B&W mPower Small Modular Reactor

Creating the future of nuclear power
“Twin Pack” mPower Plant Site Layout

- 2 x 180MWe* units
- Compact <30-acre site footprint
- Separated Nuclear and Conventional Islands
- All safety-related systems underground
- Optimized for minimum staff and O&M
- Water- or air-cooled condenser option
- “Island Mode” and load following operation
- Smaller Emergency Planning Zone
**mPower Nuclear Island Features**

**Fully underground**
- Protected from external threats
- Enables security-informed architecture
- More efficient seismic design
- Robust containment, with space for O&M

**“Passive safety” design**
- No safety-related emergency AC power
- 72-hour safety-related control/monitoring battery
- No shared active safety systems between units
- Passive protection for 14 days under station blackout
- Simple, with no sprays, sumps, or recirculation
- Multi-layered defense-in-depth for $\sim 10^{-8}$ CDF

**Enhanced spent fuel pool configuration**
- Underground, inside reactor building
- Large heat sink with 30-day water inventory

“Simple and robust” architecture lowers cost and risk, enhances licensing
**Full protection against “Fukushima-type” Events**

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<tr>
<th>Threats</th>
<th>mPower Design Features</th>
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<tr>
<td>Earthquakes and Floods</td>
<td>• Seismic attenuation&lt;br&gt;• “Water-tight” and isolated from environment</td>
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<td>Loss of Offsite Power</td>
<td>• Passively safe safety-systems&lt;br&gt;• Defense-in-depth eliminates “cliff edge”</td>
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<td>Station Blackout</td>
<td>• 72-hour safety-related DC power supply&lt;br&gt;• Robust 14-day extended plant passive protection</td>
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<td>Emergency Core Cooling</td>
<td>• Gravity, not pumps deliver cooling&lt;br&gt;• Slow postulated accident progression</td>
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<td>Containment Integrity</td>
<td>• Passive hydrogen recombiners&lt;br&gt;• Internal long-term cooling source</td>
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<td>Spent Fuel Cooling</td>
<td>• Underground, protected structure&lt;br&gt;• Large 30-day passive heat sink</td>
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**Multi-layer defense ... mitigates extreme beyond-design basis challenges**
Competitive Levelized Cost of Electricity (LCOE)

Minimize Overnight Cost
- Optimum power output (180 MWe)
- Simple standard plant layout and design
- Competitive global supply chain
- Innovative modularization
- Short construction schedule (3 years)
- $5000/kW for 360 MWe greenfield plant

Optimize Operating Costs
- “Plug and Play” design levers existing infrastructure
- 80% reduction in security staff with normal DBTs
- 3 licensed operators/shift for “two-pack”
- Fleet O&M support enabled by standardization
- DCWG approach with IAC for utility-centric design

Typical North American LCOE Comparison

Key Assumptions:
- Fuel range = $4.00 - $10.00/MMBtu (NG); $2.20/MMBtu (Coal)
- CO2 price range = $0 - $30/ton
- Capacity factor = 92% (Large Nuclear and Coal); 95% (SMR)
- CCGT: 85% (Base Load); 40-60% (Intermediate Load)
- CAPEX range = $4600 - $6000/kW (Large Nuclear)

Competitive LCOE range: $82-97/MWh
Plant Systems and Components Test Program

- Production-representative Main Control Room
- Early risk reduction on advanced plant control architecture
- Supports mPower simulator and testing facilities
Active NRC Pre-Application Engagement
Licensing Process Supporting 2014 DCA, 2015 CPA Schedules

- Monthly meetings, weekly interaction
- 20 + Topical (LTR) and Technical Reports
- Technical approach to Security, Source Term
- No regulatory changes required

Coordinated Part 50/Part 52 Process: One Design, One Review


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2012: Prep DCD
2013: Prep CPA
2014: NRC Review/Rule
2015: Design Cert
2016: CP
2017: Prep OLA
2018: NRC Review/Hrng
2019: OL
2020: OL
2021: OL
2022: OL
DOE selects mPower America Project

- Demonstrates SMR innovation....near-term
- Teams B&W, TVA, Bechtel, and DOE
- 2x180MWe mPower units at Clinch River, TN
- Commercial Operation date targeted 2022
- Includes design and licensing of mPower SMR
- DOE Cooperative Agreement in March 2013
TVA Clinch River Project

**Construction Work Contracted:**
- Geological Surveys (site borings)
- Environmental Reviews
- Site-specific Conceptual Designs
- Preliminary Safety Evaluation (PSAR)

**mPower America Project:**
- ✓ Construction Permitting started 2013
- Manufacturing start target 2015
- Construction start target 2017
- Reactor Modules ready by 2019
- Commercial Operation (COD) by 2022
mPower Value Proposition

• Near-term (2020) regulatory response option
  ▪ Addresses tightening environmental constraints (CSAPR, MATS)
  ▪ Hedges against mid-term GHG “carbon tax” uncertainty
• Portfolio “balancing” opposite natural gas build-out
  ▪ Environmentally clean, stable fuel cost, dispatchable generation
• Competitive “utility scale” power plant economics
  ▪ $5000/kW ONC equivalent or better than GW-class options
  ▪ Acceptable $82-97/MWh LCOE from low security and plant staffing
• Reasonable ($1.8B) investment and project risk
  ▪ Incremental investment for incremental generation (360 MWe)
  ▪ ~70% factory and off-site construction supporting 3-year schedule
• Low-risk technology and infrastructure for ~2020 COD
  ▪ NSSS 60% complete, DCA pre-application licensing underway
  ▪ Existing North American reactor manufacturing capability