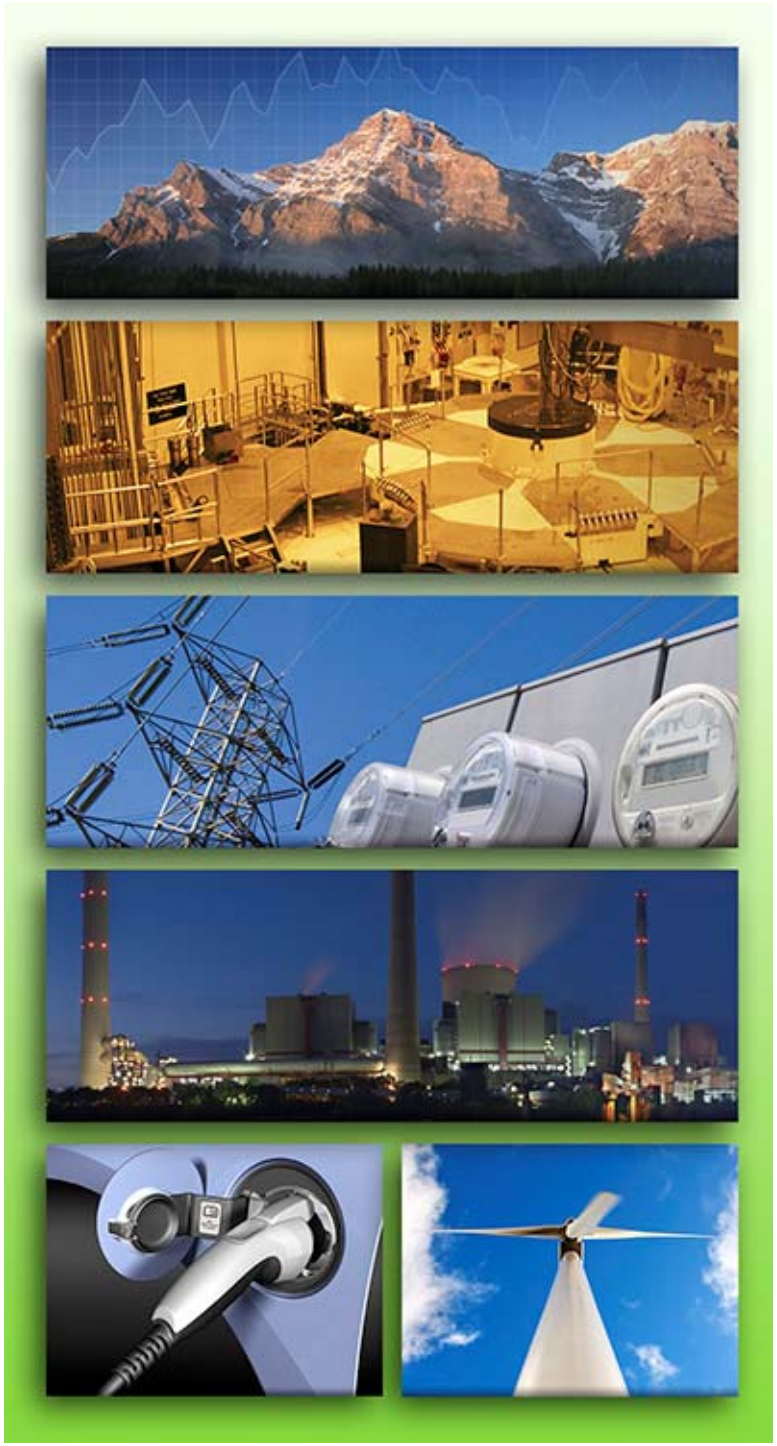

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

U.S. Perspective on Advanced Nuclear Generation, Development & Deployment

Rosa Yang, Ph.D.
Vice President, Technology Innovation

CEPSI 2010 Conference
October 24-28, 2010
Taipei, Taiwan

The Electric Power Research Institute

- Independent, unbiased, non-profit, collaborative research institute
- Full spectrum industry coverage
  - *Nuclear*
  - *Generation*
  - *Power Delivery & Utilization*
  - *Environment*
  - *Technology Innovation*
- 460 participants in over 40 countries
- Major offices in Palo Alto, California; Charlotte, North Carolina; and Knoxville, Tennessee

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

Presentation Outline

- Electricity Technology Challenges
- Nuclear Power, U.S. and Worldwide
  - Current Status
  - Future Expansion
    - Advanced Light Water Reactor (ALWR)
    - Small Modular Reactor (SMR)
- Summary

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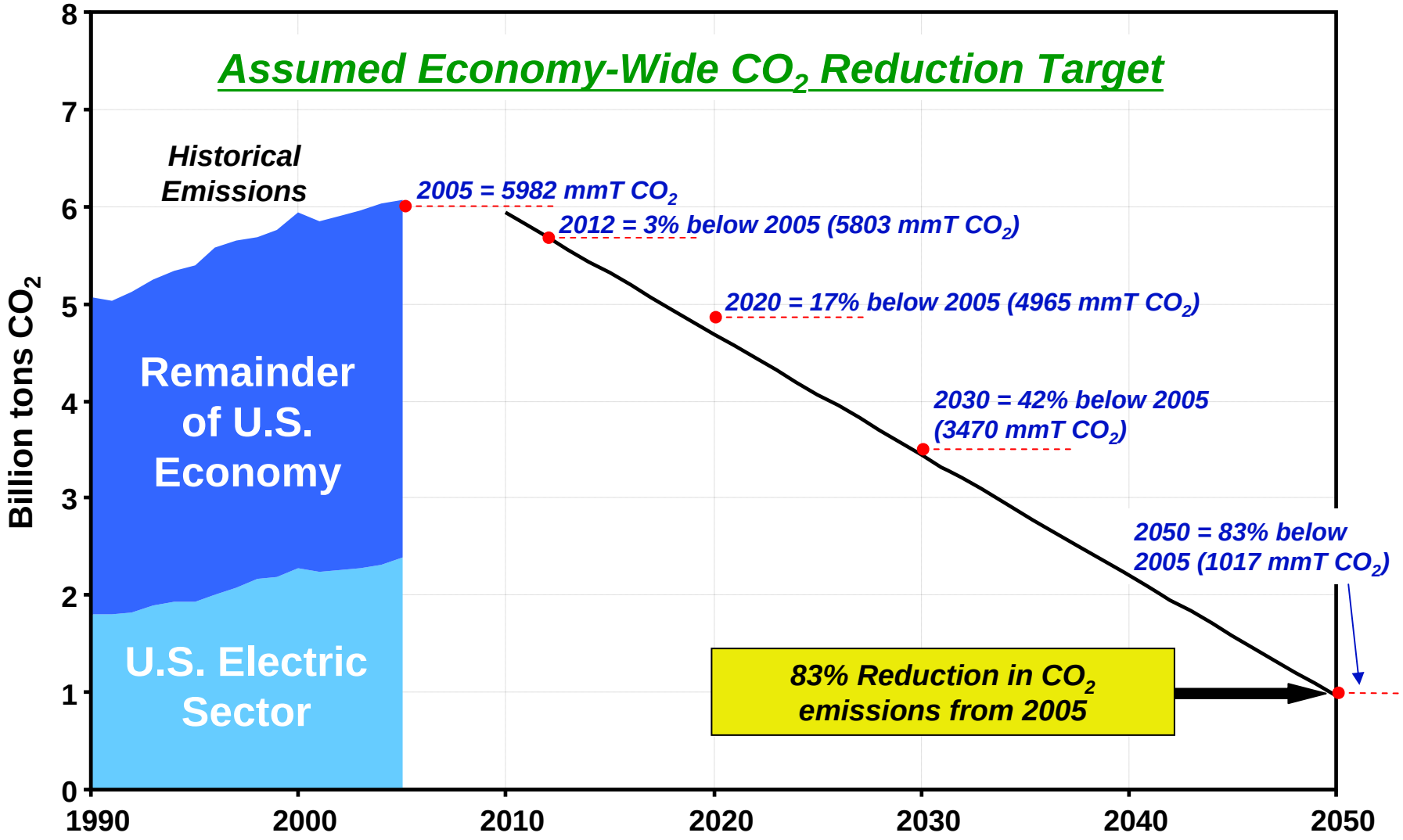
The U.S. CO_2 Challenge



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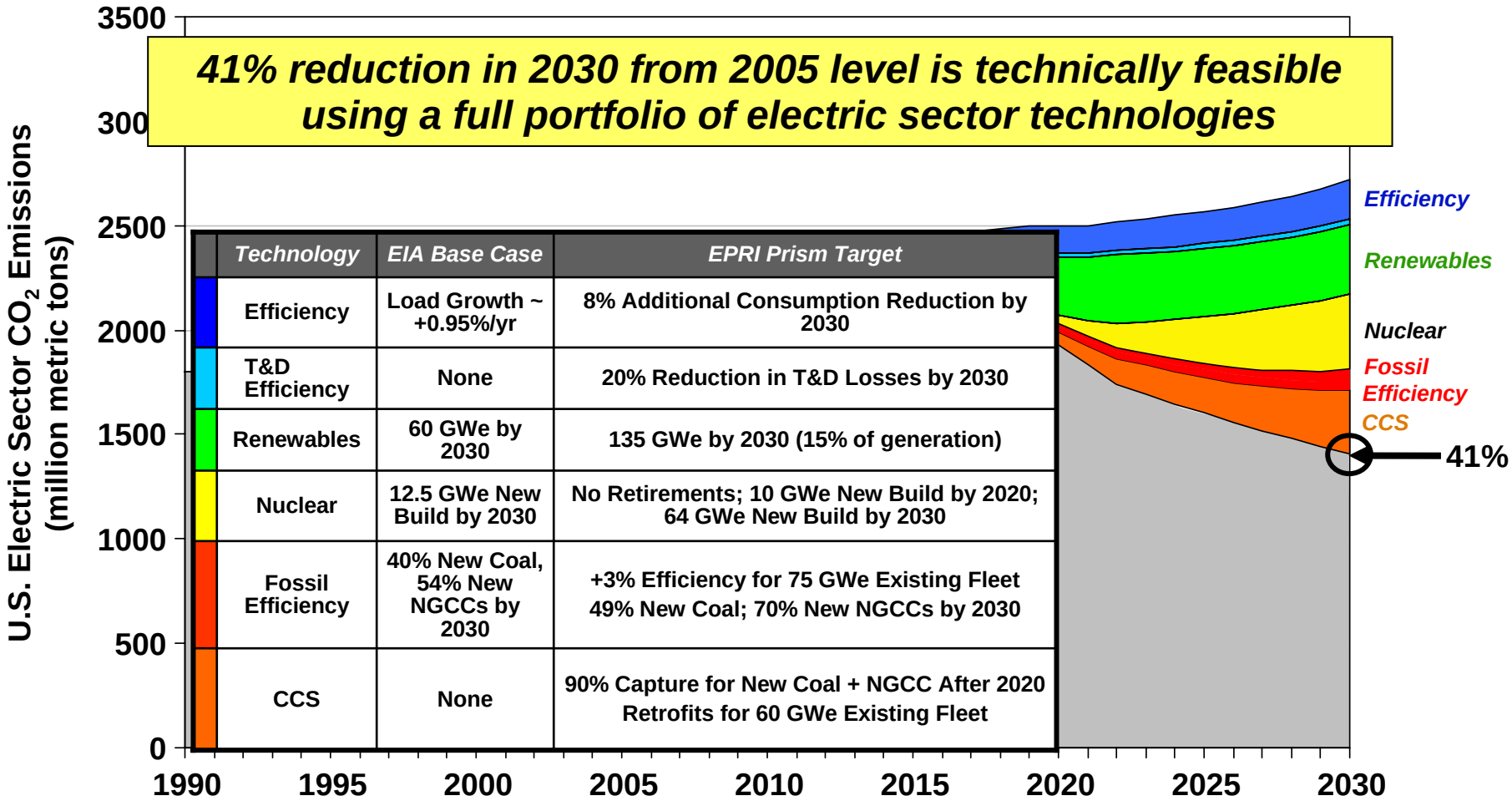
EPRI Prism Study of CO_2 Reduction Potential



Technology	EIA Base Case	EPRI Prism Target
Efficiency	Load Growth ~ +0.95%/yr	8% Additional Consumption Reduction by 2030
T&D Efficiency	None	20% Reduction in T&D Losses by 2030
Renewables	60 GWe by 2030	135 GWe by 2030 (15% of generation)
Nuclear	12.5 GWe New Build by 2030	No Retirements; 10 GWe New Build by 2020; 64 GWe New Build by 2030
Fossil Efficiency	40% New Coal, 54% New NGCCs by 2030	+3% Efficiency for 75 GWe Existing Fleet 49% New Coal; 70% New NGCCs by 2030
CCS	None	90% Capture for New Coal + NGCC After 2020 Retrofits for 60 GWe Existing Fleet

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Defining the Electricity Technology Challenge

- **De-carbonize the electricity infrastructure**
- **Provide reliable, affordable, and environmentally responsible electricity to consumers**

Two Key Metrics: CO_2 Emissions and Cost of Electricity

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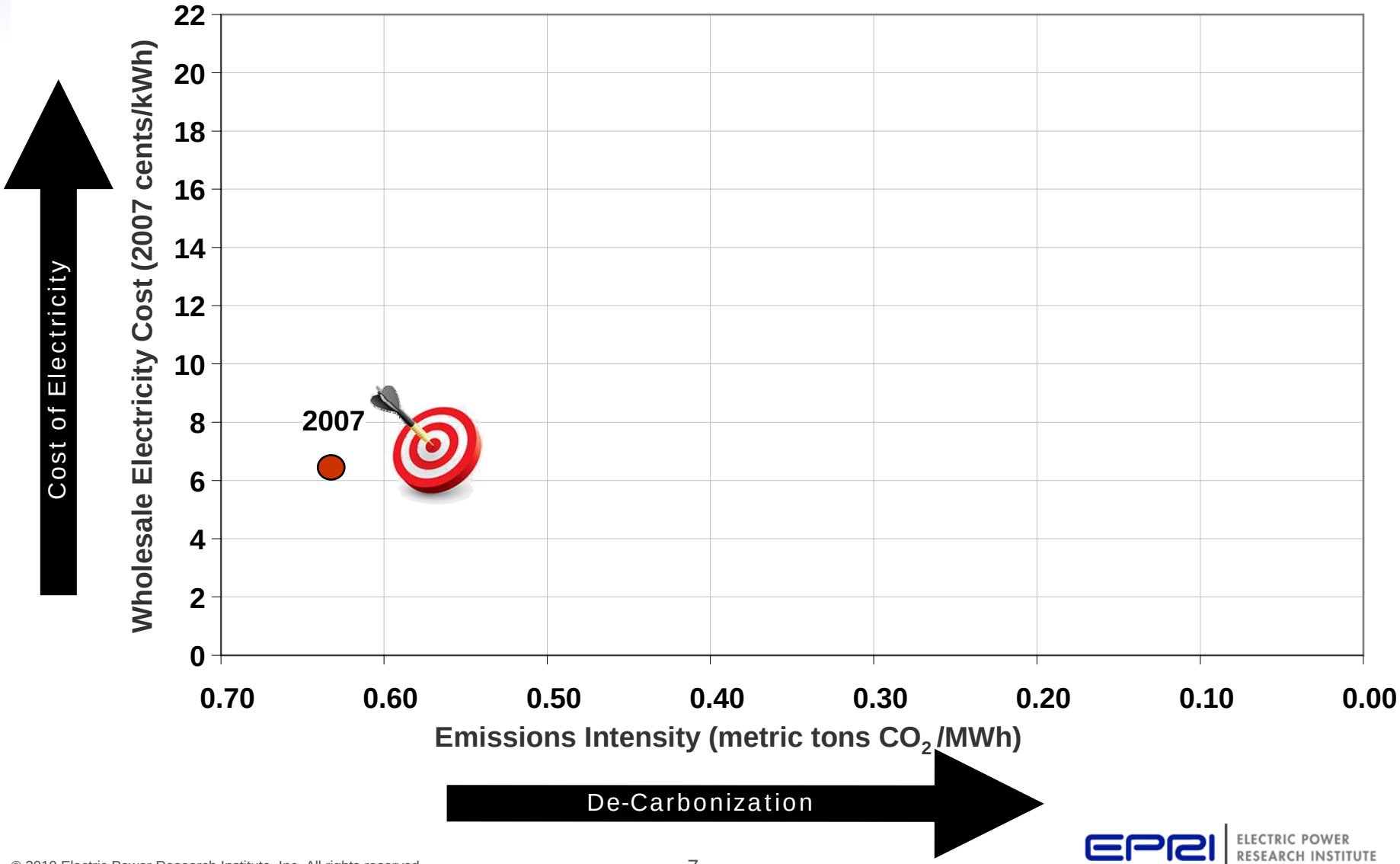
The Technology Challenge



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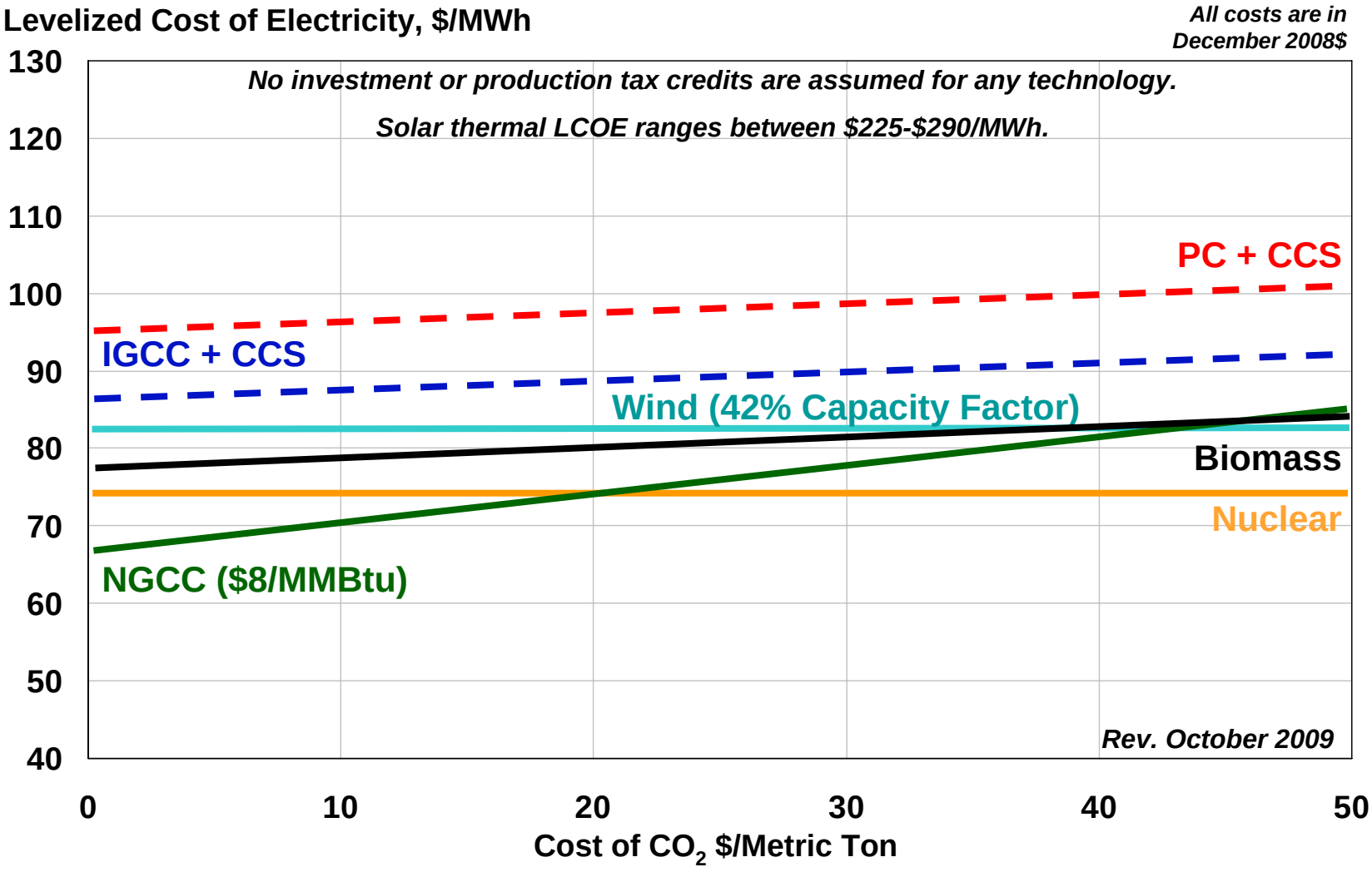
Comparative Levelized Costs of Electricity – 2025



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Some Insights from EPRI's Prism/MERGE Study

- **Near term response to high CO_2 price likely dominated by renewable, efficiency and natural gas**
  - Coal retirements offset by new renewable, efficiency
  - Natural gas fills any remaining demand

- **Longer term, nuclear and CCS will be important to provide reliable, affordable and environmentally friendly electricity to consumers**
  - Without them, rely on more costly renewable

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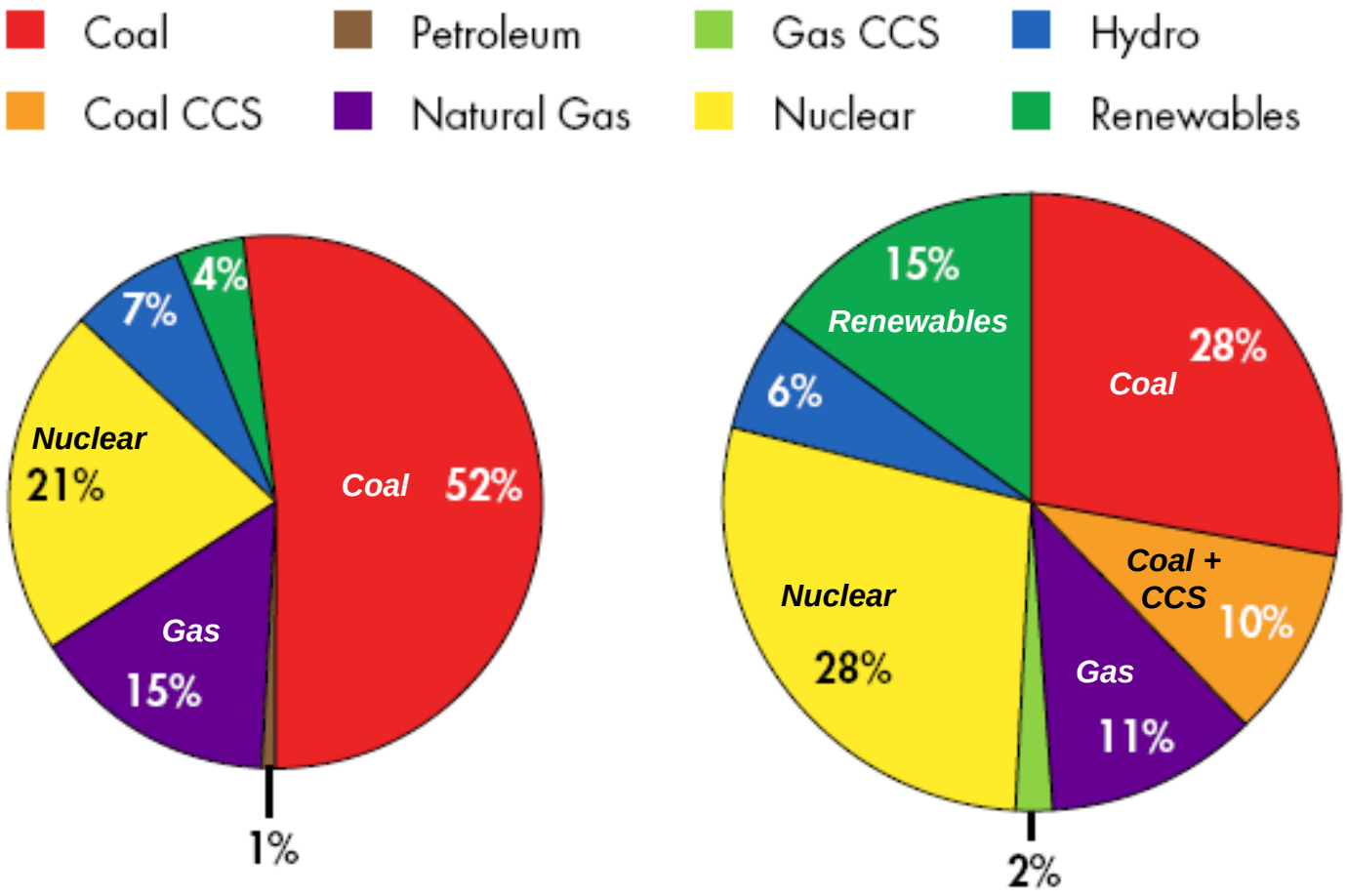
Nuclear Will Play an Increasingly Important Role –
2009 U.S. Electricity Generation Prism Study



EIA 2009
3854 TWh
"TODAY"

Prism 2030
4888 TWh
"FUTURE"

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Nuclear is a Mature Technology, with Further Improvements Expected

- Near zero CO_2 emission
- A key baseload technology, with safe and excellent performance
  - Improved safety record
  - High capacity factor
- Poised for expansion
  - U.S. and worldwide
  - New technologies are expected to be safer
    - Evolutionary improvement built on existing nuclear fleet

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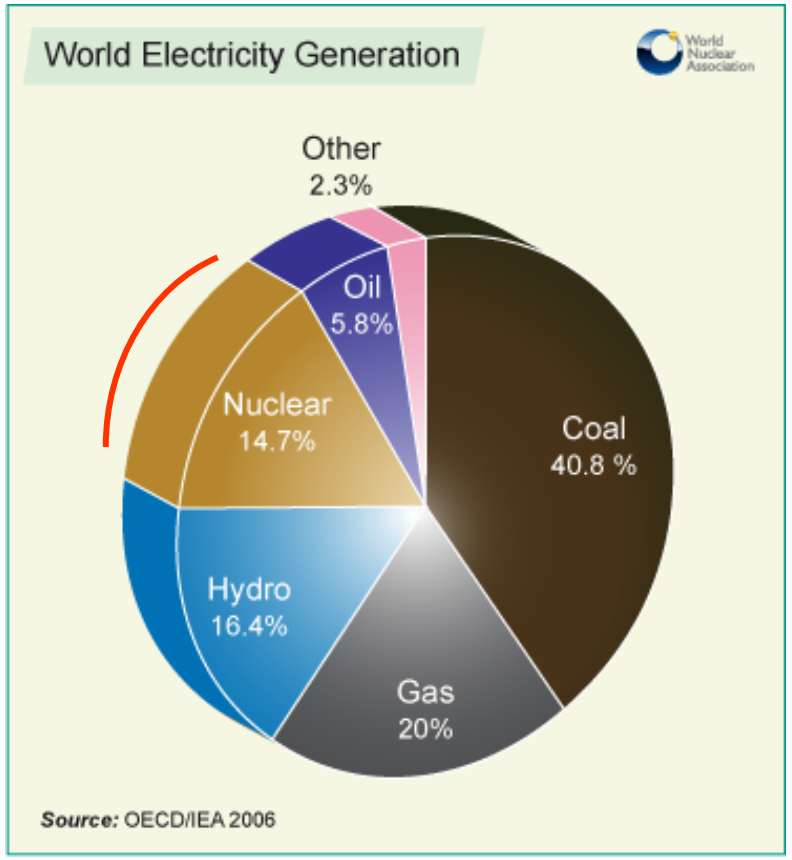
Nuclear Plant Status Worldwide

- **436** plants generating
- **15%** of world's electricity
- In **31** countries
- **370,000** MWe capacity
- **13,649** reactor years



Source: IAEA

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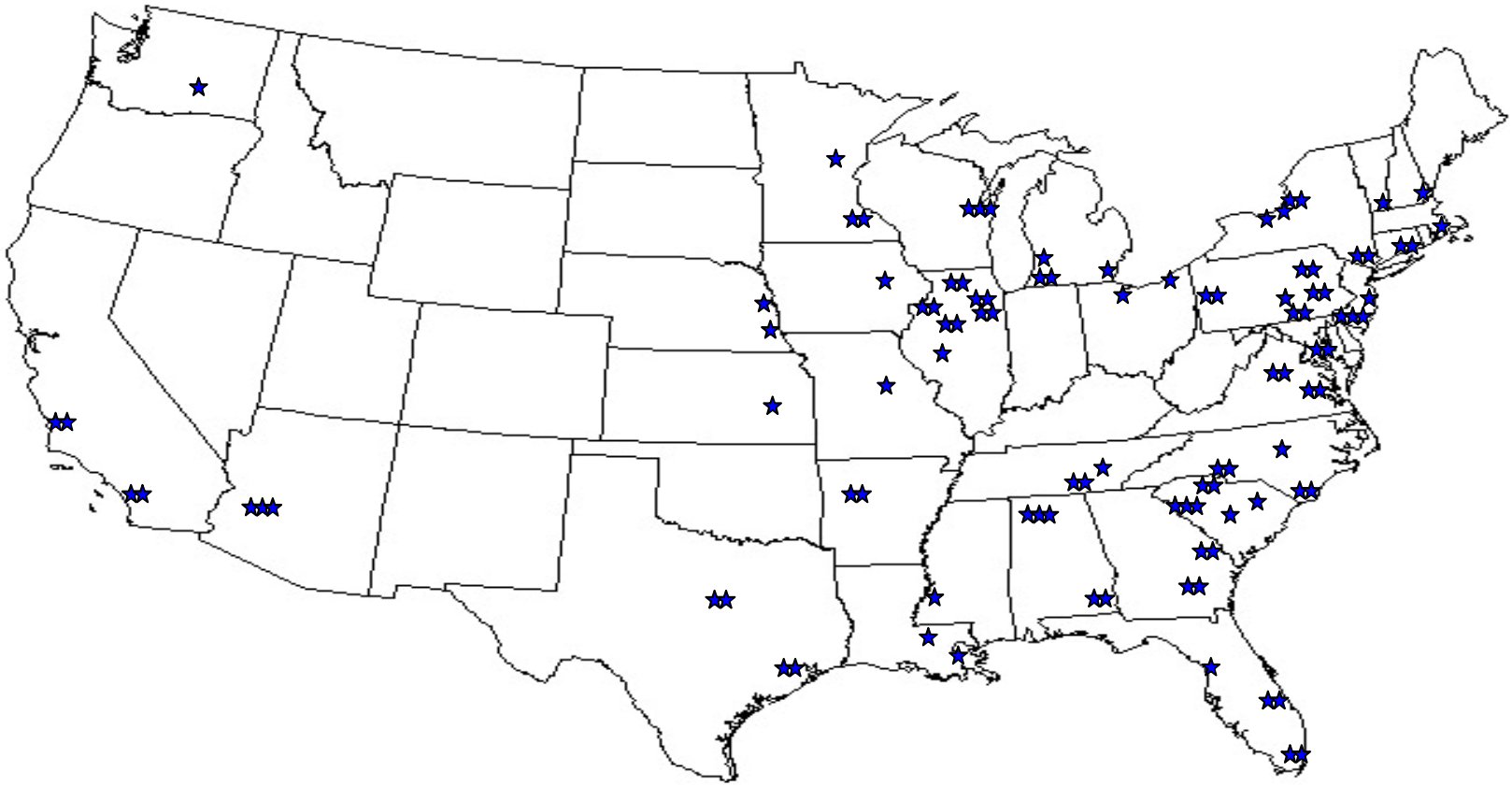
Current U.S. Nuclear Plants

104 Plants in 31 States



Source: Nuclear Energy Institute

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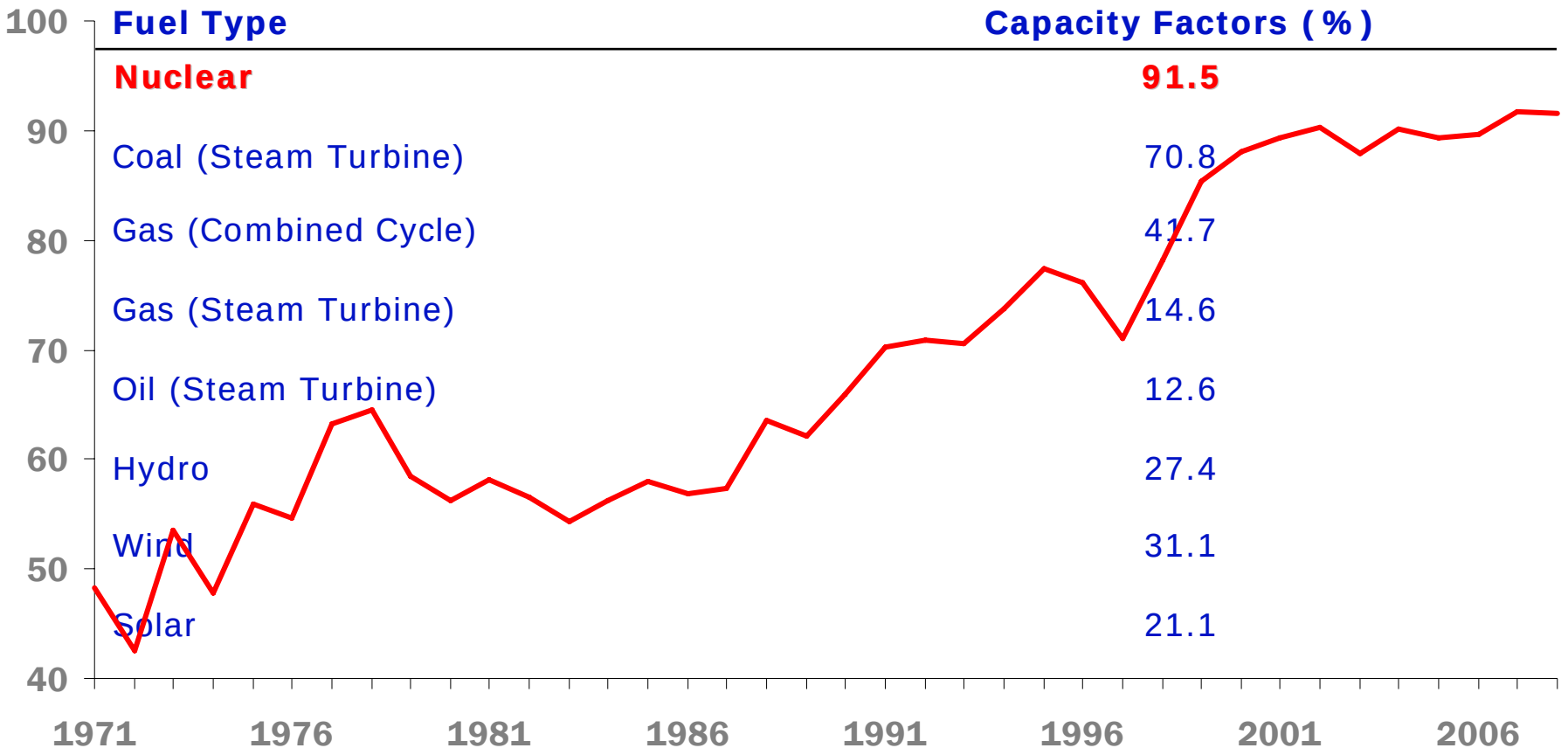
U.S. Capacity Factors by Fuel Type



Source: Ventyx Velocity Suite / Energy Information Administration

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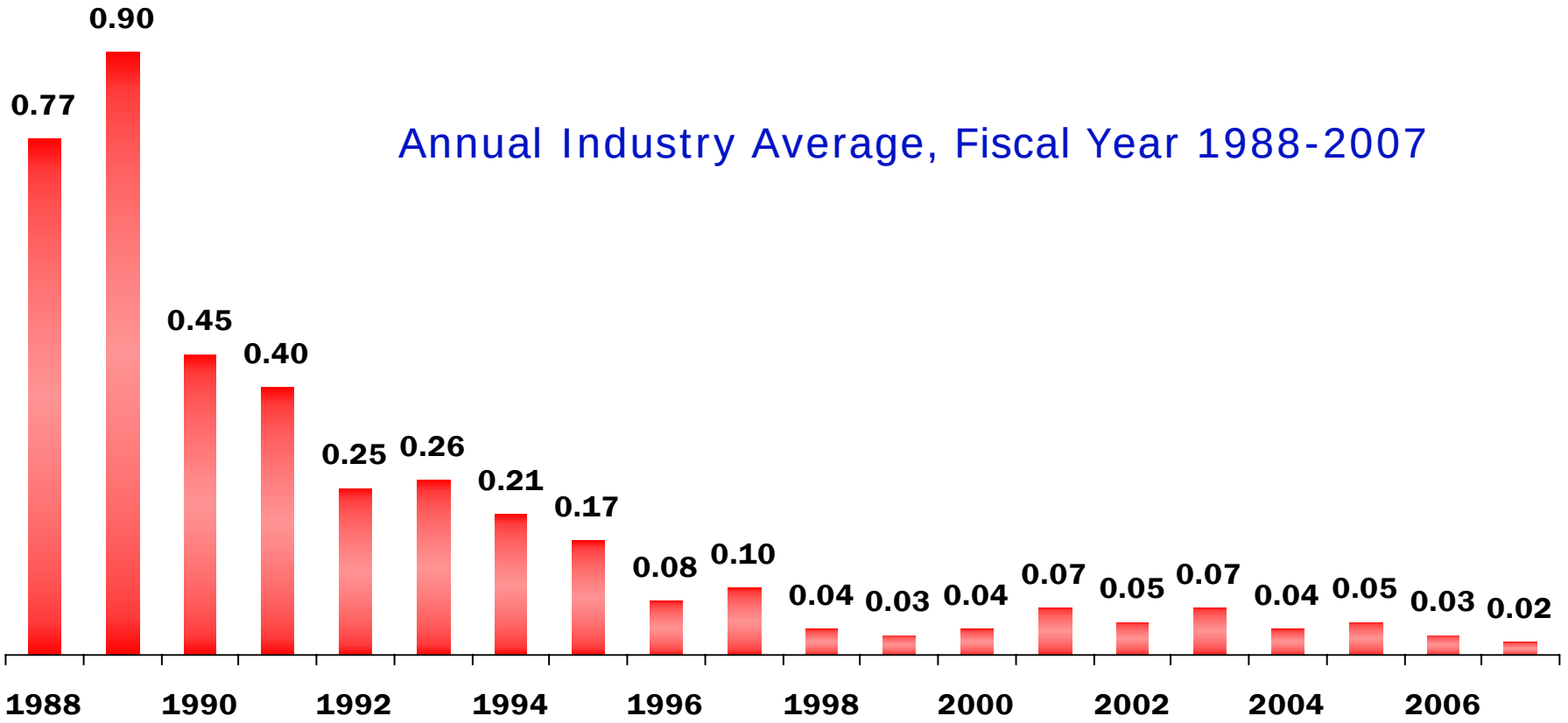
Significant Reduction in Reported Events – U.S.



Source: NRC Information Digest, 1988 is the earliest year data is available.
Updated: 4/09

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How to Grow Nuclear Electricity Generation from 21% to 28% by 2030?

- Existing plants
  - Keep existing plants running safely, reliably, economically, **and** extend plant life
    - 40 → 60 → 80 years
      - Materials, inspections, maintenance
    - Plant uprates
- Building new nuclear plants
  - Large capital investment
  - Build new plants on schedule and budget
    - Improved licensing process
    - Modular construction

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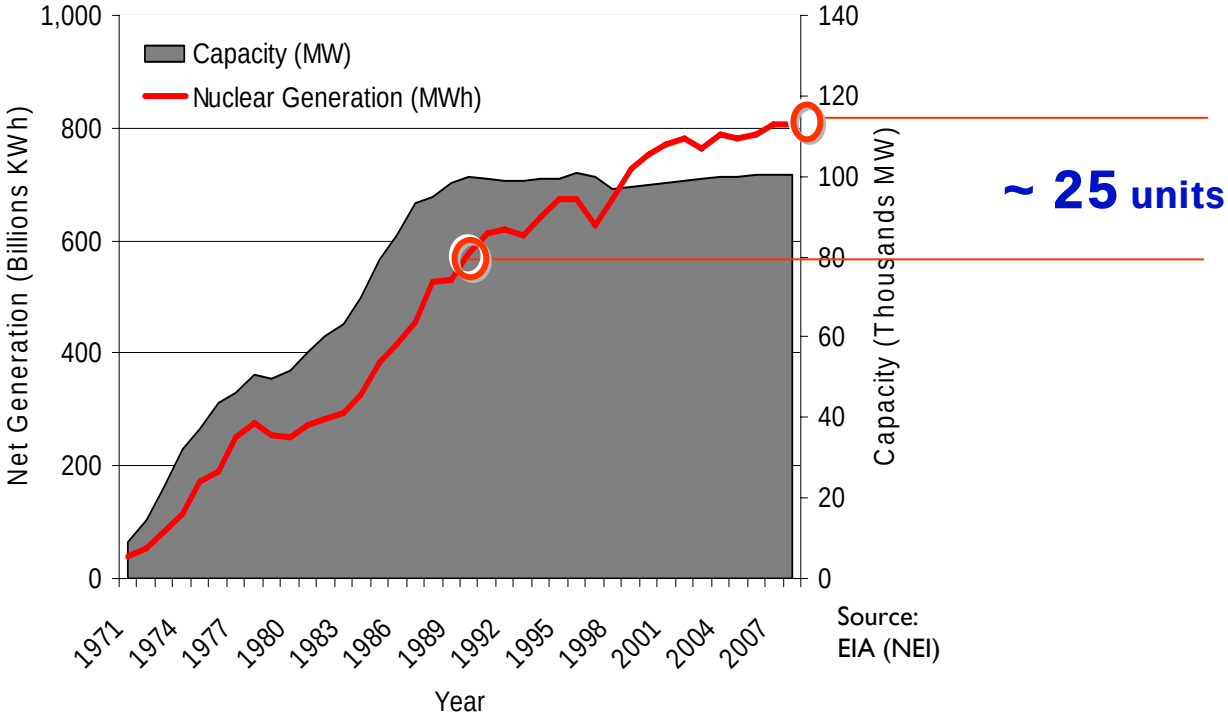
U.S. Nuclear Generation Growth



Up Rate + Capacity Increase + Fuel
~ 25 New Units

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An Examples of R & D for Plant Life Extension

- EPRI, U.S. Department of Energy, and Constellation Energy have a 3-year collaboration to assess aging concerns at Ginna and NMP-1
  - Plants are beyond 40-year life
    - To examine data, inspect and test for aging degradation
  - Lead tasks
    - Comprehensive containment examination
    - Incremental reactor internals inspection for >60 years
    - Others, e.g., confirm reactor pressure vessel (RPV) life and assess cable condition in severe environments

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Work Started at Vogtle Site in Georgia

ESP & LWA Received in August 2009; Loan Guarantee February 2010

Photos Courtesy of Southern Nuclear

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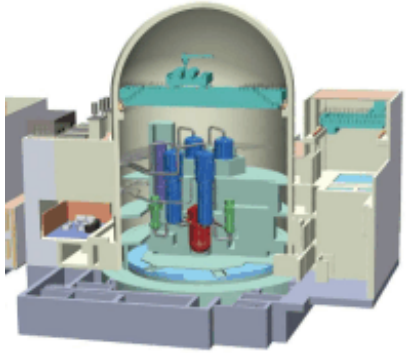
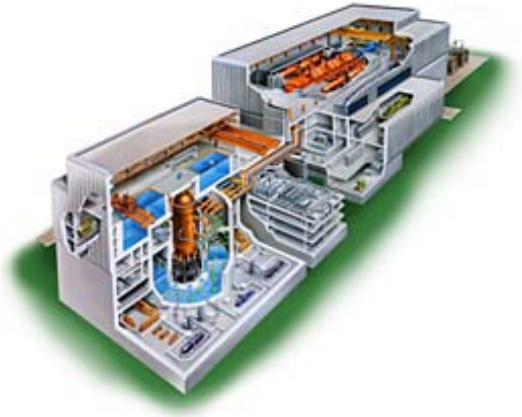
The Technology…
Gen III/III+ LWR Designs Under Consideration in U.S.

Westinghouse
* AP1000 (1117 MWe)



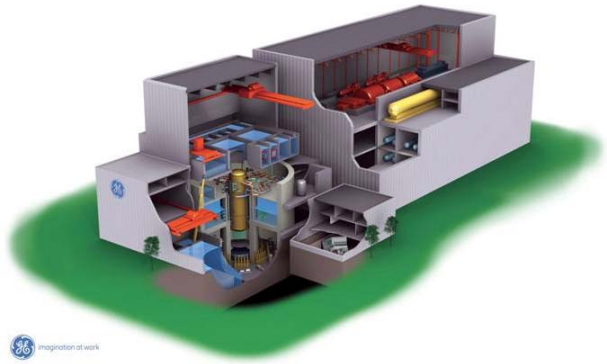
MHI APWR (1700 MWe)

AREVA US EPR (1600 MWe)



GE-Hitachi / Toshiba
* ABWR (1,371 MWe)

Current Status of Announced U.S. Intentions	
Technology	**Units**
AP1000	14
EPR	7
TBD	4
ABWR	4
APWR	2
ESBWR	1



GE-H ESBWR (1535 MWe)

**** Design Certified***

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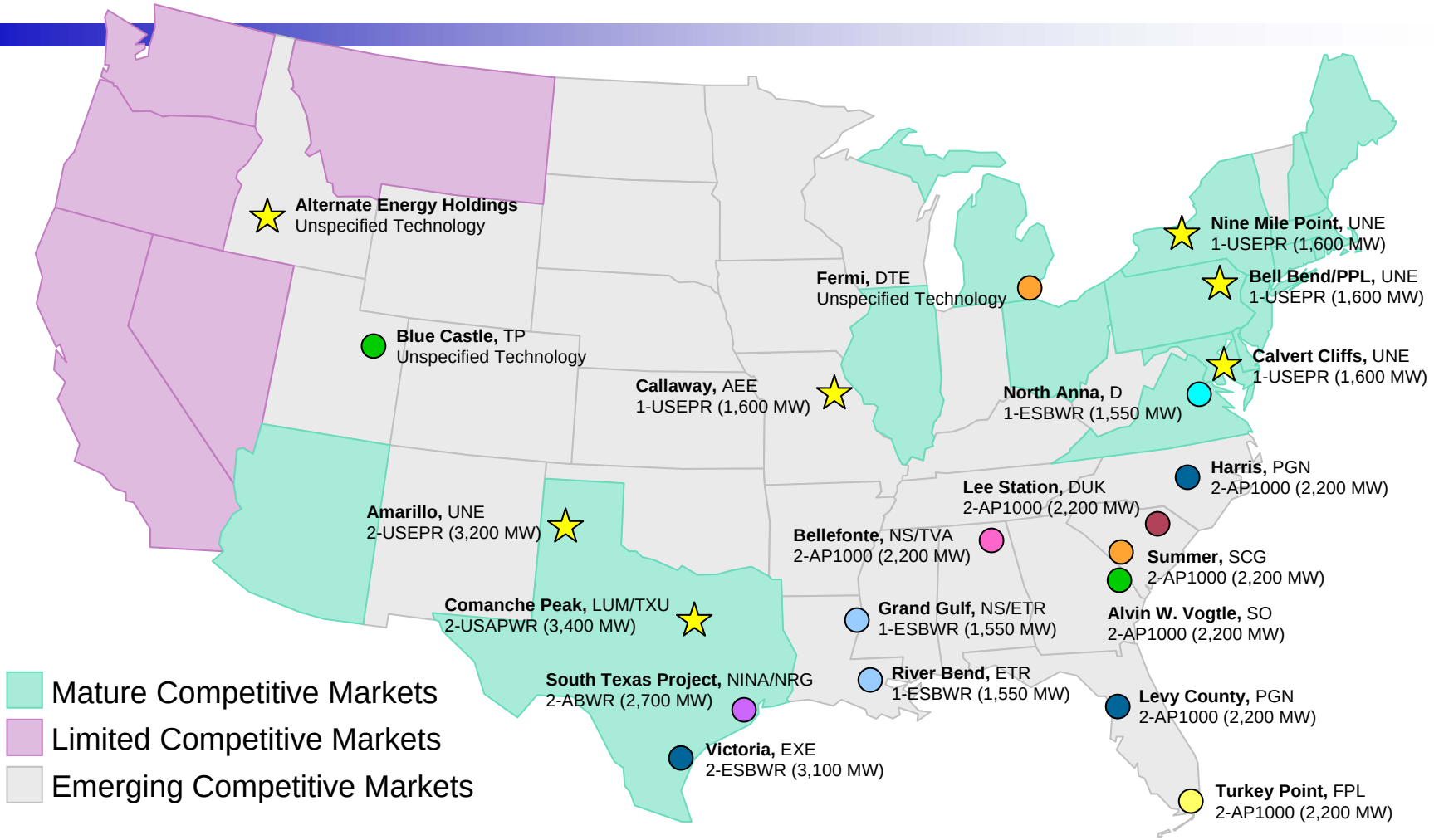
Nuclear Renaissance in the U.S.

34 Nuclear Units, 23 Nuclear Sites, 16 Nuclear Operators



*Includes 2 unidentified utilities

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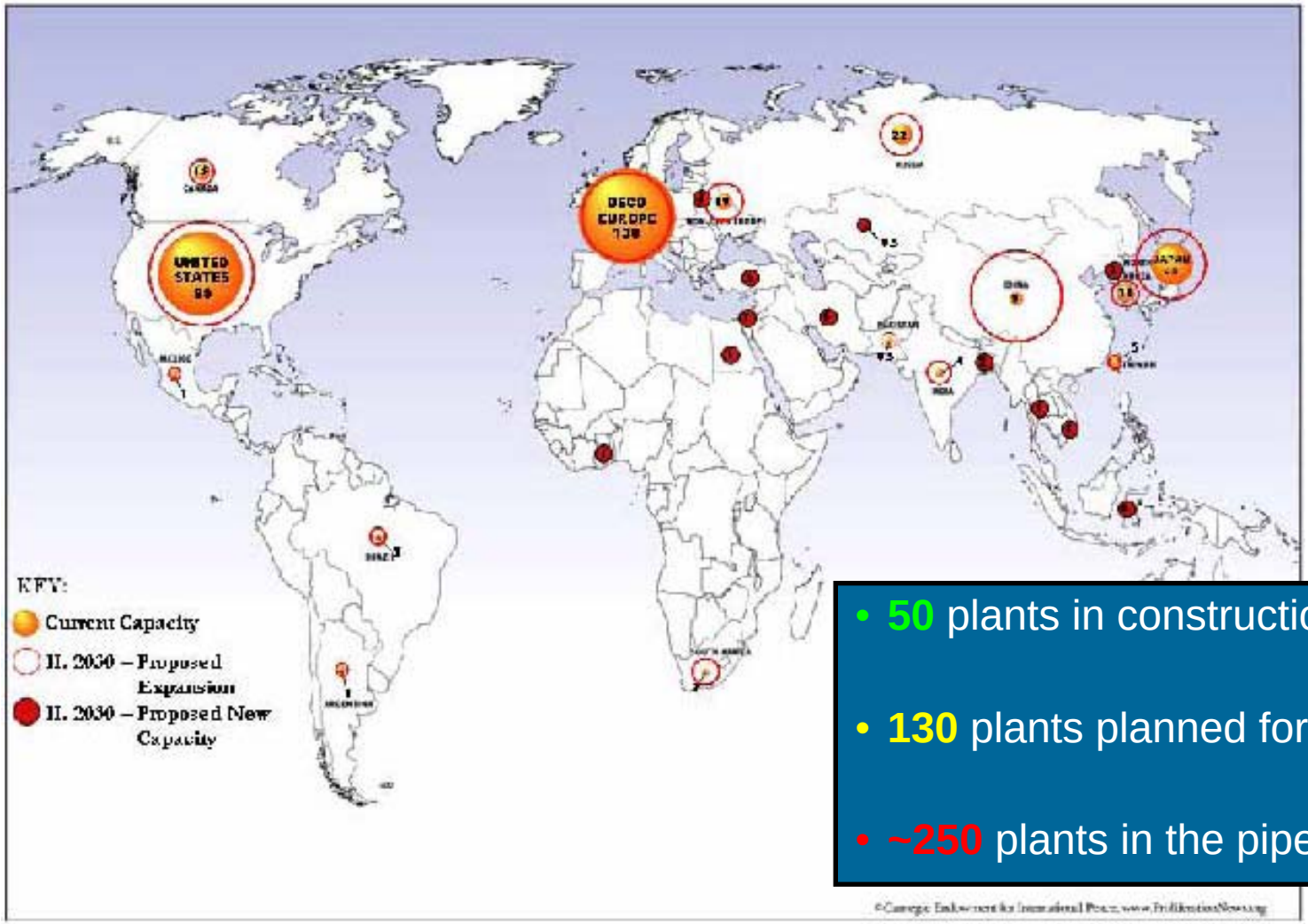
Global Nuclear Expansion



- **50** plants in constructions
- **130** plants planned for next 10 years
- **~250** plants in the pipeline

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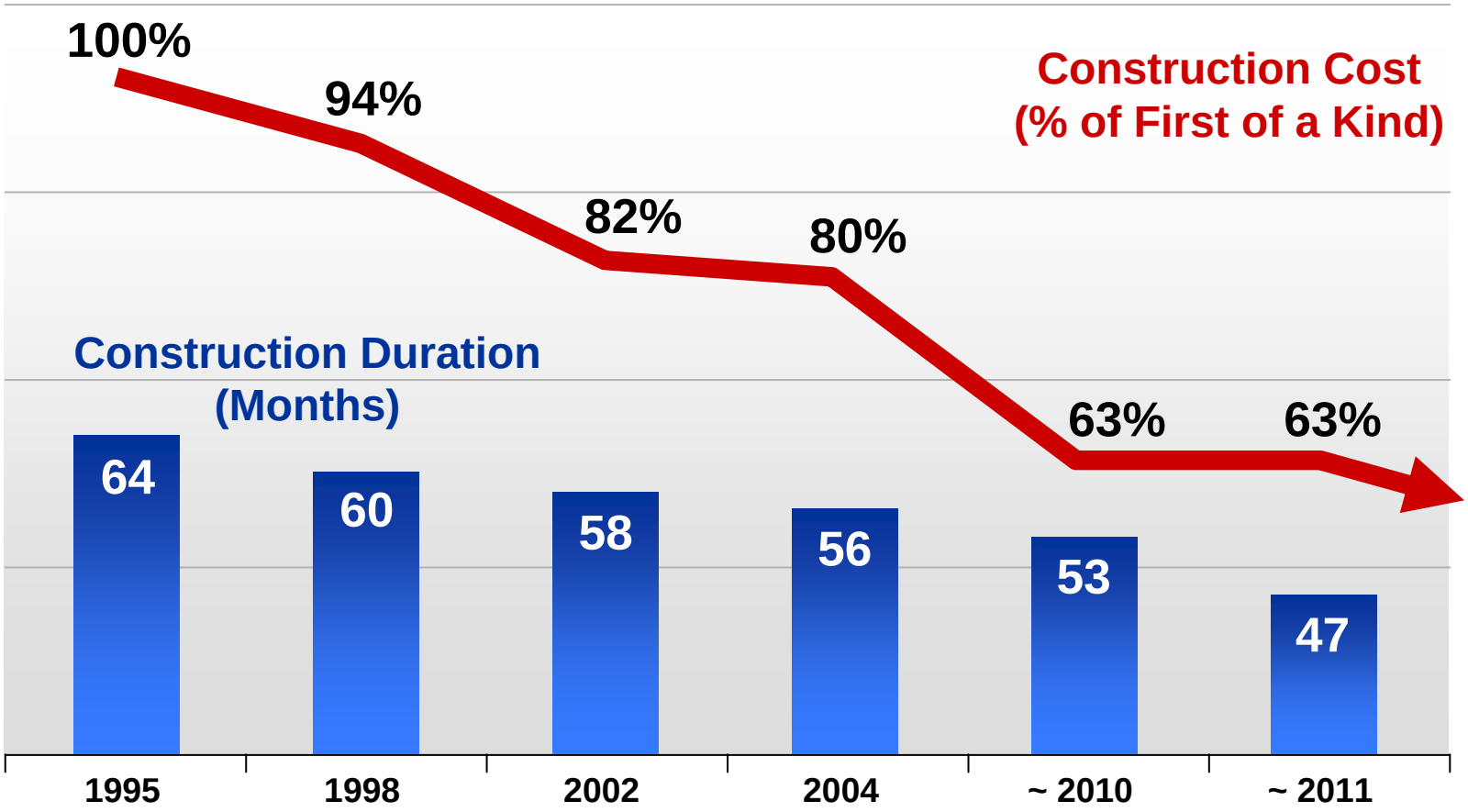
Learning Curve Opportunity – Korean Example



Repetitive Construction of Standardized Plants

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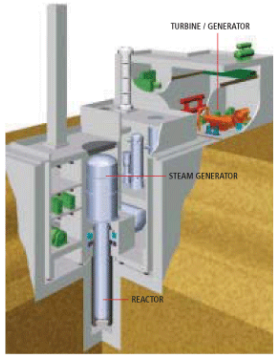
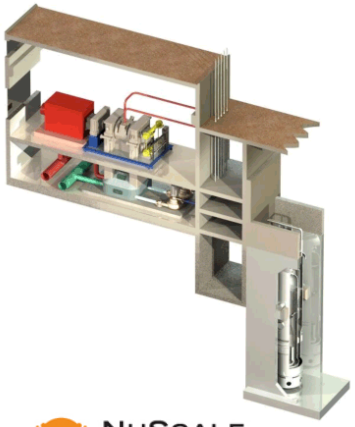
On The Horizon…Small Modular Reactors (SMR)

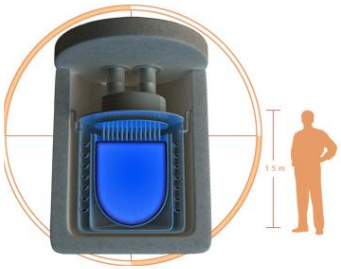
- Many different small, modular-sized nuclear technologies (SMRs) being discussed for commercialization
- Many designs present new licensing challenges and new construction/operating paradigms that have not been pursued before by current U.S. or international owner/operators



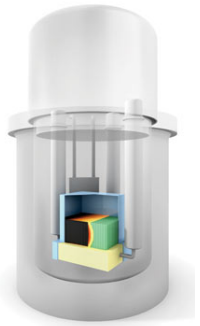
TOSHIBA



NuScale Power



HYPERION



INTELLECTUAL VENTURES

B&W babcock & wilcox modular nuclear energy

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Opportunities and Challenges to the Successful Deployment of SMR

Opportunities

- Low capital cost; shorter construction time
- Infrastructure
- Incremental additions to meet demands

Challenges

- Have sufficient resources to complete the designs in a timely fashion
- Complete licensing process in a timely manner
- Ensure continued strong U.S. Department of Energy funding
- Have a strong utility support base
- Demonstrate performance and cost

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Summary

- Nuclear power is a safe, reliable and cost-effective way to generate electricity with close to zero carbon foot print
- Maintain the nuclear power option in the 21 century
  - Continued operation of existing plants, with
    - Uprates
    - Extended operations
  - Building new plants
    - Advanced LWR
      - Cost and schedule
    - Small Modular Reactor
- Technology and innovation are critical to maintain the nuclear option

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Together…Shaping the Future of Electricity

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