Power Resources

Sources of energy, non-renewable coal, oil and gas in Pakistan, and renewable hydel, wind, solar and other sources, and why electricity supply is unreliable.

Sources of power

Fuels and how they are obtained

Fuel	How it is obtained
Coal	**open-cast mining** (the surface layers of earth are removed with machines, for coal near the surface, as in the **Thar**); **adit mining** (a **horizontal tunnel** driven into the side of a hill to reach the coal seam, common in the **Salt Range** and **Balochistan**); **shaft mining** (a **vertical shaft** is dug to reach seams deep underground, with lifts and tunnels)
Natural gas and crude oil	**exploration** (**seismic surveys** to find rock structures) followed by **drilling** a well; the gas or oil rises or is pumped to the surface; **pipelines** carry them to **refineries** and users

Renewable and non-renewable sources

- **Non-renewable**: **coal**, **oil** and **natural gas** (and **uranium** for nuclear power). They are **used up** and cannot be replaced in a human lifetime, and they cause **pollution**.
- **Renewable**: **water (hydel)**, **wind**, **sun (solar)**, and others such as **waves, tides, biofuels** and **geothermal** power. They are **replaced naturally** and **cause little pollution**.

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Generating electricity from renewable sources (briefly)

Source	How it works
Hydel (hydroelectric)	water from a **dam** flows through pipes and spins **turbines** connected to **generators**
Wind	the **wind** turns the blades of a **wind turbine**, driving a generator
Solar	**photovoltaic (PV) panels** turn **sunlight** into electricity directly (or mirrors heat water for steam)
Wave and tidal	the movement of **waves** or **tides** drives turbines
Biofuels	burning **plant material or waste** (such as **bagasse** from sugar cane)
Geothermal	**steam** from hot rocks underground turns turbines

The importance of power for development

Power is needed for **industry**, **agriculture** (tubewells), **transport**, **homes**, **hospitals and schools**, and **communications**. A reliable supply attracts **investment** and **jobs**; shortages harm **production** and **living standards**.

Non-renewable power resources in Pakistan

Coal

- Pakistan has large **coal reserves**, mainly in the **Thar Desert** (one of the world's largest **lignite** deposits, over **150 billion tonnes** by some estimates), and also at **Lakhra**, **Sonda**, **Sor Range**, **Khost** and the Salt Range.
- **Quality:** most is **lignite** and sub-bituminous coal, **low quality** (high in **ash** and **sulphur**, and low in heat value), and so it is used for **brick kilns**, **cement** and **power**. The **Thar** coal field has been developed for **power** since 2019.
- **Imports: high-quality coal** (such as **coking coal** for **steel**, and coal for **cement** and some power stations) is imported, mostly from **South Africa**, **Afghanistan**, **Indonesia** and **Australia**.
- **Transport:** by **rail** and **road** (trucks) in Pakistan; **imported coal** comes to **Karachi** and **Port Qasim** by sea and is moved inland by rail.
- **Reserves life:** Thar reserves are large (**hundreds of years** at present use), but the **other** fields are small.

Types of coal (best to worst): **anthracite** (hardest, highest carbon, burns with great heat), **bituminous** (including **coking coal** used to make coke for steel), **lignite** (soft, damp, high in ash, low heating value)

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and **peat** (the first stage of coal formation). Pakistan has mostly **lignite** and some sub-bituminous coal.

Moving coal to users. In the mines it is brought out on **trolleys** (and by animals in small mines), then taken by **truck** to **brick kilns** and **cement factories**, which use most of the coal produced, or by **rail** to power stations where this is cheaper. Imported coal arrives at **Karachi and Port Qasim** and goes inland by **rail**.

Natural gas

- The main field is **Sui** in Balochistan (discovered in **1952**); others include **Mari**, **Qadirpur**, **Uch**, Kandhkot, **Pirkoh** (Balochistan) and **Meyal** and **Dhurnal** (Potwar). Gas is found above the oil in rock beneath a layer of non-porous rock. Gas is Pakistan's **most important fuel** (for homes, fertiliser factories, industry and power).
- **Reserves are falling**: production no longer meets demand, and, at current rates, reserves will last **only a few decades** (the figure depends on the source).
- **Pipelines:** a **network** of **pipelines** carries gas to **Karachi**, the **Punjab** and **Khyber Pakhtunkhwa** cities (the grid is operated by **SNGPL** and **SSGC**).
- **Areas away from the pipelines:** gas is supplied as **LPG** (liquefied petroleum gas) in **cylinders** or **CNG** (compressed natural gas) for vehicles. **Limitations:** it is **more expensive**, requires **transport by road**, is **less convenient**, and carries **safety** risks. **LNG** (liquefied natural gas) is also imported.

Oil

- Pakistan produces **only a small part** (roughly **15–20%**) of its needs from fields such as **Potwar**, **Badin** (Sindh) and **Dhulian**. Reserves are small.
- **Imports:** the rest is imported (mostly **crude oil and refined products** from **Saudi Arabia and the UAE**), because **demand is large** (for transport, power and industry), and local production is small. **Oil imports** are a large part of the import bill.
- **Pipelines:** an **oil pipeline** runs from **Karachi** to **Mahmood Kot** and on to the **Punjab** (Machike, near Lahore).
- **Refining:** crude oil must be **refined** into petrol, diesel, kerosene, furnace oil, wax and chemicals. It is cheaper to import crude and refine it at home. Main refineries include **Attock Refinery** (Rawalpindi), **National Refinery** and **Pakistan Refinery** (Karachi), and the **Pak-Arab Refinery (PARCO)**, whose pipeline runs from Karachi (Port Qasim) to **Mahmood Kot** and on towards the north, where most consumption lies. A newer **white-oil pipeline** carries refined products inland.
- **Imported oil** is unloaded from tankers at an **oil pier** at **Keamari** or **Port Qasim** and pumped to storage tanks. **Pipelines** are the cheapest, safest and cleanest way to move oil inland; **road and rail tankers** are slower, dearer and damage roads, but reach places the pipeline does not.

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- **Other methods: oil tankers** by sea to **Karachi**, and then **rail tankers and road tankers** to other areas.

Thermal power stations

Electricity can be generated in **thermal power stations** by burning **coal, oil, gas or waste** to make steam that turns turbines, or with **nuclear** energy (for example at **Chashma** and **KANUPP**, Karachi). **KANUPP** (Karachi Nuclear Power Plant, about 137 MW) started in **1971**, and the first **Chashma** plant (built with Chinese help) began working at the end of the 1990s. Oil and gas together supply most of Pakistan's primary energy, and most electricity comes from **thermal** stations, with a quarter or so from **hydel**. **Problem:** non-renewable fuels are **running out** and are **increasing in price**, especially oil.

Renewable power resources

Advantages and disadvantages

Source	Advantages	Disadvantages
Hydel	**cheap** to run, **no fuel**, **no air pollution**, **dams** also give **irrigation and flood control**	**very expensive** to build; **flooding** of land and **displacement** of people; **silting**; depends on **rainfall and snowmelt**; far from users
Wind	**free** and **clean**, can be used in remote areas	needs **strong, steady** wind (the **Gharo–Jhimpir corridor** in Sindh is the best site); **not reliable**; noisy and uses much land
Solar	**abundant sunshine**; **clean**; **good for remote areas** and **small scale** (**Quaid-e-Azam Solar Park**, Bahawalpur); falling costs	high **set-up cost**; only works in **daylight**; needs **storage**; needs **large areas**
Wave, tidal, geothermal, biofuel	clean or use waste	**expensive**, **small scale**, little used in Pakistan

Biogas. Animal dung and plant waste ferment in a tank to give **methane**, used for cooking and light. It is cheap and good for villages, but the dung can then **no longer be used as manure**, and methane is a **greenhouse gas** if it leaks.

Multi-purpose hydel schemes

Conditions that favour a **multi-purpose dam** (irrigation, power, flood control, water supply):

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- **Physical:** a **river with a large and steady flow**, **high rainfall or snowmelt**, a **steep, narrow valley** (to store much water with a short dam), a **strong rock foundation**, and **low risk of earthquakes**.
- **Human: sparse population** in the reservoir area (little to move), **money and technology**, **demand** for electricity and irrigation, **government support**, and **good access** for building.

Examples: **Tarbela, Mangla, Warsak** and **Ghazi Barotha**.

Factors that help or hinder the supply of electricity

Promote	Hinder
rivers and mountains (hydel); **sunshine** and **wind** in parts	**lack of money** to build and **maintain** power stations
government policy and **foreign investment**	**line losses** and **electricity theft** (the **"kunda"** system), **old equipment**
coal in Thar; **gas fields**	**circular debt** (unpaid bills between the power companies) and **expensive fuel imports**
small-scale systems: **micro-hydel** schemes in **mountain valleys**, **solar panels** and **biogas** in villages	**difficult terrain** and **scattered villages** (it is costly to extend the grid), and **security** problems

Why is the supply of electricity not sufficient or reliable?

Demand is growing quickly with **population and industry**; **power stations** are not built fast enough; **fuel** is imported and costly; **transmission and distribution** lose much power; **theft** and **unpaid bills** drain the system; **droughts** reduce **hydel** output; and **some areas** (rural and mountain) are **not connected**. The result is **load-shedding** (planned power cuts), which harms **industry**, **jobs**, **farming** and **daily life**.

> **NOTE**
>
> Production and reserves figures change every year, and **different books give different numbers**. In the exam, use the numbers in the question; for your own notes, use the **figures your teacher gives you**.

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