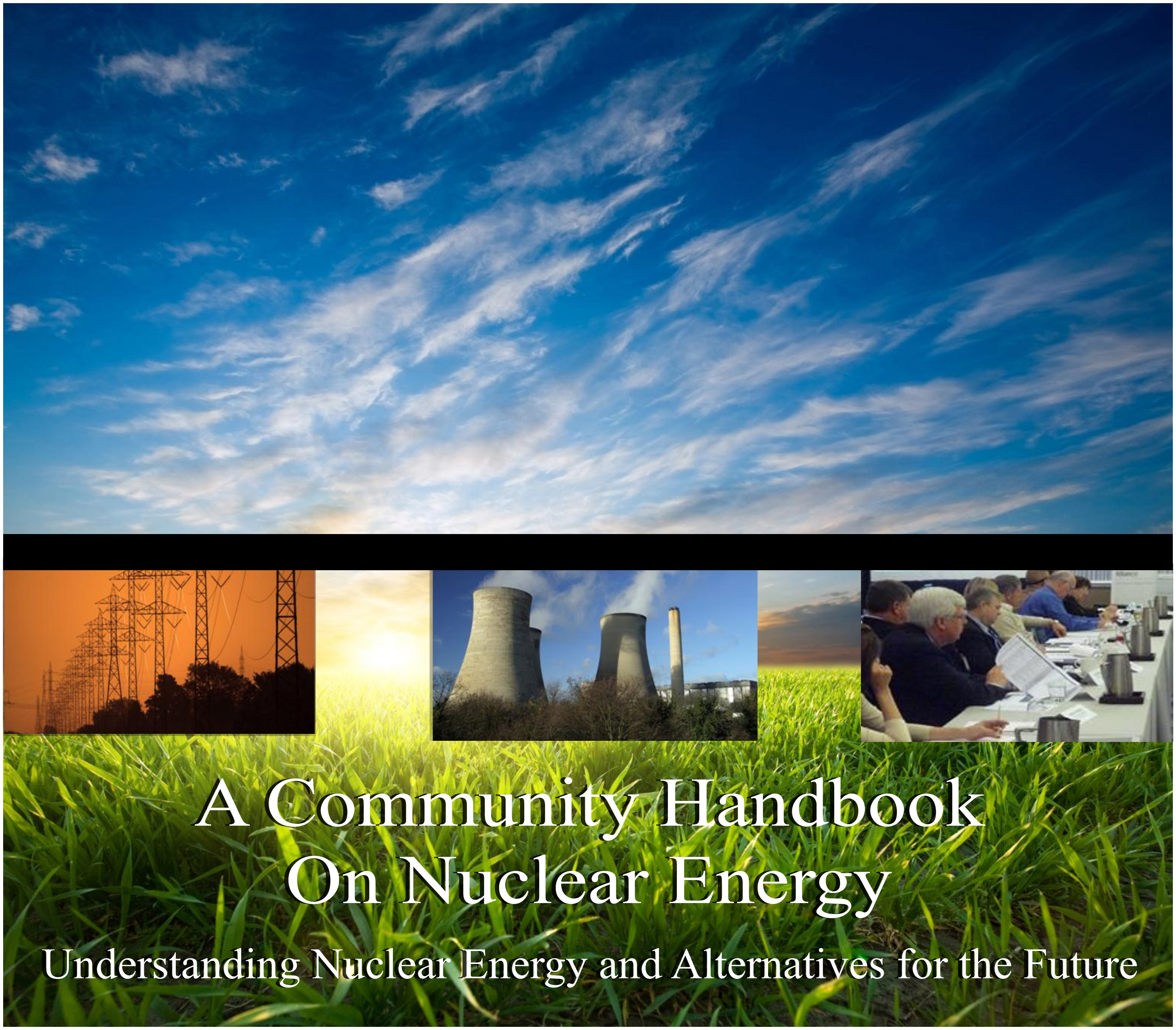

A Community Handbook On Nuclear Energy

Understanding Nuclear Energy and Alternatives for the Future

Energy Communities Alliance

A COMMUNITY HANDBOOK ON NUCLEAR ENERGY:

Understanding Nuclear Energy and Alternatives for the Future

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ACKNOWLEDGEMENTS

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This handbook is an update to the version originally released in March 2012. The authors are Kara Colton, Allison Doman and Seth Kirshenberg of ECA. The authors gratefully acknowledge the assistance of many local government officials, including the ECA Board of Directors impacted by nuclear waste and storage issues, those interested in nuclear fuel cycle alternatives, and those communities considering support for new nuclear energy facilities and technology development. We also appreciate assistance from Department of Energy officials who provided input and resources.

Finally, ECA would like to thank the many individuals who reviewed and provided input and technical guidance to ECA on the drafts of this handbook.

LIST OF ABBREVIATIONS

AEA: Atomic Energy Act
AEC: Atomic Energy Commission
AEO: Annual Energy Outlook
AFCI: Advanced Fuel Cycle Initiative
BIA: Bureau of Indian Affairs
BNFL: British Nuclear Fuels
BRC: Blue Ribbon Commission on America's Nuclear Future
BWR: Boiling Water Reactor
CO_2: Carbon Dioxide
DHLW: Defense High-Level Waste
DNFSB: Defense Nuclear Facilities Safety Board
DOE: Department of Energy
DOE-EM: Department of Energy-Office of Environmental Management
DOE-NE: Department of Energy-Office of Nuclear Energy
DOE STRATEGY: Department of Energy's Strategy for the Management and Disposal for Used Nuclear Fuel and High-Level Radioactive Waste
DOI: Department of Interior
DOT: Department of Transportation
ECA: Energy Communities Alliance
EDF: Électricité de France
EIA: Energy Information Administration
EM: Environmental Management or Office of Environmental Management
EPA: Environmental Protection Agency
EPRI: Electric Power Research Institute
FEMA: Federal Emergency Management Agency
FFHR: Fusion-Fission Hybrid Reactor
GAO: Government Accountability Office
HLW: High-Level Waste
IAEA: International Atomic Energy Agency
INL: Idaho National Laboratory
ISFSI: Independent spent fuel storage installation
JAEA: Japan's Atomic Energy Agency
kWh: Kilowatt Hour
LLW: Low-Level Waste
LWR: Light Water Reactor
MDO: Waste management and disposal organization
MOX: Mixed Oxide
MRS: Monitored Retrievable Storage
NARUC: National Association of Regulatory Utility Consumers
NAS: National Academy of Sciences
NE: Nuclear Energy or Office of Nuclear Energy
NEI: Nuclear Energy Institute
NFS: Nuclear Fuel Services
NGO: Non-Governmental Organization
NIF: National Ignition Facility
NIMBY: Not in My Backyard
NNSA: National Nuclear Security Administration
NRC: Nuclear Regulatory Commission
NRG: NRG Energy, Inc.
NUMO: Nuclear Waste Management Organization of Japan
NWF: Nuclear Waste Fund
NWPA: Nuclear Waste Policy Act
NWTRB: National Waste Technical Review Board
ONSIR: Office of Nuclear Security and Incident Response
OPEC: Organization of the Petroleum Exporting Countries
PFS: Private Fuel Storage, LLC
MIT: Massachusetts Institute of Technology
PILT: Payment in Lieu of Taxes
PUREX: Plutonium-Uranium Extraction
PWR: Pressurized Water Reactor
R&D: Research and Development
RCRA: Resource Conservancy and Recovery Act
SFR: Sodium-Cooled Fast Reactor
SMR: Small Modular Reactor
SNF: Spent Nuclear Fuel
TEPCO: Tokyo Electric Power Company
TMI: Three Mile Island
TRU Waste: Transuranic Waste
UN: United Nations
UREX+: Uranium Reduction and Extraction
WANO: World Association of Nuclear Operators
WIPP: Waste Isolation Pilot Plant
WNA: World Nuclear Association

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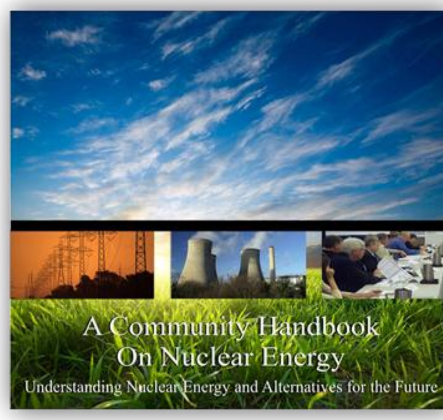
CONTENTS

APPENDICES

EXECUTIVE SUMMARY

Local governments have a critical role to play in the development of new nuclear facilities and need to be part of the discussion on future nuclear policy with decision-makers at the federal, state and regional levels. Nuclear facilities and activities can provide a community, region and state with economic opportunities. Expanding nuclear energy manufacturing and resources also can provide a "clean" and reliable electricity supply. However, risks do exist and a community must become educated in order to understand and address such risks.

Energy Communities Alliance (ECA) developed *A Community Handbook on Nuclear Energy: Understanding Nuclear Energy and Alternatives for the Future* (Handbook) to assist local communities in identifying and understanding the myriad issues associated with potentially hosting a nuclear power production, manufacturing, defense, disposal or other facility. Included in this Handbook is the history of issues that should be considered and more importantly the role that local governments and communities can play in the development of a nuclear facility in their community.



This Handbook is an update of the May 2012 version of *A Community Handbook on Nuclear Energy* (Original Handbook). Although many of the lessons learned and the history have not changed since the Original Handbook was published, a number of efforts to prioritize and address nuclear waste management have evolved and key issues such as the role of the local government in siting a nuclear waste facility are addressed in this update. Further, this Handbook expands on local community strategies, provides an update on the future of the nuclear industry in the United States, and addresses new waste management legislation that has been introduced in the past two Congresses.

This Handbook is not written by people who work for the nuclear industry, the federal government, or anti- or pro-nuclear groups. Instead, this Handbook is written from the experience of local governments that host nuclear facilities, which have been and will be most impacted by any policies regarding nuclear energy development and nuclear waste management. ECA's leadership consists of mayors, councilmembers, commissioners, chairpersons, judges, city and county managers, Community Reuse Organization executives and board members, economic development professionals, and others. They assisted in the development of this Handbook and provided input into the realities of hosting such a facility, including the benefits and challenges.

Handbook Outline

From the outset this Handbook introduces local governments that may be interested in hosting nuclear facilities to the concepts, terminology, benefits and challenges associated with nuclear energy and nuclear waste. This Handbook aims to assist local communities to better understand the development and impact of nuclear energy policies; the various stages of the "nuclear fuel cycle;" alternatives to manage, store and dispose of nuclear waste; and the new nuclear technologies that are being developed.

At the beginning of each chapter, key issues are outlined for local governments and communities to consider, and, at the end of each chapter, this Handbook makes recommendations for local governments and communities interested in taking an active role in the future of nuclear energy.

Finally, this Handbook includes case studies in Appendix A that consider how nuclear waste issues are handled in other countries. Specifically, the case studies examine the role of local governments in other countries that are evaluating whether to (1) increase the use of nuclear energy, (2) close the fuel cycle to manage nuclear waste or (3) develop a permanent geological repository for high-level nuclear waste. Some aspects of the case studies can serve as models for communities in the United States to consider.

Recommendations

Nuclear energy policy — in regards to new nuclear facility development and nuclear waste management — is constantly evolving. In 2012, the United States Department of Energy (DOE) announced the first award of a small modular nuclear reactor (SMR) grant to the Babcock & Wilcox Company to support accelerated development of its mPower™ SMR technology. In addition, DOE announced $13 million in new investments for university-led nuclear innovation projects.[1] A year later, DOE awarded NuScale Power a second round of funding to develop SMR technologies. Also in 2013, DOE announced it was investing $3.5 million for four advanced nuclear reactor projects[2] and funding a new dry storage research and development project led by the Electric Power Research Institute (EPRI).[3]

In 2013 the Department issued *The Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* (DOE Strategy) in response to a Congressionally-mandated requirement.[4] The DOE Strategy relies on a new federal entity to manage nuclear waste that will need to be created through federal legislation. The Senate Energy and Natural Resources Committee released two pieces of legislation in subsequent Congresses[5] on nuclear waste issues. As of this printing neither piece of legislation had moved beyond that committee,[6] and the House and Senate are still in disagreement on the necessity of new nuclear waste management legislation.

Several questions have evolved out of the nuclear waste policy debate:

- What is the role of local government in manufacturing or utilizing SMRs?
- What is the role of local governments in communities that could become hosts for interim or permanent waste management?
- Why would a community — specifically states, local governments and, where applicable, tribal lands — want to a host a new facility?

- What incentives exist for hosting a new facility?

This evolution has created opportunities for local governments to engage with state and federal decision-makers to develop, support and implement plans for the future of nuclear energy.

Below are five general recommendations for local communities to consider as they evaluate whether to host nuclear reactors to produce electricity and nuclear waste facilities:

1. Local governments must be educated and actively engage with DOE, regulatory bodies (including NRC and EPA), federal policy-makers, the state (in its multiple roles), and industry early (and often) in the decision-making process on siting new nuclear facilities.

Local government and community involvement in the discussion of future nuclear policy decisions is critical at all stages of the discussion — beginning with the development of the vision, refining the goals and priorities, and providing input when conflicts arise. A community can make more informed decisions if it has a full understanding of the benefits and risks that come with constructing, operating and hosting a new nuclear power plant, a nuclear waste storage facility, a manufacturing plant or enrichment facility.

Community leaders need to be informed and engaged with officials at the state and federal level. Hiring experts to provide independent analyses of key community issues to local governments will enable them to educate their citizens and citizens in adjacent communities. In addition, this information can help local governments ensure that state and federal policy-makers and regulators understand community priorities. Education will be helpful as nuclear advocates are sure to face political and public opposition to the siting of a nuclear facility.

A new, consent-based siting process has been proposed to facilitate transparency and the engagement of impacted parties including local, state and federal governments. While the process for achieving "consent" has not been formally defined, the goal is to ensure that all impacted parties are engaged on decisions regarding the management of spent nuclear fuel and nuclear waste.

2. Companies and government entities leading the siting of a new nuclear facility should engage local governments.

Without local support, any nuclear facility project will likely fail. By meaningfully engaging the local community, federal government entities and companies constructing a nuclear facility can assist in creating an advocate. In addition, it is up to local governments and communities, at sites where high-level waste and spent nuclear fuel have been produced and stored and as potential hosts for new production facilities, to ensure federal agencies understand the local community's unique health, safety and environmental needs and concerns. Local governments also must ensure federal decision-makers understand the impact of their decisions and policies on any surrounding communities.

In order to become engaged, a local community needs financial resources. These resources will be used to help provide and develop the education and outreach programs outlined in the first recommendation. They also will ensure the community can hire its own experts to verify and engage in the technical and policy decision-making. Further, the resources can be used to train and engage the local workforce.

3. Local government and community support alone will not lead to the successful siting of a new nuclear facility; support from the state government is necessary. Local governments and state governments must work together.

For new nuclear facilities, state and local governments working together can ensure that political support remains constant and effective for a project. If there are clear disagreements between the state and local government on whether a facility should be located in a state, siting can become more difficult. Both the local government supporting the project and the private company and/or federal agency supporting the project should ensure that the state and local governments are included in the decision-making process.

The Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, is an example of how communities and governments can successfully be involved in siting and developing a new nuclear waste facility. (See the Case Study in Chapter 2 for further discussion). When dealing with waste facilities, experiences at WIPP can be applied in developing a new siting plan for nuclear facilities. For example, the State of New Mexico received financial support from the Department of Energy[7] to analyze safety issues and implement a regulatory scheme that allowed the permitting of WIPP. In addition, the state's oversight responsibilities and incentives for a host community were negotiated. DOE and the State worked together on the technical regulatory issues. The support of local governments hosting the site, along with education and outreach efforts helped to ensure state political support for the project. The development of WIPP demonstrates that through collaboration and cooperation, state and local governments can build political support, mitigate opposition and increase the likelihood of successfully siting a nuclear facility.

4. Communities should consider and encourage policy-makers to look at lessons learned to avoid pitfalls and to develop an improved governance plan for future nuclear energy development and waste management.

There are numerous examples of siting processes for new nuclear power plants and nuclear waste storage and disposal facilities in the United States and abroad for local communities to consider. The lessons learned, as identified in this Handbook and other reports including the Blue Ribbon Commission's (BRC) Final Report to the Secretary of Energy, help to illustrate processes that are critical for any community supporting such a facility. [8]

On the waste front, the siting of a new facility has been difficult. The Yucca Mountain Project and WIPP, as well as experiences in France and Sweden, provide technical and political lessons that can be applied to the development of a new siting process, the creation of a waste management organization, incorporation of affected communities and stakeholders, and identification of funding mechanisms. There is no need to start from scratch.

5. Real progress requires that (1) all necessary parties are engaged, (2) there is trust among the parties, (3) there is confidence in the path forward and (4) there is the political will and means to implement new policies or governance plans.

One of the challenges when developing new nuclear facilities is creating trust and providing a clear project schedule. Currently a new nuclear power facility regulated by the Nuclear Regulatory Commission (NRC) can take several years to go through the regulatory approval process. There must be continued long-term support from all levels of government and the utilities that will purchase the power. Over time, some projects may fail if support or the market for electricity changes.

Further, when addressing waste issues or siting any new nuclear facility, communities must be prepared for a long process. The current high-level waste debate has impacted several communities' trust that the process for a permanent geological repository will continually be impacted by politics (and technical issues). Without trust, public acceptance and political support will be hard to retain.

Ensuring there is a forum for local governments, states, tribes and other stakeholders to have a definitive role in developing a new process, and providing the resources needed for their meaningful participation will help build trust in DOE and NRC.

CHAPTER 1: INTRODUCTION AND BACKGROUND

When deciding whether to host a nuclear facility, a local community needs to identify and consider the benefits and drawbacks that come with this role. A community should understand the health and environmental issues, the time frame to actually obtain benefits, and the length of time benefits will continue to accrue to the community, among other issues.

This chapter provides an introduction to nuclear issues and identifies recent events that will impact a community's understanding of the costs and benefits of hosting a nuclear facility, as well as lessons learned. Any community considering such projects needs to hear from the parties that are for and against the proposed project to be able to make an informed decision.

What communities should consider when reading this chapter:

- Economic opportunities exist for a community that hosts a nuclear facility.
- Communities must understand the law and the terminology that define the nuclear industry and siting of any facility.
- There is bipartisan support for nuclear expansion as a "clean energy" resource. Federal loan guarantees have been made available to support development of new nuclear reactors.
- Nuclear expansion faces challenges, including public acceptance, comparative energy production costs, trust in DOE and the nuclear industry, lack of waste management solutions, safety and proliferation concerns, and construction and regulatory delays.
- The political decision on how high-level nuclear waste ultimately will be managed and disposed has not been made, even though the Blue Ribbon Commission has issued its final recommendations and DOE has released its Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste.
- Legislation to consider these issues has been introduced in the last two Congresses, but the House and Senate do not appear to be close to agreeing on how to proceed.
- The 2011 earthquake and tsunami in Japan have impacted public support for nuclear energy in the U.S. at least in the short term, but prior to the events public support was at an all-time high.

Economic Benefits

Many local governments are interested in hosting new energy production facilities and/or the resulting manufacturing industries.[9] Expansion of the nuclear energy industry can bring economic opportunities in the form of a skilled workforce, high paying jobs and an expanded tax base. However, there is a burden for communities — from building support for new nuclear policies and facilities, to emergency response and safety concerns, to ensuring the development of a disposal path for high-level nuclear waste that is generated during the nuclear production process.

Communities usually host a nuclear facility to obtain the benefits and economic growth created by the construction and operation of the facility. However, each project is different, and the community must look beyond the economic projections and understand the actual number of jobs and other benefits that will be provided to the community.

The Obama Administration offered $8.3 billion in loan guarantees to support the construction of new nuclear reactors — the first in more than 30 years — at Southern Company's Plant Vogtle site (next to two operating reactors) in Waynesboro, Georgia. This photograph shows the Unit 4 foundation excavation with Units 1 and 2 in background and water vapor rising from cooling towers.

Jobs can come from various types of facilities, including nuclear energy production. In Augusta, Georgia, Southern Company[10] is building two new nuclear generating units. It is the largest infrastructure project in the state. Construction fully began in 2012 and the two units are expected to be complete in 2017 and 2018, respectively. Construction jobs will peak at about 5,000 in the 2014 timeframe. There will be approximately 800 permanent jobs once the units are operating.[11]

Prospects for new nuclear power development are creating jobs at fuel-cycle facilities. In June 2010, URENCO USA/LES began commercial operation at its new uranium enrichment plant in New Mexico. It is the first enrichment facility to be built in the US in 30 years. Construction will continue until the facility reaches full capacity - estimated to be in 2016. The project will provide more than 300 full-time and contract jobs and another 700-800 multi-year construction jobs.

Communities in Idaho worked hard to attract an enrichment facility. Areva is pursuing a license from the NRC to build and operate the Eagle Rock Enrichment Plant near Idaho Falls, which will create 1,000 jobs during construction, and 310 permanent jobs to support the operation of the facility. In October 2011, the NRC issued a license for the facility. DOE offered a conditional $2 billion loan guarantee for the project but financing is not yet finalized. However, Areva says the plant remains a "priority."[12]

Economic benefits can also come with storing and disposing of nuclear waste. In Nye County − the host county for the Yucca Mountain repository project − officials estimate that 3,000 jobs would be created during construction of the facility and about 1,500 jobs would be created permanently.[13]

Clean Energy

As the United States prioritizes clean energy resources, there is public support for nuclear energy. In March 2010 (one year prior to the nuclear accident in Japan), a Gallup Poll showed general public support for nuclear energy at 62 percent — its highest level since Gallup first posed the question in 1994. Two years later, even after the incident at Fukushima, 57 percent of Americans continued to favor the use of nuclear energy as part of the mix of ways to provide electricity; and a majority continues to believe nuclear power plants are safe.[14]

Development of new nuclear production facilities is proceeding slowly. Nuclear energy accounts for 19 percent of electrical generation in the United States, including 64 percent of the country's emission-free electricity generation in 2012. The nuclear industry is looking to expand to meet growing electricity demand without increasing carbon emissions. In February 2012, the NRC granted a license for the construction and operation of the first new commercial reactors in 30 years. Prior to the crisis in Japan, NRC estimated that by the end of 2016, it would receive up to 23 license applications for 37 new nuclear units. However, with an abundance of cheap natural gas, together with the current political and economic climate, a number of license applications have been suspended. The World Nuclear Association predicts as few as four new reactors will come on line in the United States by 2020.[15]

Political Support

In February 2010, President Obama announced $8.33 billion in federal loan guarantees to support the construction and operation of two new nuclear reactors in Georgia, the first nuclear development of its kind in the United States in more than 30 years. The loan guarantees are the first to come from the $18.5 billion originally authorized in the Energy Policy Act of 2005 for projects that "avoid, reduce or sequester air pollutants or anthropogenic emissions of greenhouse gases." Shortly thereafter, in May 2010, then-Energy Secretary Steven Chu declared, "We are taking action to restart the nuclear industry as part of a broad approach to cut carbon pollution and create new clean energy jobs."[16] Even in the wake of the 2011 earthquake and nuclear incident in Japan, the Obama Administration has maintained support for new nuclear facilities.

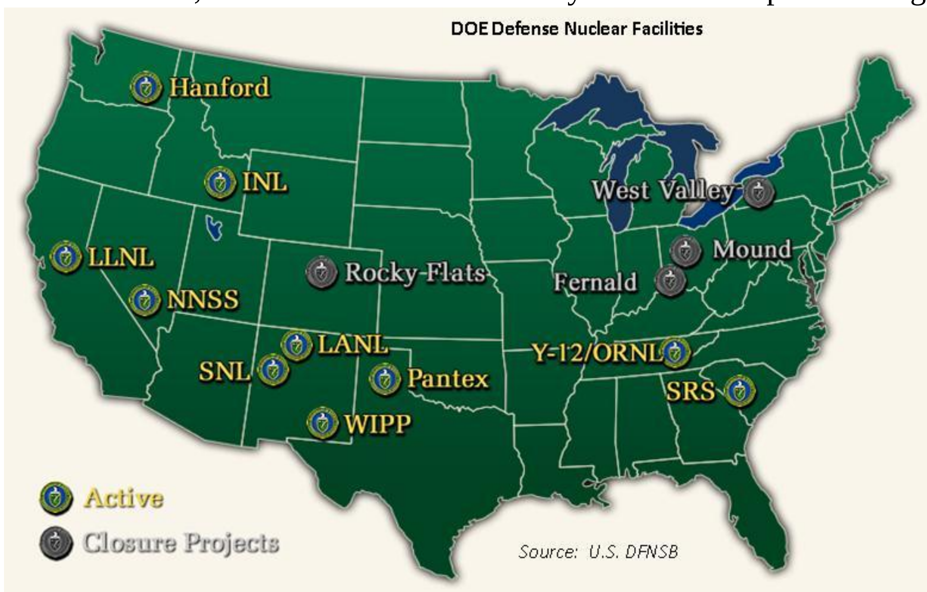
There also is support for nuclear expansion from both political parties on Capitol Hill. Legislation was introduced in June 2010 to mitigate the financial risks associated with building new nuclear power plants, to fund nuclear education, to accelerate the development of small modular reactor designs, and to address used nuclear fuel management.[17] In 2011, legislation with bipartisan support was introduced for construction of nuclear power plants,[18] small modular reactors and clean energy legislation with an emphasis on nuclear investment.[19]

Nuclear proponents believe loan guarantees will help spur nuclear plant construction. Government funding demonstrates that there is support for nuclear power as part of the country's future energy portfolio, which also includes other generation resources like wind, solar, natural gas or clean coal. Government funds can help alleviate the financial risk for early builders of new nuclear plants using more advanced nuclear technologies.

Opponents of nuclear expansion believe federal loan guarantees serve to shift the financial risk from the private sector to the taxpayers and do nothing to address long-held concerns regarding nuclear development: historic construction and regulatory delays, safety and proliferation concerns, and the significant challenge of nuclear waste management.

History of Nuclear Waste Issues

During World War II, the United States began its pursuit of nuclear weapons. The Manhattan Project started in June 1942, and it took less than three years to develop a working atomic bomb. As part of the Manhattan Project, the Army Corps of Engineers managed the construction of facilities to enrich uranium, as well as three production reactors to make plutonium and two reprocessing plants to extract plutonium from reactor fuel.[20]



Shortly after World War II, the Cold War between the United States and the Soviet Union began and the research and development of nuclear weapons intensified. Up until the late 1980s, work was done in a network of facilities across the country that came to be known as the "nuclear weapons complex."[21]

Congress encouraged the use of nuclear energy in the civilian sector. The Atomic Energy Act of 1946 created the Atomic Energy Commission[22] to look beyond building a stockpile of nuclear weapons to the peaceful use of atomic energy, including the production of electricity.[23] In the 1950s, nuclear reactors started to be used to generate electric power. As with weapons production, the utilities assumed that the nuclear fuel, once "spent," would be recycled and reused.[24] However, commercial reprocessing of spent nuclear fuel was done in the United States with only limited success.

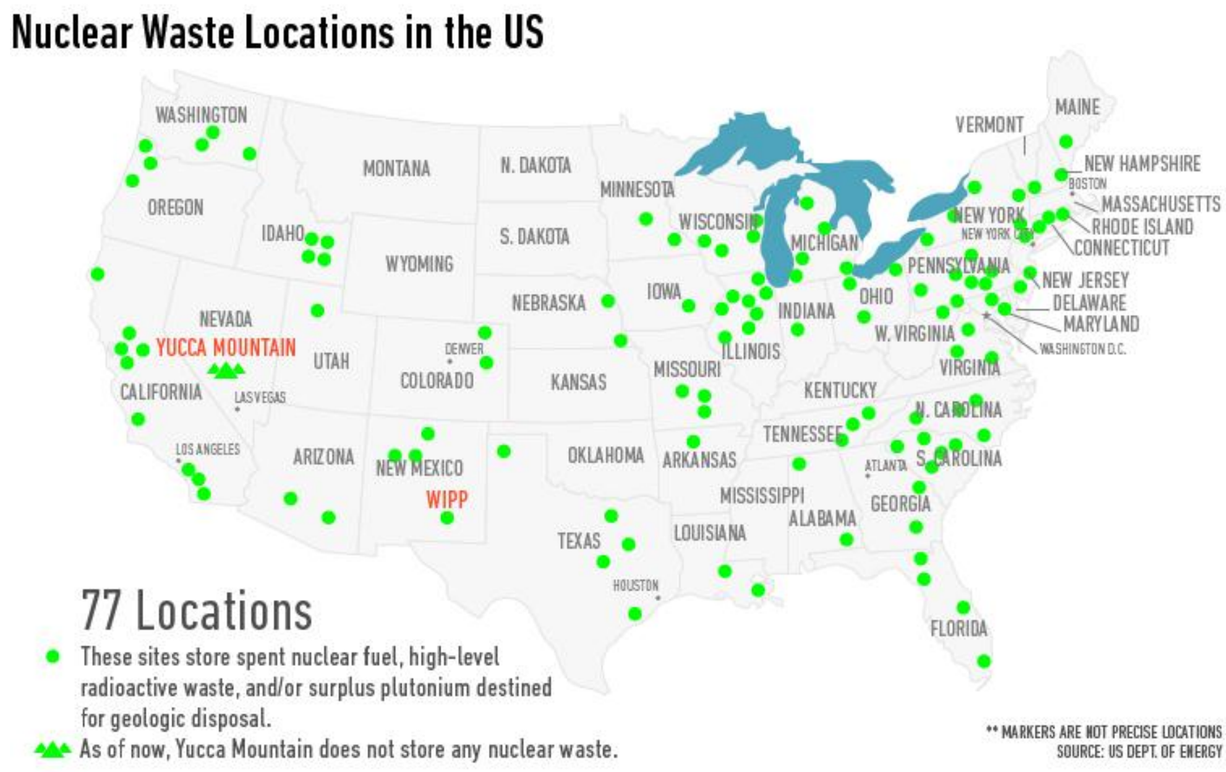
In 1982, Congress passed the Nuclear Waste Policy Act (NWPA) to address the back end of the fuel cycle. The Act provided for the development of repositories for the disposal of high-level spent nuclear fuel and the high-level waste resulting from defense and commercial activities. In 1987, Congress amended the Act, directing DOE to exclusively study Nevada's Yucca Mountain as the site for the first potential geological repository. However, while the NWPA is still the law, the future of the Yucca Mountain Nuclear Waste Repository in Nevada is unknown (See Chapter 7 for further discussion of Yucca Mountain). Thus, the path forward for the disposal of spent nuclear fuel and high-level waste remains undetermined and it is unlikely that Congress will make major revisions to the law in the short term. This gives rise to uncertainty about the future of the nuclear energy industry and, in light of the partial nuclear meltdown involving spent fuel pools at the Fukushima Daiichi Nuclear Power Plant in Japan, concerns regarding the safety of nuclear energy and spent nuclear fuel storage facilities.

Managing nuclear waste is an important issue for supporters and opponents of new nuclear development. This Handbook considers nuclear waste in general but focuses on specific concerns related to the disposal of high-level nuclear waste and spent nuclear fuel.

Spent nuclear fuel (SNF) comes from commercial nuclear power plants, domestic research reactors, nuclear powered naval warships, DOE-run research and defense reactors, reactor design testing, and energy and medical research. In the United States, nuclear fuel, once used in a nuclear power reactor, can be referred to as "spent" nuclear fuel rather than "used" nuclear fuel. It is not uncommon, however, to see the two terms used interchangeably. Regardless, in the United States nuclear fuel is used only once and is not reprocessed or recycled to recover remaining energy potential.

High-level waste (HLW) includes solid material such as glass logs that are derived from liquid wastes that contain fission products in sufficient concentrations. It also includes liquid waste produced directly during the reprocessing of spent nuclear fuel to recover usable plutonium and uranium.

There is general agreement among experts that stockpiles of high-level waste and spent nuclear fuel should be buried in a geological repository.[25] While Yucca Mountain was designated in July 2002 to be the site of the nation's first geological repository, that decision is yet to be a reality and remains the subject of intense political wrangling. At present, there is no agreement on where a geological repository should be sited or how waste should be handled until a repository is functional. Options range from reusing spent nuclear fuel as a new energy resource in nuclear reactors to leaving it onsite at nuclear plants for periods longer than host communities expected. Another option is development of interim storage sites. Impacted stakeholders at the federal, state and local levels should be involved in the process for selecting and implementing options and also in defining what is meant by "interim storage."



Currently, all of the nuclear production sites and sites where defense nuclear waste activities occurred are *de facto* waste storage sites. Communities need to understand that until a disposition path becomes a reality, any community that undertakes new nuclear projects will become a waste storage site.

Impact of Fukushima Daiichi[26]

On March 11, 2011, a 9.0-magnitude earthquake hit Japan. At the time, three of the six reactors at Tokyo Electric Power Company's (TEPCO) Fukushima Daiichi nuclear plant were offline for routine inspection. The three operating reactors, designed by General Electric to automatically shut down in the event of an earthquake, did so without incident. However, the tsunami that followed — estimated to have exceeded 45 feet (14 meters) in height[27] — compromised the diesel generators that should have pumped water around the reactors to keep them cool. When the generators stopped functioning, the reactors heated up.

Over the next few days, radiation levels at the plant, as reported by Japan's Nuclear and Industrial Safety Agency, climbed to levels significantly above normal. Fears grew that fuel rods were melting.

In the period that followed, TEPCO reported some stabilization, but nine days after the earthquake, the pressure in the containment vessel of Reactor 3 had become increasingly dangerous. One month after the earthquake and tsunami hit, Japanese authorities rated the incident at the Fukushima Daiichi plant as a Level 7 — the highest on the International Nuclear Event Scale — indicating that there is severe damage to the reactor core, radioactive materials are likely to be released and radiation levels are potentially fatal.[28]

By mid-April, close to 78,000 people had been evacuated from within almost 12.5 miles of the plant and another 60,000 people beyond the initial evacuation zone were told to remain sheltered. Radiation levels around the plant dropped and the situation stabilized but remained serious. TEPCO laid out a six- to nine-month timetable for a complete shutdown of the reactors.[29] By July 2011, the Prime Minister of Japan called for the country to "wean itself" from nuclear power and a Japanese news agency poll reported that 70.3 percent of those polled supported that position.[30]

One week after the Japanese crisis began, a *USA Today/Gallup* poll reported that 44 percent of the public were in favor of constructing new nuclear plants (versus 62 percent in March 2010). The decrease in support can most likely be attributed to the concern that what happened in Japan could happen in the U.S.

Congress, local governments, state regulators, newspapers, interest groups, critics and concerned citizens have raised various concerns since the crisis unfolded. Concerns include:

- The NRC license renewal process;
- Measures for protecting the public from potential nuclear accidents;
- The age of nuclear power reactors;
- The cost of constructing new nuclear reactors;
- The amount of spent nuclear fuel in spent fuel pools at reactor sites;
- The safety of spent nuclear fuel storage;
- The need for long-term storage for spent nuclear fuel;
- The future of the Yucca Mountain project; and
- The need for domestic nuclear power.

On the regulatory side, NRC reacted by undertaking a systematic and methodical review of the safety of domestic nuclear facilities.[31] An initial review was completed in 90 days. NRC also established a task force of experts to determine lessons learned from the accident and to initiate a review of its regulations that ensure the safety of nuclear power plants. The task force issued a report in July 2011 that concluded there was no imminent risk from continued operation and licensing activities. The task force also concluded that enhancements to safety and emergency preparedness are warranted. NRC is considering recommendations from the report and could amend regulations to help ensure nuclear plant safety.[32]

In testimony provided to House Energy and Commerce Committee's Environment and the Economy and Energy and Power subcommittees, NRC Chairman Allison Macfarlane explained that reactor licensees have been required to submit reports or plans to the NRC on specific capabilities including:

- Protecting against seismic and flooding events;
- Mitigating beyond-design-basis accidents by procuring additional systems to maintain or restore core cooling, containment and spent fuel pool cooling for all units at a site simultaneously following an extreme natural disaster;
- Emergency preparedness and response capacity;

- Installation of enhanced spent fuel pool instrumentation to ensure water levels and conditions during an extreme event can continuously monitored; and
- Installation of hardened vents in order to relieve high pressure in reactor containment.[33]

In addition, the NRC looked at whether to require expedited transfer of spent fuel to a dry cask storage (decision pending); and the Commission is working with the National Academy of Sciences on a study assessing lessons learned from Fukushima for improving the safety and security of domestic nuclear plants. That study is expected to be complete in mid-2014.

NRC currently has a webpage dedicated to its actions after the Japanese nuclear accident.[34]

In the private sector, plans for new nuclear development by companies such as Duke Energy and NRG Energy (NRG) were affected. In a press release, NRG's president and CEO stated, "The tragic nuclear incident in Japan has introduced multiple uncertainties around new nuclear development in the United States."[35] Some industry experts expect that nuclear utility owners will focus on securing license extensions for existing facilities rather than on supporting efforts to build new nuclear projects.

The events in Japan also significantly impacted some countries in Europe. In May 2011, the German government announced it would reverse its year-old policy to extend the life of the country's nuclear plants[36] and would begin instead a process to phase out all nuclear power reactors by 2022.[37] Similarly in Switzerland, where five nuclear reactors provide 40 percent of the country's electricity, plans were announced to not replace any reactors and to completely phase out nuclear power by 2034.[38] In Italy, a one-year moratorium was placed on plans to build nuclear reactors. The government later held a referendum on whether to restart the nation's nuclear energy program. The referendum was rejected by Italian voters, leading Prime Minister Silvio Berlusconi to state, "We must probably say goodbye to the possibility of nuclear power stations."[39]

The question now is not whether events in Japan will affect the nuclear energy industry and nuclear waste management, but whether those effects will be short- or long-term. While the authors of this Handbook highlight how events in Japan may influence future nuclear policy development, the nature of that development is still unclear.

2012 Blue Ribbon Commission on America's Nuclear Future Report

In January 2010 the Obama Administration established the Blue Ribbon Commission on America's Nuclear Future (BRC). Over a period of almost two years, the BRC held hearings around the country visited national and international nuclear facilities and listened to testimony from multiple parties — including the federal government, state and local governments, state regulators, state legislators, industry representatives, tribal governments, community reuse organizations, anti-nuclear organizations, foreign governments, and academics — and developed final recommendations for the Secretary of Energy on future nuclear policy development. Included in the membership of the BRC was now-Energy Secretary Ernest Moniz. The BRC charter said the commission must address "[O]ptions to ensure that decisions on management of used nuclear fuel and nuclear waste are open and transparent, with broad participation."[40] In addition, the commission was advised by then-Energy Secretary Steven Chu that it will not make any siting decisions on waste storage facilities and it should not reconsider halted plans for a geological repository at Yucca Mountain.[41]

Per the BRC charter, the options explored included:[42]

- A evaluation of existing fuel cycle technologies and R&D programs based on cost, safety, resource utilization and sustainability, and the promotion of nuclear non-proliferation and counter-terrorism goals.
- Safe storage of spent nuclear fuel while new disposition pathways are selected and deployed.
- Permanent disposal of spent fuel and/or high-level waste, including deep geological disposal.
- Legal and commercial arrangements for the management of spent nuclear fuel and nuclear waste in a manner that takes the current and potential full fuel cycles into account.
- Decision-making processes for management and disposal that are flexible, adaptive and responsive.
- Decisions on the management of spent nuclear fuel and nuclear waste that are reached through an open and transparent process with broad participation from stakeholders.
- The possible need for additional legislation or amendments to existing laws, including the Nuclear Waste Policy Act of 1982, as amended.

In January 2012, the BRC released its final report[43] outlining eight-recommendations to improve the domestic strategy for managing HLW and SNF:

1. A new, consent-based approach to siting future nuclear waste management facilities.
2. A new organization dedicated solely to implementing the waste management program and empowered with the authority and resources to succeed.
3. Access to the funds nuclear utility ratepayers are providing for the purpose of nuclear waste management.
4. Prompt efforts to develop one or more geological disposal facilities.
5. Prompt efforts to develop one or more consolidated storage facilities.[44]
6. Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available.
7. Support for continued U.S. innovation in nuclear energy technology and for workforce development.
8. Active U.S. leadership in international efforts to address safety, waste management, non-proliferation, and security concerns.

The BRC also proposed legislative changes that address:

- Establishing a new facility siting process.
- Authorizing consolidated interim storage facilities.
- Establishing a new waste management organization.
- Ensuring access to dedicated funding.
- Broadening support to jurisdictions affected by transportation.
- Promoting international engagement to support safe and secure waste management.

Of particular note for local governments, the BRC recommended that the new waste management organization's authority and responsibility to consult, cooperate and negotiate binding agreements with host states and tribes (as provided under the NWPA) be extended to include local governments. The final report did not, however, propose any specific facilities at any specific sites nor, it is important to note, did it propose specific steps to assist in implementing its recommendations.

DOE's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste

In January 2013, DOE released the Administration's response to the BRC's final report and recommendations. *The Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste (DOE Strategy)*[45] provides "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel (UNF) and high-level radioactive waste (HLW) from civilian nuclear power generation, defense, national security and other activities."

The DOE Strategy lays out the following timeline for a new waste management system:

1. A pilot interim storage facility to be sited, designed, licensed, constructed and opened by 2021.
2. A larger interim storage facility to be sited, licensed and available by 2025.
3. A geological repository to be opened by 2048.

The Strategy includes activities the Obama Administration believes are necessary to undertake in the next 10 years to fulfill its waste management mission. While a broad framework for implementation is provided, specifics must be addressed in legislation. A number of key issues remain undefined:

- The consent-based process for selecting sites;
- How to reform funding the waste management mission; and
- The structure of the proposed new waste management organization.

For the Strategy to be fully implemented, the Administration recognizes that new legislation is necessary. In the interim, DOE identified that it will continue to move forward with various components pursuant to current law and in coordination with Congress. As specifically noted in the DOE Strategy, DOE will work closely with potential host states, tribes and communities whose engagement will be "essential" for success.

The Strategy prioritizes management and disposal of commercial UNF. There is a focus on reducing government liabilities for its failure to meet its obligation for UNF disposal in order to ease the burden on taxpayers. The Strategy identifies that the commercial UNF at shuttered reactors should be moved to a storage facility first followed by UNF at operational commercial reactors. What it does not specify, however, is when defense nuclear waste will be moved or whether it will be stored at the same facility as the commercial waste.

The elements and activities in the Strategy that are most likely to impact local governments and energy communities include:

- The need for a phased, adaptive and consent-based approach to siting and implementing a waste management and disposal system.
- The Administration plans to work with Congress to define a consent-based process and identify incentives for potential host states and communities.
- Assurances for hosts of interim storage sites that efforts to open a repository will continue and they will not become *de facto* permanent storage facilities without consent.
- The Administration will move ahead with initial planning for engagement and technical assistance for transportation operations with states and local governments.
- The once-through fuel cycle is likely to continue for the "next few decades" although DOE will continue research on advanced fuel cycles.
- Prospective host jurisdictions must be recognized as partners. In addition, public perceptions of the waste management program in regards to protecting public health, safety and security must be continuously addressed.
- The need for a new waste management and disposal organization charged with managing and disposing of commercial UNF and the associated interface with utilities.
- The federal government will maintain management of its own HLW and UNF until they are transferred to a new waste management organization for storage and/or disposal.
- DOE's Office of Fuel Cycle Technology has initiated a planning project with activities that fall within the constraints of the NWPA including development of an interim storage facility; geological repository and the supporting transportation infrastructure. These activities can be transferred to a new waste management and disposal organization (MDO) when it is established and will not limit the options for consideration.

Nuclear Waste Administration Act of 2013

In spring 2013, leaders of the Senate Energy and Natural Resources Committee, Ron Wyden (D-OR) and Lisa Murkowski (R-AK), along with Senators Dianne Feinstein (D-CA) and Lamar Alexander (R-TN), released a "discussion draft" of nuclear waste management legislation. Like DOE's Strategy, the draft legislation seeks to implement the BRC's recommendations. It also adopted the same timeline for opening a pilot interim storage facility, a larger consolidated interim storage facility, and a repository as laid out by DOE.

Echoing the sense of urgency expressed by the BRC in its final report, the senators asked for comment from "experts and stakeholders, including utilities, conservation groups, Blue Ribbon Commission members and others" on the draft and on eight specific policy and technical questions. The questions highlighted key issues where consensus had not yet been reached. Those issues included governance, oversight and the linkage between the development of a repository and storage facilities.

After taking into account more than 2,500 comments[46] about the discussion draft, the Nuclear Waste Administration Act of 2013 was formally introduced in July 2013. Key elements of the legislation include:

- Implementation of a consent-based siting process for both nuclear waste storage facilities and repositories.
- Creation of a new federal agency — the Nuclear Waste Administration — to manage the nuclear waste program in place of the DOE (DOE would maintain responsibility for maintaining, treating, packaging and storing defense wastes until it is accepted for disposal into a repository). The administrator of the new agency would serve a term of six years, as would the deputy administrator.
- Creation of an oversight board to oversee the administration of the program. The Board would consist of five members appointed by the President with the consent of the Senate and would serve staggered five-year terms. No more than three members would be of the same political party.
- Creation of a working capital fund in the U.S. Treasury into which fees collected from utilities for nuclear waste management would be deposited and available to the Nuclear Waste Administration without further appropriation. The fees already collected in the Nuclear Waste Fund, however, would remain subject to appropriations.
- Authorization for the Nuclear Waste Administrator to begin siting consolidated nuclear waste storage facilities immediately.
- Removal of waste volume restrictions at storage facilities.
- Authorization for the Secretary of Energy to reevaluate the decision to commingle defense wastes with civilian wastes. The Secretary would have to determine no later than one year after the enactment of the bill (two years were provided in the discussion draft) whether to reevaluate and the Secretary must notify the President

and appropriate committees of Congress as to why that decision is being made. If after a reevaluation, the Secretary of Energy determines that separate waste facilities are necessary — and the President concurs — the bill provides for the siting, construction and operation of one or more facilities for storage or disposal of defense waste.

Now as before, the federal government's greatest challenge is to engender confidence in its approach to managing and disposing of nuclear waste. All impacted parties and stakeholders — local governments, state policy-makers, state regulators, tribal governments, and citizen groups — must be able to participate in the decision-making process. They must have the necessary resources and opportunities to provide input in a transparent process. They also must have access to the information needed to determine whether they want to host any new nuclear facilities and whether they will have support within their community, state and region. In doing so, the federal government will significantly increase its ability to develop a safe and environmentally sound long-term disposal plan for high-level waste and spent nuclear fuel.

Recommendations

- Local governments must be engaged and given the financial resources to ensure they are educated and able to participate in any nuclear energy siting project.
- Local governments must ensure their communities are informed of the technical and political issues related to hosting a nuclear facility. In this regard, local governments should use the lessons learned by experienced communities.
- Local governments must assure their communities that a proposed facility will be safe in order to gain public acceptance.
- Local governments should work together to highlight the need for DOE and Congress to act as quickly as possible to develop long-term waste disposal and storage solutions so that waste currently sitting in communities and at reactor sites longer than originally expected can be removed. Communities should highlight – and educate state and federal policymakers on – the effects of this waste remaining in place, including increased security costs and the suspension of new nuclear development.

CHAPTER 2: LOCAL GOVERNMENT ROLE IN SITING

As hosts and potential hosts of nuclear power production and waste facilities, local governments have been identified by the Administration and Congress as key decision-makers on nuclear energy issues. This chapter addresses the role for local government in building support for nuclear development and identifies steps that a local government should take as it considers whether to host such a facility.

What communities should consider when reading this chapter:

- Local governments have a key role in nuclear development in their communities.
- As potential hosts of nuclear facilities, local governments must be educated on the impacts a nuclear project will have in their communities and should be engaged as early as possible in decision-making regarding any local nuclear activities.
- Community outreach and education efforts are necessary to ensure the public is aware of the risks and benefits associated with new nuclear development and to address local concerns. These programs *will* impact the success of the siting process.
- Communities should identify the terms — financial incentives, oversight requirements, resources and legal assurances — under which they will consent to host a nuclear facility.
- Local governments should work as partners with federal and state regulators and political leadership, as well as with industry, to help ensure community interest, concerns and priorities are considered.
- A local government is uniquely positioned to negotiate on behalf of its community, as is a governor for a state.
- Without local support, projects likely will fail.

The Roles and Responsibilities of Local Governments

Local governments and their communities will be the constituents closest to a new nuclear project. A local government will commit resources to engage in the siting process. The local community will potentially realize the benefits of developing a nuclear facility, but it must understand and accept the risks. A local government needs to have as much information as possible to ensure it can fulfill its most important role: protecting the health, safety, quality of life and economic future of its citizens.

As a community considers whether to host a new nuclear mission, the local government has to factor in its primary responsibilities into the decision-making process. In general terms, these responsibilities include:

- Securing a viable economic future through retail, housing, industrial and commercial development.
- Providing services such as police and fire protection, emergency response, public works, and public health services.
- Developing and maintaining park and recreation opportunities; traffic management; education; land use planning; property recordkeeping; and property protection through zoning control, building permits and deed notices.

Local governments play a key role in addressing these responsibilities and balancing competing interests (e.g, protection of public space such as parks versus the need for development). A major concern in this regard is the possible conflict between environmental protection and economic development. To be credible in this role, local government officials must demonstrate a transparency in their decision-making. Interest groups do not expect to get all they want, but they do expect to be heard, to be taken seriously and to be informed of their local government's decisions and processes.

Once a local government determines it is interested in hosting a nuclear facility, local government officials must engage their community, provide education and outreach addressing the potential benefits and risks, and create opportunities for public comment. These efforts will demonstrate legitimacy and transparency in decision-making, which can alleviate concerns and help build support.

Education and outreach efforts may include:

- Hosting meetings for the community with site managers, contractors, utilities and economic development entities;
- Creating public information centers and campaigns online and in community centers;
- Coordinating programs with local universities and community colleges;
- Building websites and producing written materials for distribution − such as fact sheets or issue briefs − that explain the pros and cons of nuclear initiatives.

Support can only be built if a potential host community understands the process, can choose independent experts to supply scientific data and, most importantly, if the community trusts that its interests, concerns and priorities are being recognized and meaningfully considered. Without local support, projects are likely to fail.

The development of new nuclear facilities regularly gives rise to a "not in my backyard" (NIMBY) reaction, and a potential host community is likely to encounter opposition from neighboring communities or the state. Thus, local governments also must be prepared to help educate and work with state and regional regulators and political leaders, as well as with the federal government and private companies, to ensure that local values, concerns and priorities are taken into account when decisions are made. Support will be needed at all these levels to successfully site a new nuclear facility.

Local Government Role in Consent-Based Siting

As explained in Chapter 1, the establishment of the BRC renewed the national discussion of alternatives for managing and disposing of nuclear waste. Recognizing that "finding sites where all affected units of government, including the host state or tribe, regional and local authorities, and the host community, are willing to support or at least accept a facility has proved exceptionally difficult,"[47] the BRC recommended the development of a phased, adaptive and consent-based approach to siting future nuclear waste facilities. The BRC explains that this approach is most likely to "sustain the public trust and confidence needed to see controversial facilities through to completion."[48]

DOE has endorsed the consent-based approach to facilitate transparency and the engagement of impacted parties including local, state and federal governments. According to DOE's Strategy, a consent-based process should be "transparent, phased, adaptive, standards- and science-based, and governed by legally-binding agreements between the federal government and host jurisdictions."[49] In addition, DOE calls for prospective host jurisdictions to be recognized as "partners." Senate legislative proposals similarly have outlined that a consent-based process should be open to the public and allow interested parties to be heard in a meaningful way; should be flexible and allow decisions to be reviewed and modified in response to new information or new technical, social and political developments; and should be based on sound science and meeting public health, safety, and environmental standards.[50] A 2013 Senate bill, The Nuclear Waste Administration Act, more directly states that "affected communities [should] decide whether, and on what terms, the affected communities will host a nuclear waste facility."

Thus, a community volunteering to host a nuclear facility should be prepared to identify what it needs and wants — from the federal government, regulators and industry contractors — as a host. The parties should then negotiate terms and come to a mutually agreed upon, legally enforceable consent agreement. The parties to the agreement must also agree on when the consent agreement becomes binding. When it comes to potentially siting a nuclear waste facility in a community, the local government is the institutional authority that needs to speak on a community's behalf and to collaborate with federal and state governments in support of community interests. Local governments also are uniquely positioned to negotiate economic benefits on behalf of the impacted community with the developers of a new nuclear project.

The terms and conditions of a consent agreement should promote the economic and social well-being of the people living near a nuclear facility and may include:

- Financial compensation and incentives for the host community, impacted communities surrounding the site, and the state;
- Economic development assistance;
- Operational limitations – such as limits on acceptable volumes of waste − or requirements including funding or training to ensure emergency response capabilities at the state and/or local level;

- Regulatory oversight authority for the state; and
- In the case of a storage facility, an enforceable deadline for removing nuclear waste from the storage facility.

In addition, potential hosts may want to negotiate the following items specifically related to the operations of a nuclear facility:

- Amending any existing state or federal compliance agreements or statutory limitations that may prohibit nuclear waste storage or disposition at a site.
- Penalties to be incurred by the federal and/or state governments for failing to meet obligations under the consent agreement.
- Triggers for termination of the consent agreement.
- Agreement of indemnification to compensate local communities for any accidents or releases that impact their community.
- Local preferences in hiring and in the purchase of goods and services by the waste management facility.[51]
- Opportunities for universities and community colleges related to future nuclear energy missions and workforce development.
- Research and development projects in coordination with national laboratories.
- Designation of transportation routes to a storage facility or repository.
- Reserving a position for local representatives on any oversight boards or advisory committees.
- Any other issues important to the specific community.

It is important to note that the terms of a consent agreement will be specific to each potential host community and state. There is no one-size-fits-all consent agreement. According to the BRC, determination of consent ultimately should be decided by the host jurisdiction. Furthermore, "a good gauge of consent would be the willingness of the host local government and state government to enter into legally binding agreements with the facility operator, where these agreements enable states, tribes, or communities to have confidence that they can protect the interests of their citizens."[52]

Implementing a Consent-Based Process — What Local Governments Should Consider

While there appears to be consensus that a transparent, adaptive consent-based process under which potential hosts are encouraged to volunteer is more likely to lead to successfully siting new nuclear facilities, it is unclear how the process may be implemented.

The Nuclear Waste Administration Act, introduced by a bipartisan group of four senators in 2013, proposed that:

> "…A potential storage site will be eligible for evaluation if recommended by a Governor or duly authorized official of the State in which the site is proposed to be located; each affected unit of general local government; and any affected Indian tribe. The head of a new waste management organization (the Administrator) must then submit a program plan that includes, among other things, a schedule for removing the spent fuel from and decommissioning of the

storage facility and an estimate of the cost of any financial assistance, compensation, or incentives proposed to be paid to the host State, Indian tribe, or unit of local government.

For repositories, the Administrator would consider for review sites recommended by 'the Governor or duly authorized official of the State in which the site is located; the governing body of the affected unit of general local government; the governing body of an Indian tribe within the reservation boundaries of which the site is located.' The Administrator may also seek out sites to review, but must still consult with and get consent from the parties named above.

Before selecting a site for characterization, the Administrator will hold public hearings in the vicinity of the site and at least one other location within the State where the site is located. The purpose of the hearings is to inform the public and the proposed characterization activities and to solicit public comment and recommendations. The Administrator must also enter into a consultation and cooperation agreement to provide 'compensation … for any potential economic, social, public health and safety, and environmental impacts associated with site characterization.' Under the consultation and cooperation agreement, financial and technical assistance must be given to enable the State, any affected units of local government, and any affected Indian tribes to "monitor, review, evaluate, comment on, obtain information on, and make recommendations on site characterization activities."

Before making a final determination, additional public hearings must be held. Prior to submitting a license application, the Administrator will enter into a consent agreement ratified by law that expresses the consent of and contains the terms and conditions on which each State, local government, and Indian tribe consents to host the repository or storage facility. Once ratified, the consent agreement can only be amended or revoked through mutual agreement of the parties."[53]

Another possible way to implement a consent-based siting process is by taking a progressive approach. In each successive step of such an approach, certain criteria must be met by a potential host facility in order for the federal government, DOE or a new waste management organization (Selection Entity) to allocate federal funds for feasibility and technical studies, and education and outreach efforts to build public support.

Step 1: Site Selection

- The Selection Entity establishes available resources and technical criteria — for example, acceptable geologies, geography and proximity to population centers — to guide interested parties and help them determine if a potential site is eligible to host a nuclear waste storage or disposal facility.
- The Selection Entity seeks expressions of interest from potential host communities, states or consortia throughout the country.

- Upon receiving an informal letter of interest from a local government or state, and provided the preliminary criteria for a site are met, the Selection Entity (or another entity) will provide sufficient funding for education at the local, state and, as applicable, tribal levels (Hosts) on the technical aspects and potential risks and benefits of hosting a facility. Resources also would be provided for independent experts and consultants for the Hosts.
- Funding should allow for a potential host to gauge (with the Selection Entity) whether it is likely to meet NRC licensing standards and the Selection Entity's site-specific requirements.
- Funding should also allow potential hosts to conduct a public outreach process that would determine whether their communities are supportive of such action.

Step 2: Begin Negotiations

- Provided sufficient support still exists, and the Selection Entity can certify initial technical site criteria can be met, potential Hosts will receive funding to develop a consent-based agreement outlining the terms and conditions under which they would agree to host a nuclear waste storage facility at a specific site.
- Site technical analysis continues.
- Potential Hosts present proposed consent-based agreements to the Selection Entity to begin negotiations.
- Selection Entity selects one or more sites to negotiate the agreement outlined in Step 3.

Step 3: Legally Binding Agreements

- Based on the negotiations, Selection Entity selects a consent agreement that meets criteria including health and safety standards, security requirements, oversight, reporting, linkage, decommissioning and assurance of continued federal funding. All parties structure an enforceable and legally binding consent agreement (Agreement).
- Once an Agreement is approved by parties authorized to contract on behalf of the Hosts, additional funding will be provided to begin design development at the specific site and to prepare an NRC license application.
- The Selection Entity will continue to provide funding throughout the NRC licensing process until the license is formally issued or abandoned. The funding for the Hosts will include technical assistance to ensure the Hosts can participate in the technical licensing process and hire independent consultants and experts to confirm conclusion of the Selection Entity and NRC.
- During the NRC process the Agreement will be implemented by the parties.

While the debate continues on whether and how a consent-based process will be implemented, there are a number of questions that local governments should consider, along with states, tribes and federal policy-makers. These are unlikely to change based on the specific host state or community.

Questions for Further Consideration
• Who within the state and local community should be empowered to commit a potential host to volunteer? The governor? The state legislature? The mayor or county executive? The city or county legislative body? • How much money should be allocated for initial site studies and public outreach campaigns? • How will public support or "consent" be measured? • Before a site is chosen, is an industry/contractor partner necessary? • At what point in the process should a potential host state, community or tribe be able to pull out of the siting process? At what point are they committed to continue?

Ultimately, there is room for flexibility in the approach, but there needs to be clear objectives and goals and an understanding of available resources laid out at the beginning. A potential host needs to know it can secure technical expertise and develop public outreach and education programs; that the host will have an ability to actively monitor and intervene in the process; and that it will be able to negotiate benefits for the community, state or tribe putting up the resources.

Community Involvement with Federal and State Governments — Models to Consider

At the federal level, the Nuclear Waste Policy Act (NWPA) provides a good starting point for consideration of how local governments have been engaged in nuclear facility development. The law, which relates to siting and developing nuclear waste facilities, can help potential host communities for new nuclear missions better understand what resources they may need, what resources or incentives they may want, and how those resources can be used.

The NWPA allocated dedicated funding for "affected units of local governments," to help:

- Provide resources to permit the local community to hire third-party scientists to review data and increase public confidence in the scientific integrity of a project;
- Provide impacted citizens with the information and means to interact with the federal government and any operator; and
- Demonstrate a commitment to external oversight over nuclear projects.

In 1987, the NWPA was amended to authorize DOE to develop a monitored retrievable storage (MRS) facility for temporary nuclear waste storage, subject to progress in developing a repository (not entirely dissimilar in concept to the consolidated interim storage currently being considered by federal decision-makers, states and local governments). The amendments provide a good example of how the federal government approached potential volunteer hosts. The amendments created the office of Nuclear Waste Negotiator. The Nuclear Waste Negotiator was empowered to find a state or Indian tribe willing to host a repository or MRS facility, and to negotiate the terms and conditions with a governor of a state or governing body of an Indian tribe under which a prospective host would accept a facility. In conjunction with the creation of the negotiator's office, the Secretary of Energy was authorized to make grants of financial assistance to states and tribes to assess site feasibility in their jurisdictions. The grants were divided into two categories: Phase I (preliminary) and Phase II (advanced). Under Phase I, grantees could receive up to $100,000 for use over a six-month period "to develop an understanding of the nuclear waste management system and to determine if they have a real interest in pursuing feasibility of hosting an MRS facility." Under the two stages of Phase II, grantees could receive up to $3 million more to support a more detailed examination of site feasibility. By the end of the first stage, a governor or chief executive of an Indian tribe had to inform the negotiator that one or more areas had been identified as potential MRS sites. By the end of the second stage, feasibility studies would continue as formal discussions and negotiations for a proposed host agreement got underway.

A more recent example of the federal government reaching out to interested states and local governments is the Global Nuclear Energy Partnership Initiative.[54] In 2006 and 2007, DOE reached out to local governments interested in hosting new nuclear energy reprocessing facilities, awarding a total of close to $16 million in grants to conduct siting studies.

Finally, one of the most successful examples of coordination among the federal government, states, and local governments to site and open a nuclear waste facility is the Waste Isolation Pilot Plant, located 26 miles southeast of Carlsbad, New Mexico.

Case Study: The Waste Isolation Pilot Plant

The Waste Isolation Pilot Plant (WIPP) was built to dispose of transuranic (TRU) waste resulting from the research and production of nuclear weapons. At the site, waste is disposed of in thick salt beds located 2,150 feet below the surface. WIPP was developed outside of the NWPA framework since the site does not take high-level waste or spent nuclear fuel. However, its evolution from drawing board to repository is a good example of effective local engagement in the siting process.

Drums of transuranic waste in specially mined disposal panels underground at WIPP
Source: U.S. Department of Energy

Seeing an opportunity to diversify its economy, local politicians from Carlsbad reached out to the federal government and initiated the process to host a repository. As a result of legislation, litigation and communication, the state of New Mexico and DOE agreed that New Mexico would be part of the decision-making process for WIPP; DOE would provide funding for state oversight of WIPP; and federal funding would be allocated to ensure safe transportation of waste to the site. In addition, the local government and community in Carlsbad had a role in all phases of WIPP: site selection, testing, construction, legislation, permitting, startup, operation and funding. Furthermore, the community received specific economic benefits including stable jobs, above average salaries and federal appropriations for educational institutions and infrastructure[55] for hosting the site.

In 1992, Congress enacted the Waste Isolation Pilot Plan Land Withdrawal Act to authorize operation and establish a regulatory framework for the facility. The state also had regulatory authority under the Resource Conservation and Recovery Act (RCRA) because some of the TRU waste was mixed hazardous radioactive waste (waste that contains both radioactive and chemically hazardous materials). Before it issued its final certification decision for WIPP in 1998, EPA considered approximately 1,400 written and oral public comments on the proposal. EPA first recertified WIPP in 2004, and recertified it again in November 2010. The decision to recertify signifies that, after an extensive review, EPA has verified the site's continued compliance with federal disposal regulations. Further, recertification indicates that the underground repository continues to demonstrate that it will safely contain TRU waste for the duration of WIPP's 10,000-year regulatory period.

A 2008 presentation by a DOE Carlsbad Field Office official outlined the keys to the successful siting and licensing of WIPP, including:

- Recognized a national need to clean up the nuclear weapons complex.
- Existence of a "clear" benefit for citizens of the state and community in which the repository is sited.
- Solid local support (with "clout").
- Competent technical oversight by the state of New Mexico.
- Intense and early outreach.
- Rigorous quality assurance from the earliest stages of the project such as traceability, transparency and independent review to facilitate the open discussion of technical and scientific if they arise.

In addition, the presentation detailed technical and regulatory lessons learned, notably:

- Reliable and powerful local political support prior to the licensing and construction is worth any cost.
- Credibility is paramount.

As of January 29, 2014, WIPP has received 11,872 shipments and disposed of 90,807 cubic meters of waste and 170,946 containers underground.[56]

There also are international examples of local government involvement in siting nuclear facilities to consider. In a presentation on French support for building nuclear power infrastructures, the Deputy Director of the French Nuclear International Agency stated, "It is not possible to develop nuclear energy against the population. Public acceptance is a key issue. It is fully true also during the process of site selection." See Appendix A for a discussion of the process in Finland, France, Japan, Sweden and the United Kingdom.

Nuclear waste management is being recognized as a priority for governments at the federal, regional, state and local levels. Failure to address it increases the risks to the health and environment of energy communities. As new laws and authorities are debated, local governments have an opportunity to help define the consent-based process and become involved at the beginning of the decision-making process for managing nuclear waste. The first step is to request the resources communities need to be able to engage at a local and national level.

Recommendations

- Local governments that are or may become hosts must be included throughout the entire decision-making process.
- Local governments should ensure coordination with their state government in order to maximize positive outcomes.
- There is no one-size-fits-all consent agreement — the terms of a consent agreement will be specific to each potential host community, tribal entity and State, as negotiated with the federal government.
- A consent agreement among local, state and federal governments must be legally enforceable and reflect the terms and conditions under which a community will agree to host a nuclear waste facility.
- Local communities need to better understand how a new comprehensive nuclear waste policy will be implemented and by whom.

CHAPTER 3: NUCLEAR ENERGY IN THE UNITED STATES

The information in this chapter can help local governments determine whether they are interested in hosting a nuclear facility, whether the preferred facility is a power plant or nuclear waste storage facility, and whether the political and economic outlook for the short and long term is likely to be favorable for nuclear development. Ultimately, examining the current profile of the nuclear energy industry will help local governments better understand the risks and benefits associated with nuclear expansion.

What communities should consider when reading this chapter:

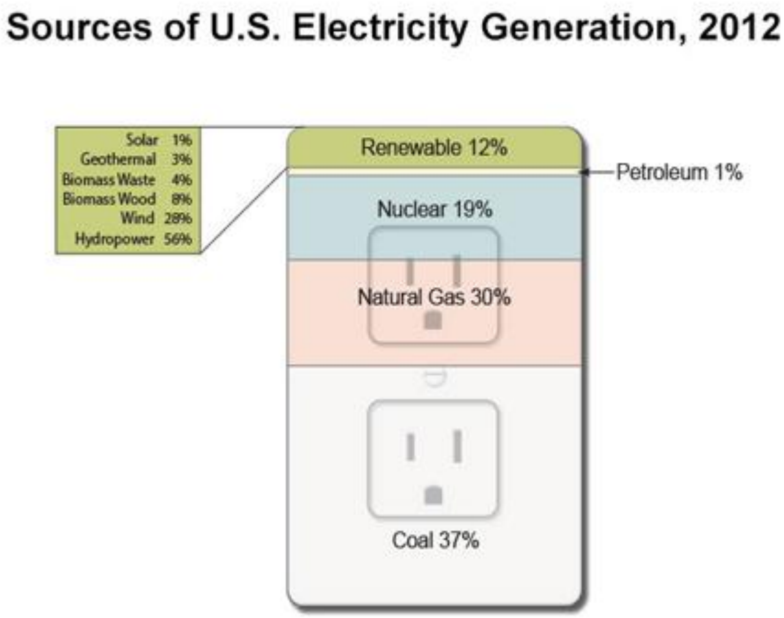
- There are 100 operable nuclear reactors in the U.S. Four shut down in 2013 and one is scheduled to shut down at the end of 2014. Five are under construction.
- Defense high-level nuclear waste and spent nuclear fuel from commercial nuclear reactors do not have a disposition path. Both eventually will need to be disposed of in a permanent geological repository.
- Nuclear power is the single largest contributor (more than 70 percent) of non-greenhouse-gas-emitting electric power generation in the United States.[57]
- There are safety and security concerns about hosting a nuclear facility, including proliferation, radiation exposure and reactor accidents.
- A nuclear power plant can provide an economic boost to a community. It can create up to 1,800 jobs during construction and up to 700 jobs during operation.

Current Profile

The United States generates about 30 percent of the world's nuclear power, making it the largest producer of nuclear energy in the world.[58] There are 100 operating nuclear reactors in 31 states and five under construction. In 2013, four nuclear reactors were taken out of service[59] and one more is scheduled to go offline at the end of 2014. In 2011, nuclear plants generated 790 billion kilowatt hours (kWh) and provided slightly more than 19% of electricity and about 8% of all energy consumed in the United States.[60]

All domestic nuclear reactors are light water reactors (LWRs). In LWRs, ordinary water, or "light water," is used to help moderate the chain reactions, to act as the cooling agent and to help remove the heat used to produce steam for turning the turbines of the electric generators.[61] Between 1985 and 1996, 34 new LWRs were put into service in the United States.[62] Of the

100 total reactors, 65 are pressurized water reactors (PWRs) and 35 are boiling water reactors (BWRs).[63] The Tennessee Valley Authority's Watts Bar 1 in Tennessee was the last commercial reactor to come online, in 1996.[64] In 2012, nuclear reactors generated the largest percentage of electricity in seven states: Vermont, South Carolina, New Jersey, Illinois, Connecticut, New Hampshire, and Virginia.[65]

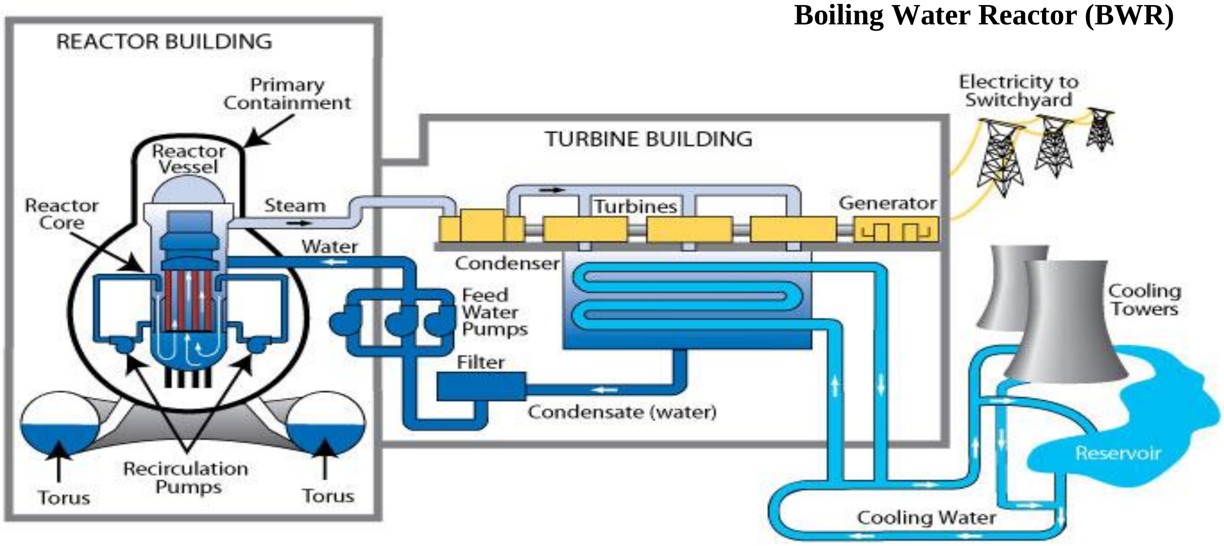


Source: U.S. Energy Information Administration, *Electric Power Monthly* (March 2013). Percentages based on Table 1.1 and 1.1a; preliminary data for 2012

Improved operating efficiency and maintenance have allowed the nuclear industry to increase the capacity factor for nuclear power plants from 56.3 percent in 1980 to an average of about 90 percent.[66] The capacity factor is a measure of how often an electric generator runs. It compares how much electricity a generator actually produces with the maximum it could produce during a specific period of time.[67] The average capacity factor for nuclear power plants has remained around 90 percent since 2000, the highest of any energy source in the United States.[68] To compare, in 2012 when the average capacity factor for nuclear was 86.4, coal and natural gas[69] each had a capacity factor of about 55 percent.[70] The U.S. Energy Information Administration estimates that nuclear power capacity will increase from 101.1 gigawatts in 2011 to a high of 114.1 gigawatts in 2025, before declining to 108.5 gigawatts in 2036, largely due to plant retirements. New nuclear plants in the later years are projected to bring nuclear capacity back up to 113.1 gigawatts in 2040.[71]

But while the capacity factor for nuclear power plants in the U.S. remains high, the age of the fleet presents a challenge. The domestic nuclear fleet originally was licensed to operate for 40 years and the NRC can renew each reactor license for an additional 20 years. While nuclear technology can function beyond that time period, there are economic concerns for plant owners to consider, such as fuel costs and cost competitiveness with other forms of electricity generation. In addition, there may be concern that components, structures or systems have been engineered only for the 40-year operating period initially expected, [72]and could yield higher maintenance costs over time.

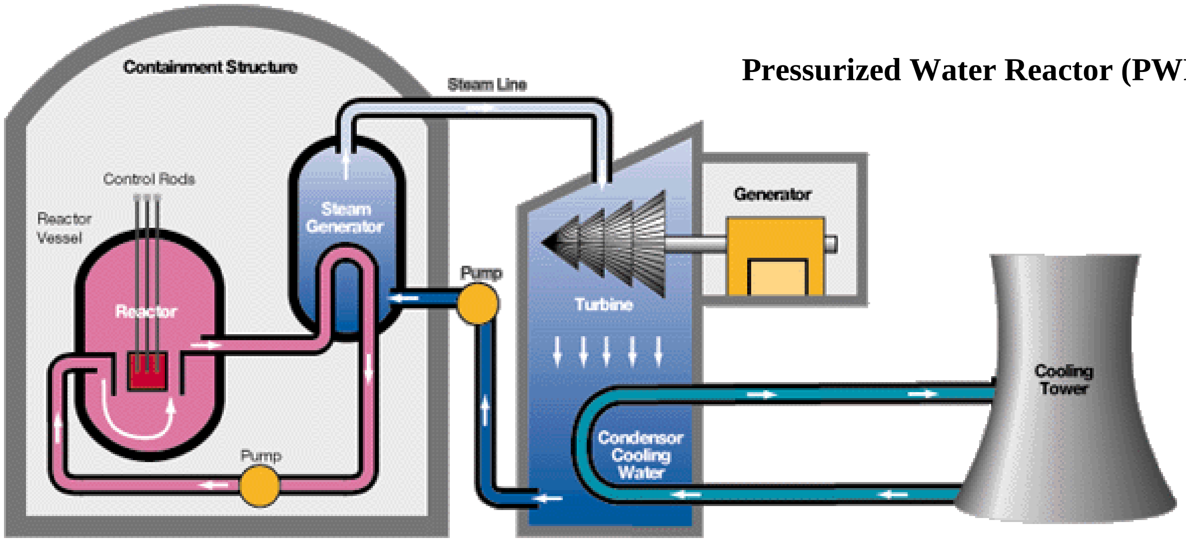
Boiling Water Reactor (BWR)



The boiling water reactor (BWR) operates in essentially the same way as a fossil fuel generating plant. Neither of these types of power plants has a steam generator. Instead, water in the BWR boils inside the pressure vessel and the steam water mixture is produced when very pure water (reactor coolant) moves upward through the core absorbing heat. The water boils and produces steam. When the steam rises to the top of the pressure vessel, water droplets are removed and the steam is sent to the turbine generator to turn the turbine.

Source: U.S. EIA and U.S. NRC

Pressurized Water Reactor (PWR)

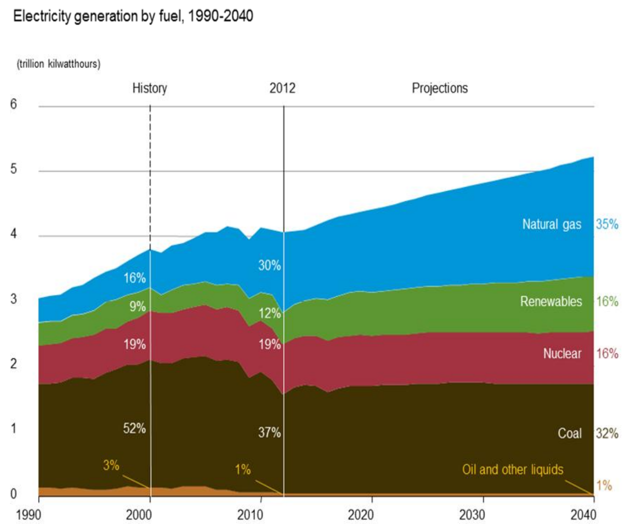


The pressurized water reactor (PWR) differs from the BWR in that the steam to run the turbine is produced in a steam generator. In the PWR plant, a pressurizer unit keeps the water that is flowing through the reactor vessel under very high pressure to prevent it from boiling. The hot water then flows into the steam generator, where it is converted to steam. The steam passes through the turbine, which produces electricity. About two-thirds of the reactor power plants in the United States are of the PWR type.

Source: The Virtual Nuclear Tourist and U.S. NRC

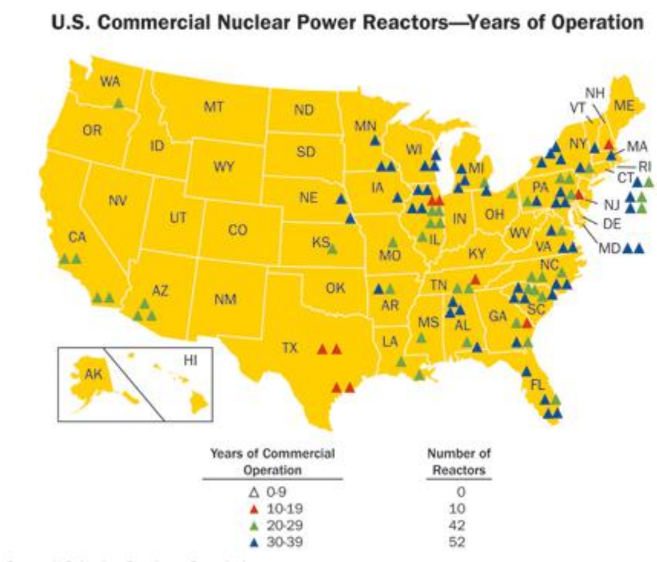
The Economics of Nuclear Energy

The economics related to building nuclear power plants long have been a significant stumbling block for the nuclear power industry. A long regulatory process, variable demand for electricity and soaring interest rates resulted in construction delays and ballooning budgets. The last nuclear plant ordered by a United States utility began construction in 1973 and was not ready for operation until 1996.[73] For the 75 nuclear power plants built in the United States between 1966 and 1986, the average actual cost of construction exceeded the initial estimates by more than 200 percent.[74]



Source: Energy Information Administration

As of October 2009, NRC had received 18 applications for a total of 28 new nuclear units.[75] In 2010 the federal government offered support in the form of construction loan guarantees.[76] But despite these signs of a potential nuclear "renaissance," the industry again is in a holding pattern. Electricity demand is one key factor that will drive a utility's decision to build. Demand was down four percent in 2009 from 2007; and the slow growth in electricity demand has continued. This, along with current low natural gas prices, could mean there is less impetus to build new nuclear plants. However, several factors including the push for an "all-of-the-above" energy strategy to develop all domestic energy sources; EIA's projection that electricity demand, while slow, will increase by 28% from 2012 to 2040; and the expectation the electricity mix will gradually shift to lower-carbon options,[77] should encourage new nuclear development.



The World Nuclear Association projects that between four and six new nuclear reactors may come on line by 2020 in the U.S., the first of those resulting from 16 license applications made since mid-2007 to build 24 new nuclear reactors.[78] Maintaining nuclear energy's current share of generation would require building one reactor every year starting in 2016, or 20 to 25 new units by 2040, based on DOE forecasts.[79]

Advocates for nuclear power argue it can be economical, potentially providing electricity for about 1.87 cents per kilowatt-hour.[80] Opponents often point out that that figure does not take into account the front-end costs of building a nuclear power plant, which typically are much higher than the cost of building a new coal-fired plant. John Rowe, BRC commissioner and CEO of Exelon, the nation's largest nuclear utility, once stated that "new nuclear plants are more expensive than any other energy source except photovoltaic cells."[81]

Pre-construction work - excavation, clearing of land and setting up temporary buildings — at sites for new nuclear reactors is underway.[82] However, these preparations for nuclear expansion may be at risk. An April 2011 study by the Massachusetts Institute of Technology (MIT) predicts that, as a result of the Fukushima crisis, costs for currently operating and new nuclear power plants are likely to go up (at least in the short term) as the perceived risk is higher and security requirements may increase along with the cost for on-site spent fuel management.[83]

The oldest commercial plants in the United States are now operating beyond their original licensing period of 40 years, and their first 20-year license renewal period began in 2009. According to the U.S. Energy Information Administration, in December 2012 the NRC had granted license renewals to 72 of the then-104 operating U.S. reactors;[84] and NRC is reviewing license renewal applications for 13 reactors. Fifteen more applications for license renewals were expected between 2013 and 2019, but in August 2012 NRC issued an order suspending actions related to issuance of operating licenses and license renewals.[85]

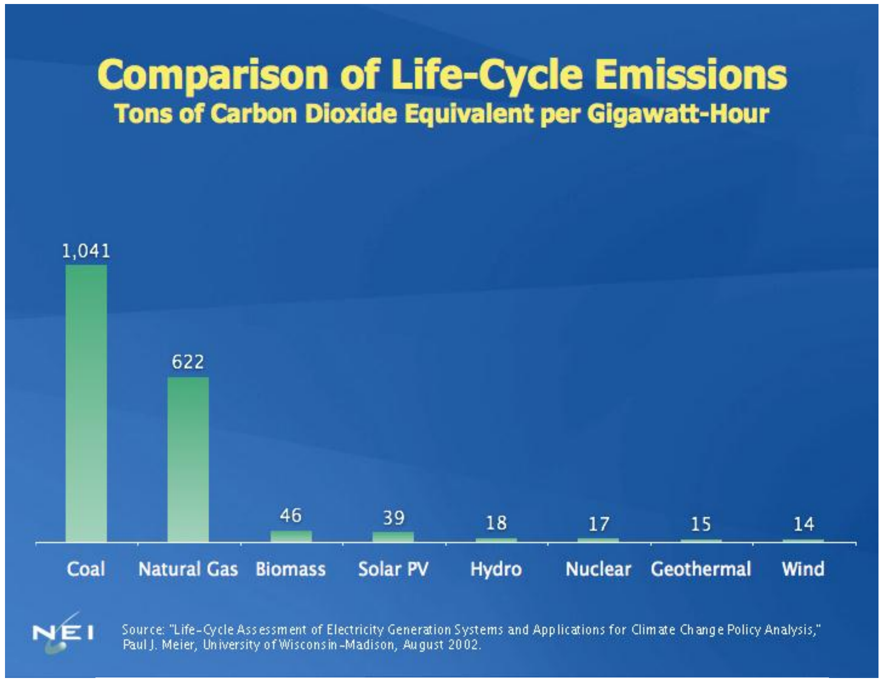
NRC regulations do not limit the number of license renewals a nuclear power plant may be granted, but NRC Chairman Allison Macfarlane has stated, "NRC is not yet in a position to pass judgment on the viability of operation beyond 60 years."[86]

DOE's Office of Nuclear Energy Light Water Reactor Sustainability (LWRS) Program aims to develop the scientific basis to extend existing nuclear power plant operating life beyond the current 60-year licenses (the 40-year initial license and a 20-year renewal) and ensure long-term reliability, productivity, safety, and security. The 60-year licenses issued by NRC will begin expiring between 2029 and 2039. Utilities are likely to begin looking at how to replace baseload power in 2014. A key question will be whether retaining the current fleet will be the most efficient and cost-effective way to help meet demand over time without increasing greenhouse gas emissions.

Despite the challenges, nuclear expansion can strengthen local economies. According to the Nuclear Energy Institute (NEI), up to 3,500 jobs are created during construction of a nuclear power plant. Operating a plant creates 400 to 700 permanent jobs.[87] NEI's most recent economic study found that the average nuclear plant generates almost $16 million annually in state and local tax revenue.[88]

Nuclear Energy and the Environment

Greenhouse gases, which trap heat in the atmosphere, are emitted as a result of naturally occurring processes and human activity, including the burning of fossil fuels. Some of the main greenhouse gases emitted by the production and burning of fossil fuels are carbon dioxide, methane and nitrous oxide. The increased presence of these gases in the atmosphere has been linked to global warming.[89]



Source: University of Wisconsin via NEI

The Electric Power Research Institute (EPRI) finds that sustaining electricity production from the operating nuclear plants is critical to national efforts aimed at significant carbon dioxide reductions.[90] Only 30 percent of power in the United States comes from "clean" energy sources which includes nuclear power plants, hydroelectric plants, and wind and solar energy facilities. Nuclear power plants account for almost three-fourths of that clean energy.[91] NEI reports that nuclear-generated electricity in 2012 avoided almost 570 million metric tons of carbon dioxide in the United States (the same amount as is emitted from nearly all passenger cars in the country). Worldwide, nuclear energy prevents production of about 2.5 billion metric tons of carbon dioxide each year.[92]

Nuclear power plants generate power from fission — a nuclear reaction in which a nucleus splits into smaller nuclei with the simultaneous release of energy — rather than by burning hydrocarbons like traditional fossil fuel-fired power plants. Nuclear power plants do not emit air pollutants or greenhouse gases as they produce electricity.[93] According to NEI, the generation of 1 million kilowatt-hours of electricity by a coal-fired plant would emit 996 metric tons of carbon dioxide, an oil-fired plant would emit 809 metric tons of carbon dioxide and a natural gas-fired plant would emit 476 metric tons of carbon dioxide. To generate the same amount of electricity, a nuclear power plant would emit no carbon dioxide.[94]

Opponents of nuclear energy cite the fact that nuclear energy is not an absolute zero-emission resource. Generating electricity, regardless of resource type, will impact the environment to some extent. The life-cycle emissions of a nuclear power plant include emissions created by the construction of the plant, the mining and processing of uranium used to fuel the reactor, routine operation of the plant, the management and disposal of used fuel and other wastes, and decommissioning. However, numerous studies show that the life-cycle emissions for nuclear energy are comparable to other renewable energy resources such as wind, geothermal and hydro power, but still are significantly less than the life-cycle emissions resulting from energy produced by coal or natural gas.[95] (See chart above.)

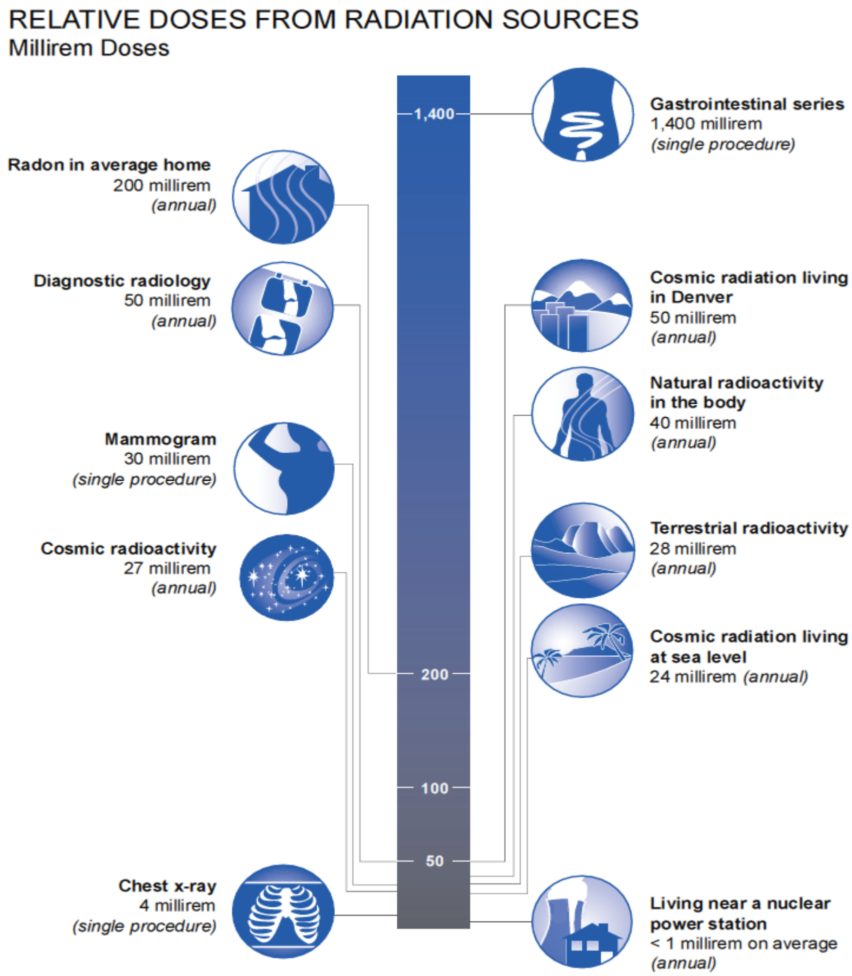
Furthermore, nuclear energy is the only proven "clean" resource providing baseload power ready for expansion. A baseload power plant normally is operated to take all or part of the minimum load of a system, producing electricity at an essentially constant rate and running continuously. These units are operated to maximize system mechanical and thermal efficiency and minimize system operating costs.[96]

Renewables like solar and wind power are considered intermittent energy resources, or resources where the output is controlled by the natural variability of the energy resource rather than dispatched based on system requirements.

What is Radiation?

Radiation is energy that travels in the form of waves or high speed particles. Radiation can be naturally occurring or manmade.[97] There are two types of radiation: non-ionizing radiation and ionizing radiation.

Radiation that has enough energy to move atoms in a molecule or cause them to vibrate, but not enough to remove electrons, is referred to as "non-ionizing radiation." Non-ionizing radiation includes visible light and microwaves.[98]



Source: U.S. Environmental Protection

"Ionizing radiation" has enough energy to remove electrons from atoms, creating ions and destabilizing the nucleus of an atom, creating "radionuclides." When people refer to "radiation," they usually mean ionizing radiation.[99] All radionuclides (also known as radioactive atoms and radioisotopes) seek to become more stable. Their nuclei release radiation by ejecting particles and high-energy waves in a process known as radioactive decay.[100] Some radionuclides, such as radium, uranium and thorium, occur naturally. Human activities such as the splitting of atoms in a nuclear reactor also create radionuclides.

In the United States, radiation doses are measured in a unit called a "rem." Scientists estimate that the average person in the United States receives a dose of about 360 millirem of radiation per year, with 80 percent of exposure coming from natural sources (like cosmic radiation and terrestrial radiation from soil and rocks), and the other 20 percent coming from manmade radiation sources, primarily medical X-rays.[101]

Radiation affects humans by depositing energy in body tissue, which can cause cell damage or cell death. In some cases there may be no noticeable effect. In other cases, a cell may survive but become temporarily or permanently abnormal. Abnormal cells may become malignant. The extent of damage to the body tissue depends upon the total amount of energy absorbed, the time period and the dose rate of the exposure, and the particular organs exposed.[102]

Radiation is known to cause cancer in humans and can cause other adverse health effects, including genetic defects in the children of exposed parents or mental retardation in the children of mothers exposed during pregnancy. Much of the knowledge about the risks of radiation is based on studies of survivors of the World War II atomic bombs at Hiroshima and Nagasaki, Japan, and of people receiving large doses of medical radiation. These studies revealed that:

- The more radiation a person receives, the greater the chance of developing cancer.
- It is the chance of cancer occurring, not the severity of cancer, that increases as the radiation dose increases.
- Radiation-induced cancers do not appear until years after the radiation dose is received.
- The risk from radiation exposure varies between individuals.[103]

Radiation Near Nuclear Power Plants

Nuclear power plant operations account for less than one 1/100 of 1 percent (<0.01%) of the average American's total radiation exposure.[104] However, as illustrated by the Fukushima Daiichi crisis in Japan, fear of exposure to radiation from nuclear power plants is a critical concern during nuclear emergencies.

Radiation standards in the United States have been developed by a number of regulatory authorities to protect human health. In 1987, EPA issued guidance for federal agencies to use in the development of radiation exposure standards for workers. These standards limit the amount of radiation that workers in the nuclear power and waste management industries may receive. NRC implements these standards for nuclear power reactors and other uses of nuclear materials; DOE implements these standards at its facilities.[105]

During routine operations, nuclear power plants emit negligible amounts of radiation.[106] Radiation doses for workers are controlled by installing physical shielding inside plants, limiting the time workers spend in areas with high levels of radiation, and using remote handling equipment for operations in the reactor core.[107] Shielding at nuclear power plants also protects nearby residents.

State and local governments retain primary responsibility for protecting the public and the environment during radiological emergencies.[108] All nuclear power plants in the United States must have emergency plans for protecting the public from radiation exposure and the potential release of radioactive material into the environment. EPA has developed guidance and recommended actions to protect the public. Communities are involved in emergency planning and training to help ensure emergency response teams can deal with a potential radioactive emergency. Since the 2011 earthquake and tsunami in Japan, there is a greater emphasis on ensuring financial resources, proper training and emergency procedures are in place to deal with nuclear accidents in the United States.

Any activity that produces or uses radioactive materials creates radioactive waste that must be disposed of properly. Radioactive waste can be in liquid or solid form, and levels of radioactivity vary. Items and equipment used during an activity that produces or uses radioactive materials also can become contaminated and must be disposed of as radioactive waste. Radioactive waste will decay eventually, but can retain dangerous levels of radioactivity for anywhere from days to thousands of years. Waste that is not properly stored and isolated from the public and the environment can contaminate air, soil and water supplies.[109]

Domestic Approach to Nuclear Safety and Security

Nuclear reactor accidents are low-probability events but present high-consequence risks.[110] The ability of the federal government, the nuclear industry, and state and local governments to ensure the health and security of the people living around nuclear reactors and waste storage sites is critical to winning and maintaining public support for nuclear energy development.

In 1974, Congress created NRC as an independent agency to enable safe use of radioactive materials for civilian purposes. NRC regulates commercial nuclear power plants and other uses of nuclear materials (such as medical isotopes) through licensing, inspection and enforcement of its requirements.[111] NRC does not regulate defense nuclear facilities operated by DOE, the National Nuclear Security Administration or the Department of Defense.

In a 2010 speech on nuclear safety challenges, then-NRC Chairman Gregory Jaczko stated that “dramatic growth of interest” in new nuclear reactors has significantly increased the licensing and regulatory workload at the commission. As a result, in “a short span of time” the agency’s budget increased by more than 50 percent and its staff grew by more than 30 percent to keep up with its mission.[112]

Prior to approving an operating license, NRC requires assurance that the effects of a core meltdown could be contained within a plant and not require the evacuation of nearby residents.[113] In addition, new designs for nuclear reactors contain numerous safety features such as passive safety systems that require no operator intervention in the event of a major malfunction.[114]

In regard to security, NRC focuses its efforts on activities that include:[115]

- Developing more formal, long-term relationships with federal, state and local organizations that share responsibilities for protecting nuclear facilities and responding to incidents.
- Verifying continued validity of NRC design-basis threats — a profile of the type, composition and capabilities of an adversary that nuclear facility licensees must demonstrate they can defend against. The design-basis threat is a basis for designing safeguards systems to protect against acts of radiological sabotage and to prevent the

theft of special nuclear materials − such as plutonium or enriched uranium − that can be weaponized.[116]
- Identifying vulnerabilities and developing mitigation strategies at licensed facilities.
- Revising requirements to provide additional protection that ensures the secure use and management of radioactive materials.
- Improving methods of communicating sensitive information to licensees.
- Enhancing controls, such as regulatory and safety-related, on high-risk radiation sources.

New safeguards were introduced after the terrorist attacks of September 11, 2001. The Office of Nuclear Security and Incident Response was established to centralize security oversight of all NRC-regulated facilities, coordinate with law enforcement and intelligence agencies, and handle emergency planning activities.[117]

Similarly, after a severe earthquake on March 11, 2011, caused multiple reactors at the Fukushima Daiichi site in Japan to shutdown, NRC convened a task force to conduct "a methodical and systematic review of relevant NRC regulatory requirements, programs, and processes, and their implementation, to recommend whether the agency should make near-term improvements to [the] regulatory system. The task force was also responsible for identifying a framework and topics for review and assessment for a longer-term effort."[118]

In July 2011, the Task Force issued a report with 12 overarching recommendations to improve the safety of operating and new nuclear reactors.[119] The NRC press release announcing the report stated that "a sequence of events like the Fukushima accident is unlikely to occur in the United States" and "plants can be operated safety." The report itself stated that, "continued operation and continued licensing activities do not pose an imminent risk to public health and safety."[120]

The recommendations included:

- Requiring plants to reevaluate and upgrade as necessary their design-basis seismic and flooding protection of structures, systems and components for each operating reactor and reconfirm that design-basis every 10 years.
- Requiring that facility emergency plans address prolonged station blackouts and events involving multiple reactors.
- Requiring additional instrumentation and seismically protected systems to provide additional cooling water to spent fuel pools, if necessary; and at least one system of electrical power to operate spent fuel pool instrumentation and pumps at all times.
- Strengthening and integrating onsite emergency response capabilities such as emergency operating procedures, severe accident management guidelines and extensive damage mitigation guidelines.
- Pursuing, as part of a longer-term review, emergency preparedness topics on decision-making, radiation monitoring and public education.[121]

It is important for local governments to note that nuclear plant security forces are supposed to be aided by local law enforcement officers if an incident occurs at a plant.[122] Thus, the federal government and the nuclear industry need to work with local governments to ensure they have the necessary resources, training and contacts with plant owners and operators to help respond to emergencies effectively.

Case Study: Three Mile Island

The 1979 accident at Three Mile Island in Pennsylvania was the most serious incident in the history of commercial nuclear power plant operations in the United States. On March 28, 1979, Three Mile Island Unit 2 (TMI-2) experienced either a mechanical or electrical failure that set into motion a series of events, ultimately leading to a severe core meltdown, described by NRC as "the most dangerous kind of nuclear power accident."[123] Confusion ensued, all non-essential personnel were evacuated from the plant, and citizens deemed most at risk[124] were advised to leave the area. While state officials, utility representatives and federal authorities from DOE, EPA, NRC and Brookhaven National Laboratory arrived as quickly as possible at the scene, the accident caught them off-guard.[125] It was not until five days later that the situation was considered under control.

Anti-nuclear protest in Harrisburg, Pennsylvania in 1979, following the Three Mile Island accident
Source: Renewable Energy Sources

The accident did not result in a massive radiation release nor were there any related deaths. After radiation monitoring and detailed studies were completed, it was estimated that the average dose to the population of close to 2 million people near the reactor was very small — about 1 millirem above the usual background dose.[126]

However, the accident had significant impacts at NRC and for the nuclear power industry. NRC made sweeping changes regarding how licensees were regulated in order to reduce risk to public health and safety. Regulations were tightened in areas including reactor operator training; human performance; design and equipment requirements; and emergency response planning. The new emergency response planning regulations required local agencies to participate in emergency response drills along with state agencies, FEMA and NRC several times a year.[127]

The accident at Three Mile Island had a significant negative impact on the public perception of the safety nuclear power. Safety concerns were considerably heightened at a time when the industry was already suffering from major cost overruns and construction delays. Even before the accident, domestic utilities had begun to cancel orders for new nuclear facilities. After Three Mile Island, no new plants were ordered in the United States for close to 30 years.[128]

After the Accident: Chernobyl Reactor 4
Source: atomicarchive.com

Case Study: Chernobyl

In 1986, one of the four nuclear reactors comprising the Chernobyl Power Complex in Ukraine (at the time, part of the Soviet Union) experienced severe "overpressure" —

when pressure is significantly above what is normal or usual[129] — resulting in damage to the fuel rod assemblies. Ultimately, operator error and design deficiencies (for example, there was no containment structure) destroyed the reactor. At least 5 percent of the reactor core[130] blew into the atmosphere as radioactive dust and debris, which was then spread by the wind across the Soviet Union and a large portion of Europe.[131] Two plant workers died from the explosion and an additional 28 died from whole-body irradiation. According to the World Nuclear Association, it was the only time in the history of commercial nuclear power that radiation-related fatalities occurred.[132]

A 1995 report released by the United Nation's Chernobyl Forum[133] found:

> fewer than 50 deaths had been directly attributed to radiation from the disaster, almost all being highly exposed rescue workers. Furthermore, 116,000 people were evacuated in the spring and summer of 1986 from the area around the plant, and in subsequent years, another 220,000 people were relocated. [I]nternational experts estimated that radiation could cause up to about 4,000 eventual deaths among the higher-exposed Chernobyl populations, i.e., emergency workers from 1986-1987, evacuees and residents of the most contaminated areas.[134]

According to the World Health Organization (WHO), the 4,000 eventual deaths represents about a 3 percent increased chance of radiation-induced cancer for those individuals.[135]

In 2006, the WHO released a report increased the estimate to about 9,000 excess cancer deaths due to Chernobyl among workers who participated in the cleanup operations, evacuees and residents of highly and lower-contaminated regions.[136] However, opponents of nuclear energy argue in their own studies that the number is actually much higher since The Chernobyl Forum and WHO did not consider areas outside of Belarus, Ukraine and Russia, where, as one study contends, more than half of Chernobyl's fallout was deposited.[137] One such study estimated that 30,000 to 60,000 excess cancer deaths could be caused by the Chernobyl nuclear disaster — seven to 15 times higher than the 4,000 originally cited in 1995.[138] Still other studies cite lower numbers.

The accident highlighted safety concerns related to the nuclear power industry as well as how to communicate with and evacuate the public when necessary. It was reported that an accident like the one at Chernobyl could not as easily happen in the United States due to different plant designs — all nuclear power reactors in the United States have containment structures[139] — and more public involvement with the government.[140] *Time* magazine reported in 1986 that about 60 percent of the U.S. public was opposed to building any new plants and the incident at Chernobyl did not have any significant impact on that figure.[141]

International Approach to Nuclear Proliferation, Safety and Security

Domestic and international security concerns related to nuclear energy and nuclear expansion include proliferation, the risk that fissile nuclear materials and/or nuclear technology could be more easily obtained by terrorists and the alternate use of nuclear materials to develop weapons.. Proliferation, or the spread of nuclear technology to non-nuclear states, was the main reason President Carter cited when he ceased federal support for the domestic reprocessing of used nuclear fuel in 1977. Conventional wisdom holds that nuclear power reactors do not pose a proliferation risk;[142] light water nuclear reactors need uranium U-235 enriched from 0.7 percent to 3 to 5 percent while nuclear weapons require U-235 enriched to at least 80 percent. However, at least a perception of a proliferation risk remains.[143]

The International Atomic Energy Agency (IAEA) was set up by the United Nations in 1957 to promote and control the use of atomic energy. As of November 2010, 151 nations were members.[144] IAEA has three main areas of work: safety and security; safeguards and verification; and science and technology. As the "world's nuclear inspectorate,"[145] IAEA verifies that safeguarded nuclear material and activities are not used for military purposes. In regard to security, its focus is to prevent, detect and respond to malicious acts. In regard to safety, IAEA sets and promotes international standards for managing and regulating nuclear and radioactive materials. The IAEA Incident and Emergency Centre specifically focuses on preparedness, event reporting and response to nuclear and radiological incidents and emergencies regardless of cause.[146]

Nuclear safety also is the focus of the World Association of Nuclear Operators (WANO). Created in 1989, WANO collects information on the performance of nuclear power plants worldwide, conducts peer reviews and consolidates the best practices and operating experience of nuclear power plants to enhance safety and reliability.[147] WANO is a voluntary organization whose membership is open to any operator or owner of a nuclear power plant or nuclear fuel reprocessing facility, as well as any non-governmental organization that has a nuclear safety mission.[148]

One concept that would allow for the expansion of nuclear energy and help offset proliferation concerns is the establishment of an international nuclear reactor fuel bank to ensure reliable access to a fuel supply for peaceful nuclear programs. The concept has support from President Obama.[149] The United States has supported the program to facilitate the development of nuclear power while eliminating the need for countries to build uranium enrichment facilities (where fuel could be weaponized). It has been envisioned that only countries that renounce nuclear weapons and the pursuit of nuclear fuel production could participate in the program and purchase fissile fuel for nuclear reactors.[150] IAEA would provide oversight.

The United States contributed $50 million to IAEA[151] in 2010 to support an international fuel bank administered by the agency.[152] In December 2010, the Board of Governors of the IAEA adopted a resolution to create an international low-enriched uranium fuel bank. The next step will be to create the framework and define the fuel bank's structure, access and location.[153] In mid-2011, Kazakhstan formally announced its interest in hosting the fuel bank and the IAEA is assessing two potential sites there.[154]

Recommendations
• Local governments should provide education to their communities regarding potential benefits and risks related to hosting nuclear power or nuclear waste storage facilities. • Local governments should be educated concerning the politics of siting a nuclear waste storage or nuclear waste disposal facility. • Potential host states and communities need to ensure they address perceptions of risk in education and outreach programs, as perception and reality do not always align. A heightened perception of risk could be one of the most significant challenges — along with the economic environment — for the industry and local or state governments interested in hosting new nuclear facilities to overcome.

CHAPTER 4: THE NUCLEAR FUEL CYCLE IN THE UNITED STATES

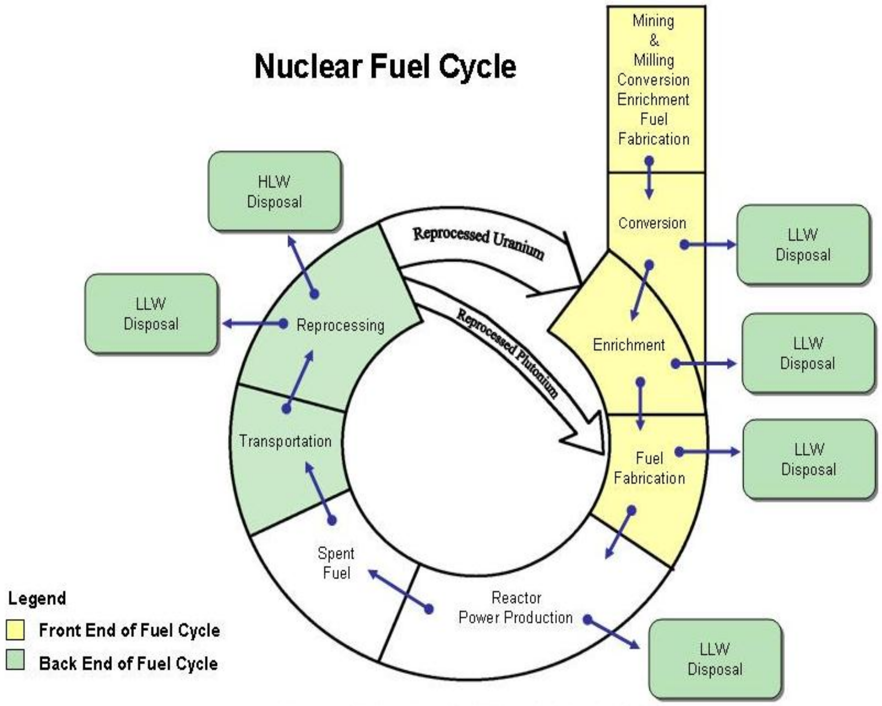
As the federal government looks to support new nuclear development and works toward a new plan for managing nuclear waste, all fuel cycle technologies and options for the management, storage and disposal of nuclear waste should be studied. In doing so, decision-makers should understand that the long-term viability of any recommendations and future federal policy actions hinge, in part, on carefully considering the impacts of each alternative at the local level. Local governments — whether current, former or future hosts to nuclear production or waste storage missions — will play an important role in educating their congressional and state delegations, as well as their constituents, on how nuclear energy is produced, what happens to nuclear waste, and whether there is public support for new nuclear missions. This chapter will explain the nuclear fuel cycle and the challenges associated with managing nuclear waste.

What communities should consider when reading this chapter:

- The United States employs an "open" fuel cycle in which fuel is used only once in a power plant.
- After spent nuclear fuel is removed from a reactor, it is stored in a specially designed pool and eventually is moved into on-site storage where it remains until a final disposition path is selected or a remote interim storage capability is developed.
- While "closing" the fuel cycle allows the fuel used in a nuclear power plant to be reprocessed for further use in a power plant, shifting from an "open" to a "closed" fuel cycle is considered a longer-term alternative in the United States.
- The status of a geologic repository for final waste disposition is uncertain, as the future of Yucca Mountain remains unclear.

Local governments should understand the various stages associated with the production of electricity from nuclear reactions. The process of preparing, burning and disposing of the fuel collectively referred is to as the nuclear "fuel cycle." The fuel cycle also is described as "a concept that encompasses both the kind of fuel used to power a reactor … and what happens to the fuel after it has been used."[155] In the United States, the nuclear industry employs an "open" or "once-through" fuel cycle, wherein nuclear fuel is used once in a power plant. Once it is removed from the reactor, the nuclear fuel is considered "spent" or "used" and is not recycled to recover remaining energy potential[156] but is treated as waste for eventual disposal in a geological repository. The terms "spent" and "used" in reference to nuclear fuel often are used interchangeably in the United States.

It is important to note that spent nuclear fuel not only comes from commercial nuclear power plants, but also from domestic research reactors, nuclear-powered American naval warships, DOE-run research and defense reactors, reactor design tests, and energy and medical research.



Source: Nuclear Security Science & Policy Institute

The "Front End" of the Nuclear Fuel Cycle

The "front end" of the nuclear fuel cycle starts with the mining of uranium ore, after which the uranium is separated from the waste rock and upgraded into "yellowcake." The United States once had a robust uranium mining industry, but the current level of uranium concentrate production is about 10 percent of the peak reached in 1980. Most of the uranium that goes into fuel for the United States nuclear reactor fleet comes from ore deposits from foreign countries that are higher quality and cost less to mine and process. The yellowcake produced from ore mined in the United States is extracted from western and midwestern states, including Colorado, Nebraska, Texas and Wyoming.[157]

Yellowcake is the uranium oxide concentrate typically sold to nuclear power plant operators or utilities who then contract for its conversion into a gas — uranium hexaflouride[158] — the form used by most commercial uranium enrichment facilities to put into fuel assemblies for use in nuclear reactors.[159] The front end includes the following additional steps:

Enrichment

Most commercial nuclear power reactors require "enriched" uranium fuel that contains the fissile isotope of uranium (U-235) at a certain level to support chain reactions, which give off heat and can be utilized to produce steam. To accomplish this, the content of U-235 in naturally occurring uranium must be enriched from about 0.7 percent to 3 to 5 percent, at which point it is known as "low enriched uranium."[160] "Highly enriched uranium" contains more than 20 percent U-235 and has been produced primarily for military applications and weapons, but it is no longer produced in the United States. The bulk of the remaining uranium is made up of the isotope U-238.

Uranium enrichment in the United States was once entirely within the domain of the federal government, but now is performed by the private sector.[161]

Two types of processes have been used to commercially enrich uranium in the United States: gaseous diffusion and gas centrifuges.[162] An enrichment plant in Paducah, Kentucky,[163] utilized the gaseous diffusion process in which uranium hexafluoride gas is passed through many stages of barriers to separate the U-235 and U-238 isotopes. Uranium also can be enriched by using gas centrifuges to spin uranium hexafluoride gas at high speed, forcing the heavier U-238 isotope outward, resulting in the separation of U-235. Centrifuges require significantly less electrical energy to enrich uranium than the gaseous diffusion process and can be done in smaller, more economical facilities.[164] The advanced centrifuge enrichment facility in Lea County, New Mexico, when operating at full capacity, should provide enough enriched uranium for nuclear fuel to supply approximately 10 percent of the electricity needs for the United States.[165]

NRC has issued licenses for a new uranium enrichment facility using centrifugation in Idaho and a first-of-a-kind facility in North Carolina that would use laser technology to separate uranium isotopes. Neither project has a projected date to begin construction or operation.[166]

Fuel Fabrication

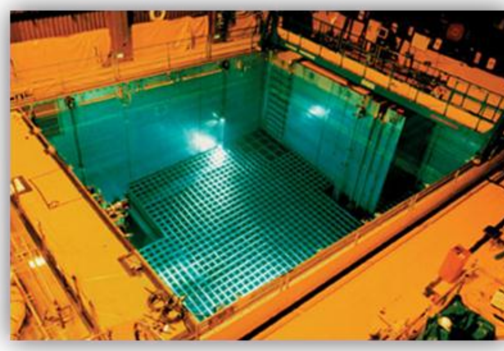
Once the uranium hexaflouride is enriched, it goes to a fuel fabrication plant to be converted into uranium dioxide powder and pressed into small pellets. The pellets are inserted into thin tubes to form fuel rods. The rods then are sealed and assembled in clusters to form fuel assemblies used in the core of nuclear reactors.[167] A fuel assembly includes up to 300 rods[168] and a reactor core contains many fuel assemblies.[169]

The Nuclear Reactor

In order to generate electricity, the fuel assemblies or bundles are inserted into the nuclear reactor. Water separates the fuel tubes in the reactor. Fission produces heat which in turn heats the water to produce steam. The steam turns the turbine blades. As they turn, the blades drive generators that make electricity.[170]

The "Back End" of the Nuclear Fuel Cycle

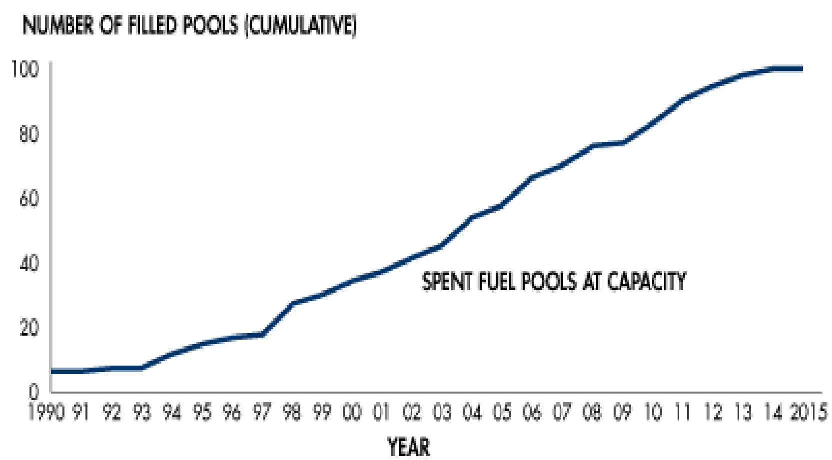
After 12, 18 or 24 months, about one-third of the nuclear fuel in an operating reactor is removed, replaced with fresh fuel, and begins a cooling and storage process that will prepare it for permanent geological disposal (as addressed in Chapter 8). Another option is reprocessing, which is no longer done in the United States, but is done in other countries.[171]



Spent fuel rods cool in a spent fuel pool
Source: U.S. NRC

Once removed from the reactor core, used fuel is thermally hot and can be very radioactive.[172] It is moved into specially designed water pools at the reactor site. These pools are robust constructions made of reinforced concrete several feet thick, with steel liners. The water is typically about 40 feet deep, and serves both to shield the radiation and cool the rods.[173]. Under an open fuel cycle — as employed by the United States — the fuel removed from the reactor will not be used again. Instead, it will move from temporary storage to a permanent repository.

According to NRC, nuclear power plant designers expected that spent fuel would be reprocessed, but commercial reprocessing was not successful in the United States (as briefly described in Chapter 5). Without reprocessing or a repository for the permanent disposal of spent nuclear fuel, spent fuel pools at reactor sites in the United States are reaching capacity.[174] Utilities have had to identify alternatives, such as re-racking the spent fuel grid or implementing fuel consolidation, in order to maximize the amount of spent fuel that can be stored in a spent fuel pool. Re-racking allows plants to use high-density storage racks with closer spacing between fuel assemblies in spent fuel pools.[175] In fuel consolidation, after the fuel assembly is dismantled, spent fuel rods are rearranged into a close packed geometry in a storage container.[176] Both options require NRC review and approval. Alternatively, spent fuel can be moved from spent fuel pools for temporary dry cask storage.

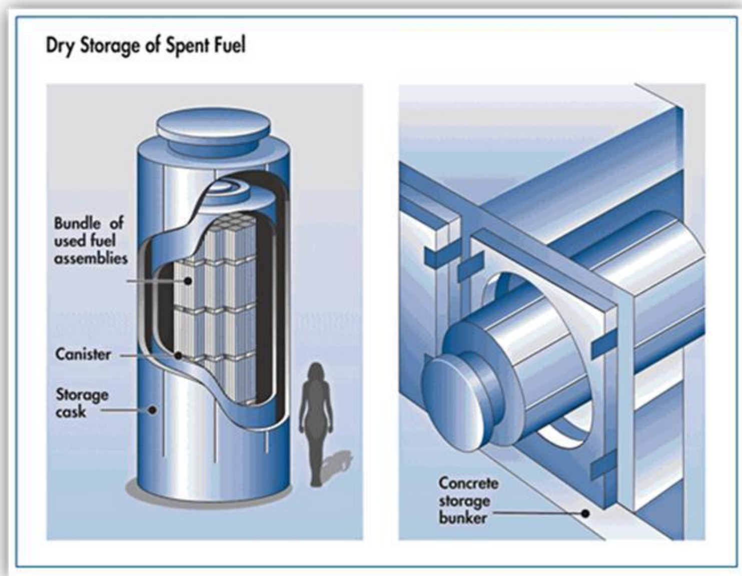


Note: All operating nuclear power reactors are storing used fuel under NRC license in spent fuel pools. Some operating nuclear reactors are using dry cask storage. Information is based on loss of full-core reserve in the spent fuel pools.

Source: Energy Resources International and DOE/RW-0431 – Revision 1

Temporary Storage in Dry Casks

Once spent fuel has cooled in a spent fuel pool for the time period required by the NRC, it can be transferred inside a steel cylinder called a cask. NRC has authorized transfer as early as three years; the industry norm is about 10 years.[177] As part of the transfer, all air and water is removed before the cask is filled with an inert gas and sealed shut either by bolting or welding. The cask then is enclosed within metal, concrete or another type of outer shell that shields workers from radiation (as shown in the illustration above).



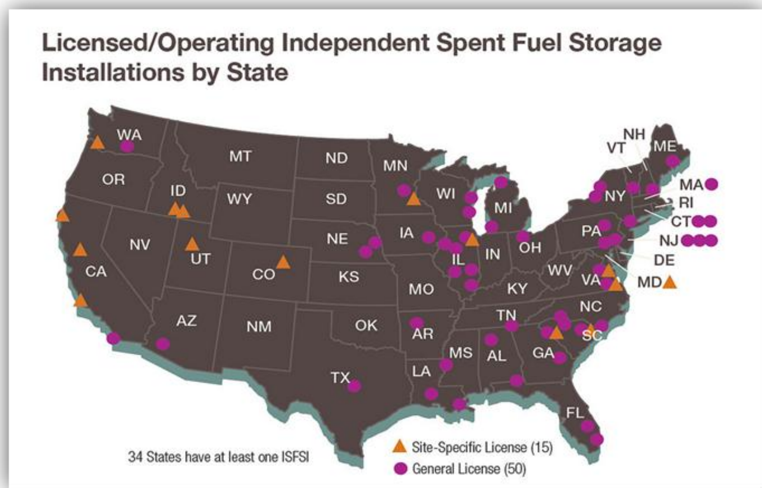
Source: U.S. NRC

David Lochbaum, Director of the Nuclear Safety Project with the Union of Concerned Scientists, described the benefits of the "passive safety system" used in dry cask storage:

> "… it takes no pumps, no power, no switches, and no forced circulation of water to protect spent fuel in dry casks from damage. Instead, air enters an inlet in the bottom of the dry cask, gets warmed by the heat from the spent fuel, and flows out an outlet in the top of the dry cask via the chimney effect …"[178]

A 2006 report on the safety and security of spent nuclear fuel storage by the National Academy of Sciences found that in addition to the passive system for cooling described above, dry cask storage for older, cooler spent nuclear fuel is safer and more secure. Dry cask storage divides the inventory of spent fuel among a large number of individual, robust containers making it more difficult for someone to attack a larger amount of spent fuel simultaneously. It also reduces the consequences in the event of a natural disaster, substantial impact or successful attack.[179]

NRC reviews and approves the designs for dry storage systems for commercial spent nuclear fuel.[180] Depending on its design, casks can be stored horizontally or vertically on a concrete pad. Dry cask storage systems, or Independent Spent Fuel Storage Installations (ISFSI), are designed and constructed for the interim storage of spent nuclear fuel and are often a concrete storage pad on which the casks are stored. These facilities are licensed by the NRC separately from a nuclear power plant and are considered independent even though they may be located on the site of another NRC-licensed facility.[181]



NRC authorizes storage of spent nuclear fuel at an ISFSI in two ways: site-specific or general license. For site-specific applications, the NRC reviews the safety, environmental, physical security and financial aspects of the licensee and proposed ISFSI and a license is issued when the NRC concludes it can operate safely. This license contains requirements on topics such as leak testing and monitoring and specifies the quantity and type of material the licensee is authorized to store at the site. A general license authorizes storage of spent fuel in casks previously approved by the NRC at a site already licensed to possess fuel to operate a nuclear power plant. Licensees must show the NRC that it is safe to store spent fuel in dry casks at their sites, including analysis of earthquake and tornado intensity. Licensees also review their programs (such as security or emergency planning) and make any changes needed to incorporate an ISFSI at their sites.[182]

During his testimony in the March 2011 BRC hearing, Mr. Lochbaum asserted that the fuel stored in dry casks at the Fukushima Daiichi plant in Japan was not damaged by the tsunami or earthquake. He recommended that after a five-year cooling period, it would be safer to move spent fuel as quickly as possible from spent fuel pools to dry cask storage, rather than waiting until the spent fuel pools are close to capacity as is the more common practice in the United States.[183]

Impact for Local Governments and Communities

NRC regulations do not specify a maximum time for storing spent fuel in pools or casks. Dry casks for commercial spent fuel are licensed or certified by NRC for 20 years, with possible renewals of up to 40 more years.[184] Regardless of whether the time limit is extended, dry cask storage is still just a temporary storage option, and a permanent repository will be required. While industry critics argue that more spent fuel should be moved into safer dry cask storage, NRC does not force utilities to do so, and critics believe the costs associated with dry cask storage are high enough that some utilities will choose not to do so.[185] According to NEI, a dry storage facility is estimated to cost $10 million to $20 million initially, and $5 million to $7 million a year in operating costs.[186]

The nuclear industry has stated that it will comply with NRC regulations and that there is potential danger in moving spent fuel more often than is necessary. Regardless, as lessons are learned from Japan and any new recommendations for storage developed by the NRC, communities face the prospect of having spent nuclear fuel stored longer than originally planned at sites they host.

Recommendations
• Local governments should provide education within their communities and to their federal delegations on issues related to the fuel cycle, specifically the differences between open and closed fuel cycles, and the issues that may impact the facilities in their own communities. • Local governments should understand the history of reprocessing used nuclear fuel in the United States and abroad.

CHAPTER 5: LOOKING TO THE FUTURE: SMALL MODULAR REACTORS, RECYCLING AND NEW NUCLEAR TECHNOLOGIES

This chapter examines the promising potential for the development of small modular reactors (SMRs) and discusses the regulatory and political support for these future projects.

What communities should consider when reading this chapter:

- Advanced SMRs may present new economic opportunities and burn spent nuclear fuel as part of a waste management strategy.
- SMRs appear to have support from Congress, the White House and DOE.
- DOE's Asset Revitalization Initiative can provide opportunities for communities to build clean energy resources — including nuclear energy projects like SMRs, and solar, wind and other renewable projects — at their own sites as part of cleanup plans and goals.

In April 2010, DOE's Office of Nuclear Energy presented to Congress its *Nuclear Energy Research and Development Roadmap* (Roadmap).[187] The report included an outline of research, development and demonstration activities that will ensure nuclear energy remains a viable domestic energy option. Specifically it described four main R&D objectives that address challenges to expanding the use of nuclear power:

1. Develop technologies and other solutions that can improve the reliability, sustain the safety and extend the life of current reactors;
2. Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Obama Administration's energy security and climate change goals;
3. Develop sustainable nuclear fuel cycles; and
4. Understand and minimize risks of nuclear proliferation and terrorism.[188]

This chapter examines some of the most promising new nuclear reactor technologies that are being supported by the U.S. Department of Energy, national laboratories, and industry, and will help DOE's Office of Nuclear Energy to achieve the strategy outlined in the Roadmap.

Many local governments around DOE's nuclear weapons complex recognize an opportunity to work with DOE at the cleanup sites or national laboratories within their communities to support the development and demonstration of new nuclear technologies. By doing so they can help to ensure future nuclear missions, attract economic development opportunities and create new nuclear jobs. In addition, these communities can use existing assets — a highly trained workforce, extensive infrastructure, natural resources, property and location. Given their familiarity with nuclear issues, there is a greater likelihood of support for a project and recognition of the benefits, as long as impacted communities and local governments are engaged from the outset in the decision-making process.

Small Modular Reactors

DOE defines SMRs as a nuclear power plant with an output of less than 300 megawatts electric.[189] Accelerating the development of SMR designs is a high priority within DOE's Office of Nuclear Energy (DOE-NE) that can help to achieve the objectives outlined in the Roadmap.

At his April 2013 confirmation hearing, Energy Secretary Ernie Moniz stated that SMRs are "a very promising direction that we need to pursue … it's where the most innovation is going in nuclear energy."[190] The Obama Administration's 2014 budget request included $70 million for licensing technical support[191] and DOE's Office of Nuclear Energy states on its webpage "DOE anticipates continuing efforts toward a 5-year $452 M program." The Senate Energy and Water Development Appropriations Subcommittee also has shown support for SMRs and "the unique attributes in meeting base-load power supply needs of the future," and provided funding.[192]

As former Secretary Chu has stated, "If commercially successful, SMRs would significantly expand the options for nuclear power and its applications … Their small size makes them suitable to small electric grids . . . and for locations that cannot support large reactors. Their modular construction process would make them more affordable by reducing capital costs and construction times." The cost of an SMR has been estimated between $800 million and $2 billion per unit, whereas a large reactor costs between $10 billion and $12 billion.[193]

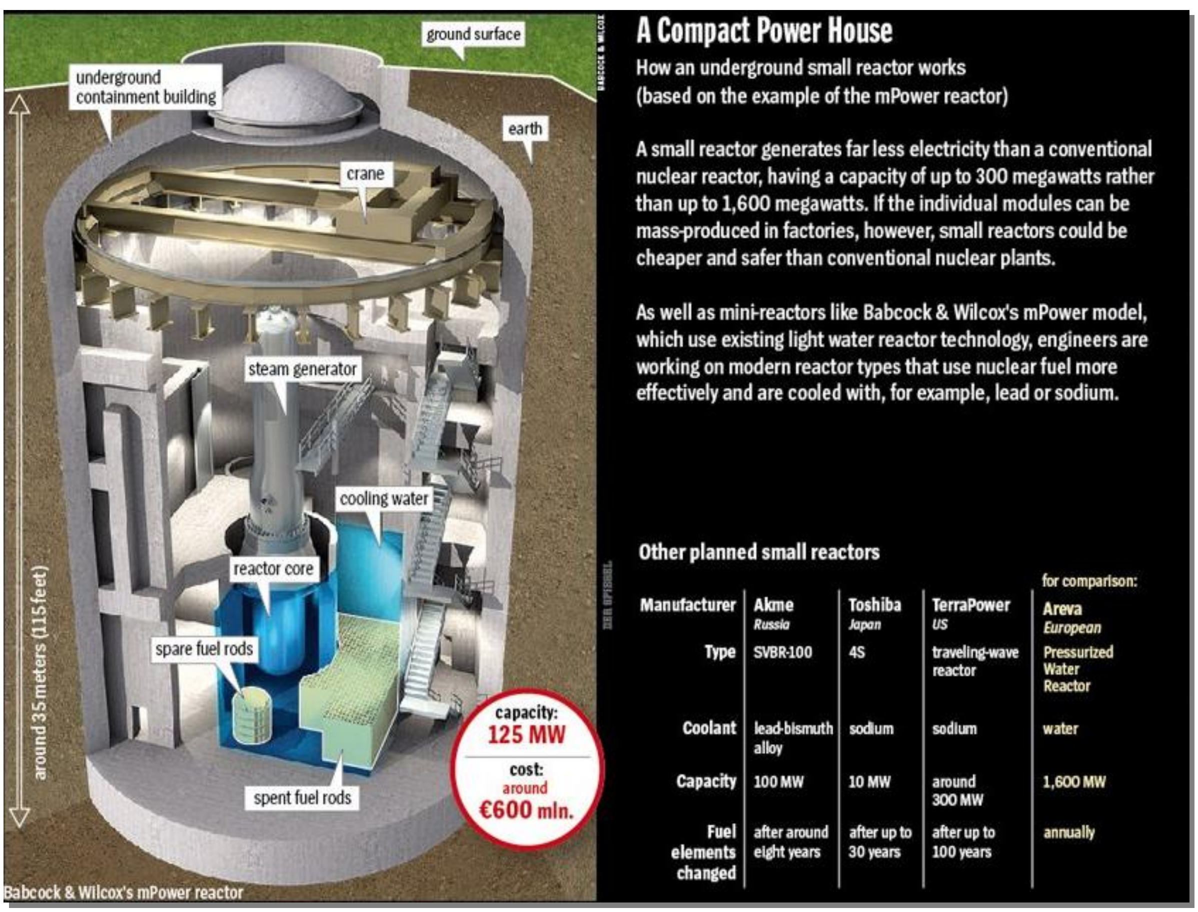
The size of an SMR, approximately one-third the size of current nuclear plants, also would increase flexibility for utilities since they could add units as demand changes, or use them for on-site replacement of aging fossil fuel plants.[194] Some of the designs for SMRs use little or no water for cooling, which would reduce their environmental impact. And, as Assistant Energy Secretary Pete Lyons has suggested, SMRs are the right size to replace coal plants being shut because of age and inability to meet modern pollution standards.[195]

The DOE Office of Nuclear Energy's Small Modular Reactor Licensing Technical Support program began in 2012 with a mission to advance the licensing and commercialization of domestic SMR designs that are relatively mature and can be deployed in the next decade. Specifically, the program supports certification and licensing requirements for U.S.-based SMR projects through cooperative agreements with industry partners, and by supporting the resolution of generic SMR issues.

In March 2012, the Obama Administration announced an effort intended "to help jumpstart America's nuclear energy industry,"[196] making available $450 million for SMR development. Funds were authorized to support engineering, design certification, and licensing for up to two SMR designs over five years, and a goal to deploy the reactors by 2022.

Specifically, DOE sought proposals that included innovations to improve SMR safety, operations and economics through lower core damage frequencies, longer coping periods in the event of an accident, enhanced resistance to hazards presented by natural phenomena, and potentially reduced emergency preparedness zones or workforce requirements.[197] Through the use of cost-share agreements with private industry, DOE projected the funding could potentially help to create a total investment of $900 million.

DOE's first award went to the mPower program, led by Babcock & Wilcox (B&W) in partnership with the Tennessee Valley Authority (TVA) and Bechtel, to support the development of licensing documentation that could lead to SMR deployment in west Oak Ridge by 2022. The project is based in Tennessee and will support additional suppliers and operations in Indiana, Maryland, North Carolina, Ohio, Pennsylvania and Virginia.[198] Under the agreement signed in April 2013, DOE will share costs on the design, certification and licensing of the mPower SMR design, with B&W providing at least 50 percent of the total cost. Oak Ridge National Laboratory (ORNL) supports the effort and the plans to deploy the design, a light water reactor with the reactor and steam generator located in a single reactor vessel situated in an underground containment, for commercial operation in Roane County, Tennessee, on the Clinch River Site adjacent to ORNL.[199] It has an electrical output of 180 MWe and a four-year operating cycle without refueling. In August 2013, federal officials announced additional funding of $20.5 million for the project. According to ORNL's SMR Program Director, ORNL is involved in initial discussions to receive power from the projects under a power purchase agreement.[200] The



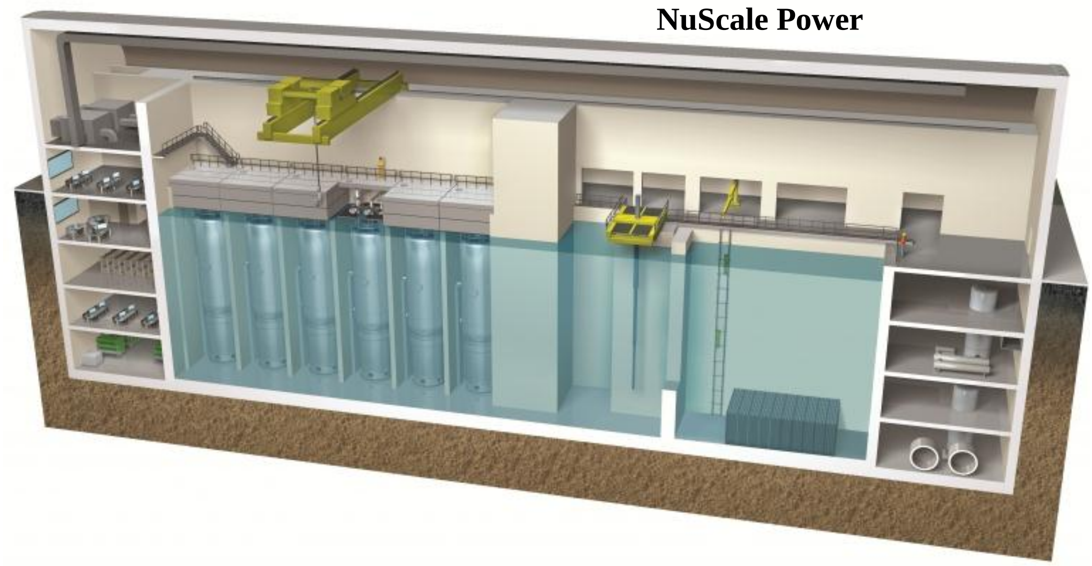
NRC is currently engaged in pre-application activities on the mPower SMR.

In December 2013, DOE announced that NuScale Power LLC won the Department's second funding award, specifically to support the accelerated development of its SMR technology, a 6 to 12 module (270MW-540ME) plant to be located at a site like the Idaho National Laboratory. The goal is for the plant to become operational in the around 2025 timeframe.

Several western governors voiced support for the project, including Idaho Gov. C.L. "Butch" Otter who stated, "The technology of small modular reactors holds real promise for cleanly and safely addressing long-term energy needs in the west. I'm pleased that western governors are engaging with industry to realize that promise."[201]

As with the first award, DOE will invest up to half of the total project cost under the five-year cost-share agreement with private industry providing the balance of the funding. The cooperative agreement also requires that the reactors be built domestically in order to help strengthen American manufacturing capabilities and to help create export opportunities. The project will be based in Oregon and will support suppliers in California, Idaho, Washington, Pennsylvania, South Carolina, Virginia, Kansas, Texas and Maryland.[202]

NuScale Power



Reactor Building Cross Section — NuScale nuclear power reactors are housed inside high-strength steel containment vessels and submerged in a large steel-lined pool of water below ground level in the reactor building. The reactor building is designed to withstand earthquakes, tsunamis, tornados, hurricane force winds and aircraft impact. The fuel pool and control room also are housed below ground level. © 2013 NuScale Power, LLC.

A number of other companies competed for federal grants and are expected to continue to work on developing SMR technology. These include NuHub, which is working with the state of South Carolina and Holtec International Inc. to develop an SMR at the Savannah River Site.

DOE and its Savannah River Site have three public-private partnerships to develop deployment plans for SMR technologies at locations near the facility. These partnerships will help leverage Savannah River's land assets, energy facilities and nuclear expertise to support potential private sector development, testing and licensing of prototype SMR technologies.[203] In addition, Westinghouse Electric has partnered with nuclear utility Ameren to develop its SMR at Ameren's existing Callaway nuclear plant site in Missouri.

Recycling Spent Nuclear Fuel

As described in Chapter 4, the United States currently employs an open fuel cycle in which reactor fuel is used once, removed from the reactor and sent to storage for eventual emplacement in a repository. However, when the nuclear fuel is removed from the reactor, approximately 95 percent of it is uranium and 1 percent is plutonium, both of which can be reprocessed. Reusing the nuclear fuel potentially can extend the fuel supply and result in a fivefold decrease in the volume of the waste and a tenfold reduction in its toxicity.[204] Proponents say it can begin to address two problems long associated with nuclear power: the sustainability of nuclear waste management strategies and the risk of proliferation.

Supporters also argue that closing the fuel cycle could reduce the need for new uranium in the United States by about 25 percent.[205] The materials potentially available for recycling (but locked up in stored used fuel) could conceivably run the existing domestic reactor fleet for almost 30 years with no new uranium input.[206] This could be a benefit if uranium supplies become limited, although that seems unlikely in the near future. An April 2011 study by MIT found sufficient domestic uranium supplies to negate the need to consider recycling for the foreseeable future,[207] stating that "at any reasonable expected growth of nuclear power over this century, the availability of uranium will not be a constraint" in the United States or any other country."[208]

History of Recycling in the United States and Impact on Local Governments

There is a history of reprocessing spent nuclear fuel in the United States. In 1954, Congress amended the Atomic Energy Act to promote private industry participation in nuclear fuel reprocessing.[209] The federal agency that preceded DOE encouraged the transfer of used nuclear fuel reprocessing from the federal government to private industry. The transfer was promoted to ensure a self-sufficient, domestic commercial nuclear power industry.[210] Three commercial reprocessing facilities were built in response to the new policy: Nuclear Fuel Service's facility near West Valley, New York; General Electric's Midwest Fuel Recovery Plant at Morris, Illinois; and Allied General Nuclear Services plant at Barnwell, South Carolina. Of these, only the West Valley facility reprocessed spent nuclear fuel commercially.

At the local level, significant benefits at West Valley never were fully realized during the period of time that reprocessing activities took place from 1966 to 1972. The plant reprocessed uranium and plutonium from spent nuclear fuel; sixty percent of this fuel was generated at defense facilities. When commercial operations were discontinued, there were approximately 600,000 gallons of liquid HLW in two of four underground storage tanks and the Main Plant Process Building, the facility that was used to reprocess the spent nuclear fuel.

The West Valley Demonstration Project Act, enacted in 1980, directs the Secretary of Energy to enter into a cooperative agreement with New York and to carry out a radioactive waste management demonstration project. The project includes solidifying the HLW, developing waste containers suitable for permanent disposal, and DOE is responsible for transporting the solidified waste to a federal repository for permanent disposal. The West Valley Site began vitrifying waste in 1996 and completed production in 2002.[211]

Local government officials believe the property values have been negatively affected by the perception of a failed plant and waste disposal sites. While cleanup activities under the demonstration project provided jobs for 1,200 people at its peak in the 1990s, the current number of employees is closer to 300. Finally, because the site now is owned by the state, the property and any improvements are exempt from county, town and school district property taxes. While the state provides an annually appropriated payment in lieu of taxes that is split among the town, the county and the school system,[212] there is concern that the payments could end.[213]

In 1977, President Carter called for the indefinite suspension of reprocessing civilian spent nuclear fuel in the United States due to proliferation concerns related to the separation of plutonium. Although President Reagan lifted the ban in 1981, it would take 25 years for reprocessing to gain significant domestic attention.

Global Nuclear Energy Partnership (GNEP)

While a number of other countries including France, Japan, Russia and the United Kingdom developed technologies to reprocess used nuclear fuel, reprocessing was not considered seriously again in the United States until 2006 when DOE introduced the Global Nuclear Energy Partnership (GNEP) as part of President George W. Bush's Advanced Energy Initiative. In January 2007, DOE announced it would consider possible locations for one or more of three proposed projects: a nuclear fuel recycling center, an advanced recycling reactor and an advanced fuel cycle research facility. Of the 14 applications submitted in response to DOE's announcement,[214] eleven commercial and public consortia[215] were chosen to receive funding to conduct detailed studies. However, no siting decisions were made and the Obama Administration decided in 2009 not to pursue domestic commercial reprocessing.[216]

Recycling in the Future?

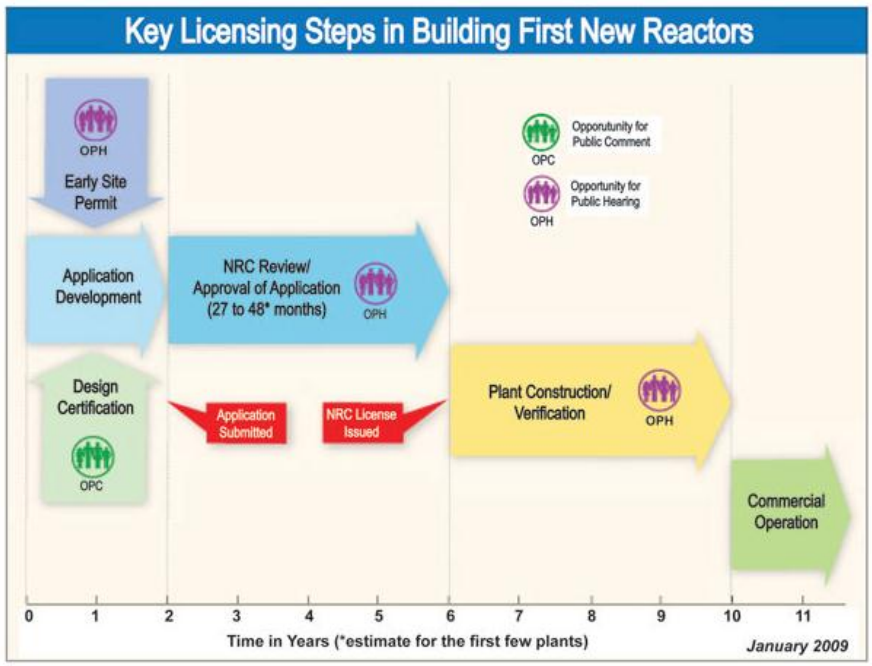
Some communities remain interested in hosting recycling facilities. But even with the potential opportunity to avoid the "not-in-my-backyard" (NIMBY) hurdle, there remain a number of difficult issues to overcome: the long-term availability of uranium, perception of a proliferation risk, waste management and economics. If uranium is readily available, as noted above in the MIT study, a closed fuel cycle where used fuel is reprocessed is likely to be more expensive than an open fuel cycle.[217]

Critics also point out that the most widely used method for reprocessing separates uranium and plutonium from the fission products and from one another. The separate plutonium stream is considered by DOE to be "a proliferation risk inherent in existing recycling technologies"[218] as it potentially can be used to make weapons.[219]

The BRC considered recycling as one alternative for a new strategy for managing the back end of the nuclear fuel cycle, concluding "that no currently available or reasonably foreseeable reactor and fuel cycle technology developments — including advances in reprocessing and recycling technologies — have the potential to fundamentally alter the waste management challenge [in the United States] over at least the next several decades, if not longer."[220] Even if the United States decided to recycle, a permanent geological repository would still be necessary.

Advanced Reactor Technologies

Along with its work under the Light Water Reactor Sustainability (LWRS) Program to extend the life of existing nuclear power plants, DOE's Office of Nuclear Energy is responsible for research, development and deployment (RD&D) activities related to future reactor concepts. These activities are designed to address technical, cost, safety and security issues associated with advanced reactor concepts and ultimately, to make nuclear energy a more competitive resource in the future.[221]



The NRC's new licensing process offers multiple opportunities for public input.

Source: Nuclear Energy Institute

Ultimately, the BRC recommended that research and development continue on a range of fuel cycle technologies. DOE's Strategy for waste management echoes this need, stating that, "consistent with past practice and the BRC's recommendations, DOE will continue to conduct research on advanced fuel cycles to inform decisions on new technologies that may contribute to meeting the nation's future energy demands while supporting non-proliferation and used nuclear fuel and high-level radioactive waste management objectives." The work is done through the Office of Nuclear Energy's Fuel Cycle Technologies program. Identifying and selecting preferred fuel cycle options to address key challenges, including deployment of advanced uranium enrichment technologies to enhance national energy security, is considered a near-term goal of the program; conducting research to fully evaluate and characterize the selected fuel cycle options is a medium-term goal; and deployment, a long-term goal.[222]

The RD&D work is done through national laboratories and universities, as well as through partnerships with the nuclear industry. Local governments and communities interested in new nuclear missions and nuclear workforce development can benefit from understanding nuclear technologies that are being prioritized and developed for the future, including:

High-Temperature, Gas-Cooled Reactor Technologies

A high-temperature, gas-cooled reactor (HTGR) could be used for electricity generation, but is especially well-suited to providing process heat for industrial purposes, including hydrogen production. An HTGR could be used in the development of tar sands, oil shale and coal-to-liquids applications and would reduce the life-cycle carbon footprint of all these activities.[223]

In January 2013, DOE awarded the NGNP Industry Alliance Limited a $1 million cost-shared contract to continue business and economic analysis for using HTGR technologies and expanding the nuclear energy footprint from electricity production into the process heat and steam industry.[224] The NGNP alliance is comprised of potential end users, owner operators and technology companies including: Savannah River Site Community Reuse Organization (SRSCRO) and the Advanced Research Center, AREVA, ConocoPhillips, Dow Chemical, Entergy, Graftech International Ltd., Mersen, Petroleum Technology Alliance Canada, SGL Group, Technology Insights, Toyo Tanso Co. Ltd., and Westinghouse.

Liquid Metal and Gas-Cooled Fast Reactors

A fast reactor uses neutrons of much higher energy to cause fission and, unlike today's commercial thermal reactors,[225] does not have a moderator to slow down high-speed neutrons in order to sustain the chain reaction.[226] Fast nuclear reactors "consume" plutonium via fission (transforming it into other forms of nuclear waste that are not as useful for weapons). Liquid metal and gas-cooled fast reactor technologies hold the promise of distributed nuclear applications for electricity, water purification and heating in remote communities. Fast reactors also can provide sustainable nuclear fuel cycle services, such as breeding new fuel and consuming recycled nuclear waste as fuel, and support nonproliferation efforts by consuming material from former nuclear weapons.[227]

Industry is interested in fast reactors, but the primary challenges to developing and deploying them are cost and support at the public and political levels. Proponents of fast reactor technology argue that the potential for advanced reactors to destroy the longest-lived radioactive components of the fuel means only relatively short-lived radioactive isotopes would be left for permanent disposal.[228] Opponents argue — and supporters acknowledge — that recycling (even with fast reactors) would not eliminate the need for a repository.[229]

Advanced SMRs

DOE is conducting research and development on advanced SMR concepts for use in the mid- to long-term. Through innovative concepts, advanced SMRs would use non-light water reactor coolants such as liquid metal, helium or liquid salt that could potentially offer added functionality and affordability.[230] They also could potentially burn used fuel or nuclear waste.

NRC will be responsible for licensing SMRs and any new reactors. NRC is working on its strategy to address licensing applications for advanced concepts anticipated over the next two decades, as well as potential licensing activity beyond that time.[231]

Nuclear Waste Storage in the Future

Research and development of new concepts for storage of nuclear waste in the future also is a focus for DOE. Improvements in fuel technologies have already allowed plant operators to achieve higher burn-up levels and can almost double the amount of energy captured.[232] Nuclear fuel burn-up, also known as fuel utilization, is the amount of fuel consumed in a reactor.

In April 2013, DOE announced plans to invest $15.8 million over five years for research into the design and demonstration of dry storage cask technology for high burn-up spent nuclear fuels removed from commercial nuclear power plants. The project builds on BRC recommendations and will be led by the Electric Power Research Institute (EPRI). The nuclear power industry will contribute 20 percent of the full cost.

DOE's Asset Revitalization Initiative

DOE should consider its own sites as hosts for SMRs and other new technologies. Communities with ongoing DOE missions that are interested in new nuclear missions should reach out to DOE about this possibility. DOE has already identified the potential for 15,000 acres that could be made available in the next 10-12 years for beneficial reuse. One DOE program worth considering is the Asset Revitalization Initiative. Originally proposed in late 2008 by the Office of Environmental Management (EM), the initiative aims to leverage existing EM assets, such as highly trained workforces, extensive infrastructures, abundant natural resources, property and location, and "create opportunity to enable rapid development of energy-related facilities … particularly those with significant potential for sustained progress towards energy independence, regional economic vitality, national security, environmental sustainability, and other national concerns."[233]

The initiative was formalized in the FY 2011 Defense Authorization Act. An ARI task force has been created and organized into five teams: diversification, real property and assets, modernization, energy, and communications.

The Asset Revitalization Initiative would encourage partnerships between DOE and the communities surrounding DOE sites to convert "liabilities" — contaminated sites, facilities and materials — into reusable energy-related assets. The initiative could save DOE money and years of cleanup, while at the same time creating opportunities for public-private partnerships and long-term green energy-related jobs, developing clean energy technologies, including wind and solar resources, and creating economic development opportunities.

Prospective nuclear development under this initiative has the potential to help DOE fulfill its stated goals of investing in clean energy jobs, increasing energy security, closing the carbon loophole and reducing emissions. Communities and community reuse organizations around DOE's nuclear weapons complex may consider future nuclear projects, ranging from SMRs to uranium enrichment to nuclear technology demonstrations, as part of the Asset Revitalization Initiative.

Recommendation
• Local governments and communities should identify the benefits they hope to gain when volunteering to host a new nuclear energy facility such as an SMR. • Local governments should identify whether their communities would support hosting SMRs or other new nuclear energy projects. Local governments interested in policies to recycle used nuclear fuel in the future also could benefit from being engaging with DOE and the private companies interested in building new recycling facilities. • Communities need to work together to support SMR development at multiple sites across the country. Geographic dispersion of SMR projects can help build political support. • Local governments should engage with the nuclear industry to better understand their plans for SMR development. • Communities interested in SMR projects should begin to consider manufacturing and workforce development issues. • Communities should work with their local colleges and universities to identify opportunities to attract new nuclear facilities and nuclear missions. • Communities should consider how to integrate the waste discussion when evaluating new nuclear technology development. This can help to ensure the costs and issues related to waste management and disposal are included as early as possible in developing a vision for new nuclear facilities.

CHAPTER 6: REGULATING NUCLEAR WASTE

The regulation of nuclear facilities, activities and waste involves many federal agencies. As hosts to nuclear waste storage sites, defense nuclear facilities, and commercial power plants, and as potential hosts of new nuclear missions, local governments need to understand the role of each regulatory agency. Local governments can use the information in this chapter to understand who at the federal level is working with the nuclear facility owners and operators in their communities, which agencies to engage with regarding oversight roles and resources, and which agencies can provide support for outreach and training efforts.

What communities should consider when reading this chapter:

- NRC is the agency responsible for the regulation of nuclear activities, excluding defense-related nuclear facilities.
- DOE is responsible for defense nuclear facilities and waste and civilian radioactive waste facilities.
- Other federal agencies, including the EPA, the Department of Interior and the Department of Transportation, also regulate nuclear waste facilities.
- Under the DOE Strategy, a new waste management and disposal organization (MDO), would be created to manage and dispose of commercial used nuclear fuel. The federal government will maintain management of its own HLW and UNF, but eventually those wastes will also be transferred to the new waste management organization for storage and/or disposal.
- There is support among decision-makers for a proposal under which a new federal agency would be established to manage the nuclear waste program in place of the Department of Energy.
- Creating a new waste management organization responsible for the storage and disposal of high-level waste and used nuclear fuel will require new federal legislation.

DOE is responsible for managing large inventories of nuclear waste and nuclear by-products in accordance with national and international principles. These principles require the protection of the environment and human health, compliance with independent regulatory agencies, and a practicable minimum of waste generation. The primary waste and by-product categories are defined below.

Federal Regulators

Under the Atomic Energy Act of 1954, the Atomic Energy Commission (AEC) had the sole responsibility for the development and production of nuclear weapons and for the development and the safety regulation of the civilian uses of nuclear materials. The Energy Reorganization Act of 1974 abolished AEC and split the weapons and civilian functions between the Energy Research and Development Administration (now part of DOE) and NRC. Today, several federal agencies regulate nuclear energy activities, facilities and waste. The agencies, their roles and their advisory bodies are outlined below:

Nuclear Regulatory Commission: NRC was created as an independent agency by Congress in 1974. NRC is responsible for licensing facilities developed for permanent disposal of high-level waste and spent nuclear fuel. NRC also regulates spent fuel pools and dry cask storage. NRC would also be responsible for licensing any reprocessing facility for commercial spent nuclear fuel.[234] NRC also regulates spent fuel pools and dry cask storage.

CATEGORIES OF RADIOACTIVE WASTES AND BY-PRODUCTS	
Spent nuclear fuel (SNF)	Fuel elements and irradiated targets (designated “reactor-irradiated nuclear material” and often simply called “spent fuel”) from reactors. DOE’s spent fuel is not categorized as waste, but it is highly radioactive and must be stored in special facilities that shield and cool the material.
High-level waste (HLW)	Material generated by the reprocessing of spent fuel and irradiated targets. Most of DOE’s HLW comes from the production of plutonium. A smaller fraction is related to the recovery of enriched uranium from naval reactor fuel. This waste typically contains highly radioactive, short-lived fission products as well as long-lived isotopes, hazardous chemicals, and toxic heavy metals. It must be isolated from the environment for thousands of years. Liquid high-level waste is typically stored in large tanks, while waste in powdered form is stored in bins. DOE has plans to vitrify and encapsulate its HLW and has already done so at some locations.
Transuranic waste (TRU)	Waste generated during nuclear weapons production, fuel reprocessing, and other activities involving long-lived transuranic elements. It contains plutonium, americium and other elements with atomic numbers higher than that of uranium. Some of these isotopes have half-lives of tens of thousands of years, thus requiring very long-term isolation. Since 1970, TRU waste has been stored temporarily in drums at sites throughout the complex.
Low-level waste (LLW)	Any radioactive waste that does not fall into one of the other categories. It is produced by every process involving radioactive materials. Low-level waste spans a wide range of characteristics, but most of it contains small amounts of radioactivity in large volumes of material. Some wastes in this category (e.g., irradiated metal parts from reactors) can have more radioactivity per unit volume than the average high-level waste from nuclear weapons production. Most low-level waste has been buried near the earth’s surface. A limited inventory remains stored in boxes and drums.

CATEGORIES OF RADIOACTIVE WASTES AND BY-PRODUCTS	
Mixed waste	Waste that contains both radioactive and chemically hazardous materials. Some low-level waste is mixed waste.
Uranium-mill tailings	Large volumes of material left from uranium mining and milling. While this material is not categorized as waste, tailings are of concern both because they emit radon and because they usually are contaminated with toxic heavy metals, including lead, vanadium and molybdenum.
Source: U.S. Department of Energy, Office of Environmental Management	

NRC does not have licensing authority over:

- Receipt or possession of high-level waste used for or as part of DOE activities in DOE research and development facilities;
- DOE facilities used as short-term storage for high-level waste from DOE activities;
- DOE facilities used for the storage or disposal of transuranic waste, foreign high-level waste not resulting from licensed activity, and low-level waste;
- DOE's decommissioned facilities (except those specified in Section 202 of the Energy Reorganization Act); and
- DOE's high-level waste-processing facilities.[235]

Department of Energy: While there is no "regulator" for defense nuclear waste, DOE is the federal agency responsible for the development and production of nuclear weapons, promotion of nuclear power, and other energy-related work. In addition, DOE is in charge of planning and carrying out programs for the safe handling of DOE-generated high-level waste, developing waste-disposal technologies, and for designing, constructing and operating disposal facilities for DOE-generated high-level waste and commercial spent nuclear fuel.[236] Specific timelines and responsibilities for developing a permanent waste disposition path — including geological repositories — are set forth in the Nuclear Waste Policy Act of 1982 (NWPA); and more specifically in regard to Yucca Mountain, when NWPA was amended in 1987. NRC is required to license any repositories.

Two boards also were created by Congress to serve in an advisory oversight capacity to DOE. They are:

Nuclear Waste Technical Review Board: Congress created the Nuclear Waste Technical Review Board in 1987 to increase public confidence in DOE decision making, to allay concerns over whether waste would be stored correctly, and to provide independent scientific and technical oversight of DOE's program. The board advises Congress and the Secretary of Energy on technical issues related to nuclear waste management; and it evaluates the technical validity of all activities undertaken by the Secretary of Energy related to DOE's continuing obligation to manage and develop an approach for the disposition of spent nuclear fuel and high-level radioactive waste.[237]

Defense Nuclear Facilities Safety Board: Created by Congress in 1988, the Defense Nuclear Facilities Safety Board is responsible for independent oversight of all activities affecting nuclear safety within DOE's nuclear weapons complex.[238] Housed within the executive branch, the board may conduct investigations, issue subpoenas, hold public hearings, gather information, conduct studies and establish reporting requirements for DOE. It also is empowered to make recommendations to the Secretary of Energy.[239] The board is required by statute to report to Congress each year concerning its oversight activities, its recommendations to the Secretary of Energy and improvements in safety achieved at defense nuclear facilities as a result of its activities.

Other federal agencies with roles in regulating nuclear waste include:

Environmental Protection Agency: EPA's regulatory role is to develop environmental standards and federal radiation protection guidance for offsite radiation due to the disposal of spent nuclear fuel, high-level waste and transuranic wastes. The standards limit (1) the amount of radioactivity entering the biosphere outside the boundaries of the facility, and (2) the radiation exposure to the public from management of spent fuel and waste prior to disposal. The guidance also establishes waste-disposal criteria. EPA environmental standards apply to DOE-operated and NRC-licensed facilities. NRC is responsible for implementing the standards developed by EPA and for determining that DOE can meet them.[240]

Department of Transportation (DOT): DOT regulates the packaging and carriage of all hazardous materials in the U.S., including high-level nuclear waste. Packaging must meet NRC regulations, and the package design must be reviewed and certified by NRC. DOT prescribes limits for external radiation levels and contamination and controls the mechanical condition of carrier equipment and qualifications of carrier personnel.[241]

Department of Interior (DOI): DOI works with DOE to conduct laboratory and field geological investigations in support of waste disposal programs. Within DOI, the Bureau of Land Management manages certain public lands, and DOI can withdraw such public lands for limited use by DOE to study as potential radioactive waste storage or disposal sites. Development of a permanent waste repository other than Yucca Mountain would likely require congressional action to withdraw the land from public use.[242]

Oversight by and Input from State and Tribal Governments

States

Before 1992, NWPA gave states a limited role in regard to how nuclear waste from the federal government's weapons program was stored, treated or disposed of in their jurisdictions. However, with the passage of the Federal Facility Compliance Act in 1992, affected states have worked jointly with DOE in shaping treatment and disposal plans for various waste categories (although states do not have regulatory authority over high-level waste), negotiating and enforcing cleanup milestone agreements, working with congressional delegations to ensure adequate funding levels, and providing oversight.[243]

Tribes

Affected tribes also were provided an oversight role by NWPA, but they wanted to be more engaged in decisions regarding the storage, treatment and disposal of nuclear waste resulting from the federal government's weapons programs in their jurisdictions. Since 1989, tribes have participated in the Office of Environmental Management's State and Tribal Government Working Group (STGWG). In that capacity, members of affected tribes participate in the Office of Environmental Management's Five Year Plan planning process which projects EM's planned strategies, funding and accomplishments over a given five-year period.[244]

In addition, through Executive Order 13175 of November 6, 2000, executive departments and agencies are required to recognize a "special relationship" with tribes by engaging in regular consultation and collaboration with tribal officials in the development of federal policies with tribal implications.[245]

New Oversight Roles under a Consent-Based Process?

While the oversight provided by federal and state agencies is important, a formal oversight role for affected local governments and other non-federal entities (such as tribes) also should be considered. Communities and local governments adjacent to DOE sites are impacted directly by DOE decisions and are readily familiar with nuclear energy and waste issues. Third-party oversight can increase the credibility of DOE decisions, offset opposition and build trust.

DOE's Strategy and legislation introduced in the Senate both propose a new waste management organization that is dedicated solely to assuring the safe storage and ultimate disposal of spent nuclear waste fuel and high-level radioactive waste; and both support a consent-based siting process. DOE's Strategy states, "… prospective host jurisdictions must be recognized as partners. Public trust and confidence is a prerequisite to the success of the overall project…" Similarly, a consent-based siting process as outlined in legislation should allow "affected communities to decide whether, and on what terms, the affected communities will host a nuclear waste facility."[246]

As Congress and DOE work together to define the governance structure of a new waste management entity and a consent-based process, local governments have an opportunity to outline the role they want as potential hosts for nuclear facilities. A local government representative should serve on any newly created oversight board to ensure local perspectives and concerns are identified and represented. In addition, any member of a host community should learn about the health, safety and other issues that are inherent in hosting a site.

Potential host communities must be given the means – either from Congress or DOE − for education and other activities, including:

- External oversight.
- Independent analysis of proposed activities.
- Facilitating interaction among local, state, regional and federal governments.
- Hiring independent experts whose responsibilities are to the potential host community.

Ensuring input from the parties that will be most directly affected by a decision on nuclear waste management will help build trust that the federal government is being as inclusive and transparent as possible.

Recommendations

- Communities should identify, understand and advise federal policy-makers to look at lessons learned from past experiences regarding nuclear activities, siting and oversight.
- Communities should refer to existing provisions in NWPA regarding "affected units of local governments." This can help communities identify what provisions they want included in new legislation or consent agreements, such as: :
    - Provide the local community with resources to hire third-party scientists to review data and the scientific integrity of a new nuclear project, which could potentially increase public confidence;
    - Ensure citizens in host communities have a means to interact with the federal government and any nuclear facility operator; and
    - Demonstrate a commitment to external oversight independent of DOE.
- Potential host communities should consider whether they want to require a position on an oversight board of advisory committee (if a new waste management organization is created) as a condition for hosting a nuclear waste storage or disposal site.

CHAPTER 7: NUCLEAR WASTE DISPOSAL IN THE UNITED STATES

Nuclear waste management has long been a challenge in the United States. This chapter will outline the history of domestic nuclear waste management, the key issues being reexamined by the federal government, and the impact for local governments and communities where waste is stored. These communities have unique health and safety concerns and needs, both of which will only increase over time. Local governments should understand the pitfalls of the past and work with the federal government, nuclear plant operators, and regulators to ensure their priorities and needs are addressed in any legislation developed as part of a new national waste management plan.

What communities should consider when reading this chapter:

- High-level waste and spent nuclear fuel are being stored at locations throughout the country that were never intended for long-term storage.
- As a result of the Obama Administration's request to withdraw the disposal license application for Yucca Mountain, the future of the repository there is uncertain.
- Uncertainty over the future of Yucca Mountain could affect environmental safety and health, as sites and facilities will end up storing waste beyond originally anticipated time frames.
- Differences between high-level waste and spent nuclear fuel must be considered when exploring waste management alternatives.
- The Blue Ribbon Commission's recommendations are being used to inform future nuclear policy.

Key NRC Waste Definitions

NRC defines nuclear waste as "a subset of radioactive waste that includes unusable by-products produced during the various stages of the nuclear fuel cycle, including recovery (or extraction), conversion, and enrichment of uranium; fuel fabrication; and use of the fuel in nuclear reactors."[247]

NRC defines high-level waste as the by-product of the reactions that occur inside nuclear reactors. High-level wastes take one of two forms:

(1) spent reactor fuel when it is accepted for disposal; or

(2) waste materials remaining after spent fuel is reprocessed.[248]

Under the NWPA,[249] the federal government is directed to build a geological repository for the storage of both forms.

Spent nuclear fuel is used fuel taken from a reactor that no longer efficiently creates electricity because its fission process has slowed. However, spent nuclear fuel is highly radioactive, generates significant heat, can be harmful, and requires remote handling and shielding, as it remains radioactive for hundreds of thousands of years.[250] As discussed in Chapter 4, the United States does not reprocess spent nuclear fuel produced by commercial nuclear reactors. That waste ideally will be stored temporarily, on site or at an Independent Spent Fuel Storage Installation (ISFSI), allowed to cool and then sent to a geological repository for final disposal.

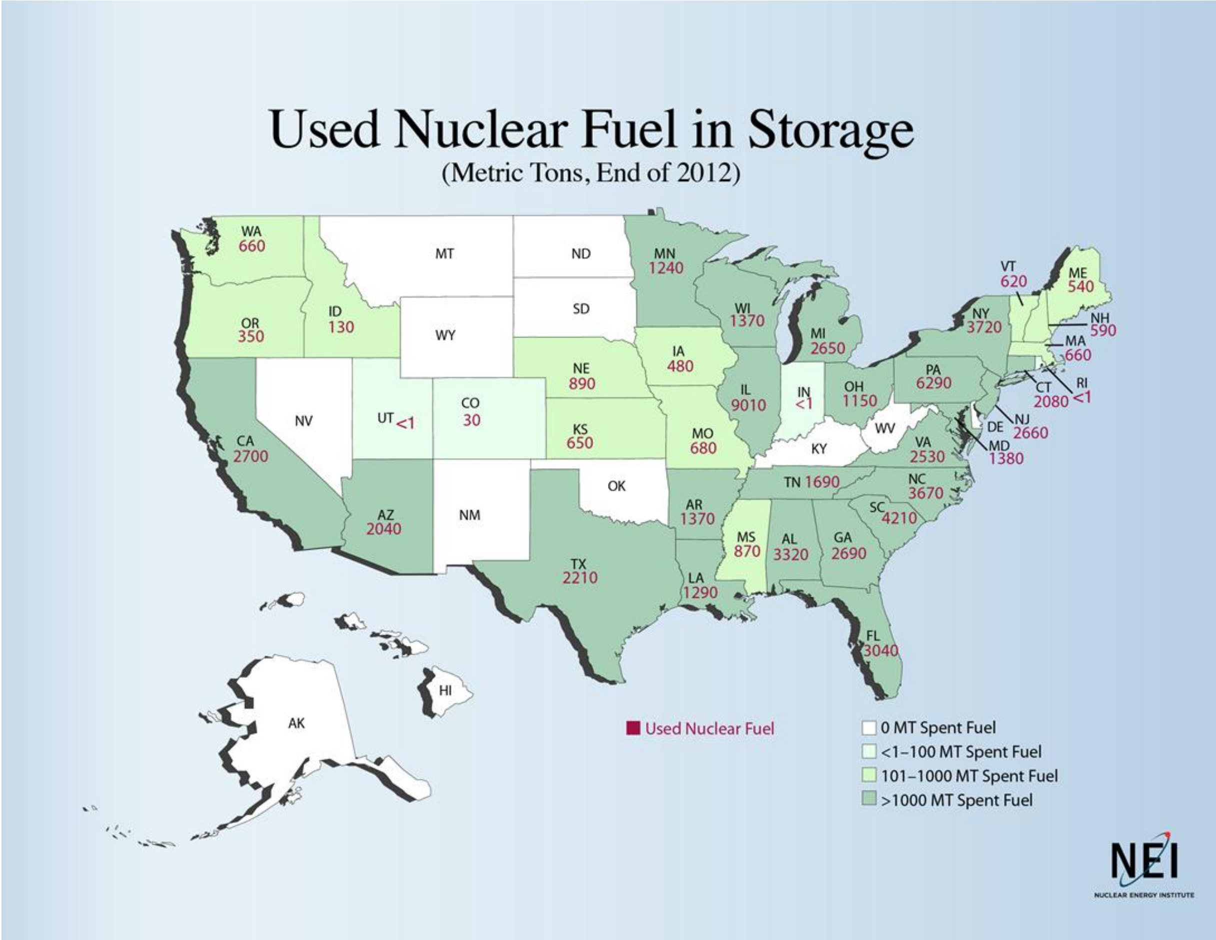
Defense High-Level Waste

DOE produced high-level waste through its defense reprocessing programs carried out at various sites, including the Hanford Site in Washington, Idaho National Laboratory and the Savannah River Site in South Carolina. In some cases, high-level waste remains at those sites, while some defense high-level waste has been shipped from one defense site to another for "temporary" storage pursuant to agreements with various states.

Defense high-level waste is supposed to be treated to satisfy international treaty obligations, or packaged to meet repository standards and stored in temporary buildings.[251]

DOE has 332 underground tanks used to process and store liquid high-level radioactive waste. The large tanks sit at three locations: Hanford, Washington (56,000,000 gallons); Idaho National Laboratory (900,000 gallons); and at the Savannah River Site in South Carolina (36,000,000 gallons). Some of these tanks are made of only a single shell of steel and would pose a serious threat to public health and the environment if the tank walls were to be compromised by corrosion.

Much of the defense high-level waste is being vitrified, which involves blending the waste with glass-forming materials and heating it to 2,100 degrees Fahrenheit. The resulting mixture is poured into stainless steel canisters to cool and solidify. In this glass form, the waste is stable and considered safe for long-term storage.[252] It is ultimately destined for disposal at Yucca Mountain. Where high-level waste has already been vitrified, it is being on-site. However, if it is determined that the Yucca Mountain geological repository is not an option, this waste will need a new deposition path. As a by-product of reprocessing of DOE spent nuclear fuel, defense high-level waste is not a candidate for additional reprocessing or recycling.



Commercial Spent Nuclear Fuel

A typical nuclear power plant produces 20 metric tons of spent nuclear fuel each year. The nuclear industry in the United States generates close to 2,300 metric tons of spent nuclear fuel annually.[253] Over the past 40 years, the commercial nuclear industry has produced about 69,720 metric tons of spent nuclear fuel.[254] This inventory is expected to more than double by 2055.[255] The nuclear industry's policy arm provides this perspective: "If used fuel assemblies were stacked end-to-end and side-by-side, this would cover a football field about seven yards deep."[256]

Regulated by NRC, commercial spent nuclear fuel is stored in steel-lined concrete pools of water or in dry casks (see Chapter 4). Today, spent fuel sits at close to 100 nuclear reactors in 33 states at more than 75 sites.[257] As is the case with defense high-level waste, if the Yucca Mountain geological repository is not an option, there will no longer be a final disposition path for this waste and it could remain at sites that never were intended for long-term storage.

MOX in the United States

Mixed oxide nuclear fuel, or MOX, is comprised of a blend of uranium oxide and plutonium oxide. MOX fuel is predominantly uranium, with average concentrations of plutonium that range from 3 to 10 percent. MOX fuel was fabricated and used in several commercial reactors in the United States in the 1970s as part of a development program on MOX fuel technologies. However, when the federal government called for the indefinite suspension of spent nuclear fuel, the development and deployment of MOX technologies also stopped.

As part of a nuclear security strategy and plutonium disposition program, the National Nuclear Security Administration (NNSA) began building a MOX Fuel Fabrication Facility at DOE's Savannah River Site near Aiken, South Carolina in 2007. Construction of the facility is reportedly 60 percent complete and employs 1,800 people from surrounding communities. The facility is designed to take surplus weapon-grade plutonium, remove impurities, and mix it with uranium oxide to form MOX fuel pellets for commercial nuclear reactor fuel.

The facility is also expected to help meet terms of the Plutonium Management and Disposition Agreement (PMDA) DOE made with Russia in 2000. Under the PMDA, each nation agreed to dispose of no less than 34 metric tons of weapons-grade plutonium. Once MOX fuel assemblies have been irradiated in commercial power reactors, the plutonium can no longer be readily used for nuclear weapons.

According to the Nuclear Energy Institute, the policy organization for the nuclear technologies industry, technically almost every nuclear reactor in the United States could accept MOX as one-third of its fuel, but the reactors would require some investment in upgrades to monitoring equipment.

The design of the MOX facility in South Carolina is based on proven French technology in use at the MELOX and La Hague facilities in France. However, there have been a number of issues with cost and scheduling estimates related to the project. The MOX plant is reported to be $3 billion over budget, with estimated construction costs revised to $7.7 billion. Citing the greater-than-anticipated expense along with DOE's limited resources, the Obama Administration announced it was placing the project in "cold standby" in its FY 2015 budget request.

South Carolina has filed a lawsuit against the U.S. Department of Energy (DOE) and the National Nuclear Security Administration (NNSA) over the future of the facility.

Sources:

"Fact Sheet: NNSA's MOX Fuel Fabrication Facility and United States Plutonium Disposition Program"
August 3, 2010

"American Nuclear Society's Background: Disposition of Surplus Weapons Plutonium Using Mixed Oxide Fuel"
November 2002

Interagency Review Group on Nuclear Waste Management

One of the first major examinations of how to handle nuclear waste came in 1978, when President Carter established the Interagency Review Group on Nuclear Waste Management to help develop a national nuclear waste disposal policy. The group considered a large number of alternatives for disposal, ultimately supporting deep geological storage.

The group did not consider closing the fuel cycle to reprocess spent nuclear fuel into new fuel for nuclear reactors. President Ford ceased reprocessing in the United States in 1976, and President Carter indefinitely suspended reprocessing civilian spent nuclear fuel in 1977 due to proliferation concerns related to the separation of plutonium. Since then, there have been no commercial reprocessing activities in the United States.

Nuclear Waste Policy Act

The recommendations from the Interagency Review Group, in large part, led to the enactment of the Nuclear Waste Policy Act in 1982. NWPA established the need to identify final disposition paths for high-level waste and spent nuclear fuel.[258] The legislation aimed to "provide for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel, to establish a program of research, development, and demonstration regarding the disposal of high-level radioactive waste and spent nuclear fuel, and for other purposes."[259]

NWPA called for the development of two permanent geological repositories. It was anticipated that one site would be in the West and one in the East, in order to maintain a geographical balance. Under the law, DOE became responsible for siting, building and operating the repositories.[260] DOE also would be responsible for disposing of high-level waste and spent nuclear fuel, with disposal beginning by January 31, 1998.[261]

1983 Geological Repository Solution

In 1983, DOE selected nine sites in six states as potential hosts for the initial geological repository. DOE recommended three sites to President Reagan for characterization as candidate sites: Hanford, Washington; Deaf Smith County, Texas; and Yucca Mountain, Nevada. The President was to submit his first choice for licensing and construction to Congress after reviewing an environmental impact statement prepared by DOE comparing the three sites, and based on the recommendation of the Secretary of Energy.

1987 Nuclear Waste Policy Act Amendments

As the process to characterize the three recommended sites proceeded more slowly than expected and as cost estimates ballooned, strong resistance developed in Eastern states against siting a repository there. Congressional leaders felt they had to move forward and limit costs. Yucca Mountain has been identified by both supporters and detractors as a "political decision." Some opposed to the selection of Yucca Mountain contend that when Yucca Mountain was chosen as the site for a geological repository, the Nevada delegation lacked the influence of the other states. At the time, Representative Tom Foley of Washington was the House Whip and Jim Wright of Texas was the House Majority Leader. The senior senator from Nevada had served less than one term.[262]

Regardless of whether there was a stronger influence of politics or science, in 1987 Congress amended NWPA, directing DOE to characterize Yucca Mountain as the sole site for the first geological repository and prohibiting DOE from looking for a second site unless authorized by Congress.

Yucca Mountain

The Senate last voted to approve the development of a repository at Yucca Mountain, a site in the desert 100 miles northwest of Las Vegas, in 2002. Shortly thereafter, President George W. Bush signed House Joint Resolution 87, allowing DOE to take the next step in establishing the repository in Yucca Mountain. The governor of Nevada objected to the approval of the Yucca site, but Congress ultimately voted to override his veto by joint resolution.[263] Since then, Nevada has been in the courts contesting the decision.[264]

On June 3, 2008, DOE formally submitted the license application for construction of a permanent repository at Yucca Mountain to NRC, with hopes it would be operational in 2020.[265]

The proposed repository at Yucca Mountain has engendered strong feelings on both sides of this issue. Support came from the nuclear energy industry, various state regulators in states with high-level waste and spent nuclear fuel, nuclear waste transport firms, and even from citizens of Nye County, where Yucca Mountain is located. Supporters often cite national security interests and the benefit of consolidating high-level waste and spent nuclear fuel in one location rather than leaving it at reactor sites in many communities across the country as reasons for the project to go forward.[266] There also is a recognized need among supporters that the issue of nuclear waste disposal must be addressed in order to support future expansion of nuclear energy resources and related economic opportunities.

There also is support among lawmakers. Congress has voted twice in favor of Yucca Mountain as the only option for a long-term storage site. In 2007, the House of Representatives voted overwhelmingly against an attempt to eliminate funding for the program.[267]

The leading opponent of Yucca Mountain is Nevada Senator Harry Reid, first elected to the Senate in 1986. The opposition includes more than 750 national, state and local environmental, public interest and anti-nuclear groups, such as the Alliance for Nuclear Accountability and Greenpeace USA.[268] These groups cite flawed scientific studies, a threat to tourism and risks to public safety along the routes on which waste would be transported to Yucca Mountain as reasons to abandon the project. Reid became Senate majority leader in 2007 and has systematically reduced funding for the project in order to force the closure of the repository. He is considered by many as the force behind the push to discontinue the Yucca Mountain project. Reid's re-election in 2010 cemented his influential position.

Similarly, the Obama Administration filed a motion to withdraw the Yucca Mountain license application submitted to NRC in 2008. With that goal in mind, DOE did not request funding for Yucca Mountain in the White House's budget proposal for fiscal years 2011 and 2012. However, House appropriators provided continuing resolution funds in FY2011, eliminated funding in FY2012, and requested $25 million in FY2013 and FY2014 to continue the viability of the program for the future. No new funding was appropriated to DOE or the NRC to work on activities related to Yucca Mountain.

The Blue Ribbon Commission on America's Nuclear Future (as introduced in Chapter 1) was tasked with identifying alternatives to Yucca Mountain, which, as then- Energy Secretary Chu directed, was no longer an option. In a letter to BRC dated February 11, 2011, he wrote, "The only way to open the path toward a successful nuclear future for the United States was to turn the page and look for a better solution — one that is not only scientifically sound but that also can achieve a greater level of public acceptance than would have been possible at Yucca Mountain. It is time to move beyond the 25-year-old stalemate over Yucca Mountain."[269]

As required by its charter, the BRC submitted its final report to the Secretary of Energy in January 2012. While the BRC recommended prompt efforts to develop one or more geological repositories, it did not propose any specific sites. Similarly, specific sites are not proposed in any recent legislative proposals introduced in the Senate, nor are any proposed in DOE's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste. Rather, the focus has shifted to implementing a consent-based process, wherein states, local and tribal governments will be solicited to volunteer to host a geological repository (or interim storage facility).

However, DOE's Strategy includes the goal of having a permanent geological repository operating by 2048.

Implications of Yucca Mountain Shutdown

A number of federal lawsuits were filed challenging DOE's authority to withdraw the Yucca Mountain license application. Among them were suits filed by the State of South Carolina; Aiken County, South Carolina; the State of Washington, three leaders from the Tri-Cities in Washington state and Nye County, Nevada. The Savannah River Site and Hanford are two of the three DOE-owned sites that store defense high-level waste destined for disposal at Yucca Mountain. The lawsuits challenged DOE's legal authority to withdraw the license application, stating that the federal government is violating the NWPA as well as the National Environmental Policy Act.[270]

In August 2013, the U.S. Court of Appeals for the D.C. Circuit ruled in a 2-1 vote that the NRC must resume consideration of the Yucca Mountain license application. The 29-page decision reads:

> "It is no overstatement to say that our constitutional system of separation of powers would be significantly altered if we were to allow executive and independent agencies to disregard federal law in the manner asserted in this case by the Nuclear Regulatory Commission. … For present purposes, the key point is this: The Commission is under a legal obligation to continue the licensing process, and it has at least $11.1 million in appropriated funds — a significant amount of money — to do so."[271]

After the ruling, NRC Chairman Allison Macfarlane ordered the agency to use the remaining carryover funds to continue the safety review of the Yucca Mountain license application. The FY 2014 Omnibus budget ensures that the NRC can use the unspent Yucca-specific funds to continue its safety evaluation reports.

In December 2013, Macfarlane testified before Congress that the NRC has asked DOE to prepare a supplemental environmental impact statement (EIS) needed by NRC staff to complete its environmental review of the application. However, during questioning at the hearing NRC commissioners confirmed they do not have sufficient funds to complete the licensing review.[272] While the commissioners all stated they would comply with the law, it remains unclear if the commission will request the funds necessary to do so, or if Congress will appropriate additional funding to ensure NRC will not have to suspend activities due to lack of financial resources.

In regards to commercial spent nuclear fuel, NWPA stipulates that DOE was to begin accepting spent nuclear fuel from utilities for disposal by January 31, 1998. However, DOE has not started accepting the waste and is overdue in its obligation. In response, many utilities have filed partial breach of contract lawsuits against DOE.[273] Lawsuits also were filed by the industry and state regulators to suspend fees paid by utilities into the Nuclear Waste Fund to cover the costs of constructing and operating a permanent geological repository.[274] A Government Accountability Office (GAO) report released in April 2013 states that as of November 2012, DOE reported that the cost of the lawsuits to taxpayers is $2.6 billion and future liabilities for DOE not taking the spent fuel are approximately $19.7 billion for a total of about $22.3 billion. DOE also estimated that future liabilities may cost about $500 million each year after 2020.[275]

Nuclear Waste Fund

Since 1983, nuclear utilities have been required by NWPA to pay a fee of one-tenth of one cent for every kilowatt-hour of nuclear power sold into the Nuclear Waste Fund. The charge is passed through to nuclear utility customers. The fund was established to fully finance DOE's disposal of commercial spent nuclear fuel.[276] The fees collected are deposited into the general fund of the federal government. The fund also earns interest as if invested in federal securities.

DOE can spend the money only when Congress appropriates it through the annual federal budget.[277] While there is debate over the actual amount of the fund, DOE's fiscal year 2012 financial report shows the Nuclear Waste Fund collects approximately $750 million per year, but grows by over $1 billion each year from accumulated fees and interest.[278] The report stated that the fund currently has about $29 billion.[279]

There have been several proposals for what to do with the money in the wake of DOE's request to withdraw the Yucca Mountain license application and the Obama Administration's efforts to shut down the Yucca Mountain project. NWPA specifies that the money be used only for the completion and operation of the Yucca Mountain repository.[280]

The BRC recommended, as DOE has in its Strategy for nuclear waste management, and as Congress has proposed in legislation, that either a new government corporation or independent waste management organization be established to take over the federal government's responsibilities for spent nuclear fuel and high-level radioactive waste from DOE. The establishment of a new Working Capital Fund in the Treasury also has been recommended, into which fees collected from utilities for nuclear waste management will be deposited and available to the new government corporation or waste management organization without further appropriation. The fees already collected in the Nuclear Waste Fund, however, will remain subject to appropriations, as it is highly unlikely that Congress will abandon its oversight via the appropriations process.

Another proposed solution is to return the money in the Nuclear Waste Fund to ratepayers or provide compensation to local communities or states where the waste is currently stored.

Fee Adequacy

NWPA requires the Secretary of Energy to review annually the adequacy of the fee being paid by nuclear power utilities for the permanent disposal of their spent nuclear fuel (SNF) and high-level radioactive (HLW) waste by the federal government.[281]

DOE assesses the fee by estimating the projected costs of the planned civilian nuclear waste disposal system, and comparing those costs to projected fee revenues and Nuclear Waste Fund earnings. The Agency then evaluates the adequacy of the fee by projecting the future balance of the Nuclear Waste Fund at the end of the civilian nuclear waste disposal system's life cycle while adjusting for variables such as inflation, interest rates, and the allocation of costs between civilian and defense waste.[282]

In the event the Secretary determines that either insufficient or excess revenues are being collected to recover the costs incurred by the federal government, the Secretary is required to propose an adjustment to the fee to ensure full cost recovery.[283]

After the Administration decided that Yucca Mountain was no longer a "workable solution," the National Association of Regulatory Commissioners and the Nuclear Energy Institute challenged the collection of the fee and DOE's annual 2010 assessment, wherein the Secretary did not propose an adjustment. The Court decided not to suspend collection of the fee but gave DOE until January 18, 2013, to provide an assessment that it believes is legally sufficient.

In DOE's annual report on fee adequacy released in January 2013, the Secretary of Energy determined not to propose an adjustment to the fee. To justify the continued collection of the fee without a permanent disposal site, DOE cited the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," outlining the Administration's plans to develop a disposal system consisting of one pilot storage facility, one full-scale storage facility, and one geological repository. (See Chapter 2 for further discussion of DOE's Strategy).

However, in November 2013, the U.S. Court of Appeals for the District of Columbia Circuit ruled that the federal government could no longer require nuclear plant operators to pay into the Nuclear Waste Fund.

The issue before the court focused not on the government's failure to dispose of waste, but instead on its failure to conduct an adequate fee assessment. In a sternly worded ruling, the court said, "Because the Secretary is apparently unable to conduct a legally adequate fee assessment, the Secretary is ordered to submit to Congress a proposal to change the fee to zero until such a time as either the Secretary chooses to comply with the Act as it is currently written, or until Congress enacts an alternative waste management plan."

Accordingly, Secretary of Energy Moniz sent a letter to Vice President Joe Biden (in his capacity as President of the Senate) in January 2014 with a proposal to suspend the collection of fees for the Nuclear Waste Fund.[284] After 90 days of continuous session, the order to change the statutory fee to zero in the absence of the necessary statutory prerequisites will go into effect.

Waste Confidence

The Nuclear Waste Fund exists to help cover the costs of spent nuclear fuel and high-level nuclear waste disposal in the future. However, in order to license new reactors or renew the licenses of existing reactors in the absence of a final waste disposition path, NRC requires a positive finding of "waste confidence." NRC's waste confidence rule expresses assurance that radioactive waste can be safely stored, managed and, eventually, disposed. In September 2010, although the future of Yucca Mountain was in question, NRC updated its waste confidence regulation. Under the revised rule, the period that high-level waste and spent fuel from commercial nuclear power plants can be stored safely without significant environmental impact doubled to at least 60 years beyond the licensed life of the reactor. The revision applied to on-site storage as well as offsite independent spent-fuel storage installations.

NRC noted that the rule "is not intended to signal an endorsement of indefinite storage of spent fuel at reactor sites" and expressed confidence that sufficient repository capacity will be available "when necessary." NRC also noted that it may consider longer periods in the future.[285] Anti-nuclear groups filed lawsuits to challenge the revised rule.

In June 2012, the U.S. Court of Appeals for the District of Columbia Circuit struck down the rule, finding that the NRC did not conduct a sufficient analysis of the environmental risks and did not satisfy the NRC's obligations under the National Environmental Policy Act (NEPA).

Three specific deficiencies were cited:

1. The NRC failed to satisfy NEPA by not evaluating the potential environmental impacts of a repository never becoming available;
2. The NRC did not conduct a forward-looking evaluation of the risks from spent fuel pool leaks; and
3. The NRC did not sufficiently evaluate risks from spent fuel pool fires.

The Commission issued a Draft EIS, Draft Waste Confidence Decision and Proposed Waste Confidence Rule in fall 2013; and expects to issue the final EIS and Rule by October 2014.

Until then, the NRC has put a hold on issuing licenses for new nuclear power reactors or license extensions.

The updated rule could provide the nuclear industry with the regulatory assurance and support it needs to feel comfortable planning and building new reactors — even in the absence of a permanent disposition plan for spent nuclear fuel.

Impact for Local Governments and Communities

As long as the legal issues regarding Yucca Mountain remain unresolved, neither defense high-level waste nor the commercial spent nuclear fuel has a disposition path. Approximately 75 communities around the United States are hosting sites where waste is being stored indefinitely. With adequate monitoring and maintenance, spent nuclear fuel and high-level waste may present acceptable safety, environmental and health risks. However, communities need assurances that the necessary funding and training exist to monitor and maintain the waste for a period longer than what was originally envisioned. As recommended in MIT's April 2011 Nuclear Fuel Cycle Study, "While managed storage is believed to be safe for [about a century], an R&D program should be devoted to confirm and extend the safe storage and transportation period."[286] NRC has plans to examine the safety case for extended interim storage.

On the commercial side, without Yucca Mountain or an alternative site for a geological repository, it is unclear how and when spent nuclear fuel will be managed in the future. DOE reported in its fiscal year 2012 Agency Financial Report that utilities had filed 78 lawsuits seeking to recover the costs of storing the used fuel and that the Department of Treasury's judgment fund had paid about $2.6 billion in claims. DOE estimates that further claims — i.e., taxpayer liability — will amount to about $19.7 billion through 2020, which is the year by which DOE had determined Yucca Mountain could begin disposal operations when the license application was filed in 2008. Of the utilities that successfully sued the federal government, the majority chose not to settle and, despite judgments in their favor, have not received any money."

In December 2010, there were 13 states with restrictions on the construction of new nuclear power facilities: California, Connecticut, Hawaii, Illinois, Kentucky, Maine, Massachusetts, Minnesota, Oregon, Rhode Island, Vermont, West Virginia and Wisconsin. In eight of these states, in order for construction of new nuclear facilities to be considered, there must be an identification of a demonstrable technology or a means for high-level waste disposal or reprocessing.

The defense high-level waste that has been vitrified is being packaged to Yucca Mountain standards. If Yucca Mountain is terminated and a new repository has different acceptance criteria, there will be a significant loss of time and money, as new facilities will have to be constructed and/or the waste repackaged at great cost to the taxpayer. In addition, much of the defense facility cleanup activities were predicated on final disposition at Yucca Mountain. States made agreements with DOE to take certain wastes with the understanding that a final disposition plan existed.

As Rob McKenna, attorney general of the State of Washington explained:

> "The people of the Tri-Cities did their part to help our country fight World War II and the Cold War and the federal government should honor that sacrifice. [DOE's] move to permanently remove Yucca Mountain as a potential nuclear waste repository with no identified alternative significantly sets back cleanup at Hanford and puts our people and our environment at risk."[287]

Regardless of the ultimate path forward, there is agreement that geological disposal is a necessity. At best, the BRC's recommendations can provide the framework for a solution that will take many more years to develop. If the federal government starts over the process to study, site and license a new nuclear facility for waste storage or reprocessing, it should at least learn from the past and include impacted communities from the beginning. If the affected local government has a role where DOE recognizes it as an educated party with a necessary perspective, there will be a greater chance for a new permanent solution to succeed.

Recommendations

- Local governments should understand how DOE's Strategy and Congress's legislative proposals will impact how and when nuclear waste will be managed in the future.
- Local governments should understand and engage in discussions on any changes to the NWPA that are likely to be proposed for interim storage and selecting a geological repository site.
- Local governments should consider what they need to protect their communities should nuclear waste remain at sites they host longer than originally expected (such as funding for security or to construct new storage facilities).
- Without a waste confidence rule, local governments should understand that new nuclear power projects are not being licensed and license renewals are not being granted to extend the life of aging nuclear reactors.

CHAPTER 8: PERMANENT GEOLOGICAL DISPOSAL

The communities storing defense high-level nuclear waste and commercial spent nuclear fuel were never intended to become permanent waste storage sites, but without a disposition path, they have become *de facto* long-term storage sites. Uncertainty regarding where waste will end up impacts health and safety decisions for these communities. Several communities believe their economies will be negatively impacted unless a clear decision is made on the disposal of the waste. Other communities see an economic opportunity to host a geological repository and new nuclear waste facilities, provided they have a meaningful role in their development. This chapter outlines alternatives and challenges for high-level waste and spent nuclear fuel disposal, and looks at other countries' repository programs.

What communities should consider when reading this chapter:

- Geologic disposal is widely considered to be the best option for the disposal of high-level waste and spent nuclear fuel.
- No country has yet successfully opened a geological repository for spent nuclear fuel or high-level waste.
- The potential for nuclear expansion may be hindered, and host communities are unlikely to volunteer until a final waste management plan is determined.

A "geological repository" is defined as:

> An excavated, underground facility that is designed, constructed, and operated for safe and secure permanent disposal of high-level radioactive waste. A geological repository uses an engineered barrier system and a portion of the site's natural geology, hydrology, and geochemical systems to isolate the radioactivity of the waste.[288]

Even as the Yucca Mountain project falters, disposal in a geological repository still is considered the best disposal method in the United States and abroad.

Other alternatives have been considered, including disposal in polar ice sheets, sub-seabed disposal and transport into space. These alternatives were rejected or deemed not viable.[289] Ultimately, the National Academy of Sciences (NAS) recommended deep geological disposal of long-lived, highly radioactive wastes from nuclear reactors in 1956, suggesting that buried salt deposits and other rock types be investigated as options for permanent repositories.[290]

More than 40 years later, another NAS report concurred, "There has been, for decades, a worldwide consensus in the nuclear technical community for disposal through geological isolation" for high-level waste including spent nuclear fuel, and waste resulting from reprocessing nuclear fuels.[291] While a Finnish repository is under construction, no country has successfully opened a repository for geological disposal of high-level radioactive waste or spent nuclear fuel.

A number of common challenges have been found:

- Understanding the nature and rates of geological processes (such as erosion and plate tectonics);
- Predicting long-term environmental change;
- Predicting repository and waste package performance;
- Predicting long-term human behavior for the purposes of risk estimation; and
- Building public understanding and support.[292]

There also are difficult questions to consider: should high-level waste be retrievable from deep geological storage or permanently sealed for added security? After 1,000 years, how radioactive will the waste be? How will we communicate to future generations what has been buried in the ground?

Dr. John Garrick, chairman of the Nuclear Waste Technical Review Board (NWTRB), when testifying before the BRC, noted that technical lessons learned at the Waste Isolation Pilot Plant (WIPP) and abroad demonstrate that building a deep geological repository is technically feasible. He also pointed out that a license application that meets NRC's requirements can be done, and a variety of geological environments can work. He also said the NWTRB was studying different countries' approaches to their repository programs.[293]

Status of Nuclear Waste Management and Repository Programs in the United States and Abroad[294]

Country	Policy	Facilities and Progress Toward Final Repositories
Belgium	Reprocessing	▶ Central waste storage at Dessel ▶ Underground laboratory established in 1984 at Mol ▶ Construction of repository to begin in about 2035
Canada	Direct disposal	▶ Nuclear Waste Management Organization set up in 2002 ▶ Deep geological repository confirmed as policy ▶ Waste would be retrievable ▶ Repository site search started in 2009, planned for use by 2025
China	Reprocessing	▶ Central used fuel storage at LanZhou ▶ Repository site selection to be completed by 2020 ▶ Underground research laboratory should be operational by 2020, disposal to begin in about 2050

Status of Nuclear Waste Management and Repository Programs in the United States and Abroad[294]		
Country	**Policy**	**Facilities and Progress Toward Final Repositories**
Finland	Direct disposal	▶ Program start in 1983; two used fuel storage sites in operation ▶ Posiva Oy set up in 1995 to implement deep geological disposal ▶ Underground research laboratory Onkalo under construction ▶ Repository near Olkiluoto; to open in 2020
France	Reprocessing	▶ Underground rock laboratories in clay and granite ▶ Parliamentary confirmation in 2006 of deep geological disposal; containers to be retrievable and policy "reversible" ▶ Bure clay deposit is likely repository site to be licensed by 2015, operating by 2025
Germany	Reprocessing but moving to direct disposal	▶ Repository planning started in 1973 ▶ Used fuel storage at Ahaus and Gorleben salt dome ▶ Geological repository may be operational at Gorleben after 2025
India	Reprocessing	▶ Research on deep geological disposal for HLW
Japan	Reprocessing	▶ Underground laboratory at Mizunami in granite since 1996 ▶ Used fuel and HLW storage at Rokkasho since 1995 ▶ Used fuel storage under construction at Mutsu ▶ NUMO set up in 2000, site selection for deep geological repository underway and completed by 2025, operation expected to begin 2035, waste to be retrievable
Russia	Reprocessing	▶ Sites for final repository under investigation on Kola peninsula ▶ Various interim storage facilities in operation ▶ Underground laboratory in granite or gneiss in Krasnoyarsk region from 2015, may evolve into repository ▶ Pool storage for used VVER-1000 fuel at Zheleznogorsk since 1985 ▶ Dry storage for used RBMK and other fuel at Zheleznogorsk from 2012
South Korea	Potentially direct disposal	▶ Waste program confirmed 1998 KRWM set up 2009 ▶ Centralized interim storage facility planned to open by 2016
Spain	Direct disposal	▶ ENRESA established in 1984, plan approved in 1999 ▶ Central interim storage at Villar de Canas from 2016

Status of Nuclear Waste Management and Repository Programs in the United States and Abroad[294]		
Country	**Policy**	**Facilities and Progress Toward Final Repositories**
		(volunteered location) ▶ Research on deep geological disposal, decision after 2010
Sweden	Direct disposal	▶ Central used fuel storage facility (CLAB) in operation since 1985 ▶ Underground research laboratory at Aspo for HLW repository ▶ Osthammar site selected for repository (volunteered location)
Switzerland	Reprocessing	▶ Central interim storage for HLW and used fuel at ZZL Wurenlingen since 2001 ▶ Small used fuel storage at Beznau ▶ Underground research laboratory for high-level waste repository at Grimsel since 1983 ▶ Deep repository operation targeted for 2020, containers to be retrievable
United Kingdom	Reprocessing	▶ Low-level waste repository in operation since 1959 ▶ HLW from reprocessing is vitrified and stored at Sellafield ▶ Repository location to be on basis of community agreement ▶ New subsidiary of the Nuclear Decommissioning Authority planning deep geological repository
United States	Direct disposal, but reconsidering	▶ DOE responsible for used fuel since 1998; $29 billion waste fund[295] ▶ Considerable research and development on repository in welded tuffs at Yucca Mountain, Nevada; license application to construct a repository here was submitted to NRC in June 2008 ▶ 2002 decision that geological repository be at Yucca Mountain countered politically ▶ Central interim storage for used fuel now likely ▶ DOE's Strategy for nuclear waste management proposes that a pilot interim storage facility will begin operations in 2021 with an initial focus on accepting used nuclear fuel from shutdown reactor sites; that a larger interim storage facility will be operational by 2025; operations will start at a geological repository by 2048

The country furthest along in siting and constructing a geological repository for spent nuclear fuel and high-level waste is Finland. Posiva Oy, the nuclear waste company jointly owned by two Finnish nuclear utilities, is responsible for the final disposal of spent nuclear fuel of the owners. Posiva Oy applied for a construction license for the final repository in December 2012. The operating license application is expected in 2020, with operation projected to begin in 2022.[296]

In the United States, the license application for the Yucca Mountain project was submitted to the NRC in 2008. However in 2010, the Obama Administration moved to withdraw the application after deeming Yucca Mountain "unworkable". In 2011, NRC staff was ordered to close out its technical review of the Yucca Mountain license application, and the Atomic Safety and Licensing Board suspended its adjudicatory hearing on the application. As a result, the states of Washington and South Carolina; Aiken County, South Carolina; Nye County, Nevada; three businessmen from the Tri-Cities in Washington state; and the National Association of Regulatory Utility Commissioners filed a petition claiming the NRC was obligated under the Nuclear Waste Policy Act to continue processing the license application. While the U.S. Court of Appeals for the District of Columbia Circuit since has ruled that the NRC must resume consideration of the Yucca Mountain license, politics still may be the most influential factor in determining whether the repository ever opens. At the time of writing, the NRC has $11.1 million in appropriated funds to continue the license review. It will be up to Congress to appropriate future funding necessary to ensure the site is licensed, constructed and opened.

The communities storing high-level defense waste never intended to become permanent storage sites. These communities have operated on the premise that the defense waste would ultimately be disposed of in a geological repository. They now wait for a new consent-based process for siting nuclear waste facilities to be defined; for Congress and DOE to determine how to implement a new comprehensive waste management and disposal program; or for a repository decision to be decided in the court system.

Recommendation
• Local governments and communities may want to consider as models how their counterparts abroad are engaged in the development of geological repositories and other nuclear facilities. Appendix A provides details on the role of local governments in Finland, France, Japan, Sweden and the United Kingdom.

CHAPTER 9: INTERIM STORAGE OF WASTE

Based on the current political climate, a repository will not be operational at Yucca Mountain in 2020, and under DOE's Strategy, the goal is to facilitate the availability of a geological repository by 2048. Thus, "interim" storage is the near-term alternative for consideration. The Energy Information Administration defines interim storage as "the temporary holding of wastes on or away from the generator's site when disposal space is not available." However, law does not define the term, and policy-makers use it loosely. Some local governments see a short-term solution for shipping waste out of their communities, and others see a longer-term opportunity for economic growth as the host of an interim storage facility. Either way, local governments first need clarity on what interim storage really means. This chapter highlights the challenges of defining and siting temporary storage and outlines key questions for local governments to consider as they identify their role.

What communities should consider when reading this chapter:

- The term "interim" is not defined by law and could mean anything from a few years to hundreds of years.
- There has been no decision on whether interim storage should be centralized or if multiple interim storage sites should be built. However, DOE's Strategy proposes, as does legislation introduced in the Senate, a pilot interim storage to begin operations in 2021 focusing on taking used nuclear fuel from shut-down reactor sites; and a second, larger interim storage site opening in 2025 with enough capacity to accept used nuclear fuel.
- Waste at decommissioned nuclear reactors may have a different disposition path than waste stored at active reactor sites.
- Interim storage can provide safe storage of waste and buy time for new waste technologies to be developed and deployed, or to begin development of a geological repository.
- Interim storage will not replace the need for a geological repository. The development of a geological repository remains a necessity.

Interim storage and monitored retrievable storage[297] (MRS) facilities, defined as "a complex designed, constructed, and operated by DOE for the receipt, transfer, handling, packaging, possession, safeguarding, and storage of spent nuclear fuel aged for at least one year, solidified high-level radioactive waste resulting from civilian nuclear activities, and solidified reactor-related Greater-Than-Class-C waste, pending shipment to a high-level waste repository or other disposal," have long been included in the discussion of waste management. However, there is significant concern among potential hosts that interim storage sites will become *de facto* permanent repositories in the absence of a long-term waste management strategy. New storage capacity at the reactor sites or elsewhere must be developed. Several options are being considered.

Centralized Interim Storage Versus Multiple Interim Storage Sites

A number of challenges arise in regard to siting potential interim storage facilities:

- Where should interim storage facilities be located?
- Should they be located on the site where the waste was generated?
- Should there be a national centralized storage facility or multiple facilities developed around the country?
- What should be done for waste currently stored on-site at decommissioned reactors?
- What should be done for government-generated and government-owned waste?
- Who should host interim storage facilities?
- What would the site selection process be? How would support be gauged at the local and state level?
- Should the state and/or local community have the option to refuse an interim storage facility?
- What guarantees exist that an interim storage facility does not become permanent?
- Should the development of an interim storage site be linked to the development of a geological repository?

Some industry experts favor developing a centralized interim storage facility rather than multiple regional storage facilities. They argue that security risks would decrease because spent nuclear fuel would be consolidated at one location. They also believe creating centralized interim storage could allow the federal government to take responsibility for the spent nuclear fuel, move it from the reactor sites and alleviate liability for failing to move the waste to a repository by 1998,[298] as mandated by NWPA. MIT's *Nuclear Fuel Study*, released in April 2011, recommended that the United States begin to establish centralized spent nuclear fuel storage sites capable of managed storage for up to a century.[299] Former NRC Chairman Dale Klein also supports centralized interim storage, asserting that it is more efficient to regulate.[300]

A drawback for centralized interim storage is that moving waste from points all over the country raises concerns about the safe transportation of spent nuclear fuel.

Some experts suggest that only waste from decommissioned reactors should be moved into a centralized facility,[301] while on-site storage facilities should be built at sites with operational reactors. The argument for this approach is that on-site storage is much easier to establish than a centralized storage facility.[302] As former Secretary Chu explained, the interim storage of nuclear waste in dry casks at individual nuclear plants is safe today and "… buys us time to formulate a comprehensive plan on how we deal with nuclear waste."[303]

Regardless of where an interim storage site is located, it offers a temporary solution to store waste safely and makes room at reactors for newly produced spent nuclear fuel while a geological repository is sited and developed. Further, as outlined in MIT's *The Future of the*

Nuclear Fuel Cycle study, managing and storing waste at facilities where it is retrievable "preserves future options for spent fuel utilization" and "fuel cycle choices" in response to changing energy demand, economics, availability of fuel, and the development and deployment of new technologies to address waste.[304] Proponents suggest interim storage can be cost-effective, estimating the cost of maintaining storage over 40 years at less than one-tenth of one cent per kilowatt hour of electricity generated after any up-front capital costs are paid.[305] Permanent disposal of all commercial spent nuclear fuel also has been estimated to cost less than one-tenth of one cent per kilowatt hour of electricity generated with nuclear power.[306]

If interim storage is pursued, however, it should not supplant the identification and pursuit of a permanent storage solution. Siting interim storage facilities will be highly problematic if the potential hosts do not believe the waste ever will be moved. As Bunn, et al., note in their study on interim storage of spent nuclear fuel: "The most difficult and complex issues facing interim storage are not technical but political, legal, and institutional."[307] Transparency will be crucial.

Legislation being considered in the Senate and DOE's Strategy for managing used nuclear fuel and high-level waste both aim to begin the process of developing interim storage facilities. However, unless amended, the authority to construct an interim storage facility under existing law comes only after DOE formally recommends to the President that the Yucca Mountain site be selected as a repository. Given the Administration's effort to withdraw the Yucca Mountain project license application, stop the project, draft and pass legislation to create a new waste management organization, and begin again to identify sites for interim storage and a geological repository using a consent-based process, it is questionable if interim storage development can proceed now and if the timelines proposed by DOE which are included in the draft legislation being considered by the Senate are achievable at all.

Private-sector interim storage is another alternative to consider. However, there remains the need for regulatory coordination across different federal agencies and to build political and public support at the state and local levels.

Case to Consider: Private Fuel Storage, LLC

In 1990, the Skull Valley Band of Goshute Indians received a federal grant to investigate the feasibility of hosting a federal facility for temporary nuclear waste storage. In 1997, the tribe agreed to lease 820 acres of its reservation in Utah to Private Fuel Storage, LLC (PFS), a consortium of eight nuclear utilities,[308] to host a private temporary storage facility for commercial waste.[309] Proponents of the project claimed the proposed storage facility could hold 1,000 dry storage casks of used nuclear fuel similar to those used by utilities on-site at nuclear reactors' independent spent fuel storage installations. In February 2006, NRC granted a license for the facility. However, the state of Utah strongly opposed it and quickly filed a challenge to the license. A few months later, the U.S. Department of Interior (DOI) denied a right-of-way over federal lands for a railroad to the site, which halted construction.

PFS and the tribe contended that the decision was influenced by political pressure from the state. In addition, the Bureau of Indian Affairs (an office of DOI) refused to back the project based on concerns that without anywhere else to go, waste would be stored there permanently.

In July 2007, the tribe filed a federal lawsuit to overturn the DOI administrative decisions.[310] On July 26, 2010, a federal district court overturned the DOI's decisions and remanded the PFS right-of-way application and lease of tribal land to DOI for further consideration.

DOI never published another decision and at the end of 2012, PFS asked the NRC to terminate the unused license immediately in order to avoid further maintenance fees.[311]

The Role for Local Governments and Interim Storage

If legislation is passed to give DOE authority to site an interim storage facility, the next step will be to find a host community, preferably a volunteer community. As policy-makers and experts consider interim storage alternatives — which can be a legitimate part of a long-term strategy — policy-makers should identify affected units of government interested in hosting these facilities. The federal government should be prepared to negotiate with affected units of government and their partners to offer incentives and to provide assurances — both legal and financial — that host communities would not become the long-term answer.

Recommendations

- "Interim storage" should be defined to a specific term.
- Communities should consider how funds were outlined for "affected units of local governments" in the past (see Chapter 2) and evaluate how money can be used to, among other things:
    - Hire third-party scientists to review data and increase public confidence in the scientific integrity of a project;
    - Provide impacted citizens the means to interact with the federal government and any operator; and
    - Demonstrate a commitment to external oversight over a nuclear project.
- Local communities also should look at what they need and want an incentive package for hosting an interim storage site to include. Options may include co-location of a recycling facility; money for state and local universities; siting a national laboratory nearby; and workforce training.
- Local governments should be prepared to negotiate conditions for consenting to host an interim storage facility. These may include: volume limitations, enforceable milestones, penalties if conditions are not met, triggers for termination of an agreement with the federal government, and an agreement of indemnification.
- As a potential host for an interim storage facility, a local government should consider how closely it wants to link progress on the development of a permanent repository and progress on the development of an interim facility.

CHAPTER 10: CONCLUSION

This Handbook is a tool to inform local governments and communities on the key nuclear issues and fuel cycle alternatives as discussed by the Blue Ribbon Commission on America's Nuclear Future, Congress and the nuclear power industry. While there has been talk of a nuclear renaissance, the questions of economics, political support, nuclear waste management and the federal budget outlook are restricting new nuclear development. The recent political stalemate over the future of Yucca Mountain and subsequent court cases over fee adequacy and the Nuclear Waste Fund also will have a significant impact on when and how new nuclear facilities will be developed.

Support for nuclear energy use had been increasing, but that support wavered as a consequence of the 2011 accident in Japan and interest has waned in the wake of low natural gas prices. Still, the Obama Administration has stated its support for nuclear generation as part of an "All-of-the-Above"[312] energy policy. A number of alternatives for short-term and long-term waste management are being discussed:

- Interim storage.
- Permanent waste disposition.
- Advanced technologies that increase fuel utilization and burn spent nuclear fuel.
- "Closing" the nuclear fuel cycle to recycle spent nuclear fuel.

Each offers significant challenges and potential opportunities for communities.

Communities interested in hosting a new nuclear facility — be it an interim storage site, small modular reactor or geological repository — can benefit economically. Given the early stage of policy discussions on the federal, state and industry levels, local governments can benefit from engaging with these other parties now. With widespread support for a yet-to-be-defined consensus-based siting process, communities have time to identify what incentives they want and need, and to apply lessons learned from siting processes abroad, before deciding whether to volunteer to host a site.

Communities concerned about waste being stored indefinitely at their sites can highlight the need for new policies to focus on breaking the gridlock over whether and where to site a geological repository.

Other communities may be looking to benefit from the development of new technologies that will introduce new energy production facilities like SMRs to the market, contribute to waste management and provide economic opportunities, energy independence and energy security.

Local governments have a critical role to play in the future development of policies related to waste management, interim storage, and advanced nuclear technology development. It is essential that communities understand the issues, are engaged early and actively, and ensure their perspectives are considered as America's nuclear future is decided.

One of the great challenges in regard to new nuclear policy and facility development is trust. The Obama Administration's decision to withdraw the license application and stop funding for Yucca Mountain while the Nuclear Waste Policy Act still is the law, and without any alternatives, was seen by many stakeholders as a politically motivated and unilateral decision. It exacerbated matters that there was no proposed alternative or feasible path forward. Input from stakeholders provided to the Blue Ribbon Commission on the erosion of trust in DOE led to a recommendation that responsibility be moved from DOE to a new single-purpose, independent organization at the federal level to implement the nation's nuclear waste management policy. Whether existing law will be amended to change this, or whether new legislation will be passed, trust is paramount to public acceptance of federal policies regarding nuclear waste management, disposal decisions and successful development of future nuclear facilities.

Some of the most significant discussions are focused on implementing a consent-based siting process for new nuclear facilities. It is notable that the Administration and Congress recognize that the chance for success is greater if the process allows "affected communities to decide whether, and on what terms, the affected communities will host a nuclear waste facility." Energy communities have an opportunity to affect how consent will be defined and under what conditions. This Handbook should be viewed by communities as a starting point for public discussions about the local desire and consent to host nuclear power and waste disposal facilities.

Finally, this Handbook covers numerous issues related to nuclear energy and nuclear waste management. Some key recommendations for local governments and energy communities are repeated because they likely are to remain integral for building partnerships and winning support for a community's own nuclear development goals.

How, whether, when and by whom the Blue Ribbon Commission on America's Nuclear Future's recommendations will be implemented remains to be seen. But it is clear that coordination and education is needed at the federal, state, local and tribal levels from the beginning of the decision-making process to the end.

Overarching Recommendations for Local Governments
• Real progress requires that all necessary parties are engaged, that there is trust among the parties, that there is confidence in the path forward, and that there is the political will and means to implement new policies or governance plans. • Local governments must identify and ask for resources in order to build support within a community for new nuclear missions. • Local governments must define what they need in a consent-based process and develop legally enforceable agreements and conditions that minimize political influence over time. Local governments should not expect a one-size-fits all approach. • Local governments must be educated and actively engage with DOE, NRC, federal policy-makers, the state, and industry as early as possible in the decision-making process on siting new nuclear facilities. • Companies and government entities leading the siting of a new nuclear facility should engage local governments. • Local government and community support alone will not lead to the successful siting of a new nuclear facility; support from the state government is necessary. Local governments and state governments must work together. • Communities should consider and encourage policy-makers to look at lessons learned to avoid pitfalls and to develop an improved governance plan for future nuclear energy development and waste management.

APPENDIX A: EXAMPLES OF ENGAGING LOCAL GOVERNMENTS FROM ABROAD

Like the United States, other countries are developing or considering nuclear waste repositories and recycling facilities. It may be useful to consider how local governments and potential host communities outside of the United States are being integrated into the conversation.

Finland

Esko Ruokola, the former principal advisor at STUK, the Finnish nuclear safety authority somewhat like NRC[313] in the United States, described Finland's siting process to the BRC's Disposal Subcommittee in October 2010. Finland chose to build a spent nuclear fuel repository at the Olkiluoto site in the municipality of Eurajoki. The operating license application is expected in 2020, operations are expected to commence in 2022, and the repository is expected to be sealed in 2120.

According to Ruokola:[314]

> Finland utilizes a three-step decision-making process, similar to the process [in the United States]. The Decision-in-Principle requires an application and the regulators' safety appraisal, short of a definitive safety assessment. Next, a potential host municipality may decide to exercise its right of veto; Olkiluoto voted by clear majority to approve siting of the repository in that municipality. The government then decides whether the decision is in the overall good of the society, followed by parliamentary endorsement. The Finnish parliament endorsed the Olkiluoto site nearly unanimously nine years ago. After endorsement, the utility submits construction and operation license applications subject to STUK approval.

Another BRC meeting participant noted that Eurajoki has been a nuclear community since the late 1970s. However, the community twice opposed a repository during the 1990s. The local council eventually approved the repository, but only after there was greater cooperation and collaboration with Finnish utility TVO, as well as agreement on a compensation package for the municipality in exchange for siting of the repository.[315] Compensation included:

- Infrastructure improvement with the construction of an ice hockey arena and renovation of a local mansion.
- Funding of the Eurajoki Business Development Fund.
- TVO granting a loan for the municipality to help it overcome liquidity problems.
- TVO buying a water area owned by the municipality.[316]

It is interesting to note that now that the site has been chosen, the municipality no longer has veto power. Only the regulator, by finding deficiencies in safety, or parliament by changing legislation, is able to stop the repository from moving forward.[317]

One Finnish researcher commented that the process for siting in Sweden (see page A-3) allowed for more public participation than in Finland.[318]

France

France has unique disposal requirements due to the national focus on reprocessing used nuclear fuel, which changes the quantity and nature of nuclear materials that ultimately require disposition.

In 1991, the Waste Management Act established the Agence Nationale pour la gestion des Déchets Radioactifs (ANDRA). The organization is investigating clay and granite as mediums for a geological repository, as well as long-term surface storage with conditioning.

In June 2006, the French government passed a law creating a National Plan for the Management of Radioactive Materials and Waste (PNGMDR). The purpose of the PNGMDR is to draw a balance on existing management measures of radioactive materials and waste, to make an inventory on foreseeable needs for storage and waste disposal, to indicate the necessary capacities for such installations and the duration of storage and — for the radioactive wastes for which a definitive management method does not still exist — to determine the objectives to reach.[319] The initial draft was produced by a pluralistic working group comprising representatives of the waste producers, the National Radioactive Waste Management Agency, environmental protection associations, associations of radioactive source suppliers, elected officials, the administrations concerned, the managers of conventional waste management centers and technical experts.[320] It is important to note that the involvement of the public and stakeholders is considered a major point in the development of the National Plan.

The first plan was established and assigned to the parliament in March 2007, and the government is required to update it every three years.

The plan states:

> *One major point is the involvement of the citizens and the interested stakeholders in the PNGMDR. The institutional framework for drafting of the PNGMDR should allow as broad a consultation as possible of the citizens and stakeholders, so that their comments can be taken into account to produce a plan that is both effective and usable, and should allow the involvement of local and national elected officials, who have an important role to play at all levels in the decision-making process surrounding radioactive waste management.*[321]

ANDRA held a series of public meetings 2013 to consider the plan to build the Cigeo geological repository near Bure; it intends to submit a license application for CIGEO to the French Nuclear Safety Authority by 2015. Construction of the facility would begin in 2019 and operations would commence in 2025.

Japan

Like France, Japan has unique disposal requirements due to the national focus on reprocessing used nuclear fuel. Public attitudes in Japan towards nuclear safety issues also make it relatively difficult to achieve local consent in siting a repository.

The Specified Radioactive Waste Final Disposal Act was enacted in 2000, and led to the creation of the Nuclear Waste Management Organization of Japan (NUMO). In December 2002, NUMO began open solicitation for candidate sites from municipalities throughout Japan. NUMO is expected to identify a site between 2023 and 2027, and begin operation of the facility in approximately 2035. NUMO's efforts to identify a willing host, however, have been unsuccessful to date.

The Science Council of Japan (SCJ) recommends the use of temporary storage facilities instead of underground burial sites due to concern over seismic instability. Japan's Atomic Energy Commission asked the SCJ to study the matter in 2010 in support of efforts to identify a permanent repository.

Japan found it had a need for a new type of waste repository after the accident at TEPCO's Fukushima Daiichi nuclear power plant in March 2011. In September 2012, the Environment Ministry identified the neighboring communities of Yaita in Tochigi Prefecture and Takahagi in Ibaraki Prefecture as candidate sites primarily for waste produced as a result of the accident. The towns later protested the selection, however, and the ministry decided to start over. "There was a lack of communication between the ministry and local authorities on how we select candidate sites and share the results with them," said Senior Vice Environment Minister Shinji Inoue. Plans now include setting up a public forum to share information and receive feedback.

The integration of local governments into the siting process for other nuclear facilities also are worth examining.

Individual reactors require approval from local authorities in Japan. For example, the construction of the J-MOX plant at Rokkasho was approved by the Aomori prefecture and an agreement was signed by the governor of the prefecture, the mayor of Rokkasho-mura and the head of Japan Nuclear Fuel Limited, which operates a commercial enrichment plant at Rokkasho. Accidents at nuclear facilities over the past 15 years[322] — prior to the crisis at Fukushima Daiichi — had shaken public confidence and slowed nuclear growth more than the government and industry wanted. As Takuyuki Kawauchi of Japan's industry ministry's nuclear-energy policy division stated, "We can't just start putting reactors wherever we want. We have to get the understanding of the local residents, and that takes time."[323]

In addition, the development of Japan's Long-Term Program for Research, Development and Utilization of Nuclear Energy, as led by Japan's Atomic Energy Commission, also seeks to involve key stakeholders. During the most recent revision process in 2000, the commission organized a Long-Term Planning Council, which, in turn, formed six subcommittees. The subcommittees comprised 115 individuals, including experts in the nuclear power industry, members of the legal and business communities, the mass media, and local townships and cities that host nuclear facilities. Over an 18-month period, the subcommittees met 57 times. Similar to the process employed by the Blue Ribbon Commission in the United States, public input also was sought at open forums across Japan.[324]

Sweden

In June 2009, the Swedish Nuclear Fuel and Waste Management Company (SKB)[325] announced it had chosen a site adjacent to an interim storage facility near Forsmark for a permanent repository for high-level nuclear waste. The site was chosen after a process to identify candidate sites began in 1977. As explained during a meeting of the Disposal Subcommittee of the Blue Ribbon Commission in October 2010, the process to identify candidate sites was not voluntary at the outset; rather, it was more scientific. Originally, SKB would gain access to land it was interested in first by purchasing it from the owner and then by contacting the local mayor about beginning feasibility studies.[326] The process did not help to build dialogue or political support. Over time, the need for a voluntary siting process was recognized and implemented.

Feasibility studies were conducted in eight municipalities. During the study phase, municipalities were able to set up organizations to follow the work being done by SKB. In some municipalities, entire community councils were involved while in others there was less participation by local politicians. Municipalities were allowed access to monies in the Swedish Nuclear Waste Fund[327] (as were SKB and the national government) to facilitate participation in the process by conducting their own studies and, in at least one case, by hiring consultants to assist in the technical review of the project.[328] Municipalities also were given the veto power to end their involvement in the process. In fact, a number of municipalities rejected further participation after the feasibility studies were completed and after holding referendums on whether to continue in the siting process.[329]

Eventually, the decision came down to two volunteer sites. Both already were hosts to nuclear facilities, and public acceptance levels in both towns hovered around 80 percent.[330] In April 2009, SKB signed an investment agreement with both volunteer municipalities specifying investment of $245 million (U.S. dollars) in the two, with the majority going to the unsuccessful bidder, which was considered disadvantaged financially.[331]

The Osthammer Municipality, formally chosen as the site host in June 2009, has an extensive administrative apparatus to work on repository issues, including national experts, a long-term Safety Committee and a Consultative Committee to control interaction between the public and the municipality. Municipal officials also work with SKB, which has emphasized the need for public information. According to information provided to the BRC by the former site manager for SKB site investigation at Forsmark:

> [SKB] set a goal to get in touch with every resident within ten kilometers. They met people in their own homes. Public meetings have been held once or twice every year, with greater than 100 residents attending. Several free two-day facility tours have been arranged and about 20 percent of residents have participated . . . An annual poll is conducted on public opinion on the Forsmark site with acceptance increasing over time. Opposition has also decreased from 27 percent down to 10 percent. The process continues and will never be complete.[332]

In addition, the mayor of Osthammer told the BRC that "the foundation of a trustworthy local process for siting a repository: a legal framework that spells out roles of participants and an industry that produces a safe method."

Other notable key lessons learned were outlined even during the Swedish siting program. A paper presented at the 2003 Waste Management Conference outlined the following:[333]

- The process itself must be well known and clear in order to gain acceptance. The stakeholders also must see the possibilities for how or in what way the process can be affected or changed and what is fixed.
- All actors in the process must be prepared to answer questions.
- All actors must be prepared to listen to (and learn from) the arguments raised during the process.
- Discussion in small groups with the people who potentially will be most affected is most valuable in regard to building trust and learning about key questions.
- There never will be consensus regarding all questions.
- The attitudes of the people involved in the process must reflect their belief that dialogue and discussion of these questions will create a better repository — both technically and socially.

SKB applied for a license to construct the repository in March 2011. It plans to begin site works in 2013, with full construction starting in 2015, and operation expected to start after 2020.[334]

The repository will have 12,000 tonnes capacity at 500 metres depth in 1.9 billion year-old granite. A 5 km ramp will connect to an eventual 60 km of tunnels over 4 sq km, housing 6000 copper-cast iron canisters containing the used fuel. Each 25-tonne canister will hold 2 tonnes of used fuel. Bentonite clay would surround each canister to adsorb any leakage. The repository concept is known as KBS-3.

United Kingdom

In November 2009, the British government released six draft National Policy Statements on future energy policy. The statements implemented a new planning regime to assist in the siting and development of nuclear reactors.[335] Under the new proposal, only local issues can be debated during local hearings and not the virtues of or national need for nuclear energy.[336]

Recommendations regarding the role for local governments in the construction and operation of a geological disposal site were made by the Committee on Radioactive Waste Management in July 2006; members are independent experts appointed by the government.[337] In response, the government prepared a white paper, "Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal," in June 2008.

The national government is looking for communities interested in volunteering to potentially host the site. Participation up until late in the process, when underground operations and construction are due to begin, will be without commitment to further stages, whether on the part of the community or government. If at any stage a community or government wishes to withdraw, its involvement in the process would stop.

The white paper identifies three types of community:

Host Community: the community in which any facility will be built. This will be a small geographically defined area and include the population of that area and the owners of the land. For example, it could be a town or village.

Decision-Making Body: the local government decision-making authority for the host community.

Wider Local Interests: other communities that have an interest in whether a facility should be built in the Host Community. For example, the next village, a neighboring district or a community on the local transport routes to the Host Community.

All three levels of community are expected to consult with each other, as well as with the national government and the Nuclear Decommissioning Authority, as the process moves forward.[338]

If a community wishes to continue, a formal Community Siting Partnership will be established. Costs of local community engagement in the Community Siting Partnership will be funded, either partly or wholly, by the national government to assist communities in considering the issues.[339] Community Siting Partnerships will develop advice and recommendations for local decision-making bodies that will make decisions about moving to the next stage.[340]

The Geological Disposal Facility (GDF) is expected to have a site selected by approximately 2025, commence operations around 2040 and close in approximately 2100. The communities of Allerdale and Copeland from Cumbria expressed interest in hosting the facility, however, the Cumbria County Council voted to cease the project in January 2013. The Copeland Council wanted to continue consideration of hosting the facility, however, it appears that the Cumbria Council's ruling is authoritative.

APPENDIX B:ENDNOTES

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