leading	0.98 leading
THDi	7%	20%	12%
Efiiciency	70%	85%	95%

Static Power Converters

Static power converters, such as VFDs, rectifiers, and inverters, are nonlinear loads and thus are often sources of harmonics. VFDs are notable for their high-efficiency operation. Because of that, they are typically found, for example, on fans, chilled-water pumps, and heating, ventilation, and air-conditioning equipment in data centers; but their efficiency benefit can be offset by resulting harmonic issues. A VFD has a similar topology to a UPS, only without a backup energy source. That is, it coverts an AC voltage to a DC voltage and back to AC again. The rectified conversion is a nonlinear element, which causes upstream harmonics.

Rectifiers

In past data center installations, rectifiers caused significant harmonics when switching. These included 6-pulse, 12-pulse, 18-pulse, and 24-pulse rectifiers. Each time a device is switched, losses and harmonics are generated. Today, pulse width–modulated (PWM) rectifiers (e.g., active power semiconductor switching rectifiers such as insulated-gate bipolar transistors and metal oxide semiconductor field-effect transistors) can switch more than a thousand times per cycle, but mitigation steps implemented in the switching circuit considerably reduce the amount of harmonics generated. Figure 5, Figure 6, and Figure 7 show unfiltered current waveforms for each of the three types of rectifiers.

UPSs

Harmonics also can be caused by a UPS rectifier, as described in the Rectifiers section above. Similarly, harmonics generated while a UPS is in eco mode or bypass mode (or in any situation in which the UPS is not in line with the power path) will flow upstream to the building transformers, which could cause problems elsewhere in the data center's distribution system. The potential issue exists when the UPS is in eco or bypass mode and the power is supplied by the generator sets. This issue will likely need to be addressed in the future as eco and bypass mode UPSs become more prevalent.

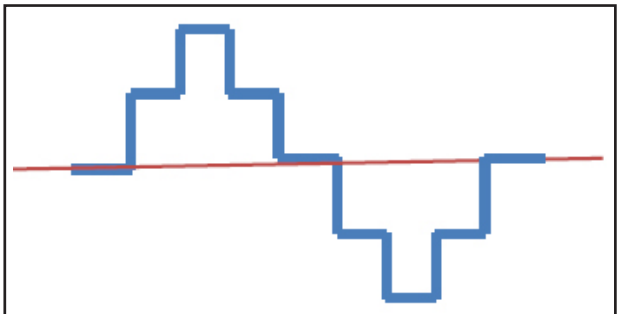

Figure 5. 6-pulse rectifier

Generators

The harmonic profile of a data center can change when a load transfer occurs between two power sources with different impedances, such as between a utility source and standby generator. With the change in impedance, there is a change in the voltage distortion and resonance of the system. Generator rotor/stator pitch can aggravate or mitigate various frequencies, depending upon the pitch ratio. While resonance is not typically an issue in a system (It is affected by various combinations of inductance and capacitance.), the introduction of harmonics into a system can hit a resonance point that can cause overvoltages. This can also cause problems for the facility in other ways, such as stressing insulation.

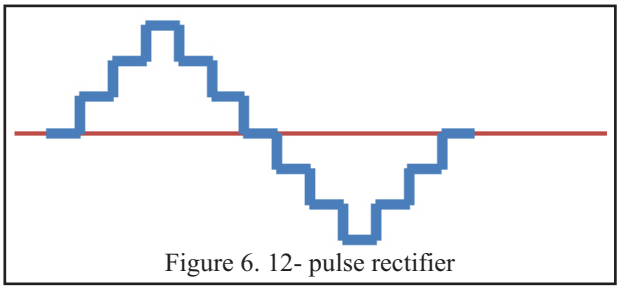

Figure 6. 12- pulse rectifier

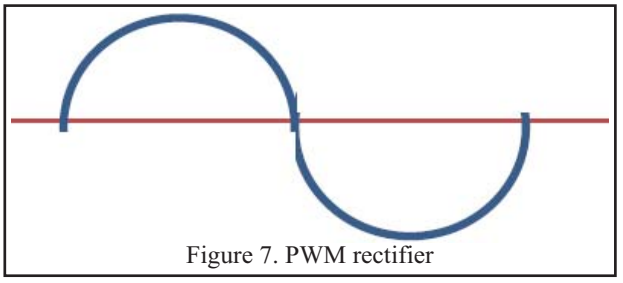

Figure 7. PWM rectifier

Transient Events

A phenomenon similar to harmonic currents can be caused by ongoing cumulative transient events in the data center, not just by certain types of equipment. Shutdown and turn-on events, including those for light bulbs, transformers, capacitors, and IT PSUs can be sources of harmonic frequencies. Since a harmonic is a distortion of a pure sine wave, an initial inrush is a high momentary surge that is not continuous. The individual events can last only a few microseconds to a few milliseconds, so they are not continuous. A data center's harmonics may fluctuate. If the facility has many on-going turn-on and shutdown events, it may appear to have one continuous source of varying-frequency harmonics.

ADDITIONAL CAUSES OF HARMONICS

As previously discussed, harmonics typically come from nonlinear loads, but a nonlinear source can be a cause as well. If either the source or the load is nonlinear, harmonics are generated. For example, when nonlinear currents react with the linear source impedance, they distort the source voltage. What starts as a sinusoidal source voltage is distorted by the presence of the nonlinear load. Linear source impedance multiplied by load current distortion creates nonlinear voltage that adds and subtracts from the sinusoidal source voltage. The higher the source impedance, the greater the interaction effect with other loads.

IV. Finding Harmonics Problems in your Data Center

Instrumentation is readily available that can detect and quantify harmonic currents that may be present in a data center's power distribution system. Such metering is appropriate at a point of common coupling, such as at the circuit breaker panelboard on a Power Distribution Unit (PDU). Switchboards, panelboards, and PDUs frequently have metering capable of measuring the level of harmonic current at each frequency as well as total harmonic distortion. Such metering typically measures up to about the 40th order; other metering is available to read the higher frequencies. Where permanent metering is not built into the system, portable power-quality measurement devices can be deployed for temporary measurement. Temporary devices should remain in place for at least 30 days in order to capture a complete harmonic profile over time. Instruments are available that can measure harmonic orders into 100s.

A word of caution: Harmonics can create inaccurate readings on devices that do not give "true RMS" readings. Voltage and current meters commonly found in rack-mounted power strips and similar devices are frequently unreliable in a harmonics-rich environment. If such meters are relied upon to calculate power usage effectiveness (PUE™), the results may be misleading.

V. Acceptable Harmonics Limits

Specifications for the maximum acceptable voltage distortion emissions may vary from one IT device to another, but they are typically 5% Total Harmonic Distortion (THD) and no single harmonic greater than 3%. Table 2 provides the harmonic limits recommended in IEC 61000-3-2.

Table 2. IEC recommendation for harmonic emission limits

Harmonic	Maximum Permissible Harmonic Current Per Watt
3	3.4
5	1.9
7	1
9	0.5
13	0.35
Other odd harmonics upto 39	3.85/n

The conversion of distributed AC power to DC power at critical loads is always accompanied by the generation of higher-frequency harmonics. A DC distribution system will minimize this issue, as will additional mitigation equipment as discussed later in this paper.

VI. Harmonics and Efficiency

CAUSES OF EFFICIENCY LOSS

Several factors contribute to reductions in data center systems' efficiency caused by harmonics. Typically, the issues are a tradeoff between efficiency, costs, and tolerable harmonic amounts that need to be reviewed by each data center and its particular business case.

Aside from ordinary resistive losses, losses in a conductor also occur because of the skin effect. At higher frequencies, the current in a wire flows to the outer surface of the conductor. The core is not utilized fully (i.e., the same current flows in a smaller conductor), which further increases losses and decreases efficiency. In general, if the distances are short and the cables are well dimensioned, the effect of harmonics will be minimal. When transmission distances are longer and conductors are operating near their rated power levels, their efficiency may be noticeably decreased.

Second, transformer eddy currents, hysteresis, and core losses from the additional heat of the harmonics all can reduce efficiency. Triplen harmonics can also induce heating inside an enclosure, resulting in a secondary loss mechanism. In this situation, the current does not sum to zero; where there was originally no current, there now is current. This means additional losses because of the increase in circulating currents in the neutrals. These triplen harmonics are higher in frequency in the neutral, which can then induce more currents on top of that via inductive coupling (similar to a transformer). This heats the enclosure, which is both wasteful and dangerous.

Transformers that are removed for efficiency gains can also have negative effects. Removal means harmonics can now flow back to the UPS, which could be a problem if the UPS is unable to handle them. In addition, losses in other mitigation components (such as active or passive filters, power factor correction equipment, and transformers) can reduce efficiency in the overall system.

The UPS inverter may need to carry high peak currents and experience higher switching losses in semiconductors, which again translates to lower inverter efficiency. The UPS efficiency losses caused by the harmonics are more significant for low loads than for higher loads. At higher loads, the fundamental is greater and dominates the power flow. At lower loads, the fundamental is lower, so the effect on harmonics is larger. Developed by the Institute of Electrical and Electronics Engineers (IEEE), the IEEE 519 standard introduces the concept of total demand distortion (TDD), which allows a higher level of harmonics at lighter loads to account for this situation even though the THD percentage of harmonics increases at lower loads, the absolute harmonic levels are lower overall in the system.

HOW MUCH IS TOO MUCH? THE EFFICIENCY TRADEOFF

The problems currently associated with harmonics found in data centers are much different from the harmonics issues of past decades. Today, equipment is more sensitive to input power. The main concern is the amount of voltage distortion. Active PFC is available on server power supplies and works well to mitigate effects of harmonic currents, but it can come with a cost to efficiency. It is important to find the balance of PFC, harmonics, and efficiency. When PFC is not tightly regulated, efficiency can increase. Some harmonic currents and voltage distortion might result, but they may remain within a range deemed tolerable by the data center operator. The expense of having a power factor at or near unity is incrementally higher than it would be (for example) for a power factor in the range of 0.8 to 0.9 (leading or lagging).

While low-level harmonics do have an effect on the efficiency of the data center, that effect is relatively small compared with other sources of inefficiency. In general, if a data center is looking to gain efficiency but does not have major harmonics issues (e.g., THD is <15% for current and <8% for voltage), harmonics mitigation will likely not yield much in efficiency gains.

As a general guideline, for every percentage point that THDi increases, there may be a 2% increase in losses (half from the copper and half from the transformers) in the electrical system. To determine a specific site's losses due to harmonics, the harmonics losses must be calculated per branch circuit and feeder circuit and summed up. Always conduct a harmonic study when a data center is new (i.e., acceptance testing), after the data center is fully populated and running applications, and then again following any major updates; the studies should be conducted during both standard and contingency operation modes. Particularly for high-frequency harmonics, efficiency points may be gained through line loss reduction.

VII. Mitigating Harmonics

Harmonics mitigation has a point of diminishing returns; the closer one tries to get to zero harmonics, the harder (i.e., more costly) it is to reduce them further. Harmonics can be minimized both in existing data centers and in the design of a new data center. Mitigating harmonics is an important consideration when designing a power system for a data center. Computer simulations can be conducted to predict what harmonics could arise from a system. Some specifications are available for facilities and systems that deal with harmonics.

UPSs

When connecting loads to the UPS, it is obvious that the UPS inverter must be able to handle the total amount of harmonic currents pulled from it by downstream equipment. One aspect often overlooked is that any upstream bypass source must also be able to handle all harmonics and nonlinear loads when the UPS is in bypass mode (for maintenance or in response to a fault), as well as any harmonic currents created by the UPS itself. For example, a generator's pole pitch can either amplify or suppress harmonics. The generator's internal impedance will also be a factor in the severity of the harmonics. Table 3 gives some examples of devices commonly found in data centers that can change the impedance within the power system.

Some static UPSs and rectifiers—especially 6- and 12-pulse rectifiers using Silicon-Controlled Rectifiers (SCRs)—can create enough harmonic currents to interfere with the regulation of upstream generators. A lower impedance generally means a higher potential fault current, which in turn can mean that all circuit breakers downstream may have to be rated with a higher current interrupting capacity (kAIC).

Table 3. Comparison of impedance characteristic of various power equipment types

Device	Typical Impedance
Transformer less static Ups	Zero up to current limit
Utility transformer	5-7%
Ups with transformer	4-10%
Generator Set	12-20%

TRANSFORMERS

Making modifications to an existing system, such as replacing a transformer-based PDU with a transformerless PDU to improve efficiency, can have a measureable impact on harmonics. Removing the transformer reduces the impedance of the circuit, which can increase current harmonics while simultaneously decreasing voltage harmonics. The consequences of this change should be reviewed prior to the removal of the PDU transformer.

De-rating the power capacity (i.e., the kVA rating) of a standard transformer may be necessary when nonlinear loads are introduced into a data center. De-rating means a transformer is overrated in order to deal with the harmonic currents. De-rating may not be the most desirable approach because a de-rated transformer takes up more space and is physically heavier than other transformers, can cost more money, and puts out more heat.

A European-type distribution system (i.e., distributed neutral, four-wire system) does not use the three-wire, wye isolation transformer that is found in North America. In the absence of a transformer, currents will sum in the neutral. However, the neutral then takes the harmonic currents back to the service entrance (or the first separately derived source).

When designing new systems, be sure to consider transformers that are designed for use with any anticipated nonlinear loads. Such transformers are type-rated by "k-factor." A higher k-factor indicates a higher compatibility with nonlinear loads. Changing the k-factor rating to match the anticipated loads is important when dealing with loads that create harmonics. However, higher k-factor transformers are more expensive and typically physically larger, and they can be less efficient than non-k-factor-rated transformers. To mitigate the skin effect at high frequencies, nonlinear transformer design should optimize the surface area of the conductors in the windings. Greater surface area minimizes the skin effect; the more surface area there is, the less skin effect there is. Rectangular conductors have greater surface area compared with round conductors. In the end, a smaller, more efficient transformer that is sized appropriately and contains a better steel core (i.e., lower loss) may be the best solution, even though it is more expensive.

Zigzag transformers can be obtained with varying phase shifts, and when applied properly, paralleled zigzag transformers can cancel higher-order harmonics.

OTHER MITIGATION TECHNIQUES

Other harmonics mitigation techniques are available for new data centers in the design phase. These include selecting PWM rectifiers over 12-pulse rectifiers, 12-pulse rectifiers over 6-pulse rectifiers, and high-frequency PWM inverters over lower-frequency PWM inverters. Avoid equipment that has high surge start-up characteristics. Reduce source impedances, and check for harmonic characteristics at lighter loads as well as at heavier loads. Harmonics generation is a characteristic that needs to be considered during system design, similar to other considerations. Higher-order frequency harmonics can be mitigated using waveform correction technology.

As with all engineering design challenges, there are compromises with each harmonic mitigation technique. The Green Grid recommends contacting a qualified power engineer for assistance with designing any new data center.

FIXING HARMONICS WITH ADDITIONAL HARDWARE

Fixes for harmonics issues are available in many form factors and price ranges. Harmonic filters can be fitted on site-wide UPSs. Zigzag transformers can act as a higher-order harmonics filter and be used when triplen

harmonics are present for non-PFC loads, such as motor drives. Simply adding a zigzag transformer can trigger side effects, however. For example, zigzag transformers add impedance for the source in addition to their effect of cancelling or minimizing harmonics, and they are a passive filter that needs to be tuned and reviewed carefully at installation. At the other end of the cost spectrum, active harmonic filters have higher costs but can cover a broad spectrum with minimal tuning. It should be noted that adding any equipment detracts from the reliability of the system, increases the need for maintenance, and usually reduces availability.

It is impossible to completely remove low-order harmonics from the electrical system. The amplitude of low-order harmonics is large compared with higher-order harmonics, especially the 3rd and 5th harmonics. It is preferable to select equipment that minimizes the generation of low order harmonics in the first place. To mitigate low-order harmonic amplitudes, large chokes (harmonics filters) can be installed in series. These chokes shunt the low order harmonic currents back to their source. It is a typical but not a preferred practice to shunt higher-order harmonics to ground. However, injecting higher-order harmonics into ground conductors can cause problems elsewhere. In addition, for personnel safety reasons, there are limitations imposed on total ground current levels.

In view of the negative consequences of higher-order harmonic noise in a data center's electrical system, the Green Grid strongly recommends using a waveform-correcting technology that also has low pass filtering capability to remove higher-order harmonics. Such waveform correctors should not shunt energy to the ground and should be installed in parallel. (Series filters are relatively large in size and also consume more energy for their no-load operation.) The most reliable solution is to design a system to handle expected harmonics without overheating or producing too much voltage distortion.

VIII. Conclusion

Harmonic currents can be a major factor in power quality and efficiency issues within a data center and can be a complex subject to understand. Causes of harmonic currents can come from any number of nonlinear loads in the data center, including older IT server PSUs, non-server IT equipment, external power supplies for laptop computers, electronic ballasts, variable frequency drives, UPSs in eco or bypass mode, and electronic and magnetic ballasted lighting. The expectation is that without careful study and planning, harmonics in the data center will continue to increase as the number and types of devices that generate harmonics are more widely adopted. Mitigation techniques for harmonics are available, but without proper analysis and planning, they may come at a cost to efficiency. Similarly, harmonics may increase as data centers strive to make improvements in efficiency; careful study and analysis must be made to find the optimal balance of harmonic currents and efficiency in the data center.

IX. About The Green Grid

The Green Grid Association is a non-profit, open industry consortium of end users, policy makers, technology providers, facility architects, and utility companies that works to improve the resource efficiency of information technology and data centers throughout the world. With its member organizations around the world, The Green Grid seeks to unite global industry efforts, create a common set of metrics, and develop technical resources and educational tools to further its goals. Additional information is available at www.thegreengrid.org.

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The greater danger for most of us is not that our aim is too high and we miss it, but that it is too low and we reach it – MICHELANGELO

COME LIVE IN THIS ZERO CARBON HOME FOR FREE

Australian property developer Mirvac, announced a plan to build an ultra-sustainable home which will not generate any electricity bills, and is inviting one family to live rent-free in the property for a year.

An artists impression of what the House with No Bills in Cheltenham, Melbourne, will look like. Image: Mirvac

Dubbed the House with No Bills , the three-bedroom unit will be built in Mirvac's new development at Jack Road in Melbourne's Cheltenham suburb, and is part of the company's efforts to reduce its environmental and social impact by offering affordable, off-grid homes to communities.

John Carfi, head of residential development, Mirvac, said: "We want to reduce the everyday cost of living for home owners and protect them against rising energy and utility prices." This will also help people live self-sufficiently and sustainably in their homes, he added.

Mirvac's move is the latest in a series of strides by Australia's building sector to improve its environmental performance. The green building movement has gained much traction in the country in recent years, with more than 1,000 projects certified under the Green Star programme, a national rating scheme for sustainable buildings.

Romilly Madew, chief executive officer of the Green Building Council of Australia (GBCA), noted that sustainable building designs and technologies have been a mainstay of commercial buildings for some years now. Mirvac's initiative has the potential to drive the adoption of similar solutions in residential developments, she added.

The house, which will commence construction early next year and be completed by late 2017, aims to be **carbon positive** - *that is, when a home generates more energy from renewables than it uses and sells the surplus back to the grid. In such a home, residents offset any energy costs they rack up by selling renewable power to utilities.*

Mirvac's project will look like a typical home, but will be kitted out with sustainability features such as rooftop solar panels, energy efficient appliances, and increased roof insulation.It will also make use of passive design, an architectural technique which maximises use of surrounding environmental factors such as sunlight or shade, to reduce the need for lighting, heating, and cooling.

Mirvac will also install smart meters and energy monitoring systems to help home-owners track their power use and costs. Carfi shared that the first phase of this project will entail a year-long study of the family invited to live for free to track how average families consume energy and to measure the performance of sustainable technology and design features in the house.

Such a study is an industry first, and will help Mirvac understand how to scale up the construction of homes where resident's do not have to pay for energy, he noted. Mirvac is looking for a family of four to participate in this study by spending a year in the house after construction ends. They must be first-time home buyers, and two residents should be children. At least one member of the household should be in a care-based industry such as education or nursing.

The company may also provide the family with electric cars and bicycles for the duration of their stay to help them reduce their transport costs and associated greenhouse gas emissions.Following the year-long study, Mirvac will explore ways to minimise and offset the costs of water and sewage bills in new development sites, noted Carfi, adding that **"we will also use the learnings from phase one to identify the potential of going fully off-grid"**. GBCA's Madew added that Mirvac's study is an important study in creating affordable and energy efficient communities across the country.

MILESTONE IN SOLAR CELL EFFICIENCY BY UNSW ENGINEERS

Australian engineers have edged closer to the theoretical limits of sunlight-to-electricity conversion by photovoltaic cells with a device that sets a new world efficiency record.

A new solar cell configuration developed by engineers at the University of New South Wales has pushed sunlight-to-electricity conversion efficiency to 34.5% – establishing a new world record for unfocused sunlight and nudging closer to the theoretical limits for such a device.The record was set by Dr Mark Keevers and Professor Martin Green, Senior Research Fellow and Director, respectively, of UNSW's Australian Centre for Advanced Photovoltaics, using a 28-cm^2 four-junction mini-module – embedded in a prism – that extracts the maximum energy from sunlight. It does this by splitting the incoming rays into four bands, using a hybrid four-junction receiver to squeeze even more electricity from each beam of sunlight.

The new UNSW result, confirmed by the US National Renewable Energy Laboratory, is almost 44% better than the previous record – made by Alta Devices of the USA, which reached 24% efficiency, but over a larger surface area of 800-cm^2. "This encouraging result shows that there are still advances to come in photovoltaics research to make solar cells even more efficient," said Keevers. "Extracting more energy from every beam of sunlight is critical to reducing the cost of electricity generated by solar cells as it lowers the investment needed, and delivering payback faster." The result was obtained by the same UNSW team that set a world record in 2014, achieving an electricity conversion rate of over 40% by using mirrors to concentrate the light – a technique known as CPV (concentrator photovoltaics) – and then similarly splitting out various wavelengths. The new result, however, was achieved using normal sunlight with no concentrators.

"What's remarkable is that this level of efficiency had not been expected for many years," said Green, a pioneer who has led the field for much of his 40 years at UNSW. "A recent study by Germany's Agora Energiewende think tank set an aggressive target of 35% efficiency by 2050 for a module that uses unconcentrated sunlight, such as the standard ones on family homes."So things are moving faster in solar cell efficiency than many experts expected, and that's good news for solar energy," he added. "But we must maintain the pace of photovoltaic research in Australia to ensure that we not only build on such tremendous results, but continue to bring benefits back to Australia."

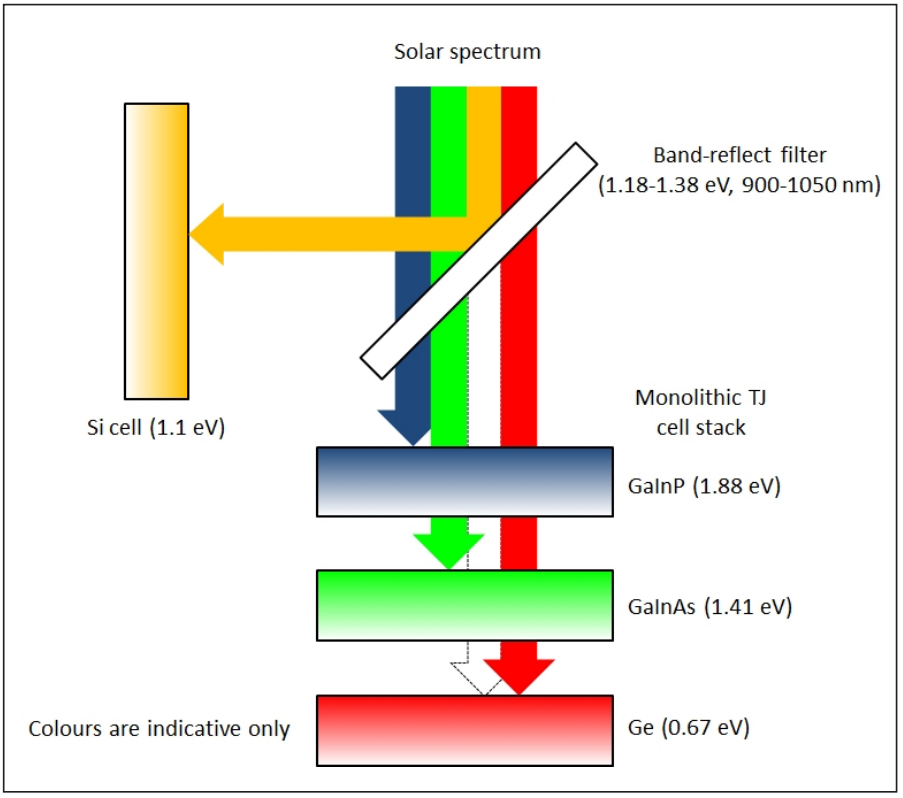
Australia's research in photovoltaics has already generated flow-on benefits of more than $8 billion to the country, Green said. Gains in efficiency alone, made possible by UNSW's PERC cells, are

forecast to save $750 million in domestic electricity generation in the next decade. PERC cells were invented at UNSW and are now becoming the commercial standard globally. The record-setting UNSW mini-module combines a silicon cell on one face of a glass prism, with a triple-junction solar cell on the other.

The triple-junction cell targets discrete bands of the incoming sunlight, using a combination of three layers: indium-gallium-phosphide; indium-gallium-arsenide; and germanium. As sunlight passes through each layer, energy is extracted by each junction at its most efficient wavelength, while the unused part of the light passes through to the next layer, and so on.

A diagram of the spectrum-splitting, four-junction mini-module developed at UNSW.

Some of the infrared band of incoming sunlight, unused by the triple-junction cell, is filtered out and bounced onto the silicon cell, thereby extracting just about all of the energy from each beam of sunlight hitting the mini-module.



The 34.5% result with the 28 cm^2 mini-module is already a world record, but scaling it up to a larger 800-cm^2 – thereby leaping beyond Alta Devices' 24% – is well within reach. "There'll be some marginal loss from interconnection in the scale-up, but we are so far ahead that it's entirely feasible," Keevers said. The theoretical limit for such a four-junction device is thought to be 53%, which puts the UNSW result two-thirds of the way there. Multi-junction solar cells of this type are unlikely to find their way onto the rooftops of homes and offices soon, as they require more effort to manufacture and therefore cost more than standard crystalline silicon cells with a single junction. But the UNSW team is working on new techniques to reduce the manufacturing complexity, and create cheaper multi-junction cells.

However, the spectrum-splitting approach is perfect for solar towers, like those being developed by Australia's RayGen Resources, which use mirrors to concentrate sunlight which is then converted directly into electricity.The research is supported by $1.4 million grant funding from the Australian Renewable Energy Agency (ARENA), whose CEO Ivor Frischknecht said the achievement demonstrated the importance of supporting early stage renewable energy technologies.

"Australia already punches above its weight in solar R&D and is recognised as a world leader in solar innovation," Frischknecht said. "These early stage foundations are increasingly making it possible for Australia to return solar dividends here at home and in export markets – and there's no reason to believe the same results can't be achieved with this record-breaking technology."He noted that the UNSW team is working with another ARENA-supported company, RayGen, to explore how the advanced receiver could be rolled out at concentrated solar PV power plants." With the right support, Australia's world leading R&D is well placed to translate into efficiency wins for households through the ongoing roll out of rooftop solar and utility-scale solar projects such as those being advanced by ARENA through its current $100 million large-scale solar round, he added. "Over the longer term, these innovative technologies are also likely to take up less space on our rooftops and in our fields."

Other research partners working with UNSW include Trina Solar, a PV module manufacturer and the U.S. National Renewable Energy Laboratory.

Technical Seminar Photos - 27.05.2016

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Mr. VISHWADEEP NANDA,
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(in his absence Er. C. KARTHIKEYAN receiving the momento)

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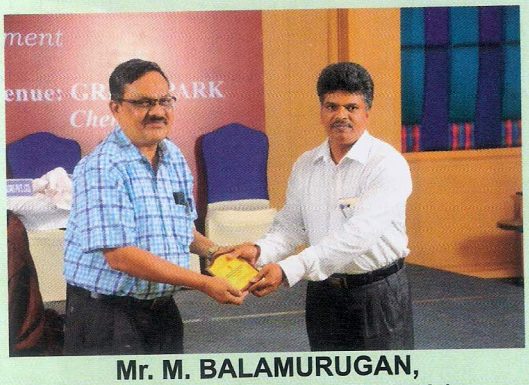

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Delegates at the Meeting

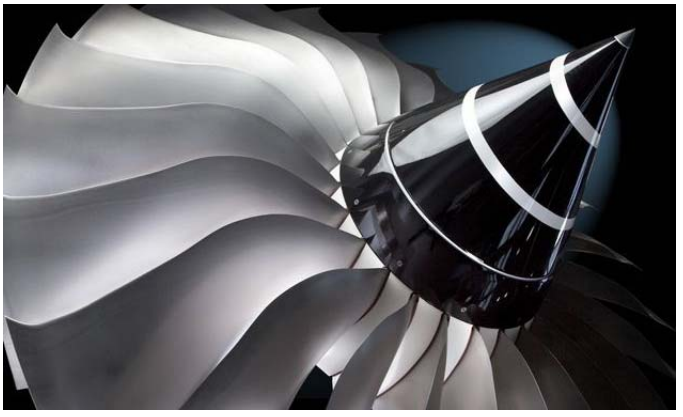
GAS TURBINE TECHNOLOGY

Gas turbines convert the energy from burning fuel via three main elements - a compressor, combustor and turbine. As gas turbines operate in a continuous thermodynamic cycle, they have a higher power density than internal combustion engines.A gas turbine can accelerate air to create thrust (aero engines) or drive generators to make electricity, or turn pumps and ship propellers (industrial / marine gas turbines).

Fans

The fan in a gas turbine draws air into the engine, compressing the bypass stream to produce 80 per cent of the engine's thrust, and feeding air to the gas turbine core.

The hollow, titanium wide-chord fan blade, pioneered by Rolls-Royce and introduced into airline service in the 1980s, set new standards in aerodynamic efficiency and resistance to foreign object damage. Since that time we have continued to innovate and improve on our design of wide-chord fan blades. Designed specifically for high-bypass turbofans, the breadth of these blades sets them apart from the narrow and less efficient earlier equivalents.



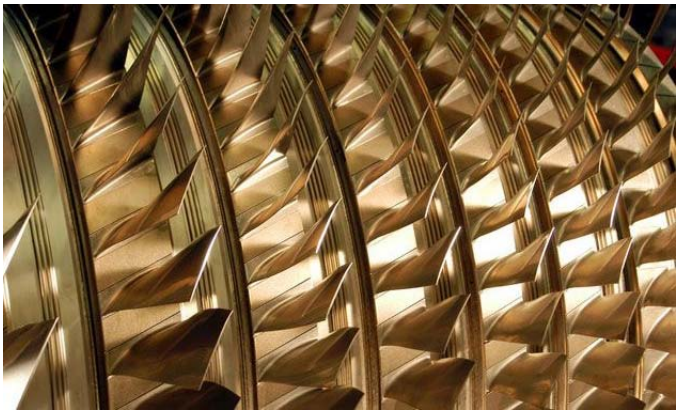
Compressors

The primary purpose of the compressor is to increase the pressure of the air through the gas turbine core. It then delivers this compressed air to the combustion system.

The compressor comprises the fan and alternating stages of rotating blades and static vanes.

Advanced aerodynamics

Rotors and stators embody an aerodynamic design to maximise the efficiency of the compression process. The evolvement of aerodynamic design has been made possible by the continued development of computational fluid dynamics allowing accurate modelling of the airflow.



Ice protection

The Trent 1000 anti-icing function is designed to prevent ice formation due to water freezing as it hits cold metal. The core engine section stators (ESS) warm-air, anti-icing bleed (delivered from the Intermediate Pressure compressor) is switched on automatically only when needed, such as during descent – controlled by rating, altitude, ambient temperature, and forward speed – and on the ground during taxi in cold conditions such as freezing fog. The heated ESS removes the requirement for most fan anti-icing procedures.

Combustion

Fuel and air are mixed and burned within the combustion chamber to convert chemical energy of the fuel into thermal energy within the gas-stream prior to entry into the turbines.

The needs of the system depend greatly on the application (civil aerospace, military aerospace, marine or power generation). However there are many common themes of technology that span all sectors.

Emissions and pollutant reduction

The key discriminating technology of combustion is the generation and control of pollutant emissions - In particular NOx, particulate matter, un-burned hydrocarbons and carbon monoxide. For each product, these are closely regulated and monitored. Rolls Royce has a clearly laid out, long term strategy and commitment to control gaseous emissions.

Military combustion

The requirements in the military sector are complementary to other business sectors but also have unique elements of their own. The design of the main combustion system is driven far more by constraints of weight and excursions to extremely high fuel:air ratio, which can have implications for stealth. The reheat system or afterburner also requires distinctive technology, being the only application in our business where low pressure combustion is required in vitiated (oxygen reduced) air.

Manufacturing technology

Research and technology is undertaken in a wide range of areas to improve the productivity of existing processes and to develop new manufacturing processes. The focus of this work is cost reduction and increased design capability.

Hot end technology

The temperatures within the combustion chamber are amongst the hottest in the engine yet they are still expected to last the many hours of operation between service and overhaul. This requires substantial technology in the form of wall materials (both metallic and ceramic), coatings and manufacturing technology.

Turbines

Rolls-Royce has a variety of turbine architectures to suit each application.

The tradition of Rolls-Royce three-shaft engines for the large civil market has allowed the optimisation of power extraction through the turbine and improves overall engine efficiency. The three-shaft architecture also brings benefits to three-shaft marine and large military applications.

Two shaft turbine designs for corporate, regional and defence applications have been optimised and developed through advanced aero dynamics and materials.

This architecture allows an engine to have fewer stages giving a shorter, stiffer structure.

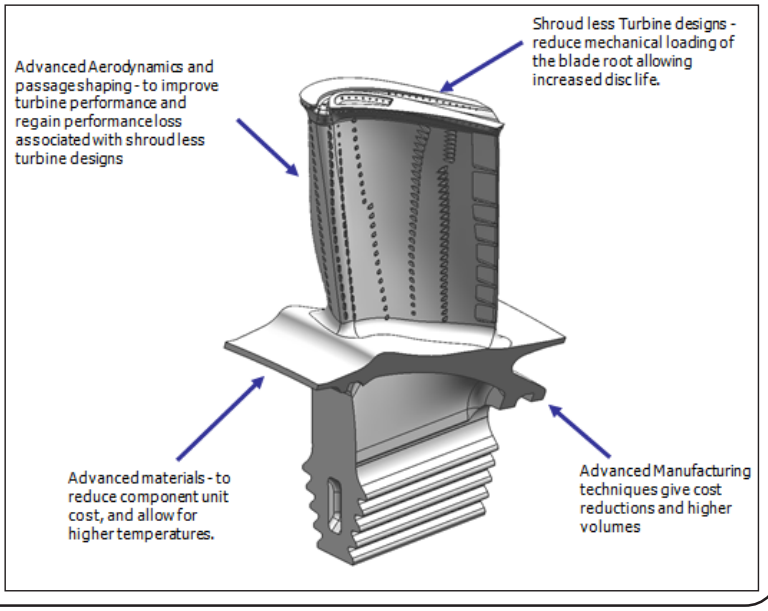
An increasingly detailed understanding of the turbine is necessary to produce more fuel efficient engines.

Measurements from turbine rigs provide accurate data vital for analysing the complex external and internal air flows in the harsh environment of the turbine. Techniques for taking detailed turbine measurements in a running engine enhance understanding and increase the store of reliable data for computer code validation.

The turbine is dependent on three main components being developed and working correctly; the blade, nozzle guide vane and seal segment.

The turbine blade is the rotating component within the turbine which presents many challenges to the design and manufacturing communities. This component leads the way in terms of future technology. Below are some of the key technologies to be implemented on to the turbine blade.

The nozzle guide vane is a static engine component which has the main function of cleaning up flow from the upstream blade and is key to maximising downstream blade performance. Below are some of the key technologies to be implemented on to the Turbine Nozzle Guide Vanes:



The Seal segment is crucial to reducing over tip leakage over the blade helping to maximise blade performance. Below are some of the key technologies to be implemented on to the Seal segments:

About The Company

Rolls-Royce is one of the most famous brands in the world. It is also one of the company's most important assets: it opens doors to new business; reassures existing customers; attracts talented people and differentiates us from our competition.

A strong brand also gives the company the ability to move into new markets with confidence and today as well as having a strong presence in aerospace and marine, we are growing in civil nuclear and reciprocating engines.

Our reputation for engineering excellence has been built over 110 years, today however, reputation also depends on service and performance – how we deliver on our promises.

***Our brand promise of 'trusted to deliver excellence'** embodies the values of the business: trust, deliver and excellence.*

***Trust:** is something we know can only be earned. It comes from the way we behave towards our colleagues, our customers, shareholders and partners. They need to know we can be relied on to do the right things in the right way.*

***Deliver:** part of earning trust is delivering on our promises. We seek to meet our customers' needs by ensuring the quality, performance and reliability of our products and matching this with first-class services that add value and that they can rely upon.*

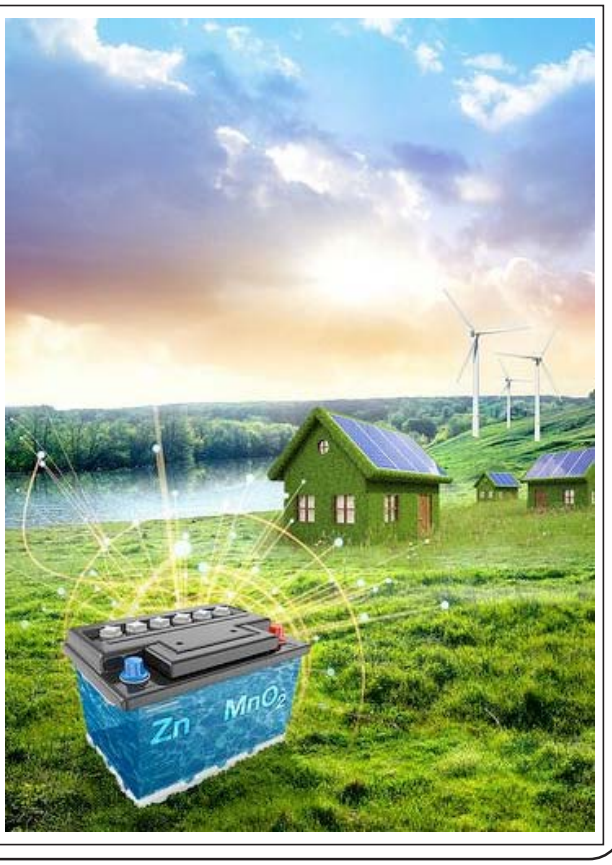
***Excellence:** standard, a way of life; few companies can aim higher. If we can be trusted and we deliver on our promises then we will be regarded as an excellent company; one that people are proud to work for, work with and, invest in.*

UNEXPECTED DISCOVERY LEADS TO A BETTER BATTERY

An unexpected discovery has led to a rechargeable battery that's as inexpensive as conventional car batteries, but has a much higher energy density. The new battery could become a cost-effective, environmentally friendly alternative for storing renewable energy and supporting the power grid.

A team based at the Department of Energy's Pacific Northwest National Laboratory identified this energy storage gem after realizing the new battery works in a different way than they had assumed. The journal Nature Energy published a paper today that describes the battery.

"The idea of a rechargeable zinc-manganese battery isn't new; researchers have been studying them as an inexpensive, safe alternative to lithium-ion batteries since the late 1990s," said PNNL Laboratory Fellow Jun Liu, the paper's corresponding author. "But these batteries usually stop working after just a few charges. Our research suggests these failures could have occurred because we failed to control chemical equilibrium in rechargeable zinc-manganese energy storage systems."



Chemically inclined

After years of focusing on rechargeable lithium-ion batteries, researchers are used to thinking about the back-and-forth shuttle of lithium ions. Lithium-ion batteries store and release energy through a process called intercalation, which involves

lithium ions entering and exiting microscopic spaces in between the atoms of a battery's two electrodes.

This concept is so engrained in energy storage research that when PNNL scientists, collaborating with the University of Washington, started considering a low-cost, safe alternative to lithium-ion batteries " a rechargeable zinc-manganese oxide battery " they *assumed* zinc would similarly move in and out of that battery's electrodes.

After a battery of tests, the team was surprised to realize their device was undergoing an entirely different process. Instead of simply moving the zinc ions around, their zinc-manganese oxide battery was undergoing a reversible chemical reaction that converted its active materials into entirely new ones.

Attractive alternative

Liu and his colleagues started investigating rechargeable zinc-manganese batteries because they are attractive on paper. They can be as inexpensive as the lead-acid batteries because they use abundant, inexpensive materials (zinc and manganese). And the battery's energy density can exceed lead-acid batteries. The PNNL scientists hoped they could produce a better-performing battery by digging deeper into the inner workings of the zinc-manganese oxide battery.

So they built their own battery with a negative zinc electrode, a positive manganese dioxide electrode and a water-based electrolyte in between the two. They put small, button-sized test batteries through the wringer, repeatedly charging and discharging them. As others had found before them, their test battery quickly lost its ability to store energy after just a few charging cycles. But why?

Detailed investigation

To find out, they first performed a detailed chemical and structural analysis of the electrolyte and electrode materials. They were surprised to not find evidence of zinc interacting with manganese oxide during the battery's charge and discharge processes, as they had initially expected would happen. The unexpected finding led them to wonder if the battery didn't undergo a simple intercalation process as they had previously thought. Perhaps the zinc-manganese battery is less like a lithium-ion battery and more like the traditional lead-acid battery, which also relies on chemical conversion reactions.

To dig deeper, they examined the electrodes with several advanced instruments with a variety of scientific techniques, including Transmission Electron Microscopy, Nuclear Magnetic Resonance and X-Ray Diffraction. The instruments used were located at both PNNL and the Environmental Molecular Sciences Laboratory (EMSL), a DOE Office of Science user facility located at PNNL. Combining these techniques revealed manganese oxide was reversibly reacting with protons from the water-based electrolyte, which created a new material, zinc hydroxyl sulfate.

Typically, zinc-manganese oxide batteries significantly lose storage capacity after just a few cycles. This happens because manganese from the battery's positive electrode begins to sluff off, making the battery's active material inaccessible for energy storage. But after some manganese dissolves into the electrolyte, the battery gradually stabilizes and the storage capacity levels out, though at a much lower level.

A simple fix

The team used the new knowledge to prevent this manganese sluff-off. Knowing the battery underwent chemical conversions, they determined the rate of manganese dissolution could be slowed down by increasing the electrolyte's initial manganese concentration.

So they added manganese ions to the electrolyte in a new test battery and put the revised battery through another round of tests. This time around, the test battery was able to reach a storage capacity of 285 milliAmpere-hours per gram of manganese oxide over 5,000 cycles, while retaining 92 percent of its initial storage capacity.

"This research shows equilibrium needs to be controlled during a chemical conversion reaction to improve zinc-manganese oxide battery performance," Liu said. "As a result, zinc-manganese oxide batteries could be a more viable solution for large-scale energy storage than the lithium-ion and lead-acid batteries used to support the grid today."

The team will continue their studies of the zinc-manganese oxide battery's fundamental operations. Now that they've learned the products of the battery's chemical conversion reactions, they will move on to identify the various in-between steps to create those products. They will also tinker with the battery's electrolyte to see how additional changes affect its operation.

This research was supported by DOE's Office of Science and used resources at the Environmental Molecular Sciences Laboratory (EMSL), a DOE Office of Science user facility located at PNNL.

Source: US Dept of Energy

SOLAR WIND ENERGY, INC. OFFERS A BOLD NEW APPROACH TO OVERCOME THE CURRENT LIMITATIONS OF CONVENTIONAL WIND ENERGY SOURCES

First-To-Market Hybrid Solar-Wind Energy Technology

The Solar Wind Downdraft Tower is the first hybrid solar-wind renewable energy technology in the market. The patented structure is comprised of a tall hollow cylinder with a water injection system near the top and wind tunnels containing turbines near the bottom.

COMPARISON of 4,380,000 MWH ANNUAL PRODUCTION FACILITIES

	WIND	SOLAR	SOLAR/WIND
Site Size	100,000 acres	10,000 acres	300 Acres
Installed Cost	$5.3 Billion	$5.7 Billion	$1.5 Billion
Useful Life	20 Years	25 Years	50 Years
Inverter Required	Yes	Yes	No
Gov't Subsidy Required	Yes	Yes	No
Generates Power 24/7	No	No	Yes
Predictable Output	No	No	Yes
Predictable Peak Demand	No	Yes	Yes
Available Tax/Carbon Credits	Yes	Yes	Yes

SOLAR WIND ENERGY TOWER

To start, a series of pumps deliver water to the Tower's injection system at the top where a fine mist is cast across the entire opening. The water introduced by the injection system then evaporates and is absorbed by hot dry air which has been heated by the solar rays of the sun. As a result, the air becomes cooler, denser and heavier than the outside warmer air, and falls through the cylinder at speeds up to and in excess of 50 mph. This air is then diverted into wind tunnels surrounding the base of the Tower where turbines inside the tunnels power generators to produce electricity.

In geographic areas where atmospheric conditions are conducive, the exterior of the Tower may be constructed with vertical "wind vanes" that capture the prevailing wind and channel it to produce supplemental electrical power. This dual renewable energy resource greatly enhances its clean energy-producing capability and productivity.

Solar Wind Energy's Tower is unique in that it does not have any operational limitations in terms of time. It's capable of operating around the clock, 24 hours per day, and seven days per week. Whereas there are operational limitations with solar collectors that work only when the sun shines, and with wind turbines that work only when the wind blows.

It also has the ability to be operated with virtually no carbon footprint, fuel consumption, or waste production. It generates clean, cost effective and efficient electrical power without damaging effects.

Proprietary Global Energy Generation Calculator

To complement its renewable energy technology and aid in its expansion efforts, Solar Wind Energy developed a proprietary software based analytical program to determine the energy generation capabilities of its Towers based on the climate in geographic locations around the world, and has taken the appropriate steps to protect its intellectual property invention. This essential tool applies "known" scientific meteorology data of a specific area to the Tower's variables in order to determine and project energy outputs on a daily basis. Advancements in the scientific community over the last decade make it possible to predict and pin-point specific weather conditions and have provided significant insights into the tool's development process and direction.

Solar Wind Energy's analytical tool, combined with its proprietary technology and existing core patents, provide it with a unique opportunity to plan and target the global positioning of its Towers to help meet the world's energy needs. Solar Wind Energy can now rapidly respond to a request from virtually any country reasonably suitable to host a project and determine specifically where the Tower should be located, the size of it and the amount of electricity it can produce.

Abundant, Clean, Economical Energy Production

Through consistent innovation, the Company has successfully managed to economize the Tower, reducing capital costs while enhancing projected financial performance. This development was made possible by utilizing its Global Energy Generation Calculator software which can calculate and predict energy production of the Towers given a projected location and incorporating that locations' local weather data. By feeding weather data of its future site location into the program, the Tower's height and diameter can be adjusted along with the amount of water required as fuel to create a desired amount of energy. The outcome dictates the optimum size of each Tower.

Under the most recent design specifications, the Tower designed for a site near San Luis, Arizona, has a gross production capacity on an hourly basis, of up to 1,250 megawatt hours. Due to lower capacities during winter days, the average hourly output per day for sale to the grid for the entire year averages approximately 435 megawatt hours/hr.

Each Tower will be constructed on location using conventional materials, equipment and techniques, associated industries, as well as local workers in the surrounding town or city. Each location will benefit significantly from the creation of professional manufacturing, construction and transportation jobs, in addition to having a high efficiency energy resource close by – providing clean renewable energy at a cost more favourable than nuclear plants with no negative impacts to the environment.

ANTARCTIC GLACIER MELT COULD RAISE SEA LEVEL BY 3M

A huge glacier in the frozen wastes of East Antarctica, a region previously thought stable, could melt much faster than expected, scientists say.

One of Antarctica's great glaciers could become unstable if global warming continues at the present pace. As warm seas wash the ice shelf, the land-based mass of ice could begin to retreat, cross a critical threshold in the present century and then withdraw 300 kilometres inland. In the course of doing so it would spill tremendous quantities of water into the oceans: enough to raise global sea levels by 2.9 metres and threaten cities that are home to billions.

And here is the bad news: glaciologists have known for decades that West Antarctica's ice sheets are unstable. But the Totten glacier is part of the East Antarctic Ice Sheet, a mass of ice most researchers had believed to be stable and highly unlikely to lose much of its ice, even in a warming world. Scientists from Australia, New Zealand, the US and Britain report in Nature that they explored the underlying geology of the Totten glacier to build up a picture of its advance and retreat over many millions of years.

Greater vulnerability

"The evidence coming together is painting a picture of East Antarctica being much more vulnerable to a warming environment than we thought," said Martin Siegert, co-director of the Grantham Institute at Imperial College London. "This is something we should worry about."Totten Glacier is losing ice now, and the warm ocean water that is causing this loss has the potential to also push the glacier back to an unstable place."In the past few years researchers have pinpointed the insidious effect of warming sea currents, and identified immediate hazards to the glaciers of the fast-warming West Antarctic region.They have, in separate studies, warned that climatologists may have under-estimated the pace of change and even proposed scenarios in which the loss of ice over the whole continent could become inexorable.

But nobody expected any of these things to happen, or even begin to happen, in a human lifespan. Even in a rapidly-warming world, Antarctica will remain the coldest place on Earth, sheathed by 30 million cubic kilometres of ice, containing 70 per cent of the planet's fresh water, a mass so vast that – were it to melt entirely – sea levels would rise by 60 metres.

The latest study suggests that rapid melting could begin within the next century. "Totten Glacier is only one outlet for the ice of the East Antarctic Ice Sheet, but it could have a huge impact," said Professor Siegert. "The East Antarctic Ice Sheet is by far the largest mass of ice on earth, so any small changes could have a big influence globally."

Interesting Facts about Antartica

1. Antarctica is the coldest, windiest, highest and driest continent on the planet.
2. Antarctica is a desert, even though it holds 70 percent of the world's freshwater.
3. The annual snow accumulation across much of East Antarctica adds up to less than two inches of rain. This is actually very comparable to the Sahara Desert.
4. In wintertime, the sea ice around Antarctica grows at the rate of 40,000 square miles a day
5. Only 2 percent of the continent is actually exposed
6. Antarctica's ice is so heavy that it deforms the South Pole. In fact, its weight makes the Earth look slightly pear shaped
7. Antarctica holds the top spot for the lowest recorded temperature on Earth, which was –129°F (–84.5°C) at the Russian Vostok station in 1983. At this temperature steel will shatter and water will explode into ice crystals.
8. The continent experiences regular Katabatic (downhill) winds, reaching 300 km per hour (185 miles/hour), that blow out of the continental interior
9. The first people to reach the South Pole were from the Norwegian-led expedition of Roald Amundsen on December 14, 1911.
10. Today seven countries have made territorial claims (Argentina, Australia, Chile, France, New Zealand, Norway and UK), but not all countries, including the USA and Russia, recognise these claims.
11. One of the biggest dangers to researchers and others living on the continent is actually fire. The dry environment makes it very possible and hard to stop.
12. ANTARCTICA IS THE ONLY CONTINENT WITHOUT A TIME ZONE. The scientists who reside there go by either the time of their home land or the supply line that brings them food and equipment.

THE ANTARCTIC AND CLIMATE

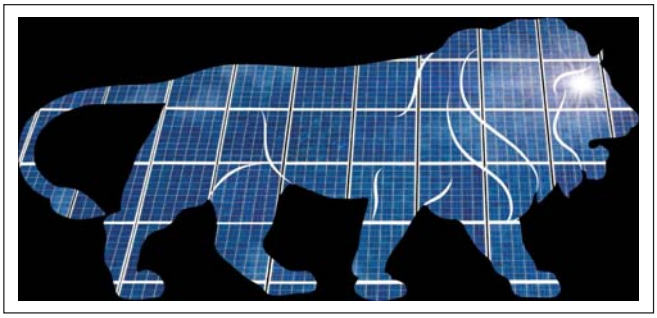
Local Antarctic effects of climate change are only part of the problem. Antarctica comprises two geologically distinct regions, East Antarctica and West Antarctica, separated by the great Trans-Antarctic Mountains but joined together by the all-encompassing ice sheet. The presence of the high ice sheet and the polar location make Antarctica a powerful heat sink that strongly affects the climate of the whole Earth. Furthermore, the annual sea ice cover around the continent, which seasonally reaches an area greater than that of the continent itself, modulates exchanges of heat, moisture, and gases between the atmosphere and ocean and, through salt rejection when it freezes, forces the formation of cold oceanic bottom waters that spread out under the world's oceans. Alterations to this system will affect climate all over the planet.

*A map of West Antarctica with the West Antarctic Ice Sheet.*Both the ice sheet and the sea ice are potentially subject to change in a changing climate; the ice sheet, in fact, may be changing now in response to past climate change. The greatest threat to the inhabited world comes from the West Antarctic ice sheet (WAIS), which rests on a bed far below sea level and so may have the potential for rapid shrinkage. The Antarctic is so vast, remote, and difficult to monitor, however, and the physical behaviour of the ice sheet so complex, that there is as yet no definitive demonstration (or disproof) of such change, even though a pronounced climatic warming is ongoing in one northerly portion of the continent. The Antarctic ice sheet contains sufficient ice to raise world-wide sea level by more than 60 meters if melted completely. The amount of snow deposited annually on the ice sheet is equivalent to about 5 mm of global sea level, as is the mean annual discharge of ice back into the ocean. Thus, a modest imbalance between the input and output of ice might be a major contributor to the present-day rise in sea level (1.5–2 mm per year), but the uncertainty is large.

Antarctic species are dramatically impacted by climate as well. Krill often feed on algae underneath sea ice and populations have been declining around the West Antarctic Peninsula as sea ice has decreased. Adélie penguin populations have been declining in recent years due to reductions in krill populations and changing weather conditions in their traditional nesting areas. Emperor penguins are highly vulnerable as well and are predicted to suffer when the world's average temperature increases by 2 degrees Celsius. Furthermore, a 2008 study has additionally identified Antarctic toothfish as highly vulnerable to climate change. Climate change in Antarctica will thus have dramatic effects both globally and locally - and perhaps harm some of the world's most beloved species.

SOLAR POWER IN INDIA CROSSED THE MILESTONE OF 5,000 MW

The Ministry of New & Renewable Energy has announced that the installed capacity of solar power in India crossed the milestone of 5,000 MW. The cumulative installed capacity has reached to 5,130 MW with installed capacity of 1385 MW in current FY. The state-wise break-up of 5,130 MW is given in the Table below. The state of Rajasthan stands 1st in the country with 1264 MW, followed by Gujarat (1024 MW), Madhya Pradesh (679 MW), Tamil Nadu (419 MW), Maharashtra (379 MW) and Andhra Pradesh (357 MW).



The Government has set the ambitious target of generating 100 GW of solar power by the year 2021-22 under the National Solar Mission. It is envisaged to generate 60 GW ground mounted grid-connected solar power and 40 GW through roof-top grid interactive solar power to fulfil the 100 GW of solar power. The Ministry has also fixed year-wise targets to monitor the solar power generation in the country. The target for the current year is 2,000 MW and next year target is 12,000 MW. The Ministry is putting all efforts through various schemes of Central Government and State Governments to achieve the targets. It has been planned that around 18,000 MW tender should be out by 31st March, 2016.

To achieve above stated objective, the Ministry of New & Renewable Energy has initiated several projects like Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects; Scheme for Development of Solar PV Power Plants on Canal Banks/ Canal Tops; Scheme for setting up 300 MW of Grid connected Solar PV Power Projects by Defence Establishments under Ministry of Defence and Para Military Forces with viability Gap Funding; Scheme of setting up 1000 MW of Grid- Connected Solar PV Power Projects by CPSUs with Viability Gap Funding ; Scheme for Setting up of 15000 MW of Grid connected to achieve this target. Solar PV Power Projects by NTPC/NVVN; setting up of 2000 MW Grid connected solar power with Viability Gap Funding through Solar Energy Corporation of India (SECI). This apart, an ambitious scheme has been launched by the Ministry for roof-top solar installation. Various state governments are coming up with solar power projects under their own policies.

Sr. No.	State/UT	Total commissioned capacity till 14-01-16 (MW)
1	Andhra Pradesh	357.34
2	Arunachal Pradesh	0.265
3	Chhattisgarh	73.18
4	Gujarat	1024.15
5	Haryana	12.8
6	Jharkhand	16
7	Karnataka	104.22
8	Kerala	12.025
9	Madhya Pradesh	678.58
10	Maharashtra	378.7
11	Odisha	66.92
12	Punjab	200.32
13	Rajasthan	1264.35
14	Tamil Nadu	418.945
15	Telangana	342.39
16	Tripura	5
17	Uttar Pradesh	140
18	Uttarakhand	5
19	West Bengal	7.21
20	Andaman & Nicobar	5.1
21	Delhi	6.712
22	Lakshadweep	0.75
23	Pondicherry	0.025
24	Chandigarh	5.041
25	Daman & Diu	4
26	Others	0.79
Total		**5129.813**

ENERGY CONSERVATION THROUGH ENERGY EFFICIENCY – 16

Energy Conservation through 'Overall' Efficiency

Improvement of Motor Driven Systems:

It is important to remember that out of the 'End Use Forms' of Energy, namely HEAT, FUEL and ELECTRICITY, almost 60% of the Energy is Electricity. This Percentage is steadily increasing and almost 80% of Electrical Energy is used through Electric Motors, to 'Convert' Electrical Energy to Mechanical Energy to put the Energy to 'Productive Use'. It can, therefore be seen; that almost 50% of all Energy use is through Motors and this is an important area to examine for **'Energy Conservation through Energy Efficiency'**.

A study has shown that the 'Overall' Motor Driven System Efficiency (this is dealt in some elaboration in the later part) of all uses of Motors in all applications put together (Industries, Agriculture, Commercial, Domestic, Municipal etc) is as low as 25%, which means that 75% of Energy is wasted as losses. Assuming that the overall Efficiency is improved to 50%, which incidentally is the International Standards, as per the study referred, we can estimate the massive Energy Conservation that will be achieved. The Overall Efficiency is also referred as **"End Use Efficiency"**.

A simple calculation – Present Total Generation of Electricity in India is (Appx) 1000 Billion Units PA

Accounting T & D Losses of 40% (up to the point of utilization) 600 Billion Units come for 'End Use'

Motor Systems Consume 80% or 480 Billion Units.

If end use Efficiencies are improved to 50%, input Energy required for the same outputs would reduce to 240 Billion Units, accounting for a saving of 240 Billion Units at the end use level and a saving of (240/0.6) 400 Billion Units at the Generation Level.

1 Ton of Coal (at 5000K.Cal/Kg) with 30% Generation Efficiency can Generate about 2000 Units (1000 x 5000 x 0.3/ 860 = 1744 Units – 1 Kwh = 860 K.Cal)

50 Tons of Coal, 1 Lakh Units; 500 Tons 1 Million Units; 5 Lakh Tons = 1 Billion Units

400 Billion Units Generation reduction will account for 200 Million Tons of coal saving!?!?

This will certainly sound unbelievable, but this is the kind of potential available in saving of Coal (as presently most of the Electricity is generated through Coal) ultimately through Efficiency improvements in end use through Motors.

The Motor Driven System comprises of Drive (Motors), Driven (equipments like Pumps, Blowers, Compressors and so on) and the Controls (Starter and other control devices if any), to convert Electrical Energy to useful Mechanical Energy and achieve productive use of the Energy. The overall System Efficiency will depend on all the 3 of the following combined –

a. Efficiency of the Drive (at the loads operating) – We have seen details of Energy Efficient Motors earlier.
b. Efficiency of the Driven Equipment (at the loads operating) – It may vary vastly depending on Solution to Solution, selection and the Manufacturer
c. Efficiency of the Controls employed.
d. The illustration below will show that the 'Overall' System Efficiency will be better with better Equipment Efficiencies and Control Efficiency.

Motor Speeds/ Output/ Output Control:

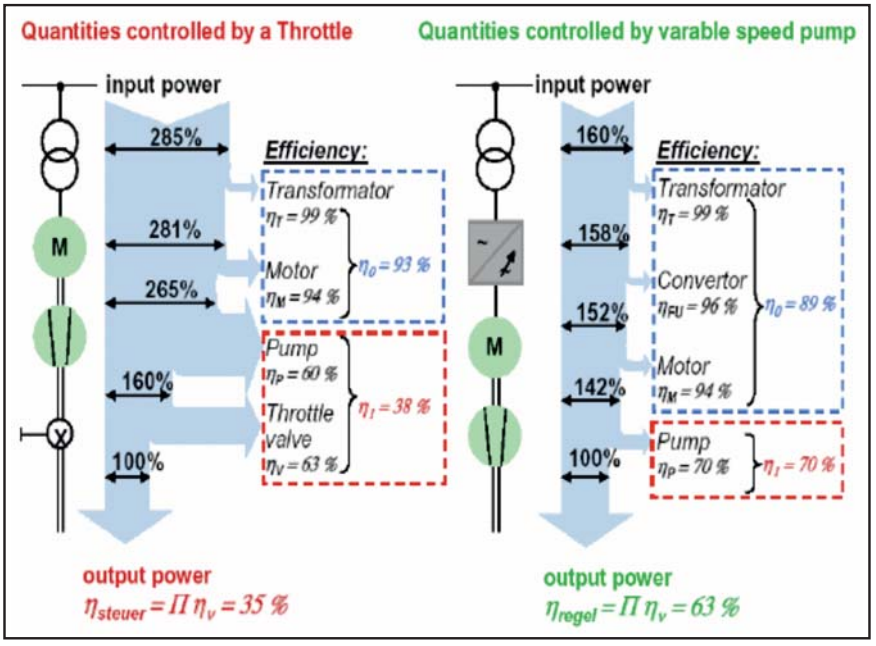
Reviewing some of the basics of Motor Speeds, Output and Output Controls, we understand that

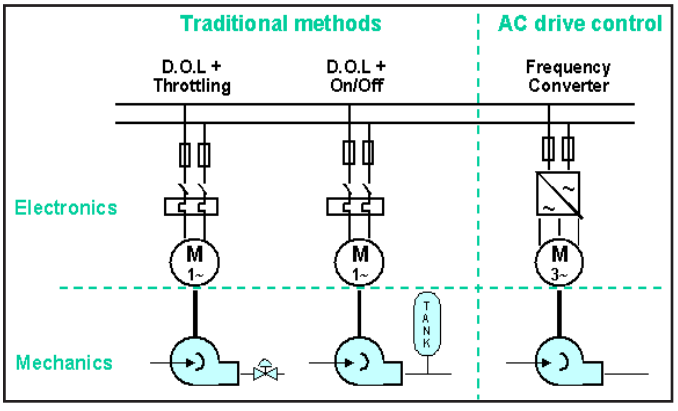
$$\textit{Synchronous Speed}\ (\text{RPM}) = \frac{120 \times \textit{Frequency}}{\textit{Poles}}$$

$$\textit{Slip}\ (\%) = \frac{\textit{Synchronous Speed} - \textit{Full Load Speed} \times 100}{\textit{Synchronous Speed}}$$

'SLIP' is decided by the Rotor Design, Losses, Efficiency…….

'SLIP' or the Running Speeds decide the Actual Load and the Loading Speeds decide the 'OUT PUT' which has to tune with requirements and hence the output control. The picture below shows the choices for output control.





The Electronic or AC Drive controls address the RPM of the Motors to control the outputs and the RPM control has lot of relevance in the context of Energy conservation due to "Affinity Law" which is applicable to Centrifugal Loads (which form the bulk of the loads) where the –

Output is proportional to RPM and the Input is proportional to RPM^3

For example if the output is reduced by 20% by reducing the speed of the Motor Electronically (VFD), the input power will be 0.8 x 0.8 x 0.8 = 0.512 or reduce by 48.8%. We have seen in Part 15 comparison of Energy Consumption with Mechanical and 'Drive' controls of outputs in cases of Pumps and Blowers.

Concerning 'End Use' Energy Consumption and Electrical Energy Conservation, the following technologies are considered as big contributors.

- LED Lights
- VFD Drives
- EE Appliances and **** Marking

Let us examine the details of Technology and Applications about the VFDs (Variable Frequency Drive) which concern the control of Motor Driven Systems and Energy Conservation.

VSDs and VFDs

Variable Speed Drives

VSDs, also known as adjustable speed drives, works at different speeds to help control the speed of the machinery that it is controlling. The ability to change speeds helps when working on assembly lines, for example, because various parts of the line may need to operate at different speeds. Additionally, not all mechanical equipment is going to work at the same speed so a variable speed drive can help. VSD types of drives can be mechanical, hydraulic, electromechanical, or electronic.

It is also important to note that there may be a difference between a variable speed drive and an adjustable speed drive. The adjustable speed drive works within a preset range, but the operating speed on a variable speed drive can be adjusted outside of those limits.

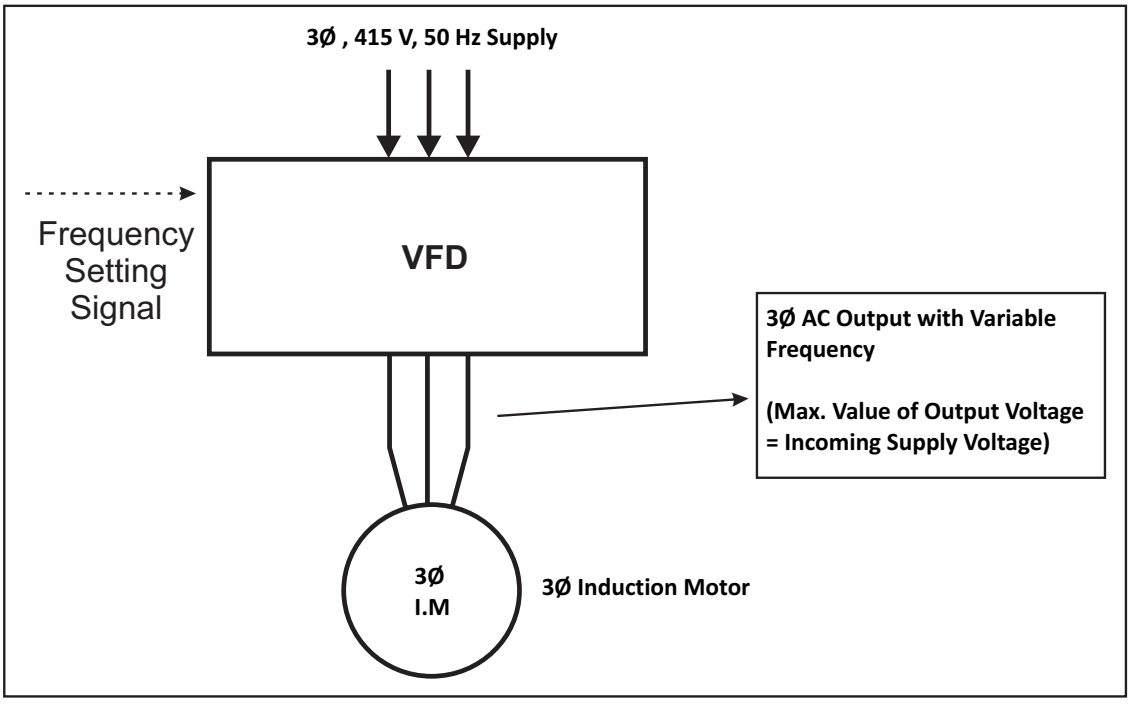
Variable Frequency Drives

VFDs operate equipment at different speeds as well, but it by varying the voltage and/or frequency of the electric motor. This type of drive is beneficial because it allows machinery to run at lower than full speed. This provides cost efficiency and reduces energy consumption. Additionally, using a VFD may help to improve the quality and lifetime of the equipment and can decrease production costs.

As can be seen, there are some differences between a VSD and a VFD, but there are also many similarities. At times, a variable frequency drive varies the speed of the equipment that it is operating, so it can actually be referred to as a variable speed drive as well. Not all variable frequency drives work this way.

Variable Speed Drives, AC drives, or inverters, Variable Frequency Drives, or **VFDs**, are

responsible for controlling the speed and torque of an AC motor. It works by adjusting the voltage and input frequency to synchronous motors. The recent technologies in VFDs are capable of simplifying the entire process of adjusting the speed of AC motors with three phases.



It is very important to have an in-depth understanding of how to configure, install and apply VFDs. After all, there are some issues involved in the application and operation of VFD such as over-voltage, overload, selection, grounding problems, electromagnetic field or electromagnetic interference and poor parameter settings or configurations.

Primarily, VFDs have the capacity to prevent overload and adjust deceleration/ acceleration. These can also minimize the in rush current in motors during startup, which is crucial when controlling the maximum power load to its corresponding peak demand. So, when specifying a VFD, it is necessary to choose the appropriate drive and know the application process involved. Be sure to take into account the load's operating profile, whether it is a constant torque application or a variable torque application.

To prevent drive overload, it is necessary to make it a point that the peak torque demand and maximum current requirements are considered when selecting the size of the VFD. This is important since considering the KW Ratings alone would not be able to meet the maximum demands on the motor.

VFD Basics:

Variable Output Frequency from the VFD is available, and from the relation for Induction Motors,

$$\text{RPM} = \frac{120 \times F}{P}$$

Where,

F = Frequency

P = No. of Poles

Speed in terms of RPM

If frequency changes, then speed of the Motor changes proportionately.

(To be continued)

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Consultant, Energy and Energy Efficiency,
Mobile: 98401 55209

"There are two kinds of solar-heat systems: 'passive' systems collect the sunlight that hits your home, and 'active' systems collect the sunlight that hits your neighbors' homes, too." – DAVE BARRY

JASWANTIBEN JAMNADAS POPAT
LIJJAT POPAT

Lijjat Papads: An Enterprise of the Women, By the Women, For the women

Everyone enjoys 'rags to riches' stories and everyone likes tales of stupendous success achieved through sheer determination. The story of seven illiterate and poor women who borrowed Rs 80 to start the papad business popularly known as Lijjat Papad, is indeed a fairy tale.

Lijjat had an annual turnover of around Rs. 650 crore (over 100 million USD) in 2010, with Rs. 29 crore in exports. It provides employment to around 42,000 people. Lijjat has 67 branches and 35 divisions all over India.

It is considered as one of the most remarkable entrepreneurial initiatives by women that are identified with female empowerment in India. Sticking to its core values for the past forty years, Lijjat has ensured that every process runs smoothly, members earn a comfortable profit, agents get their due share, consumers get the assurance of quality at a good price, and society benefits from its donations to various causes.

The chief value that holds the institution firmly is a sense of self-dignity and respect. The members share the same values, are a democratic set up and, are from every community, every religion, every language. They work together and dream together for a better tomorrow. They leveraged their basic skill and turned it into a weapon because they believed in themselves and in each other.

The growth of the Lijjat Brand is often seen in the larger canvas of women and their empowerment. **The members proudly claim 'consistently good quality' to be their USP.** It is evident in the fact that even without modern machines, every consumer of Lijjat Papad, wherever she is, gets the same consistent quality of papad, How?

Because every member rolls the papad to the same specification and every lot of papad goes through testing. **The quality does not differ whether it is for exports or for the local market. There is just one quality. And that's good quality. Again and again and again!**

20 MOST PEACEFUL COUNTRIES IN THE WORLD - 20

MAURITIUS

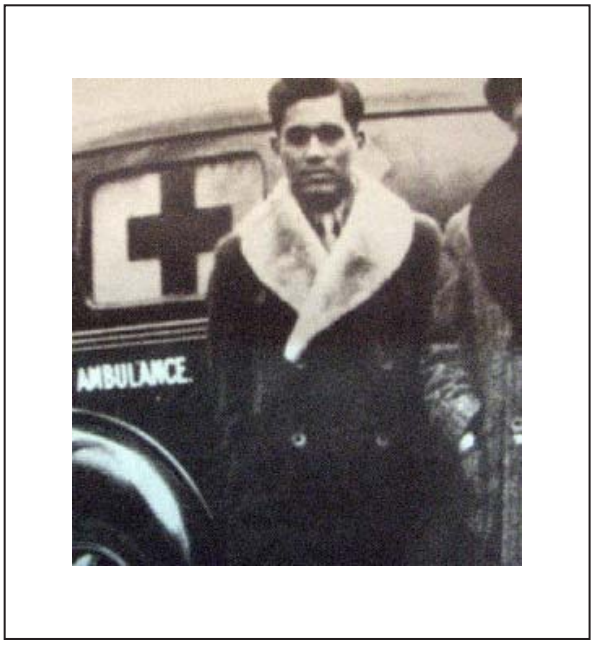
According to the GPI Report 2013, **Mauritius** is one of the most peaceful nations on Earth and it was also ranked the most peaceful country in Africa. The strong score of this island country in the GPI highlights the relative stability of the region and thus further promotes it as a trusted platform for wealth management services and estate planning.

It's a great advantage to live in a peaceful country, and if you are lucky to live in one of the above-mentioned countries, you must be proud of it!

Courtesy: Amerikanki

சீனா போற்றும் இந்திய 'மக்கள் மருத்துவர்' - டாக்டர் கோட்னிஸ்

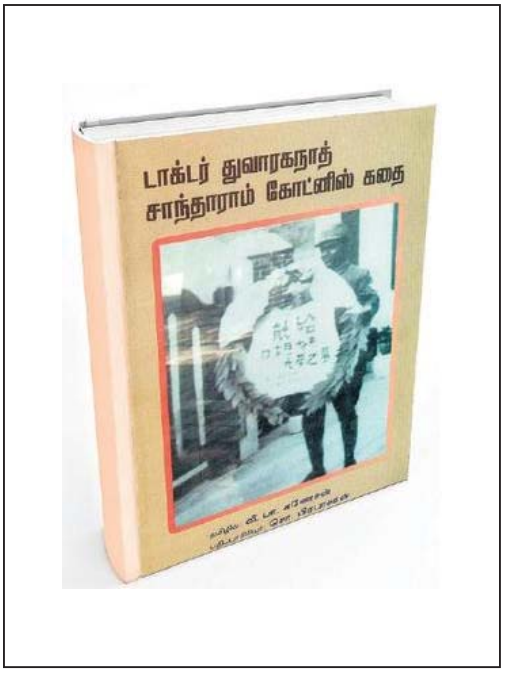
இந்த மருத்துவரின் பெயர் இந்தியாவில் அதிகப் பிரபலம் இல்லை. ஆனால், இந்தியாவுக்கு வரும் ஒவ்வொரு சீன அதிபரும் கோட்னிஸின் பெயரை உச்சரிக்கத் தவறுவதில்லை. இரு நாட்டு எல்லைப் பிரச்சினைகளைத் தாண்டி, சீனாவில் இன்றைக்கும் பெரிதாக மதிக்கப்பட்டு, கொண்டாடப்படுபவர் **இந்திய டாக்டர் கோட்னிஸ்**.



இவ்வளவுக்கும் சீனாவில் அவர் மருத்துவ சேவையாற்றிய காலம் வெறும் ஐந்து ஆண்டுகள்தான். அந்த ஐந்து ஆண்டுகளும் நவீன சீனாவின் வரலாற்றில் மிக மிக முக்கியமானவை. அப்போதுதான் ஜப்பானுக்கு எதிராக சீன மக்கள் படை போரிட்டுக் கொண்டிருந்தது. போர்க் களத்தில் காயமடைந்த வீரர்களுக்கு மருத்துவச் சிகிச்சை அளித்தது மட்டுமில்லாமல், ராணுவ மருத்துவப் பணியில் இருந்தவர்களுக்கு சீன மொழியிலேயே மருத்துவமும் பயிற்றுவித்தார் டாக்டர் கோட்னிஸ். சீன மக்கள் இன்றுவரை அவரைப் போற்றி வருவதற்கு இதுதான் காரணம்.

போர்க்களத்தில் சிகிச்சை

மகாராஷ்டிர மாநிலம் ஷோலாப்பூரில் பிறந்தவர் கோட்னிஸ். **டாக்டர் துவாரகநாத் சாந்தாராம் கோட்னிஸ்** என்ற முழு பெயர் கொண்ட அவர் 1938-ல் சீனாவுக்குப் போன இந்திய மருத்துவக் குழுவில் இணைந்துகொண்டார். அதற்கான ஏற்பாடுகளைச் செய்தவர்கள் நேருவும் காங்கிரஸ் கட்சித் தலைவர் சுபாஷ் சந்திர போஸும். அப்போது கோட்னிஸின் வயது 28 தான். போர்க்களத்தில் காயமடையும் வீரர்களுக்கு மருத்துவச் சிகிச்சை அளிக்கும் நடமாடும் மருத்துவமனையில் அவர் பணிபுரிந்தார். போரில் காயமடைந்தவர்களுக்குச் சிகிச்சை அளிப்பதில், அறுவைசிகிச்சைப் பிரிவுக்கு அவர் பொறுப்பேற்றிருந்தார்.



அவருடன் சென்ற மற்ற நான்கு இந்திய மருத்துவர்களும் வெவ்வேறு காரணங்களுக்காக நாடு திரும்பிவிட்ட நிலையில், அவர் மட்டுமே சீனாவில் தொடர்ந்து பணியாற்றினார். அவருக்கு முன்னதாக கனடாவிலிருந்து உதவ வந்திருந்த டாக்டர் நார்மன் பெத்தூனும், போர் நடந்துகொண்டிருந்த காலத்திலேயே இறந்து போயிருந்தார். அவருடைய நினைவாக பெத்தூன் பன்னாட்டு அமைதி மருத்துவமனை, போர்ச் சூழலில் மிகக் குறைந்த வசதிகளுடன் உருவாக்கப்பட்டது. அந்த மருத்துவமனையின் முதல் தலைவராகப் பொறுப்பேற்றவர் கோட்னிஸ். போர்க்கள மருத்துவக் குழுவுக்குத் தலைமை வகிக்கும் பொறுப்பும் கோட்னிஸிடமே வந்தது.

இந்தப் பின்னணியில் காலத்தையும் தன் உடலையும் பொருட்படுத்தாமல் சீன மக்களுக்கு அவசியம் தேவைப்பட்ட மருத்துவ உதவியை டாக்டர் கோட்னிஸ் வழங்கினார். அந்தக் காலத்தில் ஆயிரக்கணக்கான படை வீரர்களுக்கும் மக்களுக்கும் போர்க்களத்துக்கு அருகிலேயே அவர் அறுவைசிகிச்சை செய்தது சாதாரணமானதல்ல.

தூங்கா மருத்துவர்

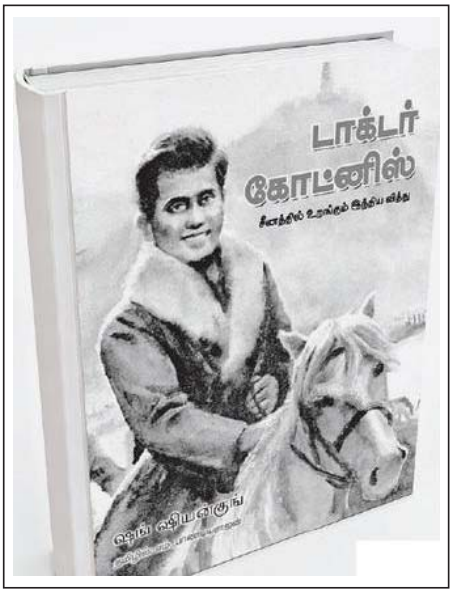
முழுமையான வசதிகள் இல்லாத சூழல். கடுமையான தட்பவெப்பத்துக்கு இடையில் சில நேரம்

தொடர்ச்சியாக மூன்று நாட்களுக்குத் தூங்காமலும் இடைவெளி இன்றியும் பணிபுரிய வேண்டிய கட்டாயம் கோட்னிஸுக்கு ஏற்பட்டது. 1940-ல் போர் கடுமையாக நடந்து கொண்டிருந்த போது, தொடர்ச்சியாக 13 நாட்களுக்கு இடையில் 72 மணி நேரம் தூக்கம் இல்லாமல் 588 அறுவை சிகிச்சைகளை கோட்னிஸ் மேற்கொண்டிருக்கிறார். இன்றைக்கு ஒரு எளிய அறுவை சிகிச்சைக்குக்கூடப் பல லட்சம் ரூபாய் வசூலிக்கப்படும் நிலையில், போர் முனையில் படைவீரர்களுக்குச் சிக்கலான அறுவை சிகிச்சைகளை உடனுக்குடன் செய்து, உயிரைக் காப்பாற்றிய அவருடைய பணியை என்னவென்று சொல்வது?

இப்படிப்பட்ட பல்வேறு காரணங்களால் உடல்நலம் குன்றிய அவர், 1942 டிசம்பர் 9-ம் தேதி 32 வயதிலேயே காலமானார். சீன மக்கள் படை செவிலியரான கோ சிங்லான் என்ற பெண்ணை மணந்திருந்த கோட்னிஸ், இடைப்பட்ட காலத்தில் தன்னுடைய தந்தை இறந்தபோதுகூட இந்தியாவுக்குச் செல்லவில்லை. கோட்னிஸ் இறந்தபோது அவருடைய மகன் யின் ஹுஆ மூன்றரை மாதக் கைக் குழந்தை. யின் ஹுஆ மருத்துவப்படிப்பு படித்துக்கொண்டிருந்த காலத்தில், தவறான மருத்துவச் சிகிச்சையால் 24-வது வயதிலேயே துரதிர்ஷ்டவசமாக இறந்துவிட்டார்.

சீனாவில் மூதாதையருக்கு ஆண்டுதோறும் மரியாதை செய்யும் சிங்மிங் பண்டிகையின்போது, இன்றைக்கும் கோட்னிஸின் கல்லறையில் மலர்கள் குவிந்துவிடுகின்றன. சீனாவுக்குப் பங்களித்த அயல்நாட்டவர்களின் வரிசையில் முதல் 10 பேரில் கோட்னிஸுக்கு சீன மக்கள் இடமளித்துள்ளனர். அவருடைய வாழ்க்கையை அடிப்படையாகக் கொண்டு புகழ்பெற்ற இந்தி இயக்குநர் சாந்தாராம், **'டாக்டர் கோட்னிஸ் கி அமர் கஹானி'** என்ற திரைப்படத்தை எடுத்துள்ளார். தமிழில் அவரைக் கொண்டாடும் வகையில் **'டாக்டர் கோட்னிஸ்'** என்ற ஓவியப் புத்தகம் வந்திருக்கிறது.

கோட்னிஸுக்கு ஓவிய அஞ்சலி



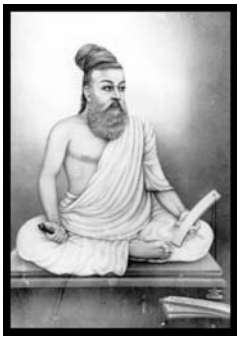
'டாக்டர் கோட்னிஸ்' என்ற சிறந்த ஓவிய வாழ்க்கை வரலாற்று நூலை என்.சி.பி.எச். (NCPH) வெளியிட்டு உள்ளது. இந்தப் புத்தகத்தை எழுதி வரைந்துள்ளவர் சீன ஓவிய – எழுத்தாளர் ஷங் ஷியன்குங். தமிழில் மொழிபெயர்த்தவர் ஊடகவியலாளர் எம். பாண்டியராஜன். இந்தப் புத்தகம் பெரியவர்களை மட்டுமில்லாமல், குழந்தைகளையும் கவரும் வகையில் அழகு நிறைந்த 101 முழுபக்கக் கறுப்பு-வெள்ளை ஓவியங்களுடன், கோட்னிஸின் வாழ்க்கையை ஒரு நழுவுபடக் காட்சியைப் போல எளிமையாகச் சொல்லிச் செல்கிறது. சமூக மேம்பாட்டுக்கும், மாற்றத்துக்கும் தங்களை அர்ப்பணித்துக்கொண்டவர்களின் வாழ்க்கையை இதுபோன்ற முறையில் சொல்வது குழந்தைகள், இளைஞர்கள் மத்தியில் புதிய உத்வேகத்தை உருவாக்கும்.

டாக்டர் கோட்னிஸ் பற்றி **'டாக்டர் துவாரகநாத் சாந்தாராம் கோட்னிஸ் கதை'** என்ற சிறிய புத்தகத்தையும், அவருக்கு முன்னதாக சீனர்களுக்கு உதவிய கனடா டாக்டர் நார்மன் பெத்தூன் பற்றி **'டாக்டர் நார்மன் பெத்யூன் கதை: ஒரு சர்வதேசிய போராளியின் உயிர்ப்பும் அர்ப்பணிப்பும்'** என்ற விரிவான மொழிபெயர்ப்புப் புத்தகத்தையும் சவுத் விஷன் புக்ஸ் ஏற்கனவே வெளியிட்டுள்ளது.

டாக்டர் கோட்னிஸ்
- சீனத்தில் உறங்கும் இந்திய வித்து,
ஷங் ஷியன்குங்,
தமிழில்: எம். பாண்டியராஜன்,
வெளியீடு: நியு செஞ்சுரி புக் ஹவுஸ்,
தொலைபேசி 044-26241288

Courtesy: தி இந்து, 30.04.2016

TIRUKKURAL AND MANAGEMENT IN A 'NUTSHELL' – 39



Tirukkural is a work by Tiruvalluvar as a 'MORAL' guide for the whole World for living a 'USEFUL' and 'HAPPY LIFE'. KURALS can provide guidance for every one in every walk of life including Professionals, Managers and Management. Every issue of this News Letter has carried Messages of Tiruvalluvar bringing out the relevance of them in all contexts.

This Issue of the News Letter is its 125th Issue and the Kural 125 and the other Kurals in that 'Adhikaram' or Chapter were revisited for a Presentation. It is no wonder that these Kurals were conveying some of the 'Most Powerful' Messages most relevant to Management.

As we have discussed frequently, some of the most important qualities of Managers and Management include "Humility" apart from some more like Professionalism, Equality, and Equivanimity. Tiruvalluvar deals with the concept and importance of Humility in ten kurals stressing its importance, in particular, for the 'Successful' and the 'Wealthy'.

The following Kurals chosen will bring out the Lessons for our adoption.

Ellarkkum Nandruam Panithal; Avarullum Selvarkke Selvam Thakaiththu ***Kural 125***

எல்லார்க்கும் நன்றுஆம் பணிதல்: அவருள்ளும் செல்வர்க்கே செல்வம் தகைத்து குறள் 125

"Humility is Beautiful in all men : but alone on the rich it shines in all its splendor."

Serivuarindu Seermai Payakkum; Arivuarinthu Aatrin Adankap Perin ***Kural 123***

செறிவுஅறிந்து சீர்மை பயக்கும் அறிவுஅறிந்து ஆற்றின் அடங்கப் பெறின் குறள் 123

"Behold the men who rateth the things of this world at their true value and liveth a life of self control; wisdom and every other blessing will come unto him."

Kadamkaththuk Katruadangal Aatruvan Sevvi Arampaarkum Aatrin Nuzhainthu ***Kural 130***

கதம்காத்துக் கற்றுஅடங்கல் ஆற்றுவான் செவ்வி அறம்பார்க்கும் ஆற்றின் நுழைந்து குறள் 130

"Behold the men who hath learned wisdom and self control and when alloweth not anger to harbor in his heart; Righteousness pilgrimeth to his home in order to have a sight of his face."

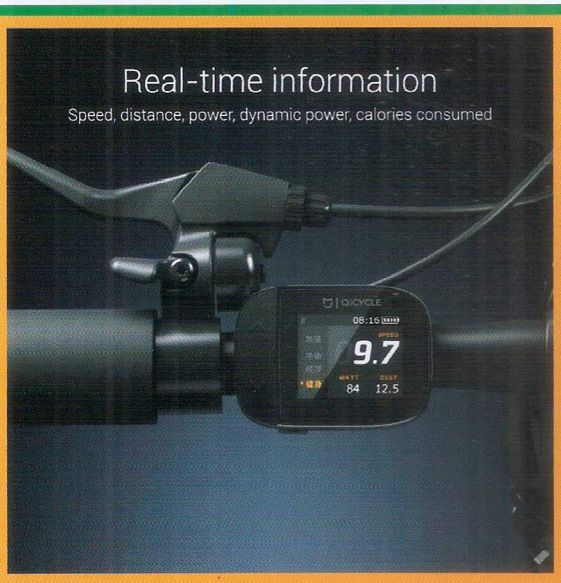
HOME FESTIVALS – 8

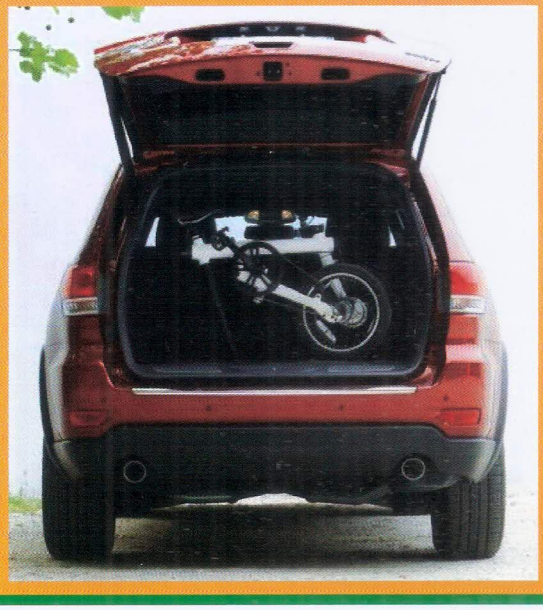
ஆவணி – AVANI (August/September)

This is a busy month, with two major festivals celebrated both at home and at the temple. Krishna Jayanthi, the birth of Lord Krishna, comes first. In the painting at right is the rescue of the baby Krishna, who was born in a prison. His father carries him across a swollen stream while the seven-headed serpent, AdiSeshan, protects the incarnation of Lord Vishnu from the storm. In the Home, offerings of butter and yoghurt are made to Krishna's image, and footprints made with red powder reveal his path from the home's front door to the shrine room, suggesting that Krishna has come to participate. Ganesha Chathurthi is a mammoth festival across all of India, ten days in celebration of His manifestation. Shown in the center of the painting is a statue of Lord Ganesha and a devotee offering obeisance by pulling his ears and bobbing up and down, a practice called *thopukarnam* in Tamil, done only for Ganesha – one explanation being that it is to make the Baby Ganesha laugh. The icon of Ganesha is made by the devotees from river clay and painted and decorated. At festival's end is the Visarjana or departure, when the clay icon is placed into the river the Deity is bid farewell. In North India Visarjana is celebrated by millions of people. At far right in the art is depicted the story of Ganesha consuming so many sweet offerings that He had to tie a snake around his belly to keep it from bursting. Ganesha chastised the Moon for laughing at His predicament, and as penance the Moon has ever since waxed and waned through the month instead of remaining constantly bright.

(To be continued)

XIAOMI





Xiaomi is a giant of the Chinese electronics world, and since releasing its first smartphone in 2011, it has branched out into a range of consumer electronic devices, including drones, smart TVs and fitness bands. Now, joining its personal mobility offerings is a new foldable eBike called the MiQicycle.

Weighing in at just 14.5 kg (32 lb), the Qicycle uses a lithium-ion Panasonic battery pack to power a 250W, 36V high-speed motor. Energy output is managed by an in-house battery management system, which feeds information to a smartphone companion app tracking the battery status, GPS navigation and riding statistics.

There's also a built in trip computer, providing speed, range, power and calories burned, just like any off-the-shelf Garmin. Unlike a Garmin, however, the system lets users scroll through *fitness, power-saving, balanced* and *battery charge* modes for the EV assist.

Range is pegged at just under 45 km (28 mi), and if the battery runs flat there is a Shimano Nexus 3-speed gear hub to make life a bit easier. When it comes time to hop into a train or car, the bike folds up for easy storage.

As is the case with most Xiaomi products, the Qicycle is unlikely to leave China. Pricing starts at RMB¥2,999 (US$450), and there will be a range of colors available.

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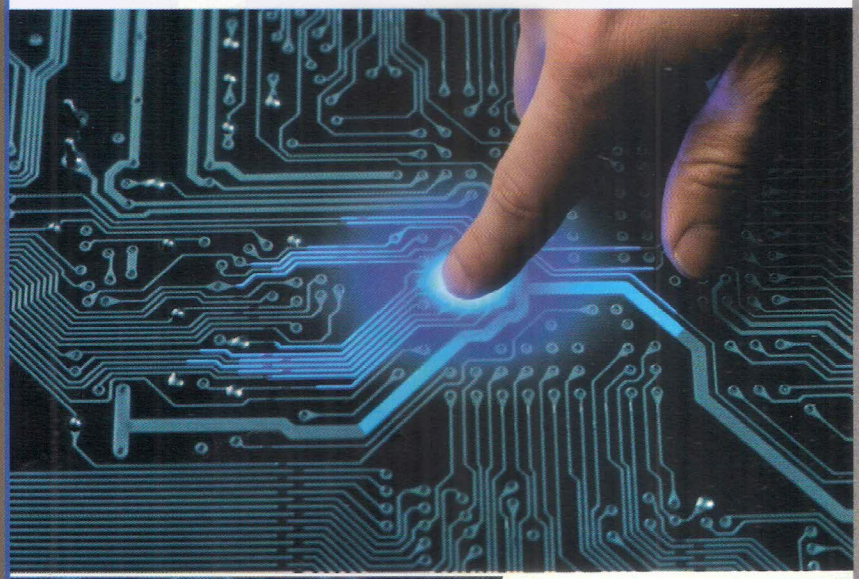

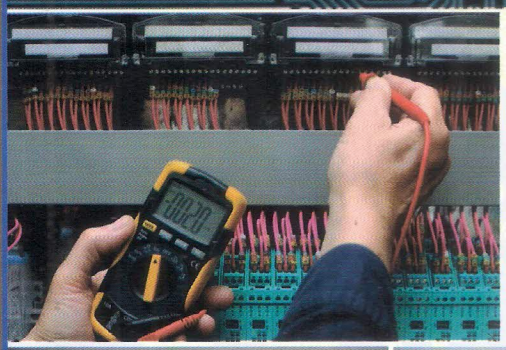

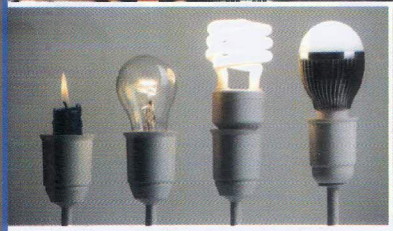

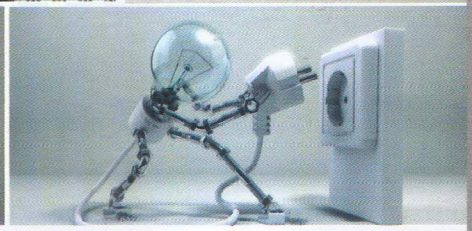

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