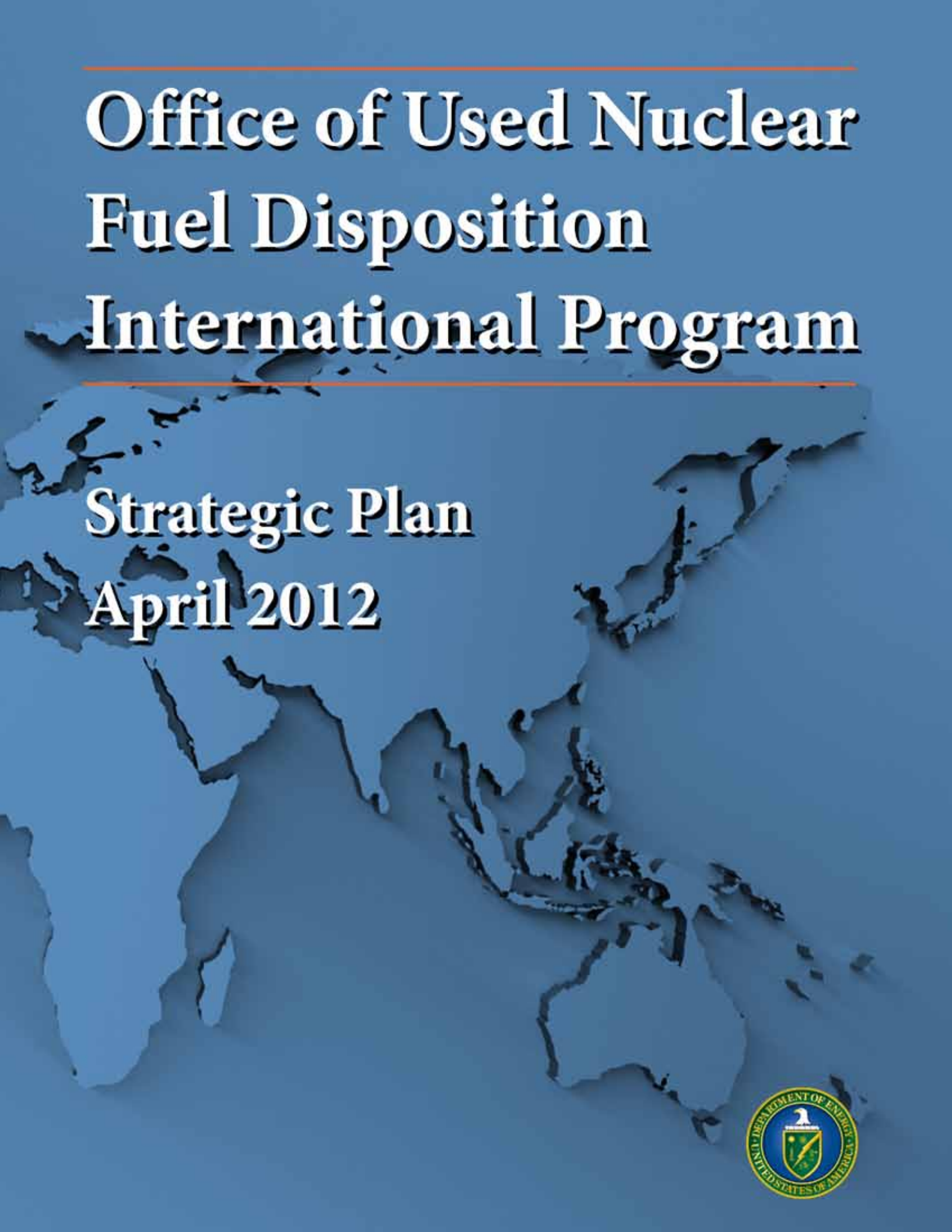
Office of Used Nuclear Fuel Disposition International Program

Strategic Plan
April 2012



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FOREWORD

Message from the Deputy Assistant Secretary for Fuel Cycle Technologies

The proper disposition of used nuclear fuel is a key component of a safe and secure nuclear fuel cycle. The Blue Ribbon Commission on America's Nuclear Future was formed to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle, followed by evaluating alternatives and providing our nation's policymakers with recommendations for a new plan. In its January 2012 report, the Commission emphasized the need for "an integrated strategy that combines safe storage of spent nuclear fuel with expeditious progress toward siting and licensing a disposal facility or facilities."

The Department of Energy's Office of Nuclear Energy, Used Nuclear Fuel Disposition Research and Development Office (UFD), performs the critical mission of addressing this need for an integrated strategy. The UFD International Program plays a key role in the approach presented in this plan. International collaboration provides a forum for exchanging strategies, expertise, and technologies with other nations that have already been investigating other solutions to the problems of nuclear waste disposal—information that otherwise would have to be recreated domestically, entailing years of effort and substantial costs. Joint sponsorship of research, development and demonstration activities adds to the world's evolving used nuclear fuel and high-level waste practices.

The UFD International Program and the Office of Nuclear Energy's Office of International Nuclear Energy Policy and Cooperation work together and in conjunction with other Department offices and federal agencies in the coordination, development, and implementation of formal agreements with other nations that enable the acquisition and exchange of detailed scientific and technical information.

Benefits from the UFD International Program accrue to both the United States and its international partners. Working with other countries optimizes limited resources by integrating related and complementary knowledge developed by researchers around the world. The program advances global scientific understanding, leading to advanced techniques for high-level waste disposal, enhanced environmental protection, and improved nuclear security worldwide.

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Acronyms

AIT/TECRO	American Institute in Taiwan/Taipei Economic and Cultural Representative Office
DECOVALEX	Development of Coupled Models and Their Validation Against Experiments
DOE	Department of Energy
EDRAM	International Association for Environmentally Safe Disposal of Radioactive Materials
HLW	High-Level Waste
IAEA	International Atomic Energy Agency
IFNEC	International Framework for Nuclear Energy Cooperation
INEC	International Nuclear Energy Cooperation
JNEAP	U.S.–Japan Nuclear Energy Action Plan
JSCNEC	Joint Standing Committee on Nuclear Energy Cooperation
NE	Office of Nuclear Energy
NEA	Nuclear Energy Agency
OECD	Organization for Economic Cooperation and Development
PUNT	U.S.–China Peaceful Uses of Nuclear Technology
R&D	Research and Development
SNF	Spent Nuclear Fuel
UFD	Office of Used Nuclear Fuel Disposition Research and Development
UNF	Used Nuclear Fuel
URL	Underground Research Laboratory

1. Introduction

The Department of Energy (DOE) is responsible for the disposition[1] of used nuclear fuel (UNF) and high-level waste (HLW) resulting from commercial- and defense-related activities. This strategic plan explains the role of the International Program within the Office of Nuclear Energy (NE), Office of Used Nuclear Fuel Disposition Research and Development (UFD), in addressing this responsibility.

The Obama Administration has stated the importance of global cooperative efforts to achieve energy and security goals. Reiterating this imperative, the May 2011 DOE *Strategic Plan* calls for international partnerships to advance common goals for developing and deploying clean energy technologies and addressing climate change, energy security, and energy scarcity. To this end, NE's Office of International Nuclear Energy Policy and Cooperation serves as the overall lead in strategically integrating international activities to support NE goals.

In a parallel effort, the UFD International Program is charged with capitalizing on the considerable global knowledge base and research and development (R&D) efforts to tackle the unique technical challenges posed by UNF and HLW management. Many other nations have conducted substantial research into geologic disposal of these materials, applying a variety of approaches with different geologic media. Effectively utilizing this extensive knowledge can augment the effort to research alternatives to the volcanic tuff at Yucca Mountain, which had been the primary focus of domestic R&D.

Effective participation in multinational R&D activities entails navigating today's complex global landscape, as well as the coordination of diverse agencies, both international and domestic. In order to achieve its goals, the UFD and its International Program must employ informed strategies that are aligned with the overarching goals of NE and DOE.

This plan articulates how the UFD International Program will act to work effectively amidst complex challenges and opportunities. The document also summarizes what activities the program pursues and why those activities have been chosen, thereby explaining the direction that the U.S. program—working in concert with international partners—will take.

[1] Throughout this document, disposition refers generally to the handling of products from the back end of the fuel cycle. Storage is discussed in the context of a temporary interim (intermediate-term or long-term) solution. Disposal refers to permanent disposition, such as burial in a geologic repository. Used nuclear fuel (UNF), the currently accepted terminology used throughout this document, is equivalent to spent nuclear fuel (SNF) with the additional connotation that the material retains some useful purpose.

2. Challenges and Opportunities

Challenges

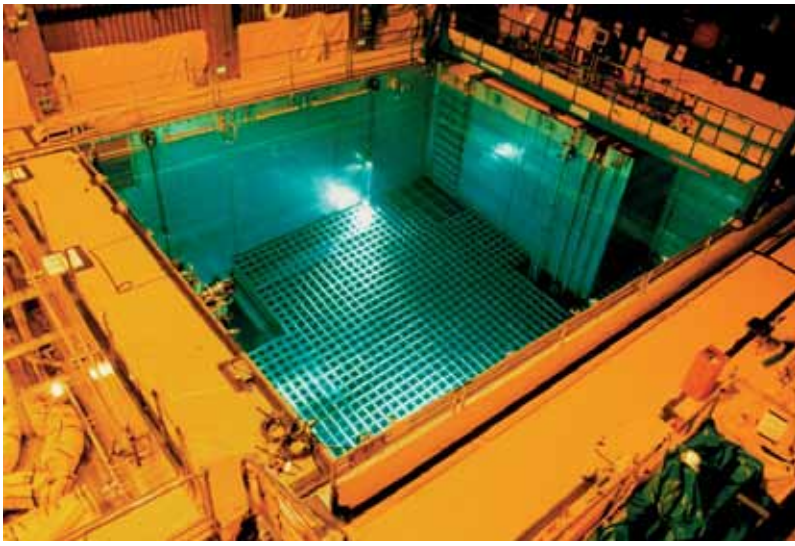
UNF and HLW disposition is an increasingly important issue. Clean energy demands are driving a nuclear renaissance, which in turn will accelerate the rate at which used fuel is produced. Storing used fuel at geographically distributed utility sites, while viable for at least the next several decades, is not a permanent solution.

NE raises these issues in the April 2010 *Nuclear Energy Research and Development Roadmap* in Objective 3, the development of sustainable nuclear fuel cycles, and Objective 4, understanding and minimizing risks of nuclear proliferation and terrorism. These objectives, in turn, support DOE goals stipulated in the May 2011 *Strategic Plan*: supporting responsible civilian nuclear power development and fuel cycle management and enhancing nuclear security through nonproliferation and environmental efforts. The NE R&D roadmap notes that making informed decisions about UNF and HLW management is one of the key challenges to developing sustainable fuel cycles. The document also speaks to the importance of building safeguards into nuclear systems and fuel cycles, as well as maintaining and strengthening non-proliferation frameworks and protocols. UNF and HLW disposition are directly linked to two of the four primary challenges, as stipulated in the roadmap, to achieving DOE goals:

- There is currently no integrated and permanent solution to HLW management.
- International expansion of the use of nuclear energy raises concerns about proliferation.

Thus, DOE supports relevant R&D with both near- and long-term objectives. While research into alternative methods is ultimately expected to result in a permanent solution for disposition of UNF and HLW generated by existing and future nuclear fuel cycles, next-generation methods yet to be developed do not address the immediate concerns such as those noted above (e.g., mounting quantities of waste stored at reactor sites and

Until a permanent repository is available, UNF continues to be stored in dry casks and spent fuel pools at geographically distributed utility sites.



UNF is delivered to the centralized interim storage facility in Würenlingen, Switzerland (above), in large storage containers (below). | ***Photos courtesy of Comet Photoshopping, Nagra***

a new global nuclear climate). In its January 2012 report, the Blue Ribbon Commission notes that existing and near-term technologies will not suffice—and long-term technology developments will not be timely enough—to avert "the underlying need for an integrated strategy that combines safe storage of SNF with expeditious progress toward siting and licensing a disposal facility or facilities."[2] Simultaneous with investigations into alternative approaches for disposition, therefore, DOE also supports near-term R&D related to transportation, processing and long-term storage of UNF and HLW.

The United States does not face these challenges alone. As noted above, UNF disposition is by its very nature an international issue. One country's fuel disposition issues are not entirely separate from those of another country, and the consequences of events at a nuclear power plant are not necessarily constrained by national boundaries. In addition, improperly secured spent fuel from one country could be diverted for unintended uses to an entirely different region of the globe.

The safety, security, and environmental protection dimensions of a successful UNF disposition program cannot be addressed independently of a global basis. To that end, no single nation encompasses the complete breadth of scientific understanding, technical depth, experience, and diverse other resources needed to best address the complex scientific, engineering, and sociopolitical issues involved in managing UNF and HLW.

[2] Blue Ribbon Commission on America's Nuclear Future. *Report to the Secretary of Energy*, January 2012: page 100. Note: The Blue Ribbon Commission was established by the Obama Administration in accordance with the President's Memorandum for the Secretary of Energy dated January 29, 2010. The 15-member Commission completed a comprehensive review of policies for managing the back end of the nuclear fuel cycle and issued recommendations in their report.

Opportunities

DOE and affiliated U.S. researchers have an unparalleled opportunity to share knowledge, identify best practices, and develop technical solutions with international counterparts. A global wealth of experience and expertise already exists and grows continually. Many other nations are also testing and implementing approaches to UNF disposition and pursuing R&D on key technical issues. Countries are now researching a variety of different engineering approaches, generating knowledge that could be leveraged within the U.S. program.

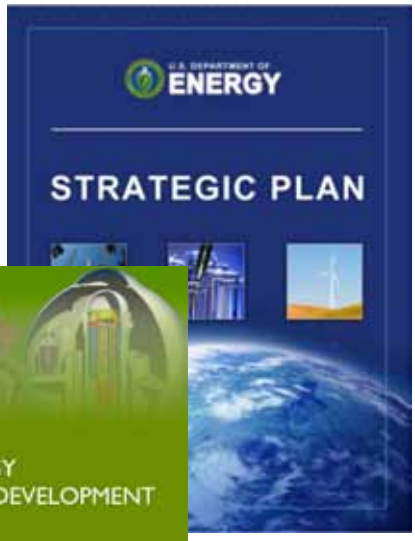
Each country's efforts are shaped by the legal, environmental, and technical requirements governing nuclear waste in that country—a diversity of requirements that, while complex, offers an expanded wealth of potential R&D opportunities. The UFD International Program must track individualized country-specific approaches, examining them within the context of local requirements and determining applicability to national and global efforts. Carefully investigating and coordinating participation in the international arena will facilitate information sharing and ensure that the UFD program benefits from country-specific bodies of experience. The variety of viewpoints, priorities, and experience leads to comprehensive and synergetic findings.

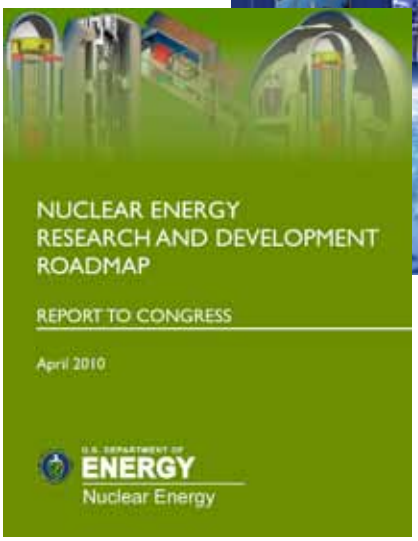
By remaining abreast of international activities and coordinating with foreign counterparts, DOE not only avoids wasting scarce resources on redundant efforts, but also leverages global resources to consolidate findings and accelerate learning. Sharing information supports mutual awareness and understanding and averts duplication of efforts, supporting cost and schedule efficiency.

Sweden's centralized interim storage facility for UNF has been in operation since 1985. The underground portion (illustrated below) comprises two rock caverns with eight storage pools.

Collaboration also provides opportunities for cost and schedule reductions through cost sharing, simultaneous with a multifaceted research approach that provides the benefits of diverse vantage points, expertise, and experience. International collaboration has already enabled the acquisition and exchange of much valuable information, particularly related to complex activities such as performance assessment, nuclear database development, and multilateral expert peer reviews.

While the United States will benefit from the experience of those countries with mature nuclear systems, assisting emerging nuclear states is also essential to a safe and secure nuclear community. As noted above, not all risks are generated domestically. While there is truly an international wealth of capability, not all enabling ingredients for progress are distributed evenly across nations. This disparity highlights the need to share technology internationally to prevent countries from adopting solutions and practices that involve undue and unnecessary risks. The UFD International Program monitors developing nuclear countries' activities and involves their scientists in sharing knowledge.





The UFD International Program addresses issues raised in the DOE 2011 *Strategic Plan* and the NE 2010 R&D roadmap.

Nuclear plant safety and minimized proliferation risk are also bolstered by consensus on certain nuclear fuel and waste management policies and procedures, and potentially through provision of full fuel cycle services to other countries. As noted in the DOE 2011 *Strategic Plan*, the Obama Administration has called for a new framework for international nuclear energy cooperation to reduce incentives for countries to pursue their own fuel cycle facilities. Establishing the foundation for shared protocols—or more extensive multilateral endeavors (e.g., international fuel banks and storage facilities)—necessitates extensive international awareness and coordination. By developing productive partnerships in a global nuclear community—a community of conscientious stewards working together to provide, as best they can, security for themselves and others—the UFD International Program supports the Department's goal of responsible UNF disposition.

3. An International Approach to Used Fuel Disposition

The challenge of managing UNF and nuclear waste demands a focused institutional response, which NE has provided by establishing the UFD. This office is responsible for leading DOE's efforts in this area, including managing R&D efforts and coordinating the Department's interaction with other stakeholders, both domestic and foreign.

The UFD is responsible to a multiplicity of domestic and foreign stakeholders.

The UFD International Program plays a crucial role in attaining UFD goals. For any organization to act strategically, it must consider and adapt to both internal and external conditions. With full awareness of the state of worldwide UNF and HLW disposition technologies, the UFD International Program clarifies the issues—both technical and sociopolitical—and provides the foundation to address those issues through mutual cooperation. The **mission** of the UFD International Program is to foster international cooperation on UNF and HLW disposition leading to an optimized national system and to promote the exchange of institutional and technical knowledge with the international community. Doing so will help accomplish the ultimate **vision** of ensuring that safe, secure, and environmentally responsible UNF and HLW disposition is available both domestically and internationally.

The NE 2010 roadmap emphasizes the advantages of international coordination across all R&D areas: "There is potential to leverage and amplify effective U.S. R&D through collaboration with other nations via multilateral and bilateral agreements.... In addition to these R&D activities, international interaction supported by NE and other government agencies will be essential in establishment of international norms and control regimes to address and mitigate proliferation concerns." The Office of International Nuclear Energy Policy and Cooperation was established to capitalize on these opportunities and serves as the overall lead

for implementing the Department's International Nuclear Energy Cooperation (INEC) program.[3] The UFD International Program works closely with this office, along with other NE offices and federal agencies, to maximize their contributions to UFD program objectives. The UFD International Program is accountable to the R&D agendas set by NE and seeks to meet the challenges set forth in the roadmap.

As part of the UFD, the International Program is responsible not only to other NE offices but also to a variety of domestic stakeholders who will be affected by program outcomes. Local, state, and regional governments, Native Americans, Congress, public interest groups, and other coalitions and non-governmental organizations attentively track the progress of nuclear waste disposal issues and solutions. Nuclear plant owners are included on the list of interested parties.

The program's activities will affect the global nuclear community as well. Countries with mature nuclear systems and those with developing ones will profit from both joint research activities and shared security measures. Possible provision of full fuel cycle services to new members of the nuclear community would involve the international counterparts of the domestic stakeholders listed above. In the management and disposition of UNF and HLW, health and safety issues are a consideration for stakeholders across the globe.

[3] INEC serves to consolidate and integrate NE international activities by 1) effectively coordinating international cooperative R&D activities that further NE's mission, 2) leading international nuclear energy collaboration efforts through bilateral and multilateral forums, and 3) providing advice and support to other DOE offices and federal agencies that are pursuing new agreements or commitments related to civilian nuclear energy.

4. Strategic Goals

The UFD International Program aims to focus its efforts and allocate resources among initiatives intended to achieve four main goals. The goals address making use of global knowledge to meet domestic goals, increasing technology deployment, building an effective foundation for achieving the benefits of collaboration, and accelerating learning. Collectively, the goals represent how the UFD International Program intends to respond to domestic and international realities and provide a framework for action.

UFD International Program Mission and Vision

- **Program Mission:** To foster international cooperation on UNF and HLW disposition leading to an optimized national system and to promote the exchange of institutional and technical knowledge with the international community.
- **Program Vision:** To ensure safe, secure, and environmentally responsible UNF and HLW disposition is available both domestically and internationally.

- **Leverage global knowledge to meet domestic goals:** Just as each country makes a unique contribution to the shared fund of knowledge and experience in UNF and HLW disposition, so each partner will experience different benefits from collaboration. The United States faces its own challenges in achieving safe and secure UNF disposition. To meet these challenges, the United States must coordinate with countries that have mature nuclear systems, effectively leveraging global advancements, knowledge, experience and resources to find near-term solutions in a cost-effective manner. Integrated activities will expand the technical depth of domestic programs, maximize resource utilization, and optimize the national system for disposition. The UFD International Program is best positioned to capitalize on the synergies and efficiencies of international collaboration in order to expedite cost-effective solutions to the technical challenges posed by the back end of the fuel cycle.
- **Increase global deployment of advanced technology:** Technical advancements are essential to affordable and safe UNF and HLW disposition. In a world where nations possess diverse capability, technology, and resources, the nuclear community must work together toward increased accessibility and deployment of advanced technology. Especially given the security and environmental hazards posed by unsecured UNF, it is essential to mitigate disparity among nations and ensure that global learning and innovation are effectively leveraged to address UNF problems and needs at a global level. The UFD International Program coordinates with countries that have developing nuclear systems to promote responsible waste management practices and, when appropriate, shared protocols to support a safe and secure global nuclear community. The program stands to facilitate progress towards advanced technology deployment in every partner country, as well as in the United States.
- **Build a foundation for collaboration, trust, and joint action:** The world is rapidly becoming more of a global community. Recent developments in the Middle East and in global economic networks have shown the increasing interconnection between seemingly separate political and economic systems. Beyond human systems, natural disasters and patterns of resource scarcity

create impacts that are unconfined by national borders—as are modern concerns regarding energy needs, climate change, and nuclear safety and nonproliferation. Given the increasingly international character of the nuclear community, it is essential that countries with the capabilities and expertise to develop nuclear energy systems work collaboratively towards increased knowledge sharing and consensus. Collaborative work builds a foundation for increased trust and cooperation, which in turn supports a shared understanding of opportunities, priorities, risks, challenges, and solutions. With this solid platform as a foundation, each partner is best able to effectively advance technology solutions and implement shared protocols.

- **Accelerate global learning and innovation:** Coordination of global research and learning efforts enhances and expedites technical advancements. Integrated efforts maximize resource utilization, avoid costly duplication of efforts, and support communication among researchers. Effective information sharing accelerates worldwide innovation and technology advancement. The UFD International Program capitalizes on collaborative synergy and expedited learning to help pioneer new methods of managing the back end of the fuel cycle.

The four strategic goals comprise a response to world conditions and an integrated approach towards achieving the UFD International Program's mission and vision. Essentially, these four goals provide a rationale for the program actions discussed in the next section, all of which are directed at achieving one or more of these strategic goals.

Scientists across the globe are investigating the fuel cycle and waste management. Above, researchers from the University of Michigan and the Joint Research Centre in Ispra, Italy, take measurements on a fresh fuel bundle. Below, researchers at Argonne National Laboratory work on a waste minimization process in a hot cell.

5. International Program Actions

Significant opportunities exist to combine and leverage the existing strengths of the international nuclear community to advance the science of UNF and HLW disposition, with a focus on achieving our domestic objectives. To achieve the four major goals previously described—leveraging global knowledge to meet domestic goals; increasing the global deployment of advanced technology; building a foundation for collaboration, trust, and joint action; and accelerating global learning and innovation—the UFD International Program must pursue multiple activities.

It is important to note that the UFD program does not have management responsibility for all international agreements, projects, and efforts (including some of those described in this section). The Office of International Nuclear Energy Policy and Cooperation serves as the central coordinating office for NE's international engagement, representing the Department in international nuclear policy interactions. The UFD International Program works cooperatively with this office and others within NE and DOE, as well as external governmental agencies, serving as a conduit and enabler for actions that bring the United States together with other nations to address the challenges of UNF and HLW disposition.

This chapter lays out two interdependent areas of action for meeting program strategic goals: participating in international scientific and technical forums and conducting collaborative research with international scientists. These action areas, their associated benefits, and their relationship to program goals are explained below.

Action Areas

Cooperate with the international nuclear community through agreements, international organizations, working groups, committees, and other mechanisms. Participation in international organizations and working groups typically involves information exchanges, expert panels, reviews, and training and education.

Benefits

These collaborative efforts provide a forum and arena for building trusted relationships and a means for all partners to remain informed of each other's progress. This shared awareness provides a platform for jointly leveraging that progress to make best use of each partner's resources, efforts, and insights. This type of international involvement is important in helping to identify and facilitate avenues of active R&D collaboration. Further, participation in high-level collaborations increases the United States' visibility as a key member of the international nuclear community.

Planned work

Recent or ongoing NE work in this area includes participation in both multinational activities and bilateral agreements. Multilateral activities include (but are not limited to) already established partnerships: International Atomic Energy Agency (IAEA) peer reviews, consultancies, and conferences; and the Integration Group for the Safety Case and the Thermochemical Database, both sponsored by the Organization for Economic Cooperation and Development's Nuclear Energy Agency (OECD/NEA). NE also actively supports numerous bilateral cooperative mechanisms, such as the U.S.–China Peaceful Uses of Nuclear Technology (PUNT) agreement, the U.S.–Japan Nuclear Energy Action

Swiss scientists investigate the influence of groundwater on radioactive substances in the rock.

Plan (JNEAP), and the U.S.–Germany Memorandum of Understanding for Cooperation in the Field of Geologic Disposal of Radioactive Wastes. More examples of international partnerships can be found at the end of this section.

The UFD International Program will continue participation in and/or support of ongoing international activities, such as international conferences, information exchanges, and expert panels. The program will identify, actively monitor, and compile information on the scope and direction of international R&D efforts, progress in UNF and HLW management policies and practices, and regulatory environments; program staff will use such avenues as NEA Country Profiles and Reports, Joint Convention National Reports, and Program Update Reports from the International Association for Environmentally Safe Disposal of Radioactive Materials (EDRAM). Proper information compilation will necessitate administrative tasks such as maintaining and updating international resource databases.

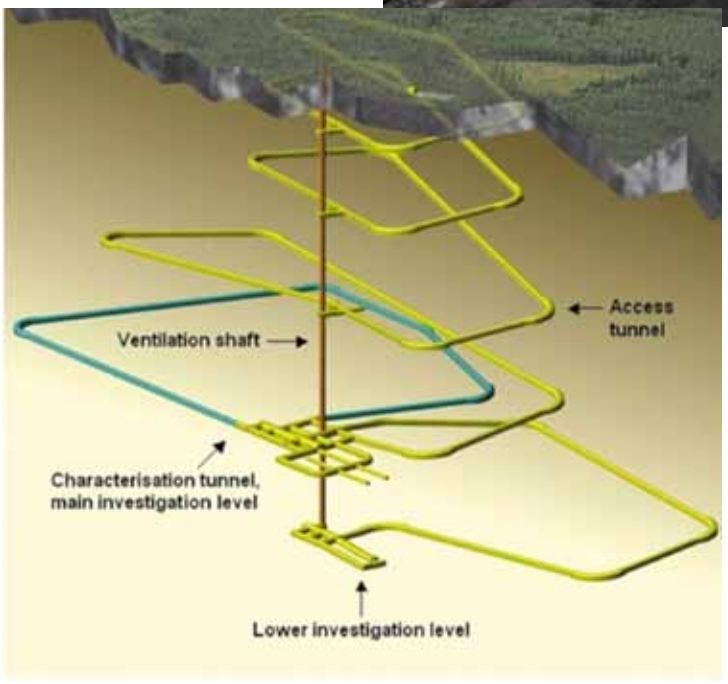
The program will also review and monitor existing bilateral cooperative mechanisms, assessing these agreements and identifying the need for expanding or extending their scope to further those opportunities that are of most benefit to the campaign. Program staff will also identify opportunities for appropriate new frameworks for bilateral and multilateral cooperation. Developing new agreements and other opportunities and mechanisms should happen with an eye toward furthering U.S. understanding of waste management experience and research findings, as well as changes to the global nuclear landscape.

Finally, the UFD International Program serves as a conduit between international and domestic stakeholders to ensure productive two-way dissemination of experience and advancements. In cases where the UFD International Program does not have direct responsibility, a representative will attend/monitor the activity to serve as an information channel. To best achieve strategic goals, the program should assess the relevance of international experience to meet domestic needs, as well as the relevance of U.S. knowledge to international activities. With this focus, the program can effectively coordinate with DOE, other federal agencies, and other entities to ensure that international experience informs appropriate domestic program activities and decision making. Outreach includes facilitating the integration of commercial expertise into international collaborations.

Conduct collaborative research between U.S. and international scientists. The established cooperative mechanisms discussed above provide vehicles for the UFD International Program to manage or sponsor active collaboration on specific scientific topics. This may include exchange of scientists and engineers, exchange of scientific and technical information and

R&D results, exchange of samples and materials for testing, visits to specific facilities of interest, and joint projects on research areas of mutual agreement. Active collaboration can be achieved under different working models. One option stems from informal peer-to-peer interaction between scientists based on their personal relationships developed from participating in international workshops and meetings, or from R&D collaboration outside of UFD scope. Continued support for participation of researchers in relevant international meetings will help to foster and expand such relationships.

Other working models may require formal agreements and long-term financial commitment before R&D collaboration can take place. For example, several valuable multinational and multipartner initiatives that promote active R&D in nuclear waste disposal science would require DOE "membership": the Thermochemical Database, the DECOVALEX Project, the Mont Terri Project, and the Colloid Formation and Migration Project. In addition, some bilateral agreements would provide access to underground research laboratories (URLs) in other countries. A third model is direct participation of DOE National Laboratories in specific projects run by individual international disposal programs; this may or may not require formal bilateral agreements.



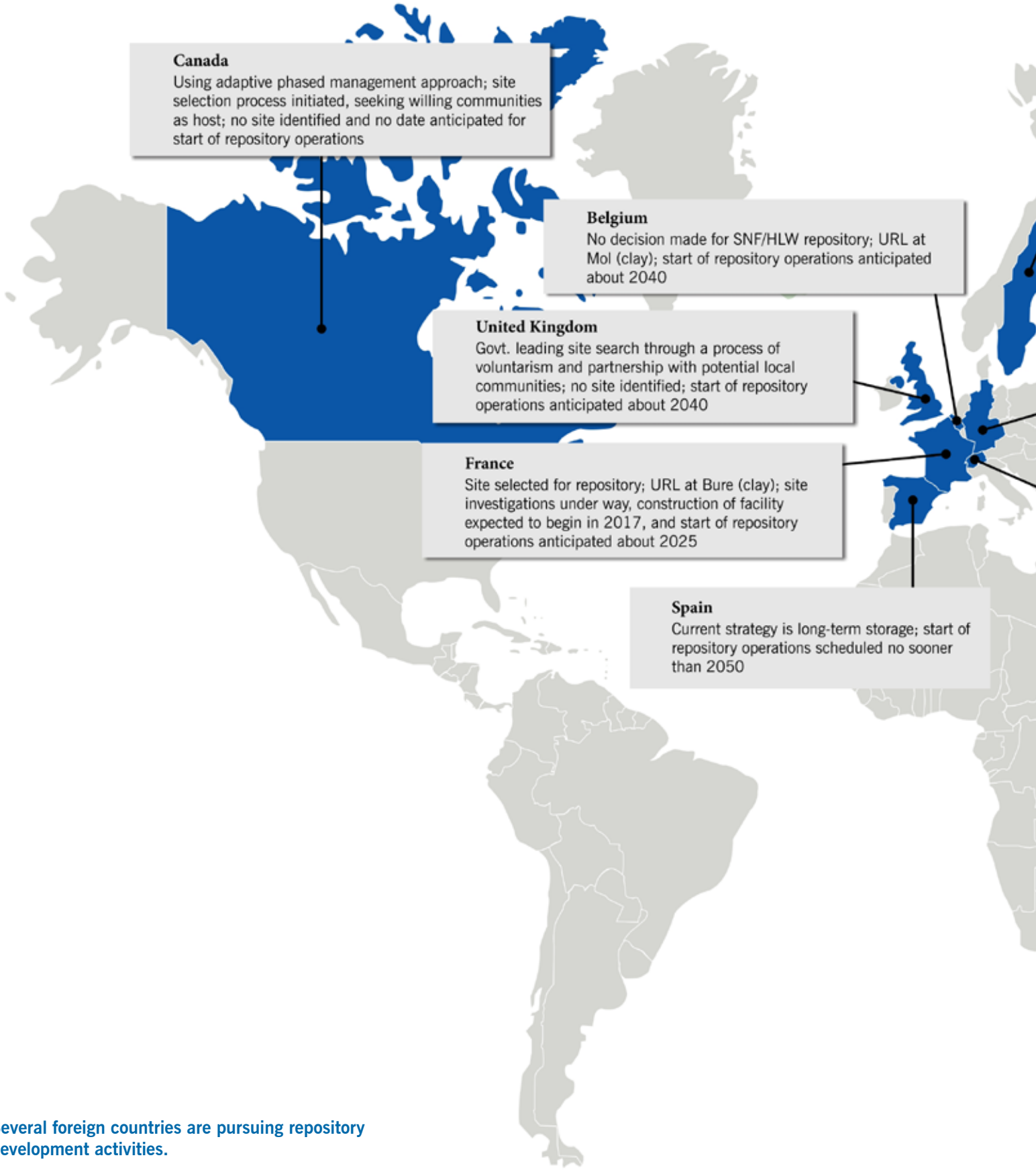
Site investigations in Olkiluoto, Finland, will be conducted in the underground rock characterization facility currently under excavation. | *Photos courtesy of Posiva Oy*

Benefits

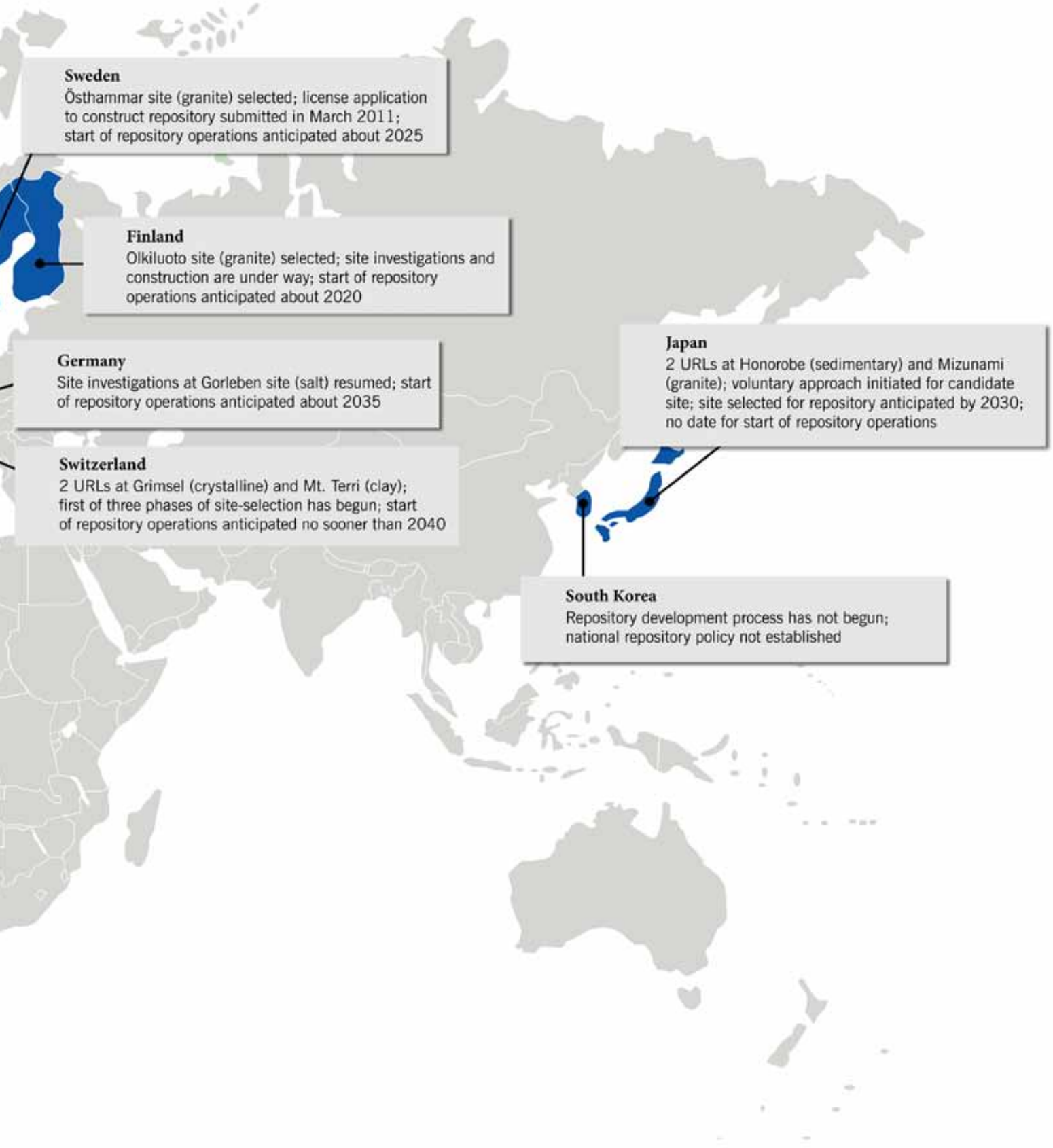
Collaboration with international scientists on R&D projects provides direct access to data and expertise on a variety of relevant topics. Prominent in international studies is investigation into various disposal options and geologies, including those that have not been extensively studied in the United States. International nuclear partners have also conducted research into extended spent fuel dry storage and subsequent transportation, the results of which would enhance U.S. efforts in this area. In addition to the knowledge benefits, collaboration on specific R&D projects that are relevant to both sides also increases good will among members of the international nuclear scientific community.

Planned work

The UFD International Program will maintain involvement in current opportunities for scientific and technical exchange, e.g., the Extended Storage Collaboration Program, which has recently elicited international participation, and the IAEA Advisory Group on Spent Fuel. Program staff will assess these opportunities and identify ways to expand



Several foreign countries are pursuing repository development activities.


Sweden
Östhammar site (granite) selected; license application to construct repository submitted in March 2011; start of repository operations anticipated about 2025
Finland
Olkiluoto site (granite) selected; site investigations and construction are under way; start of repository operations anticipated about 2020
Germany
Site investigations at Gorleben site (salt) resumed; start of repository operations anticipated about 2035
Switzerland
2 URLs at Grimsel (crystalline) and Mt. Terri (clay); first of three phases of site-selection has begun; start of repository operations anticipated no sooner than 2040
Japan
2 URLs at Honorobe (sedimentary) and Mizunami (granite); voluntary approach initiated for candidate site; site selected for repository anticipated by 2030; no date for start of repository operations
South Korea
Repository development process has not begun; national repository policy not established

involvement that would help the United States meet its strategic goals.

Program staff will also target new opportunities for potentially fruitful participation in research projects with which the United States has not been involved. For example, many field experiments relevant to disposal are being conducted internationally in operating URLs in clay/shale, granite, and salt environments. The map on the preceding pages depicts the status of major international repository siting programs. U.S. researchers may be able to participate in these programs, and thereby get early access to the data without constructing *in situ* research facilities in the United States.

Such active R&D activities are most beneficial to help efficiently achieve long-term UFD goals, such as conducting experiments to fill data needs and confirm advanced modeling approaches by 2015, and having a robust modeling and experimental basis for evaluation of multiple disposal system options by 2020. Advancing such opportunities will be a primary focus of the UFD's international activities in the next few years.

UFD International Program representatives will strive to ensure that collaborative research efforts encourage international cooperation, common understanding, and mutual trust.

Current International Activities

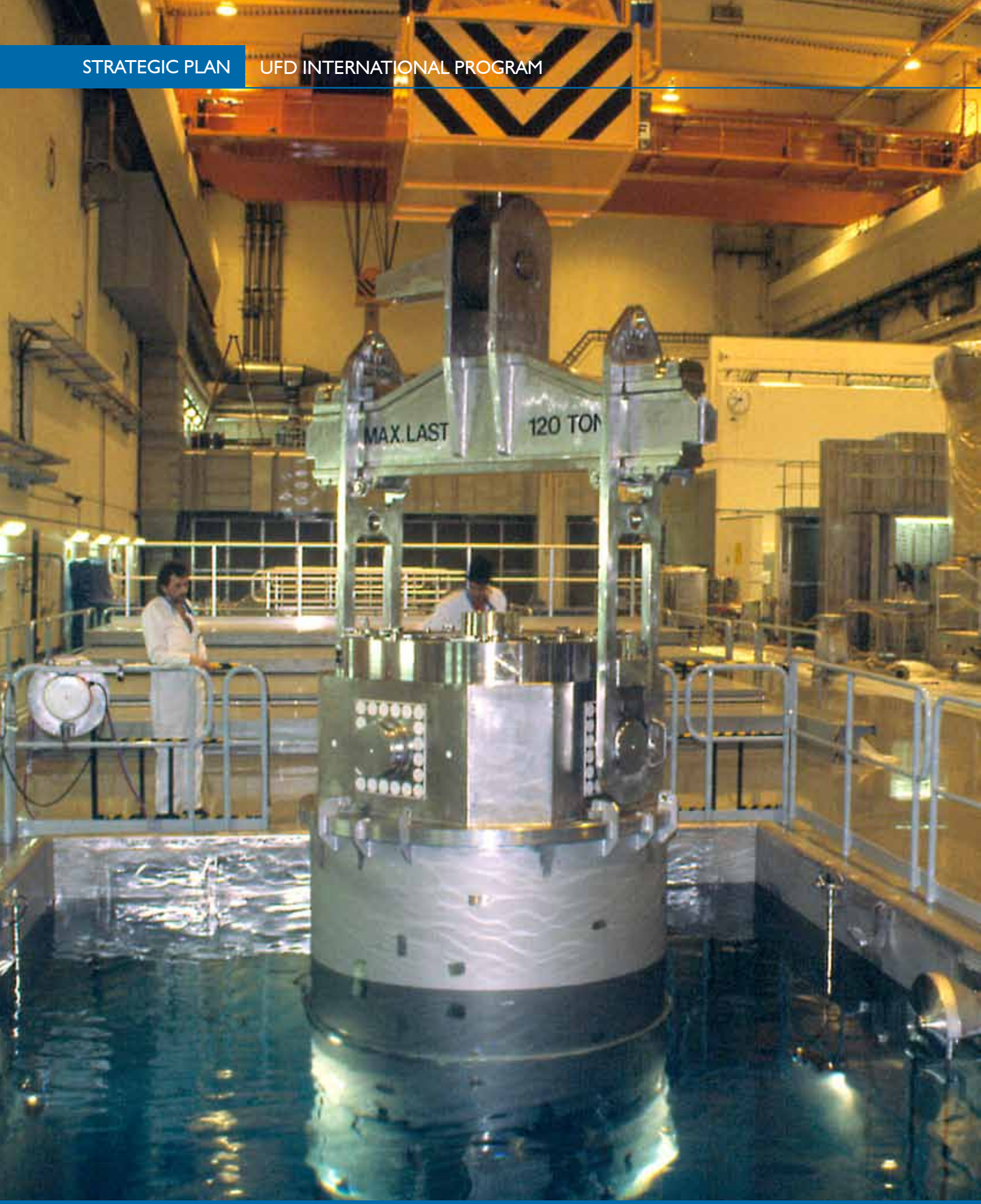
The United States currently works with many other countries on radioactive waste management programs. This collaboration is not limited to the UFD International Program but rather is handled through several venues and organizations. As noted above, the UFD International Program is responsible for serving as a conduit between the organizations involved in these efforts. The following list includes a short description of some of the groups with whom the United States and DOE have continued interactions:

- **Organization for Economic Cooperation and Development/Nuclear Energy Agency, Radioactive Waste Management Committee:** The U.S. delegation participates in annual meetings, provides status reports on the country's radioactive waste and decommissioning programs, and reviews/updates international reports prepared as reference documents.
- **International Association for Environmentally Safe Disposal of Radioactive Materials:** EDRAM is an association of executives and chairmen of worldwide radioactive waste management organizations that meets biannually to share and compare program information among the eleven member countries: Belgium, Canada, Finland, France, Germany, Japan, Spain, Sweden, Switzerland, United Kingdom, and United States.
- **International Atomic Energy Agency:** The IAEA sponsors technical meetings, some of which pertain to different topics related to radioactive waste management such as long-term storage, transportation, and safety. DOE and National Laboratory staff may participate and/or monitor the progress for these meetings, depending on the topic and expertise needed.

The Joint Convention holds triennial meetings at the IAEA in Vienna, Austria. | *Photo courtesy of IAEA*

Both domestic and foreign researchers are investigating issues with UNF transportation to both interim storage sites and permanent disposal facilities.

- **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention):** The Joint Convention establishes an international peer review process among approximately 60 countries, holding triennial meetings in which the United States participates. Under the terms of the Joint Convention, the U.S. government prepares a national report that describes domestic radioactive waste management in both commercial and government sectors and provides information on UNF and HLW management facilities and current inventories.
- **International Framework for Nuclear Energy Cooperation (IFNEC):** IFNEC is a forum through which participating states explore mutually beneficial approaches to ensure the use of nuclear energy for peaceful purposes proceeds in a manner that is efficient and meets high standards of safety, security, and nonproliferation. Participating states do not give up any rights and voluntarily engage in information sharing. Two relevant working groups are under the IFNEC umbrella:
  - *Reliable Nuclear Fuel Services Working Group* seeks to identify common interests among the participant countries and recommend practical measures for moving towards reliable comprehensive fuel service arrangements, including front-end services, spent fuel management, and approaches for selection of back-end fuel cycle options.
  - *Infrastructure Development Working Group* supports the safe and secure development of nuclear energy infrastructure, including infrastructure needs for international nuclear fuel service frameworks. Under the working group, there is a sub-group on radioactive waste management, which aims to share information, experiences, and broader knowledge that could inform countries' development of radioactive waste management positions and strategies.
- **State Department initiatives:** DOE supports and participates in international cooperative interactions, including:
  - *American Institute in Taiwan/Taipei Economic and Cultural Representative Office (AIT/TECRO) Joint Standing Committee for Civil Nuclear Cooperation*, which includes a working group on radioactive waste management.
  - *Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC)* with Argentina, Brazil, and Korea.
- **Bilateral agreements and memoranda of understanding:** DOE uses these mechanisms to establish and address technical cooperative activities for radioactive waste management activities of mutual interest, to leverage resources, and to minimize duplication of effort. Cooperation between the parties is based on mutual benefit, equality, and reciprocity. These vehicles are used for efforts such as exchange of scientists and engineers, exchange of scientific and technical information and R&D results, exchange of samples and materials for testing, seminars and meetings on agreed-upon topics, visits to specific facilities of interest, and joint projects for topics of mutual agreement.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6. Conclusions

International activities link the United States to the world's evolving UNF and HLW management practices, providing a forum for exchanging strategies and technologies with other nations. The UFD International Program pursues development and implementation of formal agreements with other countries, enabling an exchange of detailed scientific and technical information or joint sponsorship of R&D activities. Overall, this program serves the goals of DOE, as established in the DOE 2011 *Strategic Plan* and NE 2010 R&D roadmap, and supports other federal agencies in advancing scientific understanding, enhancing environmental protection, and improving global security.

Critical to achieving U.S. goals is a foundation for increased trust and cooperation in the nuclear community, which in turn supports a shared understanding of opportunities, priorities, risks, challenges, and solutions. The UFD International Program has established such a foundation and will utilize this platform to facilitate both bilateral and multilateral coordination, not only with countries that already have mature nuclear systems, but also with countries that are developing nuclear technology. To move forward, program staff will review existing bilateral mechanisms and seek out new cooperative frameworks that are most beneficial to program goals. They will assess the relevance of international experience vis-à-vis domestic needs and coordinate with other federal agencies and stakeholders to ensure that knowledge informs U.S. activities and decision making. A review of current international forums for technical and scientific exchange will identify opportunities to expand U.S. involvement that will hasten progress towards accomplishing the nation's strategic goals. In concert, staff will target increased collaboration in new research projects to leverage international scientific data relevant to waste disposal.

Program activities will capitalize on global synergy to develop both near-term solutions and innovative methods of managing the back end of the fuel cycle, and will promote responsible waste management practices. When appropriate, the program will encourage shared protocols to support a safe and secure global nuclear community. By coordinating efforts both domestically and abroad, the program will help achieve an optimized national waste disposal system for the United States, while simultaneously participating in the development of a global solution.