Vermont Energy Storage Activities

March 28, 2023

Contents

1. Statute

1.1 Act 53 of 2017: An act relating to the Public Service Board, energy, and telecommunications

Sec. 22. ENERGY STORAGE; REPORT

….

(b) Report. On or before November 15, 2017, the Commissioner of Public Service shall submit a report on the issue of deploying energy storage on the Vermont electric transmission and distribution system.

….

(3) The report shall:

(A) summarize existing state, regional, and national actions or initiatives affecting deployment of energy storage;

(B) identify and summarize federal and state jurisdictional issues regarding deployment of energy storage;

(C) identify the opportunities for, the benefits of, and the barriers to deploying energy storage;

(D) identify and evaluate regulatory options and structures available to foster energy storage, including potential cost impacts to ratepayers; and

(E) assess the potential methods for fostering the development of cost-effective solutions for energy storage in Vermont and the potential benefits and cost impacts of each method for ratepayers.

(4) The report shall identify the challenges and opportunities for fostering energy storage in Vermont.

1.2 Act 31 of 2019: An act relating to miscellaneous energy subjects

* * * Energy Storage Facilities * * *

Sec. 24. amends 30 V.S.A. § 201

Sec. 25. amends 30 V.S.A. § 248

Sec. 26. DEPARTMENT OF PUBLIC SERVICE RECOMMENDATIONS

On or before January 15, 2020, the Department of Public Service, after consultation with stakeholders, shall provide to the General Assembly recommendations, including proposed statutory language, for the regulatory treatment of energy storage facilities. These recommendations shall address both energy storage facilities with a capacity of less than 500 kW and energy storage facilities of any size with grid-exporting capabilities not subject to direct or indirect control by a Vermont distribution utility.

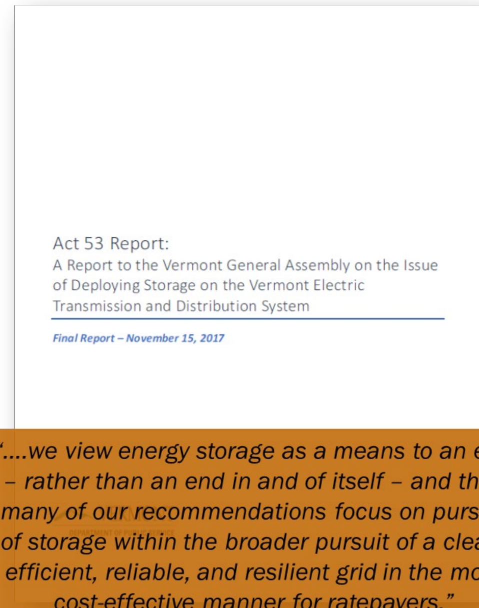
1.3 Act 54 of 2021: An act relating to miscellaneous energy subjects

* * * Energy Storage * * *

Amendments to: 10 V.S.A. § 6001; 24 V.S.A. § 4413; 30 V.S.A. § 201; 30 V.S.A. § 203; 30 V.S.A. § 209; 30 V.S.A. § 231; 30 V.S.A. § 248; 30 V.S.A. § 8002; 30 V.S.A. § 8011; plus directives in Sec. 12. PUBLIC UTILITY COMMISSION RULEMAKING; INTERCONNECTION RULE

2. Reports

2.1 Act 53 Report: A Report to the Vermont General Assembly on the Issue of Deploying Storage on the Vermont Electric Transmission and Distribution System


Act 53 Report:
A Report to the Vermont General Assembly on the Issue of Deploying Storage on the Vermont Electric Transmission and Distribution System
Final Report – November 15, 2017

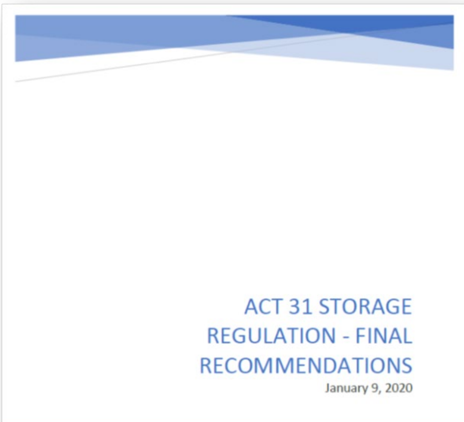
"….we view energy storage as a means to an end – rather than an end in and of itself – and thus many of our recommendations focus on pursuit of storage within the broader pursuit of a clean, efficient, reliable, and resilient grid in the most cost-effective manner for ratepayers."

- PSD received input from stakeholders (including electric transmission & distribution utilities, renewable energy and storage project developers, nonprofits, land use planners, neighboring states, and the regional transmission organization.
- Report included:
  - Benefits and Costs of Storage Systems in Vermont
  - Ownership Options and Delivery Pathways for Promoting Storage
  - Other Considerations
  - Potential Programs and Policies to Encourage Storage in Vermont
  - Recommendations

Procurement targets

The Department does not believe it is prudent to adopt utility storage procurement targets at this time. Many of Vermont's distribution utilities are already actively deploying – or exploring near-term deployment of – energy storage projects, either under utility ownership or in partnership with customers and third parties. Under Vermont's least-cost planning framework, utilities are required to look at the most cost-effective solution to their needs; imposing a storage-specific target would presuppose that storage is the right solution to a particular need, without allowing for full consideration of other, potentially more cost-effective alternatives such as load control and rate design. If after a period of time there is little to show for the very active current discussion around utility adoption of storage, it may be appropriate to re-evaluate the concept of procurement targets. However, any such future targets should allow for flexibility in implementation and should be predicated on cost-effectiveness of investments to ratepayers.

2.2 Act 31 Storage Regulation – Final Recommendations


ACT 31 STORAGE REGULATION - FINAL RECOMMENDATIONS

January 9, 2020

- Provide a clear path to permitting storage projects
- Ensure storage projects and their operations do not adversely impact the grid or ratepayers; and
- Provide public and environmental safety

The Department's storage regulation recommendations seek to expand upon the recommendations in its 2017 report in the following ways:

• *Clarify the PUC's general jurisdiction over storage absent specific modifications to Title 30 requirements;*

• *Offer specific modifications to Title 30 requirements for storage facilities including a presumption of waivers of 30 V.S.A. § § 107-109 and – except for aggregators - § 231;*

• *Require storage over 100 kW be subject to 30 V.S.A. § 248 review, with appropriate process modifications for smaller and aggregated storage facilities and storage facilities interconnected or otherwise co-located with renewables;*

• *Recommend an appropriate pathway for siting and interconnection review of storage facilities;*

• *Offer potential revisions to various PUC rules to include storage.*

https://publicservice.vermont.gov/about-us/publications-and-resources/energy-resources/2019-energy-storage-regulatory-recommendations

3. Rules

3.1 21-3883-RULE: Proposed creation of Vermont Public Utility Commission rule concerning energy storage

- Process & criteria for storage ≥ 100 kW and < 100 kW
- Electrical & fire safety, power quality, interconnection, metering, and decommissioning
- Aggregators and operation of aggregations
- ES paired with other resources

3.2 19-0856-RULE: Proposed revisions to Vermont Public Utility Commission Rule 5.500 [interconnection rule]

- Defines and explicitly incorporates storage resources
- Includes options for storage operating regime
- Requires that utilities consider storage operating characteristics

4. Plans

4.1 2022 Vermont Comprehensive Energy Plan (see in particular Ch. 4, Grid Evolution)

- **CEP Vision for an optimized grid:** *A secure and affordable grid that can efficiently integrate, use, and optimize high penetrations of distributed energy resources to enhance resilience and reduce greenhouse gas emissions.*
- "Storage technologies and markets are evolving rapidly. To both keep pace and ensure that storage deployment benefits Vermonters, nimble and flexible regulatory and policy frameworks will need to be embraced.

  At the same time, Vermont must use what levers it can to promote vital innovations in storage technologies, from seasonal storage to support a high-renewables future to materials innovations that reduce or eliminate the need to mine rare earth minerals, reduce the impacts of battery manufacturing, and recycle end-of-life waste."

4.2 Climate Action Plan

- Electric Sector Pathway 1>Strategy 1 recommends that, "Specifically, the General Assembly adopt a carbon reduction policy that directs the Public Utility Commission, utilizing expertise as appropriate, to identify, review, and research as needed design parameters for a 100% carbon-free or renewable electric portfolio standard that equitably promotes electrification.
  ….
  Questions that warrant further research in such a study include:
  - Using existing renewables and new resources – the right mix for equity and additionality
    - Date of qualification for 'new' resources – considering both regional and instate generation
  - In-state and out-of-state generation – the right mix for economic development, equity, affordability, land use, and other considerations
  - Supporting generation of all sizes and types (small/large/hydro/wind/solar/**storage** etc.)
  - Pace of increased requirements by type of resource/RES Tier
  - Incentivizing resources to deliver when needed (e.g. during peak hours, noting that these are likely to shift over time; seasonal needs such as winter loads; how **storage** may fit in), taking into account the time scale on which renewability is measured now (annually) and in the future (e.g., quarterly, monthly, hourly)
  - Siting, including environmental, community, and transmission system considerations
  - Carbon impact of resources; what source/criteria are utilized; whether the framework changes to a carbon standard rather than a renewable standard
    - Informed by any additional GHG inventory recommendations"
- Adaptation & Resilience Pathway 2>Strategy 1 recommends that Vermont, "Seek federal stimulus (ARPA), infrastructure bill, and other non-ratepayer funding to defray costs of utility resilience upgrades that exceed benefits to ratepayers, such as:
  - Ubiquitous communications networks that enable full utilization and participation of distributed energy resources in an interactive grid.
  - Resilience Zones: **batteries** installed at or near critical facilities, potentially paired with solar (and/or small wind) and with a microgrid /islanding where possible, to allow them to continue to operate in the event of extended disruptions to electric service.

- Strategic upgrades to substations, distribution, and transmission capacity across the Vermont grid needed to enable the state's renewable and electrification goals, after first exploring feasibility of any lower-cost options, e.g. flexible load management, curtailment, and **storage**.
    - Emerging non-wires technologies that address major challenges system resilience (e.g. long-duration outages).
- Adaptation & Resilience Pathway 2>Strategy 4 recommends Vermont, "Deploy foundational informational and operational technology statewide to enable and optimize **storage** and other distributed energy resources (e.g., GridLogic, Virtual Peaker, other emerging distributed energy resource management systems, in particular those that are open-source to various technologies and vendors)"

4.3 Utility Integrated Resource Plans (IRPs)

- VELCO 2021 Long-Range Transmission Plan: Many sections discuss storage, for example:
    - Transmission-level generation constraints can be mitigated through use of tools including optimized geographical solar deployment, curtailment, and storage:

> **Location matters just as much for storage as it does for generation and load.**
>
> In the 2018 long range plan, it was found that storage could be utilized to mitigate thermal and voltage concerns with the business-as-usual DG distribution. Storage was modeled where thermal and voltage concerns were located, and that analysis yielded approximately 400 MW of storage requirements. In addition, the optimized DG distribution was compared to the business-as-usual distribution, and it was found that approximately 250 MW of storage with 5 hours of energy would be needed to manage the excess energy. The assumption in these scenarios is that the storage devices would be properly located.

> Location matters just as much for storage as it does for generation and load. The ideal location for storage to address excessive DG concerns is at a DG plant, in the same way that a DG plant is better located at a load site. The farther the storage is from a constraint, the less effective it will be in addressing it. In fact, if not operated optimally, storage could negatively affect the transmission system in similar ways to excessive DG depending on its location. For example, if storage is located south of a north to south constraint, the concerns will be aggravated during the charging cycle of the battery, even if the energy absorption mitigates a local issue. Given this concern, it may be that the operational limitations that would be placed upon a hypothetical storage installation may make the project undesirable to pursue. Studies should be conducted to evaluate system impacts of storage projects, as is done for DG and large loads. The DG optimized distribution map also applies to storage when discharging. Our understanding is that ISO-NE treats a battery's charging load as non-firm load that can be disconnected during system constraints. This would suggest that the battery's discharging load is the critical factor in determining the maximum amount of new storage that can be installed in one of the planning zones noted on the map. Storage solutions can be costly, and often require a stacking of economic benefits to remain an attractive option. In Vermont, these benefits may fall across a wide range of stakeholders, creating an additional barrier to the cost-benefit analysis and overall funding viability of these projects.

- GMP 2021 IRP: Many sections discuss storage; for analysis of potential quantities & duration, see in particular pp. 7-7 to 7-9:

We anticipate that our next IRP will include a more detailed analysis of how battery storage can further be integrated into our portfolio. Factors considered will likely include the optimal sizing of storage in terms of nameplate capacity and duration; the value of shifting excess renewable generation from hours when GMP is a net seller to ISO-NE to hours where intermittent generation is low and GMP is a net purchaser from ISO-NE, which will enhance the hourly percentage of renewable energy meeting load on an annual basis; the ability of larger storage devices primarily used to shift energy between hours with excess renewables to hours with more demand than resources; the ability to participate in ISO-NE ancillary markets or provide other value to our customers such as enhance power quality or reliability; and an understanding of how changing economics will affect future opportunities for deploying large scale storage

MOU for 2024 IRP in part requires GMP conduct: *"An analysis of the optimal power, energy, location, and size distribution of energy storage on GMP's system in the planning horizon to increase hosting capacity, to defer a T&D upgrade and/or pursue resiliency opportunities, as well as an analysis of the costs and benefits of deploying storage vs. alternatives such as flexible loads and curtailments."*

- "Developed a "Storage Impact Analysis Report," which shows the impact of charging and discharging at the substation level of adding a specific size storage facility to every substation. It looks at historical loading, transformer capacity and DER to evaluate the remaining capacity of the substation transformer for adding DERs. It also allows addition of a specified load for evaluation."
- Implementation and Action Plan items include:
    - Extend and expand Tariffed offerings for battery storage in homes and businesses improving both customer reliability as well as greater system resiliency and distributed management
    - Develop a minimum of 6 resiliency zones utilizing a combination of technology, DER's, storage and other resources to drastically improve reliability and prepare areas for greater electrification, such as transportation
    - Continue updating tools, maps and interconnection guidelines for distributed generation and storage resources to assure least cost, efficient interconnection processes exist while assuring system stability, reliability and safety.
    - Plan for the retirement of the remaining GMP fossil-fuel peaking sites and evaluate the suitability of these locations for new peaking storage resources.
    - Evaluate pairing energy storage with existing renewable facilities or construct new storage-paired systems directly or through other procurement methods.
- GMP 2018 IRP included the following table:

Location	Type	Rationale and Value	Potential Scale	Comments
BTM	Non-Battery Resources	Leverage all available DERs to knock down peak, such as water heaters, car chargers, and heat pumps.	10 MW	Includes growth in electrification of fossil fuel processes.
BTM	Residential Resiliency	Grid transformation and customer resiliency. Assumes 8,000 homes over the next decade install some form of integrated battery storage.	32 MW	Includes Powerwall program and BYOD. Install smaller scale, residential battery systems in homes.
BTM	C&I Resiliency & Power Quality	Resiliency package offering to C&I customers in addition to peak value stacking; replacing fossil generation or providing power quality support for sensitive commercial processes. Assumes up to 25 customers over the next decade with an average installed system size of 500 kW per location.	12.5 MW	Leverage storage to optimize customer operations, reduce certain costs, and improve power quality and resiliency.
BTM and Grid	T&D System Support & Hosting Capacity	Potentially includes anything from T&D upgrade deferrals to distributed generation hosting and other location-specific improvements, including constrained areas (such as SHEI).	25 MW	As T&D constrained pockets arise over the next decade, storage and flexible demand will be evaluated as a solution.
Grid	Grid Connected Storage Systems	Strategically located storage on our distribution system to provide resiliency, T&D benefits, and all power supply benefits. Also includes fossil fuel peaker unit replacements.	25 MW	Mix of PPA, GMP-developed, and other projects connected at grid scale.

Table 8-3. Illustrative Storage and Flex Demand Portfolio Over the Next Decade

- VEC 2022 IRP: Many sections discuss storage. See in particular Section 5 – Impacts of a Rapidly Decentralized Grid

  Storage Plan

  VEC performed an analysis of locations suitable for a battery near or at VEC substations based on locational impacts, and system constraints. Through this process we identified a potential of an additional 31 MW of utility scale storage that it could site. However, given the cost constraints identified throughout this section, it is unlikely we will be able to site batteries at all these locations.

  MOU for 2025 IRP in part requires VEC conduct: "*An analysis of the optimal power, energy, location, and size distribution of energy storage on VEC's system in the planning horizon; an analysis of the costs and benefits of deploying storage vs. alternatives such as flexible loads and curtailments; and continued evaluation on the confidence with which the peak hour of a given month could be forecasted considering various levels of additional load management and/or battery storage*."

  - Other sections in part:
    - Asked, "How many additional megawatts (MW) of battery storage can be installed state-wide before VEC's current utility-size battery strategy is uneconomic moving forward?" and developed tool to assess;
    - Assessed costs and challenges of serving load with 100% renewables on a 24-7 basis, including various permutations of generation resources and storage power/energy;
    - Discusses the importance of long-duration storage and need for funding to support deployment;

- Discusses residential BYOD program and utility-scale battery storage deployments including project that in part explores mitigating generation constraints

- Municipal IRPs generally all reflect evaluation or pursuit of storage, to the extent it is cost-effective. For example:
    - Ludlow 2022 IRP:

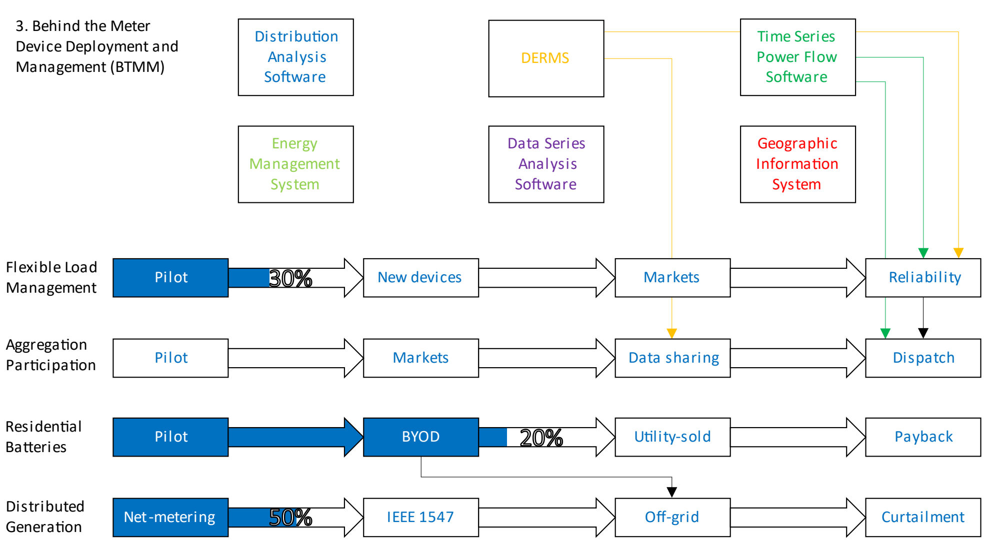
      VPPSA conducted a Request for Information (RFI) process in 2020 to better understand the business case for storage. Nine companies responded, including four that were based in Vermont and two that are among the largest developers in the US. The pricing that was received was used to develop a net-present value positive business case for peak shaving that is congruent with other storage projects that have already been built in Vermont. Based on a peak shaving business case and the strength of the responses to the RFI, VPPSA conducted a Request for Proposals (RFP) process in 2021, and selected a development partner, Delorean Power.

      Delorean is presently developing a series of storage sites, including two in Ludlow. The size of the project is approximately 4 MW and 12 MWH, and it is presently in the early planning stages.

      MOU for 2025 IRP requires Ludlow in part conduct a:

      e. Quantitative analysis of implemented, planned, and potential strategies to manage DERs to minimize integration challenges and costs and optimize deployment for system benefits, including peak load management. This analysis shall compare the potential and cost-effectiveness (both to ratepayers and societally) of at least storage, innovative rate designs, and active load control/management programs to the extent implementation has occurred, and including discussion of plans for further active load control efforts.

- Integrated Resource Planning Guidance: Department's draft updated IRP Guidance directs utilities to consider storage including within technology deployment progress charts, for example:



4.4 Regional and Municipal Energy Plans

Updated Act 174 energy planning standards ask regions and municipalities to consider storage. For example:

> *9. Does your plan's energy element contain policies and objectives on the development and siting of renewable energy, storage, and transmission and distribution resources?*

5. Deployment

5.1. Storage projects built or *permitted/in permitting*

Project	MW	MWh*	Proceeding	Type
GMP Powerwall & BYOD pilots/tariffs	22.5	60.75	19-3167-TF and 19-3537-TF	GMP tariffs approved June 2020; 2586 installations thru 2/28; various pilots ongoing
GMP Stafford Hill Solar + Storage, Rutland	2	3.4	Docket 8098	First utility storage project in VT (GMP, permitted 2014). Actually 4 MW but inverter-limited to 2 MW.
Panton Storage	1	4	Case No. 17-2813-PET	GMP battery co-located with solar; amended to enable islanding
Essex Solar + Storage	2.1	8	Case No. 18-2902-PET	GMP JV Solar + Storage
Milton Solar + Storage	2	8	Case No. 17-5003-PET	GMP JV Solar + Storage
Ferrisburgh Solar + Storage	2.1	8	Case No. 17-5236-PET	GMP JV Solar + Storage
Dynapower	1.5	6	N/A	Backup power only
E. BarreCo Barre	4.999	20	Case No. 18-1658-PET	ESA with GMP
Viridity Hinesburg	1.9	5.3	18-3088-PET	ESA with VEC
Georgia Storage	*4.99*	*10*	*21-1042-PET*	*ESA with GMP*
Springfield Storage	*4.99*	*10*	*21-1254-PET*	*ESA with GMP*

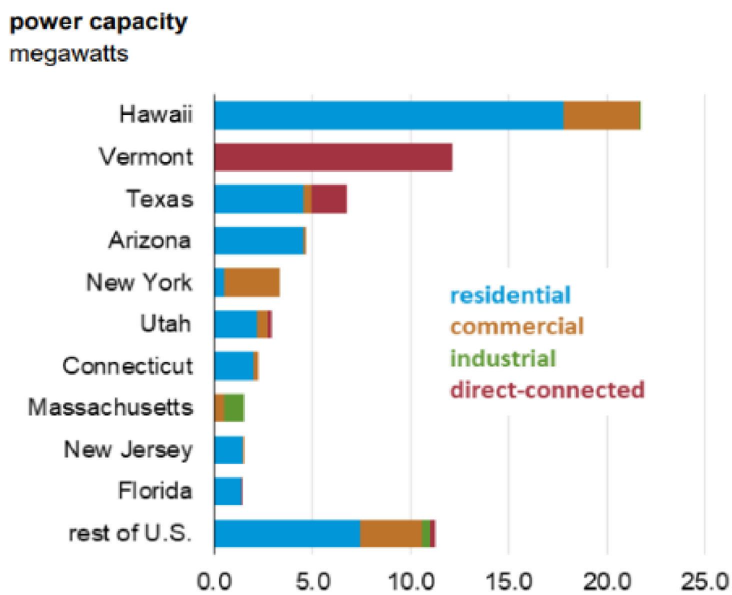
Bristol Solar & Storage	*2.958*	*11.832*	*21-0974/5-PET*	*Co-located (but not integrated) with 2.2 MW Standard Offer solar project*
Pittsford Solar & Storage	*0.498*	*2*	*21-0100-NMP*	*Net metered project with integrated storage behind the inverter*
Royalton Storage	*4.9*	*19.6*	*21-2114-PET*	*ESA with GMP*
S. Hero Storage	*4.99*	*14.94*	*21-5049-PET*	*ESA with VEC*
E.R. South St. Storage	*2*	*8*	*21-3022-PET*	*ESA with GMP*
Troy Storage	*3*	*12*	*22-4009-PET*	*GMP & VEC Joint owners; testing reducing transmission congestion*
TOTAL:	**68.425**	**211.822**		*Assumes all systems are 4 hours

5.2 Vermont Storage Deployment in Context

2022 Vermont Clean Energy Industry Report:

> Vermont is rapidly growing its energy storage capacity. In fact, the U.S Energy Information Administration (EIA) identified Vermont as one of the states with the most small-scale battery storage capacity (Figure 7).[20] As defined by the EIA, small-scale battery storage refers to storage at facilities th: have less than 1 MW of generating capacity. As of 2019, Vermont ranked second in the nation behind Hawaii in terms of small-scale storage capacity (excluding California).[21]

FIGURE 7. SMALL-SCALE ENERGY STORAGE CAPACITY OUTSIDE OF CALIFORNIA BY STATE & SECTOR (2019)[26]



Other New England State Targets and Status (*best available numbers found, need to confirm; summer peak #s from ISO 2022 CELT report*):

- CT goal 1000 MW x 2030 (300 MW x 2024) ➡ 13% of 2022 summer peak (3.9% of 2022 summer peak) (currently at 0.2% of peak if at 12 MW)
- ME goal 400 MW x 2030 (300 MW x 2025) ➡ 17.8% of 2022 summer peak (currently at 2.2% if at 50 MW)
- MA goal 1000 MW x 2025 ➡ 7.2% of 2022 summer peak (currently at 2.4% of peak if at 330 MW)
- VT has 40 MW installed currently which is *already* 3.7% of 2022 peak; when all projects permitted/in permitting are built we'll have 68 MW installed which is 6.3% of peak

5.3 Additional Initiatives Removing Barriers, Driving Deployment, or With Potential to Create New Opportunities

- ARPA:
  - The Department of Public Service is preparing to issue an RFP(s) for $7 million of allocated ARPA funds for the Energy Storage Access Program to support LMI storage, municipal storage, and platforms to enable Vermont's municipal and cooperative electric utilities to harness the benefits of distributed storage and other flexible load resources.
  - BGS Municipal Energy Resilience Program includes ability for municipalities to obtain free building energy resilience assessments including, "an evaluation on the reasonableness of battery storage and EV charging stations and recommended locations, as applicable."
- BIL: The Department, in conjunction with electric distribution utilities, is seeking federal funding under the Bipartisan Infrastructure Law to facilitate the installation and dispatch coordination of

battery energy storage systems across Vermont, including small-scale distributed storage and utility-scale, long-duration storage.

- Utility RFPs: GMP Distributed Peaking Resources RFP issued Oct. 2019, soliciting up to 15 MW of resources through long-term contracts.
- Efficiency Vermont initiatives around flexible load management
- Renewable Energy Standard (RES) Tier III:

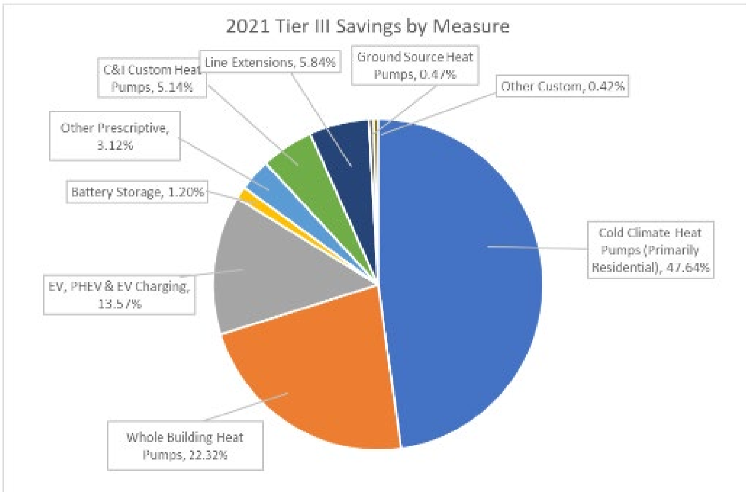


Figure 2. 2021 Tier III compliance measures

- RES Redesign: The Department is in the middle of a year-long stakeholder engagement process around the RES and its supporting policies such as net-metering. Questions under consideration include:
  - What resources and/or technologies should or should not be eligible under an updated renewable or clean energy standard (e.g., hydroelectric, nuclear, **storage**, solar, wind)?
  - Where those resources should be located (e.g., within Vermont or the New England region more broadly)?
  - How equity related considerations around meaningful engagement of communities, affordability, and access to renewable energy resources through various programs (e.g., net-metering) might be advanced?
  - The need to assess resources related to issues like cost-effectiveness, greenhouse gas reduction potential and additionality, equity, etc.
- Technical Working Group: An evolution of the Generation Constraints Subcommittee and the Department's 2019 Rate Design Initiative, this group will be hosted under the auspices of the Vermont System Planning Committee and aims to facilitate discussion among subject matter experts regarding present and future practices on items such as interoperability, optimization of dispatch for storage and other distributed energy resources, system hosting capacity, and others.
- FERC Order 2222 for distributed energy resource aggregations
- Storage as a transmission asset in ISO-New England (at FERC)
- Federal ITC for standalone storage
  - 30% tax credit, up to 70% with additional incentives, through 2032
  - Transferrable, also direct-pay option for state governments