The Road to 100% Renewable Electricity

2030

Public Workshop #2
Agenda for September 29, 2020

Remarks from Commissioner Ucci

Presentation Part 1

Break (≈ 10:20 – 10:30)

Presentation Part 2

Q&A

Concluding Remarks

The Road to 100%

Commissioner Nicholas Ucci

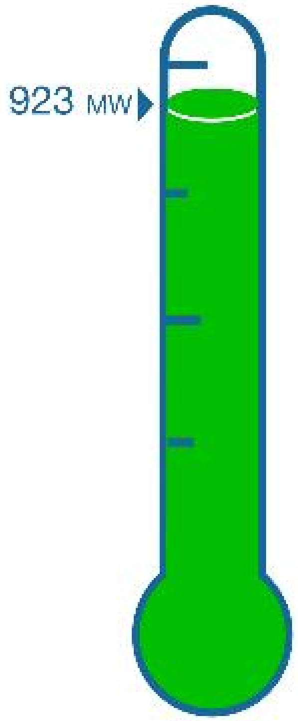
2020 Qtr. 2

Rhode Island Clean Energy Portfolio

1,000 MW by end of 2020

923 Megawatts

9 MW	35 MW	144 MW	305 MW	430 MW
Small Hydro	Landfill Gas / Anaerobic Digestion	Onshore Wind	Solar	Offshore Wind



State of Rhode Island and Providence Plantations

SECRETARY OF STATE
PUBLIC INFORMATION CENTER
2020 JAN 17 AM 10: 52

Gina M. Raimondo
Governor

EXECUTIVE ORDER

20-01

January 17, 2020

ADVANCING A 100% RENEWABLE ENERGY FUTURE
FOR RHODE ISLAND BY 2030

WHEREAS, Rhode Island and the world face significant environmental, economic, energy, and public health challenges from the impacts of climate change; and

WHEREAS, Rhode Island is committed to mitigating economy-wide greenhouse gas emissions and their effect on climate change, while spurring new and innovative opportunities for investment and job growth throughout the state's clean energy economy; and

WHEREAS, Rhode Island's clean energy sector has seen a 74% increase in jobs since 2014, demonstrating that protecting against climate change and strengthening our economy are complementary goals; and

WHEREAS, the Resilient Rhode Island Act establishes targets for Rhode Island to reduce greenhouse gas emissions to 10% below 1990 levels by 2020, to 45% below 1990 levels by 2035, and to 80% below 1990 levels by 2050; and

WHEREAS, the Rhode Island Executive Climate Change Coordinating Council (EC4), in its December 2016 Greenhouse Gas Emissions Reduction Plan, made clear that a business-as-usual approach to reducing economy-wide greenhouse gases is insufficient to meet Resilient Rhode Island Act emission reduction targets; and

Executive Order 20-1

Goal
Meet 100% of the state's electricity demand with renewable energy resources by 2030.

Process
OER shall conduct economic & energy market analysis, and develop viable policy & programmatic pathways.

Results
Implementable action plan by December 31, 2020.

Project Timeline

Report due by December 31, 2020

Please note that all 2020 dates are subject to change.

100% x ‘30 Webpage

www.energy.ri.gov/100percent

Workshop materials will be posted here.

Public Comment

Please submit public comments by November 1, 2020 to:

Energy.Resources@energy.ri.gov

State Project Team

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100% Renewable Energy by 2030 in Rhode Island

PUBLIC WORKSHOP #2

PRESENTED BY

Dean Murphy

Jurgen Weiss

Michael Hagerty

SEPTEMBER 29, 2020

THE Brattle GROUP

Webinar Logistics

This webinar is being recorded

By default, everyone but the panelists will be muted

If you have a substantive question, ask via the Q&A button at the bottom of your webinar screen

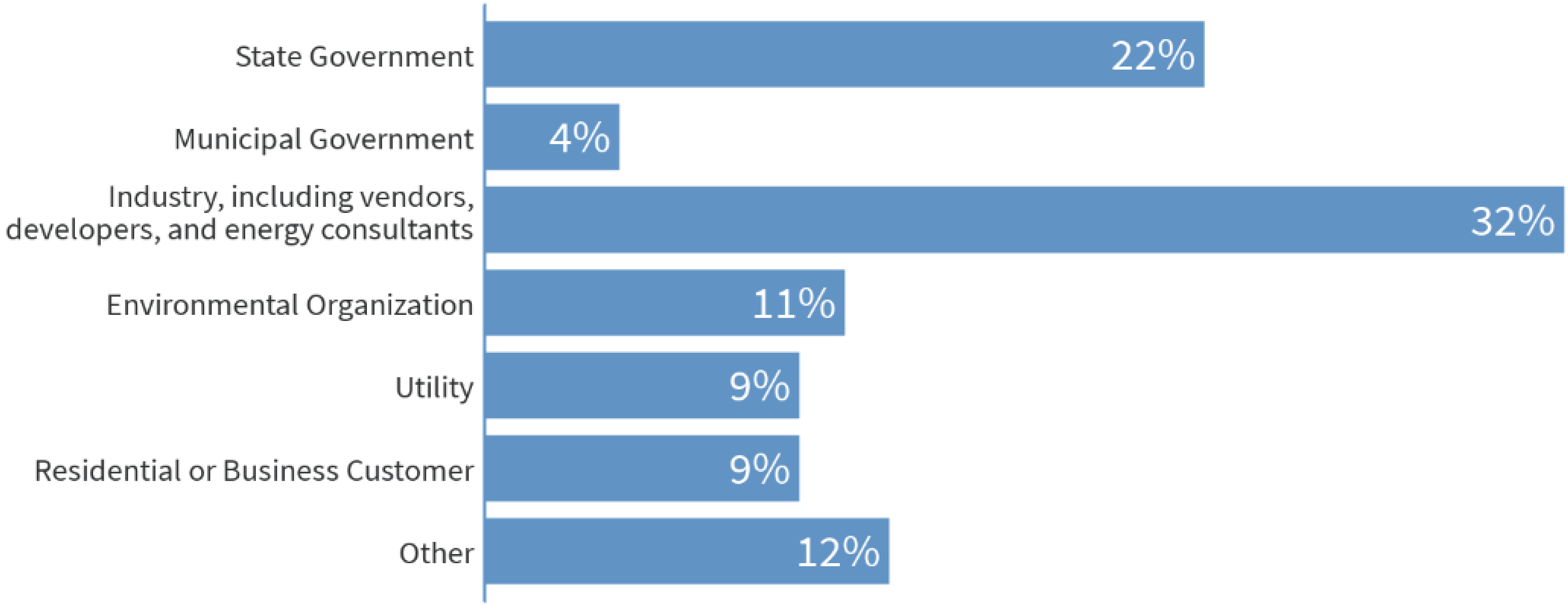
- You can see all the questions that have been asked – give a thumbs up if you want to ask a similar question
- If you are connected only by phone, press *9 to be recognized and allowed to speak during Q&A (please identify yourself by name and organization)

For technical questions about webinar logistics, send a chat to Ellen Paal (host)

- Any logistical question you can't figure out through the webinar: email ellen.paal@brattle.com

We'll have a 10-minute break at approximately 10:20

What sector are you representing (choose one)



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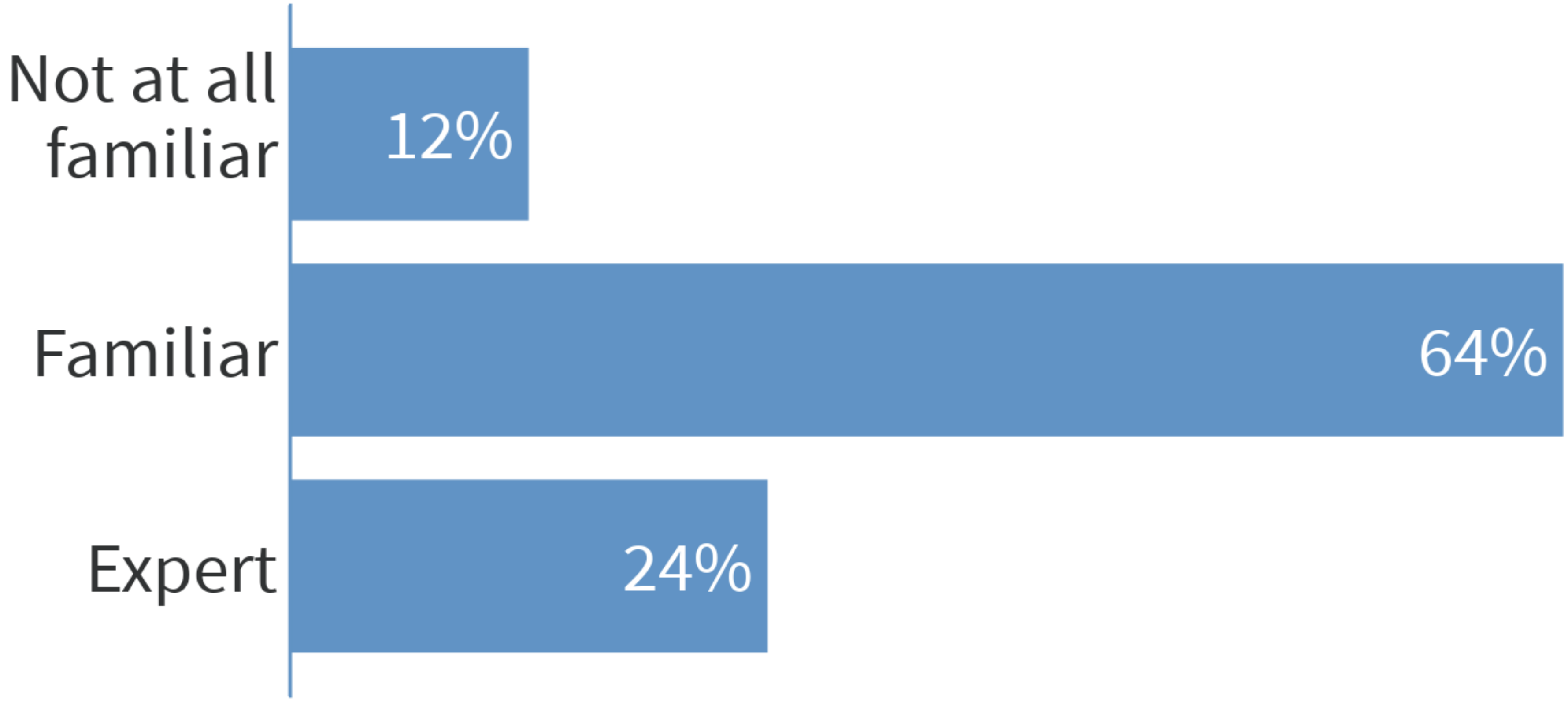
How familiar are you with the region's electricity systems? (choose one)



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Workshop #2 Agenda

- **Introduction – Recap of Workshop 1**
- **Updated Outlook of 2030 Load and Renewable Generation Requirements**
- **Renewable Resource Options and Costs**
  - Break, Q&A
- **New England Market Modeling**
- **Renewable Portfolio Analysis – Results for Bookend Portfolios**
- **Next Steps for Developing Policy Recommendations**
  - Final Q&A

Project Team

Rhode Island State Agencies

Office of Energy Resources
Division of Public Utilities and Carriers
Department of Environmental Management

Additional technical input provided by staff from the Public Utilities Commission

Consulting Team

THE Brattle GROUP

An economic and energy consulting firm with 11 offices in North America, Europe and Australia, with over 50 partners and 500 employees. Team most recently completed Heating Sector Transformation Strategy for RI as well as New England 80by50 report.

Dean Murphy

Jurgen Weiss

Mike Hagerty

Kasparas Spokas

Highlights of Workshop #1

The first public workshop was held (via Zoom) on July 7, 2020

- Slides are available on the OER website: http://www.energy.ri.gov/100percent/

Overview of Workshop #1:

- Executive Order 20-01
- The Importance of Decarbonizing Electricity
- Electricity System Basics: How the system operates now, and in a decarbonized future
- Guiding Principles and Stakeholder Engagement
- The 100% Goal: Defining and Measuring It
- Project Timeline

Feedback: Please Offer Your Comments after Workshop

- Range of electrification assumptions to inform load forecast
  - How much new electrification load do you expect? Electric vehicles, heat pumps, …
- What objective(s) should be primary in pursuing 100% by 2030? E.g.:
  - Low ratepayer cost
  - In-state renewable resources
  - Technology preference (why?)
  - Equity, environmental considerations, etc.?
- Resource costs – are projections realistic? Are all important cost factors included?
- Additional policies to consider?

Email feedback to Energy.Resources@energy.ri.gov

Rhode Island Electricity Demand and Renewable Energy Needs for 100%

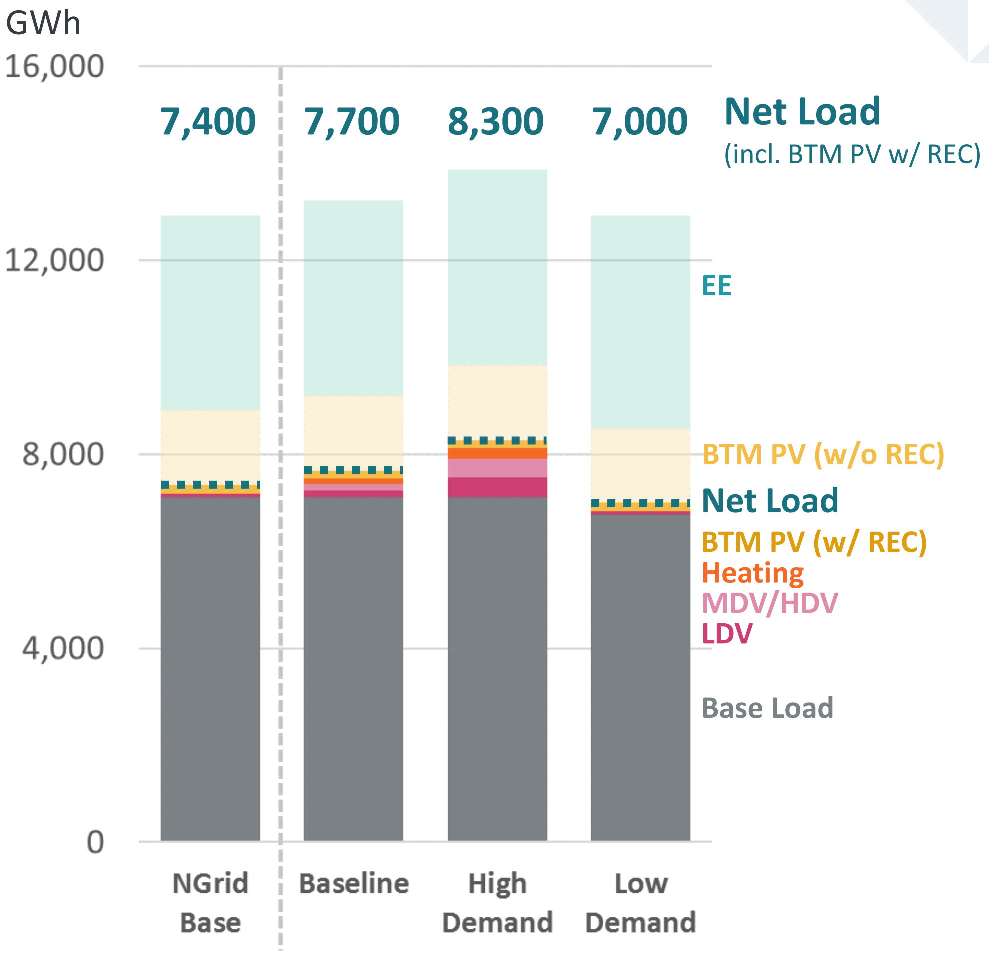
Projected Electricity Demand

Updated 2030 forecast of RI electricity demand accounts for greater electrification

- ***Transportation Electrification***
  - Baseline: 5% Light Duty Vehicle (LDV) electrification by 2030
  - High Demand: 15% LDV electrification (+300 GWh in 2030)
- ***Heating Electrification***
  - Baseline: 5% electrified by 2030, from ISO-NE load forecast
  - High Demand: doubles adoption to 10% (+100 GWh)
- ***Energy Efficiency***
  - Baseline: National Grid forecast (1.3%/year, due to saturation)
  - Low Demand: maintain EE at 1.8%/year (-400 GWh)
- If finalized in time, we will incorporate National Grid's updated 2020 load forecast into our study

Range is moderate due to limited electrification by 2030

2030 Projected Electricity Demand



Note: Behind-the-meter PV production that produces RECs is included in load, to prevent double-counting its renewable generation. Most BTM PV in RI does not earn RECs.

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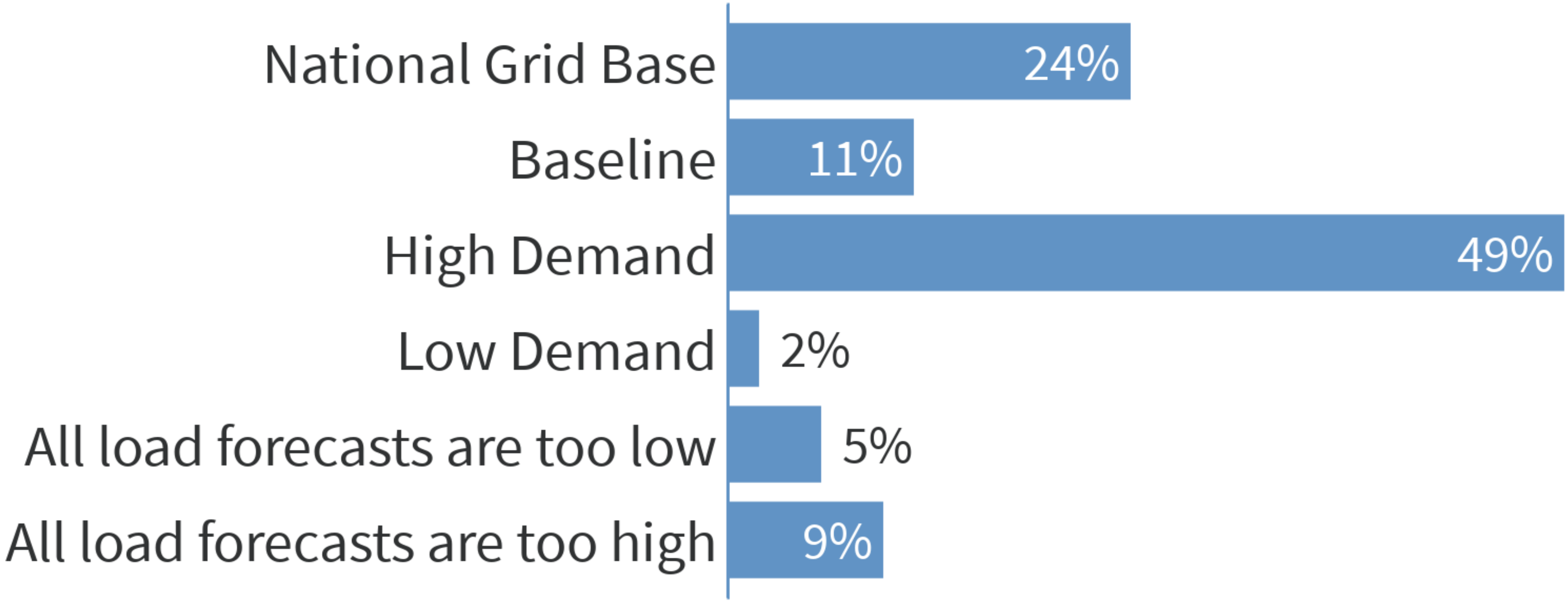
Which load forecast do you think is most realistic? (choose one)



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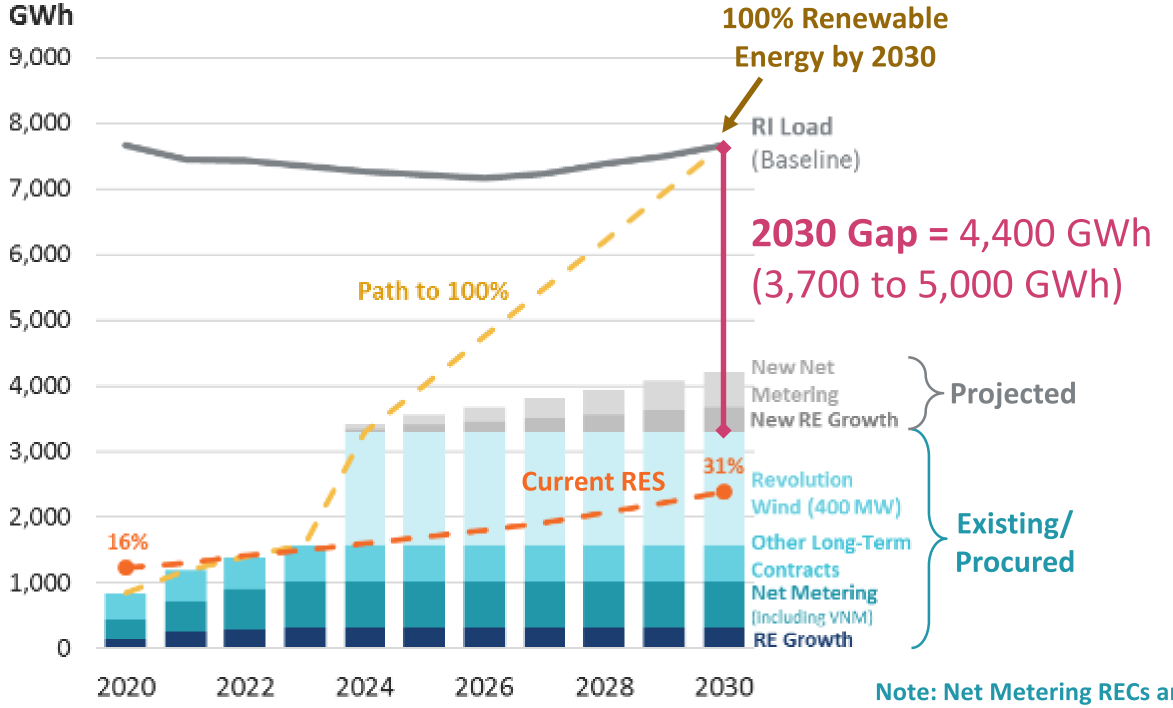
Renewable Energy Generation to Meet 100% in 2030

Rhode Island will need to increase its RES mandates and accelerate its renewable energy programs to achieve 100% Renewables in 2030

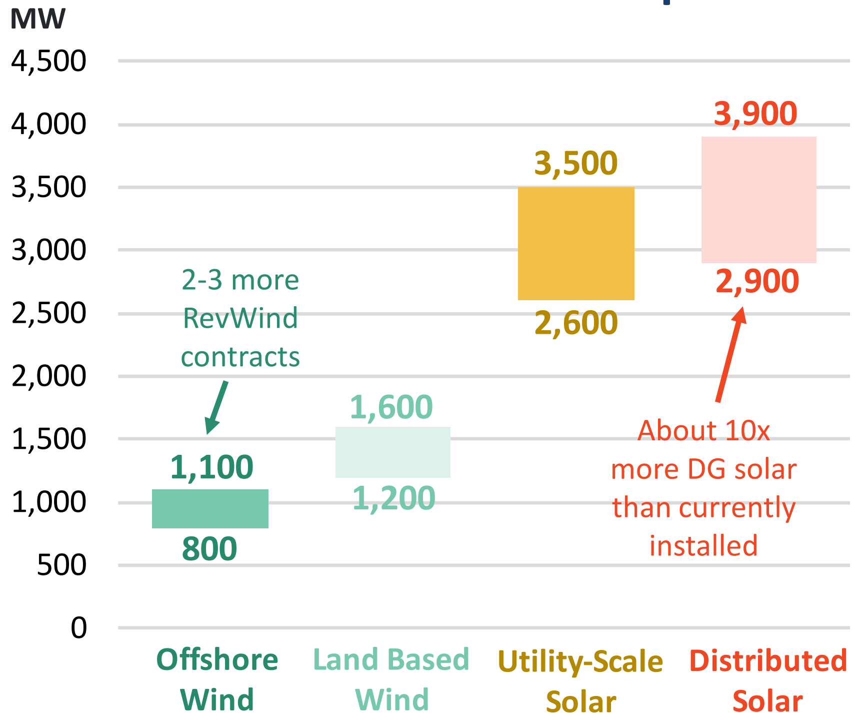
Rhode Island Energy Demand and Renewable Generation



Note: Load is grossed up to account for BTM PV that produces RECs.

Note: Net Metering RECs are not contracted, but are instead purchased through the market – see next slide

Single-Technology Capacities Needed to Fill Gap



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The Role of Net Metering in Achieving 100% Renewables

Meeting RI's 100% renewable goal requires increasing the amount of RECs acquired and retired in Rhode Island

The current Net Metering program allows the generation owner to retain RECs

- RECs can be sold to meet RPS mandates in other states
- To count these RECs toward RI's 100%, those RECs must be purchased or otherwise acquired by Rhode Island energy users (by LSEs on their behalf)

This raises a question about the extent to which the Net Metering can be counted toward Rhode Island's 100% Renewable goals, as the program is currently structured

Note: REGrowth and other contracting programs do not have this issue; RECs from these programs are assigned to utility

Post-2030 Renewable Energy Needs to Maintain 100%

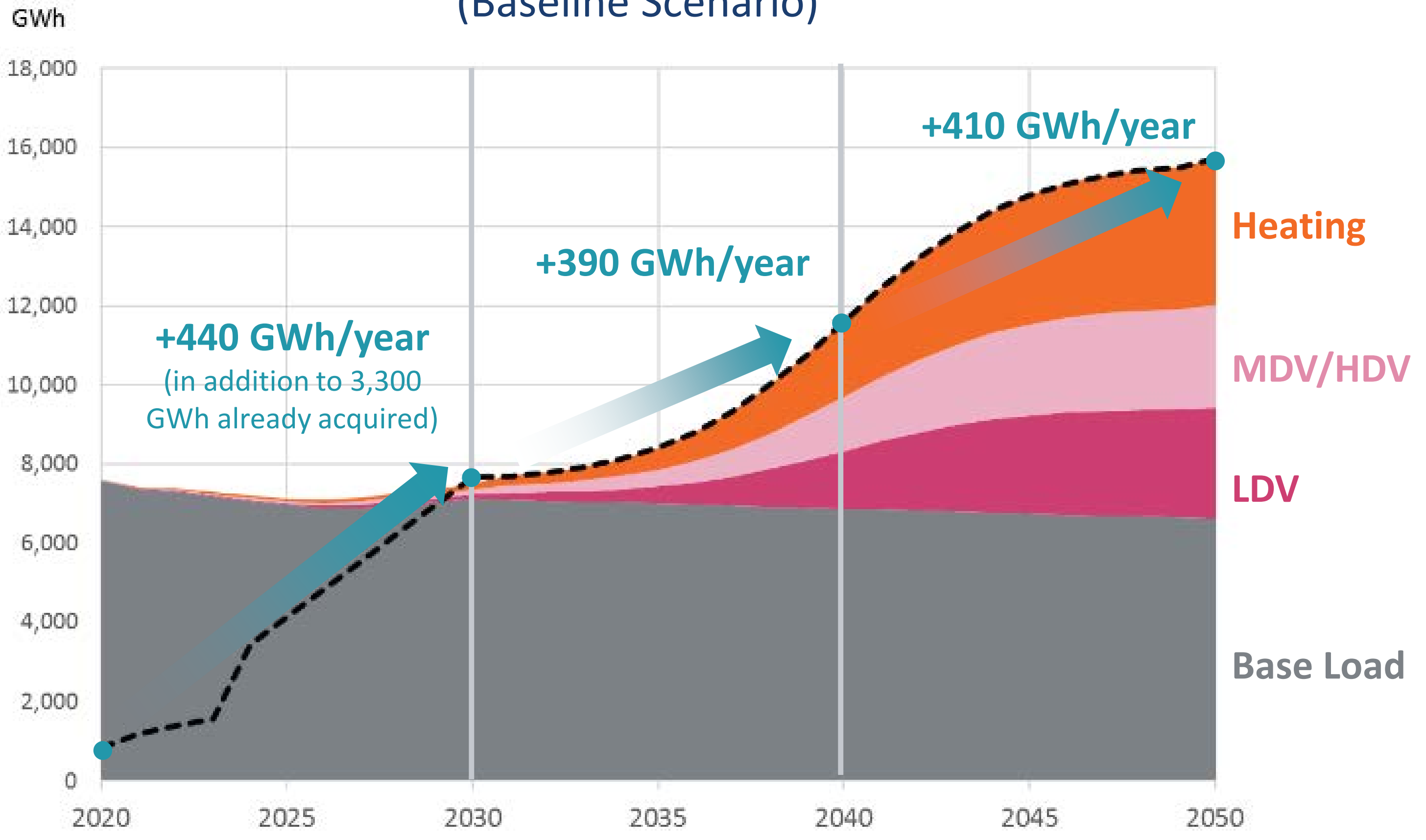
Long-term Demand Projections

- Demand projected to grow from 2030 to 2050 due to electrification to achieve 80x50 decarbonization goals
- Load may double, even with increasing Energy Efficiency for base load (0.4%/year)

Long-Term Renewable Needs

- Rhode Island must keep adding renewable generation at a similar rate after 2030 to maintain 100%
- By 2040, must also begin replacing resources as they reach retirement

2020-2050 RI Load Projection
(Baseline Scenario)



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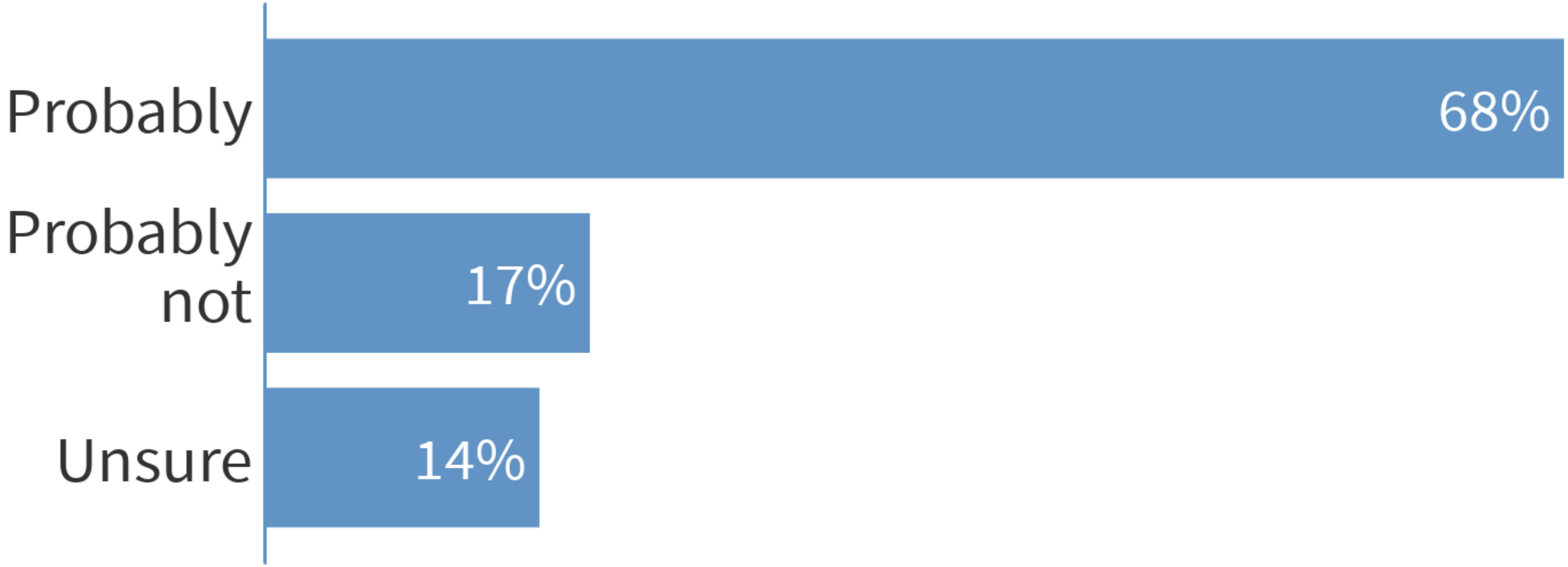
Policy Implications

- **Increase Renewable Energy Standard to 100% by 2030**
  - Tracks progress, but higher RES is unlikely to succeed in isolation
  - Other renewable supply mechanisms also needed – e.g., RE programs, procurements
  - Modify definition of demand to account for behind-the-meter PV that produces RECs to avoid creating a gap in renewable accounting (current structure can double-count)
- **Policies must adapt to a range of future load projections**
  - 2030 load is uncertain, so policy must have flexibility in Renewable Energy quantity
- **Consider the role of Net Metering resources to achieve 100% goal**
- **Continue to seek out cost-effective energy efficiency**
  - Lower load reduces Renewable Energy needs and customer costs

Would you support increasing the Renewable Energy Standard (RES) to 100% by 2030? RES is currently at 16% rising to 38.5% by 2035



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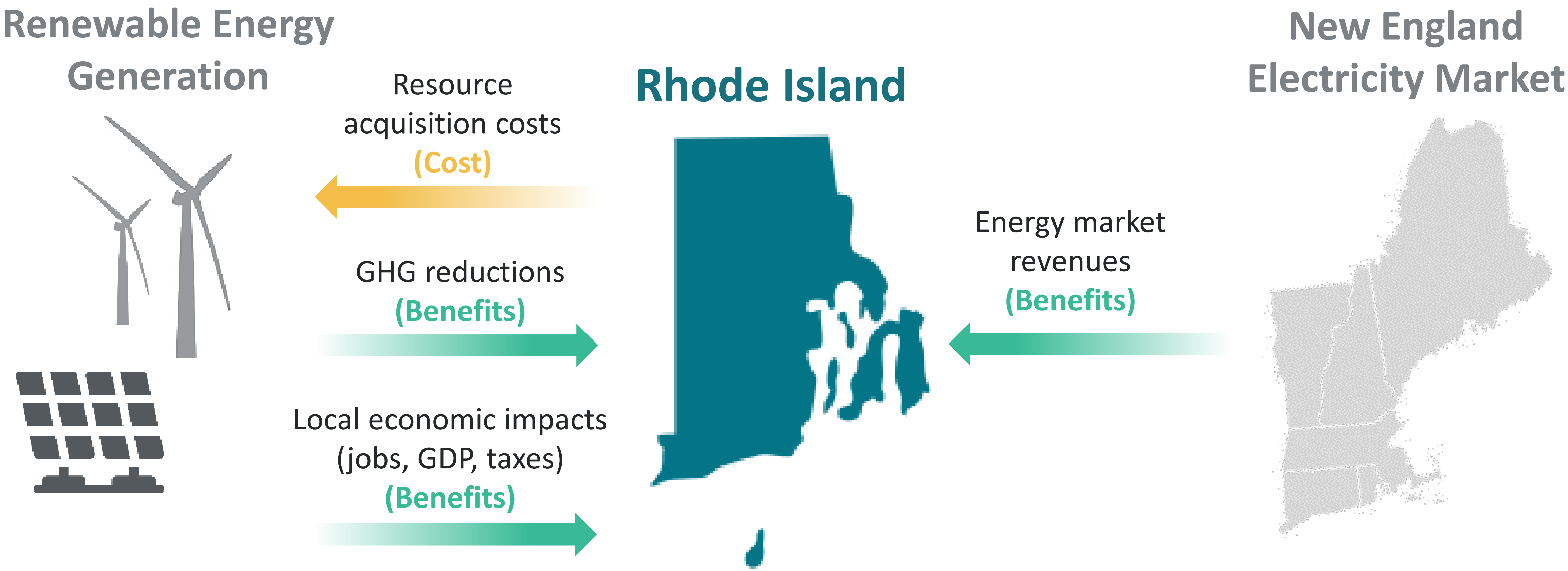
Analysis of Renewable Resource Options

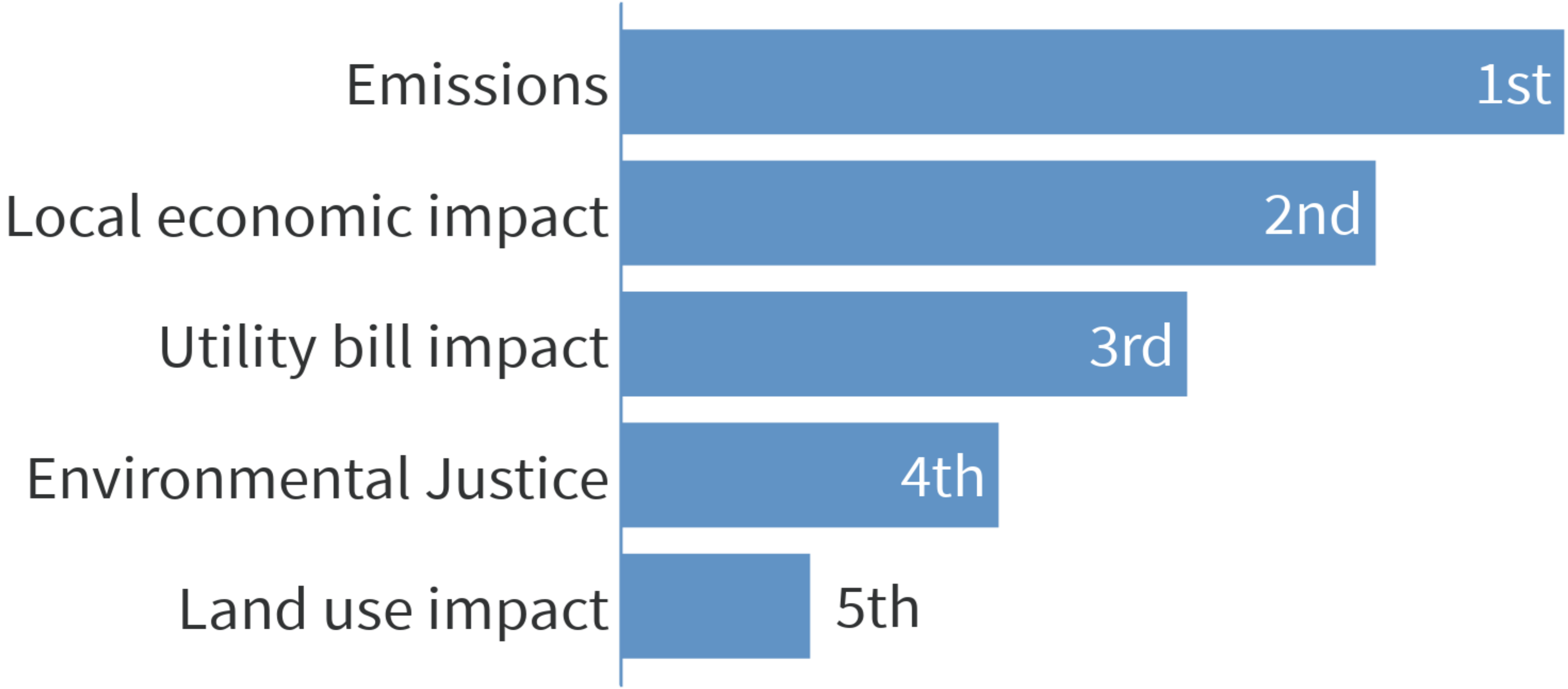
Analyzing Renewable Costs and Benefits to Rhode Island



Net Cost to RI Ratepayers = Resource Acquisition Costs - Energy Market Revenues

Other factors to be considered: economic impact, jobs, land use, equity

What priorities should be considered? (please rank)



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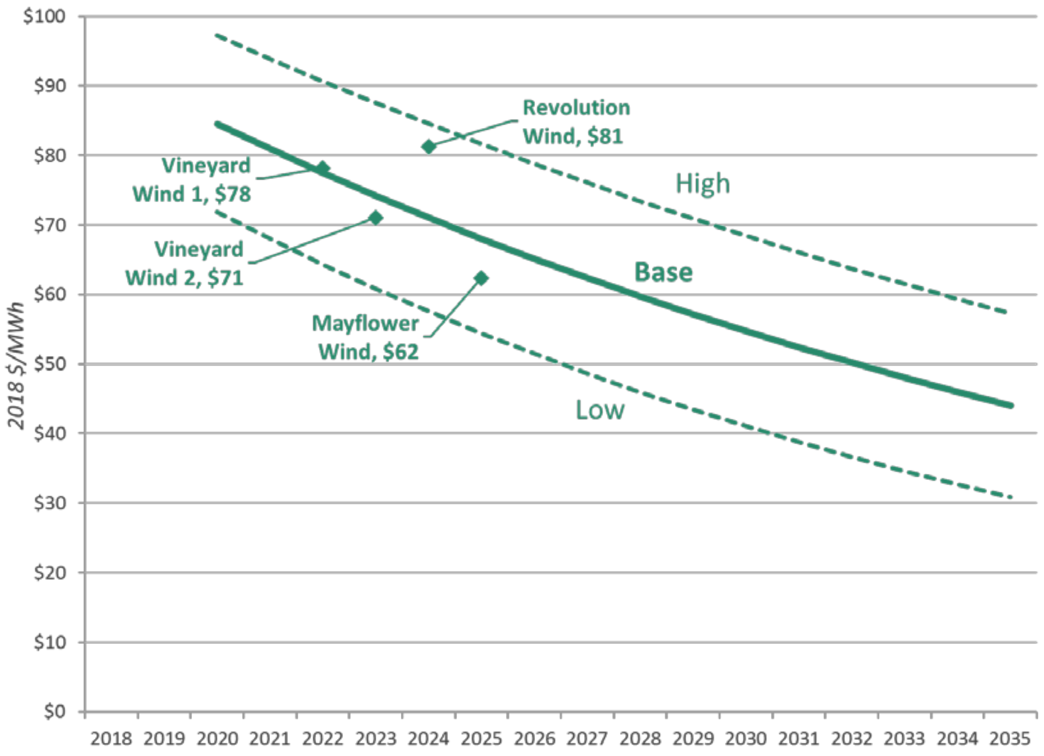
Approach to Estimating Renewable Resource Costs

1. **Market Data:** Identify publicly-available reference points for resource costs based on renewable energy programs across New England; make adjustments to reflect consistent economic life, escalation, and online year, and to account for federal tax credit phase out
2. **Cost Projections:** Develop cost projections over time from available reference points and long-term cost trends from NREL
3. **Cost Uncertainty:** Develop high and low cost projections based on range of reference points and cost trend range in NREL scenarios
4. **Market Changes:** Consider additional factors that could impact overall future renewables costs, such as trends in the cost of T&D system upgrades

Example: Offshore Wind Resource Costs



Notes: Values exclude expiring tax incentives & market revenues (those effects are included subsequently in the analysis)

Similar analyses of land-based wind and solar costs are included in the appendix

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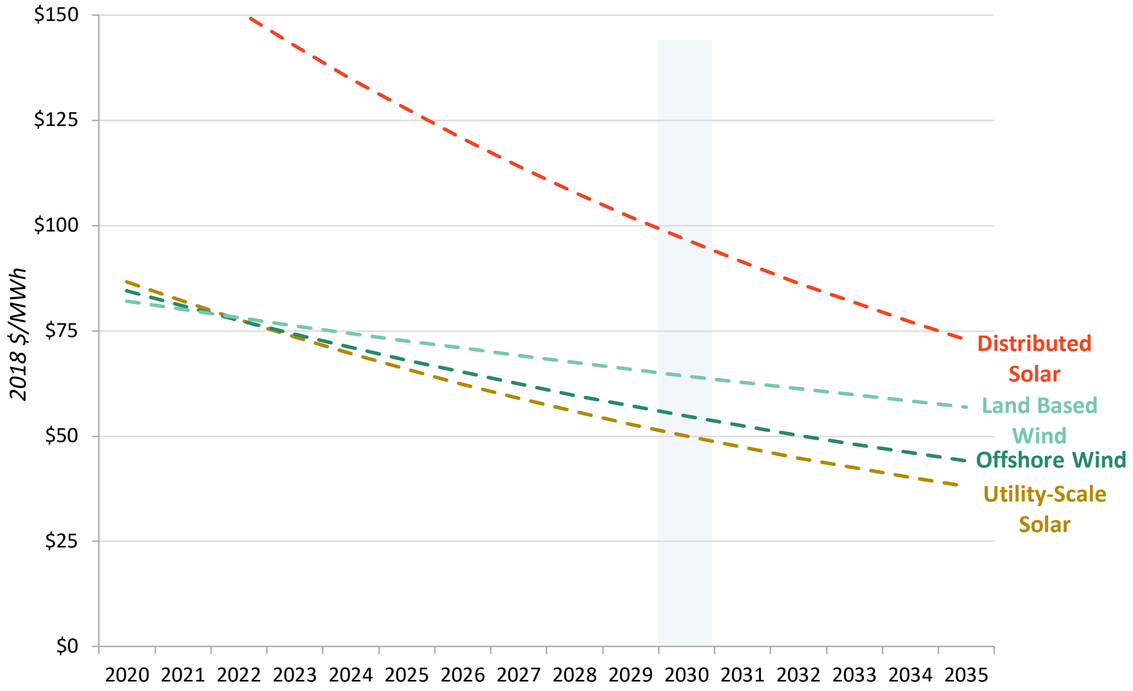
2020 – 2035 Base Renewable Resource Cost Projections

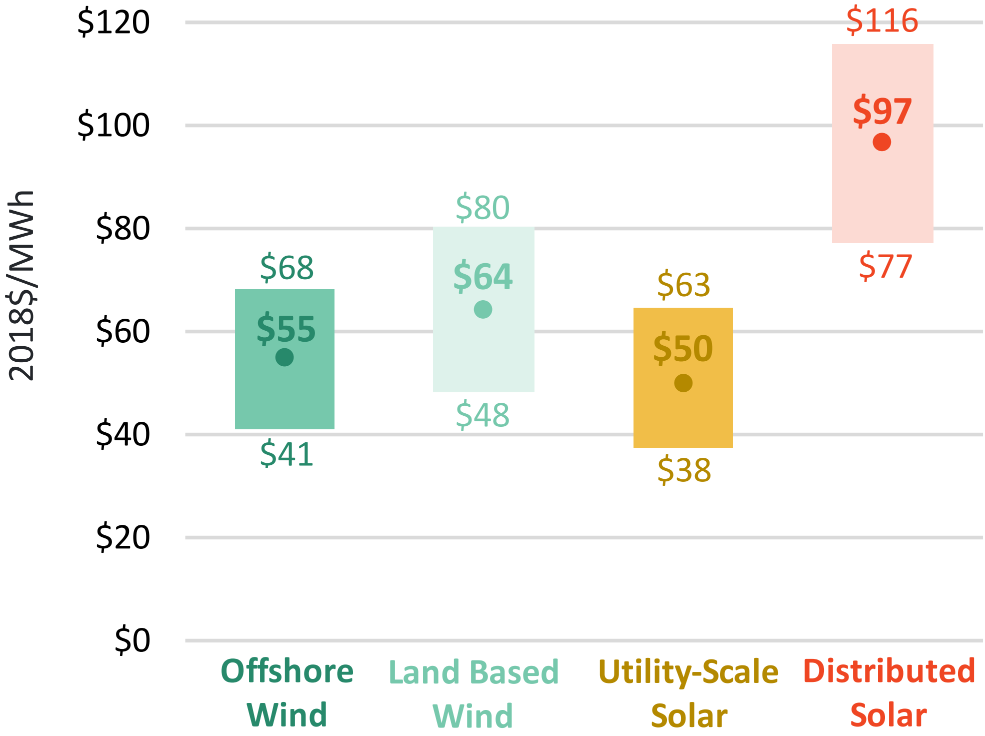
- Based on available data, costs are similar across offshore wind, land-based-wind, and utility-scale solar
- However, significant uncertainties in future costs exist that could result in costs outside these ranges

2020-2035 Base Resource Cost Projections



Note: Distributed solar is the weighted-average of the various classes specified in the RE Growth program, using 2020 shares (16% small-scale, 7% medium-scale, 26% commercial-scale, 50% large-scale).

2030 Uncertainty Range of Cost Projections



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Offshore and Land-Based Wind – Additional Cost Factors

Offshore and Land-Based Wind Availability Considerations

Resource Type & Location	Capacity in Queue	Capacity Limitations
Offshore Wind	>12,000 MW	• 15 GW of capacity on existing leases • Uncertainty in resource costs as industry developed in New England • Limited onshore interconnection points • Future costs of system upgrades (see box)
ME & NY Land-Based Wind	ME: 2,200 MW NY: 4,000 MW	• Significant potential in NY with limited regional system constraints • About 700 MW of ME wind can be added before requiring significant system upgrades that could add $10 – 25/MWh
RI Land-Based Wind	0 MW	• Wind quality and land availability

Offshore wind interconnection costs:

- All onshore and offshore interconnection costs for contracted offshore wind resources included in contract prices
- Future offshore wind procurements are likely to result in higher transmission costs due to:
  - Higher offshore transmission costs to access more distant injection points
  - Higher onshore system upgrade costs to reach load centers
- Estimate an increase in interconnection costs of $5 – 15/MWh for future procurements

Source: Pfeifenberger, et al., Offshore Transmission in New England: The Benefits of a Better Planned Grid, Prepared for Anbaric, May 2020

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Distributed and Utility-Scale Solar – Additional Cost Factors

- Small-scale & medium-scale solar resources may play a smaller role in meeting 100% based on limited technical potential (850 MW is 22% of 2030 Gap; economic potential is 5 – 10%)
- Significant potential for larger solar units based on technical potential and capacity in ISO-NE queue

Solar Availability Considerations

RE Growth Classes (Small-Scale through Large-Scale)

Resource Capacity	Examples	Capacity Potential
Small-Scale (<25 kW)	Residential and small-business rooftop	Synapse Technical: 540 MW (Economic: 110 – 260 MW)
Medium-Scale (25 – 250 kW)	Mid- to large-business rooftop	Synapse Technical: 310 MW
Commercial-Scale (250 – 1,000 kW)	Small-scale ground mounted	Synapse Technical: 2,500 – 6,500 MW in RI ISO-NE Queue: 4,000 MW (400 MW in RI)
Large-Scale (1 – 5 MW)	Medium-scale ground mounted	
Utility-Scale (>5 MW)	Large-Scale ground mounted	

Distributed solar interconnection costs :

- Average interconnection costs for distributed solar ranged from $100-200/kW since 2015
- "Pending" 2020 projects increase to $400/kW
  - Most projects remain under $200/kW
  - Trend in costs reflect limited availability of low cost interconnection points for 1 – 10 MW scale DG solar going forward
- An increase in interconnection costs of $200-300/kW would increase DG solar costs by $10-24/MWh

Source: National Grid provided interconnection costs for distributed solar resources from 2015 to 2020.

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Renewable Cost Uncertainty Summary

Cost projections here are necessarily uncertain – potential upward cost risks include:

- **Offshore Wind**
  - Highly competitive early projects may have depressed prices, limiting future cost declines
  - Transmission upgrade costs may increase as the most attractive interconnections are utilized
- **Land-Based Wind**
  - Transmission availability and upgrade costs, particularly for northern New England
  - Siting issues
- **Utility scale solar**
  - Interconnection costs, siting availability
- **Distributed Solar**
  - Interconnection costs: rules allocating cost to project vs including in distribution charge

Potential downward cost factors: Technological/costadvances could reduce costs more/faster for any of these technologies, as seen recently for offshore wind and solar

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Other Renewable Resources – Limited Potential

Other technologies have limited potential: not evaluated, but may be useful in limited amounts available

- **Landfill Gas and Digester Gas:**
  - Currently contract for 32 MW LFG ($146/MWh) and 3 MW Digester ($101/MWh)
  - RI has not received any recent proposals for these technologies; no capacity is currently in ISO-NE queue
- **Other Eligible Biomass:**
  - Includes excess foresting material, agriculture waste, wood pellets, etc.*
  - Primarily located in northern New England (no capacity currently in ISO-NE queue)
- **Small (<30 MW) hydro:**
  - Limited RES eligibility for existing small hydro; must consider additionality in context of resource viability
- **Tidal hydro:**
  - Not currently commercially viable
- **Fuel cells:**
  - Limited development (just 25 MW in the ISO-NE queue in CT), and sustainability of fuel source

* Eligible biomass includes brush, stumps, lumber ends and trimmings, wood pallets, bark, wood chips, shavings, slash and other clean wood that is not mixed with other solid wastes; agricultural waste, food and vegetative material; energy crops; landfill methane; biogas; or neat bio-diesel and other neat liquid fuels that are derived from such fuel source

Policy Implications

- **RI should develop mechanisms that adapt to significant uncertainty in procurement costs**
  - Create programs that allow resources compete to provide renewable energy at lowest cost
- **No resource limitations identified to meeting 100% renewable goals**
  - Small/medium (rooftop) solar is limited, but can contribute to a distributed solar portfolio
- **Interconnection costs to existing T&D system will become increasingly important**
  - Hosting capacity studies can provide near-term information for developing distributed resources
  - Consider longer time horizon for T&D upgrades, given multiple growing demands over time
    - Cost assignment rules and practices may be important across resources
    - Whether costs are put on the project or socialized across the transmission/distribution system
    - Consider how to provide comparable treatment for alternative technologies and scales
  - Rhode Island should work with other New England states to ensure there is sufficient transmission capacity to access and integrate renewable generation resources at lowest cost to ratepayers

The Road to 100%

Q&A, Break

Presentation will resume at 10:30 AM

New England Market Modeling

Understanding the Future New England Market is Key to Evaluating Renewable Portfolios

Electricity generators (including renewables) sell power in the New England wholesale market

This market will change substantially by 2030 (and especially thereafter) due to the significant addition of renewable energy generation

- Other states are also decarbonizing their electricity sources (less quickly than Rhode Island)

Adding more intermittent renewables to the system affects the market value of renewables

- Output of renewable resources is highly correlated, and power is hard to store
- Once a lot of solar has been added to the system, adding more provides diminishing value
- Same for wind, but in different hours

We use GridSIM (our in-house capacity expansion and dispatch model) to characterize grid operation and estimate prices in a decarbonized future with high renewables penetration

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GridSIM Model Framework

INPUTS

Supply
- Existing resources
- Fuel prices
- Investment/fixed costs
- Variable costs

Demand
- Hourly demand for representative days
- Capacity needs

Transmission
- Zonal limits
- Intertie limits

Regulations, Policies, Market Design
- Capacity market
- Carbon pricing
- State energy policies and procurement mandates

GridSIM OPTIMIZATION ENGINE

Objective Function
- Minimize NPV of Operating and Investment Costs

gridSIM

Constraints
- Market Design and Co-Optimized Operations
  - Capacity
  - Energy
  - Ancillary Services
- Regulatory & Policy Constraints
- Resource Operational Constraints
- Transmission Constraints (not modeled in this instance)

OUTPUTS

Generation Additions and Retirements (Clean Energy Additions)

Hourly Operations

Hourly Energy Market Price (Supplier Revenues, Energy Costs to Customers)

Emissions

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Validated GridSIM to 2018 New England Market Prices

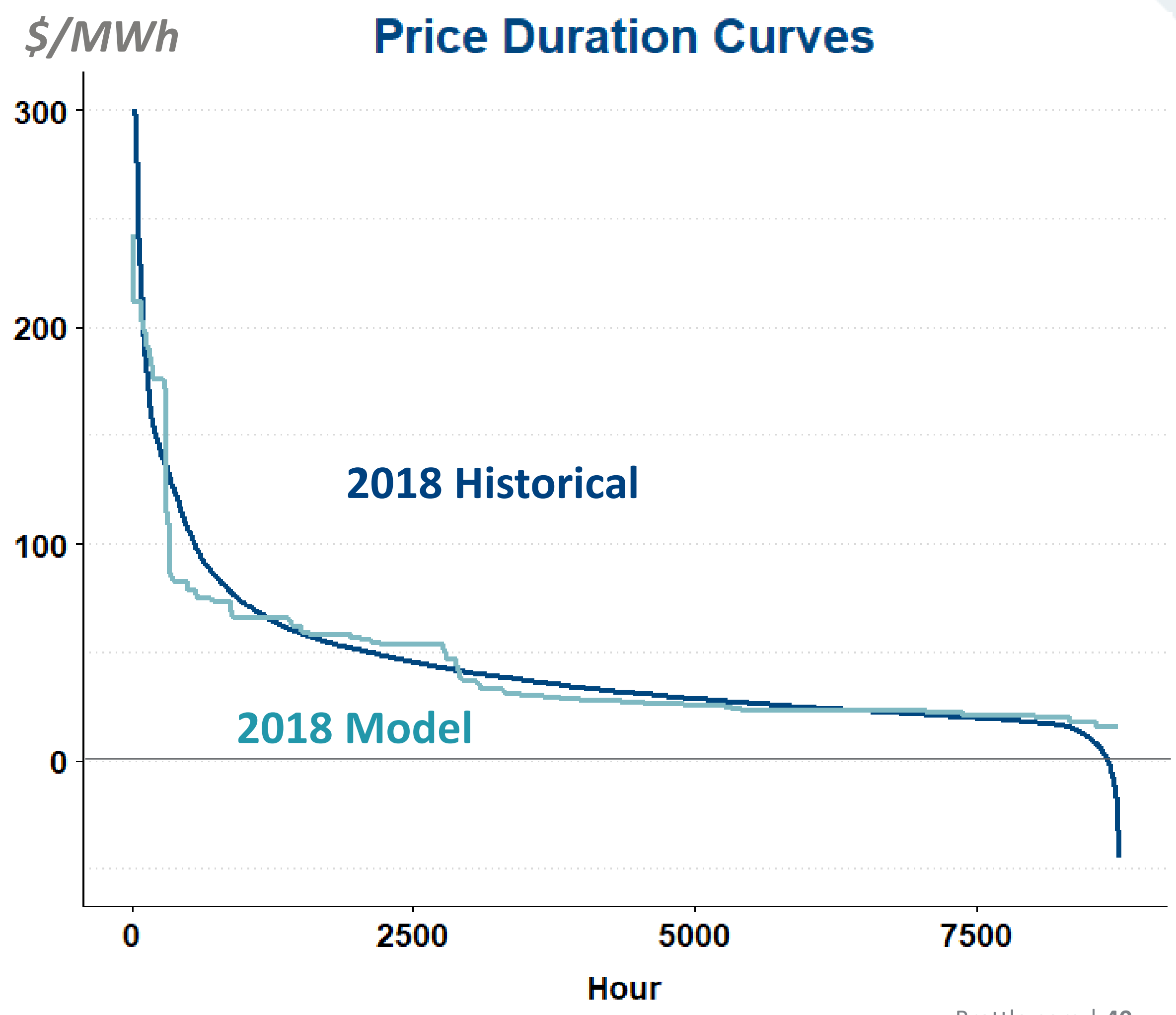
We validated GridSIM by replicating 2018 market conditions, including gas prices and generation mix

We compared modeled 2018 prices to realized 2018 market prices to see how well they align

- Historical All-Hours Average = $43.2/MWh
- Model All-Hours Average = $41.6/MWh

Model matches historical prices quite well

- Does not fully capture extremes – a few hours of extremely high or low prices
- Due to: hourly resolution limitations; not modeling scarcity pricing/bidding; single-zone representation of New England



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New England Demand Projection

Demand outlook is similar to Rhode Island's

- Moderate load growth through 2030
- Significant growth from 2030 to 2050 due to heating and transportation electrification

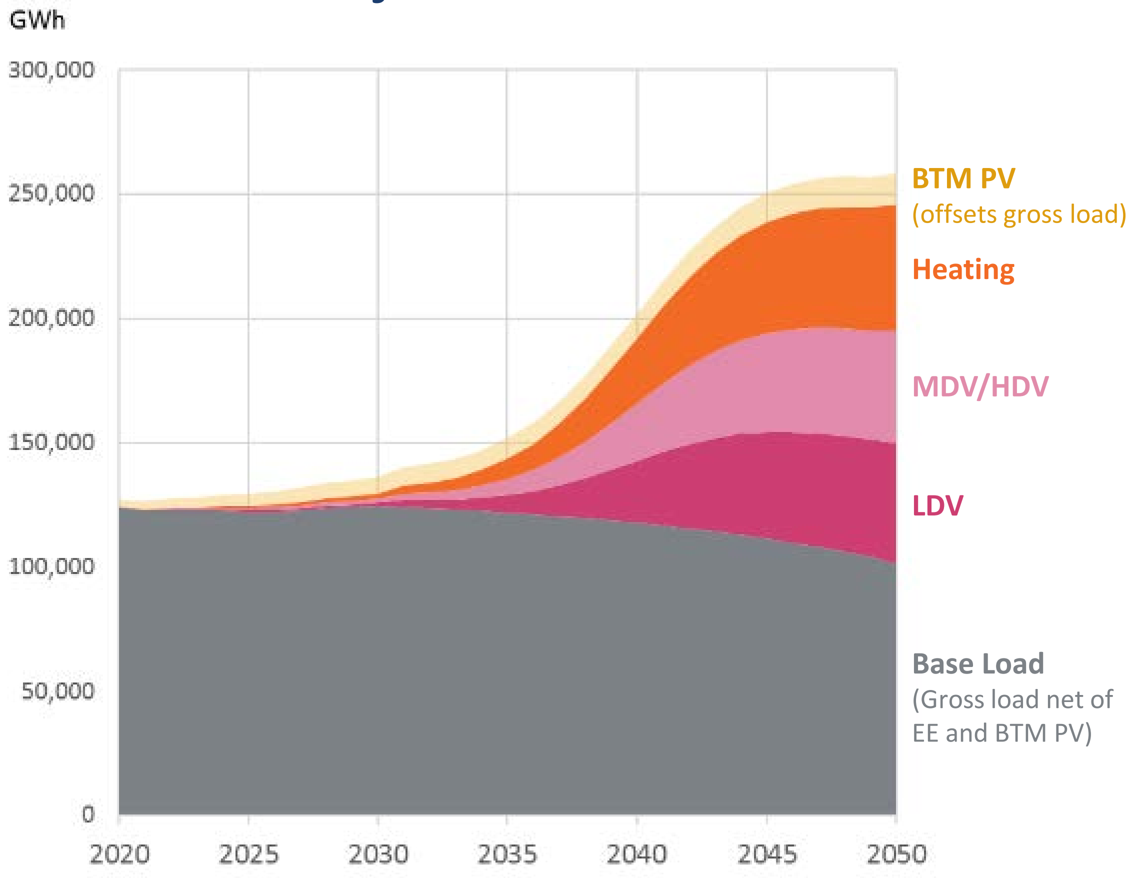
2020 to 2030:

- ISO-NE's CELT 2020 forecast with modifications to Rhode Island PV and EE additions for consistency
- Assume moderate electrification by 2030

2030 to 2050:

- Achieve region-wide 80x50 decarbonization goals though aggressive EE and electrification
- Load projections based on earlier 2050 load from previous New England analysis*

Load Projection for ISO-NE



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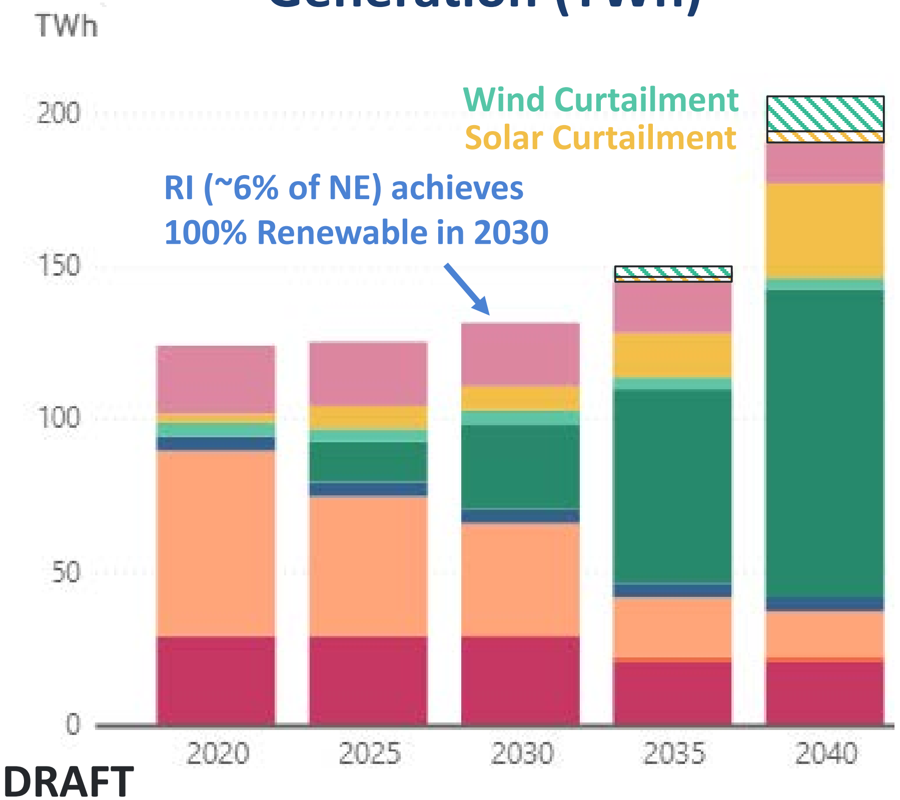
* Achieving 80% GHG Reduction in New England by 2050, prepared for Coalition for Community Solar Access, The Brattle Group, September 2019.

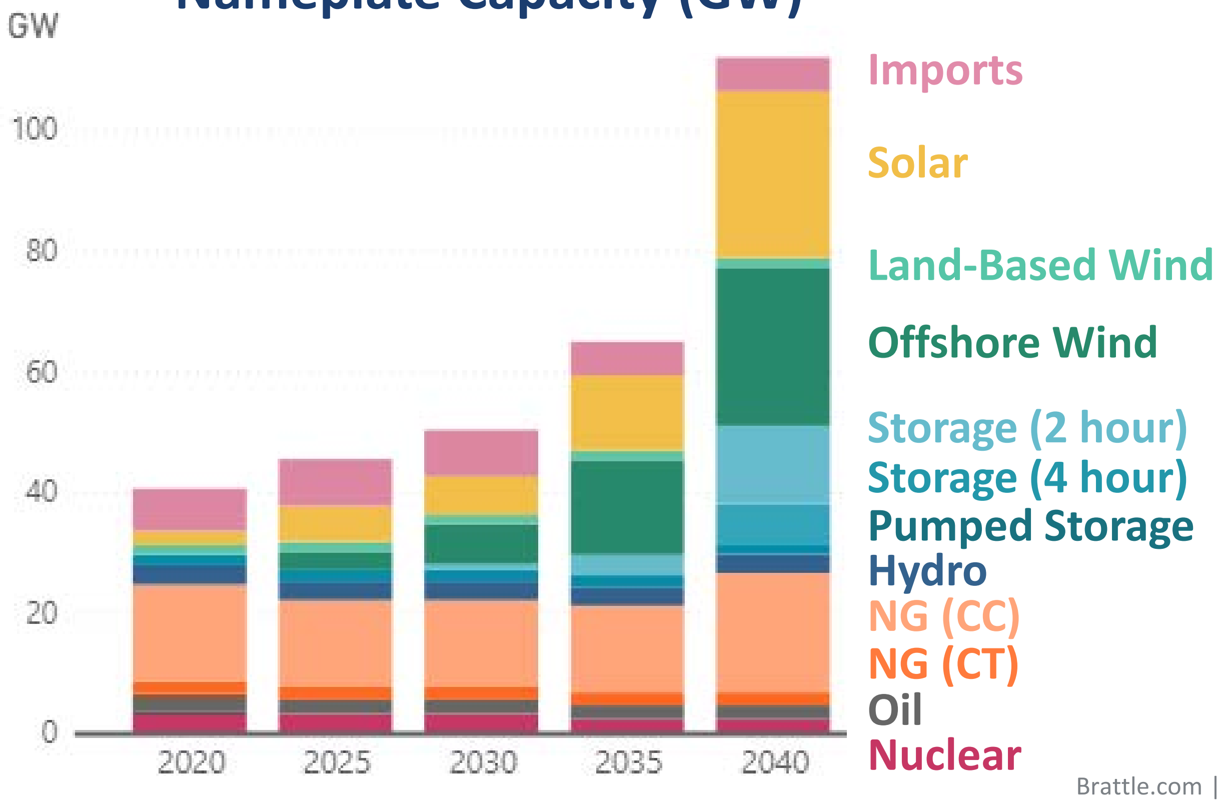
Projected New England Generation and Capacity to 2040

- Significant OSW and Solar additions; wind provides more energy due to higher capacity factors
- Gas generation drops sharply, but gas capacity remains for reliability; storage also important 2030+

Generation (TWh)



Nameplate Capacity (GW)



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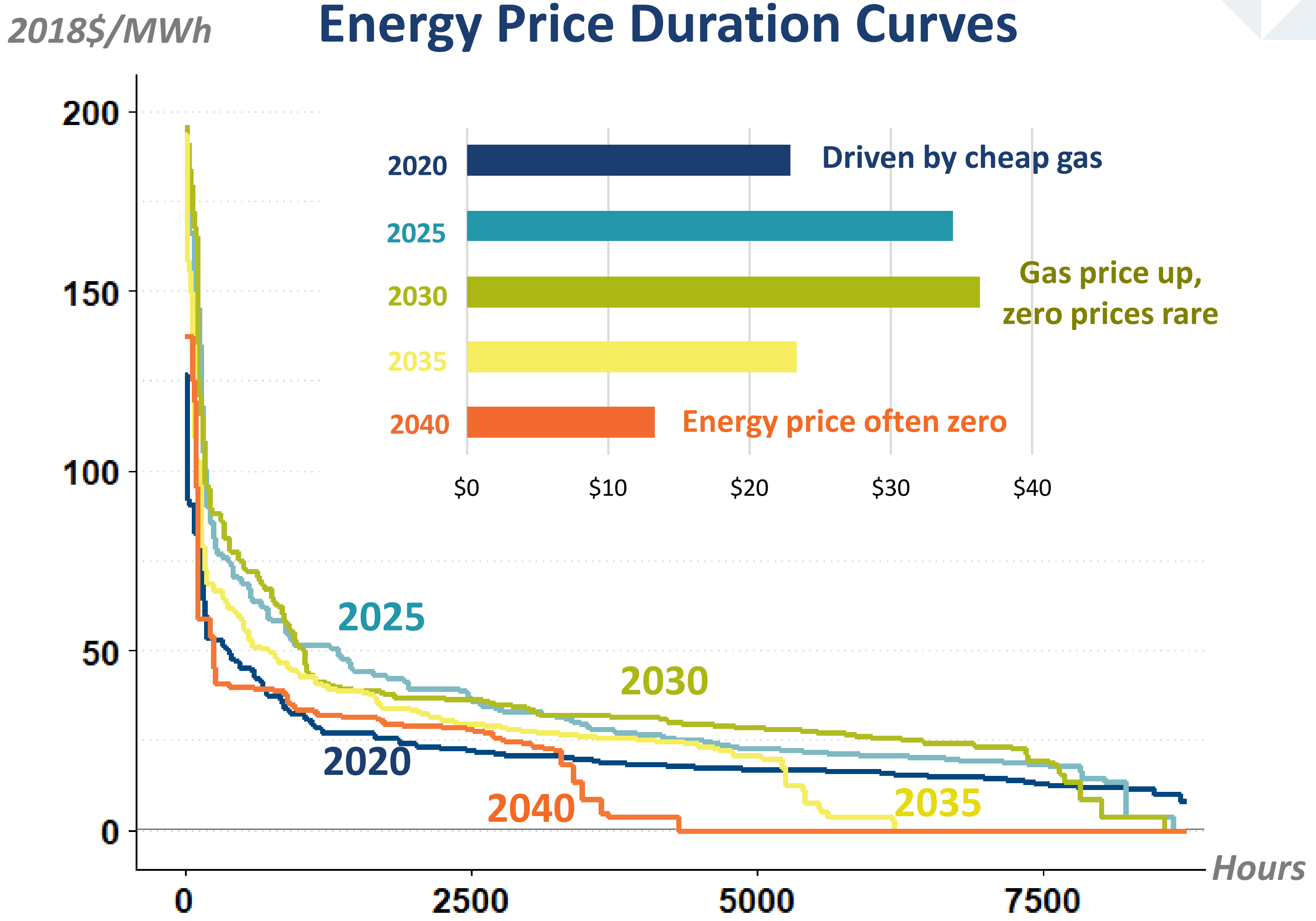
Projected Energy Market Prices

- As more renewables are integrated and fuel prices rise from current lows, electricity prices reflect several dynamics:
  - Higher prices throughout the year due to higher fuel (natural gas) prices
  - More frequent low (zero, negative?) prices as Renewables increase in later years
- Revenues for generation resources will shift from the energy market toward capacity, ancillary service and REC markets
  - Energy component itself will fall, but overall electricity costs may not

Energy Price Duration Curves



Note: Negatively priced hours are assumed to be zero.

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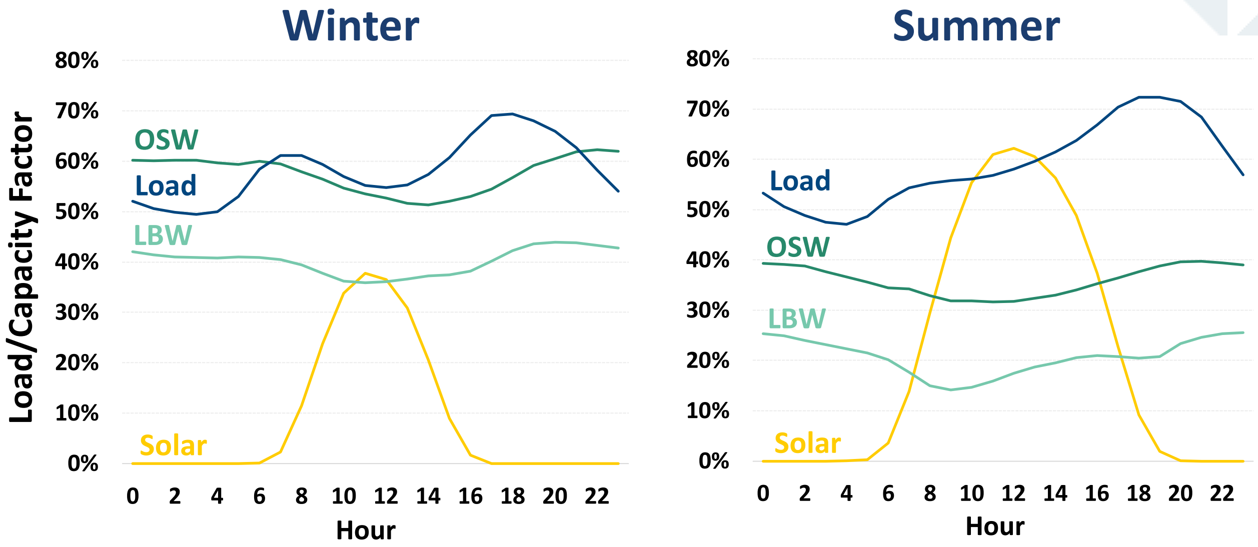
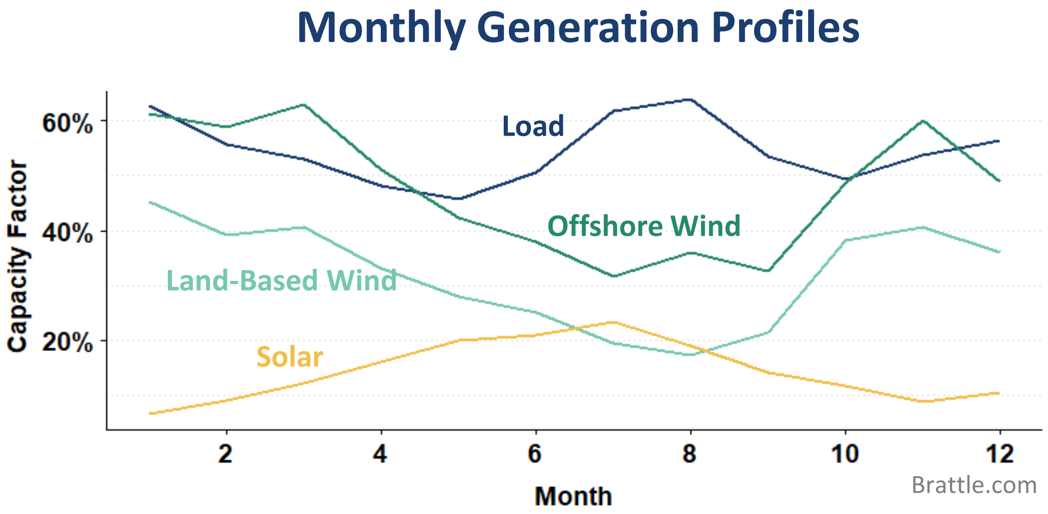
Generation Hourly Shape vs Load Affects Value

- Comparing renewable generation shapes vs load illuminates sources of value
- Load:
  - Higher in morning, evening
  - Higher in summer/winter vs spring/fall
- Renewable Generation:
  - Solar peaks mid-day; most in summer
  - Wind is fairly flat through the day; lower overall in summer
- Hourly prices are correlated with load, so market value is also affected





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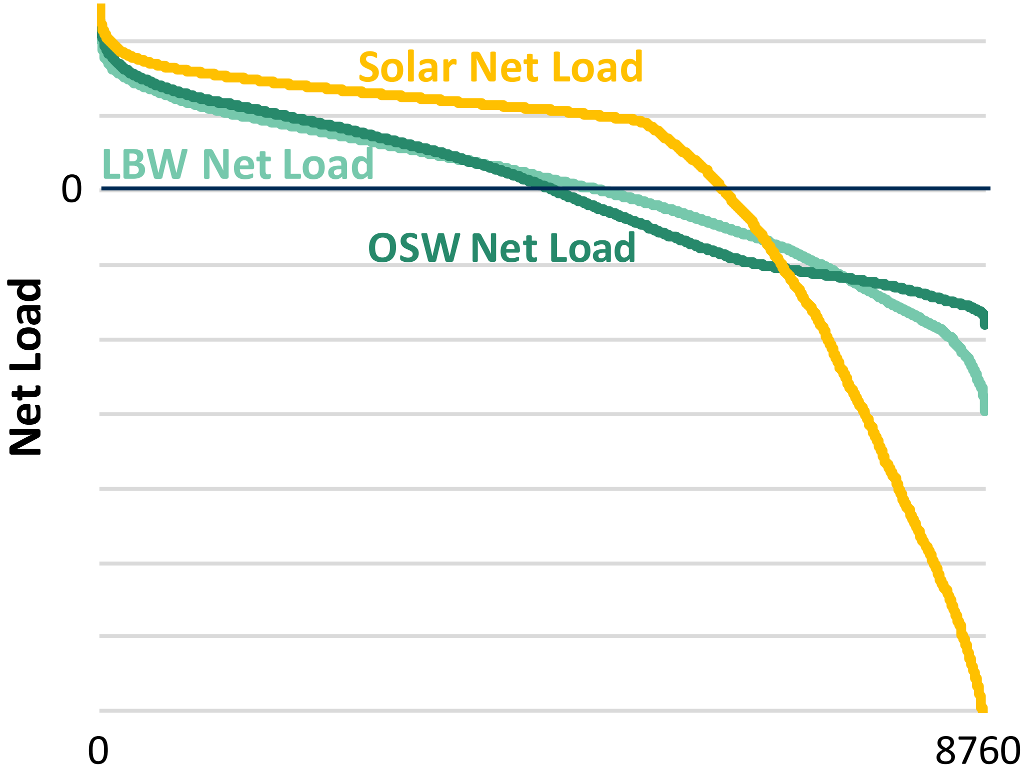
Coincidence between Load and Renewable Generation

Annual Net Load Duration Curve
(Net Load = Load – Generation)



- Compare hourly shape of load and renewable generation to understand coincidence for Solar, OSW, LBW
  - Scale generation from a resource to match slice of load
  - Load and each resource have different hourly profiles
- "Net Load" measures the match, hour by hour
  - OSW and LBW have better match to load
    - Solar output is concentrated in fewer hours, mostly summer, with no solar at all in most hours
    - Wind (OSW, LBW) shape is better, though still imperfect
  - Solar may nonetheless complement wind
    - Both daily and seasonally
- High renewable penetration can depress market price
  - In the hours that most renewable power is produced
- Storage helps match generation to load, at a cost

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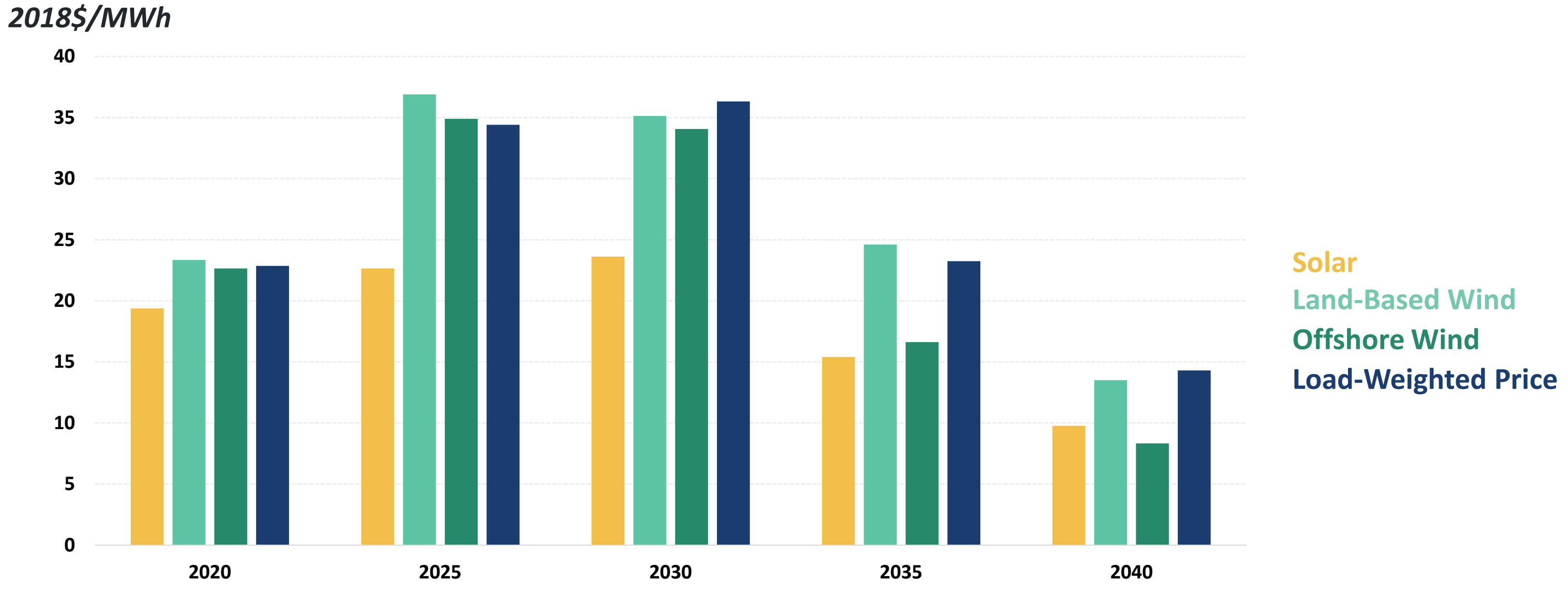
Projected Market Revenues for Renewable Energy

- Renewable resources can receive significantly different energy prices – due to generation timing
- Solar has lower market value, esp. 2025-2030; OSW also drops later as its penetration increases
  - Lower solar value is due also to summer-weighted output, when gas (thus power) prices lower

Energy Market Revenue Offset by Resource Type ($/MWh)



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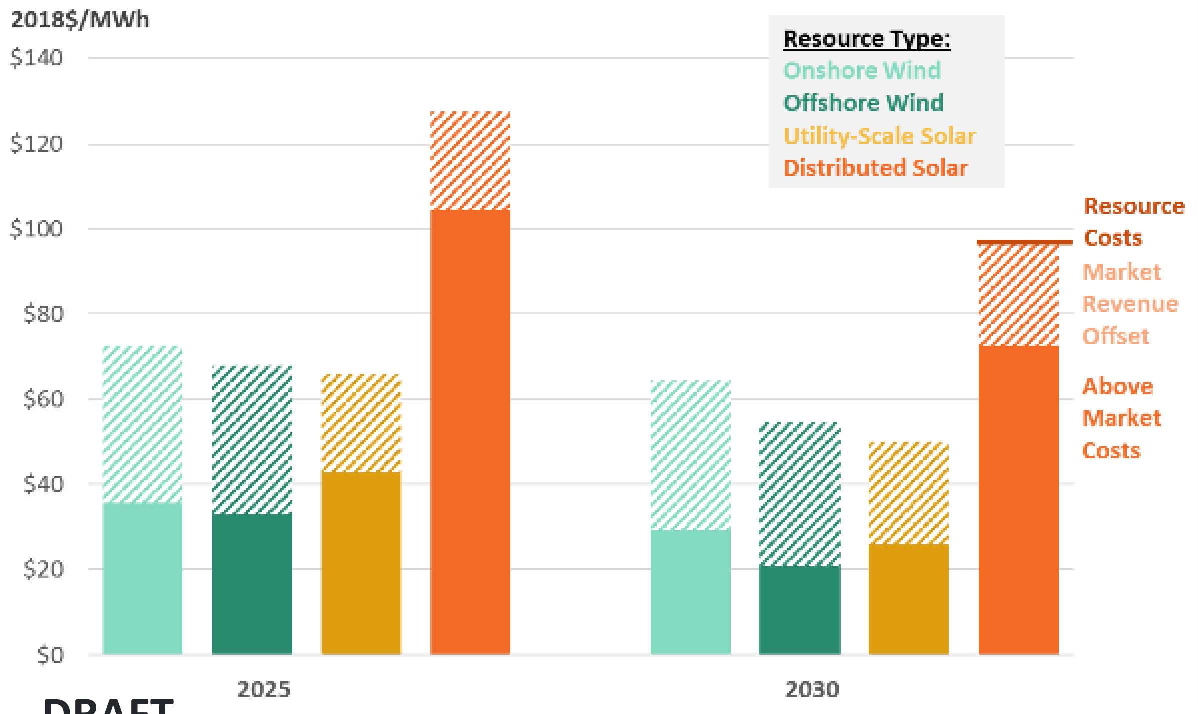
Bookend Portfolio Analysis

Net Costs of Renewable Resources to RI Customers

- Above-market costs are similar and relatively low for larger resources based on current cost projections
- Higher for distributed solar, though it may offer economic development benefits associated with local economic activity

First-Year Above Market Costs by Resource Type



Range of First-Year Above Market Costs in 2030

2018$/MWh	Low Costs	Base Costs	High Costs
Onshore Wind	$13	**$29**	$45
Offshore Wind	$7	**$21**	$34
Utility-Scale Solar	$14	**$26**	$39
Distributed Solar	$48	**$73**	$97

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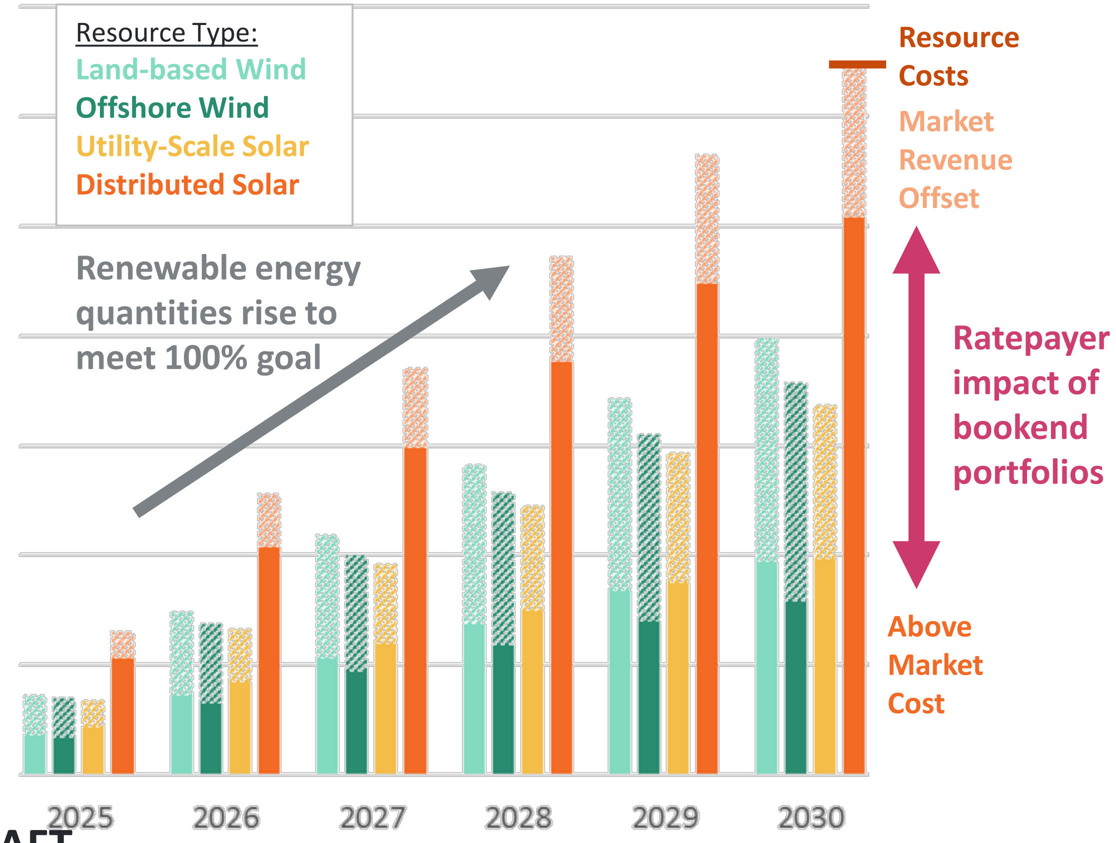
Net Costs to Ratepayers – Bookend Portfolios

Ratepayer Cost Impact to Fill the Gap

(Baseline Demand, Base Cost Projections)



Illustrated cost impact is for the additional renewables to fill the Gap

- Does not show cost to RI customers of previously acquired RECs (such as Revolution Wind)
- Ratepayer costs increase with quantity as more new resources are acquired over time
  - A bit less than proportional since costs declining
- Beyond 2030, above-market cost (₵/kWh) should stabilize
  - Renewable share won't go beyond 100%
  - Additional Renewables beyond 2030 to meet increasing electrification load will be spread across the higher load, thus don't raise unit cost (₵/kWh)

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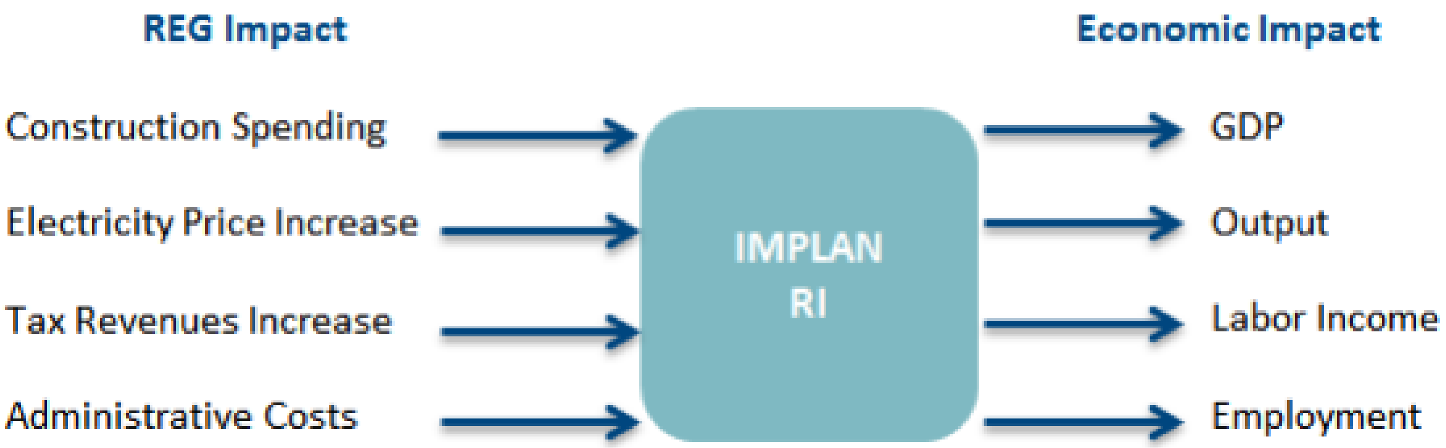
IMPLAN – Economic Impact Analysis (in process)



Example of Results from Prior RE Growth Analysis - 2017

	Employment	Labor Income	GDP	Output
Direct Effect	62	$108,800,000	$176,300,000	$266,500,000
Indirect Effect	2	$1,600,000	$2,400,000	$4,100,000
Induced Effect	25	$32,000,000	$57,300,000	$94,000,000
Total Effect	88	$142,400,000	$236,000,000	$364,700,000

Economic impact of several factors affected by additional renewables

- **Local expenditures** for in-state renewable construction create jobs and economic activity
- Higher **electricity prices** reduce consumers’ disposable income, blunting economic activity
- **Taxes** and **administrative costs** also considered

We will quantify in IMPLAN the Direct, Indirect, and Induced effects on:

- GDP, Output
- Employment, Labor Income

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Source: Berkman & Weiss, Renewable Energy Growth Program Analysis: Economic, Jobs and Environmental Impacts for Program Years 2015 and 2016 and the Overall Program Years 2015 to 2019, May 2017

Next Steps for Analyzing Renewable Portfolios

Economic Impact analysis

- GDP; jobs impact of in-state activity (for resources installed or sourced in-state)
- Net Metering and VNM cost shifts amongst ratepayers

Develop and evaluate additional portfolios

- Combinations of resource types (though not all possible combinations and shares)

Environmental (GHG) impacts

- Will be similar for all portfolios: all achieve 100% renewable energy and offset similar fossil generation

Consider more qualitative factors as well

- Land use; equity impacts

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Next Steps: Developing Policy Recommendations

Next Steps: Policy Recommendations

Consider procurement mechanisms and system needs

- Direct competition between all resource types may be challenging due to differing scales
  - But should at least inform one another
    - Compare prices paid via programs or procurements to available alternative RE resource types
    - E.g., via reservation price in auctions
- Learning over time
  - Cost declines unlikely to follow projections exactly, and may deviate substantially in even a few years
  - Revise procurement targets and mechanisms with learning from RI and other states' experience
- Load uncertainty means quantity uncertainty – could plan to fill any unexpected gap with NE RECs?
  - Plan to maintain 100% renewable beyond 2030 – will likely require significantly more renewables
- Consider policy changes needed
  - E.g., raise RES share target to 100% by 2030
  - Amend treatment of BTM resources (those with RECs)

Q&A

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)

Post-Workshop Survey

We invite all attendees to respond to a short survey via PollEverywhere at PollEV.com/eresources411. All responses will be anonymous. Thanks in advance for your responses!

Thank You

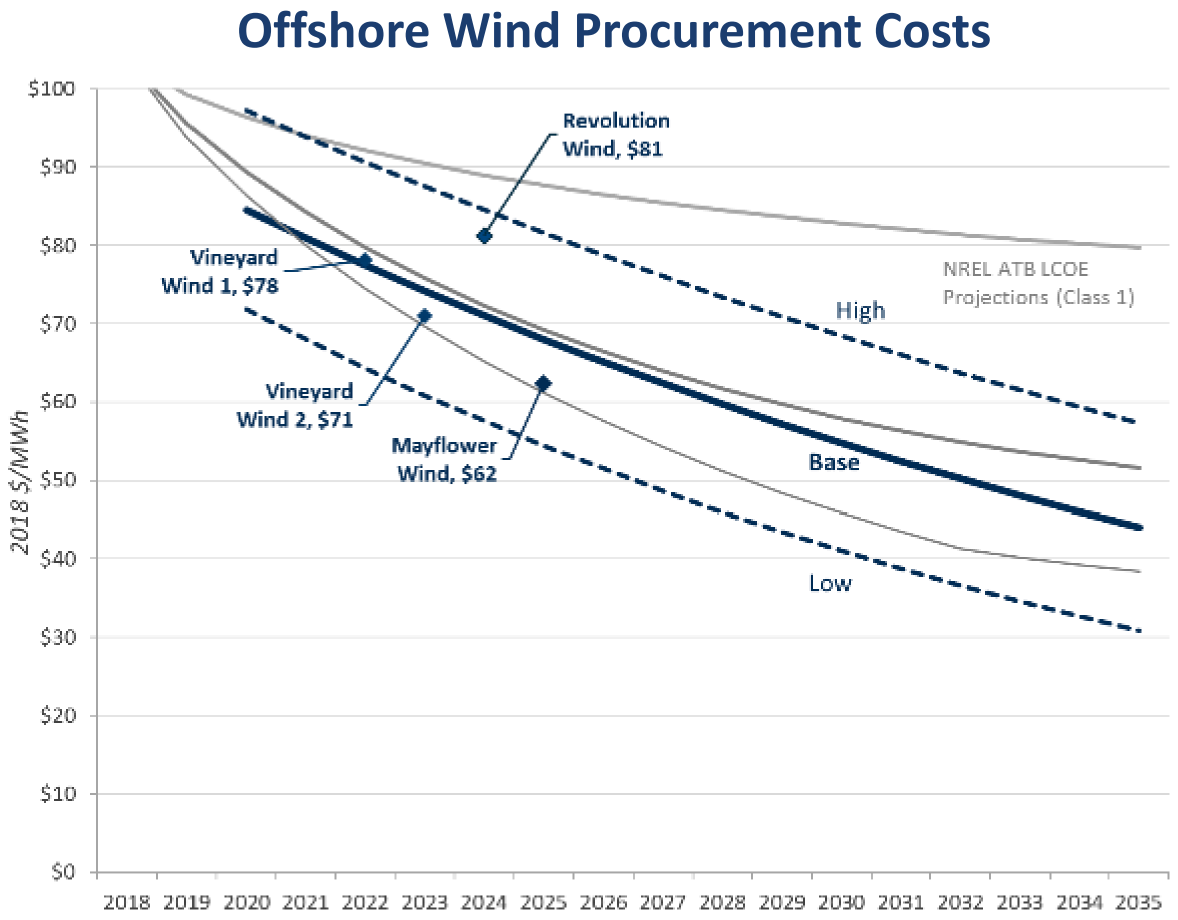
www.energy.ri.gov/100percent

Energy.Resources@energy.ri.gov

We invite you to attend, contribute, and help shape pathways to a clean, reliable and affordable electricity future!

Appendix

Offshore Wind Procurement Costs



Offshore Wind Reference Points

	Vineyard Wind 1 ($/MWh)	Vineyard Wind 2 ($/MWh)	Revolution Wind ($/MWh)	Mayflower Wind ($/MWh)
Energy & REC Contract Price	**$74**	**$65**	**$98**	**$58**
Adjustments for years, escalation, and contract length	-$7	-$8	-$28	-$10
Tax Credit Value	+$5	+$8	+$5	+$8
Capacity Value	+$6	+$6	+$6	+$6
Total Resource Cost	**$78**	**$71**	**$81**	**$62**

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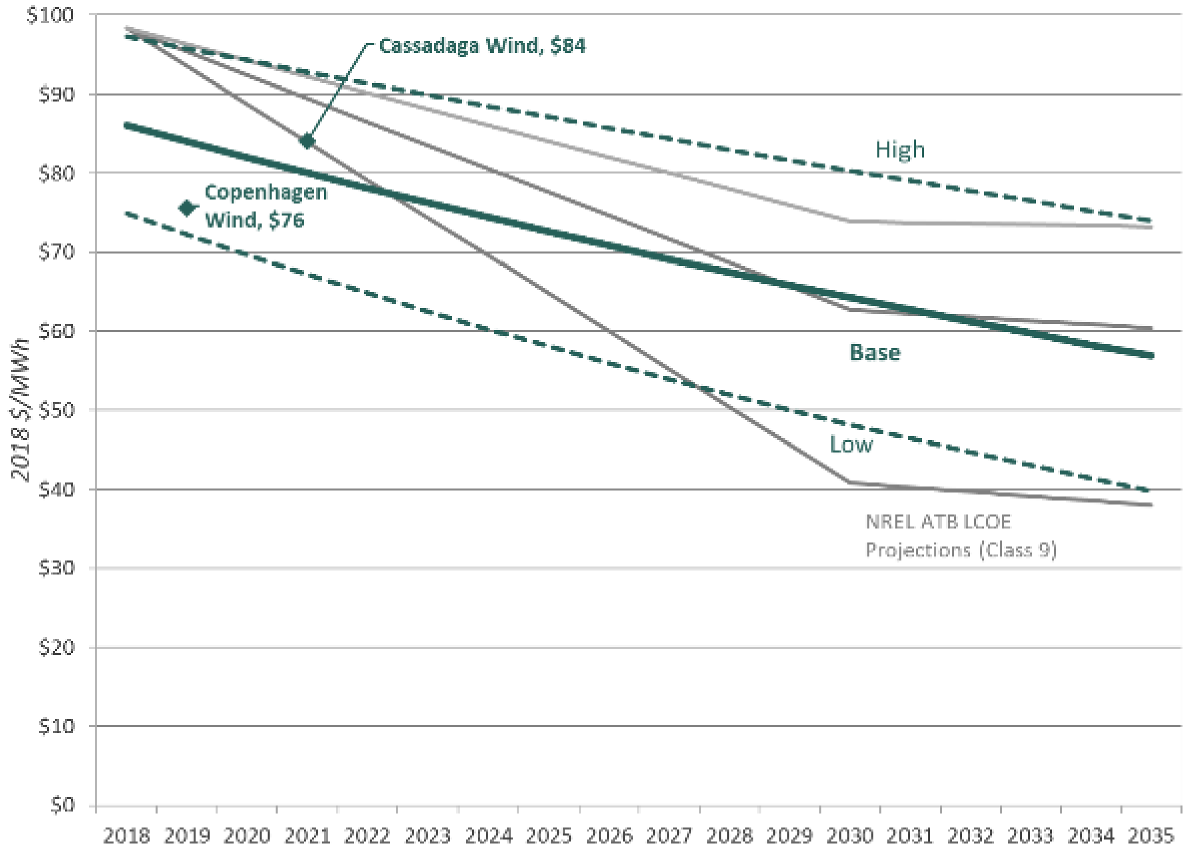
Land-Based Wind Procurement Costs

Lnad-Based Wind Procurement Costs



Land-Based Wind Reference Points

	Copenhagen Wind ($/MWh)	Cassadaga Wind ($/MWh)
Energy & REC Contract Price	**$80**	**$78**
Adjustments for years, escalation, and contract length	-$18	-$5
Tax Credit Value	+$8	+$5
Capacity Value	+$6	+$6
Total	**$76**	**$84**

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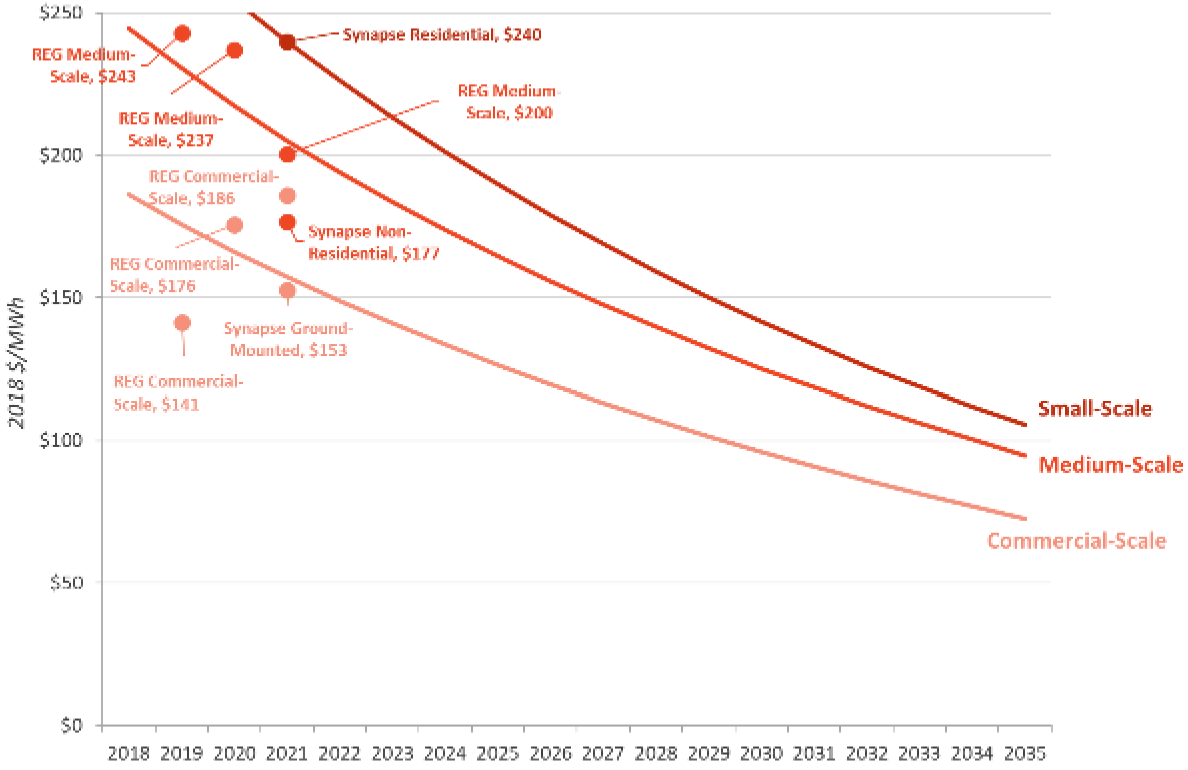
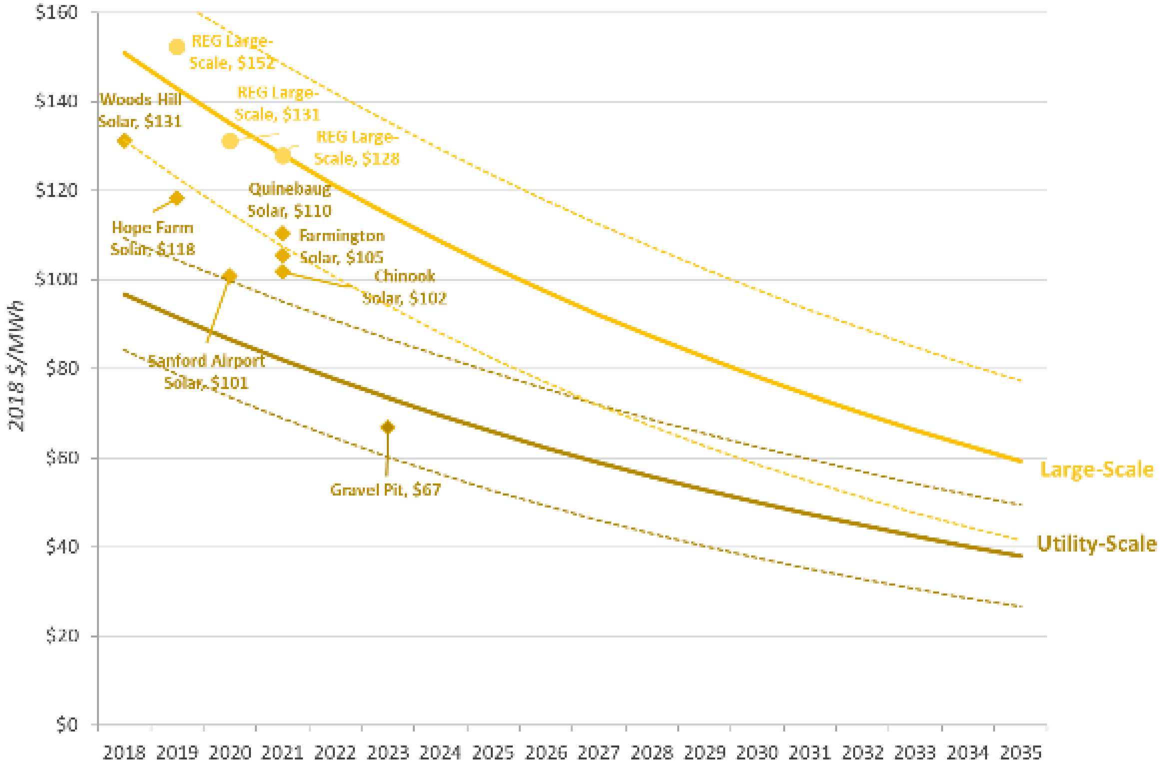
Solar Procurement Costs

Small-, Medium-, and Commercial-Scale Solar Costs



Large- and Utility-Scale Solar Costs



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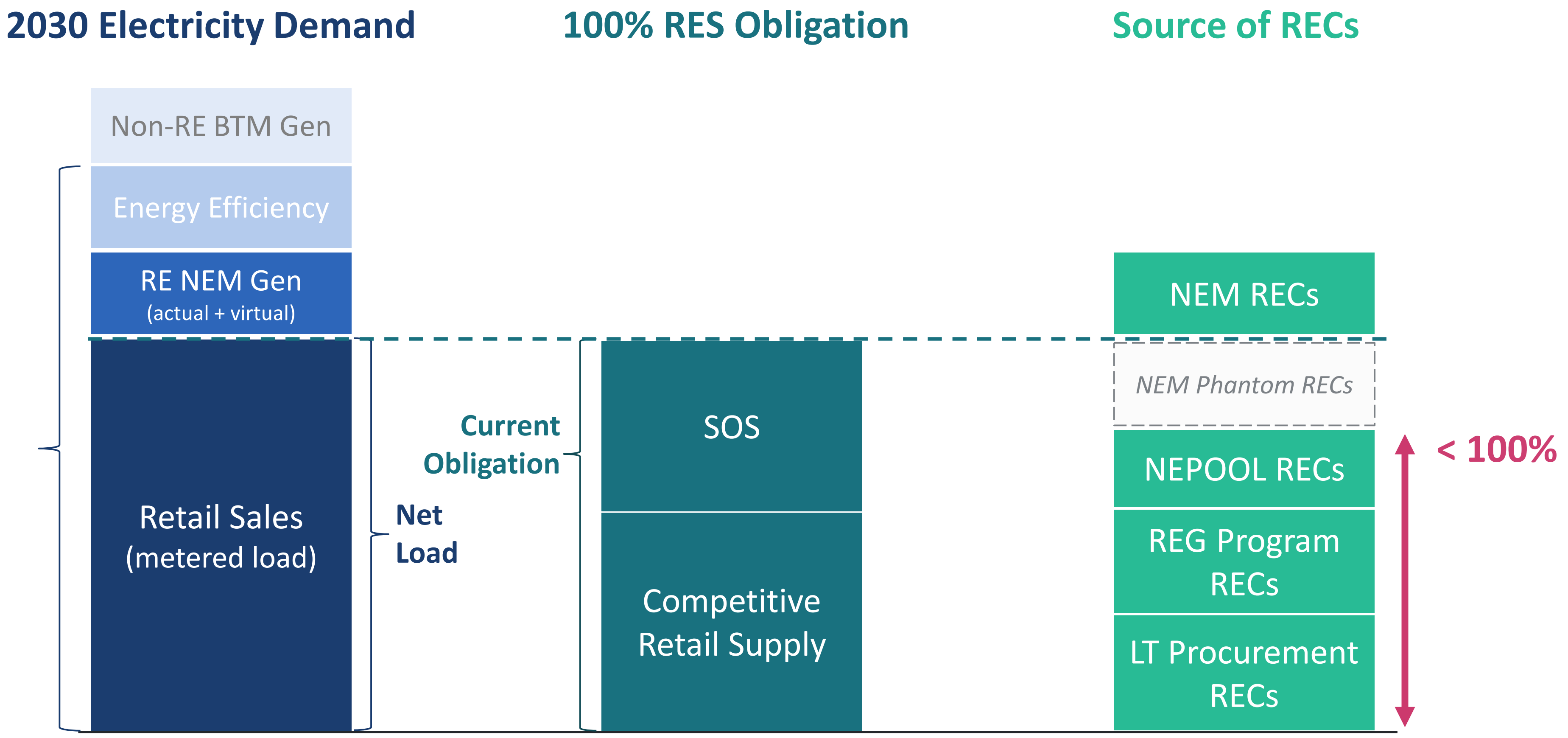
Solar Procurement Costs

Solar Reference Points

	Chinook Solar, 2021 ($/MWh)	Gravel Pit Solar, 2023 ($/MWh)	RE Growth, 2020 Large Scale ($/MWh)	RE Growth, 2020 Commercial Scale ($/MWh)	RE Growth, 2020 Medium Scale ($/MWh)
Energy & REC Contract Price	**$82**	**$53**	**$127**	**$185**	**$199**
Adjustments for years, escalation, and contract length	-$6	-$5	-$30	-$41	-$43
Tax Credit Value	+$19	$12	+$24	+$35	+$37
Capacity Value	+$7	$7	+$7	+$7	+$7
Total	**$102**	**$67**	**$128**	**$186**	**$200**

100% RES Obligation based on Net Load



Issue: If load served by net metered renewables is not included in RES, RECs from these renewables would dilute RES and result in less than 100% renewable energy

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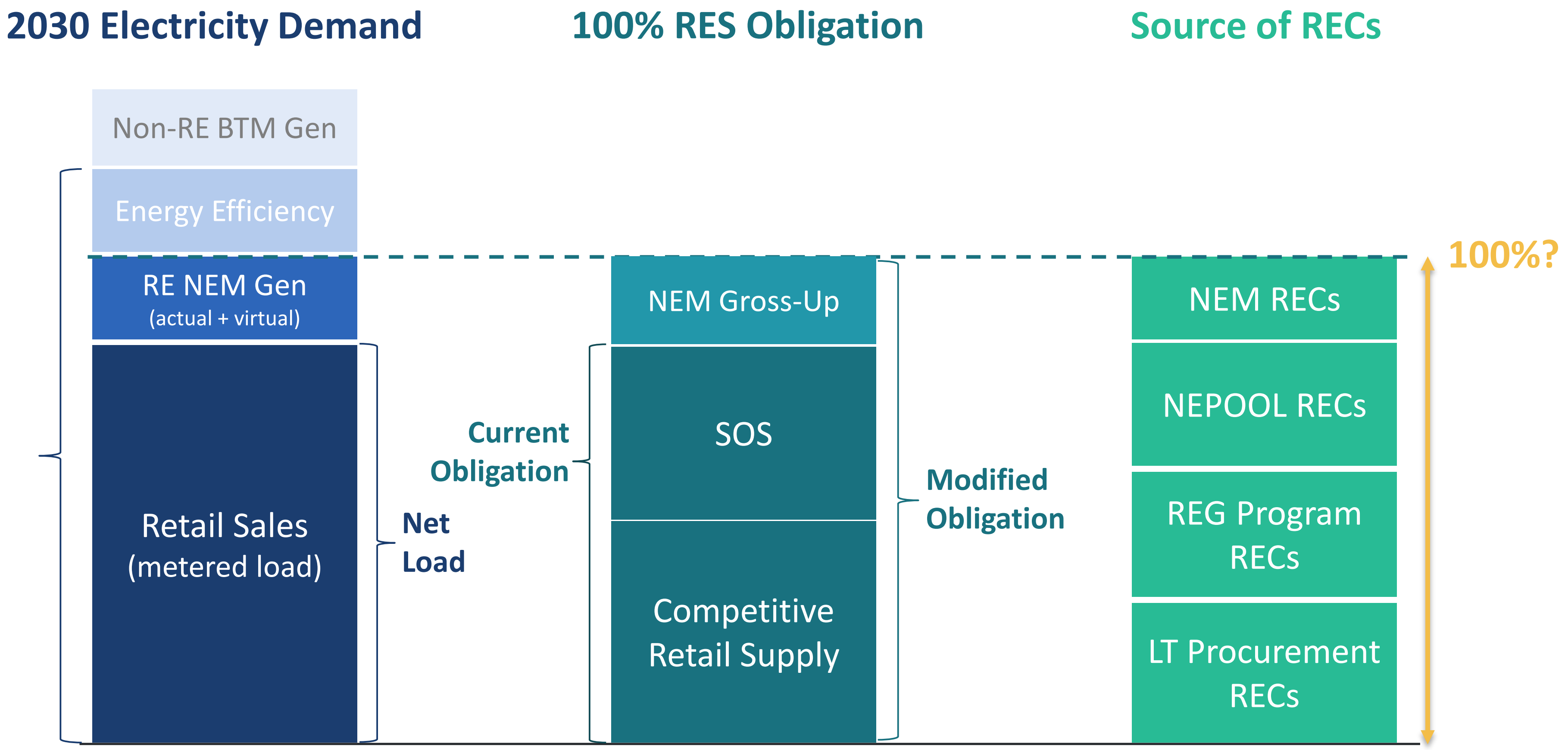
100% RES Obligation based on Net Load **with NEM Gross-Up**



Proposal: Gross up Metered load with load served by (renewable) NEM generation; this is equal to the number of RECs generated by the NEM resources

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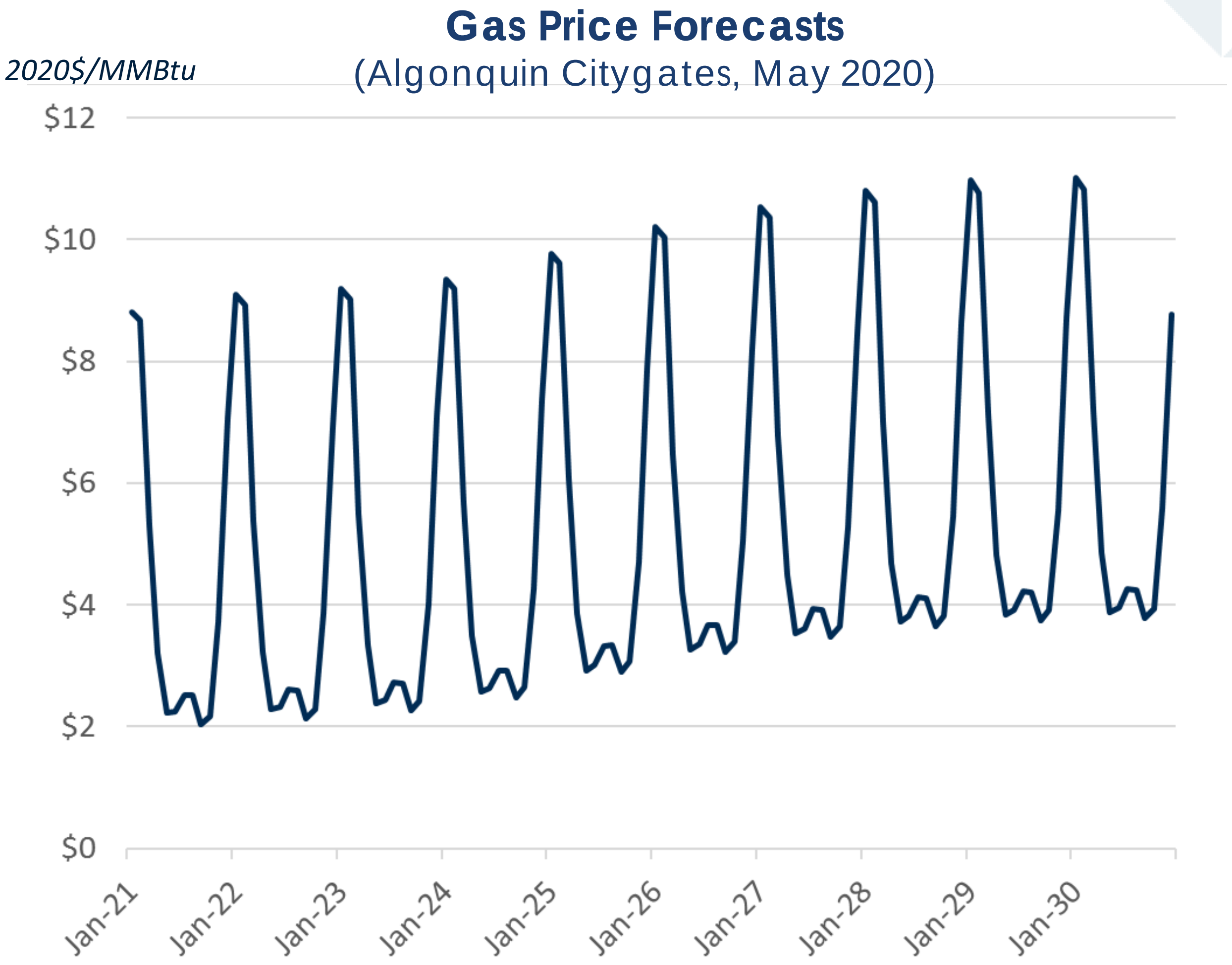
Existing and planned renewable supply additions

- **Rhode Island**
  - Offshore Wind: 430 MW
  - RE Growth: About 400 MW
- **Tri-State (RI/MA/CT) RFP**
  - Solar: 300 MW
  - Wind: 150 MW
- **Massachusetts**
  - Offshore Wind: 1,600 MW (*plus* 1,600 MW)
  - Solar (SMART): 3,200 MW
  - Hydro Imports: 1,200 MW
  - Energy Storage: 1,000 MWh
- **Connecticut**
  - Offshore Wind: 1,100 MW (*plus* 1,200 MW)
- **Maine**
  - Distributed Renewables: 375 MW

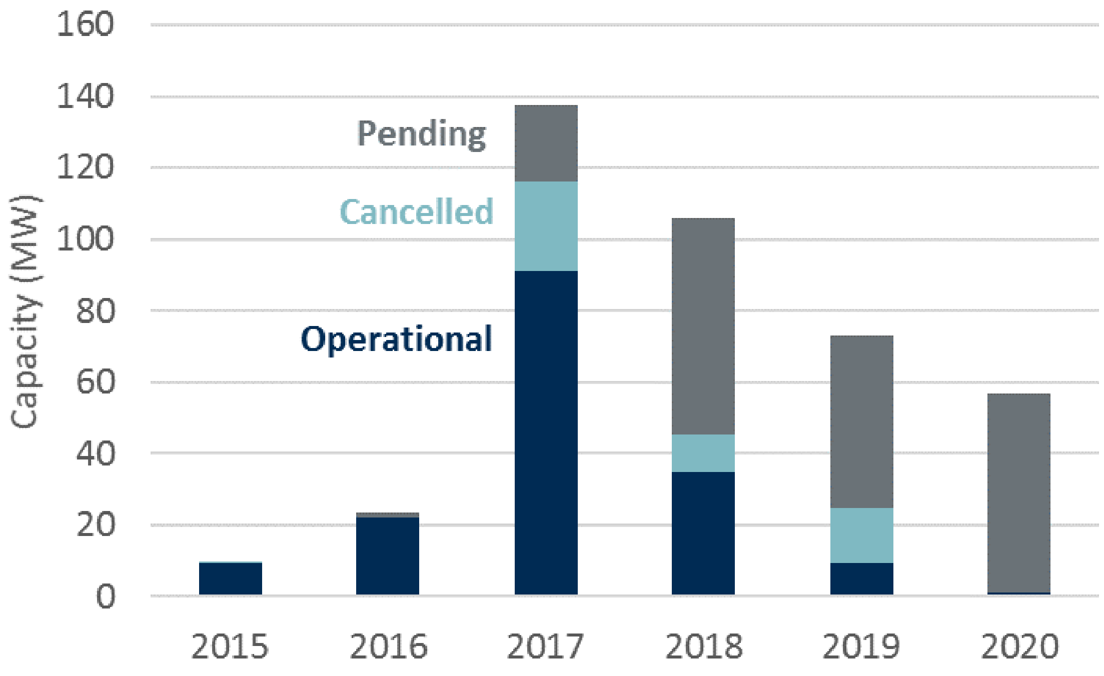
Gas Price Forecast

- Developed monthly gas prices using an approach relying on:
  - Near-term futures for the relevant hubs
  - Long-term fundamentals-based projections from the EIA Annual Energy Outlook
- Gas prices rise from an average of $4/MMBtu in 2020 to $6/MMBtu in 2030
- Gas price projection developed for 4 NE hubs:
  - Algonquin Citygates, Iroquois Zone 2, TGP Dracut, TGP Zone 6



Sources and Notes:
Gas price forecast based on NYMEX and CME Clearport market data from S&P Global Market Intelligence and EIA Annual Energy Outlook

Solar Interconnection Costs



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