Need for Energy Management by Industrial Sector

Presented By

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- Energy management is more important than ever as businesses look to control costs, control energy and attract younger customers conscious about corporate social responsibility. Unfortunately, many commercial facilities and businesses do not have their own energy manager or lack automated solutions to carry out a strategic energy management program.

Energy management offers multiple benefits to organizations which include:

- Cutting costs through competitive procurement and strategically decreasing consumption
- Reducing greenhouse gas emissions for greater corporate social responsibility
- Tracking your utility costs to prepare more accurate budgets and gain greater insight into your operational costs
- Reducing reliance on supply chains that are inherently volatile

- Energy management is very important as all well-planned actions can help reduce an organization’s energy bills and minimize the damage it does to the environment. The two main energy management strategies are conservation and efficiency. This requires the establishment of a system of collection, analysis, and reporting on the organization’s energy consumption and costs.
- In the industrial sector, the major consumers of energy are fertilizer, textile, sugar, cement, and steel. It has been estimated that the **total conservation potential of this sector is around 25% of the total energy used** by it.

Introduction to Energy Conservation in Industrial Sector

- The industrial sector is a major energy-consuming sector in India and uses about 50% of the total commercial energy available in the country. Of the commercial sources of energy, coal and lignite account for about 56%, oil and natural gas around 40%, hydro-electric power about 3% and nuclear power accounting for 1%. The level of energy consumption is very high.
- In general, the Indian industry is highly energy-intensive and energy efficiency is well below that of other industrialized countries. Efforts to promote energy conservation by such industries could lead to substantial reduction in cost of production, making them more competitive globally. A comparison of energy use in some of the energy-intensive industries in India and their counterparts in developed countries

- The **industrial sector uses about 50% of the total commercial energy** available in India. Of the commercial sources of energy, coal, lignite, and oil and natural gas are mainly used. The Indian energy sector is highly energy intensive and efficiency is well below that of other industrialized countries. Efforts are made on a regular basis to promote energy conservation in these countries as this will help reduce the cost of production.
- There is considerable scope for improving energy efficiency in industries dealing with iron and steel, chemicals, cement, pulp and paper, fertilizers, textiles, etc. If such industries can promote energy conservation, it could lead to substantial reduction in their costs of production

Conservation initiatives

- Waste heat recovery systems, cogeneration, and the utilization of alternative sources of energy are also important for the conservation of energy.
- Technology, upgradation, modernization, and the introduction of control instrumentation are necessary to realize the full potential of energy conservation in industry.
- To motivate the industrial sector to take up energy conservation seriously, the government has from time to time introduced fiscal incentives such as cut on import duty for specific items. Effectively from 1983 certain tax benefits have been given to energy-saving devices and systems in the industrial sector such as cogeneration systems, power factor correcting devices, and specialized boilers and furnaces.
- The coal industry is both a source of energy and a consumer of energy. Energy can be conserved in both these areas. Coal reserves can be conserved through proper methods of exploration, improved recovery, and introduction of new mining technologies.
- Hydrocarbons continue to be the major source of energy. The conservation of this form of energy is essential as it will reduce environmental pollution.

- There is substantial scope to improve the end-use energy efficiency of the Indian industry. It has been estimated that the total conservation potential of the Indian industry is around 25% of the total energy used by this sector.
- t is also estimated that over 5% to 10% saving is possible simply by better house-keeping and another 10-15% with small investments towards low-cost retrofitting, use of energy-efficient devices and controls, etc. The quantum of saving is much higher if high cost measures like major retrofitting, process modifications, etc., are considered.

Policy Recommendations for Energy Conservation in Industrial Sector

- The Government of India has, from time to time, constituted expert groups to examine specific aspects of energy supply and demand and recommend appropriate policy measures. In the work of the earlier government-appointed committees, the emphasis, understandably, was more on aspects of energy supply.

Some of the important policy measures recommended by the expert groups are given below

(i) Technical and operational measures:

i. Detailed energy audits should be carried out in at least all large- and medium-sized industries.

ii. Measures to improve the efficiency of energy utilization in industries should be the most important element of energy policy in the industrial sector. Standards for fuel efficiency for each type of industry should be fixed with gradual improvement in efficiency over time.

iii. Cogeneration policies in existing industries should be identified and pursued if necessary by providing financial incentives.

Fiscal and economic measures:

i. Investments and subsidies for energy conservation schemes should be provided by creating an energy conservation fund by levying energy conservation cess on industrial consumption of petroleum products, coal and electricity.

ii. Customs duty relief on both components and equipment related to energy conservation should be offered.

(iii) Energy pricing

i. Energy pricing policies must ensure that:

(1) Sufficient surplus is generated to finance the energy sector investments;

(2) Economy in energy use is induced; and

(3) Desirable inter-fuel substitution is encouraged.

ii. Penal levies on industries that exceed the laid down norms and fiscal incentives for those who improve on them should be considered.

(iv) Industrial licensing, production and growth

i. Before licences are given to new units, the capacities of the existing units and the capacity utilization factors for these units should be taken into consideration.

ii. In setting up new industries, the technologies used should be the least energy-intensive option.

iii. The possibility of utilizing waste heat from power plants, especially the super thermal stations, by setting up appropriate industries in the vicinity should be seriously considered.

- **Organizational measures:**

In large- and medium-sized industries, it must be made mandatory to appoint energy managers. In small-scale industries, a mechanism of energy auditing, reporting and improvement in energy use should be instituted.

- **Energy equipment:**

i. Better standards must be set for energy-consuming equipment.

ii. Restrictions must be placed on the production and sale of low-efficiency equipment.

iii. Manufacture of sophisticated instruments required for monitoring energy flows must be encouraged. Import of such instruments and spare parts should be free of customs duty.

(vii) Research and development:

i. Every major industrial process should be reviewed to identify the R&D efforts required to reduce energy consumption.

ii. The Government as a distinct component of the science and technology plan should sponsor R&D programmes in energy conservation technologies.

(viii) Other measures:

i. Formal training courses for developing energy conservation expertise should be introduced in various technical institutions to maintain a steady flow of experts in the field.

ii. A system of governmental recognition and awards should be instituted for honouring individuals and organizations for outstanding performance in energy conservation.

iii. Pamphlets in local languages, suitable documentary films and programmes on radio and television should be introduced to create energy conservation awareness. While some of the measures recommended above have already been implemented, there are many where no decisions have been taken so far.

- **Barriers to Energy Conservation in Industrial Sector:**

While the technical and economic viability of improving the energy efficiency in India is quite substantial, there also exists a set of barriers that restrict the actual realization of this potential. The sector, in spite of being relatively organized, is highly disparate and dispersed, consisting of a large number of small manufacturing units. Although there has been a gradual improvement in the specific energy use by the industrial sector, the energy conservation move has not acquired the desired momentum.

- **Some key factors responsible for this are listed below:**

i. Conflict of investment priority between energy conservation projects and capacity expansion.

ii. Importance given by many towards initial cost minimization, disregarding the more efficient options (which generally are more expensive).

iii. Existence of limited competitive pressure of reduce cost because of the growing economy.

iv. Shortage of capital to fund energy conservation projects.

v. Shortage of skilled staff and lack of knowledge/information on technological options.

vi. No check on manufacture and marketing of cheaper inefficient products.

- **Fiscal incentives:**
- In order to motivate the industrial sector to take up energy conservation seriously, the Government, from time to time, introduced fiscal incentives that ranged from offering 100% depreciation allowance to cut on import duties for specific items to offering energy audit subsidy schemes through various agencies. Effective from April 1983, a 100% depreciation allowance has been allowed on certain energy-saving devices and systems.
- **These can be categorized as:**
- i. Specialized boilers and furnaces,
- ii. Instrumentation and monitoring systems for monitoring energy flows,.
- iii. Waste-heat recovery equipment and cogeneration systems, and
- iv. Power factor correcting devices.
- Specified imported equipment (both energy-efficiency equipment as well as instruments to monitor energy flows) are fully exempt from the customs duty.

Need for Energy Management by Building and Houses

- Globally the building sector accounts for more electricity use than any other sector, 42 per cent. No wonder considering that we spend more than 90 per cent of our time in buildings.
- With increasing urbanization, higher in developing countries, the number and size of buildings in urban areas will increase, resulting in an increased demand for electricity and other forms of energy commonly used in buildings.
- Africa's rate of urbanization of 3.5 per cent per year is the highest in the world, resulting in more urban areas with bigger populations, as well as the expansion of existing urban areas. There are currently 40 cities in Africa with populations of more than a million and it is expected that by 2015 seventy cities will have populations of one million or more.

- In many developing countries there is normally very little margin between existing power supply and electricity demand. With increasing electricity demand, new generation needs to be brought in. Although renewable sources of electricity such as hydro, geothermal or wind provide electricity at a much lower cost, their capital outlay is large, they are complex and take much longer to implement. Dieselbased generation is usually brought in the short term to meet this demand, which results in increased cost of electricity.

- Investments in energy efficiency in a building can be compared with the cost of capital investments necessary on the supply side of the energy system to produce a similar amount of peak capacity or annual energy production.
- One consistent quality in the building sector is that it is subject to a high degree of regulation. Building codes often influence material use and appliance standards that have a significant effect on energy efficiency.

- Energy used in buildings (residential and commercial) accounts for a significant percentage of a country’s total energy consumption. This percentage depends greatly on the degree of electrification, the level of urbanization, the amount of building area per capita, the prevailing climate, as well as national and local policies to promote efficiency. The following are estimated figures for different regions: European Union countries > 40 per cent 1 Philippines 15-20 per cent 2 Brazil 42 per cent 3 Florida/USA 47 per cent 3 California 66 per cent 4

- The building sector encompasses a diverse set of end use activities, which have different energy use implications. Space heating, space cooling and lighting, which together account for a majority of building energy use in industrialized countries, depend not only on the energy efficiency of temperature control and lighting systems, but also on the efficiency of the buildings in which they operate. Building designs and materials have a significant effect on the energy consumed for a select set of end uses. On the other hand, building design does not affect the energy use of cooking or appliances, though these end uses are nonetheless attributed to the building sector. Appliance efficiency matters more for some end uses than for others. Water heating and refrigeration each account for significant shares of building energy use since they are in constant use.

What is the energy efficiency of a building?

- The energy efficiency of a building is the extent to which the energy consumption per square metre of floor area of the building measures up to established energy consumption benchmarks for that particular type of building under defined climatic conditions.
- Benchmarks are applied mainly to heating, cooling, air-conditioning, ventilation, lighting, fans, pumps and controls, office or other electrical equipment, and electricity consumption for external lighting. The benchmarks used vary with the country and type of building.

- The measure of heat loss through a material, referred to as the U-Value, is also used as a way of describing the energy performance of a building. The U-value refers to how well an element conducts heat from one side to the other by rating how much the heat the component allows to pass through it. They are the standard used in building codes for specifying the minimum energy efficiency values for windows, doors, walls and other exterior building components. U-values also rate the energy efficiency of the combined materials in a building component or section. A low U-value indicates good energy efficiency. Windows, doors, walls and skylights can gain or lose heat, thereby increasing the energy required for cooling or heating. For this reason most building codes have set minimum standards for the energy efficiency of these components.

Why is energy efficiency in buildings important?

- . In many developing countries there is normally very little margin between existing power supply and electricity demand. With increasing electricity use from existing consumers and new connections, new generation needs to be brought on line to meet increasing demand. In addition, due to changing climate patterns and the increasing risk of drought, countries that are highly dependent on electricity from hydro as their main source of electricity are losing much of their generation capacity resulting in intensive power rationing.
- Although renewable sources of electricity such as hydro, geothermal or wind provide electricity at a much lower cost than electricity generation from petroleum, their capital outlay is large, they are complex and take much longer to implement. Petroleum-based generation is usually brought in in the short term to meet this demand, which results in increased cost of electricity, over dependence on petroleum and subsequently vulnerability to oil price fluctuations.

- Investments in energy efficiency in a building can be compared with the cost of capital investments necessary on the supply side of the energy system to produce a similar amount of peak capacity or annual energy production. Usually, the capital costs of efficiency are lower than comparable investments in increased supply and there are no additional operating costs of efficiency compared to substantial operating costs for supply-side options.

- The main benefit from measures to improve energy efficiency buildings is lower energy costs but there are usually other benefits to be considered too. Energy efficiency measures are meant to reduce the amount of energy consumed while maintaining or improving the quality of services provided in the building

- Benefits:

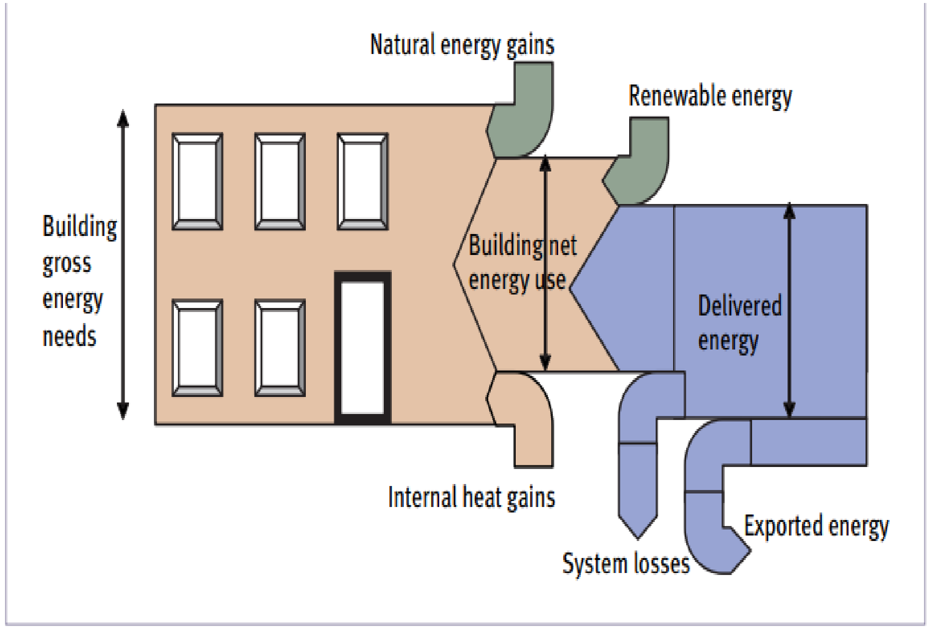
Reducing energy use for space heating and/or cooling and water heating; Reduced electricity use for lighting, office machinery and domestic type appliances; Lower maintenance requirements; Improved comfort; Enhanced property value.

- In developing countries where electricity is intermittent and power rationing is frequent, there is a large demand for diesel or renewable energy-based backup/stand-by power generation from end-users. Reducing power and energy requirements in buildings reduces the capital outlay required and the running costs of these stand-by systems.

- In industrialized countries, policy, incentives, climate change targets and corporate image drive more efficient approaches to energy use in buildings. Codes and practice on energy regulations for buildings in developed countries include obligations for energy audits, requirements for building certification with ratings based on energy efficiency, carbon reduction targets for buildings, levies on energy consumption—charged per unit consumed to discourage high consumption, incentives such as exemption from building tax for good energy efficiency ratings, access to interest free/low-interest loans and grants for undertaking energy efficiency measures in buildings and, as part of their corporate social responsibility, some companies would like to be seen as a green company that promotes energy efficiency.

ENERGY EFFICIENCY IN BUILDINGS METHODOLOGY

The building gross energy needs represent the anticipated buildings requirements for heating, lighting, cooling, ventilation, air conditioning and humidification. The indoor climate requirements, 8 outdoor climatic conditions and the building properties (surface/transmission heat transfer and heat transfer due to air leakage) are the parameters used for determining what the gross energy needs of the building will be



- delivered energy, natural energy gains and internal heat gains all contribute to providing the energy needs of a building.
- Natural energy gains

These include passive solar heating, passive cooling, natural ventilation flow, and daylight. Intelligent maximization of natural energy gains can result in significant reduction of delivered energy required to meet a building's energy needs. Environmentally smart buildings make intelligent use of energy resources, while minimizing waste.

- Natural energy gains can be maximized by exploiting the potential contribution to a building’s performance offered by the site and its surroundings through: A building plan which places functions in locations that minimize the need for applied energy; A shape which encourages the use of daylight and natural ventilation, and reduces heat losses; An orientation that takes account of the potential benefits from solar gains while reducing the risk of glare and overheating; Effective use of natural daylight combined with the avoidance of glare and unwanted solar gains; Natural ventilation wherever practical and appropriate, with mechanical ventilation and/or air conditioning used only to the extent they are actually required; Good levels of thermal insulation and prevention of unwanted air infiltration through the building envelope; Intrinsically efficient and well-controlled building services, well-matched to the building fabric and to the expected use.

- Internal heat gain

Internal heat is the thermal energy from people, lighting and appliances that give off heat to the indoor environment. Whereas this is desirable in cold weather as it reduces the energy requirements for heating, in hot weather it increases the energy required for cooling. In office buildings, commercial stores, shopping centres, entertainment halls etc., much of the overheating problem during the summer can be caused by heat produced by equipment or by a high level of artificial lighting. When there are a large number of occupants or clients their metabolic heat can also add to the problem.

- Delivered energy

This is the amount of energy supplied to meet a building's net energy demand i.e. to provide energy for heating, cooling, ventilation, hot water and lighting. Itis usually expressed in kilowatt hours (kWh) and the main energy carriers are electricity and fuel, i.e. gas, oil or biomass for boilers. As seen , the delivered energy could be supplemented by on-site renewable energy, this could be in the form of solar PV, solar water heaters or wind.

Exported energy

This is the fraction of delivered energy that, where applicable, is sold to external users.

System losses

System losses result from the inefficiencies in transporting and converting the delivered energy, i.e. of the 100 per cent delivered energy, only 90 per cent may be used to provide the actual services, e.g. lighting, cooling or ventilation, due to the inefficiency of the equipment used.

- Energy use indicators The calculation of energy use in buildings is based on the characteristics of the building and its installed equipment. It is structured in three levels as illustrated below and the calculation is performed from the bottom up.

- Step One is the calculation of the building’s net energy requirements, i.e. the amount of energy required to provide the indoor climate requirements9 as specified by the building code. The calculation is used to determine the net energy required based on the outdoor climate and indoor climate requirements while considering the contributions from internal gains, solar gains and natural lighting and losses due to building properties, i.e. heat transmission and airflows (air infiltration and exfiltration). This calculation is used to determine the intrinsic energy performance of the building.

- Step Two is the determination of the building's delivered energy, i.e. the energy performance of the building in actual use. This is the amount of energy used for heating, cooling, hot water, lighting, ventilation systems, inclusive of controls and building automation, and includes the auxiliary energy needed for fans, pumps, etc. Energy used for different purposes and by different fuels is recorded.
- Step Three is the determination of the overall energy performance indicators: It combines the results from Step 2 above for different purposes and from different fuels to obtain the overall energy use and associated performance indicators. Since a building can use more than one fuel (e.g. gas and electricity), the different energy sources have to be converted and combined in terms of primary energy to provide the optional end result of the calculation of energy performance. Commonly used energy indicators for buildings are kWh/m2 (energy consumption in kilowatt hours per metre square of floor area) or CO2 emissions

- Benchmarks Building energy consumption benchmarks are representative values for common building types against which a building's actual performance can be compared. The two main purposes of benchmarks are: To identify if a building's energy performance is good, average or poor with respect to other buildings of its type; To identify potential savings, shown by the variance between the actual data and the benchmarks: the worse the performance against a benchmark, the greater the opportunity for improving performance, and making cost savings.

- ENERGY EFFICIENCY MEASURES FOR BUILDINGS Energy efficiency measures for buildings are approaches through which the energy consumption of a building can be reduced while maintaining or improving the level of comfort in the building. They can typically be categorized into: Reducing heating demand; Reducing cooling demand; Reducing the energy requirements for ventilation; Reducing energy use for lighting; Reducing energy used for heating water; Reducing electricity consumption of office equipment and appliances; Good housekeeping and people solutions.

- Reducing heating demand Heating demand can be reduced by: Limiting the exposed surface area of the building; Improving the insulation of the building’s fabric; Reducing ventilation losses; By selecting efficient heating systems with effective controls. Limiting the exposed surface area of the building The shape of a building determines how much area is exposed to the outdoors through exterior walls and ceilings. To save energy, try to keep this exposed area to a minimum. The most economical house to build and heat is one with a simple square or rectangular floor plan. Complex shapes increase the exposed surface area as well as the construction and energy costs when a house has a complex shape.

- Improving air tightness Air leaks reduce a building’s energy efficiency. Air can leak through cracks or holes in walls, ceilings, floors and around doors and windows. A typical building can lose about one-third of its heat through this infiltration (outside air coming in) and exfiltration (inside air escaping). An airtight house will reduce heat and air movement and be quieter and cleaner. Infiltration and exfiltration losses can be reduced by: Installing continuous vapor retarders on walls and ceilings; Caulking any holes or cracks on the inside surfaces of walls and ceilings; Caulking around windows and door trim on the outside; Sealing around window and door trim, and electrical outlets on the inside; Sealing around any pipes or ducts that penetrate the exterior walls; Weather-stripping windows and doors.

- Improving the insulation of the building’s fabric The other two-thirds of heat loss occurs by conduction through foundations, floors, walls, ceilings, roofs, windows and doors. Heat flow in and out of the building from conduction can be reduced with high levels of insulation in the attic, sidewalls, basement walls and doors. Windows should have a low U-value. Effectively using controls The main controls used in a heating system are time, temperature and boiler controls and ensuring these are set correctly is the best place to start when looking for savings in a heating system. Time controls turn the heating on and off at predetermined times; advanced time controls monitor internal and/or external temperatures and switch the heating on at the right time to ensure the building reaches the correct temperature by the time it is occupied

- Identifying a suitable heating system The most appropriate and efficient form of heating for a building will vary depending on the use to which the building is to be put. For buildings which are used intermittently (such as churches) or which have large air volumes (such as industrial units) radiant heating may be an effective form of heating. For buildings which are used more regularly and with smaller air volumes, conventional central hot water systems will be more effective. For non-domestic buildings with varying loads, modular boilers should be used to prevent boilers operating at part load. Condensing boilers should be used in place of conventional boiler plant due to their higher seasonal efficiency; they can be up to 30 per cent more efficient than standard boilers if operating correctly. Where condensing boilers are installed, the use of weather compensation controllers and under-floor heating systems, will improve their efficiency by reducing water flow temperatures.

- Reducing cooling demand

Energy use in typical air-conditioned office buildings is approximately double that of naturally ventilated office buildings. The need for air-conditioning or the size of the systems installed can be reduced by: Controlling solar gains through glazing; Reducing internal heat gains; Making use of thermal mass and night ventilation to reduce peak temperatures; Providing effective natural ventilation; Reducing lighting loads and installing effective lighting controls.

- Avoiding excessive glazing

Windows should be sized to provide effective day light while avoiding excessive solar gains. Large areas of glazing will increase solar heat gains in summer and heat losses in winter making it more difficult to provide a comfortable internal environment.

- Use of shading Solar gains can be reduced by the use of external shading, mid pane blinds (where blinds are integrated between the panes of the double or triple glazing unit) or by internal blinds. Internal blinds are the least effective method of controlling solar gains as the heat will already have entered the space. External blinds are the most effective but may be difficult to maintain and are less easily adjusted for controlling glare.
- Solar control glass Glazing is available with a range of selective coatings that alter the properties of the glass; ideally glazing should be selected with the highest light transmittance and the lowest solar heat gain factor. This will help provide daylight while reducing solar gains.

- Selecting equipment with reduced heat output Selecting office equipment with a reduced heat output can reduce cooling demands and by ensuring equipment has effective controls that automatically switch it off when not in use. The use of flat screen monitors can significantly reduce heat gains, while at the same time reducing energy use for the equipment and using office space more effectively
- Separating high heat load processes from general accommodation Where a building includes energy intensive equipment such as mainframe computers, these are best located in a separate air-conditioned space, avoiding the need to provide cooling to the whole building.

- Reducing heat gains from lighting Heat gains from lighting can be reduced by making best use of day lighting and by providing energy-efficient lighting installations with good controls.
- Predicting the impact of passive cooling strategies Computer simulation tools can be used to predict the likely comfort conditions in buildings and optimize glazing and shading arrangements.
- Reducing the energy requirements for ventilation When the cooling demand is sufficiently reduced by implementing the above measures, it may be possible to reduce heat gains so that air-conditioning is unnecessary and comfort conditions can be maintained through the use of natural ventilation. The energy required for ventilation can be minimized by: A building design that maximizes natural ventilation; Effective window design; Use of mixed mode ventilation; Using efficient mechanical ventilation systems.

- Building design The most effective form of natural ventilation is cross ventilation, where air is able to pass from one side of a building to the other. For this to work effectively it typically dictates that buildings are no more than 12-15 m in depth. However, in deeper plan spaces, natural ventilation can be achieved by introducing central atria and making use of the “stack effect” to draw air from the outer perimeter and up through the centre of the building.
- Effective window design Windows should allow ease of control by building occupants and controlled ventilation that will not blow papers off desks, or cause draughts. Night ventilation can be an effective method of maintaining comfort conditions in summer. Where night ventilation is used, it is important that building occupants understand how the building is intended to be operated, or that effective control measures are introduced, as it is counter intuitive to open windows before leaving a building at night. Other factors to consider include maintaining security, and controlling wind and rain. In some cases, high ambient noise levels or air pollution may prohibit the use of natural ventilation.

- Mixed mode ventilation Mixed mode ventilation strategies allow natural ventilation to be used for most of the year or to serve parts of a building. Mechanical cooling is used to deal only with peak design conditions in summer or to serve areas of the building that experience a higher build up of heat. Reducing energy use for mechanical ventilation The main use of energy for both mechanical cooling and for air conditioning is the fans needed to circulate the air. Fan energy use for mechanical ventilation can be reduced by: Designing the system to reduce pressure drops; Selecting efficient fans; Utilizing variable speed fans to respond to varying load requirements; Avoiding excessive air supply volumes.

- Reducing energy use for lighting This can be accomplished through: Making maximum use of daylight while avoiding excessive solar heat gain; Using task lighting to avoid excessive background luminance levels; Installing energy-efficient luminaires with a high light output to energy ratio; Selecting lamps with a high luminous efficacy; Providing effective controls that prevent lights being left on unnecessarily.
- Maximizing the use of daylight Introducing natural light into buildings both saves energy but also creates an attractive environment that improves the well-being of building occupants. The provision of effective daylight in buildings can be assessed using average daylight factors and by ensuring that occupants have a view of the sky.

- Energy-efficient lighting system An efficient lighting installation should be able to provide the required illuminance level for a particular use with minimum energy consumption. Efficient lights should be able to provide illuminance levels of 500 lux12 on a working plane for less than 12W/m2 of installed power. Lighting controls Lighting controls should be designed so that small groups of lights can be controlled individually with the controls provided adjacent to the work area. Perimeter lighting should be controlled separately to core lighting so that perimeter lights can be switched off when there is adequate daylight. Absence detection should be provided to rooms that are used intermittently. This should switch lights off automatically after a room or space has been unoccupied for a set period of time. Daylight sensors and timed switches should be used to prevent external lighting being left on unnecessarily. Daylight sensors can also be used to switch off internal lighting when daylight levels are sufficient.

Need for Energy Management by Transport Sector

- Transport is the sector with a high final energy consumption. Energy consumption in this sector is expected to grow significantly and emissions could increase at a faster rate if aggressive and sustained mitigation policies are not undertaken. The sector has direct and indirect linkages with all important sectors of the respective national economies.
- Transport is strongly linked with economic activities. Economic growth triggers transport demand for the facilitation of movement of people and goods. Transport connects the economic activities and increases access to markets and services. Transport is a key to enhancing integration to global economy. Today, the transport needs have changed drastically. Personal mobility today is a major energy-consuming activity. Mobility of individuals has increased by many folds and is expected to continuously increase in the future. New patterns of trade and businesses have evolved. The road networks within the countries and beyond the borders have increased. Freight transport has grown rapidly and is expected to continue to do so in the future.

- The transport sector is a huge consumer of energy; it is indeed the largest consumer of petroleum-based fuels, accounting for 20% of global final energy consumption and 60% of total oil consumption. More than one third of the total greenhouse gas emission comes from the transport sector. With the economic growth of the SAARC countries, all transport modes have shown substantial increases in activity, which in turn has resulted dramatic surge in energy demand. Along with the growth of industrial, commercial and transport sectors, people are using energy at unprecedented rates. Demand for energy in all the sectors in the region is expected to grow significantly in the future. All modes of transport are expected to grow significantly and the road transport (passenger and freight), in particular, will continue to dominate overall transport energy and oil use in the region although air travel and shipping too are expected to grow substantially.

- In developing economies like India, increased economic activity leads to growing income per capita; as standards of living rise and the demand for personal transportation increases, from a non-motorised mobility to a motorised one. The European experience is useful for pursuing the correct choices in the transport domain for as far as possible. From the energy supply viewpoint, uncertainty about the present and future availability and security of oil supplies, the prospect of rising oil prices and environmental concerns about emissions are the major challenges. Market forces and government policies could drive the development of highly efficient vehicle technologies and of the transport systems itself, with the potential to alter future demand for transportation fuels, reduce emissions, improve energy security and provide significant energy savings. Widespread adoption of alternative vehicle and transport technologies, combined with expansion of mass transit infrastructure and personal mobility, could be an attractive option for long term development of the whole transportation sector.

- Urban population and registered motor vehicles in India India is the second most populous country in the world, with over 1.21 billion people – according to the census of 2011, more than a sixth of the world’s population. India is projected to become the world’s most populous country by 2025, surpassing China, according to present trends and projections. The level of urbanization, i.e. inhabitants living in urban areas, has increased from 27.81% in 2001 to 31.16% in 2011. Migration to major cities caused rapid increase in urban population
- In India, personalised motorised mobility, satisfied mainly by two wheelers and passenger cars, accounted for more than four-fifth of the motor vehicle population. Two-wheelers account for about 72%, followed by passenger cars at 13.3% and other vehicles at 8.4%. At lower levels of income, 2-wheelers are an affordable and cost effective means of personalised mobility. In contrast to personalised mode, the share of buses in total registered vehicles has declined from 11.1% in 1951 to a mere 1.3% in 2009. The erosion of share of buses in the vehicle population reflects slow growth in public passenger bus transport services.

- The reasons for this are:

a. Focus on the growth of the National Highway network though with lack of maintenance of arterial roads;

b. Introduction of small and cheap cars, like Nano car from Tata Group, which are rising rapidly in the Indian market. Sales data show that total vehicle sales increased by an annual average rate of 15% over the last 5 years.

Effect of GDP Transport sector accounted for a share of 6.6% in India's Gross Domestic Product (GDP) in 2008–09, with road transport being the dominant mode of transport, with a share of 4.8 per cent in GDP. It may be noted how the entire increase in the percentage share of transport in GDP since 1999–2000 has come from the road transport sector only, with a share of other modes remaining either constant or falling marginally. The total air passenger traffic in India has increased from 109 million in 2008–09 to 143 million in 2010–11, a 31% increase in 3 years, international 20% and domestic 37%, but its contribution to India's economy is negligible.

- Transport by mode Walking to work remains the prevailing mode of transport for Indian households today. Car ownership is still very low in India but sales of cars are starting to increase rapidly. Not surprisingly, bicycles are the most widely used vehicle type owned by households. Traveling by bus is by far the most used means of transport in India, accounting for 56% of total passenger-km. This results from a high passenger load factor in bus transport.

Transport and energy

Transport and energy are closely related. Energy is nowadays a crucial constraint on transport and transport is a major determinant of energy demand. India's commercial energy resource base is meagre compared with the population; while India has a sixth of the world's population, it accounts for only about 0.8% of total geological reserves, with 5.7% of world's proven coal reserves, and 0.4% of the world's proven hydrocarbon reserves. According to present trends, India's transportation energy use is projected to grow at the fastest rate in the world, averaging 5.5%, compared with the world average of 1.4% per year. India is increasingly dependent on imported petroleum. While India's dependence on imported petroleum is growing towards uncomfortable levels, its energy usage efficiency in the transport sector is estimated to be only half that in the industrialised countries. In the transport sector, based on existing estimates in 1996–97, 85% of oil use is in the road sector where energy- inefficient designs, poor vehicle maintenance and inadequate and low-grade roads are widely prevalent. Energy conservation, substitution of imported by domestic fuels and the pursuit of transportation policies have to become vital national concerns.

- Gasoline and diesel transport consumption In 2004, diesel and motor gasoline represented 90% of final energy consumed in the transport sector, while jet kerosene represented 8% and electricity 2%. Diesel is the most used form of energy, with a share of 66%, and motor gasoline representing 24%. Statistics of energy consumption over time from the Ministry of Oil and Gas show a steady increase of motor gasoline, however statistics for diesel consumption show uneven trends
- Energy projection in transportation sector Considering final energy consumption as the direct amount of energy consumed by end users while primary energy consumption including final consumption plus the energy that was necessary to produce and deliver electricity, in India, the factor primary on final energy is relatively high, i.e. 4.2, because of high transmission losses. In 2020, the transportation sector is projected to account for 21% of total final energy use and 14% of primary energy use, versus 16% of total final energy use and 12% of primary energy use in 2005. This sector is expected to grow rapidly, with a projected annual growth rate of 6.8% for the period 2005 to 2020. Energy consumption from trucks is also expected to increase rapidly at 8.8% AAGR (average annual growth rate), followed by air transportation at 7.9%. In terms of share, energy used by buses will decrease from a share of 20% to 8% while energy used by trucks, still representing the largest consumption, will grow from 28% to 38%, and energy used by cars will increase from 10% to 18%

- Carbon dioxide emissions Two-thirds of world emissions for 2008 originated from just ten countries, with the shares of China and the United States far surpassing those of all others. Combined, these two countries alone produced 12.1 Gt CO2, about 41% of world CO2 emissions. India, with 17% of world population, contributed less than 5% of the CO2 emissions .
- The WEO 2009 Reference Scenario projects that CO2 emissions in India will increase by more than 2.5 times by 2030 from 2008. A large share of these emissions is produced by the electricity and heat sector, which represented 56% of CO2 in 2008. The transport sector, which was only 9% of CO2 emissions in 2008 , is growing relatively slowly compared to other sectors of the economy

Generation of electricity for transport systems

- Electricity is an energy vector which can be produced by a large variety of primary energy sources, both fossil fuels, renewables and nuclear. In 2008, 69% of electricity in India came from coal, another 10% from natural gas and 4% from oil. The share of fossil fuels in the generation mix grew from 73% in 1990 to 85% in 2002. The share of fossil fuels has declined steadily since then, falling to 81% in 2007 . As regards to the use of electricity in vehicles, the use of electric motors proves to be highly efficient, nevertheless it remains to be analysed how the energy stored in their batteries is produced and/or distributed. Electricity can be supplied to the motor either by direct link to the electricity grid (e.g. for trolley buses or trains) or it can be stored on board through batteries. For road transport the most common system used is through on board batteries; the system can work either as a pure battery electric vehicle or as a plug-in electric hybrid vehicle in combination with an internal combustion engine

Improvement of vehicle concepts

- In terms of road transport, technology improvements of the internal combustion engine and aerodynamics of the vehicle can lead to efficiency gains. If improvements in car and trucks follow the trends of the last decades, we can await a significant reduction of energy consumption.
- By 2050, it is possible to expect 30 % reduction in fuel consumption thanks to improvements of the internal combustion engine. Progress is underway to conceive engines running with two cylinders while other research is addressing the possibility to electronically deactivate some cylinders in a multi-cylinder engine. Electronics has become a centerpiece of automotive technology (it represents 35 % of a car's cost in Europe) and will play a growing role in operating the engine at even lower consumption levels.
- A better control of injection and ignition is expected to deliver substantial energy consumption. The use of electronics not only for the engine but also all over the vehicle with sensors, controllers, and other new innovations will further improve existing systems.
- A further path for progress is making the vehicles lighter using new materials thanks to the development of composite materials and carbon fiber technology. New high strength steels achieve weight savings of 30 % compared to conventional cold forming grades without reducing the safety performance. Therefore, fundamental research into materials is a key factor in transportation.
- One particularly effective way to increase energy efficiency of automotive vehicles is reducing their dynamic performance. It is also crucial to reduce energy consumption from heavy-duty transportation in the EU. Research into advanced active and passive aerodynamic properties for trucks and semitrailers is under way

Improvement of efficiency of ancillaries

- Relevant improvements during recent years have been made in the transmission systems, including automatic gear boxes, but innovative engineering is ongoing and will require more onboard electricity generation. The generation of electricity in a car engine has a very low efficiency as a result of the complexity of the process: the chemical energy of the fuel is transformed into heat, then into mechanical energy first in the engine and then in the alternator to finally generate the electricity. This is a relevant field of research but challenging because normally only inexpensive solutions are applied in the automotive industry (probably delaying the use of fuel cells).
- A drastic improvement will be to directly convert the heat energy of the exhaust gas into electricity using the thermoelectric effect. Energy consumption of lighting (like LED) and other auxiliary equipment may be considered of only incremental improvement but these steps are nevertheless very important as they affect numerous applications. Design engineers are working on all these topics with the aim to reach a reduction of up to 10 % of the total fuel consumption of a vehicle through improvements of its auxiliary equipment.

- Oil-based fuels The balance of gasoline and diesel engines has a strong impact on oil refineries. Oil refineries in Europe are challenged by the development in other parts of the world with more modern installations and less stringent rules. Already today due to the competition between diesel and gasoline, EU needs to import diesel oil. Accordingly, finding solutions for rebalancing the diesel-gasoline share is also demanded, e.g., by improving diesel engine efficiency when running on gasoline. Liquefied petroleum gas, LPG, a by-product of oil production and oil refining, is a clean transport fuel that needs to be kept and if possible expanded.

- Compressed natural gas (CNG) and liquefied natural gas (LNG) Due to their higher energy density, oil products have been widely and globally preferred. In 2013, 17.7 million vehicles in the world used natural gas, the vast majority of which (16.3 million) were light commercial vehicles running mostly on compressed natural gas (CNG). Iran, for example, which does not have the refining capacity to produce motor fuel and cannot export its gas, has decided to use natural gas in the transportation sector: it has 3.3 million vehicles running on natural gas, or 27 % of its total fleet. In addition to Iran, six other countries have more than 1 million gas-powered vehicles: Pakistan (2.8 million), Argentina (2.2 million), Brazil (1.7 million), China (1.6 million), and India (1.5 million). While the development of CNG started to emerge in Europe, the development of shale gas in USA has generated a strong interest for liquefied natural gas (LNG) for transportation. Shale gas producers realized that their truck fleets can operate with the fuel that they are actually producing. This has prompted a strong development in the use of LNG also in others fleet sectors (e.g., parcel deliveries and school buses). In 2013, the European Commission launched the LNG Blue Corridors project,2 which will run until 2017 and which aims to establish the LNG as a real alternative for medium- and long-distance transport—first as a complementary fuel and later as an adequate substitute for diesel. The program provides for the construction of a fleet of around 100 LNG heavy-duty vehicles meeting EURO IV standards3 along with 14 new stations along four corridors with an LNG refueling station every 400 km on average

- Electricity Typically, conventional gasoline engines effectively use only 15 % of the fuel energy content to move the vehicle or to power accessories, and diesel engines can reach onboard efficiencies of 20 %, while electric vehicles have an onboard efficiency of around 80 %. Bear in mind that from 1890 to 1910, the electrical car surpassed any other type of vehicle. After the end of the first World War, battery-operated vehicles disappeared. Thereafter, a number of tries with electrical cars could be observed but batteries remained unreliable to use in the car industry. To overcome these drawbacks, current research focuses on the development of new solid electrolytes (polymer) and electrodes that are resistant to passivation of the batteries. The unique characteristics of graphene, including its excellent electrical conductivity and high surface area, could make it an ideal medium for the electrodes of batteries. A breakthrough in this technology can be expected if low capacity losses after multiple charge and discharge cycles, and a long-life can be demonstrated. Of course, mass production of such batteries has to yield a compatible price.

- Supercapacitors While the batteries are electrochemical, capacitor devices are electrostatic. Another advantage is that they can handle up to one million charge- and discharge cycles without degeneration. Charging can be done in less than a second. The disadvantage is that the amount of energy is limited, and the time the charge can be stored is only minutes. A version of capacitors, which eliminates some of these drawbacks, is so-called supercapacitors. In order to overcome the limited availability of lithium, research is now focusing also on sodium. In addition to the lifetime limitation of present batteries, their too low output voltage is a disadvantage. In the future, organic chemistry and electrochemistry will play a fundamental role in the production of energy and electricity in particular. Therefore, these disciplines of the chemistry need to receive proper attention.

- Range extender In a hybrid car, the torque on the wheel is given by an electric engine and an internal combustion engine working in tandem. In the Range Extender, it is always the electrical engine that drives the wheels, where the energy to run the electrical engines always coming from a battery. When the charge of the battery is too low (usually 30 %) then an internal combustion engine drives an alternator to charge it up again. As they are smaller and simpler than the internal combustion engines used in conventional vehicles, Range Extender are considered at present to have advantages.

Need for Energy Management by Electric power

- To understand the role of Energy Management Systems in power systems control, a discussion of the electric system is required. Power systems are made up of components including generators at power plants, substations, transformers and transmission and distribution lines.
- The first step is electrical energy production. Generators convert thermal, chemical, mechanical or nuclear energy to electrical energy. This energy must be efficiently transmitted to points of use.
- Electric power delivery systems are unique compared to gas or oil delivery as electric energy is not easily or practically stored in large quantities. Electric energy must be produced and consumed at the same instant

Drivers for Changes in the Electric Power System

- Far-reaching changes in technologies, markets, and public policies are transforming electricity delivery. There are five key trends driving this transformation:
- Changing mix and characteristics of electricity generation sources that are shifting electricity generation from relatively few large central station plants to many smaller and sometimes variable generators
- Changing demand loads in retail electricity markets resulting from demographic and economic shifts; the adoption of more energy-efficient, end-use technologies; growing consumer participation; broader electrification; and use of electronic converters (rather than induction motors and other types of loads with favorable inertia and droop curves)7
- Integration of smart grid technologies for managing complex power systems, driven by the availability of advanced technologies that can better manage progressively challenging loads
- Growing expectations for a resilient and responsive power grid in the face of more frequent and intense weather events, cyber and physical attacks, and interdependencies with natural gas and water systems
- Aging electricity infrastructure that requires new technologies to enable better failure detection, upgrade capabilities, and improve cybersecurity

- Changing Mix and Characteristics of Electricity Generation Sources

The nation's electric generation mix is in the midst of substantial change. From 2000 to 2013, natural gas' share of the power generation mix grew from about 16% to more than 27%, and the renewables share increased from more than 9% to about 13%, while coal's share decreased from almost 53% to about 40%.8 These trends are projected to continue. Because electricity is not easily stored, balancing authorities must continuously match electricity supply with demand on a second-by-second basis to maintain reliability. The growing penetration of variable generation resources, such as wind and solar, adds higher levels of non-dispatchable resources to the system.9 With more variable generation, transmission system operators require tools and resources to maintain reliability while addressing the need for short, steep ramps; the potential for over-generation—particularly with distributed generation where curtailment is not readily achievable; and decreased frequency response. These changes require new ways for managing grid operations to increase the flexibility of the system such as expanding balancing areas, increasing the ramping capability of the generation fleet, using dispatchable demand resources, adding power flow controllers, and increasing energy storage to maintain reliability.

Changing Demand Loads in Retail Electricity Markets

- Changes in customer preferences are also affecting utility markets and electricity delivery.For example, growing installations of more affordable rooftop photovoltaic (PV) arrays and more energy-efficient appliances, buildings, and industrial equipment, are reducing the amount of electricity needed from power companies. This is changing the traditional business models of the regulated utility industry.
- Consumers are increasingly becoming “prosumers” who both use and produce electricity. For example, the number of homes in the United States with solar PV installations has grown from 15,500 in 2004 to more than 600,000 by the end of 2014. The total generation capacity of residential PV today is about 1,460 megawatts (MW), and more than 80% of that capacity was added in the past four years.12
- The use of digital electronics and computer controls in homes, offices, and factories is also on the rise, enabling the nation’s electricity consumers to operate more efficiently and expand capabilities for improving productivity and performance. Changes from purely electro-mechanical to power-electronic-based components affect power quality requirements and other aspects of grid operations. For example, in many industrial and consumer applications, induction motor loads have been replaced by variable speed drive systems. Fans, pumps, and motors—in applications ranging from sewage treatment to air conditioning—have been equipped with electronic drive systems that offer increased control, and tremendous efficiency gains. However, the electronic drive systems decouple the inertia of these motor loads from the system, preventing them from supporting the stability of the grid during disturbances.

- Integration of Smart Grid Technologies for Managing Complex Power Systems
- New digital devices and communications and control systems (often referred to as “smart grid” devices) are improving the ability of operators to monitor and manage electric transmission and distribution systems. These devices include phasor measurement units (PMU) for transmission; automated capacitor banks and feeder switching for distribution; and advanced metering infrastructure for customers that provides new capabilities.Cost reductions of high-bandwidth communications systems are enabling more timely and granular information about conditions along power lines and within buildings that can also be used by grid operators and customers. This has created challenges in managing and analyzing large volumes of data and the need to develop new tools for data management, visualization, and analytics.
- While technology advancements for monitoring the system are occurring, such as the deployment of PMU technology, further advancement is needed in the control systems, algorithms, and grid models that utilize these data. For example, PMU technology can detect low-frequency oscillations that were missed by supervisory control and data acquisition (SCADA) systems, allowing operators to take action and prevent widespread disturbances (see Figure 3.5). However, the use of data for automated, coordinated, system-level control remains an area of research rather than practice. At the distribution level, automated controls for voltage and reactive power management technologies are now being deployed by some utilities to address power quality requirements and enhance conservation.

- Growing Expectations for a Resilient and Responsive Power Grid
- Electricity disruptions are estimated to cost the economy roughly $80 billion or more annually and seriously endanger public health and safety. The growing interdependence of the electricity infrastructure with other critical infrastructures (such as communications and information technology, water, fuels, and transportation) is increasing the consequences of power outages. Natural disasters such as Hurricane Katrina and Superstorm Sandy demonstrate the overwhelming economic and human loss that results when storms devastate large areas and damage the electric power system.18 Increasing weather-related outages can affect millions of people and cause economic losses of $10 billion or more from power disruptions.Yet, severe storms are not the only threat; sophisticated cyber attacks have emerged as a high-risk source of potential harm, requiring strong cybersecurity technologies and practices from design through implementatio

Need for Energy Management in Agricultural sector

- The world relies on agriculture to feed humanity. We simply cannot survive without food, and therefore, without agriculture. Energy is an essential component of agricultural production. It fuels the equipment, irrigates the crops, fertilizes the soil, sustains the livestock, transports the food, and processes the food into its final forms. As the population continues to grow, more agricultural production is required to support the increased food demand. At the same time, energy and environmental constraints mandate that agricultural production be accomplished effectively with minimal energy consumption. It is necessary to increase agricultural yields per unit area of land, while preserving the soil integrity and environment. Efficient energy management practices will help achieve and maintain this delicate balance.

- Energy is required for many aspects of the agriculture industry and the industries that support agriculture. Agriculture can be defined in several ways. In its most general sense, agriculture includes livestock, food crops, energy crops, fibers, ornamental plants, forestry activities, hunting, fishing, mariculture, and aquaculture.
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- There are many barriers to promoting energy efficiency in agriculture. Barriers include variations in geography, climate and industry structure, as well as a lack of information and access to the capital needed to implement efficiency upgrades. Federal programs that attempt to address these barriers have been important in driving the market towards efficient equipment and practices.

- Agriculture sector also consumes thousands of tonnes of High Speed Diesel (HSD) and LDO (light diesel oil).
- Study shows that present energy-use efficiencies in the agriculture sector are low and there exists a great potential for energy conservation in this sector. By eliminating inefficiencies in the tube wells, huge quantity of high speed diesel and electricity can be saved yearly. Similarly, by improving tractor efficiency, huge quantity of fuel per year can be saved.

- **Energy Conservation Opportunities in Pumps Used in Agriculture Sector:**
- In the context of Indian agriculture sector, majority of the energy used particularly the electricity is in pumping water for irrigation purpose. Water withdrawal is an energy intensive operation throughout the agriculture sector.
- In India, irrigation pumping electricity use is at the heart of the subsidy issue and along with other issues such as losses in power distribution are affecting the power sector performance. So, it is of utmost importance to conserve energy in all possible ways in water pumping area in agriculture sector along with efficient power supply distribution network. In agriculture farms, water is mostly pumped from tube wells by using pumps which are operated by electric motor or are engine driven operated from fuel such as diesel. Sometimes tractor engine is also used to drive the pump by using suitable transmission.
- In addition to this submersible pumps are also used, which are driven by specially designed motor fitted along with turbine and submerged in water and in some cases turbine is submerged in water and motor is mounted on the surface at ground level and motor-turbine connection is through shaft.

Tips to conserve energy in agricultural sector

- 1.Selection of right capacity of pumps according to the irrigation requirement.
- 2. Matching of pump set with source of water – canal or well.
- 3. Matching of motor with appropriate size pump.
- 4. Proper installation of the pump system – shaft alignment, coupling of motor and pump.
- 5. Use of efficient transmission system. Maintain right tension and alignment of transmission belts.
- 6. Use of low friction rigid PVC pipes and foot valves.
- 7. Avoid use unnecessary bends and throttle valves.
- 8. Use bends in place of elbows.
- 9. The suction depth of 6 meters is recommended as optimum for centrifugal pumps. The delivery line should be kept at minimum require height according to requirement.
- 10. Periodically check pump system and carryout corrective measures – like lubrication, alignment, tuning of engines and replacement of worn-out parts.
- 11. Over irrigation can harm the crops and waste vital water resource. Irrigate according to established norms for different crop.

- Use drip irrigation for specific crops like vegetable, fruits, tobacco, etc. Drip systems can conserve up to 80% water and reduce pumping energy requirement.
- 13. Tune up your tractor and farm machinery regularly.
- 14. Service your tube well/pumping station regularly.
- 15. Do not use tube well in morning/evening peak electricity consumption hours.
- 16. Irrigation during day time results in vaporization of large quantities of water, which can be saved if crops are irrigated during night time.
- 17. Rewind the burnt tube-well motor with good quality wire which not only prolongs the motor's life but also reduces your electricity bill.

Need for Energy Management in Domestic Sector

Lighting System

- One of the best energy-saving devices is the light switch. Turn off lights when not required.
- Many automatic devices can help in saving energy used in lighting. Consider employing infrared sensors, motion sensors, automatic timers, dimmers and solar cells wherever applicable, to switch on/off lighting circuits.
- As for as possible use task lighting, which focuses light where it's needed. A reading lamp, for example, lights only reading material rather than the whole room.
- Dirty tube lights and bulbs reflect less light and can absorb 50 percent of the light; dust your tube lights and lamps regularly.
- Fluorescent tube lights and CFLs convert electricity to visible light up to 5 times more efficiently than ordinary bulbs and thus save about 70% of electricity for the same lighting levels.
- Ninety percent of the energy consumed by an ordinary bulb (incandescent lamp) is given off as heat rather than visible light.
- Replace your electricity-guzzling ordinary bulbs (incandescent lamps) with more efficient types. Compact fluorescent lamps (CFLs) use up to 75 percent less electricity than incandescent lamps.
- A 15-watt compact fluorescent bulb produces the same amount of light as a 60-watt incandescent bulb.

Room Air Conditioners

- Use ceiling or table fan as first line of defense against summer heat. Ceiling fans, for instance, cost about 30 paisa an hour to operate - much less than air conditioners (Rs.10.00 per hour).
- You can reduce air-conditioning energy use by as much as 40 percent by shading your home's windows and walls. Plant trees and shrubs to keep the day's hottest sun off your house.
- One will use 3 to 5 percent less energy for each degree air conditioner is set above 22°C (71.5°F), so set the thermostat of room air conditioner at 25°C (77°F) to provide the most comfort at the least cost.
- Using ceiling or room fans allows you to set the thermostat higher because the air movement will cool the room.
- A good air conditioner will cool and dehumidify a room in about 30 minutes, so use a timer and leave the unit off for some time.
- Keep doors to air-conditioned rooms closed as often as possible.
- Clean the air-conditioner filter every month. A dirty air filter reduces airflow and may damage the unit. Clean filters enable the unit to cool down quickly and use less energy.
- If room air conditioner is older and needs repair, it's likely to be very inefficient. It may work out cheaper on life cycle costing to buy a new energy-efficient air conditioner.

Refrigerators

- Make sure that refrigerator is kept away from all sources of heat, including direct sunlight, radiators and appliances such as the oven, and cooking range. When it's dark, place a lit flashlight inside the refrigerator and close the door. If light around the door is seen, the seals need to be replaced.
- Refrigerator motors and compressors generate heat, so allow enough space for continuous airflow around refrigerator. If the heat can't escape, the refrigerator's cooling system will work harder and use more energy.
- A full refrigerator is a fine thing, but be sure to allow adequate air circulation inside.
- Think about what you need before opening refrigerator door. You'll reduce the amount of time the door remains open.
- Allow hot and warm foods to cool and cover them well before putting them in refrigerator. Refrigerator will use less energy and condensation will reduced.
- Make sure that refrigerator's rubber door seals are clean and tight. They should hold a slip of paper snugly. If paper slips out easily, replace the door seals.
- When dust builds up on refrigerator's condenser coils, the motor works harder and uses more electricity. Clean the coils regularly to make sure that air can circulate freely.
- For manual defrost refrigerator, accumulation of ice reduces the cooling power by acting as unwanted insulation. Defrost freezer compartment regularly for a manual defrost refrigerator.

Water Heater

- To help reduce heat loss, always insulate hot water pipes, especially where they run through unheated areas. Never insulate plastic pipes.
- By reducing the temperature setting of water heater from 60 degrees to 50 degrees C, one could save over 18 percent of the energy used at the higher setting.

Microwave Ovens &Electric Kettles

- Microwaves save energy by reducing cooking times. In fact, one can save up to 50 percent on your cooking energy costs by using a microwave oven instead of a regular oven, especially for small quantities of food.
- Remember, microwaves cook food from the outside edge toward the centre of the dish, so if you're cooking more than one item, place larger and thicker items on the outside.
- Use an electric kettle to heat water. It's more energy efficient than using an electric cook top element.
- When buying a new electric kettle, choose one that has an automatic shut-off button and a heat-resistant handle.
- It takes more energy to heat a dirty kettle. Regularly clean your electric kettle by combining boiling water and vinegar to remove mineral deposits.
- Don't overfill the kettle for just one drink. Heat only the amount of water you need.

Computers

- Turn off your home office equipment when not in use. A computer that runs 24 hours a day, for instance, uses - more power than an energy-efficient refrigerator.
- If your computer must be left on, turn off the monitor; this device alone uses more than half the system's energy.
- Setting computers, monitors, and copiers to use sleep-mode when not in use helps cut energy costs by approximately 40%.
- Battery chargers, such as those for laptops, cell phones and digital cameras, draw power whenever they are plugged in and are very inefficient. Pull the plug and save.
- Screen savers save computer screens, not energy. Start-ups and shutdowns do not use any extra energy, nor are they hard on your computer components. In fact, shutting computers down when you are finished using them actually reduces system wear - and saves energy

Energy Forecasting Techniques

Methods of Forecasting

- • Time Series

– trend analysis

- • Econometric

– structural analysis

- • End Use

– engineering analysis

Time Series Forecasting

- • Linear Trend

– fit the best straight line to the historical data and assume that the future will follow that line (works perfectly in the 1st

- example)– Many methods exist for finding the best fitting line, the most common is the least squares method.
- • Polynomial Trend
- – Fit the polynomial curve to the historical data and assumethat the future will follow that line– Can be done to any order of polynomial (square, cube, etc) but higher orders are usually needlessly complex
- • Logarithmic Trend
- – Fit an exponential curve to the historical data and assume that the future will follow that line

- Econometric Forecasting
- • Econometric models attempt to quantify the relationship between the parameter of interest (output variable) and a number of factors that affect the output variable.

Example

– Output variable

– Explanatory variable

• Economic activity

• Weather (HDD/CDD)

• Electricity price

• Natural gas price

• Fuel oil price

- Estimating Relationships

• Each explanatory variable affects the output variable in different ways. The relationships can be calculated via any of the methodsused in time series forecasting. Can be linear, polynomial, logarithmic…

•Relationships are determined simultaneously to find overall best fit.

• Relationships are commonly known as sensitivities

- End Use Forecasting
- End use forecasting looks at individualdevices, aka end uses (e.g., refrigerators)

•How many refrigerators are out there?

• How much electricity does a refrigerator use?

• How will the number of refrigerators change in the future?

• How will the amount of use per refrigerator change in the future?

• Repeat for other end uses

Energy Integration

- A number of factors are contributing to increases in renewable energy production. They include declining costs of electricity produced from renewable energy sources, regulatory and policy obligations and incentives, and moves to reduce pollution from fossil fuel-based power generation, including greenhouse gas emissions. While not all renewable energy sources are variable, wind and solar PV currently dominate the growth of renewable electricity production and their production tries to capture the freely available but varying amount of wind and solar irradiance. As the share of electricity produced from variable renewable resources grows, so does the need to integrate these resources at the lowest possible cost. Also, a future electric system characterized by a rising share of renewable energy will likely require concurrent changes to the existing transmission and distribution (T&D) infrastructure

- To foster sustainable, low-emission development, many countries are establishing ambitious renewable energy targets for their electricity supply. Because solar and wind tend to be more variable and uncertain than conventional sources, meeting these targets will involve changes to power system planning and operations. Grid integration is the practice of developing efficient ways to deliver variable renewable energy (VRE) to the grid. Good integration methods maximize the costeffectiveness of incorporating VRE into the power system while maintaining or increasing system stability and reliability
- When considering grid integration, policymakers, regulators, and system operators consider a variety of issues, which can be organized into four broad topics: • New renewable energy generation • New transmission • Increased system flexibility • Planning for a high RE future.

GRID INTEGRATION TERMINOLOGY

- Balancing area: the collection of generation, transmission, and loads within the metered boundaries of the responsible entity (i.e., the balancing authority) that maintains balance between electricity supply and demand within this boundary.
- Capacity value: the contribution of a power plant to reliably meet demand, measured either in terms of physical capacity (kW, MW, or GW) or as a fraction of the power plant’s nameplate capacity (%). Flexibility: the ability of a power system to respond to changes in electricity demand and supply.
- Demand response: voluntary (and compensated) load reduction used as a system reliability resource. Grid integration of renewable energy: the practice of power system planning, interconnection, and operation that enables efficient and cost-effective use of renewable energy while maintaining the stability and reliability of electricity delivery.
- Grid integration study: an analysis of a set of scenarios and sensitivities that seeks to inform the stakeholders on the ability and needs of a power system to accommodate significant VRE. Storage: technologies capable of storing electricity generated at one time and for use at a later time.
- Variable renewable energy (VRE): electricity generation technologies whose primary energy source varies over time and cannot easily be stored. VRE sources include solar, wind, ocean, and some hydropower generation technologies.
- Variability: the changes in power demand and/or the output of a generator due to underlying fluctuations in resource or load. Uncertainty: the inability to perfectly predict electricity demand and/or generator output.

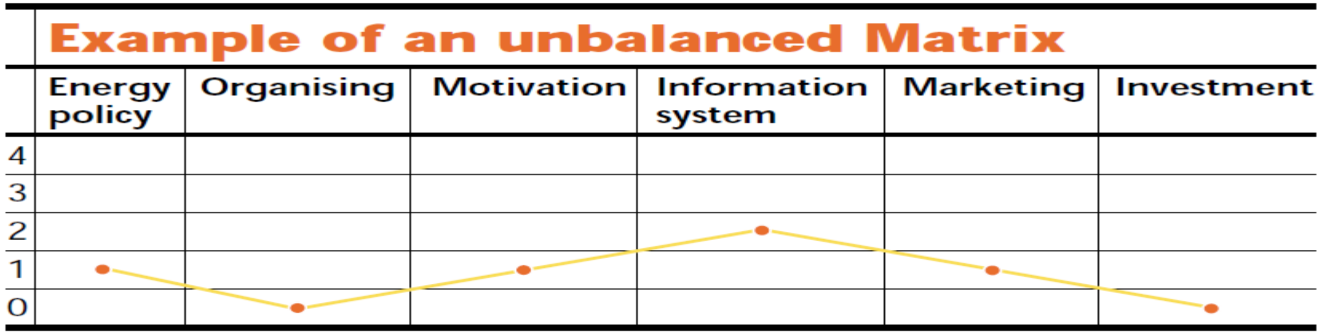
Energy Matrix

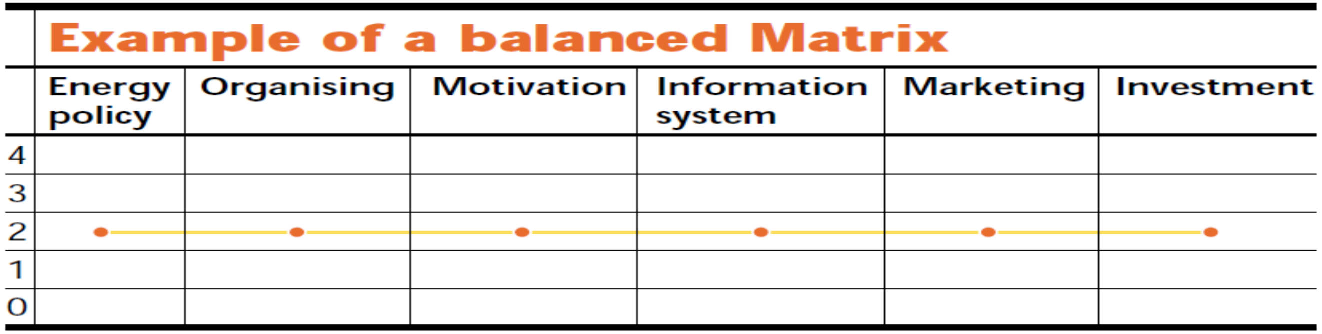
- The Energy Management Matrix has been devised to:

• assist you to identify and describe the current level of sophisticationof different aspects of energy management in your organisation;

• assist you in organising an energy management strategy.

- The Matrix provides an efficient, easy to use and effective methodof establishing your Organisational Profile.
- Reading the Matrix is quite simple. Each column deals with one of six crucialenergy management issues: policy, organisation, motivation, informationsystems, marketing and investment. The ascending rows, from 0 to 4,represent the increasingly sophisticated nature of these issues.


Example of an unbalanced Matrix
Energy policy
Organising
Motivation
Information system
Marketing
Investment
4
3
2
1
0


Example of a balanced Matrix
Energy policy
Organising
Motivation
Information system
Marketing
Investment
4
3
2
1
0

Level 0

- At this level, it is fair to say that energy management is not on yourorganisation’s agenda. There is no energy policy, no formal energymanagement structure, no means of reporting, and no specific person in charge of energy use.

Level 1

- Your organisation’s energy management situation starts to improve.While there is no official energy policy, someone has been delegated therole of energy manager. The energy manager promotes an awarenessof energy matters via a loose network of informal contacts with those directlyresponsible for energy consumption. This person also responds to requestsfor advice on an ad hoc basis.

Level 2

- Energy management is acknowledged as important by senior managementbut, in practice, there is little active commitment or support for energy management activities.

Level 3

- Senior managers acknowledge the value of an energy reduction program.Energy consumption issues are therefore integrated into the organisation’sstructure. There is a comprehensive information system and establishedsystem of reporting. There is also an agreed program for energy management and investing in energy efficiency.

Level 4

- Energy consumption is a major priority throughout the organisation.Actual performance is monitored against targets and the benefits of energyefficiency measures calculated. Achievements in energy management arewell reported and energy consumption is related to its impact on wider environmental issues. Senior management is committed to energy efficiency.