

# Assumptions Development for IPM Modeling to Support RGGI Program Review

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# Presentation Outline

## Modeling Overview

## RGGI Assumptions Development by Category

- Category A
- Category B
- Category C
- Category D
- Category E

## Data Sources

# What are Reference Case Assumptions?

- IPM relies on several user-defined parameters to set the overall requirements and boundaries for its projections. For example, the user must tell IPM what level of energy demand it must meet by year for each model region.
- Most of these parameters are not known with certainty, so users must make assumptions about their values going forward over the time horizon of the analysis.
- We use the term “assumptions” to describe the collection of input parameters that will go into the model.
- The model’s projections are developed using market fundamentals informed by the assumptions.

# RGGI Reference Case Assumption Development Overview

- The following slides describe assumptions that must be defined for the RGGI Reference Case and offer potential sources for those assumptions.
- The following discussion elements are included for each assumption:
  - Description of the input variable for which the assumption is needed
  - Source of assumption in original RGGI analysis (2004-2006)
  - Potential assumptions (sources) for the current Reference Case
  - States' initial leaning on each assumption

# Bounding Projections using Sensitivity Analysis

- No single set of assumptions or resulting projection is going to be “right” because of the uncertainty affecting many of the underlying drivers of power sector behavior.
- Important points of uncertainty can be examined by altering assumptions in sensitivity analysis to develop bounds around the Reference Case projections.
- RGGI may choose to model sensitivities around the Reference Case for the Program Review.
- Based on the modeling work performed for the original RGGI analysis, the most critical drivers of the projections include:
  - Electric load growth
  - Fuel prices, particularly natural gas
  - Regulation impacting the power sector, including new pollutant and energy requirements
- RGGI asks that Stakeholders, in addition to providing comments on the assumptions for the Reference Case, also provide suggestions on approaches for developing sensitivities around these key assumptions.

# Assumptions will be Presented in Category Groupings

## CATEGORY A

- Cost and performance of new generation
- Coal plant construction in RGGI
- Nuclear plant construction in RGGI
- Firmly planned generation and retirements
- Firmly planned transmission additions

## CATEGORY B

- Fuel prices
- Regional energy and peak demand

## CATEGORY C

- Federal environmental policies

## CATEGORY D

- Renewable portfolio standards
- State environmental policies
- Cost and performance of pollution controls and firmly planned control installations

## CATEGORY E

- Transmission capability
- Reserve margins and local reserve requirements
- Offsets

# CATEGORY A ASSUMPTIONS

# Cost and Performance of New Generation

- DESCRIPTION
  - Capital and operating costs, heat rates, and emission rates for new generating capacity options, including combined cycle gas, coal, nuclear and renewable types
  - IPM builds new capacity to meet energy and peak needs based on relative economics
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - Fossil/Nuclear – EIA AEO with RGGI region-specific cost adjustments
  - Renewables – Sustainable Energy Advantage and LaCapra
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - EIA AEO with RGGI region-specific cost adjustments
  - Utility announcements and filings, including integrated resource plans (IRPs)
  - Technology studies (National Academies report)

**LEANING: EIA AEO with RGGI region-specific cost adjustments;  
Nuclear based on study by the National Academies**



# Coal Plant Construction in RGGI

- DESCRIPTION
  - Limits on the amount and type of new coal capacity that can be built within the RGGI region
  - In IPM, such limits supersede decisions based on market fundamentals
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - New coal capacity of any type was not allowed to be built within the RGGI-affected region over the time horizon of the analysis
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) Disallow coal capacity additions in the RGGI region
  - Allow coal additions on an economic basis without limit
  - Require that new coal capacity meet emission rate standards or be equipped with specific controls

**LEANING: Only coal with carbon capture can be built in the RGGI region.**

# Nuclear Plant Construction in RGGI

- DESCRIPTION
  - Limits on the amount and type of new nuclear capacity that can be built within the RGGI region
  - In IPM, such limits supersede decisions based on market fundamentals
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - Existing nuclear units were offered options to relicense and uprate
  - Nuclear additions limited to existing plants with sites for additional units, based on information provided by Nuclear Energy Institute
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) Limit nuclear additions to existing sites
  - Disallow new nuclear additions in the RGGI region
  - Allow nuclear additions on an economic basis without limit

**LEANING: Nuclear can be built on an economic basis at existing plant sites.**

# Firmly Planned Generation and Retirements

- DESCRIPTION
  - Firmly planned capacity additions and retirements are those that are far enough along in the process to be included in the Reference Case
  - IPM will take firm capacity additions and retirements into account in making projections
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - ISO studies and data
    - NYISO – Article X list
    - ISO-NE – 2004 RTEP, filtered for units under construction
    - PJM – Interconnection Request Queues, filtered for units under construction
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) ISOs (NYISO – 2010 Draft RNA; ISO-NE – 2010 CELT; PJM -- Interconnection Queue, filtered for units under construction, and retirement requests)
  - State agency information
  - Utilities and developers, via public announcements

**LEANING: ISO studies and queues, supplemented with additions by States (including additions for Cape Wind, Bluewater Wind, and retirement of Vermont Yankee)**

## Firmly Planned Transmission Additions

- DESCRIPTION
  - Additions to existing capacity in planning or construction stages and assumed to be firm
  - IPM relies on transmission capability to help meet regional electricity demand
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - Capabilities, including any planned additions, provided by ISOs
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) Firm transmission capacity expansions/additions based on ISO projections

**LEANING: Use ISO timing for capability expansion – TrAIL in 2011; MAPP in 2014; PATH in 2015; Susquehanna-Roseland by 2014**

# CATEGORY B ASSUMPTIONS

# Fuel Prices

- DESCRIPTION

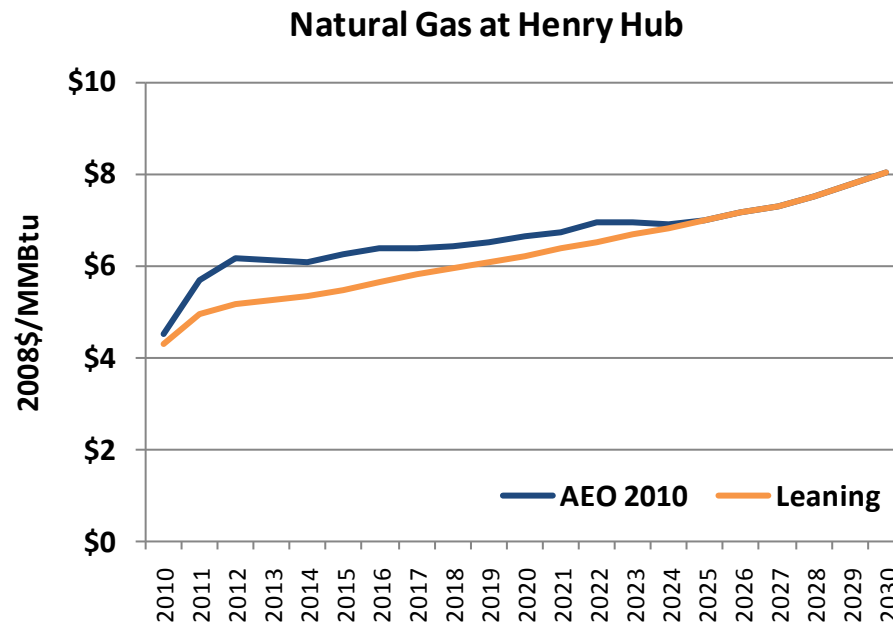
- Commodity and delivered prices for natural gas, oil products and coal
- Delivered fuel prices are included in unit operation and investment decisions

- 2004-06 RGGI ANALYSIS ASSUMPTIONS

- EEA (third party) projections for natural gas and oil
- ICF supply curves calibrated to EIA AEO 2004 for coal

- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW

- EIA AEO 2010
- NYMEX futures
- Historical trends
- Other public third party projections



**LEANING: (Oil and Gas) NYMEX near-term phasing into EIA AEO 2010 long-term, with transportation costs based on 10-year historical averages; (Coal) ICF supply curves calibrated to EIA AEO 2010**

# Regional Energy and Peak Demand

- DESCRIPTION

- Energy (MWh) and peak (MW) demand requirements by state for the period 2010 to 2030
- IPM meets regional energy needs by running existing plants, building new plants and using transmission resources

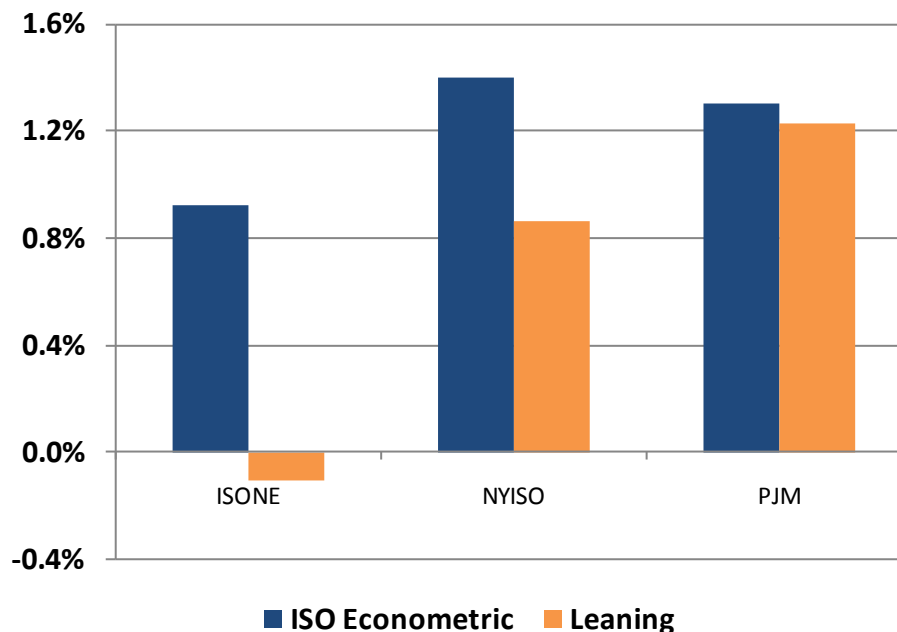
- 2004-06 RGGI ANALYSIS ASSUMPTIONS

- RGGI States – ISOs
- Other – EIA AEO

- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW

- (2004-06 Approach) ISOs and EIA AEO
- EIA AEO for all states
- State projections
- Based on historical growth over some period

Average Annual Energy Growth, 2010-2030



**LEANING:** ISO projections, adjusted for efficiency as provided by the States

# CATEGORY C ASSUMPTIONS



# Federal Environmental Policies

- DESCRIPTION
  - Federal air pollution requirements for SO<sub>2</sub>, NO<sub>x</sub> and mercury under Clean Air Act
  - Regulation of coal combustion residuals (ash) under Resource Conservation Recovery Act (RCRA)
  - Regulation of water intake under Clean Water Act Section 316(b)
  - IPM must comply with assumed regulations as it operates units to meet demand
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - Representative 3-pollutant (SO<sub>2</sub>, NO<sub>x</sub>, mercury) policy, consistent with legislative proposals at the time
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (EPA Approach) Existing federal programs (Clean Air Interstate Rule for SO<sub>2</sub> and NO<sub>x</sub>)
  - EPA proposed programs (Clean Air Transport Rule for SO<sub>2</sub> and NO<sub>x</sub>; coal combustion residuals)
  - Proposed and expected regulations (hazardous air pollutants MACT; Clean Water Act 316(b) Phase II)
  - Legislative proposals (Senator Carper's Clean Air Act Amendments of 2010)

**LEANING: Clean Air Transport Rule for SO<sub>2</sub> and NO<sub>x</sub> (EPA preferred approach);  
Mercury MACT (90% removal from input)**

# CATEGORY D ASSUMPTIONS

# Renewable Portfolio Standards (RPSs)

- DESCRIPTION

- RPS programs require that a portion of retail sales be met with generation from qualifying sources
- IPM will comply with RPS requirements in making operation and investment decisions, up to assumed alternative compliance payments (ACP)

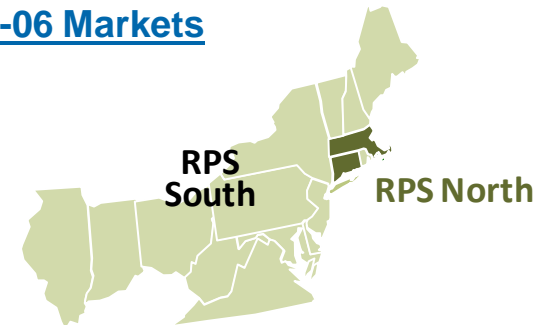
- 2004-06 RGGI ANALYSIS ASSUMPTIONS

- State generation requirements, provided by states, modeled in two regional markets (Northern and Southern)

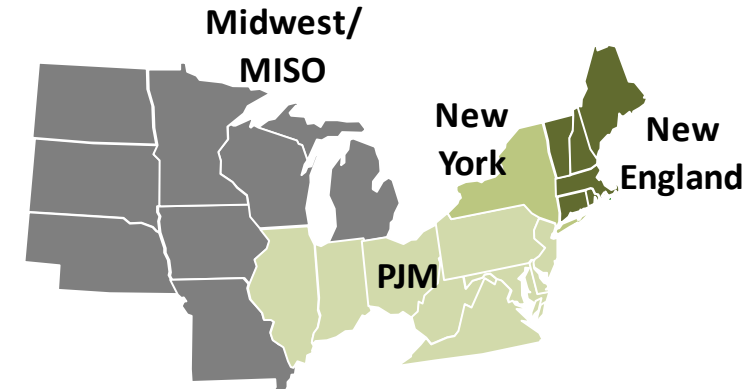
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW

- State generation requirements, provided by states, modeled in three regional markets, by ISO. ACP levels specified by states
- State-specific markets
- One regional market

## 2004-06 Markets



## 2012 Leaning



**LEANING: Three regional markets, by ISO, with regional ACPs specified by States**

# State Environmental Policies

- DESCRIPTION
  - State emission limits for SO<sub>2</sub>, NO<sub>x</sub>, and mercury, either as statewide cap and trade programs or unit-specific requirements
  - IPM must comply with state requirements in making operation and investment decisions
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - Requirements as provided by state agencies
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) Existing requirements for SO<sub>2</sub>, NO<sub>x</sub> and mercury, as provided by state agencies
  - Potential state requirements

**LEANING: Existing requirements, provided by States**

# Cost and Performance of Pollution Controls and Firmly Planned Control Installations

- DESCRIPTION

- Capital and operating costs of controls to control emissions of SO<sub>2</sub>, NO<sub>x</sub> and mercury, along with assumed percentage reduction in emissions
- Firmly planned installations are those that are far enough along in development (planning or installation) that they are included in the model
- IPM projects other control installations on an economic basis in response to regulatory requirements

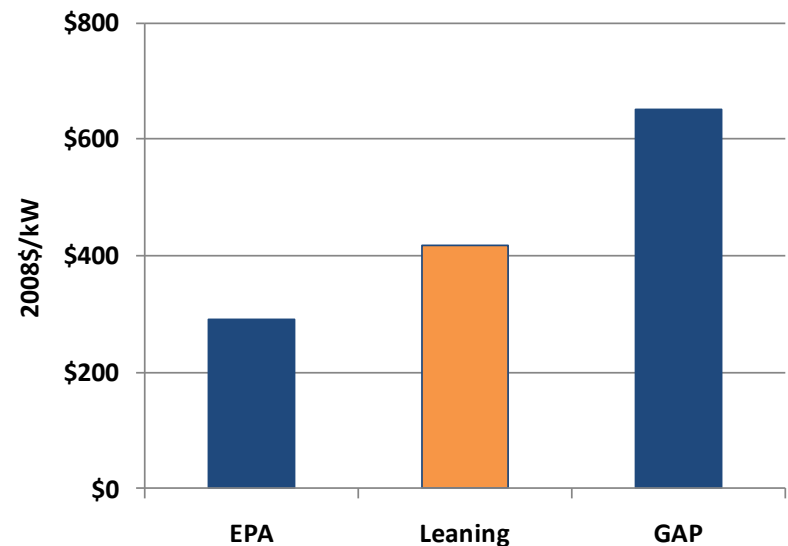
- 2004-06 RGGI ANALYSIS ASSUMPTIONS

- EIA for SCR (NO<sub>x</sub>) and ACI (mercury) controls
- EPA for FGD, or scrubber (SO<sub>2</sub>)
- Firm controls based on state input

- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW

- (2004-06 Approach) EPA and EIA for cost and performance; states for firm controls
- Regulatory proceedings (e.g., Midwest Ozone Group 2007 analysis)
- Industry reports (e.g., Generators for Affordable Power)

FGD Cost for 500 MW Unit



**LEANING: Midwest Ozone Group analysis for FGD and SCR; EPA for ACI; States for firm controls**

# CATEGORY E ASSUMPTIONS

# Transmission Capability

- DESCRIPTION
  - Existing interregional transmission capacity for use in moving energy across regional boundaries
  - IPM relies on transmission capability to help meet regional electricity demand
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - Capabilities provided by ISOs
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) Capabilities based on ISO reports and modeling

**LEANING: ISO studies and modeling**

# Reserve Margins and Local Reserve Requirements

- DESCRIPTION
  - Backup capacity required above peak demand to maintain system reliability, expressed as a percentage of peak demand
  - NYISO locational minimum installed capacity requirements for Zones J and K specify the percentage of peak load that must be met with in-zone resources
  - IPM must use existing capacity and build new capacity to meet reserve requirements in each region
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - ISO projections
  - NYISO local reserve requirements for Zones J and K
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) ISO projections; NYISO for Zones J and K

**LEANING: Latest ISO projections for PJM and ISO-NE; projected 2010 reserve margin for NYISO, held constant; NYISO Zone J and K local requirements**



# Offsets

- DESCRIPTION
  - Offsets are CO<sub>2</sub>-equivalent emission reductions generated by eligible projects in sectors not affected by the RGGI program. They may come from domestic or international sources.
  - In determining the least-cost means of compliance with RGGI and the CO<sub>2</sub> allowance price, IPM will utilize offsets to the extent that they are cost-effective relative to on-system reductions and subject to program limitations
  
- 2004-06 RGGI ANALYSIS ASSUMPTIONS
  - (Domestic) EPA U.S. marginal abatement cost curves (MACCs) by source category (e.g., landfill gas), scaled to RGGI region based on relevant data (e.g., RGGI landfill capacity as percentage of U.S. landfill capacity)
  - (International) Offsets available at recent European market prices, based on World Bank report
  
- POTENTIAL ASSUMPTION/SOURCE(S) FOR RGGI PROGRAM REVIEW
  - (2004-06 Approach) EPA and World Bank
  - EPA domestic (scaled to RGGI) and international MACCs, as used in EPA Waxman-Markey analysis

**LEANING: EPA domestic (scaled to RGGI) and international MACCs, adjusted to reflect recent market activity in U.S. and international markets**

# DATA SOURCES

# Potential Assumptions Sources

- This presentation included the following possible sources of assumptions:
  - **EIA AEO:** U.S. Energy Information Administration's 2010 Annual Energy Outlook
  - **ISOs:** Reports of PJM, ISO-NE, and NYISO, including:
    - PJM – 2009 Regional Transmission Expansion Plan (RTEP) and 2010 Load Forecast
    - ISO-NE – 2010 Capacity, Energy, Loads and Transmission report (CELT)
    - NYISO – 2010 Draft Reliability Needs Assessment (RNA) and 2010 Load & Capacity Data (Gold Book)
  - **EPA:** Base Case 2009 ARRA
  - **Other**
    - State agencies
    - Other federal agencies
    - Utility public announcements and filings
    - Publicly available analyses

# Data Sources for “Leaning” Assumptions

- **EIA AEO:** <http://www.eia.doe.gov/oiaf/aeo/assumption/index.html>
- **ISOs:**
  - PJM RTEP – <http://pjm.com/documents/reports/rtep-report.aspx>
  - PJM Load Forecast – <http://www.pjm.com/~media/documents/reports/2010-load-forecast-report.ashx>
  - ISO-NE CELT – [http://www.iso-ne.com/trans/celt/fsct\\_detail/index.html](http://www.iso-ne.com/trans/celt/fsct_detail/index.html)
  - NYISO Draft RNA – [http://www.nyiso.com/public/webdocs/committees/mc/meeting\\_materials/2010-08-25/agenda\\_06\\_RNA\\_2010\\_Draft\\_6\\_MC\\_81810.pdf](http://www.nyiso.com/public/webdocs/committees/mc/meeting_materials/2010-08-25/agenda_06_RNA_2010_Draft_6_MC_81810.pdf)
  - NYSIO Gold Book – [http://www.nyiso.com/public/webdocs/services/planning/planning\\_data\\_reference\\_documents/2010\\_GoldBook\\_Public\\_Final\\_033110.pdf](http://www.nyiso.com/public/webdocs/services/planning/planning_data_reference_documents/2010_GoldBook_Public_Final_033110.pdf)
- **EPA:**
  - ARRA Base Case: <http://www.epa.gov/airmarkt/progsregs/epa-ipm/index.html>
  - Offsets: “EPA S.280 mitigation cost schedules for capped sectors and domestic and international offsets.” EPA memo to the Energy Information Administration (EIA), March 2007. Available at: [www.epa.gov/climatechange/economics/economicanalyses.html](http://www.epa.gov/climatechange/economics/economicanalyses.html)
- **Other**
  - Midwest Ozone Group – [http://www.ladco.org/reports/control/white\\_comments/egu/mog.pdf](http://www.ladco.org/reports/control/white_comments/egu/mog.pdf)
  - National Academies – [http://www.nap.edu/catalog.php?record\\_id=12091](http://www.nap.edu/catalog.php?record_id=12091) (Available for purchase)