Welcome to the Pathways to the Future Grid Meeting

June 1, 2022
Via WebEx

The meeting will begin at 10:00 AM

Please note: This meeting will be recorded

WEBEX FEATURES OVERVIEW

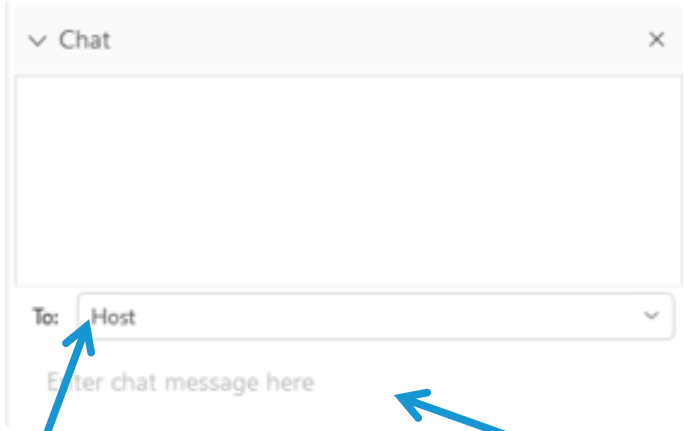
Note: This meeting is being recorded

For today's meeting

- Today's meeting is being recorded
- All attendee lines are muted
- If you are experiencing technical issues or have a question you would like to submit, send it via **Chat** to the **host**
- Questions and Answers will be addressed throughout the meeting

Sending a chat message

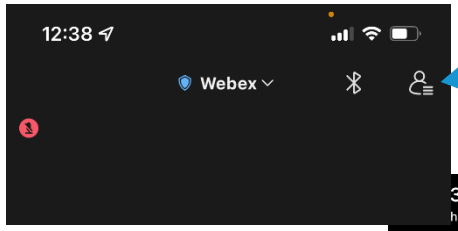
From a computer



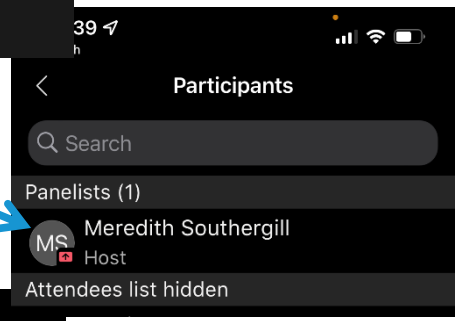
1. Select **Host** from the **To** field

2. Type your message in the space provided. Press **Enter** to send

From a mobile device



1. Tap the **Participants** icon



2. Tap the **Host** name

3. Type your message at the bottom of the window and tap **Send**

Depending on your device, button controls and screen layout may appear differently

RESOURCES FOR STAKEHOLDERS

Online Resources, Recent Publications, and Upcoming Events

FOR MORE INFORMATION…

Subscribe to the *ISO Newswire*

ISO Newswire is your source for regular news about ISO New England and the wholesale electricity industry within the six-state region

Log on to ISO Express

ISO Express provides real-time data on New England's wholesale electricity markets and power system operations

Follow the ISO on Twitter

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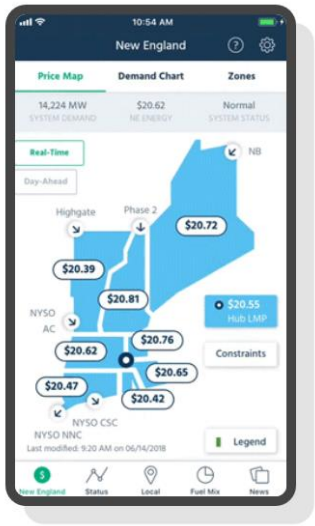
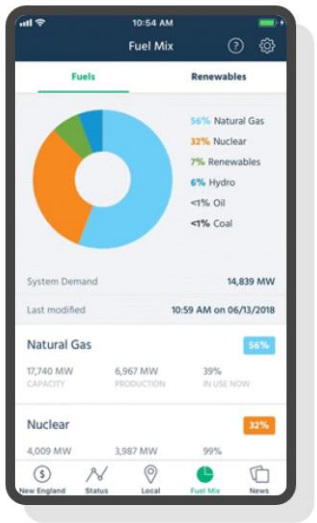
Download the ISO to Go App

ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand





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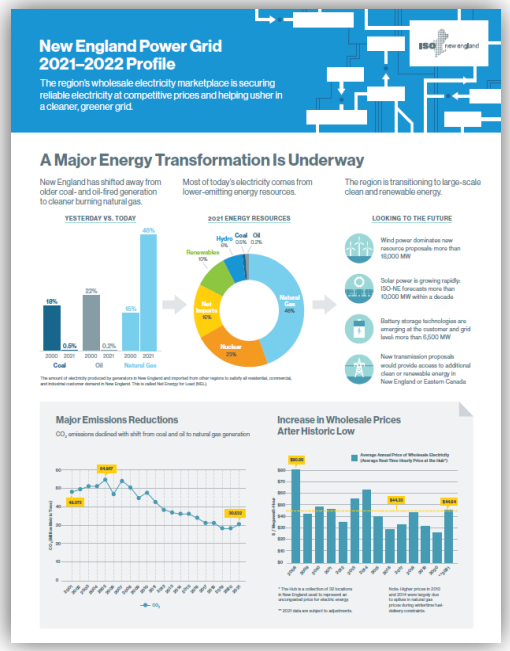
ISO New England Releases Several Publications

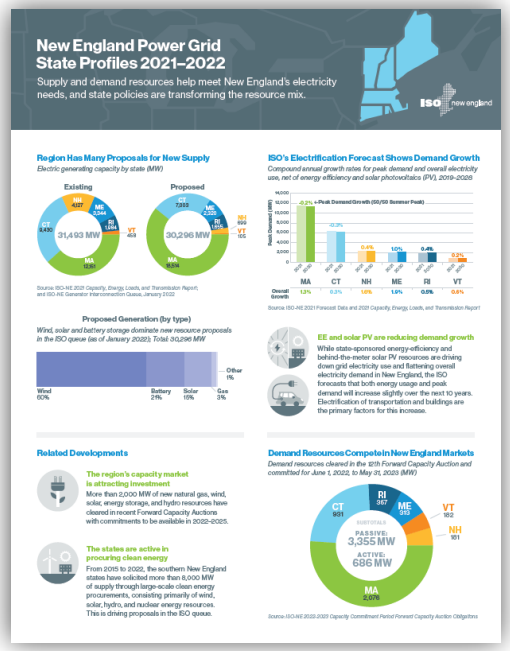
2021 Regional Electricity Outlook

Provides an in-depth look at New England's biggest challenges to power system reliability, the solutions the region is pursuing, and other ISO New England efforts to improve services and performance



New England Power Grid Profile

Provides key grid and market stats on how New England's wholesale electricity markets are securing reliable electricity at competitive prices and helping usher in a cleaner, greener grid



New England State Profiles

Provides state-specific facts and figures relating to supply and demand resources tied into the New England electric grid and state policies transforming the resource mix in the region

Consumer Liaison Group: 2021 Report, 2022 Meetings

- On March 9, the ISO and the CLG Coordinating Committee posted the **2021 annual report**
- **2022 meeting dates**:
  - June 9
  - September 15
  - November 30
- CLG meetings are:
  - A **forum** for sharing information between ISO New England and electricity consumers in the region
  - **Developed** by the CLG Coordinating Committee and **facilitated** by ISO New England
  - **Free** and **open** to the public

2021 CLG Annual Report is posted at: https://www.iso-ne.com/static-assets/documents/2022/03/2021_report_of_the_consumer_liaison_group_final.pdf

More information on the CLG is available at: https://www.iso-ne.com/committees/industry-collaborations/consumer-liaison/

Pathways Study: Evaluation of Pathways to a Future Grid

Regional Update and Study Overview

Eric Johnson
DIRECTOR, EXTERNAL AFFAIRS

Chris Geissler
MANAGER, ECONOMIC ANALYSIS

Key Takeaways From *Pathways* Analysis

- State-driven environmental mandates in New England require the development of significant quantities of clean energy resources
- The ISO's Board of Directors directed an assessment of solutions that could further advance the evolution of the regional power grid
- The *Pathways* study provides a significant foundation to evaluate four approaches that could meet the New England states' policy goals
  - All of the studied pathways are capable of achieving substantial levels of decarbonization
- While more discussion will occur between the states, stakeholders, and the ISO on the appropriate way forward, the study identifies the status quo as the most expensive and least efficient pathway

ISO NEW ENGLAND OVERVIEW AND REGIONAL UPDATE

ISO New England's *Mission and Vision*

Mission: *What we do*

Through collaboration and innovation,
ISO New England plans the transmission system, administers the region's wholesale markets, and operates the power system to ensure reliable and competitively priced wholesale electricity

Vision: *Where we're going*

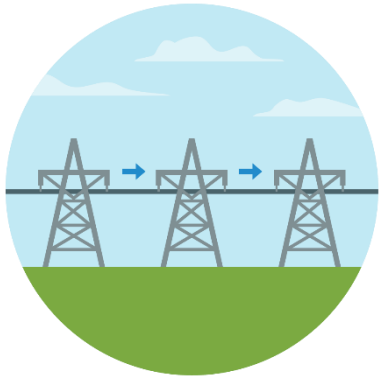
To harness the power of competition and advanced technologies to reliably plan and operate the grid as the region transitions to clean energy

*The ISO's new **Vision** for the future represents our long-term intent and guides the formulation of our Strategic Goals*

ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

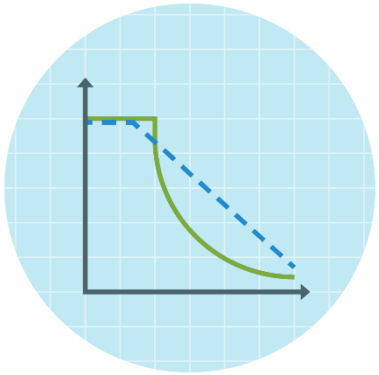
Grid Operation

Coordinate and direct the flow of electricity over the region's high-voltage transmission system



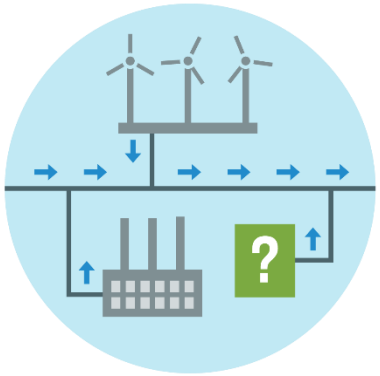
Market Administration

Design, run, and oversee the markets where wholesale electricity is bought and sold



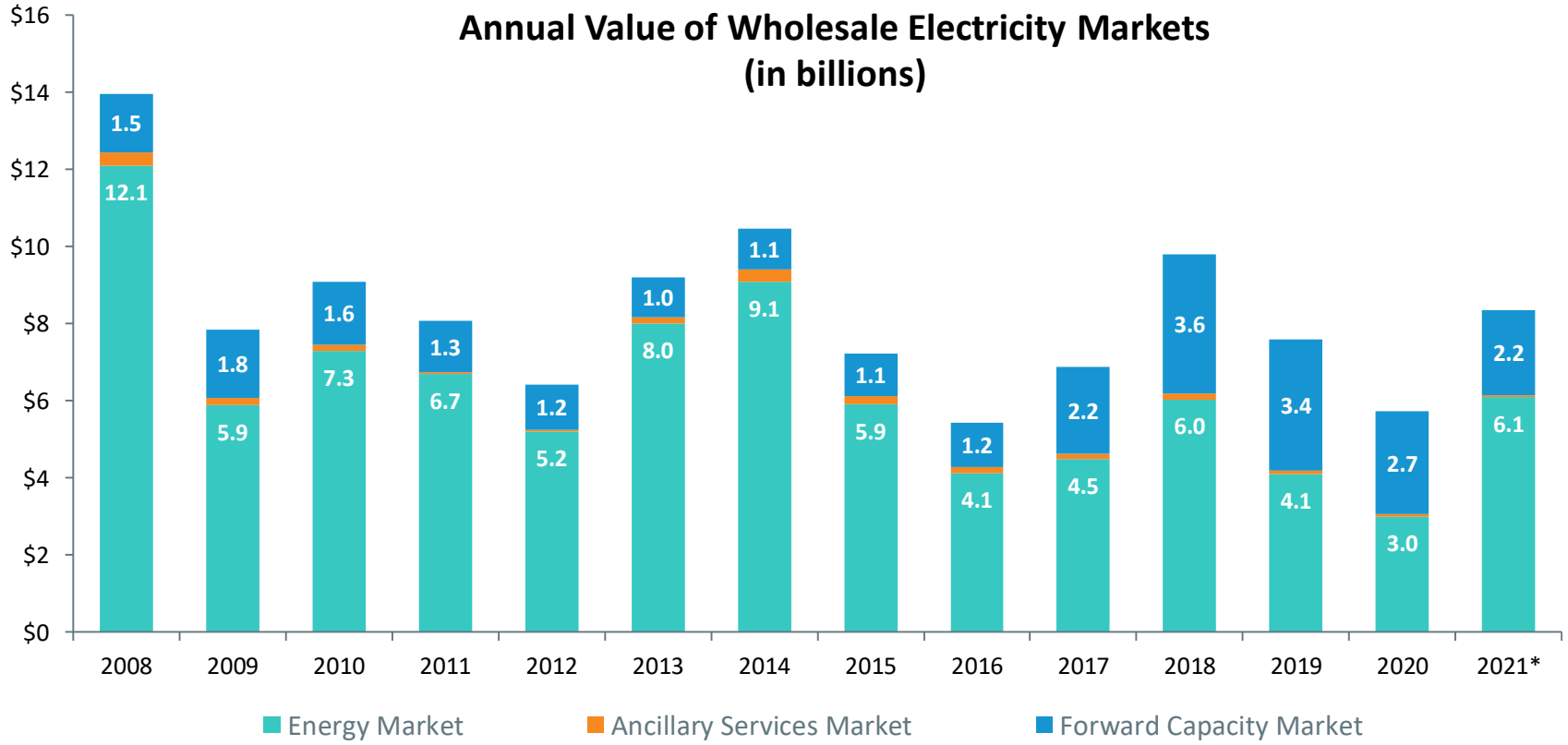
Power System Planning

Study, analyze, and plan to make sure New England's electricity needs will be met over the next 10 years



Markets Select the Most Cost-Efficient Resources to Meet Current and Future Electricity Needs

Energy Market Values Vary with Fuel Prices, While Capacity Market Values Vary with Changes in Supply

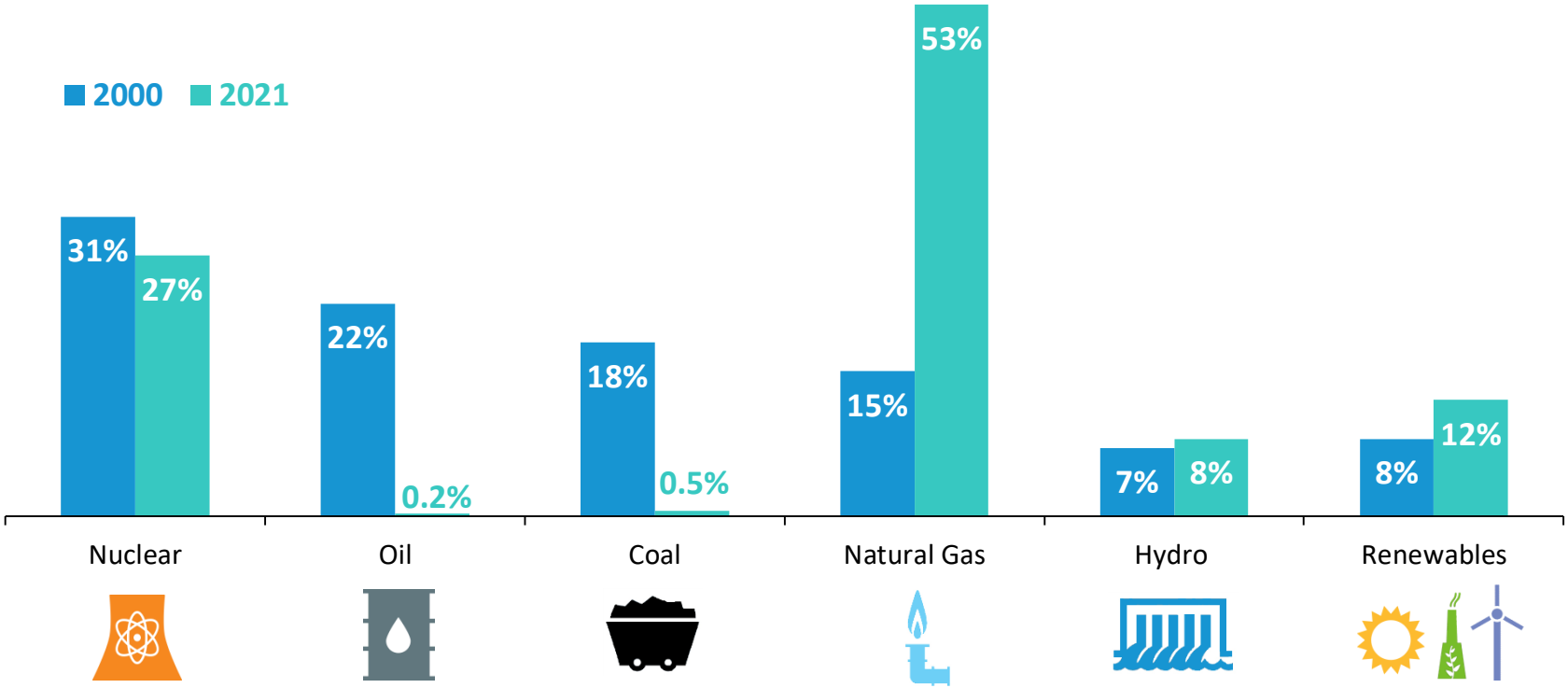


Source: *2021 Report of the Consumer Liaison Group*; *2021 data is preliminary and subject to resettlement

Dramatic Changes in the Energy Mix

The fuels used to produce the region's electric energy have shifted as a result of economic and environmental factors

Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2021)

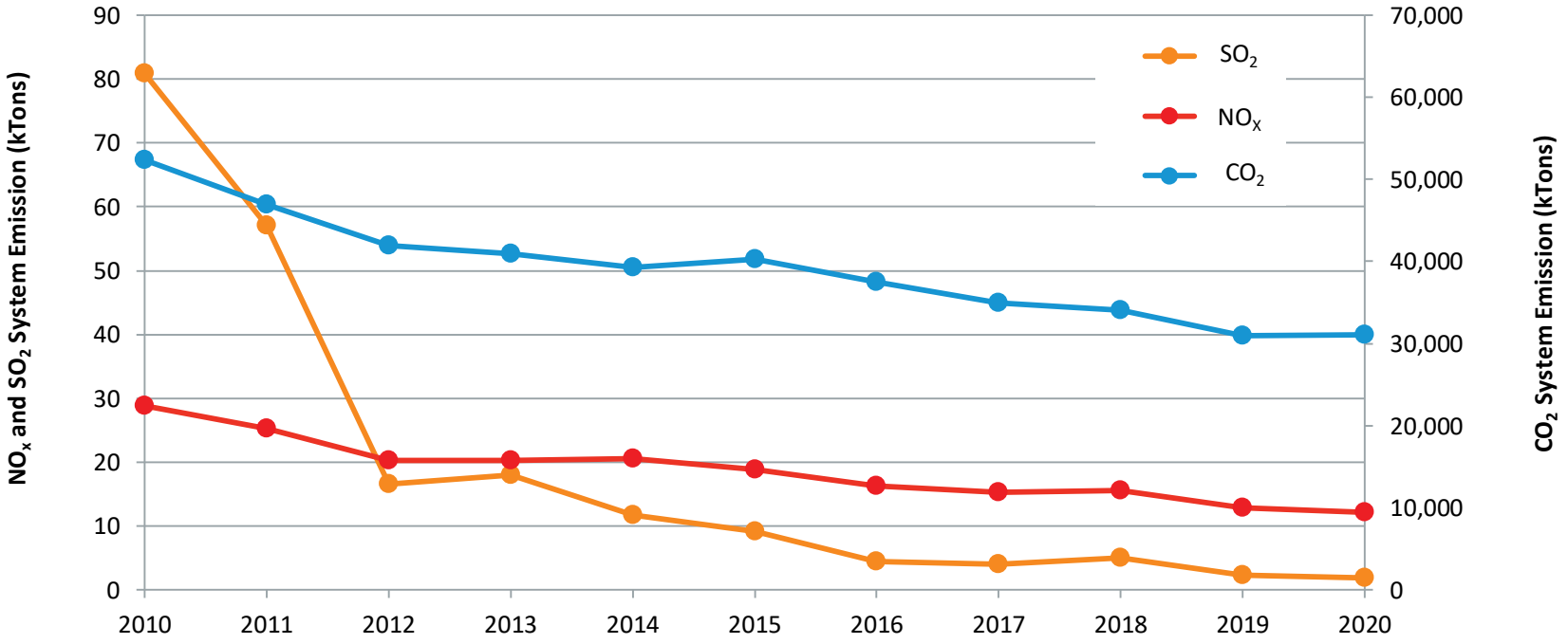


Source: ISO New England Net Energy and Peak Load by Source; data for 2021 is preliminary and subject to resettlement
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.
This data represents electric generation within New England; it does not include imports or behind-the-meter (BTM) resources, such as BTM solar.

Major Emissions Reductions

Emissions from regional generators have fallen significantly since 2001

Annual New England System Generator Emissions, 2010-2020* (Thousand Short Tons)



Carbon Dioxide (CO_2) ⬇41% **Nitrogen Oxide (NOx) ⬇58%** **Sulfur Dioxide (SO_2) ⬇98%**

*2020 data is preliminary and subject to change. Source: ISO New England, *New England Electric Generators Air Emissions Report*

States Are Targeting Increases in Renewable and Clean Energy and Deep Reductions in CO_2 Emissions

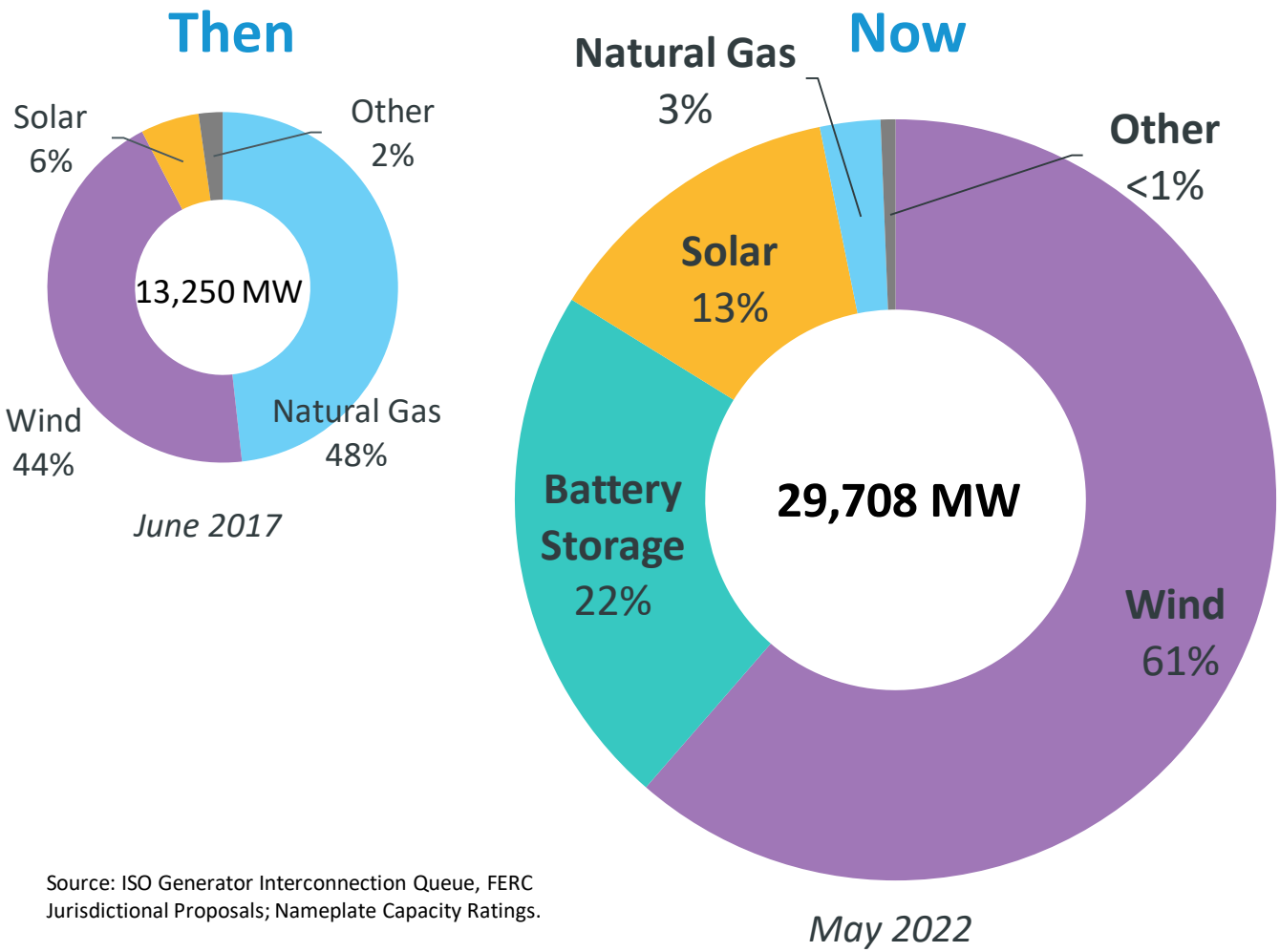
≥80% by 2050	Five states mandate greenhouse gas reductions economy wide: MA, CT, ME, RI, and VT (mostly below 1990 levels)
Net-Zero by 2050 80% by 2050	MA statewide GHG emissions limit MA clean energy standard
90% by 2050	VT renewable energy requirement
100% by 2050 Carbon-Neutral by 2045	ME renewable energy requirement ME emissions goal
100% by 2040	CT zero-carbon electricity goal
100% by 2030	RI renewable energy goal

States Accelerate Clean Energy Procurements (2017-2022)

State	State Procurement Initiatives for Large-Scale Clean Energy Resources	Eligible Resources	RFP Target MW (nameplate)	Projected COD/ Selected MW
ME	2022 Northern Maine Transmission and Renewable RFP	Transmission and Newly Developed Renewables	700-1,200 MW	TBD
MA	2021 Section 83C III Offshore Wind RFP	Offshore Wind	1,605 MW	2027 (1,200 MW) 2028 (405 MW)
ME	2020-2021 RPS RFP	ME RPS Class IA renewables	2,360,000 MWh	2022-2024
CT	2019 Offshore Wind RFP	Offshore Wind	400 – 2,000 MW	2026 804 MW
MA	2019 Section 83C II Offshore Wind RFP	Offshore Wind	800 MW	2025 804 MW
RI	2018 Renewable Energy RFP	Solar, Wind, Biomass and Other Eligible Resources	400 MW	2023 50 MW
CT	2018 Zero-Carbon Resources RFP	Nuclear, Hydro, Class I Renewables, Energy Storage	Approx. 1,400 MW (12,000,000 MWh)	2020-2026 11,658,080 MWh
CT	2018 Clean Energy RFP	Offshore Wind, Fuel Cells, Anaerobic Digestion	252 MW	2019-2025 252 MW
MA RI	2017 Section 83C I Offshore Wind RFP	Offshore Wind	800 MW (MA) 400 MW (RI)	2023(800 MW) 2025 (400 MW)
MA	2017 Section 83D Clean Energy RFP	Hydro Imports	Approx. 1,200 MW (9,554,000 MWh)	2022 9,554,940 MWh/year

The ISO Generator Interconnection Queue Provides Snapshots of the Future Resource Mix

Dramatic shift in types of proposed resources from natural gas to wind



Source: ISO Generator Interconnection Queue, FERC Jurisdictional Proposals; Nameplate Capacity Ratings.

PATHWAYS STUDY: EVALUATION OF PATHWAYS TO A FUTURE GRID

An Overview of Final Study Results

Chris Geissler

MANAGER, ECONOMIC ANALYSIS

How We Got Here: Future Grid Background

- In 2019, the New England states and stakeholders requested that the ISO help evaluate how market approaches could facilitate a more decarbonized electricity sector[1]
- The ISO worked with Analysis Group, an economic consulting firm with expertise in electricity markets, to conduct and share analysis that is responsive to this request
- This analysis is summarized in a report prepared for the states and stakeholders that was published in April

[1] New England State's Vision Statement (Oct. 2020) https://nescoe.com/resource-center/vision-stmt-oct2020/

Study Evaluates Four Pathways to Decarbonization

- **Status Quo** (SQ): States continue to pursue long-term power purchase agreements with renewable energy developers
- **Forward Clean Energy Market** (FCEM): Centralized clean energy market with forward procurement that awards certificates for clean energy production
- **Net Carbon Pricing** (NCP): Generators pay for each unit of carbon emitted
- **Hybrid Approach**: Includes both an FCEM for new resources and an NCP for all resources

Status Quo: Continuation of Current State Policies

- States continue to pursue long-term power purchase agreements with renewable developers
- Selection of these resources may depend on various factors including costs, technology type, location, etc.
- Model assumes states will pursue a technology mix that aligns with their publicly stated ‘roadmaps’ to decarbonization

FCEM: Introducing Clean Energy Certificates

- Clean energy certificates (CEC) are awarded to resources for each MWh of 'clean' energy produced
- States buy CECs in a forward auction to meet environmental objectives and clean energy owners sell CECs to earn revenues for their (expected) clean energy production
  - Spot market allows for resources to cover their forward positions
- Clean energy resources would lower offer price to obtain CECs
- Novel concept, though many design details have not been fully evaluated (interaction with existing REC programs, etc.)

Net Carbon Pricing: Directly Pricing Carbon Emissions

- Carbon emitting resources increase offer price to account for cost of carbon emissions
- Leads to higher energy market prices, where some of these costs are returned to load, and the remainder goes to clean and low-emitting resources
- Not a novel design – carbon pricing has been studied and implemented in many regions
  - New England already has a version of this mechanism in the Regional Greenhouse Gas Initiative (RGGI)

Hybrid Approach: FCEM for Some, NCP for All

- There are many ways to combine elements of an FCEM and carbon price, though this version was requested by the New England states during the study process
- Includes a carbon price applied to all resources, and an FCEM that only awards CECs to new resources
- Target an average energy price of $41/MWh to try and retain existing clean resources
- Like FCEM, a novel concept

Study Assesses Differences Between Pathways

- Quantitative analysis:
  - How costly is decarbonization under each pathway?
  - How does the set of resources that provide energy to meet demand differ between pathways?
  - Each pathway's prices for energy, environmental attributes, capacity
- Qualitative analysis:
  - Design and implementation challenges for each pathway
  - Level of regional coordination needed under each pathway

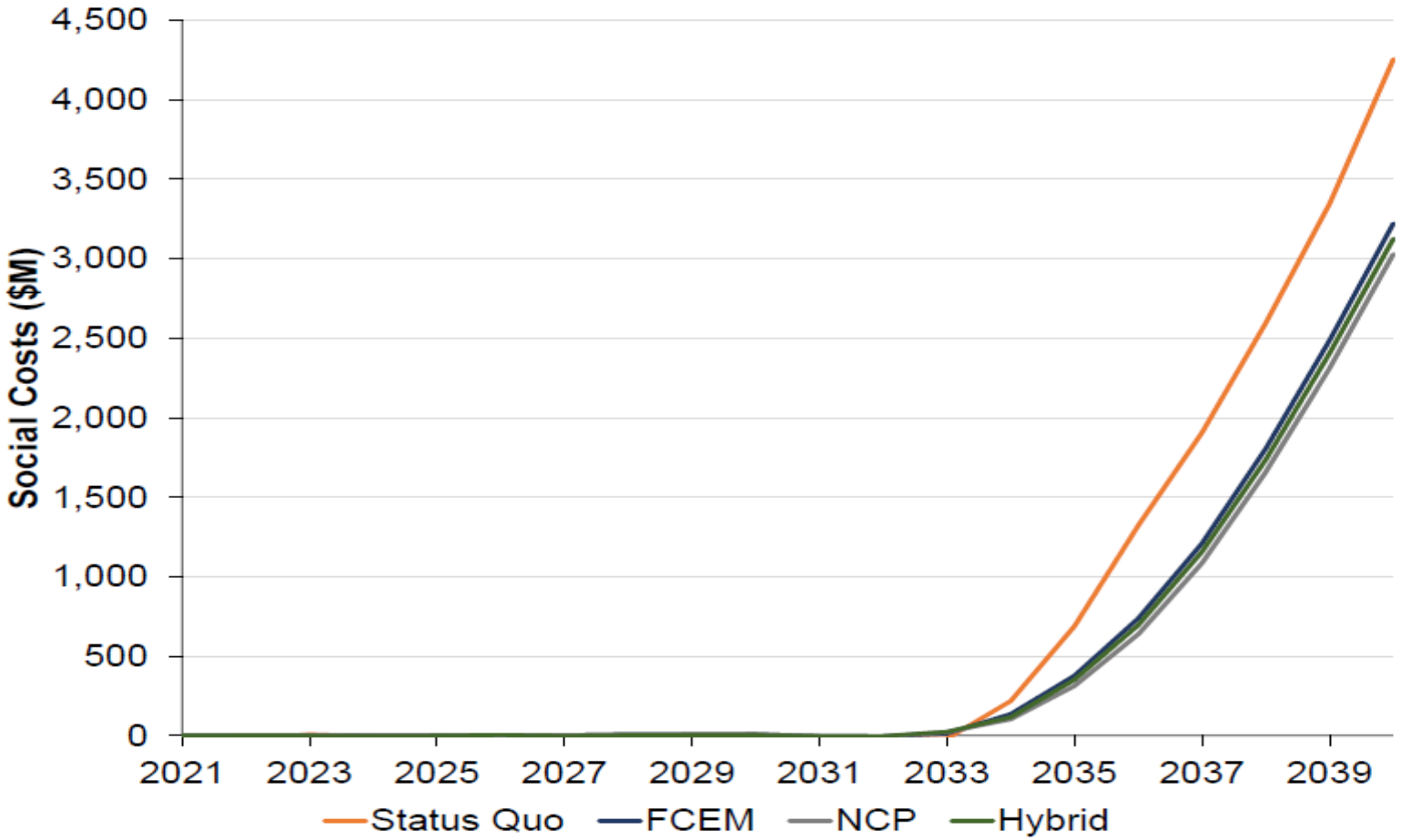
Modeling Framework for Quantitative Analysis

- For each pathway:
  - Reduce 2040 carbon emissions by 80 percent from 1990 level
  - Simulate capacity and energy market outcomes from 2020 to 2040
  - Solve for optimal resource mix each year, and dispatch each hour
  - Calculate energy, environmental, and capacity prices based on incremental costs of providing each attribute
- Where possible, assumptions are consistent with current market rules
- Differences between the Pathways become evident in model outputs in later part of study period

Key Quantitative Takeaways: Costs

- NCP is the most cost-effective approach to decarbonizing
  - Hybrid costs $100 million more per year in 2040
  - FCEM costs $200 million more per year in 2040
  - SQ costs $1.2 billion more per year in 2040
- NCP provides incentives for all forms of decarbonization, including development of new clean resources and switching from higher to lower emitting resources

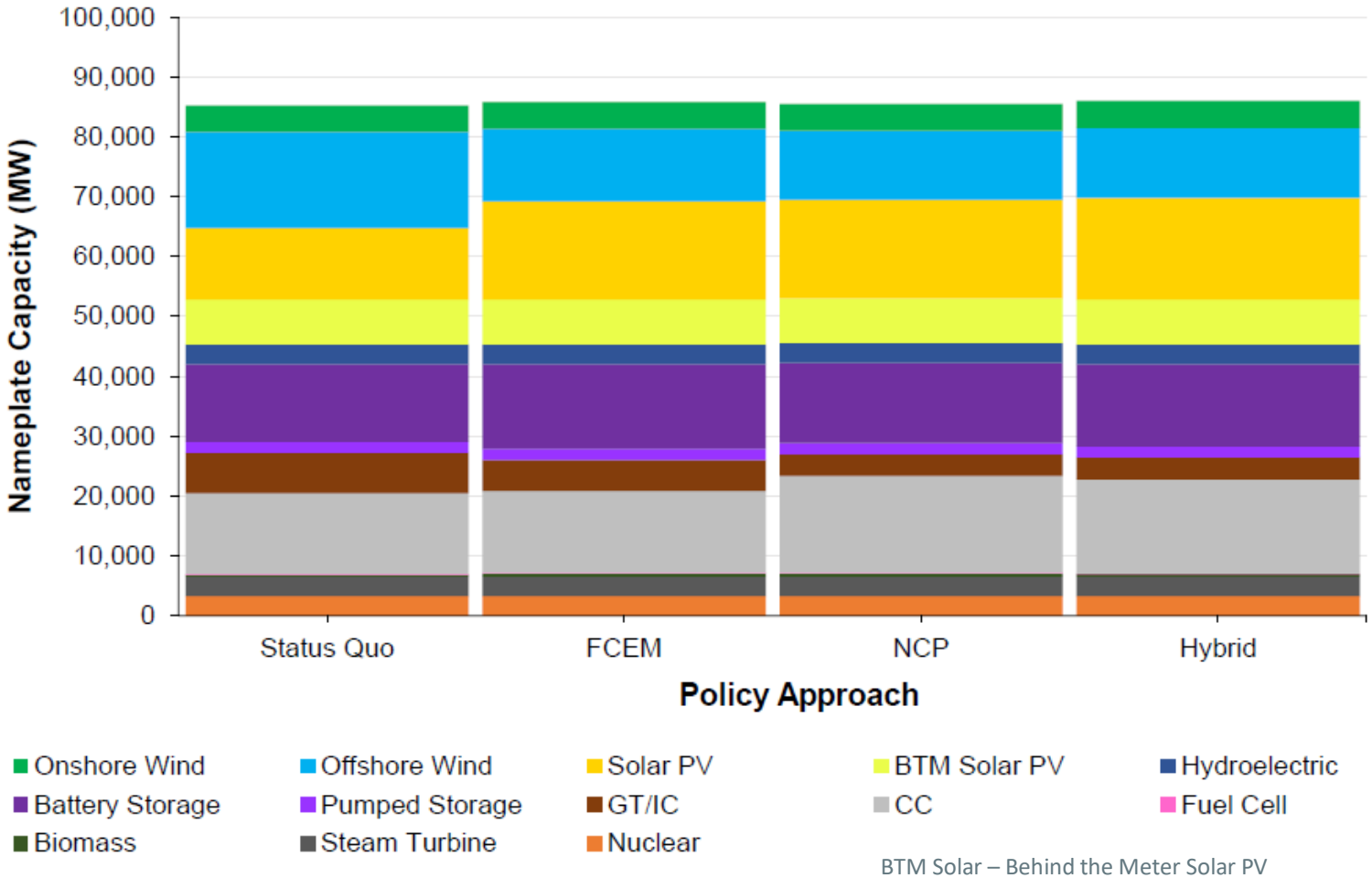
Incremental Costs by Pathway Relative to Reference Case



Key Quantitative Takeaways: Resource Mix

- New resources are needed across all pathways to meet growing electricity demand caused by the electrification of the heating and transportation sectors
- Some fossil resources remain, but large majority of new resources under each pathway are non-emitting
- SQ procures the most offshore wind resources, as this aligns with current state plans and roadmaps
- Other pathways procure more onshore wind and solar energy

2040 Resource Mix by Pathway

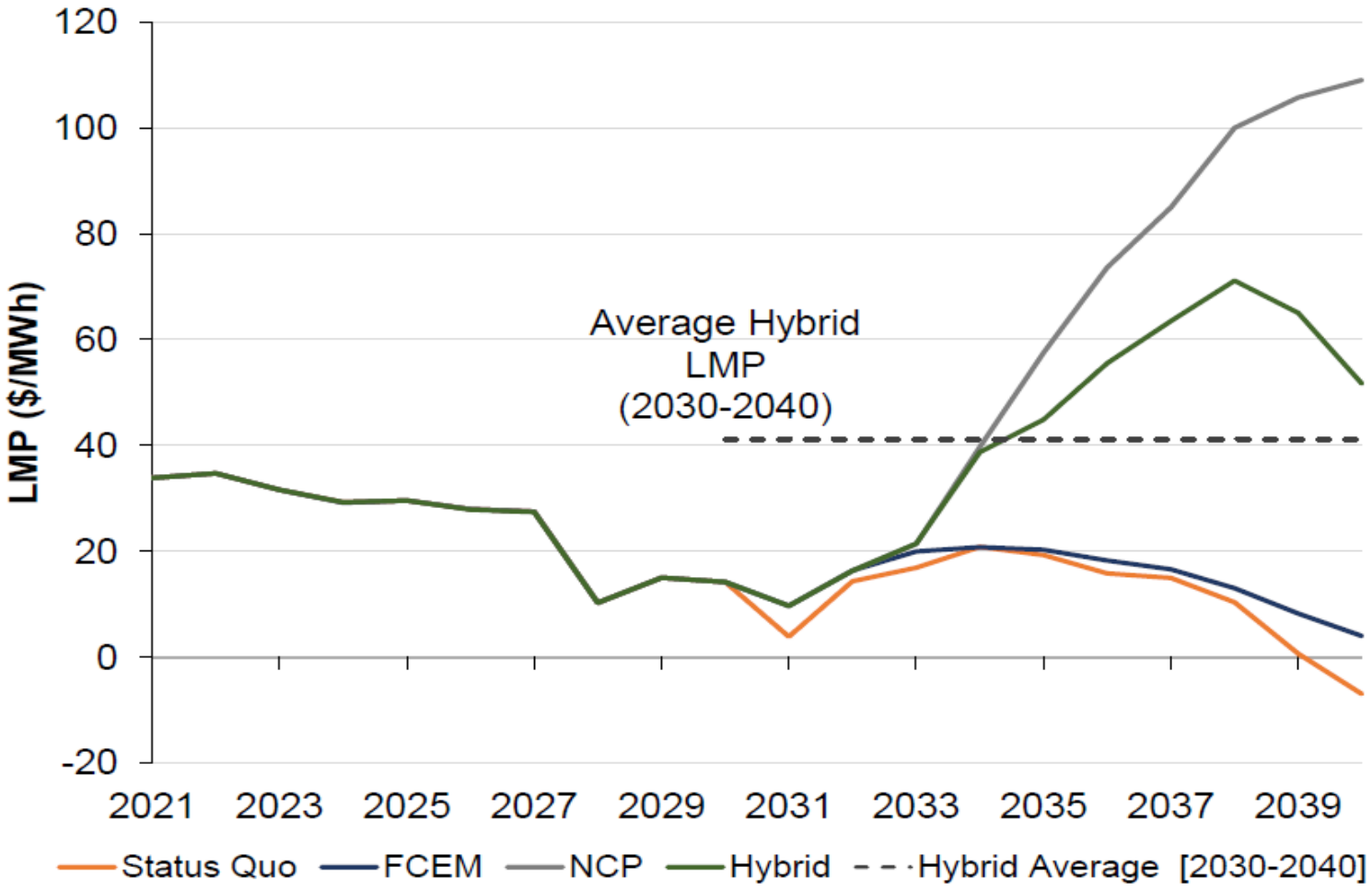


BTM Solar – Behind the Meter Solar PV
GT/IC – Gas Turbine/Internal Combustion Engine
CC – Natural Gas Combined Cycle

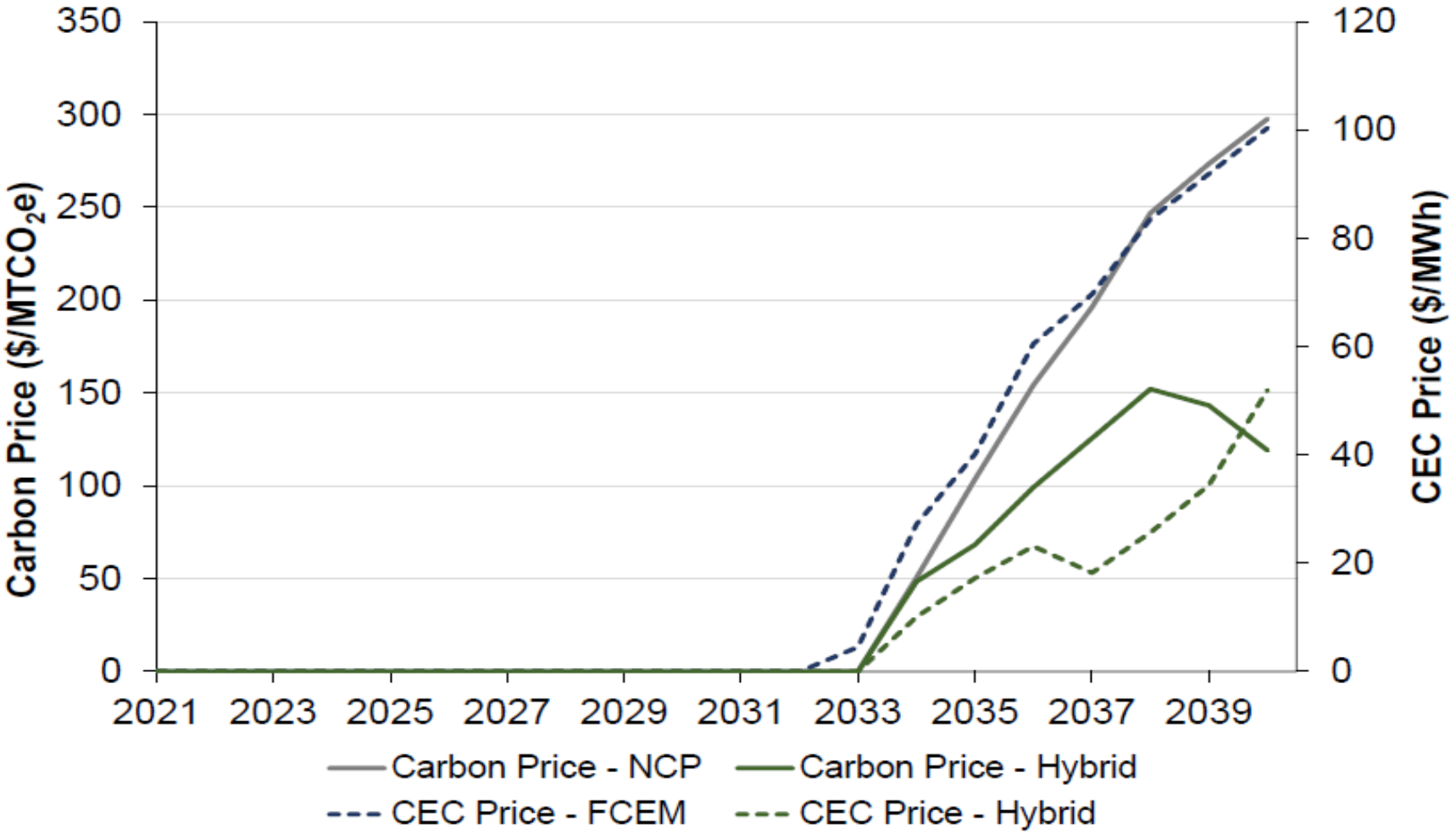
Key Quantitative Takeaways: Prices

- Environmental prices impact consumer costs in multiple ways
  - Carbon price increases wholesale energy prices, but also result in a direct rebate to consumers
  - Clean energy certificates reduce wholesale electricity prices, but also result in a direct additional charge to consumers
- As the fraction of renewables increases, SQ and FCEM produce negative energy market prices with increased regularity
  - Renewables offer energy at negative prices to reflect contract terms or value of clean energy certificates
  - Negative energy prices in roughly one-third of hours in 2040

Average Energy Market Prices by Pathway, 2021-2040



Average Environmental Prices by Pathway, 2021-2040



Key Qualitative Takeaways: Design and Implementation

- SQ represents a continuation of current policies, but may present long-term challenges as region further decarbonizes
- NCP is simpler to design and implement than FCEM or Hybrid
  - Carbon pricing is well understood and region already has a form of it via Regional Greenhouse Gas Initiative (RGGI)
- FCEM is a novel design that would require more work to define the product(s) procured, auction/mechanism to procure these products, interaction with existing state programs, etc.
- Hybrid may add yet further complexity by including elements of both NCP and FCEM

Key Qualitative Takeaways: Regional Coordination Among States

- SQ requires lowest degree of regional coordination, whereas NCP likely requires the greatest
- SQ reflects the current approach in the region
- For FCEM, region must agree to common definition of clean energy, but states can buy different clean energy quantities
- Under NCP, region must decide on a single regional carbon price or emissions target

Key Study Limitations and Caveats

- Studies each Pathway at a conceptual level
  - Many important design elements remain outstanding
- Any study looking ahead 20 years is heavily dependent on the modeling assumptions
  - Study's focus is on differences across pathways, rather than economic outputs for any given Pathway (e.g., total costs)
- Study focuses on market outcomes and does not consider other key factors such as reliability outcomes, legal questions about jurisdiction

Pathways Materials

- Pathways report: https://www.iso-ne.com/static-assets/documents/2022/04/schatzki-et-al-pathways-final.pdf
- Summary of the report: https://isonewswire.com/2022/04/20/iso-ne-finalizes-study-analyzing-potential-market-designs-for-the-future-grid/
- Library of materials on Future Grid Initiative: https://www.iso-ne.com/committees/key-projects/new-englands-future-grid-initiative-key-project/

Questions

APPENDIX

Summary Table of Key Policy Tradeoffs

Policy Factor	Status Quo	FCEM	Net Carbon Pricing	Hybrid Approach
Policy Flexibility and Challenges				
Reliance on Regional Coordination and Consensus	• Low (unilateral state policies)	• Can coordinate state clean energy goals • Requires consensus on CEC product definition (and potentially CEC target and state allocations)	• Requires CO2 price or target consensus	• Requires consensus on CO2 price and CEC product
Cost Allocation Flexibility	Low (bound by unilateral policies)	High (through assignment of CEC obligations)	Moderate (through allocation of carbon revenues)	Moderate/High (through assignment of CEC obligations and allocation of carbon revenues)
Emission (and Cost) Uncertainty	Medium		Low-High (varies by design, with tradeoff between emission and cost uncertainty and need for forward policy commitment)	
Implementation Challenges (Examples)		• Determining CEC quantity needed to achieve GHG target • Integration of FCEM with FCM (if proposed)	• Determining carbon price needed to achieve GHG target (with a fixed carbon price)	• Risk of existing clean energy resource exit • Tension between retaining existing clean energy resources and potential customer savings from price discrimination • Complexity of administrative calculations of carbon price and CEC quantity
Other Policy Dimensions				
Legal	Pathways Study does not address legal and regulatory issues associated with alternative policy approaches, including jurisdictional issues and compliance with existing federal and state statues and policies, such as requirements not to create undue discrimination in competitive markets			
Reliability	Pathways Study does not address variable renewable integration, capacity market uncertainty, or other dimensions of reliability			
Transmission	The Pathways Study accounts for some (but not all) transmission costs and accounts for certain transmission constraints, but does not provide a thorough analysis of transmission needs of a decarbonized system			

Summary Table of Key Policy Tradeoffs (Cont.)

Policy Factor	Status Quo	FCEM	Net Carbon Pricing	Hybrid Approach
Economic and Market Outcomes				
Cost-effective CO_2 Emission Reduction	Low	Moderate/High	High	Moderate/High
Cost-effective incentives for reductions in carbon-intensity	No	No	Yes (efficient)	Yes (but less than efficient level)
Cost-effective incentives for clean energy investment	NA (no in-market incentive, depends on administrative planning)	Partial (Incents clean energy generation, but not necessarily cost-effective choice among clean energy resources)	Yes (efficient)	Yes (mix of FCEM and carbon price)
Cost-effective incentives for investment across time	No (no in-market incentive, depends on administrative planning)	Yes (for clean energy investment)	Yes (efficient)	Yes (mix of FCEM and carbon price)
Transparent Price Signals	No	Yes (creates carbon or CEC price signal)		
Negative LMPs	Yes (potential storage "churning", inefficient battery use/investment)	Yes (potential storage "churning", inefficient battery use/investment)	No	Yes (potential storage "churning", inefficient battery use/investment, less than Status Quo and FCEM)
Price Discrimination	Yes (risk of inefficient entry/exit, capital turnover; need for additional out-of-market contracts)	No	No	Yes (risk of inefficient entry/exit, capital turnover)
Potential Distortions in Market Offers	Yes (*e.g.*, curtailment based on PPA price, not costs)	No	No	No

Overview of Studies Supporting Future Grid

- **Weather**: Operational Impacts of Extreme Weather Events
  - Rigorously model likelihood and impact
  - Discussion of initial steps commenced in May, study **is expected to take 15-18 months (continuing into 2023)**
- **Transmission**: 2050 Transmission Study
  - What transmission is needed to support renewable/high load future
  - Initial results presented at the Planning Advisory Committee in March and April
- **Operations**: Future Grid Reliability Study (Phase 1)
  - Examine operational effects of renewable-heavy grid, initial results available
  - The most up-to-date information is available here
- **Markets**: Pathways to the Future Grid
  - Evaluate different market options to support a renewable-heavy grid
  - Final report available
- **Reliability**: Transmission Planning for the Clean Energy Transition
  - How should near-term needs assessments evolve with renewables?
  - Final report available

Markets Select the Most Cost-Efficient Resources to Meet Current and Future Electricity Needs

Energy Market

Electric Energy: The Day-Ahead and Real-Time Energy Markets are forward and spot markets for trading **electric energy**. Energy prices **fluctuate** throughout the day and at different locations in New England, reflecting the amount of consumer demand, constraints on the system, and the price of fuel that resources use to generate electricity.

Ancillary Services

Short-Term Reliability Services: Resources compete in the ancillary markets to provide backup electricity as well as services needed to support the physical operation of the system, such as frequency regulation and voltage support. These services are **critical** during periods of heavy demand or system emergencies.

Forward Capacity Market

Long-Term Reliability Services: Resources compete to sell **capacity** to the system in three years' time through annual Forward Capacity Auctions. The Forward Capacity Market works in tandem with the Energy Markets to **attract** and **sustain** needed power resources today and into the future.