

12. Natural Gas

- It is formed from the remains of plankton that fell to the bottom of the sea, which were changed into gases over millions of years
- Since natural gas is lighter than both oil and water it is found on the top of oil traps
- For decades natural gas was considered useless, but in the 1950's it gained importance as an energy source

12. Natural Gas

- Pipelines are the only method of moving natural gas – Liquefied Natural Gas (LNG) can be transported in special containers but is more expensive
- Reasons for its popularity is its low price and because it is clean burning

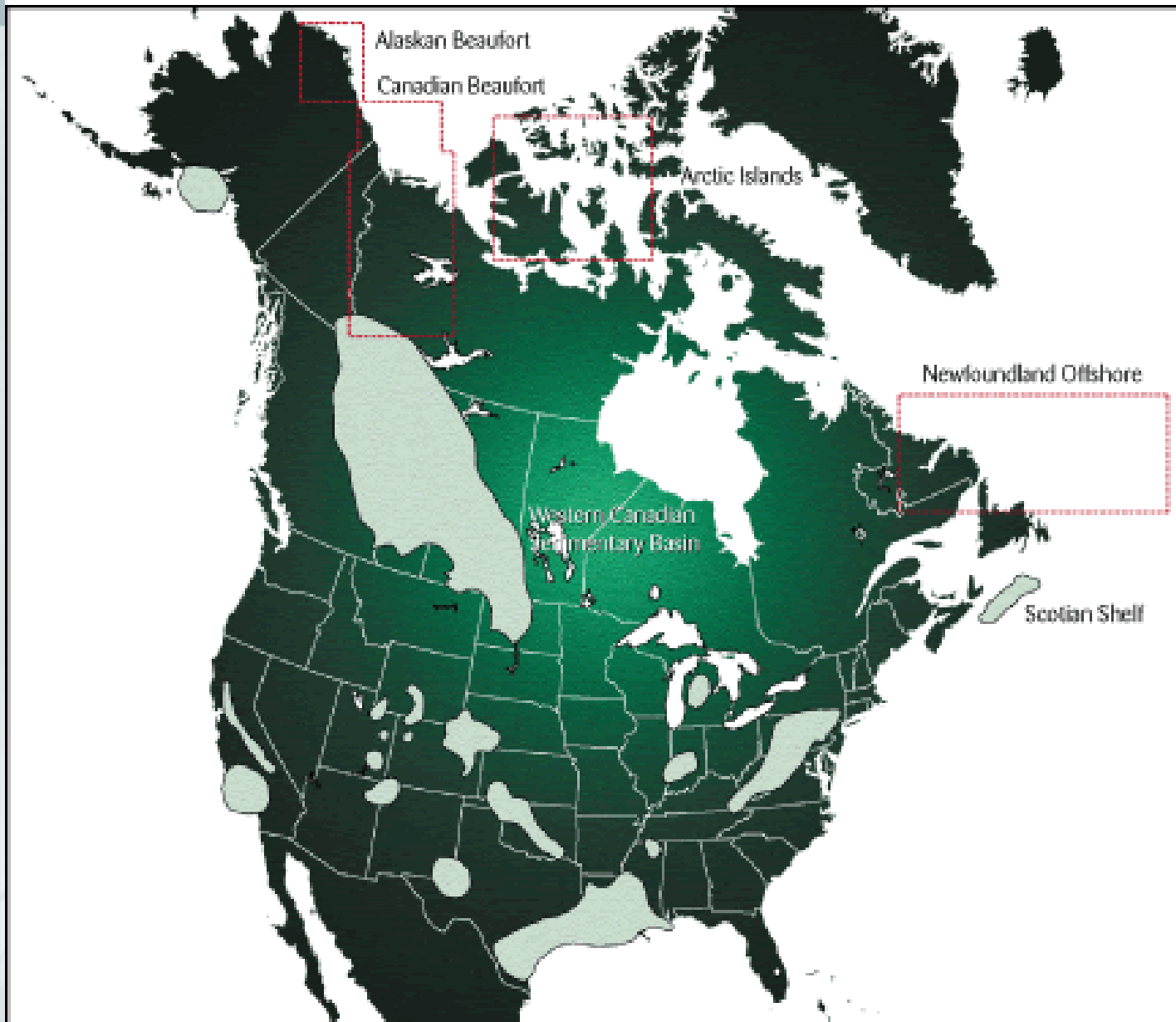


- **Large gas reserves are found in:**
 - The Arctic Islands
 - Beaufort Sea-Mackenzie Delta
 - Eastern Canada offshore basin
 - Western Canada



Figure 8.4

Natural Gas Bearing Sedimentary Basins



Producing Gas Basins

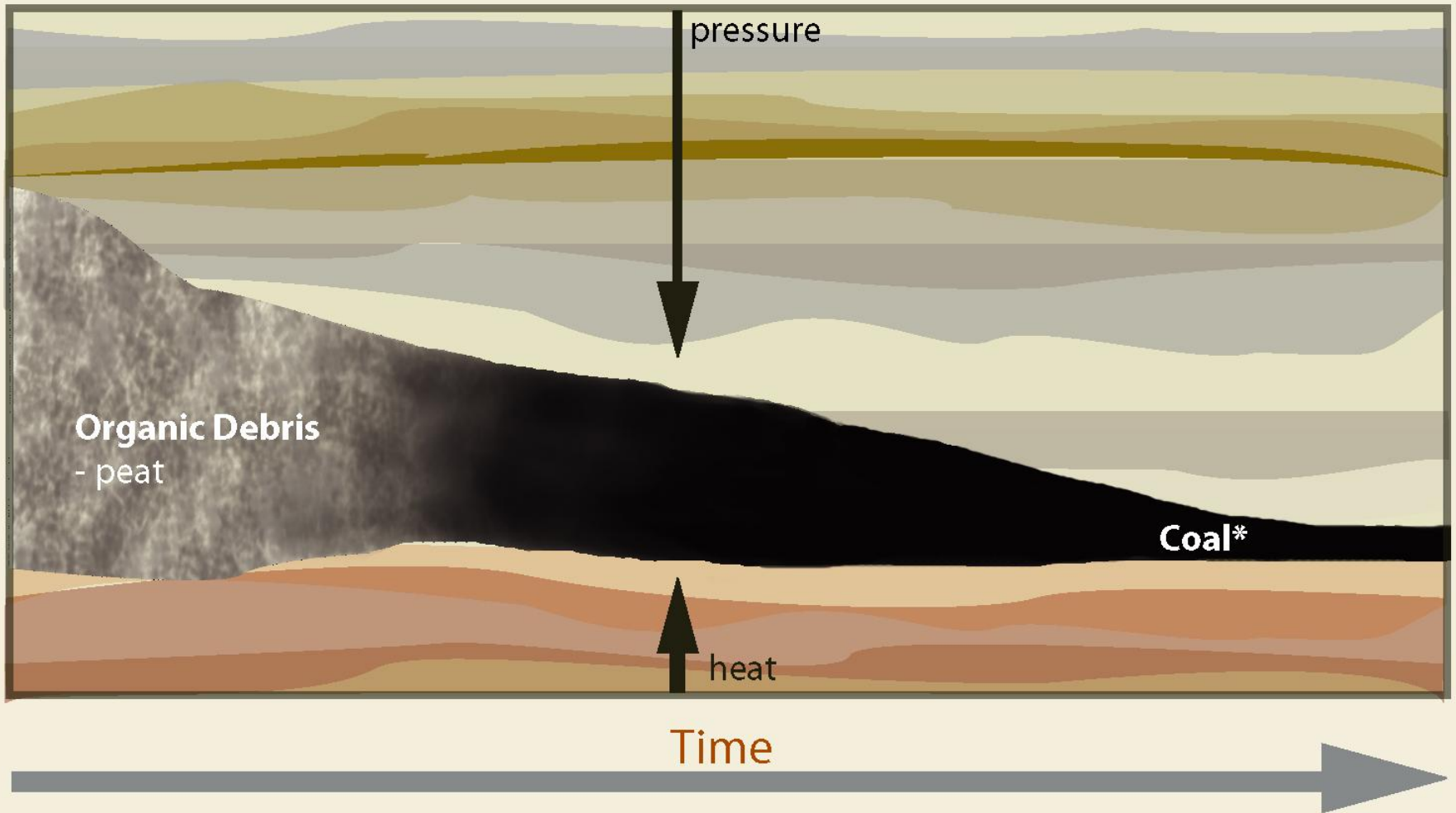
Basins not yet Producing

Figure 3.6
Canadian Natural Gas Pipeline Systems



— Westcoast — Alberta System (TCPL) — Alliance — TransGas — Foothills — TransCanada Pipelines (TCPL)
..... TransQuebec and Maritimes — Maritimes and Northeast Pipeline — Union

Coalification Process



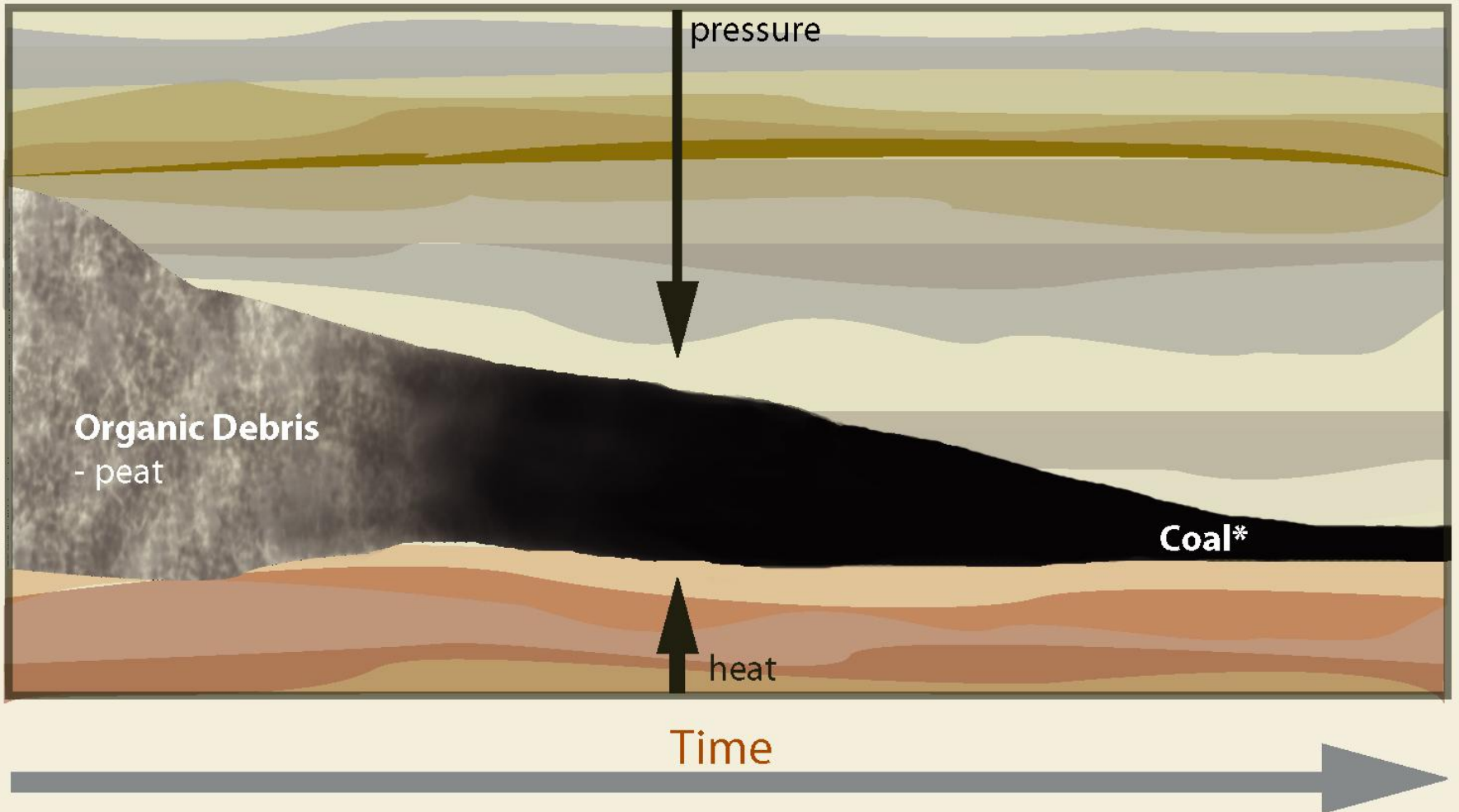
13. Coal

- It is the third non-renewable fossil fuel formed from the remains of ancient forests and swamps
- Dead leaves, branches and trunks from trees and plants fell into the swamp, (unable to decay in these waters), they accumulated - forming thick layers of vegetal remains

13. Coal

- These vegetal remains were buried by muds and sediments and underwent pressure and chemical changes
- After millions of years these sediments turned into sedimentary rocks such as sandstone, shale and the vegetal remains, then turned into coal

Coalification Process

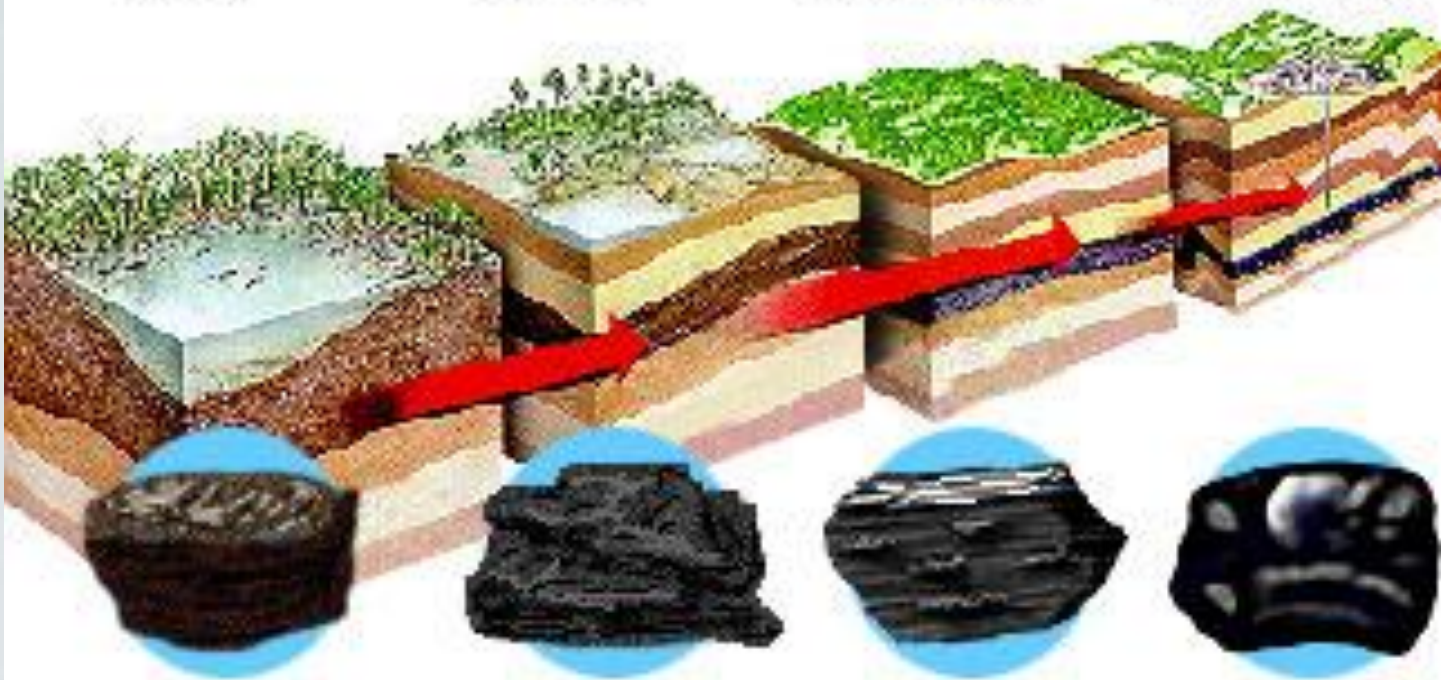


peat

lignite

bitumen

anthracite



3 Types of Coal:

1. **Lignite** – is a soft, low value coal with many impurities, formed close to ground level where pressure was greatly reduced
2. **Bituminous** – is softer than anthracite and contains more impurities, formed where pressure is not as great
3. **Anthracite** – a hard, carbon rich coal that is produced under high pressure



Anthracite



Bituminous

1 cm



Lignite

Coal Facts

- During the half of the century coal was an important energy source
- Coal's popularity gave way in the 1950's to oil, natural gas and hydroelectric power
- Of the total electricity generated in Canada, approximately 17% from the combustion of coal and oil



- A revival of coal production in the 1970's in B.C., Alberta, Saskatchewan, where there are vast reserves of bituminous and lignite coal



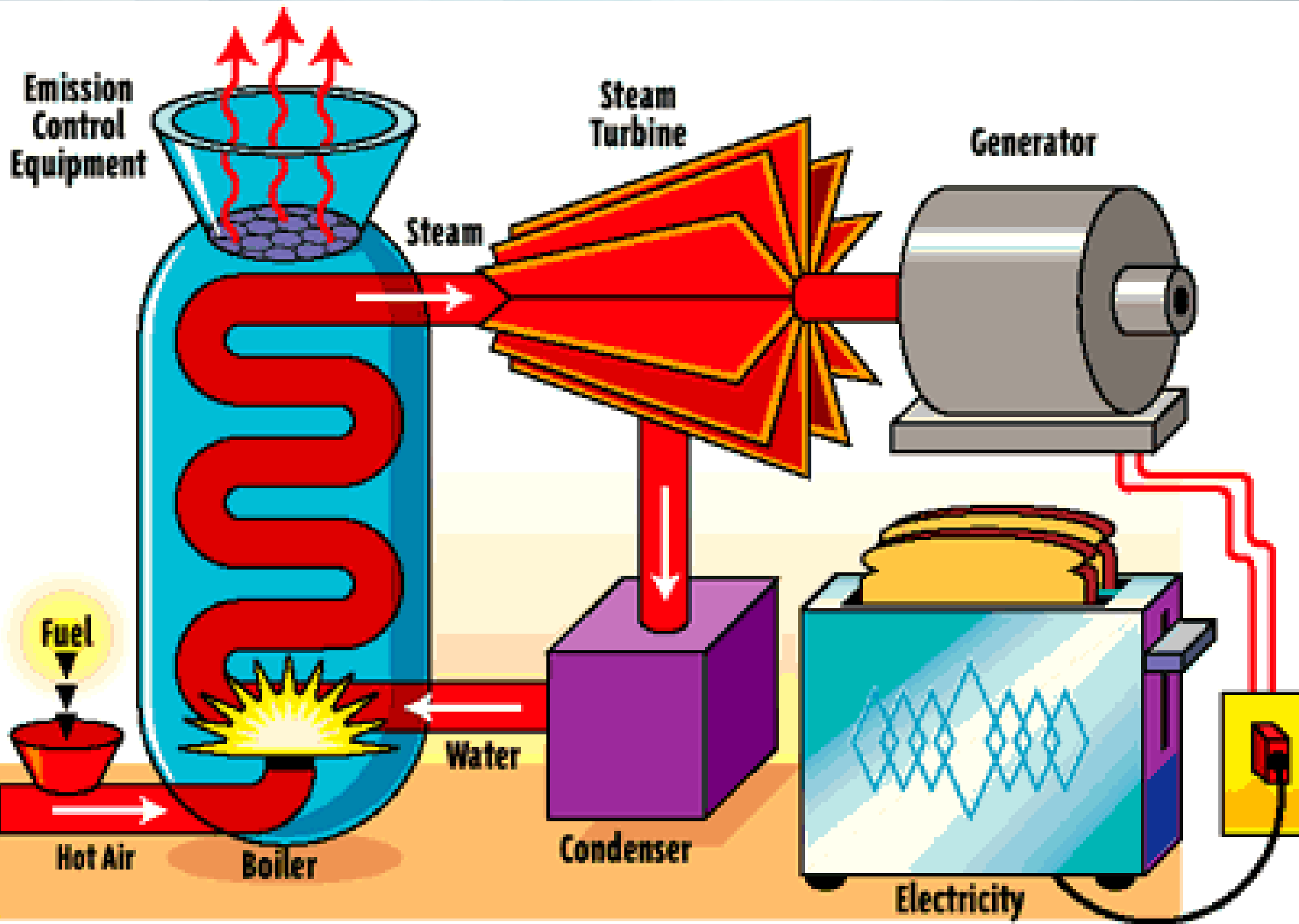
Coal Facts

- The growth in coal production was a result of two factors:
 - A. Increased demand for thermal electricity in western Canada, and
 - B. The opening of large export markets for coal in Asia

14. Thermal Electric Power

- **Thermal electric power** is a secondary energy source that is produced using primary energy sources such as coal, oil and natural gas
- To create thermal energy, fossil fuels are burned to heat water to create jets of hot steam under high pressure
- Fig 11.26 page 232





14. Thermal Electric Power

- Electricity produced by thermal energy varies, 1% in Québec to 100% in P.E.I
- Most commonly used in provinces where coal and natural gas are in large supply
- Coal Power Plant

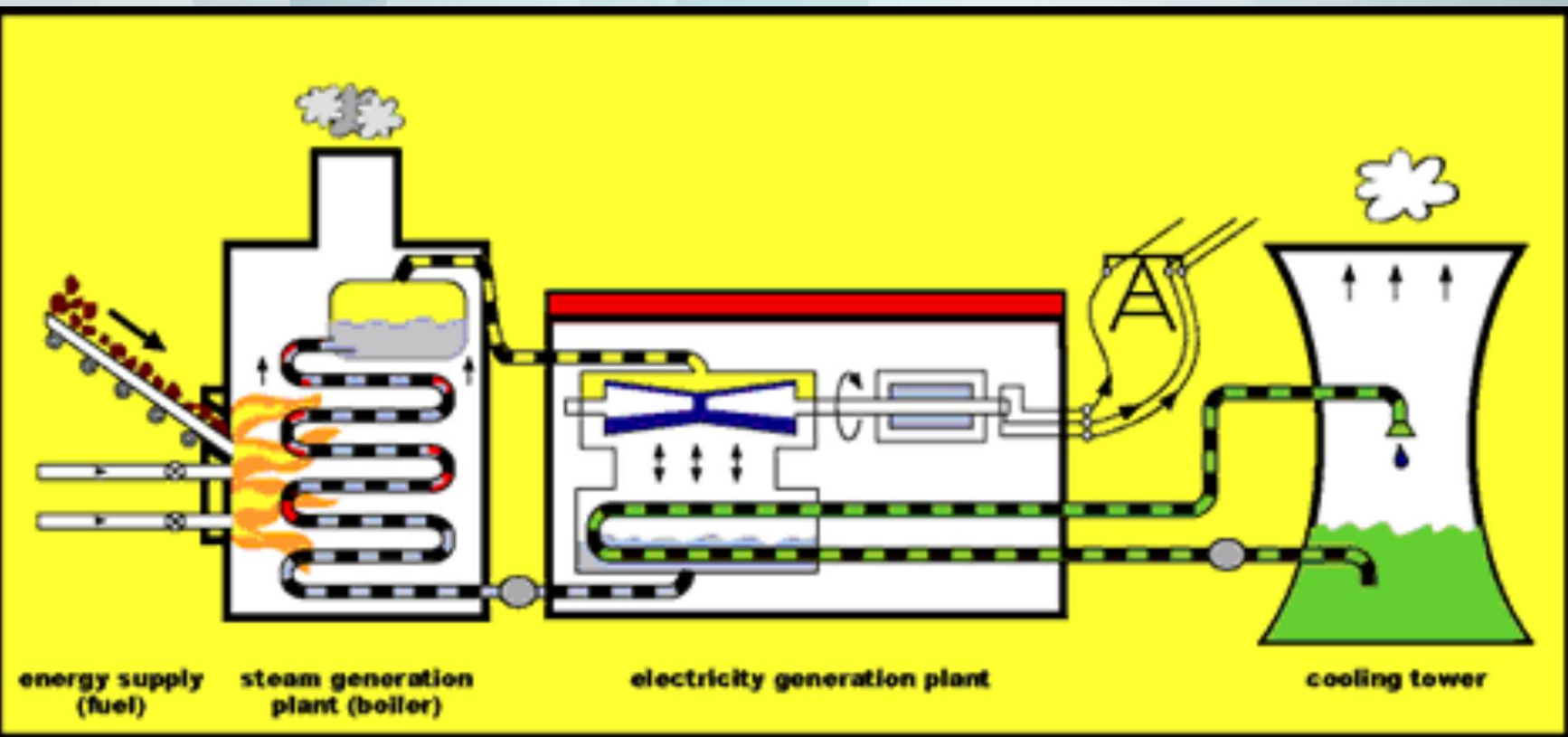
14. Thermal Electric Power

- **Advantages:**
- Produced from a variety of fuels
- Cheaper than other sources except hydro
- Thermal plants can be located next to high demand areas
- Co-generation – where if there is hot water left over after power is generated, it can be used to heat factories, offices and houses

14. Thermal Electric Power

- **Disadvantages:**
- Emits large amounts of carbon dioxide, sulphur dioxide and nitrous oxide which contribute to global warming and acid precipitation
- Thermal energy plants rely on nonrenewable energy, so they are not the solution to future energy shortages





Source of Energy	Pros	Cons
Burning of coal, oil or natural gas	<ul style="list-style-type: none"> • not expensive source or set-up • readily available 	<ul style="list-style-type: none"> • environment • not renewable

15. Nuclear Thermal Power

- Thermal energy generated by nuclear power
- Methods used to generate electricity in a nuclear power plant is similar to conventional thermal, the only difference is the heat source

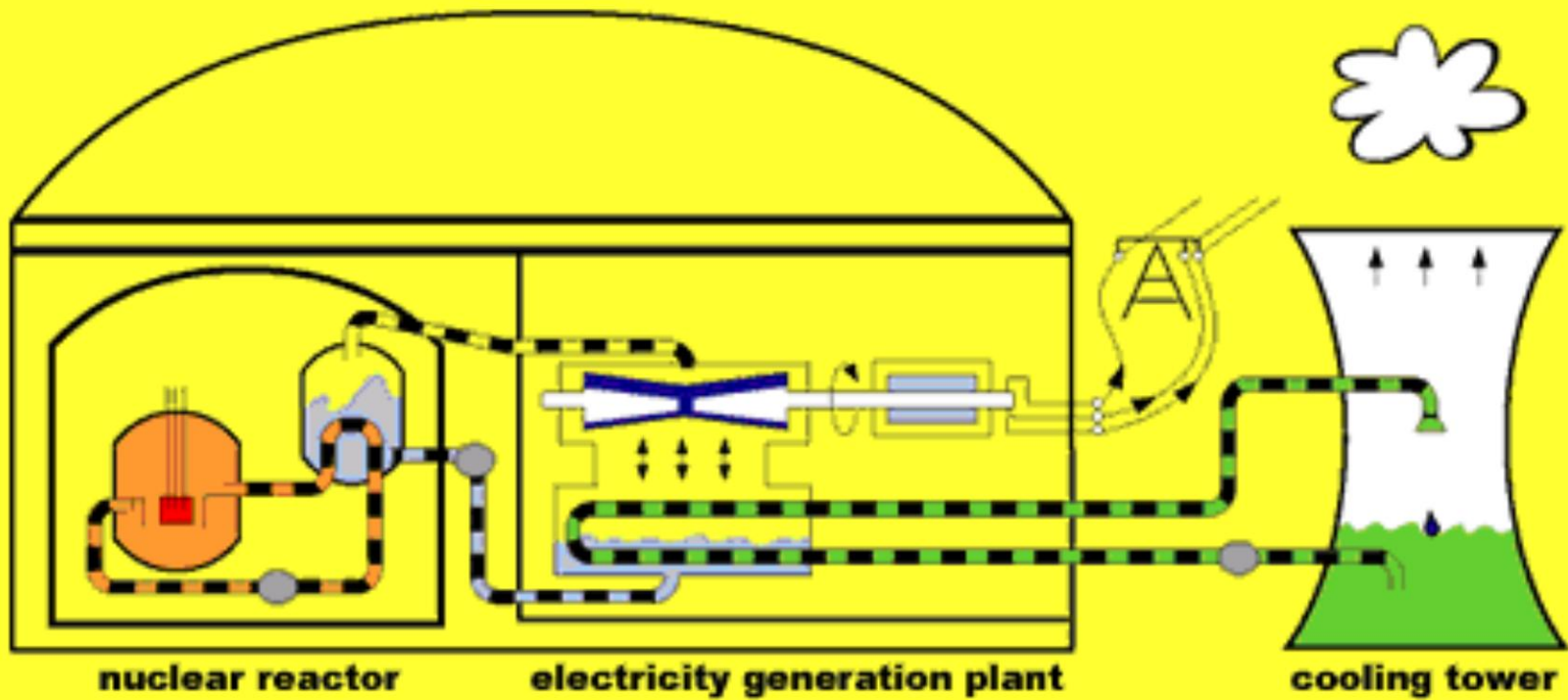


- Nuclear plants use heat generated by splitting atoms of radioactive materials, called nuclear fission
- Nuclear reactors control the amount of heat produced

- [Nuclear Fission Animation](#)

- [Inside a Nuclear Power Plant Animation](#)





Source	Pros	Cons
Atom splitting	<ul style="list-style-type: none"> • not expensive source • lots of source • relatively small amounts of waste • no carbon emissions 	<ul style="list-style-type: none"> • safety concerns • expensive set-up • weapons possible

15. Nuclear Thermal Power

- Of the total electricity generated in Canada, approximately 15% is nuclear energy
- Nuclear power is an important electricity source in Ontario and New Brunswick
- Once considered the fuel of the future, but nuclear accidents and breakdowns in reactors have caused grave concerns

Chernobyl

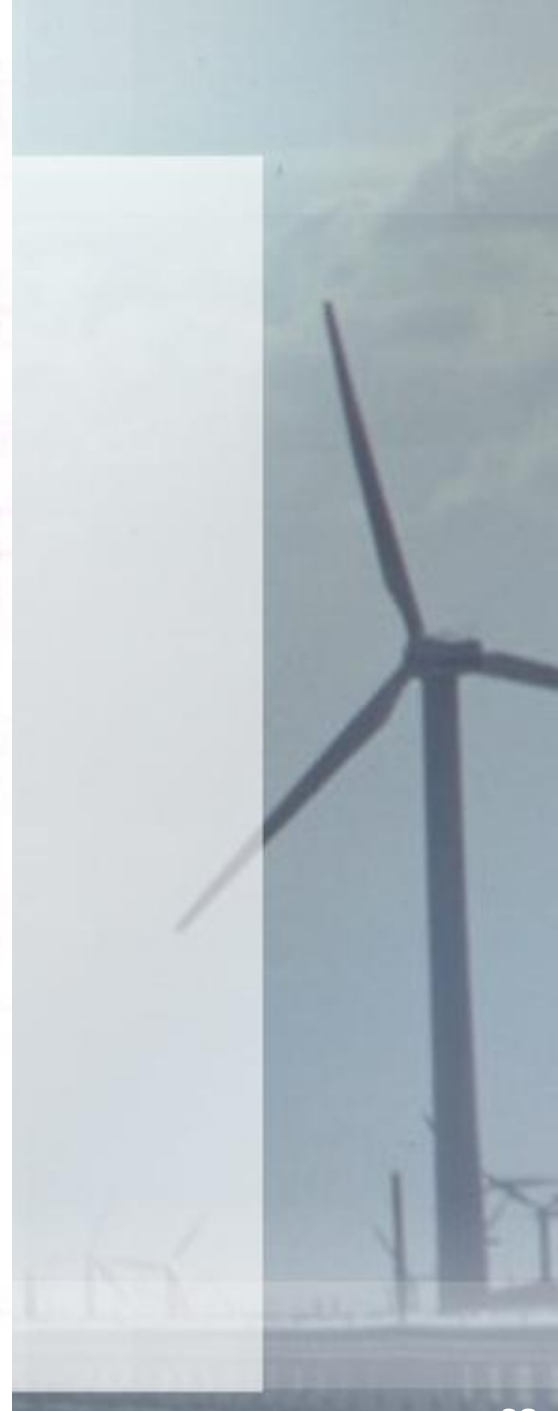


After the reactor explosion

Figure 31. Radiation Hotspots Resulting From the Chernobyl Nuclear Power Plant Accident



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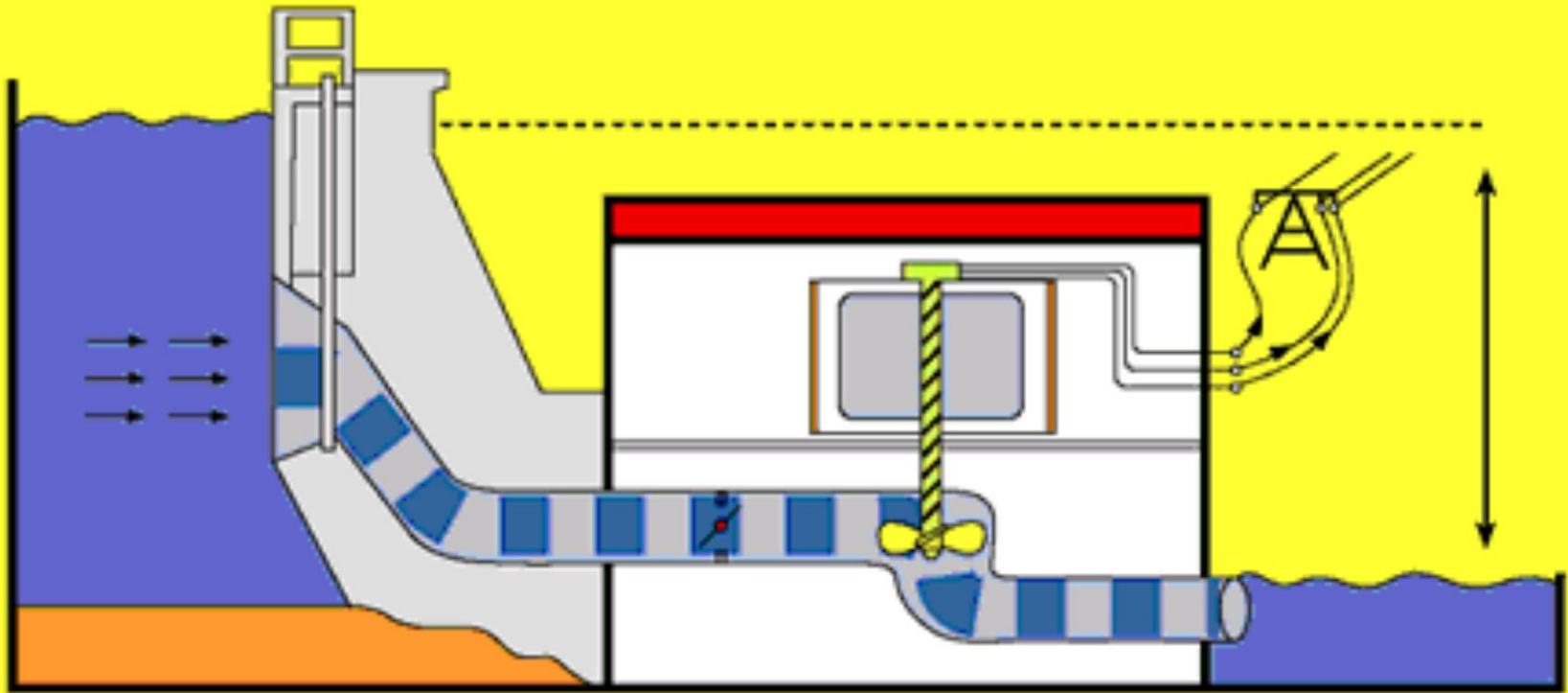
16. Renewable Energy Sources

A. Hydroelectric Power

- Clean and safe
- Harnesses the power of falling water
- Canada's major source of renewable energy
- Canada produces 14% of the world's total output



- Physical geography is the main reason for our hydroelectric resources (abundant precipitation, mountains, drainage basins, plains and lowlands)
- Only problems are the costs of building dams and the environmental concerns



Energy Source

Moving river water

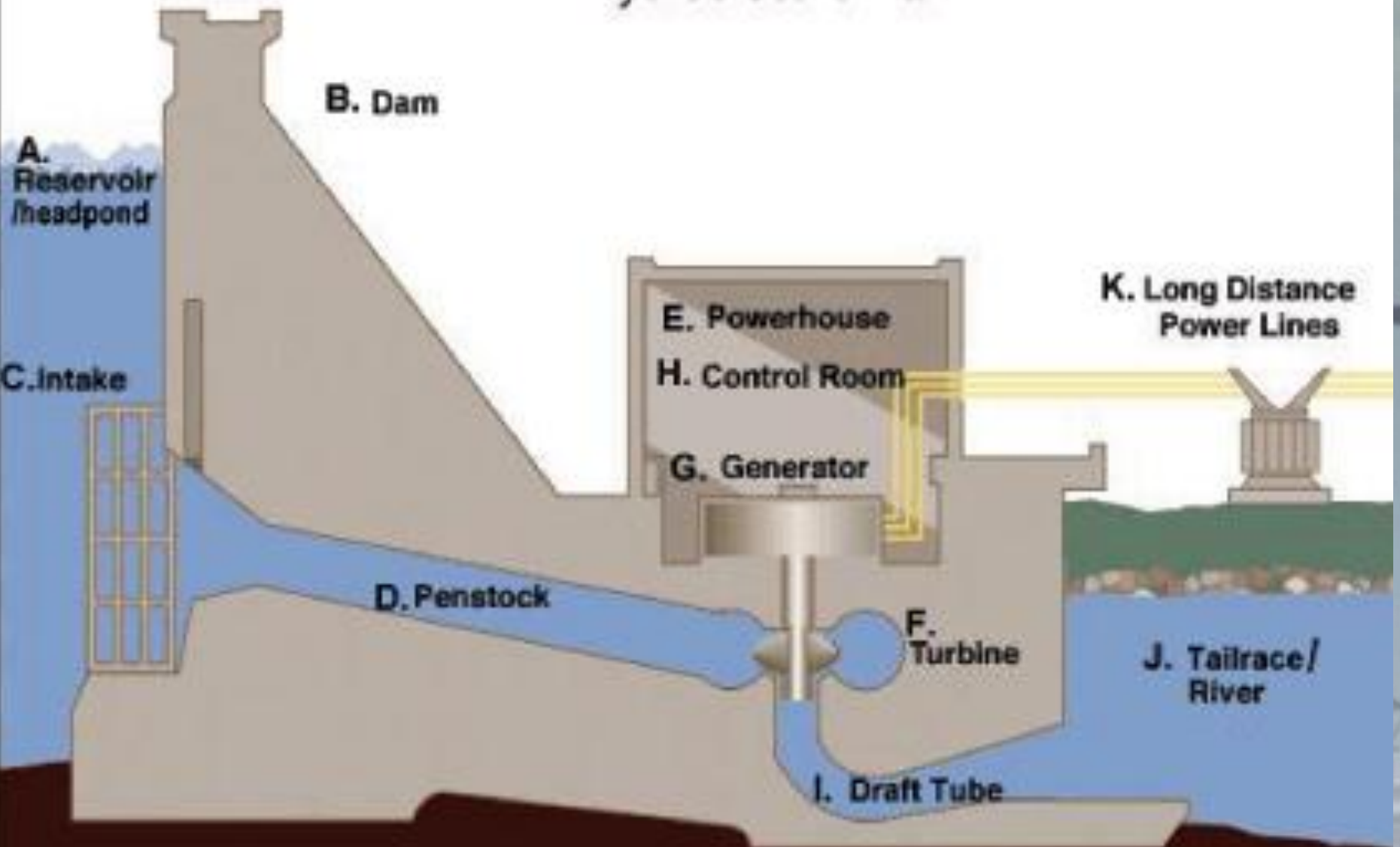
Pros

- cheap energy source
- Env. Friendly (no emissions)

Cons

- flooding impacts
- expensive set-up
- some env. damage

Hydroelectric Dam



- Hydroelectric Animation
- Hydroelectric Power Station
- 49 Megawatts



Hydroelectric Dam in Yukon



B. Tidal Power

- **Tidal Range:** the difference in the water height between the highest and the lowest tides
- Tides are created by the gravitational pull of the moon and the sun on the oceans
- In the oceans, tides cause the surface water to rise or fall by about 1m

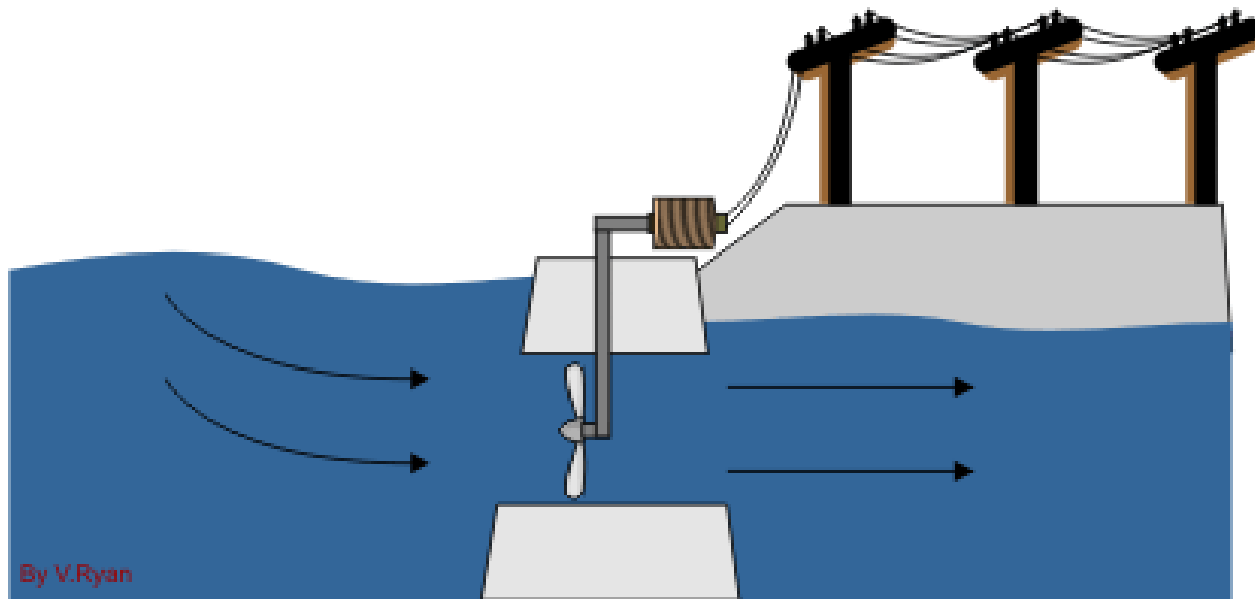
- The Bay of Fundy in New Brunswick has the highest tides in the world



Tidal Power Plant in Annapolis, NS

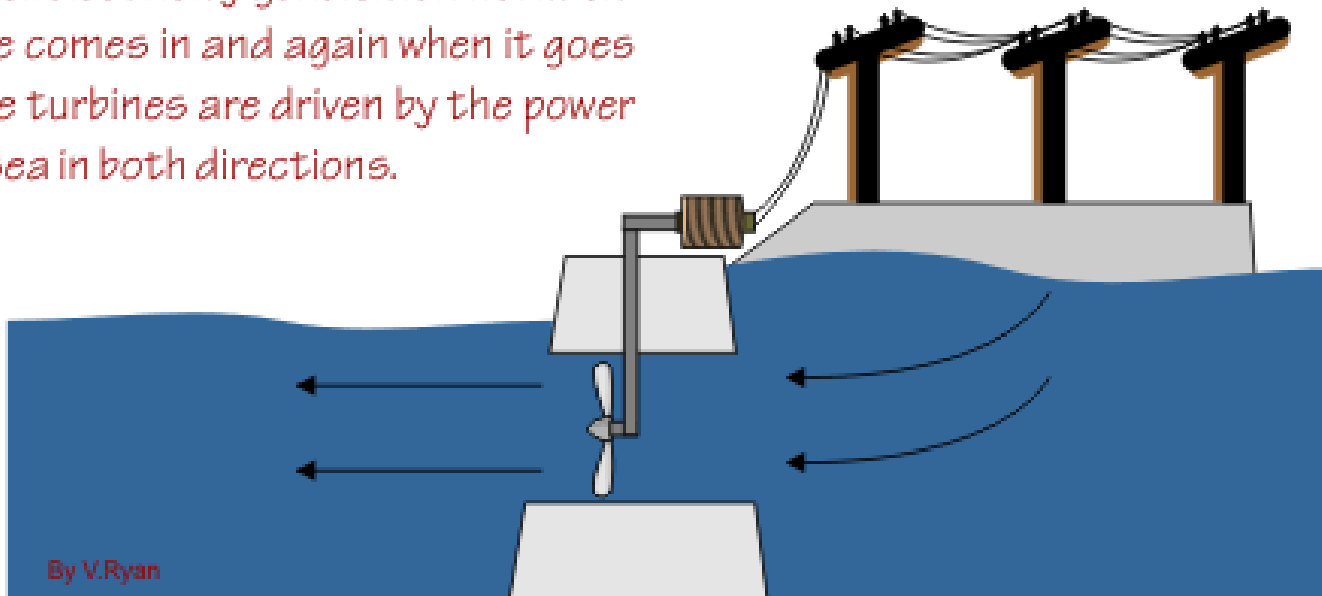
- Hydroelectric power could be produced here by damming the tidal basin and harnessing the tidal flow through gates and turbines
- Major disadvantages are the construction costs, flexibility of hours when tides can produce energy and the environmental concerns





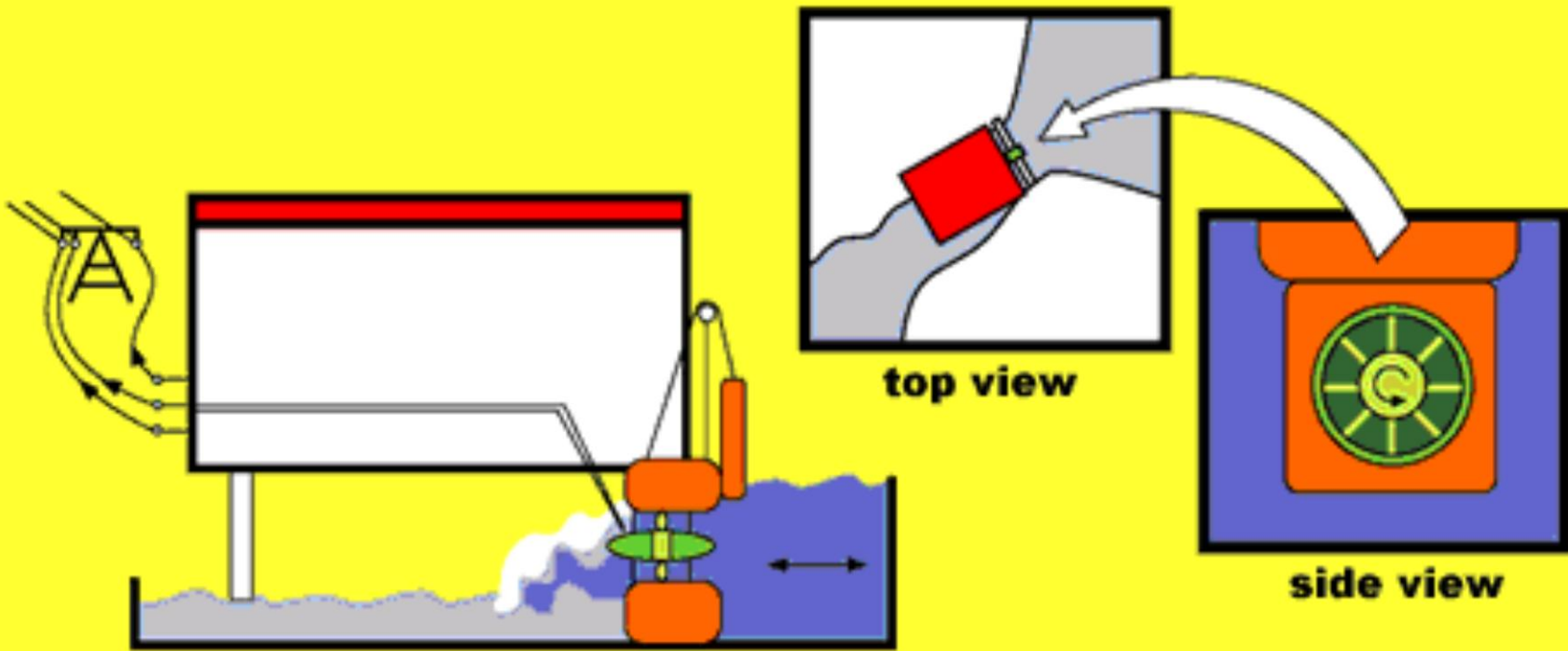
TIDE COMING IN

This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.



TIDE GOING OUT





Energy Source	Pros	Cons
Rising and falling water	<ul style="list-style-type: none"> ● free source ● unlimited ● two-way 	<ul style="list-style-type: none"> ● only 25 locations ● navigation safety ● eyesore

C. Solar Energy

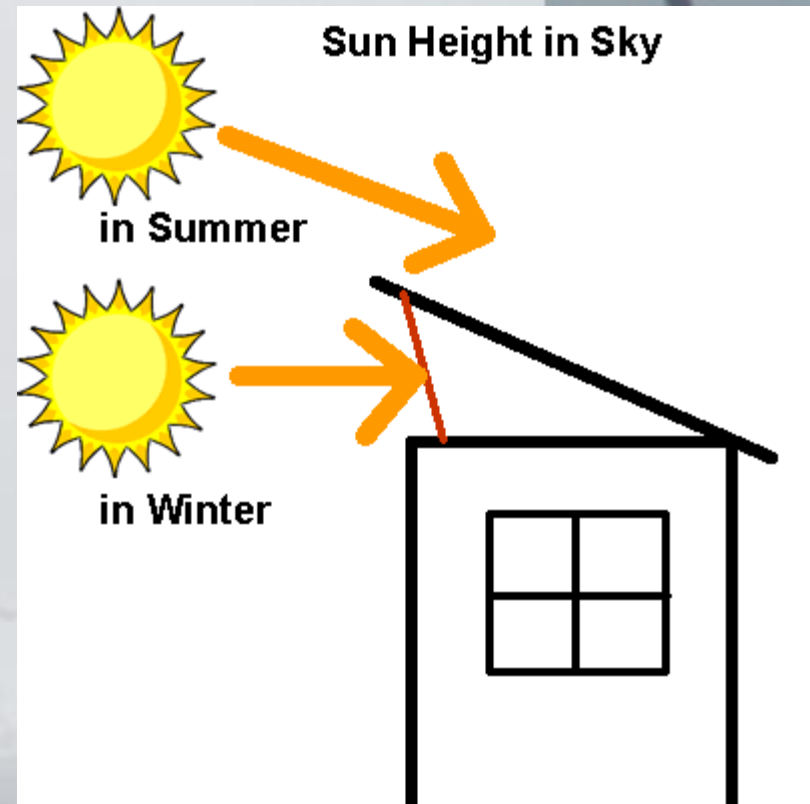
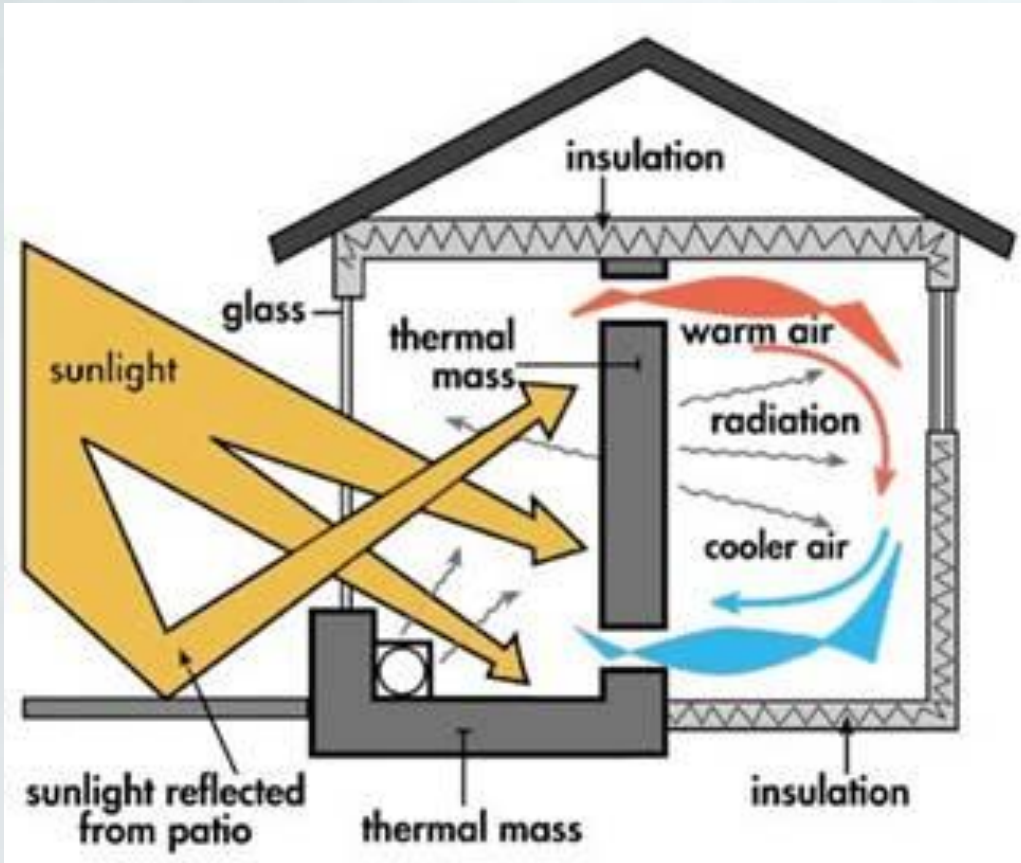
- The most widely recognized alternative energy source
- It is clean, inexhaustible and renewable
- It costs much more than conventional energy due to our northern latitude
- Cloud cover also reduces the amount of solar radiation we receive (e.g. Great Lakes Region)

- **Solar energy can be harvested in one of three ways:**

i. Passive Solar Energy

- Involves the design of homes, offices, factories and other buildings to capture the maximum benefits of solar heat
- The careful placement of windows allows for more sunlight and the use of thermal windows reduces heat loss

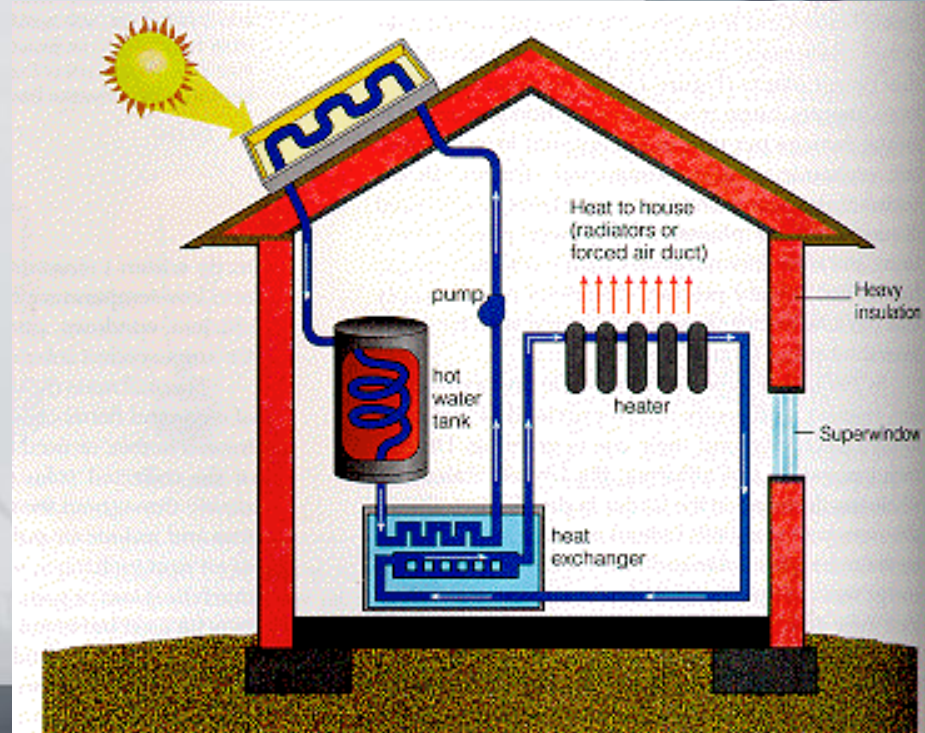
Passive Solar Energy



ii. Active Solar Energy

- Uses the sun to heat fluids or air and to drive turbines to generate electricity
- Used to heat industrial buildings, outdoor pools and water heaters

- Solar Energy - Water



iii. Photovoltaic Energy

- Produces electricity directly from the sun
- Supplies small amounts of power for lighting, telecommunication and monitoring devices in remote locations

**Telecommunications
Repeater Station Powered
by a Photovoltaic-Hybrid
System. Northwest
Territories**

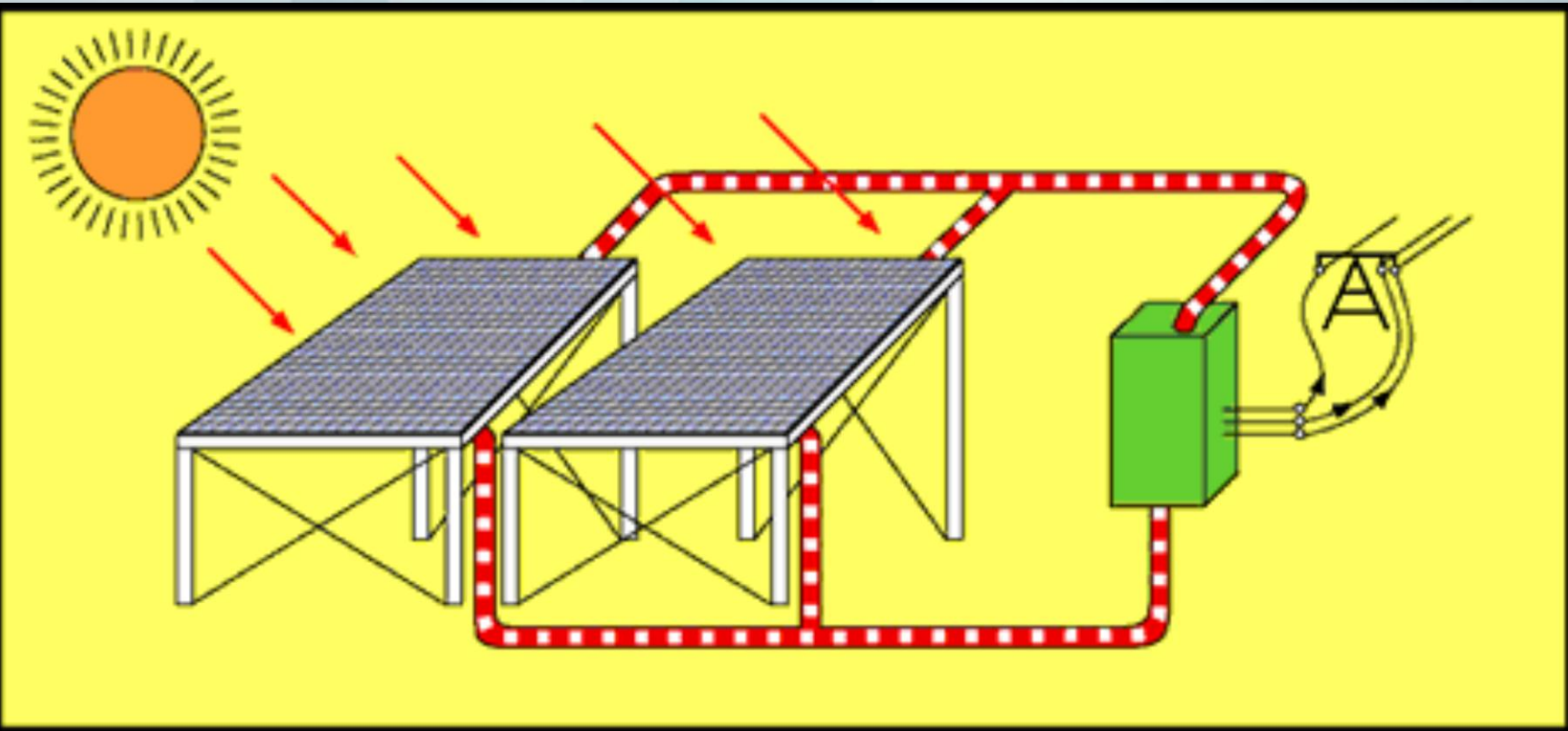


- Photovoltaic



Photovoltaic array for a hybrid system at the Warden Station in Ellesmere Island National Park in the Canadian Arctic





Source	Pros	Cons
Sun	<ul style="list-style-type: none"> ● free source ● unlimited ● env. Friendly 	<ul style="list-style-type: none"> ● not efficient ● expensive set-up

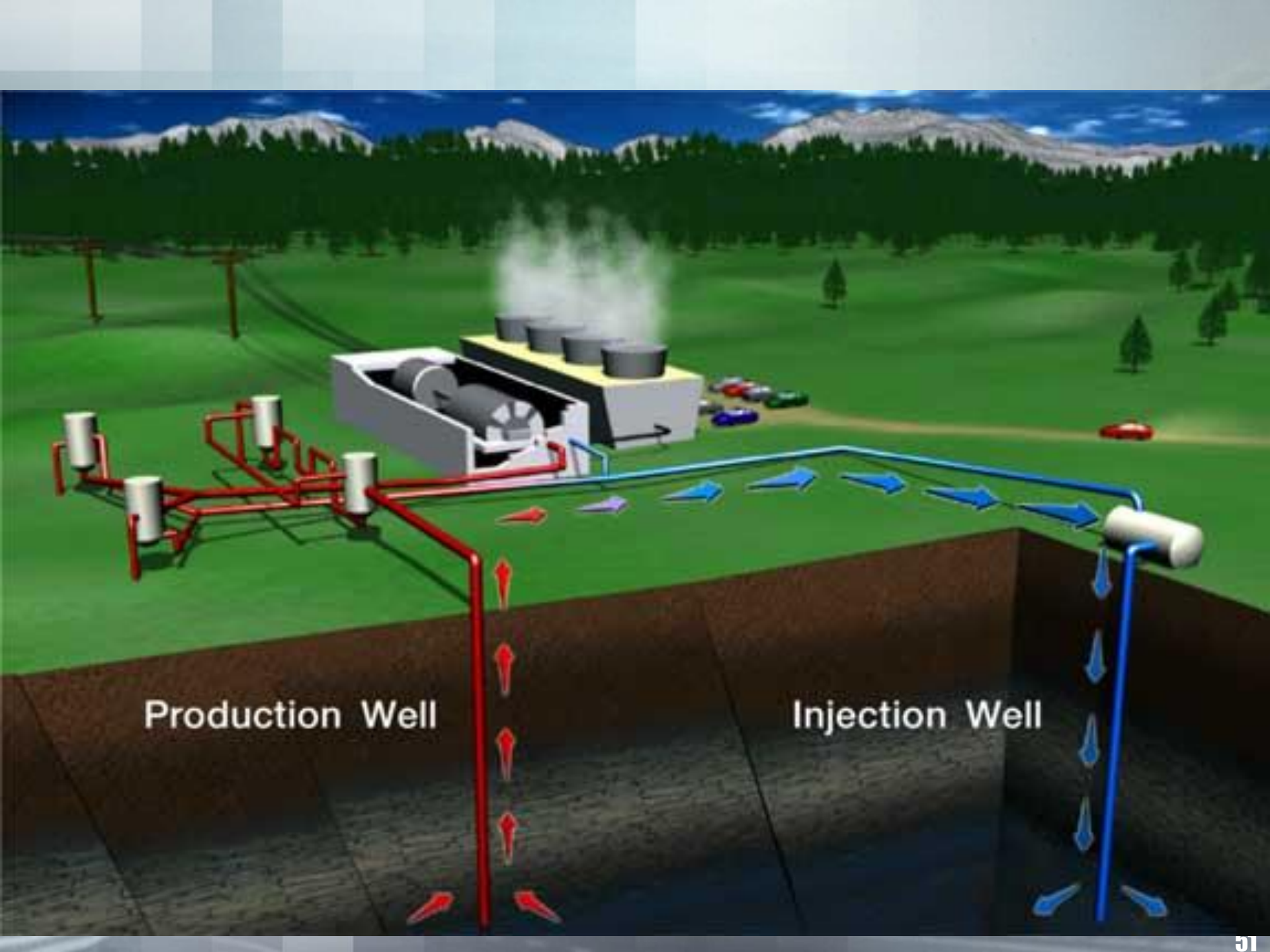
D. Geothermal Energy

- The heat of the earth's interior can be used to generate geothermal energy**
- At 30 km below ground, rock temperatures can reach 900°C – this happens when magma has moved close to the earth's surface (due to volcanic activity)**
- Energy develops where groundwater comes close enough to the hot rocks to heat it to 200°C or more**



Hottest Known Geothermal Regions

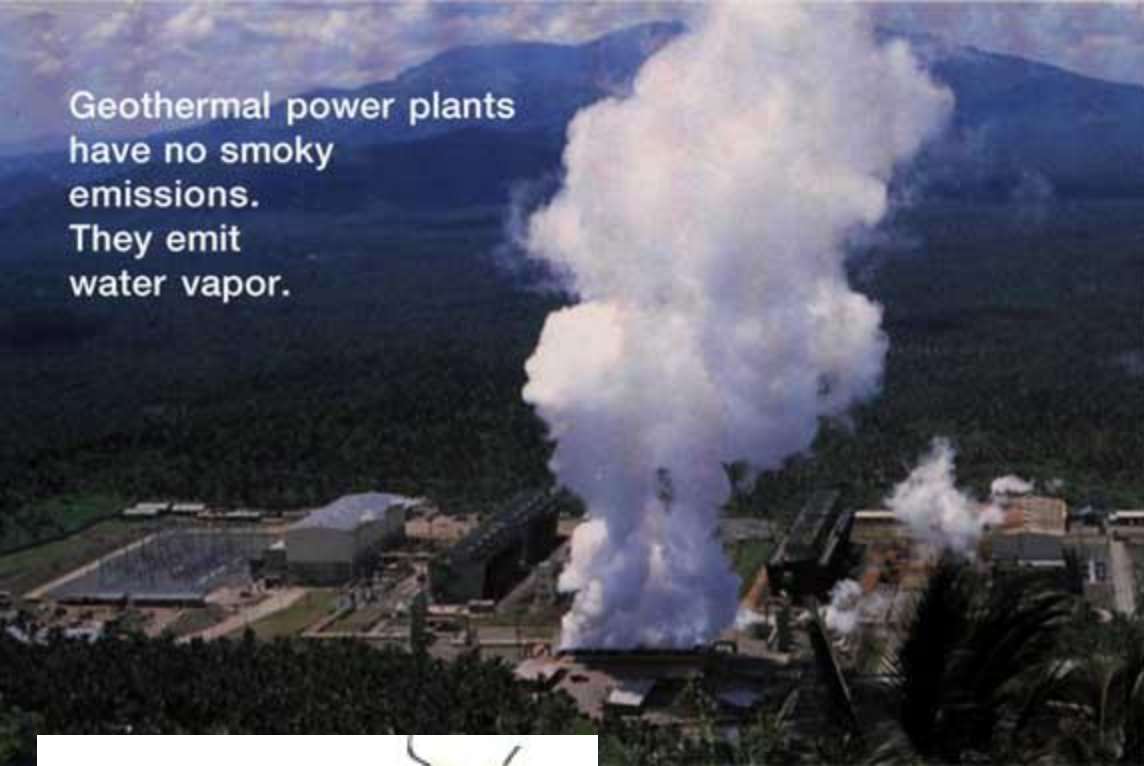
- **The water flows under high pressure through cracks leading towards the earth's surface**
- **When this superheated water is brought to the surface it instantly turns into steam, which is used to drive turbines and generate electricity**
- **Geothermal power is clean, renewable and a sustainable energy source**



Production Well

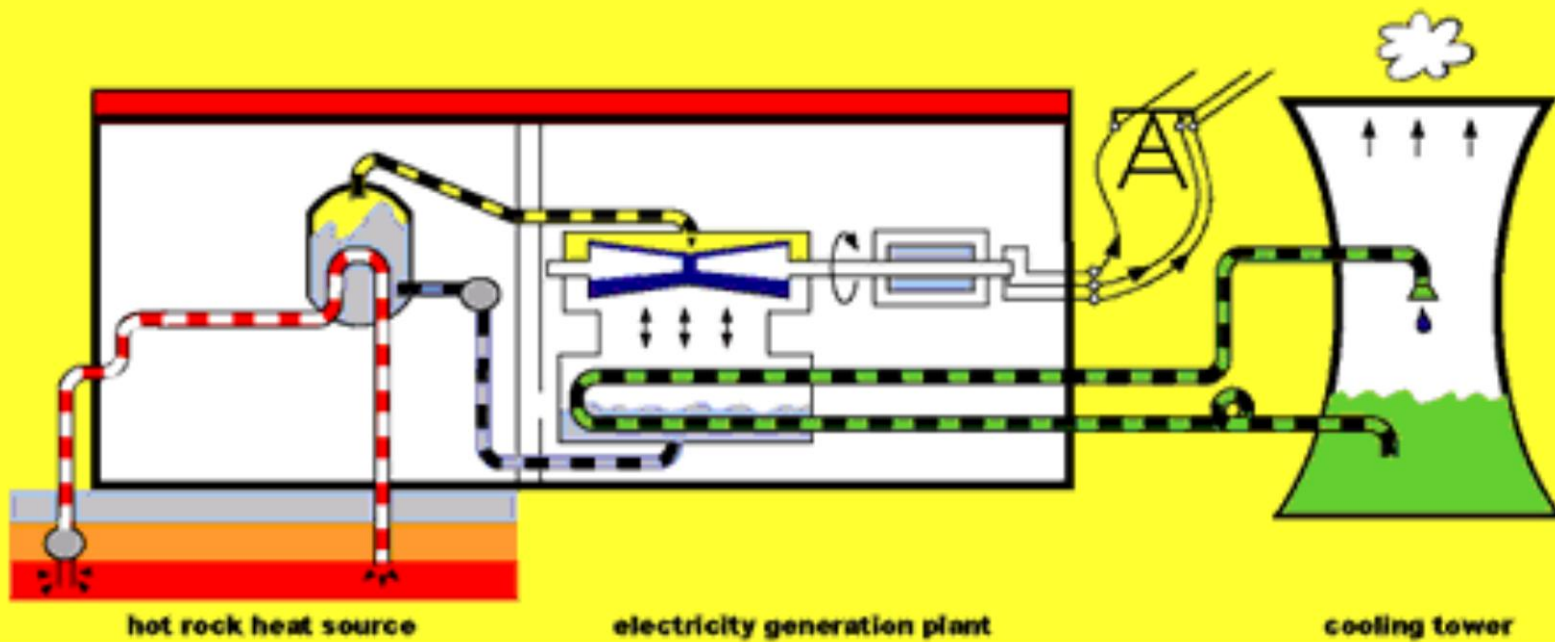
Injection Well

Geothermal power plants have no smoky emissions. They emit water vapor.



Geothermal Energy





Energy Source	Pros	Cons
Natural heating from the Earth	<ul style="list-style-type: none"> • free source • unlimited source • env. friendly 	<ul style="list-style-type: none"> • expensive set up • few locations

E. Wind Power

- It is clean, non-polluting, and a renewable source of energy**
- Best locations are where mountains or hills funnel air into narrow passes, where wind speed is increased**
- Only natural gas and hydroelectricity are cheaper**

Wind Power

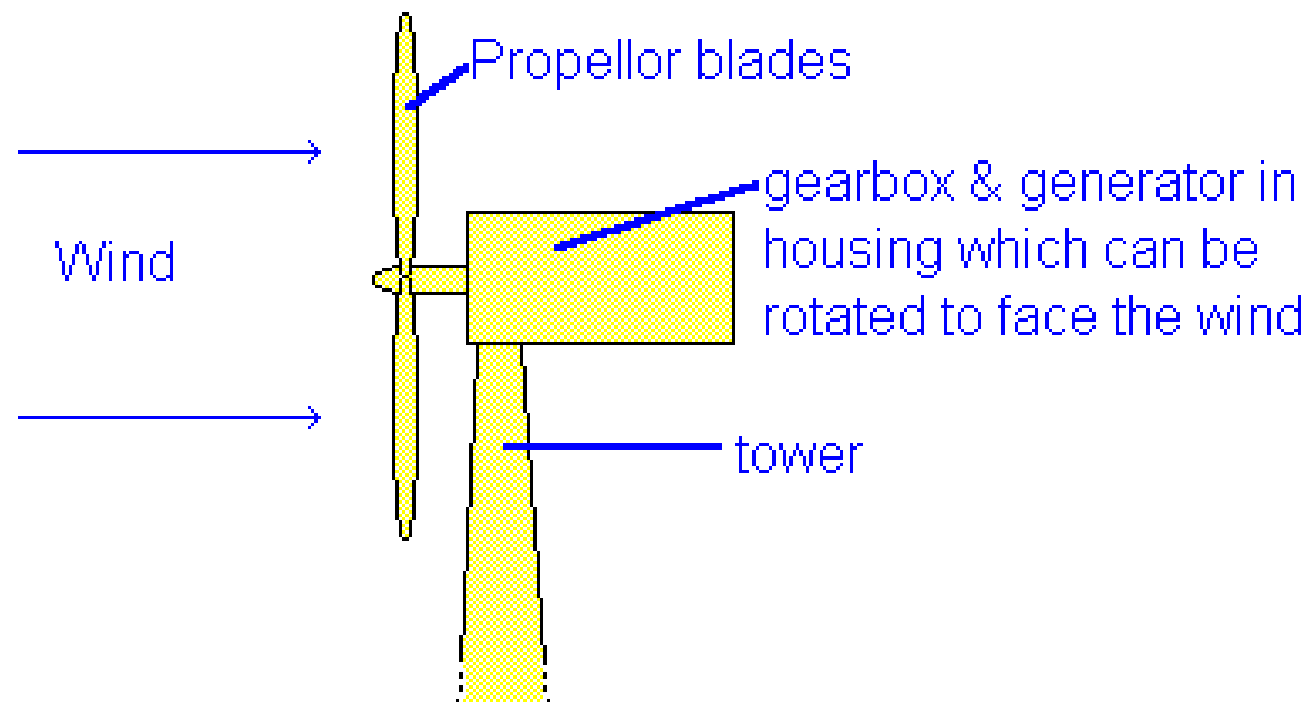


UK Offshore Wind Farm

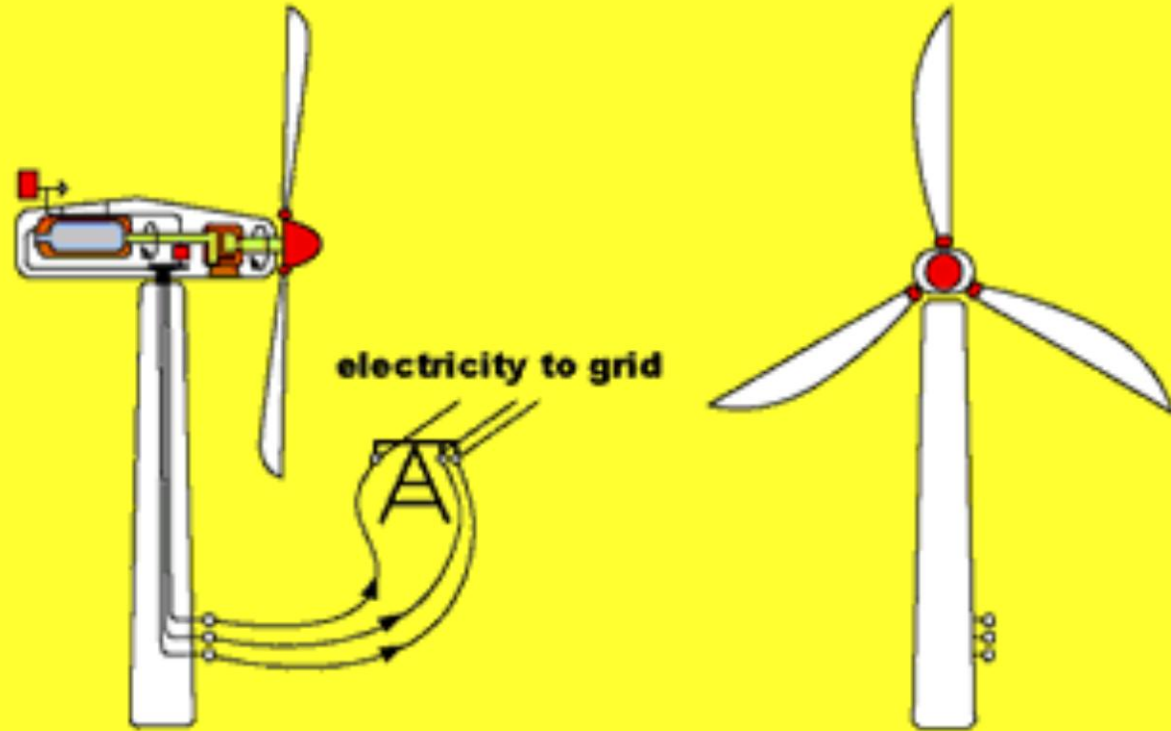


Wind Farm in Alberta

- [Wind Turbines in Action](#)
- [Wind Energy Animation](#)
- [Offshore Wind Farm in the UK Video](#)
- [Wind Farm in the UK](#)



50 metres
 35 metres
 20 metres
 ground level



Source of Energy

Pros

Cons

Moving air

- free source
- env. Friendly

- expensive set-up
- eyesore, birds
- inconsistent source

F. Biomass Energy

- It is derived from organic waste products from forests, paper and lumber mills, farms and municipal garbage
- The energy potential from biomass is believed to exceed Canada's total energy needs many times over
- [Great Biomass Video - Takes time to load](#)

- **Unfortunately, burning biomass fuels adds to the carbon dioxide levels in the atmosphere**
- **More research is needed before we can fully benefit from this untapped energy source**



- Bioenergy Animation



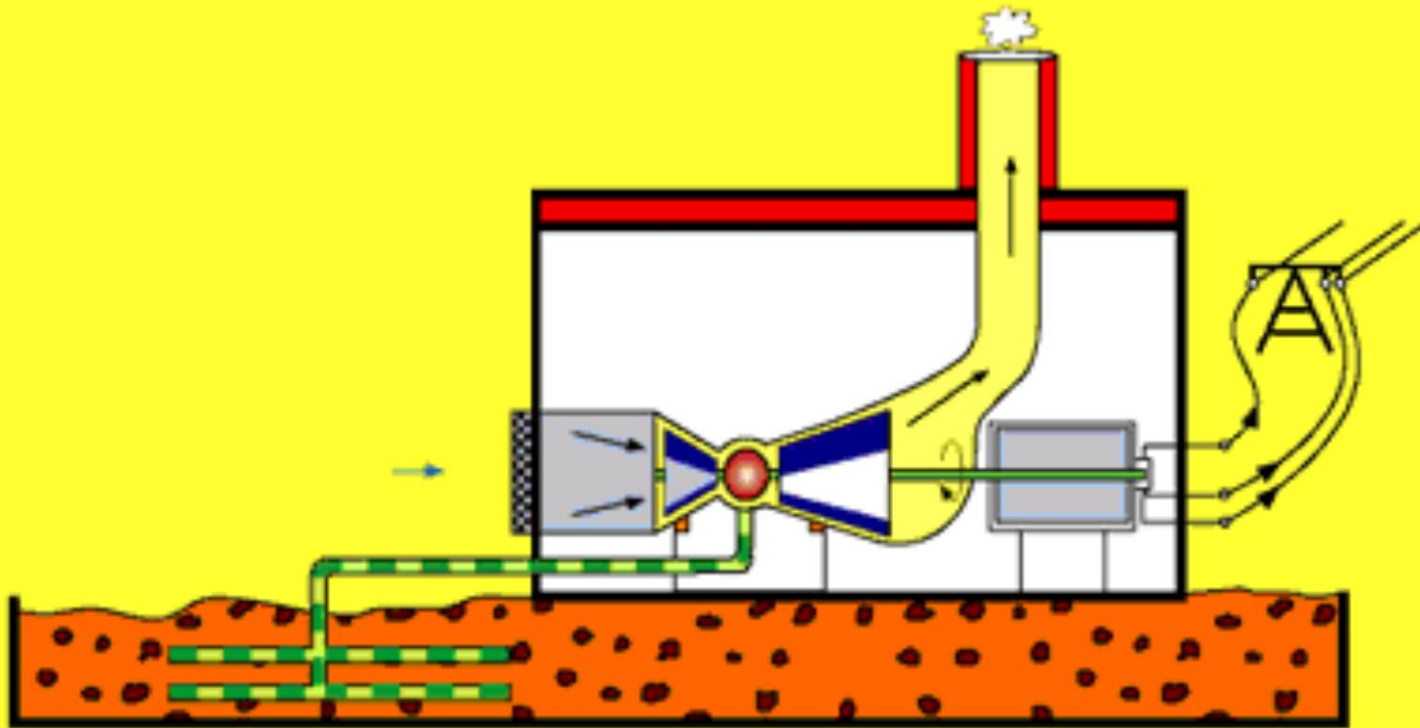
**Biomass (Wood-Fire)
Power Plant, USA**



**Biomass Power Plant,
Hawaii**

The most common form
of Biomass energy:
wood burning stoves!





Energy Source	Pros	Cons
Burning natural products or wastes	<ul style="list-style-type: none"> • free source • gets rid of wastes 	<ul style="list-style-type: none"> • Env. impacts by adding CO₂ to atmosphere • expensive set-up

17. Energy Conservation

- **Conservation is one of the most effective methods of reducing demand on our energy sources**
- **Cars supposedly became smaller and more fuel efficient**
- **Appliances became more energy efficient**
- **Government encourages businesses and homeowners to upgrade their insulation**

- **Building codes were revised to increase insulation standards**
- **Federal government study suggested that energy saving through conservation could be as high as 30% of energy demand**
- **See Handout on “Saving Energy at Home”**

18. Energy and the Environment

- **Most serious environmental issue is the burning of fossil fuels and the air pollution it creates**
- **Coal, oil, and natural gas produce gases like carbon dioxide, nitrous oxide and sulphur dioxide which contributes greatly to global warming, acid rain, urban smog and pollution**

- **Canadians are among the highest energy users in the world – thus we are contributing greatly to the global warming**
- **In 1992, Canada pledged to reduce the amount of CO₂ emissions to 1990 levels by the year 2000.**

- **To meet this goal the Canadian government introduced emission guidelines for automobiles and established the Efficiency and Alternative Energy program to promote greater energy efficiency and alternative energy sources**
- **The only real solution to this problem is to switch from fossil fuel energy sources to renewable sources**