Nuclear Energy: Today and Tomorrow

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Types of Advanced Reactors

Range of sizes and features to meet diverse market needs

Micro Reactors (< 20MW)

Oklo (shown)
Several in development

LWR SMRs <300MW

NuScale (shown)
GEH X-300
Holtec SMR-160

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

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

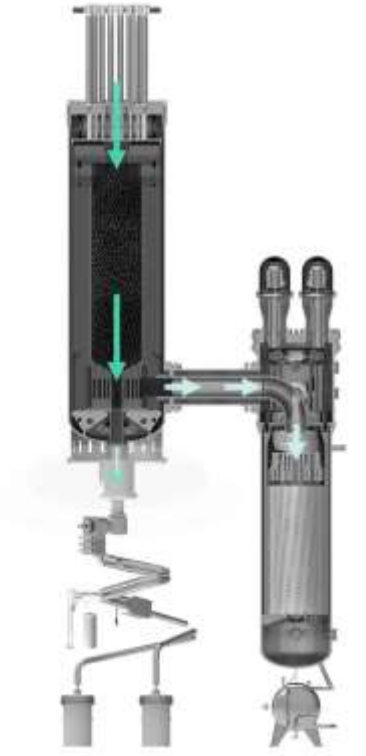
- Established and Funded in FY 2020 Appropriations
- Awards announced October and December 2020 – contracts finalized months later
- Three pathways
  - Advanced Reactor Demonstrations - Technical feasibility that the demonstration can be operational in five to seven years – 50/50 cost share – two awardees
  - 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

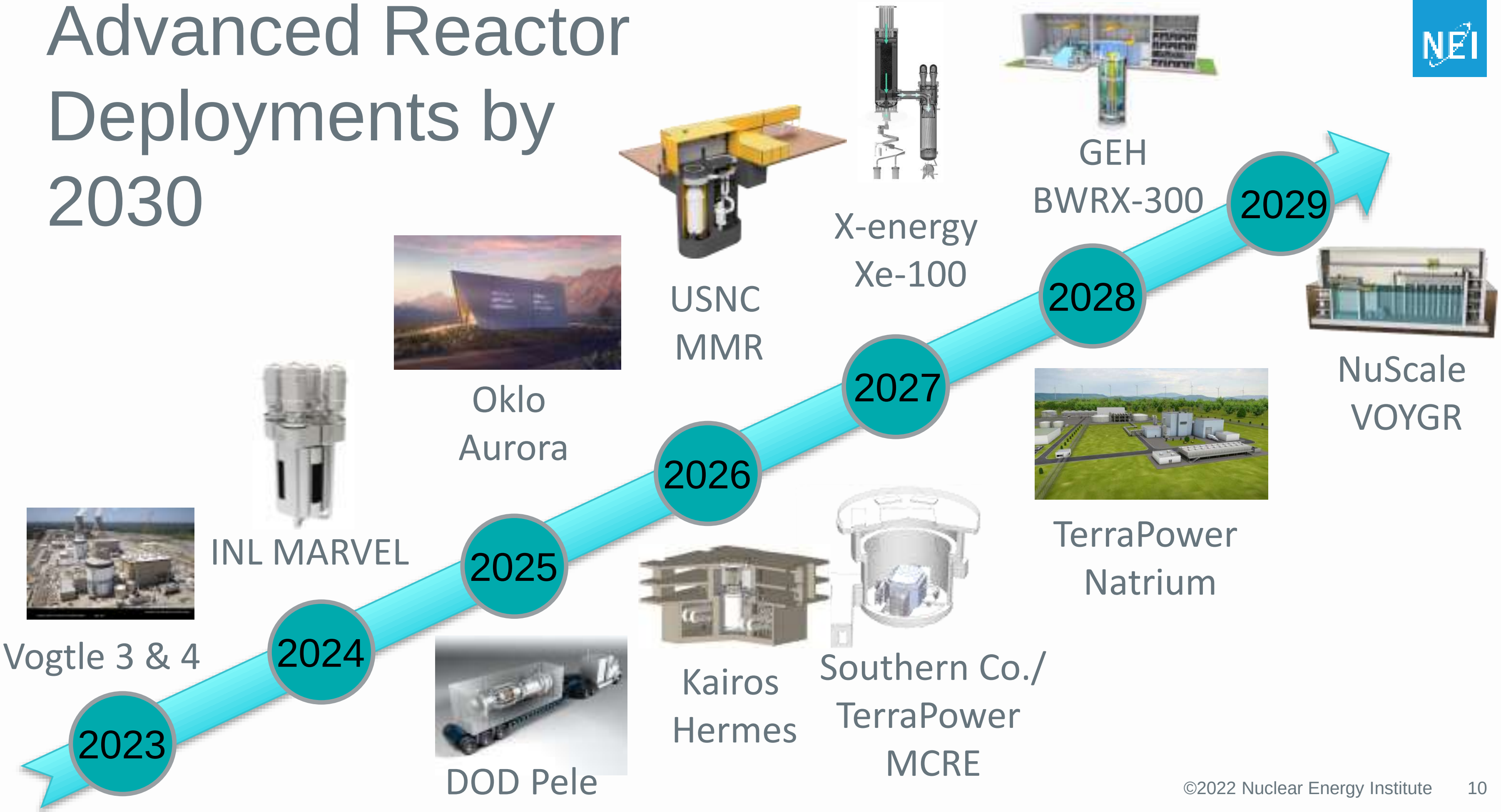
ARDP ARC-20 Awards

- 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

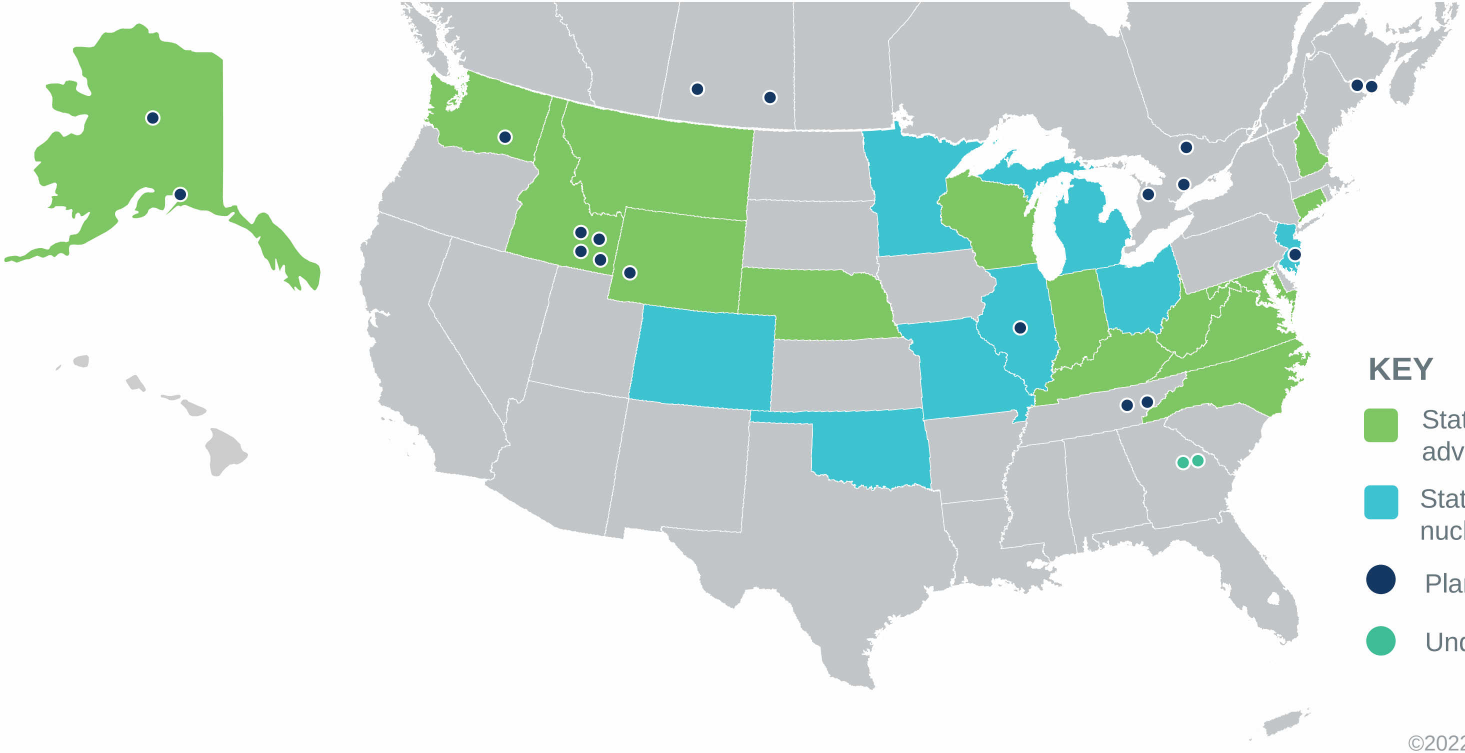
Project Pele – transportable micro-reactor demonstration being planned by DoD and BWXT for Idaho National Lab around 2024

Advanced Reactor Deployments by 2030



Advanced Nuclear Deployment Plans

Projects in planning or under consideration in U.S. and Canada; >30 globally



KEY

- State policies to support advanced nuclear in place
- State policies to support advanced nuclear under consideration
- Planned project
- Under construction

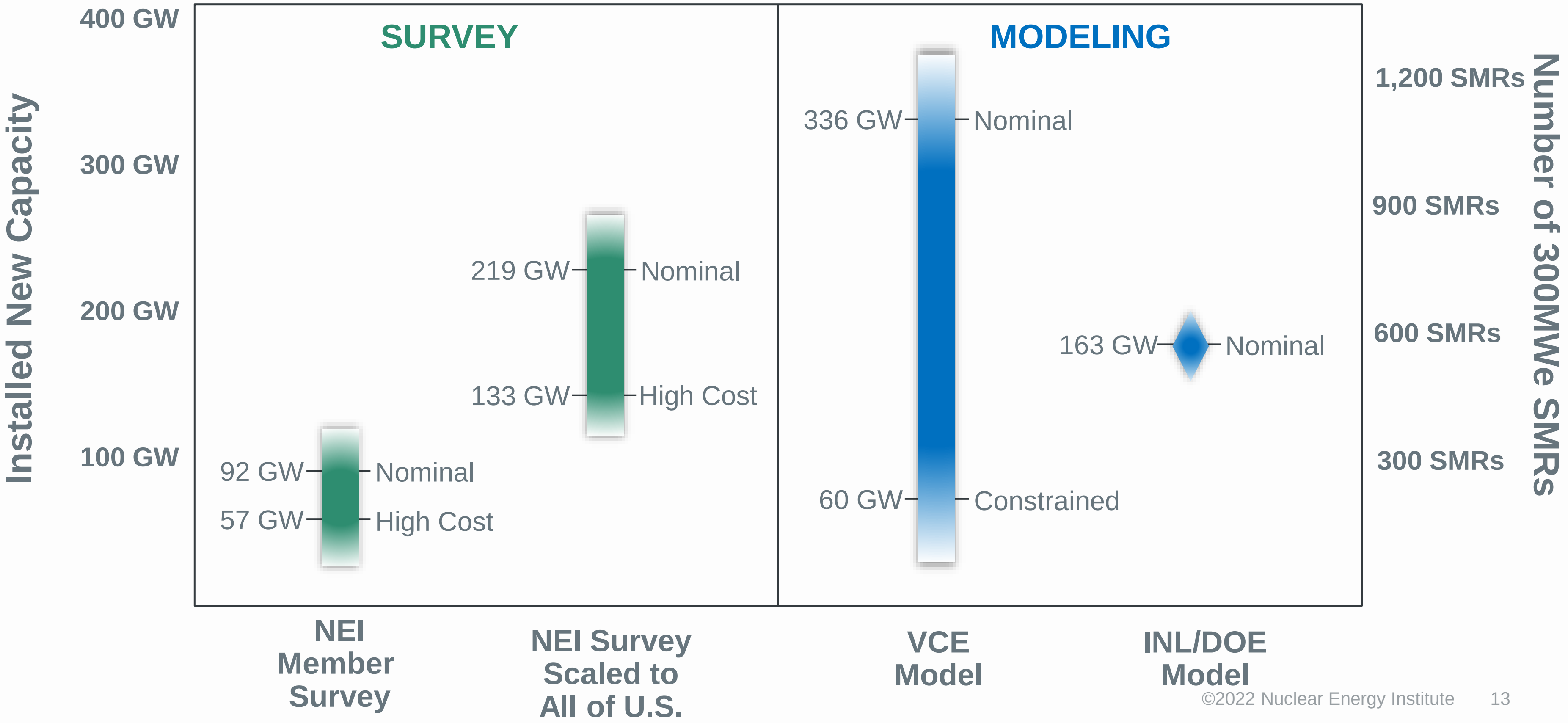
NEI Member Survey: Top-Level Results

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

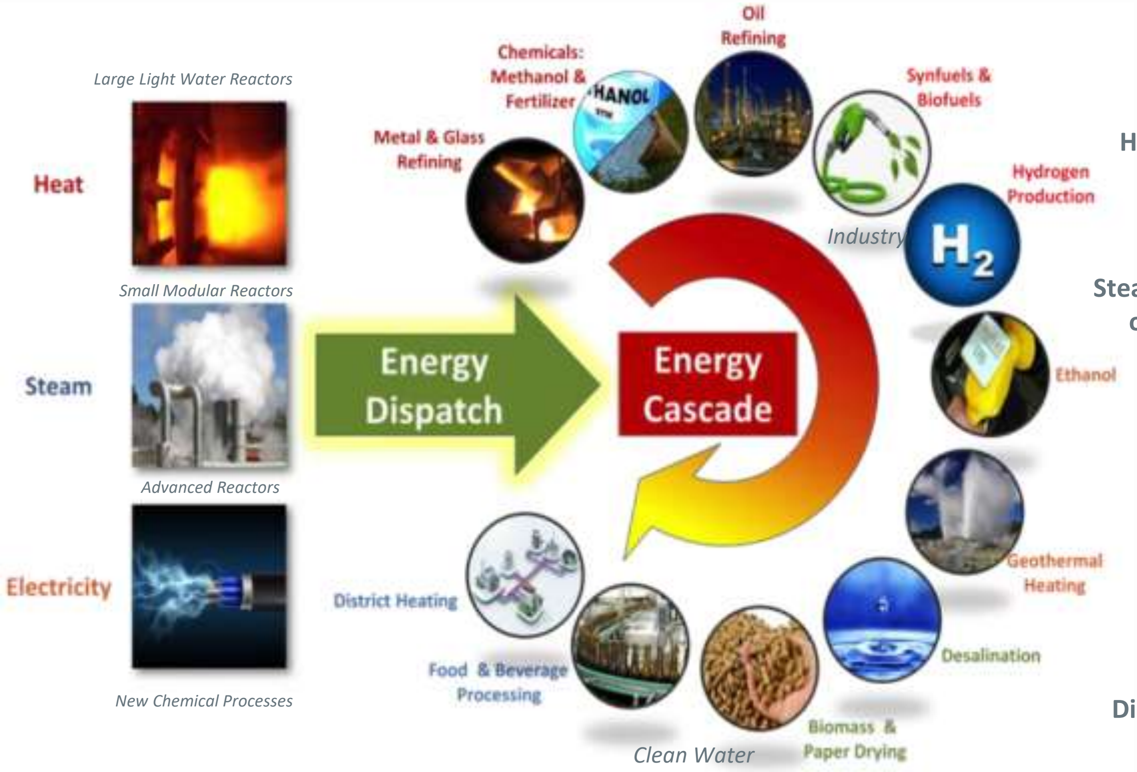
- **SLR** >90% of fleet expects to operate to at least 80 years
- **GW** 90 GW of new nuclear opportunity by 2050s
- **SMRs** Translates to nearly 300 SMR-scale plants

* NEI utility member companies produce less than half of all US electricity

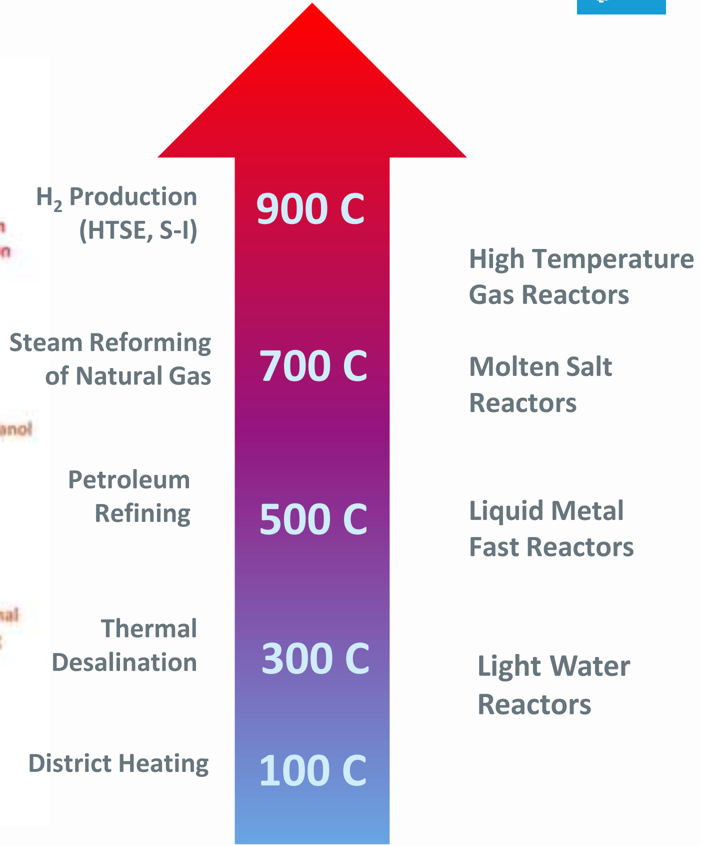
Nuclear Demand to Support Decarbonization by the 2050s – Grid Only



Versatility - New Applications



Source: *Idaho National Laboratory*



Oil Sands
Pathways to Net Zero

Canadian Natural
cenovus
ConocoPhillips Canada
Imperial
MEG Energy
Suncor

Nucor eyes nuclear power for EAF mills

Steelmaker makes investment in modular nuclear power systems provider.

April 7, 2022

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.

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

Future Front End of the Fuel Cycle?

Mining

U_3O_8

Conversion

UF_6

Enrichment

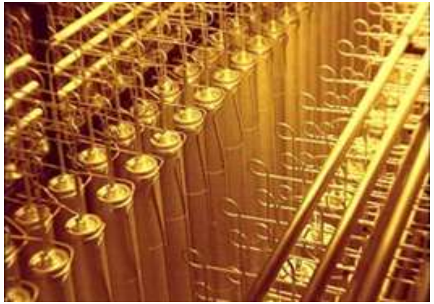
Deconversion

U metal

UF_6

UO_2

U_3O_8



Fabrication

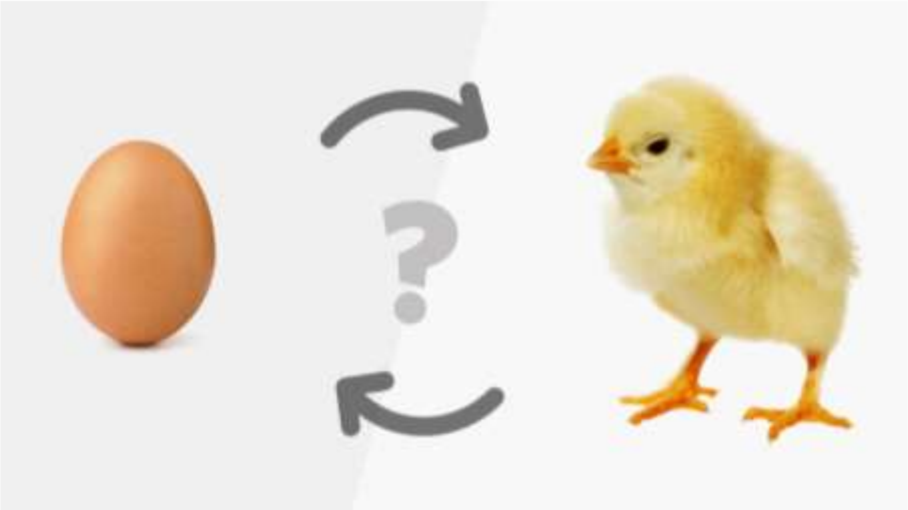
UO_2 Metal

Salt

Reactor

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

QUESTIONS?

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By Third Way, GENSLER