P O W E R R E S O U R C E S

Power Resources

Are those substances through which we can generate energy to meet the power requirements of the country.

Energy can be obtained from various resources i.e. water, wind, sunlight and fuels. It can exist in various forms e.g. heat, light, electrical and chemical. All forms of energy can be converted into power, which can be used to do work e.g. petrol or diesel in burnt in car engines which produce chemical energy and is used to make the car move.

Pakistan is a small consumer of energy. Per capita energy consumption in Pakistan is very low i.e. 10 times less energy than the world average and about 80 times less than the United States, but now with the development in industry and other sectors of economy, demand of power supply is increasing. Despite the low consumption of energy, Pakistan is not self-sufficient in power resources. A certain quantity has to be imported.

The main sources of energy in Pakistan are, in order of importance, **Oil**, **Natural Gas**, **Hydel** and **Coal**. Minor energy sources include **Nuclear** and **LPG** (Liquefied Petroleum Gas) and **CNG** (Compressed natural Gas).

Types of Resources

(i) Renewable resources **(ii) Non-Renewable resources**

Renewable Resources

Are those resources which can be used again and again and do not finish e.g. water, solar power and wind power.

Non-Renewable Resources

Are those resources which cannot be used again and again and finished e.g. coal, oil and gas.

Fossil Fuel

Remains of animals and plants are called fossils fuel. e.g. coal, oil and gas.

Coal

Coal is the oldest fossils fuel discovered in the world and formed by the decomposition of natural vegetation. It has different qualities ranging from Anthracite to Peat. In Pakistan Bituminous to Lignite qualities are found. It has low carbon content and a lot of ash, sulphur and volatile matter. The seams in general are lean and thin, on an average 1-3 feet thick. More than 91 % of the coal produced in Pakistan is used in brick kilns and 9% in the power generation.

Types of Coal.

There are four types of coal according to grade and quality which is determined by their carbon content. They are:

1. Anthracite **2. Bituminous** **3. Lignite** **4. Peat**

1. Anthracite

Blackest coal of all and found in thin layers, deep underground. It is the best quality of coal, hardest, with highest carbon content and burns with great heat.

2. Bituminous

It is darker in color and found further" deep underground and has two types.

1. Steam Coal
It is superior, hard and black coal and found in highly compressed seams and burn rapidly with great heat. Its carbon content is less than that of anthracite.

ii. Coking Coal
This coal is burnt to produce coke, it is hard, grey and porous ,material. It is used in blast furnaces for the extraction of iron from iron ore.

3. Lignite

It is found near the surface and easier to mine. It is a low quality coal with a high moisture and ash content. It has a low heating value.

4. Peat

It is exclusively vegetative matter and represent the initial stage of coal formation.

Coalfields of Pakistan

Pakistan possesses low quality coal, lignite to sub-bituminous. It has low carbon content, high ash sulphur and volatile matter. The seams in general are lean on an average, 1-3 feet thick. The total coal reserve are estimated at 185 billion tones, of which 175 billion tones is found in Thar coalfield. More than 91 % of coal produced in Pakistan, used in brick kilns and remaining 9% in power generation. There are three major coal producing regions in Pakistan which are as follows:

1. **The Salt Range and Makarwal-Gullakhel Coalfield**
2. **The Quetta Coalfield**
3. **The Lower Sindh Coalfield**

i. The Salt Range Coalfields

The coalfields in the Salt Ranges are found on the eastern and central portions, covering an area of 260 square kilometers. The thickness of the seams of these coal mines are 0.43 to 0.46m. The coal in this region are of poor quality, with high ash and sulphur content. The main mines are at Dandot and Pidh. Other mines are Pir Jehanian, Chittidand, Dhakkhatta and Arakhatta.

ii. Makarwal-Gullakhel coalfields

These coalfields are located in the Trans-Indus Salt Range. The seams are slightly thicker and the coal is some what better in quality. There is also a connection with the main railway station in the area, allowing the coal to be transported to other parts of the country.

2. Quetta Coalfields

Quetta coalfields comprises of three major coalfields:

i. **Khost Sharig-Harnai Coalfield**
ii. **The Sor Range-Degari Coalfield**
iii. **The Mach Coalfield**

i. Khost Sharig-Harnai Coalfields

The largest coalfield in Balochistan is at Khost Sharig-Harnai and covers an area of 210 square kilometers. The coal though poor in quality, is better than that produced in the other coalfields of Pakistan. Sharig coal, in particular has coking properties. This means that it can be turned into coke, which is a solid fuel made by heating coal in the absence of air so that the volatile components are driven off. The Sharig mine is managed by the Mineral Development Corporation of Pakistan, Which has established a coal washing plant there. The coal, after being washed at the plant, is mixed with high-grade imported coal and transformed into metallurgical coal, which can then be used in the steel industry in Karachi.

ii. The Sor Range-Degari Coalfields

It is an important coalfield located 16 kilometres east of Quetta. The coal is sub-bituminous, containing ash and sulphur. It is fit for brick kilns It covers an area of 49 square kilometers. Pakistan Mineral Development Corporation manage these mines.

iii. The Mach Coalfields

The Mach Coalfield is located 55 kilometres south of Quetta on both side of the Sibi-Quetta railway and covering an area of 40 square kilometers. The coal is of inferior quality and is comparatively closer to the surface and used in brick kilns. Other coalfields are Aab-e-Gum, Ali Gul, Pir Ismail, Ziarat and Dukki. Dukki is biggest one as compared to others.

3. The Lower Sindh Coalfields

The **Lower Sindh** coalfield comprises of **four** major coalfields:

i. The Jhimpir-Meting Coalfield,
ii. The Lakhra Coalfield,
iii. The Sonda- Thatta Coldfield,
iv. The Thar Coalfield,

i. The Jhimpir-Meting Coalfield

It is located south of Hyderabad and covers an area of 900 square kilometers. It is a relatively small field at the base of a low limestone hill. The coal found here is of poor quality i.e. lignite.

ii The Lakhra Coalfield

It is located north of Hyderabad in the Dadu District 16 kilometres west of the khanot railway station. It has reserves of about 60 million tones. The coal is lignite.

iii. The Sonda - Thatta Coalfield

In 1981, The Geological Survey of Pakistan discovered the Sonda -Thatta Coalfield. The field is located on both banks of the River Indus, covering an area of 620 square kilometers. The coal is of good quality and the reserve is about 6 million tones.

iv. The Thar Coalfield

The Geological Survey of Pakistan discovered the Thar Coalfield in 1992. This accounts for more than 94 percent of Pakistan's total coal reserves 175 billions tones out of 185 billions tones. The exploitation of Thar coal is not easy. It is of inferior quality and is located at a great depth. Technology and sources of finance are required before it can be fully exploited.

Mining Processes (Coal)

Mining is a process of digging rocks and minerals from the earth. Minerals are found at different depths.

Methods of Mining. There are **two** methods of mining.

1. Open Cast Mining
2. Underground Mining.
i. Adit Mining
ii. Shaft Mining

1. Open Cast Mining

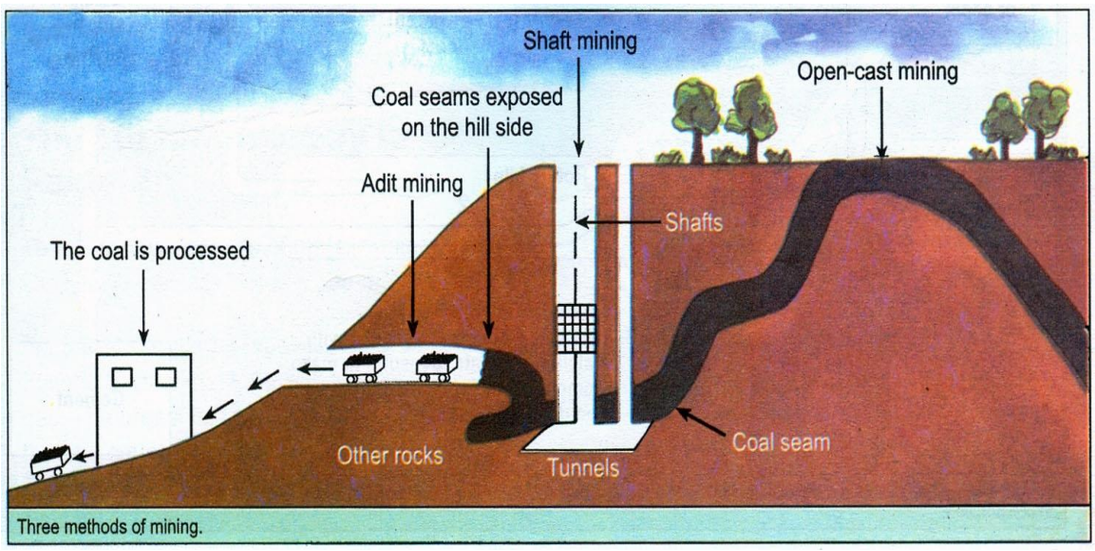
Some minerals like coal and iron often lie near the surface. Open cast mining scoops up these minerals from near the surface. The minerals bearing rocks are stripped off by giant excavators and power shovels, which then load the material into lorries of railway wagons to be carried away.

2. Adit Mining

An adit is an opening or passage. Adit mining is done in hilly areas where a mineral seam is exposed on a hillside.
Horizontal shafts into hillside
Possibly several shafts at different levels.
Pick and shovel.
Transported by trucks / trolleys.

3. Shaft Mining

Main shaft (vertical or sloping).
Tunnels / side shafts along seems.
Pick and shovel.
Lifted to surface.
Transported by trucks / trolleys.



Three methods of mining.

Problems (Underground Mining)

1. Ventilation and underground transport problem.
2. Dangerous gases may produced.
3. Due to use of explosive material, the roofs of tunnel may be collapse.

Transportation of Coal

After the extraction of coal it is loaded onto trolleys. In some small coal mines donkeys are used as an underground transport. Ones the coal comes out of the mine, the qualities of coal are separated and sold to the middleman who further loads it into trucks and supplies it to the brick kilns and cement factories etc. where it is used as a fuel. When the coal is supplied to thermal power stations, rail transport is also used if it is economically feasible.

Study **Fig.1**, a cross section showing two types of coal mine.

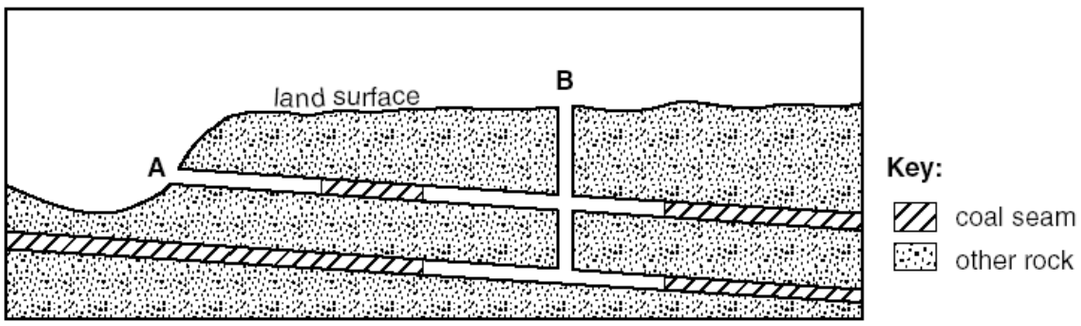


Fig.1

Q.1. ***For each of the mine A and B, name the type of mine.***
Ans ***A*** *– adit / drift*
B *- Shaft*

Q.2. ***Explain why that is the type of mine there.***
Ans. ***A*** *– Coal (seam) exposed on a slope / can dig tunnels along the seem.*
B *– Coal (seam) underground.*

Q.3. ***Describe the method of mining.***
Ans. ***Adit mine***
Horizontal shafts into hillside
Possibly several shafts at different levels.
Pick and shovel.
Transported by trucks / trolleys.

Shaft mining
Main shaft (vertical or sloping).
Tunnels / side shafts along seems.
Pick and shovel.
Lifted to surface.
Transported by trucks / trolleys.

Q.4. ***Name three ways by which coal is mined.***
Ans. *Shaft, Adit / Drift, Open cast.*

Q.5. ***Why is coal produced in Pakistan described as low quality?***
Ans. *Lignite.*
Low burning temperature / produces less energy.
Low carbon content / more impurities / more smoke.
High ash content.
High sulphur content.

Study the map **Fig.2**, showing coalfields and coal mining centres in Pakistan.

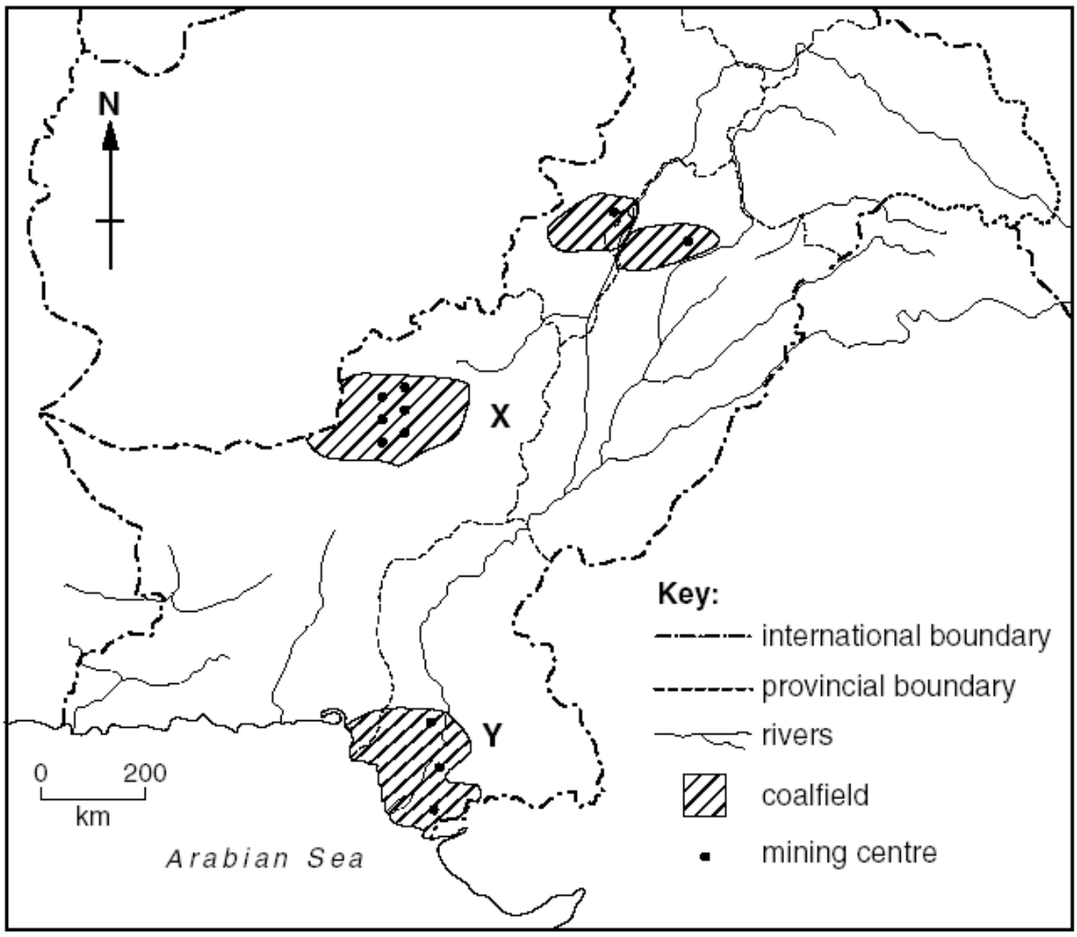


Fig.2

Q.6. ***Name the coalfield X and one of the mining centres there.***
Ans. ***Quetta coalfield.***
Sor range, Mach, Khost, Shahrig, Harnai.

Q.7. ***Name the coalfield Y and one of the mining centres there.***
Ans. ***Lower Sindh coalfield.***
Blakhra, Jhimpir, sonda.

Q.8. ***State the two main uses of coal mined in coalfield X.***
Ans. *Brick making / brick kilns.*
(Mixed with imported coal) For steel making / in the blast furnace.

Q.9. ***Explain why coal has to be imported.***
Ans. *Not enough mined in Pakistan.*
Not good enough for iron smelting / needed for Pakistan steel.
Difficult to mine / seems thin.
For mixing with the local coal.

Q.10. ***Why does coal only supply 4 % of the energy supply in Pakistan? OR***
Explain why coal is of limited value as a source of energy in Pakistan.
Ans. *Low quality / lignite.*
Not mined / reserves not developed.
Bulky / heavy to transport.
Used for other things e.g. coke, bricks, cement.
Coal seams difficult to mine because – thin, faulted.

Q.11. Explain why the extraction of coal is limited in Pakistan.

Ans. ***1****. Coal is of low or inferior quality.*
2*. Reserves of coal not developed.*
3*. Seams of the coal are thin.*
4*. Lack of finance.*
5*. Technology problem.*
6*. Extraction of the coal with traditional methods.*
7*. Risky jobs (Labour problem).*
8*. Lack of experts.*
9*. Not enough mine in Pakistan.*

Study **Fig.3**, shows the output from the Sor Range Coalfield.

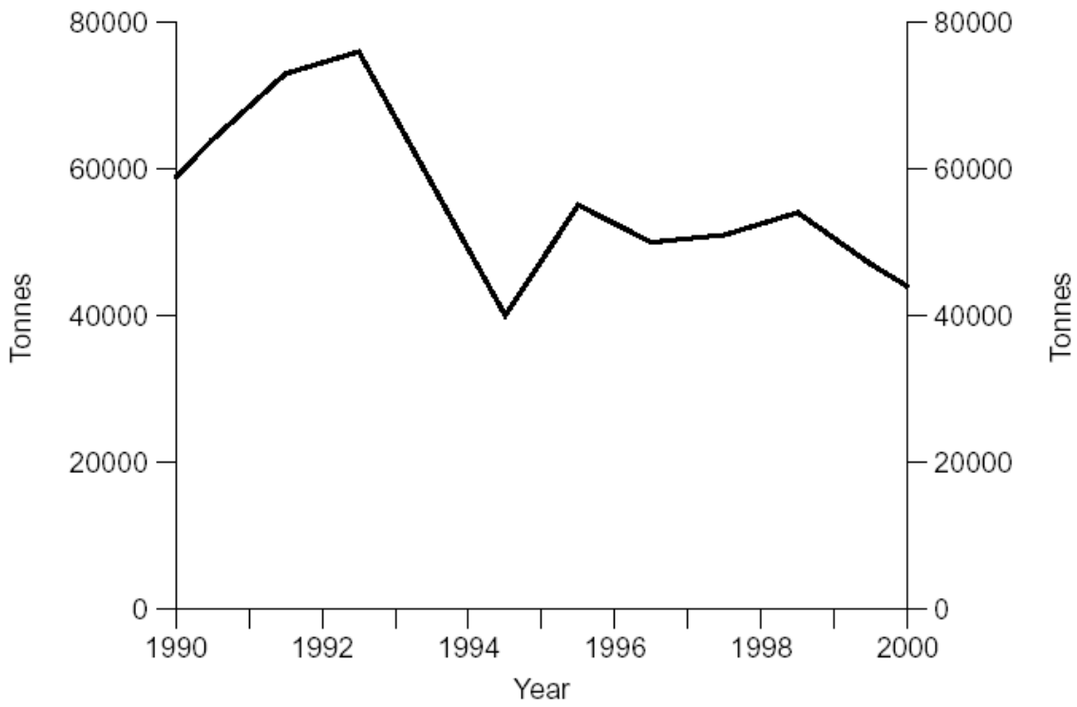


Fig.3

Q.12. Describe coal output from the Sor Range Coalfield from 1990 to 2000.

Ans. *Fluctuated.*
Highest production in 1992-3 (75,000).
Sharp declined in 1994-95 (40,000).
Increased in 1995.
After 1995 the production has fluctuated.
After 1998 slow decline.

Q.13. The Sor Range Coalfield is the part of Quetta Coalfields. Name the other two main areas of coal production in Pakistan.

Ans. *The Salt Range and Makarwal-Gullakhel Coalfield.*
The Lower Sindh Coalfield.

Mineral Oil (Petroleum)

Mineral Oil is the most important fossil fuel today. It is also known as a '**Black Gold**'. It occurs in the porous spaces sedimentary rocks. It mainly occurs in dome shaped anticlines between two layers of non-porous rocks. The oil is trapped in the anticline with gas above and water below. It can be found many hundreds of meters underground or under the sea bed.

The search for oil began in the 1860s and is still underway. In 1961, the Oil and Gas Development Corporation was set up to organize and undertake the exploration, development, production, refining and sale of oil.

In 1991, the first petroleum policy was framed by the government. The main objective of this policy was to give financial concessions to foreign firms to explore and develop oil in Pakistan. As a result, several foreign petroleum firms are now working in the country.

Oil Drilling (Process)

Oil is liquid and cannot be extracted in the same way as coal. It is normally trapped deep underground. It is extracted by drilling into the ground. It is a very costly operation and involves big drilling machines. A derrick which is a big steel structure is erected to hold the drilling machinery. Drilling is done to a depth of 2000 to 5000 metres or more till the layer of oil deposit is reached. The oil comes out by itself because of the pressure of rocks. The oil well is properly tapped to prevent wastage.

Study **Fig.4**, a cross section showing an anticline oil trap.

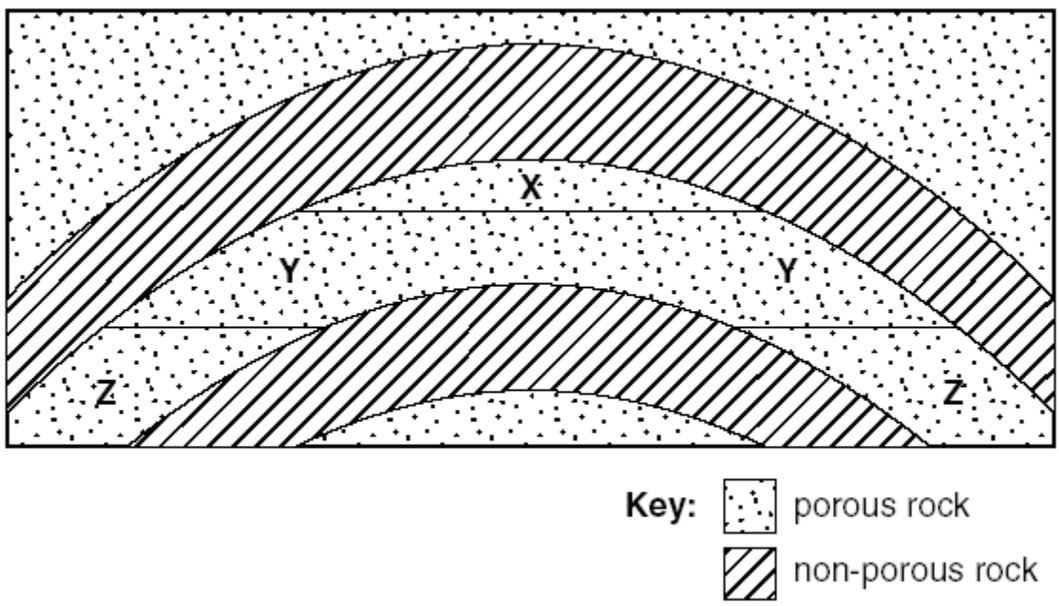


Fig.4

Process Steps

Derrick /drill rig built.
Pipes inserted.
Diamond / tough metal drills into rock.
Oil rises when pressure released / pumped up / sucked up.
Cooled with mud mixture / water
Valves to control flow into pipeline.
Derrick removed.

Oilfields

There are **two** main oil producing regions in Pakistan. These are as follows.

1. Potwar Plateau Oilfield, **(Northern Region)**
2. Lower Sindh Oilfield, **(Southern Region)**

1. Potwar Plateau Oilfield (Northern Region)

The Northern Region was identified as an oil producing region in 1915, with the discovery of the Khaur Oilfield. Since then, a number of other oilfields have been discovered in the region. Dhulian, Joya Mir, Balkassar, Karsal, Meyal, Toot, Adhi, Fimkassar, Dakhni and Dhurnal. Production of Khaur, Dhulian, Joya Mir and Balkassar has considerably declined and they are at present minor producers. Dhurnal, Meyal, Toot and Adhi are major producers. Dhurnal became the second most productive field. Fimkassar is a new comer. It is still a minor producer. Dakhni oilfield has yet to go into production.

2. Lower Sindh Oilfield (Southern Region)

Lower Sindh emerged as an oil region in 1981 when Khashkeli oilfield was discovered. Laghari became the leading oil producer in the country in the very next year after it started production. Tando Alam was discovered in 1984 and became an important producer during the same year. Dhabi has also gone into production. Lower Sindh oil region produces 35% of Pakistan's oil. Nari, Tajedi, Mazari, South Mazari and Turk are other fields of Sindh, which have not yet started production.

Study **Fig.5**, shows the location of **oilfields** in Pakistan.

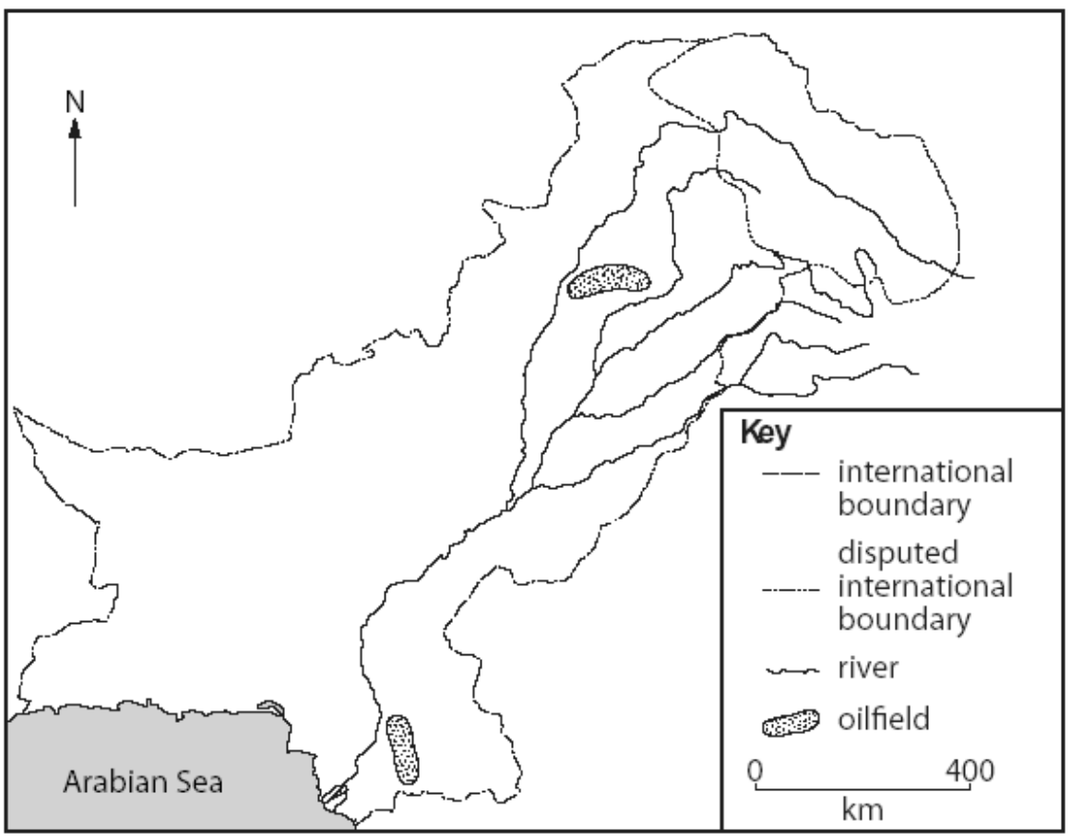


Fig.5

Oil Refining **(Purifications of oil)**

Crude oil cannot be used in its raw state. It has to be processed and refined into useful products such as petrol for cars, aeroplanes, , kerosene, diesel oil for trucks and buses.

Oil Refinery

There are **Five** Oil Refineries in Pakistan:

1. Morga Oil Refinery
2. Mahmood Kot Oil Refinery
3. Pakistan Oil Refinery
4. National Oil Refinery
5. Hub Oil Refinery

1. Morga Oil Refinery / Attock Oil Refinery

It is located at Morga near Attock or Northwest of Punjab. This Refinery refine the oil produced from Potwar Plateau and supplies oil to the Northern areas of Pakistan ..

2. Mahmood Kot Oil Refinery

It is located west of Multan between River Indus and Chenab. This Refinery refines the imported oil from Iran and Karachi. This Refinery supplies the oil to the Central Pakistan and Lower Punjab.

3. Pakistani and National Oil Refineries

Both Refineries are located in Karachi and Refine the imported oil from Saudi Arabia and the oil produced from the Lower Sindh. Both Refineries supply oil to Karachi and adjacent areas.

4. Hub Oil Refinery

It is located near Karachi in Balochistan and refines the imported oil. This refinery supplies oil to industrial areas of Hub and Karachi.

Study **Fig.6**, which shows the location of oil refineries in Pakistan.

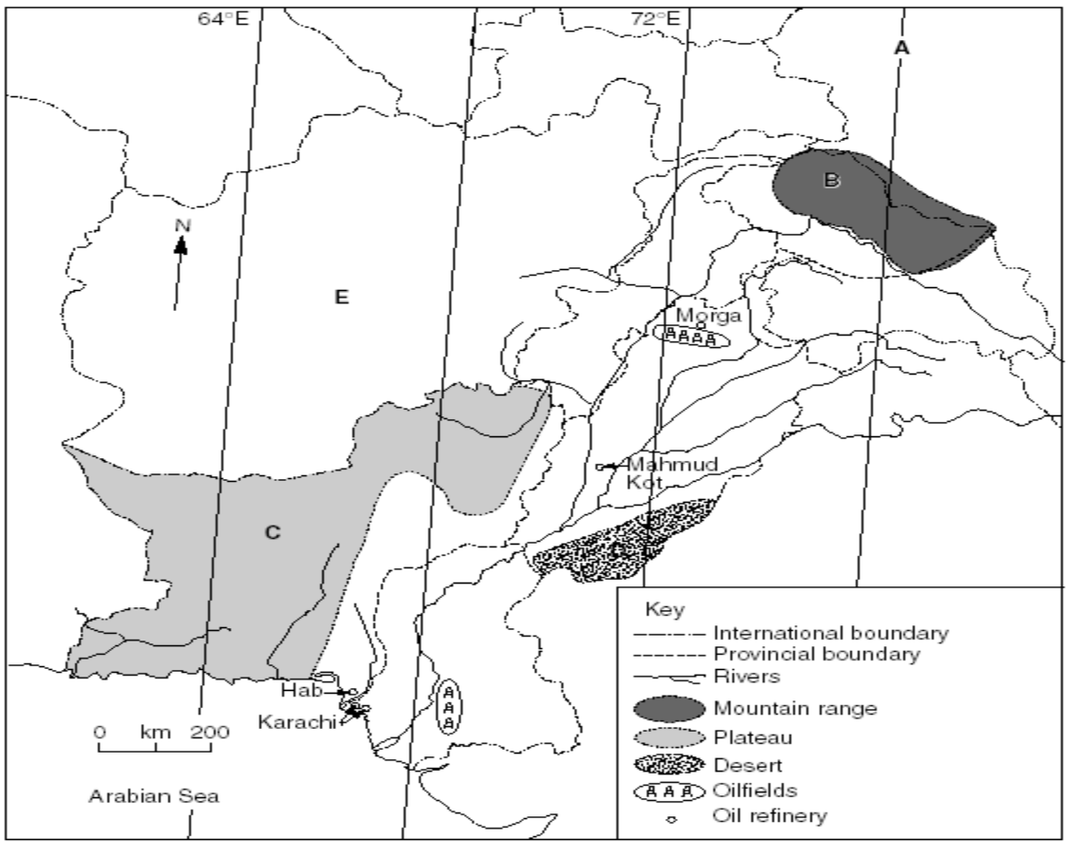


Fig.6

Q.1. Study Fig.6, Describe and explain the distribution of oil refineries.

Ans.

Distribution

1. *Morga refinery is on Potwar Plateau near Attock (oilfield) NW Punjab.*
2. *Mahmood Kot refinery / southern Punjab / between river Indus and Chenab.*
3. *On coast near Karachi / at Hub / Sindh coast.*

Explanation

1. *Morga refinery refines oil from local / Potwar Plateau oilfields for upper Punjab and NWFP.*
2. *MahmoodKot placed to serve central Pakistan / lower Punjab.*

... supplied with crude oil by white pipeline from Karachi.

... supplied by pipeline from Iran across Baluchistan.

3. *Karachi refineries refine imported oil.*
4. *Karachi refineries crude oil from lower Sindh oilfields.*
5. *Hub refinery supplied by pipeline from Karachi.*
6. *Hub and Karachi to serve industrial area / large population.*
7. *High demand .*

Transportation of Oil **(Imported)**

Pakistan's imported petroleum, both crude and refined, is transported by sea from oil producing countries, especially from **Saudi Arabia** and the **United Arab Emirates** (UAE). It is transported in special ships called 'Oil Tanker'. At Keamari (Karachi) Port or Port Qasim, the oil tanker is berthed at the designated oil pier. 'The pier is a platform with an oil handling system'. Through the pier the ship is connected to the oil handling system. The oil products (crude or refined) are pumped from the oil tanker ship to the oil marketing companies I refineries storage tanks at Keamari and Korangi. The products may be further transported up country.

Transportation of Oil **(Land)**

On land oil is transported by **three** ways:

1. By Pipeline, **2. By Road Tanker,** **3. By Rail Tanker**.

Transportation by roads and rail tankers is relatively costly, time-consuming and inefficient as compared to transmission by pipelines. Movement of these products by road is 'not only dangerous for traffic but because of their weight, it can also cause extreme degradation to the existing road surface and be a danger to human lives. Pipeline transportation is the most efficient, convenient and cheapest mode of transportation besides being far more environment friendly.

Crude Oil **(Unrefined / raw / it comes out of the ground)**

Crude Oil is pumped through pipes from the oil tankers at the oil terminals on the coast to the refineries nearby. The Pak Arab Refinery Company (PARCO) is playing an important role in the inland transportation of crude oil from Karachi. A pipeline has been constructed from Karachi port to **PARCO's** mid-country refinery located at Mehmood Kot for transportation of crude oil. After refining the crude oil is supplied to the up and mid-country.

Parco's Projects **(Transportation of Oil)**

In 2002 PARCO launched a White Oil Pipeline Project which will carry refined oil from Karachi to the north. After conversion of PARCO'S existing pipeline network of crude oil transportation, the White oil Pipeline will be used for the transport of refined petroleum products to the central and northern regions of Pakistan. These areas account for almost 60% of the total petroleum consumption in the country. Bin Qasim Port will be the initiation point of the White Oil Pipeline Project, where the refined products will be unloaded from the ships into the pipeline for onward transportation to the country's northern and central regions.

The new underground pipeline costing $480 million will also carry refined oil from the Pakistan Oil Refinery at Port Qasim to Mahmood Kot in district Muzaffargarh covering a distance of 817 km. The demand for petroleum products is rising at a rate of 10% per annum up country. The project will also create employment opportunities in many areas of the country and will contribute to the economic welfare of the people and the country. This will have a stabilizing effect on all sectors of the country's economy.

Uses of Oil

The uses of oil which may be grouped into four categories. The greatest use of oil is as an indispensable motor fuel. It drives nearly all the motor vehicles and aircraft of the world as well as a large proportion of trains and ships.

Oil is also used as a lubricant for machine to reduce friction. It is also very important as a source of power to generate electricity. The by-products of oil refining have many domestic and industrial uses.

Study **Fig.7**, which shows the uses of oil.

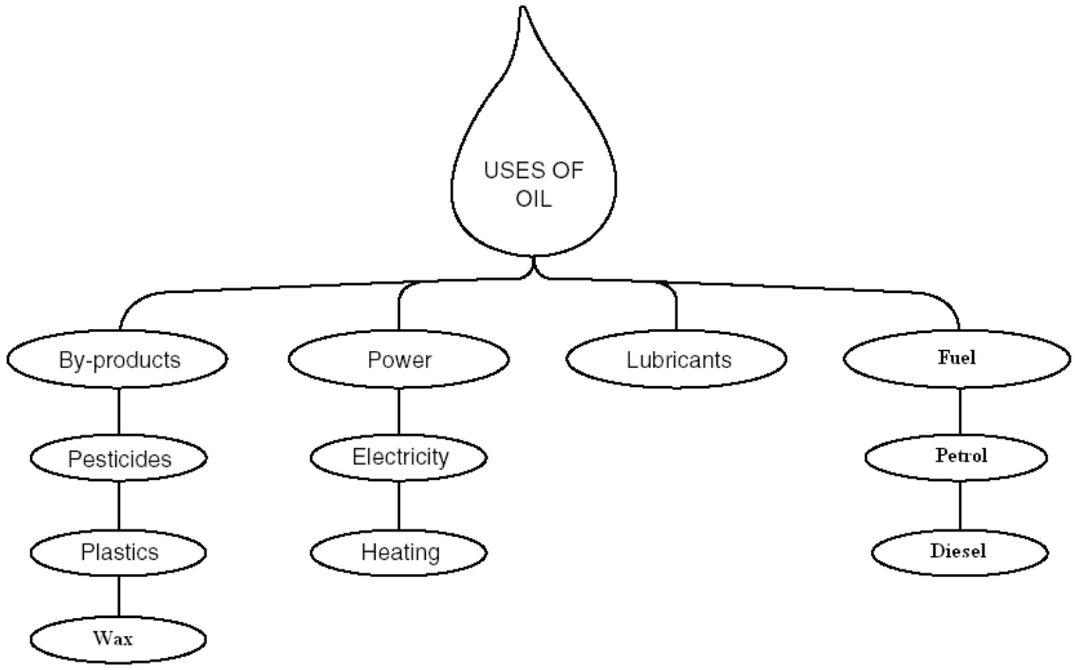


Fig.7

Sectorial Consumption of Oil

1. Transport	**42.34 %**
2. Power	**37.50 %**
3. Industry	**13.01 %**
4. Domestic	**03.17 %**
5. Government	**02.23 %**
6. Agriculture	**01.47 %**

Problems (Extraction of Oil)

1. Financial problems.
2. Lack of Technology.
3. Lack of Experts.
4. Less Quantity of Oil.
5. Remote areas.

Q.2. ***Study Fig.5, describe the distribution of oilfields.***
Ans. *North West Punjab Province.*
Southern / Lower Sindh.

Q.3. ***Explain in detail why it is necessary for Pakistan to import so much petroleum (crude oil) even though petroleum is produced in Pakistan.***
Ans. *Oil production is Pakistan is low.*
Pakistan cannot satisfy its own needs for oil.
Growing demand due to increasing population.
Increasing number of industries.
Extension of road network.
Increasing number of vehicles.
Conversion to diesel locomotives.
Mechanization of agriculture.
Most thermal power stations use oil.
Lubricant for machinery.
Source of many by-products e.g. Paraffin / wax / plastics.
Increasing demand for electricity.

Q.4. What problems are caused for Pakistan because so much is spent on importing petroleum?

Ans. *Negative trade balance.*
Increasing burden of debt.
Economy goes down.
Uses foreign exchange.
Less money for education / health care / infrastructure / industry / agriculture.
More taxes imposed.
Cannot afford to exploit new oilfields.

Study **Fig.8**, which shows the amount spent by Pakistan on importing petroleum and petroleum products from **1991 to 2002**.

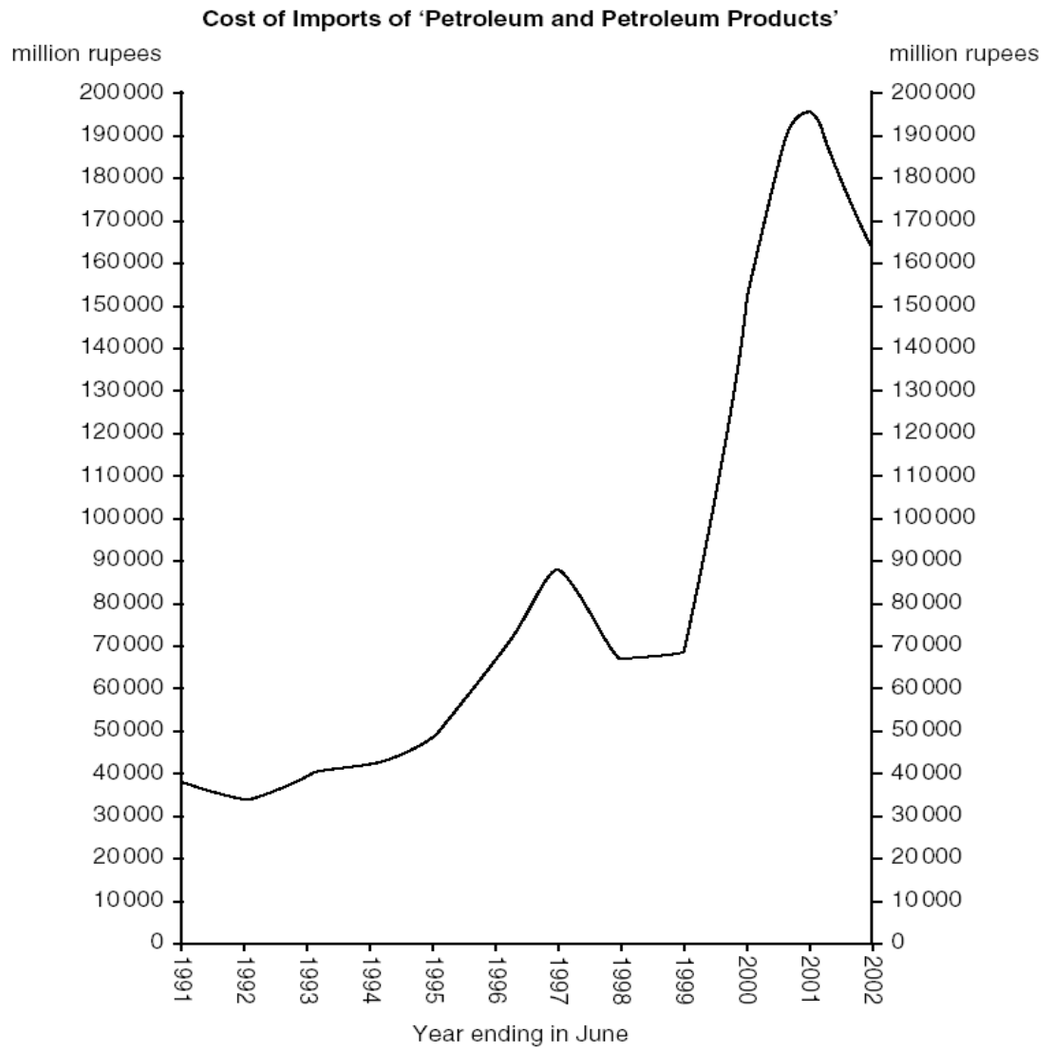


Fig.8

Q.5. Describe the trends in the cost of 'Petroleum and Petroleum products' imports shown on Fig.6.

Ans. *Overall rise.*
Fluctuated.
Fell slightly from 1991 to 1992 in first year.
Increase from 1992 to 1997.
Faster increase from 1995 to 1997.
Fell back 1997 to 1998.
Slightly increase 1998 to 1999.
Rapid rise 1999 to 2001.
Fell again in 2002.

Study **Fig.9**, a cross section showing an anticline oil trap.

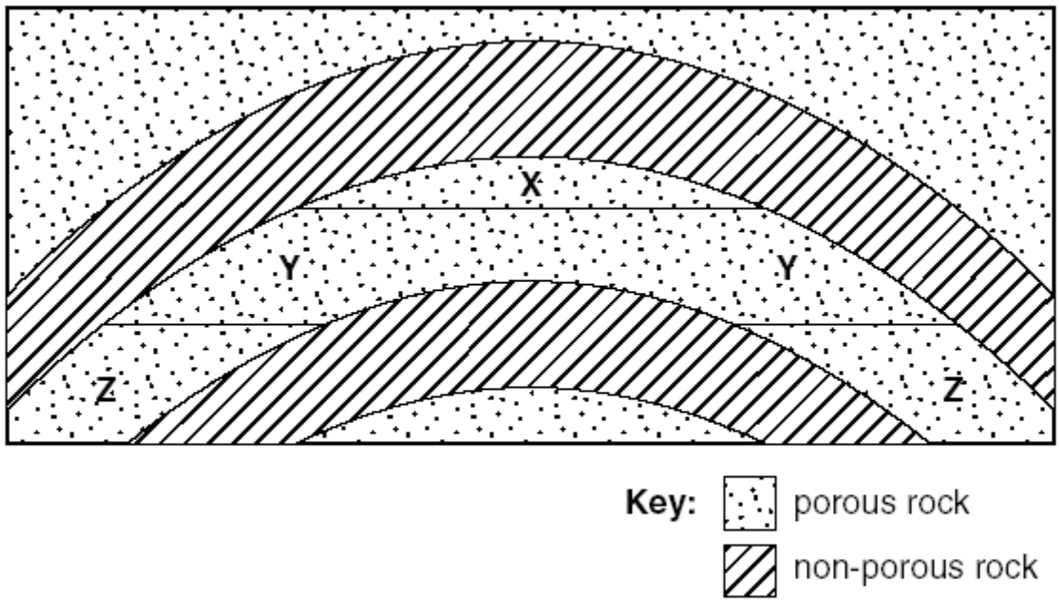


Fig.9

Q.6. ***The area of rock containing oil.***
Ans. ***Y***

Q.7. ***The area of rock containing natural gas.***
Ans. ***X***

Q.8. ***What is meant by the term 'Porous rock'?***
Ans. *Has pores / holes / spaces (to hold liquids / gases)*

Q.9. ***Why is the feature in Fig.6 called an oil 'trap'?***
Ans. *Cannot get through rocks around it.*
Between layers of non-porous.
Rises to top of anticline / top of bend.

Q.10. ***How is oil extracted from this 'trap'?***
Ans. *Derrick /drill rig built.*
Pipes inserted.
Diamond / tough metal drills into rock.
Oil rises when pressure released / pumped up / sucked up.
Cooled with mud mixture / water
Valves to control flow into pipeline.
Derrick removed.

Q.11. ***Locate an oil refinery near the coast and give one reason why it is there.***
Ans. ***Karachi.***
Refine imported oil.
Demand of the area.
Oilfields in southern Sindh.

Q.12. ***Locate an oil refinery in the province of Punjab and give one reason why it is there.***
Ans. ***Mahmood Kot oil refinery.***
Pipeline from Karachi.
Demand from named area / Multan.

Attock / Morga oil refinery.
Local oilfield in Potwar plateau area.
Demand from named area / Islamabad / Rawalpindi.

Q.13. State three ways in which refined oil can be transported in Pakistan and give an advantage and disadvantages of each.

Ans. ***1. Pipeline*** ***(Advantages)***

Large quantities can be transported.
Cheap.

Disadvantages

Costly to build and maintain.
Problem of leakage.
Only a single product can be transported.
Supply only to a few centres.

2. Railway ***(Advantages)***

Can go to more places than pipeline
More products can be carried.

Disadvantages

Smaller quantities.
Expensive.
Chances of accidents.

3. Tanker / Lorry ***(Advantages)***

Can go any where by road.
More products can be carried.

Disadvantages

Expensive.
Chances of accidents.
Theft.
Carry small amount.

Study **Fig.10**. which shows some examples of four main uses of oil.

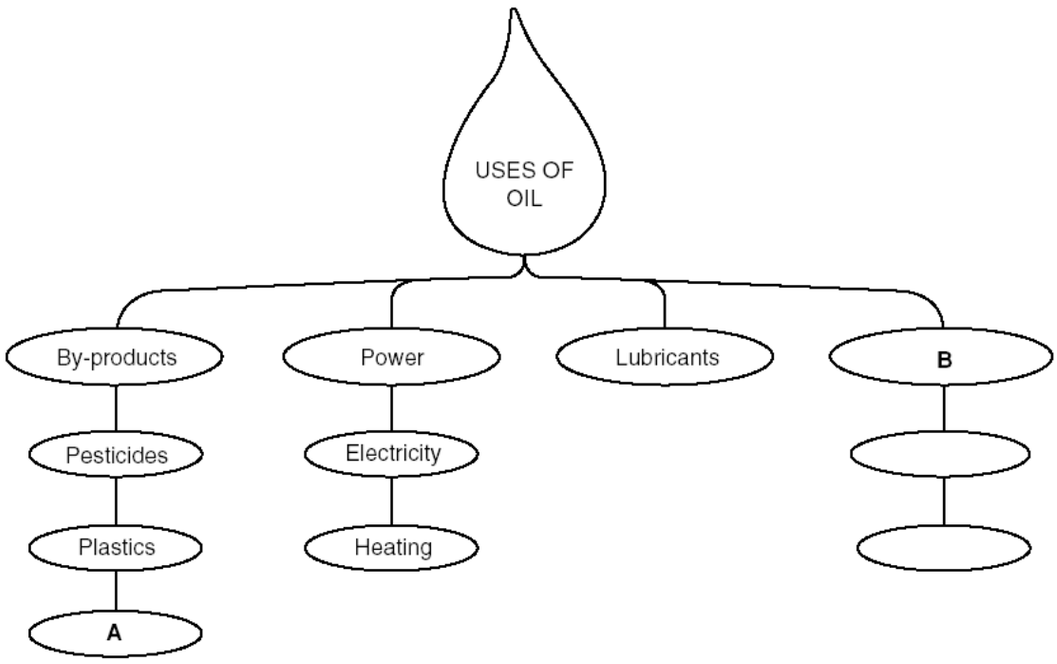


Fig.10

Q.14. Name another by-product A.
Ans. *Wax / detergent / furnace oil / synthetic rubber.*

Q.15. Name the fourth main use of oil B.
Ans. *Fuel.*

Q.16. With reference to Fig.10, explain how oil products are important to either farming or manufacturing.

Ans. ***<u>Farming</u>***

Fuel for machines.
Fuel for transport.
Electricity generation for power.
Fertilizer for growth.
Lubricants for machines.
Pesticides for healthy growth.

<u>Manufacturing</u>

Fuel for machines.
Fuel for transport vehicles.
Electricity generation for power / heat / light.
Fuel for heating.
Raw material for named products.
Tarmac for better roads / metalled roads.

Study **Fig.11**, a map of Pakistan.

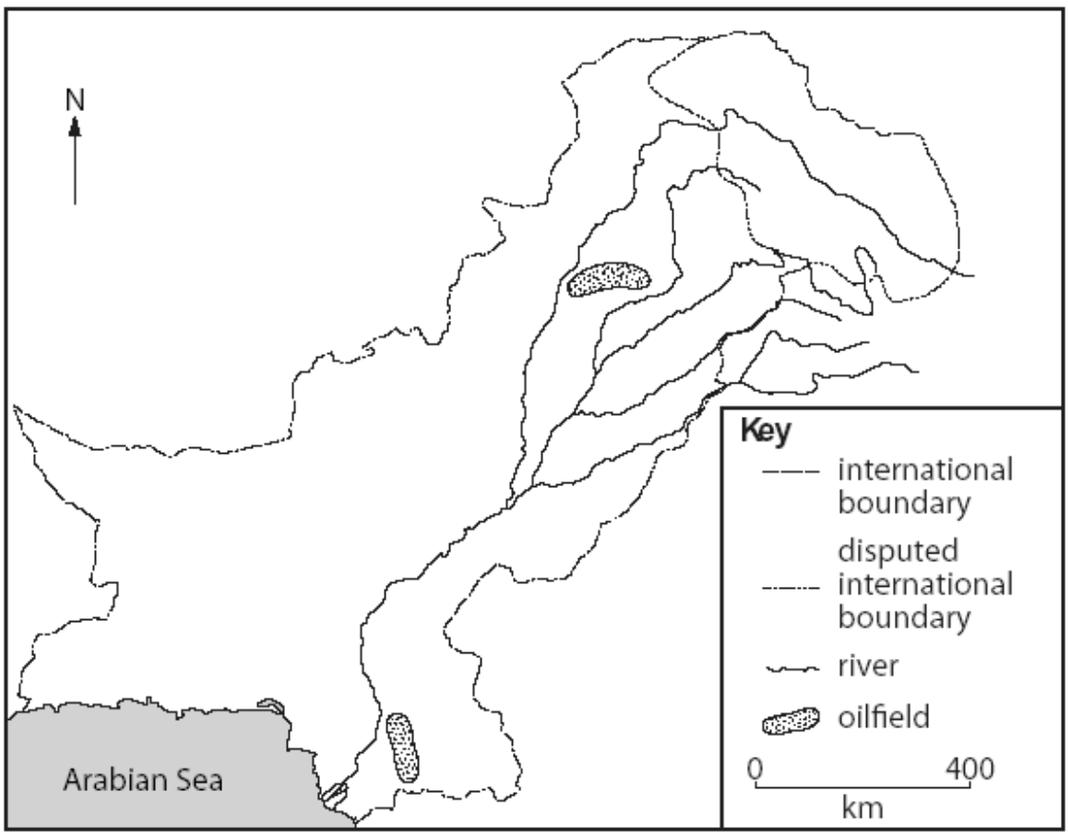


Fig.11

Q.17. Describe the location of the two main oil fields shown on the map.

Ans. *Northern Punjab / Potwar Plateau.*
Southern Sindh / Lower Sindh.

Natural Gas

It is the second most important source of energy being the cheapest as compare to Oil and coal and supplying 35% of the energy. About 95 % of the gas is derived from the gas field and the 5% is associated with oil. The industries are the main consumers. Amongst them the fertilizer industry is outstanding, followed by power generation, domestic consumers and commercial use. The original recoverable reserve of gas at December 31, 1997 was 17.3 89 trillion cubic feet.

Natural gas is an important fuel found in oil bearing rocks above the oil. These rocks have millions of tiny holes. They act like a sponge and soak up the gas as it is formed. Above this rock there is a layer of non-porous rocks that trap the gas underground and stop it from leaking out to the surface. Natural gas is made up of many gases especially **Methane, Ethane, Propane** and **Butanes**. The natural gas has no smell. Its smell has been added for safety.

Natural gas was discovered in 1952 at **Sui**, Balochistan, by Pakistan Petroleum Limited (PPL) While drilling in search of oil. This gas field is considered to be one of the largest in the world. It was the first milestone of Hydrocarbon exploration.

Importance of natural Gas

1. It is the source of energy and fulfill 35 % requirements of the country.
2. Used as a chief raw material in different industries, especially in Fertilizer Industry.
3. Used at Domestic level.
4. Used in power generation (Thermal).
5. Low cost energy.
6. Used in transport in the form of CNG and LPG.

Gas Fields

There are **three** major gas fields in Pakistan:

1. East Central Balochistan and Upper Sindh
2. Lower Sindh Gas Field
3. The Northern Region

1. East Central Balochistan and Upper Sindh

The major gas producing region of Pakistan is East Central Balochistan and Upper Sindh, where the Sui Gas Field is located. This gas field is located at the foothills of the Marri-Bugti Hills in Balochistan, is the oldest and most productive gas field in Pakistan. The gas, which is of good quality with a methane content of 90 percent, is found in the limestone in that area.

Sui gas is transmitted by pipeline to Karachi via Sukkur and Hyderabad. Another pipeline goes to Lahore via Rahimyar Khan, Multan and Faisalabad. From Faisalabad a pipeline goes to Rawalpindi, Islamabad, Wah and Peshawar. Sui gas is also transported to Quetta.

The Pirkoh Gas Field was discovered in 1977 and went into production in 1983-4. It is located about 100 kms north of Sui and is quite a large field. Gas from Pirkoh is fed into the Sui transmission line. Zin and Uch are two other gas fields in Balochistan close to Sui.

Mari is the second largest gas field in Pakistan and was discovered in 1957. It is located in Upper Sindh. Marl gas has a 73 percent methane content. It is used primarily in the production of fertilizer at Daharki, Mirpur Mathelo and Machi Goth. Other important gas fields in the region include Kandhkot, Which was commissioned in 1987 and which supplies gas to the Gudu Thermal Plant and Khairpur.

2. Lower Sindh Gas Field

The Lower Sindh region is the second largest producer of gas in Pakistan. Khorewah, South Buzdar, Turk, Turk Deep, Bulchari and Bhatti are some of the important gas fields in this area.

3. The Northern Region

The Northern Region is the third largest gas producing region in Pakistan. Dhodhak, Adhi, Pindori and Meyal are some important gas fields in this area.

Liquefied Petroleum Gas (LPG)

When natural gas is cooled to a very low temperature it turns into a liquid. This liquid is called Liquefied Petroleum Gas. It can be moved from place to place in special cylinders. In mountainous areas like Murree, Gilgit, Abbotabad, where there are no gas pipelines, many people use LPG for heating and cooking.

Sectorial Consumption of Gas

1. Power	**29.44 %**
2. Fertilizer Industry	**24.36 %**
3. Household	**21.60 %**
4. Industry	**19.40 %**
5. Commercial	**03.27 %**
6. Cement Industry	**01.89 %**
7. Transport	**00.66 %**

Organizations to develop Oil and Gas resources,

1. Geological Survey of Pakistan. (GSP) 1947.
It is responsible for the study of geology of the country in detail and assesses, its mineral potential through geological mapping, geo-scientific surveys and applied research.

2. Oil and Gas Development Company Limited. (OGDCL) 1961.
To plan, promote, organize and implement programmes for the exploration and development of oil and gas resources.

3. Sui Northern Gas Pipeline Limited. (SNGPL) 1963.
Transmission, purification and distribution of natural gas in Punjab and NWFP.

4. Sui Southern Gas Company Limited. (SSGCL) 1963.
Buying, Storing, distributing, transporting, processing and selling of natural gas and liquefied petroleum gas in Sindh and Balochistan. SSGCL also purifies for SNGPL.

5. Pak Arab Refinery Co. Ltd. (PARCO) 1974.
The Government of Pakistan and the Abu Dhabi National Oil Company own PARCO. It manages a 16-inch diameter, 864- kIn long pipeline from Karachi to Multan to carry 11000 tons of oil daily. It also has storage facilities at Korangi and Mahmood Kot.

6. Pakistan State Oil CompanvLimited. (PSO) 1976.
Pakistan State Oil is quoted on the stock exchange. It sells nearly three-quarters of the total requirements of petroleum products in the country. It has four terminals at Keamari, one at Pipri and 30 up-country depots.

7. Hvdrocarbon Development Institute of Pakistan 1970.
The Hydrocarbon Development Institute of Pakistan carries out research and provides services to both Government and industry. It helps the Govt. in maintaining the quality of oil products with the help of its regional petroleum centres operating at Islamabad, all the Provincial capitals and Multan.

Distribution and Transmission of Natural Gas

With the help of pipelines, the gas is transported to the consumer centers. However, the difficulty lies in the fact that the pipelines cost much and its purification at remote places is another drawback.

The chief risk lies in maintaining a level of pipelines operation sufficient to meet expenses and earn a profit on the investment, because of inadequate and variable nature of market.

In Pakistan, for transmission and distribution of natural gas two companies have been established for domestic and commercial purpose. They are as follows;

1. Sui Northern Gas Pipeline Limited
2. Sui Southern Gas Company Limited

1. Sui Northern Gas Pipeline Limited.

This gas pipeline was incorporated in 1963 and converted into a public sector limited company in 1964. The principal business of the company is transmission, purification and distribution of natural gas in Punjab and N.W.F.P.

2. Sui Southern Gas Company Limited.

Sui Southern Gas Limited, covering the provinces of Sindh and Baluchistan, carries out transmission and distribution functions largely in public sector.

The **SSGCL** and **SNGPL** are expected to be privatized shortly and all work will be done in the private sector.

Q.1. ***Which gas field produces most natural gas in Pakistan?***
Ans. *Sui (1952).*

Q.2. ***Name two industries in Pakistan that use natural gas as a raw material.***
Ans. *Fertilizer industry.*
Cement Industry.
Chemical Indutry.

Q.3. ***Why is natural gas an important fuel in Pakistan?***
Ans. *Can reach remote areas in cylinders.*
Easier to transport than coal.
Alternative to oil in vehicles.
Used in power stations.
Cleaner than oil or coal.
Reduces dependence on imported fuels.
Shortage of oil and coal in Pakistan.
Cheaper.

Study **Fig.12**, which shows the gas pipelines in Pakistan.

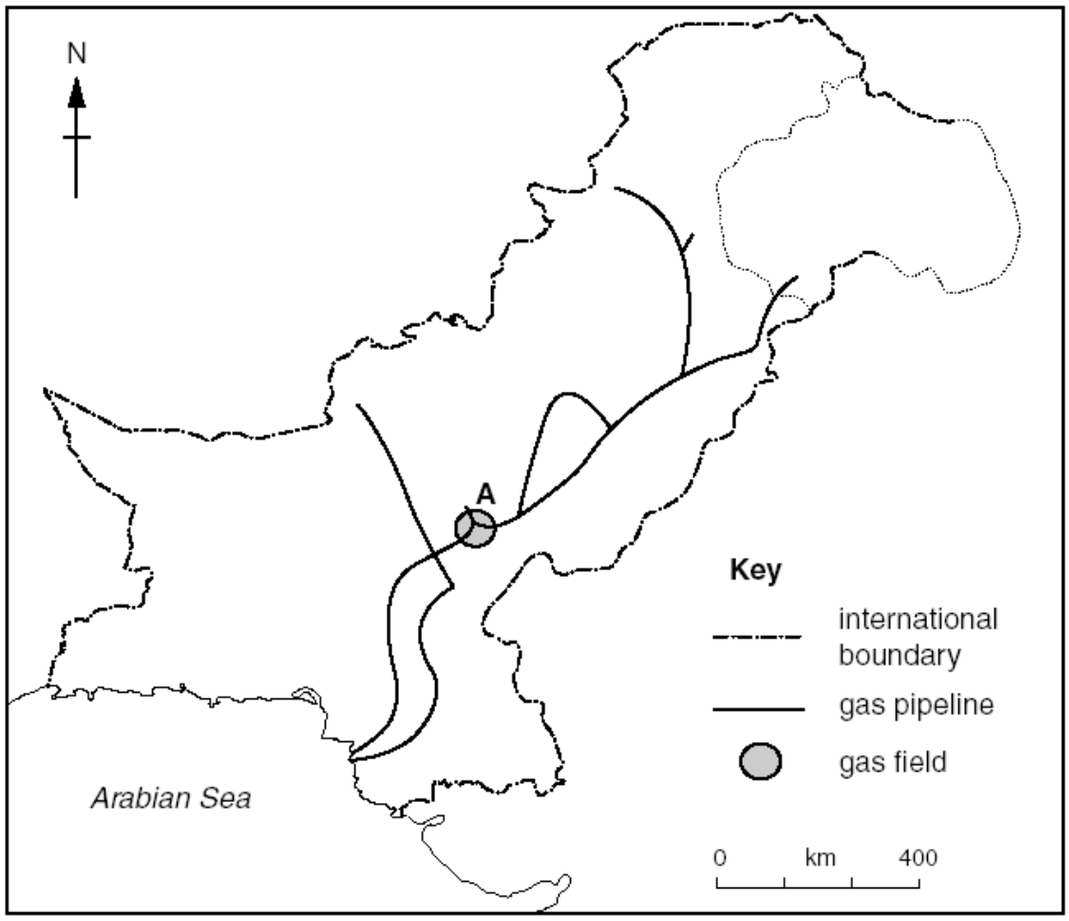


Fig.12

Q.4. ***Name the gas field A.***
Ans. *Sui.*

Q.5. ***State two ways in which gas can be supplied to areas away from pipeline.***
Ans. *Changed to a liquid / LPG /CNG.*
Cylinders.
Tankers (Pressueised).

Q.6. ***What is natural gas used for in homes and why is this fuel chosen?***
Ans. ***Uses*** ***(Homes).***
Heating.
Cooking.

Why
Available in cities / towns.
Cheaper than oil and coal.
Easier than collecting firewood.
Less bulky / easier to transport than coal / wood.
Cleaner than coal / wood / oil.

Study **Fig.13**, which shows the uses of natural gas in Pakistan.

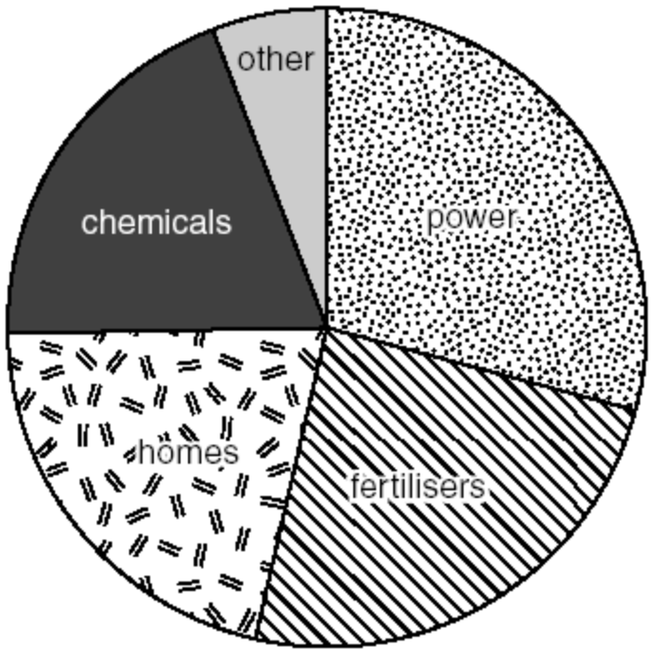


Fig.13

Q.7. ***state the largest use of natural gas.***
Ans. ***Power.***

Q.8. ***Name a use in the 'other' sector.***
Ans. ***Commercial / office.***
Cement.
Transport / cars / lorries / motor vehicles.

Q.9. ***Why is natural gas called 'non-renewable'?***
Ans *It will run out.*

Study **Fig.14**, a pie chart showing the **sources of energy** supply.

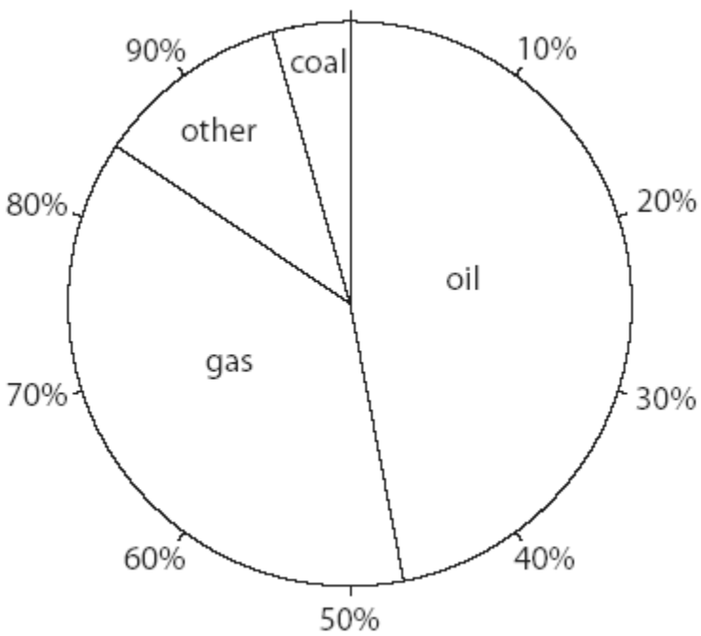


Fig.14

Q.10. Name the two largest suppliers of energy.
Ans. *Oil and Gas.*

Q.11. What percentage of energy comes from oil?
Ans. *47 – 48 %.*

Q.12. Name two other sources not named on the chart.
Ans. *HEP, Nuclear, Solar, Wind, Geothermal, Waves, Tidal and Bagasse.*

Study **Photograph A**, a gas extraction unit at Nautheh in the Potwar plateau.

Photograph A

Q.13. With reference to Photograph B, explain why natural gas is an easy fuel to extract.
Ans. *Small size of land.*
Little impact on the environment.
Simple machinery / small machinery is used.
Pipes go into ground.
Works automatically / no / little manpower needed.
Controlled by valves / valves control pressure.
Near road for easy access.

Study **Fig.15**, an advertisement for natural gas.

Fig.15

Q.14. Suggest why this advertisement states tht natural gas is 'A cheap fuel. Easy to use'.

Ans. *Produced in Pakistan / in Balochistan / at sui / not imported.*
Large reserves.
Lightweight.
Available in pipeline.
Portable in cylinders.
Cleaner than burning wood / coal.
Easy to extract.

Bio-Gas

Biogas produced from animal waste specially cow dung. It gives off methane gas. This gas is used for cooking, heating and other purposes. It is a cheap source of energy. In 1980-81 Pakistan launched a national level programme for the development of Bio-gas energy. A three phases programme was scheduled;

1. In the first phase, free of cost bio-gas plants were provided by the Government, with technical expertise.

2. In the second phase, the beneficiary has to share the 50 % cost of the bio-gas plant.

3. While in the third phase beneficiary have to bear the whole cost of the plant and Government will only provide the technical know-how.

Near about **4000** bio-gas plants have been installed in Pakistan.

Advantages

1. It is a cheap source of energy.

Disadvantages

1. Causes air pollution because methane gas is a green house gas.
2. Less availability of cow dung.

Biomass

It refers to organic material, plants and vegetables matter, both living and decaying that can be used as fuel. Most commonly, biomass refers to plant matter grown to generate electricity or produce biofuel. Examples of biomass include trees and grass, agricultural residues like used vegetable oils, wheat straw, or corn, sugar beets, grains, sugar cane, wood waste like paper trash, yard clippings, sawdust or wood chips, methane that is captured from landfills, livestock and municipal waste etc. Numerous processes such as gasification and fermentation, can tap into this energy source to produce energy available for human use.

In Pakistan the use of biomass is not new to Pakistan. The village women make patties of cow-dung, straw and clay to dry and use as home cooking fuel.

Unfortunately it is a relatively inefficient use of the biomass and causes severe indoor air pollution with well documented adverse health effects such as lungs and chest infections.

Advantages

1. Cheap
2. Easy availability of raw material.

Disadvantages

1. Nonrenewable.
2. Causes air pollution.

Solar Energy

It is energy of sunlight. In Pakistan there is enough potential for solar energy, as there are 250 to 300 sunny days a year in many parts of the country. Continuous cloudy days are also rare. Solar energy can be used for rural electrification, water heating, pumping water from wells and for cooking purposes. Solar energy has the advantage of being safe, pollution free, efficient and in limitless supply. But the construction of solar power stations is expensive and requires further advances in technology.

Ways of Collecting Solar Energy.

1. Solar Cells

Solar cells can power radios and even small cars.

2. Solar Panels

Solar panel collects heat from the sun and uses it to heat water. The steam from water is used to turn a turbine to generate electricity.

3. Solar Furnaces

Solar furnaces use giant mirrors to focus the sun's rays on a boiler. Steam from the boiler is used to make electricity.

Nuclear Energy

Nuclear energy is power that is released from atoms and the most powerful source of energy.

Fission: In atomic fission energy is released when atoms splits up into small substances.
Fusion: In atomic fusion, energy is released when atoms are joined together to form a bigger atom that releases energy.

Both process used heat energy to generate the electricity. Pakistan is also utilizing nuclear energy for electricity generation. Two nuclear power plants have been established in Pakistan.

Karachi Nuclear Power Plant (KANUPP)

The Karachi Nuclear Power Plant (KANUPP) was commissioned in 1971 and was built with the help of Canadian aid. Although its installed capacity is 137 MW, the supply has greatly fluctuated owing to technical problems.

Chashma Nuclear Power Plant

This plant was commissioned in 1999 with an installed capacity of 300 MW. It was established with the help of Pakistan Atomic Energy Commission.

Factors Needed for Commissioning Nuclear Power Plant

1. Requires qualified man power.
2. Required advance technology.
3. Required advance facilities.
4. Availability of raw material (Uranium, polonium).

Advantages

1. Large output.
2. Reliable.
3. Small input of raw material.
4. Less pollution / environment friendly.
5. Less chances of accidents in nuclear power plant.
6. Less chances of Green House effect.
7. Pakistan is deficient in fossils fuels so nuclear energy can solve the energy problem.

Disadvantages

1. The fuel rods in reactors produce dangerous rays. People exposed to the rays get cancer and their children can be born deformed.
2. Expensive to buy and build.
3. Nuclear waste can remain radioactive for many years. There are problems with reprocessing and strong nuclear waste.
4. Lack of technology.
5. Risk of terrorism.
6. Use for bombs.

Wind Power

Humans use wind power. Or motion energy, for many purposes like sailing, flying a kite and generating electricity.

In the recent past, wind energy has emerged as clean, abundant, affordable, inexhaustible and an environment friendly source of energy. The terms wind energy or wind power describes the process by which the wind is used to generate mechanical power or electricity. Wind mills and wind pumps convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks such as grinding grain or pumping water. A wind turbine has a generator which converts the mechanical power into electricity. Large scale wind farms, which consist of many turbines, are connected to electrical grids to provide electricity to a large area. Individuals turbines can provide electricity to isolated locations.

Three bladed wind turbine is the most common modern design for the generation of electricity. Each turbine has a generator. Wind energy is plentiful, renewable, widely distributed, clean and an environment friendly with no emission of green house gases.

Unfortunately, at present wind power does not contribute to power production in Pakistan, coastal areas and mountains with high wind potential are considered most suitable for generation of wind power.

Feasibility (Developing Wind Power in Pakistan)

The coast of Pakistan is about 1000 kilometres long and has a population of about 10 million people. High wind is available nearly all the year round in these areas. It is observed that the annual wind speed is maximum in Balochistan (Ormara, Jivani and Pasni) and Karachi is such that it can be sued to generate electricity.

Gharo wind power plant is planned to be built at **Gharo, Sindh** province. This will be the first wind power project of 50 MW to take advantage of strong winds in the coastal areas.

Advantages of Wind Power

1. Wind is a renewable resource.
2. It is environment friendly.
3. It can be used independently at local in rural and remote areas of Pakistan.
4. Wind farms provide a source of income for farmers and may attract small industries to rural part of Pakistan where job opportunities are limited.
5. Wind power can help to solve Pakistan's energy problems thus leading to industrial and agricultural expansion.
6. No chance of green house gases.

Disadvantages of Wind Power

1. Wind turbines are expensive to build thus increasing the burden on the economy.
2. The strength of wind is not constant and varies. This means that wind turbines do not produce the same amount of electricity all the time.
3. They automatically stop working when there is a storm.
4. Wind farms can be developed only in coastal and mountainous areas with high wind speeds.
5. Cannot develop in plain areas due less speed of wind.
6. Wind turbines can kill birds.

Geothermal Power

Geothermal is a combination of **two** words i.e. **Geo** and **Thermal**. **Geo** mean **earth** and **thermal** mean **heat**. It means the energy derived from the **heat of the Earth's core**.

Geothermal energy is produced fro Earth's heat absorbed in underground water such as hot springs. The holes are drilled into the land to pump out **hot water**. This hot water or steam is used to derive turbines to produce electricity.

Advantages

1. Renewable.
2. Constant supply.
3. Pollution free.
4. Sustainable energy.
5. Solve energy problem in Pakistan.

Disadvantages

1. Expensive to construct.
2. It can destroy due to volcanic eruption and earthquakes.

Geothermal potential in Pakistan

Geothermal resources of the world are within areas of crustal weakness such as plate margins and centers of volcanic activity. Pakistan seems to have geothermal potential because a plate margin passes through Pakistan and it lies in an earthquake zone.

According to a geotectonic framework survey conducted by **United Nations** and **Italian** experts. Pakistan has a potential of commercially exploitable sources of geothermal energy in **Himalayas** and **Chagi** region in Balochistan plateau.

Wave Power

Waves have exceptionally high energy levels. Wave motion can be used to compress air to drive turbine to generate electricity.

Pakistan has about 1000 kilometers long coastline. The **Makran Coastal areas** have strong wave energy which could be harnessed for the generation of electric poweer for rapidly developing coastal cities, Gwadar, Pasni, Ormara and Godani.

Advantages

1. Renewable.
2. Pollution free.
3. Sustainable energy.
4. Can solve energy problem in Pakistan.

Disadvantages

1. Expensive

Tidal Power

It is a renewable method of producing electricity by using the movements of the tides. The tide (The alternate rise and fall of the surface of the sea, caused by the gravitational pull of the moon) comes in and out once and usually twice in every 24 hours. This is due to the gravitational pull of the moon.

Advantages

1. Renewable.
2. Constant supply.
3. Pollution free.
4. Sustainable energy.
5. Can solve energy problem in Pakistan.

Disadvantages

1. Expensive.
2. Destroy the wildlife habitats.

Tidal Power Potential in Pakistan

The power resources potential of the Indus Deltaic Creek (smaller distributaries) System is a great asset for future energy supply in Sindh Province. The **National Institutes of Oceanography** shows encouraging results in its initial survey. The creek system of the Indus delta extends over an area of 170 kilometers. Tidal water flows in these creeks with high velocity which is a favorable requirements for the extraction of energy from tidal currents.

Electricity

It is the energy produced by rotation of turbines either by running water or heat or nuclear activity. Pakistan produces from all these three resources namely Hyde! 30 %, Thermal 68 % and Nuclear 02 %. Thermal includes electricity produced from petroleum, gas and coal. Hydel power is obtained from running water and Nuclear from atomic energy. Punjab consumes the largest quantity of electricity followed by Sindh, NWFP and Balochistan.

Availability of Electricity

Pakistan started its life in 1947 with a shortage of electricity. From 1947 to 1952 Pakistan had to import some electricity from India. In 1952 Rasul Hydel Plant was installed, after which import from India was stopped. From that day onward regular increase in electric generation has taken place. Thus, within 30 years, about 10 times increase in electricity was achieved. Though the increase is phenomenal, the per capita consumption of electricity in Pakistan is about 2 %.

Transmission of Electricity

The transmission of electricity in Pakistan is done through a national grid system. All the provinces are knit by this grid. This system has some advantages.

Advantages

1. Every part of the country receives electricity according to its needs. If any area generate less electricity than it needs, the shortage is met from other parts of the country.
2. In case of power failure in a particular area, the loss is compensated instantly from from other areas.

Disadvantages

1. Because of long distances, the transmission and distribution losses of electricity are heavy about 30 %.

2. The transmission lines were laid at a colossal cost and their maintenance also demands heavy, expenditures.

3. During the winter season the hydel power generation decreases with the reduced flow of water in the rivers.

4. Siltation in the reservoirs of dams also causes disruption in electricity generation by reducing the flow of water.

5. Industrialization, urbanization and rural electrification have increased demand for electricity.

For regular generation of hydro-electricity, the rivers must have regular flow. In Pakistan, more rainfall takes place in summer. This is also the time when glaciers melt. Therefore, the rivers have a good flow in summer. In winter, the river flow diminishes because of less rainfall and conversion of some water into snow at higher elevations. Therefore, regular supply of electricity is affected and load shedding takes place.

Hydroelectricity

Hydroelectricity is an important source of energy in Pakistan. Most of the hydel plants in Pakistan are located on the rivers in the mountainous north, where the rugged topography provides a good head for the generation of electricity. A good head means that the water falls from a sufficient height on the turbine, making it turn. A regular flow of water is also essential to ensure the year round generation of electricity. Unfortunately, the rivers of Pakistan have a low discharge in the winter season, which reduces their power-generating capacity. As a result power shortages generally occur in winter. To overcome this problem the government has set up a number of small hydel plants in different parts of the country. A few low artificial waterfalls along canals have been utilize for small hydel plants.

Hydel Plants

At the time of independence there were two hydel plants in Pakistan namely Renala and Malakand since then more hydel plants have been set up. Of which Tarbela, Mangla and Warsak are large multi-purpose projects that perform a number of other functions other than producing electricity.

TarbelaDam

Tarbela Dam is located on the River Indus. It is a multi-purpose project which was primarily constructed to supply water for irrigation, but also produces electricity. Its installed capacity is 3478 MW.

ManglaDam

It is located on the River Jhelum. It is also a multi-purpose project designed to provide water for irrigation and for the generation of electricity. It generates 1000 MW of electricity.

WarsakDam

Warsak, another multi-purpose project, is designed to provide water for irrigation and for the generation of electricity. It is located on the Kabul River. Its installed capacity is 240 MW.

Small Hydel Plants

There are a small number of small hydel plants in Pakistan. One of them is Renala located on the Upper Bari Doab Canal. It was commissioned in 1925 and it is the oldest hydel plant of Pakistan. There is another plant known as Rasul Hydel Plant and it was commissioned in 1952 after which import of electricity from India was stopped~ Chichoki Mallian Hydel plant is another one of the hydel plant and is located about 45 kms from Lahore. It was completed in 1959. Other hydel plants are Nandipur hyde1 plant near Gujranwala, Shadiwal hydel plant, Malakand hydel plant, which was constructed in 1938, Kurramgari hydel plant and the Chitral hydel plant, along with Gomalzam and Dargai.

Factors which influence the production of Hydroelectricity

1. Glacier Fed Rivers. Floods.
2. Old Machinery in the power plants. Mishandling of Funds.
3. Taking not much care.
4. Variability of Rainfall.

Methods to check the fluctuation in the production of Electricity

1. Construction of small dams on seasonal rivers especially in NWFP and Balochistan.
2. Large dams to store the flood water.
3. Installation of modern machinery in the power plants in place of old one.
4. Improvement in the grid system to save the line losses.
5. Development of alternate resources to help in meeting the growing demand.

New Hydel Projects

New hydel projects are also being developed, including the Ghazi Barotha Project, which is located on the River Indus near Ghazi town. It is a large project with a capacity of 1450 MW. It is expected to be completed soon.

The feasibility of more than 20 small hydel projects have been stuclied. The private sector is also taking interest in some of these projects. It has been planned to increase the contribution of hydel plants in production of electricity to 70 percent.

Q.1. ***What is load 'shedding' and how does it affect industry and business in Pakistan?***

Ans. ***Definition*** ***(Load shedding)***
Planned power cuts.

Effects
Interrupts production.
Damage machinery.
Cannot meet deadlines.
Loss of quality.
Loss of orders.
Loss of money / profit.
Cost of generators.
Lights / computers / air conditioners / heating etc. stops.
Transport / traffic problems.

Study **Fig.16**, a diagram showing how hydro-electric power is made.

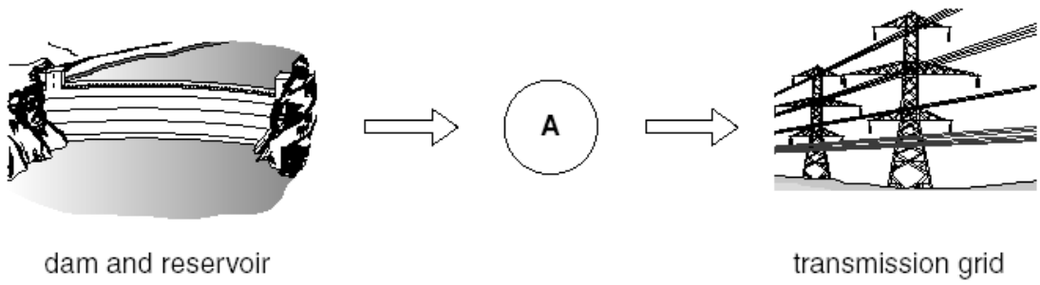


Fig.16

Q.2. ***Name the machine A and explain how it uses the flow of water to make electricity.***
Ans. *Turbine spins / rotates / moves.*

Q.3. ***Why is HEP (hydel)a cheap source of electricity?***
Ans. *Free raw material / rain in mountains.*
Will never run out.
Not imported.
Efficient / high power output.

Q.4. ***What problems occur when supplying electricity from reservoirs to areas of high population?***

Ans. *Long distance to areas of use / high population.*
Cost of wires and poles / difficult terrain / Pakistan cannot afford.
Loss by damage.
Loss by theft.
Loss of power by resistance / transmission.
Shortage of money.

Study **Fig.17**, a pie chart showing the different users of electricity in Pakistan.

Fig.17

Q.5. ***With reference to Fig.17, which sector uses the largest percentage of electricity.***

Ans. *Domestic / homes.*

Q.6. ***State two more large users of electricity shown on the chart and explain what they use it for.***

Ans. ***Industry*** - *for machinery, computers, lighting, air conditioning etc.*
Farming - *for much of above, tubewells, drying crops etc.*
Offices - *computers, lighting, communication, air conditioning*

Q.7. ***What problems are caused when the electricity supply to factories breaks down?***

Ans. *Stops production / slows production / output reduced.*
Damages machinery short circuit / explosion.
Damage goods / affects the quality e.g. food, cloth.
Delays orders.
Loss of money / profit.
Workers laid off / sit idle.

Q.8. ***Name two environmentally-friendly ways of making electricity other than hydro-electric power.***

Ans. *Solar, Wind, Tidal, Biogas, Bagasse, Geothermal.*

Q.9. ***Explain why each of the to ways you have named could be used in Pakistan.***

Ans. ***Solar*** *Long hours of sunshine / many sunny days / many days of clear shy.*
Wind *Indus plain flat, on mountains, wind in coastal areas.*
Tidal *For coastal areas specially Karachi.*
Biogas *Cheap, small scale, disposes of waste product.*
Bagasse *Many sugar cane factories, disposes of waste product, cheap.*
Geothermal *Not in Pakistan.*

Q.10. ***Why is it important that more renewable energy schemes are developed in Pakistan? You may use your answer to Fig.17 and your own knowledge.***

Ans. ***General reasons for needing more power supplies.***
Frequent power cuts and stoppages / load shedding / shortage of HEP.
Increasing population / industrialization / development.
Higher loving standard.
To encourage development.
Rural electrification.

Reasons for more renewable schemes.
Fossil fuels running out / renewable do not run out.
Fossil fuels expensive.
Renewable cheap / free after installation.
Can be generated in remote areas.
Nuclear is dangerous / problems of disposal waste.
Fossil fuels cause air pollution.
Poor quality of coal.

Q.11. ***How is electricity produced in power stations such as Warsak / Mangla / Tarbela and how is it transmitted to cities.***

Ans. ***How produced:***
Water from reservoir / water from dam / head of water rushes down / passes through dam.
Steep / narrowing pipes.
Drives turbine.
Which turns shaft rapidly inside generator / works generator.

How transmitted:
From transformer at hydel / HEP stations which controls the voltage.
Onto national grid / power lines / cables wires which is a network of wires.
Over head / underground.
Onto local / city supply grid.
Voltage dropped / adjusted.

National Grid Systam

The National Grid connects hydel generation in the north and thermal generation in mid country and the south managed by WAPDA and KESC. It consists of a large network of transmission lines and grid stations to transmit power to load centers and then to commercial and domestic consumers throughout the country.

The purpose of forming a National Grid System is to supply electricity to different areas according to their requirements and not on the basis of their own power generation. For example some areas of Pakistan where heavy industries are located require more electricity than they are capable of generation supplying electricity through the National Grid System solves this problem. On the other hand, there are some areas where more electricity is generated than their actual requirements. This surplus electricity can then easily be transferred to other areas through this system. However, there is lot of wastage of electricity through the transmission lines and grid stations if they are not properly maintained, also due to the long distances involved.

Q.1. ***Many areas of Pakistan are still not connected to the national electricity grid. How does this affect the development of industry in these areas?***

Ans. *Severely limited.*
Mainly for local needs.
Small scale industries only.
Simple / hand / foot powered machinery.
Labor intensive.
Work only possible by daylight.
Small / slow output.
Part time activity.

Q.2. ***Why is it difficult to provide electricity on the national grid to all the populated areas of Pakistan?***

Ans. *Lack of money / Pakistan is a poor country.*
Too costly to extend to all areas.
Large country / people are scattered.
Remote areas e.g. mountains and deserts.
Some places are far away from fuel resources.
Power loss due to long transmission lines.
Poor maintenance is a hindrance.

Thermal Electricity

Electricity is a flexible form of energy that can be easily converted to heat, light or sound energy. Electricity that is generated by non-renewable resources like oil, coal, gas, nuclear fuel is called 'Thermal Electricity'. Fossil fuels and nuclear power stations produce heat energy. This is used to turn water into steam which is then used to run turbines.

Unlike the hydel plants which are concentrated in the NWFP and Northern Punjab, the thermal plants are well distributed through out the country.

The main centre for the production of thermal power in Sindh is Karachi. Other important thermal stations in Sindh are located at Kotri, Hyderabad, Sukkur and Guddu. Large thermal plants in Punjab have been installed at Rawalpindi, Lahore, Faisalabad, Multan and Kot Addu. In Balochistan, thermal plants are at Quetta, Pasni and Hub.

In a recent study it was stated that over 46 % of thermal power is generated in the area around Karachi.

Q.1. ***Why is so much thermal power generated in this area?***

Ans. *Gas / coal fields in Lower Sindh.*
Coal mines in Lower Sindh e.g. Lakrha / Jhimper / Sonda.
Gas pipeline from Sui.
Imports of oil from Karachi.
Demand from industry.
Oil refineries at Karachi.
Other demands e.g. railway.

Q.2. ***What problems are created when there are many thermal power stations in one area?***

Ans. *Air pollution.*
Shortage of oil / gas / coal supply.
Depletion of oil / coal reserves in the area.
Lack of investment in renewable energy generation.
Hot water flows out into rivers.

Read the extract from 'Dawn'.

The reasons for the high cost of production which damage industry are many. They include the high cost of power, frequently breakdowns at the power stations and the unsteady supply of electricity from them.

Q.3. ***Give three reasons for the high cost of power from thermal power stations in Pakistan.***

Ans. *Need to import oil / fossil fuels.*
Natural gas expensive.
Oil is expensive / expensive to import oil.
Oil prices have increased.
Independent power stations charge higher prices.
Cost of power lines / transmission.
Cost of technology.
Theft.

Q.4. ***Suggest one reason why power stations frequently breakdown.***

Ans. *Machinery is old / poorly maintained.*
High demand.
Silt from reservoir entering HEP turbines.

Q.5. Other than 'the frequent breakdowns at the power stations', why is the supply of electricity 'unsteady'?

Ans. *Breakage of wires due to long transmission lines.*
Illegal tapping into supply / theft.
Demand exceeds supply.
Power sharing / shedding practiced.
Less HEP in winter.

Q.6. How many factories try to overcome the problem of unreliable electricity supply from the national grid? Why is it important for them to do so?

Ans. ***How****:*
Government encouraging private power stations.
Use of alternative sources e.g. Solar / Biogas.
Have stand by generators.

Why*:*
Interrupted production.
Interrupts supply to market.
May lose market / sales.
Profits fall / loss in income.
Damage machinery.

Comparison Between Thermal Power and HEP Station:

Thermal Power Station

1. Fossil fuels will eventually be exhausted.

2. Fossil fuels cause pollution when they are burnt and are not environment friendly.

3. Thermal power stations can be developed at any place where fossils fuel are available.

4. Thermal power stations are less expensive to build than HEP stations, but except for nuclear power stations, running costs are very high. Nuclear power stations are very expensive to de-commission.

Hydro Electric Power Stations

1. Water is renewable resource, which will used to generate HEP and will not be exhausted.

2. HEP is referred to as white coal. It produces power with out any thing having to be burnt and environment friendly.

3. HEP stations have certain physical and climatic requirements for their development.

4. The initial cost for the construction of an HEP station is very high but the running costs are low.

Rural Electrification

66.5 % of the population lives in the rural areas. Most of the rural areas are deprived of even the basic facilities of modern life. Electricity is one of those facilities that can prove a milestone in rural development.

Advantages of Rural Electrification

1. Tubewells can be installed for irrigation. This will also help to control water logging and salinity. Consequently, there could be a marked increase in agricultural production.

2. Small Scale Industries can be developed to provide employment and to meet the demand for industrial goods.

3. The standard of living increases. People can use electrical appliances.

4. People can receive the electronic media and access information technology.

Rural Development Programme

There are many Programmes for rural development like Village Aid, Basic Democracy and Rural Works Programm. Providing electricity to rural areas was one of the main targets of these programmes. There are many constraints to village electrification like:

1. Many of the small villages especially in NWFP and Baluchistan are far from transmission lines.

2. The cost of laying and maintaining transmission lines is high and is an extra burden on the country's meager economic resources.

Factors (deciding about the electrification of villages)

1. Distance from the power supply line. Villages within one kilometer of supply line will be electrified.

2. Villages with larger population will be supplied with electricity. Villages with 1000 people in Punjab and Sindh, and 300-500 people in Balochistan and NWFP will be supplied with electricity.

Sustainable **(Development of Power Resources)**

Although the uses of power resources are considered to be one of the most effective instruments and indicators of development, the mismanagement of these resources can lead to an energy crises for the future generation. In order to have sustainable development of power resources the following measures must be taken.

1. The development of renewable resources of energy by using advanced technology.

2. The preservation and conservation of the non-renewable resources of the earth to guard against the danger of their future exhaustion.

3. The protection of the environment by enforcing the strict laws through environment protection.

4. Faulty and damaged transmission lines should be replaced on an emergency basis to avoid losses in electricity.

5. Strict measures to avoid the chances of theft.