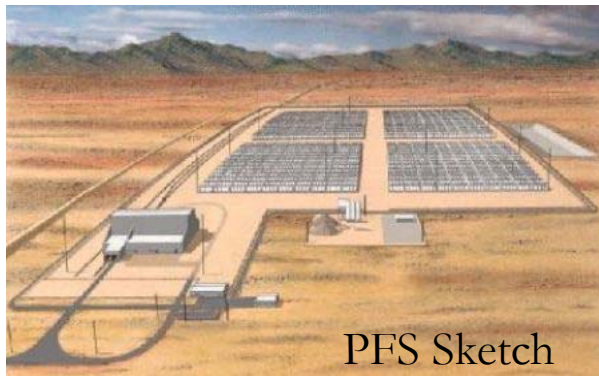


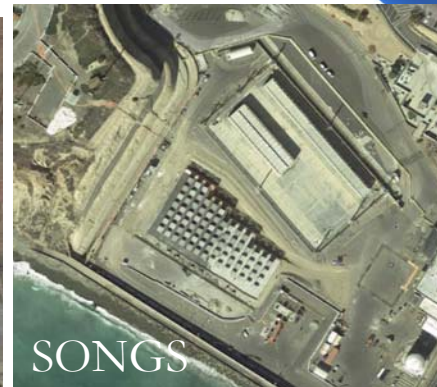


Cost Considerations for CISF Funding Under Existing Law

Consolidated versus



Distributed SNF Storage



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INMM SNF Seminar
1/12/2017

Cost Considerations for CISF Operations Under Existing Law



- In the context of mitigating cost impacts, what are the costs of distributed storage that have to be beaten?
 - My sources include the 2011 cost analysis performed by Navigant for the Blue Ribbon Commission, the 2012 Congressional Research Service Report on SNF storage, the 2014 GAO report on SNF Storage, the 2016 Cost Sensitivity Analysis for CISF compiled by ORNL, and a composite 2016 study by Argonne, PNNL, Complex Systems Group and SRNL.
 - No proprietary, legally protected or business sensitive information was used in compiling this analysis.
 - Projections for the growth of annual storage costs are based on utility announcements for planned early closures of currently operating nuclear power plants.
 - Given the comparatively small contribution that operation plants make to the overall cost of distributed storage, they were ignored in this assessment.
 - Given that DOE has already taken title to the SNF at Fort St Vrain, and that fuel has a non-standard configuration, it was also left out of this assessment.

Cost Considerations for CISF Operations Under Existing Law



From available information, the cost for ISFSI storage at shutdown plants depends on the status of the shutdown. While decommissioning is still active, many common costs are shared between the plant and DOJ under the settlement agreements. Once decommissioning is complete the full costs revert to the DOJ judgement fund. What the available data indicates is:

Data Source / Cost Category	2011 MIT Study	2014 GAO Report	2016 ORNL Cost Assessment	Costs Used for this Analysis
At reactor ISFSI Cost per year for a fully decommissioned site	\$8,000,000 \$8,772,800	\$6,500,000 \$6,773,000	\$10,000,000 \$10,278,000	\$9,000,000
At Reactor ISFSI Storage Cost per year for a shutdown reactor undergoing decommissioning	\$4,000,000 \$4,386,400			\$4,500,000
At Reactor ISFSI Storage Cost per year for an operating reactor		\$300,000 \$312,600	\$1,000,000 \$1,027,800	\$670,000

Projections for Shutdown Nuclear Power Plant Schedules in the US



Plant	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	
Big Rock Point 1/08/07				α		Ω														
Haddam Neck 11/07				α		Ω														
Humboldt Bay 3/8/17	α																			Ω
LaCrosse 2019		α																		Ω
Maine Yankee 2019				α																Ω
Rancho Seco 2006				α		Ω														
Trojan 5/23/05				α		Ω														
Yankee Rowe 8/07				α		Ω														
Zion 1 & 2 2020					α															Ω
Kewaunee 2072							α													Ω
SONGS 2 & 3 2031							α													Ω
Crystal River 2067							α													Ω
Vermont Yankee 2052								α												Ω
Fort Calhoun 2058								α												Ω
Oyster Creek >2050									α											?
Palisades >2050									α											?
Diablo Canyon 1 & 2 > 2050										α										?
Pilgrim > 2050										α										?
Indian Point 1, 2 & 3 > 2050										α										?

α – Date of plant shutdown

Ω = Date of Part 50 License Termination or Shrink Licensed area to ISFSI Only

All dates came from PSDARs, from goals published by the utility, or are shown to be beyond the period of this analysis

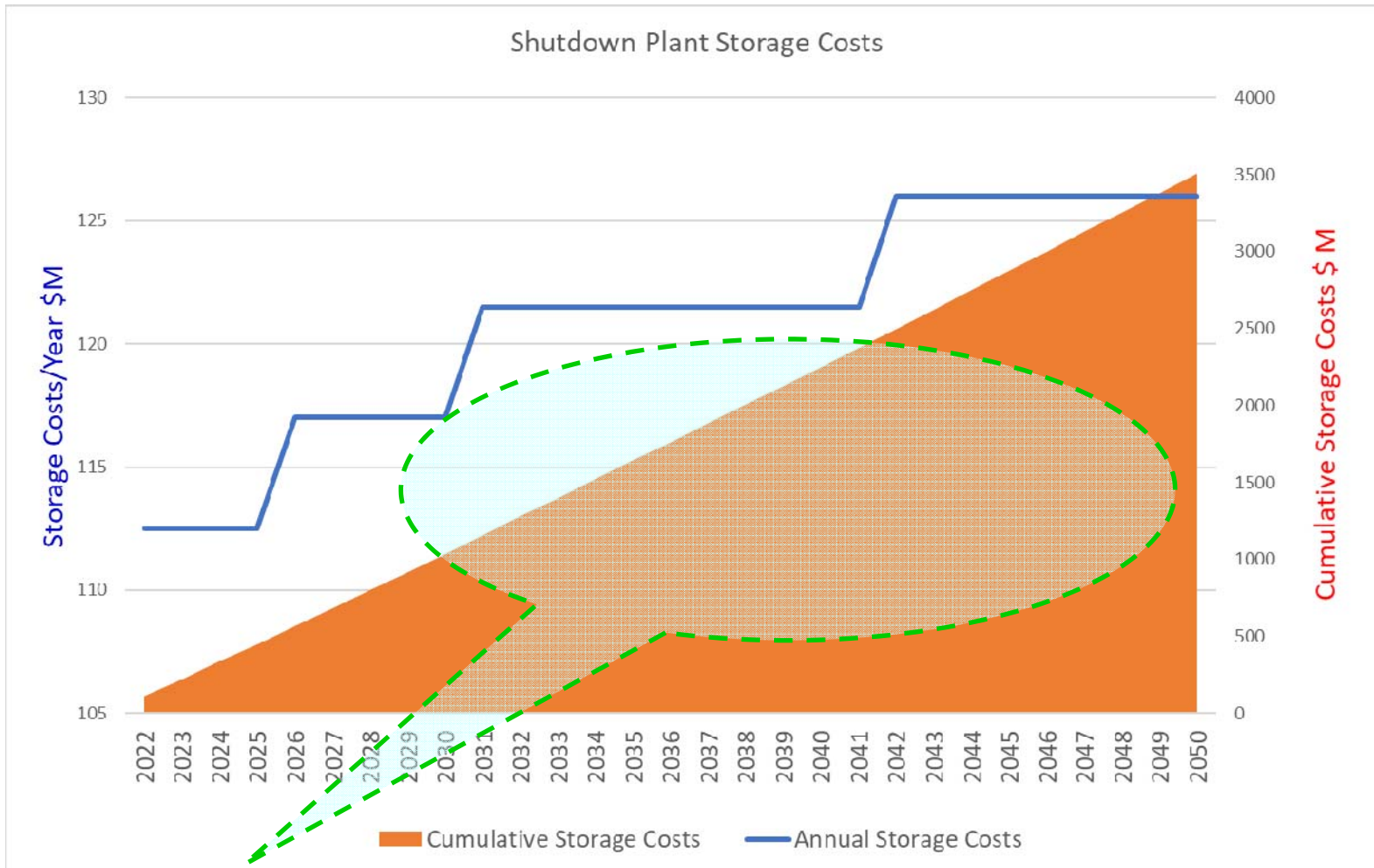
Annual Storage Costs by Shutdown Plant Site in 2018 \$M



DOJ Storage Costs	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Big Rock Point	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Connecticut Yankee	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Humboldt Bay	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
LaCrosse	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Maine Yankee	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Rancho Seco	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Trojan	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Yankee Rowe	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Zion 1 & 2	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Kewaunee	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
SONGS 1, 2 & 3	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Crystal River	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
Vermont Yankee	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0	\$9.0
Fort Calhoun	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
Oyster Creek	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
Palisades	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
Diablo Canyon 1 & 2	\$0.0	\$0.0	\$0.0	\$0.0	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
Pilgrim	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5
Indian Point 1, 2 & 3	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5	\$4.5

Operating sites that have announced early shutdowns (Oyster Creek, Pilgrim, Palisades, Indian Point & Diablo Canyon) don't have approved Post Shutdown Decommissioning Activity Reports or Licensing Termination Plans and their situations may change. These costs are based on current plans. Costs through 2050 were selected to align with DOE's Strategic Plan for repository operations beginning in 2048.

Projected Costs for Shutdown Nuclear Plants Based on Cost and Schedule Data Presented



A private storage entity could negotiate with a collection of shutdown plants and if their cumulative cost of consolidated storage is less than the status quo, they would have a contractual argument for providing consolidated storage services for that collection of fuel.

Private Consolidated Storage Costs Competing with Current Distributed Storage Costs

- Facility design & Licensing
- Facility Construction
- Transportation Planning & Ops
- New Storage Modules
- Transfers from storage modules to transportation and back to storage modules
- Facility O&M
- Facility Decommissioning
- Profit

Current Storage Costs

- Annual Justice Fund Payments to a Collection of Shutdown Sites

Uncertain Costs:

- Transportation Assets – Rail Cars, Transport Casks, Impact Limiters & Skids. Are these costs allocated to consolidated storage, or to disposal with a loan for storage operations? Arguments can be made both ways.
- Are NWPA Section 180(c) Costs Charged to Private Storage?



- **The NWPA Has Explicit Restrictions on Establishing a Federal Monitored Retrievable Storage Facility before a Repository is Operational**
 - This constraint does not apply to private consolidated storage facilities funded by investors.

- **The courts have held that Nuclear Waste Funds Cannot be used for constructing Independent Spent Fuel Storage Installations (ISFIs) Without Explicit Authorizing Legislation**
 - Again, this only applies to NWPA funding of storage capability. Nuclear Waste Funds can still be appropriated for disposal activities

 - A privately funded CISF is not barred by the NWPA. If it was decided to place some disposal processing facilities at a private CISF, that would seem to be allowed under the NWPA with Nuclear Waste Fund Appropriations from Congress. Adding the necessary repackaging facility to move SNF from dual purpose canisters used for storage and transportation into disposal ready casks that meet the repository requirements for thermal limits, criticality poisoning and corrosion resistance would seem to shorten the overall waste management schedule for disposal.

Conclusions



- The annual costs for storage are much higher at shutdown sites than at operating plants;
- The bulk power market has become dominated by inexpensive electricity produced by gas turbines. This is causing many nuclear plants to close long before their operating licenses expire;
- The cost of spent fuel storage is somewhat independent of the amount of fuel in storage. This means costs duplicated at multiple storage sites can be undercut by consolidating the storage capability;
- The number of shutdown sites now planned creates a significant opportunity for life cycle cost savings;
- The legal construct of minimizing damages seems to offer a path forward without legislation or DOE action.