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Fuel Cycle Research and Development Program

Presentation to
Office of Environmental Management
Tank Waste Corporate Board

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Outline

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- Changes from the Former Advanced Fuel Cycle Initiative
- The Science-Based Approach
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Fuel Cycle R&D Mission

The mission of Fuel Cycle Research and Development is to develop options to current fuel cycle management strategy to enable the safe, secure, economic, and sustainable expansion of nuclear energy while reducing proliferation risks by conducting research and development focused on nuclear fuel recycling and waste management to meet U.S. needs.

Fuel Cycle R&D's focus is on long-term, science-based research and development of technologies with the potential to produce beneficial changes to the way in which the nuclear fuel cycle, and particularly nuclear waste, is managed.

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Changes from the Former Advanced Fuel Cycle Initiative

Advanced Fuel Cycle Initiative

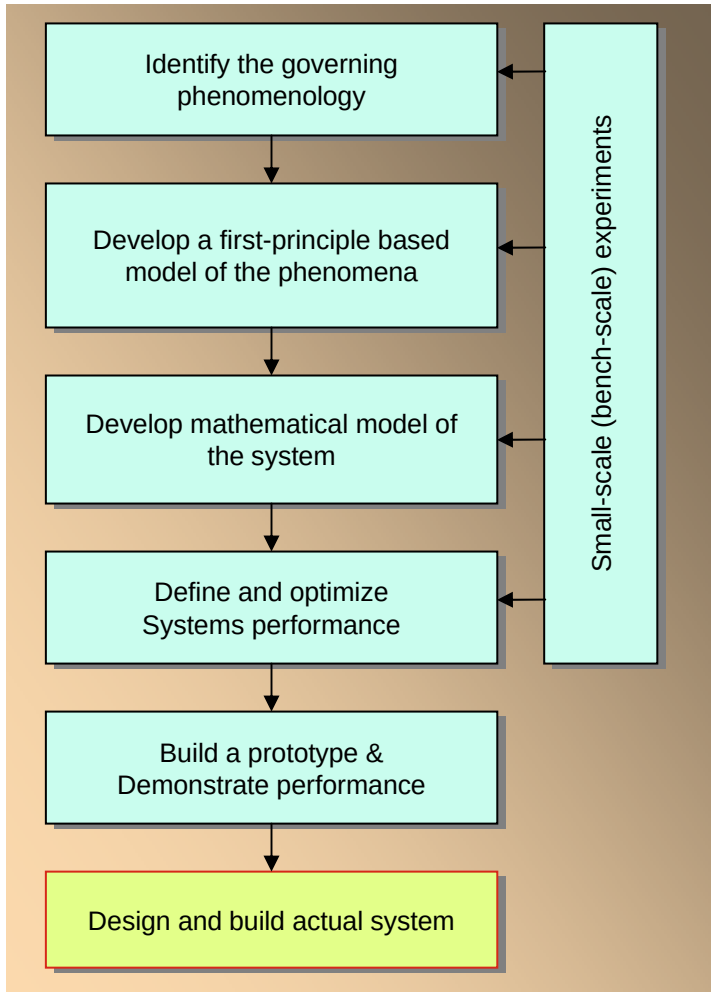
- Incremental improvement of existing technologies
- Driven by better utilization of Yucca Mountain repository
- Focused on near-term technology deployment

Fuel Cycle R & D

- Transformational breakthroughs
- Unconstrained range of disposal options
- Long-term, science-based approach

The Science-Based Approach

- **Small-scale experiments, coupled with theory development and advanced modeling and simulation with validation experiments.**



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Key DOE Collaborators

- **Generation IV R&D Program**
  - Transmutation using Generation IV reactors.
  - Modeling and Simulation Hub
- **Nuclear Energy University Program**
  - 20% of R&D funds allocated to universities
- **Idaho Facilities Management**
  - Operations and maintenance of INL research facilities
  - Planning for future infrastructure needs
- **Science**
  - Basic research and theory development in materials and nuclear science
- **Civilian Radioactive Waste Management**
  - Waste forms and waste package development
  - Geologic disposal options
- **Environmental Management**
  - Waste forms and waste package development
  - SNF and HLW processing
- **NNSA**
  - Safeguards and process monitoring instrumentation

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External Collaborators

- **Industry**
  - Vendors – identify R&D needs
  - Utilities – economic analysis of options
- **International collaborations**
- **Peer Review of concepts**
- **Nuclear Energy Advisory Committee**
  - NE Roadmap for the future
  - R&D Facilities requirements

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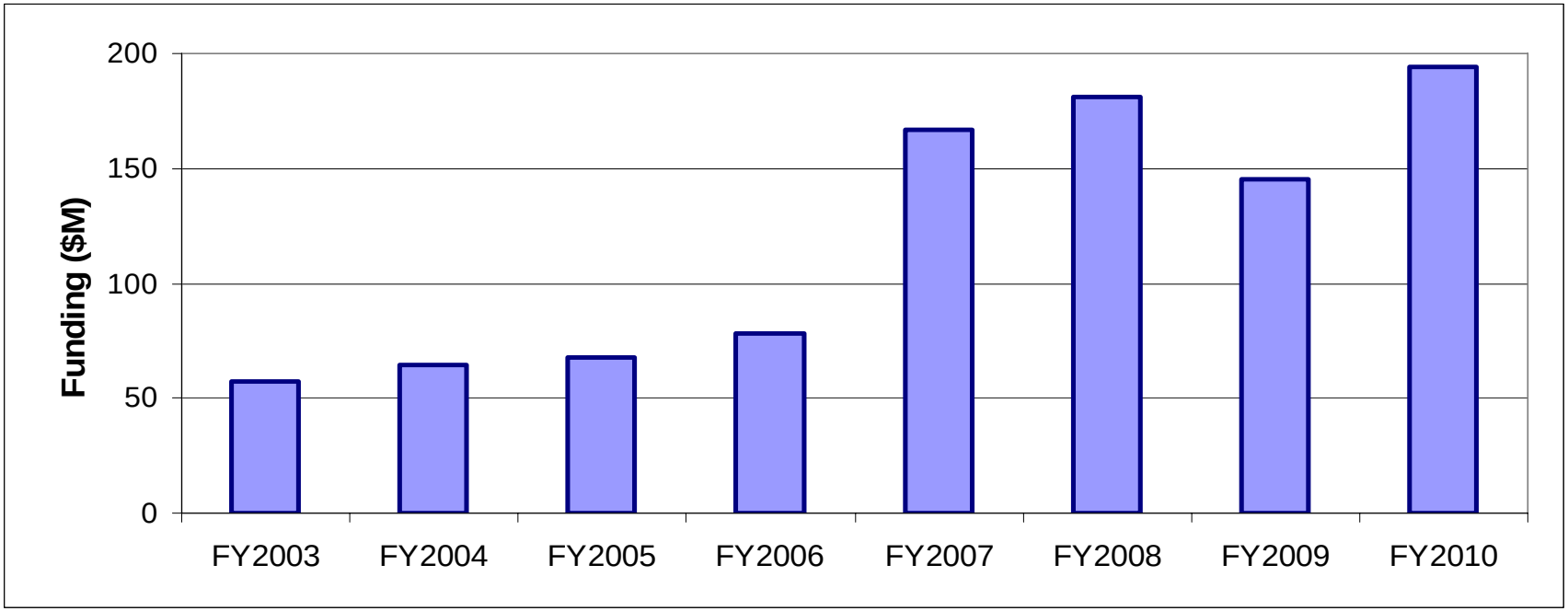
AFCI/Fuel Cycle R&D Funding History



Funding ($M)							
FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010 (request)
57.3	64.6	67.5	78.4	167.5	181.0	145.0	192.0

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Separations Objectives

- Develop the next generation of fuel cycle separation and waste management technologies that significantly reduce cost, waste quantities, and are readily safeguardable.
- Develop the required waste forms for various high level waste storage environments.
- Collaborate with NNSA to develop advanced safeguards technologies.

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Separations "Grand Challenges"

- **Separations technologies and systems with improved proliferation resistance, very low process losses and minimal undesirable waste streams.**
- **Waste forms with predictable, long-term behavior and enhanced resistance to long-term degradation suitable for a variety of potential geologic repository environments.**
- **Process control and accountability instruments and techniques that permit an order of magnitude improvement in the ability to detect fissile materials in fuel cycle systems.**

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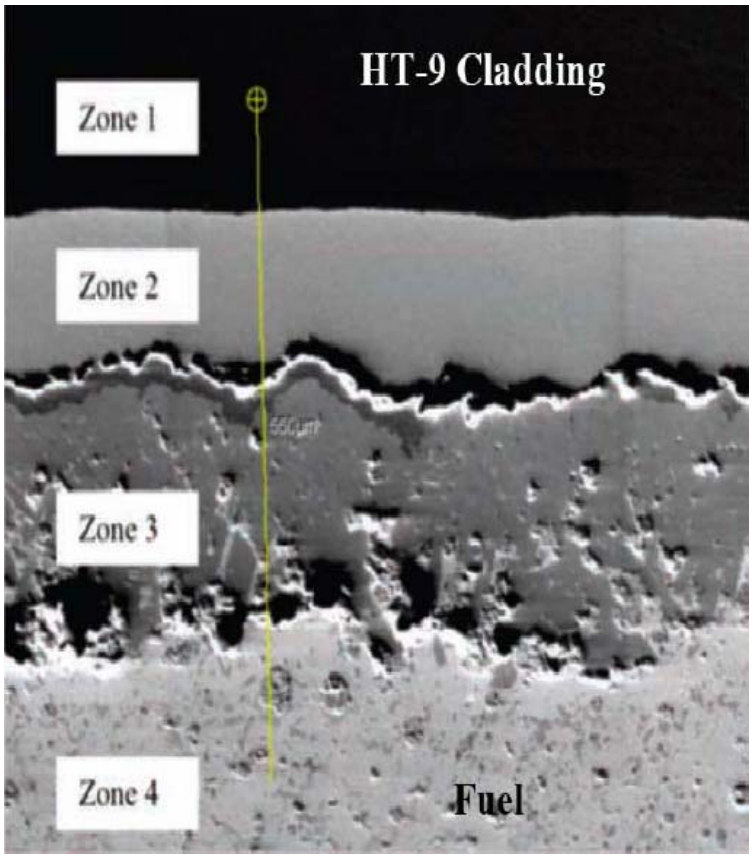
Fuels Objective and Grand Challenge



- **Objective: Establish a fundamental understanding of fuel/target systems with varying compositions and design fuels at microstructural levels to achieve targeted performance characteristics.**
- **Grand Challenge: Nuclear fuels and/or targets with multi-fold increases in performance over previous generation fuels, with very low fabrication losses, and that permit high transmutation of radiotoxic elements.**

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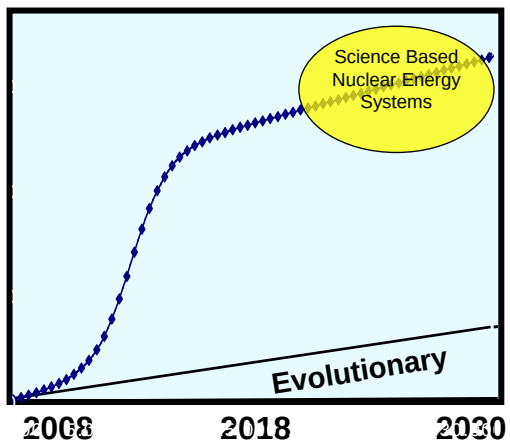
Advanced Modeling and Simulation

- **Vision: Enable a dramatic increase in the pace of innovation by developing a suite of validated predictive computational tools prior to the design of mock-up experiments. Add the modern supercomputer to our suite of experimental facilities.**

- **Goals:**
  - Reduce operating margins for existing designs
  - Explore innovative designs with minimal reliance on mock-up experiments
  - Explore innovative materials for new and existing designs
  - Reduce regulatory costs



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Extreme Materials Hub (new for 2010)

- **Focus and integrate the national effort to develop and test advanced materials needed to transform the performance of nuclear energy systems to never-before achieved levels.**
- **Address significant scientific challenges:**
  - At the microstructural level: (1) understand the chemical and physical conditions and behavior of materials and (2) develop methods to design materials.
  - Develop approaches to understanding materials that rely on basic and established laws of nature without additional assumptions or special models.
  - Develop novel measurement techniques to understand fundamental physical and chemical phenomena.
  - Integrate new-found knowledge into models that span multiple length and time scales.

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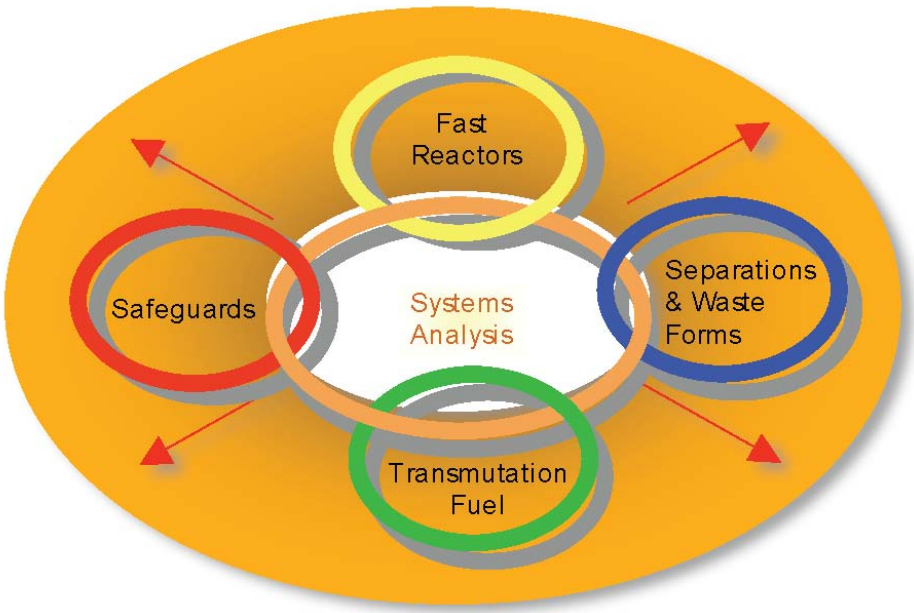
Systems Analysis Objective and Grand Challenge



- **Objective: Provide the tools to understand the behavior of various fuel cycles and their impact on the associated policy choices with a specific emphasis on repository and disposal options.**

Grand Challenges:

- **Develop a decision support and education simulation tool that can synthesize and visually present multivariable attributes of potential fuel cycles.**
- **Develop a functional knowledge management capability that permits data to be available on-line to program researchers.**

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Used Nuclear Fuel Disposition R&D

- **The Fuel Cycle R&D program will be broadened in scope to support:**
  - R&D on storage technologies
  - Security systems
  - Alternative disposal pathways (e.g., salt formation and deep borehole, etc.)
- **This effort will be informed by the Options study being performed in FY 2009**
- **Begin revisiting the scientific consideration of long-term geologic storage in conjunction with the Office of Civilian Radioactive Waste Management (RW)**
- **We anticipate results will be shared with the Secretary's Blue Ribbon Panel when it is established**

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Summary

- **DOE's Fuel Cycle R&D program focus has changed from a near-term deployment of evolutionary closed fuel cycle technologies to a long-term, science-based program that will evaluate the entire spectrum of options for used nuclear fuel management:**
  - Pursue breakthrough technologies to address fuel cycle challenges
  - Integrate theory, experimentation and advanced modeling
  - Engage end-users and key stakeholders to inform the R&D effort

- **Continue to evaluate a broad suite of fuel cycle options**
  - Comprehensive systems analysis studies to evaluate options and explore deployment alternatives and implications