Fuel and Energy Security Study
Assumptions and Data

NYISO ICAPWG/MIWG
March 28, 2019
# Table of Contents

- **Overview**
- Weather Data and Assumptions
- Gas Market Data and Assumptions
- Electrical Market Data and Assumptions
- Key Outputs
- Alternative Assumptions and Scenarios
- Next Steps
Overview

Context and Assignment

- Reminder: NYISO fuel security study will assess winter fuel/energy security for the New York Control Area (NYCA) under various assumptions (and variations to assumptions) and scenarios, and provide a report documenting the approach and findings
  - The analysis is not trying to predict the future; instead, conducting a scenario analysis
    - Creating future year baseline assuming an extended period of adverse cold weather conditions
    - Testing the resilience of the electric system to gas and electric system contingencies
    - Analysis conducted using a combined gas & power balance model
  - Scenarios/contingencies are not predictive – their development is an analytic tool intended to assess various adverse conditions for winter power system operations

- This presentation will review the proposed input assumptions and sources of data that feed into the fuel security model, along with alternative assumptions and system stress scenarios
  - Assumptions/scenarios will be merged to create a manageable number of cases representing a range of conditions

- Data used are a mix of publicly-available data and NYISO internal data, with preference to assumptions previously vetted with stakeholders (where possible)
Model Setup Diagram: Gas and Electric Balance

- **Assumptions** – vary “base case” load, resource, and LDC demand assumptions
- **Scenarios** – postulate natural gas and electric system failures to stress test the results
Table of Contents

Overview of Assignment

Weather Data and Assumptions

Gas Market Data and Assumptions

Electrical Market Data and Assumptions

Key Outputs

Alternative Assumptions and Scenarios

Next Steps
Weather Data and Assumptions

Weather

- In the fuel security model, decreasing temperature has two effects:
  - Increase in LDC gas demand
  - Increase in electrical demand

- NYISO weather data analyzed from winters 1993-2018

- To set the modeling period, we identified 7 periods where temperatures hit 90th percentile lows for wind-adjusted temperature for 14 or more consecutive days across NYISO system
  - Winter 2017-2018 was the coldest of these periods, with average temperature across all zones of 11.4 F for 14 days

- Model also includes a “cold snap” of 3 days, to represent hours of extreme system stress
  - In Winter 2017-2018, the coldest three days of the 14-day cold period had a 5.3 F average system temperature
  - In Winter 1993-1994, the coldest three days had a 2.9 F average system temperature

- Proposed baseline assumptions: 17 day period (including 3 day “cold snap”) based on Winter 2017-18 average temperature profile with Winter 1993-94 cold snap profile
## Historic Consecutive Multi-day Cold Periods

<table>
<thead>
<tr>
<th>Cold Snap Period</th>
<th>Number of Days</th>
<th>Average Wind-Adjusted Temp (F)</th>
<th>Average Unadjusted Temp (F)</th>
<th>% Increase of Avg. Daily Energy Above Winter Baseline</th>
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<tr>
<td>12/19/2000 - 01/05/2001</td>
<td>17</td>
<td>10.6</td>
<td>20.7</td>
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<tr>
<td>01/10/2003 - 01/28/2003</td>
<td>18</td>
<td>3.8</td>
<td>15.2</td>
<td>6.0%</td>
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<tr>
<td>01/18/2004 - 02/01/2004</td>
<td>14</td>
<td>2.1</td>
<td>14.6</td>
<td>8.2%</td>
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<tr>
<td>01/14/2005 - 01/29/2005</td>
<td>15</td>
<td>1.2</td>
<td>12.4</td>
<td>10.1%</td>
</tr>
<tr>
<td>02/02/2007 - 02/19/2007</td>
<td>17</td>
<td>4.6</td>
<td>17.4</td>
<td>9.0%</td>
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<tr>
<td>02/07/2015 - 02/21/2015</td>
<td>14</td>
<td>3.1</td>
<td>14.0</td>
<td>10.1%</td>
</tr>
<tr>
<td>12/25/2017 - 01/08/2018</td>
<td>14</td>
<td>-0.8</td>
<td>11.4</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

Notes:
[1] Wind-Adjusted Temperature is calculated using the Wind-chill formula from Weather.gov, valid for temperatures (T) at or below 50 degrees F and wind speeds (W) above 3 mph: WindChill = 35.74 + (0.6215 × T) - (35.75 × W^0.16 ) + (0.4275 × T × W^0.16).
[2] Percentage Increase of Avg. Daily Energy Above Winter Baseline is calculated using: ((Average daily system load during cold snap - 50th percentile daily system load for that winter)/50th percentile daily system winter load for that winter).
[3] Daily load calculated by first summing hourly load and then averaging over the period of the cold snap.

Sources:
### Historic Consecutive 3-day Cold Snaps

<table>
<thead>
<tr>
<th>Winter</th>
<th>3-day period w/ min temperature</th>
<th>Average Temp during 3-day min temp period</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003 - 2004</td>
<td>01/13/2004 - 01/16/2004</td>
<td>3.4</td>
</tr>
<tr>
<td>2004 - 2005</td>
<td>01/20/2005 - 01/23/2005</td>
<td>5.2</td>
</tr>
<tr>
<td>2017 - 2018</td>
<td>01/04/2018 - 01/07/2018</td>
<td>5.3</td>
</tr>
<tr>
<td>1995 - 1996</td>
<td>01/04/1996 - 01/07/1996</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Source:
Load and Temperature during 2017/18 Cold Period

Average System Temperature and Peak Loads for 14-day Cold Period (12/25/2017 - 01/08/2018)

Sources:
# Table of Contents

- Overview of Assignment
- Weather Data and Assumptions
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- Key Outputs
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- Next Steps
Gas Market Data and Assumptions

Gas Demand

- Model of daily LDC gas demand by heating degree day (HDD)
  - NYISO weather data
  - Historical winter gas flow data from SNL
  - Estimated separately for upstate and downstate.

- Residual gas (available for electric generation) assumed ratable during study period – i.e., available hourly quantity for electric generation is 1/24th of daily residual quantity

- Winter Peak Day Demand by LDC based on NY DPS Winter Natural Gas Supply Readiness report 2018-2019

- We will scale gas demand model so that predicted system demand for ~65-75 HDD matches documented totals for peak design day demand
  - LDCs peg design-day demand to 65-75 HDD
  - Only net gas available through pipeline (not from storage or LNG) is considered as available for electric generation
### LDC Design Day Capability from NYDPS/NYPSC filings for 2018/19

#### Winter Peak Day Capability Summary Table

New York State DPs Case 18-M-0272 2018-2019 Winter Supply Review Data Request Table 1

<table>
<thead>
<tr>
<th>NYISO Zone Group Capability</th>
<th>Upstate (MMcf) 1</th>
<th>Downstate (MMcf) 2</th>
<th>Total Design Day Capability (MMcf)</th>
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<tr>
<td>Zones Covered</td>
<td>A-F</td>
<td>G-K</td>
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<td>Pipeline</td>
<td>1,964</td>
<td>3,306</td>
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<td>Storage</td>
<td>1,120</td>
<td>838</td>
<td>1,959</td>
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<tr>
<td>LNG</td>
<td>0</td>
<td>395</td>
<td>395</td>
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<tr>
<td>Other</td>
<td>60</td>
<td>67</td>
<td>126</td>
</tr>
<tr>
<td><strong>Total Design Day Capability (MMcf)</strong></td>
<td><strong>3,143</strong></td>
<td><strong>4,605</strong></td>
<td><strong>7,749</strong></td>
</tr>
</tbody>
</table>

Notes:


[2] Downstate includes Central Hudson, Consolidated Edison, and National Grid: Brooklyn Union and KeySpan LDCs.

[3] Pipeline includes flowing supplies, less NFGSC fuel = National Fuel Gas Supply Co. natural gas pipeline, winter peaking service = "City Gate Delivered by Others and In-Territory Supplies (not LNG or CNG)", total marketer provided supplies, and recallable capacity (AMAs). Assumes all ConEd gas comes from pipeline.

[4] Storage includes storage withdrawals and CNG.

[5] Other includes cogen supplies, local production = "Local Production, landfill gas, renewables, etc. delivered directly into the LDC distribution system", and renewable gas = "Local Production, landfill gas, renewables, etc. delivered directly into the LDC distribution system".

Sources:


[B] Conming Natural Gas Corporation, Case 18-M-0272 - Winter Supply Review Data Request, July 5, 2018, Table 1.


LDC Demand vs Degree Day - Upstate

Historical Winter Demand and Best-Fit Line 2016 - 2018
New York State - Erie and Niagara Counties

Notes:
[1] Total deliveries are the sum of scheduled capacity during the intraday 3 nomination cycle to LDCs and End Users. Chart includes all Erie and Niagara county gas points in the National Fuel Gas LDC territory not located right next to a gas power plant.
[3] Effective degree day is defined as 65 degrees - Temperature, and is taken from Zone A temperature data.
Sources:
[B] Temperature: NYISO.
LDC Demand vs Degree Day - Downstate

Historical Winter Demand and Best-Fit Line 2016 - 2018
New York State - Westchester and Rockland Counties

Notes:
[1] Total deliveries are the sum of scheduled capacity during the intraday 3 nomination cycle to LDCs and End Users. Chart includes all Westchester and Rockland county gas points not located right next to a gas power plant.
[3] Effective degree day is defined as 65 degrees - Temperature, and is taken as the simple average of Zone H and Zone I temperature data.
Sources:
[B] Temperature: NYISO.
Gas Pipeline Supply

- Pipeline capacities for delivery to generation by zone based on SNL and EIA data, net of average outflows to neighboring regions (see Appendix A for details)
- No LNG or storage capacity is assumed to be available for delivery to generators
- Model will reflect limitations of supply to gas generators based on temperature, as provided by LDCs
# Table of Contents

- Overview of Assignment
- Weather Data and Assumptions
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- Next Steps
Electric Market Data and Assumptions

Electrical Demand, Supply, and Reserves

- NYISO zonal load and EE forecasts for 2023/2024 from 2017 CARIS Phase 1 Study used as starting point to derive estimated future load during modeled cold weather event
- Model of daily load increase by heating degree day (HDD) based on historical NYISO winter data, similar to LDC demand model
- Existing resources generally consistent with 2017 CARIS Phase 1 “System Resource Shift” case (see Appendix B for additional details)
  - All NY coal units retired
  - Indian Point retired
  - Assumptions regarding simple cycle gas turbine deactivations in response to the proposed NYSDEC “peaker rule”
  - Integration of new renewables and energy efficiency to meet 50 by 30 Clean Energy Standard
- No changes assumed to existing natural gas system infrastructure
- Imports/exports fixed with 0 MW net interchange between neighboring regions
- Emissions restrictions based on NYISO review of public sources
- Liquid fuel replenishment based on NYISO fuel survey data; baseline scenario assumes winter refuel available for all units consistent with historical averages
- Zonal required reserves based on NYISO data
Electric Market Data and Assumptions

Interzonal Transmission Capability

- Transmission Limits between Zone Groups based on N-1-1 contingency analysis

![Diagram showing interzonal transmission capability between different zone groups and power stations with specified transmission limits.]
Electric Market Data and Assumptions

Resource Dispatch

- Reminder: Fuel security study does not include an economic commitment/dispatch model

- Solar and Wind generation dispatched based on 2023/24 hourly profiles used in 2017 CARIS Phase 1 “System Resource Shift” case

- Hydroelectric and Nuclear assumed at fixed capacity factor based on historical winter averages; do not respond to load

- Fossil units run in the following order during modeling period, within type by heat rate:
  - Natural Gas Only (to extent pipeline gas available)
  - Dual Fuel using NG as fuel (to extent pipeline gas available)
  - Dual Fuel using Oil as fuel (if inventory available)
  - Oil Only (if inventory available)
  - No.6 oil-only units

- Hourly liquid inventory tracked at plant level
  - Each hour, ending inventory is starting inventory minus amount used
  - Assumed replenishments are based on historical data from NYISO fuel surveys
# Table of Contents

- Overview of Assignment
- Weather Data and Assumptions
- Gas Market Data and Assumptions
- Electrical Market Data and Assumptions
- Key Outputs
- Alternative Assumptions and Scenarios
- Next Steps
Key Outputs

Key Output Metrics

- Identified inabilities to meet reserve and/or load requirements
  - Hours with deficits that violate reserve requirements and necessitate emergency actions (e.g. required SCR/EDRP activations to maintain reserves)
  - Hours with deficits where load is not met with emergency actions
  - Magnitude of any identified reserve and/or supply deficits
  - Duration and frequency of any identified reserve and/or supply deficits

- Restrictions on gas and oil units’ availability due to fuel shortage/restrictions (i.e., gas- and oil-fired capability not operating due to fuel unavailability)

- Indications of gas pipeline tightness or LDC system restrictions (available gas supply for electric generation, by zone)

- Restrictions on units’ availability due to environmental limits (if any)

- Amount of gas and oil used during modeling period

- Category of scenario (e.g. baseline, more severe cold, baseline with contingencies, more severe cold with contingencies)
Table of Contents

Overview of Assignment

Weather Data and Assumptions

Gas Market Data and Assumptions

Electrical Market Data and Assumptions

Key Outputs

Alternative Assumptions and Scenarios

Next Steps
Alternative Assumptions and Scenarios

Variations in Assumptions

- Baseline
  - Reference case for comparison with other alternatives
- Variations – four basic categories (at least one variation per category)
  1. Higher than expected load due to factors such as:
     - Greater economic growth
     - Electrification of heating
     - Electrification of transportation
  2. Lower than expected load due to factors such as:
     - Increased investment in energy efficiency
     - Increased distributed resource output
     - Lower economic growth
  3. Increased reliance on gas-fired capability due to factors such as:
     - Increased non-gas generation retirements due to market factors
  4. Increased transferability due to factors such as:
     - New transmission in response to the WNY and AC Transmission public policy needs
Alternative Assumptions and Scenarios

Scenarios

- Will apply to baseline/business as usual, as well as the four alternatives discussed previously
- Purpose: stress-test results against low probability/high impact events
- Four basic event types (at least one scenario per event type)
  1. Extreme temperature – colder temperatures than historical-based profile (e.g., colder than design-day conditions)
  2. Weather event-driven restrictions on fuel replenishment
  3. Higher than anticipated generation outages – Loss of key non-gas generating capacity (e.g., nuclear) on top of typical seasonal average outage rates
  4. Gas system event – loss of major interstate pipeline capability
Alternative Assumptions and Scenarios

Combination Cases

- Develop a manageable set of cases to run and evaluate
- Goal – capture a plausible range of futures, and a representative set of potentially extreme events
- This represents an initial set; as cases are run, others may need to be developed if gaps in the assessment are identified
- Current thinking
  - Run each scenario category on the baseline/BAU and each variation in assumptions
  - Minimum of 20 cases
  - Consider additional groupings based on initial results
- Possible cases
  - Baseline/BAU with no contingencies
  - High load + Extreme weather
  - Decreased non-gas generation + Large upstate generation outage
  - Total loss of gas supply to generators
# Table of Contents

- Overview of Assignment
- Weather Data and Assumptions
- Gas Market Data and Assumptions
- Electrical Market Data and Assumptions
- Key Outputs
- Alternative Assumptions and Scenarios
- Next Steps
Next Steps

- **Tentative Schedule**
  - Early/Mid April 2019: Follow-up on assumptions/data and scenarios
  - Late April 2019: AG presentation of initial fuel security analysis findings
  - June 2019: AG presentation of final findings and initial recommendations
  - July 2019: AG presentation of final recommendations
# Appendix A: New York State Pipeline Capacity

<table>
<thead>
<tr>
<th>Pipeline Groupings</th>
<th>From PA</th>
<th>From ON</th>
<th>From NJ</th>
<th>From CT</th>
<th>Import</th>
<th>To PA</th>
<th>To ON</th>
<th>To NJ</th>
<th>To CT</th>
<th>To MA</th>
<th>Export</th>
<th>Net</th>
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<td>National Fuel Gas Supply Co</td>
<td>757</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>757</td>
<td>(484)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(484)</td>
<td>273</td>
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<td>Penn York Energy Corp</td>
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<td>0</td>
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<td>95</td>
<td>(60)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(60)</td>
<td>35</td>
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<td>Norse Pipeline Co</td>
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<td>(1,697)</td>
<td>0</td>
<td>(1,972)</td>
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<td>New York State Pipeline Total</td>
<td>4,648</td>
<td>3,315</td>
<td>5,065</td>
<td>895</td>
<td>13,923</td>
<td>(1,508)</td>
<td>(1,050)</td>
<td>(275)</td>
<td>(2,785)</td>
<td>(1,169)</td>
<td>(6,787)</td>
<td>7,136</td>
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</table>

Sources:
[1] EIA, State to State Pipeline Capacity, Jan. 2019
## Resource Additions
- New capacity by year shown in graphic

## Energy Efficiency Impact
- 17,816 GWh energy reduction in NYCA for 2024
- 1,638 MW Winter coincident peak reduction in NYCA for 2024

## Distributed Generation Impact
- 2,323 GWh energy reduction in NYCA for 2024
- 332 MW Winter coincident peak reduction in NYCA for Winter 2023-2024

<table>
<thead>
<tr>
<th>Zone</th>
<th>Capacity (MW)</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
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<tbody>
<tr>
<td>Total</td>
<td>Land-Based Wind</td>
<td>-</td>
<td>89</td>
<td>541</td>
<td>463</td>
<td>498</td>
<td>360</td>
<td>345</td>
<td>854</td>
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<td>Utility-Scale Solar</td>
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<td>-</td>
<td>-</td>
<td>605</td>
<td>746</td>
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<td>1,088</td>
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<td>-</td>
<td>229</td>
<td>229</td>
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<td>89</td>
<td>445</td>
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Contact

Paul Hibbard, Principal
617 425 8171
phibbard@analyisgroup.com