Nuclear Energy University Programs
U.S. Department of Energy

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FY2011 NEUP Workshop Used Fuel Disposition

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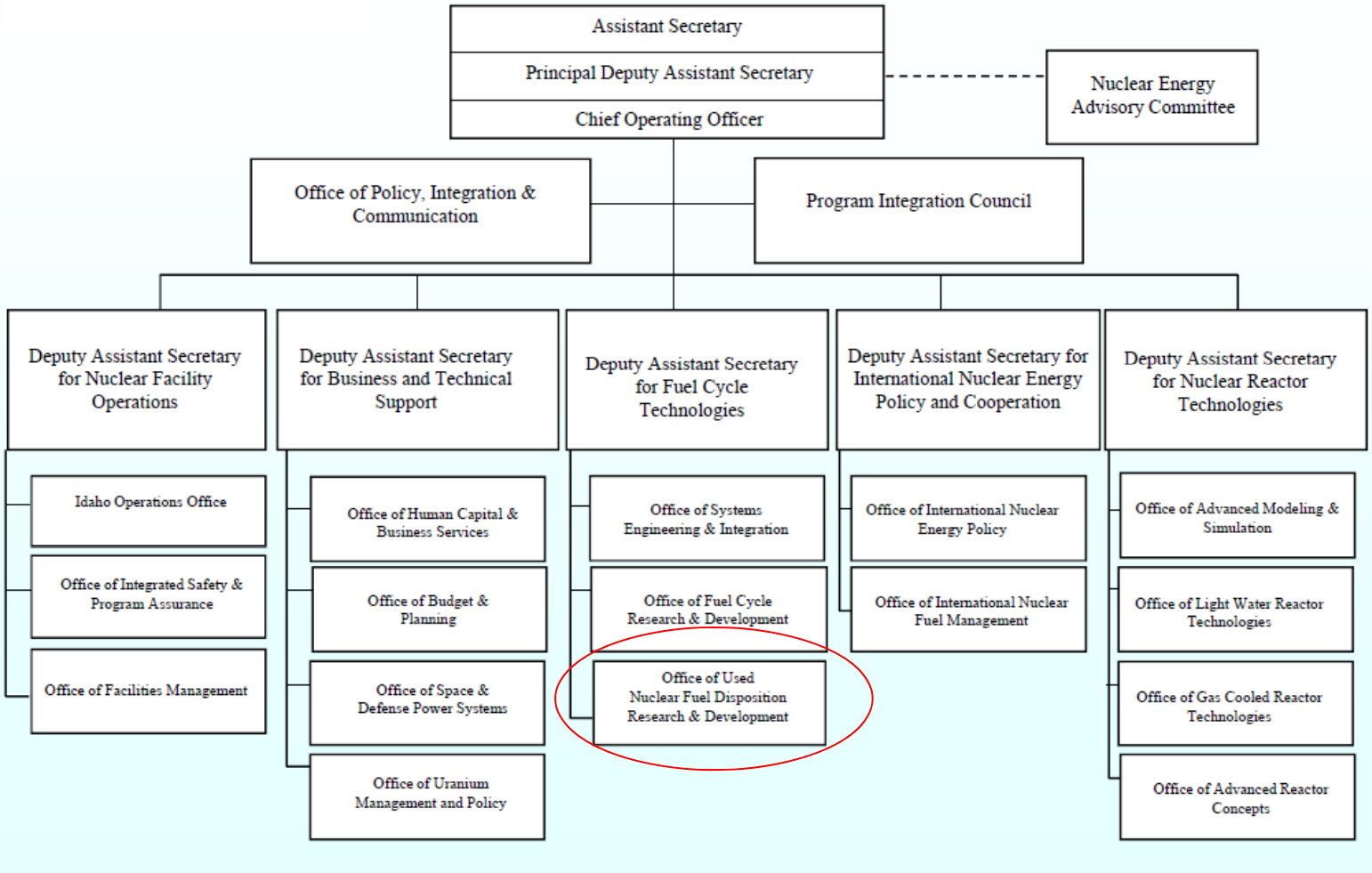
Breakout Session 2

Rockville, Maryland

DOE-NE Office of Used Fuel Disposition



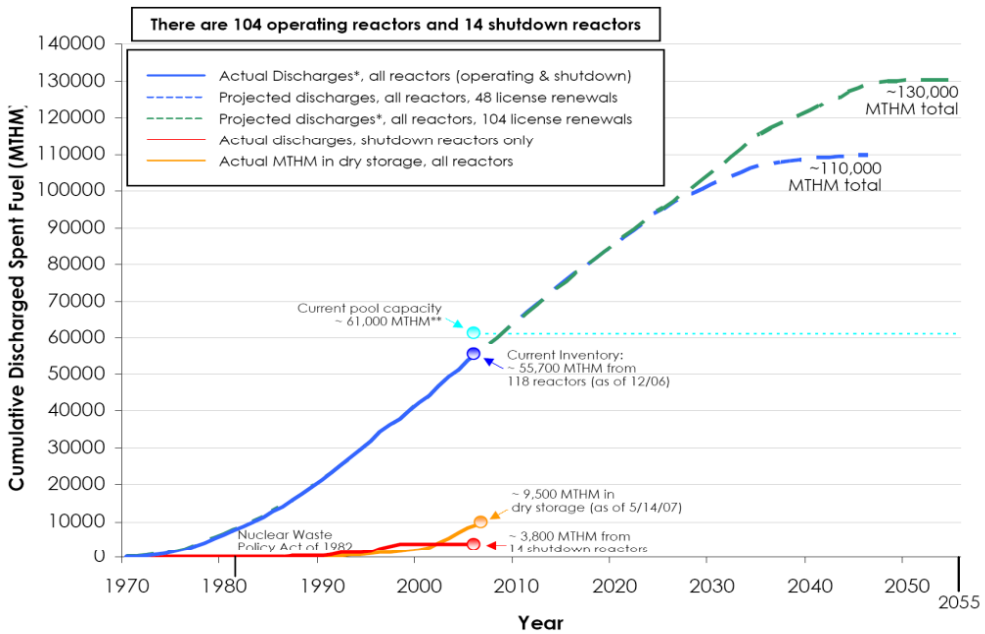
DOE NE
Used Fuel Disposition Campaign

- The MISSION of the Used Fuel Disposition Campaign is *to identify alternatives and conduct scientific research and technology development to enable storage, transportation and disposal of used nuclear fuel and wastes generated by existing and future nuclear fuel cycles.*

- The GRAND CHALLENGE for the Used Fuel Disposition Campaign is *to provide a sound technical basis for absolute confidence in the safety and security of long-term storage, transportation and permanent disposal of used nuclear fuel and wastes from the nuclear energy enterprise.*

- R&D will occur in three areas
  - Storage
  - Transportation
  - disposal

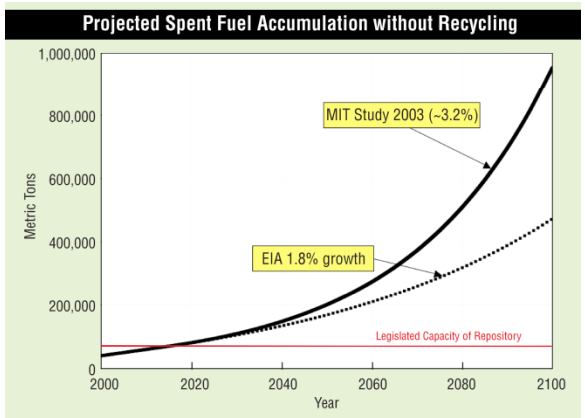
Used Fuel Disposition: background



The US inventory of commercial used fuel will increase in all scenarios

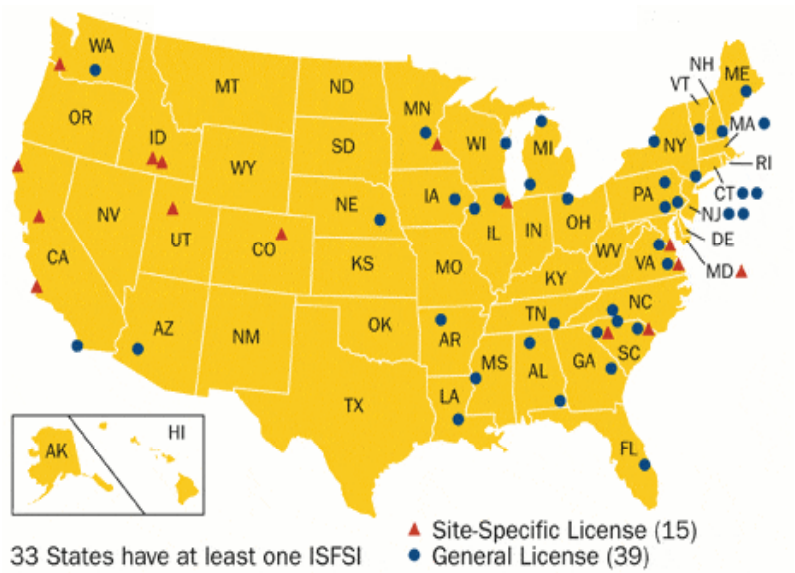
Existing power plants (above)

With new power plants (right)



Storage of Used Nuclear Fuel

- Currently 54 dry cask storage NRC-licensed Independent Spent Fuel Storage Installations (ISFSIs) in 33 states
- Orphaned fuel: There are 14 shutdown reactors at 13 sites in 9 states with used fuel in wet or dry storage



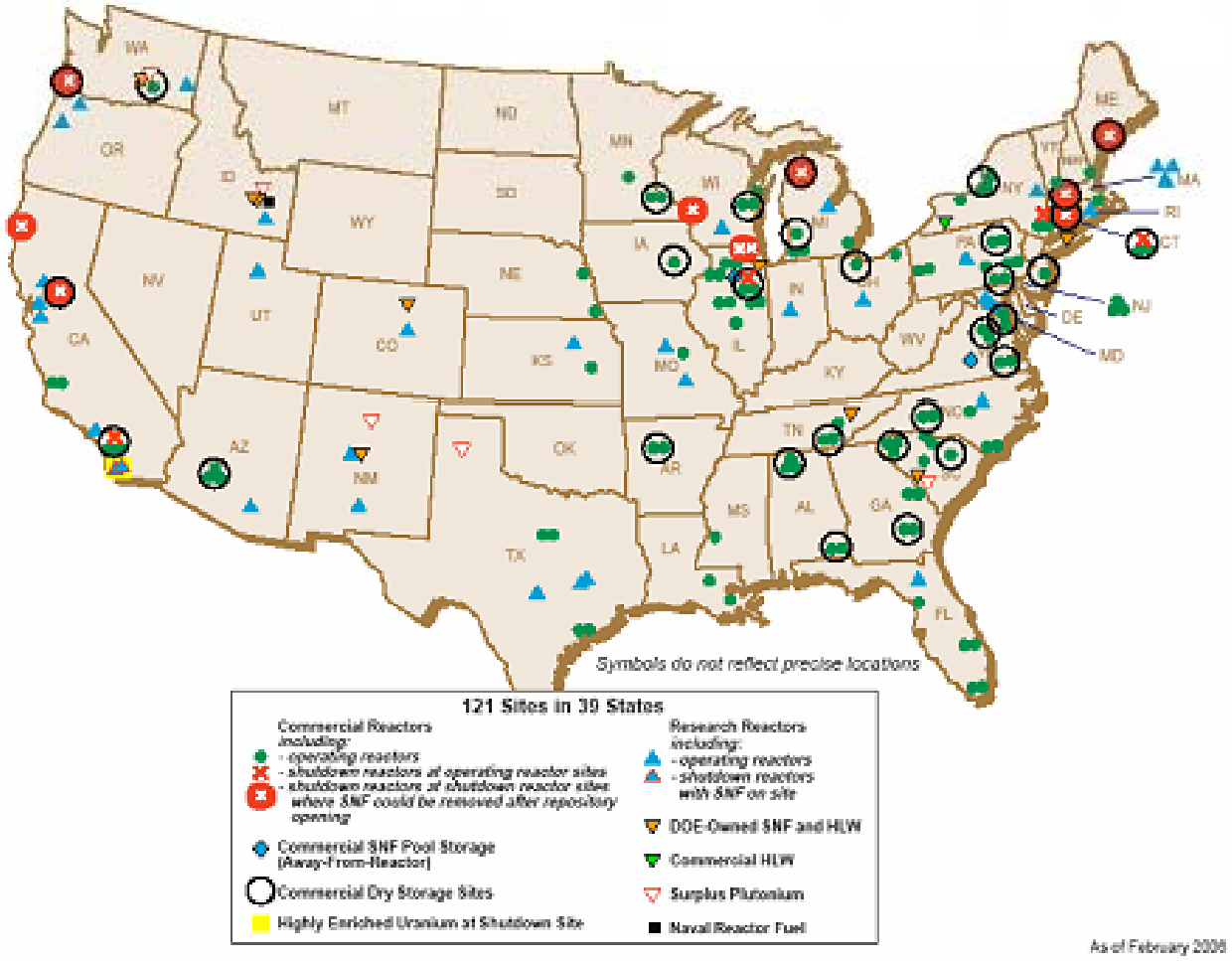
Storage

- Interim storage of UNF is demonstrated to be safe and licensable
  - Existing facilities can be licensed to store low-burnup light water reactor (LWR) fuel (<45 GWD/MTU) up to 60 years
  - Additional regulatory and technical basis needed for interim storage of low-burnup fuels past 60 years and for interim storage of high-burnup fuels

Transportation

Current Locations of Used Nuclear Fuel and High-Level Radioactive Waste in the United States

<u>121 sites in 39 states</u>



Transportation

- Extensive operational experience exists for LWR fuels and DOE HLW
- Less experience with transportation of high-burnup fuels and advanced fuel forms
- Secure transportation options are currently limited for Category I and II materials

Waste Disposal

- Yucca Mountain is not an option, but we're not starting from scratch
  - There is an international consensus that deep geologic disposal is a robust and necessary solution for permanent isolation of high-level radioactive waste
  - Internationally, mature safety assessments indicate that multiple geologic options may be suitable
    - E.g., Clay (France, Belgium, Switzerland), Granite (Sweden, Finland), Salt (US)

- DOE is limited by law to considering generic disposal concepts
  - No site specific investigations

- Goals of disposal R&D at this stage:
  - Provide confidence that the US has viable disposal options that will be available when national policy is ready
  - Identify and research the generic sources of uncertainty that will challenge the viability of disposal concepts and complicate licensing
  - Increase confidence in the robustness of generic disposal concepts to reduce the impact of unavoidable site-specific complexity

Potential Disposal Options

- Eight Preliminary Disposal Concepts
  - Surface Storage
  - Near Surface Disposal
  - Mined Geologic Disposal (Hard Rock, Unsaturated)
  - Mined Geologic Disposal (Hard Rock, Saturated)
  - Mined Geologic Disposal (Clay/Shale, Saturated)
  - Mined Geologic Disposal (Salt, Saturated)
  - Deep Borehole Disposal
  - Other (sub-seabed, carbonate, …)

- Six Preliminary Waste Form / Inventory Categories
  - Used Fuel
  - Glass
  - Ceramic / Glass Ceramic
  - Metal Alloy
  - Lower than HLW
  - Other (molten salt, future WFs, ….)

Used Fuel Disposition
Proposed R&D Areas

Storage

- Degradation and aging phenomena
  - Aging of fuel, cladding, and primary container
  - Aging of storage site infrastructure
  - Long-term monitoring and non-destructive examination techniques
- Radiological consequences
  - Advanced modeling for aircraft crash analysis
  - Advanced modeling for sabotage event analysis
  - Integration of security requirements with storage design and operations
  - Advanced modeling for dispersion of radioactive materials

Used Fuel Disposition
Proposed R&D Areas

Transportation

- Risk-informed cask qualification
  - Modeling
  - Data
- Radiological consequences
  - Advanced modeling for dispersion of radioactive materials following accident or intentional destructive acts
  - Data for behavior of high-burnup and advanced fuels

Used Fuel Disposition
Proposed R&D Areas

Disposal

- Waste form performance
  - E.g., volume, activity, thermal output, durability in a range of environmental conditions
- Container materials for alternative disposal concepts
  - Evaluation of material performance in a range of environmental conditions
- Advanced modeling and simulation tools to evaluate performance of generic disposal concepts
  - E.g., coupled thermal-hydrologic-chemical-mechanical models for disposal environments
- Field and laboratory experiments to validate models for generic disposal concepts
- Operational design validation for alternative disposal concepts
  - E.g., deep borehole disposal concepts