Next Generation Nuclear Plant Demonstration Project

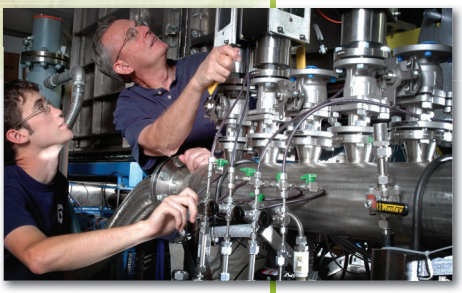
The U.S. Department of Energy's Office of Nuclear Energy

NGNP will extend the benefits of nuclear energy by providing carbon-free, high-temperature process heat to industry.

The Department of Energy (DOE) is laying the groundwork for a lower emissions future, free of reliance on imported energy. The Next Generation Nuclear Plant (NGNP) Demonstration Project is a vital part of this vision.

DOE's NGNP Demonstration Project supports a transformative application of nuclear energy to address the President's goals for reducing greenhouse gas emissions and enhancing energy security.

BENEFITS OF THE NGNP PROGRAM



Through scientific and international collaboration, NGNP supports the development of gas-cooled nuclear reactor technology that promises improved performance in sustainability, economics, and proliferation resistance. As a result of these efforts, nuclear energy will increase its contribution to the reduction of CO_2 emissions when it is used to replace conventional sources of process heat, such as the burning of fossil fuels.

By investing in gas-cooled reactor technology that makes possible more efficient electricity production and the production of nuclear process heat for industry, NGNP is endeavoring to jump-start a new application for nuclear energy with potential benefits to the environment that rival the reduction in greenhouse gas emissions credited to current generation nuclear power plants.

The NGNP Demonstration Project will provide:

High-Temperature Gas-Cooled Reactor Technology — Gas-cooled reactors are a revolutionary advance in reactor technology. They are inherently safe and 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 carbon-free, high-temperature process heat for a variety of applications, including petroleum refining, biofuels production, and production of chemical feedstocks for use in the fertilizer and chemical industries

Underlying Technologies — Underlying technologies (fuels, materials, neutronic, and thermofluid modeling) benefit the majority of reactor concepts and sizes that are being investigated as part of the overall Office of Nuclear Energy research and development (R&D) portfolio.

Next Generation Nuclear Plant Demonstration Project

Program Budget	
Next Generation Nuclear Plant ($ in Millions)	
	FY 2012 Request
	$49.6

PROGRAM BACKGROUND

The NGNP Demonstration Project was formally established by the Energy Policy Act of 2005 (EPAct 2005) to demonstrate the generation of electricity and/or hydrogen with a high-temperature nuclear energy source. The Project is executed in collaboration with industry, DOE national laboratories, universities, and the international community. The U.S. Nuclear Regulatory Commission (NRC) is responsible for licensing and regulatory oversight of the demonstration nuclear reactor. The NRC and DOE are collaborating on the establishment of a licensing framework for gas-cooled reactors in the United States.

The NGNP Demonstration Project includes design, licensing, construction, and R&D conducted in two phases. Phase 1 includes pre-conceptual and conceptual design leading to the selection of a single technology for NGNP. Phase 2 includes the selection of a single technology for preliminary and final design necessary for licensing and construction of a demonstration plant. R&D as well as licensing activities are included in both Phase 1 and Phase 2. Licensing scope supports the development of a licensing framework for high-temperature gas reactors and includes the preparation and submission of a Combined Operating License Application (COLA) for the NGNP. R&D activities are organized into four major technical areas: (1) Fuel Development and Qualification, (2) Graphite Qualification, (3) High-Temperature Materials Qualification, and (4) Design and Safety Methods Validation.

INTERNATIONAL COOPERATION

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

PLANNED PROGRAM ACCOMPLISHMENTS

The Nuclear Energy Advisory Committee (NEAC) commenced a review of NGNP including industrial deployment studies, R&D, licensing, and conceptual design activities to determine if the Project is ready to move into Phase 2. NEAC is expected to provide a recommendation to DOE in May 2011 which will be factored into the Secretary's decision on NGNP Phase 2 readiness.

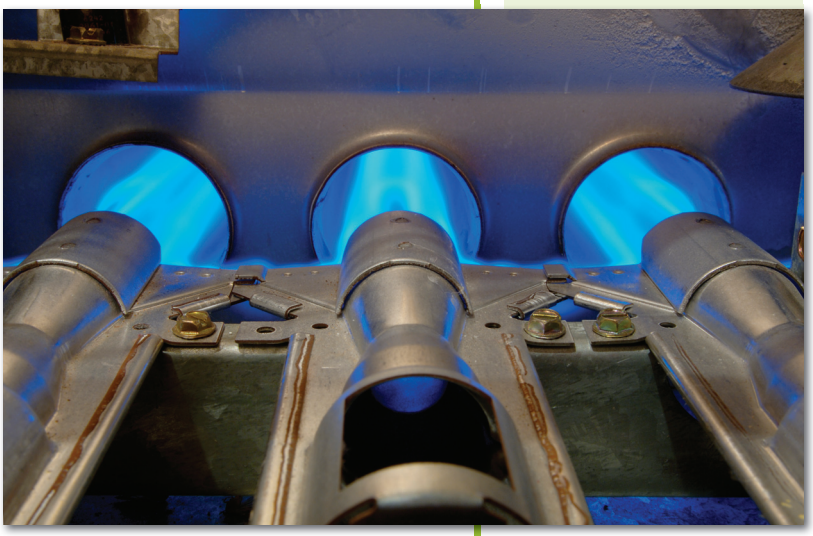
In FY 2011, DOE is conducting market research and preparing a formal solicitation to establish a cost-shared public-private partnership with industry to conduct the Phase 2 activities. It is anticipated that the Secretary will determine whether to proceed with Phase 2 in FY 2011.

FY 2011

- Sponsor an independent review of NGNP activities by the Nuclear Energy Advisory Committee.
- Support a decision by the Secretary of Energy on NGNP Phase 2 readiness.
- Continue the irradiation in the Idaho National Laboratory (INL) Advanced Test Reactor (ATR) of the first NGNP fuel produced in commercial scale production equipment (Advanced Gas Reactor (AGR-2)).
- Continue post-irradiation examination of the first NGNP fuel tested in the ATR.
- Continue selection and characterization of NGNP graphite and composite materials, including the completion of the irradiation of the first Advanced Graphite Capule (AGC-1) test experiment and commencement of AGC-2 to provide data for nuclear graphite qualification.

- Initiate assembly of High-Temperature Vessel experiments 1 and 2 for irradiation at Oak Ridge National Laboratory that are necessary to obtain critical data (physical expansion, process monitoring) for designing AGC-5 and AGC-6.
- Continue environmental, mechanical property, and joining method (e.g. welding) studies for selected heat exchanger and reactor pressure vessel materials for code-case data package development and qualification.
- Complete a Regulatory Gap Analysis that will review existing NRC rules and regulations and identify their applicability to gas reactors.
- Continue white paper analyses and responses to possible Requests for Additional Information from the NRC to support the NRC's development of form and content requirements needed to submit a license application for an advanced gas-cooled reactor.
- Begin phased implementation of an Appendix B Quality Assurance Program that incorporates the newest ASME NQA-1 Standard endorsed by the NRC.
- Continue international R&D collaborations established under the GIF Very-High-Temperature Reactor System Arrangement and associated second tier Project Arrangements.
- Develop the capability to subject structural materials to a combination of tension and torsion to simulate the stress state in the NGNP and to understand and model component materials response under complex stress states.
- Use existing test facilities (High-Temperature Test Reactor in Japan) and construct separate effects and integral effects test equipment to perform thermal-fluid behavior validation experiments.
- Conduct research on process heat applications, including system interface requirements and materials compatibility issues, for coupling NGNP to various non-electric applications.
- Continue fuel performance modeling, fabrication modeling, and fission product transport modeling.
- Complete fabrication of Oregon State University (OSU) 600kW High Temperature Test Facility (HTTF) to support experiments and analysis needed for the design and licensing of the NGNP in the areas of core thermal hydraulics and accident analysis, particularly loss of forced cooling events.
- Conducting methods development and experimental validation to determine the capability of the passive system to remove decay heat and validate state-of-the-art thermal-fluid models for the unique geometry of the NGNP reactor cavity cooling system.

The Very-High-Temperature Reactor is a high-efficiency system that can supply process heat to a broad spectrum of high-temperature and energy-intensive, non-electric processes.



FY 2012

- Continue the irradiation in the INL ATR of the first NGNP fuel produced in commercial scale production equipment (AGR-2), and make preparations to commence post-irradiation examination activities.
- Complete post-irradiation examination and simulated accident testing of the first NGNP fuel tested in the ATR (AGR-1).
- Initiate irradiation in ATR of NGNP fuels containing designed-to-fail fuel particles to provide data on fission product release and transport for use in development of improved models (AGR-3/4).
- Continue design of the AGR-5/6 experiment to demonstrate compliance with fuel performance requirements under normal operation and accident conditions.
- Conduct post-irradiation examination of the first graphite samples tested in the ATR to understand the influence of irradiation, temperature, and dose on the properties of nuclear graphite (AGC-1).
- Complete the irradiation of the AGC-2 test experiment and commence post-irradiation examination to provide data for nuclear graphite qualification.
- Continue to characterize graphite samples for use in additional AGC experiments, base-lining the "as received" material properties to establish accurate physical, thermal, and mechanical response data.
- Continue property measurement and characterization of candidate high temperature materials for use in heat exchangers and reactor pressure vessels to support code-case data package development and qualification.
- Continue methods development and experimental validation to determine the capability of the passive system to remove decay heat and to validate state-of-the-art thermal-fluid models for the unique geometry of the NGNP reactor cavity cooling system.
- Complete shakedown testing of the OSU HTTF and conduct initial experiments studying High Temperature Gas Reactor Depressurized Conduction cool-down scenarios.
- Continue validation of current analytical methods in reactor and plant simulation against benchmarks and experimental data, including benchmarking against NRC tools, and develop and test new methods to investigate performance and safety significant phenomena, if needed.
- Continue research on process heat applications, including resolution of component longevity issues, system interface requirements, and materials compatibility issues.
- Continue modeling and analysis studies of coupling NGNP to various non-electric end-user applications.
- Continue working with the NRC to develop the process for licensing gas-cooled reactors.