Power Generation Advisory Panel
Meeting 4

November 20, 2020

NEW YORK STATE OF OPPORTUNITY. | Climate Action Council

PowerGenPanel@dps.ny.gov

Agenda

> Presentation: Future for Electricity

> Housekeeping

- Key Group Engagement
- Cross-Panel Engagement
- December Report Out to Climate Action Council

> Subgroup Kickoff (*Continued from Nov. 5 meeting*)

> Next Steps

Future for Electricity Presentation

Energy+Environmental Economics

Power Generation Advisory Panel: Scoping Plan Analysis Discussion

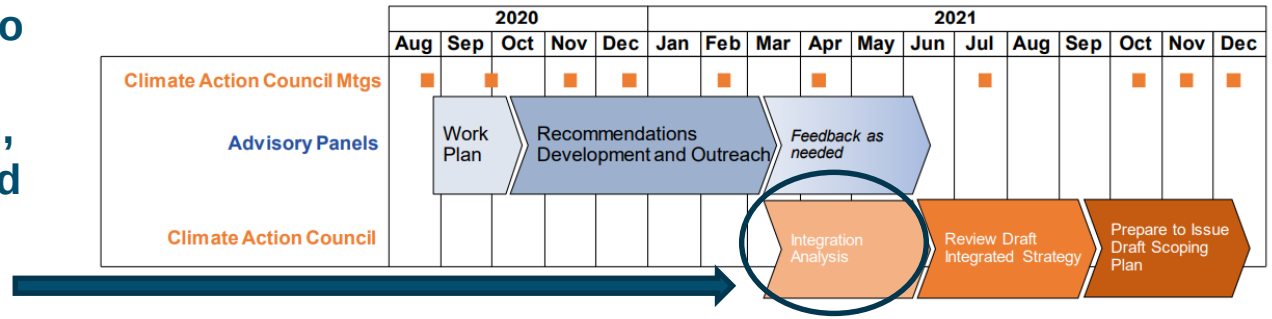
11/20/2020

Energy+Environmental Economics

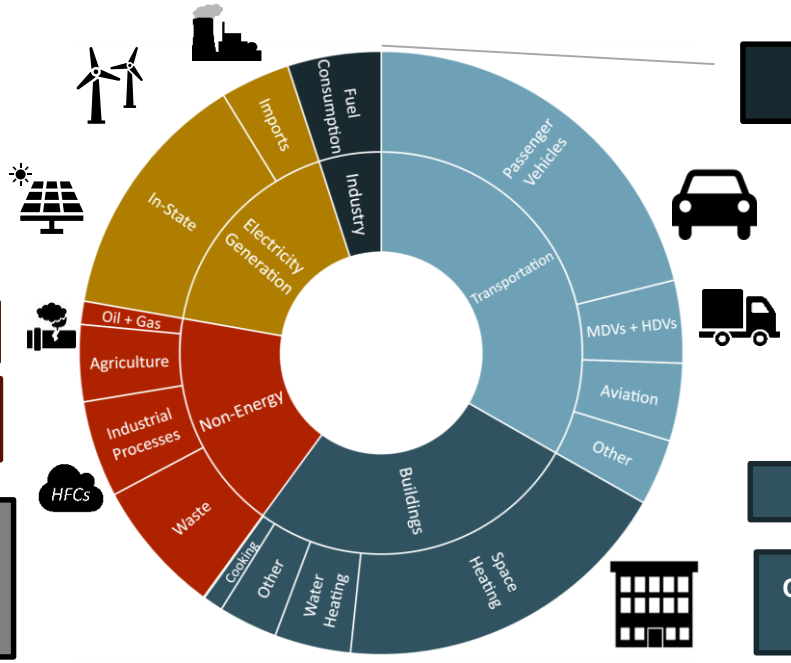
Scoping Plan Analysis Discussion

CLCPA Integration Analysis

+ **E3 Pathways framework to provide *integration analysis* for Scoping Plan, incorporating insights and recommendations from Advisory Panels and complementary studies**



Distribution of GHG Emissions by Sector*



- Power Generation AP
- Power Grid Study
- CES Cost Study
- Waste AP
- Agriculture & Forestry AP
- Methane Mitigation Potential from in-State Oil & Gas Systems Study
- Updated GHG Accounting
- Communities & Local Gov't AP
- Climate Justice WG
- Just Transition WG
- Energy Intensive & Trade Exposed Industries AP
- Transportation AP
- Transportation Roadmap
- Energy Efficiency & Housing AP
- Carbon Neutral Buildings & Building Electrification Roadmaps

* Based on current NYS GHG Inventory. Does not yet incorporate CLCPA emissions accounting

CLCPA Integration Cost Approach

- **The pathways framework produces economy-wide resource costs for the various mitigation scenarios relative to a Reference scenario**
  - The framework is focused on annual societal costs and benefits and does not track internal transfers (e.g. incentives)

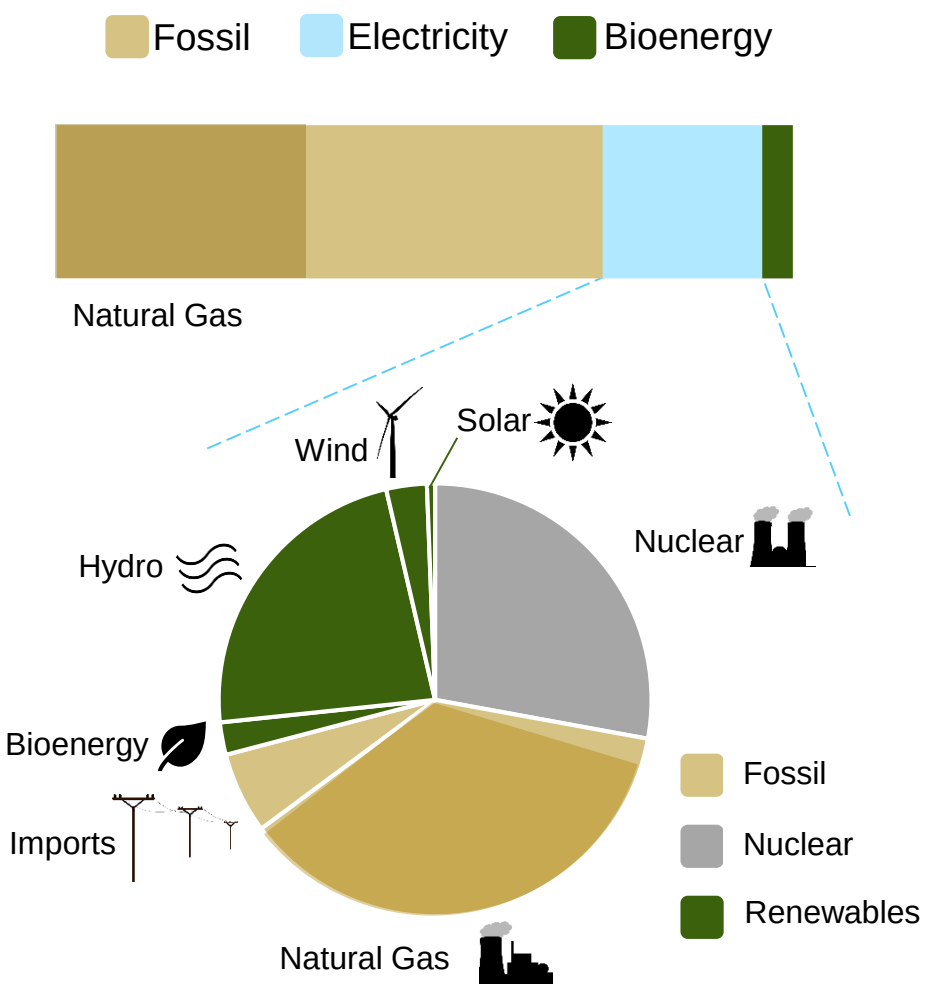
- **Outputs are produced on an annual time scale for the state of New York, with granularity by sector**
  - Annualized capital cost for energy infrastructure (e.g. devices, equipment, generation assets, T&D)
  - Annual fuel expenses by sector and fuel (conventional or low-carbon fuels, depending on scenario definitions)
  - Does not natively produce detailed locational or customer class analysis

Energy+Environmental Economics

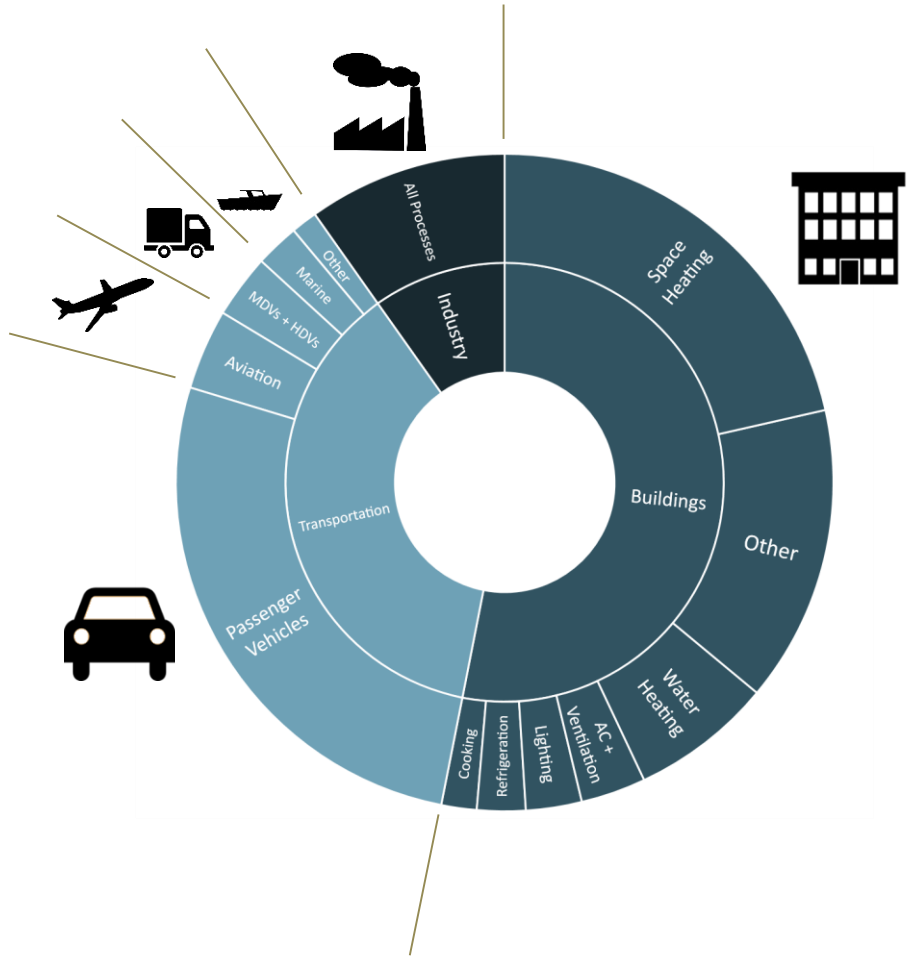
New York State's Energy System: Current Snapshot

New York State Energy Consumption

NYS Site Energy Consumption by Fuel



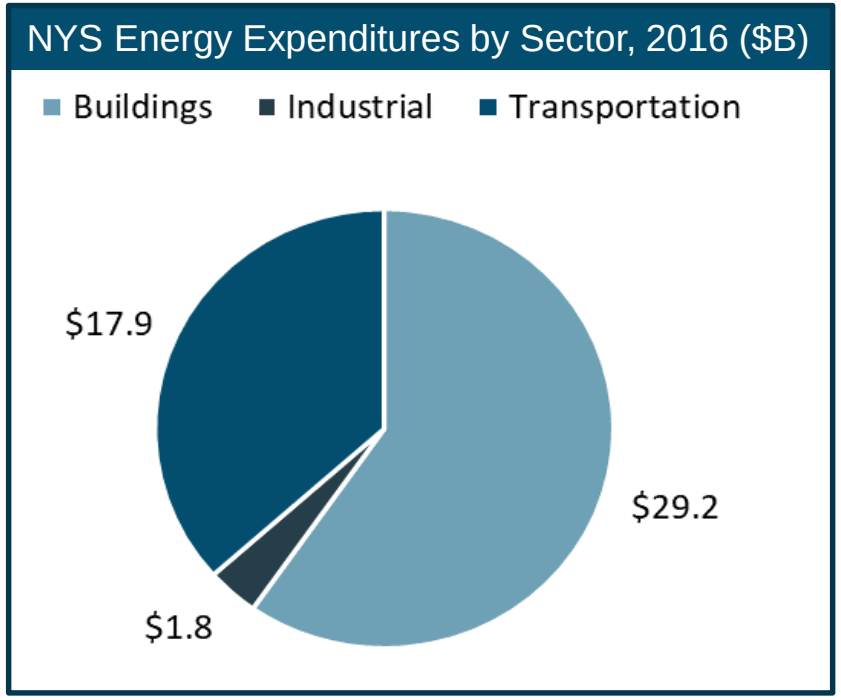
NYS Site Energy Consumption By Sector*

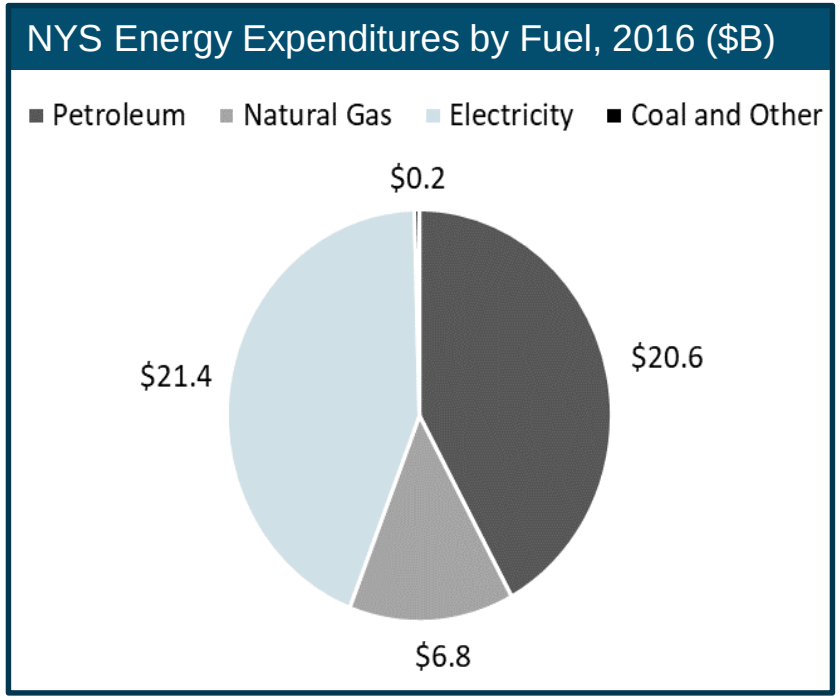


*Includes electricity, fossil fuels, and bioenergy

New York State Energy Expenditures

- **In 2016, total annual energy expenditures were approximately $50bn**
  - $22bn is estimated to leave NYS
- **Buildings sector spends the most on energy services, followed by industry and transportation**
- **Electricity and petroleum are the fuels with the largest share of total expenditures**





https://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/2002-2016-Patterns-and-Trends.pdf

Energy+Environmental Economics

Energy System Transition: Key Considerations

Evolution of New York State Energy Demand

TRANSPORTATION

+ Increased vehicle efficiency and major shift **to zero-emission vehicles** (battery electric, plug-in hybrid, and hydrogen fuel cell) across all vehicle classes
+ Substantial reductions in vehicle miles of travel through **smart growth, transit**, and other transportation demand management measures

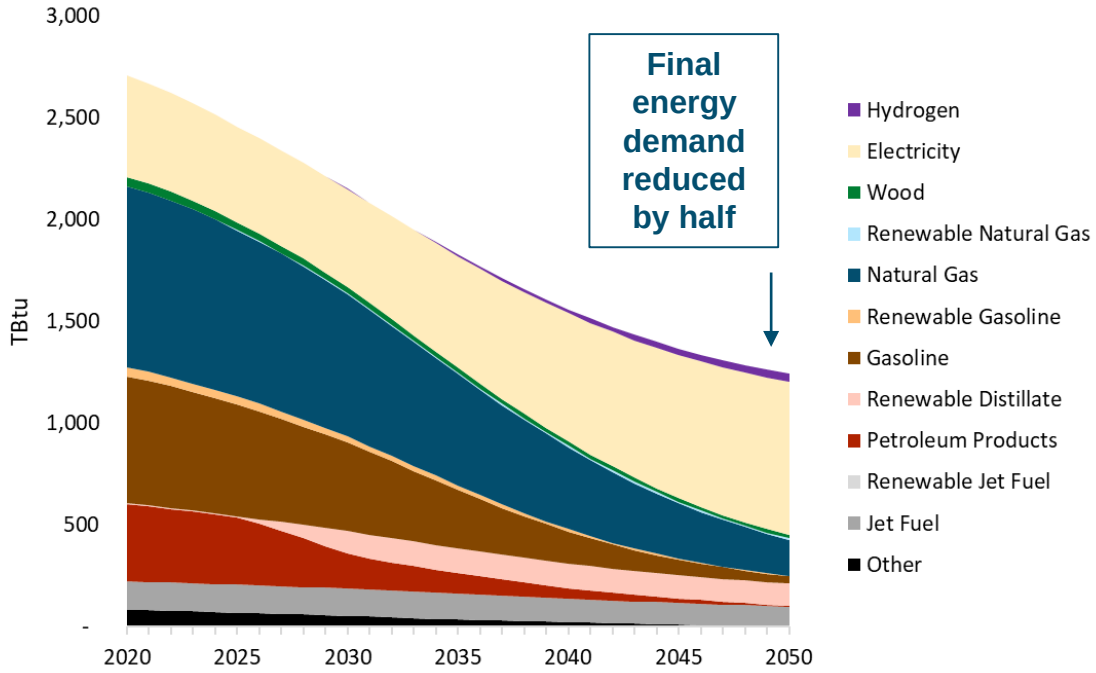
BUILDINGS & INDUSTRY

+ Efficiency across all building end-uses and building shell scales dramatically
+ Major shift to **end-use electrification** in buildings**,** particularly in space and water heating
+ In industry, continued investment in **energy efficiency** with innovation over time in areas like electrification and carbon, capture, utilization, and storage

LOW-CARBON RENEWABLE FUELS

+ Share of remaining combustible fuel use in medium- and heavy-duty vehicle fleets, non-road transportation, buildings, and industry met by **low-carbon renewable fuels** (*e.g.,* advanced biofuels or synthesized fuels)

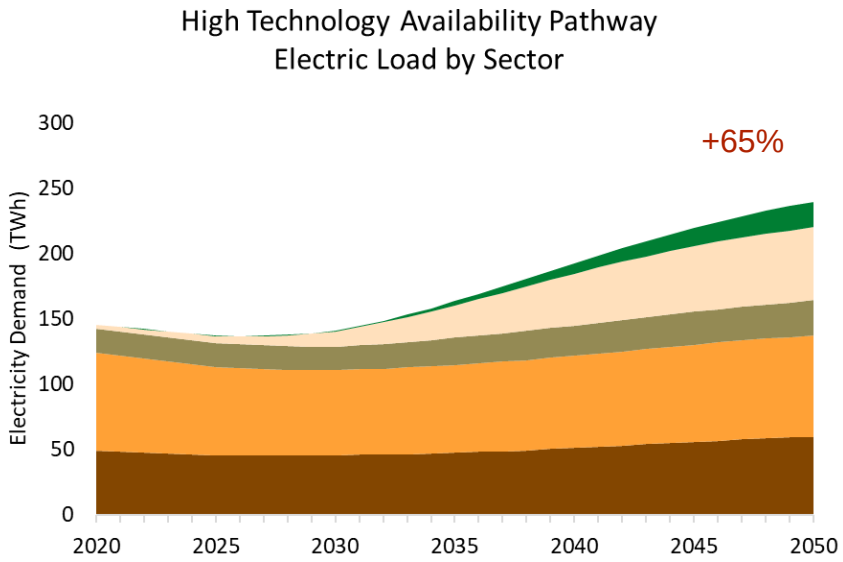
High Technology Availability Pathway

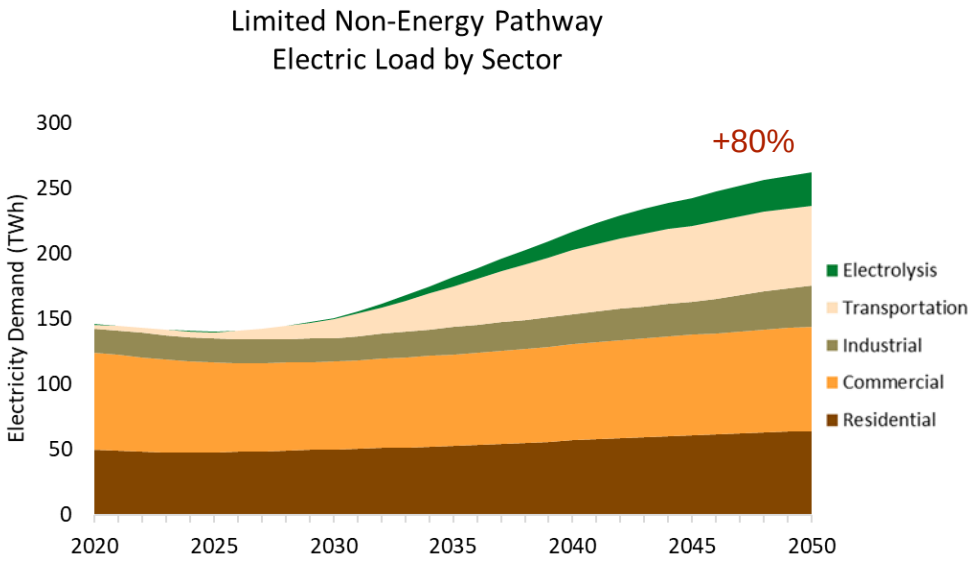


Evolution of Annual Electric Load

+ Electrification of buildings and transportation drives significant increase in electric load

- Analysis within range found in the literature, which project annual load increases ranging 20%-100% by midcentury
- Range primarily reflects extent and timing of end-use electrification, with some studies assuming lower electrification and larger role for renewable and/or zero-carbon fuels

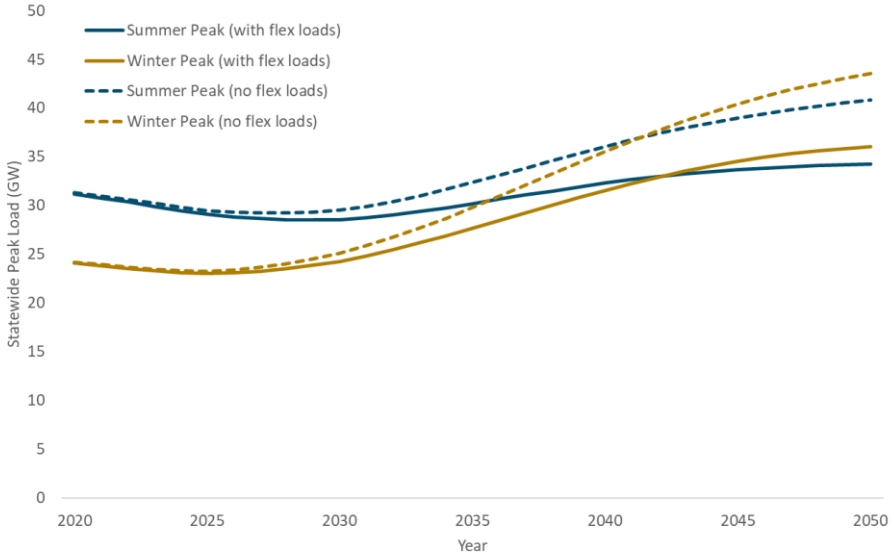




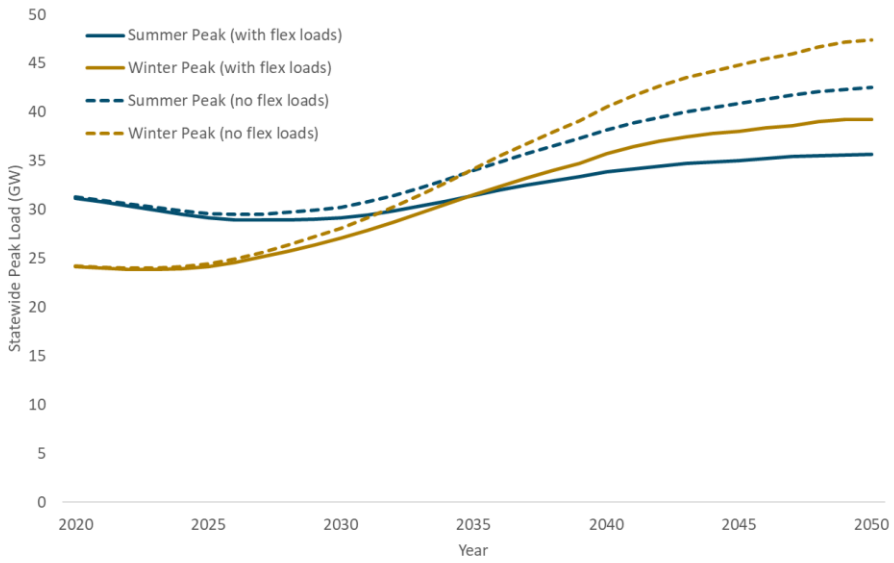
Evolution of Peak Electricity Demand

- **New York State shifts from summer peak to winter peak between 2035 and 2040, driven primarily by electrification of heating in buildings and EV battery charging**
  - Timing of shift to winter peak will depend on the pathway and the timing and technology shares of building and transportation electrification
  - Flexibility in electric vehicles and building loads can significantly reduce peak demands and the need for new generation capacity

High Technology Availability Pathway
Peak Electricity Demand

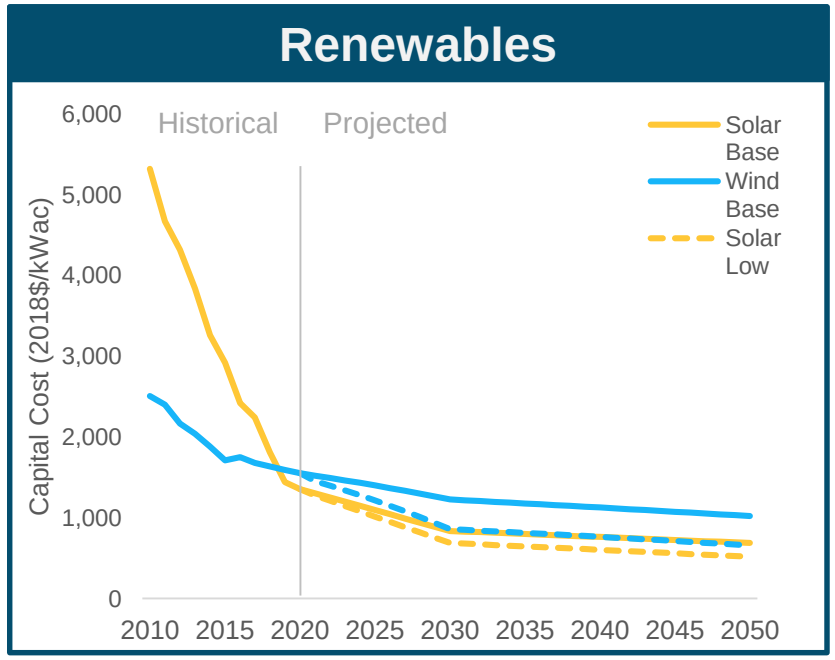


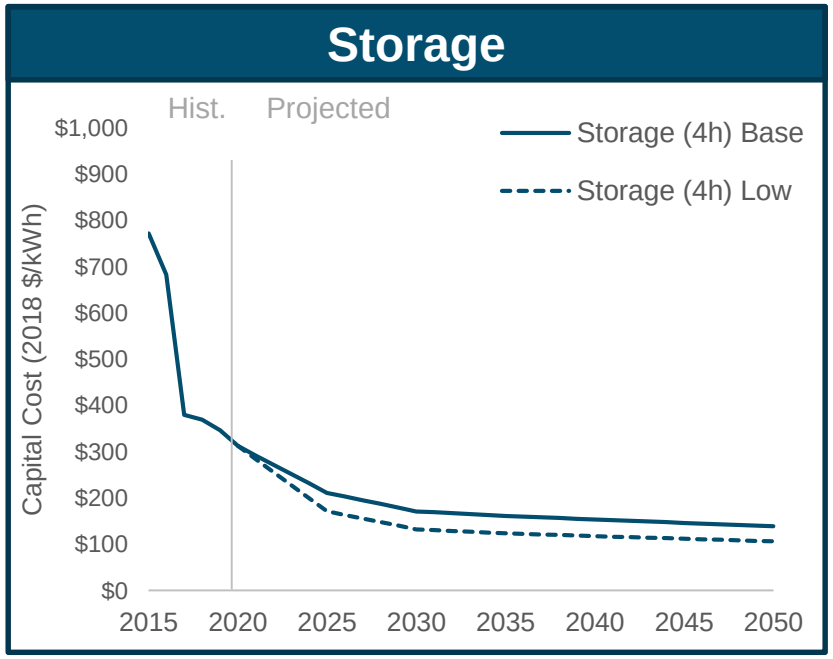
Limited Non-Energy Pathway
Peak Electricity Demand



Key Technology Costs

- **Wind and solar capital costs have declined by 43% and 73% respectively over the past decade**
- **Costs of Li-ion battery storage have declined by 51% since 2015**
- **Our analysis incorporates future cost declines for each technology as projected by NREL**

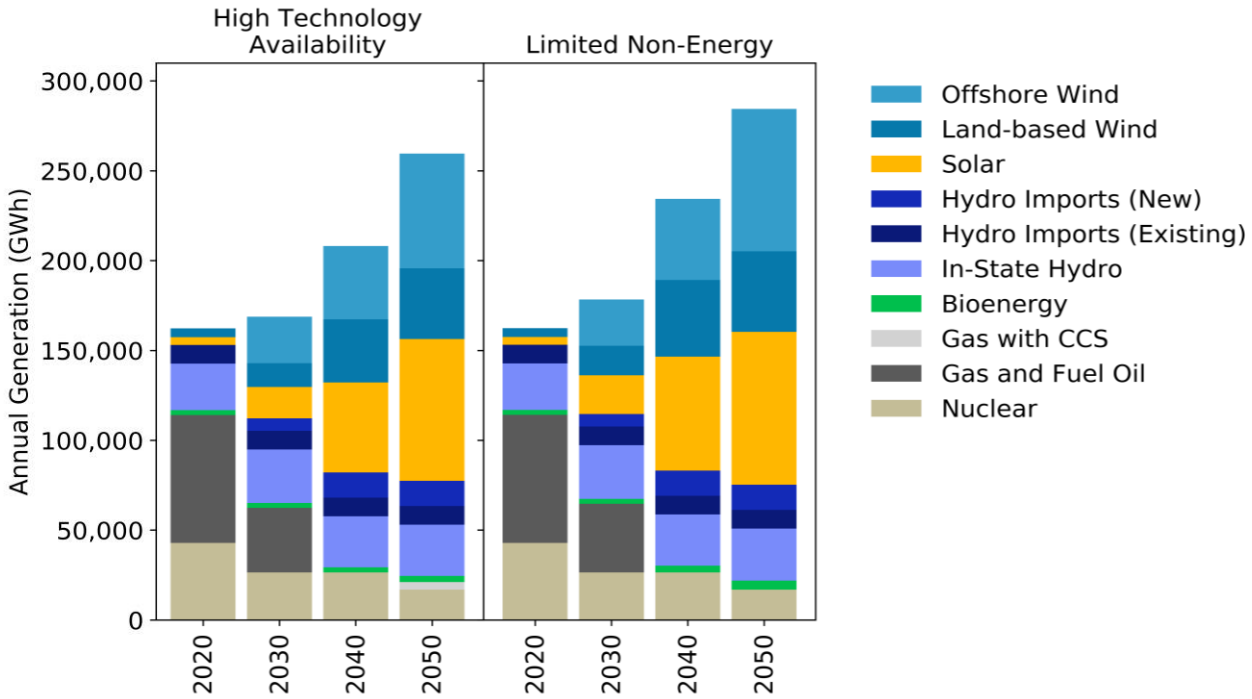




Sources: LBNL, NREL, Lazard

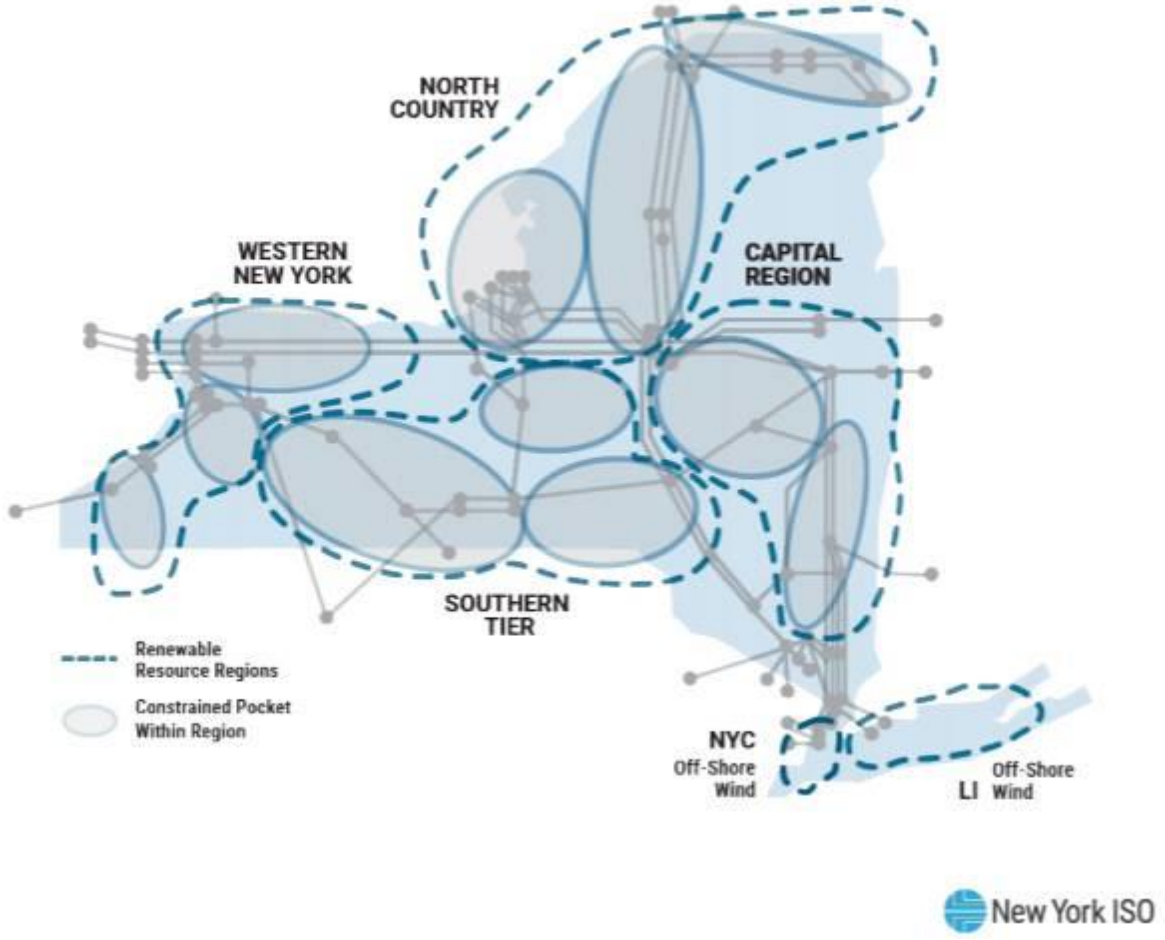
Evolution of Electricity Supply

- To decarbonize electricity supply, New York must meet rapidly growing loads while transforming to a system powered primarily by variable renewable resources
- Battery storage and demand-side flexibility can play a key role in balancing output of high levels of variable renewables



Evolution of Electricity Supply

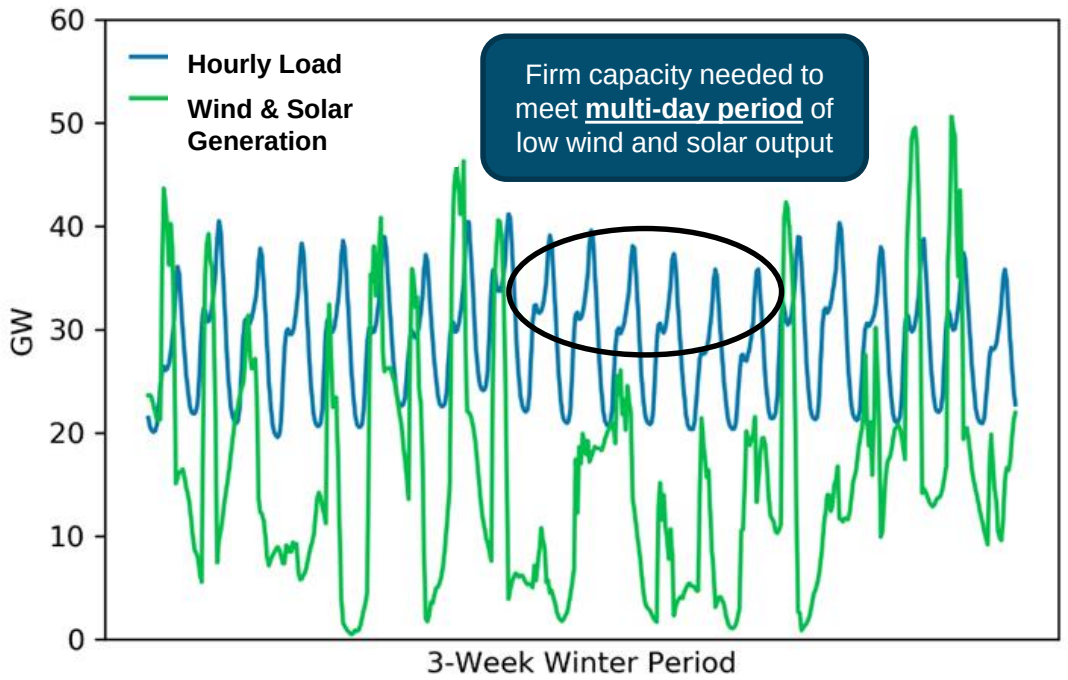
- Western NY, AC Transmission, recent NYPA Northern NY and expected Clean Energy Standard Tier 4-NYC transmission projects support State's clean electricity goals and alleviate near-term bulk system curtailment
- However, there may be substantial curtailment at sub-transmission levels of the system



Maintaining System Reliability

- As the share of intermittent resources like wind and solar grows substantially, some studies suggest that complementing with firm, zero-emission resources, such as bioenergy, synthesized fuels such as hydrogen, hydropower, carbon capture and sequestration, and nuclear generation could provide a number of benefits[1,2,3]
- The need for dispatchable resources is most pronounced during winter periods of high demand for electrified heating and transportation and lower wind and solar output

NYS Electric Load and Wind + Solar Generation in 2050 Pathway



Hourly loads based on six years of historical weather 2007-2012

[1] Sepulveda, N., J. Jenkins, F. de Sisternes, R. Lester. (2018) The Role of Firm Low-Carbon Electricity Resources in Deep Decarbonization of Power Generation. Joule, 2(11), pp. 2403-2420. DOI: https://doi.org/10.1016/j.joule.2018.08.006.
[2] Jenkins, J., M. Luke, S. Thernstrom. (2018) Getting to Zero Carbon Emissions in the Electric Power Sector. Joule, 2(12), pp. 2498-2510. DOI: https://doi.org/10.1016/j.joule.2018.11.013.
[3] E3. 2019. Resource Adequacy in the Pacific Northwest. https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf

Electricity Decarbonization Resources

+ **RESOLVE modeling relies on the following key inputs for decarbonization resources:**
  - **Existing and Planned Capacity**
    - NYISO Gold Book
  - **Costs of Candidate Resources:**
    - **Thermal Generators:** NYISO Demand Curve Study
    - **Renewable Generators:** Clean Energy Standard Whitepaper and NREL Annual Technology Baseline
    - **Storage:** Lazard Levelized Cost of Storage, NYSERDA Storage Roadmap, NREL Annual Technology Baseline
  - **Fuel Prices**
    - NYISO CARIS Report, EIA Annual Energy Outlook
  - **Peak Load Impacts and Load Flexibility**
    - Parallel Workstreams

Resource Type	Examples	Considerations
Thermal Generation (Fossil Fuels)	• Simple cycle combustion turbines (CTs) or combined cycle gas turbines (CCGTs)	• Balancing near-term reliability needs with long-term phaseout
Thermal Generation (low-carbon / zero-emission)	• Nuclear • Combustion turbines utilizing zero-emission fuels (RNG, H2) • CCGTs with CCS	• Techno-economic feasibility • Crossover with long-duration storage
Renewable Generation	• In-state hydro • Hydro imports • Solar PV (utility-scale and distributed) • Wind (onshore & offshore)	• Execute on processes for planning, siting, and integration
Energy Storage	• Short-duration storage (>1hr) • Long-duration storage (>12hr)	• Continue progress • Long-duration storage a priority for innovation
Customer Technologies	• Flexible loads	• Need for temporal and locational price signals • Optimize across the meter

Key Advanced Technology Priorities for a Clean, Reliable, and Affordable Energy System

Buildings

- Thermal storage (including phase change materials, integration with heating systems)
- Innovation in cold-climate heat pumps (including low-GWP refrigerants)
- Grid interactive building controls
- Building envelope retrofit solutions

Transportation

- Fast EV charging infrastructure
- Smart vehicle charging networks
- Aviation solutions

Electric Grid

- Energy storage for T&D services
- Advanced grid solutions and business models
- Long-duration storage
- Dynamic line ratings and improved transmission utilization
- Power flow control devices
- Advanced high-temperature, low sag (HTLS) conductors
- Compact tower designs

Low-Carbon Fuels and Carbon Dioxide Removal

- Industrial CCS
- Production of zero-carbon fuels (e.g. low-cost electrolyzers)
- Direct Air Capture

Note: Technologies above are illustrative examples; list is not intended to be exhaustive or indicative of prioritization.

Energy+Environmental Economics

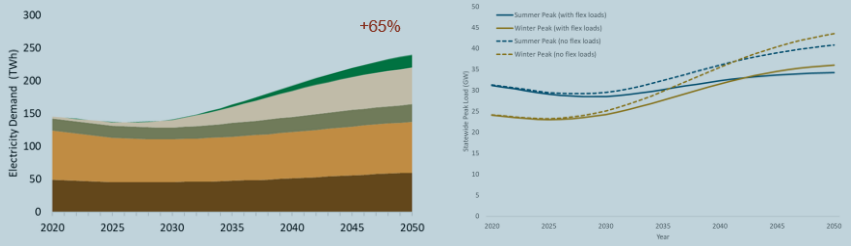
Analyzing Impacts of Electrification on New York Power System

Linkages to Parallel Workstreams

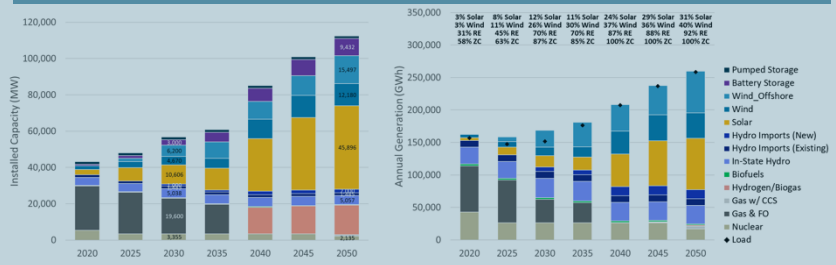
- **CLCPA electric sector analysis will draw on insights from other workstreams to more fully understand the impacts and costs of electrification of the buildings and transportation sectors**
- **Impacts of electrification will depend on technology shares, customer behavior, and complementary policies and strategies**

Pathways Framework

Annual and Peak Electricity Demand



Electric Sector Resource Portfolio



Starting Point Pathways

Impacts of Electrification

Parallel Workstreams

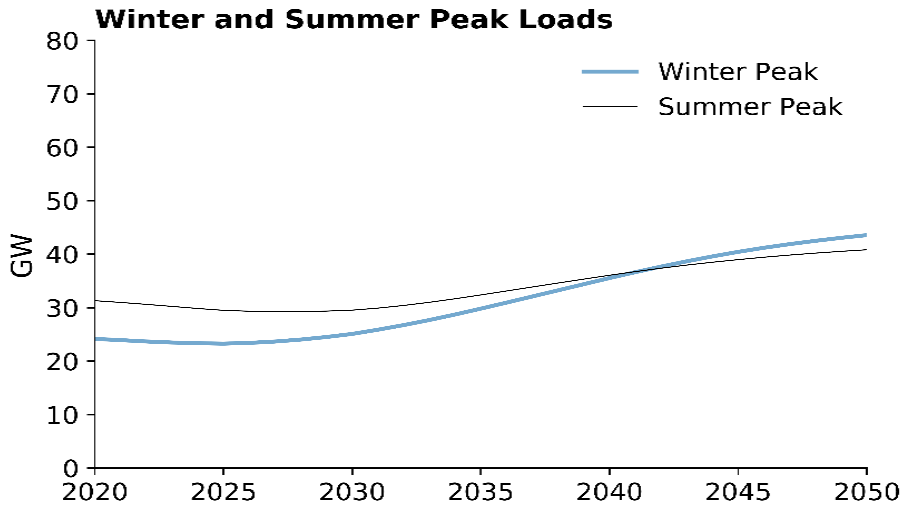
Transportation Roadmap
NYSERDA, Cadmus, Nexant

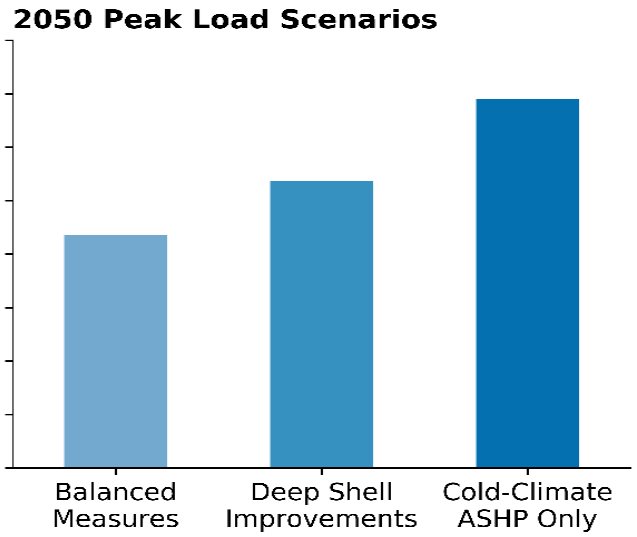
Carbon Neutral Buildings Roadmap
NYSERDA, RMI, NBI

Building Electrification Roadmap
NYSERDA, Cadmus, IEc

Insights from Parallel Workstreams in Buildings Sector

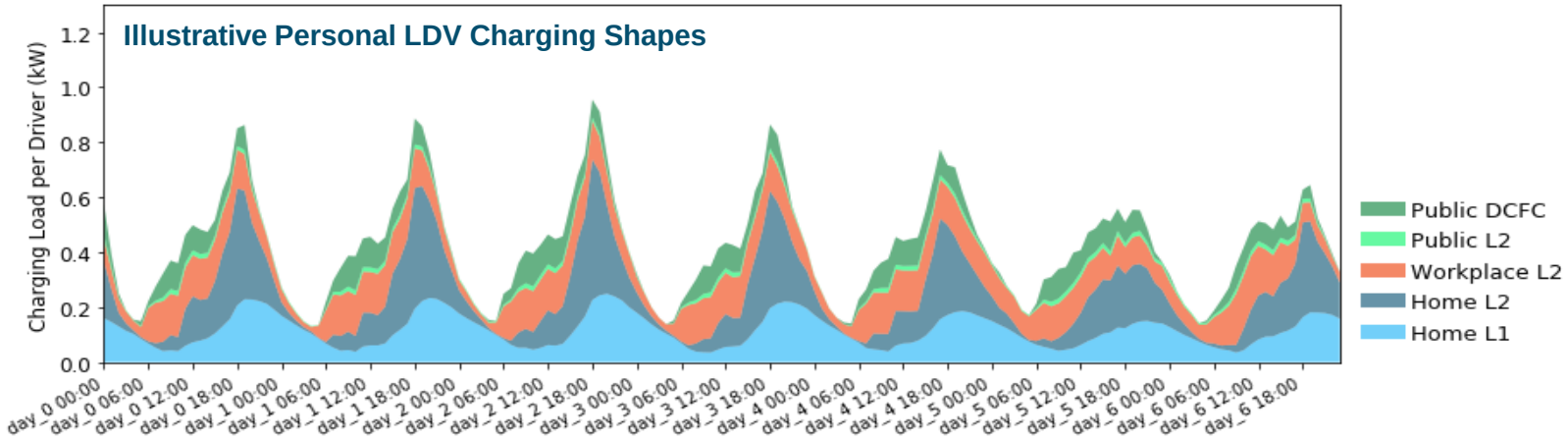
- **The Carbon Neutral Buildings Roadmap examines key questions around the load and resource impacts of heat pump adoption:**
  - What are the hourly and peak load impacts of carbon neutral buildings under different electrification scenarios? What are the impacts of measures that can help mitigate "peak heat" – e.g. building shell improvements, load flexibility, or combustion backup?
- **The Building Electrification Roadmap examines key questions around the timing and economics of heat pump adoption:**
  - What near-term strategies and policies are needed to reach heat pump adoption levels aligned with the CLCPA targets?





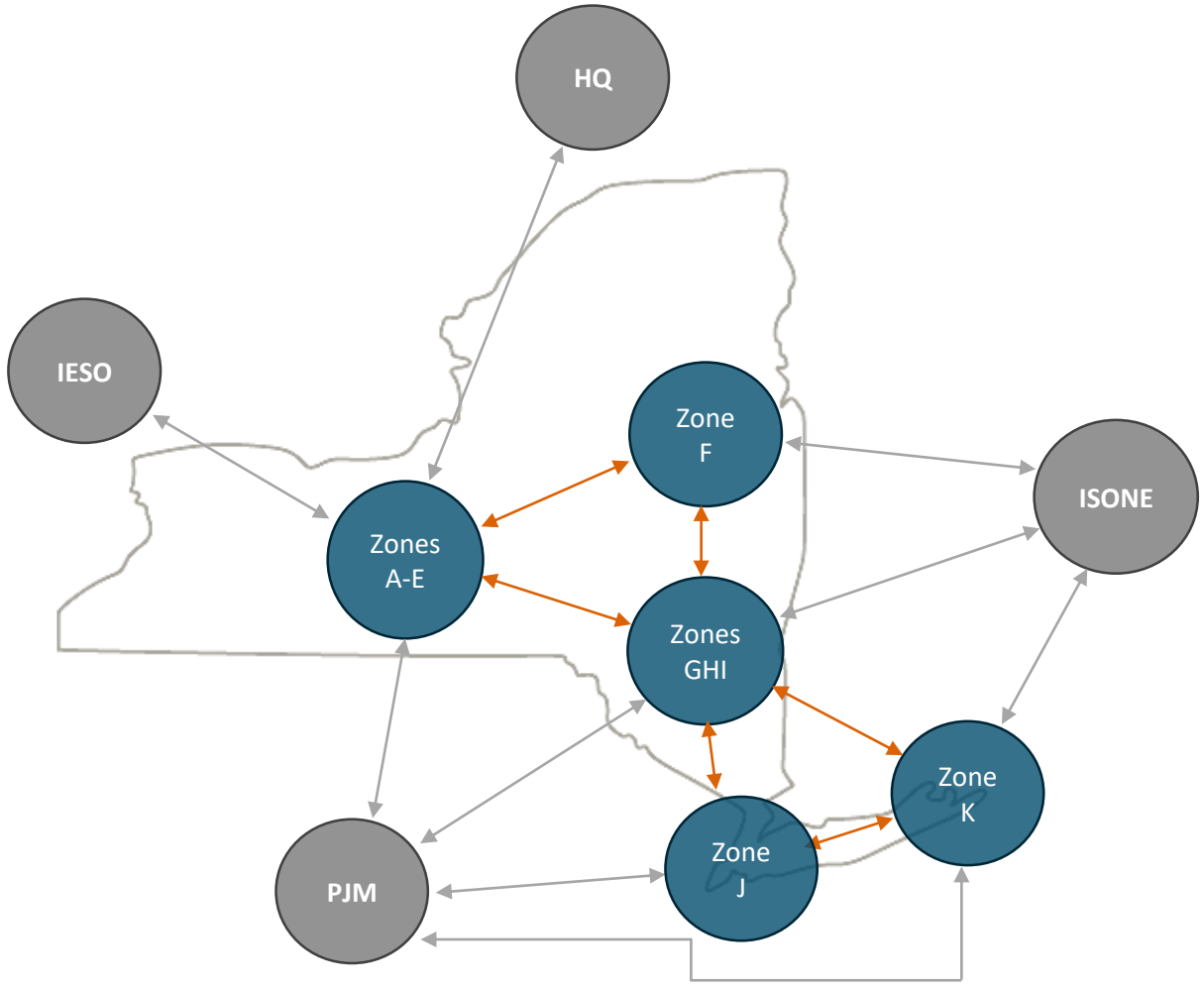
Insights from Parallel Workstreams in Transportation Sector

- **The Clean Transportation Roadmap will examine different trajectories to meet New York's transportation sector goals**
  - What are the hourly and peak load impacts of electrified transportation under different vehicle shares for light-duty and medium to heavy-duty vehicles?
  - What are the implications of varying levels of charger deployments and other EV infrastructure investments?
  - How do different EV charging patterns and flexibility incentives affect New York's needs for new electricity supply?
- **The Roadmap analysis will also analyze the impacts of building and transportation electrification on distribution infrastructure**



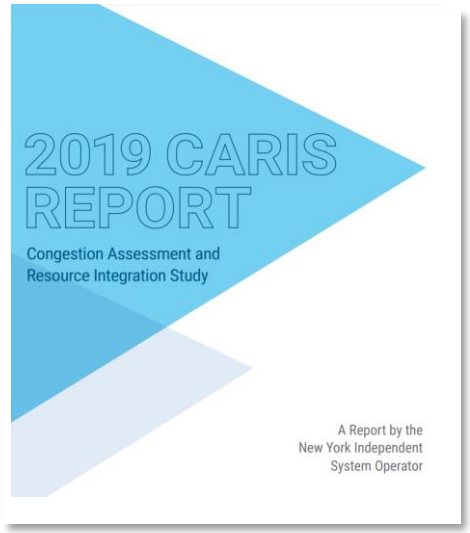
Bulk Transmission

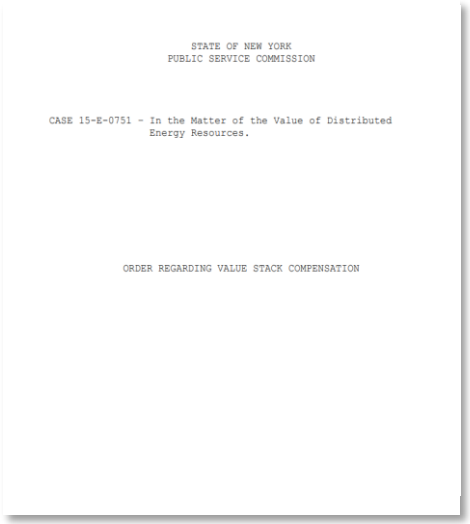
- Updated framework will contain more detailed representation of Downstate NY
- Will capture important local dynamics including CES Tier 4, impacts of offshore wind on zonal capacity requirements
- Costs of Bulk Transmission upgrades are based on AC Transmission docket
- Will incorporate learnings from Power Grid Study



Local Transmission and Distribution

- **Local transmission upgrades will be needed to "unbottle" renewables generation and ensure deliverability**
  - Analysis will seek to draw on findings from CARIS Report and Power Grid Study
- **Distribution infrastructure will need to be enhanced as the electrification of transportation and buildings drives new load growth**
  - Cost estimates based on marginal cost studies and demand reduction value (DRV) identified in Value of DER proceeding
- **Will seek to incorporate learnings from Nexant on implications of electrification on distribution infrastructure**





Next Steps

- Share key input assumptions with Power Generation Advisory Panel for review and feedback
- Incorporate recommendations and insights from other Advisory Panels and complementary studies into integration analysis
- As part of the integration analysis explore electricity system scenarios testing implications of different assumptions

Energy+Environmental Economics

Appendix

Economy-wide analysis combines detailed energy accounting model and electric sector optimization

E3's integrated analytical framework combines a detailed accounting model of energy supplies and demands across the entire economy with an optimized capacity expansion model in the electric sector

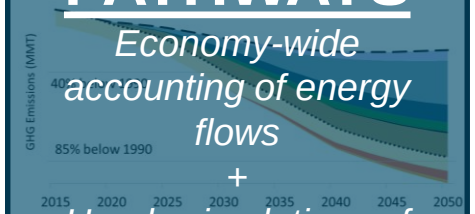
1 Use detailed energy accounting model to examine pathways to reaching long-term economy-wide goals and implications for electric loads

PATHWAYS

Economy-wide accounting of energy flows

+

Hourly simulations of electrified end uses



Future System Load Shapes

Electric Sector Emissions

Electricity Module

Optimized Capacity Expansion

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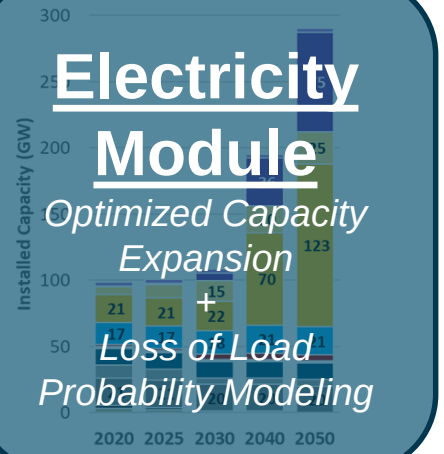
Loss of Load Probability Modeling

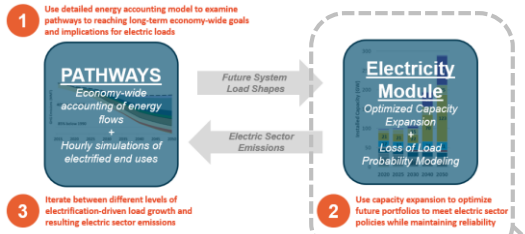


3 Iterate between different levels of electrification-driven load growth and resulting electric sector emissions

2 Use capacity expansion to optimize future portfolios to meet electric sector policy goals while maintaining reliability

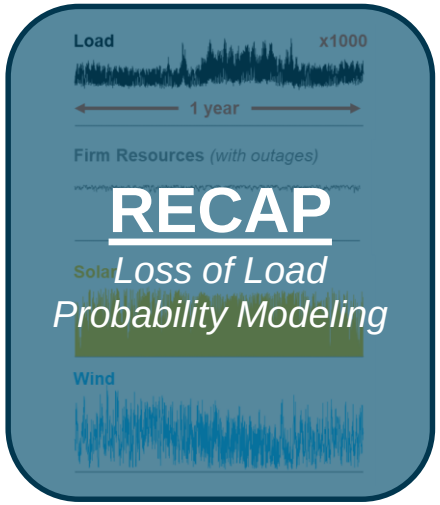
Confidential and Deliberative Draft

Electric sector module combines capacity expansion and loss-of-load-probability modeling



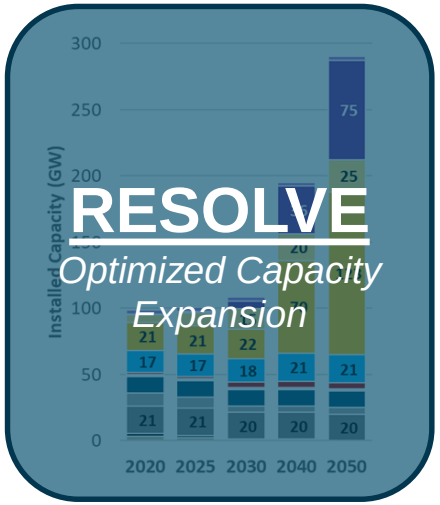
Pairing a capacity expansion model with loss-of-load-probability modeling provides a framework to capture the detail needed for resource adequacy, without explicitly modeling all conditions in the capacity expansion model

2a Use LOLP model to quantify "effective load carrying capability," which measures contribution of each resource to reliability across 100s of simulations



Technology ELCC curves

Optimized Portfolios

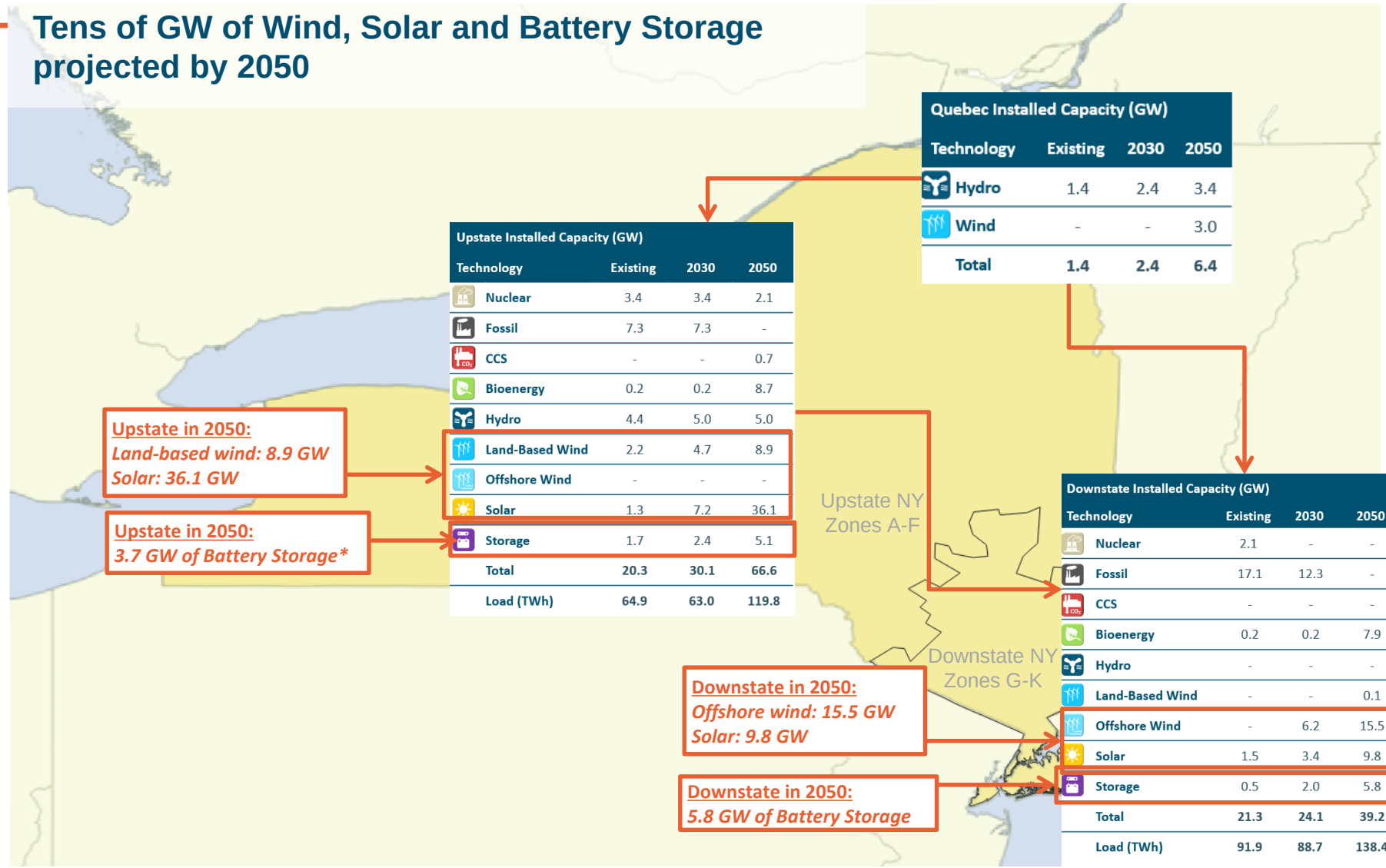


2c Use LOLP model to simulate resulting portfolios across wide range of conditions, validating resource adequacy

2b Use capacity expansion to optimize future portfolios to meet reliability and clean energy goals while minimizing cost

Evolution of Electricity Supply

+ Tens of GW of Wind, Solar and Battery Storage projected by 2050



Quebec Installed Capacity (GW)

Technology	Existing	2030	2050
Hydro	1.4	2.4	3.4
Wind	-	-	3.0
Total	**1.4**	**2.4**	**6.4**

Upstate Installed Capacity (GW)

Technology	Existing	2030	2050
Nuclear	3.4	3.4	2.1
Fossil	7.3	7.3	-
CCS	-	-	0.7
Bioenergy	0.2	0.2	8.7
Hydro	4.4	5.0	5.0
Land-Based Wind	2.2	4.7	8.9
Offshore Wind	-	-	-
Solar	1.3	7.2	36.1
Storage	1.7	2.4	5.1
Total	**20.3**	**30.1**	**66.6**
Load (TWh)	**64.9**	**63.0**	**119.8**

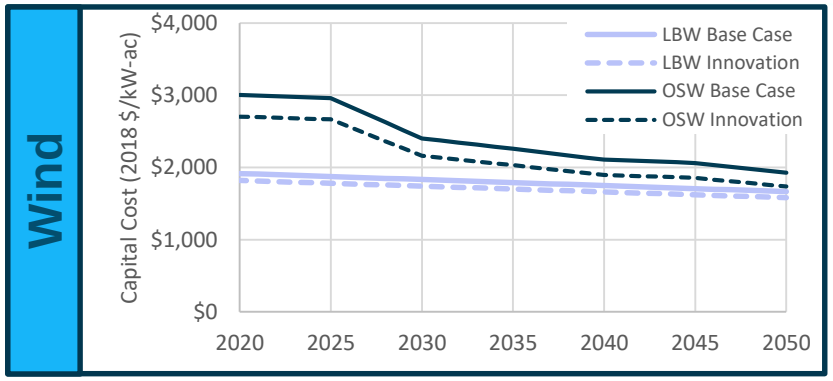
Downstate Installed Capacity (GW)

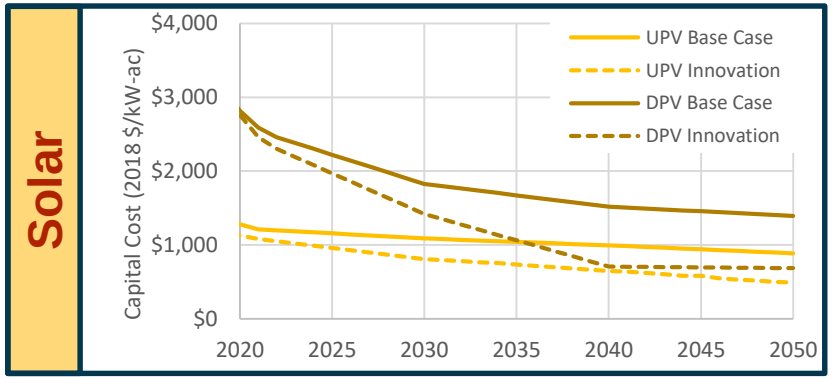
Technology	Existing	2030	2050
Nuclear	2.1	-	-
Fossil	17.1	12.3	-
CCS	-	-	-
Bioenergy	0.2	0.2	7.9
Hydro	-	-	-
Land-Based Wind	-	-	0.1
Offshore Wind	-	6.2	15.5
Solar	1.5	3.4	9.8
Storage	0.5	2.0	5.8
Total	**21.3**	**24.1**	**39.2**
Load (TWh)	**91.9**	**88.7**	**138.4**

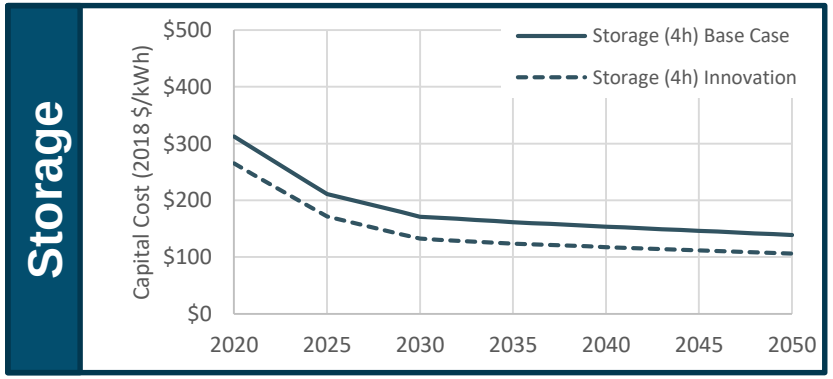
*Total 5.1 GW includes existing pumped storage capacity

Key NYS Technology Costs

- Current costs of wind and solar resources in New York State were developed using the Clean Energy Standard Cost Analysis
- Projections for future cost declines of wind and solar resources are based on NREL's Annual Technology Baseline
- Cost estimates for battery storage resources are based on New York Storage Roadmap, NREL, and Lazard







Housekeeping

Key Group Engagement

Objective: To hear directly from groups their views on the most pressing issues, on “good” outcomes, and on suggested recommendations or recommendation topics.

> **Labor**
- Climate Jobs New York
- NYS AFL-CIO
- Other?

> **Customer Groups**
- *Public Utility Law Project (PULP)*
- AARP
- *Utility Intervention Unit (UIU)*
- New York Energy Consumers Council (NYECC)
- Association for Energy Affordability (AEA)
- NYPIRG
- Consumer Reports
- Citizens Union
- Common Cause
- Mothers Out Front
- North Country Community Conversation on Poverty
- Consumer Power Advocates
- Other?

> **Environmental Justice Groups**
- Sane Energy Project
- NY Renews
- PUSH Buffalo
- Nobody Leaves Mid-Hudson
- We Act for Environmental Justice
- ALIGN (Alliance for a Greater New York)
- Other?

> **Environmental Groups**
- New York League of Conservation Voters (NYLCV)
- *Natural Resources Defense Council (NRDC)*
- Environmental Defense Fund (EDF)
- Other?

> **Other**
- *New York Independent System Operator (including on Carbon)*
- New York State Reliability Council (NYSRC)
- *DEC (Carbon)*
- City of New York

Cross-Panel Engagement

> **Climate Justice Working Group**

- CJWG interested in providing early guidance to panels on what they should be thinking about when considering disadvantaged communities in developing recommendations
- Panels are invited to send a delegation to one of the upcoming CJWG meetings to get input:
  - December 2 at 12pm
  - December 16 at 1pm
- Need to let CJWG best date for our panel
- The full panel does not need to attend but are welcome

December Report Out to Climate Action Council

- **Each panel will report out to Climate Action Council at November or December meeting**
- **Opportunity for panels to:**
  - Speak to panel efforts to-date and identify upcoming activities
  - Provide overview of panel discussions
  - Seek input on priority policies/strategies and progress towards recommendations
- **For key strategies/recommendations under consider, present:**
  - Rationale for recommendation
  - Equity considerations
  - Implementation challenges/barriers
  - Issues to explore further
- **Power Generation Panel slotted for December 15th Climate Action Council meeting**
  - Will aim to provide materials for panel review a week in advance

Subgroup Kickoff

Scope of Work Topics

Resource Mix

- Electrification of Buildings and Transportation
- Natural Gas System
- Downstate Peakers
- Instate Renewables
- Regional Connections (beyond NYS)
- Downstate Renewables
- Resource Transition/Ramping Fossils Down
- Energy Conservation
- Local/DER
- Energy Storage

Equity

- Equity - access to clean solutions
- Community impacts
- Affordability
- Jobs/Prevailing Wage/Equity of access

Solutions Needed for Future

- Reliability of the Future Grid – Storage, Flexible/Dispatchable Resources
- "Last" Clean Megawatts (Final X%)
- Encouraging the Needed Investment
- Markets for the Future (Including Resource Adequacy, Carbon)
- Needed Innovation
- Energy Delivery

(Potential) Barriers

- Clean Energy Siting
- Energy Delivery
- Interconnections

Scope of Work Topics

Resource Mix

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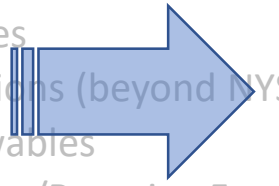

- **Peakers**
- **Natural Gas Transition**
- **Demand Response**

Solutions Needed for Future

- Reliability of the Future Grid – Storage, Flexible/Dispatchable Resources
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- Encouraging the Needed Investment
- Markets for the Future (including Resource Adequacy, Carbon)
- Needed Innovation
- Energy Delivery

- **Technology Innovation**
- **Markets**
- **Bioenergy**

Equity

- Equity - access to clean solutions
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- Affordability
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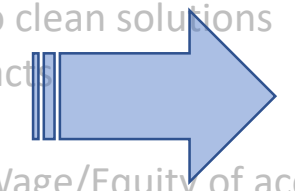
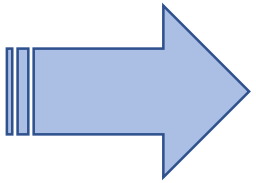


- **Affordability**
- **Access**
- **Jobs**

(Potential) Barriers

- Clean Energy Siting
- Energy Delivery
- Interconnections



- **Siting**
- **Transmission**
- **DG Compensation**

Continuing the Discussion

- **Resource Mix** *(Discussed at 11/5/2020 Panel meeting)*
  - **Renewables**
  - **Fossil Fuels**
- **Solutions Needed for the Future**
  - **Technology**
  - **Last Clean Megawatts**
  - **Markets**
- **Potential Barriers**
- **Equity** *(Discussed at 11/5/2020 Panel meeting)*

Solutions Needed for the Future

- **What longer-term solutions are needed for reliability and flexibility that we should start addressing today?**
- **Key Questions:**
  - What innovations are the highest priority?
  - What changes are needed to the power markets to better align with the flexibility and clean energy goals of the state?
  - Should reliability standards remain the same or become more stringent as more sectors are electrified?
  - Are there new technologies that would help to meet reliability needs without a significant overbuild of renewable resources?
  - How can targeted technology development (e.g., long duration storage) help to accelerate the pace or reduce the cost of the transition to a cleaner grid?
  - What is the role of bioenergy and synthetic fuels?
  - What regulatory or statutory framework is needed for the development and use of CCS technology?
- **Example Recommendations (for Panel to resolve and flesh out with specific actions):**
  - Facilitate the development of dispatchable emission-free resources that can run for extended periods
  - Expand market design to allow for hybrid storage and wholesale distributed energy resources

Potential Barriers

- **What actions, if implemented today, would accelerate the pace and/or reduce the costs of the transition of electric system?**
- **Key Questions:**
  - What can be done to improve the siting of large-scale renewables to reach the significant levels of in-state development required?
  - What are the limitations to our current T&D systems?
  - Are there regulatory barriers that are preventing smart transmission and distribution system investments?
  - How can the timeframe of the interconnection study process be reduced?
  - How do we equitably distribute the costs of required deliverability infrastructure?
- **Example Recommendations (for Panel to resolve and flesh out with specific actions):**
  - Public-Private Partnerships to facilitate clean energy siting
  - Specific changes to the interconnection process
  - Suggested proceedings for the PSC to open

Resource Mix

- **What is needed to ensure we have the resources necessary to meet our goals?**
- **Key Questions:**
  - How do we ensure grid side readiness and flexibility as electrification of buildings and transportation add load to the electric grid?
  - Are there good opportunities to expand demand response resources and programs to provide for increased grid flexibility?
  - How do we handle the stranded costs of existing natural gas infrastructure assets as natural gas is transitioned?
  - How do we increase renewables deployed downstate?
  - How do we accelerate advanced energy storage deployment?
  - How quickly should peakers be phased out?
  - Are there opportunities to improve regional coordination to help integrate larger amounts of intermittent resources?
  - How do we advance to goals and prepare for reliability while also anticipating that technology advancements (including carbon capture) may provide an opportunity which we may otherwise plan away from?

Resource Mix

> **Example Recommendations (for Panel to resolve and flesh out with specific actions):**

- Ensure that electrification of buildings and transportation is managed with proper attention to optimizing grid-side impacts
- Peakers:
  - Aggressive ramp down of peaker use, driven primarily by emissions reductions goals; OR
  - Tempered ramp down of peaker use, driven both by emissions reductions goals and reliability requirements
- Natural Gas:
  - End all investments in system; OR
  - Continue to invest in gas system according to stringent standards to ensure safety, reliability, and flexibility of the electric system while gradually reducing gas use
- Encourage downstate distributed renewables through changes to compensation/interconnection

Equity

- **Key Questions:**
  - How can we ensure solutions are accessible to everyone?
  - How can we “replace” jobs lost in the fossil-fuel industry?
  - How do we maintain energy affordability, particularly for those most vulnerable, while transitioning the power sector will require massive investment?
  - Are their disproportionate gaps in clean energy industry jobs?
  - How should the disproportionate impacts of continued peaker operations on their local communities’ health and environment be weighed against the cost of replacement?
- **Example Recommendations (for Panel to resolve and flesh out with specific actions):**
  - How can we ensure solutions are accessible to everyone?
  - How can we “replace” jobs lost in the fossil-fuel industry?
  - How do we maintain energy affordability, particularly for those most vulnerable, while transitioning the power sector will require significant investment?
  - Are their disproportionate gaps in clean energy industry jobs?
  - How should the disproportionate impacts of continued peaker operations on their local communities’ health and environment be weighed against the cost of replacement?

Next Steps

Next Steps

> Climate Action Council meeting on November 24th, 2pm EST (https://climate.ny.gov/)

> Continue discussion of issues and development of draft recommendations through subgroups

> Engage in cross-panel discussions

> Report out on Panel progress at December 15th Climate Action Council meeting

> Power Generation Advisory Panel meeting on December 21st, 9:30am EST