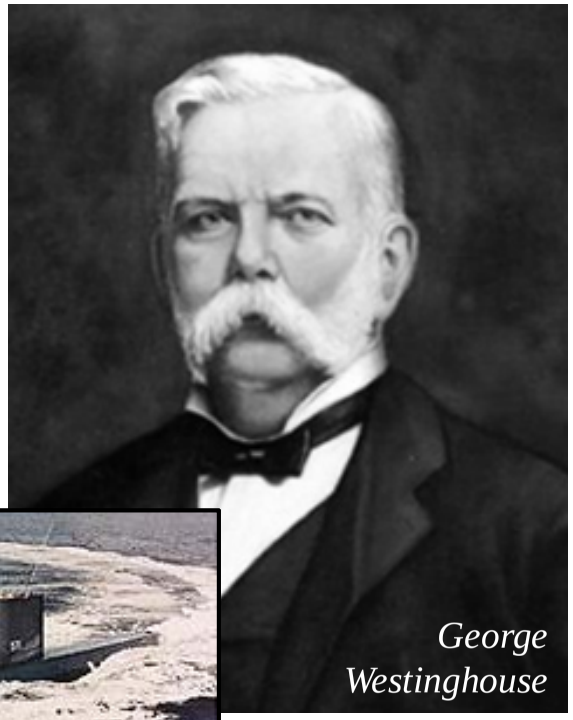
AP1000™ Technology: Passive & Proven
The Right Fit for Brazil

Jeff Benjamin
Senior Vice President
Nuclear Power Plants (NPP)

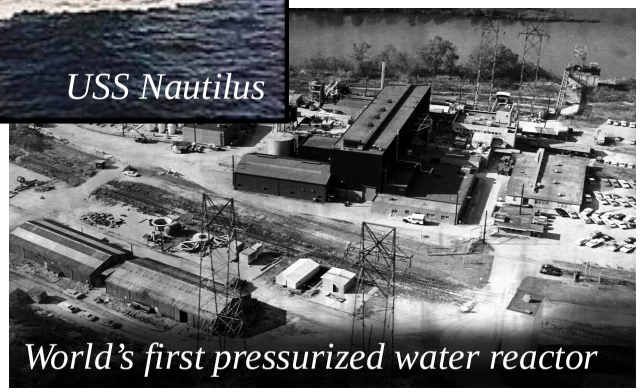
Westinghouse Electric Company

- Incorporated in 1886 by George Westinghouse
- Responsible for some of the world's most important achievements:
  - AC technology
  - 1st commercial radio broadcast
  - USS Nautilus
  - 1st camera on the moon
  - **Commercial nuclear power**

Vision: to be the customers' choice in supplying leading-edge nuclear technology to satisfy the world's growing demand for energy


George Westinghouse


USS Nautilus


World's first pressurized water reactor

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Solely Focused on Commercial Nuclear Technology

*Nearly **50 percent** of the nuclear power plants in operation worldwide are based on Westinghouse technology*

- Our newest design – the AP1000® pressurized water reactor (PWR) – features innovative passive safety systems and proven technologies based on Westinghouse's 50+ years of experience

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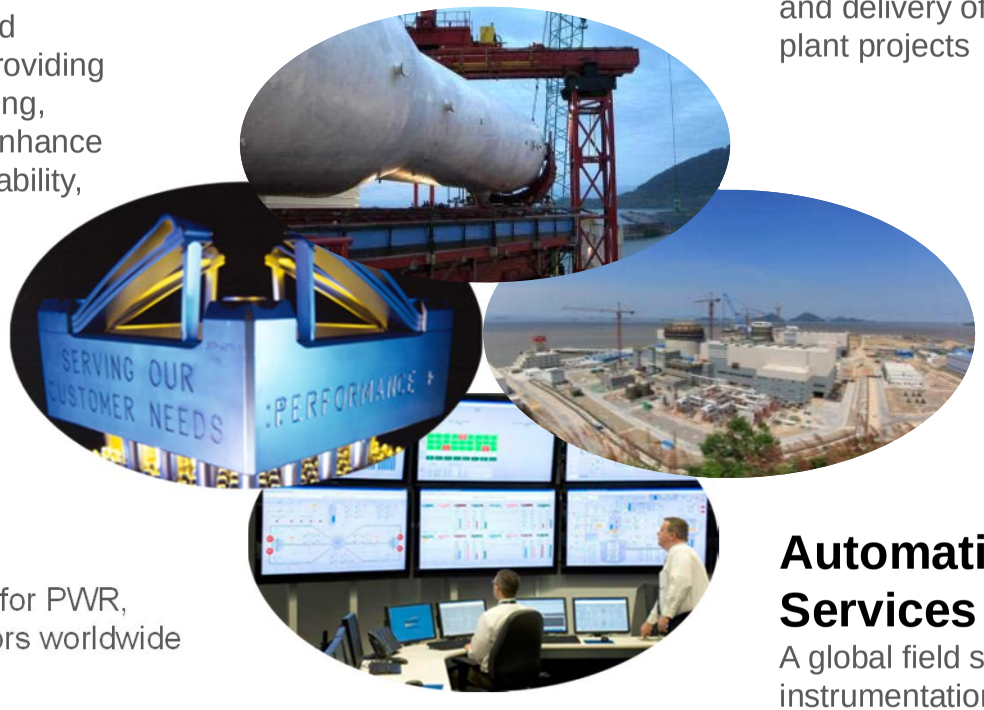
Westinghouse Electric Company Business Structure

Engineering, Equipment and Major Projects

Focused on ensuring new and operating plant success by providing technically superior engineering, hardware and services that enhance plant safety, ensure plant reliability, extend plant life and improve plant performance

Nuclear Power Plants

Specializing in the development and delivery of new nuclear power plant projects



Nuclear Fuel

A single-source fuel provider for PWR, BWR, VVER and AGR reactors worldwide

Automation and Field Services

A global field services and instrumentation and control solutions provider, focused on delivering industry-leading operations solutions and better outage services worldwide

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Westinghouse Locations

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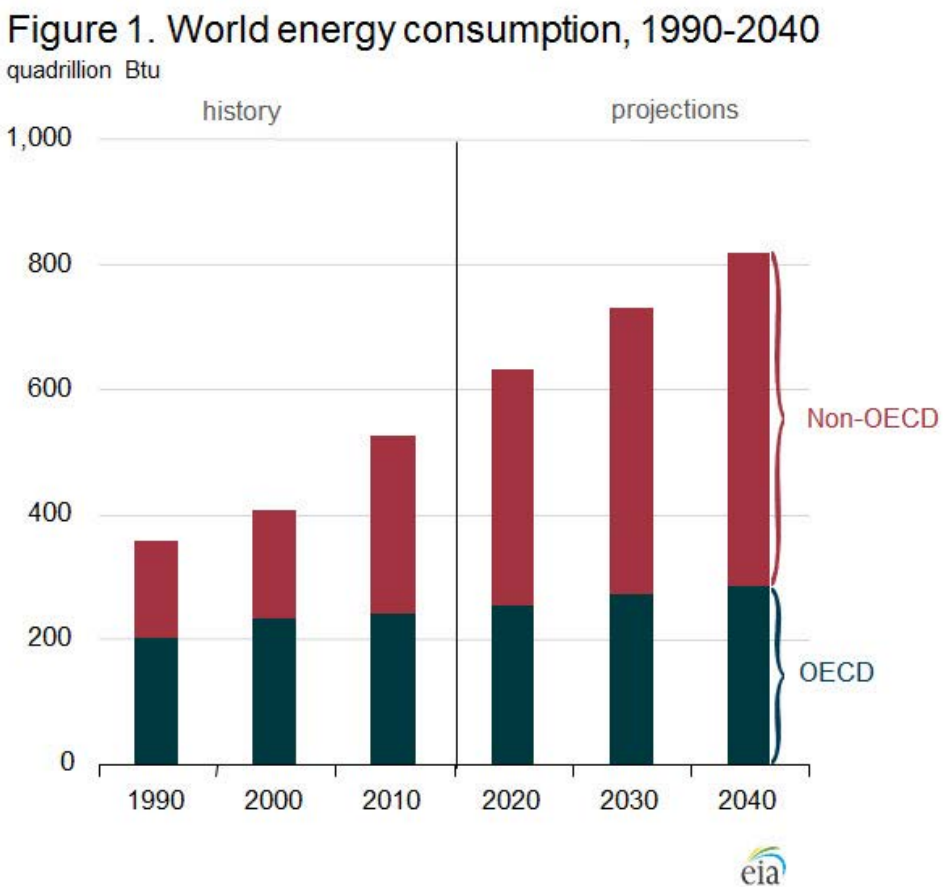
60+ Sites Worldwide!

World Energy Demand Is Growing

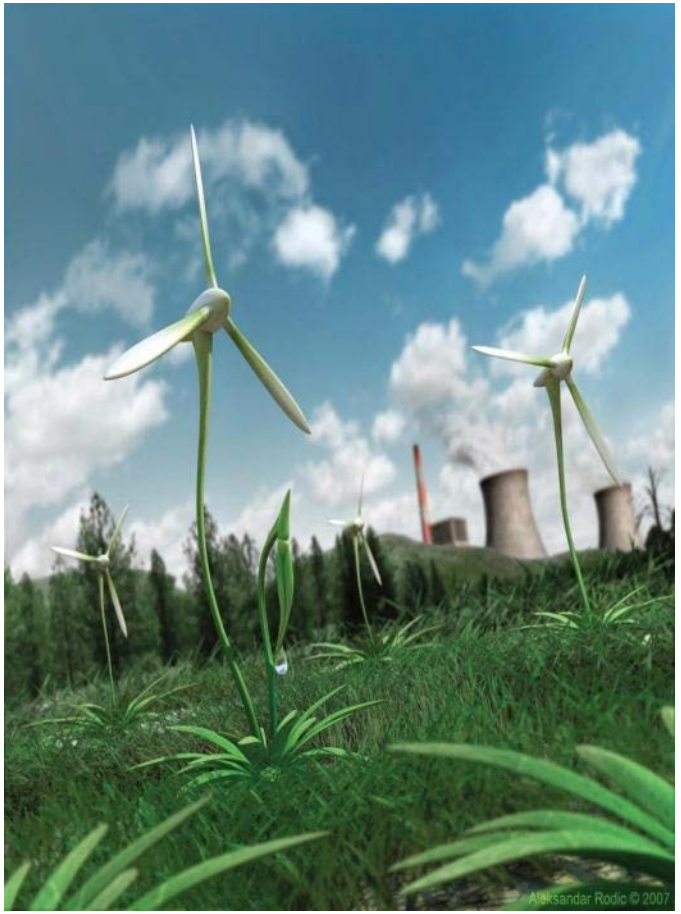
- World population will increase 14 percent in the next 12 years
- Rising energy demand from economic output and improved standards of living will strain energy supplies
- World energy consumption is projected to grow 56% between 2010 and 2040



Source: U.S. Energy Information Administration, July 2013

Critical Decisions Must Be Made

- We need to address growing energy needs with environmentally responsible energy solutions that benefit our communities
- Multiple ways to achieve these goals:
  - Conservation
  - Balanced portfolio of “clean” energy technologies
  - Deployment of vehicles powered from clean energy sources



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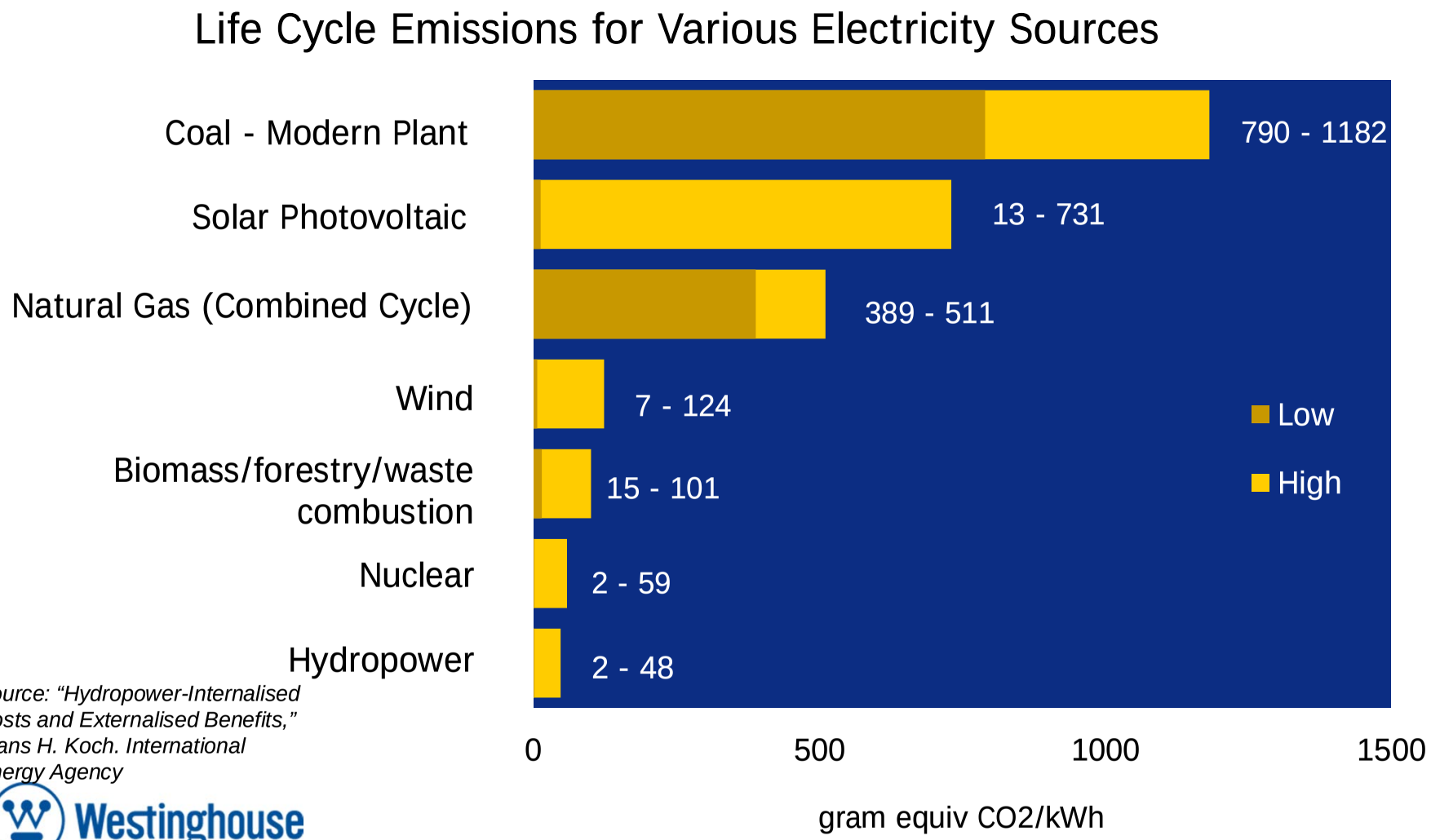
Nuclear Energy Has an Environmental Impact Comparable to Renewables



Source: "Hydropower-Internalised Costs and Externalised Benefits," Frans H. Koch. International Energy Agency

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For a Number of Reasons…

Nuclear energy MUST be part of the future energy landscape

- Increasing energy demand
- Climate change
- Security of supply
- High-paying jobs
- Economic value for communities

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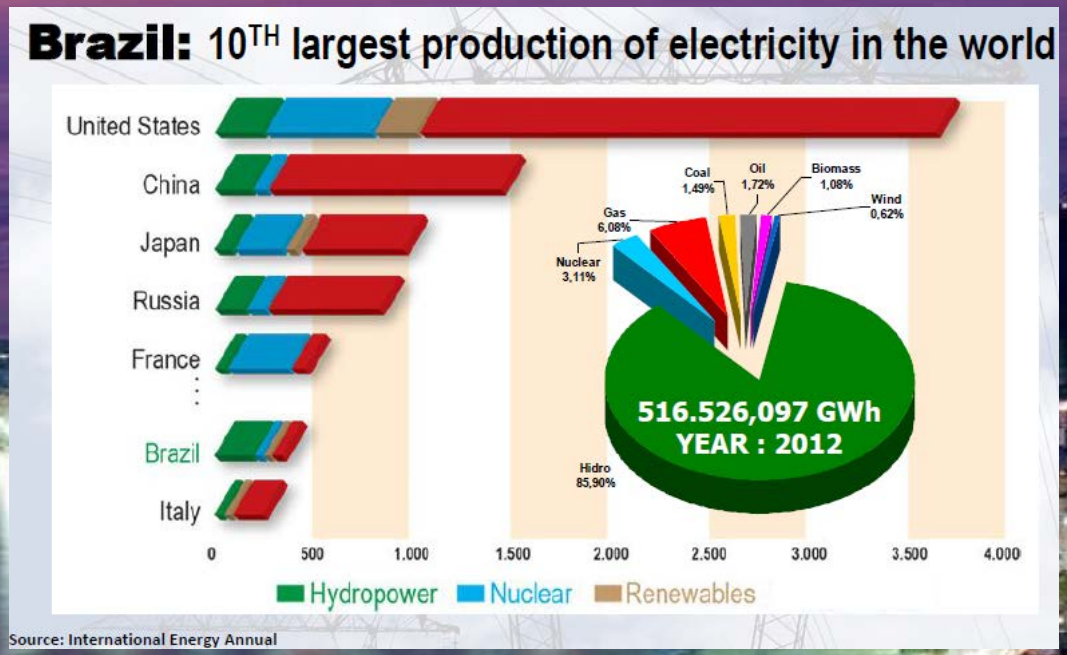
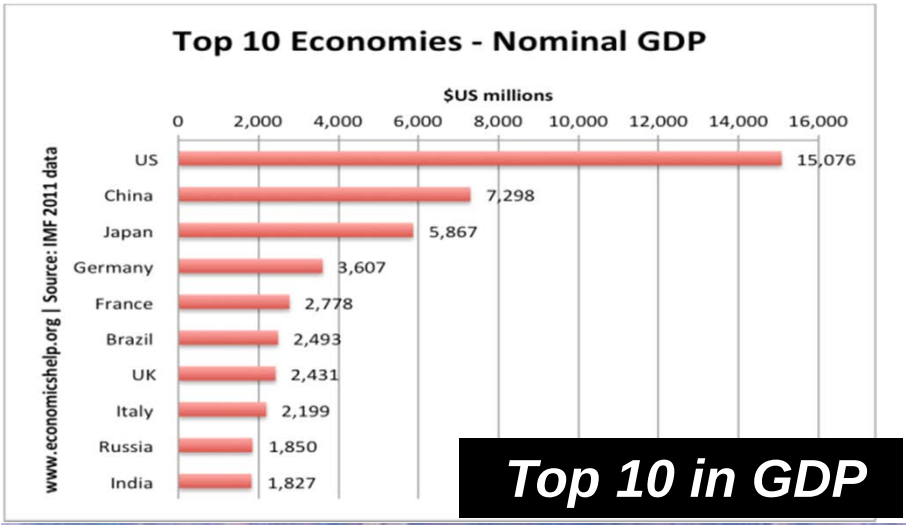
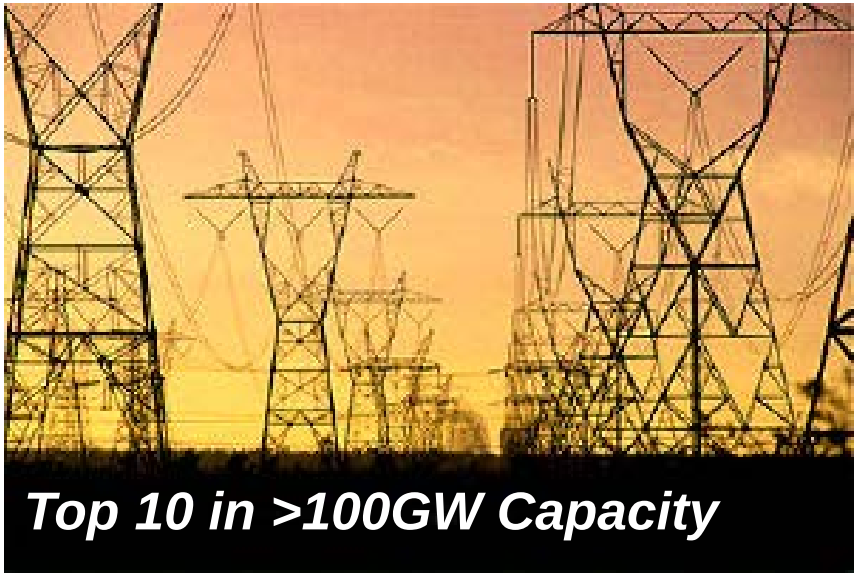
Brazil's Unique Position in the World Today

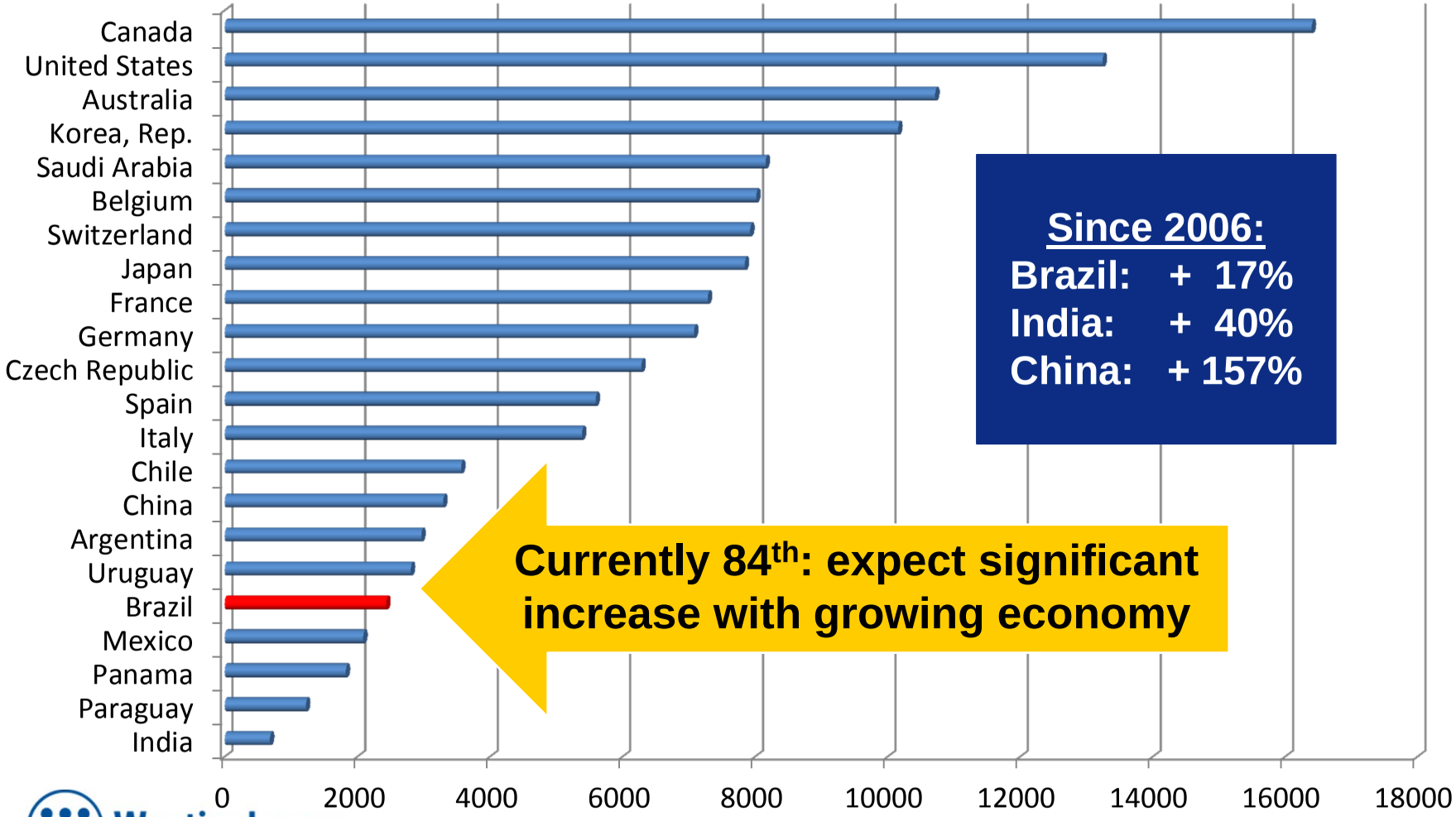


Brazil's Unique Position in the World Today





Electric Energy Consumption (kWh per Capita)



Source: World Bank 2011

Brazil's Rich and Diversified Energy Reserves

Hydro

100 yrs: 76.948

Wind

100 yrs: 19.102

Biomass

100 yrs: 122.040

Estimated National Energy Reserves
(equivalent in millions of barrels of oil)

Coal

63.560

Uranium

55.633

Oil

16.453

Natural Gas

3.249

Source: BEN 2007 (Note: does not account for recent O&G discoveries offshore)

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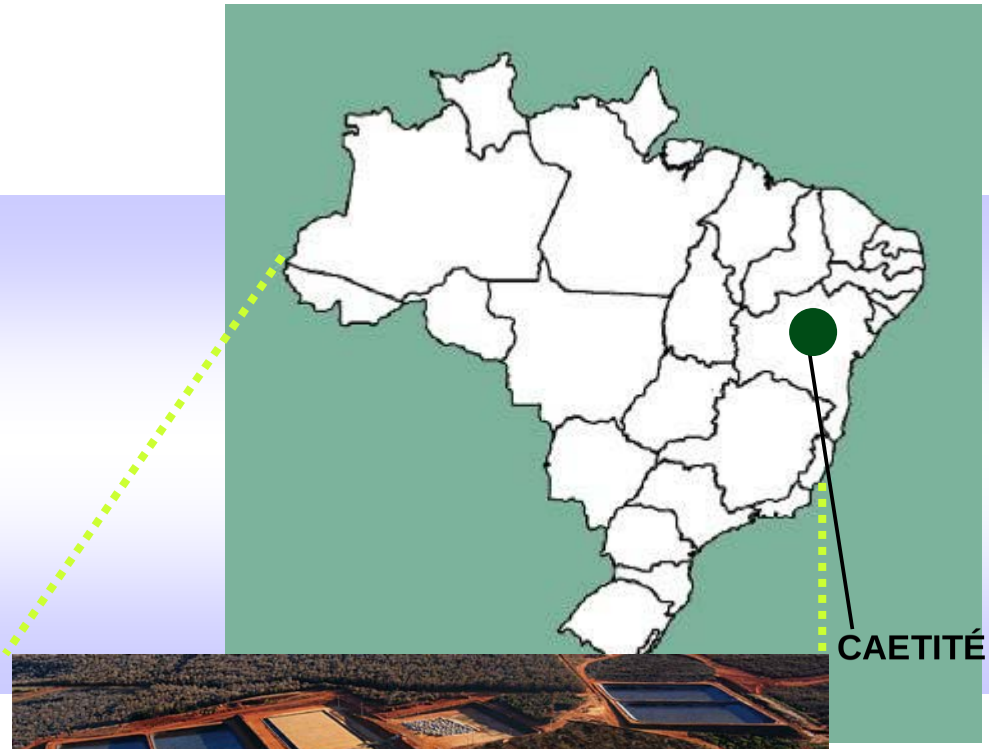
Uranium Resources in Brazil

Today's capability: > 300 million tons de U3O8

6th Reserve in the World

- with only 30% of the national territory explored
- allows for availability of material and stability of fuel prices
- existing capability of fuel technology



Estimate:
>800 million tons

Source: BEN 2007

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Fuel Cycle Technology Established and Growing

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Source: Industrias Nucleares do Brasil

Mature Nuclear Energy Generation Experience

Generation through 2012: 198.490.932 MWh

Generation record 2012: 16 TWh

2nd Best Availability Factor in the World in 2011

Angra 1&2 : 95.7%

Sustainability of Brazilian Nuclear Industry

- Brazil has Competitive Edge for Supporting New Build
  - Capable, recognized nuclear operator
  - Fuel Cycle Capability
  - Mature Regulatory Body
  - Nuclear Construction Experience
  - Strong Engineering & Sciences Programs
  - Experienced Supply Chain
- Demographics Challenging Industry
- New Projects Attracting Limited Amount of New Talent
- Maintaining the Key Skills Needs to be part of Debate

Scale of Industry is KEY to Sustaining Brazil Nuclear Sector

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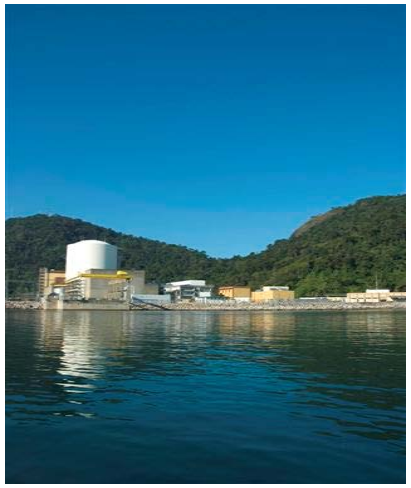
Westinghouse Presence in Brazil



Angra 1
Eletronuclear (ETN)

- Angra 1 NSSS supplied in 70's
- Operations support
- Outage support
- Codes & Methods

INB
Indústrias Nucleares do Brasil (INB)

- Provided technology for manufacturing of Angra 1 reload fuel
- Joint Development of 16x16 Next Generation Fuel Program
- Codes & Methods

A long partner with the nuclear industry in Brazil

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AP1000 Plant: Safe, Simple and Standardized

AP1000 *Plant Site at Sanmen, China*

- **Passive safety** replaces mechanical and electrical systems – harnesses natural forces like gravity, convection and condensation to achieve safe shutdown
- **Strong licensing pedigree** based on reviews in multiple countries; first and only Generation III+ reactor to receive design certification from the U.S. NRC
- **Simplified design and modular construction** provides a plant that is easier and less expensive to build, operate and maintain

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Major Safety Advancements of the **AP1000** Plant

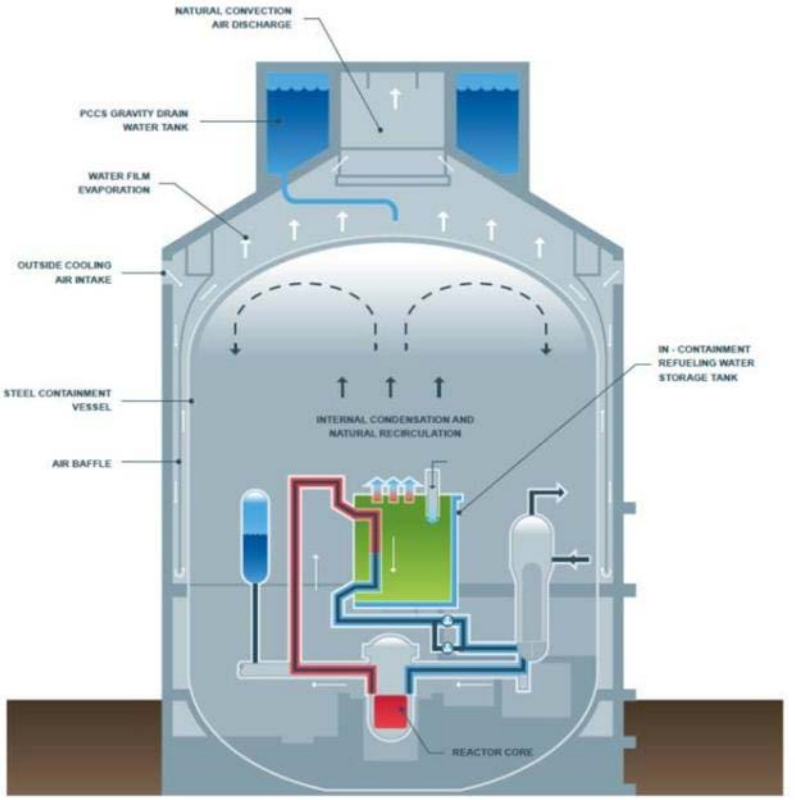
Passive Safety-Related Systems

- Use "passive" processes only, no active pumps, diesels, ….
- One-time alignment of valves
- No support systems required after actuation
- Greatly reduced dependency on operator actions

Active Defense in Depth-Related Systems

- Reliably support normal operation
- Redundant equipment powered by onsite diesels
- Minimize challenges to passive safety systems
- Not necessary to mitigate design basis accidents

- Severe accident scenario effects are mitigated by in-vessel retention of the melted fuel



All Critical Station Blackout Response Features FAIL SAFE

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Regulatory Certainty

- EUR confirms the **AP1000** plant can be **successfully deployed** in Europe (May 2007)
- **AP1000** plant amended design **unanimously approved** by NRC (December 2011)
- UK regulators grant **Interim Design Approval** (December 2011)
- China licensing activities on-track, with **Final Safety Analysis Report** (FSAR) submitted to customer (2012).
- Combined construction and operating licenses (COL) approved for **Vogtle 3&4** site (February 2012) and **V.C. Summer 2&3** site (March 2012)

Summary of Key Conclusions AP1000 Plant Response to Extreme Events

- Westinghouse assessment concluded that **AP1000** Plant maintains all safety limits
- The **AP1000** Plant passive design assures
  - Containment integrity
  - No fuel damage (both spent fuel and reactor)
  - No radiological release as a result of the event

AP1000 achieves and maintains Safe Shutdown, protects public health and safety, and prevents loss of utility investment.

[…], ***as has been pointed out to me by Japanese colleagues as they reflect upon Fukushima, had the plant been operating AP1000 reactors, it is likely that the outcome would have been very different.*** *The AP1000's passive safety systems provide the ability to maintain core cooling for at least 72 hours with little human intervention. 72 hours to make repairs, transport emergency equipment, and take other actions in response to the earthquake and tsunami that assaulted the Fukushima site would have made a very significant difference.*

US NRC Commissioner William D Magwood

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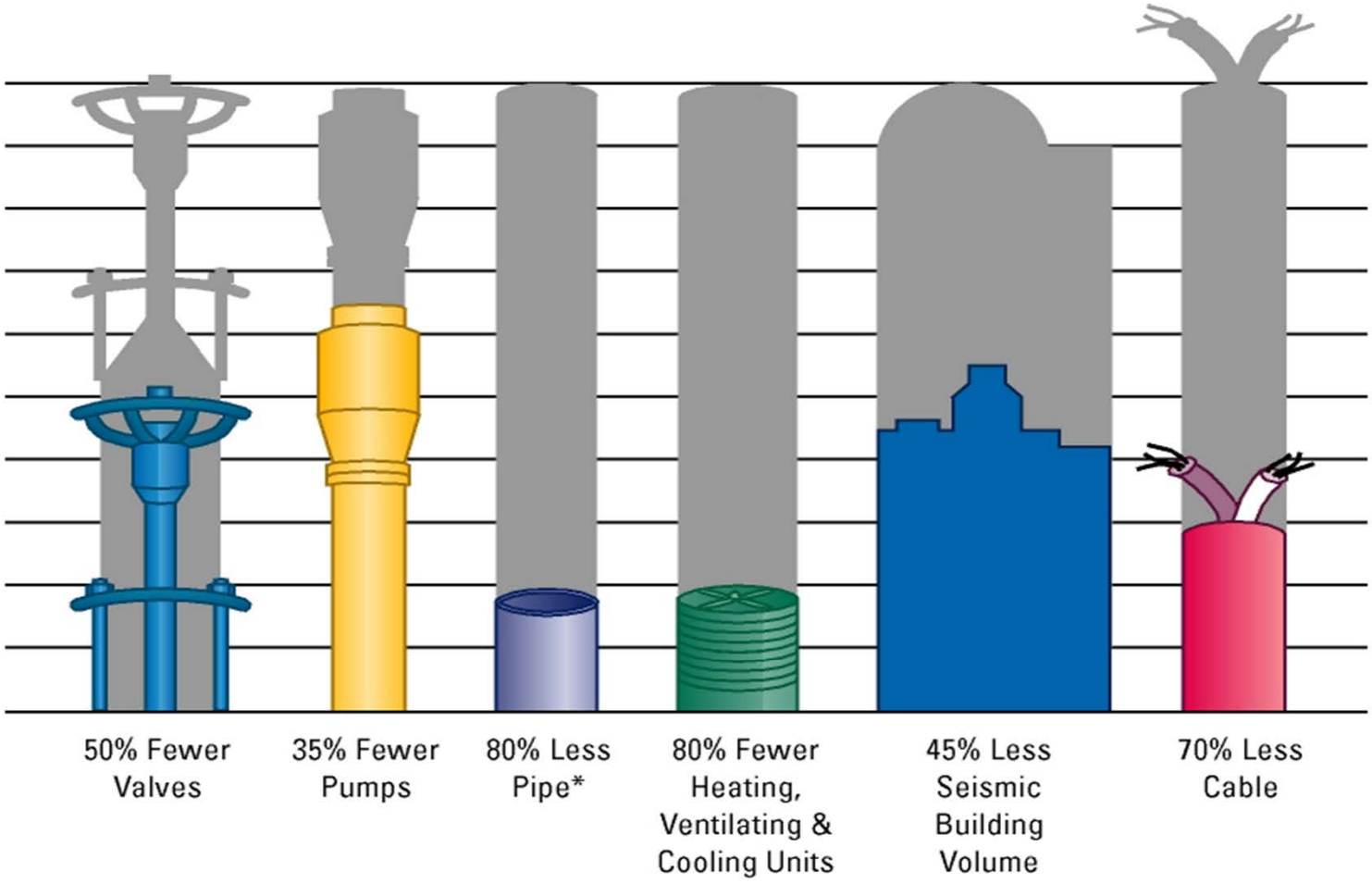
AP1000 Plant Focus on Simplicity



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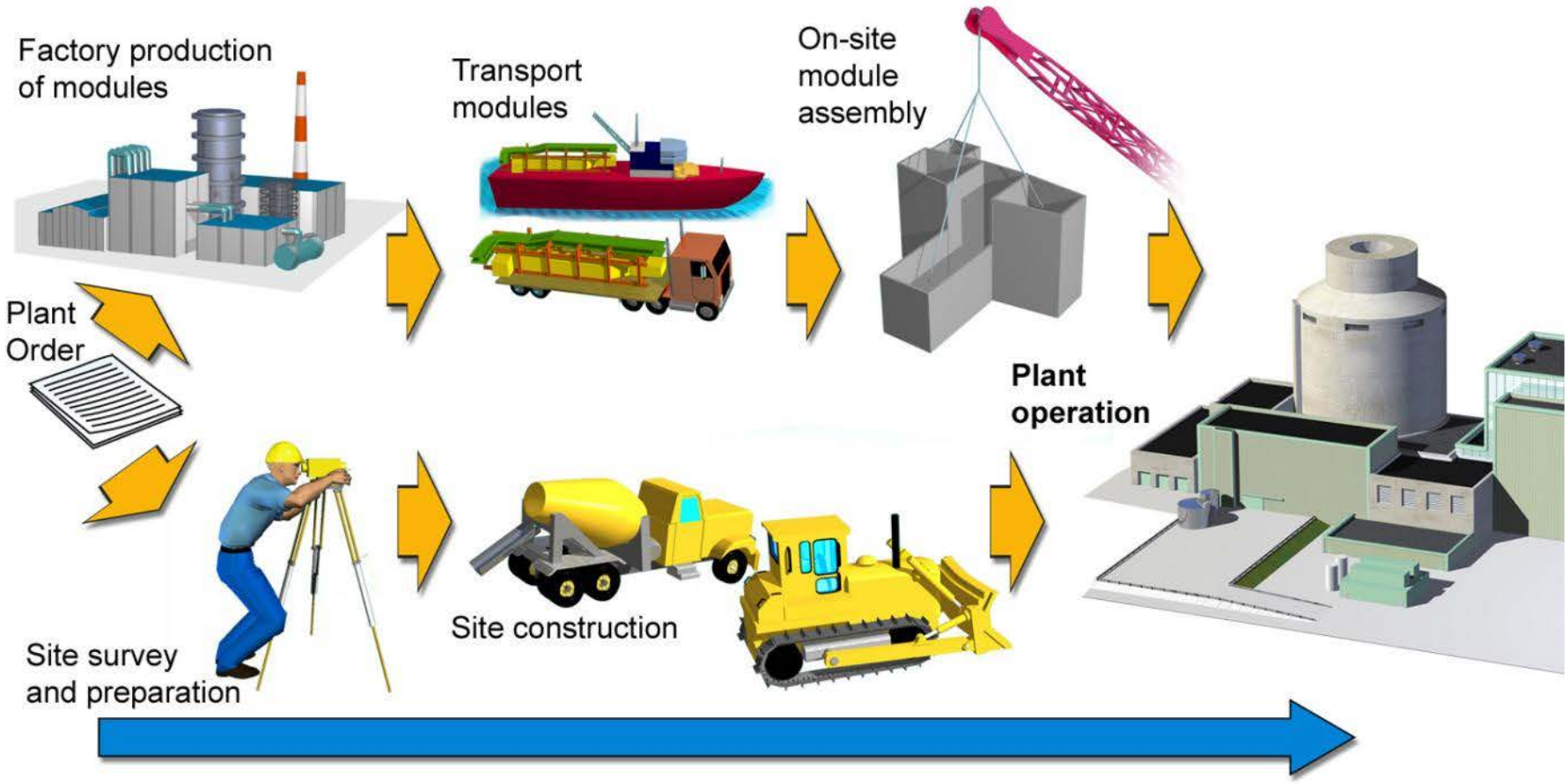
Modular Construction Allows More To Be Done in Parallel Result: Shorter Construction Schedule



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AP1000 Plant Modular Construction
An Innovative Approach Unique in our Industry

Improved Quality Control and Efficiency
Reduced Construction Schedule and Optimized Costs

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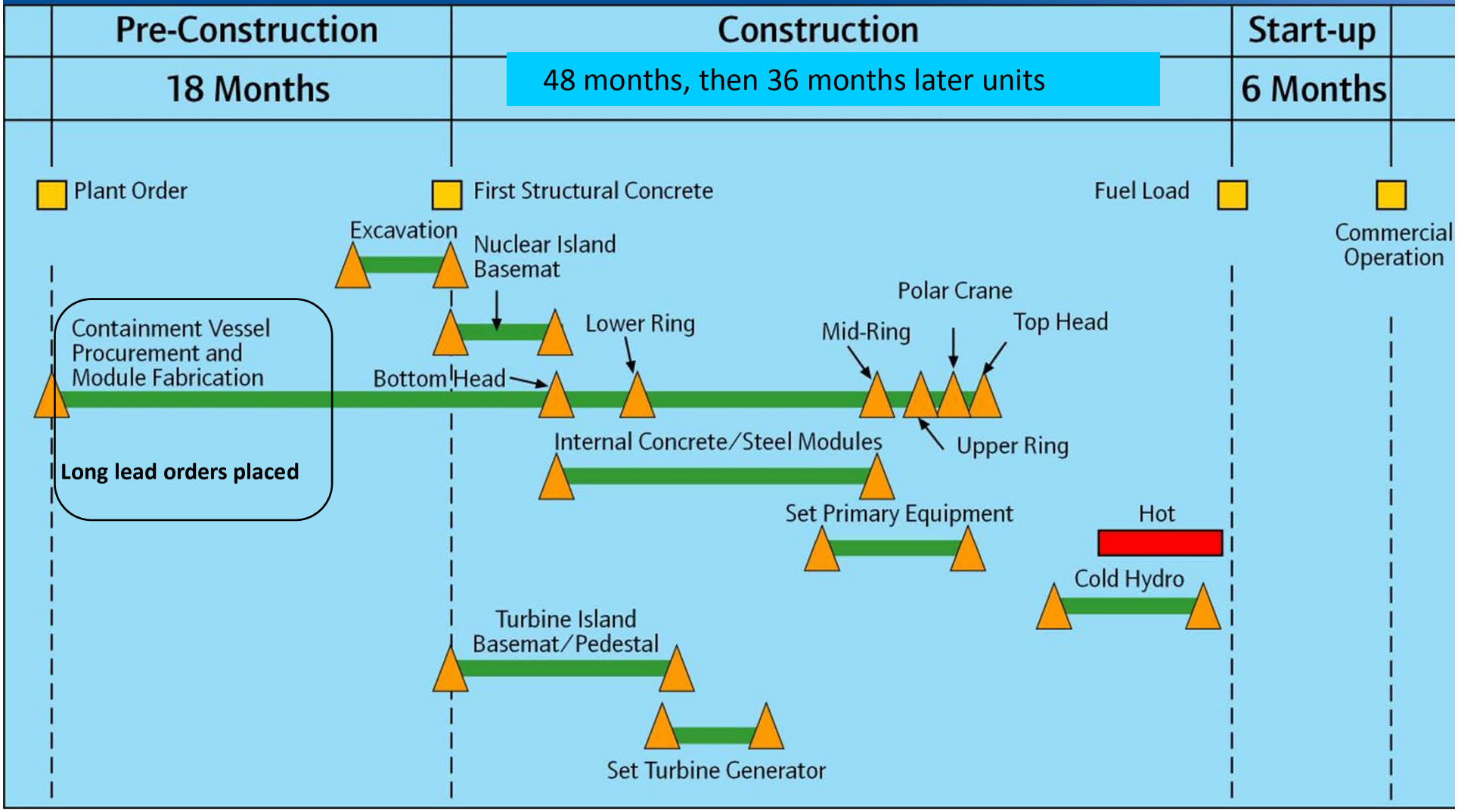
Typical AP1000 Construction Schedule



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Local Content & Technology Transfer

Localized Supply Base as a partner with Westinghouse in the AP1000 Integrated Global Supply Chain network

1. **Localization & horizontal integration – We Buy Where We Build™**
2. **Progression of Localization**
   - **Minimum Development/Investment:** Construction labor and construction commodities.
   - **Medium:** Localization of equipment by qualified local industries. Mainly Commercial off the shelf, build-to-spec, non-safety, but need to be commercially competitive.
   - **Maximum:** Qualified safety-related, Tech Transfer (TT). TT develops local industries, licensed technology. Usually viable only for national fleet program aspirations.

AP1000 Plant Global Project Delivery

- Eight **AP1000** units under construction worldwide
  - Four units in China
  - Four units in the United States

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China **AP1000** Plant Progress: Sanmen

Unit 1 First Concrete – March 2009

Unit 2 SG/Refueling Canal Module – December 2010

Unit 1 Reactor Vessel – August 2011

Unit 1 CVTH Set – January 2013

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Sanmen 1 Reactor Vessel Internals (RVI) Manufacturing Progress (cont.)

Core Shroud

Upper Cylinder Assembly

Upper Support Cylinder

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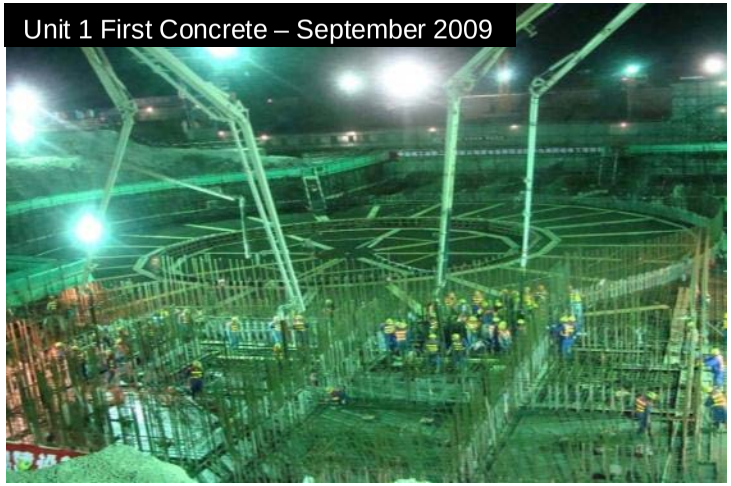
China **AP1000** Plant Progress: Haiyang

Unit 1 First Concrete – September 2009



Unit 2 Auxiliary Building – December 2010

Unit 1 Reactor Vessel – January 2012

Unit 1 CVTH Set – March 2013

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Progress of China Projects: Summary

- Major equipment delivered and installed at Sanmen Unit 1 and Haiyang Unit 1 includes:
  - Reactor Vessel
  - Steam Generators
  - Reactor Vessel Internals
  - Polar Crane
  - Integrated Head Package
- Containment Vessel Top Head (CVTH) set at Sanmen Unit 1 in January 2013 and Haiyang Unit 1 in March 2013
- Digital I&C turnover to Startup staff in progress
- Potential Sanmen operators have completed simulator training; Haiyang operators started simulator training in July
- Technology transfer well advanced

Sanmen Site – October 2013

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Haiyang Site – October 2013

Photo © Shandong Nuclear Power Company, Ltd. All rights reserved.

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Sanmen Site Progress: Time Lapse View

2009 to 2013

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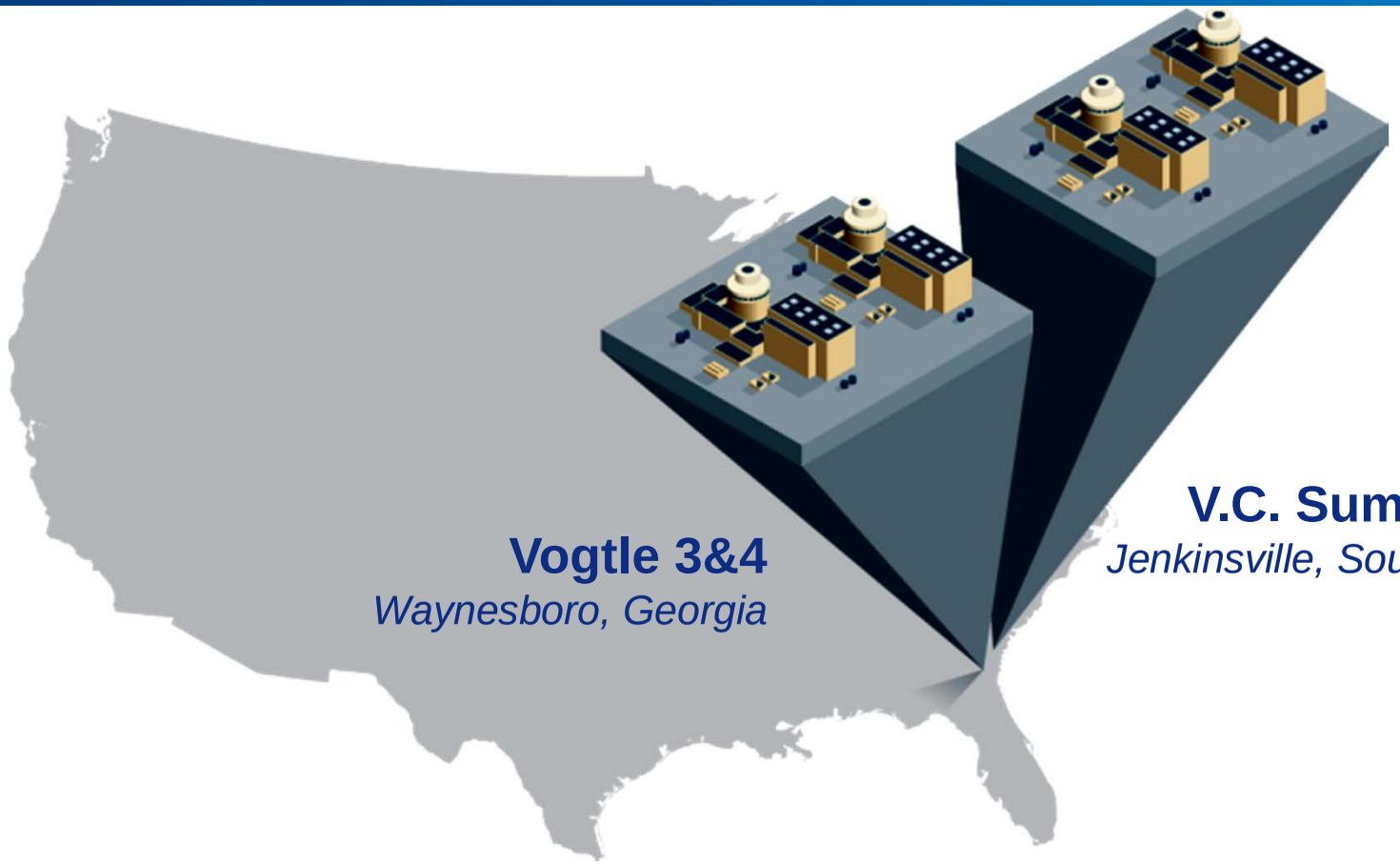
U.S. **AP1000** Plant Projects



Vogtle 3&4
Waynesboro, Georgia

V.C. Summer 2&3
Jenkinsville, South Carolina

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U.S. **AP1000** Plant Progress: Vogtle Site

Unit 3 CVBH Set – June 2013

Unit 3 Accumulator Tank Delivery – October 2013

Unit 3 CA20 Module Assembly – October 2013

Unit 3 Turbine Building – September 2013

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U.S. **AP1000** Plant Progress: V.C. Summer Site

Unit 3 First Concrete Pour – November 2013

Unit 2 Reactor Vessel Delivery – June 2013

Unit 2 CVBH Set – May 2013

CH80 Module Lift – September 2013

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Progress of U.S. Projects: Summary

- Nuclear island basemat concrete pours completed for V.C. Summer Units 2&3; Vogtle Unit 3
- Containment Vessel Bottom Head (CVBH) set in nuclear island for initial units at each site
- CV ring fabrication underway
- Component and module fabrication proceeding
- Reactor vessels delivered for initial units at each site; additional equipment and component deliveries continue to proceed

Vogtle Unit 3 Nuclear Island – October 2013

Photo © 2013 Georgia Power Company. All rights reserved.

V.C. Summer Site – August 2013

Photo © 2013 South Carolina Electric & Gas. All rights reserved.

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Benefits of **AP1000** Technology and Westinghouse Approach to New-Build Business

- **AP1000** plant combines proven technologies and innovative passive safety systems
  - 5,000 man-years of design work
- Eight units under construction worldwide; more are planned
  - First nuclear concrete placed for first eight
- Regulatory certainty
  - Almost 300 man-years of licensing review in US and UK alone
- We Buy Where We Build™ approach provides rich opportunities for local suppliers
- Committed to developing the next generation of engineers and other technical professionals in Brazil

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Lessons Learned: Requirements for a Successful New-Build Program

- **Strong reference plant**
- Leverage “Country of Origin” Licensing
- Utilize Modern Construction Methods
- Defined Approach to Sustainable Localization
- Avoid First-of-a-Kind Deployment Issues
- Take Advantage of Nth-of-a-Kind Experience

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AP1000 Plant Value Proposition

Proven Technology with Passive Safety Systems

Simplified Design with Modular Construction

Reviewed in Multiple Countries by Independent, Technically Rigorous and Transparent Regulators – Using a Well Defined Safety Standard

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Westinghouse Technology and Brazil: The Right Fit

- Westinghouse Looks Forward to Continuing our Long Nuclear Partnership with Brazil
- Our Approach Helps Achieve
  - …a balanced energy supply
  - …safe, clean electricity generation
  - …sustainable economic growth

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Obrigado! Questions?

Please visit us at http://www.westinghousenuclear.com/

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