# Unit No: 01 "Source of Electrical Energy."

Q.1 Mention the different sources of energy. (S-17-6M)

Ans: The different sources of energy are water, sun, wind, terrestial heat, ocean tides & fuels, radioactive substances etc.

Q.2: state the advantages of electrical energy over other energy forms?

Ans: The advantages are listed below

Advantages

i) Electrical energy is comparatively cheaper to that of other forms of energy.

ii) its transmission over a long distance through conductors of suitable size is convenient as well as efficient.

iii) Electrical system starting, control & operation is very simple & convenient.

iv) Electric drive & heating do not produce any smoke, dust & other undesirable conditions.

v) Electrical systems are flexible i.e. electric power can be taken to any corner of the house, factory, street, hospital, mines etc.

W-16 (8M)

Q3 What are the different types of power stations which are used to generate electric power

1) Thermal power station: The main principle of generation of electric power is to use thermal energy of fuel mostly coal to generate steam from water in the boiler & to run the steam turbine by introducing this steam into the steam turbine, which produces mechanical energy. This mechanical energy drives the generators, the turbo-alternators in this case, which generate the power.

2) Hydro power station: The naturally available water is the main source of energy in these type of stations. This water is diverted by building the diversion dams. Also these dams provides the required head, which is necessary for the power station production. The water is stored behind this dam, which is used during the dry season of the year to have continuity in power generation. The water at required head is taken to the power house though penstocks, under pressure, which drives the hydraulic turbines in the power-house which, in turn, are coupled to generators which generate the power

3) Nuclear power station: The nuclear reactor is the main working part in this station. The nuclear fission of radioactive elements generate the great amount of heat, which can be used up to generate steam. The main fuel in these power station is Uranium. The uranium is bombarded by the neutron

which causes the fission of uranium atom with liberation of more neutrons which causes the fission of nearby uranium atoms. Thus chain reactions continues & this reaction is controlled in nuclear reactor. The large amount of heat in this process is carried away by cooling medium which transfer it to heat exchanger which in turn generates steam which drives the steam turbine & the electric power is generated.

4) Diesel power station : The diesel power station are outdated now-a day since the main fuel used is diesel oil which is very costly. The diesel engine is the main working part of diesel station. This engine may be two-stroke or four stroke. This engine produces mechanical power, which in turn is used to drive the alternator to generate the steam.

This station is not economical & may be used as emergency plant.

Q4 Explain base load plants & peak load plants
(S-16/4M)

The changing load on the power station makes it's load curve of variable nature. Fig. 1 shows typical load curve of power station. It is clear that load on the power station varies from time to time. However, a clock look at the load curve reveals that load on the power station can be considered in two parts
i> Base load
ii> peak load

i> Base load : The unvarying load which occurs almost the whole day on the station is known as base load.
Reffering to the load curve of fig. 1, it is clear that 20 MW of load has to be supplied by the station at all times of days & night i.e. throughout 24 hr. Therefore 20 MW is the base load of the station. As base load on the station is almost of constant nature, therefore, it can be suitably supplied without facing the problems of variable loads.

ii> peak load : The various peak demand of load over & above base load of the station is known as peak load

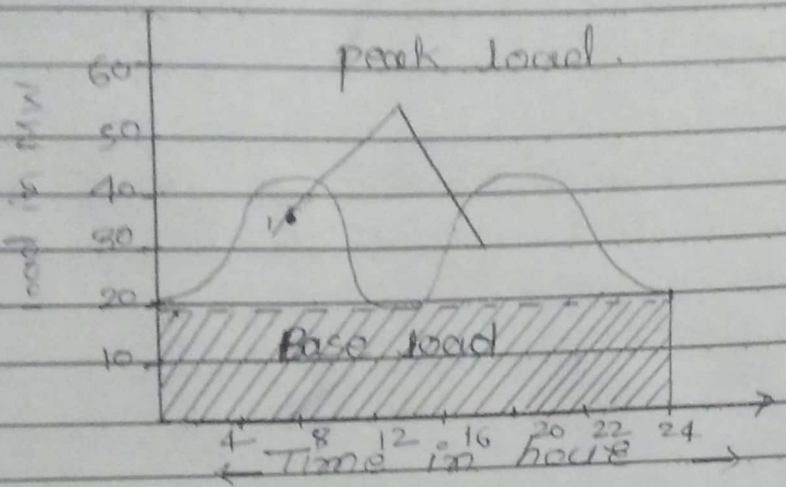



fig 1>

Reffering to the load curve of fig 1 it is clear that there are peak demand of load excluding base load. These peak demand of the station generally form a small part of the total load & may occur throughout the day.

5. Load curve

The curve showing the variation of load on the power station with respect to time is known as load curve

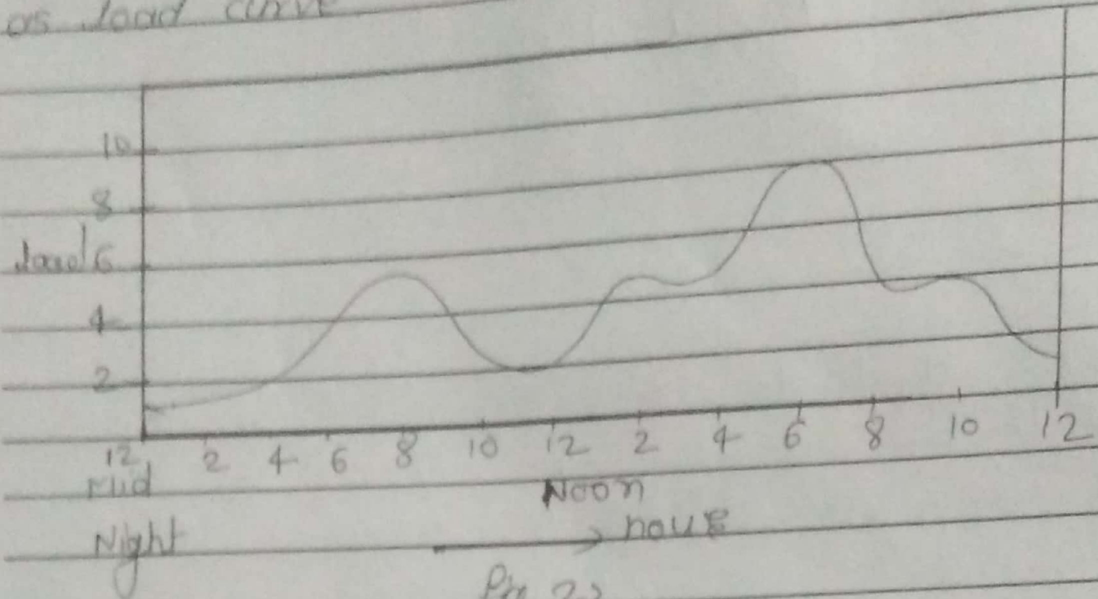



fig 2)

The load curve on a power station is never constant; it varies from time to time. The load variation during the day are recorded half-hourly or hourly & are plotted against time on graph. This curve thus obtained is known as daily load curve as it shows the variations of load w.r.to time during the day. fig 2 shows a typical daily load curve of power station.

it is clear that load on the power station is varying being maximum at 6pm. in this case it may be seen that load curve indicates at a a glance the general character of the load that is being imposed on the plant.

6. Definations

(W-16/S-17/S-18) 6M)

1) Connected load: it is the sum of continuous rating of all the equipment connected to supply system

2) Maximum demand: It is the greatest demand of load on the power station during a given period

3) Demand factor: it is the ratio of maximum demand on the power station to it's connected load i.e

$$\text{Demand factor} = \frac{\text{maximum demand}}{\text{connected load}}$$

4) Average load: The average of load occurring on the power station in a given period is (day or month or year) is known as average load or average demand.

$$\text{Daily average load} = \frac{\text{No. of unit (KWh) generated in day}}{24 \text{ hours}}$$

$$\text{monthly average load} = \frac{\text{No. of unit (KWh) generated in a month}}{\text{No. of hour in month}}$$

$$\text{yearly average load} = \frac{\text{No. of units (KWh) generated in year}}{8760 \text{ hr}}$$

5) Load factor: The ratio of average load to to the maximum demand during a given period of is called load factor.

$$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}}$$

If the plant is in operation for T hour.

$$\text{Load factor} = \frac{\text{Average load} \times T}{\text{Max. demand} \times T}$$

$$= \frac{\text{Units generated in T hours}}{\text{max. demand} \times \text{T. hours}}$$

6) Diversity factor: The ratio of the sum of individual maximum demand to the maximum demand on power station is known as diversity factor i.e

$$\text{Diversity factor} = \frac{\text{Sum of Individual max demand}}{\text{max. demand on power stat}^{n}}$$

7) plant capacity factor: it is the ratio of actual energy produced to the maximum possible energy that could have been produ--ced during a given period i.e

$$\text{plant capacity factor} = \frac{\text{Actual energy produced}}{\text{max. energy that could have been produced}}$$

$$= \frac{\text{Average demand} \times T}{\text{plant capacity} \times T}$$

$$= \frac{\text{Average demand}}{\text{plant capacity}}$$

8) plant use factor : It is ratio kWh generated to the product of plant capacity & the number of hours for which the plant was in operation i.e

$$\text{plant use factor} = \frac{\text{station output in kWh}}{\text{plant capacity} \times \text{hours of use}}$$

$$\text{plant use factor} = \frac{7.35 \times 10^6}{(20 \times 10^3) \times 2190}$$

$$= 0.167 = 16.7\%$$

9) utilisation factor =

Subject: Name of Faculty:

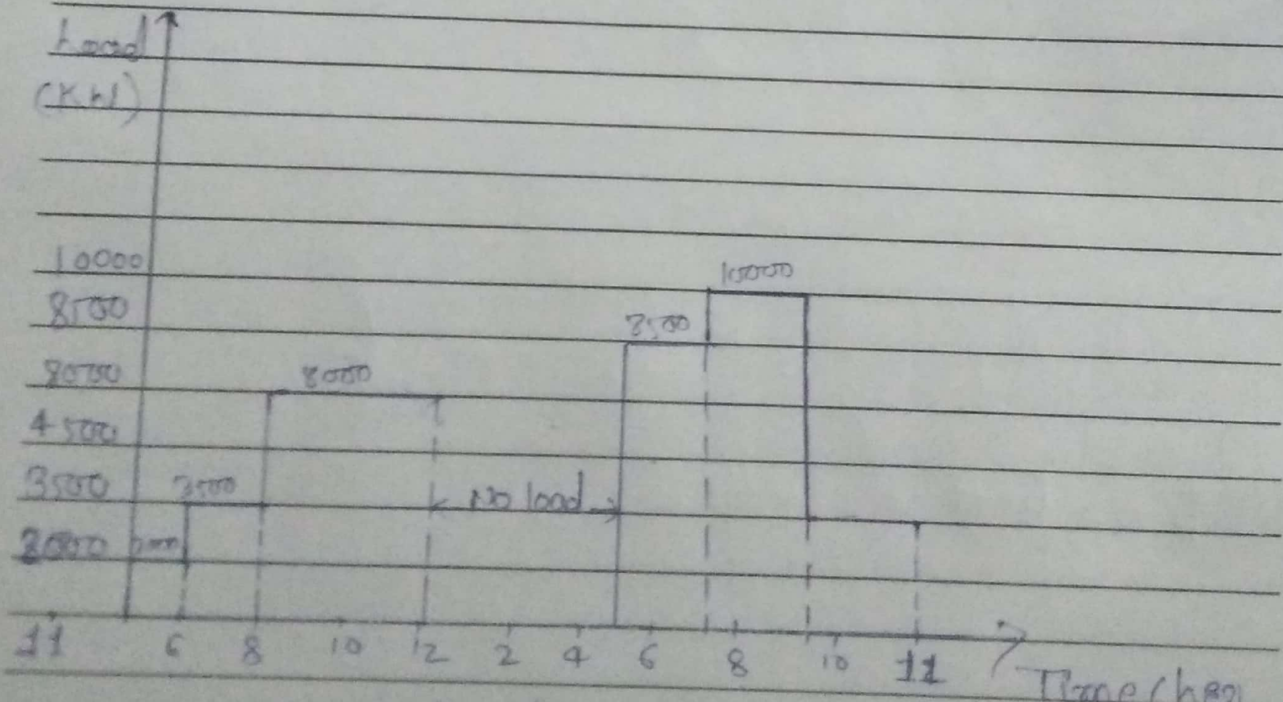
Numerical

(S-16/10 Marks)

1) A station has maximum demand of 10,000 kW & a daily load on station is as follows

| | |
|---|---|
| 11 pm to 6 am | 2000 kW |
| 6 am to 8 am | 3500 kW |
| 8 am to 12 am | 8000 kW |
| 12 noon to 5 pm | No load |
| 5 pm to 7 pm | 8500 kW |
| 7 pm to 9 pm | 10,000 kW |
| 9 pm to 11 pm | 4500 kW |

calculate load factor & plant capacity factor




Load curve

Maximum demand = 10,000 kW

Area under load curve gives the energy generated during 24 hrs

∴ The energy generated in 24 hours

$= 2000 \times 7 + 3500 \times 2 + 8000 \times 4 + 8500 \times 2 + 10000 \times 2 + 4500 \times 2$

$= 99000$ kW

∴ Load factor = $\frac{\text{Energy generated during 24 hrs}}{\text{maximum demand} \times 24 \text{ hrs}}$

$= \frac{99000}{10000 \times 24}$

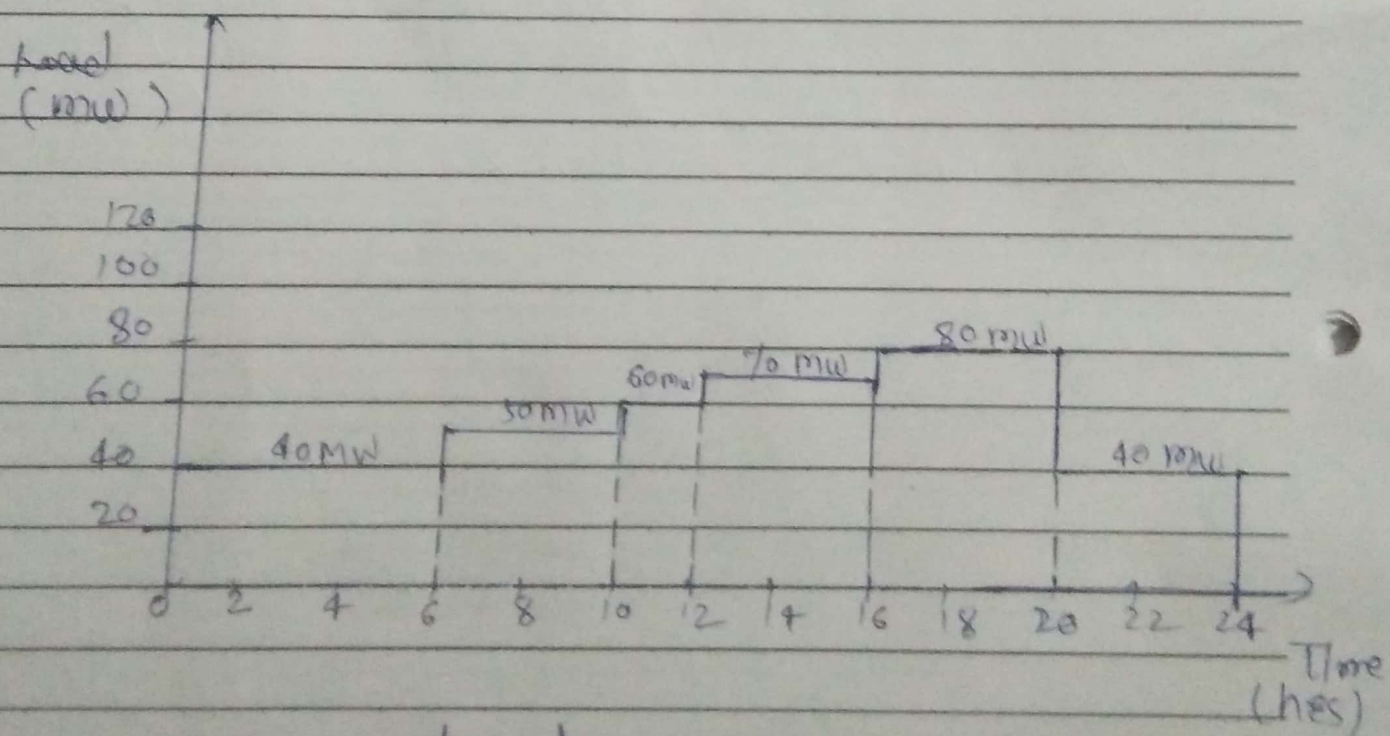
Load factor = 41.2 %

8) A generating station has the following daily load cycle (S-17/8M)

| Time (hrs) | Load MW |
|---|---|
| 0 - 6 | 40 |
| 6 - 10 | 50 |
| 10 - 12 | 60 |
| 12 - 16 | 70 |
| 16 - 20 | 80 |
| 20 - 24 | 40 |

Draw Load curve & find i) Load factor ii) KWh. iii) Average demand iv) maximum demand.

Sol^n:




Load curve

Sol^n:

i) Energy generated during 24 hr

$= 40\times6 + 50\times4 + 60\times2 + 70\times4 + 80\times4 + 40\times4$

$= 1320$ MWh

ii) Maximum demand = 80 MW

iii) Load factor = $\frac{\text{Energy generated during 24 hrs}}{\text{maximum demand} \times 24 \text{ hrs}}$

$= \frac{1320}{80} \times \frac{1}{24} = 68.75\%$

iii) Average demand = $\frac{\text{Energy generated during 24 hrs}}{24}$

$= \frac{1320}{24}$

Average demand = 55 MW

9) Draw a load curve from the following data

| | |
|---|---|
| 23 hrs to 5 hrs | 0.5 MW |
| 5 hrs to 9 hrs | 1.425 MW |
| 9 hrs to 12 hrs | 2 MW |
| 12 hrs to 13 hrs | 1.5 MW |
| 13 hrs to 17 hrs | 2.5 MW |
| 17 hrs to 19 hrs | 2 MW |
| 19 hrs to 21 hrs | 2.5 MW |
| 21 hrs to 23 hrs | 1 MW |

Calculate load factor. choose the number & size of units of supply this load. find reserve capacity.

soln: maximum demand = 2500 kW.

Area under load curve gives the energy generated during 24 hours

$\therefore$ Energy generated in 24 hours
$= 500 \times 6 + 1425 \times (4) + 2000(3) + 1500(1) + 2500(4)$
$+ 2000(2) + 2500(2) + 1000(2)$

$= 37200$ kW

Load factor $= \dfrac{\text{Energy generated during 24}}{\text{Maximum demand} \times 24 \text{ hrs}}$

$= \dfrac{37200 \text{ kW}}{2500 \times 24} \times 100 = 62\%$



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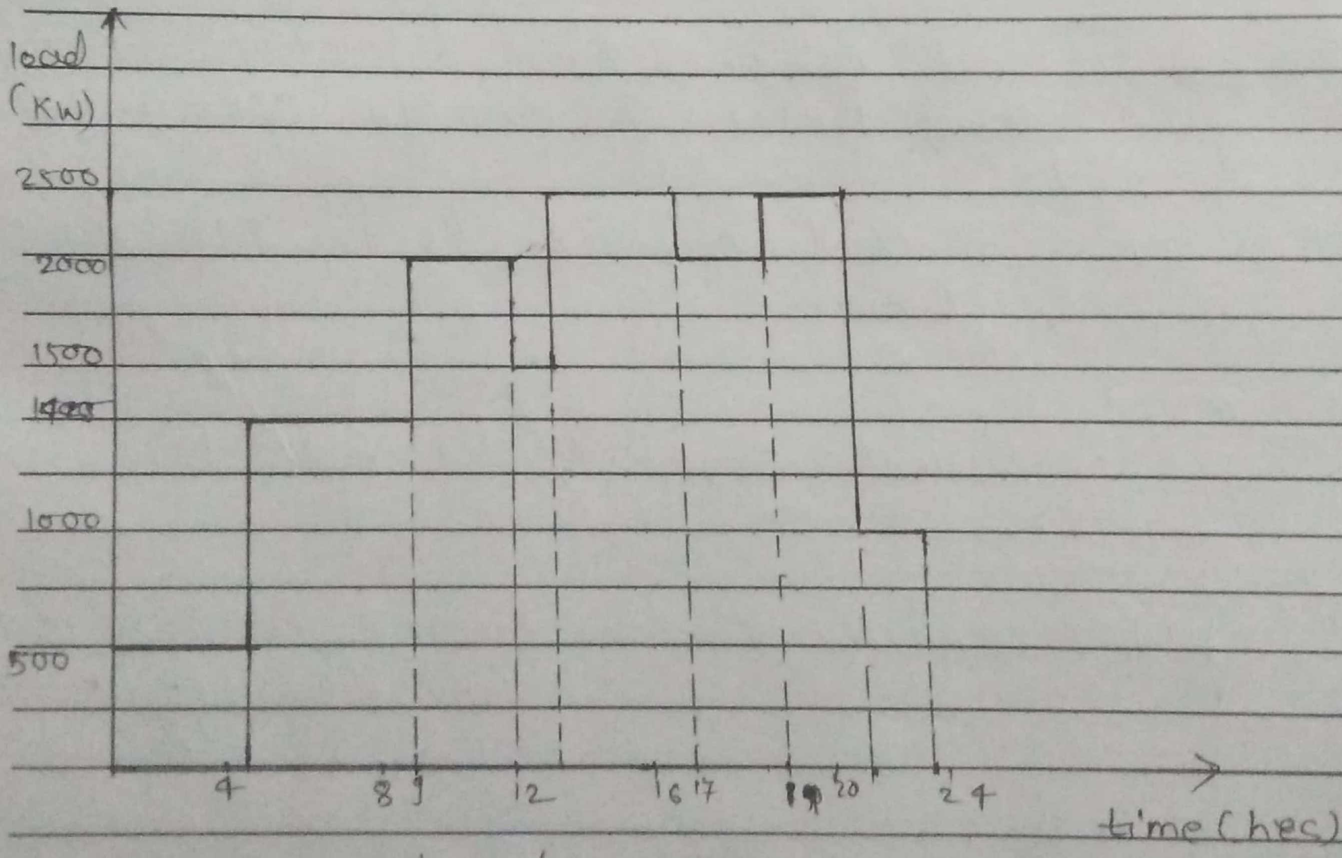
∴ ~~No of units generated in~~

From the load curve it will be seen that three generator set will suffice with following rating 500 KW, 500 KW & 1500 KW.

∴ Reverse capacity = Largest size of unit in the station
= 1500 KW




Load curve

(S-16/7M) (W-16/7M)

Imp.

1) Load variations on power plant on a typical day is as follows

| Time (hrs) | Load (MW) |
|---|---|
| 12 - 5 am | 20 |
| 5 - 9 am | 40 |
| 9 - 6 pm | 80 |
| 6 - 10 pm | 100 |
| 10 - 12 mid night | 20 |

i) plot load curve & load duration curve

ii) find load factor & energy consumed in 24 hrs.

iii) If installed capacity is 125 MW, find capacity factor.

Soln:

iii) installed capacity is = 125 MW.

plant capacity factor = $\frac{\text{Energy Produced during 24}}{\text{install capacity} \times 24 \text{ hrs}}$

=

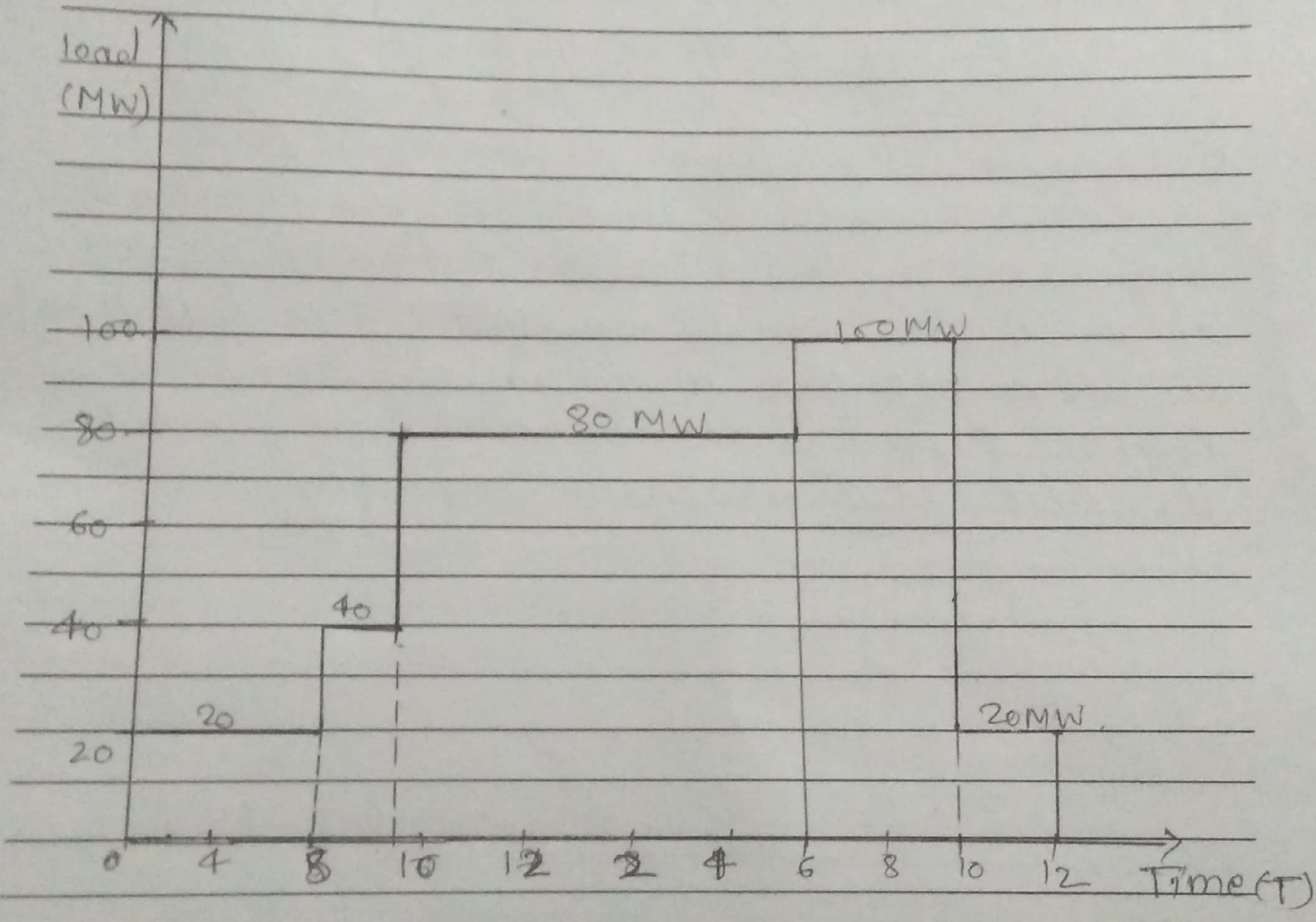
Energy generated during 24 hours = 20×5 + 40×4 + 80×9 + 100×4 + 20×2

=

Load factor = $\dfrac{\text{Energy generated during 24 hr}}{\text{maximum demand} \times 24 \text{ hrs}} = \dfrac{}{100 \times 24}$

Plant capacity factor = $\dfrac{\text{Energy Produced during 24}}{\text{install capacity} \times 24 \text{ hr}} =$

=




load curve

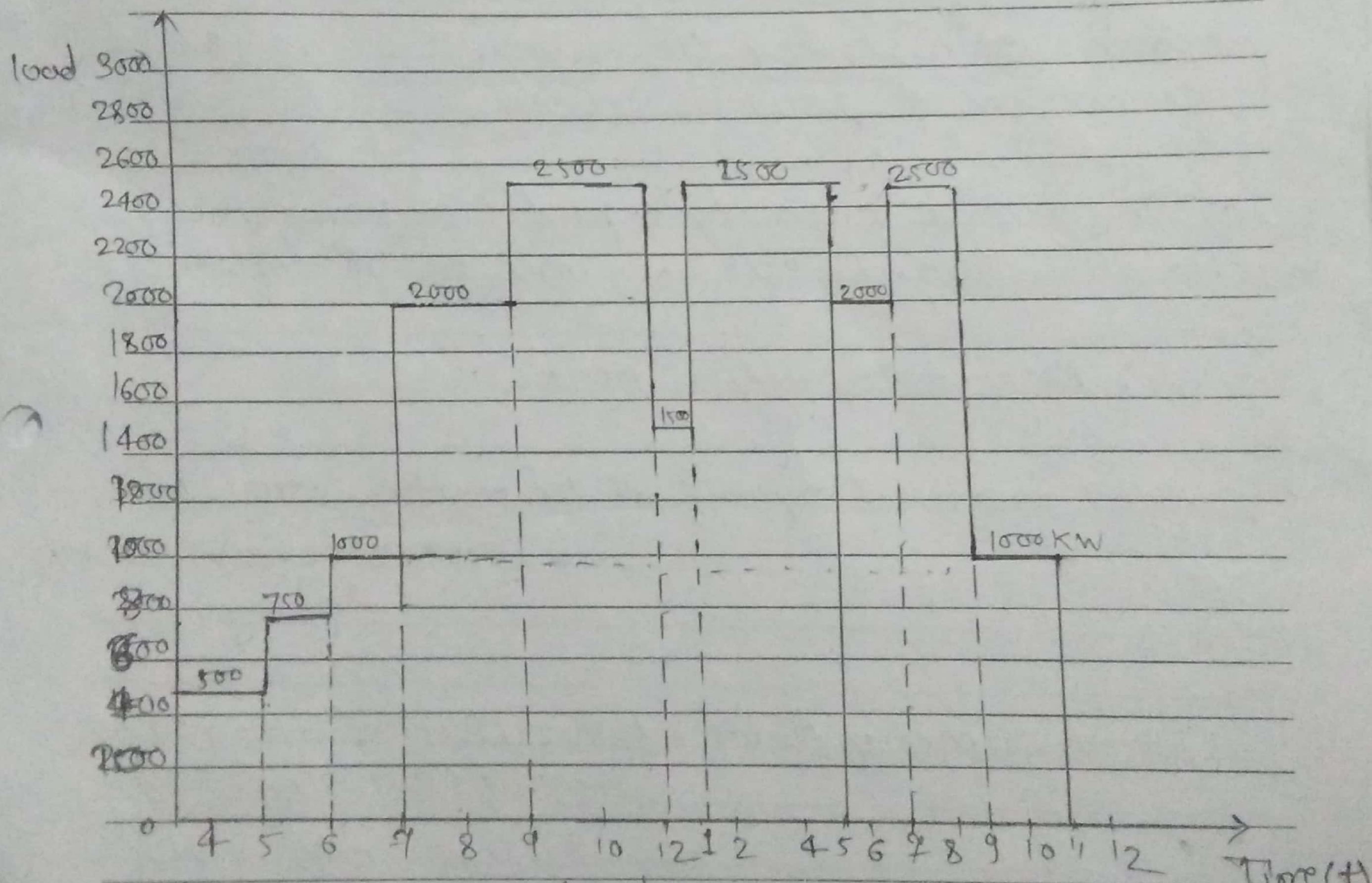
Q. How are the size of generating units, the number of unit for a given load curve, & operation schedule decided ?

Ans: The number of generating units & their size can be choosen in two ways first one is that choosing one number of units with the capacity of maximum load.
The second way of choosing generator units & size is to choose number of units of fit into the load curve as closely as possible
The number of units are such choosen that they work on the suitable portion of the load curve & will operate on about their full load at which they give maximum efficiency. The Reserve capacity choosen will correspond to the unit with maximum capacity.

5) A power station has to supply load as follows

| Time (hr) | Load (KW) |
|---|---|
| 11pm to 5am | 500 |
| 5am to 6am | 750 |
| 6am to 7am | 1000 |
| 7am to 9am | 2000 |
| 9am to 12noon | 2500 (Max demand) |
| 12 noon to 1pm | 1500 |
| 1pm to 5pm | 2500 |
| 5pm to 7pm | 2000 |
| 7pm to 9pm | 2500 |
| 9pm to 11pm | 1000 |

Soln:




Load curve

From graph maximum demand = 2500 KW

Energy generated during 24 hours = 500×6 + 750×1 + 1000×1 + 2000×2 + 2500×3 + 1500×1 + 2500×4 + 2000×2 + 2500×2 + 1000×2

= 38750 KWh = $\frac{38750}{24}$ = 1614.58

∴ Load factor = $\frac{38750}{2500 \times 24}$ = 0.646 = $\frac{1614}{2500 \times 24}$

= 64.6% = 0.0269

b) From the load curve, the numbers of generator units are having the rating: Two sets of 1000 KW capacity each having the rating.
one set of 500 KW rating.

c) The reserve capacity required will corresponds to the largest size of unit in the station

∴ Reserve capacity = 1000 KW.

∴ Total installed capacity of the station = 1000 + 1000 + 500 + 1000 (reserve) = 3500 KW

∴ plant capacity factor = $\frac{\text{Energy Produced during 24 hrs}}{\text{installed capacity} \times 24 \text{ hrs}}$

= $\frac{38750}{3500 \times 24}$ = 0.46 = 46%

d) operating schedule

| Time period | set running | Remarks |
|---|---|---|
| 11 pm to 5 am | one set of 500 kW | As load is only 500 kW during this period, the generator of 500 kW capacity is started at 11 pm |
| 5 pm to 6 am | one set of 1000 kW | The generator of 500 kW capacity is stopped as the load during this period is 750 kW & the generator 1000 kW is started & runs under load condition. |
| 6 am to 7 am | one set of 1000 kW | During this period 1000 kW capacity generator run at full load. |
| 7 am to 9 am | Two sets of 1000 kW | set of 1000 kW capacity started at 7 am & 1000 kW set is alredy running. |

| | | |
|---|---|---|
| 9 am to 12 am | Two sets of 1000kw one set of 500kw | The generator of 500kw capacity is started at 9 am as the load total load required is 2500kw |
| 12 noon to 1pm | one set of 1000kw one set of 500kw | The one generator of 1000 kw capacity is stopped at 12 noon as the load required is only 1500kw |
| 1pm to 5pm | Two set of 1000 kw one set of 500kw | The generator of 1000 kw capacity is started at 1pm as total load required is 2500 kw |
| 5pm to 7pm | Two sets of 1000kw | one set of 500 kw capacity is stopped at 5pm as total load required is 2000kw |
| 7pm to 9pm | Two set of 1000kw one set of 500kw | one set of 500 kw capacity is started at 7 pm to meet the total required load of 2500kw. |

9 pm to 11pm | one set of 1000 kW | one set of 1000 kW capacity & set of 500 kW capacity are stopped at 9pm as the total load is only 1000 kW & only 1000 kW generator is running.

e) Actual energy during 24 hours = 38750 kWh

The energy that could have been generated by the capacity of plant running for schedule there

= 500×6 + 1000×1 + 1000×1 + 1000×2 + (1000×2 + 500×1)3 + 1000×1 + 500×1 + (1000×2 + 500)4 + 1000×2 + 2(1000×2 + 500×1)2 + 1000×2

= 39000 kWh

Plant use factor = Actual energy produced during 24 hrs / Energy that could have been produce during the period of operation

$$= \frac{38750}{39000} = 0.991 = 99\%$$

Q.1 a) What are various factor related with power generation sector. Define six important factor from the various factor

Ans:

Q6. A power station supplies the load as following

| Time (hrs) | Load (KW) |
|---|---|
| 6 am to 8 am | 1200 |
| 8 am to 9 am | 2000 |
| 9 am to 12 am | 3000 |
| 12 noon to 2 pm | 1500 |
| 2 pm to 6 pm | 2500 |
| 6 pm to 8 pm | 1800 |
| 8 pm to 9 pm | 2000 |
| 9 pm to 11 pm | 1000 |
| 11 pm to 5 am | 500 |
| 5 am to 6 am | 800 |

Soln:

Maximum demand 3000 KW.

∴ Total energy generated during 24 hours

$= 1200 \times 2 + 2000 \times 1 + 3000 \times 3 + 1500 \times 2 + 2500 \times 4 + 1800 \times 2 + 2000 \times 1 + 1000 \times 2 + 500 \times 6 + 800 \times 1$

$= 37800$ kWh

Average load = $\dfrac{\text{Total energy generated during 24 hr}}{24}$

$= \dfrac{37800}{24} = 1575$ KW

Load factor = $\frac{\text{Average load}}{\text{maximum load}} = \frac{1575}{3000} = 0.525$

b) The five generating set will suffice with the following

one set of 1200 kW

one set of 800 kW

one set of each 500 kW (2 set)

one set of 300 kW

c) Reserve capacity = 1200 kW

$\therefore$ Install capacity = 1200 + 800 + 2×500 + 300 + 1200

= 4500 kW

plant capacity = $\frac{\text{Energy generated during 24 hrs}}{\text{maximum demand} \times 24}$

$= \frac{37800}{4500 \times 24} = 0.35 = 35\%$

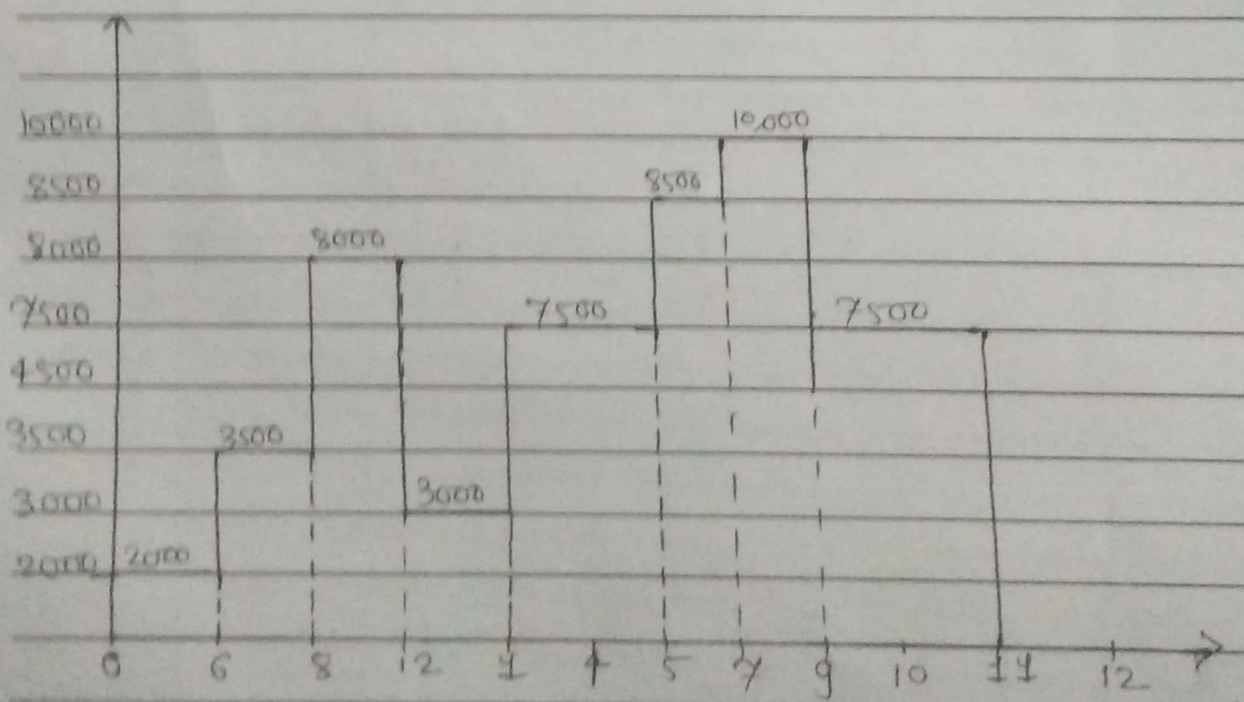
Q.7 A proposed generating station is expected to have a daily load curve cycle as under (S-16/10M)

| Time (hrs) | Load (KW) |
|---|---|
| 11 pm - 6 am | 2000 |
| 6 am - 8 am | 3500 |
| 8 am - 12 Noon | 8000 |
| 12 Noon - 1 pm | 3000 |
| 1 pm - 5 pm | 7500 |
| 5 pm - 7 pm | 8500 |
| 7 pm - 9 pm | 10,000 |
| 9 pm - 11 pm | 4500 |

Generating station has a maximum demand of 10 MW

i) Daily load curve ii) Find load factor
iii) choose size & number of sets iv) Reserve capacity
v) plant factor v) plant use factor.

Soln :




Load curve

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ii) Total energy generated during 24 hours

$= 7\times2000 + 2\times3500 + 4\times8000 + 7\times3000 + 4\times7500$
$+ 2\times8500 + 2\times10,000 + 2\times4500$

$= 132,000$ MW hr

Averag load $= \frac{132000 \text{ MW hr}}{24 \text{ hr}}$

$= 123,375$ MW

Load factor $= \frac{123,375}{\text{maximum demand} \times 24}$

$= \frac{123,375}{10,000 \times 24} = 296.1$

iii) choose size & number of sets

maximum demand $= 10,000$ MW

one set of 5000 KW

one set of 2000 KW

one set of 3000 KW

one set of 500 KW

iv) Reserve capacity = The maximum value of the unit of generating station

= 5000 MW

Install capacity = Sum of all the generating units + Reserve capacity

= 10500 + 5000

= 15500 MW

plant capacity factor = $\frac{\text{energy generated during 24 hrs}}{\text{Install capacity} \times 24 \text{ hrs}}$

$= \frac{132000}{15500 \times 24}$

=

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Give advantages of interconnected grid system
(W-17/4M)

The connections of several generating station is parallel is known as interconnected grid

The various problems facing the power engineers are considerabby reduced by interconnecting different power stations in parallel Although interconnection of station involves extra cost, yet considering the benefits derived from such an arrangement it is gaining much favour these days

Advantages of interconected grid system

i) Exchange of peak loads

ii) use of older plant

iii) Ensure economical operation

iv) Increase diversity factor

v) Reduce plant reserve capacity

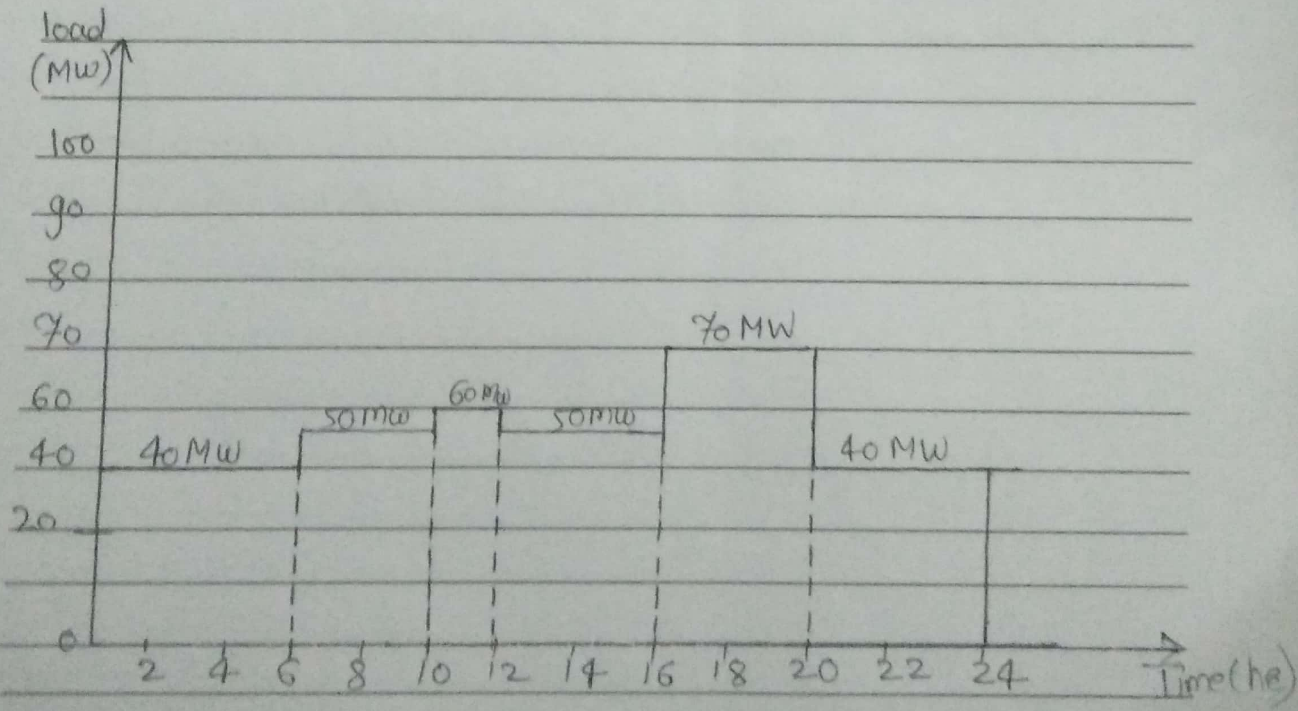
vi) Increase reliability of supply

8. A generating station has the following daily load cycle (W-17 / 6M)

| Time (hrs) | Load (MW) |
|---|---|
| 0 - 6 | 40 |
| 6 - 10 | 50 |
| 10 - 12 | 60 |
| 12 - 16 | 50 |
| 16 - 20 | 70 |
| 20 - 24 | 40 |

Draw the load curve & find
(i) maximum demand ii) Units generated per day
iii) Average Load iv) Load factor

Soln :




Load curve

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i) maximum demand = 70

ii) Units generated per day = 6×40 + 4×50 + 2×60 + 4×50 + 4×70 + 4×40

= 1200 mwhr

iii) Average load = $\frac{\text{units generated per day}}{24}$

$= \frac{1200 \text{ MW hr}}{24 \text{ hr}}$

= 50 MW

iv) Load factor = $\frac{\text{Average load}}{\text{maximum demand} \times 24}$

$= \frac{50}{70 \times 24} = 0.029$

= 2.97 %

Name of Subject :.................................... Sem:..........

What do you mean by conventional & Non conventional energy sources. Explain with Example (W-16/5M)

Ans:

Energy is the one of the parts of economic infrastructure, being the basic uni input needed to sustain the economic growth.

The more developed is a country, higher is the per capita of energy consumption & vice-versa. Human civilization relies on different sources of energy.

Two major sources can be classified

1) Conventional energy sources
2) Non-conventional energy sources

below you should see the difference between conventional & non-conventional sources energy.

Sources of Energy

Conventional sources | Non-conventional sources

| Commercial | Non-commercial | Non-conventional sources |
|---|---|---|
| Coal | Fire wood | 1) Bio-energy |
| petroleum | Straw | 2) Solar energy |
| Electricity | Dried dung | 3) Wind energy |
| | | 4) Tidal energy |
| | | 5) Energy from Urban waste. |

fig. sources of Energy

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Conventional sources of Energy

These sources of energy are also known as non-renewable sources of energy & are available in limited quantity apart from hydro-electric power further it can be classified under commercial & non-commercial energy.

Commercial energy sources

The coal, electricity & petroleum are known as commercial energy since the consumer need to pay its price to buy them

a) Coal : coal is the most important source of energy. There are more than 148790 coal deposits in India. In betn 2005-2006, the annual productn went up to 343 million tons. India is the fourth largest coal-production went up to 343 million tons. India is the fourth largest coal producing country.

b) Oil & Natural Gas

Today oil is consideratred to be the liquid gold & one of the crucial sources of energy in India & the world oil is mostly used in planes, automobiles, trains & ships

c) Electricity : Electricity is a common source of energy & used for domestic & commercial purpose. This uses in electrical appliances fridge, TV washing machine & air conditining.

i) Thermal power

Thermal power is generated at various power station by oil & coal. it is vital source of electric current & it's share in total capacity of the nation in 2004 was 70 percent.

ii) Hydroelectric power

The hydro-electric power is produced by constructing dam above flowing rivers like Damodar valley project & Bhakra Nangal project The installed capacity of hydro-electric power was 587.4 mw in 1950-51 & went upto 19600 mw in 2005

iii) Nuclear power

The fuel used in nuclear power plants is which is uranium, which costs less than coal, Nuclear power plant can be found in Kota (Rajasthan), Narora (UP) & Kalpakam (chenai)

Non-commercial energy source

The non-conventional sources are also known as renewable sources of energy. The example include solar energy, bioenergy, tidal energy & wind energy

i) Solar energy

This is the energy that is produced by the sunlight. The photovoltic cells are exposed to sunlight based on the form of electricity the need to be produced. The energy is utilized for cooking & distillation of water

ii) Wind energy

The kind of energy is generated by harnessing of power of wind & mostly used in operating water pumps for irrigation purpose.

iii) Tidal Energy.

The energy that is generated by exploiting the tidal waves of the sea is known as tidal energy. This source is yet to be tapped due to the lack of cost-effective technology.