Nuclear
Nuclear Waste Management

Nuclear waste from current and future uses of nuclear energy

Nuclear energy produces waste like any industrial or human activity, though the amount of waste is more than 1000 times smaller than any other energy-producing technology, as nuclear fuel has a very high energy density not matched by any other fuel..

A typical nuclear reactor of 1 GWe capacity produces, on average, 20 tonnes of spent fuel which is the equivalent of 9 grams of spent fuel per year for a typical family. The amount of uranium mined for a family's annual electricity demand is around 100 grams. Of those 9 grams annually, only 0,5 grams are considered as radioactive waste; the other constituents of the spent fuel can be recycled into new fuel as part of a circular economy.

Apart from spent fuel, nuclear reactors and their fuel cycle produce operational waste which is, compared to spent fuel, much less radioactive and already part of mature industrialised waste management activities around the world for safe and environmentally responsible final disposal.

The spent fuel does contain long-lived radioactivity, however, the radiological risks of spent fuel or any other radioactive waste from the processing of spent fuel does not present an environmental risk as interim and geological disposal facilities are well-engineered to contain such radioactivity for the appropriate length of time.

More integrated waste management practices are currently being deployed by the nuclear industry worldwide to minimise the amount and improve the characteristics of radioactive waste produced from nuclear energy and to further reduce any concerns with respect to long-term safety and environmental impact.

Nuclear waste management for sustainable development

The use of nuclear energy can create waste issues with spent fuel, which require responsible long-term management. Siting nuclear waste management facilities is a challenge that may pose a roadblock to clean, carbon-free nuclear electricity. However, advanced reactor technology and careful waste management could mitigate concerns.

The most sustainably-managed nuclear waste is the waste not generated. Many advanced nuclear reactor designs produce less waste as they create power. New types of fuels that these reactors use are designed to last longer in the reactor core than traditional fuels. Thus, over time, they produce more energy and less waste. Certain advanced reactors can also consume nuclear waste from currently-operating nuclear reactors. This innovation would also reduce the total amount of nuclear waste that requires permanent storage.

All reactors generate some amount of waste. In the United States, waste is stored on site in large, concrete containers. Though it is safe, it is regarded as an interim solution. Permanent solutions must be tailored to the waste's composition to protect human and environmental health for current and future generations. Consent-based policy solutions can ensure that local communities receive social and economic benefits from siting a waste storage facility.

U.S. law dictates that nuclear waste from commercial reactors must ultimately be disposed of and isolated in a deep geologic repository, the preferred management option in many other countries as well. New methods of waste isolation utilising drilling technologies commonly used in the oil and gas industry are under development.

Sustainable management of spent fuel

Fuel used in a nuclear power plant generates electricity for three to five years. After this time, it becomes less efficient and needs to be replaced. This spent fuel still contains 96% of the original uranium, but also about 3% of waste products, and 1% of plutonium. At this stage, spent fuel can either be sent for storage pending final disposal, or reprocessed to recover the uranium and plutonium.

The residual uranium can be recycled. The plutonium which is produced in the reactor is fissile, i.e., it can support a nuclear chain reaction. It can be combined with uranium to produce Mixed Oxide (MOX) fuel. The waste products are transformed into a solid insoluble glass form by a vitrification process and stored pending final disposal, for instance into a deep geological repository.

There is also new technology being developed that will allow radioactive waste to power a new age of nuclear power stations and small modular reactors. In doing so, these reactors will also produce waste, but in much smaller quantities than initially taken in as fuel. In addition to this, there are also other technologies, such as Nano Diamond Batteries, that can utilise fuel cycle waste to generate power. These batteries incorporate a betavoltaic cell using Carbon-14 which emit beta particles, generating electrical current. These batteries have low power, compared to current battery technology, but have a lifetime that can extend to hundreds of years. This makes them ideal for applications where replacement is not easy.

Viewpoint
by Nuclear Waste Management Organization

The NWMO completes fuel cycle as the potential of nuclear power continues to be explored.

Canada has been generating electricity from nuclear power to light our homes, businesses and cities for over half a century. As global demand for energy grows and the need to address climate change intensifies, nuclear power is increasingly part of the conversation.

The Nuclear Waste Management Organization (NWMO) fulfils an important part of the nuclear fuel cycle. We are the guardians entrusted to ensure Canada's used nuclear fuel is safely managed for the very long term, in a manner that protects people and the environment for generations to come.

In 2002, the Government of Canada assigned responsibility for the long-term management of Canada's used nuclear fuel to the NWMO. Canada's plan, also known as Adaptive Phased Management, emerged through a three-year dialogue with Canadians and Indigenous peoples.

Canadians made it clear that they want to move forward now on managing used nuclear fuel and not leave the burden for future generations. The NWMO is working collaboratively with Indigenous peoples and communities currently involved in our site selection process to do just that. We are on track to identify a single, preferred site by 2023, having gradually narrowed our focus over the past several years.

Canada's plan calls for used nuclear fuel to be contained and isolated in a deep geological repository, a system of naturally occurring and engineered barriers, in an area with informed and willing hosts. A deep geological repository is considered international best practice, and the project will benefit from the best available science and research, including Indigenous Knowledge.

As the potential for nuclear power to assist in the fight against climate change is explored globally, Canadians and Indigenous peoples can rest assured that the safe, long-term management of the country's used nuclear fuel is well in hand.

nwmo
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES