TUTORIAL - 1

Energy Scenario and Techniques for Energy Conservation

PARUL INSTITUTE OF ENGINEERING & TECHNOLOGY

1. Define Work, Power and Energy. Give unit of each.

1. Work

Work can be defined as transfer of energy. In physics we say that work is done on an object when you transfer energy to that object. If one object transfers (gives) energy to a second object, then the first object does work on the second object.

Work is the application of a force over a distance. Lifting a weight from the ground and putting it on a shelf is a good example of work. The force is equal to the weight of the object, and the distance is equal to the height of the shelf (W= Fxd).

The Joule is the unit of work.

1 Joule = 1 Newton * 1 meter

1 J = 1 N * m

2. Energy

Energy defines as "ability to do work" OR "capacity to do work" Energy is one of the major inputs for the economic development of any country. In the case of the developing countries, the energy sector assumes a critical importance in view of the ever increasing energy needs requiring huge investments to meet them.

- **Various Units of Energy**

Jules British Thermal Units(Btu) Kilowatt-hours (Kwh) Calorie Tones of oil equivalent (Toe)	**l Btu=1055.1 J** **1 kWh=3.6 MJ** **l cal=4.186 J**

3. Power

Power is the work done in a unit of time. In other words, power is a measure of how quickly work can be done. The unit of power is the **Watt = 1 Joule/ 1 second**.

One common unit of energy is the kilowatt-hour (kWh). If we are using one kW of power, a kWh of energy will last one hour.

2. Why energy conservation is important in the prevailing energy scenario?

- **Energy Conservation** Reduction in growth of energy consumption, measured in physical terms. Achieved as a result of several processes or developments such as productivity increase or technological progress.

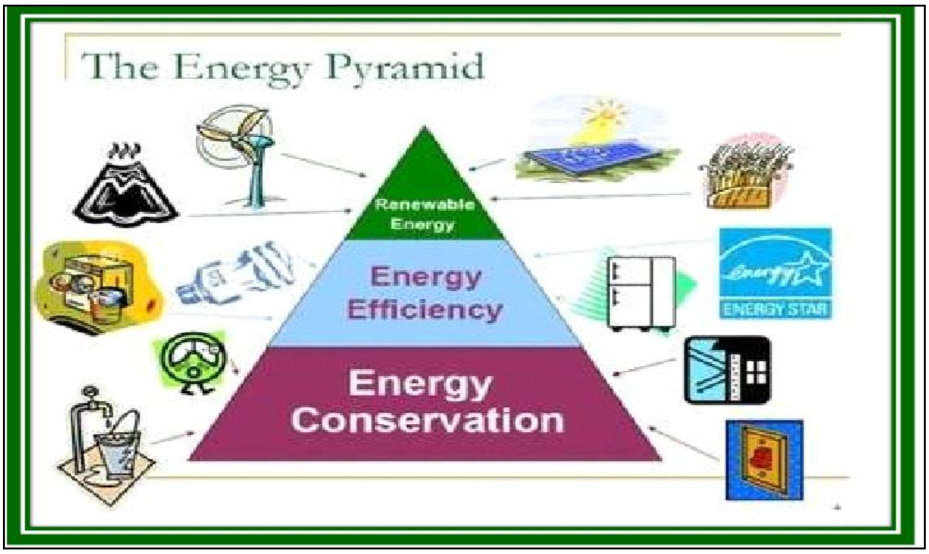


Figure: Energy Pyramid

- **Energy Efficiency** Reduction in energy intensity or reduction in consumption without affecting output, consumption or comfort levels. Achieved by using energy efficient systems, processes and equipments.

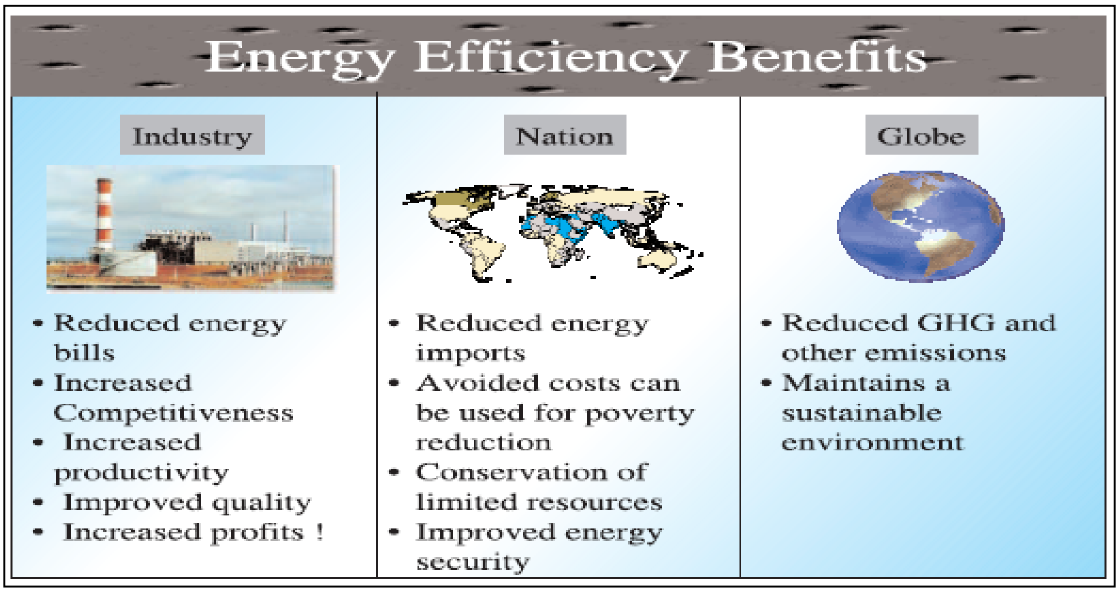


Figure: Energy Efficiency Benefits

Energy Conservation Objective

Broadly energy conservation program initiated at micro or macro level will have the following objectives of manufactured goods (either lower process or increased) availability and profitability, and in consequence raise the standard of living both of the workers in industry and of those who buy the products.

a. To reduce imports of energy and reduce the drain on foreign exchange.
b. To improve exports of manufactured goods (either lower process or increased availability helping sales) or of energy, or both.
c. To reduce environmental pollution per unit of industrial output - as carbon dioxide, smoke, sulphur dioxide, dust, grit or as coal mine discard for example.
d. Thus reducing the costs that pollution incurs either directly as damage, or as needing, special measures to combat it once pollutants are produced.
e. Generally to relieve shortage and improve development

Energy Conservation and Energy Efficiency are separate, but related concepts.

Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms.

Energy Conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress.

Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels.

Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies.

Energy conservation ACT 2001

- Enacted on 1st October 2001.
- Become effective from 1st March 2002.
- Objective of providing necessary legal framework for promoting energy conservation measures in the country.
- Bureau of Energy Efficiency (BEE) operationalized from 1st March2002.

Purpose of the EC-ACT 2001

- The purpose of this act is to provide for efficient use of energy and its conservation.
- Provide a policy framework and direction to national energy conservation activities.
- Coordinate policies and programs on efficient use of energy with stakeholders.
- Establish systems and procedures to verify measure and monitor EE improvements.
- Leverage multilateral, bilateral and private sector support to implement the EC Act.
- Demonstrate EE delivery systems through public-private partnerships.

- **Important Features Of Energy Conservation Act-2001**

  - Energy Conservation Building Code (ECBC)
  - Standards & Labeling (S & L)
  - Demand Side Management (DSM)
  - Bachat Lamp Yojana (BLY).
  - Promoting Energy Efficiency in Small & Medium Enterprise (SMEs).
  - Designated Consumers.
  - Certification of Energy Managers and Energy Auditors.

- **Conclusion of energy scenario**

To make sure we have plenty of energy in the future, it's up to all of us to use energy wisely. We must all conserve energy and use it efficiently. It's also up to those who will create the new energy technologies of the future.

All energy sources have an impact on the environment. Concerns about the greenhouse effect and global warming, air pollution, and energy security have led to increasing interest and more development in renewable energy sources such as solar, wind, geothermal, wave power and hydrogen. But we'll need to continue to use fossil fuels and nuclear energy until new, cleaner technologies can replace them.

- India, one of the stable economic country depend upon thermal power plant to meet 45 % demand
- To make future brighter India gear up to utilize renewable resources
- Still the share of renewable energy is not significant
- Various renewable energy mission launch by government of India
- Growth of renewable sector show that still in future thermal plant is a main source of energy.
- Nuclear plant and large hydro plant replace thermal power plant in future

Finally, Indian authorities will have the difficult task of not sacrificing the medium and long-term future to short-term and present pressure. Indeed, the capital needs for nuclear plants and infrastructure are larger than those for coal plants, and especially for coal plants that do not avoid local pollution. Nuclear is competitive only if one considers the operation of the plant for decades. In addition, if there is a premium for not emitting CO_2, then nuclear should be very competitive. But at the time decisions are made in a country that is developing rapidly, there may be very strong pressure to minimize the capital investment.

3. Briefly explain energy scenario in India. OR Discuss the current energy scenario of India.

Coal dominates the energy mix in India, contributing to 55% of the total primary energy production. Over the years, there has been a marked increase in the share of natural gas in primary energy production from 10% in 1994 to 13% in 1999. There has been a decline in the share of oil in primary energy production from 20% to 17% during the same period.

- **Coal Supply**

India has huge coal reserves, at least 84,396 million tons of proven recoverable reserves (atthe end of 2003). This amounts to almost 8.6% of the world reserves and it may last for about 230 years at the current Reserve to Production (R/P) ratio. In contrast, the world's proven coal reserves are expected to last only for 192 years at the current R/P ratio.

Reserves/Production (R/P) ratio- If the reserves remaining at the end of the year are divided by the production in that year, the result is the length of time that the remaining reserves would last if production were to continue at that level. India is the fourth largest producer of coal and lignite in the world. Coal production is concentrated in these states (Andhra Pradesh, Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra, Orissa, Jharkhand, and West Bengal).

- **Oil Supply**

Oil accounts for about 36 % of India's total energy consumption. India today is one of the top ten oil-guzzling nations in the world and will soon overtake Korea as the third largest consumer of oil in Asia after China and Japan. In the current scenario, India's oil consumption by end of 2007 is expected to reach 136 million tonne(MT), of which domestic production will be only 34 MT. India will have to pay an oil bill of roughly $50 billion, assuming a weighted average price of $50 per barrel of crude. In 2003- 04, against total export of $64 billion, oil imports accounted for $21 billion. India imports 70% of its crude needs mainly from gulf nations. The majority of India's roughly 5.4 billion barrels in oil reserves are located in the Bombay High, upper Assam, Cambay, and Krishna-Godavari. In terms of sector wise petroleum product consumption, transport accounts for 42% followed by domestic and industry with 24% and 24% respectively. India spent more than Rs.1, 10,000crore on oil imports at the end of 2004.

- **Natural Gas Supply**

Natural gas accounts for about 8.9 per cent of energy consumption in the country. The current demand for natural gas is about 96 million cubic metres per day (mcmd) as against availability of 67 mcmd. By 2007, the demand is expected to be around 200 mcmd. Natural gas reserves are estimated at 660 billion cubic meters.

- **Electrical Energy Supply**

The all India installed capacity of electric power generating stations under utilities was 1,12,581 MW as on 31st May 2004, consisting of 28,860 MW- hydro, 77,931 MW - thermal and 2,720 MW- nuclear and 1,869 MW- wind (Ministry of Power). The gross generation of power in the year 2002-2003 stood at 531 billion units (kWh).

- **Nuclear Power Supply**

Nuclear Power contributes to about 2.4 per cent of electricity generated in India. India has ten nuclear power reactors at five nuclear power stations producing electricity. More nuclear reactors have also been approved for construction.

- **Hydro Power Supply**

India is endowed with a vast and viable hydro potential for power generation of which only 15% has been harnessed so far. The share of hydropower in the country's total generated units has steadily decreased and it presently stands at 25% as on 31st May 2004. It is assessed that exploitable potential at 60% load factor is 84,000 MW.

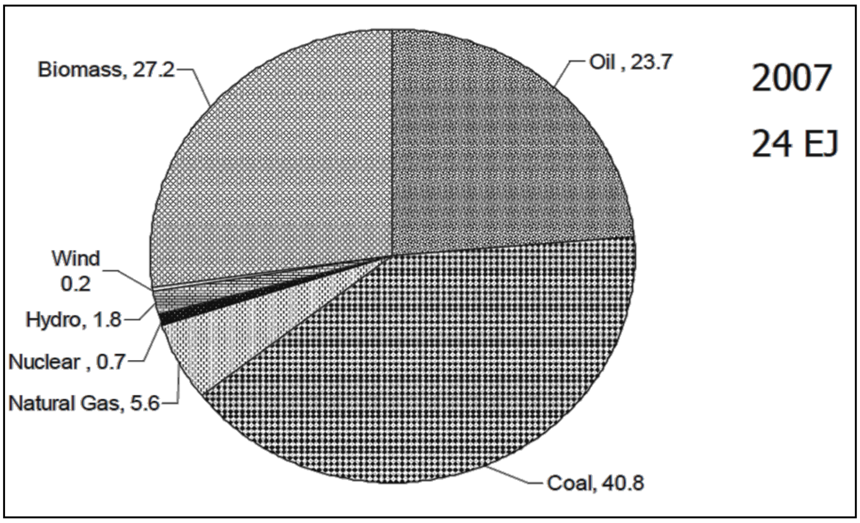


Figure: Primary Energy Mix for India

Final Energy Consumption

Final energy consumption is the actual energy demand at the user end. This is the difference between primary energy consumption and the losses that takes place in transport, transmission & distribution and refinement. The actual final energy consumption (past and projected) is given in Table.

Source	Units	1994-95	2001-02	2006-07	2011-12
Electricity	Billion Units	289.36	480.08	712.67	1067.88
Coal	Million Tonnes	76.67	109.01	134.99	173.47
Lignite	Million Tonnes	4.85	11.69	16.02	19.70
Natural Gas	Million Cubic Meters	9880	15730	18291	20853
Oil Products	Million Tonnes	63.55	99.89	139.95	196.47

Table: Demand for commercial energy for final consumption

Sector	1980/81	1990/91	1995/96	2000/01	2005/06	2010/11
Agriculture	1.6(2.3%)	4.9(3.9%)	8.4(5.3%)	15.2(7.9%)	15.1(6.9%)	23.14 (7.32%)
Industry	36.9(53.7%)	62.9(50.4%)	77.5(48.6%)	77.4(40.4%)	96.2(44.4%)	137.98 (43.62%)
Transport	17.4(25.3%)	28(22.4%)	37.2(23.4%)	33.5(17.5%)	36.5(16.8%)	55.34 (17.5%)
Residencial & Commercial	5.6(8.1%)	12.6(10.1%)	15.3(9.6%)	24.1(12.6%)	32.6(15.1%)	43.43 (13.73%)
Other energy uses	1.9(2.8%)	3.9(3.1%)	6.8(4.3%)	13.4(7.0%)	18.7(8.6%)	30.35 (9.56%)
Non – energy uses	5.3(7.7%)	12.6(10.9%)	14.1(8.8%)	28(14.6%)	17.5(8.1%)	26.15 (8.27%)
Total	68.7 (100%)	124.9 (100%)	159.3 (100%)	191.6 (100%)	216.6 (100%)	316.29 (100%)

Table: Final commercial energy consumption (In MTOE) in India By Sector

- India ranks sixth in the world in total energy consumption.
- India has increased installed power capacity from 1,362MW to over 1, 62,366MW since independence.
- India has electrified more than 50,000 villages.
- India is the Eleventh largest economy in the world, in terms of purchasing power.

4. Discuss present energy scenario in Gujarat.

India **Gujarat**

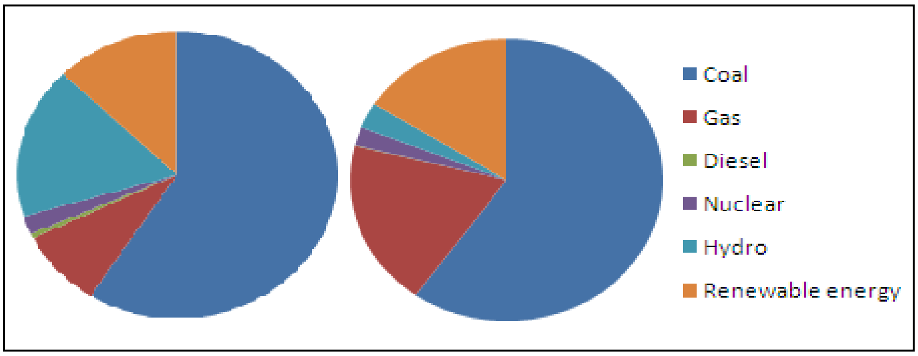


Figure: Total Installed Capacity - India vis-à-vis Gujarat

- **Non-Renewable energy scenario in Gujarat**
- **Natural gas**

Natural gas being energy efficient and pollution free fuel and the availability in Gujarat in abundance in the years to come will certainly increase the demand of natural gas in Gujarat in the times ahead. Other states have to bear transportation charges besides the burden of sales tax which is more than 10% and they do not have LNG terminal. In order therefore, to promote the use of natural gas available in the state extensively in the coming years for optimum benefits, the Government may consider reduction in the **sales tax tariff on the natural gas** at the appropriate time and in a revenue neutral way depending on the increase in volume and the price of natural gas.

- **Electricity**

Indian power sector is facing challenges despite the significant growth in generation capacity over the past few decades. The power situation in India is characterized by demand in excess of supply, high transmission and Distribution losses, peak demand and energy shortages, low plant load factors and decreasing availability of best quality fuel to run the power plants. However, over the last few years, Gujarat has successfully crossed all these barriers. Gujarat has become successful in securing its overall energy requirements with installed power generation capacity of 23,927 MW (as of Aug 2012).

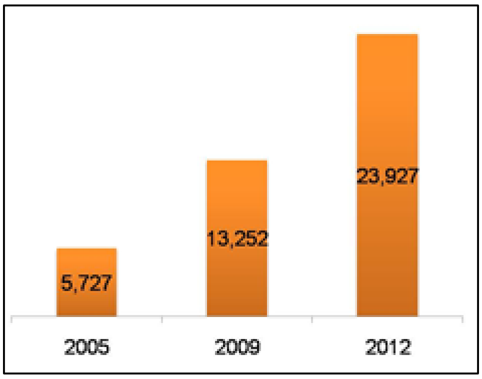


Figure: Installed electricity generation capacity in Gujarat (In MW)

- **Institutional structure of power sector in Gujarat**

In the year 1999, the state of Gujarat established the Gujarat Urja Vikas Nigam Limited (GUVNL) under the Companies Act, 1956. The GUVNL was created by the Gujarat Electricity Board (GEB) as its wholly owned subsidiary towards restructuring of the power sector for better management. GUVNL was incorporated as a Government of Gujarat Company which holds 100% of shares in the other six companies i.e. Gujarat State Electricity Corporation Limited(GSECL), Gujarat Energy Transmission Corporation Limited GETCO), Uttar Gujarat Vij Company Limited (UGVCL), Dakshin Gujarat Vij Company Limited (DGVCL), Madhya Gujarat Vij Company Limited (MGVCL) and Paschim Gujarat Vij Company Limited (PGVCL).

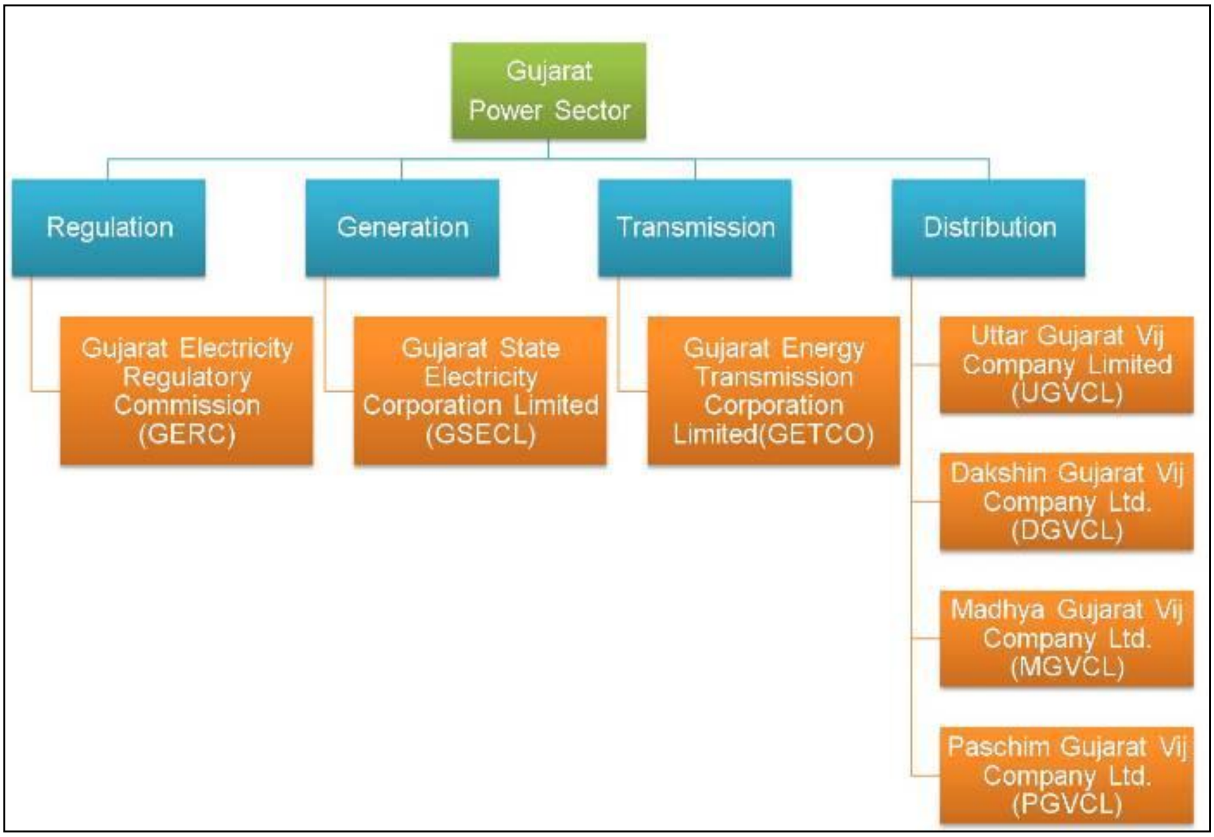


Figure: Institutional structure of power sector in Gujarat

All six companies are 100% subsidiaries of GUVNL. The GUVNL is engaged in Supervision, Co-ordination and facilitation of the activities of its six Subsidiary Companies.

Power supply-demand position in Gujarat As a result of growing installed power generation capacity, the peak demand-peak deficit in the state has decreased by Compound Annual Growth Rate of 31%.

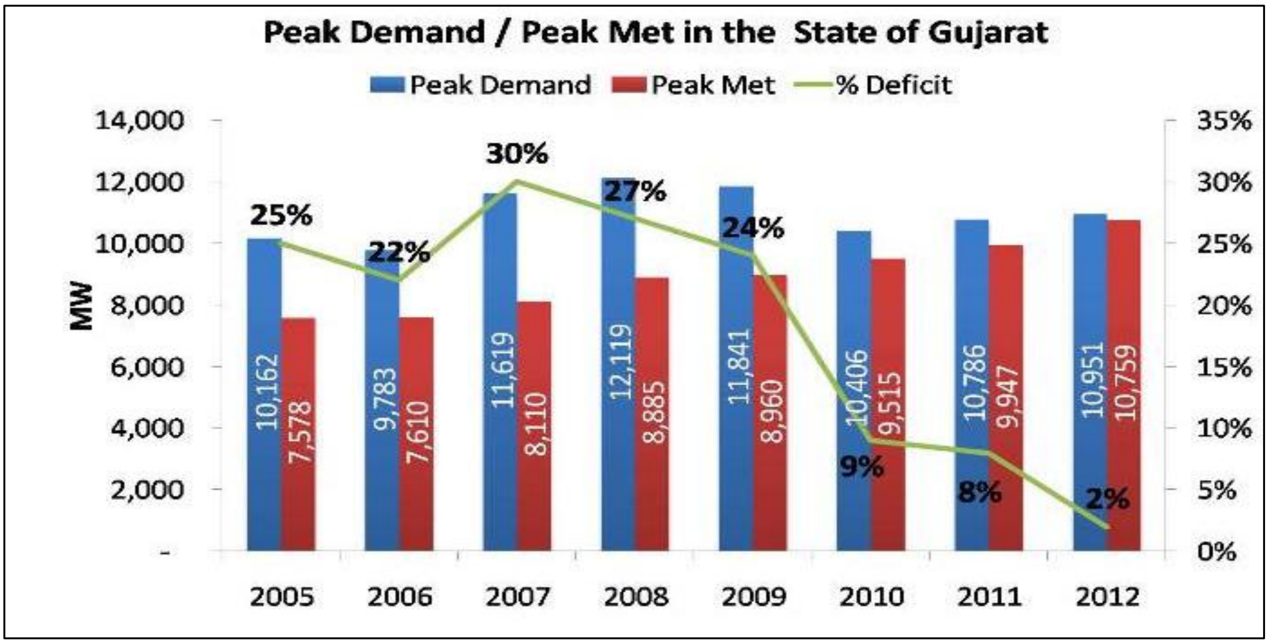


Figure: Peak Demand and Peak Met in the State of Gujarat, Source: CEA

Actual power supply position of the state of Gujarat has improved in the last seven years considerably. The power requirement and availability deficit in the state has been decreased by CAGR of 38%. Year 2012 shows nearly zero percent deficit made Gujarat power sufficient.

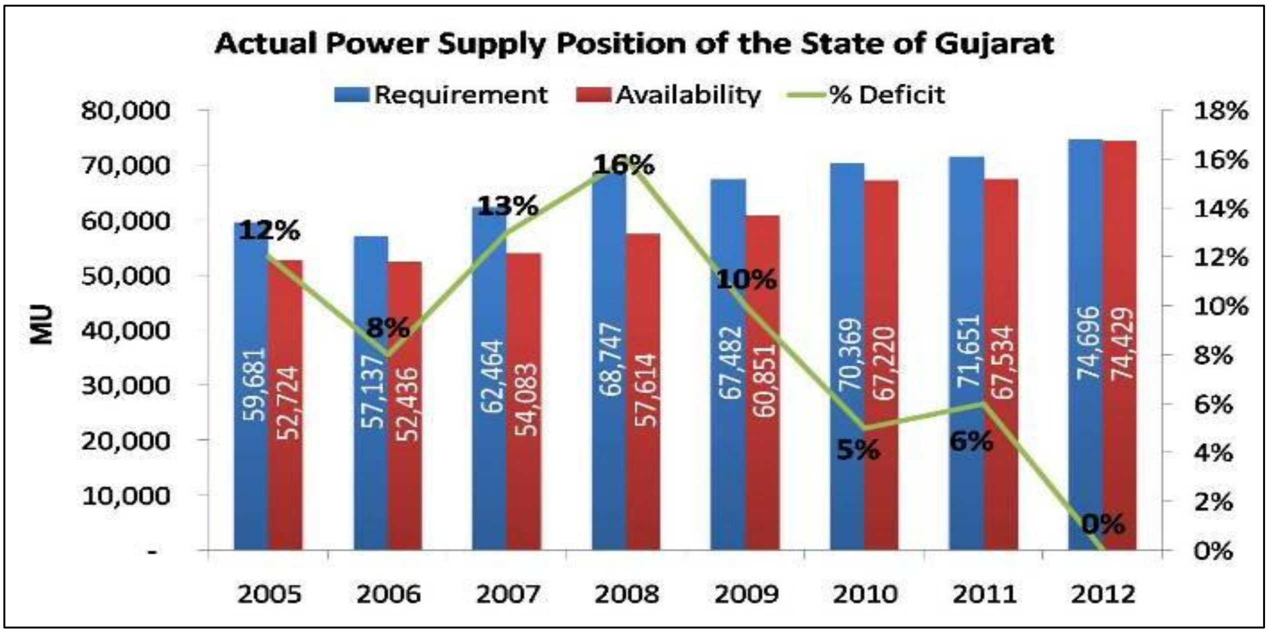


Figure: Actual Power Supply Position of the State of Gujarat, Source: CEA

- **Renewable energy scenario in Gujarat**

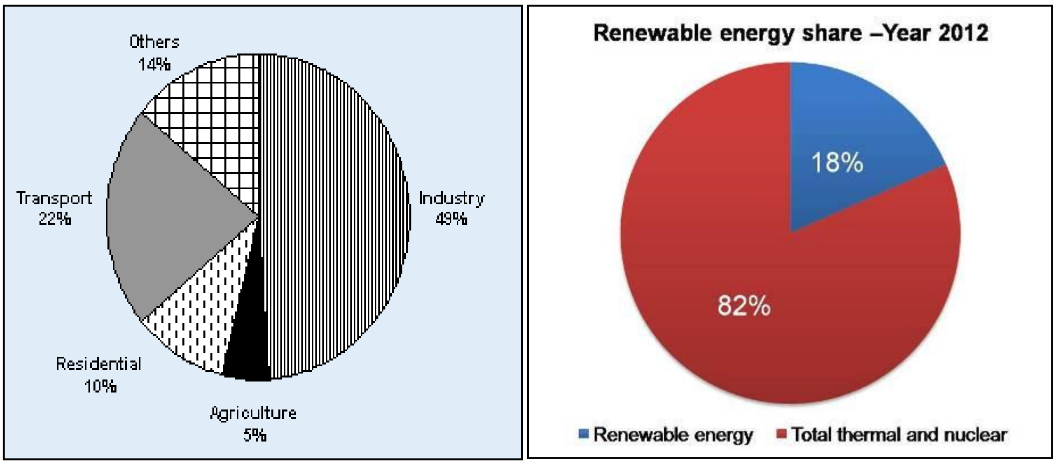


Figure: Renewable energy scenario in Gujarat

Gujarat is rich in solar energy, biomass and wind energy. It is also the leading state in terms of overall solar energy installation in India. As part of its renewable energy promotion policy, Gujarat enacted the country's first Wind Energy policy in 1993 and become the first state with a Solar Policy in 2009. As per the Gujarat Energy Development Agency (GEDA), the state has tremendous renewable energy potential; Table showing renewable energy potential of the state of Gujarat.

Table: Energy Generation in Gujarat

Source	Resource	Energy Generation/Saving Potential
Solar	Solar Radiation 300 days	5.6 -6.0 kwh/m^2/ day
Biomass	24 million tones	900 MW of electric power could be generated to meet energy requirements of almost all villages in Gujarat.
Biogas	200 lakh cattle population (Dung avaible at 70% collection efficiency)	Could generate 5.6 million cubic meter of biogas per day to cater cooking gas to 2.8 million families or generate electric power equivalent to 933 MW
Biogas Energy Plantation	67 lakh hectare wasteland	Could yield 67 million tons of Biomass which can sustain power generation to the order of 15000 MW
Wind	Coastline and hilly regions	5000 MWe
Tidal	Gulf of Kachchh Gulf of Khambhat	9000 MWe 9000 MWe

The economics time quoted, "Gujarat's overall integrated renewable energy potential is estimated to be around 748.77 GW. A study conducted by TERI, Gujarat's potential for concentrated solar power (CSP) with water availability stands at 345.71 GW, solar photovoltaic (SPV) wind hybrid excluding CSP at 240.60 GW, only SPV excluding wind and CSP at 21.36 GW, only wind excluding solar potential at 139.21 GW and biomass at 1.89 GW." (ET, 20 April 2012).

Increasing power generation capacity in each year along with the growing share of Renewable energy in its total energy mix has made Gujarat a prominent destination for investment. Gujarat government is positively looking towards renewable energy which reduces dependency on conventional fuel. Let's hope for a similar model in other parts of the country.

- **Solar**
  Gujarat has the highest solar generation potential in India–300 days of 5.6 to 6 kWh/sq.m/day solar radiations& to generate 10000 MW from 1% of available wasteland. Gujarat is the first state to achieve its RPO target.

- **Wind**
  Gujarat has a potential to generate 12000 MW, whereas total capacity installed till date is 3010 MW which costs to approx. Rs. 60 million per MW.

- **Bio**
  Bio Gas Plant–1500 MT3/day added and Biomass Gasifier Plant-1500 MT3/day added.

- **Geo thermal**
  Available in plenty in the geothermal zone located in Cambay between Narmada and Tap River. Gujarat has plans to generate 10,000MW in a decade.

- **Tidal**
  India's first tidal energy plant Of 50 MW plant at the Gulf of Kutch.

5. Explain the principles of energy conservation OR discuss various methods of energy conservation.

Some general principles of energy conservation are explained below –

I. **Recycling of Wastes:** Using recycled material almost always consumes less energy than using new materials. Recycling reduces energy needs for mining, refining, and many other manufacturing processes.

II. **Modernization of Technology:** Modern energy efficient technology should be adopted by replacing/retrofitting the existing old inefficient equipment.

III. **Waste Heat Utilization:** Waste heat recovery or waste heat utilization is effective principle to save energy in various industrial processes. Various industrial processes require heat of different grades. Waste heat from one process serves the need of another, which requires heat at lower grade.

IV. **Judicial Use of Proper Type of Energy and Fuel:** There are different forms of energy. But, for economic reason, one should never use a higher-grade energy than required. A cheaper primary source should be proffered wherever possible in place of a costly one.

V. **Co-generation:** It is nothing but a generation of electricity and heat in a single installation, which is feasible and economically viable, instead of separate generation of electricity and heat.

VI. **Proper Lighting Practices:** In the typical home, lighting accounts for six percent of the total energy bill. Much of this expense is unnecessary, caused by using inefficient incandescent light bulbs. Only 10 percent of the energy consumed by an incandescent bulb produces light; the remainder is given off as heat. Compact fluorescent light bulbs (CFLs) provide the equivalent amount of light. Although CFLs cost more initially, they save money in the long run because they use only one- quarter the energy of an equivalent incandescent bulb and last 10 times longer.

VII. **Training of Manpower/Public Awareness:** Awareness among the people is very important and hence they should be trained to adopt habits for efficient use of energy. Unknowingly the people are wasting a tremendous energy in the form of electricity and other.

VIII. **Proper operation and maintenance:** In case of equipment, machineries, appliances etc., proper lubrication, proper thermal insulation, proper leakage reduction/elimination etc. is important as this is the part of energy conservation.

6. What are the economic impacts of energy conservation?

Energy Conservation is the deliberate practice or an attempt to save electricity, fuel oil or gas or any other combustible material, to be able to put to additional use for additional productivity without spending any additional resources or money. Conservation reduces the energy costs and improves the profitability.

Energy saving is important and effective at all levels of human organizations in the whole world, as a nation, as companies or individuals.

Energy Conservation reduces the energy costs and improves the profitability. The nation-wide Energy Conservation efforts will contribute to lessening dependence on imported energy such as crude oils.

Private companies are also sensitive to energy costs, which directly affects their profitability and even their viability in many cases. Especially factories in the industrial sectors are of much concern, because reduced costs by Energy Conservation mean the more competitive product prices in the world markets and that is good for the national trade balance too.

Energy conservation ultimately leads to economic benefits as the cost of production is reduced. In some energy- intensive industries like steel, aluminum, cement, fertilizer, pulp and paper, the cost of energy forms a significant part of the total cost of product. Energy cost as a percent of total cost of product in the entire industrial sector in India varies from as low as 0.36% to as high as 65%.

Energy conservation usually requires new investments in more energy efficient equipment to replace old inefficient ones, monitoring of energy consumption, training of manpower etc. Thus energy conservation can result in new job opportunities.

7. Briefly explain conservation of commercial energy sources.

The energy sources that are available in the market for a definite price are known as Commercial energy, e.g., electricity, coal, and refined petroleum products. Commercial energy forms the basis of industrial, agriculture, transport and commercial development.

Commercial energy sources are

- Oil
- Coal
- Natural gas
- Electricity etc.

➢ **Energy Conservation tips for Oil**

- Plug all oil leakage. Leakage of one drop of oil per second amounts to a loss of over 2,000 litres/year.
- Filter oil in stages. Impurities in oil affect combustion.
- Pre-heat the Oil. For proper combustion, oil should be at right viscosity at the burner tip. Provide heat capacity.
- Use of low air pressure "film burners" helps save oil up to 15 per cent in furnaces.

➢ **Energy Conservation technologies of Coal**

- Sub-critical Pulverized coal firing with steam pressure and temperature below 22.00 MPa and 550 degree centigrade with generating efficiency of 33 to 37%.
- Circulating Fluidised-Bed Combustion technology (CFBC) where air is combined in combustion process in a circulating fluid bed. Lime stone, used as fluidising material, is especially useful for low quality Indian coal with high ash content and Lignite.
- Integrated Gas Combined Cycle (IGCC) – It is a superior technology involving coal gasification, driving gas turbines with 20% more efficiency than conventional pulverized Combustion technologies, with low emission of carbon dioxide Nitrous Oxide sulphur dioxide. Ash discharged in the form of molten slag could be used in construction works
- Underground Coal Gasification.
- Coal bed Methane

- **Energy Conservation tips of Natural Gas**

1. **In Buildings:**

- **Optimize combustion efficiency.**

  Inspect furnaces, space heaters, and water heaters. Tune and adjust natural gas burners to achieve proper excess air settings and uniform, efficient combustion.

- **Lower thermostat settings.**

  For each degree the thermostat setting can be lowered, a 3 percent reduction in fuel consumption can be achieved. Relax the dress code to allow the use of warmer clothing.

- **Lower setback temperatures during unoccupied periods.**

  For a typical building, a 10 percent reduction in annual fuel consumption can be achieved if the thermostat setting is lowered 10 degrees an average of 8 hours each day.

- **Minimize outdoor air use for ventilation consistent with code requirements.**

  Many large installations use 100 percent outside air to ventilate hazardous areas, meaning that none of the heated air is recirculate.

- **Shut off nonessential equipment and spaces.**

  Isolate unoccupied building areas to further reduce space temperatures and provide only minimum freeze protection.

- **Reduce and eliminate major sources of infiltration.**

  Leakage of outside air into heated spaces during the coldest winter days can be the largest single contributor to the heating load in some buildings. Keep large overhead doors tightly closed in warehouses, hangars, and industrial buildings.

2. **In Central Heating Plants**

- **Optimize combustion efficiency.**

  Maintaining too much excess air is a common occurrence and unnecessarily wastes fuel. It is important to maintain steady excess air levels, which ensure that burners will mix air and fuel efficiently and assure complete combustion.

- **Minimize boiler blowdown.**

  Reliable steam plan operation requires that a portion of the boiler water be discharged to drain in order to maintain solids concentrations. Blowdown rates are often excessive and waste fuel. Plant personnel should continuously monitor boiler blowdown to minimize energy losses.

- **Optimize boiler loading.**

  Selected boilers should be shut down during the low load periods so that the remaining boilers can operate at higher, more efficient firing rates.

- **Perform boiler maintenance.**

  Clean combustion chamber and heat transfer surfaces. Stack temperature more than 150 degrees Fahrenheit above steam temperature often indicates the presence of excessive water-side scaling, which can reduce heat transfer and increase fuel consumption by as much as 10 percent.

3. **In cooking appliances**

- **Turn it off, turn it down, and keep it clean**

  Some cooking appliances can really guzzle the energy so it's important to turn them off or down when they are not being used. Posting a start-up and shutdown schedule on the appliance is one way to give the kitchen staff guidance.

- **Specify ENERGY STAR Steamers**

  When purchasing new equipment, an easy way to identify energy efficient steamers is to look for the ENERGY STAR logo. An ENERGY STAR qualified appliance will save thousands of dollars in utilities over its lifetime.

- **Pay attention to the thermostat**

  Install an ENERGY STAR programmable thermostat with a locking cover and make sure it is set properly. Thermostats should be set to 68°F for occupied hours and 55°F for unoccupied hours.

- **Check the ductwork for leaks**

  It is common for ventilation ductwork to become loose or separated, spilling heat into crawl spaces or the space above the ceiling tiles where it is simply wasted.

- **Maintain the dishwasher and use it wisely**

  A poorly maintained dish machine will waste precious hot water. Fix any leaks and replace worn rinse nozzles.

- **Tune up the hot water heater**

  Heating water is expensive; so maximize the performance of hot water heating system to minimize natural gas use. Set the water heater thermostat to 140°F and verify by measuring the temperature at the pot-sink or pre-rinse station closest to the dish machine.

- **Energy Conservation tips of Electricity:**

  1. Replace five lights with ENERGY STAR® light bulbs and save 62 kwh.
  2. Turn off lights, appliances, TVs, stereos, computers, when not in use and save 58 kwh.
  3. If you have a large television (greater than 32"), turn it off when not watching and save 50 kwh.
  4. Unplug your electric space heater or hot tub and save 270 kwh.
  5. Unplug and recycle your old, second refrigerator and save 150 kwh.
  6. Washing your clothes in cold water can save 63 kwh.
  7. Repair leaky faucets and save on your electric hot water. You can save 40 kwh.
  8. Unplug chargers, laptops, anything with remote control or "instant on" features and save 29 kwh.
  9. On your electric dryer: clean dryer filter, clean and straighten exhaust hose/duct and vent outside and save 23kwh.
  10. When buying new appliances, always choose ENERGY STAR. This can save 75 kwh.

8. List down the various energy conservation opportunities available in a steam system?

1. Attend to steam leaks in steam lines and valves.
2. Providing Dry Steam for Process
3. Proper Utilization of Directly Injected Steam
4. Minimizing Heat Transfer Barriers
5. Proper Air Venting
6. Insulation of Steam Pipelines and Hot Process Equipments

1. Attend to steam leaks in steam lines and valves.

Steam leakage is a visible indicator of waste and must be avoided. It has been estimated that a 3 mm diameter hole on a pipeline carrying 7kg/cm^2 steam would waste 33 KL of fuel oil per year. Steam leaks on high-pressure mains are prohibitively costlier than on low pressure mains. Any steam leakage must be quickly attended to. In fact, the plant should consider a regular surveillance programme for identifying leaks at pipelines, valves, flanges and joints. Indeed, by plugging all leakages, one may be surprised at the extent of fuel savings, which may reach up to 5% of the steam consumption in a small or medium scale industry or even higher in installations having several process departments.

2. Providing Dry Steam for Process

The best steam for industrial process heating is the dry saturated steam. Wet steam reduces total heat in the steam. Also water forms a wet film on heat transfer and overloads traps and condensate equipment. Superheated steam is not desirable for process heating because it gives up heat at a rate slower than the condensation heat transfer of saturated steam.

Boiler without a superheated cannot deliver perfectly dry saturated steam. At best, it can deliver only 95% dry steam. The dryness fraction of steam depends on various factors, such as the level of water to be a part of the steam. Indeed, even as simple a thing as improper boiler water treatment can become a cause for wet steam. As steam flows through the pipelines, it undergoes progressive condensation due to the loss of heat to the colder surroundings. The extent of the condensation depends on the effectiveness of the lagging.

Wet steam can reduce plant productivity and product quality, and can cause damage to most items of plant and equipment. Since dry saturated steam is required for process equipment, due attention must be paid to the boiler operation and lagging of the pipelines.

3. Proper Utilization of Directly Injected Steam

The heating of a liquid by direct injection of steam is often desirable. The equipment required is relatively simple, cheap and easy to maintain. No condensate recovery system is necessary. The heating is quick, and the sensible heat of the steam is also used up along with the latent heat, making the process thermally efficient. In processes where dilution is not a problem, heating is done by blowing steam into the liquid (i.e.) direct steam injection is applied. If the dilution of the tank contents and agitation are not acceptable in the process (i.e.) direct steam agitation are not acceptable, indirect steam heating is the only answer.

Ideally, the injected steam should be condensed completely as the bubbles rise through the liquid. This is possible only if the inlet steam pressures are kept very low around 0.5kg/cm^2 and certainly not exceeding 1 kg/cm^2. If pressures are high, the velocity of the steam bubbles will also be high and they will not get sufficient time to condense before they reach the surface.

4. Minimising Heat Transfer Barriers

The metal wall may not be the only barrier in a heat transfer process. There is likely to be a film of air, condensate and scale on the steam side. On the product side there may also be baked-on product or scale, and a stagnant film of product.
Regular cleaning of the surface on the steam side may also increase the rate of heat transfer by reducing the thickness of any layer of scale, however, this may not always be possible. This layer may also be reduced by careful attention to the correct operation of the boiler, and the removal of water droplets carrying impurities from the boiler.

5. Proper Air Venting

When steam is first admitted to a pipe after a period of shutdown, the pipe is full of air. Further amounts of air and other non-condensable gases will enter with the steam, although the proportions of these gases are normally very small compared with the steam. When the steam condenses, these gases will accumulate in pipes and heat exchangers. Precautions should be taken to discharge them. The consequence of not removing air is a lengthy warming up period and a reduction in plant efficiency and process performance.

Air in a steam system will also affect the system temperature. Air will exert its own pressure within the system, and will be added to the pressure of the steam to give a total pressure. Therefore, the actual steam pressure and temperature of the steam/air mixture will be lower than that suggested by a pressure gauge of more importance is the effect air has upon heat transfer. It is very important therefore to remove air from any steam system.

Automatic air vents for steam systems (which operate on the same principle as thermostatic steam traps) should be fitted above the condensate level so that only air or steam/air mixtures can reach them. The best location for them is at the end of the steam mains.

6. **Insulation of Steam Pipelines and Hot Process Equipments**

   Heat can be lost due to radiation from steam pipes. As an example while lagging steam pipes, it is common to see leaving flanges uncovered. An uncovered flange is equivalent to leaving 0.6 metre of pipe line unlagged. If a 0.15 m steam pipe diameter has 5 uncovered flanges, there would be a loss of heat equivalent to wasting 5 tons of coal or 3000 litres of oil a year. This is usually done to facilitate checking the condition of flange but at the cost of considerable heat loss.

9. What are the potentially available resources of energy?

1. Non-Renewable Resources of Energy:

Those natural resources which are exhaustible and cannot be replaced once they are used. Examples are fossil fuels such as coal, oil and gas which together supply 98% of the total world energy demand today.

Table 1 shows reserved and consumed fuel by India and World. While Table2 shows the fossile fuel reserves in India. **Coal Reserves.** Put the country's coal reserves (up to a depth of 1200 m) at nearly 34000 million tones. **Oil Reserves the** worldwide proved oil reserves stand at 3522.5 million tones, in India it is 700million tones

	Proved reserve	consumption
India	700	97.7
World	142700	3522.5

Table: Proven Oil Reserve/Consumption (in Million Tones): India vs. World

Fuel	Reserves
Coal +Lignite (Million Tonnes)	34000
Oil (Million Tonnes)	760
N.Gas Billion m3	920
Uranium Tonnes	61000

Table: India - Fossil Fuel reserves

Renewable Energy- Renewable sources of energy are those natural resources which are inexhaustible and can be used to produce energy again and again. Examples are solar energy, wind energy, geothermal energy, tidal energy, water energy and bio energy.

2. Hydro Energy:

Hydroelectric energy is produced by the force of falling water. When water builds up behind a high dam, it accumulates potential energy. This is transformed into mechanical energy when the water is released and strikes the blades of a turbine. The turbine's rotation spins electromagnets that generate a current in stationary coils of wire. Finally, the current is put through a transformer where the voltage is increased for long-distance transmission over power lines. The power of water is harnessed to provide electricity for our homes, make machines work and more.

3. Solar Energy:

Solar energy is the radiant energy (light or heat) that comes from the sun. Only a small amount of the sun's energy strikes the Earth, one part per 2 million. But even that one part is an enormous amount of energy.

4. Geothermal Energy:

Geothermal energy comes from the heat stored in the Earth's core, about 4,000 miles/ 1,609 kilometres below the surface, and heat from the sun warming the Earth. The word geothermal originates from the Greek words geo (earth) and therme (heat).The ground is a good insulator and stores the heat as energy. Pipes are run through a large area several feet underground. Water is heated as it passes through these pipes. New drilling technologies are being researched and developed to capture the heat in deeper areas.

5. Wind energy:

Wind energy is the process by which the wind is used to generate mechanical power or electricity.

10.Discuss the energy consumption pattern.

India is the second largest commercial energy consumer in Non-OECD **(**Organisation for Economic Co-operation and Development**)** East Asia, comprising 19 percent of the region's total primary energy consumption. Economic growth in India has largely been associated with increased energy consumption. While 60% of total energy needs in India are met by commercial energy sources, remaining 40% are comprised of non-conventional fuels.

Energy Use profile for Indian Economy

Sectorial demand for energy arises mainly from lighting and cooking in the household sector; irrigation and other operations in the agricultural sector; transport of passengers and freight and fuel input requirements in the industrial sector. Table 1 shows sector-wise activity level and energy consumption pattern in India.

Indicator Analysis

Energy use can be viewed as a function of total GDP, structure of the economy and technology. Aggregate energy intensity is taken as an energy performance indicator in energy demand analysis. Literature on indicator analysis adopts either of the two approaches: energy consumption approach or energy intensity approach. We follow the intensity approach and decompose total energy-GDP ratio into structural effect (S.E) and intensity effect (I.E). Structural effect shows that part of change in energy use which is attributable to change in activity composition of an economy. Intensity effect tells us that keeping GDP effect and structural effect unchanged, what has been the change in energy use solely due to conservation measures. Figure 1 and accompanying table show the respective values for the structural effect (Dstr), intensity effect (Dint) and the total effect (Dtot) comprising of these two effects.

Year	Industry	Agriculture	Domestic	Commercial	Traction and Railways	Others	Total energy consumed
2007-08	1,89,424	1,04,182	1,20,918	46,685	11,108	29,660	5,01,977
	(37.74)	(20.75)	(24.09)	(9.30)	(2.21)	(5.91)	(100.00)
2008-09	2,09,474	1,09,610	1,31,720	54,189	11,425	37,577	5,53,995
	(37.81)	(19.79)	(23.78)	(9.78)	(2.06)	(6.78)	(100.00)
2009-10*	2,36,752	1,20,209	1,46,080	60,600	12,408	36,595	6,12,645
	(38.64)	(19.62)	(23.85)	(9.89)	(2.03)	(5.97)	(100.00)

Table: Sector wise energy consumption pattern in India

Sectoral Energy Intensity

Based on that projected GDP (from 2006-2030), future Energy Consumption has been calculated up to the year of 2030. From the trend (1990-2006) of Energy Consumption, average Energy Consumption has been calculated. And found a constant Energy Consumption (EC) values. This constant value is added with the previous successive years EC to get next year Energy Consumption (EC) up to the year of 2030. So, annual GDP and Energy Consumption up to 2030 have been estimated on the basis of collected data and trend analysis.

This can be traced to demographic changes, including relatively faster growth in urban areas, high per capita GDP, penetration of more end use devices, technological improvements in conversion equipment and inter-fuel substitution with more efficient alternatives in the energy intensive industries.

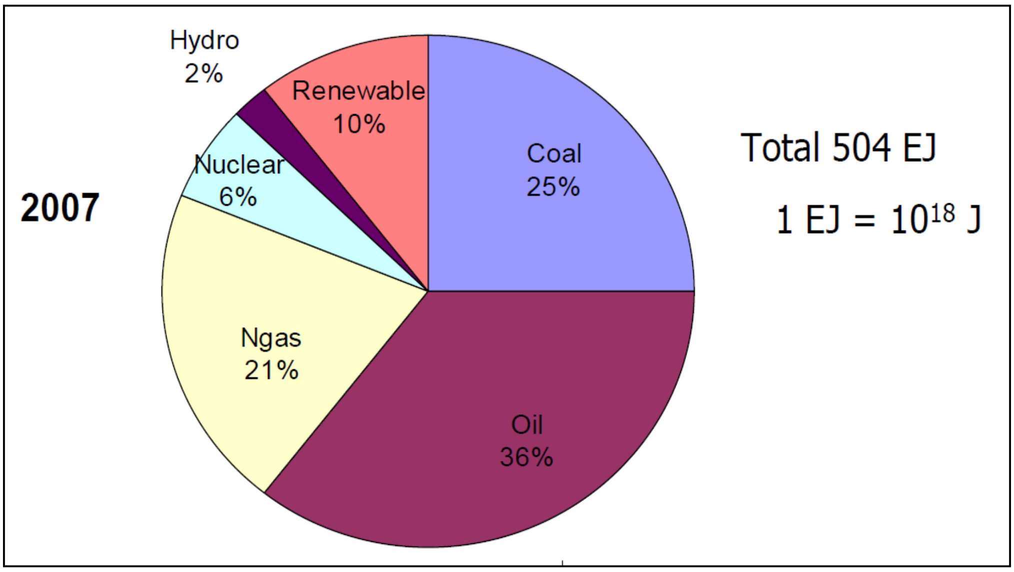
Since sectoral output growth is the main contributing factor to rising energy intensity, one might think that policies should be designed to curb this growth. However, this would mean imposition of real cost on the economy. Hence, policy alternatives should see how to offset this increasing output effect by negative intensity and structural effects. Declining structural effect can be achieved by a greater shift towards non-energy intensive industries, expansion of service sector etc. Negative trend in intensity effects can be intensified by inter-fuel substitution, introducing efficient technology to improve energy productivity.

Per- capita Energy Consumption & Energy Intensity

Per-capita Energy Consumption (PEC) during a year is computed as the ratio of the estimate of total energy consumption during the year to the estimated mid-year population of that year. Energy Intensity is defined as the amount of energy consumed for generating one unit of Gross Domestic Product (At constant prices).

There is the graph shows the consumption pattern all over the world shown below.

- **World Primary Energy Consumption:**



11.How is economic growth linked to energy consumption?

It is recognized that energy consumption and economic growth are related, but the direction of this relationship is not always clear, for example, when does a country's economic growth stimulate energy consumption or when does increased energy consumption of a country promote its economic growth?

It is thought that an increasing share of renewable energy in the energy mix of a country can help meet the growing future demand for energy while influencing economic development. As well as reducing the environmental impact associated with fossil fuels, renewable energy sources can increase diversity of energy sources and, potentially, contribute to energy security and to the long-term availability of energy supply. Renewable energy sources can also promote regional development as they can be used in less developed areas without conventional energy sources, and could reduce costs associated with climate change.

In this study, the researchers explored the relationship between energy consumption and economic growth in the EU, using an average of all 27 Member States, plus Romania and Spain as examples of two individual Members States, for the period 1990 to 2010. The researchers tracked gross domestic product (GDP) per capita to represent economic growth. Energy consumption came from coal, oil, natural gas and renewable sources. Renewable sources included biomass, hydropower, geothermal energy, wind and solar energy.

Results from the analysis reveal that during this time, the share of renewable energies in the energy mix has been steadily increasing both in Romania and Spain, but also in the whole of the EU. For Romania, energy consumption, which is based on natural gas, petroleum products and renewables, is likely in the long-term to stimulate economic growth. For Spain, energy consumption, which is based on natural gas and petroleum products is also likely in the long-term, to stimulate economic growth. For the EU-27, in the long-term, energy consumption based on renewables and petroleum products are likely to stimulate economic development.

In the short-term, increasing energy consumption, including that from renewable sources, stimulates economic growth for Romania. Similarly, energy consumption, based primarily on natural gas, promotes economic growth in Spain in the short-term. But for the whole of the EU, in the short-term, there was no clear relationship between economic growth and energy consumption.

Renewables were seen to play a significant role in economic growth In Spain, development of renewable energy is taking place at twice the rate of Romania, even though, for example, renewables accounted for about 7% of its overall energy consumption, compared with about 12% of energy consumption in Romania in 2007. The results of this study suggest that increasing exploitation of renewable energies would be beneficial to the Romanian economy. Being aware of the marked influence of renewable energy on growth helps decision makers to define specific measures for developing the infrastructure needed to produce green energy. At the same time, decision makers are able to design aid schemes for promoting renewable energy and attracting investors.

12. Write a note on energy efficient machines. OR Briefly explain energy efficient equipment.

Efficient energy use, sometimes simply called energy efficiency, is the goal to reduce the amount of energy required to provide products and services. For example, insulating a home allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Installing fluorescent lights or natural skylights reduces the amount of energy required to attain the same level of illumination compared with using traditional incandescent light bulbs. Compact fluorescent lights use one-third the energy of incandescent lights and may last 6 to 10 times longer. Improvements in energy efficiency are generally achieved by adopting a more efficient technology or production processes or by application of commonly accepted methods to reduce energy losses.

There are many motivations to improve energy efficiency. Reducing energy use reduces energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy efficient technology. Reducing energy use is also seen as a solution to the problem of reducing carbon dioxide emissions. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases.

- **Automatic Power Factor Controllers**

Various types of automatic power factor controls are available with relay / microprocessor logic. Two of the most common controls are: Voltage Control and kVAr Control

1. Voltage Control

Voltage alone can be used as a source of intelligence when the switched capacitors are applied at point where the circuit voltage decreases as circuit load increases. Generally, where they are applied the voltage should decrease as circuit load increases and the drop in voltage should be around 4 – 5 % with increasing load.

Voltage is the most common type of intelligence used in substation applications, when maintaining a particular voltage is of prime importance. This type of control is independent of load cycle. During light load time and low source voltage, this may give leading PF at the sub-station, which is to be taken note of.

2. KILOVAR Control

Figure: KVAR

Kilovar sensitive controls (see Figure) are used at locations where the voltage level is closely regulated and not avail-able as a control variable. The capacitors can be switched to respond to a decreasing power factor as a result of change in system loading. This type of control can also be used to avoid penalty on low power factor by adding capacitors in steps as the system power factor begins to lag behind the desired value. Kilovar control requires two inputs - current and voltage from the incoming feeder, which are fed to the PF correction mechanism, either the microprocessor or the relay.

It controls the power factor of the installation by giving signals to switch on or off power fac-tor correction capacitors. Relay is the brain of control circuit and needs contactors of appropri-ate rating for switching on/off the capacitors.

There is a built-in power factor transducer, which measures the power factor of the installation and converts it to a DC voltage of appropriate polarity. This is compared with a reference voltage, which can be set by means of a knob calibrated in terms of power fac-tor

When the power factor falls below setting, the capacitors are switched on in sequence. The relays are provided with First in First out (FIFO) and First in Last Out (FILO) sequence. The capacitors controlled by the relay must be of the same rating and they are switched on/off in lin-ear sequence. To prevent over correction hunting, a dead band is provided. This setting deter-mines the range of phase angle over which the relay does not respond; only when the PF goes beyond this range, the relay acts. When the load is low, the effect of the capacitors is more pro-nounced and may lead to hunting. Under current blocking (low current cut out) shuts off the relay, switching off all capacitors one by one in sequence, when load current is below setting. Special timing sequences ensure that capacitors are fully discharged before they are switched in. This avoids dangerous over voltage transient. The solid state indicating lamps (LEDS) dis-play various functions that the operator should know and also and indicate each capacitor switching stage.

3. Soft Starter

When starting, AC Induction motor develops more torque than is required at full speed. This stress is transferred to the mechanical trans-mission system resulting in excessive wear and premature failure of chains, belts, gears, mechanical seals, etc. Additionally, rapid acceleration also has a massive impact on electricity supply charges with high inrush currents drawing +600% of the normal run current.

The use of Star Delta only provides a partial solution to the problem. Should the motor slow down during the transition period, the high peaks can be repeated and can even exceed direct on line current.

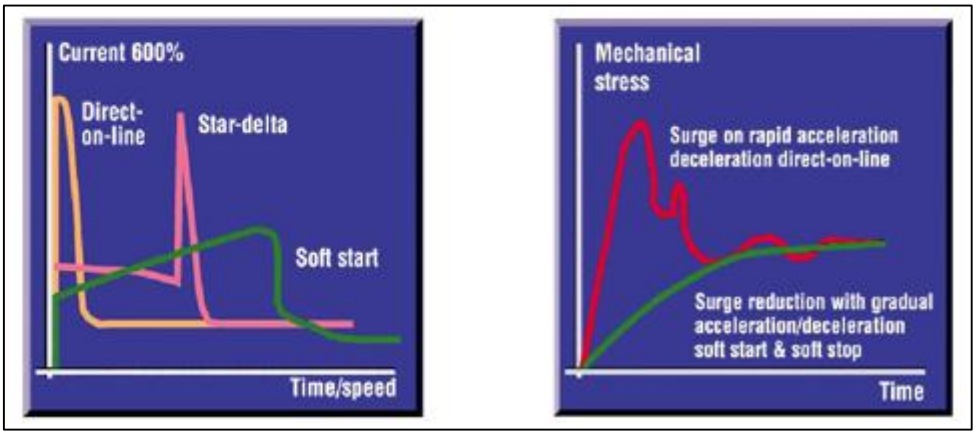


Figure: Soft Starter: Starting current, Stress profile during starting

Soft starter provides a reliable and economical solution to these problems by delivering a controlled release of power to the motor, thereby providing smooth, step less acceleration and deceleration. Motor life will be extended as damage to windings and bearings is reduced. Soft Start & Soft Stop is built into 3 phase units, providing controlled starting and stopping with a selection of ramp times and current limit settings to suit all applications (see Figure).

- **Advantages of Soft Starter**
  - ✓ Less mechanical stress
  - ✓ Improved power factor.
  - ✓ Lower maximum demand.