Exelon Alternative Border Adjustment Methodology

May 2021

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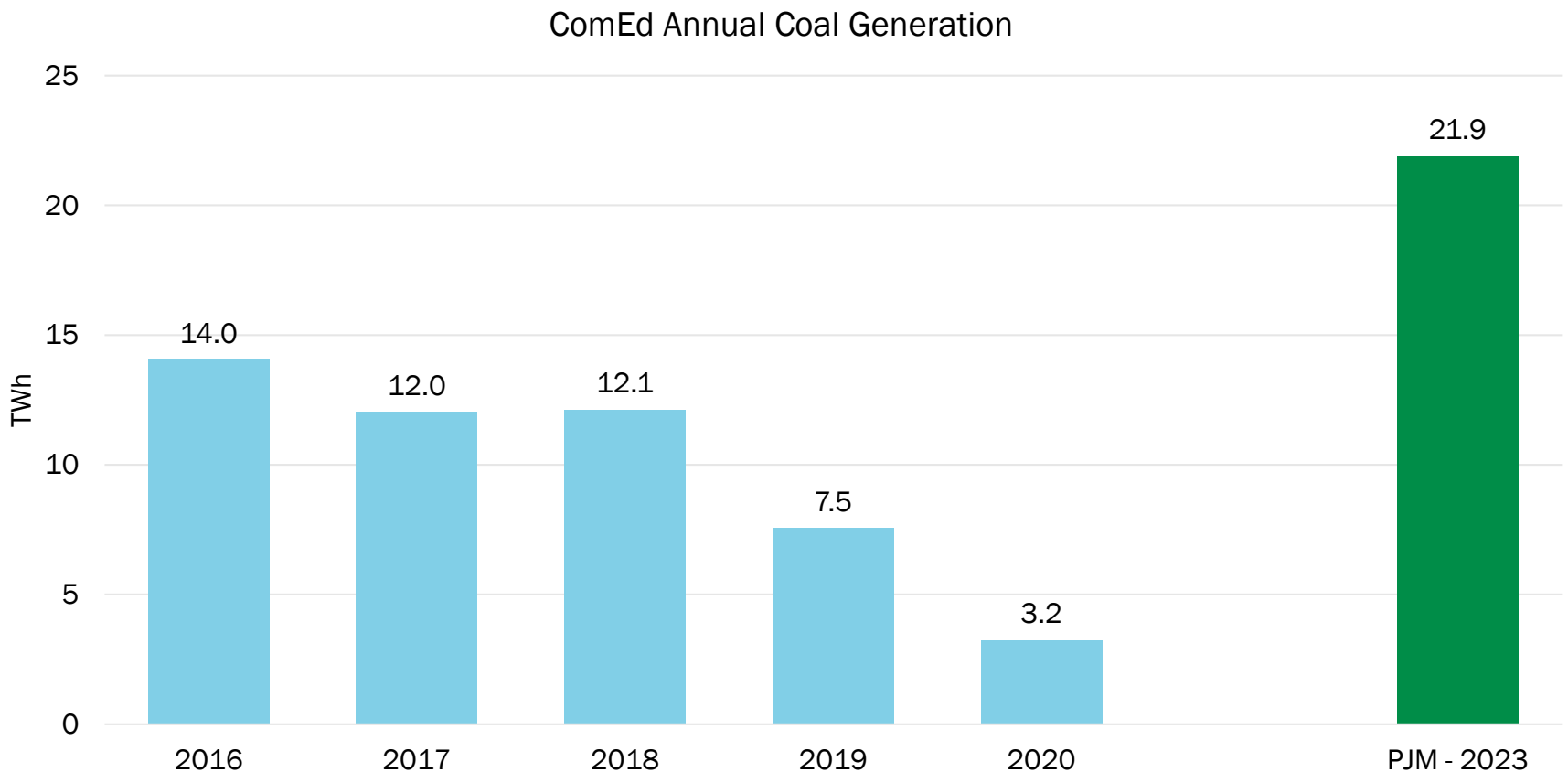
ComEd Coal Generation is Above Historical Levels



Note: PJM values represent an average of the ComEd generation from the scenarios that include a carbon price of $0/ton or $6.88/ton (scenarios 1-0W, 4-0W, 4-1W, 4-2W, 6-0W, 6-1W, 6-2W, 8-0W, 8-1W, 8-2W, 12-0W, 16-0W, 16-1W, 16-2W).

- Data above were included in the expanded results dataset released on 1/19/2021

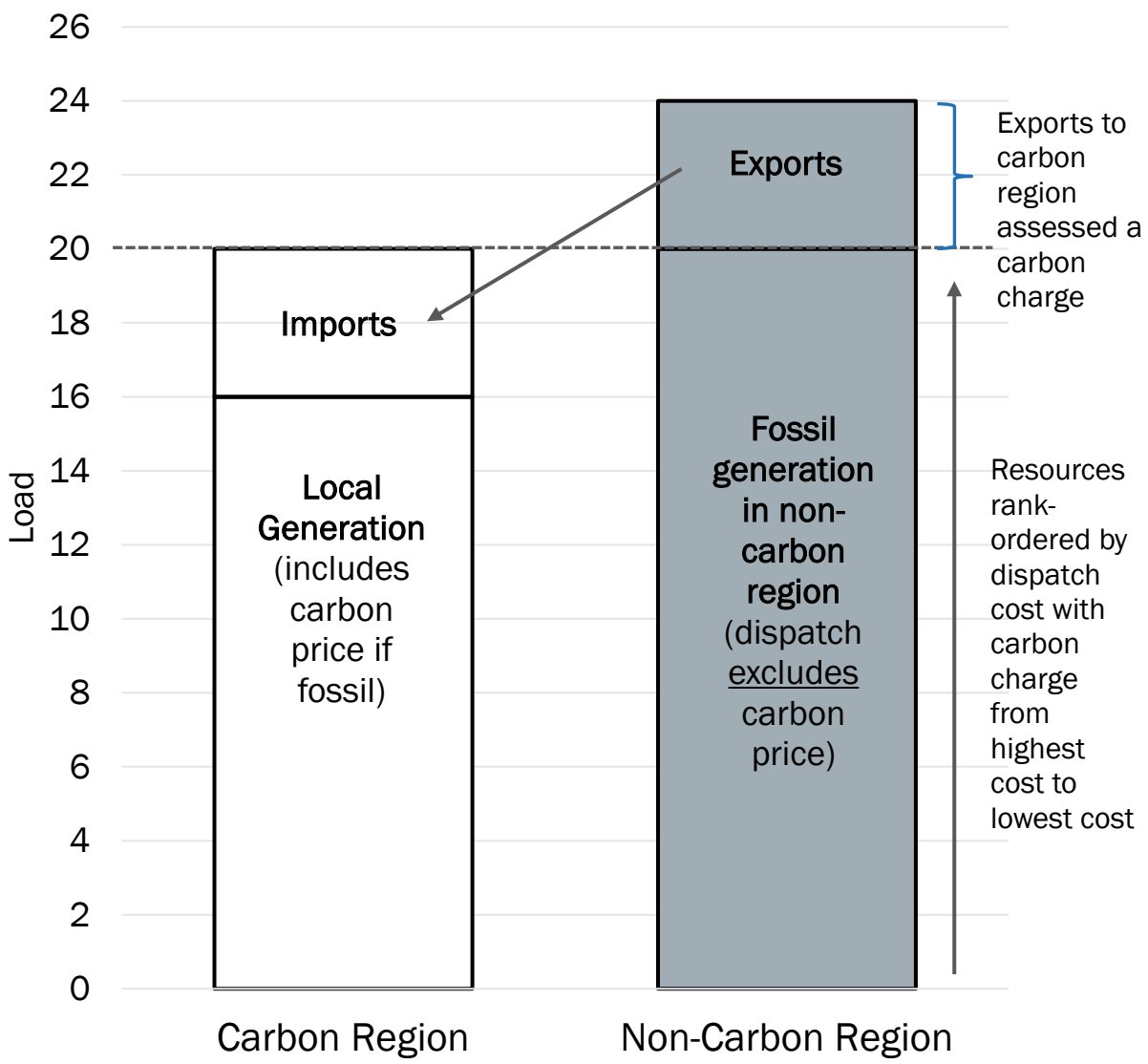
PJM 1-Way Border Adjustment Methodology

One-Way Border Adjustment Case in PLEXOS

- Carbon-Price Sub-Region:
  - Each fossil fuel generator was restricted to use only the fuel that included the cost of carbon emissions.
- Rest of RTO Sub-Region:
  - Each fossil fuel generator was allowed to use either fuel available to it.
- Border Adjustment Constraint:
  - A custom constraint was added to the model that restricted the amount of generation from fossil fuel generators using fuels that did not include the cost of carbon emissions to the amount of load in the Rest of RTO sub-region.

Source: *PJM Study of Carbon Pricing & Potential Leakage Mitigation Mechanisms Example Problem Formulations*, Carbon Pricing Senior Task Force, February 25, 2020.

PJM 1-Way Border Adjustment Methodology – Example 1



- The border adjustment constraint is essentially a balancing constraint
- In this example, all generation in the carbon region is fossil
- Fossil generation in non-carbon region exceeds load in non-carbon region
- Any fossil generation in non-carbon region that exceeds non-carbon region load is assumed to be imported into carbon region and assessed a carbon charge
- The optimization will rank order the carbon-region resources from highest cost to lowest cost. Units with the lowest cost will deemed as exporters
- The border adjustment constraint functions independently of the topology of the system

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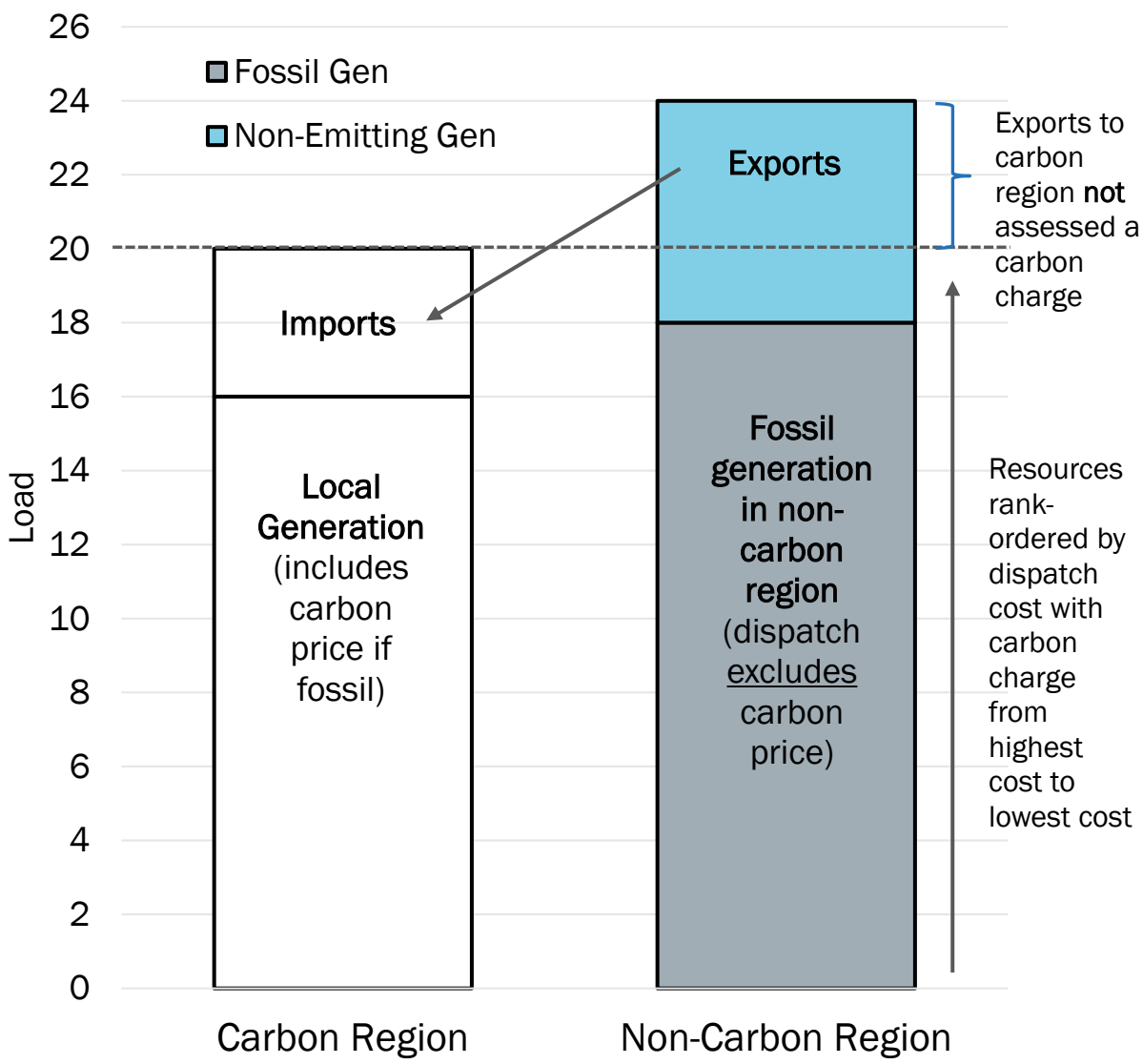
PJM 1-Way Border Adjustment Methodology – Example 2



- Fossil generation in non-carbon region exceeds load in non-carbon region
- This methodology is based on resource shuffling
- Non-emitting resources are "deemed" as exporters from carbon region to non-carbon region in order to minimize total system costs
- Resource shuffling is *just another type of leakage*

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Alternative Approach Based on NYISO Carbon Proposal

Objectives

- Apply a consistent carbon charge to all energy consumed by carbon region loads
- Apply a charge to imports based on the marginal resources serving carbon region loads
- Avoid undue disruption to market design

Delayed two-pass approach

- The RTO tracks aggregate net imports/exports into the carbon region on a continuous basis
- The carbon costs of net imports = carbon price x marginal emission rate x net import volume
- Marginal emission rate is a constant value that may be updated periodically
- Because carbon import costs are included in the objective function, LMPs and resource dispatch system-wide will be consistent with the marginal dispatch economics, including carbon, in both regions
- In settlement, the RTO reruns the market clearing model assuming net imports equal zero in order to determine which non-carbon-region resources, if any, are levied a carbon charge

Model Implementation

- Used PJM Market Efficiency Case model in PROMOD
- In Scenarios 1 and 2, assigned a carbon charge to ComEd fossil units
- Created an interface that aggregates all the transmission linkages between nodes in the ComEd region and all external nodes (in PJM and adjacent RTOs)
- Set up an interface monitor that applies a penalty, like a wheeling charge, to all net inflows into ComEd on an hourly basis
- If hourly net inflows are negative (i.e., ComEd is a net exporter), there is no penalty assessed. If inflows are positive, the total charge would be volume of inflows x the interface penalty
- To calculate the interface penalty, we used the PJM 2020 average marginal CO_2 emissions rate of 1,110 lbs/MWh (0.56 short tons/MWh) x $20/ton, yielding a value of $11.10/MWh

Million Short Tons	Base Case	Scenario 1	Scenario 2
Model	PJM Market Efficiency Model (3/4/2021)		
Year	2025		
ComEd CO_2 Charge ($/Short Ton)	$0	$20	$20
Rest of RTO Charge*	$0	$0	$0
Interface Penalty (Net Flows into ComEd, $/MWh)	$0	$0	$11.10

*RGGI is modeled and includes all states currently participating in the program

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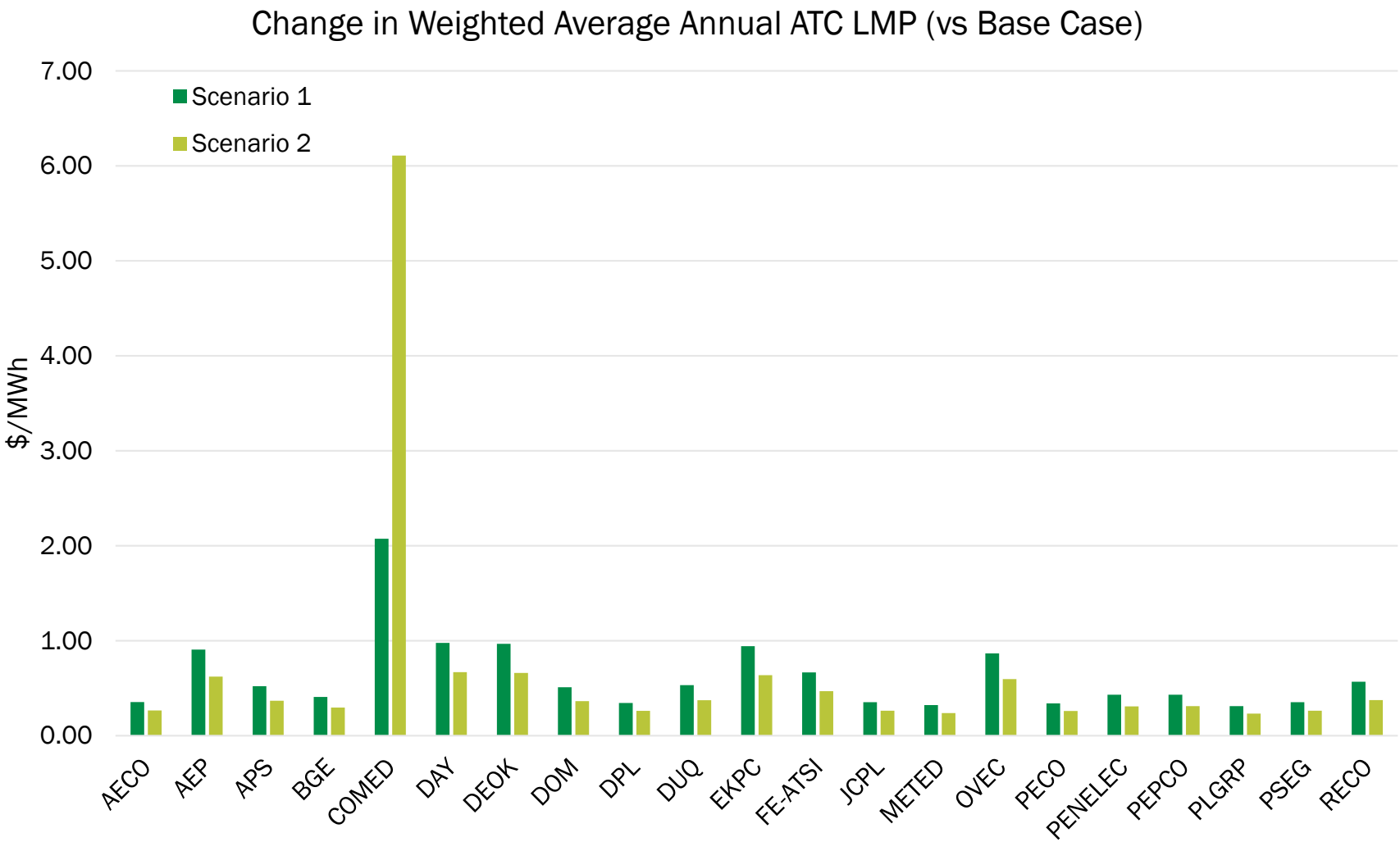
Power Price Impacts



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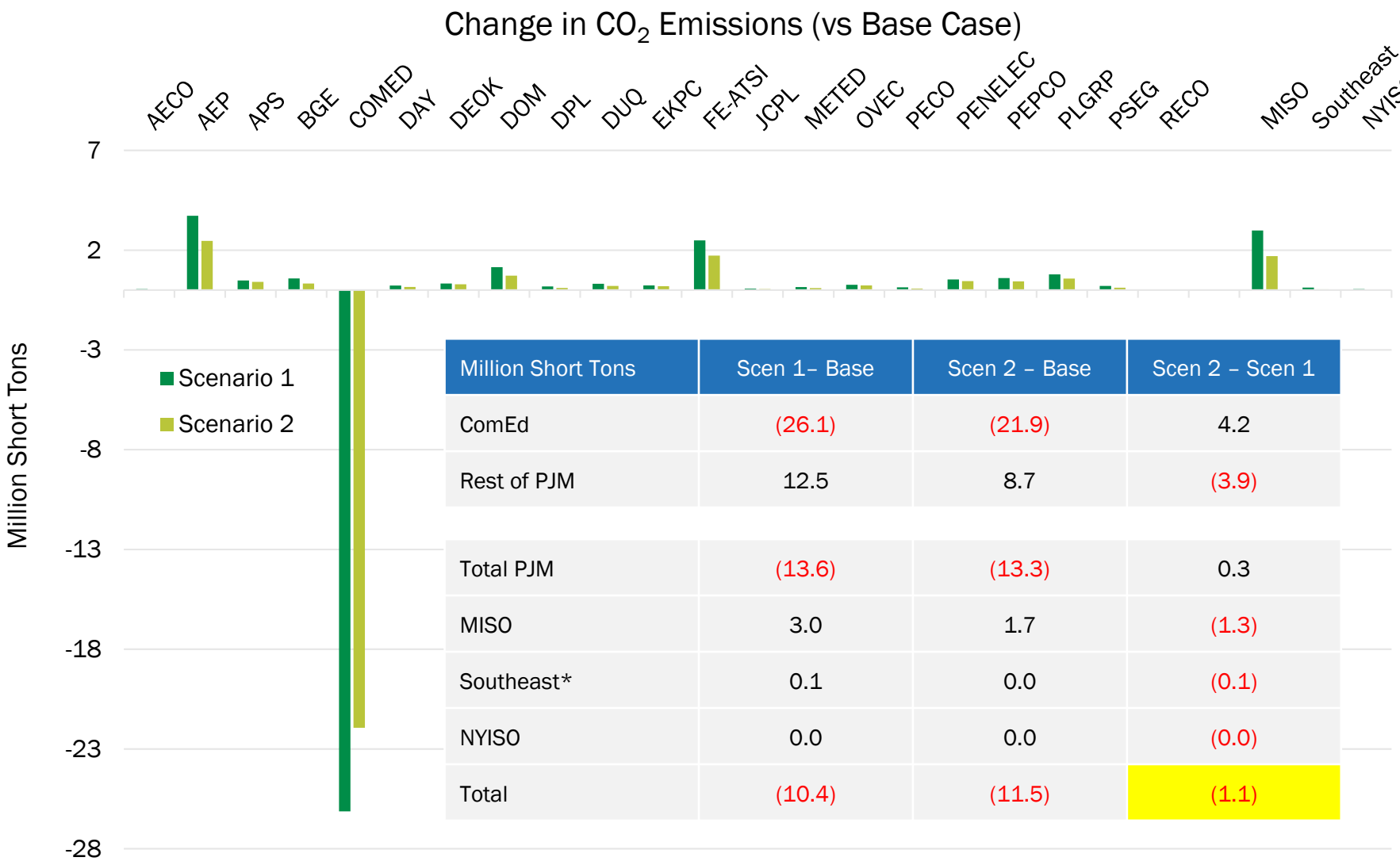
Emissions Impacts



Million Short Tons	Scen 1– Base	Scen 2 – Base	Scen 2 – Scen 1
ComEd	(26.1)	(21.9)	4.2
Rest of PJM	12.5	8.7	(3.9)
Total PJM	(13.6)	(13.3)	0.3
MISO	3.0	1.7	(1.3)
Southeast*	0.1	0.0	(0.1)
NYISO	0.0	0.0	(0.0)
Total	(10.4)	(11.5)	(1.1)

*AECIZ, CPLE, CPLW, DUK, LKE, SC, SCEG, TVAZ

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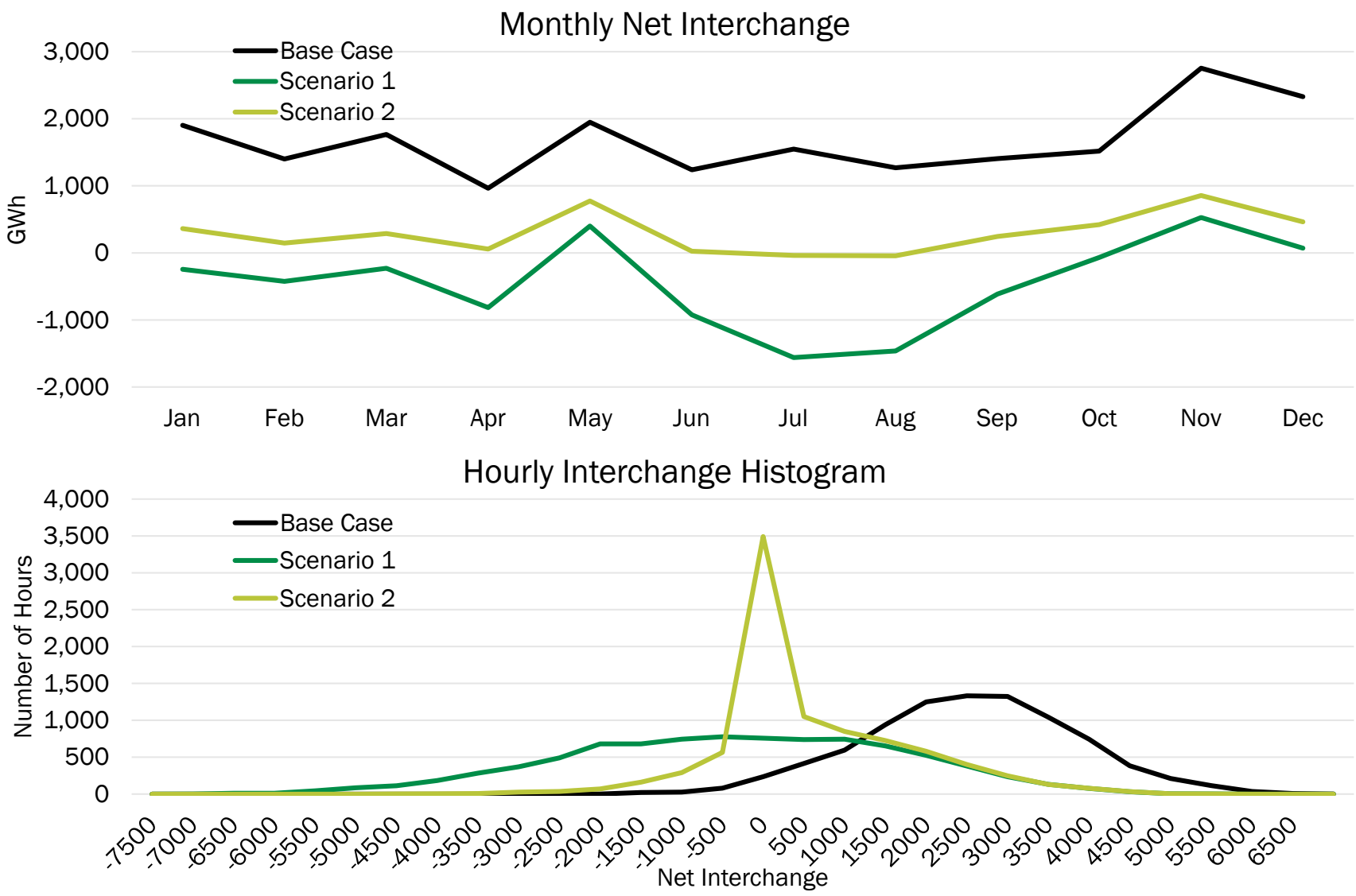
ComEd Interchange



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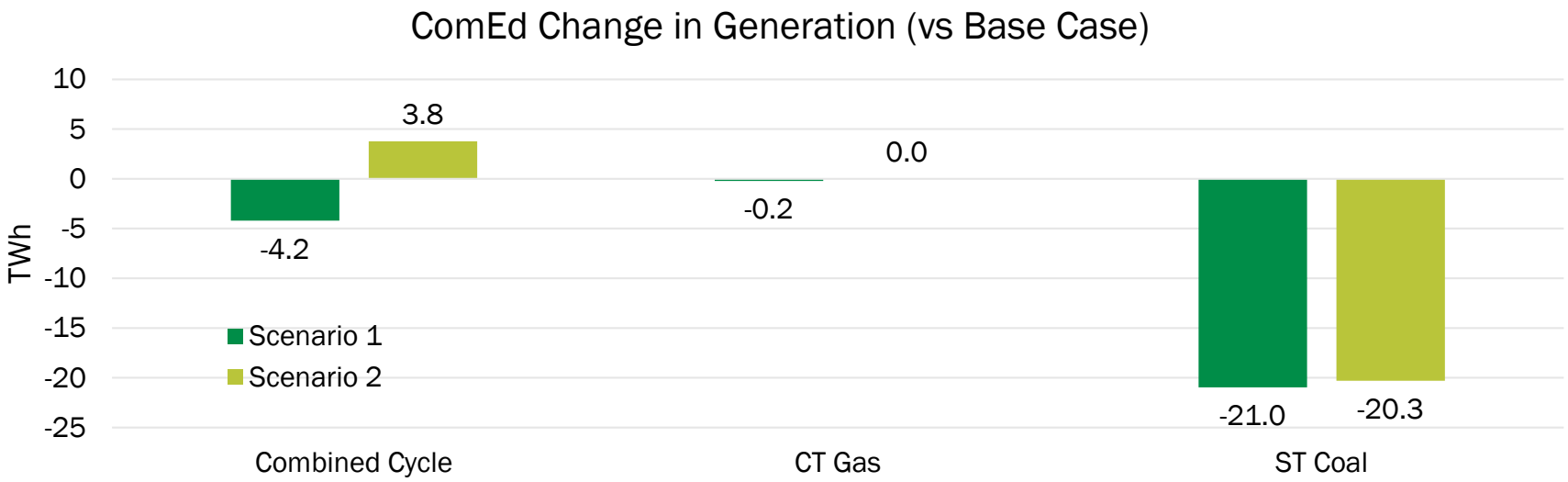
Generation and Production Costs



Change in Production Costs

$million	Scenario 1 - Base	Scenario 2 - Base	Scenario 2 – Scenario 1
PJM	-78.9	83.8	162.7
MISO	183.7	101.5	-82.2
Southeast*	19.5	10.6	-8.8
NYISO	0.3	0.4	0.1
Total	125	196	71.8

*AECIZ, CPLE, CPLW, DUK, LKE, SC, SCEG, TVAZ

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What's Next?

- Request that PJM explore implementing this concept in their own modeling in PLEXOS and/or PROMOD
- Consider counter-factual case with transmission limits across the interface set to zero
  - Identifies which units in non-carbon region are "exporting" to carbon region
  - Mechanics of assessing charges are TBD

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