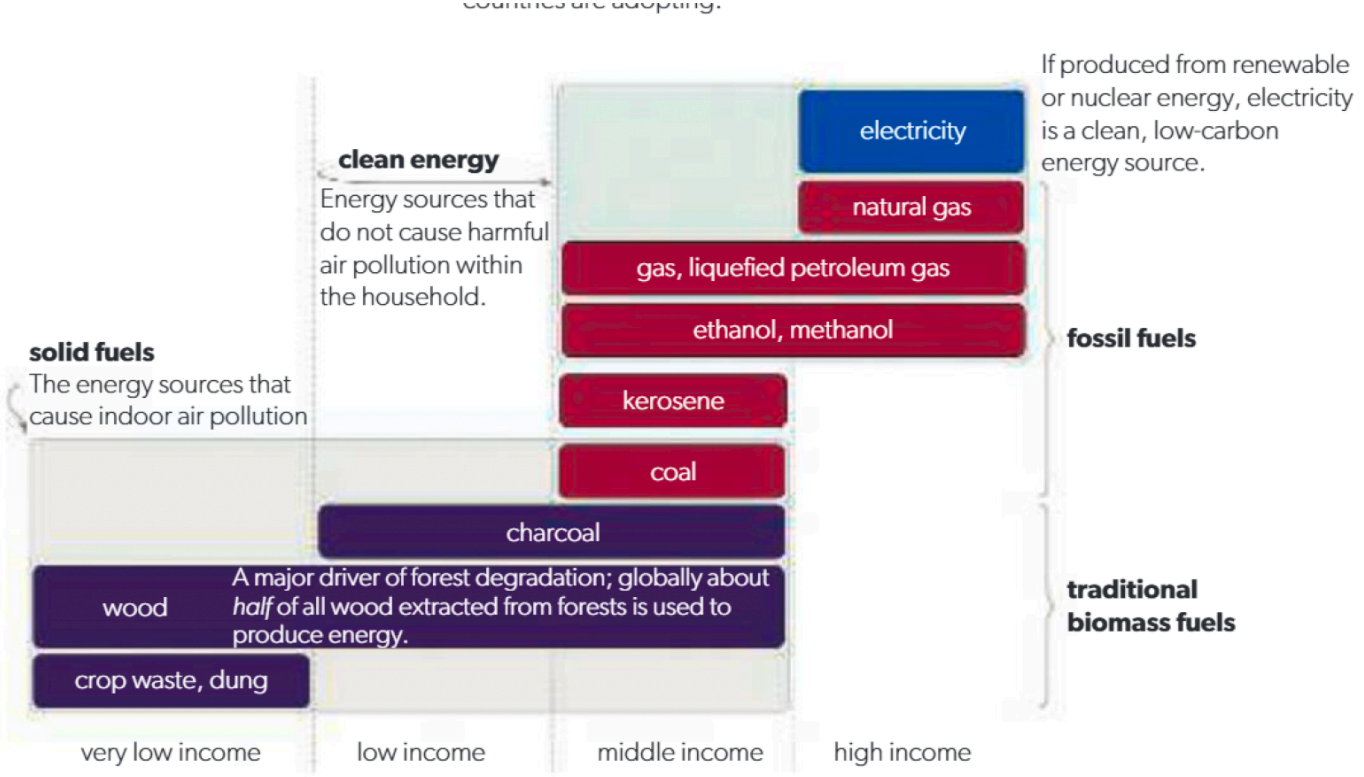
[AHL] 7.2.2 Energy Security

Objectives

- Outline the energy ladder
- Discuss nuclear energy and batteries

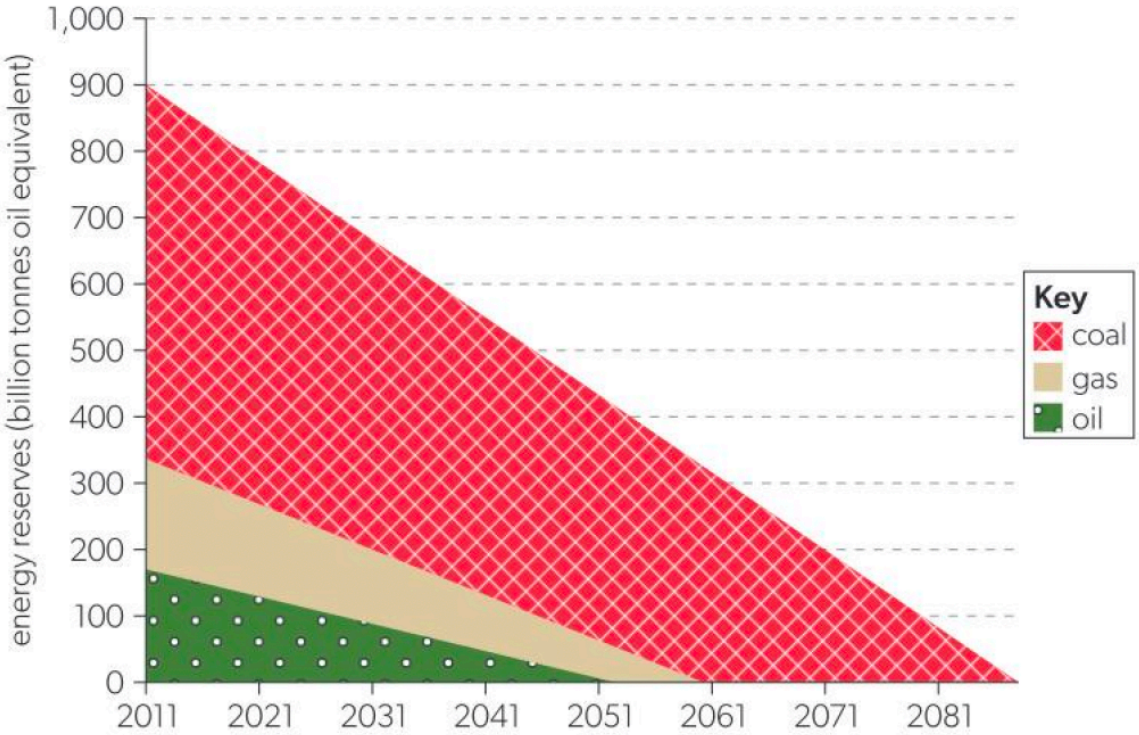
The energy ladder: the dominant energy source for cooking and heating, by level of income



How much longer for fossil fuels?

- Climate change, campaign groups and energy security needs are focusing governments' policies and forcing them to act.
- So too is depletion of fossil fuel reserves—no country wants to run out of energy.

How much longer for fossil fuels?



How much longer for fossil fuels?

- Timelines for final depletion off ossil fuels depend on:
  - rate of consumption—increased efficiency and energy conservation measures slow down the rate
  - discovery of new deposits—and these are still being discovered
  - developments in technology for extraction—for example, from tar or oil sands of Canada and Venezuela
  - increased use of renewables or nuclear power—which replace fossil fuel use.

Nuclear power

Nuclear power

- Most nuclear power stations generate energy through fission reactions involving uranium or plutonium.
- The thermal energy released during fission is transferred to a working fluid—typically water—producing steam that drives turbines to generate electricity.

Nuclear power

- Although the initial capital expenditure for nuclear power facilities is high, operational costs are relatively low because nuclear fission is approximately 8,000 times more efficient than fossil-fuel combustion.

Nuclear power

Advantages

- Provides low-cost, zero-carbon electricity during operation.
- Offers a continuous and reliable baseload power supply.
- Enables recycling of up to 90% of nuclear fuel.
- Requires comparatively low maintenance after construction.

Nuclear power

Disadvantages

- Involves substantial construction and decommissioning costs.
- Presents safety risks, including the potential for nuclear accidents and radiation exposure.
- Raises concerns about diversion of nuclear materials for weapons proliferation.
- Generates radioactive waste that remains hazardous for up to 10,000 years and must be securely stored.
- Contributes to environmental degradation through uranium mining.
- Causes thermal pollution due to the discharge of heated cooling water into marine environments, altering local water chemistry.

Battery Storage

Battery Storage

- Large-scale energy storage is essential because renewable sources such as solar, wind, and tidal power are inherently intermittent.
- Batteries currently represent the primary technological solution for grid-scale storage.

Battery Storage

Environmental and Social Considerations

- Battery production requires extensive mining, transport, and processing of raw materials, all of which consume significant energy and produce emissions and pollutants.

Battery Storage

Environmental and Social Considerations

- Recycling and material recovery remain challenging and energy-intensive.
- Key materials—such as lithium, cobalt, and various rare earth elements—generate toxic by-products during extraction and processing, contributing to land and ocean pollution.

Battery Storage

Environmental and Social Considerations

- Failures of mine tailings dams further exacerbate ecological risks.

Battery Storage

Environmental and Social Considerations

- The geographic concentration of these minerals in a limited number of countries, combined with rising global demand, creates geopolitical tensions and potential conflicts.