Nuclear Energy Ecosystem

May 15, 2024

Christine King, GAIN

Webinar: Advanced Nuclear: Benefits & Progress

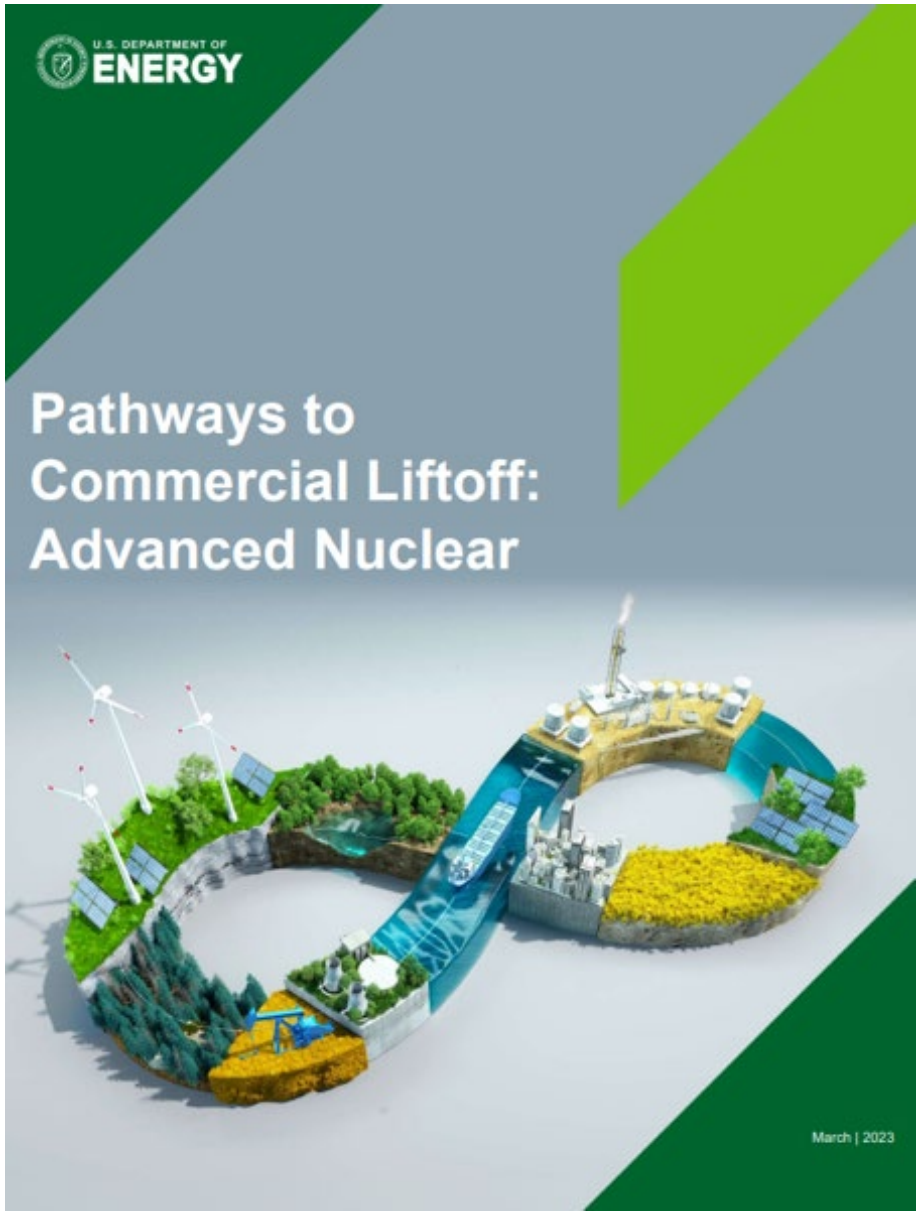
GAIN
Gateway for Accelerated
Innovation in Nuclear

INL/MIS-18-50189

Reaching U.S. net-zero goals, we need new nuclear capacity

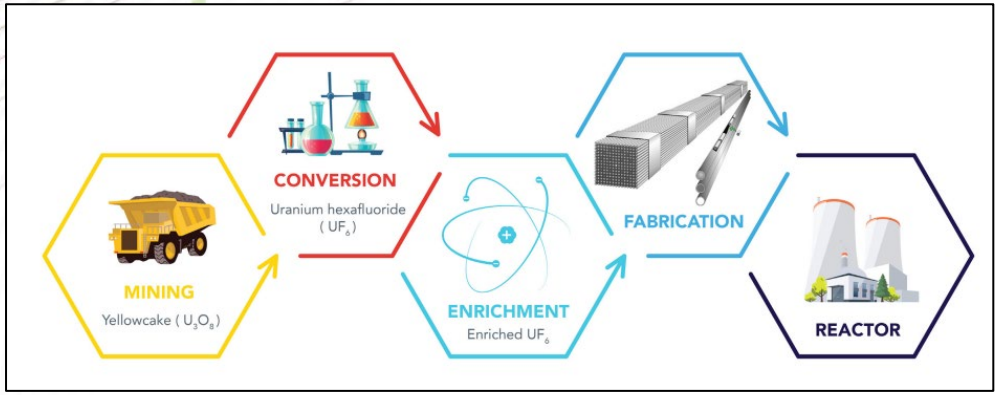
"Power system decarbonization modeling, regardless of level of renewables deployment, suggests that the ***U.S. will need ~550–770 GW of additional clean, firm capacity to reach net-zero."***

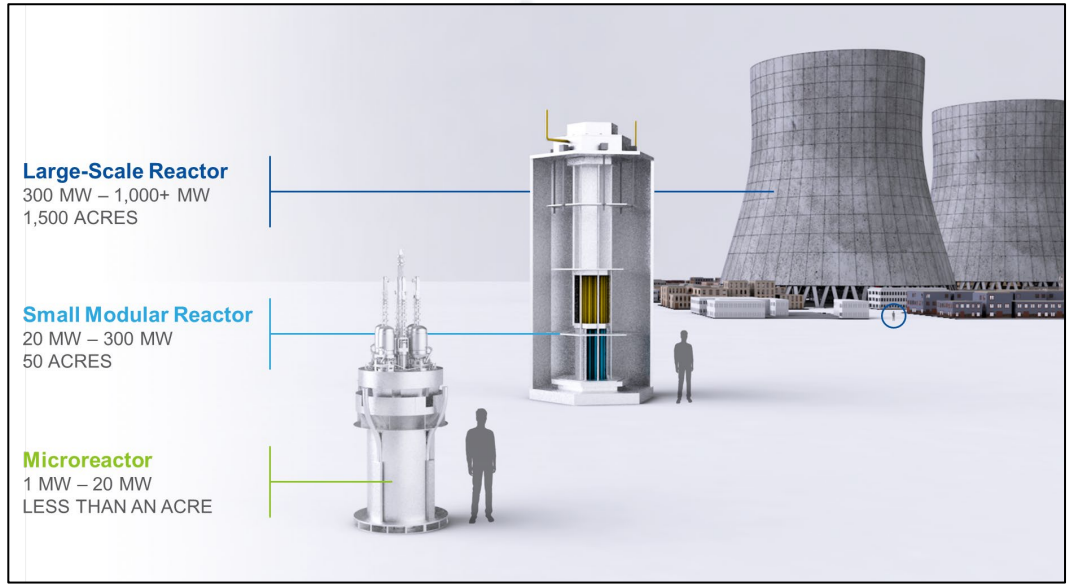
Domestic nuclear capacity has the ***potential to scale from ~100 GW in 2023 to ~300 GW by 2050***

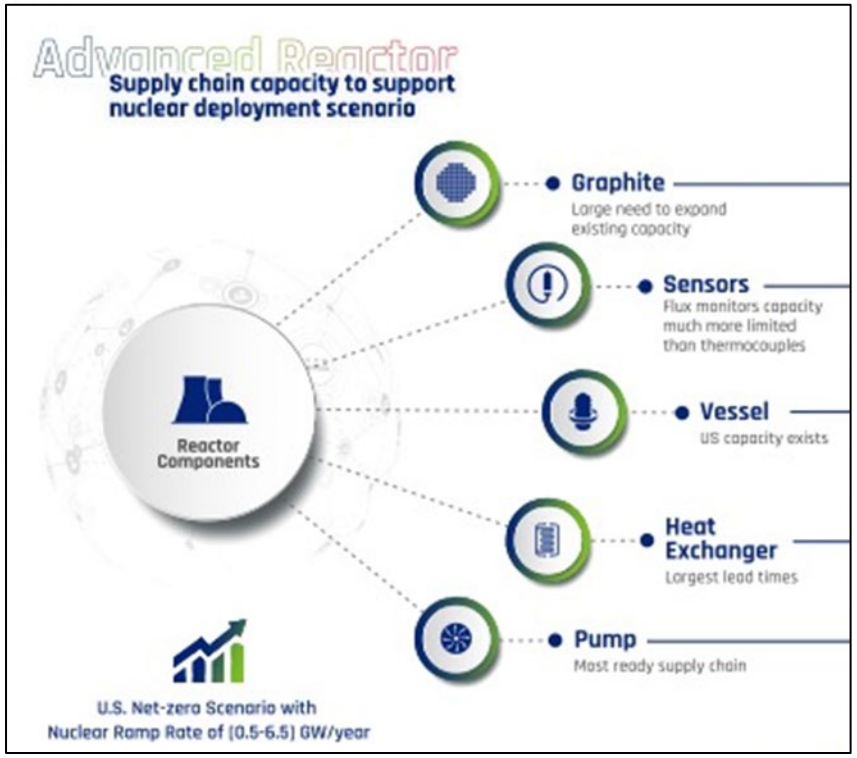


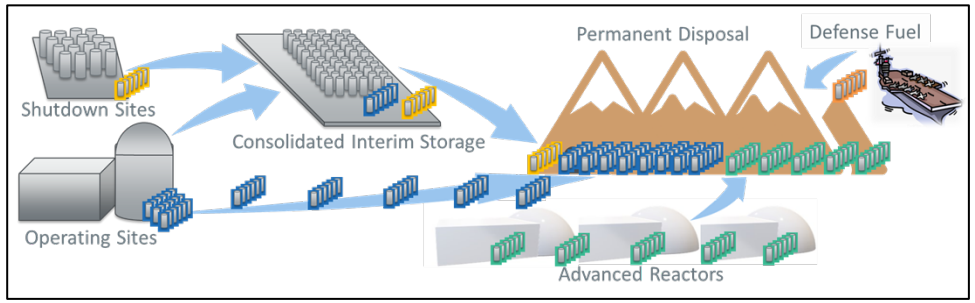
Nuclear Ecosystem

GAIN Gateway for Accelerated Innovation in Nuclear









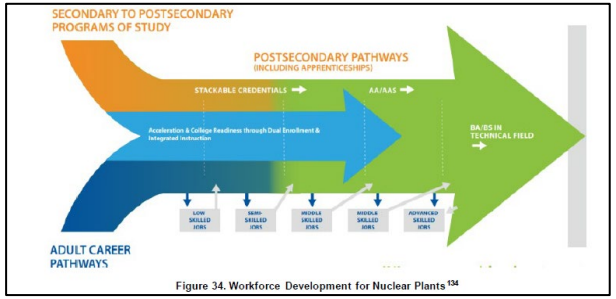
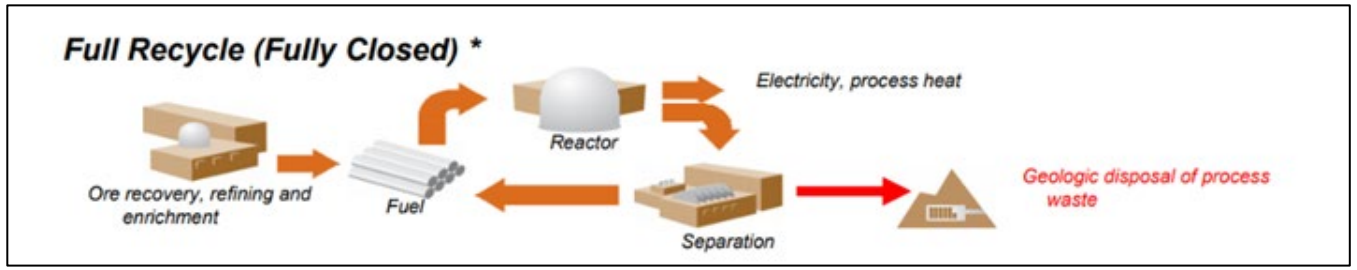
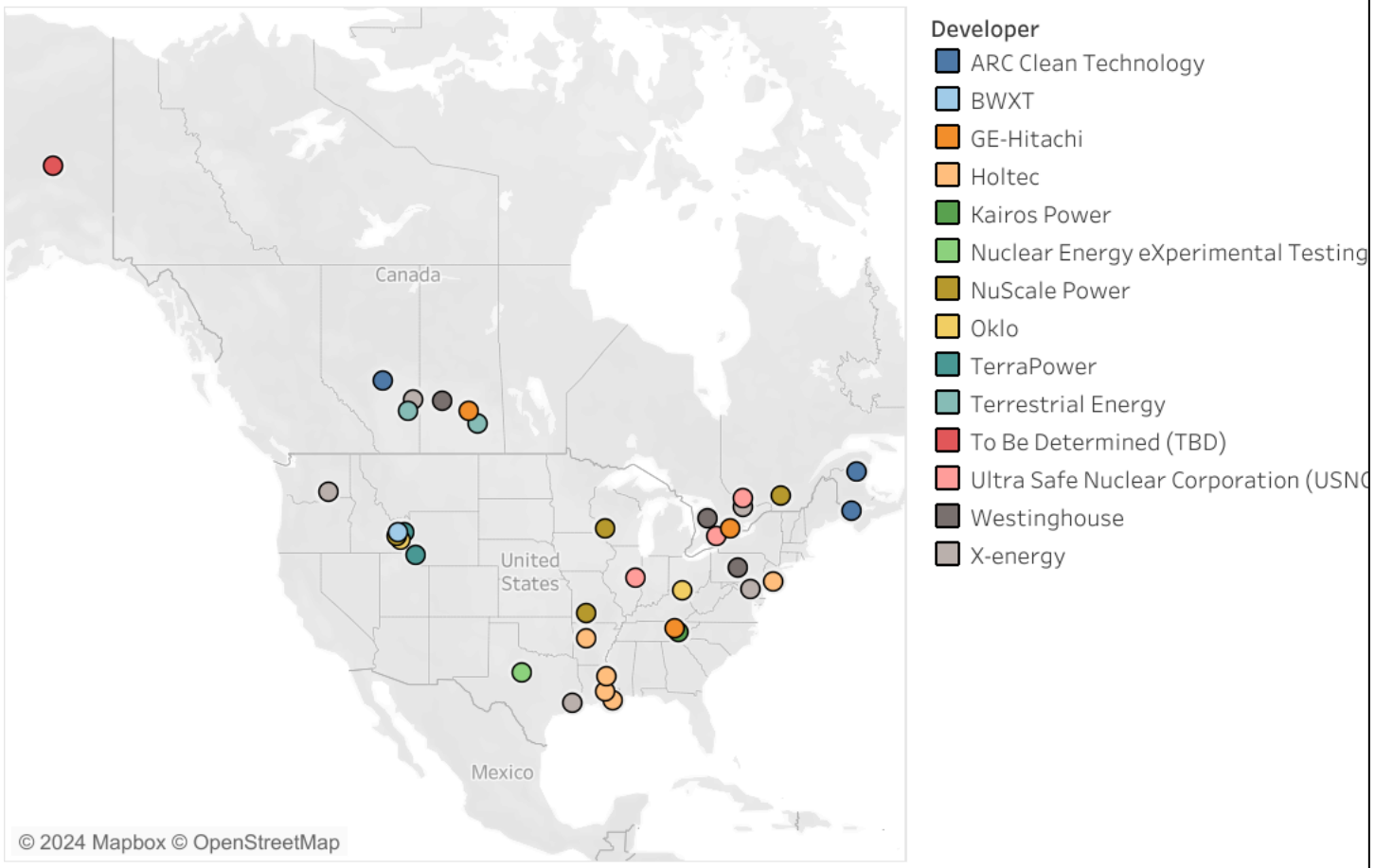


Figure 34. Workforce Development for Nuclear Plants [134]



North American Adv Nuclear
Nuclear Innovation Alliance June 23

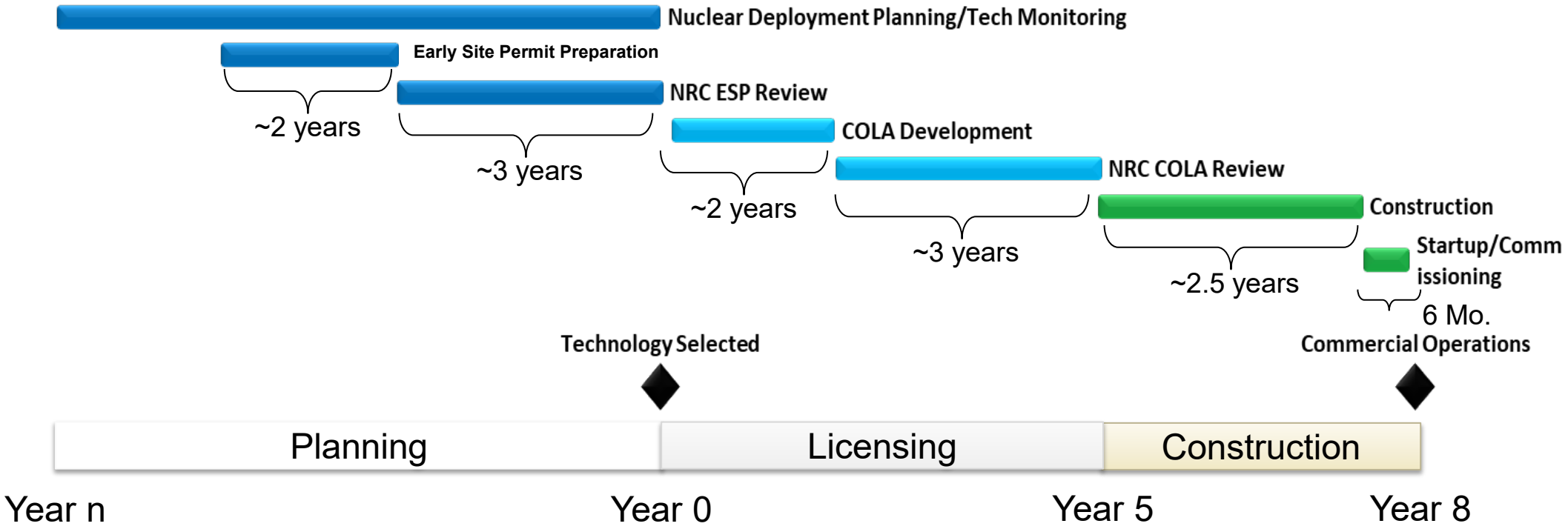


https://public.tableau.com/views/NIAMap-NorthAmerica-June8/Sheet1

37 Projects
- 12 Micro
  - 4 High Temperature Gas Reactor (HTGR)
  - 2 Sodium Fast Reactor (SFR)
  - 2 Molten Salt Reactor (MSR)
  - 3 Solid Core Heat Pipe Microreactor (HP)
  - 1 TBD
- 25 SMRs
  - 12 Light Water Reactor (LWR)
  - 5 High Temperature Gas Reactor (HTGR)
  - 4 Sodium Fast Reactor (SFR)
  - 2 Molten Salt Reactor (MSR)
  - 2 Fluoride Salt-Cooled High-Temperature Reactor (FHR)

18 deployment dates prior to 2030

Reactor Potential Deployment Path (Example Only)



State Nuclear Energy Feasibility Studies

Completed Working Groups

- Nebraska
- South Dakota

Completed Studies

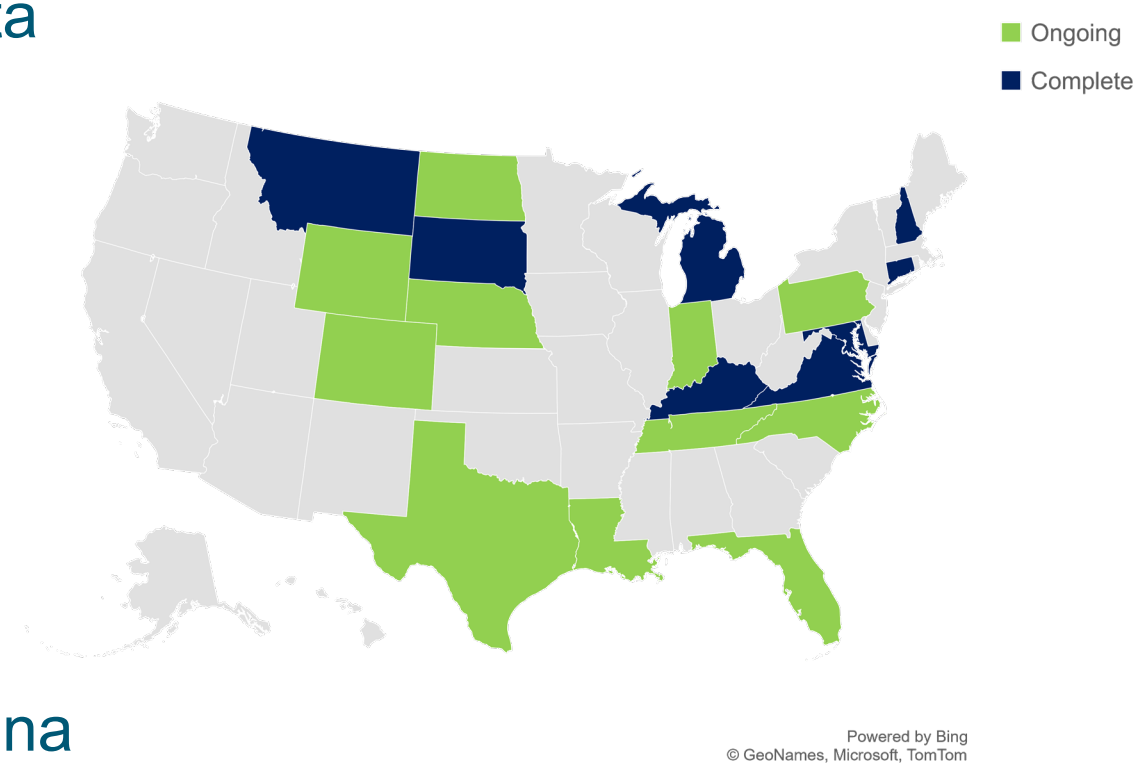
- Connecticut
- Kentucky
- Maryland
- Michigan
- New Hampshire
- Pennsylvania
- Virginia

Ongoing Working Groups

- North Dakota
- Tennessee
- Texas
- Virginia

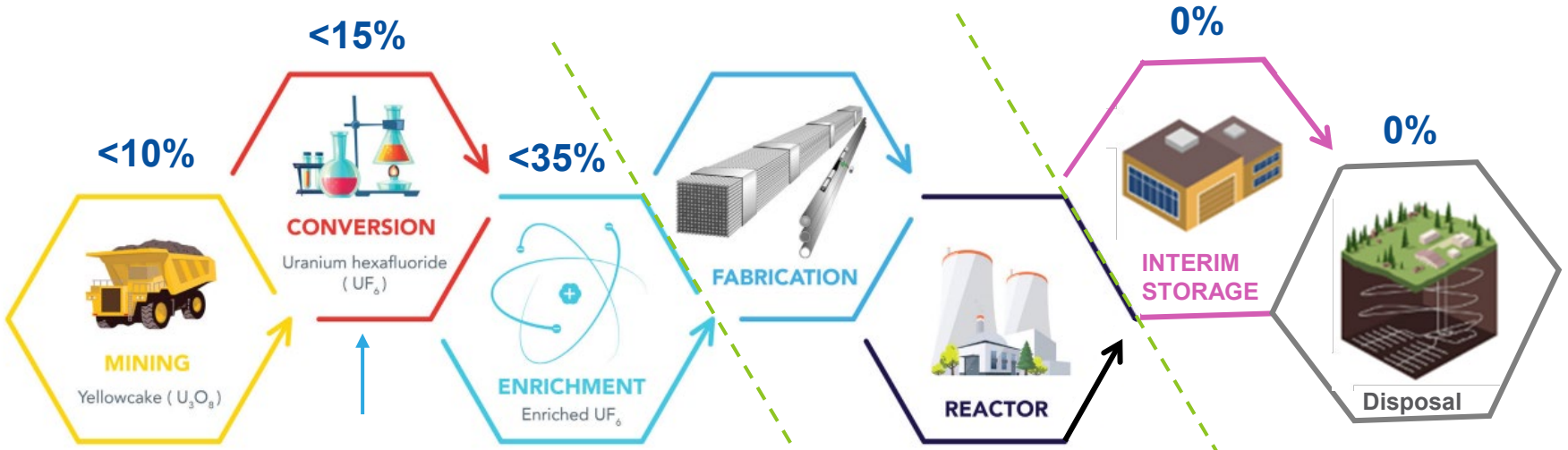
Ongoing Studies

- Colorado
- Florida
- Indiana
- Nebraska
- North Carolina
- Tennessee
- Texas



Current U.S. nuclear fuel cycle

Open fuel cycle, mainly LWRs using LEU fuel, with a limited front end and missing two key facilities to manage used fuel. The fragmented and incomplete fuel cycle is due to socio-political factors, not a lack of technologies.



Canada
Australia
Namibia
Kazakhstan
Uzbekistan
South Africa
Russia

Canada
United Kingdom
Australia
South Africa
Germany
Netherlands
Russia
France

Russia
United Kingdom
Netherlands
France
Germany

Used fuel options

- Direct disposal
- Recycling with HLW disposal

https://www.energy.gov/sites/prod/files/2020/04/f74/Restoring%20America%27s%20Competitive%20Nuclear%20Advantage-Blue%20version%5B1%5D.pdf

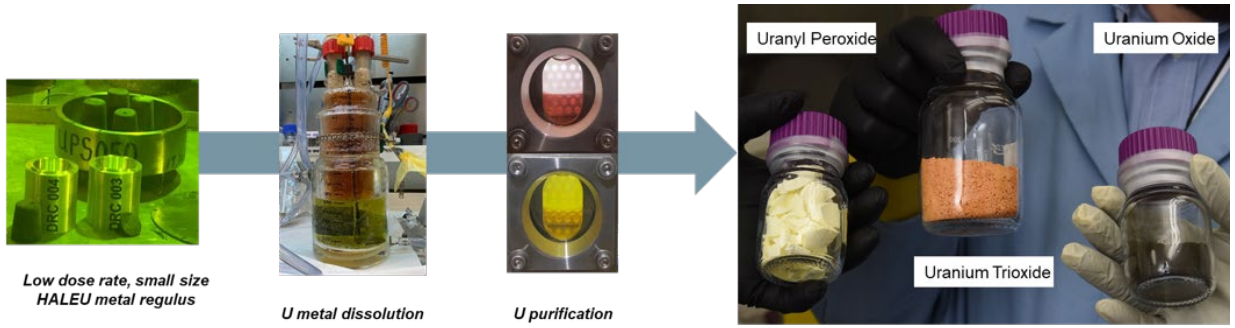
Establish a secure reliable supply chain is needed

The HALEU fuel cycle represents an opportunity to reinvigorate the domestic fuel cycle in the U.S. and is key to fueling our nuclear future.

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	Potential 10MT and 40MT by 2025. Downblending excess/surplus HEU
Enrichment	
American Centrifuge Operating LLC	900 kgs of UF_6 ongoing 16 machine cascade demonstration
URENCO USA	Commercial enrichment facilities for HALEU enrichment between 5% and 10%

HALEU enrichment

- Insufficient amounts
- Some early movers are not able to use recovered materials
- Some early movers are not able to receive UF_6 as the feedstock



Low dose rate, small size HALEU metal regulus

U metal dissolution

U purification

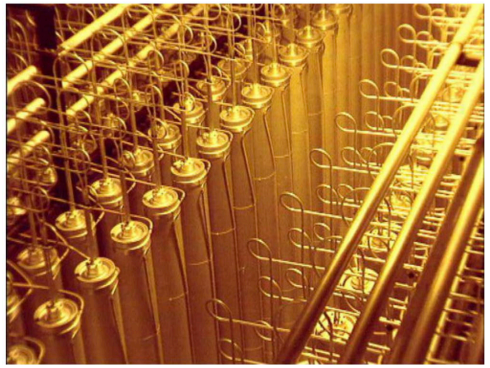
Progress towards a reliable U.S. supply chain

What is needed?

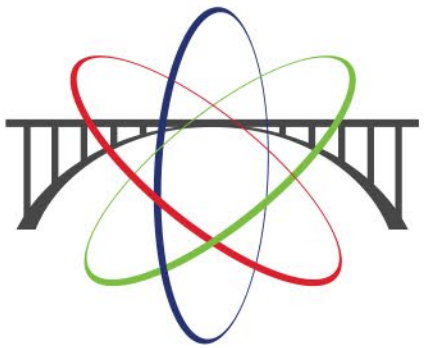
A little less than 20 MT/yr. HALEU domestic capability is needed to support current government commitments and initial cores for advanced reactor demonstrations

- DOE contract Centrus to demonstrate commercial scale HALEU production.
- The Energy Act of 2020 authorized the Advanced Nuclear Fuel Availability (ANFA) to make available small quantities of HALEU for RDD.
- The Inflation Reduction Act provided $700M to support HALEU availability through the ANFA program.
- The Nuclear Fuel Security Act (NFSA) expanded DOE's authorization to partner with industry to create a commercial supply of LEU and HALEU and to downblend HALEU to meet the initial needs of advanced reactors until a commercial supply is available.
- The FY24 appropriation reallocated $2.72B in excess funds from the Civil Nuclear Credit program to be utilized for the programs authorized in the NFSA.
  - Recently enacted with ban on Russian uranium imports.
  - Congress will still need to act to ensure long-term market certainty.

Advanced centrifuge cascade, Piketon, Ohio
Centrus Energy Corp



Bank of Centrifuges, Eunice, NM
Urenco USA



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DRAFT – Information for Review