EVALUATING NUCLEAR WASTE & SAFETY CONSIDERATIONS FOR ADVANCED NUCLEAR DEPLOYMENT

SEPTEMBER 27, 2023

2:00 – 3:00 PM ET

EVALUATING NUCLEAR WASTE & SAFETY CONSIDERATIONS FOR ADVANCED NUCLEAR DEPLOYMENT

Moderator: Hon. Bobby Janecka, Texas Commission on Environmental Quality

Panelists:

Dr. Catherine Wise, Program Officer, Board on Energy and Environmental Systems, The National Academies of Sciences, Engineering, and Medicine

Dr. Robert Ledoux, Program Director, ONWARDS, ARPA-E

Jon-Michael Murray, Nuclear Policy Manager, Clean Air Task Force

Housekeeping

- Use the Q&A box on the zoom toolbar to ask questions at any time
- This webinar will be recorded, and posted to NARUC's YouTube channel
- Slides will be shared with attendees via email after today's webinar

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Merits and Viability of Different Nuclear Fuel Cycles and Technology Options and the Waste Aspects of Advanced Nuclear Reactors

Janice Dunn Lee, Chair

Patricia A. Baisden, Vice Chair

Charles D. Ferguson, Study Director

Catherine F. Wise, Co-Study Director

NARUC ANSC WEBINAR
SEPTEMBER 27, 2023

Advanced Nuclear Reactors and Fuel Cycles

- In recent years, the U.S. Congress, DOE, and private sector have expressed considerable interest in developing and deploying advanced nuclear reactors to augment, and possibly replace, the U.S. operating fleet of reactors.
- Potential advantages of these advanced reactors and fuel cycles include:
  - improvements in economic competitiveness,
  - reductions in environmental impact via better natural resource utilization and/or lower waste generation,
  - enhancements in nuclear safety and proliferation resistance.
- This National Academies' study is in response to tasking from Further Consolidated Appropriations Act of FY2020 and Consolidated Appropriations Act of FY2021. The Department of Energy's Office of Nuclear Energy sponsored the study.

About the Study – Task Statement

1. Evaluate the merits and assess the viability of different nuclear fuel cycles, including fuel cycles that may use reprocessing, for both existing and advanced reactor technology options by:
   - Accounting for linkages among all elements of the fuel cycle.
   - Examining potential costs of different nuclear fuel cycles required for advanced reactors.
2. Evaluate nonproliferation implications and security risks of fuel cycles for advanced reactors by:
   - Including assessments of HALEU, U-Pu MOX fuel, and advanced fuel cycles that require separating Pu from spent fuel.
   - Examining nuclear material accounting and control, containment, surveillance, monitoring, and timeliness of detection of diversion.
   - Accounting for how these can be addressed by IAEA safeguards activities.
3. Evaluate the waste management and disposal options for the various proposed advanced nuclear reactors by:
   - Accounting for typical volumes and characteristics of waste streams, including from possible reprocessing, from advanced nuclear reactor technologies.
   - Examining transportation, storage, and ultimate disposal requirements for these wastes.

About the Study – Committee

Janice Dunn Lee (Chair)
International Atomic Energy Agency (retired)

Patricia Baisden (Vice Chair)
Lawrence Livermore National Laboratory (retired)

Rodney C. Ewing (Vice Chair, NAE)[1]
Stanford University

Margaret S.Y. Chu (NAE)
M.S. Chu and Associates LLC

Paul T. Dickman
Argonne National Laboratory

Craig S. Hansen
Cadence, Inc.

John C. Lee[2]
University of Michigan

Edwin S. Lyman
Union of Concerned Scientists

Allison M. Macfarlane
University of British Columbia

Albert J. Machiels
EPRI (retired)

Christophe Poinssot
Bureau de Recherches Géologiques et Minières

Jeffrey D. Semancik
Connecticut Department of Energy and Environmental Protection

Ken B. Sorenson
Sandia National Laboratories (retired)

Jasmina Vujic[2]
University of California, Berkeley

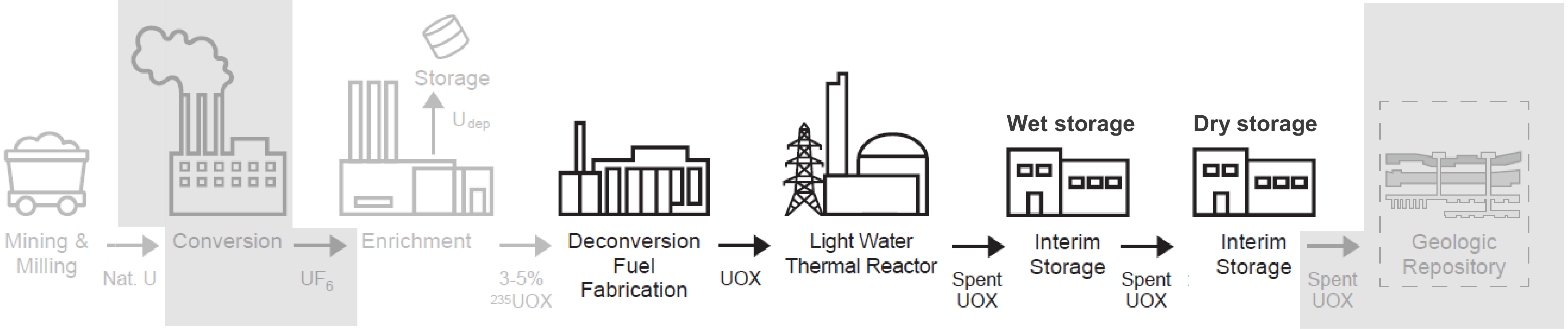
Nathalie A. Wall
University of Florida

Houston G. Wood[3]
University of Virginia

[1] Until July 2022; [2] Until September 2022; [3] Until September 2021

Where are we now?

Once-Through Fuel Cycle with Light Water Reactors (LWRs) and Low-Enriched Uranium (LEU) Fuel



no domestic capacity

partial domestic capacity

From Finding 2: Merits of the once-through fuel cycle

(1) Less expensive than fuel cycles involving recycling
(2) Currently reliable international nuclear fuel market with multiple suppliers
(3) Compatible with projected available uranium resources
(4) Well-understood proliferation resistance, both of spent fuel and entire fuel cycle

LWR spent fuel is reasonably consistent and uniform across the entire fleet!

What advanced reactor designs did the committee consider?

	LWR-SMR	Liq.-Metal-Cooled FR	High Temp. Reactor	Gas-Cooled FR	Molten Salt Reactor
Coolant	Light water	Liq. Na or Pb	Helium; FLiBe molten salt	Helium	NaF-BeF_2; ^{7}LiF-BeF_2; Cl salt (^{37}Cl), $MgCl_2$/NaCl (^{37}Cl)
Fuel Type	U-oxide, Zr clad	U-metal alloy/Steel clad; UN (^{15}N)/Steel clad	UCO TRISO pebble	UC/SiC clad	Liq. U or Th fluoride; liq. U or Pu chloride; Moltex static fuel pins
Enrichment	LEU	HALEU	HALEU	HALEU	LEU, DU, or HALEU
Spectrum	Thermal	Fast	Thermal	Fast	Thermal or Fast
Proposed fuel cycle	OTC	OTC* → CFC	OTC*	OTC* → CFC	OTC* → modified OTC → CFC
Waste	LWR spent U-oxide assemblies	Irrad. Na or Pb; U metal or UN spent fuel with FP & residual MA	Spent TRISO with FP and MA, dust, F salt; tritium	Spent UC/SiC clad fuel; recycle with residual MA and FP to waste	FP noble gas off-gas, F- or Cl-fuel salt with FP & residual MA, tritium, graphite
Example(s)	NuScale; GE-H; BWXT	Natrium-SFR; ARC-100; LeadCold Sealer 55; Westinghouse LFR	X-energy Xe-100; Framatome SC-HTGR; Kairos KP-X-FHR	General Atomics EM^2	Terrestrial Energy IMSR-400; ThorCon; Flibe Energy; TerraPower MCFR; Moltex Stable Salt Wasteburner

SMR = small modular reactor; FR = fast reactor; OTC = Once-through cycle; CFC = closed fuel cycle * = increased burnup

NATIONAL ACADEMIES Sciences Engineering Medicine

Important Observations for Advanced Reactors

Wide range of advanced reactor designs, with various:

- coolants (water, liquid metal, gas, molten salts)
- fuel types (^{235}U, ^{239}Pu, ^{233}U(Th))
- fuel forms (U metal, metal alloy, UN, UC, TRISO, liquid fuel salts)
- fuel enrichment (most require HALEU)
- neutron spectrum initiating the fission reaction (thermal, fast)

Most advanced reactor developers opting for **once-through fuel cycle initially** with the possibility of closing the fuel cycle in the distant future.

Should these reactors be commercially deployed, the resulting spent fuel and associated waste streams will ***vary considerably from the current standard spent LWR LEU-oxide fuel assemblies.***

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What types of waste do advanced reactors generate?

From Finding 13: Proposed advanced reactors will use a once-through fuel cycle with fuels of higher uranium enrichment and/or burnup, and new types of fuel materials and designs.

Compared to uranium oxide spent fuel, these new fuel types may result in changes of:

- amounts (either in mass or volume), chemical compositions, and radionuclide inventories
- thermal power of fuel assemblies
- durability of spent fuel in a disposal environment

From Finding 15: Most proposed advanced reactors would generate waste streams for which there is little experience or mature technical ability to manage, and which would entail additional costs not encountered in managing and disposing of spent LWR fuel.

Examples include:

- Large volumes of spent TRISO fuel from high-temperature gas reactors
- Radioactive dust from pebble bed reactors
- Irradiated sodium waste and sodium-bonded spent fuel from sodium-cooled fast reactors
- Radioactive off-gases and spent fuel salt waste from molten salt reactors
- Large quantities of irradiated graphite waste from moderators or reflectors in several reactor designs

Can advanced reactors "solve the waste problem"?

From Finding 12. Without a final geologic disposal strategy, expanding nuclear power with advanced reactors will add to the amount of spent fuel and associated waste requiring disposal and will increase the complexity of this challenge because new types of fuels and waste streams will need to be disposed of.

From Finding 9. Reprocessing and recycling of spent nuclear fuel would introduce additional safety and environmental considerations over the management of open cycle LWR oxide fuels.

From Finding 14. Reducing the ~86,000 tonnes of legacy spent nuclear fuel using advanced reactors is not practicable to achieve in the near future.

Even a fully closed fuel cycle with recycle and transmutation operated over decades will still require a geologic repository for disposal of fission products.

Moving Forward on Nuclear Waste Disposal

From Recommendation G. Congress should establish a single-mission entity responsible for the management and disposal of nuclear wastes.

From Recommendation J. The immediate-future focus of the U.S. nuclear waste management and disposal program should be to plan for geologic disposal of existing spent nuclear fuel.

From Recommendation I.

- DOE, NRC, and EPA should develop regulations and standards for a generic repository and new types of spent fuel and waste forms to support geologic disposal of fuel types from advanced reactors.
- Advanced reactor developers need to anticipate the impact of new fuel types on their performance in a geologic repository.

Conclusions

The vast array of advanced reactor and fuel cycle concepts, if realized, would significantly diversify reactor and fuel cycle technologies used in the U.S.

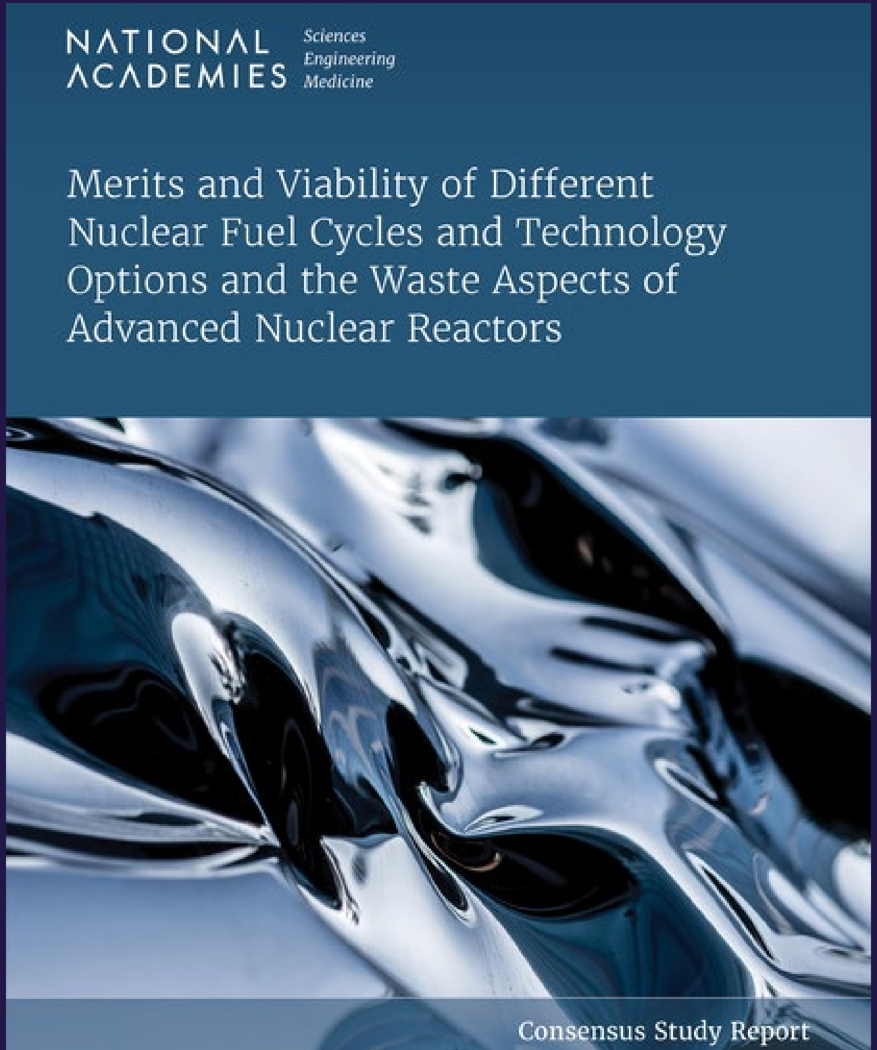
Tradeoffs are necessary when assessing potential merits and viabilities of different reactors and their associated fuel cycles. Not one advanced technology can concurrently provide for all the potential benefits relevant to the scope of this study.

The U.S. government and industry going forward will have to decide which features or attributes of advanced reactors and fuel cycles best align with the U.S. energy needs without increasing proliferation risks, having an adverse impact on the environment, or imposing an unacceptable economic burden on current and future generations.

DOWNLOAD THE REPORT:
www.nap.edu/26500

Thank you!

Questions?



Extra Slides

(Full Text of Findings and Recommendations)

Finding 2: Continued use of the once-through fuel cycle for the existing U.S. light water reactor (LWR) fleet has several merits: (1) lower cost compared with any fuel cycle that involves reprocessing and recycling, (2) a reliable international market for nuclear fuel services from multiple suppliers (although that could be disrupted by international crises, such as war); (3) compatibility with the projected available uranium resources; (4) well-understood proliferation resistance of the entire fuel cycle; and (5) theft resistance of spent nuclear fuel. However, the once-through cycle remains incomplete in the United States because there is still no progress toward establishing an operating geologic repository for the spent fuel from nuclear power plants. Pursuing the monorecycling fuel cycle with existing LWRs in the United States would add cost to nuclear power generation but produce no significant benefits, given the projected abundant supply of natural uranium and uranium enrichment at relatively low cost for the foreseeable future.

Finding 9: As proposed for some advanced reactor closed fuel cycles, reprocessing and recycling of spent nuclear fuel introduces additional safety and environmental considerations over the management of open cycle light water reactor oxide fuels. In assessing the safety and environmental performance of advanced reactors, the risks and environmental impacts will require optimization over the entire fuel cycle, including front end processes (mining, enrichment, and fabrication), back-end processes (reprocessing and recycling together), and disposal (interim and final). Currently, advanced reactor developers focus primarily on the safety aspects of the reactor and its operation and put less priority on the safety aspects of other parts of the fuel cycles.

Recommendation G: Congress should establish a single-mission entity with responsibility for the management and disposal of nuclear wastes.

- Such an entity should be responsible for "cradle-to-grave" care and disposition of spent nuclear fuel – that is, from its discharge from a reactor plant to its final disposal in a repository. This entity should have continuity of leadership and funding, as well as a consistent disposal strategy. It should also have high technical and scientific competence, be able to organize and lead research programs, as well as large construction projects, and, importantly, be able to engage the public in a way that engenders trust. Finally, the entity should operate effectively over the many decades that will be required to manage the present inventory of nuclear waste, as well as waste generated by future advanced reactors.
- Congress should ensure that funds collected from ratepayers that use electricity from nuclear power plants, now more than $45 billion, are applied to the disposal of the spent fuel generated by nuclear power plants and that collection of funds from all commercial generators of nuclear power resumes. Moreover, funding for the entity should be held in a true escrow account and not be subject to the annual appropriations process.
- The entity should immediately initiate steps to begin the process of site selection. Before sites are considered, a decision-making process with appropriate technical criteria and an acceptable method of public engagement, such as consent-based siting, needs to be defined in collaboration with impacted communities, tribes, and states. Congress should make a decision on what to do with Yucca Mountain, which could include keeping it as a possible site for consideration depending on the plans of the new entity.

Finding 12: The advanced reactor developers' presentations to the committee focused on the reactors themselves, with little or no attention to nuclear waste management or disposal of the nuclear waste generated because there is no incentive for them to do so. In the absence of a final geologic disposal strategy in the United States, the expansion of nuclear power using advanced reactors will add to the amount of spent nuclear fuel and associated waste that require disposal and increase the complexity of this challenge because of the need to dispose of new fuel types and waste streams.

Finding 13: Presently proposed advanced reactor technologies will initially use a once-through fuel cycle; however, compared with those currently in use, the fuels will have a higher uranium enrichment (e.g., high-assay low-enriched uranium [HALEU]) and a higher burnup; also, they will use new types of fuel materials and designs (e.g., Tristructural ISOtrppic [TRISO] fuels). As compared with the disposal of the present uranium oxide spent fuel, these new fuel types may result in changes of: (1) the amounts (either in mass or volume), chemical compositions, and radionuclide inventories, (2) the thermal power of fuel assemblies, and (3) the durability of the spent fuel in a disposal environment. More specifically, from the waste management and disposal perspective, it is important to note the following:

- Radiological risks from disposed waste are dominated by the mobility of long-lived radionuclides and not by the radiotoxicity inventory. Therefore, radiotoxicity itself is a poor metric for repository performance and risk to the public from waste disposal. The long-term safety of disposal of actinides in appropriate geologic settings is largely independent of the actinide inventory of the repository, except in the off-normal situation where the geological barrier is bypassed – for instance, by human intrusion. Because the amount of mobile long-lived fission products generated is independent of reactor type, most advanced reactor technologies will have little impact on estimates of long-term repository performance. Key factors for long-term repository performance are the redox conditions of the geochemical environment, waste form stability, groundwater flow rates, and solubility/sorption of radionuclides. A reducing environment is preferred. Advanced reactor technologies will have little or no impact on these factors.

Finding 13 continued:

- The total quantities of fission products generated are generally related to fission rate and are largely independent of the reactor technologies, although the distributions of different isotopes may differ. Both short-lived and long-lived fission products are important on the timescales relevant to geologic disposal. Short-lived fission products (e.g., strontium-90 and cesium-137) produce significant heat, while long-lived fission products (e.g., iodine-129 and technetium-99) are extremely mobile in a repository environment. Advanced reactor technologies will, in general, generate a higher amount of fission products in each spent nuclear fuel package because of the higher burnups, resulting in a higher thermal load. Increased thermal loads of waste containers will impact a number of repository design features, such as the size and spacing of waste packages, the size of the repository footprint, and engineering designs, thereby impacting the cost of repository construction.
- Enhanced stability and durability of waste forms in a repository environment can be beneficial to the performance of a repository by limiting the release of radionuclides from the spent fuel. Some advanced reactor technologies propose using advanced fuel designs with the potential to contain radionuclides (e.g., TRISO fuel), but this potential must first be demonstrated by experimental programs that examine the fuel's long-term integrity in intense radiation fields and at high temperatures.

Recommendation I: The principal agencies (U.S. Department of Energy, U.S. Nuclear Regulatory Commission, and U.S. Environmental Protection Agency) should initiate a coordinated effort to develop regulations and standards for a generic repository (i.e., not specific to Yucca Mountain) and new types of spent fuel and waste forms in order to support geologic disposal of new fuel types from advanced reactors. Developers of advanced nuclear reactors also need to anticipate the impact of new fuel types on their performance as a waste form in a geologic repository.

Finding 14: Conceptually, advanced reactors could be used to reduce the current inventory of transuranics in the approximately 86,000 metric tons of legacy spent fuel to date; the required infrastructure would require considerable resources and time to design, develop, prototype, build, and make operational. Creating this infrastructure is not practicable to achieve in the near future, as long as uranium and enrichment services are readily available.

Recommendation J: The immediate-future focus of the U.S. nuclear waste management and disposal program should be planning for the geologic disposal of the existing spent fuel that is presently stored at 79 sites in 35 states and the approximately 2,000 metric tons per year being generated by existing commercial reactors.

Finding 15: Most of the advanced reactor types proposed would generate waste streams for which there is little experience or mature technical ability to manage. All additional waste treatment options would entail additional costs not encountered in the management and disposal of spent light water reactor (LWR) fuel. High-temperature gas reactors will produce much larger volumes of spent fuel compared with equivalent energy-production from LWRs. It may be possible to reduce the volume by removing graphite from the spent fuel, but those technologies are immature. Dust production from pebble bed reactors would pose waste and decommissioning challenges. Sodium-cooled fast reactors would produce large volumes of irradiated sodium waste that would require treatment and disposal; sodium-bonded spent fuel is not suitable for direct disposal and would require treatment by methods not yet technically mature at the industrial scale. Molten salt reactors produce two waste streams, radioactive off-gases and the spent fuel salt waste, that would require processing into waste forms suitable for disposal. These treatment methods and suitable wastes forms are in early stages of exploration. Most of these advanced reactors would produce large quantities of irradiated graphite waste—from use as moderators or reflectors—and this material would prove challenging to manage as well. While European researchers have analyzed graphite waste disposal extensively, researchers in the United States generally lack this expertise.

Advanced Reactor Fuel Cycle Portfolio at ARPA-E

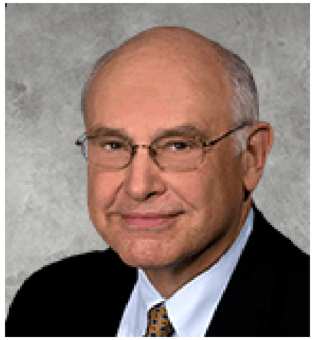
Robert Ledoux

September 27, 2023

Meet the ARPA-E Fission Team

Jenifer Shafer,
Program Director

Robert Ledoux,
Program Director



Bill Horak,
Program Director

Chris Vandervort,
Tech-to-Market

Othon Monteiro,
Tech-to-Market

Christina Leggett,
Tech SETA

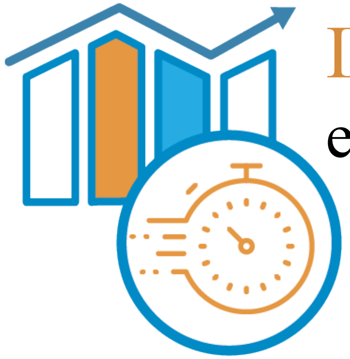
Gene Carpenter,
Tech SETA

Curt Nehrkorn,
Tech SETA

Gideon Bass,
Tech SETA

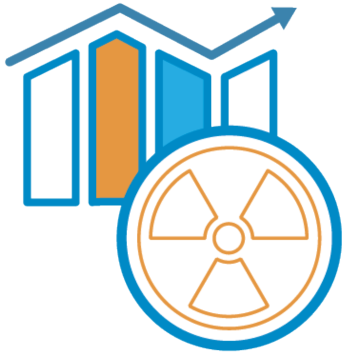
Harry Andreades,
Tech-to-Market

REDUCE
imports



IMPROVE
efficiency

REDUCE
emissions



IMPROVE
radioactive waste management

IMPROVE
energy infrastructure resilience

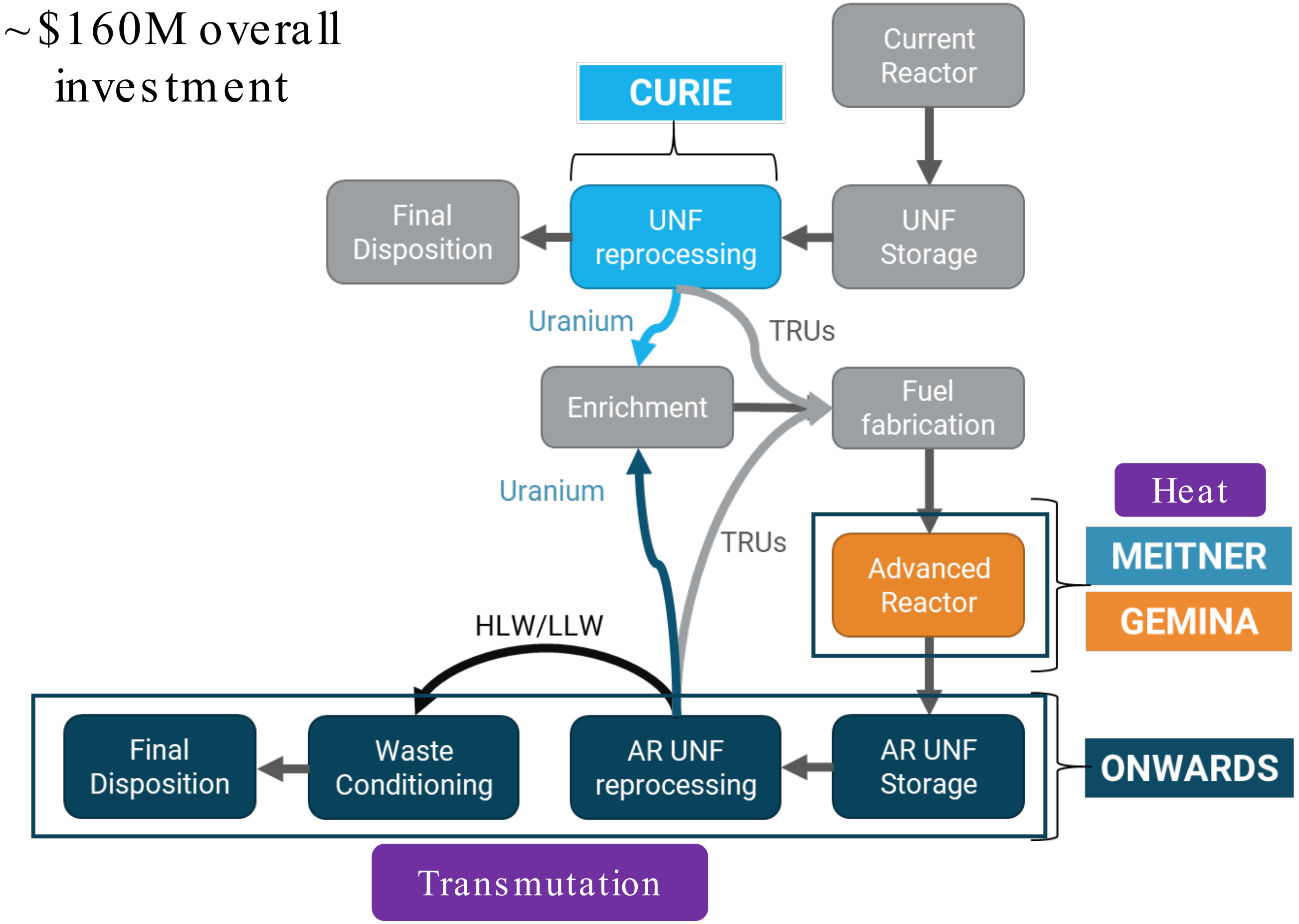
ARPA-E Advanced Nuclear Fission Portfolio

- 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 reprocessing?
  - Transmutation & Heat
    - Active areas of program development

Current Fleet

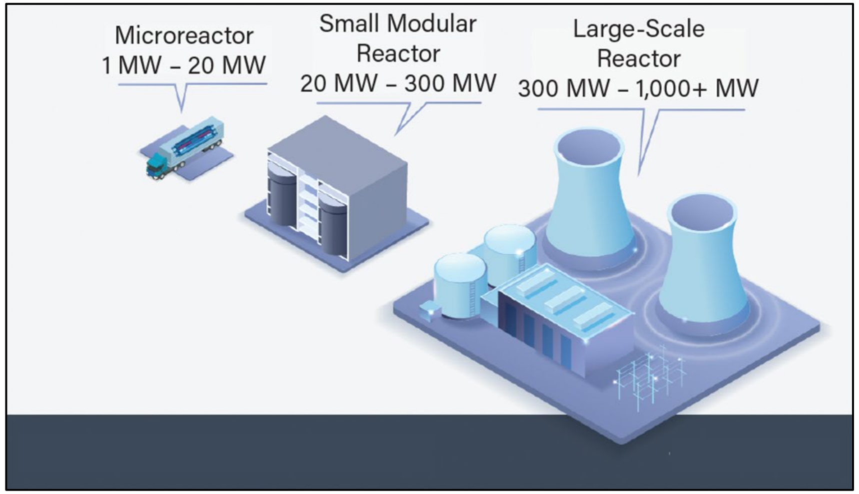
Advanced Reactor Fleet

~$160M overall investment



Attentive to commercialization & deployment

General Demo and Deployment Timelines



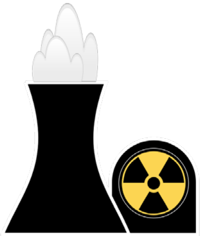
Digitization

Recycling SNF

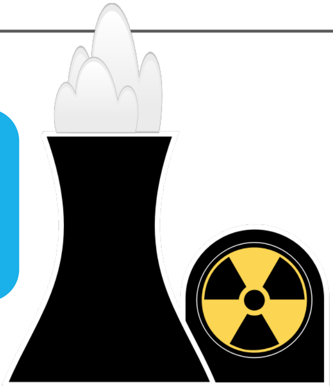
Waste Disposal

HITACHI

energy



2 GWe
Installed Capacity?



6 GWe
Installed Capacity?
2033

2030

2021

OKLO
~2025

Kairos Power
~2026

TerraPower
~2028

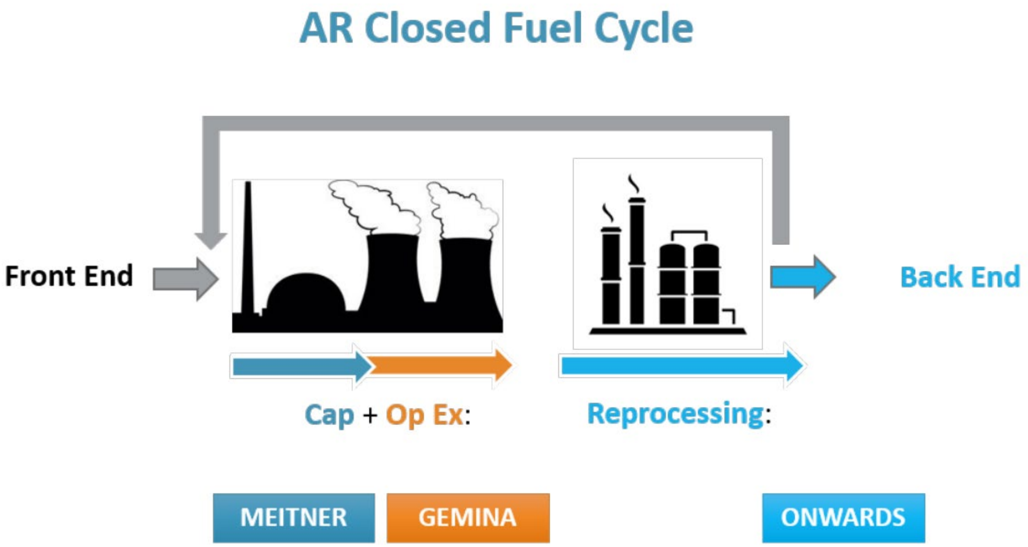
NUSCALE
~2029

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
- 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.



[ONWARDS | arpa-e.energy.gov]

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),
3. provide a 1¢/kWh fuel cost for a 200 metric tons heavy metal (MTHM)/yr n^{th}-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

ILLUSTRATIVE PROJECT HIGHLIGHTS

ONWARDS: Oklo Inc.

Project Title:

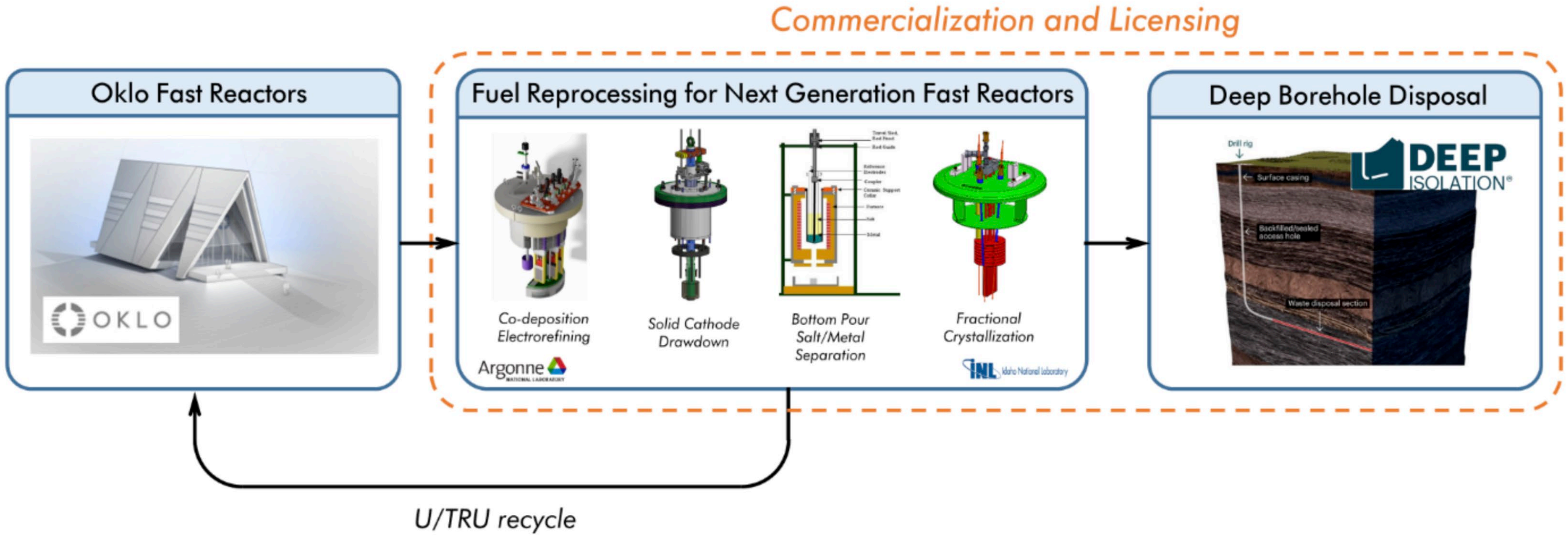
Enabling the Near-Term Commercialization of an Electrorefining Facility to Close the Metal Fuel Cycle

PI:

John Hanson
john@oklo.com

Project Outcomes:

Industrialize key electrorefining facility processes, develop a commercial licensing basis for the facility, and develop a final waste disposal strategy utilizing deep borehole disposal



Key takeaways: Significantly improve advance reactor fuel economics, reduce ultimate waste volume, and close the fuel cycle through commercial fuel recycling

CURIE: University of Colorado, Boulder

Project Title:

Achieving 1 % Assay of Special Nuclear Materials in 2 Minutes with Microcalorimeter-Array Gamma-Ray Spectroscopy

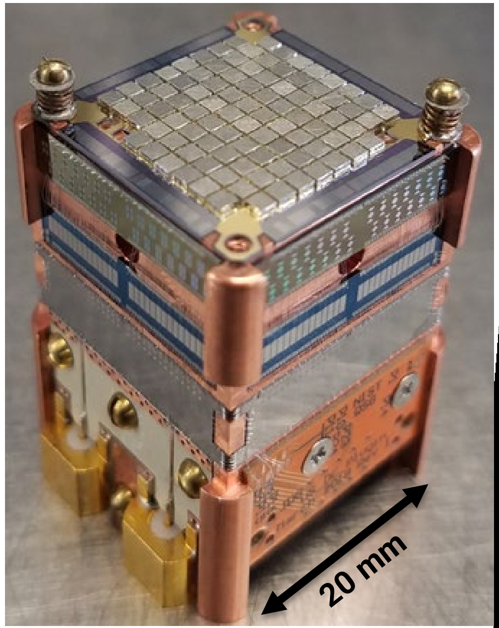
PI:

Dan Becker
daniel.becker@colorado.edu

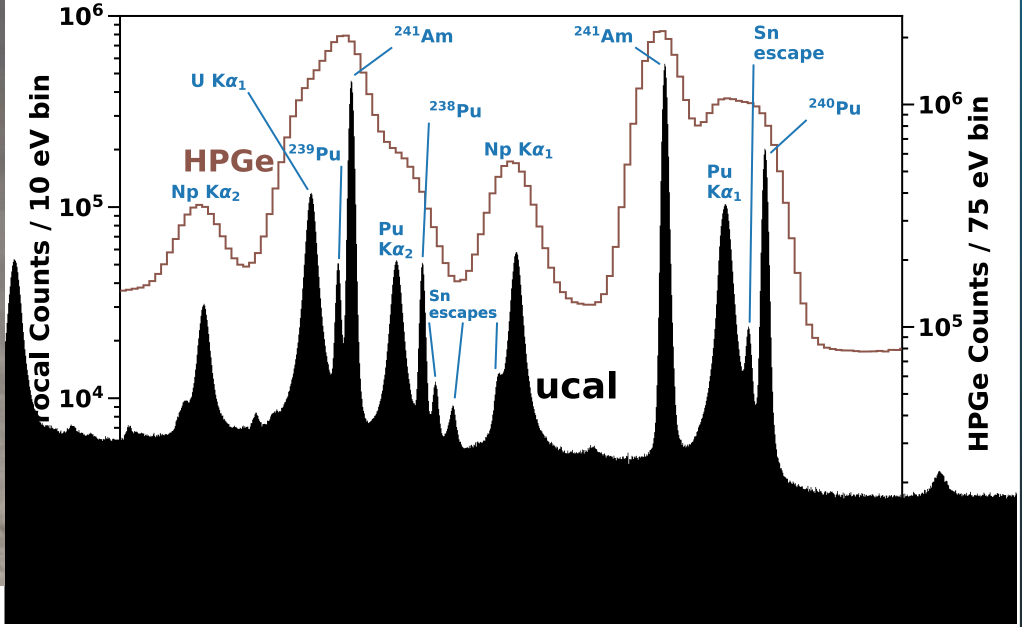
Project Outcomes:

Microcalorimeter submodule featuring 20x improvement in detector speed, and demonstration using pyroprocessing samples from INL

96-pixel microcalorimeter submodule



Superior energy resolution of microcalorimeters allows separation of closely spaced gamma-ray peaks, enabling Pu isotopic assay to within 1 %



Key takeaway: Faster microcalorimeters enable better approaches to nuclear materials accountancy and control at lower operating cost

ONWARDS: Citrine Informatics, Inc.

Project Title:

Halogen-related Advanced Waste forms through Artificial Intelligence Integration (HAWAII)

PI:

Dr. James Saal
jsaal@citrine.io

Project Outcomes:

Novel molten salt reactor waste forms with >3x reduction in volume, improved durability, and >50% reduction in facility costs.

CONVENTIONAL TECHNOLOGY
[GLASS-BONDED SODALITE]

>3x reduction in volume

>50% reduction in CapEx and O&M costs

Improved durability and other properties

NEW TECHNOLOGY
[PHOSPHATE GLASS, PROPOSED]

Key takeaway: AI-driven dehalogenated phosphate waste form design

ONWARDS: Deep Isolation

DEEP ISOLATION® | BERKELEY LAB | Berkeley UNIVERSITY OF CALIFORNIA | NAC INTERNATIONAL

Project Title:

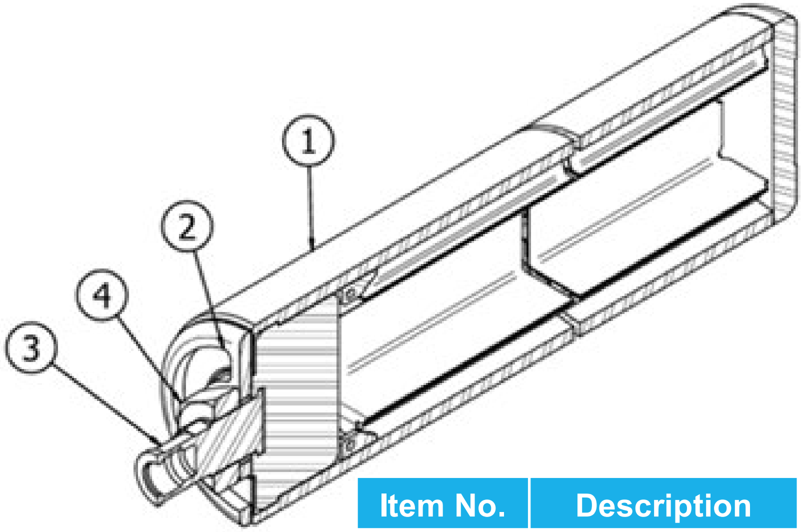
UPWARDS: Universal Performance Criteria and Canister for Advanced Reactor Waste Form Acceptance in Borehole and Mined Repositories Considering Design Safety

PI:

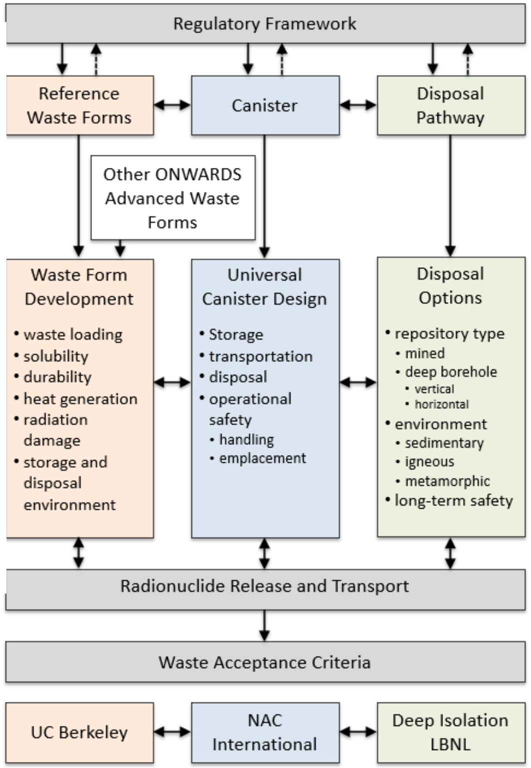
Jesse Sloane, PE
jesse@deepisolation.com

Project Outcomes:

Provide an integrated waste management system for the disposition of advanced reactor (AR) waste forms compatible with both mined and deep borehole disposal.



Item No.	Description
1	Canister Assembly
2	Cover Ring
3	Lift Adapter
4	Jam Nut



Key takeaway: Universal Canister System to Dispose of Multiple AR Waste Streams

If it works…

will it matter?

arpa·e
CHANGING WHAT'S POSSIBLE

arpa·e
CHANGING WHAT'S POSSIBLE

Questions

Thank You!

September 27, 2023

Emergency Planning Zones and SMRs

September 2023

CLEAN AIR
TASK FORCE

— Objective and Agenda

To understand the concept of Emergency Planning Zones (EPZs) and their significance for nuclear reactor safety in the United States, as well as to understand the implications of the NRC's new EPZ rule.

- Background on CATF
- What is an EPZ
- Background of EPZs and current regulations
- New EPZ rule and key changes

CATF snapshot

Founded in 1996

>185 staff

Major offices in Boston, DC, Brussels, emerging activity cluster in MENA, major expansion plans for India, China, SE Asia, Latin America

Budget, 95% foundations and individuals (corporate donations small and selective; no government funding)

Climate, News & Media

CATF named most effective climate organization

December 3, 2021

BOSTON — This week, Clean Air Task Force (CATF) was rated by multiple external evaluators as one of the most effective organizations in the world working to address climate change, "a clear validation of the pragmatic, unconventional, and science-based approach CATF has used to push the envelope and advance climate action for more than 25 years," said **Armond Cohen, Co-Founder and Executive Director at CATF.**

Both Giving Green and Founders Pledge recognized CATF as a highly effective climate charity — recommending the organization as one of the very best in the climate space to support in terms of donor impact. On Giving Tuesday, the digital news outlet Vox issued its annual list of the most effective organizations working on climate change, rating Clean Air Task Force number one.

These groups recognized CATF for its effective policy design and advocacy, its focus on innovation and technology optionality, its ability to take on the hard challenges in the climate space, and its willingness to look past traditional thinking and rigid ideology in the climate space.

Vox said: "CATF stands out not only for its impressive impact on US climate policy but also for being a pioneer in the environmental space. It was one of the first major environmental organizations to publicly campaign against neglected superpollutants like methane, which plays a central but underrecognized role in the ongoing climate catastrophe."

Founders Pledge said: "CATF's role in the environmental NGO ecosystem has often been to focus on sources of emissions that are neglected by other environmental NGOs to conceive and design pragmatic campaigns to target those emissions, and to crowd-in support from philanthropists and other larger environmental NGOs. CATF also produces high quality research, which is well-regarded among the philanthropists, scientists, policy experts, and government bureaucrats that we have spoken to."

Giving Green said: "We recommend Clean Air Task Force because of its strong track record of policy accomplishments at the national level (including policies with bipartisan support), its focus on relatively neglected issue areas, the strength of its staff, and its ability to productively absorb additional funds in coming years."

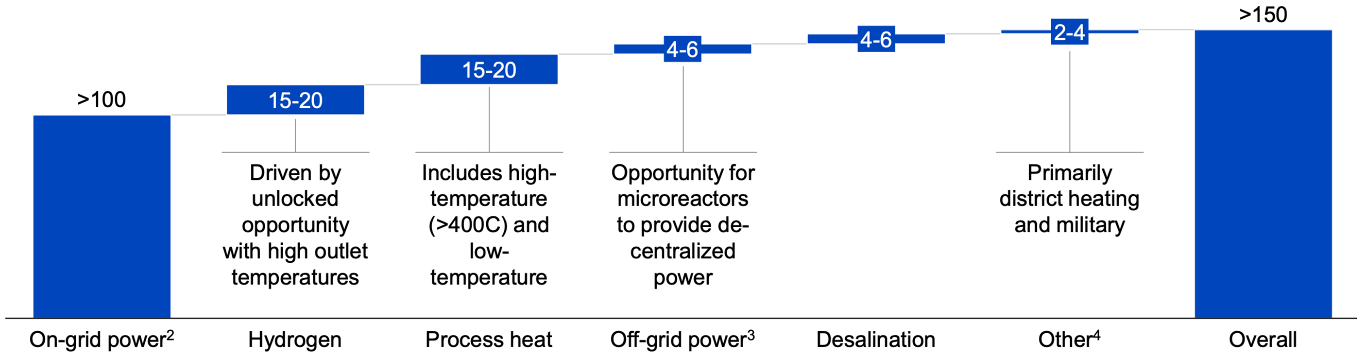
Premise and Mission of CATF Nuclear Program

Nuclear deployment at 100+ GW year* is needed, more than 10X recent history

* For reference, 1 GW = 1 large reactor. Only 390 GW of nuclear energy reactors are installed today.

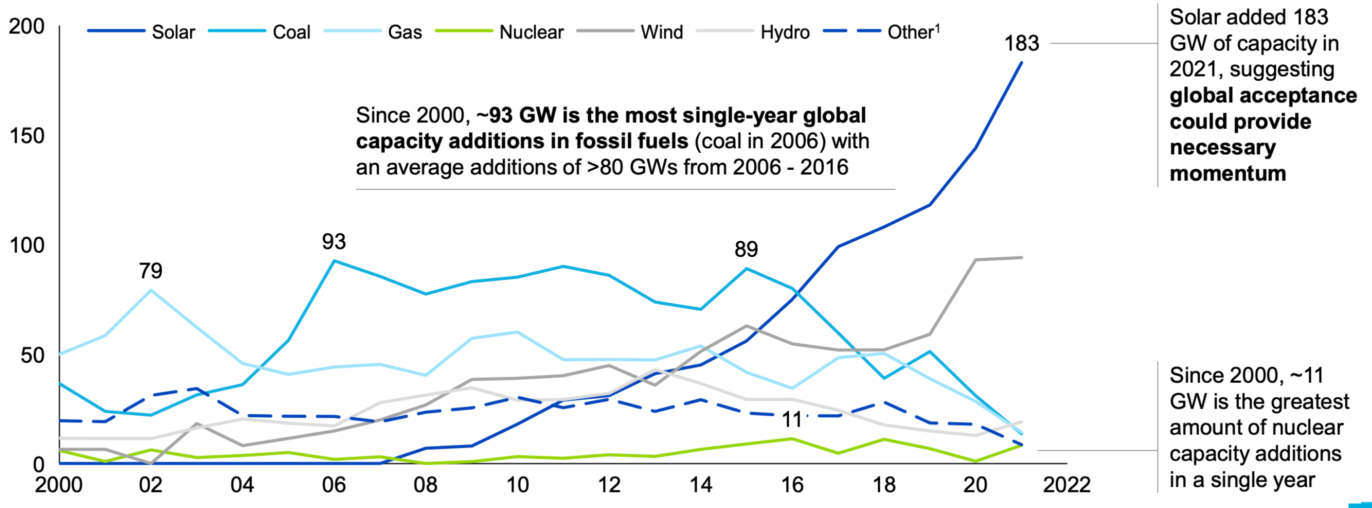
The mission of CATF's nuclear program is to catalyze the commercial and policy conditions for a global nuclear energy sector that can, by the 2040s, begin to scale at a rate commensurate to the climate challenge

Annual nuclear capacity additions, 2030-2050 GWs / year[1]



While nuclear need will be driven by on-grid power production, it can also play an important role in decarbonizing non-electricity energy production

Global capacity additions by energy source, GW

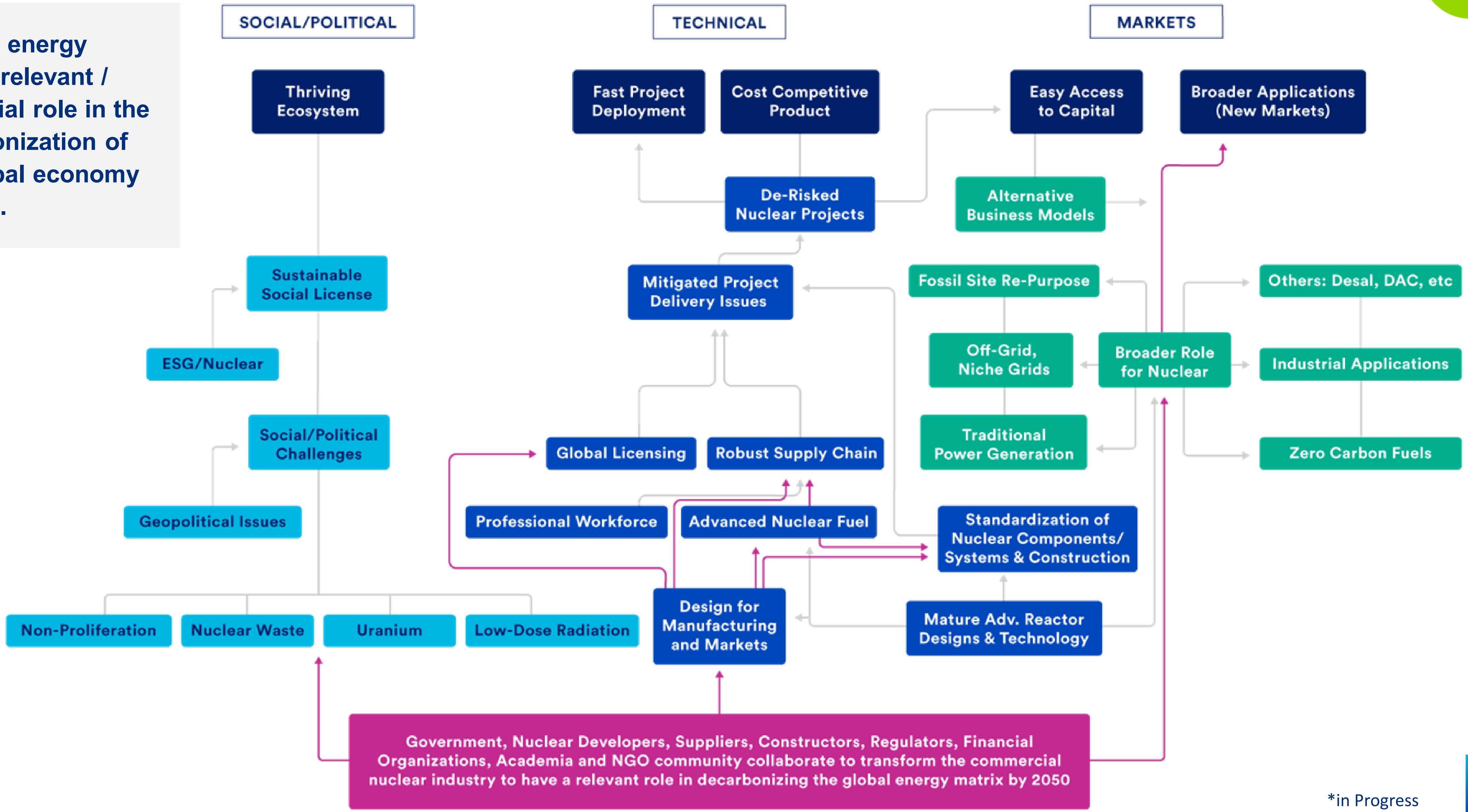


1. Includes biomass, waste, oil, geothermal, and hydrogen

Source: UDI; GWEC; BNEF

NUCLEAR THEORY OF CHANGE*

Nuclear energy plays a relevant / influential role in the decarbonization of the global economy by 2050.



*in Progress

An Emergency Planning Zone (EPZ) is a designated area around a nuclear reactor where specific **emergency preparedness measures** are in place to protect public health and safety from radiological emergencies.

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As a precaution. Nuclear is very safe.

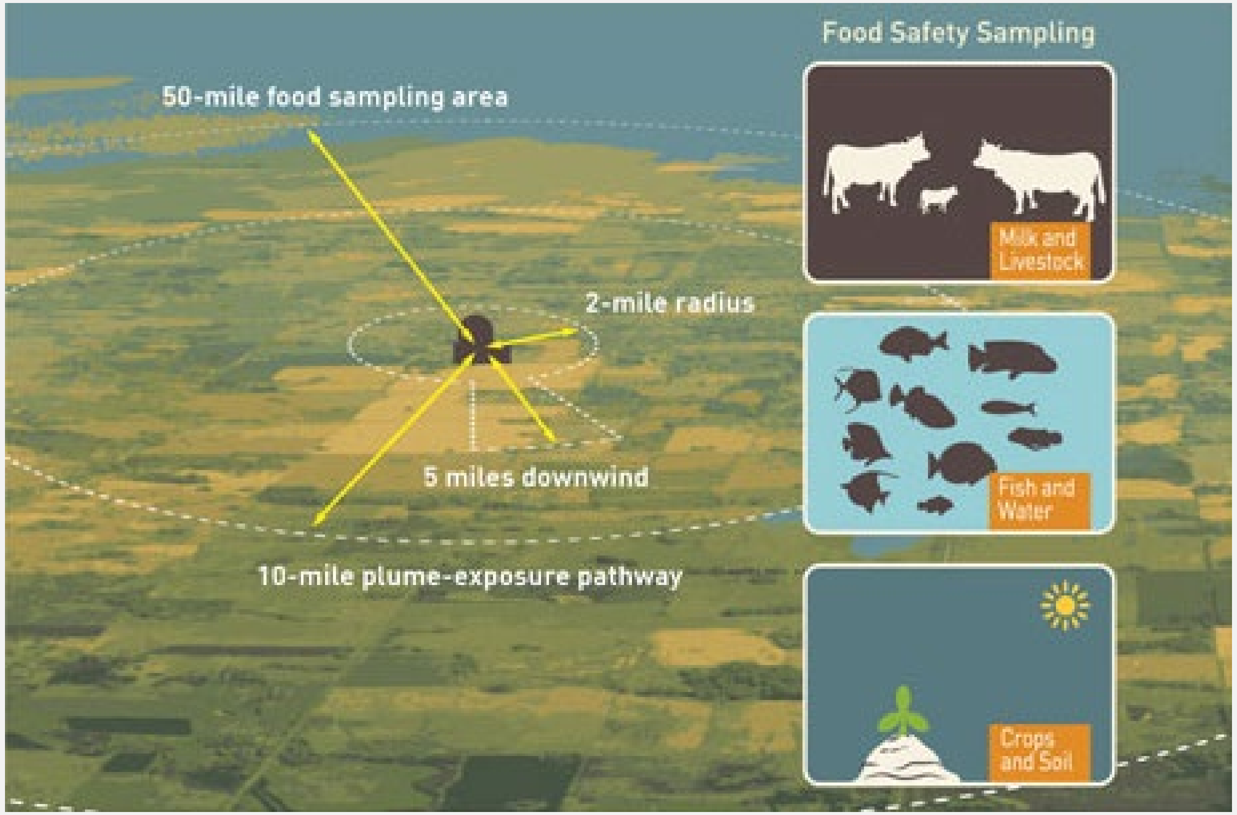
Background on EPZs

- The NRC and EPA published published a report in 1978 (NUREG-0396/EPA 520/1-78-016) detailing the planning basis for emergency response plans developed by state and local governments. The report determined that the most significant impacts of a nuclear plant accident would be experienced in the area located within an approximately 10-mile radius of the plant. At greater distances—beyond a 10-mile radius—the principal health concern in the event of an accident would be consumption of contaminated water, milk or food.
- After additional proceedings and new considerations following the accident at the Three Mile Island nuclear power plant in 1979, NRC codified the 10- and 50-mile EPZs through the rulemaking process in August 1980 with 10 CFR 50.47(c)(2).
- 10 CFR 50.47(c)(2) included a provision allowing for a case-by-case determination of the appropriate EPZ for reactors with an authorized power level less than 250 megawatts thermal and for gas-cooled reactors.
- As a result, each commercial nuclear power reactor has onsite and offsite emergency plans to assure that adequate protective measures can be taken to protect the public in the event of a radiological emergency. FEMA and NRC share responsibilities, but NRC has overall authority for both onsite and offsite emergency preparedness.

NuScale went through this

— Types of EPZs

- Primary EPZ (Plume Exposure Pathway): Immediate area around the reactor, typically within a 10-mile radius.
  - Plans in place for rapid evacuation or sheltering in place
- Secondary EPZ (Ingestion Exposure Pathway): Extends beyond the primary EPZ, up to 50 miles, with fewer immediate response measures.
  - Evacuation is scenario-specific
  - Focus on managing food and water contamination.



Existing regulations and guidance focus on large LWRs. Recognizing requirements (especially potentially reduced EPZs) were **important for reducing regulatory uncertainty for reactor licensing and enhancing the business case** for SMR and advanced reactor developers, NRC order a new rulemaking in 2016.

— SMR and Advanced Reactor Rulemaking

- In an August 2023 press release, the NRC announced its intent to finalize by the end of 2023 its rulemaking for “Emergency Preparedness for Small Modular Reactors and Other New Technologies.” The NRC published its proposed rule in May 2020 and, after a lengthy comment period and public meeting, finalized its rulemaking package for Commission review in early 2022.
- Facilities covered by the Final Rule are limited to SMRs (defined by the rule as light -water reactors generating 1,000 MW thermal power or less per module), advanced reactors (i.e., non-light-water reactors), research and test reactors, and medical radioisotope facilities.
- The final rule will apply “risk-informed, performance-based emergency preparedness requirements to small modular reactors and other new technologies” to “address how state-of-the-art facility designs and safety research apply to future operation of small modular reactors and other new technologies.”

CATF

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Final Vote Required Stakeholder Urging

CATF

Key Changes

- The Final Rule will create a new, alternate, **performance-based** emergency preparedness framework in 10 CFR Section 50.160. Current regulations for reactors require site-specific emergency plans designed around 16 planning standards, a **deterministic** structure that works well for large LWRs whose risks are well understood.

- However, because SMRs and other new nuclear technologies may use a wide range of designs and safety features, a performance-based approach would be better suited, and would **reduce the administrative burden** to evaluate expected exemption requests from existing regulations.

- The Final Rule also amends 10 CFR Section 50.33 to provide for a **scalable approach to determining the size of the emergency planning zone (EPZ)**.

- Rather than setting a predetermined inflexible distance for the EPZ (i.e., 10-50 miles), the distance would be **determined by the potential consequence** of an accident based on factors such as accident likelihood and source term, timing of the accident sequence, and meteorology.

— Key Changes (Continued)

- The new framework will include requirements for demonstrating effective responses via drills and exercises. Significantly, the facility **will not need to involve local responders in these drills and exercises where the EPZ does not extend beyond the facility's perimeter**, as is being proposed by some advanced designs.
- The Final Rule also clarifies that an emergency plan that satisfies the Section 50.160 requirements **will also satisfy the emergency preparedness requirements for co-located independent spent fuel storage** installations licensed under 10 CFR Part 72.

— Summary

- EPZs are emergency preparedness measures to protect public health and safety but in addition to potentially being too conservative are not sell suited for the newest generation of reactors
- The updated emergency planning regulations will allow flexibility, while fostering predictability in how the NRC will evaluate emergency plans.
- Significantly, the resource burden for drills and exercises will be significantly reduced for those reactor designs that can achieve an EPZ that does not extend beyond the facility’s perimeter.
- The new regulations will also potentially aid the adaption of SMRs and advanced reactor designs for uses other than traditional electric generation, like providing industrial process heat.

Thank you

EVALUATING NUCLEAR WASTE & SAFETY CONSIDERATIONS FOR ADVANCED NUCLEAR DEPLOYMENT

Moderator: Hon. Bobby Janecka, Texas Commission on Environmental Quality

Panelists:

Dr. Catherine Wise, Program Officer, Board on Energy and Environmental Systems, The National Academies of Sciences, Engineering, and Medicine

Dr. Robert Ledoux, Program Director, ONWARDS, ARPA-E

Jon-Michael Murray, Nuclear Policy Manager, Clean Air Task Force

Upcoming

NASEO Annual Meeting, Portland, OR

October 16-19, 2023

NARUC Annual Meeting, La Quinta, CA

November 12-15, 2023

Registration & agenda available on the NASEO & NARUC websites

ANSC Member facilitated Discussion 3:00-3:30pm

- Facilitated discussion for ANSC members begins directly after this webinar
- Zoom join link available via outlook calendar appointment and in inbox from kkline@naruc.org
- Please email Kelsey or Kathryn if you're having difficulty joining