NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

April 2022

Programs around the world for managing used nuclear fuel

Canada's plan for the long-term management of used nuclear fuel calls for it to be contained and isolated in a deep geological repository. Canada's approach is consistent with best practices around the world. Most countries with commercial nuclear power production are planning to isolate the waste by-product of their nuclear fuel cycle in a deep geological repository.

Deep geological repositories use a combination of engineered and natural barriers to safely contain and isolate used nuclear fuel from people and the environment. There is a consensus among major nuclear regulatory and monitoring organizations around the world that deep geological repositories are the responsible way forward for long-term management of these materials.

A small number of countries partly recycle their used nuclear fuel in existing reactors. Some countries are planning advanced reactors that would also recycle used nuclear fuel. These fuel cycles and advanced reactors generate high-level waste, a by-product with thermal and radiological characteristics similar to used nuclear fuel. Studies conducted around the world have concluded that high-level waste from reprocessing and advanced reactors should also be contained and isolated in a deep geological repository.

CONSTRUCTION UNDERWAY	
Country	**Status**
Finland	Construction is in progress. Application for a licence to operate was submitted in 2021.

SUBMITTED A LICENSING APPLICATION TO BUILD A REPOSITORY	
Country	**Status**
Sweden	In January 2022, the Swedish government approved SKB's proposed final repository system. The next step in the licensing process is for the Swedish Land and Environment Court to establish conditions for the facilities. The Swedish Radiation Safety Authority will also decide on permit conditions under the *Nuclear Activities Act*. Only when all licences are in place can construction start, after which time it will take about 10 years to build the spent fuel repository.

SITE SELECTED	
Country	**Status**
France	The application for the construction licence is expected to be submitted in 2022. Construction is expected to take place after a regulatory examination.
Russia	Construction will occur after a period of research using an Underground Research Laboratory, which is currently under construction at the candidate site.

ACTIVE SITE SELECTION	
Country	**Status**
Canada	Two sites are under investigation, with site selection expected by 2023.
China	A site was selected to host an Underground Research Laboratory in 2019. It has strong potential to become the eventual site of the repository.
Czech Republic	Technical evaluation underway at four potential sites, construction to begin by about 2050 and in-service around 2065.
Germany	Siting criteria are being developed. The site selection process will be accompanied by extensive public participation.
Hungary	The site selection process is expected to be complete by 2032.
India	Siting activities are focused in the northwest region of Rajasthan.
Japan	The site selection process is expected to be completed by 2025, with repository operation from about 2035.
Slovakia	Two sites are undergoing detailed site investigations, which are expected to be complete in 2023.
Switzerland	Potential sites are being evaluated. Test drilling began at several potential sites in 2017. Site selection is expected in 2022. Nagra expects to submit a construction licence application by 2024.
United Kingdom	A new siting process was launched in 2018, beginning with community consultations. The initial consultation period ended in 2019, with the results integrated into Site Evaluation documents, published in early 2020, which describes the planned approaches to find a site in England and Wales. Since 2021, several community partnerships have formed to take forward discussions around siting a geological disposal facility (GDF) for high-level radioactive waste.

International Co-Operation and Research

The NWMO has co-operation agreements with our counterparts in Belgium, Finland, France, Japan, South Korea, Sweden, Switzerland, and the United Kingdom. We also have a memorandum of understanding with our counterpart in Taiwan. Partnering with other radioactive waste management organizations allows us to:

- Foster international co-operation on the development and demonstration of technology;
- Learn from other countries' experience; and
- Keep abreast of developments in repository design and safety case development for various host rock formations.

As part of our commitment to international collaboration, the NWMO is working on joint projects with other countries to bolster our knowledge and inform the design and engineering of Canada's plan. Some of these projects are underway at underground research laboratories. The NWMO has participated in experiments at the Mont Terri Laboratory and the Grimsel Test Site in Switzerland, the ONKALO facility in Finland, and the Äspö Hard Rock Laboratory in Sweden.



NWMO scientists host Taiwanese counterparts on a visit to a corrosion/electrochemistry lab at Western University.

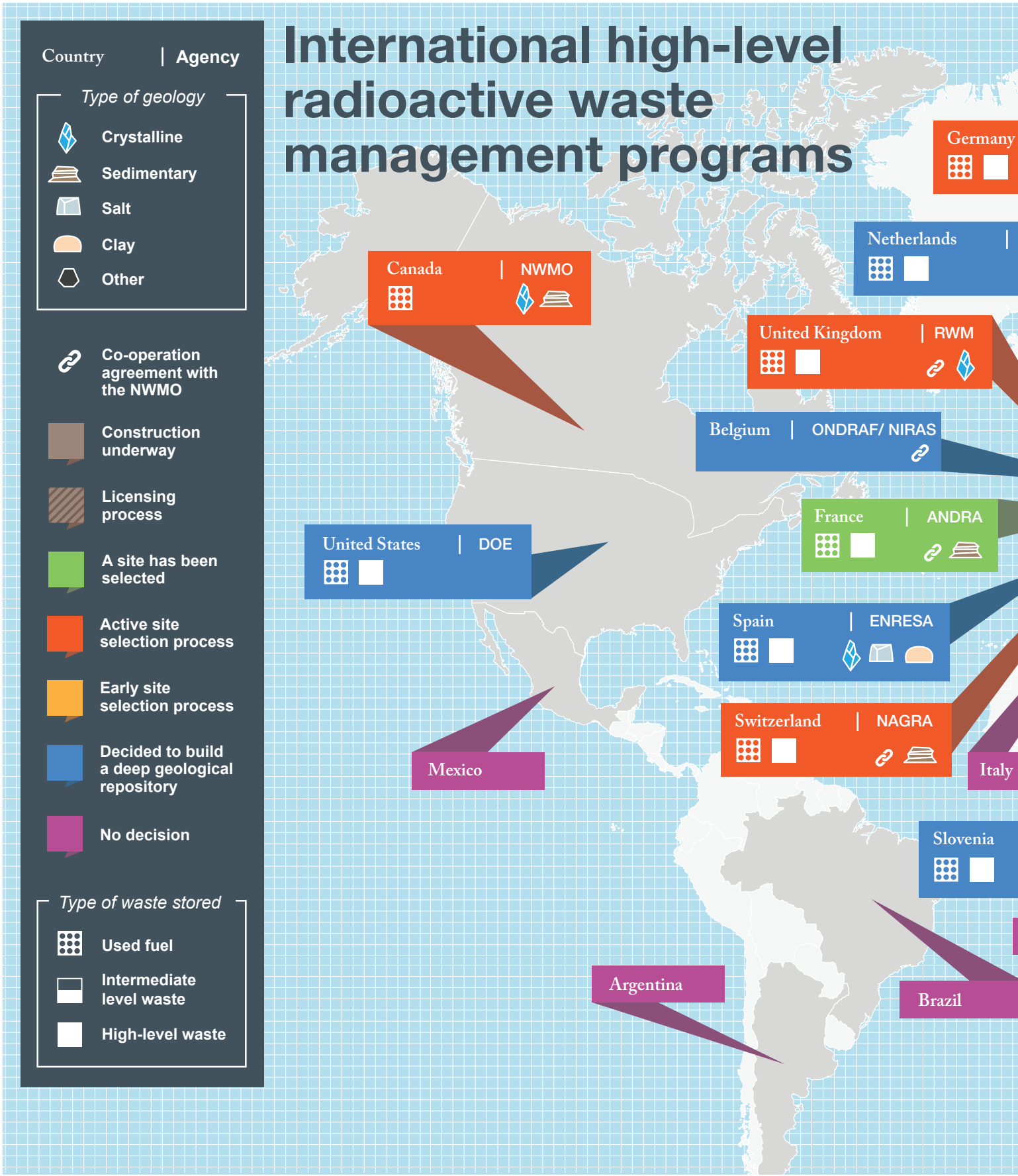


NWMO scientists travel to Finland.



The NWMO renews co-operation agreement with South Korean counterpart.

Country	Examples of international collaboration
Belgium National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)	The NWMO and ONDRAF/NIRAS are collaborating to measure extremely low rates of corrosion to verify the stability of copper and steel in a deep geological repository.
Finland Posiva	The NWMO is learning from Posiva's used fuel container and engineered barrier emplacement trials at their ONKALO Underground Rock Characterization Facility.
France French National Agency for Radioactive Waste Management (ANDRA)	The NWMO and ANDRA share learnings and research.
Japan Nuclear Waste Management Organization of Japan (NUMO)	The NWMO is collaborating with NUMO to develop copper coating for used fuel containers.
South Korea Korea Radioactive Waste Agency (KORAD)	The NWMO and KORAD have supported student exchanges.
Sweden Swedish Nuclear Fuel and Waste Management Company (SKB)	The NWMO, SKB and Posiva are working together to understand the mechanical behaviour of rock, including tests at a surface laboratory in Sweden. The NWMO, SKB, RWM and COVRA are also collaborating on a study of permafrost hydrology.
Switzerland National Cooperative for the Disposal of Radioactive Waste (NAGRA)	The NWMO is conducting joint research with NAGRA at their Mont Terri Underground Research Laboratory and Grimsel Test Site, where we test our understanding of the behaviour of engineered barriers and rock formations under deep geological conditions.
Taiwan Institute of Nuclear Energy Research (INER)	The NWMO and INER are developing areas for collaboration. This may include opportunities for its team members to work as visiting scientists at some of our partner research facilities.
United Kingdom Radioactive Waste Management (RWM)	The NWMO and the RWM share learnings. Recent cooperation has included staff from RWM working at NWMO. The NWMO, SKB and RWM are collaborating on a study of permafrost hydrology.


International high-level radioactive waste management programs
Country | Agency
Type of geology
Crystalline
Sedimentary
Salt
Clay
Other
Co-operation agreement with the NWMO
Construction underway
Licensing process
A site has been selected
Active site selection process
Early site selection process
Decided to build a deep geological repository
No decision
Type of waste stored
Used fuel
Intermediate level waste
High-level waste
Canada | NWMO
Germany
Netherlands
United Kingdom | RWM
Belgium | ONDRAF/ NIRAS
France | ANDRA
United States | DOE
Spain | ENRESA
Switzerland | NAGRA
Mexico
Italy
Slovenia
Argentina
Brazil


Sweden | SKB
Finland | Posiva
Russia | NO RAO
| BGE
Czech Republic | SÚRAO
COVRA
Slovakia | UJD SR
Hungary | PURAM
Japan | NUMO
Ukraine | SAUEZM
China | CNNC
Armenia
Iran
Romania | ANDR
Taiwan | INER
| ARAO
Bulgaria
Pakistan
South Korea | KORAD
India | AEC
Croatia
South Africa | NRWDI
Australia

International high-level radioactive waste management programs

Country	Name of organization	What have they decided for their long-term management?
Argentina	Comisión Nacional de Energía Atómica (CNEA)	No decision (decision must be taken by 2030 under Law No. 25018)
Armenia		No decision
Belgium	National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/ NIRAS)	No decision
Brazil	Brazilian Nuclear Energy Commission (CNEN)	No decision
Bulgaria	State Enterprise Radioactive Wastes (SE RAW)	No decision
Canada	Nuclear Waste Management Organization (NWMO)	Deep geological repository for used nuclear fuel
China	China National Nuclear Corporation (CNNC)	Deep geological repository for used nuclear fuel and high-level waste
Croatia		Deep geological repository for used nuclear fuel
Czech Republic	Radioactive Waste Repository Authority (SÚRAO)	Deep geological repository for used nuclear fuel and high-level waste
Finland	Posiva	Deep geological repository for used nuclear fuel
France	French National Agency for Radioactive Waste Management (ANDRA)	Deep geological repository for used nuclear fuel and high-level waste
Germany	Bundesgesellschaft für Endlagerung (BGE)	Deep geological repository for used nuclear fuel and high-level waste
Hungary	Public Limited Company for Radioactive Waste Management (PURAM)	Deep geological repository for used nuclear fuel and high-level waste
India	India Atomic Energy Commission (AEC)	Deep geological repository for high-level waste
Iran	Iran Nuclear Waste Management Company (INWM)	No decision
Italy	Società Gestione Impianti Nucleari (SOGIN)	Deep geological repository for intermediate-level and high-level waste
Japan	Nuclear Waste Management Organization of Japan (NUMO)	Deep geological repository for high-level waste
Mexico		No decision

Where are they currently in the process	Type of geology?	Co-operation agreement
Geological R&D underway to identify potential sites for DGR for either HLW or used fuel	To be determined	
R&D to support a safety case for a deep geological repository for used fuel and/or HLW underway	Focus is on clay (Other geologies studied to a lesser degree)	Yes
Active site selection process	Crystalline and sedimentary	
Active site selection process. URL under construction at potential site	Crystalline	
Site selection to begin approximately 2050 to find a site in Croatia or Slovenia (joint ownership of fuel)	To be determined	
Active site selection process. Technical evaluation underway at four potential sites, in-service planned for 2065	Crystalline	
Construction underway. Application for a licence to operate was submitted in 2021	Crystalline	Yes
Construction licence application expected to be submitted in 2022	Sedimentary	Yes
Active site selection process	Crystalline, sedimentary and salt	
Active site selection process	Clay	
Active site selection process	Crystalline, sedimentary and basalt	
Early site selection process	To be determined	
Active site selection process	Crystalline and sedimentary	Yes

Country	Name of organization	What have they decided for their long-term management?
Netherlands	Central Organisation for Radioactive Waste (COVRA)	Deep geological repository for used nuclear fuel and high-level waste
Pakistan	Pakistan Atomic Energy Commission (PAEC)	No decision
Romania	Nuclear and Radioactive Waste Agency (ANDR)	Deep geological repository for used nuclear fuel and high-level waste
Russia	National Operator For Radioactive Waste Management (NO RAO)	Deep geological repository for high-level waste
Slovakia	Jadrova a vyradovacia spolocnost, a. s. (JAVYS) - Nuclear and Decommissioning Company	Deep geological repository for used nuclear fuel and high-level waste
Slovenia	Agency for Radwaste Management (ARAO)	Deep geological repository for used nuclear fuel and high-level waste
South Africa	National Radioactive Waste Disposal Institute (NRWDI)	Deep geological repository for used nuclear fuel and high-level waste
South Korea	Korea Radioactive Waste Agency (KORAD)	Deep geological repository for used nuclear fuel and high-level waste
Spain	National Company of Radioactive Waste (ENRESA)	Deep geological repository for used nuclear fuel and high-level waste
Sweden	Swedish Nuclear Fuel and Waste Management Company (SKB)	Deep geological repository for used nuclear fuel
Switzerland	National Cooperative for the Disposal of Radioactive Waste (NAGRA)	Deep geological repository for used nuclear fuel and high-level waste
Taiwan	Institute of Nuclear Energy Research (INER)	Deep geological repository for used nuclear fuel
Ukraine	State Agency of Ukraine on Exclusion Zone Management (SAUEZM)	Deep geological repository for high and intermediate level waste
United Kingdom	Radioactive Waste Management Limited (RWM)	Deep geological repository for used nuclear fuel and high-level waste
United States	Department of Energy (DOE)	Deep geological repository for used nuclear fuel and high-level waste

Where are they currently in the process	Type of geology?	Co-operation agreement
Decided to build a deep geological repository	Salt and clay	
Early site selection process	Salt, clay, crystalline and green schists	
Site Selected. URL under construction	Crystalline	
Active site selection process	Crystalline and sedimentary	
Site selection to begin approximately 2050 to find a site in Croatia or Slovenia (joint ownership of fuel)	To be determined	
Decided to build a deep geological repository	To be determined	
Decided to build a deep geological repository	To be determined	Yes
Decided to build a deep geological repository	Crystalline, clay and salt	
Submitted a licensing application to build a repository	Crystalline	Yes
Active site selection process	Clay	Yes
Early site selection process	Crystalline	
Decided to build a deep geological repository	Crystalline, clay and salt	
Active site selection process	Crystalline, sedimentary and salt	Yes
Decided to build a deep geological repository	To be determined	

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