

Nuclear Portfolio at **ARPA-E**

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ARPA-E Advanced Nuclear Fission Portfolio

► Fission

– MEITNER (2018)

- Can we greatly reduce AR CapEx?

– GEMINA (2020)

- Can we greatly reduce AR OpEx?

– ONWARDS (2021)

- Can we greatly minimize the disposal impact of AR wastes?

– CURIE (2022)

- Can we improve the cost and monitoring of UNF (used nuclear fuel) reprocessing?

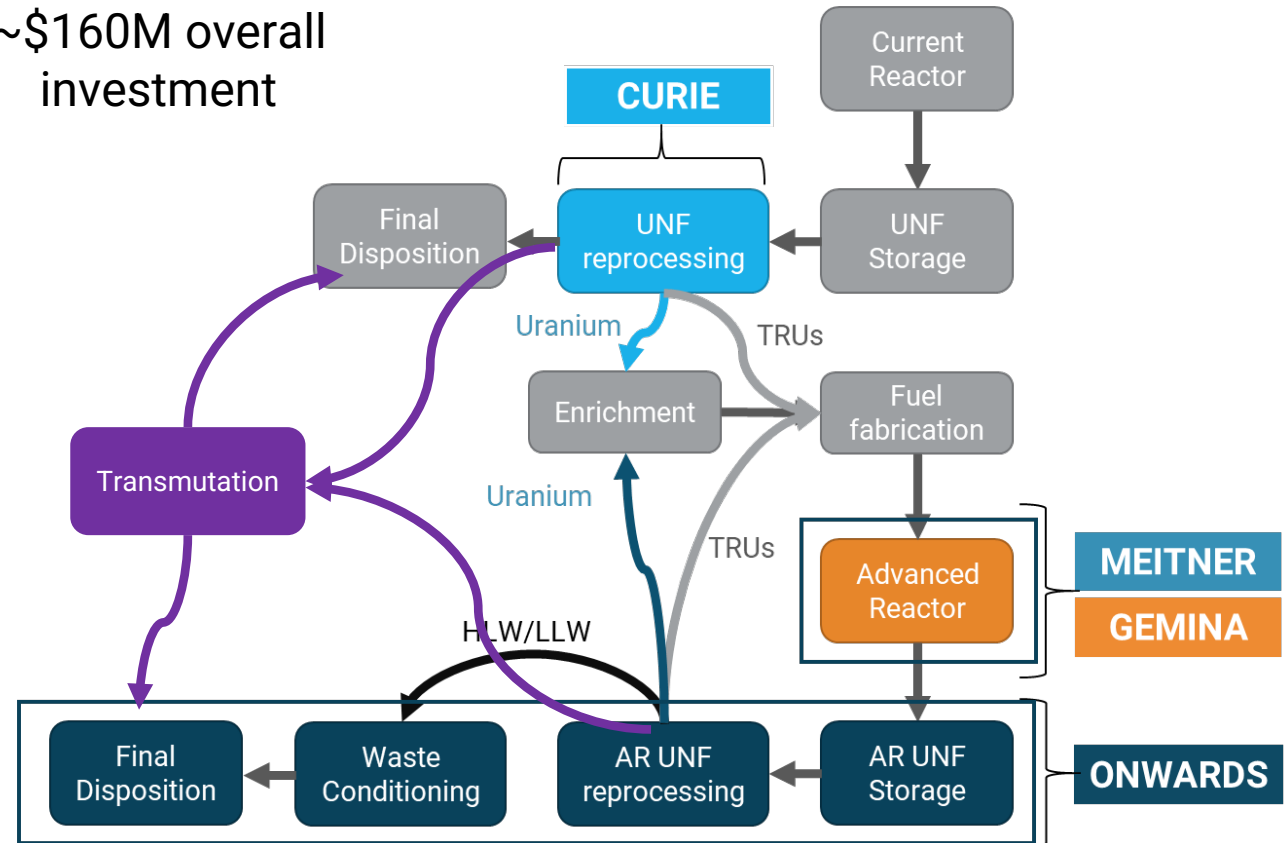
– Transmutation

- Active area of program development

Current Fleet

Advanced Reactor Fleet

~\$160M overall investment



Attentive to commercialization & deployment

MEITNER (Modeling-Enhanced Innovations Trailblazing Nuclear Energy Reinvigoration)

- ▶ **Goal:** Develop and demonstrate technologies that **greatly improve advanced reactor** performance

MEITNER is supporting transformative technologies for AR plant designs that simultaneously achieve:

- **Low overnight construction cost**
- **Largely autonomous operations to staffing level**
- **Safety** when considering
 - time before intervention in an accident
 - potential for public exposure to radiation
- **Very short on-site construction time**
- **Proliferation resistance via safeguards by design**
- **The ability to achieve either or both:**
 - easy electrical grid integration with intermittent sources such as wind and solar
 - availability to provide economical industrial process heat

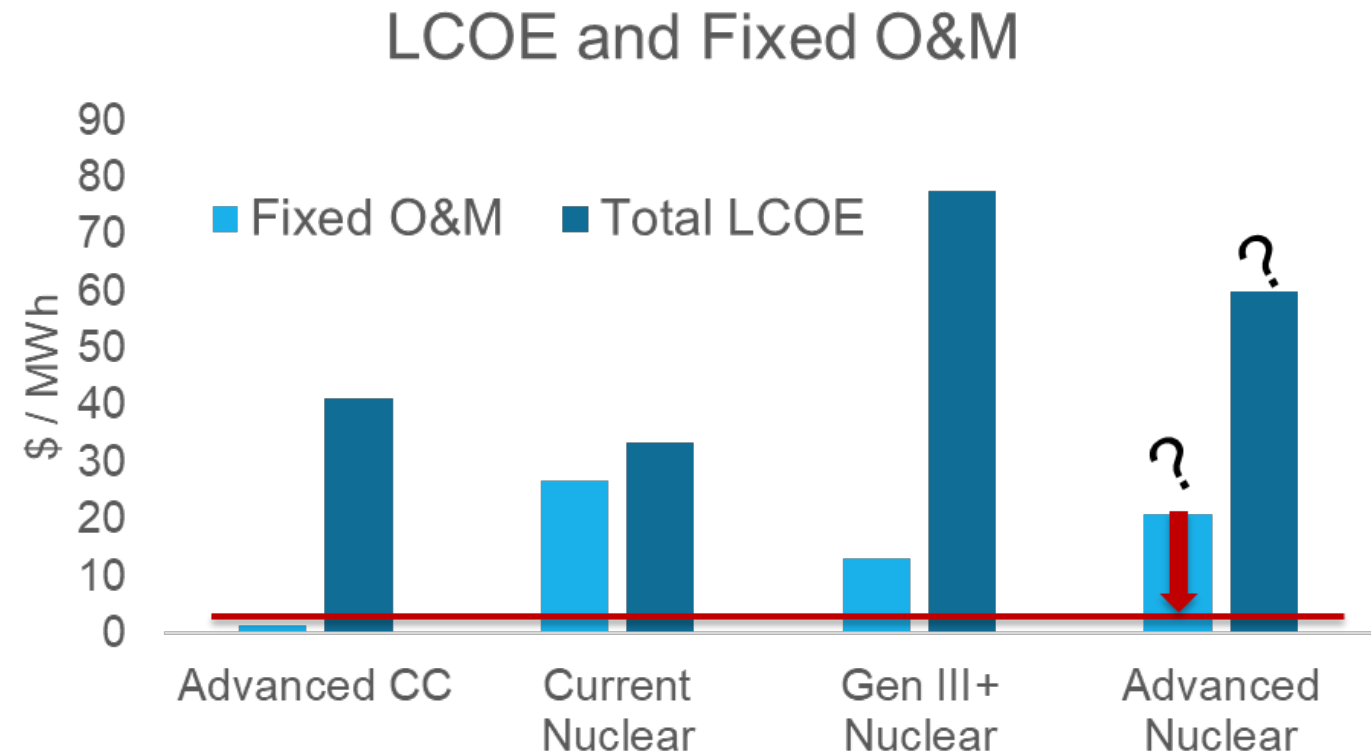
Metric	Units	State-of-the-Art
Overnight construction cost	\$/W _e	2-7
On-site construction time	Months	> 60
Total staffing level (on-site & off-site)	FTE/GW _e	450-750
Emergency planning zone (EPZ)	Miles	10 and 50
Time before human response required for an accident	Days	3
Onsite backup power	kW _e	> 0 kW
Ramp rate without steam bypass	power capacity/min	5%
Process heat temperature	°C	N/A

GEMINA (Generating Electricity Managed by Intelligent Nuclear Assets)

- ▶ **Goal:** Develop the tools and cost basis for ARs to **achieve fixed O&M costs of \$2/MWh** without shifting costs to other parts of LCOE

Awardee teams are developing the following for one or more of the most promising AR designs:

- **Digital twins for advanced reactor systems**
- **Relevant cyber physical systems**
- **O&M approaches for advanced reactors**
- **Cost models and design updates**

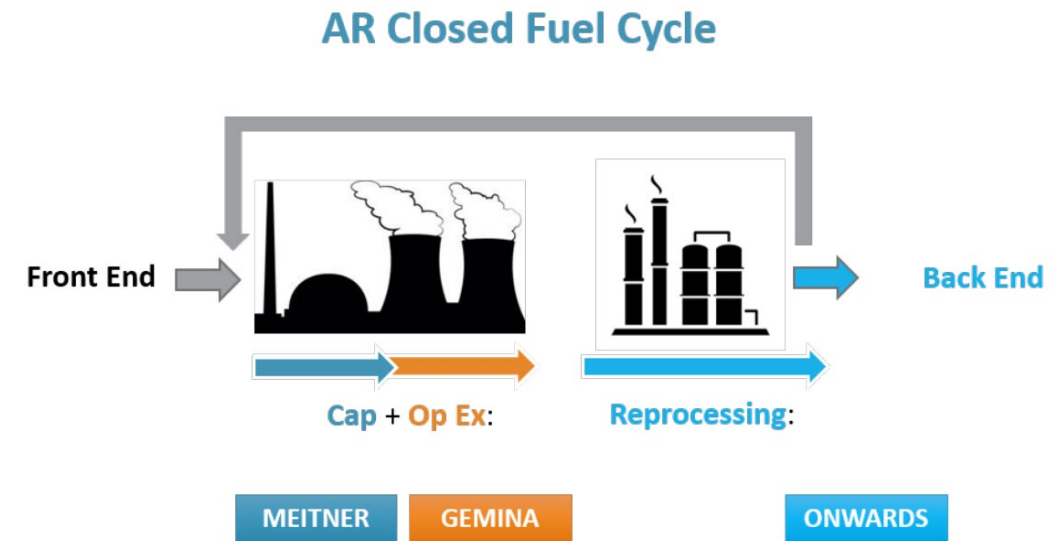


ONWARDS (optimizing Nuclear Waste and Advanced Reactor Disposal Systems)

- ▶ **Goal:** Develop technologies to **significantly minimize the disposal impact** of wastes from ARs while maintaining disposal costs in the range of **\$1/MWh**

ONWARDS seeks to support the development of technologies that enable:

- **10x reduction in waste volumes or repository footprint with no weakening of **safeguards** standards**
 - Better than 1% accuracy in fissile mass measurement in UNF processing in high-radiation backgrounds
- **Improving proliferation resistance of U and TRU materials recycling**
 - No pure fissile material streams produced during processing (< 0.1% actinides by mass in waste streams)
- **High performance waste forms for AR HLW across multiple disposal environments.**



The production of new waste streams is required to be minimal relative to a once-through fuel cycle and have an established path to a robust waste form or final disposition.

CURIE (Converting UNF Radioisotopes Into Energy)

Goal: Enable commercially viable reprocessing of used nuclear fuel (UNF) from the current light water reactor (LWR) fleet by resolving key gaps/barriers in reprocessing *technologies*, *process monitoring*, and *facility design*

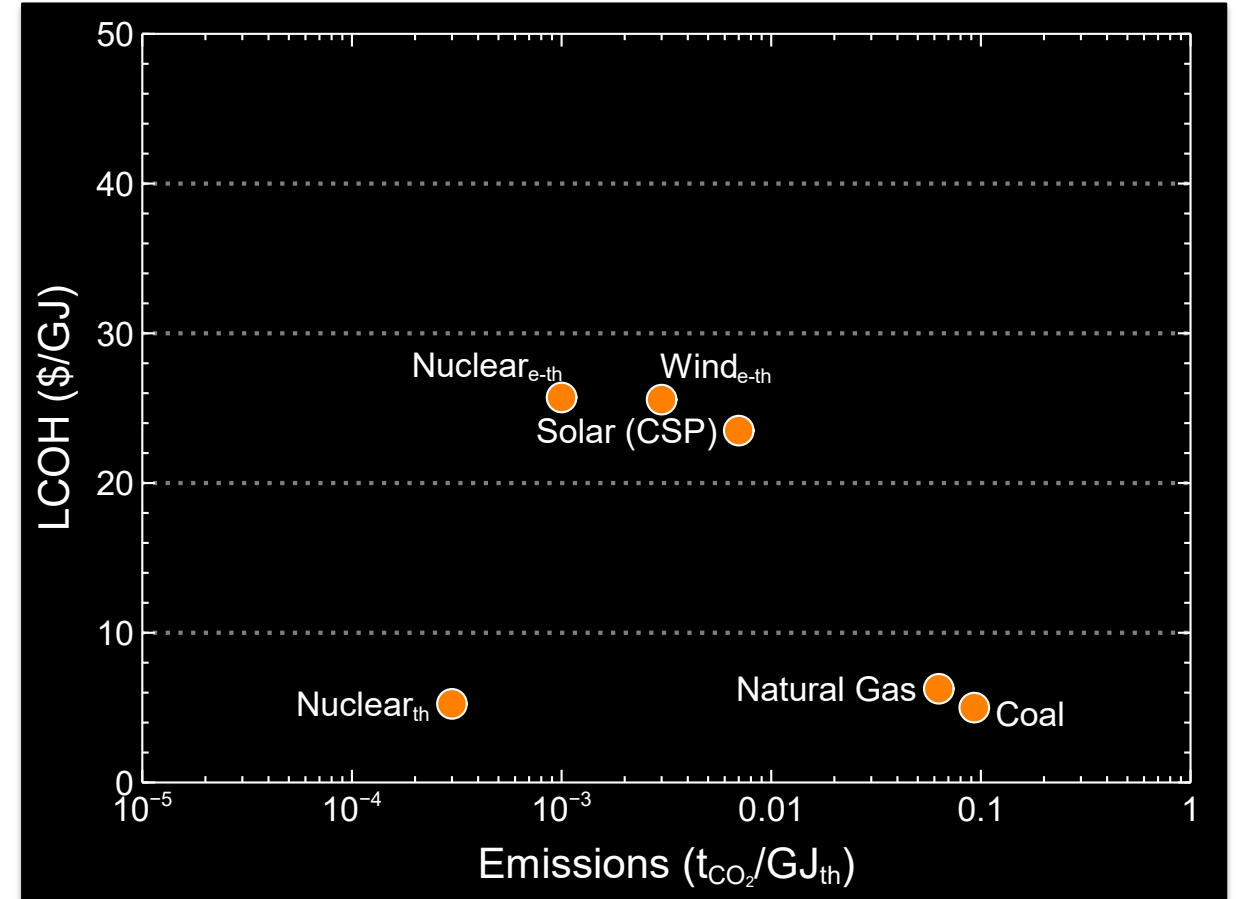
Global Metrics

1. significantly (i.e., at least an order of magnitude) reduce the volume of LWR HLW requiring permanent disposal,
2. maintain disposal costs in the range of 0.1¢/kilowatt-hour (kWh)⁴,
3. provide a 1¢/kWh⁵ fuel cost for a 200 metric tons heavy metal (MTHM)/yr nth-of-a-kind (NOAK) facility,
4. in situ SNM process monitoring approaches that predict, within 1% uncertainty and under representative conditions, the post-process material accountancy, and
5. development of UNF separations which do not produce pure plutonium streams



Nuclear Heat for Industrial Decarbonization

- ▶ Nuclear reactors provide clean firm **heat** primarily & **electricity**
- ▶ Maximize constant use of nuclear by hybridizing with **heat**, **electricity** or **heat + electricity** consumers



DE-FOA-0003011: REQUEST FOR INFORMATION (RFI) ON NUCLEAR HYBRID AND NON-ELECTRICITY ENERGY SYSTEMS

Closes today (3/30) at 5 pm!



If it works...

will it matter?