Types of Advanced Reactors

Range of sizes and features to meet diverse market needs

- Micro Reactors (< 20MW)
  - Oklo (shown)
  - NuScale (shown)
  - GEH X-300
  - Holtec SMR-160
  - Several in development

- LWR SMRs <300MW
  - Several in development

- High Temp Gas Reactors
  - X-energy (shown)
  - Several in development

- Liquid Metal Reactors
  - TerraPower Natrium (shown)
  - Several in development

- Molten Salt Reactors
  - Terrestrial (shown)
  - Several in development

- Non-Water Cooled
  - Most <300MW, some as large as 1,000 MW

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UAMPS and NuScale

- **UAMPS**
  - Plans to deploy a NuScale reactor at Idaho National Lab around 2029

- **NuScale**
  - Light-water SMR
  - Four to 12 modules - 77 MWe each
  - 308 MWe to 924 MWe gross
  - Ability to rapidly adjust total power output by adjusting individual modules
  - Air cooling for condensers is an option
U.S. Department of Energy Advanced Reactor Demonstration Program

• Established and Funded in FY 2020 Appropriations
• Awards announced October and December 2020 – contracts finalized months later
• Three pathways
  • Advanced Reactor Demonstrations - Technical feasibility that the demonstration can be operational in five to seven years – 50/50 cost share – two awardees
  • Risk Reduction for Future Demonstrations - Commercial horizon approximately 5 years later than the Demos – up to 80/20 cost share – five awardees
  • Advanced Reactor Concepts 20 - Lowest design maturity – commercial horizon in the mid-2030’s – up to 80/20 cost share – three awardees
• Bipartisan Infrastructure Bill, enacted in 2021, included $2.477 billion for demonstrations
Natrium Reactor

- Liquid sodium fast reactor - 345 MWe
- Metallic fuel
- Molten salt thermal storage for peaking to 500 MWe
- Location: Kemmerer Wyoming – retiring coal facility
- Operational: around 2028
Xe-100

- Pebble bed helium cooled gas reactor
  80 MWe
- Four reactors – 320 MWe total
- TRISO fuel
- Location: Washington State
- Operational: around 2027
ARDP Risk Reduction Awards

- develop commercially viable transportable microreactor
- early-stage engineering, design and licensing for SMR-160
- design, construct, operate a test reactor
- design, construct, operate a molten chloride reactor experiment
- advance design of eVinci microreactor
ARDP ARC-20 Awards

- conceptual design of a seismically isolated advanced sodium-cooled reactor
- fast modular reactor conceptual design
- conceptual design of the Modular Integrated Gas-Cooled High-Temperature Reactor (MIGHTR) concept
Micro-Reactors for Remote Locations and Transportable Micro-Reactors

Project Pele – transportable micro-reactor demonstration being planned by DoD and BWXT for Idaho National Lab around 2024
Advanced Reactor Deployments by 2030

- 2023: Vogtle 3 & 4
- 2024: INL MARVEL, DOD Pele
- 2025: Oklo Aurora, Kairos Hermes
- 2026: USNC MMR
- 2027: X-energy Xe-100, Southern Co./TerraPower MCRE
- 2028: GEH BWRX-300, TerraPower Natrium
- 2029: NuScale VOYGR
KEY
- Green: State policies to support advanced nuclear in place
- Blue: State policies to support advanced nuclear under consideration
- Black: Planned project
- Under construction

Advanced Nuclear Deployment Plans
Projects in planning or under consideration in U.S. and Canada; >30 globally
NEI Member Survey: Top-Level Results

Nuclear power’s potential role in meeting company decarbonization goals:

- **SLR**: >90% of fleet expects to operate to at least 80 years
- **GW**: 90 GW of new nuclear opportunity by 2050s
- **SMRs**: Translates to nearly 300 SMR-scale plants

* NEI utility member companies produce less than half of all US electricity
Nuclear Demand to Support Decarbonization by the 2050s – Grid Only

SURVEY

NEI Member Survey
- 92 GW Nominal
- 57 GW High Cost

NEI Survey Scaled to All of U.S.
- 219 GW Nominal
- 133 GW High Cost

MODELING

VCE Model
- 336 GW Nominal
- 163 GW Constrained

INL/DOE Model
- 60 GW Constrained

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Versatility - New Applications

Source: Idaho National Laboratory
Nucor eyes nuclear power for EAF mills

Steelmaker makes investment in modular nuclear power systems provider.

April 7, 2022

Dow Weighs Buying Nuclear Power in Low-Carbon Push, CEO Says

- Dow looking at two small-scale sites in the United States
- Nuclear can provide baseload power to industry Fitterling

Phase 2: 2030-40

Improve efficiencies
Includes using emerging technologies to improve processes and increase carbon capture; exploring alternative power sources, such as small modular reactors, for oil sands production.
Future Front End of the Fuel Cycle?

Mining \(\rightarrow U_3O_8\) Conversion \(\rightarrow UF_6\) Enrichment \(\rightarrow UF_6\) Fabrication \(\rightarrow\) Deconversion

\(U_3O_8\) \(UO_2\) \(UO_2\) Metal

Reactors

Salt

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Challenges to Establishing Future HALEU Fuel Cycle

• Technology is not the problem
• Market development and infrastructure investment (enrichment and transportation) is the challenge
Key Challenges

- Successes with First-of-a-Kind
  - Establish nuclear builds as predictable

- NRC Licensing Efficiency
  - Unprecedented scale can’t be addressed by increasing staff

- Siting
  - Suitability, environmental reviews, public

- Supply Chain Ramp-up
  - Global demand race

- Workforce Expansion
  - Licensing, construction, supply chain, operation

- Facilitation of Export
  - Global demand may dwarf U.S. – heavy competition