Federal Support for the Growth of the Small Modular Reactor Industry

3rd Annual Platts SMR Conference

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DOE Support for GW-Class Reactor Deployment

- Recently completed $1.4 billion joint government-industry program to overcome barriers to new reactor deployment
  - 50-50 cost-share between government and industry
- NRC approved amended version of the Westinghouse AP1000 reactor design for use in U.S.
- GEH ESBWR certification expected by Fall 2012
- First COLs in the U.S issued for Vogtle Project (GA) and Summer Project (SC)
SMR Technologies
Why is DOE and the United States Interested?

- **SMR Benefits**
  - Enhanced safety and security
  - Reduced capital cost makes nuclear power feasible for more utilities
  - Shorter construction schedules due to modular construction
  - Improved quality due to replication in factory-setting
  - Meets electric demand growth incrementally
  - Re-establish U.S. technical leadership
  - Expand/create economic opportunities and jobs

- **Potential Markets**
  - Expanded siting options - air cooling, reduced water usage & site acreage
  - Repower/replace aging fossil plants
  - Non-electrical (process heat/desalination) customers
Business prospects predicated on (at least) three premises:

- Significant investment needed to reach commercialization
  - DOE SMR licensing technical support and R&D programs geared to resolve technical and regulatory issues
- Strong market appeal to power producers
  - Risk management
  - Electricity production cost
- Construction cost must be competitive
  - Factory fabrication - economies of replication vs. economies of scale
  - Utilize advanced manufacturing and fabrication techniques - improved quality > reduce schedule > reduce costs
  - Need a factory to make the price attractive - need an attractive price to produce the orders to warrant building the factory
SMR Fleet Deployment
Evolution of Public-Private Partnership

Phase 1: Licensing
Phase 2: First Mover
Phase 3: Early Adopters
Phase 4: Full-Scale Factory Production

- Sustain Clean Energy Deployment
- Reward First Movers of Clean Energy
- Encourage Investment
- Risk sharing

SMRs Deployed
Accelerate commercialization of SMR technologies

- U.S.-based SMR designs (nominally 300 MWe or less per unit)
- Open to LWR and Advanced SMR designs

Cost-Shared Industry Partnership Program

- Five-year program, totaling $452M (DOE contribution)
- First-of-a kind engineering, design certification application and licensing support
  - Construction costs not included

- Goal is to have electricity on the grid by 2022
<table>
<thead>
<tr>
<th>Step</th>
<th>Date/Timeframe</th>
<th>Status</th>
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<tr>
<td>Release draft FOA</td>
<td>January 19, 2012</td>
<td>Completed</td>
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<td>30 day industry comment period</td>
<td>January 19 – February 17, 2012</td>
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<td>Incorporate Stakeholder comments</td>
<td>February 17 – March 22, 2012</td>
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<td>Issue Final FOA</td>
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<td>Industry day</td>
<td>April 12, 2012</td>
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<td>Receive Applications</td>
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<td>Conduct merit review, make selection, internal reviews</td>
<td>May 22 – September 2012</td>
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<td>Award Selection</td>
<td>September 2012 timeframe</td>
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<td>Cooperative agreement negotiation</td>
<td>October - November 2012 timeframe</td>
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<td>Release Funding to awardees</td>
<td>Prior to the end of CY12 (Goal)</td>
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DOE recognizes the need to invest in Advanced SMR R&D

- Deployment of Advanced SMRs would follow the near-term SMR deployment path as they mature

DOE is seeking greater interaction with industry and other stakeholders on the development of its R&D program

Established a Technical Review Panel (TRP) in 2012

- Reviews advanced reactor concepts and help identify R&D needs
- TRP members include experts from industry, national labs, and academia
- Issued Request for Information (RFI) for industry to voluntarily submit information on reactor concepts
- Results of the TRP review will be used to help inform DOE’s R&D program
Advanced SMR R&D Focus Areas

- **Safety and Licensing Framework**
  - Perform R&D to resolve generic licensing issues
  - Site suitability and screening tools
  - Examine underground siting to reduce security costs

- **Components and Technology Development**
  - Materials qualification and corrosion studies
  - Modular construction – fabrication approaches and economic analysis
  - Energy Conversion technology – Supercritical CO₂ Brayton cycle

- **Instrumentation, Controls and Human-Machine Interface**
  - Sensors and measurement systems for in-vessel and self-calibrating applications
  - Innovative operational control concepts for multi-module plants
  - Performance monitoring – reduce staffing and maintenance needs
Capital cost of building new nuclear plants is a challenge to new nuclear plant deployment including SMRs

- Modular construction techniques need to be incorporated into designs
- Factory fabrication of modules needs to be implemented
- Latest construction technology needs to be applied
- Industry codes and standards needs to be updated and/or developed

NE is launching R&D programs to improve affordability of nuclear power

- Advanced Methods for Manufacturing (AMM) – improved manufacturing, modularization and fabrication technologies, methods and techniques
- Development of associated industry codes and standards to use advanced technologies and methods.
Funding Opportunity Announcement – $3M

- Issued February 15, 2012
  - Conduct Independent and Merit reviews - April 16 - May 11, 2012
  - Award Selection - Planned for July 2012

- Areas Requested
  - Technology development in laser-hybrid welding processes,
  - Integrated welding and non-destructive examination systems,
  - Near-shape component manufacturing systems,
  - Assembly and material innovation to enhance modular building techniques such as advances in composite structures, seismic based isolation, and pre-assembled rebar systems,
  - Sophisticated modeling to improve module design, fabrication and field assembly sequencing, resource and project management,
  - SMR “factory fabrication” concepts
Industry Codes & Standards
Nuclear Energy Standards Coordinating Collaborative (NESCC)

- Joint effort with NIST, NRC and DOE to ensure appropriate codes and standards are available for new builds

- Establish task groups on particular areas/issues
  - Working groups consist of appropriate code and industry stakeholders
  - Review current standards against need
  - Identify code/standard changes and any R&D required

- AMM and other research are expected to address key R&D needs identified by NESCC Task Groups
Additional Activities to Support SMRs

- Energy Policy Institute at the University of Chicago commissioned to analyze economics and business case of SMRs
  - Phase I – “Small Modular Reactors – Key to Future Nuclear Power Generation in the U.S.”
    - Completed December 1, 2011
  - Phase II – “The Economics of Mass Manufacturing of Small Modular Reactors”
    - Planned for 2012-2013

- Electric Power Research Institute (EPRI) updating current Advanced Light Water Reactor Utility Requirements Document (URD) to include SMRs
  - Identify utility requirements for Light Water SMRs
  - Support SMR standardization, reduce capital, and operation and maintenance costs
DOE is very positive on the prospects of SMR deployment and is making major investments in the technology

“The Obama Administration and the Energy Department are committed to an all-of-the-above energy strategy that develops every source of American energy, including nuclear power, and strengthens our competitive edge in the global clean energy race .... through the funding for small modular nuclear reactors announced today, the Energy Department and private industry are working to position America as the leader in advanced nuclear energy technology and manufacturing.”

Energy Secretary Steven Chu
Vogtle Plant
February, 2012