

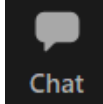
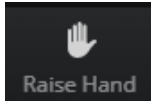



Regional Greenhouse Gas Initiative Program Review:

Public Meeting

December 13, 2021

Meeting Protocols

- This meeting is being recorded and will be shared publicly on the RGGI website.
- Participants will be muted throughout the meeting.
- For technical assistance, use the chat function  or send a message to info@rggi.org
- During the Q&A portion, use the raise hand function  to let the host know when you have a question (*phone participants dial *9*) or use the Q&A function  to send a question to the host.
- During the Public Comment portion, use the raise hand function to let the host know that you'd like to make a verbal comment (*phone participants dial *9*).
- The host will let you know when it is your turn to speak.

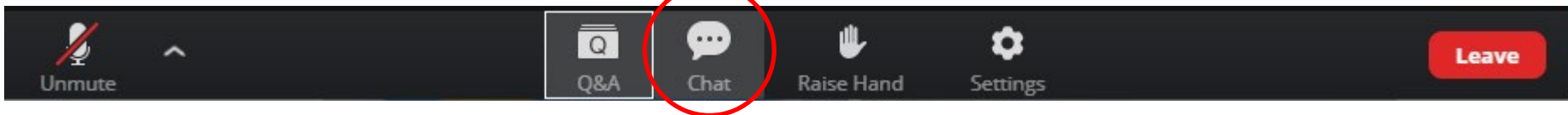
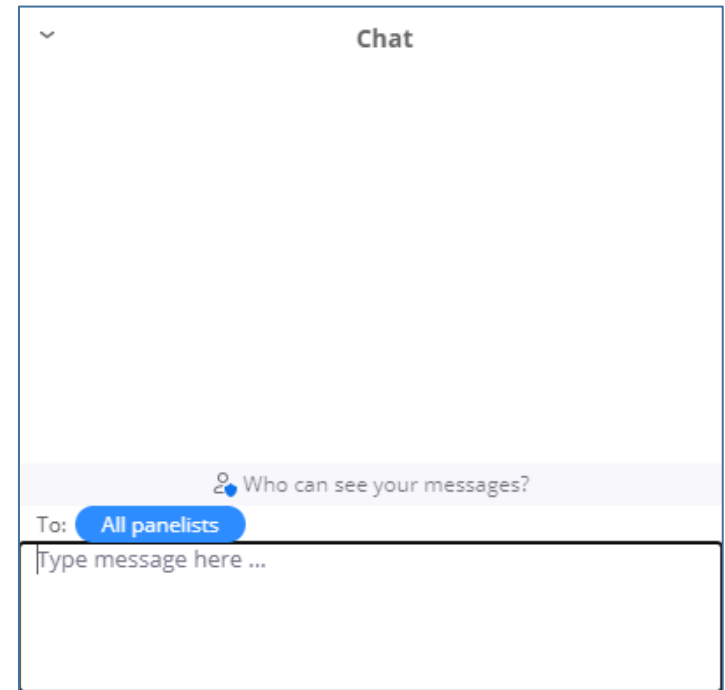
Connect and Merge Audio

The screenshot displays the Zoom meeting interface for connecting to audio. At the top, there are two tabs: "Phone Call" (selected) and "Computer Audio". Below the tabs, the instructions are as follows:

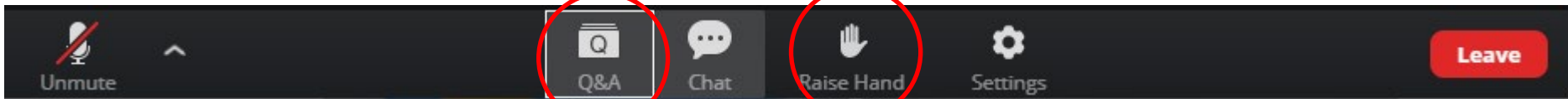
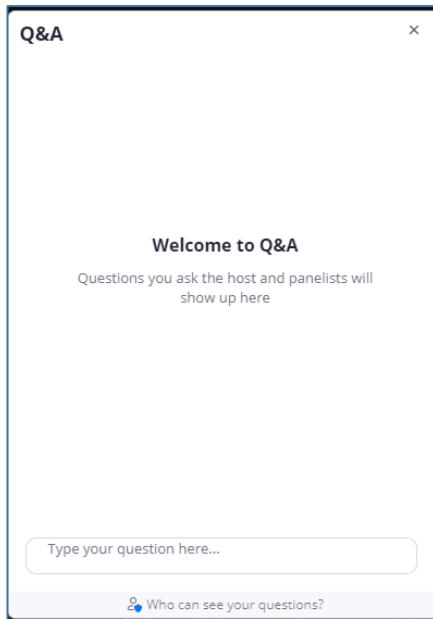
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 - +1 646 558 8656 (US Toll)
 - +1 669 900 9128 (US Toll)
- 2. Conference ID 990 9527 1002 #
- 3. Participant ID 346736 #

At the bottom of the interface, there is a "Join Audio" button with a headset icon, which is circled in red. To its right are icons for "Q&A", "Chat", "Raise Hand", and "Settings".

Chat for Technical Assistance



Raise Hand to Provide Comment



Meeting Agenda

- Welcome & Introductions
- IPM Modeling Overview
- RGGI IPM Base Case Modeling Assumptions Overview
- Question & Answer
- Public Comment
- Next Steps & Adjournment

Overview of IPM Modeling Process for RGGI

December 13, 2021





Agenda

- ICF History with RGGI
- Overview of ICF's Integrated Planning Model (IPM[®])
- Developments in IPM
- Reconsidering Reporting Structure



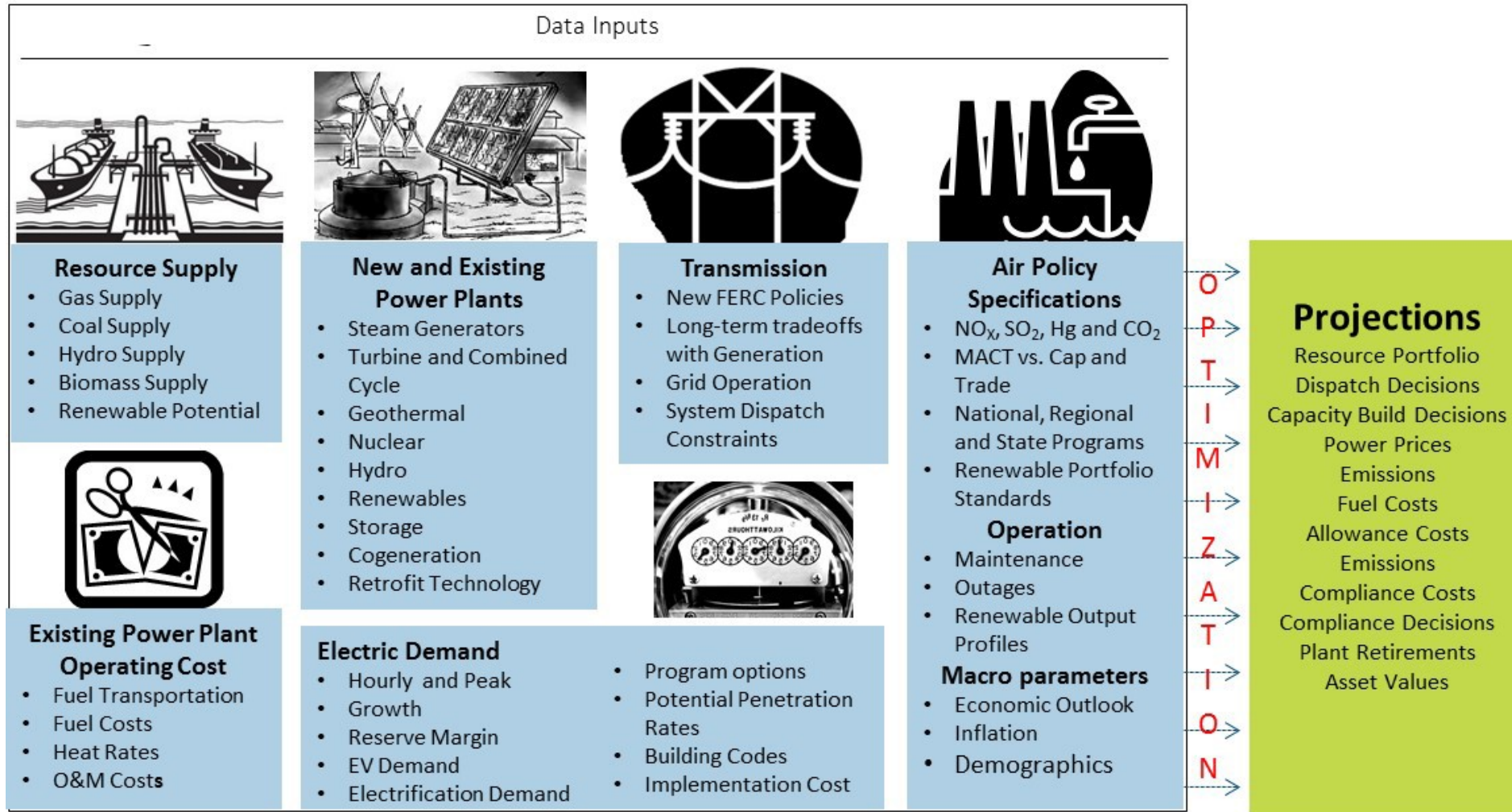
ICF Experience with RGGI

2004-2006	RGGI MOU Analysis
2011-2013	Program Review
2015-2017	Program Review
2017, 2020	Analysis for VA
2018	Analysis for NJ
2019-2021	Analysis for PA

IPM Overview

- IPM is a Zonal production cost model
 - The zonal configuration reflects ISO load zones in ISO areas
 - Solves for capacity expansion and retirement by zone
- IPM optimizes to lowest cost solution for the system as a whole to meet zonal demand requirements while complying with specified constraints such as policy requirements (RGGI, RPS, CES).
- The optimization occurs across the time horizon of the analysis with perfect foresight, so the solution in the near-term is determined with knowledge of future assumptions on in response to long-term requirements and costs.
 - Solves for select years over time horizon (“run years” or “model years”)
- The graphic on the following slide shows inputs into IPM (blue boxes) and typical outputs (green box)

IPM Overview



IPM Inputs - Assumptions

- **Fuel Prices**
- **Regional energy and peak demand**
- Firmly planned generation and retirements
- Cost and performance of new generation
- Firmly planned transmission additions
- Transmission capability
- Coal plant construction
- Nuclear plant construction
- Nuclear retirements
- Reserve margins and local reserve requirements
- Cost and performance of pollution controls and firmly planned control installations
- **State environmental policies (RPS, CES, etc.)**
- **Federal environmental policies**
- Carbon price for CA/Quebec/Ontario
- State-specific generation minimums
- RGGI Requirements: Cap, Reserve price, CCR, Offsets

Typical sources for these assumptions include EIA, EPA, NREL, ISOs, and state agencies

IPM Outputs - Projections

- Typical results provided to RGGI for each state include:
 - Generating capacity by type (gas combined cycle, gas turbine, solar, wind, etc.)
 - Generation by type
 - Fuel consumption by type (oil, gas, coal)
 - Emissions (CO₂, SO₂, NO_x)
 - Electricity and capacity prices
 - Import and exported power by source/destination
- Results are presented for select years over the time horizon

RGGI Representation in IPM

- IPM represents electricity policies such as state-specific and regional renewable portfolio standards (RPS), clean energy standards (CES), emission reduction targets as well as carbon market policies such as RGGI.
- The modeling of RGGI in IPM is defined by assumptions such as the participation by States in specific years, programmatic elements such as facility size and technology type eligibility criteria, and policy instruments such as the Emission Containment and Cost Containment Reserves (ECR and CCR).
- The modeling of the RGGI program results in a forecast for RGGI allowance prices over the forecast horizon, built on the assumptions around cap trajectories over time and the projected emissions in the RGGI Footprint
- The projected emissions account for all the assumed policies at the same time with perfect foresight, capturing the interactive effects between RGGI and other policies such as RPS or CES targets in all states.
 - IPM discounts economic actions so that assumptions and outcomes later in the model time horizon do not carry as much weight in near-term decisions

IPM Logic and RGGI

- As a result of its forward-looking optimization, IPM optimizes the banking and withdrawal of allowances over time.
 - The optimization can impact allowance prices, including those in the near-term, by "linking" them to the costs of emission reductions later in time.
 - In essence, IPM trades off the use of allowances today based on what it knows is coming in the future with respect to emission reduction opportunities and related costs.
- This optimization has two implications for the projections related to RGGI:
 - The projections assume that any allowance bank is exhausted within the timeframe of the analysis.
 - Projections in the near-term including generation, emissions, and allowance pricing, can be a function of projections in later years of the analysis.

Base Case, Scenarios, and Sensitivities

- A Base Case (or Reference Case) is based on assumptions representing the best guess at what will occur without any change in policy
 - This serves as the basis for comparison for sensitivity cases and scenarios that follow
- Assumptions can be combined in different ways to form sensitivities or scenarios that differ from the Base Case
 - Typically, sensitivity cases focus on assumptions related to market drivers or assumptions not specific to the RGGI program (such as the High Case shown at right)
 - Scenarios tend to emphasize changes related to the specification of RGGI, such as RGGI caps or other elements

Assumption	2017 Base Case	2017 High Case
Non-RGGI National CO ₂ Program (NP) Targets	No NP	NP: States outside of RGGI subject to mass-based goals covering existing and new sources
Gas Prices (2017-2031 Avg., 2015\$/MMBtu)	Average of AEO 2017 Reference Case and High Resource Case (\$3.84)	AEO 2017 Reference Case (\$4.30)
Nuclear Retirements	Pilgrim retires in 2019; Indian Point retires in 2020/2021	50% reduction of NY and NE generation by 2024, incl. Pilgrim and Indian Point
Transmission	Includes 1,050 MW line from Canada to New England, 2022	Remove Reference Case 1,050 MW line from Canada to New England
Renewable Costs	NREL 2016 Base Case	NREL 2016 High Case
Firm Builds	Reference Case Assumptions	

Questions?



IPM Base Case Modeling Assumptions Presentation Overview

- Program Review IPM Modeling Assumptions Overview
- Assumptions: Framework, Considerations, Approaches
- Question & Answer
- Public Comment

Considerations

- Seeking input:
 - How should state-specific electricity sector or economy-wide net-zero emissions targets be incorporated?
 - How should state-specific goals for decarbonization through fuel switching and beneficial electrification be incorporated?
 - How should states address uncertainty regarding climate and energy policy in the 2030-2040 timeframe?
 - Should the model assume that the excess allowance pool is completely exhausted or that a residual bank remains at the end of the analysis period, if so, what percentage remains and why?

Base Case Assumptions Outline

Presentation Focus for Input:

- Fuel prices
- Regional energy and peak demand
- Offshore wind capacity additions
- Energy storage capacity additions
- Firmly planned transmission additions

For information on other assumptions, please see the Appendix.

RGGI Base Case Assumption Development

- Each slide covers a modeling assumption category broken down as follows:
 - Description
 - Considerations
 - 2017 Program Review Approach
 - Current potential approaches and data sources

Fuel Prices

- Description
 - Commodity and delivered prices for natural gas, oil products, coal, hydrogen, renewable natural gas
 - Fuel prices are critical because IPM uses them for investment decisions
- Considerations for base case building
 - States are considering current fuel prices and supply challenges when discussing what trajectory fuel prices will follow

Fuel Prices – Natural Gas

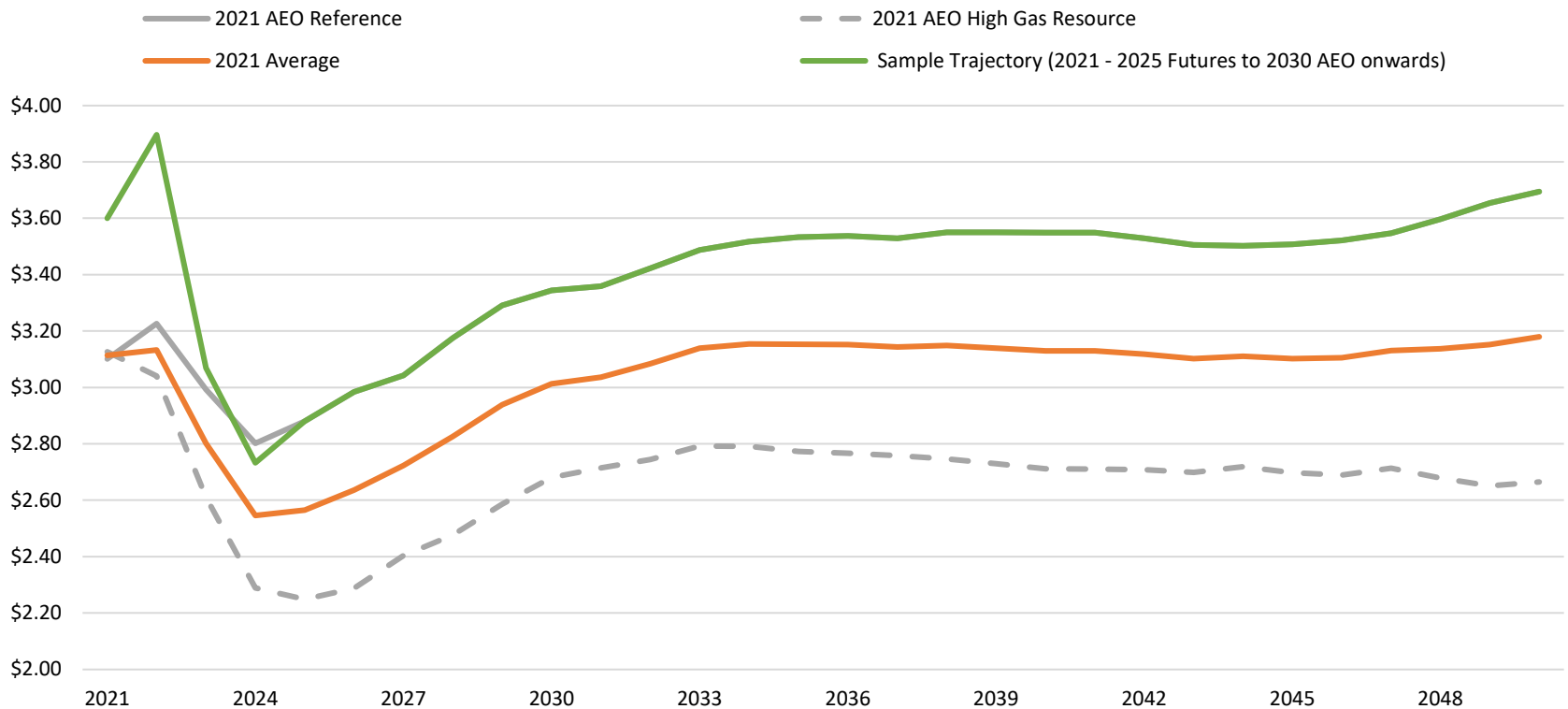
- 2017 Program Review Approach
 - Reference Case used average of AEO 2017 Reference Case and High Resource (low price) Case
- Potential approaches
 - Consider combining data from one or more sources:
 - Energy Information Administration Annual Energy Outlook (AEO) 2022 Reference Case
 - AEO 2022 Low Resource (high price) case forecast
 - Henry Hub futures contract prices (at time of modeling)
 - For AEO 2022, basis point adjustments would be used to convert Henry Hub prices to delivered local prices based on historical weather-normalized delivered cost

Natural Gas Fuel Prices

- Specific potential approaches
 - Energy Information Administration Annual Energy Outlook (AEO) 2022 Reference Case
 - AEO 2022 Low Gas Resource Case
 - AEO 2022 Reference/Low Gas Resource Cases Average
 - AEO 2022 Reference Case blended with Henry Hub natural gas futures

Natural Gas Fuel Prices

Illustrative Example - Henry Hub Pricing Options (2020\$/MMBTu)



*Graph made using AEO 2021 data for illustrative purposes only – AEO 2022 data will be used for RGGI state modeling

Fuel Prices - Oil & Coal

- 2017 Program Review approach & data sources
 - Oil products – AEO 2017 Reference Case
 - Coal – ICF Supply Curves
- Potential approach – Oil products
 - AEO 2022 Cases (Reference/Low Resource)
- Potential approach – Coal
 - ICF Supply Curves

Fuel Prices – Hydrogen and Renewable Natural Gas

- Consideration: not previously modeled in 2017 Program Review
- Potential approach – Hydrogen
 - Seeking comment on how to consider availability and pricing
- Potential approach – Renewable Natural Gas
 - Seeking comment on how to consider availability and pricing

Regional Energy and Peak Demand

- Description
 - Energy (MWh) and peak demand (MW) requirements by state for 2022-2040
 - IPM meets regional energy needs by simulating existing plants, building generation, and using transmission to meet load

Regional Energy and Peak Demand

- Considerations for base case building
 - Current ISO forecasts do not go out to 2040
 - States are seeking additional data sources through the modeling horizon
 - States are discussing how much climate and energy policies will impact load through 2040
 - States want to consider trends for beneficial electrification, energy efficiency, renewable buildout, and transportation electrification
 - Additional data sources include National Renewable Energy Lab (NREL), ISO electrification studies, or state-generated forecasts

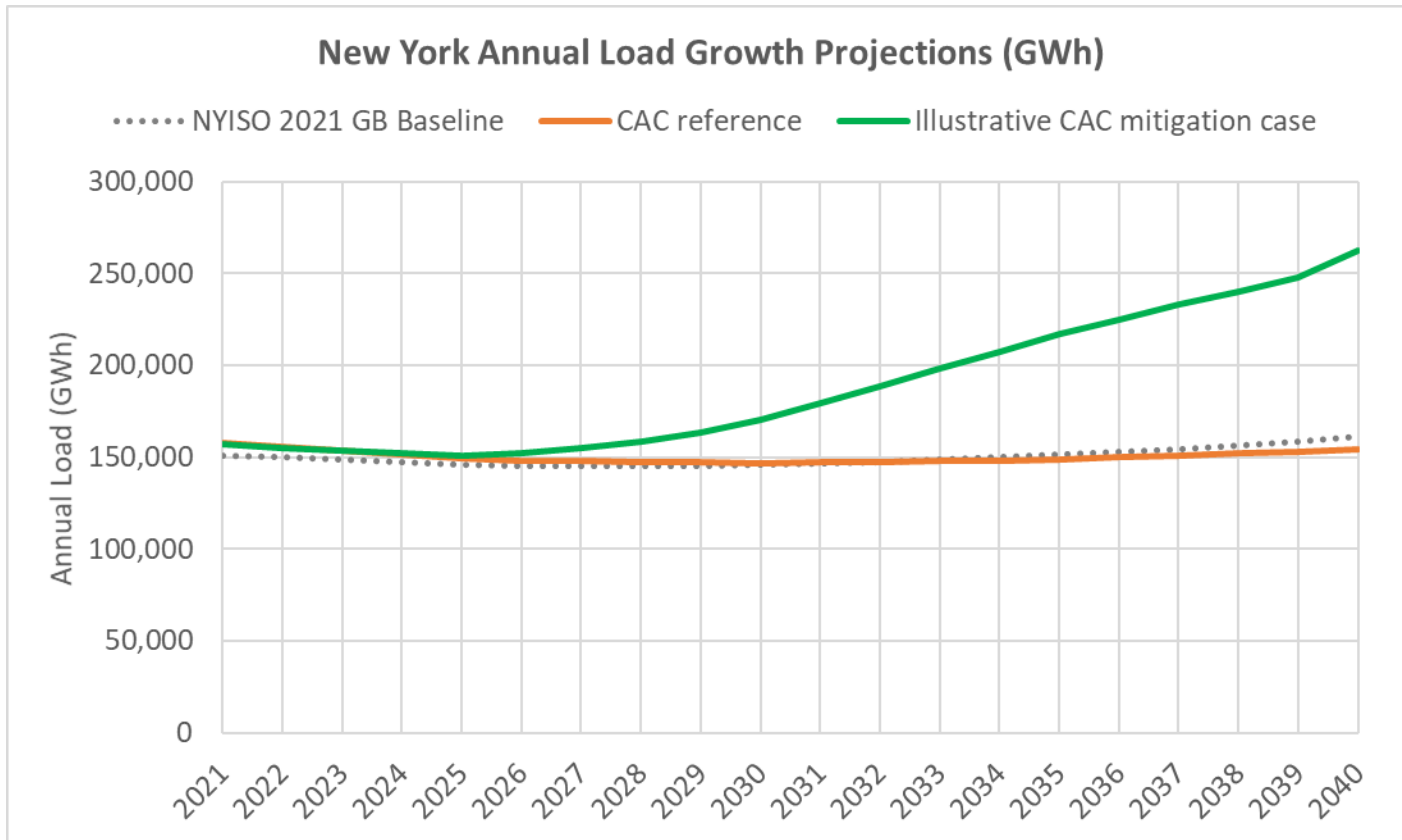
Regional Energy and Peak Demand

- 2017 Program Review Approach
 - NYISO
 - New York State Clean Energy Standard White Paper forecast
 - ISO-NE
 - 2016 ISO-NE CELT forecast
 - RGGI-PJM States
 - PJM 2017 forecast
 - Outside of RGGI
 - ISO reports (as available) or EIA AEO 2017 regional growth estimates

Regional Energy and Peak Demand – New York

- Potential approaches and data sources
 - State-provided study-driven load forecasts based on legislative and regulatory requirements (CAC study)
 - Forecast from NYISO “Gold Book”

Regional Energy and Peak Demand – NYISO



- NYISO 2021 GB baseline reflects impacts of energy savings programs, BTM generation and includes T&D losses.
- CAC reference and mitigation case load reflects impacts of energy savings programs, BTM generation, include electrolysis load, and includes T&D losses

Regional Energy and Peak Demand – ISO-NE

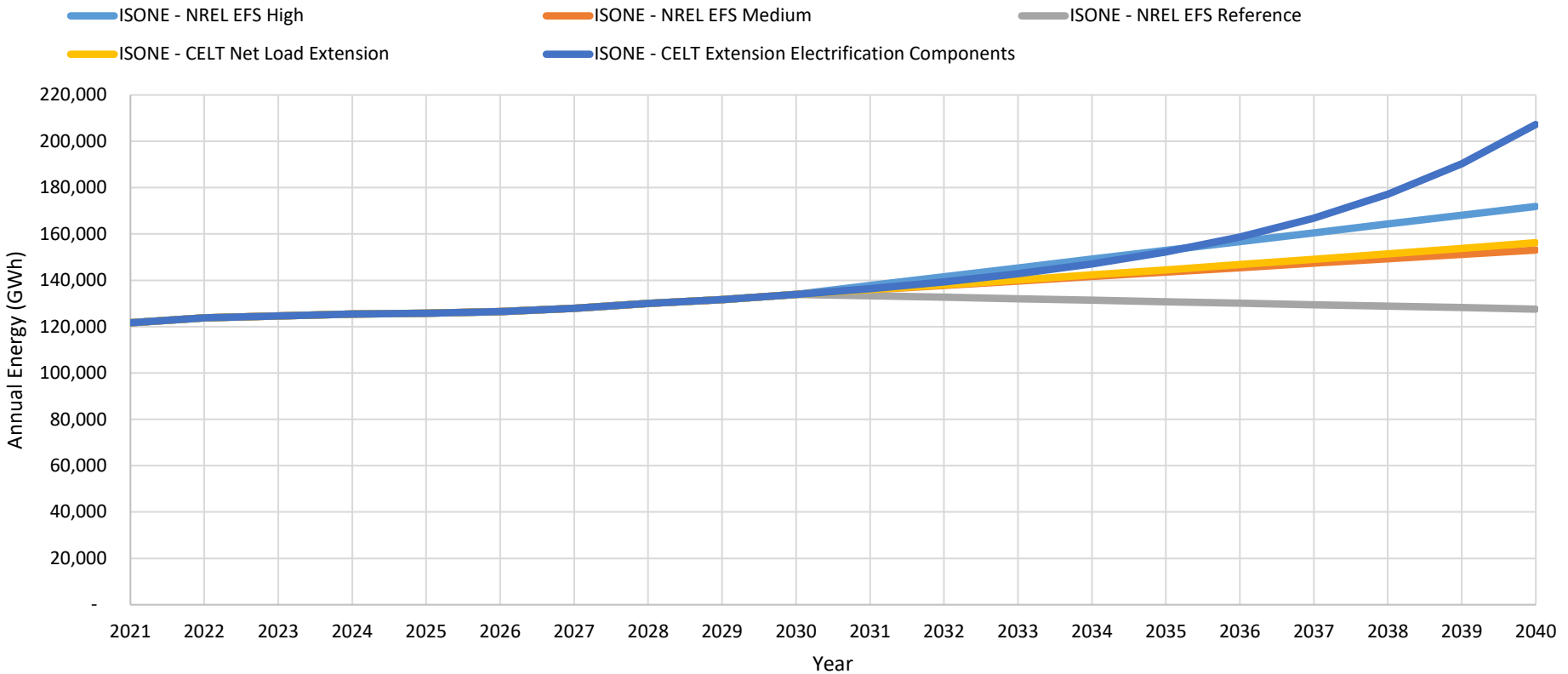
- Potential approaches and data sources
 - ISO forecast (with extension of electrification trends)
 - Utilize study-driven load increase estimates for beneficial electrification
 - National Renewable Energy Lab (NREL) Electrification Futures study

Regional Energy and Peak Demand – ISO-NE

- Specific potential approaches
 - ISO-NE 2022 Capacity, Energy, Loads, and Transmission (CELT) report
 - Extend CELT trajectory by extrapolating from component trends (i.e. beneficial electrification, energy efficiency, behind-the-meter resources) through the modeling horizon
 - Use NREL Electrification Futures Study to interpolate load growth (high, medium, or reference electrification scenarios)
 - Use load assumptions from ISO-NE study on Pathways to the Future Grid – Central Case

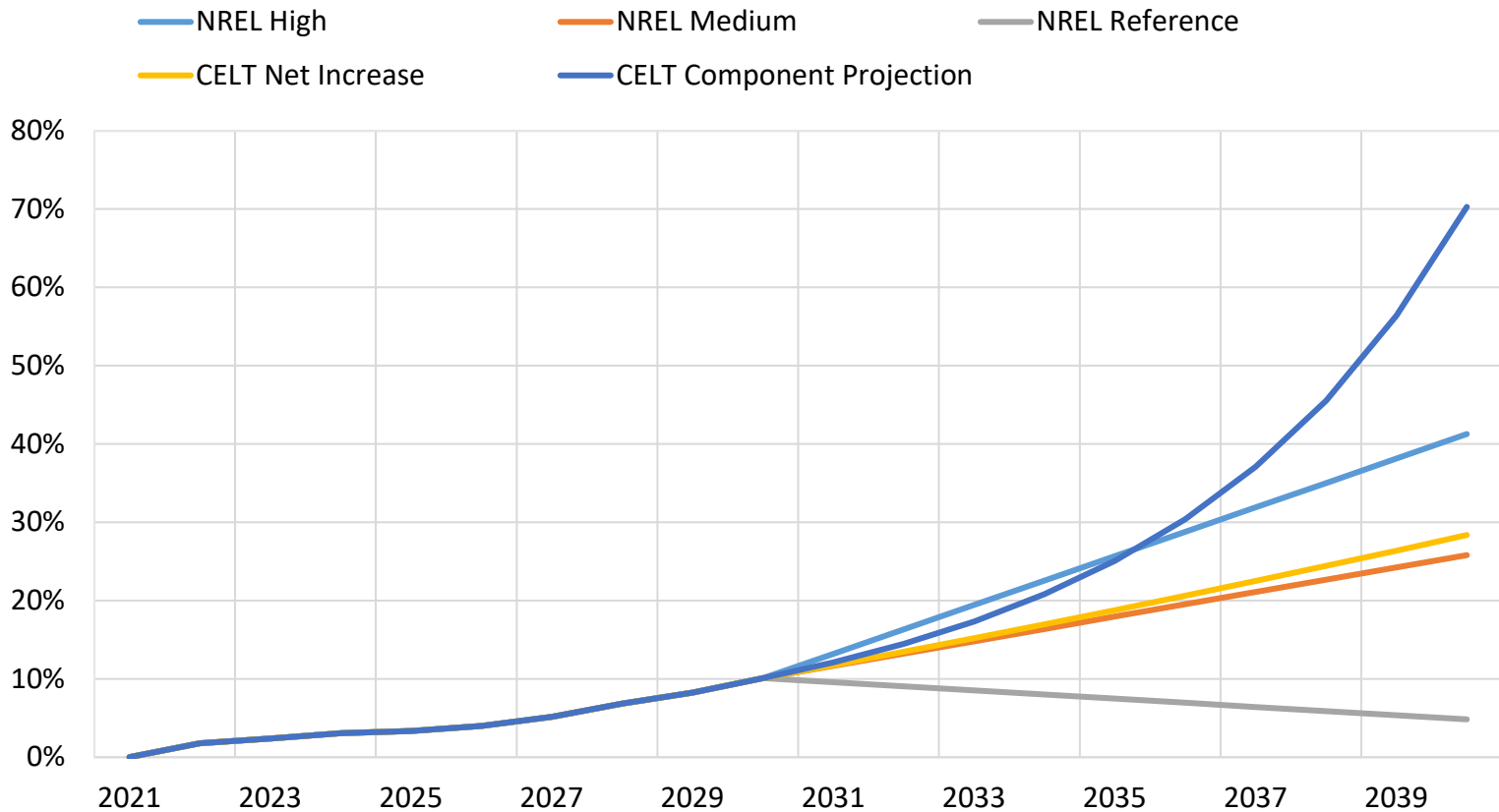
Regional Energy and Peak Demand – ISO-NE

ISO-NE Annual Energy Projections (GWh)



Regional Energy and Peak Demand – ISO-NE

ISO-NE Load Forecast Percent Growth Comparison



Regional Energy and Peak Demand – RGGI-PJM States

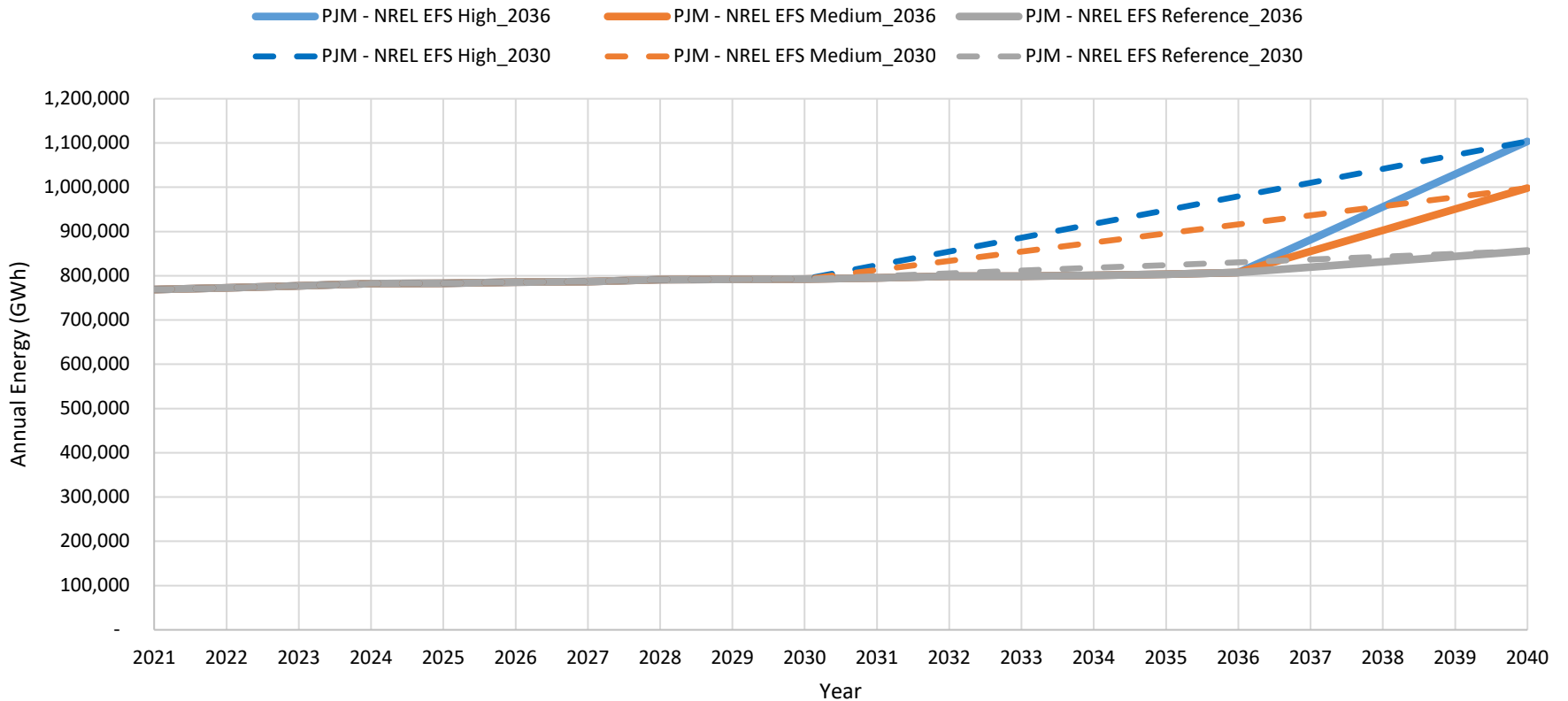
- Potential approaches and data sources
 - ISO forecast
 - Generate state-specific load forecasts based on legislative and regulatory requirements for Maryland and New Jersey
 - Utilize study-driven load increase estimates for beneficial electrification from National Renewable Energy Lab (NREL) Electrification Futures study

Regional Energy and Peak Demand – PJM

- Specific potential approaches
 - PJM Load forecast
 - Adjust PJM forecast for electric vehicle requirements in RGGI-PJM states
 - Use NREL Electrification Futures Study to interpolate load growth (high, medium, or reference electrification scenarios)
 - Use state-specific analysis for New Jersey and Maryland

Regional Energy and Peak Demand – PJM

PJM Annual Energy Projections (GWh)



Regional Energy and Peak Demand – Outside of RGGI

- Potential Approaches
 - ISO reports (as available)
 - EIA AEO 2022 regional growth estimates

Firmly Planned Capacity Changes – Offshore Wind

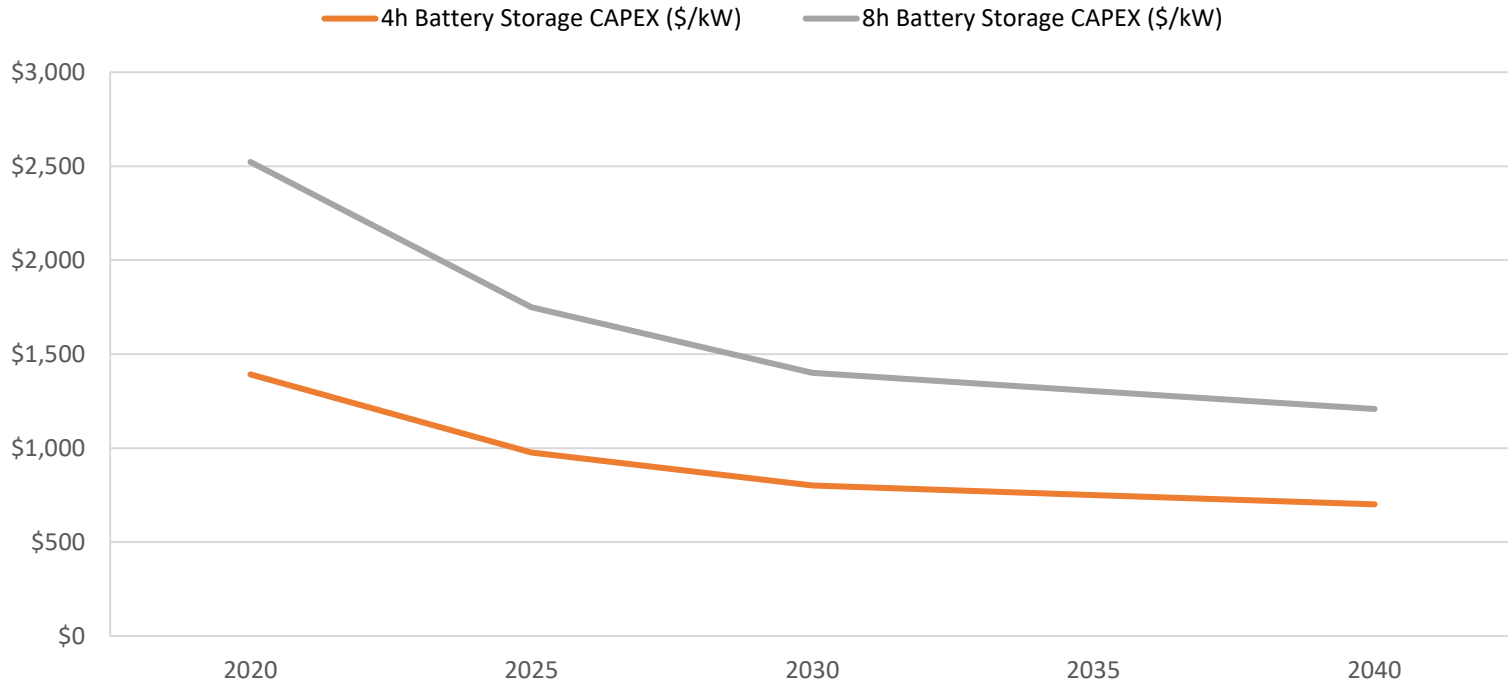
- Description & Considerations
 - IPM can handle offshore wind generation specifically to meet state RPS mandates
 - Some states have recent regulatory requirements for offshore wind capacity additions
- 2017 Program Review Approach
 - Not a separate category from other renewables; 1,600 MW of capacity included in a sensitivity
- Potential Approach
 - Model firm achievement of state offshore wind capacity goals and mandates
 - Generation contributes to state RPS programs

Energy Storage Capacity Additions

- Description
 - IPM will use storage deployment to manage peak load and transmission resources
- Considerations
 - IPM can model energy storage buildout
 - Not previously modeled in 2017 Program Review
- Potential Approaches
 - Assume storage duration (4 and/or 6-hour)
 - 2021 NREL Annual Technology Baseline (2022 if available)
 - Allow IPM to deploy energy storage economically
 - Alternatively, specify energy storage deployment based on state mandates

Energy Storage Capacity Additions

NREL 2021 ATB Storage CAPEX (\$2020)



Firmly Planned Transmission Additions

- Description & Considerations
 - Additions to existing transmission capacity in planning or construction stages and assumed to be firm
 - IPM relies on transmission capability to help meet regional electricity demand
- 2017 Program Review Approach
 - Based on ISO studies with review by states
 - Add transmission line from Canada to New England (1,050 MW)

Firmly Planned Transmission Additions

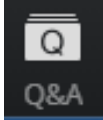
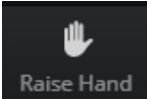
- Potential Approaches
 - PJM
 - Review region-wide transmission project updates
 - ISO-NE
 - Review region-wide transmission project updates
 - Add transmission from Canada
 - NY
 - Western NY, AC Transmission and Northern New York
 - A basic proxy for Long Island Public Policy Transmission
 - NY Clean Energy Standard Tier 4 projects: 1,250 MW HVDC line from HQ to NYC; 1,300 MW HVDC line from Zone E to NYC

How to Provide Comment

- 1. Submit verbal comments during public meetings:** Meetings throughout Program Review will include opportunities for verbal comment from members of the public.
- 2. Submit written comments during open comment periods:** Public meetings will be paired with comment periods, during which comments may be sent to info@rggi.org.

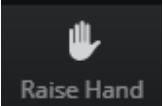
*Submit written comments for this meeting by **January 12, 2022.**
with the subject line “RGGI Program Review Comment.”*

Clarifying Questions

- Use the Q&A function  to send a question to the host.
- Or
- Use the raise hand function  to let us know you have a question (*phone participants dial *9*).
 - The host will let you know when it is your turn to speak.

Send additional questions to info@rggi.org

Public Comment

- Individuals who reserved time to comment will provide comment first.
- Use the raise hand function to let us know you would like to comment.  (*phone participants dial *9*)
- The host will let you know when it is your turn to speak.
- Speakers will have 3 minutes to provide comment.

Note: *This meeting is being recorded. If you prefer, you may submit a written comment to info@rggi.org*

Next Steps

- Submit written comments to info@rggi.org by **January 12, 2022**.
- Use the subject line “RGGI Program Review Comment.”



Thank You!



Appendix

Appendix Table of Contents

Appendix

- Renewable portfolio standards
- Firmly planned generation and retirements
- Cost and performance of new generation
- Cost and performance of pollution controls
- Transmission capability
- Nuclear plant construction/retirements & coal plant construction
- Reserve margins and local reserve requirements
- State environmental policies
- Federal environmental policies

Supplementary Slide

- Firmly Planned Offshore Wind Capacity Additions

Renewable Portfolio Standards (RPS)

- Description & Considerations
 - RPS and Clean Energy Standard (CES) regulations require a portion of retail electricity sales to be met with generation from qualifying tiers based on generation source or deliverability
 - IPM complies with RPS targets in operation and investment decisions, up to the cost of alternative compliance payments (ACPs)

Renewable Portfolio Standards (RPS)

- 2017 Program Review Approach
 - Modeled in regional ISO markets (ISO-NE, NYISO, PJM)
 - RPS targets were met in New England (except NH) and PJM with aggregated state-level RPS implementation; ACP levels specified by the states
 - Fulfillment of New York Clean Energy Standard
- Potential Approach
 - Model state RPS targets as part of aggregated regional markets (ISO-NE, NYISO, PJM); ACP levels specified by the states
 - Assume fulfillment of all RPS requirements (except NH)
 - MA & NY Clean Energy Standard treated as RPS

Firmly Planned Generation and Retirements

- **Description & Considerations**
 - Reflect in IPM power plants that are planned to either come online or be retired during the modeled time horizon
 - IPM uses firm capacity additions/retirements into account for projections and investments
- **2017 Program Review Approach**
 - Utilize ISO queues and other relevant data sources for facilities meeting 2 of 3 criteria: 1. fully permitted, 2. fully financed, 3. PPA for 50% or more of output
- **Potential Approach**
 - Utilize ISO queues and other relevant data sources for facilities meeting 2 of 3 criteria: 1. fully permitted, 2. fully financed, 3. PPA for 50% or more of output

Cost and Performance of New Generation

- Description & Considerations
 - 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
- 2017 Program Review Approach
 - NREL 2016 for cost and performance of wind and solar; AEO 2017 for other generation
 - RGGI Region-specific cost adjustments
 - State-specific renewable costs or changes to biomass builds
- Potential Approaches
 - Use EPA and NREL assumptions for renewables
 - Use AEO 2022 for traditional generation and storage
 - Incorporate ITC and PTC

Cost and Performance of Pollution Controls and Firmly Planned Installations

- Description and Considerations
 - Capital and operating costs of emissions control for SO₂, NO_x, mercury, and assumed emissions percentage reduction
 - 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
- 2017 Program Review Approach
 - Costs and unit control status from EPA Base Case v.5.15, with review by the states
- Potential Approaches
 - Costs and unit control status from EPA Base Case v6

Transmission Capability

- Description & Considerations
 - 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
- 2017 Program Review Approach
 - Capabilities based on ICF review of most recent ISO reports and modeling
- Potential Approaches
 - Capabilities based on ICF review of most recent ISO reports and modeling

Coal and Nuclear Plant Capacity Changes in RGGI

- Description & Considerations
 - Limits on the amount and type of new coal and nuclear capacity that can be built within the RGGI region
 - In IPM, such limits supersede decisions based on market fundamentals
- 2017 Program Review Approach
 - New Source Performance Standards (NSPS) rate for new coal of 1,400 lbs./MWh, consistent with a supercritical unit with 20% carbon capture
 - Nuclear: No new units unless specified by state as firmly planned
- Potential Approaches
 - NSPS rate for new coal of 1,400 lbs./MWh, consistent with a supercritical unit with 20% carbon capture
 - Nuclear: no new units
 - Seeking comment on assumption of nuclear plant lifespan

Reserve Margins & Local Reserve Requirements

- Description & Considerations
 - Reserve margins reflect backup capacity required above peak demand to maintain system reliability, expressed as a percentage of peak demand. NYISO also has locational minimum installed capacity requirements for Zones J, K, and G-J, specified as a percentage of peak load that must be met with in-zone resources.
 - IPM must use existing capacity, transmission, and new capacity options to meet reserve requirements in each region.
 - Other requirements include units that must operate at certain times in order to maintain system reliability or that must burn specific fuels to meet state or local rules. These choices might not otherwise be made on an economic basis.

Reserve Margins & Local Reserve Requirements

- 2017 Program Review Approach
 - ISO projections, including local requirements for NYISO Zones J, K, and G-J
 - Include minimum unit operation levels to meet reliability and minimum fuel burn requirements in NYISO; other minimum fossil fuel generation as specified by the states
- Potential Approaches
 - ISO projections, including local requirements for NYISO Zones J, K, and G-J
 - Include minimum unit operation levels to meet reliability and minimum fuel burn requirements in NYISO; other minimum fossil fuel generation as specified by the states
 - Maintain current levels of UCAP throughout model time horizon

State Environmental Policies

- Description and Considerations
 - State emission limits for SO₂, NO_x, 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
- 2017 Program Review Approach
 - Existing requirements for SO₂, NO_x and mercury, as provided by state agencies
 - State-specific CO₂ requirements, as provided by the states for state polices which potentially affect generation or carbon emissions at RGGI sources
 - NY: no coal generation after 2020.

State Environmental Policies

- Modeling Approach
 - Existing requirements for SO₂, NO_x, and mercury, as provided by the states

Federal Environmental Policies

- Description and Considerations
 - Federal air pollution requirements, regulation of coal combustion residuals, Effluent Limitation Guidelines and Regulation of water intake under Clean Water Act, IPM must comply with assumed regulations as it operates units to meet demand
- 2017 Program Review Approach
 - MATS (Mercury and Air Toxic Standards)
 - ASH Rule (Disposal of Coal Combustion Residuals from Electric Utilities)
 - CSAPR (Cross-state Air Pollution Rule)
 - 316B: States will provide any information on units impacted by 316 b (i.e. offline) (cooling water intake rule)
 - Federal Production Tax Credit / Investment Tax Credit

Federal Environmental Policies

- Potential Approach – Similar to 2017 Approach
 - MATS (Mercury and Air Toxic Standards)
 - ASH Rule (Disposal of Coal Combustion Residuals from Electric Utilities)
 - CSAPR (Cross-state Air Pollution Rule)
 - 316B: States will provide any information on units impacted by 316 b (i.e. offline) (cooling water intake rule)
 - Federal Production Tax Credit / Investment Tax Credit extension added
 - Inclusion of federal policy and incentives for clean energy and/or carbon management as appropriate



Supplemental Slides

Firmly Planned Capacity Changes – Offshore Wind

State	Offshore Wind Goals
CT	304 MW + 800 MW online by 2025 Additional 1,196 MW authorized Additional 1,900 MW post 2030
ME	11 MW
MD	1,568 MW online by 2030
MA	3,200 MW online by 2027 5,600 MW online by 2036
NJ	7,500 MW by 2035
NY	9,000 MW by 2035
RI	30 MW online; additional 400 MW by 2025
VA	2,400 MW online by 2026 3,920 online by 2030 5,200 MW online by 2034