U.S. DEPARTMENT OF ENERGY

Integrated Waste Management
Office of Spent Fuel and Waste Disposition
Nuclear Energy

Does Consolidated Interim Storage Make Sense in an Integrated Waste Management System?

Josh Jarrell
Oak Ridge National Laboratory

NEI Used Fuel Management Conference
May 2017
Savannah, GA

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

Disclaimer

- **This technical presentation reflects concepts which could support future decision-making by DOE. No inferences should be drawn from this presentation regarding future actions by DOE. To the extent this technical presentation conflicts with the provisions of the Standard Contract, the Standard Contract provisions prevail.**

U.S. DEPARTMENT OF ENERGY

Nuclear Energy

The issue of whether to include consolidated interim storage as part of an integrated waste management system has been considered repeatedly

- **Consolidated storage facilities were included as a potential component of the US spent fuel management system in the Nuclear Waste Policy Act of 1982 (NWPA)**
- **The NWPA and amendments placed capacity and timing constraints on a consolidated interim storage concept referred to as a "Monitored Retrievable Storage" facility**
  - Constraints were intended primarily to keep a focus on pressing towards a more permanent solution to the waste problem through the development of a geologic repository
  - Potential advantages may be diminished with the application of such constraints
- **This presentation provides information to further that discussion**
  - Advantages & Disadvantages

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Having consolidated storage would provide improved reliability and flexibility with increased (and potentially different) storage capacity

- **Supports decoupling of at-reactor and repository operations**
- **Provides capabilities to deal with unexpected developments or emergencies throughout the waste management system**
- **Provides the ability to continue to accept fuel in case of upset conditions at a repository**
- **Provides an opportunity to explore technical challenges**
  - Develop new operational processes
  - Develop new inspection and monitoring capabilities
  - Confirm fuel and cask characteristics
  - Supports future verification and validation for analysis software

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Earlier acceptance and additional capacity would have a number of benefits

- **Would allow for earlier clearing of shutdown sites**
  - Would reduce government liability
  - Would allow land repurposing/reutilization
- **Would demonstrate functioning spent fuel management system**
- **Would provide capacity above Yucca Mountain legal limit for all spent nuclear fuel (SNF) and high-level waste**
  - 70,000 MTHM total capacity (NWPA)
    - 63,000 MTHM commercial
    - 7,000 MTHM defense

    75,000 MTHM commercial SNF already discharged; ~140,000 MTHM projected
  - Facilities for handling commercial SNF
    - 90% Transportation, Aging, and Disposal canisters (TADs)
      - Loaded at reactor sites

      0 TADs deployed
    - 10% bare fuel (dual-purpose canisters {DPCs})
      - 346 DPCs analyzed in pre-closure analysis

      ~2,750 casks deployed + ~165 per year

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Some disadvantages for consolidated storage also exist

- **Would necessitate further handling of spent fuel and high-level waste, potentially increasing safety and security risks as well as costs**
  - More transportation
  - More canister transfers
- **There could be a risk of losing repository project momentum**
  - Linkage is included in NWPA to avoid interim storage facility (ISF) becoming *de facto* repository
  - The possibility that interim storage may reduce the focus on repository development is not unique to a *consolidated* ISF.
    - The development of independent spent fuel storage installations (ISFSIs) at 77 sites in the United States has eliminated any immediate need to remove spent fuel from those sites for operational reasons.
    - NRC's *Continued Storage of Spent Nuclear Fuel* (10 CFR Part 51) has also lessened an immediate need to remove SNF from reactor sites

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Are the economics of an ISF an advantage or a disadvantage?

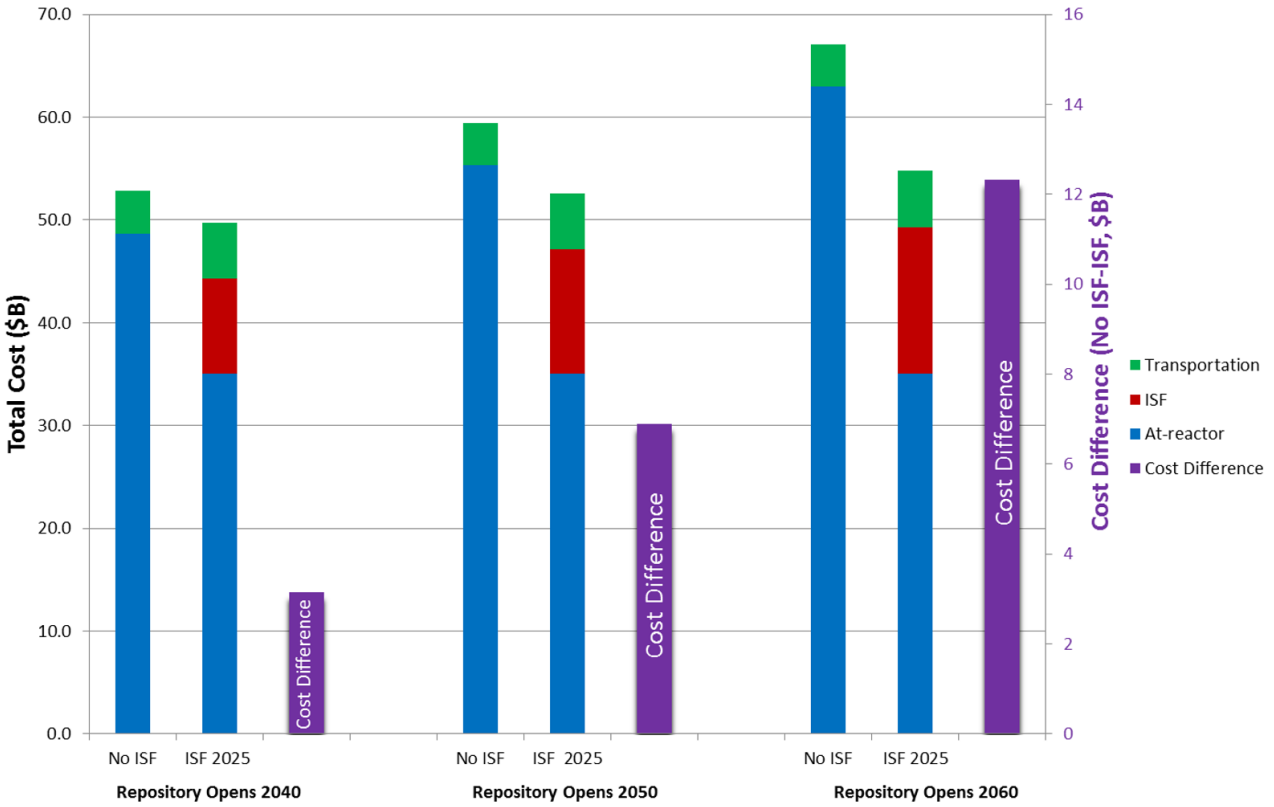
- **ISF would have a near-term cost**
  - Would increase system-wide yearly expenditures in the next few decades
- **However, costs in the future may be reduced**
- **Any system-wide cost avoidance (though potentially large) may not offset the initial investment in an ISF for multiple decades.**
  - Assumptions on unit costs and economic environment will dominate
- **Recent Work**
  - *Cost Implications of an Interim Storage Facility in the Waste Management System* – 2016
    - https://curie.ornl.gov/content/cost-implications-interim-storage-facility-waste-management-system-0
  - *Cost Sensitivity Analysis for Consolidated Interim Storage of Spent Fuel: Evaluating the Effect of Economic Environment Parameters* – 2016
    - https://curie.ornl.gov/content/cost-sensitivity-analysis-consolidated-interim-storage-spent-fuel-evaluating-effect-economic
  - *Potential Cost Implications of an Interim Storage Facility for Commercial SNF* – 2017 Waste Management Symposia Paper
    - https://curie.ornl.gov/content/potential-cost-implications-interim-storage-facility-commercial-snf

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

2016 ORNL work showed an ISF could reduce total system cost (used no discounting, inflation, etc.)

Assumptions

- $1B for ISF deployment costs
- All fuel goes through ISF
- 3000 MTHM/year
- Oldest Fuel First Allocation
- Shutdown sites as of 2011 were cleared first
- Full-scale ISF begins operation in 2025



Cost Implications of an Interim Storage Facility in the Waste Management System (Jarrell et al., FCRD-NFST-2015-000648 Rev. 1 ORNL/TM-2015/18) Available at https://curie.ornl.gov/content/cost-implications-interim-storage-facility-waste-management-system-0

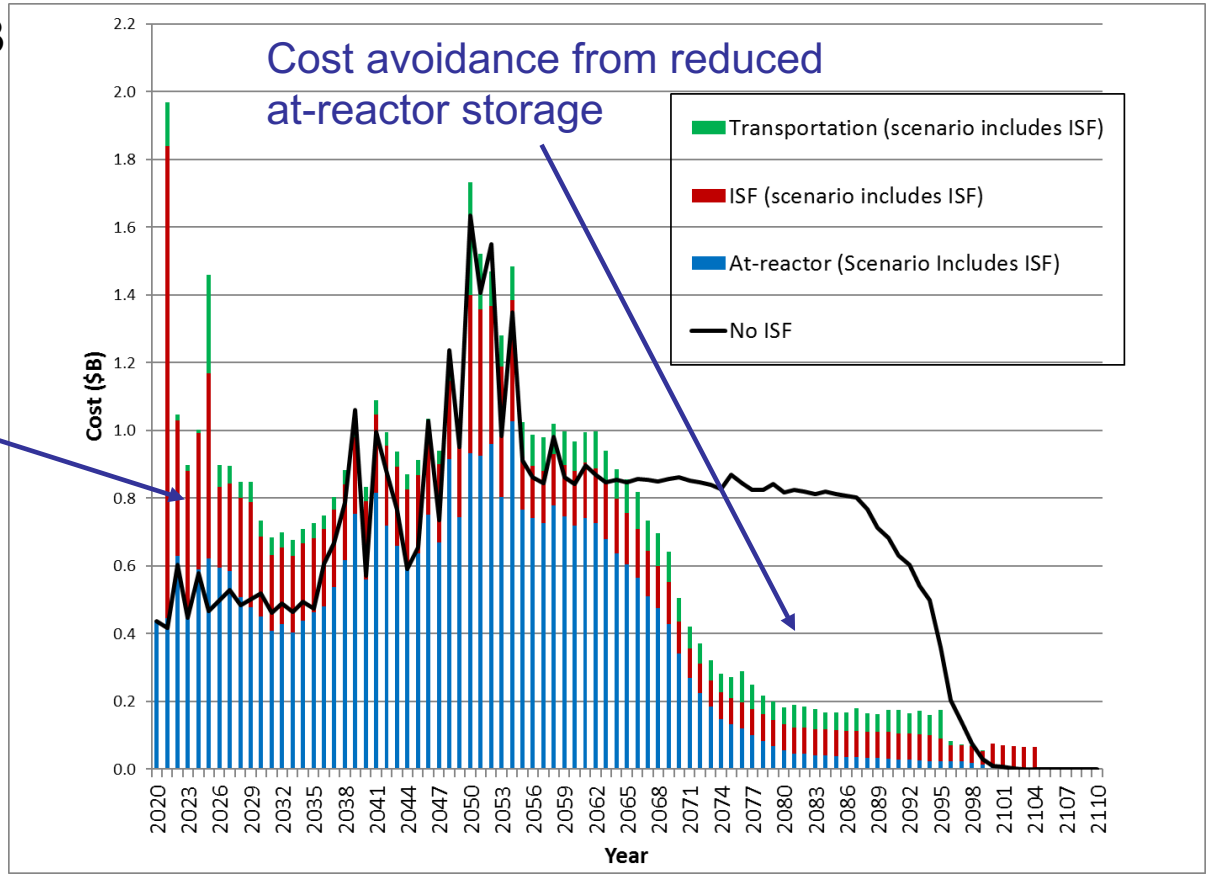
U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Constant dollar results show cost avoidance in the long term

- **Total System Cost (no repackaging or repository)**
  - Without an ISF ~ $59.5B
  - With an ISF ~ $54.4

Increased costs due to ISF operations as well as transportation

Potential Cost Implications of an Interim Storage Facility for Commercial SNF (Jarrell et al.) Available at https://curie.ornl.gov/content/potential-cost-implications-interim-storage-facility-commercial-snf



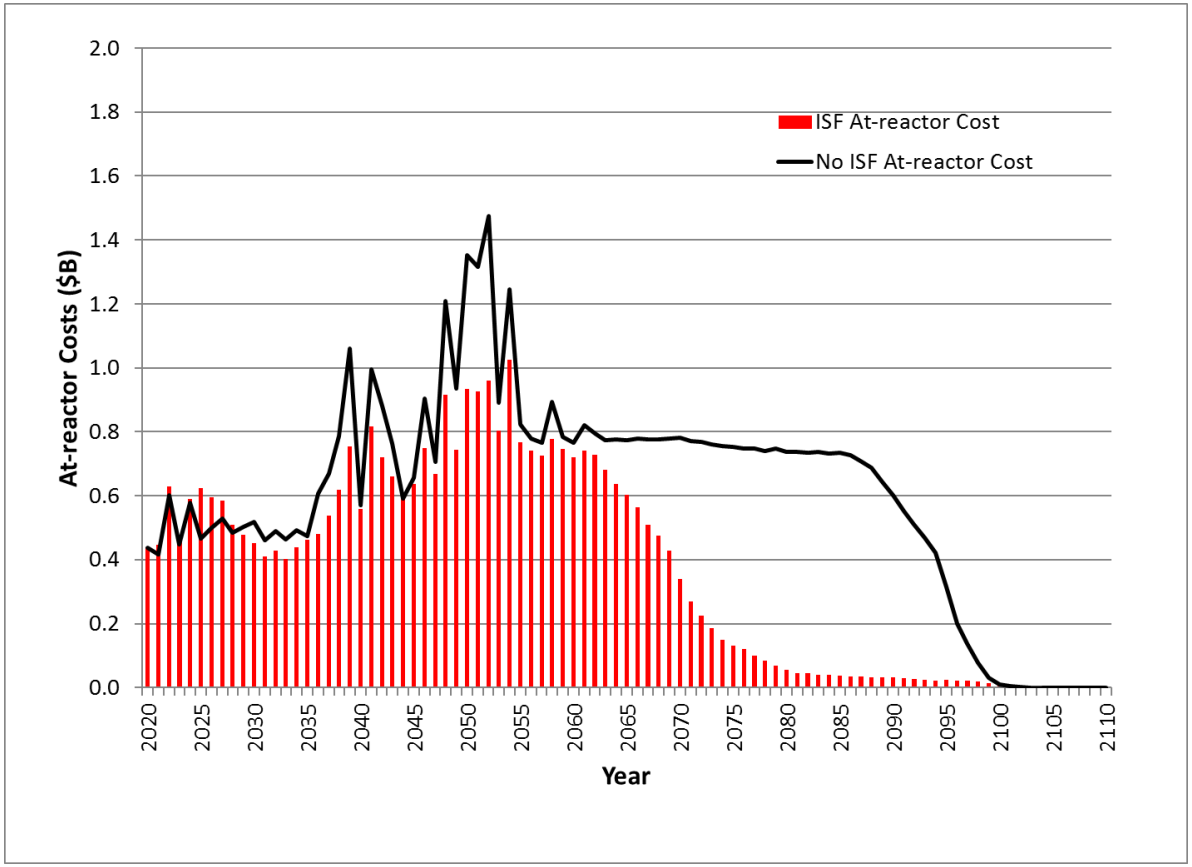
Costs (at-reactor, ISF, and transportation) as function of year for scenarios with and without an ISF (2025). Repository Operations begin in 2050.

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

At-reactor and ISFSI costs could be reduced by including an ISF in the system

- **At-reactor costs**
  - Without an ISF ~ $55.4B
  - With an ISF ~ $34.2B

Potential Cost Implications of an Interim Storage Facility for Commercial SNF (Jarrell et al.) Available at https://curie.ornl.gov/content/potential-cost-implications-interim-storage-facility-commercial-snf

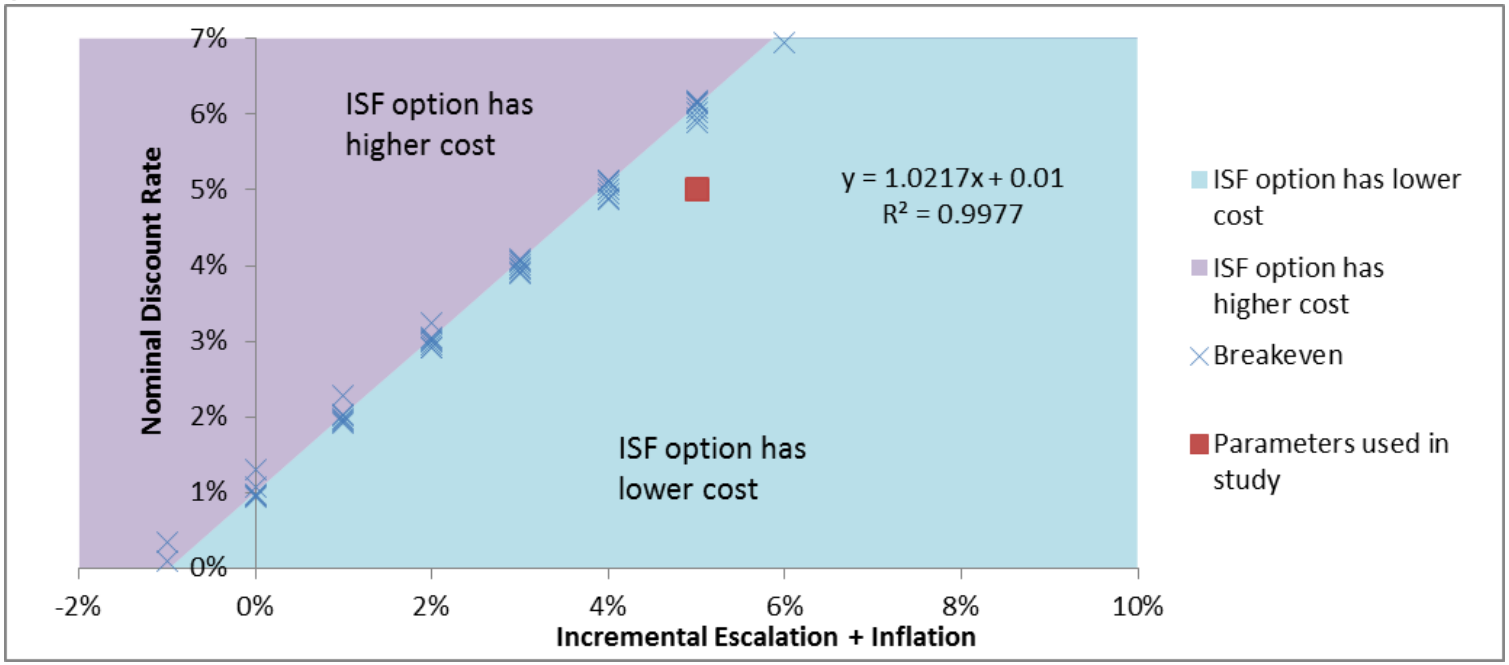


All results are based on constant dollars.
How does economic environment (inflation, discounting) impact results?

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Economic environment (discounting, escalation, inflation) dominate the costs due to long-time frames

- Assumptions related to long-term economic environment dominate "break-even" evaluation
- Assumptions related to unit costs for storage and transportation can also change the results



Cost Sensitivity Analysis for Consolidated Interim Storage of Spent Fuel: Evaluating the Effect of Economic Environment Parameters (Cumberland et al., FCRD-NFST-2016-000721, Rev. 1 ORNL/SR-2016/681) Available at https://curie.ornl.gov/content/cost-sensitivity-analysis-consolidated-interim-storage-spent-fuel-evaluating-effect-economic

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Conclusion: An ISF makes sense if advantages are judged to outweigh disadvantages, but requires near-term investment

- **Advantages**
  - Would improve system reliability and flexibility
    - Would avoid single-point system failures
    - Would decouple at-reactor and repository operations
    - Would add additional opportunity to explore technical challenges
  - Earlier SNF acceptance from reactor sites and additional storage capacity
    - Federal liability would be reduced as reactor sites are cleared of SNF
    - Shutdown site land reutilization/repurposing
    - Development and demonstration of SNF management beyond at-reactor storage
- **Disadvantages**
  - ISF would increase near-term system cost
  - Would require more SNF transportation and handling
  - Could lose repository momentum
- **Long term total system cost estimates increase or decrease based on economic and schedule assumptions used**