NuScale Introduction

Generating Resources Advisory Committee

Chris Colbert – Chief Strategy Officer

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NuScale Power™

NuScale Power History

- NuScale first of current US SMRs to begin design of commercial NPP
- NuScale technology in development and design since 2000 (DOE) MASLWR program with INL
- Electrically-heated 1/3-scale integral test facility first operational in 2003, leverages experience from AP600/1000 ¼-scale testing facility (built and operational)
- Began NRC design certification (DC) pre-application project in April 2008
- Acquired by Fluor in October 2011
- DOE $217 million cost-share contract executed May 2014
- ~600 full time equivalent staff currently on project, ~$250MM invested project life-to-date
- 181 patents pending/granted in 19 countries

NuScale engineering offices Corvallis, Oregon

One-third scale test facility

NuScale control room simulator

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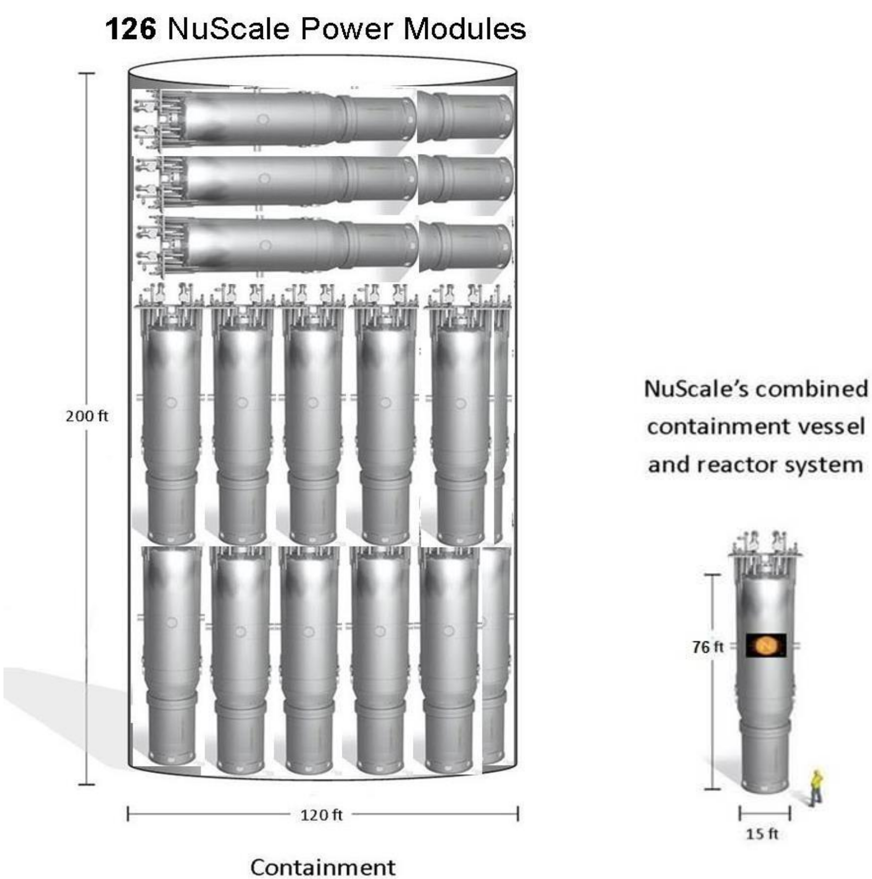
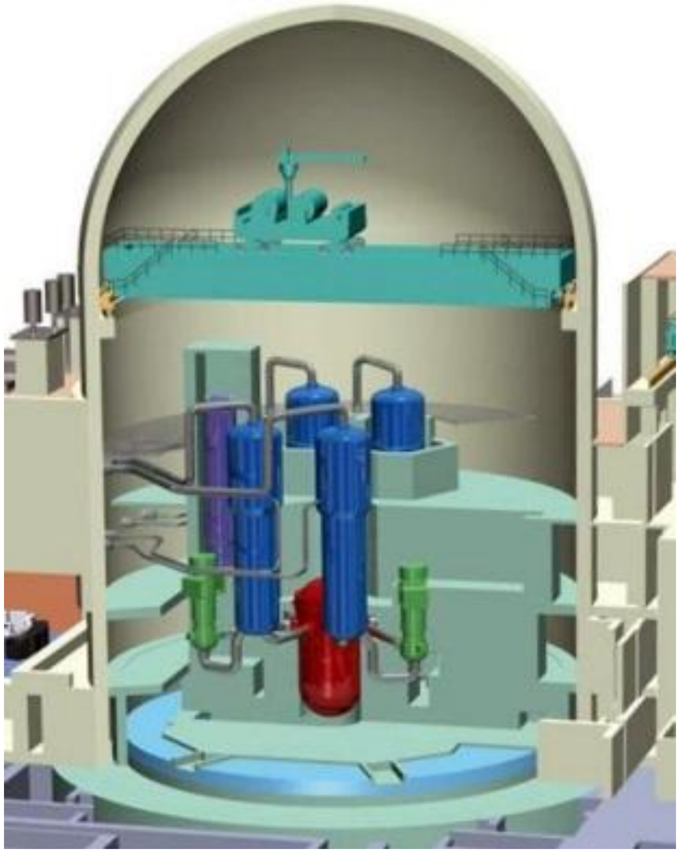
Design Overview

Size Comparison

Comparison size envelope of new nuclear plants currently under construction in the United States



Typical Pressurized Water Reactor



*Source: NRC

Reactor Module Overview

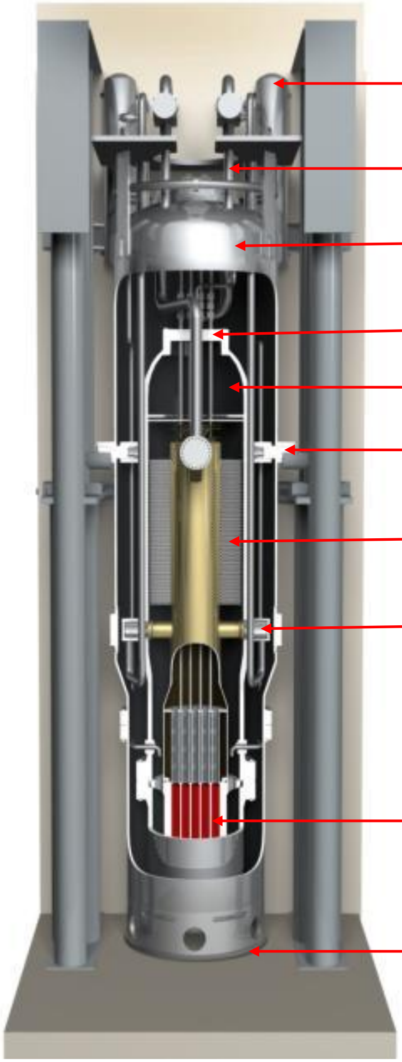
Natural convection for cooling

- passively safe, driven by gravity, natural circulation of water over the fuel
- no safety-related pumps, no need for emergency generators

Simple and small

- reactor is 1/20th the size of large reactors
- integrated reactor design, no large-break loss-of-coolant accidents

Click HERE for video



Plant Design Overview

Basic Plant Parameters

Overall Plant	
• Net electrical output	Up to 570 MWe (nominal)
• Plant thermal efficiency	> 30%
• Number of power generation units	Up to 12
• Nominal plant capacity factor	> 95%
• Plant protected area	~44 acres
Power Generation Unit	
• Number of reactors	One
• Gross electrical output	50 MWe
• Steam generator number	Two independent tube bundles (50% capacity each)
• Steam generator type	Vertical helical coil tube (secondary coolant boils inside tube)
• Steam cycle	Superheated
• Turbine throttle conditions	3.3 MPa (475 psia)
• Steam flow	67.5 kg/s (536,200 lb/hr)
• Feedwater temperature	149°C (300°F)
Reactor Core	
• Thermal power rating	160 MWth (gross)
• Operating pressure	12.7 MPa (1850 psia)
• Fuel design	UO_2 (< 4.95% U^{235} enrichment); 37 half-height 17x17 geometry lattice fuel assemblies; Zircaloy-4 or advanced cladding material; negative reactivity coefficients
• Refueling interval	24 months

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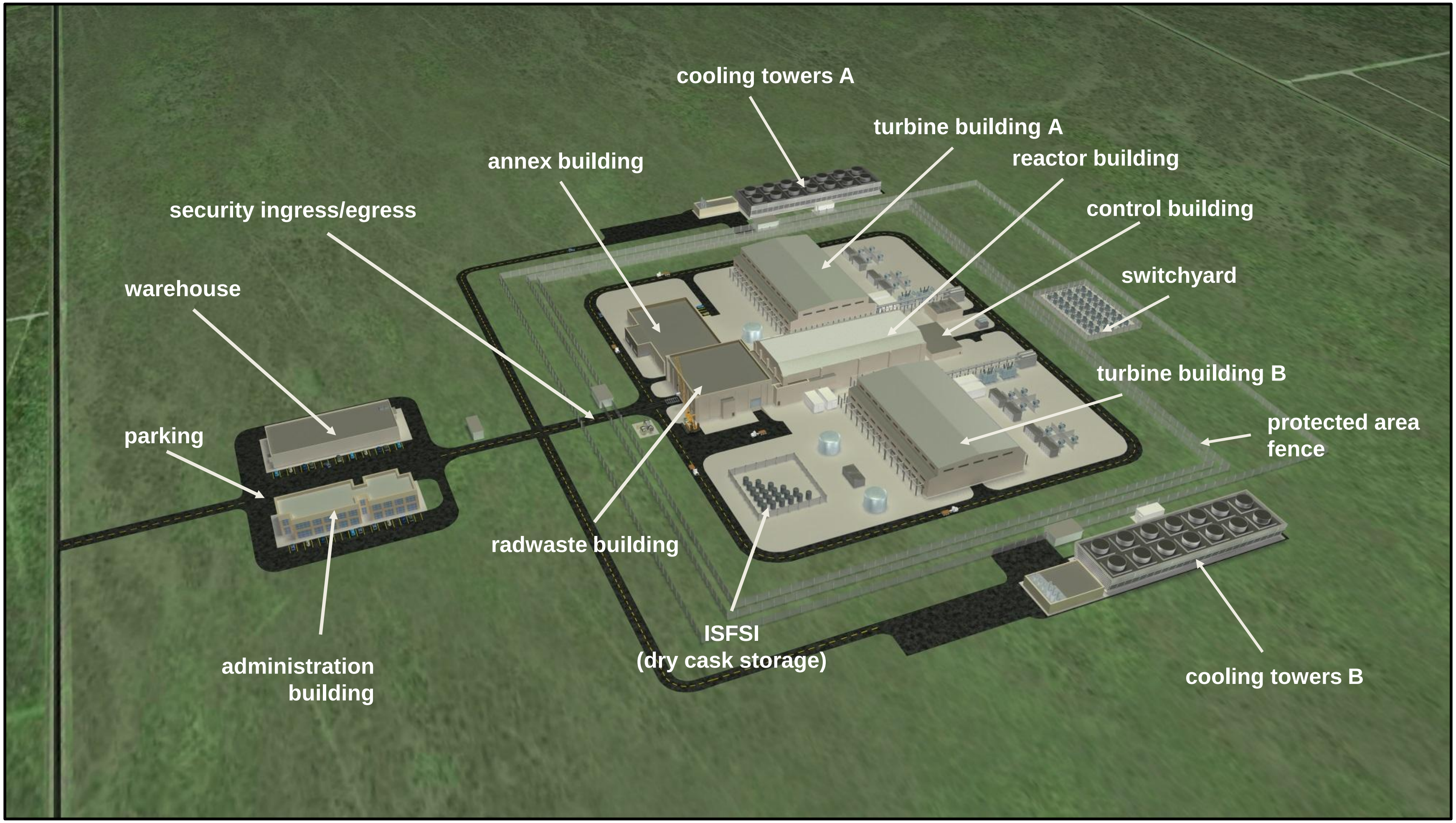
Site Layout

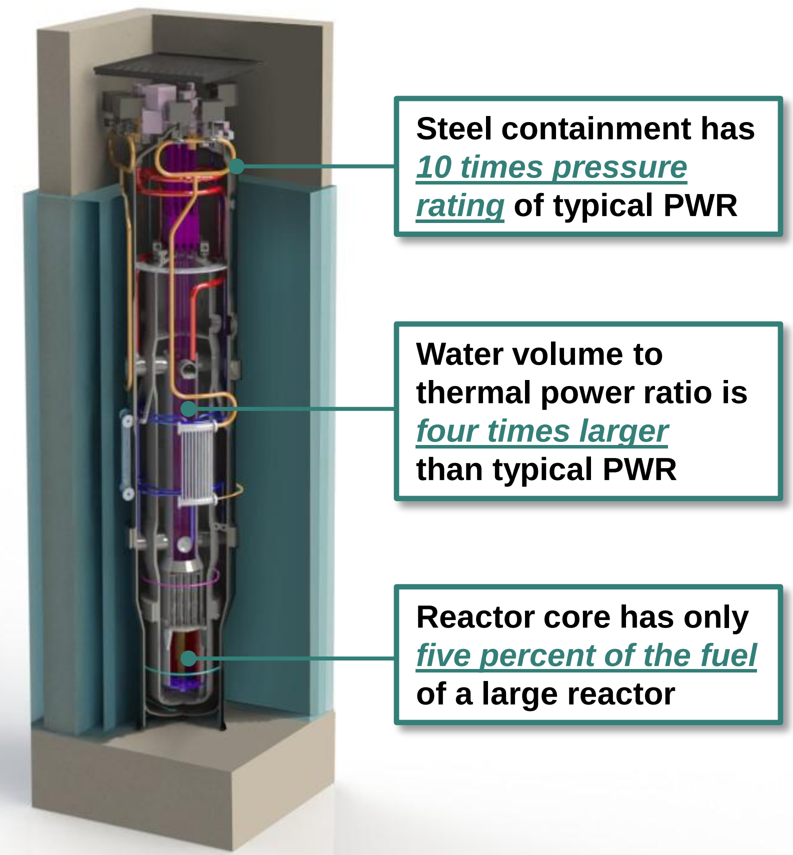

cooling towers A
turbine building A
reactor building
annex building
control building
security ingress/egress
switchyard
warehouse
turbine building B
protected area
fence
parking
radwaste building
ISFSI
(dry cask storage)
cooling towers B
administration
building

Safety

Design Simplicity Enhances Safety

All safety equipment needed to protect the core is shown in this picture

- Natural convection for cooling
  - passively safe, driven by gravity, natural circulation of water over the fuel
  - no pumps, no need for emergency generators
- Seismically robust
  - system submerged in a below-ground pool of water in an earthquake resistant building
  - reactor pool attenuates ground motion and dissipates energy
- Simple and small
  - reactor core is 1/20th the size of large reactor cores
  - integrated reactor design, no large-break loss-of-coolant accidents
- Defense-in-depth
  - multiple additional barriers to protect against the release of radiation to the environment
- **Resistant to extended loss of AC power**
  - **indefinite reactor core cooling without pumps, power, operator action, or external water supply (unlimited coping period)**



160 MWt NuScale Power module

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NuScale Major Breakthrough in Safety

- NuScale design has achieved the "Triple Crown" for nuclear plant safety.
- The plant can safely shut down and self-cool indefinitely (unlimited coping period), with:
  - **No operator action**
  - **No AC or DC power**
  - **No additional water**
- Safety valves align in their safest configuration on loss of all plant power.
- Details of the alternate system fail-safe concept were presented to the NRC in December 2012.

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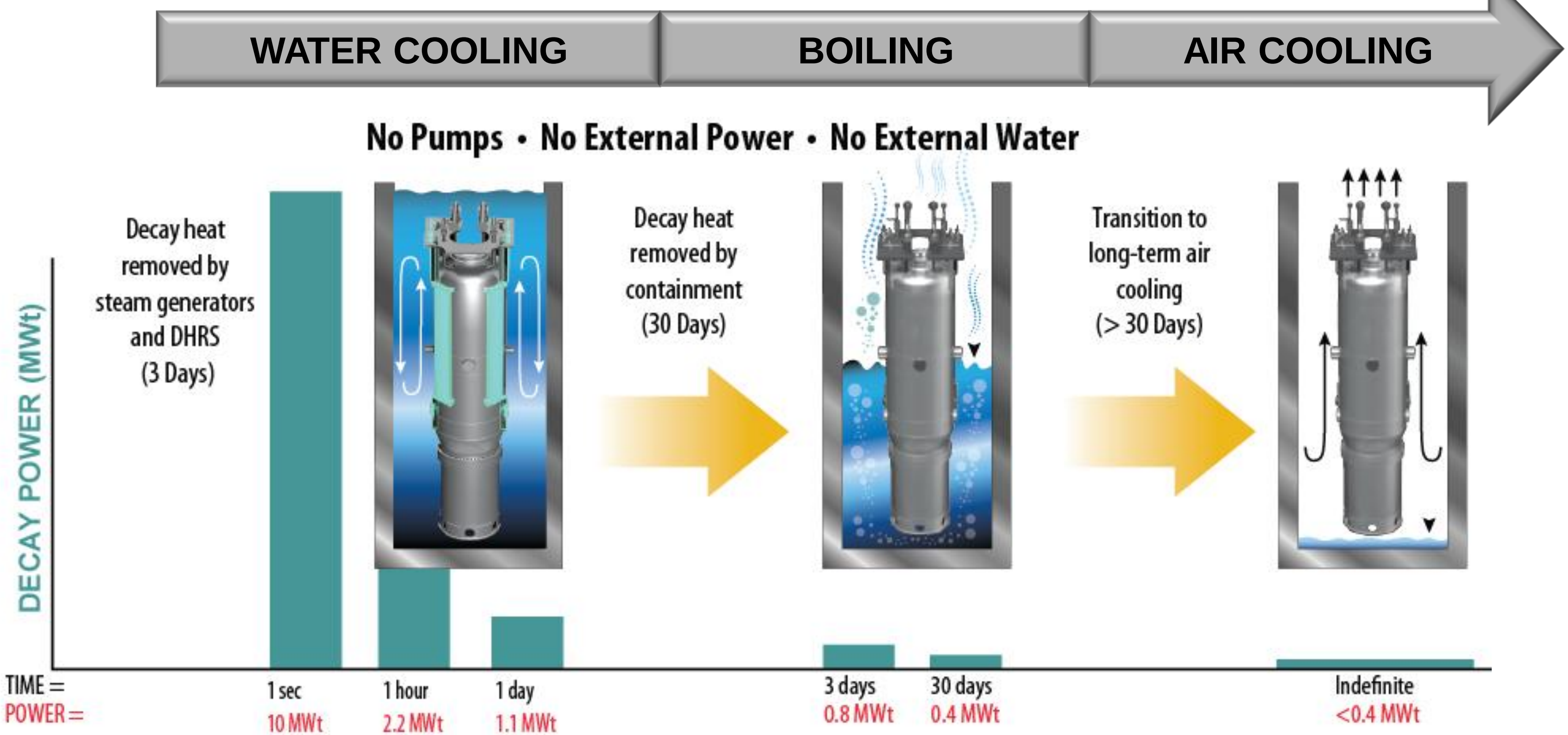
Extended Loss of AC Power*

Stable long-term cooling under all conditions

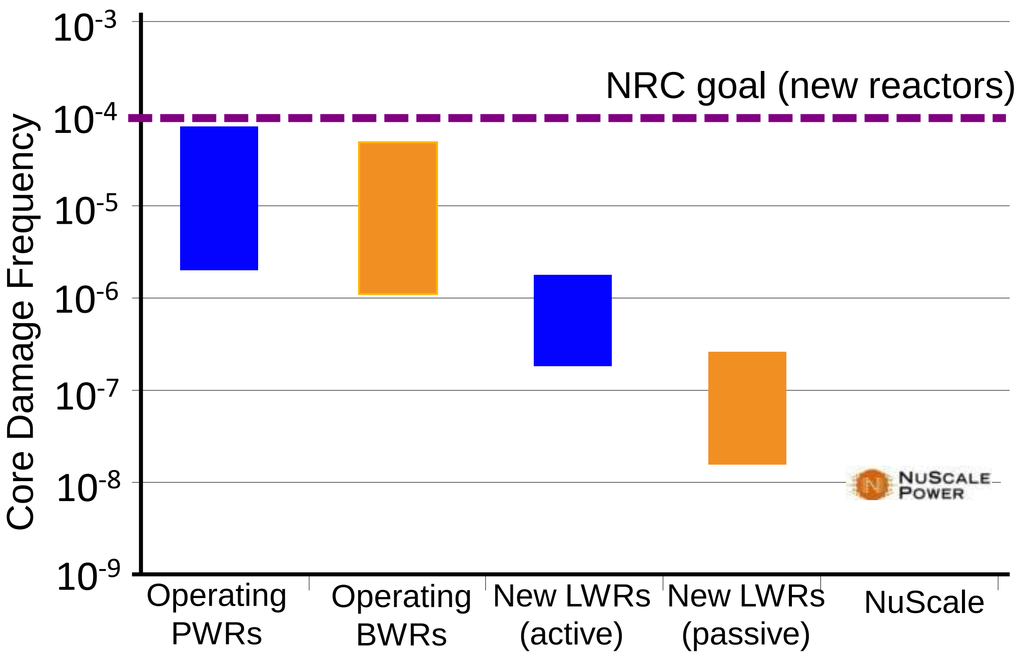
Reactor and nuclear fuel cooled indefinitely without pumps or power



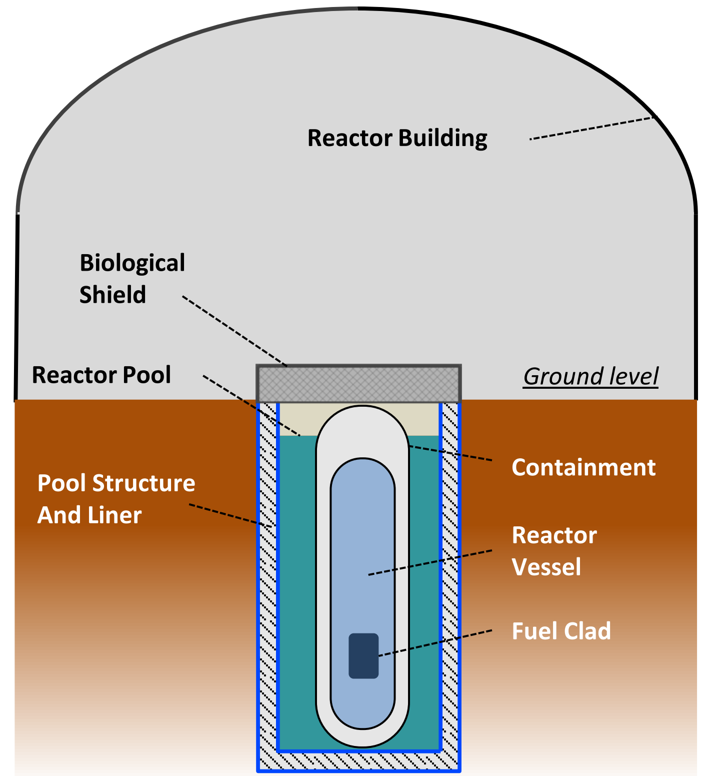
*** Based on conservative calculations assuming all 12 modules in simultaneous upset conditions and reduced pool water inventory***

Reducing Plant Risk

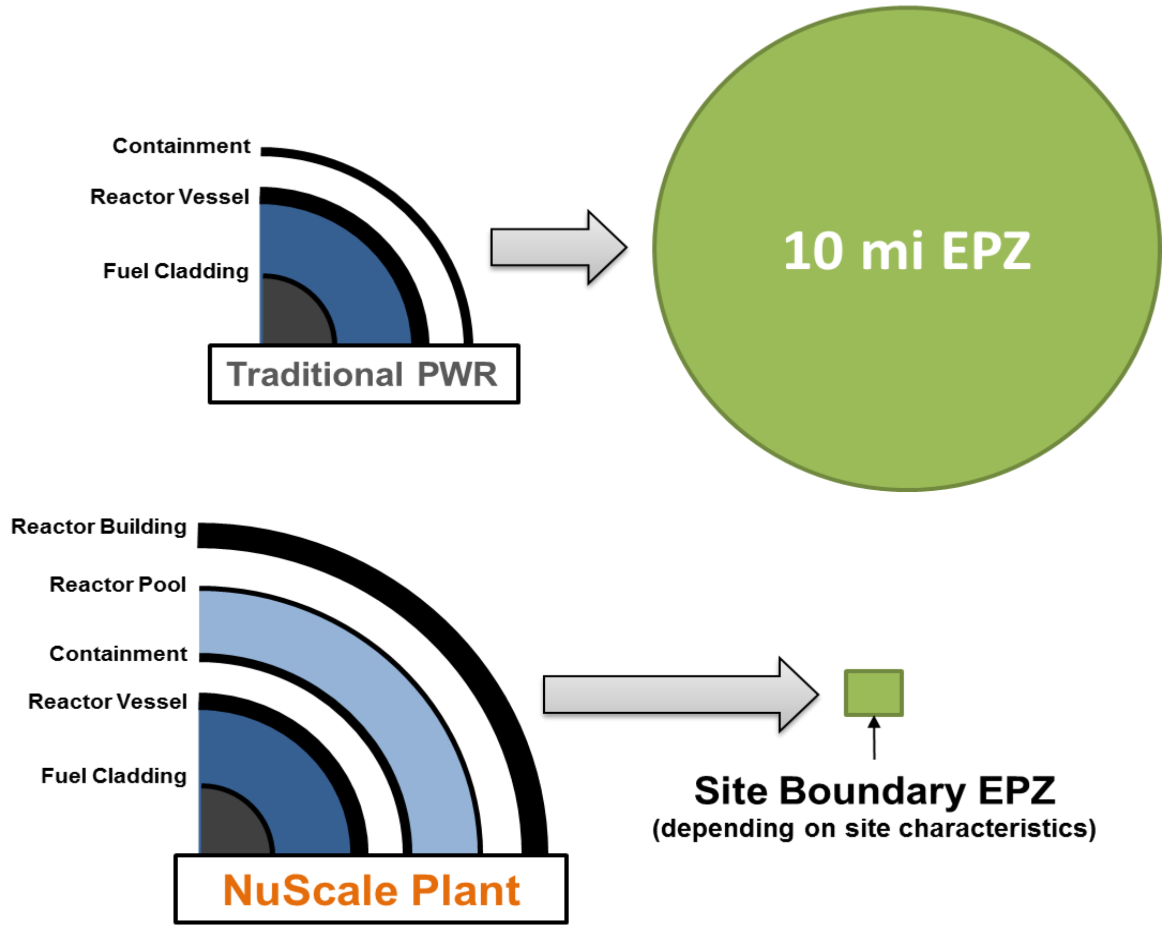
Risk = (frequency of failure) X (consequences)



Probability of core damage due to NuScale reactor equipment failures is ***1 in 100,000,000 years***



Right-Sized Emergency Planning Zone



- *Passive Safety*
- *Additional Fission Product Barriers*
- *Significant Delay in Release of Fission Products*

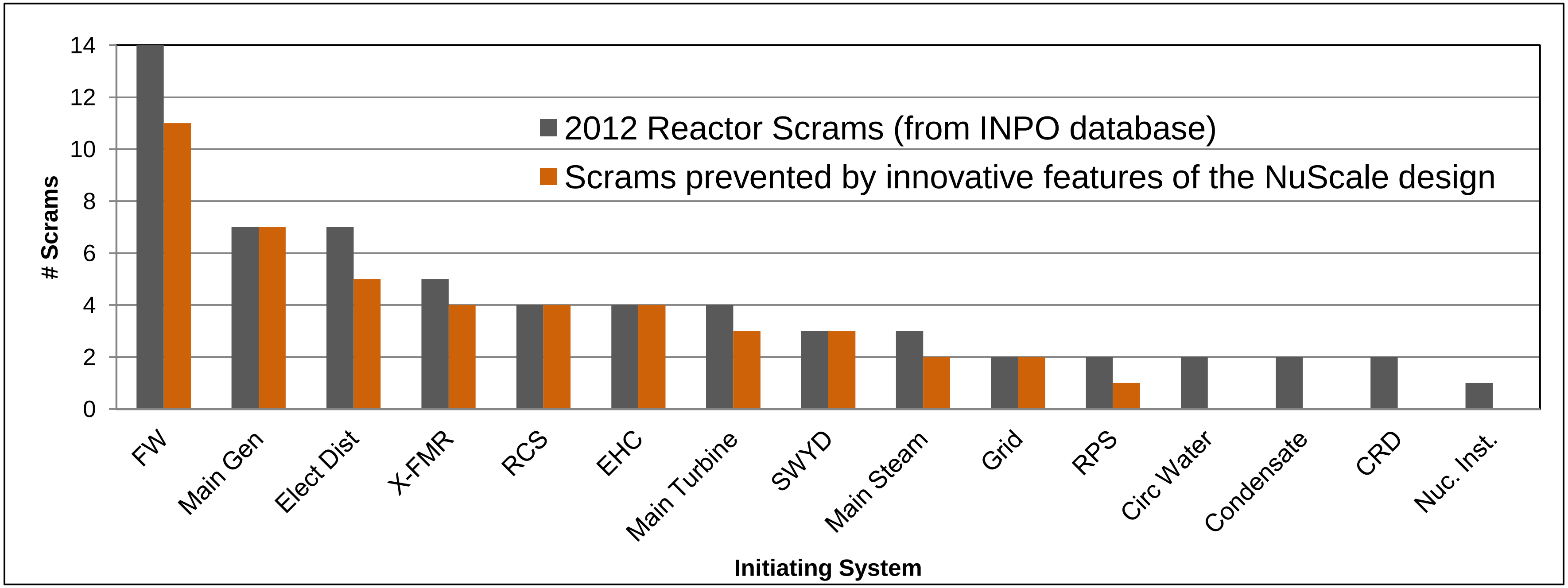
Economics

Cost Competitiveness

- NuScale's power module enables utility companies to "right-size" their power plants for current needs, then add capacity as necessary
- Design simplification enhances safety, reduces maintenance, and improves plant availability
- Off-site fabrication and assembly reduces cost, and components are delivered to the site in "ready-to-install" form
  - as a result, construction occurs in a shorter, more predictable period of time
- The workforce required to construct NuScale power plants are measured in the hundreds, not the thousands
- Our short 3-year construction schedule provides greater assurance that the plant will achieve operation before unforeseen external events impact the schedule
- Projected first plant levelized cost of energy (LCOE) $95/MWhr, and improving

Simple Design Eliminates Plant SCRAMs*

SCRAM – an unplanned shutdown of a nuclear reactor



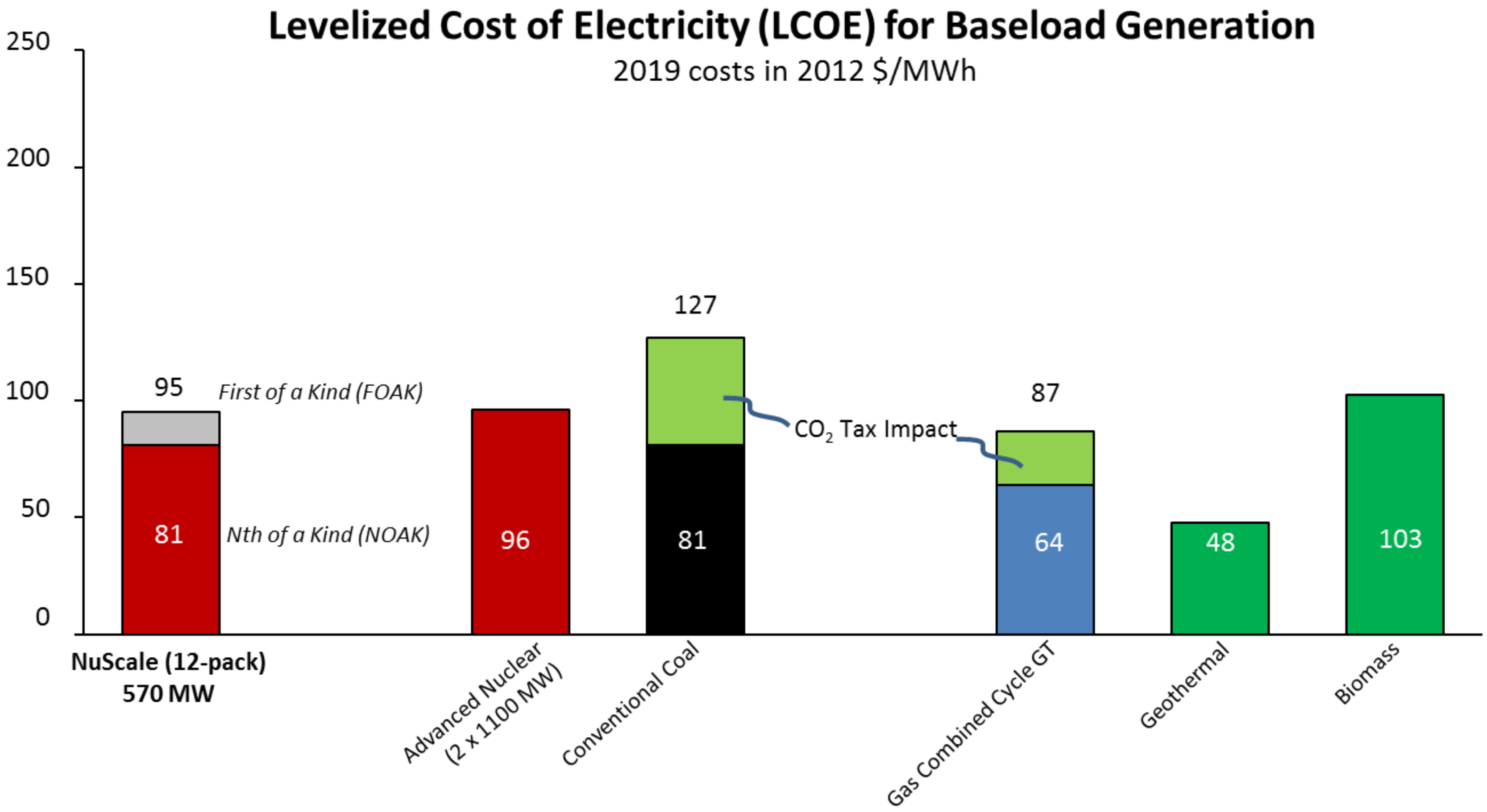
58% of events caused by power conversion systems

86% of power conversion related SCRAMs prevented by NuScale design

27% of events caused by electrical distribution system

82% of electrical related SCRAMs prevented by NuScale design

NuScale LCOE in North America

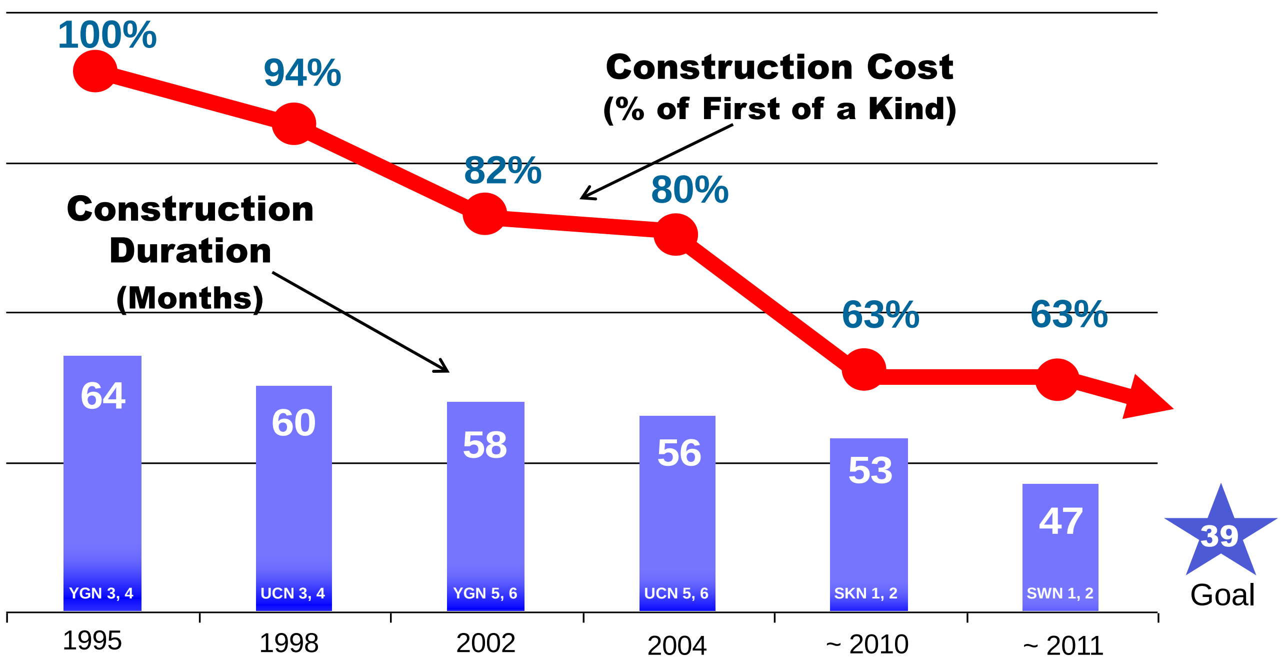


Sources
1. U.S. Energy Information Administration, Levlized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2014
2. NuScale LCOE Model for NuScale (12-pack), FOAK and NOAK
3. "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866"

Notes
(1) Sources 1 and 2 assume WACC of 6.5%; 30 year cost recovery period
(2) Source 1 assumes Henry Hub spot natural gas prices of approx.$4.70/mmbtu
(3) CO2 tax of $46/ton based on 2019 Annual SCC value from Reference 3, Table A1, 3% Discount Column

Learning Curve – South Korea

Learning Curve Opportunity – Korean Example



Repetitive Construction of Standardized Plants

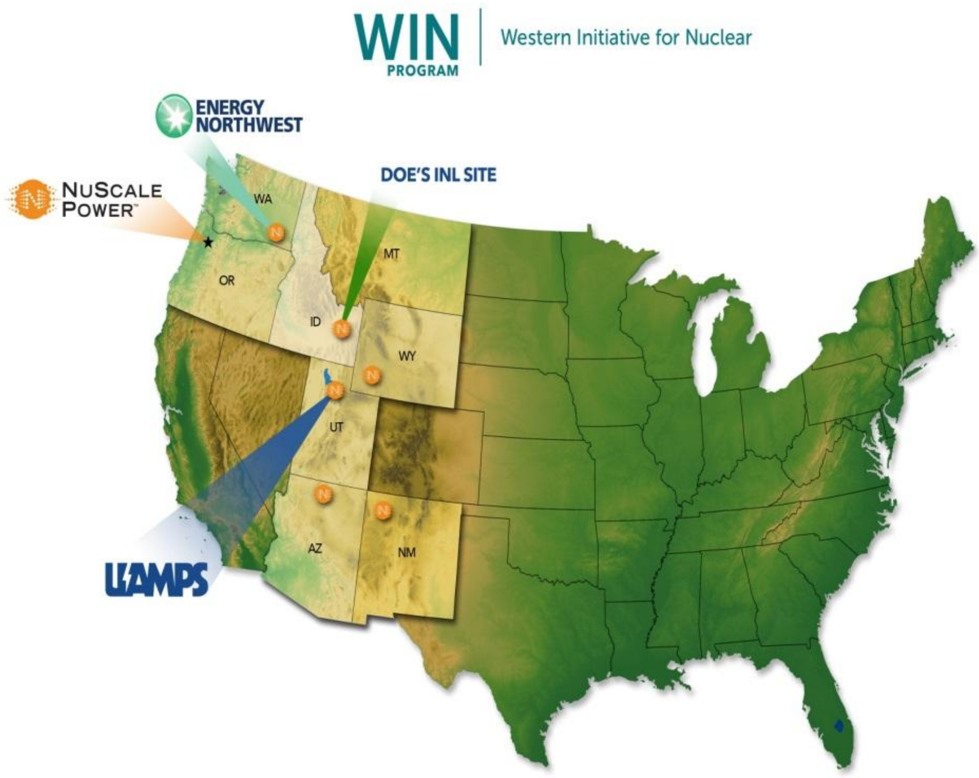
Program WIN

Program WIN

- Program WIN (Western Initiative for Nuclear) is a multi-western state collaboration to deploy a series of NuScale Power projects

- Involved Program WIN participants: NuScale, UAMPS, Energy Northwest

- 5 Other projects: WIN-WA, WIN-UT, WIN-AZ, WIN-NM, WIN-WY



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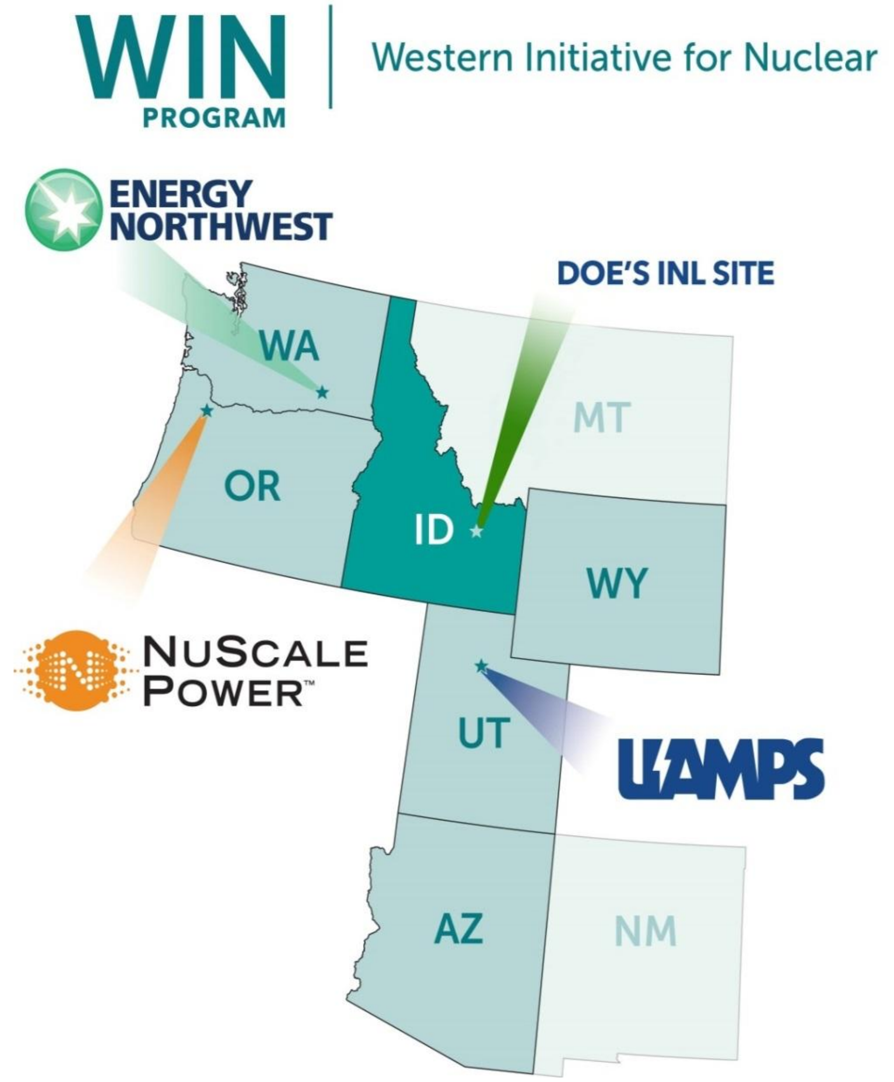
First Deployment: UAMPS CFPP

- Utah Associated Municipal Power Systems (UAMPS) Carbon Free Power Project (CFPP) will be first Program WIN project
- UAMPS consists of 46 members serving load in 8 western states



Challenges Ahead

To Ensure a Successful Project

- Need a committed owner/buyer
- Suitable land, sufficient water, transmission access
- Must demonstrate sufficient need for or use of electricity
- State, tribal, public, and political support
  - Favorable local and state permitting and approval processes
- Suitable plant economics/investment profile
- Timely regulatory review
  - US NRC Design Certification review estimated at 39 months
- Sufficient capable facility workforce
- Active and competitive supply chain engagement

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