Energy Storage in Vermont
Act 53 Storage Report

• On or before Nov. 15, 2017, Commissioner of Public Service “shall submit a report on the issue of deploying energy storage on the Vermont electric transmission and distribution system.”
  • Summarize existing state, regional, and national actions or initiatives affecting deployment of energy storage;
  • Identify and summarize federal and state jurisdictional issues regarding deployment of storage;
  • Identify the opportunities for, the benefits of, and the barriers to deploying energy storage;
  • Identify and evaluate regulatory options and structure available to foster energy storage, including potential cost impacts to ratepayers; and
  • 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.

• Report can be accessed at: http://publicservice.vermont.gov/content/energy-storage-study
Report Process

• Act 53 signed into law May 30, 2017
• July 2017: PSD issued request for comments and input on proposed study outline
• August 2017: 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.
• October 2017: PSD issued a draft report for public comment
• November 15, 2017: PSD submitted the final report to HET

Written comments on the proposed outline and the draft report are available at http://publicservice.vermont.gov/content/energy-storage-study.
Report Outline

- Introduction
- 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
- Appendix A: Act 53 Storage Report Language
- Appendix B: Energy Storage in the State, Region, and Nation
Act 53 Storage Study

“...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.”
State energy policy

30 V.S.A. § 202a

It is the general policy of the State of Vermont:

(1) To assure, to the greatest extent practicable, that Vermont can meet its energy service needs in a manner that is adequate, reliable, secure, and sustainable; that assures affordability and encourages the State's economic vitality, the efficient use of energy resources, and cost-effective demand-side management; and that is environmentally sound.

(2) To identify and evaluate, on an ongoing basis, resources that will meet Vermont's energy service needs in accordance with the principles of least-cost integrated planning; including efficiency, conservation and load management alternatives, wise use of renewable resources, and environmentally sound energy supply.
Energy storage technologies

- Mechanical
  - Pumped Hydro (Conventional Storage)
  - CAES (Compressed Air Energy Storage)
  - Flywheel

- Electrochemical
  - Lead acid, Lithium Ion, Sodium Sulfur, and Sodium Nickel Chloride
  - Flow batteries - Vanadium redox, Zinc-bromine

- Thermal
  - Sensible - Molten salt, chilled water
  - Latent - Ice storage, Phase change materials
  - Thermochemical storage

- Electrical
  - Supercapacitors
  - SMES (Superconducting Magnetic Energy Storage)

- Chemical (Hydrogen)
  - Power-to-Power (Fuel Cells, etc)
  - Power-to-Gas

Courtesy Massachusetts Department of Energy Resources, from “State of Charge”
Storage benefits

- Peak shaving
- Other electricity market services
- Renewables integration
- Resilience
Solar PV impacts in April
Vermont Net Loads

Source: VELCO
VELCO Load Curve Study

Case #1

Increase of solar generation “behind the meter” is offsetting VELCO demand curve

<table>
<thead>
<tr>
<th></th>
<th>3/30/2015</th>
<th>3/31/2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Cover</td>
<td>Overcast</td>
<td>Sunny</td>
</tr>
<tr>
<td>High/Low (°F)</td>
<td>41/26</td>
<td>42/24</td>
</tr>
<tr>
<td>Max Radiation (w/m²)</td>
<td>241</td>
<td>965</td>
</tr>
</tbody>
</table>

VELCO Load Curves (Overcast vs. Sunny Days)

Source: VELCO
Peak management/regulation/other market opportunities

Grid resiliency/microgrid

Integration of renewables
Storage costs

- Equipment (battery, inverter, containers, etc.)
- Soft costs (interconnection, engineering, etc.)
- Software
- O&M
Lithium-ion battery price declines

Source: Bloomberg New Energy Finance
Analyzing the Value of Storage

Developing a business case usually requires stacking multiple benefits.
Ownership options & delivery pathways

<table>
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<tr>
<th>Battery control</th>
<th>Benefits</th>
<th>Challenges</th>
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| **Utility**     | - Potentially best positioned to deploy storage where it is most beneficial to the grid, and in the near term, to hit peaks  
- Utility can usually capture market benefits on behalf of all ratepayers  
- Utility can capture reliability benefits on behalf of multiple customers  
- Can be grid-scale or aggregated distributed storage | - Can crowd out other entities from participating in this market space  
- Projects must benefit ratepayers and therefore tend to prioritize monetizable benefits  
- Selection of one technology or software to minimize investment and risk may discourage exploration of newly emerging products |
| **Customer**    | - Potentially best positioned to address on-site reliability  
- Customer can tailor system to needs  
- Customer can place a value on reliability | - Without shared access/control by utility or third party, difficult to capture sufficient benefit streams |
| **Third party** | - Can capture market values and potentially resiliency/integration/reliability benefits for utilities and customers | - Rate design and software platforms to allow shared access and benefits still under development  
- Slim margins when values shared with many  
- Coordination to allow full realization of values by all parties challenging |
Utility storage activities

Stafford Hill 2 MW solar + 3.4 MWh storage project in Rutland. Batteries are in the shipping containers in the upper right. Credit: GMP

Vermod Sonnenbatteries (6 or 8 kWh) at McKnight Ln. project in Waltham

GMP Tesla Powerwall 5.5 kW install

Sunverge 8 kWh in Plymouth

Simpliphi 82 kWh system at Emerald Lake

BED RFP for a 1 MW, 4 MWH battery at BTV

Pending PUC decision for GMP 1 MW/4 MWh battery on Panton PV site

GMP petitions for 5 MW PV + 2 MW/8 MWh battery microgrid projects in Milton & Ferrisburgh

VEC reviewing proposals for utility-scale storage in time for summer 2018 peak

VELCO analyzing potential for storage to alleviate N. VT export constraints
Non-utility storage activities

Dynapower test pad in S. Burlington

Bill Laberge of Grassroots Solar with a Sonnenbatterie

Tesla Powerwall unit installed by Peck Electric in S. Burlington.

Northern Reliability VTA solar + storage in Rochester

PowerGuru 32 kWh battery in Pownal
Other considerations

- Federal and state jurisdictional issues
- Safety training for first responders
- Sales and property tax treatment
- Software platforms
- Enabling technologies
- Emissions
Exploring Storage Programs and Policies

- Utility planning exercises
- Rate design, tariffs, and distinct pricing of storage-related services
- Energy assurance efforts
- Regulatory review process and criteria
- Interconnection standards
- Modification of existing or development of new programs/incentives
- Procurement targets
Questions?

http://publicservice.vermont.gov/content/energy-storage-study

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