



Transforming America's Power Industry: The Investment Challenge

Preliminary Findings

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Power Industry Transformation

America's electric utilities are facing the greatest challenge in their history:

- Fuel costs remain at record-setting levels
- Plant construction costs have soared in the past several years
- Combating global climate change requires
 - ▶ “decarbonization” of supply
 - ▶ enhanced energy efficiency
- New technologies require a larger, “smarter” grid

The American Power Industry: 20th vs. 21st Century

20th

- Economies of scale create ever-cheaper power
- Traditional fuels and sources
- Primarily supply-focused
- Passive “one-way” grid



21st

- Cost of key materials and fuels increasing costs for all parts of the industry
- Cleaner supply technologies and greatly reduced carbon emissions
- Energy efficiency and demand response critical for customer value, reliability, and environment
- Transformation to “Smart” Power Grid



The New Capital Investment Challenge – New Generation

- Even with substantial energy efficiency measures, new and replacement plant through 2030 is at least 150,000 MW at an approximate cost of \$560 billion. Much of this will be new renewable power
- Global climate policies will increase overall cost of electricity supply, affect the mix of new capacity built and add to the capital cost of new capacity.
- More aggressive efficiency improvements and price effects can significantly reduce demand and new generating capacity builds – but overall capital needs may not decline in the same proportion

The Investment Challenge – Transmission and Distribution

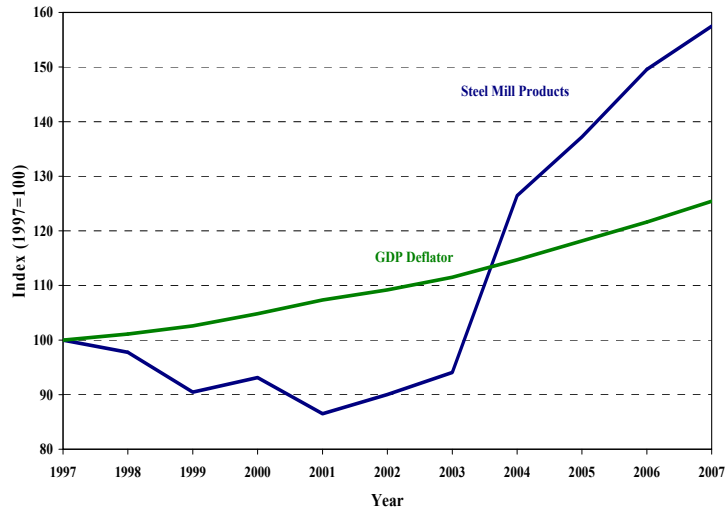
- Transmission and distribution together require nearly twice the investment in generation -- \$900 billion by 2030
- Grid must be expanded to connect renewable and distributed sources
- “Smart Grid” technologies enable greater efficiency improvements, better service, and small-scale resources
- Plug-in hybrid vehicles create a large new grid use

Drivers of Utility Cost Increases

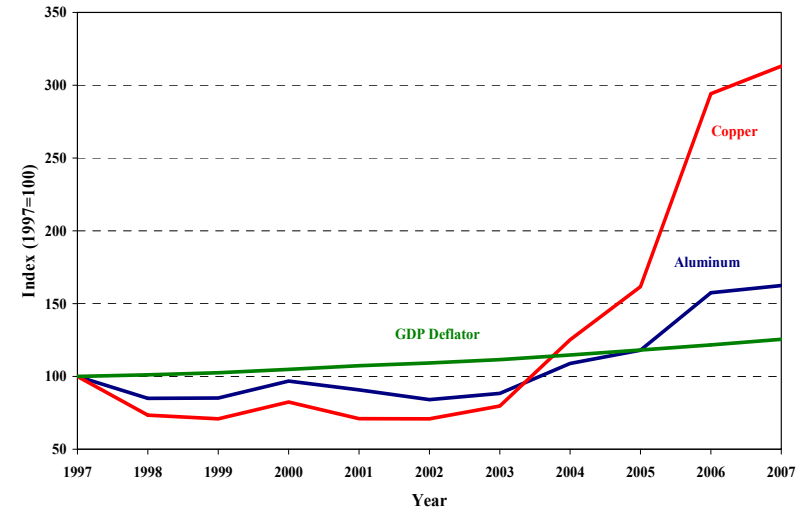


Commodity Prices Continue to Rise

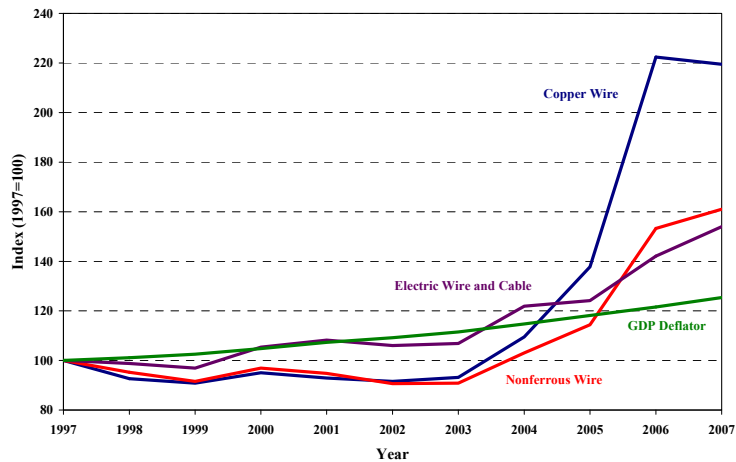
Steel Mill Products Price Index



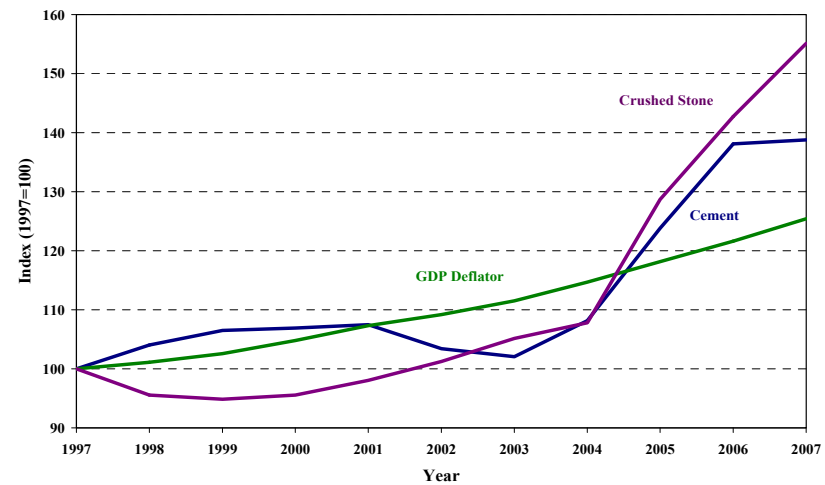
Aluminum and Copper Price Indexes



Electric Wire and Cable Price Index

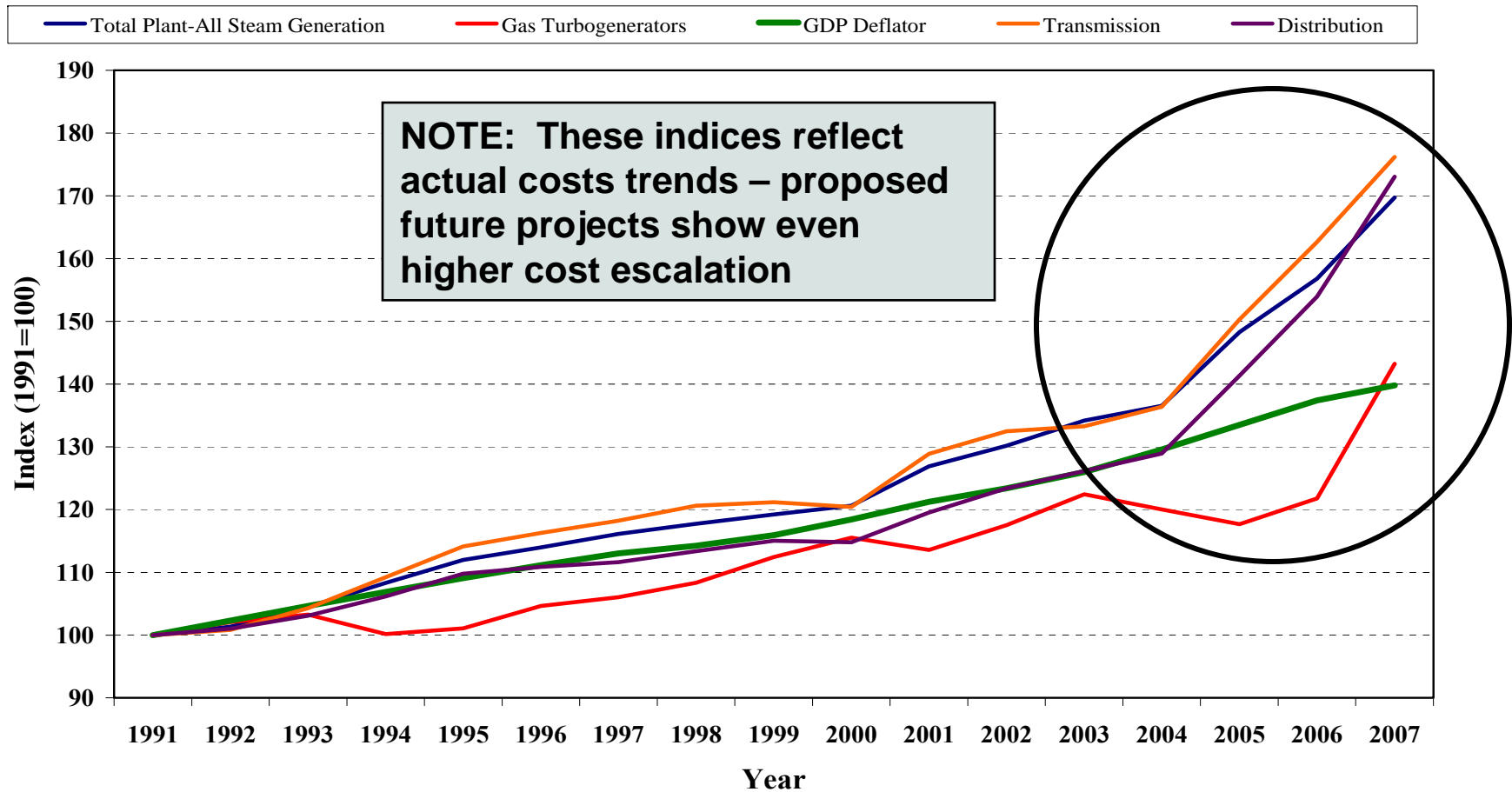


Cement and Crushed Stone Price Indexes



Utility Construction Costs Also Rising

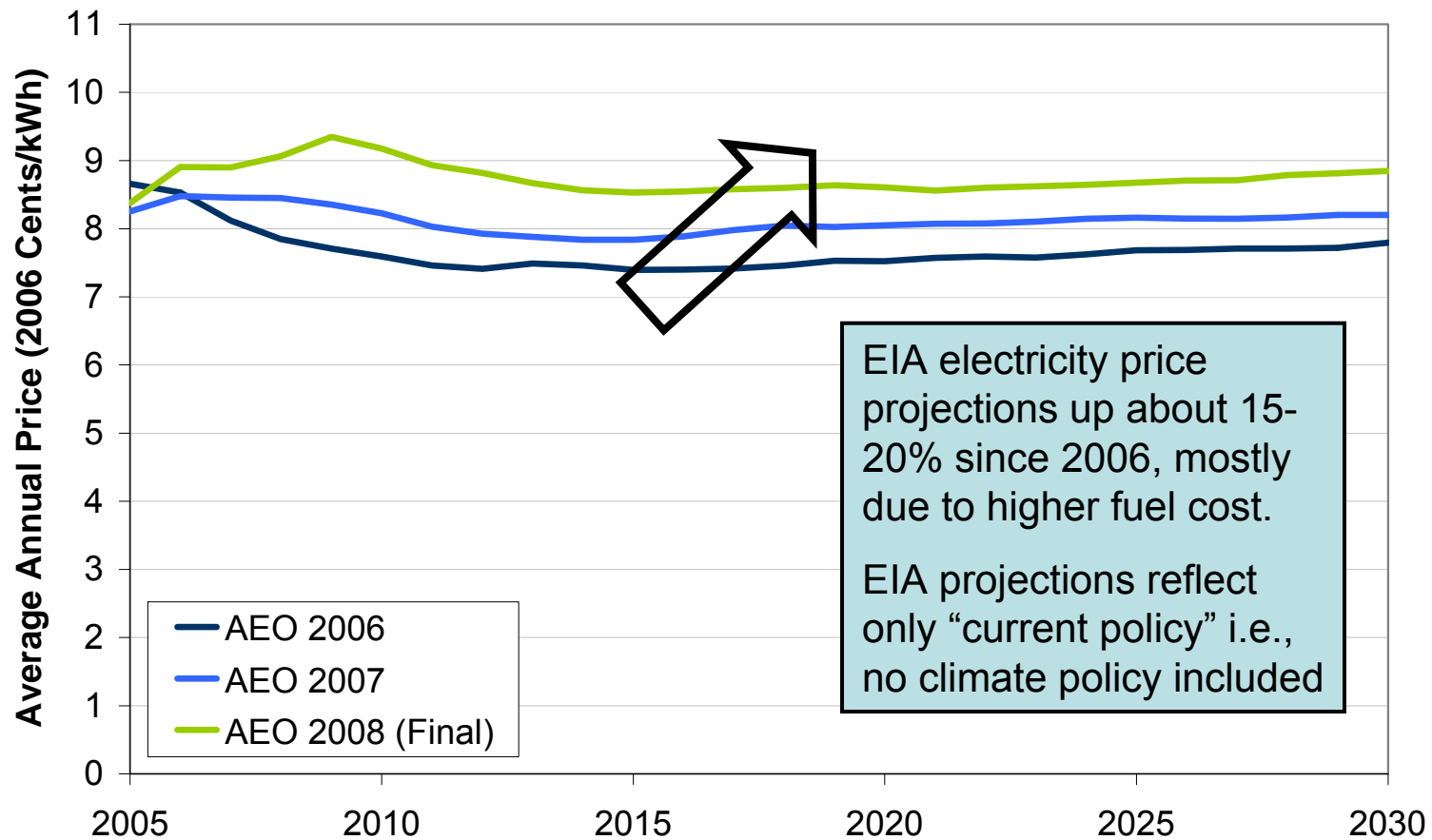
National Average Utility Infrastructure Cost Indices



Source: The Handy-Whitman© Bulletin, No. 165 and the Bureau of Economic Analysis.
Simple average of all regional construction and equipment cost indexes for the specified components.

EIA Price Projections Rising Over Time

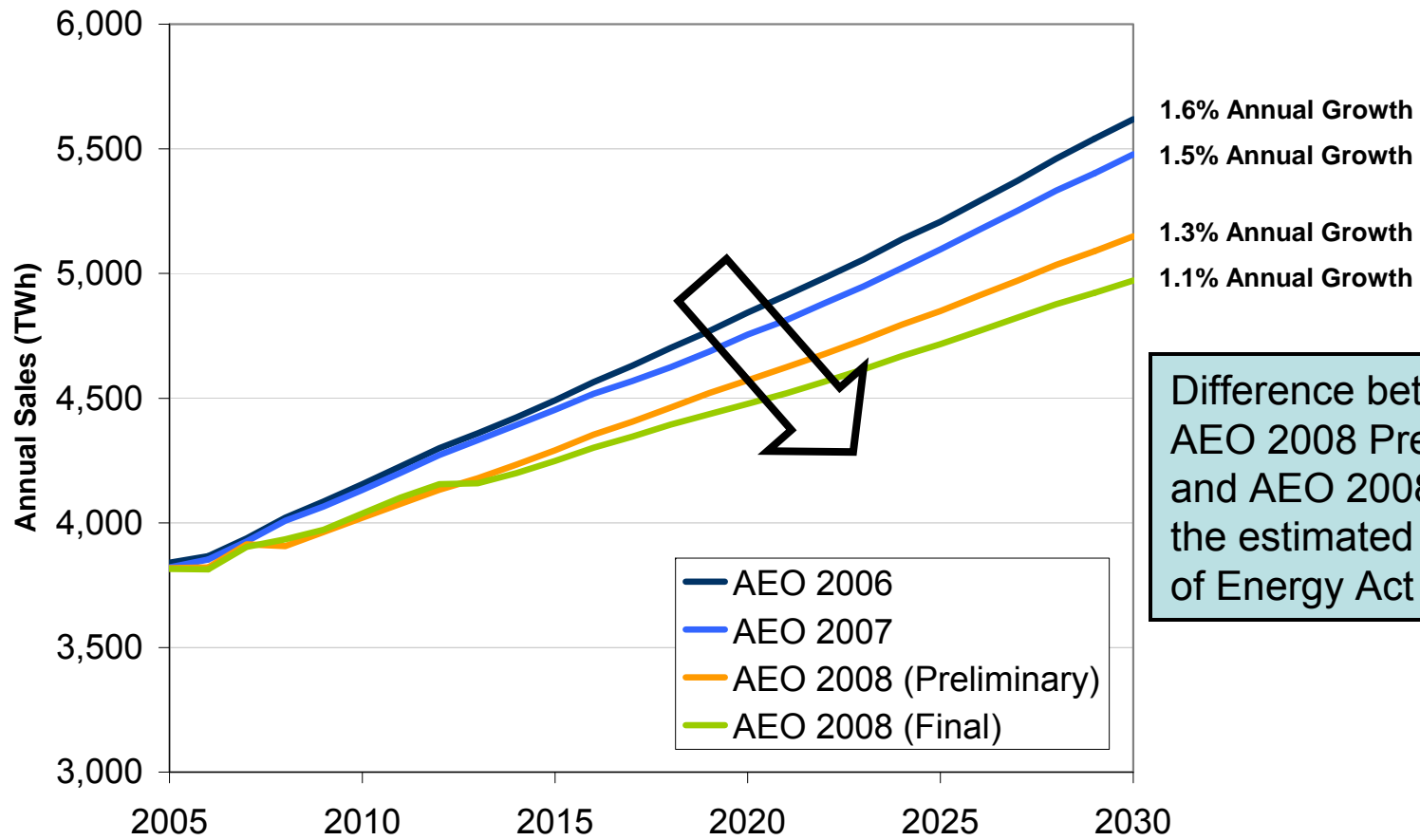
Comparison of AEO U.S. End-Use Price Forecasts



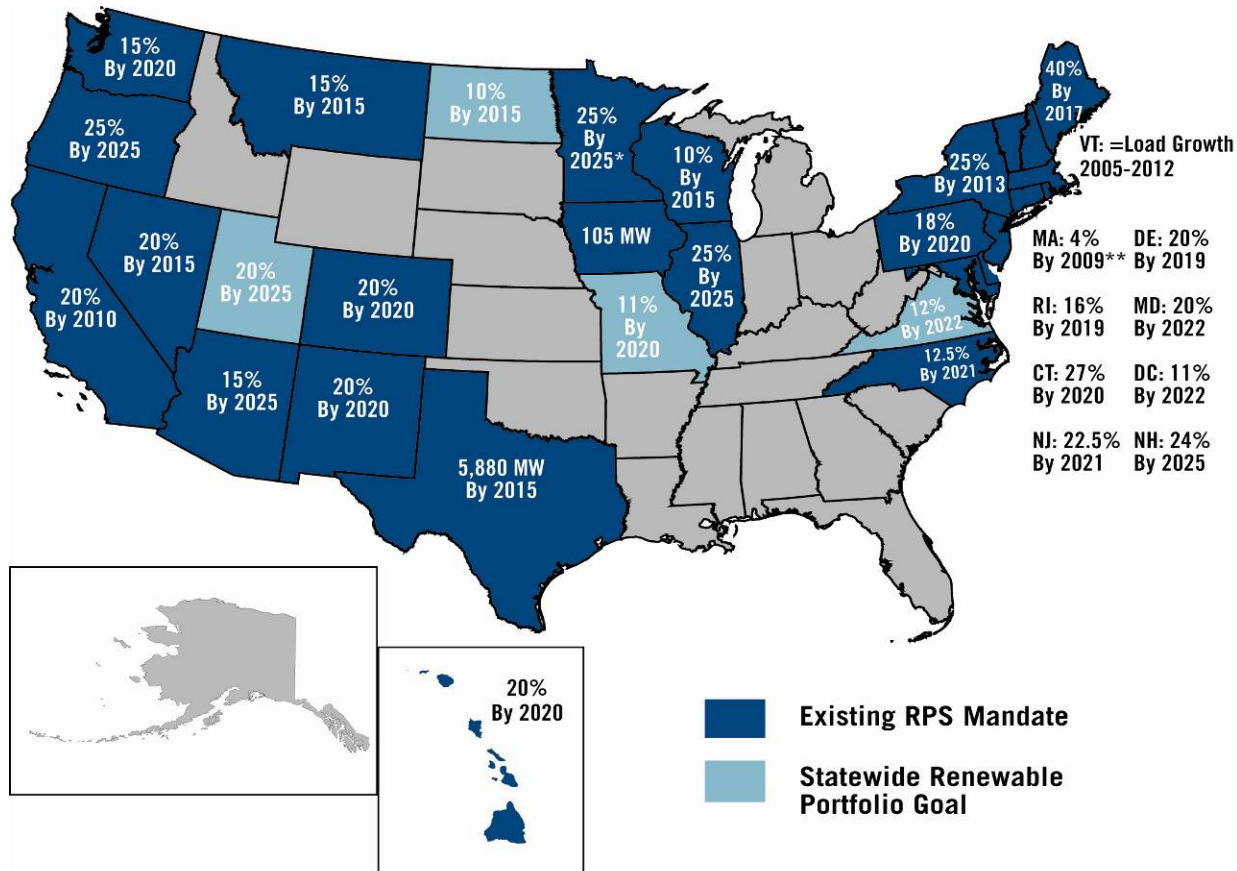
EIA electricity price projections up about 15-20% since 2006, mostly due to higher fuel cost.
EIA projections reflect only "current policy" i.e., no climate policy included

EIA Sales Forecasts Falling

Comparison of AEO U.S. Annual Sales Forecasts



Renewable Standards Ratcheting Up



NOTE: The renewable standards rise rapidly over the next decade. Renewable generation capacity will have to be built to meet these standards regardless of load growth or regional reserve margins.

*Xcel Energy: 30% By 2020 **Increasing 1% per year there-after

Source: Edison Electric Institute, status as of April 8, 2008.

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Investment Scenarios



An Illustrative Carbon Policy Scenario

Two simplified carbon policy scenarios presented:

- No change from present U.S. carbon policies (EIA assumption)
- Replace all new conventional coal builds with Advanced Coal Technology (ACT) w/carbon capture & storage (CCS)

Our illustrative “Replace with ACT” carbon scenario estimates new plant investment impacts only – it is not an integrated climate policy analysis that account for all costs

- Only consider “first-order” impact on new capacity cost
- Demand response and fuel price substitution effects are not reflected in these estimates

Impacts of Two Enhanced Energy Efficiency Cases Considered (Based on EPRI/EEI Study)

Realistic Achievable Potential (RAP):

- Most likely impact of expanded energy efficiency programs
 - ▶ Forecast of moderate customer changes and penetration rates of existing efficient technologies
 - ▶ Accounts for existing market, financial, political & regulatory barriers – but not full price effects

Maximum Achievable Potential (MAP):

- Higher-end of potential impact of cost-effective energy efficiency programs
 - ▶ Accounts for customer preferences and budget constraints
 - ▶ An aggressive but feasible customer participation rate

Generation Impacts Analyzed Using *Brattle's* RECAP Model

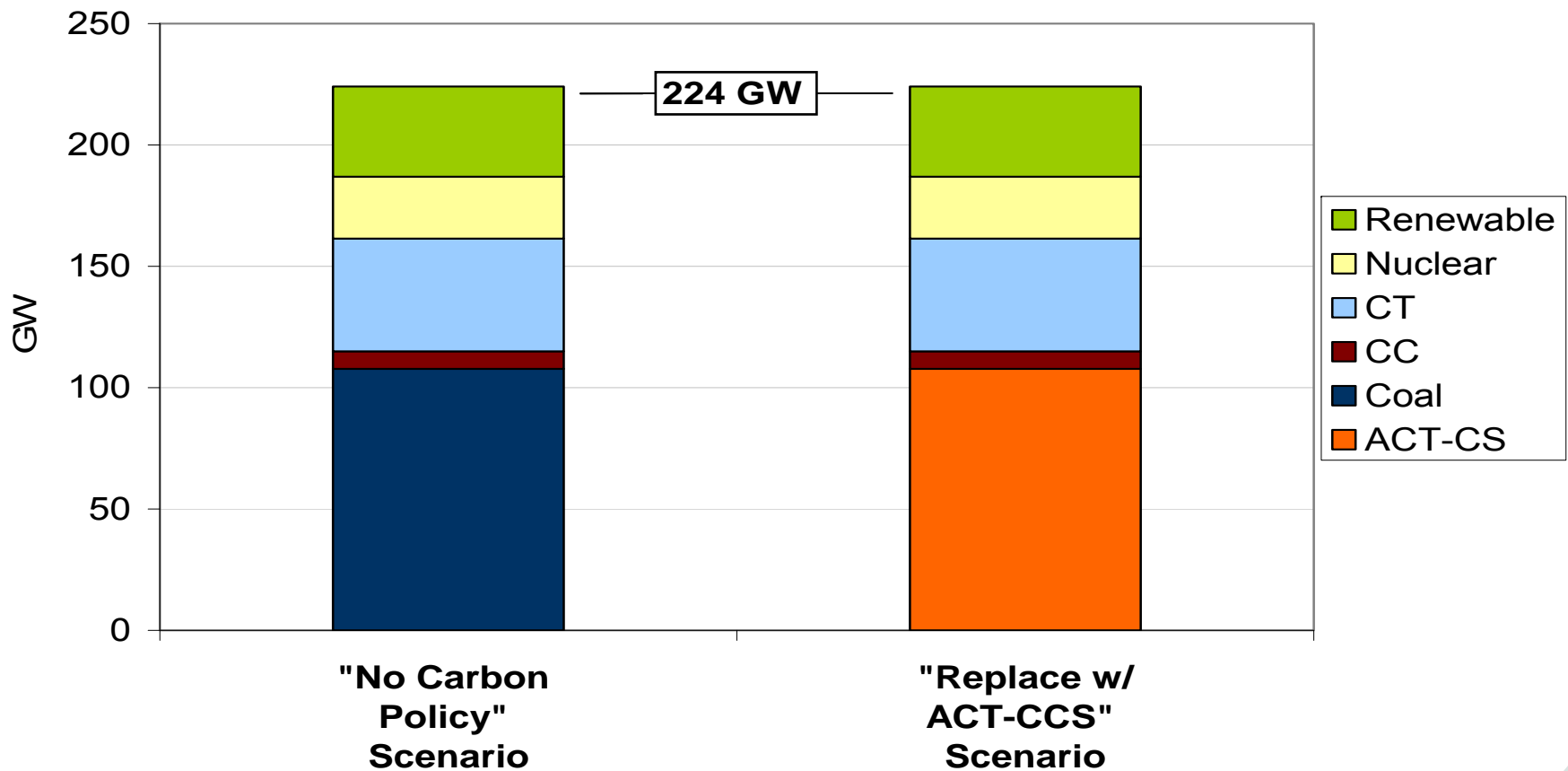
- The *Brattle* Regional Capacity (RECAP) model was used to project capacity additions and costs
- RECAP model results calibrate closely to the EIA Annual Energy Outlook (AEO) capacity additions when using AEO assumptions (fuel prices, demand growth, no carbon policies)
 - ▶ We assume higher construction costs than EIA, implying higher future customer rates
 - ▶ We also assume state-level Renewable Portfolio Standards (RPS) are met, also adding rate pressure
 - ▶ Full price feedbacks are not yet included, overstating sales growth

Generation Investments by Carbon Scenario



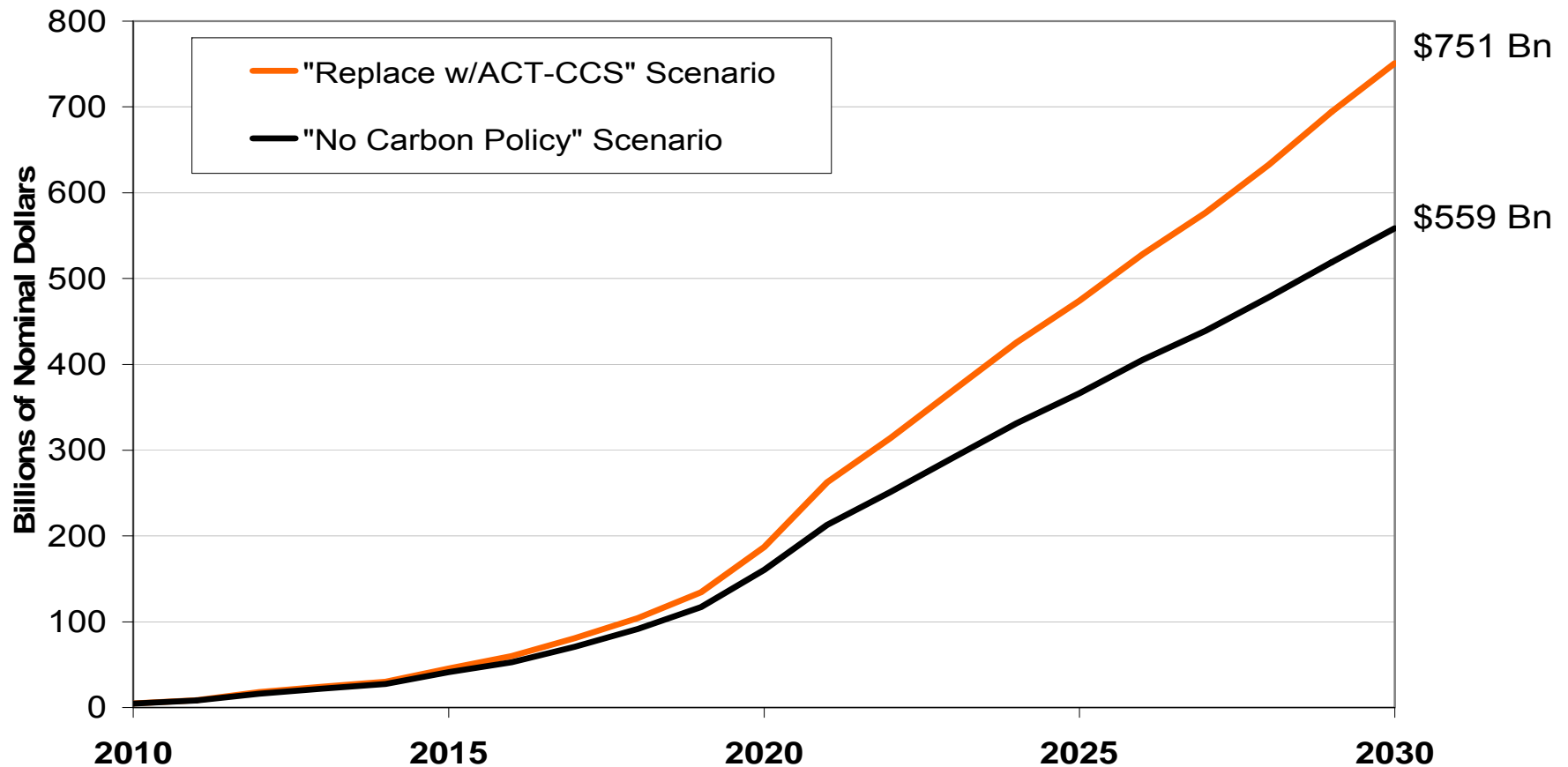
Assumed Impact of Carbon Policy on Capacity Mix

New Capacity Mix by Carbon Scenario (2010 - 2030)



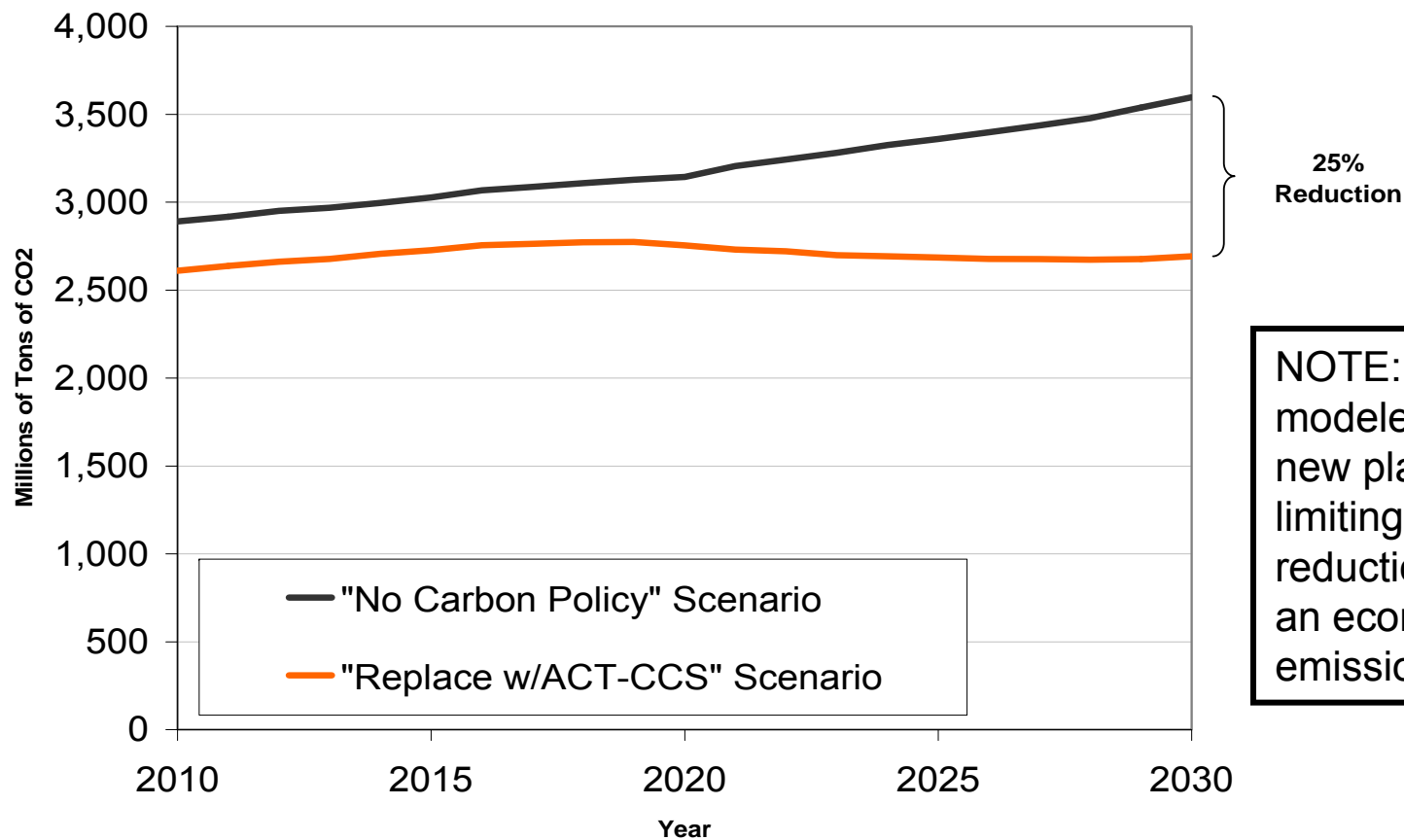
Capital Investment 2010-2030 is \$190 Billion Higher in the ACT-CCS Scenario

Cumulative Capital Investment by Scenario (Billions of Nominal \$)



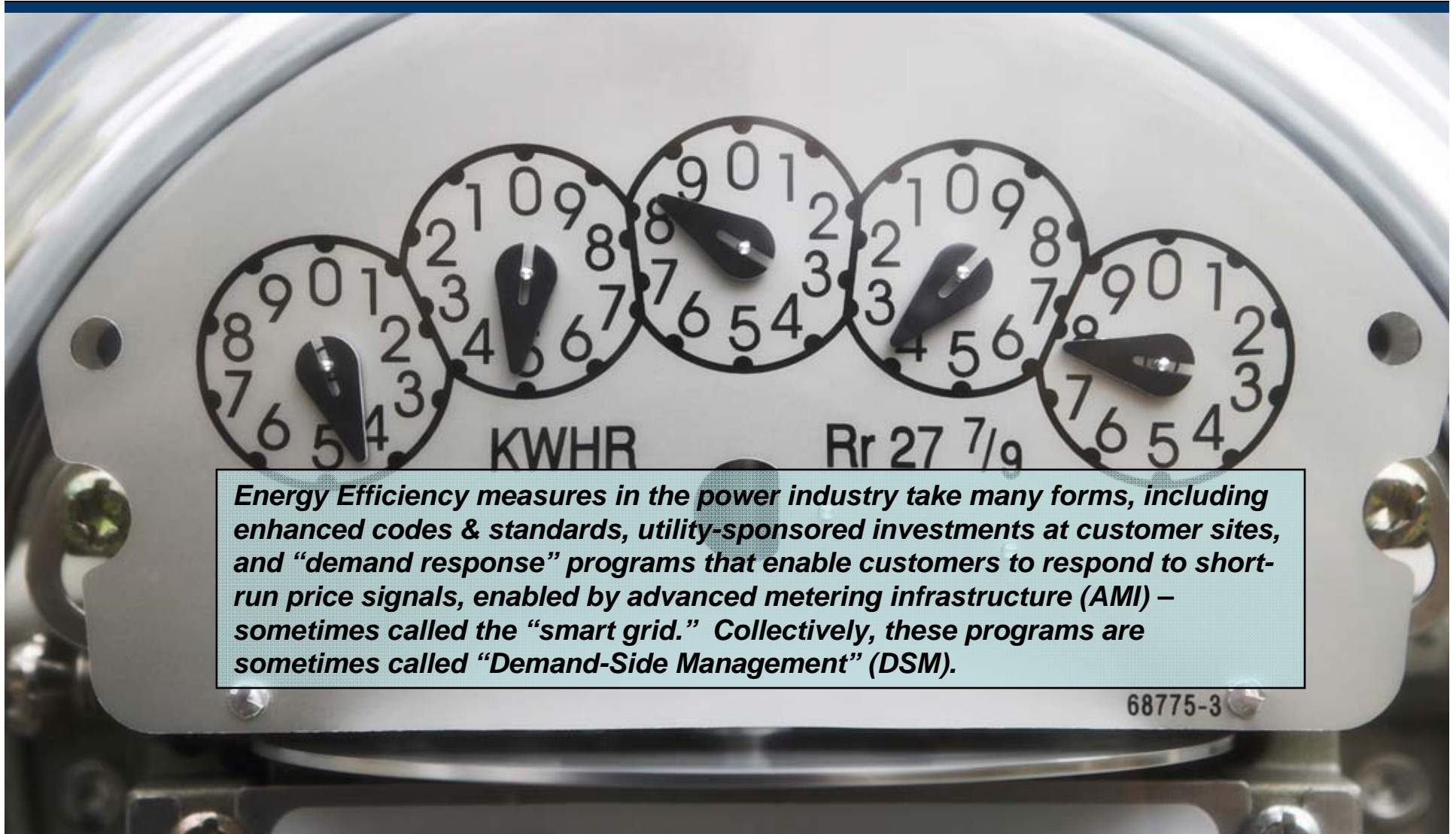
Electricity CO₂ Emissions Reduced by 25% in 2030 Under Assumed ACT-CCS Carbon Policy

Forecast of Annual CO₂ Emissions by Scenario



NOTE: the CO₂ policy modeled only affects new plant construction, limiting overall CO₂ reductions compared to an economy-wide emission cap policy.

Investment Impact of Enhanced Energy Efficiency Measures

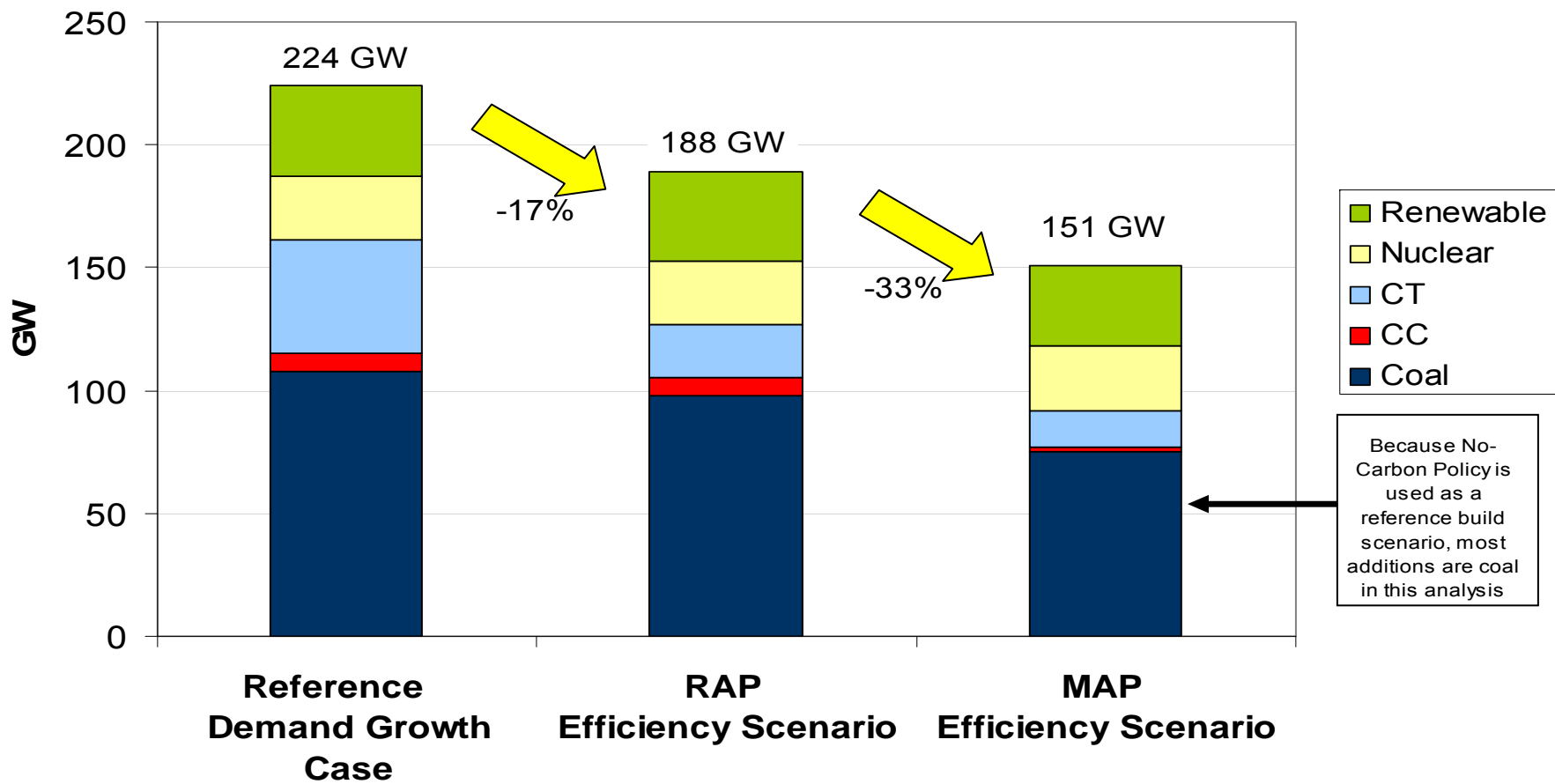


Energy Efficiency measures in the power industry take many forms, including enhanced codes & standards, utility-sponsored investments at customer sites, and “demand response” programs that enable customers to respond to short-run price signals, enabled by advanced metering infrastructure (AMI) – sometimes called the “smart grid.” Collectively, these programs are sometimes called “Demand-Side Management” (DSM).

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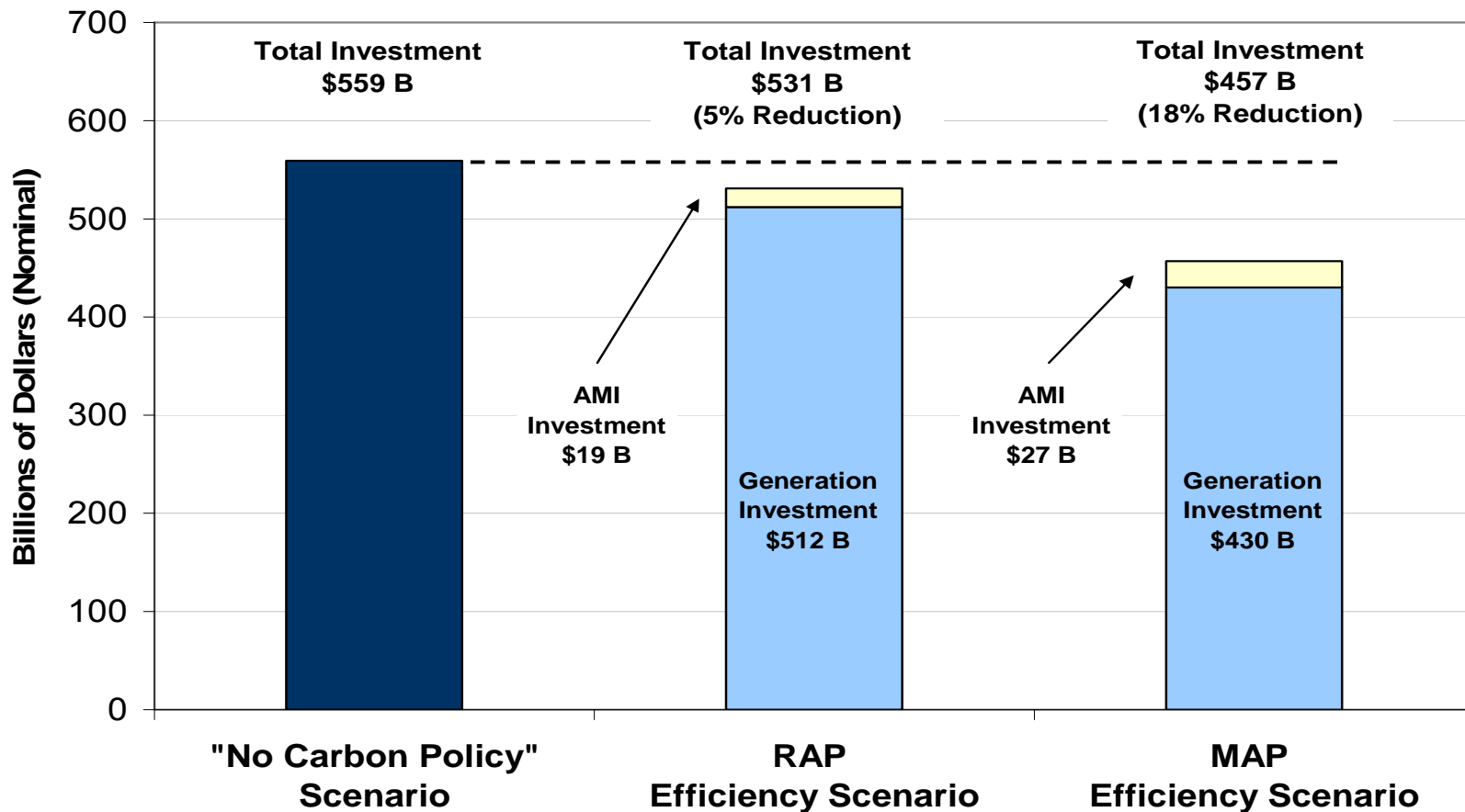
Enhanced Efficiency Reduces Capacity Built by at Least 17-33%

Illustration of Enhanced Efficiency Impacts Based on "No Carbon Policy" Build Scenario (2010 - 2030)



Enhanced Energy Efficiency Reduces Capital Investment to Meet Demand by 5% to 18% in 2030

Summary of Avoided Capital Investment Due to Enhanced Efficiency Illustrated Using "No Carbon Policy" Scenario



Capital Savings and Energy Efficiency Policies

- The percentage reduction in generation capital costs (\$) is smaller than the reduction in new capacity builds (MW) in the enhanced energy efficiency scenarios:
 - ▶ Mostly peaking capacity avoided (e.g., gas CTs), which have lower \$/kW installation cost than coal or nuclear.
 - ▶ In RAP Scenario, new coal capacity decreases by 8% while peaking capacity decreases by 54%
 - ▶ In MAP Scenario, new coal capacity decreases by 30% while peaking capacity decreases by 68%
 - ▶ Mandated renewable investments largely unaffected, which are also more expensive than peaking units on a \$/kW installed basis.
 - ▶ These impacts are a function of the assumed mix of enhanced energy efficiency measures that focus on demand response. Greater emphasis on overall energy saving measures would slow the rate of baseload plant additions but also increase energy efficiency investments
- Investment in AMI also offsets some of the capital savings in generating capacity
 - ▶ In RAP Scenario, AMI investment is 42% of avoided capacity cost
 - ▶ In MAP Scenario, AMI investment is 21% of avoided capacity cost
- Other efficiency investments may also be capitalized by the industry – these would add still more to the industry's capital needs.

Transmission and Distribution



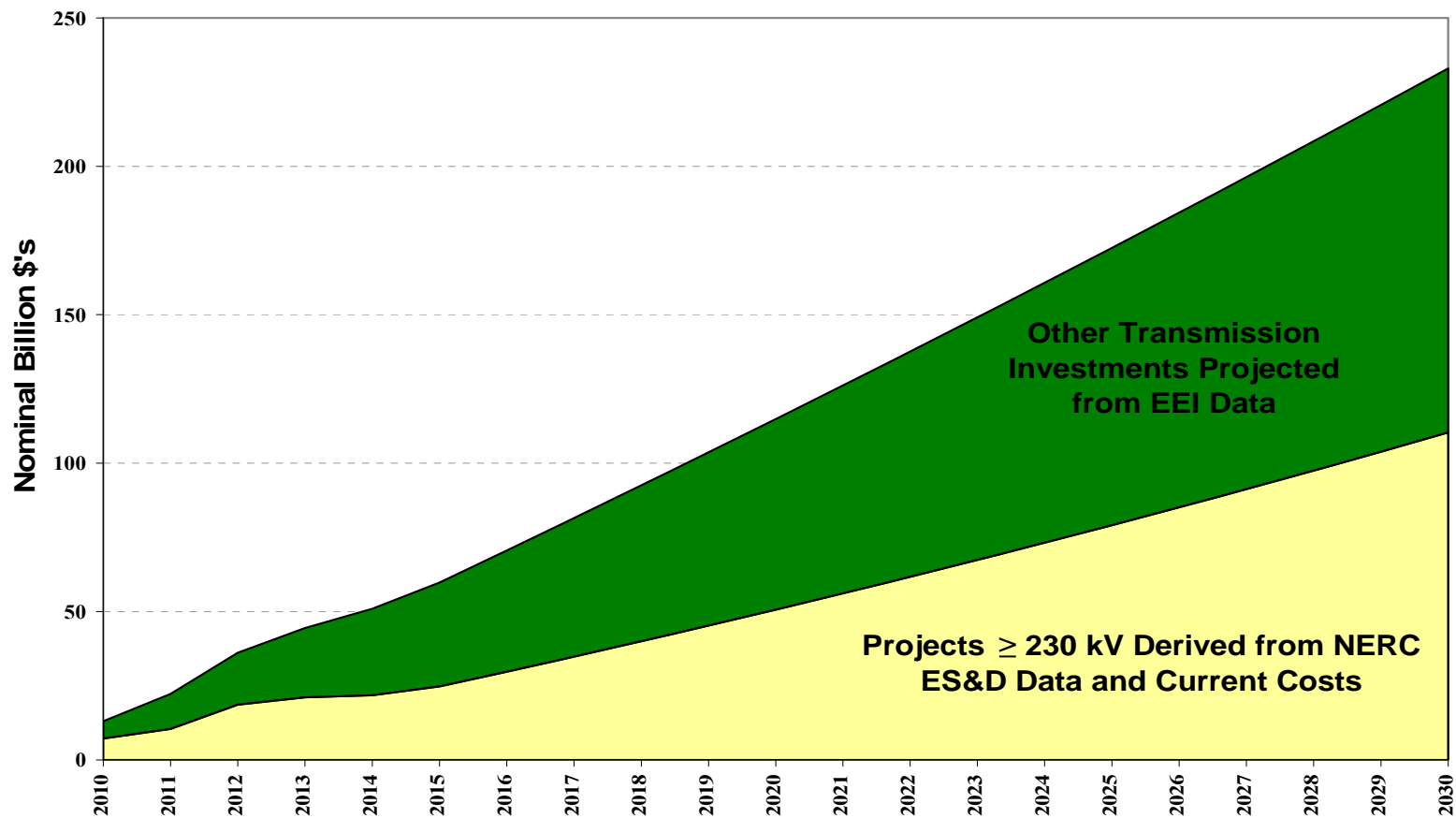
Transmission & Distribution Forecasts

The T&D forecasts 2010 – 2030 reflect only recent cost and expenditure trends

- Not a formal investment analysis of future needs
- **Near term transmission capital forecasts & data:**
 - ▶ NERC ES&D data on transmission project miles proposed to 2015 (by region, voltage classes \geq 230 kV)
 - ▶ EEI member survey data on actual spending and planned expenditures (\$) through 2010
 - ▶ Project costs (\$/mile, \$/MW-mile) from actual & proposed
- Historic distribution capital expenditures from EEI member survey data are only source for distribution

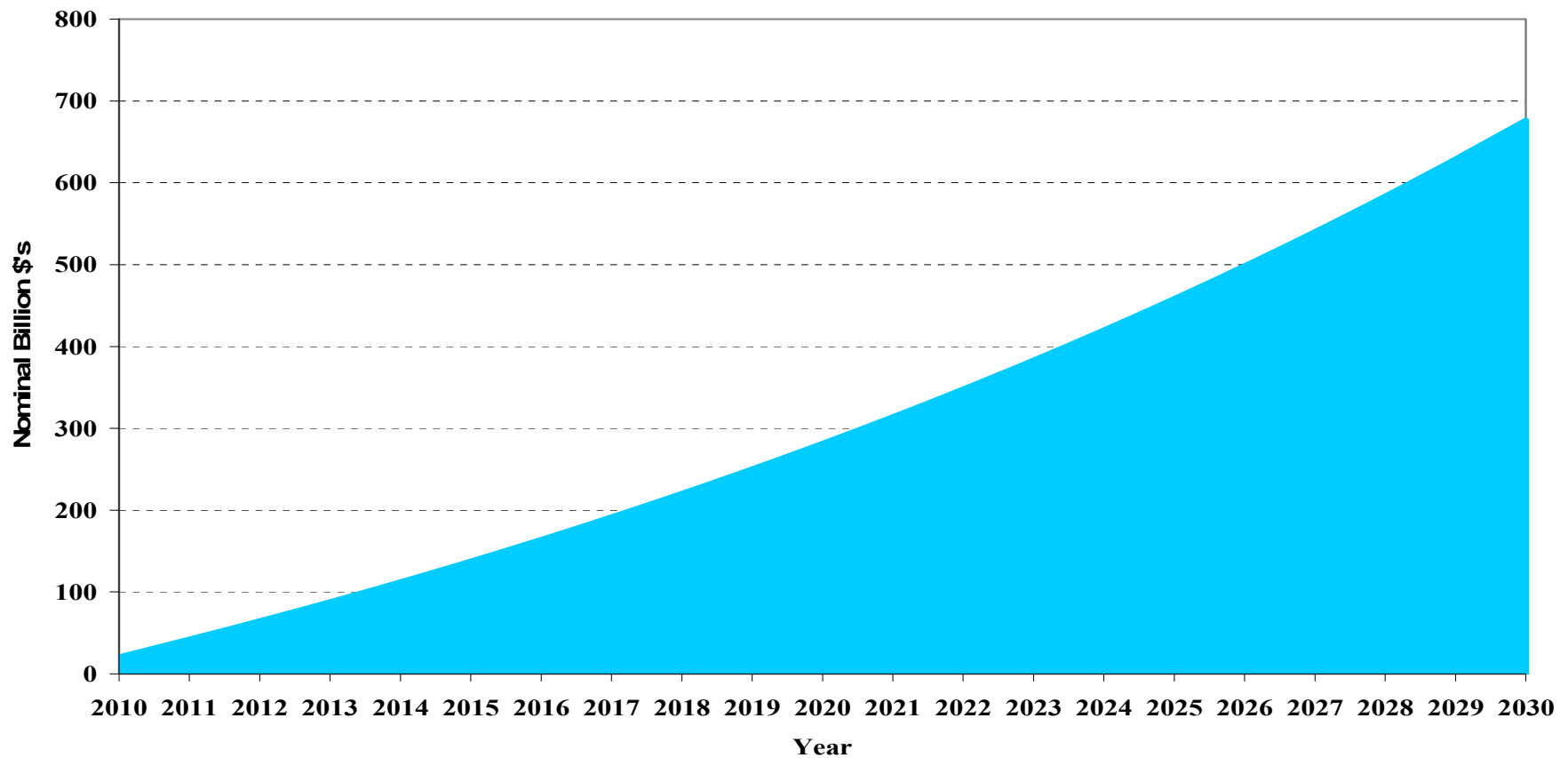
Transmission Investments Could Reach \$233 Billion 2010 - 2030

PROJECTED COST OF NEW TRANSMISSION (2010-2030)



Distribution Investments Could Reach \$675 Billion 2010 – 2030

Cumulative Forecasted Distribution Costs (2010-2030)



Overall Study Results

Investment on the order of \$1.5 trillion will be required over the 2010 – 2030 period

- Distribution - \$675 billion
- Transmission - \$233 billion
- Generation - \$560 billion, with no changes in carbon policy

While enhanced energy efficiency measures will reduce sales growth and generating capacity needs substantially, overall capital requirements are less affected:

- Reduced peak demand tends to displace less expensive generation capacity
- Costs of energy efficiency measures add back significant cost

Overall Study Results

Climate initiatives will add to new generation capital needs, in our illustrative carbon policy case:

- Use of Advanced Coal Technology with Carbon Capture and Storage could add about \$200 billion in capital cost
- As applied to new capacity builds only, this hypothetical policy would reduce CO₂ from electric utilities by about 25% in 2030