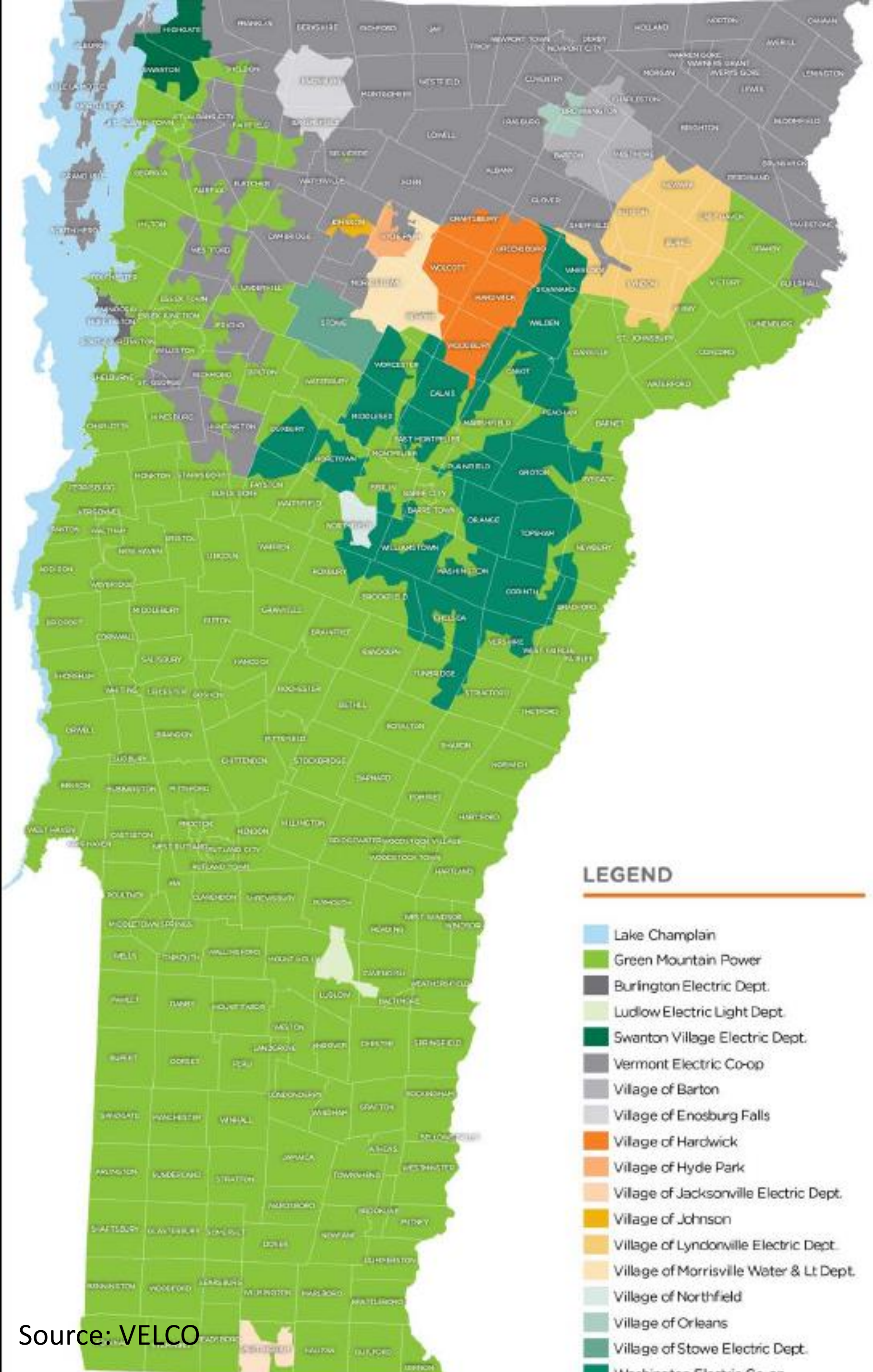
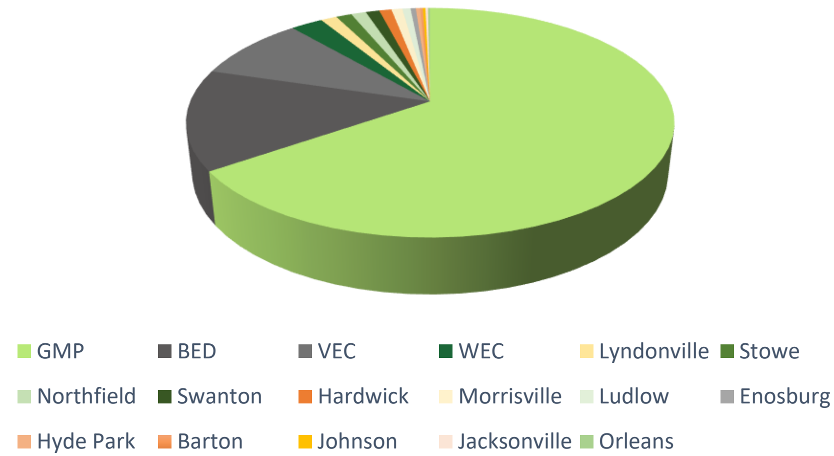
Grid Modernization in a Rural State: The View from Vermont

T Department of Public Service



Source: VELCO

Share of VT load



Vermont Electric Utilities

- 1 IOU
- 2 Coops
- 14 Municipals

Vermont Demographics

- Population: 625,000
- Population per Square Mile: 67.9
- Median Household Income: $56,104
- Poverty Rate: 11.6%
- Median Age: 42.7

Source: U.S. Census

Burlington's electric grid starts operating in 1886 using hydroelectricity from the Winooski River

Victory, Vermont is one of the last two towns in the state to connect to the grid – in 1963.

How Burlington, Vermont, Became The First City In The U.S. To Run On 100% Renewable Electricity

--Fast Company, 02/06/15

Source: UVM

End of the Line? As Vermonters Cut the Cord, Rural Phone Customers Hear Static

--Seven Days, 07/19/17

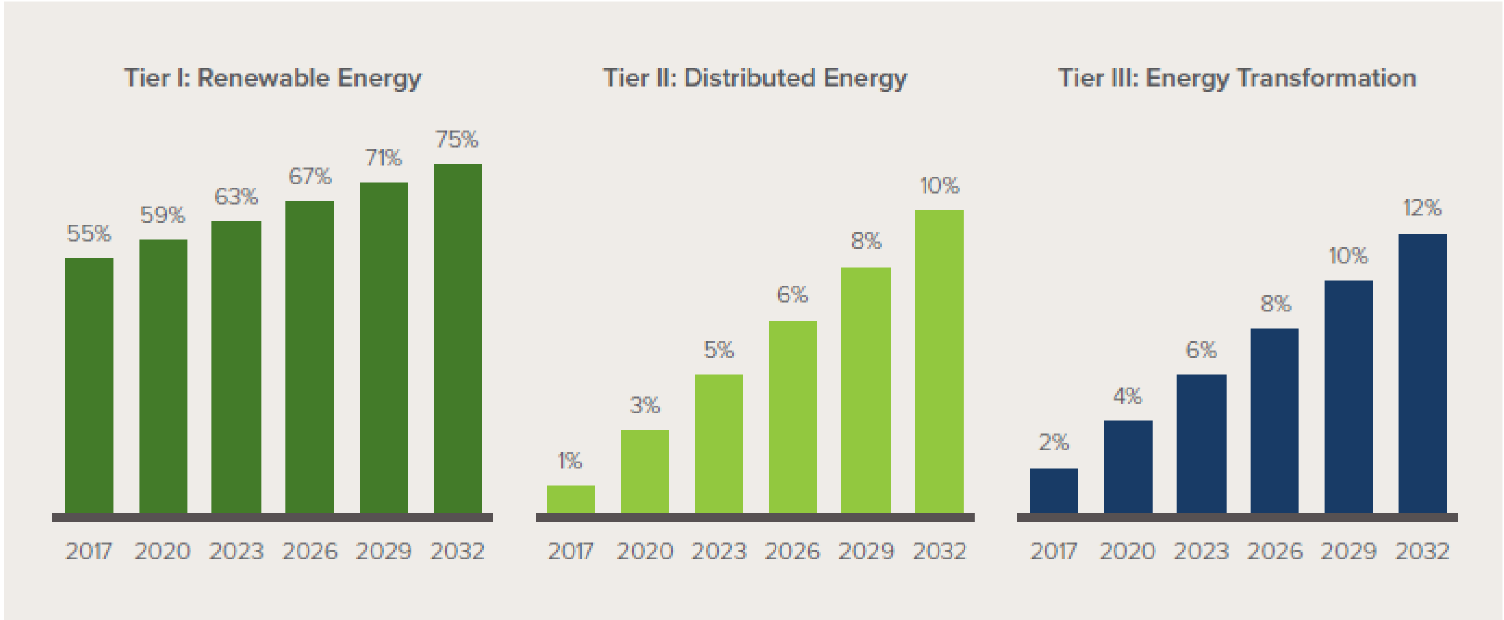
Rural Vermont once again feeling left behind by technology

Broadband is slow to arrive in remote areas

--Boston.com 01/30/11

Source: AP/CVPS

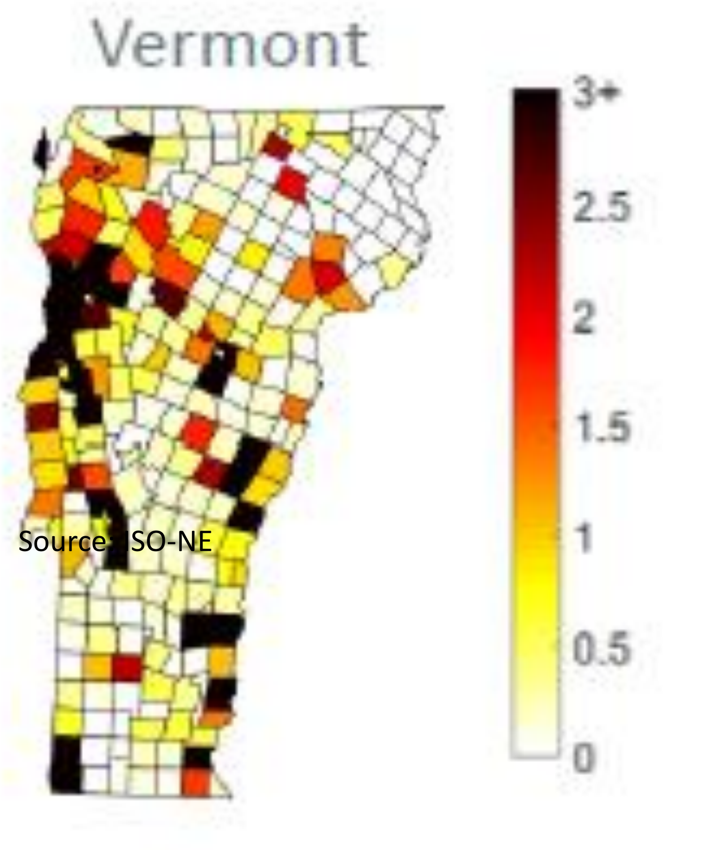
Renewable Energy Standard (Act 56 of 2015)

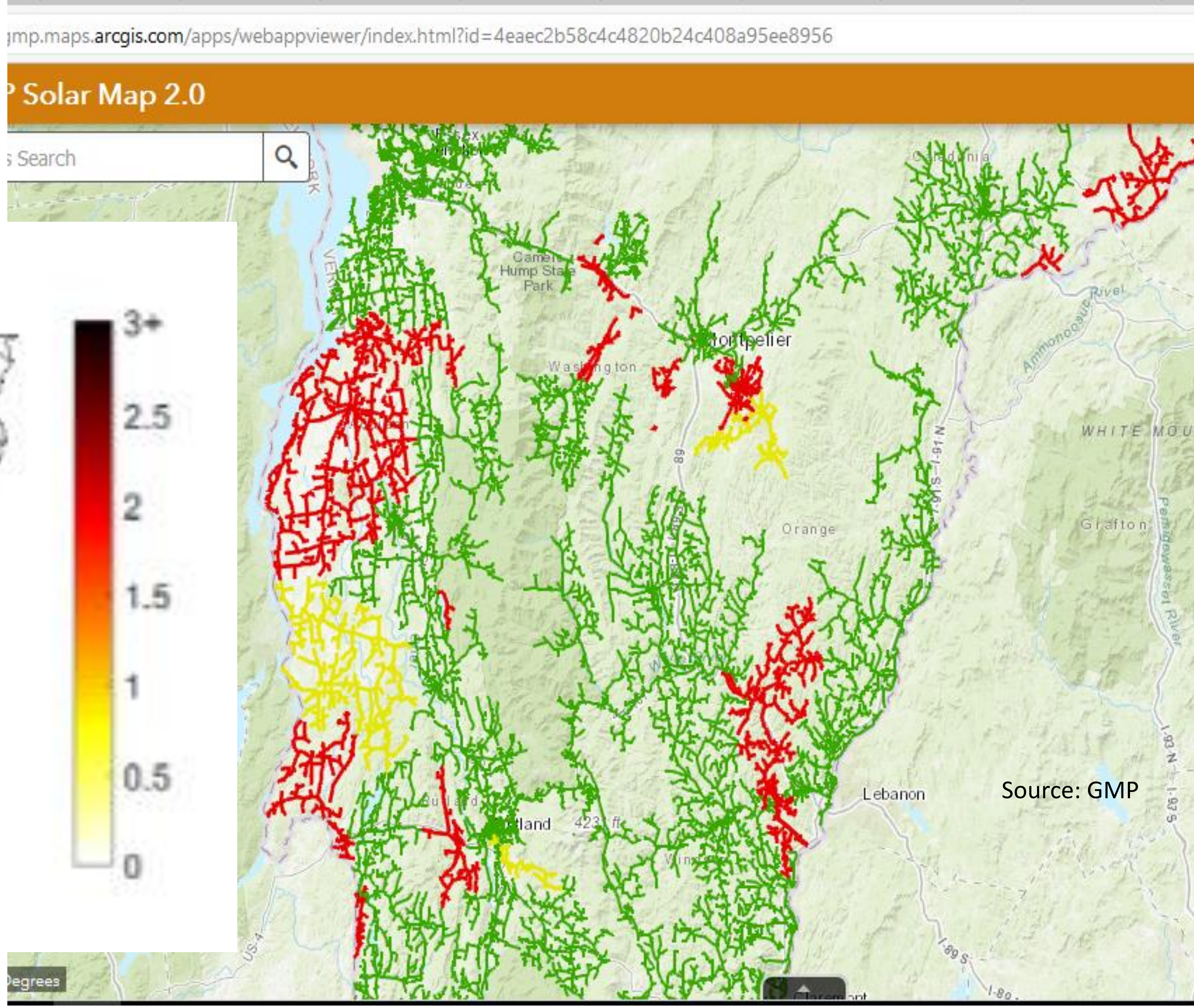


Source: RMI

- 260 MW Solar PV
- 150 MW Wind
- 200 MW In-State Hydro
- 70 MW Biomass
- 8 MW Landfill Gas
- 5 MW Methane Digesters

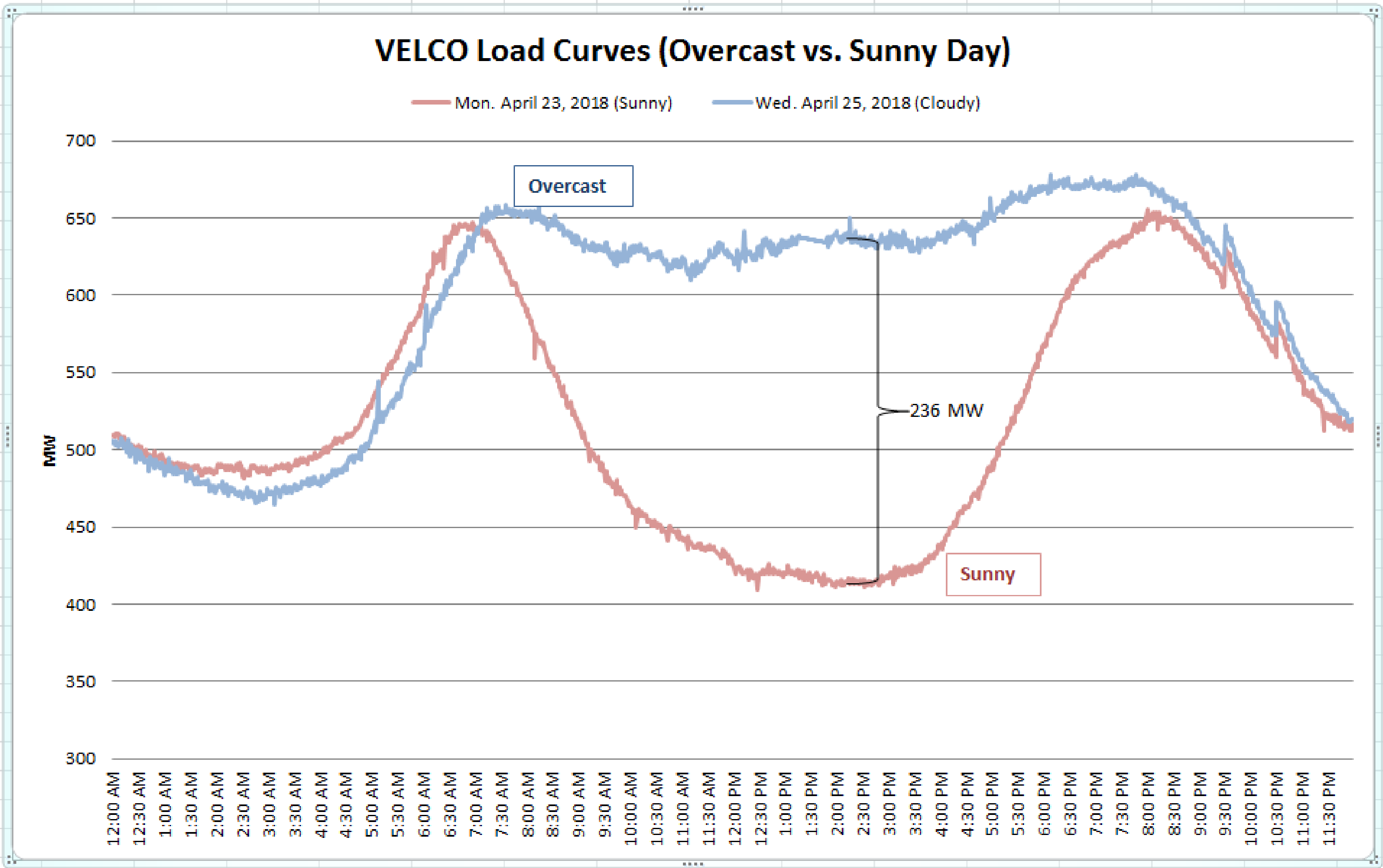
1000 MW Peak





Source: ISO-NE

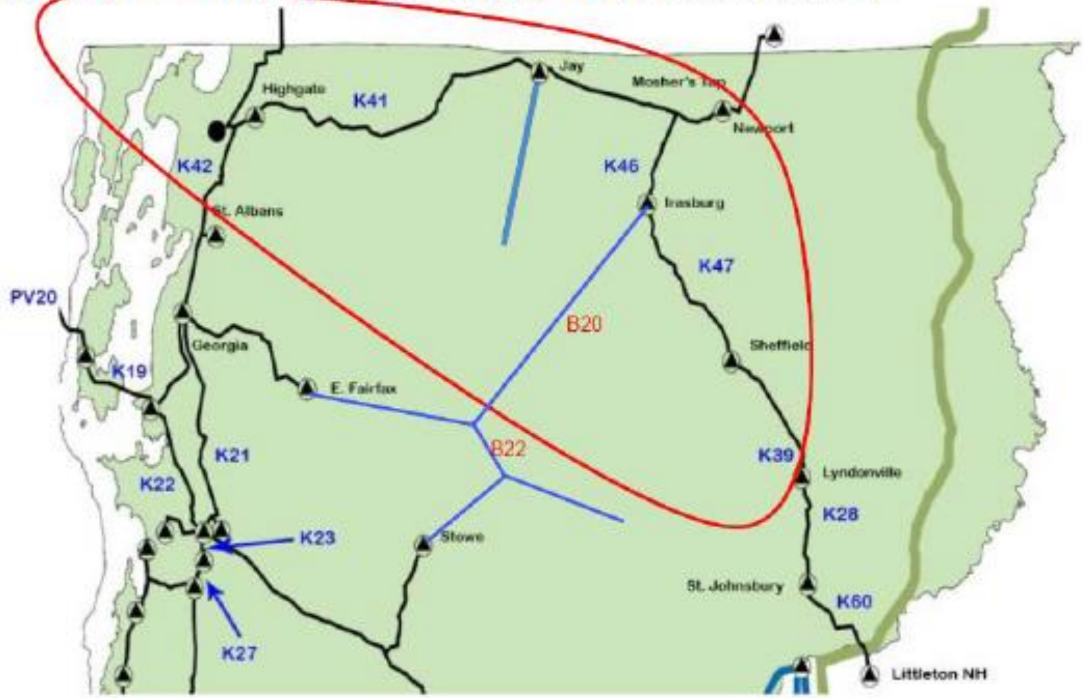
Source: GMP



Source: VELCO

Where is the SHEI?

ISO-NE determines SHEI limits at or below which the system can withstand potential system contingency events (e.g., line outage, equipment failure)

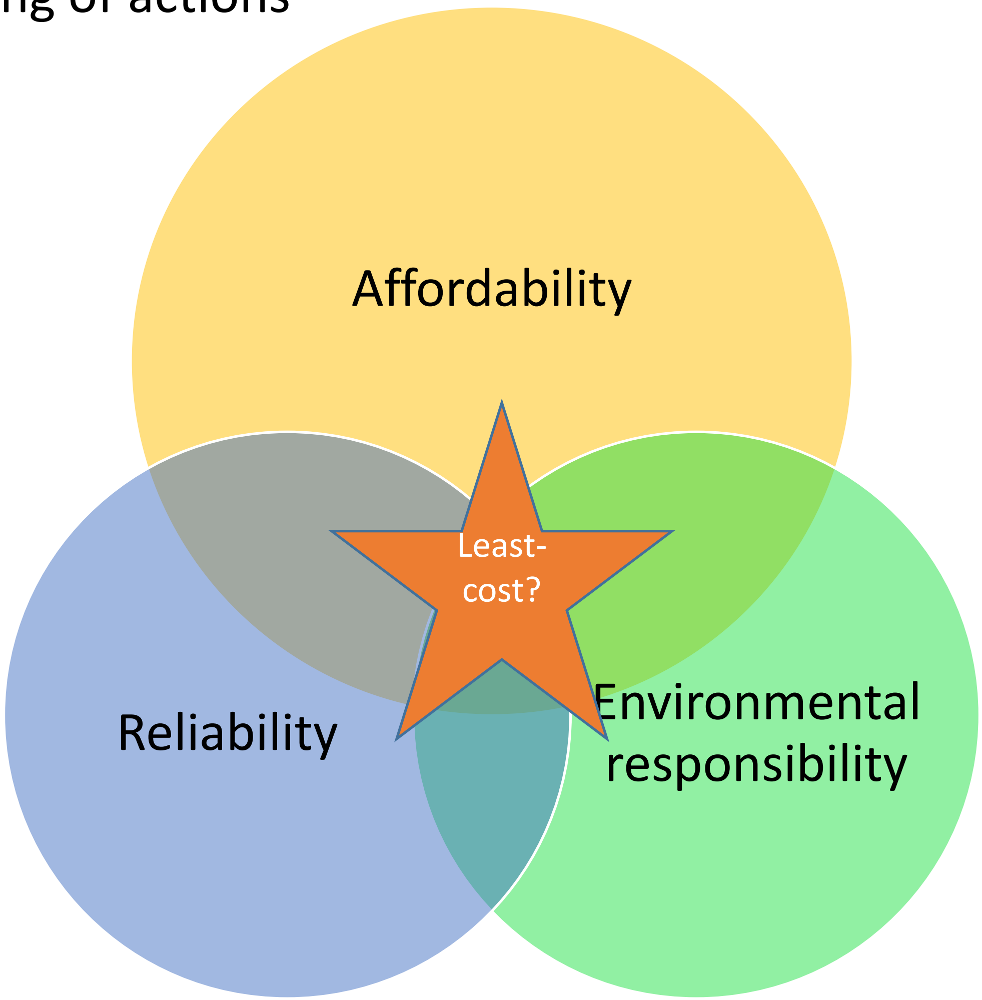


- Total load is between 20 MW and 60 MW
  - Average load is 35 MW
- Total generation is 430 MW (all at maximum potential output)
  - Including Highgate 225 MW HVdc converter – largest resource within SHEI
    - Highgate typically runs at maximum capacity almost 24 hours a day

Generation dispatchable by ISO-NE		Generation not dispatchable by ISO-NE	
Utility-scale wind	105 MW	Landfill methane	8 MW
Utility-scale hydro	35 MW	Total solar PV (small & large)	11 MW
Utility-scale thermal (rarely runs)	45 MW	Other standard offer (hydro, farm methane)	3 MW

Source: VELCO

- Defining objectives of and roles in grid modernization
- Sequencing, prioritization, and pacing of actions
  - Choreography of generation & load
  - Rate design & price signals
  - Beneficial electrification
  - Flexible loads
  - DERs
  - Grid sensing & management
  - Grid maintenance & redundancy
- Enabling multiple future scenarios
  - No- or low-regrets investments
  - Encouraging innovation
  - Minimizing risk to ratepayers
  - Awareness of cross-subsidies
  - Societal vs. customer benefits
  - Avoiding perverse outcomes



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

VERMONT
DEPARTMENT OF PUBLIC SERVICE

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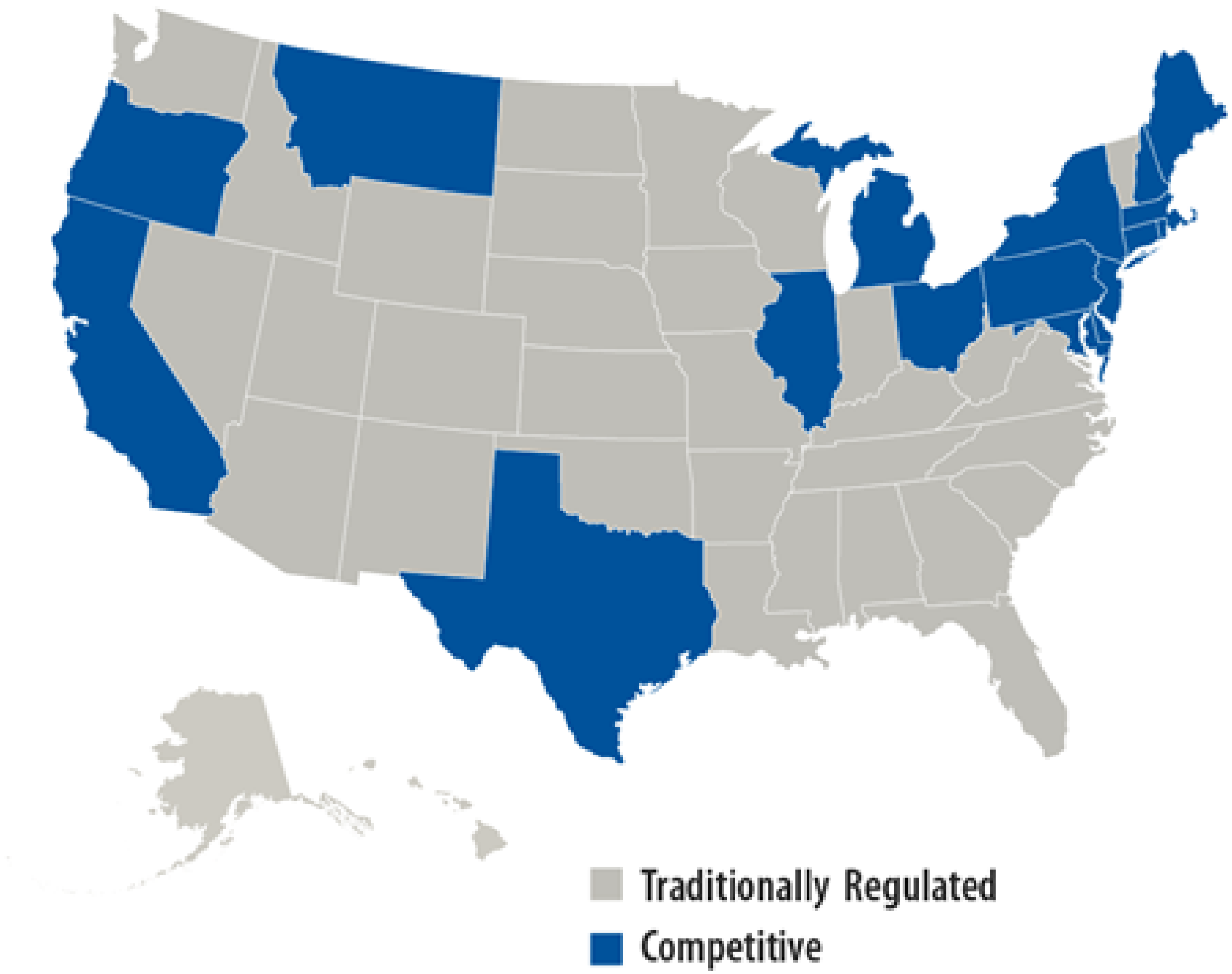
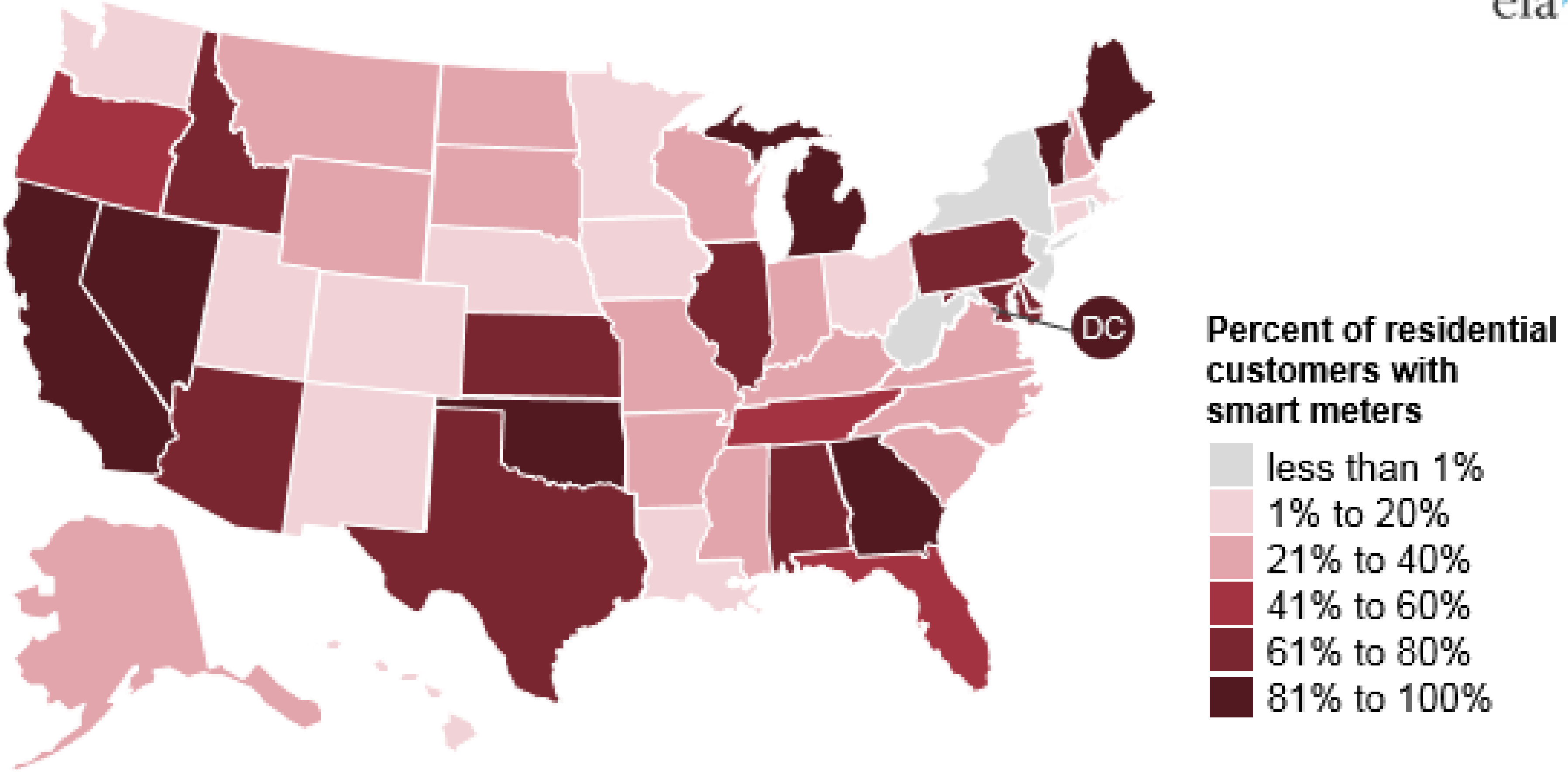
Supplemental Slides

Retail Electric Power Markets



Source: EPA

Residential smart meter adoption rates by state, 2016



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.

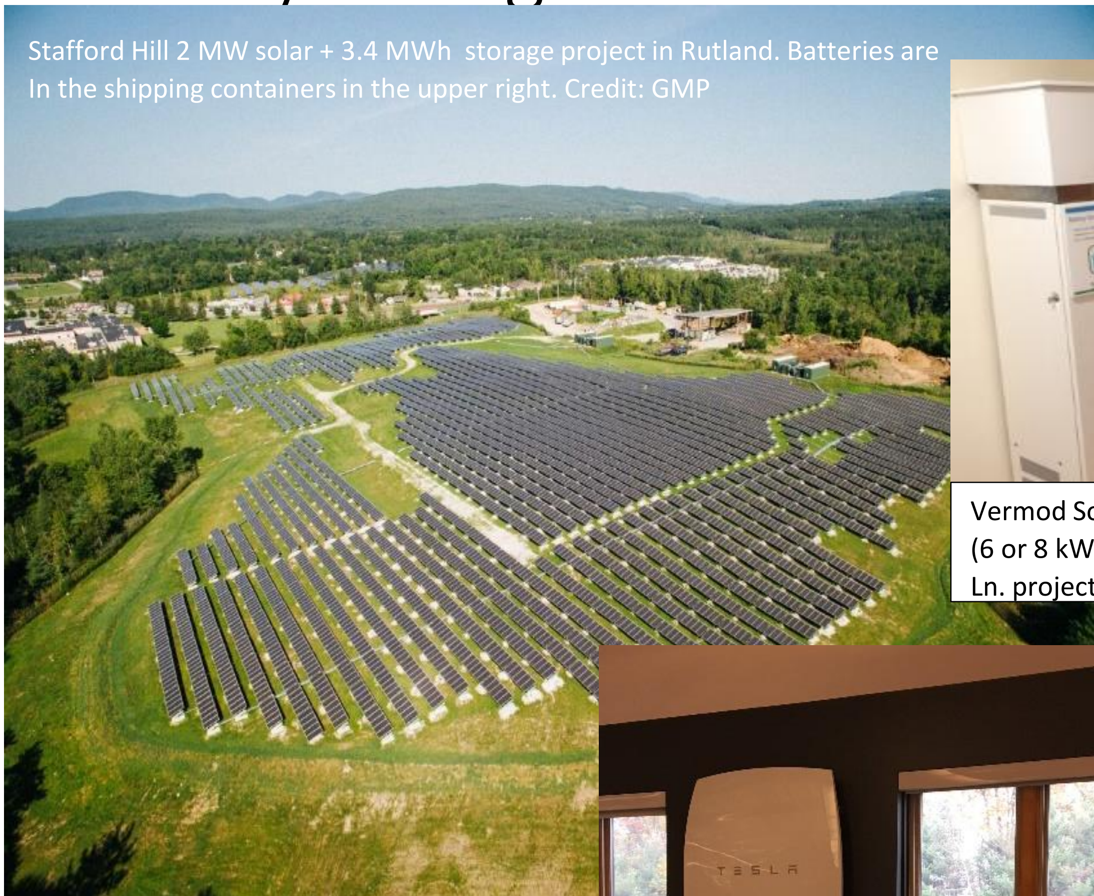
Ownership options & delivery pathways

Battery control	Benefits	Challenges
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

Also…..

- 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



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

Simpliphi 82 kWh system at Emerald Lake

Sunverge 8 kWh in Plymouth

GMP Tesla Powerwall 5.5 kW install

BED King St. Youth Center storage project

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

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