




Status of National Used Fuel/ High-Level Radioactive Waste Management Programs


Many countries are developing plans for, or are proceeding with, programs for the long-term management of used nuclear fuel or high-level radioactive waste. Several countries have advanced programs regarding the siting of long-term management facilities.





	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>Canada</p> <p>WASTE AGENCY: NWMO</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 20</p> <p>% NUCLEAR ELECTRICITY: 16</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline & sedimentary</p>	<ul style="list-style-type: none"> » Technical research to support development of the siting process and to refine technology for long-term used fuel management » Social research program on best practices for citizen engagement, community impacts and dialogue » Co-operation agreements with national radioactive waste management organizations: SKB (Sweden), Posiva (Finland), Nagra (Switzerland) and Andra (France) » Active participant with international research organizations: Nuclear Energy Agency (NEA) and International Atomic Energy Agency (IAEA) 	<ul style="list-style-type: none"> » Collaboratively developed a process to select a site with interested individuals and organizations under Adaptive Phased Management in 2008 and 2009 » Siting proposal developed in 2009 and siting initiated in 2010 » Initial screening, then feasibility studies in potential candidate areas followed by more detailed studies in potential host communities » Selection of a preferred site for a deep geological repository (DGR) followed by an Environmental Assessment and licensing approval process 	<ul style="list-style-type: none"> » Earliest possible date for deep geological repository (DGR) operation is likely in the late 2030s » Currently, for conservative cost estimating purposes, the assumed date for DGR operation is 2035


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<p>China</p> <p>WASTE AGENCY: CNNC</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 11 (28 under construction)</p> <p>% NUCLEAR ELECTRICITY: 2.3</p> <p>NATIONAL DECISION FOR USED FUEL/HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline</p>	<p>» China National Nuclear Corporation (CNNC) developing transportation and repository technology for used CANDU fuel and high-level waste from reprocessing used Light Water Reactor fuel</p>	<p>» Siting process started in 1985</p> <p>» Preliminary site characterization activities at a potential site (Beishan region, Gansu province in the Gobi desert in northwest China) for a site-specific Underground Research Laboratory (URL) and future geological repository</p> <p>» Site drilling program began in 2000</p> <p>» Siting program consists of 3 phases:</p> <ul style="list-style-type: none"> » Phase 1: Basic Study and Site Selection (2009-2020) » Phase 2: In-Situ research and development in URL (2020-2040) » Phase 3: Repository Construction (2040-2050) 	<p>» Deep geological repository (DGR) operation by 2050</p>


	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>Finland</p> <p>WASTE AGENCY: Posiva</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 4</p> <p>% NUCLEAR ELECTRICITY: 25</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline</p>	<ul style="list-style-type: none"> » Joint research and development program with SKB (Sweden) and other national organizations including NWMO (Canada) » Demonstration of underground technology at Äspö Hard Rock Laboratory in Sweden » Development and demonstration of copper used fuel containers » Construction of ONKALO underground characterization facility started in 2004 and will end in 2011 » Confirming site suitability at Olkiluoto 	<ul style="list-style-type: none"> » Siting process started in 1980s » Site identification from 1983 to 1985 » Preliminary site characterization and feasibility studies at 5 potential sites from 1986 to 1992 » Detailed site characterization and feasibility studies at 2 nuclear sites (Olkiluoto and Loviisa) from 1993 to 2000 » Posiva proposed Olkiluoto site in 1999 » Host municipality approved Olkiluoto site in January 2000 » Finnish government approved siting decision-in-principle in December 2000 » Finnish parliament ratified siting decision-in-principle in May 2001 	<ul style="list-style-type: none"> » Deep geological repository (DGR) construction licence application by 2012 » DGR operation by 2020


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<p>France</p> <p>WASTE AGENCY: Andra</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 59</p> <p>% NUCLEAR ELECTRICITY: 78</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: sedimentary</p>	<ul style="list-style-type: none"> » Research and development program driven by national legislation in 2001 » Crystalline studies based on foreign Underground Research Laboratories (URLs) (e.g. Canada, Sweden) » Sedimentary studies at Bure URL » Study reports and recommendation submitted in 2006 » National law of 2006 gives research and development direction and schedules » Reprocessing of most used fuel – capacity is about 1,700 t HM/year » Assessment of industrial feasibility of partitioning and transmutation by 2012 » Transmutation pilot facility by 2020 	<ul style="list-style-type: none"> » Planned to develop Underground Research Laboratories (URLs) in crystalline rock and sedimentary rock starting 1991 » Sited Bure URL in sedimentary rock in 1994 » Law of 2006 requires final repository to be located in same host rock formation as the URL (thus in sedimentary rock near Bure URL) » Siting studies near Bure region started in 2007 » Final site selection for a reversible geological repository by 2015 	<ul style="list-style-type: none"> » Reversibility issue subject to national debate by 2012 » Application for deep geological repository (DGR) construction licence for high-level waste, used fuel and long-lived intermediate-level waste by 2015 » DGR operation by 2025


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<p>Germany</p> <p>WASTE AGENCY: BfS</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 17</p> <p>% NUCLEAR ELECTRICITY: 33</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: salt, crystalline & sedimentary</p>	<ul style="list-style-type: none"> » Research on salt for a deep geological repository (DGR) started in 1967 at the Asse mine » Federal Office for Radiation Protection (BfS) conducting research for used fuel and high-level waste management » Co-operative research with other national radioactive waste management organizations 	<ul style="list-style-type: none"> » Siting process started in 1973 » Gorleben salt dome selected for national repository for radioactive waste in 1977 » Site investigations at Gorleben stopped in 2000 » AkEnd Committee issued technical siting process recommendation in 2002 » At least 2 sites required for underground exploration 	<ul style="list-style-type: none"> » Deep geological repository (DGR) operation to be determined


	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>India</p> <p>WASTE AGENCY: AEC</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 17</p> <p>% NUCLEAR ELECTRICITY: 2.6</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline</p>	<p>» Atomic Energy Commission (AEC) conducts research on repository development and siting at Bhabha Atomic Research Centre (BARC)</p>	<p>» Siting based on technical process to identify repository site in stages</p> <p>» Focus of siting activities in northwest Rajasthan region</p>	<p>» Not known</p>

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>Japan</p> <p>WASTE AGENCY: NUMO</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 55</p> <p>% NUCLEAR ELECTRICITY: 30</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline & sedimentary</p>	<ul style="list-style-type: none"> » Japan Atomic Energy Commission (AEC) decided on a geological repository for high-level waste in 1976 » Research and development conducted by various organizations: PNC, JNC, JAEA, etc. » Developing Underground Research Laboratories (URLs) in both crystalline rock (Mizunami) and sedimentary rock (Horonobe) 	<ul style="list-style-type: none"> » In 2000, Law on Final Disposal of Specified Radioactive Waste requires geological repository for high-level waste from reprocessing » NUMO siting process started in 2002 » Open solicitation for candidate sites sent to all municipalities » Siting process based on volunteerism envisions selection of Preliminary Investigation Areas (PIAs), followed by selection of Detailed Investigation Areas (DIA) at candidate sites for underground studies and analyses » Toyo town in Kochi prefecture applied as a volunteer area for feasibility studies in January 2007 » Following a municipal election, Toyo town withdrew its application in April 2007 » Japanese siting process is evolving 	<ul style="list-style-type: none"> » Deep geological repository (DGR) operation by 2040

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<p>Sweden</p> <p>WASTE AGENCY: SKB</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 10</p> <p>% NUCLEAR ELECTRICITY: 50</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline</p>	<ul style="list-style-type: none"> » Joint research and development program with Posiva (Finland) and other national organizations including NWMO (Canada) » Demonstration of underground technology at Äspö Hard Rock Laboratory in Sweden » Development and demonstration of copper used fuel containers 	<ul style="list-style-type: none"> » Siting process started in early 1990s » Feasibility studies in 8 municipalities » Local referenda held in Storuman (1995) and Mala (1997) » Further evaluation of potential host communities » Detailed underground evaluation of 2 potential candidate sites in Östhammar and Oskarshamn from 2002 to 2008 » SKB selected the Forsmark site in Östhammar in June 2009 	<ul style="list-style-type: none"> » Deep geological repository (DGR) construction licence application in 2011 » DGR operation by 2025

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>Switzerland</p> <p>WASTE AGENCY: Nagra</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 5</p> <p>% NUCLEAR ELECTRICITY: 40</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: sedimentary</p>	<ul style="list-style-type: none"> » Nagra has been conducting research on developing a deep geological repository (DGR) for used fuel and high-level waste since 1972 » Research and development program examined DGR feasibility in crystalline rock (e.g. Grimsel Underground Research Laboratory) and sedimentary rock (e.g. Mont Terri Underground Research Laboratory) » Co-operative research with other national radioactive waste management organizations » Research and development focus on sedimentary rock 	<ul style="list-style-type: none"> » Siting process started in 1972 » Initial siting focus was on crystalline rock (Project Gewähr, 1985); only 2 potential candidate areas were identified » Recently, siting focus has been on sedimentary rock (Project Opalinus Clay, 2002) » Zürcher Weinland has been identified as a potential siting region for a deep geological repository (DGR) » In 2005, Swiss government issued the <i>Nuclear Energy Act</i> and requested Nagra to identify other alternative siting regions » In 2007, Swiss Federal Office of Energy issued draft Sectoral Plan for Geological Repositories for public review » In 2008, Swiss Federal Council approved the strategic part of the Sectoral Plan for Geological Repositories. Potential sites are being evaluated in a step-wise process. 	<ul style="list-style-type: none"> » Deep geological repository (DGR) operation by 2040

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>United Kingdom</p> <p>WASTE AGENCY: NDA</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 19</p> <p>% NUCLEAR ELECTRICITY: 20</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: crystalline</p>	<ul style="list-style-type: none"> » Nuclear Decommissioning Authority (NDA) responsible for research and development program, previously conducted by NIREX (Nuclear Industry Radioactive Waste Executive) » Co-operative research with other national radioactive waste management organizations » Committee on Radioactive Waste Management (CoRWM) issued recommendation for phased deep geological disposal in 2006 » Conducting a Managing Radioactive Waste Safely (MRWS) programme 	<ul style="list-style-type: none"> » Siting process started in 1979 and terminated in 1981 » In 2007, Nuclear Decommissioning Authority (NDA) established the Radioactive Waste Management Directorate (RWMD) to devise a geological disposal solution for high-level waste » In 2007, Department of Environment, Food and Rural Affairs (Defra) issued framework document for implementing geological disposal for broad public consultation and dialogue. Siting a geological repository will be based on a voluntarism and partnership approach » In June 2008, UK government invited communities for “no commitment” discussions on hosting a deep geological repository (DGR) » Implementing the siting process will include: <ul style="list-style-type: none"> » Preparatory studies » Surface-based investigations » Borehole drilling » Site selection » Regulatory review and approval » Construction » Operation » Closure » In 2010, several communities have expressed interest in learning more about hosting a DGR 	<ul style="list-style-type: none"> » Deep geological repository (DGR) operation by 2040

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
<p>United States of America</p> <p>WASTE AGENCY: DOE</p> <p>OPERATIONAL NUCLEAR POWER PLANTS: 104</p> <p>% NUCLEAR ELECTRICITY: 19</p> <p>NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT: geological repository</p> <p>POTENTIAL ROCK TYPE(S) FOR REPOSITORY: volcanic tuff & other</p>	<ul style="list-style-type: none"> » Department of Energy (DOE) disposal research and development focused on deep geological repository (DGR) designs and site characterization activities in unsaturated volcanic tuff at Yucca Mountain, Nevada » Reprocessing used fuel ended in 1977 (civilian) and 1992 (defence) 	<ul style="list-style-type: none"> » National screening of 9 candidate sites reduced to 3 sites from 1983 to 1986 » Congress directed Department of Energy (DOE) to study only 1 site, Yucca Mountain, in 1987 » Yucca Mountain is located near US nuclear weapons test site in Nevada, about 160 km north of Las Vegas » Secretary of Energy recommended Yucca Mountain to the President in 2002 » Governor of Nevada submitted notice of disapproval in 2002 – overridden by Congress » President approved Yucca Mountain site in 2002 – State of Nevada have strongly opposed Yucca Mountain Project » In June 2008, DOE submitted deep geological repository (DGR) licence application to Nuclear Regulatory Commission (NRC) » In February 2009, the US administration indicated that Yucca Mountain is no longer an option – Blue Ribbon Commission on US nuclear future formed to provide recommendations for developing a safe, long-term method to manage nuclear waste 	<ul style="list-style-type: none"> » To be determined

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