2017-11-27

Carbon Free Boston Energy Advisory Working Group, November 27, 2017 meeting slide deck

Carbon Free Boston
Energy Advisory Working Group



Institute for Sustainable Energy, Boston University
November 27, 2017

Meeting Goals

Inform TAG members about overall project scope, people, process, and timeline

Inform TAG members about overall model structure and proposed methodology underlying energy supply model

Receive feedback from TAG members about methodology, policy instruments, data issues, etc.

Determine optimal use of TAG over course of project

Meeting Agenda

Welcome and introductions (Christine Meier)

Overview of *Carbon Free Boston* project (Cutler Cleveland)

Description of modeling approach (Michael Walsh)

Description of energy sector approach (Peter Fox-Penner)

Discussion (All)

Summary and plan for next meeting (Cutler Cleveland)

Project Goals

Provide quantitative assessment of the effectiveness of alternative strategies to reduce GHG emissions that enable City to be carbon neutral by 2050

Assist City with the integration of model results into the next *Climate Action Plan (CAP)* update (late 2018)

High-Level View of Process

Build Modeling Platform and Generate Scenarios

- Sector-specific models for buildings, transportation, energy supply, and waste
- Integrating module that ties together sector models

Establish Close, Transparent Collaboration with Key Partners

- Environment Department, City of Boston, and related units
- Consultants
- Technical Advisory Groups and Social Equity Advisory Group
- Broader stakeholder groups (to be managed by City and GRC)

Submit Final *Carbon Free Boston* Report to GRC

- Iterative process involving multiple reviews of interim model results and report drafts

Project Funding

Barr Foundation
Leventhal Foundation
Kendall Foundation
Hewlett Foundation (anticipated)
Commonwealth of Massachusetts
City of Boston
Eversource
National Grid
Bank of America

Project Staffing

Boston University

- Dr. Cutler Cleveland, PI
- Dr. Peter Fox-Penner, co-PI
- Dr. Christine Meier, Project Manager
- Dr. Michael Walsh, Senior Research Scientist
- Other senior personnel:
  - School of Public Health: Dr. Jon Levy, Dr. Pat Kinney
  - College of Arts and Sciences: Dr. Suchi Gopal, Dr. Lucy Hutrya

Consultants

- Cambridge Systematics (Transportation)
- Arup (Buildings)

City of Boston

- Dr. Alison Brizius, Director of Climate and Environmental Planning

GRC

- John Cleveland and Amy Longsworth

Buildings Technical Advisory Group

Member	Affiliation
Benjamin Silverman	City of Boston-EEOS
John Dalzell	City of Boston-BPDA
Jim Newman	Linnean Solutions, LLC
Dennis Carlberg	Boston University
Ben Myers	Boston Properties
Chris Schaffner	Green Engineer
Maura Zlody	City of Boston-EEOS
Hong-Hanh Chu	Commonwealth/EEA
Galen Nelson	MA CEC
Matt Foran	National Grid
James Cater	Eversource
Karthik Rao	Enernoc
Stephanie Horowitz	Zero Energy Design
Rebecca Hatchadorian	ARUP
Brian Swett	ARUP

Transportation Technical Advisory Group

Member	Affiliation
Christos Cassandras	Boston University
Peter Furth	Dukakis Center-Northeastern University
Josh Weiland	City of Boston-Transportation Dept.
Haidee Janak	City of Boston-EEOS
Jonathan Lee	City of Boston-BPDA
Hong-Hanh Chu	Commomwealth-EEA
Jennie Hatch	Boston University-ISE
Jieping Li	MPO/CTPS
Jules Williams	MassDOT
Steve Gehrke	MAPC
Eric Sundquist	SSTI
Jay Gordon	MIT Transit Lab
Rafael Mares	Conservation Law Foundation
Marc Ebuña	Transit Matters
Henry Kelly	BU/ISE; University of Michigan
Kathryn Carlson	A Better City
Brian Morris	Eversource
Sandeep Dudhwewala	National Grid
Chris Porter	Cambridge Systematics

Energy Technical Advisory Group

Member	Affiliation
Amlan Saha	M.J. Bradley & Associates
Bruce Biewald	Synapse Energy Economics
Sanem Sergici	The Brattle Group
Patty DiOrio	National Grid
Bill Fahey	Veolia
Sharon Weber	Commonwealth/DEP
Cammy Peterson	MAPC
Brad Swing	City of Boston
Tony Janetos	Boston University
James Shuckerow	Eversource
Matthias Ruth	Northeastern
David Cash	UMass/Boston
David Ismay	Conservation Law Foundation
Kate McKeever	Enel

Outputs from Analytical Work

Scenarios

- Sector-specific models for buildings, transportation, energy supply, and waste
- Integrating module that ties together sector models

Direct Benefits/Costs

- Emissions reductions
- Sector-specific benefits, e.g., changes in congestion and commuting time
- $ value of benefits and costs associated with specific policy/technology combinations
  - limited by budget and data availability

Co-benefits

- Public health
- Social equity
- Technical innovation
- Employment

Outline of Final Report

Introduction

- Historical overview of city's commitment to GHG Mitigation
- Why mitigate? Benefits and costs
- Description of CFB process

Challenges and Opportunities

Methodology

Boston's greenhouse gas emissions

- Inventory and accounting
- Baseline scenario

Detailed results for each sector

Summary of Options (not recommendations!)

Next Steps

- CAP update, performance management, integration into City planning, engagement with region and state

Timeline and Deliverables

Fall 2017

- Launch of modeling work
- Initial meetings of all advisory groups

Late winter 2017

- Results from first model runs
- Feedback from advisory groups and stakeholders

Mid-spring 2018

- Results from second model runs
- Feedback from advisory groups and stakeholders

Mid-summer 2018

- Draft final report
- Feedback from advisory groups and stakeholders

Early Fall 2018

- Final report

Modeling Philosophy

Software Principals

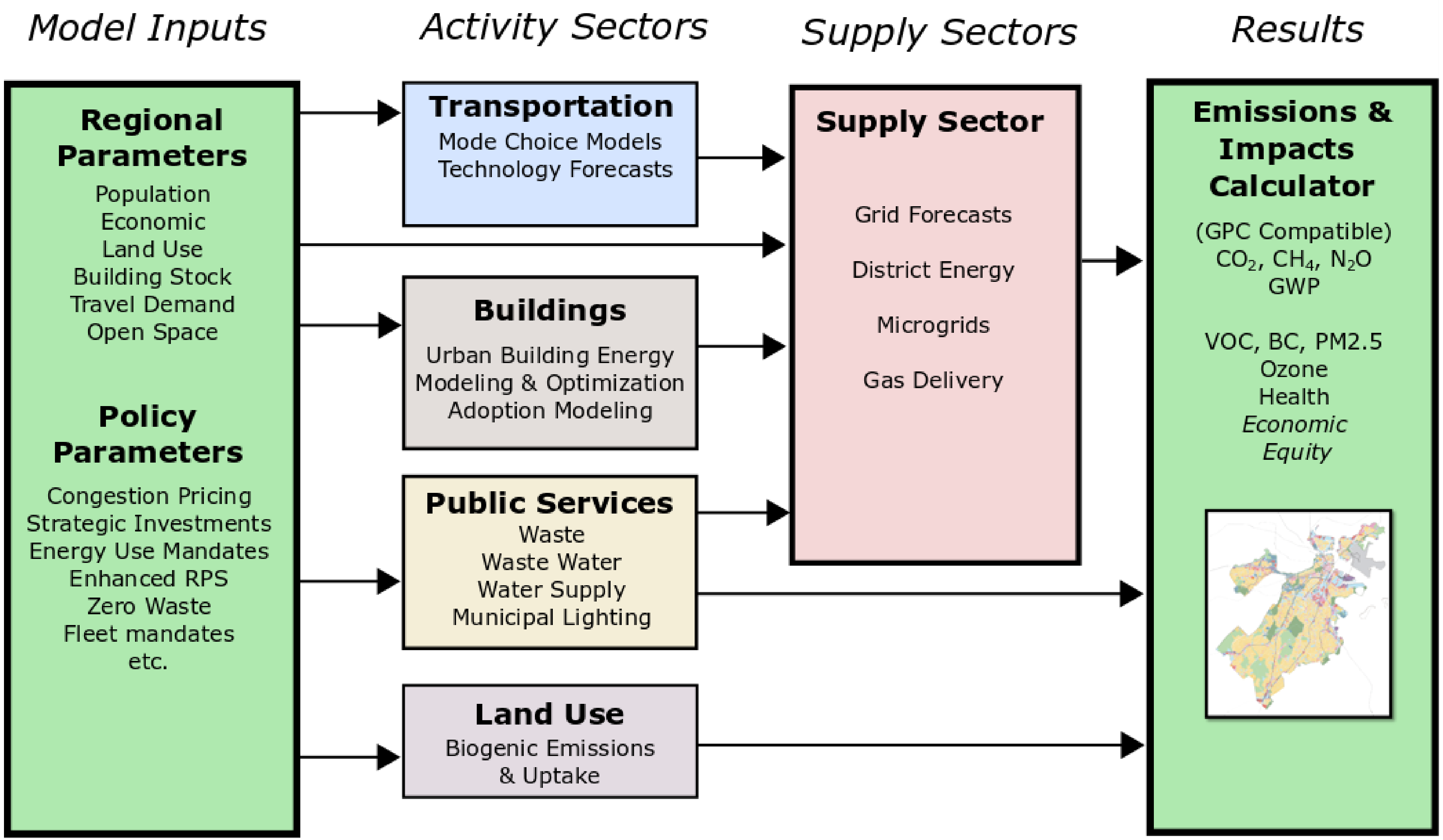
- Open Source (copyleft)
- Modular, Extensible, Scalable
- Aim for Continuous Integration
- Cloud-based
- Python 3 + associated models

Analysis Design

- Bottom-up, sector-based approach
- Spatially Explicit (Boston)
  - Limited by geographic boundary
- Compatible with existing frameworks (e.g. GPC)
- Use scenario narratives to contextualize uncertainty

Model Structure

Urban Integrated Assessment Framework



Sector Activity Model

Domain	Sector	Modeling Approach
Buildings	Residential Buildings	BEM (E+) coupled with residential adoption model
Buildings	Commercial Buildings	BEM (E+) coupled with commercial adoption model
Buildings	First Movers	BEM (E+) coupled with planed technology adoption
Transportation	Passenger Transportation	Mode Choice, vehicle ownership
Transportation	Fleet Transportation	Planned technology adoption
Transportation	Freight Transportation	Planned technology adoption
Public Services	Municipal Lighting	Planned technology adoption
Public Services	Solid Waste	Boston Zero Waste Plan + LCA
Public Services	Water Delivery	Water demand, planned technology adoption
Public Services	Wastewater Collection	Wastewater demand, planned technology adoption
Public Services	Wastewater Processing	Wastewater demand, planned technology adoption
Land Use	Land Use	Flux accounting
Supply	Distributed Generation (in city)	Planned technology adoption
Supply	Imported Electricity	Ensemble analysis of grid forecasts
Supply	Steam	Planned technology adoption
Supply	Imported Steam	Planned technology adoption
Supply	Gas	Account for delivery losses

Electricity Sector Approach

We do not expect CFB's and the City of Boston's policy options to **greatly** influence the path of ISO-NE grid decarbonization

-**but-**

We do expect there to be some degree of feedback and desired consistency.

Our goal is to find an existing model of ISO-NE grid emissions <u>through 2050</u> that is <u>reasonably consistent</u> with the ultimate CFB plan. Since we don't yet have the plan formulated, this is an exercise in "skating to where we think this puck will be going"

We've found three long term simulations of the ISO-NE grid

Electricity Sector Approach

- Our proposed approach is to:
  - Further understand data and assumptions used in each simulation, including assumed policies
  - Compare and contrast them with the general character of CFB results
  - See if one (or more) simulations appear usable
- We propose to do this work and present it to you at the next meeting
- We are open to other solutions that (a) don't require new full-scale simulations and (b) offer means of judging consistency with CFB
- Importantly, this is not an exercise in judging whose "model is better". The high quality of the models is beyond dispute; the question is probably consistency with CFB.

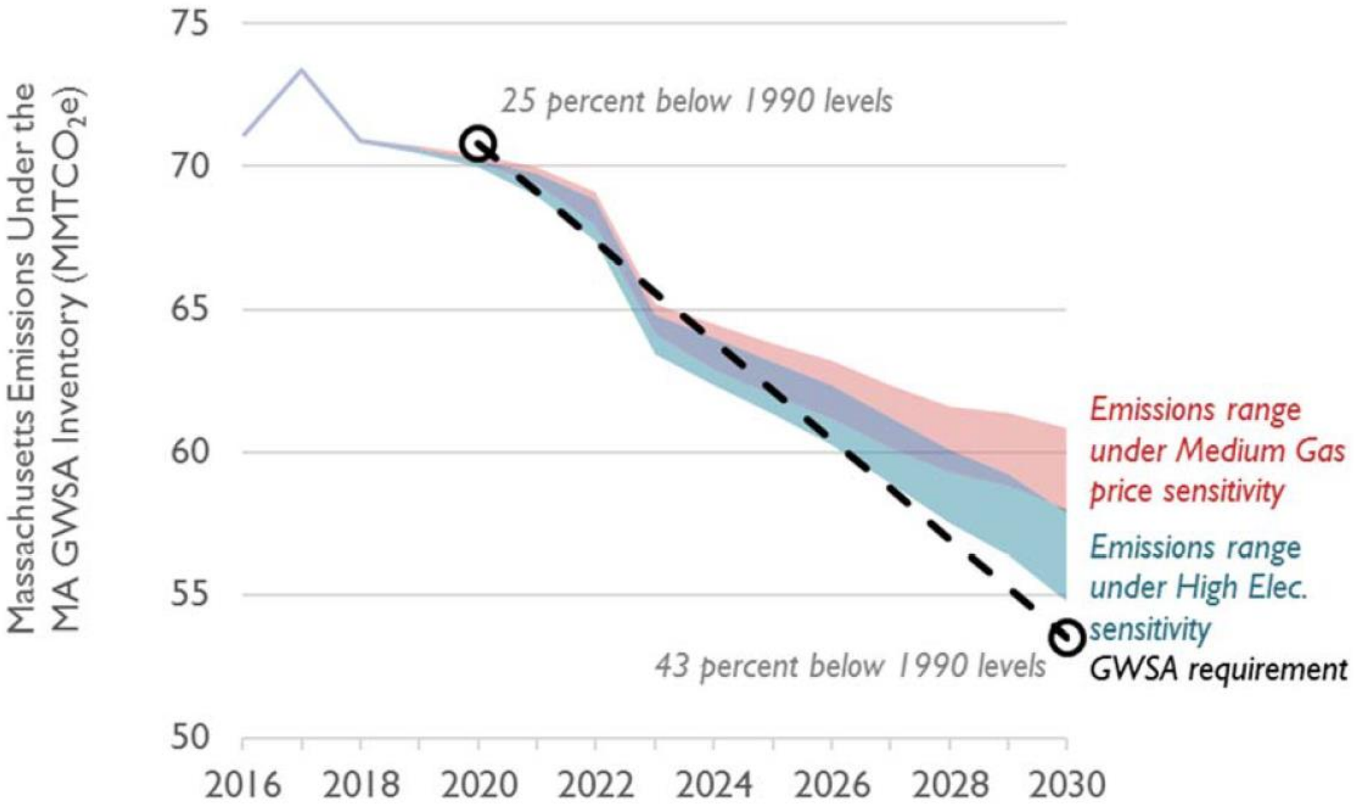
An Analysis of the Massachusetts Renewable Portfolio Standard

Synapse Energy Economics, Inc.

Sustainable Energy Advantage, LLC

May 2017

- **Commissioned by** *NECEC & Mass Energy Consumers Alliance*
- **Funders**: *E4TheFuture & Barr Foundation*
- Capacity expansion modeling of increasing state RPS
- 2030 – Massachusetts focused



An Analysis of the Massachusetts Renewable Portfolio Standard, **Synapse Energy Economics, Inc.**; **Sustainable Energy Advantage,** May 2017

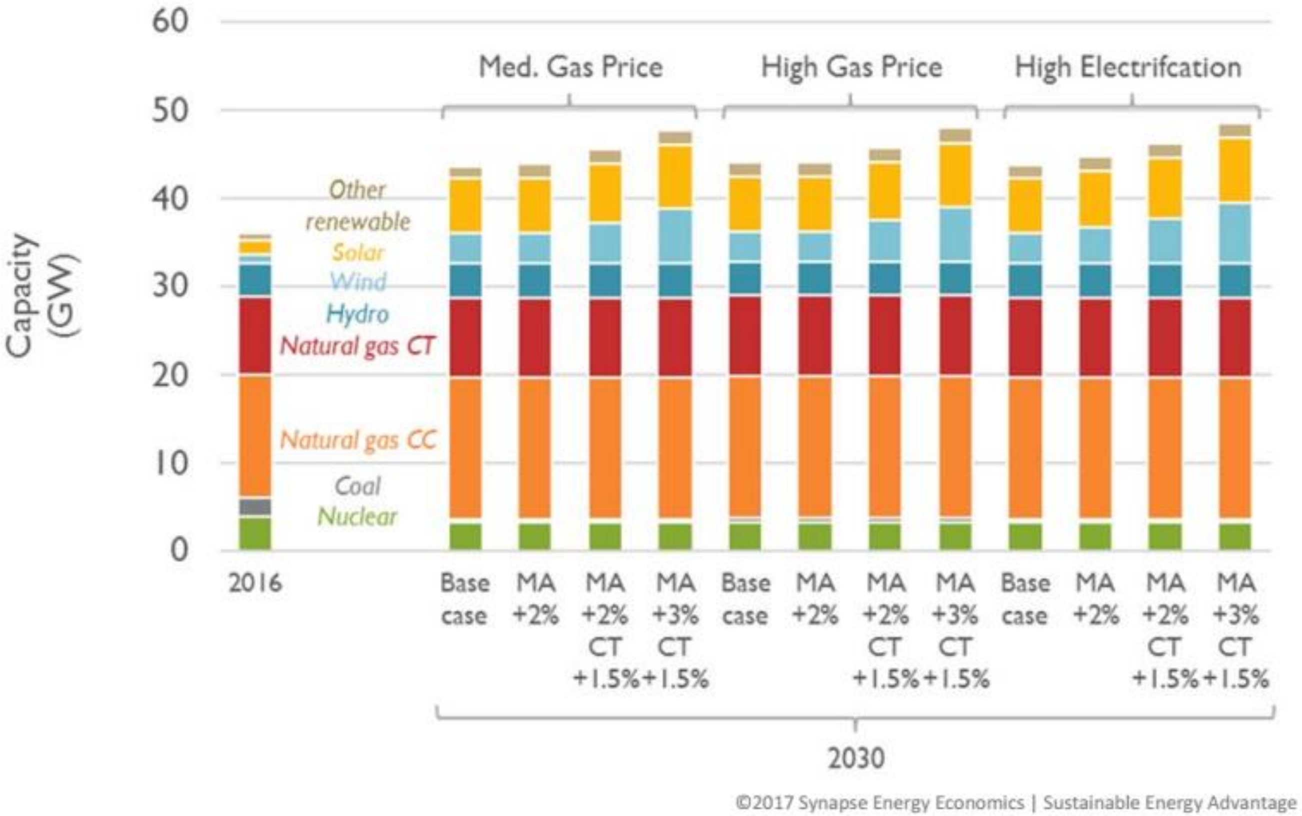
An Analysis of the Massachusetts Renewable Portfolio Standard

Synapse Energy Economics, Inc.

Sustainable Energy Advantage, LLC

Table 3. Overview of modeling runs

	Medium natural gas price sensitivity	High natural gas price sensitivity	High electrification sensitivity
Base Case (+1% MA RPS)	Base Case, Medium natural gas price	Base Case, High natural gas price	Base Case, High electrification
+2% MA RPS	MA Class I RPS increases to 2% per year in 2018, Medium natural gas price	MA Class I RPS increases to 2% per year in 2018, High natural gas price	MA Class I RPS increases to 2% per year in 2018, High electrification
+2% MA RPS and +1.5% CT RPS	MA Class I RPS increases to 2% per year in 2018, CT Class I RPS increases to 1.5% per year in 2021, Medium natural gas price	MA Class I RPS increases to 2% per year in 2018, CT Class I RPS increases to 1.5% per year in 2021, High natural gas price	MA Class I RPS increases to 2% per year in 2018, CT Class I RPS increases to 1.5% per year in 2021, High electrification
+3% MA RPS and +1.5% CT RPS	MA Class I RPS increases to 3% per year in 2018, CT Class I RPS increases to 1.5% per year in 2021, Medium natural gas price	MA Class I RPS increases to 3% per year in 2018, CT Class I RPS increases to 1.5% per year in 2021, High natural gas price	MA Class I RPS increases to 3% per year in 2018, CT Class I RPS increases to 1.5% per year in 2021, High electrification



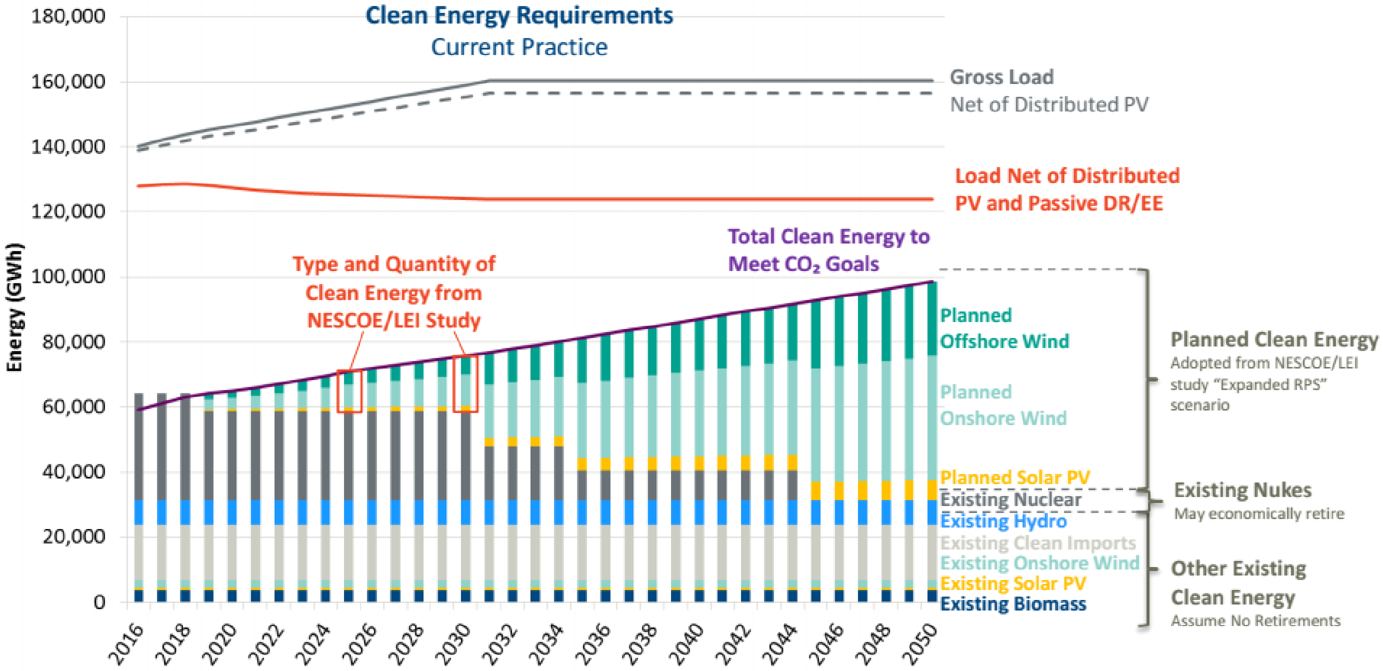
An Analysis of the Massachusetts Renewable Portfolio Standard, **Synapse Energy Economics, Inc.**; **Sustainable Energy Advantage,** May 2017

A Dynamic Clean Energy Market in New England

THE Brattle GROUP

November 2017

- Commissioned and Funded by:
  - Conservation Law Foundation
  - Brookfield Renewable
  - NextEra Energy Resources
  - National Grid
  - Robert Stoddard
- Capacity expansion modeling of a dynamic clean energy market
- 2050 Outlook
- ISO-NE



A Dynamic Clean Energy Market In New England, **The Brattle Group**, November 2017

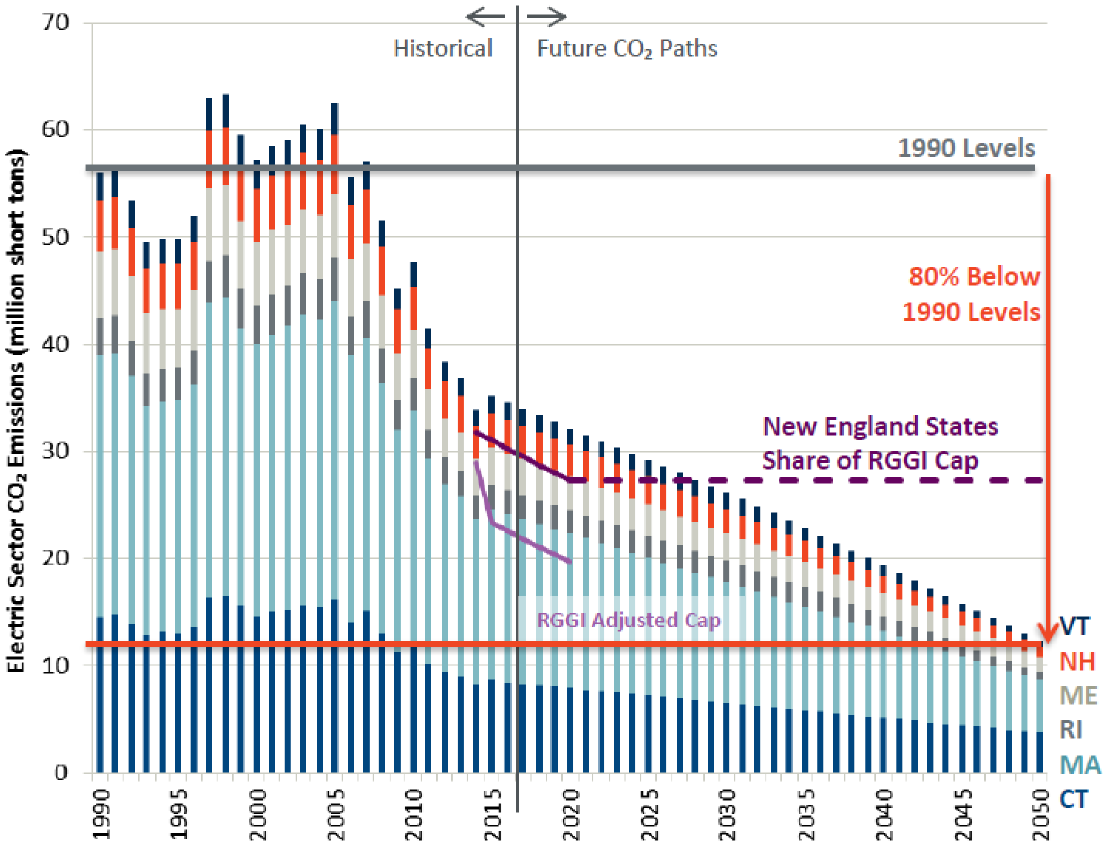
A Dynamic Clean Energy Market in New England

THE Brattle GROUP

Scenarios:

- *Current Practice*, \$5/ton CO_2 R
- *CO2 Cap* imposed across ISO-NE
- *New-Only Clean Energy Market*
  - Only new clean energy earn dynamic payments
- *Two-Tier New/Existing Clean Energy Markets*
  - New and existing resources are legible for dynamic payments

Historical Electric Sector CO_2 Emissions and Future Targets

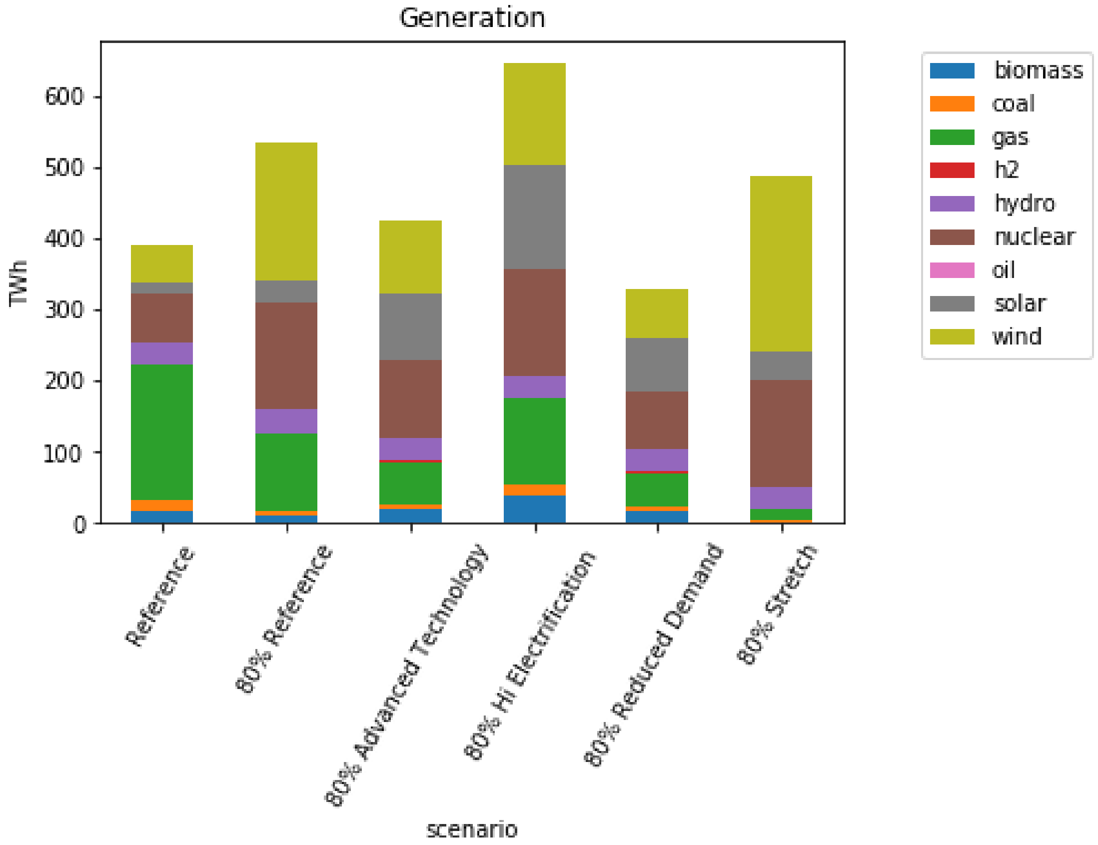


A Dynamic Clean Energy Market In New England, **The Brattle Group**, November 2017

GCAM-USA Analysis of U.S. Electric Power Sector Transitions

May 2017

- Report out of the US Low Carbon Futures Workshop
- Dynamic recursive economic equilibrium modeling of various 80% grid reduction scenarios
- 2050 Outlook
- Impacts of national policy with state-level resolution
- Open source model/study



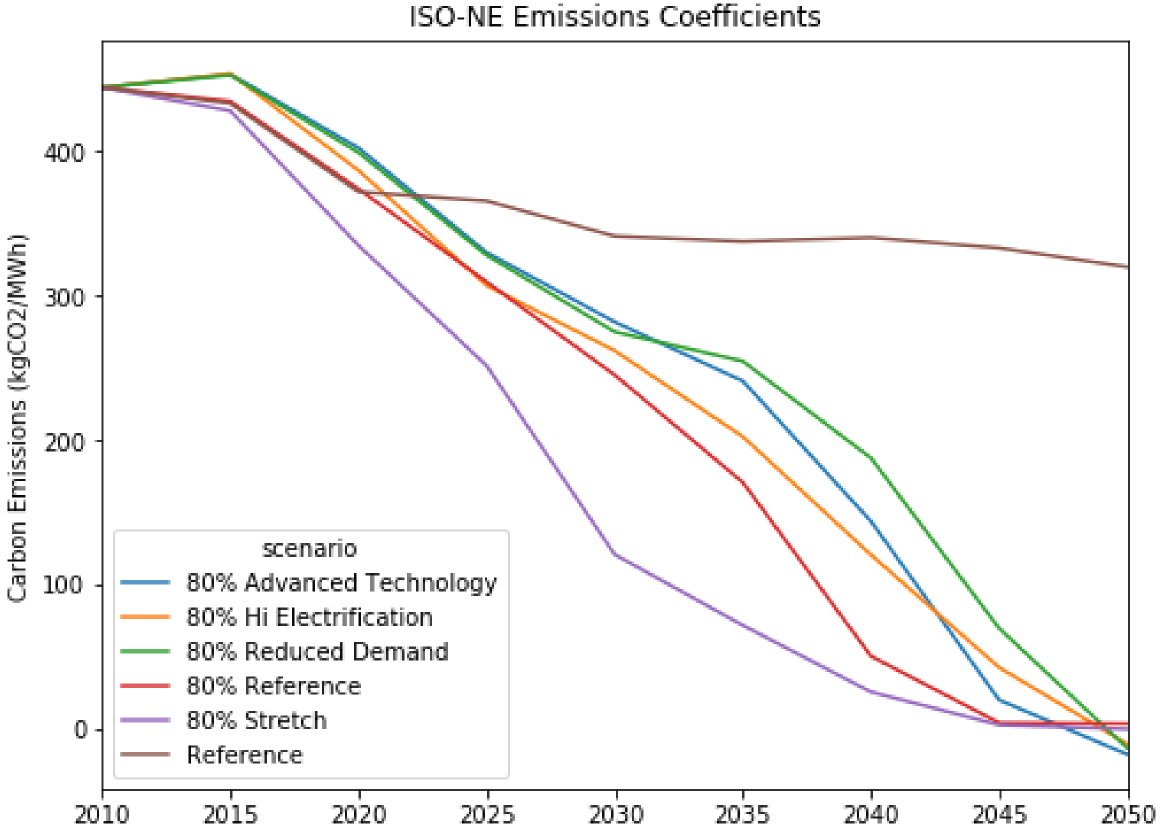
GCAM-USA Analysis of the U.S. Electric Power Sector Transitions, **PNNL-JGCRI**, May 2017

GCAM-USA Analysis of U.S. Electric Power Sector Transitions

Pacific Northwest NATIONAL LABORATORY

Scenarios:

- Reference
- National 80% CAP
    - Advanced Technology
    - High Electrification
    - Reduced Demand
    - Stretch Technology



GCAM-USA Analysis of the U.S. Electric Power Sector Transitions, **PNNL-JGCRI**, May 2017

	An Analysis of the Mass. Renewable Portfolio Standard	A Dynamic Clean Energy Market In New England	GCAM-USA Analysis of Electric Power Sector Transitions
Research Team	Synapse	Brattle	PNNL/JGCRI
Last model year	2030	2050	2050
Spatial Resolution	State/ISO+NE	State/ISO+NE	State/ISO+NE
Policy Analysis	RPS & GWSA	Dynamic payments, tax, cap	Emissions cap (80x50)
Region of Policy Focus	MA	New England	National
Model Platform	EnCompass (Anchor)	Scenario Impact Model (Brattle)	GCAM-USA (open source)
Model Methodology	Grid operations and planning optimization	Capacity expansion	Dynamic recursive economic allocation of grid resources
Scenarios	1, 2, 3% yr. RPS increase Moderate natural gas High natural gas High electrification	Current Practice CO_2 Cap New-Only Clean Energy Two-Tier New/Existing	Reference 80% Reduction 80% Advanced Tech 80% High Electrification 80% Reduced Demand 80% Stretch Technology

Questions for Energy TAG

General:

- Is the overall model appropriately conceptualized?
- Are there important activities or issues that fall through the cracks?

Energy Supply:

- What scenarios are important to consider for CFB?
- What analytical methods are important for supplying grid assumptions for CFB?

Next Steps for Energy TAG

- What stage of process is optimal for next meeting?

- What additional information can we provide?