



January 17th, 2017

NuScale Power Small Modular Reactors

Briefing to Idaho State Legislature
Senate and House State Affairs
Committees

Mike McGough
NuScale Power



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Agenda

- DOE SMR Licensing Technical Support Program
- NuScale Technology Overview
- How Do We Know It Works?
- The Safety Case
- Commercialization Plan
- Q and A

Brief NuScale 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, >22K Mhrs
- Acquired by Fluor in October 2011
- ~400 people currently on project, ~\$500MM spent project life-to-date (\$12MM/mo)
- >350 patents pending/granted, 19 countries
- Portland, Corvallis, Rockville, Charlotte, Richland, London
- US DOE SMR Awardee, 12/12/13, \$217MM



NuScale Engineering Office Corvallis, Oregon



One-third scale Test Facility



NuScale Control Room Simulator

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DCA Status-Completed 12/31/16

- Pre-application accomplishments
 - >130 meetings
 - 15 NRC audits and inspections
 - >1,000 documents on our docket
 - September Readiness Assessment
 - 84 NRC personnel
 - 8 working days
 - Cost >\$1 Million
 - 85 docketing items identified
- 12,000 pages, 13.5 feet of bookshelf space
- 14 Topical Reports



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Final DCA Assembly and Submittal



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DCA Hand-off to NRC



Bottom row from left to right: John Hopkins (NuScale, Chairman and CEO); May John-Ross Lee (USNRC NER Deputy Director of Engineering); Tim Bergman (NuScale VP Regulatory Affairs); Dale Atkinson (NuScale COO/CMO); Maria Olski (NRC Acting Director of NRO); Mike Johnson (USNRC DEDO); Frank Jankowski (USNRC NRO Director of New Reactor Licensing); Anna Ruffner (USNRC NRO Deputy Director of New Reactor Licensing); Steven Mirsky (NuScale Manager of Regulatory Affairs)

Top row from left to right: Mike McCough (NuScale Chief Compliance Officer); Dr. John Hayes (NuScale Chief Technology Officer); Greg Cristofalo (USNRC NRO Lead Reactor Plant Manager); Max Felsosky (USNRC Acting Associate Secretary, Office of Nuclear Energy); Tom DeWitt (USNRC NuScale Project Manager); Dan Lee (USNRC NRO Branch Chief of Licensing Branch 1); and Greg Takahashi (USNRC NRO Nuclear Safety Project Manager)

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DCA Announcement PR Event – Jan. 12th

Dr. Lynn Dr. Undersecretary for Oceans and Energy

John Higgins, Chairman and CEO of NuScale Power

Rep. Denton (R-UT 2nd)

Rep. Shuster (D-OR 5th)

Mike McHugh, Chief Commercial Officer of NuScale Power

Rep. Veasey (D-TX 33rd)

Nels Harstad, CEO
The Utah Energy Institute

Rep. Wilson (R-NC 2nd)

Rep. Hironaka (R-WA 4th)

Speakers: John Higgins, Chairman and CEO of NuScale Power, Mike McHugh, Chief Commercial Officer of NuScale Power, Dr. Lynn Dr. Undersecretary for Science and Energy, U.S. Department of Energy, Nels Harstad, CEO Nuclear Energy Institute. Members of Congress including Rep. Neuhouse (R-WA 4th), Rep. Shuster (D-OR 5th), Rep. Stewart (R-UT 2nd), Rep. Veasey (D-TX 33rd), Rep. Wilson (R-NC 2nd)

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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

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NuScale Technology Overview

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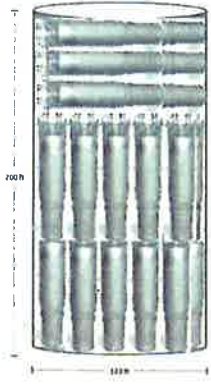


Size Comparison

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

Typical Pressurized Water Reactor

126 NuScale Power Modules



Containment

NuScale's combined containment vessel and reactor system



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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

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How Do We Know It Works?

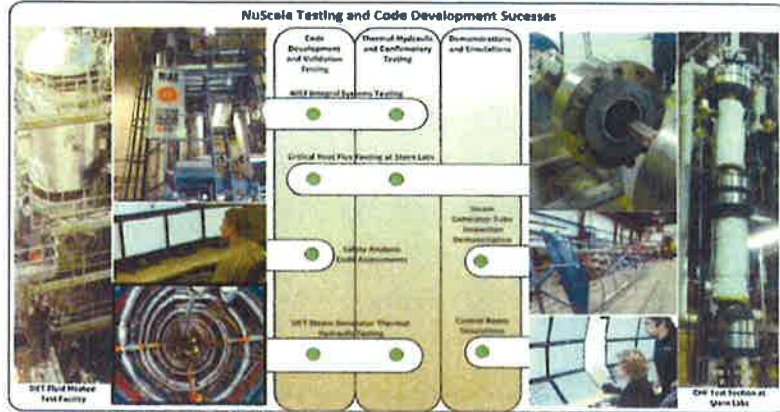
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NuScale Reactor Qualification Test Plan

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.



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Full Length SG Test (TF-2) Construction/Hardware



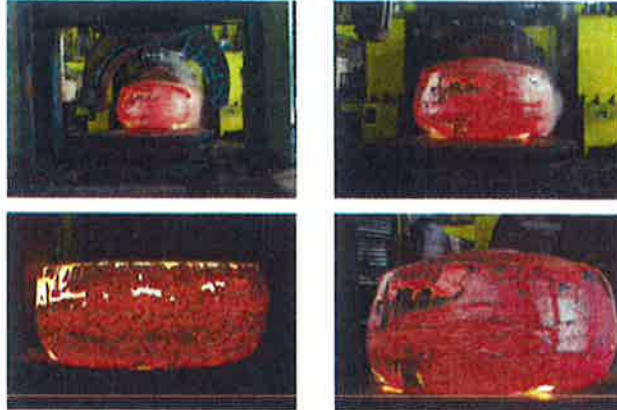
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NuScale RPV Head Ingot Being Forged

- 150 inches diameter
- 30 inches high
- 142,000 pounds



Images Provided courtesy of Sheffield Forgemasters International Ltd

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Machining of the NuScale RPV Head



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Control Rooms



President Jimmy Carter briefed by James R. Floyd, supervisor of TMI-2 operations, with Harold R. Denton, director of the Office of Nuclear Reactor Regulation in the Nuclear Regulatory Commission. This control room design was complete in the late 1960s, before construction began in 1970.



In this April 29, 2015 photo, Chris Dujado, left, and Billy Horton, right, control room operators for Unit 2, review information from monitoring panels at the Watts Bar Nuclear Plant near Spring City, Tenn. The control room design is strikingly similar to those of the 1960s, despite innovations behind the panels. (AP Photo/Mark Zaleski)

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NuScale Power Control Room Simulator



The NuScale Power simulator control room design brings together decades of Digital I&C, Human Factors Engineering and Human Systems Interface research and field experience.



At a recent NuScale Family day, 10-year-old Sam Shore felt completely at home in the NuScale Control Room Simulator.

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NuScale Control Room Simulator



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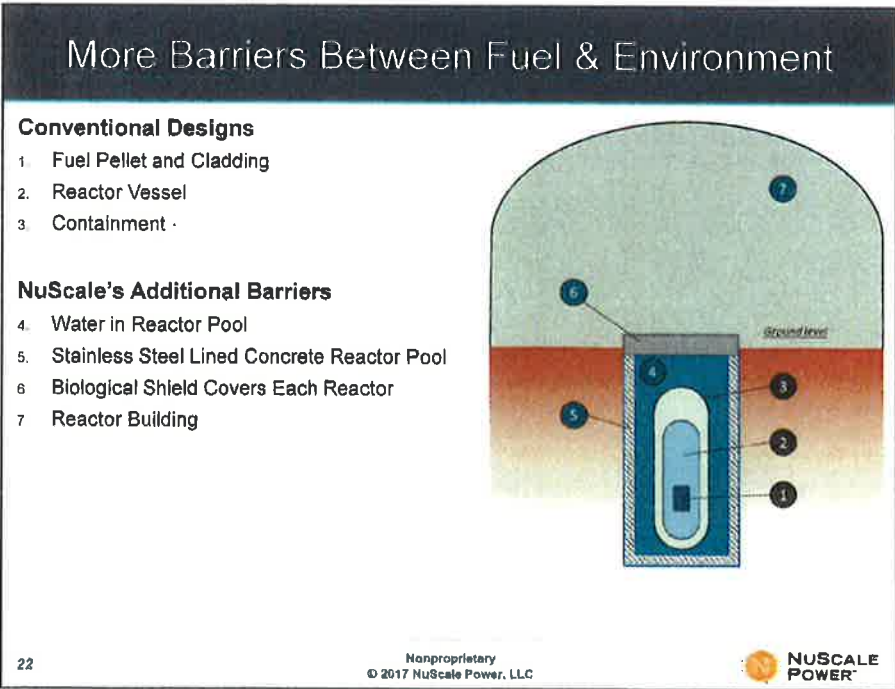
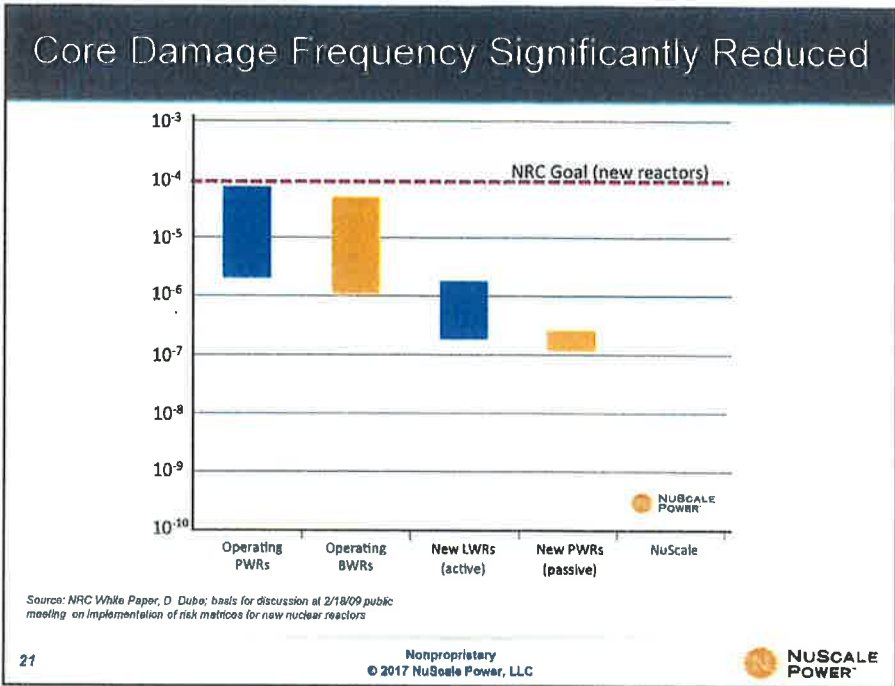


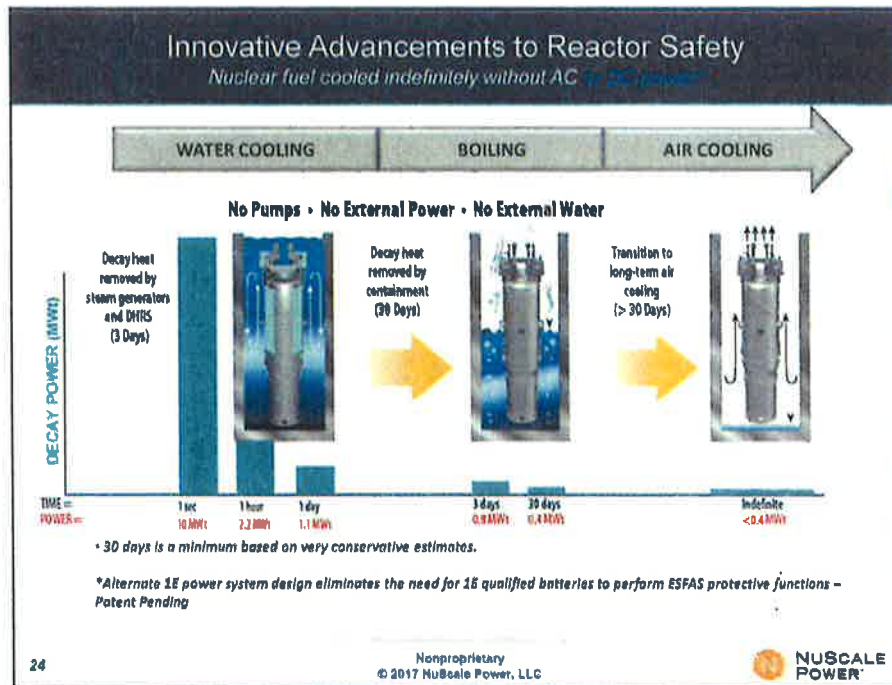
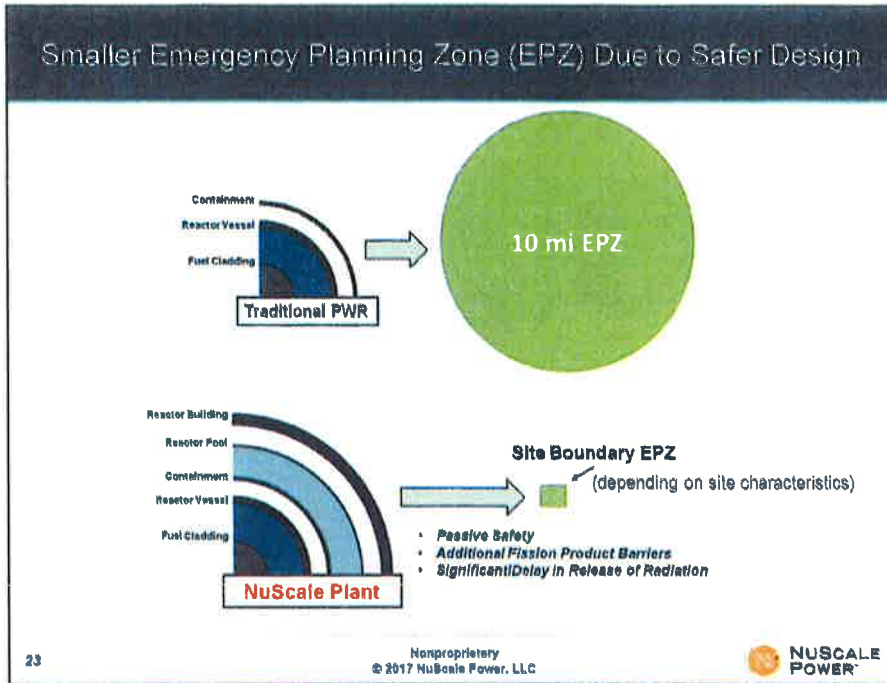
The Safety Case

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Commercialization Plan

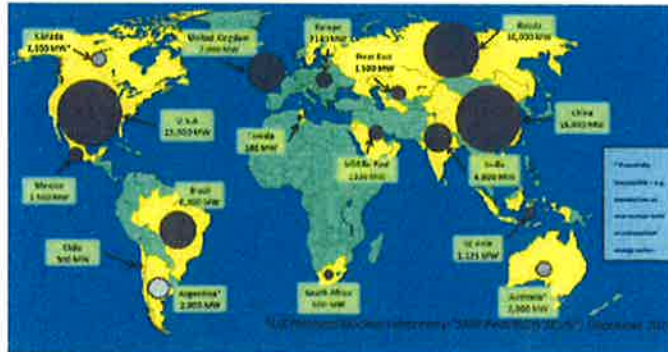
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SMR Market Potential

- UK NNL* calculated the potential SMR market to be approximately 65-85GW by 2035, 55-75 GW excluding Russia



- This is equivalent to 1100 – 1500 NuScale Power Modules (NPMs)
- At 25% market share, and 10 year deployment timeframe, 28–38 NPM / year
- At 36 NPM / year, approximately 1000 workers dedicated to machining, assembling and testing NPMs

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NuScale Advisory Board (NuAB)

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NUSCALE POWER

Site Overview

cooling towers A
annex building
warehouse
parking
administration building
radwaste building
18FBI (dry cask storage)
cooling towers B
turbine building A
reactor building
control building
switchyard
turbine building B
protected area fence

34.5 acres (~14 hectares) within the protected area fence

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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?, CO?

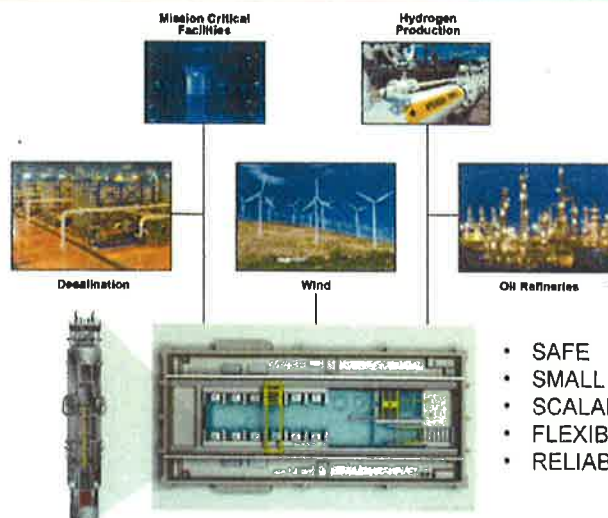


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NuScale Diverse Energy Platform (NuDEP) Initiative



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NuScale/UAMPS/ENW Study on Integration with Wind Farm

- NuScale includes unique capabilities for following electric load requirements as they vary with customer demand and rapid output variations from renewables: NuFollow™
- There are three means to change power output from a NuScale facility:
 - **Dispatchable modules** – taking one or more reactors offline for extended periods of low grid demand or sustained wind output
 - **Power Maneuverability** – adjusting reactor power for one or more modules (intermediate time frames)
 - **Turbine Bypass** – bypassing turbine steam to the condenser (short time frames)
- Explored integration with Horse Butte wind farm in Idaho
- Partnered with Utah Associated Municipal Power Systems and Energy Northwest



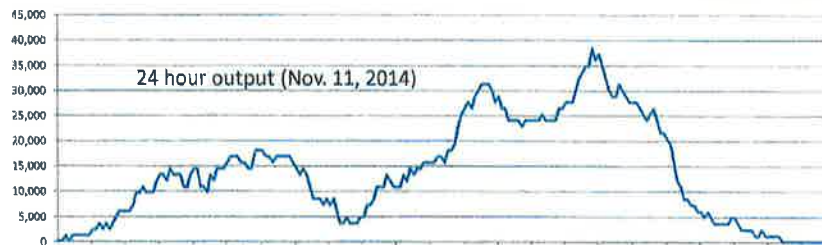
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Horse Butte Wind Farm

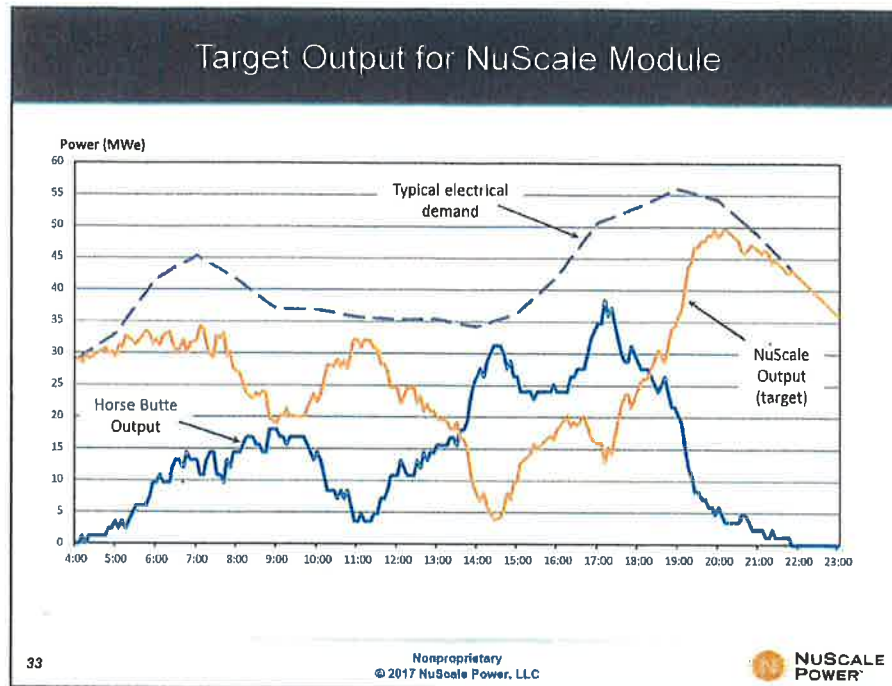
- Commissioned in 2012
- 32 Vestas V100 turbines
- 1.8 MWe capacity per turbine
- 57.6 MWe total capacity
- 17,600 acres



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What Will Project WIN mean to Idaho?

- Establishes INL as key player in SMR deployment
- Creates slipstream for other NuScale projects, both within WIN family and elsewhere worldwide
- Project will create ~1000 construction jobs at peak, for duration of 2-3 years
- Indirect economic benefits and associated job multipliers
- Full-time plant employment ~360 at average salaries \$85K
- Indirect economic benefits
- Establishes Idaho as potential desired location for NuScale supply chain members—Premier already working under contract

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What is Needed to Ensure Success in Idaho?

- Need a committed owner/buyer – will ultimately drive site selection decision for first project—UAMPS CFPP
- Project will need to demonstrate sufficient need for/use of generated power
- State should consider doing economic impact study
- Suitable plant economics/investment profile (e.g. long-term PPA's)
- Favorable/supportive local and state permitting and approval processes
- Economic development incentives (ala Eagle Rock?)
- Sufficient capable facility workforce and community interest
- Possible implementation of new federal programs for Port of Lewiston and bridges/roads upgrades on haul route

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Supplier Scope - Minimum

- Fabricate the NuScale Power Module
 - Containment Vessel
 - Reactor Vessel
 - Reactor vessel internals and piping
 - Steam Generator
 - Assembly and testing, including ITAAC
- Install equipment from other OEMs
- For domestic plants with an opportunity for international export
- A plan to increase production to meet demand
- Value > \$350M in fabricator scope per plant



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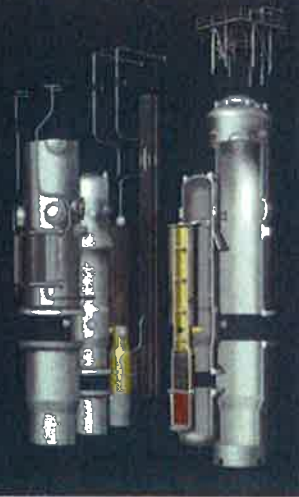


NuScale Plant Needs

EACH 12 MODULE NUSCALE PLANT

WILL NEED

- OVER 211,000 CY OF CONCRETE
- OVER 5000 TONS OF STEEL
- OVER 150,000 LINEAR FEET OF PIPE
- OVER 30,000 VALVES
- OVER 7 MILLION LINEAR FEET OF WIRE AND CABLE
- OVER 1.5 MILLION LINEAR FEET OF CABLOUT
- OVER 40,000 LINEAR FEET OF CABLE TRAY
- OVER 12,000 INSTRUMENTS
- OVER 500 ITEMS OF ELECTRICAL EQUIPMENT (SWITCHGEAR, MCC'S, PCC'S, INVERTERS, VFD'S, ETC.)
- OVER 900 MISC. ITEMS OF MECHANICAL EQUIPMENT



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NuEx Tours – NIST, Control Room Simulator and UMM



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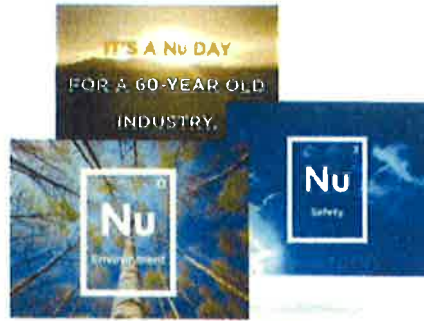
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The Element of Nu

