COMMENT

National and Multinational Strategies for Radioactive Waste Disposal

by Kerri Morrison

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Research into atomic energy and nuclear fission began in the early to mid-1900s, with scientists recognizing the technologies' potential to produce both energy and weapons.[1] Today, nuclear technology is used in a variety of applications, including energy, medicine, research, and agriculture.[2] These applications produce waste that is radioactive and, therefore, harmful to humans for a certain period of time.[3] In order to protect human health and prevent harm to the environment, radioactive waste must be carefully stored until it is no longer so radioactive that it poses a threat to humans or the environment.[4]

Radioactive wastes are generally sorted into three categories based on how radioactive the waste is: low-level waste (LLW), intermediate-level waste (ILW), and high-level waste (HLW).[5] How waste is defined under these categories varies between countries and organizations,[6] but generally LLW emits relatively low levels of radiation for a short period of time; ILW contains higher levels of radiation for a longer period of time; and HLW is the most radioactive or radioactive for the longest period of time, and usually consists of the materials inside the nuclear reactor when energy is produced.[7]

Appropriate strategies for the storage and disposal of LLW and ILW exist.[8] However, the storage and disposal of HLW poses a challenge because of the level of radiation emitted from this waste and/or the longevity of the radiation.[9] Because HLW may be radioactive for hundreds of thousands of years, storage and disposal strategies must consider the safety of future generations and the environment.[10] While multiple methods of disposing of HLW have been proposed, only one method, deep geologic disposal, is considered by most countries to be appropriately feasible and secure enough to protect future generations and the environment.[11]

HLW is generated mainly from military and energy applications of nuclear technology.[12] Most HLW is created through the processes that occur within nuclear reactors, and includes spent or used fuel—the fuel left over after energy production.[13] More than 50 nations have HLW,[14] and disposal of this waste remains a concern not only for the nations that have generated it, but other nations as well.[15] Each nation is responsible for its own radioactive wastes under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the most comprehensive international agreement on radioactive wastes.[16] While some nations have resolved to dispose of their radioactive waste within their own borders,

1. World Nuclear Association, *Outline History of Nuclear Energy*, http://world-nuclear.org/information-library/current-and-future-generation/outline-history-of-nuclear-energy.aspx (last updated Mar. 2014).
2. International Atomic Energy Agency (IAEA), Getting to the Core of Radioactive Waste, Int'l Atomic Energy Agency 2, *available at* https://www.iaea.org/OurWork/ST/NE/NEFW/_nefw-documents/RadioactiveWaste.pdf (last visited Dec. 9, 2016).
3. *Id.*
4. *Id.*
5. *Id.*
6. *Id.*
7. World Nuclear Association, *Radioactive Waste Management*, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx (last updated Oct. 2016).
8. IAEA, *supra* note 2, at 4.
9. U.S. Nuclear Regulatory Commission (NRC), *High-Level Waste*, http://www.nrc.gov/waste/high-level-waste.html (last updated Nov. 30, 2016).
10. *Id.*
11. World Nuclear Association, *Storage and Disposal of Radioactive Wastes*, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/appendices/radioactive-waste-management-appendix-2-storage-an.aspx (last updated Oct. 30, 2016).
12. U.S. Department of Energy (DOE), Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste 1 (2013), *available at* http://energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf.
13. *Radioactive Waste Management*, *supra* note 7.
14. World Nuclear Association, *International Nuclear Waste Disposal Concepts*, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/international-nuclear-waste-disposal-concepts.aspx (last updated Nov. 2016).
15. Association for Regional & International Underground Storage, *The World Needs Nuclear Power: Nuclear Power Needs Multinational Facilities*, http://www.arius-world.org/ (last visited Feb. 20, 2017).
16. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, art. 21, *opened for signature* Sept.

other nations and organizations have proposed creating multinational repositories for radioactive waste disposal.[17]

Part I of this Comment will examine the progress of four nations on their national plans to dispose of radioactive waste: the United States, Finland, Russia, and Japan. Part II will briefly describe the international structures, organizations, and agreements that regulate or otherwise impact radioactive waste disposal. Part III will analyze the concept of creating multinational repositories for HLW. Part IV concludes.

I. National Programs

Currently, 55 countries have nuclear reactors for energy generation or research purposes, all of which must manage their radioactive waste.[18] Some nations have progressed further in making plans for long-term HLW disposal, and each country faces unique challenges in disposing of HLW. This part will look in depth at the history and progress of four countries (the United States, Finland, Russia, and Japan) that have significant amounts of HLW and are working on various strategies to handle that waste.

A. The United States

1. History

On December 2, 1942, Enrico Fermi and other scientists switched on the world's first nuclear reactor in Chicago, Illinois.[19] During the 1940s, U.S. research into nuclear technology was focused on weaponizing the technology through the Manhattan Project for use in World War II.[20] This project culminated in the only use of nuclear weapons by one country against another: the U.S. nuclear bombing of the cities of Hiroshima and Nagasaki in August 1945.[21] Following the end of World War II, U.S. scientists studied the use of nuclear technology to generate electricity.[22] In 1946, the U.S. Congress passed the Atomic Energy Act (AEA), which created the Atomic Energy Commission (AEC),[23] and in 1957, the first commercial nuclear power plant in the United States began supplying energy in Pennsylvania.[24] By 1971, 22 commercial nuclear power plants were operating in the United States.[25]

Early U.S. policy on nuclear waste disposal centered on plans to reprocess spent nuclear fuel for military applications,[26] a process that essentially recycles elements of the used nuclear fuel.[27] Because reprocessing produces its own HLW, deep ground disposal was proposed to deal with HLW.[28] However, in the 1970s, the U.S. government adopted a non-proliferation policy, eliminating reprocessing as a viable option for reducing HLW.[29] During the 1970s, Congress split the responsibilities formerly held by the AEC between what is now the U.S. Department of Energy (DOE) and the newly created Nuclear Regulatory Commission (NRC).[30]

Beginning in the 1970s and continuing for a decade, the United States injected 7,500 cubic meters of LLW into underground rock formations in Tennessee.[31] The practice was halted due to concerns that the waste would spread, and a similar project proposed for South Carolina was terminated before implementation due to the concerns of the public.[32] In the 1970s and 1980s, the National Aeronautics and Space Administration investigated launching nuclear waste into space, but the idea was considered too costly and posed too high of a risk for failure and as a result was abandoned.[33] In the past, the United States also disposed of some nuclear wastes in the sea; however, that practice is now banned by international agreements.[34]

Following a nuclear reactor accident at Three Mile Island in Pennsylvania, and the resulting panic, the U.S. public became more concerned with the safety of the nuclear fuel cycle.[35] In 1983, Congress passed the Nuclear Waste Policy Act (NWPA), which required the government to identify a site for the geologic disposal of HLW.[36] The NWPA also required nuclear energy producers to contract with the government so that in exchange for a fee, the U.S. government would take possession of spent nuclear fuel for disposal by 1998.[37]

In the 1987 amendments to the NWPA, Congress ordered DOE to focus its efforts for HLW disposal exclusively on one site, effectively choosing the location: Yucca Mountain in Nevada.[38] The selection of this site was vehemently opposed by politicians and the public, both in Nevada and elsewhere.[39] Despite this opposition, 15 billion dollars were spent studying Yucca Mountain as a potential repository site.[40]

29, 1997, https://www.iaea.org/sites/default/files/infcirc546.pdf (entered into force June 18, 2001).

17. *International Nuclear Waste Disposal Concepts*, *supra* note 14.
18. World Nuclear Association, *Nuclear Power in the World Today*, http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx (last updated Jan. 2017).
19. DOE, The History of Nuclear Energy 6-7 (DOE/NE-0088), *available at* http://www.energy.gov/sites/prod/files/The%20History%20of%20Nuclear%20Energy_0.pdf.
20. *Id.* at 7.
21. *Id.* at 13.
22. *Id.* at 8.
23. Atomic Energy Act of 1946, Pub. L. No. 585, 60 Stat. 755. The Act was amended by the Atomic Energy Act of 1954, 83 Pub. L. No. 703, 68 Stat. 919.
24. The History of Nuclear Energy, *supra* note 19, at 15.
25. *Id.* at 17.
26. Christopher M. Keegan, *What's Worse, Nuclear Waste or the United States' Failed Policy for Its Disposal?*, 49 U. Rich. L. Rev. 1265, 1269 (2015).
27. NRC, *Reprocessing*, http://www.nrc.gov/materials/reprocessing.html (last updated Feb. 17, 2017).
28. Keegan, *supra* note 26, at 1269.
29. *Id.*
30. NRC, *Governing Legislation*, http://www.nrc.gov/about-nrc/governing-laws.html (last updated Mar. 30, 2016).
31. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
32. *Id.*
33. *Id.*
34. *Id.*
35. NRC, *Backgrounder on the Three Mile Island Accident*, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html (last updated Dec. 12, 2014).
36. Nuclear Waste Policy Act of 1982, Pub. L. No. 97-425, 96 Stat. 2211 (1983) (current version at 42 U.S.C. §10133).
37. 42 U.S.C. §10156.
38. 42 U.S.C. §10172.
39. Jeff Tollefson, *Battle of Yucca Mountain Rages On*, Nature, May 17, 2011, http://www.nature.com/news/2011/110517/full/473266a.html.
40. Elizabeth Gibney, *Why Finland Now Leads the World in Nuclear Waste Storage*, Nature, Dec. 2, 2015, http://www.nature.com/news/

DOE submitted an application to NRC to license Yucca Mountain as a repository for HLW in 2008.[41] That same year, presidential candidate Barack Obama promised he would end plans to place a repository at Yucca Mountain.[42] Once elected, President Obama fulfilled this promise by cutting the budget for the Yucca Mountain project and working with DOE to withdraw the Yucca Mountain license application.[43] President Obama also ordered the creation of the Blue Ribbon Commission on America's Nuclear Future (BRC) to study and report on alternatives to Yucca Mountain.[44] The BRC released its report in 2012.[45]

Despite the Obama Administration's efforts to terminate the Yucca Mountain project, NRC denied DOE's attempt to withdraw the Yucca Mountain application.[46] Though NRC did not allow the withdrawal of the application, it stopped its efforts to approve or disapprove the project.[47] Several entities and individuals filed suit in order to get a writ of mandamus ordering NRC to complete the licensing process.[48] The U.S. Court of Appeals for the District of Columbia (D.C.) Circuit granted the petition for a writ of mandamus, finding that NRC was obligated under the NWPA to continue its review of the project, even if NRC did not have enough funds to actually complete the review.[49] NRC subsequently continued its review of the Yucca Mountain application, but the project currently remains suspended.[50]

2. Current Status

Some LLW and ILW produced from military uses is stored in the Waste Isolation Pilot Plant (WIPP)[51] in Carlsbad, New Mexico.[52] The facility is the only one in the world that stores ILW in a deep geologic repository; at least 87,500 cubic meters of ILW from 12 DOE sites have been deposited there, requiring at least 11,500 shipments over roadways.[53] LLW and ILW with relatively short half-lives from commercial sources are stored in five near-surface disposal facilities operated by private companies in South Carolina, Tennessee, Texas, Utah, and Washington.[54] HLW from commercial sources is temporarily stored at the nuclear power plants where it was generated.[55] Currently, 70,000 metric tons of HLW are stored in 75 facilities in the United States,[56] and this waste is increasing at a rate of 2,200 metric tons per year.[57] An additional 13,000 metric tons of waste from military applications are also in temporary storage at five sites.[58]

Two federal government agencies are primarily responsible for the regulation and management of radioactive waste: DOE and NRC.[59] The U.S. Environmental Protection Agency (EPA) also has some responsibilities with regard to site selection for a geologic repository.[60] Although states have some powers regarding the regulation of nuclear technology, attempts to regulate radioactive waste by state governments have been held to be preempted by federal law.[61]

3. Issues With Implementation

The BRC's 2012 report cited several major reasons for the failure of the Yucca Mountain project: (1) the decision to focus solely on Yucca Mountain as a repository and not to pursue the development of a second repository as initially planned; (2) the lack of state and local control over the project; (3) the selection of "unrealistic and rigid deadlines" for the project; and (4) the "inflexibility and prescriptiveness" of the project, which resulted in failure to adapt to changing scientific and political circumstances.[62] In January 2013, DOE released a report on its policy stance on HLW disposal, which stressed a "consent-based approach" for choosing a location for a repository.[63] DOE proposed storing wastes at a "pilot short-term interim facility," to begin operations by 2021, and then at a second larger, longer-term interim facility, to begin operations by 2025, before finally placing the wastes in a repository to begin operations in 2048.[64] In the report, DOE called for new legislation to enact the policy standards it proposed and for the creation of a new organization for implementation, although DOE also noted it is still analyzing disposal options under the NWPA.[65]

One criticism of the solutions proposed in DOE's report is that if the interim facilities and the geologic repository

why-finland-now-leads-the-world-in-nuclear-waste-storage-1.18903.

41. U.S. Government Accountability Office (GAO), Spent Nuclear Fuel Management 2 (2014) (GAO-15-141), *available at* http://www.gao.gov/assets/670/666454.pdf.
42. Tollefson, *supra* note 39.
43. Randall W. Miller, *Wasting Our Options? Revisiting the Nuclear Waste Storage Problem*, 4 Wash. & Lee J. Energy, Climate & Env't 359, 379-80 (2013).
44. DOE, *Blue Ribbon Commission on America's Nuclear Future Report to the Secretary of Energy*, http://energy.gov/ne/downloads/blue-ribbon-commission-americas-nuclear-future-report-secretary-energy (last visited Feb. 20, 2017).
45. *Id.*
46. Miller, *supra* note 43, at 379-80.
47. In re Aiken County, 725 F.3d 255, 258, 43 ELR 20190 (D.C. Cir. 2013).
48. *Id.*
49. *Id.* at 266-67.
50. NRC, *High-Level Waste Disposal*, http://www.nrc.gov/waste/hlw-disposal.html (last updated May 17, 2016).
51. *Stop Wasting Time—Create a Long-Term Solution for Nuclear Waste*, Sci. Am., Apr. 1, 2016, http://www.scientificamerican.com/article/stop-wasting-time-create-a-long-term-solution-for-nuclear-waste.
52. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
53. *Id.*
54. *Id.*
55. GAO, *Disposal of High-Level Nuclear Waste*, http://www.gao.gov/key_issues/disposal_of_highlevel_nuclear_waste/issue_summary (last visited Feb. 20, 2017).
56. Warren Cornwall, *Deep Sleep*, Sci., July 10, 2015, at 132-35.
57. *Disposal of High-Level Nuclear Waste*, *supra* note 55.
58. Cornwall, *Deep Sleep*, *supra* note 56.
59. *Disposal of High-Level Nuclear Waste*, *supra* note 55.
60. *Id.*; 42 U.S.C. §§10101 et seq.
61. *See*, *e.g.*, United States v. Kentucky, 252 F.3d 816, 31 ELR 20657 (6th Cir. 2001) (holding that a state statute attempting to limit the amount of radioactive material that could be placed in landfills was preempted by the AEA).
62. BRC, Report to the Secretary of Energy 24 (2012), *available at* http://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf.
63. DOE, *supra* note 12, at 1.
64. *Id.*
65. *Id.*

are not located in the same place, shipping all the HLW multiple times to three different sites will take decades.[66] Additionally, such shipping may increase the probability of an accident during transportation. Locating a new site may take decades, and even if a state agrees to store nuclear waste in a geologic repository, states through which the waste must be transferred may oppose transporting it through their jurisdictions.[67]

In March 2015, the White House announced that instead of placing all HLW in one location, it would place the waste in multiple locations.[68] This strategy could help to resolve the issues involved in transporting nuclear wastes through states. However, multiple locations mean multiple points at which an accident could occur, although the scope of such a failure may not be as great as if all HLW was placed in a single location. The White House strategy also did not resolve the "not in my backyard" (NIMBY) problem of state and local opposition to HLW storage.

However, whether the federal government eventually decides to develop one repository or multiple repositories, the 2012 BRC report argues that finding a location is feasible.[69] For example, the WIPP, which operates in New Mexico, was constructed with the consent of local and state governments after "years of legal, regulatory, and political activity and complex negotiations between the State of New Mexico and the federal government."[70] The current standstill could potentially terminate in a couple of ways. President Donald Trump has indicated that he is considering reinstating funding for the Yucca Mountain project.[71] Alternatively, Congress could enact new legislation on radioactive waste disposal.[72]

One method of waste disposal that DOE is actively considering and funding research for is deep boreholes.[73] Deep boreholes can only hold certain types of radioactive waste, and cannot hold spent fuel rods, which make up the majority of HLW.[74] However, boreholes may be ideal for tubes of cesium-137 and strontium-90, waste from defense applications that is highly radioactive and that currently sits in pools in Hanford, Washington.[75] That facility is at the highest risk of any DOE facility for failure.[76]

Efforts to conduct research on deep boreholes in North Dakota were withdrawn after the local county commission of the testing site resolved to oppose the testing, citing fears that testing would lead to actual nuclear waste disposal.[77] Many of the same political obstacles faced by geologic repositories are therefore still present for the deep borehole idea.[78] There are significant technical challenges as well, as this type of disposal has not been done before and is not well tested.[79] Additionally, federal regulations require that the waste can be retrieved, which may be impossible or difficult with boreholes.[80] The idea may not survive if progress on a geologic repository is made, as deep boreholes may be more expensive than deep ground disposal for large quantities of waste.[81]

As the federal government fails to identify a site for and begin construction of a geologic repository, it loses taxpayer money. The U.S. government has paid back the nuclear energy industry $4.5 billion in fees collected for waste disposal under the NWPA because the government did not fulfill its contractual obligation to take possession of the waste by 1998.[82] The government expects to owe $22.6 billion in future liabilities as well,[83] assuming the government takes title and possession of the waste starting in 2021 and completes the process by 2071.[84] These payments are made out of the U.S. Department of the Treasury's judgment fund, which is supplied with taxpayer money.[85] Therefore, the federal government has a strong interest in resolving the HLW disposal problem not only for public and environmental welfare reasons, but for financial reasons as well.

B. Finland

1. History

Nuclear power plants began operating in Finland in the late 1970s.[86] At first regulated by the Atomic Energy Act of the 1950s, the Act was replaced by the Nuclear Energy Act in 1987, which includes regulations for radioactive waste management.[87] When Finland was admitted to the European Union (EU) in 1994, the Nuclear Energy Act was

66. *Disposal of High-Level Nuclear Waste*, *supra* note 55.
67. Tollefson, *supra* note 39.
68. Cornwall, *Deep Sleep*, *supra* note 56.
69. BRC, *supra* note 62, at 48-49.
70. *Id.* at 49.
71. Jennifer A. Dlouhy, *Trump Advisers Eye Reviving Nevada Yucca Nuclear Waste Dump*, Bloomberg, Nov. 15, 2016, https://www.bloomberg.com/politics/articles/2016-11-14/trump-advisers-eye-reviving-nevada-s-yucca-nuclear-waste-dump. Although during the 2016 presidential campaign Trump was undecided on the issue of whether he would pursue the option of disposing of radioactive waste at Yucca Mountain, he stated that once he "[took] a look at it" he would "come [out] very strongly one way or the other." Timothy Cama, *Trump Punts on Yucca Nuclear Waste Site*, The Hill, Oct. 6, 2016, http://thehill.com/policy/energy-environment/299575-trump-punts-on-yucca-nuclear-waste-site. Two sources allegedly "familiar with Trump's transition planning," have stated that Trump's advisers are looking at the issue. Dlouhy, *supra* note 71.
72. Congress may endorse Yucca Mountain as a repository site as the strongest U.S. Senate opponent to the Yucca Mountain project, Sen. Harry Reid (D-Nev.), retires and Republicans, who have voiced support for the project, are the majority in both houses of Congress. Dlouhy, *supra* note 71.
73. *Energy Department Selects Battelle Team for a Deep Borehole Field Test in North Dakota*, DOE, Jan. 5, 2016, http://www.energy.gov/articles/energy-department-selects-battelle-team-deep-borehole-field-test-north-dakota.
74. Warren Cornwall, *This Time, It's North Dakota That Sinks an Experiment Related to Burying Nuclear Waste*, Sci., Mar. 23, 2016, http://www.sciencemag.org/news/2016/03/time-it-s-north-dakota-sinks-experiment-related-burying-nuclear-waste.
75. Cornwall, *Deep Sleep*, *supra* note 56.
76. *Id.*
77. Cornwall, *This Time*, *supra* note 74.
78. Cornwall, *Deep Sleep*, *supra* note 56.
79. *Id.*
80. *Id.*
81. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
82. *Disposal of High-Level Nuclear Waste*, *supra* note 55.
83. *Id.*
84. GAO, *supra* note 41, at 2.
85. *Id.*
86. Finland Ministry of Employment & the Economy, Nuclear Energy in Finland 2 (2011), *available at* https://tem.fi/documents/1410877/2937056/Nuclear+Energy+in+Finland.
87. Organization for Economic Co-Operation & Development (OECD), Nuclear Energy Agency (NEA), Nuclear Legislation in OECD and

amended to reflect the Euratom Treaty,[88] which regulates nuclear energy within the EU.[89]

In 1983, the Finnish government issued a policy directive on the disposal of HLW.[90] In accordance with this policy, nuclear power company Teollisuuden Voima Oy (TVO) studied optimal locations and eventually chose five potential sites to house a nuclear waste repository, including the now licensed site, Olkiluoto.[91] At first, the local council in Olkiluoto opposed the site; however, through a process of community engagement and financial incentives for the community, the council eventually supported the project.[92] In 1999, Posiva, a nuclear management firm, overtook site selection from TVO.[93] At that time, Posiva submitted its application for the repository and an environmental impact statement to the government.[94] The Finnish government approved Olkiluoto as the site for the repository in 2001.[95] Construction was approved by the government in December 2012.[96] In November 2015, Finland approved the operating license for the world's first geologic repository for spent nuclear fuel.[97]

2. Current Status

Nuclear power is the source of about 30% of the electricity produced in Finland.[98] Four nuclear reactors currently operate within the country, two in Olkiluoto and two in Loviisa.[99] Two companies operate the plants: Fortum Power and Heat Oy, whose majority owner is the state, and TVO.[100] The two companies created and own the corporation Posiva to manage HLW disposal at the geologic repository planned for Olkiluoto, where the HLW generated by the power plants at Olkiluoto and Loviisa will be stored.[101] Another reactor at Olkiluoto is under construction and a sixth is being planned by the industrial/energy consortium Fennovomia, which will be supplied by Russia.[102] Finland and Russia have entered into an agreement allowing the supply of the reactor and agreeing that certain international treaties on nuclear energy signed by each party will apply to the other.[103]

Radioactive waste disposal in Finland is regulated by the Nuclear Energy Act of 1987 as supplemented by the Nuclear Energy Decree.[104] Under the Nuclear Energy Act, most radioactive waste generated in Finland must be disposed of in Finland, with the exception of small amounts of waste shipped to other countries for research purposes.[105] Additionally, the Nuclear Energy Act mandates that Finland cannot import radioactive waste.[106] The companies generating nuclear waste in Finland are responsible for its disposal.[107] Waste management is overseen by both the Ministry of Trade and Industry and the Finnish Radiation and Nuclear Safety Authority.[108]

Finland is the most advanced country in terms of building and operating a deep ground repository for HLW, including spent fuel. No other nation has licensed a geologic repository for the storage of HLW and spent nuclear fuel, although Sweden is expected to license a facility in 2017.[109] For Finland's LLW and ILW, near-surface nuclear waste disposal sites have operated at Olkiluoto and Loviisa since 1992 and 1998, respectively.[110]

3. Future Implications

Finland's geologic repository will be located on the island of Olkiluoto.[111] It is expected to cost 3 billion euro and begin operating in 2023.[112] Olkiluoto is also currently the site of a nuclear power plant,[113] eliminating the need to transport waste from that plant long-distance. Finland's success in licensing a geologic repository could serve as a model for other nations. The BRC in the United States examined Finland's strategy as a part of its study on methods for HLW disposal.[114] Sweden is using a similar process to that used in Finland, and is expected to decide on whether to license Forsmark as the location for its HLW disposal in 2017.[115]

Despite the success of Olkiluoto, Finland still faces challenges in the future. Posiva claims the Olkiluoto disposal site will only have room for nuclear wastes from two of Finland's nuclear power plants, located at Olkiluoto and Loviisa, and not for a proposed third plant located in Hanhikivi.[116] The reactor planned for Hanhikivi is being developed through Fennovomia, the only nuclear energy

NEA Countries: Finland 3 (2008), *available at* http://www.oecd-nea.org/law/legislation/finland.pdf.

88. *Id.*
89. European Commission, *Nuclear Energy*, https://ec.europa.eu/energy/en/topics/nuclear-energy (last updated Feb. 21, 2017).
90. BRC, *supra* note 62, at 49.
91. Gibney, *supra* note 40; OECD NEA, *supra* note 87, at 3-4.
92. *Id.*
93. *Id.*
94. World Nuclear Association, *National Policies and Funding*, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/appendices/radioactive-waste-management-appendix-3-national-p.aspx (last updated Sept. 2016).
95. OECD NEA, *supra* note 87, at 4.
96. *National Policies and Funding*, *supra* note 94.
97. Gibney, *supra* note 40.
98. *National Policies and Funding*, *supra* note 94.
99. OECD NEA, *supra* note 87, at 3.
100. *Id.*; *National Policies and Funding*, *supra* note 94.
101. *National Policies and Funding*, *supra* note 94.
102. World Nuclear Association, *Nuclear Power in Finland*, http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/finland.aspx (last updated Jan. 31, 2017).
103. *Id.*
104. OECD NEA, *supra* note 87, at 9.
105. *Id.*
106. *Id.*
107. *National Policies and Funding*, *supra* note 94.
108. OECD NEA, *supra* note 87, at 9.
109. Gibney, *supra* note 40.
110. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
111. Gibney, *supra* note 40.
112. *Id.*
113. *Id.*
114. BRC, *supra* note 62, at 49.
115. Gibney, *supra* note 40.
116. *National Policies and Funding*, *supra* note 94.

company that does not have ownership interest in Posiva.[117] Although Fennovomia is negotiating with Posiva for use of the repository, a second repository may be necessary to dispose of wastes that will be generated from Hanhikivi.[118]

C. Russia

1. History

Russia began working with nuclear technology as early as 1900.[119] Paralleling the development of nuclear technology in the United States and elsewhere, the focus of Russian nuclear research was on military applications during World War II.[120] After the end of the war, the Soviet Union continued its research into producing an atomic bomb.[121] In 1945, construction began on nuclear reactors, the first of which began operating in 1948, and the first nuclear power plants in the Soviet Union were commissioned in 1964.[122] In 1957, the Soviet Union began searching for sites to inject liquid radioactive waste into rock formations that could seal the waste within the rock; three sites were identified and used, two of which are still active today.[123] Tens of millions of cubic meters of radioactive waste have been injected into underground rock formations in Russia.[124]

Russia also dumped some nuclear waste at sea, both directly into the sea and contained in decommissioned ships.[125] Additionally, several ships fueled by nuclear energy were lost at sea.[126] Russia has worked with other countries and international organizations to identify the locations of sunken ships and retrieve them.[127]

The world's worst nuclear accident occurred under Soviet rule in Ukraine at the Chernobyl nuclear power plant.[128] The accident began on April 25, 1986, and was attributed directly to design flaws and faulty operating, and indirectly to Cold War policies of secrecy of nuclear technology, including safety standards.[129] The accident resulted in 30 deaths, increased rates of thyroid cancer, and the evacuation of a 30-kilometer area around the plant.[130] The Chernobyl disaster resulted in increased safety measures in nuclear power plants worldwide; it also increased public fear and distrust of nuclear technology worldwide.[131]

The Ministry for Atomic Energy implemented nuclear energy policy until December 2007, at which time it was replaced by law with Rosatom, a publicly owned state atomic energy corporation.[132] Rosatom owns and operates all components of the nuclear fuel cycle and is responsible for implementing laws related to nuclear energy.[133] In 2003, Krasnokamensk was identified as a potential site for a geologic repository.[134] In 2005, Russia ratified the Vienna Convention on Civil Liability for Nuclear Damage, and in 2006, Rosatom declared it would not import spent nuclear fuel of foreign origin.[135]

2. Current Status

Russia has 10 nuclear power plants, and about 17% of energy in Russia is derived from nuclear energy.[136] Russia's nuclear energy consumption will increase in the future as 10 nuclear reactors are under construction and 20 more are planned.[137] Nuclear energy safety standards are regulated by an independent regulatory commission, Rostechnadzor.[138]

Scientists in Russia have proposed placing HLW in deep shafts, and then using nuclear explosions to immobilize the material within the shaft.[139] This idea has been rejected because of the potential to disturb rock formations and contaminate groundwater, and it goes against current policies not to set off nuclear explosions.[140] Russia practices fuel leasing, whereby enriched uranium is provided to other nations for purposes of producing nuclear energy, notably non-weapon Nuclear Non-Proliferation Treaty (NPT) nations such as Iran and India, where Russia has built nuclear power plants, and then the spent fuel is shipped back to Russia for storage and eventual disposal.[141]

Russia's default policy is for the receiving nation only to return the spent fuel, while the receiving nation keeps the waste generated.[142] A law passed by the Duma, Russia's parliament, in 2001 allows the importation of spent fuel for purposes of reprocessing and the return of the waste to the originating country.[143] Russia also practices fuel reprocessing, which involves storing spent fuel for several years before reprocessing it, and then vitrifying the resulting waste.[144]

117. Thomas Nilsen, *Finland's Nuclear Dilemma*, Barents Observer, Mar. 25, 2015, http://barentsobserver.com/en/energy/2015/03/finlands-nuclear-dilemma-25-03.
118. *Id.*
119. *Outline History of Nuclear Energy*, *supra* note 1.
120. *Id.*
121. *Id.*
122. *Id.*
123. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
124. *Id.*
125. Walter Sullivan, *Soviet Nuclear Dumps Disclosed*, N.Y. Times, Nov. 24, 1992, http://www.nytimes.com/1992/11/24/science/soviet-nuclear-dumps-disclosed.html; Laurence Peter, *Russia Explores Old Nuclear Waste Dumps in Arctic*, BBC, Jan. 25, 2013, http://www.bbc.com/news/world-europe-21119774.
126. Sullivan, *supra* note 125; Peter, *supra* note 125.
127. Sullivan, *supra* note 125; Peter, *supra* note 125.
128. World Nuclear Association, *Chernobyl Accident 1986*, http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx (last updated Nov. 2016).
129. *Id.*
130. *Id.*
131. *Id.*; BRC, *supra* note 62, at 24.
132. International Energy Agency, Russia 2014, at 250 (2014), *available at* http://www.iea.org/publications/freepublications/publication/Russia_2014.pdf.
133. *Id.*
134. *International Nuclear Waste Disposal Concepts*, *supra* note 14.
135. *Id.*
136. International Energy Agency, *supra* note 132, at 243.
137. *Id.* at 243-44.
138. *Id.* at 251.
139. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
140. *Id.*
141. *International Nuclear Waste Disposal Concepts*, *supra* note 14.
142. *Id.*
143. *Id.*
144. International Energy Agency, *supra* note 132, at 255. Vitrification in the nuclear waste context involves incorporating the waste into a stable glass

Because of Russia's experience with fuel leasing and reprocessing, Russia may be particularly suited to assist other nations in their nuclear waste disposal solutions. Russia already allows the importation of foreign spent fuel and has legal structures in place for the importation of nuclear waste. However, Russia has yet to develop concrete plans for a repository to store its own HLW, and is not as advanced as nations such as Finland, Sweden, and France in this area.

D. Japan

1. History

Japan has few energy resources, and after World War II, the country became highly invested in the development of nuclear energy.[145] In 1955, Japan passed the Atomic Energy Basic Law, establishing several agencies to research, implement, and regulate the use of nuclear technology.[146] Japan's first commercial reactor began operating in 1966.[147] Before the accident at Fukushima, Japan had more than 50 nuclear reactors, which supplied about 30% of the country's energy.[148] Japan planned to increase the amount of power supplied by nuclear energy, but in March 2011, a 9.0 magnitude earthquake caused a devastating tsunami, which in turn caused an accident at the nuclear power plant in Fukushima.[149] More than 100,000 people were evacuated because of the nuclear accident, and cleanup of the impacted areas is still ongoing.[150] Following the Fukushima incident, Japan stopped operating all its commercial nuclear reactors and is in the process of testing those reactors and reinstating them for use.[151]

In the past, Japan disposed of some nuclear wastes in the sea; however, that practice was banned by the London Convention on Prevention of Marine Pollution by the Dumping of Waste and Other Matters in 1994.[152] In 2000, the Law on Final Disposal of Specified Radioactive Waste was passed, mandating that HLW be disposed of in a deep ground repository.[153]

2. Current Status

LLW and some ILW with relatively short half-lives have been stored at Rokkasho-Mura since 1992.[154] The facility is operated by a private company, Japan Nuclear Fuel Limited, which is led by 10 domestic power companies.[155] Japan sends its spent nuclear fuel to Europe for reprocessing and vitrification, and the vitrified fuel is then returned to Japan and stored at Rokkasho-Mura.[156]

The Ministry of Economy, Trade, and Industry is responsible for radioactive waste management, and radioactive waste is managed under the Regulation Law.[157] Deep ground disposal of wastes is regulated by the Law on Final Disposal of Specified Radioactive Waste.[158] The private sector formed the Nuclear Waste Management Organization to comply with this law.[159] The Atomic Energy Commission and the Nuclear Safety Commission regulate waste management policy through licensing nuclear activities.[160]

3. Future Implications

Japan plans to build a geologic repository to store HLW.[161] Originally, Japan asked for municipalities to volunteer to be the site of a geologic repository.[162] Only one town, with poor finances, volunteered in 2007, but withdrew after significant local opposition.[163] Japan now plans to identify potential sites and then work with the communities to choose a site.[164] While this remains the official policy, some have raised concerns that the site would be susceptible to earthquakes.[165] Japan has not started to choose sites for such a repository, and so a repository would not begin operating until the 2040s at the earliest[166] to store Japan's 17,000 metric tons of HLW.[167] Japan faces a similar problem to the United States, as public fear and distrust of the presence of a geologic repository will likely make site selection difficult politically, especially in the wake of such a significant nuclear accident.[168]

Additionally, Japan faces an ever-increasing amount of nuclear waste from the cleanup of cities and towns affected by the Fukushima accident, which has been collected in bags and is being moved between temporary storage locations.[169] Although the government plans to build an interim storage facility to store all of the waste collected,

form. World Nuclear Association, *Treatment and Conditioning of Nuclear Wastes*, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/treatment-and-conditioning-of-nuclear-wastes.aspx (last updated Sept. 30, 2016).

145. Wayne Drash, *Why Japan Relies on Nuclear Power*, CNN, Mar. 15, 2011, http://www.cnn.com/2011/WORLD/asiapcf/03/14/japan.nuclear.history.qa/index.html; World Nuclear Association, *Nuclear Power in Japan*, http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/japan-nuclear-power.aspx (last updated Feb. 8, 2017).
146. Drash, *supra* note 145.
147. *Id.*
148. *Id.*
149. *Id.*
150. *Id.*; Peter Wynn Kirby, *Playing Pass the Parcel With Fukushima*, N.Y. Times, Mar. 7, 2016, https://www.nytimes.com/2016/03/08/opinion/playing-pass-the-parcel-with-fukushima.html.
151. Drash, *supra* note 145; Yuriy Humber et al., *Japan's 17,000 Tons of Nuclear Waste in Search of a Home*, Bloomberg, July 10, 2015, http://www.bloomberg.com/news/articles/2015-07-10/japan-s-17-000-tons-of-nuclear-waste-in-search-of-a-home.
152. *Storage and Disposal of Radioactive Wastes*, *supra* note 11; OECD NEA, Nuclear Legislation in OECD and NEA Countries: Japan 9 (2011), *available at* http://www.oecd-nea.org/law/legislation/japan.pdf.
153. *National Policies and Funding*, *supra* note 94.
154. *Storage and Disposal of Radioactive Wastes*, *supra* note 11; *National Policies and Funding*, *supra* note 94.
155. *Storage and Disposal of Radioactive Wastes*, *supra* note 11; *National Policies and Funding*, *supra* note 94.
156. *National Policies and Funding*, *supra* note 94.
157. *Id.*; OECD NEA, *supra* note 152, at 8.
158. OECD NEA, *supra* note 152, at 8.
159. *National Policies and Funding*, *supra* note 94.
160. OECD NEA, *supra* note 152, at 8.
161. Gibney, *supra* note 40.
162. Humber et al., *supra* note 151.
163. *Id.*
164. *Id.*
165. *Id.*
166. Gibney, *supra* note 40.
167. Humber et al., *supra* note 151.
168. Kirby, *supra* note 150.
169. *Id.*

the government does not yet even own all the land it needs to build this facility.[170]

II. International Structures

A. Organizations

The most significant international organization related to all aspects of nuclear technology, including the waste produced from the technology, is the International Atomic Energy Agency (IAEA). The IAEA assists States with the management of radioactive wastes through several mechanisms. Through its Radioactive Waste and Spent Fuel Management Program, the IAEA develops safety standards for the management and disposal of radioactive waste, and assists nations in accomplishing those standards.[171] The IAEA also operates several projects on the disposal of both LLW and HLW.[172] Additionally, the IAEA provided the forum for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[173]

B. International Agreements

The most comprehensive international agreement on the disposal of radioactive waste is the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[174] There are 69 parties, all nations, to the agreement, through which 65 of the Parties have submitted reports on the status of radioactive waste disposal in their countries.[175]

International agreements, notably the United Nations Convention on the Law of the Sea and the London Convention on Prevention of Marine Pollution by the Dumping of Waste and Other Matters, currently prevent all forms of sea disposal of radioactive waste, including sea dumping, disposal at a subduction zone, and sub-seabed disposal.[176] Until 1980, some nations considered disposing of nuclear waste in ice sheets, such as those located in Greenland and Antarctica; however, such disposal is not permitted by the 1959 Antarctic Treaty, so parties to the treaty have rejected the idea.[177]

III. Multinational Repositories

Not all countries have the geographic or financial capabilities to build their own repositories.[178] Additionally, building multiple disposal sites within a relatively small area is not economically efficient and provides more opportunities for interference by terrorism, natural disasters, or human error.[179] Several countries without the capabilities to dispose of nuclear wastes have become proponents of building a multinational repository.[180]

A. Proposals

Multinational approaches to radioactive waste disposal can be traced back to at least 1975, when the IAEA studied the idea of multinational regional nuclear fuel cycle centers, including reprocessing and waste disposal in such centers.[181] This idea was never undertaken, with nations preferring to develop their own programs for nuclear energy.[182] In the 1990s, the United Kingdom company Pangea Resources identified Argentina, Australia, southern Africa, and western China as the optimal locations for multinational repositories in terms of geographic attributes.[183] The company identified Australia as the best of these sites because of the economic and political well-being of the nation.[184] Consequently, the Western Australian government passed a law requiring parliamentary approval for the disposal of any foreign HLW.[185]

B. Organizations

The IAEA has encouraged the investigation and development of multinational repositories.[186] In both 1998 and 2004, the IAEA issued reports on the subject of multinational repositories.[187] In its 2004 report, the IAEA acknowledged it was likely the organization best-suited to assist nations in developing a national repository.[188] It also suggested in its report the creation of an international organization to facilitate the development of a multinational repository.[189]

As a successor to the Pangea proposal, the Association for Regional and International Underground Storage (ARIUS) was created in 2002 to "explore ways of providing shared radioactive waste management approaches and facilities."[190] ARIUS, which includes both nations and relevant industrial organizations as members, is currently focusing its efforts on the possibility of multinational

170. *Id.*
171. IAEA, *Safety of Radioactive Waste and Spent Fuel Management*, http://www-ns.iaea.org/tech-areas/waste-safety/disposable.asp (last updated Dec. 9, 2014).
172. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
173. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, *supra* note 16.
174. IAEA, Developing Multinational Radioactive Waste Repositories: Infrastructural Framework and Scenarios of Cooperation 33 (2004) (IAEA-TECDOC-1413), *available at* http://www-pub.iaea.org/MTCD/publications/PDF/te_1413_web.pdf.
175. Joint Convention on the Safety of Spent Nuclear Fuel Management and on the Safety of Radioactive Waste Management, Fifth Review Meeting of the Contracting Parties, Final Summary Report 3 (2015), http://www-ns.iaea.org/downloads/rw/conventions/fifth-review-meeting/summary-report-fifth%20review%20meeting-e.pdf.
176. *Storage and Disposal of Radioactive Wastes*, *supra* note 11.
177. *Id.*
178. *Id.*
179. *Id.*
180. IAEA, *supra* note 174, at 1.
181. *Id.* at 8.
182. *Id.*
183. *International Nuclear Waste Disposal Concepts*, *supra* note 14.
184. *Id.*
185. *Id.*
186. *Id.*
187. IAEA, *supra* note 174, at 1-2.
188. *Id.* at 39.
189. *Id.* at 40.
190. *International Nuclear Waste Disposal Concepts*, *supra* note 14.

repositories in Europe.[191] From 2003 to 2005, ARIUS conducted a pilot project, the Strategic Action Plan for Implementation of European Regional Repositories (SAPIERR), with Slovakia coordinating the project.[192] The project was approved by the European Commission (EC), and "allowed potential options for regional collaboration and for regional repositories to be identified."[193]

From 2006 to 2009, the EC funded the SAPIERR project "to assess the feasibility of European regional waste repositories, with fifty entities from 21 nations participating" to further the goals of the EC's Radioactive Waste Directive; the project resulted in 10 countries creating the European Repository Development Organization (ERDO).[194] While these countries have decided to pursue a multinational strategy, other European countries, including Finland, France, and Sweden, have decided to dispose of wastes within their own borders.[195]

ARIUS is also developing programs similar to ERDO in the Gulf, Middle East, and Africa region, as well as the Southeast Asia region.[196] These efforts are funded by two U.S. charitable organizations.[197] In the Middle East, ARIUS expects a regional repository would cost about $4 billion and would increase the security of the wastes, but would not be needed until 2080.[198] In April 2012, a meeting organized by the Arabic Atomic Energy Association, the IAEA, and ARIUS was held to work on nuclear waste disposal strategies in the region.[199] While the United Arab Emirates, a country that uses nuclear power, hosted the meeting, all the participants were countries with no nuclear power, highlighting the concerns of those countries about the safe disposal of nuclear waste.[200]

C. *The Current State of International Radioactive Waste Disposal and Opposition to Multinational Repositories*

Shipment of nuclear waste between nations has occurred from as early as 1950, with fuel being transferred between European nations for reprocessing.[201] Currently, the United States and Russia take back spent fuel used for research in other nations.[202] Some nations have also transferred wastes in a limited capacity or on a one-time basis. For example, in 2000, some LLW from industrial medical applications was shipped from Spain to the United States for disposal at Hanford, an LLW/ILW waste disposal site in Washington, because the waste was not accepted at Spain's disposal facility.[203] Another interesting example is an exchange between Sweden and Germany. Sweden committed 57 tons of fuel for reprocessing, but was not able to store the reprocessed waste with its other radioactive wastes.[204] Since Germany was without a place to store 24 tons of mixed oxide fuel, the nations traded wastes, which could be appropriately stored at the other nation's facility.[205]

The IAEA suggests that the transfers of limited amounts of waste and spent nuclear fuel that currently occur could serve as a basis for transferring wastes between nations for placement in a geologic repository.[206] If countries enter into negotiations to form a multinational repository, those nations will need to determine which nation(s) will be liable for the waste and for how long.[207] Additionally, international agreements limit the movement of nuclear materials, including radioactive wastes, between countries. For example, the NPT will require a multinational repository to be approved by the signatories to the treaty, which include nearly all the countries in the world except for India, Israel, North Korea, and Pakistan.[208] Therefore, only a country that can be almost universally trusted to securely and safely dispose of the wastes, including having the necessary political, financial, and geographic stability, may be agreed upon as an acceptable location.[209]

Additionally, many countries that supply uranium, enriched uranium, or spent nuclear fuel supply those materials while maintaining control over where the materials and wastes go and how they are used.[210] For instance, the United States has such "consent rights" over 33,000 metric tons of spent fuel located in other countries.[211] The United States therefore would need to approve the wastes for disposal in a multinational repository, and transfer and disposal would need to comply with U.S. policy on nuclear waste.[212]

Despite the potential legal feasibility of transferring radioactive waste and the current practice of doing so in limited applications, most nations remain skeptical about the possibility of a multinational repository.[213] Currently, nuclear waste transferred between countries either originated in some form in the disposal nation, involved minor amounts of LLW, or was a part of a fuel reprocessing program. Even in the case of fuel reprocessing and fuel leasing, the waste is either shipped back to the country in which it was generated through use in a nuclear reactor (in the case of fuel reprocessing) or wastes other than the

191. *Id.*
192. *Id.*
193. *Id.*
194. *Id.*
195. *Id.*
196. *Id.*
197. Association for Regional & International Underground Storage, *supra* note 15.
198. *International Nuclear Waste Disposal Concepts*, *supra* note 14.
199. Association for Regional & International Underground Storage, *supra* note 15.
200. *Id.*
201. IAEA, *supra* note 174, at 7.
202. *Id.*
203. *Id.*
204. *Id.* at 6.
205. *Id.* at 6-7.
206. *Id.* at 35.
207. *Id.*
208. *International Nuclear Waste Disposal Concepts*, *supra* note 14.
209. *Id.*
210. IAEA, *supra* note 174, at 35-36.
211. *Id.*
212. *Id.* at 6.
213. Joint Convention on the Safety of Spent Nuclear Fuel Management and on the Safety of Radioactive Waste Management, *supra* note 175.

spent fuel are retained by the lessee country (in the case of fuel leasing).[214]

Choosing a location that is acceptable to the national governments involved, as well as the people in those nations, is perhaps the most difficult component of creating a multinational repository.[215] Even if a nation's government agrees to host a multinational repository, its people will almost certainly oppose responsibility for nuclear wastes that have no connection to their own nation.[216] For example, although current fuel reprocessing standards are to return the waste generated from reprocessing to the country that used the nuclear fuel, originally under fuel reprocessing contracts the reprocessing nation generally kept the nuclear wastes.[217] Due to public concern about nuclear issues, post-1976 reprocessing contracts allowed for waste return.[218]

As circumstances in the United States indicate, identifying a location to store a nation's own nuclear waste can incur public opposition that suspends the construction of a repository altogether.[219] Gaining public support for a multinational repository will likely be even more difficult. Additionally, no national program has yet started storing HLW in a geologic repository. It may prove difficult for nations to agree to storing the waste internationally when disposal of their own wastes has not even begun. Some scholars have suggested that a multinational repository will not be feasible until at least one nation has started operating its own HLW facility because "[t]he public at large will need to see that such a facility is feasible on a 'local' level before the attempt at a multi-national effort can become a reality."[220] This event is likely to occur relatively soon, with Finland's repository expected to begin operations in 2023.[221]

However, the mere existence of a functioning HLW repository will not resolve the complex issues surrounding public acceptance of a multinational repository. In 1998 and 2001, the EC conducted studies on the opinions of European citizens about nuclear waste.[222] Several of the questions included in a survey of European citizens related to the disposal of radioactive waste in the producing nation's own borders and the development of multinational repositories.[223] Between 1998 and 2001, the attitudes toward the acceptability of multinational repositories increased somewhat, although only 18% of those surveyed thought radioactive wastes should be stored in such a facility, and 63% of those surveyed still thought radioactive waste should remain within the borders of the nation that produced the waste.[224] Further, the study appeared to indicate that a serious discussion of a multinational repository could increase public opposition to such a repository,[225] and that roughly 80% of European citizens were against importing waste from other nations for purposes of storage, processing, or disposal.[226]

SAPIERR reported that although the EC stopped asking questions about multinational radioactive waste disposal in future surveys, asking such questions would be helpful in measuring general public opinion in Europe about multinational repositories.[227] However, a subsequent study by the Institute for Technology Assessment & Systems Analysis demonstrated that even among national populations relatively open to the idea of a multinational repository within their nation's borders, respondents were against the placement of such a repository within their own region.[228]

SAPIERR noted that one of the most significant sources of political opposition to a multinational repository would likely be ethical opposition to such a repository.[229] One of the major concerns of the public that scholars predict is the possibility of dumping radioactive waste in a nation with low public input in the political process, low governmental accountability to the people, weak environmental and safety laws, and/or "financial difficulties."[230] SAPIERR notes, though, that international law provides safeguards against disposing nuclear wastes in a nation that does not have the "administrative and technical capacity, as well as the regulatory structure, needed to safely manage the spent fuel or radioactive waste," through Article 27 of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[231]

Another reason for political opposition to multinational repositories identified by SAPIERR is the idea that nations will use the existence (or even the concept) of a multinational repository as an excuse not to develop national disposal programs.[232] Further, communities that will likely be skeptical about a national repository in their area to begin

214. IAEA, *supra* note 174, at 6; *International Nuclear Waste Disposal Concepts*, *supra* note 13.
215. Piero Risoluti et al., European Commission, SAPIERR II, Strategic Action Plan for Implementation of European Regional Repositories: Stage 2, Work Package 1 Legal & Business Options for Developing a Multinational/Regional Repository 8 (2008), *available at* http://www.erdo-wg.eu/SAPIERR_2_files/SAPIERR%20II%20WP-1%20web_2.pdf.
216. IAEA, *supra* note 174, at 24.
217. *Id*. at 6-7.
218. *Id*.
219. *See* Part I.A.3., *supra* (discussing U.S. political opposition to storing nuclear wastes in Yucca Mountain).
220. Mark Callis Sanders & Charlotta E. Sanders, *A World's Dilemma "Upon Which the Sun Never Sets"—The Nuclear Waste Management Strategy (Part I): Western European Nation States and the United States of America*, 90 Progress Nuclear Energy 60, 75 (2016).
221. Gibney, *supra* note 40.
222. European Commission, SAPIERR II, Strategic Action Plan for Implementation of European Regional Repositories: Stage 2, Work Package Public and Political Attitudes 7 (2008) (Report WP 5), *available at* http://cordis.europa.eu/pub/fp6-euratom/docs/sapierr-2-5-public-and-political-attitudes_en.pdf.
223. *Id*.
224. *Id*. at 8.
225. *See id*. at 8 (proposing that a relatively high percentage of Swedish citizens surveyed favored national disposal after a debate in Sweden on the idea).
226. *Id*. at 9.
227. *Id*.
228. *See id*. (discussing the results of the study, which found that 40% of Germans surveyed "accepted the idea of a multinational repository located in Germany"; however, 80% of the surveyed citizens were "against the repository being sited in their own region of Germany").
229. *Id*. at 10.
230. *Id*. at 10-11.
231. *Id*. at 11. The Joint Convention additionally provides that producing nations cannot store or dispose of radioactive wastes "south of latitude 60 degrees South." *Id*.
232. *Id*. at 12.

with may increase their opposition if those communities have the perception, whether correct or not, that such a repository could accept waste from other nations.[233] SAPIERR notes, though, that several nations have begun preparing strategies for national waste disposal while "leaving the door open to the possibility of joining a multinational repository."[234] SAPIERR further identified several other potential challenges to a multinational repository, some of which are similar to those faced by the United States in creating a national repository.

For example, SAPIERR noted that "the benefits of a shared repository would be enjoyed by all the participating countries, whereas the disadvantages would be borne only by the local community hosting the international waste facility,"[235] which is similar to the situation in the United States, in which the majority of nuclear waste is produced in the eastern states, while western states have received most of the focus for placement of a national repository. Additionally, similar to the concern in the United States about transporting radioactive waste long distances, increasing the chance of an accident occurring, transporting radioactive wastes across Europe would produce the same concern.[236]

Although several international organizations have and are working to study the possibility and promote the development of multinational repositories, significant public and governmental opposition remains. The concerns of the public and of governments are not unfounded, but not unresolvable. SAPIERR, among other organizations and academics, has analyzed potential solutions to the issues raised by a multinational repository. Further, existing international agreements may already provide limitations that could alleviate some of the concerns raised by multinational repositories.

D. Potential Pathways to a Multinational Repository

Several international agreements may provide not only protections against the potential ethical, technical, and logistical concerns of multinational repositories, but may also provide a justification, or even an obligation, to develop multinational repositories. Such agreements exist both on a worldwide scale and on a regional scale. Further, in certain nations, the nation's own laws can provide protection against forced acceptance of nuclear waste.

Because of the inherent danger posed by radioactive wastes, notably a danger that may not be limited to the locality in which the wastes are disposed, the international community is highly vested in disposing of radioactive wastes in the safest way possible. The international agreement most relevant to the potential development of multinational repositories, and the potential safeguards involved in such a project, is the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[237] Indeed, the very preamble of the Joint Convention states:

> [R]adioactive waste should as far as is compatible with the safety of the management of such material, be disposed of in the State in which it was generated, whilst recognizing that, in certain circumstances, safe and efficient management of spent fuel and radioactive waste might be fostered through agreements among Contracting Parties to use facilities in one of them for the benefit of the other Parties, particularly where waste originates from joint projects[.][238]

Further, the Convention provides that nations have "the right to ban import into [their] territory of foreign spent fuel and radioactive waste."[239] In addition to providing these and other protections, the treaty can also form the foundation of a multinational repository. The goals of the Joint Convention are expressed as being "worldwide," to "defen[d] against potential hazards so that individuals, society and the environment are protected."[240] Additionally, the Convention makes requirements for the safety of humans and the environment that would apply to a multinational repository, and provides specific provisions for the transboundary movement of radioactive waste.[241]

Other international agreements may assist not only in providing a framework for a multinational repository, but may create an obligation to create at minimum some sort of method to dispose of radioactive material on an international scale. For example, the Paris Agreement, entered into force on October 5, 2016, obligates developed-nation parties to assist developing-nation parties with accomplishing the goals of the Agreement, which seeks to limit the impacts of climate change.[242] Nuclear energy has the potential to be an even more widely used source of energy and provide an alternative to greenhouse gas-emitting fossil fuels; however, not all nations have the capabilities to use nuclear power and provide for the safe storage/disposal of the wastes produced.[243] The Paris Agreement provides that developed nations should support developing nations in efforts to mitigate climate change and its effects.[244] Additionally, the Agreement encourages the development of international cooperation and institutions in order to assist with the adaptation to climate change, technical support, and good practices.[245]

Regionally, Europe is the region closest to achieving a multinational repository through support from the EC's SAPIERR project, which has undertaken extensive anal-

233. *Id.*
234. *Id.*
235. *Id.* at 13.
236. *Id.*
237. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, *supra* note 16.
238. *Id.* at pmbl. xi.
239. *Id.* at pmbl. xii.
240. *Id.* at art. 1.
241. *Id.* at chs. 2-5.
242. Paris Agreement on Climate Change, arts. 2, 4, *opened for signature* Apr. 22, 2016.
243. IAEA, Viability of Sharing Facilities for the Disposal of Spent Fuel and Nuclear Waste 8 (2011) (IAEA Doc. TECDOC-1658).
244. Paris Agreement, *supra* note 242, at art. 9.
245. *Id.* at art. 7.

ysis of the establishment of a multinational repository in Europe,[246] including international and national law mechanisms for producing such a repository as well as the laws of EU countries.[247] The efforts started by the SAPIERR project have continued through the ERDO Working Group, which includes 12 European Member nations.[248] One of ERDO's goals is to assist nations with compliance with the EC Waste Directive of 2011, which specifies that member states must create national programs for the disposal of all radioactive waste.[249]

In particular, ERDO has noted the failure of the EU to assist member states with their compliance in regard to spent nuclear fuel and HLW disposal, and has proposed the development of the COMS-WD project to assist states with waste disposal programs and further analyze the "viability and value of regional repositories."[250] In regard to a regional repository, ERDO noted that "divergent opinions have been expressed in the EU."[251] The focus of COMS-WD seems to be national, at least for the first stage of the project,[252] perhaps indicating hesitation by the region to continue working toward a multinational repository.

IV. Conclusion

There is a wide disparity in the progress of national programs for the permanent storage of HLW. While nations such as Finland, France, and Sweden are nearing the operational stages of a deep ground repository for HLW, other nations are just beginning to construct nuclear power plants and do not have plans for the disposal of HLW. Japan, Russia, and the United States were all early users of nuclear power and weapons, and yet have not decided on a site for a geologic repository, and so HLW will remain in temporary storage for decades at least.

While nations are responsible for their own nuclear wastes under international treaties, disposing of HLW within the nation's own borders is not feasible for some nations. For example, in Japan, earthquakes (or the fear of earthquakes) may render deep geologic disposal an impossibility. Yet, deep geologic disposal is currently the best option for the disposal of HLW. These circumstances may necessitate the creation of at least one multinational repository through which nations can dispose of their wastes securely.

Based on current legal structures for the transportation and exchange of nuclear materials between countries, a multinational repository may be legally feasible. Almost all the nations involved in nuclear technology are also involved in international cooperation on nuclear technology, and there are several international organizations and treaties that could facilitate the creation of a multinational repository. However, it may be nearly impossible politically for one nation to agree to carry the burden of another nation's or nations' nuclear wastes for as long as 100,000 years. Overall, national strategies for permanent disposal of HLW are making progress in some countries, but a multinational repository may become a necessity as HLW continues to pile up in countries that cannot safely dispose of it within their own borders.

246. *See generally* European Commission, SAPIERR II, Strategic Action Plan for Implementation of European Regional Repository Final Activity Report (2009) (PAR No. 2), *available at* http://cordis.europa.eu/pub/fp6-euratom/docs/sapierr-ii-final-report.pdf (summarizing the efforts of the SAPIERR program).
247. *Id.*; SAPIERR II, *supra* note 222, at 14-15 tbl. 3.
248. ERDO Working Group, *Members*, http://www.erdo-wg.eu/Members.html (last visited Feb. 20, 2017).
249. ERDO Working Group, COMS-WD: A New Proposal for Cooperation Between EU Member States Responding to the EC Waste Directive, *available at* http://www.erdo-wg.eu/Documents_files/COMS-WD.pdf.
250. *Id.*
251. *Id.*
252. *Id.*