Small Modular Reactors: New Nuclear Opportunities

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Energy Communities Alliance
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Evolving national goals will affect nuclear development

- **Investing in the Next Generation of Energy Technologies.** Invest $150B over ten years in energy research and development to transition to a clean energy economy.
  - *President Obama:* “80% reduction in greenhouse gas emissions by 2050”

- **New Clean Energy Standards Under Development**
  - *Congress* considering new definitions and applicability for clean energy definition and requirements
Interest in small modular reactor deployment is building

- Affordable base-load electricity generation
  - Smaller utilities with low capitalization
  - Larger utilities with small load growth
  - Distributed or remote communities
  - Sites/facilities requiring special power needs
  - Energy-intensive manufacturing
Key Benefits of SMRs

• Reduced capital cost
• Competitive power costs expected
• Smaller incremental capacity addition to match power demand and growth rate
• Domestic supply chain
• Low carbon energy source
• Enhanced safety and robustness from simplified designs
• Enhanced security from below-grade siting
• Adaptable to a broader range of energy needs
• Flexible siting (access, water impacts, seismic, etc.)
Integral Design: Simple and Robust

Loop-type Primary System

Integral Primary System

- Core
- Pressurizer
- Control Rod Drive
- Pump
- Steam Generator

Managed by UT-Battelle
for the U.S. Department of Energy
Simplified SMR construction should reduce cost and schedule
Demonstrating the “M” in “SMR” is a key to economic viability

12-Module (540 MWe) 
**NuScale Plant**

4-Module (500 MWe) 
**mPower Plant**
Fabrication and construction benefits

• Eliminate large forgings from foreign suppliers

• Substantial in-factory fabrication; less site-assembly
  – Reduces schedule uncertainty
  – Improves safety/quality
  – Reduces cost

• Reduced size and weight for easier transport to site
  – Access to a greater number of sites
  – Allows parallel construction of NSSS and BOP
U.S. LWR-based near-term SMR designs for electricity generation

- **Westinghouse SMR**
  - 200 MWe class

- **mPower (Babcock & Wilcox)**
  - 125 MWe

- **NuScale (NuScale)**
  - 45 MWe
SMR Deployment Challenges

• Technical issues due to design differences
  – Internal sensors and instrumentation
  – Validation of analysis methods for SMR designs and conditions

• Financial issues due to new business model
  – Fixation on economy-of-scale
  – Perceived risk factors for nuclear plants

• First of Kind regulatory issues due to existing NRC standards
  – Staffing and security force size
  – Plant vs module licensing
  – Standard 10-mile radius EPZ (in the U.S.)
TVA’s Clinch River Site will be First of Kind for SMR Deployment

- Proximity of SMR to DOE facilities
- Wealth of technical expertise
- Power island for grid security
- Community familiarity with nuclear
Today: ORNL’s carbon footprint is driven by purchased electricity

![Graph showing ORNL's carbon footprint]

<table>
<thead>
<tr>
<th>ORNL GHG emissions, 2008</th>
<th>CO₂ equivalent (metric tons)</th>
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<tbody>
<tr>
<td><strong>Scope 1:</strong> Direct emissions</td>
<td>53,200</td>
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<tr>
<td><strong>Scope 2:</strong> Indirect emissions from electricity production</td>
<td>226,000</td>
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<tr>
<td><strong>Scope 3:</strong> Other indirect emissions</td>
<td>52,300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>331,500</td>
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</tbody>
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**DOE GHG emissions, 2008:** 4,600,000 metric tons
Oak Ridge SMR project enables ORNL to meet GHG goals

Even aggressive efficiency improvements and emission reductions will not satisfy EO 13514 goals by FY20