

DRAFT

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*The U.S. Nuclear
Energy Sector
Response to
President Bush's
Climate Change
Initiative*



NYE!



Summary

1. Nuclear energy sector contribution to carbon mitigation

- Historic

- Future

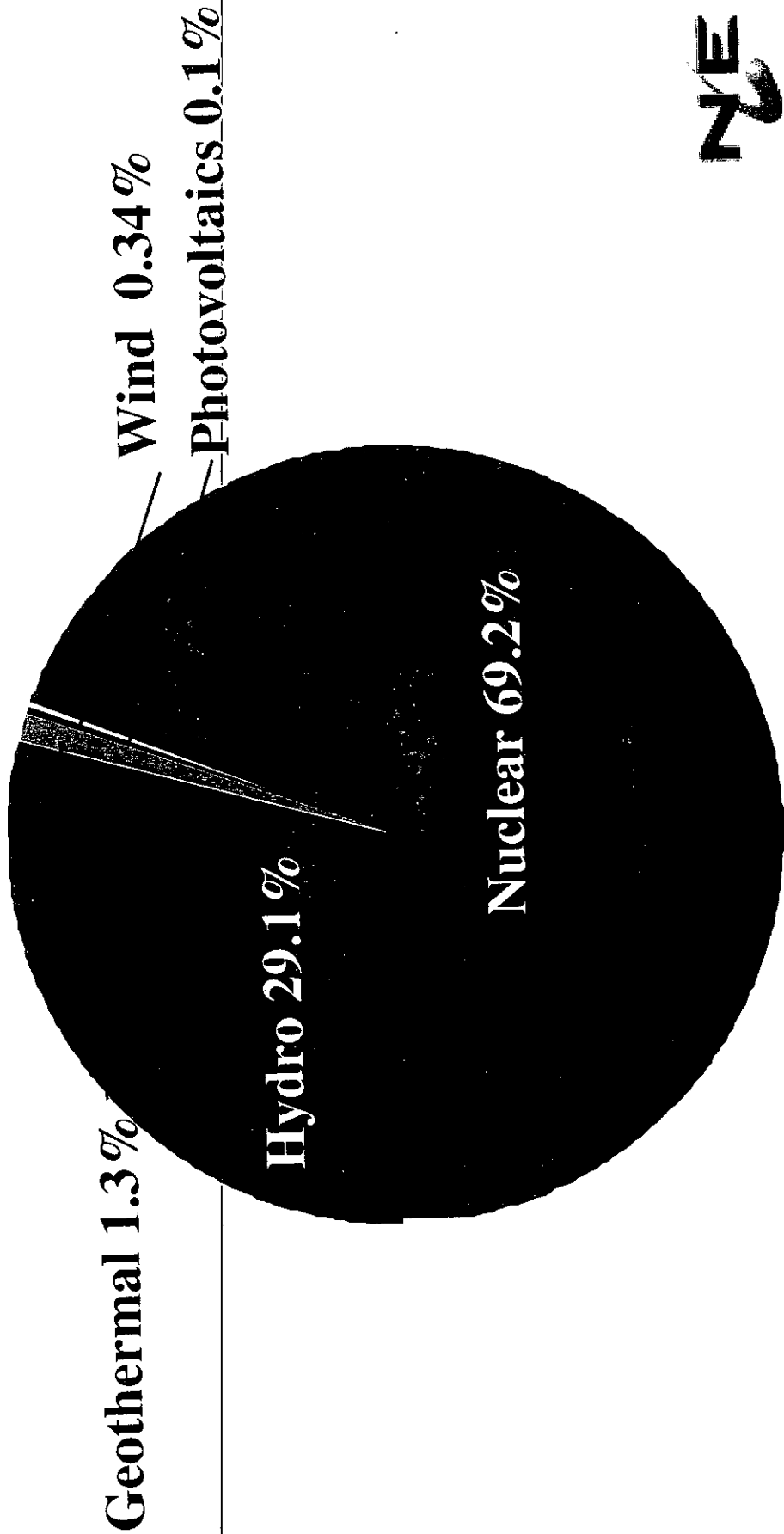
2. Impact of nuclear energy sector initiatives 2001-2012

3. Impact of nuclear energy sector initiatives 2012-2020

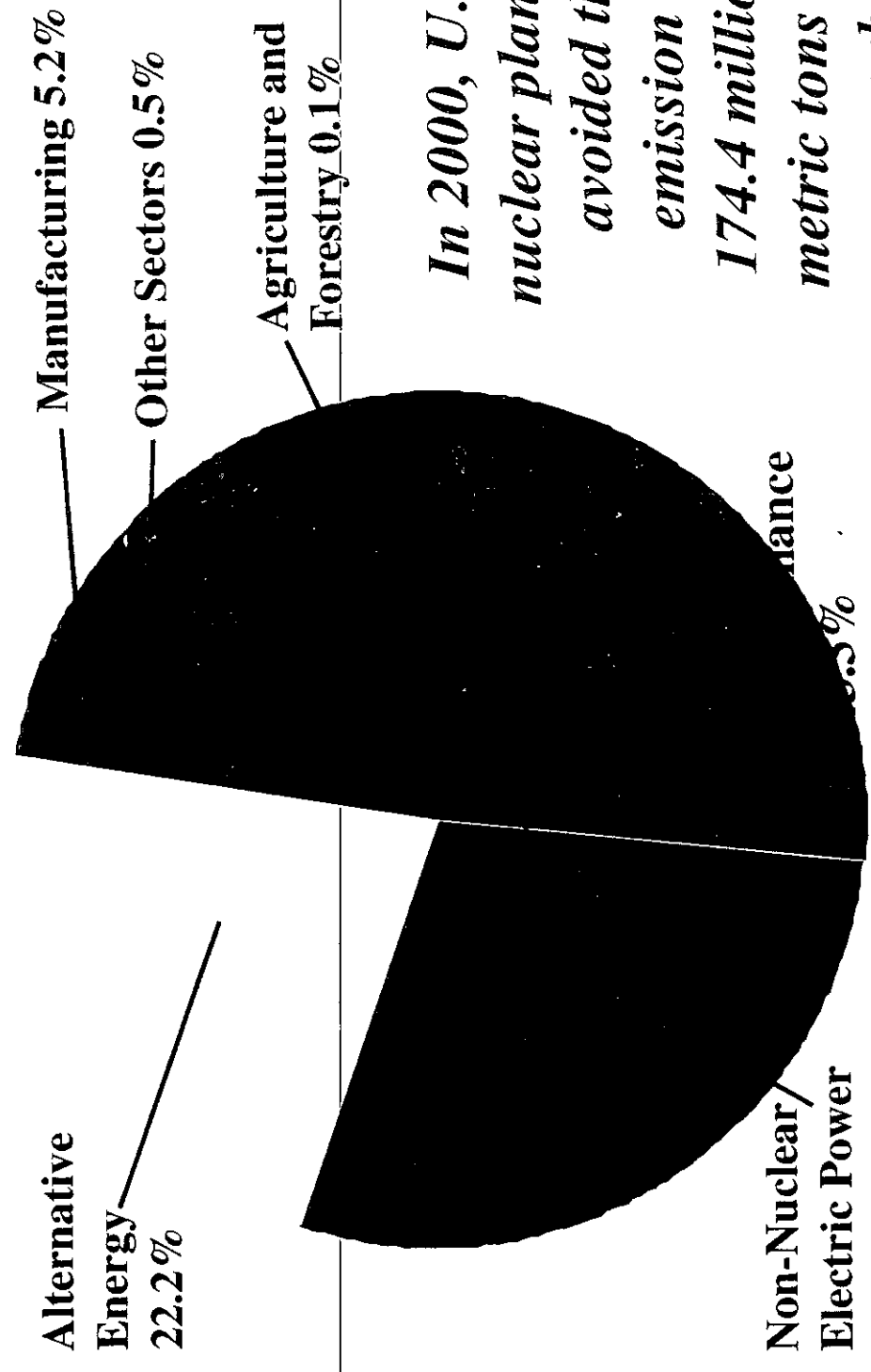
1. Nuclear energy
sector
contribution to
carbon
mitigation

- Historic
- Future

Nuclear Energy: Largest Source of U.S. Emission-Free Generation



Nuclear Energy: Largest Share of U.S. Voluntary Carbon Reduction Program



In 2000, U.S. nuclear plants avoided the emission of 174.4 million metric tons of carbon



Nuclear Energy and DOE's 1605(b) Program

Tons Reported in 2000 Under 1605(b) Program (metric tons of carbon dioxide)		
<i>Reporting Sector</i>	<i>Tons Reported</i>	<i>Percent of Total</i>
Nuclear Energy	116,776,270	43.3%
Non-Nuclear Electric	77,471,385	28.6%
Alternate Energy	59,867,258	22.2%
Industry	13,966,044	5.2%
Agriculture and Forestry	112,747	0.1%
Other Sectors	1,424,390	0.5%



The President's Climate Change Initiative

- ▶ Bush Administration goal: Reduce greenhouse gas intensity of the U.S. economy by 18% by 2012 (announced 2.14.2001)
- ▶ If current trends continue (“business as usual”), the U.S. will record a 14% reduction in intensity
 - White House analysis used emissions and GDP data from EIA’s *Annual Energy Outlook 2002*



U.S. Nuclear Energy Sector Climate Initiative: Key Assumptions

- ▶ 2012 goal: 10,000 MW added from uprates, plant restarts, productivity gains
- ▶ 2020 goal: 50,000 MW from new plants (to maintain emission-free generation at ~ 30% of total supply)
- ▶ In addition, NEI restored 4,500 MW retired in AEO by 2010, 9,500 MW retired in AEO by 2020
- ▶ Key question: Is it plausible to expect 10,000 MW additional capacity equivalent by 2012? (*More on this later.*)



NEI Analysis: Methodology

- ▶ Forecast data for incremental coal-fired production, incremental gas-fired production, carbon emissions from coal-fired and gas-fired capacity taken from *AEO 2002*
- ▶ Additional nuclear capacity converted to kilowatt-hours (assuming 90% capacity factor)
- ▶ Two approaches:
 - Additional nuclear displaces coal-fired generation first, then gas-fired generation
 - Additional nuclear displaces an average of coal-fired and gas-fired generation

Methodology: Calculating Marginal Emission Rates

Approach #1: Additional nuclear displaces coal-fired generation first, then gas-fired generation

- ▶ Incremental nuclear kWh displaces incremental coal-fired kWh first, then incremental gas-fired kWh:
 - In 2012, incremental (*i.e.*, above 2002 levels) nuclear does not exceed incremental coal (incremental coal = 303 billion kWh; incremental nuclear = 114 bkWh)
 - In 2020, incremental (*i.e.*, above 2012 levels) nuclear exceeds incremental coal, also displaces incremental gas (incremental coal = 180-bkWh; incremental-nuclear = 418-bkWh; incremental-gas = 437-bkWh)
- ▶ Using AEO 2002 forecast of GHG emissions in 2012 and 2020, calculate emissions rates (mtCe/GWh) for coal-fired generation. For example:
(total coal-fired power plant carbon emissions in 2012 – total coal-fired power plant carbon emissions in 2002) / (total coal-fired kWh in 2012 – total coal-fired kWh in 2002)
- ▶ Identical methodology used to calculate emission rates for gas-fired generation
- ▶ Multiply emissions rates by incremental nuclear kilowatt-hours in 2012 and 2020 to derive estimates of tons avoided

Approach #2: Additional nuclear displaces an average of coal-fired and gas-fired generation

- ▶ Identical methodology to calculate marginal emissions rates for incremental kilowatt-hours produced by all fossil generation



2. Impact of
nuclear
energy
sector
initiatives

2001-
2012

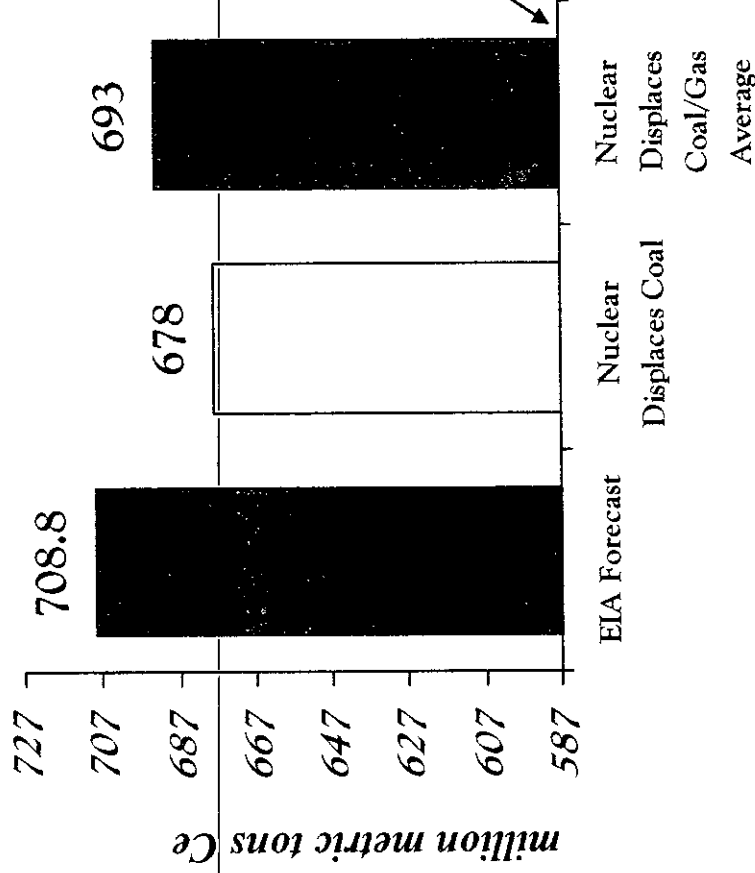


Impact of Additional Nuclear Energy On Electric Industry GHG Emissions

U.S. ELECTRIC SECTOR GHG EMISSIONS IN 2012

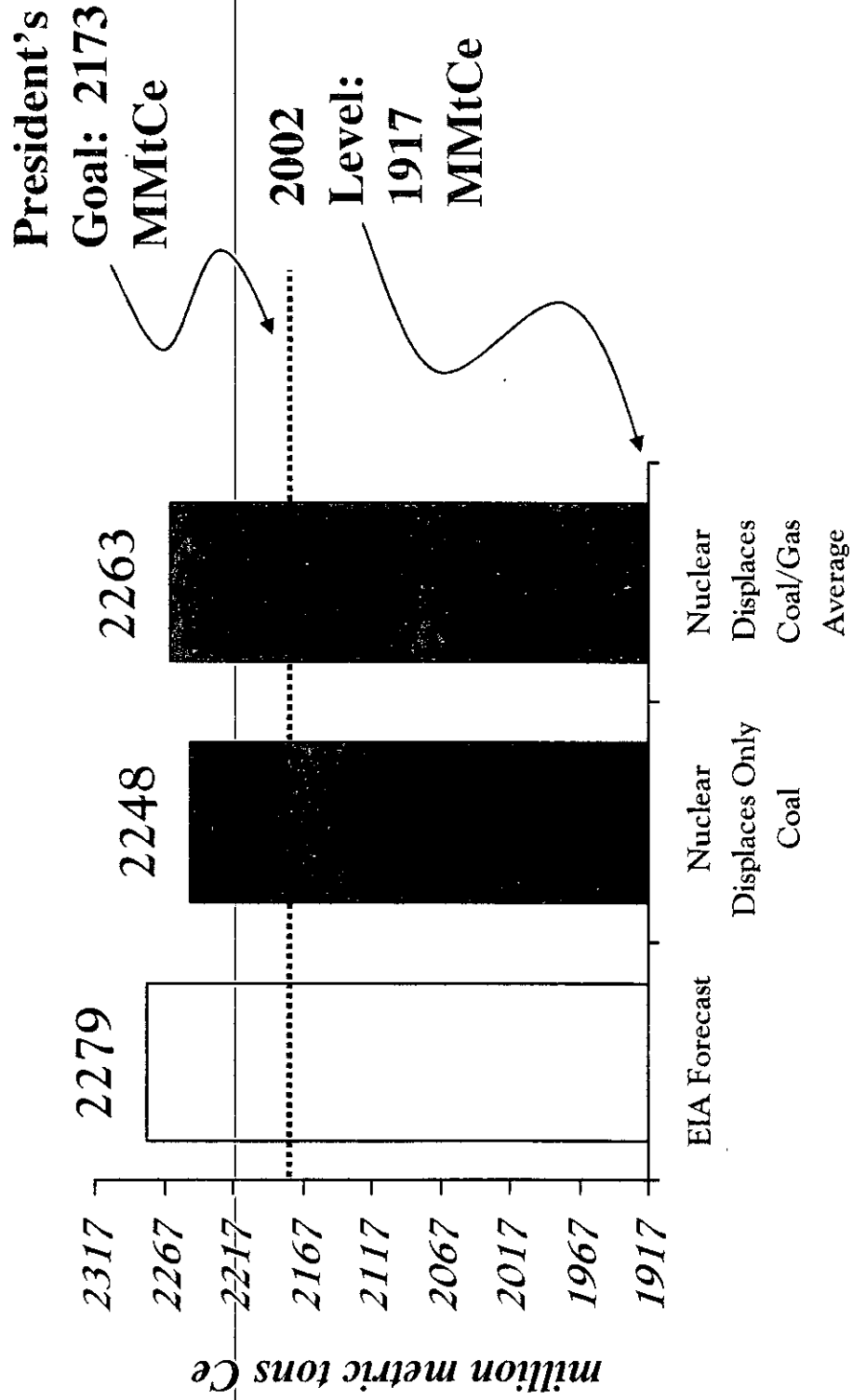
2002 Level:
587 MMtCe

- ▶ The nuclear energy industry can avoid the emission of as much as 31 MMtCe by 2012, assuming incremental nuclear production displaces coal-fired generation



Impact of Additional Nuclear Energy On U.S. GHG Emissions

U.S. GHG EMISSIONS IN 2012

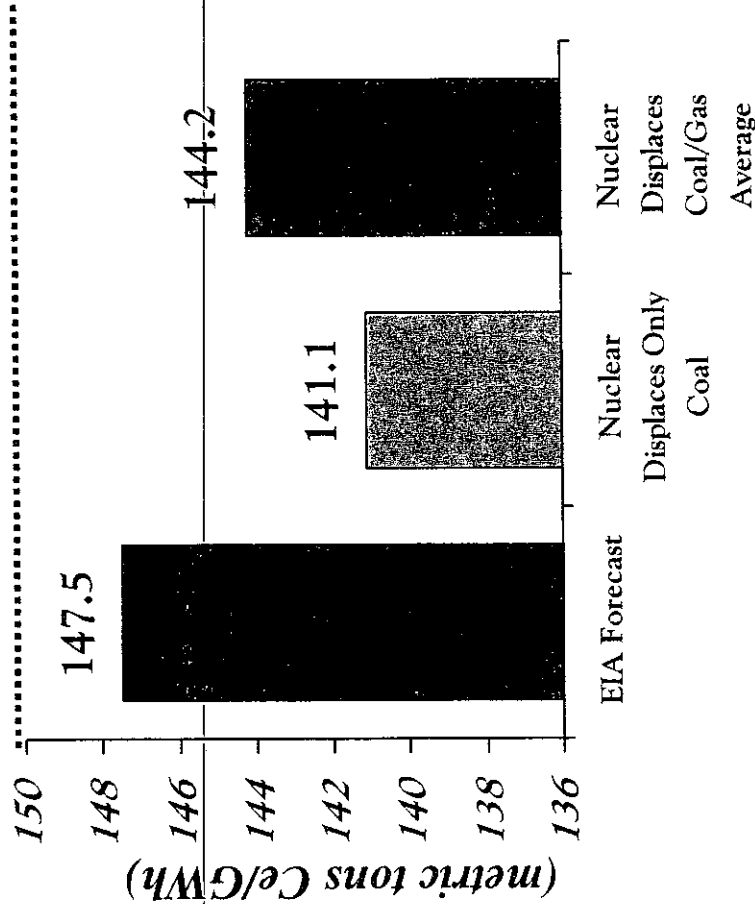


Nuclear Energy Reduces Electric Industry's GHG Emissions Rate

U.S. ELECTRIC SECTOR EMISSIONS RATE IN 2012
(in metric tons of carbon equivalent per gigawatt-hour)

2002 emissions rate: 150.4 mtCe/GWh

- ▶ The GHG emission rate for the electric industry is expected to decline by 2012. Increased nuclear generation will cause the rate to fall faster.

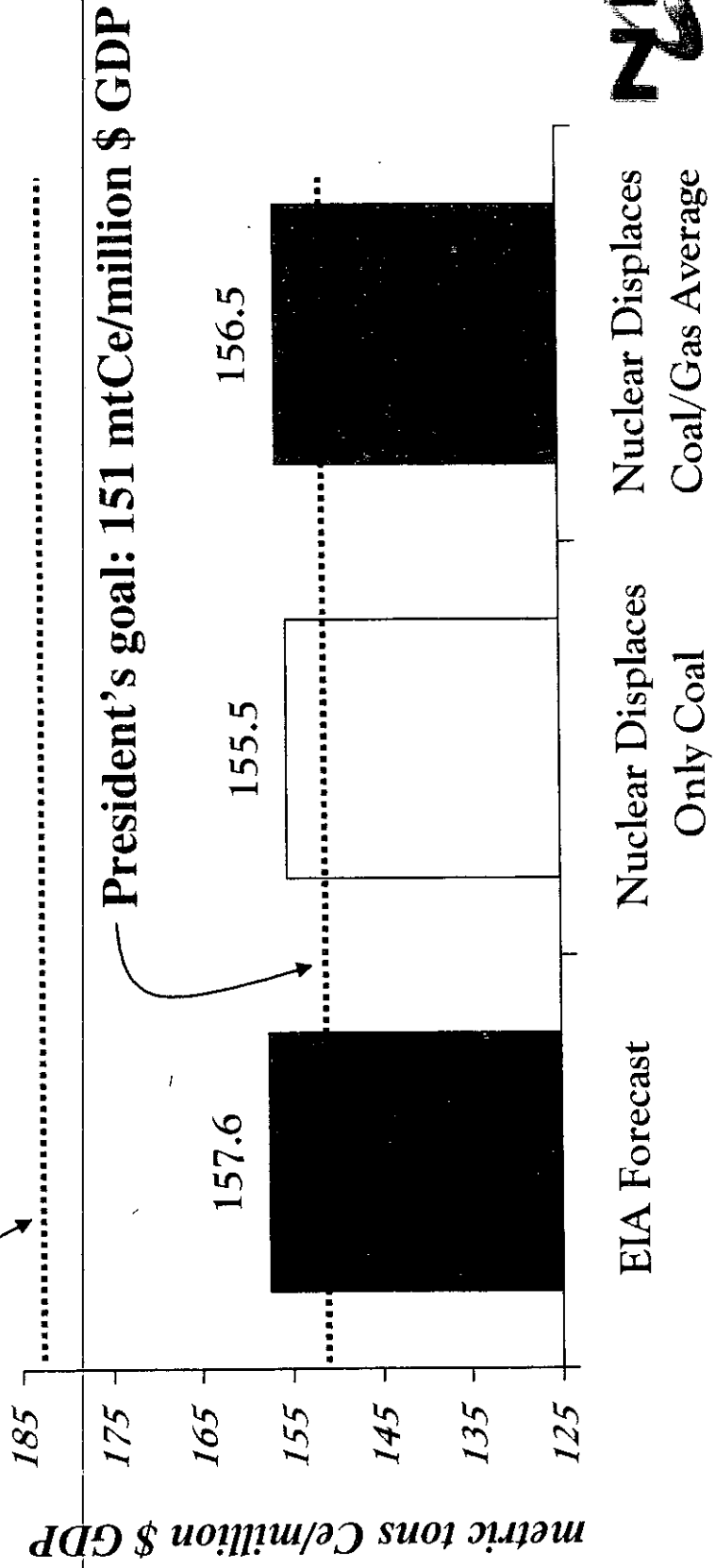


Additional Nuclear Energy Production Will Drive Down U.S. GHG Intensity

U.S. GHG INTENSITY IN 2012

(in metric tons of carbon equivalent per million dollars of GDP)

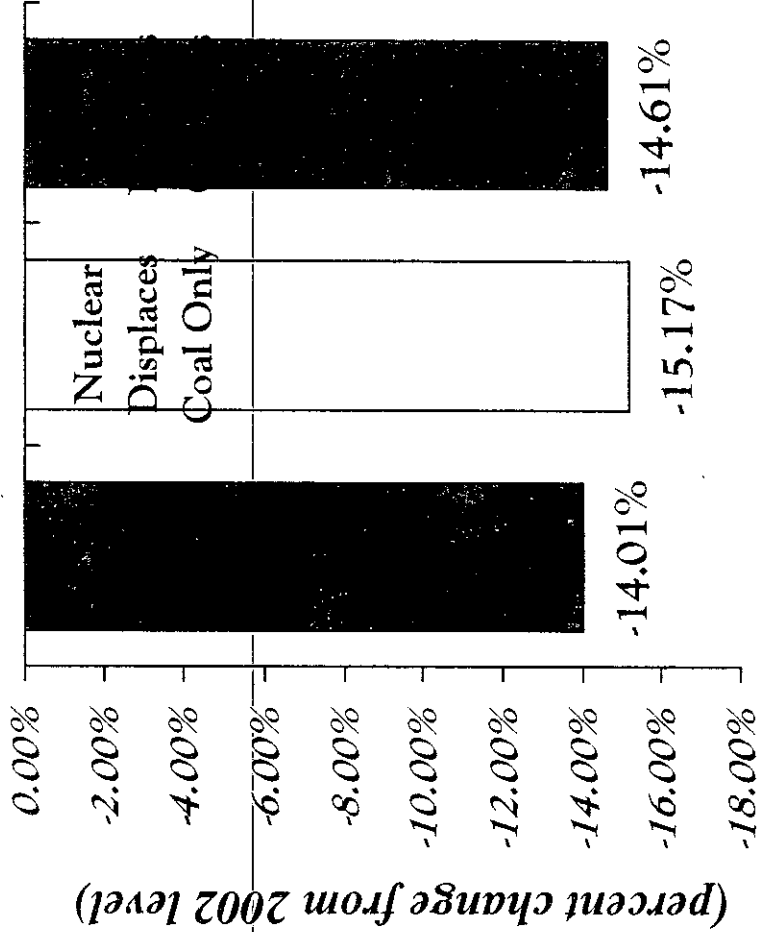
2002 intensity: 183.3 mtCe/million \$ GDP



Additional Nuclear Capacity Can Meet Part of President's Intensity Goal

CHANGE IN U.S. GHG INTENSITY BY 2012

- ▶ Nuclear energy can achieve approximately one-third of the President's GHG intensity reduction goal, assuming incremental nuclear displaces coal-fired generation, and if business conditions encourage uprates, productivity gains, license renewal and continued operations



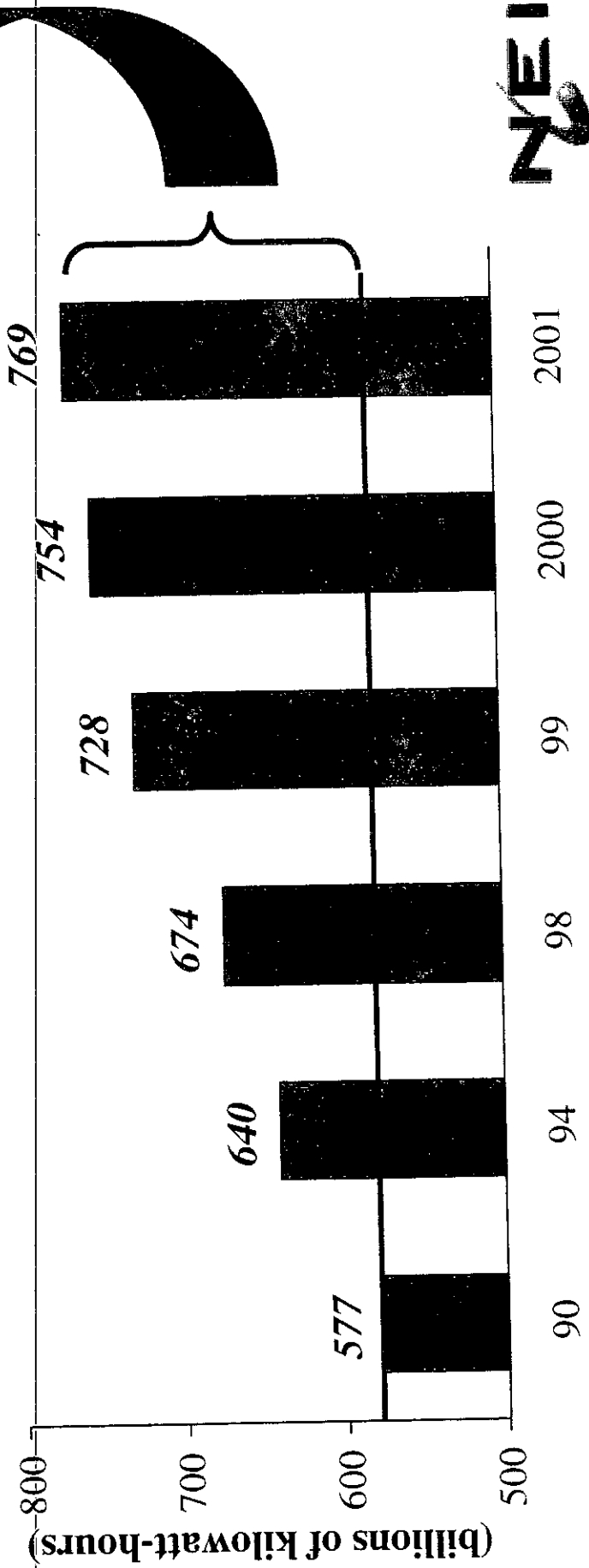
An Additional 10,000 MW by 2012: A Plausible Assumption?

- ▶ Existing nuclear capacity: ~ 98,000 MW
- ▶ Productivity improvements (higher capacity factors): 3,000 – 5,000 MW
- ▶ Uprates: 5,000 – 6,500 MW
- ▶ Restarts: 1,065 – 3,145 MW
 - Browns Ferry (1,065 MW)
 - Zion 1, 2 (2,080 MW)

Potential: 9,065 – 14,645 MW

Nuclear Plant Output: Growth During the 1990s

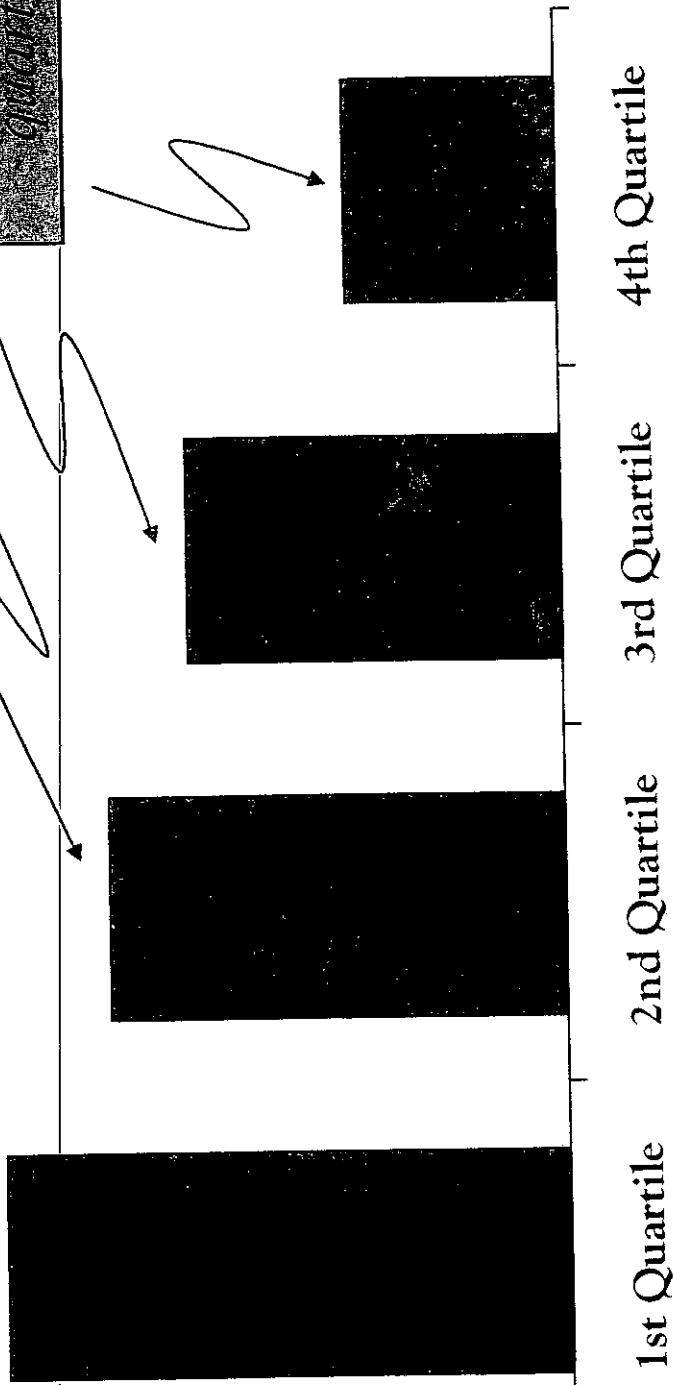
- ▶ Equivalent to 24 1,000-megawatt power plants
- ▶ Satisfied ~26% of growth in U.S. electricity demand



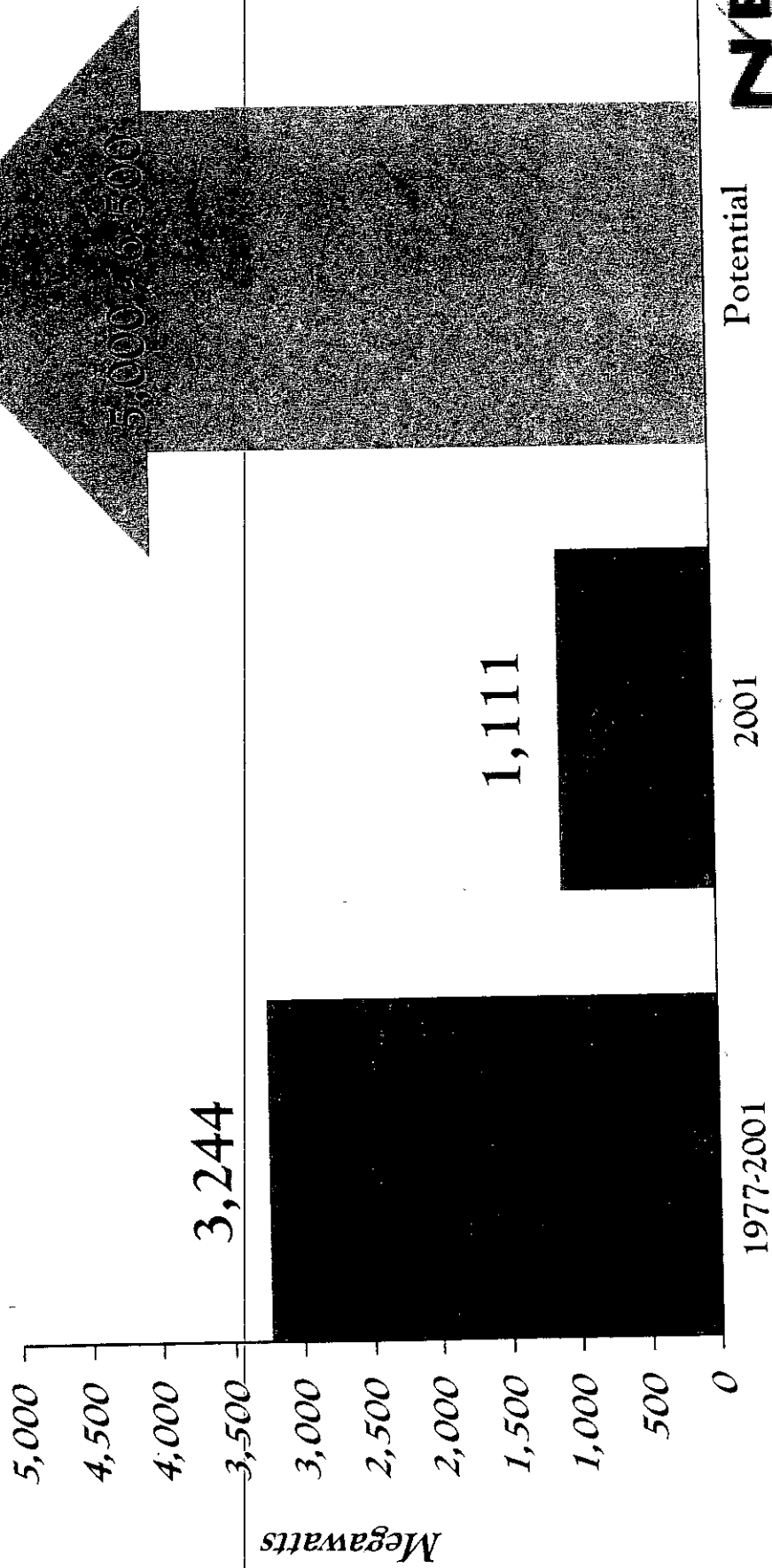
Increasing Plant Capacity Factors: Untapped Potential

*U.S. Nuclear Plant Capacity Factors
3-Year Rolling Average 1999-2001*

Untapped
Potential in
2nd, 3rd and 4th
quartiles



U.S. Nuclear Plant Uprates: Untapped Potential



Source: U.S. Commercial Nuclear Power Industry: Assessment for Department of Energy, October 2001

Upgrades ... In Brief

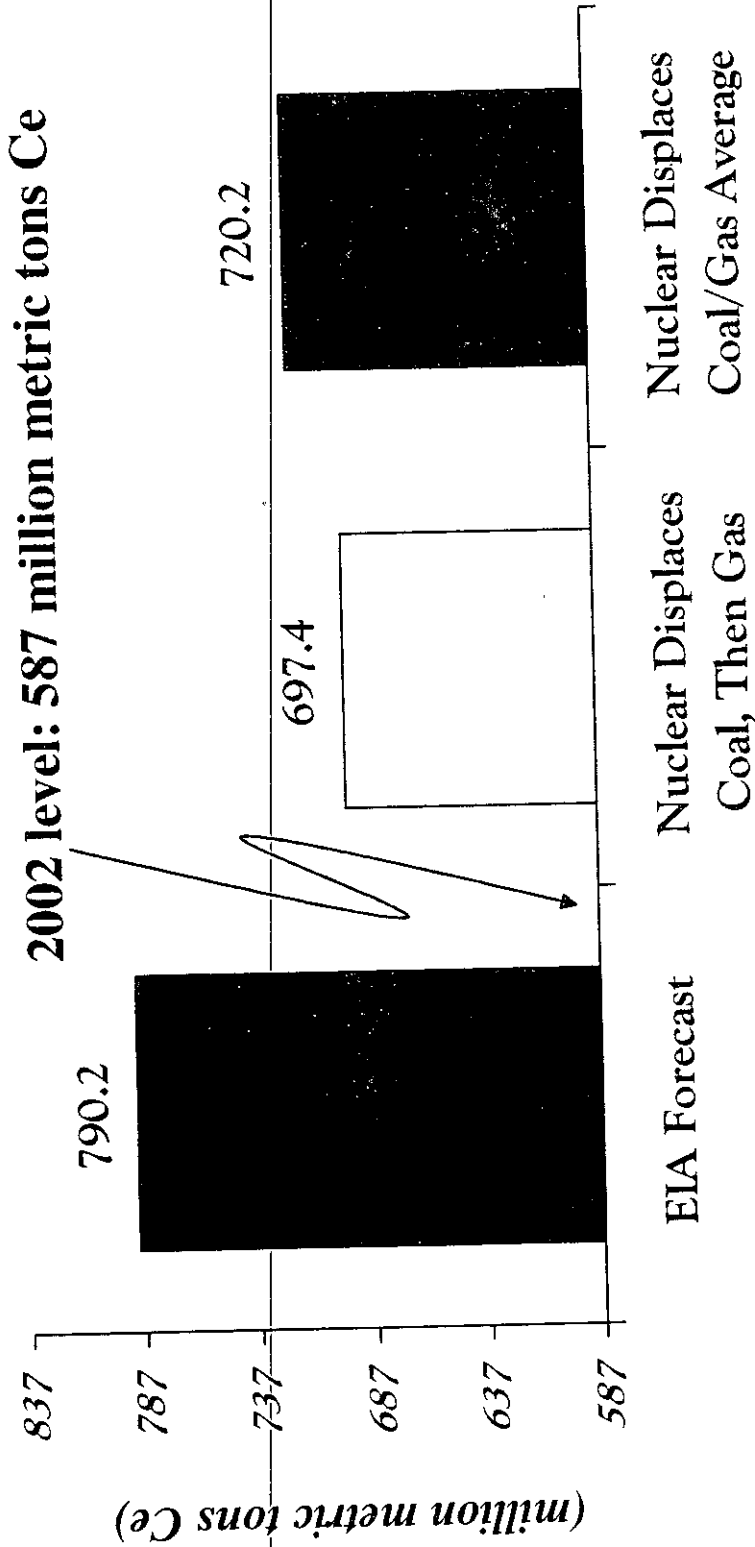
- ▶ Nuclear plants licensed for less than design capacity:
 - PWRs: (2/3 of U.S. capacity): + 10%
 - BWRs: (1/3 of U.S. capacity): + 20%
- ▶ 3 types of uprate:
 - *Measurement uncertainty recapture* (< 2%)
 - *Stretch* (up to 7%)
 - *Extended* (up to 20%)
- ▶ Cost increases as size of uprate increases:
 - *Measurement uncertainty recapture*:
 - ◆ engineering and licensing costs
 - ◆ minimal hardware changes
 - *Extended*:
 - ◆ substantial equipment upgrades (high-pressure turbines, condensate pumps and motors, transformers, etc.)
 - ◆ Cost measured in tens of millions of dollars (e.g., \$70 million for 20%, 190-MW uprate at Clinton)
 - ◆ \$350-400 per kW (lower than new combined cycle gas plant).

3. Impact of
nuclear
energy
sector
initiatives

2012-
2020

Impact of New Nuclear Capacity by 2020

U.S. ELECTRIC SECTOR GHG EMISSIONS IN 2020

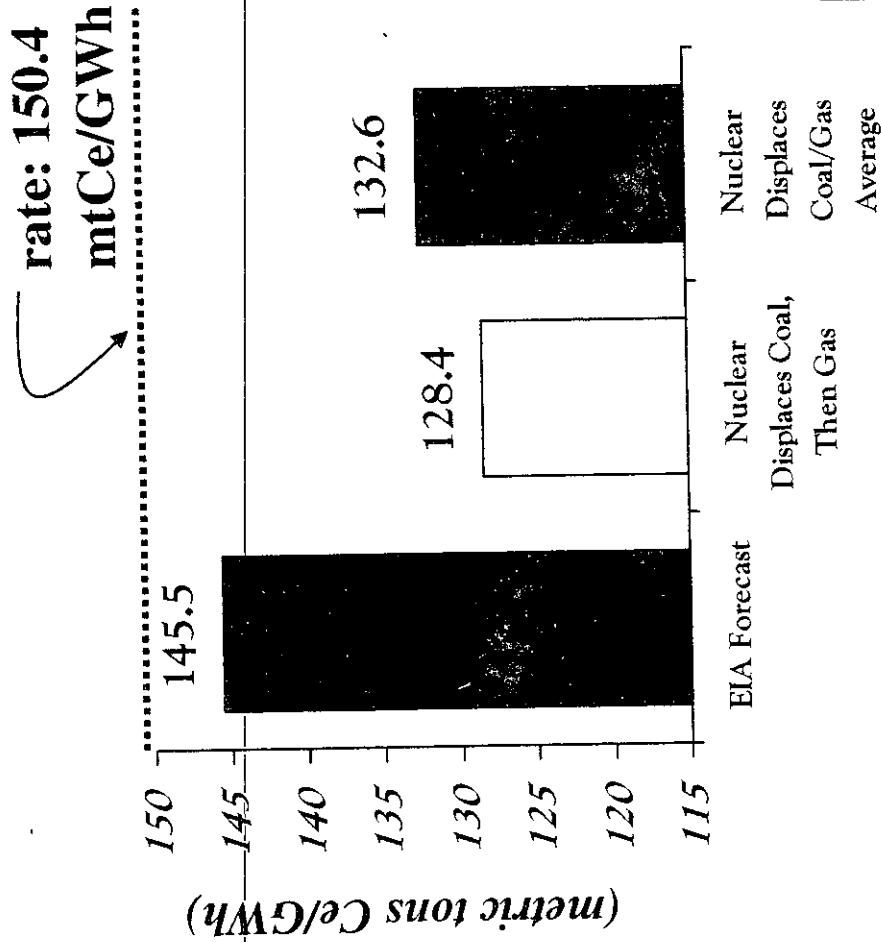


Nuclear Energy Reduces Electric Industry's GHG Emissions Rate

U.S. ELECTRIC SECTOR EMISSIONS RATE IN 2020

Looking beyond 2012, adding 50,000 MW of new nuclear capacity by 2020 would have a significant impact on the U.S. electric sector's GHG emissions rate

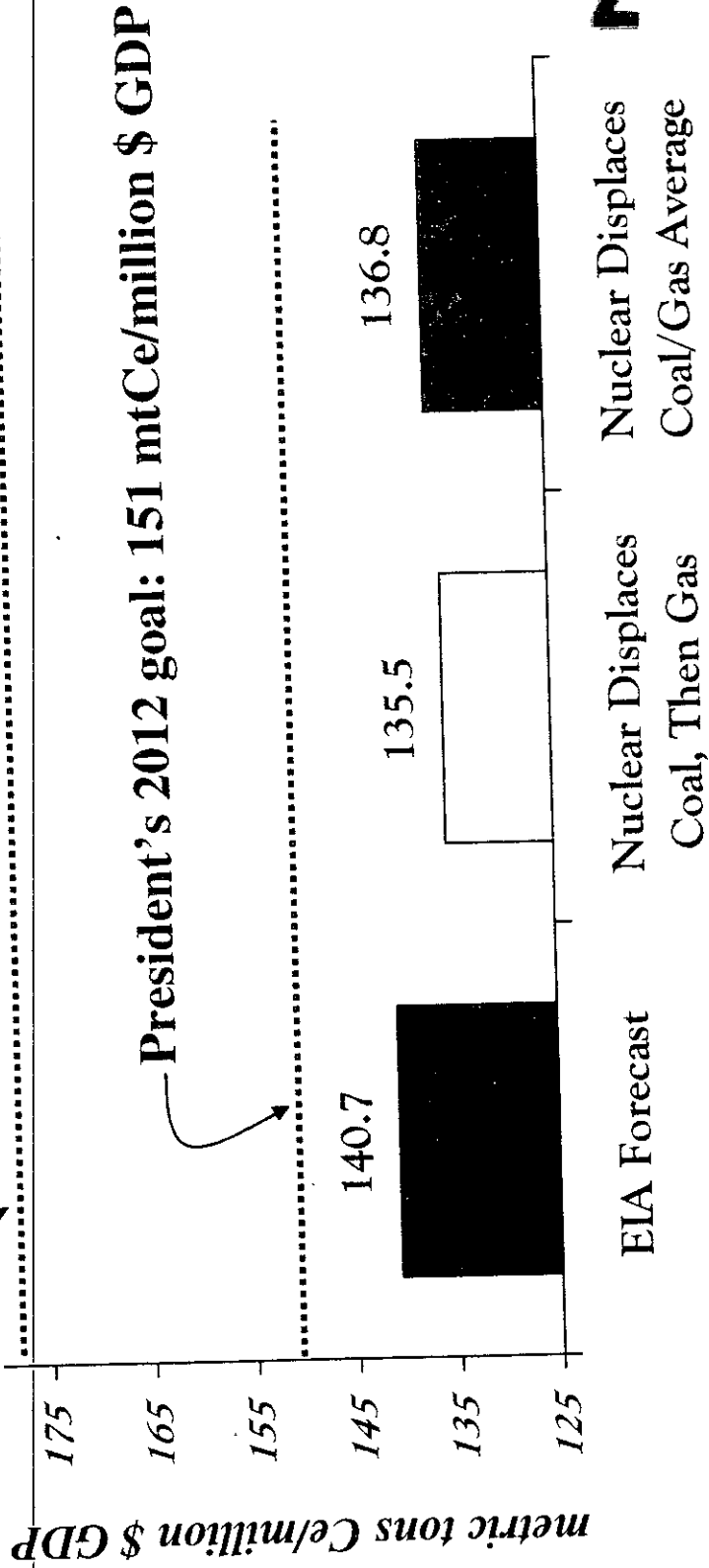
2002 emissions rate: 150.4 mtCe/GWh



Additional Nuclear Energy Production Will Drive Down U.S. GHG Intensity

U.S. GHG INTENSITY IN 2020
(in metric tons of carbon equivalent per million dollars of GDP)

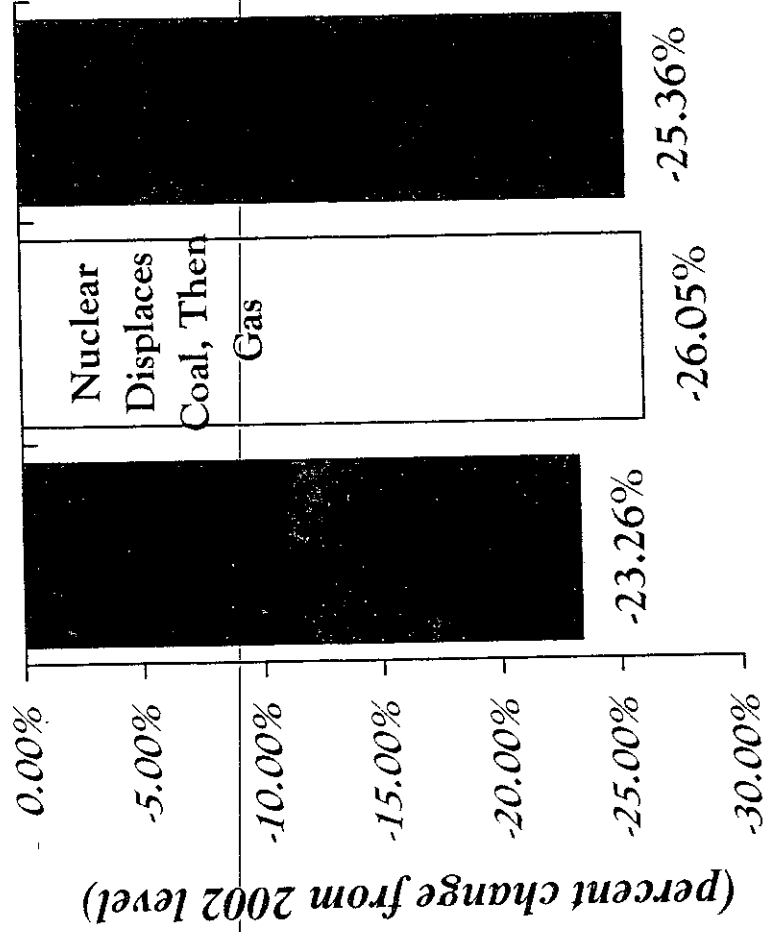
2002 intensity: 183.3 mtCe/million \$ GDP



Additional Nuclear Capacity: Major Reduction in U.S. GHG Intensity

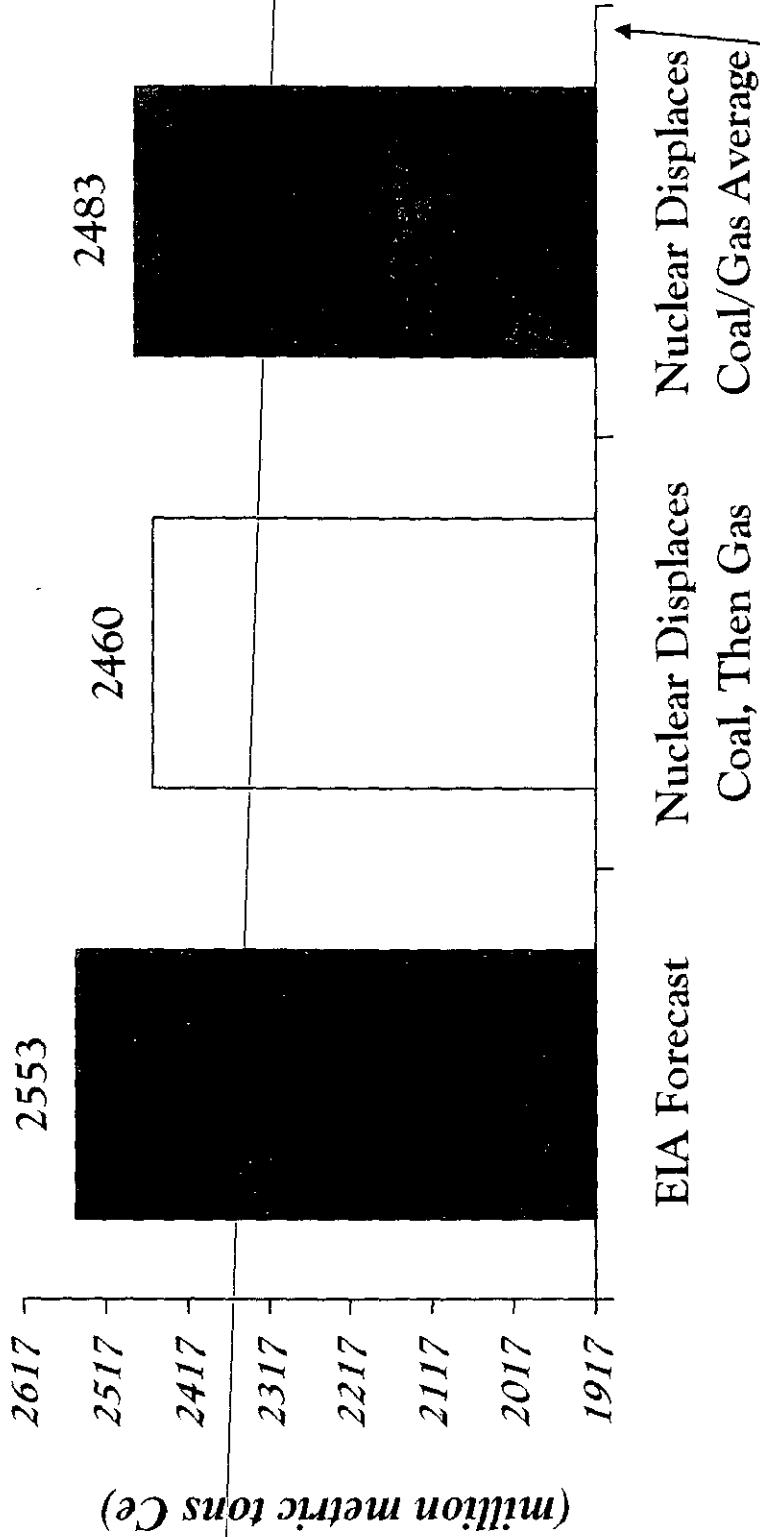
CHANGE IN U.S. GHG INTENSITY BY 2020

- ▶ The U.S. could reduce its GHG intensity by more than 26% from 2002 levels by building 50,000 MW of new nuclear capacity, thereby maintaining emission-free generation at ~30% of U.S. electricity supply



Impact of New Nuclear Capacity by 2020

U.S. GHG EMISSIONS IN 2020



2002 level: 1917 million metric tons Ce

