Examination of the Value of and Need for Energy Storage Resources in Rhode Island

Report to the Rhode Island Senate in Response to Resolution 416

Rhode Island Public Utilities Commission

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Executive Summary

Introduction

On June 23, 2023, the Rhode Island Senate passed Senate Resolution 416 (the Resolution). The Resolution requested the Public Utilities Commission (PUC) to study the costs and benefits of energy storage resources in Rhode Island, identify any barriers and market inefficiencies facing energy storage resource deployment today, and to report on whether new tariffs or programs for energy storage resources are necessary to achieve the state's goals related to reducing the cost of the electric power system and facilitating the transition to carbon-free electricity. Additionally, the Resolution requested the PUC adopt a framework for an electric service tariff to apply to energy storage resources connected to the electric distribution system in Rhode Island.[1] The PUC presents the results of the requested analysis and review in this Report.

The Commission acknowledges the significance and timeliness of the questions raised by the Rhode Island Senate in its Resolution and welcomes the opportunity to evaluate energy storage resources with stakeholders. As an economic regulator, the Commission serves the role of market designer for the state's public utilities. Through that role, the Commission has developed unique expertise in cost-benefit analysis and market design, particularly related to the electric power system. The Commission and its staff drew from this expertise to carry out the critical analysis requested by the Resolution.

Recognizing the importance of stakeholder collaboration to delivering a fair, balanced Report, the Commission initiated a stakeholder engagement process in December 2022. For administrative purposes, the Commission conducted the stakeholder engagement process in Docket No. 5000, a preexisting and open investigation into the treatment of storage as an electric distribution resource.[2] The stakeholder engagement process consisted of a public kickoff meeting and four PUC staff-led workshops between December 2022 and March 2023. Over the course of the workshops, staff led stakeholders[3] in a qualitative review of storage costs and benefits using the Rhode Island Benefit-Cost Framework, invited stakeholders to present on existing storage procurement mechanisms, and moderated roundtable discussions among stakeholders regarding barriers facing energy storage deployment in Rhode Island. The results presented in this Report are directly informed by the discussions and analysis from the Docket No. 5000 stakeholder workshops.

Costs and Benefits of Energy Storage

Chapters 1 and 2 of the Report present the results of staff and stakeholders' qualitative analysis of the costs and benefits of energy storage resources. As with all electric power resources, the value of energy storage resources is dependent on the actual needs of the electric power system and the ability of resources to meet those needs, recognizing that the needs of the electric power system change from moment to moment and from location to location. For that reason, evaluating the potential values and/or benefits from a resource requires careful consideration of how that resource could perform during different power system conditions.

Energy storage resources are inherently flexible and can perform a wide variety of functions to meet system needs. Whereas traditional load or generation resources can only perform a single function (consuming energy or generating energy, respectively), energy storage resources can perform four different functions:

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[1] The Resolution also requested the PUC adopt targets for installed storage capacity. The Commission communicated to the sponsors of the Resolution and to stakeholders alike that it did not have sufficient resources to perform the necessary quantitative technical and economic analysis to recommend specific deployment targets for energy storage.

[2] The RIPUC Docket No. 5000: https://ripuc.ecms.ri.gov/eventsactions/docket/5000page.html

[3]Participating stakeholders represented a range of interests and backgrounds, from private developers to environmental advocates to state agencies. A list of stakeholders who participated in the workshops can be found in Appendix A.

charging, discharging, sitting as an empty vessel, and sitting as a full vessel. Because of this functional flexibility, storage resources have vast *theoretical* potential to create useful value. Whether or not they will deliver *actual* value at any given moment depends on the *actual potential* to perform a specific function in that moment. It is important to keep in mind that while storage resources are technically capable of performing many different functions, they can only perform one function at a time. Even if multiple functions would be beneficial at a given moment, a storage resource can only deliver those benefits associated with the single function it performs in that moment.

To illustrate the importance of time, location, and function to the actual value of energy storage, staff and stakeholders qualitatively analyzed the function(s) an energy storage resource would likely perform under five illustrative power system scenarios and the resulting costs and benefits of that performance. The five scenarios represent a typical range of system conditions that occur on the local electric power system in Rhode Island and the regional electric power system in New England.

The results of the scenario analysis are presented in Chapter 2 of the Report. The results indicate that energy storage resources are capable of performing many different functions that have value to the electric power system and to society. The magnitude of that value depends on the condition(s) of the power system when and where storage performs the function(s). Qualitatively, the Commission finds that, across the full range of power system conditions represented by the five scenarios, energy storage can deliver broad benefits. These benefits, discussed in greater detail in Chapters 2.1 and 2.2 of the Report, are:

- **Benefits associated with power generation.** By charging when electricity prices or emissions (and associated externalities) are low and discharging when prices or emissions are high, energy storage can reduce the market price for electricity and the negative externalities caused by electricity generation. Because the need for electricity generation is constant, storage resources always have the opportunity to perform these functions and deliver the associated benefits.
- **Benefits associated with power quality and performance.** When power imbalances or other negative conditions arise on the electric power system that diminish the quality of the power served to customers, storage resources can improve power quality by charging or discharging as needed.
- **Benefits associated with relieving capacity constraints.** When peak conditions near or exceed the capacity of the power system (e.g. generation capacity, transmission capacity, distribution capacity), utilities and system operators must upgrade or expand their existing infrastructure. By performing during these peak conditions, storage can avoid the need for new capacity investments. Unlike the constant need for power generation, capacity constraints – and the opportunity for storage to relieve them – are periodic.
- **Backup power benefits during outage conditions.** Storage can supply backup power to individual customers or groups of customers (e.g. a microgrid) during grid outages. Unlike the prior benefits that are shared between all electric customers, backup power benefits flow only to those customers who are in the right location to receive power from the storage resource (as is the case with backup diesel generators). To supply backup power, a storage resource must be fully charged going into an outage and located on the "right side" of the outage near customers who are out of service. Charging up and holding on to stored energy may require a storage resource to forego performing otherwise valuable functions outside of outage conditions, which could limit its actual value.

Energy storage is not the only resource that can perform valuable functions for the power system. Alternative resources include new generation capacity (including distributed generation), new transmission or distribution capacity, demand response, and energy efficiency. Given current technology costs, these alternative resources are often capable of meeting the same system needs (and delivering the same values) as energy storage at a lower cost. In the future, the value of energy storage may increase in response to changing system conditions driven by increasing customer demand and investment in clean intermittent generation, and the costs of energy storage may fall. If that happens, the net benefits (i.e. cost savings) of energy storage will increase. Chapter 2.2 contemplates future system needs and presents a detailed outlook on the future of energy storage value under each of the five power system scenarios.

Existing procurement mechanisms for energy storage resources

In collaboration with stakeholders, PUC staff identified four existing procurement mechanisms (i.e. programs and tariffs) through which storage resources are procured in Rhode Island. These four existing procurement mechanisms include: the ConnectedSolutions demand response program and the System Reliability Procurement program administered by Rhode Island Energy; the energy storage incentive program administered by the Renewable Energy Fund (REF); and ISO-NE wholesale market tariffs. Through these procurement mechanisms, storage developers and customers receive revenue for certain values that their storage resources create. Chapter 3 reviews these procurement mechanisms in greater detail.

In terms of the scale of existing storage procurements, more than 250 residential customers already participate in the ConnectedSolutions program with a battery storage device; commercial customers participate with individual battery storage devices as large as 10 MW. The REF storage incentive program awarded more than $250,000 in storage incentives to 88 small scale storage facilities and 4 commercial storage facilities in 2022. While Rhode Island Energy's System Reliability Procurement plans have led to contracts with energy storage resources, no storage facility supported by those plans has achieved commercial operation yet. Regarding the ISO-NE wholesale markets, stakeholders identified at least one utility-scale storage facility located in Rhode Island (a 3 MW, 9 MWh battery in Pascoag, Rhode Island) that was installed to avoid system capacity constraints and participate in ISO-NE's wholesale markets.

The existing storage programs and tariffs have been instrumental in the early deployment of energy storage resources in Rhode Island. However, the four programs operate in a patchwork. As a result of design inefficiencies, they may not incentivize the full range of net positive value that energy storage resources are capable of delivering today. This potentially leaves significant value on the table.

Are new tariffs or programs for energy storage resources necessary to achieve state goals?

Chapter 4.1 presents an analysis of whether the existing storage procurement mechanisms presented in Chapter 3 are sufficiently designed and administered to procure the full range of net benefits from energy storage resources. The Report concludes that Rhode Island's existing storage procurement mechanisms feature critical design limitations that can be addressed and improved through the implementation of at least two new tariffs: a retail service tariff for standalone energy storage resources and an interconnection tariff specific to storage resources. Chapter 5 presents a procedural framework for developing such tariffs.

Chapter 4.2 addresses whether new programs or tariffs are needed to facilitate the transition to carbon-free electricity. Here, the analysis is premised on meeting the state's decarbonization mandates for the electric sector defined in the Renewable Energy Standard (RES) and the Act on Climate. Chapter 4.2 presents a forecast of renewable energy supply and demand through 2032, based on publicly-available data. The forecast demonstrates that even without new storage programs or tariffs, there will likely be sufficient RES-eligible renewable energy supply to meet the RES and Act on Climate until at least 2032. While the output of these renewable energy resources is sold in a regional market and could be used to meet the mandates of other New England states, the PUC expects Rhode Island's retail electricity suppliers are likely to be able to capture enough of that supply of renewable energy to meet Rhode Island's RES and Act on Climate mandates due to regional market dynamics, which are discussed in greater detail in Chapter 4.2.

While storage is not likely needed in the near term to meet the RES and Act on Climate mandates, the PUC expects storage likely will be needed sometime after 2030 to balance new supplies of renewable generation with load and to avoid renewable energy curtailment. At that point, storage will likely be needed to cost-effectively meet the RES and Act on Climate.

Final Note

Energy storage resources are capable of delivering potentially significant benefits to the electric power system and to society. The specific magnitude of benefits that a storage resource is capable of delivering at any given moment will depend on the function it chooses to perform in that moment and the underlying power system conditions. Some of these benefits will flow to a specific customer (or customers), some will flow to the entire power system and/or energy market, and some will flow to society at large. For a storage resource to be net beneficial, the value of its benefits must exceed its costs. As recognized above, there are alternative resources that can deliver the same benefits as storage for a lower cost.

Recognizing the significant value potential of energy storage and the need for alignment between who receives those benefits and who pays for them, the Public Utilities Commission identifies that existing tariffs could be improved to ensure that energy storage resources in Rhode Island are able to sell all of the benefits they're capable of creating. The Commission also identifies that existing tariffs could be improved to ensure that the benefits that flow locally to Rhode Island ratepayers are paid for by Rhode Island ratepayers, that the benefits that flow to the region are paid for by the region, and that the benefits that flow broadly to society are paid for by society. With these improvements, energy storage investors and developers will gain assurance that there is a market for their products, and Rhode Island electric ratepayers will gain assurance that they are buying net beneficial products from energy storage resources.

Chapter 1. Introduction

1.1 How Energy Storage Resources Serve the Needs of the Electric Power System

In Senate Resolution 416[4] (the Resolution), the Senate requested the Public Utilities Commission (PUC, or Commission) identify which electric system needs can be served by energy storage resources. The electric system needs two things to function.

First, the power system needs power generation to convert some initial form of energy into electrical energy. Electricity generation and consumption must be balanced at all times. Second, the power system needs a delivery system to move electrical energy from where it is generated to where it is consumed. The delivery system may comprise various components that serve different functions, such as a high-voltage transmission system that moves electricity over longer distances and a lower-voltage distribution system that moves electricity from the transmission system to the location where it will be consumed. Delivery system equipment has limits that must be respected. If not, damage will occur.

Energy storage resources can serve both of these power system needs. Storage can balance electricity generation and consumption in real time. To do so, storage must be in the right state (charged or discharged) at the right time. Additionally, storage can relieve constraints on the delivery system. Whereas balancing electricity generation and consumption is a matter of timing, relieving delivery constraints is a matter of timing *and location*.

For a given power system, the usefulness of energy storage always depends on the timing of its operations. In some situations, the usefulness of energy storage also depends on the location of its operations. Recognizing this, the goal of this Report is to identify when and where energy storage can create value on the current and future electric system. Before identifying those value streams, it is useful to recognize how the PUC evaluates the needs of the electric power system, how that evaluation applies to the functions of energy storage resources, and how the PUC would evaluate the costs and benefits of serving system needs with storage resources versus storage alternatives.

1.2 The Rhode Island Benefit Cost Framework

The PUC's Rhode Island Benefit Cost Framework (Framework) was developed through a stakeholder process in Docket No. 4600[5] and adopted by the PUC in 2017 in Docket 4600A, along with goals for the electric system and rate design principles.[6] The Framework includes the following components: more than 30 individual categories of benefits and costs that the PUC considers when evaluating proposals related to Rhode Island Energy's regulated electric business; identification and evaluation of the system attributes that drive costs and benefits in each category; and potential methodologies to quantify or qualify the value of those costs and benefits. The Framework represents a comprehensive list of the needs of the electric

[4] Rhode Island Senate Resolution 416, passed on June 23, 2022: http://webserver.rilegislature.gov/BillText/BillText22/SenateText22/S3064.pdf

[5] Stakeholder Committee Final Report, RIPUC Docket No. 4600. Report available at: https://ripuc.ecms.ri.gov/sites/g/files/xkgbur841/files/eventsactions/docket/4600-WGReport_4-5-17.pdf

[6] Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving The Narragansett Electric Company d/b/a National Grid, Docket No. 4600A: https://ripuc.ri.gov/eventsactions/docket/4600A-GuidanceDocument-Final-Clean.pdf.

system, customers, and society. In this regard, it is the appropriate tool for answering the questions presented in the Resolution.

The Framework has two uses. First, the benefit and cost categories comprise a benefit-cost test known as the Rhode Island Test. The Rhode Island Test represents the PUC's standard for determining cost-effectiveness through benefit-cost analysis. Cost-effectiveness is explicit and implicit in much of the PUC's statutory authority, and therefore represents a critical element of the overall business case for most proposals.[7] Second, the Framework can serve as a guide for identifying current and future power system needs. Even without a specific project in mind, one can use the Framework's benefit and cost categories to explore how system attributes might change in the future, thereby identifying potential unmet system needs and value opportunities. For example, forecasted increases in demand might indicate an opportunity to reduce the cost of power generation and delivery relative to some baseline; alternatively, forecasted increases in fuel costs might indicate an opportunity to reduce the cost of power generation relative to some baseline.

1.3 Organization of the Report

Following this introduction, Chapter 2 presents a stakeholder-informed qualitative answer to the question "what are the potential benefits of energy storage resources in Rhode Island?" To do this, the analysis uses the Framework as a guide to identify power system needs (including the need to meet the Renewable Energy Standard and the Act on Climate) that could be served or achieved through deployment of energy storage resources. The chapter presents five scenarios that illustrate present and future power system conditions in which energy storage resources could be useful and identifies which benefits are likely to be created under each scenario.

Building on Chapter 2 and with additional input from stakeholders, Chapter 3 reviews design elements of procurement and analyzes Rhode Island's existing storage procurement mechanisms (programs and tariffs) against those design elements.

Chapter 4 addresses the central question of the Resolution: whether new storage tariffs or programs are needed to meet certain goals. The question is addressed in two parts. Chapter 4.1 addresses whether new tariffs and programs are needed for energy storage resources to reduce the cost of the electric power system. Chapter 4.2 addresses whether new tariffs or programs are needed for energy storage resources to facilitate the transition to carbon-free electricity.

Finally, Chapter 5 presents potential next steps for the PUC to advance cost-effective energy storage development in Rhode Island.

[7] For example, if Rhode Island Energy proposes to execute a contract to purchase the generation output from an offshore wind farm, the cost-effectiveness of the specific project is determined by quantifying the costs and benefits caused by executing the contract (for each Framework category) relative to a baseline in which the contract is not executed.

Chapter 2. RI Benefit Cost Framework Evaluation of Energy Storage Resources

In order to build familiarity with the Framework, Chapter 2.1 provides an introduction to the Framework and a review of how it can be used to analyze the flexible functions of energy storage. Chapter 2.2 follows with a qualitative analysis of the potential benefits of time- and location-specific storage configurations.

2.1 Applying the Framework to Energy Storage Resources

In its review of the Framework with stakeholders, staff presented the functions of energy storage resources as four separate states: charging, discharging, empty vessel, and full vessel. While a storage resource may be able to perform multiple functions, its ability to perform multiple functions at the same time will depend on their requisite state(s). A storage resource can only perform multiple functions simultaneously if each of the functions require it to be in the same state at the same time (e.g. if all functions require it to be charging). If the different functions require it to be in different states at the same time (e.g. charging and discharging), the storage resource cannot perform them simultaneously – it must choose one at a time.

Conceptualizing storage as separate functions dependent on the state of the storage resource can help simplify the analysis of how storage can impact the individual benefit and cost categories of the Framework. For example, regarding those Framework categories related to energy and power, an energy storage resource discharging stored energy is no different than an electric generation resource supplying energy. Therefore, qualitatively identifying the energy and power impacts of discharging an energy storage resource is an identical exercise to qualitatively identifying the energy and power impacts of an electric generation resource. On the other hand, a storage resource charging from the grid is no different than another customer consuming electricity. As a result, qualitatively identifying the energy and power impacts of a storage resource that is charging up from the grid is an identical exercise to qualitatively identifying the energy and power impacts of traditional customer consumption.

After staff familiarized stakeholders with the Framework categories, staff and stakeholders qualitatively analyzed whether and how storage resources can create positive value for each benefit category when acting in each of its four states (charging, discharging, empty vessel, and full vessel). Staff provided stakeholders with a template Framework for analysis and invited stakeholders to complete the Framework with their qualitative benefits analysis. In addition to receiving responses from multiple stakeholders, staff also completed their own qualitative benefits analysis. After reviewing their own initial analysis alongside the submissions and input of stakeholders, staff developed a consolidated analysis of the potential qualitative benefits of energy storage resources.[8] The results of that consolidated qualitative benefits analysis are summarized in Table 1.[9]

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[8] The consolidated analysis does not represent a consensus document, but rather the PUC's analysis, informed by stakeholders through direct participation and input. Staff and stakeholders performed independent analyses and reviewed them together over the course of a 4-hour stakeholder workshop on January 10, 2023.

[9] Table 1 presents a reorganized version of the Framework relative to the version published and adopted in Docket 4600A. Although the categories in Table 1 are not identical to the list of categories in the original Framework, staff assures that each Framework category is captured in Table 1.

Table 1. Applying the Framework to Energy Storage Resources

Ref. #	Benefit-Cost Category	Charging	Discharging
Group 1: Benefits related to displacing or avoiding generation			
1	Market Value of Energy	Possible when generation is export-constrained	When economically dispatched
2	Energy Market Price Effects	Increases demand	Decreases demand or increases supply
3	Non-Electric: Oil, Gas, Water, Wastewater	Increases demand	Decreases demand or increases supply
4	Public Health	Increases demand	Decreases demand or increases supply
5	National Security	Increases demand	Decreases demand or increases supply
6	RGGI Compliance	Increases demand	Decreases demand or increases supply
7	Act on Climate Compliance	Increases demand	Decreases demand or increases supply
8	Incremental Greenhouse Gas Externality	Increases demand	Decreases demand or increases supply
9	Other Environmental Compliance (e.g. Criteria Air Pollutant)	Increases demand	Decreases demand or increases supply
10	Other Environmental Externality	Increases demand	Decreases demand or increases supply
Group 2: Benefits related to avoiding or relieving system constraints			
11	Generation Capacity (and Capacity Market Effects)	Could only increase power demand (not expected)	Can reduce peak demand for power or provide incremental power supply
12	Delivery Capacity (Trans. & Distr.)	Could only increase need for delivery capacity to serve load	Can reduce demand for delivery capacity to serve load
13	Export Capacity Infrastructure for Resources (Trans. & Distr.)	Can reduce T & D needed for generation export	Could only increase need for export capacity
14	Renewable Energy Certificates (RECs)	Charging from export-constrained renewables	Discharge is necessary to create net benefit when RPS/RES is 100%
15	Investment Under Uncertainty: Real Options Value	Can reduce forecasted T & D needed for generation export	Can reduce any forecasted capacity needed for serving demand
Group 3: Benefits related to system operation			
16	Trans. & Distr. Delivery (Line Losses & Equipment Cycling)	Can enable siting generation closer to load and reduce equipment cycling	
17	Trans. & Distr. System Safety	Can reduce the exposure of system risks by slowing growth and/or reducing risk of operational error	
18	Incremental Trans. & Distr. System Performance	Storage can increase the flexibility and operational options and asset management of the system	
Group 4: Benefits related to resilience			
19	System and Customer Reliability & Resilience Impacts	Maintain/restore power when located downstream from fault	
20	Net Risk Benefits to Utility and System Operations	Storage can increase resource diversity and adaptability of the system	
Group 5: Benefits related to the size and volatility of the market			
21	Retail Supplier Risk Premium	Flexibility can reduce costs to mitigate supply portfolio risk and customer demand risk	
22	Incremental Avoided Ancillary Services Value	Can provide ancillary services at lower cost	
23	Consumer Empowerment & Choice	Can increase power system and home power options that increase customer empowerment and choice	
Group 6: Benefits related to Equity and LMI customers			
24	Incremental Utility LMI Customer Service	Incremental operational benefits specific to low-income customer impacts	
25	Incremental LMI Participant Benefits	Incremental savings/participant benefits specific to low-income customer impacts	
26	Incremental Societal Impacts related to LMI Customers	Incremental benefits of avoided societal costs specific to low-income customer impacts	
27	Rate and Bill Impacts on Equity	Can enable least-cost procurement that lowers the risk of inequitable cost allocation	
Group 7: Other benefits			
28	Innovation and Market Transformation	Local and regional potential for operational, development, and market innovation through storage	
29	Option value of individual resources	Can enable greater economies of scale for a single site	
30	Conservation and community benefits	Can reduce the nameplate capacity of the clean and intermittent fleet needed to meet environmental mandates	
31	Economic Development	Can create desired economic benchmark impacts	

In Table 1, green boxes indicate that energy storage resources could create the given benefit category under the right set of conditions.[10] Gray boxes indicate that energy storage resources either have no impact on the benefit category or could create costs.[11] When reviewing Table 1, it is important to remember that green boxes only indicate that storage can *potentially* have a positive impact on the given benefit category. Table 1 does not address whether or not the necessary time and location conditions exist for storage to actually create positive value for the given benefit category nor whether that value is net positive when considering the cost of storage. Rather, Table 1 is intended to demonstrate how to apply the Framework to energy storage resources. It should not be used to infer the actual value of energy storage under specific system conditions. The value of storage under specific system conditions is qualitatively analyzed and presented in Chapter 2.2.

Staff organized the Framework into seven groups of individual categories. Because the usefulness of energy storage is so tightly connected to time and location, these groups comprise individual categories with similar time and location triggers or characteristics. The groups are explained below in greater detail.

Group 1: Benefits Related to Displacing or Avoiding Generation. This group comprises the direct and indirect market costs of electric power generation. Because power generation is a continuous event (with the exception of unexpected disruptions), the green boxes in this group indicate that storage has the potential to create these benefits at any given moment. Specifically, storage always has the potential to create benefits when discharging. In contrast, storage never has the potential to create benefits when charging, with one exception: the Market Value of Energy. The Market Value of Energy is unique because storage may be able to create these benefits by charging when prices are negative.

Group 2: Benefits Related to Avoiding or Relieving System Constraints. This group recognizes to the need for generation capacity (i.e., a fleet of power plants) as well as transmission and distribution delivery capacity (i.e. appropriately rated power lines and equipment). Whereas the opportunity to create Group 1 benefits is effectively continuous, Group 2 benefits are driven by peak conditions on the power system (e.g. peak demand or peak generation) that occur during brief periods of time.[12] When peak conditions near or exceed the capacity of some element of the power system, utilities and system operators will upgrade or expand existing infrastructure. By discharging stored energy during peak demand (to avoid a demand-related constraint) or charging up during peak generation (to avoid a generation export-related constraint), storage can avoid the need for new capacity investments.

Group 3: Benefits Related to System Operation. This group comprises categories related to delivering power safely and reliably. Similar to Group 2, these benefits come from improving the performance of the

[10] For example, the first category in Table 1 is the Market Value of Energy. This category includes the wholesale market cost for (electric) energy. When storage is discharging, it supplies electricity to the market. Energy supply from storage will always add value if it is economically dispatched. To indicate this in Table 1, the discharging box is marked green for this benefit category.

[11] For example, the second category in Table 1 is Energy Market Price Effects. This category captures the economic expectation that price increases when demand increases and that price decreases when supply increases. When storage charges, it can increase the market price for energy by increasing demand. For that reason, the charging box is marked gray for this benefit category.

[12] Within Group 2, export capacity infrastructure benefits are unique in that they are driven not by peak demand. Instead, they are driven by peak generation. If the output from a generation resource (or group of generation resources) exceeds the physical limits of the delivery system, the delivery system will be unable to move that power from where it is generated to where it will be consumed. With nowhere for the energy to go, limits must be placed on the generating resources' output. By charging from the generating resource during such an export constraint, storage can avoid the need to limit the power generation while simultaneously avoiding the need for new export capacity investments. The benefit category of Renewable Energy Certificates (REC) is included in Group 2 because the value of energy storage to the REC market comes from relieving constraints that would otherwise result in renewable energy curtailment.

delivery system. However, similar to Group 1, achieving these benefits is associated with continuous performance rather than a short period of peak demand. The special ability of energy storage to create these benefits derives from its flexibility to either discharge to the power system or charge from it. For that reason, charging and discharging are not disaggregated in Table 1.

Group 4: Benefits Related to Resilience. This groups comprises categories related to creating a more resilient and reliable power system that is more adaptable to disruptive events or less exposed to the risk of such events. As in Category 3, the ability of energy storage to create these benefits derives from its flexibility to either discharge to the power system or charge from it. For that reason, charging and discharging are not disaggregated in Table 1. Note that some portion of these benefits may be captured in Groups 1-3. To the extent that this overlap occurs, Group 4 only refers to the incremental value of storage beyond what is already captured by Groups 1-3.

Group 5: Benefits related to the Size and Volatility of the Market. This group comprises categories related to the incremental risks, costs, and benefits of the electricity market not already covered by other categories. Staff notes that the ancillary services benefits included in Group 6 comprise specific market products such as forward reserves and black start service that are intended to be incremental to the ancillary services benefits captured in Group 3. The need for these benefits and services is continuous in nature and, except for black start service, is not differently created through charging or discharging. For example, to provide forward reserve benefits, a storage resource must be charged and at the ready, not actively charging or discharging. For this reason, charging and discharging are not disaggregated.

Group 6: Benefits Related to Equity and Low and Moderate Income (LMI) Customers. This group comprises categories that assure social equity is considered in any cost-benefit analysis. The Framework distinguishes average utility, participant, and societal benefits from the incremental utility, participant, and societal benefits that flow to or are caused by LMI customers. The Framework does this to account for the risk that the unique energy consumption patterns and socioeconomic characteristics of LMI customers might not be well represented by the residential population average. Separately, the category of rate and bill impacts addresses the risk that rate design may allocate to LMI customers more than their fair share of costs. These four benefits are not dependent on whether storage is charging or discharging. For that reason, charging and discharging are not disaggregated.

Group 7: Other Benefits. This group comprises the remaining benefit categories that do not fall into one of the previous groups. It includes innovation, option value, conservation benefits, and economic development benefits.

Innovation captures incremental benefits not already included in other market categories. It is a useful category to consider when evaluating pre-market products and pilots. The category may have less relevance for developed products and programs.

Option value benefits and conservation benefits are separate but related categories. If energy storage enables greater economies of scale for a generation resource, it may enable the generation resource to build at a larger nameplate capacity, thereby creating option value for that individual generation resource. The option to build a larger nameplate capacity may have the effect of reducing land conservation at the project site. However, if energy storage is deployed to improve the option value of the generation resource as well as to reduce the intermittency of its generation profile, it may reduce the total nameplate capacity needed to serve customers. This can have the effect of increasing land conservation.

Regarding economic development, in recent proceedings the PUC has taken the approach of considering economic impacts alongside, but apart from, the monetary benefit-cost analysis of the Rhode Island Test. The PUC's approach recognizes that the achievement of economic development goals may not be appropriate to include in the Rhode Island Test but should be considered as part of the overall business case of a proposal.[13] It is in this spirit that the economic development benefit category was included in Table 1. Notably, progress on some economic development goals (e.g. local job creation) could be met by deploying storage resources even if the resources never operate once constructed. Thus, achieving economic development goals with energy storage may be independent of creating net benefits through storage deployment.

2.2 Energy storage benefits under different power system scenarios

Evaluating how energy storage resources can meet the needs of the electric power system requires consideration of time and location. For the functions of energy storage to be useful to the power system, the timing and location of those functions must align with the timing and location of system constraints. To illustrate the importance of time and location to storage value and to facilitate discussions with stakeholders, staff designed five scenarios with unique time and location constraints.

The five scenarios represent a typical range of system conditions that occur on the local electric power system in Rhode Island and the regional electric power system in New England. Under the idealized conditions presented in these scenarios, energy storage resources perform different functions to serve different system needs, thereby causing different benefits.

The five scenarios include:

1. Unconstrained hours on the power system,
2. Hours when clean or renewable energy is export-constrained,
3. Peak demand on the power system,
4. A present-day cold snap, and
5. A transmission or distribution line fault

Through roundtable discussions, staff and stakeholders reviewed the usefulness of energy storage under each scenario and qualitatively analyzed the potential value of storage given the specific constraints represented by each scenario. Where potential value differed between scenarios, staff and stakeholders examined the reasons behind such differences. Informed by this stakeholder process, the PUC presents the potential value of energy storage resources in the section below.

The PUC's analysis finds that across all five scenarios, the potential to create benefits in Groups 6 and 7 are unchanged from Table 1. In other words, the potential to create these benefits always exists and is

[13] Economic impact analyses are a common tool used to identify economic development benefits. These analyses aim to reveal the macroeconomic effects of a proposal, such as changes to gross state or domestic product, increases in tax revenue, increases in local spending, and job growth. Experts believe these benefits are largely included in the other categories of the Framework and caution that including the effects identified through an economic impact analysis would double-count a significant portion of benefits. For example, job growth spurred by deploying energy storage is already included the Rhode Island Test as part of the cost of deploying storage. There is, however, some disagreement whether economic development benefits are entirely counted or mostly counted in the other categories. One panel of witnesses found that there may be incremental indirect and induced economic impacts from increased local spending and recommended that these economic impacts be included in the Rhode Island Test as incremental monetary benefits. *See*, Review *of RI Test and Proposed Methodology Prepared for National Grid,* Mark Berkman and Jürgen Weiss, January 31, 2019. https://ripuc.ri.gov/media/93046/download. However, a separate witness recommended the full macroeconomic impacts be presented alongside the results of the Rhode Island Test rather than within the Test in order to avoid double-counting. *See*, *Division of Public Utilities and Carriers Joint Pre-Filed Direct Testimony (Part 2), Direct Testimony of Tim Woolf And Ben Havumaki*, Docket 5189, November 17, 2021. https://ripuc.ri.gov/eventsactions/docket/5189-DIV-Woolf-Havumaki Testimony (11-17-21).pdf.

independent of system conditions. Thus, the analysis presented below focuses on the benefits in Groups 1 through 5 and how those benefits change between scenarios.

Table 2 provides a summary of the potential value of energy storage resources under the five scenarios. For each scenario, Table 2 indicates the potential storage "value stack" given the specific system conditions represented by the scenario. [14] The composition and magnitude of the storage value stack under any given scenario are shaped by two factors: the needs of the power system and the primary functionality of storage under that scenario.

First, within a given scenario, the values that comprise the storage value stack and the magnitude of those values are defined, in part, by the needs of the electric power system. Within each scenario, some benefits are simply unachievable because the power system conditions do not present a need for them. For example, when the power system is outside of a peak event, storage cannot create Group 2 benefits. This is described below as "benefits that fall outside the primary function's values stack."

Second, the values that comprise the value stack within each scenario and the magnitude of those values are defined, in part, by what functions one assumes the storage resource will perform in response to system needs and what state (charging, discharging, sitting empty, or sitting full) it must be in to perform those functions. At any given moment, there may be multiple benefits that a storage resource can technically create but that are mutually exclusive because they require the resource to perform multiple incompatible functions at the same time. For example, a storage resource may receive a price signal from the wholesale market to charge because energy prices are low while simultaneously receiving a signal from the distribution utility to discharge because the local delivery lines are at capacity. Because the storage resource cannot simultaneously charge and discharge, it must choose one function to perform and forgo the other.

The analysis presented below in Chapter 2.2 addresses this nuance by postulating a "primary function" that a typical storage resource would perform under each scenario. For each scenario, the primary function is based on the unique needs of the power system given the unique conditions envisioned by the scenario. In turn, the primary function defines what a storage resource must be doing before, during, and/or after the scenario. By doing so, the designation of a primary function determines the components of the storage value stack under the scenario.

The primary function for each scenario is intended to represent the largest, most reliable value-generating opportunity for a storage resource given the specific conditions envisioned by the scenario. However, recognizing that there may be other valuable functions beyond the primary function, the PUC acknowledges that alternative value stacks may prove to be more cost-effective in reality than the illustrative primary value stack. Accordingly, each scenario description presented below describes "alternative functions and value stack benefits" that a storage investor may consider when designing and evaluating the performance of their resource under the given scenario.

Whereas Table 1 is intended only to introduce the Framework and should not be used to infer the potential value of energy storage resources, Table 2 can be used to infer storage value potential. To do this, one must evaluate the size of the potential benefits and multiply that value by the frequency and/or duration of the different scenarios over the course of a given period of time (e.g. one year, the life of the energy storage resource, etc.). Each scenario discussion below provides a brief description of the scenario and an outlook for the qualitative value of storage in the near future.

[14] "Value stack" refers to the full range of values and benefits that storage is capable of providing.

Table 2. Value Potential of Energy Storage Resources in Scenarios 1-5

		Theoretical Value		Scenario 1: Unconstrained Hours		Scenario 2: Clean or Renewable Export Constraint		Scenario 3: Peak Demand		Scenario 4: Present-Day Cold Snap		Scenario 5: Service Disruption, Line Fault	
Ref.	**Benefit-Cost Category**	**Charge**	**Disch.**	**Charge**	**Disch.**	**Charge**	**Disch.**	**Charge**	**Disch.**	**Charge**	**Disch.**	**Charge**	**Disch.**
	Operational Hours			**Anytime**		**During**	**After**	**Off Peak**	**During**	**Before**	**During**	**During**	
Group 1: Benefits related to displacing or avoiding generation													
1	Market Value of Energy												
2	Energy Market Price Effects												
3	Non-Electric: Oil, Gas, Water, Wastewater												
4	Public Health												
5	National Security												
6	RGGI Compliance												
7	Act on Climate Compliance												
8	Incremental Greenhouse Gas Externality												
9	Other Environmental Compliance (e.g. Criteria Air Pollutant)												
10	Other Environmental Externality												
Group 2: benefits related to avoiding or relieving constraints													
11	Generation Capacity (and Capacity Market Effects)												
12	Delivery Capacity (Trans. & Distr.)												
13	Export Capacity Infrastructure for Resources (Trans. & Distr.)												
14	Renewable Energy Certificates (RECs)												
15	Investment Under Uncertainty: Real Options Value												
Group 3: Benefits related to system operation													
16	Trans. & Distr. Delivery (Line Losses & Equipment Cycling)												
17	Trans. & Distr. System Safety												
18	Incremental Trans. & Distr. System Performance			*		*		*		*		*	
Group 4: Benefits related to resilience													
19	System and Customer Reliability & Resilience Impacts												
20	Net Risk Benefits to Utility and System Operations												
Group 5: Benefits related to the size and volatility of the market													
21	Retail Supplier Risk Premium												
22	Incremental Avoided Ancillary Services Value			*		*		*		*		*	
23	Consumer Empowerment & Choice												

**Asterisks indicate benefit categories that a storage resource can potentially deliver in the scenario, but only when operating to serve a secondary function. Therefore, they are not included in the value stack of the primary function for the scenario.*

Scenario 1: Unconstrained hours on the power system

In Scenario 1, both the power generation and delivery systems are unconstrained. In this hypothetical scenario, whatever amount of demand consumers have, there is always sufficient generation and delivery capacity to serve it. A real-world example of Scenario 1 might occur on a mild spring day when the range of demand throughout the day is far below the limits of the generation fleet and the delivery system.

<u>Primary Function and Key Value Stack Categories</u>
Even on an unconstrained system, power generation will vary over time. If there is diversity within the power generation fleet, prices will vary with time, as will GHG emissions, public health impacts, and other market externalities caused by power generation. Storage located anywhere on an unconstrained power system can deliver benefits by charging from the power system when prices and market externalities are low and discharging to the system when prices and externalities are high. Under this scenario, storage resources can deliver Group 1 benefits associated with displacing or avoiding generation.

In this scenario, alternative solutions to energy storage include any dispatchable generation or load resource that can respond to a market signal (e.g. a gas-fired power plant, demand response, etc.).

<u>Benefits Outside the Primary Function's Value Stack</u>
Under this scenario, storage cannot deliver Group 2 benefits associated with relieving capacity constraints because, by definition, there are none to relieve. Additionally, storage cannot create benefits associated with backup and resiliency benefits because the power system is up and running. Although storage could behave like an insurance policy against power outages, doing so will only yield benefits when an outage occurs. Just like an insurance policy, there is no backup power benefit from storage (only cost) until and unless the unwanted event occurs. Note that discharging a storage resource in response to a market price signal limits the amount of stored energy available to serve as a backup power during an outage.

<u>Alternative Functions and Value Stack</u>
In this scenario, energy storage resources can improve system performance by providing ancillary services related to power quality and frequency support. However, the price signals sent by the wholesale electricity market (around which a storage resource will likely organize its charging and discharging activity under this scenario) may not align with the charging and discharging performance requirements to serve operational needs and improve system performance. If they do not align, a storage investor or operator would have to choose which signal to respond to and which function to perform. These benefits are marked with and asterisk in Table 2 to convey the expectation that they are assumed to be inaccessible when a storage resource is performing its primary function under this scenario.

<u>Outlook</u>
Under this scenario, energy price benefits represent a potentially significant revenue opportunity for storage resources today. That revenue opportunity only exists when prices differ across time (e.g. when periods of low pricing are followed by high pricing or vice versa). The size of this revenue opportunity is likely larger than the size of the revenue opportunity associated with system performance and operations benefits given the current size of the respective markets. However, in the New England region today, differences in electricity prices and emissions are relatively small across most of the hours when the power system is unconstrained. Accordingly, the net benefits from charging when prices or emissions are low and discharging when prices or emissions are high are relatively small and likely do not outweigh the cost of energy storage.

Price differences across unconstrained hours may get larger in the future as more intermittent renewable energy is added to the system and consumption patterns become more variable due to the electrification of the heating and transportation sectors. These same changes may also increase the need for system performance regulation, which may shift value that is typically paid for by the energy market to the ancillary services market. In either case, future system conditions may increase the need for storage during unconstrained hours.

Scenario 2: Hours when clean or renewable energy is export-constrained

Under this scenario, the power system is generally unconstrained, with one key exception: clean or renewable energy is stuck behind a congested transmission or distribution delivery element and cannot export all of the electricity it is technically capable of generating onto the system for end-use consumption. This event is called "curtailment."

Primary Function and Key Value Stack Benefits

Curtailment deprives the market of clean energy. Under this scenario, storage can avoid curtailment of clean energy by charging during congestion and discharging after the delivery element returns to an unconstrained state. Storage can avoid curtailment if located downstream of the congested delivery element. Figure 1 illustrates four examples where clean energy is trapped behind an export constraint (indicated in red). In each example, storage located at any location marked by a yellow star can provide value by charging when clean energy would otherwise be curtailed and discharging once the export constraint is relieved.

By avoiding clean energy curtailment, storage can increase the total amount of energy generated by the existing low carbon generation fleet without requiring new transmission or distribution capacity. Additionally, periods of renewable energy curtailment likely correspond to periods of negative energy market prices. By charging when wholesale electricity prices are negative, storage will be paid to charge.

Additionally, by enabling the delivery of clean energy that would otherwise be curtailed, storage will enable incremental supply of Renewable Energy Certificates (RECs). This can reduce REC prices, which would lower the cost to meet the mandates of the Renewable Energy Standard and the Act on Climate.

In this scenario, an alternative solution for avoiding curtailment is to invest in more transmission and/or distribution capacity. If the cost of curtailment avoidance from storage is less than the cost of curtailment avoidance from building incremental transmission or distribution capacity, then storage can deliver Group 2 benefits associated with avoiding the need to build higher-cost delivery infrastructure.

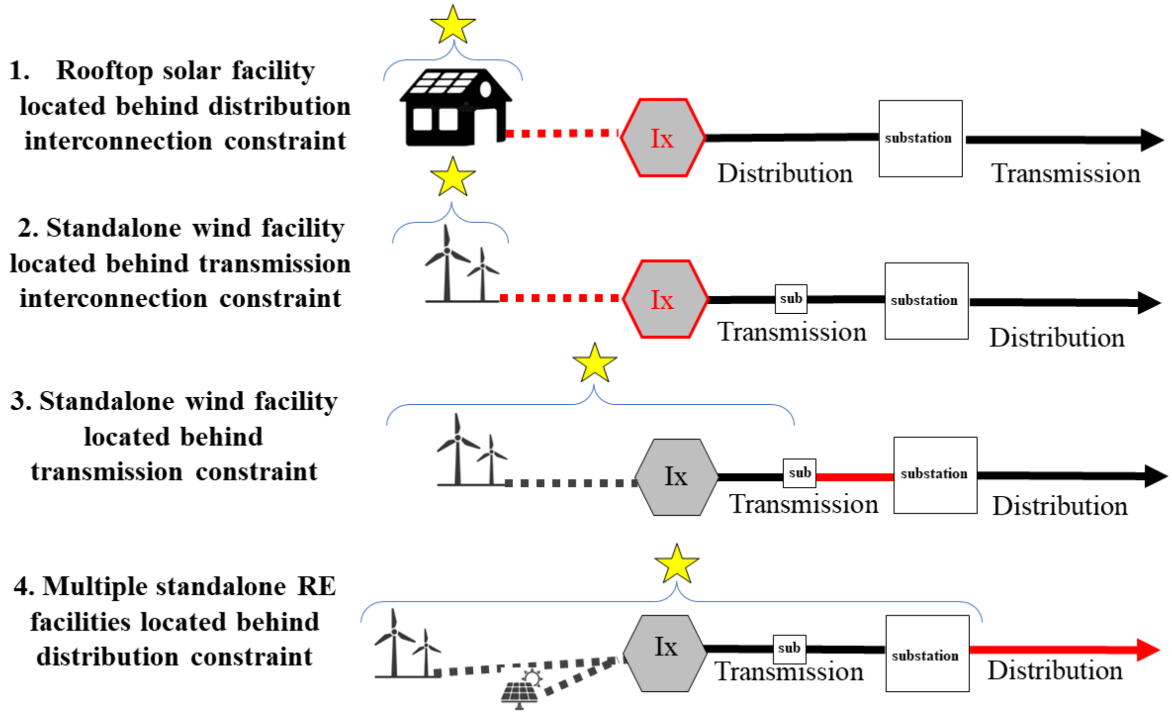
Benefits Outside the Primary Function's Value Stack Primary

Under this scenario, storage cannot deliver benefits associated with relieving demand-related delivery constraints because, by definition, there are no demand-related constraints to relieve. The delivery constraints under this scenario are caused by generation, not consumption. As in the previous scenario, storage cannot create benefits associated with backup and resiliency benefits because there has not been a disruption to the electric power system. Note that if a storage resource discharges its stored energy in response to multiple, consecutive periods of high generation are expected (e.g., daily), it may not have any stored energy available to serve as backup power during an outage if the outage coincides with the periods of high generation.

Alternative Functions and Value Stack Benefits

As in the case with Scenario 1, it is possible for energy storage resources to improve system performance by providing ancillary services related to power quality and frequency support. However, to avoid clean energy curtailment, a storage resource must respond to the specific physical conditions created by the clean energy resource and the delivery constraint that limits it. To reliably perform this task, a storage resource must be in the appropriate physical state to respond to the export constraint. While performing other secondary functions may be valuable, they may not align with what is required to avoid clean energy curtailment.

Figure 1: Timing and Location Requirements During Renewable Energy Export Constraint



<u>Outlook</u>

To relieve the export constraint and avoid clean energy curtailment, an energy storage resource must be able to do two things. First, it must be able to charge fast enough from the clean generating facility so that all of the generation that would have otherwise been curtailed gets stored. Second, it must have large enough storage capacity to hold on to all of the generation that would otherwise be curtailed during a single curtailment event. These two factors tend to make energy storage a more expensive alternative for curtailment avoidance than a traditional wires upgrade. The cost of storage may exceed the benefits under this scenario given the cost of storage today.

Additionally, on today's power system, clean energy curtailment occurs infrequently and for relatively short durations.[15] Accordingly, the net benefits from avoiding renewable and clean energy curtailment are relatively small. Opportunities to avoid curtailment may be sporadic and hard to predict and/or respond to, especially given their locational specificity.

Without investment in the delivery system or alternatives like energy storage, clean energy curtailment will become more frequent and last longer in the future as more clean energy resources are added to the system. In turn, this will increase the value opportunity for storage and any other curtailment avoidance solution.

[15] US DOE found that average onshore wind curtailment in ISO-NE was less than 2% in 2021. US DOE Land-Based Wind Market Report, 2022 Edition. https://www.energy.gov/sites/default/files/2022-08/land_based_wind_market_report_2202.pdf

Scenario 3: Peak demand on the power system

Peak demand occurs when customers' consumption of electricity is at its highest. Peak demand can be measured over different time increments such as hours, days, months, or seasons. The examples provided in this scenario assume peak demand on the order of minutes or hours. When peak demand exceeds the capacity of an element on the electric system (e.g. bulk generation, transmission elements, or distribution elements), new infrastructure must be built to safely and reliably serve customers.

Peak demand can occur across all sections of the power system at the same time (coincident) or can occur in specific locations at different times (non-coincident). Figure 2 presents various examples of peak demand on different sections of the system. The first example assumes insufficient generation capacity. The second example assumes insufficient transmission capacity to transmit the power from where it is generated into a local distribution network. The third example assumes insufficient distribution capacity to deliver the power between two sections of the distribution system. The fourth example assumes insufficient localized distribution capacity (e.g. a line drop) to deliver power to the end-user.

Primary Function and Key Value Stack Benefits

Storage can provide relief for the relatively brief period of time during which peak demand occurs by discharging stored energy. This can avoid the need for additional generation, transmission, or distribution infrastructure.

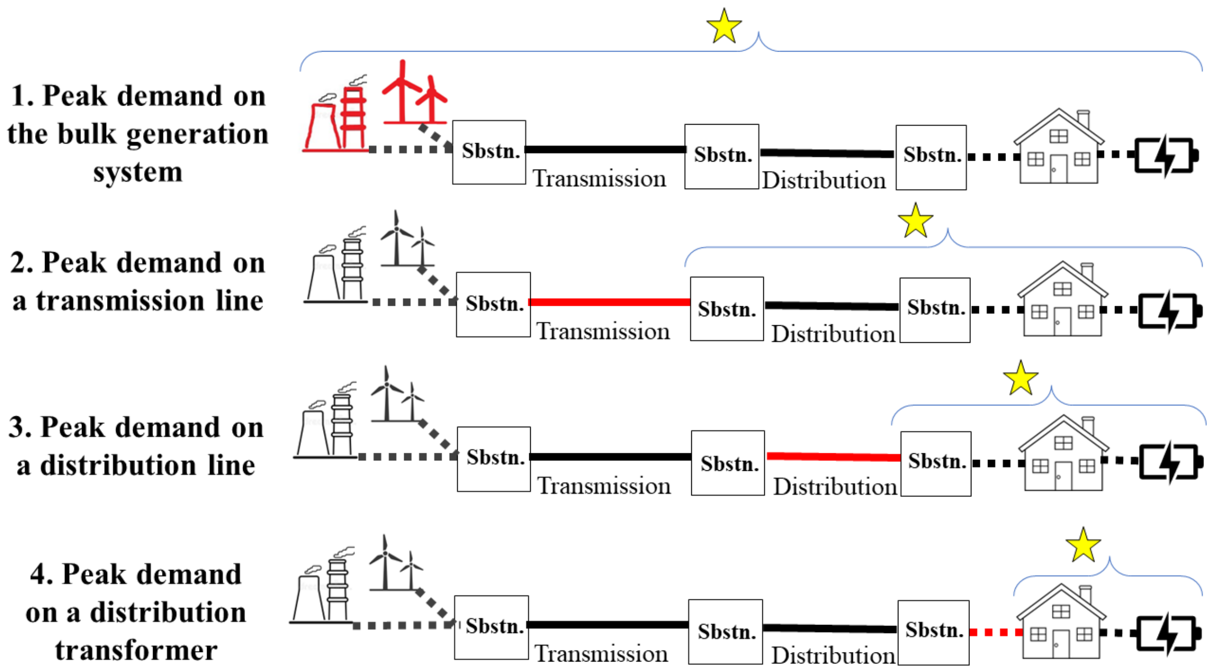
Figure 2 depicts four different constraints on the power system caused by peak demand (the constrained element is indicated in red). To avoid the costs caused by peak demand under each example, storage must be located downstream of the element that is constrained during the peak demand conditions (depicted by the yellow stars). Operationally, storage must be charged before the peak demand period and must have sufficient stored energy and power output capabilities to discharge for the entire duration of the peak demand until customers lower their consumption and the peak period ends.

As depicted in Figure 1, the locations where storage can provide value by discharging during peak demand gets smaller as the congestion becomes more localized. For example, when peak demand exceeds the capacity of generation fleet (example 1), storage located anywhere on the system can deliver value by discharging on-peak. However, when peak demand exceeds the delivery capacity of a specific transmission line, storage can only deliver value by discharging on-peak from a location that is downstream of the congested line (example 2).

Notably, discharging during a peak period is likely aligned with creating Group 1 benefits because when congestion occurs, it results in less efficient generation or delivery of power compared to when the system is unconstrained. This inefficiency raises energy prices, emissions, and other externalities caused by power generation. When storage functions to alleviate peak demand-related constraints, it will also reduce the cost of electricity generation and associated externalities.

In this scenario, an alternative solution for serving peak demand is to invest in more generation, transmission or distribution capacity. If the cost of on-peak capacity from storage is less than the cost of building incremental capacity (e.g. a bigger wire), then storage can deliver Group 2 benefits associated with avoiding the need to build higher-cost new infrastructure.

Figure 2: Timing and Location Requirements During Peak Demand



The primary value stack for this scenario presented in Table 2 assumes that peak demand occurs at the same time on all sections of the power system and that the storage resource is located as close to the customer demand as possible. Accordingly, when it discharges stored energy to serve peak demand on any one section of the system, it will automatically serve peak demand on all sections of the system. This assumption results in largest possible value stack for the scenario.

On a real system, peak demand conditions on different sections of the power system may not overlap in time. For example, a local transmission and distribution delivery peak may occur later in the day than the bulk power system peak. If that happens, a storage resource that discharges stored energy to reduce peak demand on the bulk system will not simultaneously reduce peak demand on the local delivery system (because it is not experiencing peak demand conditions in that moment). In that moment, the benefits of reducing transmission and distribution capacity investment represent "benefits that fall outside the primary function's value stack." Eventually, however, peak demand conditions on the local transmission and distribution systems will arise and the storage resource may then respond to those peaks. At that time, the benefits of reducing transmission and distribution capacity investment can be added back into the storage value stack.

If peak demand conditions arise on different sections of the system at different times, a storage resource must pick a primary demand peak around which to organize its charging and discharging cycle. In doing so, the resource faces the risk that discharging to serve one peak will leave it physically unable to respond to another peak if there isn't sufficient time to recharge or if prices aren't sufficiently low to support recharging. Thus, serving a secondary peak represents an "alternative function and value stack." In the most extreme case, the timing of peak demand conditions could be so misaligned that a storage resource that recharges in order to respond to future peak demand conditions on one element of the system might end up exacerbating peak demand conditions on another section of the system. None of this nuance is captured in the simple value stack presented in Table 2, but would be captured in the decision-making of a storage developer and in the application of the Rhode Island Test to a specific storage resource.

Benefits Outside the Primary Function's Value Stack

This scenario is defined as having no constraints that limit the ability of the power system to generate clean electricity and move it to where it will be consumed. Thus, there are no Group 2 benefits related to relieving an export constraint. Additionally, energy storage has no net impact on the REC market under this scenario. While energy storage will decrease total demand for electricity by discharging stored energy on-peak, it will have previously increased total demand for electricity by charging up.[16] Because the power system is fully operational, there are no backup power or resiliency benefits under this scenario. Note that if an outage occurs after a storage resource has discharged its stored energy on-peak and before it can recharge, it will not be able to serve backup power supply if outage conditions arise.

Alternative Functions and Value Stack Benefits

As in the previous two scenarios, it is possible for energy storage resources to improve system performance by providing ancillary services related to power quality and frequency support. The limitation on simultaneously performing this function as well as the primary function of serving peak demand is that storage must be sufficiently charged before the peak demand conditions arise. Gaining and maintaining the requisite supply of stored energy during this period may cause a storage resource to miss out on other valuable revenue-generating opportunities associated with discharging (e.g. Group 1 benefits and other benefits related to system performance and regulation).

Outlook

Today, peak demand typically occurs on sections of the power system for 1-2 hours during the summer.[17] Across all sections of the power system in New England (including the local distribution system), peak demand has decreased in recent years primarily driven by energy efficiency and distributed generation resources (e.g., rooftop solar). Despite this downward trend, there is value in providing on-peak capacity, as there are discrete locations on the grid where consumption is increasing and new capacity is needed. Across the entire regional bulk power system, ISO-NE forecasts peak demand will increase by as much as 6% by 2032, driven by consumers adopting electric heating and vehicles.[18]

Changes in peak demand conditions will change the value proposition of energy storage under this scenario. Given the summer-peaking nature of today's power system, storage resources primarily time their peak demand reduction around summer peak(s). In the future, peak demand reduction will likely be valuable in both the winter and summer in response to new electrified heating and transportation loads. As this occurs, not only will the timing, frequency, and duration of the winter peak differ from the timing, frequency, and duration of the summer peak, but the locations at which storage is needed to serve peak demand may shift between summer and winter.

[16] Most RES/RPS compliance obligations are annual in nature. So long as charging and discharging occur during the same annual compliance period, storage will have no net impact on the total volume of load subject to RES/RPS compliance, and therefore no impact on the REC market.

[17] Peak demand on the regional bulk power system peaked at 28,130 MW on August 2, 2006. Peak demand on the local distribution system peaked at 1,985 MW on that same day. Source: The Narragansett Electric Company's 2022 Electric Peak Demand Forecast.
https://systemdataportal.nationalgrid.com/RI/documents/RI_PEAK_2022_Report.pdf

[18] ISO-NE "New England's Electricity Use" statistics. https://www.iso-ne.com/about/key-stats/electricity-use

Scenario #4: Present-day cold snap

During a present-day cold snap, there may be insufficient fuel supply to serve electricity demand over some portion of the day or days. In contrast to the prior scenario, a winter cold snap creates conditions under which there is sufficient electric generating capacity to serve demand but not enough fuel supply to run the generation fleet. Much of New England's power generation fleet relies on fossil fuels to generate electricity, particularly natural gas. When home heating begins in the winter, the supply of natural gas coming into New England via interstate natural gas pipelines can be insufficient to serve both demand for natural gas caused by home heating as well as demand for natural gas caused by electric power generators. Whereas natural gas utilities, on behalf of their "firm supply customers" (e.g. home heating customers), have long-term contracts for pipeline natural gas supply, power plants do not. As a result, when demand for both home heating and electricity spike during a cold snap, gas-fired power plants may not be able to access sufficient pipeline gas supply to generate electricity.

To ensure sufficient fuel supply during a cold snap, many of the region's power plants store liquid fuels (e.g. oil) on-site. Throughout the region, liquid natural gas (LNG) is also stored. If pipeline natural gas supply becomes unavailable or uneconomic, the power plants will burn these stored liquid fuels. In the winter of 2021/2022, New England power plants burned approximately 80 million gallons of stored fuel oil for electricity generation.[19]

If a cold snap persists for so long that power plants deplete their liquid fuel stocks, the region's power generation fleet may be unable to generate sufficient electricity to serve demand. This could result in future bulk system outages.[20] Furthermore, stored liquid fuels can be higher-emitting and higher cost than pipeline gas supply. Considering these dynamics, cold snaps present winter reliability, price, and climate risks.

<u>Primary Function and Key Value Stack Benefits</u>
During a cold snap, storage resources located anywhere on the power system can discharge their stored energy to relieve fuel constraints and avoid the need to burn liquid fuels. To do so, storage resources must charge before the cold snap, hold on to that energy, and discharge it once power plants start to burn stored fuels.

Under this scenario, storage can deliver Group 1 benefits by charging before the cold snap when cleaner, cheaper fuels are powering electricity generation and then later discharging that stored energy to avoid or offset the burning of oil or LNG. Table 2 shows that the potential to create Group 1 benefits during a cold snap is similar to the other scenarios (especially Scenario 3), with a few key caveats.

First, present-day cold snaps cause fuel constraints that can last for multiple consecutive days, a duration beyond what most energy storage technologies today can perform. In 2022, 4,798 MW/12,181 MWh of energy storage was deployed in the U.S.[21] On average, those resources had an average discharge time of 2.5 hours at their maximum power output.[22] If summer peak demand lasted for 2.5 hours, those storage resources could discharge energy for the entirety of the peak-demand related fuel constraint. However, winter fuel constraints caused by a cold snap can last far longer than 2.5 hours.

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[19] ISO-NE Winter 2022/23 Analysis: Assessment and Recommendations. https://www.iso-ne.com/static-assets/documents/2022/07/a09_mc_2022_07_12-14_winter_2022_2023_presentation.pptx

[20] The bulk generation system is not currently experiencing outage conditions under this scenario. However, because of fuel availability constraints, there is a risk that outage conditions could arise.

[21] U.S. Energy Storage Monitor, 2022 Year-End Review. Wood Mackenzie. https://www.woodmac.com/industry/power-and-renewables/us-energy-storage-monitor/

[22] 12,181 MWh / 4,798 MW = 2.53 hours

Second, while storage can undoubtedly reduce or offset liquid fuel combustion during a cold snap, the power plant generating the electricity from which a storage resource will charge before the cold snap is likely to be a natural gas-fired unit. Thus, the emissions reductions likely to be delivered by storage during a cold snap today are not as significant as those that could occur in the future if storage charges from a clean electricity generation fleet.

Under this scenario, storage resources can create Group 2 benefits in a similar manner to Scenario 3 (peak demand), again with some caveats. To create Group 2 capacity benefits, there must be non-fuel resources that would otherwise be deployed. For example, if incremental offshore wind capacity is the chosen alternative to meet energy needs during winter cold snaps, storage resources could reduce the amount of incremental offshore wind capacity necessary to endure cold snaps so long as the wind resource has sufficient excess energy to charge the storage resources before the cold snap occurs. Similarly, storage can offset transmission investments if the transmission investment is designed to deliver energy from a non-fuel resource.

Finally, storage can reduce the cost of investment risk associated with winter reliability. In the absence of storage, existing power generators may invest in incremental on-site oil or LNG storage tanks. There is a risk that those investments may prove to be unneeded. If energy storage is a cheaper alternative than building incremental on-site oil or LNG storage tanks, it can delay the need for those costlier investments and buy time to reduce investment uncertainty.

Benefits Outside the Primary Function's Value Stack

Under this scenario, the benefits that fall outside the value stack are identical to those that fall outside the value stack under Scenario 3 (peak demand), for similar reasons. During a fuel constraint caused by a winter cold snap, the risk of clean energy curtailment is very low. Export capacity is likely unconstrained, as is the supply of RECs. Without export capacity or REC supply constraints to relive, there is no value to relieving them. Similarly, the power system is not experiencing outage under this scenario. Thus, storage cannot deliver backup power or resilience benefits. Note that a storage resource that discharges during a cold snap will be unavailable if outage conditions arise unless it has an opportunity to recharge.

Alternative Functions and Value Stack Benefits

Under this scenario, the alternative functions are identical to Scenario 3. It is possible for energy storage resources to improve system performance by providing ancillary services related to power quality and frequency support. The conflict with this alternative function and the primary function of supplying energy during a cold snap is similar. To provide value during a present-day cold snap, storage must be sufficiently charged before the start of the cold snap event. Holding energy to serve demand during a cold snap may be inconsistent with charging and discharging patterns necessary to improve system performance.

It is also notable that even after the cold snap ends, a storage resource looking to recharge may need to wait a long period of time before prices drop low enough to justify the cost of recharging. Recharging when electric prices are high only makes economic sense if you expect a subsequent period of even higher prices during which you can discharge again. Given this, if electric prices remain high after a cold snap, a storage resource may forego immediately recharging. In that case, the resource will be unavailable to serve other valuable functions until prices drop low enough to recharge.

Outlook

As discussed above, fuel constraints caused by present-day cold snaps can last for multiple days or longer. In recent winters, the region has relied on approximately 12,000 MW of oil-fueled generation capacity to serve demand during cold snaps when pipeline gas supply is constrained.[23] Available power (MW) from storage resources is small by comparison.[24]

If the winter reliability issues associated with cold snaps are to be mitigated with energy storage, only long-duration, high-capacity energy storage projects will meet the reliability need. Stakeholders agree that long-duration storage is not readily available in the New England market today. Therefore, while the potential benefits of storage during today's winters are significant, the likelihood that those benefits will exceed the cost of storage is low given current technological and economic limitations.

The value of energy storage during a cold snap could change in the future as renewable generators displace natural gas in the region. Rather than supporting natural gas units when cold snaps draw down fuel supplies, these storage units could transition to balancing intermittent wind and solar PV generators when unfavorable natural conditions (e.g., windspeed and solar irradiance) lead to extended periods of low output.

Scenario #5: A transmission or distribution line fault

In this scenario, a specific transmission or distribution line experiences a fault, thereby interrupting electric service to customers who are served by that line. A real-world example of Scenario 5 might occur after a local storm event during which a tree branch falls on a distribution feeder, knocking out power to all of the customers served by that feeder.

Primary Function and Key Value Stack Benefits

During an electric service disruption, demand for energy is no longer served by the electric power system because power cannot physically travel over the delivery system. To maintain electricity supply, a backup power resource must be deployed. Backup power resources include, but are not limited to, backup diesel generators, an islanded distributed generation resource,[25] or energy storage.

Energy storage can supply backup power during an electric service disruption. This benefit is specifically captured in Group 4 (benefits related to resilience and risk). Table 2 depicts the potential value of energy storage during such a wires-related service disruption. The primary function contemplated for storage during this scenario is to support the use of intermittent or fuel-limited generation resources as backup power supply. While a standalone storage resource can supply backup power during an outage if it is charged, its value as a backup power resource may be severely limited if it is not paired with a generating resource like solar PV. Without being paired with a generating resource, it will not be able to recharge once it discharges all of its stored energy, at which point its backup power value will be exhausted.

Similar to Scenarios 2 and 3, storage must be located on the customer-side of the line fault in order to provide value. To supply backup power during a service disruption, storage must also be sufficiently charged before the disruption.

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[23] ISO-NE Oil Depletion Charts. https://www.iso-ne.com/static-assets/documents/2023/04/2023-04-18_oil_depletion_graphs.pdf

[24] The largest storage facility in New England (the Northfield Mountain Pumped Hydro Storage Station) can discharge energy at a maximum rating of 1,168 MW for up to 7.5 hours.[24] While there is no question that the Northfield Mountain Pumped Hydro Storage Station is extremely valuable to the region, this example illustrates that New England could need 11 more Northfield Mountain Pumped Hydro Stations to fully displace the combustion of liquid fuels during winter cold snaps. Source: https://www.firstlightpower.com/facilities/?location_id=346

[25] "Islanded" refers to the ability of a distributed generation resource to continue generating electricity during a grid outage for purposes of supplying it to a co-located customer, as opposed to exporting it to the wider distribution system. Islanding requires incremental technology.

Under this scenario, the value of energy storage is not in preventing an outage but in serving backup power supply once the outage has occurred. Once a power outage occurs, storage becomes part of a smaller electric power system. For example, a storage resource may be a component in a single-residence power system or a microgrid that serves multiple residences. At that time, the smaller power system will be in one of the previous conditions described in Scenarios 1 through 4. For example, the microgrid may be unconstrained or may be experiencing peak demand conditions. Thus, to serve the primary function of backup power, the storage resource must perform the primary function needed to serve the smaller power system.

Unlike the other scenarios above, the value of energy storage as a backup power resource is independent from the electric power system (and the markets that support it) because customer demand for energy is no longer served by the power system. Instead, it is served by the microsystem that supports it (including the power generation resource that serves it, such as a diesel generator) or not served at all. As a result, the value of energy storage during a service disruption differs potentially significantly from the value of energy storage under the prior four scenarios.

Storage resources can reduce the price of and emissions from backup power supply by offsetting dirtier, more expensive backup generation fuels. Those values are captured by the non-electric resource benefits in Group 1. Storage resources also have the potential to create Group 2 benefits by offsetting incremental investment in intermittent backup generation capacity (e.g. adding panels to an existing solar PV system) or by enabling new REC supply that would not have otherwise been created (e.g. charging from a renewable generator that would have otherwise sat idle while electric power system is down).

<u>Benefits Outside the Primary Function's Value Stack</u>

Once a storage resource begins to serve as a backup power resource during a grid outage, nearly all of the benefits achievable in Scenarios 1 through 4 are achievable on the smaller power system in effect during the outage (e.g. the single residence being powered by the storage resource or a larger microgrid). Delivering benefits to that smaller power system is subject to the same conditions and rules as deliver benefits to the larger power system under Scenarios 1 through 4.

It is reasonable to assume that during the outage, the delivery system used to move power from where it is generated to where it is consumed will simply comprise a smaller section of the existing delivery system. For example, on a microgrid that serves 5 neighboring homes, the delivery system that delivers power from the generation resource to those homes will likely consist of the utility's existing distribution wires (enabled by incremental microgrid islanding technology). Whereas a new source of generation capacity is required to provide power during an outage, we assume that the existing delivery system is used to move power from that new generation capacity resource to the end user. In other words, we do not assume that an independent backup delivery system springs into action during a power outage. Accordingly, it would be impossible for a storage resource to provide avoided transmission or distribution capacity benefits during an outage. We also assume that benefits related to equipment cycling and line losses are not possible during an outage because the storage resource will be sited similarly close to load as any other backup power resource.

Notably, the electricity market value and electric energy market price effect benefits vanish from the value stack because the consumer is physically disconnected from the electricity market. Thus, their energy usage has no bearing on electricity market outcomes. Finally, because the consumer and the storage resource are disconnected from the electricity market, incremental ancillary services benefits and benefits associated with reducing supplier risk premium are also not possible to create during an outage.

<u>Alternative Functions and Value Stack Benefits</u>

Similar to all other scenarios, storage may be able to improve operations and power quality. However, to dedicate capacity to serving that task, a storage resource may undermine its availability to charge or discharge in response to customer demand for backup power. Even when storage is part of a smaller electric power system, it can still only move in one direction at a time, and therefore may not be able to provide operational benefits at the same time that it is supplying power or charging up.

In order to guarantee that it is sufficiently charged when outage conditions arise, a storage resource must hold on to its stored energy for the eventuality of an outage and forego participating in other revenue-earning opportunities during normal system operations. It is worth noting that retaining stored energy for a future grid outage can be subject to greater risk than other market activities, as forecasting power outages may prove more difficult than forecasting peak demand or cold snaps. While the timing of outages may correlate with the same weather conditions that drive peak demand or a winter cold snap, other hard-to-measure environmental factors may make predicting the location of outages harder than predicting the locations where peak demand conditions or and cold snaps may arise.

Outlook

The value of storage as a backup power resource depends on the frequency and duration of outages on the delivery system, the cost of alternative backup power resources, and the value of personal energy reliability (in those cases where storage serves as an onsite backup power resource).

Regarding outages, Rhode Island electric distribution customers have made significant investments in distribution system reliability, many of which are designed to reduce the frequency and duration of outages. In Rhode Island, tree-related events represent the leading cause of customer interruptions (excluding major storm events).[26] To minimize the risks of tree-related disruptions, Rhode Island Energy customers invest anywhere from $10-$25 million per year in vegetation management. As a result of these and other reliability investments, the distribution system has consistently met or exceeded system reliability goals. In 2021, the System Average Interruption Duration Index (SAIDI)[27] for Rhode Island Energy distribution customers was 68.8 minutes.[28] According to the US Energy Information Administration, the 2021 national average SAIDI was 121 – 125 minutes.[29] Given the relatively high reliability of Rhode Island's electric distribution system, storage may not be able to provide net benefits during a service interruption today.

Regarding costs, current battery prices are considerably higher than the costs of other backup power alternatives, particularly when considering that storage resources only gain the ability to refuel during an outage when paired with investments in distributed generation. Given the potentially significant cost differential between storage resources and other backup power resources, customers seeking backup power may choose to invest in cheaper alternatives.

The future reliability of the distribution system is unknown. On the one hand, grid modernization and system hardening investments could improve reliability. If the frequency and duration of outages decreases, the value of backup power supply from any resource – including storage - may decrease. On the other hand, future reliability might be threatened by weather- or climate-related disruptions. If the frequency and duration of outages increases, the value of backup power supply may increase. As existing storage

[26] Division Testimony in Electric ISR Docket No. 22-53-EL (page 71 of 80); RI Energy Response to DPUC Data Requests 1-1 and 1-11 (Bates pages 5, 52).

[27] SAIDI is a measurement of how long, in minutes, the average customer is without power during a year.

[28] The Narragansett Electric Company's Proposed FY 2024 Electric Infrastructure, Safety, and Reliability (ISR) Plan. RIPUC Docket No. 22-53-EL. Staff notes that the Company excludes major event days from its SAIDI metrics. Major event days are defined as any day on which the daily system SAIDI exceeds a Major Event Day threshold value (6.67 minutes for CY 2021).

[29] Table 11.1 Reliability Metrics of US Distribution System. US EIA: https://www.eia.gov/electricity/annual/html/epa_11_01.html. Staff nots that the national average SAIDI metrics exclude major event days.

technologies improve and costs decrease – or if the cost of alternative backup fuels increases - storage may become a more cost-competitive backup power resource.

Finally, the value of uninterrupted power service is customer-specific. A customer who uses an electric medical device at home may value power reliability differently than their neighbor. That being said, the value of uninterrupted power service often moves in the same direction for groups of customers. For example, as more residential customers worked from home in recent years, home energy reliability may have become more important for the collective residential customer group than in the past. Regardless of individual customer preferences and values, it is difficult to imagine a scenario in which reliable power supply is valued less in the future than today.

2.3 Summary of Scenario Analysis

The scenario analysis presented above illustrates the storage value stack under different power system conditions, given the primary functions a storage resource could perform to serve the unique conditions of each scenario. Taken together, the scenarios illustrate the range of opportunities for using storage resources to create value and can provide a gauge for how storage resources might operate throughout the day, season, or year. The magnitude of the storage value stack under each scenario is related to the real-world frequency and duration of the power system conditions presented by the scenario.

Storage resources could potentially create value under all of these scenarios as they occur on the real-world system. Actual conditions on the power system change throughout time. For storage resources to be able to perform valuable functions across time and across changing system conditions, one of two things must be true: the ability of the storage resource to perform valuable functions under the next (i.e. upcoming) set of system conditions must not have been fully exhausted by the activities it previously performed (e.g., if a line fault occurs during peak demand, the storage resource must not have fully discharged if it wants to have some stored energy available to serve backup power supply), or there must be enough of a predictable time gap between system conditions for the storage resource to transition from serving the previous set of system needs to serving the next set of system needs (e.g., if a storage resource discharges all of its stored energy for purposes of serving peak demand, it must have enough time to recharge before providing backup power should outage conditions arise).[30]

Regarding grid outage conditions, it may be challenging for a storage resource to perform the primary (or even secondary) functions associated with Scenarios 1 through 4 and simultaneously preserve its ability to serve as backup power supply during a grid outage. To serve as backup power supply, storage must be fully charged going into the outage. Charging up and holding on to that energy may be inconsistent with the functions required to deliver the full value of the resource outside of outage conditions.

Qualitatively, the PUC finds that across the range of power system conditions represented by the five scenarios, storage can create potentially significant value. However, even if one assumes that a storage resource can maximize its total value by carefully designing its real-time performance around current and future system conditions, this value may not exceed the cost of storage. Additionally, alternative resources

[30] Regarding the importance of transition time between system conditions, energy storage is often likened to a Swiss army knife because of its ability to perform different functions from a single device. Borrowing from the Swiss army knife comparison, having multiple different tools available in a single gadget is only useful if the need for each individual tool is separated by enough time to fold away one tool and unfurl the next. If, for example, someone needed the screwdriver in one instant and immediately needed the scissors in the next, there might not be enough time to fold up the screwdriver and pull out the scissors. If there wasn't enough time to do so, that person might be better off having a discrete screwdriver tool and a discrete pair of scissors, as opposed to a Swiss army knife that contained both.

exist that can serve the needs of the power system under the specific conditions discussed above. Currently, the cost of these alternatives is often lower than the cost of storage.

In the future, as storage costs fall, energy storage resources will increasing be able to provide value at least-cost under certain time- and location-based constraints. The PUC also expects the magnitude of the storage value stack under each scenario may grow in the future in response to changing system conditions driven by changes in customer demand and investment in clean, intermittent generation. The outlook presented for each scenario confirmed that future conditions on the power system will likely increase the need for the functions that energy storage resources (and alternative resources) can perform, thereby increasing the value that storage will be able to deliver.

Chapter 3. Qualitative Analysis of Existing Energy Storage Procurement

In its storage Resolution, the Senate directed the PUC to analyze whether new programs or tariffs are necessary for storage resources. To answer that question, staff identified two guiding questions:

What are the necessary elements of any good procurement strategy?

How is value procured from energy storage resources in Rhode Island today?

To answer these questions, staff and stakeholders reviewed the basic elements of procurement and analyzed existing storage procurement mechanisms in Rhode Island. The results of staff and stakeholders' discussion of procurement supported the PUC's analysis presented below.

3.1 Procurement Guide

Drawing from the PUC's expertise in market design and procurement, staff developed a procurement guide to simplify discussions about energy storage procurement with stakeholders. The procurement guide can apply to any product in any market. It is designed to be a useful tool for reviewing existing storage procurement mechanisms or designing future ones.

The procurement guide presented to stakeholders contains five basic elements:

1. **Identify the need and define the product:** Procurement begins with identifying a specific need and translating that need into a specific product that can be purchased. Often, the identified need and defined product are the same. For example, if one needs additional power, there is only one product that can serve it: more power. Other times, the need and product are different. For example, if one needs additional reliability, there is not a single reliability product to buy. In this case, the consumer needs to further define what "reliability" means to them. Clearly identifying and defining need is a critical first step for any procurement. The scenario analysis of power system needs presented in Chapter 2.1 was motivated by this step.
2. **Defining eligible supply:** Defining eligible supply entails articulating one's supply preferences and translating them into eligibility criteria. Prospective suppliers will be screened against that criteria before being able to participate in the market.
3. **Building the demand curve:** The demand curve for a given product or value reflects the quantities of product that demand (e.g. a consumer) is willing to buy at a given price. Typically, a demand curve is a downward-sloping graphical curve, indicating consumers' willingness to buy more of a product as its price decreases. Demand curves can also be vertical (indicating that demand will pay anything to get a specific quantity of product or value), horizontal (indicating that demand will buy potentially infinite quantity of product or value at a fixed price), and anything in between.
4. **Executing procurement:** Executing procurement consists of allowing suppliers to make offers, determining which offers should be accepted based on the demand curve, and transacting the procurement. Procurement can be executed through many different design mechanisms (e.g. auctions, request for proposals, retail and wholesale electric tariffs, program enrollments, etc.). Determining the best mechanism to procure a given product or value will depend on the nature of the product or value, the characteristics of suppliers, and the characteristics of demand.
5. **Validating the transaction:** Validation applies the rights and obligations of both supply and demand over the term of the transaction to ensure performance. If the transaction is instantaneous, validation can be very limited. For longer-term performance periods, such as those that might apply

to resources within the electricity market, continuous validation of performance can be critical to ensuring consumers actually receive the products they paid for.

3.2 Existing storage procurement mechanisms in Rhode Island

Staff and stakeholders used the procurement guide to review existing procurement mechanisms in Rhode Island: Rhode Island Energy's ConnectedSolutions program; Rhode Island Energy's System Reliability Procurement program; the Renewable Energy Fund (REF) storage grant program; and wholesale electricity market participation. The first three represent existing programs, and the fourth is enabled by existing ISO-NE tariffs. In roundtable discussions, staff and stakeholders evaluated how the five elements of the procurement guide manifest in each of the storage procurement mechanisms. Staff also conducted one-on-one conversations with stakeholders to confirm and expand on what was learned in the roundtable discussions.

Based on the input from stakeholders, the PUC presents its review of each of the storage procurement mechanisms below, with the intent to explore the adequacy (or inadequacy) of these programs for enabling net beneficial procurement of energy storage resources. Related to this review, Chapter 4.1 of this Report addresses the question posed by the Resolution of whether new programs or tariffs are needed to reduce the cost of the electric system.

Rhode Island Energy's ConnectedSolutions program

Need and product: On-peak demand reduction
Eligible Supply: Demand response, energy storage
Demand Curve: Annual program size and incentive level
Procurement: Open enrollment at fixed incentive price
Validation: Equipment controls, direct and indirect metering
Limitations: Only procures one product, short term price signal, action-based incentive

The goal of the ConnectedSolutions program is to reduce retail customers' demand for electricity during the peak hour(s) of demand on the regional power generating system. As illustrated in Chapter 1.1, discharging energy storage during peak demand (Scenario #3) can avoid significant power system costs, as well as other costs. The avoided costs from reducing bulk system peak demand will be shared among all customers of Rhode Island Energy and potentially the region. In return for lowering their demand during the peak, participating customers receive an incentive payment in addition to sharing in the avoided costs.

All Rhode Island Energy electric customers are eligible to participate in ConnectedSolutions. Eligible technology differs between Commercial and Residential customers. Both groups can participate with battery energy storage; Residential customers are specifically incentivized to participate using batteries. Outside of a demand response call, the battery charges and stores that energy for a future call.

Rhode Island Energy forecasts the timing of peak demand on the bulk power system and calls a series of demand response events with the intent that one will coincide with actual bulk system peak demand for that year. During a demand response call, participating customers receive a signal from the utility to reduce demand. For customers participating with a battery, the call will signal the battery to discharge its stored energy. If the participant reduces demand in response to that signal, they are eligible to earn incentive payments.[31] Given the current summer-peaking nature of the bulk system, all demand response calls occur in the summer.

The utility sets the size of the program (in MW) and the incentive rates on an annual basis and allows for open enrollment. In determining the program size and incentives, the utility balances the benefits of demand reduction against the costs of incentives and program administration. At the end of the summer, participating customers are paid for each kW that they reduced when called upon to do so. Notably, the payment of the incentive is not based on whether the ConnectedSolutions fleet actually offsets peak demand. If RIE forecasts peak incorrectly, participating customers are still paid for their participation. In 2022, the incentive rates offered by the utility were $400 per kW for residential battery participants and $300 per kW for commercial and industrial participants. The total cost of incentives paid to program participants in 2022 was $5.87 million.[32]

In 2022, the ConnectedSolutions program reduced peak demand by 51 MW. [33] That demand reduction was delivered by 6,432 participants, 256 of whom were residential customers participating with batteries.

System Reliability Procurement – Non-wires alternatives

Need and product: Demand reduction to relieve a distribution system (delivery) constraint
Eligible Supply: Demand response, energy storage, distributed generation, energy efficiency
Demand Curve: Sized to meet a specific need and must cost less than the utility-owned alternative
Procurement: Requests for Proposals (typically)
Validation: Equipment controls, direct and indirect metering
Limitations: Only contracts for the specific relief needed, RFP participation barrier, timeline requirements, sporadic opportunities

The Least Cost Procurement (LCP) statute requires electric distribution companies[34] to procure distribution system reliability in a cost-effective, least-cost manner. [35] The utility SRP Plan, approved by the PUC, includes screening criteria and procurement processes for identifying needs on the distribution system that can be met at least-cost with non-utility investments. These needs typically arise when the utility's demand forecast for a specific distribution asset exceeds the capacity of that asset, thereby requiring a capacity upgrade to reliably serve demand. In SRP, the product that is needed is reduction in or reversal of load growth at the specific distribution system location. As illustrated in Chapter 1.1 (Scenario #3), avoiding or delaying distribution capacity constraints can save power delivery costs and other related costs.

Neither the LCP statute nor the Commission's LCP standards limit the range of technologies that can compete to serve SRP needs. The utility can and does evaluate energy storage resources as potential SRP

[31] Demand response performance involves a customer foregoing the consumption of power from the electric grid at a specific time (either by reducing total consumption or by consuming power from a source other than the electric grid, such as a behind-the-meter battery). Because the utility cannot meter consumption that was never consumed in the first place, demand response performance is not directly measured. Instead, the utility imputes a customer's demand response performance by comparing their actual consumption of grid power to a historic baseline.

[32] 2022 Annual Energy Efficiency Plan Q4, RIPUC Docket No. 5189

[33] The Narragansett Electric Company's 2022 Performance-Based Incentive Mechanism Year-End Report, page 2. RIPUC Docket No. 4770

[34] Rhode Island General Laws § 39-1-2 defines electric distribution company as "a company engaging in the distribution of electricity or owning, operating, or controlling distribution facilities and shall be a public utility pursuant to subsection (20) of this section."

[35] Rhode Island General Laws § 39-1-27.7

solutions. Targeted energy efficiency, demand response, and distributed generation have also been eligible SRP solutions in past projects.

Through its distribution system planning process, the utility forecasts demand on its distribution system, identifies where existing distribution infrastructure is insufficient to serve that demand, and plans and completes system upgrades to serve growth. If the distribution system need that would otherwise be served by traditional system upgrades meets the SRP screening criteria, the utility will issue a Request for Proposals (RFP) for third-party solutions to avoid the upgrade.[36] To be selected, an alternative proposal is expected to be lower cost than the traditional utility investment.

If selected, an SRP proposal may be compensated up to the deferral value (or avoided cost) of the traditional utility investment. This compensation would be incremental to other compensation the proposal earns through other revenue streams (e.g., a distributed generation resource would still be eligible for net metering credits in addition to SRP compensation).

There have been multiple RFPs for projects in the past, including at least one RFP in which the sole eligible technology was battery storage. In 2017, the Narragansett Electric Company issued an RFP for the Little Compton Battery Storage Project. The Company selected a winning bidder and moved toward implementation, but construction delays and equipment unavailability ultimately resulted in project cancellation.[37]

If an energy storage resource were to be selected for an SRP project and achieve commercial operation, its performance might be validated in a stricter manner than storage projects in ConnectedSolutions. That is because non-performing ConnectedSolutions projects are responding to timing only. There are likely other resources throughout the system available at the time of non-performance, so the consequence of that non-performance is tempered. On the other hand, delivery constraints addressed by SRP solutions have both timing *and location* requirements. An SRP project may be the only resource available in the needed location that is able to respond at the needed times. As a result, the consequence of its non-performance may be more significant (e.g. reliability degradation).

During the procurement workshop, stakeholders addressed barriers facing storage participation in SRP. Stakeholders highlighted the cost differential between batteries and traditional distribution solutions as a primary barrier to storage proposals being selected through SRP. A stakeholder from the utility explained that they have received various battery storage proposals through SRP, but the costs of the proposals were five to ten times higher than the cost of the next best utility-owned solution. Stakeholders also acknowledged that the needs of the distribution system can change faster than the utility's pace of procurement through SRP and faster than bidders' ability to redesign proposals in response to changing conditions. In the instance of the Little Compton Battery Storage Project, the selected project faced financial and construction challenges that could not be overcome on the timescale needed to meet the SRP project requirements. In other words, it may be that SRP RFPs are too sporadic in their timing and requirements to represent a clear signal of market opportunity to energy storage developers. This may limit the ability or interest of the storage market to respond to SRP RFPs, thereby limiting the role that storage resources can play in serving distribution system needs.

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[36] SRP RFPs are published on Rhode Island Energy's Non-Wires Alternatives homepage: https://www.nationalgridus.com/Business-Partners/Non-Wires-Alternatives/

[37] The Narragansett Electric Company d/b/a National Grid 2019 System Reliability Procurement Plan Report, Docket 4889, at 30. https://ripuc.ri.gov/eventsactions/docket/4889-2019-NGrid-SRPReport(10-15-18).pdf.

Rhode Island Renewable Energy Fund's energy storage incentives

Need and product: Participants, peak power demand reduction
Eligible Supply: Residential battery storage paired with new renewable generation
Demand Curve: Incentives and programs size vary periodically
Procurement: Open enrollment
Validation: None/Unknown
Limitations: Must be paired with new solar, lacks validation, lacks product definition

The Rhode Island Commerce Corporation (Commerce) administers the Renewable Energy Fund (REF). The REF offers various grants and incentives to support the customer development of renewable energy resources. Through the REF, Commerce offers an energy storage incentive.[38] The storage incentives are funded by $1.5 million in Regional Greenhouse Gas Initiative (RGGI) auction proceeds.[39] Eligibility for the storage incentives extends to all electric customers in Rhode Island regardless of their utility. To be eligible for the incentive, customers must pair their energy storage facility with a new renewable energy generation facility (e.g. solar PV).[40] The incentives are available to small scale storage facilities and commercial scale storage facilities. The incentive for small scale storage facilities is $2,000 per project. The incentive for commercial scale storage facilities is $0.50/Watt[41], capped at $40,000 per project. The incentives are disbursed on a first-come-first-served basis.

While the REF obligates incentive recipients who are customers of Rhode Island Energy to participate in the ConnectedSolutions program, thereby indicating some intent to reduce peak power demand, incentive recipients can opt-out of the program at any time without consequence. If they do, their REF storage incentive amounts to an incentive to build, not a payment in return for delivering value or benefit.

In 2022, the REF awarded $266,000 in storage incentives to 88 small scale storage facilities and 4 commercial scale storage facilities.[42] According to a representative from the Office of Energy Resources, more than 20% of all battery storage projects in Rhode Island have received the REF storage incentives.

Wholesale electric market participation

Need and product: Various (energy, capacity, ancillary services)
Eligible Supply: All resources
Demand Curve: for the energy market, defined by customer demand; for the capacity market, set administratively
Procurement: supply and demand bids (energy), reverse auction (capacity)
Validation: Metering, data communication and analysis
Limitations: Does not procure local system products, does not procure wholesale products that lack existing market definition, market volatility, market entry barriers

[38] RI REF Energy Storage Incentive Program: https://commerceri.com/wp-content/uploads/2020/09/REF-Storage-Adder-RFP-FINAL-.pdf

[39] OER allocated $1.5 million to the REF through its 2019-B RGGI Proceeds Allocation Plan.

[40] Energy storage systems that are added on to an existing renewable energy generation facility are ineligible to receive the REF energy storage adder.

[41] The commercial scale incentive is equal to $.50/Watt based on the battery's maximum continuous power rating over three hours.

[42] RI REF Annual Financial Performance Report for the Calendar Year Ending 12/31/2022. https://commerceri.com/wp-content/uploads/2023/03/REF_Financial-and-Performance-Report-CY22-FINAL_signed.pdf

ISO-NE administers multiple wholesale markets including the spot energy market, Forward Capacity Market (FCM), and ancillary services market. Participation in the wholesale markets is open to energy storage resources. Market participation involves offering a product that is needed, meeting the eligibility requirements and rules of the market, and transacting the product to earn revenue. Storage participation in wholesale markets is relatively new but growing. As of May 2022, battery resources comprised 20% of all generating capacity in ISO-NE's Interconnection Queue.[43] Those resources may be sited anywhere in the region, including Rhode Island.

Wholesale market participation differs from the retail utility programs described above. Wholesale electricity markets require all resources to compete on price, whereas the retail utility programs described above do not necessarily facilitate competition among supply. For example, rather than procure on-peak power generation via an open enrollment with a static price (as in ConnectedSolutions), ISO-NE administers annual auctions in which thousands of different resources compete to supply generating capacity at the lowest price. Resources that offer their capacity for less than the market clearing price will secure a place in the market, thus ensuring least-cost market outcomes. In contrast, the incentives offered through ConnectedSolutions are not set competitively, and participating storage resources do not have to outcompete others on their cost of capacity to secure a spot in the program.

ISO's wholesale markets are designed to drive down costs through competition. This benefits electricity customers, who will pay less for their bulk power system needs. However, competition should reduce wholesale revenues for market participants, as competition can improve efficiency. If a participating resource's costs are higher than their market revenues, market participation may be financially infeasible.

One stakeholder representing a battery storage developer presented the following illustrative example: their batteries are capable of earning monthly revenues of $8/kW from the energy, capacity, and ancillary services markets. The monthly cost to run their 4-hour, 100-MW battery can be as low as $15/kW and as high as $27/kW. That leaves a monthly revenue gap of $7/kW to $19/kW. To remain operational, that missing money must come from some other source. The stakeholder acknowledged that their batteries are able to sell all of the wholesale products they are capable of producing, and that the barriers to wholesale market participation are cost-based, not rules- or eligibility-based.

3.3 Summary of Existing Storage Procurement Mechanisms

In summary, energy storage resources are already being developed in Rhode Island through the state's existing storage programs and tariffs. These procurement mechanisms vary in terms of their procurement design and the range of values they procure from participating storage resources. While existing programs and tariffs have been instrumental in the early deployment of energy storage resources in Rhode Island, staff and stakeholders identified several limitations within existing procurement mechanisms that limit their usefulness and leave potentially significant value on the table. The next chapter will analyze storage procurement policy in greater detail and offer recommendations on whether new programs or tariffs are necessary.

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[43] https://www.iso-ne.com/about/what-we-do/in-depth/batteries-as-energy-storage-in-new-england

Chapter 4. Procurement Policy Analysis

The Senate Resolution requested the PUC to report on whether new tariffs or programs are needed to achieve energy storage deployment goals. The Resolution identified three such goals: 1) reducing the costs of the electric generation, transmission, and distribution systems; 2) facilitating the transition to a safe and reliable carbon-free electricity supply; and 3) reducing peak demand on and improving the efficiency of the electric distribution system. Recognizing the overlap between the first and third storage deployment goals, staff reorganized the Resolution inquiry into two questions to investigate with stakeholders:

> *Are new tariffs or programs needed for energy storage resources to reduce the cost of the electric power system?*
>
> *Are new tariffs or programs needed for energy storage resources to facilitate the transition to carbon-free electricity?*

Below, Chapter 4.1 addresses whether new storage programs or tariffs are needed to reduce the cost of the electric system. Chapter 4.2 addresses whether new storage programs or tariffs are needed to facilitate the transition to carbon-free electricity.

4.1 Tariffs to Reduce the Cost of the Electric Power System

In Chapter 4.1, we examine the whether the existing storage procurement mechanisms presented in Chapter 3 are sufficiently designed and administered to procure the net benefits identified in Chapter 2.[44]

4.1.1 Analysis of Existing Procurement Mechanisms

Need and product

The procurement mechanisms presented in Chapter 3.2 represent the programs and tariffs that exist today to procure benefits from storage resources under some of the scenarios from Chapter 2.2. When examining the products they procure, it became apparent that existing programs along with utility and wholesale tariffs do procure many of the power system benefits included in the Framework. Notably, these existing programs and tariffs represent individual procurements, not a unified procurement mechanism. While they each procure some value(s) from storage, none of them procures all of the valuable benefits that storage can provide through a single, cohesive procurement design. Developers can attempt participation in multiple of these compensation programs or tariffs. In some unique circumstances, they might have trouble (or even be prohibited from) participating in the various existing programs and tariffs at the same time.

For example, if a resource participates in ConnectedSolutions, there is no compensation for energy market revenue or local distribution system benefits outside of the demand response calls issued by Rhode Island Energy. The resource would have to separately register and participate in the wholesale energy market to earn energy market revenue outside of those demand response calls. The same resource would also have to sign a contract for a site-specific SRP project to receive revenue for local distribution system benefits

[44] Chapter 2 concludes that energy storage resources can save electric system costs given the functions they are capable of performing and current and future conditions on the electric power system. In the future, one could build on the work of Chapter 2 to examine whether those potential cost savings are net savings. In other words, are the costs of owning and operating energy storage systems less than the benefits they create and lower than the cost of storage alternatives?

created outside of Rhode Island Energy's demand response calls, if such an opportunity even exists where the resource is located.

To summarize, Rhode Island's existing storage procurement mechanisms do procure some useful power system values from energy storage resources, as do wholesale market tariffs. However, the siloed nature of these programs may be leaving significant value on the table. For this reason, existing procurement mechanisms may not procure the maximum useful value from energy storage resources today or in the future. Thus, new solutions are likely needed to overcome the limitations of existing storage procurement mechanisms.

Eligible Supply

Taken as a whole, the existing procurement mechanisms do allow for energy storage participation. ConnectedSolutions and the REF storage incentive program define eligibility more narrowly than SRP or wholesale market tariffs. Whereas SRP and wholesale market tariffs are technology-agnostic, ConnectedSolutions (specifically, the residential battery carve-out) and the REF storage incentive are specifically targeted at energy storage resources. As a result, storage resources have a procurement advantage in ConnectedSolutions and the REF program compared to other resources. In contrast, SRP and wholesale market tariffs may define supply eligibility more broadly, thereby forcing storage to compete against alternative resources.

Demand Curve

In SRP and the wholesale markets, demand for the respective products is well-founded and well-defined. For example, the market clearly understands that the amount of capacity being procured through the ISO-NE Forward Capacity Market is based on total regional demand for power during the annual peak hour. However, the volumes and prices of demand for the products being procured through SRP and the wholesale markets can be volatile. For example, the Tiverton/Little Compton SRP project showed that the need for a multi-MW battery resource might materialize one year, disappear the next, and then reappear the year after that. It is difficult for suppliers – including energy storage developers—to gain traction when the market is subject to volatile forecasts, however real and appropriate they may be.

On the other hand, in the ConnectedSolutions and REF incentive programs, demand for the respective products may not always be well understood by the market and the way in which the programs set their respective demand curves may lack sophistication. This injects more risk into the market. In their current state, the simplified way in which the ConnectedSolutions and REF incentive programs determine their demand curves creates a risk that customers are paying too high a price for too much product or, conversely, that customers are buying too little because prices are inappropriately low. Simultaneously, the simplified way in which the ConnectedSolutions and REF incentive programs determine their demand curves creates a risk that suppliers offer too much or too little supply.

Staff heard from some stakeholders that the price signals sent by existing programs lack clarity and reliability. One stakeholder explained that because the ConnectedSolutions price signal (i.e. incentive level) can change from one program year to the next, it may not be reliable enough to entice large storage resources to patriciate in the program. Regarding the amount of demand in a year, the stakeholder representing Rhode Island Energy explained that the utility sets the program size annually by considering the prior year's program size (MW) and budget, and then adjusting the next program year based on the utility's estimates of supplier availability at the chosen incentive level. These factors are not always transparent to storage developers and may render them unable or unwilling to rely on the size of the ConnectedSolutions market. Like an unreliable price, an unreliable market size may lead to suboptimal supplier participation.

Procurement Execution

SRP and the wholesale market tariffs are advanced procurement mechanisms that require participating resources to have a high level of market sophistication, which can be cost-prohibitive for some resources. For example, taking on the responsibility of a market participant in the wholesale markets requires the participant be able to respond to volatile changes in market conditions as well as administrative changes in the tariff. This responsibility derives from the sophistication of the market. The sophistication of the market is a benefit to customers and established resources. However, if market participation requirements pose a barrier to entry for new and emerging resources that might otherwise be least-cost, then a market inefficiency exists. This could result in suboptimal outcomes. In contrast, the open enrollment participation model of ConnectedSolutions and the REF incentive program are likely easier processes for storage developers to participate in.

Validation

On the electric system, the gold standard for validation is billing-quality metering. Direct and indirect device metering are also reliable validation methods. While energy storage resources can be directly metered, some existing procurement mechanisms require them to compete against other resources (e.g. demand response) that are not subject to direct metering and must be indirectly metered. For this reason, when energy storage directly competes with other resources, the method of validation may create inequities between storage and its competitors. Whether that validation inequity creates a significant advantage or disadvantage for storage is dependent on the specific program or tariff and may be difficult to identify. Regardless, the validation process should not reduce the fairness and neutrality of the market.

4.1.2 Improving procurement with new tariffs

Throughout the stakeholder process, representatives of storage developers expressed a desire that energy storage resources be allocated costs and benefits according to their unique use of and provision of benefits to the electric power system. Costs and benefits are typically allocated through retail rate design. While costs and benefits can technically be allocated through programs, programs will necessarily sit atop retail service tariffs. For example, standalone energy storage resources must charge from the electric system. As a customer of the electric system, standalone storage resources will be allocated costs and benefits through their retail service tariff. If the state wanted to develop a program for standalone storage resources, whatever costs and benefits were allocated through the program would be incremental to the costs and benefits allocated by the underlying retail service tariff.

Without a separate retail service tariff for standalone storage resources, they will be grouped with the next closest rate class and take service under the retail service tariff that corresponds to such rate class. It is likely that a standalone storage resource in Rhode Island will be assigned to the large commercial or industrial rate class; in that case, they will pay the same rates to charge as any other customer in that rate class. All rate classes are allocated costs through rates based on the typical characteristics of the average customer in that class. In the large commercial and industrial classes, the average customer is a consumption-only load customer (e.g. manufacturing facility) whose usage of the electric power system represents a one-way flow of power from the system to the customer.

However, unlike traditional load customers who only consume power from the grid, standalone storage resources consume power from the grid *and* deliver power to it. This difference in power system usage reflects the fact that storage resources have a fundamentally different relationship to the power system than traditional load customers. Traditional load customers consume energy for the purpose of creating new value in some other market (e.g., frozen lemonade, plastics, etc.). In contrast, storage resources consume energy for the purpose of increasing the value of that energy within the same electric market. For this reason, the power system usage characteristics of storage resources (and the resulting costs and benefits) can be significantly different from the usage characteristics (and the resulting costs and benefits) of traditional load customers. Assigning the same costs to standalone storage resources as consumption-only load customers and making them pay the same rates may be inaccurate and may pose a hinderance to the deployment of net beneficial storage resources.

Given this, the state's ability to procure useful power system values from energy storage resources could be improved by the development and implementation of a new retail service tariff specifically for energy storage resources. Developing such a tariff would clarify the size of the market for the products and values storage resources can deliver, formalize their basic rights and responsibilities, and establish a fair method for allocating them the costs and benefits of their unique usage of the power system. In total, this can reduce the risk of developing energy storage resources in Rhode Island.

Designing such a tariff is a necessary prerequisite for new storage programs. Designing and implementing such a tariff before layering on incremental programs (and any associated incremental incentives) will yield better outcomes than implementing new programs and attempting to layer on a new retail service tariff at a later date. For example, consider a scenario wherein the retail service tariff for storage resources perfectly allocates costs and benefits between other customers and energy storage customers, but the revenue a storage resource can expect to earn under the service tariff is not enough to secure project financing and spur storage investment. This would suggest that the benefits of storage do not exceed its costs. In this case, if the State wishes to spur more storage development than a service tariff alone would, the State could create an out-of-market program to subsidize energy storage resources and provide the missing revenue. Under this example, the State would be able to carefully identify what need(s) it is trying to meet from storage and choose the appropriate out-of-market revenue source(s) to fund the subsidy program.

In Chapter 5.1 of this Report, the Commission proposes the basic elements of a retail service tariff for energy storage resources and outlines a process through which it could develop and adopt such a tariff.

4.1.3 Improving procurement outcomes with an interconnection tariff

Before energy storage resources can start delivering value to the power system, they must first interconnect to it. Currently, storage resources seeking to interconnect to the electric distribution system in Rhode Island must do so under Rhode Island Energy's standards for connecting distributed generation, a PUC-approved interconnection tariff. Based on discussions with stakeholders, Rhode Island Energy's interconnection tariff does not sufficiently recognize the potential flexibility and dispatchability of energy storage resources.

Under the existing interconnection tariff, the utility studies the interconnecting resource's impact to the system under the most extreme operations – that is, the operational configuration that will result in the most significant impact to the distribution system. This "stress-test" interconnection study process may be appropriate for inflexible loads or non-dispatchable generators. However, energy storage resources are flexible and thus capable of ramping up or down in response to a signal. A more flexible interconnection tariff could allow energy storage resources to interconnect to the system with dynamic operating allowances, which could potentially reduce their interconnection timeline and costs and improve their ability to deliver value to the power system.

In Chapter 5.2 of this Report, the Commission outlines a process through which it could develop a flexible interconnection tariff for storage resources.

4.2 Facilitating the transition to safe and reliable carbon-free electricity supply

The Resolution identifies the State's need to meet the Act on Climate and the related transition to carbon-free electricity as a motivation for the Resolution. Subsequently, the Resolution specifically requests the PUC report on whether new tariffs or programs for storage are necessary to facilitate the transition to a safe and reliable carbon-free electricity supply.

The PUC has interpreted the request as a question of whether and how electric energy storage can help the state meet the Renewable Energy Standard (RES) and/or meet the carbon emissions reduction mandates of the Act on Climate. The remainder of Section 4.2 describes the requirements of each statute, explains why each statute needs to be read with consistency, and analyzes the effect that energy storage could have on compliance today and in the future. Based on that analysis, the PUC finds that energy storage is not likely needed to meet the RES or the Act on Climate before 2032 but may be needed after that if laws or regulations change.

4.2.1 Compliance with The Renewable Energy Standard

The RES (R.I. Gen. Laws § 39-26) requires the State's retail electricity providers (referred to as Obligated Entities)to supply a defined proportion of their annual retail electricity sales from Eligible Renewable Energy Resources.[45] Legislative and regulatory actions have altered the annual RES requirement since its original passage in 2004. Most recently, the RES statute was amended in 2022 to speed up the annual percentage increases beginning in Compliance Year 2023, which now culminate in a 100% RES in Compliance Year 2033 and each year thereafter.[46]

The PUC is the state agency that regulates and administers the RES. Per the statute and the PUC's RES regulations, Obligated Entities can comply with the RES through two methods. First, Obligated Entities can meet the RES by purchasing and retiring eligible New England Power Pool Generation Information System (NEPOOL GIS) Certificates. One NEPOOL GIS Certificate is created for each megawatt-hour (MWh) of electrical energy generated within, or imported into, the ISO New England (ISO-NE) control area, which includes Rhode Island. A single NEPOOL GIS Certificate for one MWh of eligible renewable energy generation is also commonly referred to as a Renewable Energy Certificate (REC).[47] Rhode Island meets its RES when Obligated Entities retire sufficient eligible RECs for compliance.

Alternatively, Obligated Entities can also comply with the RES by paying Alternative Compliance Payments (ACP) to the Rhode Island Commerce Corporation (Commerce) in lieu of retiring eligible RECs. [48] For example, if at the end of the Compliance Year, an Obligated Entity is required to have served 100 MWh of renewable energy, the Obligated Entity can retire 100 eligible RECs or make a payment to

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[45] The RES specifically exempts the Pascoag Utility District and Block Island Utility District from compliance obligation.

[46] R.I. Gen. Laws § 39-26-4(a); P.L. 2022, ch. 218, § 1, effective June 27 http://webserver.rilin.state.ri.us/PublicLaws/law22/law22218.htm.

[47] As explained on its website, NEPOOL GIS "issues and tracks certificates for each megawatt-hour (MWh) of generation produced in the ISO New England control area, including imports from adjacent control areas, and all load served." The terms "GIS Certificate" and "Renewable Energy Certificate," or "REC," are often used interchangeably in the marketplace. While REC is the more general term used to denote a generator's descriptive characteristics (i.e. fuel type, vintage and geographic location), it is the settlement of GIS Certificates within the Obligated Entity's NEPOOL GIS account that substantiates RES compliance.

[48] The PUC notes that while Obligated Entities can technically comply with the RES by paying ACPs, the state will not meet the goals of the RES if Obligated Entities only ever pay ACPs as opposed to purchasing and retiring RECs.

Commerce of 100 times the applicable ACP rate. The ACP rate is calculated annually by the PUC. For 2023, the ACP rate stands at $80.59. In contrast, the average cost of a REC is typically $40.

The RES statute delineates which generation technologies meet the definition of "renewable" for the purpose of the RES. The statute also requires the PUC to formally certify each renewable generation unit before its output can be used by an Obligated Entity to comply with the RES. In this regard, every wind and solar PV facility (among other generation technologies) in New England and New York are likely capable of generating RECs that could be used to meet the RES. However, only those facilities that have formally registered with the PUC can actually generate Rhode Island-eligible RECs. NEPOOL GIS tracks which facilities have established eligibility in Rhode Island and marks those RECs as Rhode Island-eligible.

4.2.2 Compliance with The Act on Climate

The Act on Climate (R.I. Gen. Laws § 42-6.2) establishes mandatory and economy-wide greenhouse gas (GHG) emissions reductions of 45% and 80% below 1990 emissions by 2030 and 2040, respectively, and net-zero emissions by 2050. Whereas the RES places the burden of compliance on private entities, the Act on Climate places the mandate to reduce emissions on the State and the obligation to implement coordinated actions on state agencies. Further, while the RES explicitly defines compliance, the Act on Climate leaves it to the Executive Climate Change Coordinating Council (EC4) to annually report on "its findings, recommendations, and progress on achieving the purposes and requirements of [the Act on Climate]." [49]

It is not controversial to assume that achieving even the first mandate of the Act (a 45% reduction by 2030) will require nearly all—if not all—electricity use to be 100% clean by 2030. The EC4 establishes how to account for and report on electric sector emissions. Currently the Rhode Island Department of Environmental Management (DEM) executes the emissions inventory for the state.

In order to calculate annual electric sector emissions, DEM uses a REC-based accounting system that is consistent with the RES.[50] DEM determines the emissions caused by Rhode Islanders' electricity consumption by looking at how much electricity was consumed and what specific NEPOOL GIS Certificates are associated with that consumption. DEM then sums the GHG emissions associated with these specific NEPOOL GIS Certificates to calculate electric sector emissions.

Under this methodology, if every MWh of electricity consumed in Rhode Island in 2033 was associated with RECs from non-emitting resources like solar PV and wind generators, Rhode Island's electric sector emissions would be zero. Alternatively, if no RECs or clean-energy NEPOOL GIS certificates are legally associated with Rhode Island's energy consumption in 2033, the emissions would be equivalent to the New England System Residual Mix, which is the generic average pool of NEPOOL GIS Certificates not associated with specific energy use. New England System Residual Mix is expected to have high GHG emissions for the foreseeable future given the makeup of the regional power generation fleet.

4.2.3 The Usefulness of Consistent Statutory Compliance

Consistency between the requirements of the RES and the Act on Climate is necessary to ensure that the incremental money Rhode Islanders pay for the right to claim the renewable attributes associated with RECs—which includes the right to claim low-to-no GHG emissions—also counts toward the emissions reduction requirements of the Act on Climate. Without that consistency, Rhode Island electric customers

[49] R.I. Gen. Laws § 42-6.2-7.

[50] Rhode Island Department of Environmental Management 2019 Rhode Island Greenhouse Gas Emissions Inventory, at 12. https://dem.ri.gov/sites/g/files/xkgbur861/files/2022-12/ridem-ghg-inventory-2019.pdf.

might pay to be 100% renewable per the RES and pay again to be 100% emissions-free per the Act on Climate.

Unified accounting between the RES and Act on Climate is also consistent with a little-known but essential section of the RES known as the Energy Source Disclosure Requirements. The Energy Source Disclosure Requirements define how emissions from electricity consumption shall be determined and reported. This section of the RES requires Obligated Entities to disclose to their customers "what sources of energy were used to generate electricity for each electrical energy product…" and "… the emissions created as a result of generating the electricity."[51] The disclosure is required to "take into consideration and account for voluntary purchases of generation attributes or related products."[52] Finally, the section directs the PUC to "allow for or require the use of NE-GIS certificates for the calculation of the energy source disclosure."[53] For consistency with the requirements of the RES,[54] the PUC's Rules Governing Energy Source Disclosure state "NE-GIS certificates shall be used for the calculation of the Energy source disclosure."[55]

Together, the tracking, trading, retirement, and eligibility status of RECs and other NEPOOL-GIS Certificates creates a simple, transparent method to assure compliance with the RES, Act on Climate, and the Energy Source Disclosure Requirement of the RES. This system helps prevent double-counting of renewable and clean generation toward our goals and assures that Rhode Islanders do not pay twice to be 100% renewable and 100% emission-free. Additionally, this accounting methodology enables Rhode Island to protect its rights associated with claiming the emissions attributes of the RECs that have been purchased and retired for Rhode Island RES compliance, in the event that another entity attempts to claim those attributes.

4.2.4 Restating the Resolution's Problem Statement

Because electric sector compliance with the RES and Act on Climate can be primarily achieved through the procurement and retirement of RECs and other emissions-free NEPOOL GIS Certificates, the question of whether new tariffs or programs for storage are necessary to facilitate the transition to a safe and reliable carbon-free electricity supply can be restated as:

> *Are new tariffs and programs for storage necessary to facilitate an attainable supply of eligible RECs and clean NEPOOL GIS certificates to match Rhode Island's annual consumption of electric energy?*

In Chapter 2.2, the PUC illustrated specific times and locations under which energy storage resources can increase the supply of RECs and decrease the emissions of the System Residual Mix (presented in Scenario 2). The usefulness of energy storage under those system conditions depends on whether there is a sufficient, lower-cost supply of Rhode Island-eligible RECs to meet the mandates.

Based on publicly available information, the following sections examine whether there will likely be sufficient supply of Rhode Island-eligible RECs under current and future conditions. Sections 4.2.5 through 4.2.7 present expectations for the balance of REC supply and demand over the next ten years forecastable period. The need for energy storage to lower the cost of the REC market will be based on that balance.

[51] R.I. Gen. Laws § 39-26-9(b).

[52] R.I. Gen. Laws § 39-26-9(d).

[53] R.I. Gen. Laws § 39-26-9(c).

[54] Promulgation of the PUC's Rules Governing Energy Source Disclosure predate enactment of the Act on Climate.

[55] PUC 810-RICR-40-05-3

Section 4.2.8 then examines what changes to markets and laws could affect those assumptions, thereby affecting the need for energy storage.

4.2.5 Forecasting Demand for RECs to meet the RES and Act on Climate

The RES statute requires the PUC to report annually on compliance with the RES. The PUC's most recent Annual Report on the RES includes an examination of current and future demand for RECs based on the ISO New England (ISO-NE) forecast of energy use in Rhode Island.[56]

Table 3 below shows historical and forecasted obligated energy sales and the associated number of RECs that would be necessary to meet the RES.[57]

Table 3. Forecast of RES Compliance Year Obligations for New and Existing Resources

Compliance Year	**Actual or *Forecasted* RES-Obligated Retail Sales [a] (MWhs)**	**Minimum MWhs from New Renewable Energy Resources [b, c]**	**MWhs from *either* New *or* Existing Renewable Energy Resources [b, c] (2.0%)**
2021 (Actual)	7,663,780	1,187,900	153,290
2022	*7,764,000*	*1,320,000*	*155,000*
2023	*7,799,000*	*1,638,000*	*156,000*
2024	*7,869,000*	*2,046,000*	*157,000*
2025	*7,900,000*	*2,528,000*	*158,000*
2026	*7,954,000*	*3,102,000*	*159,000*
2027	*8,028,000*	*3,693,000*	*161,000*
2028	*8,172,000*	*4,372,000*	*163,000*
2029	*8,301,000*	*5,105,000*	*166,000*
2030	*8,477,000*	*5,934,000*	*170,000*
2031[d]	*8,676,000*	*6,854,000*	*174,000*

[a] Based on 2022 ISO-NE CELT forecast and assumes 2.86% of load is exempted from RES obligation in future years.

[b] The historical actual RES obligations include effects of rounding protocols for individual Obligated Entities.

[c] The annual targets are listed in Table A5 of Appendix 5.

[d] The 2022 ISO-NE CELT forecast ends in 2031.

The forecast presented in Table 3 shows that by 2031, approximately 6,854,000 RECs from New Resources will need to be retired to meet the RES. To decarbonize electric consumption by 2030 using only Rhode Island-eligible RECs, the state will require approximately 8,477,000 RECs from New Resources.

[56] RIPUC Annual RES Report for Compliance Year 2021: https://rhodeislandres.com/wp-content/uploads/2023/05/2021-RES-Annual-Compliance-Report-1.pdf

[57] Table 3 is taken from the Annual Report, which distinguishes between "New" and "Existing" Renewable Energy Resources. Rhode Island General Laws § 39-26-2(15) defines both terms. The PUC notes that "New" does not mean a resource recently added, nor does "Existing" mean all resources that were in existence prior to a Compliance Year. Rather, "New" is defined as renewable generation resources in service after December 31, 1997. "Existing" is defined as renewable generation resources in service before December 31, 1997.

4.2.6 Conservative Forecasted Supply of RECs from New Resources

The Annual RES Report also includes an examination of the current REC supply based on NEPOOL GIS Certificate statistics and PUC data on the capacity of eligible facilities. In 2021, NEPOOL GIS's public report for certificate statistics indicates that 6,843,587 certificates were generated from facilities that were eligible as a "RI New Renewable Energy Resource."[58] This large quantity of Rhode Island-eligible RECs is not surprising (or unintentional) given the size of the renewable generation fleet that Rhode Island ratepayers have invested in and that the PUC has certified as RES-eligible. In 2021, the Rhode Island-eligible renewable generation fleet comprised nearly 850 MW of solar PV, more than 2800 MW of onshore and offshore wind, and more than 380 MW of other facilities like bio-generators and small-scale hydroelectric facilities. While not all of these RECs are truly available to be used for compliance with Rhode Island RES (for example, they may be under contract to settle in other states), the facility owners' registration of their generation units with the PUC indicates some willingness to sell these RECs to Rhode Island entities that have RES obligations.

In 2021, the total potential supply of Rhode Island-eligible RECs was 6,843,587. The actual RES obligation was only 1,187,900 MWh. Furthermore, in 2031, the RES obligation is only forecast to be 6,854,000. In this regard, the in-place fleet of renewable generators operating 2021 is very nearly technically capable of supplying enough renewable energy to meet the forecasted RES requirements through at least Compliance Year 2031.

It is important to note that the fleet of eligible New Resources presented in Table 3 does not include the 400 MW Revolution Wind I power purchase agreement between Revolution Wind, LLC and the Narragansett Electric Company. The terms of the power purchase agreement require the facility to register with the PUC for RES eligibility.[59] Annual energy generation from the 400 MW of Revolution Wind I capacity is forecast to be 1,631,795 MWh. Thus, on an annual basis, the facility is expected to supply 1,631,795 additional RECs to meet Rhode Island's RES and Act on Climate needs.[60] The terms of the power purchase agreement specify that Rev Wind I must be commercially operational no later than January 15, 2028.[61]

Adding the 1,631,795 RECs expected from Revolution Wind I to the 2021 supply of RECs from eligible New Resources, the total Rhode Island-eligible REC supply forecast for 2028 is 8,475,382. Only an additional 1,618 MWh of eligible renewable energy would need to be generated to meet a 100% RES obligation in that year (i.e., 2028, two years earlier than required) and in time to have 100% renewable electricity to support achieving the 2030 mandate of the Act on Climate. A single 1 MW solar PV facility could fill this annual gap.

Assuming the Revolution Wind I output begins operation before 2030, there exists today an eligible generating fleet capable of producing a sufficient annual supply of RECs to meet the demand driven by the RES and Act on Climate. Beyond the existing eligible fleet, there are many more renewable generating facilities that exist today that have not taken the simple, low-cost step to register with the PUC as eligible resources. If they were to register with the PUC, their output would create even more Rhode Island-eligible REC supply. Furthermore, the PUC expects many new eligible facilities will begin operating between now and 2030, in response to the state's robust renewable energy programs. This will further increase the supply

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[58] *See* NEPOOL GIS Public Report, GIS Certificate Statistics, accessible at https://www1.nepoolgis.com/myModule/rpt/ssrs.asp?rn=104&r=%2FPROD%2FNEPOOLGIS%2FPublic%2FNEPOOL_CertificateStatistics&apxReportTitle=GIS%20Certificate%20Statistics.

[59] Schedule NG-1, Offshore Wind Generation Unit Power Purchase Agreement Between The Narragansett Electric Company d/b/a National Grid as Buy and DWW REV I, LLC as Seller December 6, 2018 at 5. https://ripuc.ri.gov/eventsactions/docket/4929-NGrid-PPA-NG-1.pdf.

[60] *Id*. at 69.

[61] *Id*. at 18.

of eligible RECs and will likely result in a total supply of Rhode Island-eligible RECs that far exceeds the requirements of the RES and Act on Climate.

Whether or not this supply of RECs remains or becomes economically viable for use to meet the RES and Act on Climate will depend on various factors, including the value of Rhode Island's ACP compared to other states' ACPs, actual energy use in the region, the continued operation of Rhode Island's eligible renewable generation fleet, and the ability and willingness of eligible resources that generate RECs to sell their RECs for use in Rhode Island. Notably, Rhode Island has highest ACP rate for general New/Class I RECs in the region (excluding resource-specific carveouts). Given the current ACP rate, Rhode Island's RES sets the highest value for New/Class I RECs in the region and will likely continue to do so through the foreseeable future. For this reason, even if a regional shortage of RECs occurs, there is fair likelihood that suppliers of RECs will sell their RECs to Rhode Island obligated entities, who are willing to pay more for them than obligated entities in any other state. As a result, it is likely that obligated entities in Rhode Island will be able to purchase sufficient RECs to meet their RES obligations even if regional REC supply becomes tighter.

4.2.7 Storage is not Likely Needed to Meet the RES or Act on Climate Before 2032

At present, neither Rhode Island's existing eligible renewable fleet nor the expected commercial operation of Revolution Wind 1 requires energy storage to deliver the quantity of renewable energy and RECs described above. Based on this, the PUC forecasts that new storage resources will not be needed to meet the requirements of the RES and Act on Climate between now and 2032.

While this conclusion may be new to some readers, it should not be new to energy stakeholders who have contributed to energy policy development in Rhode Island in recent years. For example, the 'Road to 100% Renewable Energy Electricity by 2030 in Rhode Island Report' (often referred to as the 100% Renewable Report) prepared for the Rhode Island Office of Energy Resources by The Brattle Group in December 2020 reached a similar conclusion regarding the timing of the need for energy storage for purposes of meeting the RES:

> *"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 ... 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."* [emphasis added][62]

4.2.8 Storage may be Needed Beyond 2030 or if Law and Regulations Change

Although the PUC did not conduct its own market or engineering analysis, the PUC agrees with Brattle's general assessment that, as the penetration of intermittent resources increases in New England, energy storage may become necessary to balance the generation output of these facilities with customer demand for electricity. Without the ability to balance load and generation in the future as renewable penetration increases, incremental renewable nameplate capacity will generate fewer and fewer incremental RECs to meet the RES and Act on Climate.

[62] *Id*. at 16.

This issue represents a possible physical constraint that storage could mitigate or resolve. When this physical constraint will actually arise depends on many factors, including load growth, the effectiveness of demand response and demand management programs, the growth of solar PV and offshore wind, and the addition of regional and interregional transmission facilities.

Finally, the PUC seeks to clarify that if the nature of RES or Act on Climate compliance is changed by amendment to either or both laws, storage might become needed in the nearer term to meet such mandates. For example, if either the RES or Act on Climate required seasonal or hourly matching of electricity generation and consumption, there may be hours or seasons wherein the supply of RECs becomes constrained relative to demand, given the generation profiles and intermittency of wind and solar PV generating facilities. Alternatively, if the RES or Act on Climate required RECs to be sourced exclusively from generation within the borders of Rhode Island, such a strict location-based compliance requirement could increase the need for storage locally.

4.2.9 The need for Tariffs and Programs to Facilitate Meeting the RES and Act on Climate

The PUC's forecast shows that there will likely be sufficient REC supply to meet the RES and Act on Climate until at least 2032. Rhode Island also has a fair likelihood to procure these RECs because its ACP rate is the highest in New England.

The stability and viability of the REC compliance pathway is the direct result of Rhode Island's nation-leading clean energy and climate policy. Not every state has such a stable, viable compliance pathway for its climate and clean energy policies. Having spent years developing and implementing the foundational programs that yield this stable, viable compliance pathway for the next decade, Rhode Island can now focus its efforts on carefully evaluating how best to pace the deployment of more complex new resources like storage and how to balance those resources against other alternatives like new transmission and distribution facilities, demand response, and incremental renewable generation.

Thus, while storage is not likely needed in the near term to meet the RES and Act on Climate, it may not be long before storage is needed to cost-effectively meet the RES and Act on Climate. For this reason, the PUC believes it is advisable to consider reasonable tariffs and limited programs today that provide the State and the storage market with the necessary experience to prepare for significant growth in electricity demand and compliance obligations after 2030.

Chapter 5. Outline for PUC Tariff Framework Proceeding

The final element of the Resolution "requests the PUC to adopt a framework for electric rate tariffs to apply to energy storage systems interconnecting and providing retail service to their distribution system and targets for installed storage capacity by 2032." The PUC agrees that these are worthy objectives but concedes that the effort required to produce a high-quality tariff framework and procurement targets are beyond what could be completed with the resources available for this Report.

Fortunately, as discussed above in Section 4.2, the progressive and successful clean and renewable energy policies enacted in Rhode Island and New England over the previous two decades have created a brief but reliable cushion of time during which there is sufficient supply of renewable energy to meet the State's renewable energy and GHG emissions mandates. During that brief but reliable cushion of time, more advanced resources like energy storage are unlikely to be needed to meet the state's goals. To prepare for a future scenario wherein available renewable energy supply may be insufficient to meet the Rhode Island's renewable energy and GHG emissions mandates, the PUC believes that prudent, measured progress on energy storage should be the near-term goal.

Separately from the need to meet the RES and Act on Climate, energy storage resources have the potential to deliver significant value to the power system. Some of those power system values are procured today through existing markets or programs. However, the design of existing procurement mechanisms may not enable procurement of maximum useful value from storage resources.

As described in Section 4.1, the Commission believes a retail service tariff for standalone storage resources and an accompanying flexible interconnection tariff could overcome the limitations of existing storage procurement mechanisms in Rhode Island. Consistent with this analysis, the remainder of this Chapter presents how the PUC would develop and implement these storage tariffs and perform the other procurement-related functions raised by the Resolution once the necessary resources become available to it.

5.1 Developing a Retail service tariff framework for standalone energy storage resources

In a typical regulatory proceeding, Rhode Island Energy, as the incumbent electric utility, proposes new tariffs by filing them with the PUC for review and approval, supported by evidence and testimony, and subject to cross-examination and rebuttal by other parties. The process can be a difficult way to explore and advance useful but complicated ideas like a storage service tariff. In a typical regulatory proceeding, the utility is not required to seek input from the Commission nor stakeholders on the design of a proposal before filing it with the PUC. Given the novel nature of a service tariff for standalone storage resources[63], the PUC does not believe that a typical regulatory proceeding would be the most efficient or inclusive process for developing an energy storage service tariff. Instead, a better method would be for the PUC to lead a process to:

[63] The objective of the service tariff is to more fairly allocate costs and benefits to storage resources than currently occurs through existing rate design. The PUC believes it is appropriate to focus the service tariff on standalone storage resources rather than behind-the-meter load-coupled storage resources. Future time of use (TOU) rates will present behind-the-meter load-coupled storage resources will an enhanced opportunity to liquidate their products. However, because standalone storage resources are not coupled with any load, they will not be able to take advantage of TOU rates in the same way behind-the-meter load-coupled storage resources will be able to. For that reason, the PUC recommends focusing the retail service tariff on standalone storage resources.

1. create a framework for a standalone storage retail service tariff, developed with stakeholder input; then
2. adopt the service tariff framework; then
3. review a model tariff suitable for Rhode Island Energy's service territory with stakeholder input; then
4. adopt the model tariff; then
5. through an appropriate regulatory action, require Rhode Island Energy file a completed tariff at an opportune time that is consistent with the model tariff or show cause why the model tariff should not be filed.

A service tariff has three basic elements: a definition of the eligible customer class; rate structures and the derivation of rates; and additional terms and conditions for service. To be consistent with the PUC's Guidance Document adopted in Docket 4600A, an energy storage service tariff should recognize the unique characteristics of energy storage resources and the costs and benefits caused by their unique usage of (and provision to) the electric system. [64]

The service tariff framework development would build upon the work of Chapters 2 and 3 of this Report to identify net beneficial products and values from standalone energy storage resources, the specific charging and discharging activities through which those products and values are delivered, and the time- and location-based constraints under which values from standalone storage resources are actually exchanged. The Commission would develop the service tariff framework through an informal stakeholder process that welcomes stakeholder participation and input.

The development of a service tariff framework would serve to inform the later development of a model tariff. The model tariff would be filed with the Commission by a party (the utility or a third party) in a formal docketed proceeding. If there was sufficient time between the filing of the model service tariff and the utility's next distribution rate case, the Commission would review the model tariff through its formal review procedures. should there be enough time between now and the next rate case.

Whereas the service tariff framework will identify net beneficial products or values from standalone storage resources, the necessary charging or discharging activities required to deliver them, and the costs and benefits of such activity, the model tariff will formalize how those costs and benefits will be allocated to storage customers taking service under the service tariff, as well as the terms of such service. At a minimum, the model tariff should address each the following elements:

- Eligibility: which customers should be eligible to take service under the future tariff?
- Allowable activity: what charging and discharging activity should be allowed for customers taking service under the future tariff?
- Metering: what should be the metering requirements for customers taking service under the future tariff?
- Cost and benefit allocation: how should storage customers taking service under the future tariff be charged for the cost of their charging and discharging activity? What should customers taking service under the future tariff be paid for the benefit of their charging and discharging activity?
- Rate design: how should storage customers taking service under the future tariff pay for their costs and be compensated for their benefits? (e.g. demand charge vs. energy charge, fixed charge, etc.)

[64] Rhode Island Energy's service tariffs applicable to electric customers, see here: https://www.rienergy.com/media/pdfs/billing-payments/tariffs/ri/a16_ripuc_2224.pdf, which makes incorporates other tariff provisions by reference that can be found here: https://www.rienergy.com/ri-home/rates/tariff-provisions.

Before adopting the model tariff, the PUC would need to find that the model tariff is consistent with all requirements of state and federal law, including the requirement that rates be just and reasonable, and consistent PUC policies, including those adopted in RIPUC Docket 4600A.

Upon adopting a model tariff, the PUC may then require Rhode Island Energy to either file an actual service tariff that includes actual rate schedules informed by a cost-of-service study or other industry-standard analysis sufficient for setting rates or to file an explanation why no tariff should be filed.

Developing the service tariff framework and adopting a model tariff requires more time and resources than were available to the PUC as part of its energy storage stakeholder proceeding. The Commission is committed to carrying out this work once additional resources become available.

5.2 Developing an Interconnection tariff framework for energy storage resources

Chapter 4.1.3 explained that Rhode Island Energy's interconnection tariff does not recognize the potential flexibility and dispatchability of energy storage resources. At a staff-led roundtable discussion on storage business models, stakeholders discussed the business model and value proposition differences between having an interconnection that is based on nameplate capacity versus operational capacity. With an interconnection that is based on a nameplate capacity, storage resources can expect to charge from and discharge to the distribution system without restrictions. With an interconnection that is based on operational capacity, storage resources trade-off operational flexibility and the revenue potential associated with that operational flexibility for shorter interconnection timelines and lower interconnection costs.

Based on the roundtable discussion, it is unclear whether providing for interconnection based on operational capacity would be useful in the near future given likely business models for storage resources. However, clarity on the interconnection rights and obligations of storage could lower barriers for storage resources looking to site in Rhode Island.

Given this, the PUC could initiate a stakeholder proceeding to develop a framework for an energy storage interconnection tariff once resources become available at the PUC. At the conclusion of the proceeding, if it was determined that the interconnection tariff framework was useful, the PUC would provide next steps for developing and approving a storage interconnection tariff.

5.3 Periodic storage market assessment and procurement

In the normal course of its business, pursuant to prudent regulation and multiple provisions of the law, the PUC reviews the status of various markets for procurement opportunities that would benefit ratepayers. This includes, but is not limited to, energy supply, energy efficiency, distributed generation, utility scale energy projects, and demand response resources including energy storage systems.

To enable opportunities for electric utilities to procure net beneficial storage capacity, the PUC could formally conduct a periodic assessment of local and regional markets for energy storage. The PUC could conduct this periodic storage market assessment itself if resources were provided to it. Otherwise, Rhode Island Energy could conduct the periodic storage market assessment and file the results of the assessment as part of its three-year review of system reliability and three-year least-cost procurement plan, as reviewed by the PUC pursuant to R.I. Gen. Laws § 39-1-27.7.

The periodic market assessment could evaluate existing and forecasted time and locational constraints on the electric distribution and bulk power systems that have the potential to increase costs. When reviewing bulk power system values, the PUC could specifically assess market opportunities for long-duration and short-duration energy storage resources and identify any differences in value between the two. The periodic storage market assessment could serve as the basis for an evidentiary record upon which the PUC could adopt or amend prudent procurement targets for energy storage.

Final Note

This document is a draft Report for public comment. The Commission welcomes comments on all elements of the draft Report from all interested stakeholders and members of the public. The Commission will review the public comments its receives and incorporate them into the Report where appropriate and possible. Additionally, the Commission will publish all of the comments it receives on the Docket No. 5000 website for public review at the link below. Public comments will be due by August 4, 2023.

Comments can be submitted electronically to Emma.Rodvien@puc.ri.gov or delivered to the Public Utilities Commission offices at 89 Jefferson Blvd, Warwick RI, 02888.

Once the Commission has received and reviewed all comments, it will deliver a final version of the Report to the Senate. The final Report will also be published and archived on the PUC's webpage at https://ripuc.ri.gov/eventsactions/docket/5000page.html

Appendix A: Stakeholder Workshop Participants

		Stakeholder Workshop Date			
Stakeholder Name	**Stakeholder Organization**	**12-Dec-22**	**10-Jan-23**	**26-Jan-23**	**21-Feb-23**
Shauna Beland	Office of Energy Resources	x	x		
Stephanie Briggs	Rhode Island Energy	x			
Sean Burke	BlueWave	x			x
Kathy Castro	Rhode Island Energy	x			
Ryan Constable	Rhode Island Energy	x	x	x	x
Al Contente	Division of Public Utilities and Carriers	x	x		
Brett Feldman	Rhode Island Energy	x		x	
Carrie Gill	Rhode Island Energy			x	x
Kate Grant	Rhode Island Energy	x	x	x	x
Seth Handy	Handy Law	x	x	x	
Maggie Hogan	Division of Public Utilities and Carriers	x	x		x
Craig Johnson	Optimal Energy	x			x
Kaitlin Kelly O'Neill	ECA Solar	x	x	x	x
Sevag Khatchadourian	Oak Square Partners	x			
Emma Marshall-Torres	Convergent Energy and Power	x	x	x	
Rob Mastria	Flatiron Energy	x			
Tony Paradiso	E3	x	x	x	x
Jamie Rhodes	Rhodes Consulting	x	x	x	x
Erica Russell-Salk	Rhode Island Energy	x			
Tom Saunders	BW Solar	x			
Katie Sause	Mass American	x	x		
Matt Sullivan	Green Development	x	x	x	x
Natalie Treat	NECEC	x			
John Typadis	Oak Square Partners	x			
Matt Ursillo	Green Development	x			
Nick Vaz	Office of the Attorney General	x	x	x	x
Hank Webster	Acadia Center	x	x		
Stephen Wollenburg	Sustainable Energy Advantage	x	x		x

x = Stakeholder Workshop attendance