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NuScale - Blazing the Trail for Modular SMRs

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NuScale Differentiators

**Simple**
- Factory-built integral reactor and containment
- Modular constructability
- Fewer systems to construct and maintain
- Based on proven LWR experience

**Safe**
- Indefinite cooling on total loss of power with no operator action or additional water provided
- Unprecedented nuclear safety (one postulated module core damage event in 3 billion years)
- Environmentally benign – Carbon/emission-free

**Economic**
- FOAK Levelized Cost of Electricity US$76-107/MWh over a range of capital costs. (NOAK ~15% lower)
- Shorter reliable construction schedule
- 60+ year asset life
What is a NuScale Power Module?

- A NuScale Power Module (NPM) is a light water reactor that includes the nuclear reactor, steam generators, pressurizer and containment in an integral package that eliminates reactor coolant pumps and large diameter pipes (no LB-LOCA)
- Each NPM is 50 MWe (gross) and factory built for easy transport and installation
- Each NPM supplies 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 570 MWe total net output
**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.
Size Comparison

Typical Pressurized-Water Reactor Containment & Reactor System

NuScale Power Module
Combined Containment Vessel and Integral Reactor System

*Source: NRC
The NuScale plant can safely shut-down and self-cool, \textit{indeedinitely}, with:

- \textbf{No Operator Action}
- \textbf{No AC or DC Power}
- \textbf{No Additional Water}

Safety valves align in their safest configuration on loss of all plant power.
Smaller Emergency Planning Zone Due to Safer Design

Barriers Between Fuel and Environment

- Containment
- Reactor Vessel
- Fuel Cladding

Traditional Large Reactor

10 mi EPZ

Current Regulations

Site Boundary EPZ

- Passive Safety
- Reactor core < 1/20 size of large reactors
- Additional Fission Product Barriers
- Significant Delay in Release of Radiation

NuScale Goal

NuScale Plant

NuScale Nonproprietary
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Small Footprint

34.5 acres within the protected area fence
Factory Fabrication
Transportable
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)
Flexible Operation
Construction Assurance

Large GWe Class

NuScale Factory Fabrication

Large GWe Class
Estimated Average U.S. Levelized Cost of New Generation Resources
2022 Costs in 2016 $/MWh

Non-Dispatchable

NuScale 12-module plant

Note: Lower with Municipal financing

NuScale 12-Pack FOAK and NOAK include Owner’s Cost of $6.1/MWh and $1.1/MWh for transmission investment. EIA includes transmission investment from $1.1/MWh (Advanced Nuclear) to $4.80/MWh (Onshore Wind).

Assumptions for EIA and NuScale 12-Pack
WACC of 5.50%; 30-yr cost recovery

NuScale Diverse Energy Platform

- Mission Critical Facilities
- Desalination
- Wind Integration
- Oil Refineries

- Hydrogen Production
- Reliable Power – Protecting Critical Infrastructure
- Clean Transportation Fuel – Hydrogen Production

- Clean Water – Desalination
- Clean Energy - Facilitating Growth of Renewables – Load Following
- Clean Air - Reduction of Carbon Emissions at Oil Refineries

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SMR Case for Utility Scale Generation

- Provide the proven benefits of nuclear power
  - Emissions-free power production
  - Reliability – 7 x 24 in all weather conditions
  - Economic development – good paying jobs
  - Transmission grid voltage and frequency support - resiliency

- New SMRs, like NuScale, add additional potential benefits:
  - Enhanced unprecedented levels of safety
  - Affordable capital investment and competitive cost of electricity
  - More power plant siting options with smaller planning zones
  - Less construction risk with improved cost and schedule certainty
  - More flexible operation (load following) with renewables and other energy applications
Moving Ahead From Here
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