U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Fuel Cycle Research and Development: Moving to a Long-Term, Science-Based, Goal-Oriented Program

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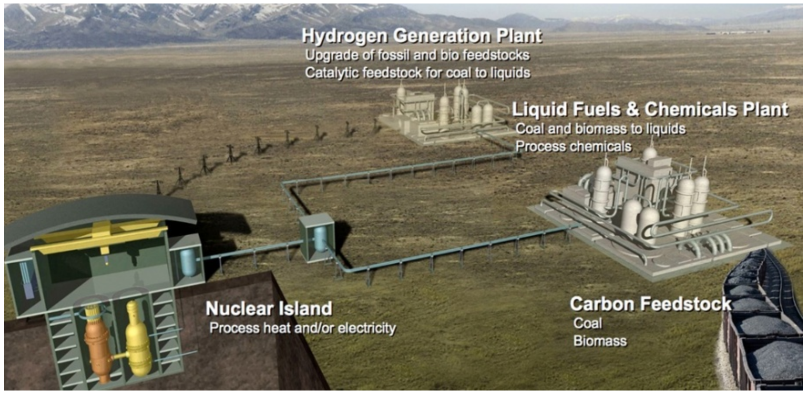
Fuel Cycle Information Exchange
June 30, 2010

Outline

- NE Context – mission, four objectives, Objective 3, fuel cycle options
- NE Budget and Organization
- FCR&D Program Overview
- Working with Other DOE Offices – RW, EM, NA, SC
- Status of Transition

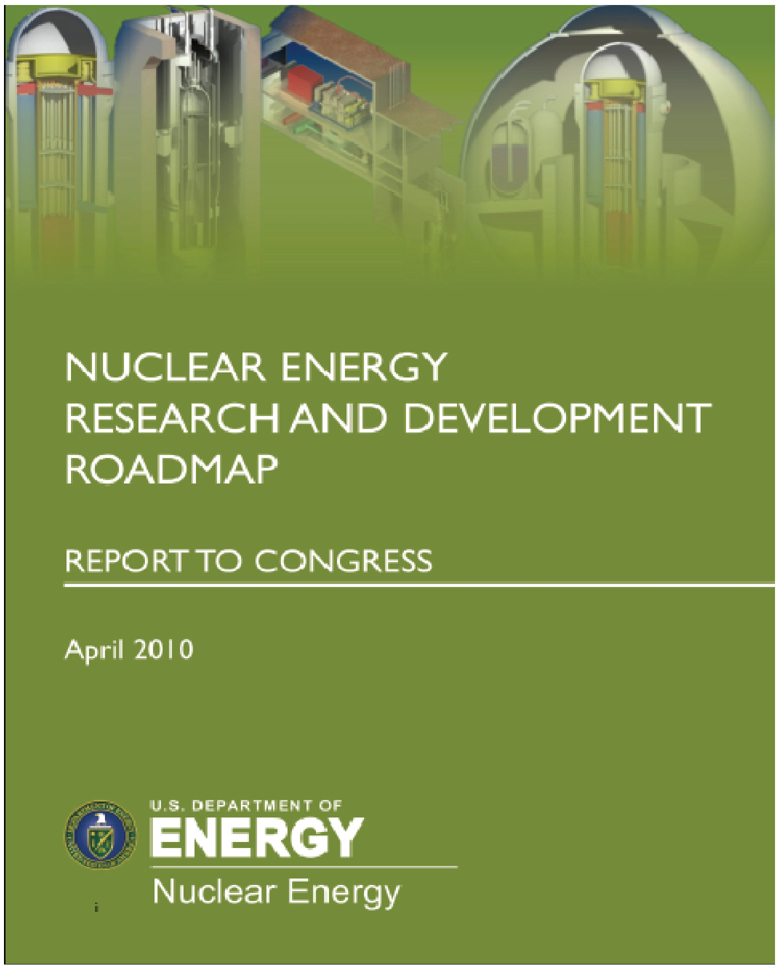
Office of Nuclear Energy Mission



- **The primary mission of NE is to advance nuclear power as a resource capable of making major contributions in meeting the Nation's energy supply, environmental, and energy security needs by resolving technical, cost, safety, security and regulatory issues through research, development, and demonstration (RD&D).**

- **Objective is to enable the development and deployment of fission power systems for**
  - Production of electricity (MWe)
  - Process heat (BTUs)

NE R&D Roadmap Issued in April 2010



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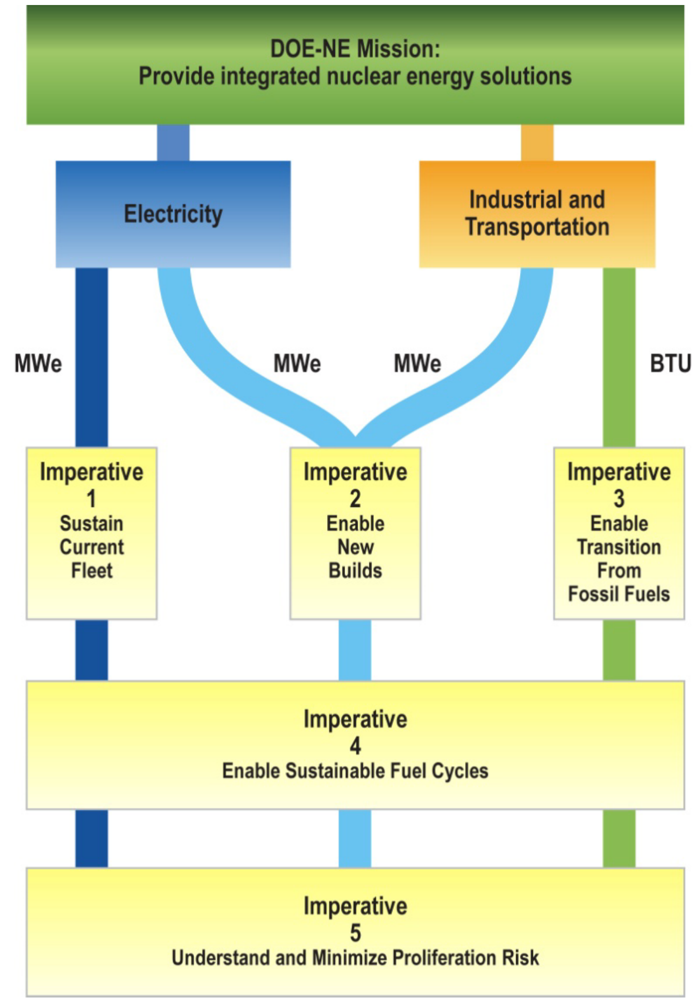
Nuclear Energy R&D Objectives

1. **Extend life, improve performance, and sustain health and safety of the current fleet**

2. **Enable new plant builds and improve the affordability of nuclear energy**

3. **Enable sustainable fuel cycles**

4. **Understand and minimize proliferation risk**



Objective 3. Enable Sustainable Fuel Cycles

- **Near term – Define and analyze fuel cycle technologies to develop options that increase the sustainability of nuclear energy**
- **Medium term – Select preferred fuel cycle option(s) for further development**
- **Long term (2050) – Fuel cycle technologies ready for commercial deployment**

(FCR&D program also supports fuel cycle R&D for Objectives 1 & 2 reactors and safeguards technologies for Objective 4.)

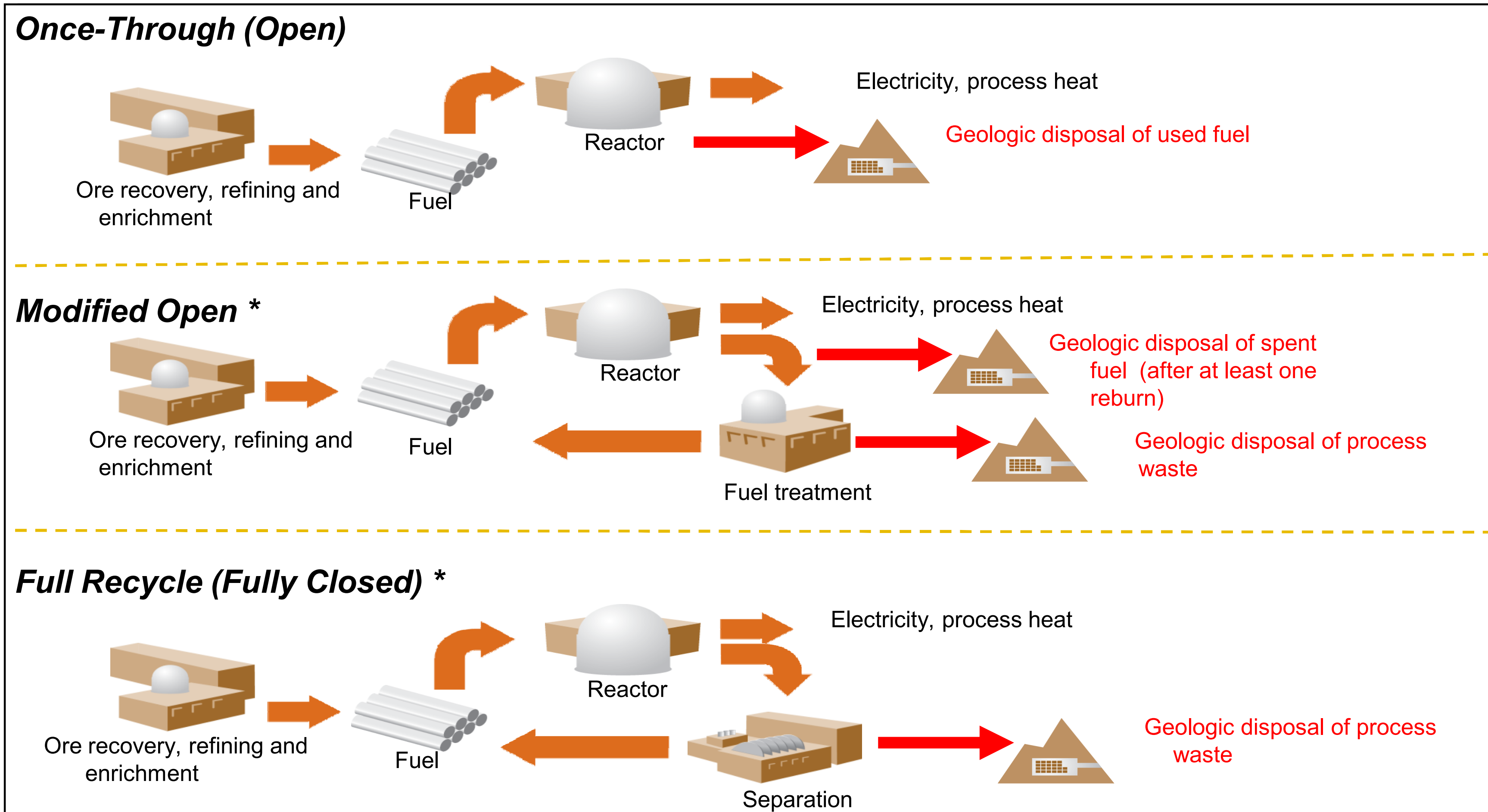
Potential Fuel Cycle Options

- **Once-Through – One pass through reactor, used fuel directly disposed in a geologic repository.**

- **Modified Open – No or limited separations and processing applied to used fuel to extract more energy.**

- **Full Recycle – All actinides important for waste management are recycled in thermal or fast spectrum systems to reduce radiotoxicity and more fully utilize uranium resources.**

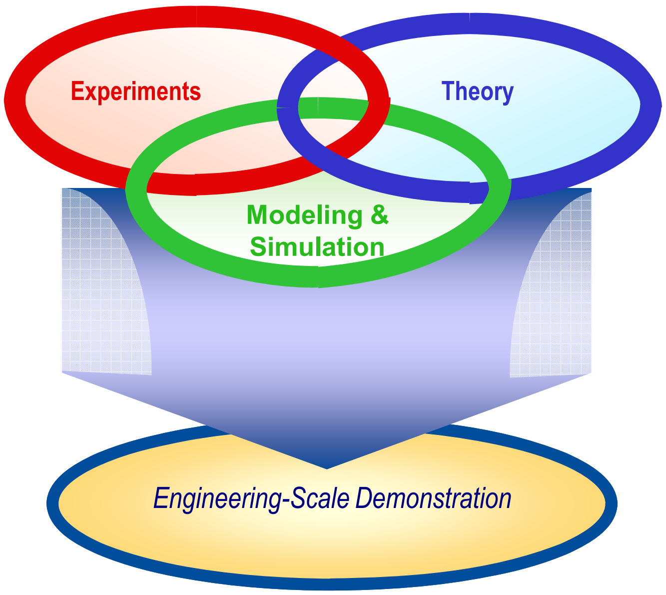
Three Potential Fuel Cycle Options



*A specific fuel cycle strategy may include more than one fuel design, reactor design, or fuel treatment process.

Science Based Approach to Nuclear Energy Development

- ***Experiments*** **– Physical tests done to develop understanding of single effects or integrated system behaviors.**
- ***Theory*** **– Creation of models (i.e., theories) of physical behaviors based on understanding of fundamental scientific principals and/or experimental observations.**
- ***Modeling and Simulation*** **– Use of computational models to develop scientific understanding of the physical behaviors of systems. Also used to apply scientific understanding to predict the behavior of complex physical systems.**
- ***Demonstrations*** **– New technologies, regulatory frameworks, and business models integrated into first-of-a-kind system demonstrations that provide top-level validation of integrated system technical and financial performance.**



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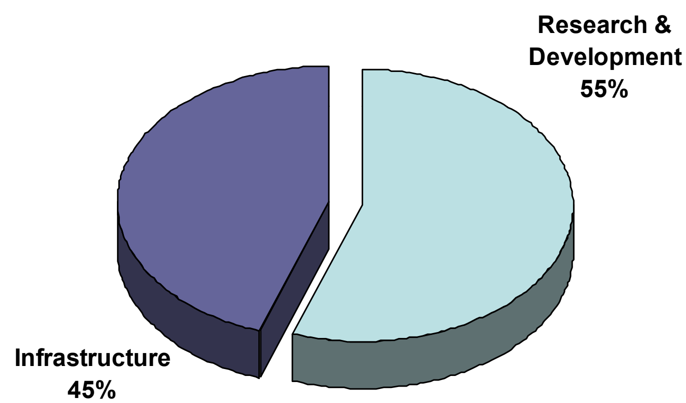
Nuclear Energy

FY 2011 Budget Request Office of Nuclear Energy

Program:	FY 2010 Approp	FY 2011 Request
Research & Development		
Nuclear Energy Enabling Technologies	0	99,300[a]
Integrated University Program	5,000	0
Re-Energyse	0	5,000
Reactor Concepts RD&D	0	195,000[a]
Generation IV Nuclear Energy Systems	220,137	0
Nuclear Power 2010	105,000	0
Fuel Cycle Research and Development	136,000	201,000[a]
International Nuclear Energy Cooperation	0	3,000
Infrastructure		
Radiological Facilities Management	72, 000	66,818
Idaho Facilities Management	173,000	162,482
Idaho Sitewide S&S	83,358	88,200
Program Direction	73,000	91,452
Congressionally Directed Projects	2,500	0
Total NE:	**869,995**	**912,252**

FY 2011 Request

Total: $912,252



a) up to 20% of R&D funds are competitively awarded to universities

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

Organization of the Office of Nuclear Energy

NE-1/2 — Assistant Secretary for Nuclear Energy
Warren "Pete" Miller, Jr., Assistant Secretary
Peter Lyons, Principal Deputy Assistant Secretary
Shane Johnson, Chief Operating Officer

Nuclear Energy Advisory Committee

NE-21
Office of Policy, Integration & Communication
Tim Frazier, Acting

Program Integration Council
NE Senior Managers

NE-3
Deputy Assistant Secretary for Nuclear Facility Operations
Dennis Miotla
- Idaho Operations Office
- NE-31 Office of Integrated Safety & Program Assurance
- NE-32 Office of Facilities Management

NE-4
Deputy Assistant Secretary for Business and Technical Support
Bob Lange, Acting
- NE-41 Office of Human Capital & Business Services
- NE-42 Office of Budget & Planning
- NE-43 Office of Space & Defense Power Systems
- NE-44 Office of Uranium Management and Policy

NE-5
Deputy Assistant Secretary for Fuel Cycle Technologies
Buzz Savage, Acting
- NE-51 Office of Systems Engineering & Integration
- NE-52 Office of Fuel Cycle Research & Development
- NE-53 Office of Used Nuclear Fuel Disposition Research & Development

NE-6
Deputy Assistant Secretary for International Nuclear Energy Policy and Cooperation
Ed McGinnis
- NE-61 Office of International Nuclear Energy Policy
- NE-62 Office of International Nuclear Fuel Management

NE-7
Deputy Assistant Secretary for Nuclear Reactor Technologies
Shane Johnson, Acting
- NE-71 Office of Advanced Modeling & Simulation
- NE-72 Office of Light Water Reactor Technologies
- NE-73 Office of Gas Cooled Reactor Technologies
- NE-74 Office of Advanced Reactor Concepts

FY 2011 FCR&D Budget Request

Budget Summary
$ in thousands

Program Element	**FY 2010 Approp**	**FY 2011 Request**
Separations and Waste Forms	41,615	31,324
Advanced Fuels	29,651	40,000
Transmutation R&D	4,288	0
Modeling & Simulation	26,009	15,570
Systems Analysis & Integration	14,783	15,664
Materials Protection, Accountancy & Controls for Transmutation	6,826	7,814
Used Nuclear Fuel Disposition	9,124	45,000
Modified Open Cycle	0	40,000
SBIR/STTR	3,704	5,628
Total:	**136,000**	**201,000**

Mission

- Research and develop nuclear fuel and waste management technologies that will enable a safe, secure, and economic fuel cycle.

FY 2011 Planned Accomplishments

- Examine 3 fuel cycle strategies: once-through, modified open, and full recycle.
- Continue to develop advanced concepts for electrochemical processing and alternative waste forms.
- Begin to develop innovative fuel systems that support advanced fuel cycles.
- Provide technical expertise to inform decision-making for storage, transportation, and disposal of used nuclear fuel and radioactive waste.

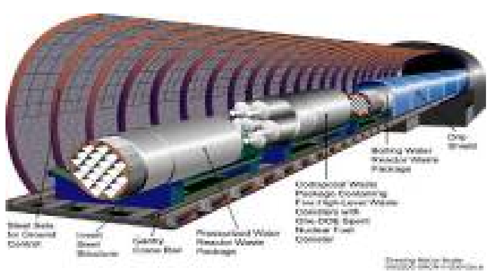
Used Nuclear Fuel Disposition

Today's Technology Challenges

- Storing and disposing UNF, HLW, GTCC, and LLW from a range of fuel cycles
- Understanding and predicting geologic repository performance
- Safe, secure, and cost effective storage, transportation and disposal

Grand Challenge

Integrated waste management with near zero radionuclide release from storage and disposal system



Development Path (with RW, EM)

- Develop an understanding of geologic repository performance
- Review extensive technical basis developed in the U.S. and internationally over the past several decades including recent work by SNL and LANL on a generic salt repository
- Explore a range of potential geologic settings, including granite, salt, clay, and tuff, and range of disposal concepts, including shaft-room, ramp-drift, and deep boreholes
- Investigate storage concepts for UNF and a range of waste streams
- Develop an integrated waste management strategy applicable to a range of fuel cycle options

Transformational Result

Predictive capability for performance of storage and disposal options for a range of fuel cycles

Fostering Innovation: University Research

- **University research provides FCR&D with innovative ideas from a different perspective than the national labs**
- **NE dedicates up to 20 percent of its R&D budget to university programs**
- **Combination of collaborating and funding through the FCR&D program ($7M in FY 2010) and funding through NE University Programs (NEUP)**
- **More than 50 universities are involved and more than 300 students have benefitted from the FCR&D program**
- **Many students continue to contribute to the program after graduation**
- **NEUP FY 2009**
  - 22 three-year awards, $14.9 million
  - Emphasis on modeling and simulation
- **NEUP FY 2010**
  - Emphasis on separations.
  - Awards in May 2010.

Collaborating with Other DOE Offices

- **RW – Used and spent nuclear fuel disposition**
- **EM – Proposed research initiative on waste management technology development (e.g., salt disposal); waste forms**
- **NNSA – Domestic safeguards technology research and development; proliferation risk assessment tool development; international collaborations**
- **SC – Modeling and simulation, materials, nuclear physics, separations**

EM Proposed Research Initiative

Focuses on development of technologies vital to the success of both tank waste treatment and closing the nuclear fuel cycle in the U.S.

- **Waste form development**
- **Waste form behavior in disposal environments**
- **Waste processing**
- **General waste chemistry**
- **Waste disposition options (e.g., salt)**
- **Public perception**

U.S. Direction on Future Fuel Cycles

- U.S. has decided that used nuclear fuel storage in dry casks is safe for many decades. Therefore the U.S. has no immediate need to implement used fuel reprocessing or geologic disposal.
- The Blue Ribbon Commission has been established to provide advice and recommendations on a broad range of technical and policy options concerning the future nuclear fuel cycle and disposal of high level waste.
- DOE has established a goal-oriented, science based research and development program to provide fuel cycle and used fuel management options to future decision makers.
- If the U.S. chooses to recycle, deployed technologies must be cost effective, safe, environmentally sound and have low proliferation and security risk.

RW Transition to NE

- RW planning to close out all contracts and transfer all federal staff to new offices by Sep. 30, 2010
- FY 2011 budget request says NE will assume NWPA responsibilities
- Used Fuel Disposition R&D Office created in part to support RW transition into NE
- Current status of transition – moving forward
- Congress, courts, Blue Ribbon Commission will all likely influence future direction of program