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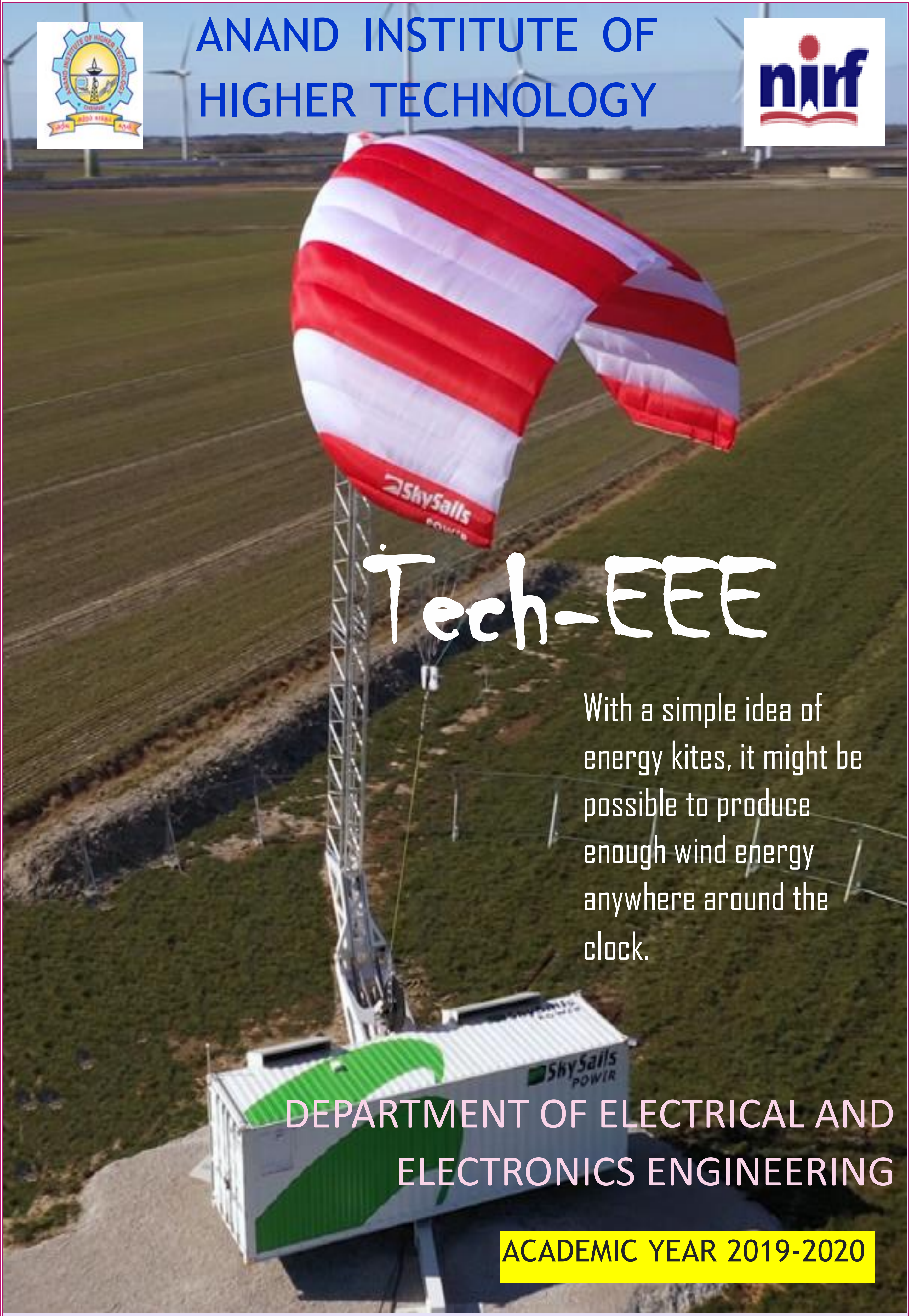

Tech-EEE

With a simple idea of energy kites, it might be possible to produce enough wind energy anywhere around the clock.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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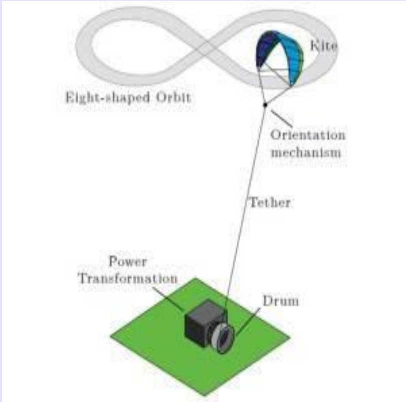
The Kite Generator System

The article discusses the principals involved in various HWAE technologies, the disadvantages of conventional wind turbine systems, and the need to replace them with the kite generator systems especially in India.

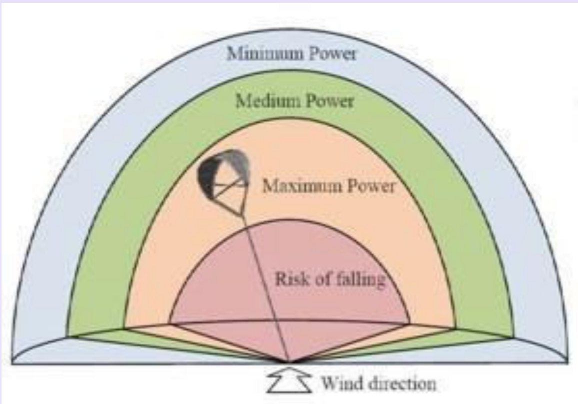
The third option is to use power kites as renewable energy generators such as the 'Kite Wind Generator' of Politecnico di Torino, and the 'Laddermill' of the Delft University of Technology as shown in figure. In this case, mechanical power is generated when the kites are pulled by wind, transformed them into an electrical one using an on-ground generator. This allows the flying part of the system to be much lighter and avoid using conducting cables. This technology is expected to produce huge amounts of power using a much simpler and safer structure.

Figure shows the basic elements of a Kite Generator System (KGS). On the top is the kite in the shape of a parachute. The natural path followed by this kite is upward with the wind in an eight shaped orbit. The tether is a cheap rope made of fibre having good mechanical strength. The one end of the tether is connected to the kite and the other end is wounded on a drum. The drum rotates to unroll the tether and the kite goes upwards. An electromechanical energy conversion (EMEC) device is connected on the same shaft as the drum through a gearbox. Hence, the linear kinetic motion of the kite is converted into rotational motion of the drum and is used to generate electricity using an EMEC device.



Comparison of Wind Energy Conversion Technologies

From the grid connection point of view, wind turbines are not able to produce their rated power continuously due to wind irregularity at their working altitudes, a problem that is less significant in the case of HAWE systems which are supposed to be working at an altitude higher than 400m where the winds are more regular.



Concerning the quality of generated power, it depends whether the system returns power to the energy source or not, meaning whether it as a recovery phase or not. In general, a classic turbine has only one phase of functioning that is a generation, which means that while generating, the resulted power is continuous as long as the turbine is in the power region limited by its cut-in speed and cut-out-speed.

Challenges in adopting Tethered airfoils (Kites) generator system.

The power electronic circuitry to act as an intermediate between the grid and the generator is easily available. But it is difficult to design a power electronic circuitry which will act as an intermediate between the generator and the Tethered airfoil (kite) because of the variations in speed. Further, it is difficult to design a control mechanism for the orientation, the curvature of the kite and the gearbox. Finally, the most difficult task is to control and optimize the trajectory of the kite. But the solution to the problem exists and is adopted by various organizations like Makani, Kitenge etc all over the world.

Conclusion

KGS is being adopted worldwide; it is the future of the power industry. Since India is having huge wind energy potential, it should start focusing on technology. As India's on-shore wind capacity remains underutilised and off-shore wind capacity is un-utilised, KGS provides an economical solution to the problem. This technology has the potential to pace up the growth of wind energy contribution to the whole world and it may outperform existing solar PV Modules.

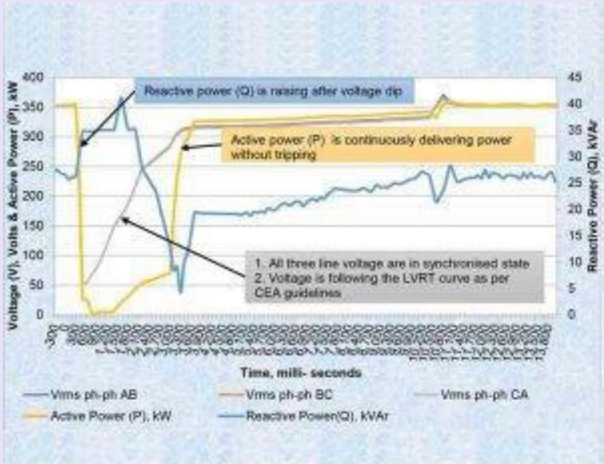
Significance of Low Voltage Ride Through (LVRT) in Solar Inverters

Grid stability is one of the important aspects of energy supply. The article speaks about the LVRT technology that helps power generation companies to stay connected to the grid in order to avoid power outages. Solar power plants have been increasing in number each year in India and we also see an increase in the use of renewable energy.

The use of renewable energy enables the country to become more independent. Solar power plants mainly consist of solar PV modules, grid-connected inverters, and transformers. Owing to an increasing number of power plants, the demand for inverters will be high considering we have a target to achieve 175 GW by the year 2020 and 500 GW by 2025.

With one of the leading developing countries, India is pushing onward with a large-scale addition of renewable energy by the year 2030. Because of the availability if high renewable energy systems, the stability of the power system needs to be safeguarded. Grid stability is one of the important aspects to consider with regard to energy supply.

In the past, renewable generating plants such as wind turbines were allowed to disconnect from the grid during such a fault and try to reconnect after a certain period of time. Today, because of the significant share of renewables, such a procedure would be fatal. If too many generating plants disconnect at the same time the complete network could break down, a scenario which is also called a 'blackout'.



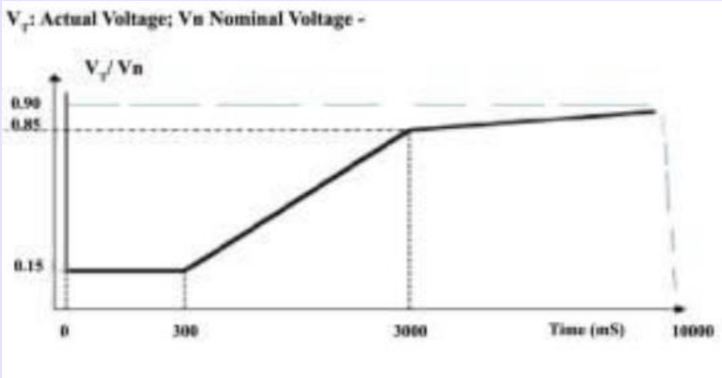
In this diagram, the voltage drops to about 85 per cent of the nominal voltage for a time of 300 ms. The PV inverter recognises the voltage drop and feeds a reactive current of approximately 100 per cent of the nominal voltage into the system for the duration of the fault in order to support the grid. After fault clearance, the active power output is increased to the value prior to the occurrence of the fault within 1 second. Before a generating plant can be connected to the grid, the transmission system operator normally requires a test report or certificate. One of the certification requirements is the measurement of electrical characteristics that includes a test of the LVRT capability.

Simulation of LVRT

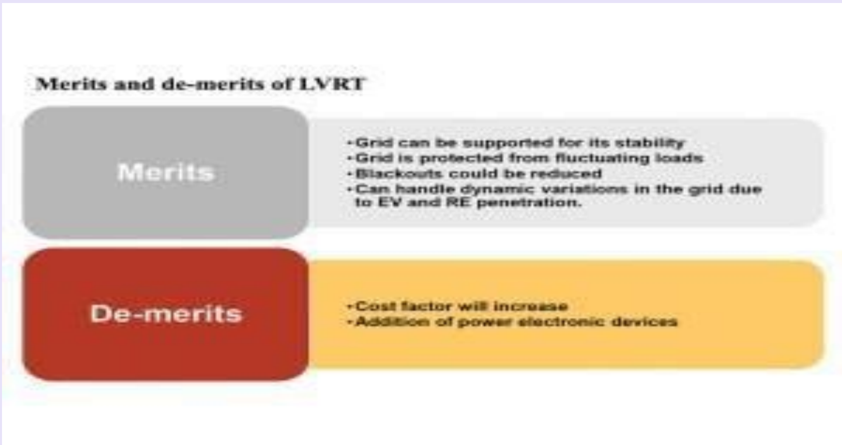
The simulation of voltage dips requires special technology. Most grid codes and guidelines have specific requirements for the test equipment. According to the international standard for the measurement of power quality characteristics of wind turbines (IEC 61400-21) for example, an inductive voltage divider is recommended which is to be connected ahead of the plant to be tested. For India, CEA Regulations, 2019 for grid connected equipment. Clause 4(c), Clause B2, Sub Clauses of Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2019, Ministry of Power, Notification

(New Delhi, dated 6th February 2019) Part III Section 4 provides the requirement for grid-connected equipment for LVRT.

By using the grid simulator, the voltage dip can be configured. Depending on the respective grid code, different depths of voltage dips have to be simulated, for wind turbines, usually, the dip is less than 5 per cent, 25 per cent, 50 per cent and 75 per cent of the rated voltage are required; for grid-connected inverters usually, the dip is 85 per cent. The duration of the dip is 300 ms only. In some cases, the duration can also be extended to several minutes. German and international guidelines demand the simulation of three-phase as well as two-phase faults. In England, guidelines additionally demand one phase faults against earth. The test system is normally stored in specially equipped standard sea containers and mainly contains the coils and switching devices. Large-size test systems (for generating plants in the multimegawatt range), often require two or more 40-feet containers. The mobile test system can thus be transported to the respective test site for free-field measurements. PV systems are often tested in the laboratory where the LVRT test system is normally part of the test facility. In cases, however, where manufacturers do not have their own test facility, mobile test containers are used instead.



As an independent measuring institute, CPRI has recently started testing the LVRT capability of grid-connected inverters. Since very recently, CPRI is also able to perform fault ride-through tests with own test systems. These consist of a smaller system for testing generating



plants up to 0.5 MW, in grids up to 415 V. The test system is also well equipped for future requirements because it is possible to simulate so-called HVRT tests (overvoltage tests) and FRT test (frequency ride-through from 47.5 Hz to 52 Hz). The first projects with CPRI's own test setup have already been completed successfully on a solar-based grid-connected inverter of 1250 kW capacity, tested at 350 kW. CPRI is accredited by the NABL (National Accreditation Board of Laboratories), according to ISO/IEC 17025:2017. Other terms frequently used and describing the same subject are Fault-Ride-Through, response to voltage drops, performance in case of voltage dips, voltage dip- tests, transient stability, network faults, double-dip test, voltage drops, and performance during network disturbances and behaviour during network disturbances.

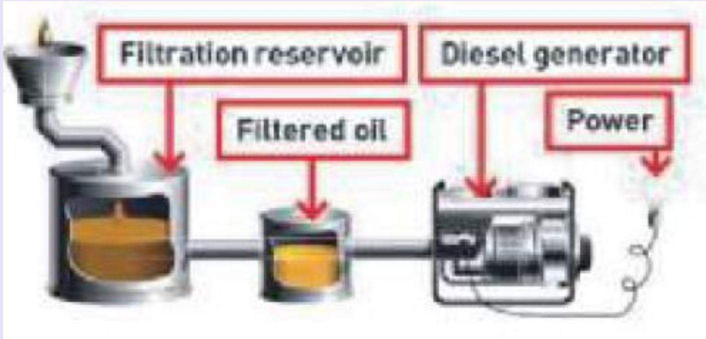
Examples of LVRT in Solar Power Plants

For short system faults (lasting up to 150ms or 300 ms) the inverter in the solar plant has to remain connected to the grid. For High voltage grids, voltage dips of longer durations like 500 ms or 1000 ms or higher, the inverter in the solar power plant have to remain connected to the grid up to more than 2 ½ minutes. As the curve shown in CEA says the inverter to be on top of the curve if voltage follows it. During grid faults or brownouts a solar power plant has to supply maximum reactive current to the grid without exceeding the transient rating of the plant. This will boost the voltage of the grid to maintain stability. On HV grids, during voltage dips lasting more than 300 ms, the active power output of a solar plant has to be retained at least in proportion to the retained balanced HV grid voltage.

LVRT for Electric Vehicle Charging Infrastructure (EVCI)

Grid-connected inverters need to have LVRT feature in-built in them to support the grid. As electric vehicle supply equipment (EVSE)/ EVCI contains the grid-connected inverter for V2G power flow, the importance of LVRT is increased. EV loads are going to be fluctuating and this making the existing conventional load curve of each region or entire country different than the present scenario. EV loads may not increase the load in the near future but will vary the load curve. Multiple EVCI's connected to the grid can really help the grid if they possess the LVRT feature in them apart from taking power from EV to the grid (V2G). LVRT based grid-connected inverters in the EVCI's can play a major role in maintaining the grid stability and security of the country.

Veaawatt



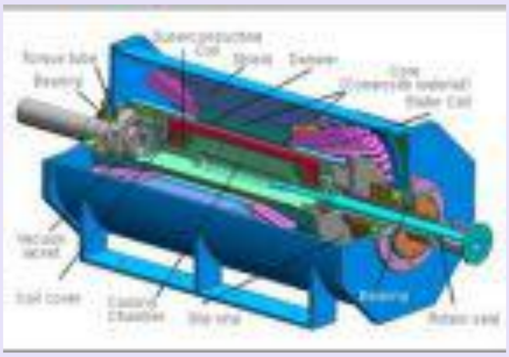
Transforming waste vegetable oils into electricity and heat.. Restaurant Filtrati on reservoir Diesel generator owners often grabble with what to do with waste oil generated from deep fat fryers. Each year more than I l billion liters (2.9 billion U.S. gallons) of waste Fillered oil Power vegetable oil is produced by restaurants, food processing plants and fast food restaurants in the USA. Although there are regulations for proper disposal of the waste oil, most disposal options involve removal and transport of the oil to another location. Vegawatt has come up with a unique system to turn vegetable waste oil into energy at the restaurant. The very first system was just installed at a fish fry restaurant in Dedham. Waste oil recycling and energy creating compact system.

Vega watt is a unique renewable-source energy system that generates electricity and hot water, on-site, for restaurants and foodservice operations by using the waste vegetable cooking oil (WVO) from their fryers as a fuel source. Vegawatt is a 5kW unit that will provide a return of investment (ROD of only 3 years for operations that dispose of 50 gallons per week of WVO and 2 years for operators disposing of 80 gallons each week. Our generator is fully automated;

Super Conducting Generators

Introduction: -

Superconducting elements are the most important part of electromechanical systems because of their functioning and these systems form the superconducting electric machines. Lack of DC resistance in super conductors contributes much to its greater efficiency. In a super conducting machine very high magnetic field is produced otherwise impossible in a conventional machine and is the main characteristic of super conductors. High magnetic field results in lesser motor volume and ultimately more power density. Cryogenics are highly used in super conductors to maintain a specific temperature which is less than the room temperature upto hundred degrees, super conducting transition temperature (Tc), at which the superconductors reach the zero resistance.



Superconducting AC synchronous electric machines which include alternators and synchronous motors have become more common nowadays than before. The rotor or the rotating member of the machines has an electromagnetic field winding on itself for direct current which employs superconductors. The stationary member or stator of the machines however utilizes the same old conductors constituting of copper conductors which undergo normal conduction. An attempt to reduce the resistive loss of the stator conductors they are cooled but the loss is not permanently removed.

Principle

The working principle previously used in old electric generators which included synchronous permanent magnet generators or motors and the induction machines is also being used nowadays in the **superconducting generators**. The only difference between the two is the windings of the superconducting generator. These windings are able to support a more powerful magnetic field as compared to that of conventional generators. Using this coil in other various rotating machines will also improve their efficiency; make them more compact and eco-friendly. Three insulations are also present, first is the shield to protect the release of magnetic field to the surrounding, second is the vacuum jacket which forms the vacuum insulation layer and last is the torque tube which is the insulating structure.

Industrial Revolution in Energy

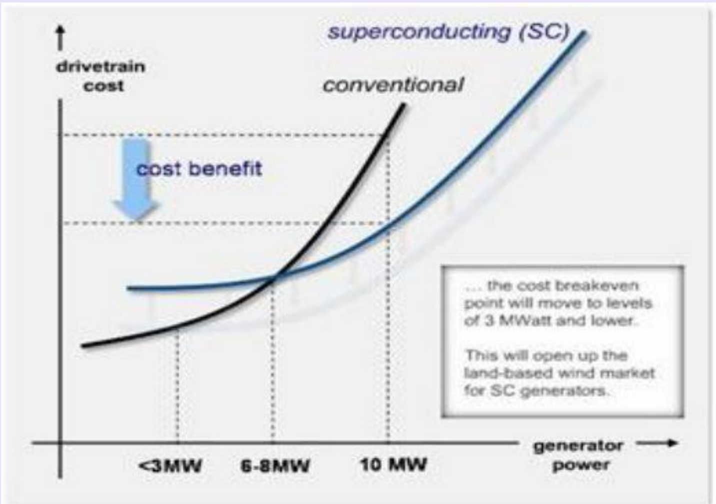
Superconductivity technology is not without benefits and its scope and ability is now much understood. The magnetic resonance imaging techs in medicine and super-colliders or particle physics analysis done in research are a few beneficial outcomes of this technology which clearly are upgrading different areas of our society.

The size, cost and efficiency of the production and usage of electricity will also be greatly affected by super conductors.

Comparison between super conductor and conventional tech generators

Cost comparison is done between the generators working on super conducting technology and those working on conventional tech and is shown in the “Superconducting Generator Cost Comparison” chart. The results obtained from the comparison show that the conventional technology costs cheaper when dealing with low power levels. This is so because the cost of copper cable used in the conventional machines is much less than that of the superconducting cable. The cost of superconducting generators also increases because of the use of cryogenics to cool the machine up to a specific temperature while the cooling cost of old generators is much less.

The case is reverse when talking about high power levels. Super conductors become more cost effective at this point because the power per unit of increase becomes more favourable. The break-even point for both generators comes out to be between the ranges of 4-6 MW. It is expected in future that further research and improvement in superconductor production tech and the cooling method through cryogenics will decrease the cost a great deal. The cost utilized for superconducting power generation will also decrease. The break-even point mentioned earlier will also reduce.



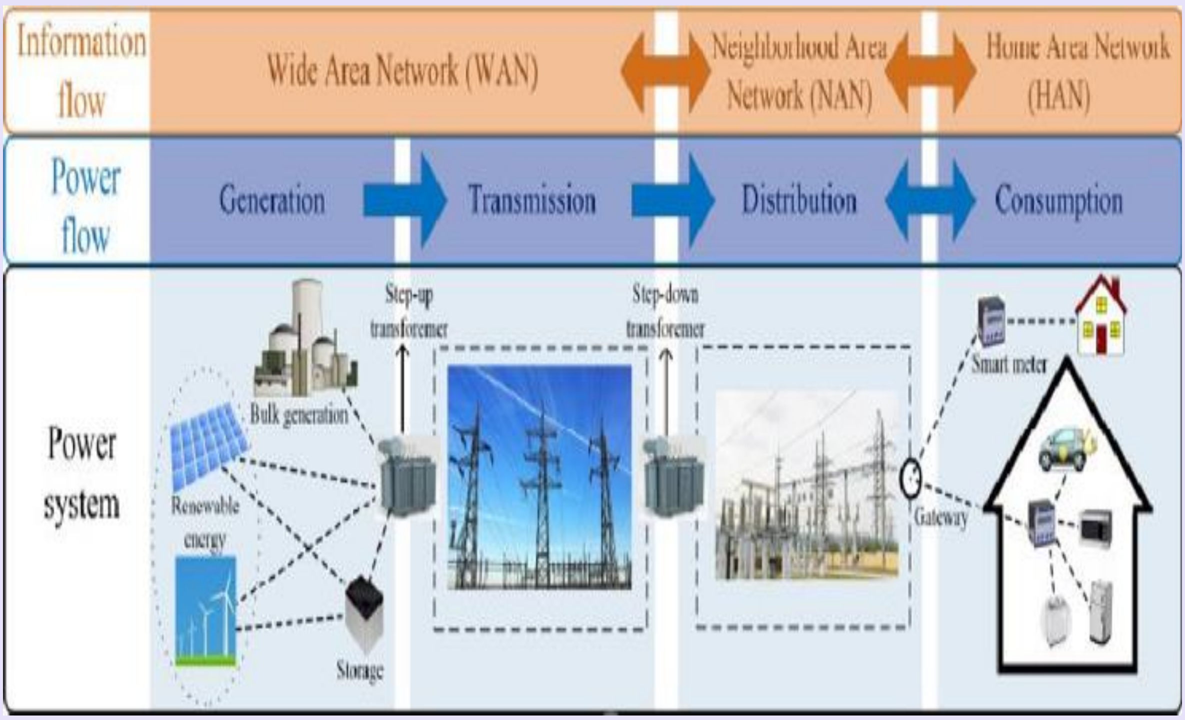
If it decreases up to 2 MW, competition for superconducting generators will also decrease.

Internet of Things-Aided Smart Grid

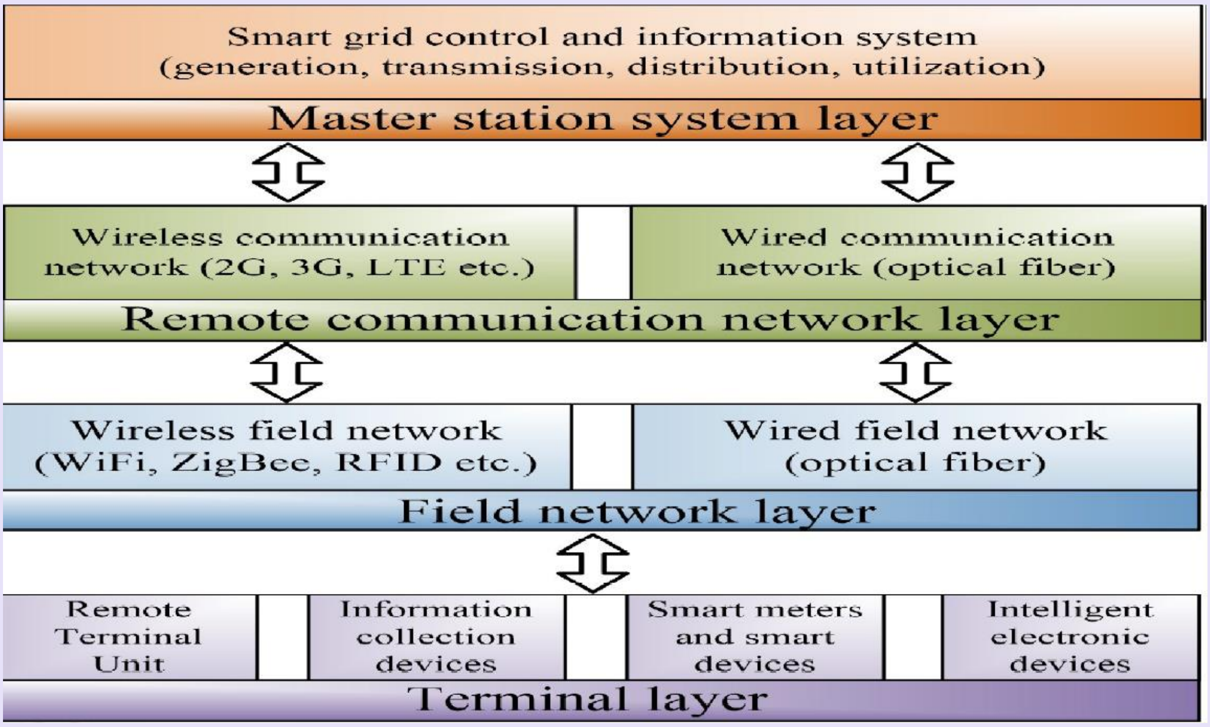
A traditional power grid consists of a large number of loosely interconnected synchronous Alternate Current (AC) grids. It performs three main functions: generation, transmission and distribution of electrical energy in which electric power flows only in one direction, i.e., from a service provider to the consumers. Firstly in power generation, a number of large power plants generate electrical energy, mostly from burning carbon and uranium based fuels. Secondly in power transmission, the electricity is transmitted from power plants to remote load centers through high voltage transmission lines. Thirdly in power distribution, the electrical distribution systems distribute electrical energy to the end consumers at reduced voltage. Each grid is centrally controlled and monitored to ensure that the power plants generate electrical energy in accordance with the needs of the consumers within the constraints of power systems. Nearly, all the generation, transmission and distribution of electrical energy is owned by the utility companies who provide electrical energy to consumers and bill them accordingly to recover their costs and earn profit. The traditional power grid worked very well from its inception in 1870 until 1970. Even though the consumers' demand for energy grew exponentially, it was still rather predictable. However, there has been a dramatic change in the nature of electrical energy consumption since 1970, as the load of electronic devices has become the fastest growing element of the total electricity demand and new sources of high electricity consumption have been developed, such as electric vehicles (EVs).

SG deploys various types of devices for monitoring, analyzing and controlling the grid. Such monitoring devices are deployed at power plants, transmission lines, transmission towers and distribution centers and consumers premises. The numbers of such devices is large. One of the main concerns for SG is the connectivity, automation and tracking of such large number of devices, which requires distributed monitoring, analysis and control through high speed, ubiquitous and two-way digital communications. It requires distributed automation of SG for such devices or "things". This is already being realized in the real world through the Internet of Things (IoT) technology.

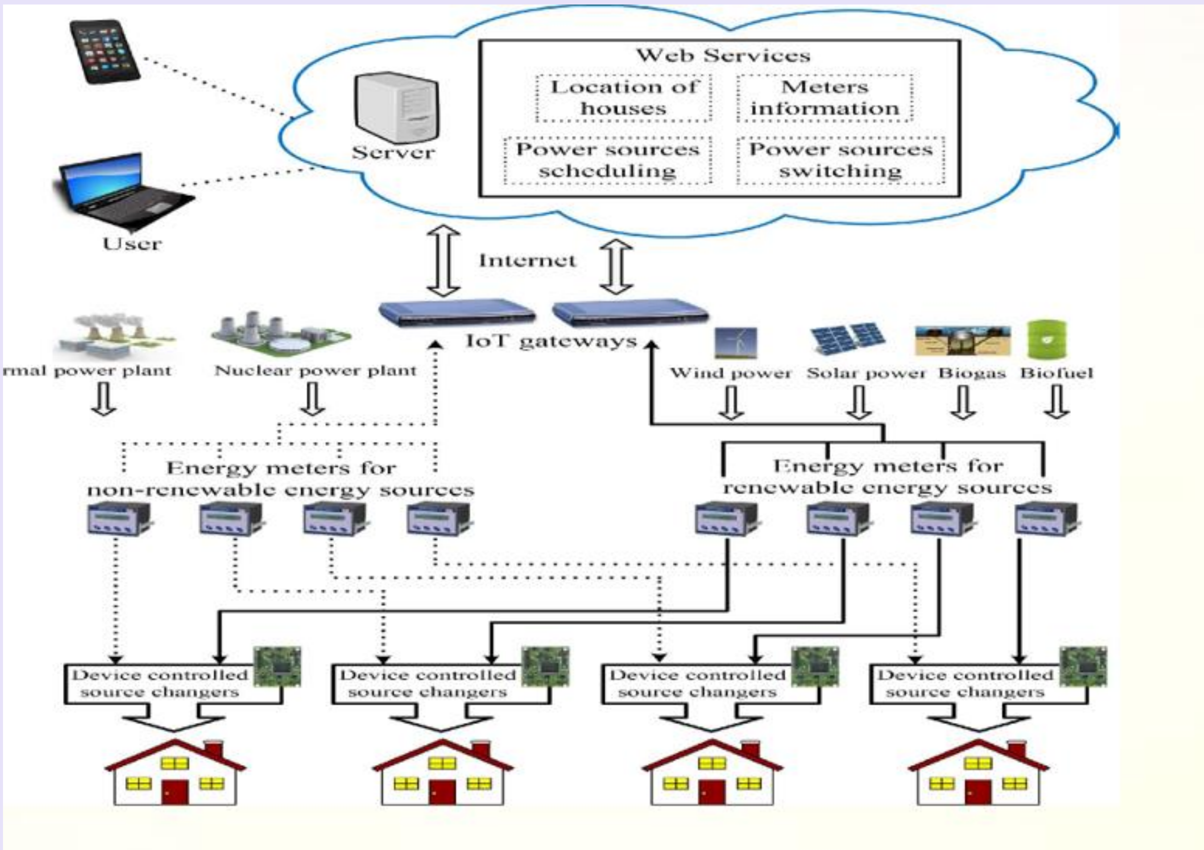
IOT AS A PART OF SMART GRID:-



IOT-AIDED SMART GRID SYSTEM ARCHITECTURE: -



WEB ENABLED SMART GRID ARCHITECTURE: -



CONCLUSION

Smart Grid (SG) is the future grid which solves the problems of uni-directional information flow, energy wastage, growing energy demand, reliability, and security in the traditional power grid. The Internet of Things (IoT) technology provides connectivity anywhere and anytime. It helps SG by providing smart devices or IoT devices (such as sensors, actuators, and smart meters) for the monitoring, analysis and controlling the grid, as well as connectivity, automation and tracking of such devices. This realizes the IoT-aided SG system which supports and improves various network functions at the power generation, transmission, distribution, and utilization.