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The Future of Nuclear Power

Introduction

Chairman Alexander, Ranking Member Feinstein, and members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the future of nuclear energy in the United States.

For the past two decades, nuclear power has reliably and economically contributed nearly 20 percent of electricity generated in the United States. It produces more than 60 percent of our non-greenhouse-gas emitting power, making nuclear energy our nation's single largest contributor of carbon-free electricity, and as such is responsible for avoiding hundreds of millions of tonnes of carbon dioxide emissions each year. Under President Obama's Clean Power Plan, the goal is a reduction of carbon dioxide emissions by 32 percent below 2005 levels by 2030. A strong domestic nuclear energy sector could help with meeting this goal and is also critical for the U.S. to continue as a global leader in nuclear nonproliferation.

The Paris Agreement and Mission Innovation, both announced at the 2015 United Nations Climate Change Conference (COP21), have shown the enormous international interest for low-carbon technologies including nuclear energy, the need to accelerate clean energy innovation, and the potential for U.S. industry to develop these advanced technologies.

A prerequisite for nuclear power continuing as a vital part of the nation's clean energy portfolio is public confidence in the safety of nuclear plants and commercial confidence that the plants can be operated safely, reliably, and economically. Additionally, we have an obligation to develop a workable, long-term solution for storage and disposal of spent nuclear fuel and high-level radioactive waste.

Innovation

The Department supports innovation across all energy technologies, and we are involved in the entire nuclear energy lifecycle. This includes supporting research, development, and licensing of new technologies; providing infrastructure for testing and experimentation; working with industry to support the safe, reliable and economical operation of today's nuclear plants; and advancing the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-level Radioactive Waste.

Mission Innovation, an initiative launched in November 2015 by the U.S. and 19 other countries represents an unprecedented commitment to accelerate global clean energy innovation. The Department's FY17 request invests in key areas to support this initiative. The Department's fiscal year (FY) 2017 Budget Request invests in key areas to accelerate investment in nuclear energy innovation. Specifically, the FY17 request includes $994M for the Office of Nuclear Energy's research and development (R&D) programs, $8M above FY16. These investments include advancing technologies that support the existing reactor fleet and that develop new, next-generation options. Of this total, the FY 2017 Budget Request for the Office of Nuclear Energy includes $804 million in support of Mission Innovation.

Improvements in Light Water Reactor Technology

Our nation's existing nuclear power fleet consists of 99 operating light water reactors (LWR), and the Department's programs advance LWR technologies in a variety of ways to support the existing fleet's continuing role providing reliable low-carbon power for the United States.

The Light Water Reactor Sustainability Program is developing the scientific basis to extend the life of our existing nuclear reactor fleet while also improving economics and reliability and sustaining safety and security through research on materials aging and degradation, safety margin characterization, and digital modernization technologies. The Department also is working on enhancing the accident tolerance of light water reactors through cost-shared efforts to develop advanced accident tolerant fuels for existing commercial nuclear power plants with improved safety and performance characteristics.

We have been successful in improving modeling and simulation to enhance the performance of currently operating light water reactors through the Consortium for Advanced Simulation of Light Water Reactors (CASL), one of the Department's Energy Innovation Hubs, and a program I was honored to serve as the Chairman of the Board for its first two years. Established in 2010 and centered at the Oak Ridge National Lab, CASL uses the Department's most advanced computing infrastructure to model and simulate a Virtual Environment for Reactor Applications (VERA) that is being used to understand performance and safety issues of currently operating Pressurized Water Reactors. VERA has been used to simulate the full operating history of the Watts Bar Nuclear Power Plant Unit 1 Pressurized Water Reactor in Spring City, Tennessee. This simulation included high-fidelity predictions of more than 18 years of reactor operations including fuel loading, depletion, shuffling, and discharge. The results have been compared with measured plant data and showed a high degree of consistency. CASL is working with Westinghouse, one of their founding partners, to use VERA to simulate the startup of the AP1000 reactor to confirm their engineering calculations.

Currently in its second and final phase, CASL will enhance the development of VERA for applications beyond pressurized water reactors, to include boiling water reactors and new reactor designs like small modular reactors.

Small Modular Reactors

Small modular reactors (SMRs) are one area in which we are seeing rapid innovation, with several companies researching light water SMR designs in the United States.

SMRs have the potential to offer a new standard of passive nuclear safety with designs that safely shutdown without operator interaction, off-site power, or off-site water. They may also offer greater affordability by requiring potentially lower upfront capital cost investments than traditional gigawatt-scale nuclear plants, and potentially shorter construction times through factory fabrication. DOE sees SMRs as a vital part of the world's low-carbon future, including the United States.

The Department's SMR Licensing Technical Support program was created to realize these and other benefits by advancing the first domestic SMR designs. DOE's cost-shared investment has generated progress, and we expect that our reactor design partner, NuScale, is expected to submit the first SMR design certification application to the U.S. Nuclear Regulatory Commission by the end of the calendar year. FY 2017 will be the final year of funding for SMR LTS activities.

SMRs may also offer an important new option for power generation in a variety of settings. For one of our site partners, the Utah Associated Municipal Power Systems (UAMPS), SMRs may be an option to replace the power from retiring coal plants in the mid-2020s. UAMPS has identified a preferred site on federal land at the Idaho National Laboratory to potentially build a NuScale SMR. Our other site partner, the Tennessee Valley Authority, has submitted an early site permit application to the U.S. Nuclear Regulatory Commission for an SMR project at the Clinch River site that could deliver highly-reliable power to ratepayers in the Tennessee Valley region. The Idaho National Laboratory has been investigating how SMRs could be part of a hybrid energy system demonstration along with renewable energy sources.

Several factors, however, pose challenges to the path to deployment for SMRs, including the current low price of electricity and low electricity demand growth.

Further, the production tax credits (PTC) enacted by the Energy Policy Act of 2005 that are available to new nuclear power plants would likely not apply to the first SMR deployments because SMRs would begin operation after the nuclear PTC sunset of December 2020, and because current law does not include a statutory mechanism for non-profit SMR owners to take advantage of the credits through transfers.

In light of the progress and the challenges, DOE continues to study the path to deployment of SMRs. As part of that effort, DOE held a public workshop on June 22-23, 2016 to solicit industry input, and we expect a summary report from that workshop to be available in October 2016.

Executive Order 13693 set clean energy targets for federal facilities to meet over the subsequent decade and SMRs are among the set of technologies that count towards meeting those targets. DOE is currently conducting a study to enumerate and analyze the various legal authorities available to it and other federal agencies to meet the clean targets set out in Executive Order 13693, including utilizing power from SMRs.

Advanced Reactor Concepts

Across all areas of nuclear reactor technology, we are now seeing a considerable focus by American industry to invest in the development of novel nuclear reactor concepts—almost 50 companies and institutions are working on nuclear innovation, according to a study by Third Way.[1] This level of activity in industry on novel ideas is a new development with potentially significant implications for the future of nuclear power in the U.S.

To help take advantage of this industry focus, DOE started this year the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative to make DOE's nuclear energy research capabilities accessible to industry engineers and scientists in a public-private partnership. The opportunities available through GAIN include: access to nuclear and radiological facilities and testing capabilities (e.g. thermal-hydraulic loops, control systems testing, etc.); computational capabilities including state-of the art modeling and simulation tools; information and data through a knowledge and validation center. In June, the GAIN program announced that eight small businesses will be provided up to $2 million for the Nuclear Energy Voucher pilot program, granting them access to the extensive nuclear research capabilities available at DOE's national laboratories and Nuclear Science User Facilities (NSUF) partners.

The Department's ongoing advanced reactor programs specifically support research to develop technologies for advanced concepts—Generation IV designs—that could dramatically improve nuclear power performance in sustainability, economics, safety, and proliferation resistance. Next-generation concepts each have potential significant advantages: high-temperature gas-cooled reactors (HTGR) could provide higher-efficiency power generation and high quality process heat for industry, thereby reducing carbon emissions; liquid metal-cooled fast reactors could be used to generate electricity while addressing long-lived nuclear waste issues; fluoride salt-cooled high-temperature reactors (FHRs) could have the high temperature capabilities of HTGRs while operating at atmospheric pressure; and innovations like tristructural-isotropic (TRISO) coated particle fuel and graphite core structural components could allow for advanced designs with extremely high safety margins in all imaginable scenarios.

In FY 2016, Congress appropriated $12.5 million for two ongoing industry cost-shared awards to further the development of two performance based advanced reactor concepts. Earlier this year, DOE announced awards to two companies, X-energy and Southern Company, seeking to develop such novel reactor concepts. These awards will support two new designs with advantages in safety, operations, and economics from companies who presented clear plans for demonstration of these concepts in the 2030's. These two designs, an advanced pebble bed HTGR and a molten chloride fast reactor, are among many with significant potential for performance advantages for the next generation of nuclear power reactors.

The final step in bringing these novel technologies to market will be obtaining certification and licensing by the Nuclear Regulatory Commission (NRC). Most commercial reactor types licensed

[1] Todd Allen, Matt Goldberg, Amber Robson, and Kemal Pasamehmetoglu (Idaho National Lab), "What's Missing in U.S. Nuclear? An Innovation Culture," Third Way, March 29, 2016. Accessed September 9, 2016. Available at: http://www.thirdway.org/report/whats-missing-in-us-nuclear-an-innovation-culture.

to date in the U.S. have had designs using water as the primary heat transfer medium. A joint DOE-NRC initiative supports development of Advanced Reactor Design Criteria (ARDC) for Nuclear Power Plants with advanced reactor designs, specifically addressing the safety and operating characteristics of reactors with non-water coolants. The NRC has released draft ARDC for public comment and plans to hold another public meeting later this year and intends to have regulation guidelines finalized by the end of 2017. This key activity is important for the potential of these novel concepts to be realized.

Nuclear Energy Infrastructure

A robust research, development, and demonstration program depends on an infrastructure of experimental facilities, computational facilities, and highly trained scientists and engineers dedicated to meeting the needs of the Nation. The Department supports a nuclear research infrastructure across the Nation incorporating a broad range of facilities, from small-scale laboratories to hot cells and test reactors. Computing facilities, ranging from desktop workstations to highly-parallel supercomputers at the national laboratories, are routinely employed to gain new insights and guide experiment design.

The FY 2017 budget proposes $102 million to support DOE nuclear test reactors at the Idaho National Laboratory (INL), including strategic investments at the Advanced Test Reactor (ATR) to improve reliability and availability, and refurbishments to major Transient Reactor Test (TREAT) Facility systems to support restart efforts. Both facilities play a critical role in meeting nuclear reactor technology R&D program objectives. The FY 2017 budget also proposes $75 million for sustainment of unique nuclear and radiological R&D capabilities at the Materials and Fuels Complex (MFC) at INL that are required for examination, characterization, fabrication, and separation of materials, components, and fuels.

The High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory also is an important component of DOE's Nuclear Science User Facilities (NSUF), which have a singular focus on advancing technologies supporting nuclear energy applications. HFIR is a versatile 85 MW research reactor offering the highest steady-state neutron flux in the western world. It is able to quickly generate isotopes that require multiple neutron captures and perform materials irradiations that simulate lifetimes of power reactor use in a fraction of the time. Each year, NSUF conducts a rigorous competitive process leading to awards providing university, national laboratory and industry principal investigators no-cost access to the unique NSUF research capabilities, including HFIR.

The Department supports 25 university research reactors located at 24 U.S. universities that provide significant in-core fuels and materials irradiation experiment capabilities as well as hands on teaching tools for hundreds of students each year. The Department's FY 2017 Budget Request includes $7 million to continue providing fresh and used nuclear fuel services for these reactors, in addition to funds for university reactor-supported research each year. In FY 2017, the Department will also complete a multi-year $15 million investment to complete safety upgrades at the TRIGA International fuel production facility in France to ensure a continuing and stable fuel source for the 12 U.S. university TRIGA research reactors, and many more such reactors world-wide.

Crosscutting and Other Innovation Initiatives

The Department also supports innovation of nuclear energy technologies through a variety of other initiatives outside of the Office of Nuclear Energy.

Several of our Crosscutting Initiatives, which harness funding and capabilities from many DOE program offices to advance key science and technology objectives with impact across DOE's missions, can support the advancement of some nuclear energy technologies. In FY 2017, the Advanced Materials crosscutting initiative will coordinate $113 million across five DOE program offices to advance innovation for affordable, reliable, high performance materials—a key to next-generation nuclear technologies. The Subsurface Crosscutting Initiative will coordinate $258 million in R&D investment across five program offices at DOE to advance science, technology and engineering in the subsurface, which could benefit nuclear waste disposal. Our Supercritical CO_2 Crosscutting Initiative is advancing a technology that could significantly improve the efficiency of future, generation IV nuclear plants—improving both their capital and operating costs. Our Exascale Computing Crosscutting Initiative continues to support activities, such as CASL, by significantly accelerating the development and deployment of high performance computing capabilities.

DOE's Loan Programs Office also plays an important role in the deployment of innovative nuclear reactor designs. The Vogtle Plant, now under construction in Georgia, was financed using $8.3 billion in DOE loan guarantees to support construction of the facility. These newly constructed units will provide enough reliable, zero-carbon, baseload electricity to power 1.5 million homes in the Southeastern United States. In addition, a new solicitation, first issued in December 2014, will support up to $12.5 billion in loans for advanced nuclear projects in the U.S., potentially including small modular reactors to help jumpstart this innovative new area.

The Nuclear Energy Workforce

To maintain and grow its vibrant domestic nuclear energy industry while continuing its global leadership in nuclear nonproliferation, the U.S. requires a strong domestic workforce of nuclear scientists and engineers.

DOE engages with industry to address workforce needs. The Integrated University Program at DOE has funded each year approximately 30 multi-year student fellowships and 46 single-year scholarships in the nuclear engineering and science fields of study. Since 2009, this program has awarded nearly $25 million to more than 500 students for nuclear energy-related scholarships and fellowships. Ninety-eight percent of the students who have completed nuclear energy-related fellowships have subsequently pursued careers in nuclear energy fields at the Department's national laboratories, other government agencies, academic institutions or private companies.

DOE implemented in fiscal year 2016 a Nuclear Energy Traineeship initiative to address priority nuclear energy workforce needs in critical areas of science, technology, engineering, and mathematics (STEM) to advance critical disciplines and competencies necessary for DOE's nuclear energy mission responsibility. The $3 million Traineeship in Radiochemistry, which was

recently awarded to a consortium led by Washington State University, is the Department's first jointly-funded traineeship, supported by $2 million from the Office of Nuclear Energy and $1 million from the Office of Environmental Management. The Office of Nuclear Energy requested $1 million for FY 2017 to produce a study on areas where the market is not providing sufficient educational resources for specific nuclear fields and why those market failures exist.

Finally, at any given time, between 400-500 university students are participating in university-led research funded by the Office of Nuclear Energy, helping to provide diverse thought and capabilities to these activities and to develop the future nuclear workforce.

The Path Ahead for Nuclear Energy Innovation

Accelerating nuclear energy innovation and ensuring the commercialization of those new technologies will require a decades-long vision. To that end, in 2014, I established a Task Force of the Secretary of Energy Advisory Board (SEAB) to focus on the Future of Nuclear Power.

The Task Force's principal charge is to develop a report that will describe the landscape to go from today's reliance largely on light water reactors to a situation from 2030 to 2050 where one or many nuclear technologies have reached technical and commercial maturity and are deploying at a rate that could contribute carbon free nuclear power for 20 percent of global electricity generation. This report could include historical operating performance; evolving end-user requirements such as process heat, hydrogen production, and desalination; options for new development and test facilities; and reactor design and development.

I expect the report to be discussed at the upcoming SEAB meeting on September 22 and look forward to its recommendations informing this conversation.

Existing Plants and the Energy Market Landscape

Status of the Current Fleet

As I mentioned previously, there are currently 99 reactors operating in the United States, totaling 99 gigawatts-electric (GWe) of capacity. As already stated, this nuclear fleet is the largest part of America's clean, emission-free electricity generation, with these reactors provide about 20 percent of electricity in the United States and approximately 60 percent of our zero-carbon electric generation. Nuclear power plants provide reliable power, maintaining the highest capacity factors of all electricity generators.

In May 2016, the Tennessee Valley Authority's Watts Bar Unit 2 achieved criticality, and in June 2016, it produced power for the first time and is currently undergoing start-up testing with commercial operation planned for the fall of 2016. It is the United States' first new commercial nuclear generation in the 21st century. Additionally, two Vogtle units in Georgia are scheduled to come on-line in 2019 and 2020 respectively. Construction of two new AP-1000 units at V.C. Summer in South Carolina are also under construction.

Market Structure and Early Closures

In spite of the good news associated with these new nuclear plants, there are significant challenges facing the existing nuclear fleet. In just the past four years, five reactors have shut down earlier than the end of their licensed operating period and even more have announced intensions to close early. The shutdown of these power plants eliminates needed zero-carbon electricity generation just as states begin design of Clean Power Plan implementation.

The challenges facing operation of these plants are largely due to a combination of complex market factors. Inexpensive electricity prices driven primarily by low natural gas prices, low demand growth, and other market factors have made operating nuclear power plants uneconomical in some parts of the country.

The current fleet of reactors was built under a very different market structure: cost-of-service regulated utilities that incentivize large capital investments. 54 GWe of the current generating capacity is in regulated markets, with the rest in restructured electricity markets, and all five new plants are in regulated markets. Today, however, many nuclear reactors have to compete in wholesale power markets, and some reactors with higher operating costs—especially single-unit, smaller plants—are struggling. Several more reactors may be at risk of early closure due to these economic forces and the increasing costs of operation.

The Federal Energy Regulatory Commission (FERC) is working on reconsideration of price formation—or how electricity prices are established to balance supply and demand. Following several workshops in the Fall of 2014 and following extensive industry response, FERC required the regional transmission organizations and independent system operators to submit reports considering a number of potential issues for improving the function and transparency of pricing in electricity markets. FERC has also docketed several proposed and final rules with new market requirements that reconsider price formation principles. Actions like these could ultimately help appropriately price the value nuclear plants offer, which could in turn help their economics.

At DOE, we have been using our convening power to advance the conversation. In May 2016, I convened a meeting of experts and stakeholders in the nearby Hart Senate Office Building to discuss these economic challenges and the unintended consequences that could arise from early closures. I appreciate that Senator Crapo hosted this event and that both he and Senator Booker participated and provided remarks. At the meeting, we identified potential policy options that can be pursued at federal and state levels to address these concerns, as well as technical options that utilities can use to improve the economic competitiveness of operating nuclear power plants.

Actions at the State level were also discussed in the May meeting, including power purchase agreements, tax credits, and clean energy standards, and some are now being implemented. In August, New York established a Clean Energy Standard that will give Zero Emission Credits to some of the State's nuclear power plants. This action has the potential to keep open three plants that were all at risk of closure. In Illinois, a similar clean energy standard is under consideration by the State, which has the potential to keep open about 3 GWe of clean electricity generation. As States struggle with these energy related issues, we in DOE are available to provide technical assistance as needed.

DOE's research programs are also working in a number of areas that may begin having an impact in the 2020 timeframe to address longer-term solutions to these issues. DOE is supporting R&D jointly with industry through the Light Water Reactor Sustainability Program, Accident Tolerant Fuel development, and CASL that can enable plant performance gains and reduce operating costs. DOE recently convened a panel of experts from industry, national laboratories, academia, and regulators to identify research, development, and demonstration opportunities that could prove economically beneficial, an effort that highlighted the potential improve materials—already an area of emphasis for DOE's R&D programs. Lastly, our joint work between the Office of Nuclear Energy and Energy Efficiency and Renewable Energy in nuclear-hybrid systems has the potential to further improve the economics of nuclear power.

Clean Power Plan

The Clean Power Plan can also benefit the existing nuclear fleet—although with implementation a few years off, bridge solutions may still be required in the near-term. The plan is projected to reduce greenhouse gas emissions from the power sector by 32 percent versus 2005 levels by 2030. Its limits on carbon pollution from fossil fuel power plans help by taking the cost of that pollution into account, enabling the market to internalize the value of zero-emitting sources like nuclear.

Under the Plan, the EPA's targets for each state provide tremendous flexibility in implementation, leaving it up to the states to determine incentives for the existing nuclear fleet. For example, the Clean Power Plan allows either mass-based or rate-based approaches for compliance. Under a mass-based approach, states can choose whether to cover new as well as existing fossil fuel plants. By covering new as well as existing coal and gas plants, a state would provide the greatest incentive for the nuclear fleet because it most clearly reflects the value of zero-emitting sources.

Quadrennial Energy Review and Valuation

The crux of the challenge for owners and regulators is economic. Taking into account the climate benefits and the potential value of baseload power, the benefits of nuclear power can outweigh the costs of operating our nuclear fleet. This alignment requires characterizing and pricing the benefits and costs provided by all electricity resources to determine an optimal generation mix for the various regions across the United States. Some benefits are regional, such as grid stability, while others are national, such as improved energy security.

The first installment of the Quadrennial Energy Review (QER) included a recommendation to appropriately value electricity services and technologies. We are acting on this recommendation in our Quadrennial Energy Review 1.2, which is focused on electricity from generation to end-use. We are focused not just on valuing new grid services and technologies, but also on understanding how existing assets—like nuclear plants—should be valued as the grid's physical and institutional structures evolve. Decisions about energy tariffs, policies, and market structures should consider a full suite of value streams, including reliability, flexibility, resilience, environmental benefits, security, and others.

Some value streams that nuclear plants provide, like carbon-free electricity and high availability, are either not valued completely or are valued differently across jurisdictions. As a result, nuclear plants are not always fully valued through electricity prices. Changes in capacity markets to reward capacity performance are a step in the right direction toward valuing firm capacity.

We also must remember that maintaining a vibrant nuclear industry is important for national security. It is important for the United States to serve a major role in setting international standards of safeguards, physical security, nonproliferation, and safety, we must be a major player in domestic nuclear energy. These and other valuation issues are central to the analysis we are doing for the next installation of the QER.

Nuclear Waste Strategy

To help ensure the long-term contribution of nuclear power in meeting the nation's energy needs and to fulfill the federal government's responsibility to manage the more than 75,000 tons of waste accumulated over decades of defense activities and clean energy production, we must find a sustainable path forward for the storage and disposal of nuclear waste.

As outlined in the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, the Department is planning for an integrated waste management system to transport, store, and dispose of spent nuclear fuel and high-level radioactive waste from commercial electricity generation, as well national defense and research and development activities.

Consent-Based Siting

To achieve an integrated waste management system, the Department is developing a consent-based siting process to help work collaboratively with the public, communities, stakeholders, and governments at the local, state, and tribal levels. In FY 2016, the Department launched an effort to solicit input from the public and interested parties on what elements to consider when designing a fair and effective consent-based siting process.

DOE issued an Invitation for Public Comment in December 2015 and held a kickoff meeting in January 2016 requesting feedback from communities, states, Tribal Nations, and other interested stakeholders. From March through July, DOE hosted a series of eight public meetings across the United States in order to engage with citizens at a national level and discuss the development of a consent-based approach to siting nuclear waste facilities. DOE is hosting a long-scheduled meeting tomorrow, September 15, to wrap up this process and discuss comments collected in our public meetings across the country. A report will subsequently be issued summarizing the results of those meetings.

By the end of the calendar year 2016, the Department will issue a number of documents, discussed below, for public comment and discussion. These include a draft consent-based siting process, as well as siting considerations for interim storage facilities and deep geologic repositories.

The Department's FY 2017 Budget Request includes funding to help transition mutual learning and engagement activities for consent-based siting to the community level through a Funding Opportunity Announcement. Funds will enable communities to learn more about nuclear waste management and explore their potential roles in consent-based siting and the management of our nation's nuclear waste. In total, our FY 2017 Budget proposes $39.4 million to supports our efforts continuing to move forward with a consent-based approach to siting storage and disposal facilities, including $25 million for grants to states, Tribal Nations, and local governments.

Consolidated Interim Storage

In parallel with developing a consent-based approach to siting, the Department is developing the concept of consolidated interim storage of commercial spent nuclear fuel. As outlined by the Administration's Strategy, consolidated storage will benefit the nation regardless of how and when the waste is ultimately disposed.

Interim storage would encompass siting, though a consent-based process, a pilot interim storage facility and subsequently a consolidated interim storage facility with greater capacity and greater capabilities. A pilot facility would be focused on the near-term need of receiving spent fuel from the existing shutdown reactor sites around the country. A larger consolidated interim storage facility, potentially co-located with a pilot facility, would provide needed flexibility in the waste management system and allow for important capacity in implementing the federal commitment to manage the nation's spent nuclear fuel. These interim storage facilities, as part of an integrated waste management system, would perform important functions including:

1) Allowing for the permanent removal of spent nuclear fuel from shutdown reactor sites;
2) Allowing the federal government to begin meeting its contractual waste management commitments;
3) Providing crucial flexibility for the overall nuclear waste management system, such as the ability to conduct thermal management activities and re-package spent nuclear fuel and high-level radioactive waste if necessary to prepare for permanent disposal, as well as the ability to regulate the future flow of waste shipments to a permanent disposal facility as circumstances require; and,
4) Providing useful learning and experience, including opportunities to conduct R&D on the behavior of spent nuclear fuel and high-level radioactive waste over time.

DOE is currently in the process of developing generic design safety analyses for interim storage concepts for two primary reasons. The first is to inform potential host communities interested in learning more about how such a facility may fit into their future in terms of risks and benefits. This second is to develop the necessary regulatory strategies for moving the spent fuel from existing facilities, where in some cases it has been located for decades, and receiving it at new facilities in a safe and efficient manner.

Private Initiatives for Interim Storage

It should be noted that in order to construct an interim storage facility, DOE would need additional congressional authorization. However, in parallel with DOE's efforts to develop DOE-constructed and -operated facility concepts, we have seen the emergence of private initiatives that may provide interim storage services and potentially accelerate the schedule to remove spent fuel from the shutdown reactor sites.

These initiatives present a novel approach that is distinctly different from DOE's consent-based siting approach, as they essentially already include an aspect of community, state, and tribal consent. DOE is encouraged by the opportunities presented by these private initiatives, and we are preparing to seek public input on how a privately-owned storage facility could fit into the overall integrated waste management system. DOE will issue a Request for Information within the coming weeks.

Ongoing Efforts Towards Permanent Disposal

Moving forward with developing a consolidated interim storage concept does not mean we are putting on hold efforts to find a permanent disposal solution for nuclear waste. The Department continues to work to better understand different methods and geologies that can effectively isolate spent nuclear fuel and high-level waste from the biosphere for thousands of years into the future.

We are conducting analyses, as well as lab and field tests, including collaborations with international partners, to evaluate three main rock types for geologic disposal: crystalline, clay/shale, and salt. This information is essential to starting a meaningful dialogue with any community, state, or Tribe that is interested in learning about hosting a waste disposal facility. As with interim storage concepts, communities should have the most up-to-date information on waste disposal facility risks and benefits to allow them to make an informed decision on whether they wish to play a role in hosting such a facility.

DOE is also pursuing our planned deep borehole field test to advance the science and engineering knowledge and determine the feasibility of using the deep borehole approach for the possible disposal of smaller, DOE managed-waste as an alternative to mined geologic repositories.

Our earlier effort to begin the deep borehole project in January met with deep community concern after the contract was awarded, as local governments felt they we not sufficiently part of the procurement process. While this activity is a non-radioactive science project, the initial mistrust led to a general fear and suspicion that the Federal Government would force the community to accept waste at some point in the future. We recognized that a "reset" was in order to form the bonds of partnership from the onset and to ensure any community, state, or Tribe who played a role in the field test would be an important and valued partner.

As a result, the Department issued a new solicitation in August of this year that now includes a phased approach and allows for making more than one award. This will allow the best quality proposal to continue through community outreach and support and permitting approval before the more technically challenging design, testing, and drilling phases are started by the most promising

contractor team. The results and data from this project, if the borehole disposal concept is proven feasible, will be essential to inform a yet-to-be-determined, future community on what it would take to host such a waste facility.

This improved approach is well underway, and we have recently received Letters of Intent to Submit Proposals that indicate there is continued strong interest. Full proposals are due October 21st with plans to select one or more of those applicants early in 2017.

Defense Waste Repository

Consistent with the March 2015 Presidential determination that a defense-only repository is required, DOE is also developing plans for a defense waste repository. As I laid out in March of 2015, there are many advantages to pursuing defense and civilian waste on separate, parallel paths.

Unlike commercial spent fuel, which has an inventory that continues to grow, the United States is no longer generating defense high-level waste associated with weapons production, and the inventory is essentially finite and known. Some defense waste is also less radioactive, cooler, and easier to handle than commercial spent fuel, and a defense repository could therefore have a simpler design and present fewer licensing and transportation challenges. In addition, defense high-level waste streams are heterogeneous, existing in many different waste forms, which could allow for different disposal pathways. A majority of the inventory of defense high-level waste has been or will be vitrified, which means that it could be disposed in a separate repository with a simpler design.

A defense high-level waste repository could be selected, licensed, and built sooner than if it were disposed of in a common repository with civilian waste. This could potentially reduce ongoing storage, treatment, and management costs for defense waste currently stored at DOE facilities. Finally, successful development of a defense-waste-only repository could play an important role in a broader nuclear waste strategy by providing important experience in the design, siting, licensing, and development of the facility that could be applied to the development of a future repository for commercial spent fuel.

A repository for disposal of defense high-level waste allows greater flexibility in the selection of a site—and greater flexibility can help to keep costs down. Over the last year and a half, we have begun early planning to identify various activities that need to be performed to evaluate and design a separate repository for defense waste. Although these plans are preliminary, they begin to describe the different components—including technical, regulatory, risk management, cost and schedule considerations—that must come together to build a viable program, all within the framework of a consent-based siting process.

FY 2017 Budget to Continue Progress on Nuclear Waste Strategy

Overall, our budget proposes $76.3 million for integrated waste management system activities, a $53.8 million increase from FY 2016, to work towards waste storage and disposal solutions, in addition to $74.3 million for Used Nuclear Fuel Disposition R&D, to make progress on the

needed research for transportation, storage and disposal. This budget will carry forward our consent-based siting, consolidated interim storage, and disposal activities in FY 2017 to move us toward a solution for managing the nation's nuclear waste and avoid leaving the burden to future generations.

Conclusion

In conclusion, I appreciate the opportunity to discuss how nuclear energy is a vital component of the U.S. clean energy strategy. The Administration looks forward to working with the Subcommittee and other Members of Congress to ensure that our nation can continue to benefit from the significant contributions of nuclear power to our energy needs and efforts to mitigate climate change.

The Department of Energy's programs continue to push to achieve these goals by advancing reactor technologies, developing used fuel management technologies and approaches, and supporting a world-class nuclear energy research infrastructure.

Chairman Alexander, Ranking Member Feinstein, and members of the Subcommittee, thank you for inviting me to discuss this important topic and the work that Department is currently doing. I will be happy to answer any questions you may have.