



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

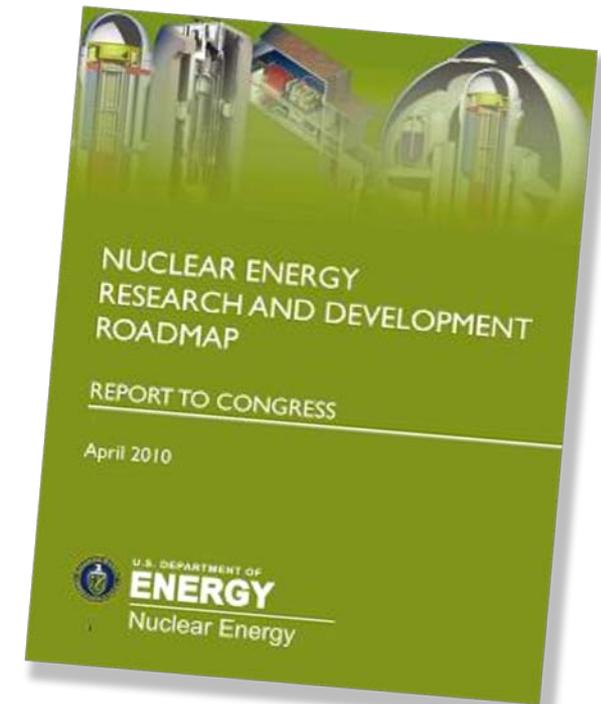
Update on the Fuel-Cycle Technology Activities of the U.S. Department of Energy's Office of Nuclear Energy (DOE-NE)

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**Nuclear Waste Technical Review Board Winter Meeting
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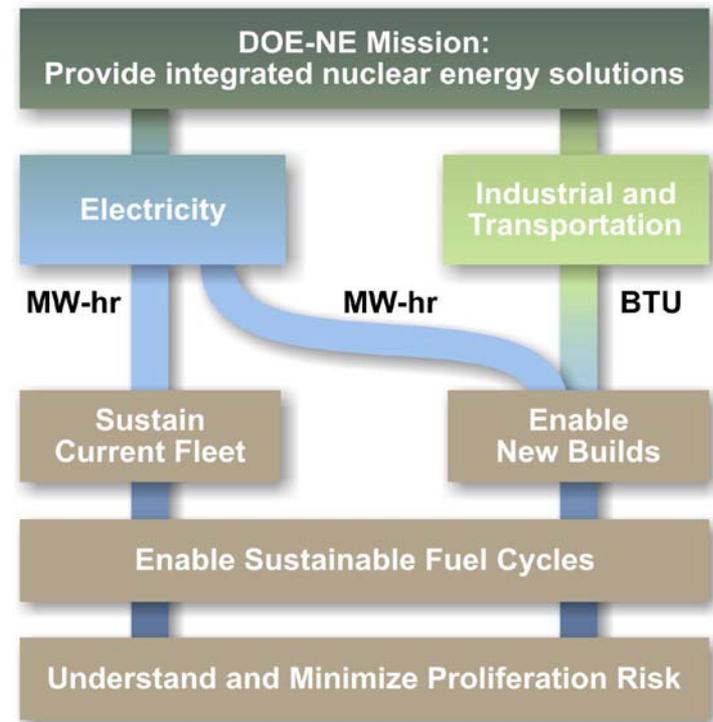
- Objectives of DOE's Office of Nuclear Energy (DOE-NE) support national imperatives for clean energy, economic prosperity, and national security.
- Roadmap outlines an integrated approach to meet these objectives.
- Roadmap addresses transformation of programs to a more science-based approach.
- Roadmap can be found at www.ne.doe.gov





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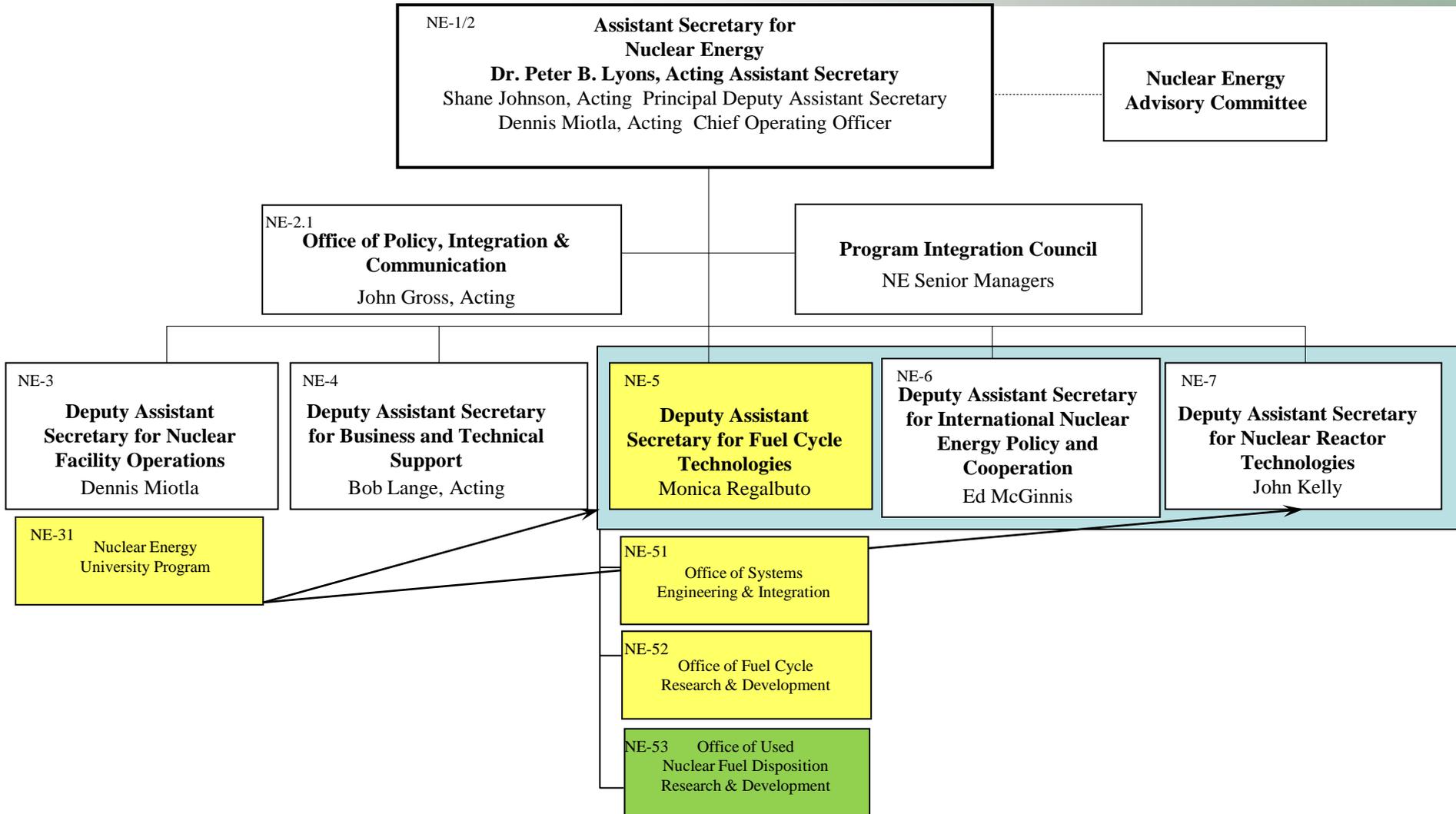
- **Develop technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors**
- **Develop improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration's energy security and climate change goals**
- **Develop sustainable nuclear fuel cycles**
- **Understand and minimize the risks of nuclear proliferation and terrorism**





DOE-NE Organization

Nuclear Energy





Fuel Cycle Technologies Mission and Program Objectives

- ***Support decision-makers by developing a suite of options to manage used fuel***
- ***Demonstrate technologies that support commercial deployment of sustainable fuel cycles by 2050***
- ***Sustainable fuel cycles are those that:***
 - *improve uranium resource utilization*
 - *maximize energy generation*
 - *minimize waste generation*
 - *improve safety*
 - *protect the environment*
 - *limit proliferation risk*
 - *are economically viable*

Three Potential Fuel Cycle Options

Nuclear Energy

■ **Once-Through**

- No recycling or conditioning of used fuel

■ **Modified Open Cycle**

- Very limited used fuel conditioning or processing

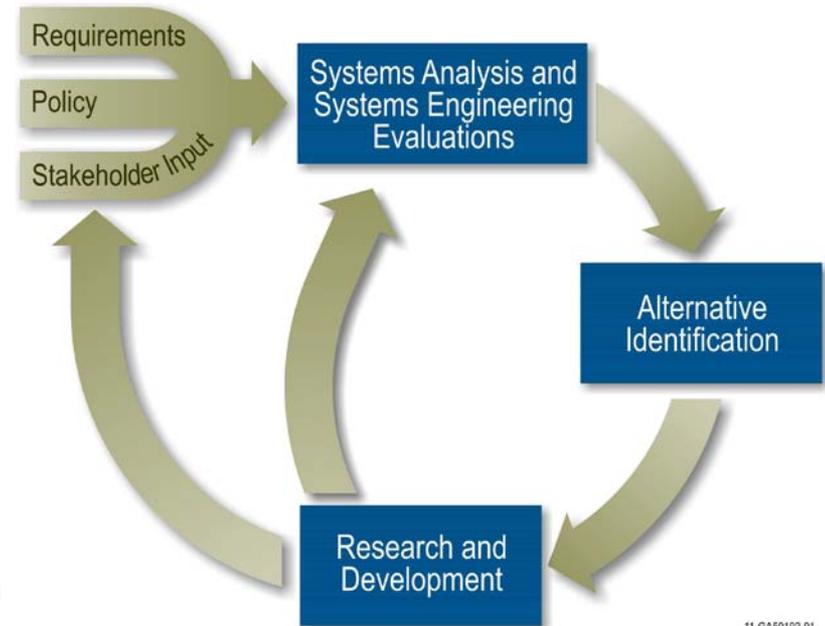
■ **Full Recycling**

- Multiple reprocessing steps and transmutation of actinides



Office of Systems Engineering and Integration

- **Objective is to inform fuel cycle research and development, programmatic decisions, strategy formulation, and policy development.**
- **Office performs integrating analyses of nuclear energy systems.**
 - Evaluates technology alternatives
 - Evaluates gaps, disconnects, and off-ramps
 - Examines deployment options
 - Understands system dynamics
 - Identifies critical program elements to inform where R&D should be targeted



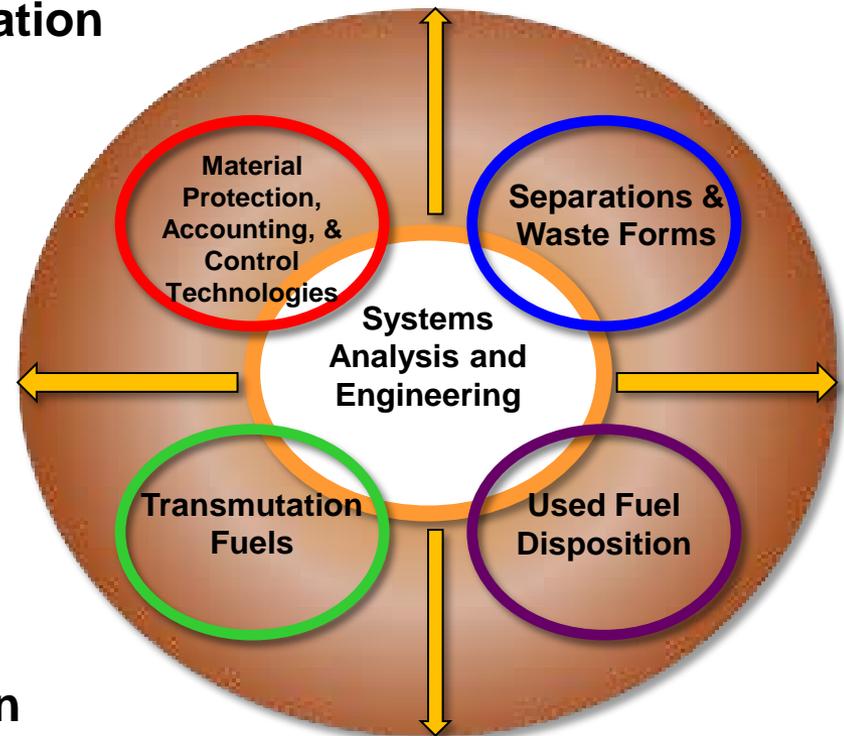
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Systems engineering and analysis provide a systematic and objective process to identify and prioritize research and development activities and to manage the results to inform programmatic decisions.



Office of Fuel Cycle Research and Development

- Objective is to enable the safe, secure, economical, and sustainable expansion of nuclear energy while reducing proliferation risks.
- Office conducts science-based, goal-oriented research and development in support of developing options to the current U.S. commercial fuel cycle management strategy.
 - Separations and Waste Forms
 - Transmutation Fuels
 - Materials Protection, Accounting, and Control Technologies
- Office of Used Nuclear Fuel Disposition Research and Development (covered in the next presentation)





Today's Technology Challenges

- Minimizing waste generation from the fuel cycle
- Recovering fuel resources, from natural materials or used fuel, in an economic manner



Development Path

- Develop fundamental understanding of separation processes and waste form thermodynamics
 - Exploit thermodynamic properties to effect separations
 - Elucidate microstructural waste form corrosion mechanisms
- Perform economic analysis of uranium recovery technologies

Outcomes

- Advanced separations technologies
- Robust waste forms
- Predictive models for separations technology and waste form performance



Today's Technology Challenges

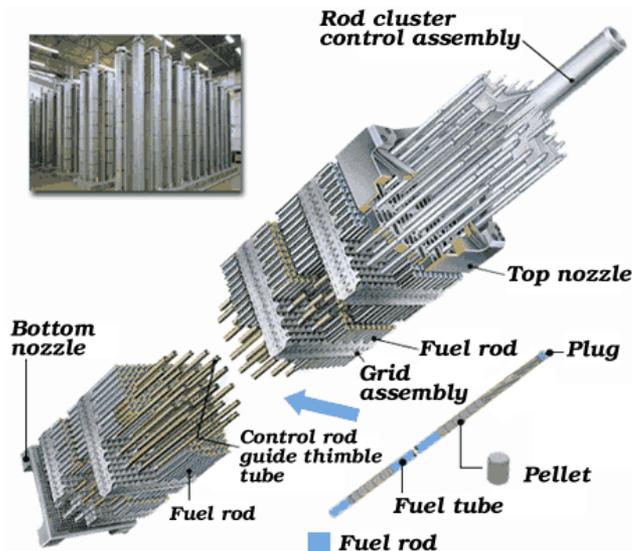
- Producing fuels that enable improved fuel cycle options (waste management and resource utilization)
- Enabling fuels with variable compositions
- Minimizing defects and process losses from fuel fabrication

Development Path

- Develop a fundamental microstructural understanding of fuels and materials
 - Separate effect testing and properties measurement at sub-grain scale
 - Effect of nano-scale implantations
 - Closure of combined transport and phase-field equations
- Develop clean and reliable fabrication techniques with tightly controlled microstructures tailored to desired performance

Outcomes

- Advanced fuel forms
- Predictive models for fuel performance

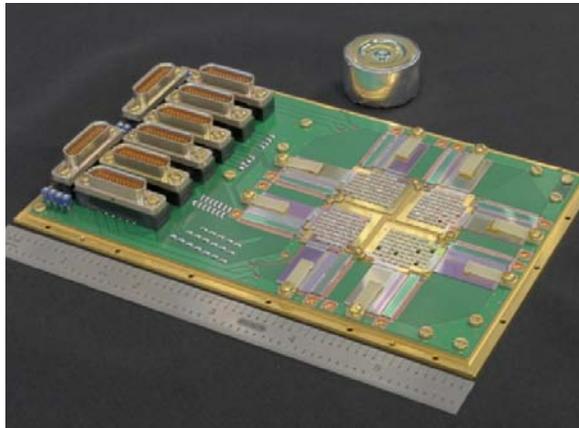




Materials Protection, Accounting, and Control Technologies (MPACT)

Today's Technology Challenges

- Developing nuclear material management systems for advanced nuclear systems
- Improving nuclear material management systems at large fuel cycle facilities
- Moving from reactive to preventive systems approach



Development Path

- Develop next generation instrumentation enabled by new physics data
 - High sensitivity and specificity
 - New sensor materials
- Integrate disparate data in quantitative manner
 - Real time assessments
 - Probability basis with uncertainties

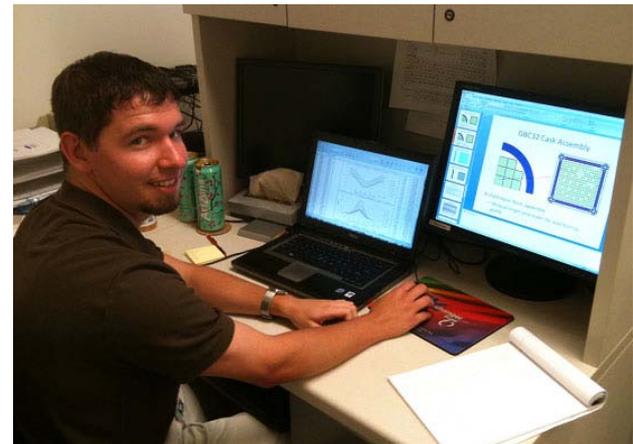
Outcomes

- Real time nuclear materials management with continuous inventory
- Predictive models for nuclear material management



Nuclear Energy University Program (NEUP)

- Objective is to bolster U.S. university research and development infrastructure and to provide the next generation of nuclear professionals.
- Universities are engaged to provide resources that support nuclear energy research and development.
 - Program directed research
 - Program supporting research
 - DOE-NE mission supporting research
 - University infrastructure development
 - Student fellowships and scholarship grants
- NEUP supports all DOE-NE research programs.





- **DOE's Fuel Cycle Research and Development Program is an integrated, goal-oriented, science-based program to provide fuel cycle and used fuel management options to future decision makers.**
- **Program is focused on development and assessment of technical options.**
- **Research is focused on improvements to once through, modified open cycle, and full recycle.**