



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
**ENVIRONMENTAL
MANAGEMENT**

German Fuel Processing Update to the South Carolina Nuclear Advisory Council

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Presentation Outline

- **Update on the National Environmental Policy Act (NEPA) process for the German Pebble Bed Research Reactor Fuel.**
- **Status of EM's efforts on the feasibility study regarding the potential acceptance and disposition of graphite-based spent nuclear fuel from Germany at the Savannah River Site (SRS)**
- **Potential Path forward**

Background

- **The Department's effort is to ensure US-Origin materials are stored, processed, and dispositioned to reduce, and potentially eliminate, the amount of US-origin highly enriched uranium (HEU) at civilian facilities worldwide.**
- **German Pebble Bed Research Reactor Fuel under consideration is approximately 1 million graphite spheres stored in Jülich and Ahaus, Germany originally containing ~900 kg of HEU (prior to irradiation) from US.**
- **At request of German government, EM is conducting a feasibility evaluation for possible acceptance, return to SRS, and alternatives for disposition.**
- **Savannah River National Laboratory (SRNL) researched the ability to chemically oxidize the graphite matrix encapsulating the HEU fuel kernels to allow processing of the fuel.**
- **Environmental Assessment (EA) is being prepared to evaluate impacts of return of this US-origin material to the Savannah River Site and alternatives for disposition if the decision is made to accept the material.**

NEPA Process for German HEU Fuel Environmental Assessment (EA)

- **Published Notice of Intent to prepare the German HEU Spent Nuclear Fuel EA (DOE/EA-1977) in June 4, 2014 *Federal Register*; this began the NEPA process**
- **Draft EA evaluates the new technological approach**
- **The Draft EA approval expected within a few days followed by a Federal Register Notice announcing its availability and public meeting.**

NEPA

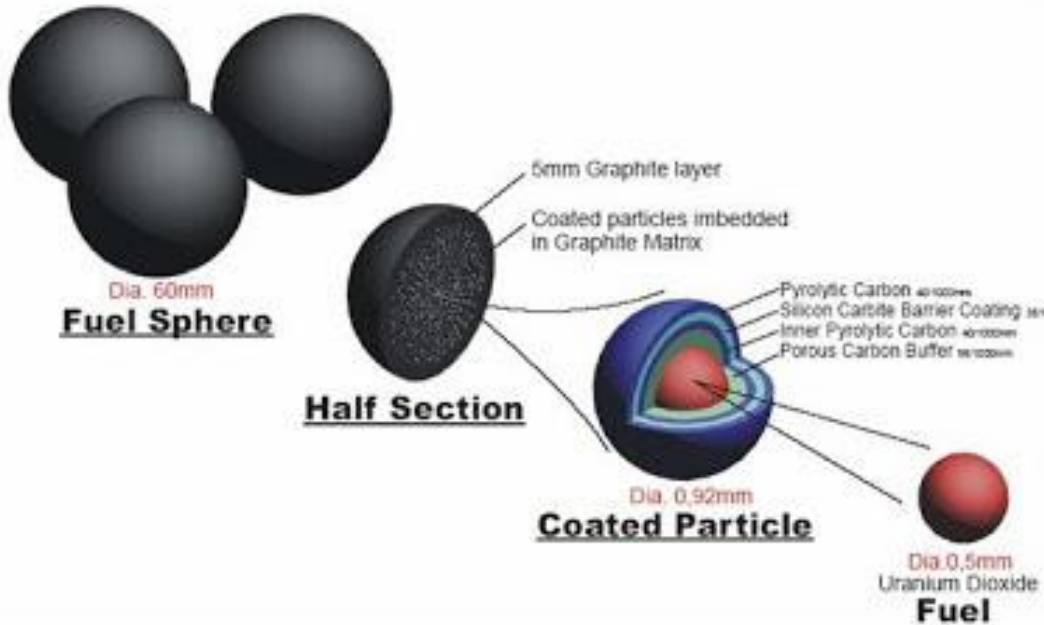
The National Environmental Policy Act establishes a process for decisionmakers to use in considering the potential environmental impacts (both positive and negative) of major actions before making decisions.

It requires a Federal agency to consider the potential environmental, human health, and socioeconomic effects of a proposed action and a range of reasonable alternatives for implementing the action, including the option of taking no action at all. The No Action Alternative provides a baseline against which to compare other alternatives.

- EM-1 signs the Draft EA for release to public
- Notice of Availability is published in the Federal Register within 3 working days after released by signature
- Public meeting will be held approximately 2 weeks after Federal Register notice
- Public comment period will be a 45-day duration
- Comments received will be evaluated and incorporated to the extent appropriate
- A final EA will be issued along with the NEPA determination

The Final EA and a positive NEPA determination will NOT constitute a decision to accept the German material by the Department.

Composition of German HEU Fuel



- **Approx. 1 million, 60mm graphite spheres**
- **Characteristics of a Sphere:**
 - ~ 200 g of A3-3 graphite
 - 1g of Uranium, ~93% enriched
 - 10g of Thorium
- **Currently Stored in 455 CASTOR casks:**
 - AVR, (Jülich)
 - THTR-300 (Ahaus)

Source of Material

- **US origin HEU material was provided for purposes of peaceful uses and development of nuclear energy**
 - Explored the use of coated fuel particles embedded in graphite spheres, used in pebble-bed reactors, cooled by helium (high temperature gas-cooled reactor, HTGRs)
- **Used in two research reactors in Germany**
 - AVR Reactor (1967-1988) was the first high temperature reactor in Germany to test the technology of graphite spheres
 - THTR-300 (1983-1989) was a demonstration research reactor to prove the AVR concept design to produce electricity

graphite SNF spheres



AVR Research Reactor,
15MW(e), Jülich



THTR-300, Prototype Research
Reactor, 300 MW(e),
Hamm-Uentrop

CASTOR Cask

- Casks are certified in Germany by the German equivalent to the US Nuclear Regulatory Commission (NRC)
- Casks are being reviewed for acceptance as DOE/US Department of Transportation (DOT) - certified Type B Casks.



CASTOR Cask cut away

Research Efforts to Date

- Separation of fuel kernels from the graphite matrix is a concern for processing
- Funding for Research and Development (R&D) is being provided by Forschungszentrum Jülich (FZJ) via two Work for Other contracts. FZJ transferred ownership of the Jülich material to the Arbeitsgemeinschaft Versuchs-Reaktor (AVR) GmbH. Effective January 1, 2016, the AVR company changed to Jülicher Entsorgungsgesellschaft Für Nuklearanlagen mbH (JEN)
- SRNL research and development is focused on chemical digestion of the graphite; results to date are very successful
- Due to found efficiencies, SRNL changed from a molten salt digestion technology to a vapor digestion technology
- This change in technology :
 - allows better control of the digestion process
 - is more adaptable to remote handling operations; and
 - reduces the amount of waste generated
- Next steps are to demonstrate the technology on a pilot scale size and optimization of the process. **(Contingent on NEPA Determination and future funding from FZJ/JEN)**



Results after 6 hours on
graphite only pebbles



Recovered fuel from unirradiated graphite pebbles

FUNDED ACTIVITIES:

- **An independent Technology Readiness Assessment (TRA) was conducted in December, 2015**
- **The TRA assessed progress, validated system components, and determined maturity of the technology.**
- **This assessment supports the SRNL Technology Development Team by identifying data gaps and allows for planning subsequent actions to help reduce risks related to successful scale-up and eventual implementation of the system.**
- **Final TRA Report is expected to be finalized by end of January, 2016.**

POTENTIAL FUTURE ACTIVITIES:

The following activities must be completed before DOE can make a decision on the acceptance of German material containing US-origin HEU:

- Irradiated sample testing to confirm anticipated fission products pathways
- Development of a pilot scale system including the remote handling of the CASTOR casks.
- A Technology Readiness Assessment to confirm Engineering Scale of the System has been achieved
- Establishment of a full cost recovery contract with the appropriate German entities.
- Department would hold a Public meeting to discuss the decision if technology is proven successful.

Summary

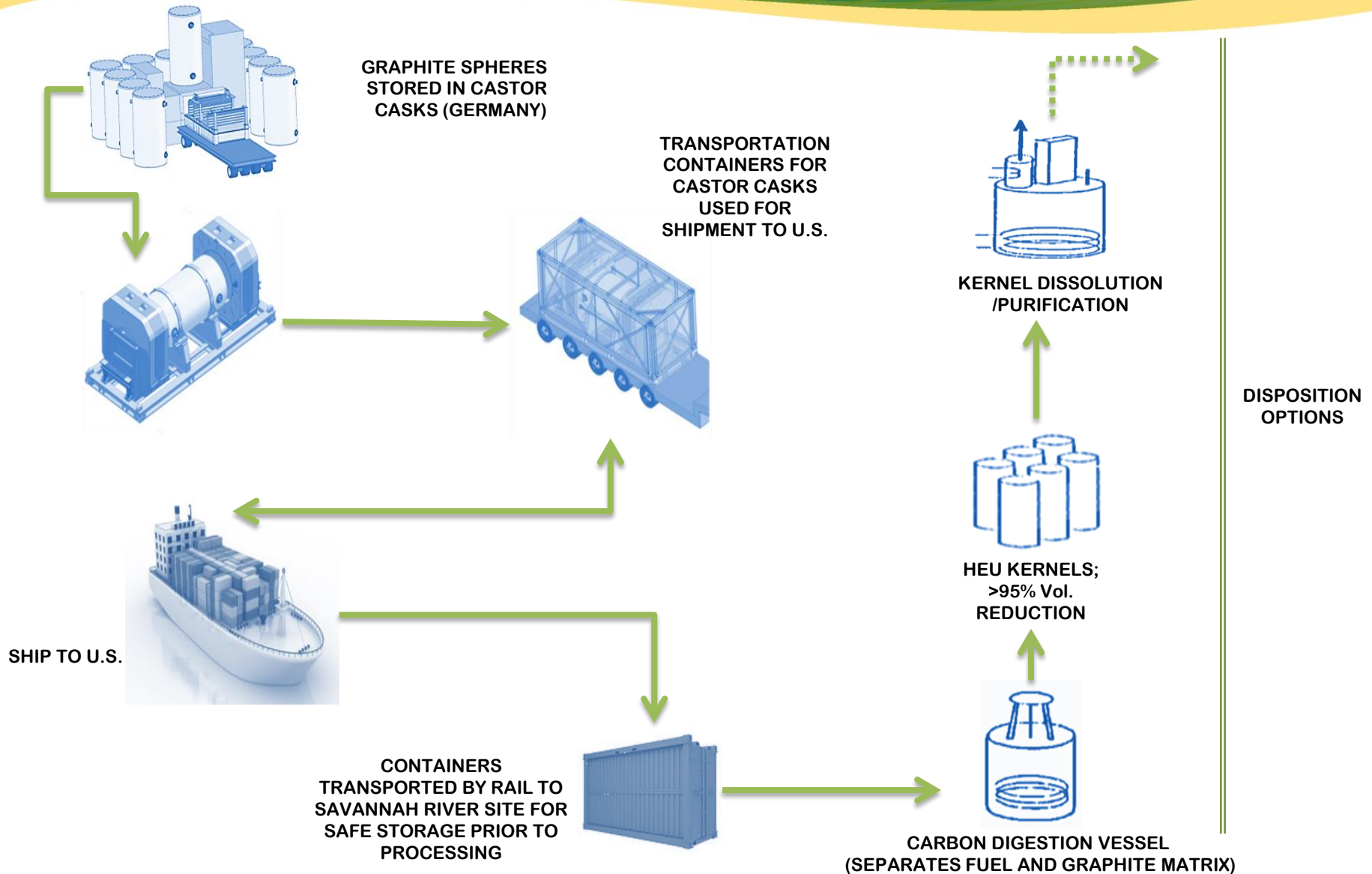
- The disposition of this material supports the Department's objectives to reduce and eliminate the amount of US-origin HEU at civilian facilities worldwide.
- The Technology Maturation work is being done at SRS and funded by Germany
- Public involvement is an important component in DOE's decision making process
- More technology maturation is necessary before the Department can make a decision

BACKUP SLIDES

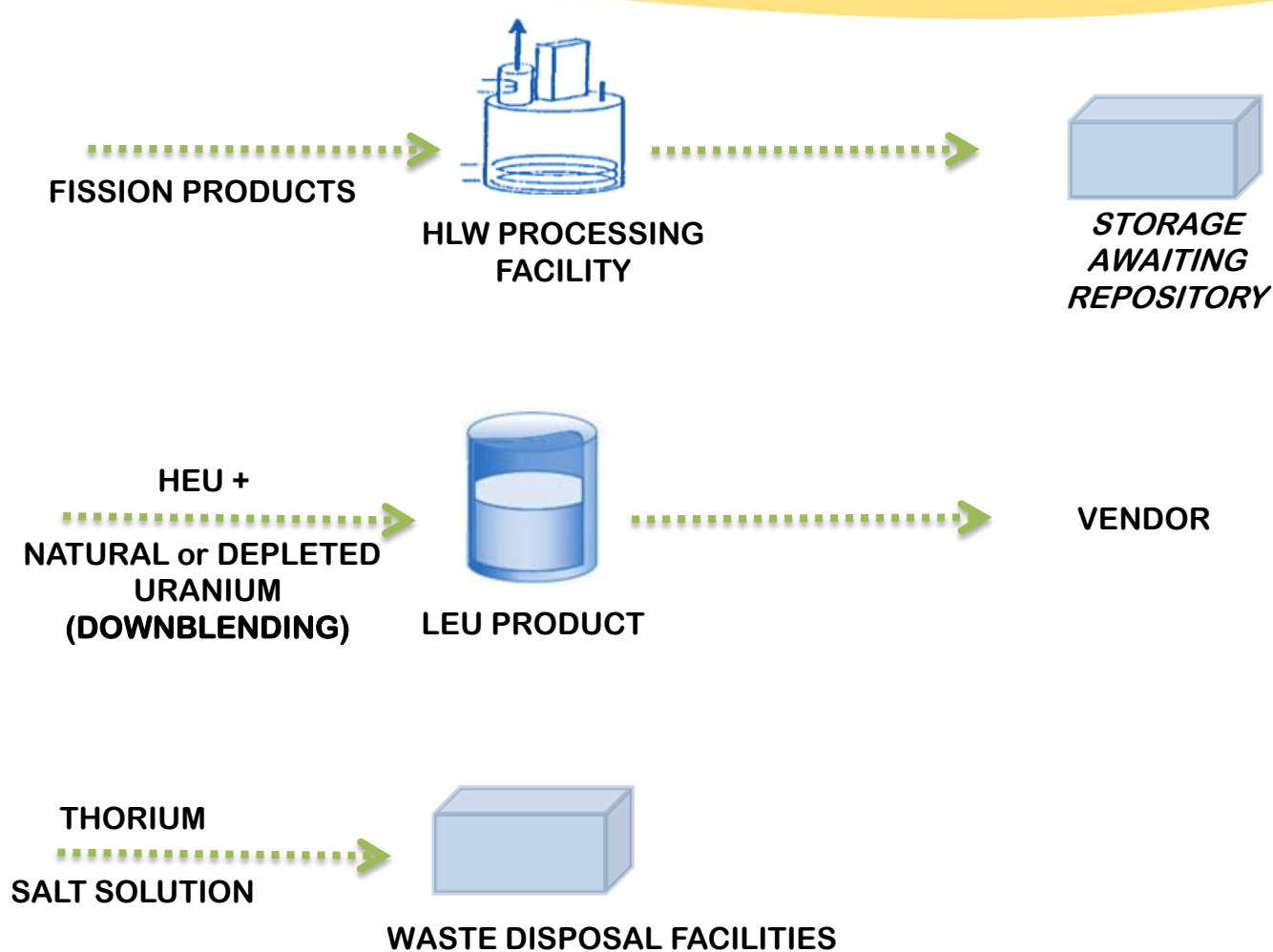
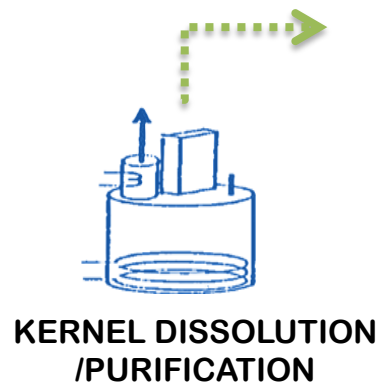
Alternatives being evaluated in the Draft EA

- **No action**
- **Options for disposition of the uranium after receipt, storage and chemical digestion of the graphite:**
 - 1) **Dissolution of the fuel kernels followed by, purification, and down blending the highly enriched uranium to low-enriched uranium for reuse as a reactor fuel**
 - 2) **Dissolution of the fuel kernels followed by vitrification in a High Level Waste Processing Facility at SRS with disposal of waste without down blending**
 - 3) **Dissolution of the fuel kernels followed by separating the uranium, down blending to LEU, solidifying, and sending the uranium as waste to an appropriate radioactive waste disposal site**

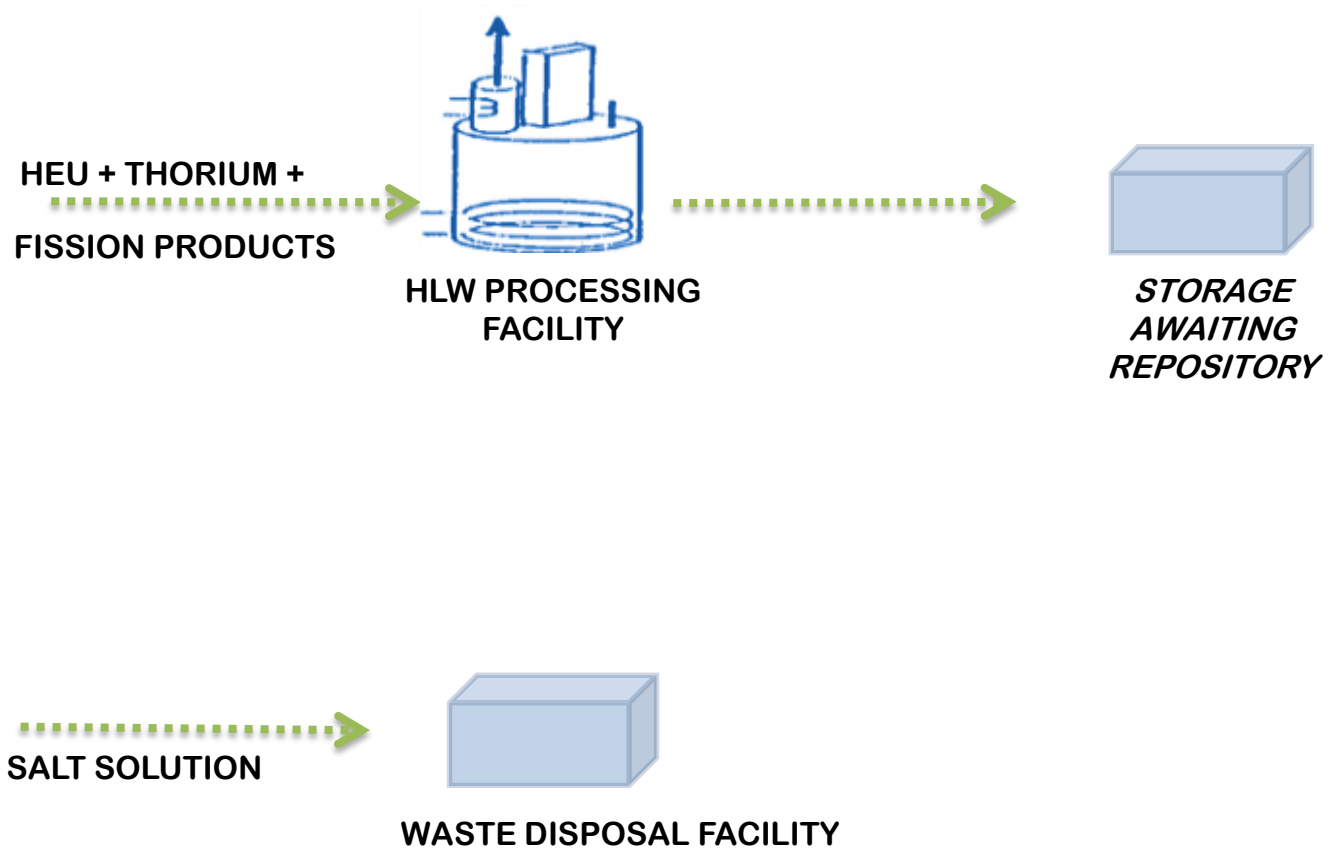
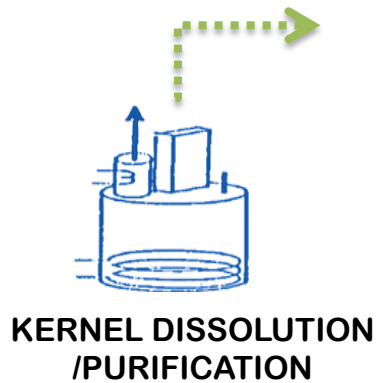
German Research Reactor HEU Fuel Potential Disposition Options Common Processes



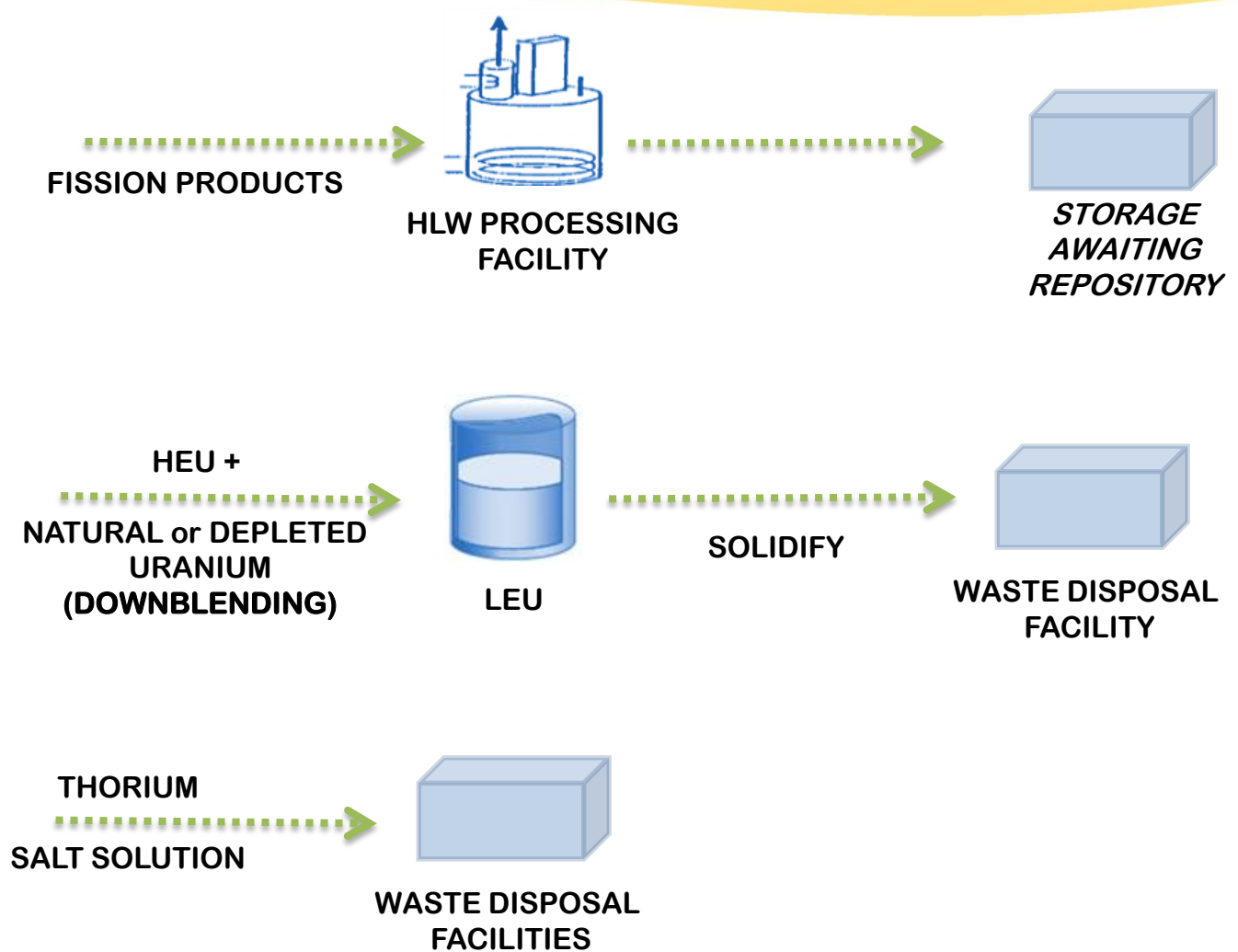
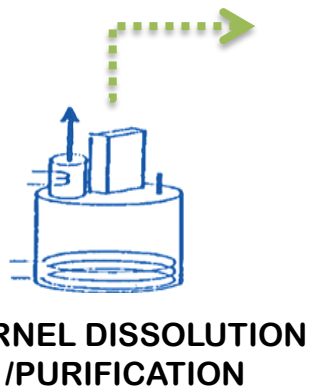
Option 1: Downblend for Reuse



Option 2: Vitrification in a HLW Facility - No Downblend



Option 3: Separate Uranium, Downblend, Solidify and Disposal



- **German HEU Fuel EA considers:**
 - Transportation in the global commons, US territorial waters and in the United States
 - Receipt and storage of the German Spent Nuclear Fuel
 - Carbon digestion (SRNL technology)
 - Processing of the fuel kernels after digestion
 - Material Disposition
 - Waste Management



Areas to be Analyzed as part of the EA

(not all inclusive - listed only to facilitate comment on the scope of the EA)

- **Impacts to general population and workers**
- **Impacts of emissions on air and water quality**
- **Impacts on ecological systems and threatened and endangered species**
- **Impacts on waste management activities**
- **Impacts on transportation of radioactive materials, including transport across the ocean**
- **Impacts that could occur as a result of postulated accidents and intentional destructive acts (terrorist actions and sabotage)**
- **Potential disproportionately high and adverse effects on low-income and minority populations (environmental justice).**
- **Short and long term land use impacts, including potential impacts of disposal**
- **Cumulative impacts**
- **Socioeconomic effects**