Resurgence of Nuclear Energy in the US and RP Challenges

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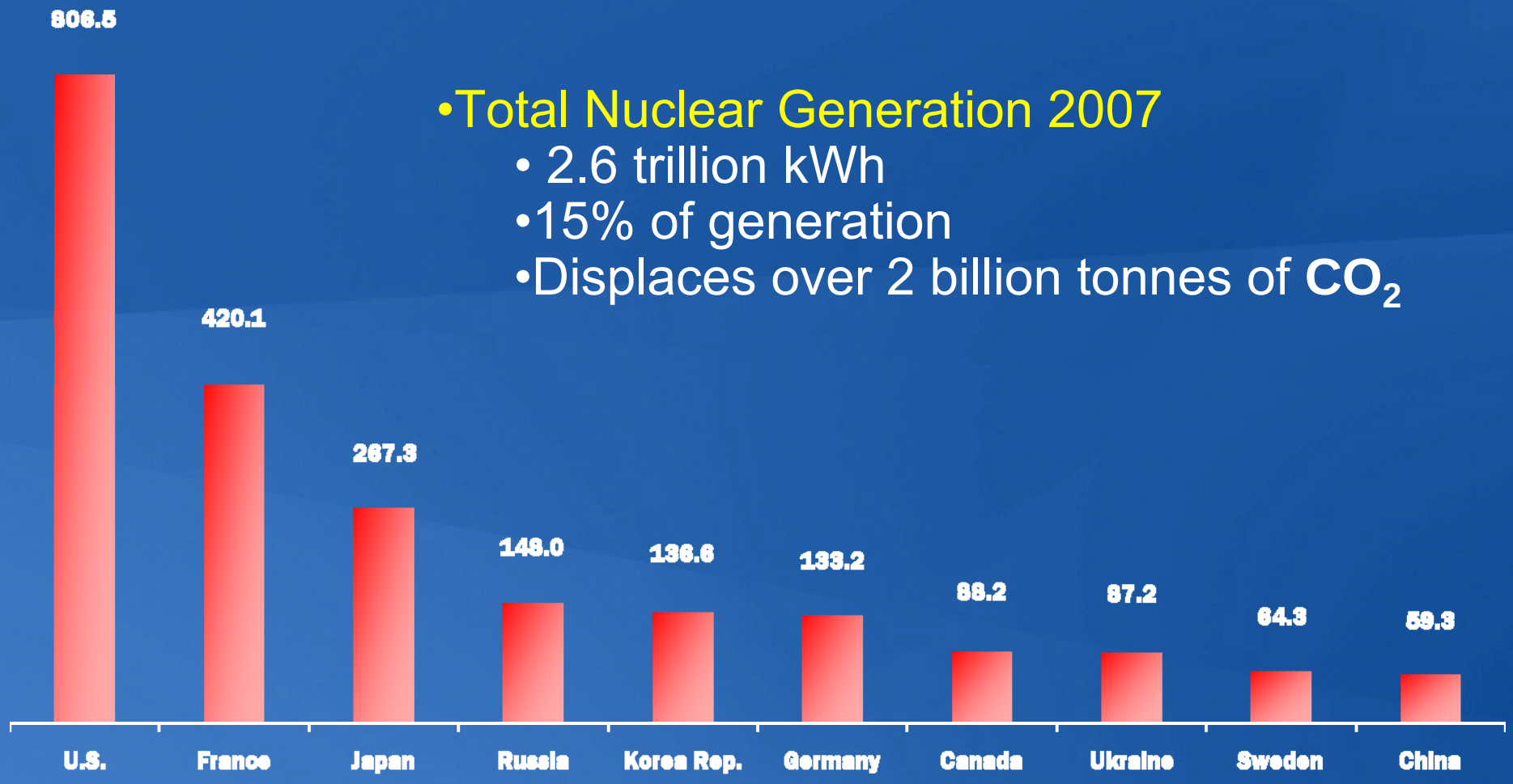
NUCLEAR ENERGY INSTITUTE

Top 10 Nuclear Generating Countries

2007, Billion kWh

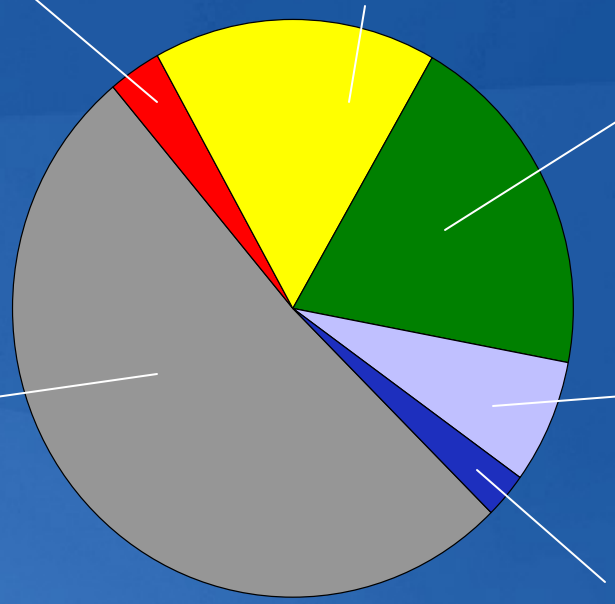


- Total Nuclear Generation 2007
  - 2.6 trillion kWh
  - 15% of generation
  - Displaces over 2 billion tonnes of CO_2

Source: International Atomic Energy Agency, U.S. is from Energy Information Administration

Updated: 9/08

Sources of U.S. Electricity (2007)



21.5% Natural Gas
Low construction cost
Volatile fuel cost
Combined cycle capacity factor: 43.3%
Steam plant capacity factor: 16.0%
Emissions: NOx, CO_2

1.6% Oil
Volatile fuel cost
Capacity factor: 19.6%
Emissions: SO_2, NOx, CO_2

19.4% Nuclear
High construction cost
Stable fuel cost
Capacity factor: 91.8%
Emissions: None

5.8% Hydro
Large-scale opportunities gone
No fuel cost
Capacity factor: 27.8%
Emissions: None

48.6% Coal
High construction cost
Capacity factor: 71.1%
Emissions: SO_2, NOx, CO_2, particulates, mercury, toxic metals

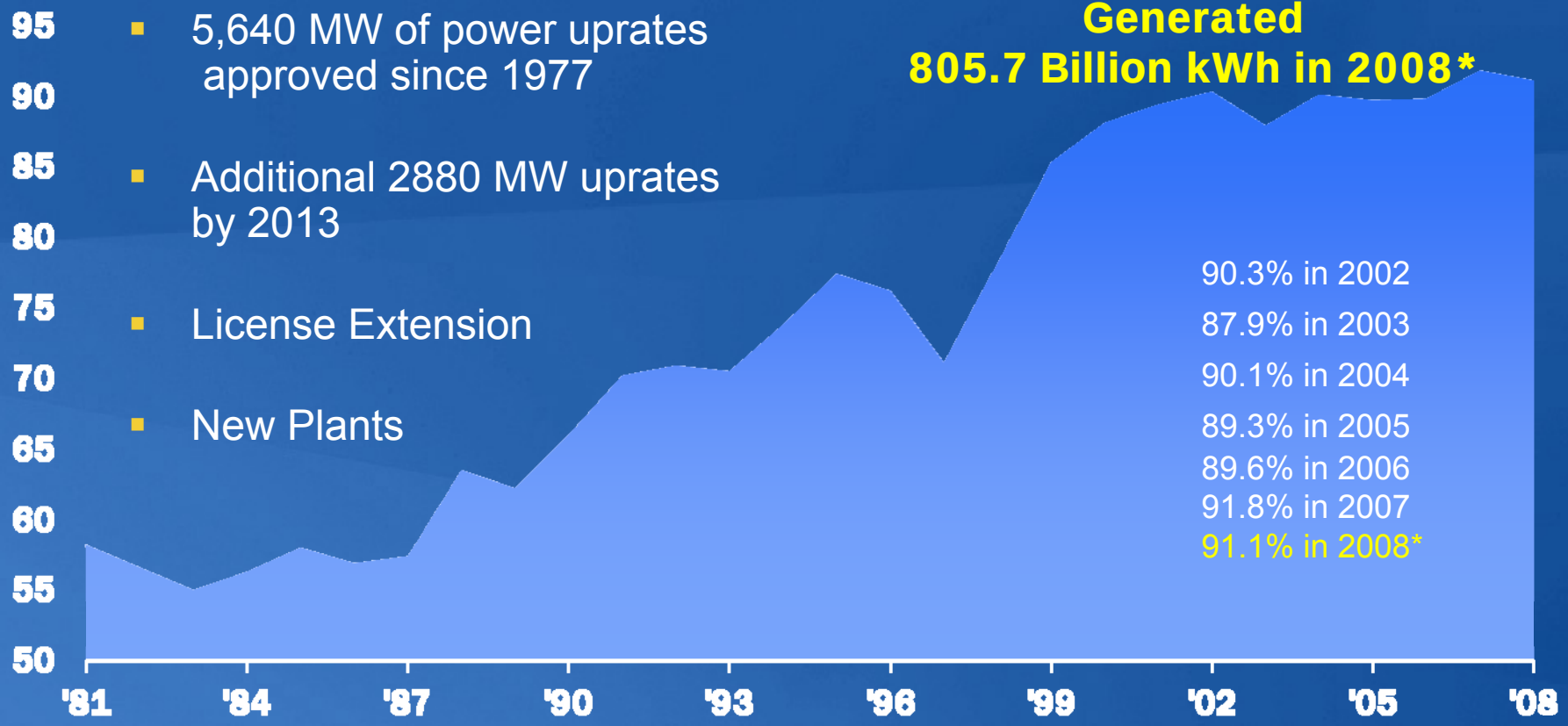
3.2% Renewables (and Other)
High construction cost No fuel cost
Capacity factors: 30.4% (Wind), 19.8% (Solar)
75.0% (Geothermal) 70.9% (Biomass)
Emissions: None

Source: Global Energy Decisions / Energy Information Administration 4/08

Sustained Reliability and Productivity

U.S. Nuclear Capacity Factor, Percent

- 5,640 MW of power uprates approved since 1977
- Additional 2880 MW uprates by 2013
- License Extension
- New Plants



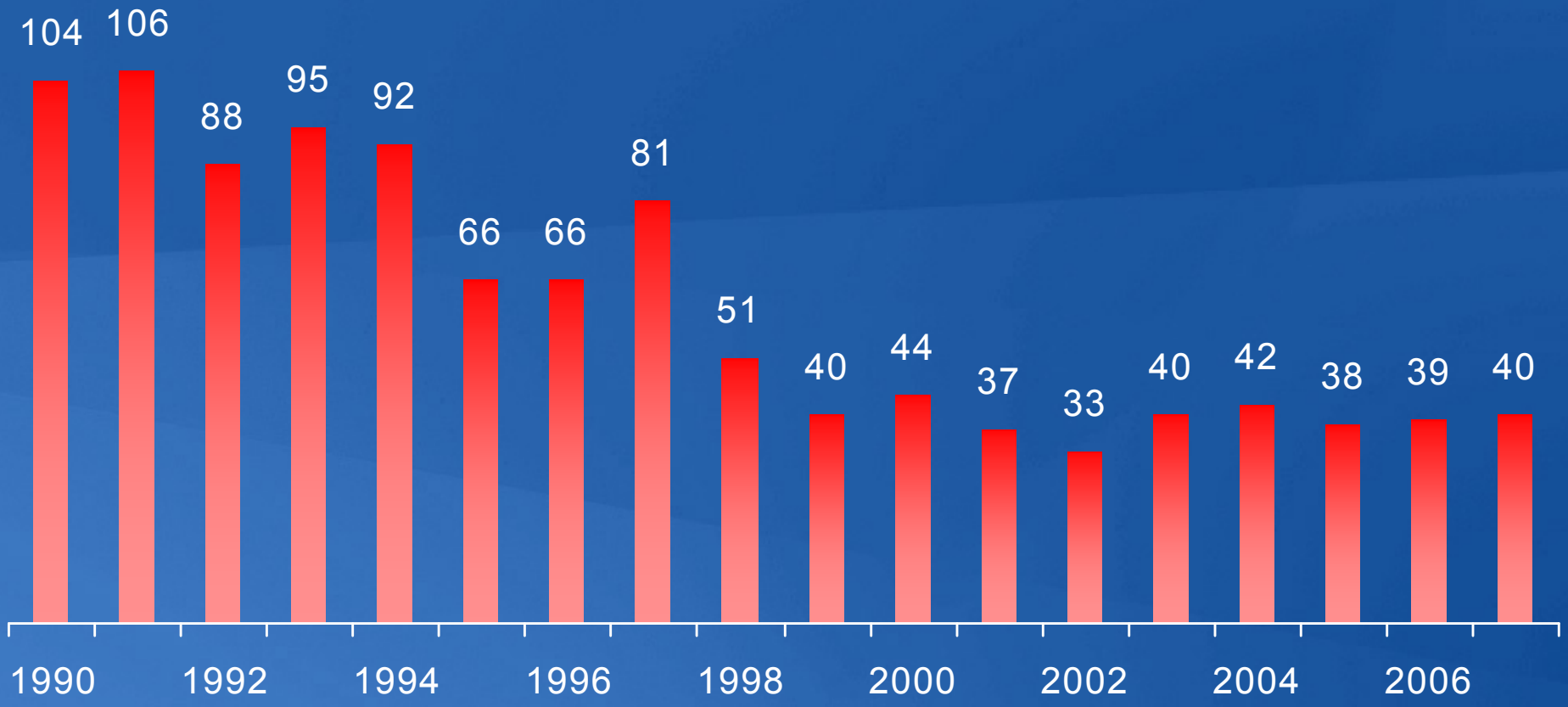
* NEI Estimate

Source: Ventyx Velocity Suite / Energy Information Administration

Updated: 1/09

U.S. Nuclear Refueling Outage Days

Average

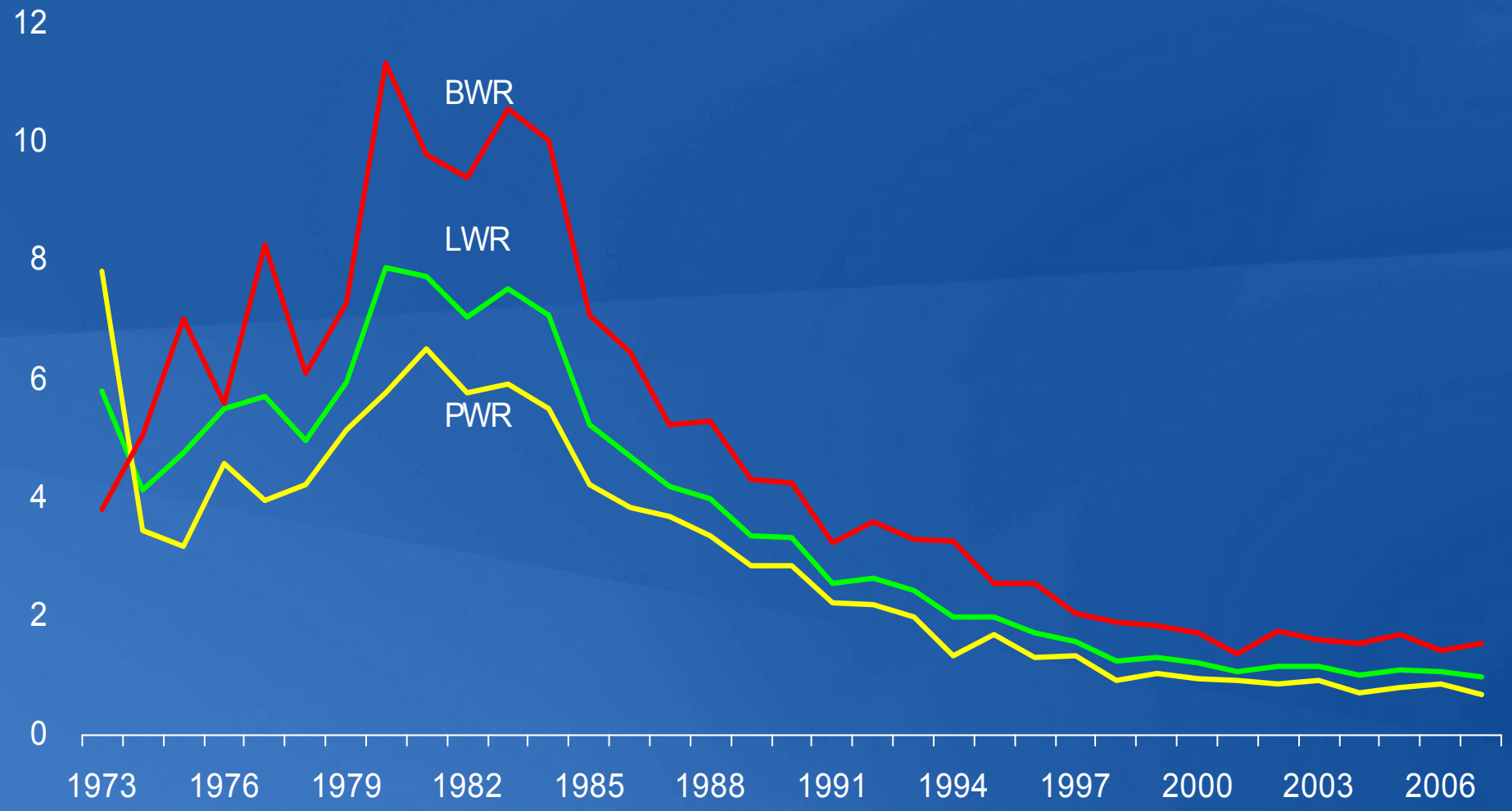


Source: 1990-98 EUCG, 1999-2007 Energy Velocity / Nuclear Regulatory Commission

Updated: 2/08

Average Collective Dose Per Reactor

1973-2006, Person-Sv

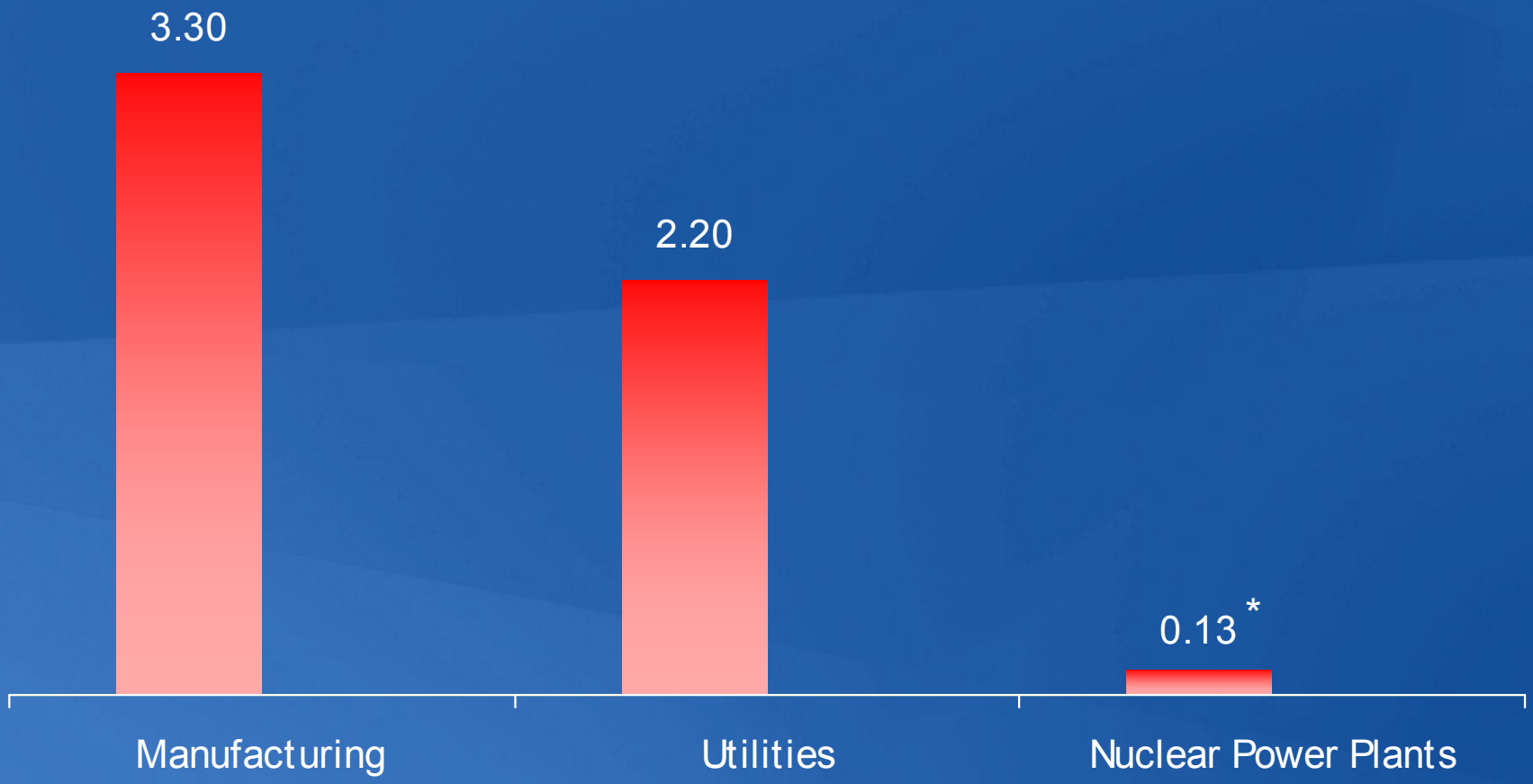


Source: Nuclear Regulatory Commission - Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2006

Updated: 5/08

High Industrial Safety Standards

2007



ISAR = Number of accidents resulting in lost work, restricted work, or fatalities per 200,000 worker hours. Electric utilities and manufacturing do not include fatality data.

*Includes non-utility personnel for provisional 2008 results

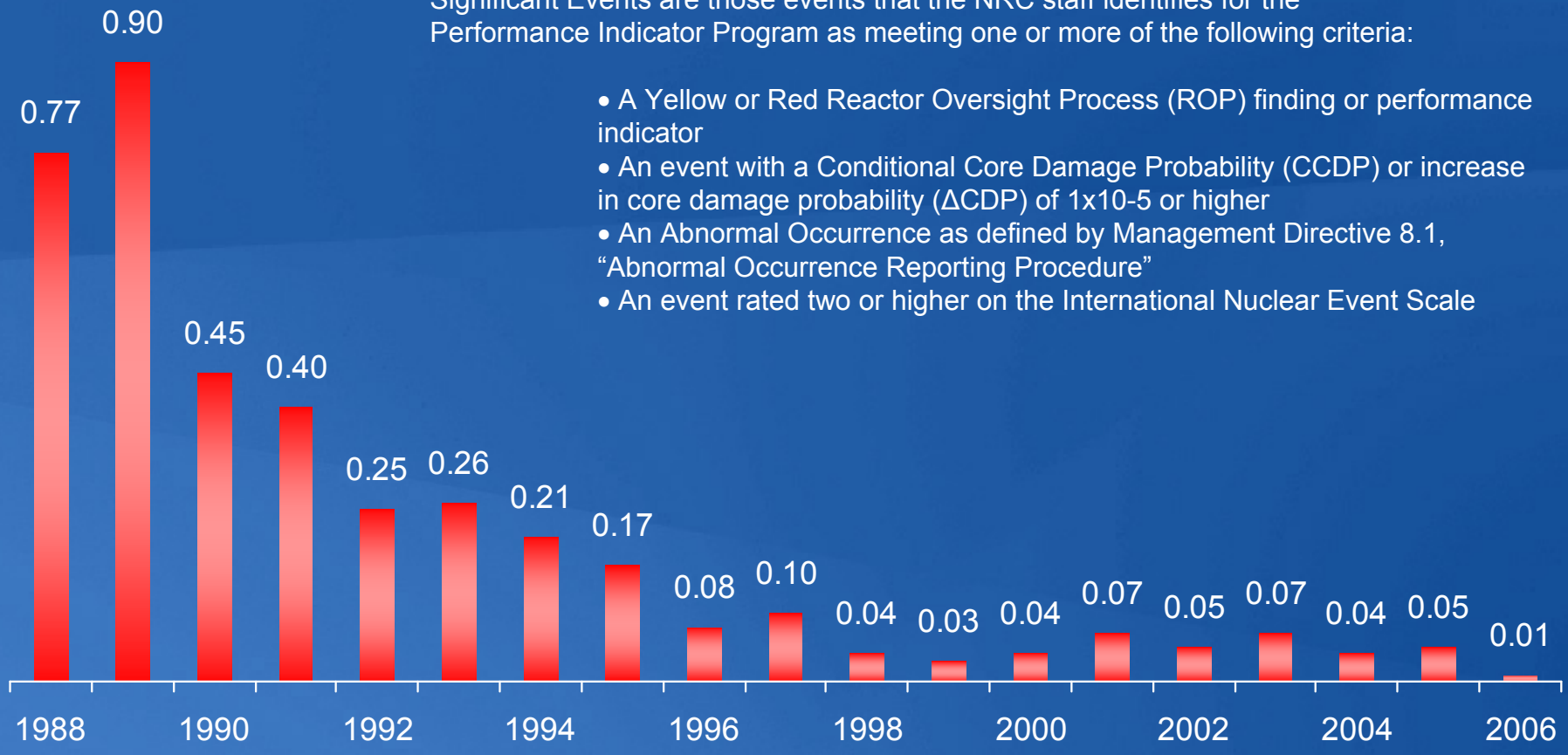
Sources: Nuclear (World Association of Nuclear Operators), 2006 Data for Electric Utilities and Manufacturing (U.S. Bureau of Labor Statistics).

Significant Events at U.S. Nuclear Plants:

Annual Industry Average, Fiscal Year 1988-2006

Significant Events are those events that the NRC staff identifies for the Performance Indicator Program as meeting one or more of the following criteria:

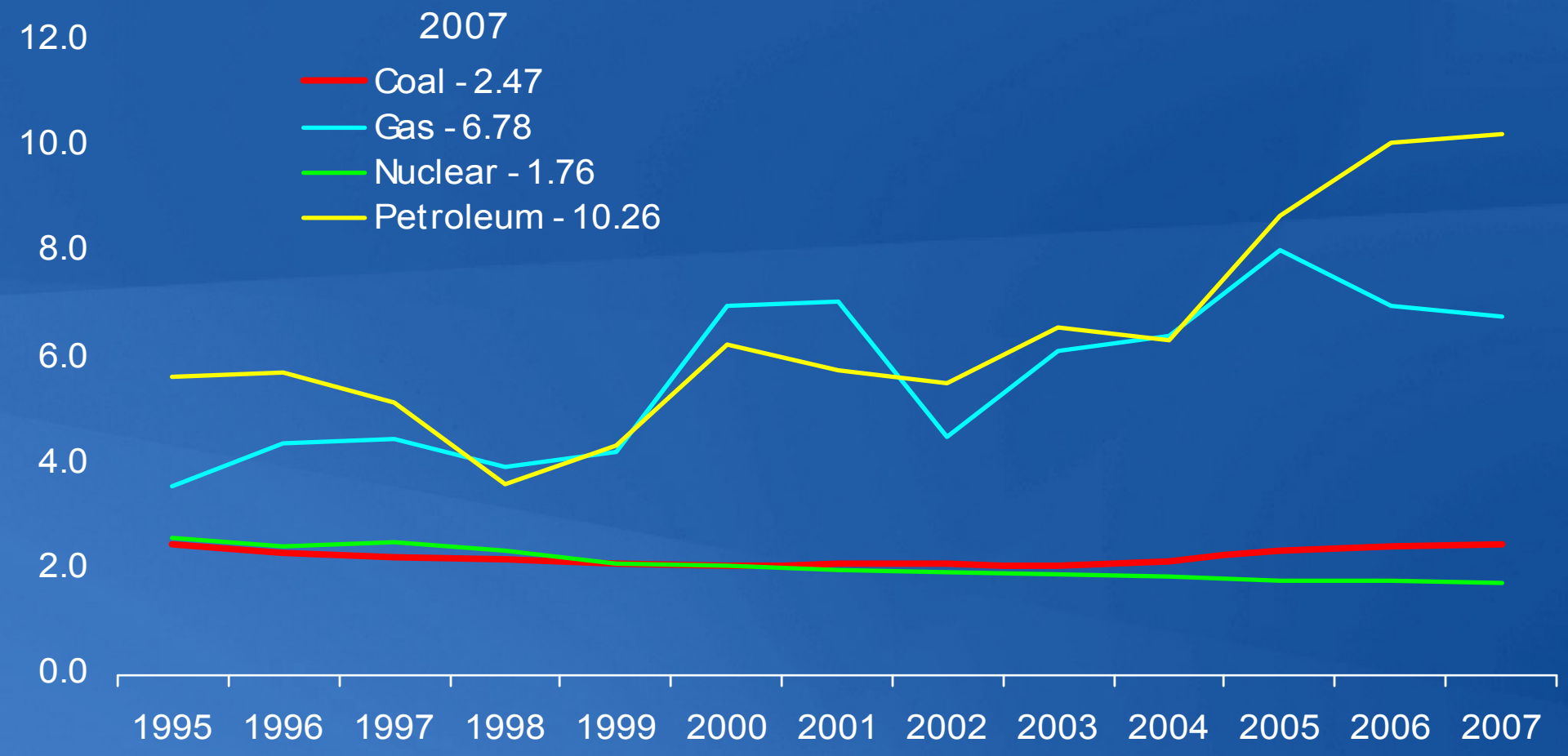
- A Yellow or Red Reactor Oversight Process (ROP) finding or performance indicator
- An event with a Conditional Core Damage Probability (CCDP) or increase in core damage probability (ΔCDP) of 1x10-5 or higher
- An Abnormal Occurrence as defined by Management Directive 8.1, "Abnormal Occurrence Reporting Procedure"
- An event rated two or higher on the International Nuclear Event Scale



Source: NRC Information Digest, 1988 is the earliest year data is available.
Updated: 11/07

U.S. Electricity Production Costs

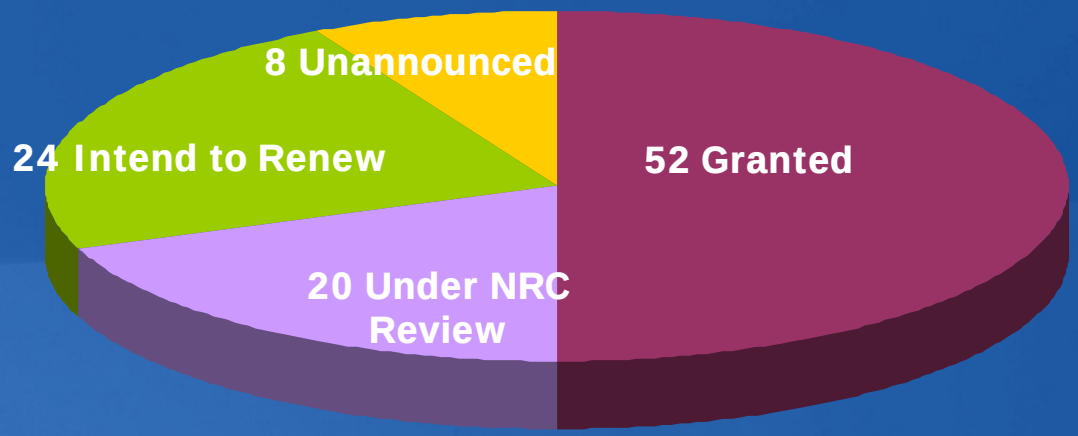
1995-2007, *In 2007 cents per kilowatt-hour*



Production Costs = Operations and Maintenance Costs + Fuel Costs

Source: Global Energy Decisions
Updated: 5/08

License Renewals Continue



… And Plant Restarts

- TVA's Browns Ferry 1 back in service May 2007 (5-year, $1.8 billion project)
- TVA approved Watts Bar 2 completion August 2007 (5-year, $2.5 billion project)

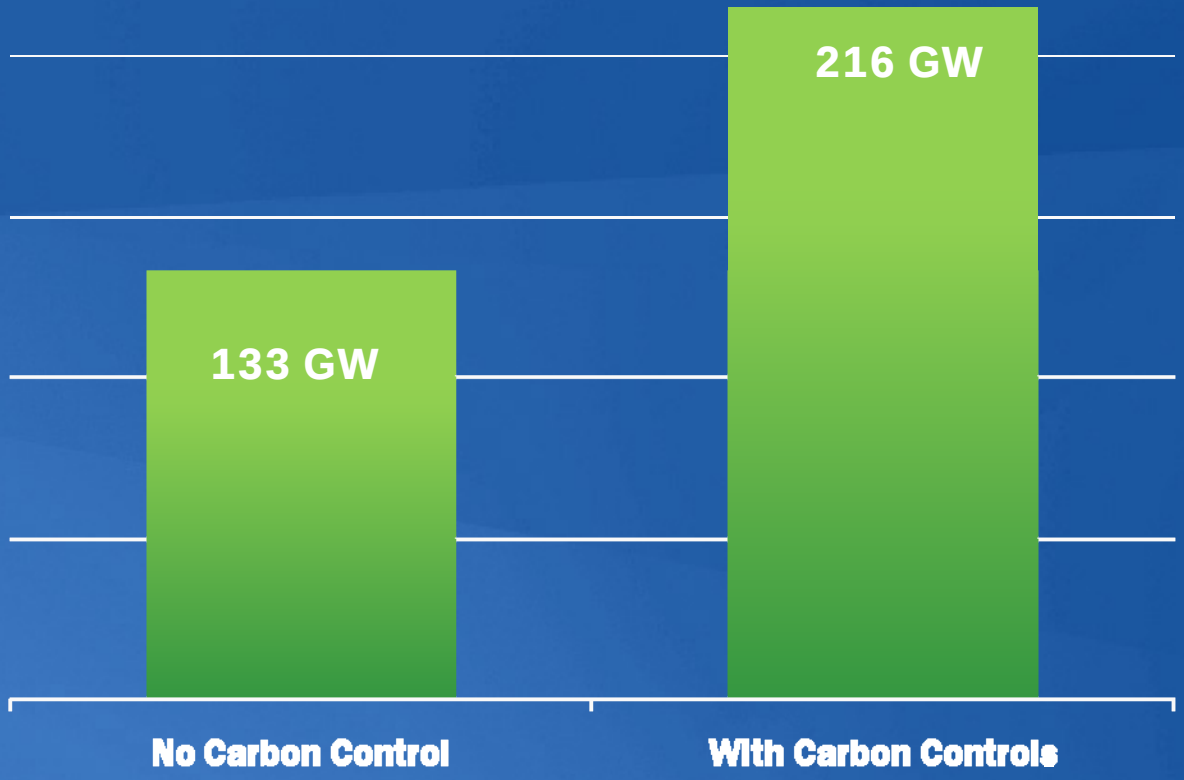
Source: U.S. Nuclear Regulatory Commission

Updated: 4/08

New Generating Capacity Needed

Assumes 0.7% Annual Growth in Peak Load

Average Electricity Growth Rate 2000 to date: 1.5%/yr
Average Electricity Growth Rate in 1990s: 1.8%



Source: The Brattle Group, "Transforming America's Power Industry: The Investment Challenge 2010-2030," November 2008

Need for New Nuclear Plants

- Need for baseload generation
  - Customer growth rates >20,000/yr
  - No new baseload generation for 15+ years
- Climate change
  - Nuclear does not emit greenhouse gases while generating
- Low and stable cost of electricity
  - Fossil fuel price volatility

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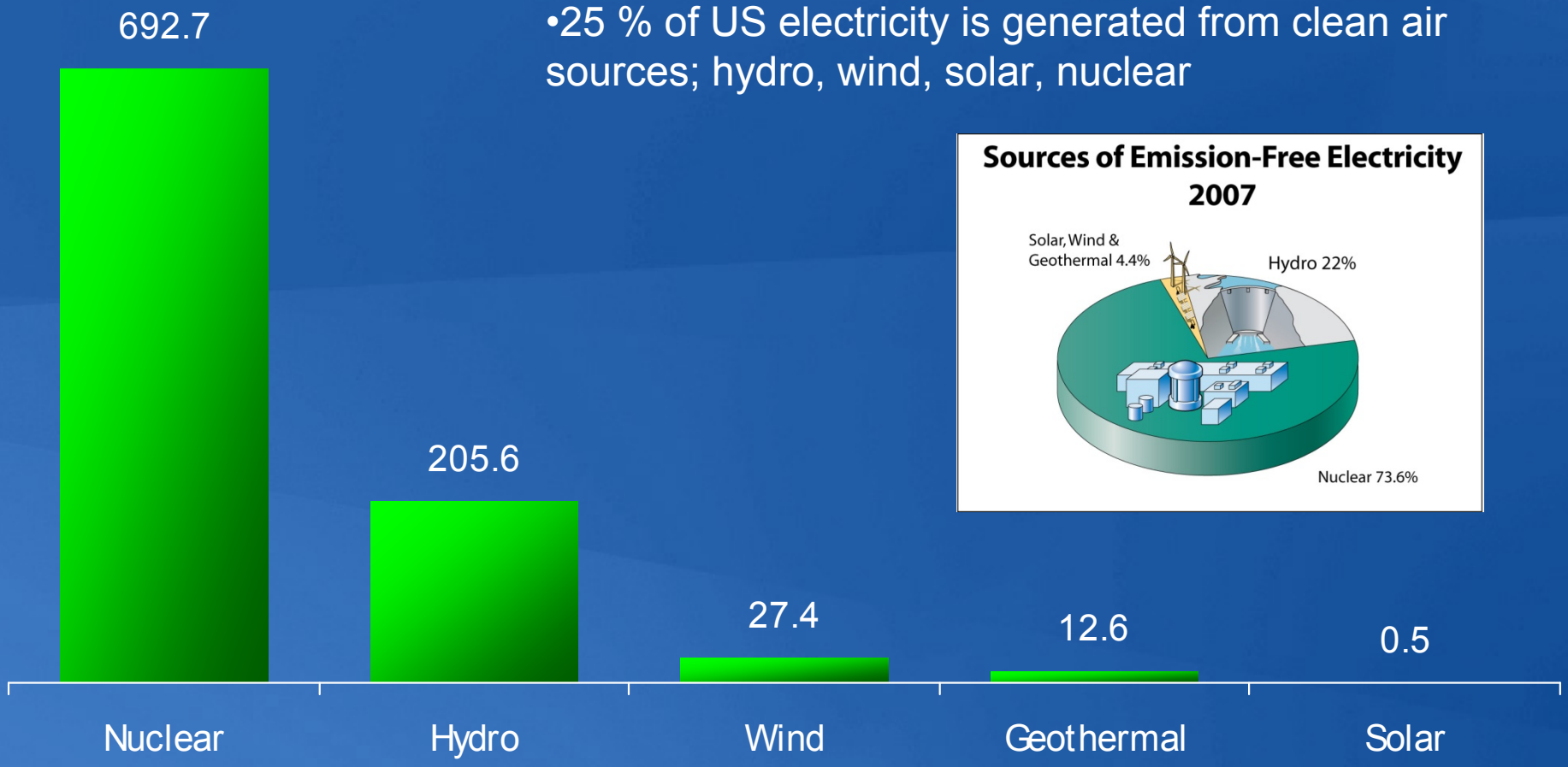
U.S. Electric Power Industry CO_2 Avoided

Million Metric Tons, 2007



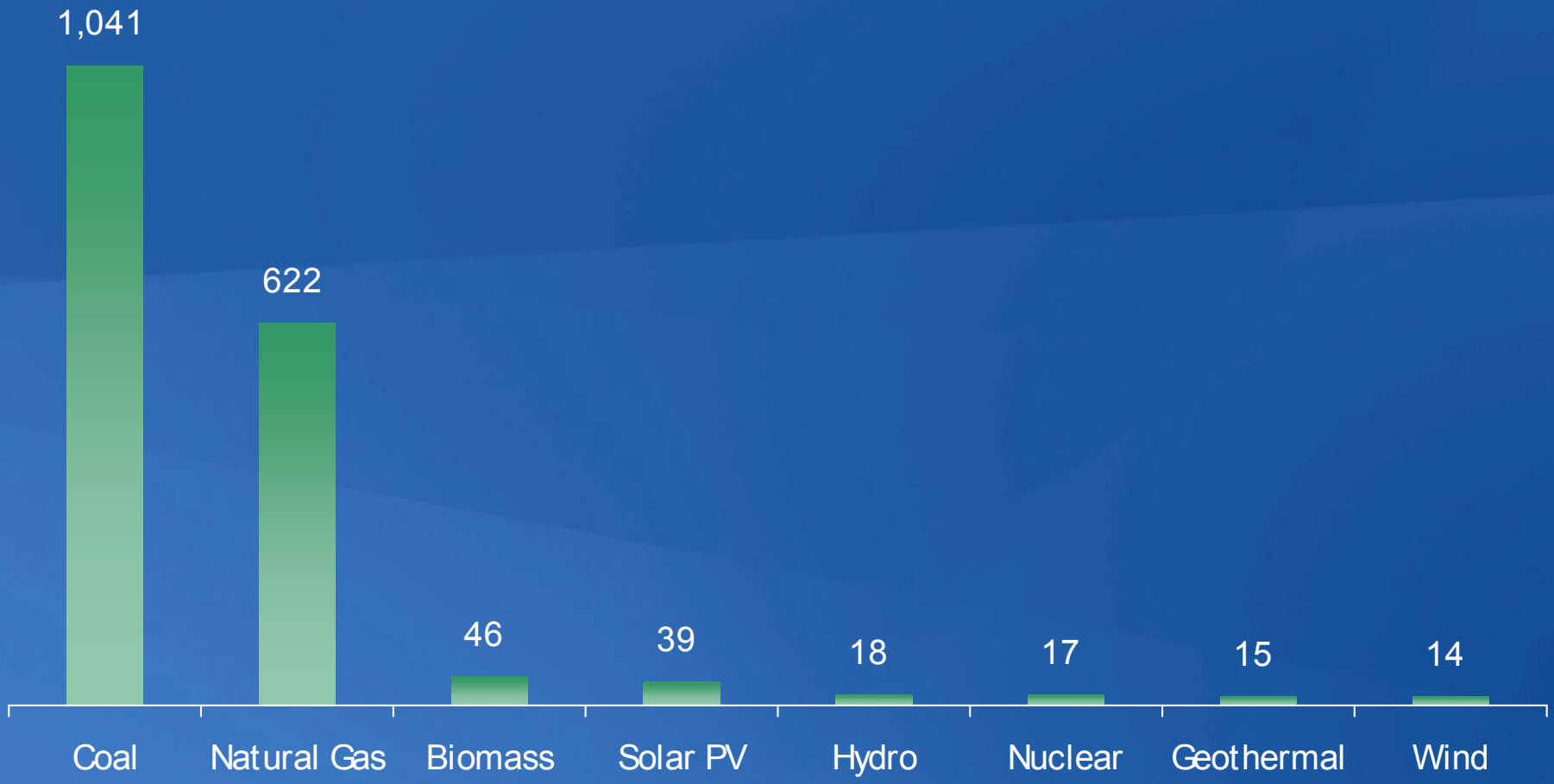
- 25 % of US electricity is generated from clean air sources; hydro, wind, solar, nuclear

Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the Environmental Protection Agency and plant generation data from the Energy Information Administration.

Updated: 4/07

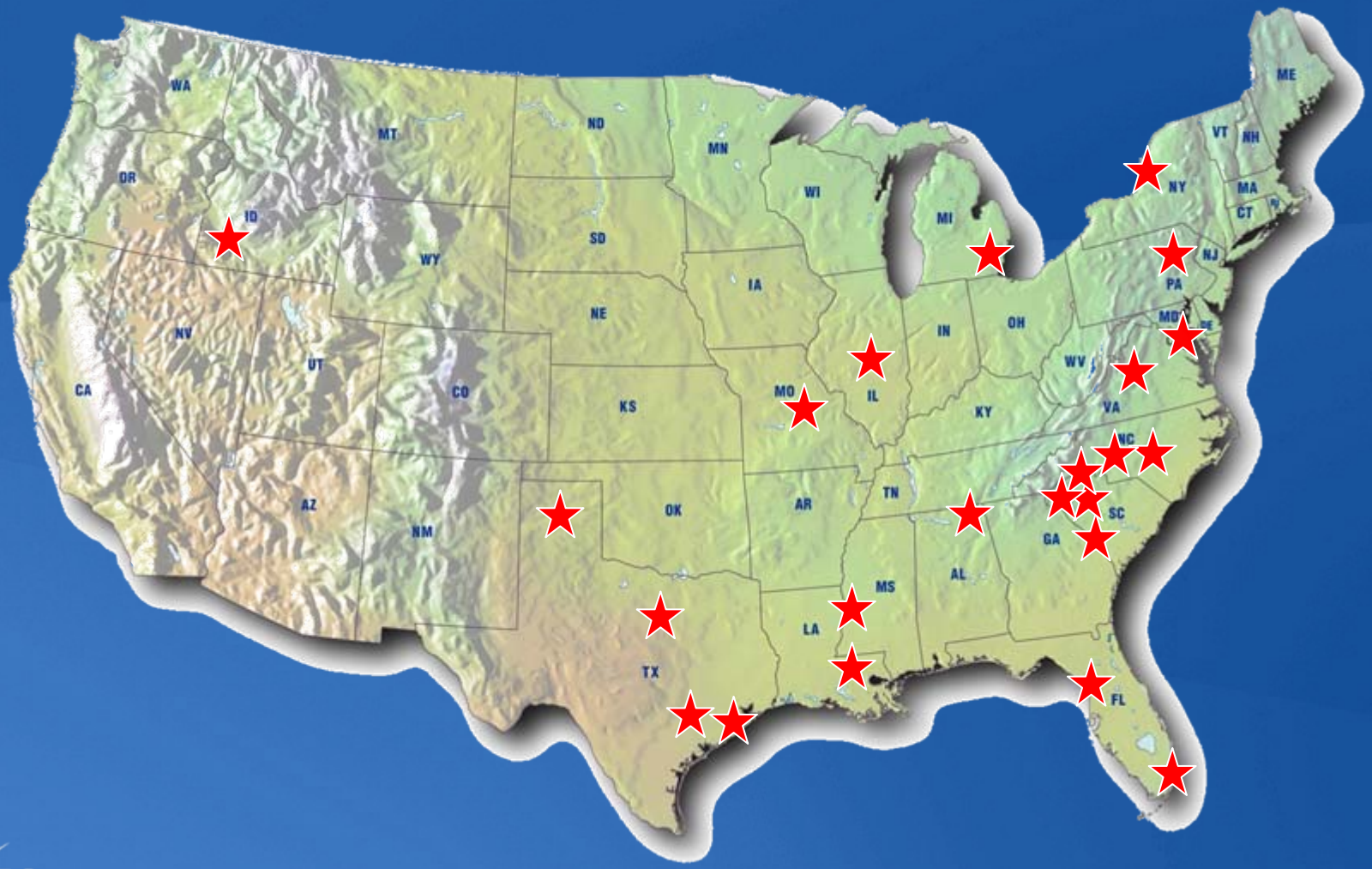
Comparison of Life-Cycle Emissions

Tons of Carbon Dioxide Equivalent per Gigawatt-Hour



Source: "Life-Cycle Assessment of Electricity Generation Systems and Applications for Climate Change Policy Analysis," Paul J. Meier, University of Wisconsin-Madison, August 2002.

Potential New US Nuclear Plants



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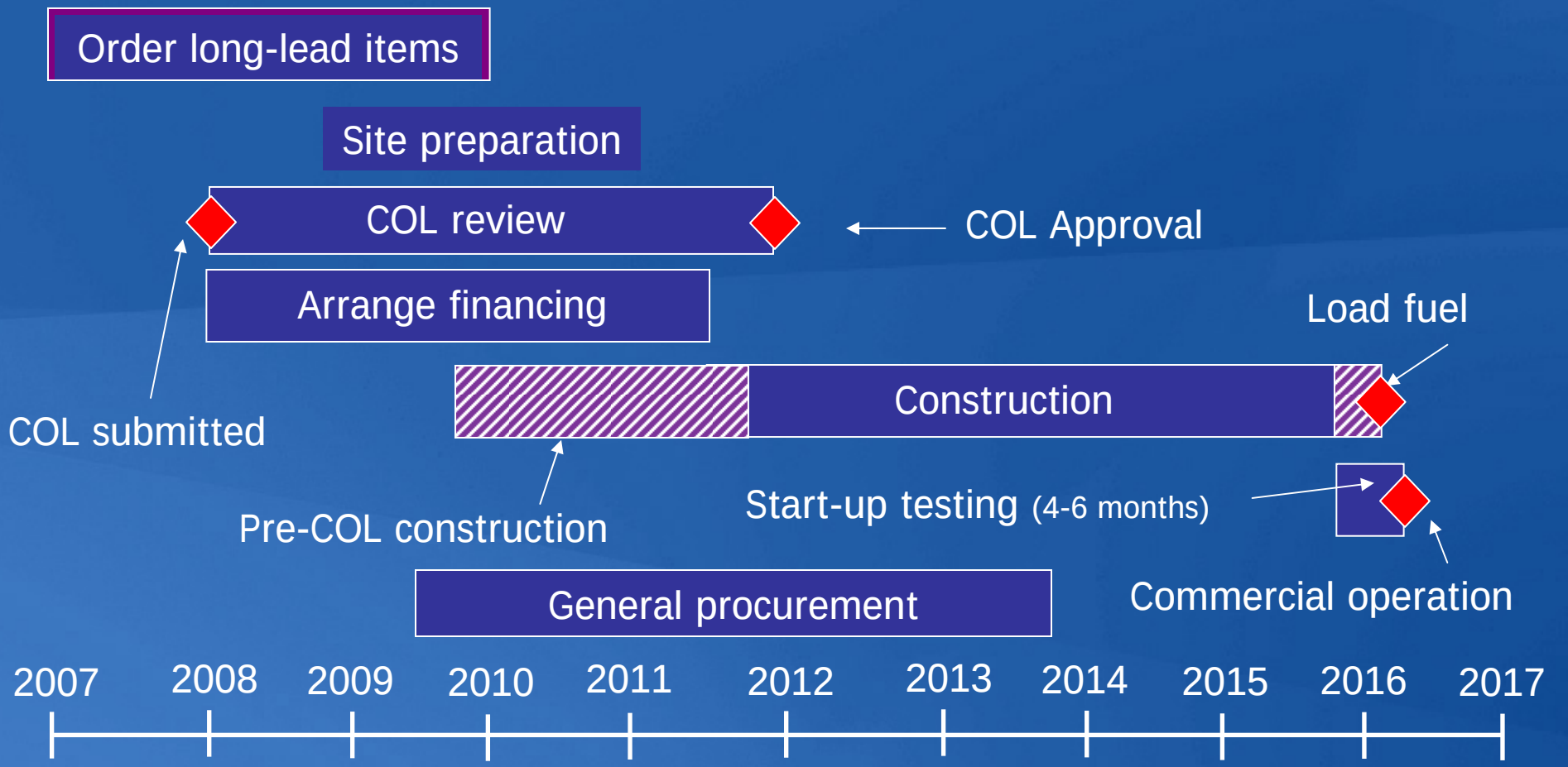
Licensing & Construction Status



Future Designs
Post 2020 Deployment

- Small Light-Water Reactors, Gas-Cooled High Temperature Reactors, & Fast Reactors
- Generation – remote areas of N America & overseas developing countries
- Process heat – industrial applications
    - Petro-chemical industry
    - Hydrogen manufacture
    - Coal/gas to liquid fuels
        - Eliminate carbon footprint
    - Water purification & desalination
    - Fertilizers, ammonia
  - Commercial deployment mid-2020s

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Challenges to New Deployment

- Funding & financing in economic recession
- Workforce
- Supply chain
- High Temperature Reactors
  - Materials – characterization & testing
  - Fuel & graphite
    - Fabrication, testing, quality controls, modeling,
  - Minimal regulatory & industry understanding of technology

Radiation Protection Challenges & Opportunities

Emergent Factors

- New issues emerging in radiation science
  - *Challenges to the linear non-threshold theory, higher sensitivity of women to radiation, non-cancer health effects (e.g., heart disease), lower hereditary risk*
- International radiation standards being updated
  - *For the U.S. – Some criteria more restrictive, new dosimetry, and new units & terminology*
- Increasing emphasis on environmental protection
  - *protection of non-human species (flora and fauna), resource conservation versus public health and safety*

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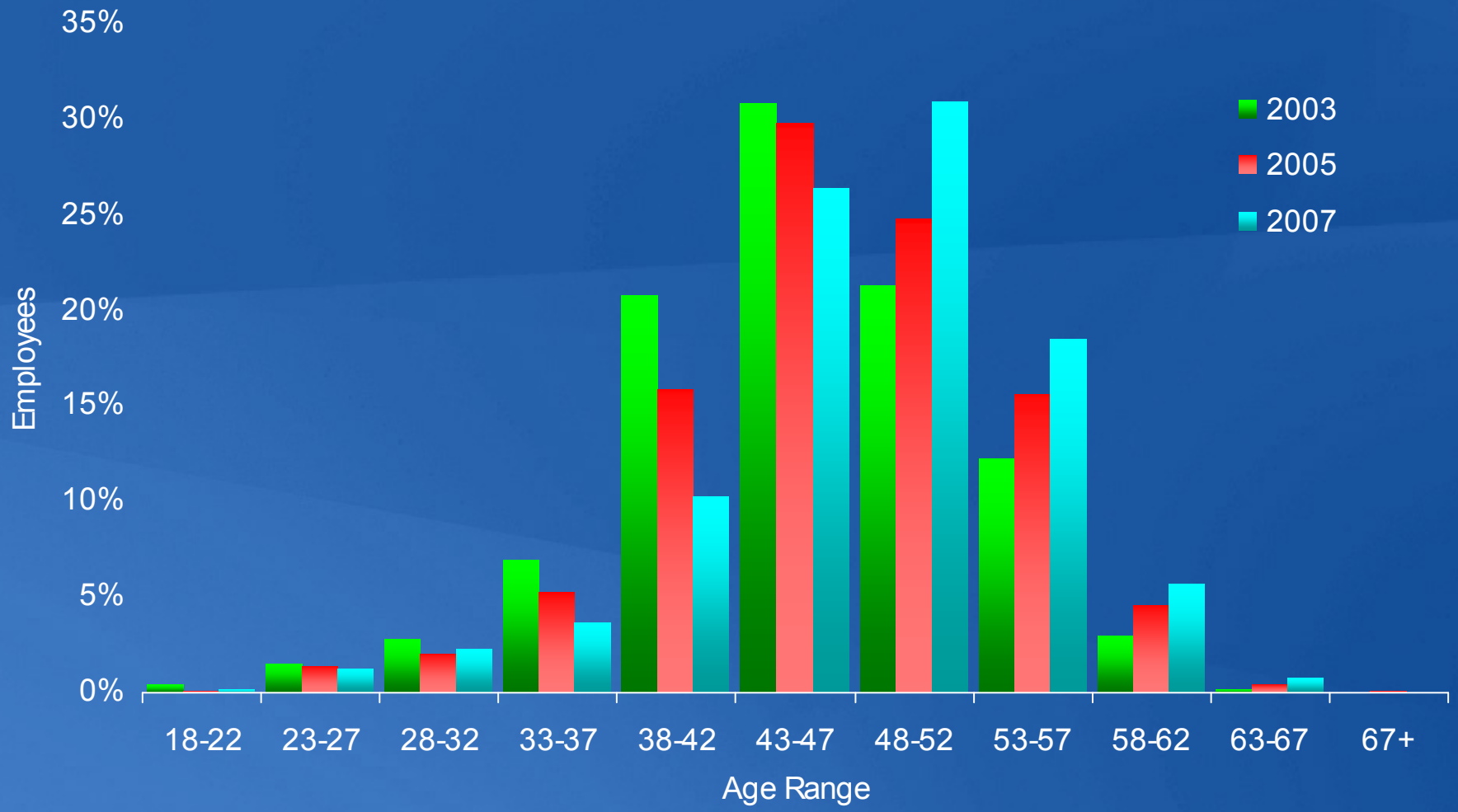
US Nuclear Industry Situation

- Radition protection performance is good, but…
- The staffing “crunch” is here now
- More restrictive dose standards are likely
- We are an expanding and increasingly more global industry

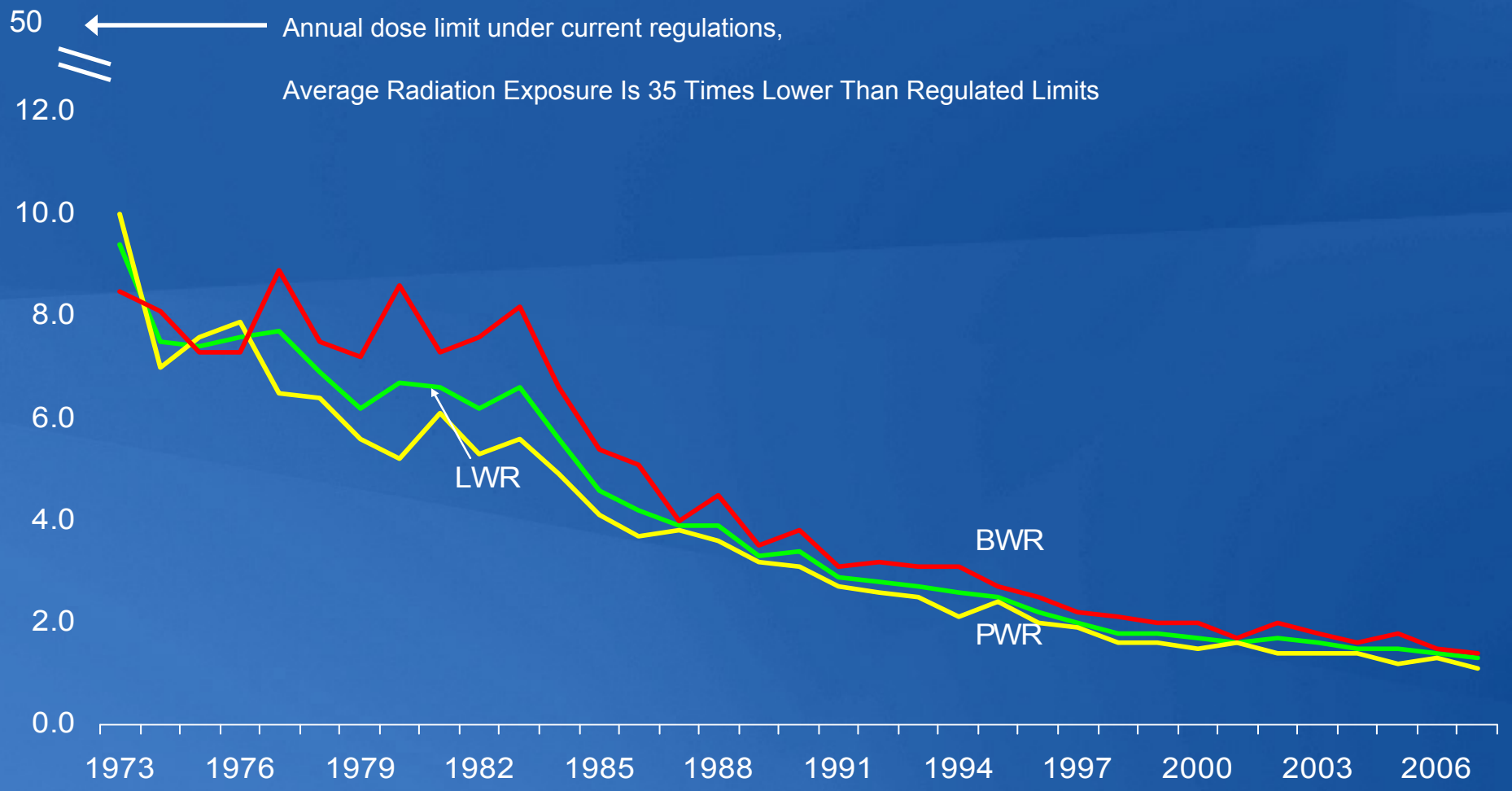
Nuclear Generation Radiation Protection Distribution by Age



Source: 2007 NEI Pipeline Survey

Average Measurable Dose Per Worker

1973-2006 - mSv

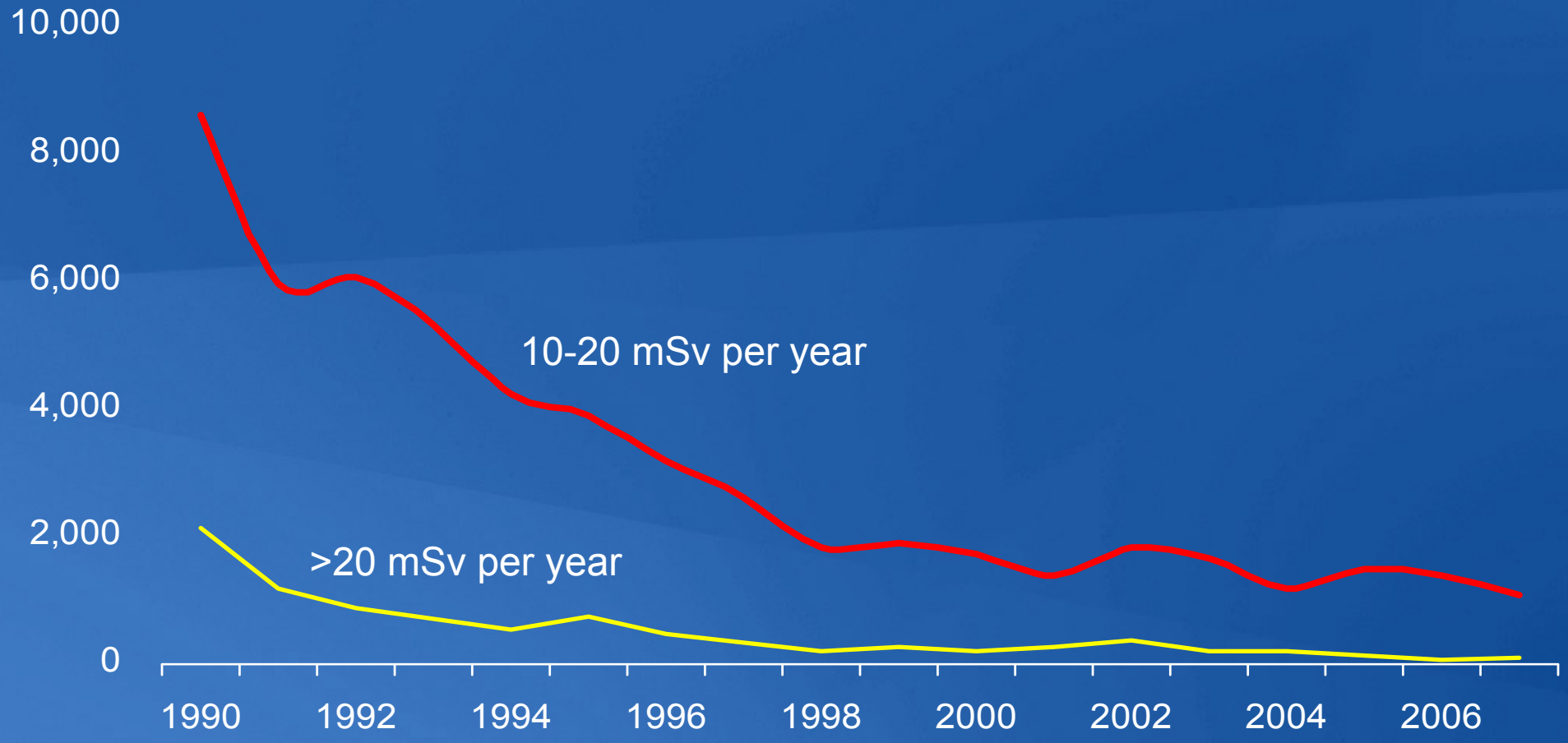


Source: Nuclear Regulatory Commission - Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2006

Updated: 5/08

Annual Individual Worker Exposure at U.S. Nuclear Power Plants

1990-2006, Number of Workers per Year



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Updating NRC RP Regulations

- We agree that the current regulations are fully protective
- In light of nuclear industry globalization, we support better alignment of U.S. regulations with international standards
- We encourage reform, not just updating

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Strategy

Reshape radiation protection at nuclear power plants to achieve significant improvements in safety performance and cost-effectiveness

Objectives

1. Inform and influence RP regulations
2. Reduce radiation fields
3. Improve technologies utilization
4. Standardize RP practices
5. Align RP workforce supply & demand
6. Improve RP transparency and openness

Principles

1. Radiation is managed safely
2. Radiation doses are ALARA
3. Step-change improvements are needed
4. Dose is the bottom-line metric
5. Workers and the public need to be informed and involved
6. RP is global

Ongoing Industry Actions

- Reduce Radiation Fields (EPRI)
  - Collect and analyze radiation field data
  - Corrosion, transport and activation mechanisms
  - Effects of surface treatments and chemical additions
- Improve Technologies Utilization (EPRI)
  - Inspection and welding
  - Communication and monitoring
  - Shielding and scaffolding
- Workforce (NEI)
  - Activities to improve RP workforce pipeline

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2009-2010 Projects

1. Determine impacts of new RP regulations & recommend industry actions

2. Evaluate permanent and temporary RP staff utilization

3. Evaluate improvements to RP transparency & openness

RP is Global

- We are already sharing workers and radiation protection technicians
- We are all projecting a shortfall in new RP staff
- We have common challenges with human performance and safety culture issues
- We have learned that an event at one of our plants is an event at all of our plants
- Any source of misinformation about radiation safety affects us all

Some Global Opportunities ?

- Common standards and expectations for:
  - Radiation workers
  - RP technicians
- Common approaches to human performance & safety culture in regard to radiation protection
- Common protocols for public communication about radiation & radiation safety
- Global occupational dose tracking system
- Global “heads-up” information sharing system