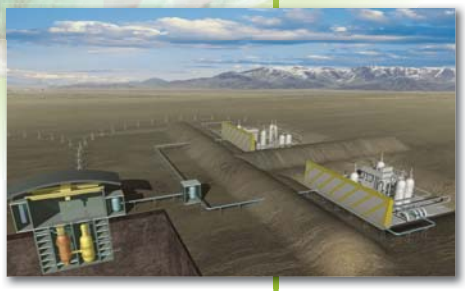
Generation IV Nuclear Energy Systems

The U.S. Department of Energy's Office of Nuclear Energy

Generation IV systems concepts excel in safety, sustainability, cost effectiveness, and proliferation resistance.

The Department of Energy (DOE) is laying the groundwork for a zero emissions future, free of reliance on imported energy. The Generation IV (Gen IV) program is a vital part of this vision.

The goal of the Gen IV Nuclear Energy Systems Initiative is to address the fundamental research and development (R&D) issues necessary to establish the viability of next-generation nuclear energy system concepts to meet tomorrow's needs for clean and reliable electricity, and non-traditional applications of nuclear energy. Successfully addressing the fundamental R&D issues will allow Gen IV concepts that excel in safety, sustainability, cost-effectiveness, and proliferation risk reduction to be considered for future commercial development and deployment by the private sector.



The program focuses on Gen IV reactor concepts with an emphasis on very high-temperature reactor technologies and on the underlying Gen IV technologies that will improve the economic and safety performance of the previous generations of existing light-water reactors (LWRs).

BENEFITS OF THE INITIATIVE

Through scientific R&D and international collaboration, Gen IV supports the development of next-generation nuclear reactor technologies that promise improved performance in sustainability, economics, and proliferation resistance. As a result of these efforts, nuclear energy will be able to increase its contribution to the reduction of CO_2 emissions when nuclear energy is used to replace conventional sources of process heat, such as burning fossil fuels.

By investing in Gen IV technologies that make possible more efficient electricity production and the production of nuclear process heat for industry, Gen IV R&D holds the potential to match, or even exceed, the reduction in greenhouse-gas emissions credited to current generation nuclear power plants.

Generation IV R&D will provide:

- **High-temperature gas-cooled reactor technology** — Gas-cooled reactors are a revolutionary advance in reactor technology. They are inherently safe, efficient, and can use less fuel than the current generation of light-water reactor designs. Gas reactors can be used to extend the benefits of nuclear energy beyond the electrical grid by providing industry with low carbon, high-temperature process heat for a variety of applications, including petroleum refining, bio-fuels production, and production of feedstock for use in the fertilizer and chemical industries.

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Program Budget

Gen IV Nuclear Energy Systems Initiative ($ in Millions)

	FY 2009 Actual	FY 2010 Request
	$180.0	$191.0

- **Underlying Technologies —** Underlying technologies (fuels, materials, neutronic and thermofluid modeling) benefit the majority of reactor concepts and sizes. These technologies will receive limited but sustained Gen IV support in cooperation with international R&D.
- **Hub for Modeling and Simulation —** The Modelling and Simulation Hub will focus on providing validated advanced modeling and simulation tools necessary to enable fundamental change in how the U.S. designs and manages nuclear facilities. The goal is to find ways to improve waste management, reduce proliferation risk, and lower the cost of nuclear facilities.

INTERNATIONAL COOPERATION

Key to all Gen IV research and development is the multiplication effect on investment derived from international collaboration. By coordinating U.S. efforts with partner nations, our funding is leveraged by a factor of two to ten.

The United States collaborates with the international community via the Generation IV International Forum (GIF), the International Atomic Energy Agency (IAEA), and through a number of bilateral agreements pioneered under the International Nuclear Energy Research Initiative.

PLANNED PROGRAM ACCOMPLISHMENTS

FY 2009

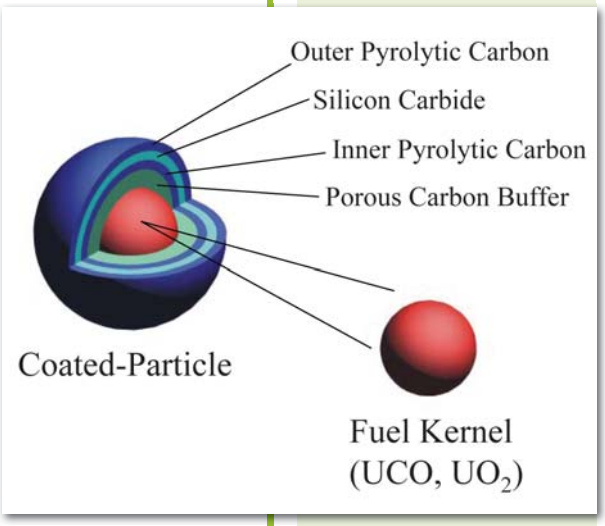
- Continue the gas reactor fuel development, manufacturing, and qualification program. The first of eight irradiation experiments (AGR-1) has survived more than two years without any evidence of failure, and some of the samples will reach 18 percent burnup before the experiment is removed early next fiscal year.
- Complete preparations for the next fuel irradiation test, AGR-2, which contains fuel that was fabricated with production scale equipment, and complete the equipment design for the next series of tests, AGR-3 and -4, that will test fuel with hypothetical fuel manufacturing defects.
- Insert the first of six irradiation capsules to determine the properties of candidate nuclear-grade graphites, while under simulated conditions. Graphite is the primary reactor core structural material, and the Advanced Graphite Creep (AGC) experiment series is designed to qualify one or more commercial graphites for this mission.
- Complete environmental and mechanical property tests for potential Intermediate Heat Exchanger (IHX) metal alloys and continue to support industry-code committees in the development of test standards and design rules for the use of these alloys under Gen IV conditions.
- Continue analytical computer modeling methods development in both physics and heat transport, and continue benchmarking of computer codes for gas reactor design concepts.

- Upgrade the laboratory-scale components and setup for demonstrating a promising advanced Brayton cycle energy-conversion system that uses supercritical carbon dioxide as the working fluid, and obtain data on the component behavior under supercritical conditions.
- Continue, in collaboration with international partners, the development of crosscutting benchmarking methodologies (economics, proliferation resistance and physical protection, and reactor safety).

FY 2010

- Perform post-irradiation examinations of unique, highly-irradiated metallic material samples obtained from the Fast Flux Test Facility and the Phoenix Fast Reactor in France.
- Continue development of advanced materials such as ceramics, composite materials, and nano-structured ferritic materials for use in structural systems, fuel claddings, and other high-temperature applications.
- Complete the first Advanced Gas Reactor fuel irradiation experiment (AGR-1), perform post-irradiation examinations of the irradiated fuel specimens, and commence irradiation of the first fuel produced in large-scale production equipment (AGR-2).
- Continue irradiation of the first Advanced Graphite Creep (AGC-1) test experiment to provide data for nuclear graphite qualification.
- Continue the development of advanced gas reactor system-simulation software and initiate bilateral cooperation with Japan on the use of their experimental gas reactor as a test facility for code validation, operational experience, and as an instrumentation and controls test bed.
- Continue study of the use of liquid salt as a circulating fluid in primary and intermediate cooling loops, and demonstrate the technical and economic viability of an advanced Brayton-cycle energy-conversion system using supercritical carbon dioxide as the working fluid.
- Continue international R&D collaborations through the Generation IV International Forum, IAEA, and bi-lateral agreements.
- Continue advanced modeling techniques utilizing the Department's high-speed, parallel computers for the development of close-coupled neutronic and thermofluid codes.

R&D focuses on enabling technologies such as high-temperature metal alloys, nuclear-grade graphites, and coated-particle fuels.



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