



## **HALEU: The Path Forward**

Elmer Dyke

Executive Vice President of LEU Operations and Corporate Business Development

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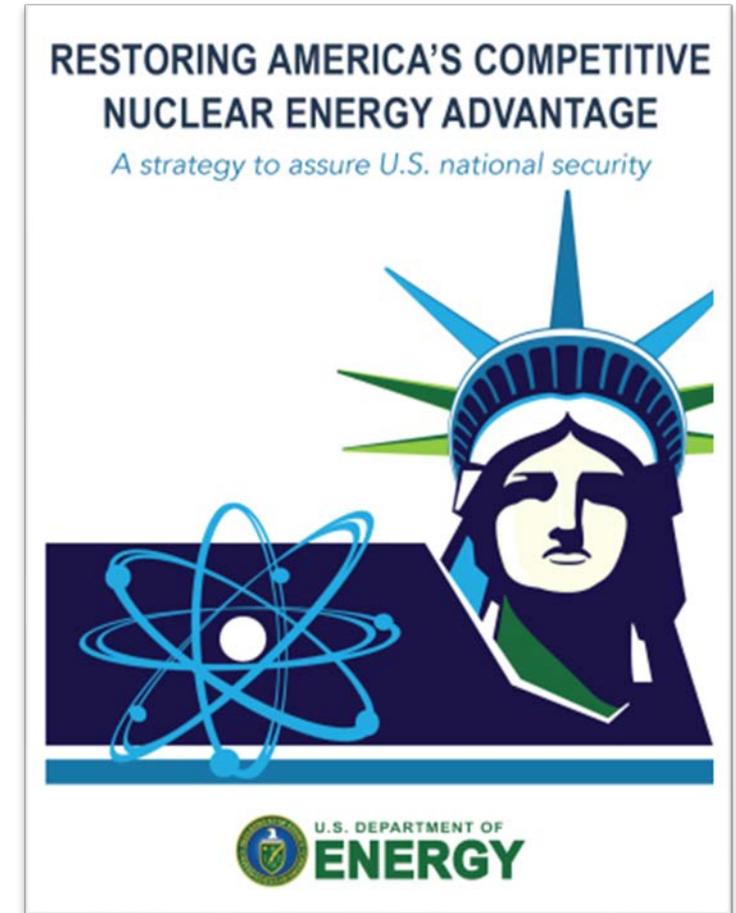
# Forward-Looking Statements

**Disclaimer:** My commentary and responses to your questions may contain forward-looking statements, including my outlook on the remainder of the year and future periods, and Centrus undertakes no obligation to update any such statement to reflect later developments. Factors that could cause actual results to vary materially from those discussed today include changes in the nuclear energy industry, pricing trends and demand in the uranium and enrichment markets and their impact on Centrus' profitability, the competitive environment for Centrus' products and services, the impact and potential extended duration of the current supply/demand imbalance in the market for low-enriched uranium, risks related to trade barriers and contract terms that limit Centrus' ability to deliver LEU to customers, risks related to actions that may be taken by the U.S. government or other governments that could affect Centrus' ability or the ability of Centrus' sources of supply to perform under contract obligations, including the imposition of sanctions, restrictions or other requirements, as well as those provided in Centrus' most recent Annual Report on Form 10-K and subsequent reports as filed by Centrus with the SEC.

**Industry / Market Data:** Industry and market data used in this presentation have been obtained from industry publications and sources as well as from research reports prepared for other purposes. We have not independently verified the data obtained from these sources and cannot assure you of the data's accuracy or completeness.

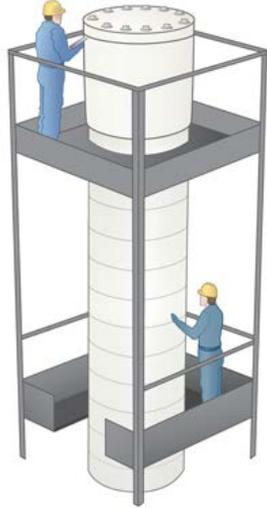
# New National Strategy to Restore U.S. Fuel Cycle Leadership

- Report from White House Nuclear Fuel Working Group offers the most comprehensive, thoughtful, and thorough statement of U.S. nuclear fuel policy in decades.
  - clearly defines the strong U.S. national interest in having robust domestic nuclear fuel production capability.
- Establishing HALEU production infrastructure is a key focus of the new national strategy to reestablish and reassert America's nuclear fuel leadership.
- Expanding American Assured Fuel Supply to include unobligated enriched uranium would help create a clear demand signal that would catalyze U.S. mining, conversion, and enrichment.



# HALEU Demonstration Program

2019-2020



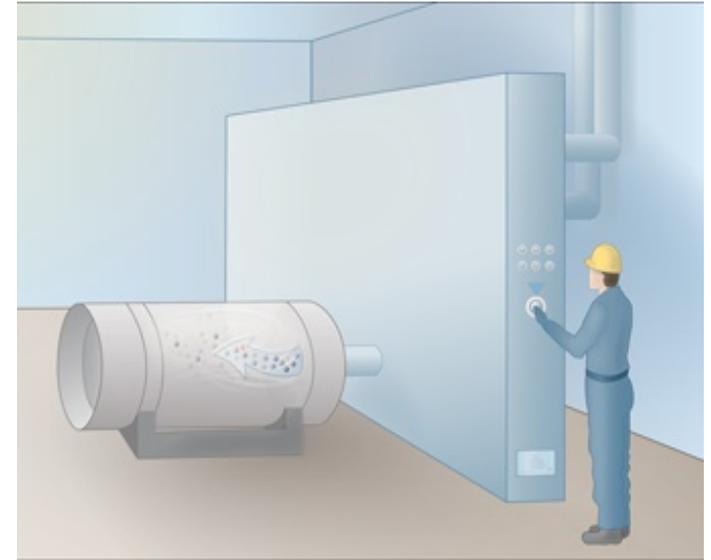
**Facility Design, Licensing, &  
Machine Manufacturing**

2020-2021



**Install, Commission, & Operate  
16-Machine AC100M Cascade**

Early 2022



**Produce 19.75% HALEU  
for DOE Use**

***Will be first U.S. enrichment facility licensed for 19.75% HALEU***

# No Coronavirus Impact on Project Schedule, Yet



- First four milestones completed on/ahead of schedule.
- Working closely with DOE to mitigate any COVID19-related impacts that may occur. Program currently is on schedule and on budget.
- Coronavirus has constrained operations in Piketon and Oak Ridge, but most unclassified work can be done via telework (licensing, etc).

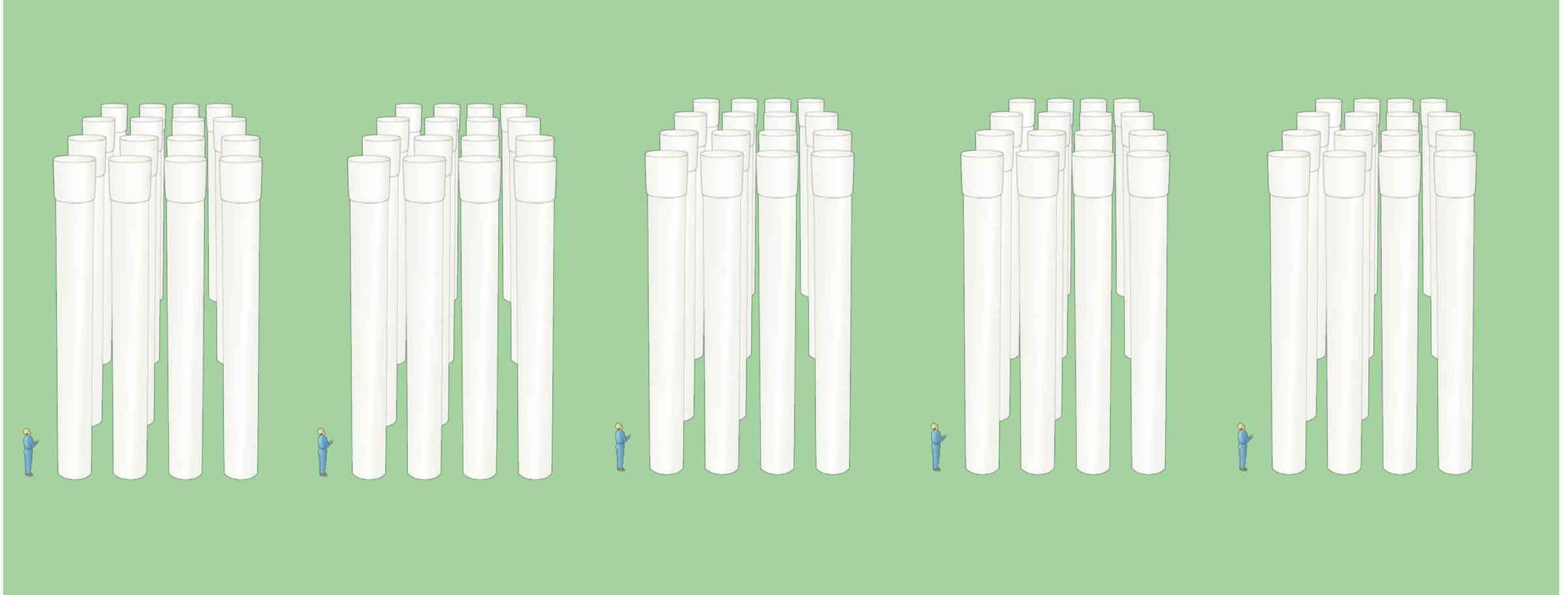
# Small Modular Fuel Production



**16 Machine Cascade:**

**~900 KgU HALEU/yr  
(19.75% U-235)**

# Small Modular Fuel Production



***Modular expansion of enrichment to match demand***

# Three Big Questions

- 1) Transportation
- 2) Economics
- 3) Demand – Chicken and Egg

# Transportation: Shared Challenge, Shared Solutions

## Government and Industry should look at this question as two distinct pathways

1. LEU+ (5% -10%)
  - EITHER: Use of existing 30B cylinder with DN30 overpack:
    - Requires analytical confirmation for regulatory/license exemption to 10% as a long-term solution
    - DN30 overpack can be demonstrated to be a safer and more robust option over the UX-30
  - OR: Development of a New Cylinder with moderation control
    - Requires Industry and Regulatory backing for design, testing and manufacture of a long-term solution
2. HALEU (10% - 20%)
  - Use existing 5B cylinder:
    - Requires development of a modified DN30 overpack with integrated 5B storage racks
  - Will need a more robust solution with increased capacity as HALEU volumes develop

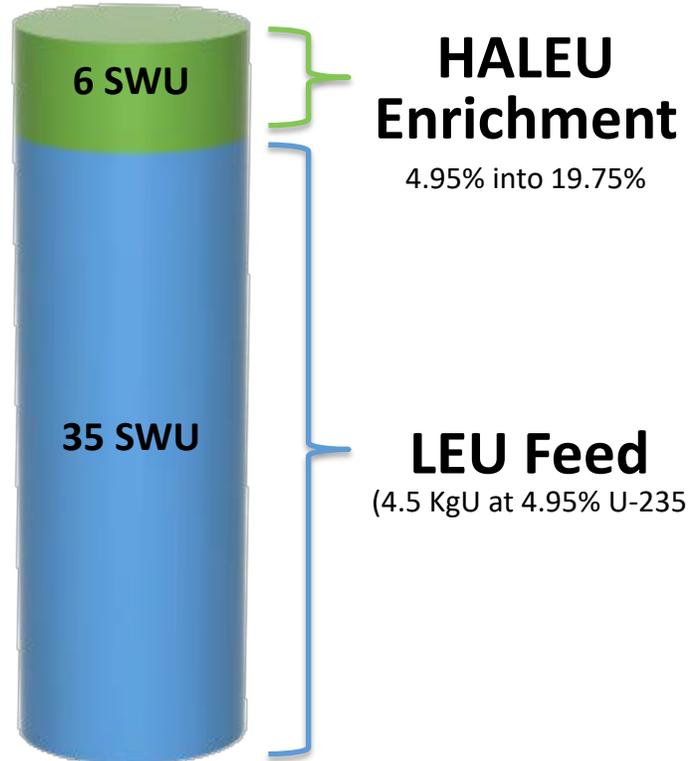
## Industry Task Force

- NRC, DOT, National Labs, Industry Groups, Enrichers, Fabricators, Utilities
- DOE Leadership to prioritize the issues, develop the project plan and channel resources
- Access to DOE testing facilities (e.g. Sandia National Labs)
- Requires sustained and dedicated funding with special funding profile such that interdependent projects are not competing for the same finite resource, i.e. Transport vs Next Generation Fuels vs Advanced Reactors

*Need for Industry & USG Cooperation & Collaboration*

# HALEU Economics

1 KgU HALEU  
(19.75% U-235)



- The feed material for a HALEU cascade is 4.95% LEU.
  - LEU feed could be produced on site by an adjacent cascade or purchased elsewhere.
- Roughly 85% of the SWU needed to produce HALEU is already contained in the LEU feed material.
- **KEY TAKEAWAY:** As we scale up, the biggest factor in fuel costs of commercial advanced reactors will be the market price of 4.95% LEU (natural uranium, conversion, & enrichment).

# USG vs. Commercial Demand for HALEU

	Quantity	Timing	Customer
Research Reactor Conversion (HEU to HALEU)	3-7 MTU/yr <sup>1</sup> (through 2033) 7-9 MTU/yr <sup>1</sup> (after 2033)	2020 -	DOE/NNSA
DOD Microreactors	~1-3 MTU (?) per reactor	Mid 2020s	DOD
First of a Kind / Demonstration Reactors	~0.5-5 MTU (?) per reactor	Mid 2020s	DOE + Commercial
Nuclear Energy Leadership Act (proposed)	10 MTU (2022) 50 MTU (2025)	2022-2025	DOE
Nth of a Kind Advanced Reactors	large, but uncertain	2030s	Commercial
Accident Tolerant Fuels	large, but uncertain	Late 2020s/ early 2030s	Commercial

In the 2020s, U.S. government requirements for HALEU are larger and more predictable than commercial demand.

Commercial demand could be larger by the 2030s but is more uncertain.

1) Source for research reactor HALEU quantities: DOE/NNSA, Amendment to NNSA RFI for Supply of Enriched Uranium (Q&A), 2017.

# Which will come first?



## Advanced Reactors:

Who will buy them from the U.S. if the U.S. lacks a guaranteed fuel supply?

## High Assay Enrichment:

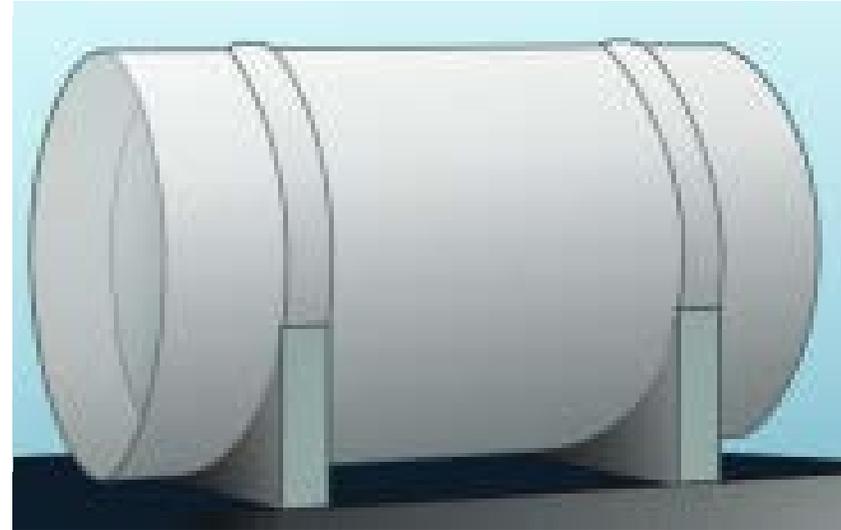
Who will invest in HALEU licensing/production without a guaranteed customer base?

# HALEU: Why Not Establish a Reserve?



**HALIBUT**

Use within 2-3 days

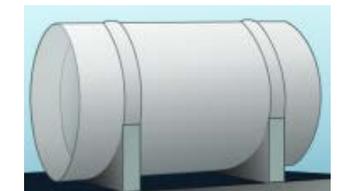
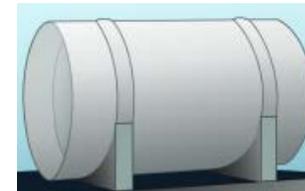
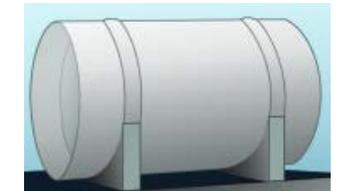
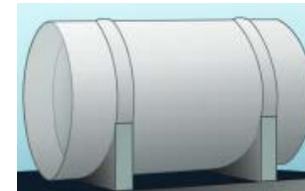
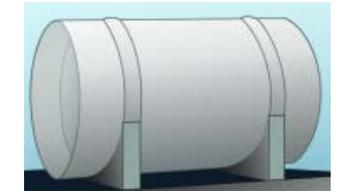
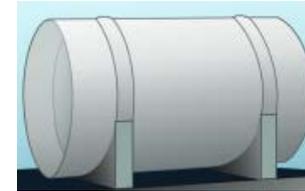
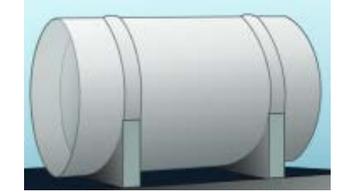
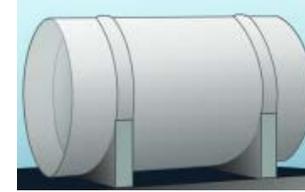
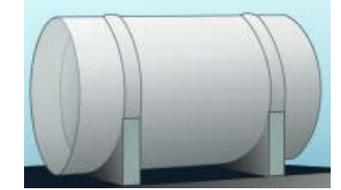
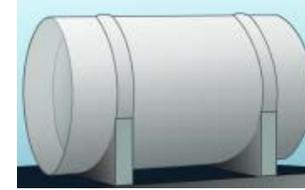


**HALEU**

Use within 703.8 million years

# Proposal: HALEU Fuel Reserve

- Scale up production to ~10 MTU/yr of unobligated HALEU and hold in reserve until needed.
  - Requires U.S. mining, conversion, enrichment, deconversion
  - Establish advanced fabrication (e.g. TRISO, molten salt, metal).
- Won't go to waste
  - NNSA needs 3-7 MMTU/yr for research reactors
  - Shelf life: 703.8 million years
- ***Solves Chicken and Egg problem.***
- Government owned, contractor operated (GOCO) sized to USG requirements. Allow privately financed modular expansion as commercial HALEU demand grows.



# A Proven Model

- U.S. built gaseous diffusion plants for military use.
- Made capacity available for peaceful nuclear power.
- Civilian nuclear power industry could not have emerged without it.
- Leadership in international fuel market allowed United States to set global standards for nonproliferation.



**U. S. TO RELEASE URANIUM FOR USE BY  
FREE WORLD IN PEACEFUL ATOM POWER**

Value Of \$1 Billion Is Set  
For U-235, To Fuel  
200 Big Reactors

The announcement said the United States will take "prudent safeguards against diversion of the material for non-peaceful purposes."

# U.S. Needs Complete Domestic Fuel Cycle for National Security

Producing unobligated fuel requires four capabilities:

**Mining**  
Declined 93% since 1980

**Conversion**  
U.S. plant offline since 2017

**Enrichment**  
Last U.S. plant closed in 2013

**Fabrication (HEU)**  
Online



**Fabrication (LEU)**  
Three plants operating in US



**Fabrication (HALEU TRISO\*)**  
Pilot scale capacity



**No foreign technology or materials may be used.**

*\*While HALEU can be fabricated into various other fuel forms (e.g. metal, molten salt, etc.), TRISO is the required HALEU fuel form for DOD's Project Pele.*

**Leverage this to create a U.S. source of HALEU for commercial reactors.**



*Fueling the Future  
of Nuclear Power*

*Fueling the Future  
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