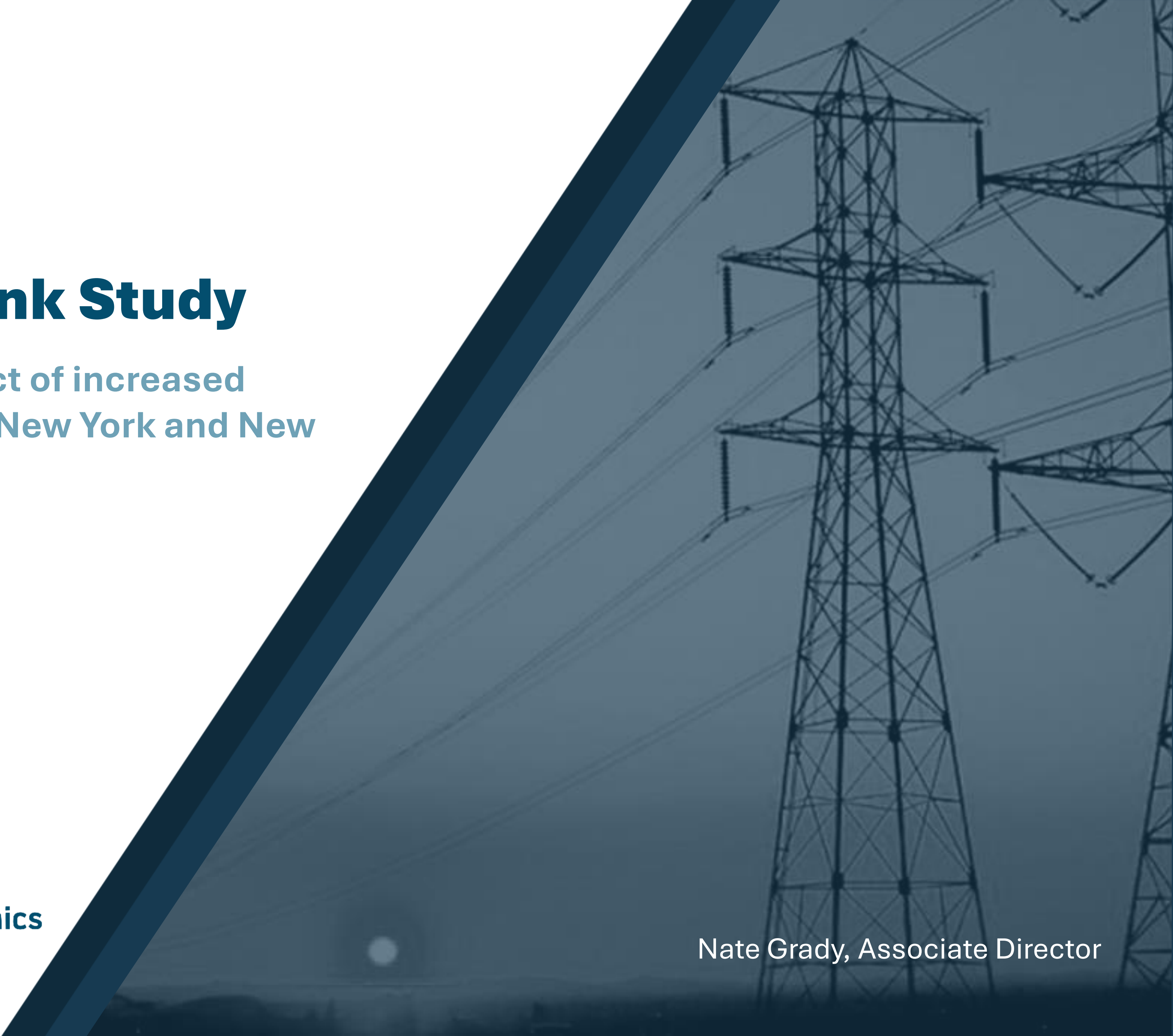
Clean Resilience Link Study

Assessing the operational impact of increased transmission capacity between New York and New England

6/19/2024



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Nate Grady, Associate Director

Agenda

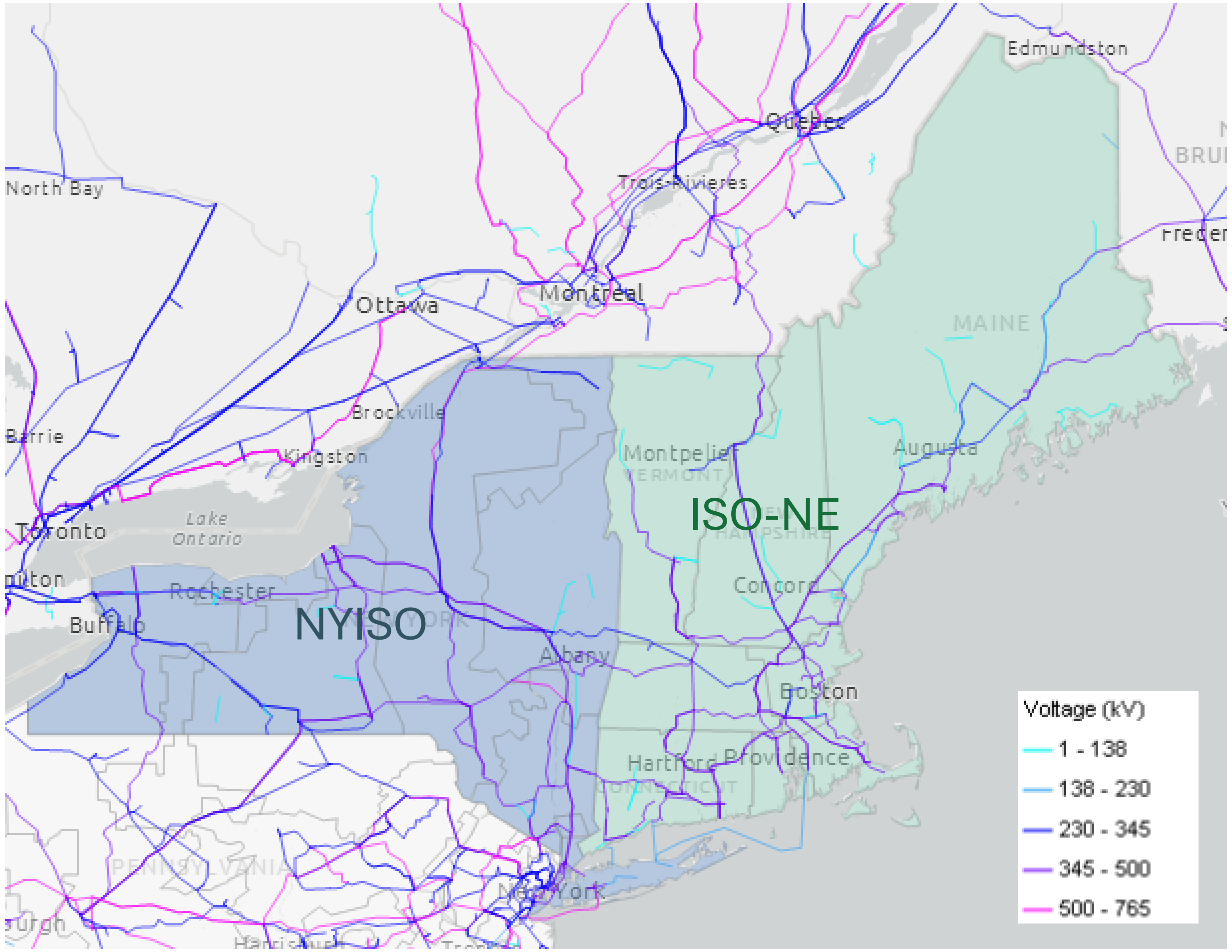
- Project Overview
- Key Drivers of Transmission Value
- Modeling Deep Decarbonization at the Nodal Level
- Key Findings
- Resilience Assessment

Project Origination and Key Study Questions

+ **The Clean Resilience Link (CRL) project involves conversion of an existing 230 kV transmission line between NY and NE to 345 kV, enabling roughly 1000 MW in incremental transfer between regions**
+ **This corridor was first identified as a primary candidate for an upgrade after an asset condition assessment in New England determined a significant portion would need replacement in the next few years**
  - This presented an opportunity to examine whether an upgrade would yield meaningful incremental benefits, particularly as both regions pursue deep decarbonization
+ **Key study questions:**
  - Does this line provide **operational benefits** to each region?
    - How will this upgrade impact **congestion** and **renewable resource curtailment** going forward?
    - Does this promote **policy achievement** of decarbonization goals in each region?
    - Does it support **offshore wind integration**?
  - What **resiliency benefits** might stem from this upgrade?
    - How would the presence of 1000 MW of incremental transfer affect operations during **extreme winter storms**, or **periods of low renewable output**?
    - Can it help avoid costly **price spikes** in either region?

Study Team, Regional Coordination, and Federal Funding Target

- **National Grid, a utility with service territory in both NY and NE and the owner of the existing 230 kV line, engaged E3 to conduct this operational and resilience study**
  - Our team worked in close collaboration with Hitachi Energy to run GridView, the nodal production cost model we used to examine system dynamics
- **After confirming initial results, National Grid reached out to regulators in each New England state as well as New York to build a coalition to further examine this opportunity, and jointly develop a proposal to the US Department of Energy for funding support**
  - This coalition worked closely together between mid-fall 2023 and the application deadline in early April, 2024
  - This is an **extremely unique collaborative effort to build interregional transmission**, and serves as a strong model that could be applied in many regions throughout North America

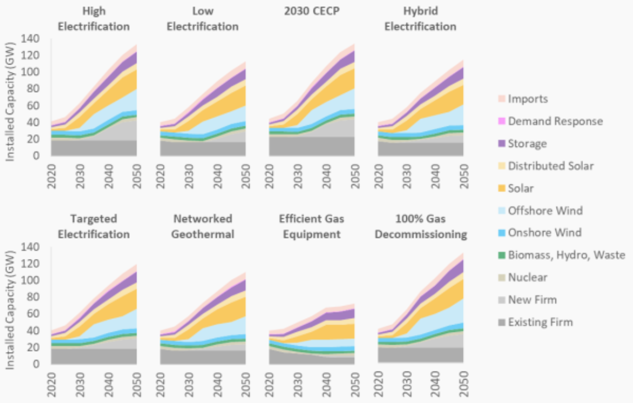


Key Drivers of Transmission Value

- **New transmission lines can create value by enabling more efficient operations, allowing for development of lower cost resources, and improving the resilience of the regional grid**
- **Typically, a significant portion of the value stems from the *investment cost* avoidance with additional value derived from *resilience* and *operations***

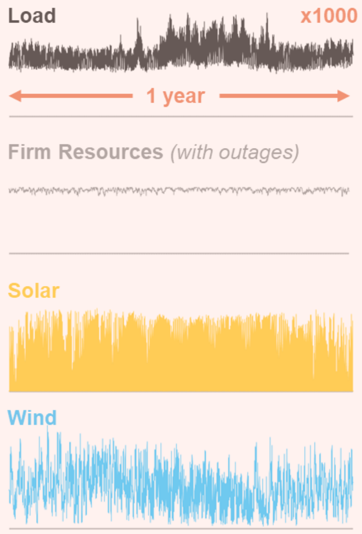
Investment Costs

Over a longer time horizon, new interregional transmission can lead to significant changes in capacity needed to maintain system-wide reliability, leading to a more cost-effective portfolio of resources across the region



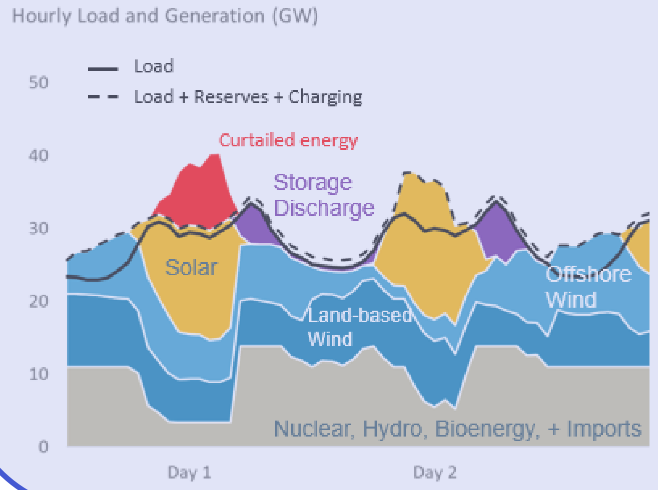
Resilience

Interregional transmission can provide the highest value during a small subset of the most challenging hours



Operational Costs

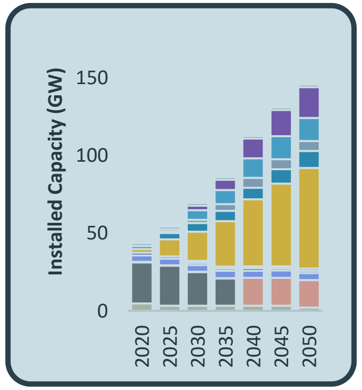
New interregional transmission can lower congestion and curtailment, resulting in reductions in operational costs across the combined footprint



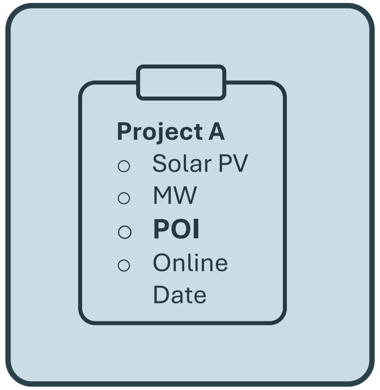
Modeling Deep Decarbonization at the Nodal Level

- Analysis ultimately focused on 3 future years: 2030, 2040 and 2050
- The process of capturing nodal detail across those years in a way that is policy compliant, cost optimal, and reflects our best current expectations of where resources will interconnect is not simple
- In order to build this model, our team started with existing capacity expansion studies E3 had conducted in each region, and developed a multi-stage allocation methodology to match capacity additions to substations

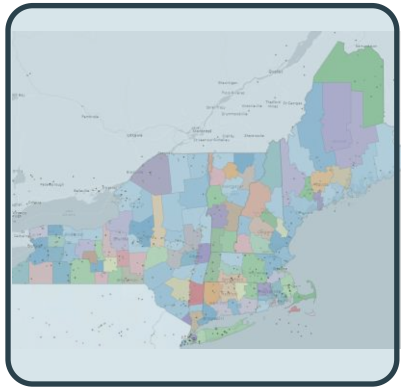
Extract zonal capacity expansion forecasts: E3's RESOLVE model has optimized, policy driven resource portfolios at the zonal level



Leverage interconnection queue: Source points of interconnect by technology from IQs and developer reports to inform initial placement

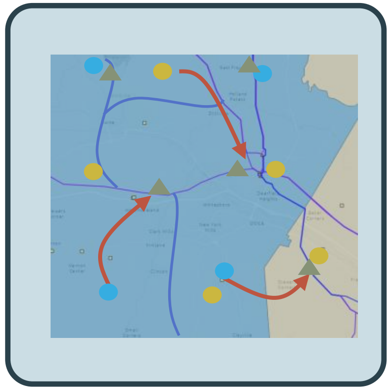


Calculate resulting county distribution for reallocation guide: Helps ensure reallocation preserves original optimal distribution

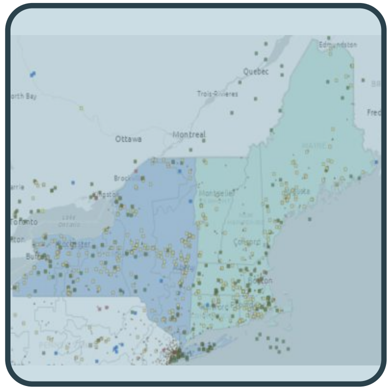


Iterate

Reallocate to avoid overloads: Using estimated hosting capacity thresholds and topology as a guide, reallocate overflow capacity to adjacent buses



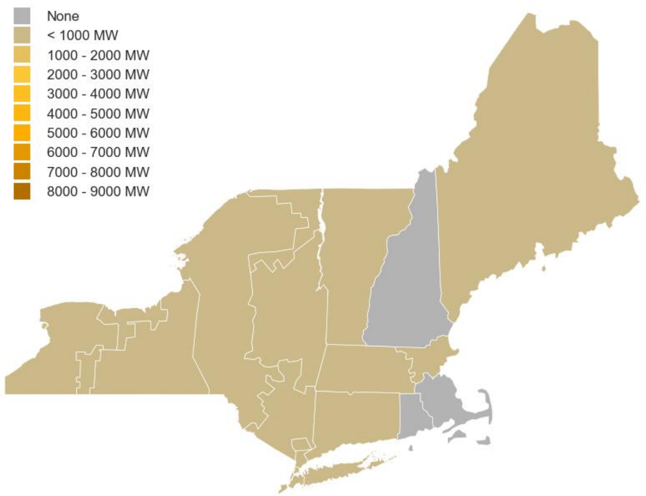
Resulting Nodal Resource Forecasts: Perform ongoing checks and refinements to mitigate unreasonable curtailment, and ensure fully reliable operations



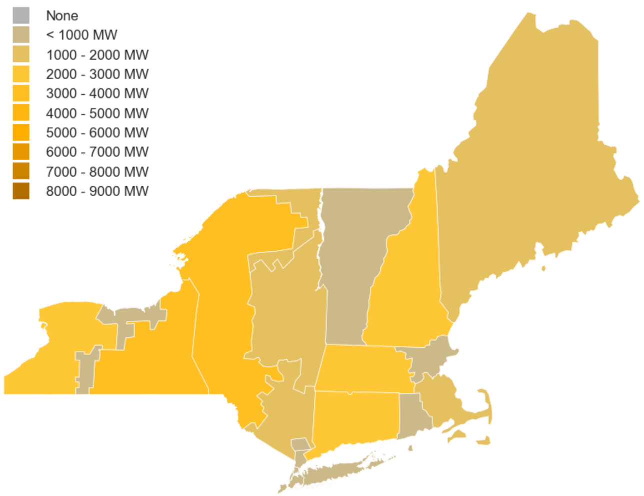
All graphics on this slide are illustrative to demonstrate the methodology used

Distribution of Resource Additions

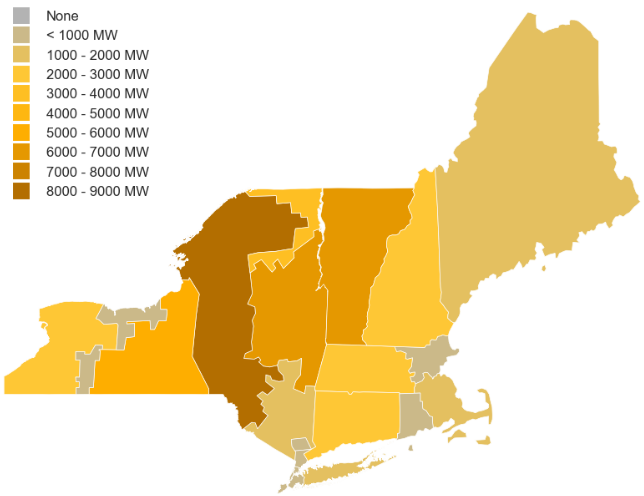
Existing Utility-Scale Solar Capacity (MW)



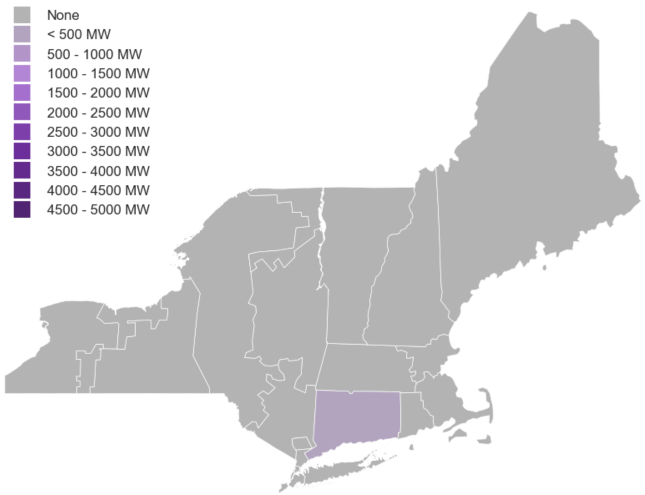
2030 Utility-Scale Solar Capacity (MW)



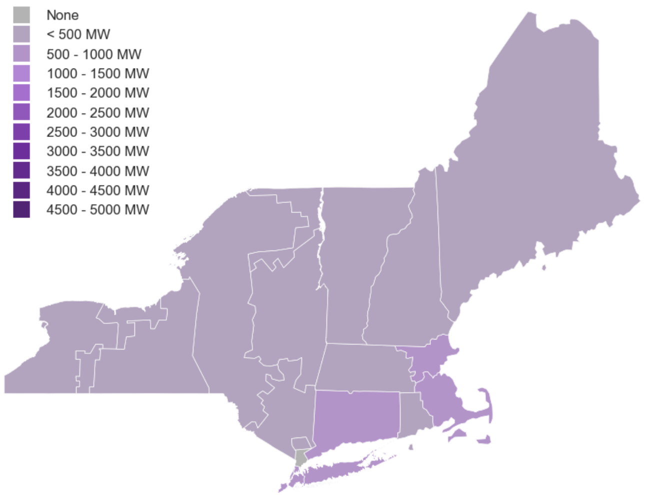
2040 Utility-Scale Solar Capacity (MW)



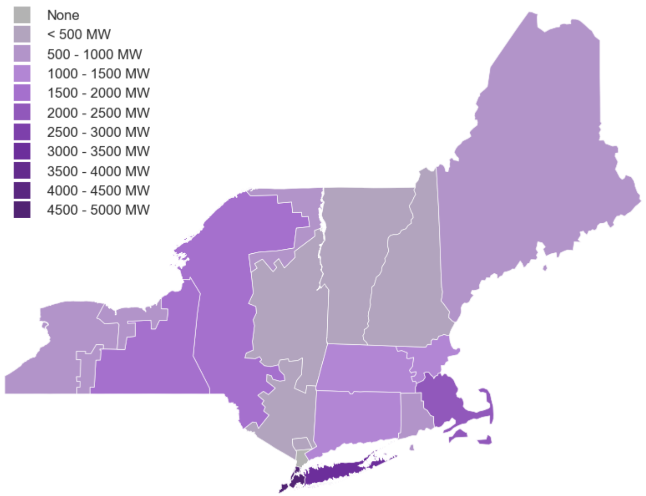
Existing Battery Storage Capacity (MW)



2030 Battery Storage Capacity (MW)

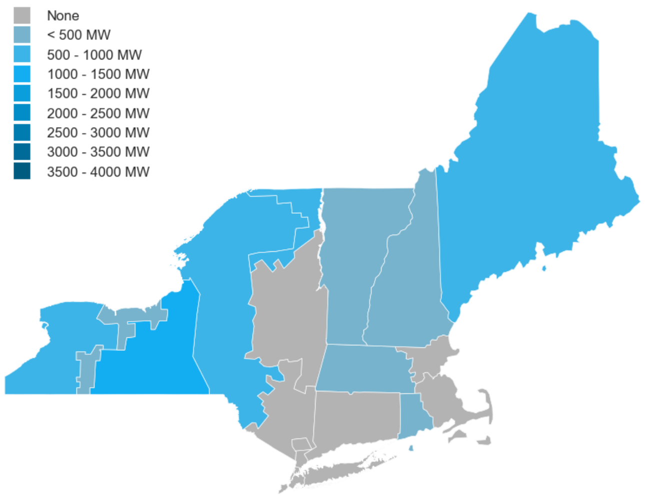


2040 Battery Storage Capacity (MW)

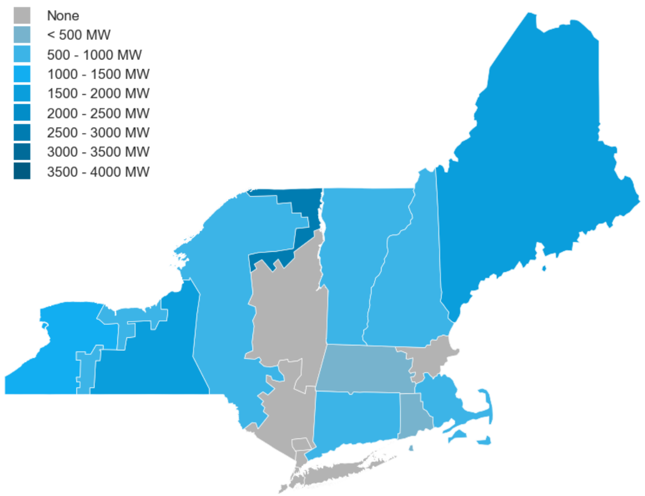


Distribution of Resource Additions

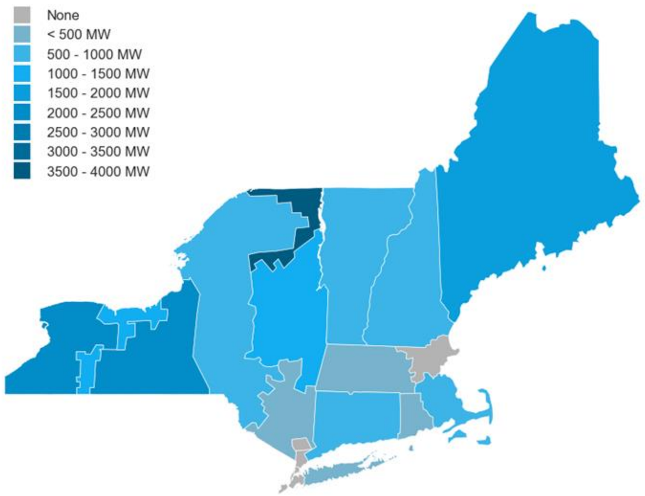
Existing Land Based Wind Capacity (MW)



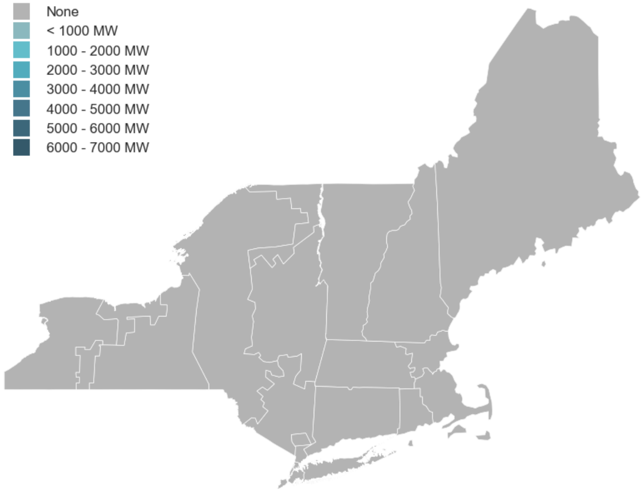
2030 Land Based Wind Capacity (MW)



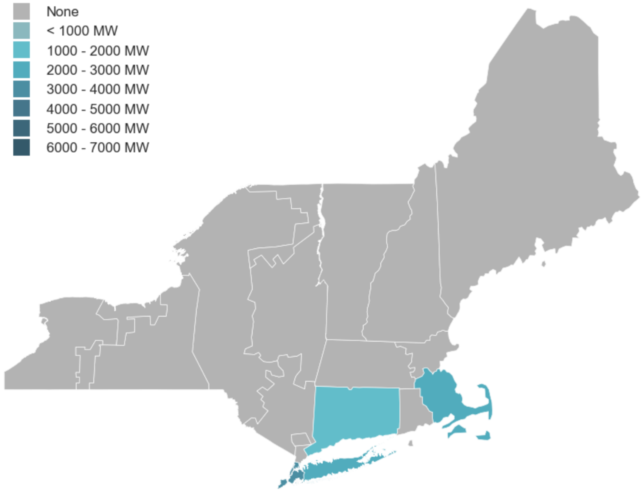
2040 Land Based Wind Capacity (MW)



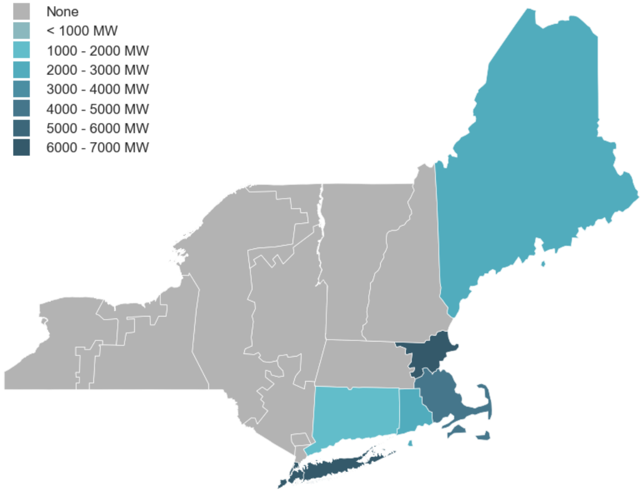
Existing Offshore Wind Capacity (MW)



2030 Offshore Wind Capacity (MW)



2040 Offshore Wind Capacity (MW)



Findings Summary

Key Findings Summary

- The Clean Resilience Link upgrade results in over **$1B NPV of operational cost savings across all scenarios examined**
- It lowers curtailment and congestion across the Northeast region, **helping to avoid between 500,000 and 1,300,000 MWh of annual renewable curtailment**
  - Avoided curtailment is highest in the 2050 case year, and equates to roughly the annual output of a 750 MW solar farm in the region
  - This has the two-fold benefit of (1) reducing high-cost hydrogen in New York and (2) displacing gas generation and associated CO2 emissions in New England in 2040
  - Delivery of that energy would also improve the economics for renewable project developers, lowering the cost of RECs purchased by New York and New England ratepayers
- The project and associated increases in renewable delivery also lead to reductions of **200K tons of CO2/year across regions,** achieved by **reducing regional reliance on thermal generation in all seasons**
  - These savings are incremental to base case emissions reductions, which are very significant given the policies and transition trajectories in NY and NE

Resilience Analysis

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Resilience Case 1: Winter Storm Event

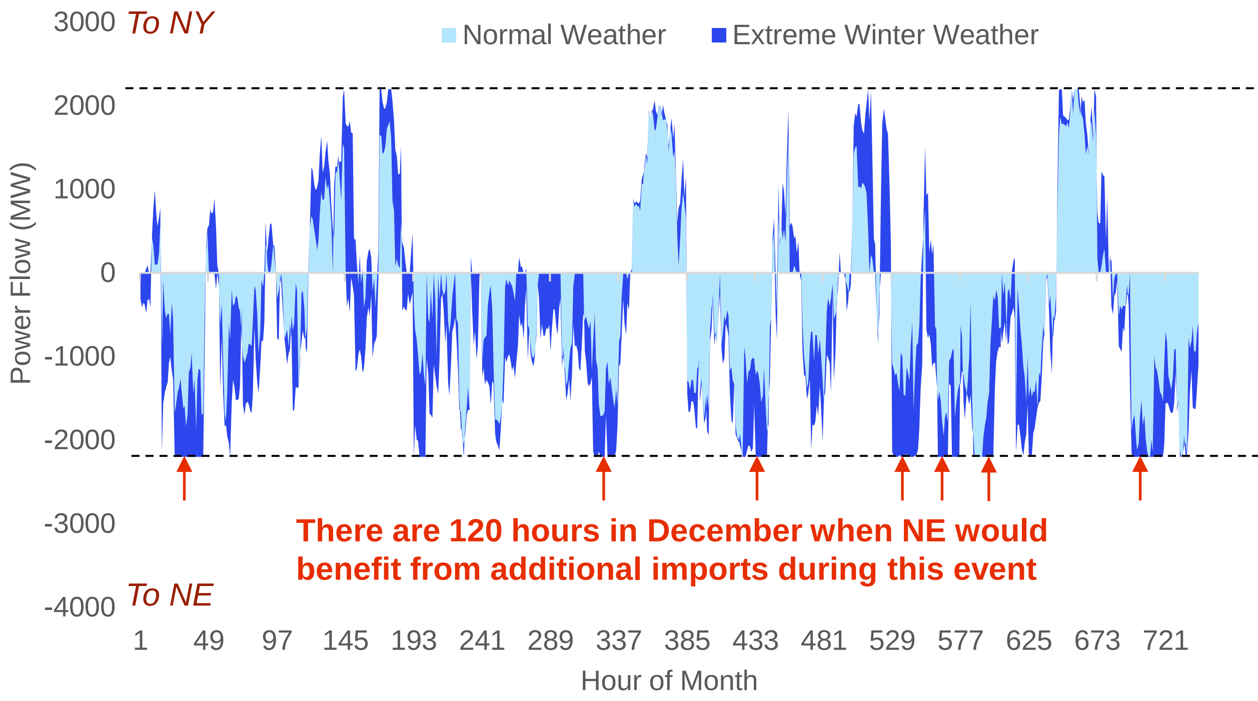
Case Design

- **The 2030 Winter Storm Resiliency Case incorporates historical data from Winter Storm Elliott (2022), The Polar Vortex (2014), and the Bomb Cyclone (2018)**
  - By drawing on data reported across multiple events we were able to construct the most comprehensive picture of the impacts of a winter storm across the region, allowing us test the performance of the Link under these conditions
- **The metrics changed included:**
  - **Outage Risk:** Increased gas plant outage risk reflects a scenario where a significant percentage of the gas fleet could be offline due to the severe weather conditions, observed in all three winter storms used as a historical reference
  - **Natural Gas and Oil Prices:** Adjusted the daily average natural gas and fuel oil prices to represent potential spikes in prices during high-demand periods caused by severe weather conditions. During the observed storms, natural gas prices increased threefold sometimes hitting 20X from their average prices
  - **Load:** To reflect the increased demand during winter storm events, we extended the peak days to align with high-load scenarios identified in the resiliency windows

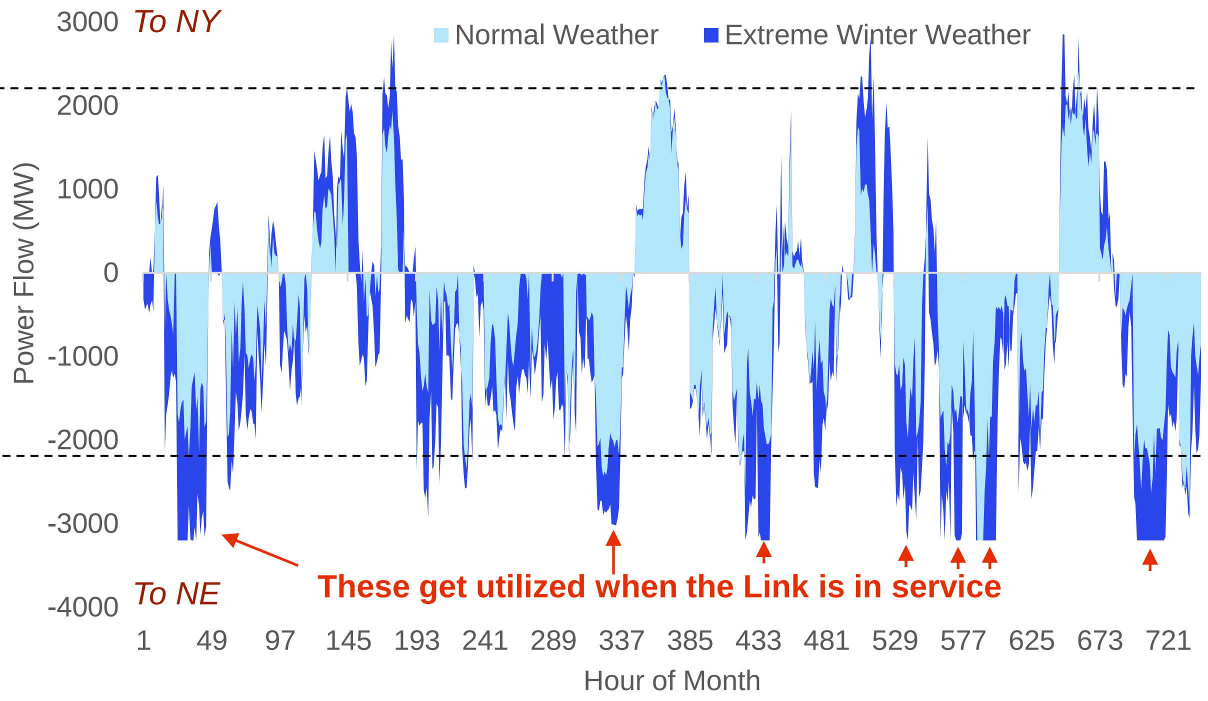
Resilience Case 1: Winter Storm Event
Results

+ **The CRL provides valuable operational flexibility to the regions during extreme events**
  - In this example case, New England is the most stressed of the three regions, and under base case conditions it is unable to import as much power as would otherwise be economic, and must instead turn to higher cost, high emissions resources to serve load
  - With the Link in service, the region imports an additional 60,000 MWh in December alone, helping avoid scarcity conditions during this storm
+ **The CRL provides incremental production cost savings during the storm in NY and NE* relative to normal weather conditions, highlighting its ability to allow for balancing over a larger area when the systems are stressed**

December NY<>NE Interface Flows **without CRL**



December NY<>NE Interface Flows **with CRL**



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*when adjusting for import/export purchase and sales

Resilience Case 2: Low Renewable Output Events

Case Design Overview

- **Extreme low renewable generation conditions across New York and New England were simulated for 2040 – when one or both regions are constrained, both in Summer and Winter**
- **Periods with low renewable generation and high load were identified in the historical record between 2007 and 2012, and we have selected 3 specific events from 2007 to analyze**

  1. Low Wind Winter Event (February 25th – March 1st, 2007)
     - Wind generation is ~60% lower than usual in both regions
     - Load remains typical in New England but peaks in New York at 41 GW
  2. Low Wind Summer Event (July 26th – August 1st, 2007)
     - Wind generation is ~60% lower than usual in both regions
     - Load remains typical in New England but peaks in New York at 46 GW
  3. Low Wind and Solar Winter Event (December 5th – December 11th, 2007)
     - All renewable generation around 40 to 50% lower in both regions
     - Load in both regions up by 25%, peaking at 44 GW and 38 GW in New York and New England respectively

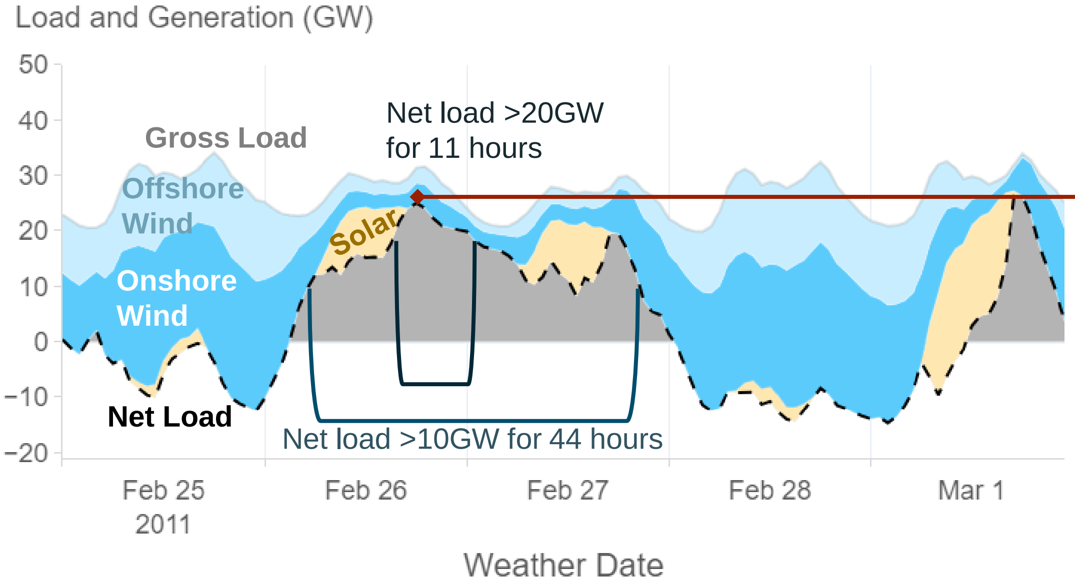
Resilience Case 2: Low Renewable Output Events

Case Design Details

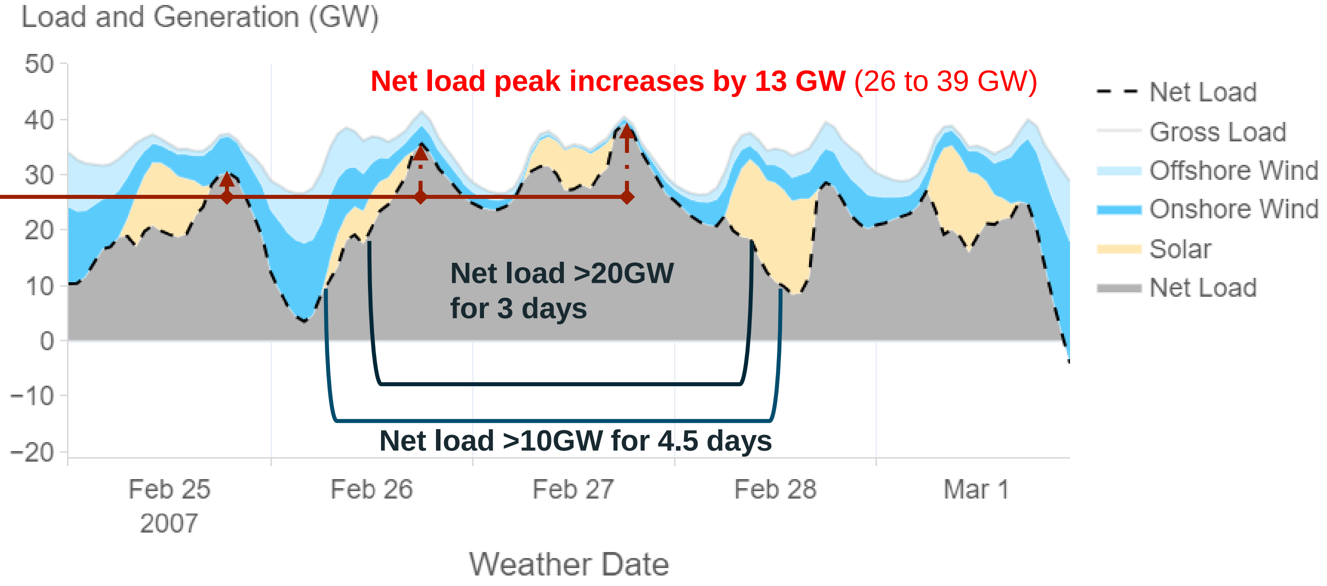
+ **Low Wind Winter Event (February 25th – March 1st, 2007)**
  - In both regions onshore and offshore wind generation is significantly lower than the typical week in the same season
  - Peak and total load in this period is similar in New England but much higher in New York
  - Solar is relatively higher, but doesn't represent a significant share of generation in winter

	Solar	Onshore Wind	Offshore Wind	Load
New York	+20%	-59%	-60%	+26%
New England	+53%	-60%	-69%	+1%

Typical 5-day period replaced in NYISO

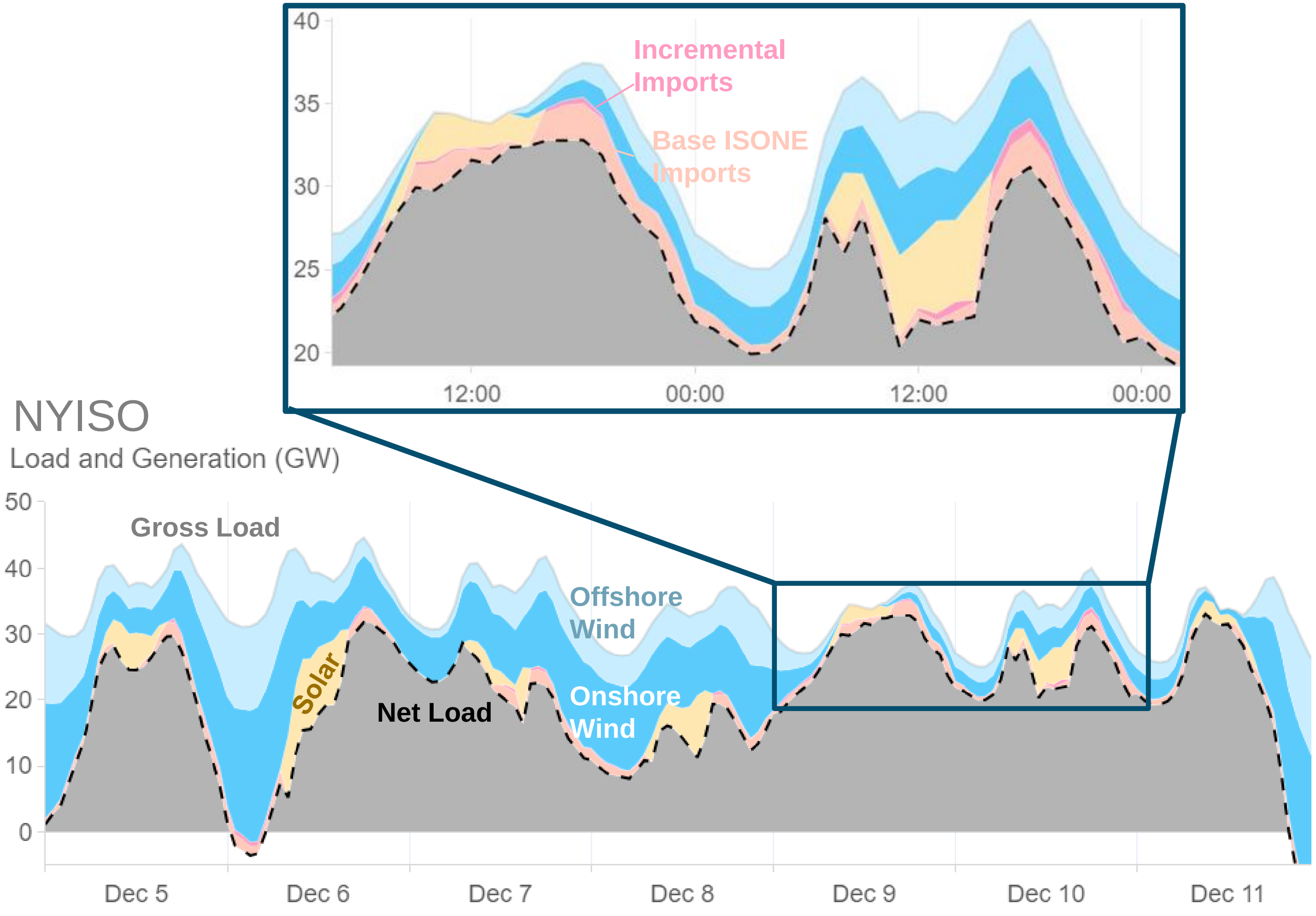


5-day period introduced in NYISO



Resilience Case 2: Low Renewable Output Events
Results

- **Similar to the Winter Storm case, we see operational flexibility benefits provided by the Intertie during each of the Low Renewable Output events**
  - During net peak conditions when the systems are most constrained, some incremental imports can yield outsized value for system operations
    - One challenge we found is that low renewable conditions in our historical data are fairly correlated between regions, limiting the incremental power that can be accessed
    - A major value driver of the CRL is its ability to unbottle renewables in many hours of the year – that is less possible during these highly constrained events, and value provision is more concentrated in select hours
- **The intertie upgrade could allow for reductions in dispatchable generation (DEFR) needs**
  - When New York is more constrained, imports from New England increase 150-160 MW on average with intermittent injections of 500+ MW
  - Even when both regions are low on renewable generation, the intertie allows for flows in both directions to reduce the overall need for dispatchable generation at any point in time



Thank You

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