

U.S. DEPARTMENT OF **ENERGY** | Nuclear Energy

Nuclear Energy R&D for existing plants

Light Water Reactor Sustainability
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NRC RIC
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Research, Development & Demonstration

NE's R&D Objectives

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 Administration's energy security and climate change goals
3. Develop sustainable nuclear fuel cycles
4. Understand and minimize the risks of nuclear proliferation and terrorism

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NE's R&D Programs

NE's R&D Programs are being restructured as Goal-Oriented, Science-Based Programs

Experiments – Generally small-scale aimed at observation of isolated phenomena; also targeted integral experiments

Theory – Developed from first principals or based on observations from experiments

Modeling and Simulation – Mathematical models of phenomena at different time and spatial scales built upon the advances in computational capabilities

Demonstrations – Useful element in proving the viability of new technologies

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Implementation Plan
 Nuclear Energy

NUCLEAR ENERGY RESEARCH AND DEVELOPMENT ROADMAP
 REPORT TO CONGRESS
 April 2010

Objective 1: Extend Life, Improve Performance, and Maintain Safety of the Current Fleet
 Implementation Plan

- DOE / EPRI Joint Strategy
- Nuclear Materials Aging and Degradation
- Advanced Instrumentation, Information, and Control Systems
- Risk-Informed Safety Margins Characterization
- Advanced LWR Fuel Development
- Economics and Efficiency Improvements

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Federal Role
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- National strategic interest in the long-term operation of existing plants
 - Supports climate change objectives
 - Supports energy security
 - Avoids higher cost to ratepayers for new plant replacements
- Industry also has an incentive, so cost-share will be employed
- Addresses fundamental scientific questions where private investment or capabilities are insufficient to make progress on broadly applicable technology issues for public benefit
- Government holds a large theoretical, computational, and experimental expertise in nuclear R&D that is not available within the industry
- Benefits will extend to the next generation of reactor technologies still in development
- The Office of Nuclear Energy has signed Memorandum of Understanding with the Nuclear Regulatory Commission and the Electric Power Research Institute to cooperate on R&D related to the long-term operation of existing plants.

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Light Water Reactor Sustainability (LWRS) Program
 Nuclear Energy

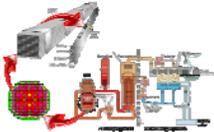
- Mission** – Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Program Goals** – Conduct research to:
 - Develop fundamental scientific basis to understand and enable continued long-term operation of existing LWRs
 - Develop technical and operational improvements that contribute to long-term economic viability of existing nuclear power plants
- The LWRS program supports the Department’s Secretarial priorities by conducting activities focused on sustaining and expanding safe and secure nuclear energy production
- The LWRS program supports Objective 1 of the NE R&D Roadmap by investing in R&D to develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors

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Energy Innovation Hub for Modeling & Simulation –
 Nuclear Energy *A key Secretarial Initiative*

- Consortium for Advanced Simulation of Light-water-reactors (CASL) selected to manage the Hub on May 28, 2010
- Create a “multi-physics computational environment” that can be used by a wide range of practitioners to conduct predictive calculations of the performance of reactors for both normal and off-normal conditions.
- Dramatically advance modeling and simulation and high performance computing to create a “virtual” model of an operating reactor.
- Improve our scientific understanding of reactor systems to increase the pace of innovation and reduce overall costs to deploy and operate.





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Advanced Modeling and Simulation –
 Nuclear Energy *Harnessing the power of advanced computers*

- Focal point for the development of modeling and simulation capabilities within NE
 - concentrates on **building** new modeling and simulation capabilities
 - capabilities will be **used** by programs that involve national laboratories, universities and industry *along with theory and experiments* to create new scientific insights about nuclear energy
- Nuclear Energy Advanced Modeling and Simulation (NEAMS) Impacts
 - Near term (Now – 4 years) – modeling and simulation tools to support NE R&D
 - Mid term (5 – 7 years) – tools with improved resolution and fidelity that predict performance and safety
 - Long term (10 – years) – tools to be used for the design and operation of new nuclear energy systems (advanced reactors, safeguarded separation systems, used fuel disposition)

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Light Water Reactor Sustainability –
 Nuclear Energy *Preserving a critical national asset*

- Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors
- Five LWRs research pathways
 1. **Nuclear Materials Aging and Degradation** - develop the scientific basis for understanding and predicting long-term environmental degradation behavior of materials
 2. **Risk-Informed Safety Margin Characterization** - better understand and characterize safety margins and improve the reliability and efficiency of plant operations
 3. **Advanced Instrumentation, Information, and Control Systems Technologies** - address long-term aging and obsolescence of existing I&C technologies and establish a strategy to modernize I&C systems
 4. **Advanced Nuclear Fuel Development** - develop high-performance, higher burn-up fuels with improved safety, cladding, integrity, and economics
 5. **Economic and Efficiency Improvements** - address high impact emerging issues and improve the efficiency of the current fleet




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Pilot Plant Projects

- **GINNA**
 - Containment assessment
 - Fiber optic strain gage measurement of tendon relaxation
 - Coring and subsequent spectroscopy and strength testing
 - Rebar condition assessment
 - NDE (test various methods)
 - Digital Image Correlation trial
 - Augmented Reactor Internals Aging Assessment (baffle bolts)
 - RPV embrittlement
 - Reconstitute specimens
 - Irradiate further
 - Re-test to expand vessel embrittlement database
- **Nine Mile Point Unit 1**
 - Investigate top guide cracking
 - Other activities TBD
- **Zion D&D**
 - Concrete Specimens
 - RPV Specimens
 - Other Specimens TBD

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Conclusion

- The existing fleet of nuclear power plants provide the majority of the Nation's non-carbon emitting electrical generation
- The continued operation of the existing fleet is in the National interest as a key strategy for meeting climate change and energy supply goals
- Federal efforts are essential to stimulate and encourage industry efforts as well as to address the longer-term, high risk research that industry can not address
- Sustained R&D on long-term LWR operations is needed to identify issues and develop the technical basis that supports industry efforts to relicense plants for long-term operation

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