RGGI and CO_2 Policy Analysis Overview

Steve Fine and Chris MacCracken

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Outline

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- RGGI Analytic Process
- Analytic Approach and IPM® Overview
- RGGI Reference and Package Scenarios
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  - Other Scenario Results
- CO_2 Policy Implications for Generators

ICF Overview

- Thirty-eight years of experience – founded in 1969
- A leading management, technology, and policy consulting firm providing advisory and program implementation services to public and private clients in many sectors:
  - Energy
  - Environment
  - Economic Development
  - Transport
  - Security
  - Social Programs
- Over 2,000 employees – 1,700 full-time, 300 part-time
- Global presence with headquarters in Washington, DC area

More than 30 years International Experience Advising Clients in the Energy Markets

Asset Acquisition & Deployment

- Wholesale power market and renewables energy analysis
- Fuel market analysis
- Transmission and interconnection assessment
- Asset valuation
- Due diligence
- Asset & portfolio optimisation

Network Analysis

- Regulatory strategy
- Network benchmarking
- Network valuation
- Value of transmission

Helping clients obtain maximum value from their energy market assets in Americas, Europe, and Asia

Emissions and Climate Change Management

- Regulatory analysis
- Value-at-risk analysis
- Project-based emissions reductions
- Emissions trading support

Other Services

- Energy efficiency
- Information management systems
- Economic & community development
- Emergency management

Selected Experience in Environmental Strategy and Analysis

- State and Regional Policy Analysis
  - California Air resources Board (CARB) Multi-sector GHG Policy Analysis
  - Regional Greenhouse Gas Initiative (RGGI) CO_2 Analysis
  - NY GHG Analysis
  - CT GHG Stakeholder Dialog
  - WRAP SO_2 Regional Haze
- Air Emissions Compliance Strategy and Expert Witness Testimony
  - Expert testimony on CO_2 prices
  - Expert testimony and analytic support for coal unit compliance plan
- Allowance Market Analysis
  - US Emission and Fuel Markets Outlooks since 1992
- Renewable Market Analysis
  - Costs and impacts of New York renewable portfolio standard
  - REC forecast for wind developer
- Federal Policy Analysis
  - EPA policy and regulatory support analysis for CAAA 1990, OTAG, SIP Call, 1997 NAAQS, CAIR, CAMR, Clear Skies, Carper
  - EIS for FERC wholesale power market rulemaking for Order 888, Order 2000, Cost-Benefit Study for Standard Market Design
- Technology Assessment
  - Projected long-term penetration of IGCC under multiple CO_2 scenarios
  - Market analysis for pollution control vendors and engineering firms
- Air Emissions Impact Analysis of Transmission Lines
  - Minnesota Arrowhead-Weston line
- Compliance Planning
  - Real Options Analysis of NO_X control strategy

Summary of Climate Change Experience

Highlights of Experience

- Provide climate policy advice to > 60 governments
- Provide analysis to RGGI and CARB
- Provide climate strategy advice to > 55 companies in the FT Global 500
- Over 230 professionals with climate-related expertise

MARKET SURVEY 2006 Environmental Finance PUBLICATIONS — ***Best Advisor***: EU Emissions Trading Scheme

MARKET SURVEY 2006 Environmental Finance PUBLICATIONS — ***Best Advisor, Runner Up***: Kyoto Project Credits

MARKET SURVEY 2006 Environmental Finance PUBLICATIONS — ***Best Advisor***: North American GHG Markets

Service Offerings

- Developing climate strategies aligned with key corporate drivers based on our *Value-at-Stake* methodology
- Carbon market pricing analysis using our IPM® and *InCaP* models
- GHG emission inventories
- Bringing CDM and JI projects through the Kyoto cycle
- Undertaking due diligence of CDM and JI projects using our *K-Prism* model
- Providing market analysis to low-carbon technology companies
- Modeling emissions scenarios
- Assisting governments establish their climate change policy framework and institutions

RGGI Analytic Process

Introduction

- NYSERDA, on behalf of the Regional Greenhouse Gas Initiative (RGGI) State Working Group (SWG) commissioned ICF to evaluate the impacts of implementing a CO_2 cap on the electric power sector in the northeast and mid-Atlantic region.

- The analysis that was produced was driven by two key issues: the **Assumptions** used and **Scenarios** examined.

- Both the technical and market assumptions that served as inputs to the modeling analysis as well as the policy scenarios evaluated were developed by the RGGI Staff Working Group (SWG) and were the sole responsibility of the SWG.

- ICF used the Integrated Planning Model® (IPM®) to analyze these policies based upon the assumptions developed by the SWG.

RGGI Analytic Process

- The bulk of the electric sector analysis for RGGI was focused on the original 9-state configuration. Maryland has since joined to become the 10th state (after MA and RI re-joined).
  - The 10 RGGI states are shown on the map on the previous page.
- Members of the 9 states participated as part of the SWG in the assumptions development and Reference and Policy case specifications.
- While ICF performed the analysis using its proprietary IPM® tool, the assumptions and scenario/policy specifications were the decisions of the SWG.

RGGI Analytic Process continued

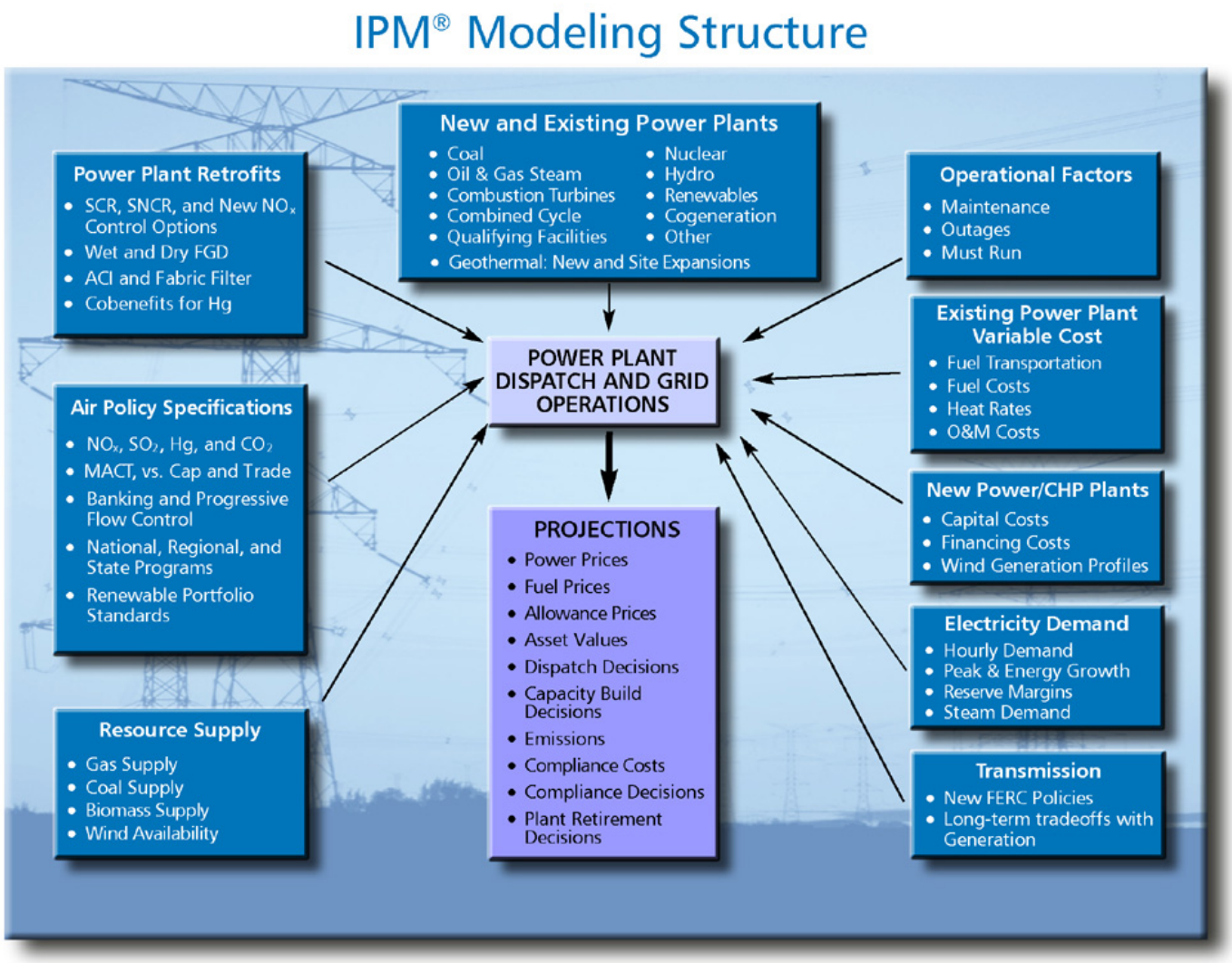
- The analytic process was carried out in multiple phases
- The first phase included 3 general stages:
  - Assumptions development
  - RGGI Reference Case Development
  - RGGI Policy Scenario Analysis
- The original RGGI Reference Case was based on the assumptions developed during the assumptions process. The entire assumptions document is available on the RGGI website.
  - Note that the vast majority of assumptions developed during this process remained the same in every Reference Case variation and policy case.
- In this first phase of the analysis, the SWG had ICF analyze the impacts of multiple CO_2 caps on electric markets in the RGGI region as compared to the Reference Case.
  - The initial cap cases included reductions ranging from 5% up to 35% from 1990 levels in the region.

RGGI Analytic Process continued

- The SWG also defined a set of alternative Reference Cases that, for the most part, varied over 3 key assumptions:
  - Natural gas prices
  - The availability of new coal capacity in RGGI
  - Electric demand growth
- The same policy (e.g., 15% below 1990 levels) was then implemented with each of the alternative Reference Cases to examine the impact of alternative assumptions on the cost of compliance with the RGGI policy. That is, comparison of the results of the alternative reference case with and without the RGGI policy would show how the impacts of the policy behaved under different market conditions.
- Later phases of the analysis included updates to the underlying Reference Case assumptions made in response to SWG and Stakeholder comments.
  - Changes were made to the gas and oil price trajectories, operating characteristics of oil and gas steam units in the RGGI region and to the representation of the New York capacity market in IPM®, among other things.
- Policy analysis after the first phase focused only on a single policy option referred to as the “Package” Case.

Analytic Approach and IPM® Overview

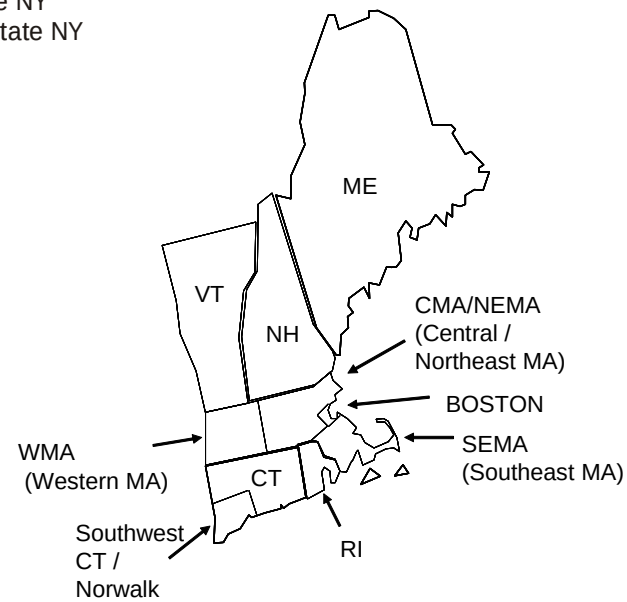
IPM® Analytic Framework



The IPM® Modeling Framework

- The Integrated Planning Model (IPM®) was used to analyze the impacts of environmental policies on allowance markets, electric markets and compliance decisions.
- IPM® is a linear programming model with a detailed representation of every boiler and generator operating in the United States. The model determines the least cost means of meeting electric energy and capacity requirements, while complying with specified air regulatory scenarios.
- In addition to optimizing wholesale and environmental markets, IPM® simultaneously optimizes coal production, transportation and consumption.
  - IPM® contains 40 coal producing regions and has over 10 coal types defined by rank and sulfur content.
  - Each coal plant is assigned to one of over 40 coal demand regions characterized by location and mode of delivery including rail, barge, and truck.
- Natural gas prices are derived within IPM® using a similar supply curve and transportation network.

IPM® North America



NOTE: PJM-East is represented as 3 IPM® regions to separate the RGGI-affected and unaffected units in the region: PJM-East-NJ, PJM-East-Delmarva, PJM-East-PA (PECO).

Key Features of IPM®

- ICF uses a national version of IPM® specifically designed for simulating the effect of environmental regulations in the electricity sector.
- For this analysis, IPM® North America included representation of at least 40 power market regions (depending on the final Northeast representation), including 10 New England regions, 5 New York regions, and 5 Canadian regions.
- IPM® explicitly models transmission links between those regions.
- The model includes endogenous pricing of coal supply, gas supply and fuel transportation costs.
- The national model determines the least cost means of complying with the specified air pollution regulations:
  - Multiple environmental compliance requirements are evaluated simultaneously - e.g., SO_2 , NO_X, CO_2, Hg.
  - Determines optimal compliance for the system from a comprehensive range of choices including: new investment in capacity and/or pollution controls, fuel switching, repowering, retirement, and dispatch adjustments.

The IPM® Optimization Process

- IPM® combines peak power demand, total energy demand, and hourly load profiles to create load duration curves for each season and region.
- To meet demand, IPM® selects units to create a stack of generators dispatched by variable cost, subject to availability and other operating constraints. The last unit to be dispatched (i.e., the unit with the highest variable costs to operate) is the marginal unit and sets the energy price for that demand period.
- IPM® will choose to endogenously bring to market new capacity where it is economically feasible, in order to minimize the *present value* costs over the lifetime of the forecast period. For example, saving 1$ in 2003 is equivalent to saving $1.60 in 2010, assuming a 7% discount rate.
- All costs are prices in IPM® are represented in real 2003 dollars.

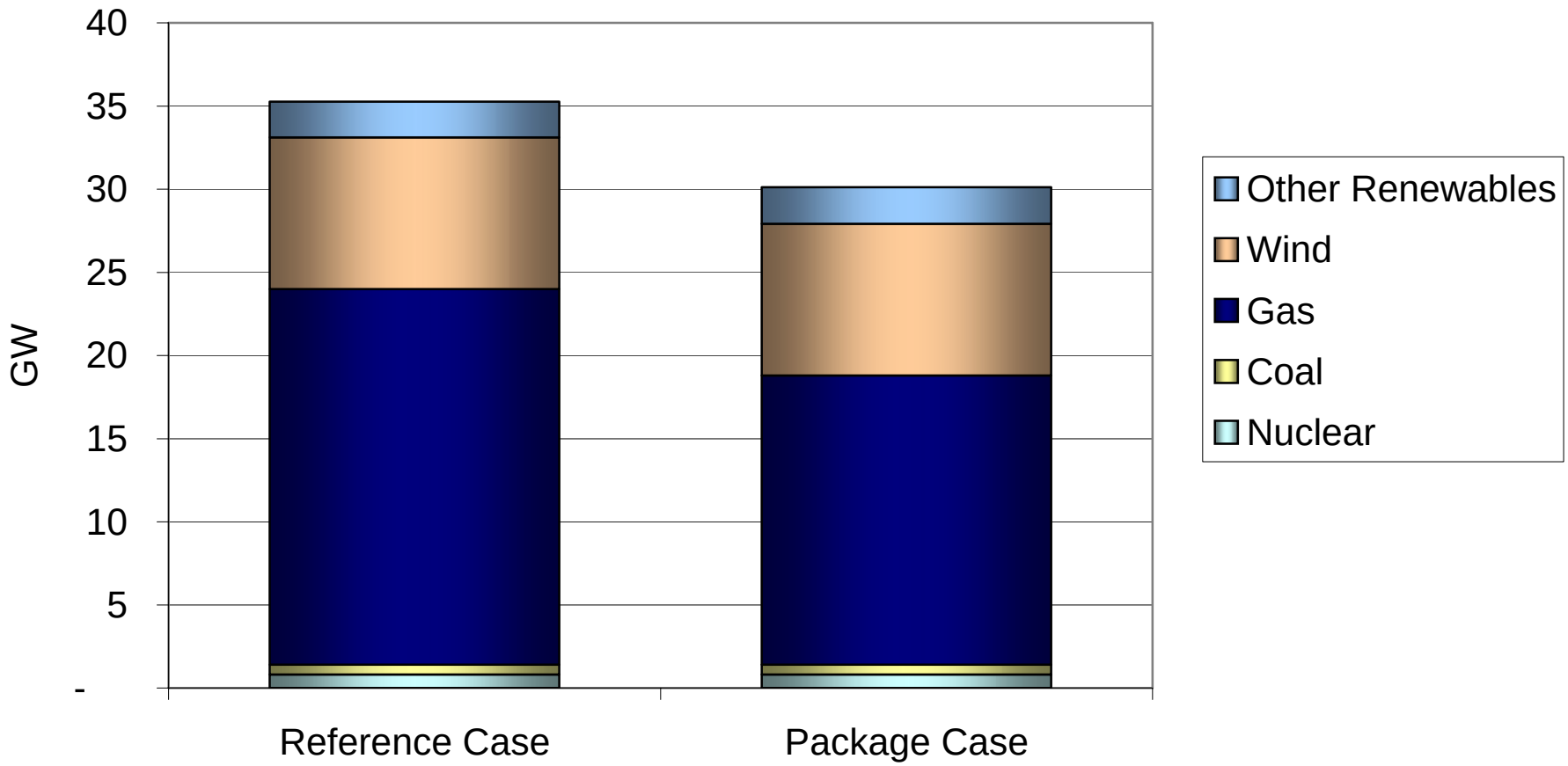
Market, Technical and Policy Assumptions

Status of Assumptions Development

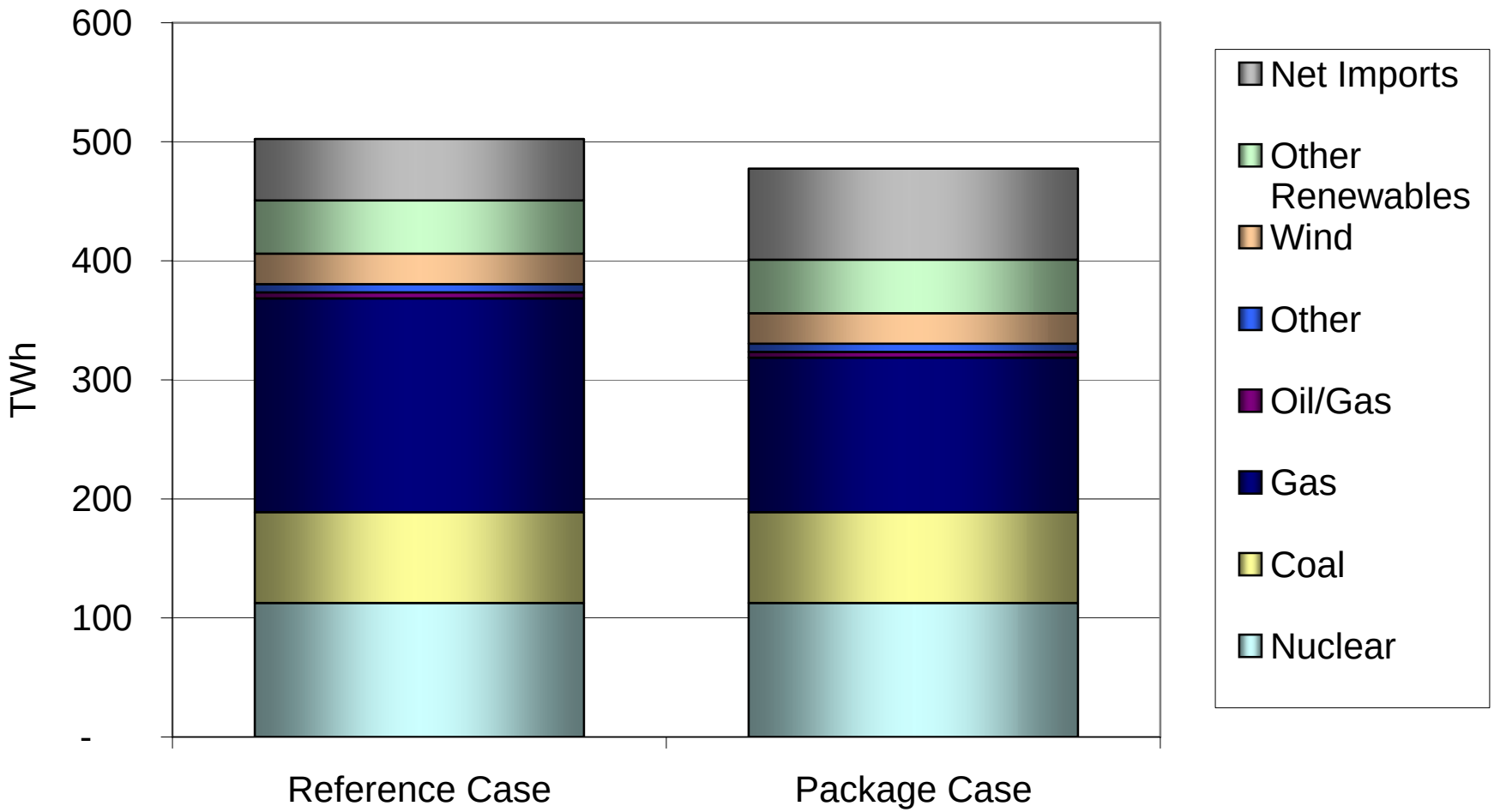
Assumption	Proposed Data Source					Status of Assumptions Development
	AEO 2004 (EIA)	EPA	ICF	ISOs/ States	Other	
Market Assumptions						
National Electricity and Peak Demand	X					Complete
Regional Electricity and Demand Breakout				X		Complete
Gas Supply and Price Forecast (wellhead and regional)					X	Complete
Oil Price Forecast	X				X	Complete
Coal Supply and Price Forecast	X		X			Complete
Financial Assumptions					X	Complete
Technical Assumptions						
Firmly Planned Capacity Additions				X		Complete
New Conventional Capacity Cost and Performance	X				X	Complete
New Conventional Capacity Emissions Profiles	X				X	Complete
Pollution Control Retrofit Cost and Performance	X	X				Complete
Renewable Power Technology Cost and Performance					X	Complete
Renewable Power Resource Availability and Cost					X	Complete
Nuclear Unit Relicensing and Uprate Assumptions		X (Rel.)			X (Uprt.)	Complete
Existing Transmission Total Transfer Capabilities				X		Complete
RTO Structure & Transmission Tariffs				X		Complete
New/Enhanced Transmission Line Capacity						Not Applicable - No New Transmission Allowed Beyond Firmly Planned
Policy Assumptions						
Renewable Portfolio Standards				X	X	Complete
3-pollutant Federal Program Specification					X	Complete

RGGI Reference and Package Cases
RGGI Region Results

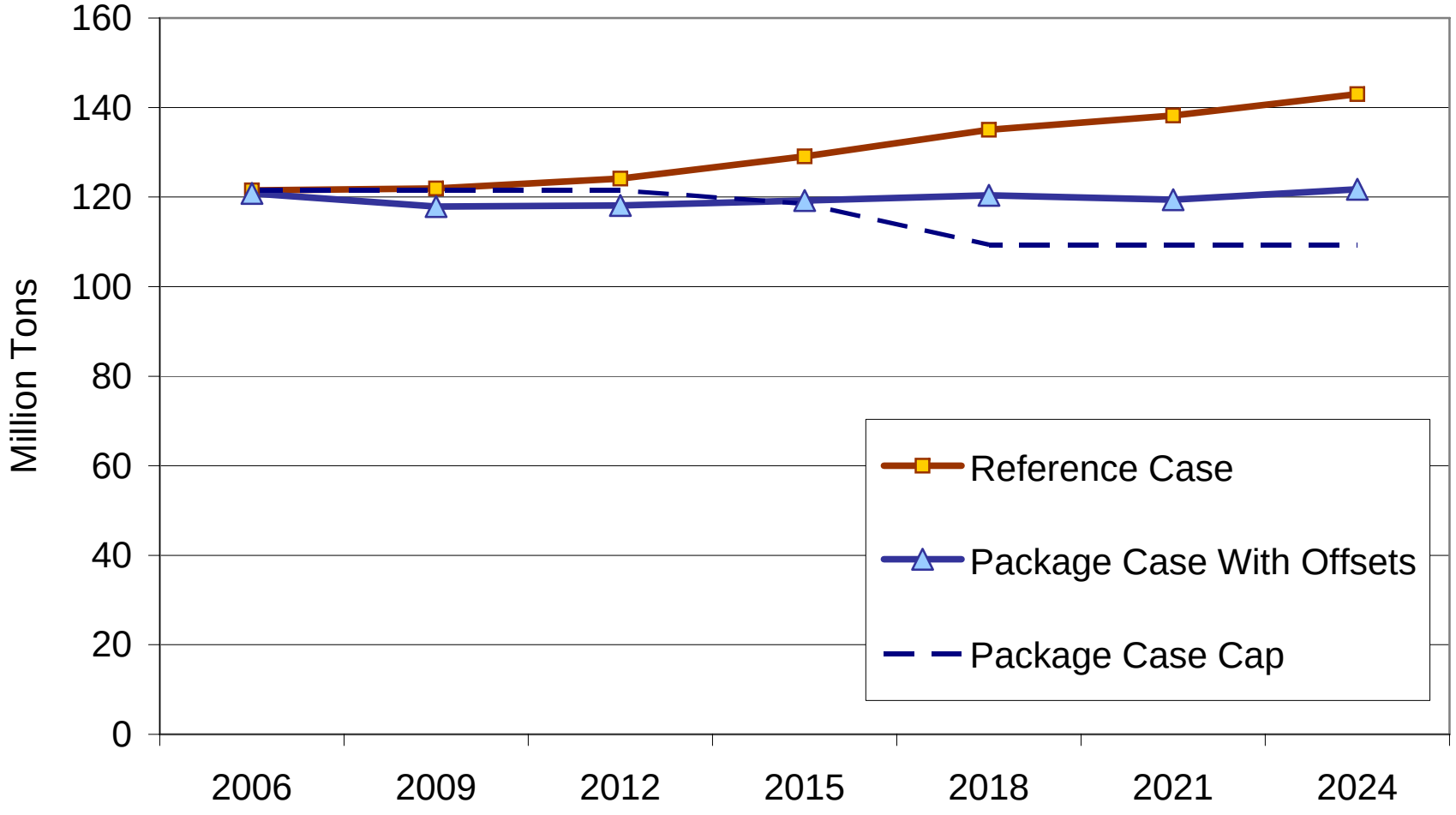
RGGI Cumulative Capacity Additions by 2024



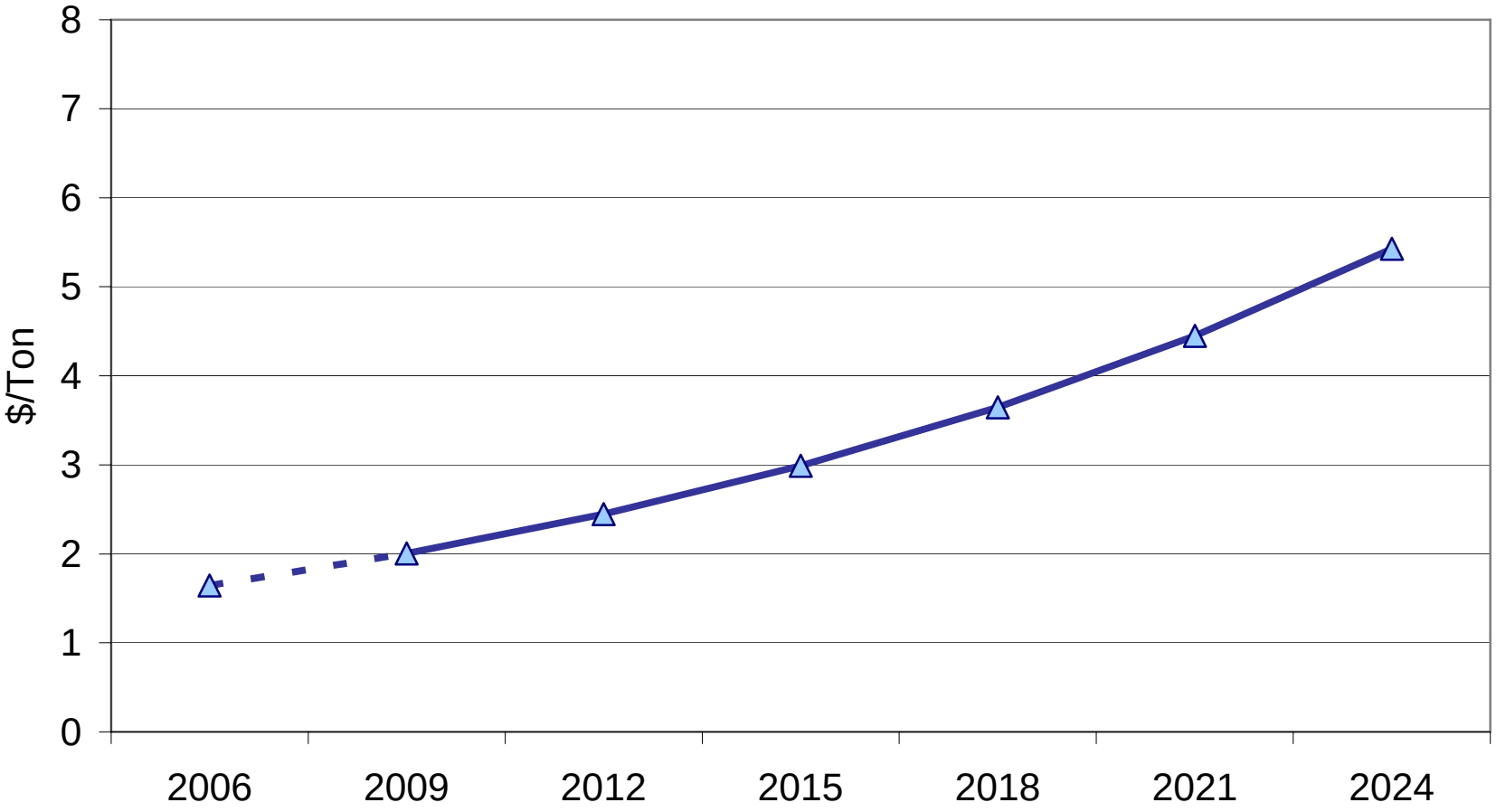
RGGI Generation Mix in 2024



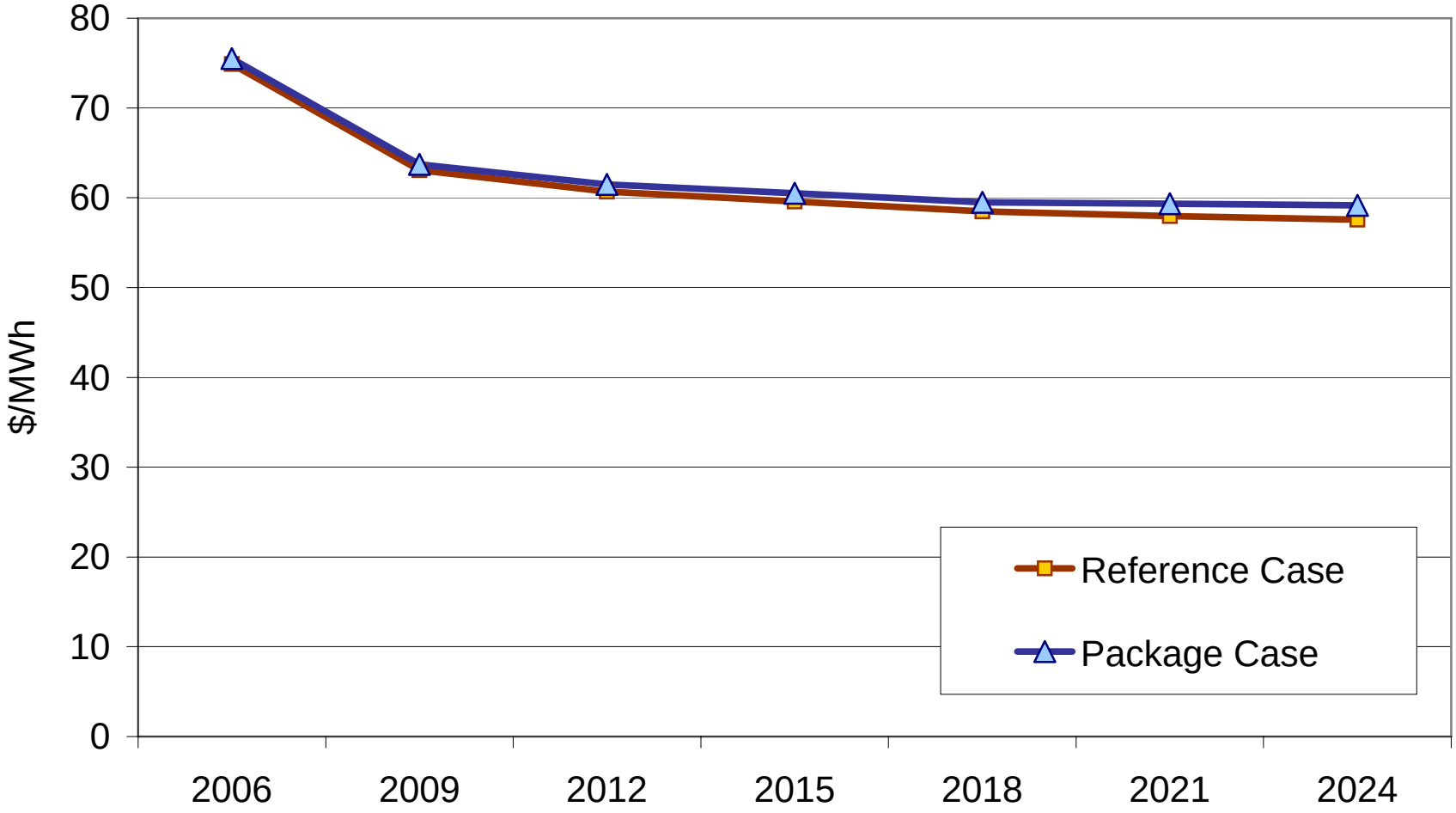
RGGI 9-State CO_2 Emissions



CO_2 Allowance Prices – Package Case

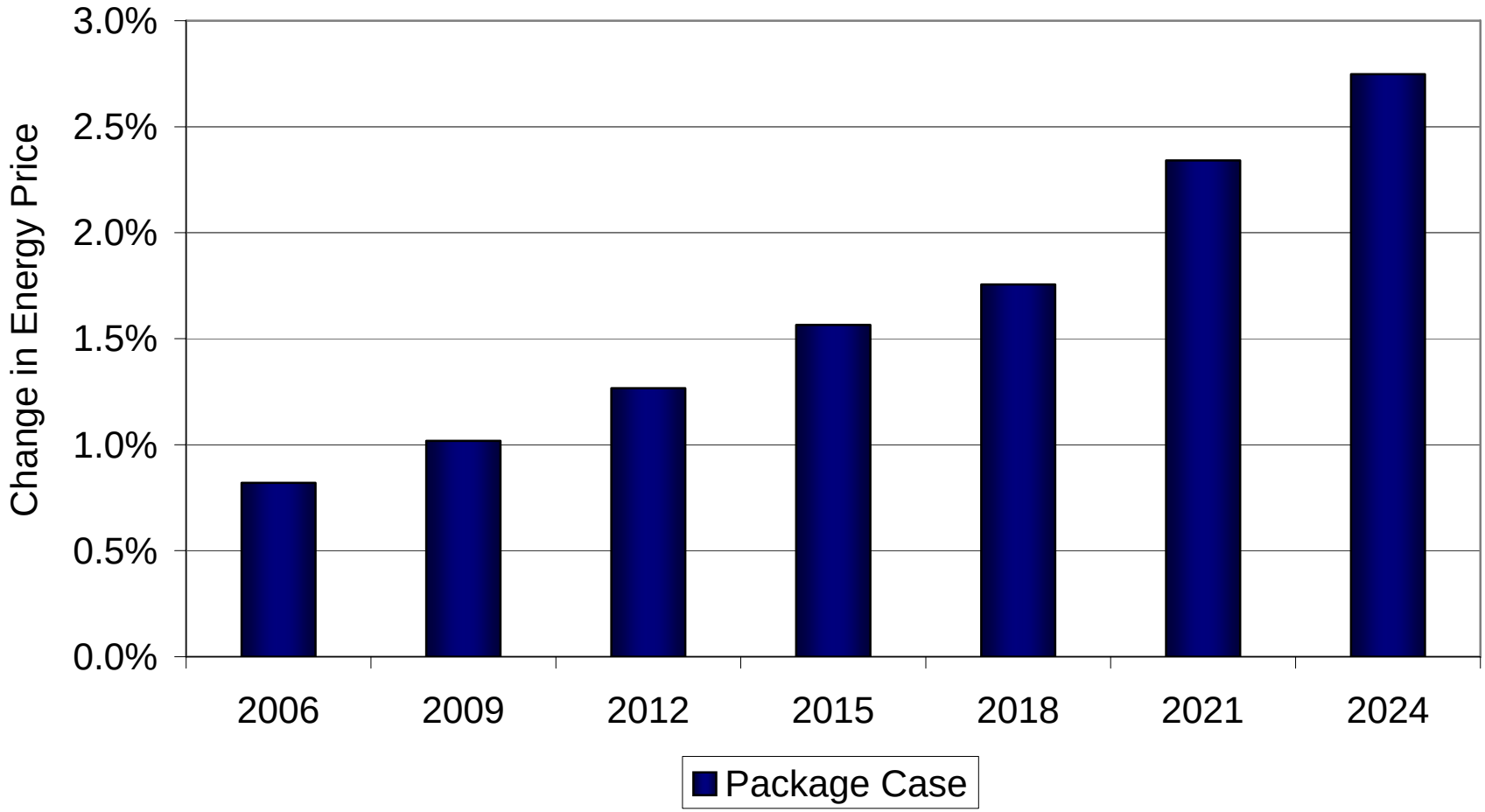


RGGI Average Annual Energy Prices



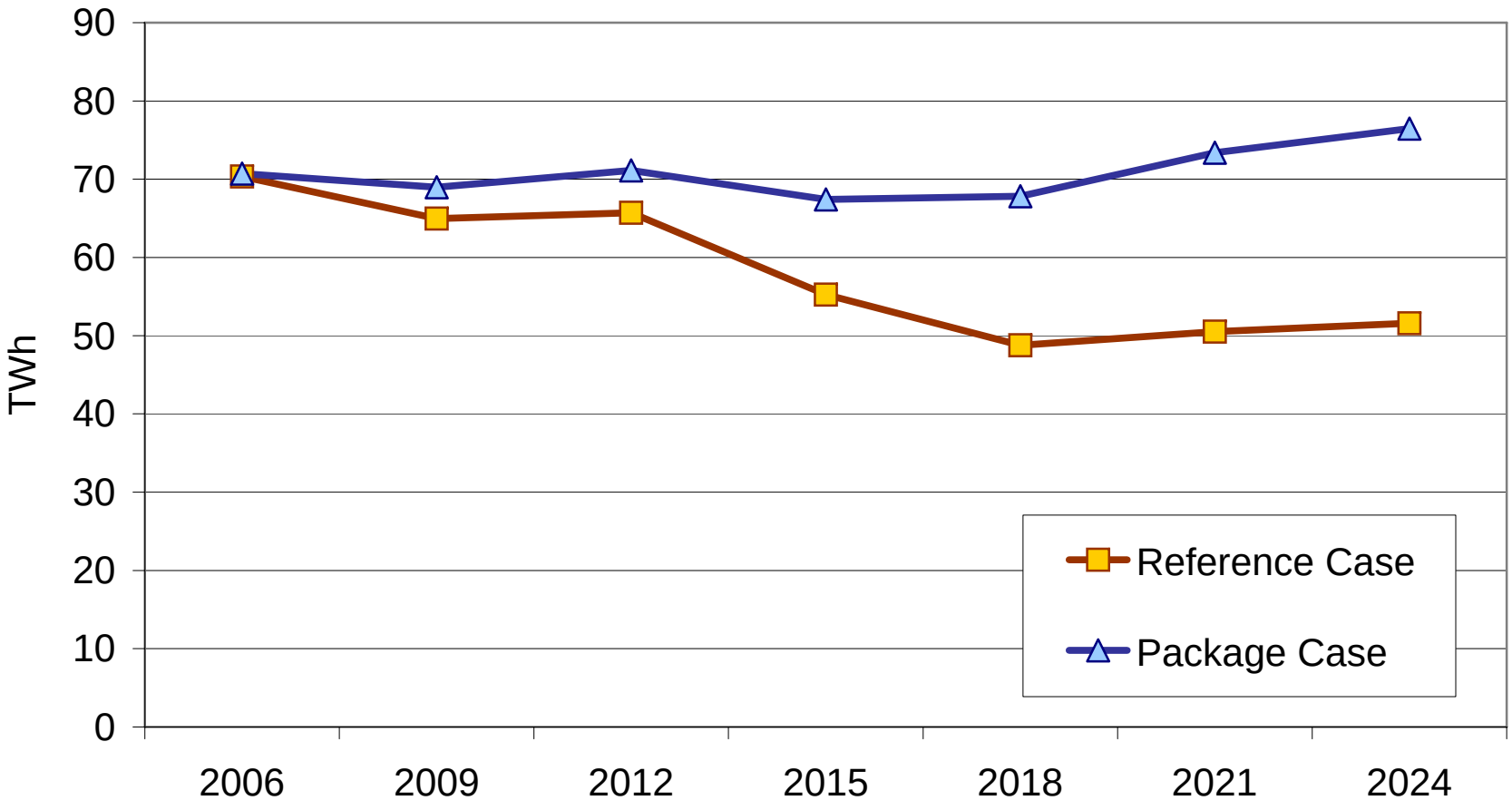
NOTE: Energy prices include annualized capacity prices.

Change in RGGI Average Annual Energy Prices



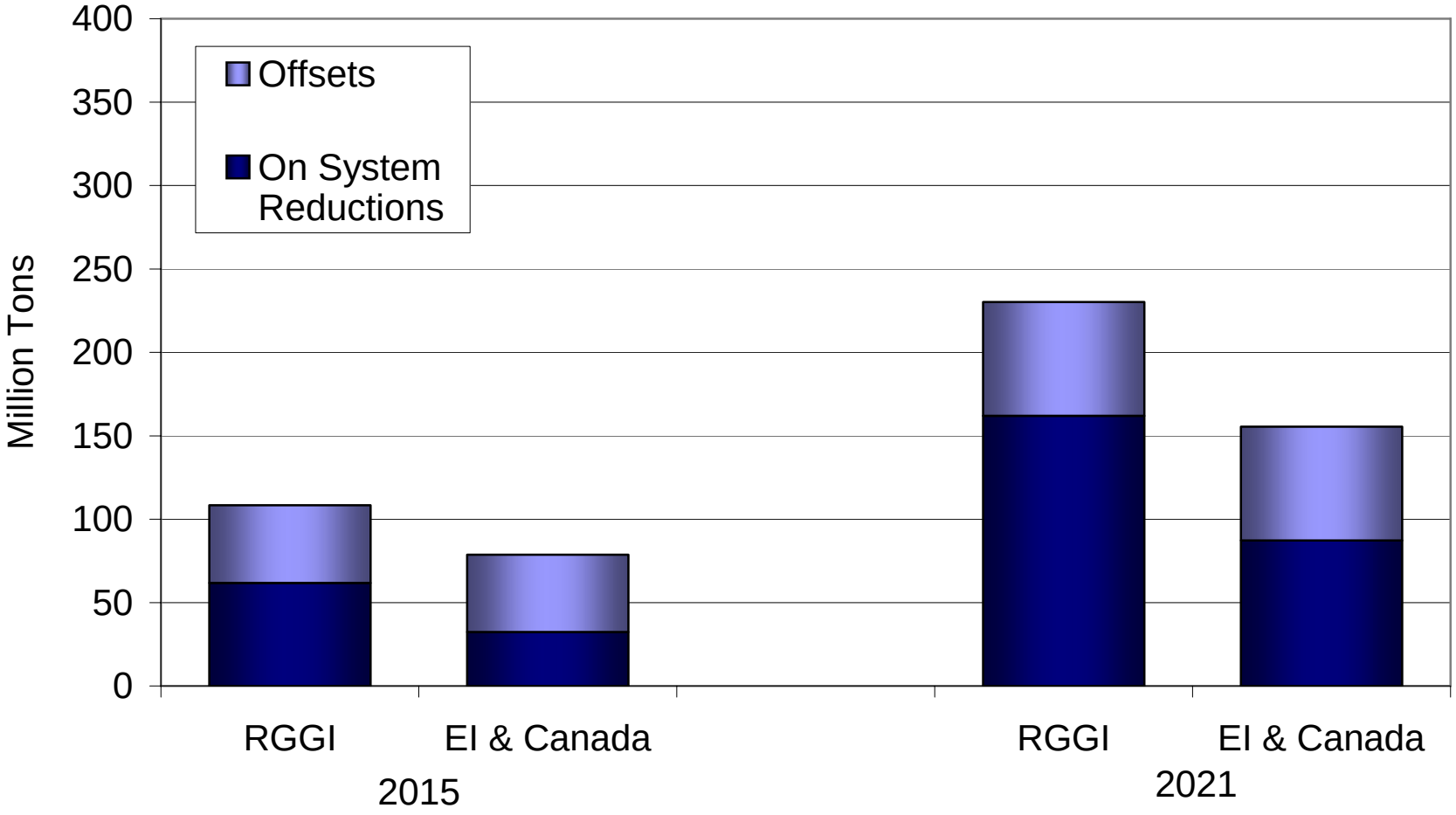
NOTE: Energy prices include annualized capacity prices.

RGGI Net Imports



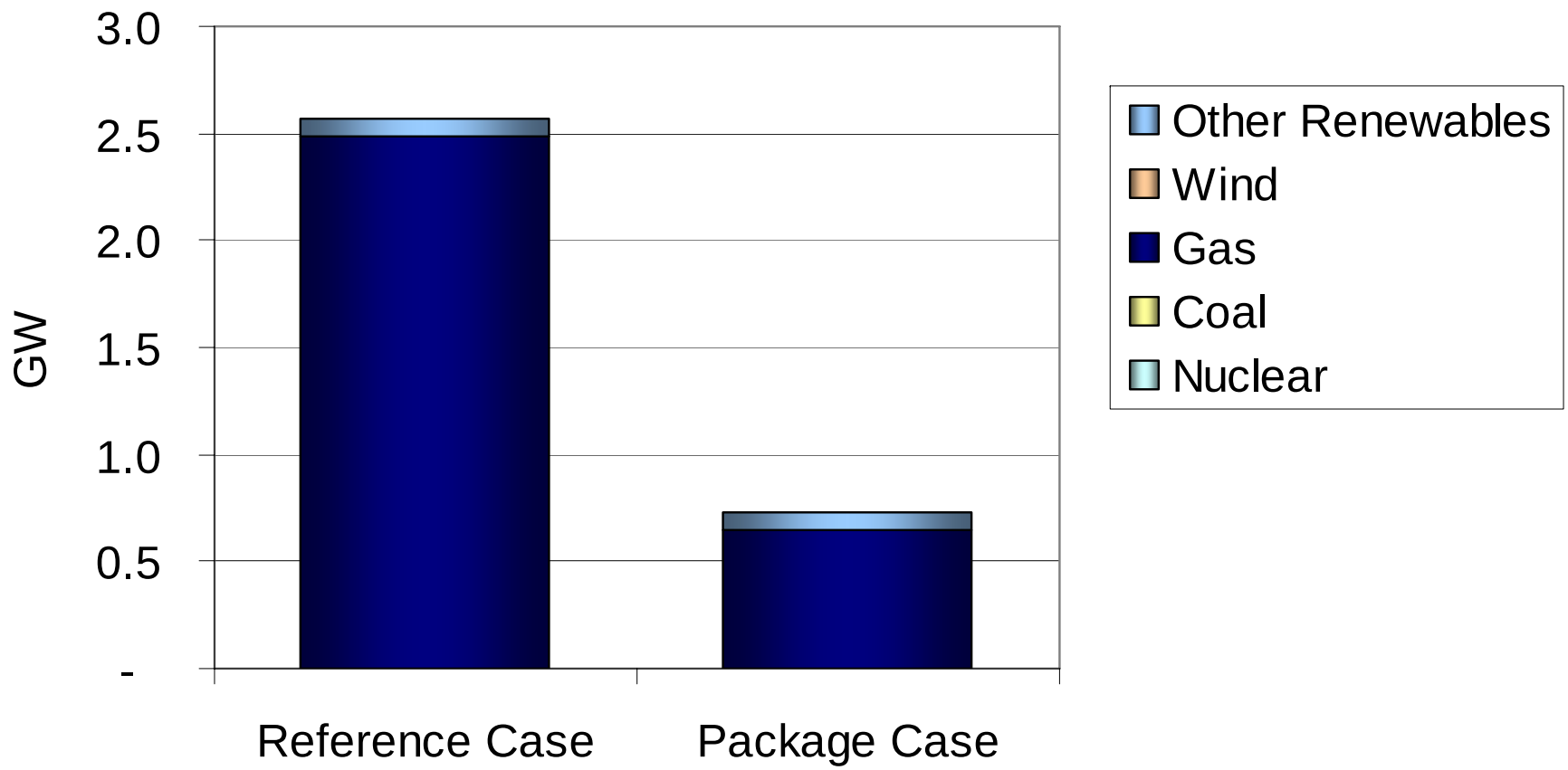
Cumulative CO_2 Reductions by 2015 and 2021

RGGI and Eastern Interconnect/Canada

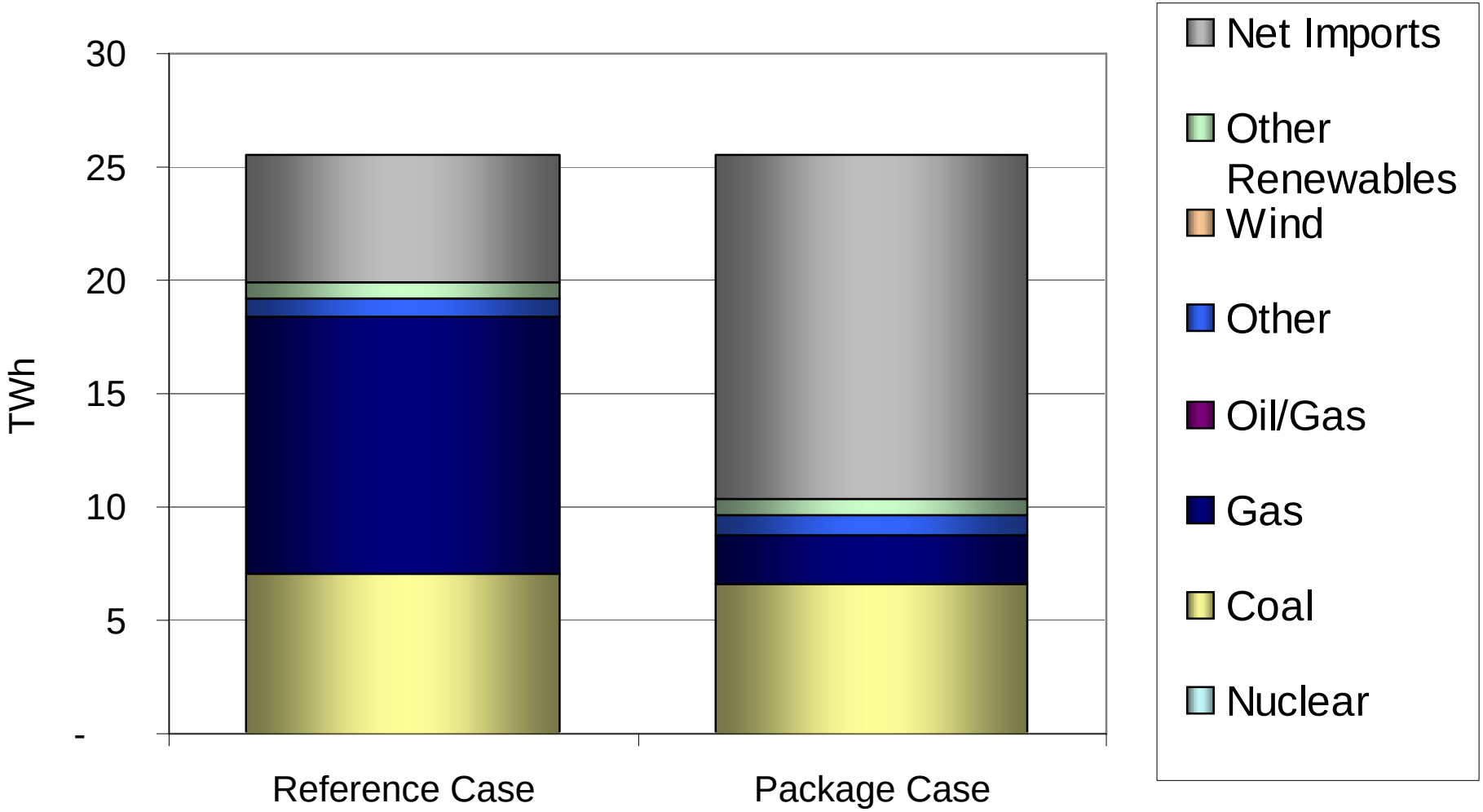


RGGI Reference and Package Cases
Delmarva Region Results

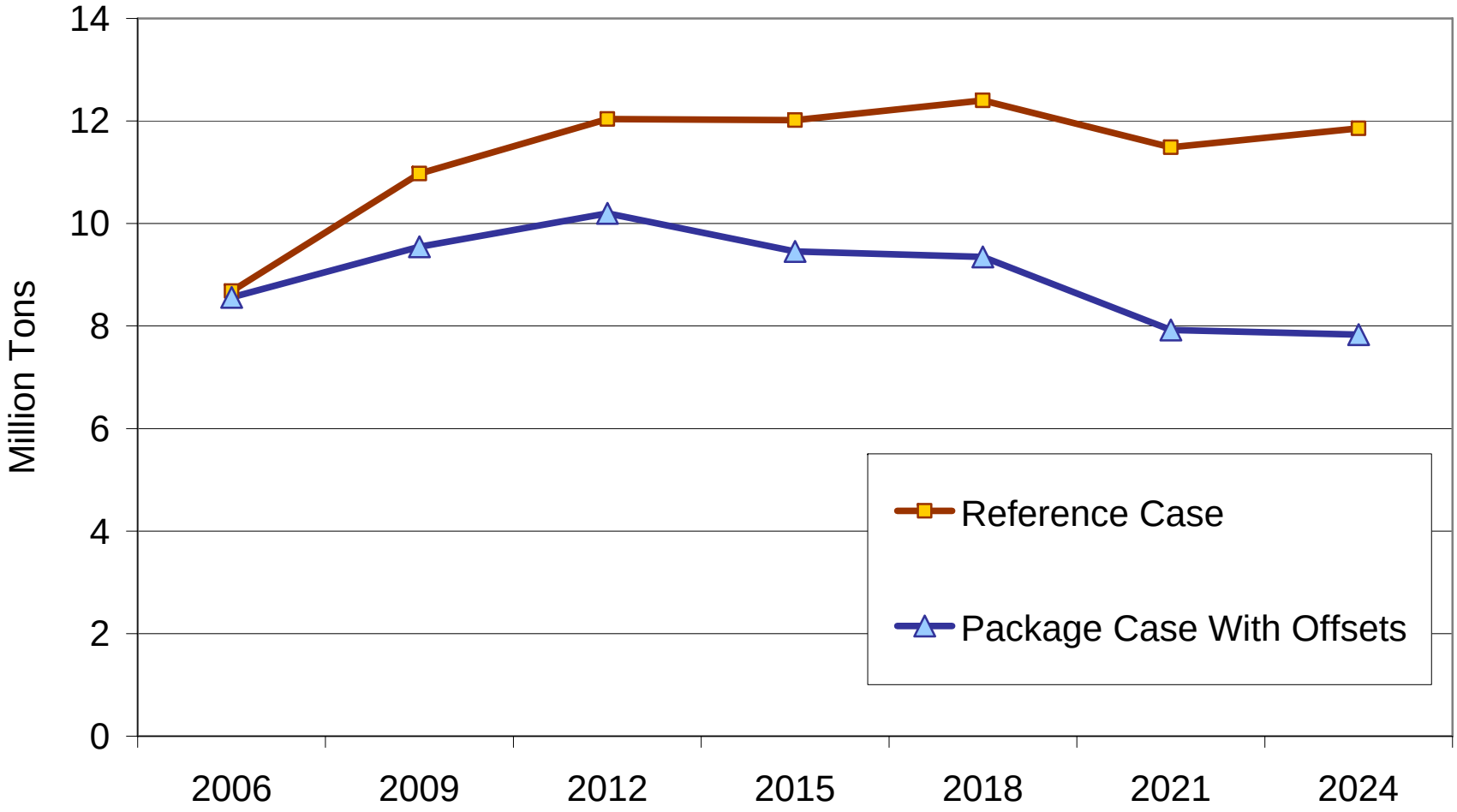
Delmarva Cumulative Capacity Additions by 2024



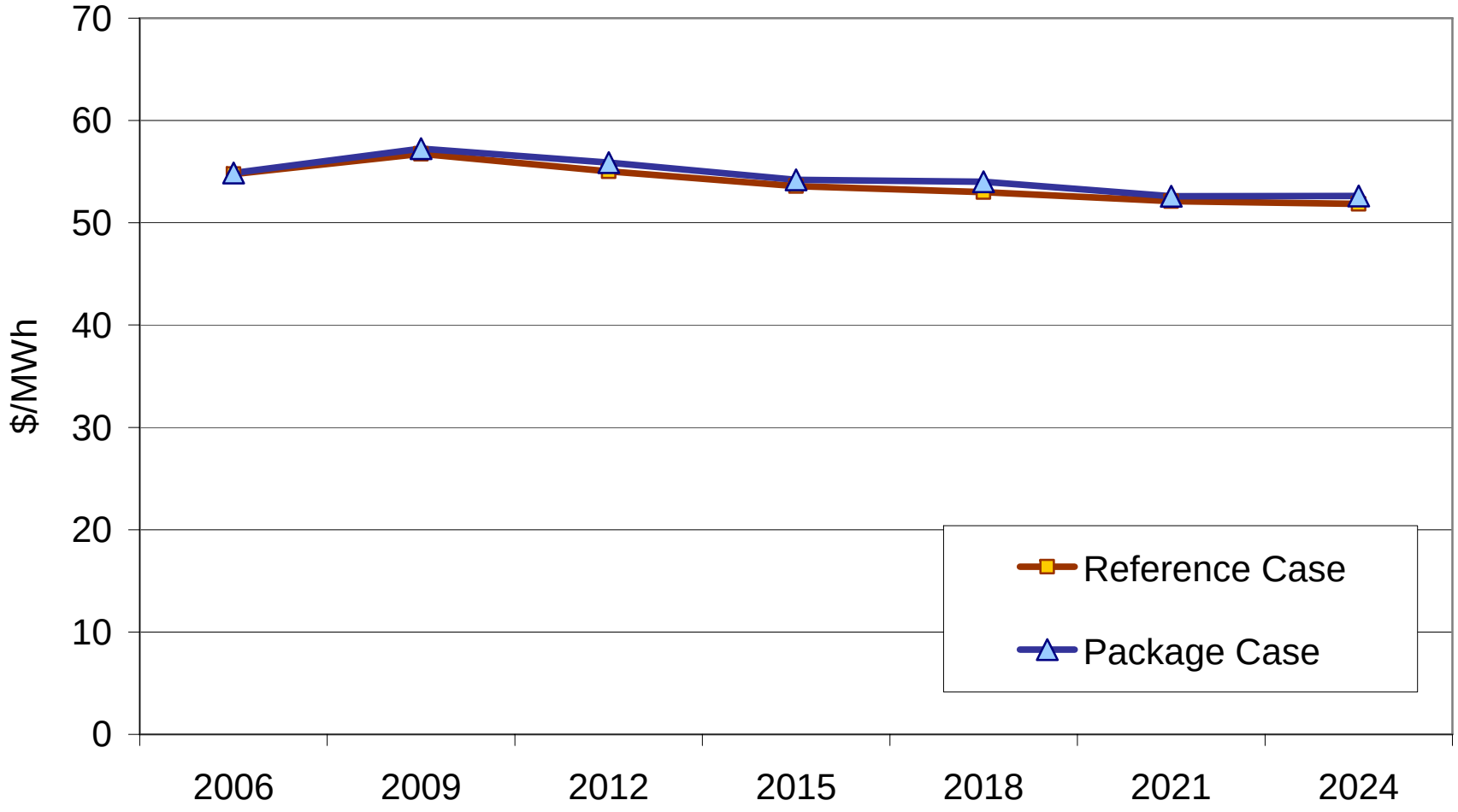
Delmarva Generation Mix in 2024



Delmarva 9-State CO_2 Emissions



Delmarva Average Annual Energy Prices



NOTE: Energy prices include annualized capacity prices.

RGGI Reference and Package Cases
Other Scenario Results

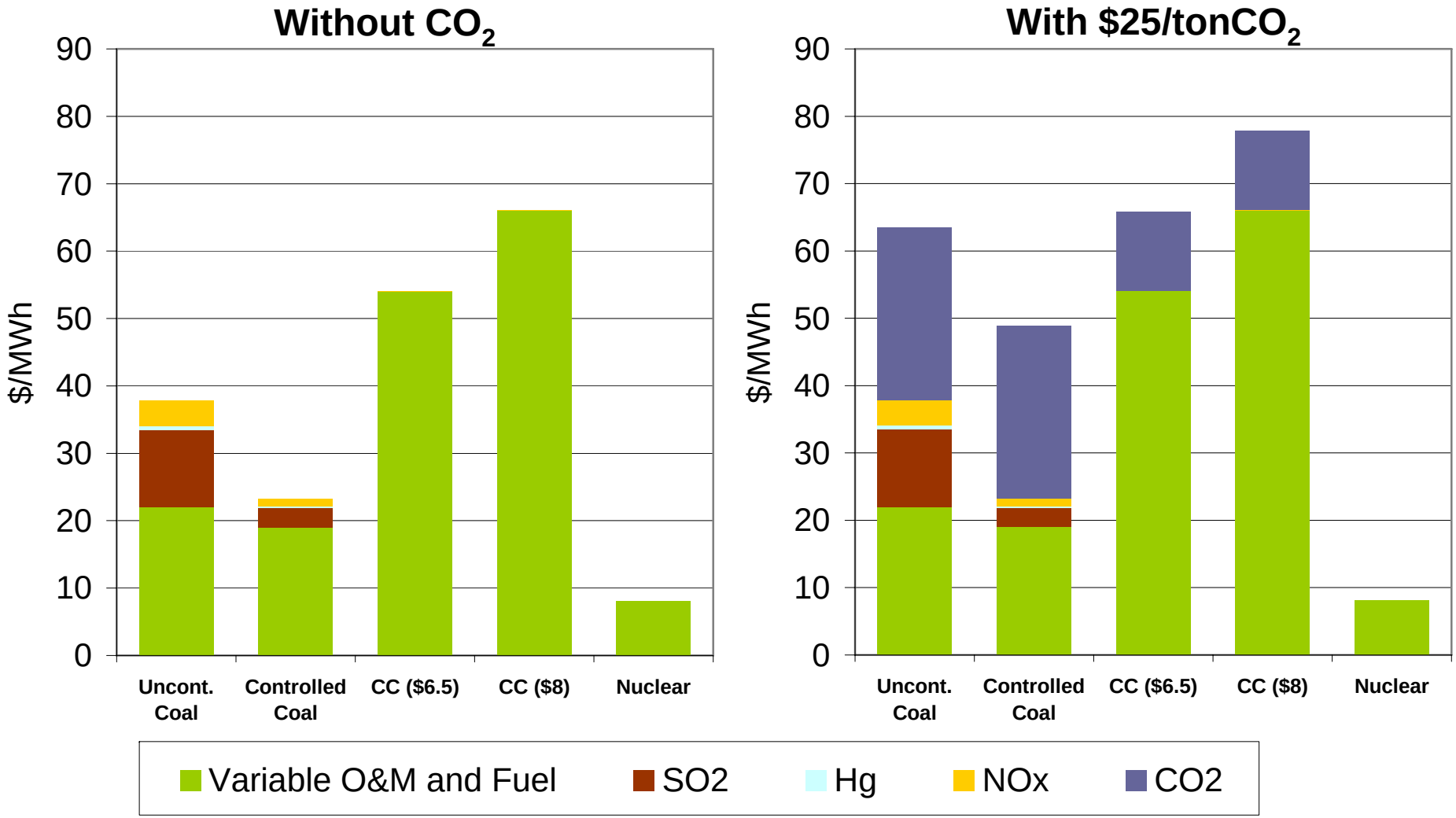
RGGI Alternative Scenarios

- In addition to the Reference and Package Cases, ICF analyzed several scenarios and sensitivities defined by the SWG. These cases were designed to assess the impacts of key uncertainties and/or policy components, including
  - High Emissions Case assumptions, including higher gas prices than in the Reference Case and new coal allowed in the RGGI region
  - Efficiency penetration
  - Federal CO_2 policy
- CO_2 prices in the High Emissions Cases were generally 2-to-3 times higher than those in the standard Package Case.
- Higher assumed efficiency penetration pushed down allowance prices and also reduced leakage.
- RGGI CO_2 prices in the cases with a federal CO_2 policy overlaying RGGI were 5-to-6 times higher than in the Package Case.

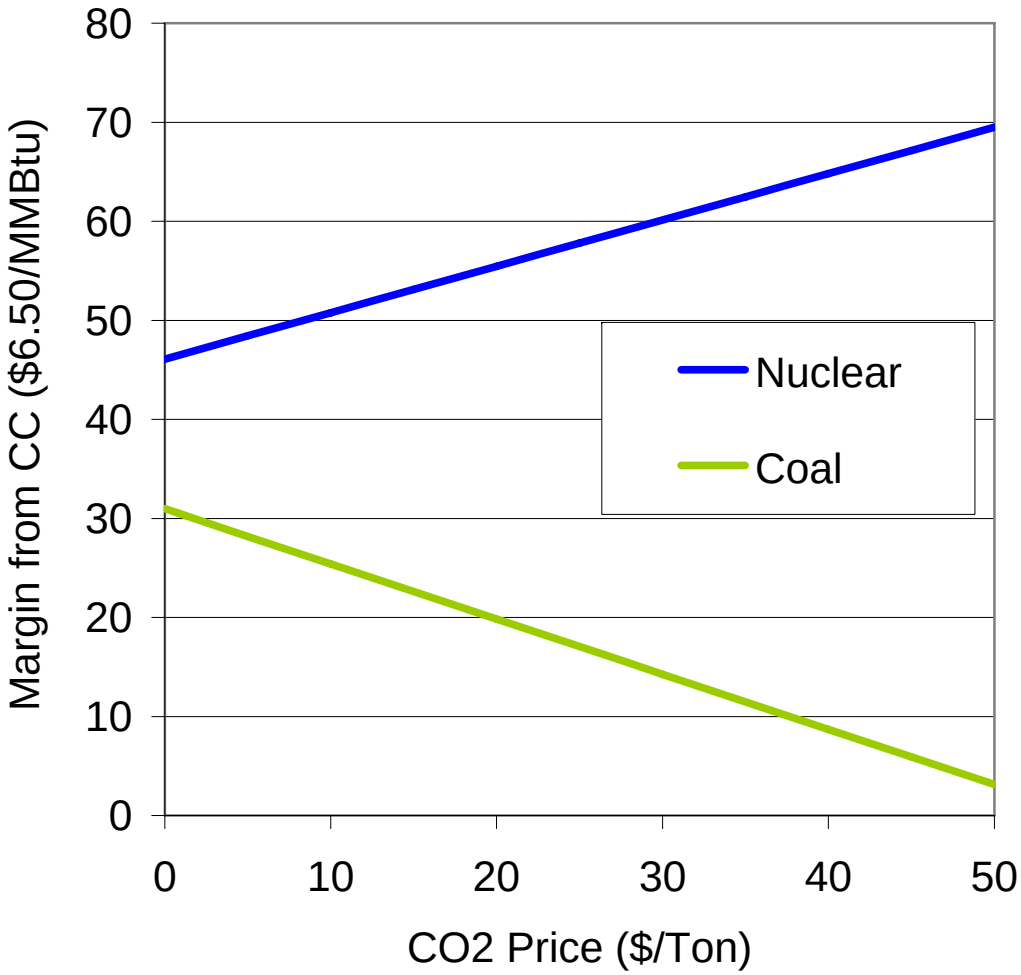
CO_2 Policy Implications for Generators

Impacts on Existing Unit Operation

CO_2 Regulations Change Dispatch Costs, but Have Modest Impacts on Dispatch Order

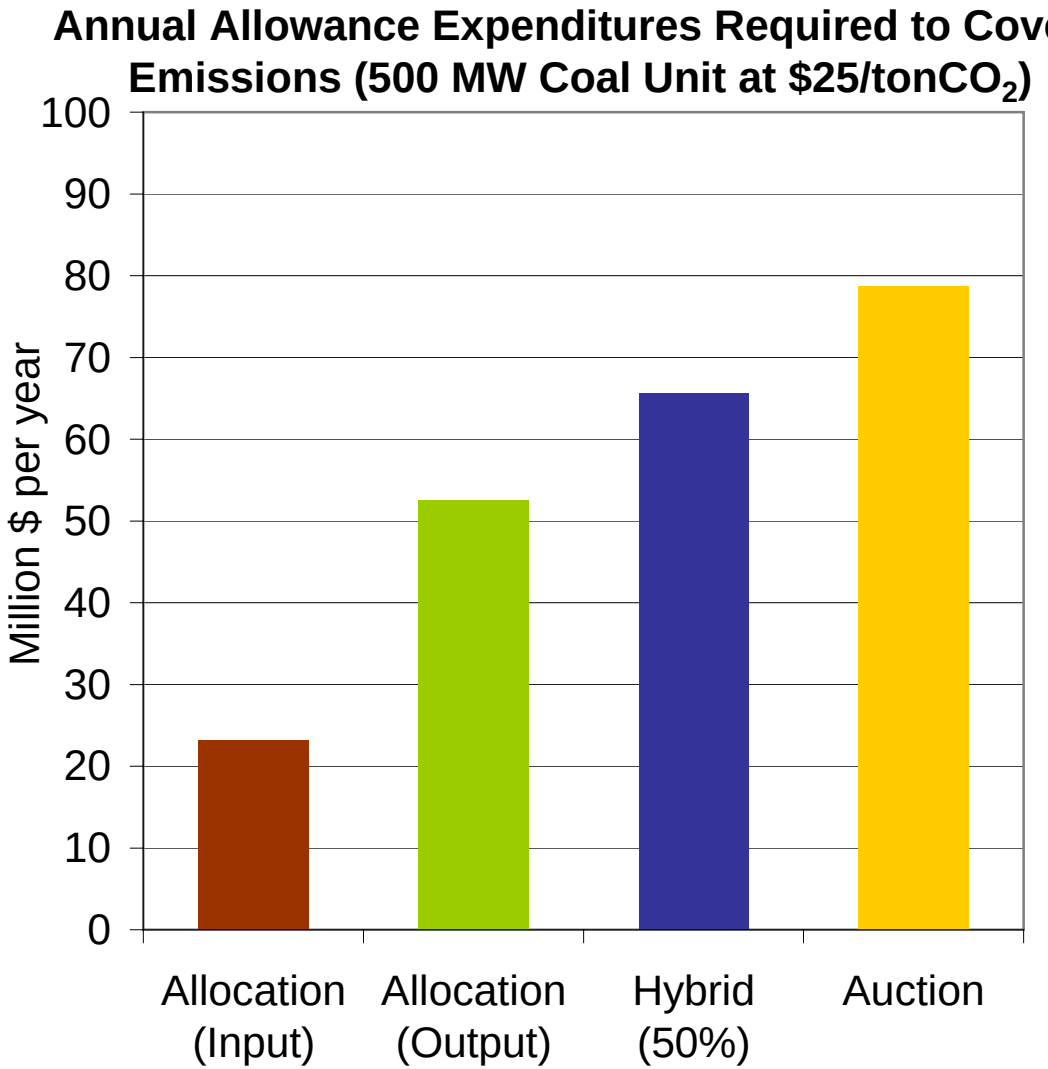


CO_2 Regulation Will Fundamentally Affect Unit Profitability



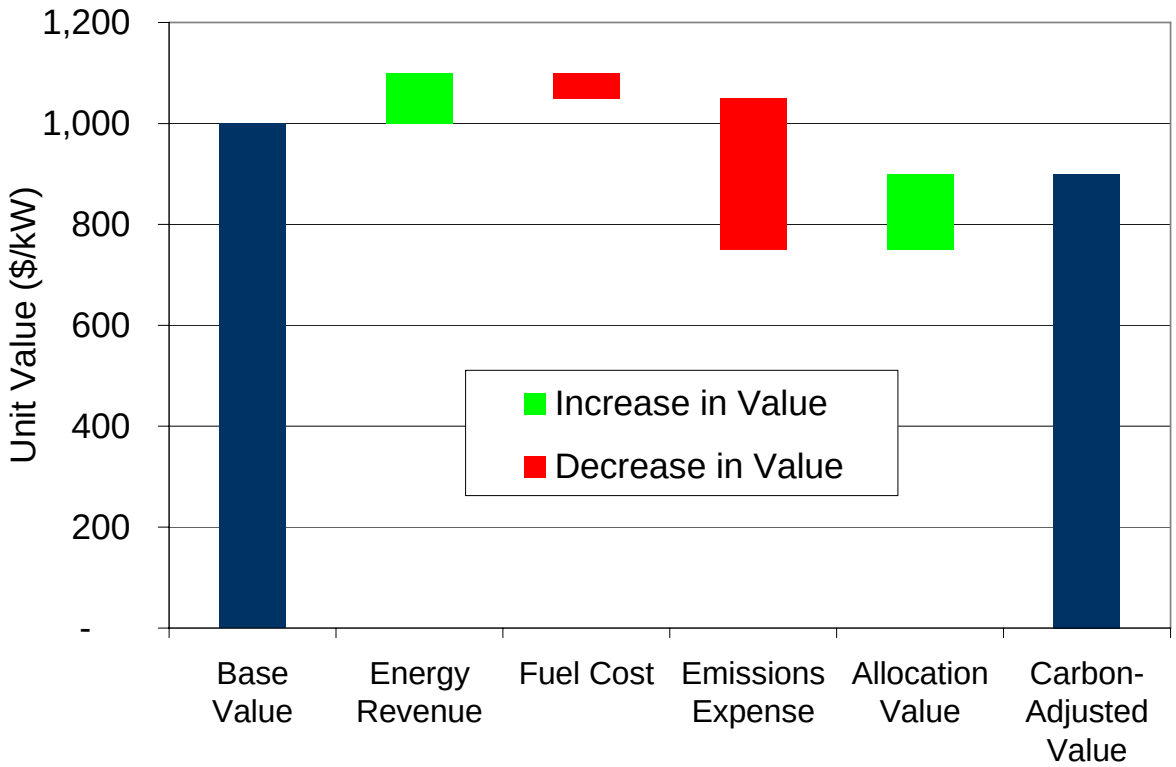
- CO_2 regulation may not reorder dispatch, but it has potentially significant impacts on operating margins in competitive markets

Allocations May be Used to Compensate for Lost Margins



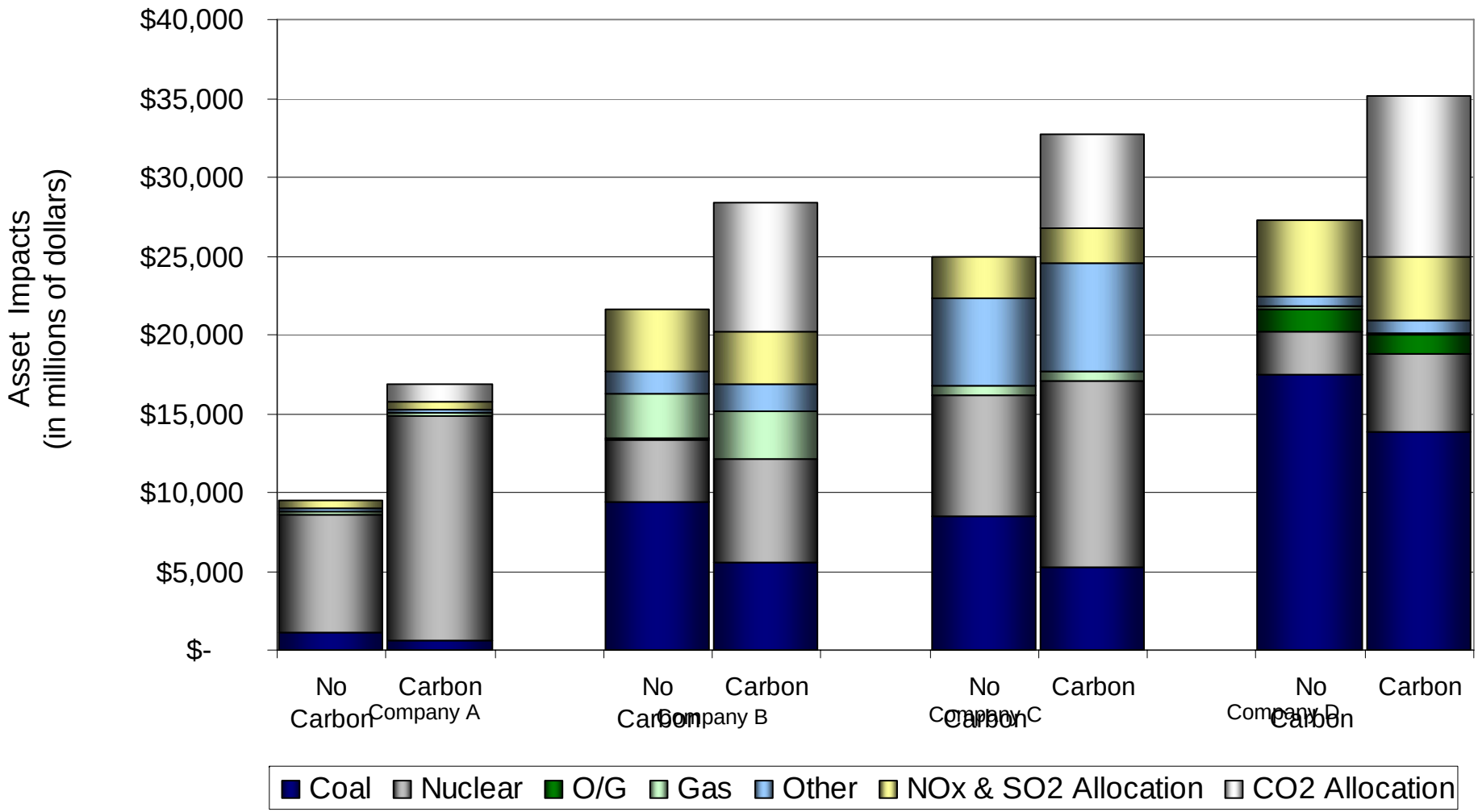
- Existing units may receive some allocation for free to help compensate them for that reduced profitability
- Or … they may be required to spend tens of millions per year on allowances at auction
  - Chart assumes 500 MW coal unit and 1990 stabilization target

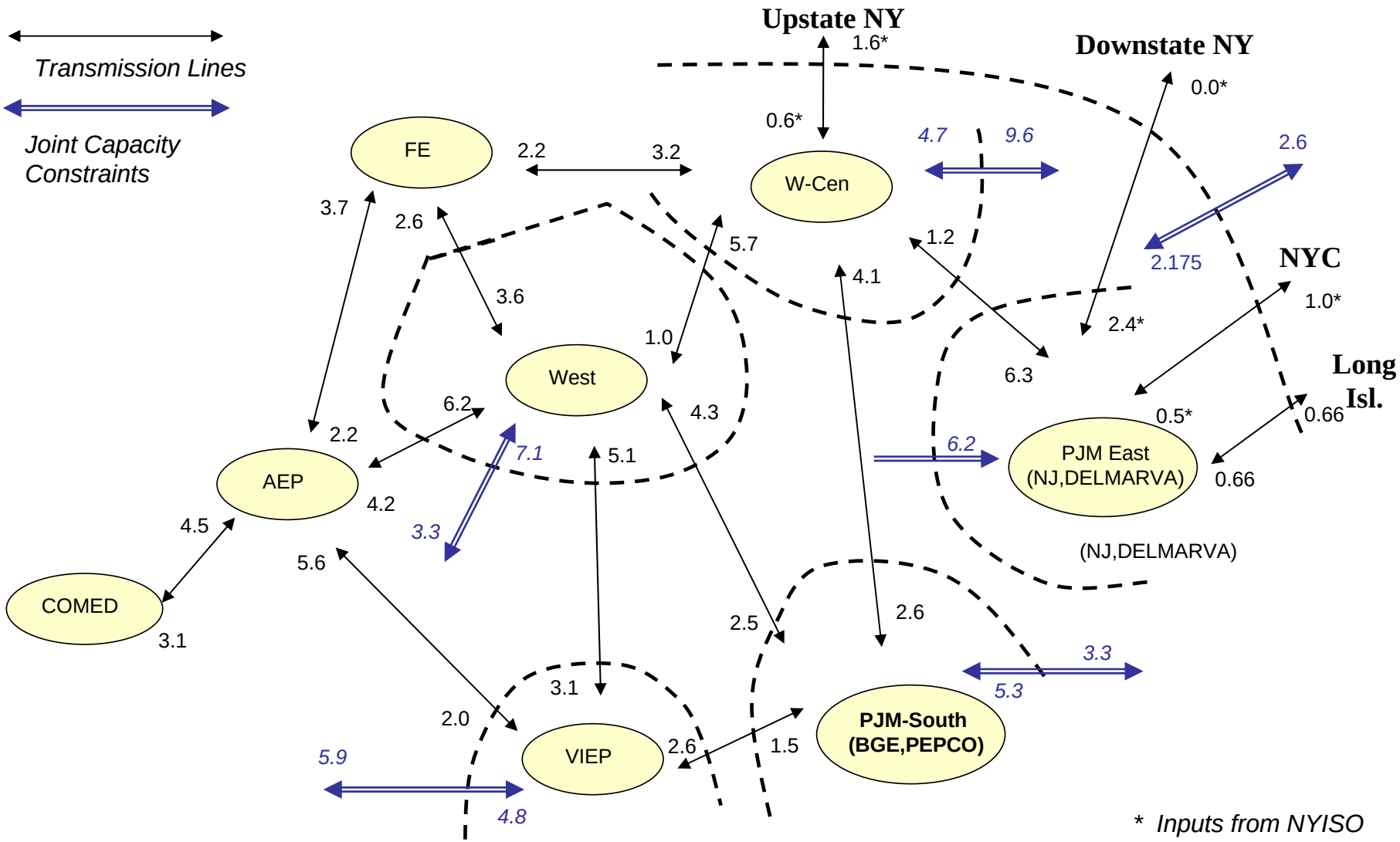
Carbon Regulations Impact Power Plant Asset Value



- Emissions costs associated with carbon regulations increase the operating costs of existing and new power plants.
- Because carbon regulations typically increase costs for all fossil fired power plants, electricity prices also rise. For an individual plant, or a power companies' portfolio, the net impact of carbon regulations depends on how much costs rise relative to the increase in power prices.

CO_2 Impacts Portfolio Asset Values



Appendix

Transmission Capability -- Energy PJM (GW)