NuScale Power – Safe, Economic, Scalable, Proven Nuclear Technology

Bruce Landrey
Vice President, International Marketing
10 August 2012
“Small Modular Reactors represent the innovation that is the competitive edge for this country.”

Nicole Y. Lamb-Hale
Assistant Secretary for Manufacturing & Services
U.S. Department of Commerce
Platts Nuclear Conference
16 February 2011
SMRs are envisioned to require limited on-site preparation and are expected to essentially be ready to “plug and play” when they arrive from the factory. Those working on SMRs expect them to provide simplicity of design, enhanced safety features, and the economics and quality afforded by factory production. It is envisioned that additional modules can be added incrementally as demand for energy increases.
### Everything Changed Except Business Risk

<table>
<thead>
<tr>
<th>Old Nuclear</th>
<th>New Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every plant is “First of a Kind”</td>
<td>NRC “Design Certification” standardizes plant designs for 20 years</td>
</tr>
<tr>
<td>Separate licenses for Construction and Operation</td>
<td>Combined Construction &amp; Operating License issued before construction begins</td>
</tr>
<tr>
<td>Capacity factors ~ 70%</td>
<td>Capacity factors routinely exceed 90%</td>
</tr>
<tr>
<td>Active safety systems require emergency power to operate</td>
<td>Passive safety systems rely on natural circulation</td>
</tr>
<tr>
<td>All plants &gt; 1000 MWe requiring large financial commitment</td>
<td>All plants &gt; 1000 MWe requiring large financial commitment</td>
</tr>
</tbody>
</table>
USA Market Driver – Aging Infrastructure

Coal
- 330 GWe from 1,112 coal-fired power plants
- 50 percent are more than 40 years old
- 230 plants canceled totaling 104 Gwe

Nuclear
- 100 GWe from 104 plants = 20 percent of total U.S. generation
- NRC licenses expire and retirements begin in 2029. All plants retire by 2050

Renewables
- For wind and solar the best sites are gone
- Intermittency an increasing issue on all grids
Drivers for Small Modular Reactors

Safety
- Smaller size and simplicity of design result in greater opportunities to enhance safety. Not subject to large LWR scenarios – large break LOCA, SBO
- Natural circulation for passive “always-on” cooling

Reduced Business Risk
- Less capital at risk for a shorter period
- No longer a “bet the company” decision

Economies of Small
- Less to design, engineer, license, build, operate, maintain, decommission
- Extensive modularity and off site manufacturing of complex components

Broad Accessible Market
- True scalability – from 45 MWe to 540 MWe in a single nuclear plant
- Multiple applications: commercial power, desalination, district heating.
Capturing the “Economies of Small”

Nuclear system construction moved off site.
Simplicity = Greater Safety, Lower Costs and Risks

- Proven technology
- Fewer systems and components than traditional plants

- Less to Develop
- Less to Design
- Less to License
- Less to Build
- Less to Operate
- Less to Maintain
NuScale Corporate Overview
NuScale Power History

- Oregon State University builds ¼ scale test facility to support Certification of the AP600 and AP1000 without requiring a “prototype” (1990s)
- OSU, Idaho National Laboratory and Nexant develop MASLWR (NuScale) design and test facility originally developed under DOE funded program in 2000-2003
- OSU refines and develops the design with proprietary improvements (2004-2007)
- NuScale Power Inc. formed in June 2007. Tech-transfer agreement with OSU provides exclusive use of the Integral System Test facility and patents.
- 2008 – 2011
  - Establish Executive Team and staff of world-class engineers. 250 FTE’s currently
  - Gain commitment from US NRC to support licensing
  - Secure support from US Congress and US DOE
  - Secure funding from Fluor Corporation
Fluor Overview

♦ Acquired majority interest in NuScale – October 2011.

♦ One of the world’s leading publicly traded engineering, procurement, construction, maintenance, and project management companies

♦ #124 in the FORTUNE 500 in 2011

♦ More than 1,000 projects annually, serving more than 600 clients in 66 different countries

♦ More than 42,000 employees worldwide

♦ Offices in more than 28 countries on 6 continents

♦ Nearly 100 years of experience

Fluor Corporate Headquarters
Dallas, Texas

♦ Revenue: $20.8 billion

♦ New Awards: $27.3 billion

♦ Backlog: $34.9 billion

♦ Investment Grade Credit Ratings: S&PA-, Moody’s A3, Fitch A-
Modular Scalable Nuclear Power

- NuScale Power is commercializing a 12-Module centralized nuclear power station that can be built in two increments:
  - Up to 270 MWe (1-6 modules)
  - Up to 540 MWe (7-12 modules)
- Sizes that are compatible with most power grids.
- Each power module consists of a 45 MWe Pressurized Water Reactor:
  - Factory Built
  - Natural Circulation
  - Passively Safe
Elegantly Simple Innovative Design
Independent TG Sets for Each Module

- Skid mounted
- Easy to transport
- Controlled fabrication
- Fast onsite installation
- Off-the-shelf models currently available
- Direct coupling to steam turbine, allowing a much safer water- or air-cooled design
Full-Scale Main Control Room Simulator
Safe and Scalable

- 12 x 45 MWe Reference Plant = 540 MWe
- Each module is independent, installed and refueled sequentially
- Reactor vessel integrated into steel containment vessel installed below grade in 4 million gallon pool
- Integrated NSSS transported to site by truck, rail or barge
Incremental Build Out

Turbine Building and 6 Turbine Generators

Power Modules

Installed: 6

Initial Installation (270 MWe)

Cooling Towers
Incremental Build Out

- Initial Installation (270 MWe)
  - Turbine Building and 6 Turbine Generators
  - Cooling Towers

- Incremental Expansion (540 MWe)
  - Power Modules
  - Installed: 12
Innovative PWR Technology
NuScale Offers an Extra Layer of Safety

- No Large Break LOCA
- No Design Basis Accident can cause core to uncover
- Peak Ground Acceleration 0.5g
- Smaller source term per reactor
- Low CDF ~2x10^-8 per reactor year
- 7 Barriers to Fission Product Release
  - Oxide fuel pellet and cladding, reactor vessel, containment, reactor building pool water, underground stainless steel lined concrete bunker, biological shield, filtered seismic category 1 reactor building
- Deeply embedded spent fuel pool with 4 x water volume per MWt of 1000 MWe plant
- Complete Station Blackout protection without pumps, AC power, or external supplies of water
  - Passive cooling of reactor for 30 days with water followed by an unlimited period of air cooling
Robust Seismic Design

- Designed for potentially higher seismically-active areas
- Structure composed almost entirely out of concrete, with well arranged shear walls and diaphragms which provides for high rigidity
- Significant portion of the structure located below grade partially supported by bedrock
- Large pools filled with water help dampen seismic forces
Added Barriers Between Fuel and Environment

**Conventional Designs**
1. Fuel Pellet and Cladding
2. Reactor Vessel
3. Containment

**NuScale’s Additional Barriers**
4. Water in Reactor Pool (10 million gallons)
5. Stainless Steel Lined Concrete Reactor Pool
6. Biological Shield Covers Each Reactor
7. Reactor Building
Stable Long Term Cooling

Reactor and nuclear fuel cooled indefinitely without pumps or power.

WATER COOLING  BOILING  AIR COOLING

No Pumps • No External Power • No External Water

Decay heat removed by steam generators and DHRS (3 Days)
Decay heat removed by containment (30 Days)
Transition to long-term air cooling (>30 Days)

TIME (sec) = POWER (10 MWt)
1 sec 2.2 MWt 3 days 0.8 MWt
1 hour 1.1 MWt 30 days 0.4 MWt
1 day Indefinite <0.4 MWt

Decay heat removed by steam generators and DHRS (3 Days)
Decay heat removed by containment (30 Days)
Transition to long-term air cooling (>30 Days)
Reduced Core Damage Frequency

NRC Goal (new reactors)

Source: NRC White Paper, D. Dube; basis for discussion at 2/18/09 public meeting—on implementation of risk matrices for new nuclear reactors
Pathway to Commercialization
Initiated first formal iPWR NRC pre-application project in April 2008 (Project 0769)
- Conducted 11 meetings to date; 5 meetings remaining in 2012; more in 2013
- Submitted 7 reports to date (2 topical reports, 5 technical reports); 8 additional submittals committed for 2012; more in 2013
- Scheduling NRC observations of extensive testing programs at integral effects facility (OSU) and major separate effects facilities (fuel, HCSG)
- NRC developing Design Specific Review Standards for NuScale and mPower
Goal – “expedite the construction and operation of the first-mover SMRs”

- $452 million, five-year program
- Starts with ~ $67 million in FY2012
- Maximum 50/50 cost share for:
  - Design Certification
  - Reference Construction & Operating License
  - First of a kind costs
  - Early site permit

Funding Opportunity Announcement decision pending
Customer Advisory Board
Suppliers and Strategic Partners

NUCLEAR “MODULE” MANUFACTURERS

- General Dynamics Electric Boat
- Huntington Ingalls Industries
- Oregon Iron Works, Inc.

ENGINEERING DESIGN AND TECHNOLOGY

- Curtiss-Wright
- Fluor
- MPR
- Studsvik
- ARES Corporation
- Siemens
- Konecranes
- GSE Systems

LICENSING AND REGULATION

- Morgan Lewis
- Talisman International, LLC
- Enercon
- OSU
- SAIC

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# NuScale SMR “Value Chain”

## Value chain

<table>
<thead>
<tr>
<th>Design &amp; Technology Development / Licensing</th>
<th>Manufacturing &amp; Equipment Supply</th>
<th>Engineering Procurement Construction</th>
<th>Training &amp; Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Engineering</td>
<td>• Engineered Components</td>
<td>• Skilled craft labor –</td>
<td>• Trainers</td>
</tr>
<tr>
<td>• Component development and testing</td>
<td>• NSSS</td>
<td>• Electricians</td>
<td>• Operators</td>
</tr>
<tr>
<td>• System development and testing</td>
<td>• Turbine-generators</td>
<td>• Welders</td>
<td>• Engineers</td>
</tr>
<tr>
<td>• Safety Analysis</td>
<td>• Heat exchangers</td>
<td>• Piping</td>
<td>• Instrument &amp; Control Technicians</td>
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<tr>
<td>• Computer modeling</td>
<td>• Pumps</td>
<td>• Instrumentation</td>
<td>• Health physics</td>
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<tr>
<td>• Software development</td>
<td>• Piping</td>
<td>• Quality assurance</td>
<td>• Security</td>
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<tr>
<td>• Legal</td>
<td>• Forgings</td>
<td>• Mechanical</td>
<td>• Administrative and Management</td>
</tr>
<tr>
<td></td>
<td>• Valves</td>
<td>• Engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Instrumentation</td>
<td>• Excavation, site preparation</td>
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</tr>
<tr>
<td></td>
<td>• Controls</td>
<td>• Construction materials –</td>
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<tr>
<td></td>
<td>• Wire and cable</td>
<td>concrete, steel</td>
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<tr>
<td></td>
<td>• Fuels</td>
<td>• Administrative and Management</td>
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<td>• HVAC</td>
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<tr>
<td></td>
<td>• Materials handling</td>
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<td></td>
<td>• Facility MRO</td>
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</tbody>
</table>
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http://www.nuscalepower.com
• Site boundary is 330 meters x 360 meters (12 hectares) “inside the fence”
• All cooling options available.
Factory Manufacturing

Module includes Containment and Reactor Vessel

Shipped by Truck, Rail, or Barge

Skid-Mounted Steam Turbine/Generator

Below-Ground Control Room provides enhanced security and state-of-the-art controls

Each Module is refueled underwater while the remainder of the plant produces power
  • Refueled once every 24 months
  • 10 Day Refueling Target

12 Module Reactor Building

Containment Reactor Vessel Steam Generator Fuel

Each Module is installed in its own seismically isolated bay
  • Natural Circulation (No Reactor Coolant Pumps)
  • Standard 17x17 PWR Fuel
  • Standard Magnetic Jack Control Rod Drives
  • Internal Steam Generator and Pressurizer
  • 45 MWe Net Power