MEMORANDUM

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SUBJ: Summary of GE MAPS Cases Used in Issue Track 5 Analysis

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NYISO and Brattle quantified the customer cost and emissions impacts of implementing a carbon charge using the GE MAPS production simulation model for three future years (2020, 2025, and 2030).[1] GE MAPS simulations were performed for a number of scenarios with each scenario comparing a Change Case (with carbon pricing) against a Status Quo Case (without carbon pricing). There are two types of Change Cases—Simple Change Case where the only difference from the Status Quo Case is the inclusion of carbon pricing, and Dynamic Change Case that assume further dynamic market responses (such as change in new builds or retirements) to the Simple Change Case. Dynamic Change Cases were modeled only for 2025 and 2030, assuming that such market dynamics would require some time after carbon price implementation.

This memo summarizes the GE MAPS scenarios and cases used in the Issue Track 5 analysis to quantify the impacts of implementing a carbon charge.

I. Scenarios Overview

As outlined in the April 23 IPPTF presentation, our analysis began with a **CARIS-Based Scenario** (referred to as Scenario A).[2] Table 1 and Note: The CARIS-Based scenario for 2030 is labeled "Lo OSW / Hi Nuclear" in the summary slides.

Table 2 below (also shown in Slides 3 and 5 of the May 21 presentation) summarize the CARIS Based Scenario assumptions. Status Quo and Simple Change Cases were evaluated for years 2020, 2025, and 2030. A Dynamic Change Case in which 500 MW of solar was added to Zone G was run for year 2025 and 2030. We next analyzed multiple sensitivities around key CARIS assumptions. For 2025, Low Load and High Load sensitivities were analyzed. For 2030, a High Offshore Wind (OSW) /High Nuclear Scenario (Scenario B) and a Low OSW / Medium Nuclear

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1 In addition, NYISO and Brattle are currently evaluating a 2022 case.

2 See Tim Duffy (2018). Consumer Impact Analysis: Proposed Assumption Framework. May 21, 2018. Posted at: https://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg_ipptf/meeting_materials/2018-05-21/IPPTF_IT5_0521_FOR%20POSTING.pdf

Scenario (Scenario C) were evaluated. Only the Simple Change Cases (against the Status Quo Cases) were evaluated for these sensitivities (i.e., no Dynamic Change Cases).

Table 1: CARIS-Based Scenario Load and Resource Assumptions

	Years	Load	New Renewable Resources	Nuclear Plants
CARIS-Based Scenario (Scenario A)	2020, 2025, and 2030	CARIS	CARIS, incl. 250 MW offshore wind; mostly onshore renewables; reflect latest renewable procurements	Indian Point retired in 2020/21 All Upstate nuclear in service past current license period
High Load Scenario	2025 only	CARIS + ~7 TWh		
Low Load Scenario	2025 only	CARIS - ~7 TWh		
High OSW / High Nuclear (Scenario B)	2030 only	CARIS	2,400 MW off-shore wind by 2030, displacing onshore renewables	
Low OSW / Medium Nuclear (Scenario C)	2030 only	CARIS	Same as CARIS-Based Scenario (Scenario A)	Same except Ginna and NMP1 retire in 2029

Note: The CARIS-Based scenario for 2030 is labeled "Lo OSW / Hi Nuclear" in the summary slides.

Table 2: CARIS-Based Scenario Transmission Assumptions

Transmission Updates from 2017 CARIS 1	Notes
Zero Operating Base Flow Effective Date Change in PJM/NY JOA	OBF set to 0 as of 10/31/2019
South Perry 230kV/115kV Transformer	In-Service for 2020
Dunkirk - S.Ripley Series Reactor	In-Service for 2020
Leeds Hurley SDU	In-Service for 2020
UPNY-ConEdVoltage Limit	Increase to 6250 MW; In-Service for 2021
Western NY (Empire State Line) Project	In-Service for 2022
AC Transmission Project (Generic)	In-Service for 2023

After reviewing the results for the CARIS Based Scenarios, we refined the CARIS assumptions with updated values for several key parameters, including natural gas prices, Upstate nuclear units retirement assumptions, and the level of renewable capacity, to develop a "most likely" case. These scenarios are referred to as the **Reference Scenarios** (or "Scenario D") in the results presented to the IPPTF on September 17.[3] We developed the Reference Cases for 2025 and 2030, starting from the CARIS Based Scenario (Scenario A). Table 3 and Table 4 list the Scenarios and the Cases run for each Scenario, and short descriptions of the Scenarios.

Table 3: CARIS-Based Scenarios (Formerly Scenarios A, B, and C)

Scenarios	Description
CARIS-Based Scenario (2020, 2025, 2030) - *Status Quo Case* - *Simple Change Case* - *Dynamic Case: Simple Change + Add'l Downstate PV (2025 and 2030)*	- Formerly known as Scenario A - Add'l Downstate PV case: Add 500 MW of PV in G
Low Load Scenario (2025) - *Status Quo Case* - *Simple Change Case*	- Reduce NYCA load from Reference Scenario levels by ~7 TWh
High Load Scenario (2025) - *Status Quo Case* - *Simple Change Case*	- Increase NYCA load from Reference Scenario levels by ~7 TWh
High OSW / High Nuclear Scenario (2030) - *Status Quo Case* - *Simple Change Case*	- Formerly Scenario B - Add 2,400 MW off-shore wind by 2030, displacing on-shore renewables
Low OSW / Medium Nuclear Scenario (2030) - *Status Quo Case* - *Simple Change Case*	- Formerly Scenario C - Ginna and NMP1 retire in 2029

Note: The CARIS-Based scenario for 2030 is labeled "Lo OSW / Hi Nuclear" in the summary slides.

3 See Newell et al. (2018). Analysis of a New York Carbon Charge. September 17, 2018. Posted at: https://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg_ipptf/meeting_materials/2018-09-17/2018_09_12%20Customer%20Cost%20Impacts%20of%20New%20York%20Carbon%20Charge_For%20Posting.pdf

Table 4: Reference Scenarios (Formerly Scenario D)

Scenarios	Description
Reference Scenario (2025) - *Status Quo Case (D2)* - *Simple Change Case (D3)* - *Dynamic Case: Simple Change + Downstate RE Shift (D7s)*	- Adjust Zones F-I gas prices * - Downstate RE Shift case (D7s): Shift 1.3 TWh renewable generation Downstate
Reference Scenario (2030) - *Status Quo Case (D5)* - *Simple Change Case (D6)* - *Dynamic Case: Simple Change + Fitzpatrick (D9f)* - *Dynamic Case: Simple Change + Fitzpatrick + Downstate RE Shift (D10fs)* - *Dynamic Case: Simple Change + Fitzpatrick + Downstate RE Shift + Add'l Downstate PV (D12fspv)*	- Adjust Zones F-I gas prices * - Retire NMP1, Ginna, and Fitzpatrick - Set all renewable capacity halfway between Base and Base+Renewables Shift, including ~1,300 MW of OSW - Fitzpatrick cases: Add Fitzpatrick - Downstate RE shift cases: shift 2.9 TWh renewable generation Downstate - Add'l Downstate PV case: Add 500 MW of PV in G

*Gas prices for Zones F though I assumed Iroquois Zone 2 gas prices with the exception of CPV Valley, Bowline, and the generic new CC, which all assumed TETCO M-3 gas prices. A generic 10 MW CC (6,300 FLHR HHV) was added in Zone G near CPV Valley to assess the potential for dynamic changes.

II. Estimation of Dynamic Effects

Several Dynamic Change cases were developed for each Reference Case to show how a carbon charge may affect prices and customer costs. These dynamic changes include the potential for retaining Upstate nuclear past 2030, shifting renewable generation Downstate, incentivizing entry of solar PV generation, and encouraging conservation and efficiency. Table 5 and **Table 6** summarize how the MAPS cases were used to develop estimates of these dynamic effects. These Dynamic Change Cases were modeled only for 2025 and 2030 (not 2020), assuming it will take time for the market to respond to carbon pricing.

Table 5: Estimation of Dynamic Effects in 2020, 2025, and 2030 Scenarios

	2020	2025	2030
Nuclear Retention	n/a	n/a	*Reference Simple Change + Fitz (D9f)* vs. *Reference Simple Change (D6)*
Renewable Shift Downstate	n/a	*Reference Simple Change + RE Shift (D7s)* vs. *Reference Simple Change (D3)*	*Reference Simple Change + Fitz + RE Shift (D10fs)* vs. *Reference Simple Change + Fitz (D9f)*
Incremental Renewable Entry	n/a	*2025 CARIS Simple Change + Add'l PV* vs. *2025 CARIS Simple Change*	*Reference Simple Change + Fitz + RE Shift + Add'l PV (D12fspv)* vs. *Reference Simple Change + Fitz + RE Shift (D10fs)*
Load Elasticity	Load elasticity effect on energy prices approximated using results from *2025 Low Load Simple Change* and *2025 High Load Simple Change*		

Table 6: Estimation of Dynamic Effects in Sensitivity Scenarios

	Lo Load 2025	Hi Load 2025	Lo OSW / Hi Nuclear 2030 (CARIS-Based)	Hi OSW / Hi Nuclear 2030	Lo OSW / Med Nuclear 2030
Nuclear Retention	n/a	n/a	n/a	n/a	*2030 CARIS Simple Change* vs. *2030 Low OSW / Medium Nuclear Simple Change*
Renewable Shift Downstate	*2030 Hi OSW / Hi Nuclear Simple Change* vs. *2030 CARIS Simple Change*				
Incremental Renewable Entry	*2025 CARIS Simple Change + Add'l PV* vs. *2025 CARIS Simple Change*		*2030 CARIS Simple Change + Add'l PV* vs. *2030 CARIS Simple Change*		
Load Elasticity	Load elasticity effect on energy prices approximated using results from *2025 Low Load Simple Change* and *2025 High Load Simple Change*				