

eCards

Research Topic Nuclear

Nuclear

Imagine a source of electricity that promises to be clean and have no emissions and whose source of fuel is found right here in Canada. After the scientific discovery of the splitting of atoms in the last century, many people held out hope for peaceful uses of nuclear technology, and countries started using nuclear power to generate electricity. But before long, environmentalists and economists began to question whether nuclear power could keep its promises, and whether it was such a good idea after all.

The energy source for nuclear power is uranium - a radioactive element found in underground deposits in Canada, Australia, West Africa and Kazakhstan. Radioactive materials give off harmful radiation through high-energy rays or particles, and they usually continue to do so for a very long time.

Uranium ore must be mined from the ground and then processed to produce fuel bundles for use in a nuclear power plant. Because uranium is radioactive, this process is a challenging one for both environmental and security reasons. Disposal of the toxic waste products created at nuclear power plants is also a challenge. Radioactive elements are unstable substances that are constantly disintegrating and giving off energy.

Canada has 19 operating nuclear reactors and 15% of Canada's electricity comes from nuclear power. Nuclear power plants were built in Europe and North

America from the 1950s to the early 1980s, but few nuclear power plants have been built since then. Some countries, such as China and South Korea, have continued to build reactors, but for a number of reasons most have not.

- Globally, there have been over 100 nuclear accidents from 1952 to 2011 including the most serious: Three Mile Island in the United States (1979), Chernobyl in Russia (1986) and the Fukushima Daiichi nuclear disaster (2011). The Chernobyl accident spread radioactive particles across much of Eastern Europe and beyond, poisoning river systems and causing cancers in thousands of people.
- There is concern that nuclear power plants could be used to make materials for nuclear weapons. India used a Canadian-built nuclear power plant to make its first nuclear weapon.
- There has been less demand for electricity and for large power plants of any type.
- Some economists feel that nuclear power costs much more over time than its alternatives.

In Ontario over the past 35 years, nuclear power has been a significant but somewhat unpopular part of overall electricity production. Ontario has nuclear reactors in Pickering, Darlington and Bruce. The nuclear power debate has recently heated up again. Some see it as a good solution for our growing energy needs and a possible way to combat global warming. Do we need it? Can we afford it? Can we accept the risks? Learn more and make your voice heard!

How Do Subatomic Particles Become Energy For Human Use?

The key component in a nuclear power plant is the nuclear reactor. Water is heated in the reactor core through fission of uranium atoms to make steam. The generator part of the reactor splits the nuclei (which is at the centre) of uranium atoms, creating heat as well as flying particles of atoms that collide and start a chain reaction. Contained within a large chamber, this very fast chain reaction of millions of tiny particles crashing into each other becomes the source of heat for tanks of water. With temperatures rising to 600 degrees Celsius, the water is turned into a constant source of steam.

The chain reaction must be carefully controlled to produce a steady output of energy. An uncontrolled chain reaction results in huge releases of energy that can cause a reactor meltdown. Most nuclear plant designs, including Canada's Candu reactors, use a containment system that is intended to prevent the release of contamination during a meltdown.

The steam produced by this process of nuclear fission is used to turn turbo-generators that generate electricity in much the same way as heat in a coal-fired power plant. After turning the turbines, the steam is cooled so that it can be returned to the steam generator, and the heated cooling water is returned to the lakes or cooling towers from which it was taken.

One of the biggest challenges of nuclear power is what to do with the used up (or "spent") fuel-bundles. Several components in these fuel-bundles remain radioactive for one million years while others could be used to make nuclear weapons.

Spent fuel-bundles can be reprocessed or transported to long-term storage sites, but neither of these options provides a safe, permanent solution. Disposal of radioactive waste is a big concern around the world and an on-going subject of international research. The Canadian federal government is considering several options for Canada's waste fuel-bundles.

What Are the Advantages and Disadvantages of Nuclear Power?

Advantages:

- Nuclear power plants produce a large amount of energy from a small amount of fuel: 1 kilogram (kg) of coal = 3 kilowatt-hours (kWh) of electricity; 1 kg uranium = 60,000 kWh.
- Nuclear power reduced about 21% of the cumulative CO₂ emissions from 1971 to 2004.
- Canada has been a leader in developing the expertise for the Candu nuclear reactors.
- Nuclear power plants require the least amount of land per unit of energy produced.

Disadvantages:

- Waste that is produced by nuclear power plants is toxic and radioactive, and it is also risky from a security and weapons proliferation point of view. Scientific knowledge about nuclear reactors and materials could be used to make nuclear weapons. So far, there is no long-term management strategy in place for this waste in Canada.
- Although the risk of severe accidents is low, the consequences of serious nuclear accidents for human health and the environment are severe.
- Building nuclear power plants involves high start-up costs and a long regulatory and construction period. Plants often end up costing a lot more than expected and taking a lot more time to build than expected.
- Canada's nuclear reactors have a poor operating record and have had frequent shutdowns for repairs and refurbishments.
- Nuclear energy is not renewable. It relies on a finite and non-renewable fuel supply – uranium. Current Canadian uranium reserves are estimated to be sufficient for 40 years at current levels of consumption. As a result, world uranium prices have increased more than six-fold since 2001.
- Even though nuclear plants release fewer GHG than fossil fuel plants, it is estimated that 84,000 tonnes of GHG emissions per year are associated with nuclear power in Canada. These indirect

associations include, but are not restricted to mining, transportation, and power plant constructions.

Can Nuclear Power Help Meet Our Needs?

The debate about nuclear power has always had strong "for" and "against" arguments. It is an issue people feel strongly about.

Those who support nuclear power believe that:

- Nuclear power can effectively meet our energy needs. It is a relatively clean energy source.
- It has a very low safety risk.

Opponents argue:

- We can meet our energy needs by supporting strong energy efficiency and conservation efforts and by investing in sources of renewable energy such as solar and wind power.
- Nuclear power is not as clean as people often say it is because the mining, production, transportation and disposal of the fuel all have a big impact on the environment.
- The risk, however small, of accidents, security breaches and weapons proliferation is unacceptable, particularly since there are other energy options available that could not have such consequences.

Today's concerns about global warming and about non-renewable energy sources like oil have brought nuclear power into the spotlight again, and we can expect to keep hearing from people on both sides of the debate.

Global Usage Facts

- As of May 2021, there are around 443 operational reactors in some 30 countries.
- It is estimated that nuclear power produces 10% of the world's electricity.
- Some countries rely on nuclear energy more than others. These are the six countries that rely on it the most (as of 2018) or the percentage of total electricity generated by nuclear:
 - Slovakia: 82.3%

- France: 70.6%
- Ukraine: 51.2%
- Hungary: 48.0%
- Bulgaria: 40.8%
- Belgium: 39.1%

- Power plant construction slowed down in the 1980s and 1990s. There was less demand for them for economic reasons and also because of environmental, security and safety concerns.

Canadian Usage Facts

- There are 6 nuclear power stations in Canada, which have a combined capacity of 14,071 megawatts. The Bruce generating station is the largest operating nuclear power plant in the world. 5 of them are in Ontario, and one is in New Brunswick.
- Canada is the second-largest producer and fourth exporter of uranium in the world, with 13% of global production in 2019.
- Nuclear power generation accounted for approximately 15% of Canada's electricity in 2018. Nuclear power is a source of energy that does not emit greenhouse gases.
- In 2019, 75% of Canada's uranium production was exported for use in nuclear power throughout the world.

Total electricity generation in Canada in 2018 was 641 terawatt hours. Hydro has the highest share of generation at 60%, followed by nuclear at 15%, coal at 7%, gas/oil/others at 11% and non-hydro renewables at 7%.