

## Advanced Fuel-Cycle Technologies Hold Promise for Used Fuel Management Program

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### Key Points

■ The resurgence of nuclear energy has led to a reassessment of the nation's long-term used fuel management program, including renewed interest in nuclear fuel recycling and advanced nuclear fuel-cycle technologies. These technologies include advanced reprocessing of used nuclear fuel, advanced fuel fabrication and development of new reactor designs that could further minimize byproducts of the uranium fuel cycle. These technologies, taken together, could reduce the volume, heat and radiotoxicity of nuclear waste byproducts requiring disposal.

■ The federal government and industry should pursue research and development for new recycling and reactor technology. However, this research and development should not delay the U.S. Department of Energy's used nuclear fuel repository project at Yucca Mountain, Nev. No advanced technology will preclude the need for a federal repository.

■ In the interim period, storage of used fuel at volunteer locations would enable movement of used fuel from operating and decommissioned nuclear power plants before recycling facilities are available.

■ A key driver behind research and development of advanced fuel-cycle technologies is the nuclear energy sector's expected growth in the United States and around the world. Any decision to pursue advanced fuel cycles in the United States must consider economic and non-proliferation challenges associated with recycling uranium fuel.

■ The nuclear energy industry supports the president's budget request of \$302 million for DOE's Advanced Fuel Cycle Initiative (AFCI)

for fiscal 2009. The mission of the initiative is to develop fuel-cycle technologies that will meet the need for economic and sustained nuclear energy production while satisfying requirements for a controlled nuclear materials management system.

### Industry Supports Integrated Used Fuel Management Strategy

The nuclear energy industry supports a three-pronged, integrated used fuel management strategy that includes:

- interim storage
- research, development and commercial demonstration to close the nuclear fuel cycle
- development of a permanent disposal facility.

Used fuel storage at nuclear plants sites is safe and secure. However, consolidated interim storage sites at volunteer locations would enable the movement of used fuel from both operating and decommissioned nuclear plants before recycling facilities begin operating. Preferably, interim storage sites would be at locations where advanced fuel-cycle facilities would be developed.

The research, development and commercial demonstration of advanced nuclear fuel-cycle technologies will take several decades and billions of dollars to complete. The industry supports research and development into advanced fuel cycles. The pursuit of this longer-term objective, however, must not compromise the federal government's obligation under the Nuclear Waste Policy Act to manage used commercial reactor fuel.



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DOE is developing a permanent disposal facility for used nuclear fuel at Yucca Mountain, Nev. Congress approved Yucca Mountain as the repository site in 2002, and the Energy Department expects to file a license application with the U.S. Nuclear Regulatory Commission to build the facility in June 2008.

### **Evaluating Closing the Fuel Cycle for the Long Term**

The United States, for economic reasons, does not recycle reactor fuel. However, to realize nuclear energy's long-term economic and environmental benefits, the industry endorses the federal government's plan to evaluate closing the fuel cycle, including the benefits and availability of advanced recycling technologies.

In the current commercial reactor fuel cycle, reactor fuel is used once and then removed from the reactor for disposal in a specially designed repository. However, in other nations, such as France, Japan and the United Kingdom, reactor fuel is recycled and reused. Ultimately, the remaining byproducts will be sent to a repository for disposal.

In the United States, such a "closed" fuel cycle would include the following:

- new fuel-fabrication technologies
- advanced used fuel reprocessing techniques
- advanced reactors to extract additional energy from the recycled fuel and further reduce the volume, heat and radiotoxicity of byproducts in the fuel
- a federal repository.

The nuclear fuel cycle could be closed after commercial development of the advanced reprocessing and recycling, fuel-fabrication, and reactor technologies and when the economic and environmental benefits can be realized. This development will take decades, so it is appropriate that the federal government vigorously pursue research and development efforts now on these technologies under the AFCI program.

Developing advanced fuel cycles encompasses more than the development of advanced reprocessing and recycling technology. It involves developing the capability to manufacture a new type of reactor fuel from the elements of used fuel made available by advanced reprocessing, and developing new reactor designs to use this type of fuel.

Advanced fuel-cycle technologies cannot eliminate all of the byproducts in used nuclear fuel. Moreover, the systems eventually developed may not have the capacity to recycle all commercial used fuel ever generated. The United States needs a federal repository for disposal of commercial reactor fuel and its byproducts and disposal of high-level radioactive waste created by the federal government during the Cold War. Most of the material resulting from defense programs is stored temporarily in Idaho, South Carolina and Washington state.

### **Administration Launches Global Nuclear Energy Partnership**

DOE launched the Global Nuclear Energy Partnership in 2006 to encourage the worldwide expansion of nuclear energy while avoiding the need for nations to develop uranium fuel enrichment or reprocessing technologies. To date, 22 nations have joined the partnership.

According to this plan, the United States and nations that already have uranium enrichment capability, such as France, Japan, Russia and the United Kingdom, would provide nuclear fuel to other nations and take back the fuel once it is used. Through this international partnership, countries will jointly develop advanced reprocessing, fuel-fabrication and reactor technologies that would minimize the volume, heat generation and toxicity of material requiring disposal at a repository.

These technologies would capture vast amounts of energy remaining in uranium fuel after a single 36- to 54-month cycle in a reactor and would greatly reduce the volume, heat and radiotoxicity

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of radioactive byproducts for disposal at the repository.

In 2006, DOE awarded grants to 11 volunteer locations to study the possibility of hosting advanced fuel-cycle developmental facilities in their communities. DOE is incorporating the studies into an environmental impact statement for potential recycling and fast reactor sites.

In 2007 and 2008, DOE provided grants to four industrial consortia to propose business plans to the department for research, development and commercial demonstration of advanced fuel-cycle facilities. These plans include preliminary designs, costs, financing requirements, etc.

### Looking to the Future

Today's reprocessing technology—known as PUREX—makes it possible to recycle and reuse only uranium and plutonium from used nuclear fuel. The remainder of the isotopes are mixed with glass for disposal as high-level waste in a process known as vitrification. The advanced process would separate uranium, plutonium and other elements—which still contain usable amounts of energy—from the radioactive waste comprising long-lived and short-lived radioisotopes that have no energy value.

The uranium and plutonium separated from used reactor fuel by PUREX reprocessing can be recycled as mixed oxide fuel. France and the United Kingdom currently use this process, and Japan has built a facility that will use it in the future. These countries use this process in a safe and proliferation-resistant manner. Nonetheless, PUREX raises concerns since it produces a pure plutonium byproduct that must be stored under strict security and safeguards as provided in internationally agreed protocols.

Advanced reprocessing would use recycling processes that do not produce pure plutonium.

One such process, called UREX+, extracts the uranium from used fuel, leaving the remaining plutonium with other radioactive materials. Like

the PUREX technology, UREX+ produces high-level radioactive waste that requires disposal. However, a significant number of isotopes in the PUREX waste stream are extracted with the plutonium and recycled as fuel.

Although proven in laboratories, the commercial application of UREX+ is many years into the future. DOE also is developing other processes, such as "pyroprocessing," that use metallurgical technology. The private sector is proposing other processes to accomplish the same goal.

Finally, a new generation of reactors would use uranium, plutonium and other elements made available by advanced reprocessing and convert them to shorter-lived, less toxic materials while extracting useful energy. These reactors are decades away from commercial development.

The industry believes that to realize fully the long-term benefits of nuclear energy, the United States and other nations must develop advanced fuel-cycle technologies that will supply recycled fuel when it is appropriate to do so, while reducing the amount of radioactive byproducts requiring disposal in a federal repository.

*This policy brief also is available at [www.nei.org](http://www.nei.org), where it is updated periodically.*