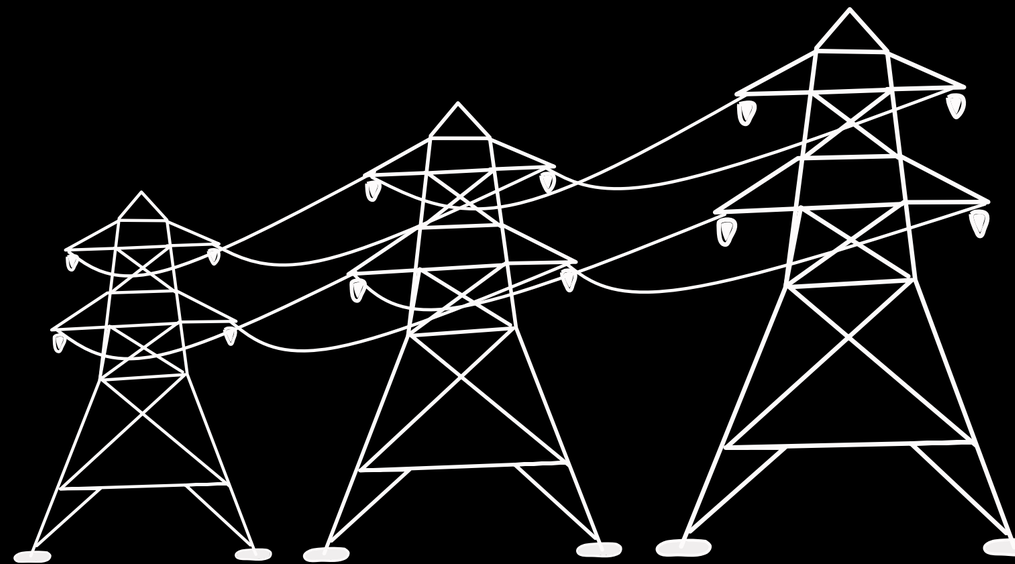
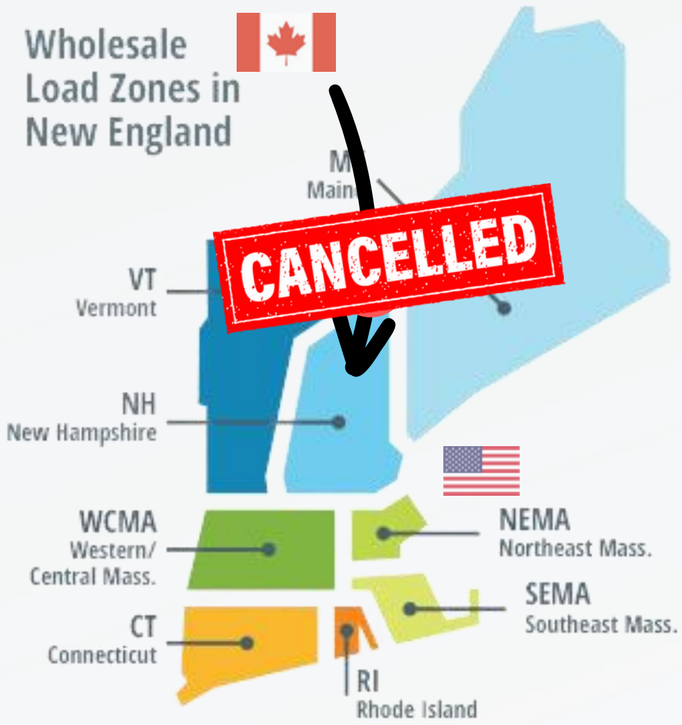
Integrating health, economic, and environmental trade-offs into decarbonization decision-making in New England

Amir Gazar, M.Eng
PhD Student

VIRGINIA TECH



THE TWIN STATES CLEAN ENERGY LINK



CLIMATE

Proposed transmission line for renewable power from Canada to New England canceled

BY THE ASSOCIATED PRESS
March 7, 2024

Transmission

National Grid says Biden-backed transmission line 'not viable'

National Grid and Citizens Energy are pulling the plug on a proposed $2 billion two-way transmission line linking New Englan financial backing from the Biden administration.

3.5.2024

2018

NORTHERN PASS

Quebec

↓

New Hampshire

↓

Massachussets

2021

NEW ENGLAND CLEAN ENERGY CONNECT

Quebec

↓

Maine

↓

Massachussets

2023

CHAMPLAIN HUDSON POWER EXPRESS

Quebec

↓

New York

2024

TWIN STATES CLEAN ENERGY LINK

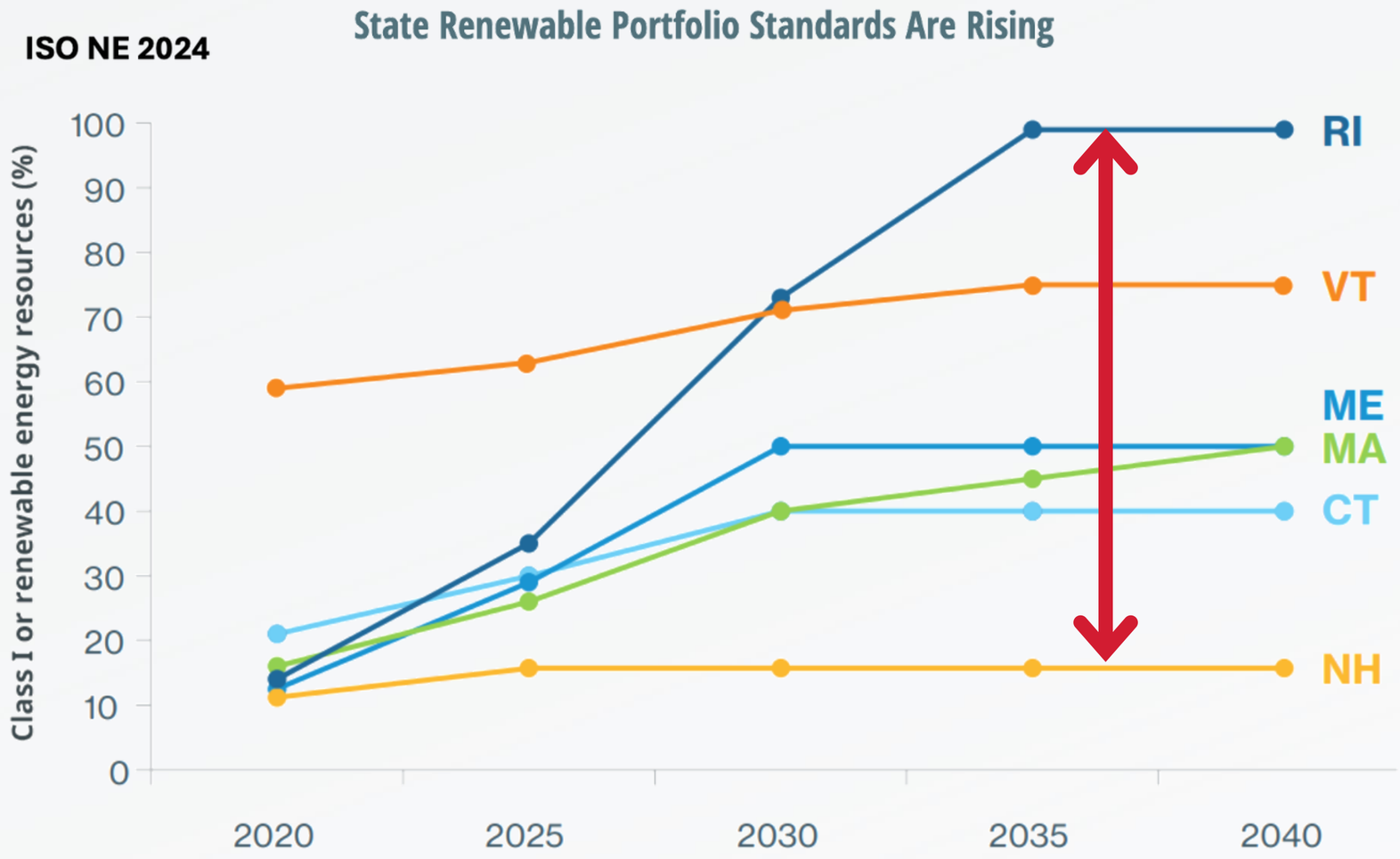
Quebec

↑

↓

New Hampshire

New England states have very different targets



Technical optimum ? Social optimum

Delayed Decarbonization

Goal: Accelarate decarbonization by picking decarbonization pathways consistent with social values

EPA United States Environmental Protection Agency

Deliberative Valuation and Integrated Modeling to Accelerate Equitable Decarbonization in New England

EPA Grant Number: R840558

PI: Dr. Ryan Calder

Virginia Tech

VIRGINIA TECH

DARTMOUTH

UMass Boston

CLEAN ENERGY NH

Your Voice in All Energy Matters

Modeling Approach

Decarbonization Pathways

Evolve Energy Inc.

ISO NE

All Options Pathway (i.e., status quo)

Daily Demand

Hourly Dispatch Curve Forecast Model

Integrated Hourly Dispatch Curve Model

Cost-Benefit Analysis

Ramp Analysis & Generation Constraints

GHGs

Air emissions

Economic impacts

Other env. impacts

Data Sources and Variables

ISO NE

Hourly Stochastic Wind and Solar Capacity Factors for NE

U.S. EPA Acid Rain Program

Fossil Fuel Hourly Capacity Factor

NREL ATB & U.S. EIA

Stochastic Wind and Solar Capacity Factors for NE

U.S. EPA eGrid

Fossil fuel nameplate capacity and retirements

Quantitative Descriptions for Community Workshops [Deliberative Valuation]

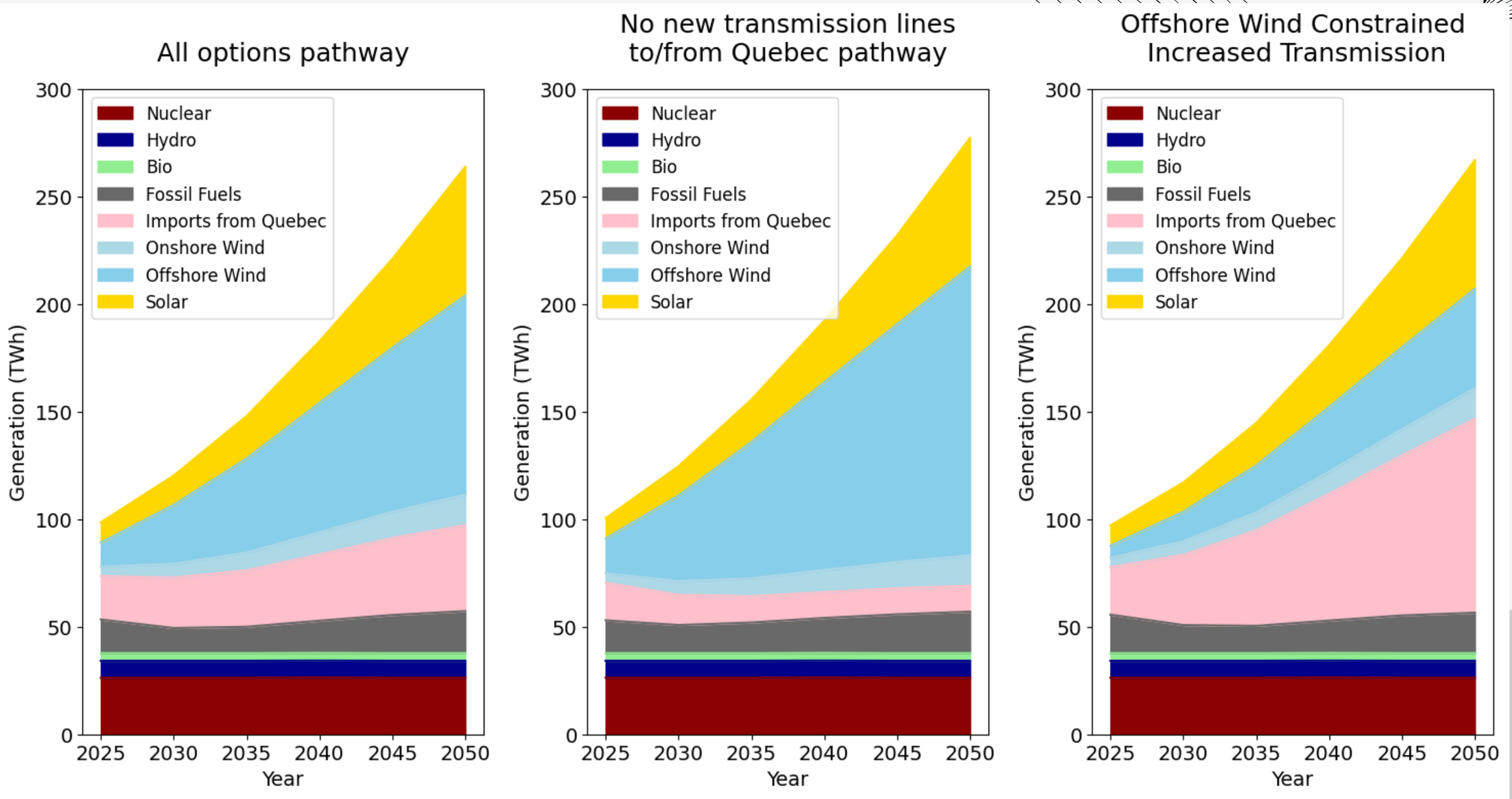
Decarbonization Pathways

	All Options	No New Transmission to/from Quebec	Offshore Wind Constrained
New transmission to/from Quebec	Least-cost ISO NE (~ 6 GW by 2050)	**Disallowed**	High (~13 GW by 2050)
New offshore wind power plants	Least-cost ISO NE (~22 GW by 2050)	Same as "All Options" + additional capacity to balance demand (~31 GW)	**10 GW Northeast cap**
New hydropower plants in Quebec	No new reservoir	No new reservoir	New reservoir (~ 9 GW increase)
Output from fossil fuels	To balance demand	Balanced to satisfy annual/hourly demand	Balanced to satisfy annual/hourly demand

The following variables are uniform across pathways evaluated in this study:

- Solar PV (FCM+BTM+EOR) and onshore wind: Economic
- New nuclear power plants and gas plants: Disallowed
- Existing nuclear power plants and gas plants: Maintain
- Use of fossil fuels (oil/coal): Disallowed by 2030
- Building & industry electrification and energy efficiency: High
- Flexible end-use loads: Medium
- Captured CO_2 Export: Disallowed

Pathways Summary (50th Percentile)



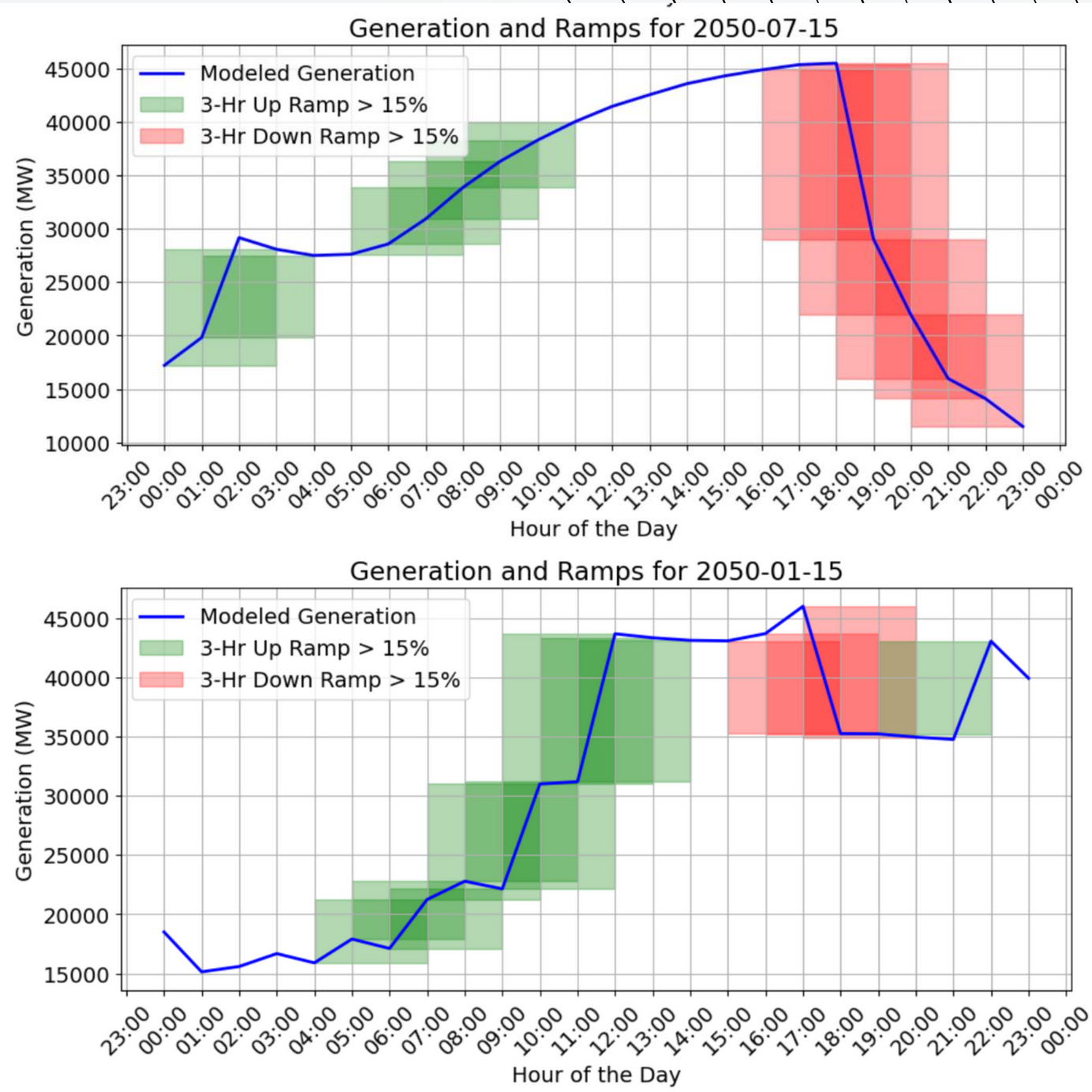
Net Present Values of Total Costs 2025-2050 (billions of 2023-USD)

	All Options	No New Transmission	Offshore Wind Constrained
Capital upfront	89 (75.12 - 107.43)	97.19 (85.27 - 121.01)	147.14 (127.3 - 159.9)
Fixed O&M	50.22 (35.98 - 57.16)	58.75 (43.51 - 67.99)	55.22 (34.93 - 59.59)
Variable O&M	4.06 (2.75 - 4.1)	4.03 (2.72 - 4.07)	4 (2.69 - 4.04)
Fuel	33.29 (22.04 - 33.71)	33.63 (22.31 - 34.14)	33.58 (22.46 - 33.86)
GHG emissions	18.06 (14.06 - 22.35)	19.07 (14.74 - 23.84)	19.9 (15.8 - 24.14)
Air pollutants	0.159 (0.152 - 0.166)	0.16 (0.151 - 0.17)	0.18 (0.171 - 0.181)
Sum	**194.79** (150.1 - 224.92)	**212.83** (168.7 - 251.22)	**260.02** (203.35 - 281.71)

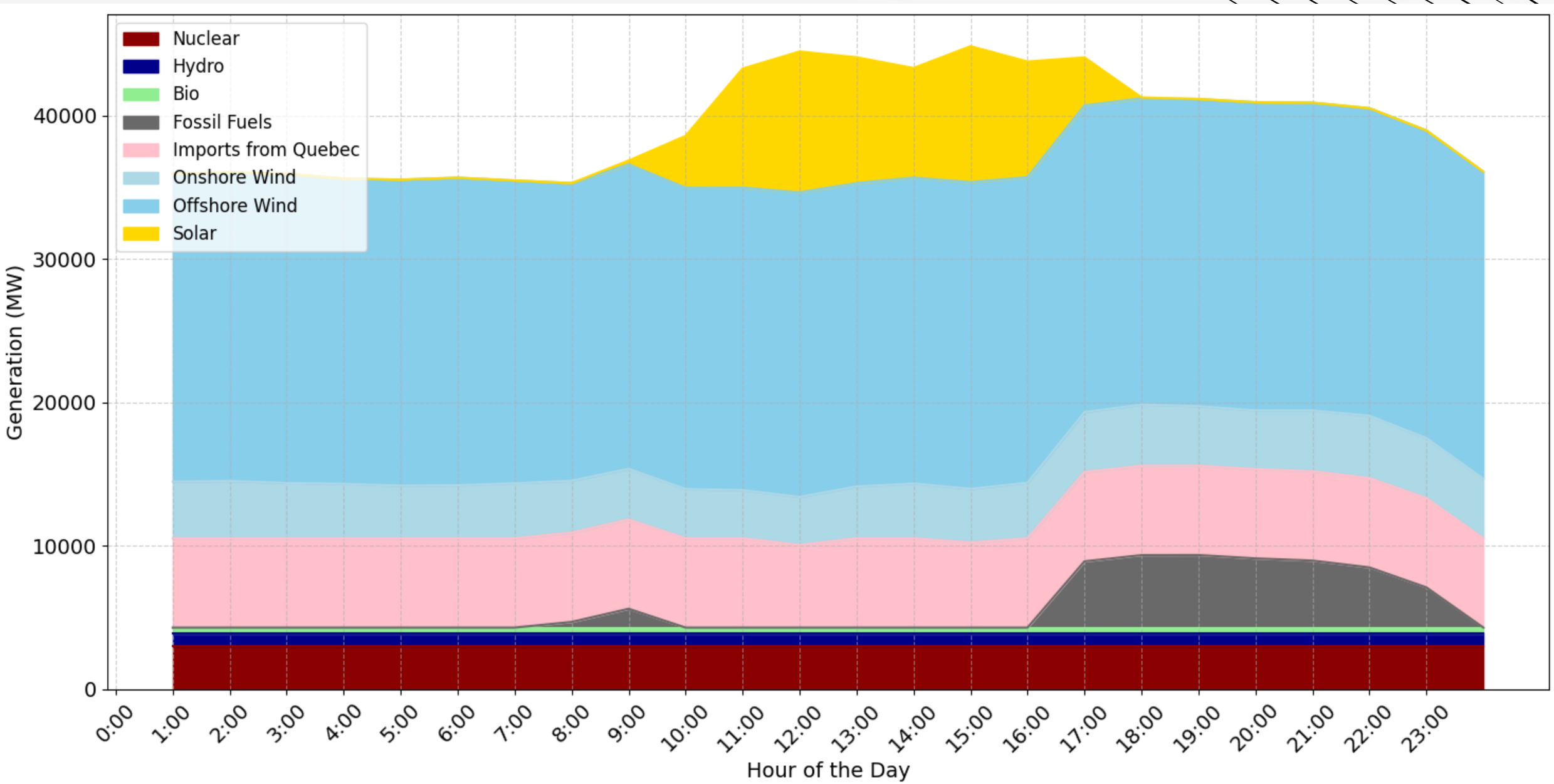
We synthesized generation, emissions, and cost data for existing and future generation assets and decarbonization pathways, adapting Calder et al. (2022) for New England.

Ramp Analysis and Generation Constraints

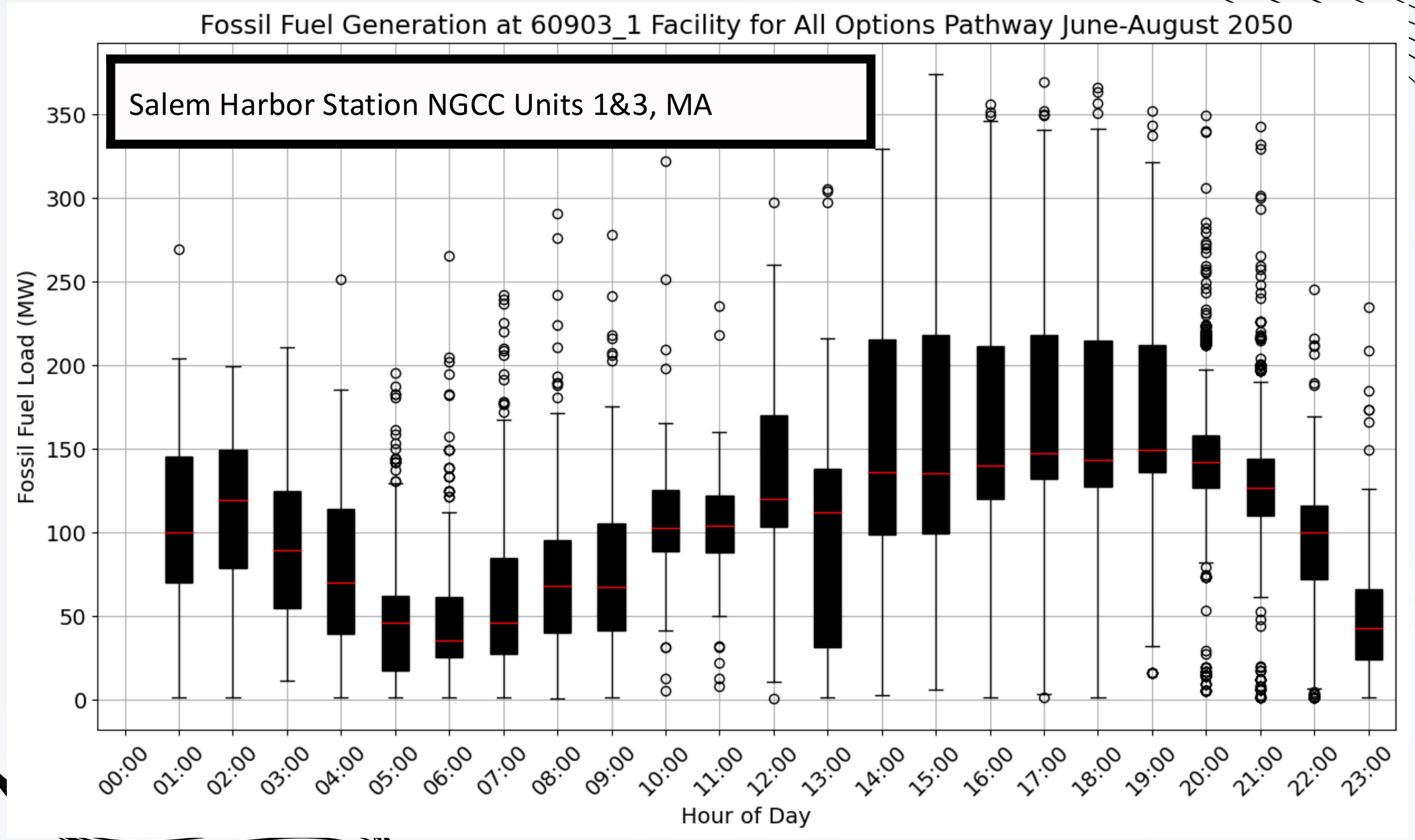
1. Ramp counts: No significant difference between “All Options” and “Offshore Wind Constrained” pathways
2. Down ramps: The “No New Transmission” pathway shows higher down ramps until 2040 compared to other pathways.
3. Shortfalls: The “No New Transmission” pathway shows shortfalls being maximized, especially at extremes.



Supply Curve Forecast, Jan, 01, 2050 All Options Pathway P50

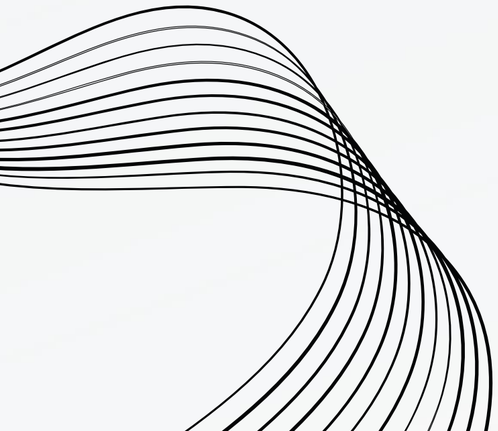


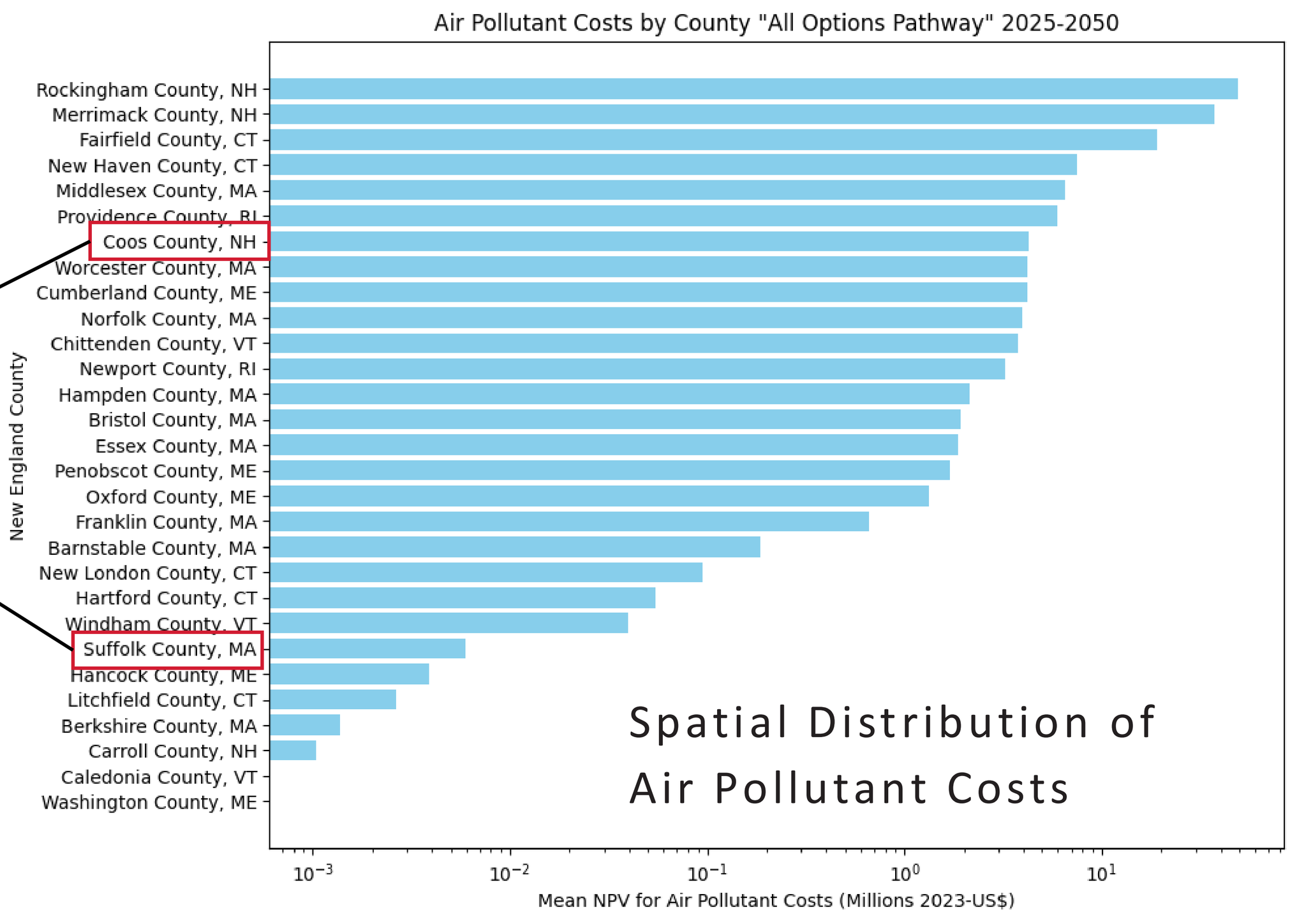
Fossil Fuel Generation Sample



Coos, NH

Suffolk, MA

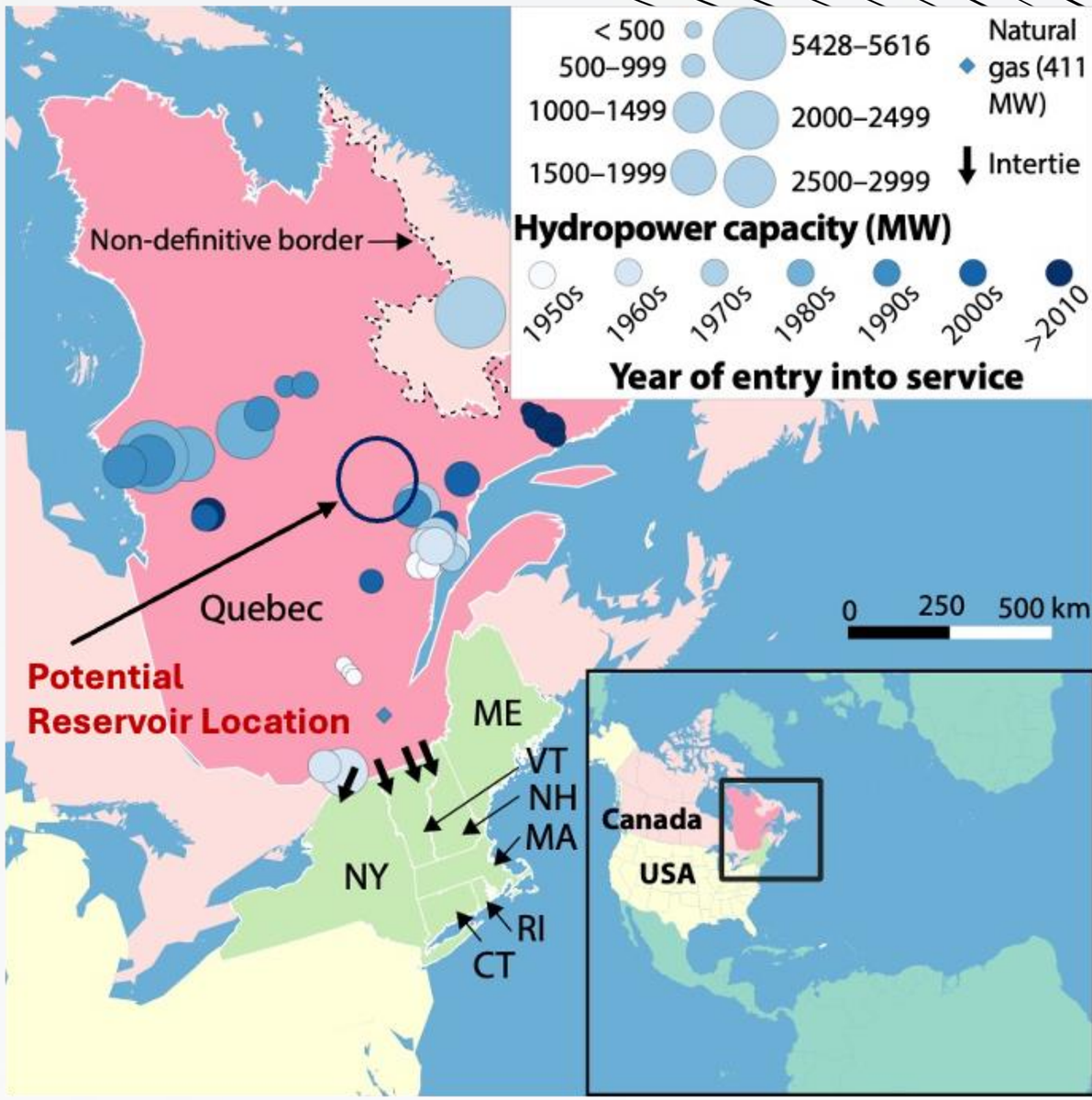




Spatial Distribution of Air Pollutant Costs

Most likely locations for new hydropower?

- 9 GW increase in installed capacity for hydropower in Quebec based on ISO NE
- Hypothetical location of new reservoirs would be in northern Quebec
- More recent reservoir developments favor smaller dams in higher quantity rather than large dams
- HQ is currently studying St. Lawrence River as part of its refurbishment requirements
- HQ utilizes basin diversions to help develop new reservoirs
- Multiple Potential Reservoirs can be placed near Manouane River Diversion Project where the annual diversion capacity is ~100 m^3/s
- ResME (Delwiche et al 2022) is used to estimate CH4 emissions



Original map from Gazar et al. (2023)

Integrated modeling to understand health, economic, environmental tradeoffs

Decarbonization Pathways

GHG Emissions

Air Pollutants

Economic Impacts

Renewables Env Impacts

Total Costs/Benefits

Attributes Validation Survey 415 respondents

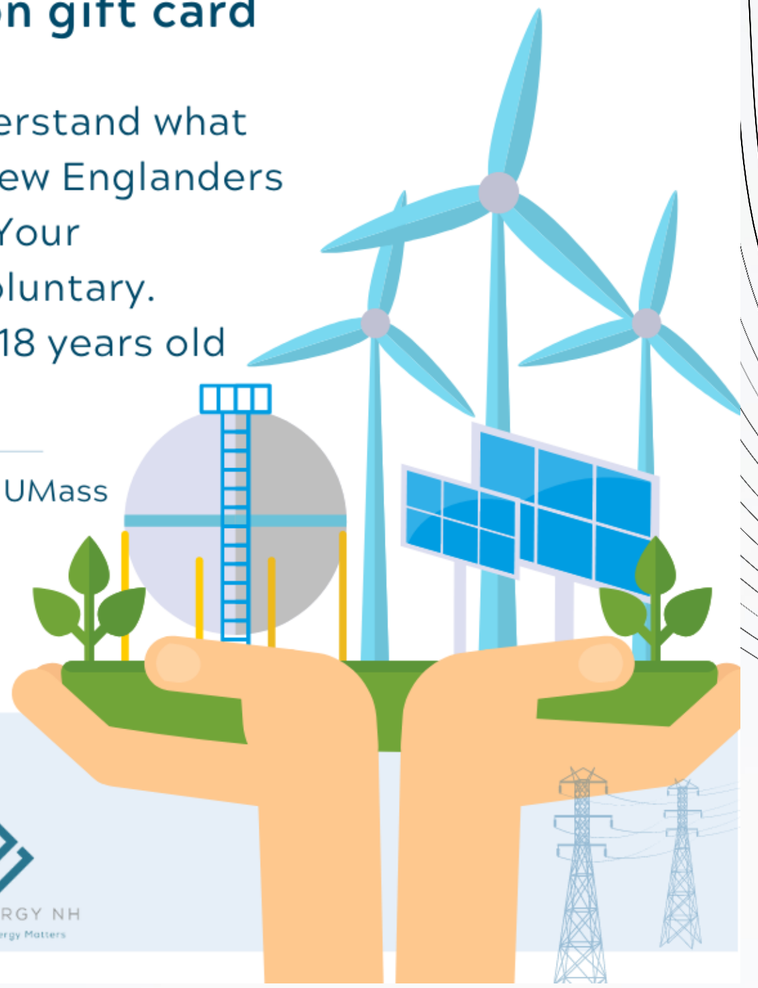
Live in New England?

Answer a 5-8 minute research survey about renewable energies and get a $5 Amazon gift card

Your answers will help us understand what attributes are important to New Englanders in decarbonization planning. Your participation is completely voluntary. Participants must be at least 18 years old and live in New England.

Questions? Contact **Chloe Jackson** at UMass Boston School for the Environment.
chloe.jackson001@umb.edu

UMass Boston IRB protocol no. 3643



Top 3 Identified Attributes

COMMUNITY VALUES

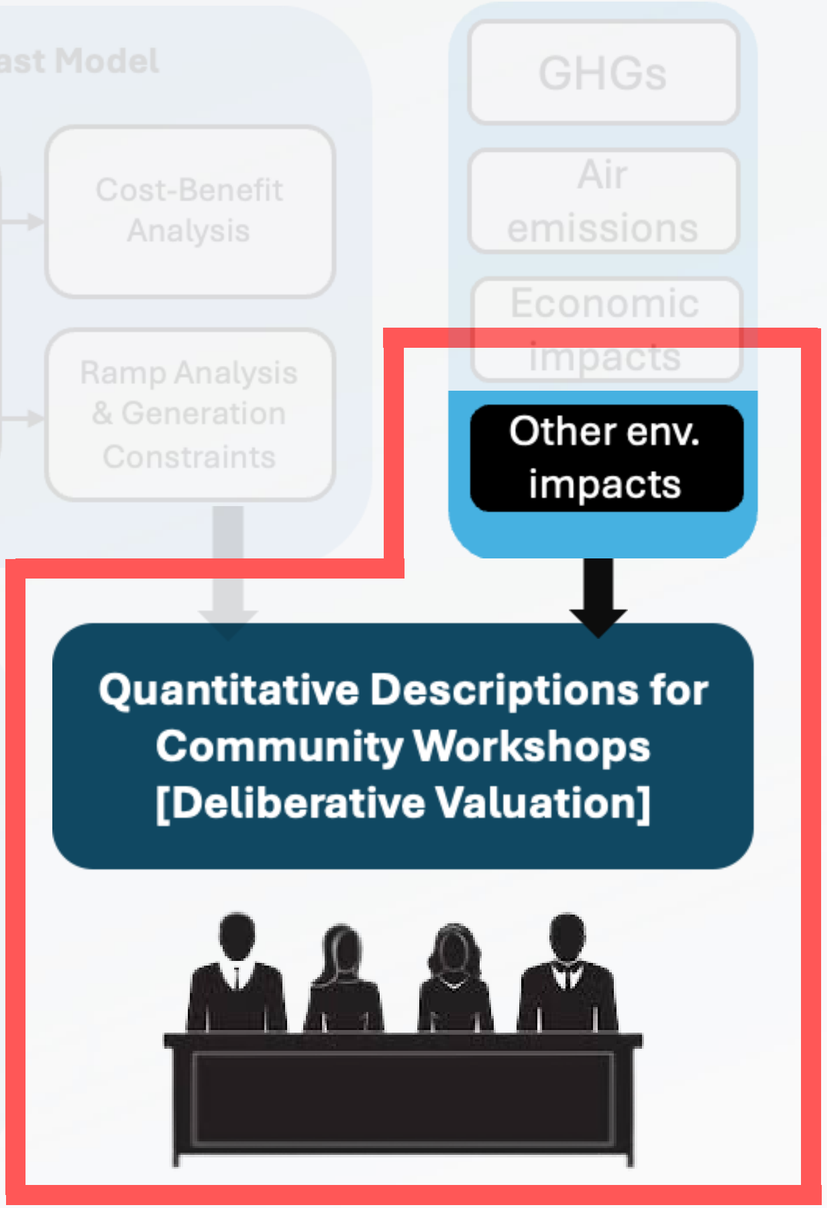
01 Health impacts from air pollutants

02 Global and U.S. climate change impacts from emissions

03 Local employment from renewable energy

New Nuclear ? Community Value

To be continued
mid 2024 - 2025



LETS CONNECT!

Email: **amirgazar@vt.edu**
LinkedIn: **Amir Gazar**

Models for Environmental Health and Policy at Virginia Tech