Addressing HALEU Demand

Monica C. Regalbuto
INL Nuclear Fuel Cycle Strategy, Director

NEI/GAIN/EPRI HALEU Video Workshop
April 28, 2020

www.inl.gov

Idaho National Laboratory

Outline

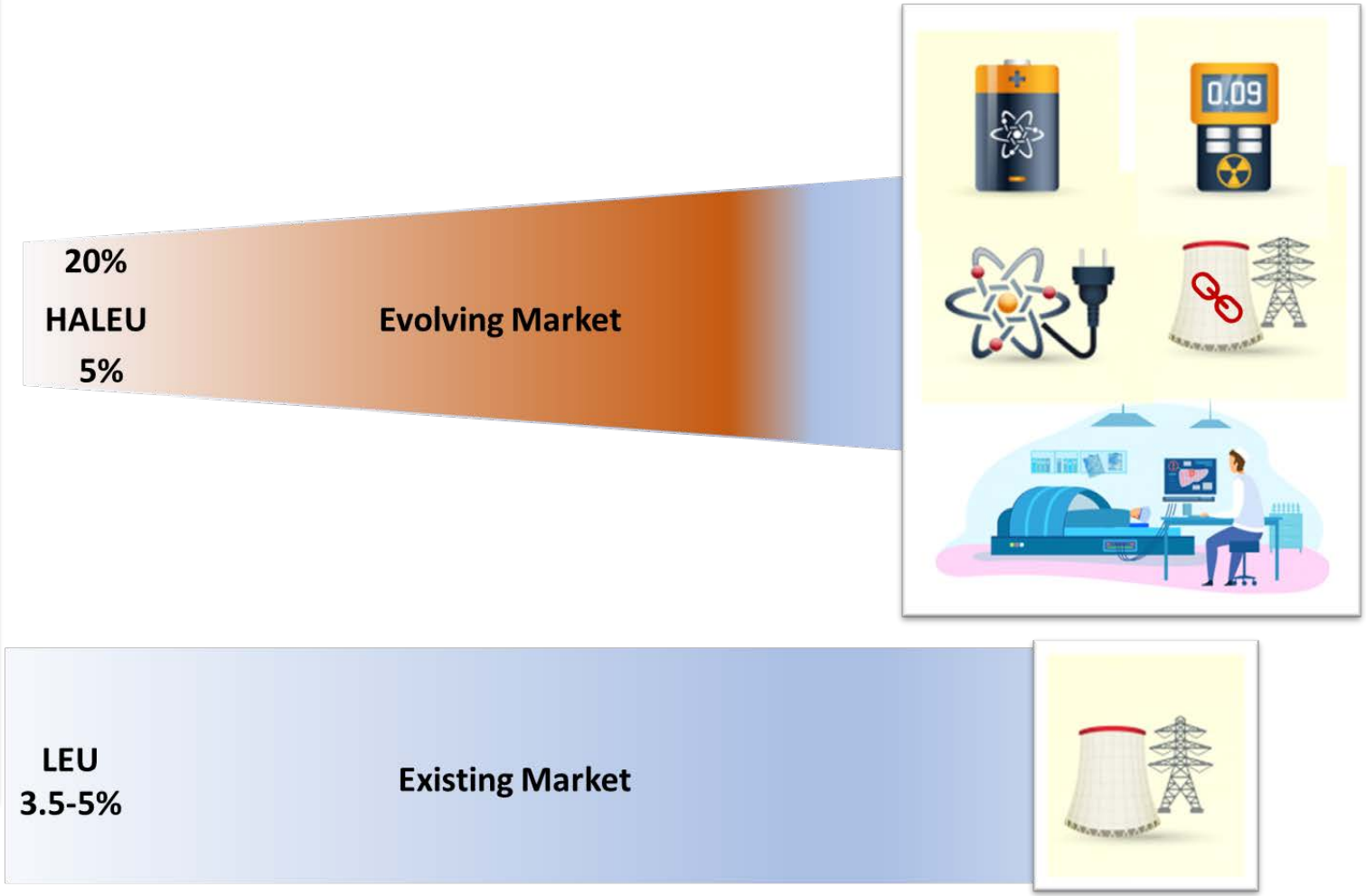
- **Demand and Timing**
- **Supply Phases**
- **Transitioning from an LEU to HALEU Economy**
- **Need for Integrated Supply Strategy**

Demand

- **Industrial Applications**
- **DOE-NE Research Reactors**
- **Long-Term Defense and Non-Defense NNSA Mission**

Timing

- **Fuel Research and Development**
- **Initial Core Demonstration**
- **Commercial Needs**



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High-Assay, Low-Enriched Uranium Supply Phases

HALEU Demand

HALEU Supply Phases

Early Movers	Market Evolution	Sustainable Market

HALEU Sources

Downblending

Current or recovered highly enriched uranium

- **Oxide, metal or other (fuel fabrication ready)**
- **Owner DOE**
- **Availability for use at DOE or alternative facility**
- **U vector 19.75% U-235 and U-238 or determined by irradiation history**

Enrichment

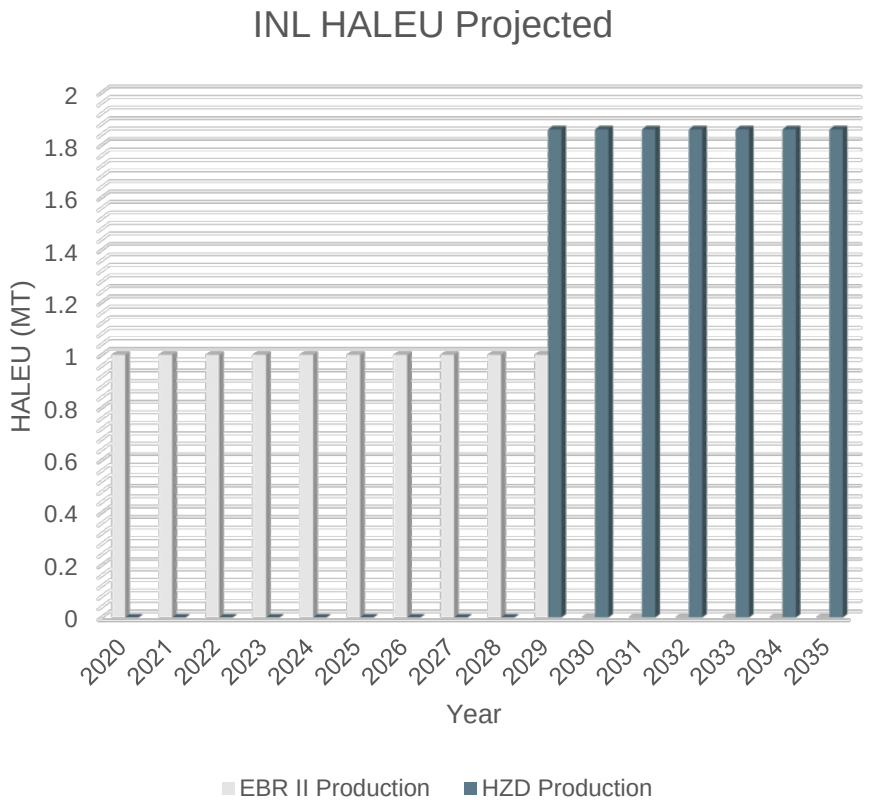
- **Uranium hexafluoride (UF_6)**
- **Owner enrichment company**
- **Availability at enrichment facility for transportation to fuel manufacturing facility**
- **U vector 19.75% U-235 and U-238**

Early Movers

An aggressive deployment schedule is being pursued by advanced reactor developers eager to penetrate an evolving world market

Various approaches support meeting HALEU demand in this phase:

- **Recovery and Downblending**
  - **INL – 1MT of HALEU per year until 2035. HEU downblending from EBR-II and ATR origin yields 10MT and 20MT**
  - **SRS – Potential 20MT HALEU available from fuel take back processing**
  - **BWXT – Downblending available HEU, 10MT by 2022 and 40MT by 2025**
- **Enrichment**
  - **The American Centrifuge Operating LLC - ongoing 16 machine cascade demonstration 600 kgs of UF_6**
  - **URENCO USA - commercial enrichment facilities for HALEU enrichment between 5% and 10%**



Market Evolution

- Without a commercial source of HALEU, only government or foreign stocks would be available to support reactor deployment.
- Relying upon market forces and demand will not be sufficient to create the needed HALEU fuel cycle capabilities at the time the industry will require them

Sustainable Market

- The HALEU market would reach the sustainable phase when
  - A large enough customer base is evident, which leads to securing long-term purchase agreements
  - Fuel procurement models and fuel cycle infrastructure financing tools evolve.
- The timing of when this point is achieved is not predictable

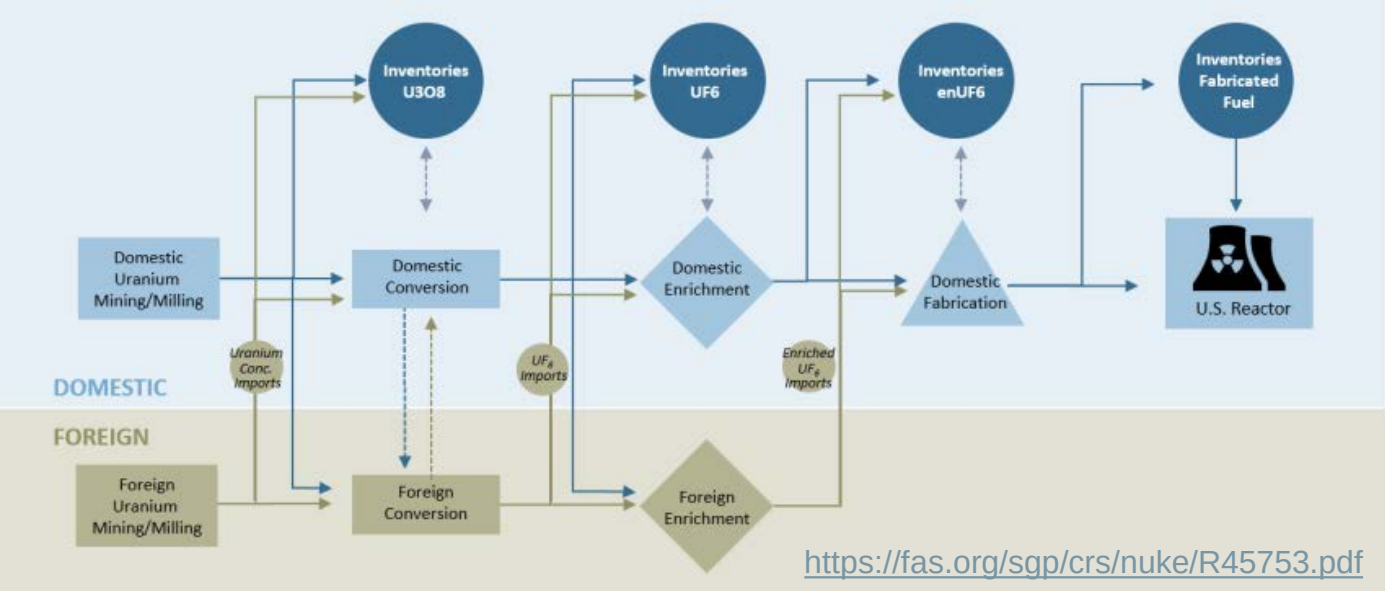
During the 1950's, LWRs were developed and government was the sole supplier of LEU. The required transition from an LEU to HALEU economy does not require starting from zero and could be achieved by right-sizing an initial HALEU fuel cycle infrastructure investment.

Transitioning from an LEU to HALEU Economy

Impacted by current front-end challenges

The HALEU market highlights the need to develop and maintain a reliable manufacturing supply chain

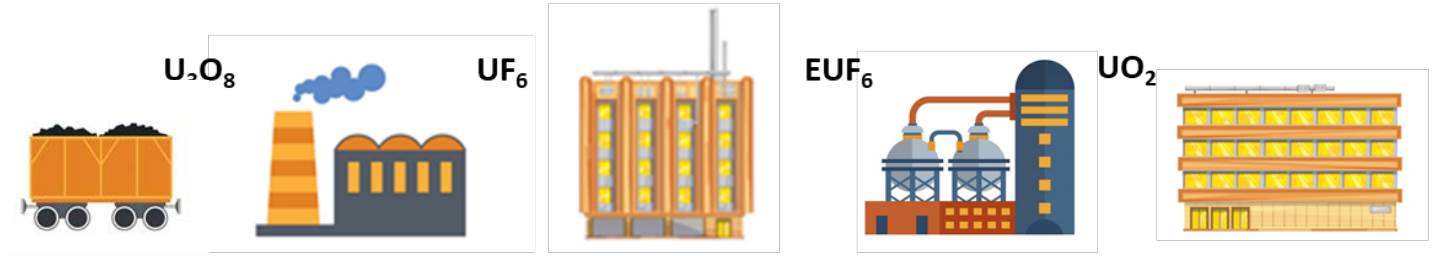
- The front-end of the U.S. fuel cycle capacity has been eroding since the early 1980s
- Uranium mining declined 92% since 1980
- The sole U.S. conversion plant idled operations due to market conditions in 2017
- The last U.S. enrichment plant capable of unobligated production shut down in 2013



https://fas.org/sgp/crs/nuke/R45753.pdf

Need for an Integrated Supply Strategy

LEU Front-end Supply Chain U-235 < 5%



Mining → Conversion → Enrichment → Deconversion → Fuel Fabrication

Transportation

HALEU Front-end Supply Chain U-235 between 5-20%

U-oxide
U-metal
U-nitride
Others

Developing the HALEU fuel cycle represents an opportunity to reinvigorate domestic mining, conversion, enrichment, deconversion and fuel fabrication in the U.S.

- ***The critical, impacted facilities that support a HALEU fuel cycle are enrichment, deconversion and fuel fabrication to include transportation***
- ***Production of HALEU enriched above 10% requires significant investments to support license, build, secure and operate HALEU fuel cycle infrastructure.***

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During this Workshop

It is important to evaluate viable options towards development of the U.S. HALEU economy that:

- **Take advantage of the existing LEU infrastructure**
- **Moves towards a right-sized integrated capability**

HALEU Demand

HALEU Supply Phases

Early Movers	Market Evolution	Sustainable Market

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