



# Carbon Charge Proposal Evaluation – Updated

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PREPARED FOR: IPPTF MEETING - Updated  
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# List of changes to August 20 presentation

- First year of study period 2021 instead of 2020 (all slides updated to reflect change)
- Eastern Interconnection replaced with NY and neighbors (defined as Modeled Area)
- Existing resources and planned resource additions combined into one slide in one figure
- Updated battery storage level to 1500 MW and added a table breaking out the additions
- SCC table updated to reflect CARIS-based RGGI forecast (escalated at an 8% growth rate)
- All figured labeled to be in nominal or real dollars
- All zonal figures changed to tables
- Added a section on border charges
- Added a few slides to describe an alternative MCC approach
- Added Day Ahead commitment constraints to the AURORA Model
- Added a slide on customer credit from emitting resources
- Added an appendix with additional zonal tables

# Overview

- Background
- Work Plan
- Results (updated)
- Border Charges
- Methodology
- Input Assumptions
- Appendix
- Questions

# Background

- New York ISO (NYISO) is considering incorporating the price of carbon emissions into the wholesale energy markets
- New York State has three public policy goals that will have a direct impact on wholesale market:
  1. Ambitious greenhouse gas reduction targets
  2. Meeting at least 50% of the state's energy demand with renewable resources
  3. Proposed reduction of electricity consumption by 3% over the 2015 baseline by 2025

# Work plan

- Evaluate direct economic impacts of implementing a carbon charge through the NYISO markets.
- Study focuses on the delta in outcomes between two cases:
  1. A “status quo” case assuming state policies are met and the carbon charge is not implemented.
  2. A “with carbon charge” case featuring the addition of the proposed carbon charge.
- Study period includes each year between 2021 and 2025 inclusive, 2030, and 2035.
- Performance metrics selected to characterize the impact of carbon charge on the market, consumers, and economic efficiency.
- Inputs tested to assess sensitivity of metrics to assumptions.

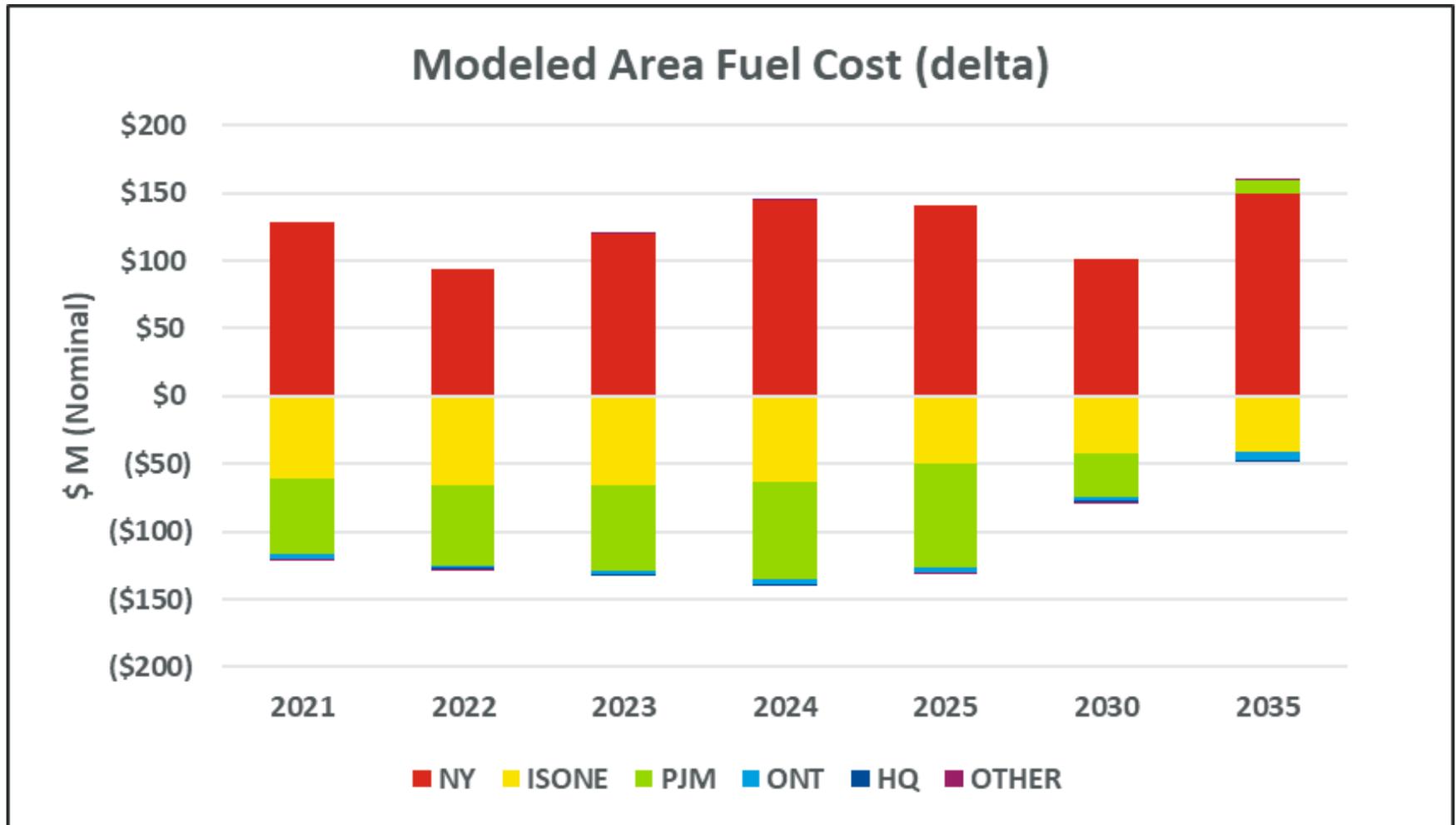
# UPDATED DRAFT RESULTS

**SUPERCEDES MATERIAL POSTED 10/15/2018**

# Metrics

- Metrics reported for New York and by Zone are the change in the following between the Status Quo and Carbon Charge cases:
  - Production Costs
  - Renewable production
  - CO<sub>2</sub> Emissions
  - Average LBMPs
  - Zonal Capacity Prices
  - Resource Gross Margin (calculated as contribution margin by proxy resource for each resource class by year)
  - Net Exports
  - Quantity and Location of Market-based Entry
  - Customer Credits from Emitting Resources

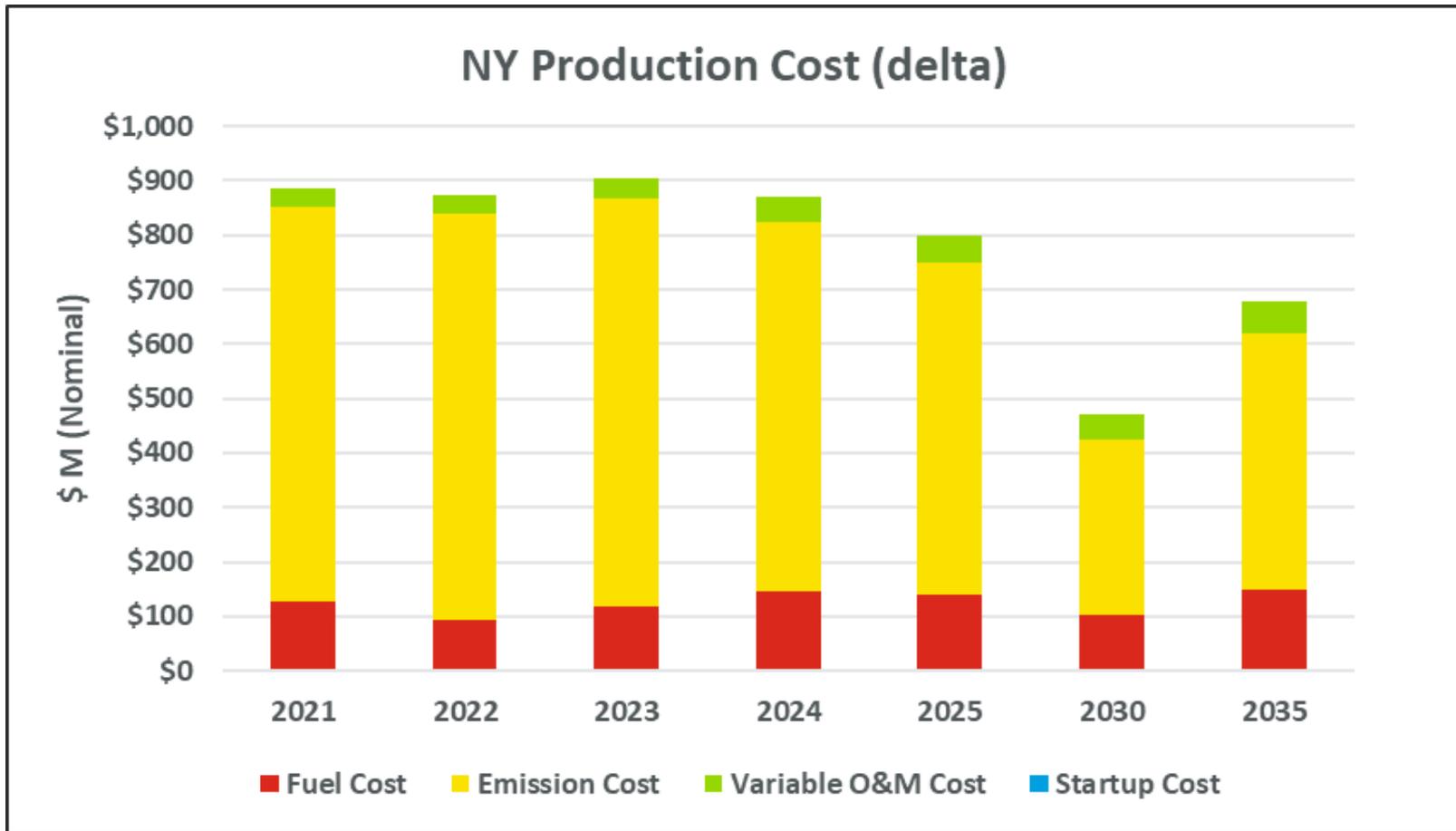
# Modeled area fuel costs



Results for OTHER includes New Brunswick and the Maritimes

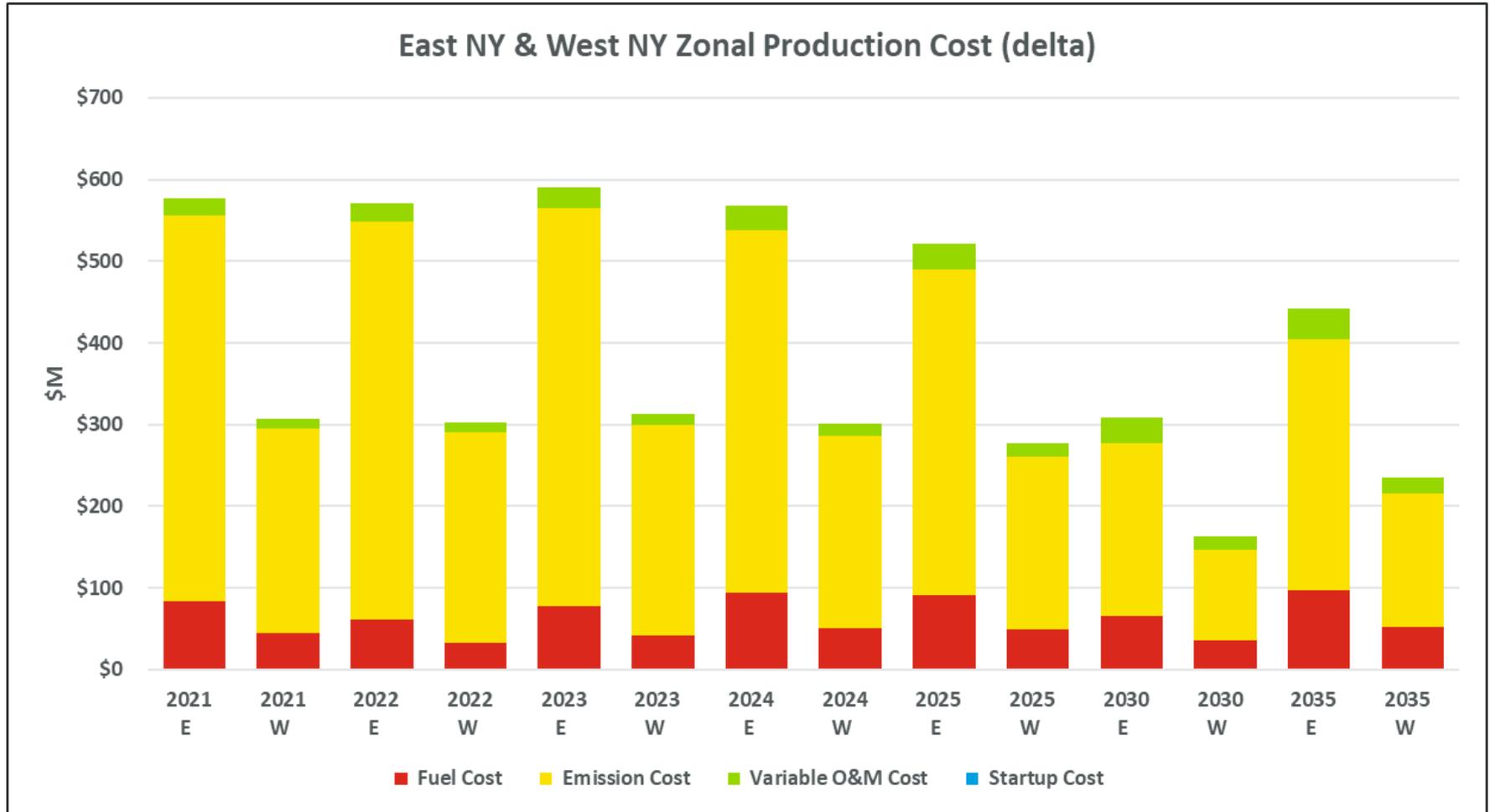
# Change in New York production costs

- Emission costs are the largest portion of the production cost change
- NY output has increased, which contributes some to these increases



Gross production costs not net of carbon charge residuals

# Change in NY production costs (West Zones A-E; East Zones F-K)



Gross production costs not net of carbon charge residuals

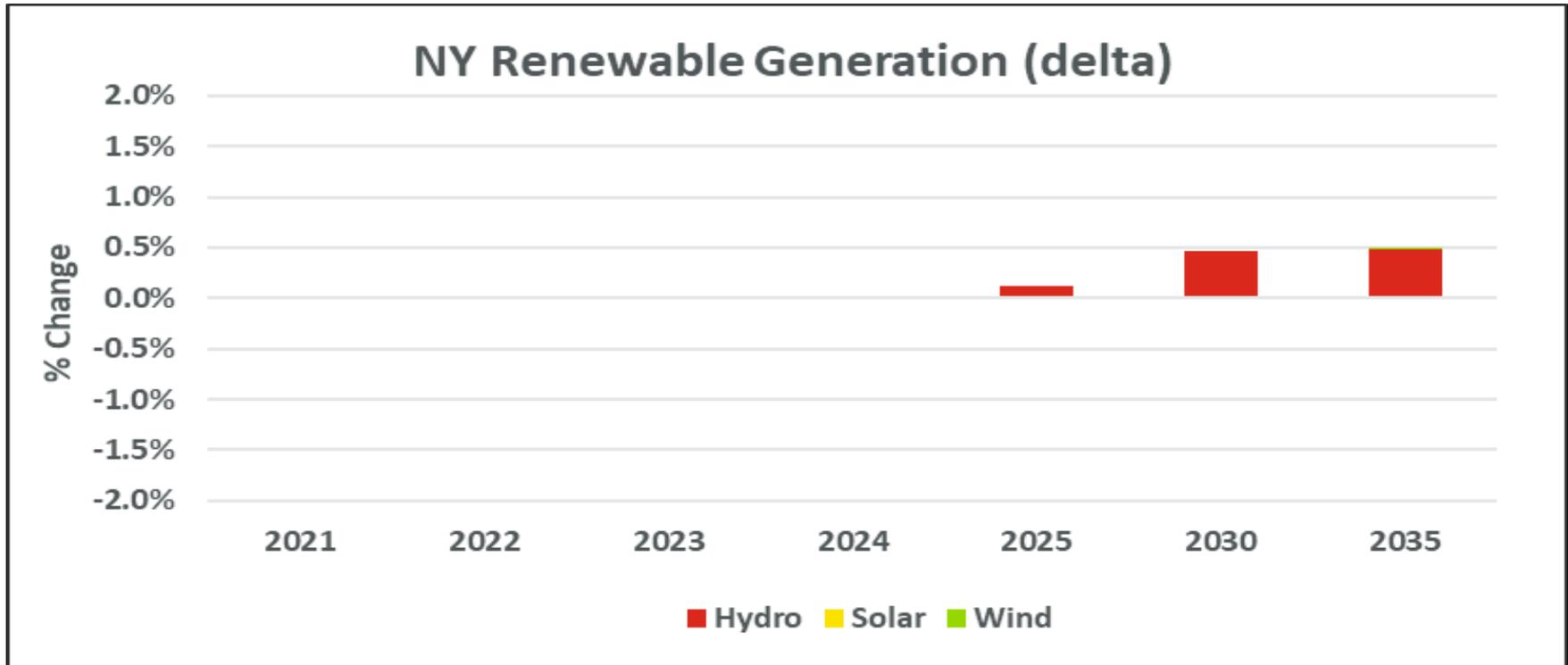
# Change in NY Zonal Production Costs

## Load Weighted NY Zonal Allocation of Total Production Cost (% Delta)

<b>ZONE</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>
A	4%	4%	4%	4%	4%	3%	3%
B	3%	3%	3%	2%	2%	2%	2%
C	4%	4%	4%	4%	4%	3%	3%
D	2%	2%	2%	1%	1%	1%	1%
E	2%	2%	2%	2%	2%	1%	1%
F	3%	3%	3%	3%	3%	2%	2%
G	3%	2%	2%	2%	2%	2%	2%
H	1%	1%	1%	1%	1%	0%	1%
I	2%	2%	2%	1%	1%	1%	1%
J	14%	13%	13%	13%	12%	9%	9%
K	6%	5%	5%	5%	5%	3%	3%
<b>NY Total</b>	<b>43%</b>	<b>40%</b>	<b>40%</b>	<b>38%</b>	<b>36%</b>	<b>26%</b>	<b>27%</b>

Gross production costs not net of carbon charge residuals

# Change in NY renewable generation



- No change in solar generation
- Small change in hydro generation
- Negligible change in wind generation

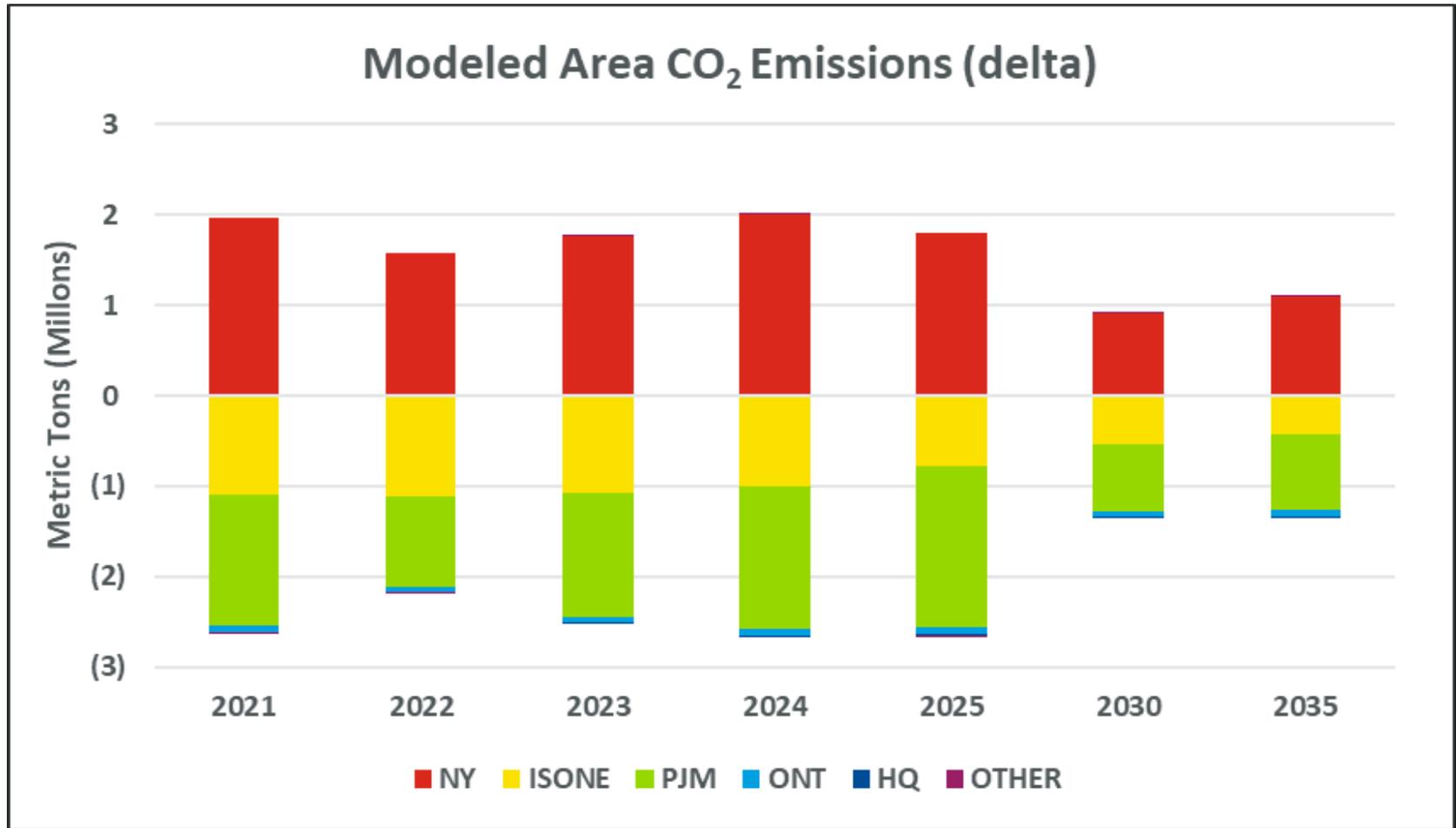
# Change in NY Zonal Renewable Generation

## NY Zonal Renewable Generation (% change)

<b>ZONE</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>
A	0.0%	0.0%	0.0%	0.0%	0.2%	0.6%	0.6%
B	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.8%
C	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.3%
D	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	0.3%
E	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%
F	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
G	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
H	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
I	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
J	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
K	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

# Modeled Area CO<sub>2</sub> emissions

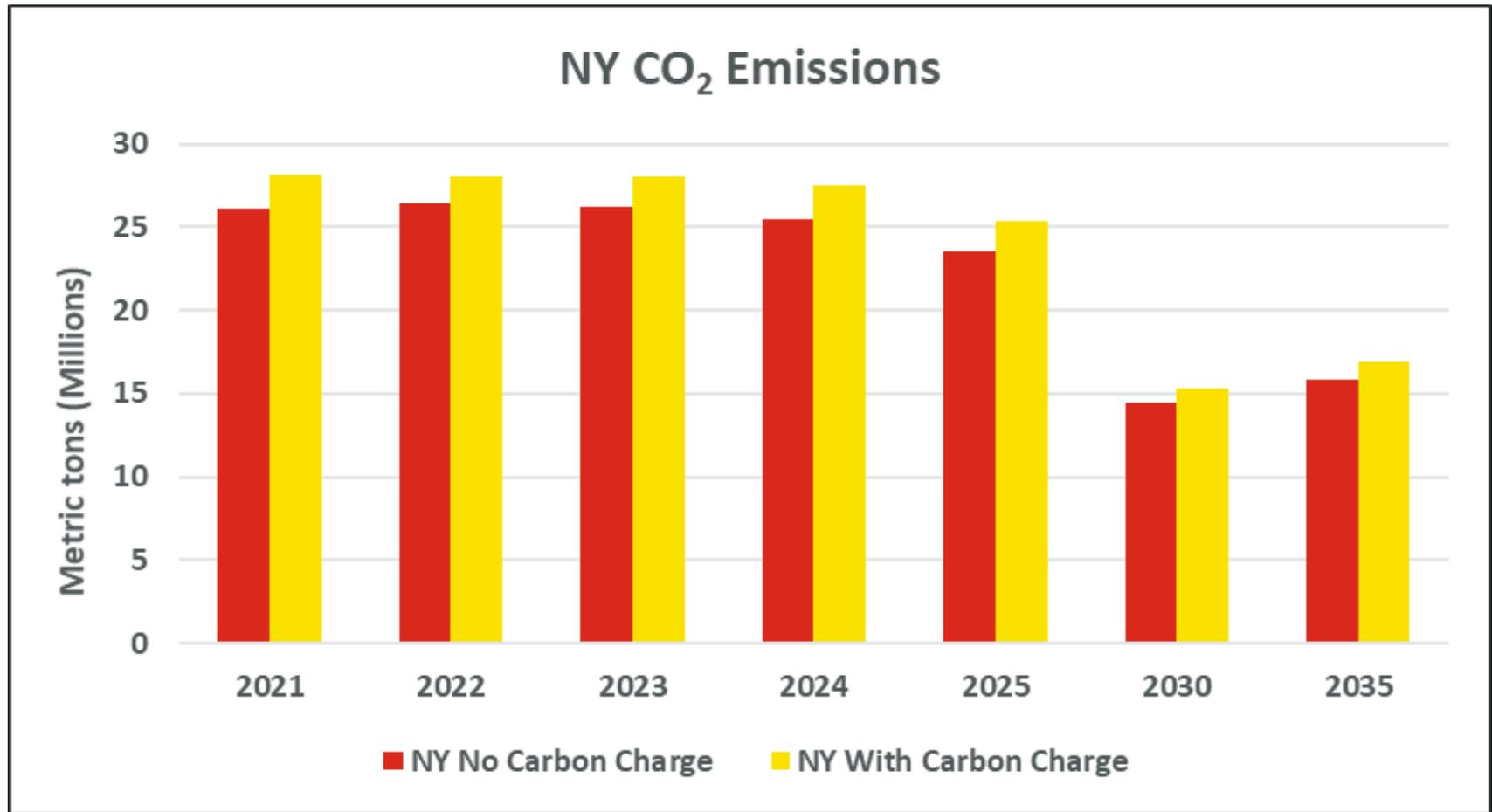
- Carbon Charge Case has lower total emissions over the study period



Results for OTHER includes New Brunswick and the Maritimes

# Total NY CO<sub>2</sub> emissions

- Carbon Charge Case has higher total emissions in NY over the study period

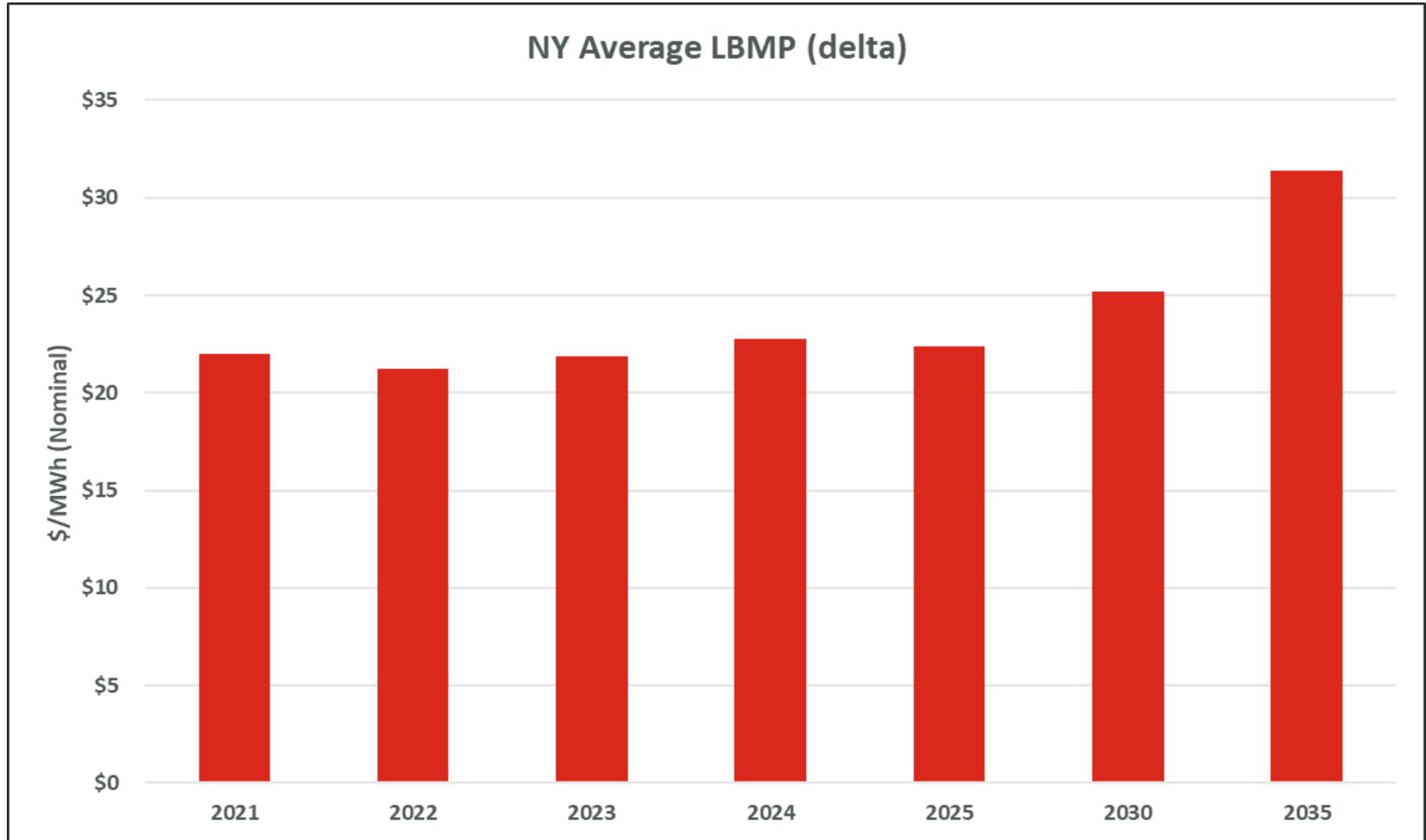


# Change in NY CO<sub>2</sub> emissions

## NY Zones Carbon Dioxide Emissions (% Delta)

<b>ZONE</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>
A	2%	0%	2%	(1%)	(1%)	(3%)	(1%)
B	8%	6%	8%	6%	4%	5%	8%
C	5%	6%	8%	8%	7%	10%	12%
D	17%	15%	18%	17%	14%	9%	12%
E	(15%)	(18%)	(19%)	(18%)	(19%)	(1%)	4%
F	19%	17%	18%	20%	20%	19%	15%
G	8%	10%	5%	13%	11%	3%	4%
H	(12%)	(15%)	(18%)	(16%)	(16%)	(20%)	46%
I	117%	119%	118%	163%	150%	31%	48%
J	7%	6%	6%	7%	8%	3%	4%
K	5%	1%	2%	2%	2%	5%	6%

# Change in NY average LBMPs



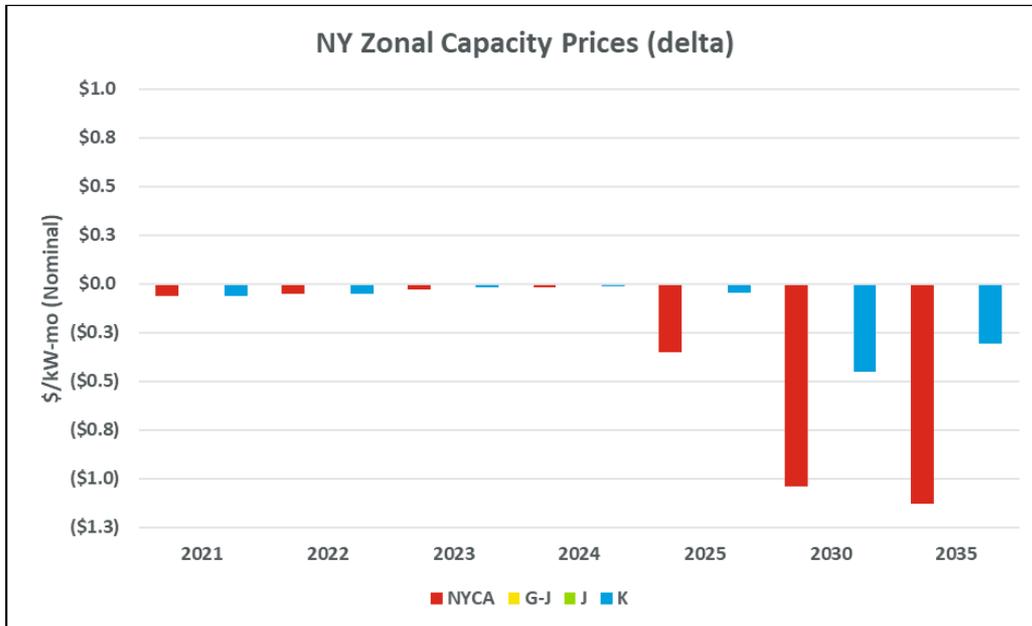
# Change in NY Zonal Average LBMPs

## NY Zonal Average LBMPs (% Delta)

ZONE	2021	2022	2023	2024	2025	2030	2035
A	106%	99%	107%	94%	93%	87%	95%
B	70%	68%	70%	67%	66%	65%	71%
C	69%	67%	69%	66%	65%	63%	68%
D	69%	67%	70%	67%	66%	63%	68%
E	69%	67%	69%	66%	65%	63%	68%
F	70%	71%	70%	72%	73%	65%	61%
G	67%	68%	67%	70%	69%	60%	54%
H	67%	68%	67%	70%	69%	60%	54%
I	67%	68%	67%	70%	69%	60%	54%
J	67%	68%	67%	70%	69%	60%	54%
K	64%	65%	64%	68%	66%	59%	54%

- Changes in average LBMPs in Eastern Zones (F-K) are about \$7 higher than Western Zones (A-E) over the study period

# Change in Zonal capacity prices



- The change in zonal capacity prices for all four regions remain about \$0 until 2030
- NYCA decreases by about \$1/kW-mo in 2030 and 2035

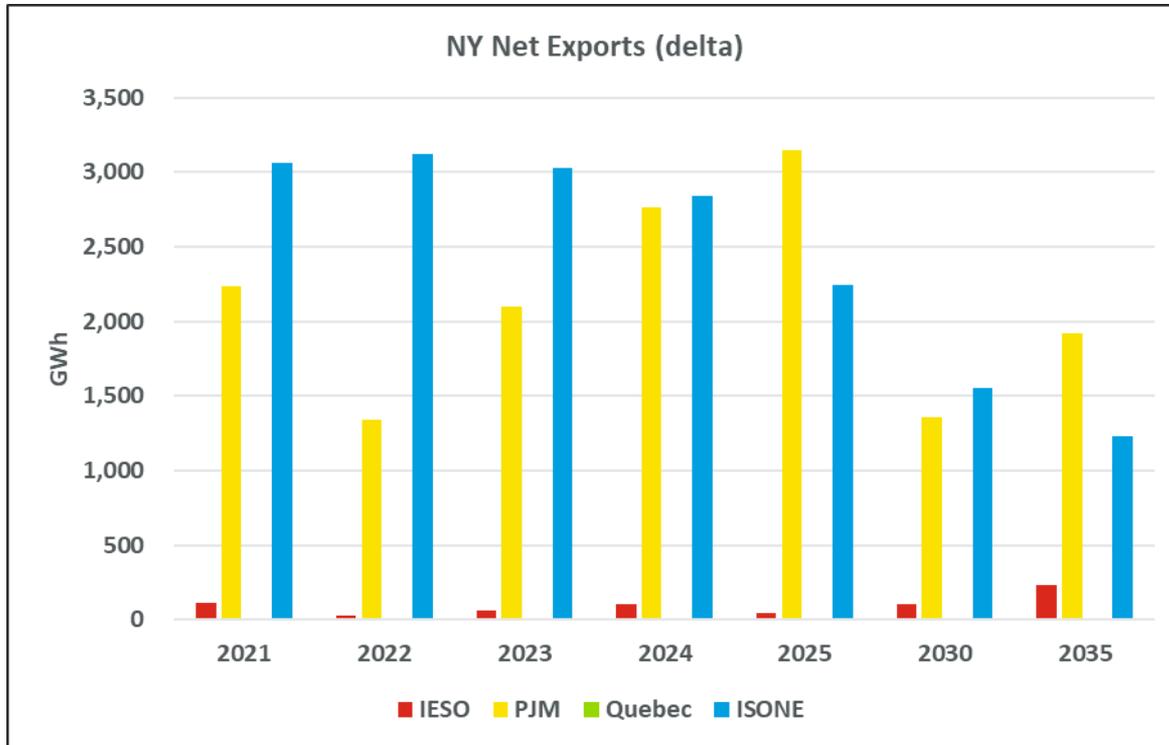
# Change in resource gross margin

## NY Gross Profit Margin\* (\$/kW, Delta)

TECH	New/ Existing	ZONE	2021	2022	2023	2024	2025	2030	2035
CC	New	C	\$14	\$11	\$8	\$11	\$10	\$11	\$10
CC	New	J	\$42	\$48	\$44	\$48	\$30	\$17	\$23
CT	New	J	\$13	\$10	\$9	\$7	\$6	\$15	\$19
SOLAR	New	C	\$0	\$28	\$30	\$31	\$29	\$22	\$22
WIND	New	D	\$59	\$51	\$53	\$55	\$52	\$57	\$60
OSW	New	J	\$0	\$0	\$0	\$0	\$97	\$124	\$175
BATTERY	New	J	\$0	\$0	\$0	\$0	\$3	\$11	\$14

\*Gross Profit Margin = Revenues minus Fuel Cost

# Change in net exports

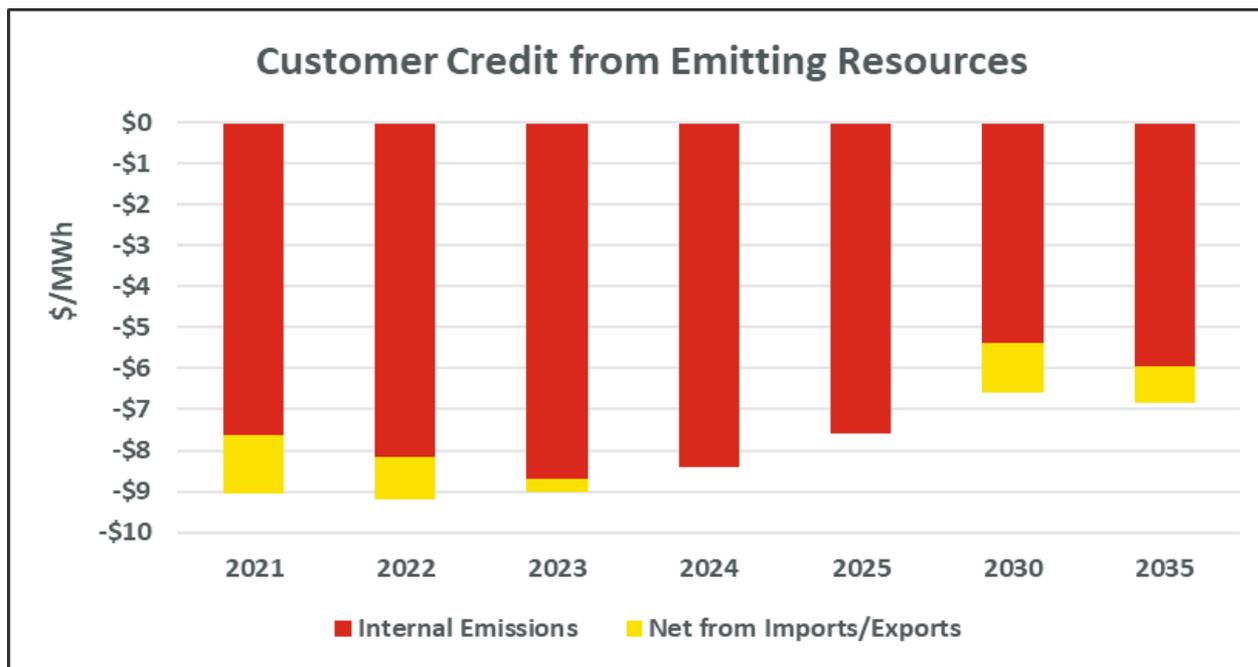


- Status Quo case benchmarks to recent history
- NY exports more to ISONE and imports less from IESO and PJM with a carbon charge

# Change in quantity and location of market-based entry

- Due to low capacity prices and large amount of renewables added to the system, it was determined that prices are too low to support new entry within the study period.

# Customer Credits from Emitting Resources



	Units	2021	2022	2023	2024	2025	2030	2035
NYCA internal carbon charges	\$M	\$1,181	\$1,234	\$1,289	\$1,291	\$1,242	\$781	\$896
Carbon charges on net import ties	\$M	\$218	\$156	\$49	-\$62	-\$156	\$177	\$134
Load	TWh	155	151	149	146	143	145	151
Internal Emissions	\$/MWh	-\$8	-\$8	-\$9	-\$8	-\$8	-\$5	-\$6
Net from Imports/Exports	\$/MWh	-\$1	-\$1	\$0	\$0	\$1	-\$1	-\$1

# BORDER CHARGES

# Carbon Charge Case Border Prices

## NY Average MCCs (2012 \$/MWh)

	2021	2022	2023	2024	2025	2030	2035
<b>MCC Approach A</b>							
East	\$20.66	\$20.09	\$19.93	\$21.08	\$20.42	\$20.10	\$22.01
West	\$16.78	\$15.45	\$16.09	\$15.62	\$14.69	\$14.07	\$15.85
<b>MCC Approach B (Alternative)</b>							
East	\$20.23	\$20.94	\$21.28	\$21.46	\$21.72	\$22.00	\$23.16
West	\$20.34	\$18.42	\$19.48	\$19.21	\$18.11	\$20.26	\$21.70

- East – average MCC assigned to Eastern NY zones with links to ISONE and Eastern PJM
- West – average MCC assigned to Western NY zones with links to IESO and Western PJM
- MCC mechanism is sensitive; small changes in dispatch can shift marginal unit emission rate and lead to large changes in net exports

# Carbon Charge Case Marginal Emission Rates

## NY Average Marginal Emission Rates (2012 tons/MWh)

	2021	2022	2023	2024	2025	2030	2035
<b>MCC Approach A</b>							
East	0.60	0.57	0.56	0.58	0.55	0.52	0.55
West	0.49	0.44	0.45	0.43	0.40	0.36	0.40
<b>MCC Approach B (Alternative)</b>							
East	0.59	0.60	0.59	0.59	0.59	0.57	0.58
West	0.59	0.52	0.54	0.53	0.49	0.52	0.54

- East – average marginal emission rates assigned to Eastern NY zones that have links to ISONE and Eastern PJM
- West – average marginal emission rates assigned to Western NY zones that have links to IESO and Western PJM
- Marginal emission rates are based on the marginal unit setting the MCC for each hour

# Impact of Modeling Approach

- Both MCC forecast methods result in greater net exports
- Daymark's application of the MCC mechanism does not assume friction-free trades at the borders
- Our method realistically reflects that hourly MCCs at the border may be greater or lesser than the "true" hourly values in any given hour
- Mismatches between the actual carbon costs of other NY generators and the forecast carbon charges will cause volatility along the NY border

# STUDY METHODOLOGY

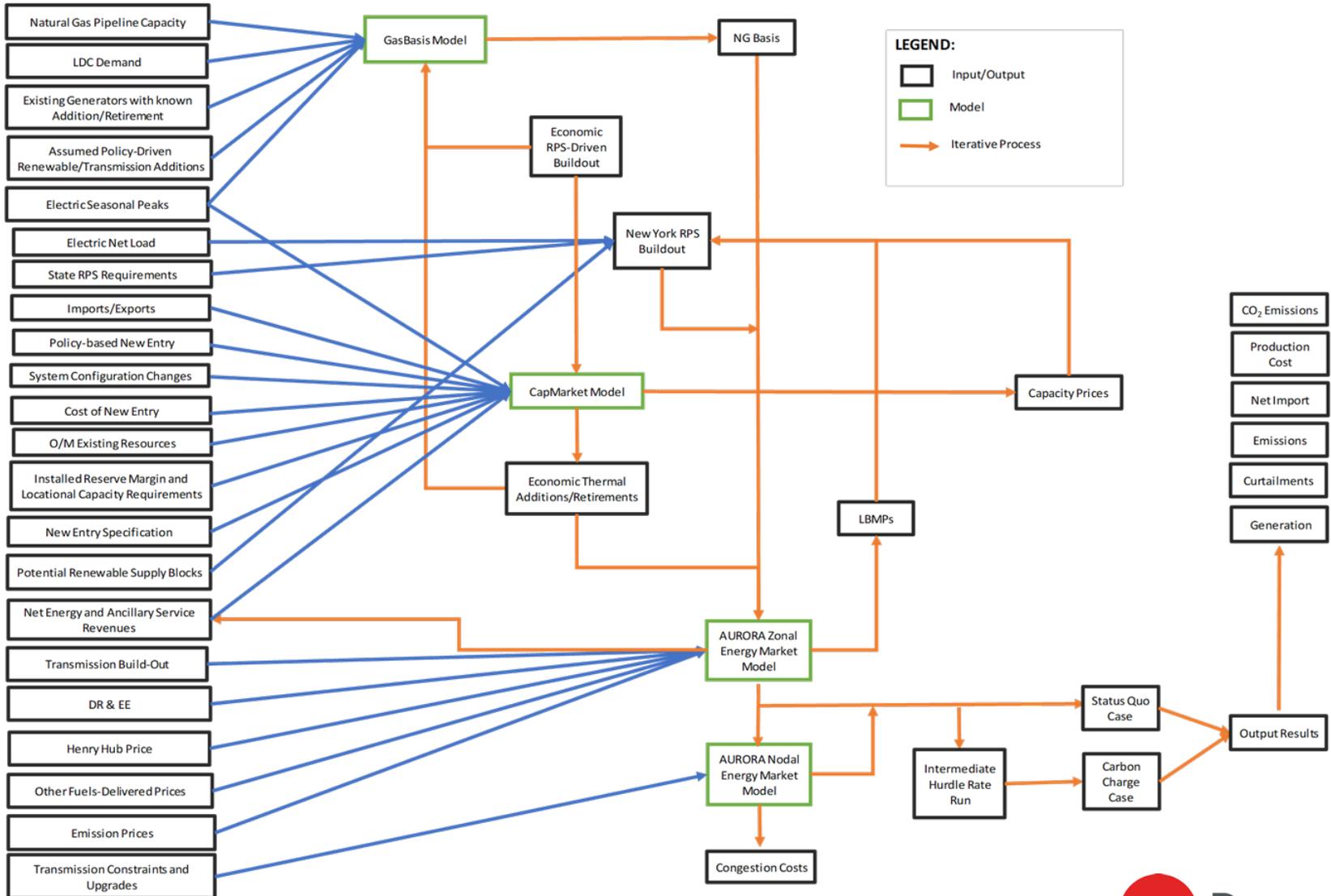
# Models

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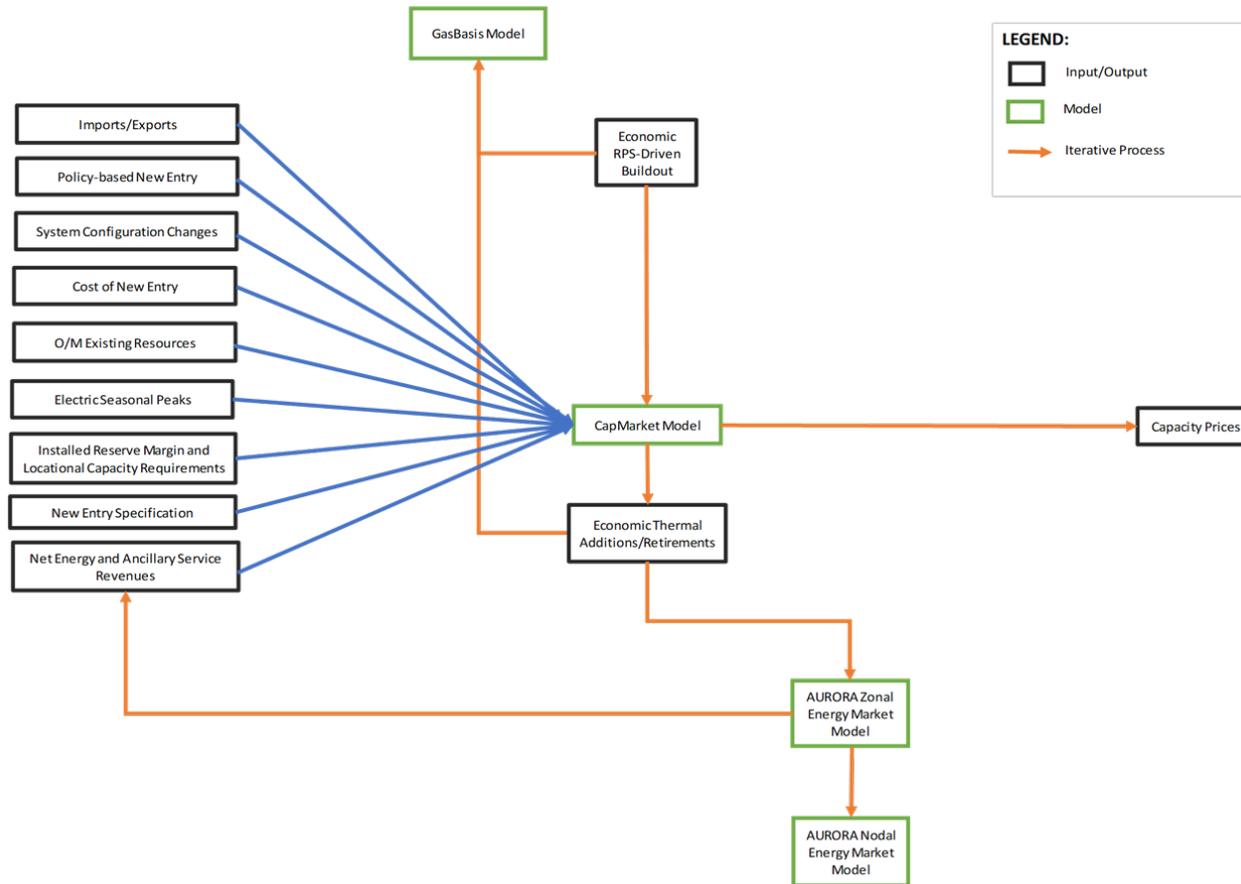
<b>DaymarkEA CapMarket Model</b>	Simulates NYISO capacity auctions to forecast capacity prices and economic entry and exit
<b>DaymarkEA GasBasis Model</b>	Simulates natural gas basis prices at market trading locations based on supply and demand and delivery constraints
<b>EPIS AURORA Zonal Model</b>	Zonal level (bubble and pipe representation) production cost model run hourly to simulate economic dispatch of power plants within a competitive framework
<b>EPIS AURORA Nodal Model</b>	Nodal level production cost model that includes the full system topology down to individual level nodes and transmission lines run hourly to simulate security constrained economic dispatch of power plants within a competitive framework

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# Carbon charge analysis schematic



# CapMarket Model schematic



# Create demand and supply curves

- Update Demand Curve characteristics (IRM, LCR, CONE and Reference Points)
  - NYCA IRM assumed to be around 18% across study period
  - Adjust for net Energy and Ancillary Service revenues
- Create supply curve
  - Estimate going forward costs for new and existing units
  - Incorporate Must Offer Renewables – Federal and State incentives
  - Estimate net imports (Note impact of expected prices in neighboring regions)

# Simulate ICAP market and assess incremental changes

- The model outputs zonal capacity prices
- Add/remove resources based on historical behavior
  - Resources do not enter and exit solely based on capacity market spot prices
  - Uneconomic units tend to delay exit
  - New resources tend to enter the market at prices below administrative net CONE
- Iterative process: added and retired resources are inputs for the AURORA Models and resulting power sector gas demand in GasBasis Model



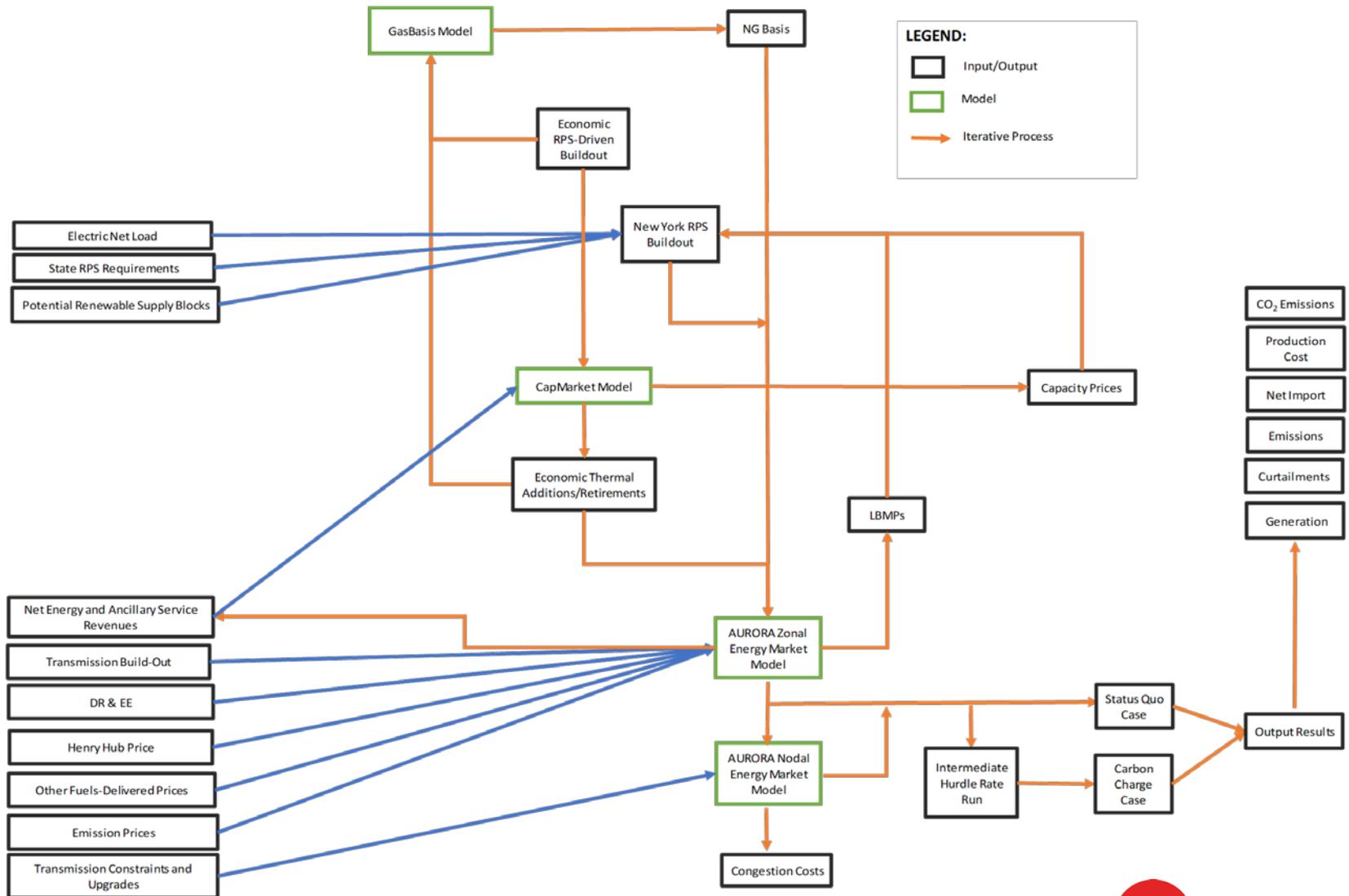
# Forecast natural gas basis against Henry Hub for NY market trading locations

- Forecast basis prices for pricing locations: Algonquin Citygate, NY Transco Zone 6, TETCO M3, Iroquois Zone 2, and Dominion South
- Input natural gas pipeline capacity, LDC demand, electric demand, imports and renewable additions, historical natural gas basis
- Calculate available natural gas pipeline capacity based on forecasted natural gas supply and demand for relevant trading regions

# Forecast delivered natural gas prices

- Simulate future basis prices
- Power sector gas demand is linked to AURORA-modeled gas-fired generation and is adjusted by iteration
- Add basis prices to Henry Hub prices
- Zonal gas prices for generation in NY assume the gas trading point weights from the most recent CARIS study

# AURORA Zonal and Nodal Model schematic



# Build New York energy market at the zonal level

- Inputs: demand, transmission, renewables, fuel prices, new and existing resources
- Model topology: NY and neighboring control areas consistent with 2018 IRM Study
  - NY is divided into 11 zones (A-K)
  - NY interfaces to PJM, ISONE, Ontario, and HydroQuebec
  - Nested interface constraints
- Outputs: hourly production data and clearing prices for each zone

# Simulate New York energy market at the zonal level

- Iterative process:
  - Net Energy and Ancillary Service revenues are output to CapMarket Model
  - AURORA Zonal Model receives economic-based resource entry and exit from the CapMarket Model
  - Power sector gas demand is input to the GasBasis Model
  - Natural gas prices input to AURORA Zonal Model
- Run models and produce outputs for the Status Quo case

# Marginal Carbon Charge (MCC) border adjustment

- NYISO proposes to post a forecast of carbon charges to be applied to DA and RT transactions
- Dynamic modeling of this proposal is infeasible
- We estimate a schedule of border charges, rather than fixing net imports
- Approach approximates impact of charges on external transactions
- Border adjustment charges are estimated in two stages

# Stage 1

- All carbon emitting resources are charged the Gross Social Cost of Carbon (SCC) on CO<sub>2</sub> emissions
- Model is run to simulate commitment and dispatch with “universal” carbon charge
- NYISO Upstate (Zones A-F) and Downstate (Zones G-K) proxy marginal units are identified for each hourly interval
- The emission rate for the proxy unit times the net SCC (Gross SCC minus RGGI price) is recorded as the marginal cost of carbon (MCC) for each hourly period

# Stage 2

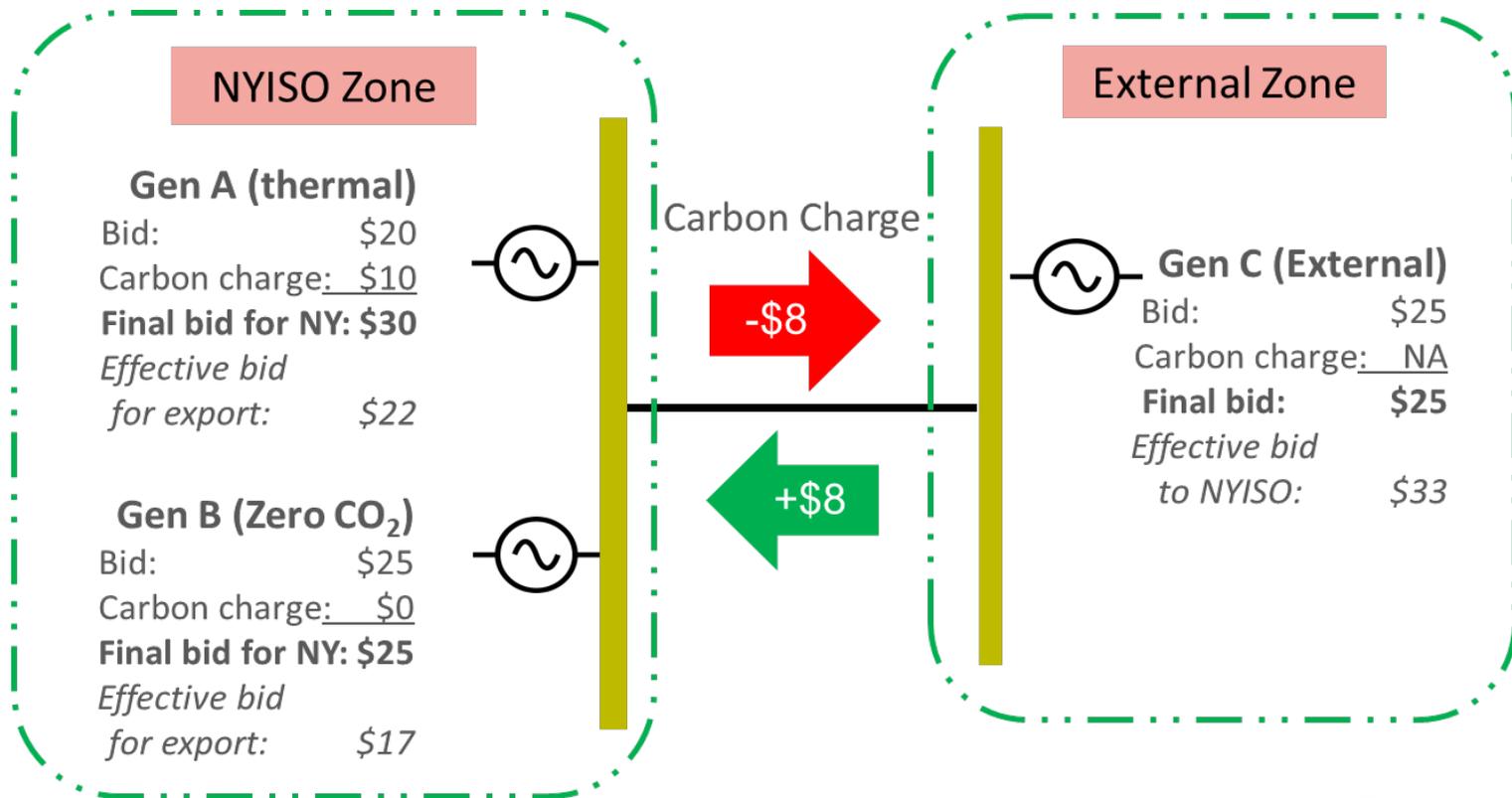
- Hourly schedule of MCCs (\$/MWh) from Stage 1 is input border adjustments between NYISO and external zones
  - Positive adjustments for flows into NYISO zones
  - Negative adjustments for flows out of NYISO zones
- Carbon charges are removed for external resources (only RGGI as applicable remains)
- NYISO resources are charged gross SCC on CO<sub>2</sub> emissions
- Model run to simulate commitment and dispatch for Approach A

# Alternative MCC border adjustment

- To evaluate the sensitivity of the results to MCC modeling approach, an alternative MCC border adjustment approach (Approach B) is evaluated
- Stage 1: Emissions rates of proxy marginal units are identified for each hourly interval from the Status Quo case and then multiplied by the SCC to establish the schedule of border charges fed to the next stage
- Stage 2: The model is rerun assuming the carbon charges are in place in NYISO with the stage 1 border charges

# Example of Carbon Charge Modeling

- For interval, Marginal Cost of Carbon (MCC) in Stage 1 was \$8/MWh. This becomes the Border Adjustment on interfaces connecting the NYISO zone to the external zone in that interval
- Imports into NY *add* Border Adjustment to offers
- Exports from NY *subtract* Border Adjustment from offers



# Nodal modeling

## Simulate New York energy market at the bus level and assess incremental changes

- Evaluate changes in congestion, technical curtailments, and LBMPs due to changes in power flow with a carbon charge
- All inputs and iterative modeling used with the AURORA Zonal Model plus complete transmission topology
- Requires mapping injection and withdrawal points to pricing nodes
- Run a security constrained economic commitment and dispatch
- We examine 2030 at the nodal level

# INPUT ASSUMPTIONS

# Common assumptions

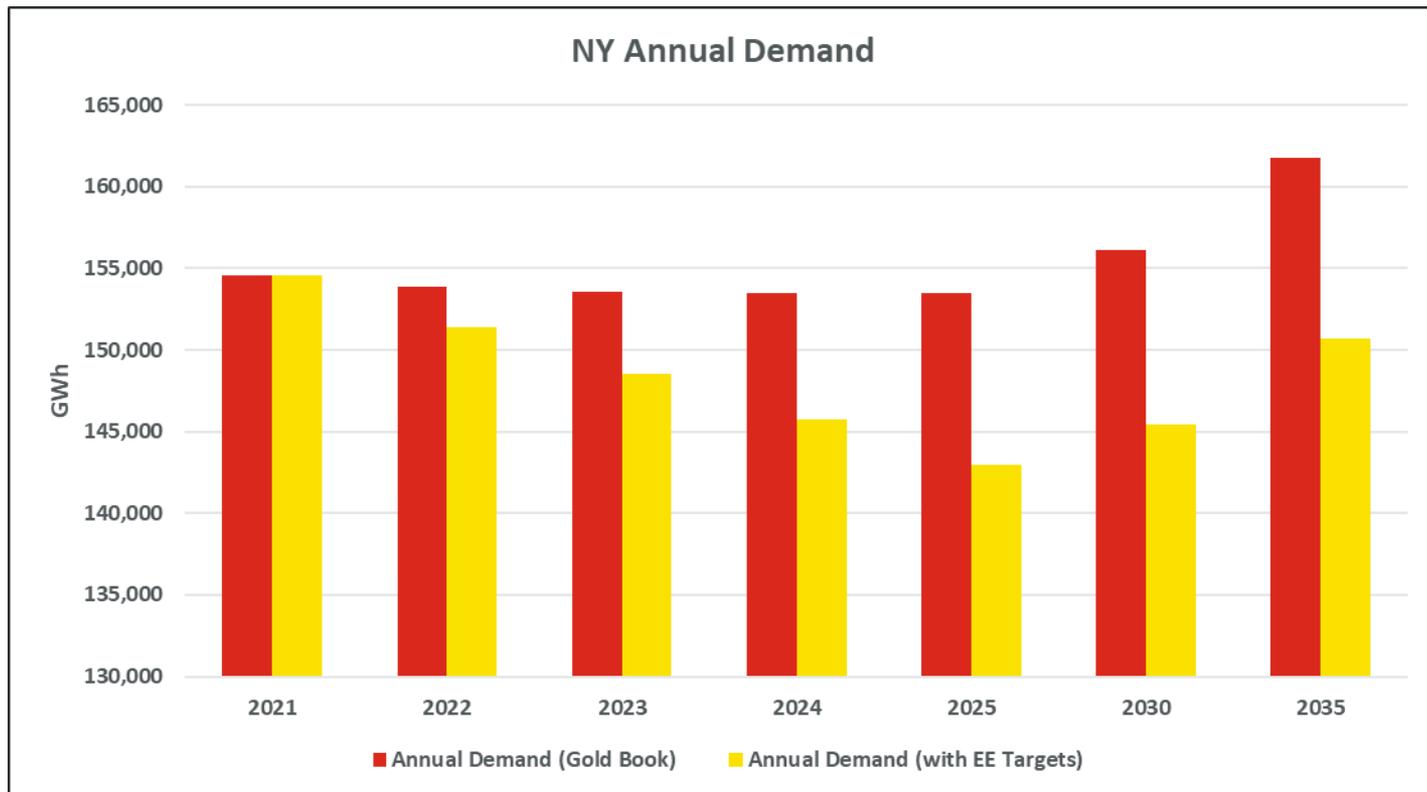
- Demand Net of BTM/EE (Peak and Base) (2018 Gold Book/NYISO EE Assumptions by 2025)
- Internal/External Transmission (2018 Gold Book)
- Existing Capacity and Specific New Units (2018 Gold Book)
- Renewable Buildout (CARIS Shift Case adjusted to include new off-shore wind and EE targets)
- Fixed O&M for existing resources (SNL Financial)
- Capital and operating costs of new technologies (2018 AEO)
- Installed Reserve Margin and Locational Capacity Requirements (NYISO ICAP Manual-Demand Curve Reset)
- Planned Retirements (2018 Gold Book)
- Oil Prices (NYISO Assumptions)
- Henry Hub prices (Futures prices escalated at 2018 AEO growth rate)
- Historical spot natural gas indexes (SNL Financial)
- Pipeline capacity, historical LDC and power sector natural gas demand (SNL Financial)
- Solar Shapes (NREL PV Watts)
- Onshore Wind Shapes (NREL SAM)
- Offshore Wind Shape (NREL SAM)
- Emission Prices – RGGI and SCC (NYISO)

# Nodal Model assumptions

- Power Flow Inputs and Topology (FERC 715 Base Case)
- Interface Definitions and Limits (Reliability Needs Assessment Report and NYCA IRM Report)
- Future Transmission Upgrades (Gold Book and System Planning Studies)
- Future Generation and Network Upgrades (Gold Book, Interconnection Queue, and System Planning Studies)
- Transmission buildout only includes firm upgrades (same as NYISO)
- All interface transmission upgrades and renewable additions to meet 50 by 30 goals will be part of this model for both case runs

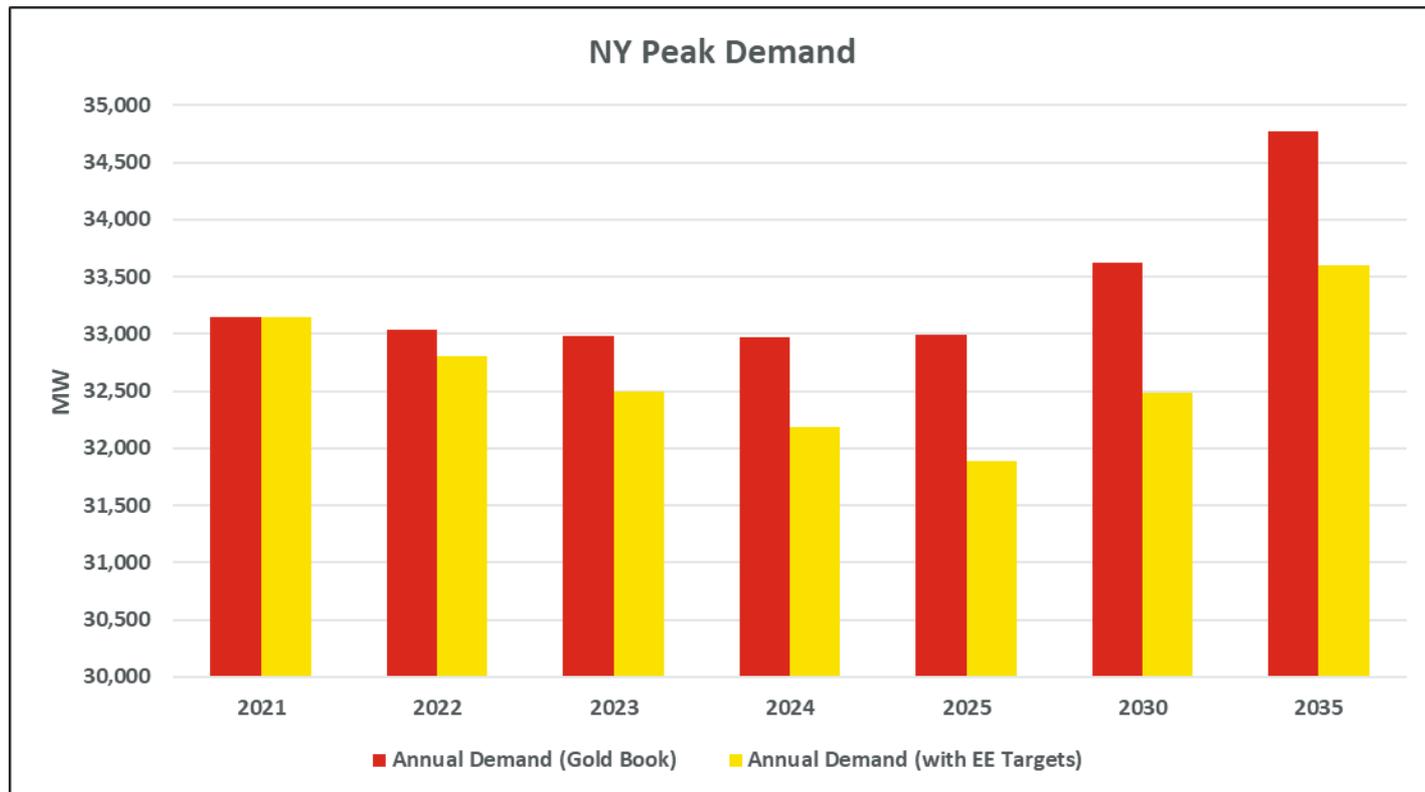
# Annual energy load

- Annual energy load from 2018 Gold Book net of EE and BTM
- Quantity of energy efficiency is increased from the baseline load forecast in 2018 Gold Book to reach NY State reduction target of 3% by 2025 (matches NYISO forecast)



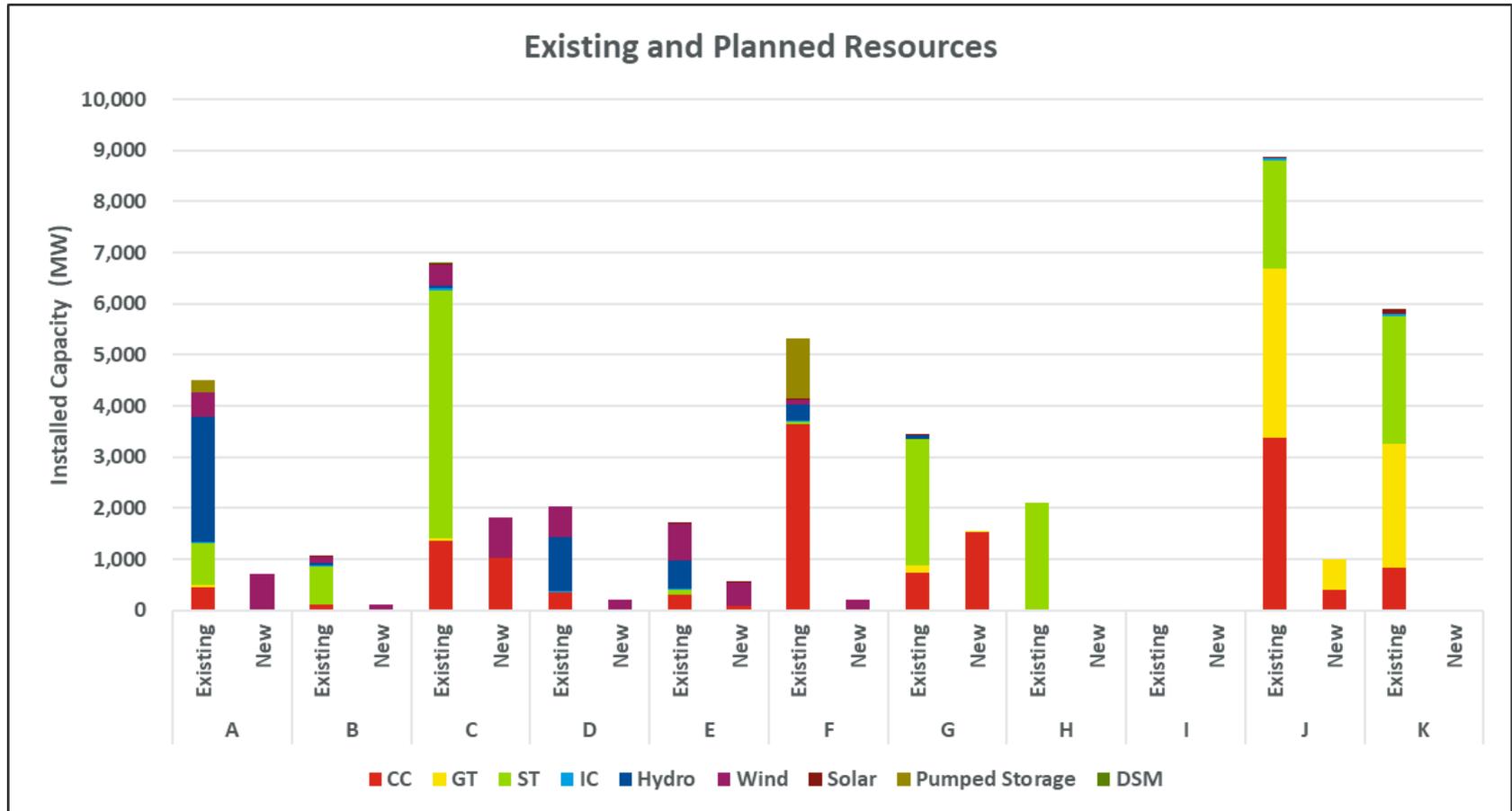
# Annual peak demand

- Annual peak demand from 2018 Gold Book net of EE and BTM
- Energy efficiency is increased from the baseline forecast in 2018 Gold Book to reach NY State reduction target of 3% by 2025 (Matches NYISO Forecast)



# Existing and planned resources

- Per 2018 NYISO Gold Book for capacity MW, type, and location existing and planned resources in NYCA



# Planned retirements

<b>NAME</b>	<b>NAMEPLATE CAPACITY (MW)</b>	<b>ZONE</b>	<b>FUEL</b>	<b>RETIREMENT YEAR</b>
Ravenswood (GT7)	22	J	Natural Gas	2017
Hawkeye Energy Greenport LLC	54	K	Kerosene	2018
Hofstra University (GEN1)	1.1	K	Natural Gas	2019
Hofstra University (GEN2)	1.1	K	Natural Gas	2019
Indian Point 2	1,299	H	Nuclear	2020
Indian Point 3	1,012	H	Nuclear	2021

We assume all coal units retire before start of study period.

# Renewable and storage additions

- Three types of renewable resources are added in the model to achieve the 50 by 30 policy:
  - Land-based wind energy resources
  - Offshore wind energy resources
  - Utility-scale solar energy resources
- After 2030, we add renewable resources sufficient to meet approximately 50% of the incremental annual energy load.
- Offshore wind is added in Zone J and Zone K
- Battery energy storage systems each with 4 hours of energy storage capability are added to Zones C, F, and J in 2020 and 2025.

<b>YEAR</b>	<b>BATTERY STORAGE ADDED IN ZONE C (MW)</b>	<b>BATTERY STORAGE ADDED IN ZONE F (MW)</b>	<b>BATTERY STORAGE ADDED IN ZONE J (MW)</b>
2025	125	125	250
2030	250	250	500

# Renewable and storage additions (cont'd)

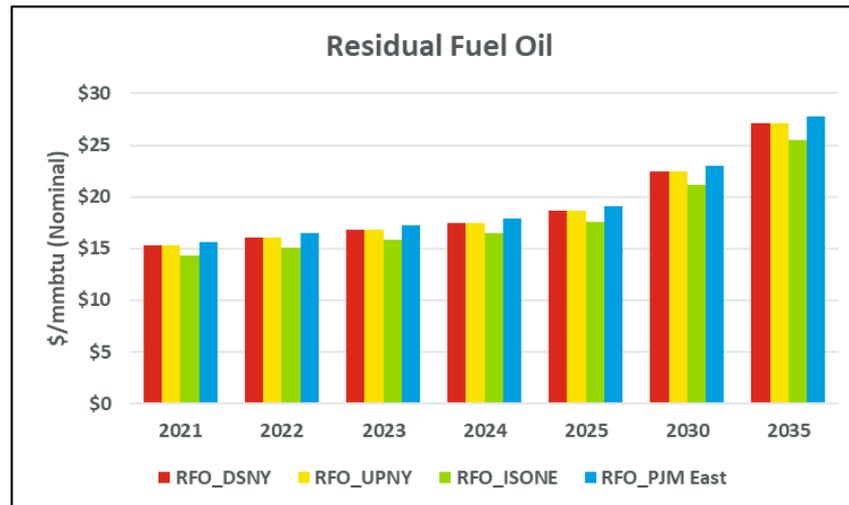
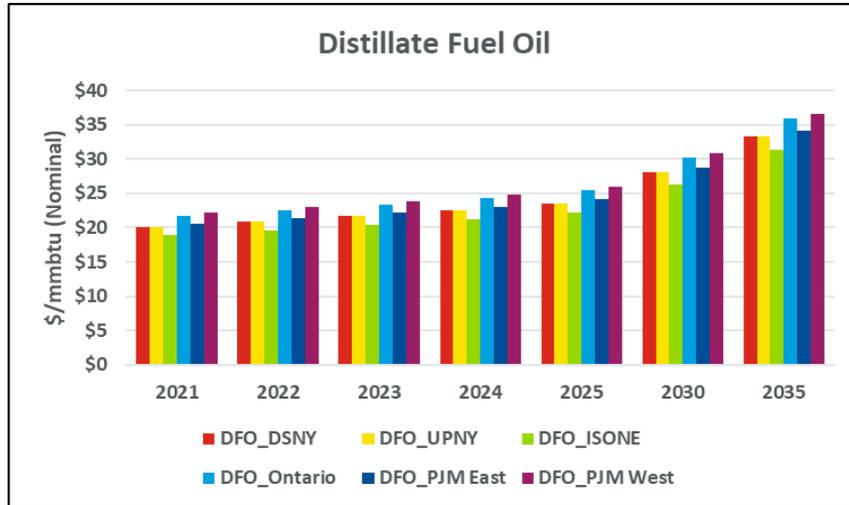
TECHNOLOGY	NAMEPLATE CAPACITY <sup>2</sup> (MW)	ANNUAL CAPACITY FACTOR (%)	COMMENTS
Utility-Scale Solar	11,189	20%	
Land-Based Wind	1,976	35%	Only added in Zones A, C, E, F, G
Offshore Wind	2,400	45%	Only added in Zone J and Zone K
Battery Energy Storage <sup>1</sup>	1500	NA	

YEAR	OFFSHORE WIND ADDED IN ZONE J <sup>2</sup> (MW)	OFFSHORE WIND ADDED IN ZONE K <sup>2</sup> (MW)
2025	500	300
2030	1,100	500

<sup>1</sup> Battery Energy Storage base assumptions being revised to reflect storage roadmap

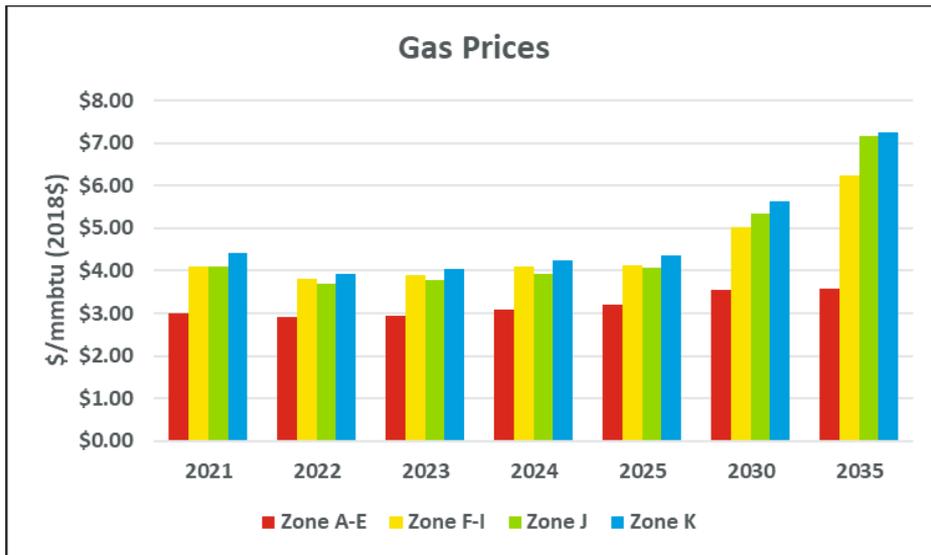
<sup>2</sup> 2020 – 2035 Renewable Buildout Total Nameplate (MW)

# Oil prices



- We use NYISO's assumption through 2030
- After 2030, prices increase at rate equal to 2020 – 2030 CAGR:
  - Distillate Fuel Oil prices increase at 3.5% per year
  - Residual Fuel Oil prices increase at 3.8% per year

# Gas prices



- Modeled gas basis for Transco Zone 6 NY, TETCO M3, Iroquois Zone 2, Dominion South, and Algonquin Citygate
- Added calculated basis to Henry Hub
- Zonal gas prices use weights assumed in CARIS study

# Planned gas pipeline buildout

<b>PROJECT</b>	<b>PIPELINE</b>	<b>MMcf/d</b>
CPV Valley Lateral Project	Millennium Pipeline	127
New Market Project	Dominion Transmission	82
Atlantic Bridge Project	Algonquin Gas Transmission	133
Eastern System Upgrade Project	Millennium Pipeline	223
Lambertville-East Project	Texas Eastern Transmission	180

# Carbon prices

## Gross and Net Social Cost of Carbon in nominal \$/US-ton

<b>YEAR</b>	<b>GROSS SCC</b>	<b>RGGI</b>	<b>NET SCC</b>
2020	\$47	\$6	\$42
2021	\$48	\$6	\$42
2022	\$50	\$7	\$44
2023	\$53	\$7	\$46
2024	\$55	\$8	\$47
2025	\$57	\$8	\$49
2026	\$60	\$9	\$51
2027	\$63	\$10	\$53
2028	\$65	\$10	\$55
2029	\$67	\$11	\$55
2030	\$69	\$12	\$57
2031	\$72	\$13	\$59
2032	\$75	\$14	\$61
2033	\$78	\$15	\$63
2034	\$81	\$16	\$65
2035	\$84	\$18	\$66

# APPENDIX

# Change in NY Zonal Production Costs

## Load Weighted NY Zonal Allocation of Total Production Cost (in nominal \$M, Delta)

<b>ZONE</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>
A	\$86	\$85	\$87	\$84	\$77	\$46	\$65
B	\$55	\$55	\$56	\$54	\$50	\$29	\$42
C	\$89	\$88	\$91	\$87	\$80	\$47	\$68
D	\$34	\$34	\$35	\$34	\$31	\$18	\$26
E	\$43	\$42	\$44	\$42	\$39	\$23	\$33
F	\$66	\$66	\$68	\$65	\$60	\$35	\$51
G	\$54	\$53	\$55	\$53	\$49	\$29	\$41
H	\$16	\$16	\$17	\$16	\$15	\$9	\$13
I	\$33	\$33	\$34	\$33	\$30	\$18	\$25
J	\$293	\$289	\$299	\$288	\$264	\$156	\$224
K	\$115	\$114	\$117	\$113	\$104	\$61	\$88
<b>NY Total</b>	<b>\$885</b>	<b>\$874</b>	<b>\$903</b>	<b>\$869</b>	<b>\$799</b>	<b>\$472</b>	<b>\$677</b>

Gross production costs not net of carbon charge residuals

# Change in NY CO<sub>2</sub> emissions

## NY Zones Carbon Dioxide Emissions (Million Metric Tons, Delta)

<b>ZONE</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>
A	22	3	16	(6)	(11)	(20)	(9)
B	13	9	10	7	5	7	9
C	272	294	365	332	270	218	251
D	101	79	91	84	69	2	2
E	(147)	(164)	(165)	(162)	(161)	(4)	16
F	713	578	629	655	621	449	401
G	183	148	105	332	298	18	62
H	(24)	(31)	(36)	(33)	(32)	(18)	0
I	0	0	0	0	0	0	0
J	722	634	694	745	701	154	261
K	117	24	60	49	34	95	96

# Change in NY Zonal Average LBMPs

## NY Zonal Average LBMPs (\$/MWh, Delta)

ZONE	2021	2022	2023	2024	2025	2030	2035
A	\$20	\$19	\$20	\$20	\$19	\$21	\$26
B	\$19	\$18	\$19	\$19	\$18	\$21	\$26
C	\$20	\$18	\$19	\$19	\$18	\$20	\$26
D	\$19	\$18	\$19	\$19	\$18	\$20	\$26
E	\$20	\$18	\$19	\$19	\$18	\$21	\$26
F	\$23	\$24	\$24	\$25	\$25	\$27	\$32
G	\$24	\$24	\$24	\$26	\$25	\$29	\$36
H	\$24	\$24	\$24	\$26	\$26	\$29	\$36
I	\$24	\$24	\$24	\$26	\$26	\$30	\$37
J	\$24	\$24	\$24	\$27	\$26	\$30	\$37
K	\$24	\$24	\$24	\$26	\$26	\$30	\$37

- Changes in average LBMPs in Eastern Zones (F-K) are about \$7 higher than Western Zones (A-E) over the study period

# QUESTIONS

# Thank you

## Let's continue the conversation

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