

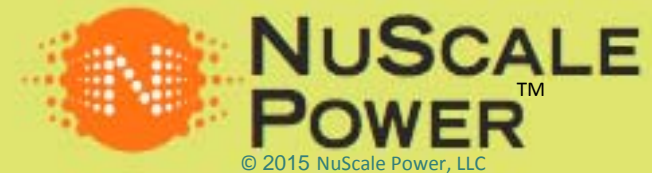
NuScale Power

Small Modular Reactors

The Future of Nuclear Energy



Presentation to
LSU Energy Summit
Mike McGough
Chief Commercial Officer
Baton Rouge, LA
October 21st, 2015



EcoModernist Manifesto

AN

ECO MODERNIST

MANIFESTO

“Urbanization, aquaculture, agricultural intensification, nuclear power, and desalination are all processes with a demonstrated potential to reduce human demands on the environment, allowing more room for non-human species.”

“Transitioning to a world powered by zero-carbon energy sources will require energy technologies that are power dense and capable of scaling to many tens of terawatts to power a growing human economy.”

- An Ecomodernist Manifesto

EcoModernist Manifesto

AN

ECO MODERNIST

MANIFESTO

“Nuclear fission today represents the only present-day zero-carbon technology with the demonstrated ability to meet most, if not all, of the energy demands of a modern economy. However, a variety of social, economic, and institutional challenges make deployment of present-day nuclear technologies at scales necessary to achieve significant climate mitigation unlikely. A new generation of nuclear technologies that are safer and cheaper will likely be necessary for nuclear energy to meet its full potential as a critical climate mitigation technology.”

- An Ecomodernist Manifesto

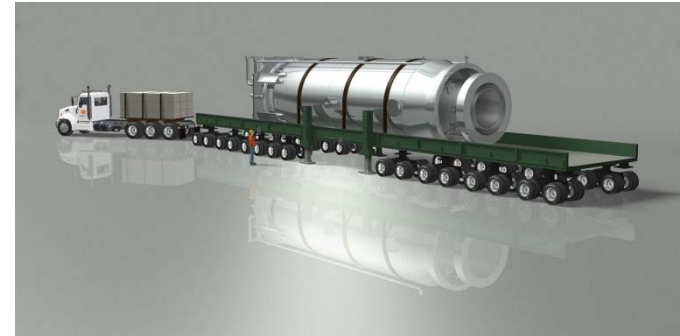
Agenda

- NuScale History/Background
- Technology Overview
- Safety Attributes
- Testing Programs
- Licensing Status
- The MarketPlace, Deployment Plan
- UAMPS Carbon Free Power Project

NuScale Differentiators

Simple

- Factory-built containment
- Modular constructability
- Fewer systems to construct and maintain
- Load following



Safe

- Indefinite cooling in station blackout
- Unprecedented nuclear safety (Core Damage Frequency 10^{-8})
- Fewer safety-related systems



Economic

- < \$3B EPC cost for FOAK 570MWe (net) plant (~\$2.5B cost for NOAK)
- LCOE below \$100/MW
- Scalable
- USDOE SMR awardee

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, lessons from **AP600/1000 1/4-scale** testing facility built and operational
- Electrically-heated **1/3-scale Integral test facility first operational in 2003**
- Began NRC design certification (DC) pre-application project in **April 2008**
- Acquired by Fluor in October 2011
- >600 people currently on project, ~\$350MM spent project life-to-date (\$12MM/mo)
- 200+ patents pending/granted, 19 countries
- Portland, Corvallis, Rockville, Charlotte, Richland, London
- **US DOE SMR Grant Awardee, 12/12/13**



NuScale Engineering Offices Corvallis, Oregon



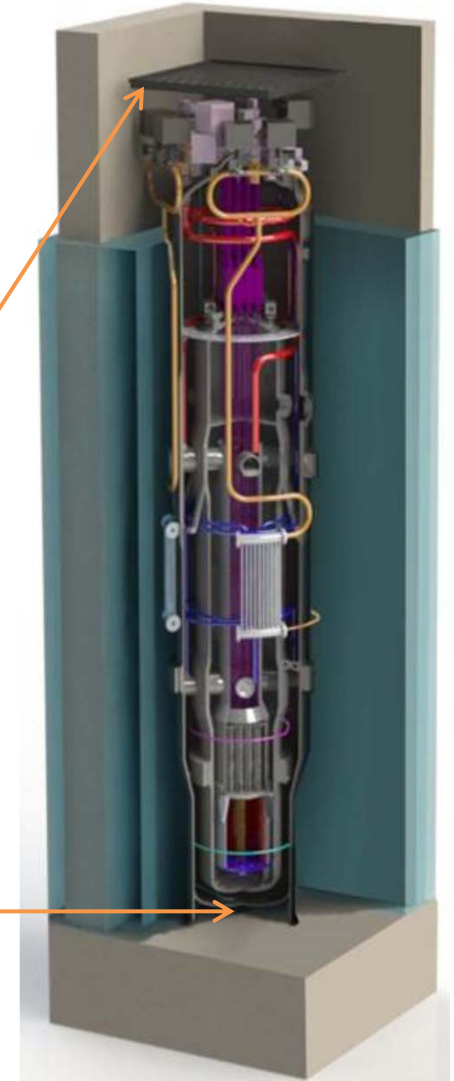
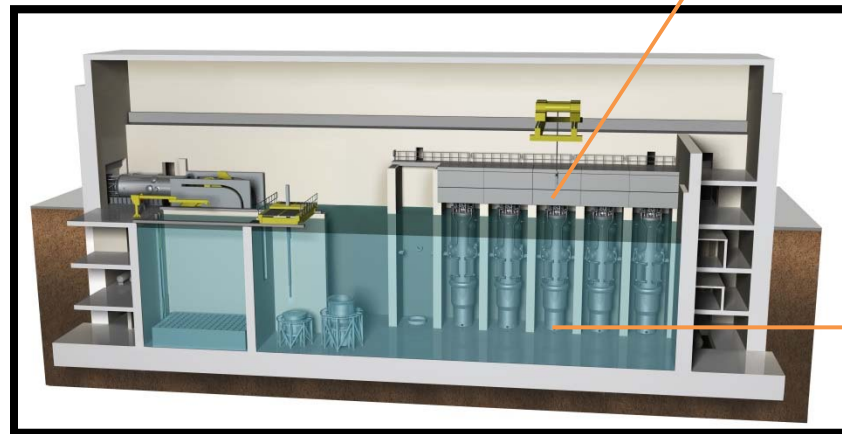
One-third scale Test Facility



NuScale Control Room Simulator

What is a NuScale Power Module?

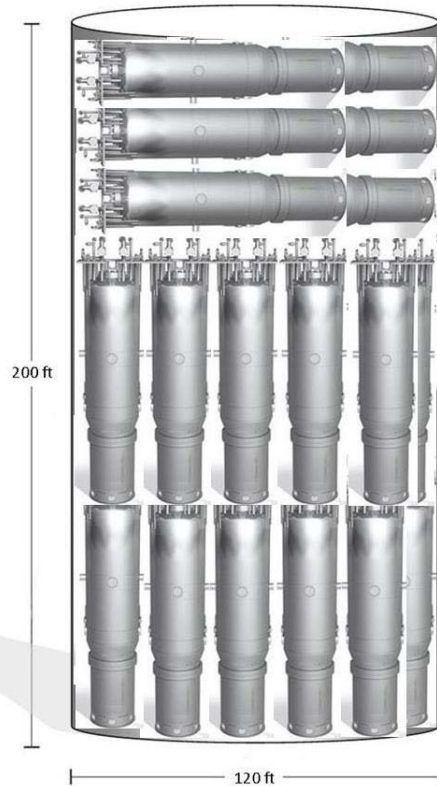
- A NuScale Power Module (NPM) includes the reactor vessel, steam generators, pressurizer and **containment** in an **integral package** that **eliminates reactor coolant pumps** and large bore piping (**no LB-LOCA**)
- Each NPM is 50 MWe and factory built for easy transport and installation
- Each NPM has its own skid-mounted steam turbine-generator and condenser
- Each NPM is installed below-grade in a seismically robust, steel-lined, concrete pool
- NPMs can be incrementally added to match load growth - up to 12 NPMs for 600 MWe gross (~570 net) total output



Size Comparison

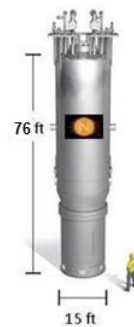
Comparison size envelope of new nuclear plants currently under construction in the United States

126 NuScale Power Modules

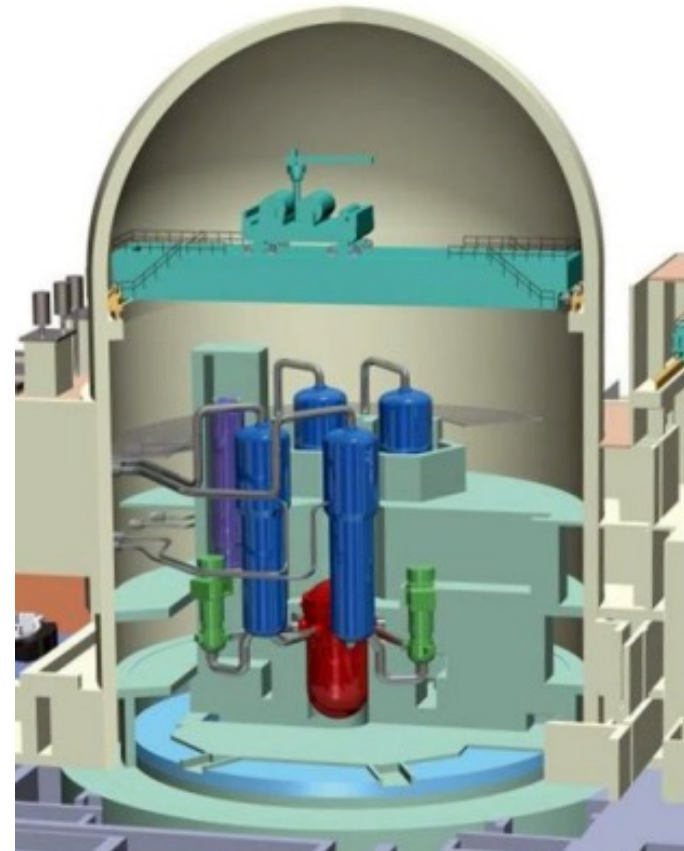


Containment

NuScale's combined containment vessel and reactor system



Typical Pressurized Water Reactor



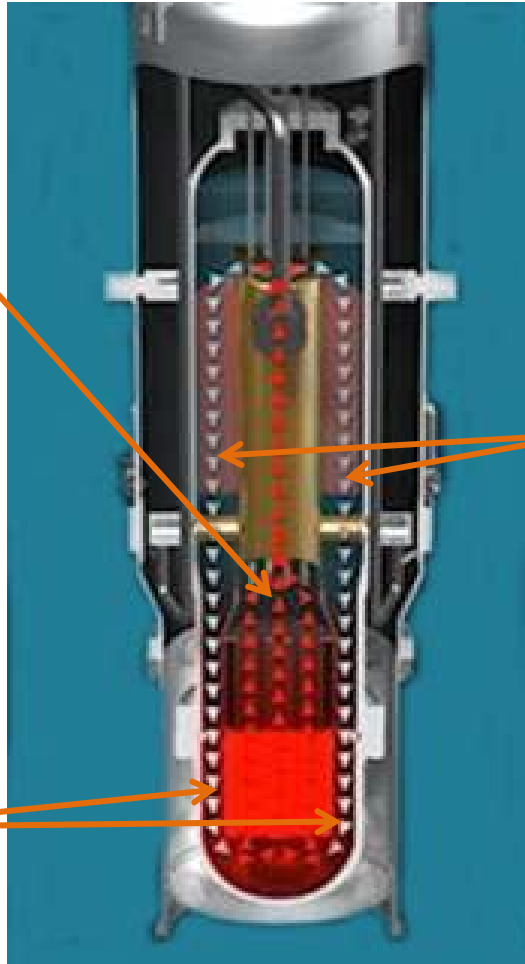
*Source: NRC

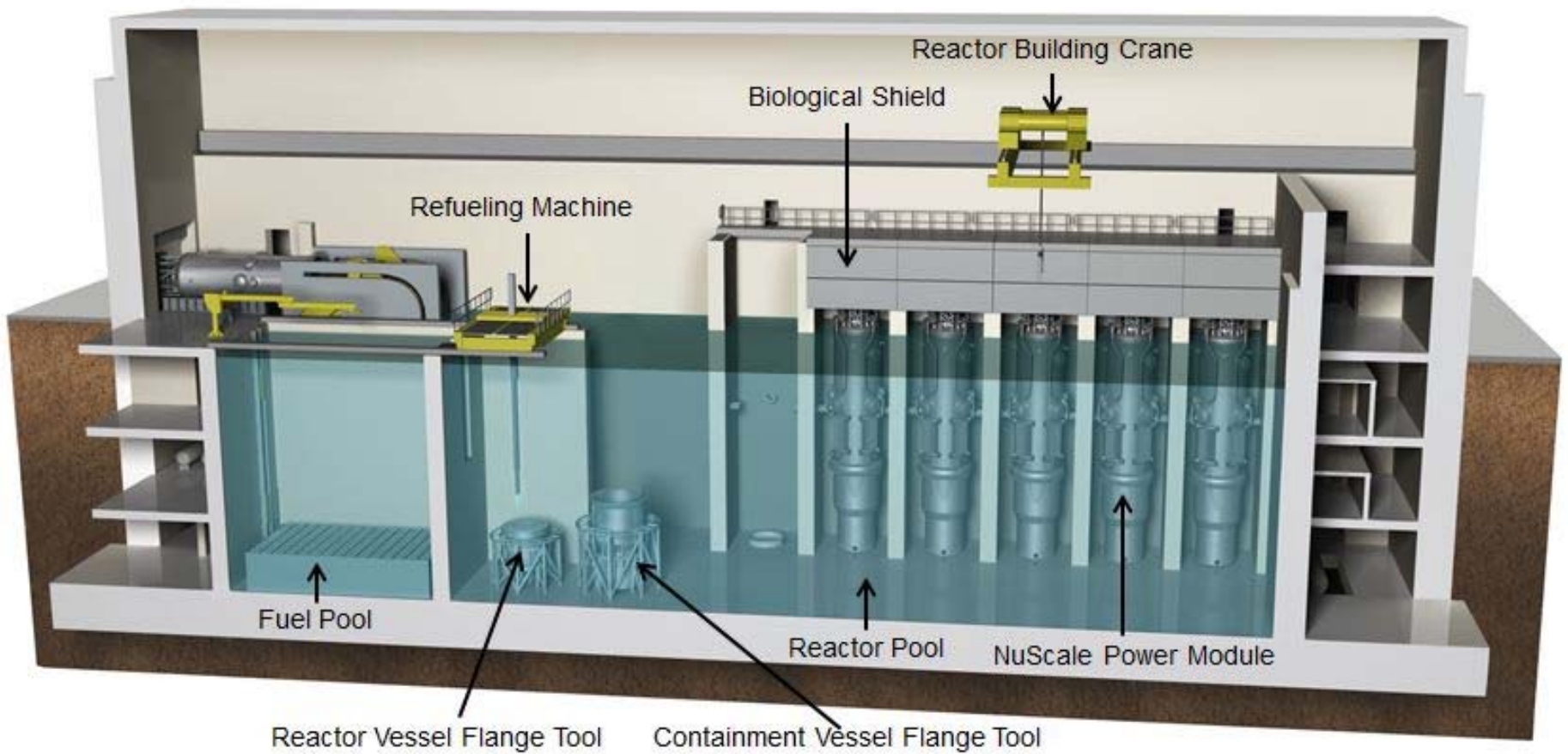
Coolant Flow Driven By Physics

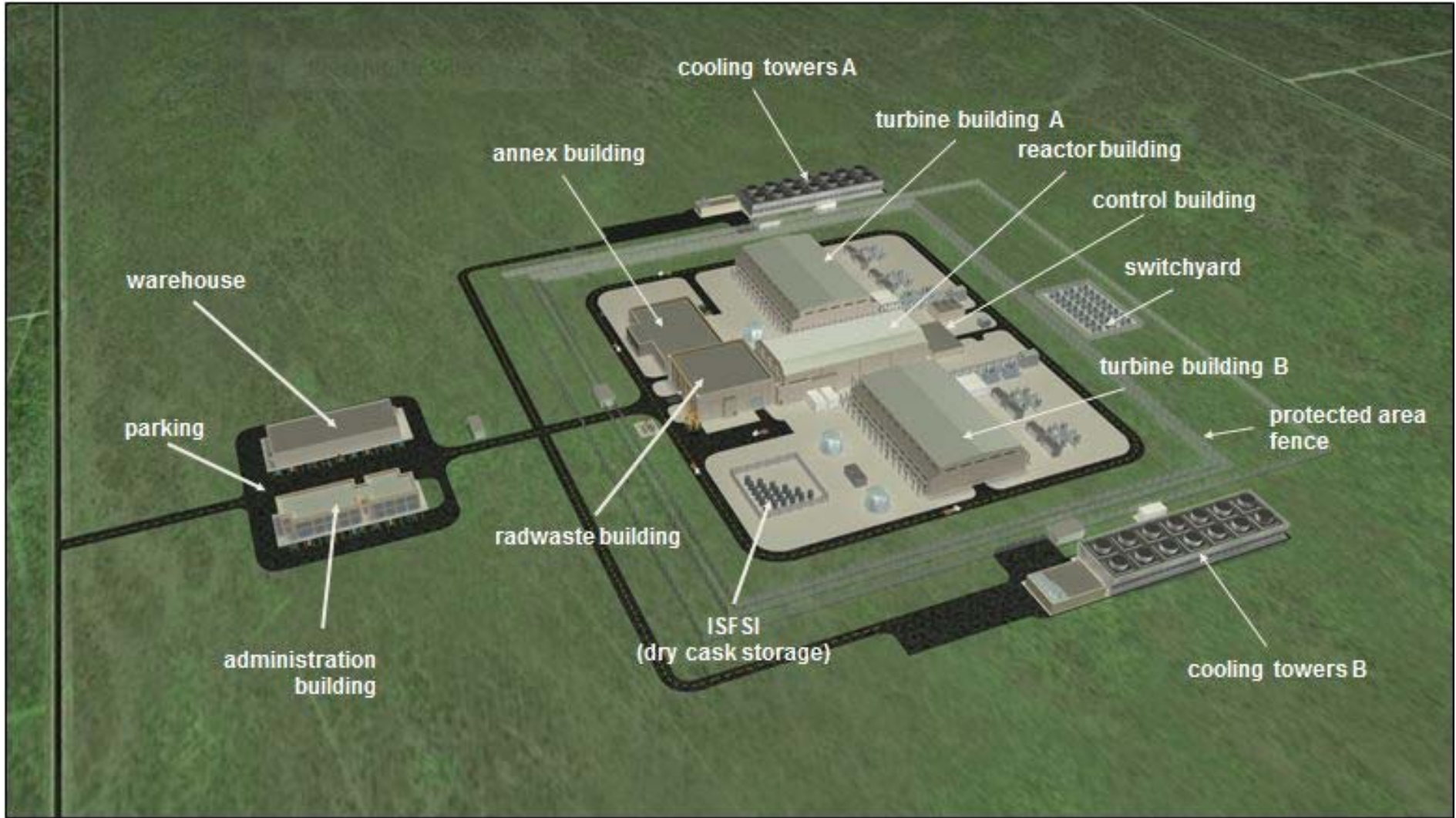
Convection – energy from the nuclear reaction heats the primary reactor coolant causing it to rise by convection and natural buoyancy through the riser, much like a chimney effect

Conduction – heat is transferred through the walls of the tubes in the steam generator, heating the water (secondary coolant) inside them to turn it to steam. Primary water cools.

Gravity – colder (denser) primary coolant “falls” to bottom of reactor pressure vessel, cycle continues







NuScale Safety Systems

Systems and Components Needed to Protect the Core:

- Reactor Pressure Vessel
- Containment Vessel
- Reactor Coolant System
- Decay Heat Removal System
- Emergency Core Cooling System
- Control Rod Drive System
- Containment Isolation System
- Ultimate Heat Sink
- Residual Heat Removal System
- Safety Injection System
- Refueling Water Storage Tank
- Condensate Storage Tank
- Auxiliary Feedwater System
- Emergency Service Water System
- Hydrogen Recombiner or Ignition System
- Containment Spray System
- Reactor Coolant Pumps
- Safety Related Electrical Distribution Systems
- Alternative Off-site Power
- Emergency Diesel Generators
- Safety Related 1E Battery System
- Anticipated Transient without Scram (ATWS) System

SAFETY

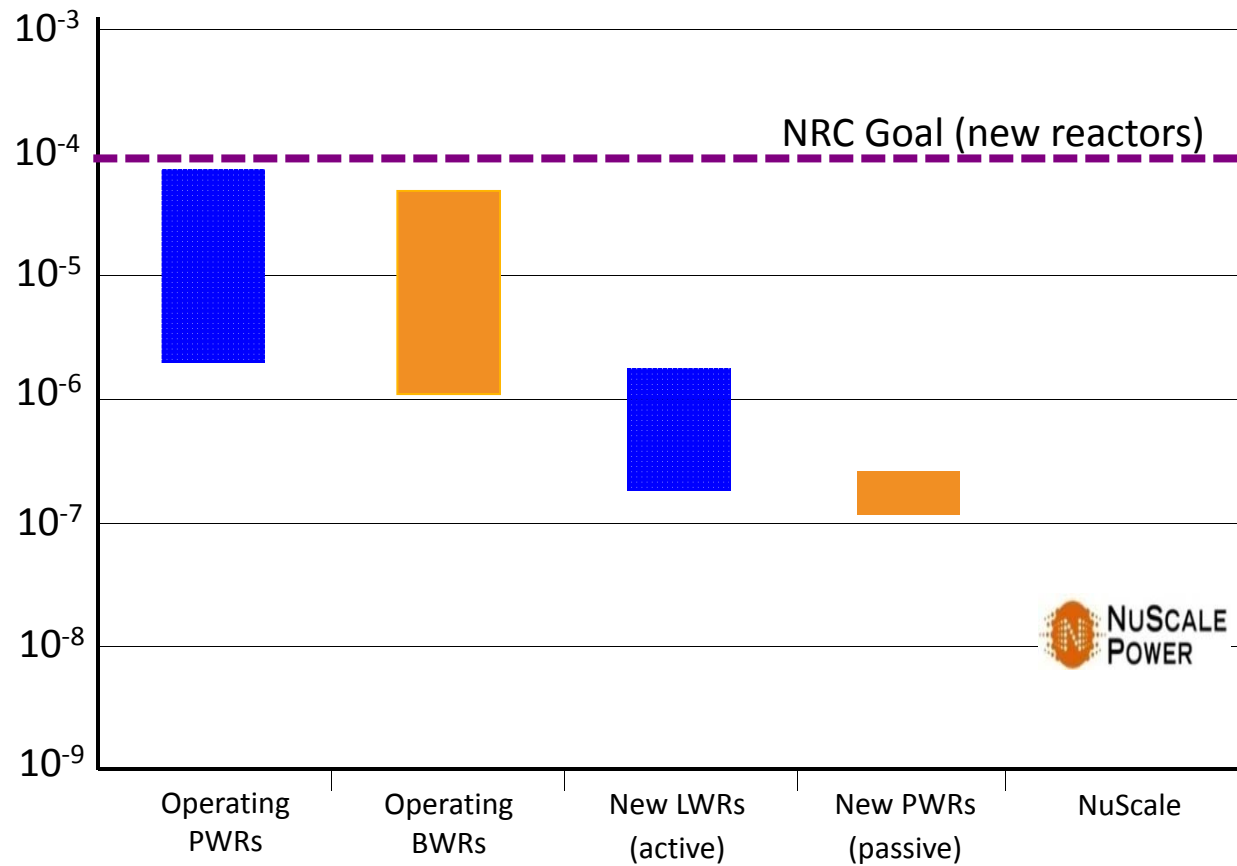
NuScale Announces Major Safety Breakthrough

Wall Street Journal April 16, 2013

- NuScale design has achieved the “Triple Crown” for nuclear plant safety. The plant can safely shut-down and self-cool, indefinitely, 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.



Reduced Core Damage Frequency



Source: NRC White Paper, D. Dube; basis for discussion at 2/18/09 public meeting on implementation of risk matrices for new nuclear reactors

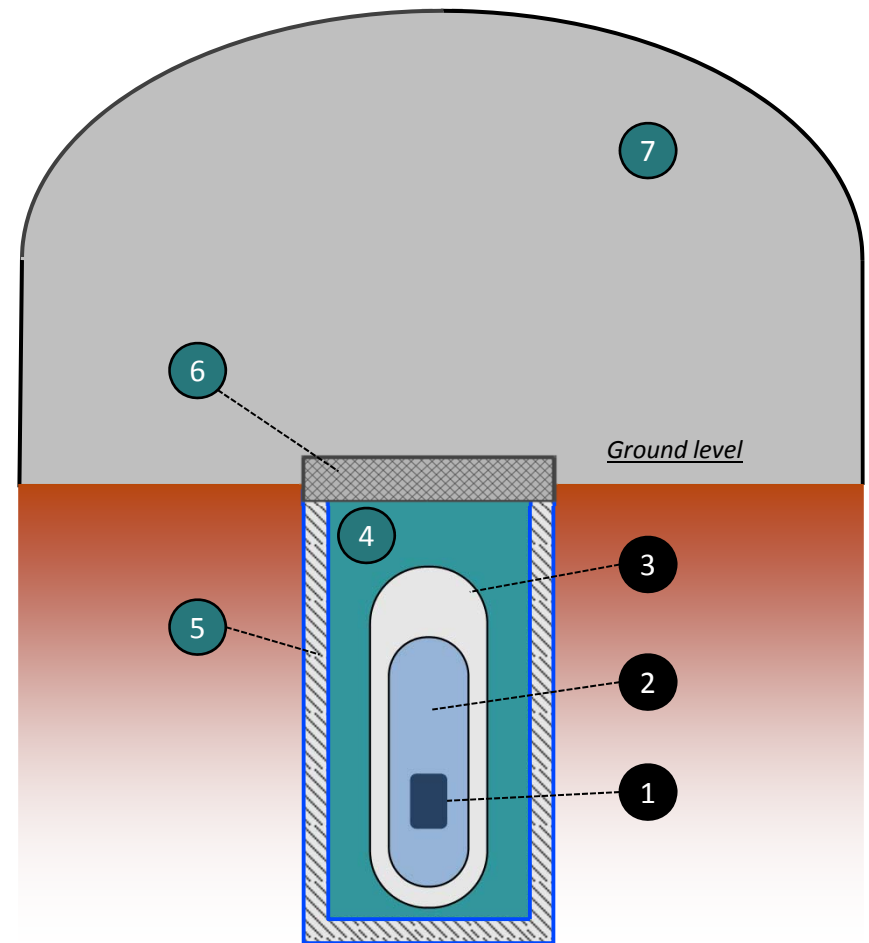
More Barriers Between Fuel & Environment

Conventional Designs

1. Fuel Pellet and Cladding
2. Reactor Vessel
3. Containment

NuScale's Additional Barriers

4. Water in Reactor Pool
5. Stainless Steel Lined Concrete Reactor Pool
6. Biological Shield Covers Each Reactor
7. Reactor Building

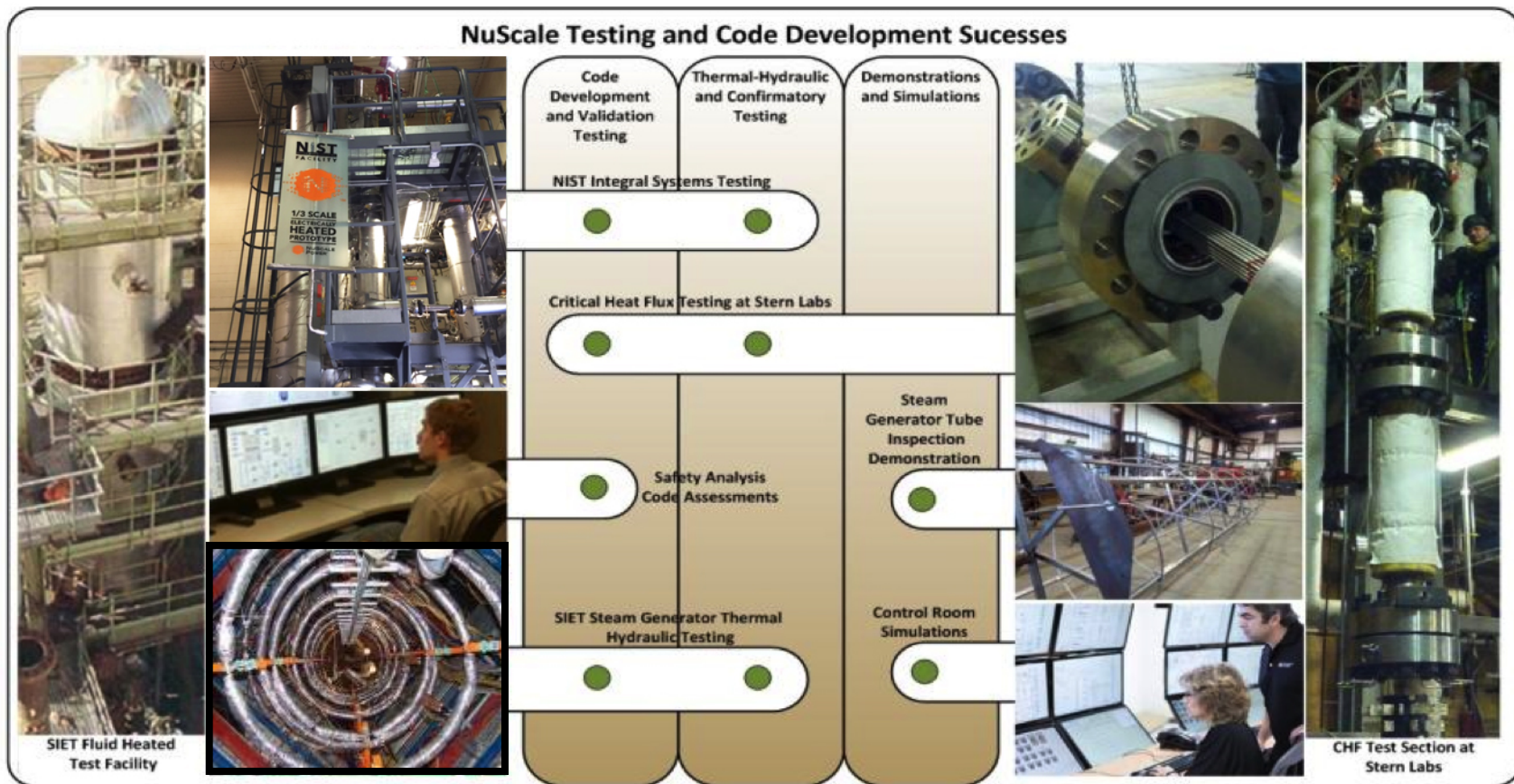


How Do We Know it Works?

Testing, Testing, Testing

NuScale Reactor Qualification Test Plan

NuScale Reactor Qualification Test Plan outlines Design Certification and First Of A Kind Engineering (FOAKE) projects for reactor safety code development, validation, reactor design and technology maturation to reduce First Of A Kind (FOAK) design risk.



UMM with ACRS Tour 7/22/15



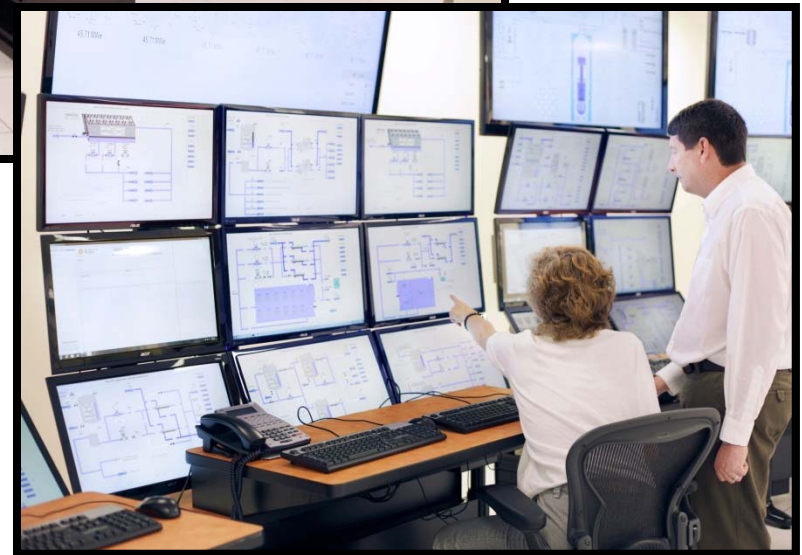
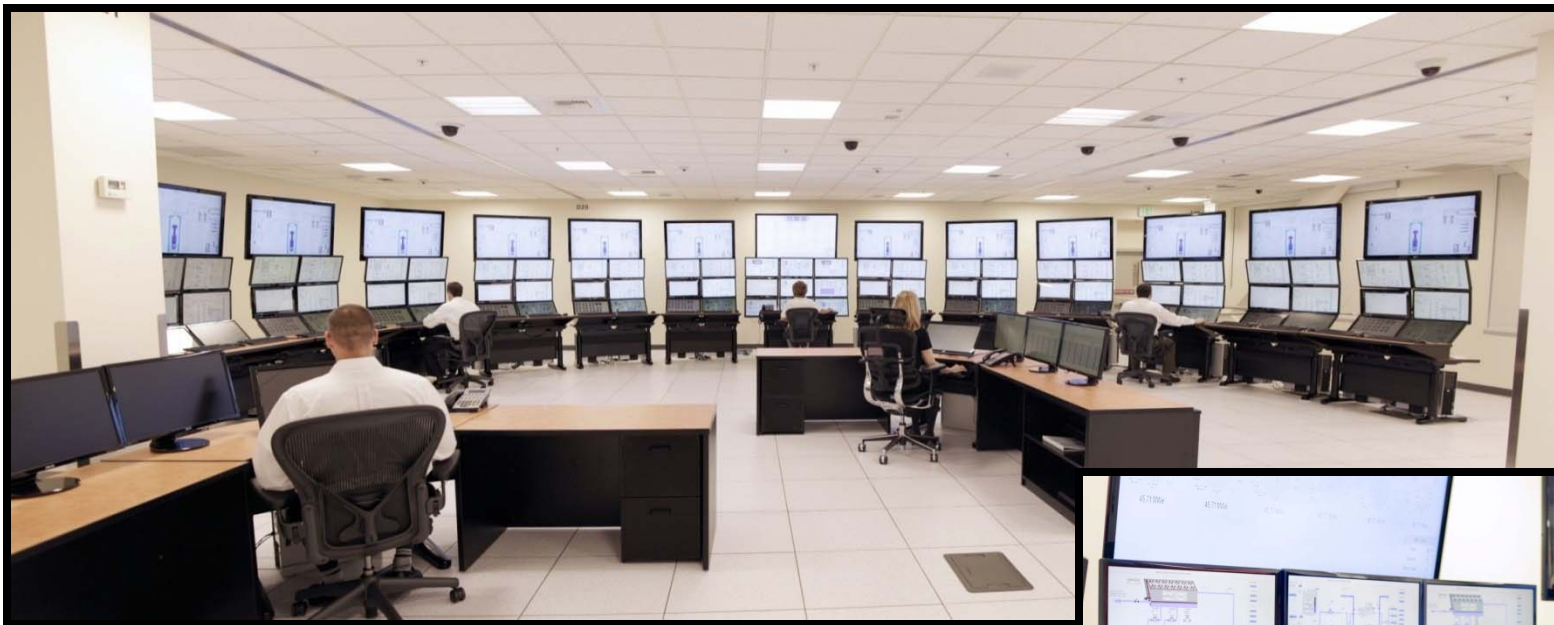
Full-length Helical Coil Steam Generator successfully installed in the SIET facility

- Successful fabrication and installation of our full-length helical coil steam generator test section:
 - Safely transported from the fabrication shop to SIET labs, then installed by crane into the test vessel at SIET.
- 252 full-length helical coil tubes will be tested (~650 tubes per steam generator in an actual NPM)
- Testing in the full length tube bundle will be conducted at prototypic fluid temperatures, pressures and flow rates to measure the steam generator's thermal performance. The data will be used to validate our state-of-the-art computer codes and help vendors optimize the performance of their steam turbines for a NuScale application. Flow induced vibration testing will also be performed as part of the assessment.



Full-Scale Main Control Room Simulator

NRC Review of HFE Program and Site Visit 1/13



Licensing Plan and Status

RIS 2015-07 Response

- NRC Regulatory Information Summary (RIS) is for budgeting, staffing and planning purposes
- Joint response by NuScale and UAMPS submitted on June 17, 2015
- DCA submittal no later than 12/31/2016
- UAMPS COLA submittal by 4Q-2017 or 1Q-2018
- COLA to reference DCA for up to 12 modules
- COL site in Idaho including INL
- Plan to establish Design Centered Working Group (DCWG)
- Key NuScale vendors and consultants identified
- UAMPS teaming agreement with ENW identified

Licensing (continued)

- NuScale has:
 - Made 48 NRC presentations
 - Planned 45 additional engagements
 - Planned to submit 17 additional topicals
 - Meets weekly with NRC NRO to review plan and schedule
 - 11 meetings held since 4/21, 4 held in July
 - 4 multi-day NRC team visits scheduled to NuScale before Halloween, scope includes NRO management, NRC QA and Projects, NRC HFE, and ACRS tours of NIST, Simulator and Upper Module Mock-up

The Marketplace

NuScale Advisory Board (NuAB) Members



Executive Order, The White House, 3/19/15

- **FACT SHEET: Reducing Greenhouse Gas Emissions in the Federal Government and Across the Supply Chain**
- **40% cut in CO2 emissions across Government agencies**
- **30% of energy must come from “alternative technologies” which include SMR’s**
- **Sec. 3. Sustainability Goals for Agencies**. In implementing the policy set forth in section 1 of this order and to achieve the goals of section 2 of this order, the head of each agency shall, where life-cycle cost-effective, beginning in fiscal year 2016, unless otherwise specified:
 - (e) include in the alternative energy portion of the clean energy target established in subsection (b) of this section alternative energy as defined in section 19(c) of this order and associated with the following actions, where feasible:
 - (i) installing thermal renewable energy on site at Federal facilities and retaining corresponding renewable attributes or obtaining equal value replacement RECs where applicable;
 - (ii) installing combined heat and power processes on site at Federal facilities;
 - (iii) installing fuel cell energy systems on site at Federal facilities;
 - **(iv) utilizing energy from new small modular nuclear reactor technologies;**
 - (v), (vi), (vii)
- <https://www.whitehouse.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade>

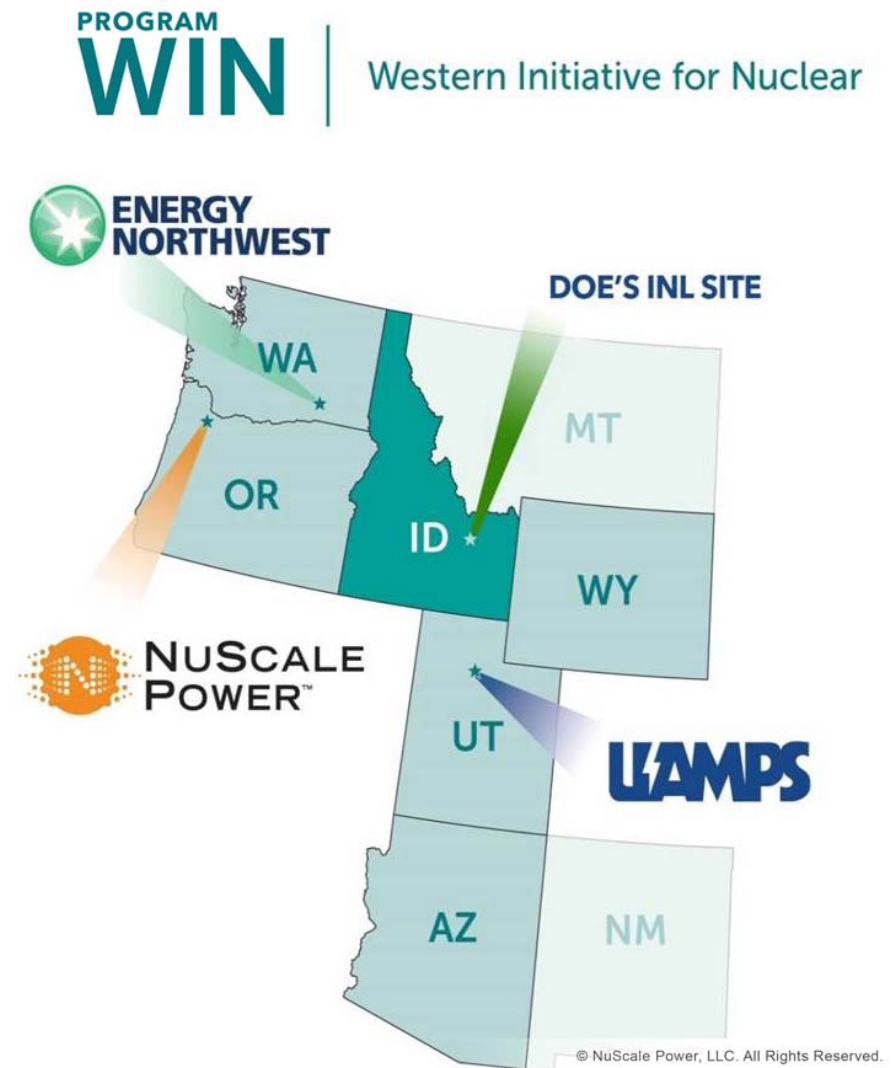
Program WIN (Western Initiative for Nuclear)

- Western Initiative for Nuclear (WIN) is a multi-western state collaboration to deploy a series of NuScale Power Projects
- Involved Program WIN participants: NuScale, UAMPS, Energy Northwest, ID, UT, OR, WA, WY, AZ, NM?, MT?

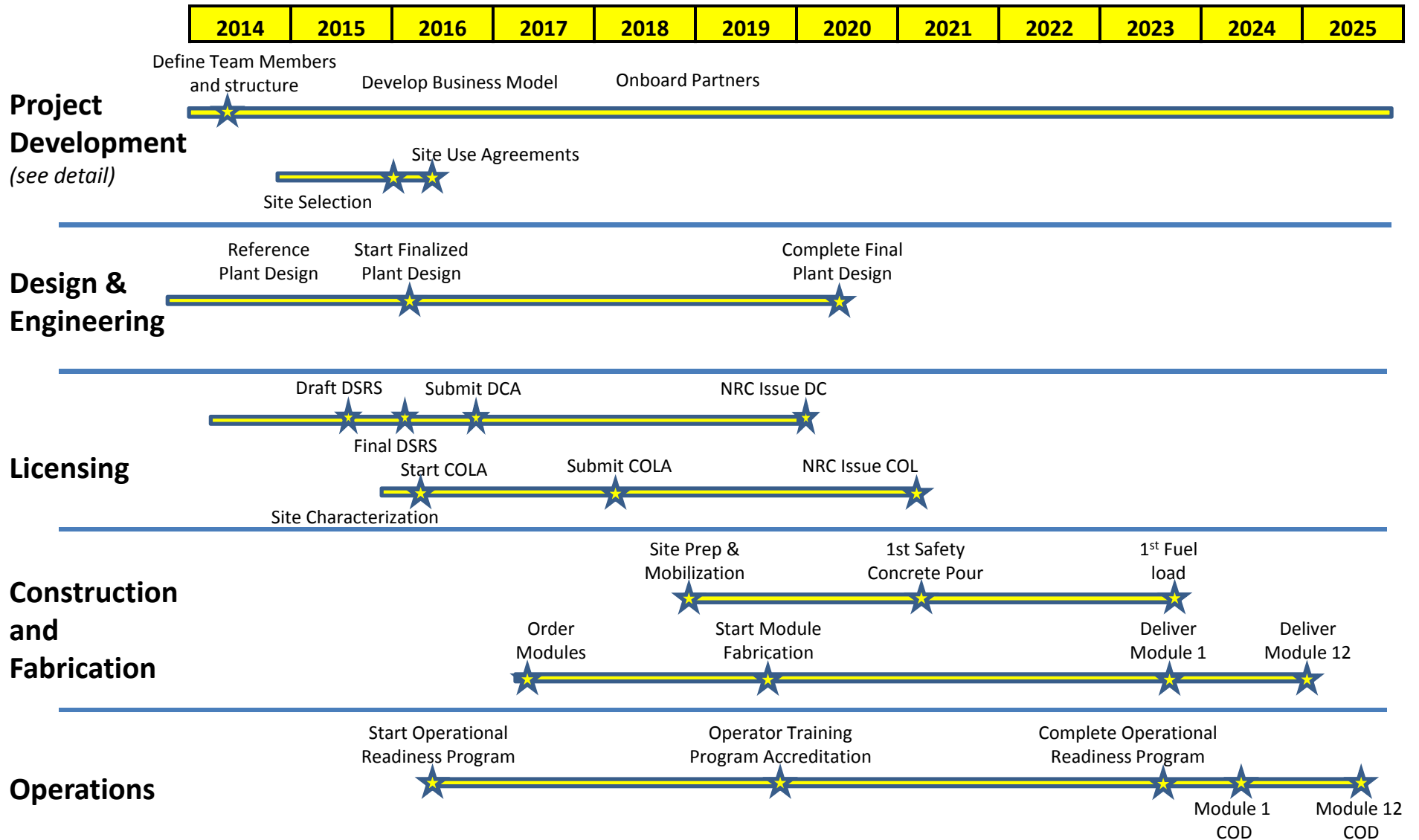


First Deployment: UAMPS CFPP

- Utah Associated Municipal Power Systems (UAMPS) Carbon Free Power Project (CFPP) will be first deployment, sited somewhere in Idaho.
- UAMPS consists of 46 members serving load in 8 western states.

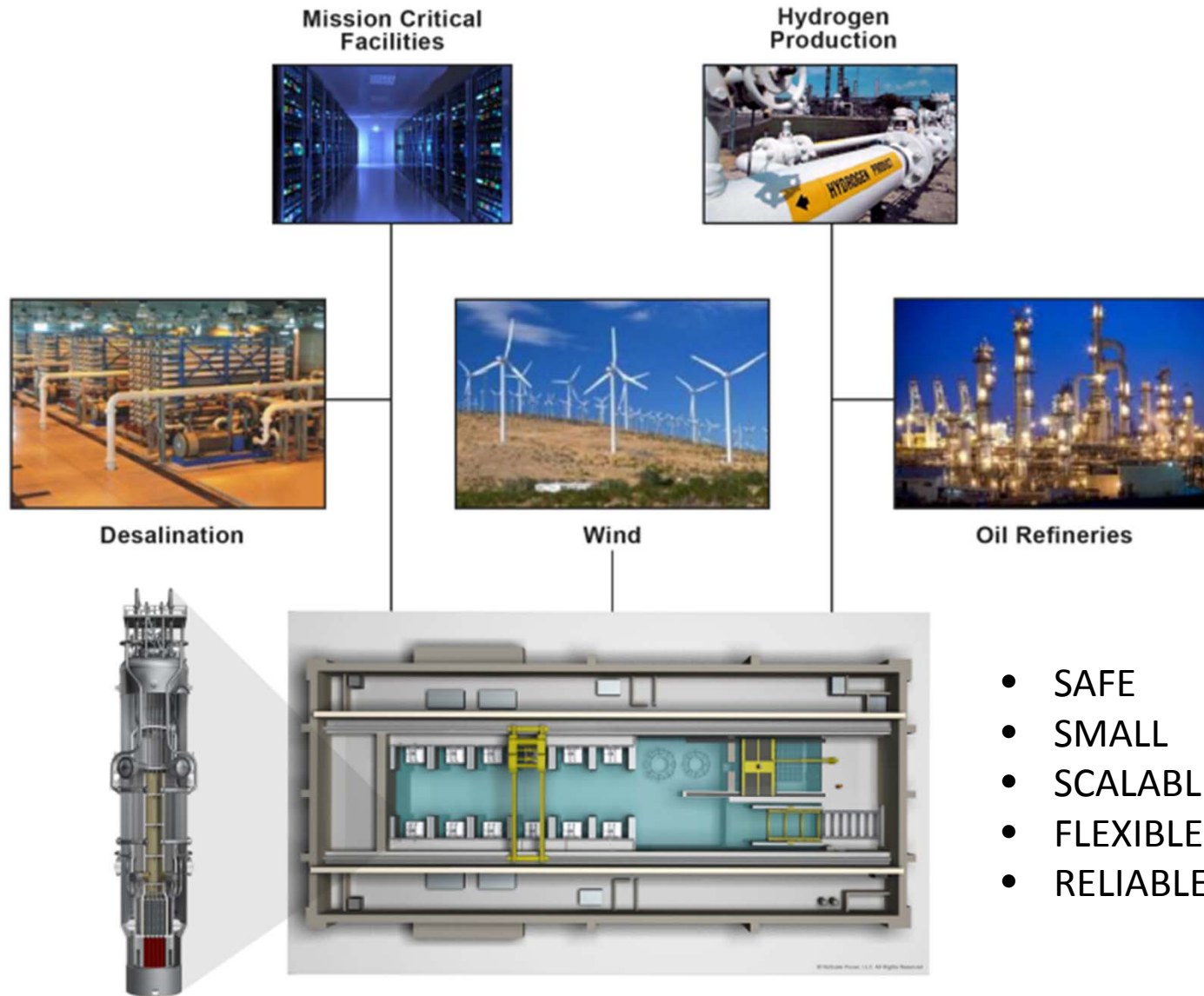


Overall UAMPS CFPP Project Schedule



Additional Applications for NuScale Power Modules

NuScale Diverse Energy Platform (NuDEP) Initiative



- SAFE
- SMALL
- SCALABLE
- FLEXIBLE
- RELIABLE

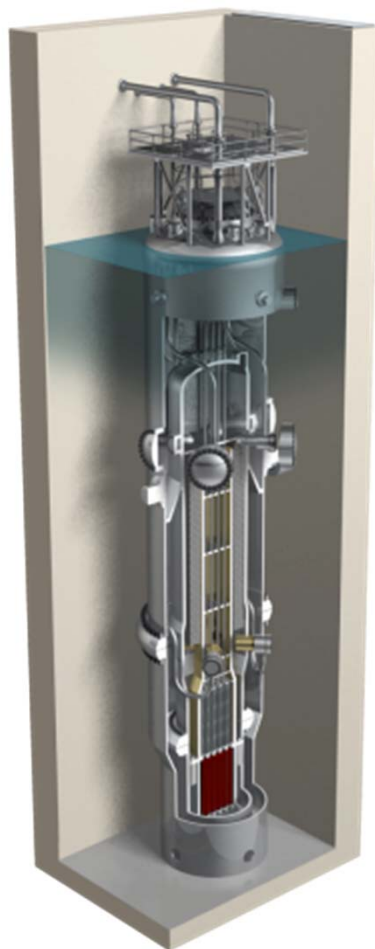
NuScale Diverse Energy Platform - Completed Studies

Oil Refineries Study - Reduction of Carbon Emissions (Fluor and NuScale)

10-Module Plant coupled to a 250,000 barrels/d refinery

Integration with Wind Study - Horse Butte Site (UAMPS, ENW and NuScale)

1-Module dedicated to UAMPS 57.6 MW wind farm



Hydrogen Production Study – High-Temperature Steam Electrolysis (INL and NuScale)

6-Module Plant for Emission Free Hydrogen Production

Desalination Study – Sized for the Carlsbad Site (Aquatech and NuScale)

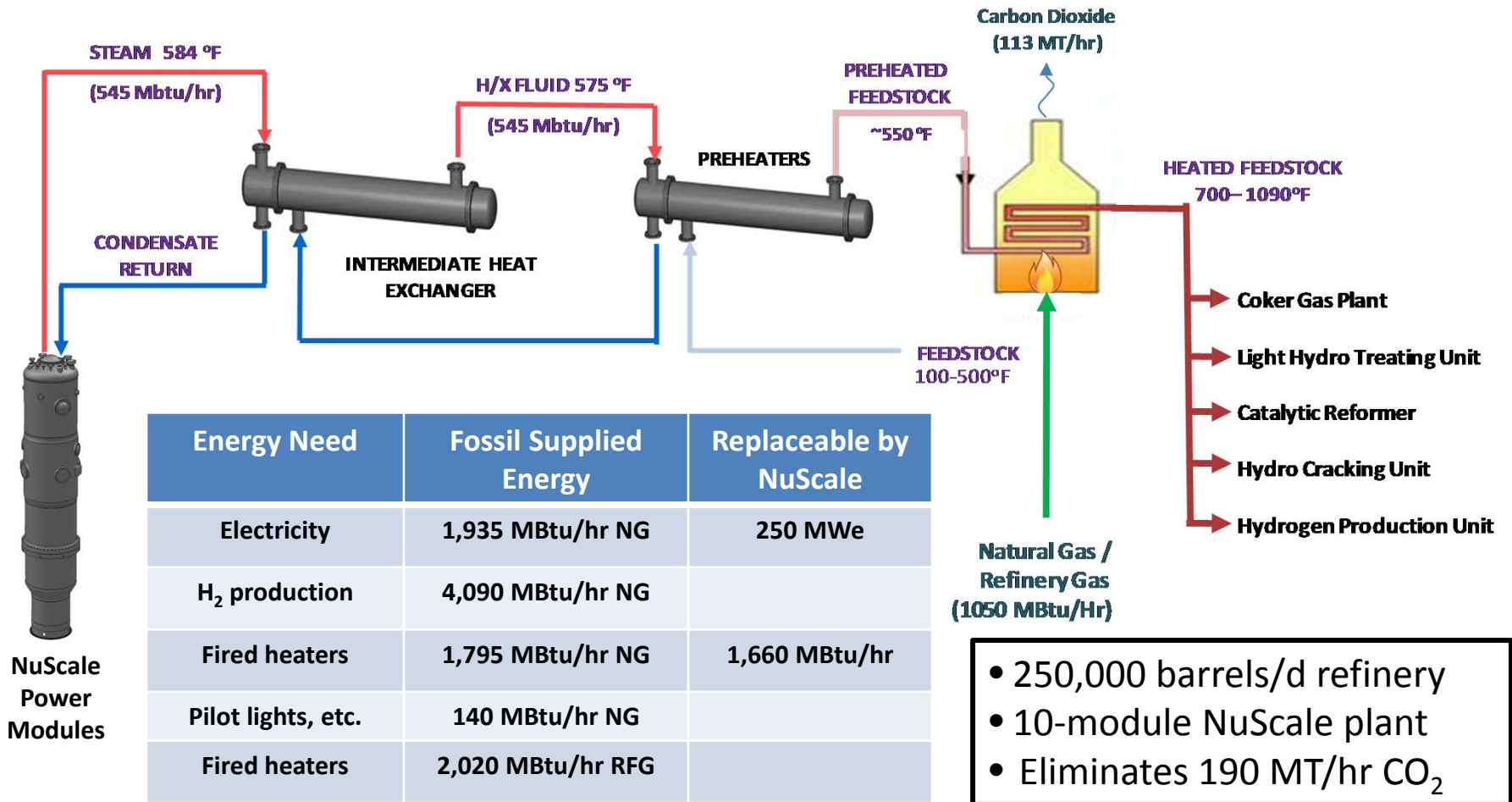
8-Module Plant can produce 50 Mgal/d (190K m³/d) of clean water plus 350 MWe



NuScale/Fluor Oil Refinery Study

Nuclear Steam – Feedstock Preheating Loop

Existing Refinery Plant



NuEx Tours – NIST, Control Room Simulator and UMM



NuEx August 20-21, 2015 Corvallis, OR



Financial Analyst Reports (NuEx)



“Small Reactors a Potentially Disruptive Power Technology – NuScale Investment Offers Possible Long-term Growth”

“NuScale appears to have the leading SMR technology and best financial support from the private sector and public agencies to commercialize the technology.”

- John B. Rogers, CFA. (2015)



“SMRs make sense given increasing carbon legislation, the expense and lack of reliability tied to renewables and potentially lower cost / scalability tied to building an SMR plant.”

“Industry experts believe SMR’s have the potential to be a \$400B opportunity over the longer term. NuScale is really the only viable SMR in town given BWXT’s cut in spend / lack of focus more recently.”

- Jaime Cook, CFA (2015)



“NuScale is the leading technology for development and commercial application of small modular reactor (SMR) technology.”

- Daniel W. Scott (2015)

William Blair

“NuScale has become the clear leader in the U.S. in developing a small modular nuclear reactor (SMR), following BWX Technologies’ decision in 2014 to wind down spending on its mPower SMR development program.”

- Chase Jacobson , CFA (2015)

Financial Analyst Reports (NuEx)

J.P.Morgan

“We came away impressed with the progress NuScale and FLR have made in development of the Small Modular Reactor (SMR) technology and an enormous market potential of this technology if adapted.”

“NuScale stands as the closest commercially viable SMR technology on the market today.”

- Jeffrey Y. Volshteyn (2015)

Bank of America Merrill Lynch

“SMR offers a scalable nuclear power gen model”

- Anna Kaminskaya, CFA (2015)



“Key takeaways were (1) NuScale development remains on schedule to submit design certification application to NRC (US Nuclear Regulatory Commissions) by the end of 2016 and for its first facility to go online 2023; (2) one of only a handful of SMR’s being developed globally, NuScale is the furthest along in development and poised to benefit from first mover advantage in a potential \$400B opportunity in 2025-2035;”

- Justin Ward (2015)

CANACCORD Genuity

“NuScale’s SMR has the potential to be a disruptive technology.”

“NuScale’s potential addressable market is huge. In a Dec. 2014 report, the National Nuclear Laboratory, a UK state body, pegged the size of the potential global SMR market at 65-85GW of installed capacity by 2035, with a market value of £250-£400bn. Fluor would have exclusive EPC rights to NuScale’s share of this market.”

- Yuri Lynk (2015)

Disclaimer

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The Element of Nu

