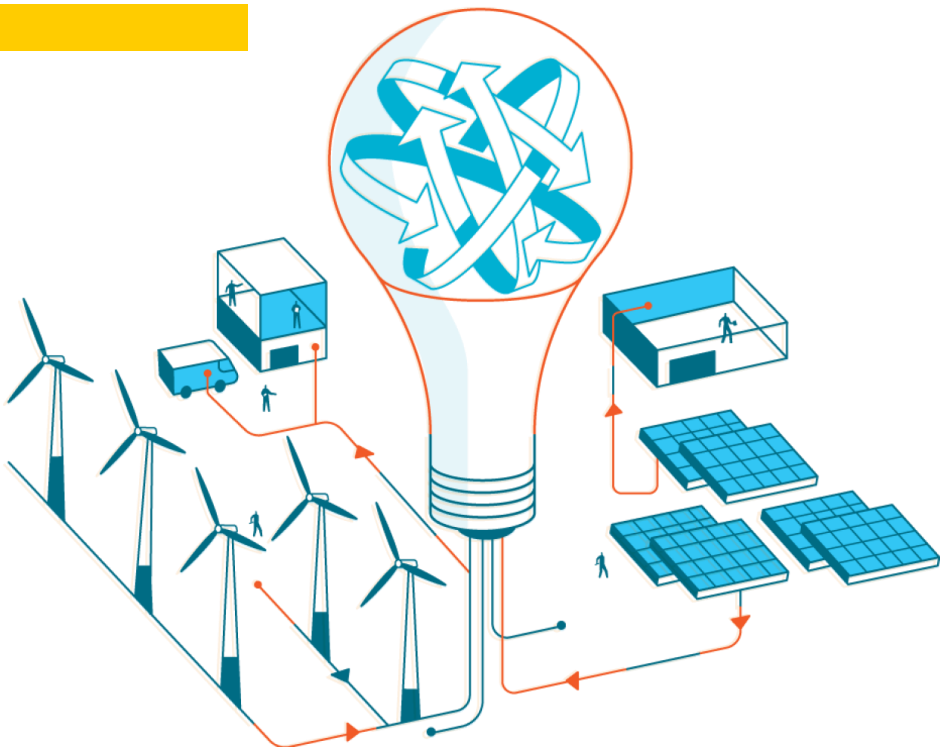
YEAR: 2016-



ELECTROSPHERE

---- A Technical Magazine

Department of Electrical Engineering

AISSMS's Institute of Information Technology, Pune.

INDEX

SOLAR PARKS INITIATIVE BY MNRE

-Aditi Abhyankar

The Concept

- The Union Ministry of New and Renewable Energy (MNRE) has announced a scheme to develop at least 25 solar parks, each with a capacity of 500 MW and above targeting over 20 GW solar power, across the country in next five years at an outlay of Rs 4050 crore.

- These solar parks are common development zones for solar power projects and offer developers location that is well characterized, with proper infrastructure and access to amenities and where the risk of the projects can be minimized. Solar Park also facilitates developers by reducing the number of required approvals.

- The idea of solar parks emerged from the success of the **'Charanka Solar**

A solar power developer can get fully developed land along with transmission and other facilities and can, therefore, set up power project immediately.

- The Charanka Solar Park has a capacity of 590 MW, out of which 224 MW has already been commissioned by 20 developers.

How implementation is possible?

- Utilizing economies of scale, the Ultra Mega Solar Power Projects (UMSPP) with capacity of 500 MW or above have also been planned.

- Large chunks of land are available in some States for solar park development.

- There are some developers who are keen to individually take up such huge solar power projects.

- Some UMSPP may be set up in the proposed Solar Parks or the entire park may individually be an UMSPP.

- Smaller parks could also be considered under the scheme in Himalayan states where large tracts of contiguous land may be difficult to acquire and in States where there is acute shortage of non-agricultural lands.

Ministry of new and renewable energy has planned to setup 25 solar parks in next five years	
Gujarat	750MW
MP	750MW+750MW
Telangana	100MW
Andhra Pradesh	2500MW
Karnataka	1000MW
UP	600MW
Meghalaya	50MW
J&K	750MW
Punjab	1000MW+1000MW
Rajasthan	700MW+1000MW+1000MW+1000MW
Tamil Nadu	500MW
Odisha	1000 MW

INDIA'S FIRST C&D (Construction & Demolition) RECYCLING PLANT

-Aditi Abhyankar,Sanket Asarkar

Don't let the future blow, don't pollute the H20 ….**Students Initiative in analysis of Waste Water in Pune.**

- Students of College of Engineering, Pune (CoEP) have claimed in a study that 44 nalas of the city are releasing 'untreated sewage and industrial water' directly into the Mutha River.
- The study claimed that this is a major factor for the decreased oxygen level in the river.
- The study, carried out under the project Jalmaitri, studied water samples from 10 locations between Vitthalwadi to Sangam Bridge in the last four years.
- About 20 students participated in the exercise.
- The report has been submitted to the Pune Municipal Corporation (PMC).

Major findings

- Insufficient Sewage Treatment Plants (STPs) lead to more pollution. Hence, more STPs need to be set up on priority.
- In Tanajiwadi STP, the capacity is only half of the total sewage generated. When there is no electricity, sewage is disposed of untreated.
- Out of 11 bridges on the river stretch only 4 have nirmalya kalash. Hence, this waste goes directly into the river.
- The readings show that the concentration of pollution is more at Vitthalwadi.

Corrective Measure

- Surface Disposal :

Generally this is disposal by irrigation. This involves spreading the wastewater over the surface of the ground, generally by irrigation ditches. There is some evaporation, but most of the wastewater soaks into the ground and supplies moisture with small amounts of fertilizing ingredients for plant life.

- Subsurface Disposal :

  By this method wastewater is introduced into the ground below its surface through pits or tile fields. It is commonly used for disposal of settled wastewater from residences or institutions where there is only a limited volume of wastewater**.**

- Chemical Methods:

  Chlorination, Ozonation, Neutraliion, Coagulation, Adsorption, Ion Exchange.

- Physical Methods:

  Sedimentation, Screening, Aeration, Filtration, Flotation and skimming, Degasification.

- India produces 10 to 15 million tonnes of Construction & Demolition waste annually.
- The traditional practice in India is to dispose of this waste in landfills.
- Faced with growing environmental concerns and a lack of landfill space, the country's first C&D waste recycling facility has opened. Indian house building industry alone is facing a shortage of aggregates to the extent of 55 billion m^3.

Plant Details

- In collaboration with Municipal Corporation of Delhi (MCD), IL&FS Environmental Infrastructure & Services ltd (IEISL) has developed a pilot project in Delhi.
- The project has proved successful as it serves the dual purpose of saving landfill space on the one hand and also developing the market for C&D recyclables.
- The facility is located in Burari on approximately seven acres of low and marshy land .

Working Process

- A stationary crushing unit has been installed for dry processing of waste.
- A wet processing system known as 'CDE C&D system' is also installed to extract soil from the unprocessed soil and plaster rejects.
- Upon arrival the mixed C&D waste needs to undergo manual segregation to segregate the waste into whole bricks, big concrete pieces and mixed C&D waste.
- All large sized pieces are resized to 200mm to 400mm by both mechanical and manual means.
- The resized particles and the mixed C&D waste are then fed to a hopper which is equipped with a vibrating grizzly feeder.

Project Cost

- The capital investment for this plant has been estimated taking into consideration the latest manufacturing cost and the costs of the equipment and materials.
- IEISL's commitment to the project is $3.32 million out of which $2.21 million has already been spent.
- The capital expenditure incurred by the project is proposed to be recovered over a period of 10 years by deriving value from the processed C&D waste.

Conclusion

- The amount of C&D waste generated in India is tremendous.

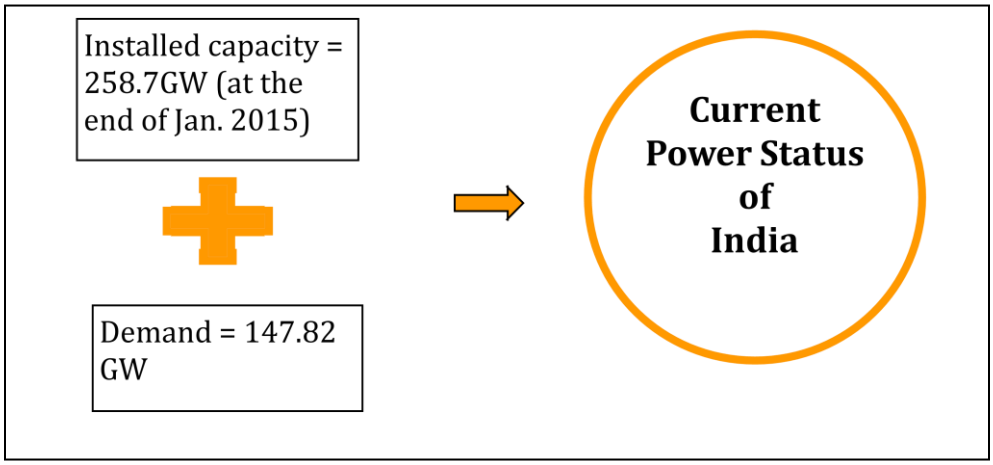
- Recycling this waste would not only lead to reduced pressure on the natural resources but would also lead to mass employment in the waste sector.
- Even though the project is still at an early stage, C&D waste recycling practices are slowly gaining awareness.
- The plant at Burari has proved to be a success. As a consequence, the company is setting up its operations in East Delhi and Gurgaon as well.

INDIA'S FIRST RENEWABLE ENERGY CERTIFICATE (REC)

-Aditi Abhyankar

Future Plans

- India's plans are not limited to building just renewable plants,.
- It also want to have 63 GW of nuclear power capacity by 2032 – an almost 14-fold increase on current levels.
- It currently has 22 nuclear reactors and plans to build 40 more in next two decades.
- India had 115 GW of coal-fired capacity on May 31, 2012 and an additional 87 GW is under construction. Thus, coal will continue to play a crucial role towards the proposed energy sufficiency but the focus will shift to the renewable.



Renewable Energy Certificate

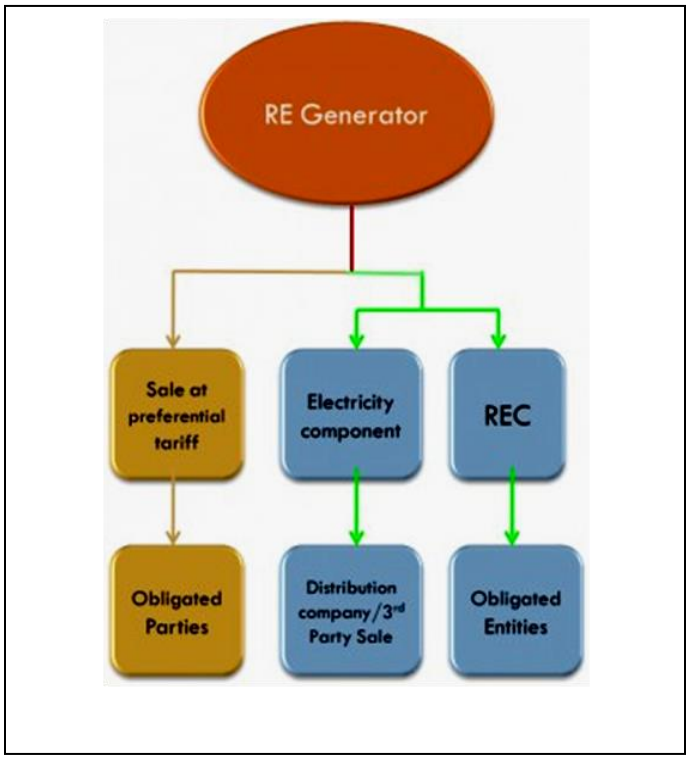
- In 2010, another thrust was given towards market driven mechanism in the form of (REC).
- It was introduced in order to help distribution companies meet their binding obligatory targets (called renewable purchase obligation (RPO)) of having a certain percentage of electricity from renewable sources in their total energy mix.
- The central regulatory agency wants the renewable component to rise progressively from 7% in 2012 to 15% in 2020 (with a sub-category for solar power of 0.25% in 2012, rising to 3% in 2020).

It is expected that this will give the market

- more freedom to choose the most cost-effective way to meet renewable energy targets.

India's First Solar REC

- On April 4, 2012 M&B Switchgear became India's first solar developer to be registered by the National Load Despatch Centre (NLDC) for solar renewable energy certificates (RECs) for its 1.5 MW solar plant.
- It is also planning to raise its capacity to 6MW and put the entire capacity under REC.



What is REC?

- The concept of Renewable Energy Certificate (REC) already exists successfully in Europe, USA and Australia. They are tradable instruments similar to carbon credits.
- The RECs are awarded in electronically (demat) form to those who generate electricity from renewable sources such as wind, biomass, hydro and solar, provided they opt not to sell the

electricity at a preferentially higher feed-in-tariff (FiT). Only grid connected RE technologies are eligible under REC mechanism.

Under the REC Mechanism, renewable energy is separated into two components – the commodity part – electricity – and the trade-able

- "environmental" attribute – REC.
- The REC is valid for 730 days and can be traded at the energy exchanges.
- In India, one REC is created for generation 1 MWh of renewable energy.
- The RECs are divided into two categories: Solar and Non-Solar.
- Solar RECs are issued to eligible entities for generation of electricity based on solar as renewable energy source; and, non-solar RECs are issued to eligible entities for generation of electricity based on renewable energy sources other than solar.

What REC is NOT ?

- The concept of REC must be clearly understood; one should also know what REC is not. For instance
- REC is **NOT** an incentive mechanism— It only enables the sale / purchase of the renewable component across the state boundaries.
- It does **NOT** represent fiscal attributes such as "Accelerated Depreciation"— it should be clearly distinguished from the "Production Tax Credits."
- Although REC represents environmental attribute, it is **NOT** related to carbon credits.

FINITE ELEMENT METHOD

-Pranali Bagal (TE Electrical)

Finite element method is a computerized method for predicting how a product performs to real world forces, vibrations, heat, fluid flow and other physical factors.

For analysis of this forces on product we have to solve mathematical equations along with set of boundary conditions in a particular situation. Finite element method allows entire design to be constructed, refined and optimized of a complex or non-uniform boundary items before the design is manufactured. Here we have done analysis of flux density distribution in an electromagnet and compared the result of FEM output and results by conventional method. We can analyze different parameters in software. FEMM is a finite element software package for solving 2D and axisymmetric problems in low frequency magnetics and electrostatics. Finite element analysis is used in different fields of engineering like mechanical, civil, electrical, etc. The complicated construction analysis can be easily done without wasting time in mathematics work. FEM decreases the time to take product from concept to product

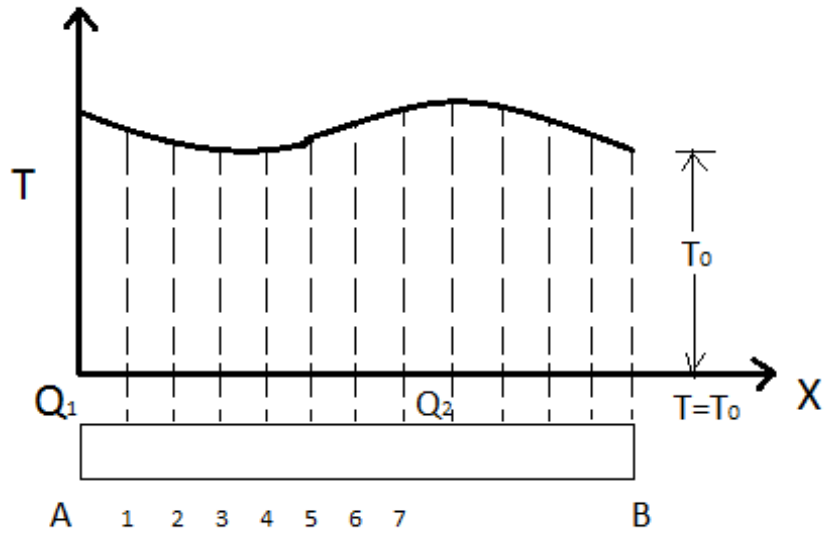
The behavior of engineering systems is governed by various laws of nature such as Newton's law of motion, Fourier law of heat conduction, stokes' law for study of various fluids, Young's law which gives relationship between stress and strain for study of load bearing capability. These laws are rewritten in the form of mathematical governing equations for engineering systems. For analysis of situations like force, heat, fluid flow, vibrations on product we have to solve the mathematical equations along with the set of boundary conditions in a particular situation. Thus we write a mathematical expression defining boundaries and associated constrains. But the movement we encounter more complex i.e. non-uniform boundary conditions, it becomes nearly impossible to write boundary conditions in mathematical form. Also the simplifications like taking constants (e.g. elastic constant, specific heat constant) often lead to illogical results, as constants don't remain constant under certain condition.

For example, in stress analysis problems, if the loads are high, plastic yielding will occur and further this yield point the coefficient of elasticity cannot be treated as constant. However, the FEM attempts to alleviate this situation and has come to boon to analysts who solve problems prevailing not only in manufacturing process analysis, but in many engineering fields wherein such complexities are expected.

The purpose of finite element analysis software is to reduce number of prototypes and experiments that have to be run when designing, optimizing or controlling a device or process.

FINITE ELEMENT METHOD

The basis of FEM is discretization of the object under analysis into a number of elements of finite size. The parameter under consideration (say temperature inthermal analysis) is assumed to vary in a known manner within the element.. -1 provides an explanation and justification for this concept.



Heat flow in a rod discretized into elements

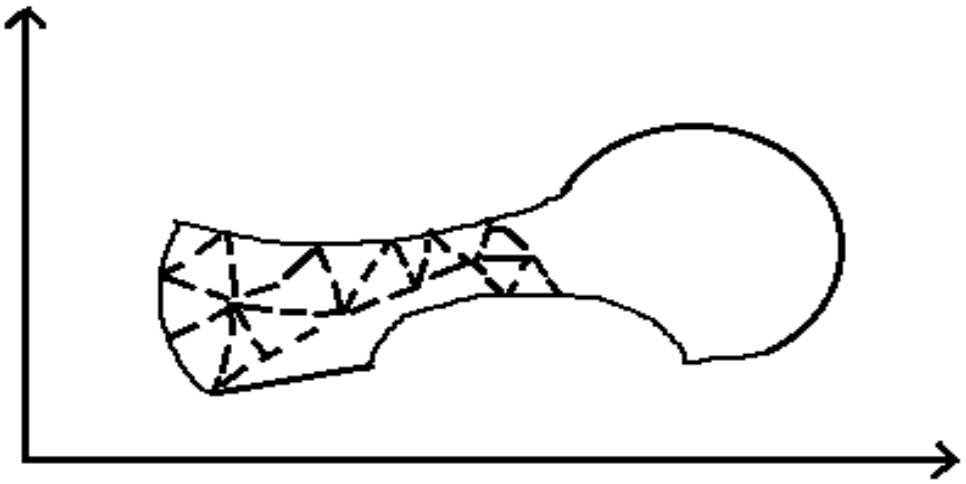
A rod AB is subjected to heating at rates Q1 and Q2 at two different locations as shown in. 1. From. we can see there is non-linear temperature distribution in x-direction. However, the subdivisions of rods into elements as A-1, 1-2, 2-3, 3-4, etc. shows that the temperature distribution in each element is very close to linear variation. Thus the governing equation of heat flow in individual element is satisfied and therefore the solution based on linear variation of temperature will provide solution very close to exact solution. The size of elements need not be equal, but the accuracy of solution will improve, if smaller elements are considered. For element 1-2 the temperature in it can be written in terms of nodal temperature T1 and T2.

2

On using this terms in governing equation, we obtain a simple expression in terms of T1 and T2. Repeating this for all elements gives expression in terms of T1, T2, T3, etc. By solving these expressions simultaneously, we get result in the form of nodal temperature. This procedure can be applied to any type of governing equation, whether in temperature or electromagnetic field analysis, stress analysis, etc. This method makes it easy to incorporate any nature of variation in material properties, as the material properties used in object may vary from element to element. It also becomes easy to subdivide any irregular boundary object into elements.

A 2D case is discretized into 3noded triangular element. This triangular method helps in accuracy of element in complex boundary.

Example is shown in .



Discretization into triangular elements.

Writing the governing equation for all elements separately and subsequent solution of all these equations demand the use of computers.

APPLICATION OF 'FEM' IN ELECTRICAL ENGINEERING

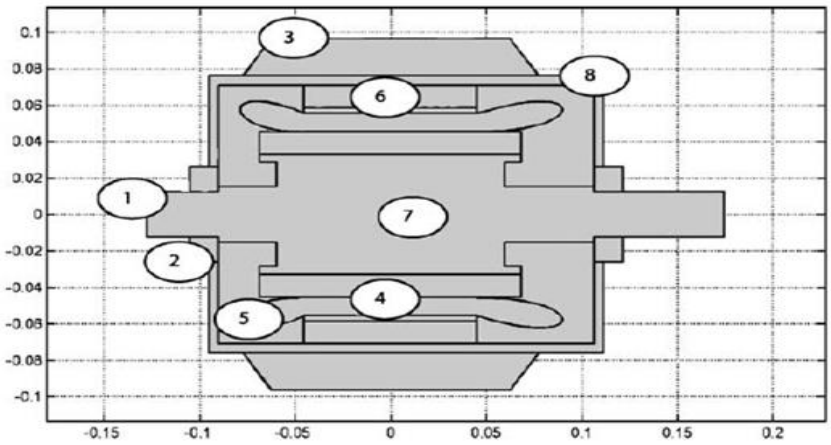
A. ANALYSIS OF TEMPERATURE RISE IN ELECTRIC INDUCTION MOTORS

In developing electric machines in general, and induction motors in particular, temperature limits is a key factor affecting the efficiency of the overall design. Since conventional loading of induction motors is often expensive, the estimation of temperature rise by tools of mathematical modelling and computational experiments becomes increasingly important.

An electric machine is a complex engineering system that consists of different materials with different thermal properties and distributed heat sources. The thermal analysis of electric induction motors can supplement effectively thermal monitoring techniques, contributing substantially to a better understanding of the overall performance and prevention of failures of these electric machines.

Firstly, a mathematical model is developed and for specific operating current temperature is analyzed. So for different current operating conditions temperature is analyzed. For analysis of temperature FEMM software represent these problems by a temperature gradient, G (analogous to field intensity, E for electrostatic problems), and heat flux density F (analogous to electric flux density, D, for electrostatic problems).

The heat flux density must obey Gauss' Law, which says that the heat flux out of any closed volume is equal to the heat generation within the volume.

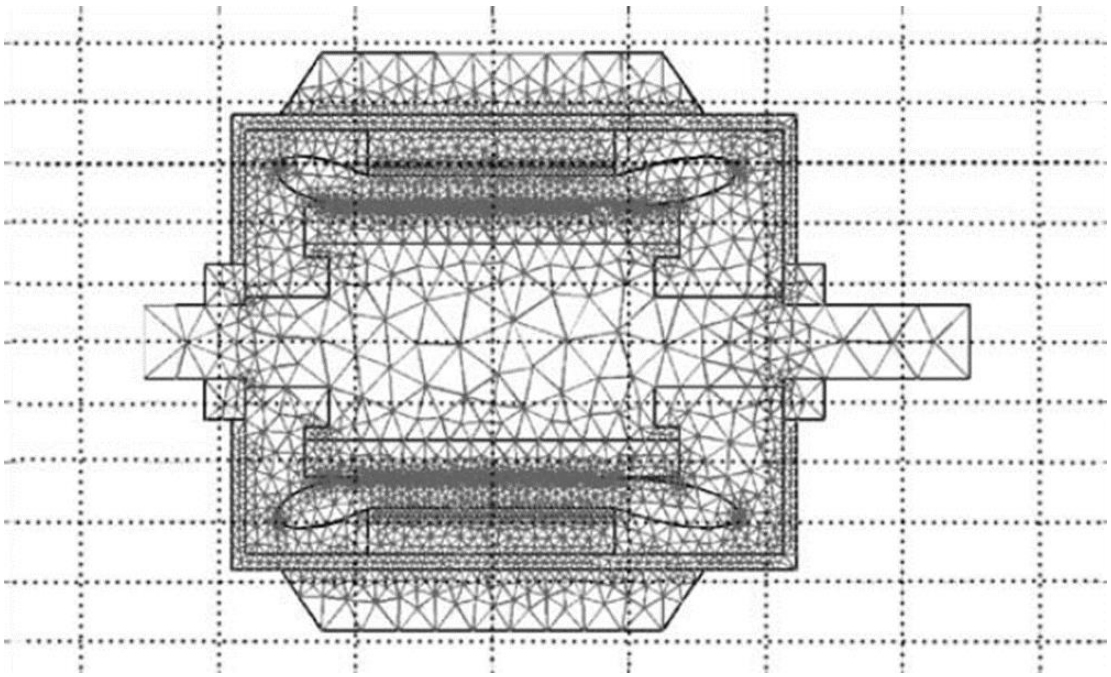


The axial cross-section geometric configuration of the motor (dimensions are given in meters).

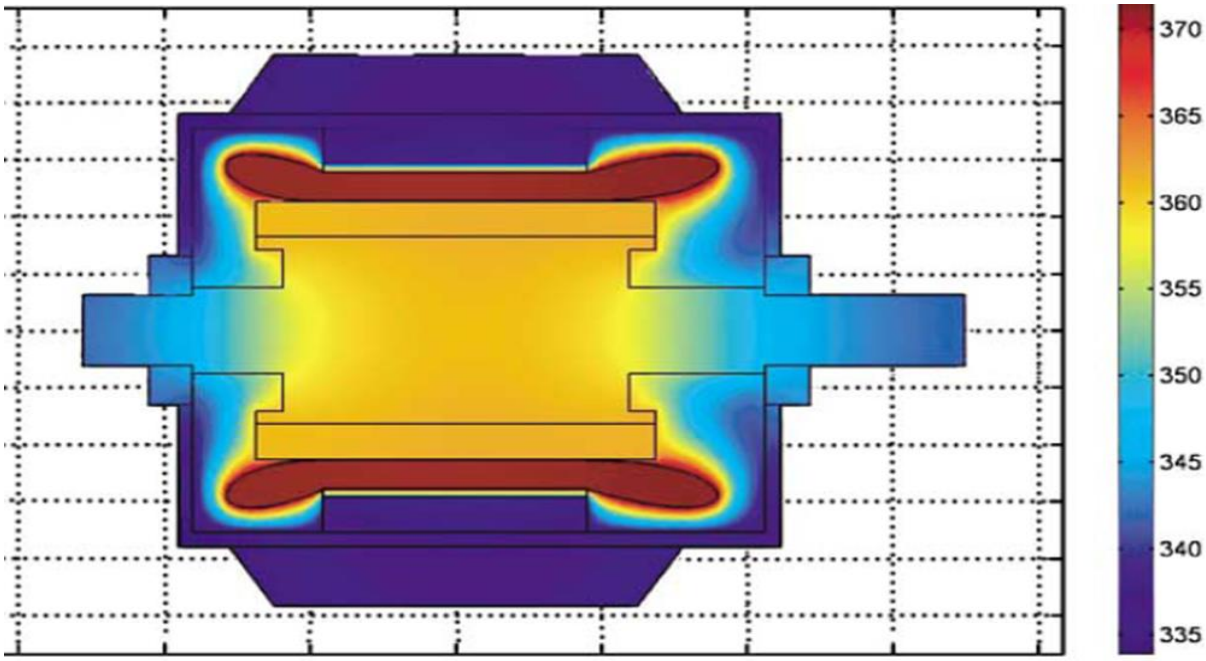
Parts of induction motor:

1) Shaft
2) Bearing
3) Frame
4) Stator coil
5) End winding
6) Stator core
7) Rotor
8) End cap

Design of induction motor



..4.2 Mesh generation

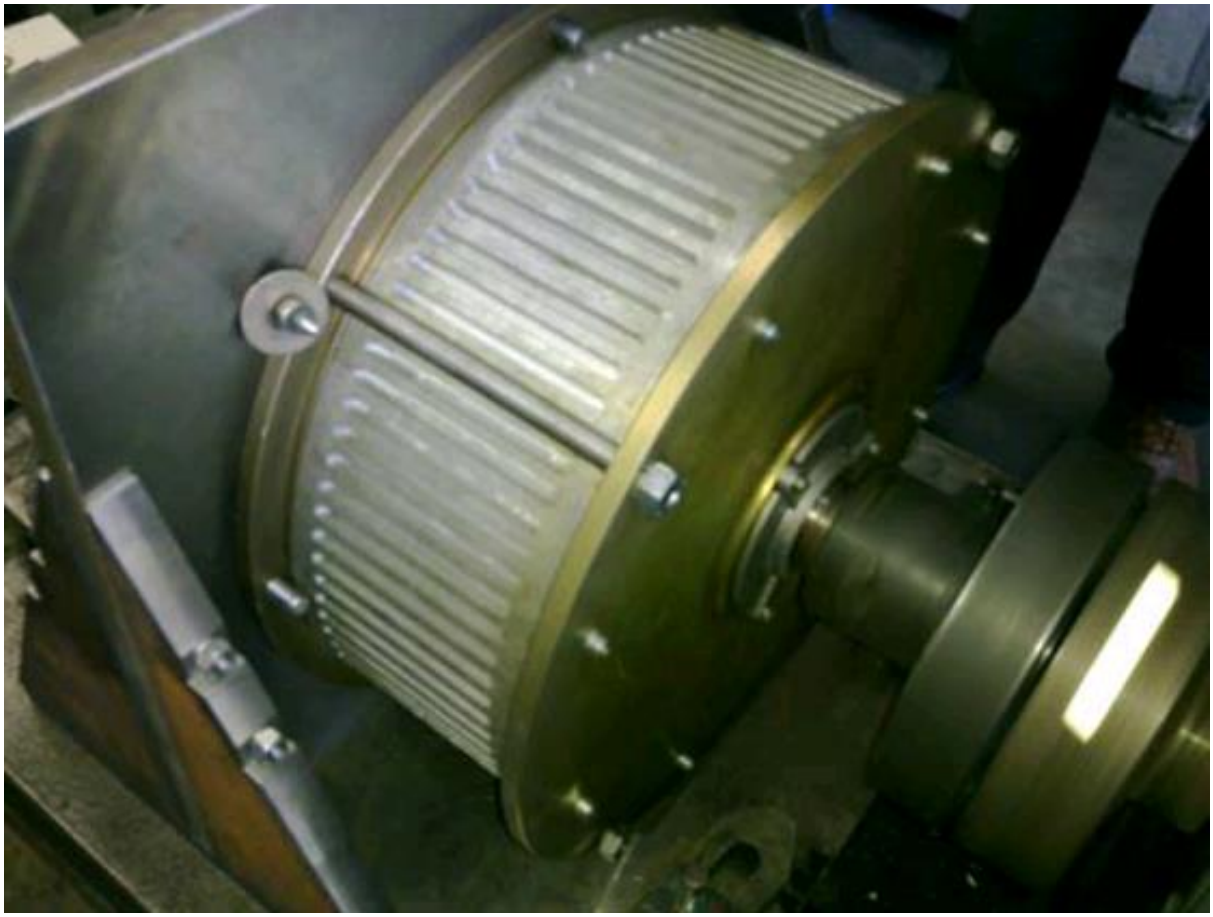


..4.3 Simulation of induction motor

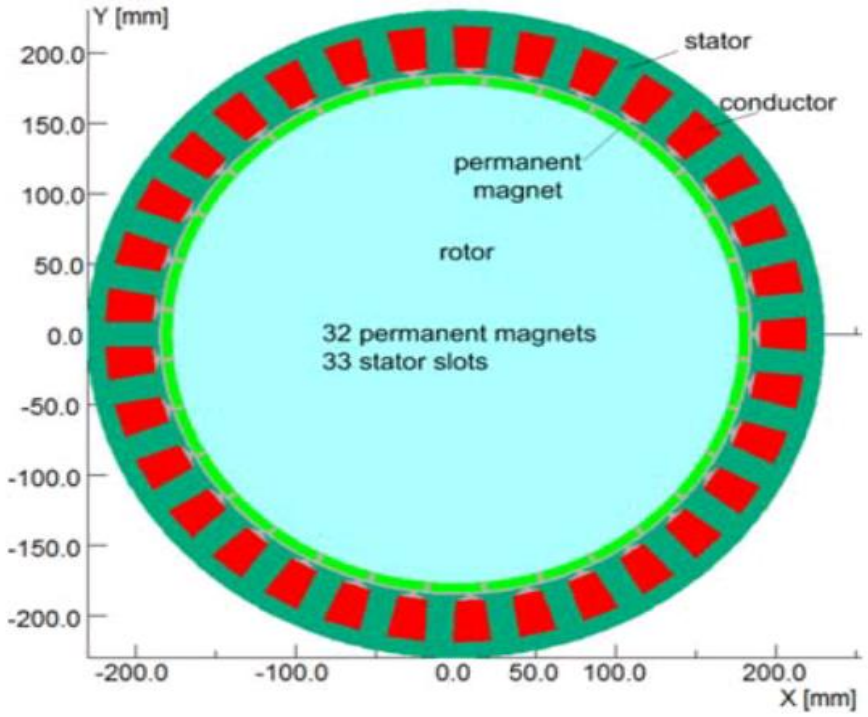
B. PERMANENT MAGNET GENERATORS USED IN WIND APPLICATION

The direct drive PM generators are preferred in the water and wind low speed turbines. Using the numerical analysis by FEM programs during the design process, we can analyze and improve the performance of the PM generator.

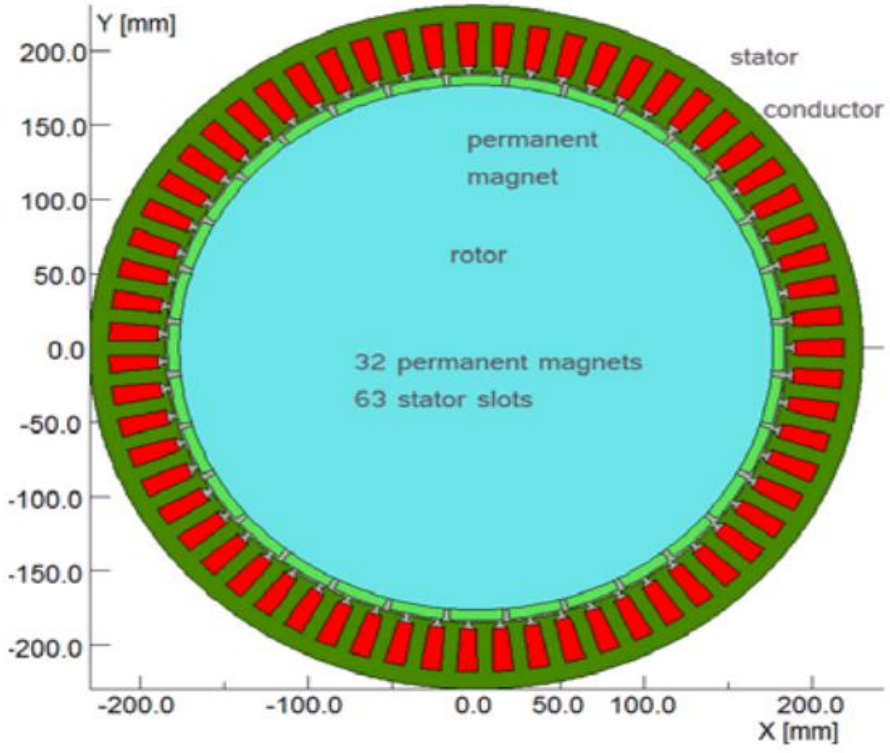
Identification of the possible saturated ferromagnetic are for which a reconsideration design process is necessary; the calculus of the iron losses in the main magnetic circuit or in different adjacent regions. In order to have information about the magnetic field generated by the permanent magnets, a static analysis is performed. The voltage shape of back EMF induced in stator windings can be analyzed.



..4.4 PM Generator.



a)



b)

..4.5 The numerical model for FEM simulation.

Thus FEM provides great advantage for analysis during design process of electrical machines. It avoids some errors that could be encountered and allows optimizing some performances of the machine by some corrections of the design.

FEM SOFTWARE

FEM software packages are developed by universities, individual as well as by industries. There are different software packages that implement the finite element method for solving partial differential equations. They are as follows;

- Agros2D by university of West Bohemia
- FEATFLOW by university of Heidelberg
- FEAP, FEATool, Abaqus, FEMM, COMSOL Multiphysics, etc.

The one we have used for electromagnetics example is FEMM (femm ver4.2) i.e. Finite Element Method Magnetics. FEMM is a finite element package for solving 2D planar and axisymmetric problems in low frequency magnetics and electrostatics.

In this software we can construct model, run analysis and then we can investigate results for different materials, etc. FEMM software includes magnetic problems, Electrostatic problems, Heat flow problems and Current flow problems. FEMM is an open source package written by David Meeker and can be downloaded from http://femm.foster-miller.net.

The 2D model to be analyzed can be designed in a CAD program and imported to FEMM in DXF format. Which we have further used in analysis of induction motor.

The finite Element Method allows to optimize design before manufacturing of the design. Thus it decreases the time to take product from concept to product line. The complicated construction analysis can be easily done, hence considerable time in solving mathematical equation is saved. The purpose of finite element analysis software is to reduce the number of prototypes and experiments that have to be run when designing, optimizing or controlling a device or process. Finite element analysis software reduces number of prototypes and experiments that have to be run when designing, optimizing or controlling a device or process. Thez results by conventional method or by experimentation is approximately equal to the result obtained by finite element method

Power Exchange in Bharat (INDIA)

-Rushikesh Bhosale (TE Electrical)

Electricity is a non-storable commodity, which indicates the electricity generated should be consumed timely. In competitive environment, the price is determined by stochastic supply and demand functions. The price can change at any time. As a consequence of increased volatility, a market participant could make trading contracts with other parties to hedge possible risks and get better returns.

Open access is the key to a free and fair electricity market. Power producers (sellers) and dealers/customers (buyers) have to share a common transmission network for wheeling the power from the point of generation to the point of consumption. Thus, interconnected transmission system is considered to be a natural monopoly so as to avoid the duplicity, the problem of right-of-the-way, huge investment for new infrastructure and to take the advantage of the interconnected network viz. reduced installed capacity, increased system reliability and improved system performance.

After the enactment of Electricity Act in 2003, the concept of Open Access and Power trading were created. Since generation and consumption of Power is not evenly distributed in India, the concept of Power trading enables surplus generation from one Region to flow to another Region which is deficit in Power or within the same Region. Power trading fundamentally means that a transaction where the price of power is negotiable and options exists about whom to trade with and for what quantum. Traditionally, trading licensee has been viewed as seller of electricity who fulfils the needs of the distribution companies by arranging electricity supply at the desired delivery point. Trading licensee can provide customized contracts according to the requirements of the buyers/sellers. Importantly, trading licensee act as risk absorbers between seller and buyer ensuring that generators are paid on time by bringing in their finances in case there is a delay in payment by a buyer. It absorbs both liquidity risks as well as credit.

Trading also facilitates competition among generators by offering various options for buying electricity to buyers. In India, power trading is in an evolving stage and the volumes of exchange are not huge In other words, the suppliers of electricity have little choice about whom to sell the power and the buyers have no choice about whom to purchase their power from

The pricing has primarily been fixed controlled by the Central and State Governments which is now being done by the Regulatory Commissions at the Centre and also in the States wherever they are already functional. Power generation, transmissions are highly capital intensive and the Fixed Charge component makes up a major part of tariff. Further, the geographical spread of India is very large and different parts of the country face different types of climate and different types of load.

The situation indicates enough opportunities for trading of power. This would improve utilization of existing capacities and reduce the average cost of power utilities and consumer . Over and above this, the Scheduled exchange of power will increase and un-scheduled exchange will reduce bringing in grid discipline, a familiar problem.

Power exchange

Power Exchange is a platform on which power is transacted i.e bought and sold.

Power Exchange provides a spot market, mainly day-ahead, for electricity, which like any other market matches demand and supply for each time block, while providing a public price index. It is a neutral platform, which provides the necessary **ELECTRONIC TRADING PLATFORM** and associated infrastructure to facilitate buying and selling of electricity by the participants. Also, it is a competitive bidding platform which enables participants to compete with each other to get the commodity at the best possible price and from all possible avenues for exercising their freedom and choice in terms of the products, the market place and time. Power Exchange in no way influences the price determination process, which is dependent on the offers and bids placed by the market participants i.e., the sellers and buyers. Trading through the Power Exchanges is a non-cooperative game. Both the sellers and the buyers place bids on the electronic platform independent of each other. No negotiation is involved in the process and the identity of the player (buyer or seller) is not known to the other participants.

India has progressed fast in the development of Electricity Market in a short span of four years from an almost no organized market situation prior to 2004 to implementation of Multiple Power Exchanges in 2008. In India, Power Exchange is a private sector initiative under the Regulatory oversight of CERC. The Regulator has adopted an approach of light handed regulation while providing an enabling framework for the development of Power Exchange. The objective was to provide operational freedom to the Power Exchange within a given framework and Regulation would be minimal and restricted to requirements

essential for preventing derailment of the process. Private entrepreneurship was allowed to play its role so as to facilitate provision of value added and quality service to the customers. The Power Exchanges formulate their own Business Rules, Rules and Bye Laws, subject to the approval of CERC.

NEED OF POWER EXCHANGE: In market driven economy market forces are contradictory. Buyer wants low price, seller wants otherwise. These conflicting forces determine the correct price of a commodity at a given time. It is thus important that market forces must remain faceless and anonymous. Facelessness and anonymity creates a level field for all players. Today's power is no more a service, it is a commodity. On an electronic power exchange, buyers and sellers of power from the length and breadth of the country can converge without revealing their identity. For this we need a nationwide Power Exchange to allow the Power Market to be driven by genuine market forces of demand and supply. Along with trans-losses and UI risks, payment uncertainties prevented the true market driven economy in power market.

PLATFORMS FOR POWER EXCHANGES

INDIAN ENERGY EXCHANGE (IEX)

- 27th June 2008
- promoted by Financial Technologies -Multi Commodity Exchange of India Ltd (MCX)

- **Co-Promoters**

    - PTC India Ltd
    - IDFC,
    - Adani Enterprises
    - Reliance Energy

- Lanco Infratech
- Rural Electrification Corporation (REC)
- Tata Power Company

POWER EXCHANGE INDIA LIMITED (PXIL)

- 22nd October 2008.
- Promoted by NSE & National Commodities & Derivatives Exchange Ltd (NCDEX).

  - **Co-Promoters**

    - Power Finance Corporation
    - Gujarat Urja Vikas Nigam
    - JSW Energy
    - GMR Energy
    - Jindal Steel & Power

TRADING ENTITIES

The Electricity act states that no person shall take up trading in Electricity unless he is authorized to do so by appropriate commission. The person 3 includes any company or body corporate or association or body of individuals, whether incorporated or not, artificial juridical person.
The Distribution licensee has been specifically exempted from taking a separate trading license. On the other hand following entities have been excluded from trading in electricity –

1) National Load Dispatch Centre
2) Regional Load Dispatch Centre
3) State Load Dispatch Centre
4) State Transmission Utility
5) Central Transmission Utility

6) A Transmission Licensee

National Load Despatch Centre (NLDC)

- Supervision Over the Regional Load Despatch Centres.
- Scheduling and dispatch of electricity over the inter-regional links in accordance with grid standards specified by the authority and grid code specified by Central Commission in coordination with Regional Load Despatch Centres.
- Coordination with Regional Load Despatch Centres for achieving maximum economy and efficiency in the operation of National Grid.
- Monitoring of operations and grid security of the National Grid.
- Supervision and control over the inter-regional links as may be required for ensuring stability of the power system under its control.
- Coordination with Regional Power Committees for regional outage schedule in the national perspective to ensure optimal utilization of power resources.
- Coordination with Regional Load Despatch Centres for the energy accounting of inter-regional exchange of power.
- Coordination for restoration of synchronous operation of national grid with Regional Load Despatch Centres.
- Coordination for trans-national exchange of power.
- Providing Operational feedback for national grid planning to the Authority and Central Transmission Utility.
- Levy and collection of such fee and charges from the generating companies or licensees involved in the power system, as may be specified by the Central Commission.
- Dissemination of information relating to operations of transmission system in accordance with directions or regulations issued by Central Government from time to time.

Regional Load Despatch Centre (RLDC)

- To ensure the integrated operation of the power system in their Region.
- Monitoring of system parameters and system security.
- Daily scheduling and operational planning.
- Facilitating bilateral and inter-regional exchanges of power.
- Analysis of tripping/disturbances and facilitating immediate remedial measures.

- System studies, planning and contingency analysis.
- Augmentation of telemetry, computing and communication facilities.
- Computation of energy despatch and drawl values using SEMs.

State Load Despatch Centre (SLDC)

- To ensure integrated operation of the power system.
- To give directions and exercise supervision and control which is required for integrated operation to achieve maximum economy and efficiency in power system operation.
- Scheduling and Re-Scheduling of available resources for optimum and economic operation of the power system.
- To coordinate shutdowns for the Generating Units and Sub-station equipment, including transmission lines taking into consideration continuity of supply.
- System Restoration in a systematic manner in shortest possible duration, following Grid Disturbances.
- Accounting of Energy handled by the State System.
- Compiling & Furnishing data pertaining to Power System Operation.

State Transmission Utility (STC)

- To undertake transmission of electricity through intra-State transmission system.
- To discharge all functions of planning and co-ordination relating to intra-state transmission system with -
    i. Central Transmission Utility;
    ii. State Governments;
    iii. Generating companies;
    iv. Regional Power Committees;
    v. Authority
    vi. Licensees;
    vii. Any other person notified by the State Government in this behalf
- To ensure development of an efficient, co-ordinated and economical system of intra-State transmission lines for smooth flow of electricity from a generating station to the load centres;
- To provide non-discriminatory open access to its transmission system for use by-

1. Any licensee or generating company on payment of the transmission charges or
2. Any consumer as and when such open access is provided by the State Commission under sub-section (2) of section 42, on payment of the transmission charges and a surcharge thereon, as may be specified by the State Commission

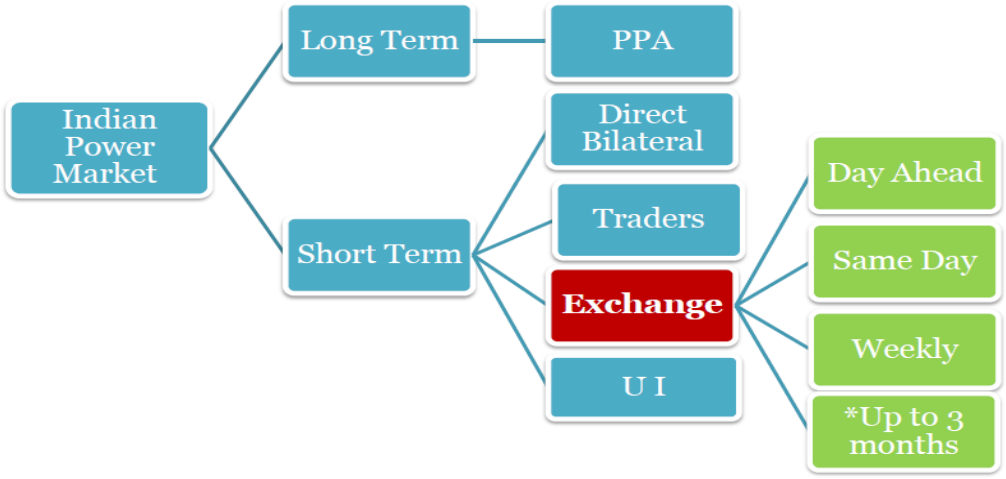
- Provided that such surcharge shall be utilised for the purpose of meeting the requirement of current level cross-subsidy:
- Provided further that such surcharge and cross subsidies shall be progressively reduced and eliminated in the manner as may be specified by the State Commission:
- Provided also that such surcharge may be levied till such time the cross subsidies are not eliminated:
- Provided also that the manner of payment and utilisation of the surcharge shall be specified by the State Commission.
- Provided also that such surcharge shall not be leviable in case open access is provided to a person who has established a captive generating plant for carrying the electricity to the destination of his own use.

Central Transmission Utility (CTU)

- To undertake transmission of electricity through inter-State transmission system
- To discharge all functions of planning and co-ordination relating to inter-state transmission system with -
- State Transmission Utilities;
- Central Government;
- State Governments;
- Generating companies;
- Regional Power Committees;
- Authority;

- Licensees;
- Any other person notified by the Central Government in this behalf;
- To ensure development of an efficient, co-ordinated and economical system of inter-State transmission lines for smooth flow of electricity from generating stations to the load centres;
- To provide non-discriminatory open access to its transmission system for use by
- Any licensee or generating company on payment of the transmission charges or any consumer as and when such open access is provided by the State Commission under sub-section (2) of section 42, on payment of the transmission charges and a surcharge thereon, as may be specified by the Central Commission.
- Provided that such surcharge shall be utilised for the purpose of meeting the requirement of current level cross-subsidy.
- Provided further that such surcharge and cross subsidies shall be progressively reduced and eliminated in the manner as may be specified by the Central Commission.
- Provided also that such surcharge may be levied till such time the cross subsidies are not eliminated.
- Provided also that the manner of payment and utilisation of the surcharge shall be specified by the Central Commission.
- Provided also that such surcharge shall not be leviable in case open access is provided to a person who has established a captive generating plant for carrying the electricity to the destination of his own use.

INDIAN POWER MARKET DESIGN



Indian Power Market Design

WORKING OF IEX

Bidding

Working of IEX

BIDDING AND ITS CLASSIFICATION

BID

Bid is an offer made by an investor, a trader or a dealer to buy a security, commodity or currency.

BID PRICE

The bid price represents the maximum price that a buyer or buyers are willing to pay for security.

ASK PRICE

The Ask price represents the minimum price that a seller or sellers are willing to receive for security.

1. SINGLE BID

- Price – Quantity pairs, one for each hour

2.BLOCK BID

- A Block bid is all or none type of a bid i.e. bid will get accepted by the system only if price and volume condition is getting satisfied.
- Can cause unpredictable movements of prices and volumes

  Sale Bid – Quantum and Minimum price

  Buy Bid – Quantum and Maximum price

PRODUCT OF INDIAN ENERGY EXCHANGES

DAY AHEAD MARKET

The Day-Ahead-Market (DAM) is the electricity trading market for delivery on the following day. The prices and quantum of electricity to be transacted is determined through a double-sided closed auction bidding process.

FEATURES OF DAM

- 15 minute time block wise bidding for next day
- Trading is on all days irrespective of holiday
- Order entry / revision /cancelation can be done on D-1 (a day before delivery) from 10:00 hrs to 12:00 hrs related to Delivery Day (D day)

CONTRACT FEATURES

- Area Clearance Price (ACP) is used for settlement of the contracts.
- Cleared Volume
- Total Contract Value: Cleared Volume multiplied by ACP
- Final settlement adjusted for any force majeure deviations

FEATURES OF THE ORDER PLACED THROUGH DAM

- Minimum volume step: 0.1 MW
- Minimum price step: Rs 1 per MWh (0.1p/kWh)

TERM AHEAD MARKET

`Term-ahead market (TAM) includes products allowing participants to transact for delivery of electricity for duration up to 1 week. It enables participants to purchase electricity for same day through intra-day contracts, for next day through day-ahead contingency, on daily basis for rolling seven days and on weekly basis to manage their electricity portfolios for different durations in a better way.

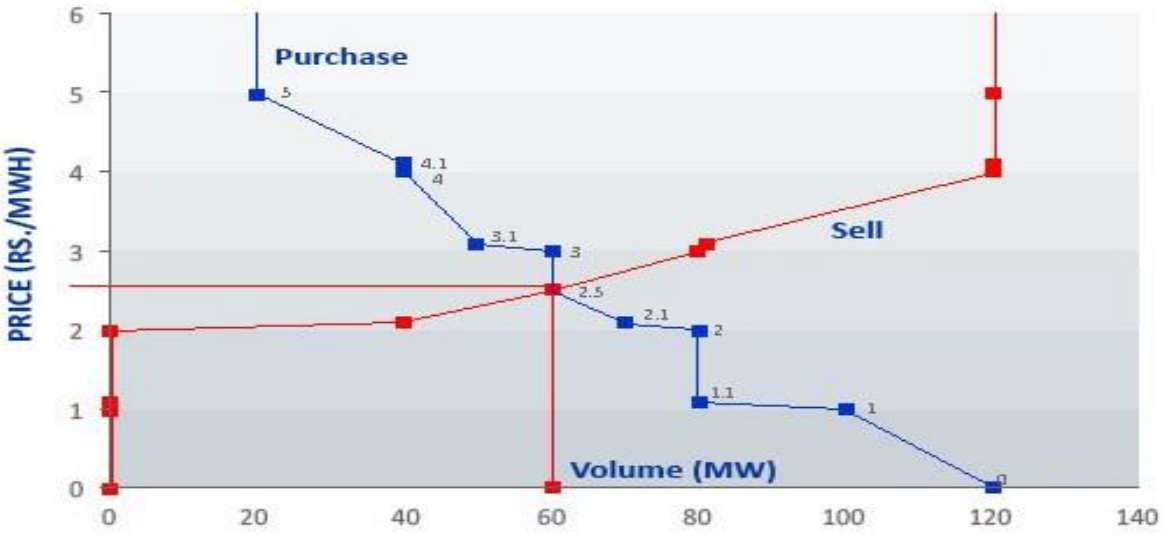
Contract	Trading	Matching
Intra-day Contracts	Trading on delivery day few hours before delivery.	Continuous trading session.
Day-ahead Contingency Contracts	Trading to a day before delivery and after DAM auction.	
Daily Contracts	Trading up to 1 Week in advance for any calendar day.	
Weekly Contracts	Trading up to 11 days in advance.	Open Uniform Price Auction

Working of IEX

MARKET CLEARING PRICE

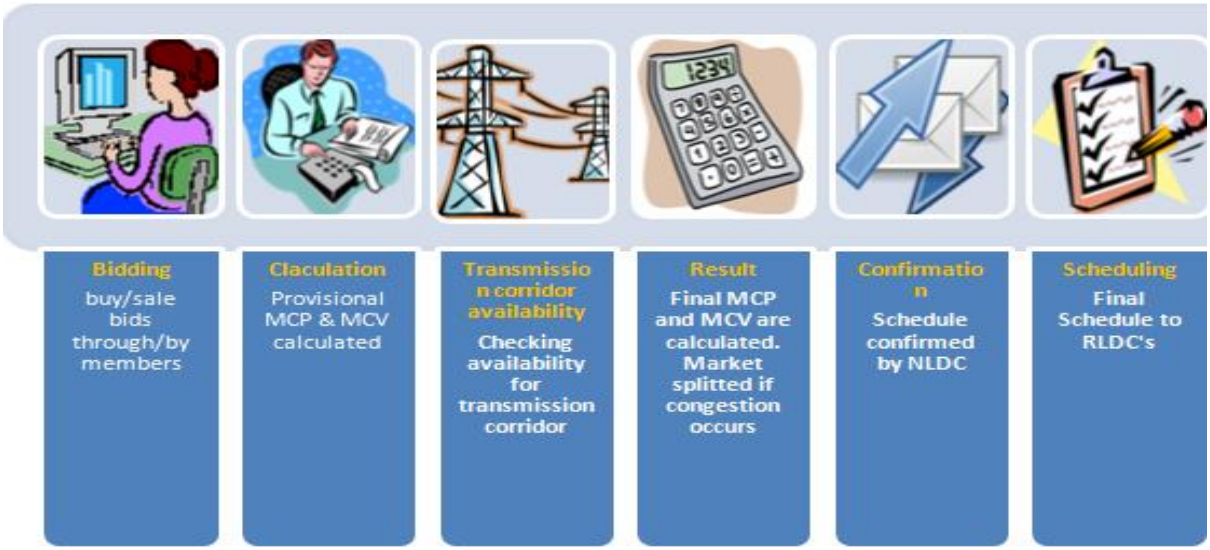
1.A market-clearing price is the price of a good or service at which quantity supplied is equal to quantity demanded, also called the equilibriumprice.

2.Quantity demanded is equal to quantity supplied

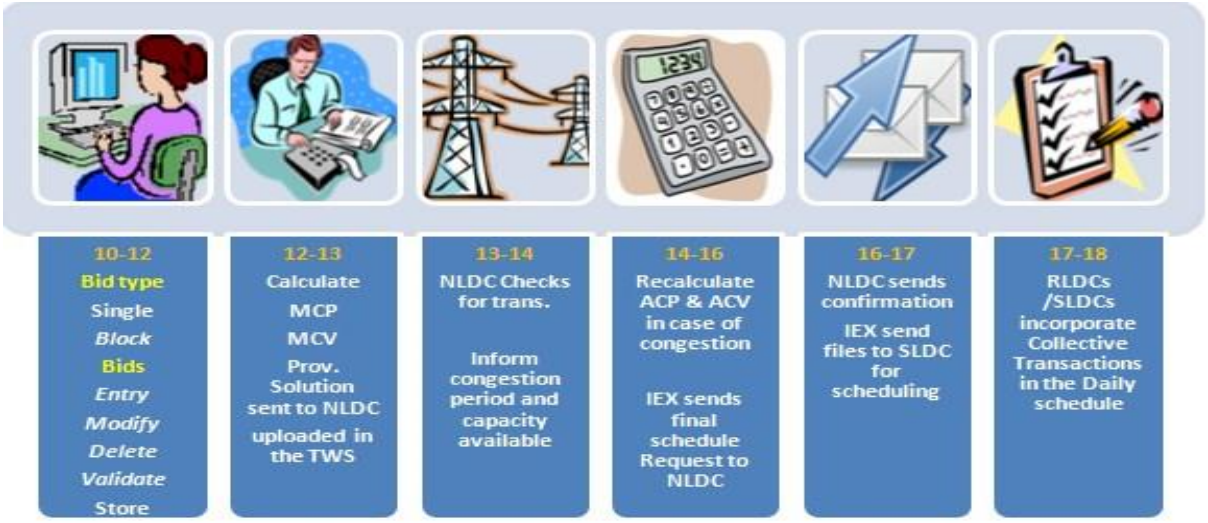


MARKET CLEARING PRICE GRAPH

SCHEDULE AND TIMELINE



SCHEDULE OF IEX



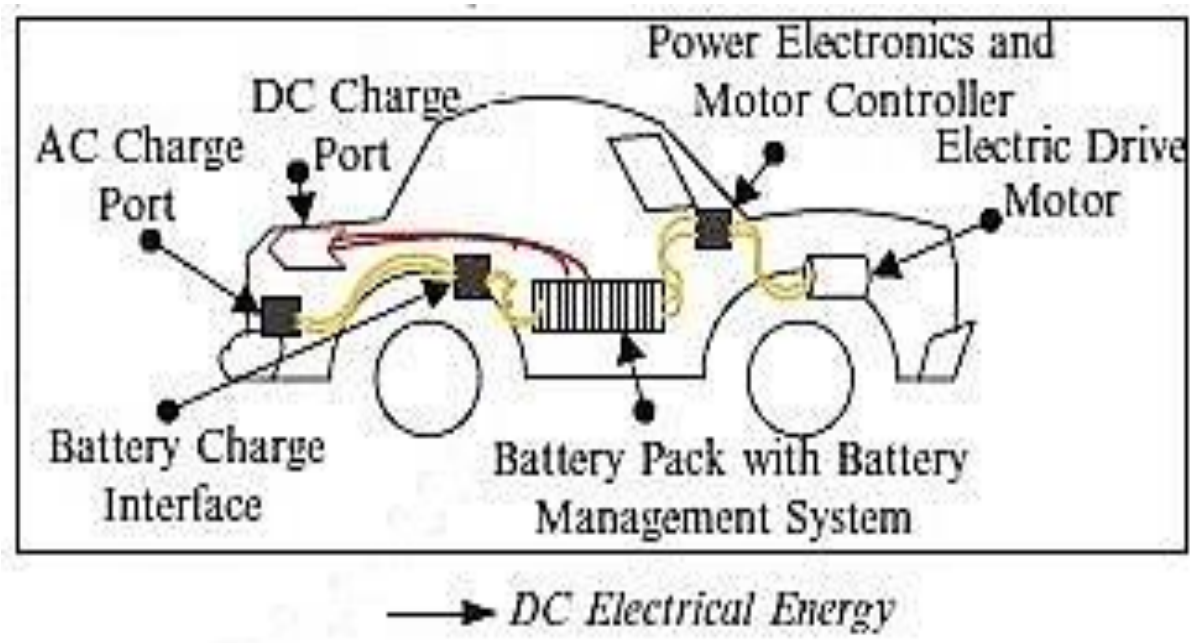
TIMELINE OF IEX

New management philosophy and principles are required for real-time operation, maintenance, and up gradation of National electricity Market. The Consultation process for the above is inprogress and it is expected that by mid 2004 the final regulations forthe same will be out. This will bring in more clarity in the market and probably increase the number of Market player consequently deepening the Electricity Market. Traditionally there have been many impediments to trading in the Electricity market of India such as Demand-Supply Imbalance. Power Grid Underdeveloped; Lack of Open Access. Single Buyer Model And Bankrupt Utilities. The electricity Act 2003 has envisioned amelioration of these difficulties by Deli censing Generation.Increased investment in Transmission And creation of National grid; Surplus Capacity through increased investment by Independent Power
Producers and Multiple Buyer Model.

COMPARATIVE STUDIES OF BATTERIES USED FOR ELECTRIC VEHICLES

Ashish Kumar Singh (TE Electrical)

Electric vehicles are powered by electricity stored in large batteries within the vehicles. These batteries are used to power an electric motor, which drives the vehicle to operate with zero emissions at their point of use. Thus helps in creating a pollution free smart society. To lead this idea there is a needy revolution to create a fast charging and large storage battery with compact size. Although BEVs produce zero emissions at point of use, the source of the electricity must be taken into account when considering the wider scale environmental benefits; if renewable energy is used then electric cars can offer a much reduced environmental impact over other vehicle technologies.



Electric Vehicle

ADVANTAGES

- Zero Emission At Point Of Use.
- Torque And Smooth Response to Urban Driving.
- Suited For Urban Drive.
- Cheap To Run.
- Quieter Operation.

DISADVANTAGES

- High capital cost.
- Generally small in size.
- Limited range.
- Limited speed.
- Slow discharge rate & limited dedicated quick recharge facilities.
- Emissions can easily be transferred to production sources.

PERFORMANCE CURVE & POWER CONSUMPTION

Studied on the dynamic system of pure electric vehicles based on dynamic performance and parameters of driving motor and power battery were determined by calculation combined with the vehicle simulation in LABVIEW.

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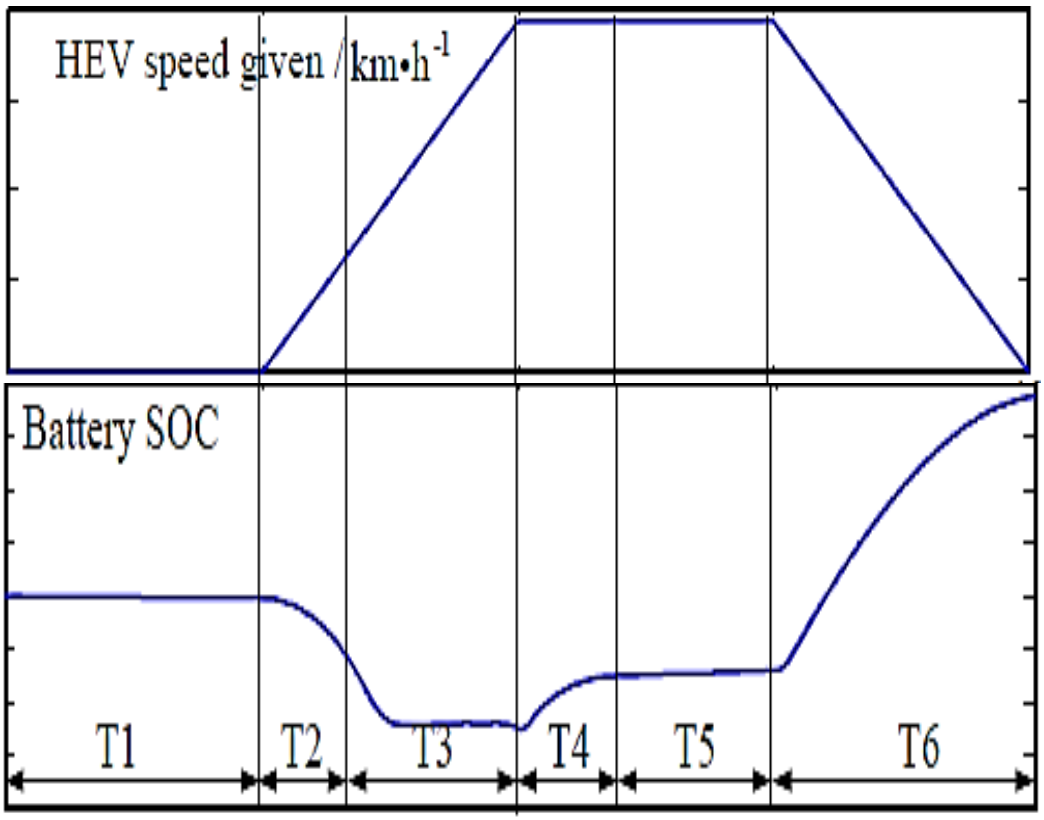
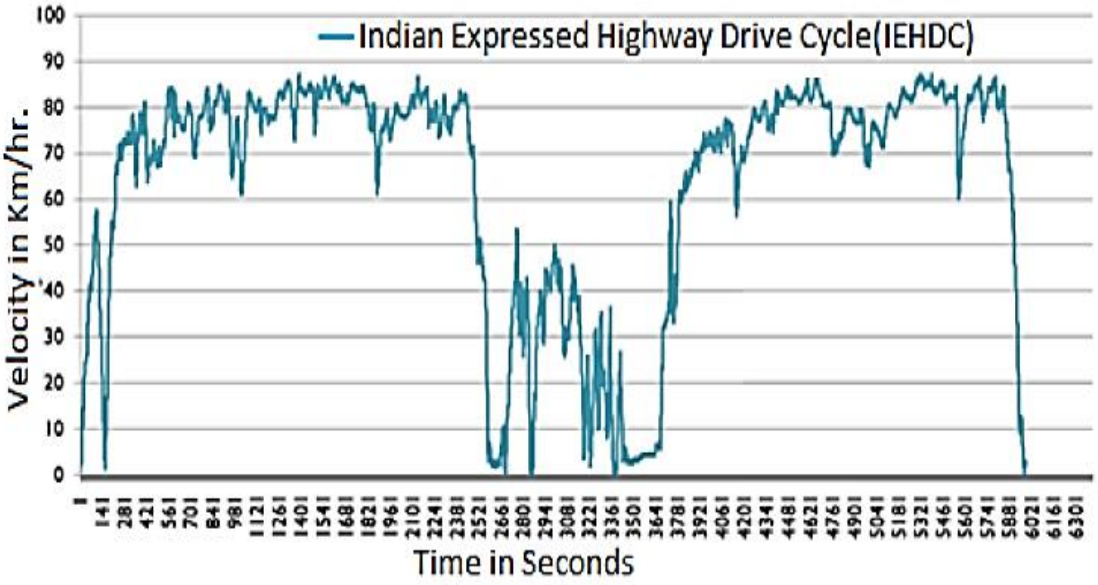


T1 -Idle speed (0kmph)T2 + T3 - acceleration

T4 + T5 -Idle speed (max. speed)T6 - Retardation/braking

IDEAL PERFORMANCE CURVE AND BATTERY STATE OF CHARGE VARIATION FOR EV



HIGHWAY DRIVE CYCLE (IEHDC) OF HEV

CONVENTIONAL BATTERIES USED FOR EV

- **LEAD ACID**
- **NICKEL CADMIUM**
- **NICKEL METAL HYDRIDE**
- **LITHIUM –ION**
- **LITHIUM POLYMER**

LEAD ACID(Pb-acid) BATTERY

ADVANTAGES

- Inexpensive and simple tomanufacture
- Mature, reliable and well-understood technology.
- Low self-discharge
- Low maintenance requirements.
- Capable of high discharge rate.

DISADVANTAGES

- Cannot be stored in discharged condition.
- Low energy density
- Allows only a limitet number of full discharge cycles
- Environmentally unfriendly.
- Transportation restrictions on flooded lead acid (chance of spillage in case of an accident.)
- Thermal runaway can occur with Impropercharging.

NICKEL CADMIUM(Ni-Cd) BATTERY

Nickel Cadmium give the longest cycle life of any currently available battery (over 1,500 cycles) buthas low energy density compared to some other battery types. It has a toxic content as Cadmium (a hazard to
both humans and animals) .

ADVANTAGES

- Fast and simple charge.
- High number of charge/discharge.
- Good load performance temperatures.
- Long shelf life.
- Simple storage and Transportation.
- Good low temperature performance.
- Forgiving if abused (one of the most rugged rechargeable batteries).
- Economically priced
- Available in a wide range of sizes and performance options (Cylindrical).

DISADVANTAGES

- Relatively low energy density
- Memory effect (must periodically be exercised to prevent memory).
- Environmentally unfriendly
- Relatively high self-discharge

NICKEL METAL HYDRIDE(Ni-Mh) BATTERY

The Nickel Metal Hydride battery is most economical for larger power application. It is similar to a NiCd battery in design, except cadmium is replaced making it less detrimental to the environment. NiMH batteries can also have 2-3 times the capacity of an equivalent size NiCd, with much less significant memory effect. Compared to li-ion batteries, energy capacity is lower and self-discharge is higher.

ADVANTAGES

- 30 – 40 % higher capacity over a standard NiCd.
- Less prone to memory than the NiCd.
- Simple storage and transportation
- Environmentally friendly

DISADVANTAGES

- Limited service life (at high load currents, the performance starts to deteriorate after 200 - 300 cycles).
- Limited discharge current.
- More complex charge algorithm needed (generates more heat during charge and requires alonger charge time thantheNiCd).
- High self-discharge.
- Performance degrades if stored at elevated temperature.
- High maintenance(to prevent crystalline formation).

LITHIUM ION (Li-ion) battery

It is the fastest growing battery system and has higher energy density and light weight which is of prime importance. This technology is fragile and a protection ckt is requied to assure safety. The technology currently has widespread use in consumer electronics (e.g. mobile phones) but has only recently begun to be used in transport applications.

ADVANTAGES

- High energy density
- Relatively low self-discharge
- Low Maintenance
- No memory effect

DISADVANTAGES

- Requires protection circuit.
- Subject to aging, even if not in use(storing the battery in a cool place and at 40 % SOCreduces the aging effect).
- Moderate discharge current.
- Subject to transportation regulations (shipment of largerquantities of Li-ion batteries may be subject to regulatory control.)
- Expensive to manufacture
- Not fully mature

LITHIUM POLYMER (Li-PO) battery

This is a similar technology to Li-ion, but typically has slightly lower charge density, greater life cycle degradation rate and an ultra-slim design (as little as 1mm thick). Disadvantages include the high instability of overcharged batteries and if the battery discharges below a certain voltage it may never be able to hold a charge again.

ADVANTAGES

- Very low profile (resemble to the profile of a credit card)
- Flexible form factor (manufacturers are notbound by standardcellformats).
- Light weight
- Improved safety (more resistant to overcharge;
- less chance for electrolyte leakage)

DISADVANTAGES

- Lower energy density compared to Li-ion
- Decreased cycle count compared to Li-ion
- Expensive to manufacture.

RECENT TRENDS

ZEBRA(Na-$NiCl_2$)

Zeolite Battery Research Africa Project

It belongs to the class of molten salt batteries.These use molten salts as an electrolyte, offering both a higher energy density, as well as a higher power density making rechargeable molten salt batteries a promising technology for powering electric vehicles. However, the normal operating temperature range is 270–350^{0}C, which placesmore stringent requirements on the rest of the battery components and can bring problems of thermal management and safety.

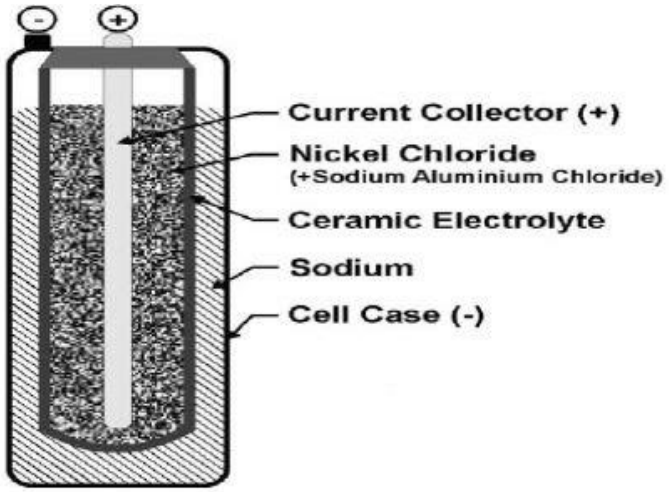


Fig.4.1- ZEBRA cell

REACTION:-

$$Ni\ (s) + 2NaCl(aq) \underset{\text{Charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} Na(s) + NiCl_2\ (aq)$$

CHARACTERISTICS:-

SPECIFIC ENERGY(Wh/kg)	125
ENERGY PER VOLUME (Wh/L)	300
POWER wrt weight	-may vary-
No. of cycles (1 battery pack)	1000
Energy efficiency	92.5%
Self-discharge(in 24 hrs)	nil
Losses due to heat	7.2%

Advantages:

- High energy density (5x Lead acid)
- High efficiency.
- Quick response
- Life (>10-15 years)
- Cycles(>1000 depending on application)
- Low capital and social cost.
- Tolerant to short circuits

Shortcomings

- Suitable for large capacity batteries only(> 20KWh).
- Limited range of available sizes and capacities.
- Only one factory in the world produces these batteries.
- Molten sodium electrode.
- High operating temperature.
- Preheating needed to get battery up to the 270°C operating temperature. (Up to 24 hours from cold)
- Uses 14% of its own capacity per day to maintain temperature when not in use.
- Thermal management needed.

SUPERCAPACITORS /ULTRACAPACITOR

Electric Double-Layer Capacitor

It is a high-capacity Electrochemical capacitor with capacitance values much higher than other capacitors (but lower voltage limits) that bridge the gap between electrolytic capacitors and rechargeable batteries. They typically store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerate many more charge and discharge cycles than rechargeable batteries. They are however 10 times larger than conventional batteries for a given charge.

CHARACTERISTICS:-

SPECIFIC ENERGY(Wh/kg)	4-9
SPECIFIC ENERGY(Wh/kg)	3-10
CAPACITANCE RANGE	100-12000F
CHARGE- DISCHARGE CYCLE	10^5 -10^6
Energy efficiency	95%
LIFE	5-10 years
SELF DISCHARGE AT ROOM TEMPERATURE	Middle(weeks)
TEMPERATURE RANGE(ºC)	-20 to 70
COST PER KWh	$10000(typical)

Advantages:

- Virtually unlimited cycle life.
- High specific power.
- Charges in seconds
- Simple charging(draws only what needed)

- Safe – forgiving if abused.
- Excellent low temperature charge and discharge performance.

Shortcomings

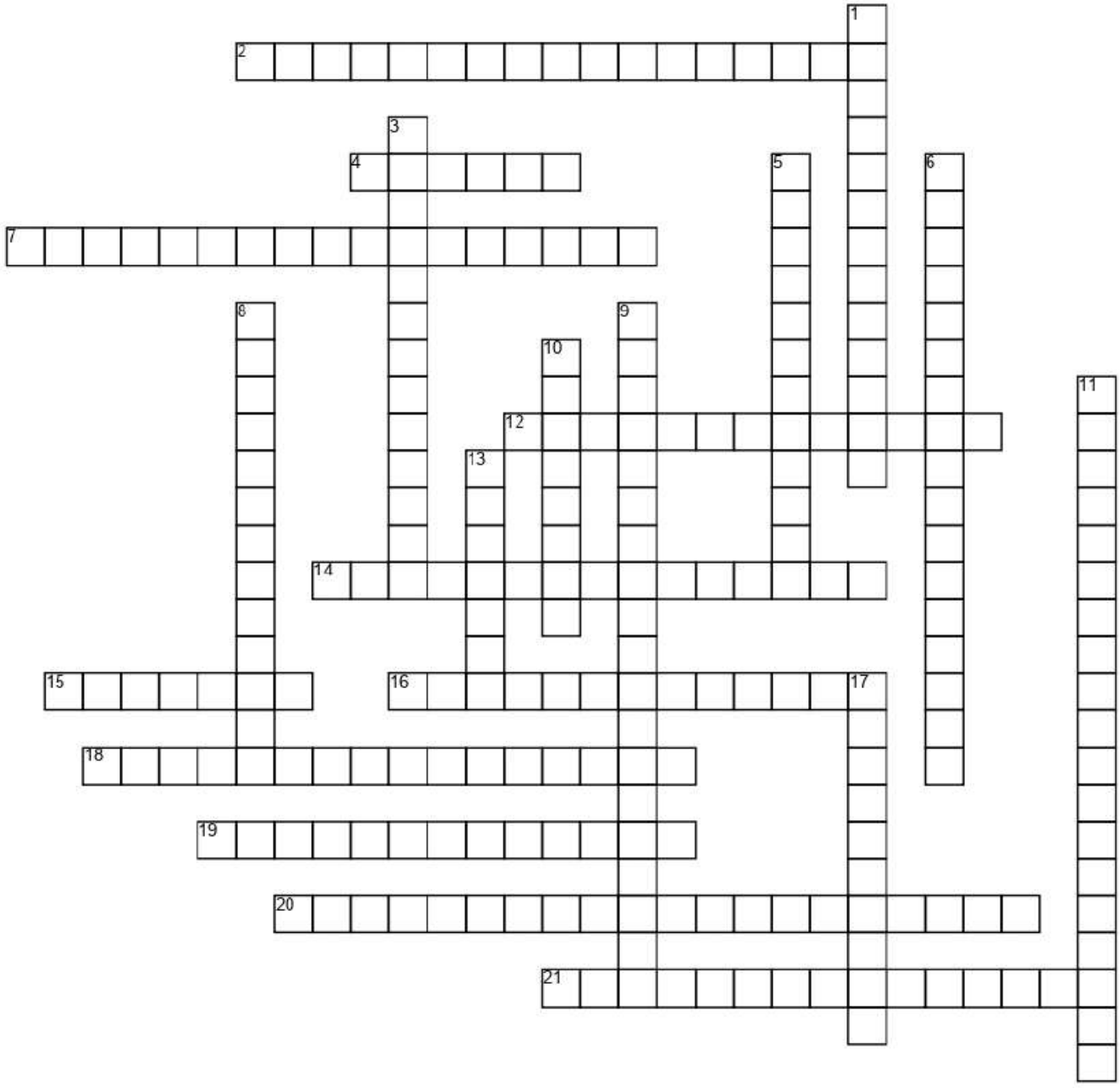
- Low specific energy
- Linear discharge voltage
- High self-discharge.
- Low cell voltage
- High cost per watt.

ELECTRICAL VEHICLES AND ITS SPECIFICATION

MODEL	BATTERY	CHARGE TIMES
Toyota Prius PHEV	4.4kWh Li-ion, 18km (11 miles) all-electric range	3h at 115VAC 15A; 1.5h at 230VAC 15A
Chevy Volt PHEV	16kWh, Li-manganese/NMC, liquid cooled, 181kg (400 lb), all electric range 64km (40 miles)	10h at 115VAC, 15A; 4h at 230VAC, 15A
Mitsubishi iMiEV	16kWh; 88 cells, 4-cell modules; Li-ion; 109Wh/kg; 330V, range 128km (80 miles)	13h at 115VAC 15A; 7h at 230VAC 15A
Smart Fortwo ED	16.5kWh; 18650 Li-ion, driving range 136km (85 miles)	8h at 115VAC, 15A; 3.5h at 230VAC, 15A
BMW i3 Curb 1,200kg (2,645 lb)	22kWh (18.8kWh usable), LMO/NMC, large 60A prismatic cells, battery weighs 204kg (450 lb) driving range of 130–160km (80–100 miles)	~4h at 230VAC, 30A; 50kW Supercharger; 80% in 30 min
Nissan Leaf*	30kWh; Li-manganese, 192 cells; air cooled; 272kg (600 lb), driving range up to 250km (156 miles)	8h at 230VAC, 15A; 4h at 230VAC, 30A
Tesla S* Curb 2,100kg (4,630 lb)	70 and 90kWh, 18650 NCA cells of 3.4Ah; liquid cooled; 90kWh pack has 7,616 cells; battery weighs 540kg (1,200 lb); S 85 has up to 424km range (265 mi)	9h with 10kW charger; 120kW Supercharger, 80% charge in 30 min

Electric vehicle (EV) is a very promising technology for reducing the environmental impacts of road transportation sector. Energy storage system is a pivotal component of PEVs. Comparative study of conventional batteries and along with the recent trends(zebra and supercapacitors) has been a part of the presented study which will help us in creating a pollution free smart society.

Electricity and Magnetism



Across

2. the release and transmission of electricity in an applied electric field through a medium such as a gas

4. a piece of iron (or an ore, alloy, or other material) that has its component atoms so ordered that the material exhibits properties of magnetism, such as attracting other iron-containing objects or aligning itself in an external magnetic field.

7. a device that converts mechanical energy to electrical energy for use in an external circuit.

12. a region around a charged particle or object within which a force would be exerted on other charged particles or objects

14. a flow of electric charge. In electric circuits this charge is often carried by moving electrons in a wire

15. a discrete region of magnetism in ferromagnetic material.

16. an electrical machine that converts electrical energy into mechanical energy

18. the interaction of electric currents or fields and magnetic fields.

Down

1. having only one path for electrons to flow

3. attraction or repulsion that arises between electrically charged particles because of their motion

5. each of the two points or regions of an artificial or natural magnet to and from which the lines of magnetic force are directed.

6. a stationary electric charge, typically produced by friction, that causes sparks or crackling or the attraction of dust or hair.

8. a soft metal core made into a magnet by the passage of electric current through a coil surrounding it.

9. used to protect us from the dangerous effects of electricity flowing through conductors. Sometimes the voltage in an electrical circuit can be quite high and dangerous.

10. a cylindrical coil of wire acting as a magnet when carrying electric current.

11. a substance in which electrical charge carriers, usually electrons, move easily from atom to atom with the application of voltage.

19. a region around a magnetic material or a moving electric charge within which the force of magnetism acts.

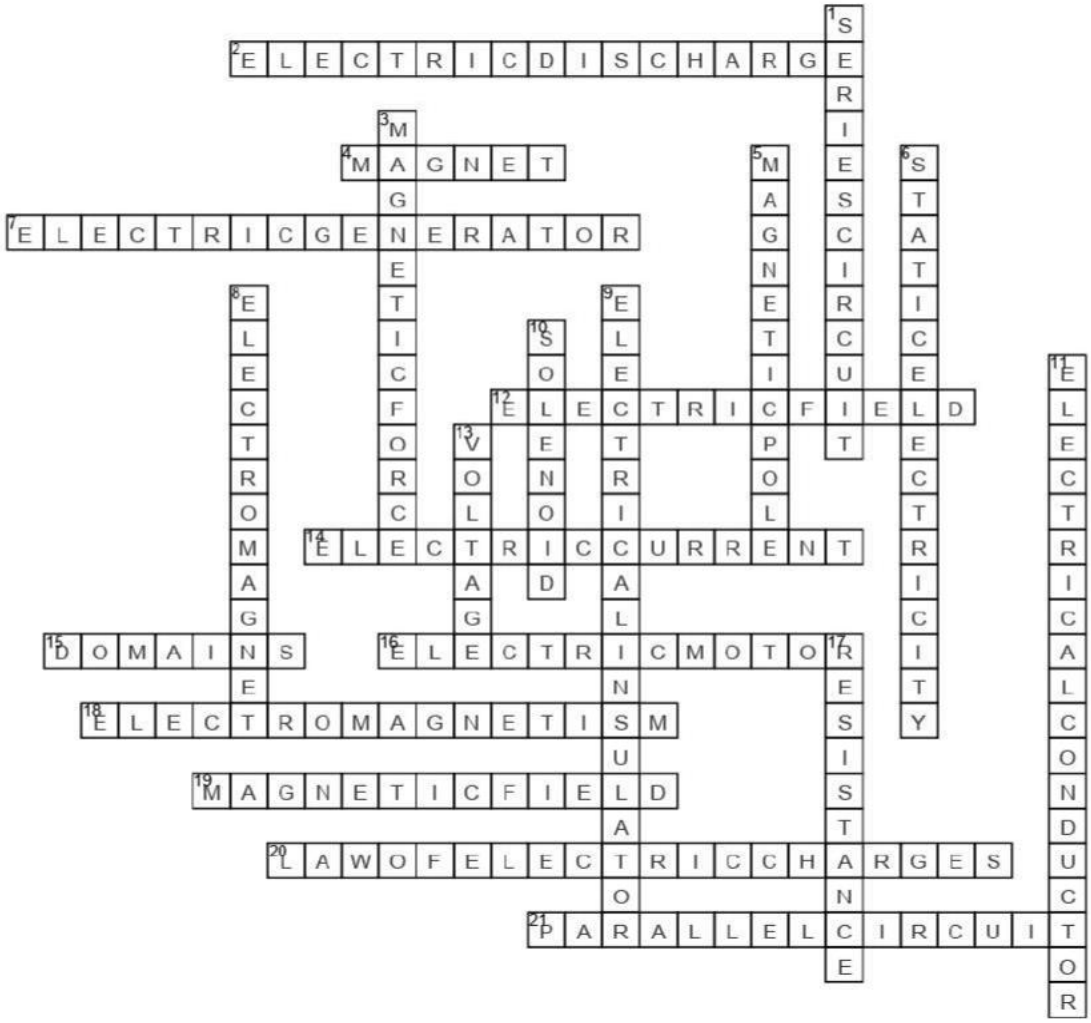
20. Things that are negatively charged and things that are positively charged pull on each other. This makes electrons and protons stick together to form atoms. Things that have the same charge push each other away

21. has two or more paths for current to flow through

13. an electromotive force or potential difference expressed in volts.

17. the impeding, slowing, or stopping effect exerted by one material thing on another

Ans



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