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Fuel Cycle Research and Development

# Nuclear Energy System Evaluation and Screening

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**Nuclear Waste Technical Review Board Meeting**

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# Fuel Cycle Research & Development Program – FCR&D

- **A major objective for the FCR&D program is to develop "sustainable nuclear fuel cycles" ***
  - A "sustainable fuel cycle" is one that improves uranium resource utilization, maximizes energy generation, minimizes waste generation, improves safety, and limits proliferation risk
- **The Nuclear Energy System (NES) Evaluation and Screening process is designed to identify the "most promising" options for sustainable nuclear fuel cycles**
  - The NES is the entire system needed for using nuclear energy and includes all aspects of the nuclear fuel cycle, from mining through disposal
  - Based on performance of the entire integrated system using evaluation criteria and metrics
  - Once identified, the "most promising" systems will be used to guide and focus R&D directions and priorities

* **Nuclear Energy Research & Development Roadmap – Report to Congress, DOE Office of Nuclear Energy, April 2010**

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# NES Evaluation & Screening Process

- **Criteria are given in the definition for a sustainable fuel cycle**
  - Additional criteria may include economics, R&D needs, etc.
- **Performance metrics for these criteria are being developed by the FCR&D program**
  - Informed by stakeholders external to DOE-NE
  - Allows comparison between different nuclear energy systems
- **The development of the NES evaluation & screening process is underway**
  - Study considers all types of nuclear fuel cycles
  - Detailed analyses are required to support evaluations
  - Process and results will be documented, independently reviewed, and publicly available
- **Report is planned to be issued on March 31, 2014**

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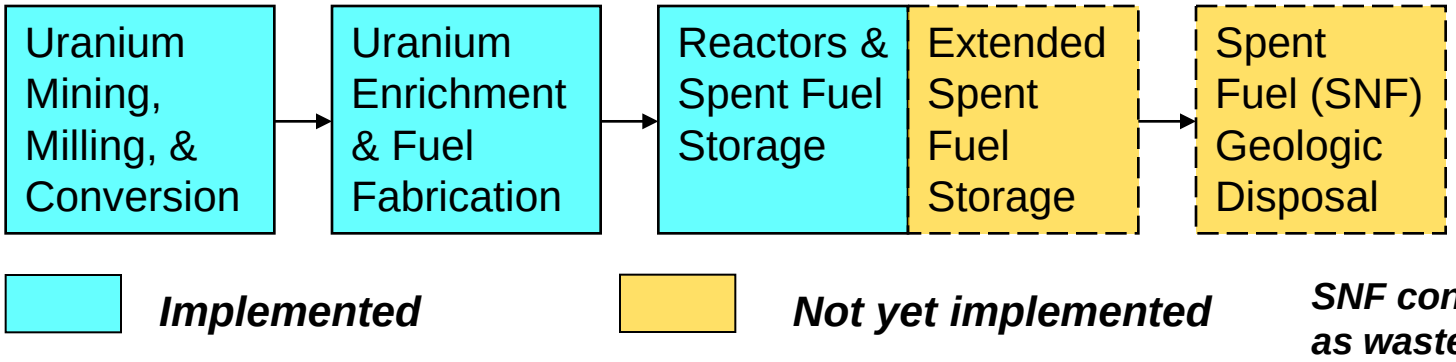
# Once-Through Nuclear Systems – Includes Current U.S. Implementation




- **Continuing storage of a growing spent fuel inventory**
  - Modern "high burnup" fuel and potential advanced fuels (e.g., accident tolerant LWR fuel, other fuel types)
  - How does extended storage affect the rest of the nuclear system?
- **Possible deployment of reactor alternatives**
  - Small Modular Reactors, Very High Temperature Reactors, etc.?
- **Geologic disposal still needs to be implemented**
  - What is the impact of alternate disposal system environments?
- **Are there "more promising" once-through options?**

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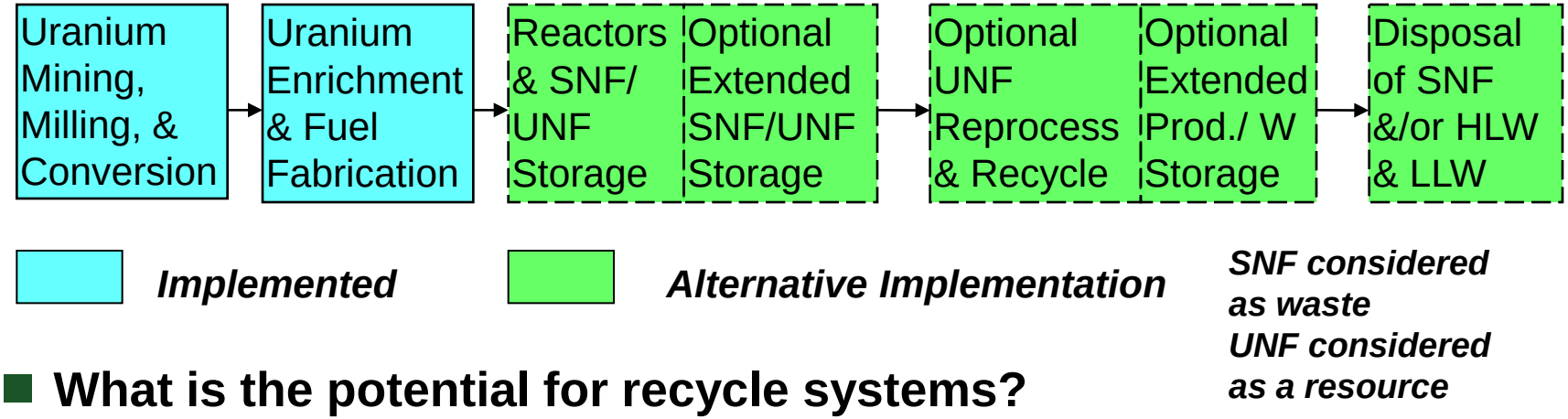
# Recycle Nuclear Systems




- **What is the potential for recycle systems?**
  - Does SNF have "value" that can be recovered by reprocessing (used nuclear fuel, UNF)? Operational and storage issues?
  - Does HLW offer disposal advantages over SNF?
  - Are other fuels useful (e.g., thorium along with uranium,…)?
- **Numerous options, including limited or continuous recycle, different reactors and fuels, use of extended storage, disposal, …**
- **What are the "most promising" alternatives?**

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# Elements of the NES Evaluation and Screening Process

- **Process must be credibly comprehensive**
  - All potential sustainable nuclear energy systems must be represented
    - *Once-through and recycle*
    - *Uranium- and thorium-based fuel cycles*
  - Evaluation criteria should cover stakeholder interests
    - *Waste management*
    - *Resource utilization*
    - *Proliferation and physical security*
    - *Economics*
    - *Safety*
- **Process must be able to identify "most promising" systems**
  - Those best able to meet the requirements for sustainable nuclear fuel cycles

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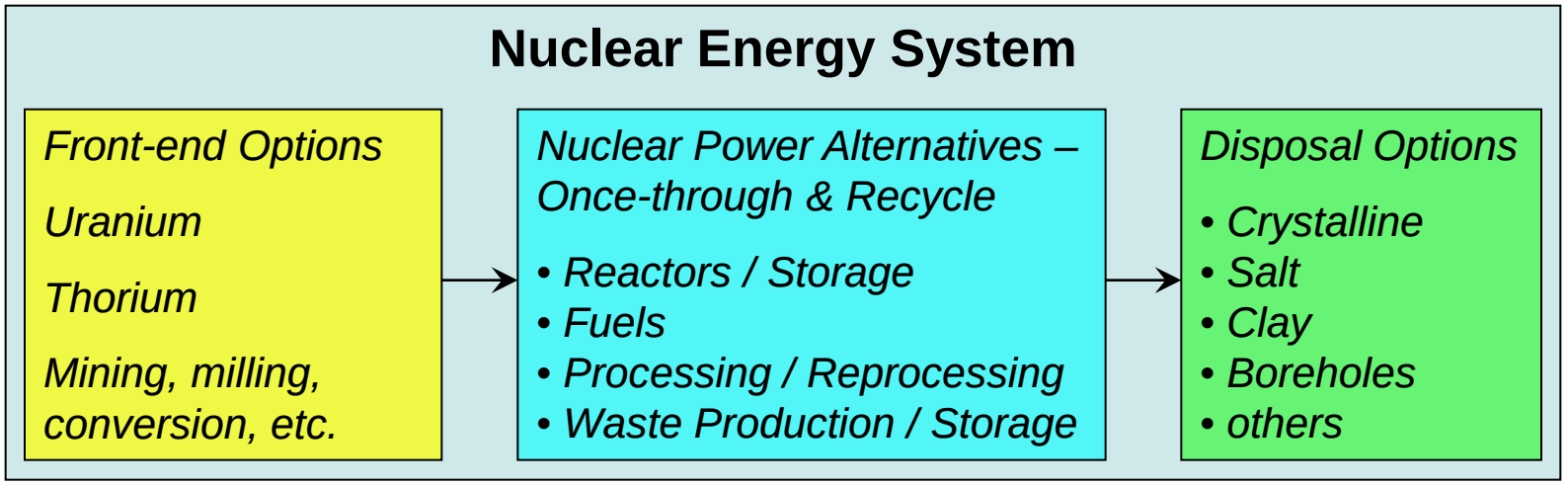
# NES Evaluation Process




- **Evaluation process will examine each nuclear power alternative with front-end and disposal options, as appropriate**
  - Identifies beneficial or detrimental interactions
  - Waste disposal includes LLW and hazardous wastes
- **Objective quantifiable metrics are used wherever possible**
  - Reduce uncertainty in the results
  - Results can be clearly documented and communicated
  - Facilitates the independent review of the process and results

# NES Screening Process

- **The nuclear energy systems will be "screened" based on performance for the evaluation criteria**
  - Do alternative nuclear energy systems offer promise in addressing the issues represented by the evaluation criteria?
  - How much improvement can be obtained?
  - What is the value of the performance improvement?
- **Policy guidance determines relative importance of criteria**
  - History shows that the relative importance of criteria evolves with time and events
  - Results show the effects of possible policy choices, and can be informative even when guidance is changing
- **The "most promising" systems are identified with this approach, and used to guide and focus R&D directions and priorities**
  - Much smaller number of potential nuclear energy systems
  - Defines functions and performance goals for the supporting technologies, integrating program activities

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# NES Evaluation and Screening Schedule

- **Goals for FY12 include developing the nuclear system evaluation process, including data, metrics, and approach to support the planned 2013 screening**
- **In FY13, the process and supporting information will be completed and NES evaluations and screenings will be performed**
  - Identify the “most promising” nuclear systems to inform DOE and the FCR&D campaigns on technology functions and requirements
  - Inform on the effects of extended storage both as may be used in a once-through fuel cycle or as part of a recycle approach
  - Inform on the effects of geologic disposal environments
- **Subsequently, the identified subset of “most promising” nuclear energy systems will be used to focus R&D efforts**
  - Evaluations will continue at a more detailed level to assist in technology evaluation and assessing effects of achieved technology performance
  - Other issues, including transition to a new nuclear energy system