Maine Renewable Portfolio Standard:
Examination of the Benefits and Costs of a Proposed RPS Policy Reform

TECHNICAL APPENDIX
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Prepared for: Maine Renewable Energy Association, Reed & Reed, Natural Resources Council of Maine, Brookfield, The Nature Conservancy, ReEnergy, Professional Logging Contractors of Maine, Sargent Corp., Longroad Energy, NextEra, Sierra Club of Maine, Maine Conservation Alliance, Union of Concerned Scientists

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Purpose & Scope

Purpose:
To examine the benefits and costs of (1) expanding Maine's Class 1 RPS to 50% by 2030, (2) long-term renewable energy procurement, (3) additional hydro eligibility, and (4) additional support for new distributed generation.
Key metrics include:

- ✓ Renewable Energy Supply Additions
- ✓ Changes in Generating Mix
- ✓ Bill Impacts
- ✓ Net Jobs
- ✓ Avoided Emissions

Scope: Reference Case + 3 Scenarios

1. Reference Case (key inputs are defined on later slides)
2. 80% by 2030 Case: Includes…
   a. Class 1 RPS = 50% by 2030;
   b. Class 2 RPS = 30% (current statute)
   c. Long-term contract procurement quantity = one-half of incremental RPS obligation
   d. 130 MW of hydro currently eligible for Class 2 becomes Class 1 certifiable, on a defined phase-in schedule
3. Distributed Solar Case
   a. 80% by 2030 Case, plus…
   b. A new distributed generation policy assumed to result in 375 MW of new solar by 2022 (125 MW per year 2020-2022)
4. Additional Hydro Case
   a. 80% by 2030 Case, plus…
   b. Expands hydro eligibility for Class 1 to include 223 MW of formerly Class 2 supply (up from 130 MW in the 80% by 2030 Case)
   c. Phase-in = 25% of annual output in 2020, increase 5% annually to reach full output in 2035

Models

SEA and Synapse deployed a suite of models for this analysis:

1. Sustainable Energy Advantage's *Renewable Energy Market Outlook* (REMO), which was used to develop scenario-specific renewable energy supply, demand and price forecasts through 2030.
2. The *EnCompass* model, a long-term optimization model that integrates data from REMO and other sources to estimate unit-specific scheduling and dispatch, long-term capital project optimization, market price forecasting for energy and capacity, and estimations of greenhouse gas emissions throughout New England.
3. The *IMPLAN* model, an input-output job impact model. IMPLAN produces net direct, indirect, and induced job impacts.
4. Synapse's *Bill Impact Model*, which estimates bill impacts for ratepayers. This model estimates the relative change in monthly retail bills between the Reference Case and each of the alternative cases for residential and small commercial and industrial (C&I) customers based on data from Central Maine Power.
5. U.S. EPA's *COBRA Model*, which estimates and monetizes public health impacts associated with changes in criteria pollutant emissions.

Methodology

REC Price Forecast

The *near-term* REC price forecast is a function of near-term renewable builds, regional RPS demand, Alternative Compliance Payment levels in each New England state, and market dynamic factors including banking, borrowing, imports and discretional curtailment.

The *long-term* REC price forecast is based on a supply curve analysis including technical potential, resource cost, financing assumptions, and market value assumptions to determine the most cost-effective portfolio of resources needed to fulfill the annual regional target demand quantities. The long-term REC price forecast is the marginal cost of entry for each year, meaning the premium requirement for the most expensive generation unit deployed for a given year.

Cost of Long-Term Contracted Supply

The cost of long-term contracted supply forecast is based on a supply curve analysis including technical potential, resource cost, **financing assumptions reflecting the availability of a "perfect hedge" of revenue**, and market value assumptions to determine the most cost-effective portfolio of resources needed to fulfill the annual long-term contract procurement volume. The unit ($/MWh) cost of long-term contracted supply is the marginal cost of entry for each year, meaning the premium requirement for the most expensive generation unit deployed to meet the procurement volume for a given year.

Methodology (2)

Iterative Analysis

SEA used initial energy and capacity price forecasts to develop initial renewable capacity buildout and REC price trajectories. Synapse used these initial outputs as inputs to its electric-sector dispatch modeling in EnCompass to estimate preliminary values for wholesale energy market and capacity market prices. SEA then used this wholesale energy market data to model final renewable energy and capacity buildouts and REC price forecasts. Finally, Synapse used these values to derive jobs impacts, emission impacts, and bill impacts.

Scenario Definitions: Demand-side Assumptions

	Reference Case	50% by 2030 Case
Maine RPS Targets	10% indefinitely	50% by 2030 (Annual schedule below)
Other state RPS targets, including MA CES	Current Statutes	”
Load Forecast, net of EE & BTMPV	2018 CELT	”
RPS Exemptions	Current Statute	”
Electrification (including electric vehicles & heat pumps)	2018 CELT	”

ME-1 Targets	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Reference Case	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Base Policy Case	10%	14%	17%	20%	23%	26%	29%	33%	37%	41%	45%	50%

Scenario Definitions: Supply-side Assumptions

	Reference Case	50% by 2030 Case
Maine Class 1 Eligibility	Current Statute	Eligibility criteria expanded to include 130 MW of existing hydro
Maine, Additional Large-Scale Procurement	All Current Contracts & projects in development that were selected in past ME PUC long-term contract RFPs	Plus competitive procurement for long-term (~20 yr) contracts for Class 1 supply. Total procurements = one-half of total incremental demand. 75% of contract quantities entered with supply on-line after 6/30/2019; 25% of contract quantities entered with supply on-line before 7/1/2019
Maine, DG Policies	Current Statute, including: Community-Based renewables and net metering	”
Regional Procurements	Current Statutes, including… **CT:** Project 150, Sec 127, 13-303, DG RFP, Zero-Carbon RFP **RI:** Land-based and offshore contracting authority **MA:** Sec 83, 83A, 83C (1,600 MW OSW), 83D (9.45 TWh hydro)	”
Regional DG Policies	Current Statutes, including… **RI**: Renewable Energy Growth Program, Virtual NM **CT**: LREC/ZREC, RSIP/SHREC, Solar Tariff, NM **MA**: SREC I&II, SMART, NM **VT**: Standard Offer, NM **NH**: Net Metering	”
Natural Gas Prices	NYMEX Futures + AEO 2019 Reference case	”
RGGI Prices	Most recent modeling by RGGI, Inc	”
Intraregional transmission	ISO-NE Regional System Plan	”
Conventional generation	Near-term, announced: most recent FCA Long-term, generic if needed: EIA’s AEO 2019	”

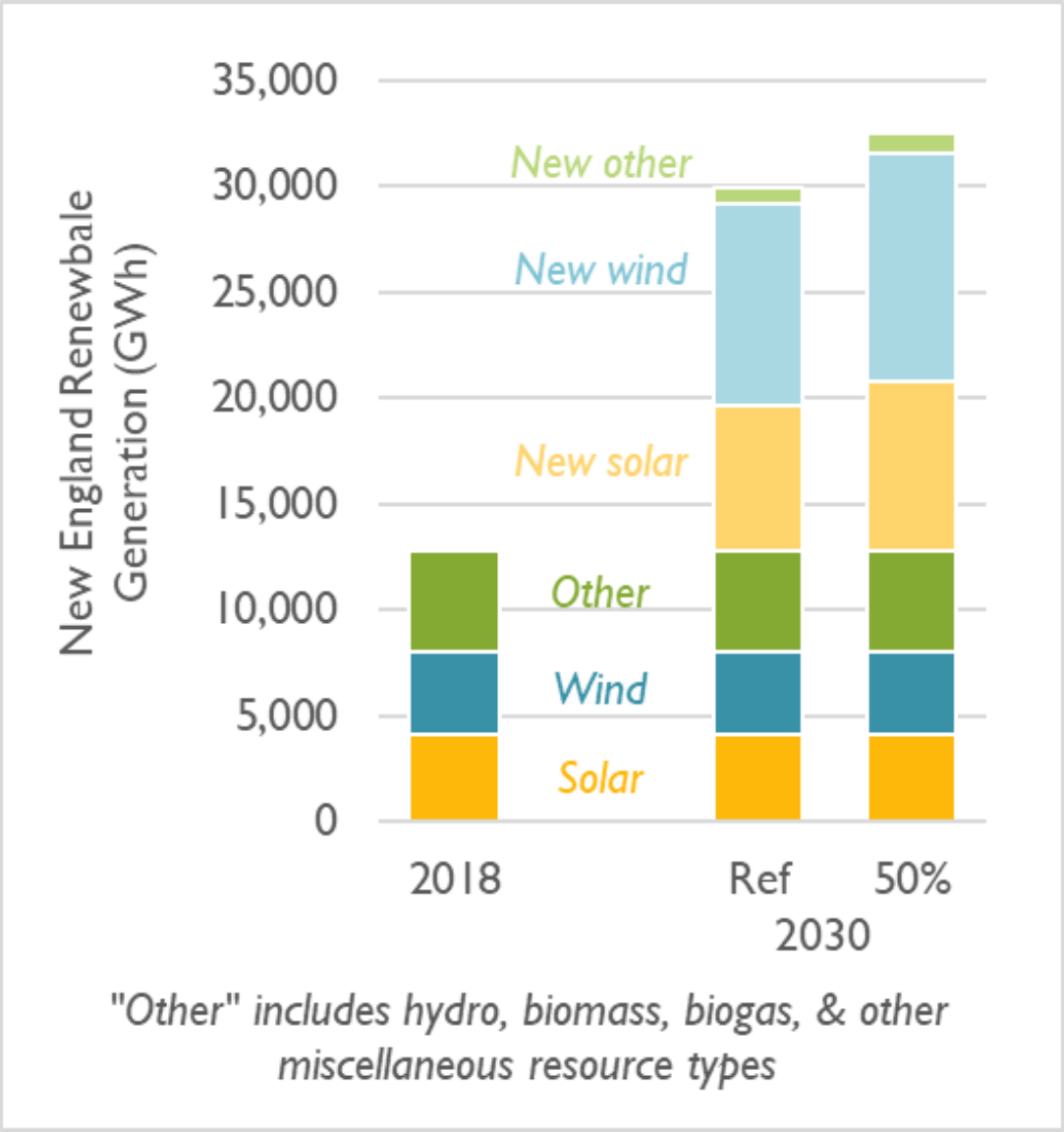
Other Key Assumptions

- New Hampshire Biomass
  - Assume SB 365 implementation is delayed until January 1, 2020 but then effective for three (3) years
  - Burgess Biopower assumed to no longer operate beginning April 1, 2023

- Probability-Weighting
  - All non-operating projects are derated based on customized probabilities of permitting and financing
  - Offshore wind policies are probability-derated as follows:
    - MA first 800 MW: Not derated
    - MA next 800 MW: derated by 15%
    - CT OSW procurement: derated by 15%
    - RI OSW procurement: derated by 15%

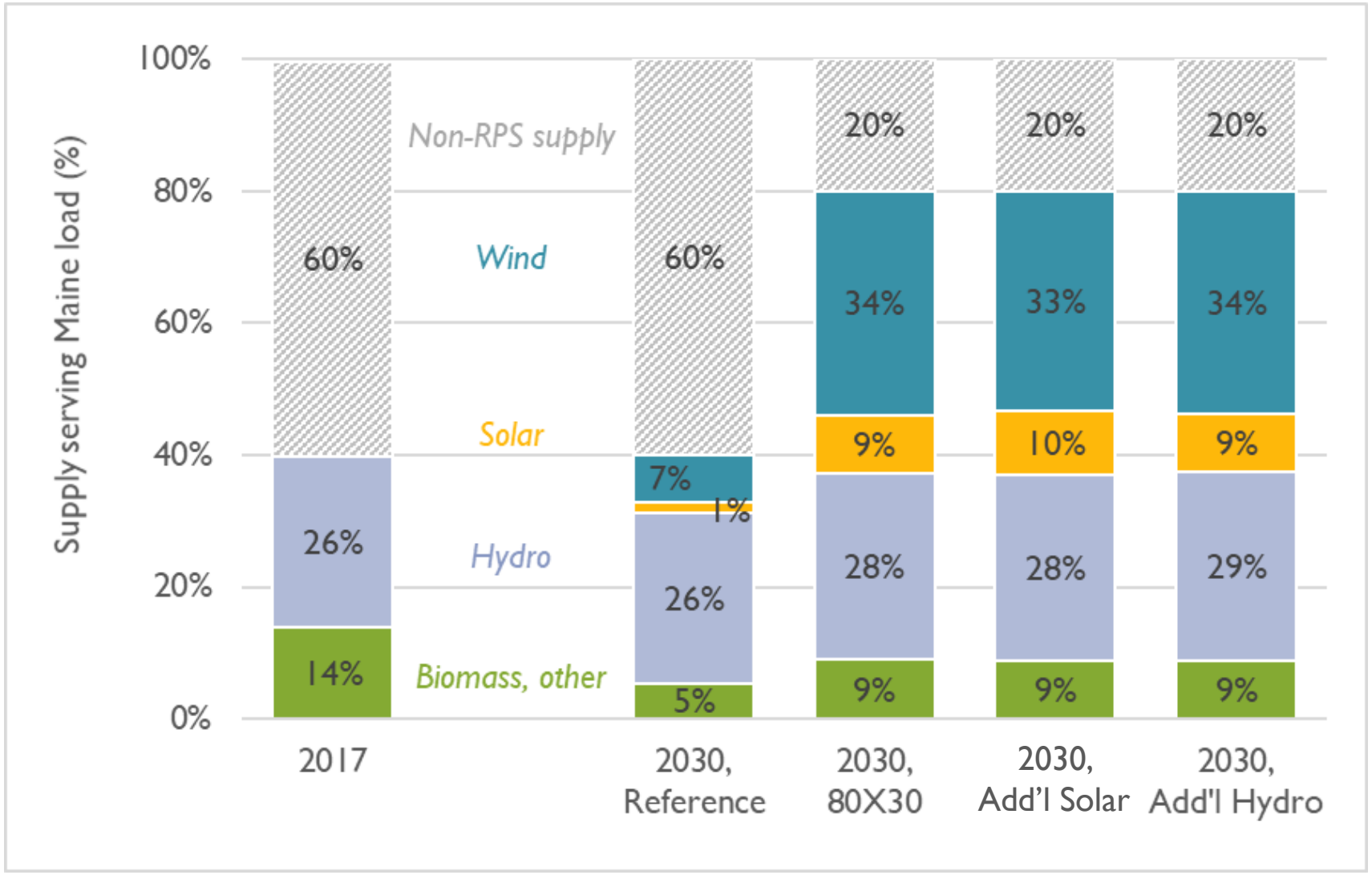
- Massachusetts Clean Energy Standard Contracting (through Section 83D)
  - 9.45 TWh of hydroelectric power assumed procured from Canada, and delivered over new (unspecified) transmission

Output: Estimate of Supply Serving New England RPS



- Wind, Solar, and Other denote generation in operation as of 2018
- New Wind, New Solar, and New Other represent the expectation of additional renewable energy buildout to satisfy regional RPS obligations.
- “New Other” is largely made up of incremental capacity additions of biogas at existing generators.

Output: Estimate of Supply Serving Maine Load



Methodology

2030 RPS compliance is comprised of:

1. Renewable supply that is eligible only in Maine
2. RECs from long-term procurement adopted with this proposed legislation
3. Pro-rata share of regional RECs eligible for multiple Class 1 RPS markets.

Output: Job impacts

Increasing the Maine RPS to 50 percent by 2030:

- Creates a net increase of 1,900 jobs between 2020 and 2030, equivalent to 170 Maine jobs per year
- This estimate accounts for changes in jobs related to decreasing the use of natural gas and coal to provide electricity, and for the impact of increased customer bills on re-spending throughout the economy.
- New wind capacity built in Maine in response to the proposed RPS expansion is expected to result in over $70M in Maine-vendor services.
- Other benefits (beyond those estimated in this analysis) may accrue if more renewable projects are located in Maine as a result of the in-state benefits weighting criteria in the renewable energy procurement.

Output: Energy Mix

- In the Reference case, energy efficiency programs, regional carbon pollution reduction programs, and other states' renewable energy policies reduces the region's reliance on fossil fuels by 42 percent by 2030
- A 50X30 RPS will cause electricity generation from fossil fuels to fall by 45 percent by 2030.
- Even a small percentage change is significant—reduced exposure to natural gas price volatility can produce millions of dollars of savings, particularly in cold winter months when customers throughout New England rely on natural gas for heating
- "Other" includes hydro, biomass, biogas, & other miscellaneous resource types

Output: CO_2 emissions

Increasing the Maine RPS to 50 percent by 2030:

- Reduces regionwide 2030 electric-sector CO_2 emissions by 10 percent, relative to a Reference case
  - A 50X30 case with additional solar reduces 2030 CO_2 emissions by 11 percent
  - A 50X30 case with additional hydro reduces 2030 CO_2 emissions by 10 percent
- Were Maine to be credited for 2030 region-wide electric-sector CO_2 emissions, Maine's emissions would fall by 55 percent, relative to a Reference case
  - A 50X30 case with additional solar reduces 2030 CO_2 emissions by 76 percent
  - A 50X30 case with additional hydro reduces 2030 CO_2 emissions by 59 percent

Output: CO_2 emissions (cont.)

Increasing the Maine RPS to 50 percent by 2030:

- Reduces New England-wide electric-sector emissions by 0.5 MMT in 2030, relative to Reference case
  - Emissions fall from 27.7 MMT in 2018 to 14.0 MMT in 2030 in the Reference case
  - Emissions fall from 27.7 MMT in 2018 to 13.4 MMT in 2030 in the Policy case
- An increase in renewable energy requirements will allow the state to provide the cleanest electricity to other decarbonization strategies, such as the deployment of space and water heat pumps and electric vehicles

Note: All CO_2 emissions estimates are consumption-based, and only include emissions from the electric sector and emissions that are produced from municipal solid waste incineration. Some numbers may not sum as a result of rounding.

Output: Other emissions and health impacts

Increasing the Maine RPS to 50 percent by 2030:

- Reduces emissions of criteria pollutants which can cause asthma and other respiratory ailments, heart attacks, lost work days, and premature death.
- From 2020 to 2030, the 50x30 case reduces criteria pollutants by the following amounts, relative to a Reference case:
  - 1.4 million pounds of NO_X
  - 1.2 million pounds of SO_2
- This translates into avoided health benefits of $500,000 per year, relative to a Reference case
  - A 50X30 case with additional solar provides health benefits of $580,000 per year
  - A 50X30 case with additional hydro provides health benefits of $510,000 per year

Output: Bill impacts

Increasing the Maine RPS to 50 percent by 2030:

- Increases electric bills for Maine residential ratepayers by 1.1 percent, or about $1.16 per month (average from 2020 to 2030, relative to Reference case).
- Increases electric bills for Maine small commercial and industrial (C&I) ratepayers by 1.1 percent, or about $1.76 per month (average from 2020 to 2030, relative to Reference case).
- Bill impacts take into account: changes to REC prices, capacity prices, and wholesale energy prices, and include the impact of price suppression from renewables
- Medium and large C&I customers were not analyzed
    - These customers frequently have complex or even unique electric rate structures, which may include kW charges or reactive demand charges
    - It is unlikely these customers would see substantially different bill impacts from residential or small C&I customers, on a relative percentage basis

Notes: We relied on rates and bills from Central Maine Power (CMP), filed with the Maine PUC in July 2018 in Docket No. 2016-00112, 2018-00069, & 2018-00065. Per data from the Energy Information Administration's Form 861, CMP made up 82 percent of all electricity sales in Maine in 2017.

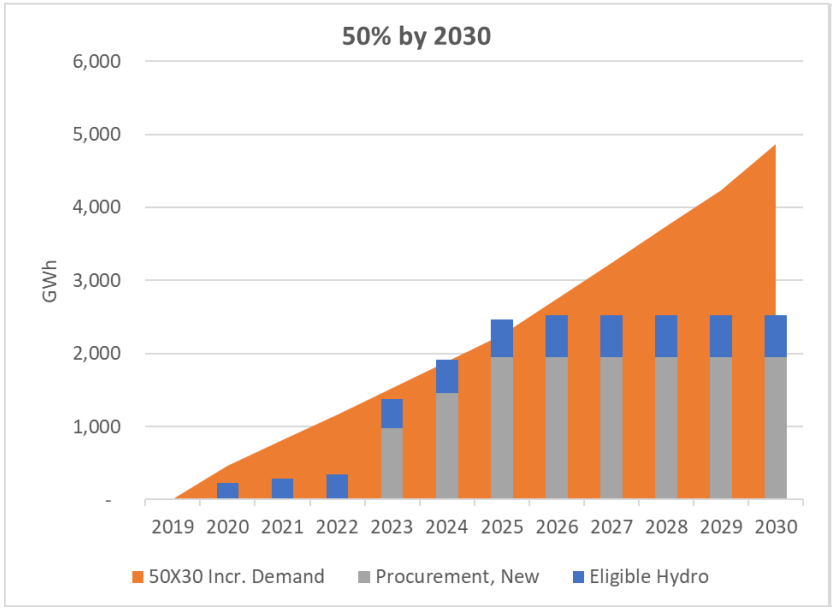
Output: System cost impacts and societal cost impacts

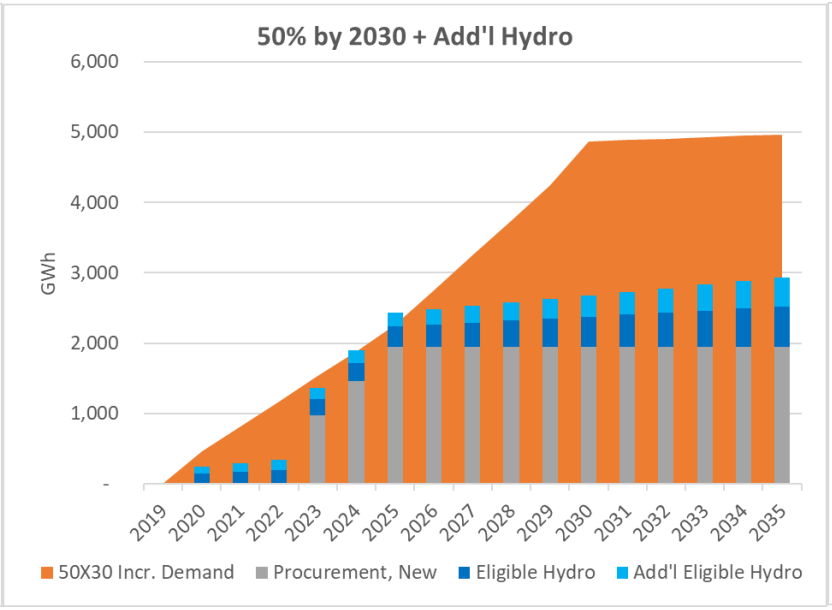
Increasing the Maine RPS to 50 percent by 2030:

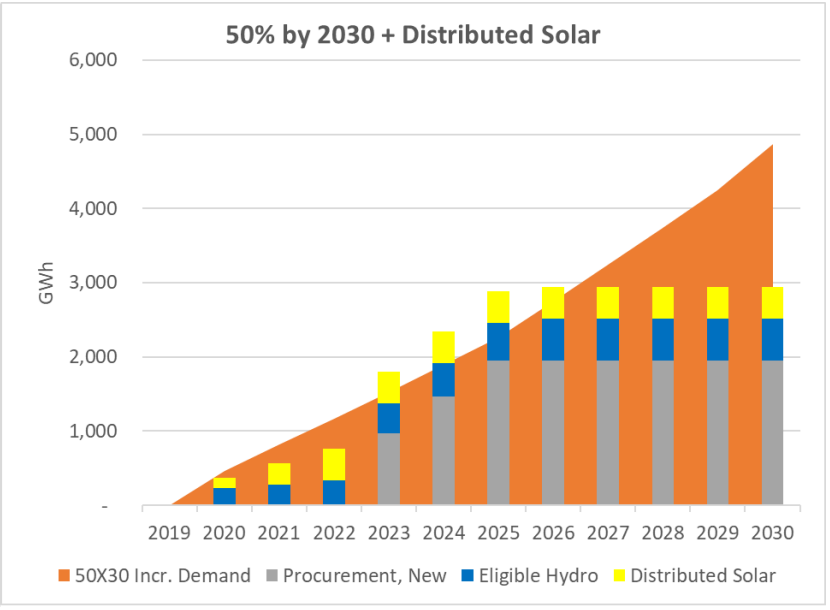
- Produces societal cost savings to Maine customers of $1.9 million per year, accounting for Maine's electricity system costs (including wholesale energy and capacity costs, and REC costs), avoided health impacts, and the social cost of carbon, relative to a Reference case
  - A 50X30 case with additional hydro reduces societal costs by $2.2 million per year
  - A 50X30 case with additional solar produces increased societal costs of $30 million per year
- Ignoring health impacts and the social cost of carbon, regionwide, relative to the Policy case:
  - A 50X30 case with additional solar reduces electric system costs by $31 million per year
  - A 50X30 case with additional hydro reduces electric system costs by $1.7 million per year
- These benefits do not include other potentially monetizable benefits, such as job impacts or impacts on state or local taxes

Output: Incremental Supply and Demand

- The charts below compare incremental RPS demand in the 50% by 2030 Case (orange area graph) to incremental RPS supply from the "new" (post 6/30/2019) portion of a long-term contracting policy (grey bar), hydro migrating from Class 2 to Class 1 (dark and light blue bars, depending on the case), and solar resulting from a new distributed generation policy (yellow bar).
- Incremental demand, defined by the gap between the orange area and the top of the stack bar (if any exists), will be satisfied by a portion of the material surplus of RECs currently present across New England's Class 1 markets.
- Between 2023 and 2025 (or 2026 in the 50% by 2030 + Distributed Solar Case), Maine's proposed policies create more incremental supply than incremental demand.







Contacts

About Sustainable Energy Advantage

Since 1998, Sustainable Energy Advantage, LLC has helped private, public and non-profit organizations develop opportunities for clean, renewable sources of energy, including wind, solar, hydroelectric, biomass and geothermal power, in competitive wholesale and retail electricity markets.

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About Synapse

Synapse Energy Economics, Inc. is a research and consulting firm specializing in energy, economic, and environmental topics. Since its inception in 1996, Synapse has grown to become a leader in providing rigorous analysis of the electric power sector for public interest and governmental clients.

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