Nuclear Energy:

Environmental Value Today and Tomorrow

Mary Quillian
Senior Manager, Environmental Policy and Planning
Nuclear Energy Institute
202-739-8013
mmq@nei.org

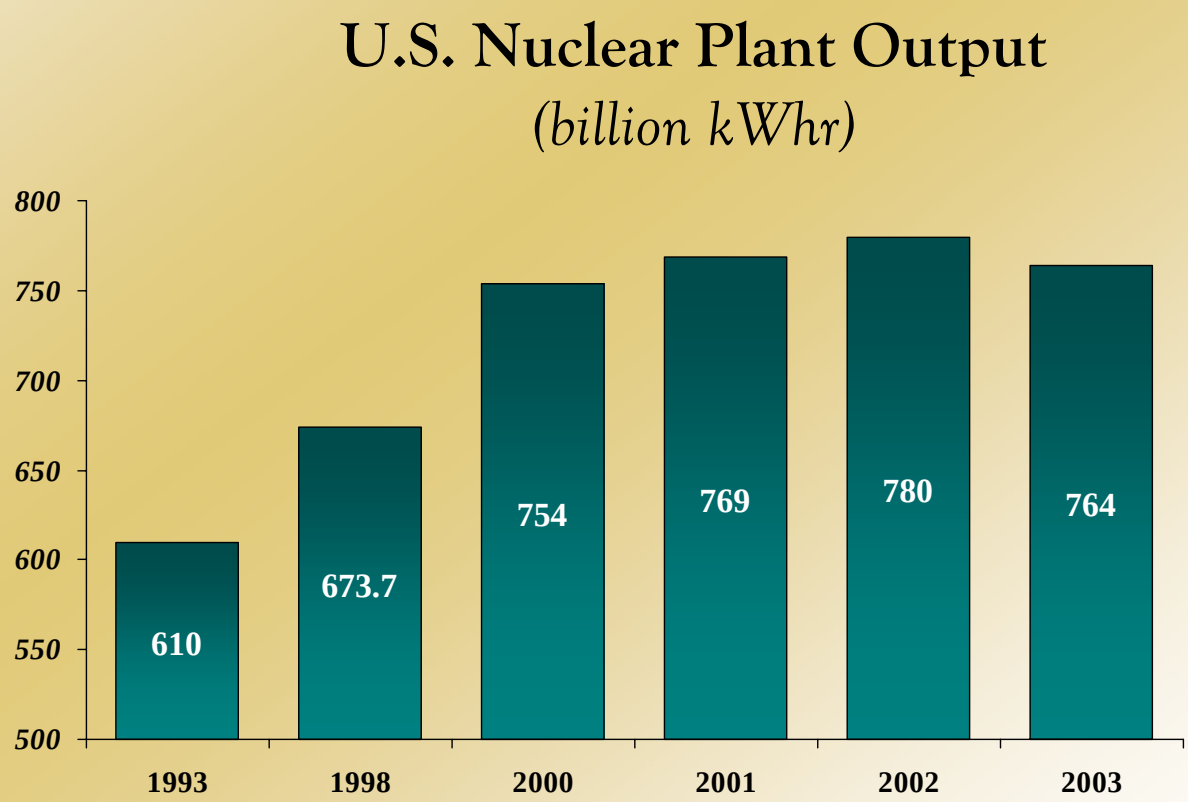
January 13, 2005

Slides for STAPPA/ALAPCO Energy Committee Phone Conference

Key Trends in Nuclear Business

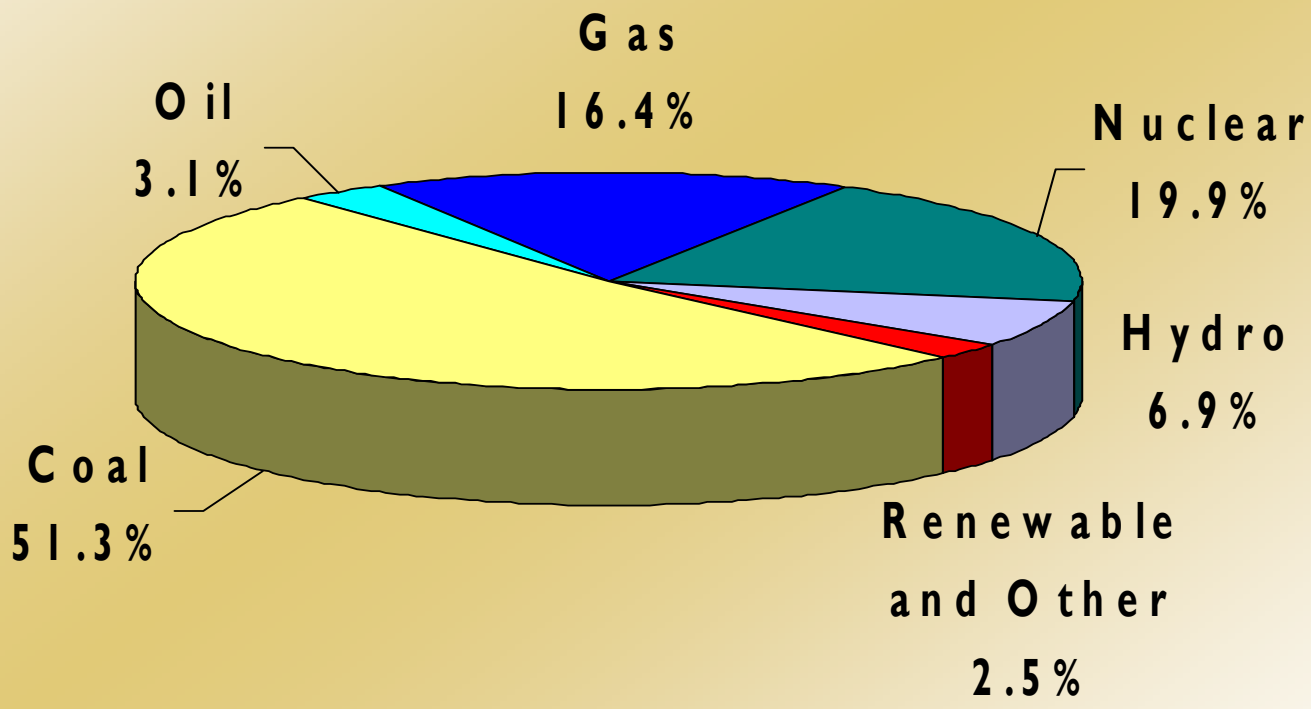
1) Consolidation of ownership, operating responsibility

2) Improved performance: equivalent to output of 19 1,000-MW plants 1993-2003



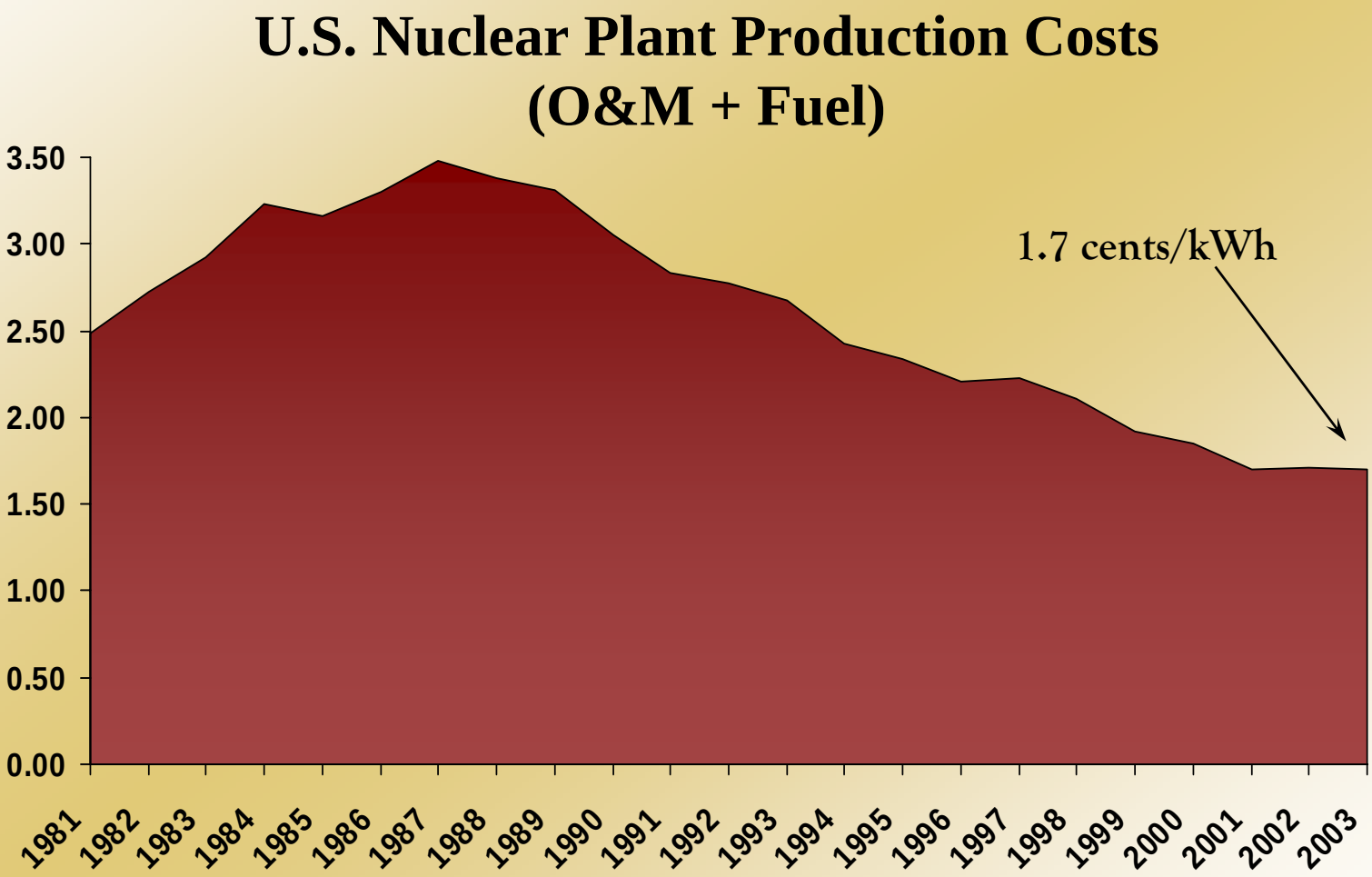
Key Trends in Nuclear Business

U.S. Electric Generation by Fuel Source (2003)



Source: EIA Updated 10/04

Key Trends in Nuclear Business

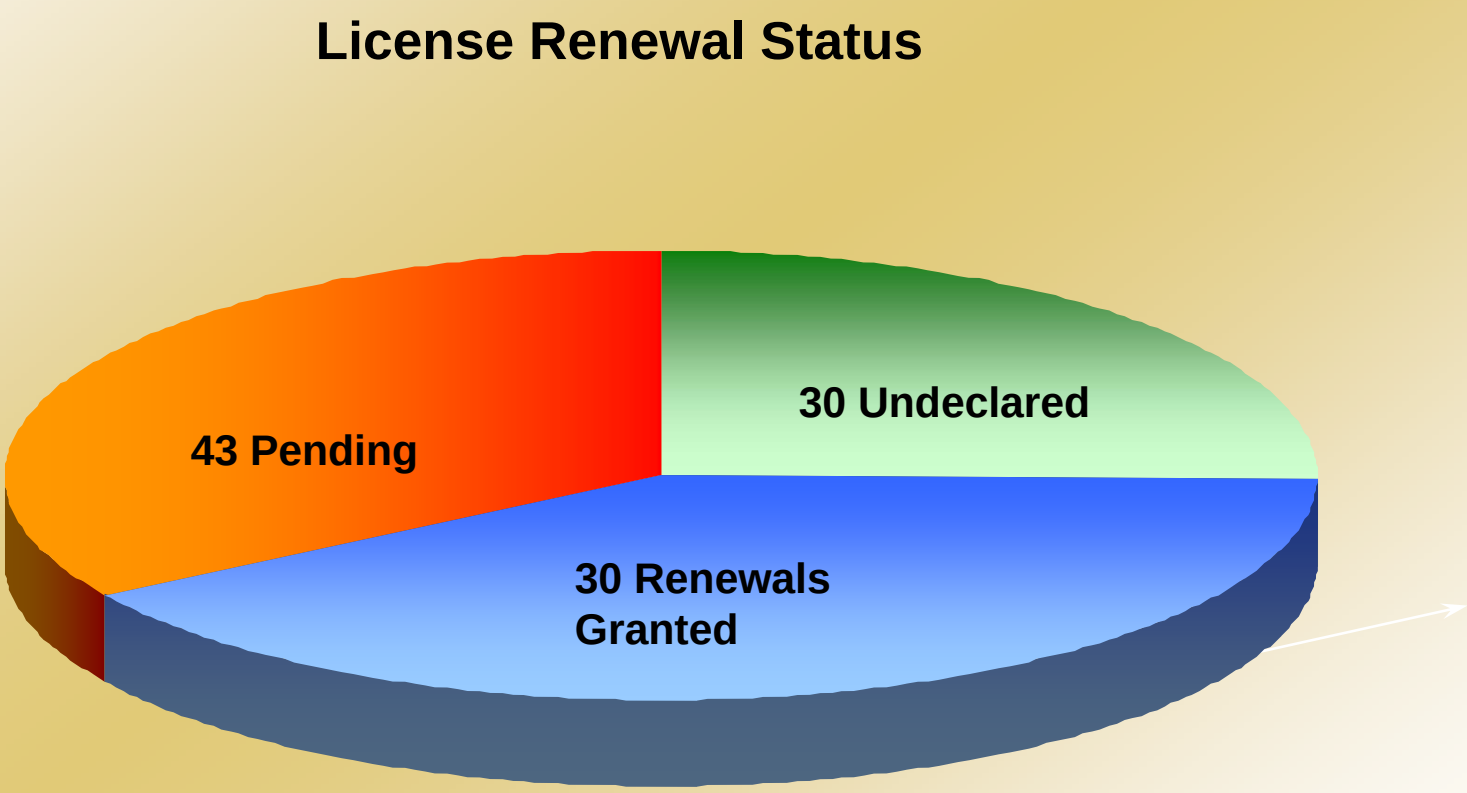


Source: FERC/EUCG Updated 9/04

Key Trends in Nuclear Business

- Power Uprates: with capital investment, existing plants can increase capacity. NRC must approve these license amendments.
  - Approximately 2,000 MWe added 2000-2003
  - Approximately 2,000 MWe under review at NRC
  - There is likely 2,500 MWe potential uprate capacity beyond

Key Trends in Nuclear Business



Update on Used Fuel Disposal
Continuing Progress

- Congressional approval for siting repository at Yucca Mountain in 2002
- DOE and industry working with Nevada to address concerns and resolve issues
- Action needed on Nuclear Waste Fund and congressional appropriations
  - Nuclear Waste Fund has collected $23 billion since 1982; $14 billion remains unspent
- DOE should be able to submit license application to the NRC in mid-2005
- Anticipate first fuel delivered to repository 2010

U.S. Emissions Control Programs ... Historical Perspective

- Legislation, policies, programs, regulations designed to reduce emissions ...
  - focus almost exclusively on reducing emissions from polluting sources
  - do not generally recognize the contribution from non-emitting sources

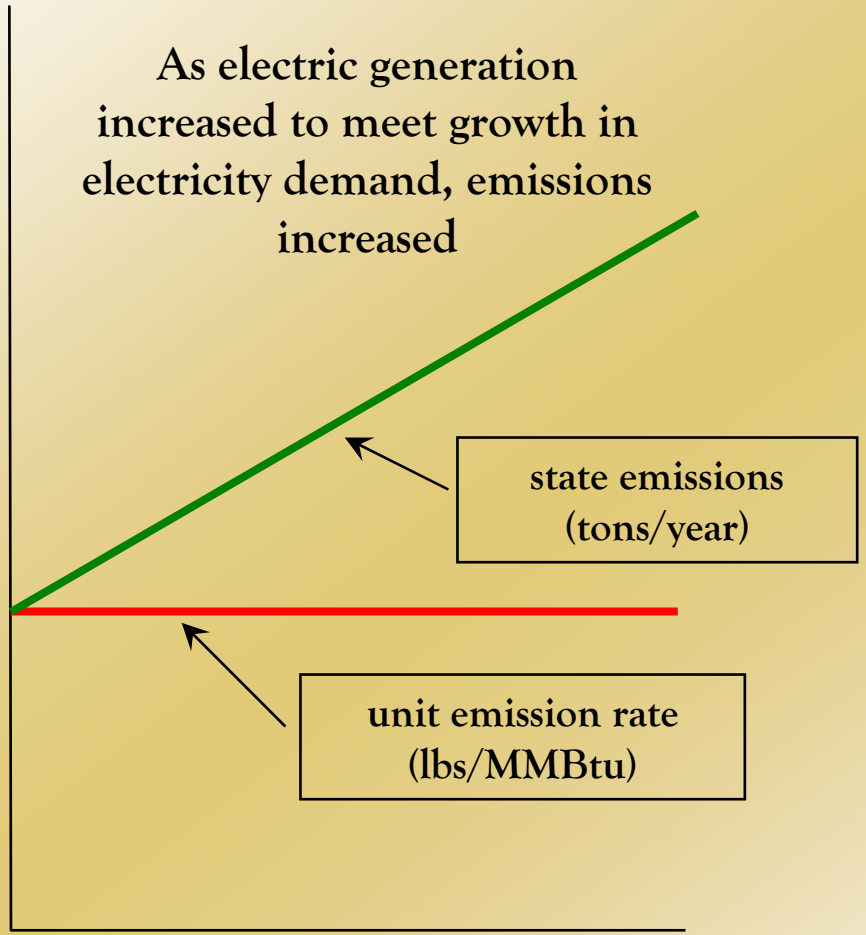
U.S. Emissions Control Programs … Historical Perspective

- When Clean Air Act passed in 1970, non-emitting sources represented < 10% of U.S. electricity supply, had little clean air compliance value
- Today, non-emitting sources represent ~30% of electricity supply
  - Non-emitting sources have a measurable clean air compliance value
  - Non-emitting sources reduce cost of electricity by reducing cost of compliance for fossil-fueled generating capacity

Impact of Cap & Trade On Emission Policies

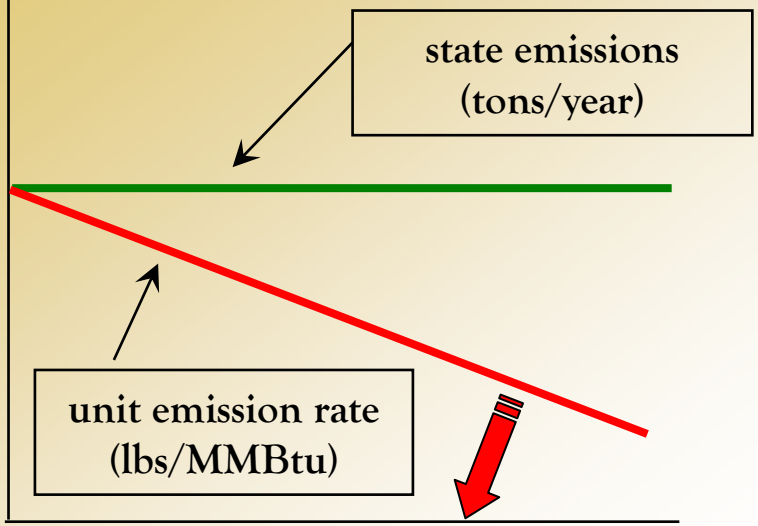
PAST

As electric generation increased to meet growth in electricity demand, emissions increased

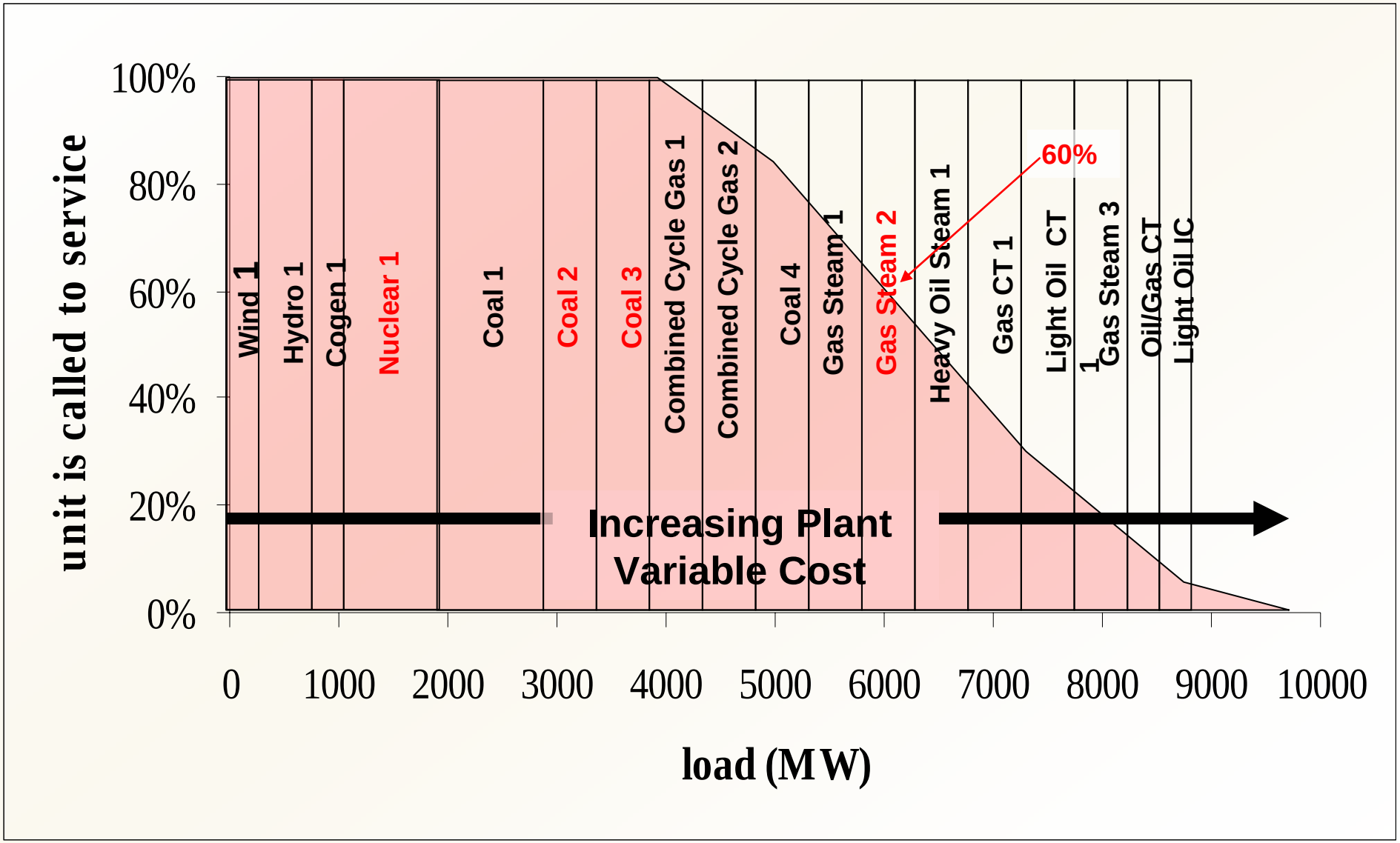


NOW

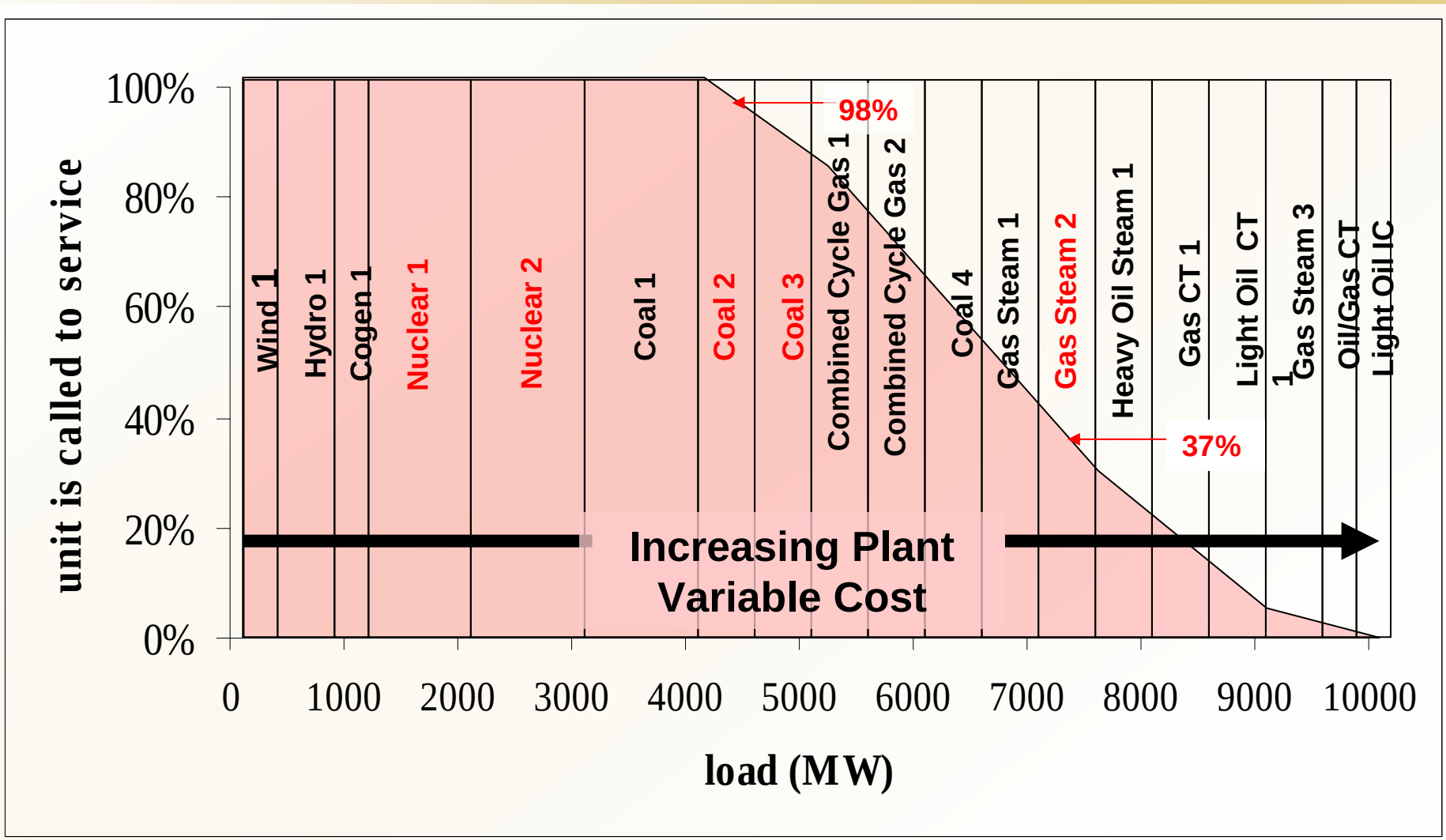
Emissions are capped: As electricity demand and generation increases, unit emission rates must decline … unless new electricity demand is met by non-emitting sources



How Non-Emitting Capacity Prevents Emissions



New Nuclear Capacity Prevents Emissions by Displacing Fossil-Fueled Capacity



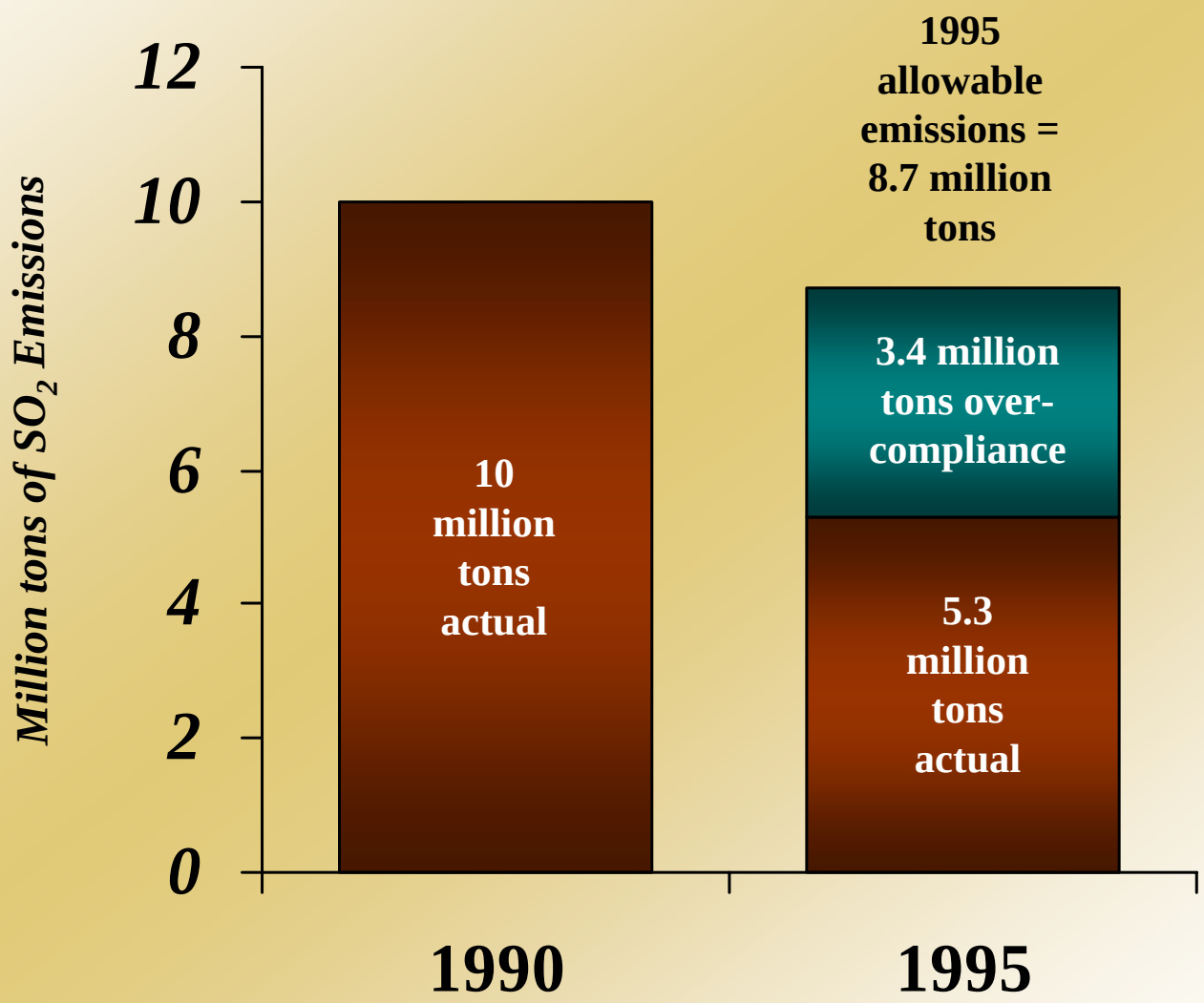
NOx, SO_2, and CO_2 Emissions Avoided by U.S. Nuclear Power Plants

Year	SO_2 *(million short tons)*	*NOx (million short tons)*	CO_2 *(million metric tons)*
2003	3.36	1.24	679.8
Emissions reduced at fossil generating plants 1990-2001 as a result of 1990 Clean Air Act amendments	5.1	1.97	***CO_2 emissions not regulated by Clean Air Act***

SO_2 emissions for the electric power sector in 1990 were 15.73 million tons; by 2001, emissions had been reduced to 10.63 million tons, a 5.1-million-ton reduction. NOx emissions from the power sector in 1990 were 6.66 million tons; by 2001, NOx emissions had been reduced to 4.69 million tons, a 1.97-million-ton reduction.

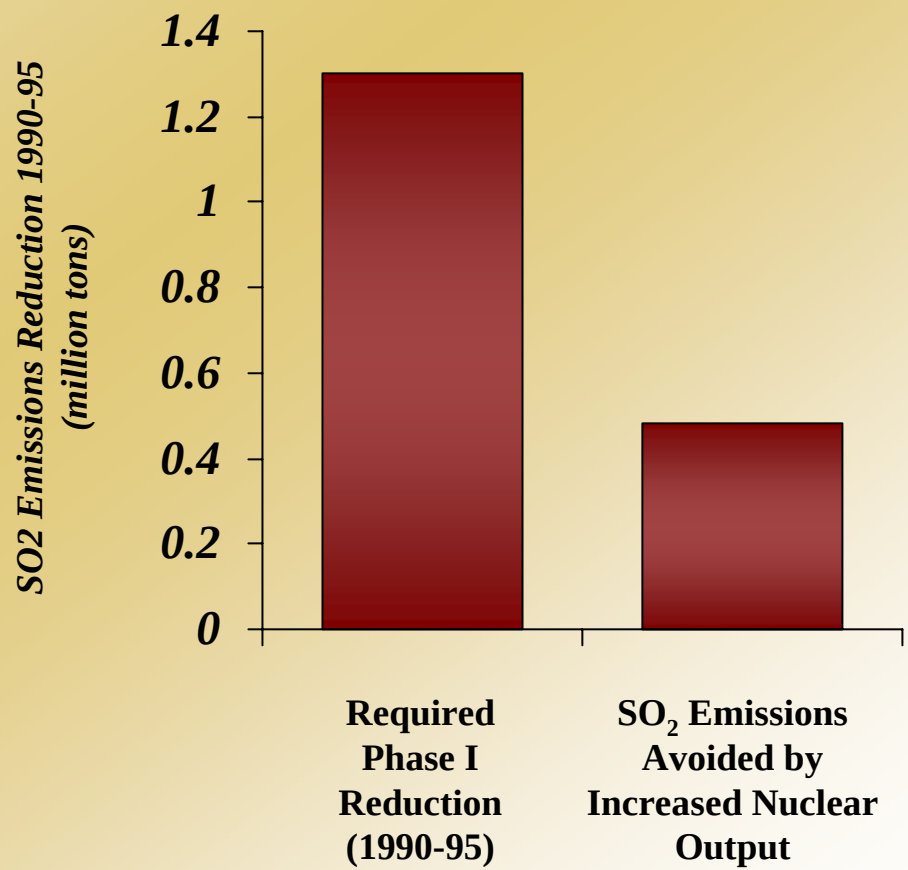
NEI

SO_2 Reductions Under Phase I of 1990 Clean Air Act



Increased Nuclear Generation Produced 480,000 Tons of SO_2 Allowances

- Nuclear generation increased by 16.4% between 1990 and 1995 due to ...
  - *increased capacity factors*
  - *reduced outages*
  - *shorter refueling time*
- 480,000 tons of SO_2 emissions were avoided ➔ no compliance cost was incurred by Phase I plants
- Avoided emissions were "banked" by Phase I plants for use in future



Nuclear Role in NOx Compliance

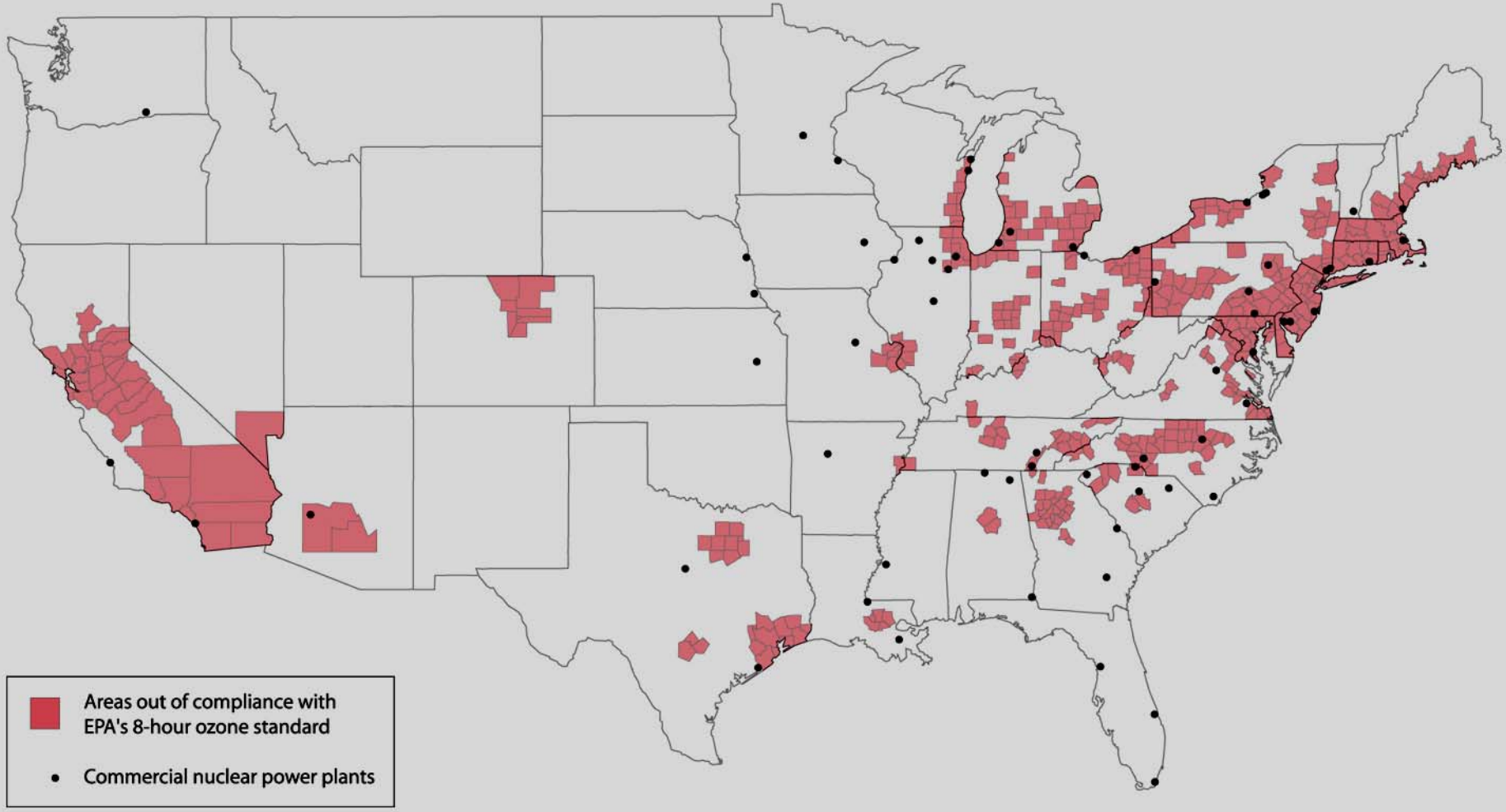
Initial concern: NOx reductions due to increase in imported power from upwind, non-OTC program units. But …

	1997 and 1998 2-Year Average MWh	2000 and 2001 2-Year Average MWh	Change in 2-Year Average MWh
Nuclear Net Generation	59,132,000	77,787,000	18,655,000
Acid Rain Unit Gross Generation	119,525,000	119,019,000	-506,000
Utility Sales	213,085,000	224,355,000	11,270,000

"… increases in OTC nuclear generation appear to offset increases in regional demand and account for much of the decrease in fossil generation."

Source: EPA-OTC NOx Budget Program 1999-2002 Progress Report

Non-Emitting Nuclear Power Plants Supply Electricity To Most Non–Attainment Areas



Nuclear Power Is Vital to the Success of CAIR

- There are 103 operating nuclear power plants in the United States today
- 91 of those plants are in states affected by the proposed CAIR rule

	Emissions prevented by nuclear power plants in CAIR region (2002)	Emission caps proposed for CAIR region (2010)
SO_2	3.2 million tons	3.6 million tons
NOx	1.2 million tons	1.6 million tons

Nuclear Power Is Vital to the Success of CAIR

License renewal is important

- Current licenses of more than 17,000 MW of nuclear capacity in the CAIR region will expire by 2015
- If that capacity were replaced by combined cycle natural gas generators, almost 29,000 tons of NOx would be added to the system

Nuclear Power Is Vital to the Success of CAIR

Nuclear power plant uprates and restarts will reduce emissions

- 6,500 MW of uprate potential* at existing nuclear power plants in CAIR region
- Adding 6,500 MW of nuclear capacity rather than 6,500 MW of natural gas fired capacity prevents the addition of 11,000 tons of NOx
- Browns Ferry 1 restart…

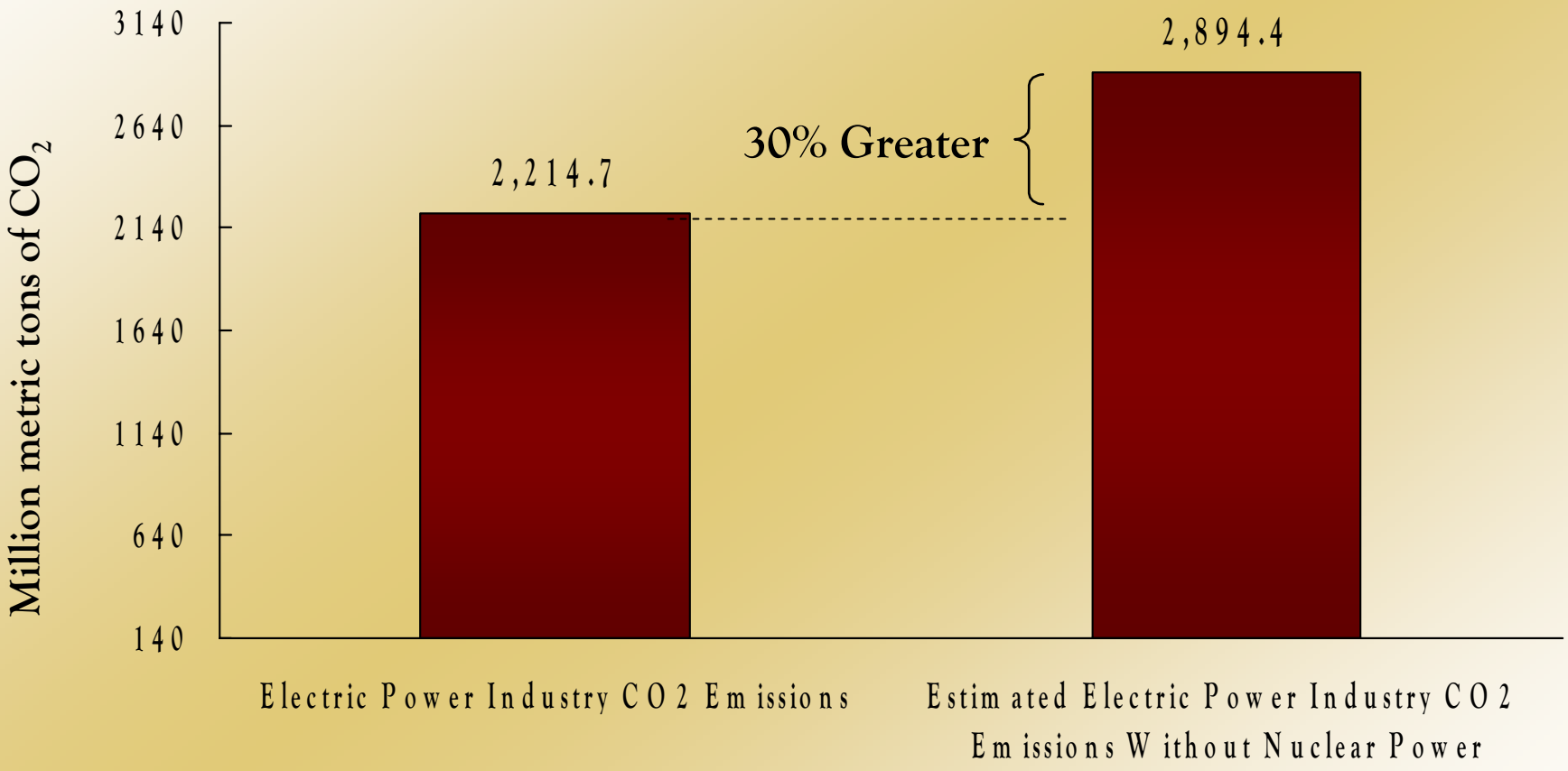
* "U.S. Commercial Nuclear Power Industry Assessment for Department of Energy, Energy Information Agency," October, 2001.

One Example of Nuclear Energy's Contribution to Clean Air Attainment

- One closed nuclear power plant scheduled to re-start before stricter clean air limits take effect.
- The Tennessee Valley Authority (TVA) is renovating Browns Ferry 1 in northern Alabama.
- Browns Ferry 1 will come back on line in 2007 and reduce regional emissions by 54,000 tons of SO_2 and 14,000 tons of NOx per year.
- Alabama's assigned budget for SO_2 = 157,582 tons; for NOx = 67,422 tons
- The restart of Browns Ferry 1 will economically reduce emissions in the Tennessee Valley

NEI

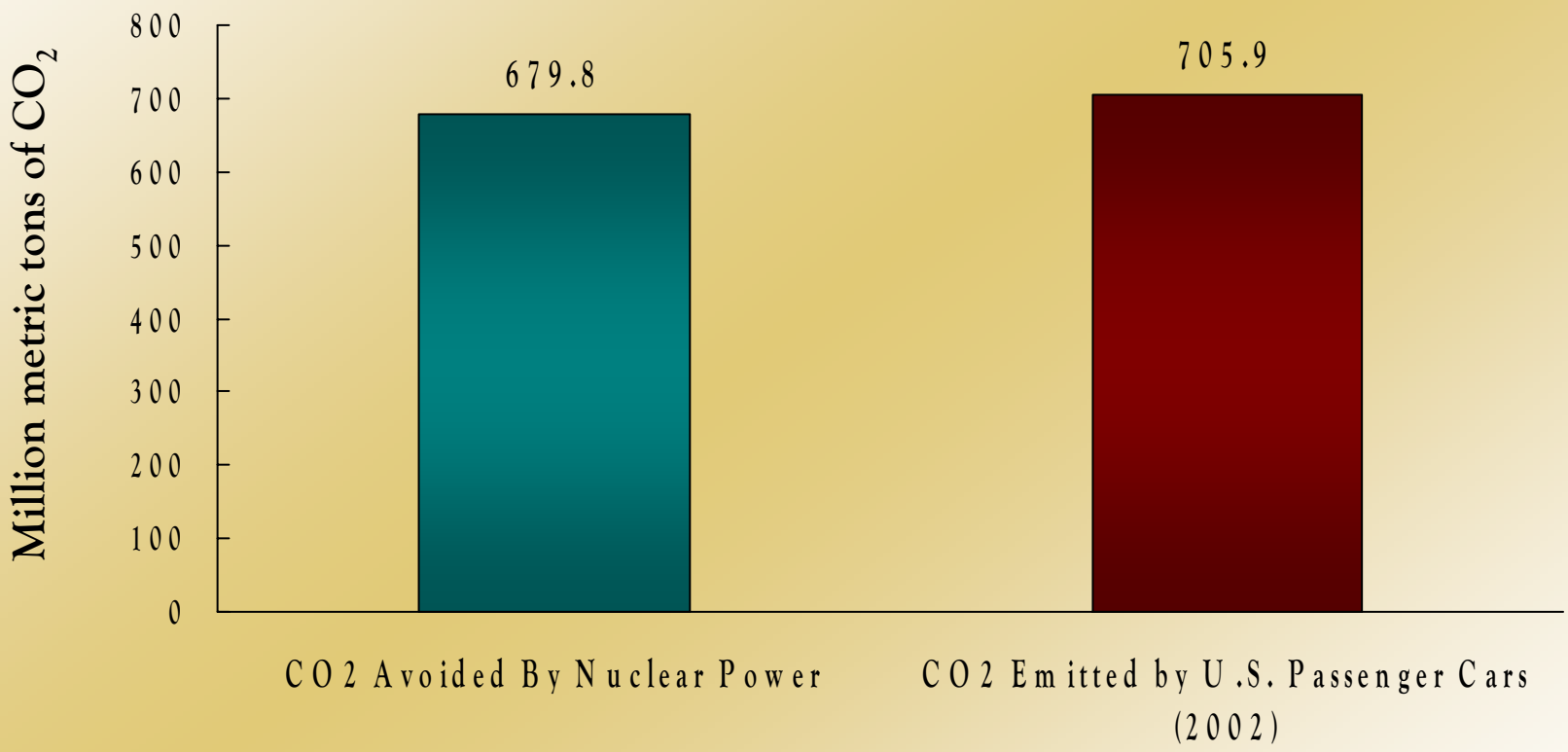
Perspective on Nuclear Power and CO_2 Emissions (2003)



Emissions avoided by nuclear power are calculated using regional fossil fuel emissions rates from EPA CEMS data and individual plant generation data from EIA. Total Emissions are calculated from EPA CEMS data. Last updated 10/08/04

Perspective on CO_2 Avoided by U.S. Nuclear Plants (2003)

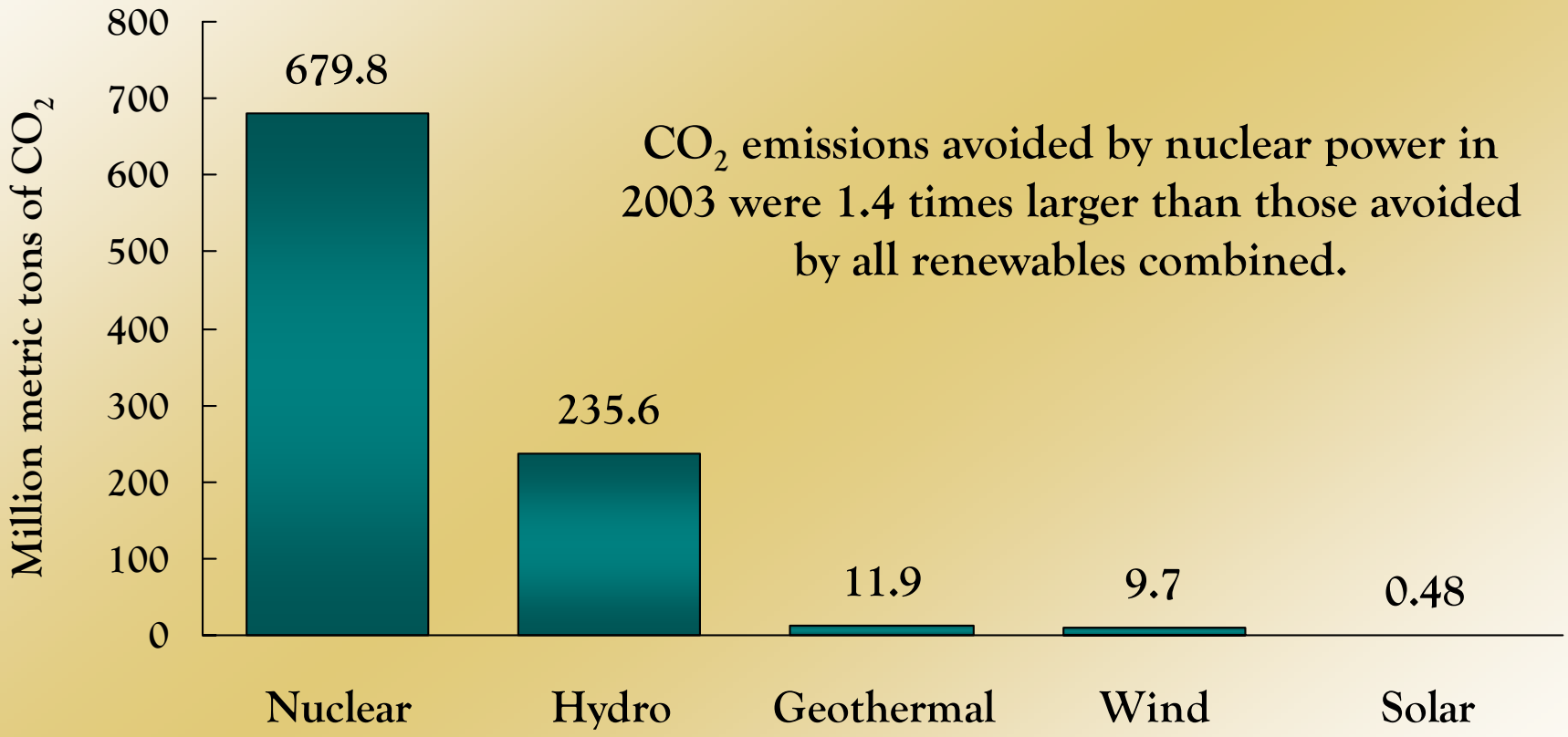
136 million passenger cars in U.S. (light trucks not included)



Emissions avoided by nuclear power are calculated using regional fossil fuel emission rates (from the Environmental Protection Agency's Continuous Emission Monitoring System) and individual plant generation data from EIA. Car emissions: EPA, Office of Transportation and Air Quality Emissions Facts (April 2000). Last updated 10/04.

NEI

Perspective on CO_2 Avoided by U.S. Nuclear Plants (2003)



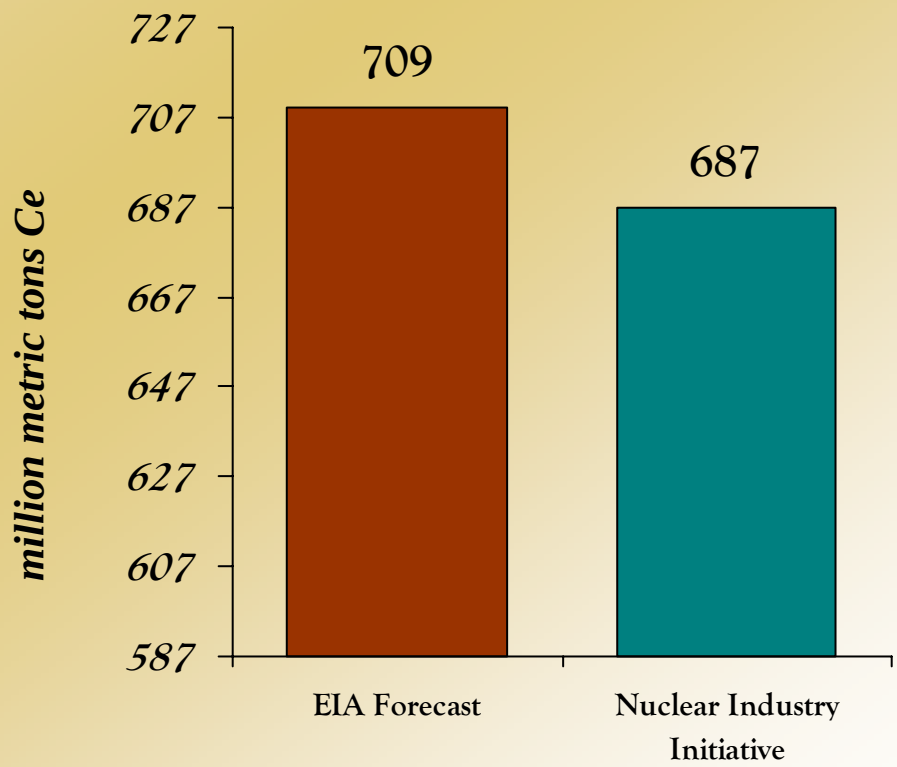
Emissions avoided by nuclear power are calculated using regional fossil fuel emission rates (from the Environmental Protection Agency's Continuous Emission Monitoring System) and individual plant generation data from EIA. Emissions avoided by other non-emitting sources are calculated using a national fossil fuel emissions rate and EIA generation data.

NEI

Impact of Additional Nuclear Energy On Electric Industry GHG Emissions

U.S. ELECTRIC SECTOR GHG EMISSIONS IN 2012

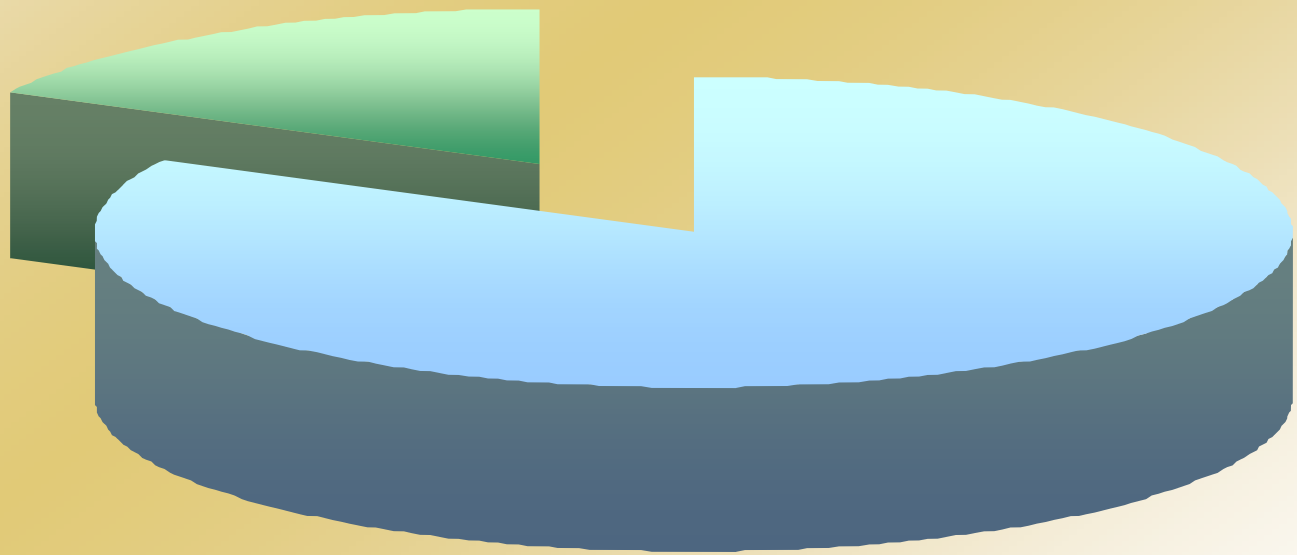
- 2012 nuclear industry goal: equivalent of 10,000 MW added from uprates, plant restarts, productivity gains
- The nuclear energy industry can avoid the emission of 22 MMtCe by 2012, assuming incremental nuclear production displaces fossil-fired generation



Impact Of Additional Nuclear Energy On Greenhouse Gas Emissions

U.S. electric sector commitment:
approx. 35 million metric tons of carbon per year

Nuclear energy sector commitment:
22 million metric tons of carbon per year



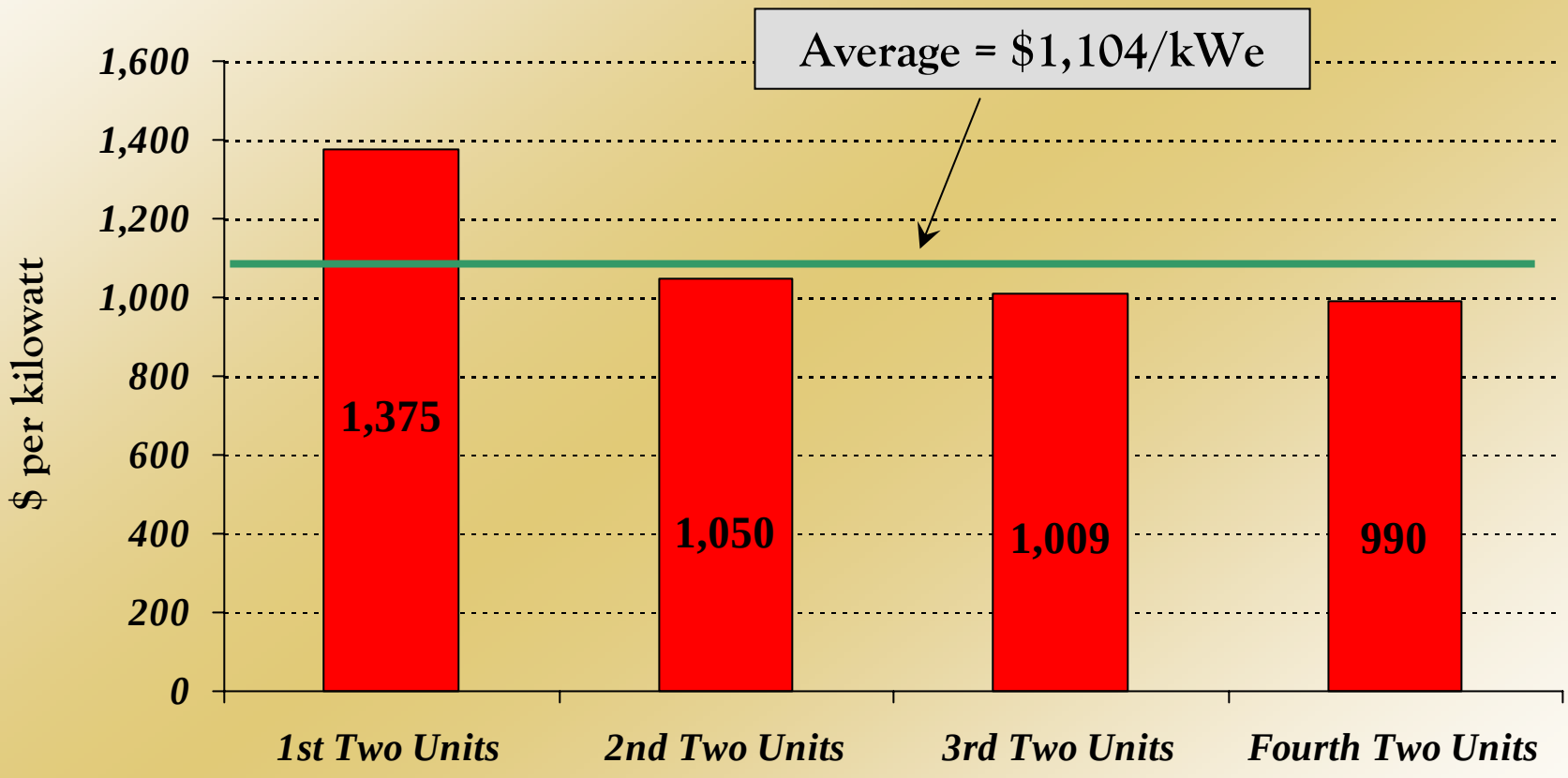
Bush administration's target:
106 million metric tons of carbon per year

NEI

New Nuclear Power Plants: The Business Case

- Industry believes new nuclear capacity can be built at an overnight capital cost of $1,000-1,200 per kilowatt
- Competitive with gas-fired combined cycle plants at $600 per kilowatt with gas delivered at $4-5 per million Btu
- Competitive with new baseload coal-fired capacity
  - *Conventional pulverized coal with full environmental controls ($1,000-1,200 per kW)*
  - *"Clean coal" technologies ($1,200-1,500 per kW)*

The Capital Cost Challenge



Validating the Licensing Process

- New licensing process created in 1992 Energy Policy Act:
  - All regulatory approvals up front
    - Early site permits
    - Design certifications
    - Combined construction/operating license (COL)
- Dominion, Exelon, Entergy seeking early site permits
- Two consortia (NuStart Energy, Dominion) have responded to Department of Energy solicitation for proposals to demonstrate process for obtaining COL (including first-of-a-kind design and engineering)
- TVA: feasibility study at Bellefonte

New Nuclear Power Plants: Market Potential by 2020

- At $1,250/kWe = 23 GW
- At $1,125/kWe = 62 GW
- Carbon tax of $5/metric ton in 2011, rising to $50/metric ton by 2020 = 108 GW[1]

1. For reference, carbon allowance price under McCain-Lieberman estimated at $79 per metric ton in 2010, $221 per metric ton in 2025 (EIA analysis of S.139)

Source: Electric Power Research Institute, 2002, using EIA NEMS forecasting model

NEI

New Nuclear Plants Under McCain-Lieberman Legislation

(2010-2016 GHG emissions capped at 2000 level)

- By 2020 = 17 GW
- By 2025 = 49 GW
- McCain-Lieberman plus high natural gas prices = 65 GW by 2025
- No new nuclear sensitivity case = significantly (34%) higher carbon allowance prices in 2025
- Nuclear capital cost assumptions: $2,118/kW ⇨ $1,660/kW in 2020

Source: Energy Information Administration analysis of S. 139

NEI

The Energy/Carbon Challenge

- To cap global CO_2 concentrations at no more than 550 ppm*, must achieve average emission rate < 0.2kgC/kWh
- Today's best technology:
  - *0.9kgC/kWh for coal-based systems*
  - *0.4 kgC/kWh for natural gas*
- This suggests need for massive deployment of zero-carbon technologies

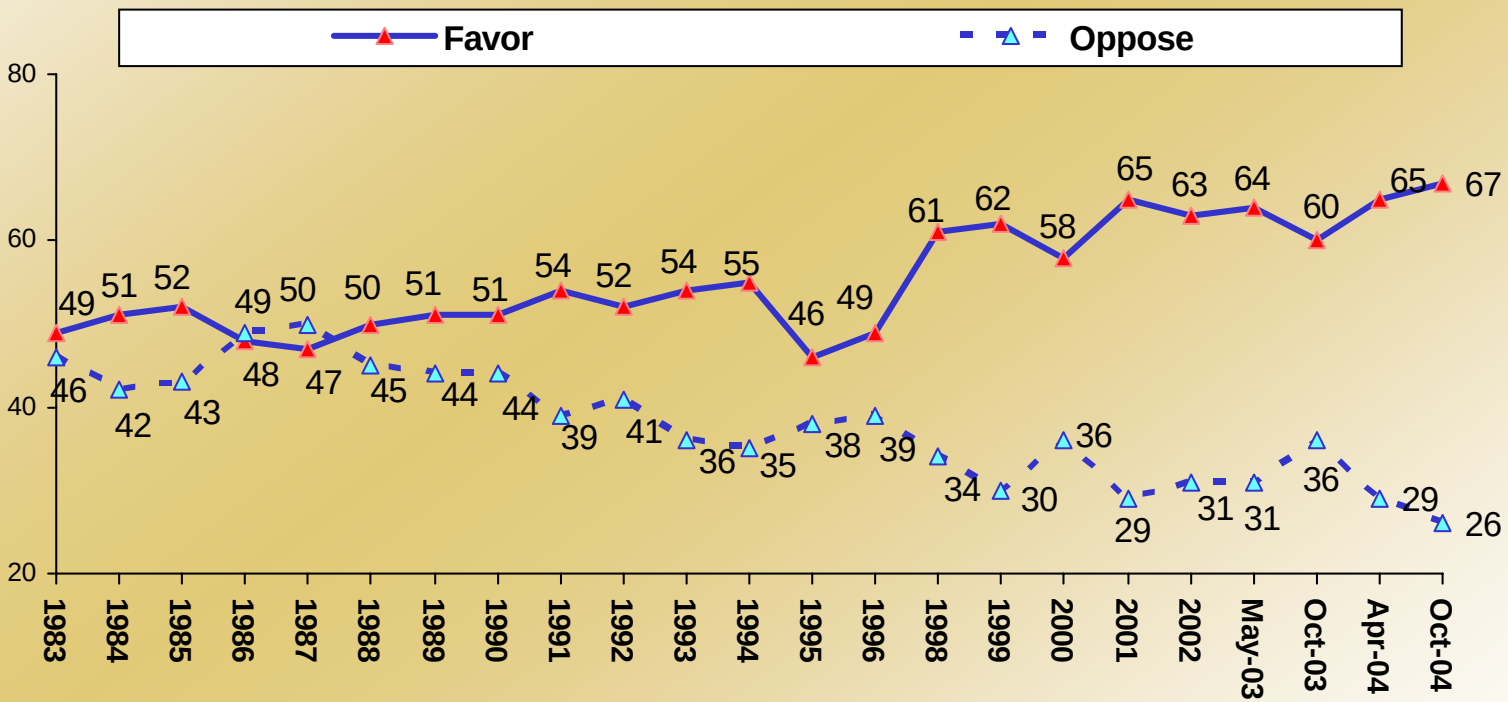
* Today's level ~ 375 ppm

Source: EPRI Electricity Technology Roadmap

Public Majority Favors Using Nuclear Energy

Trend in Percent Favor/Oppose Nuclear Energy—Annual Averages Until 2003

"Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity in the United States?"



Source:National Survey by Bisconti Research, Inc.
With NOP World (Formerly RoperASW)

Conclusions

- Continued operation of existing nuclear power plants is vital for:
  - electric price stability
  - future success of emission reduction programs
- Incremental nuclear power production has value in clean air compliance under cap-and-trade programs
- U.S. and worldwide: cannot achieve significant reductions in greenhouse gas emissions without additional nuclear power
- Policy makers should be supportive of various types of generation to maintain fuel diversity

Recommendations

- The addition of non-emission electric generation capacity (nuclear, hydro, renewables, etc.) should be recognized and accepted as a method to reduce regional emissions in all air quality attainment plans
- All non-emitting generation should be treated equally in all air quality regulations
- When designing air quality programs, regulators and environmental planners should evaluate the potential emissions and economic impacts of new nuclear power plant construction, as well as the impacts of new renewable capacity