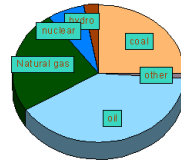


Where do we get our energy from?  
Is it Sustainable?

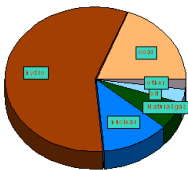


World Wide Energy Pie



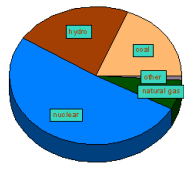
- Coal 25%
- Hydro 3%
- Nuclear 7%
- Natural Gas 24%
- Oil 40%
- Other 1%

In Canada



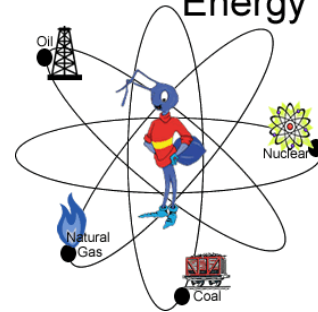
- Coal 19%
- Nuclear 12%
- Oil 3%
- Hydro 58%
- Natural Gas 6%
- Other 2%

In Ontario

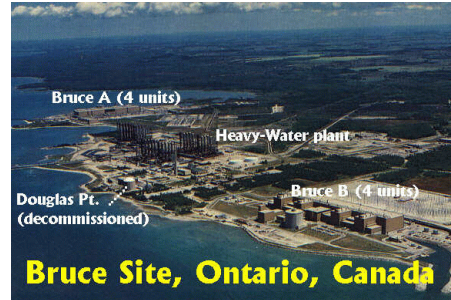


- Coal 19%
- Nuclear 51%
- Oil 0%
- Hydro 22%
- Natural Gas 7%
- Other 1%

Non-Renewable Energy



**Nuclear Power Plants in Ontario**

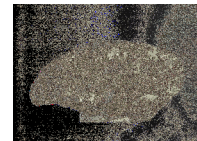


The source of Fuel for Nuclear Reactors in Ontario is Uranium

Uranium is an element found in naturally occurring pitchblende contains uraninite  $UO_2$

Mined and Refined in Canada

Uranium is a radioactive element (it's atoms are unstable and break down releasing energy)



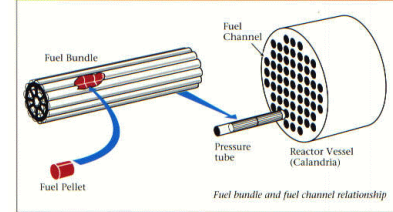
# Canada's Nuclear Reactors and Uranium Mines

- ▲ CANDU reactors [ # of reactors x net MW(e) ]**
- 1. Bruce A: 4 x 770 (2 shut and being refurbished)
  - 2. Bruce B: 2 x 795 + 1 x 825 + 1 x 660
  - 3. Douglas Point: 1 x 208 (decom) - large prototype CANDU
  - 4. Pickering A: 4 x 515 (2 shut)
  - 5. Pickering B: 4 x 516
  - 6. Darlington: 4 x 891
  - 7. Gentilly-1: 1 x 250 (decom) - Boiling water CANDU
  - 8. Gentilly-2: 1 x 635 CANDU 6
  - 9. Point Lepreau: 1 x 635 CANDU 6
  - 10. Nuclear Power Demonstration: 1 x 22 (decom) - 1st Canadian PHWR, prototype for CANDU reactors

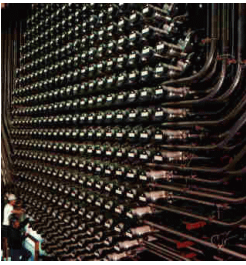
- Research reactors (thermal power)**
- A. U of Alberta, Edmonton: SLOWPOKE II, 20 kW
  - B. Saskatchewan Research Council, Saskatoon: SLOWPOKE II, 20 kW
  - C. AECL, Whiteshell Laboratories, Pinawa
    - a) WR-1 organic-cooled, 60 MW (decom)
    - b) SLOWPOKE Demonstration, 2 MW (decom)
  - D. McMaster U, Hamilton: MNR, 5 MW (cool)
  - E. U of Toronto: SLOWPOKE II, 20 kW (decom)
  - F. Royal Military College, Kingston: SLOWPOKE II, 20 kW
  - G. AECL, Chalk River Laboratories
    - a) NRX, 135 MW
    - b) NRX, 42 MW (decom)
    - c) FTR, 100 W (decom)
    - d) ZEEP, 2, 100 W
    - e) ZEEP, 250 W (decom) - first reactor outside USA
  - H. MMIR 1 and 2: 10 MW each, medical isotope production
  - I. MID: Windsor, Ontario: SLOWPOKE II, 20 kW (decom)
  - J. Ecole Polytechnique, Montreal: SLOWPOKE II, 20 kW
  - K. Dalhousie U, Halifax: SLOWPOKE II, 20 kW



Uranium is converted into pellets  
 Those pellets are placed in fuel bundles  
 Fuel bundles are placed in the reactor  
 The reactor is submerged in heavy water

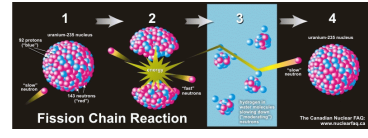


Candu Reactor Face



## Nuclear Fission

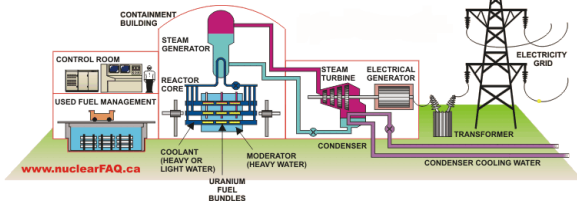
The fuel bundles are bombarded with neutrons  
 These neutrons split the uranium atom (fission)  
 This releases energy and creates a chain reaction



## The CANDU REACTOR

The energy turns the heavy water into steam.

The steam is used to turn a turbine which generates electricity



## Pros

Ontario jobs both in mining and reactor sites.

Uranium markets currently more stable than oil and gas

Once established have high energy outputs compared to the operating cost

Nuclear power takes up very little space (a volleyball size piece of uranium will provide you with enough energy for your life time)

Nuclear Plants have no atmospheric emissions.

## Cons

Uranium mining is extremely hazardous to miners health  
210 million tonnes of mining waste (tailings) have been produced so far

Power plants consume large amounts of water for cooling and release heated water back into lakes disrupting ecosystems

Nuclear Safety Risks (Chernobyl, Three Mile Island, Fukushima)

Highest set up and maintenance costs Eg. Bruce refurbishment cost 4.8 billion

Nuclear waste is extremely hazardous and will be around for 1000's of years?