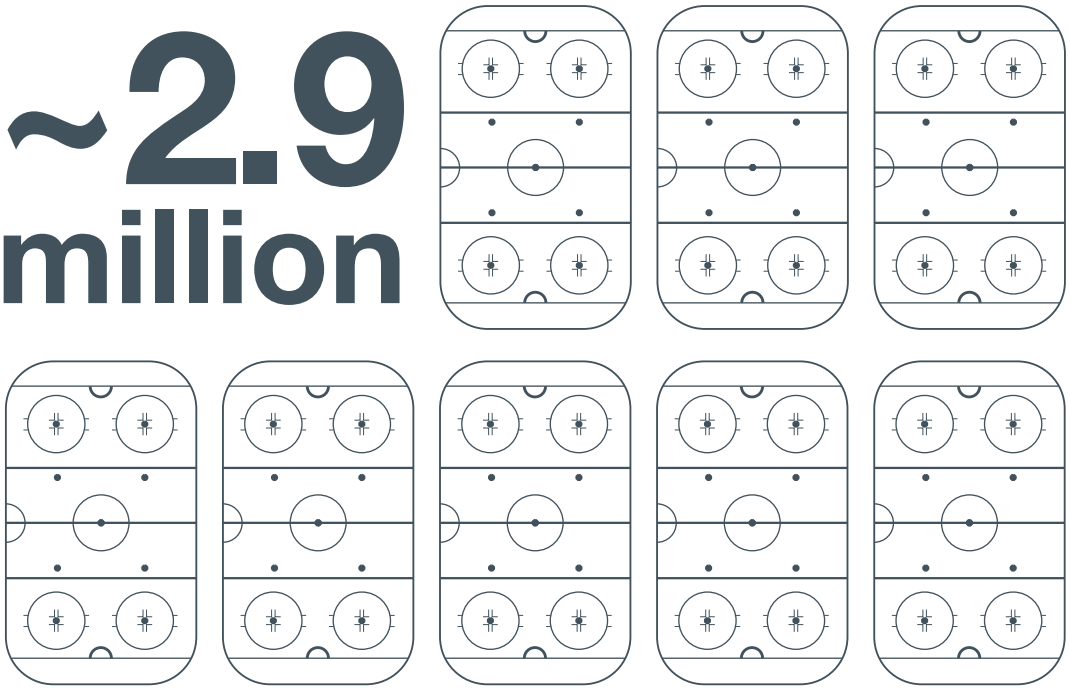
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

What is used nuclear fuel?

For decades, Canadians 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.

~2.9 million



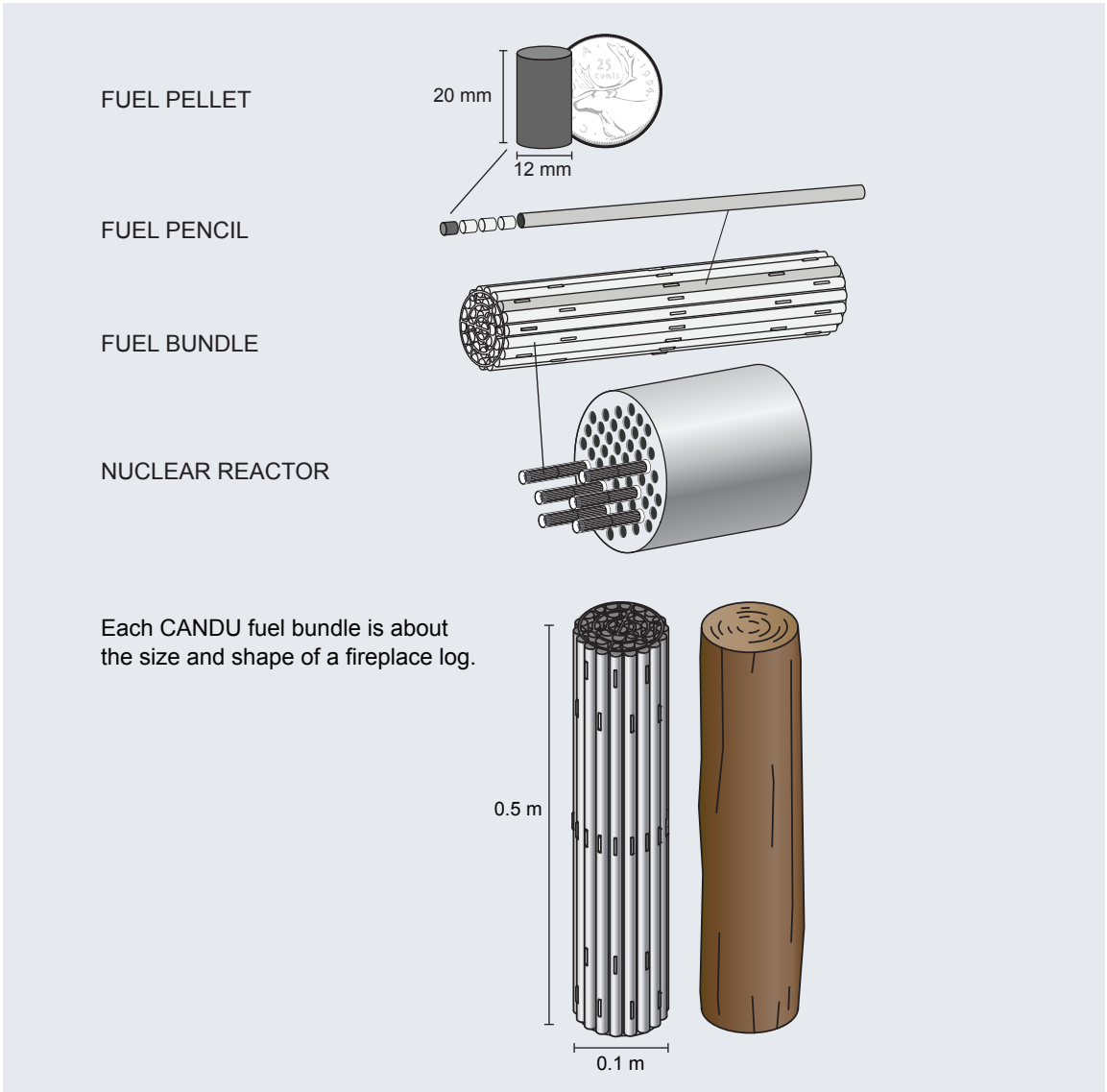
As of June 30, 2018, there are about 2.9 million used nuclear fuel bundles in Canada.

If stacked like cordwood, all this used nuclear fuel could fit into eight hockey rinks from the ice surface to the top of the boards. At the end of the planned operation of Canada's existing nuclear reactors, the number of used nuclear fuel bundles could total up to about 5.2 million.

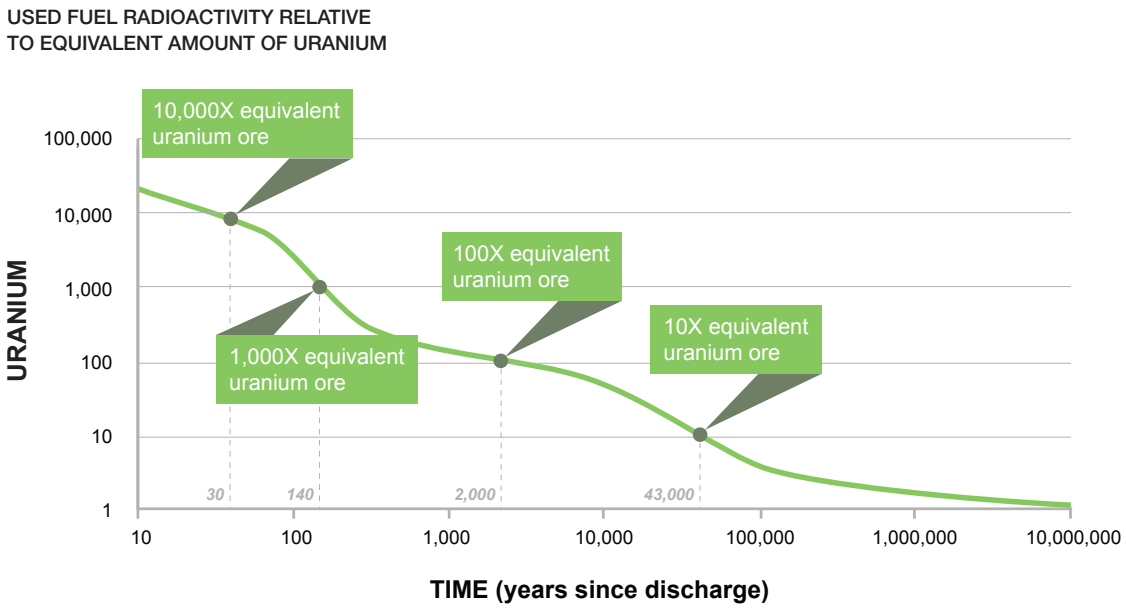
CANDU nuclear fuel

Canadian used nuclear 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.



Radioactive decay over time in a used CANDU fuel



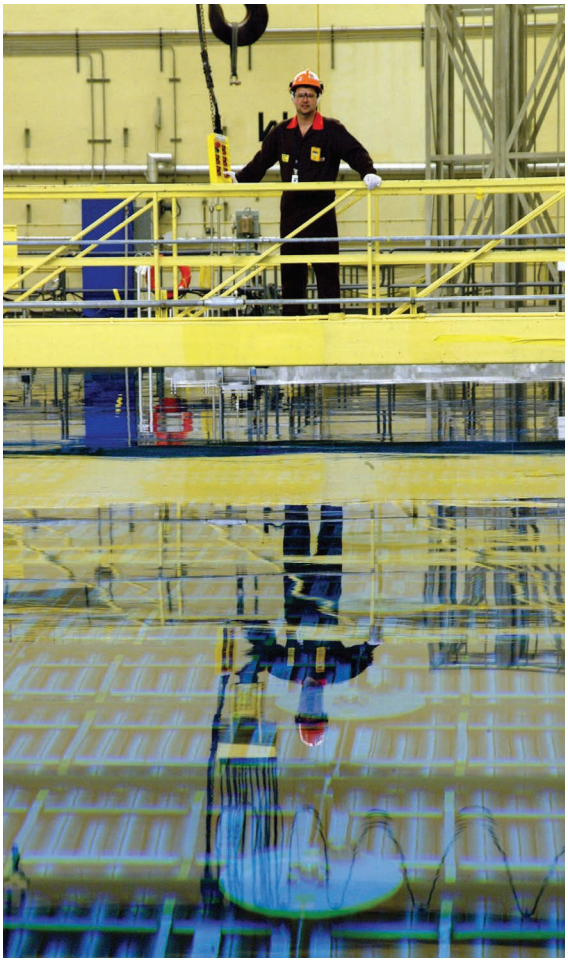
Although its radioactivity level decreases rapidly with time, residual radioactivity (together with some chemical toxicity) persists, and the used fuel remains a potential health risk for many hundreds of thousands of years.

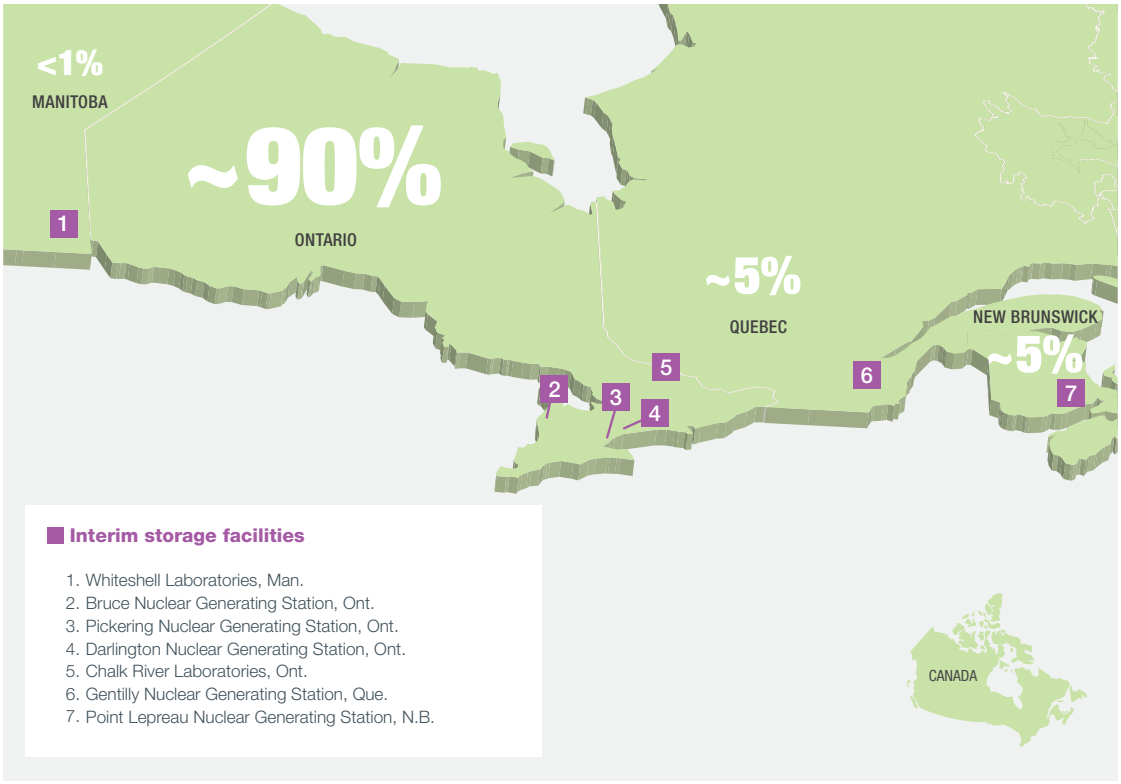
When CANDU fuel is removed from the reactor at the end of its useful life, it is considered a waste product. Used fuel is highly radioactive and requires careful management. Although its initial radioactivity level decreases rapidly with time, residual radioactivity (together with some chemical toxicity) 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. The corresponding graph provides information regarding radioactive decay over time in a used CANDU fuel.

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.





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. 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.

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

Canada's plan, known as Adaptive Phased Management (APM) is both a technical method and a management system.

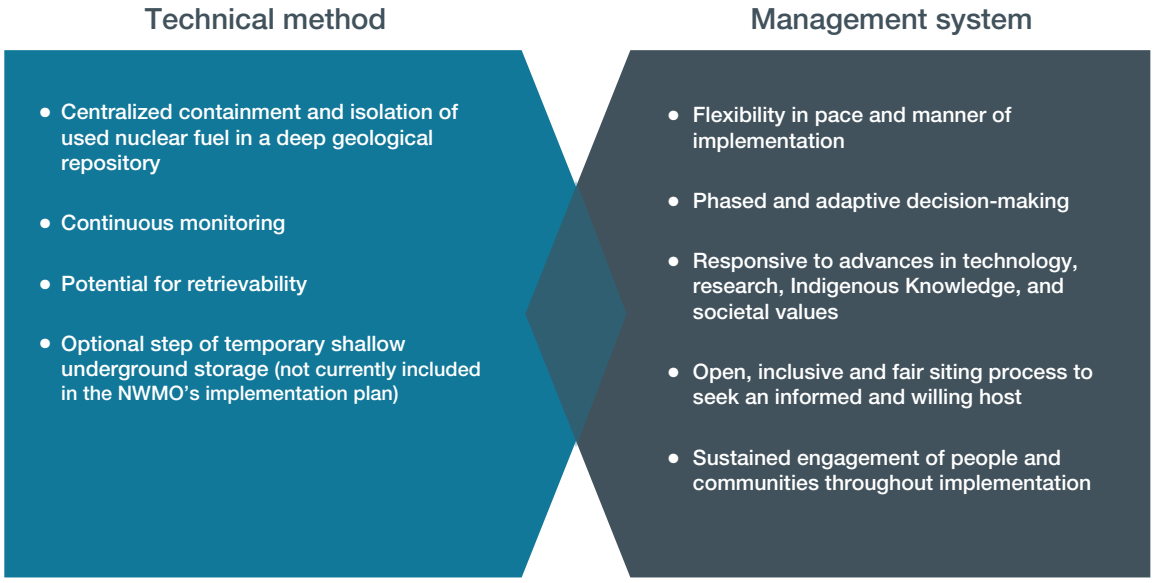
The end point of the technical method is the centralized containment and isolation of Canada's used fuel in a deep geological repository in an area with suitable geology and an informed and willing host. APM also involves the development of a transportation system to move the used fuel from the facilities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

The management system 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.

APM is also designed to meet rigorous safety standards throughout all aspects of its design and implementation.

Canada's plan emerged from dialogue with Canadians 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 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.



How much used nuclear fuel will be managed?

The *Nuclear Fuel Waste Act*, which was passed by the Government of Canada in 2002, requires the Nuclear Waste Management Organization (NWMO) to manage all nuclear fuel waste produced in Canada. This includes the used fuel bundles that exist now, as well as those produced in the future.

Currently, Canadian reactors produce about 90,000 used CANDU fuel bundles per year. If Canada's existing reactors operate to the end of their planned current lives, including planned refurbishments, the inventory of used fuel that will need to be managed in the facility could be about 5.2 million bundles, depending on future operating experience.

The NWMO's deep geological repository will need to be large enough to contain and isolate the inventory of used fuel from nuclear plants in Canada. Canada's plan was developed for managing Canada's used nuclear fuel, and no foreign used fuel will be placed in the repository.

In the future, decisions about nuclear power generation made by provincial governments, nuclear plant operators and regulators may result in a larger inventory and perhaps different types of used fuel. For instance, the lives of existing reactors might be extended through additional refurbishment. Provincial governments may also decide to build new nuclear plants. The NWMO application for regulatory review and approval, which is required by law before the facility can be constructed and operated, will be based on a specific fuel inventory.

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