CLCPA Study

Stakeholder Meeting – Scenario Assumptions

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August 3, 2022

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Agenda

- Recap and Stakeholder Feedback
- Scenario Definitions
- Modeling Assumptions
- Stakeholder Feedback and Q&A

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Objectives for Today's Session

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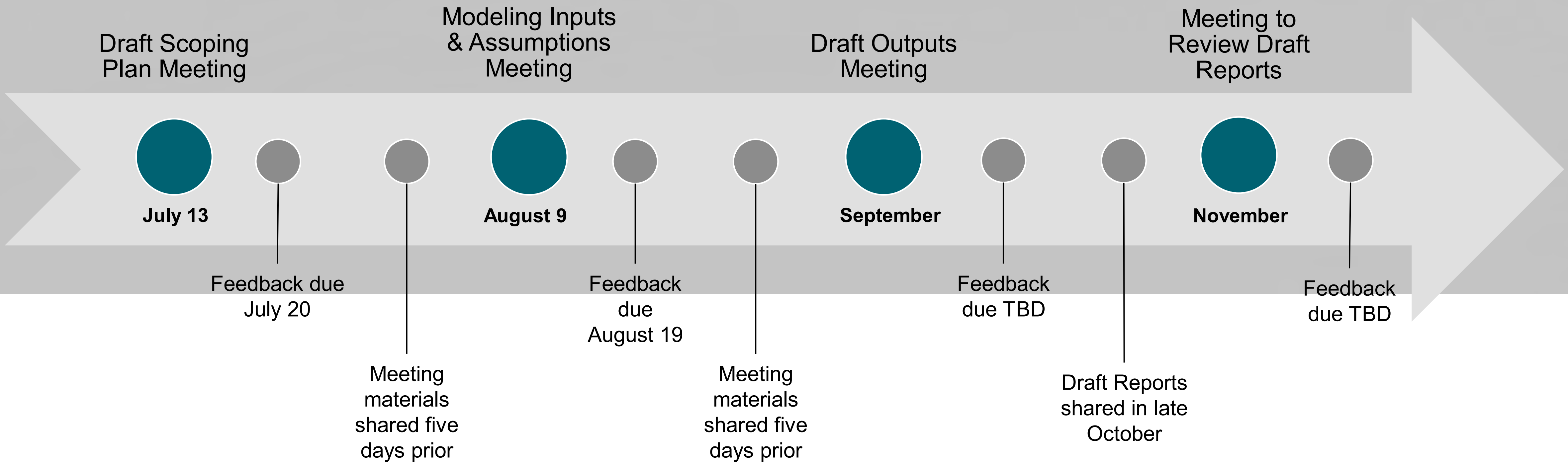
- Share draft assumptions
- Introduce input and assumptions workbook that will be shared on August 10
- Answer questions regarding the assumptions and modeling

Key Stakeholder Engagement Dates



The exact dates and timeframes shown are estimates. We will seek to give as much advance notice on exact dates as possible.

Responses to Stakeholder Feedback

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Question/Comment	Response
What is considered "near-term" in the LCP model?	Near-term is considered the next 3-5 years.
What are the assumptions around weatherization investments?	Across all scenarios, we adopt the CAC Integration Analysis assumption that building shell and weatherization reduce energy demand for space heating and cooling by 31% from 2020 to 2050.
What are the assumptions around heat pumps in hybrid heating systems?	For hybrid heat systems with air-source heat pump & fuel-fired backup, we assume heating load is split: 75% heat pump / 25% fuel in NYC / LI regions 55% heat pump / 45% fuel in other regions.
What are the inputs for the coefficients of performance for different heat technologies?	Values and data sources for equipment efficiencies will be adopted from CAC Integration Analysis and will be shared in the input spreadsheet.
Stakeholders suggested additional literature to review.	Guidehouse is reviewing the suggested literature.

Method for Estimating GHG Emissions

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- All scenarios will use CLCPA GHG accounting rules proposed by the NY Climate Action Council, which include:
  - Emissions factors capturing lifetime emissions using 20-year Global Warming Potential (GWP)
  - Emissions from biogenic CO2 and impacts of upstream emissions from fossil fuels
- Electric sector emissions are determined from the generation fuel mix, which evolves over time to meet the CLCPA target of net zero electric sector emissions by 2040

Fuel Type	Emission Factor, lbs CO2e / MMBtu
Natural Gas	215.0
Renewable Natural Gas	117.0
Distillate Fuel	219.0
Renewable Diesel	163.0
Gasoline	227.0
Renewable Gasoline	160.0
Jet Fuel	204.0
Renewable Jet Fuel	161.0

Source: NY State Climate Action Council Meeting 13 Presentation, July 22, 2021, page 26.
Available at: https://climate.ny.gov/Climate-Action-Council/Meetings-and-Materials

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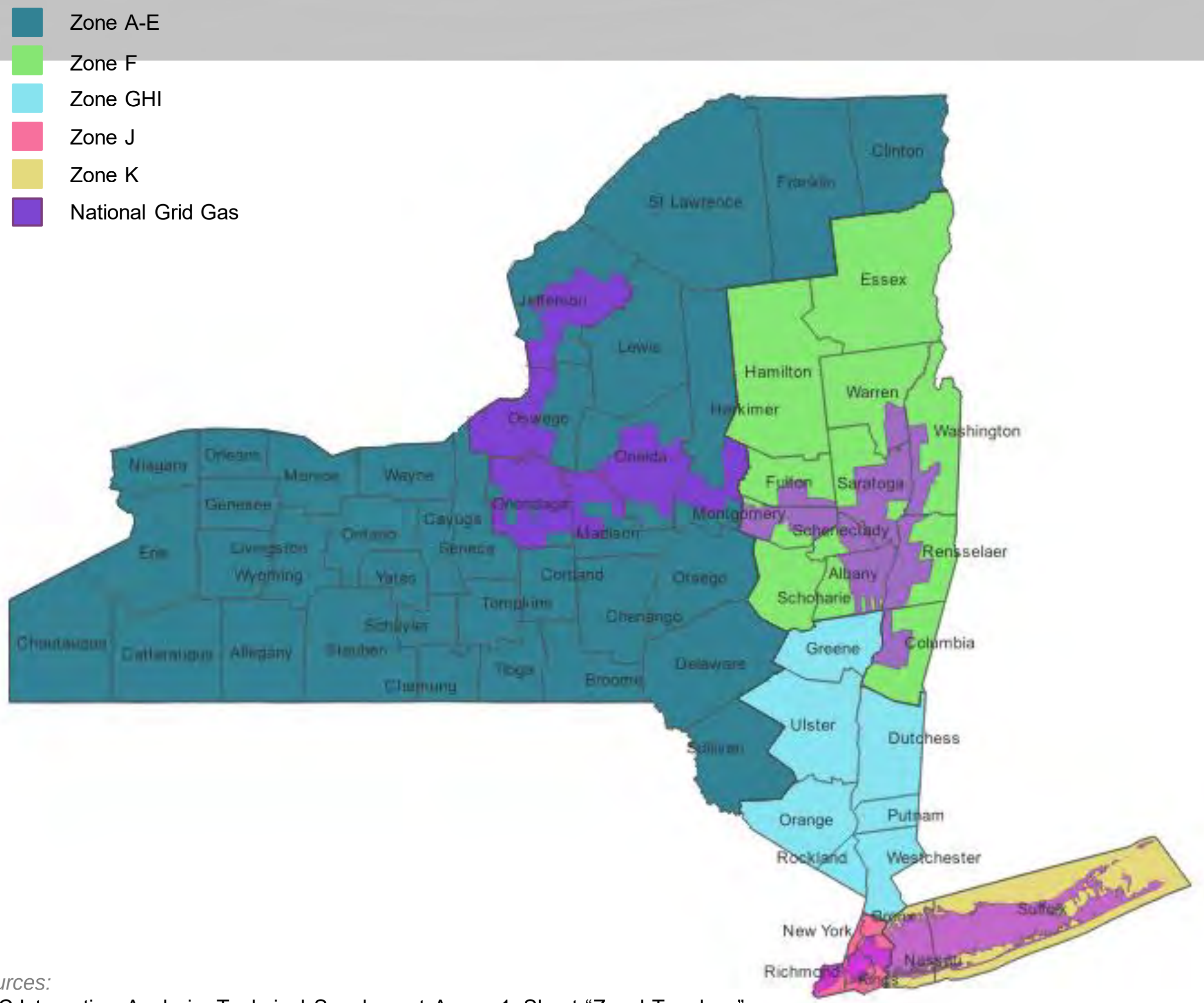
National Grid Gas Delivery in Sub-State Regions

- Five sub-state regions are defined by NYISO load zone boundaries. Regional definitions are consistent with the Integration Analysis.
- In these regions, National Grid's territory covers different shares of total gas customers and sales.
- In each region, Guidehouse will model National Grid delivery as a share of total regional delivery, proportional to National Grid's territory in the region.

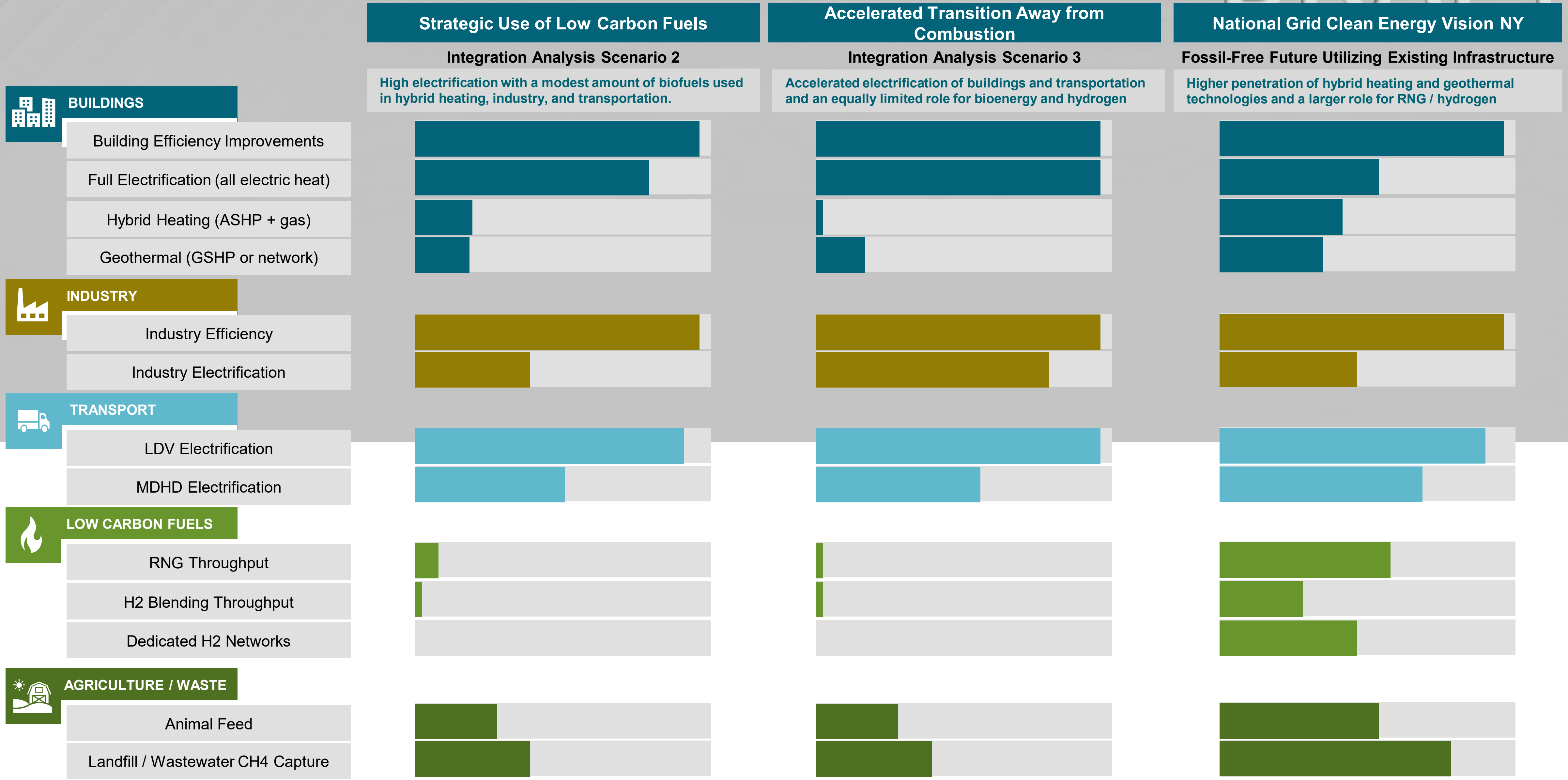
Region	Region Name	National Grid Share of Gas Delivery
Zone A-E	Upstate West	Minor share
Zone F	Upstate East	All gas sales
Zone GHI	Hudson Valley	No gas sales
Zone J	NY City	Major share
Zone K	Long Island	All gas sales

- The energy system modeled represents an interconnected energy system across all regions, with electricity and gas interconnections between regions.



Sources:
CAC Integration Analysis, Technical Supplement Annex 1. Sheet "Zonal Topology"
Available: https://climate.ny.gov/-/media/Project/Climate/Files/IA-Tech-Supplement-Annex-1-Key-Drivers-Outputs.xlsx

Updated Summary of Scenarios



Each scenario will be CLCPA compliant under Draft DEC Emission Guidelines.

For emissions sources not illustrated above (Oil & Gas, IPPU, HFCs, and Sequestration), modeling will use consistent assumptions across scenarios, aligned with Integration Analysis Scenario 2.

Detailed Scenario Definitions

<table>
<tr><th></th><th>Strategic Use of Low Carbon Fuels</th><th>Accelerated Transition Away from Combustion</th><th>National Grid Clean Energy Vision NY</th></tr>
<tr><th></th><th>Integration Analysis Scenario 2</th><th>Integration Analysis Scenario 3</th><th>A Fossil-Free Future</th></tr>
<tr><td rowspan="4">BUILDINGS
Non NYC</td><td>• 92% of buildings electrified by 2050
• Electrification is 70% ASHP, 20% GSHP, and 10% Hybrid heat (ASHP + fuel backup)</td><td>• 92% of buildings electrified by 2050
• Electrification is 77% ASHP, 23% GSHP</td><td rowspan="2">• TBD%* of gas buildings fully electrified by 2050
  • Electrification is 90% ASHP, 10% GSHP.
• TBD% of buildings convert to hybrid heat (ASHP + gas backup) by 2050
• Remaining demand served by gas blend: 93% RNG / 7% H2 blending (by energy)</td></tr>
<tr><td colspan="2">• Remaining non-electric energy demand served by RNG and low-carbon fuels (e.g., wood)</td></tr>
<tr><td colspan="2">• No hydrogen blending in pipeline gas</td><td>• Dedicated H_2 networks serve TBD% of Non-Res buildings gas demand by 2050</td></tr>
<tr><td colspan="3">• Building efficiency reduces annual GHG emissions from buildings by 31% in 2050 (from 2020 base year)</td></tr>
<tr><td rowspan="4">BUILDINGS
NY CITY

(Subject to NYC Local Law 97)</td><td>• 92% of buildings electrified by 2050
• Electrification is 70% ASHP, 20% GSHP, and 10% Hybrid heat (ASHP + fuel backup)</td><td>• 92% of buildings electrified by 2050
• Electrification is 77% ASHP, 23% GSHP</td><td rowspan="2">• TBD% of gas load fully electrified by 2050
  • Electrification is 90% ASHP, 10% GSHP
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<tr><td colspan="2">• Remaining non-electric energy demand served by RNG and low-carbon fuels (e.g., wood)</td></tr>
<tr><td colspan="2">• No hydrogen blending in pipeline gas
• NYC steam system converted to hydrogen by 2050</td><td>• Dedicated H_2 networks serve TBD% of Non-Res buildings by 2050</td></tr>
<tr><td colspan="3">• Building efficiency reduces annual GHG emissions from buildings by 31% in 2050 (from 2020 base year)</td></tr>
</table>

*TBD values will be updated and shared in August 9 presentation

Detailed Scenario Definitions

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	Strategic Use of Low Carbon Fuels Integration Analysis Scenario 2	Accelerated Transition Away from Combustion Integration Analysis Scenario 3	National Grid Clean Energy Vision NY A Fossil-Free Future
INDUSTRY	• Efficiency reduces annual industrial energy consumption: 20% by 2030, 40% by 2050 relative to 2020		
	• 33% of gas use is electrified by 2050 • Remaining gas use is served by hydrogen	• 83% of gas use is electrified by 2050 • Remaining gas use is served by hydrogen	• TBD%* of gas use is electrified by 2050 • Med- & High-temp served by hydrogen and RNG
TRANSPORT	• LDV: Sales are 90% BEV / 10% FCEV Stock is 95% ZEV by 2050	• LDV: Sales are 100% BEV Stock is 96% ZEV by 2050	• LDV: Sales are 90% BEV / 10% FCEV Stock is 95% ZEV by 2050
	• MDHD: Sales are 43% BEV / 55% FCEV Stock is 77% ZEV by 2050	• MDHD: Sales are 68% BEV / 30% FCEV Stock is 86% ZEV by 2050	• MDHD : Sales are 40% BEV / 60% FCEV Stock is 77% ZEV by 2050
	• Marine and ports fully electrified by 2050	• Marine and ports fully electrified by 2050	• Hydrogen plays a role in decarbonizing marine and aviation.
AGRI CULTURE	• Changes to animal feed yield 24% decrease in annual livestock methane emissions from 2020 to 2050		• Changes to animal feed yield TBD% decrease in annual livestock methane emissions from 2020 to 2050
WASTE	• Methane capture at landfills reduces annual landfill methane emissions by 70% from 2020 to 2050		• Wastewater methane capture reduces annual wastewater methane emissions by TBD% from 2020 to 2050
	• Wastewater methane capture reduces annual wastewater methane emissions by 25% from 2020 to 2050		• Wastewater methane capture reduces annual wastewater methane emissions by TBD% from 2020 to 2050

*TBD values will be updated and shared in August 9 presentation

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- **Modeling Assumptions**
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Approach to Sources for Scenario Assumptions

For consistency with other NY studies, some baseline modeling assumptions are sourced from the CAC's Integration Analysis.

- **Guidehouse plans to leverage the sources in the CAC Integration Analysis for most baseline modeling assumptions,** including overarching economic drivers such as**:** population growth, building stock turnover, and technoeconomic characteristics.
- **Guidehouse will work with National Grid to align on annual gas consumption and design day demand** based on each scenario's definition.
- **Guidehouse will incorporate National Grid-specific assumptions** where Integration Analysis assumptions are not provided, are out-of-date, or where utility-specific data is more relevant.
- **If neither National Grid nor the Integration Analysis provide applicable inputs** or assumptions for a topic, Guidehouse will use internal expert research and judgment.

Key Assumptions Adopted from the Integration Analysis

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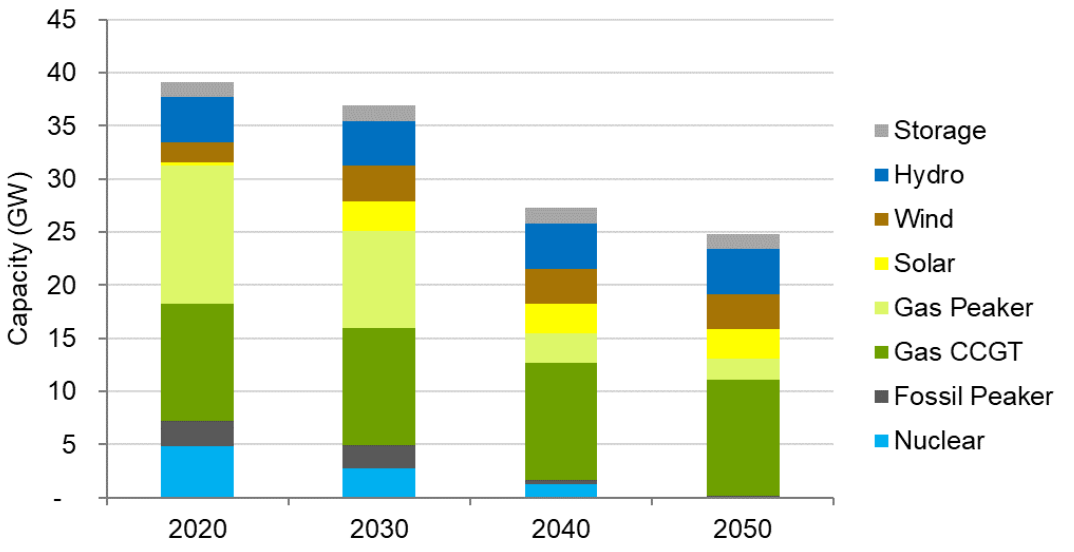
Modeling Parameter	Source
Economic Drivers	
Growth in Population, Building Stocks, and Transportation by Region	IA - Appendix 1 - "Sheet: Activity Drivers"
Emissions	
Emissions Factors (including loss rates of CH4 Pipelines)	IA - Appendix 1 - "Sheet: Emissions Factors"
Equipment Efficiencies and Equipment Costs	
Equipment Costs (e.g., $/unit for heat pumps)	IA - Appendix 1 - "Sheets: Bldg_Res Device Cost" and "Bldg_Comm Device Cost." Note that National Grid may make minor cost updates based on program experience.
Equipment Efficiencies (e.g., coefficients of performance)	IA - Appendix 1 - "Sheet: Bldg_Res Efficiency" and "Bldg_Comm Efficiency"
Supply Technology Costs (CAPEX, O&M)	
Nuclear Generation Costs	IA - Appendix 1 - "Sheet: Going Forward Fixed Costs"
Fossil Generation Costs	IA - Appendix 1 - "Sheet: Resource Costs Mid"
Generation and Capacity	
NYISO - Existing and Planned Capacity	IA - Appendix 1 - "Sheet: Existing and Planned Capacity"
NYISO Interconnections and Transfer Limits	IA - Appendix 1 - "Sheet: Zonal Topology"
Retirements	IA - Appendix 1 - "Sheet: Retirement Inputs"

Key Assumptions Adopted from the Integration Analysis

NYISO Existing and Planned Capacity

- Existing and planned capacity inputs for all current resources and near-term expected additions in NYISO.
- LCP's optimization function will add candidate resources to this planned capacity to meet scenario demands and may retire capacity on an economic basis.
- Existing nuclear and fossil peaking generation retires by 2050.

Net NYISO Capacity (Includes Existing, Planned, and Retired Capacity)

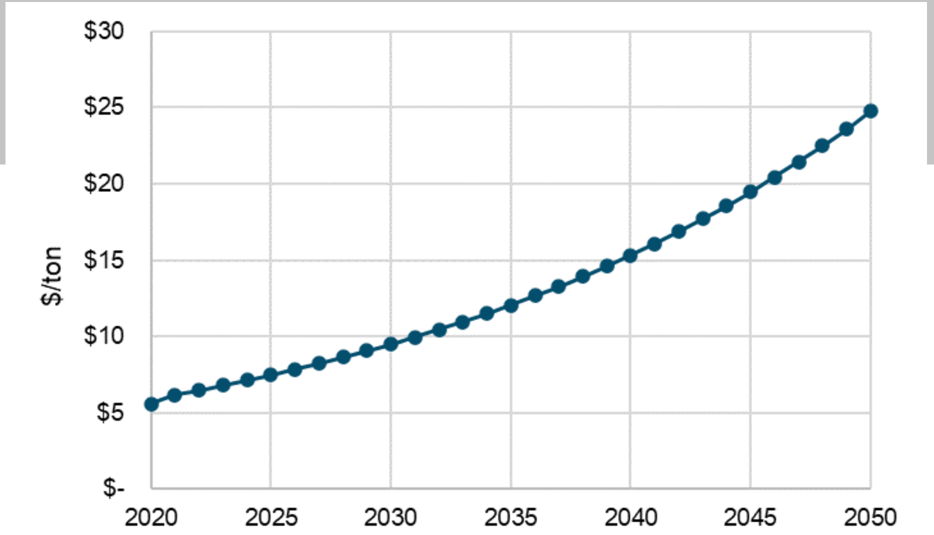


Source: CAC Integration Analysis, Technical Supplement Annex 1. Sheet "Existing and Planned Capacity" Available: https://climate.ny.gov/-/media/Project/Climate/Files/IA-Tech-Supplement-Annex-1-Key-Drivers-Outputs.xlsx

Carbon Price Forecast

- RGGI Carbon Price forecast will also adopted from the CAC analysis.
- Carbon price escalates at 5% annually over the forecast period.
- By 2050 carbon price reaches $25 per ton of CO2.

RGGI Carbon Price Forecast ($2020 Real) Adopted from the CAC Integration Analysis



Source: CAC Integration Analysis, Technical Supplement Annex 1. Sheet "RGGI Price Adders" Available: https://climate.ny.gov/-/media/Project/Climate/Files/IA-Tech-Supplement-Annex-1-Key-Drivers-Outputs.xlsx

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Updates to General Assumptions

Modeling Input	Prior Source Referenced in Integration Analysis	Updated Source for Current Analysis	Justification
Price Forecasts			
Natural Gas Price Forecast (Henry Hub)	AEO 2021	AEO 2022 (High Price Case)	Natural gas prices have increased significantly due to recent global events
Green Hydrogen Costs (In-State/Out-State)	IA - Appendix 1 - "Sheet: Hydrogen Costs "	Green Hydrogen Costs (In-State/Out-State)	More recent cost data available
Infrastructure Technology Costs (CAPEX, O&M)			
Hydrogen Pipelines (New and Retrofit)	IA - Appendix 1 - "Sheet: Hydrogen Costs "	Hydrogen Pipelines (New and Retrofit)	More recent cost data available
Hydrogen Storage	IA - Appendix 1 - "Sheet: Hydrogen Costs "	Hydrogen Storage	More recent cost data available
Supply and Infrastructure Technology Costs (CAPEX, O&M)			
Renewables (Solar/Wind/Storage)	NREL Alternative Technology Baseline (ATB) 2020	NREL ATB 2022	Source has been updated with new cost trajectories reflecting learning and supply chain disruptions
Transmission and Distribution Costs	E3 Analysis	National Grid	More recent cost data available
Networked Geothermal Costs	n/a	National Grid / Guidehouse Research	Networked geothermal is one of the main pillars of National Grid’s Clean Energy Vision in New York
Resource Availability			
RNG	Not Provided	AGF (2019) "Renewable Sources of Natural Gas," and AGA (2022) "Net Zero Emissions Opportunities for Gas Utilities"	Not provided by Integration Analysis

Updates to General Assumptions: Natural Gas Prices

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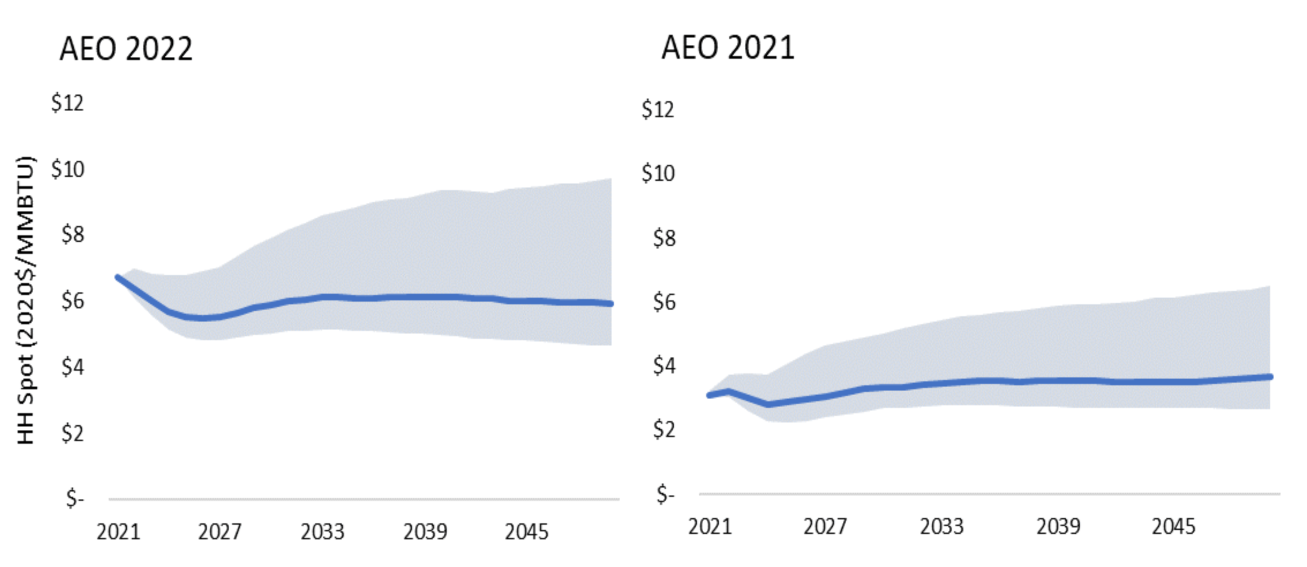
Natural Gas Prices

- **Integration Analysis Source:** Annual Energy Outlook 2021
- **Guidehouse Analysis Source:** Annual Energy Outlook 2022 (High Price)
- **Justification:** Natural gas prices have *increased significantly* due to recent global geopolitical events greatly impacting global energy markets and level of domestic LNG exports.
  - The AEO 22 reference case Henry Hub price forecasts differs by more than 60% compared to the AEO 21 reference case.
  - Since the release of the AEO 22 on March 22nd natural prices have increased further due to sustained pressure from geopolitical developments and the sustained post-COVID rebound. The AEO 22 High Price sensitivity better reflects current market conditions.

Henry Hub Natural Gas Price Sensitivity Comparison AEO21 (Integration Analysis) and AEO22



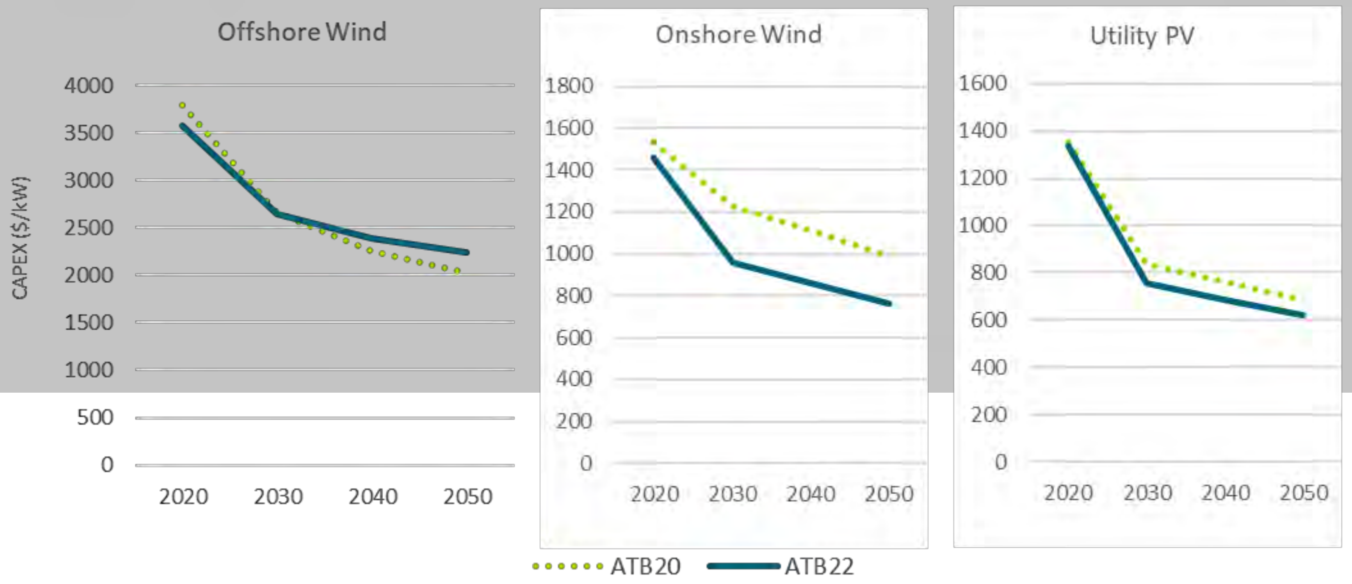
Source: Energy Information Administration, Annual Energy Outlook 2021/2022. Table 3. Available https://www.eia.gov/outlooks/aeo/tables_ref.php

Updates to General Assumptions: Renewable Capacity Costs

Renewable Technology Costs, CAPEX Basis ($/kW)

- **Integration Analysis Source:** NREL ATB 2020
- **Guidehouse Analysis Source:** NREL ATB 2022
- **Justification:** Using the updated version of the ATB that was not yet released at the time of the CAC IA analysis. Source has been updated with new cost trajectories reflecting learning and impact supply chain disruptions.
  - Offshore wind costs are projected to increase by an average of 32% by 2050 between 2020 and 2022.
  - However, utility scale PV costs have decreased by 10% and land-based wind is projected to be 22% lower by 2050 than in the previous ATB 20 forecast.

NREL Alternative Technology Baseline CAPEX Comparison ATB 20 and ATB 22



Note: Difference in scale

Source: National Renewable Energy Laboratory Alternative Technology Baseline 2020/2022. Available https://atb.nrel.gov/electricity/2022/data

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Updates to General Assumptions: Electric Transmission Costs

Transmission Costs, Levelized Costs

- **Integration Analysis Source:**
  NYSERDA Utility T&D Working Group, ***Averaged*** values
- **Guidehouse Analysis Source:**
  Same source, but using ***Individual*** instead of averaged values
- **Justification:** The Integration Analysis used averaged levelized project costs of $63/kW-yr.
  To model investments in National Grid's territory, a levelized cost specific to National Grid is more appropriate

Local Transmission & Distribution Project Estimates, by Utility and Phase

Phase 1 Projects			
	Cost ($M)	Benefit (MW)	Levelized Cost ($/kW yr)
Central Hudson	$ 152	433	$ 35
ConEd	$ 860	900	$ 96
LIPA	$ 402	615	$ 65
National Grid	$ 773	1,130	$ 68
NYSEG/RG&E	$ 1,560	3,041	$ 51
O&R	$ 417	500	$ 83
Phase 2 Projects			
	Cost ($M)	**Benefit (MW)**	**Levelized Cost ($/kW yr)**
Central Hudson	$ 138	766	$ 18
ConEd	$ 4,050	7,686	$ 53
LIPA	$ 1,281	1,830	$ 70
National Grid	$ 1,371	1,500	$ 91
NYSEG/RG&E	$ 780	943	$ 83

Source: Utility Transmission and Distribution Working Group Study, Appendix C to Initial Report on Power Grid Study, November 2020. Figure 1 and Figure 2. Available at: https://www.nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Electric-Power-Transmission-and-Distribution-Reports/Electric-Power-Transmission-and-Distribution-Reports---Archive/New-York-Power-Grid-Study
CAC's Integration Analysis converted Working Group values to levelized costs.

Updates to General Assumptions: Networked Geothermal Costs

- Networked geothermal pilot projects are underway in Upstate NY, Downstate NY, and Massachusetts
- Cost estimates are under development, and preliminary estimates below are based on findings from the MA 20-80 process and informed by HEET study and Eversource.
- National Grid and Guidehouse welcome stakeholder inputs on cost estimates of networked geothermal systems.

Input	Assumption	Data Source
Capital Cost ($/ton)	$12,700 - $20,500 (single family) $7,000 - $11,200 (multifamily)	HEET & BuroHappold (2019), GeoMicroDistrict Feasibility Study
O&M Customer-Related Costs ($/customer)	$194	Calculated value, based on weighted average gas customer O&M costs across all LDCs
O&M Distribution-Related Costs (% of capital investment)	1%	IEA (2013), District Heating Technology Brief
Coefficient of Performance (COP)	6	HEET & BuroHappold (2019), GeoMicroDistrict Feasibility Study; stakeholder feedback
Lifetime	50	Calculated value, based on average whole life from LDC utility books

Source: Massachusetts D.P.U. 20-80: Modeling Framework and Assumptions

Updates to General Assumptions: RNG Availability

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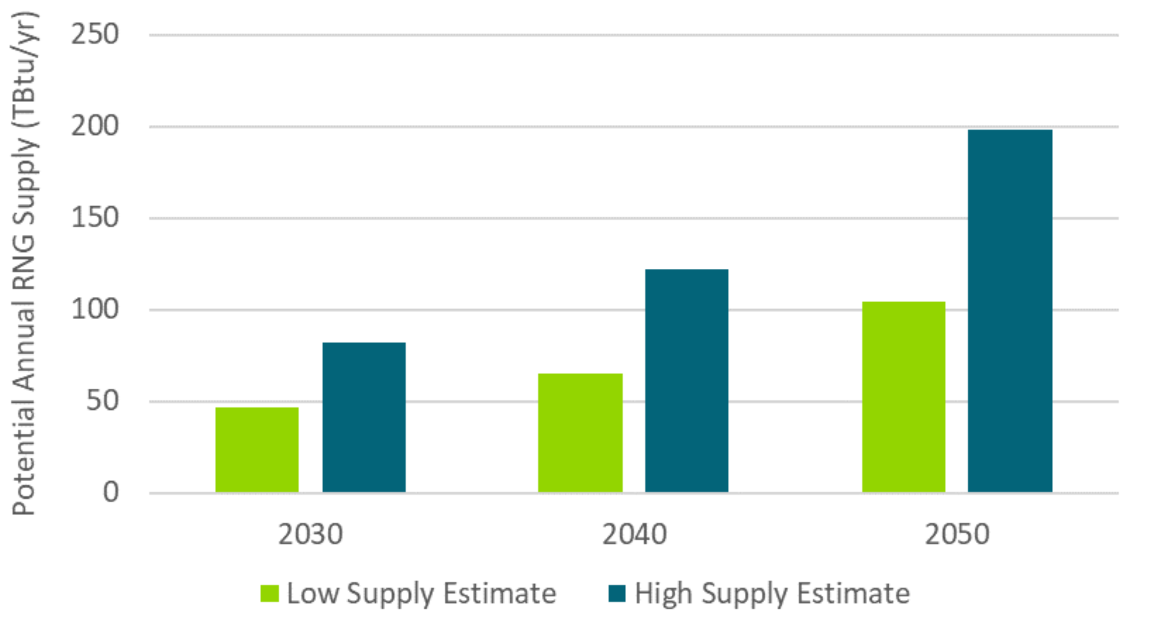
RNG Supply Potential

- **Integration Analysis Source:** The Integration Analysis did not quantify the potential supply of RNG.
- **Guidehouse Analysis Source:** National Grid / Guidehouse Analysis
- **Justification:** RNG supply potential is limited by available feedstocks, and future supply of RNG may not exceed potential.
  - The Clean Energy Vision-NY scenario assumes higher deployment of RNG compared to scenarios based on the Integration Analysis, and it requires an upper bound to the amount of available RNG.
  - The potential supply of RNG available to New York utilities is estimated by pooling RNG potential for Eastern US states, and sharing this pool based on each state's proportion of total natural gas sales in the Eastern U.S.
  - RNG potential **does not** include thermal gasification of energy crops or municipal solid waste feedstocks due to sustainability concerns.

RNG Potential Available to KEDNY, KEDLI, and NMPC, based on utilities portion of Eastern US RNG Supply Potential



Sources:
2040 potentials from: AGF (2019). *Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment*. Source: https://www.gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf

2030 and 2050 potentials scaled from: AGA (2022). *Net Zero Emissions Opportunities for Gas Utilities.* Source: https://www.aga.org/research/reports/net-zero-emissions-opportunities-for-gas-utilities/

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Input Assumptions Workbook

- In addition to providing feedback on the content provided in this session, stakeholders will have the opportunity to review an **Excel workbook with additional modeling inputs and assumptions**.
    - o The workbook will be filed in the above captioned proceedings and on the Companies' website on August 10, 2022.
- National Grid will also provide a **feedback template** to help organize feedback.
    - o Commenters are requested to use the template, wherever feasible, for feedback on the input workbook.
    - o We kindly request comments that are specific, noting the workbook tab, row number, data element, and suggested value, and a justification with citations/sources to data that may be more appropriate.
- Stakeholder comments are requested by **4pm on August 19.**

Questions?

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Guidehouse Outwit Complexity

Appendix

Modeling Approach – Low Carbon Pathway (LCP)

“What if?” modeling finds lowest-cost path to scenario outcomes

LCP Model Configuration to NY

The LCP model is an integrated capacity expansion and dispatch optimization model used to identify the lowest-cost pathway to a decarbonized energy system (electric and gas).

Different scenarios and sensitivities can be easily evaluated.

Geographic Scope: NY & neighboring regions

Energy Carriers:

- Electricity
- Hydrogen
- Methane

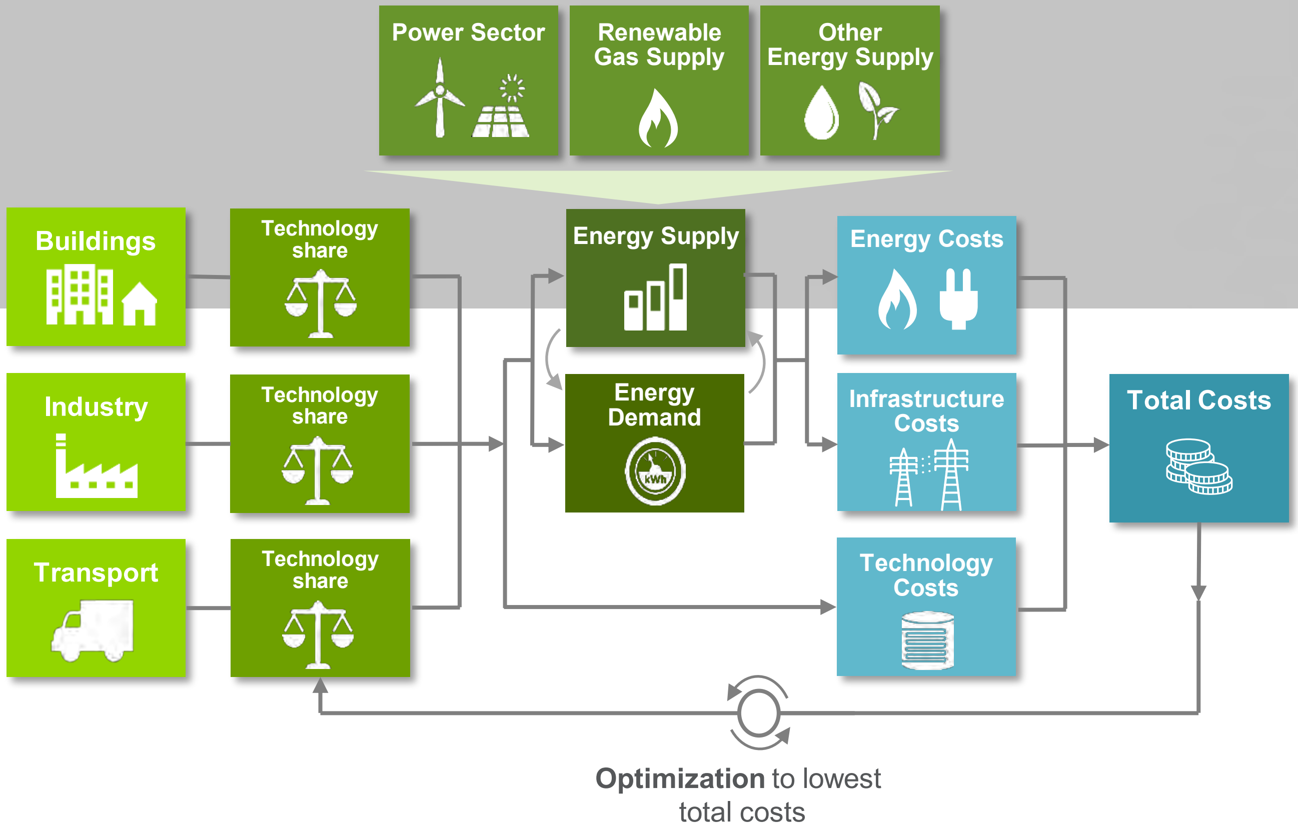
Investment Types:

- Infrastructure & supply capacity
- Elec/Gas Storage
- Conversion techs (e.g., electrolyzers)

LCP Model Key Outputs

- Low-carbon and renewable gas quantities over time (green hydrogen, blue hydrogen, RNG, etc.)
- Energy system costs including gas and electric network investments:
- Supply capacity (onshore/offshore wind, electrolyzers, SMR, etc.)
- Transmission Interconnections (transmission lines, new/retrofit pipelines, etc.)
- Storage assets (hydrogen storage, battery storage, etc.)
- Timeline of investments (2025, 2030, 2035, 2040, 2045, 2050)

Model Design



Modeling Approach – Demand Forecasting

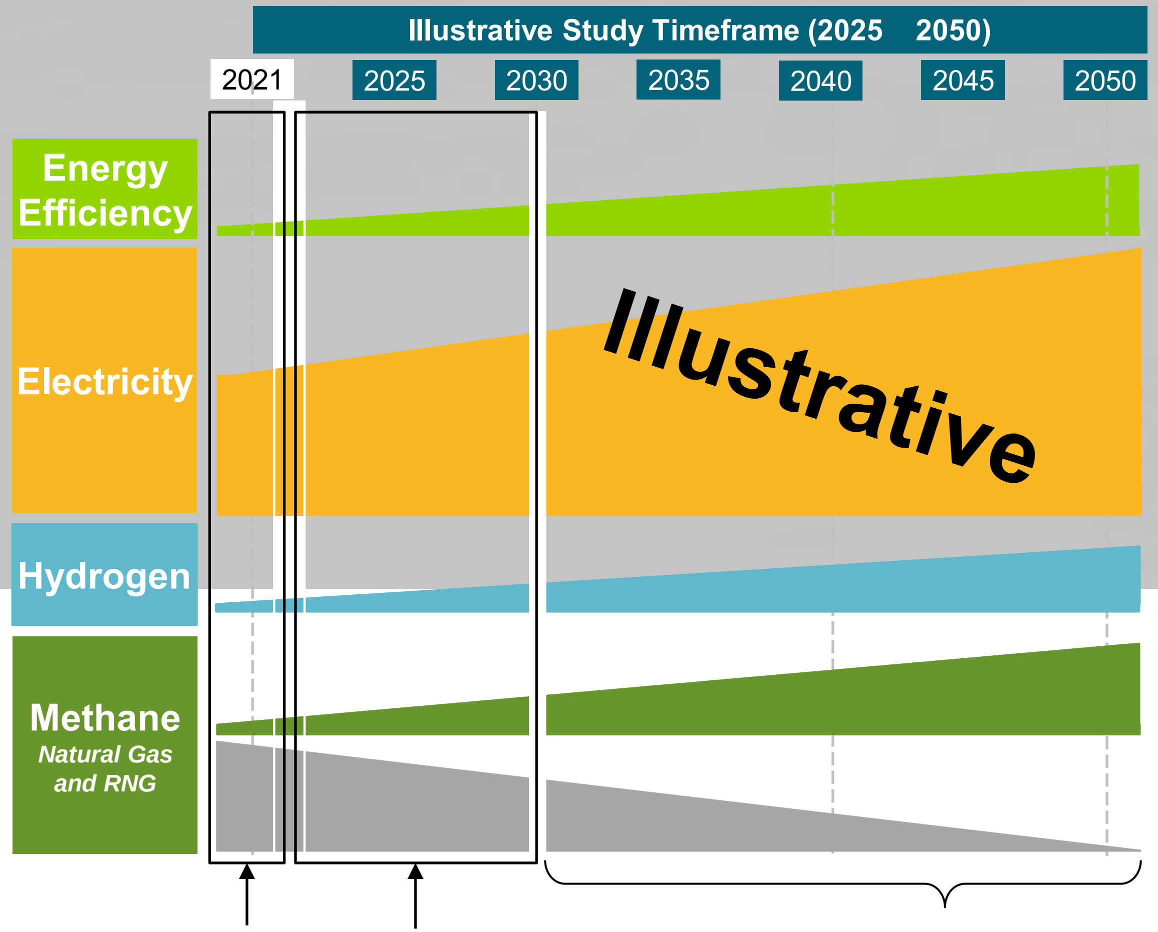
1 | Characterize base year – Establish historical electricity and gas demand, for each demand sector (buildings, transport and industry) in each region.

2 | Incorporate Planning Inputs – Include supply- and demand-side assumptions and inputs from clients' recent plans (e.g., capacity additions, planned retirements, interconnection projects, etc.) as "planned" or "expected" investments. Account for energy efficiency programs.

3 | Develop decarbonization scenarios – Each scenario has assumptions for the demand sectors (*e.g.*, 90% of residential building heating is electrified).

Note: Region-specific adjustments can be applied to individual sectors, to account for regional variations like climate, buildings mix & industry mix.

4 | Develop supply and demand sensitivities – Different scenario variations can be tested to answer questions like, "What if hydrogen costs are higher/lower than expected?" or "What if new pipelines are disallowed?"



Historical **Electricity & Gas Demand**, by demand sector, provided by client

Near-term period informed by current plans

Future trajectories informed by scenario assumptions, GHG targets, and constraints

Modeling Approach – LCP Model Overview

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OBJECTIVE FUNCTION

The model's primary objective function is to minimize energy system costs over the analysis horizon (e.g., 2020-2050) – including supply, infrastructure, and demand costs.

Supply Costs
- Cost of new entry. (CONE)
- Fixed O&M. (FOM)
- Variable O&M. (VOM)
- Fuel cost.
- Emissions cost.

Infrastructure Costs
- CONE, FOM, VOM by energy carrier. (electricity, CH4, H2, heat)
- Both inter- and intraconnections are considered.

Demand Costs
- Demand technology costs.
- Others as needed.

DECISION VARIABLES

The model determines the optimal capacity and dispatch for supply and infrastructure, as well as the optimal mix of demand-side technologies.

Supply Tech Capacity & Dispatch
- Installed cap. by supply tech, year, region.
- Fossil gen, renewables, crossloads, short- and long-term storage.
- Energy dispatched by supply tech, year, season, hour, region.

Infrastructure Capacity & Dispatch
- Installed capacity by energy carrier, region, year.
- Energy transferred by energy carrier, region, season, timestep, year.

Demand Technology Mix
- Gas boilers/furnaces
- District heating
- CHP

CONSTRAINTS

The model is constrained by existing and planned supply and infrastructure capacity, interim & final emissions reduction targets, and balancing energy supply and demand.

Emissions
- Total emissions are <= the target.
- Targets can be set by year.

Supply & Infrastructure Capacity
- MaxSupply Capacity: by supply tech, region, and year.
- Sufficient Infrastructure Capacity: by energy carrier, region, and year.

Energy Balance
- Demand = Supply
- Electricity, CH4, H2, Heat
- Energy is balanced by energy carrier, year, season, hour, and region.

Key LCP Model Outputs

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- GHG emissions over time
- Gas supply over time (energy and volume)
- Low-carbon and renewable gas quantities over time (green hydrogen, blue hydrogen, RNG, etc.)
- Electric and gas peaks over time
- Distribution network / infrastructure
- Energy system costs including gas and electric network investments
- Supply capacity (onshore/offshore wind, electrolyzers, SMR, etc.)
- Transmission Interconnections (transmission lines, new/retrofit pipelines etc.)
- Storage Assets (hydrogen storage, battery storage, etc.)
- Timeline of investments (2025, 2030, 2035, 2040, 2045, 2050)

Additional Network Geothermal Assumptions

HEET and BuroHappold’s GeoMicroDistrict Feasability Study

Horizontal loop ground coupled heat pump (GCHP)	Vertical GCHP systems	GWHP
Ideal Conditions		
Superficial Geology: saturated soils **Building Type**: residential **Population Density**: low density **Heating demand**: low heating and cooling demands	Greatest capacity is in areas with relatively shallow granite or metamorphic bedrock	SCW systems require less pumping energy
Other Working Conditions		
Building Type: mixed use **Population Density**: medium density		
Notes on Costs		
	Areas with thick glacial deposits may pose challenges, as it may not be cost-effective to drill in those locations. Classified as Class V injection wells by the EPA and a permit is required to place it within 50 feet between boreholes and private drinking water wells	Costs required for pumping typically prohibitive where groundwater depth is greater than 100 feet. Feasibility limited by well spacing, pumping costs, and environmental regulations Cost of steel casing for exterior borehole may be prohibitive where distance to bedrock is greater than 100 feet.