NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Canada's used nuclear fuel

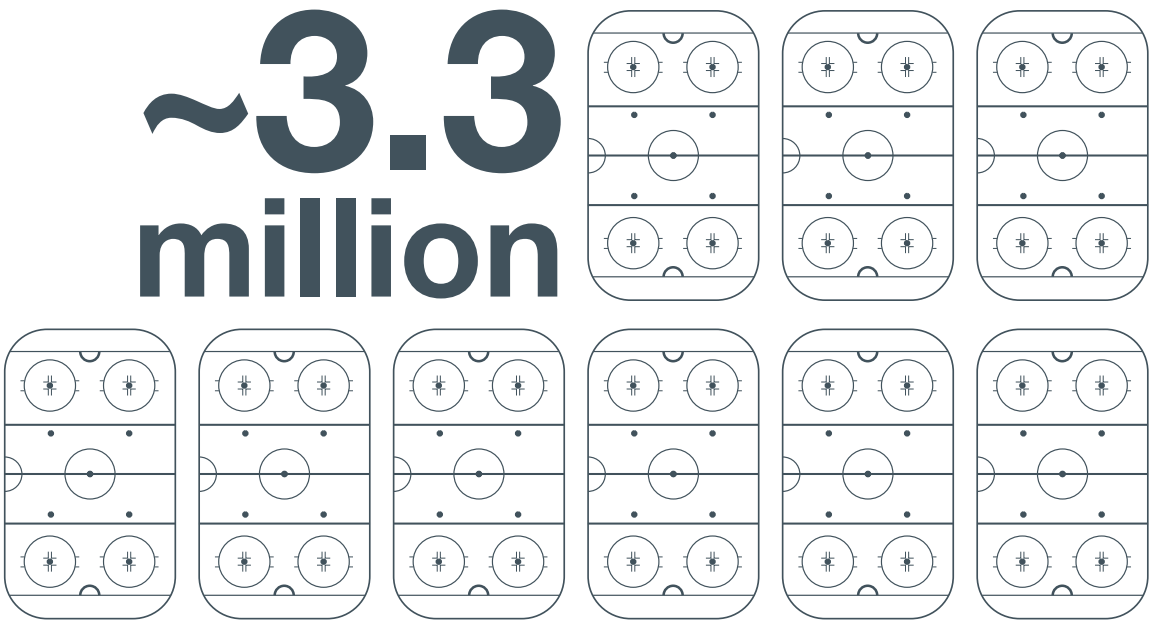
For decades, Canadians and Indigenous Peoples have been using electricity generated by CANDU nuclear power reactors in Ontario, Quebec and New Brunswick. Used nuclear fuel is a byproduct of this process.

In Canada, the nuclear sector is also actively exploring new nuclear reactors ranging from large-scale to small modular reactors and advanced reactors. New nuclear developments would increase the used fuel volume and may result in different types of used fuel.

Currently, used nuclear fuel is safely stored on an interim basis at existing federally licensed facilities in Canada. The current storage method is safe, but temporary.

Through the *Nuclear Fuel Waste Act* (NFWA), the Government of Canada assigned responsibility for the safe, long-term management of all Canada's used nuclear fuel to the Nuclear Waste Management Organization (NWMO). We led the development of a long-term management plan, called Adaptive Phased Management (APM), that is based on the values and priorities identified by Canadians and Indigenous Peoples and aligns with international best practices. It will contain and isolate Canada's used nuclear fuel in a deep geological repository.

In 2023, Canada's Minister of Energy and Natural Resources also tasked the NWMO with a new mandate to plan for the safe, long-term management of intermediate-level and non-fuel high-level radioactive waste that will be managed in a second deep geological repository. Potential used nuclear fuel from new nuclear projects may also be managed in this second repository. We are now implementing both of these plans.



If stacked like cordwood, Canada's existing inventory of about 3.3 million used nuclear fuel bundles could fit into about nine hockey rinks from the surface of the ice to the top of the boards.

Currently, Canadian reactors produce about 90,000 used CANDU fuel bundles per year. As of June 30, 2024, there are about 3.3 million used CANDU nuclear fuel bundles in Canada. If stacked like cordwood, all this used nuclear fuel could fit into about nine hockey rinks from the surface of the ice to the top of the boards.

At this time, the NWMO is developing the deep geological repository for Canada's used nuclear fuel to anticipate a total volume of 5.9 million used fuel bundles. This projection is based on the operation of Canada's existing nuclear reactors. The projected number of used CANDU nuclear fuel bundles will range from 5.7 million to 6.4 million bundles, depending on final decisions around current plans to extend the operation of Canada's nuclear reactors.

In this evolving environment, there is potential for not only extending the life of existing nuclear plants, but also building new nuclear reactors. The Canadian nuclear sector is actively exploring emerging technologies, and there are multiple new nuclear energy projects under consideration.

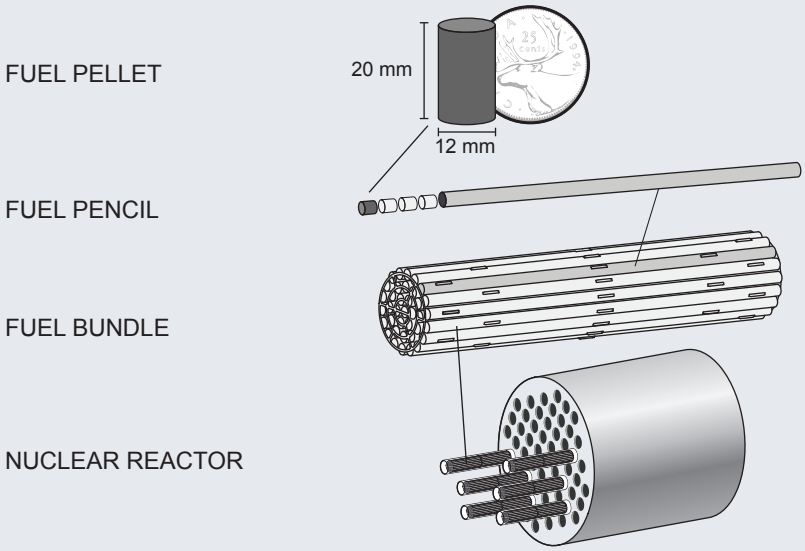
As we advance our work, we are maintaining flexibility and remaining ready to be adaptive. Our priority is planning for used fuel from existing reactors. However, in case we need additional capacity in the future, we are also exploring the potential to include future used fuel from new nuclear projects in the same repository that we will use to manage intermediate-level and non-fuel high-level waste.

No matter the source of the fuel, safety will always be our top priority.

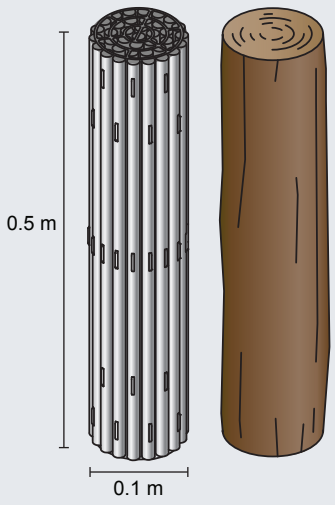
CANDU nuclear fuel

In Canada, most used nuclear fuel that exists today is CANDU fuel. This fuel is not a liquid or a gas — it is a stable solid. Under Canadian and international regulations, it is not classified as a flammable, explosive or fissile material.

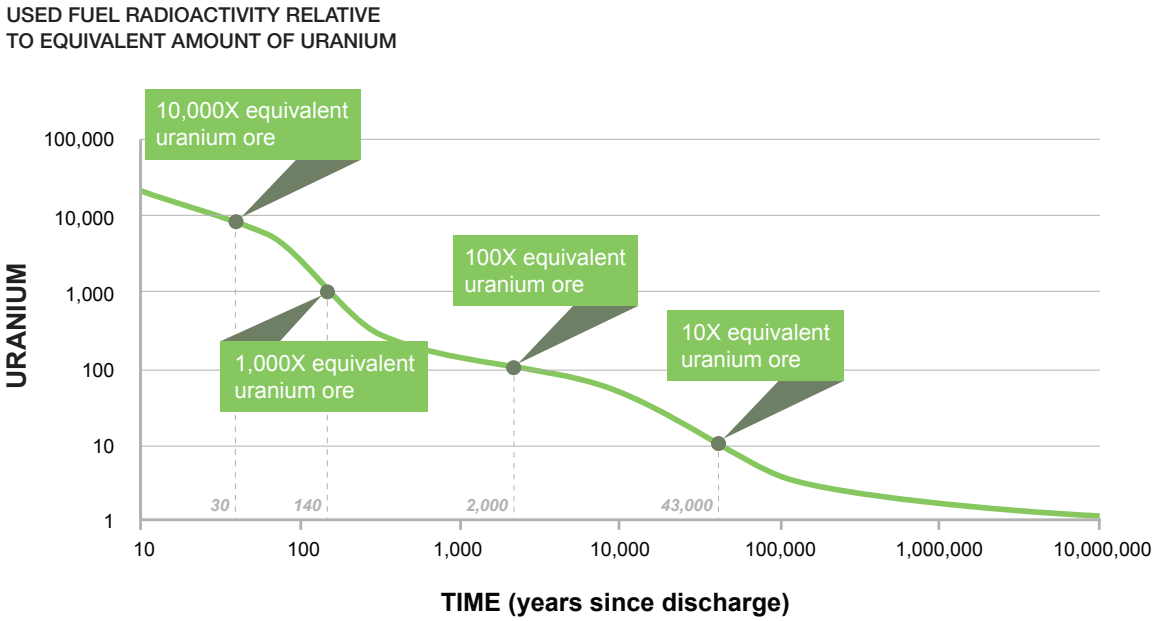
CANDU nuclear fuel consists of uranium dioxide (UO_2) made from natural uranium. During fabrication, UO_2 powder is pressed into solid pellets and then baked into a ceramic form. The ceramic pellets are placed inside a tube made of a zirconium-tin alloy, with the completed assembly called a fuel element or fuel pencil. These fuel pencils are welded together into bundles the shape and size of a fireplace log. Each CANDU fuel bundle is about 0.5 metre long, has a diameter of about 0.1 metre, contains about 20 kilograms of uranium, and has a total mass of about 24 kilograms.



Each CANDU fuel bundle is about the size and shape of a fireplace log.



Radioactive decay over time in used CANDU fuel



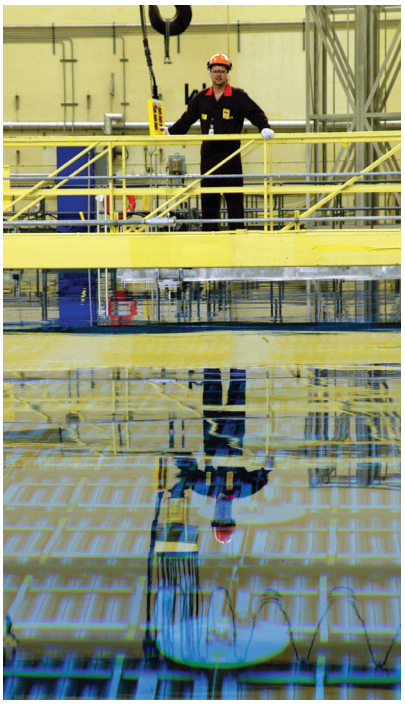
Although its radioactivity level decreases rapidly with time, residual radioactivity (together with some chemical toxicity) persists, and the used fuel remains a potential health risk for many hundreds of thousands of years.

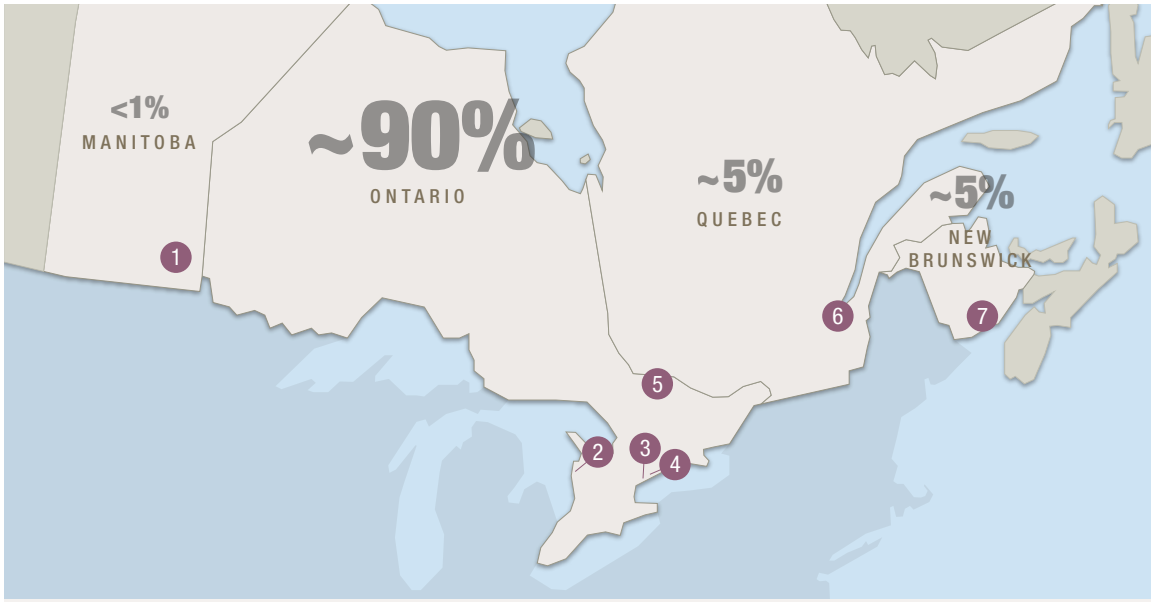
When CANDU fuel is removed from the reactor at the end of its useful life, it is considered a waste product. Used fuel is highly radioactive and requires careful management. Although its initial radioactivity level decreases rapidly with time, residual radioactivity (together with some chemical toxicity) persists, and the used fuel remains a potential health risk for a very long period of time.

It will take about one million years for the radioactivity level to reach about that of an equivalent amount of natural uranium.

How used nuclear fuel is stored today

When used nuclear fuel bundles are removed from a reactor, they are placed in a water-filled pool to reduce their heat and radioactivity. After seven to 10 years, the bundles are placed in dry storage containers, silos or vaults. Dry storage is a proven technology that has been in use around the world since the 1980s.





● **Interim storage facilities**

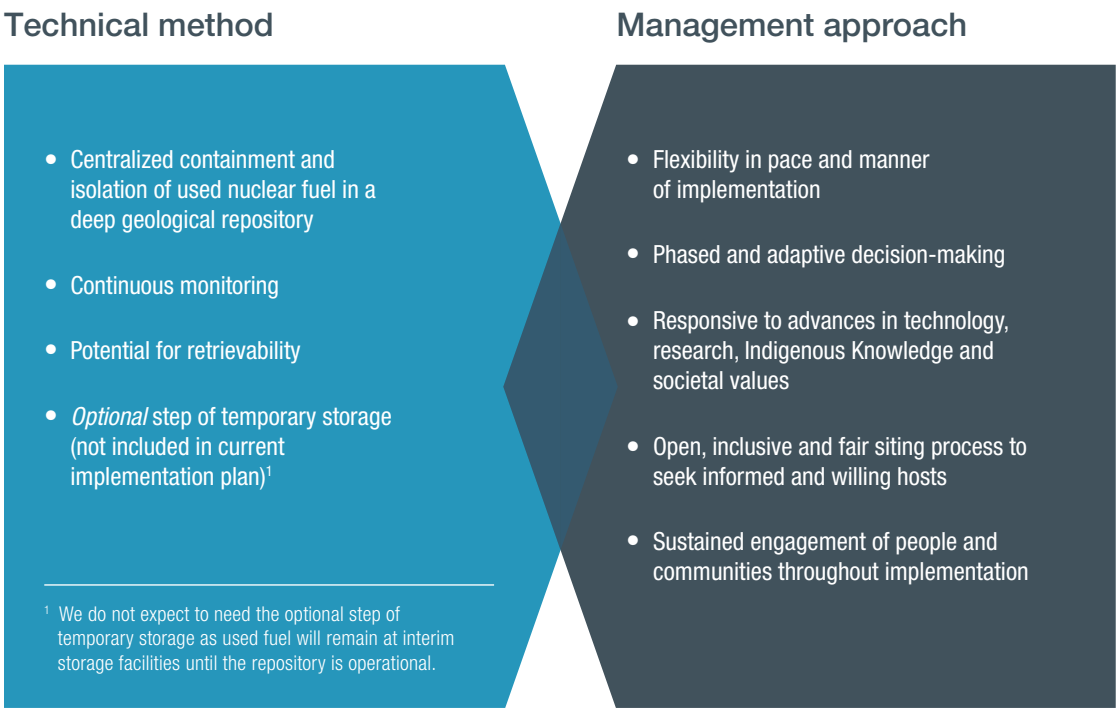
1. Whiteshell Laboratories
2. Bruce Nuclear Generating Station
3. Pickering Nuclear Generating Station
4. Darlington Nuclear Generating Station
5. Chalk River Laboratories
6. Gentilly Nuclear Generating Station
7. Point Lepreau Nuclear Generating Station

Today, used nuclear fuel is safely stored near or at the sites where it is produced in facilities licensed by the national regulator — the Canadian Nuclear Safety Commission. There are also small quantities of used research and development fuels in licensed facilities at Atomic Energy of Canada Limited's Canadian Nuclear Laboratories.

Canada has a robust regulatory framework that governs the handling of used nuclear fuel. Used nuclear fuel is carefully managed and shielded at all times to ensure that no one is exposed to an unshielded bundle.

What is the long-term plan for used nuclear fuel?

Canada's plan, known as Adaptive Phased Management (APM), is both a technical method (what we plan to build) and a management approach (how we will work with people to get it done).



The end point of the technical method is the centralized containment and isolation of Canada's used nuclear fuel in a deep geological repository in an area with suitable geology and informed and willing hosts. APM also involves the development of a transportation system to move the used CANDU fuel from the facilities where it is currently stored to the new site.

The management approach involves realistic, manageable phases, each marked by explicit decision points. It allows for flexibility in the pace and manner of implementation, and fosters the sustained engagement of people and communities throughout its implementation.

Canada's plan emerged from dialogue with Canadians, Indigenous Peoples and experts, and best meets the key priorities considered important by citizens. It was selected as Canada's plan by the federal government in June 2007.

The repository for Canada's used nuclear fuel is designed to meet rigorous safety standards throughout all aspects of its design and implementation. The plan is consistent with the long-term management approach adopted by other countries with nuclear power programs such as Finland, Sweden, Switzerland, the United Kingdom and France.

Canada's plan was developed for managing Canada's used nuclear fuel. No foreign used fuel will be placed in the repository.

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For more information, please contact:

Nuclear Waste Management Organization
22 St. Clair Avenue East, Fourth Floor
Toronto, ON M4T 2S3, Canada
Tel.: 416.934.9814 Toll free: 1.866.249.6966
Email: contactus@nwmo.ca
Website: nwmo.ca

@nwmocanada
/company/nwmocanada