

The Road to 100% Renewable Electricity

by 2030 in Rhode Island

PREPARED BY

The Brattle Group

Rhode Island Office of
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ABOUT THE RHODE ISLAND OFFICE OF ENERGY RESOURCES (OER)

- OER is Rhode Island’s lead energy policy agency, with a mission to guide the state toward a clean, affordable, reliable, and equitable energy future. OER develops policies and programs that respond to the state's evolving energy needs, while advancing environmental sustainability, energy security, and a vibrant clean energy economy. OER is committed to working with public- and private-sector stakeholders to ensure that all Rhode Islanders have access to cost-effective, resilient, and sustainable energy solutions. For more information on OER and Rhode Island’s clean energy initiatives, please visit: www.energy.ri.gov.

NOTICE

- This report was prepared jointly by the Rhode Island Office of Energy Resources (OER) and consultants at The Brattle Group. During this project, OER and Brattle received input from state agencies and numerous stakeholders. We wish to recognize staff from the Rhode Island Division of Public Utilities and Carriers (DPUC) and the Department of Environmental Management (DEM) for their insights, and thank those Rhode Island citizens, businesses, and advocacy groups that participated by attending technical workshops and listening sessions, and submitting written comment.
- This report is intended to be read and used as a whole and not in parts. The report reflects the analyses and opinions of the authors. It does not necessarily reflect those of other clients or other consultants of The Brattle Group.
- We are grateful for the valuable contributions made by OER staff and Brattle team members, including Principal Mark Berkman, Senior Research Analyst Maria Castaner, Research Analyst Megan Diehl, and Research Analyst Shivangi Pant.

CONTENTS

Executive Summary..... i

I. Introduction and Approach 1

 I.A Background and Motivation1

 I.B Project Team and Stakeholder Engagement..... 3

 I.C Objectives and Approach 3

 I.D Guiding Principles for 100% Renewable Electricity Study..... 5

II. Rhode Island’s 100% Renewable Electricity Goal..... 7

 II.A Rhode Island’s 100% Renewable Electricity Goal and the New England Electricity System 7

 II.B Operationalizing the 100% Renewable Goal10

 II.C Establishing the Gap to 100% Renewable Electricity by 2030 11

 II.D Maintaining 100% Renewable Electricity Beyond 2030 14

III. Analyzing Rhode Island’s Options for Achieving the 100% Renewable Electricity Goal.... 17

 III.A Candidate Renewable Energy Resources..... 17

 Resource Availability 18

 Resource Acquisition Costs 22

 Resource Market Value 26

 Evaluating the Candidate Renewable Resources 31

 III.B Above-Market Costs of Technology Bookends 32

 III.C Economic Impact of Technology Bookends - GDP and Employment 37

 III.D Technology Portfolios: Above-Market Costs and Economic Impacts 50

 III.E Summary of Analytic Insights 54

IV. Recommendations for Achieving 100% Renewable Electricity by 2030 56

 IV.A Policy Recommendations 57

 Renewable Energy Standard 57

 Energy Efficiency 59

 The Balance of Wholesale and Retail Renewable Energy..... 60

 IV.B Planning and Enabling Recommendations 62

 Power Sector Transformation 64

 Regional Collaboration..... 66

IV.C Equity Recommendations	67
Community Partnerships.....	67
Improve Community-Determined Outcomes.....	69
Appendix: Summary of Stakeholder Engagement.....	71
A.I Summary of Public Comment Process.....	71
Stakeholder Comments Related to Policy Recommendations	72
Stakeholder Comments Related to Planning and Enabling Recommendations Grid Modernization, Energy Storage, & Transparency	74
Stakeholder Comments Related to Equity	74
Stakeholder Comments Related to the Analysis	75
A.II Public Commenters (listed alphabetically)	76
A.III Demographic Information from Workshops & Listening Sessions.....	77
Glossary.....	81

FIGURES AND TABLES

Figure ES-1: Renewable Electricity Gap to Achieve 100% Renewables	iii
Table ES-1: Candidate Renewable Electricity Resources	iv
Figure ES-2: NPV of Above-Market Costs (2020–2040) of Achieving 100% Renewables; Bookends ..vi	
Figure ES-3: 2030 Rate Impacts of 100% Renewable Electricity	vii
Figure ES-4: NPV of Rhode Island GDP Impact (2020–2040) with Uncertainties; Bookends.....	viii
Table ES-2: Recommendations Summary	x
Figure 1: Composition of Rhode Island GHG Emissions	2
Figure 2: Projected Rhode Island Electricity Demand (2020–2030).....	12
Figure 3: Renewable Electricity Gap to Achieve 100% Renewables	13
Figure 4: Potential Rhode Island Electricity Demand Projection to 2050	15
Figure 5: Capacity of Each Technology Needed to Fill 2030 Renewable Energy Gap	18
Figure 6: Projected Resource Acquisition Costs through 2030	24
Figure 7: 2030 Resource Acquisition Costs	26
Figure 8: Projected Average Energy Market Revenues by Resource Type	27
Figure 9: Annual Net Load Duration Curves	28
Figure 10: Capacity Market Revenues – Base Case	31
Figure 11: Historical Rhode Island REC Prices (2016–2020)	32
Figure 12: Impacts of Procuring Renewable Energy to Achieve 100% by 2030	33
Figure 13: NPV of Above-Market Costs (2020–2040) of Achieving 100% Renewables; Bookends ...	34
Figure 14: Sensitivity Analysis of Above-Market Costs (Offshore Wind Technology Bookend)	36
Figure 15: 2030 Rate Impacts of 100% Renewable Electricity	37
Figure 16: GDP and Employment Impacts of 600 MW Offshore Wind Project	41
Figure 17: Rhode Island GDP Impact of Offshore Wind Technology Bookend.....	42
Figure 18: Rhode Island GDP Impact of Technology Bookends	44
Figure 19: Illustration of Uncertainties in GDP Impact	47
Figure 20: NPV of Rhode Island GDP Impact (2020–2040) with Uncertainties; Bookends	48
Figure 21: Technology Portfolios – Definitions.....	51
Figure 22: NPV of Above-Market Costs (2020–2040) of Achieving 100% Renewables; Bookends and Portfolios.....	52
Figure 23: NPV of Rhode Island GDP Impact (2020–2040) with Uncertainties; Bookends and Portfolios.....	53



Executive Summary

In January 2020, Governor Gina M. Raimondo signed Executive Order 20-01 that set a first-in-the-nation goal to meet 100% of Rhode Island’s electricity demand with renewable energy by 2030.¹ Decarbonizing the electric sector by providing energy from renewable sources is foundational to decarbonizing the Rhode Island economy, and achieving long-term economy-wide greenhouse gas reduction targets consistent with the Resilient Rhode Island Act.²

The Executive Order requires Rhode Island’s Office of Energy Resources (OER) to conduct economic and energy market analysis and develop viable policy and programmatic pathways to meet this goal. This report is a culmination of the effort by OER and consultants at The Brattle Group to inform the path forward to meeting 100% by 2030, and maintaining 100% thereafter. The project team also engaged relevant state agencies and Rhode Island stakeholders throughout the process through a series of virtual meetings, technical workshops, and listening sessions.

The purpose of the report is first to provide a high-level economic analysis of the key factors that will guide Rhode Island to meeting 100% of the state’s electricity demand with renewable electricity by 2030. This study considers the available renewable energy technologies, including their feasibility, scalability, costs, generation patterns, market value, and local economic and employment impacts, as well as barriers that may hamper or slow their implementation. It identifies ways to leverage competition and market information to ensure reasonable ratepayer costs and manage energy price volatility, while taking advantage of economic development opportunities within the state. The report’s second objective is to consider specific policy, programmatic, planning and equity-based actions that will support achieving the 100% renewable electricity goal.

To help guide the analysis and the policy recommendations for achieving the goal, the project team developed a set of guiding principles, with input and feedback from stakeholders. The Guiding Principles represent three broad themes: **A)** Decarbonization Principles; **B)** Economic Principles, and **C)** Policy Implementation Principles.

¹ Governor Gina M. Raimondo, Executive Order 20-01, [“Advancing a 100% Renewable Energy Future for Rhode Island by 2030”](#), January 17, 2020.
² Rhode Island General Laws §42-6.2, et. seq., the Resilient Rhode Island Act of 2014, establishes greenhouse gas emissions reduction targets of (A) Ten percent (10%) below 1990 levels by 2020; (B) Forty-five percent (45%) below 1990 levels by 2035; and (C) Eighty percent (80%) below 1990 levels by 2050.

Decarbonization Principles

1. Exemplify Climate Leadership
2. Create Incremental Power Sector Decarbonization
3. Facilitate Broader Decarbonization

Economic Principles

4. Pursue Cost Effective Solutions
5. Improve Energy and Environmental Equity
6. Create Economic Development Opportunities

Policy Implementation Principles

7. Ensure Solutions are Robust and Sustainable Beyond 2030
8. Build on Rhode Island's Existing Renewable Energy Mechanisms
9. Be Consistent with Other Rhode Island Priorities and Policies

One of Rhode Island's cornerstone policies for increasing renewable energy in the electricity sector is the Rhode Island Renewable Energy Standard (RES). For the purposes of the analysis, we assume that Rhode Island will track its progress to achieving 100% renewable electricity in 2030 by increasing the RES to 100% in 2030. To achieve the 2030 goal in a manner that aligns with the Guiding Principles, Rhode Island will need to match the 100% RES with programs and incentives that support the development of new renewable energy resources. Rhode Island has a number of well-established programs that support renewable energy generation resources, including the long-term contracting authority granted to National Grid, the Renewable Energy Growth program, the Renewable Energy Fund,

and regulations that support net metering and virtual net metering. In addition, Rhode Island has remained committed to its least cost procurement requirements, which drive local investment in cost-effective energy efficiency and demand response measures. With the expected addition of 400 MW of offshore wind capacity from the Revolution Wind project in 2024, Rhode Island is already on pace to support about 3,060 GWh of renewable energy generation in 2030. This equates to about 40% of Rhode Island's projected 2030 electricity demand.

Rhode Island's projected electricity demand in 2030 is about 7,700 GWh, based on our analysis of National Grid's load forecast and trends in energy efficiency and electrification. As shown in **FIGURE ES-1**, Rhode Island will need to add about 4,600 GWh of additional renewable energy to close the remaining renewable electricity gap to reach 100% by 2030, reflecting a relatively flat outlook for electricity demand.³ This represents a 150% increase in the amount of renewable energy procured to date. The estimated renewable energy gap may be 600-700 GWh larger or smaller, depending on the rate at which the transportation and heating sectors electrify to increase demand and reduce greenhouse gas emissions, and the future progress of energy efficiency efforts that decrease demand.

Rhode Island announced in October 2020 its intent to pursue a competitive solicitation for up to 600 MW of additional offshore wind resources.⁴ If the full 600 MW is acquired, the new offshore wind resource would add about 2,700 GWh per year, or about 35% of 2030 electricity demand, filling the majority of the gap. Still further additional renewable energy resources may come from new or expanded programs or procurements or from purchasing RECs from the market to reach 100%.

³ To identify the full extent of Rhode Island's path to 100% renewables, as shown in Figure 3 below, we are not accounting for future additions from existing statutory programs (e.g. Renewable Energy Growth) beyond those resources already committed to, but not yet online. We acknowledge that these programs are likely to continue (in some form) throughout the decade and will contribute to closing the gap by 2030. A number of hypothetical resource portfolios, identified later in this report, include a Retail Solar component that reflects continuation or expansion of these programs.

⁴ See <https://www.ri.gov/press/view/39674>

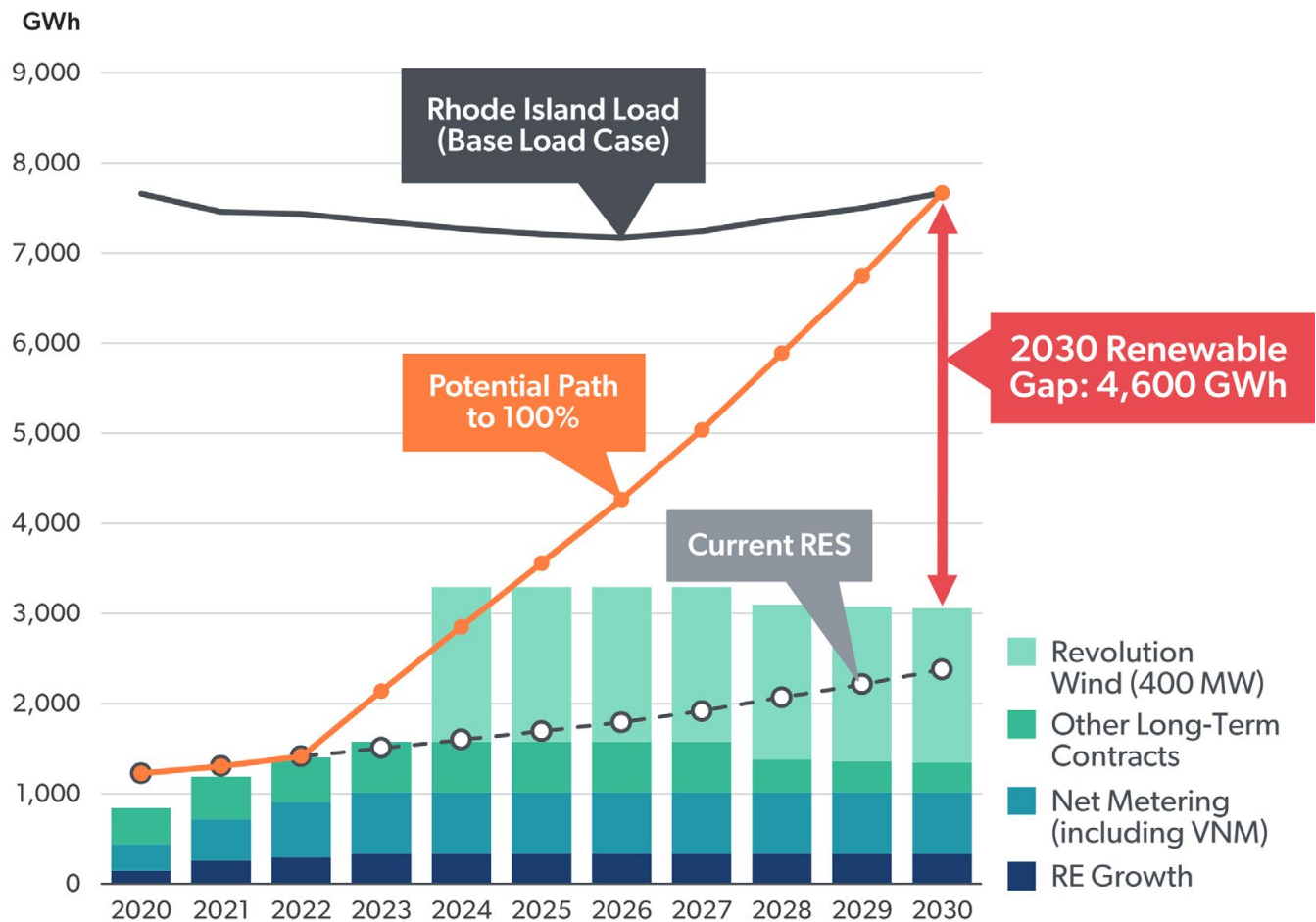


FIGURE ES-1: RENEWABLE ELECTRICITY GAP TO ACHIEVE 100% RENEWABLES

Beyond 2030, Rhode Island will likely need to continue adding renewable energy generation at a similar pace, roughly 400 – 500 GWh per year, due to an expected increase in demand from widespread adoption of electrified heating and transportation. This new electrification load may roughly double total electricity demand in the long run. Rhode Island must also understand the impacts of the increasing decarbonization of the larger New England electricity system. As other states decarbonize their own electricity supplies, the system’s greater reliance on intermittent renewable energy resources will increase the challenge of maintaining the short-term balance between electricity generation and demand. Our long-term simulation of the New England electric system indicates that such challenges are likely to still be relatively limited by 2030, but will accelerate in later years as dispatchable fossil generation

is increasingly displaced by the rising renewable ambitions of other New England states. Significantly more flexible technologies, such as short-term battery storage and demand resources, will be necessary to maintain short-term balance. As the system becomes highly decarbonized, it will ultimately require additional new technologies for seasonal energy balancing, perhaps including long-term storage technologies and renewable fuels such as methane or hydrogen. These long-term shifts in the regional power system highlight the value to Rhode Island of a renewable energy portfolio whose hourly generation profile offers a reasonably good match to the state’s electricity demand profile, which will limit exposure to market prices that will reflect these underlying dynamics and the costs to maintaining system reliability.

Rhode Island has access to several types of renewable energy generation resources to fill the gap and achieve

Technology	Location of Available Resources	Capacity of Each Technology (Needed to Fill Entire 2030 Renewable Energy Gap)	Resource Availability and System Upgrades Required
Offshore Wind	Outer continental shelf off Rhode Island coast	900 – 1,100 MW	Sufficient capacity available in current wind lease areas will require significant offshore and onshore transmission upgrades; more cost-effective upgrades will require regional coordination.
Land-Based Wind	Northern New England and Upstate New York	1,300 – 1,700 MW	Limited potential to fill the gap with New England resources without system upgrades of about \$1 billion requiring regional coordination; some capacity may be available in New York, which is building out transmission infrastructure.
Wholesale Solar	On high-voltage transmission system in RI and neighboring states	2,700 – 3,600 MW	2,500 – 6,500 MW of technical potential for ground-mounted solar in Rhode Island, though transmission access may require increasing system upgrade costs; significant additional capacity is in development across New England; land-use concerns remain a significant challenge.
Retail Solar	On lower-voltage distribution system within Rhode Island	3,200 – 4,300 MW	Economic potential of rooftop solar is limited (110 – 260 MW); smaller-scale, ground-mounted facilities connecting to distribution system can fill a portion of the gap, though may face increasing system upgrade costs

TABLE ES-1: CANDIDATE RENEWABLE ELECTRICITY RESOURCES

100% renewable electricity by 2030. Based on our analysis of recently added renewable energy resources and potential for new development, the candidate renewable energy resources are offshore wind, land-based wind, wholesale solar, and retail solar. The availability of each of these resources is summarized in **TABLE ES-1**. We considered other technologies but determined that their limited availability makes them unlikely to play a major role in achieving 100% renewable electricity.

The ratepayer cost impacts and the local economic impacts (GDP, jobs) of achieving 100% renewable electricity are considered first for four Technology Bookends, corresponding to the four candidate technologies. Each Technology Bookend assumes that the 2030 renewable energy gap is filled entirely with one of the candidate technologies. We also analyzed a series of Technology Portfolios that consist of potential mixes of these resources that Rhode Island may consider in pursuing its 2030 goal. We present here the results for the Technology Bookends, highlighting the key takeaways

for these technologies that will inform Rhode Island’s path forward. Additional results for the Technology Portfolios are presented in **SECTION III.D**.

The ratepayer above-market costs of achieving 100% renewable electricity by 2030 account for both the costs of acquiring the renewable energy resources (which includes the interconnection costs) and the market revenues the resources will earn from the New England electricity market for their energy, capacity and RECs.

- **Resource Acquisition Costs:** The projected costs of the three utility-scale resources—land-based wind, offshore wind, and wholesale solar—are similar to one another, decreasing from about \$95 – 100/MWh in the near-term (accounting for the phase-out of the federal tax credits) to about \$60 – 70/MWh in 2030 (all in 2020 dollars).⁵ The projected 2030 resource acquisition cost is considerably higher for retail solar, \$107/MWh in 2030.⁶
- **Energy Market Value:** The energy market value of the renewable energy technologies start relatively low at roughly \$20/MWh in 2020, due to current low gas prices. Market values rise as gas prices recover (particularly for wind, which generates most in winter when prices are high), then fall again after 2030 to below \$15/MWh on average in 2040, with \$0/MWh in many hours due to increasing renewable penetration.
- **Capacity Market Value:** Accounting for recent capacity market results, potential future market designs, and the ability for intermittent resources to contribute to the system’s capacity needs, these renewable energy technologies are likely to earn a modest capacity value of \$3/MWh to \$4/MWh; with range from zero to about \$12/MWh reflecting the uncertainty in capacity prices and market design.

- **REC Market Value:** REC prices are difficult to predict, as they are based on the short-term supply-demand balance between state renewable energy mandates and available renewable supply. We assume a Base REC price of \$30/MWh and analyze a range of \$15/MWh to \$45/MWh, consistent with historical REC prices as well as the net costs of acquiring utility-scale renewables.

FIGURE ES-2 compares the four Technology Bookends, showing the estimated above-market costs of achieving 100% renewable electricity entirely with each one of the four candidate technologies. The figure shows the net present value (NPV) of 2020 to 2040 above-market costs,⁷ with the labeled point reflecting Base Case cost assumptions, and the bar reflecting the uncertainty in renewable acquisition costs. The net costs of the three utility-scale Technology Bookends are quite similar, with Base Case above-market costs of \$1,900 million to \$2,100 million and largely overlapping cost ranges. The Retail Solar Bookend results in materially higher above-market costs of \$4,500 million, reflecting its significantly higher resource cost. As a reference point, the cost of market REC purchases is shown at the top of the figure, where \$30/MWh RECs could fill the entire renewable energy gap at a cost \$1,400 million. However, purchasing market RECs would provide uncertain and potentially limited additional GHG emissions reductions, and may not provide local economic development benefits.

The similar cost estimates and ranges across the utility-scale resources signal that all these technologies are competitive, with none dominating. Over the next decade, the costs of the different resource types could diverge, based on global and local markets for each resource, the local labor market, the need for system upgrades, and the approach

5 At the time of the analysis, the federal production tax credit and investment tax credit were scheduled to phase-out over the next few years. In late December 2020, the U.S. Congress extended the tax credits for 2-3 years. However, we were unable to reflect these changes in our analysis in time for the final report.

6 Retail solar costs are a capacity-weighted average of the costs of distribution-connected solar resources, ranging from 10 kW residential rooftop resources to 5 MW ground-mounted resources. The mix of solar resources is consistent with the 2020 capacity allocation for the Renewable Energy Growth program.

7 Net present value is as of 2020 and calculated using a 3% (real) discount rate. All monetary values throughout the report are in 2020 dollars, unless otherwise noted.

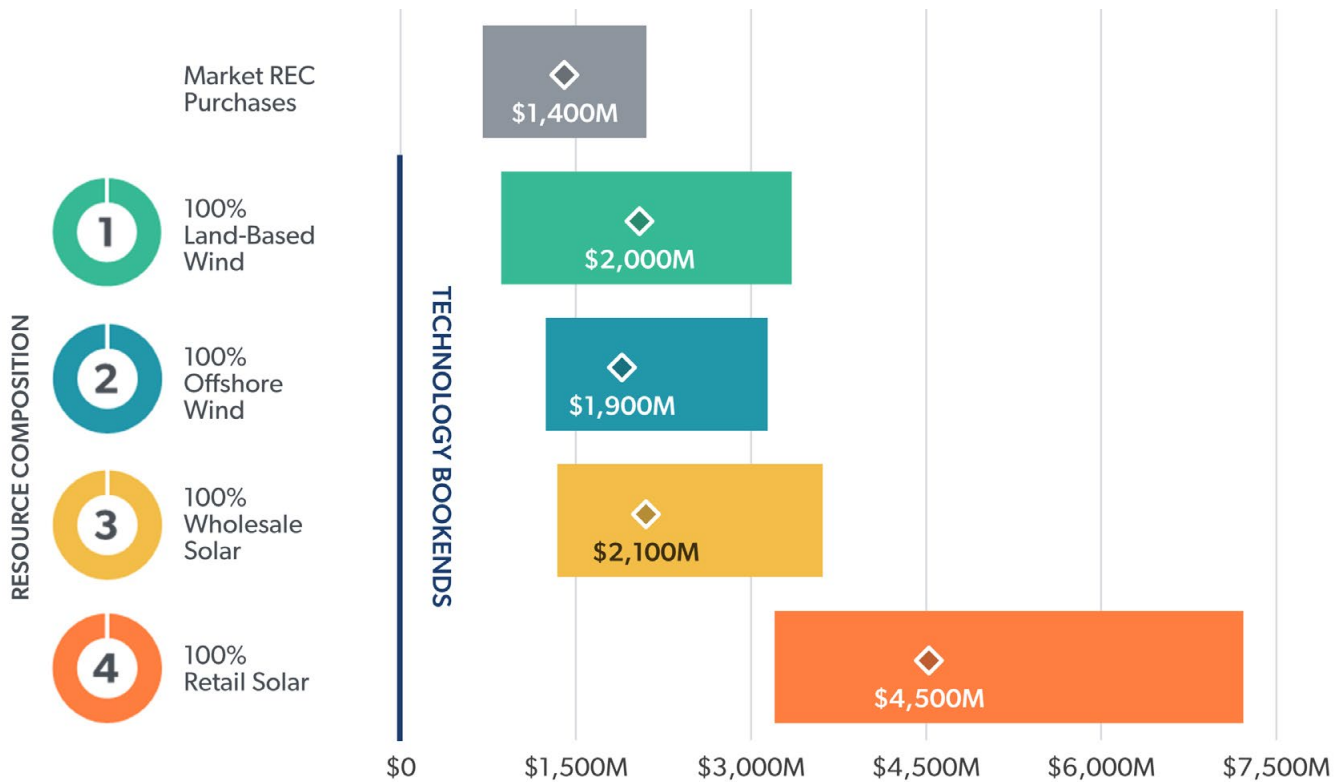


FIGURE ES-2: NPV OF ABOVE-MARKET COSTS (2020–2040) OF ACHIEVING 100% RENEWABLES; BOOKENDS
(NET OF ENERGY AND CAPACITY REVENUES, NOT REC REVENUES)

Rhode Island and other states take for planning the future regional power system. The cost diversity that has been observed across specific projects is also likely to continue. It will be valuable for Rhode Island to continue to seek out opportunities to foster competition among these resources, across types as well as within them, to identify the particular technologies and projects that are most attractive for the state to reach 100% renewable electricity. Retail solar is significantly higher cost, though as seen below, offers greater local economic benefits.

Of course, these similar costs suggest that the retail rate impacts of the three utility-scale Technology Bookends are also similar, at roughly 2 cents/kWh (range 1 to 5 cents/kWh) in 2030, while the retail solar impact is higher at 6 cents/kWh (range 4 to 11 cents/kWh), as shown in **FIGURE ES-3**. These rate impacts would increase a typical monthly residential bill in 2030 by about \$11 to \$14 with utility-scale renewables, or by \$30 if the entire gap were to be filled with retail solar.

We also analyzed the local economic impacts of these renewable energy resources – their effect on Rhode Island’s gross domestic product (GDP) and in-state employment. This impact occurs through three potential channels:

- 1. Construction Expenditures** before in-state projects come online;
- 2. O&M Expenditures** during operation of in-state projects; and,
- 3. Tariff Impacts paid for by Rhode Island ratepayers** throughout the life of the resource or contract.

For this second set of metrics, we take a relative perspective – comparing the impacts of meeting the 100% goal with the Technology Bookends versus meeting it entirely by purchasing RECs from the New England market at an assumed REC price. That is, this perspective does not reflect the overall economic impact of accelerating the RES to achieve 100% in 2030, but rather considers the impact of how 100% is achieved relative to meeting it with market REC purchases. In the body of the

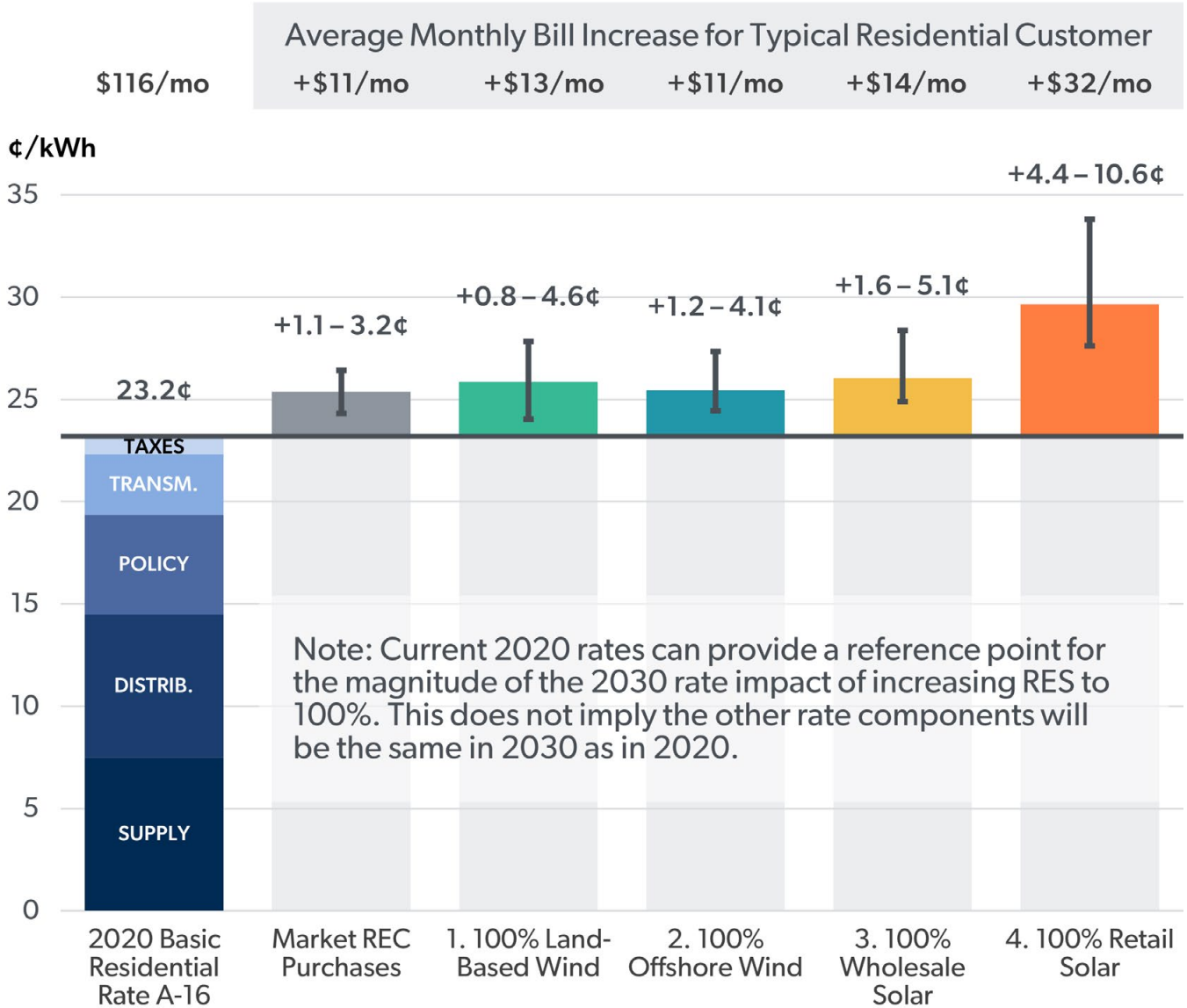


FIGURE ES-3: 2030 RATE IMPACTS OF 100% RENEWABLE ELECTRICITY

Notes: Assumes typical residential customer consumes 500 kWh/mo.

report, and in greater detail in the accompanying Technical Support Document, we show how the economic impacts evolve over time. For in-state resources, the economic benefits of construction expenditures precede the resource coming online, followed by the tariff impacts (which may be positive or negative, depending on the cost of the resource relative to the assumed REC price) and the O&M impacts.

FIGURE ES-4 shows the NPV of GDP impacts for each of the Technology Bookends. Much information is included in this

figure, including the range of uncertainty due to resource cost (the length of each bar), the REC price used as a comparison value (from one bar to the next) and comparing in-state technologies (solid bars) versus out-of-state technologies (outline bars). Of course, any technology's economic impact is better when compared to a higher REC price, and the impact is more positive at low resource cost than at high. The key insights here are that in-state resources have generally positive impacts relative to REC purchases, while out-of-state ones have lower and often negative impacts, and also a wider range of impacts.

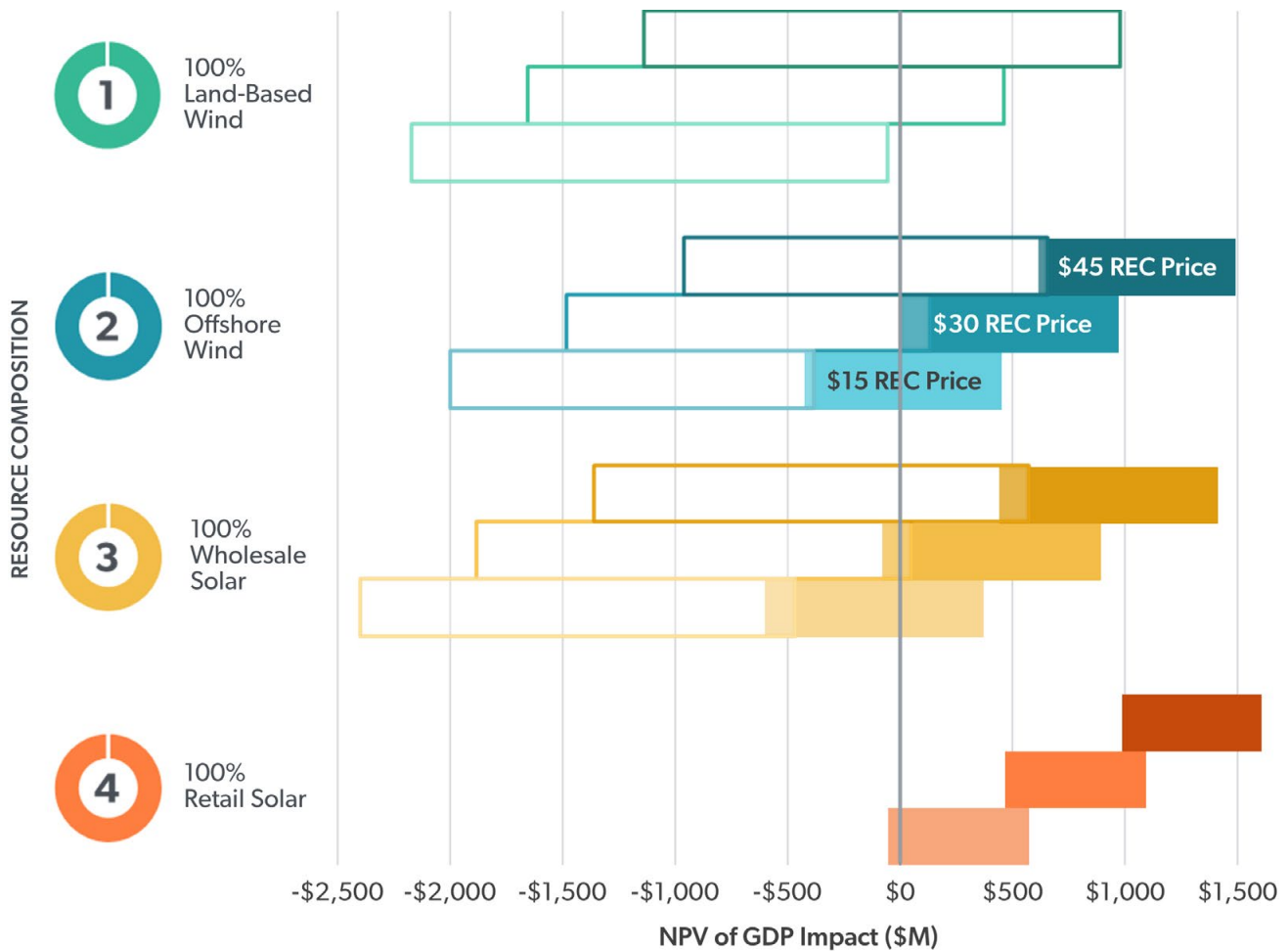


FIGURE ES-4: NPV OF RHODE ISLAND GDP IMPACT (2020–2024) WITH UNCERTAINTIES; BOOKENDS

This is because in-state resources give an economic boost to the Rhode Island economy via in-state construction and operating expenditures; out-of-state resources do not share these. Thus retail solar, which is more costly and has a negative economic impact due to higher costs to ratepayers, has a net economic impact that is comparable to other in-state resources due to the offsetting effect of higher in-state expenditures and the fact that a larger share of each dollar invested for retail solar enters the local Rhode Island economy.⁸

The two primary metrics considered here tell somewhat different stories: above-market cost draws a distinction

between utility-scale resources (which all have similar cost ranges) versus higher-cost retail (distributed) solar. But the primary differences seen in the economic impact analysis are between in-state resources, which all have similar, mostly positive impacts (including the more costly retail solar resource), versus out-of-state resources, which have lower and often negative economic impacts. The Technology Portfolios presented in the report come to similar conclusions: ratepayer above-market costs rise with increasing levels of retail solar; economic impacts primarily depend on the mix of in-state and out-of-state resources.

⁸ Our analysis here uses typical allocations of expenditures to economic sectors for each resource type. The actual local Rhode Island impact of any particular project will depend on how that project is executed, including its mix of local vs out-of-state suppliers and labor. We also assume that an out-of-state project will have no in-state impact, though in fact, because of interdependent supply chains in New England, a project located outside of Rhode Island may have some in-state benefits to the extent it utilizes materials, suppliers or labor from Rhode Island.

We summarize here the key insights from the analytic portion of the study.

- Rhode Island's goal of 100% renewable electricity by 2030 is achievable. Renewable resources are available within Rhode Island and in surrounding areas to support this goal.
- Achieving 100% renewable electricity by 2030 will not be costless. Ratepayers will need to support investments driving long-term energy, economic, and environmental benefits. In the near term, renewable electricity will cost more than fossil-fired generation, and utility bills will be higher regardless of the composition of the ultimate portfolio of renewable resources. But net economic and energy benefits and costs will be determined by how that portfolio is shaped over time.
- The existing REC structures, tracking mechanisms, and markets will allow Rhode Island to implement the 100% goal seamlessly, track its progress, and accommodate uncertainty and variability in electricity demand and renewable generation.
- Rhode Island should limit the extent to which it relies on short-term REC purchases to meet its 100% renewable goal to ensure that it will truly achieve incremental GHG reductions, and to limit the ratepayer cost impact of potentially volatile REC prices.
- All renewable energy resource types will require integrated planning and investment to build out the necessary infrastructure (the local distribution system, onshore and offshore transmission facilities, as well as the renewable generation itself) to achieve 100% cost-effectively. Different resources will require different investments, and this effort will take significant time, collaboration, and upfront investment.
- Utility-scale offshore wind, land-based wind, and solar resources are likely to be the lowest costs to ratepayers. Distributed solar resources have significantly higher above-market costs, and can also result in significant shifts between ratepayers if acquired through net metering programs. However, each of these resources types present varying levels of in-state economic development and job growth potential. Available market data and cost projections also show significant and overlapping cost uncertainties for each of these.
- In-state renewable energy resources, including offshore wind in adjacent Federal waters and higher cost retail solar, provide material local economic benefits relative to out-of-state resources and/or market purchases of RECs. The higher ratepayer costs of retail solar are partially offset by greater local economic benefits, leading to similar impacts on overall state GDP as in-state utility-scale resources. However, the GDP benefits and costs do not accrue to the same populations; retail solar will result in greater shifts of costs and benefits within the Rhode Island economy.
- Rhode Island can identify the lowest cost resources by proactively planning the system upgrades necessary to achieve 100% and procuring renewable energy resources through competitive procurements and programs. Participating in multi-state solicitations may make it possible for Rhode Island to access the economies of scale of larger projects.
- Rhode Island can reduce ratepayer costs and risks by collaborating with other New England states to update the design of regional electricity markets to account for the full value of renewable energy resources to the system.
- For the longer term, Rhode Island should consider acquiring a renewable portfolio that is a reasonable match for its hourly load profile. This will contribute to achieving the proper long-term balance across the region, and will reduce energy price risk and the costs of balancing supply and demand for Rhode Island ratepayers. With anticipated demand shapes, a portfolio of mostly wind with up to about 30% solar offers a reasonable hourly match.
- To achieve and maintain 100% renewable electricity beyond 2030, policy, programmatic and technical (e.g. storage, demand management) solutions may need to evolve, as the regional penetration of clean energy resources accelerates and increasingly-challenging grid impacts emerge. There will likely be significant increases in the overall amount of energy needed to meet new electrification loads from the transportation and heating sectors, mostly beyond 2030.

Grounded in the three main components of this project – analysis, guiding principles, and public engagement – the Office of Energy Resources and consultants at The Brattle Group developed a set of recommendations and action steps for 2021 and beyond to advance Rhode Island toward a 100% renewable electricity future.

We categorize our recommendations into three segments: **Policy, Planning & Enabling**, and **Equity** and summarize the recommendations in the table below.

TABLE ES-2: RECOMMENDATIONS SUMMARY

TOPIC	RECOMMENDATION
POLICY RECOMMENDATIONS	
Renewable Energy Standard	Amend the state’s RES to require 100% renewable electricity by 2030.
Energy Efficiency and Demand Response	Extend Least-Cost Procurement of energy efficiency and demand response beyond 2023 to at least 2030.
Balance of Wholesale and Retail Renewable Electricity	<p>Develop market-driven approaches that allow for cross-technology competition where appropriate.</p> <p>Support continuation of the Renewable Energy Growth (REG) program and net metering (NM), contingent on identification and integration of measures to improve sustainability, affordability, and equity.</p> <p>Commence a forum for stakeholder dialogue and consensus-building on the long-term costs and benefits of the state’s net metering construct.</p> <p>Extend the Renewable Energy Fund (REF) beyond its current 2022 sunset.</p> <p>Support the burgeoning offshore wind industry that will be critical to the Rhode Island clean energy economy and a decarbonized future for the region.</p>

TOPIC**RECOMMENDATION****PLANNING AND ENABLING RECOMMENDATIONS****Integrated Grid
Planning**

Consider key drivers of system needs, such as distributed renewable energy and electrification, over longer time horizons to better understand and plan for changing future system needs.

Analyze transmission and distribution system needs for several 100% renewable energy scenarios to identify potential grid challenges and development opportunities.

Initiate a collaborative effort with National Grid, state agencies, municipalities, and other key stakeholders to explore the potential for a more integrated approach to grid planning beginning in 2021.

Explore how we might collectively enhance grid visibility and improve forecasting.

**Power Sector
Transformation**

Improve forecasting and implement a stakeholder engagement plan during forecast development.

Consider strategies to compensate the value of distributed energy resources based, in part, on their location, and how those incentives align with more proactive distribution system planning.

Advance electrification that is beneficial to system efficiency and greenhouse gas emission reductions.

Consider opportunities for developing performance incentive mechanisms.

**Energy Storage
and Demand
Management**

Develop a Rhode Island-centric strategic plan for the role of energy storage and demand management as renewable deployment increases through 2030 and beyond.

Explore the role of programs and incentives in achieving optimal, cost-effective energy storage penetration at beneficial locations on the grid, as well as how demand management capabilities can be acquired and sited.

**Regional
Collaboration
on Markets and
Transmission**

Continue coordination with other New England states on wholesale market designs and transmission planning processes that facilitate energy decarbonization and renewable resource integration across the region

Coordinate with other New England states on transmission planning processes to better facilitate energy system transformation and proactively plan for the integration of large-scale resources and distributed energy resources across the region.

Identify and implement wholesale market mechanisms that fully account for the value of existing and future state-level investments in renewable resources and meet states' decarbonization mandates and maintain resource adequacy at the lowest possible cost.

TOPIC	RECOMMENDATION
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EQUITY RECOMMENDATIONS	
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<p>Community Partnerships</p>	<p>Partner with and listen to frontline communities about their needs and goals in the clean energy transition.</p> <p>Target community-based training efforts to support in-demand clean energy jobs.</p> <p>Provide education about the opportunities and challenges available in creating clean energy programs and policies, and information about energy programs, including comparative costs and benefits.</p>
<p>Equity Metrics</p>	<p>Develop metrics to track progress toward community-identified equity outcomes.</p>
<p>Improve Community-Determined Outcomes</p>	<p>Improve outcomes identified and prioritized by communities through rate design, program adjustments, and policy.</p> <p>Reduce barriers to participation through effective and culturally competent program design and delivery.</p> <p>Reduce financial burdens and provide support for low- and moderate-income households and frontline communities beyond installing technology, including structures for aiding with upkeep and services.</p>



I. Introduction and Approach

I.A Background and Motivation

Consistent with well-established scientific consensus and international commitments such as the Paris Accord, Rhode Island has committed to deep economy-wide decarbonization by 2050.¹ Acknowledging the state’s position on the front lines of climate change, including 400 miles of coastline, The Resilient Rhode Island Act of 2014 established a goal of 80% economy-wide greenhouse gas (“GHG”) emissions reductions relative to a 1990 baseline by 2050, with interim targets of 10% reductions by 2020, and 45% by 2035.² As a vital step toward meeting this commitment, Governor Gina M. Raimondo’s Executive Order 20-01 signed January 17, 2020 called for a plan to rapidly decarbonize the state’s electricity sector, establishing a nation-leading goal to acquire 100% of its electricity from renewable energy sources by 2030.³ It required the Rhode Island Office of Energy Resources (OER) to conduct economic and energy market analysis and develop viable policy and programmatic pathways to meet this goal, providing a report to the Governor with a specific and implementable action plan by the end of 2020.

Decarbonizing the electricity sector is likely to be foundational to decarbonizing the Rhode Island economy more broadly.

FIGURE 1 shows that electricity consumption accounts for just over a quarter of Rhode Island’s current total greenhouse gas emissions. Residential and commercial heating together make up another quarter, and transportation accounts for over a third of the total. Beneficial electrification – replacing direct fossil fuel use with electricity to cost effectively reduce overall emissions – combined with decarbonizing the power grid offers some of the most promising pathways for decarbonizing other major carbon-emitting sectors. Electric vehicles present an opportunity to displace petroleum-based motor fuels, and electrifying heat with heat pumps can displace the burning of natural gas and heating oil in residential and commercial buildings. Other smaller applications that combust fossil fuels directly can also be electrified – gas-fired water heaters, stoves, clothes dryers, etc.

If pursued in these other sectors, electrification could double electricity demand in New England and Rhode Island over the next few decades, while displacing most of the region’s direct fossil fuel use. By the time Rhode Island achieves its 100% renewable electricity goal in 2030, electrification-induced load growth will likely be just beginning in earnest. As electrification accelerates beyond 2030, load will rise

1 Rhode Island has reaffirmed its commitment to the principles of the Paris Climate Agreement. “Executive Order 17-06, Reaffirming Rhode Island’s Commitment to the Principles of the Paris Climate Agreement,” State of Rhode Island and Providence Plantations. June 12, 2017. http://www.governor.ri.gov/documents/orders/ExecOrder_17-06_06112017.pdf

2 Resilient Rhode Island Act of 2014 – Climate Coordinating Council, Chapter 42-6.2. <http://webserver.rilin.state.ri.us/Statutes/TITLE42/42-6.2/INDEX.HTM>

3 Governor Gina M. Raimondo, Executive Order 20-01, “[Advancing a 100% Renewable Energy Future for Rhode Island by 2030](#)”, January 17, 2020.

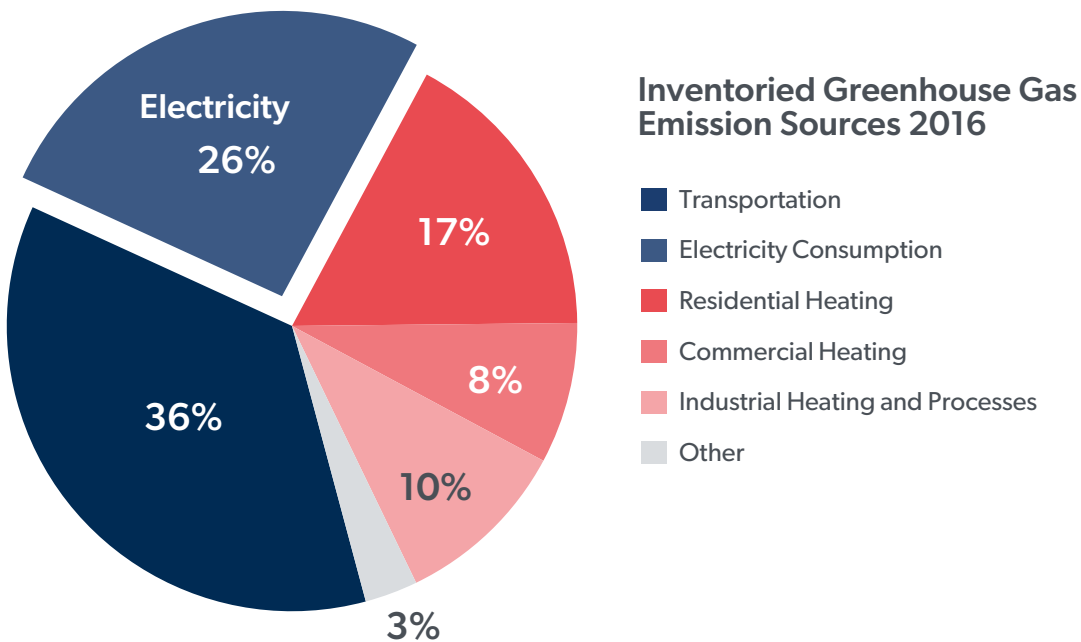


FIGURE 1: COMPOSITION OF RHODE ISLAND GHG EMISSIONS

Source: Rhode Island Department of Environmental Management, Rhode Island’s 2016 Greenhouse Gas (GHG) Emissions Inventory Update, EC4 Meeting, September 12, 2019.

sharply, and Rhode Island will need to add considerably more new renewables to maintain its 100% renewable share.⁴

Rhode Island already has a renewable energy requirement, its Renewable Energy Standard (RES), originally implemented in 2004. This standard is based on energy produced and consumed, and requires that a specified percentage of the total obligated electricity consumption in the state must come from renewable sources, on an annual basis. Compliance with the RES is tracked through the creation and retirement of Renewable Energy Certificates (RECs). The existing Rhode Island RES legislation started in 2004 with a lower renewable requirement, but was revised in 2016 to 10.0% in that year, rising at 1.5% per year. In 2020, the RES requires that energy corresponding to 16.0% of total load

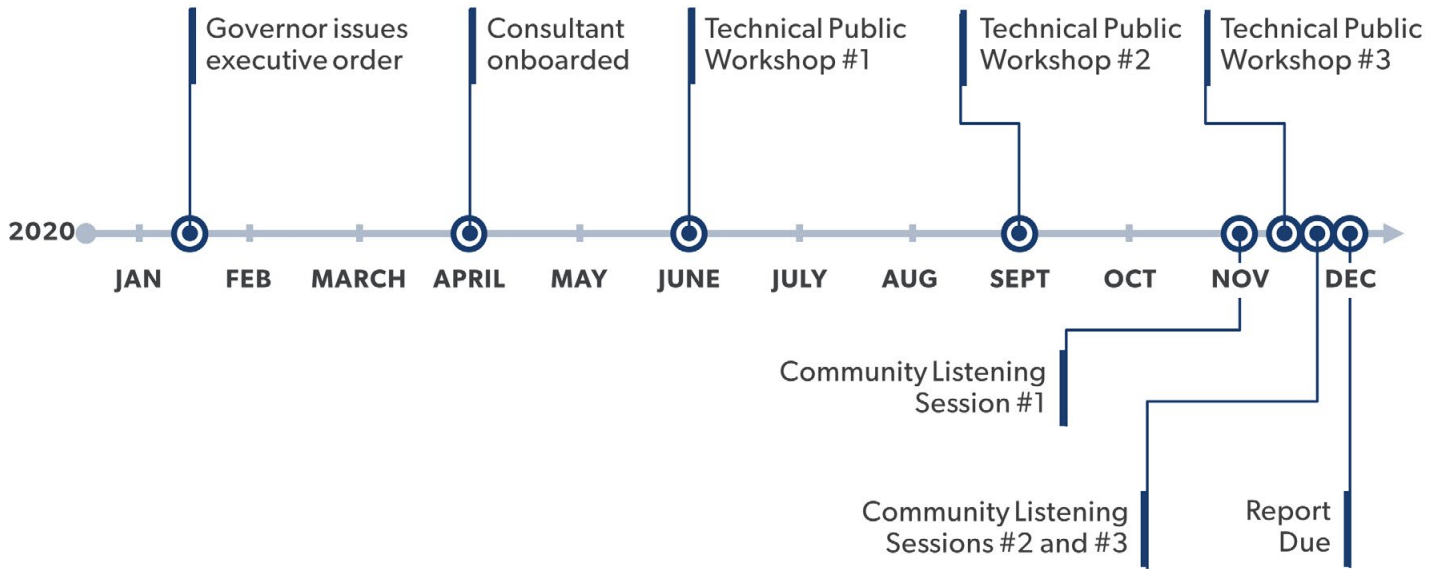
must come from qualified renewable sources; this continues to increase at 1.5% per year until it reaches 38.5% in 2035.

This effort to rapidly transition Rhode Island’s electricity supply to renewable sources is informed by and will interact with a broader set of state-level initiatives and inter-state coordination that focuses on decarbonizing the state’s primary emitting sectors. These include the implementation of least-cost procurement and energy efficiency programs; Rhode Island’s Heating Sector Transformation initiative;⁵ the state’s longtime participation in the Regional Greenhouse Gas Initiative (RGGI); its role in the Transportation and Climate Initiative (TCI); and its recent exploration of a broader carbon pricing program.⁶ Recently evolving science and evidence regarding climate change suggests that it may be

⁴ Jurgen Weiss and J. Michael Hagerty, [Achieving 80% GHG Reduction in New England by 2050](#), Prepared for the Coalition for Community Solar Access, September 2019.

⁵ Dean Murphy and Jurgen Weiss, [Heating Sector Transformation in Rhode Island: Pathways to Decarbonization by 2050](#), Prepared for the Rhode Island Office of Energy Resources and Division of Public Utilities & Carriers, April 22, 2020.

⁶ See: <http://www.energy.ri.gov/carbonpricingstudy/>



necessary to accelerate decarbonization goals even beyond the 80% by 2050 target currently in effect for Rhode Island and numerous other jurisdictions.⁷ Rhode Island’s quick transition to renewable electricity will help to enable more rapid decarbonization within the state, as well as offering some protection against challenges that may arise if weaning some particular sectors and uses from fossil fuels is more difficult or slower than expected.

I.B Project Team and Stakeholder Engagement

To carry out the Governor’s Executive Order, OER engaged consultants at The Brattle Group to analyze the impacts of achieving 100% renewable electricity by 2030 and assist in the development of policies and pathways.

A key component of this effort consisted of broad and extensive stakeholder engagement, designed to learn from stakeholders, to engage them in the process, and to inform

them of technical findings as the project progressed. A summary of the stakeholder engagement process and key questions and comments raised by stakeholders is included in the **APPENDIX**. The process included interviews with a wide range of stakeholders to provide early input into the scope and objectives of the study. Three public technical workshops were held over the course of the project to share information, present intermediate results, and collect feedback; the draft materials for these workshops was made publicly available.⁸ OER also held three community listening sessions to provide additional opportunities for the public to provide their input on the findings of the study. Stakeholders were encouraged to provide written feedback throughout the process. Stakeholders were encouraged to provide written feedback throughout the process.

I.C Objectives and Approach

The purpose of this study is to provide a high-level analysis that will help guide Rhode Island to meeting 100% of the

⁷ The U.N. Emissions Gap Report 2020 states that commitments to achieve net-zero emissions by mid-century are “broadly consistent with the Paris Agreement temperature goals.” United Nations Environment Programme, [Emissions Gap Report 2020](#), 2020.

⁸ See: www.energy.ri.gov/100percent/

state's electricity demand with renewable energy resources by 2030. This study considers the available renewable energy technologies, including their feasibility, scalability, cost, and local economic and employment impacts, as well as barriers that may hamper or slow their implementation. It identifies ways to leverage competition and market information to ensure reasonable ratepayer costs and manage energy price volatility, while taking advantage of economic development opportunities within the state. It also considers specific policy, programmatic, planning and equity-based actions that will support the 100% renewable electricity goal.

The primary steps in completing this analysis included the following steps:

1. Solicit stakeholder input and feedback early and throughout the process;
2. Define the 100% renewable electricity goal;
3. Identify the current gap in achieving 100% renewable electricity by 2030 and then maintaining 100% renewable electricity beyond 2030;
4. Identify candidate renewable energy technologies that could play a major role in filling the 2030 renewable energy gap, considering the availability of each technology;
5. Estimate the net costs of the candidate renewable energy technologies, including the costs of the generation technologies, the associated system upgrade costs, and their energy, capacity, and REC market value;
6. Analyze the total above-market costs and local economic impacts of filling the entire 2030 renewable energy gap with one of the candidate renewable energy technologies, which we refer to as Technology Bookends;
7. Define Technology Portfolios, potential combinations of renewable energy technologies to fill the gap to 100%,

and similarly analyze the total above-market costs and local economic impacts of each Portfolio, as well as additional factors that might affect their attractiveness;

8. Summarize the key analytical insights to inform the policy and programmatic recommendations to achieve 100% renewable electricity by 2030; and,
9. Develop policy and programmatic recommendations to support achievement of the goal based on the key analytical insights, stakeholder input, and an understanding of Rhode Island's existing suite of clean energy and environmental policy goals.

One of the primary objectives of achieving 100% renewable electricity is to reduce GHG emissions. Each of the Technology Bookends and Portfolios in the analysis achieves 100% renewable electricity by 2030 on a consumption basis. Thus, all of the options considered reduce GHG emissions attributed to Rhode Island electricity demand to zero by 2030. For this reason, the analysis does not identify impacts on GHG emissions as a distinguishing factor across the Technology Bookends and Portfolios.

The study was carried out amid the COVID-19 pandemic, which has severely disrupted much of the state, national and international economy, including the energy sector. Despite the near-term impacts of the pandemic, we believe that it will not fundamentally alter the long-term, system-wide needs and goals for decarbonizing the electricity sector and ultimately the entire economy. The imperative to address climate change by decarbonizing the power sector and the larger economy will still exist long after the pandemic has abated. However, near-term increases in the development of in-state renewable energy resources can play a role in accelerating the economic recovery from the impacts of the pandemic.

A Technical Support Document accompanies this report, providing additional detail on the modeling and assumptions that underlie the analytic findings.

I.D Guiding Principles for 100% Renewable Electricity Study

As an early part of this effort, the project team developed a set of principles, with input and feedback from stakeholders, to help guide the analysis and the policy recommendations for achieving the 100% renewable electricity goal. The Guiding Principles identified the important role a decarbonized electric power sector will play in achieving economy-wide decarbonization goals, clarified the key metrics for analyzing alternative paths to achieving the goal, and focused the implications of the analysis on the primary changes necessary to achieve the goal.

The Guiding Principles represent three broad themes: **A)** Decarbonization Principles; **B)** Economic Principles, and **C)** Policy Implementation Principles. These Guiding Principles can conflict with each other in some circumstances, requiring tradeoffs among them. For example, an approach that supports new renewable generation resources and clearly achieves fully additional GHG reductions may be more costly than an alternative that takes advantage of renewable energy that already exists, and thus may not actually advance decarbonization goals. These Guiding Principles are summarized on the next page.

Guiding Principles

A) Decarbonization Principles

1. Exemplify Climate Leadership

- Set goals consistent with avoiding the worst implications of climate change
- Provide an example to states attempting to achieve similar targets

2. Create Incremental Power Sector Decarbonization

- GHG reductions should be “additional” – beyond what would occur otherwise
- Verifiable, e.g., with NEPOOL-GIS tracking
- Account for load met by behind-the-meter generation, as well as metered load

3. Facilitate Broader Decarbonization

- In other sectors (transportation, heating), and beyond Rhode Island
- Collaborate with regional partners to maximize GHG reductions

B) Economic Principles

1. Pursue Cost Effective Solutions

- Lowest reasonable costs to consumers
- Leverage market competition to reduce ratepayer costs and energy price volatility
- Maintain affordability of electricity for all Rhode Islanders

2. Improve Energy and Environmental Equity

- Improve equitable outcomes as prioritized by communities

3. Create Economic Development Opportunities

- Foster opportunity in Rhode Island’s clean energy economy

C) Policy Implementation Principles

1. Ensure Solutions are Robust and Sustainable Beyond 2030

- Continue to achieve 100% renewable electricity to 2050 and beyond, at lowest reasonable cost
- Flexible in response to growing electrification load, market and technological uncertainties and surprises
- Consider early adoption of “integration” resources (batteries, long-term storage, DR, etc.)

2. Build on Rhode Island’s Existing Renewable Energy Mechanisms

- Align with and leverage Rhode Island’s existing programs and laws

3. Be Consistent with Other Rhode Island Priorities and Policies

- Responsible siting: balancing conflicting demands with open space, housing, etc.
- Social and economic policies: labor, housing, economic development, etc.
- Ensure continued power system reliability



II. Rhode Island's 100% Renewable Electricity Goal

II.A Rhode Island's 100% Renewable Electricity Goal and the New England Electricity System

To understand how Rhode Island will achieve its 100% renewable electricity goal by 2030, it is necessary to first understand Rhode Island's electricity system and how it interacts with the larger New England grid.

At a high level, the Rhode Island electricity system can be divided into the high-voltage transmission system and lower-voltage distribution system:

- The high-voltage transmission system in Rhode Island is a portion of the larger, highly interconnected transmission network that spans all six New England states and connects to neighboring systems in New York and Canada. The transmission system connects electricity produced by generation facilities across the region to the local distribution systems in each state. Rhode Island and the other states rely on ISO New England (ISO-NE), an independent, non-profit Regional Transmission Organization, to operate the regional transmission system and wholesale electricity markets.

- The lower-voltage distribution system in Rhode Island is primarily a radial system that receives electricity from the regional transmission system and local distributed generation resources, and delivers it to customers throughout the state. National Grid owns, plans, and operates the distribution system for most of Rhode Island.⁹

The regional transmission system provides Rhode Island's load serving entities—which include National Grid and many third-party electricity providers—and their customers access to generation resources across a wider region, and gives generation resources in Rhode Island access to customers across New England. For instance, a distribution utility in Rhode Island may contract for electricity generation from a hydroelectric resource in Maine. Under such an arrangement, the hydro plant injects power into the regional high-voltage transmission system in Maine, and a corresponding amount of power is withdrawn at local substations in Rhode Island. At the local substations, the voltage is lowered and the power is delivered across the distribution system to individual customers. Suppliers may also purchase power from the ISO-NE operated wholesale electricity markets.

The New England states have implemented clean energy policies that will increase renewable energy resources in the

⁹ Two municipal-centric electric utilities also operate in Rhode Island – the Pascoag Utility District (in Burrillville) and the Block Island Utility District (providing service for New Shoreham). These utilities represent less than 1% of total statewide electric demand.

New England Electricity System and Markets

Rhode Island is part of the New England power system, which is managed by ISO New England, an independent, non-profit Regional Transmission Organization. Wholesale power is produced by generators and flows across the regional interstate transmission network. It is delivered to distribution utilities, referred to as Electric Distribution Companies, or EDCs (National Grid is Rhode Island's largest EDC). The EDC's distribution system delivers the power to the customer's premises where it is metered and consumed. Customers may purchase the power itself from a third-party provider (an electricity reseller who generates power or buys it at wholesale from other generators, and resells it to customers at retail), or they can purchase it from the EDC via "default service" at a regulated rate. In either case, customers pay the EDC's regulated delivery charge for the delivery service.

Electricity consumption varies considerably with time of day, season, weather, etc., and it is not easily stored. It must be generated as it is consumed, minute-by-minute. Traditionally, dispatchable (mostly fossil) power plants are turned on and off and ramped up or down as necessary to follow changing electric demand in real time. Plants are generally operated in order of lowest incremental cost first, to minimize total cost. Wholesale power consists of several different products, managed and transacted through ISO-NE markets:

- **Energy** is the electricity actually produced and consumed to meet demand (load).
- **Capacity** is the ability to produce energy on demand, typically required to meet peak load.
- **Ancillary services** are necessary to manage power system operations, e.g., very short-term flexibility to match supply and demand.
- **RECs** (renewable energy certificates) represent the renewable attribute of generation, and can be separated from the power itself. One REC represents the renewable attribute of one MWh generated by a renewable resource. RECs are used to track compliance with states' renewable standards, which require that a specified percentage of power must come from renewable sources.

Renewable generation, such as wind and solar, is typically intermittent and cannot be dispatched to follow load. Yet it provides power at essentially no incremental cost once the generation is installed, so its energy is utilized first when it is available. As the grid transitions from a primarily fossil system toward a renewable energy system, there will still be fossil generating capacity that will generate less electricity overall but will be available to generate during periods when there is insufficient clean generation resources to fully meet electricity demand. Most fossil resources will still be in operation in 2030 when Rhode Island reaches its 100% renewable electricity goal, since the other New England states are not currently planning to increase their renewable requirements as quickly as Rhode Island. The available fossil resources will be needed to respond to maintain system reliability, responding to the intermittent operation of renewable energy resources and maintaining the balance between electricity generation and electricity demand at low cost, albeit with the associated GHG emissions.

Beyond 2030, as other New England states' renewable requirements also rise, the entire regional grid will transition to higher levels of renewable energy. Even though fossil capacity may remain for occasional usage to support reliability, the ability to operate this dispatchable generation is likely to be limited by emissions constraints. System operators will thus need additional non-emitting resources to match supply to load in real time, such as energy storage (e.g., batteries) and flexible load on a very large scale, which will increase the costs of providing reliable electricity to customers.

regional system.¹⁰ All the New England states have renewable energy requirements similar to the Rhode Island RES that mandate a specified percentage of the total covered electricity consumption in the state must come from renewable sources. Currently, the 2030 mandates are 25% in Massachusetts and New Hampshire, 40% in Maine (primarily from existing hydro resources), 48% in Connecticut, and 71% in Vermont.¹¹

Across New England, the generation of renewable energy and compliance with state-by-state renewable energy standards are tracked through Renewable Energy Credits, or RECs. Each megawatt-hour (equivalent to 1,000 kWh) of energy that a renewable energy resource generates results in one (1) REC. The generation of RECs is centrally tracked through the New England Power Pool Generation Information System (NEPOOL GIS). A qualified renewable energy resource in one New England states can generate RECs that are used to meet the requirements of another state (with some state-to-state variation in what kinds of generation qualify for RECs).¹² Load serving entities must then acquire and submit sufficient RECs to match their obligation, which is determined by the amount of electricity demand they serve and the specific requirement in their state (e.g., 16% in 2020 for Rhode Island).¹³ The buying and selling of RECs by renewable energy resources, traders, and obligated entities results in a market price of RECs that is normally quite similar across the New England states. Under a renewable energy requirement like the RES, the renewable energy generation

and RECs are tracked at an annual level; it will not necessarily balance in each hour.¹⁴

Most states with renewable energy requirements, including Rhode Island, also include an option for an alternative compliance payment (ACP) that load serving entities can pay rather than acquire RECs generated by renewable energy resources. The ACP effectively sets a cap on the REC price. Rhode Island's ACP is currently \$72/MWh and rises each year with inflation.¹⁵ The ACP effectively sets a cap on the REC price. If REC market prices are near the ACP, load serving entities will be indifferent between paying the ACP and purchasing RECs. Choosing to pay the ACP may not directly or immediately support renewable energy generation, though Rhode Island uses its ACP revenues to fund renewable energy incentives in Rhode Island. On the other hand, if RECs are very inexpensive due to an excess of RECs in the market, purchasing market RECs may not provide additional GHG reductions. That is, these RECs may represent surplus renewable energy (and GHG offsets) beyond the aggregate New England RPS requirements that would have existed whether or not the RECs were purchased. This would violate the Guiding Principle that GHG reductions should be additional and beyond what would occur otherwise.

¹⁰ There are other shared clean energy policies in New England. For example, all New England states are also members of RGGI, the Regional Greenhouse Gas Initiative that coordinates regional carbon limits in the electricity sector by pricing a limited number of carbon allowances available for larger-emitting power plants.

¹¹ See: <https://www.dsireusa.org/>

¹² Renewable energy resources that wish to have their RECs qualified for the Rhode Island RES – whether located in Rhode Island, throughout New England, or in adjacent control areas – must first be certified by the Public Utilities Commission.

¹³ National Grid is the only distribution utility in Rhode Island whose load is subject to RES requirements. Pascoag Utility District and the Block Island Utility District are statutorily exempt from the Renewable Energy Standard.

¹⁴ Market mechanisms and technologies that account for the hour-to-hour timing of renewable generation and load will begin to gain importance between now and 2030, but will not yet be critical issues since the system will still contain significant (though decreasing) amounts of fossil generation. They will become critical for reliable operations in the longer term as renewable generation increases to much higher levels across New England, and it becomes more difficult to use fossil energy to balance the system. For example, the Massachusetts Clean Peak Energy Standard is designed to provide incentives to clean energy technologies that can supply electricity or reduce demand during seasonal peak demand periods, which will reduce the residual balancing requirements between load and supply. Storage technologies will also become crucial for short-term balancing.

¹⁵ Rhode Island Public Utilities Commission, [Alternative Compliance Payment Rate](#), accessed December 13, 2020.

II.B Operationalizing the 100% Renewable Goal

Governor Raimondo's Executive Order 20-01 accelerates Rhode Island's transition to a renewable energy portfolio by setting the goal to "meet one hundred percent (100%) of the state's electricity demand with renewable energy resources by 2030." In the context of the New England electricity market discussed above, and consistent with the guiding principle to build on existing renewable energy mechanisms, we define meeting 100% renewable electricity as ensuring that the annual production of renewable energy and associated RECs

is sufficient to match all of Rhode Island's annual electricity demand. Specifically, for the purposes of this analysis, we assume that as a component of achieving its 100% goal, Rhode Island will increase the RES to 100% by 2030. Under this new RES requirement, suppliers would need to acquire and retire RECs equal to 100% of their Rhode Island customer load (plus line losses) on an annual basis in 2030 and beyond. Achieving the 100% renewable electricity goal does not require shutting down all fossil generation within Rhode Island. As further explained in the sidebar, it is likely that fossil fuel-based generating resources will continue to operate through the

Does "100% Renewable" require shutting down all fossil generation in Rhode Island?

Achieving 100% renewable electricity does not require shutting down all fossil generation resources in Rhode Island. Executive Order 20-01 challenges Rhode Island to "meet one hundred percent (100%) of the state's electricity demand with renewable energy resources by 2030", which is different from mandating the closure of in-state fossil fuel generators that supply the regional electric grid with electricity. Meeting Rhode Island's entire electricity demand with incremental renewable energy will cause a corresponding reduction in the generation of fossil energy across the regional power system, but does not require shutting down existing non-renewable generators within the state. As described above, Rhode Island is part of the New England electricity system, and depends on the regional system to ensure reliable power at reasonable cost. The regional power system will still rely on fossil fuel-fired generators beyond 2030, though to a declining extent as other New England states also shift toward more renewable energy and less fossil energy. As policies like Rhode Island's 100% renewable electricity goal

and other states' rising RPS requirements reduce generation from fossil fuel-fired generators, each of those facilities will determine whether it is economic for them to continue to operate, and will ultimately close if not.

Importantly, however, fossil generating plants can provide services other than just fossil-fired energy. In the long run, the New England system may need dispatchable, fuel-fired generators, like existing gas plants, as backup to ensure reliability for those times when renewable production is less than load. These fuel-fired plants will burn less fossil fuel over time as renewable generators displace the need for their energy, and they may ultimately switch to burning renewable fuels like hydrogen or renewable gas or oil, rather than fossil. Alternatively, it may be that cost effective storage resources will fill the role formerly played by fuel-fired generation, which would then retire. What technologies will ultimately best meet the region's electricity needs remains unclear, but it is not necessary to shut down fuel-fired generators in the near term to reduce the amount of fossil fuel burned, and it may be advantageous to keep them.

end of the decade and beyond to maintain safe and reliable power supply for Rhode Island and New England.

Solely increasing the RES to require suppliers to purchase RECs will not necessarily achieve 100% renewable electricity. An important consideration for developing policies to meet the 100% renewable goal is that the RES obligation and market REC prices provide a short-term incentive for increasing renewable energy generation. In New England this short-term incentive is often insufficient, because attracting new renewable energy resources requires making large, long-term investments. This mismatch between short-term incentives and long-term investment needs means that even very attractive REC prices for the upcoming years may not provide sufficient revenues to support investment and financing of a renewable project with a life of 20 years or more. Thus, to achieve this ambitious, nation-leading goal in a manner that aligns with the Guiding Principle to provide additional GHG reductions at the lowest reasonable cost, Rhode Island will need to match the higher demand for RECs from the 100% RES with programs and procurements that support the development of new renewable energy resources and the RECs they will produce.¹⁶

Rhode Island currently has a number of existing programs that support new renewable generation. As noted above, these programs include long-term contracting authority granted to National Grid, the Renewable Energy Growth program, the Renewable Energy Fund, and the regulations that support net metering and virtual net metering. These programs generate sufficient RECs to comply with the RES requirement for 2021 and 2022 (17.5% and 19.0%, respectively). In fact with the addition of the 400 MW Revolution Wind project in 2024, the Rhode Island programs support renewable energy resources that will go well beyond the near-term RES requirement, covering about 40% of current electricity

demand. Continuation and potential expansion of these programs, as well as additional procurements, present a path forward to help fill the gap to reach Rhode Island's 100% goal with verifiable, additional renewable electricity resources.

II.C Establishing the Gap to 100% Renewable Electricity by 2030

To identify the renewable electricity gap to achieve 100% in 2030, we first examined expected 2030 electricity demand in Rhode Island, and then projected the amount of renewable electricity generation in 2030 from resources already online or committed through Rhode Island's programs and procurements (excluding future resources that might result from continuation of existing programs).

Beginning with electricity demand, **FIGURE 2** shows Rhode Island projected electricity demand for 2020 to 2030 for three cases: Base Load Case, High Load Case, and a Low Load Case. Each case is based primarily on National Grid's 2019 electricity demand forecast, with adjustments to electrification and energy efficiency assumptions for the High and Low Load Cases. National Grid forecasts that conventional electricity demand (i.e., current uses for electricity) initially decreases, due largely to organic and programmatic energy efficiency. As efficiency opportunities become saturated, conventional load levels off and rises slightly. Electrification demand is very limited in the next several years but grows more significantly closer to 2030, such that total electricity demand begins to rise in the latter half of the coming decade to 7,700 GWh in 2030.

The Base Load Case assumes additional electrification-related demand by 2030, including 5% light-duty-vehicle electrification (dark blue), a similar share of medium- and

¹⁶ New renewable generation may not be additional in every circumstance – e.g., if it forces curtailment of other renewables and thus does not offset fossil generation. This situation is currently rare in most of New England, though could become more common in the future as renewable penetration gets high and curtailments increase.

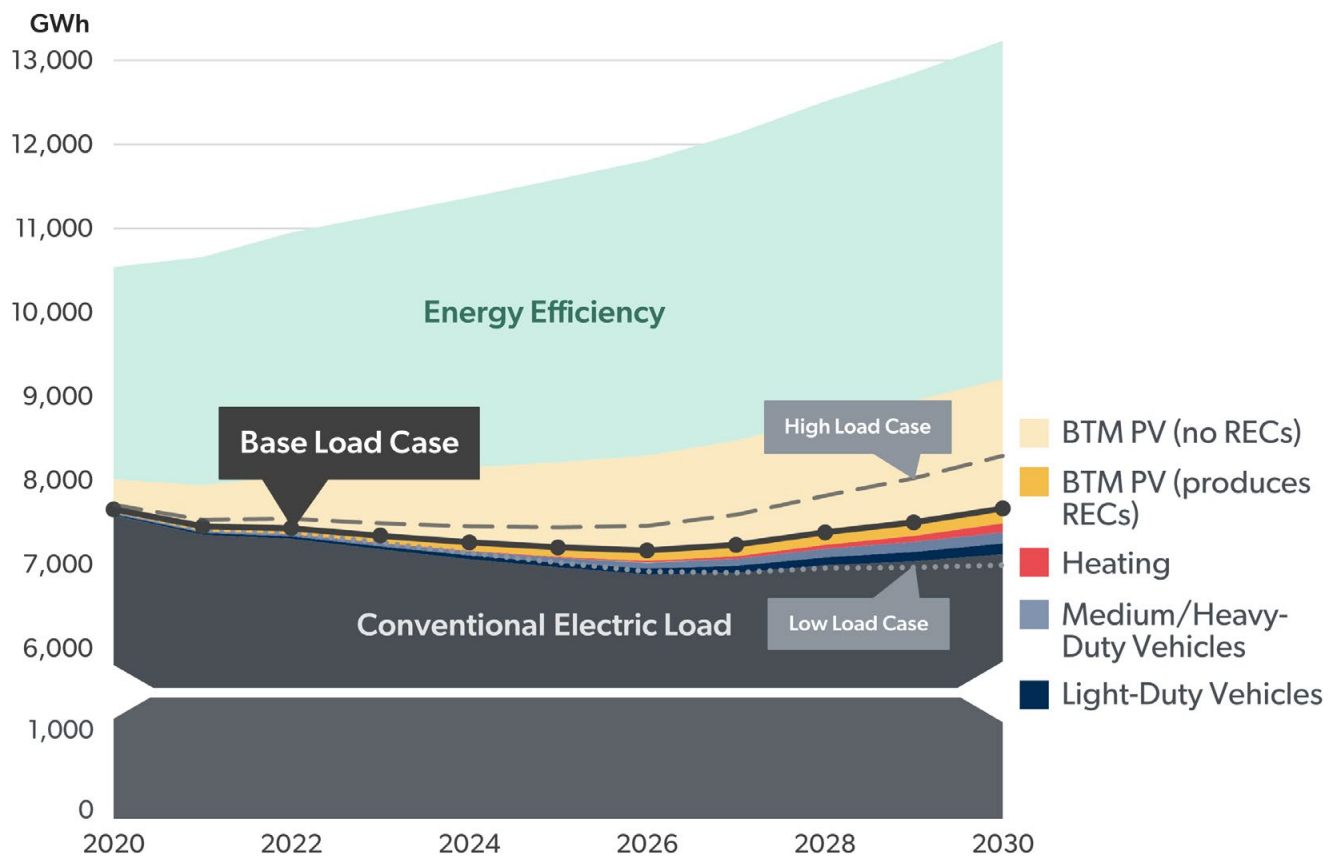


FIGURE 2: PROJECTED RHODE ISLAND ELECTRICITY DEMAND (2020–2030)

Note: “BTM PV” is Behind-the-Meter solar photovoltaic generation

heavy-duty-vehicle electrification, and 5% additional heating electrification (red).¹⁷ The High Load Case assumes a higher penetration of electrified transportation and heating (15% light-duty vehicle electrification and 10% additional heating electrification by 2030). The Low Load Case assumes the same electrification as the Base Case but with greater additional energy efficiency measures to maintain 180 GWh/year efficiency savings through 2030. Although electrification load is expected to be modest by 2030, it will likely accelerate later in the 2030s and 2040s, as electric vehicles and heat pumps become more widely available and achieve substantial cumulative uptake.

The Base Load Case assumes additional electrification-related demand by 2030, including 5% light-duty-vehicle electrification (dark blue) and 5% additional heating

electrification (red). The High Load Case assumes a higher penetration of electrified transportation and heating (15% light-duty vehicle electrification and 10% additional heating electrification by 2030). The Low Load Case assumes the same electrification as the Base Case but with greater additional energy efficiency measures to maintain 180 GWh/year efficiency savings through 2030. Although electrification load is expected to be modest by 2030, it will likely accelerate later in the 2030s and 2040s, as electric vehicles and heat pumps become more widely available and achieve substantial cumulative uptake.

To incorporate this load projection into understanding the renewable electricity gap to reach 100%, **FIGURE 3** illustrates Rhode Island’s existing renewable generation in the green and blue bars. The state currently supports about 850

¹⁷ This load projection is adjusted to include load that is served by behind-the-meter generation (such as rooftop solar) that earns RECs, to prevent double-counting the renewable attributes of such generation.

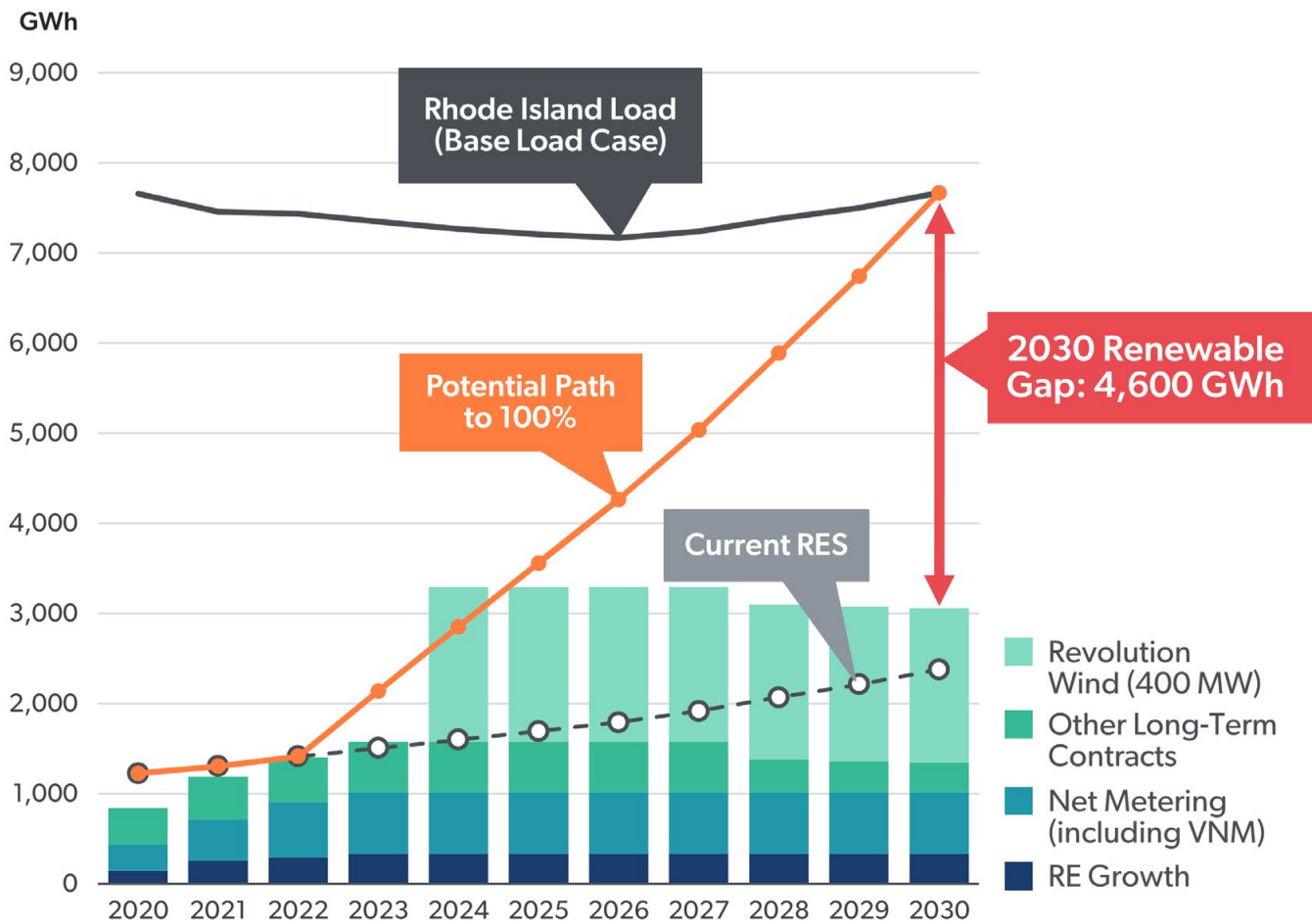


FIGURE 3: RENEWABLE ELECTRICITY GAP TO ACHIEVE 100% RENEWABLES

GWh of renewable energy in 2020, and has already made commitments that increase to 3,300 GWh by 2024. Most notably, the Revolution Wind offshore wind project, of which Rhode Island has contracted for 400 MW, is expected to come online in 2024 and will generate about 1,720 GWh of electricity annually – more than half of the existing portfolio. The total then declines slowly as some existing renewable energy contracts expire by 2030.

The orange line on Figure 3 projects a potential path for the RES, beginning at the existing RES and reaching 100% in 2030. A different trajectory is possible, as long as it reaches

100% by 2030. As shown, the difference between 2030 projected electricity demand of 7,670 GWh and the 3,060 GWh of existing and committed renewable generation leaves a 2030 renewable energy gap of 4,600 GWh. This is about 60% of 2030 electricity demand, and defines the amount of additional new renewable electricity that Rhode Island must secure by 2030 to reach its goal, beyond current commitments.¹⁸

The quantity of incremental renewable energy generation needed to meet the 2030 goal of 100% renewable electricity is uncertain. The 2030 renewable energy gap illustrated above,

¹⁸ The calculation of the 2030 renewable energy gap does not depend on how the hourly and seasonal timing of renewable energy generation compares with the timing of electricity demand, since the structure of the RES requires only that renewable energy generation and the associated RECs match the required percentage of total electricity demand on an annual basis. However, the analyses in later sections do consider hourly generation and load patterns, which are important for understanding ratepayer costs and risks, and for considering how load and generation shapes match, which will become more important farther in the future.

4,600 GWh, is our base estimate; the actual size of the gap will depend on future demand growth. A number of factors influence conventional load growth and create uncertainty in load projections; these include economic growth, organic and programmatic energy efficiency improvements, and year-to-year weather variability. Additional electricity demand uncertainties include the pace of transportation and heating electrification, and long-term temperature trends due to climate change.

Similarly, the amount of renewable energy generation that will be successfully acquired by planned programs and solicitations is uncertain due to the timing with which new resources will come online, and even the amount of energy generated based on how much the sun shines or the wind blows in that particular year. Historically, renewable energy resource potential in New England has differed year-by-year by up to 7% of the long-term annual average for solar resources and 11% for wind resources.¹⁹

Each of these factors can be projected, but not with perfect accuracy. Projections can and will be updated over time – by 2027, estimates of likely 2030 load will be less uncertain than today’s estimate – and the gap can be similarly updated. This uncertainty requires that policy mechanisms to achieve 100% renewable electricity maintain some flexibility regarding quantity. In the end, there will be some unavoidable residual mismatch between the total renewable energy generation and electricity demand in 2030, but the difference can be bridged by buying or selling RECs to match the RES requirement, and/or by banking RECs over time.

Some of this renewable electricity gap may be filled by continuation of existing renewable energy programs to acquire more new resources. If existing programs continue at roughly their projected pace from now until 2030, including 40 MW per year of retail solar through the Renewable Energy

Growth program and 80 MW per year of net metered solar, add an incremental 1,500 GWh by 2030.²⁰ Of course, these current programs could be expanded, allowed to shrink, or reach the maximum allowed capacity (such as for VNM capacity) so that they fill a larger or smaller portion of the gap, as desired.

In addition to existing programs, Rhode Island recently announced its intent to solicit proposals for up to 600 MW of additional offshore wind resources.²¹ A draft Request for Proposals is anticipated to be filed for regulatory review in early-2021. If the procurement is authorized and the full 600 MW is ultimately acquired, the new offshore wind resource would add about 2,700 GWh per year, or about 35% of 2030 electricity demand, filling the majority of the renewable energy gap. In combination, the potential future development of retail solar through existing programs and 600 MW of offshore wind through the pending solicitation could add 4,200 GWh per year, leaving a remaining gap of just 400 GWh per year of renewable electricity.

Procuring additional renewable energy resources from new or expanded programs, or possibly from purchasing RECs from the market are potential approaches to reaching 100%. These questions regarding the mix of resources that may be attractive for achieving 100% are the subject of the next several sections.

II.D Maintaining 100% Renewable Electricity Beyond 2030

The primary focus of this report is on achieving the 100% renewable electricity goal by 2030. But it is also important to consider implications of maintaining this level in the years beyond 2030. Two of the most significant factors for Rhode

¹⁹ The average annual resource potential in ISO-NE has ranged from 93% to 107% of the long-term average from 2015 to 2019 for solar and from 89% to 107% of the long-term average from 2008 to 2019 for wind. Mark Bolinger, et al., [Utility-Scale Solar Data Update: 2020 Edition](#), November 2020, p. 25; Ryan Wiser, et al., [Wind Energy Technology Data Update: 2020 Edition](#), August 2020, p. 50.

²⁰ Projected growth of net metered solar is based on National Grid’s forecast through 2023 and then maintaining the 2023 new capacity of 64 MW through 2030.

²¹ See <https://www.ri.gov/press/view/39674>

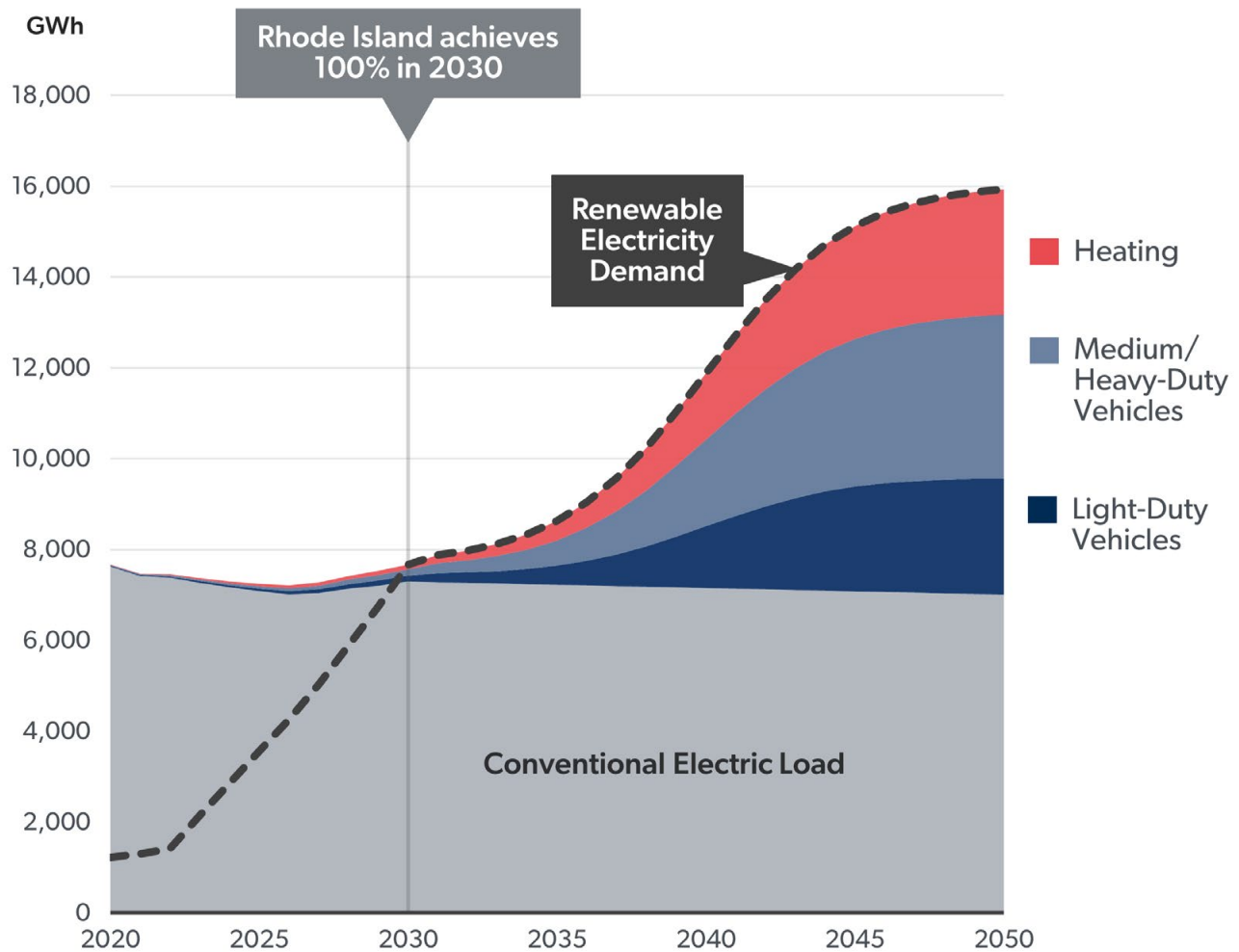


FIGURE 4: POTENTIAL RHODE ISLAND ELECTRICITY DEMAND PROJECTION TO 2050

Island to consider in the years beyond 2030 are the likely large increase in electricity demand due to electrification, and the increasing share of renewable energy resources across the New England system.

Electricity demand is likely to grow significantly after 2030 due to electrification of transportation and space heating.²² To remain at 100% renewable electricity in the longer term, Rhode Island will need to continue adding considerable amounts of new renewable generation to its portfolio beyond 2030. **FIGURE 4** shows a potential projection of Rhode Island electricity demand out to 2050 in which electrifying significant

portions of the transportation and heating sectors could cause the state’s total electricity demand to double between 2030 and 2050. If this pace of electrification materializes, Rhode Island would need to continue adding up to 400 – 500 GWh per year of new renewables beyond 2030, which is roughly similar to the pace up to 2030. In this longer-term view, achieving 100% renewable electricity by 2030 is more of a milestone along the way to decarbonizing the broader economy, rather than the fulfillment of a significant goal for just the electricity sector.

Another implication of this longer-term increase in electricity

²² The long-term demand projection assumes heating decarbonization primarily occurs through adoption of electric air-source and ground-source heat pumps. As discussed in the Heating Sector Transformation report, other decarbonization pathways include renewable fuels such as renewable hydrogen, natural gas, or diesel fuel. Dean Murphy and Jurgen Weiss, [Heating Sector Transformation in Rhode Island: Pathways to Decarbonization by 2050](#), Prepared for the Rhode Island Office of Energy Resources and Division of Public Utilities & Carriers, April 22, 2020.

demand is that the mix of renewable energy technologies in Rhode Island's portfolio by 2030 need not stay the same thereafter. Continuing to add renewable energy resources will also create ongoing opportunities for Rhode Island to rebalance the state's renewable energy portfolio beyond 2030 in response to changes in resource availability and costs, and changes in the generation mix of the broader region. By the 2040s, many of the renewable energy resources Rhode Island had first acquired may be nearing the end of their economic life and could need replacement. In this way, renewable energy development in Rhode Island will continue for the foreseeable future, requiring continued investment and reinvestment to meet the energy demands of the state and the wider New England region.

Beyond 2030, the regional power system will also continue to evolve towards greater penetration of renewable energy resources, driven by other states' policies and the declining costs of renewable energy resources. The increased reliance on renewable energy resources will increase the importance of short-term balancing issues, where a supply mix that contains a higher share of intermittent resources must still be matched with demand minute-by-minute. Longer-term, seasonal energy balancing issues are likely to become more important and the structure of wholesale electricity markets and products

may change (different definitions of capacity, ancillary services, storage products serving varying timeframes, etc.). The challenges and potentially the costs associated with addressing these issues may rise. The lowest cost approaches to balancing the system are highly uncertain given the potential for changing needs and technological advances over this long timeframe.

Most of these challenges are unlikely to be major issues by 2030, though they will be emerging by then and will become increasingly important beyond 2030. This trend is apparent, for example, in the market simulation results, described in more detail in the Technical Support Document, that show that the amount of economic 2-hour and 4-hour battery storage increases from 1,300 MW in 2030 to 19,600 MW in 2040. Additional new technologies will likely be necessary in the 2040 to 2050 timeframe for longer-term balancing, such as thermal generators fueled by renewable natural gas or renewable hydrogen.

As other New England states ramp up their clean energy goals, the manifestation of these issues could accelerate. Rhode Island will need to coordinate with other New England states and electricity market stakeholders to consider these factors in earnest.

III. Analyzing Rhode Island's Options for Achieving the 100% Renewable Electricity Goal

Rhode Island has access to several types of renewable energy generation resources to fill the gap and achieve 100% renewable electricity by 2030. In this section, we identify the primary candidate resources that can fill a significant portion of the gap, and analyze their costs, market value, and production profiles.

For each of the candidate resources, we create a hypothetical Technology Bookend corresponding to filling the entire renewable energy gap with that one renewable resource type. Reflecting the directives of Executive Order 20-01, we evaluate these Bookends based on two primary metrics to enable comparisons across the technologies. The first metric is their “above-market cost” to ratepayers – the amount by which the costs of these renewable resources exceeds the market cost of comparable (non-renewable) energy products. The second metric is the local economic development impacts, measured in terms of GDP and employment impacts. Later in this section, we look at several portfolios consisting of combinations of the resource types using the same metrics to identify tradeoffs.

III.A Candidate Renewable Energy Resources

We first review the availability of candidate resources, screening for resources that may be able to fill a substantial portion of the 4,600 GWh renewable energy gap. The primary candidate renewable energy resources are:

- Offshore wind, primarily off the coast of Rhode Island;
- Land-based wind, primarily available in northern New England and New York;
- Solar photovoltaic (PV) connected to the high-voltage transmission system in Rhode Island and across New England (“wholesale solar”); and,
- Solar PV connected to the lower-voltage distribution system within Rhode Island (“retail solar”).

Taking account of the varying generation profiles of these resources, **FIGURE 5** shows the capacity of each resource type needed to close the 4,600 GWh renewable energy gap identified in the previous section to meet the 2030 goal.²³ The figure shows that filling the renewable energy gap would require 2,700 MW to 4,300 MW of solar capacity, compared with 900 MW to 1,700 MW of wind, since each megawatt of solar

²³ Different resources produce different amounts of energy over the course of a year, relative to their maximum generating capacity. The “capacity factor” of a resource is expressed as a percentage, relating how much energy it produces in a year as a fraction of its maximum theoretical output, if it operated at full capacity for all 8,760 hours in a year. Typical capacity factors in New England are 36% for land-based wind, 52% for offshore wind, 16% for wholesale solar, and 14% for retail solar.

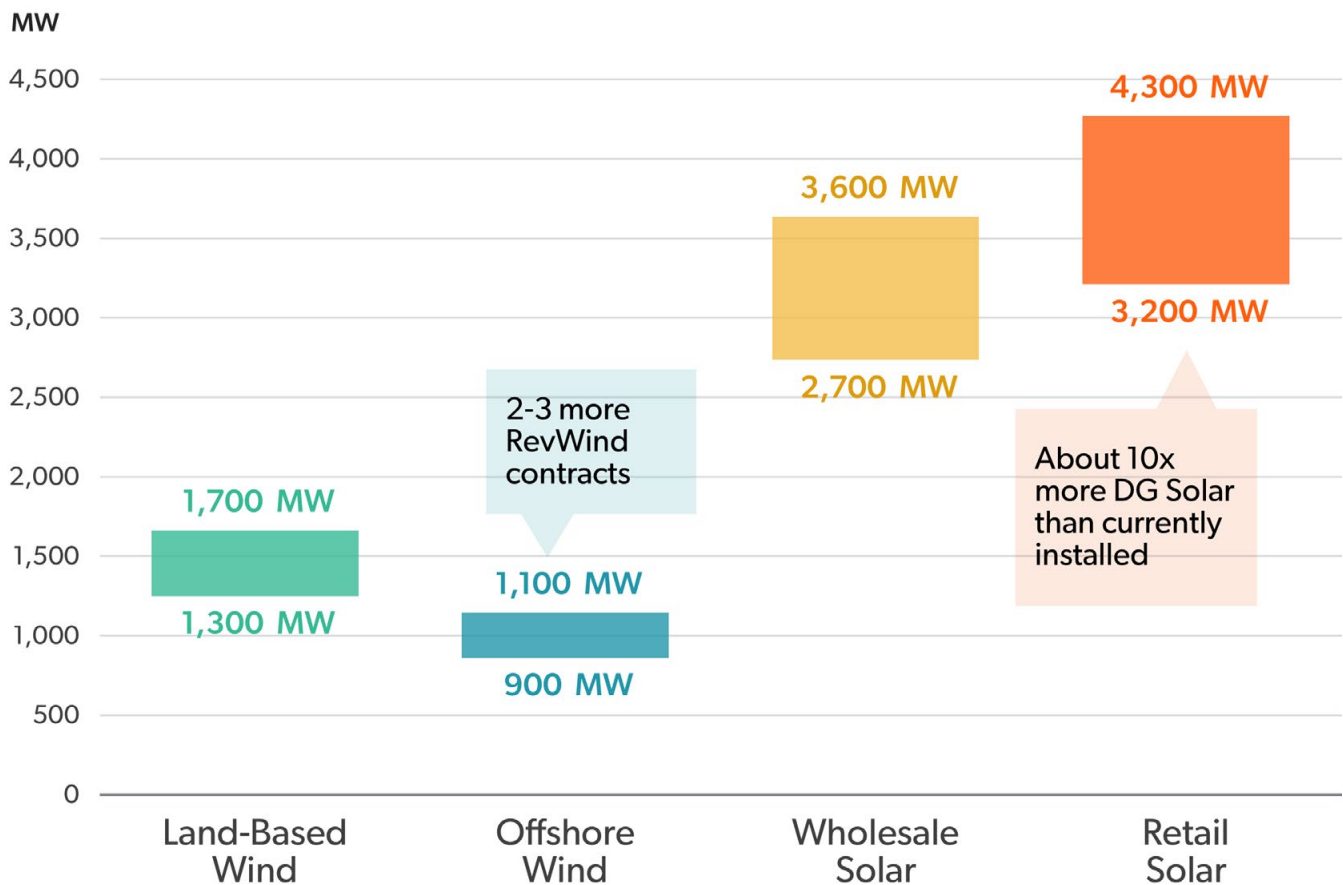


FIGURE 5: CAPACITY OF EACH TECHNOLOGY NEEDED TO FILL 2030 RENEWABLE ENERGY GAP

generating capacity produces less total energy over the year than a megawatt of wind.

Next we consider the availability of these resource types, the costs of developing them (including both the cost of the renewable generation itself and the power system upgrades necessary to deliver the power to customers), and the value of those resources in the New England electricity market (including energy, capacity, and RECs). These cost and value measures are used to estimate their resulting impact on ratepayer costs. We then examine the impact that each resource type will have on Rhode Island’s economy, including GDP and employment.

Resource Availability

The first step to understanding how to achieve 100% renewable electricity by 2030 is identifying the availability

of each of the candidate renewable energy resources and the potential for each resource to contribute to closing the gap.

Offshore Wind Resources: The first operational large-scale offshore wind facility in the U.S., Block Island Wind Farm, started operating in 2016 off the Rhode Island coast. Since then, New England states have signed contracts for 3,100 MW of offshore wind resources, including the 704 MW Revolution Wind Farm contracted jointly by Rhode Island (400 MW) and Connecticut (304 MW) utilities in 2018.²⁴ As noted above, National Grid recently initiated a new solicitation for up to 600 MW of additional offshore wind on behalf of its Rhode Island customers. In addition, Massachusetts and Connecticut target an additional 2,800 MW of offshore wind resources by 2035. In total, the New England states are targeting over 6,000 MW of offshore wind resources in the next decade or

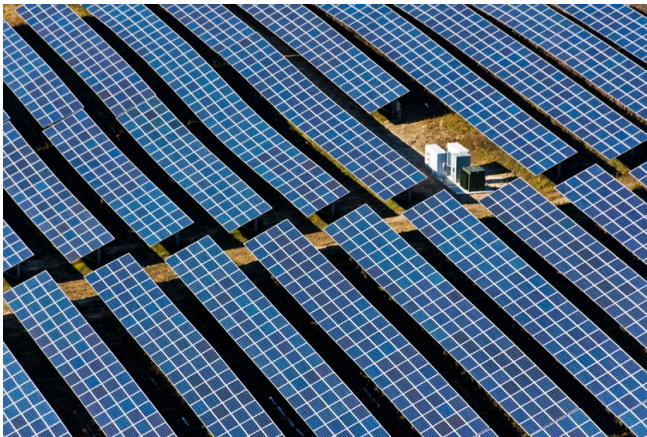
²⁴ See the Technical Support Document for a summary of completed and announced offshore wind procurements.



Land-Based Wind



Offshore Wind



Wholesale Solar



Retail Solar

so. However, the first offshore wind farm selected during the recent procurements, Vineyard Wind by Massachusetts, is not currently scheduled to begin operations until 2023 and has faced challenges obtaining all of the permits necessary to begin construction.²⁵

Offshore wind facilities are located in federal waters that require leases from the U.S. Bureau of Ocean Energy Management (BOEM). BOEM currently has identified leases for future development that can support 15,000 MW of offshore wind resources, and developers have indicated their interest in developing additional offshore wind capacity.²⁶ As of August

2020, developers submitted proposals for over 12,000 MW of offshore wind facilities for evaluation by ISO-NE to determine the need for and cost of system upgrades to connect the new facilities to the New England grid.²⁷

As we discuss in more detail below, adding this scale of offshore wind facilities to serve the New England market will require identifying and developing additional interconnection points with the onshore system, and expansions and upgrades to the existing network. As the most accessible and lowest cost interconnection points are utilized by early projects, the costs of interconnecting still more offshore

²⁵ See, e.g., Jennifer A Dlouhy and Will Wade, [Vineyard Wind Is Said to Face Lengthy Delay After Pulling Permit](#), Bloomberg, December 11, 2020; Bureau of Ocean Energy Management, [Cape Wind](#), accessed December 13, 2020.

²⁶ Pfeifenberger, et al., [Offshore Transmission in New England: The Benefits of a Better Planned Grid](#), Prepared for Anbaric, May 2020, p. 11.

²⁷ The ISO-NE interconnection queue is available here: <https://irtt.iso-ne.com/reports/external>

Other Renewable Energy Technologies

Other resource types may enter the market to help Rhode Island fill the gap. However, these resources are likely to play a smaller role in the state's clean energy future than the four primary technologies identified, and were not included in the analytic evaluations here. To the extent they may be available, some of these other options may offer attractive, if limited, opportunities. In the longer term, technological progress could change the technological and/or economic potential of these options.

- **Landfill Gas and Biogas:** Methane is produced by the anaerobic decay of organic matter, such as occurs naturally in landfills, and in a controlled environment in a biogas digester from animal or food waste. This methane can be captured and used as fuel to generate electricity. While Rhode Island currently contracts for 32 MW landfill gas and 3 MW of Digester Gas, it has not received any recent proposals for these technologies, to our knowledge, and no similar capacity is being developed.
- **Other Eligible Biomass:** Biomass, such as excess foresting material, agriculture waste, and wood pellets, can be burned to produce heat and steam to turn an electric generator. Such facilities are primarily located in northern New England near convenient sources of biomass. Currently, there is no new biomass capacity being developed in New England.
- **Solar Thermal:** Solar thermal generation concentrates sunlight with mirrors to reach very high temperatures, creating steam to turn a generator. Incident sunlight in New England is insufficient to make current solar thermal

technologies practical.

- **Small (<30 MW) hydro:** Hydroelectric generators use moving water (such as water flowing through a dam on a river) to turn an electric generator, and smaller hydro facilities are often classified as renewable generation. Rhode Island allows for limited eligibility of existing small hydro under the current RES structure, but opportunities for new small hydro are quite limited in New England.
- **Tidal hydro:** Tidal hydro works on the same principle as a dam, but uses the motion of tidal currents rather than a river. This and other experimental hydro technologies are not currently commercially viable.
- **Fuel cells:** Fuel cells convert fuel to electricity directly through a chemical process similar to a battery, rather than burning it. There is limited fuel cell development in New England, with just 25 MW in the ISO-NE queue in Connecticut. Available fuel cells use natural gas as fuel, which does not qualify as renewable in Rhode Island; hydrogen fuel cells are not currently commercially viable for power generation.
- **Nuclear:** Nuclear energy is not considered a renewable resource in Rhode Island or most other states, despite its lack of emissions, and is controversial for a number of reasons. Further, it is extremely unlikely that new nuclear generation could be developed by 2030.
- **Geothermal:** Geothermal electricity generation uses the heat deep inside the earth to create steam to drive a turbine. The availability of geothermal is highly dependent on local geology; with available technologies, New England's geology is not suitable.

wind are expected to increase.²⁸ In addition, the delays faced by the already-procured offshore wind resources may increase future development costs, require facilities to be

built under accelerated timeframes, and delay developers from improving their projection of the costs and timeline of completing future projects.

²⁸ Pfeifenberger, et al., [Offshore Transmission in New England: The Benefits of a Better Planned Grid](#), Prepared for Anbaric, May 2020

Land-Based Wind Resources: Currently, nearly all 1,400 MW of wind generation capacity in New England is from land-based wind resources.²⁹ However, development of large-scale, land-based wind resources has been limited in recent years. For example, the proposed 250 MW Number Nine Wind Farm in Maine received a contract for its output from Connecticut in 2013 that was later cancelled.³⁰ The most recently built land-based wind farm is the 29 MW Antrim Wind Farm in New Hampshire that began operation in 2019, after being selected for a contract through the three-state Clean Energy RFP process.³¹ Notably, Maine recently conducted a solicitation for renewable resources and only selected a single 20 MW land-based wind project while procuring nearly 500 MW of solar resources.³²

The challenges of accessing the high-quality wind resources in northern New England has limited development of land-based wind in the region. ISO-NE completed several planning studies over the past decade to identify transmission system upgrades to increase access to land-based wind resources; these have identified several projects, though they are costly as explained further below.³³ Despite these hurdles, land-based wind resources continue to be pursued with about 2,000 MW of resources in Maine in the ISO-NE interconnection queue.

In addition to 19 MW of small-scale wind capacity in Rhode Island through the Renewable Energy Growth program, Rhode Island has recently contracted for the output of the 126 MW Cassadaga and 80 MW Copenhagen wind farms located in New York. The New York State Energy Research

and Development Authority (NYSERDA) has procured nearly 1,000 MW of wind capacity through their 2017 to 2019 REC procurements,³⁴ but are likely to face growing transmission system upgrades necessary for continued development.³⁵ An additional 4,000 MW of wind in New York is currently being studied through the interconnection process.³⁶

With the lack of recent large-scale resources developed in New England and significant demand for renewables in New York, the potential for land-based wind to meet a significant portion of Rhode Island's renewable energy gap is likely to be limited without significant transmission system upgrades on the New England and perhaps the New York systems. However, the recent contracts signed for over 200 MW of capacity suggest that some modest additional amount may be available, and so we include land-based wind as a candidate resource for consideration.

Wholesale Solar Resources: Wholesale solar refers to large-scale solar photovoltaic generation facilities connected directly to the high-voltage transmission system, where the power is transacted in wholesale markets. It has grown steadily in New England, with about 1,700 MW installed in 2020 and another 1,700 MW projected by ISO-NE to be added by 2029.³⁷ Rhode Island has signed contracts for the output of 71 MW of solar resources through its Long-Term Contracts (LTC) program since 2018, including 5 MW from the Hope Farm Solar located within the state. Most recently, Rhode Island contracted for 50 MW from the 120 MW Gravel Pit Solar project located in Connecticut.

29 ISO-NE, [Resource Mix](#), accessed December 21, 2020.

30 Anthony Brino, [Despite energy deal loss, huge wind farm is still on track in Aroostook](#), Bangor Daily News, September 19, 2016.

31 Ethan Howland, [Three New England states move on 460 MW of renewables](#), S&P Global Platts, October 26, 2016.

32 Maine Public Utilities Commission, [2020 Request for Proposals for the Sale of Energy or Renewable Energy Credits from Qualifying Renewable Resources](#), September 22, 2020.

33 ISO-NE estimates that a \$780 million upgrade would be necessary to access 518 MW of land-based wind in Maine. ISO-NE, [Second Maine Resource Integration Study: Results](#), November 2019.

34 NYSERDA, [Solicitations for Large-Scale Renewables](#), accessed December 14, 2020.

35 NYISO, [2019 CARIS Report: Congestion Assessment and Resource Integration Study](#), July 2020, pp. 84-90.

36 The NYISO interconnection queue is available here: <https://www.nyiso.com/interconnections>

37 ISO-NE, [Final 2020 PV Forecast](#), April 29, 2020, p. 50.

The Solar Siting Opportunities for Rhode Island report identified the technical potential to build 2,540 MW to 6,500 MW of solar on landfills, gravel pits, brownfields, commercial/industrial parcels, and carports in Rhode Island, although it is unclear how many of these sites could support larger-scale, wholesale-level resources or are near to high-voltage transmission infrastructure.³⁸ Currently, the ISO-NE interconnection queue includes 450 MW of solar resources listed in Rhode Island, all of which have entered since 2018. Out-of-state development of large-scale solar resources has increased considerably in recent years; new solar resources have increased from 340 MW in 2018 to 1,410 MW in 2019 and 3,270 MW in 2020 in the ISO-NE interconnection queue.

Retail Solar Resources: The majority of solar resources across New England (2,300 MW) are behind-the-meter or distributed solar resources that are connected at the distribution system level (rather than being connected to the high-voltage transmission system). ISO-NE forecasts that an additional 2,100 MW of Retail Solar will be added through 2029.³⁹ Rhode Island has recently added over 300 MW through its Renewable Energy Growth program and its net metering programs. National Grid forecasts an additional 480 MW will be developed in the next three years, primarily through virtual net metering.⁴⁰

Retail solar resources vary greatly in scale, from small residential rooftop facilities of less than 10 kW to large-scale virtual net metering facilities of 5 to 10 MW. The recent Rhode Island solar siting study found that the technical potential for small-scale residential rooftop solar in Rhode Island is 540 MW, though the economic potential is likely only 110 – 260 MW.⁴¹ The study estimated much higher technical potential at ground-mounted sites that can accommodate a larger

facility. However, both available land and existing electrical infrastructure are necessary for developing low cost resources, and the study notes that the technical potential for such sites is likely limited by the capacity of the existing National Grid distribution system.⁴² National Grid’s analysis of the available “hosting capacity” of the existing distribution for new retail solar resources confirms that is the case for a large portion of the state with available land, especially in western Rhode Island where the most solar has been built to date.⁴³ As further discussed below, the costs of interconnecting solar facilities to the National Grid system have increased recently and are likely to remain high unless there is a coordinated distribution system buildout in anticipation of growing distributed solar and other grid demands.

Resources of several types are available: Overall, there is significant renewable energy resource capacity available within Rhode Island, in other New England states, and in adjacent federal waters to meet Rhode Island’s 100% goal. However, all of the candidate resources will require upgrades to the transmission and/or distribution systems for continued growth. Rhode Island should consider approaches to planning and investing in the necessary local distribution and regional transmission infrastructure to reach 100% cost effectively.

Resource Acquisition Costs

The costs of acquiring wind and solar generation resources of all types have declined dramatically over the past several years. However, there are several considerations to weigh for whether similar trends will continue for each of the candidate resources, including the improved economies of scale as renewable energy technologies expand, the experience gained in developing and building resources globally and

³⁸ Pat Knight, et al., [Solar Siting Opportunities for Rhode Island](#), Prepared for Rhode Island Office of Energy Resources, August 18, 2020, p. 4.

³⁹ ISO-NE, [Final 2020 PV Forecast](#), April 29, 2020, p. 50.

⁴⁰ Based on historical data and forecasts provided by National Grid on July 15, 2020.

⁴¹ Pat Knight, et al., [Solar Siting Opportunities for Rhode Island](#), Prepared for Rhode Island Office of Energy Resources, August 18, 2020, p. 4.

⁴² Ibid, pp. 54-60.

⁴³ National Grid, [Rhode Island Hosting Capacity](#), accessed on December 14, 2020.

in New England, the phase-out of federal tax credits, site availability, and future system upgrades costs.

We developed cost projections through 2030 for each of the candidate resources, grounded in the most recent publicly-available market data for renewable energy resources that have been acquired across New England, with additional input from renewable developers. We reviewed the contract prices and program costs for acquiring resources, including the long-term contracts recently signed by Rhode Island and other states for offshore wind, and contract prices for distributed solar resources through Rhode Island's Renewable Energy Growth program. Because the structure of payments to developers varies across contracts, we adjusted the contract prices to put them on a common basis, accounting for differences such as contract life, price escalation, online year, and the federal tax credit phase-out. This provides a set of consistent reference points for the current cost of each of the renewable energy resources in New England.⁴⁴ The resource acquisition costs are expressed in terms of energy cost (on a dollar-per-MWh basis) so that they are directly comparable.⁴⁵

We then applied cost decline projections from the National Renewable Energy Laboratory (NREL) 2020 Annual Technology Baseline study, characterizing how long-term technology costs may evolve over time, and calibrating NREL's "Moderate" case to the recent New England reference points.⁴⁶ NREL also develops a high-cost "Conservative" case and a low-cost "Aggressive" case, which we use to develop a reasonable uncertainty band around future resource costs. Because the NREL cost projections do not account for changes in the costs of transmission and/or distribution system upgrades, we estimated a range of potential future

system upgrade costs for each resource, based on existing projects and observed recent trends in interconnection costs, the outlook for future system upgrade needs, and feedback from renewable developers and stakeholders. More details on the reference points and development of the cost projections are available in the accompanying Technical Support Document.

FIGURE 6 shows the resulting cost projections for land-based wind, offshore wind, wholesale solar, and retail solar resources through 2030. The wide ranges of future costs for each resource reflect the uncertainty in future resource costs, which is supported by feedback from renewable developers, the variation in costs seen in recently procured resources, and the potential range of system upgrades necessary to interconnect these resources. shows the resulting cost projections for offshore wind, land-based wind, wholesale solar, and retail solar resources through 2030. The wide range of future costs for each resource reflect the uncertainty in future resource costs, which is supported by feedback from renewable developers, the variation in costs seen in recently procured resources, and the potential range of system upgrades necessary to interconnect these resources.

Below, we describe the primary drivers of the cost projections for each resource type. Additional detail on the derivation of the costs is provided in the Technical Support Document.

- **Offshore Wind:** The four offshore wind projects procured in New England to date have signed contracts for \$58–98/MWh for their energy generation and RECs. To project the long-term costs of offshore wind, we adjusted these values for the phase-out of the PTC, differences in price escalation rates across the contracts, and increasing system upgrades

⁴⁴ All costs were standardized to a 20-year contract with prices that escalate with inflation. Our analysis follows existing tax law, under which the federal production tax credit (PTC) for wind resources expires before new wind projects would come online, and the investment tax credit (ITC) for solar resources declines to 10%. As this report is going to press, the U.S. Congress is considering legislation to extend these tax credits at existing levels for several more years. If the credits are in fact maintained at levels above those assumed in our analysis, the incremental cost of renewable resources to Rhode Island ratepayers would be lower.

⁴⁵ Throughout this report, unless otherwise specified, monetary values are expressed in real, inflation-adjusted 2020 dollars.

⁴⁶ NREL, [Electricity Annual Technology Baseline Data Download](#), accessed on December 14, 2020.

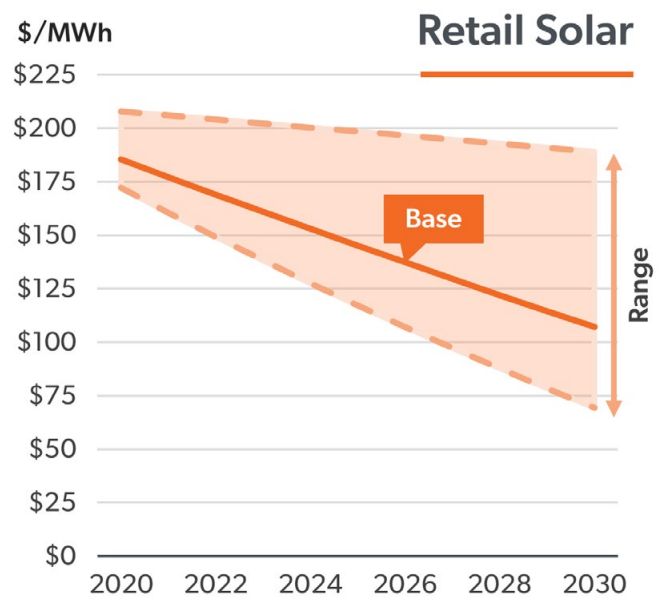
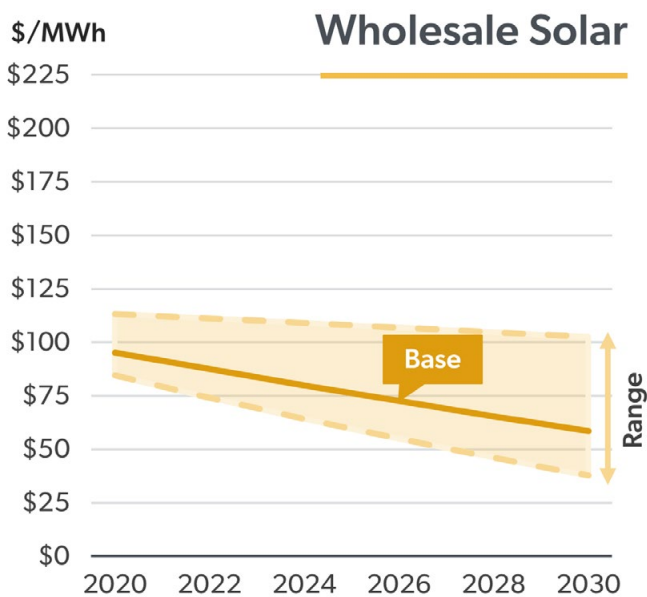
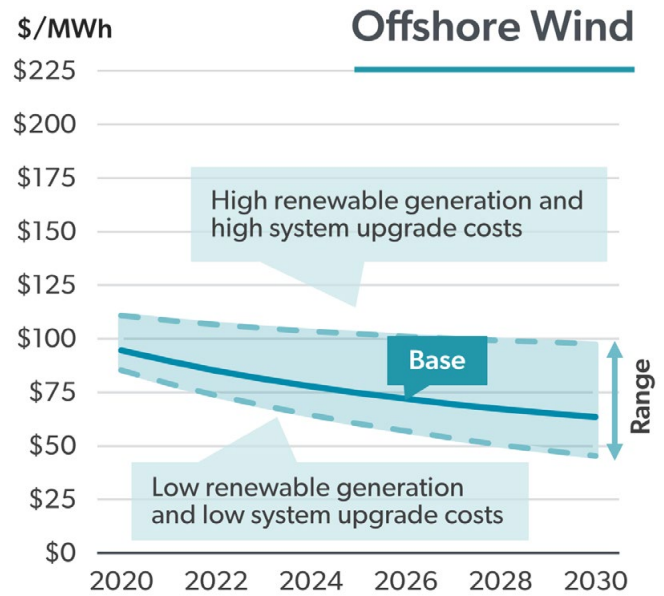
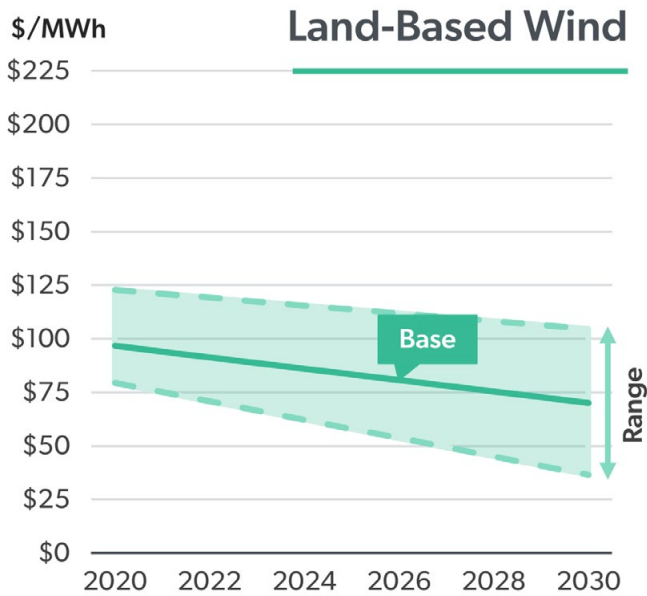


FIGURE 6: PROJECTED RESOURCE ACQUISITION COSTS THROUGH 2030

costs.⁴⁷ NREL forecasts cost declines for offshore wind of 1.5% (real) per year at the low end and 6.1% per year at the high end. The net impact of these adjustments result in 2030 offshore wind costs ranging from \$45/MWh to

\$98/MWh, with a Base Case cost of \$64/MWh. Costs may end up toward the higher end of this range if the installed costs for offshore wind are higher than is reflected in the contracts for early projects, and if additional offshore wind

⁴⁷ We estimated that the PTC reduced the costs of the offshore wind resources by \$11/MWh to \$17/MWh based on the expected online dates at the time of the contracts and the PTC phase-out schedule. The contract for Revolution Wind included prices that remained fixed in nominal terms, while the other contracts escalated prices over the contract life. We estimated that offshore wind interconnection and system upgrade costs will increase by \$10/MWh to \$15/MWh as most easily accessible landing spots and available onshore transfer capacity are filled up by the initial wave of offshore wind resources.

resources involve higher system upgrade costs once the most attractive landing points have been utilized. Costs may end up near the lower end of this range if an expanding industry results in greater economies of scale and more efficient development and construction of offshore wind farms, and if future system upgrade costs are similar to what is reflected in existing contracts.

- **Land-Based Wind:** Rhode Island recently signed contracts for New York land-based wind at around \$90/MWh. Similar to offshore wind, the phase-out of the PTC and increased system upgrade costs may tend to increase the costs of new land-based wind, while continued improvement in turbine performance, especially at low wind speeds, and economies of scale may drive unit costs down, as reflected in the NREL cost forecasts that decline from 2.4% per year to 7.5% per year. Projected Base Case 2030 land-based wind costs are \$70/MWh, ranging from \$37/MWh at the low end with aggressive cost reductions and limited additional system upgrade costs, to \$105/MWh at the high end, reflecting limited cost savings and higher system upgrade costs. As discussed above, there is likely to be limited wind capacity available in New England at the lower end of this range, and possibly at the Base Case cost projection, since major transmission infrastructure investments will be needed in Northern New England to access the highest quality resources.
- **Wholesale Solar:** Large-scale solar resources connecting directly to the transmission system have experienced significant cost reductions recently, falling from about \$90/MWh just a few years ago to around \$50/MWh for the recently contracted Gravel Pit Solar project in Connecticut. Because of this trend, our wholesale solar cost projections account for all of the identified references points, but are weighted towards the most recent contract price. Similar to wind resources, future solar costs must account for the ITC decrease to 10% over the next few years, as well as the wider industry trends in developing and constructing solar resources in Rhode Island and New England. NREL forecasts cost declines for utility-scale solar of 1.3% per year at the low end and 7.8% per year at the high end. These factors result in a projected 2030 cost range of \$38/MWh to \$103/MWh, with a Base Case value of \$59/MWh.

- **Retail Solar:** The costs of retail solar vary significantly across the wide range of sizes of distributed solar resources built in Rhode Island. As further explained in the Technical Support Document, we relied on contract prices for solar resources through Rhode Island's Renewable Energy Growth programs. These range from \$200/MWh to \$300/MWh for solar resources less than 250 kW, and are \$130/MWh to \$150/MWh for solar resources over 1 MW (1,000 kW). We relied on the most recent allocation of capacity across the RE Growth solar categories to develop a blended retail solar cost estimate. NREL projects the most significant cost declines for retail solar of 8.7% per year, but includes an upper end cost estimate that reflects only limited cost reductions. In addition, interconnection costs have been rising quickly in Rhode Island, based on data provided by National Grid. These factors result in a 2030 cost range of \$69/MWh to \$189/MWh, with a Base Case projection of \$107/MWh for a mix of retail solar resources.

To facilitate comparison of the cost ranges across the candidate resources, **FIGURE 7** shows the cost projections for each resource type for 2030, indicating the Base Case cost for each technology (diamond markers) within the potential range (bar). Although there is considerable uncertainty in the cost of all the resource types, and this uncertainty expands over time to 2030, Figure 7 shows that the resource acquisition costs of the three utility-scale resources (land-based wind, offshore wind, and wholesale solar) have similar cost ranges, despite being driven by factors specific to each resource. No one of these stands out as the lowest cost option. Over the next decade, it is not clear which, if any, of these resources may prove to have the lowest total cost, and cost variability from project to project within types may well mean that these technologies continue to be competitive with one another. What does seem clear is that projected resource acquisition cost and cost uncertainty is considerably higher for retail solar – likely to be on the order of \$40/MWh to \$50/MWh higher than for the utility scale resources. This cost difference primarily reflects the lack of scale economies for smaller facilities, and potentially higher costs due to the program structure through which they are acquired.

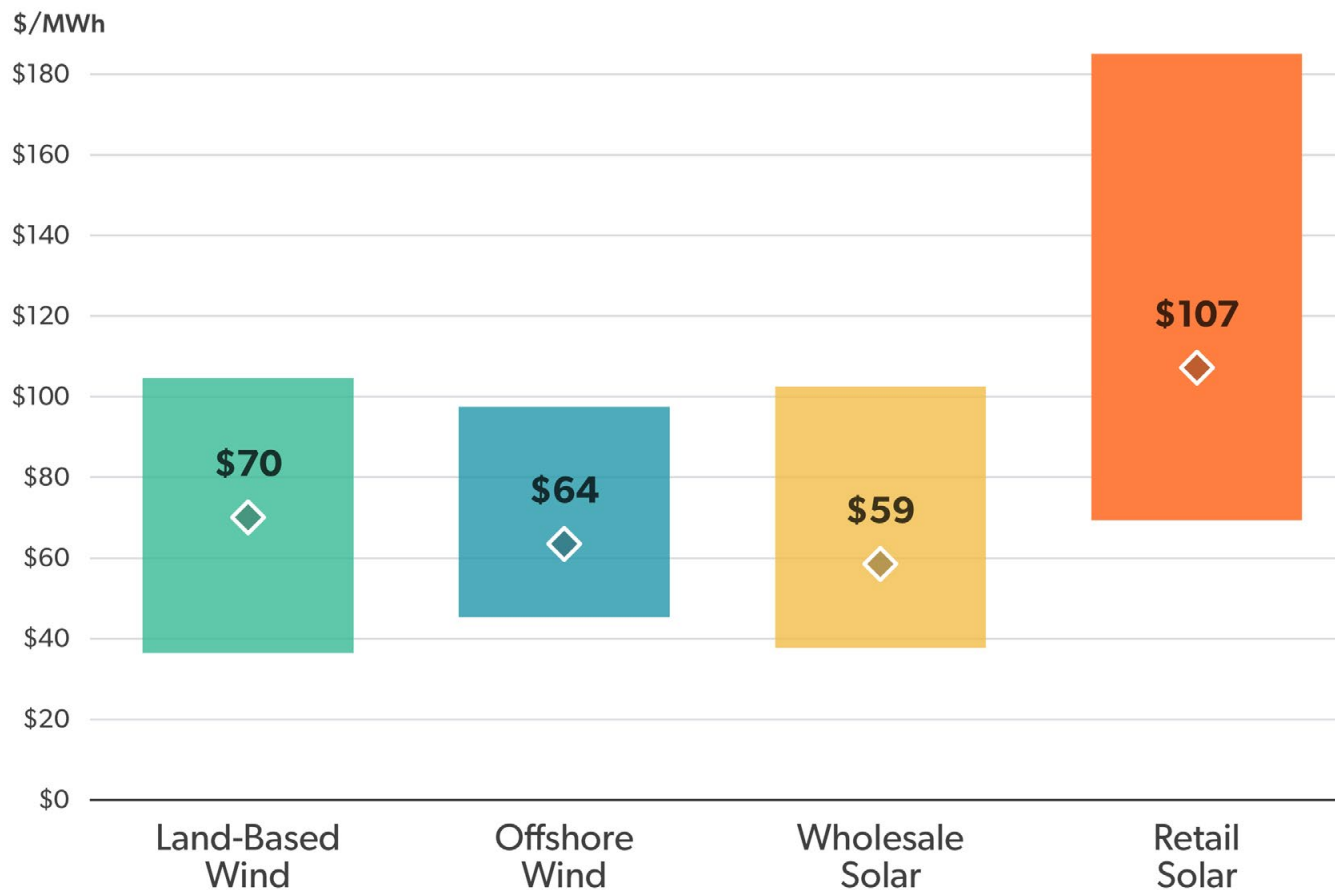


FIGURE 7: 2030 RESOURCE ACQUISITION COSTS

Note: Reflects the levelized \$/MWh cost of a new resource online in 2030, at Base Resource Cost, with range reflecting alternative High and Low Resource Cost assumptions.

Resource Market Value

The costs of future renewable energy procurements, assessed above, will be partly offset by the market value of the products those resources provide – energy, capacity, and RECs – which will then not need to be acquired from the regional wholesale markets.⁴⁸ Below, we summarize the components of market value for each of the candidate resources.

Energy Market Value: ISO-NE operates regional wholesale electricity markets where generation facilities sell their power and load serving entities purchase it on behalf of customers. The energy market sets hourly and sub-hourly prices for

energy delivered to the transmission system. Due to the different nature of solar and wind generation which produce power at different times, the market value of the resources differ. These differences figure into the ultimate above-market costs of each resource.

To determine the energy market value of these resources, we developed a New England-wide, long-term power system simulation model using The Brattle Group’s in-house capacity expansion model, GridSIM. The GridSIM model optimizes the buildout of generation resources that will be developed over time and how they will be dispatched at an hourly level, reflecting the most recent information available

⁴⁸ Potential ancillary service revenues are not included, since renewable generation typically provides few ancillary services and earns very little market revenue from them.

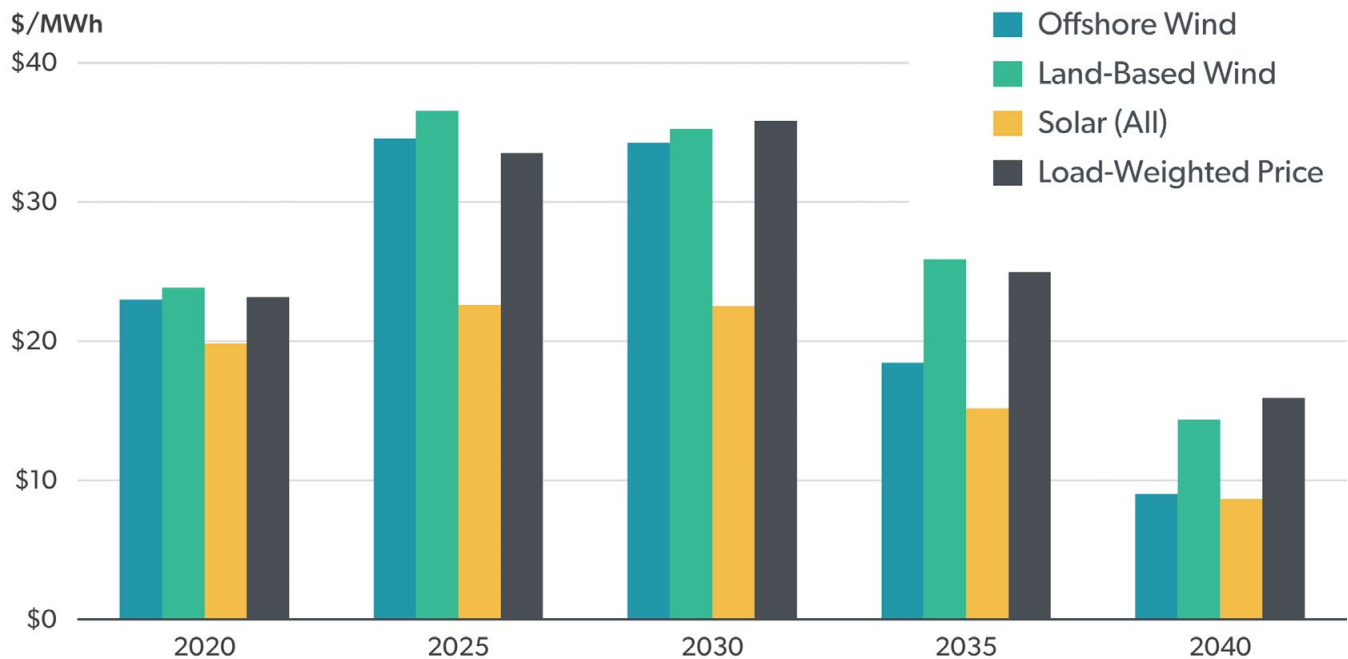


FIGURE 8: PROJECTED AVERAGE ENERGY MARKET REVENUES BY RESOURCE TYPE

concerning renewable energy resource additions, fossil fuel resource capacity and performance, electricity demand, and fuel prices. In addition, we account for renewable energy and GHG emissions policies across the New England states. GridSIM forecasts (among other things) an hourly energy price profile for each year simulated. We use these energy prices to estimate the future energy market value of the candidate renewable energy resources. Prior to analyzing future years, we compared near-term prices to recent historical prices to verify that the model properly reflects the fundamentals of the regional power system. Details of the New England GridSIM model are included in the Technical Support Document.

FIGURE 8 shows the projected average energy market value for wind and solar resources in New England over time. For a given technology, this is the weighted average hourly price, with weights determined by that technology’s generation output in that hour. Since they produce in different hours that have different prices, the technologies do not earn the same average revenues. For reference, the load-weighted price is determined similarly with weights determined by Rhode Island load in each hour. All of the resource types earn similar

market value (\$20 - \$25/MWh) in 2020, but then diverge in 2025 and 2030 as natural gas prices (which set power prices, particularly in the early years) rise from their 2020 lows. New England gas prices are highest in winter, and wind produces more energy in the winter (solar produces more in summer); this allows wind to earn relatively more than solar on average, until late in the horizon.

In later years, as New England states’ renewable energy goals rise, increasing renewable energy penetration of all types tends to push prices down in the hours when renewables generate most, reducing their average energy revenue. The average price for load also decreases, though to a lesser extent since prices are not pushed down in all hours. The higher energy market value for offshore wind and land-based wind reduces the above-market costs of these resources compared to wholesale and retail solar.

Capacity Market Revenues: In addition to their energy generation, renewable energy resources contribute generating capacity, which helps to maintain a reliable New England power system. For instance, solar supports the system by

Hourly Generation vs Load: Implications for Storage and Market Price Risk

The hourly generation profile of renewable resources does not generally match the hourly load profile particularly well. This is true for Rhode Island, and also at the New England level. This raises two important issues – one long-term, New England-wide question about how generation and load will be balanced on a system that will be dominated by intermittent renewable generation, and a second, potentially nearer-term issue for Rhode Island regarding the cost and cost risk implied by the hourly mismatch, even before significant issues arise at the system level.

Different renewable resource types have different hourly generation profiles, relative to the hourly shape of load. By choosing a renewable resource mix whose hourly generation profile matches load at least reasonably well, this issue can be partially mitigated. One way to illustrate this is shown in **FIGURE 9**. This uses offshore wind and solar as examples, and shows a hypothetical net load duration curve for each of the technologies (solid lines). The curves show the hourly difference between Rhode Island’s load shape and the generation shape of the technologies. They are scaled for this hypothetical exercise so that total generation equals total load, and the hours are ranked by net load, independently for each technology. Where the curves are above zero at the left indicates hours in which load exceeds renewable generation.

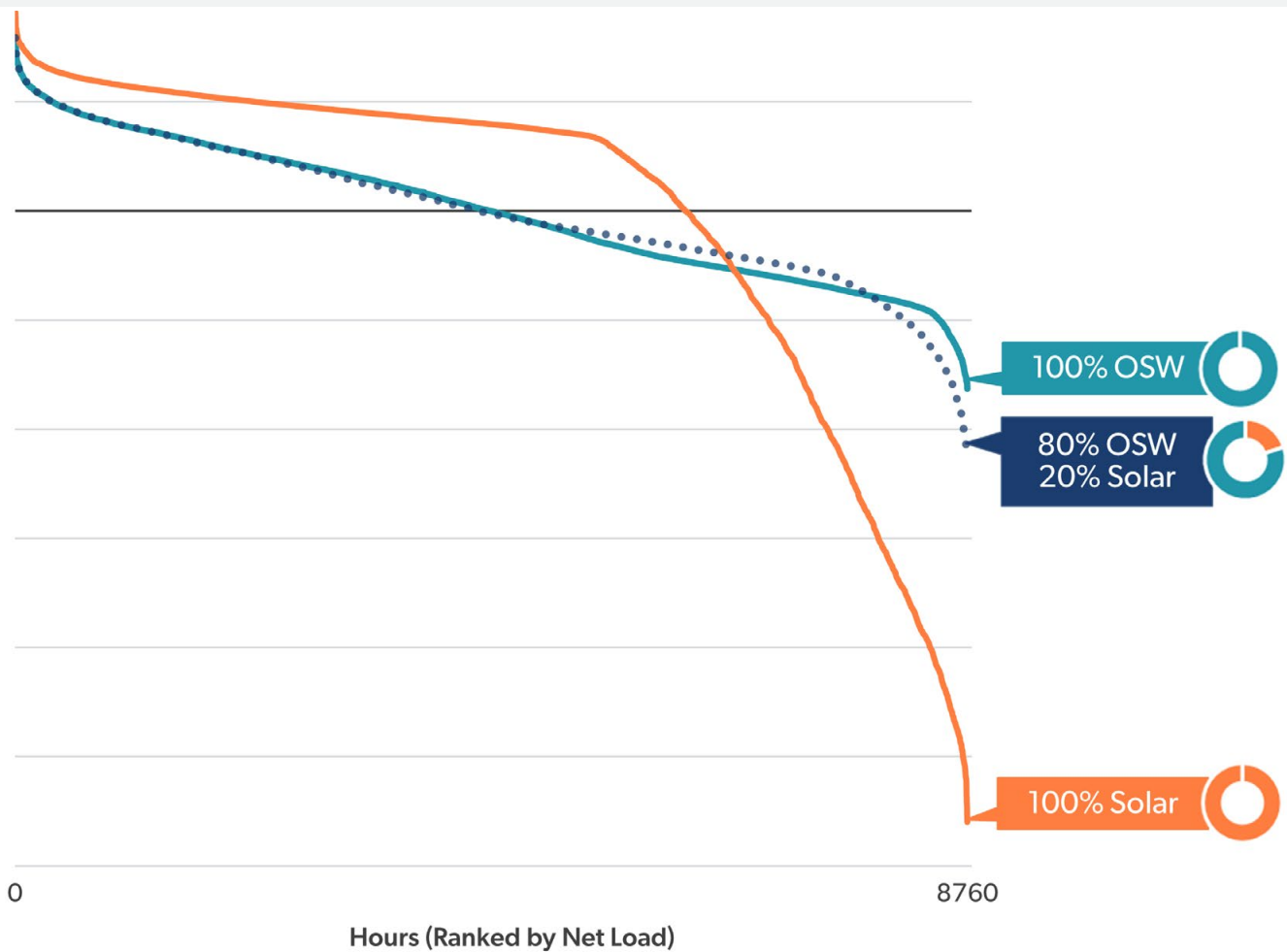


FIGURE 9: ANNUAL NET LOAD DURATION CURVES (NET LOAD = LOAD – RENEWABLE GENERATION)

Note: Hourly generation profiles are the same for Wholesale and Retail Solar, so their Net Load is also the same.

On the right, generation exceeds load (not necessarily the same hours for wind as solar). For each curve, the area under the curve and above the zero line (left side of the figure) is equal to the area above the curve on the right side. A curve that is closer to the zero line (lower on the left and higher on the right) represents a better hourly match with load. Conceptually, storage can be one way to address this mismatch, storing energy in hours of excess for use in hours of shortage. That ends up being a complicated question, since the usefulness of storage depends not only on the hourly mismatch, but also on whether the excess and shortage hours are close in time (day to night) or farther apart (summer to winter). But this simple illustration suggests the magnitude of the issue that must ultimately be faced.

Comparing the technologies, solar clearly has much larger hourly mismatches than offshore wind. Its output is concentrated into fewer hours, only daytime and mostly summer, with most hours having no solar generation at all. In order to provide enough total generation to match annual load by itself, solar would generate far more than load in a small number of hours – sunny hours with low load, like spring afternoons – but would generate much less than load (often zero) in the majority of hours. This does not mean that solar is not a useful renewable resource, however. Due to the hourly diversity between wind and solar generation, a mix of wind with some solar may offer a somewhat better match than just wind. The blue dotted line shows the net load curve of a mix of 80% offshore wind with 20% solar (by energy); its match with load is as good or better at most times, other than a small number of spring afternoon hours when generation greatly exceeds load.

This is admittedly a very rough metric; it does not account for short-term vs seasonal differences in the timing of the excess and shortage hours, for other generation types (hydro, nuclear) and their generation profiles, or for potential transmission constraints, etc. But it does suggest that this question of hourly matching will limit the amount of solar generation the New

England system can usefully accommodate. While some solar can improve the hourly match, as the overall energy share of solar goes beyond about 30%, the hourly match with load begins to worsen.

Rhode Island is a small part of New England (about 6%), so its choice of resource types will be well within any system-wide limits on the best balance of renewable resource types. If Rhode Island did choose a solar-heavy portfolio, there will be ample opportunities for the rest of the system to balance this by choosing more non-solar resources. Even so, a mismatch would create price risk for Rhode Island ratepayers, which is the second, potentially nearer-term issue.

Once it reaches 100% renewable, Rhode Island's total renewable generation will equal its total load on an annual basis, but in each particular hour its renewable generation will be either higher or lower than its load. The excess or shortage will be sold into or purchased from the New England electricity market, at the prevailing hourly price, and hourly energy prices differ, sometimes significantly. This hourly quantity mismatch thus has economic impacts for ratepayers. Over time as renewable penetration increases across the region, prices in hours with high renewable generation will tend to fall (this was seen in Figure 8, where in later years the average price earned by each renewable generation type falls below the average for load.) The above-market cost calculations below take this into account by subtracting projected market revenues of the renewables, though that is only an estimate of the effect.* Customers face additional cost risk if hourly prices differ from these projections, and the risk depends on the magnitude and timing of the hourly mismatch and hourly prices. This suggests that there is good reason for Rhode Island to try to maintain a reasonably good match between the hourly generation shape of its renewable portfolio and its own load shape. With just the renewable resources already online and committed, Rhode Island already has enough solar to provide about 14% of its 2030 energy needs.

* Another way to manage this mismatch in timing is with energy storage, such as batteries, though that also has a cost.

providing energy when the system needs it, such as in the afternoon on the hottest summer days. Renewable energy resources can receive payments for providing this value, which reduces the need to purchase capacity from other resources and reduces ratepayer costs. Based on the current rules under the regional Forward Capacity Market operated by ISO-NE, renewable energy resources supported by state programs that are unable to offer below a pre-determined price threshold (known as the Offer Review Trigger Price, or ORTP) must enter the capacity market through recently introduced “substitution auctions” instead of the primary auctions.⁴⁹ However, to date just 54 MW of renewable capacity cleared in the first two substitution auctions due to limited participation and low primary auction prices (\$2/kW-mo).⁵⁰ The limited amount of renewable energy resources that have cleared in the substitution auctions has created concerns about the viability of this path for renewable resources participating in the capacity market, and capacity market structures more generally.⁵¹

Similar to the energy market value discussed above, the capacity market value that renewable resources realize can reduce the net costs of renewable generation to ratepayers. To estimate this value, we reviewed recent New England capacity market prices and the outlook for future capacity needs. Over the past five years, capacity prices have declined from \$7/kW-month in 2016 to \$2/kW-month in 2020, reflecting excess generating capacity in the system.⁵² Prices are likely to remain low due to limited peak demand growth over the next decade. Based on these market conditions, we assume capacity prices will be approximately \$4.5/

kW-month, the average price over the past five years.⁵³ Because they are intermittent resources, renewable energy resources receive credit for a relatively small portion of their total nameplate capacity in the capacity market: 39% for land-based wind, 47% for offshore wind, and 19% for solar.⁵⁴ These values are likely to decrease in the future as more renewable energy resource additions shift the hours that drive reliability events. Given the uncertainty in whether renewable energy resources will be able to participate in the capacity market and the potential for their capacity credit to decrease with rising penetration, we discount the assumed revenues that renewables will earn from the capacity market by 50%. **FIGURE 10** shows the resulting capacity value across the candidate renewable resources, converted to an energy basis in \$/MWh – on the order of \$3/MWh to \$4/MWh, and similar across technologies. Given the uncertainties in future market conditions, we considered a range of capacity value for renewables from \$0/MWh if renewables do not clear the substitution auction to about \$14/MWh, based on an equilibrium capacity price of \$8.71/kW-mo and full realization of their current capacity credit values.⁵⁵

Renewable Energy Credit (REC) Value: Qualified renewable energy resources create a REC for each megawatt-hour they generate, which they can then sell to entities across New England that must comply with renewable energy mandates set by each state. For example, under its Renewable Energy Standard, Rhode Island requires that load serving entities, such as National Grid and third-party providers, purchase 16% of their demand from renewable energy in

49 Renewable resources can directly enter the primary auction if their net costs are below the ORTP threshold.

50 ISO-NE, [2018 Annual Markets Report](#), May 23, 2019, p. 20; [ISO-NE, 2019 Annual Markets Report](#), June 9, 2020, p. 184.

51 See, e.g., the New England Governors Statement on Electricity System Reform, October 14, 2020 (<http://nescoe.com/resource-center/govstmt-reforms-oct2020/>) and the New England States Vision Statement (<http://nescoe.com/resource-center/vision-stmt-oct2020/>).

52 ISO-NE, [Results of the Annual Forward Capacity Auctions](#), accessed December 14, 2020.

53 Capacity prices developed in our long-term New England market simulations in GridSIM are also in the range of \$4/kW-mo to \$5/kW-mo for 2020 to 2030.

54 Concentric Energy Advisors, [Net CONE and ORTP Master DCF](#), November 24, 2020.

55 Equilibrium capacity price is based on the Net CONE value estimated for the ISO-NE 2024-2025 Forward Capacity Auction. ISO-NE, [Forward Capacity Market Parameters](#), November 10, 2020.

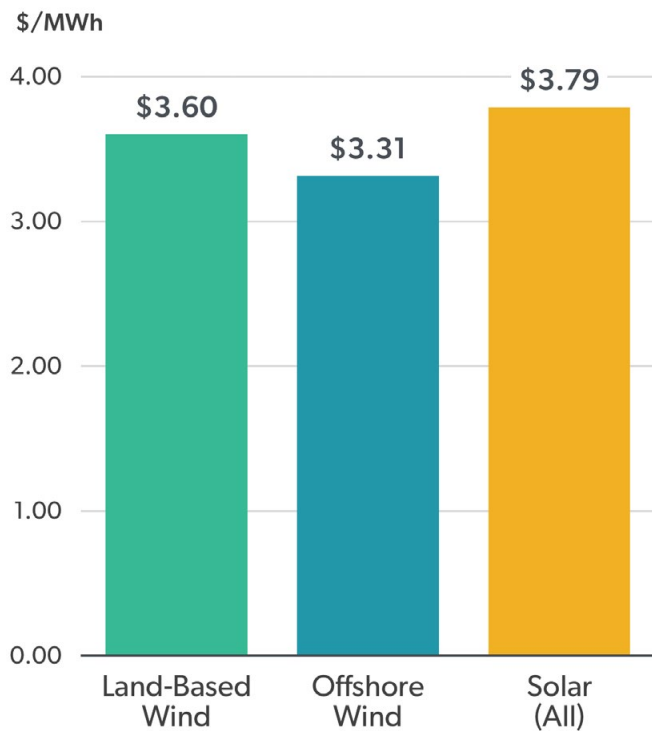


FIGURE 10: CAPACITY MARKET REVENUES – BASE CASE

Sources and Notes: Assumed average capacity price over past 5 auctions of \$4.50/kW-mo; qualified capacity based on draft 2020 ISO-NE ORTP study; Concentric Energy Advisors, Net CONE and ORTP Master DCF, November 24, 2020

2020.⁵⁶ The qualified renewable energy resources can be in Rhode Island, other New England states, or neighboring jurisdictions that can deliver the generation to New England.

Over the past five years, New England REC prices have fluctuated from about \$50/MWh to around \$5/MWh and back, as shown in **FIGURE 11**. Since RECs are relatively short-term financial instruments representing renewable generation in a given year and traded at most a few years forward, REC prices depend primarily on the short-term balance of renewable energy generation and state RPS requirements. When total renewable generation exceeds REC requirements, REC prices are low; alternatively, when demand exceeds total renewable generation, even if that

situation is short-lived, REC prices will be high (capped at each state’s alternative compliance payment, or ACP).

In the future, REC prices will continue to be driven by the short-term balance of rising state-by-state mandates and rising quantities of renewable generation, driven by state procurements through long-term contracts and other similar programs (like Rhode Island’s Renewable Energy Growth programs and offshore wind procurements). This dynamic makes it extremely challenging and perhaps futile to try to project future REC prices. Because of this, we developed a set of assumed REC prices that we use in our analyses. We reviewed historical REC prices, as well as the net costs of acquiring large-scale renewables like offshore wind and wholesale solar as determined by our analyses above. Based on these factors, we assume a Base REC price of \$30/MWh.⁵⁷ We analyze a REC price range of \$15/MWh to \$45/MWh, consistent with both the range of recent historical prices and the uncertainty ranges of our resource costs analyses.

Evaluating the Candidate Renewable Resources

The next two sections use the information developed above to evaluate how the four candidate renewable energy resource types will affect Rhode Island. This is illustrated stylistically in **FIGURE 12**. The costs of acquiring renewable energy generation resources and the market revenues they earn from the electricity market are combined to estimate the above-market costs to Rhode Island ratepayers in **SECTION III.B**. In addition, developing and paying for renewable energy resources will have broader effects on the Rhode Island economy, including the state’s Gross Domestic Product (GDP) and local employment. The cost information, plus additional information on the construction expenditures for developing renewable energy projects, as well as relationships within the local economy, are used to model these economic impacts

⁵⁶ Rhode Island Office of Energy Resources, [Renewable Energy Standard \(2004\)](#), accessed December 14, 2020.

⁵⁷ As an independent reference point, the recent analysis of the ISO-NE Offer Review Trigger Prices assumed REC prices of \$29/MWh, similar to the Base REC price assumption developed for this study. Concentric Energy Advisors, [Net CONE and ORTP Master DCF](#), November 24, 2020.

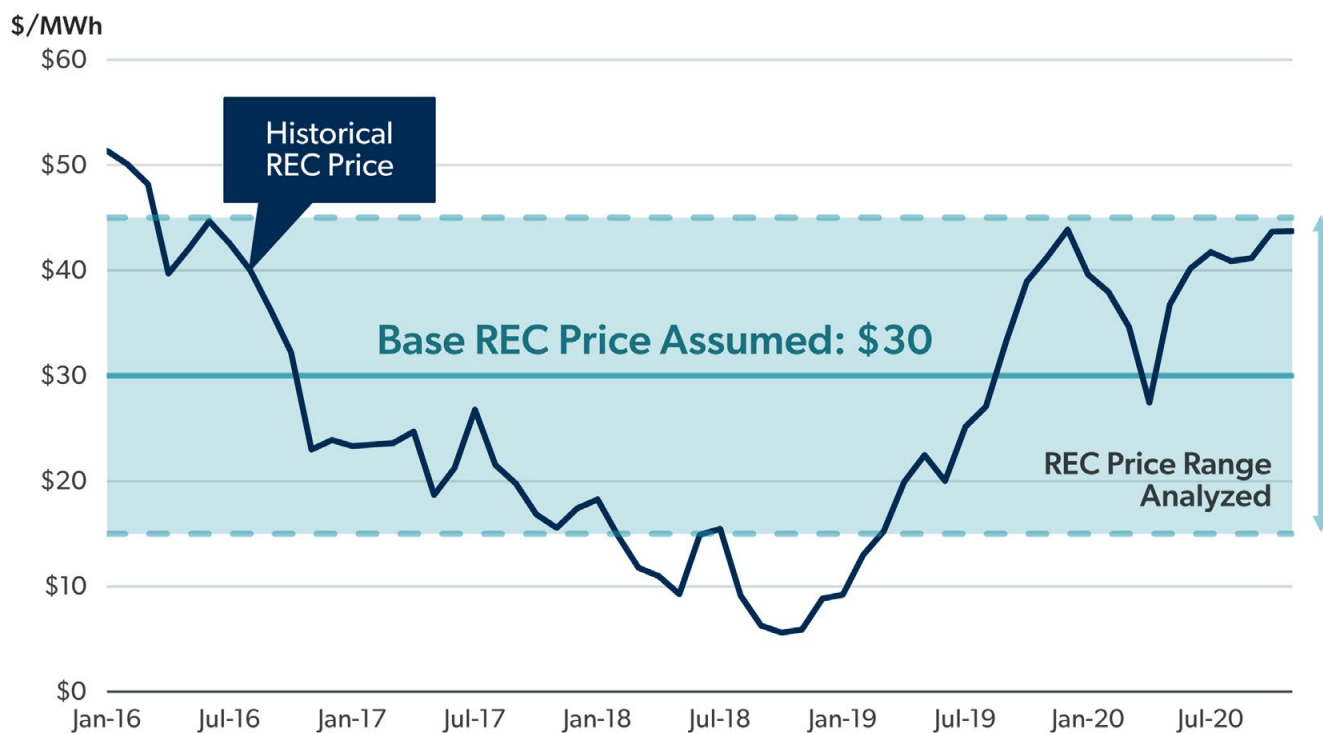


FIGURE 11: HISTORICAL RHODE ISLAND REC PRICES (2016–2020)

Source: S&P Global Market Intelligence, accessed November 23, 2020.

and estimate the resulting GDP and employment effects in **SECTION III.C.**

The two metrics used, above-market costs and economic impacts, are consistent with Executive Order 20-01. They are applied to the four Technology Bookends, hypothetical ways to fill the entire 2030 renewable energy gap with a single renewable resource. The above-market cost analysis considers the cost of going from the existing RES (16% now, rising to 38.5% in 2035) to 100% renewable (implemented through a 100% RES) by 2030. In this analysis, we show for comparison what it would cost to fill the gap entirely with RECs purchased from the market, at the assumed REC price of \$30 (alternatively, \$15 or \$45). The local economic impact analysis, in contrast, takes a comparative perspective, assessing the economic impacts of each of the renewable technologies relative to purchasing market RECs at the assumed REC price (\$15, \$30, or \$45). In doing this, it shows the relative economic impacts of alternative ways to reach the 100% goal, given that the goal must be achieved.

SECTION III.D. which follows applies these same evaluation metrics to several Technology Portfolios developed to represent alternative ways of filling the gap with combinations of different resource types. These Technology Portfolios are likely to be more illustrative of actual paths that might be followed than the single-resource Technology Bookends.

Of course, other factors such as equity and land use are also important, and must be considered in addition to the cost and economic analyses of the upcoming sections. These issues may be specific to particular projects and thus difficult to generalize to technology types, or may not be directly related to the choice of renewable technologies.

III.B Above-Market Costs of Technology Bookends

The first metric we consider for the candidate renewable energy resources identified is the impact on Rhode Island

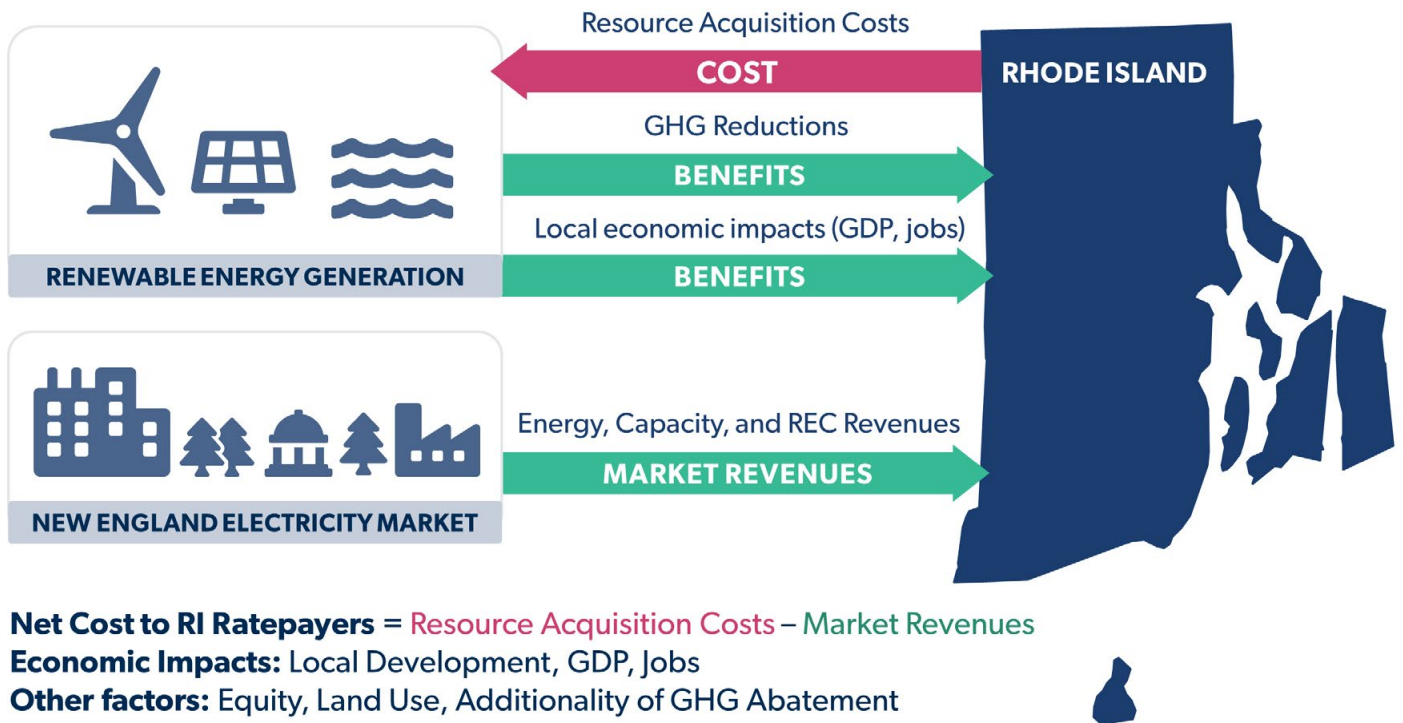


FIGURE 12: IMPACTS OF PROCURING RENEWABLE ENERGY TO ACHIEVE 100% BY 2030

electricity ratepayer costs. Ratepayer cost impacts account for the incremental costs of acquiring renewable energy to serve the state’s entire electricity demand. This can also be referred to as the “above-market costs” of renewable energy resources, relative to purchasing non-renewable energy beyond the current REC requirement. We calculate the above-market costs of each of the candidate renewable technologies based on its resource acquisition costs, deducting its energy and capacity market value. The REC value of a technology is not deducted from the above-market cost, though the resulting above-market cost can be compared to the cost of purchasing market RECs. To illustrate this in the context of the 100% goal, we consider four Technology Bookends, one for each resource type considered. Each Bookend is defined as the amount of new renewable generation of the given resource type needed

to fill the entire renewable energy gap to achieve 100%. We use this to measure the overall cost of increasing renewable energy to achieve 100% by 2030, relative to achieving the current RES. It does not include the costs of achieving the current RES, which is an existing requirement.

FIGURE 13 shows the total above-market costs to achieve 100% renewable electricity in Rhode Island with each of the Technology Bookends, in net present value (NPV) terms for 2020 to 2040, using a 3% real discount rate.⁵⁸ First, as a reference point, we show the ratepayer cost of purchasing unspecified RECs from the market at the assumed \$30/MWh price has an NPV of \$1,400 million. If RECs cost \$15/MWh or \$45/MWh, that value changes to \$700 or \$2,100 million, respectively. Alternatively, the four Bookends show the cost of filling the renewable gap with the four alternative candidate

⁵⁸ We assumed a 3% (real) discount rate that reflects a commonly used “social discount rate”, such as is often used to determine the value of avoided greenhouse gas emissions. While there is no “correct” discount rate per se, there is a large literature discussing the use of a “social discount rate” to evaluate policy that takes into account various societal issues, rather than reflecting purely private decision making. Social discount rates are generally in the range of 2.5-7% (real), with some arguing for 0%. U.S. estimates of the social cost of carbon use discount rates of 2.5%, 3% and 5%; see Resources for the Future, Social Cost of Carbon 101, August 1, 2019. See also OMB Circular A-4, September 17, 2003, which includes an in-depth discussion of the rationale for using various discount rates.

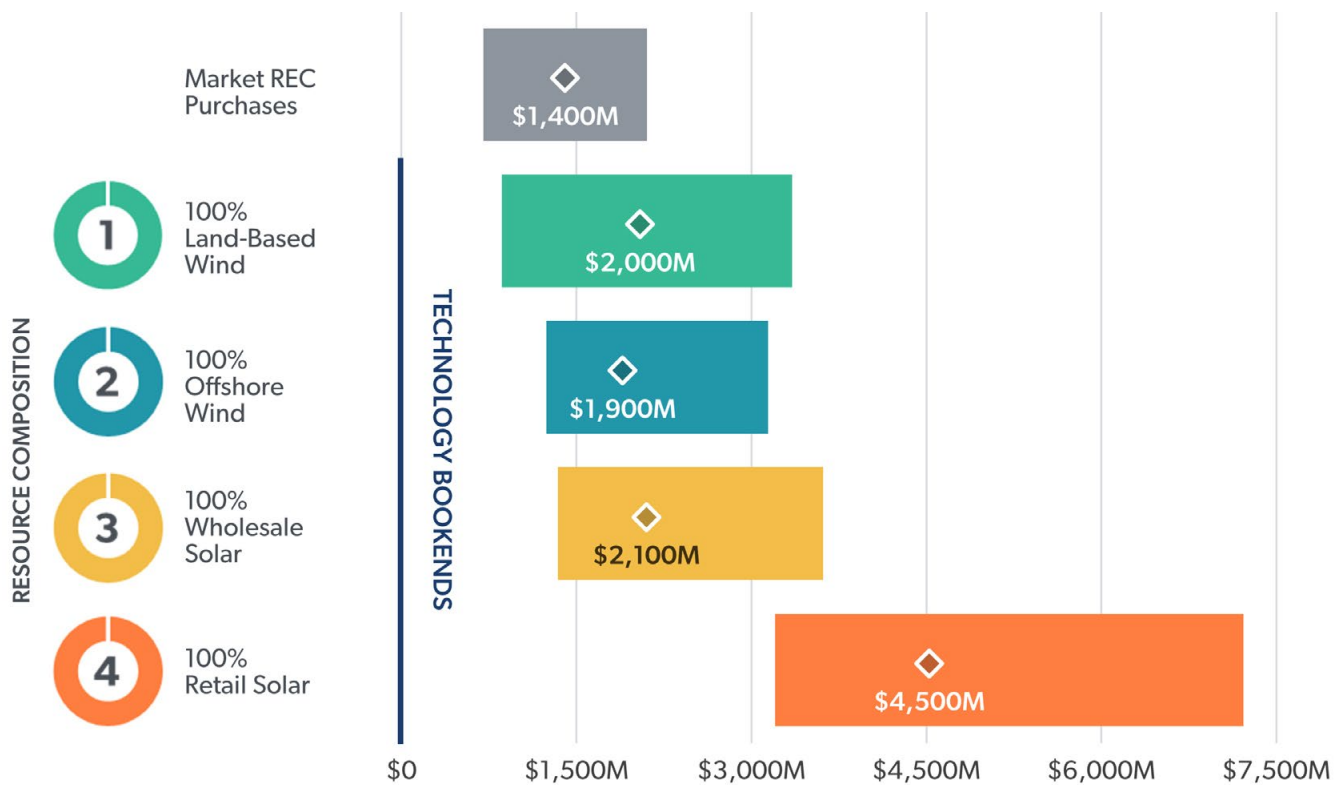


FIGURE 13: NPV OF ABOVE-MARKET COSTS (2020–2040) OF ACHIEVING 100% RENEWABLES; BOOKENDS
(NET OF ENERGY AND CAPACITY REVENUES, NOT RECS)

Note: Ratepayer costs reflect the total incremental costs of achieving 100% net of energy and capacity revenues.

renewable energy resources.⁵⁹ For each Technology Bookend, the figure shows the Base Case above-market costs (diamond marker) and the potential range of costs (shaded bar) that reflects uncertainty in the resource acquisition costs, as was reflected in Figures 6 and 7 above. Purchasing market RECs may be the lowest cost approach to achieve 100% goal by 2030 (or it may not), but as described below, this approach may not align with several of the guiding principles outlined above. The Base Case costs of the three utility-scale resource Bookends are similar to one another, with above-market costs of \$1,900 million to \$2,100 million over twenty years. The Retail Solar Bookend, however, results in a materially higher above-market costs, \$4,500 million over this timeframe. This reflects its significantly higher resource cost as identified above.

Among the utility-scale resources, the range in ratepayer

costs reflects the significant uncertainty in the outlook for renewable resource costs in Rhode Island and New England, as described above. At the low end, above-market costs of the utility scale resources are about \$900 million to \$1,300 million, which reflects significant cost declines for each resource, and system upgrade costs reflective of the recent past. On the high end of the cost range, renewable resource costs do not decline significantly from today, and system upgrade costs are significantly higher, resulting in net ratepayer costs of \$3,100 million to \$3,600 million.

The similar Base Case cost estimates and ranges signal that no one of these technologies is currently projected to be the lowest cost renewable energy resource. This conclusion is similar to the comparison above of resource acquisition costs, but it now includes the market value of the resources.

⁵⁹ While our analysis continues to account for the future incremental costs of the renewable resources that are brought online to achieve 100% by 2030, we do not include the costs of additional new resources that are likely to be needed beyond 2030 to maintain 100% as load grows further.

Pros/Cons of Meeting 100% via Market Purchases of Short-term RECs

Market purchases of short-term RECs may result in lower costs of meeting 100% RES (though it is also possible it might not, given reasonable uncertainties). However, REC purchases might also have other less desirable impacts, including:

- Lower GHG impacts, if RECs are from renewable resources that are not entirely additional (e.g., resources built ahead of other states' needs). RECs may be more likely to be inexpensive when the renewable generation is not additional.
- Limited support for local renewable resources (potentially giving up in-state economic activity).
- Increased ratepayer exposure to volatile REC prices via market REC purchases.

Over the next decade, the costs of the different resource types could diverge, based on global and local markets for each resource, the local labor market, the need for system upgrades and the approach Rhode Island and other states take for planning the future regional power system. The cost diversity that has been observed across specific projects is also likely to continue. It will be valuable for Rhode Island to continue to seek out opportunities to use competition among resources, across types as well as within them, to identify the particular technologies and projects that are most attractive for the state. This suggests that it will be valuable for Rhode Island to continue to seek out opportunities to use competition among resources, across types as well as within them, to identify the particular technologies and projects that are most attractive for the state.

The range of impacts of a broader set of uncertainties is shown in **FIGURE 14**, using the Offshore Wind Technology Bookend as an example. The figure shows that resource acquisition costs are the primary uncertainty, followed by the future energy market revenues and capacity market revenues. Renewable resources have a higher net costs when market

prices are lower, such that if future natural gas prices are \$2/MMBtu lower in 2030, reducing average energy prices by \$12/MWh, the above-market costs of achieving 100% renewables would increase by about \$320 million. Similarly, for potential changes in the capacity market that may affect the capacity value captured by renewables, above-market costs could decrease by about \$390 million if they earn full capacity credit and capacity prices rise, or costs could increase by about \$140 million if the renewable resources earn no capacity value. Uncertainty in load is expected to have a limited impact on costs.

FIGURE 15 converts the potential impact of the above-market costs into Rhode Island retail rate impacts, also showing the resulting increase in monthly costs for a typical residential customer. The rate impacts of the Technology Bookends are similar for Offshore Wind, Land-Based Wind, and Wholesale Solar, at roughly 1 to 5 cents/kWh, while Retail Solar impact is higher at 4 to 10 cents/kWh. These rate increases would increase a typical residential monthly bill by about \$11 to \$14 with utility-scale renewables, or by \$32 if the entire gap is filled with retail solar.

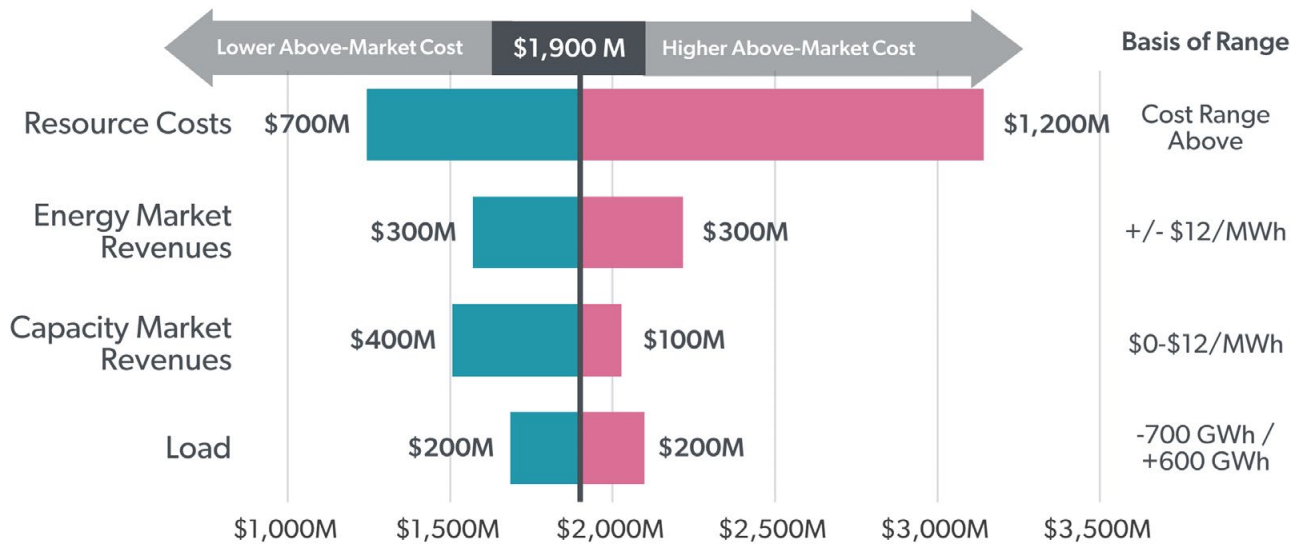


FIGURE 14: SENSITIVITY ANALYSIS OF ABOVE-MARKET COSTS (OFFSHORE WIND TECHNOLOGY BOOKEND)

Note: Above-market costs reflect the total incremental costs of achieving 100%, net of energy and capacity revenues.

NEM/VNM Cost Shifts

Most of Rhode Island’s renewable energy procurement programs are run by National Grid, with the above-market costs spread across all ratepayers. However, certain customers are able to add renewable energy resources through either net energy metering (NEM) or virtual net energy metering (VNM) arrangements. These result in cost shifts from the NEM or VNM customer to remaining customers. Under NEM and VNM programs, customers can offset a portion of their utility bill by installing solar resources on-site (such as on the roof of their house) and thus reducing their metered demand, or by receiving bill credits for VNM resources located off-site. The cost shift occurs because the avoided payments resulting from the addition of the NEM or VNM resource are greater than the actual costs avoided by reducing the customer’s demand. The difference is the costs that are shifted to other,

non-participating customers.

Based on current projections by National Grid, Rhode Island is expected to have about 400 MW of NEM or VNM generation by 2022-23, which equates to about 500 GWh per year of solar generation. The majority of this (about 85%) is from VNM facilities, which tend to be larger solar facilities (up to 10 MW) as compared to residential rooftop solar (5 – 15 kW). VNM is limited to certain customers who account for around 6% of total Rhode Island load. Based on estimated NEM credits and volumetric rates, NEM/VNM customers accounting for 400 MW of NEM/VNM resources cause a cost shift of about \$55 million per year to non-NEM/VNM customers, which increases their rates by 0.8 ¢/kWh.* Resources from the RE Growth Program or those acquired through utility-scale long-term contracts do not result in similar cost shifts.

* We assumed a volumetric retail rate of 20.4 ¢/kWh and net energy metering credits of 17.0 ¢/kWh based on our analysis of current Rhode Island electricity rates and regulations. We assumed a total market value of \$60/MWh, including energy, RECs, and capacity revenues

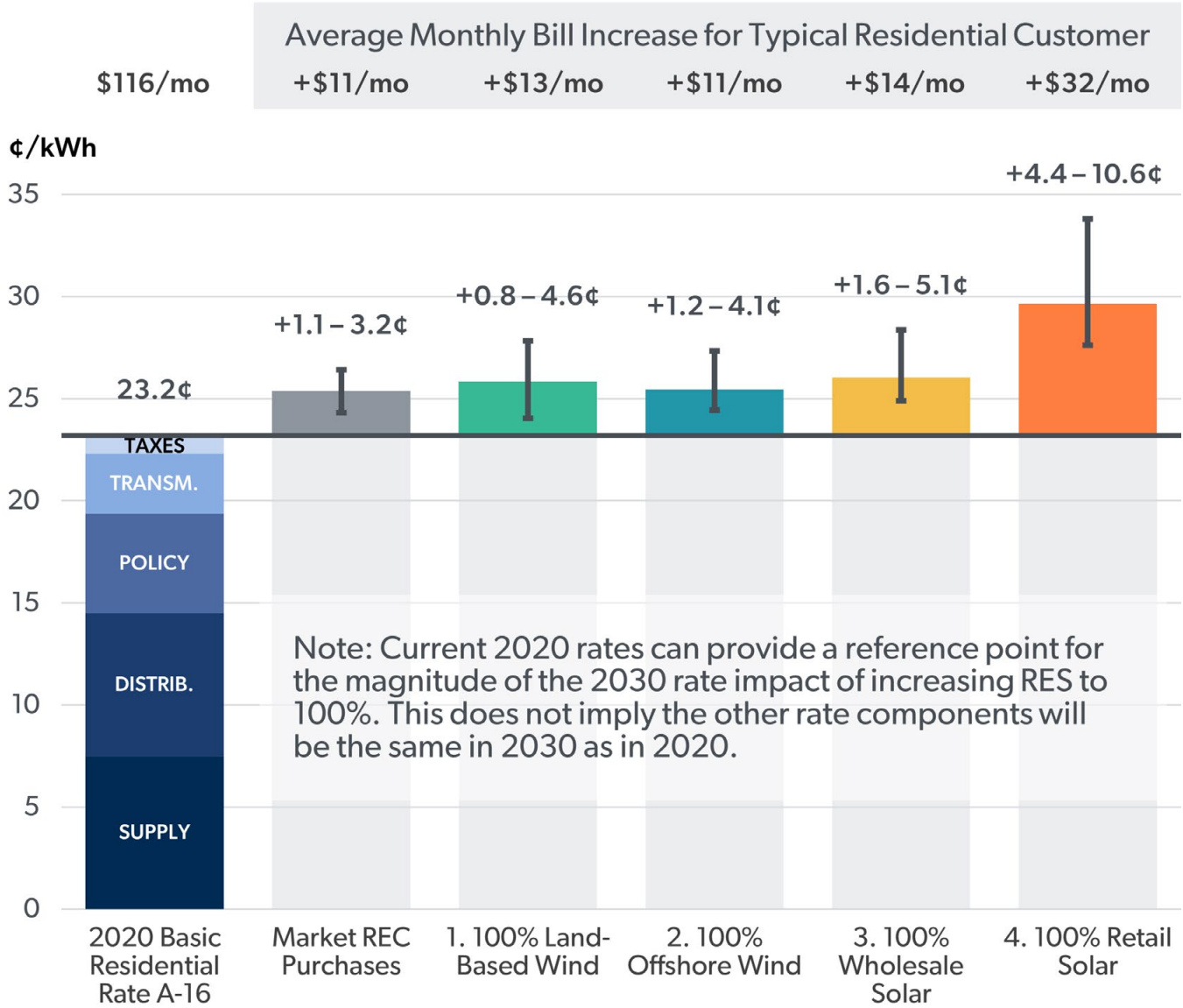


FIGURE 15: 2030 RATE IMPACTS OF 100% RENEWABLE ELECTRICITY

Notes: Assumes typical residential customer consumes 500 kWh/mo.

III.C Economic Impact of Technology Bookends - GDP and Employment

The second key metric we consider for evaluating renewable energy technologies and portfolios is their economic impact – their effect on Rhode Island’s gross domestic product (GDP) and in-state employment. The economic impacts

are influenced by the ratepayer above-market costs, and consider how the above-market costs propagate throughout the economy. In addition, the economic impacts consider the effects of the in-state investments and economic activity that occur when developing renewable energy generation projects in Rhode Island.

We use IMPLAN to estimate the economic impacts of alternative ways to reach the 100% goal. IMPLAN is a

commercial input-output model, widely used by federal, state, and local governmental agencies to measure the impacts of regulatory changes and major infrastructure investments.⁶⁰ IMPLAN estimates the economic impacts of one specified alternative compared to another – e.g., how local GDP or employment would differ between two specified alternatives.⁶¹

The economic impact analysis compares potential portfolios of renewable energy resources against the alternative of meeting 100% renewables entirely through market REC purchases, at an assumed reference REC price (nominally \$30/MWh; we also consider cases with REC prices of \$15/MWh and \$45/MWh). This allows us to evaluate each of the alternative resource mixes against the same reference case, thus facilitating comparisons between alternatives. Because of this, the economic impact analysis does not yield the overall economic impact of reaching 100% (as compared with not achieving it), but rather considers the impact of how 100% is achieved, given the 100% goal.

The impact of alternative renewable resources on Rhode Island GDP and employment occurs through three potential channels:

1. *Construction Expenditures* before the project comes online (for in-state projects);
2. *O&M Expenditures* during operation (again for in-state projects); and,
3. *Tariff Impacts paid for by Rhode Island* ratepayers throughout the life of the contract.

The construction and O&M expenditures associated with an in-state project will cause inflows into several Rhode Island economic sectors. For example, a solar project would involve specific amounts of construction labor, cement, structures, solar

panels and inverters, etc. Similarly, an offshore wind project would involve onshore and offshore labor, structures, wind turbines and blades, etc. Some of these expenditures would occur in Rhode Island, while some would go out of state (e.g., construction labor vs. solar panels), as specified in NREL's JEDI model (see sidebar: Economic Impacts Can Be Project-Specific). The direct expenditures in these sectors interact with other sectors through the economy, each causing changes in economic activity that are then tracked by IMPLAN to determine their overall effects on Rhode Island GDP and employment.

The tariff impacts reflect the economic effects of the incremental above-market costs of the acquired renewable energy resources as those costs filter through the economy. These above-market costs are assessed relative to buying market energy and RECs, and they may be negative. Contracting for a particular renewable energy resource may be cheaper than buying market energy plus RECs, if the resource is low cost or the REC price is high. Thus, a project's tariff impact would be negative if consumers pay less for the project than they would to buy comparable energy and RECs from the market. Since producers and consumers pay less for electricity, they have more to invest and spend in other ways, resulting in positive impacts on GDP and employment. If the project's cost is higher than market energy plus RECs, it increases consumer costs relative to the market benchmark, resulting in negative economic effects due to the decreased investment and spending.

A project's economic impact varies considerably over time. The initial construction phase of an in-state project results in a boost to local GDP and employment. Once construction ends and the project comes online, the net GDP and employment benefits diminish and can even reverse if the project has significant above-market costs that offset the benefits of the ongoing O&M expenditures.

⁶⁰ For more information on IMPLAN, see www.implan.com. We supplemented IMPLAN's sector allocations for renewable energy resources with data from the JEDI model (Jobs & Economic Development Impact), developed and maintained by NREL, the National Renewable Energy Laboratory. See <https://www.nrel.gov/analysis/jedi/>.

⁶¹ IMPLAN is an input-output model rather than a dynamic equilibrium model, and thus does not project the future trajectory of the economy in absolute terms. Still, since there is a level of stability in the underlying economy over time, IMPLAN provides a reasonable estimate of the relative economic impacts of one alternative compared to another.

Economic Impacts Can Be Project-Specific

IMPLAN (like any economic impact model used in this way) uses typical or characteristic allocations of expenditures to sectors in order to model a representative project of a given technology. However, the actual local Rhode Island impact of any particular project will depend on how that project is executed. Any specific project may have a different mix of local

vs out-of-state suppliers and labor that lead to different GDP and jobs impacts for Rhode Island, and this may influence the attractiveness of the project for Rhode Island. For instance, two otherwise similar solar projects may have different economic impacts for Rhode Island if one utilizes mostly in-state labor and materials, and the other relies more on out-of-state resources. The results presented here reflect a typical project of each of the resource types, but there may be project-to-project variability in impacts.

We estimate the net present value of the GDP effects for comparing across technologies and portfolios, discounting all impacts from the time they occur to the present (again using a 3% real discount rate) to facilitate summarizing and comparing the impacts of the technologies. As a second summary measure, the net employment impact is also included, expressed in undiscounted job-years.⁶²

All these impacts are assessed over the period 2020-2040. While acknowledging that the 2040 horizon cuts off part of the operating life of later renewable energy additions, projections of costs and economic benefits beyond that becomes highly uncertain, particularly because of the upcoming changes in the electric power industry. Using the same time horizon and discount rate for all portfolios helps to keep the results comparable despite the challenges of projecting so far into the future; the effect of still more

distant years would be diminished by discounting in any case.

To illustrate the analytic approach in the economic impact analysis, we first apply IMPLAN to a single hypothetical project. We then apply it to the Technology Bookends defined above, which leads to several observations about the economic impacts of each of the technologies on its own. Later, we apply this same approach to a number of representative Technology Portfolios that use combinations of technologies to fill the 2030 renewable energy gap.

We start by considering the economic impact of a hypothetical 600 MW offshore wind project such as might result from Rhode Island's recently announced request for proposals (RFP) for offshore wind. The upper panel of **FIGURE 16** illustrates the GDP impacts of this project as evaluated with IMPLAN, showing the three categories of impacts considered. For the

⁶² One job-year is a full-time job for one year.

Additional Economic Benefits

The economic impact analysis here considers only the impacts that are attributable to the renewable resources considered. It does not include potential consequential economic benefits. For instance, developing offshore wind resources to satisfy Rhode Island's own 100% goal may have additional benefits if it

contributes to seeding a new "export" industry in Rhode Island and across Southern New England. Additional economic benefits could accrue to the state from future offshore wind projects procured by other New England states in Rhode Island waters or developed and serviced from a Rhode Island port. Those benefits are not reflected here, though would be positive in terms of local GDP and employment.

Interpreting the Tariff Impact

The Tariff Impact values presented here are most useful for comparing one project or portfolio to another. The absolute values of these impacts are less meaningful because the values are measured relative to an assumed reference point – in particular, relative to an assumed REC price. Actual future market REC prices are extremely difficult to project and are likely to vary considerably over time. This means that the absolute value of the Tariff Impact calculated here may not reflect the future realized differences between resource cost and the market value of energy and RECs. Nonetheless, the relative values of these impacts, comparing one technology or Portfolio to another (within the uncertainties on technology

costs and project-to-project cost variability), are meaningful and can be useful for understanding the relative economic impacts of alternative renewable resources. The Base REC price assumption adopted here, \$30, may be conservatively low, as it is moderately below the corresponding costs of the three utility-scale renewable technologies considered. This leads to the renewable resources generally appearing in this analysis to be slightly more costly than market RECs, so that the Tariff Impact is slightly higher, resulting in a negative GDP and jobs impact. We are not projecting that acquiring renewable resources will necessarily be more costly than market REC purchases (though that is certainly possible); rather, this simply results from the \$30 REC price that is used as a reference assumption.

three years before the assumed 2027 online date, the project's Construction Expenditures (green bars) create significant economic activity and GDP benefits for the state. Once the project is online and for the duration of its operation, O&M Expenditures (blue bars), which are considerably smaller in magnitude, create additional positive annual benefits. The Tariff Impact (grey bars) here is roughly zero for the early years of project operation, and then is modestly negative for subsequent years due to declining market value of the offshore wind generation. It is important to note that this Tariff Impact is a relative value, compared to an assumed reference case in which the 100% renewable electricity goal is achieved instead through market REC purchases, and is most useful for comparing across resources or Portfolios. (See sidebar on how to interpret the Tariff Impact effects.) The solid black line represents the net annual GDP impact, combining all three categories of impacts.

The lower panel of Figure 16 shows the employment impacts of the same 600 MW offshore wind project. The three components (Construction Expenditures, O&M

Expenditures, and Tariff Impacts) and the profile over time are directionally very similar to the GDP impacts. As with the GDP measure, the Tariff Impact on jobs is most relevant for making relative comparisons between projects or portfolios, rather than for interpreting the absolute value.

In the previous section, we defined four Technology Bookends, each as a hypothetical way to fill the renewable energy gap entirely with a single technology type: Land-Based Wind, Offshore Wind, Wholesale Solar, or Retail Solar. To make these Bookends comparable, each generates the same amount of renewable energy in each year and fills the 2030 renewable energy gap by adding new capacity in equal increments in years 2025-2030.⁶³

FIGURE 17 shows that the GDP impact of the Offshore Wind Technology Bookend, which assumes the addition of about 170 MW of new offshore wind resources per year from 2025 to 2030 is about +\$700 million in present value terms. Similar to the previous figures, the construction expenditures provide early benefits that are now spread over multiple

⁶³ For offshore wind in particular, this profile is considerably less “lumpy” than actual projects that would fill the gap, since offshore wind projects tend to be quite large.

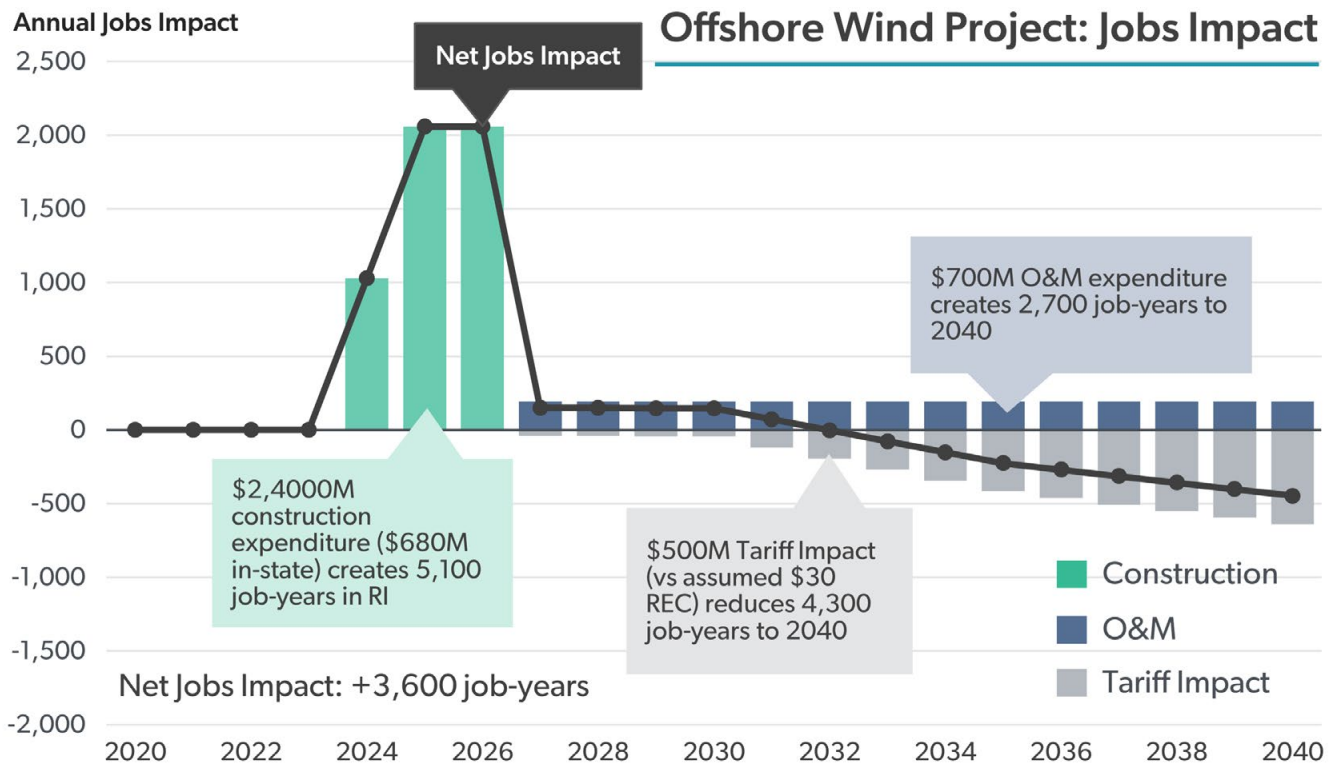
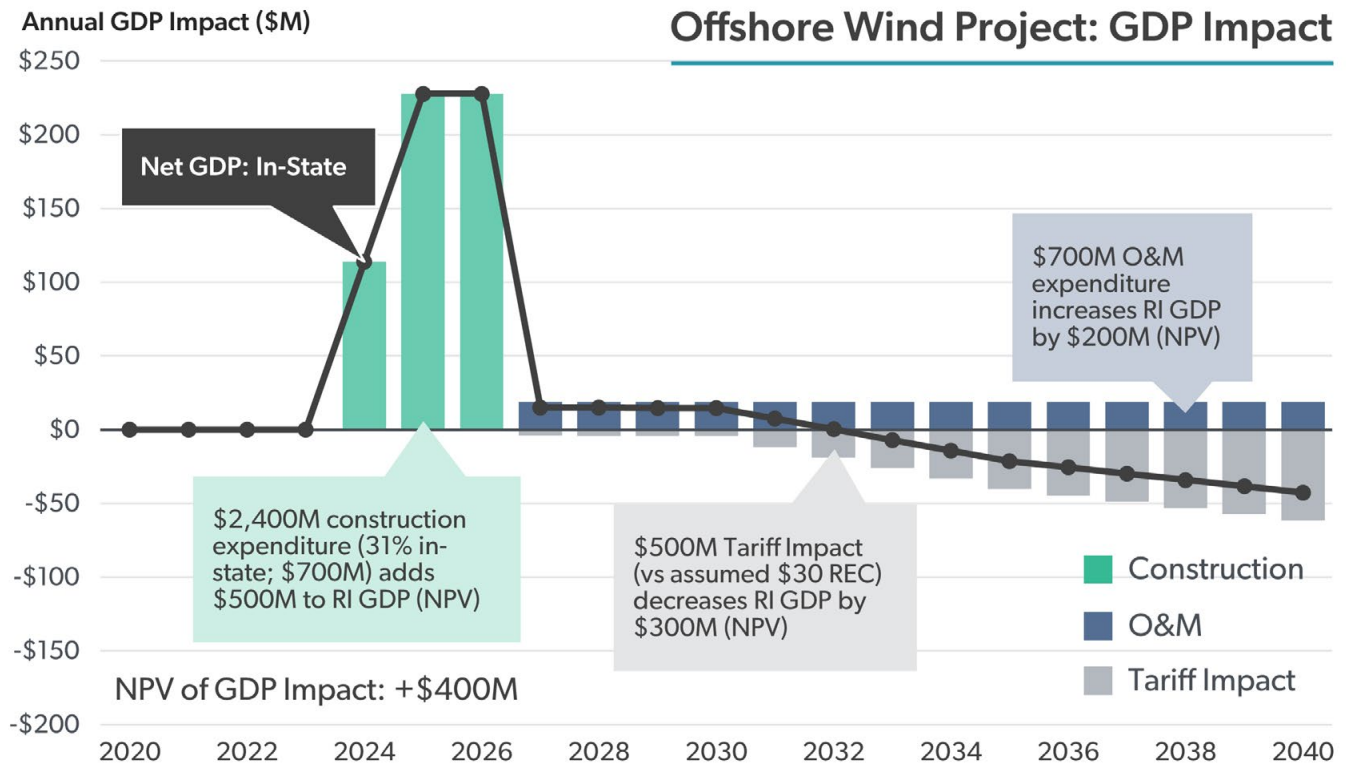


FIGURE 16: GDP AND EMPLOYMENT IMPACTS OF 600 MW OFFSHORE WIND PROJECT

Note: NPV of GDP impact shows the net present value (3% real discount rate) of GDP impacts from 2020 through 2040.

Offshore Wind Bookend: GDP Impact

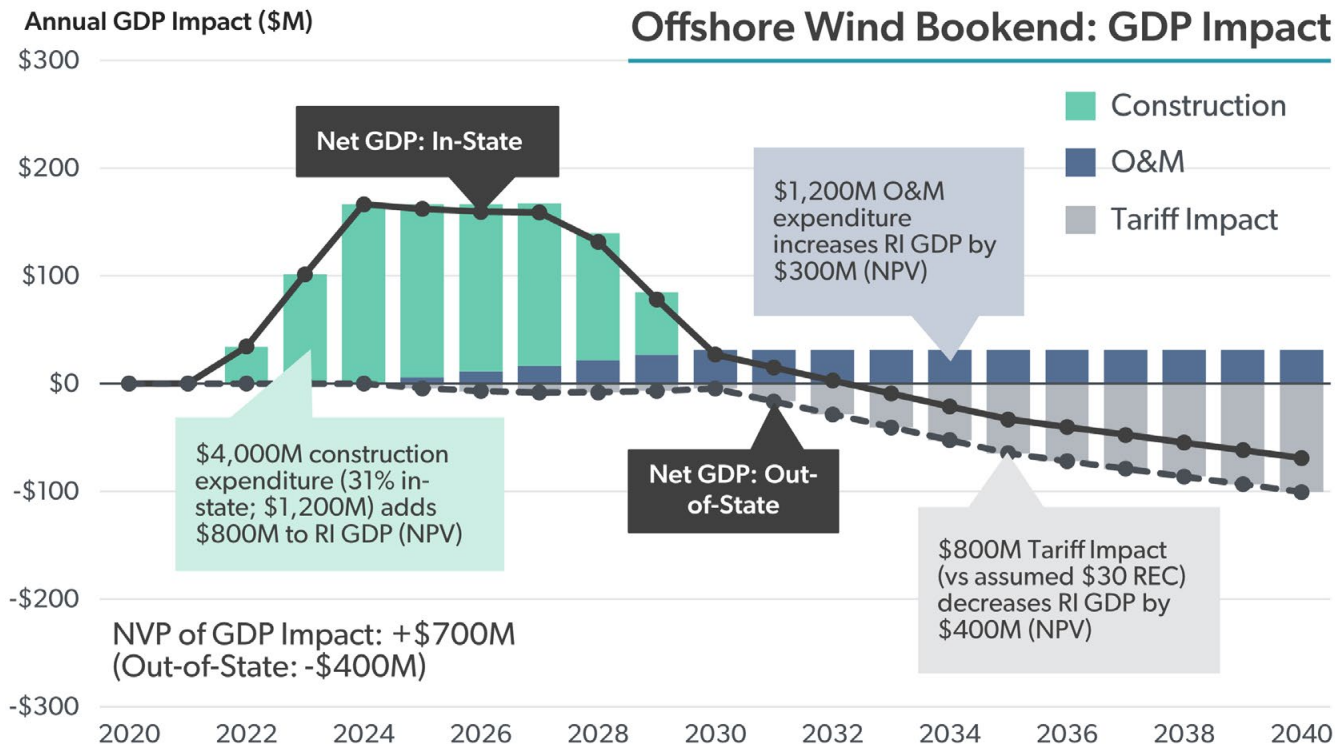


FIGURE 17: RHODE ISLAND GDP IMPACT OF OFFSHORE WIND TECHNOLOGY BOOKEND

Note: O&M and Tariff Impact continue until the off-shore wind plants shut down (or the contract terminates), but are not forecasted here beyond 2040, due to the challenges and uncertainties associated with projecting such distant periods. NPV is calculated for 2020-2040.

years, reflecting the overlapping construction periods of this assumed series of new offshore wind resources. Similarly, the effects of O&M expenditures and the tariff impacts phase in as the series of projects comes online through 2030. The solid line adds the three categories to show the net GDP impact of in-state offshore wind. Net economic benefits are positive through the construction periods and then dip to being moderately negative in later years, due to falling energy prices.

Here, we also show a second and lower dashed line to illustrate the potential Rhode Island GDP impact of a hypothetical out-of-state Offshore Wind Bookend. This would fill the renewable energy gap entirely with offshore wind that does not rely on a Rhode Island port, and does not source significant labor, equipment or material resources from Rhode Island. This out-of-

state bookend includes only the effect of the Tariff Impact, and would lead to no economic impact via the Construction and O&M Expenditure categories.⁶⁴ This illustrates the potential difference to the Rhode Island economy between sourcing renewable resources from within the state vs. from outside the state.

We apply this approach to each of the four Technology Bookends to estimate their economic impacts. **FIGURE 18** shows the resulting GDP impacts for each (comparable employment impacts are also calculated and are presented in the Technical Support Document). For Offshore Wind and Wholesale Solar, values are shown for both in-state (solid line) and out-of-state (dashed line) versions of the Technology Bookends. The Land-Based Wind Bookend, because it is only an out-of-state resource, results in a present value GDP loss

⁶⁴ In reality, any New England offshore wind project would likely utilize at least some Rhode Island resources, due to the state's location near the existing lease areas and the interconnected supply chains between Rhode Island and neighboring states. But different projects may have differing local content; this comparison makes the extreme assumption of no local content, to illustrate the potential range of local impacts. It is also possible that an offshore wind project could have more local Rhode Island content than is assumed in the typical sector allocations; this would increase the benefits for the state's economy through the Construction and/or O&M Expenditures.

Continued Renewable Additions Beyond 2030

This analysis shows the impacts of only those resources that are needed for Rhode Island alone to achieve 100% by 2030 – i.e., those online by 2030. The impacts of additional new renewables that will likely be required to stay at 100% as load grows beyond 2030 are not included here, nor are the impacts associated with resources built to meet the policy goals of other New England states.

While examining only the resources online by 2030 keeps the focus for now on how to achieve the specific 100% by 2030 goal, the impacts of subsequent renewable additions will certainly need to be considered in the future (projections become increasingly uncertain farther into the future, but the analyses here may help to structure how to think about them).

If electrification load grows significantly beyond 2030, as is expected, continued renewable additions will be needed to meet this increase, and construction and O&M expenditures and tariff impacts will all extend further in time. Over the longer term beyond 2030, there may be a more or less continuous stream of economic impacts arising from continued construction and operating expenditures and tariff impacts as additional new renewables are added to meet growing load, at least until electrification opportunities are saturated. Still farther into the future, the timing of this saturation might very roughly correspond to the end of life of the early rounds of significant renewable additions (around 2040, assuming engineering and economic lives of about 20 years). Under this potential timeline, by about the time the renewable generation portfolio is fully built out for Rhode Island, a second wave of renewable additions may be necessary to replace the first.

of \$500 million, while the in-state Offshore Wind, Wholesale Solar and Retail Solar Bookends show positive economic benefits, ranging from +\$600 million for Wholesale Solar to +\$900 million for Retail Solar. Out-of-state Offshore Wind and Wholesale Solar have impacts similar to Land-Based Wind. Retail Solar, despite having higher cost and thus a larger negative contribution to GDP from the Tariff Impact, also has a higher positive effect from construction and operating expenditures. On net, the NPV impact of Retail Solar is similar to the other in-state resources.

This leads to many important observations regarding the economic impacts of the four candidate energy resources.

- Whether a resource is located in-state or out-of-state has a substantial influence on how it affects GDP and jobs. As discussed, in-state construction and O&M expenditures create a boost for Rhode Island GDP and employment that may not exist (at least not at the same scale) with an out-of-state resource. Figure 18 gives some guidance as to the

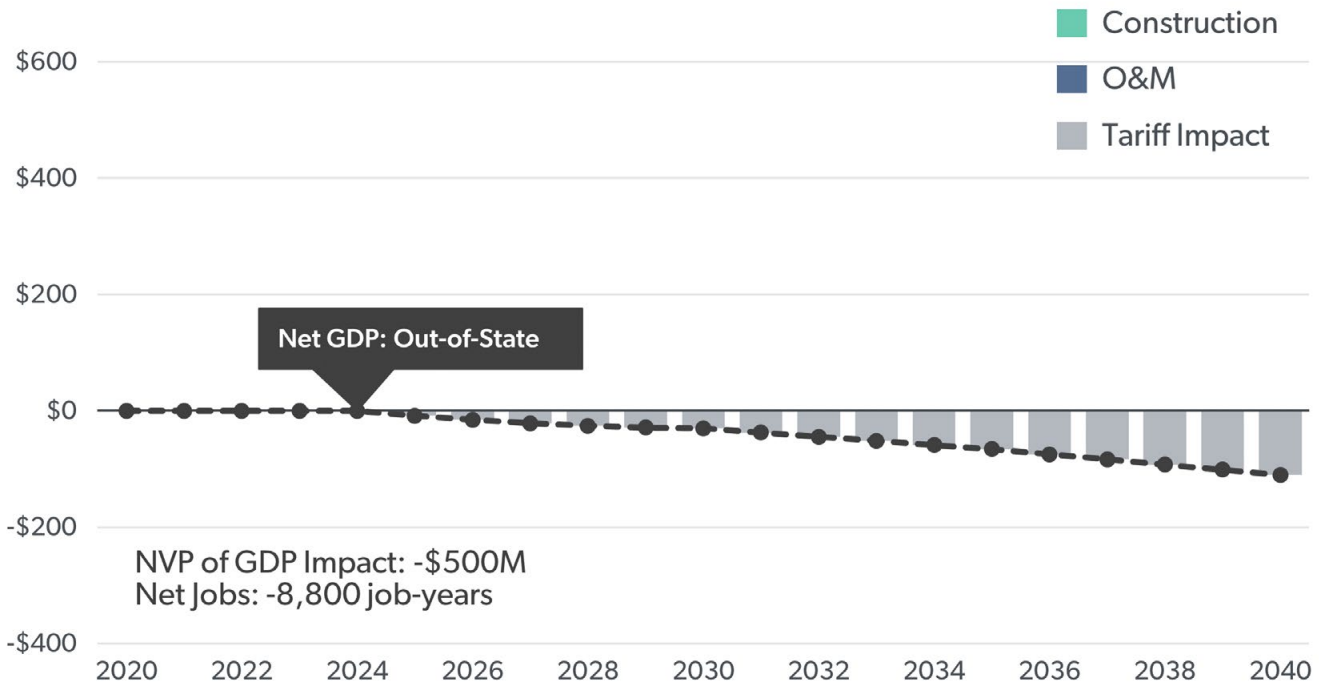
potential magnitude of the effect for different technologies, though the actual impact will be specific to each individual project and how it obtains labor, equipment and materials from in-state or out-of-state sources.

- There is little land-based wind resource available within Rhode Island, relative to the scale of the 2030 gap, due to relatively poor wind resource potential in the state. It is illustrated here only as an out-of-state resource, and thus its economic impact for Rhode Island consists only of the tariff impact.⁶⁵ Retail solar, on the other hand, is considered only as an in-state resource since only in-state locations are eligible for the Rhode Island programs that support these resources.
- As seen in the previous section, retail solar has significantly higher above-market costs than the other three technologies, which are similar to one another. The impact of this higher cost is seen in Figure 18, where the tariff impact has a significantly larger negative GDP effect than other technologies. However, the much

⁶⁵ There may be opportunities for some smaller Land-Based Wind projects within Rhode Island, and some may be attractive. Still, in-state Land-Based Wind cannot play a major role in filling the gap due to its limited availability.

Annual GDP Impact (\$M)

1. Land-Based Wind



Annual GDP Impact (\$M)

3. Wholesale Solar

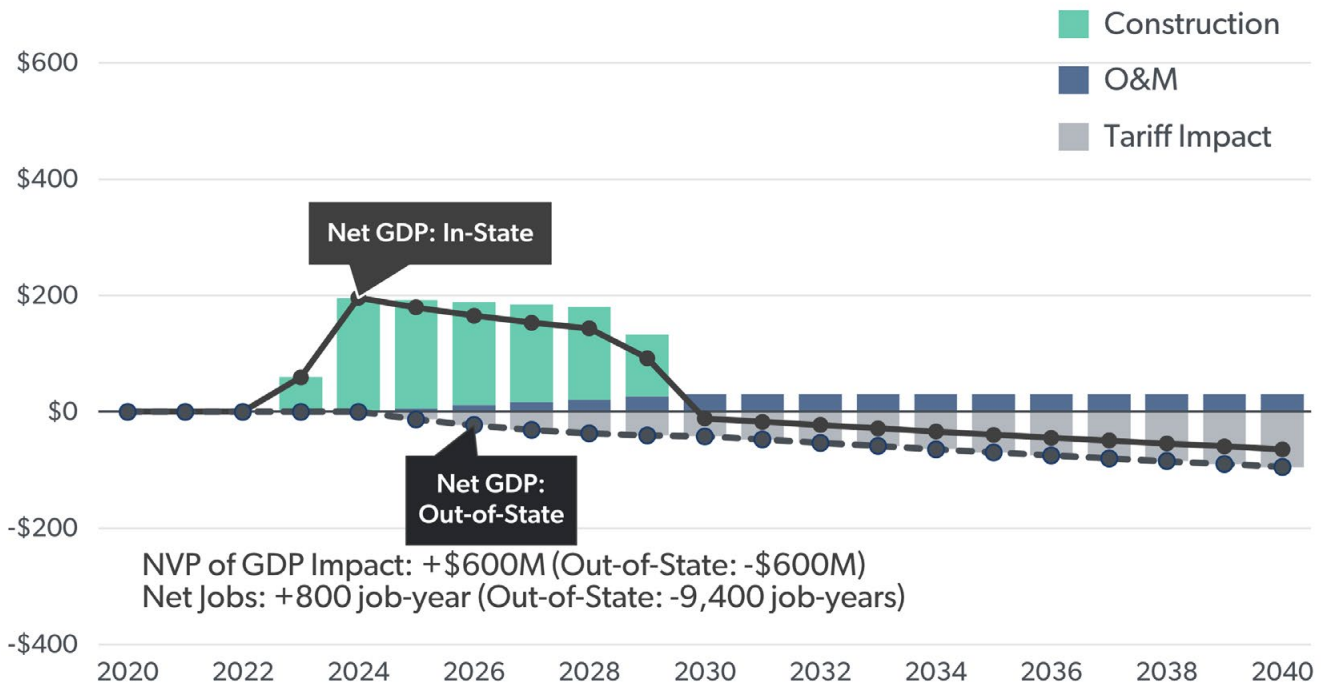
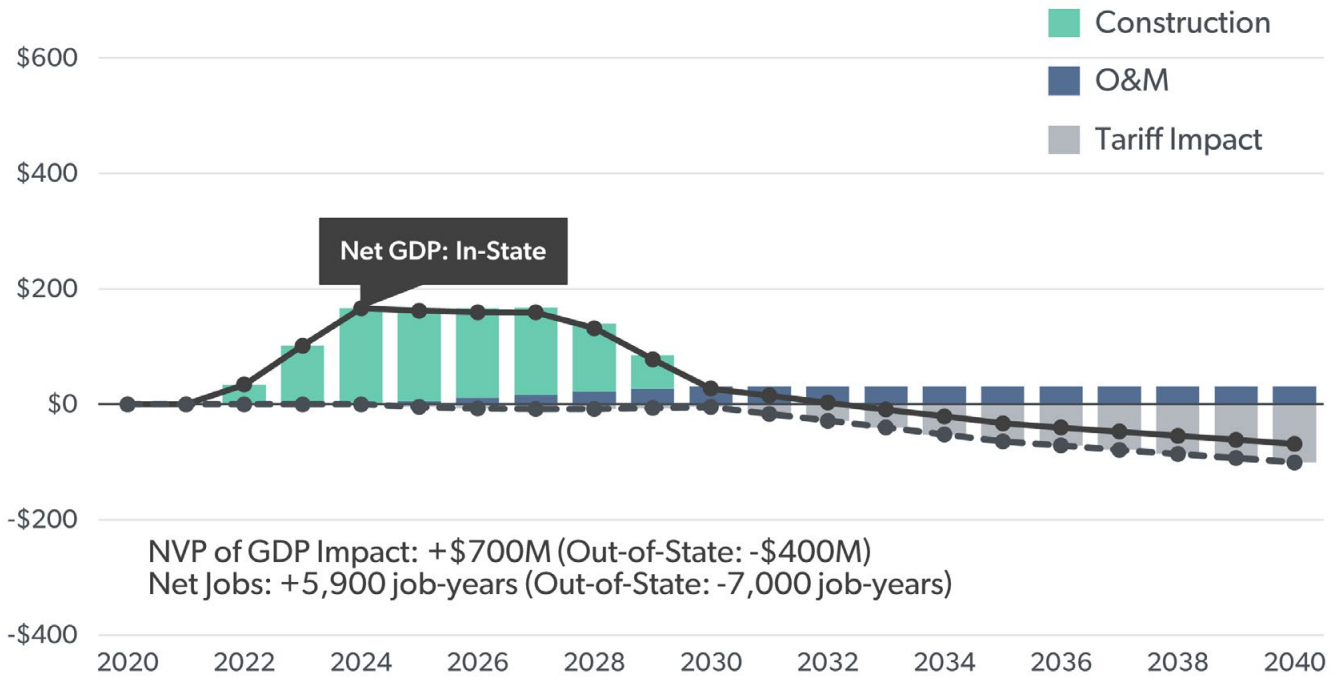


FIGURE 18: RHODE ISLAND GDP IMPACT OF TECHNOLOGY BOOKENDS

Note: NPV is calculated for 2020-2040.

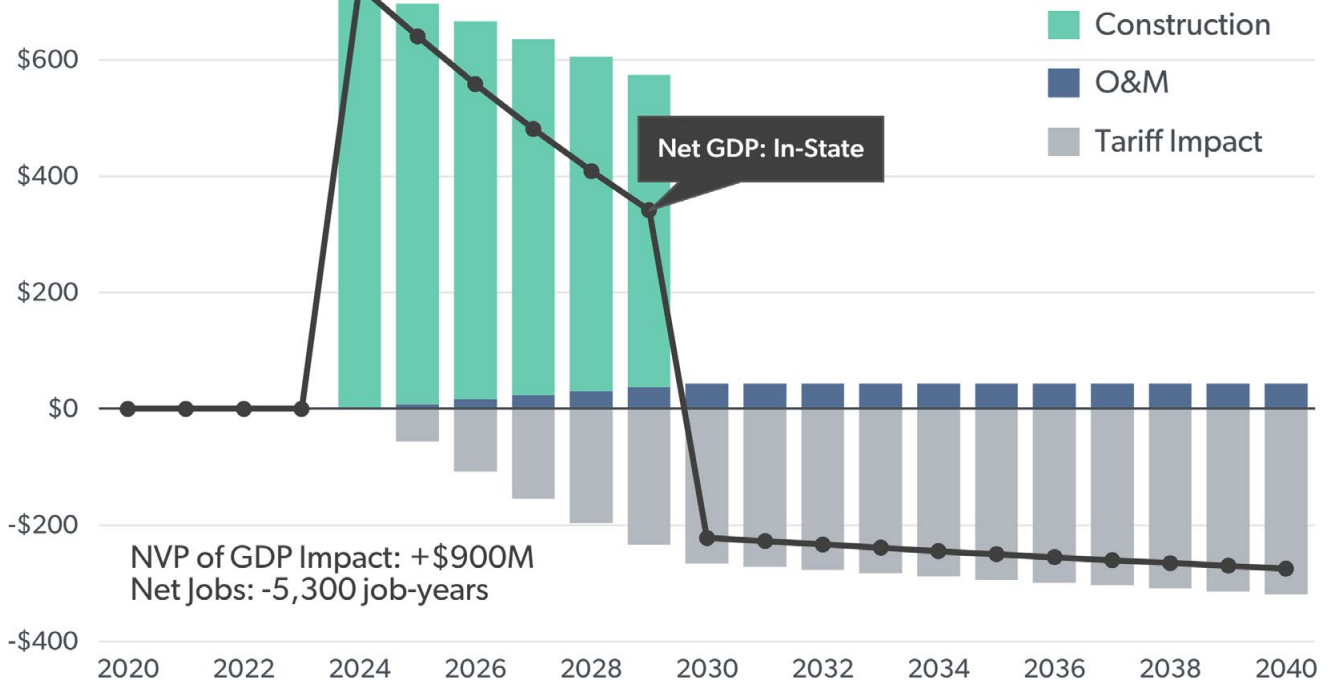
Annual GDP Impact (\$M)

2. Offshore Wind



Annual GDP Impact (\$M)

4. Retail Solar



larger positive in-state impact due to higher construction and O&M expenditures offsets much of the negative impacts of the higher costs of these distribution-level solar resources.

- Compared with wholesale solar, retail solar's higher cost means that total construction expenditures are higher, and in addition, a larger share of each construction dollar for retail solar enters the local Rhode Island economy. This is because the components that contribute the most to retail solar's higher cost also tend to be those that yield greater local economic impact – e.g., local labor and services rather than imported solar panels or wind turbines.

As we did with the analysis of above-market cost for each of the Technology Bookends, we also consider in these economic impact estimates due to the range in resource acquisition costs uncertainty. Because the economic impact for each Technology Bookend is assessed relative to the cost of purchasing RECs from the market, we also look at the impact of different assumed REC prices. **FIGURE 19** illustrates how these uncertainties can be displayed, using the Offshore Wind Bookend as an example. The upper panel shows the range of GDP impacts across the range of resource acquisition costs considered above, relative to the Base \$30 REC Cost. The solid bar for in-state offshore wind shows that at the Base Resource Cost, the NPV of GDP impacts is \$700 million, as seen in Figures 17 and 18 above. At High Resource Cost, the Construction Expenditure provides a somewhat bigger GDP boost, but the Tariff Impact causes an even larger negative GDP change such that the net GDP impact falls to +\$90 million. At a Low Resource Cost, the opposite happens, with the decreased Tariff Impact more than offsetting the smaller Construction Expenditure, leading the net GDP impact to rise to about \$1,000 million. The lower, outlined bar indicates the out-of-state version of this Bookend. Because this does not include the positive impact of in-state Construction or O&M, the overall GDP impact is

lower at any level of Resource Cost, and the effect becomes more extreme at High Resource Cost.

The second uncertainty, illustrated in the bottom panel of Figure 19, shows how changing the reference REC price affects the relative GDP impact. The middle bars in each group of three corresponds to the \$30/MWh REC price shown in the upper panel. The lower bar corresponds to a lower REC price of \$15/MWh, which increases the relative costs of the Offshore Wind Bookend, pushing GDP downward. A higher \$45/MWh market REC price (upper bar) has the opposite effect. Relative to this higher reference price, the same Bookend saves ratepayers money, causing a boost to GDP and shifting the bar upward. Thus in the bottom panel of Figure 18, the length of any bar shows the range of GDP impact based on the uncertainty in Resource Cost at a given REC price reference, with each of the three bars using a different REC price as the reference point. As before, the out-of-state version (outlined bars, shifted to the left but overlapping) has lower GDP impact at any level of Resource Cost, and the effect is exaggerated at High Resource Cost.

These same uncertainty ranges are applied to all of the Technology Bookends in **FIGURE 20**, showing both the Resource Cost uncertainty and the range of different REC prices used as a reference, and also showing in-state and out-of-state versions where appropriate.⁶⁶ This high-level summary of the economic impacts of each candidate renewable energy resources enables some additional observations.

- Achieving 100% renewable electricity by 2030 by targeting in-state offshore wind or solar resources results in net positive economic benefits for Rhode Island, compared to purchasing market RECs, across most assumptions on resource costs and REC prices. Further, the GDP impact of in-state technologies falls less quickly at higher resource costs, since the negative effects of higher ratepayer costs are partly offset by the positive economic benefits of higher in-state construction and O&M expenditures.

⁶⁶ For the purposes of this report, "in-state offshore wind" refers to offshore wind projects located in adjacent federal waters that are supported, in part, by Rhode Island ports and labor pools. Conversely, "out-of-state offshore wind" refers to projects that are entirely sourced from ports located outside of Rhode Island.

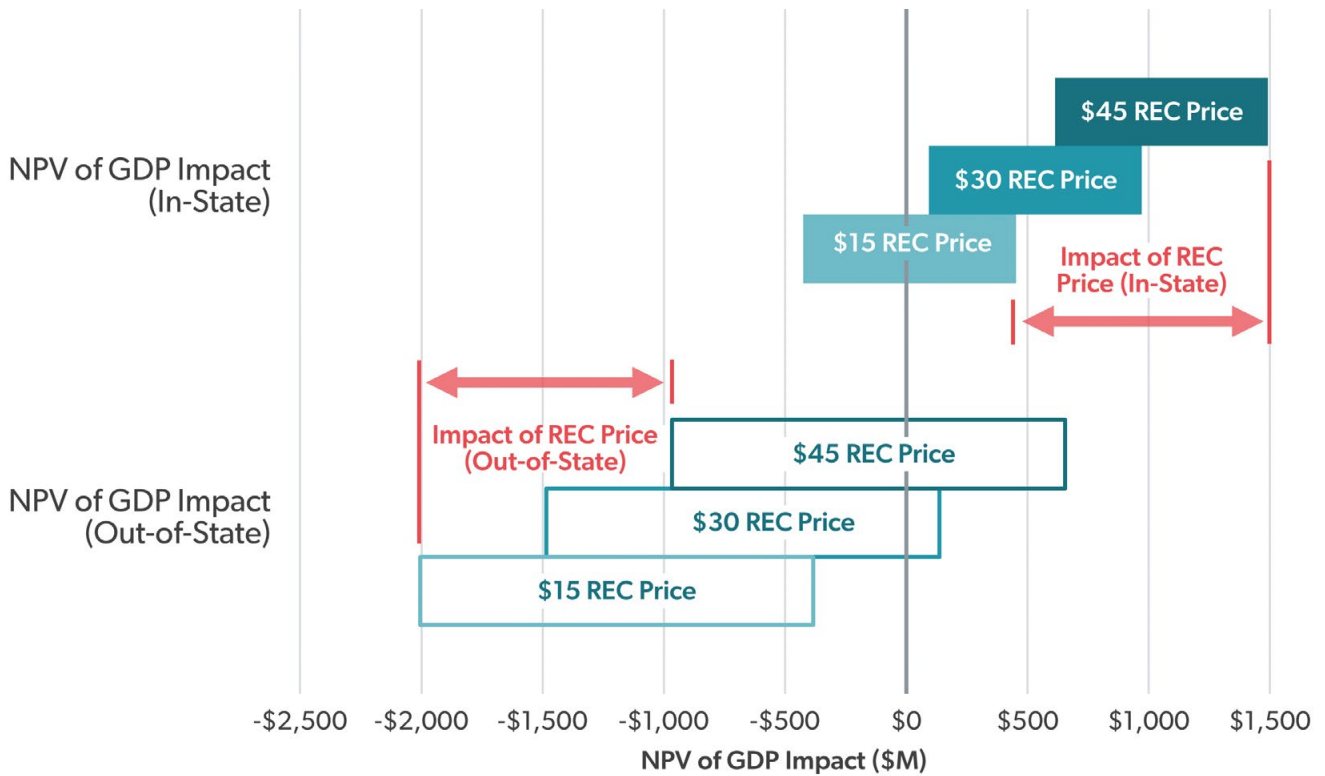
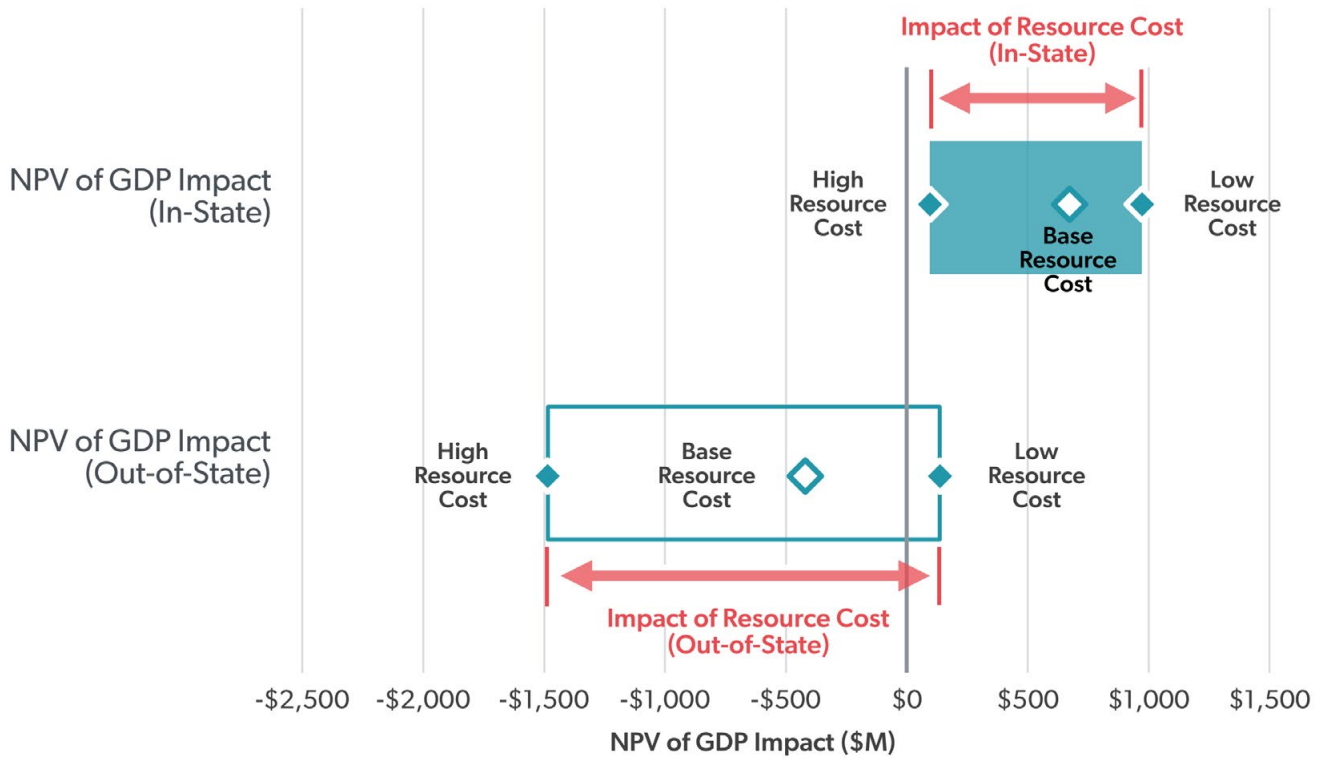


FIGURE 19: ILLUSTRATION OF UNCERTAINTIES IN GDP IMPACT (OFFSHORE WIND TECHNOLOGY BOOKEND)

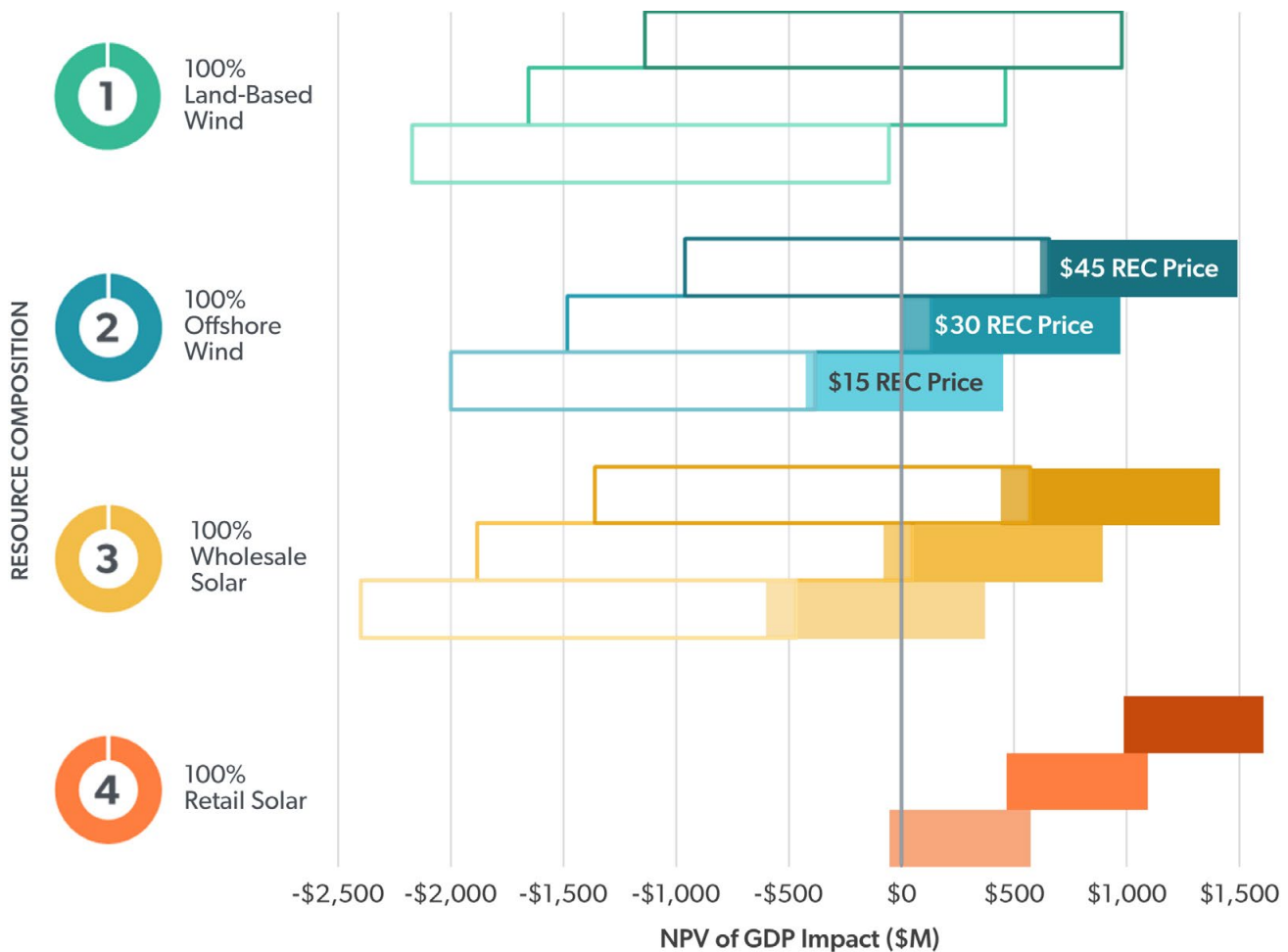


FIGURE 20: NPV OF RHODE ISLAND GDP IMPACT (2020–2040) WITH UNCERTAINTIES; BOOKENDS
(REFLECTING RESOURCE COST & REC PRICE UNCERTAINTY)

Note: In-state versions of Technology Bookends are illustrated by solid bars, and out-of-state versions by outlined bars.

- Purchasing out-of-state land-based wind, offshore wind, or wholesale solar resources may result in negative economic impacts. Only when the out-of-state resource is less costly than purchasing market energy and RECs (i.e., when resource costs are low and market REC prices are high) does procuring mostly out-of-state resources result in positive economic impacts.
- The economic benefits of achieving 100% renewable electricity by 2030 is significantly lower, and is more uncertain, when relying on out-of-state resources due to the lack of local economic benefits from construction and O&M.
- Comparing the in-state technologies, the ranges of economic benefits are similar. Since the resource costs are not necessarily related across technologies (cost of one technology could be at the high end of its range while another is at its low end), none of these technologies has a clear advantage in terms of overall economic impact (project-to-project cost variability can also contribute to this). Although retail solar has materially higher costs, its overall economic impact may be as good as (or better than) the utility-scale technologies.
- Rhode Island can increase the economic benefits associated with the 100% renewable electricity goal by developing programs and policies that procure in-state resources at the lowest reasonable cost to ratepayers.

Distribution of Economic Impacts

It is important to note that the positive and negative components of economic impacts (e.g., the positive impacts of Construction and O&M Expenditures; the potentially negative Tariff Impacts) may be unevenly distributed, and will not necessarily accrue to the same populations. Many of the jobs and much of the GDP benefit will occur in clean energy sectors, though of course this economic activity will have some positive spillover benefits into other sectors and the Rhode

Island economy in general. But all ratepayers – residential, commercial and industrial – will bear any above-market costs. While these above-market costs may be modest or nonexistent (relative to REC purchases) for the utility-scale technologies, the above-market costs of retail solar may be material. This should be accounted for in evaluating the options for reaching 100% renewables – particularly in understanding how this may affect the equitable distribution of costs and benefits resulting from the strategies Rhode Island chooses.

Analysis of the net economic impacts of each resource tells a different story from the ratepayer costs assessed previously. The technology with the lowest above-market cost is not (necessarily) the one that offers the best economic impacts in terms of local GDP and employment. While above-market costs are associated with significant uncertainty, the ratepayer cost analyses showed that the three utility-scale technologies – land-based wind, offshore wind, and wholesale solar – have similar cost ranges that may be broadly comparable to the cost of purchasing RECs. But costs for retail solar are materially higher, and since the utility-scale technologies will likely be primary factors driving regional REC prices (at least over the long term), retail solar will very likely be more costly than either buying RECs or acquiring utility-scale resources.

However, in terms of the impact on GDP and employment, the positive economic impact of in-state construction expenditures can help to offset the negative impact of higher costs. This is a particularly important factor for retail solar, since it is likely to impose materially higher above-market costs for ratepayers than utility-scale technologies or REC purchases. But it would also have the highest positive economic impacts from construction and operation. This is partly because higher costs correspond to higher in-state expenditures, and also because retail solar has a greater local impact for each dollar expended (a higher share of its costs actually enter the local economy). This offsetting positive impact on GDP and employment means that retail solar may ultimately have similar

net economic impacts across the state as in-state offshore wind or wholesale solar, though it would also result in more significant shifts among sectors of the Rhode Island economy. (See Sidebar regarding the distribution of economic impacts.)

The overall economic impact of out-of-state resources is much more dependent on the realized resource cost because they lack the offsetting local economic benefits of in-state expenditures. In Figure 19, the GDP impact of the (out-of-state) Land-Based Wind Bookend is lower at any level of resource cost than that of the in-state Offshore Wind or Wholesale Solar Bookends, despite that the above-market costs are quite similar. This is equally true of out-of-state versions of the Offshore Wind or Wholesale Solar Bookends. Importantly, this also makes the GDP impact much more sensitive to variations in the realized resource cost. For out-of-state technologies, the GDP impact falls sharply at higher resource costs (the bars have a wider range). In contrast, for in-state resources like Offshore Wind and Wholesale Solar, at higher resource costs, the correspondingly higher in-state expenditures partially offset the greater negative Tariff Impact, leading to a narrower (and higher) range of GDP impacts. While higher cost is worse on balance, the effect is partly mitigated. In order for an out-of-state resource to overcome the positive economic impact advantage of in-state resources, it would need a substantial cost advantage. There is little to indicate that out-of-state resources would be materially cheaper in general, though this could be true for some specific projects.

III.D Technology Portfolios: Above-Market Costs and Economic Impacts

The four Technology Bookends considered above are helpful for considering the relative strengths and weaknesses of each of the primary technologies that are available to fill the 2030 renewable energy gap. However, it is doubtful that the entire gap will be filled with a single technology; Rhode Island will likely use a mix of these technologies to reach 100% renewables. We created several representative Technology Portfolios to analyze the ratepayer above-market costs and economic impacts of more realistic technology mixes. Each consists of an alternative combination of the various technologies, as described in **FIGURE 21**.

These Portfolios, which all achieve 100% renewable electricity by 2030, are structured to balance three pillars: resource diversity, affordability, and local economic development. They show incremental offshore wind procurement of up to 600 MW, reflecting Rhode Island's recently announced RFP and alternative balances of wholesale and retail solar. Offshore wind is considered in increments of 600 MW in Portfolios 5 and 6, 400 MW in Portfolios 7 and 8, or 200 MW in Portfolio 9 – all assumed to come online in 2027. These amounts of offshore wind would contribute 2,700 GWh, 1,800 GWh, or 900 GWh annually, corresponding to roughly 60%, 40%, or 20% of the remaining 2030 renewable energy gap. Combinations of wholesale and/or retail solar provide the additional renewable energy to achieve 100% in 2030. The solar technologies are assumed to come online in equal increments over the period 2025-2030. One additional portfolio, Portfolio 10, involves no further offshore wind beyond Block Island and Revolution Wind; it consists mostly of wholesale and retail solar, plus 100 MW of land-based wind. Of course, many other resource combinations are possible; this set of Portfolios is intended to be representative, not comprehensive, and can offer a number of insights.

FIGURE 22 calculates the ratepayer above-market costs for each of these Portfolios, similar to Figure 13 above, and includes 100% Market REC Purchases and the four Technology Bookends for reference. The six Technology Portfolios just defined are arranged top to bottom in order of decreasing offshore wind and increasing retail solar content. The figure shows that the net present value of above-market costs rise from \$2,000 million in Portfolio 5 to \$3,000 million for Portfolio 10 (assuming Base Resource Costs), and the cost uncertainty also increases. Because retail solar has higher above-market costs and the costs of the other technologies are similar, the overall above-market cost of each portfolio is closely related to its retail solar content.

As discussed above, the cost uncertainty is primarily driven by the range of resource acquisition costs and results in significant overlap across portfolios. Because the Technology Portfolios consist of many of the same technologies, their costs are not necessarily independent of one another. For example, although Portfolios 9 and 10 each have above-market cost ranges of about \$2,000 to \$5,000 million, it is unlikely that one would be significantly more or less costly than the other because they have generally similar composition.

FIGURE 23 shows the GDP impact for each of the Portfolios. As was seen in Figure 20, the GDP impacts are similar across the in-state renewable energy resources, with Retail Solar having a slightly higher positive GDP effect. When these resources are combined into Portfolios, these relationships still hold. While there may be a slight potential increase in GDP benefits as the resource mix shifts from in-state offshore wind to in-state Retail Solar, the uncertainty in the impacts is much greater than the differences across the Technology Portfolios. As was illustrated for the Bookends, a second set of bars shown in outline represents an alternative version of the Portfolios that consists entirely of out-of-state resources. These out-of-state portfolios result in significantly lower GDP, and the effect is more pronounced at High Resource Costs. Of course, a Portfolio consisting of a mix of in-state and out-of-state resources, or a different mix of the technologies, would

	Description	Land-Based Wind	Offshore Wind	Wholesale Solar	Retail Solar
	Max OSW, plus Wholesale Solar	--	600 MW (2,750 GWh)	Fill remaining gap (1,850 GWh)	--
	Max OSW, RE Programs Maintained	--	600 MW (2,750 GWh)	Fill 50% of remaining gap (925 GWh)	Fill 50% of remaining gap (925 GWh)
	Robust OSW, RE Programs Maintained	--	400 MW (1,825 GWh)	Fill 66% of remaining gap (1,850 GWh)	Fill 33% of remaining gap (925 GWh)
	Robust OSW, RE Programs Doubled	--	400 MW (1,825 GWh)	Fill 33% of remaining gap (925 GWh)	Fill 66% of remaining gap (1,850 GWh)
	Incremental OSW, RE Programs Doubled	--	200 MW (900 GWh)	Fill 50% of remaining gap (1,850 GWh)	Fill 50% of remaining gap (1,850 GWh)
	Solar Heavy, Some LBW, No New OSW	100 MW (300GWh)	--	Fill ~60% of remaining gap (2,600 GWh)	Fill ~40% of remaining gap (1,700 GWh)

FIGURE 21: TECHNOLOGY PORTFOLIOS – DEFINITIONS

result in economic impacts that are a comparable mix of the values illustrated here.

As was seen with the Bookends, the two metrics tell different stories for the Portfolios as well. Although Portfolios with higher amounts of retail solar do have higher above-market costs, their GDP impact is generally comparable to the other Portfolios, and perhaps slightly higher, because of the offsetting positive economic impact of the in-state

Construction Expenditures. While land-based wind lacks these local benefits, its impact is not particularly apparent in the Portfolios considered here, since only Portfolio 10 contains any land-based wind, and it has only as a small portion. But as reflected in the entirely out-of-state versions of these portfolios (outlined bars), having a significant share of out-of-state resources in any of these portfolios would depress the local GDP (and employment) impact considerably.

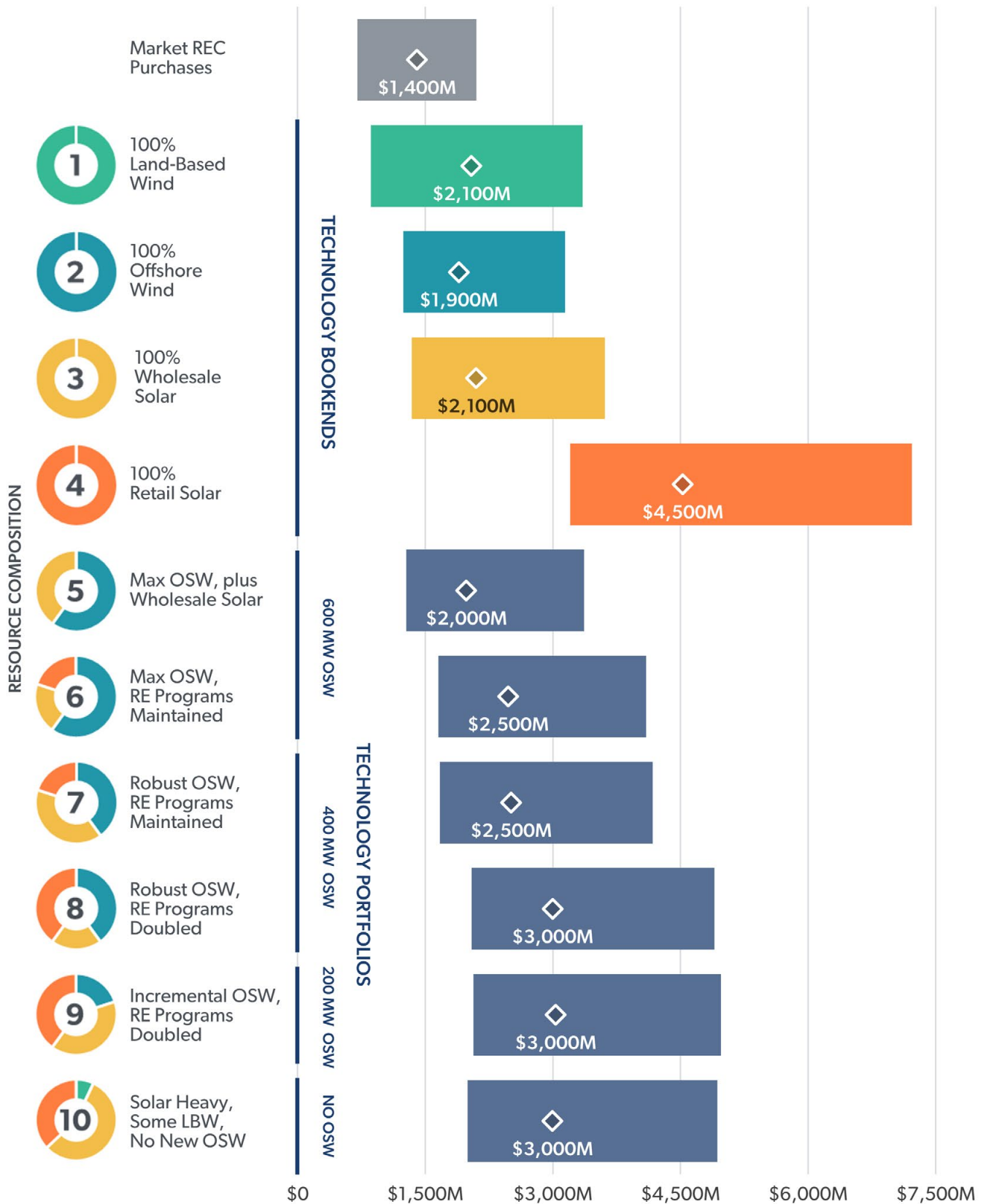


FIGURE 22: NPV OF ABOVE-MARKET COSTS (2020–2040) OF ACHIEVING 100% RENEWABLES; BOOKENDS AND PORTFOLIOS (NET OF ENERGY AND CAPACITY REVENUES, NOT REC REVENUES)

Note: Ratepayer costs reflect the total incremental costs of achieving 100% net of energy and capacity revenues.

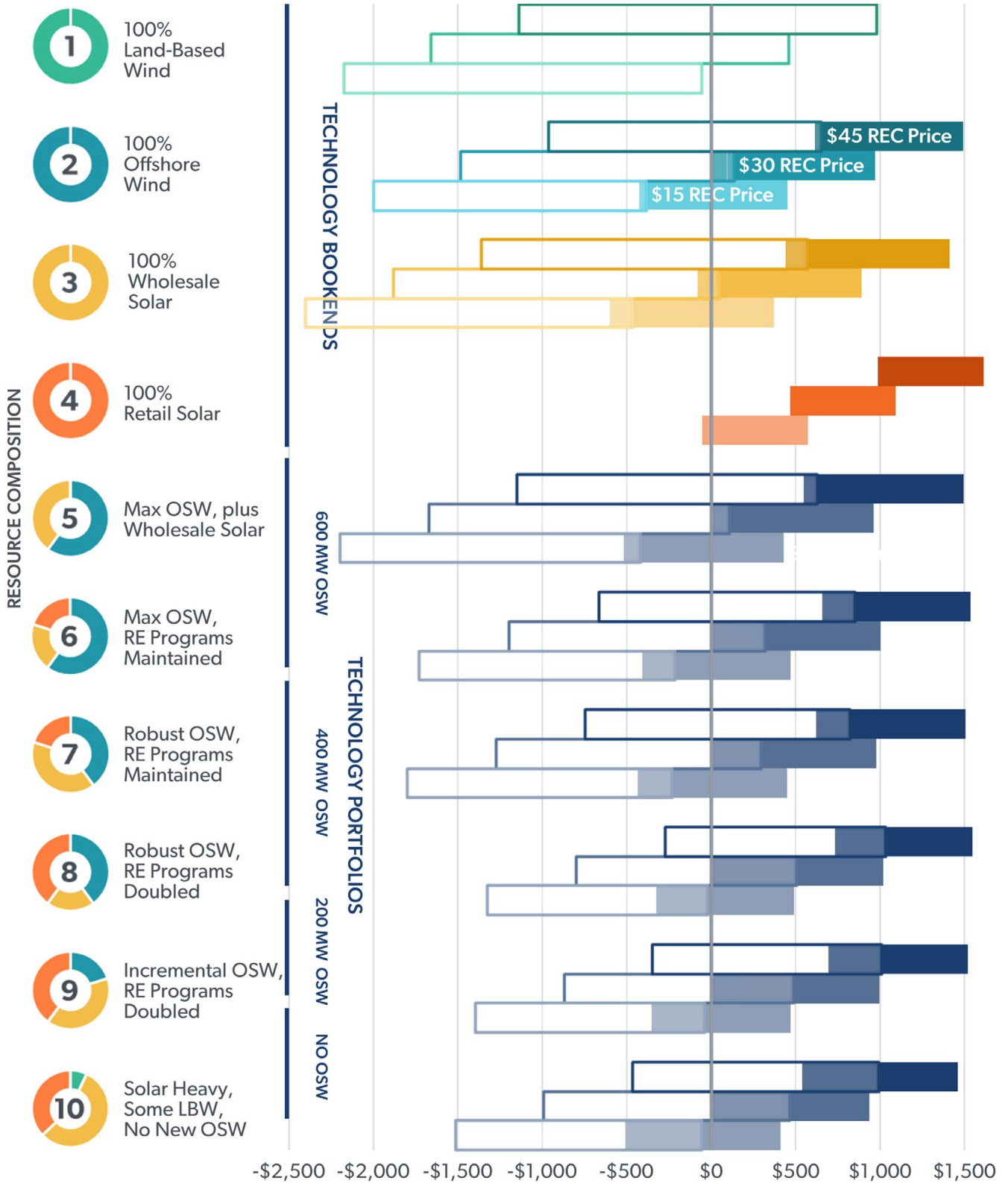


FIGURE 23: NPV OF RHODE ISLAND GDP IMPACT (2020–2040) WITH UNCERTAINTIES; BOOKENDS AND PORTFOLIOS (REFLECTING RESOURCE COST & REC PRICE UNCERTAINTY)

Note: In-state versions of Bookends and Portfolios are illustrated by solid bars (though land-based wind is out-of-state, even within an in-state portfolio). Out-of-state versions of Bookends and Portfolios are illustrated by outlined bars (though retail solar is always in-state, even within an out-of-state portfolio).

III.E Summary of Analytic Insights

We summarize here the key insights from the analytic portion of the study, regarding the renewable gap to 100%, the ratepayer costs and the economic impacts of achieving 100% renewable electricity by 2030.

- Rhode Island’s goal of 100% renewable electricity by 2030 is achievable. Renewable resources are available within Rhode Island and in surrounding areas to support this goal.
- Achieving 100% renewable electricity by 2030 will not be costless. It will require ratepayer support through bill charges to support investments that drive long-term energy, economic, and environmental benefits. In the near term, renewable electricity will cost more than fossil-fired generation (energy prices do not cover the full environmental costs of current fossil energy sources), and utility bills will be higher regardless of the composition of the ultimate portfolio of renewable resources. But net economic and energy benefits and costs will be determined by how that portfolio is shaped over time.
- Rhode Island should increase its Renewable Energy Standard to 100% renewable electricity by 2030. With changes, existing REC structures, tracking mechanisms and markets will allow Rhode Island to implement the 100% goal seamlessly, track its progress, and accommodate uncertainty and variability in electricity demand and renewable generation.
- Rhode Island should limit the extent to which it relies on short-term REC purchases to meet its 100% renewable goal. This will ensure that Rhode Island’s actions truly achieve incremental GHG reductions, and will limit the customer cost impact of potentially volatile REC prices.
- Rhode Island’s current renewable energy portfolio contains a mix of local resources and large-scale procurements. Additional capacity of similar resource types is likely to be necessary to achieve 100%, though the mix of resources may shift with evolving resource costs and the necessary infrastructure buildout.
- All renewable energy resource types will require planning and investment to build out the necessary infrastructure to achieve 100% cost-effectively. This includes the local distribution system, the onshore transmission system, and offshore transmission facilities, as well as the renewable generation itself.
- Different renewable resource portfolios will require different (and as yet unknown) distribution and transmission grid investments, and integrated planning may support cost-efficient outcomes. This effort will take significant time, collaboration, and upfront investment. Key questions will involve who determines which facilities are developed and how costs should be recovered; this is especially true for in-state offshore wind and solar resources. Utility-scale offshore wind, land-based wind, and solar resources are likely to be the lowest costs to ratepayers. However, each of these resources types present varying levels of in-state economic development and job growth potential. Available market data and cost projections also show significant and overlapping cost uncertainties for each.
- Distributed solar resources have significantly higher above-market costs; they can also result in significant shifts between ratepayers if acquired through net metering programs
- Rhode Island can identify the lowest cost resources by proactively planning the system upgrades necessary to achieve 100% and procuring renewable energy resources through competitive procurements and programs. Participating in multi-state solicitations may make it possible for Rhode Island to access the economies of scale of larger projects.
- Rhode Island can reduce ratepayer costs and risks by collaborating with other New England states to update the design of regional electricity markets to account for the full value of renewable energy resources to the system.
- In-state renewable energy resources, including offshore wind in adjacent Federal waters and higher cost retail solar, provide material local economic benefits relative to out-of-state resources and/or market purchases of RECs.
- The higher ratepayer costs of retail solar are partially offset by greater local economic benefits, leading to similar impacts

on overall state GDP as in-state utility-scale resources. However, the GDP benefits and costs do not accrue to the same populations; retail solar will result in greater shifts of costs and benefits within the Rhode Island economy.

- For the longer term, Rhode Island should consider acquiring a renewable portfolio that is a reasonable match for its hourly load profile. This will contribute to achieving the proper long-term balance across the region, and will reduce energy price risk and the costs of balancing supply and demand for Rhode Island ratepayers. With anticipated demand shapes, a portfolio of mostly wind with up to about 30% solar offers a reasonable hourly match, which

is consistent with the current offshore wind RFP. This will become increasingly important as the rest of New England also moves toward higher renewable energy shares.

- To achieve and maintain 100% renewable electricity beyond 2030, policy, programmatic and technical (e.g. storage, demand management) solutions may need to evolve, as the regional penetration of clean energy resources accelerates and increasingly-challenging grid impacts emerge. There will likely be significant increases in the overall amount of energy needed to meet new electrification loads from the transportation and heating sectors, mostly beyond 2030.

IV. Recommendations for Achieving 100% Renewable Electricity by 2030

In this section, we describe a set of recommendations and action steps for 2021 and beyond to advance Rhode Island toward a 100% renewable electricity future.

These recommendations were developed primarily by the Office of Energy Resources and consultants at The Brattle Group, and informed by Rhode Island stakeholders (individuals and organizations) who submitted public comment and/or attended Public Technical Workshops and Community Listening Sessions.

Importantly, the following recommendations are grounded in the other three main components of this project – analysis, guiding principles, and public engagement. Insights gained from the analysis not only illustrate that getting to 100% renewable electricity by 2030 is achievable but highlight important tradeoffs between the paths we can take to get there. Our guiding principles provide a foundation for how we assess these tradeoffs and act as guiderails for resulting approaches to programs and policies. Lastly, public engagement throughout this project helped identify stakeholder priorities, which informed our recommendations

Policy and Programmatic Recommendations

Study insights inform three categories of recommendations:



POLICY

Recommendations for defining, achieving, and procuring 100% renewable electricity.



PLANNING & ENABLING

Recommendations on ways to reduce risk, increase flexibility, and optimize renewable energy integration.



EQUITY

Recommendations on ways to foster equitable outcomes developed in partnership with frontline communities.

and will help ensure all Rhode Islanders participate in our clean energy transition.

We categorize the recommendations into three segments: Policy, Planning & Enabling, and Equity. Equity is set aside as its own category in order to bring salience to this important topic. However, we assure readers that equity is also integrated into each of the Policy and Planning & Enabling recommendations. These recommendations should be considered in tandem with the findings presented earlier in this report; together, the analysis, findings, and recommendations chart a path to achieve 100% renewable electricity by 2030, while attempting to balance consumer costs, stakeholder priorities, and principled objectives. Finally, we note that achieving the outcomes resulting from the following recommendations is contingent on a number of external factors including, for example, the due diligence of legal, statutory, and regulatory review and their associated processes.

IV.A Policy Recommendations

Policy recommendations are intended to support defining, achieving, and procuring 100% renewable electricity. The first two recommendations entail legislative priorities: increasing the Renewable Energy Standard to 100% by 2030 and extending statutory authorization for Rhode Island's nation-leading cost-effective energy efficiency programs, called Least-Cost Procurement. The third recommendation is programmatic, and suggests continued support of local distributed renewable resources with cost-competitive, utility-scale renewable resources. This reflects the importance of balancing energy affordability and reliability with achievement of other policy objectives, such as growing local clean energy jobs and attracting clean investment across the Rhode Island economy.

Renewable Energy Standard

Key Concept: Advance a 100% Renewable Energy Standard

The Renewable Energy Standard (RES) requires retail load serving entities (e.g. National Grid and third-party competitive electricity supply providers) to meet an increasing share of their annual electricity deliveries with renewable energy resources.¹ Currently, Rhode Island's RES sets a statewide target of meeting 38.5% of electricity deliveries with renewables by 2035.² Eligible renewable energy resources include solar, wind, wave, geothermal, small hydropower, biomass and fuel cells. Rhode Island's Public Utilities Commission (PUC) is statutorily responsible for overseeing RES compliance on an annual basis.³

RES compliance does not involve the physical procurement of power produced by renewable energy facilities. Instead, electricity providers meet their requirements by purchasing renewable energy certificates (RECs). As explained above, eligible renewable energy resources generate RECs when they produce electricity that is delivered to the New England power system. One REC equals one MWh of qualified renewable generation provided to the electric grid for delivery to end use consumers. The buying and selling of RECs by renewable energy resources, traders, and obligated entities results in a market for RECs that allows obligated parties to cost effectively procure sufficient RECs to cover their obligations. The RES provides a framework that is flexible to accommodate the uncertainty in future renewable generation and electricity demand as it provides an available mechanism to true up inevitable short-term deviations from the renewable energy target.

1 Rhode Island's RES is set forth in [RIGL 39-26](#). Other states have a similar statute called the Renewable Portfolio Standard (RPS) that is implemented in the same manner and achieves equivalent outcomes.

2 Currently, the RES in 2020 is set to 16 percent, and escalates by 1.5 percent annually until 2035.

3 See <http://www.ripuc.ri.gov/utilityinfo/res.html> for more information.

Policy Recommendations

Policy is needed to establish a strong, statewide framework and reach our goals in ways that align with our foundational principles



We must ensure we meet our clean energy goals by advancing a **100% Renewable Energy Standard**.



Continued efforts to decrease energy consumption of **Least-Cost Procurement and Nation-Leading Energy Efficiency Programs**.



Maintaining continued support for in-state development, while supporting **programmatic evolution** to deliver more affordable and sustainable outcomes.

RES compliance can also be achieved by making alternative compliance payments (ACPs) to the Rhode Island Commerce Corporation's (Commerce RI) Renewable Energy Fund (REF). The ACP functions as a price ceiling, allowing electricity providers to comply with the RES mandate if REC shortages occur. Alternative compliance payment revenues deposited into the REF are then used to support state programs that increase the supply of renewable resources on the grid, which can help ameliorate tightening of the REC market in the future.

We propose amending the state's RES to require 100% renewable electricity by 2030, which would make Rhode Island the first state in the nation to achieve this ambitious, but achievable goal. In doing so, we can also leverage existing accounting practices (e.g. NEPOOL GIS and annual regulatory reports) to transparently account for compliance. In designing a 100% by 2030 RES, we should also seek methods by which Rhode Island might retain, for statewide RES compliance, all of the RECs procured through existing policy and programmatic channels (e.g. through long-term contracts and the Renewable Energy Growth Program), as well as those RECs produced from ratepayer investment in net

metered projects. All of these RECs, which are ultimately paid for by electric distribution ratepayers, should be retired on their behalf to support compliance with the 100% RES goal.

Relying on RES to ensure we meet the 100% renewable by 2030 goal is consistent with the guiding policy implementation principle to *build on RI's existing renewable energy mechanisms*. Because the RES is also a market-based mechanism that allows obligated entities to procure renewable energy at market-driven, competitive prices, using the RES also aligns with the guiding economic principle to *pursue cost-effective solutions*. Lastly, a statutory mandate to achieve 100% renewable electricity by 2030 would propel Rhode Island to leading the nation with the fastest pace of electric sector decarbonization, and would advance the guiding principle to *exemplify climate leadership*.

There are several additional considerations related to the RES.

- First, the RES – in isolation – is unlikely to drive sufficient investment in incremental renewable energy generation. It should be paired with programs and policies to ensure there will be sufficient renewable energy generation available to meet the 100% goal. Nonetheless, the RES is a valuable tool by helping developers monetize the

environmental attributes (represented by RECs) associated with carbon-free generation. Coupled with other policy and programmatic support, a 100% RES will contribute to *creating incremental power sector decarbonization*.

- Second, the RES is blind to RECs created by renewable energy systems that are “behind-the-meter.”⁴ Behind-the-meter RECs can result in double counting: reducing REC requirements for on-site demand and also covering the REC requirements for another customer. As we approach 2030, we will need to address these considerations through programmatic adjustments to ensure in-state renewable energy generation is properly counted towards Rhode Island’s 100% goal.
- Third, in time, additional mechanisms will likely be needed to better match the timing of renewable energy generation with real-time demand.⁵ Analytical insights suggest this consideration is not critical to address until the regional electric grid approaches a higher penetration of renewable electricity. Rhode Island should monitor grid conditions within the state, renewable energy policies and electricity market conditions across the region, and the efficacy of programs and policies across the nation.
- Finally, a 100% RES should remain in effect beyond 2030 and match shifts in energy demand – particularly as other sectors of the economy (e.g. heating, transportation) increasingly electrify. This will help ensure that these new, electrified solutions are being powered by carbon-free resources. This is responsive to the guiding policy implementation principle that we *ensure solutions are robust and sustainable past 2030*.

Energy Efficiency

Key Concept: Extend Least-Cost Procurement of energy efficiency and demand response

Energy efficiency programs cost-effectively reduce energy consumption via efficiency and conservation measures, and can shift the timing of energy consumption via demand response programs.⁶ Rhode Island has consistently ranked among the top states in the nation for energy efficiency policies and programs, and Rhode Island’s largest electric distribution utility consistently ranks among the best in the country for its energy efficiency programs.⁷

Since 2007, energy efficiency programs have saved over 10 million MWh of electricity at a cost lower than that of procuring traditional electric supply, leading to substantial energy cost savings for ratepayers and reducing exposure to price volatility.⁸ Energy efficiency programs also support local businesses, investment, and job creation; in fact, energy efficiency programs support approximately two-thirds of Rhode Island’s clean energy jobs. Energy efficiency also supports improved building comfort and health, and numerous other societal values.⁹

The statute that enables Rhode Island’s energy efficiency programs is called Least-Cost Procurement.¹⁰ In 2006, the Rhode Island General Assembly passed legislation that established the Comprehensive Energy Conservation, Efficiency and Affordability Act. The Act created a groundbreaking mandate termed “Least-Cost Procurement”—a policy that requires Rhode Island electric

4 Behind-the-meter systems are electrically connected to a property’s electric panel rather than tied directly to the electric grid.

5 Examples of policy and programmatic mechanisms that may increase the generation and demand-side resources available during peak demand periods include energy market pricing reforms, a higher price on greenhouse gas emissions, a Clean Peak Standard, enhanced demand response, and targeted incentives for renewable-paired storage, among others.

6 Common examples of energy efficiency measures include lighting upgrades, heating and cooling equipment enhancements, and insulation. Common residential demand response technologies include smart WiFi-enabled thermostats and battery storage.

7 See: <https://www.aceee.org/state-policy/scorecard>

8 http://rieermc.ri.gov/wp-content/uploads/2020/05/ngrid_4888-year-end-report-2019-puc-5-15-20.pdf

9 For more information about energy efficiency program planning and implementation, please see www.rieermc.ri.gov.

10 See: [RIGL 39-1](#)

and natural gas distribution companies to invest in all cost-effective energy efficiency before the acquisition of additional supply. This strategy is “least-cost” because energy-saving measures—such as higher-efficiency lighting, HVAC systems and appliances, insulation, and air sealing—in aggregate, cost approximately 4 to 6 cents per kWh over their lifetime while electric supply costs between 8 cents and 12 cents per kWh.¹¹

We propose to extend Least-Cost Procurement of energy efficiency and demand response to at least 2030. Cost effective energy efficiency is the lowest-cost means of reducing energy costs, avoiding the need to serve the same level of energy demand with more costly resources, including renewable energy resources. Consistent with this policy recommendation, we have modeled various levels of continued energy efficiency savings in our analysis. All three cases analyzed assume continued implementation of energy efficiency measures through 2030. The Base Case and High Load Cases assume the continuation of similar efficiency programs and funding levels, which will result in continued efficiency improvements, but at a decreasing incremental rate as the most cost-effective efficiency opportunities become saturated. The Low Load Case assumes increased efficiency efforts that result in a continuation of near-term incremental energy efficiency savings through 2030.¹²

In the absence of continued efforts to expand energy efficiency measures, our analysis would underestimate the scale of renewable energy resources and investments needed to meet the 2030 renewable energy goal. *Foregoing energy savings through these programs would result in an additional 1,500 GWh of electricity demand in the Base Load Case in 2030 that would need to be served by renewable energy resources. This magnitude is roughly equivalent to 490 MW of land-based wind, 350 MW of offshore wind, 1,070 MW*

*of wholesale solar, or 1,310 MW of retail solar; this would be associated with cost increases of \$600 million to \$1.45 billion to achieve 100% by 2030.*¹³

The current Least-Cost Procurement statute sunsets following the 2023 program year, and we propose extending this foundational clean energy strategy. An extension will help ensure that robust, innovative and cost-effective energy efficiency programs remain accessible to Rhode Island energy consumers, and support business and workforce stability. In extending the availability of our cost-effective energy efficiency programs, we advance all nine of the guiding principles.

The Balance of Wholesale and Retail Renewable Energy

Key Concept: Continue to support utility-scale renewable procurements and local renewable development that reflects evolving market conditions.

Rhode Island has a history of successful and impactful renewable energy programs. Current programs include net metering (with incentives available through the Renewable Energy Fund), the Renewable Energy Growth feed-in-tariff program, and Community Remote Net Metering (CRNM), which has helped create opportunities for customers unable to install solar on their homes to participate in community-based renewable energy resources. The Renewable Energy Fund, in addition to providing grant funding for both residential and commercial solar PV systems, has also helped support solar projects on preferred locations such as brownfields and carports. In addition, utility-scale procurements, such as the procurements of 400 MW from

¹¹ See, for example, program costs and benefits of National Grid’s 2019 Energy Efficiency Program: http://rieermc.ri.gov/wp-content/uploads/2020/05/ngrid_4888-year-end-report-2019-puc-5-15-20.pdf.

¹² The Base Load Case and High Load Case assume the incremental annual energy savings from efficiency measures decrease from 190 GWh in 2020 to 120 MWh in 2030. The Low Load Case assumes incremental energy savings continue at 190 GWh per year through 2030.

¹³ The range of cost savings are the net present value of 2020 to 2040 costs based on the base resource acquisition cost assumptions for each of the Technology Bookend scenarios.

the Revolution Wind offshore wind project off the Rhode Island coast, and 50 MW from the Gravel Pit Solar project in Connecticut, are driving Rhode Island’s renewable portfolio to a larger scale.

Rhode Island’s clean energy laws and programs strive to achieve multiple policy objectives, including, but not limited to greenhouse gas emissions reductions and environmental sustainability, energy reliability, energy affordability, economic development, and job creation. These policy objectives are also reflected in the guiding principles. To achieve and sustain 100% renewable electricity while advancing broad-based policy objectives, Rhode Island will require both continued growth in local distributed generation resources and competitive procurement of large-scale renewable energy resources.

Our analysis shows that there is significant uncertainty in costs across all renewable energy technologies. Different utility-scale renewable resources have similar cost ranges, which are lower than distributed generation resources.¹⁴ We also see that a mix of resources weighted toward wind energy will best match electricity demand profiles and reduce system balancing needs that are expected to increase beyond 2030. However, in-state solar energy resources, particularly retail solar, provide economic development benefits that should be weighed against resource costs and environmental impacts.

Our analysis also helps us set guideposts for further renewable energy procurement based on the current outlook for future electricity demand and technology-specific net benefits. It does not support a single centralized procurement plan that would limit the potential to capture the benefits of evolving market dynamics and competition across resource types. Rather, we propose a market-driven approach that allows for cross-technology competition where appropriate, in line with the guiding economic principle to *pursue cost-effective*

solutions. Reaching 100% while managing potential cost increases in other components of utility bills necessitates that cost-effectiveness remain a priority across programs.

Each of Rhode Island’s existing renewable energy procurement programs has unique traits, creating multiple pathways for developers and consumers to participate in the clean energy future. However, some of these programs – particularly those supporting local distributed generation – present significant challenges that Rhode Island must begin to address. Some of these challenges include:

- Examining ways to reduce/control distributed renewable energy costs for local consumers, including cost shifts across customer classes;
- Identifying cost effective approaches to building out the Rhode Island distribution system to increase capacity for distributed renewable energy resources (as well as increasing demand from electrification of other sectors);
- Developing sustainable siting practices for local distributed renewable energy to balance renewable development with environmental stewardship;
- Integration of storage, demand management and other technological solutions; and
- Achievement of more equitable outcomes for all Rhode Islanders through improved access, participation, and cost distribution.

OER supports continuation of the Renewable Energy Growth (REG) program and net metering (NM). However, further expansion should be contingent on identification and integration of measures to improve sustainability, affordability, and equity. These challenges warrant in-depth collaboration with a diverse set of stakeholders, including policymakers, regulators, industry, environmental advocates, consumer advocates, utilities, and community organizations. In 2021,

¹⁴ Note that we use the terms “utility-scale” and “wholesale” interchangeably here to refer to large-scale procurements of renewable energy, such as through the state’s Long-Term Contracting statute ([RIGL 39-26.1](#)). In contrast, retail renewable energy and local distributed generation refer to projects that are generally smaller in scale, like rooftop solar, that are provided incentives through programs like REG, which offers a feed-in tariff, or net metering and associated incentives through the Renewable Energy Fund (<https://commerceri.com/financing/renewable-energy-fund/>).

we propose to commence a forum for stakeholder dialogue and consensus-building on the long-term costs and benefits of the state's net metering construct, as well as to consider other enhancements to reduce ratepayer costs and improve environmental sustainability and consumer equity, with recommendations due by the end of the year.

We also propose that the Renewable Energy Fund (REF) be extended by the General Assembly beyond its current 2022 sunset. OER and Commerce RI will continue to coordinate on identifying administrative and programmatic adjustments to the REF throughout 2021 that further renewable growth and clean energy innovation, and evolve the REF to address gaps in evolving market conditions, considering foundational principles. OER and Commerce have already begun this work by utilizing the REF framework to support renewables on brownfields, storage, and, soon, microgrid applications. The Clean Energy Internship program, co-managed by both OER and Commerce, should also continue beyond 2022.

Lastly, continued support of the burgeoning offshore wind industry will also be critical to the Rhode Island clean energy economy and a decarbonized future for the region. Governor Raimondo's October 2020 announcement calling for a competitive market procurement for up to 600 MW of newly-developed offshore wind energy is consistent with this recommendation.¹⁵ As future large-scale renewable procurements advance, the state should also consider the timing of similar efforts across the region, which may unlock opportunities to benefit from greater economies of scale and further expansion of clean energy supply chain investments and job growth in Rhode Island and southern New England. This recommendation advances all nine of the guiding principles.

IV.B Planning and Enabling Recommendations

Planning and enabling recommendations are actions we propose to take to reduce risk, increase flexibility, and optimize renewable energy integration. Rhode Island's suite of planning and enabling recommendations encourages exploration, collaboration, and strategic planning. The first recommendation calls for a pilot collaboration among key stakeholders to marry policy objectives into grid planning with the aim of finding efficiencies. The second recommendation continues Rhode Island's efforts related to Power Sector Transformation, while a third calls for building out a strategic role for energy storage technologies and demand management. Finally, we recommend continued collaboration with the other New England states to improve regional wholesale markets and transmission planning processes to more effectively enable a largely-decarbonized electric grid.

Integrated Grid Planning

Key Concept: Optimize the electric grid through collaborative, integrated grid planning

The poles and wires that make up Rhode Island's electric grid must be carefully planned to ensure safe and reliable service to customers. Oversight from the Division of Public Utilities and Carriers and regulatory review from the Public Utilities Commission helps to ensure that grid investments are right-sized, right-timed, and appropriate to maintain service standards. Forecasts of electric load growth and in-depth technical understanding of grid assets allow distribution system planning engineers to propose strategic investments to serve load expected to materialize in near-term. This established and well-vetted approach to grid planning can and will continue to serve Rhode Islanders well.

¹⁵ A draft RFP is anticipated to be filed with state regulators in early 2021.

Planning and Enabling Recommendations

We need to advance innovative, integrated, and collaborative **planning** to **enable** interconnection of clean energy onto the grid while minimizing costs and optimizing land use.



Optimize the electric grid through collaborative, **integrated grid planning**.



Facilitate integration of distributed energy resources by advancing **Power Sector Transformation and Grid Modernization**.



Build out a strategic role for **energy storage** technologies



Continue **regional collaboration** on wholesale markets and interstate transmission.

Analytical insights show that interconnection costs of distributed solar resources have risen significantly and are likely to continue to do so without more advanced, dynamic grid planning. Increasing electrification demand will also require additional investments in the distribution system. Increased penetration of renewable energy resources, load growth from beneficial electrification, and competing policy pressures (e.g. related to land use) are three drivers of how and where the electric grid is built out.

We propose to consider these drivers over longer time horizons to better understand and plan for changing future system needs. Our goal is to explore how we transition from today's electric grid to the electric grid required to meet Rhode Island's long-term clean energy and GHG reduction goals. The current planning approach reacts to proposals for distributed energy resource deployment. Integrated grid planning could more proactively consider state policy objectives, municipal preferences, clean energy resource opportunities/needs, land use/siting, etc. Grid planning is multi-faceted, technical, and complex. There are no simple solutions that will substantially drive down costs or advance all policy objectives completely. However, more proactive and informed planning over longer horizons will likely lead to long-term grid optimization, efficiencies,

and policy objectives. This recommendation does not advocate for immediate investments in grid infrastructure, but asks whether and how electric distribution utilities, state agencies, municipalities, and others might identify zones more favorable to renewable energy in light of competing policy interests, and remove barriers to distributed energy resource deployment.

We propose two potential areas of exploration. First, we propose to analyze transmission and distribution system needs for several 100% renewable electricity scenarios to identify potential grid challenges and development opportunities. We will identify the potential for anticipating system reliability needs and other system upgrades – whether project-specific or broader system upgrades – that might enable renewable energy growth, reduce development risks, balance environmental sustainability, and moderate long-term costs that consumers might otherwise bear. We will consider wide variations in load, renewable portfolios, and hosting capacity needs.

Specifically, we propose a collaborative effort with National Grid, state agencies, municipalities, and other key stakeholders to explore the potential for a more integrated approach to grid planning beginning in 2021. The objectives of this

collaboration are to foster improved understanding of how short- and mid-term planning can and should account for longer-term dynamics, estimate long-term impacts to the grid from both distributed energy resources and load growth, and compare grid investments under reactive and proactive approaches. We seek to identify locations for distributed energy resources that could streamline development timelines, protect the state's most sensitive environments, and offer the potential to reduce long-term, system wide costs. Critical to this effort will be the identification of underlying data sets necessary for more dynamic forecasting and planning. We recognize the complexity of this task and parties will need to remain realistic about the time and resources needed to gather information not currently in-hand while determining the full value of such an exercise.

We also propose to explore how we might collectively enhance grid visibility and improve forecasting. As part of this effort, we propose to work collaboratively to develop a strategy for improving probabilistic spatio-temporal forecasting for load, distributed energy resources, and hosting capacity, which could be used to integrate and optimize system updates while minimizing costs.

Our proposal for integrated grid planning advances all three guiding decarbonization principles. Both pieces of this recommendation innovate and supplement industry standard practice, which advances the guiding decarbonization principle to *exemplify climate leadership*. Optimizing how the electric grid is run will also reduce risk of curtailment and downsizing of renewable energy projects, which will support the guiding decarbonization principle to *create incremental power sector decarbonization*, as well as support increased grid utilization for additional beneficial electrification, which advances the guiding decarbonization principle to *facilitate broader decarbonization*. Our proposal also advances guiding principles to *pursue cost-effective solutions*, *create economic*

development opportunities, and ensure solutions are robust and sustainable beyond 2030 by optimizing how we build and use the electric grid with an eye toward long-term goals.

Power Sector Transformation

Key Concept: Continue to advance recommendations described in the Power Sector Transformation stakeholder report

In 2016, Governor Raimondo directed the Division of Public Utilities and Carriers, Office of Energy Resources and Public Utilities Commission to collaborate in developing a more dynamic regulatory framework that will enable Rhode Island and its major investor-owned utility to advance a cleaner, more affordable, and reliable energy system for the twenty-first century.¹⁶ This initiative, called Power Sector Transformation, has three explicit goals: to control the long-term costs of the electric system, to give customers more energy choices and information, and to build a flexible grid to integrate more clean energy generation.

With the support of a robust stakeholder engagement process, the three state agencies produced a report describing a series of recommendations to advance Power Sector Transformation, all of which continue to be relevant today.¹⁷ The report and stakeholder collaboration resulted in National Grid's energy storage and electric transformation initiatives, and is anticipated to result in a refined proposal for grid modernization and advanced metering. Strategic investments to modernize the grid can improve visibility into load and distributed generation, and can improve control to ensure grid reliability. These investments can reduce the cost of maintaining the electric grid and can allow more distributed energy resources to connect to the grid with less-expensive system upgrades.

We propose to continue working to advance the Power Sector Transformation recommendations. Particularly, progress should be made on the following recommendations:

¹⁶ http://www.ripuc.ri.gov/utilityinfo/electric/GridMod_ltr.pdf

¹⁷ http://www.ripuc.ri.gov/utilityinfo/electric/PST%20Report_Nov_8.pdf

- Improve forecasting and implement a stakeholder engagement plan during forecast development;
- Consider strategies to compensate the value of distributed energy resources based, in part, on their location, and how those incentives align with more proactive distribution system planning;
- Advance electrification that is beneficial to system efficiency and greenhouse gas emission reductions; and
- Consider opportunities for developing performance incentive mechanisms.

Advancement of Power Sector Transformation investments should consider (and appropriately value) the systems and tools required to support more robust deployment of demand response measures and electrification, which can be leveraged to support additional distributed generation and load-shifting. This is in line with the guiding decarbonization principle to *facilitate broader decarbonization*. We also recognize alignment between insights from the Power Sector Transformation initiative and integrated grid planning concepts. These complementary recommendations will advance the guiding decarbonization principle to *create incremental power sector decarbonization* as well as the guiding policy implementation principles to *ensure solutions are robust and sustainable beyond 2030 and be consistent with other Rhode Island priorities and policies*.

Energy Storage and Demand Management

Key Concept: Build out a strategic role for energy storage and demand management technologies

Renewable energy generation profiles do not align with the timing of electricity demand within the day and throughout the year. Rhode Island can rely on the regional system for balancing energy supply with demand in the short term, but as the rest of New England decarbonizes, we will need to participate in developing solutions for balancing supply

and demand, both in the very short term and over longer time frames. Energy storage technologies will become increasingly critical to balance the timing of intermittent, non-dispatchable, renewable energy generation with electricity demand and build grid flexibility.¹⁸ Demand management capabilities can address the same problem from the other side, by shifting electricity demand toward times when supply is more available. Doing both of these will improve reliability, reduce the need for fuel-burning backup generation, and reduce risk of curtailment of renewable energy generation, in line with the guiding decarbonization principle to *create incremental power sector decarbonization*.

While short-term energy storage technologies are becoming increasingly prevalent in the market, long-term seasonal energy storage is likely to present the most significant challenges to balancing a heavily weighted renewable energy generation portfolio. Starting now to consider long-term energy storage will advance the guiding decarbonization principle to *facilitate broader decarbonization* as we see increasing electricity demand necessitate increasing penetration of renewable energy resources. Furthermore, long-term strategic thinking will advance the guiding policy implementation principle to *ensure solutions are robust and sustainable beyond 2030*.

Energy storage technology and demand management also provide important resilience and economic development co-benefits. Locally deployed energy storage, such as battery backup systems in Rhode Island homes and businesses, can support shelter-in-place during extreme weather events and reduce costly business interruptions during outages. Deployment of in-state energy storage resources also supports local economic development and employment. Demand management approaches can provide similar benefits. In tandem, these considerations advance the guiding economic principle to *create economic development*

¹⁸ Energy storage technologies include mechanical storage (e.g. flywheels, pumped hydropower), thermal storage (e.g. water heaters, ice storage), and electrochemical storage (e.g. batteries). For more information, visit <http://www.energy.ri.gov/renewable-energy/energy-storage/>.

opportunities and the guiding policy implementation principle to be consistent with other Rhode Island priorities and policies.

Over the next several years, we propose to develop a Rhode Island-centric strategic plan for the role of energy storage and demand management as renewable deployment increases through 2030 and beyond. To determine the strategic role of energy storage and demand management, we will need to understand the timing of electricity demand and its potential flexibility, in order to estimate optimal, cost-effective penetration of local energy storage resources. Then we can assess market conditions, gaps and barriers that may prevent Rhode Island from reaching the optimal penetration of these approaches. One such barrier may be interconnection, so we propose to evaluate and potentially pursue updates to interconnection protocols for paired storage-plus-renewable systems and stand-alone energy storage systems.

We also recognize that programs and incentives may help overcome barriers to market growth. We propose to explore the role of programs and incentives in achieving optimal, cost-effective energy storage penetration at beneficial locations on the grid, as well as how demand management capabilities can be acquired and sited. Considering multiple value streams associated with these technologies to of energy storage technology advances the guiding economic principle to pursue cost-effective solutions. We aim to build on existing programs and lessons learned throughout the nation as energy storage technology and demand management are increasingly deployed and the market matures. Lastly, we will engage with municipal stakeholders to accommodate energy storage in local zoning ordinances.

Regional Collaboration

Key Concept: Continue regional collaboration on markets and transmission

Rhode Island's electric grid is part of a highly integrated regional electric system managed by ISO-NE. The other New England states – Connecticut, Massachusetts, Vermont, New Hampshire, and Maine – are all electrically connected and participate in regional wholesale markets for energy and other energy-related attributes as well as in transmission system planning.

Our analysis demonstrates the impact that regional dynamics can have on in-state outcomes. As the grid decarbonizes and electrification proceeds, the need for system upgrades and updated market designs will accelerate.

In 2020, Governor Raimondo was one of five New England governors who called for New England's regional wholesale electricity markets and organizational structures to evolve for a twenty-first century clean energy future.¹⁹ In response, a series of regional technical sessions on these issues is now being developed for early 2021 and will be accessible to stakeholders and the public.

We propose to continue coordination with other New England states on wholesale market designs and transmission planning processes that facilitate energy decarbonization and renewable resource integration across the region. We will coordinate with other New England states on transmission planning processes to better facilitate energy system transformation and proactively plan for the integration of large-scale resources and distributed energy resources across the region, along with identifying and implementing wholesale market mechanisms that fully account for the value of existing and future state-level investments in renewable resources (e.g., avoid rules that require double-procurement of capacity) and meet states' decarbonization mandates and maintain resource adequacy at the lowest possible cost.

¹⁹ The Governors' Statement is available at: <http://nescoe.com/resource-center/govstmt-reforms-oct2020/>. The Detailed Vision Statement is available at: <http://nescoe.com/resource-center/vision-stmt-oct2020/>.

Following through on this recommendation will advance the guiding decarbonization principles to *create incremental power sector decarbonization and facilitate broader decarbonization*. Furthermore, this sort of regional collaboration extends beyond Rhode Island to *exemplify climate leadership* at a regional scale.

This recommendation is also in alignment with several additional guiding principles: *pursue cost-effective solutions, improve energy and environmental equity, ensure solutions are robust and sustainable beyond 2030, and be consistent with other RI priorities and policies*.

IV.C Equity Recommendations

The equity recommendations below describe ways to foster equitable outcomes from the clean energy transition and were informed by dialogue with community stakeholders. It is worth reiterating that these equity recommendations do not stand apart from the rest of the recommendations. They are meant to center equity in the previous recommendations, give additional attention to them, and allow these recommendations to be as explicit as possible.

Unlike the policy and planning and enabling recommendations that may all be considered distinct actions that can be pursued in parallel, we propose equity recommendations that have directionality. First, we propose to partner with communities, with a particular emphasis on partnering with frontline communities, environmental justice communities, and communities of color. Then, in collaboration with these communities, we will develop metrics to track progress toward desired equitable outcomes, and adjust programs and policies strategically to improve outcomes that are identified and prioritized by the communities themselves. Community engagement, involvement, and collaboration can lead to innovative, equitable, and inclusive partnerships

by connecting the concerns of communities to the decisions that allocate public funds.

We recognize there is a long history of systemic racism and inequities in the United States and Rhode Island that have shaped current systems and processes. Because of those historic legacies, communities of color and environmental justice communities have gained lived experiences crucial to shaping better programs that serve their immediate needs. Throughout this process, we will attempt to identify those inequities within State government and the clean energy sphere and address them whenever possible. Specifically, by recognizing that energy inequities are not solely caused by wealth disparities, we are hoping to shift the narrative from solely focusing on income, which does not provide a full accounting of those in need, and focus on demographics, income, renter status, and other metrics that provide more of an intersectional approach to the problem.²⁰

We recognize that we are recommending a process, rather than a solution, and this is deliberate. It is paramount that we listen to and collaborate with communities most impacted by these decisions for direction on how to best serve their needs. As part of this process, we have built in flexibility in our recommendations and timelines for discussion and growth that will hopefully be informed through continued public partnerships. This suite of recommendations advances the guiding principle to *improve energy and environmental equity*.

Community Partnerships

Key Concepts: Partner with and listen to frontline communities about their needs and goals in the clean energy transition

We propose to establish and strengthen partnerships with frontline communities and community organizations with the objective of centering their needs. Frontline communities are

²⁰ As used here, intersectionality refers to the theory that various forms of discrimination centered on race, gender, class, disability, sexuality, and other forms of identity, do not work independently but interact to produce particularized forms of social oppression.

Equity Recommendations

We must center equity and include community engagement in program design to improve access to clean energy benefits for all Rhode Islanders. Throughout this effort, we will identify and address systemic racism and historic inequalities.



Partner with trusted community organizations to listen, learn, support, and establish foundational definitions.



Based on foundational definitions, develop **equity metrics** with the community to track and monitor progress towards equitable outcomes.



Improve **outcomes** identified and prioritized by communities through rate design, program adjustments, and policy.

communities who have historically borne a disproportionate burden, endured disproportionate harms, or have missed out on a proportionate share of benefits. Importantly, these communities, often communities of color, have not traditionally been included in decision making or designing of programs and policies. This recommendation seeks to remedy past systemic inequities by listening to these communities, providing support, and collaborating with them throughout the policy development process. Doing so can help strengthen relationships with communities and build trust. It can also lead to a more nuanced understanding of the problems we are trying to solve.

We will leverage existing forums, such as the Executive Climate Change Coordinating Council²¹ (EC4) and energy efficiency programs,²² as appropriate to identify partners, facilitate conversations, and derive guidance for future directions related to equity metrics, desired outcomes, and action items. Resulting feedback should be used to ensure the needs, experiences and priorities of frontline communities are reflected in program design and processes. Specific commitments include:

- Provide access to expert consultation as needed for communities to meaningfully engage in energy discussions and decision making
- Hold listening sessions to increase accessibility to and understanding of energy system basics, and to hold space for community concerns and suggestions
- Integrate equity considerations into energy efficiency plans and program development
- Meet with the community to define equity, benefits, outcomes, and metrics
- Develop rules for equitable engagement and a framework for more inclusive and accessible public meetings across the energy and environmental space.

Furthermore, we propose to target community-based training efforts to support in-demand clean energy jobs. To support workforce development in-state, we will explore other state models and programs focused on underserved communities in order to leverage best practices and lessons learned. This

²¹ The Executive Climate Change Coordinating Council (EC4) is a public facing entity comprised of officials from state agencies with responsibility and oversight relating to assessing, integrating, and coordinating climate change efforts, as set forth in the Resilient Rhode Island Act (RIGL 42-6.2).

²² Specifically, National Grid has proposed to convene an Energy Equity Working Group in 2021 to inform energy efficiency program development and evaluation (Section 8.1.2 of the proposed 2021-2023 Three-Year Energy Efficiency Program Plan: [http://www.ripuc.ri.gov/eventsactions/docket/5076-NGrid-2021EEPlan\(10-15-2020\).pdf](http://www.ripuc.ri.gov/eventsactions/docket/5076-NGrid-2021EEPlan(10-15-2020).pdf)).

recommendation advances the guiding economic principle to *create economic development opportunities*.

We recognize the importance of education in meaningful participation, so we propose to provide education about the opportunities and challenges available in creating clean energy programs and policies, and information about energy programs, including comparative costs and benefits. Internally, OER and other state agencies should continue to improve on their understanding of systemic racism, social justice, and energy and environmental equity.

Equity Metrics

Key Concept: Develop metrics to track progress toward community-identified equity outcomes

Following discussion with and guidance from frontline communities and community organizations, we propose to identify and track metrics that indicate progress toward community-identified equity outcomes. Community engagement will drive development of qualitative and quantitative equity measures that can also inform program design. Critical to this effort is direction from communities regarding their visions for participation in the clean energy transition.

Some metrics related to equity are already tracked and those existing processes may be leveraged if deemed useful. These include workforce diversity (tracked via the annual Clean Energy Jobs Report²³), participation of people with low- and moderate-income in clean energy programs, renter status and non-participation in energy efficiency programs, and metrics related to use of the low-income rate and other utility bill support programs. Additional metrics may include but are not limited to energy burden, demographic information, participation in public workshops and decision-making processes, and others.

While we present currently tracked metrics and potential new metrics, we ultimately turn to community partners for additional guidance on how to identify and track metrics focused on addressing systemic racism and historic inequities. These metrics may fall outside of what may be seen as normal energy metrics, such as housing indicators, health data, and technological access; however, in an effort to incorporate an intersectional approach, following community guidance and best practices from other states will be critical.

Improve Community-Determined Outcomes

Key Concept: Improve outcomes identified and prioritized by communities through rate design, program adjustments, and policy

Given guidance from frontline communities and community organizations, we will partner with communities to develop and implement plans to improve priority outcomes.

For example, if, through collaboration, education, and consultation, community partners prioritize improved access as a desired means to provide equity, then we will focus on actions that will make participation easier, reduce financial burdens, and protect consumers. First, program participation should be made as easy as possible. Barriers to participation should be reduced through effective and culturally competent program design and delivery. This includes materials that are available in multiple languages that represent areas being served, and streamlined eligibility verification processes to reduce customer burden for proving income or need.

Second, programs should aim to reduce financial burdens, and should provide support for low- and moderate-income households and frontline communities beyond installing technology, including structures for aiding with upkeep and services.

²³ <http://www.energy.ri.gov/cleanjobs/>

Third, programs should carefully consider consumer protection for all customers and determine whether additional protections for underserved customers may be needed. For example, programs that deliver energy efficiency services should also conduct heating system safety checks.

If instead, for example, through collaboration, education, and consultation, community partners prioritize improved programmatic benefits as a desired means to provide equity, then we will focus on prioritizing energy efficiency, ensuring equitable distribution of benefits and costs, and looking beyond carveouts to ensure equitable impacts.

First, programs and planning should ensure that low- and moderate-income households and frontline communities can access energy efficiency benefits as an important step for reducing energy burdens, alleviating energy poverty, and increasing household comfort and health.

Second, in tandem with tracking equity metrics, those metrics should be used to monitor and verify equitable distribution of costs and benefits. In addition to utility bill savings, benefits such as pollution reduction and increase in home comfort and health should be equitably distributed. This will ensure we are serving all populations, not just those based on economic status. We turn to communities for guidance on

which benefits are most important to improve and therefore most critical to track. We recognize that achieving 100% renewables will increase costs to drive long-term energy, economic, and environmental benefits – this requires careful consideration among communities and within program and policy development.

Lastly, we recommend looking beyond carveouts as programmatic mechanisms to ensure participation by underserved communities. Programs should do more than set aside a small portion of benefits for frontline communities. Carveouts can be the first step, but they cannot be the final step, to ensuring more deserving communities can benefit from programs. Whenever possible, programs and processes should use a targeted approach with a universal goal to achieve equitable outcomes.

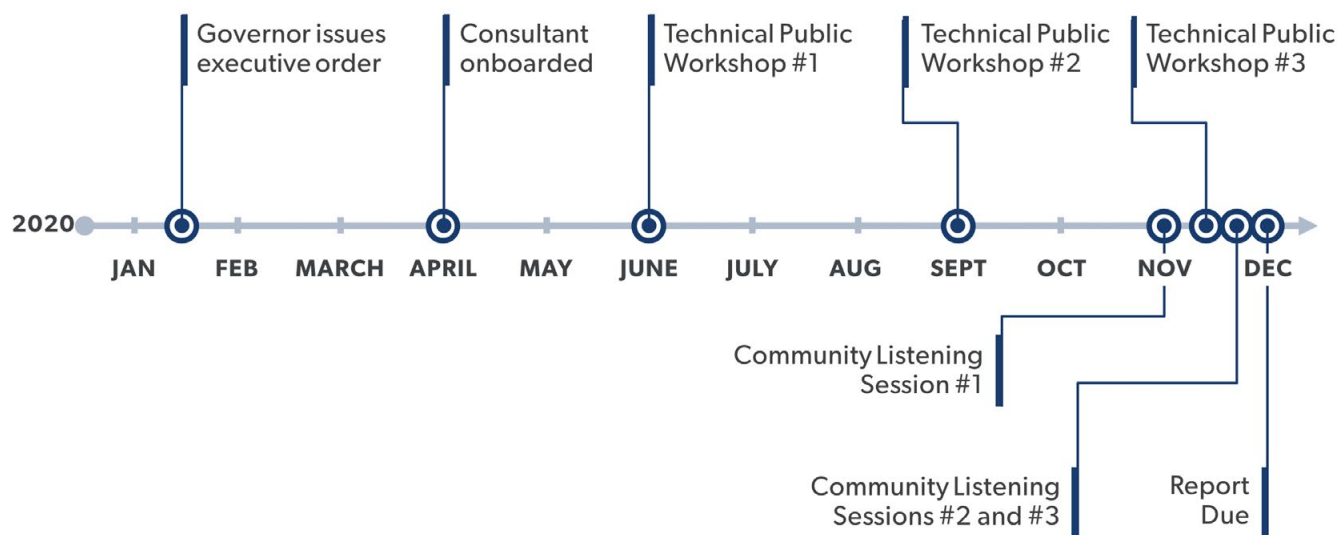
Importantly, based on community input, these recommendations may change or may be combined to prioritize both improved access and improved programmatic benefits. We must ultimately strive to prioritize the concerns of the community and address systemic inequities from our position of power as best we can.

Appendix: Summary of Stakeholder Engagement

Stakeholder engagement was a key component of this study, designed to learn from, engage and inform stakeholders. This Appendix contains an overview of the public comment process and summaries of the comments and questions received, along with the project team’s responses. Following that is a list of the organizations that provided comments, and demographic information that was shared by the attendees at the public technical workshops and the community listening sessions.

A.I Summary of Public Comment Process

To obtain feedback from a broad range of stakeholders and experts, the Office of Energy Resources held three public community listening sessions, three public technical workshops, and accepted written public comments from the start of the project through December 15, 2020. The technical workshops were held in June, September, and December with a primary focus on analytical methods, results, and policy implications. The community listening sessions were held in November and December and less technical in nature, with a focus on policy and programmatic recommendations. Meeting materials are available on www.



energy.ri.gov/100percent/. Due to the COVID-19 pandemic, all workshops and listening sessions were conducted virtually. This Appendix summarizes feedback and written comments from these sessions, which helped to inform our final report.

In total, 13 written comments were received via email from stakeholders and organizations, and over 245 comments and questions were raised verbally or via virtual chat during the listening sessions and technical workshops. A list of over thirty-five organizations that provided input is provided near the end of this summary. In addition, aggregated demographic information provided by public participants is provided at the end of this section. Overall, summary statistics provide directional insights that suggest underrepresentation from several demographic groups.

This appendix does not include every comment received; however, it aims to thoroughly summarize comments and responses related to all three policy and programmatic recommendation categories: policy, planning & enabling, and equity. This appendix is organized into sections based on recommendations versus comments and concerns raised.

Stakeholder Comments Related to Policy Recommendations

Legislation

Comment: Stakeholders recommended working with the General Assembly to pass a 100% by 2030 Renewable Energy Standard (RES).

Response: *This recommendation is consistent with our policy recommendation to advance a 100% Renewable Energy Standard.*

Comment: Stakeholders asked clarifying questions about Renewable Energy Certificates (RECs) and their associated market. Some stakeholders suggested that meeting the 100% renewable electricity goal with RECs from across New England was appropriate. However, other stakeholders suggested a

preference for in-state development and associated economic development over the purchase of regional RECs. The issue of double counting RECs was also raised by a few stakeholders.

Response: *This recommendation is consistent with our proposal to define achieving 100% renewable electricity with an amended Renewable Energy Standard. The utilization of RECs establishes a verifiable mechanism to ensure compliance while facilitating renewable energy project financing. OER also acknowledges that counting RECs from local Distributed Generation is critical to tracking progress towards the 100% renewable electricity goal. Reporting on this is conducted annually by the Public Utilities Commission. We recognize there are tradeoffs between the comparative affordability of meeting the goal through procuring regional RECs versus delivering in-state benefits through local development, and will strive to maximize value to Rhode Islanders through policies and programs.*

Comment: Stakeholders recommended a form of carbon pricing mechanism to be proposed in legislation.

Response: *Carbon pricing may be a viable supplementary policy to promote economy-wide decarbonization but is outside the scope of this specific project.*

Comment: Avoiding greenhouse gas emissions and reducing the use of fossil fuels were major concerns for community members. Shutting down fossil fuel power plants was one desired outcome voiced by multiple stakeholders. These plants were described as contributing to local pollution and are often located near frontline communities.

Response: *Please refer to the sidebar, “Does ‘100% Renewable’ require shutting down all fossil generation in Rhode Island?” on page 10.*

Comment: Stakeholders voiced concerns over total ratepayer costs of achieving 100% renewable electricity.

Response: *Utility bills will increase regardless of our ultimate portfolio of renewable resources – but net economic and energy*

benefits and costs will be determined by how that portfolio is shaped over time. Achievement of our clean energy future will require ratepayers to support investment to drive long-term energy, economic, and environmental benefits through charges on their bills. However, we must keep in mind that we are already facing increasing costs of a changing climate outside of utility bills, and the investments we make in a clean energy future will yield incremental energy, economic, and environmental benefits for Rhode Islanders, as demonstrated in our report.

Renewable Energy Programs

Comment: Stakeholders recommended the Renewable Energy Growth (REG) feed-in-tariff program be extended and expanded to provide in-state renewable energy development, allowing for pricing mechanisms to align energy development with policy goals.

Response: *This recommendation informed our policy recommendation to continue to support utility-scale renewable procurements and local renewable development that reflects evolving market conditions.*

Comment: Stakeholders recommended ensuring renewable energy programs were compatible with energy storage.

Response: *This recommendation is in line with the guiding policy implementation principle to build upon Rhode Island's existing renewable energy programs and informs the planning and enabling recommendation to develop a strategic role for energy storage.*

Comment: Stakeholders voiced concerns about the Renewable Energy Fund (REF) incentive program, including scale and allocation of available funding. Stakeholders recommended REF be extended beyond its current 2022 sunset date and should evolve to address changing market conditions.

Response: *This recommendation informed our policy recommendation to continue to support utility-scale renewable procurements and local renewable development that reflects evolving market conditions.*

Comment: Stakeholders recommended that changing market conditions be monitored and studied. Specifically, stakeholders suggested that OER adapt policies and programs to changing circumstances and evaluate market conditions on a rolling basis, similar to other New England states.

Response: *This comment informs our policy recommendation regarding continued support for local renewable energy development and pursuing program evolution that may improve affordability and better respond to evolving market conditions.*

Comment: Stakeholders described concerns over renewable energy project siting – particularly project development in open space and environmentally sensitive lands – and recommended strategic action to alleviate siting concerns and protect greenspace. Stakeholders raised concerns over clear cutting forests to site renewable energy projects. The value of maintaining forests in order to combat climate change was described as an important priority.

Response: *Environmental protection is one example of a policy objective that should be pursued in parallel to decarbonization, consistent with our guiding policy implementation principle to 'be consistent with other Rhode Island priorities and policies'. OER recognizes the authority of municipal governments in developing renewable energy zoning ordinances, and offers technical support as needed. The planning and enabling recommendation related to integrated grid planning attempts to bring key stakeholders together to explore how we may be able to integrate distributed energy resources in a manner that advances multiple policy objectives in parallel.*

Alternative Renewable Energy Resources

Comment: Stakeholders recommended expanding the eligibility of existing small-scale hydropower to hedge against new resource delays and project attrition.

Response: *While hydropower may offer some limited in-state renewable energy generation, it is not recognized as a primary*

growth resource in Rhode Island and is not a significant part of the recommendations from this study. OER agrees that policies should ensure that all renewable technologies can compete to deliver renewable energy at cost-competitive prices to Rhode Island, consistent with the guiding economic principle to pursue cost-effective solutions.

Comment: Stakeholders recommended exploring nuclear capacity as a potential technology option for achieving 100% renewable electricity by 2030.

Response: Nuclear energy will continue to be a part of New England's generation portfolio for some time, represented by Connecticut's Millstone Nuclear Plan and New Hampshire's Seabrook facility. However, no new nuclear energy resources are planned for construction in the foreseeable future.

Comment: Stakeholders suggested that Rhode Island's capacity for land-based wind is a viable option to support the 100% renewable electricity goal.

Response: Land-based wind is indeed a viable option to support the 100% renewable electricity by 2030 goal. The analysis considers land-based wind as a Technology Bookend as well as a (small) component of mixed portfolio #10 commensurate with likely future opportunities for siting and development. A regional transmission solution might enable the development of materially more land-based wind than has been considered here, though that might not be in place in time for this technology to play a significant role in Rhode Island's 2030 goal.

Comment: Stakeholders recommended that geothermal energy be considered as a viable renewable energy technology.

Response: Even though geothermal energy is a potential source for power generation, it was not included in this study as the geothermal resources in New England do not produce electricity. Geothermal electricity production is only emerging in parts of the world where the earth is hot near the surface and is not a viable option in Rhode Island. Even if this resource were to progress, the technologies would most likely not be

available before 2030. Instead this study classified geothermal as a viable technology to reduce electricity demand.

Stakeholder Comments Related to Planning and Enabling Recommendations Grid Modernization, Energy Storage, & Transparency

Comment: Various stakeholders were concerned that the topics of energy storage and grid modernization were not explicitly included in the analysis. It was also suggested that pre-discounted nameplate capacity values should also be considered when displaying solar PV forecasts to ensure that the scale of necessary development is clear.

Response: The analysis does not factor grid modernization, energy storage, or other advancements that may facilitate integration of distributed energy resources at this time. However, planning and enabling recommendations include support for such advancements, including exploring an integrated grid planning approach, continuing to drive recommendations related to Power Sector Transformation, and developing a strategic role for energy storage. Solar PV capacity needs shown in the analysis represent nameplate capacity. Further details about capacity factors and other assumptions used in the analysis can be found in the Technical Support Document.

Stakeholder Comments Related to Equity

Comment: Stakeholders recommended that environmental justice and equity should be prioritized in the state's clean energy transition. Furthermore, stakeholders recommended that OER prioritize income-eligible residents and underserved communities.

Response: This recommendation informed our suite of equity recommendations to partner with frontline communities, develop and track equity metrics, and make adjustments to drive community-prioritized equity outcomes. Centering equity and including community engagement in program design is a main focus for OER, as it is one of our core principles.

Comment: Stakeholders supported the concept of an incentive adder for low- and moderate-income customers but raised concerns about the adder being overly restrictive. Stakeholders suggested prioritizing solar projects that benefit low- and moderate-income individuals.

Response: OER acknowledges that programs need to support more equitable outcomes and is committed to centering equity and including community engagement in program design to improve access to clean energy benefits for all Rhode Islanders. This recommendation informed the suite of equity recommendations whereby we will strengthen partnerships with frontline communities to identify ways in which we can drive community-prioritized outcomes.

Comment: Stakeholders voiced the importance of community engagement and recommended increasing public understanding of the benefits of renewable energy.

Response: Stakeholder and community engagement are critical for success, and recommendations like this informed the suite of equity recommendations. Specifically, we recommend partnering with frontline communities and community organizations and supporting communities such as by developing frameworks for more inclusive and accessible public meetings across the energy and environmental space. OER is committed to including community members and stakeholders in development, implementation, and decision-making for all project recommendations.

Stakeholder Comments Related to the Analysis

Comment: Stakeholders recommended additional detailed analysis for different categories of solar projects.

Stakeholders posit that high costs are due to large-scale solar, so focus should be shifted to rooftop projects that have lower interconnection costs along with a higher probability of completion with a shorter timeframe.

Response: The analysis differentiates between wholesale (utility-scale) and retail (small-scale) solar projects. Ranges in resource acquisition costs are reflected in the cost ranges provided for each portfolio. OER acknowledges that interconnection costs of distributed solar resources have risen over time and are likely to continue to do so without a more advanced, dynamic planning approach. Stakeholder concerns over interconnection costs and delays informed the planning and enabling recommendation related to integrated grid planning.

Comment: Stakeholders recommended the high-demand forecast be used for planning purposes.

Response: The Base load forecast was used for the analyses. Sensitivity analysis showed that load forecast uncertainty at the level assessed is a relatively modest contributor to overall cost uncertainty (higher load would result in higher overall costs, though not necessarily in higher unit rates.) The load forecast can be updated over time as 2030 approaches to adjust the amount of renewable energy that is targeted. In any case, even if the forecast is quite accurate, there will be some residual mismatch between the 2030 energy production of the renewable resources acquired and actual 2030 load, both of which are variable in response to weather and other factors. The structure of a 100% RES requirement enables matching renewable production to actual load by buying or selling RECs to resolve any residual mismatch. This is discussed in **SECTION II.C** above.

A.II Public Commenters (listed alphabetically)

Acadia Center
Anbaric Development Partners
Audubon Society of Rhode Island
Brookfield Renewable
Brown University
Coalition Center for Environmental Sustainability (CC4ES)
Department of Environmental Management
E2SOL LLC
EarlyBird Power
Ecogy
ecoRI
Great River Hydro, LLC
Green Development, LLC
Green Energy Consumers Alliance
Grow Smart RI
Handy Law LLC
Hexagon Energy
HousingWorks RI
Kearsarge Energy
Longwood Energy Group
National Biodiesel Board
National Grid
National Wildlife Foundation
NEC Solar
New England Power Generations Association
Newport Solar
Northeast Clean Energy Council
Northeast Energy Efficiency Partnerships
Ocean Wave Energy Company (OWECO)
Preservation of Affordable Housing
Rhode Island Center for Justice
Rhode Island Chapter of Citizens Climate Lobby
Rhode Island Public Utilities Commission
SEA RI
Sunrise Climate Movement
Sunrun
The Nature Conservancy
Trinity Solar
University of Rhode Island
West Broadway Neighborhood Association
Approximately 80 individuals not representing specific organizations provided oral and written comments

A.III Demographic Information from Workshops & Listening Sessions

Over the course of the year, OER held three public technical workshops that focused on the project’s technical analysis and three listening sessions focused on answering questions and hearing community concerns. In aggregate, 543 people attended these workshops and listening sessions, though many people attended multiple events. We received 208 survey responses, resulting in a 40.8 percent response rate.¹ We summarize participation along demographic dimensions based on survey responses and compare participation to statewide demographic data. While we are unable to glean statistical accuracy or tease out self-selection bias from survey findings, these summary statistics provide directional insights that suggest underrepresentation from several demographic groups.

Race: Of the 208 survey respondents, 144 answered questions relating to their race. Of those respondents, the majority, 81.25 percent, identified as White or Caucasian. The state of Rhode Island is estimated to be 83.6 percent white according to U.S. Census data from 2018.² The Black population in the state is estimated to be 8.5 percent. The survey participants who identified as “Black or African-American” equaled 3.5 percent of the survey responses. Aside from White people, all other races were likely underrepresented.³

Race/Ethnicity	Survey Respondents (%)	Rhode Island population estimate (%)
White/ Caucasian	81.3%	83.6%
Black/ African-American	3.5%	8.5%
Asian/ Asian-American	2.1%	3.7%
American Indian or Alaskan Native	0.7%	1.1%
Native Hawaiian or Pacific Islander	0.0%	0.2%
Hispanic or Latino, any race	3.5%	16.3%
Prefer not to Say	9.7%	

¹ N=543 and N=208 do not represent unique attendee or respondent counts, but rather indicate aggregate sums of attendees and respondents.

² <https://www.census.gov/quickfacts/fact/table/RI/PST045219#>

³ <https://www.census.gov/quickfacts/fact/table/RI/PST045219#>

Age: Of the 208 survey respondents, 145 answered questions relating to their age. Ages 25-64 were slightly over-represented in these public meetings, and ages Under 18 and 65+ were underrepresented.⁴

Age	Survey Respondents (%)	Rhode Island population estimate (%)
Under 18	2.1%	19.3%
18-24	6.2%	10.7%
25-34	17.2%	13.8%
35-44	16.6%	11.7%
45-54	17.9%	13.2%
55-64	15.9%	14.1%
65+	10.3%	17.3%
Prefer not to Say	4.8%	

Income: The income information gathered from the survey demonstrates a higher attendance from people earning \$100,000 or more annually, and a lower representation from people who may identify as low- and moderate-income households. Survey results, when compared with state demographic data, show that families earning \$15,000 or less annually were underrepresented at 4.9 percent of attendees (compared to 12 percent of the state). It should be noted that 24.4% of survey respondents preferred not to disclose their family income.

Income	Survey Respondents (%)	Rhode Island population estimate (%)
Under \$15,000	4.9%	12.0%
Between \$15,000 and \$29,999	2.4%	7.8%
Between \$30,000 and \$49,999	7.3%	14.9%
Between \$50,000 and \$74,999	13.0%	17.4%
Between \$75,000 and \$99,999	12.2%	12.1%
Between \$100,000 and \$150,000	20.3%	17.1%
Over \$150,000	15.4%	14.3%
Prefer not to say	24.4%	

⁴ https://censusreporter.org/data/table/?table=B01001&geo_ids=04000US44,01000US&primary_geo_id=04000US44, data in graph is gender-blind.

Gender: According to the 5-year ACS data in 2018, approximately 51.2 percent of the state population is female and 48.8 percent of the state population is male. Survey results indicate that 39 percent of respondents identified as women, demonstrating an underrepresentation from women. 6.2 percent of respondents chose not to self-report their gender information, and no respondents identified as non-binary or trans.

Gender	Survey Respondents (%)	Rhode Island population estimate (%)
Woman	39.0%	51.2%
Man	54.8%	48.8%
Prefer not to say	6.2%	

Sector: Responses suggest that the 100% Renewable Electricity workshops and listening sessions were heavily attended by folks within the energy industry, comprising 37.8 percent of poll responses. The events were least attended by municipal governments and by residential or business customers, comprising 2.8 percent and 9.8 percent of poll responses, respectively.

Sector	Survey Respondents (%)
Environmental Organization	14.0%
Industry, including vendors, developers, and energy consultants	37.8%
Municipal Government	2.8%
Other	18.9%
Residential or Business Customer	9.8%
State Government	16.8%

Familiarity: Most survey respondents, 65.3 percent, stated familiarity with the energy and electricity system. 18.4% of participants self-identified as experts, and 9.5% of participants were not at all familiar with the energy and electricity system.

Familiarity	Survey Respondents (%)
Expert	18.4%
Familiar	65.3%
Not at all Familiar	9.5%

Glossary

Decarbonize	Reduce carbon emissions (greenhouse gases, or GHGs) by substituting non-fossil energy sources for electricity or in other sectors
Energy	Electric energy that is actually produced and delivered to end users
Capacity	The ability to produce energy on demand, traditionally required to meet peak loads
Heat Pump	Reversible electric heating/cooling equipment that uses technology similar to an air conditioner; can heat in winter as well as cool in summer
Renewable Energy Standard (RES)	RI 2004 legislation requires that renewable energy meet a minimum percentage of electric load, currently 16%, growing 1.5%/year; other NE states have similar RES
Renewable Energy Credit (REC)	Represents the renewable attribute of 1 MWh of renewable generation; RECs are tradeable, and used to meet the RES requirement
Renewable Energy Growth Program	Program to solicit and support smaller scale renewable projects in RI, primarily solar and wind
Renewable Energy Fund	Program of grants and loans for renewable energy technologies in RI; also direct funding for residential and commercial installations
Competitive Procurement	Competitive process used to acquire long-term contracts for renewable energy (e.g., the 400 MW Revolution Wind offshore wind project)