New York ISO
Independent System Operator

Emissions Transparency – Market Design Complete

Leila Nayar

Associate Market Design Specialist

Energy Market Design

ICAP/MIWG

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Agenda

- Background
- Implied Marginal Emission Rates
- Average Emission Rates
- Publication/Documentation
- Next Steps

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Background

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Background

- The Emissions Transparency project is a stakeholder requested project to publish marginal and average zonal emissions rates along with the LBMPs on a DAM and RT basis.

- We are targeting a 2023 Functional Requirements Specification (FRS) by the end of Q4.

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Definitions

- Marginal Emission Rates ("MER"): Change in CO2 emissions resulting from an increase in generation or consumption.
- Average Emissions Rates ("AER"): Total change in CO2 emissions resulting from total increase in generation or consumption.
- NYCA: New York Control Area
- RT: Real Time
- DAM: Day-Ahead Market
- NG: Natural Gas
- RTD: Real Time Dispatch
- RTD-CAM: Real Time Dispatch-Corrective Action Mode

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Recap from Previous MIWGs

- 4/17: Implied Marginal Emission Rates (IMER) Proposed Design
  - Stakeholders were satisfied with proposed IMER methodology.
  - There was a request that we also publish for DAM which we are planning to post as well.
- 7/27: Implied Marginal Emission Rates (IMER) Inputs' Walkthrough
  - Stakeholders were satisfied with the walkthrough of the inputs for the IMER methodology.
  - Stakeholders voiced concern with the proposal not to publish AERs.
- 10/3: Average Emission Rates (AER) Proposal
  - Stakeholders requested that NOx emission rates be added to the AER publications.
  - Stakeholders requested that the NYCA-Wide AER Calculation account for imports.

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Implied Marginal Emission Rates (IMERs)

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Implied Marginal Emission Rates (IMERs)

- IMER values will be estimated on a zonal level for RT and DAM, as tons of CO_2 and NO_x per MWh of generation.
- LBMP, fuel prices, emission costs and variable operating & maintenance ("VOM") costs will be used as inputs to estimate the implied heat rate.
  - The upper and lower boundaries for the implied heat rate will be set by using the minimum and maximum implied heat rates.
- This implied heat rate will then be used to estimate the Implied MERs based on the implied marginal fuel.
- The implied marginal fuel will be determined to be liquid fuel or natural gas based on which fuel price is lower after the implied marginal gas fuel type is estimated for the zones based on limiting constraints mapped to reserve regions and historical analysis.
  - Limiting constraints identify persistent congestion patterns and thus enable IMERs to be calculated on a more granular level than NYCA-wide

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IMER Proposed Methodology

$$Implied\ Heat\ Rate\ (IHRi) = \frac{(LBMP\left(\frac{\$}{MWh}\right) - VOM\left(\frac{\$}{MWh}\right))}{Fuel\ Price\left(\frac{\$}{mmBTU}\right) + Emissions\ Cost\ \left(\frac{\$}{mmBTU}\right)}$$

$$Implied\ Heat\ Rate\ (IHRj) = 0\ if\ (IHRi < IHRmin)\ Else\ IHRmax\ if\ (IHRi > IHRmax)\ else\ IHRi$$

$$Implied\ Marginal\ Emission\ Rate\ (IMER) = Tons\ of\ CO_2\ or\ NO_x\ per\ mmbtu * IHRj$$

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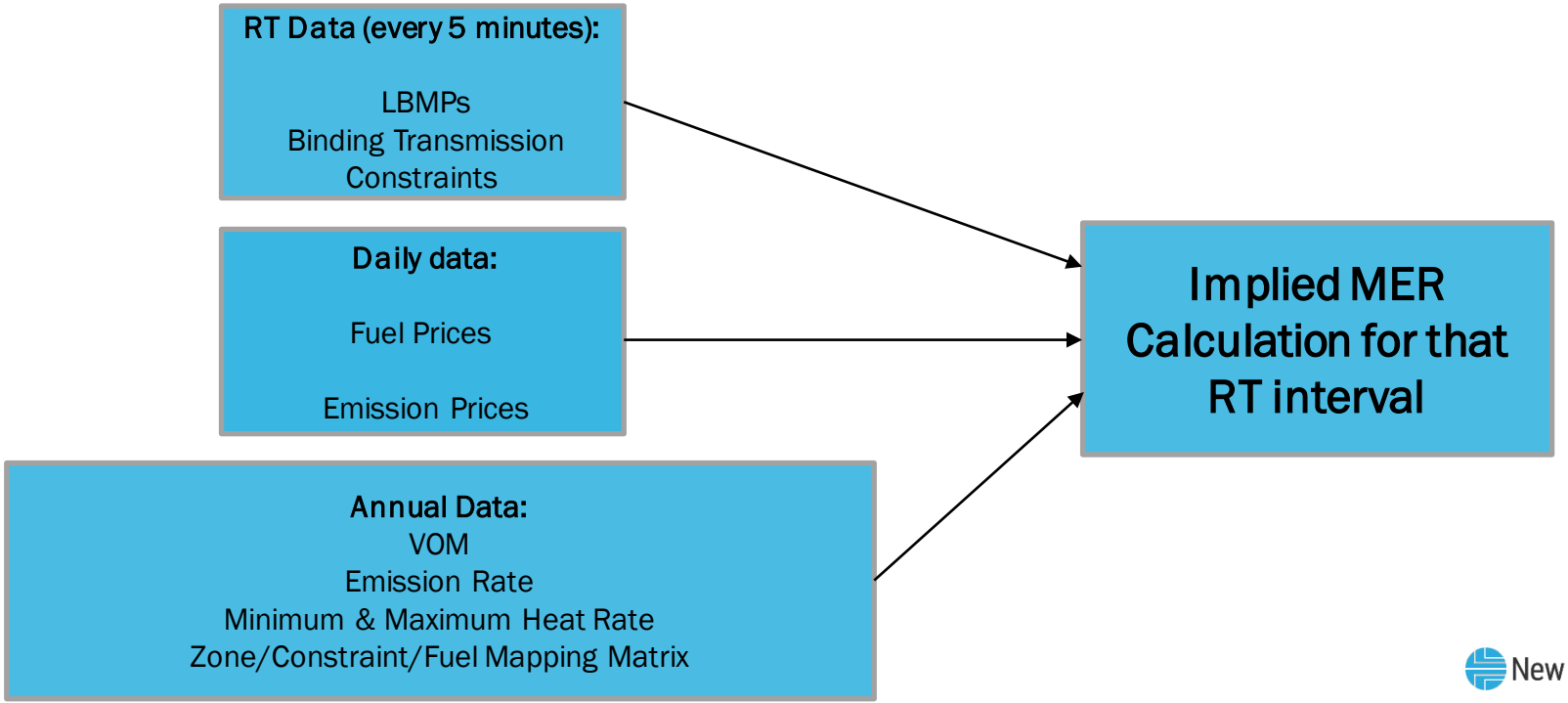
Proposed Methodology (For RT)



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Example IMER Calculation

LBMP ($/MWh)	$50
Fuel Price ($/mmBTU) *(Marg. Fuel is NG)*	$4.5
Variable Operating and Maintenance Cost ("VOM") ($/MWh)	$4
Tons of Carbon per mmBTU *(for NG)*	0.059
Tons of NO_x per mmBTU *(for NG)*	0.000087
Emissions Cost ($/mmBTU)	$2.36
Implied Heat Rate (mmBTU/MWh)	($50 - $4)/($4.5 + $2.36) = 6.71
CO_2 IMER (tons per MWh)	6.71 * 0.059 = 0.40
NO_x IMER (tons per MWh)	6.71 * 0.000087 = 0.00058

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Average Emission Rates (AERs)

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Average Emission Rates (AERs)

- Based on stakeholder feedback, NYISO proposes to calculate:
  - CO_2 and NO_x Average Emission Rates (AERs)
  - NYCA-wide and for the NYC Load Zone
- AER values will be hourly average tons of CO_2 and NO_x per MWh of generation.
- Both AER calculations will use:
  - RT Fuel Mix data (location specific)
  - Fuel-specific CO_2 and NO_x content (tons CO_2 and NO_x per MWh)
  - Location-specific Average Heat Rate by fuel type (mmbtu/MWh)
  - Import data (NYISO will provide import MW, user input feature will allow users to provide import emission intensity values)

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Input Data

Fuel Type	CO_2 /NO_x Emitting	CO_2 Content (tons per mmbtu)	NO_x Content (tons per mmbtu)	NYCA Heat Rate (mmbtu/ MWh)	NYC Heat Rate (mmbtu/ MWh)	Rest-of-NYCA Heat Rate (mmbtu/MWh)
Natural Gas	Yes	0.059	0.000087	9.7	12.4	8.7
Dual Fuel	Yes	0.061	0.000089	12.9	14.2	11.1
Other Fossil Fuels	Yes	0.119	0.00013	12.5	16.7	12.2
Nuclear	No	0	0	0	0	0
Wind	No	0	0	0	0	0
Hydro	No	0	0	0	0	0
Other Renewables	No	0	0	0	0	0

- Fuel Types are taken from the NYISO's RT Fuel Mix data.
- Dual Fuel CO_2 and NO_x content determined through analysis (see slide 15).
- Average Heat Rate and NO_x content determined through analysis.
  - Average by fuel type
- Natural gas and liquid fuel CO_2 content from EIA:
  - Natural gas
  - Liquid fuel

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Dual Fuel Historical Analysis

- A historical analysis was performed on the ratio of natural gas vs. liquid fuel usage by dual fuel units in the months of January, July, and September of 2022.
- The resulting percentages were used to determine assumed CO_2 and NO_x contents for dual fuel units in the calculation of the AER, which will be calculated and updated annually.

Fuel Type	Percentage	CO_2 Content (tons per mmBtu)	NO_x Content (tons per mmbtu)
Natural Gas	95.5%	0.059	0.000087
Liquid Fuel	4.5%	0.119	0.00013

$$CO_2\ Content = (0.95 * 0.059) + (0.045 * 0.119)$$

$$\boldsymbol{CO_2\ Content = 0.061\ tons/mmbtu}$$

$$NO_x\ Content = (0.95 * 0.000087) + (0.045\ *\ 0.00013)$$

$$\boldsymbol{NO_x\ Content = 0.000089\ tons/mmbtu}$$

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NYCA-Wide Calculation

$$AER_{h,NYCA} = \frac{Emissions_{h,NYCA} + Emissions_{h,HQ} + Emissions_{h,ISEO} + Emissions_{h,ISO-NE} + Emissions_{h,PJM}}{\sum(Generation_{h,NYCA}, Imports_{h,HQ,ISEO,ISO-NE,PJM})}$$

- **$Emissions_{h,NYCA}$ represents the emissions from NYCA's generation mix.**
  - Calculated by summing the product of each emitting fuel types CO_2 and NO_x contents, hourly MW, and average heat rate.
- **$Emissions_{h,HQ}$, $Emissions_{h,IESO}$, $Emissions_{h,ISO-NE}$ and $Emissions_{h,PJM}$ represent the carbon emissions from imports into NYCA from HQ, ISEO, ISO-NE, and PJM, respectively.**
  - Calculated by multiplying the hourly import value (MW) by emissions intensity (tons CO_2 and NO_x per MWh).
- **NYCA generation and import values will be updated by the NYISO on an hourly basis.**
- **CO_2 and NO_x contents and average heat rate for each fuel type will be updated on an annual basis.**
- **Users of the calculator will input the import CO_2 and NO_x intensity values to create the resulting output AER.**

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Definition of Imports into NYCA

- **NYCA Imports from HQ**
  - MSC/7040 path
- **NYCA Imports from IESO**
  - Ontario East – North (Zone D), Ontario South – West (Zone A)
- **NYCA Imports from ISO-NE**
  - North (Zone D) – ISONE, Capital (Zone F) – ISONE, Hudson Valley (Zone G) – ISONE
- **NYCA Imports from PJM**
  - PJM East – NYC (Zone J), PJM West – Central (Zone C), PJM West – West (Zone A), PJM East – Hudson Valley (Zone G), PJM (Rockland Electric) – Hudson Valley (Zone G)

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Example: NYCA-Wide CO_2 Calculation

Fuel Type Category	Generation (MW)	Carbon Content (tons CO_2/mmBtu)	Heat Rate (mmbtu/ MWh)
Dual Fuel	2700	0.061	12.9
Natural Gas	1900	0.059	9.7
Other Fossil Fuels	5	0.119	12.5
Non-Emitting Resources	6800	N/A	N/A
Total	11405	-	-

	HQ	IESO	ISO-NE	PJM
Emissions intensity (tons CO_2/MWh)	0	0.2	0.2	0.3
Import Value (MW)	1000	1000	1000	1000

**User Input Value*

$$Emissions_{h,NYCA} = (2700 * 0.061 * 12.9) + (1900 * 0.059 * 9.7) + (5 * 0.119 * 12.5) = 3219.44 \text{ tons } CO_2$$

$$Emissions_{h,HQ} = 0 * 1000 = 0 \text{ tons } CO_2$$

$$Emissions_{h,IESO} = 0.2 * 1000 = 200 \text{ tons } CO_2$$

$$Emissions_{h,ISEO-NE} = 0.2 * 1000 = 200 \text{ tons } CO_2$$

$$Emissions_{h,PJM} = 0.3 * 1000 = 300 \text{ tons } CO_2$$

$$\sum(Generation_{h,NYCA}, Imports = 11405 + 1000 + 1000 + 1000 + 1000 = 15405 \text{ MW}$$

$$AER_{h,NYCA} = \frac{3219.44 + 200 + 200 + 300}{15405} = \mathbf{0.25 \text{ tons } CO_2 \text{ per MWh}}$$

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Example: NYCA-Wide NO_x Calculation

Fuel Type Category	Generation (MW)	NO_x Content (tons NO_x/mmBtu)	Heat Rate (mmbtu/ MWh)
Dual Fuel	2700	0.000089	12.9
Natural Gas	1900	0.000087	9.7
Other Fossil Fuels	5	0.00013	12.5
Non-Emitting Resources	6800	N/A	N/A
Total	11405	-	-

	HQ	IESO	ISO-NE	PJM
Emissions intensity (tons NO_x/MWh)	0	0.0002	0.0002	0.0003
Import Value (MW)	1000	1000	1000	1000

**User Input Value*

$$Emissions_{h,NYCA} = (2700 * 0.000089 * 12.9) + (1900 * 0.000087 * 9.7) + (5 * 0.00013 * 12.5) = 4.71 \text{ tons } NO_x$$

$$Emissions_{h,HQ} = 0 * 1000 = 0 \text{ tons } NO_x$$

$$Emissions_{h,IESO} = 0.0002 * 1000 = 0.2 \text{ tons } NO_x$$

$$Emissions_{h,ISEO-NE} = 0.0002 * 1000 = 0.2 \text{ tons } NO_x$$

$$Emissions_{h,PJM} = 0.0003 * 1000 = 0.3 \text{ tons } NO_x$$

$$\sum(Generation_{h,NYCA}, Imports = 11405 + 1000 + 1000 + 1000 + 1000 = 15405 \text{ MW}$$

$$AER_{h,NYCA} = \frac{4.71 + 0.2 + 0.2 + 0.3}{15405} = \mathbf{0.00035 \text{ tons } NO_x \text{ per MWh}}$$

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NYC Calculation

$$AER_{h,NYC} = \frac{Emissions_{h,NYC} + Emissions_{h,Rest\ of\ NYCA} + Emissions_{h,PJM} + Emissions_{h,HQ}}{\sum(Generation_{h,NYC}, Imports)}$$

- **$Emissions_{h,NYC}$ represents the emissions from NYC's generation mix.**
  - Calculated by summing the product of each carbon-emitting fuel types CO_2 or NO_x content, hourly MW, and heat rate.
- **$Emissions_{h,Rest\ of\ NYCA}$ represents the emissions from the Rest of NYCA.**
  - Calculated by summing the product of each carbon-emitting fuel types CO_2 or NO_x content, hourly MW, and heat rate; along with the product of each import's emission intensity (tons CO_2 or NO_x per MWh) and import value (MW).
- **$Emissions_{h,PJM}$ and $Emissions_{h,HQ}$ represent the emissions from imports into NYC from PJM and from HQ, respectively.**
  - Calculated by multiplying the hourly import value (MW) by emission intensity (tons CO_2 or NO_x per MWh).
- **NYC generation, NYC and Rest of NYCA generation mix, and import values will be updated within the calculator by the NYISO on an hourly basis.**
- **CO_2 and NO_x content and average heat rate for each fuel type will be updated on an annual basis.**
- **Users of the calculator will input the import CO_2 and NO_x intensity values to create the resulting output AER.**

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Definition of Imports into NYC

- **NYC imports from NYCA**
  - Flow on Sprain Brook-Dunwoodie South interface from Upstate
  - Flow on Jamaica-Valley Stream and Jamaica-Lake Success lines from Long Island
- **NYC imports from PJM**
  - MW sink into NYC from Linden VFT, Marion-Farragut, Hudson-Farragut, Linden Goethals, HTP
- **NYC imports from HQ (expected)**
  - MW sink into NYC from Champlain-Hudson Power Express

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Definition of Imports into Rest-of-NYCA

- **NYCA Imports from HQ**
  - MSC/7040 path
- **NYCA Imports from IESO**
  - Ontario East – North (Zone D), Ontario South – West (Zone A)
- **NYCA Imports from ISO-NE**
  - North (Zone D) – ISONE, Capital (Zone F) – ISONE, Hudson Valley (Zone G) – ISONE
- **NYCA Imports from PJM**
  - PJM West – Central (Zone C), PJM West – West (Zone A), PJM East – Hudson Valley (Zone G), PJM (Rockland Electric) – Hudson Valley (Zone G)

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Example: NYC CO_2 Calculation

$$AER_{h,NYC} = \frac{Emissions_{h,NYC} + Emissions_{h,Rest\ of\ NYCA} + Emissions_{h,PJM} + Emissions_{h,HQ}}{\sum(Generation_{h,NYC}, Imports)}$$

Fuel Type Category	Rest-of-NYCA Fuel Mix (MW)	Carbon Content (tons CO_2/mmBtu)	Rest-of-NYCA Heat Rate (mmbtu/MWh)
Dual Fuel	1500	0.061	11.1
Natural Gas	1000	0.059	8.7
Other Fossil Fuels	0	0.119	12.2
Non-Emitting	6000	N/A	N/A
Total	8500	-	-

	Emissions Intensity (tons CO_2/MWh)	Import Value (MW)
HQ	0	1000
IESO	0.21	1000
ISO-NE	0.22	1000
PJM	0.23	500

**User Input Value*

$$Emissions\ Intensity_{h,Rest\ of\ NYCA} = \frac{(1500 * 0.061 * 11.1) + (1000 * 0.059 * 8.7) + (0.21 * 1000) + (0.22 * 1000) + (0.23 * 500)}{8500 + 3500}$$

$$Emissions\ Intensity_{h,Rest\ of\ NYCA} = 0.17 \text{ tons } CO_2 \text{ per MWh}$$

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Example: NYC CO_2 Calculation (Cont.)

Fuel Type Category	NYC Generation (MW)	Carbon Content (tons CO_2/mmBtu)	NYC Heat Rate (mmbtu/MWh)
Dual Fuel	1000	0.061	14.3
Natural Gas	800	0.059	12.4
Other Fossil Fuels	5	0.119	16.7
Non-Emitting	195	N/A	N/A
Total	2000	-	-

	Emissions Intensity (tons CO_2/MWh)	Import Value (MW)
Rest of NYCA	0.17	1000
HQ	0	1000
PJM	0.23	500

**User Input Value*

$$Emissions_{h,NYC} = (1000 * 0.061 * 14.3) + (800 * 0.059 * 12.4) + (5 * 0.119 * 16.7) = 1466.79 \text{ tons of } CO_2$$

$$Emissions_{h,Rest\ of\ NYCA} = 1000 * 0.17 = 170 \text{ tons } CO_2$$

$$Emissions_{h,PJM} = 500 * 0.23 = 115 \text{ tons } CO_2$$

$$Emissions_{h,HQ} = 1000 * 0 = 0 \text{ tons } CO_2$$

$$AER_{h,NYC} = \frac{1466.79 + 170 + 115 + 0}{1000 + 1000 + 500 + 2000} = \mathbf{0.39\ tons\ CO_2\ per\ MWh}$$

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Example: NYC NO_x Calculation

$$AER_{h,NYC} = \frac{Emissions_{h,NYC} + Emissions_{h,Rest\ of\ NYCA} + Emissions_{h,PJM} + Emissions_{h,HQ}}{\sum(Generation_{h,NYC}, Imports)}$$

Fuel Type Category	Rest-of-NYCA Fuel Mix (MW)	NO_x Content (tons NO_x/mmBtu)	Rest-of-NYCA Heat Rate (mmbtu/MWh)
Dual Fuel	1500	0.000089	11.1
Natural Gas	1000	0.000087	8.7
Other Fossil Fuels	0	0.00013	12.2
Non-Emitting	6000	N/A	N/A
Total	8500	-	-

	Emissions Intensity (tons NO_x/MWh)	Import Value (MW)
HQ	0	1000
IESO	0.0002	1000
ISO-NE	0.0002	1000
PJM	0.0003	500

**User Input Value*

$$Emissions\ Intensity_{h,Rest\ of\ NYCA} = \frac{(1500 * 0.000089 * 11.1) + (1000 * 0.000087 * 8.7) + (0.0002 * 1000) + (0.0002 * 1000) + (0.0003 * 500)}{8500 + 3500}$$

$$Emissions\ Intensity_{h,Rest\ of\ NYCA} = 0.00023 \text{ tons } NO_x \text{ per MWh}$$

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Example: NYC NO_x Calculation (Cont.)

Fuel Type Category	NYC Generation (MW)	NO_x Content (tons NO_x/mmBtu)	NYC Heat Rate (mmbtu/MWh)
Dual Fuel	1000	0.000089	14.3
Natural Gas	800	0.000087	12.4
Other Fossil Fuels	5	0.00013	16.7
Non-Emitting	195	N/A	N/A
Total	2000	-	-

	Emissions Intensity (tons NO_x/MWh)	Import Value (MW)
Rest of NYCA	0.00023	1000
HQ	0	1000
PJM	0.0003	500

**User Input Value*

$$Emissions_{h,NYC} = (1000 * 0.000089 * 14.3) + (800 * 0.000087 * 12.4) + (5 * 0.00013 * 16.7) = 2.15 \text{ tons } NO_x$$

$$Emissions_{h,Rest\ of\ NYCA} = 1000 * 0.00023 = 0.23 \text{ tons } NO_x$$

$$Emissions_{h,PJM} = 500 * 0.0003 = 0.15 \text{ tons } NO_x$$

$$Emissions_{h,HQ} = 1000 * 0 = 0 \text{ tons } NO_x$$

$$AER_{h,NYC} = \frac{2.15 + 0.23 + 0.15 + 0}{1000 + 1000 + 500 + 2000} = \mathbf{0.00056 \text{ tons } NO_x \text{ per MWh}}$$

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Publication/Documentation

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Publication/Documentation

- IMER and AER data will be published under a new “Emissions Data” page within the Energy Market and Operations Data page on the NYISO’s public website.
- On this page, there will be a document explaining the calculations and inputs to provide transparency and clarity on what these values represent.

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Next Steps

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Next Steps

- Return to Stakeholders for BIC
- Functional Requirements Specifications – Target Date Q4 2023

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Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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Appendix

New York ISO

NYISO-IESO Lines

IESO (Ontario)-NYISO		
Ontario East (Zone O) – North (Zone D)		
Name	**Line ID**	**Voltage (kV)**
St. Lawrence-Moses*	L33P	230
St. Lawrence-Moses*	L34P	230
Ontario South (Zone O) – West (Zone A)		
Beck-Niagara*	PA301	345
Beck-Niagara*	PA302	345
Beck-Niagara*	PA27	230
*Beck-Packard	BP76	230

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NYISO-ISONE Lines

North (Zone D) – ISONE (Zone N)		
Name	**Line ID**	**Voltage (kV)**
*Plattsburgh-Sand Bar	PV20	115
Capital (Zone F) – ISONE (Zone N)		
*Alps-Berkshire	393	345
Eastover-Bear Swamp*	E205W	230
*Hoosick –Bennington	K6	115
*Whitehall-Blissville	K7	115
Hudson Valley (Zone G) – ISONE (Zone N)		
*Cricket Valley-Long Mountain	398	345
Smithfield-Salisbury*	690/FV	69

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NYISO-ISONE Lines cont.

- **Northport-Norwalk Harbor Cable (NNC) Interconnection**
  - NNC Intertie (138 kV AC)
- **Cross Sound Cable (CSC) Interconnection**
  - CSC Intertie (150+/- kV HVDC)

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NYISO-PJM Lines

PJM East (Zone P) – NYC (Zone J)		
Name	**Line ID**	**Voltage (kV)**
Marion-Farragut*	C3403	345
Hudson-Farragut*	B3402	345
Linden-Goethals*	A2253	230
PJM West – Central (Zone C)		
*Mainesburg-Watercure	30	345
*Mainesburg-Homer City	47	345
*Homer City-Mainesburg	47	345
E. Towanda-Hillside*	70	230
Laurel Lake-Goudey*	952	115
*E. Sayre-N. Waverly	956	115
PJM West – West (Zone A)		
*Pierce Brook-Five Mile Road	37	345
*Pierce Brook-Homer City	48	345
*Homer City-Pierce Brook	48	345
Erie East-South Ripley*	69	230
*Warren-Falconer	171	115

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NYISO-PJM Lines Cont.

PJM East (Zone P) – Hudson Valley (Zone G)		
Hopatcong-Ramapo*	5018	500
*Waldwick-S. Mahwah	J3410	345
*Waldwick-S. Mahwah	K3411	345
PJM (Rockland Electric) – Hudson Valley (Zone G)		
*Closter-Sparkill	751	69
*Harings Corners- W. Nyack	701	69
*Harings Corners-Corporate Drive	703	138
*Montvale-Bluehill	44	69
*Montvale-Bluehill	43	69
*Montvale-Pearl River	491	69
*Harings Corners- Pearl River	45	34
*S. Mahwah-Ramapo	51	138
*S. Mahwah-Hilburn	65	69
S. Mahwah 138*/345	BK258	138/345

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NYISO-PJM Lines Cont.

- **PJM-Neptune**
  - Sayreville-Newbridge (500 kV HVDC)
- **PJM-HTP**
  - Bergen-West 49th St. (345 kV HVDC)

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NYC – Rest-of-NYCA Lines

SPRAIN BROOK-DUNWOODIE SOUTH		
Dunwoodie (Zone I) – NYC (Zone J)		
Name	**Line ID**	**Voltage (kV)**
*Dunwoodie-Mott Haven	71	345
*Dunwoodie-Mott Haven	72	345
Sprain Brook-Tremont*	28	345
*Sprain Brook-West 49th Street	M51	345
*Sprain Brook-West 49th Street	M52	345
*Dunwoodie-Sherman Creek	99031	138
*Dunwoodie-Sherman Creek	99032	138
*Dunwoodie-East 179th Street	99153	138

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