P1.3 National and Global Energy Resources

Non-Renewable Energy Resource
Cannot be replaced once used

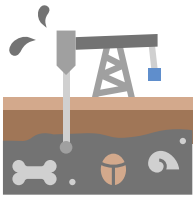
Renewable Energy Resource
Replenished as it is used

Fossil Fuels (Coal, Oil, Gas)

How they work:
- Burned to heat water → steam → turbines → electricity.
- Oil is refined for fuel in vehicles.

Renewable?
❌ No – takes millions of years to form.

Main Uses:
- Transport (oil)
- Electricity (coal/gas)
- Heating (gas).



Advantages:
- Reliable and consistent
- High energy output per kg
- Existing infrastructure

Disadvantages:
- Non-renewable – will run out
- Burning produces CO_2 → global warming
- Sulfur dioxide → acid rain (especially from coal)

Environmental Impact:
- Major contributor to climate change
- Air pollution and habitat damage from mining

Reliability:
✅ Very reliable, easy to store and transport.

Cost:
Low running cost but rising due to scarcity and emissions regulations.

Biofuels (Ethanol, Biodiesel, Methane)

How it works:
- Made from plants/waste.
- Burned to generate electricity or used in engines.

Renewable?
✅ Yes – regrows or is constantly produced.

Main Uses:
- Transport
- Electricity
- Heating

Advantages:
- Theoretically renewable and carbon-neutral
- Can use existing transport systems
- Reduces landfill waste

Disadvantages:
- Land use – may compete with food crops
- Not truly carbon-neutral if fossil fuels used in production

Environmental Impact:
- Less CO_2 than fossil fuels but can affect land use and biodiversity

Reliability:
✅ Steady supply, but limited by crop growth.

Cost:
Moderate; varies by source.

Resource	Capital Cost	Overall Cost
Gas	Low	Low
Coal (with carbon capture storage)	High	Medium
Nuclear	High	Medium
Wind	Very High	High
Solar	High	High
Hydroelectric	Medium	Low

Use	Example Resources
Transport	Oil, biofuel, electric (indirect)
Electricity	Fossil fuels, nuclear, wind, solar
Heating	Gas, geothermal, solar heating panels

Nuclear

How it works:
- Nuclear fission in reactor cores releases heat → coolant → steam → turbines.

Renewable?
❌ No – uranium is finite.

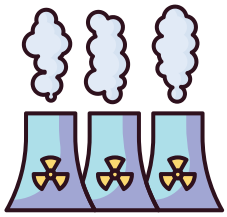
Main Uses:
- Electricity generation

Advantages:
- No CO_2 or greenhouse gases produced
- Very high energy output per kg of fuel

Environmental Impact:
- Low emissions but high-risk if accidents occur

Reliability:
✅ Provides base load – very consistent.

Cost:
High to build and decommission; relatively low to run.



Disadvantages:
- Radioactive waste (long-term storage needed)
- High capital cost and long decommissioning time
- Public concern over safety (Chernobyl)

Wind

How it works:
- Wind turns turbine blades → generator produces electricity.

Renewable?
✅ Yes – wind is unlimited.

Main Uses:
- Electricity generation

Advantages:
- No fuel cost or emissions
- Quick to build

Environmental Impact:
- No pollution, but can harm birds and spoil views

Reliability:
❌ Variable – depends on wind speed.

Cost:
High capital cost; low running cost

Disadvantages:
- Unreliable – no wind = no power
- Noise pollution and visual impact

Reliability	Resources
Most reliable	Nuclear, fossil fuels
Least reliable	Wind, solar (weather dependent)
Base laod	Nuclear, coal
Quick start	Gas, pumped storage

Base load: Continuous demand met by nuclear & coal

Renewables: Used when conditions are suitable (e.g., windy or sunny)

Variable demand: Met using gas-fired & pumped storage power stations

Stored energy: Pumped storage used to meet peak demand quickly

P1.3 National and Global Energy Resources

Resource Type	Renewable?
Fossil Fuels	No
Nuclear Fuel	No
Biofuel	Yes
Wind	Yes
Hydroelectricity	Yes
Geothermal	Yes
Tidal	Yes
Solar	Yes
Wave	Yes

Waves

How it works:
- Wave motion drives a generator that produces electricity.

Renewable?
✅ Yes – constant ocean waves.

Main Uses:
- Electricity generation

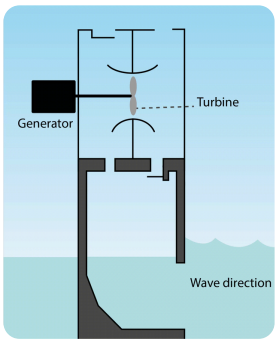
Advantages:
- No emissions
- Ideal for island nations

Disadvantages:
- Harsh marine environment – expensive maintenance
- Affects coastlines and marine ecosystems

Environmental Impact:
- Visual impact, possible disruption to sea life

Reliability:
❌ Variable with weather/ocean conditions.

Cost:
High due to engineering challenges.



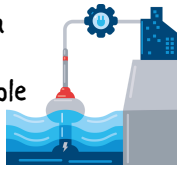
Tidal

How it works:
- Water trapped at high tide → released through turbines to generate electricity.

Renewable?
✅ Yes – driven by Moon's gravity.

Main Uses:
- Electricity generation

Advantages:
- Predictable and reliable
- No emissions



Disadvantages:
- Expensive to build (barrages)
- May affect estuarine ecosystems and migration routes

Environmental Impact:
- Disruption to aquatic life and habitats

Reliability:
✅ Highly predictable (based on tide cycles).

Cost:
Very high capital cost.

Geothermal

How it works:
- Heat from radioactive decay in Earth heats water → steam → turbines.

Renewable?
✅ Yes – natural underground heat.

Main Uses:
- Electricity generation
- Heating

Advantages:
- Clean and reliable
- Useful in volcanic areas

Disadvantages:
- Location-limited
- Expensive to drill

Environmental Impact:
- Low, but may release underground gases

Reliability:
✅ Very reliable where available.

Cost:
High setup, low running cost.

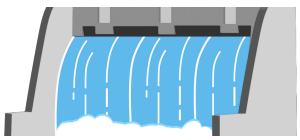
Hydroelectric

How it works:
- Water stored in reservoir flows downhill → turns turbines → electricity.

Renewable?
✅ Yes – powered by rain cycle.

Main Uses:
- Electricity generation

Advantages:
- Fast response to demand
- Reliable and efficient



Disadvantages:
- Requires large dams – can flood habitats
- Affected by droughts

Environmental Impact:
- Significant during construction (deforestation, flooding), affecting local communities and natural river flow
- Large reservoirs flood land → loss of wildlife and habitats

Reliability:
✅ Reliable in rainy areas.

Cost:
High to build; very low to run.

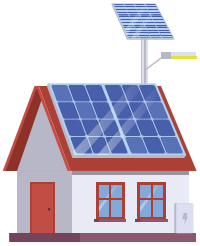
Solar

How it works:
- Cells: Sunlight → electricity.
- Heating panels: Sunlight → heats water.

Renewable?
✅ Yes – sunlight is unlimited.

Main Uses:
- Electricity
- Domestic water heating

Advantages:
- No emissions
- Good for remote locations



Disadvantages:
- Expensive to install
- Unreliable in cloudy or short-daylight areas

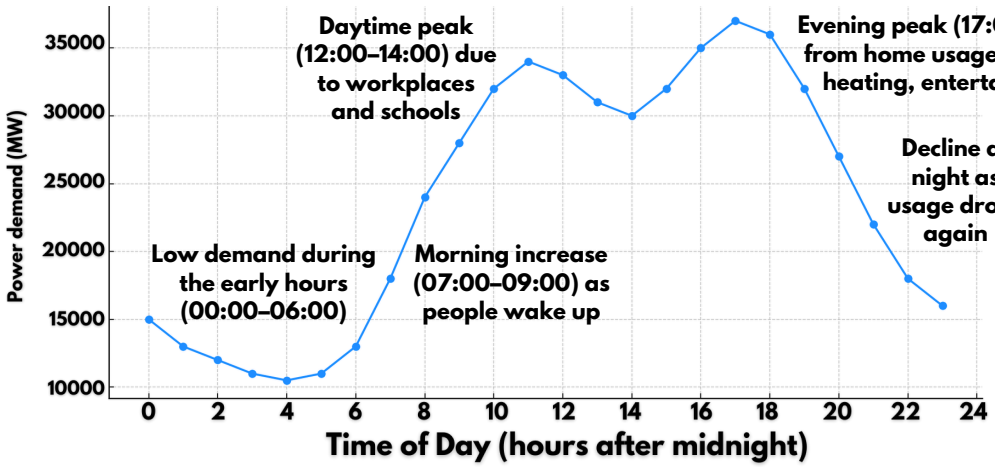
Environmental Impact:
- No pollution during use, but land use can be significant

Reliability:
❌ Depends on sunlight.

Cost:
High capital cost; very low to run.

P1.3 National and Global Energy Resources

Electricity Demands Over 24 Hours

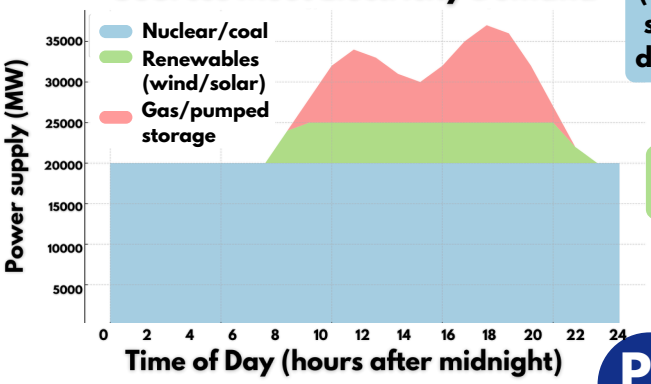


Electricity demand varies throughout the day, week, and year.

Weekly variation: usually higher on weekdays due to school, work, and industrial activity, and drops on weekends when business use is lower and more people stay at home.

Seasonal variation: higher demand in winter due to increased heating and shorter daylight hours, and lower demand in summer when heating is not needed and natural light lasts longer.

Example of how Different Energy Sources Meet Electricity Demand



Base Load (Nuclear/Coal): Constant supply to cover essential demand all day and night

Renewables (Wind/Solar): Contribute during suitable conditions (e.g. daytime, windy periods)

Gas/Pumped Storage: Fill in the gaps during peak times when demand spikes

Other political, social and ethical considerations include:

- Fossil fuel use still high due to reliability & infrastructure
- Renewables alone cannot currently meet full demand
- Government subsidies can increase renewable uptake
- Global events (e.g. oil shortages, war) affect energy choices
- Public pressure and awareness → greener solutions

Energy resource use changes over time due to technology, public opinion, and government policy.

Time Period	Trend	Reasons
Pre-1950s	Fossil fuels dominant	Industrial revolution; no alternatives
Late 20th century	Rise in nuclear	Seen as clean and efficient (but expensive)
Early 2000s	Renewables increase slowly	Public pressure, EU/UK targets
2010s–Now	Faster shift to renewables	Climate change action, cost reductions
Future (predicted)	Mixed approach	Fossil fuels reduced, nuclear + renewables

Why can't science always solve environmental issues from energy uses:

Examples:

- Carbon capture is scientifically possible, but too expensive for wide use.
- Nuclear power is efficient and low-carbon, but public fear and high costs limit uptake.
- Onshore wind farms are clean and effective, but often face local opposition.

Science Can...	But Can't Always...
Measure CO_2 levels, model climate change 🌍	Force governments to reduce emissions 🚫
Identify cleaner energy sources 🌞	Overcome the cost of switching from fossil fuels 💷
Show damage to habitats (e.g. tidal barrages) 🦩	Resolve ethical dilemmas about land use (biofuels vs food)
Recommend insulation & energy efficiency improvements 🏠	Make households or businesses adopt them 🏛️