HALEU Demand in No and Low Growth Transitions to Advanced Reactors

HALEU Demand Analysis

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ILLINOIS

Outline

Specifications

TABLE II: Mico-reactor design specifications

Design Criteria	USNC MMR™	X-Energy Xe-100™
Reactor type	Modular HTGR	Modular HTGR
Power Output (MWth)	15	200
Enrichment (% ^{235}U)	13	15.5
Cycle Length (years)	20	online refuel
Fuel form	TRISO compacts	TRISO pebbles
Reactor Lifetime	20 years	60 years
Coolant	He	He

Fuel

- TRIstructural ISOtropic fuel has core of uranium, carbon, and oxygen: and is coated in layers of ceramic
- Roughly the size of billiard balls
- Load follows
- Fuel transitions directly to dry-cask storage

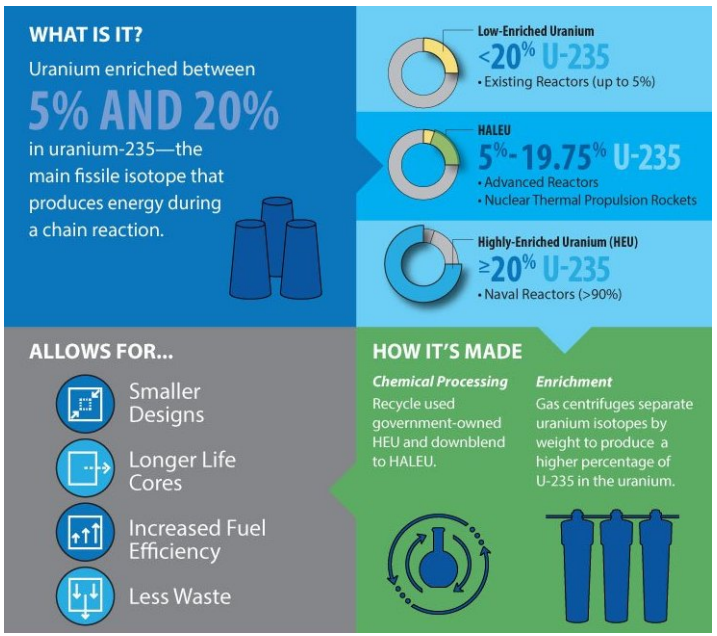

Figure: DOE HALEU Overview [1]

X-energy xe-100 Reactor

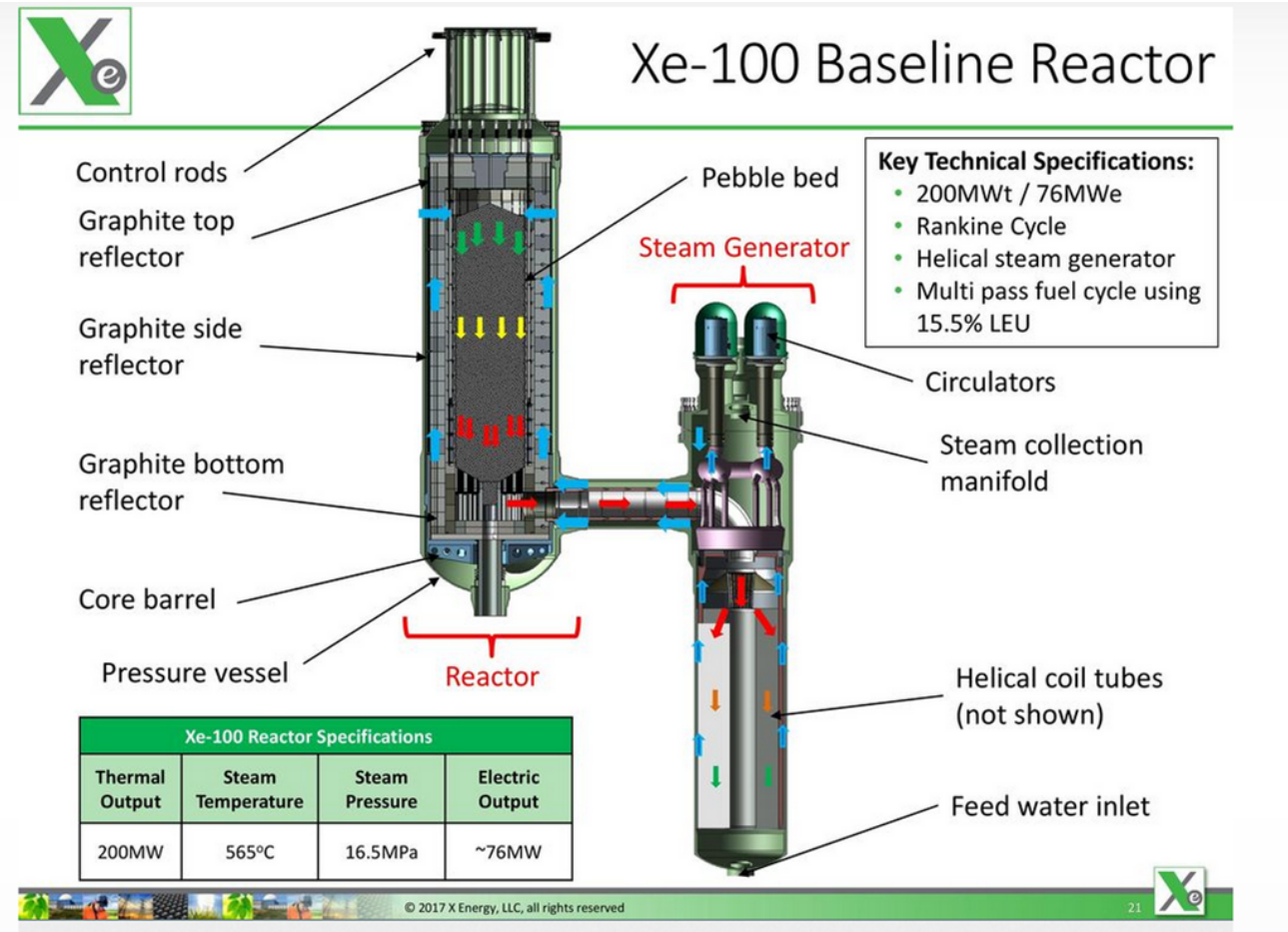

Figure: Side view of the X-energy xe-100 reactor. [3]

UNSC Plant

Figure: UNSC Nuclear Plant side view. [4]

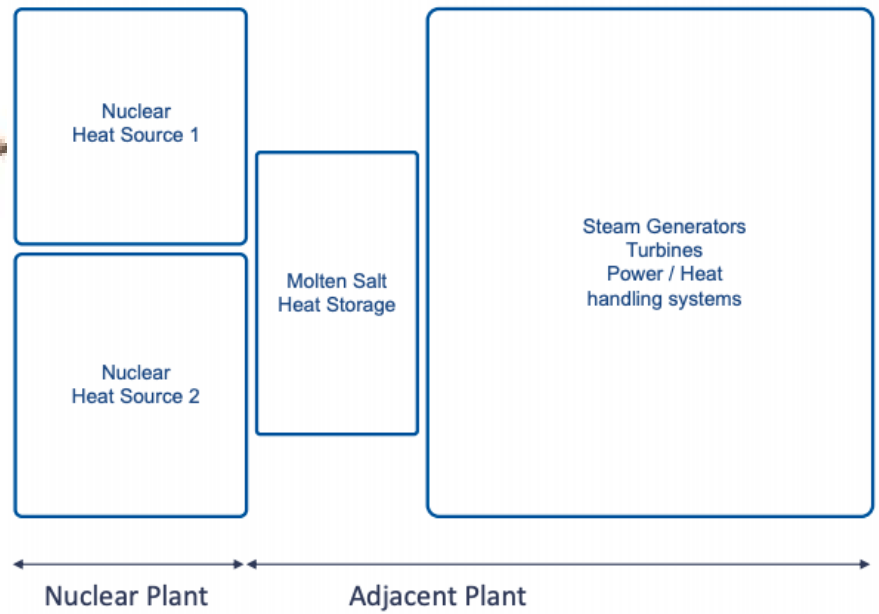

Figure: UNSC Plant Box View. [6]

Outline

Cyclus

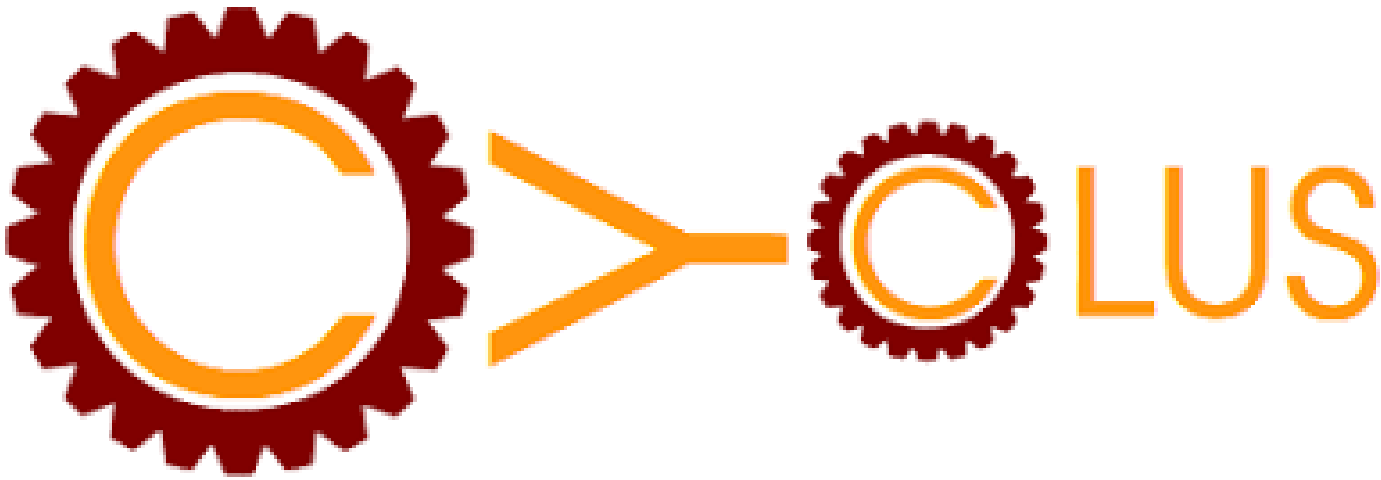

Figure: [2]

Transition Scenarios

Scenario Details:

- SMR deployments begin in 2025
- Scenarios run from 1965 to 2090
- UF_6 processing capacity limits enrichment facilities
- All scenarios incorporate existing reactors, decommissioning on current timelines (e.g. Dresden generating station is active until 2029)

TABLE I: Fuel cycle scenarios

Scenario No.	Advanced Reactor	Demand Growth
1	None	N/A
2	USNC MMR	No growth
3	X-energy Xe-100	No growth
4	USNC MMR	1% growth
5	X-energy Xe-100	1% growth

Figure: [5]

Outline

Mass and SWU

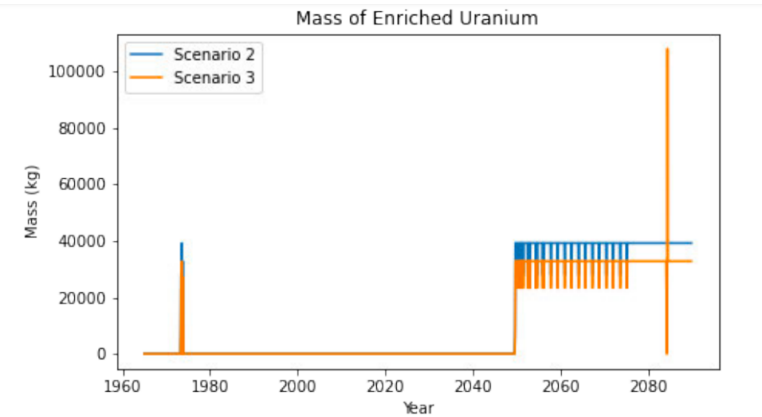

Figure: Mass of Enriched Uranium.

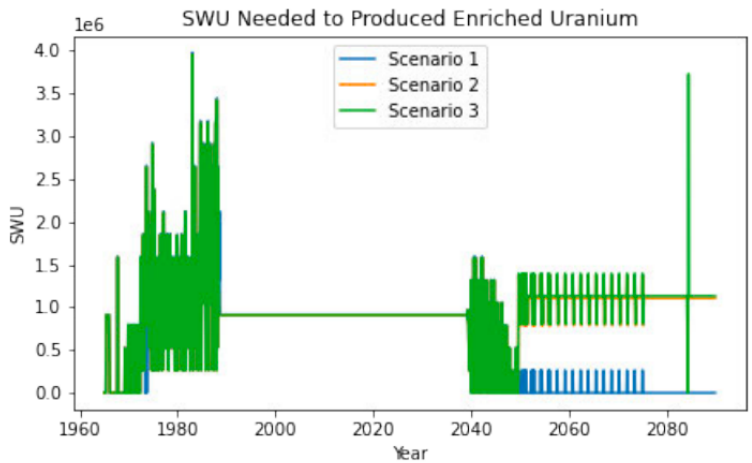

Figure: Seperative Work Units needed for enrichment.

Conclusions and Energy Use

- Transition will require a mixture of HALEU production methods and deployments
- Scenario 2 never reaches required power level
- Scenario 3 requires more SWU than 2 due to higher enrichment

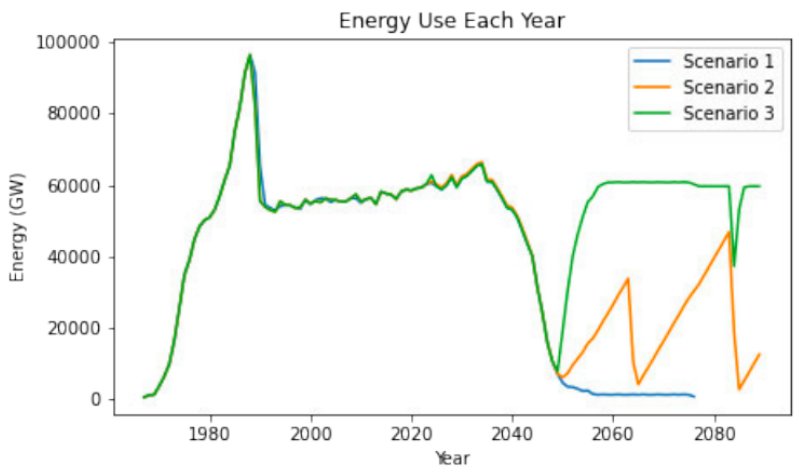

Figure: Energy use in each year. [5]

References I

[1] Infographic: What is high-assay low-enriched uranium (haleu)?, 2020.

[2] Cyclus, 2021.

[3] Reactor: Xe-100, 2021.

[4] Ultra safe nuclear corporation, 2021.

[5] Amanda M. "Bachmann and Kathryn D. Huff".
Comparing haleu demand among advanced reactor fuel cycle transitions.
Proceedings of the 2021 ANS Virtual Annual Meeting, pages 134–37, 2021.

[6] Francesco Venneri.
Micro modular reactor (mmr) energy systems, 2019.