8.1 – Energy sources

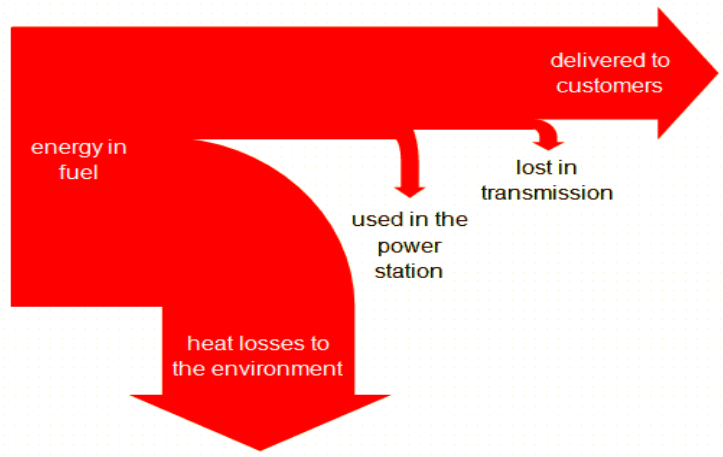
Specific energy and energy density of fuel sources

- Specific energy and energy density are useful measures of the energy that will be released from a given weight or volume of fuel when it is burned.
- Specific energy is the energy per unit mass of the fuel and can be given by energy/mass (J/kg)
- Energy density is the energy per unit volume of a fuel and can be given by energy/volume (J/m^3)

Sankey diagrams

Sankey diagrams show the total input on the left and where this energy goes on the right/below. Energy that flows to the right is useful output, energy that flows downwards is degraded (wasted) energy. The width of each arrow is proportional to the amount of energy in that section

The Sankey diagram below is for a fossil fuel power station

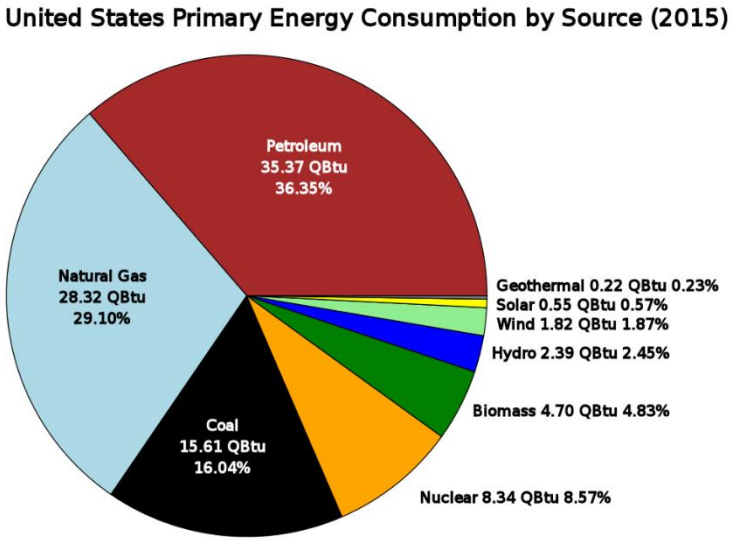


Energy degradation

While energy may be completely converted into work in a single process, a cyclical process is required to convert thermal energy to work continuously.
In accordance with the second law of thermodynamics, some energy will be lost to the surroundings and cannot be used to perform useful work. The unavailable energy is called degraded energy.

Primary energy sources

Primary energy sources are found in nature and have not been subjected to any conversion or transformation process. Examples of use of primary energy sources are shown in the chart below:



Electricity as a secondary and versatile form of energy

Electricity is a secondary source because it has to be generated from primary sources. It is a versatile and convenient form of energy. It gives us a continuous supply of energy that can power a range of appliances and is clean at the point of use.

Production of electrical power:

A fuel is burnt to release heat, which is used to boil water to produce pressurised steam.
The pressurised steam drives a turbine which is connected to a generator.
When the turbine rotates, the generator rotates. Electrical power is produced via electromagnetic induction in the generator.

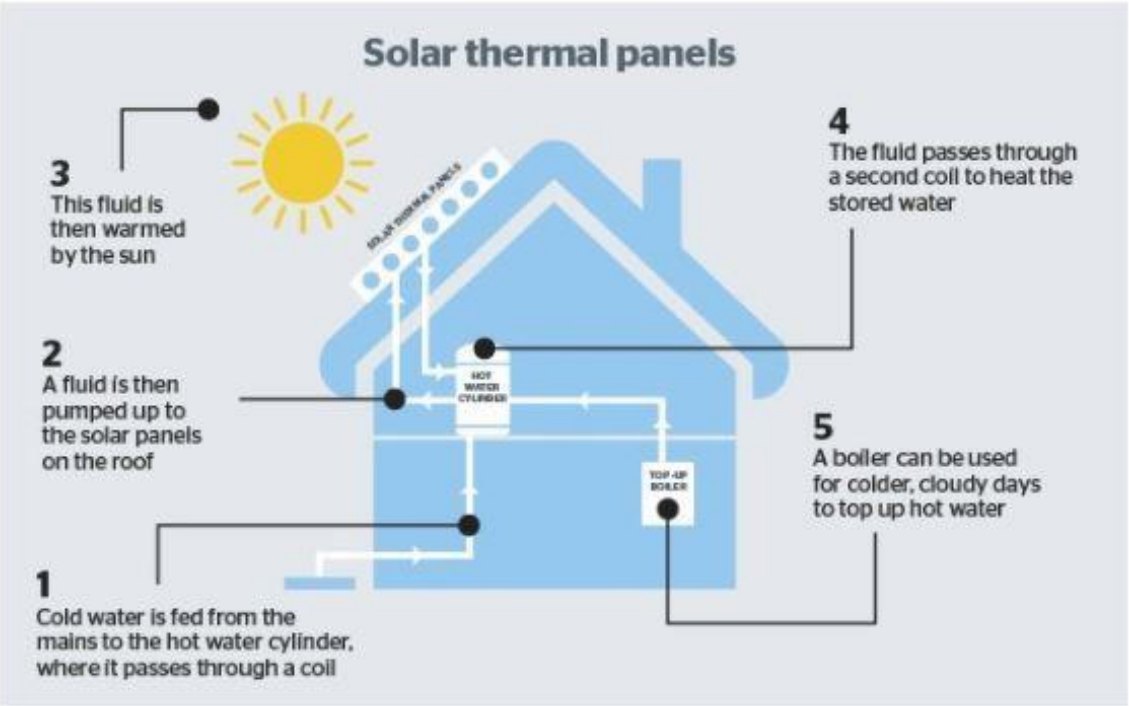
Renewable and non-renewable energy sources

- There are two categories of primary energy sources: renewable energy resources and non-renewable energy resources.
- Renewable energy sources are the ones which cannot be depleted.
- Non-renewable energy sources can be used up and become depleted.
- Most energy sources derive their energy from the sun directly (e.g. solar power) or indirectly (e.g. fossil fuels).

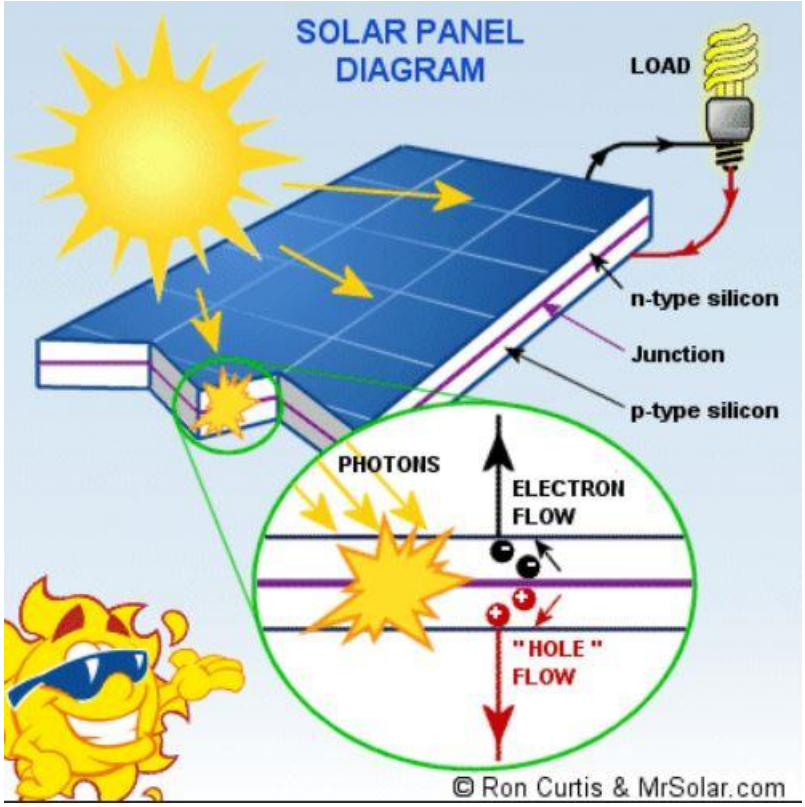
Name of renewable energy source	Information about the energy source	Advantages	Disadvantages
Solar	Solar cells generate electricity directly from sunlight. Solar thermal panels generate heat	•No pollution •Can be used away from power-plants •~~Cheaper~~ Getting cheaper.	•Only work when the sun is shining •Eye-sore
Wind	There are 300,000 wind turbines all over the world. It works best in windy places, like the sea.	•No pollution •Low running costs	•Very noisy •Spoils the view •The electricity depends on wind •High enitial costs
Tidal/wave	When the tide comes in water rushes in and the turbines spin the other way. Small rafts move up and down with the water.	•No pollution •The UK has many coastlines so there are many places it can be used.	•Very expensive •Can destroy habitats.
Biomass	Comes from living things wood is biomass fuel If we contiave to plant new trees to replace those cut down, we will always have wood to burn.	•Can be stored and used when needed •Renewable	•Can produce smoke, resulting in air pollution •Using biomass the wrong way can lead to destroyed forests.
Geothermal	Only possible where hot rocks are needed near surface of earth	•No pollution •Low running costs	•Cost of drilling several KM down hot rocks is high price. •Very few places where this possible.
Hydroelectric	We build giant dams across valleys to make new lakes (reservoirs) Lake water have gravitationpotential energy	•No pollution •No fuelcosts •Never run out (unless there is drought)	•Expensive •Need large areas of land, spoiling land-scape.

Solar power

- Solar heating panel: sunlight directly used to heat up water.



- Photovoltaic cells: sunlight directly converted into direct electrical current (dc), as the light incident on the panel releases electrons and establishes a potential difference across the cell.



Wind power

- Equation: maximum theoretical value of the **available power = ½ ρAv^3**

where ρ = density of air = 1.3 kg m^{-3}
A = area swept out by blades per revolution (=area of circle or radius = blade length);
v = wind speed

  - Assumptions: no wind, no friction or turbulence.
- Ideal places: off-shore and top of hills, due to higher wind speeds.

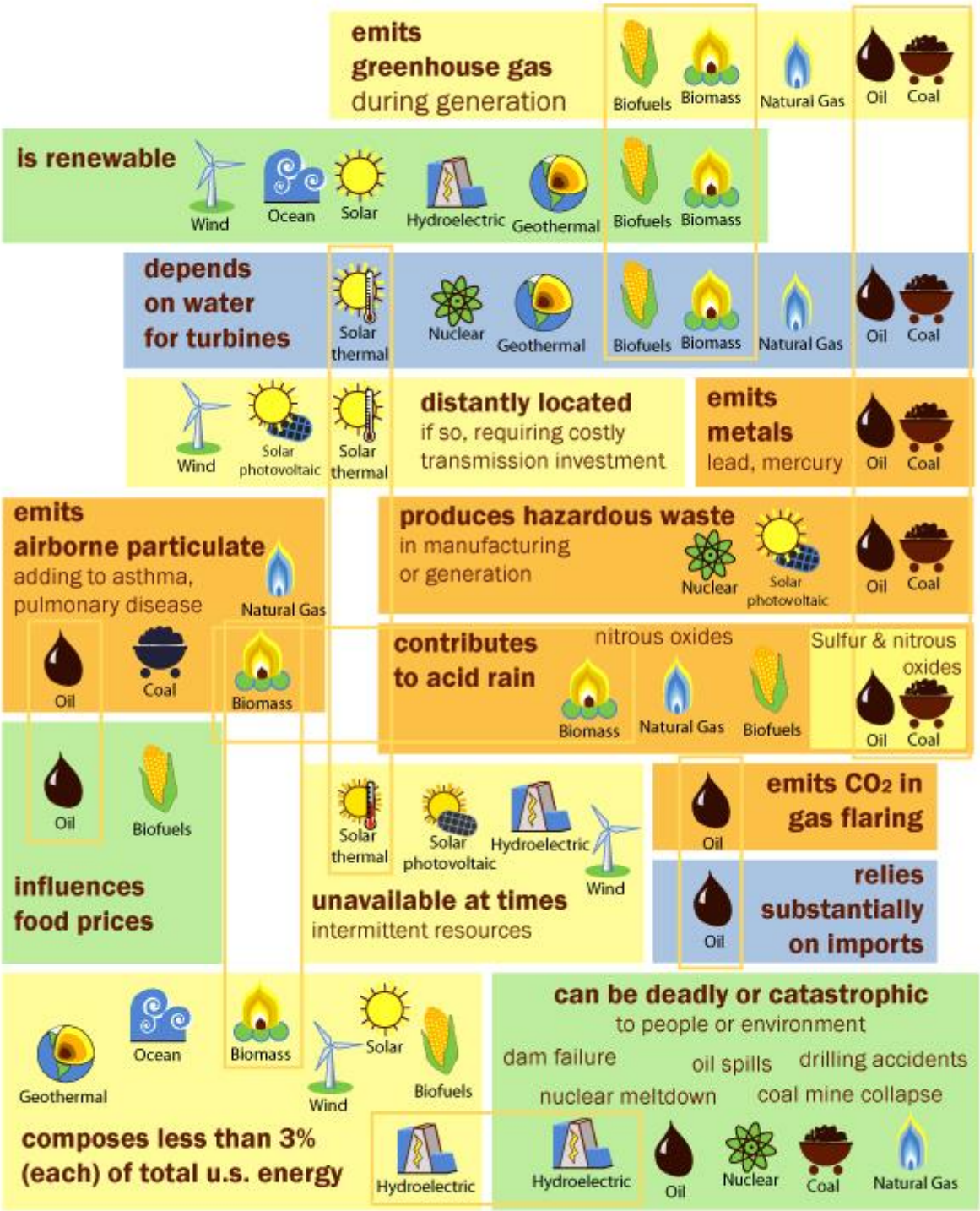
Hydroelectric power

- Process: potential energy of a mass of water transferred into electricity.
- Formula: Power = Energy/time = mgh/Δt = ρΔVgh/Δt = ρQgh, where Q = volume flow rate and ρ the water density.

- Reverse process (pumped storage system): storing energy on a large scale when needed, this requires more energy than will be gained.

Comparing Sources of Energy

Click for a simplified chart comparing advantages and disadvantages



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