Vermont Storage Rulemaking

- Authorized by VT House Bill 431
- Goal: cut “green tape” to allow accelerated deployment while handling critical issues (safety, decommissioning, and interconnection).
  - Systems under 100 kW - rules on interconnection, fire safety, and decommissioning. No application needed.
  - Systems 100 kW – 1 MW - streamlined application.
  - Integration of storage with net-metering and other renewable programs (prevent gaming, capture value).
  - Aggregations - real-time communications with distribution utilities, registration with the PUC, evaluation of system stability and reliability impacts.

NECPUC Storage Panel

Emma Rodvien
Programming Services Officer
Rhode Island PUC

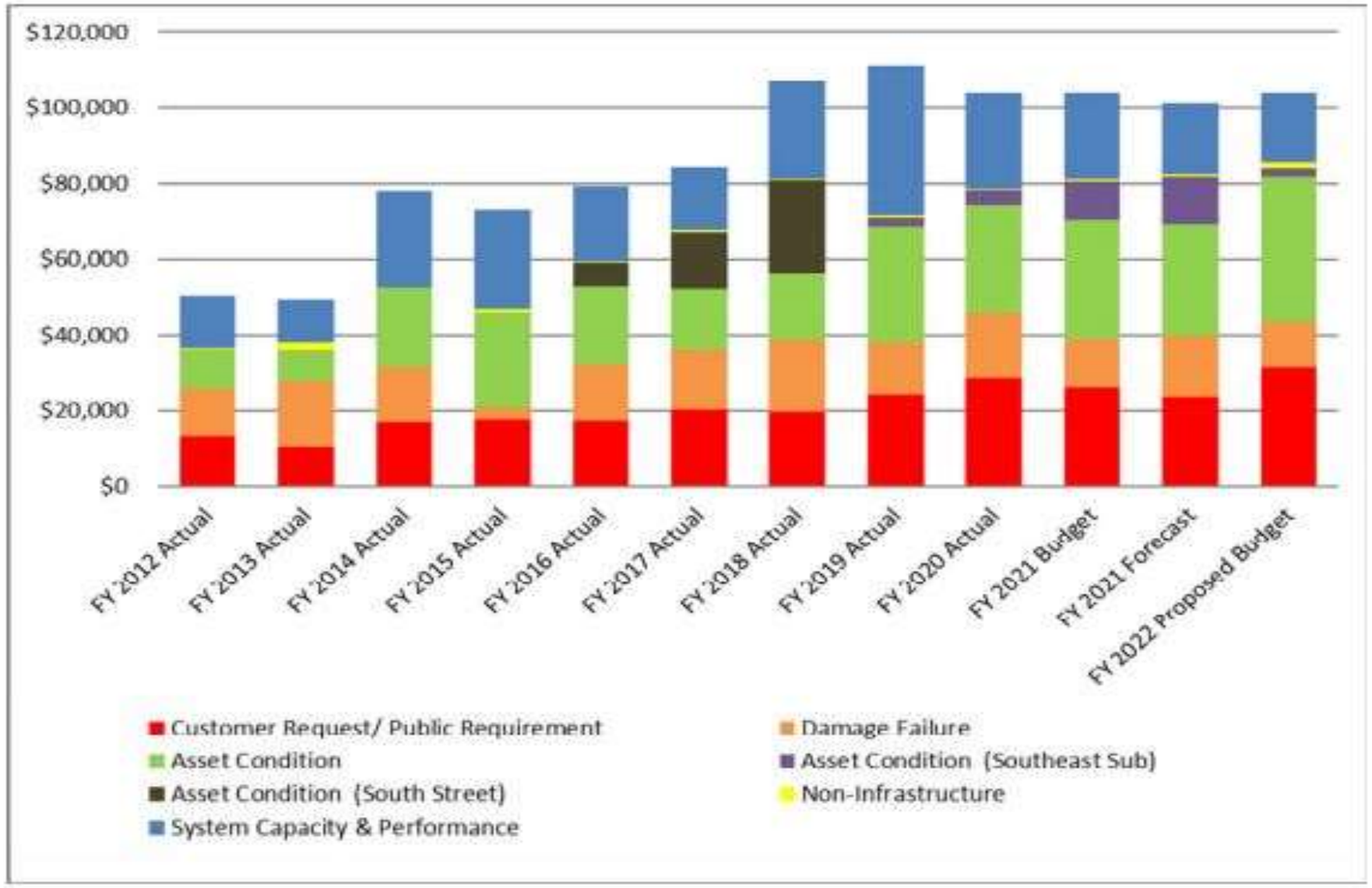
April 30, 2021

Questions on Commission staff's mind:

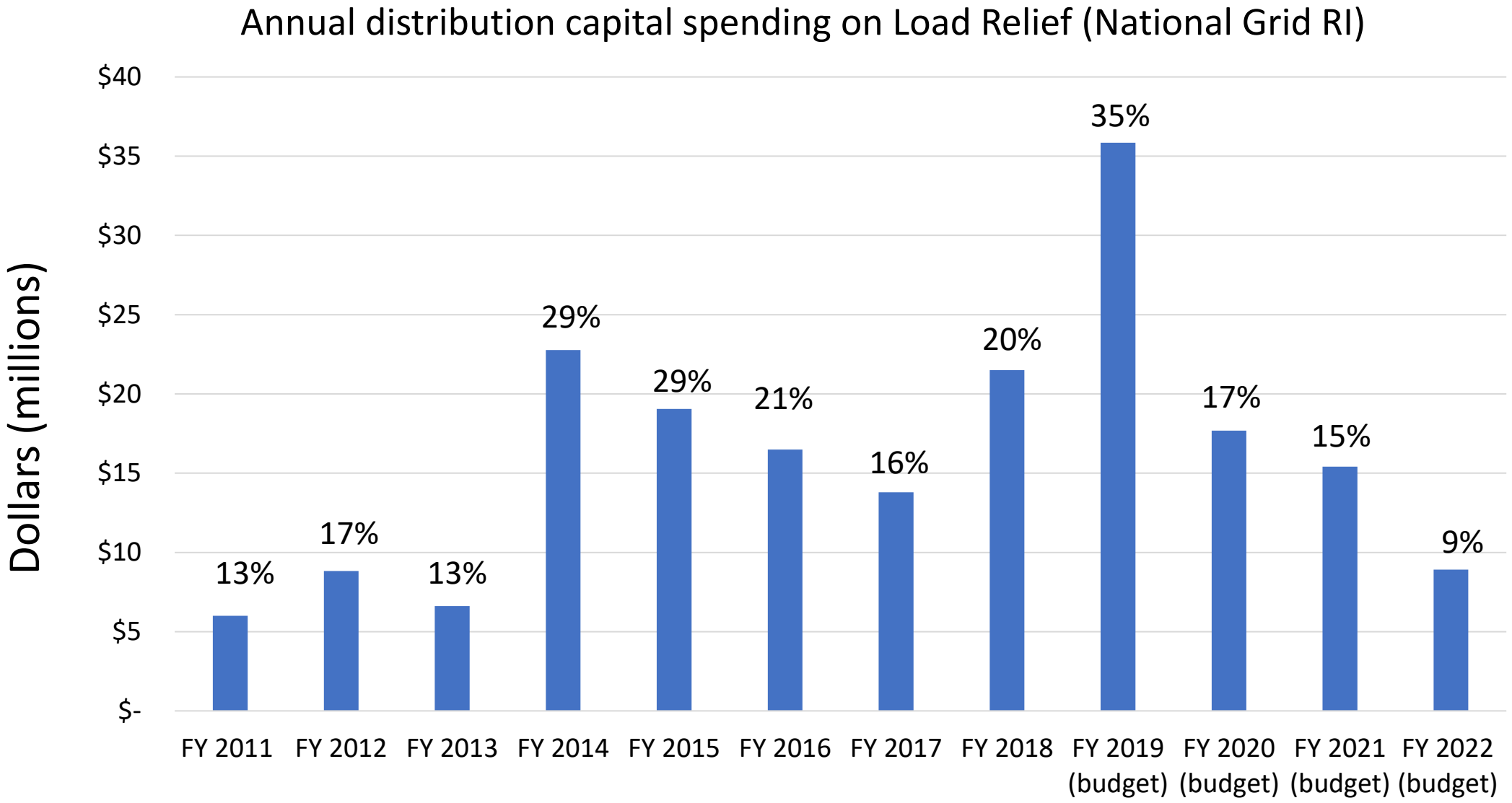
1. What are the different **use cases** for storage resources?
2. Do existing markets and program designs send **efficient signals** to storage resources such that they deliver (expected) value to storage investors?

Rhode Island example 1:
Storage as a distribution system asset

Annual distribution capital spending (National Grid RI)



Source: http://www.ripuc.ri.gov/eventsactions/docket/5098-NGrid-Electric%20ISR%20FY2022%20Plan%20(12-21-2020)w-Bates%20(Book%20Production).pdf



Source: http://www.ripuc.ri.gov/eventsactions/docket/5098-NGrid-Electric%20ISR%20FY2022%20Plan%20(12-21-2020)w-Bates%20(Book%20Production).pdf

Little Compton Battery Project NWA

December 2016: National Grid issues NWA RFP for 250 kW of load relief, up to 4 hours/day

Early 2017: National Grid selects a battery vendor offering a 1 MW / 1 MWh battery

Summer 2017: unforeseen distribution system upgrades delay project completion

Early 2018: vendor says project no longer financially viable due to unforeseen reconductoring; proposes moving project to cheaper location on the grid

Summer 2018: Vendor faces equipment delays

August 2018: vendor says project no longer financially viable, requests new rate structure (available only to RE-paired systems)

September 2018: vendor redesigns battery to pair with solar. Due to tariff ambiguity, they would need to file with PUC. Due to time constraints, National Grid cancels project

Source: http://www.ripuc.ri.gov/eventsactions/docket/4889-NGrid-DR-PUC1-Pt%202%20(11-27-18).pdf

Rhode Island example 2:
NEM program design + demand reduction

NEM program design features

- In RI, the economic proposition of NEM is to reduce your monthly bill, through:
  - Load reduction (BTM)
  - Excess generation credits (BTM and FTM)

- NEM system sizing constrained by:
  - customer usage (3-year average)
  - 10 MW individual project cap

- If your monthly bill contains demand charges, you may seek to reduce them through smart configuration of your NEM facility. How?

Method 1: add battery storage

Method 2: add more DC capacity behind AC inverter

Real customer example

- Commercial customer installed a **34 kW AC** NEM system (solar PV)
- Estimated DC system size, using traditional DC/AC ratio = **39.1 kW DC**
- Actual DC system size = **51 kW DC**
- Difference between expected and actual system sizes:
  - “Extra” 11.9 kW DC
  - Additional 30% generation capacity

Annual revenue from extra 11.9 kW = $2,100 - $2,600 →

If the customer can use this extra revenue to reduce demand charges, what incentive is there to reduce actual demand?

Energy Storage In MA

NECPUC/DOE Energy Storage Webinar Series

April 30, 2021

Michael Judge
Director, Electric Power Division
Massachusetts Department of Public Utilities

Early Work on Energy Storage

Beginning in 2013/2014, Massachusetts first began to contemplate the inclusion of battery energy storage into state policy and grant programs

- Emergency Power Generation Unit Definition
- Community Clean Energy Resiliency Initiative (CCERI)
  - $40 million grant program for local governments to design and implement local energy resilience projects
- Energy Storage Initiative RFP
  - $1 million RFP to develop a comprehensive report detailing opportunities and barriers for storage in MA

State of Charge Report

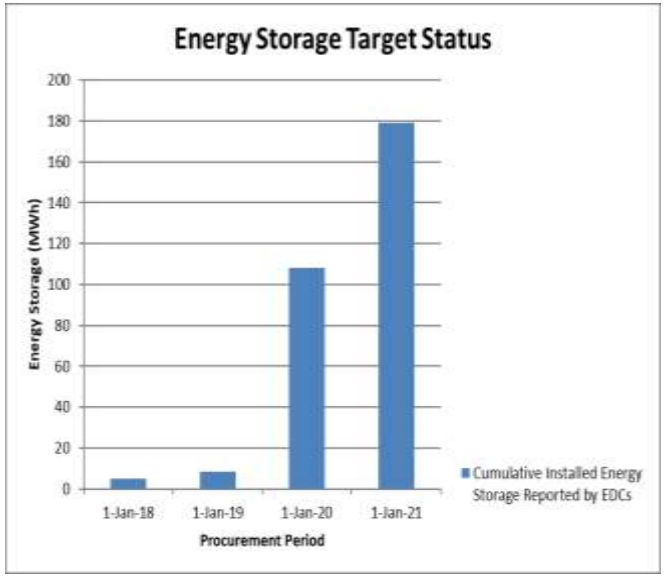
- In September 2016, the MA Department of Energy Resources and MA Clean Energy Center jointly released the *State of Charge* Report
- The report comprehensively examined a variety of use cases and business models for energy storage and contained the following findings and policy recommendations:
  - Most commodity chains (food, water, gas, oil, natural gas, etc.) have storage capacity of 10% or greater, but electricity sector has less than 1% storage capacity, resulting in excess infrastructure to meet peak demand
  - Top 10% of peak hours account for 40% of Massachusetts' total annual electric costs
  - Comprehensive system modeling revealed that 1,766 MW of new energy storage would maximize Massachusetts ratepayer benefits
  - Significant benefits from energy storage exist that are not monetizable by storage facility owners (energy, capacity, and ancillary service cost reductions, increased renewable integration, T&D cost avoidance, etc.), justifying the establishment of ratepayer funded incentives
  - Recommended that policies be adopted to deploy 600 MW of battery storage by 2025, identifying $800 million in benefits that would accrue to ratepayers as a results

State of Charge Recommendations

- The State of Charge report recommended the following specific policies be pursued:
  - Establish grant and rebate programs
  - Create performance-based incentives for storage through portfolio standards
  - Integrate storage into solar incentive programs
  - Establish peak demand reduction programs for storage through energy efficiency programs
  - Enact statutory changes to permit storage in energy procurements
  - Clarify statutory and regulatory treatment of energy storage
    - Utility ownership
    - Net metering
    - Interconnection
  - Pursue ISO-NE rule changes to better integrate storage into existing markets

2016 Energy Legislation

- Established statutory definition for energy storage system, permitting utility ownership if it can be demonstrated that the system:
  - Reduces GHG emissions
  - Reduces peak demand
  - Defers or substitutes an investment in T&D assets
  - Improves the reliable operation of the transmission and distribution system
- Permitted and encouraged the co-location of storage with large scale renewables in long-term procurements
- Directed the DOER to establish a statewide energy storage procurement target (subsequently amended by legislation in 2018)
  - Target of 1,000 MWh by 2025 established
  - 179 MWh installed and operating as of January 1, 2021
  - 874 MWh of energy storage under development



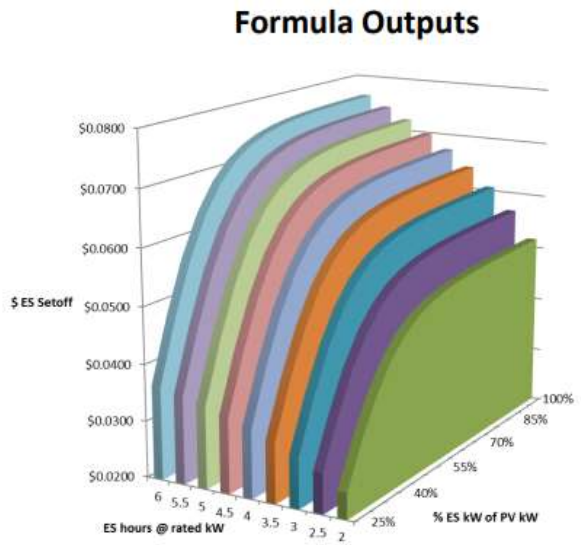
Energy Storage in SMART Program

- In 2017, DOER promulgated rules to establish a new tariff-based solar incentive program to support 1,600 MW of new distributed solar
- DPU was involved in reviewing and approving a model tariff that was jointly filed by the electric distribution companies in late 2017
- Program launched in 2018 and includes an “adder” for solar facilities that are co-located with energy storage
  - Adder value is variable and is based on size of the battery
  - Adder values decline as more solar paired with batteries are qualified
  - Rules also contain certain operational requirements
    - Batteries must discharge at least 52 complete cycle equivalents per calendar year
    - Aimed at shifting solar generation to help reduce summer and winter peak demand
    - 15-minute interval metering data must be collected and report annually to maintain adder
  - Rules designed the encourage desirable outcomes and benefits, but not to overly restrict the operation of batteries participating in the program

Energy Storage in SMART

- Several trends and issues worth noting:
  - Metering and compensation issues (DC coupled vs. AC coupled)
  - DC oversizing
    - Solar facilities paired with storage are being installed with DC nameplate capacity ratings that are 2-4x the AC rate
  - Percentage of facilities taking advantage of the storage adder is significantly increasing over time
  - Recent DOER rule changes require all solar facilities larger than 500 kW to be paired with storage

Storage Capacity in SMART as of 4/15/21			
Status	**# of Projects**	**Capacity (MW)**	**Capacity (MWh)**
Operational	890	72	167
Qualified	1,249	306	861
Total	**2,139**	**378**	**1,028**

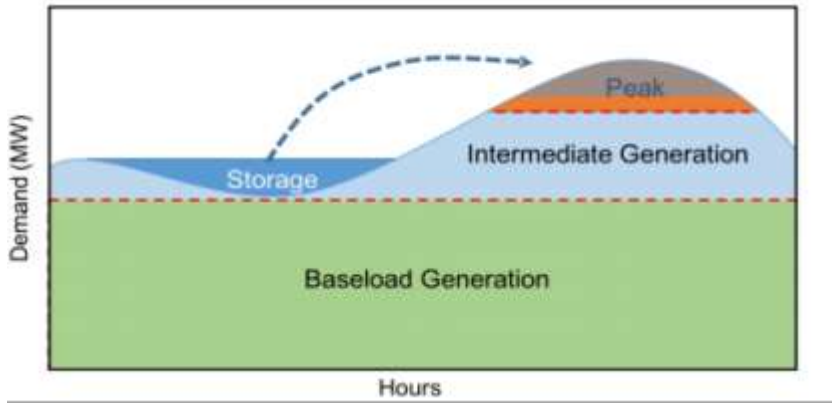


ConnectedSolutions

- First proposed and approved by the DPU as part of the electric distribution companies' 2019-2021 three-year energy efficiency plan offerings
- Active demand management program designed to dispatch customer owned batteries to reduce peak demand
  - $225 per kW during summer events
  - $50 per kW during winter events
- Dispatches can occur between the hours of 2 and 7 PM from June 1 – September 30 and December 1 – March 31
- Maximum number of dispatch events
  - 60 times per summer
  - 5 times per winter
- Maximum of 3 hours per dispatch
- 5-kW battery that is able to respond to events could earn up to $1,375 per year
- Available to residential customers of Eversource and National Grid
- Customers are eligible to apply for a 0% interest HEAT Loan for the material and labor costs associated with installing a battery storage system to participate in ConnectedSolutions

Clean Peak Energy Standard

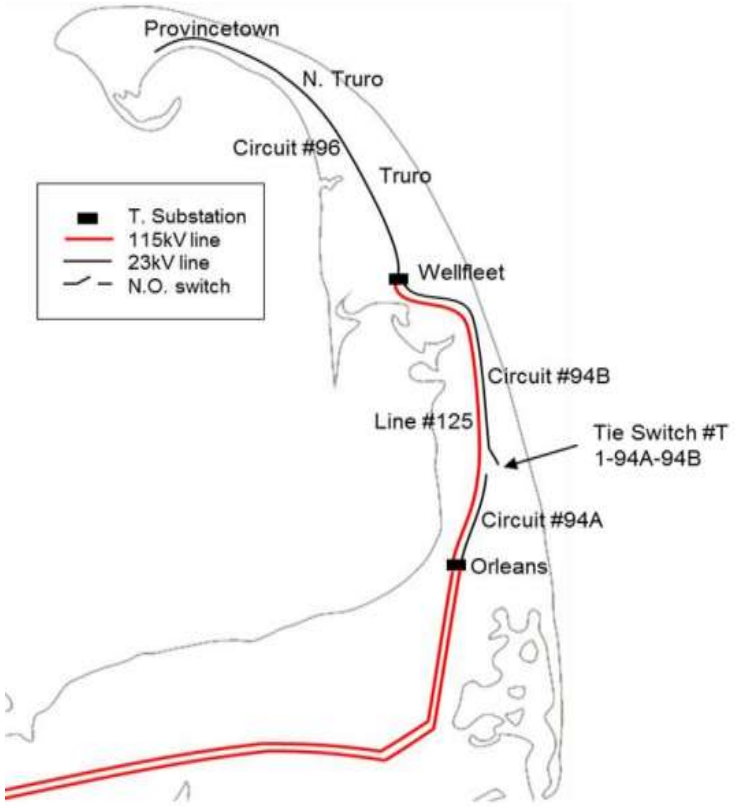
- Originally proposed by Governor Baker, the Clean Peak Energy Standard (CPS) was part of An Act to Advance Clean Energy and was signed into law in August 2018
- Market mechanism designed to shift clean energy to peak and reduce demand at peak, thereby decreasing emissions and costs
- Clean Peak Resources are defined in statute to include:
  - New renewables
  - Existing renewables that pair with new energy storage
  - New energy storage that charges primarily from renewables, and
  - Demand response resources
- Any eligible resource that generates, dispatches or discharges energy during a Seasonal Peak Period will generate Clean Peak Energy Certificates (CPECs)



Clean Peak Energy Standard

- As required by statute, DOER closely analyzed historical daily system peak data to establish the following four-hour seasonal peak periods during which qualified facilities may earn CPECs:
  - Spring (March 1 – May 14): 5 PM – 9 PM
  - Summer (May 15 – September 14): 3 PM – 7 PM
  - Fall (September 15 – November 30): 4 PM – 8 PM
  - Winter (December 1 – February 28): 4 PM – 8 PM
- Facilities earn 3x the number of CPECs for the Summer and Winter periods
- Facilities also earn 15x for performance coincident with the highest single hour of demand in the month
- Facilities may also earn 1.5x if they can demonstrate that they have the ability to increase energy resilience to outages
- First compliance year is 2020 with costs beginning to flow to ratepayers through electric supply rates in late 2020
- DOER has proposed a procurement process under which facilities that are selected through RFPs issued by the distribution companies would be entitled to receive fixed prices for their CPECs over multiple years via a DPU approved tariff mechanism
- DOER projects net ratepayer benefits of $710 million through the first ten years of the program

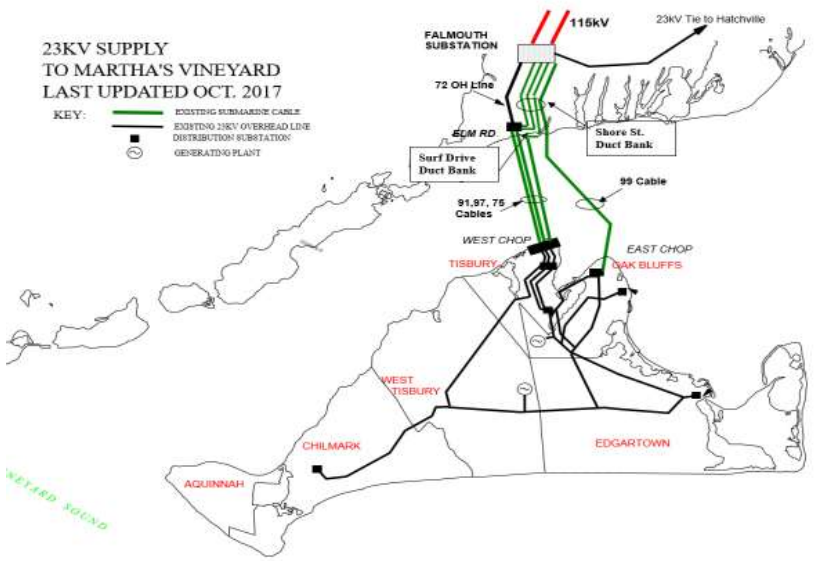
Utility Owned Demonstration Projects



- Eversource proposed four demonstration projects in 2017, two of which were approved in early 2018 as part of their most recent base distribution rate case (D.P.U. 17-05)
  - Outer Cape Cod
    - 25 MW / 30 MWh battery
    - Designed to avoid construction of a 13 mile redundant distribution line through the National Seashore
    - Expected to improve reliability by 50%
    - During normal operating conditions, will be able to reduce peak demand by removing the equivalent of 25,000 homes off the grid
    - Capable of providing 3 hours of backup power during the summer and 10 hours during the winter
  - Project is under construction
  - Department established detailed performance metrics in 2020 that will be used to assess the projects once operational

Utility Owned Demonstration Projects

- Martha's Vineyard
  - 14.7 MW / 60 MWh battery constructed in two phases
  - During current peak load conditions, cables to island can become overloaded, requiring the use of diesel peak generators
  - Battery storage designed to reduce reliance on (and possibly eventually replace entirely) 2 diesel peak generators
  - Also enhances reliability and promotes the construction of additional distributed solar resources on the island through the ability to store excess generation during minimum load conditions
- Department established detailed performance metrics in 2020 that will be used to assess both the Outer Cape and Martha's Vineyard projects once operational



Net Metering and Energy Storage

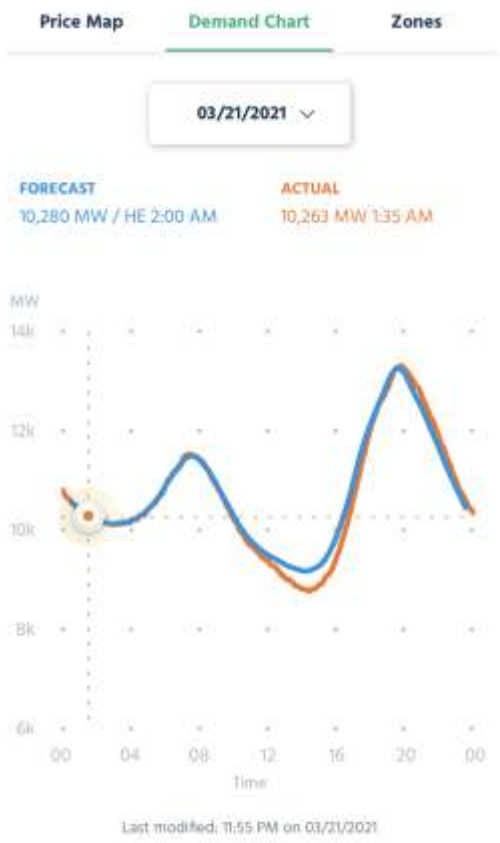
- DPU took up the issue of the ability for renewable facilities to qualify for net metering when paired with energy storage immediately following the approval of the SMART program tariff (D.P.U. 17-146)
- Examined different possible configurations of net metering facilities and storage and determined which were eligible for net metering
  - Permitted when storage charges only from the net metering facility or when it is not exporting to the grid
  - Not currently permitted when it can both charge and export to the grid
- Also examined issues related to monetization of capacity and energy revenues
  - Net metering rules provide for distribution companies to own and monetize energy and capacity rights for net metering facilities >60 kW
  - DPU established rules for “buying out” capacity rights to permit facilities to maximize the potential value of wholesale market revenue streams from storage
  - These buyouts reduce the costs of net metering to ratepayers in the year following the one in which they occur
  - Questions have been raised regarding ancillary service value streams as well

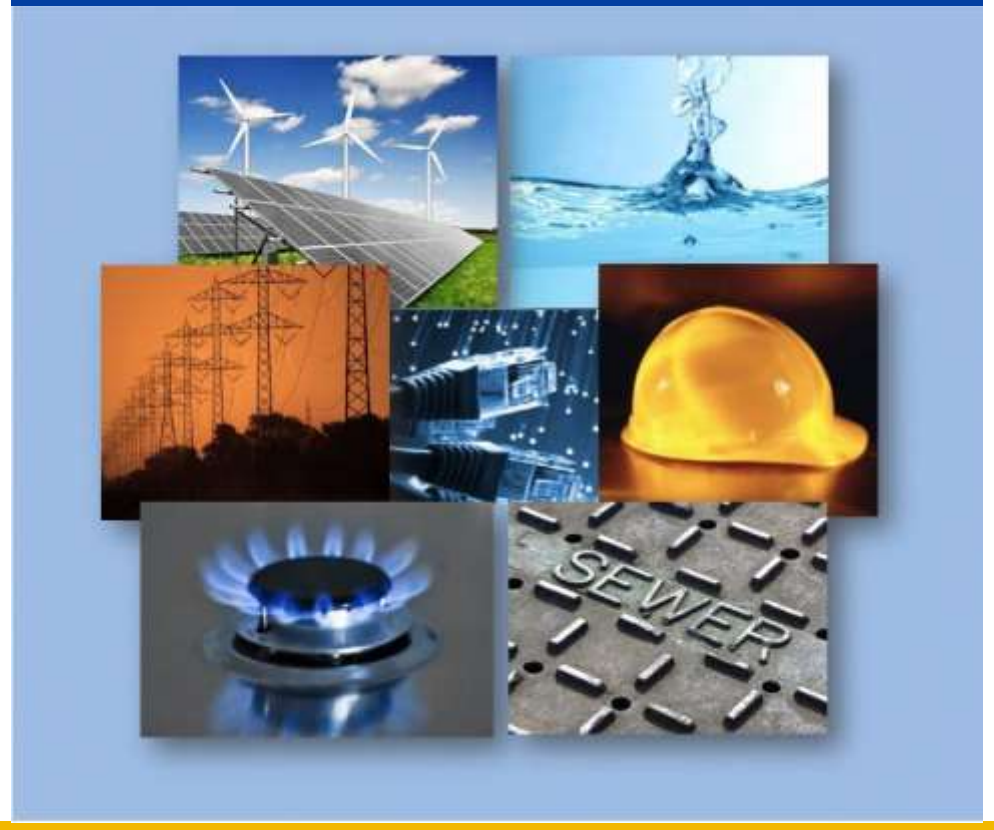
Interconnection of Energy Storage

- In May 2019, the DPU opened a broad investigation into the Commonwealth's interconnection policies (D.P.U. 19-55)
  - Significant work done on integrating energy storage into the DG interconnection tariff as part of this proceeding
  - To date, the Department has issued multiple sets of interim guidance and approved materials to facilitate applications for energy storage facilities
  - Multiple rounds of stakeholder comments were solicited in late 2019 and early 2020
  - The DPU has indicated that it plans to issue an order on this topic to more comprehensively address stakeholder comments received and integrate storage into the Commonwealth's interconnection tariff
- In October 2020, the DPU opened an investigation (D.P.U. 20-75) into alternatives to the current methodologies for assigning and recovering interconnection upgrade related costs
- As part of the opening of this investigation, the DPU also issued a straw proposal for stakeholder comment
- This investigation is ongoing and is a high priority of the Department given the many challenges and potentially prohibitively high upgrade costs currently facing distributed energy resources seeking to interconnect to the distribution system

What's Next?

- Peak Shifting and Integrating Renewables
- ISO-NE Market Reforms
- Energy Resilience
- Microgrids
- Vehicle-to-Grid
- Rate Design





Energy Storage in New Hampshire

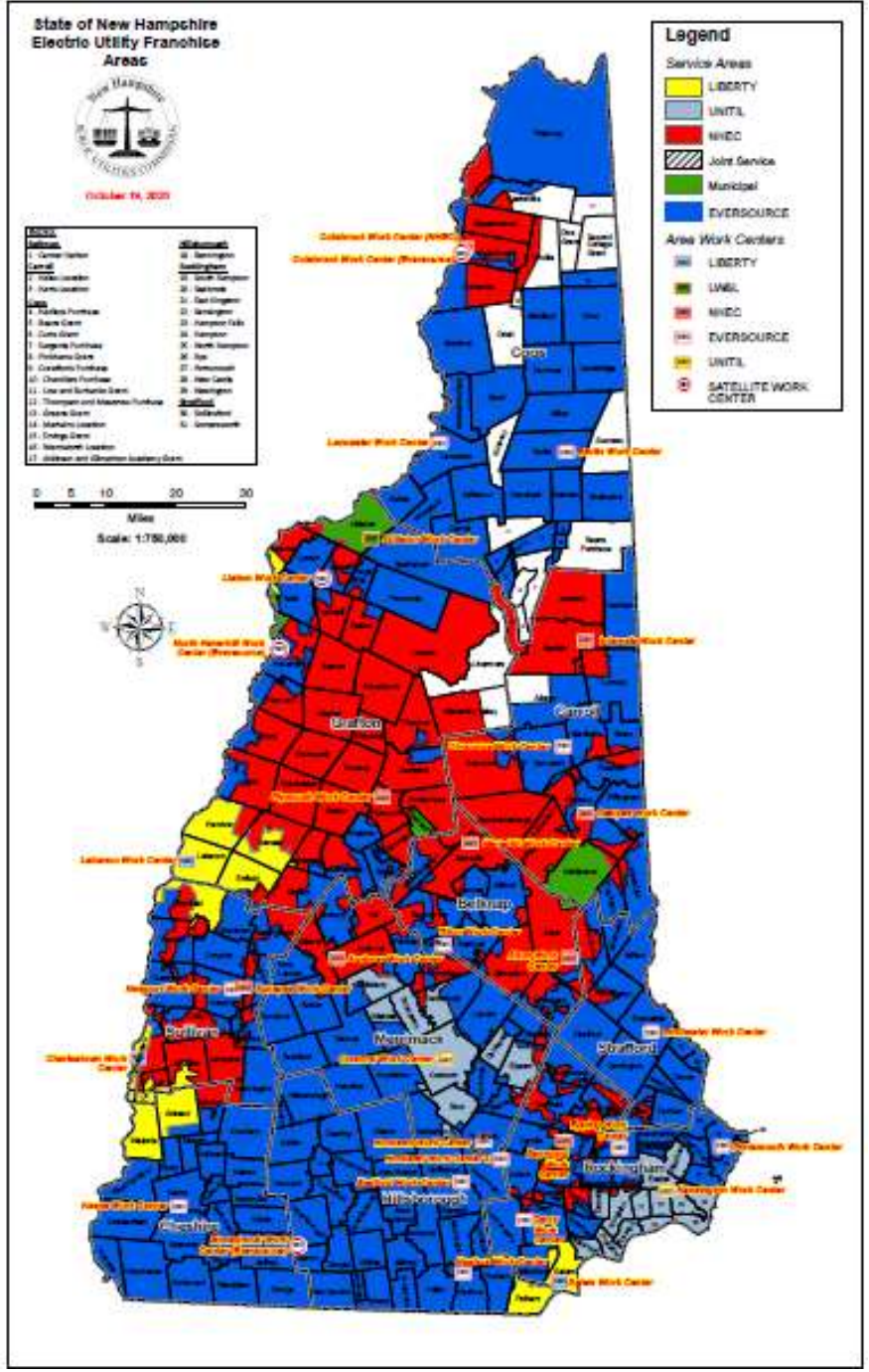
Elizabeth Nixon
Utility Analyst
New Hampshire Public Utilities Commission

NECPUC
Energy Storage Webinar Series

April 30, 2021

Energy Storage in NH

- Liberty Battery Storage Pilot (Liberty)
- EE Demand Response Pilots (Eversource, Unitil)
- IR 20-166 Energy Storage Investigation



Liberty Battery Storage Pilot

- Statutory Requirement to Balance Factors for Approval of Rate Recovery of Utility DER Investments that are “in the Public Interest.” (RSA 374-G:5, II)
- Utility-Owned Behind the Meter Tesla Powerwall 2 Batteries (13.5 kWh; 5 kW)
- Two Phased Process - Phase I Smaller-Scale “Proof of Concept”
- Main Pilot Purpose: To Reduce Transmission Charges (RNS/LNS)
- Innovative Time-of-Use Rates (Weekday Three Periods; Weekend Two Periods; Seasonal Differential)
- Benefit/Cost Analysis (BCA)
- Bring Your Own Device Component (Potential)
- Quarterly Reports Re: Pilot Status and Results
- EM&V Contractor Analysis and Reports

Liberty Battery Storage Pilot
Phase I (Initial "Proof of Concept Phase")

- At least 100 batteries; up to 200 batteries
- Residential customers only (solar & non-solar)
- 2 batteries per customer
- Customer leases with up-front payment of $2,433/battery or $25/battery/month for 10 years
- Can extend lease to 15 years at no cost
- $450/battery for removal prior to 10th anniversary
- Tesla forecasts peak events and manages battery discharging
- Batteries charge during off-peak/discharge during critical peak; solar customers currently only charge via solar production
- Compensation based on alternative net metering tariff - Monthly netting per TOU period; if net exports to the grid, then $ credit at 100% T & E; 25% of D

Liberty Battery Storage Pilot Phase II

- Only if Phase I “successful” and positive forecasted BCA with revised data
- Additional batteries up to 500 batteries total
- Up to 50 batteries (max 4/location) for municipal customers
- Will consider cost sharing of savings
- Bring Your Own Device – Potential Component

Liberty Battery Storage Pilot Benefit/Cost Analysis –Phase I

NPV Benefits ($millions)	
RNS	$0.850
LNS	$0.163
Avoided Capacity Costs	$0.419
NPV of Benefits	$1.432

NPV Costs ($millions)	
Batteries	($1.167)
Meters	($0.050)
Meter Reading	($0.049)
Billing System	($0.095)
Peak Event Compensation	($0.109)
Meter Programming	($0.100)
NPV of Costs	($1.570)

Assumptions	
Success rate of hitting peak through Year 10	75%
Max discharge to the grid	80%
Battery removal begins	Year 11
Battery charge rate round-trip efficiency	90%
Battery degradation rate beginning Year 2	3% per year

NPV of Phase I ($millions)	($0.138)

Liberty Battery Storage Pilot Benefit/Cost Analysis –Phase I & II

NPV Benefits ($millions)	
RNS	$2.015
LNS	$0.390
Avoided Capacity Costs	$0.941
NPV of Benefits	$3.347

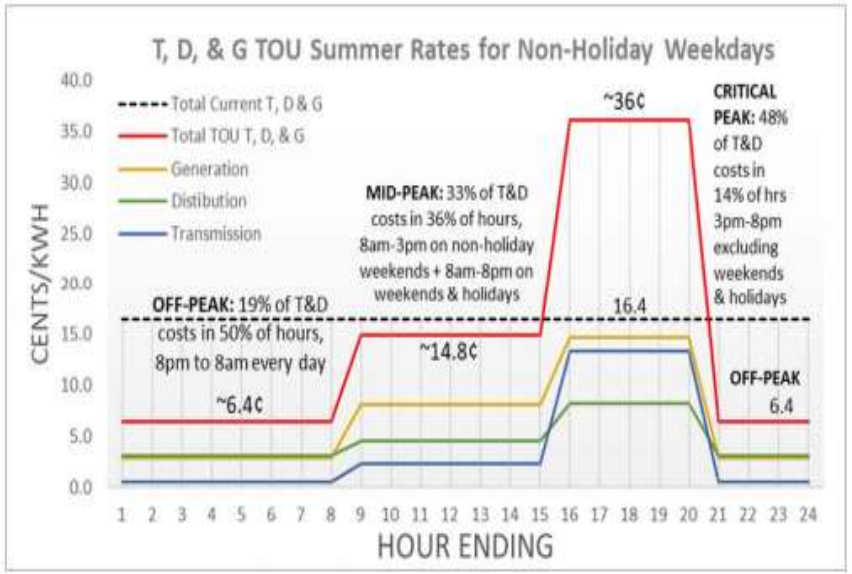
NPV Costs ($millions)	
Batteries	($2.662)
Meters	($0.115)
Meter Reading	($0.116)
Billing System	($0.095)
Peak Event Compensation	($0.251)
Meter Programming	($0.100)
NPV of Costs	($3.338)

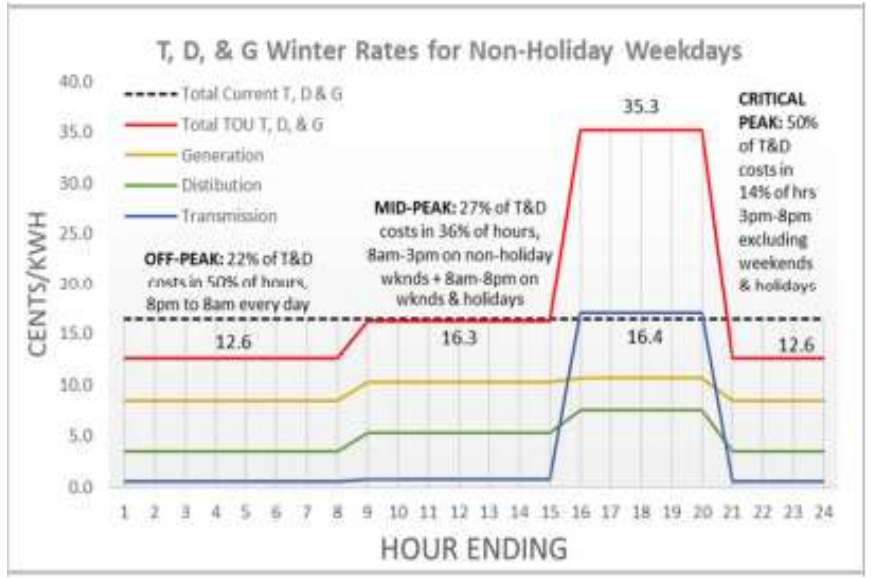
Conditions to Proceed to Phase II
Peak kWh reduction coincident with ISO-NE monthly peak with accuracy of ≥ 75%
RNS, LNS, FCM cost savings are ≥ to filed BCA with adjustment for actual rates
Revised BCA with actual updated costs and savings must have a positive NPV forecast – must take into account actual FCM rates, battery costs, revised TOU rates, customer behavioral response to TOU rates, actual compensation costs, and charging costs

NPV of Phase I&II ($millions)	$0.008

Liberty Battery Storage Pilot
Time of Use Rates (Illustrative-Non-Holiday/Weekday)

SUMMER PERIOD NON-HOLIDAY/WEEKDAY	WINTER PERIOD NON-HOLIDAY/WEEKDAY





Liberty Battery Storage Pilot
Time of Use Rates (Actual-Non-Holiday/Weekday)

SUMMER PERIOD
NON-HOLIDAY/WEEKDAY
(CENTS/KWH)

Rate	Crit-P	Mid-P	Off-P	Fixed
Energy	9.143	6.356	4.188	7.193
Dist.	9.675	5.342	3.633	5.713
Trans.	11.010	1.670	0.115	2.660
Other	0.606	0.606	0.606	0.606
Total	30.434	13.974	8.542	16.172

Based on Rate D-11, effective May 1 through Oct 31

WINTER PERIOD
NON-HOLIDAY/WEEKDAY
(CENTS/KWH)

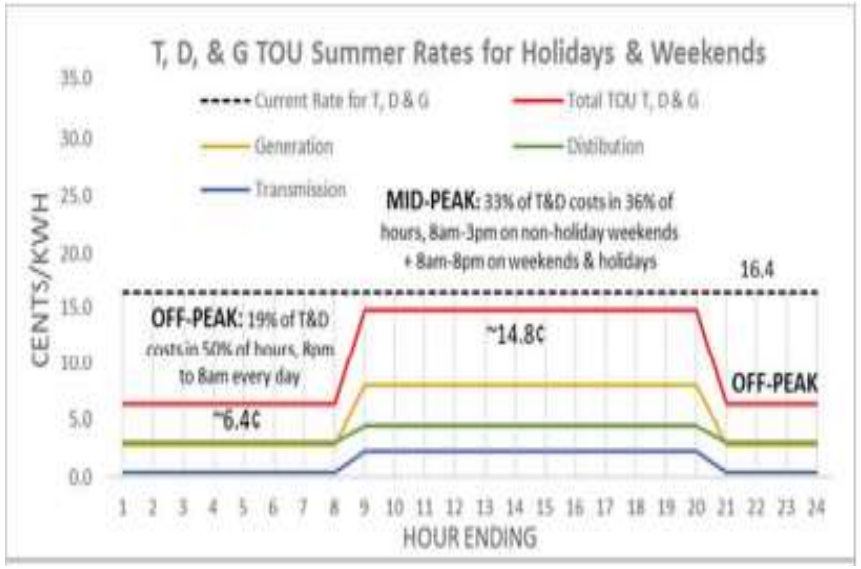
Rate	Crit-P	Mid-P	Off-P	Fixed
Energy	10.379	10.000	8.354	6.825
Dist.	8.963	6.297	4.204	5.713
Trans.	13.615	0.337	0.212	2.660
Other	0.606	0.606	0.606	0.606
Total	33.563	17.240	13.376	15.804

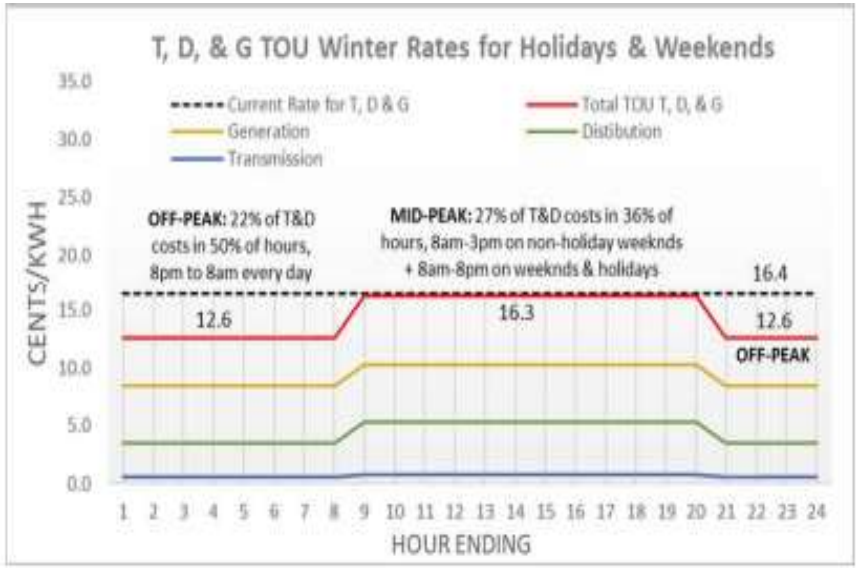
Based on Rate D-11, effective Nov 1 through April 30

*Rates change when underlying rate components change throughout the year

Liberty Battery Storage Pilot
Time of Use Rates (Illustrative-Holiday/Weekend)

SUMMER PERIOD HOLIDAY/WEEKEND	WINTER PERIOD HOLIDAY/WEEKEND





Liberty Battery Storage Pilot
Time of Use Rates (Actual-Holiday/Weekend)

SUMMER PERIOD
HOLIDAY/WEEKEND
(CENTS/KWH)

Rate	Mid-P	Off-P	Fixed
Energy	6.356	4.188	7.193
Dist.	5.342	3.633	5.713
Trans.	1.670	0.115	2.660
Other	0.606	0.606	0.606
Total	13.974	8.542	16.172

Based on Rate D-11, effective May 1 through Oct 31

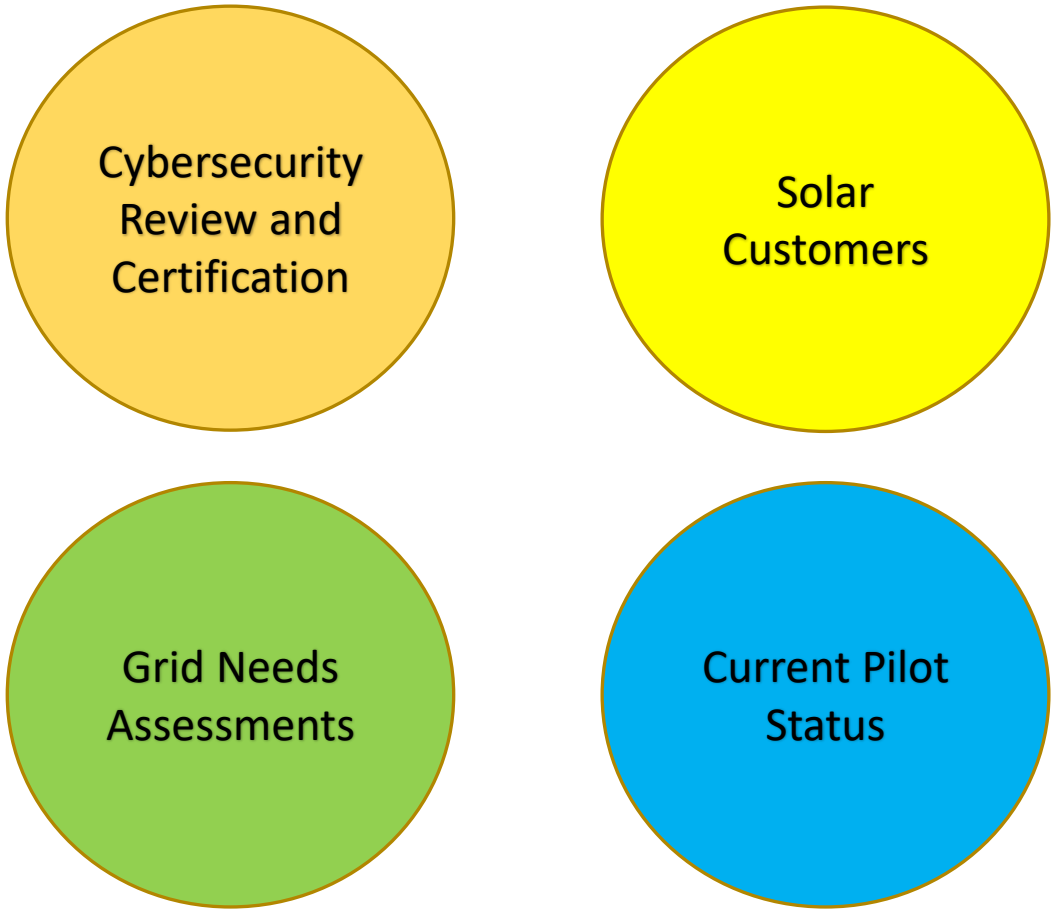
WINTER PERIOD
HOLIDAY/WEEKEND
(CENTS/KWH)

Rate	Mid-P	Off-P	Fixed
Energy	10.000	8.354	6.825
Dist.	6.297	4.204	5.713
Trans.	0.337	0.212	2.660
Other	0.606	0.606	0.606
Total	17.240	13.376	15.804

Based on Rate D-11, effective Nov 1 through April 30

*Rates change when underlying rate components change throughout the year

Liberty Battery Storage Pilot
Other Considerations and Status



Energy Storage Investigation Docket IR 20-166

The commission's proceeding will investigative the following topics related to energy storage projects:

- Setting accurate and efficient price signals to value avoided transmission and distribution costs.
- Compensation for projects participating in wholesale electricity markets for avoided transmission and distribution costs.
- Both utility and non-utility investments in projects.
- Potential bring your own device program; including costs and benefits, implementation, necessary statutory and regulatory changes, and types of DERs to include.
- Recommended statutory changes to enable energy storage projects to receive appropriate compensation for avoided transmission and distribution costs while also participating in wholesale energy markets.
- Any other topic the commission reasonably believes it should consider.

See RSA 374-H:2, II for specific language.

Schedule:

- First technical session held on January 25, 2021; next session schedule for May 27, 2021.
- Report Due: October 2022

EE Demand Response Pilots

C&I

- Load curtailment technologies and strategies – energy management systems, building management systems, HVAC controls, battery storage, etc.
- Unitil's Bring Your Own Device – Thermal (ice) storage and battery storage systems
- Pilots started Summer 2019

Residential

- Bring Your Own Device – wifi thermostats and behind the meter battery storage
- Pilots started Summer 2020

- Docket DE 17-136 2018-2020 EERS plan

Questions?

Elizabeth Nixon

Elizabeth.R.Nixon@puc.nh.gov

603-271-6018

Docket DE 17-189 Liberty Battery Storage Pilot

Docket IR 20-166 Investigation into Energy Storage Compensation

www.puc.nh.gov

Considerations for Energy Storage in New England

NECPUC/DOE Energy Storage Webinars

April 30 2021

Denis Bergeron Maine Public Utilities Commission

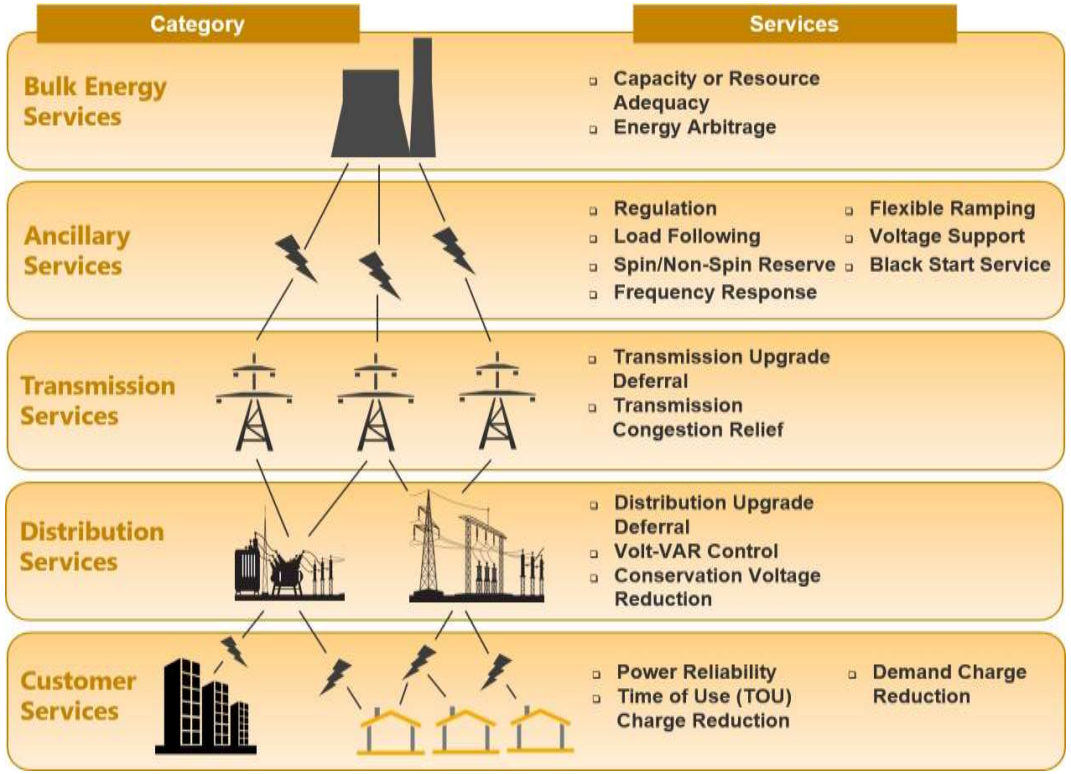
Overview

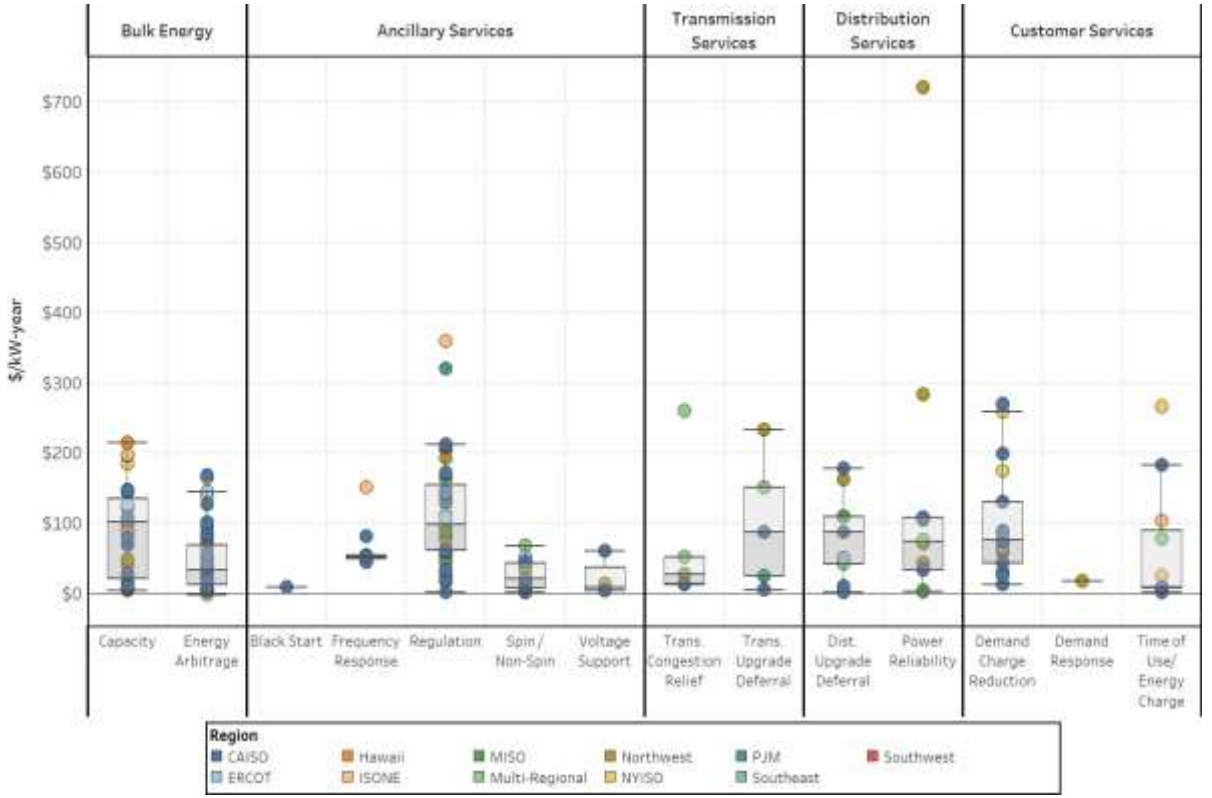
- General comments
- Concepts Introduced by other presenters
- Considerations for how those concepts apply in New England’s regulatory environment
- Areas of potential conflict
- Observations

General Comments

- Disclaimer
- Battery Energy Storage can perform multiple functions
- The cost of the technology is falling rapidly and its capability for storage is expanding
- We seem to be trying to sort multiple things all at once

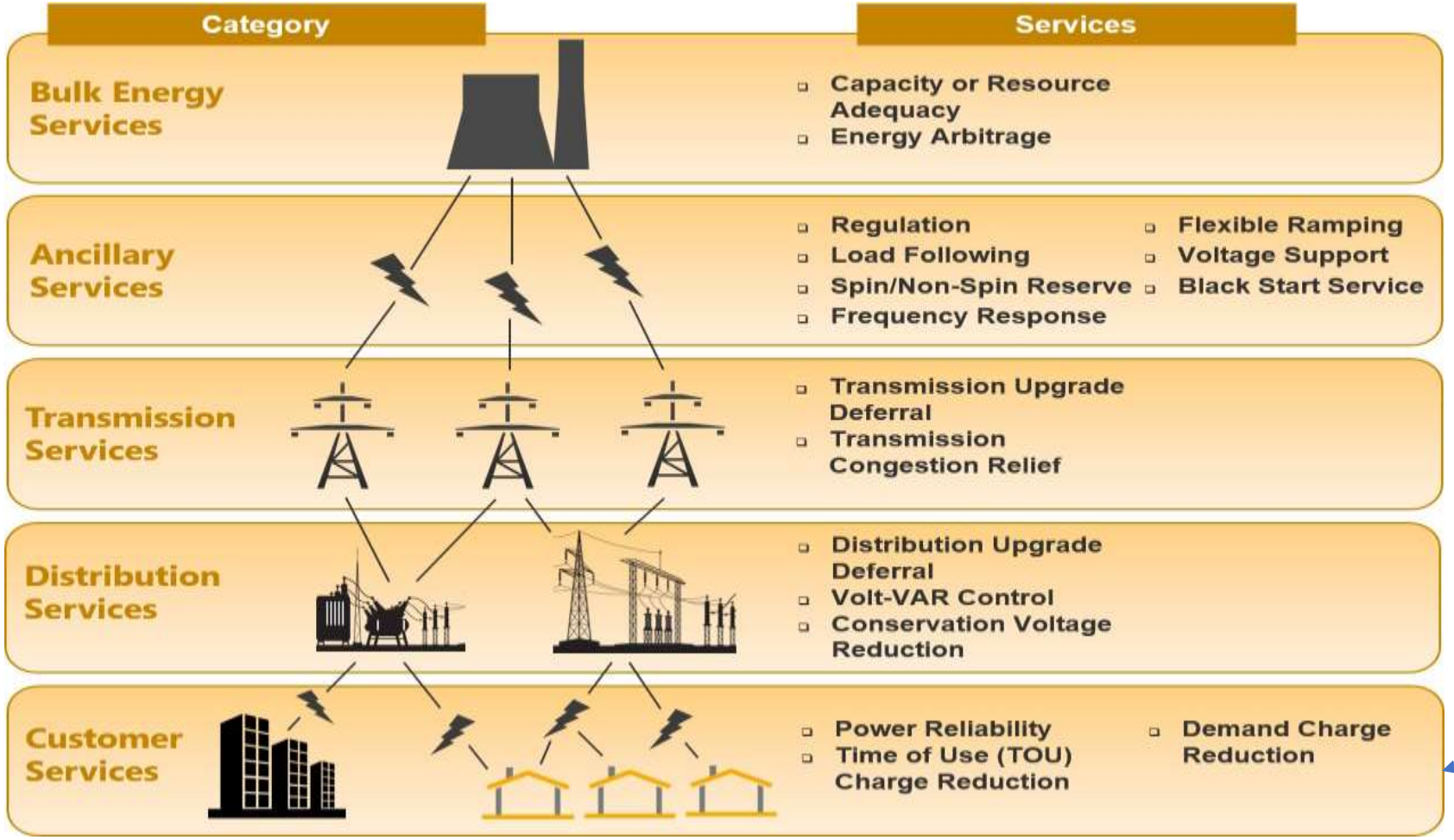
VALUATION TAXONOMY AND META-ANALYSIS RESULTS





Thanks to Patrick Balducci

Valuation Taxonomy and New England



Evidence of commercial viability

Some evidence of commercial viability (ongoing work)

Potential for market and regulatory conflicts

Potential for market and regulatory conflicts

Potential conflicts, mixed objectives

Commercial Viability: Bulk Energy and AS

- ORTP = $2.601 (NEPOOL estimate for FCA 16)
- E&ASWith FRM (estimate by MA AGO)
    - Real time energy $1.455 million
    - Reserves $3.9 million
    - Regulation $ 3.5 million
- FCA 15
    - NNE = $2.477, ROP = $2.61, SENE = $3.98
- Viability of grid facing storage was demonstrated in FCA 15.
    - 613 MW cleared (195 MW in NNE zone)
    - Most of the resources (97%) were > 20 MW

Ongoing Work – Areas of Opportunity

- Future Grid Reliability Study (NEPOOL, ISO, NESCOE)
  - Can the grid operate with the addition of large amounts of inverter based resources?
  - If not, what services will be needed? Some likely suspects:
    - Frequency response
    - Flexible ramping
    - Voltage support
    - Black Start services
  - Can market changes provide the revenues required to procure these services from new resource types?
- FERC Order 2222
  - Meter reader issues

Potential Market and Regulatory Conflicts

- Transmission Services
  - Storage as Non-wires alternatives
    - Merchant or non-merchant?
    - Entity responsible for dispatch and management of state of charge.
    - Energy market Impacts
  - Storage for transmission congestion relief
    - Is congestion relief a “transmission service” in FERC open markets with LMPs?
- Distribution Services
  - Upgrade deferrals
    - Can projects serve as both T and D project deferrals?
    - What if peaks and cost causation on the T&D are not aligned?

Some observations

- Bulk Energy and ancillary services
  - Storage is making great gains in capacity energy and AS. More opportunities may arise from future grid study
- Storage for grid services
  - New roles for transmission system operators
- Storage for distribution services
  - Distribution service or market play?
- What’s the policy?