ANS / DC Chapter Presentation
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B&W Nuclear Energy
The Babcock & Wilcox Company

Government Operations

- B&W Technical Services Group, Inc.
- B&W Nuclear Operations Group, Inc.

Commercial Operations

- B&W Power Generation Group, Inc.
- B&W Nuclear Energy, Inc. April 1, 2010

Clean Power Technologies
High-Consequence DOE Operations
Advanced Engineering and Manufacturing
B&W Nuclear Energy, Inc.

Cornerstones of B&W NE

• Nuclear Components
• Nuclear Services
• Nuclear Projects
• B&W mPower™ Reactor

B&W Headquarters
Charlotte, NC
Formal alliance between B&W NE and Bechtel Power Corp
- Executed July 14, 2010
- Substantial commitment by B&W and Bechtel

Recognized and established energy industry leaders

Bechtel backed by:
- 60 years of nuclear power industry experience
- Integrated engineering and project management leadership

Alliance objectives:
- Design, license and deploy world’s first commercially viable Gen III++ SMR
- Deliver greater project cost and schedule certainty
- Make nuclear power more accessible to utilities

www.generationmpower.com

Turning point in the nuclear power plant industry – ‘game changer’
Vertically Integrated Supply Chain

- Domestic forgings or rolled plate
- Component fabrication
  - Mt. Vernon, Indiana
  - Barberton, Ohio
  - Cambridge, Ontario, Canada
- Fuel fabrication
  - Lynchburg, Virginia
- Control rod drive fabrication
  - Euclid, Ohio

A North American solution … manufactured in existing B&W facilities
A Shifting Nuclear Landscape

Geopolitical Motivators

- Climate Change legislation
- Energy independence
- Strained supply chain
- Field craft labor availability
- Transmission capacity
- Water and land rights
- Tight capital markets

One size does not fit all …
Today’s Industry Imperatives

- Don’t “bet the company” on one project
- Practical, proven technology
- Utilize existing nuclear infrastructure
- “Repower” carbon-intensive facilities
- Incremental power additions
Goal and Value Proposition

Develop and deploy, by 2020, an SMR that offers:

✓ Schedule certainty
✓ Cost certainty
✓ Reasonable financing burden

within the constraints of:

- **Proven**: GEN III⁺, established NRC regulation
- **Affordable**: Competitive LCOE, configuration driven
- **Practical**: Standard fuel, containment and O&M
- **Simple**: Integral NSSS, passively safe
- **Benign**: Air-cooled, underground, robust margins
A Generation III++ Reactor

- Integral 125MWe NSSS module
  - Core, CRDMs, SG, Pressurizer, and Pumps
  - No penetrations below top of core

- Passively safe design philosophy
  - Core remains covered during DBAs
  - No active ECCS or safety-related AC power

- 4 yr+ fuel cycle with “standard” PWR fuel
  - 69 fuel assemblies, with <5% enrichment
  - Burnable poisons, no chemical shim in coolant

- Fully shop-manufactured; rail-shipped to site
  - Vertically integrated US supply chain (OH, VA, IN)
  - Shorter, simpler BOP field construction

Modular ALWR with best of Generation III++ features … low risk, low cost and passively safe
B&W mPower High-Level Requirements

- 125 MWe plant gross output per module & 60-year plant life
- NSSS forging diameter allows domestic forgings, unrestricted rail shipment
- Passive safety requirements – emergency (diesel) power is not required
  - Minimize primary coolant penetrations, maximize elevation of penetrations
  - Large reactor coolant inventory
  - Low core power density
- Standard fuel (less than 5% enriched U-235)
- Long fuel cycle, 4+ year core life
- Spent fuel storage on site for life of plant
- No soluble boron in primary system for normal reactivity control
- Conventional / off-the-shelf balance of plant systems and components
- Accommodate air-cooled condensers as well as water-cooled condensers
- Flexible grid interface (50 Hz or 60Hz)
- Digital instrumentation and controls
B&W mPower Containment Requirements

- Underground containment and fuel storage buildings
- Environment suitable for human occupancy during normal operation
- Simultaneous refueling and NSSS equipment inspections
- Passively limit internal pressure to 50 psig for all design basis accidents
B&W mPower Integral Reactor Design

- Primary coolant contained within integral reactor vessel
- Forced circulation via internal non-safety coolant pumps
- “Load-following” capability
- Power and pressure control with feedwater, active pressurizer
- Simple B&W once-through steam generator with superheat

<table>
<thead>
<tr>
<th>Thermal Power:</th>
<th>425 MW</th>
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<tbody>
<tr>
<td>Reactor Coolant:</td>
<td>1900 psia nominal</td>
</tr>
<tr>
<td></td>
<td>568°F Core inlet</td>
</tr>
<tr>
<td></td>
<td>609°F Core outlet</td>
</tr>
<tr>
<td></td>
<td>25.4 Mlbm/hr</td>
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<tr>
<td>Steam Conditions:</td>
<td>571°F @ 825 psia</td>
</tr>
<tr>
<td></td>
<td>(50°F Superheated)</td>
</tr>
<tr>
<td></td>
<td>(Feedwater @ 325°F)</td>
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<tr>
<td>Reactor Vessel:</td>
<td>Inside Diameter 10 ft</td>
</tr>
<tr>
<td></td>
<td>Height 76 ft</td>
</tr>
<tr>
<td>Fuel Assemblies:</td>
<td>17x17 fuel pin array</td>
</tr>
<tr>
<td></td>
<td>80 in active length</td>
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</tbody>
</table>
Nuclear Island Features

- Nuclear Island fully underground
  - Inherent security, external threat protection
- Reactor installed after construction
  - 25%+ shorter project schedule
- No containment pressure suppression pool
  - Lack of large-break LOCA, slow energy release
  - No containment spray system required
- Only DC powered safety functions, controls
  - Lower O&M and capital costs for safety systems
- Spent fuel storage underground for 60 years
  - Operations not dependent on long-term solution

*Simple solution to plant safety and spent fuel storage*
Lower Reactor Assembly

- Coolant Pumps (12)
- Control Rod Drive Mechanisms (CRDMs)
- Control Rod Guide Frames
- Core Former
- Lower Shroud
- Core (center fuel assembly shown)

61 CRDMs using a common design
Engineered Safety System Functions

- Provide long-term decay heat removal from RCS
- Provide automatic depressurization in the event of a LOCA
- Provide long-term coolant injection to the RCS
- Provide long-term RWST and containment cooling
- Provide cavity flood capability
- Provide soluble boron injection for ATWS

Functions performed by the Emergency Core Cooling System (ECCS)
Scalable Nuclear Plant: Practical, Affordable

- Fully independent reactor modules
- 1-8 modules per plant, 125-1,000 MWe
- Underground containment building
- Low-impact, air-cooled condenser
- Scalable to grid, site, load-growth
- Three-year construction schedule

Cost certainty ... Schedule certainty...Capital efficient
Four Reactor Plant 3D Layout
Generation mPower Lead Plant Baseline Schedule

Part 52 Process

Critical external constraints ... DOE solicitation, NRC review window and 2020 deployment
Program Overview

✓ A signed Consortium MOU with 3 utility partners
  - FirstEnergy, TVA, Oglethorpe Power (plus 11 other G&Ts) … others considering
  - $$ contribution to 2010 mPower initiatives – design, licensing and regulatory

✓ A budgeted DOE cost-sharing program
  - $39M and a new Small Modular Reactor (SMR) program proposed for FY2011
  - Up to two SMR designs being considered for cost-sharing for FY2012 and beyond

✓ A funded NRC organization to review and license mPower
  - New LWR SMR organization, staffed with dedicated mPower resources
  - “Preparation for the review of … [and] partially fund a DC review for a small reactor.”

✓ An improved climate in Congress and the White House
  - Obama’s State of the Union endorses nuclear: its politics, but helpful
  - Senators embrace the SMR story, with home-grown preferences

Momentum driven by politics of carbon and energy industry realities
Summary

- World’s first commercially viable Gen III++ SMR
- Proven, practical ALWR technology
- Simple, passively safe design
- Schedule and cost certainty
- Licensing within current LWR framework
- Generation mPower alliance is a game-changer
- NSSS factory built in North America
- Key design attributes:
  - 36-month construction
  - 4 year+ fuel cycle
  - Air cooled condenser
  - Target 10-day refueling outage
  - Facility design features with O&M cost focus

Deliver on the promise of a new clean energy option.
B&W mPower LCOE: 500MWe Integrated Four-Pack

LCOE, $/MWh

Cost of CO₂, $/Metric Ton

Worst Deployment Economics

Best Deployment Economics

NGCC ($10/MMBtu)
NGCC ($8/MMBtu)
Gen III+ Nuclear
NGCC ($5/MMBtu)

All costs in 12/08 $
90% confidence level
Questions?