An aerial night photograph of a city, likely Idaho Falls, Idaho, showing city lights, a winding road, and hills in the background. The image is overlaid with a dark blue gradient.

Nuclear Industry Priorities in Preparing for Large-Scale Transportation of Commercial Spent Nuclear Fuel

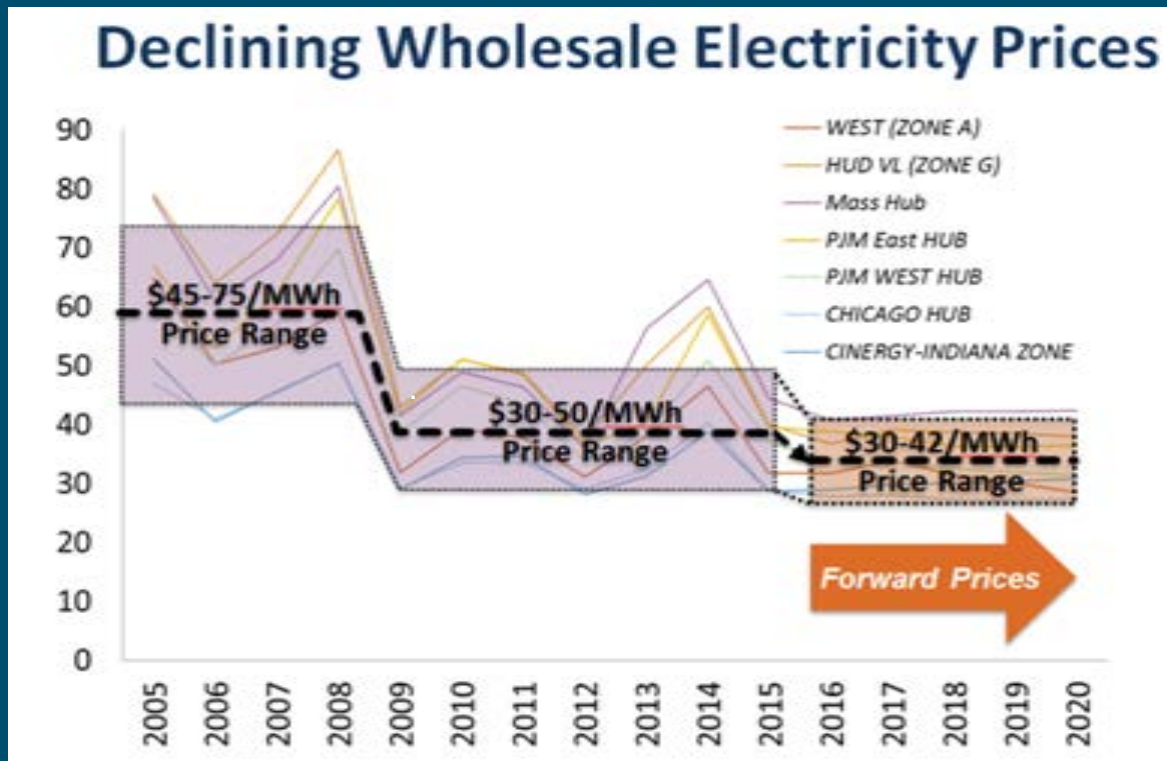
**Mark Richter, Ph.D.
Nuclear Energy Institute**

June 13, 2018

**NWTRB Summer Board Meeting
Idaho Falls, Idaho**

Industry Status

Drivers of Early Shutdown Decisions

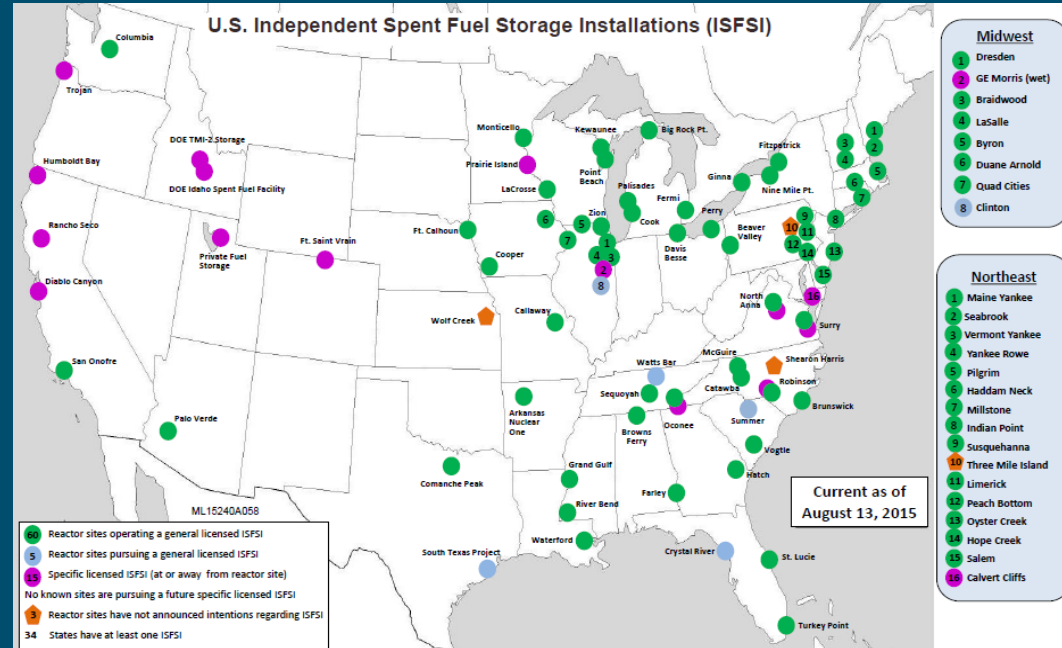


ISFSI Status in the United States

- Used fuel inventory*
 - Approximately 80,960 MTU
 - Increases 2 - 2.4k MTU annually

- ISFSI storage*
 - 117,579 assemblies
 - 33,515 MTU (39%)
 - 2,698 casks/modules loaded
 - 72 Operating ISFSIs
 - 1 pool ISFSI, 1 modular vault

- Projections for 2020
 - Estimating 86,000 MTU total
 - Estimating 35,000 MTU at ISFSI
 - 3,200 casks/modules loaded
 - At 76 ISFSIs
 - Almost all plant sites + Morris & INEL
 - Fuel from 119 reactors



*As of December 31, 2017

- Total Value Proposition
- “Back End” Actions Impactful
- Success Depends on Efficient Management

NATIONAL NUCLEAR ENERGY STRATEGY



PRESERVE

Appropriately value nuclear generation

SUSTAIN

Create sustainability via improved regulatory framework and reduced burden

INNOVATE

Innovate, commercialize, and deploy new nuclear

THRIVE

Compete globally

NATIONAL IMPERATIVES



JOB
& INFRASTRUCTURE



U.S. GLOBAL INFLUENCE
& NATIONAL SECURITY



REGULATORY
EFFICIENCY



INNOVATION
& TECHNOLOGY
LEADERSHIP



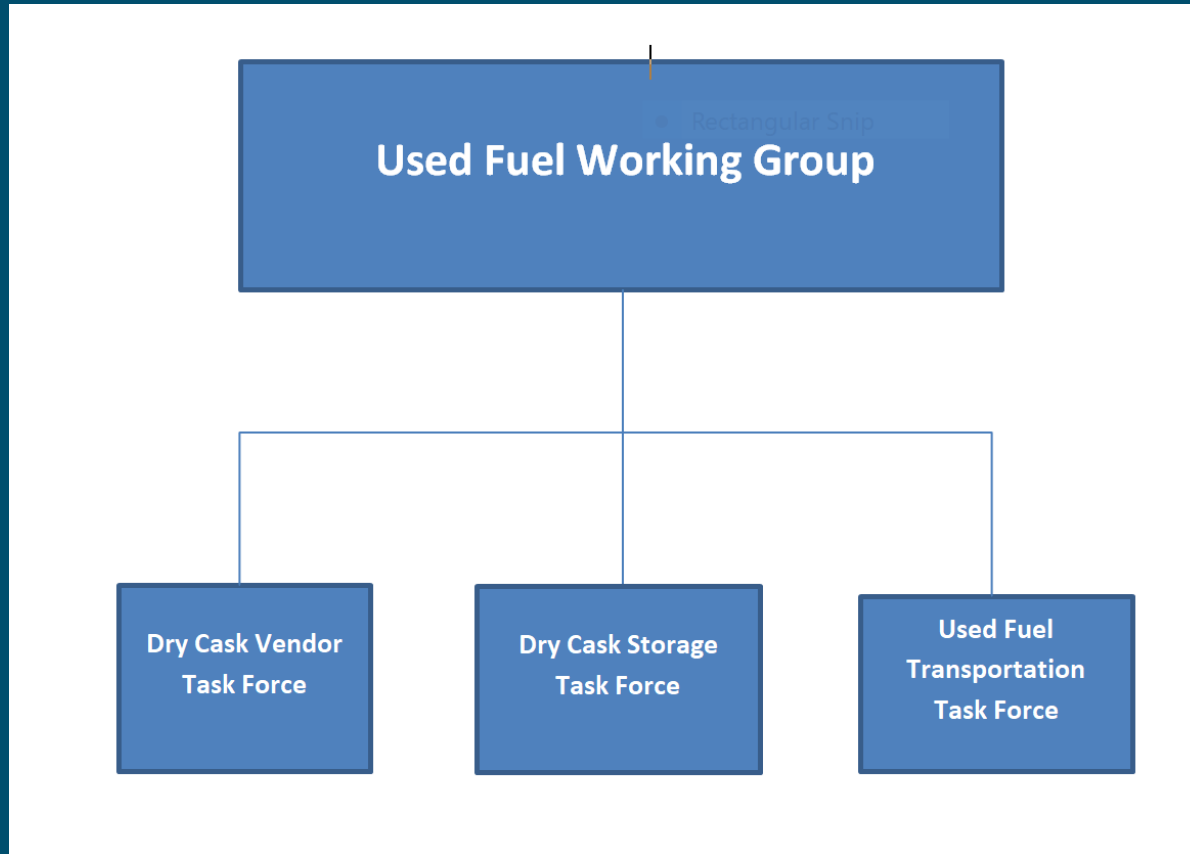
AIR QUALITY
& SUSTAINABLE
DEVELOPMENT



CLIMATE
CHANGE

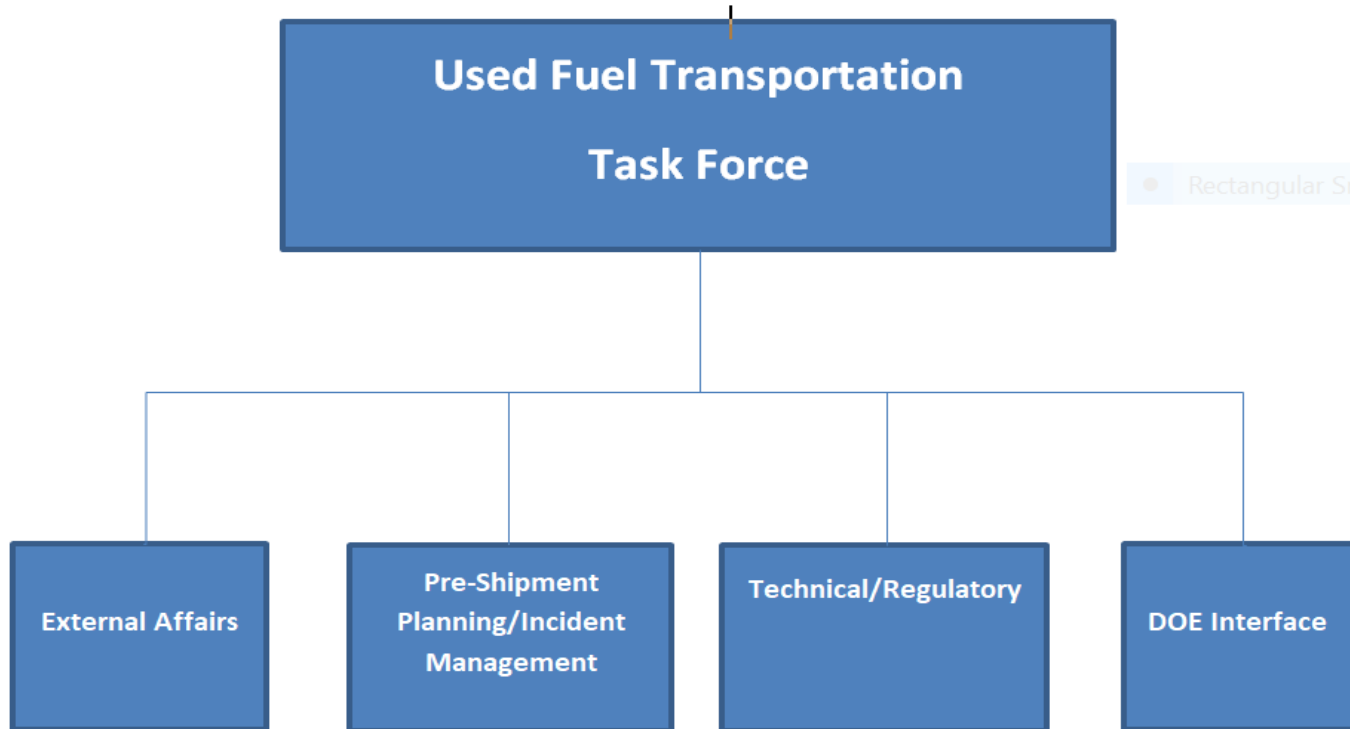


CLEAN ELECTRIC
POWER DEMAND



- Used Fuel Transportation Task Force Vision-

“Prepare industry to transport used nuclear fuel from ISFSI locations to interim and/or permanent storage facilities by 2022.”



Re-invent the Wheel?



Or Check the Tire Pressure?

Transportation Experience

- The 70+ year history of nuclear materials and used fuel transportation demonstrates a commendable safety record
 - No harmful radiation release
 - Proven regulatory requirements and industry processes
 - Safe shipment from ISFSIs to a centralized location is strongly supported by experience.

- The U.S. Navy has completed around 850 shipments totaling over 1.6 million miles of transport
- Since the mid-1970's there have been over 1,300 safe shipments of commercial used fuel in the United States
- Since 1990, more than 60 shipments including more than 250 transportation casks of foreign research reactor fuel and been shipped to and within the United States by sea, land and air
- Internationally, over 70,000 metric tons of used fuel have been transported by road, rail and sea

Opportunities for Near Term Transportation

Shutdown Sites Without An Operating Reactor

- **California**

- Humboldt Bay
- Rancho Seco
- San Onofre

- **Colorado**

- Ft. St. Vrain

- **Connecticut**

- Connecticut Yankee

- **Florida**

- Crystal River

- **Illinois**

- Zion

- **Maine**

- Maine Yankee



Humboldt Bay



Rancho Seco



Trojan

- **Massachusetts**

- Yankee Rowe

- **Michigan**

- Big Rock Point

- **Nebraska**

- Ft Calhoun

- **Oregon**

- Trojan

- **Vermont**

- Vermont Yankee

- **Wisconsin**

- LaCrosse
- Kewaunee

PREMATURE NUCLEAR PLANT CLOSURES



Plant	MWe	Closure Year	Reason	Generation in Final Year (billion kWh per year)	CO2 Emissions Avoided in Final Year (M tons/year)
Crystal River 3	860	2013	Mechanical	7.0	3.8
San Onofre 2 & 3	2,150	2013	Mechanical	18.1	8.0
Kewaunee	566	2013	Market	4.5	3.8
Vermont Yankee	620	2014	Market	5.1	2.4
Fort Calhoun	478	2016	Market	3.4	3.3
TOTAL	4,674			38.1	21.3
Oyster Creek	610	2018	Policy	5.4	4.0
Three Mile Island 1	803	2019	Market	6.9	5.1
Pilgrim	678	2019	Market	5.1	2.4
Davis-Besse	908	2020	Market	7.9	5.8
Indian Point 2 & 3	2,061	2020-2021	Market & Policy	15.3	7.3
Beaver Valley 1 & 2	1,872	2021	Market	15.3	11.3
Perry	1,268	2021	Market	9.8	7.2
Palisades	789	2022	Market	6.1	5.2
Diablo Canyon 1 & 2	2,240	2024-2025	Policy	18.0	7.5
TOTAL	11,229			89.7	55.7

Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the **Environmental Protection Agency** and latest plant generation data from the **Energy Information Administration**. Updated: March 2018.

Utility



Transport



Waste Control Specialists



REGULATORY
EFFICIENCY



REGULATORY
EFFICIENCY



Eddy-Lea Energy Alliance

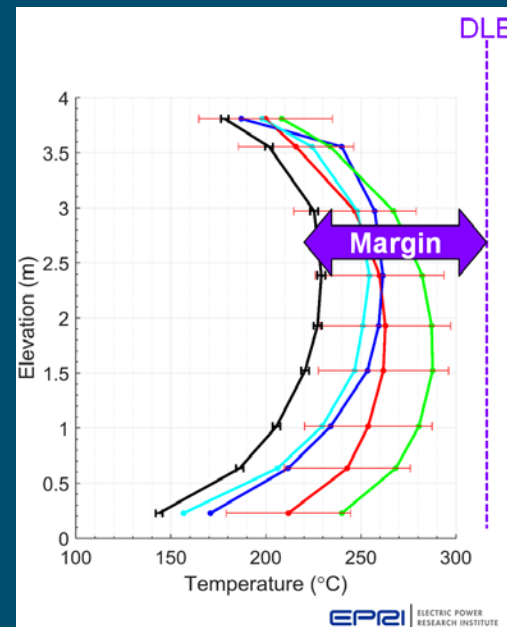
- Storage regulations (Part 72) assure safety in initial storage
- Transport regulations (Part 71) assure safety during transport
- Sandia full scale testing shows accelerations and forces are very low and transport conditions are benign
- Under normal, significant event-free transport, fuel and canister remain safe to return to storage

- Aged storage canisters transport to and storage at CISF
- Inspection guidance and assessment methodology for aging management including:
 - MAPS Report (Managing Aging Processes in Storage NUREG 2214)
 - NEI 14-03 (Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management)
 - NUREG 1927 rev. 1 (Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel)
 - Aging Management INPO Database
- Combined efforts of NEI, NRC, DOT, DOE suppliers and industry at-large

Thermal Margin



- Estimated Peak Cladding Temperatures artificially high
- Temperatures far below design limit -cladding degradation is unlikely
- Significant benefits to be realized from improved modeling



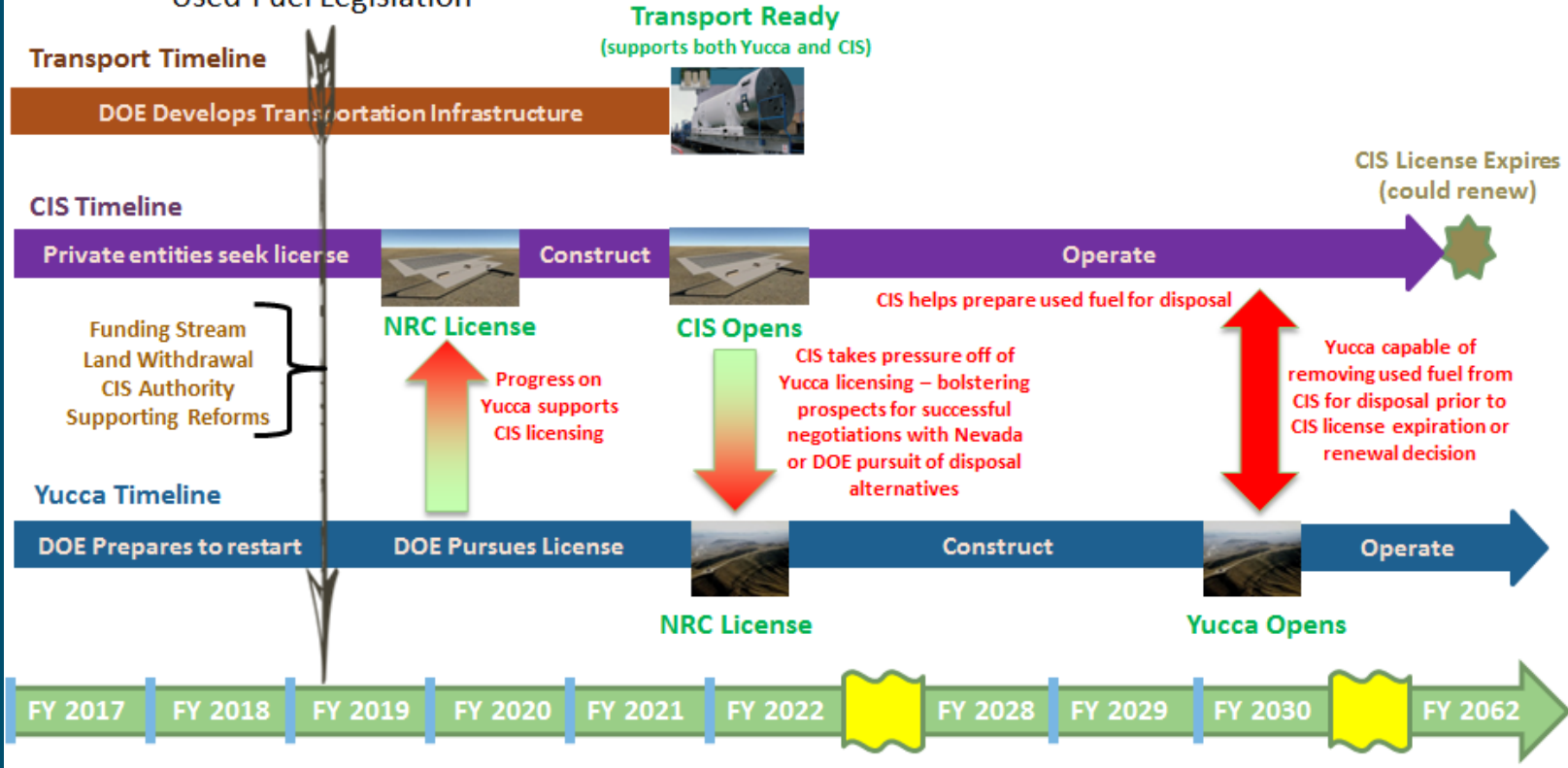
- Improve Operational Flexibility
- Support Risk Informing Dry Storage and Aging Management
- Facilitate Transportation and Ultimate Disposal



- Guidance addressing regulatory requirements with licensees and cask suppliers is being developed
- Research to address thermal margin improvement is underway
- Aging Management protocols and inspection technology are being developed

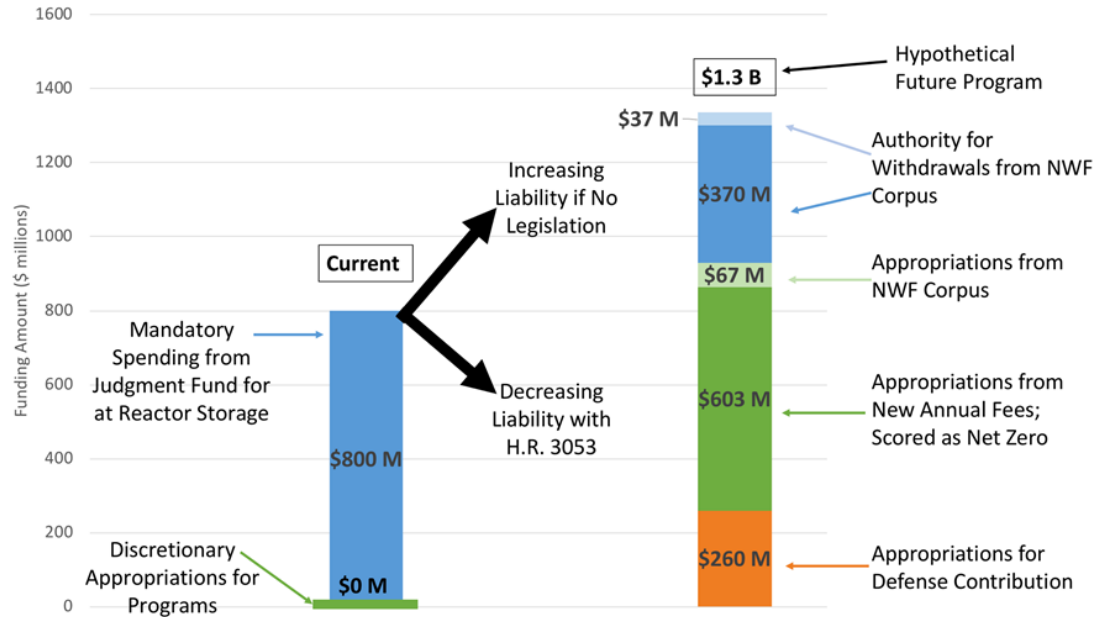
Target Milestones - Where We Are Going

Target Date to Enact Comprehensive Used Fuel Legislation



Incentive for Legislative Action

H.R. 3053 - Pathway to a Durable, Effective and Financially Disciplined Program



- **\$800 million in current mandatory spending authority** simply pays to maintain status quo with no programmatic advances; likely to increase in the absence of a renewed program.
- **New Mandatory authority represents authority to withdraw past deposits, not draw on general fund**; it is capped at less than current mandatory spending, and stage-gated based on program performance metrics.
- **Meeting legally-binding commitments** requires either upfront, lump sum appropriations or mandatory spending authority

Conclusions

- Used Fuel May Be Transported as Early as 2022
- Industry Preparations Underway
- Industry Actions Point to Readiness
- Not an Overwhelming Challenge
- Minimal Increase in Annual Shipments

- Interact with industry for planning development of transportation readiness
- Align “reasonable assurance” expectations with industry and regulators
- Increase urgency and accelerate timeline to match up with potential CISF readiness in 2022