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ANS / DC Chapter Presentation

T. J. Kim

B&W Nuclear Energy

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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

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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

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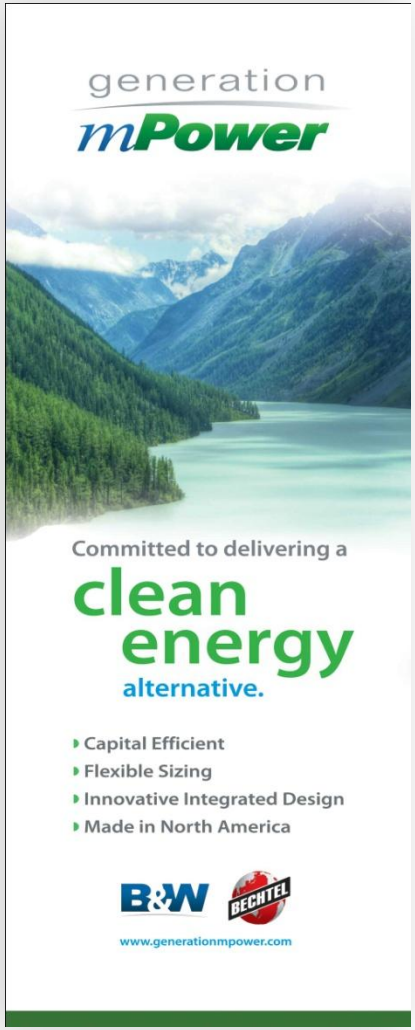
- Formal alliance between B&W NE and Bechtel Power Corp
  - Executed July 14, 2010
  - Substantial commitment by B&W and Bechtel
- Recognized and established energy industry leaders
- Bechtel backed by:
  - 60 years of nuclear power industry experience
  - Integrated engineering and project management 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'

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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

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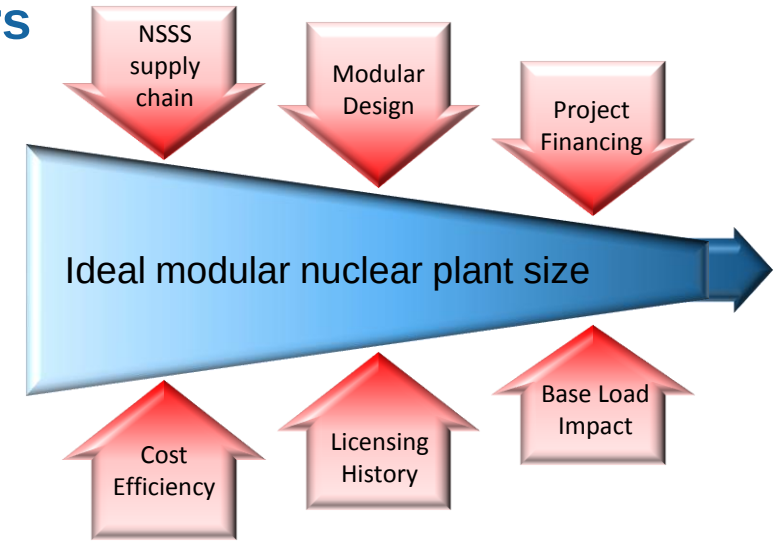
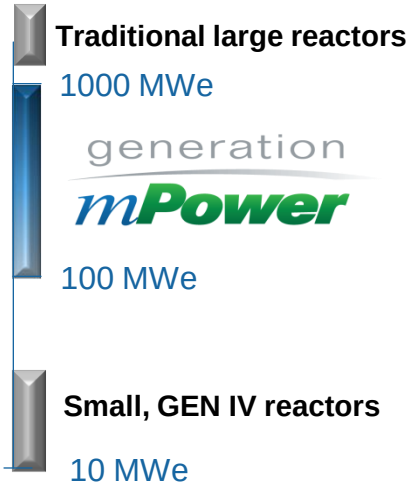
A Shifting Nuclear Landscape

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 …

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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

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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

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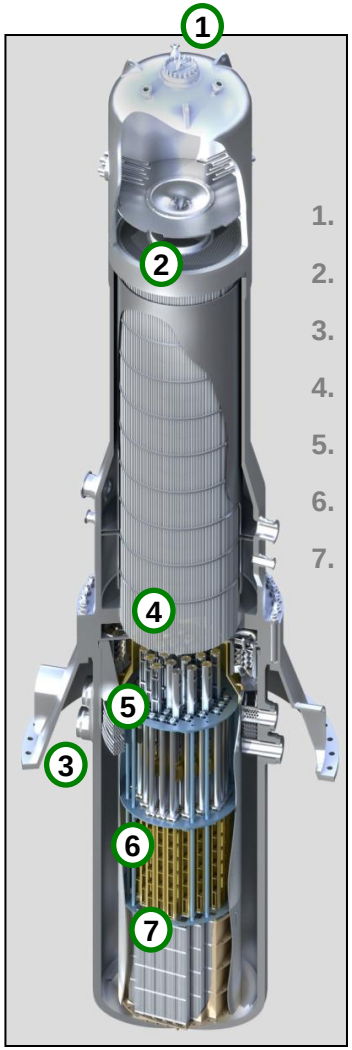
A Generation III^{++} Reactor

- 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



1. Upper Vessel Head
2. Steam Generator
3. Electro-Mechanical CRDs
4. Reactor Internal Pumps
5. Hydraulic CRDs
6. Upper Internals
7. Core

Modular ALWR with best of Generation III^{+} features … low risk, low cost and passively safe

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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

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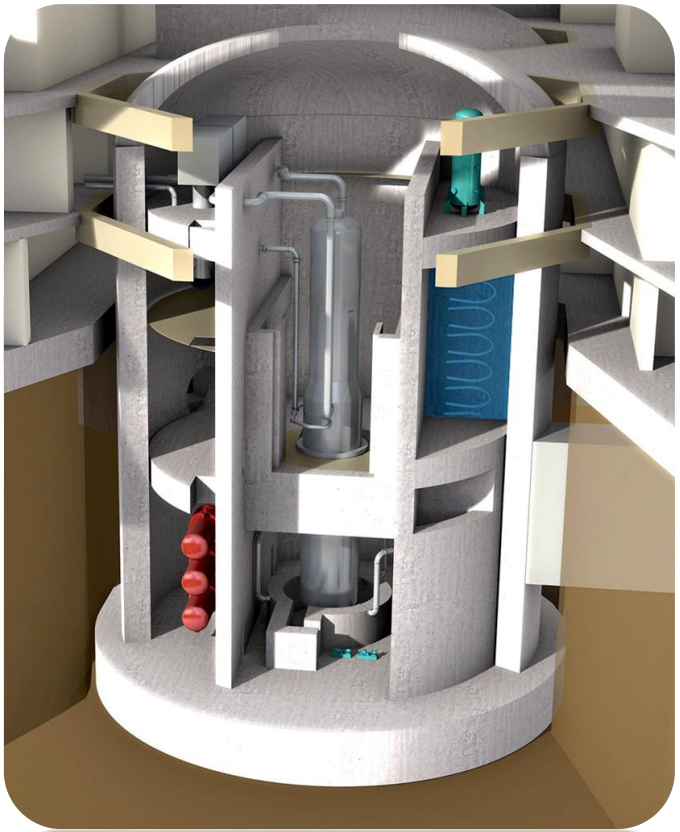
B&W mPower Containment Requirements

- 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



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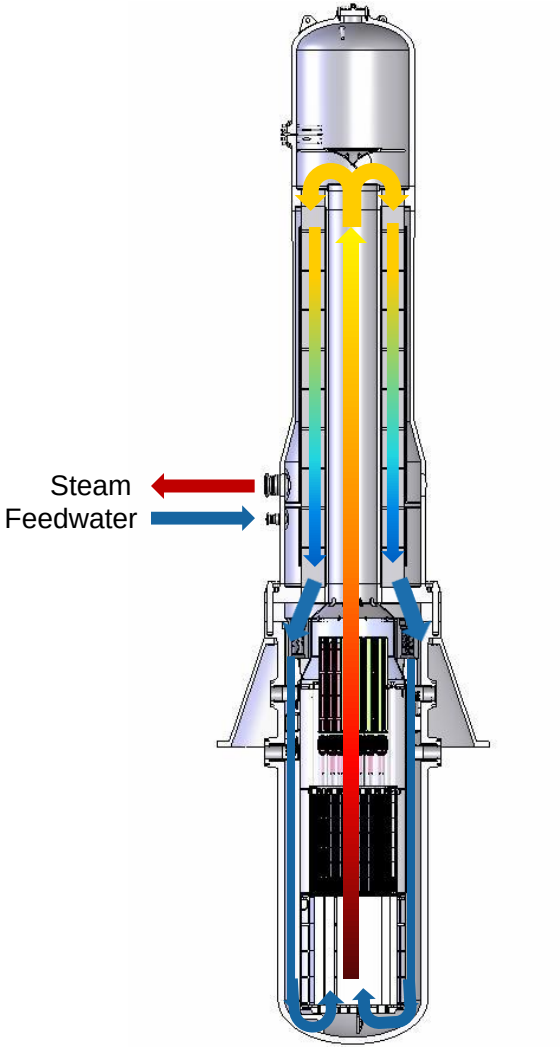

B&W mPower Integral Reactor Design

- 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

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

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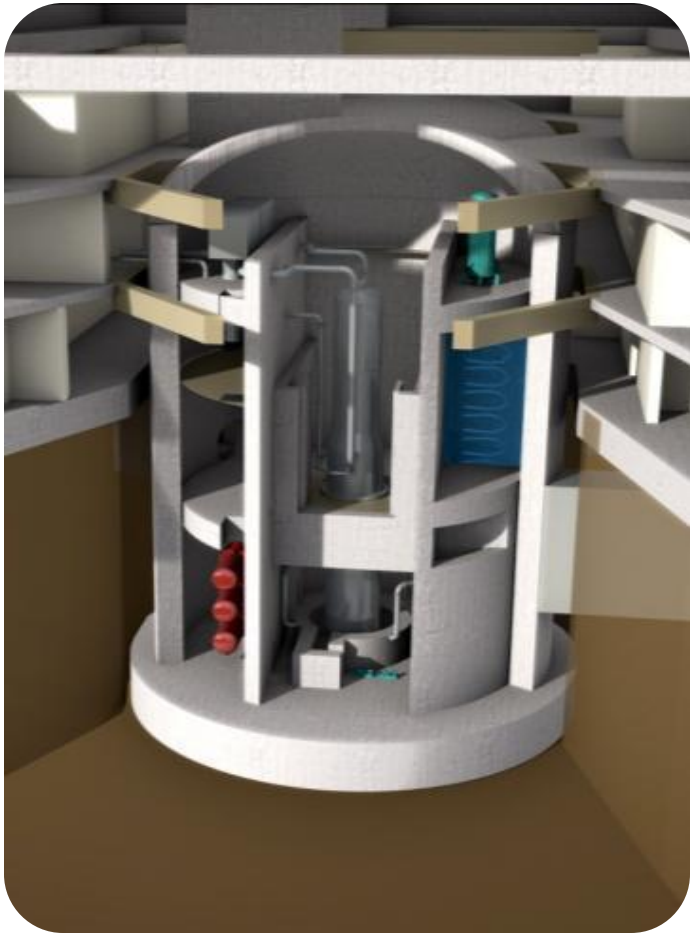
Nuclear Island Features

- 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

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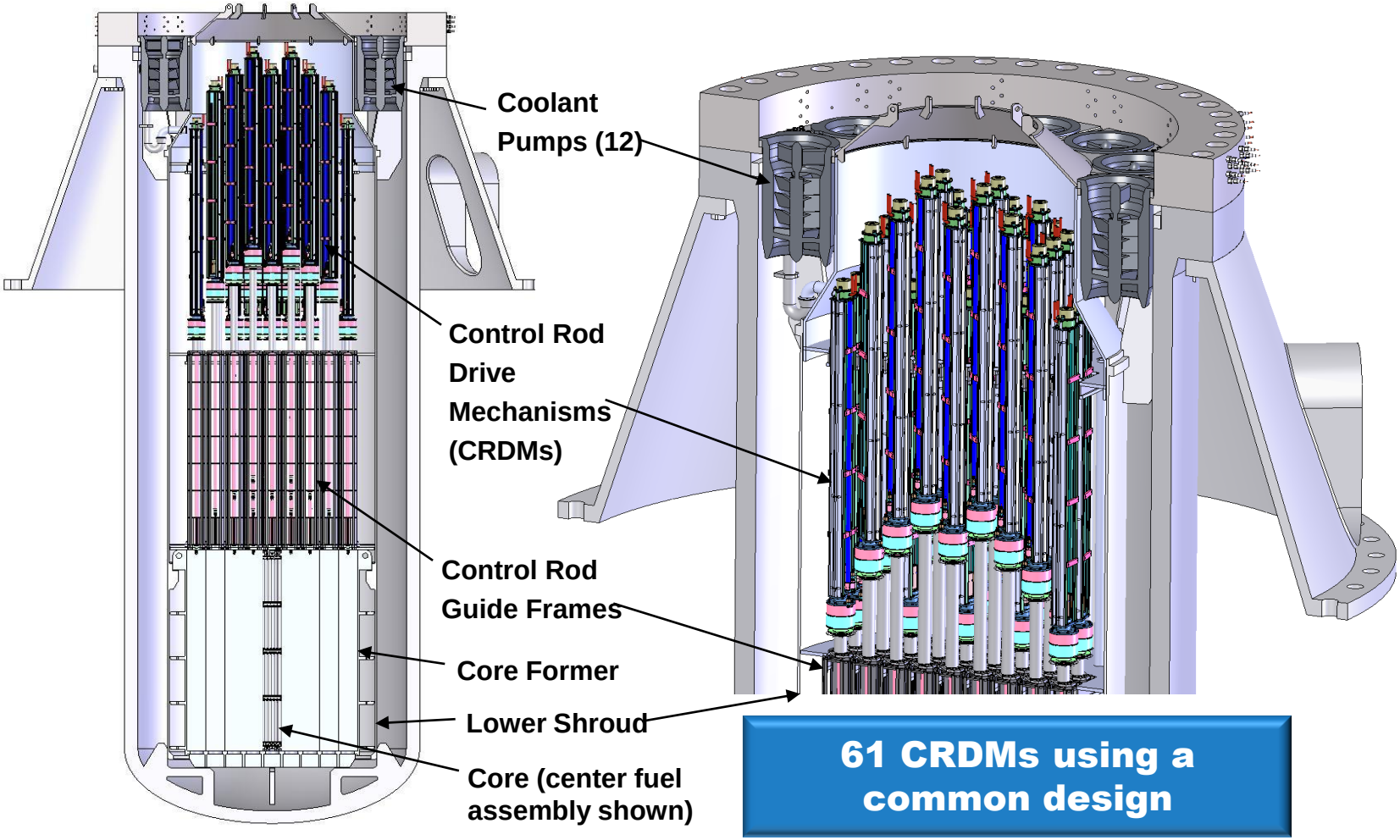
Lower Reactor Assembly



61 CRDMs using a common design

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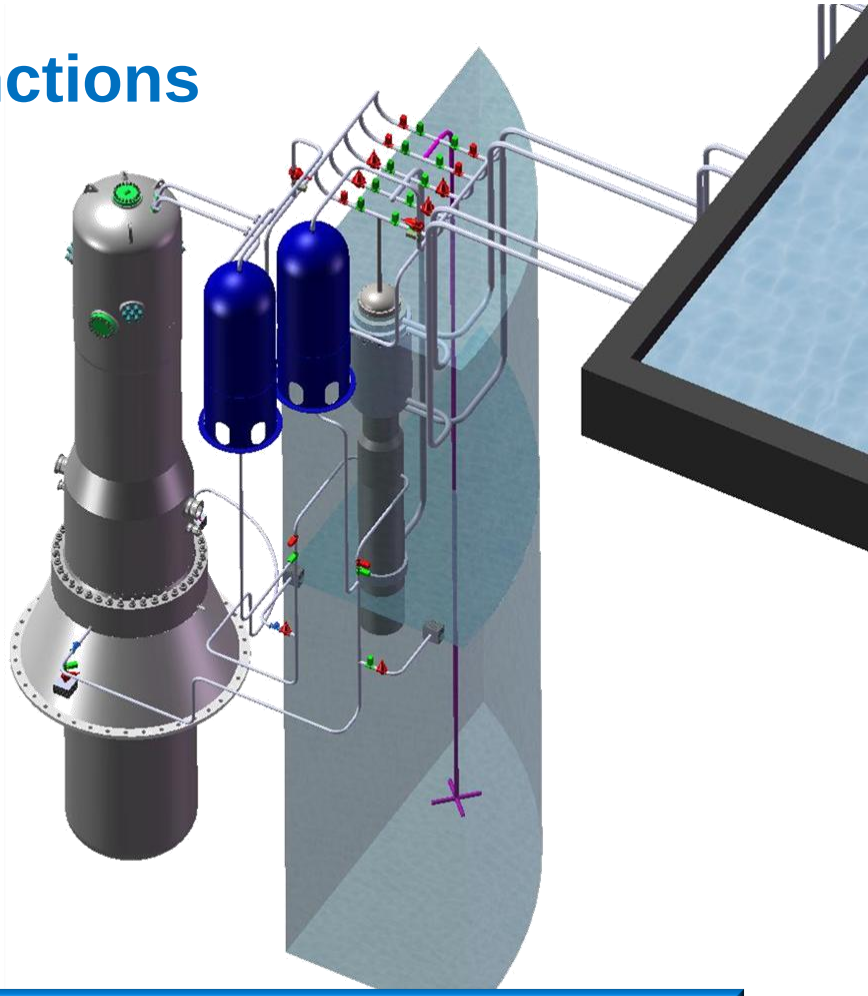
Engineered Safety System Functions

- **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)

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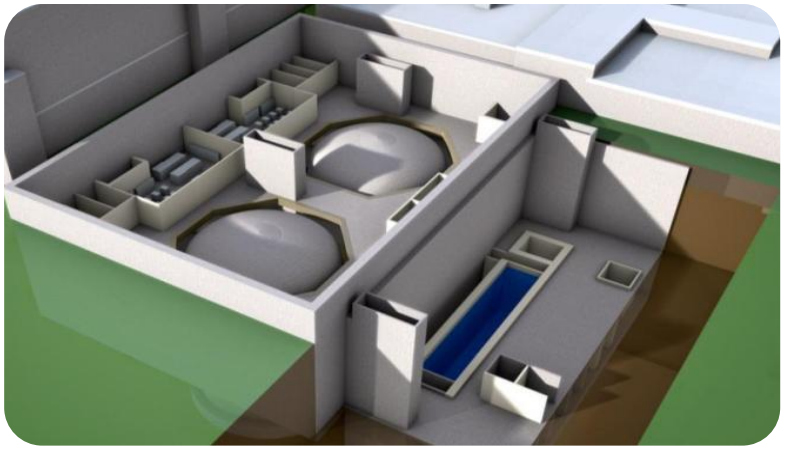
Scalable Nuclear Plant: Practical, Affordable

- 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

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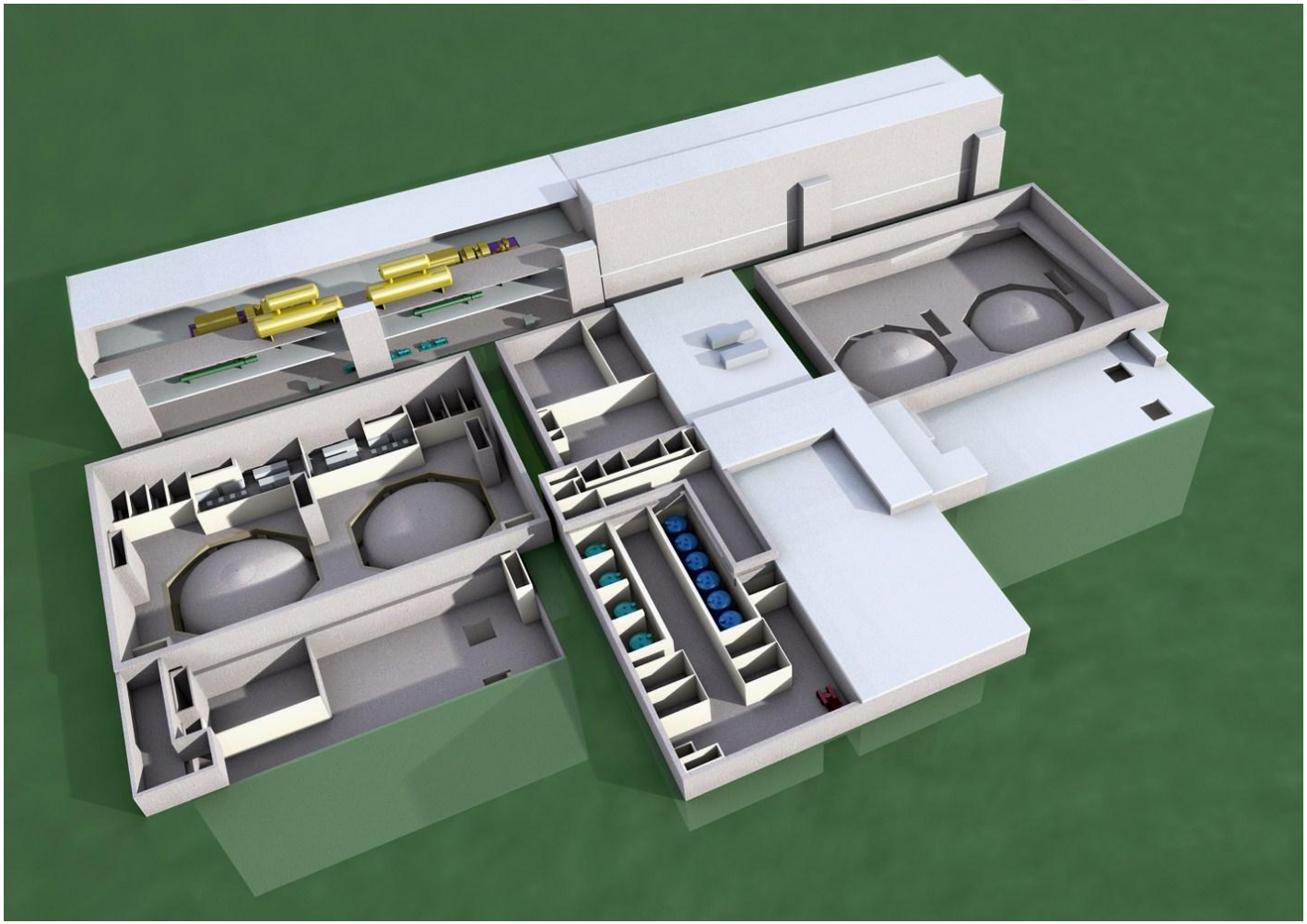
Four Reactor Plant 3D Layout



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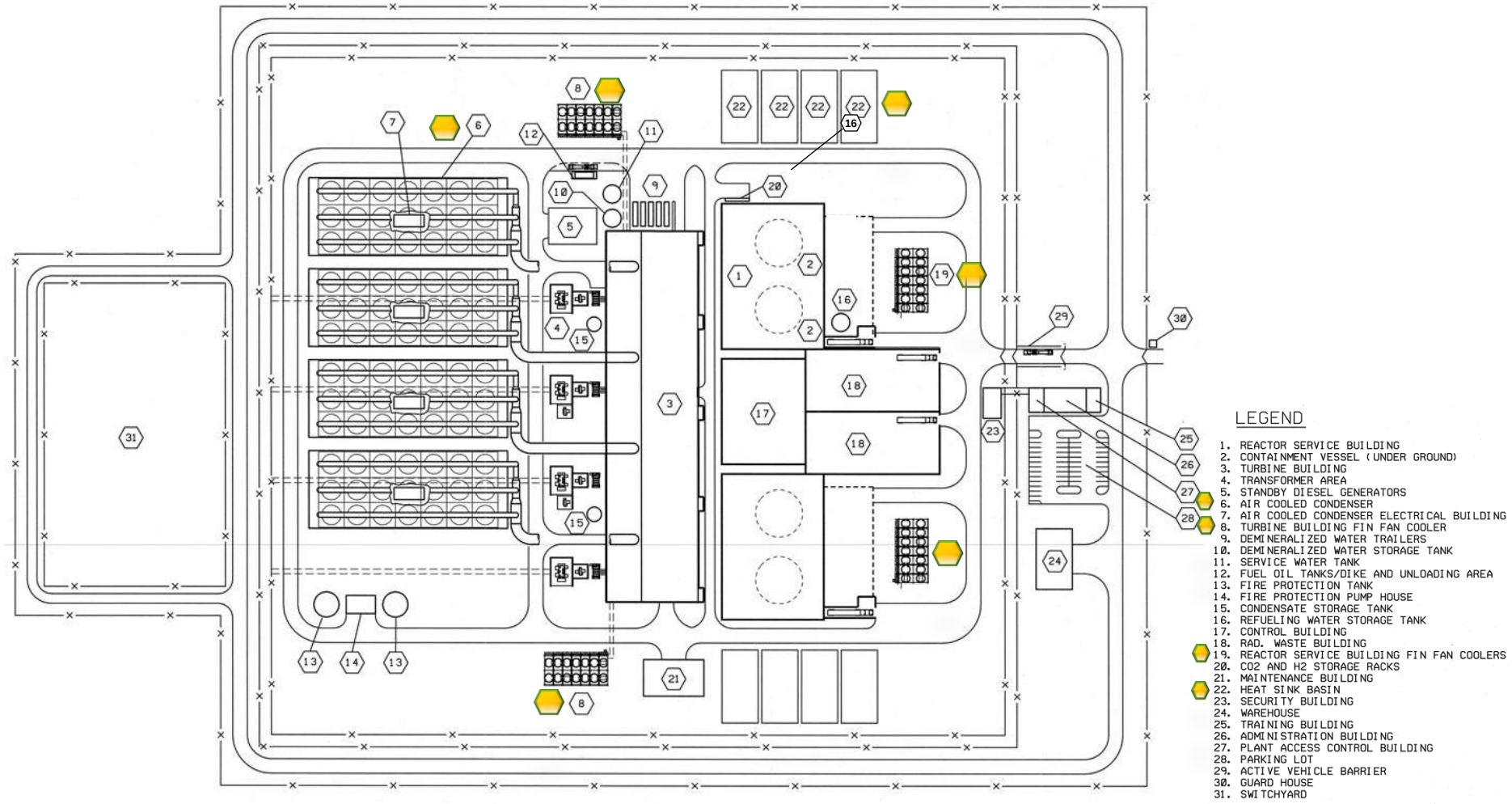
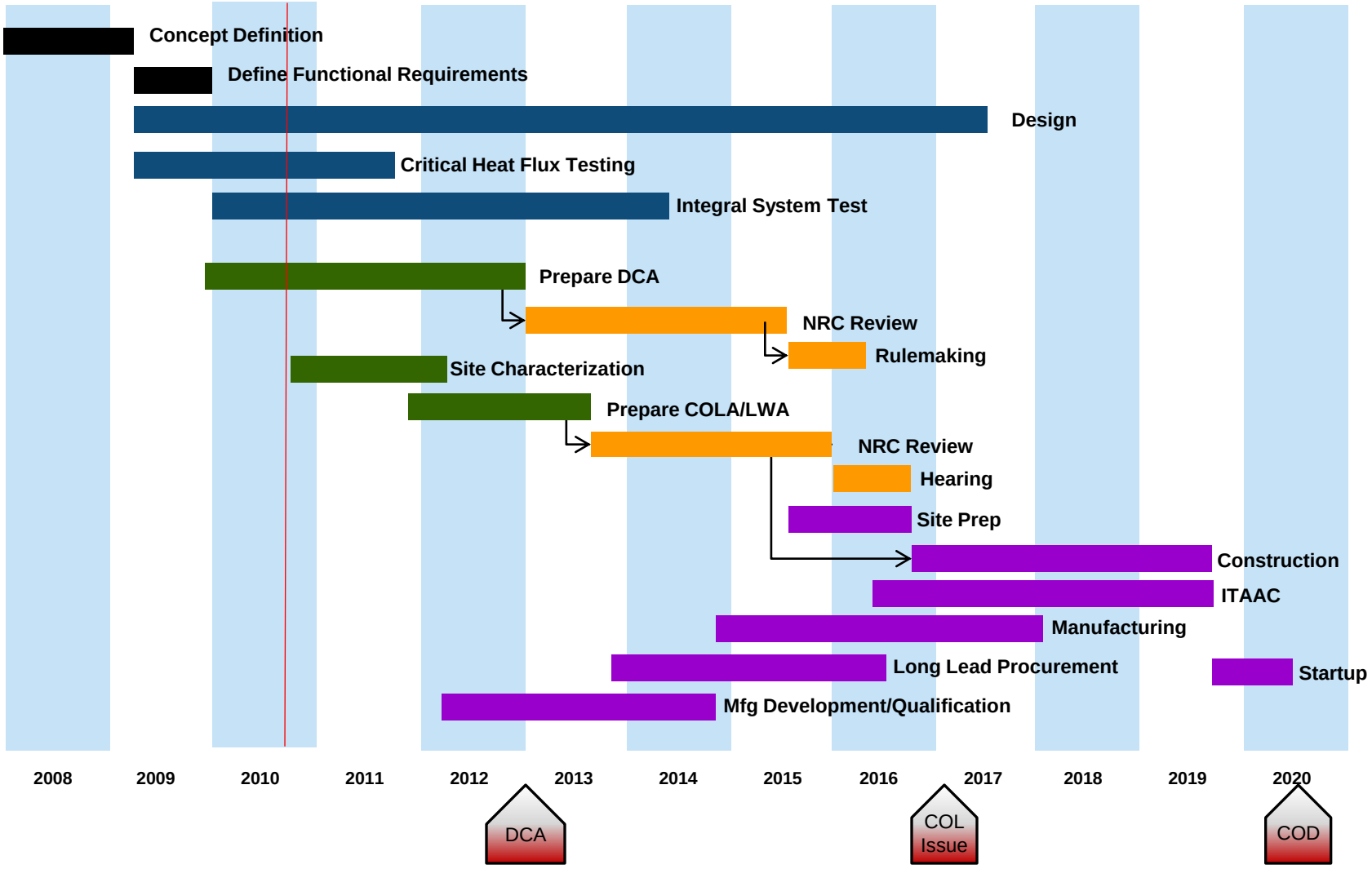
Four Reactor Plant Conceptual Layout



Generation mPower Lead Plant Baseline Schedule

Part 52 Process



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

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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

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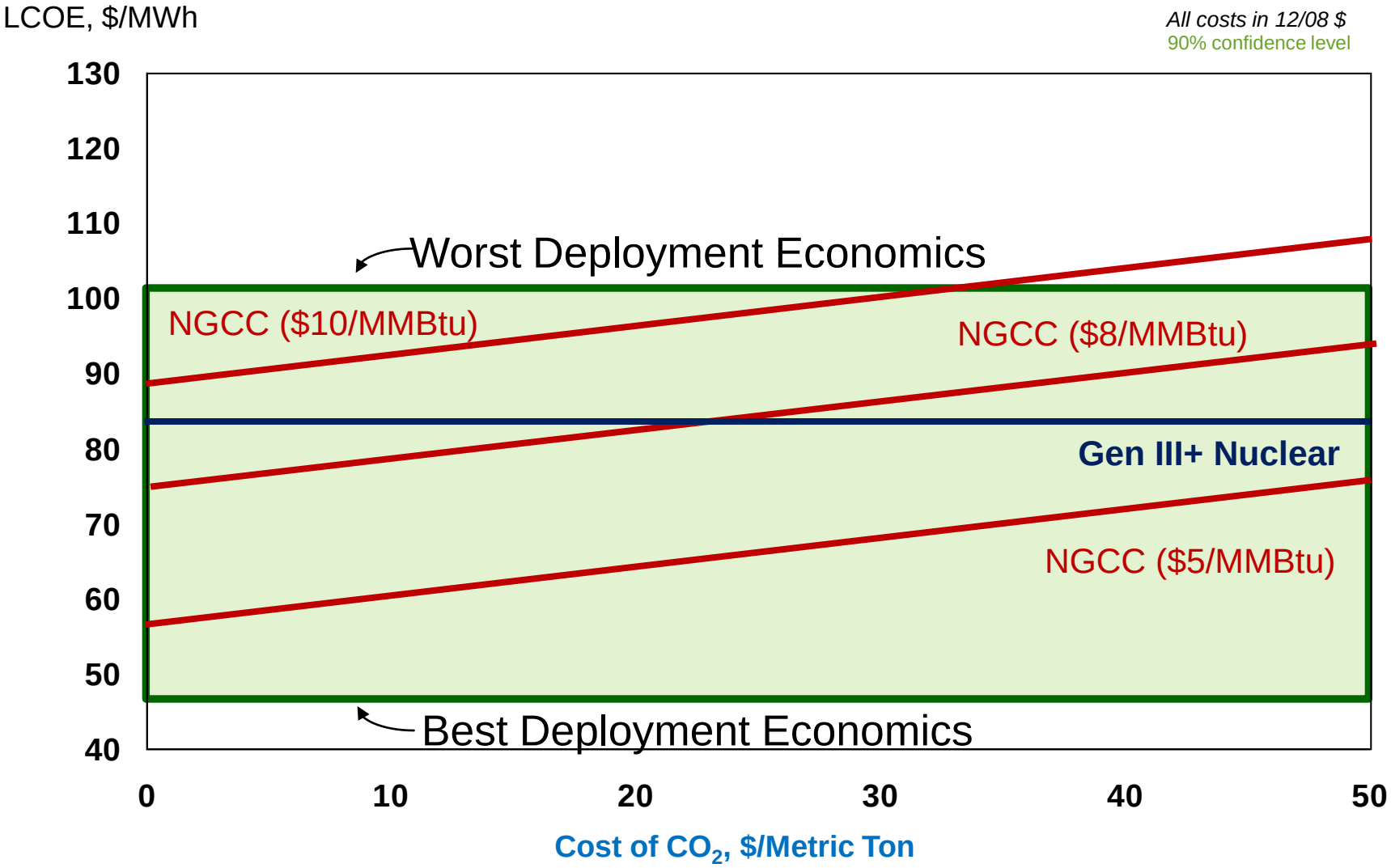
Summary

- 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



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Questions?