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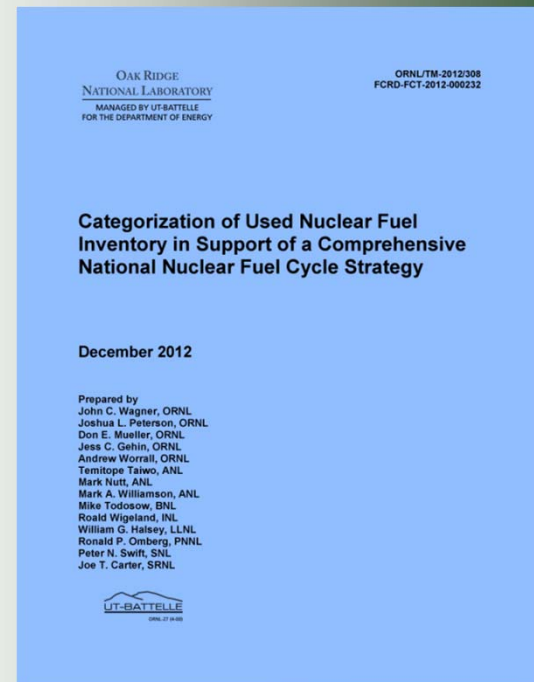
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Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy

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Supports Development of a Comprehensive Nuclear Fuel Cycle Strategy

- *“Deep geologic disposal capacity is an essential component of a comprehensive nuclear waste management system”*
- *“... deployment of reprocess and recycle technologies would clearly affect the quantity and composition of nuclear material slated for final disposition and in this way have implications for managing the back end of the fuel cycle.”*

Source: BRC Report, Jan 2012





Used Fuel Inventory – Technical Assessment

- **DOE’s Office of FCT sponsored a technical assessment of the total inventory of domestic discharged used nuclear fuel to inform decisions relative to domestic disposition options and UNF management.**
 - Clarifies fuel retention and retrievability needs
 - Informs need for reprocessing facility (ies), e.g., technology improvements, capacity and design characteristics
 - Enables focused investment on most suitable/ valuable inventory
- **Consistent with DOE NE Roadmap**

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UNF Inventory Characteristics Will Influence Alternative Fuel Cycle Development

If we conclude that we have more UNF than we would ever need

Then we can be selective

If we are decades away from transitioning to an advanced fuel cycle

Then it seems prudent to focus on characteristics of future UNF discharges

Design of future recycling facilities will be influenced by feedstock (i.e., available and projected UNF)



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DOE-NE FCT Program Objectives Requiring Access to UNF

UNF management

- Develop a strengthened technical and scientific basis for extended UNF storage
- Develop the scientific basis for multiple disposal options for UNF and high-level waste
- Implemented acceptable and safe options, strategies and solutions for management of UNF and high-level waste

Alternative fuel cycles

- Select preferred sustainable fuel cycle options for further development
- Conduct science-based, engineering-driven research for selected options
- Test and make available advanced technologies that enable sustainable fuel cycles





Based On Retention Needs, Current UNF Can Be Divided Into 3 Categories

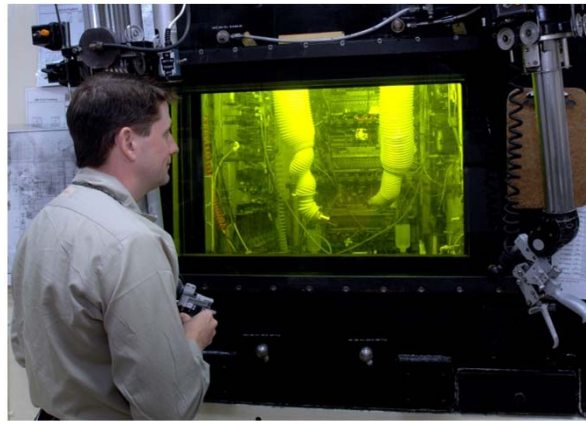
Disposal



- **Excess material not needed for other purposes**

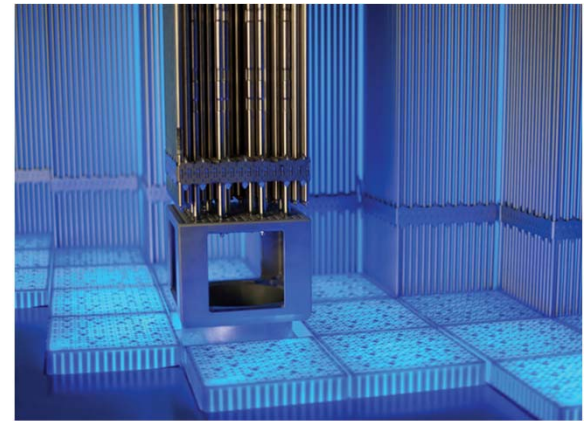
Research

(not an end-state)



- **Material needed for R&D to support**
 - UNF management
 - Alternative fuel cycle development

Recycle/Recovery



- **Material with inherent and/or strategic value**



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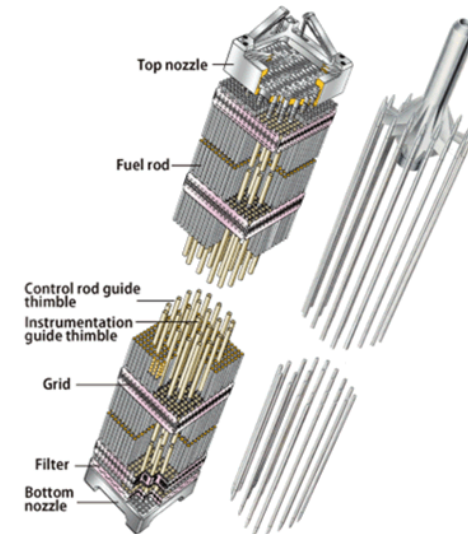
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Current Domestic UNF Inventory



Characteristics of Current UNF Inventory

- **Massive ~70,150 MTHM**
- **Geographically dispersed**
- **Diverse**
- **Growing with changing characteristics**



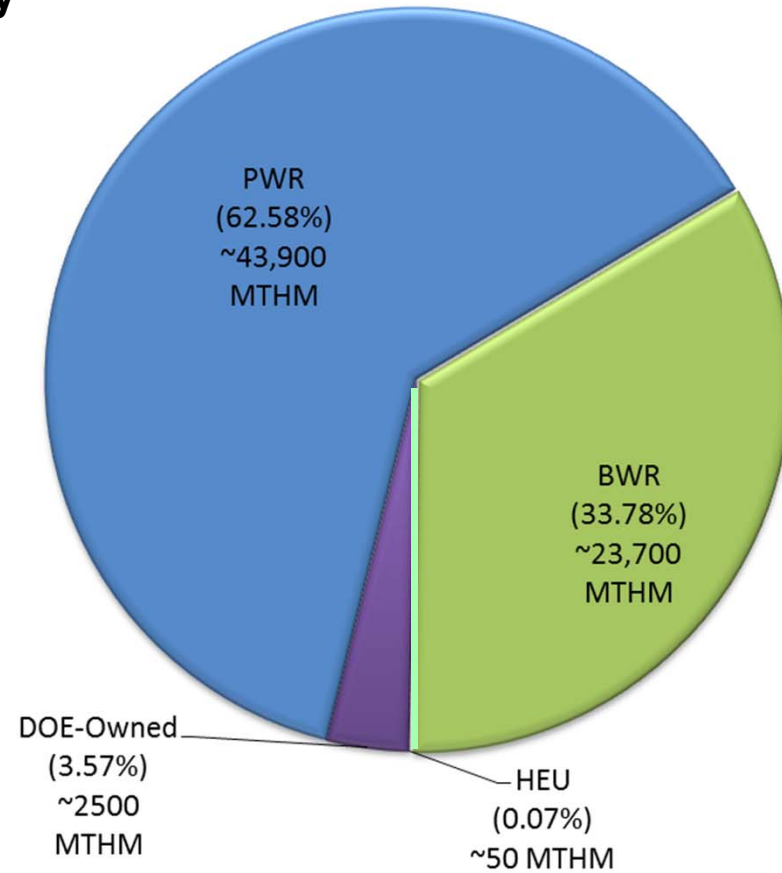
- **Significant variation exists in the discharged inventory due to the evolution of nuclear reactor and fuel assembly designs during the first 50 years of nuclear power operation**
- **UNF inventory variations influences nuclear fuel management and recycling strategies**



Mass of Current UNF Inventory

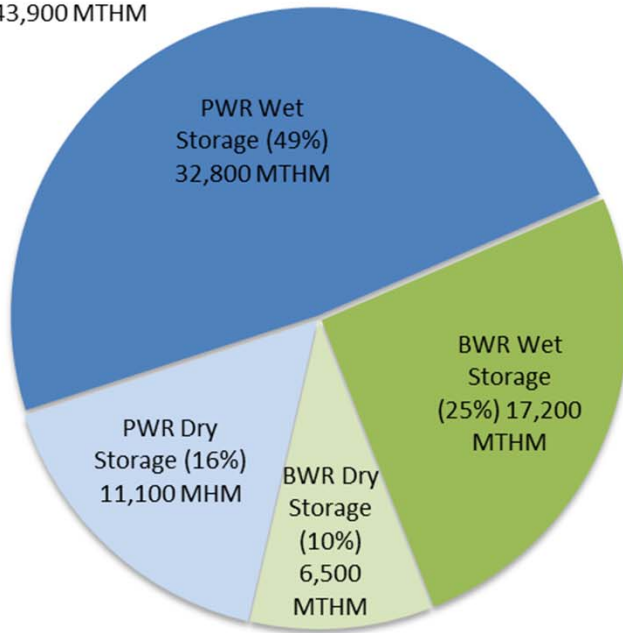
- Massive ~70,150 MTHM
- Commercial fuel dominates the inventory

Total UNF Inventory, MTHM



Commercial Wet/Dry Storage, MTHM

- BWR ~23,700 MTHM
- PWR ~43,900 MTHM

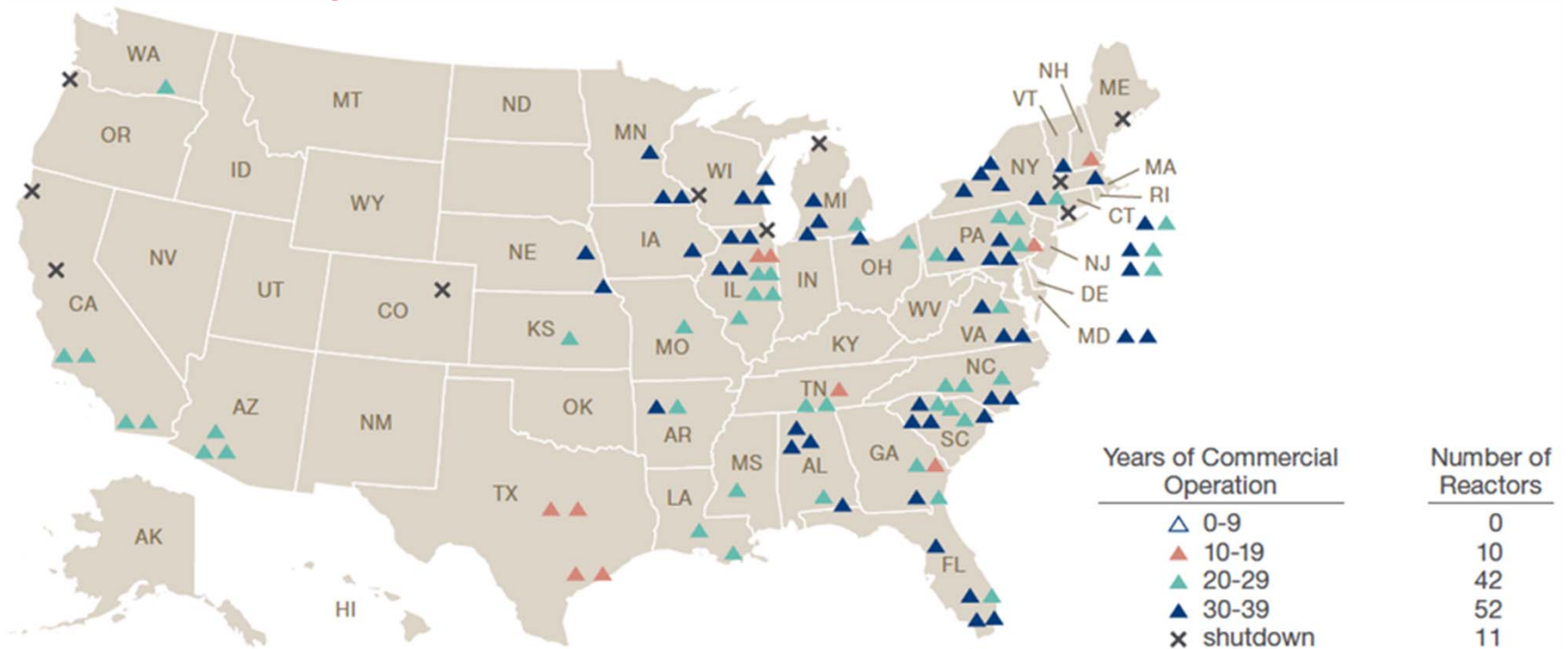




Geographically Dispersed

- UNF stored at 79 sites in 34 states
- 10 sites in 9 states no longer have operating reactors

Operating and Shutdown Commercial Reactor Sites



Source: U.S. Nuclear Regulatory Commission

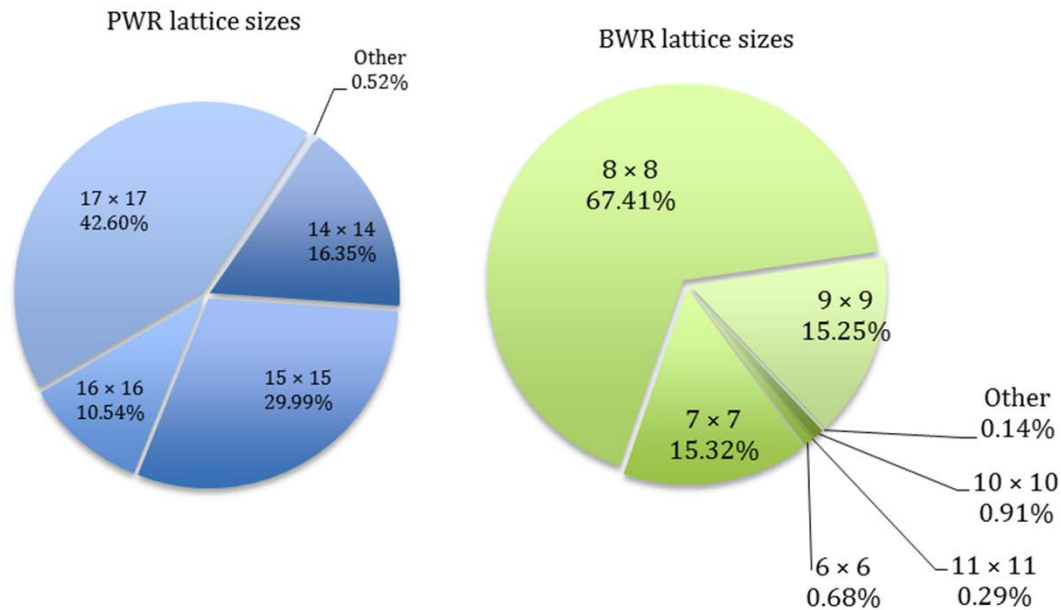


Diverse Characteristics

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- Commercial plants have been operating in U.S. since 1957
- 22 unique assembly classes, with varying physical characteristics and dimensions

Distribution of Assembly Lattices Sizes in % Mass (through 2002)

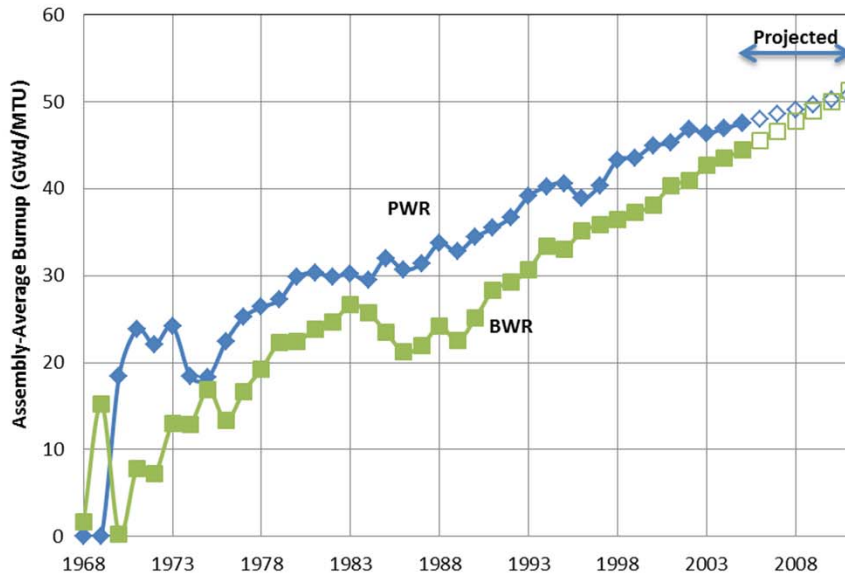




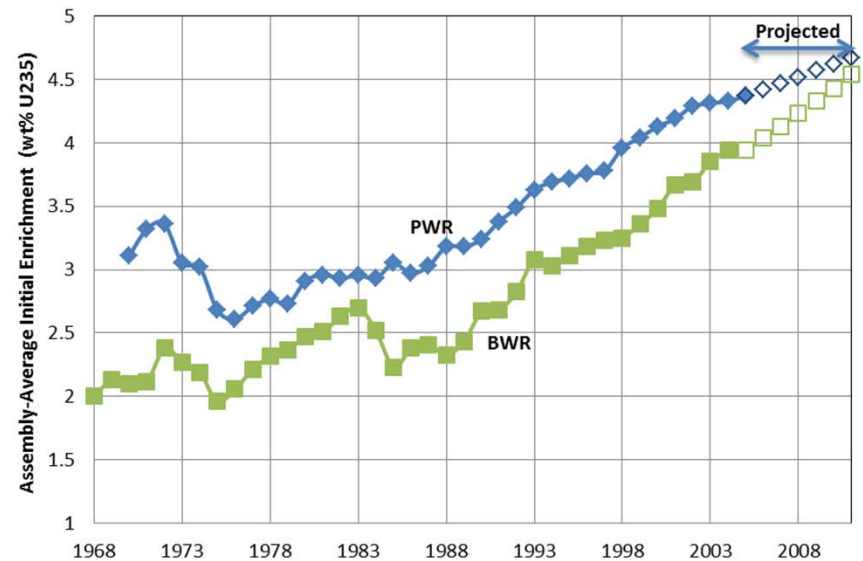
UNF Inventory Growing with Changing Characteristics

- Increasing by ~ 2000 MTHM/y
- Less diversity expected in future - movement toward higher discharge burnup and average 5 wt % initial enrichment

Average Discharge Burnup



Average Initial Enrichment





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Results of Categorization



Assessment Assumptions

- **U.S. nuclear power plants will continue to discharge ~2,000 MTHM/year of UNF for ~20 years; projections beyond this time frame are less certain**
- **The option of recycling commercial UNF at a future date is maintained**
- **Industrial-scale recycling of commercial UNF is unlikely to begin for at least 20 years**
- **Recycling in an alternative fuel cycle would likely be designed and optimized for the material needs of the associated reactor fleet based on the current and projected UNF discharges and inventory at that time, rather than UNF feedstock that is no longer produced**



Construction of new nuclear power plant at Vogtle Site



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Factors Considered in Categorization of Current UNF Inventory

- **Assuring support for DOE-NE FCT mission**
 - Quantity sufficient to accommodate projected RD&D needs and practical considerations
 - Access to a representative sample of diverse commercial UNF inventory to support UNF storage, transportation, and disposal
 - Access to high-burnup UNF representative of future discharges in quantities sufficient to support fuel cycle technology development
- **Retention of sufficient margin to provide assurance that future retrieval from disposal will not be necessary for research or reuse purposes**
- **Timeframe, material needs, projections for energy growth, and cost considerations to deploy potential alternative fuel cycles**
 - For example, evaluated Pu needs to support fast reactor deployment
- **Possible uses of UNF to support national security interests**

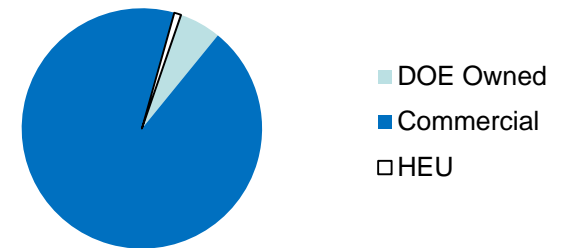


UNF Inventory Disposal/Retention Needs

Assessment evaluated how much fuel should be included in three categories:

- **Disposal** – the majority of the current spent fuel inventory should be permanently disposed ~66,000 MTHM commercial and ~2500 MTHM defense
- **Research** - up to 1650 MTHM should be considered for retention to support research, development and demonstration needs (~ 2 % of current inventory)
- **Recycle/Recovery** – up to 50 MTHM should be considered for retention in support of national security interests

Current Inventory



Disposal and Retention

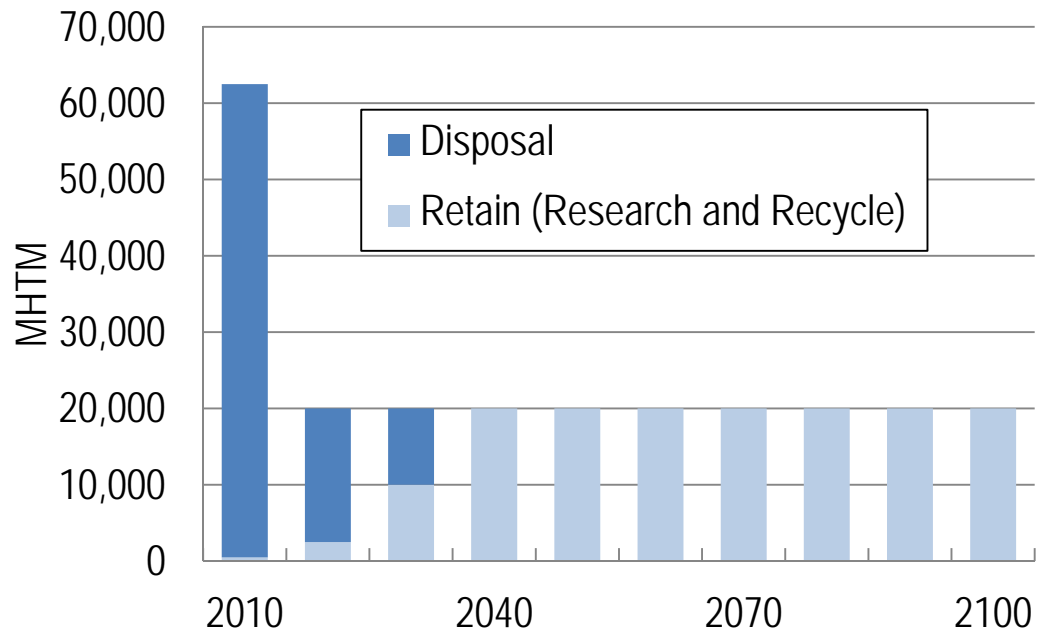




Disposal of 98% of Current Inventory - No Adverse Impact on Deployment of Future Alternative Fuel Cycles

Example Scenario:

- Current UNF discharge rate (~2,000 MTHM/year) is maintained
- By 2030, the United States builds and begins operation of an industrial-scale reprocessing facility with an annual capacity of $\leq 2,000$ MTHM that uses 5-year cooled fuel



Discharged UNF to support facility operations beginning in 2030 would not need to be retained until 2025



Concluding Remarks

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- While all irradiated fuel has some potential value as an energy source, this study concludes that only a small fraction of our existing used nuclear fuel be maintained to support a comprehensive nuclear fuel cycle strategy
- The remainder can proceed to disposal without the need to ensure retrievability for reuse or research purposes
- We have time to refine the precise amounts needed
- Permanent disposal of the current inventory does not preclude potential recycle in the future since the ~2000 MTHM generated annually could provide the feedstock needed for deployment of alternative fuel cycles

<http://info.ornl.gov/sites/publications/Files/Pub37993.pdf>