VT’s Transmission system and capacity for proposed Tier II changes

vermont electric power company
VELCO

February 14, 2020

Senate Finance Committee

Hantz Presumé

Roles & responsibilities

VELCO's vision is to create a sustainable Vermont through our people, assets, relationships and operating model.

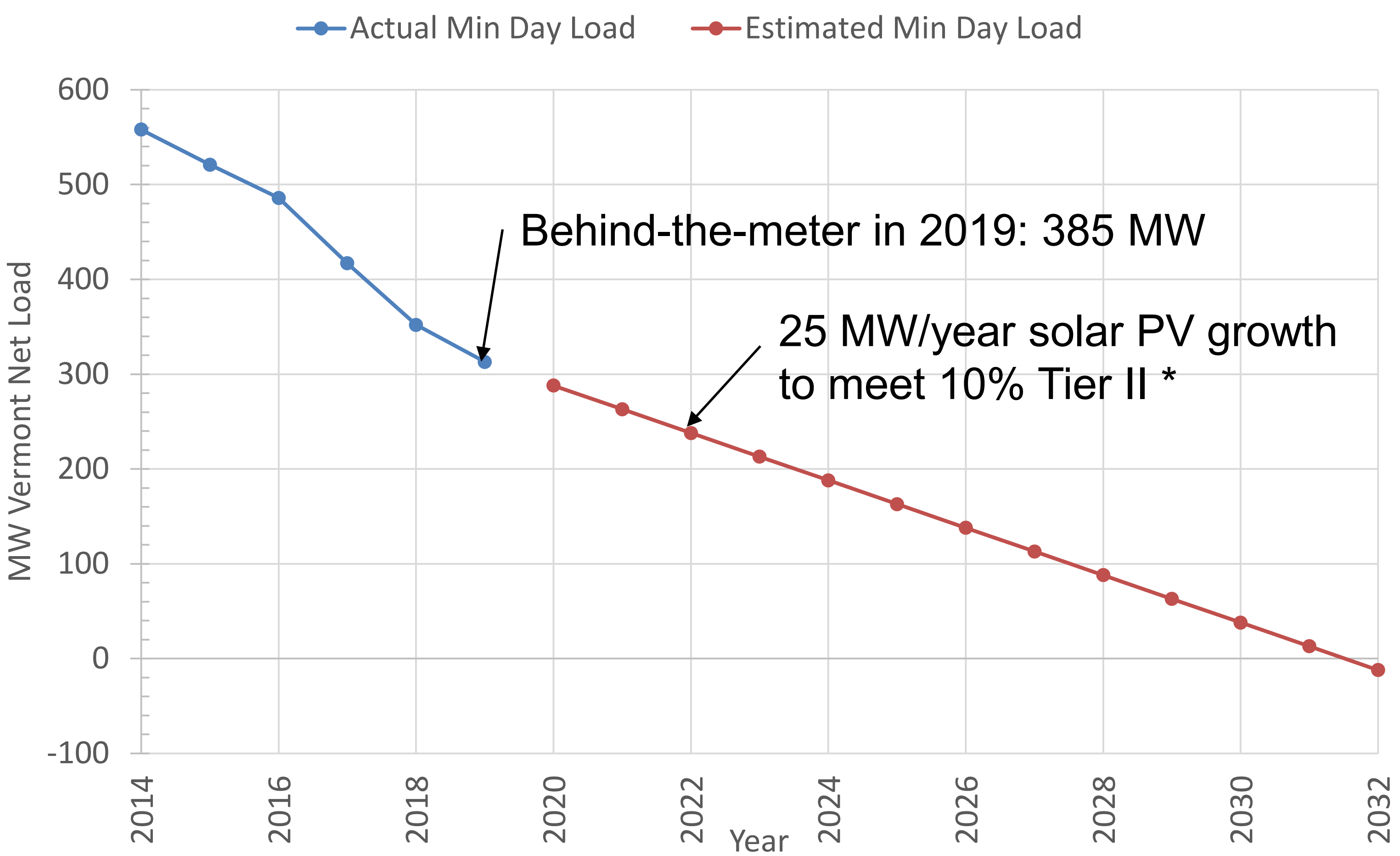
VELCO's role is to ensure transmission system reliability by planning, constructing and maintaining the state's high-voltage electric grid.

Related responsibilities

- Serve as Local Control Center for Vermont grid operations
- Develop and submit Vermont's Long-Range Transmission Plan
- Manage the Vermont System Planning Committee

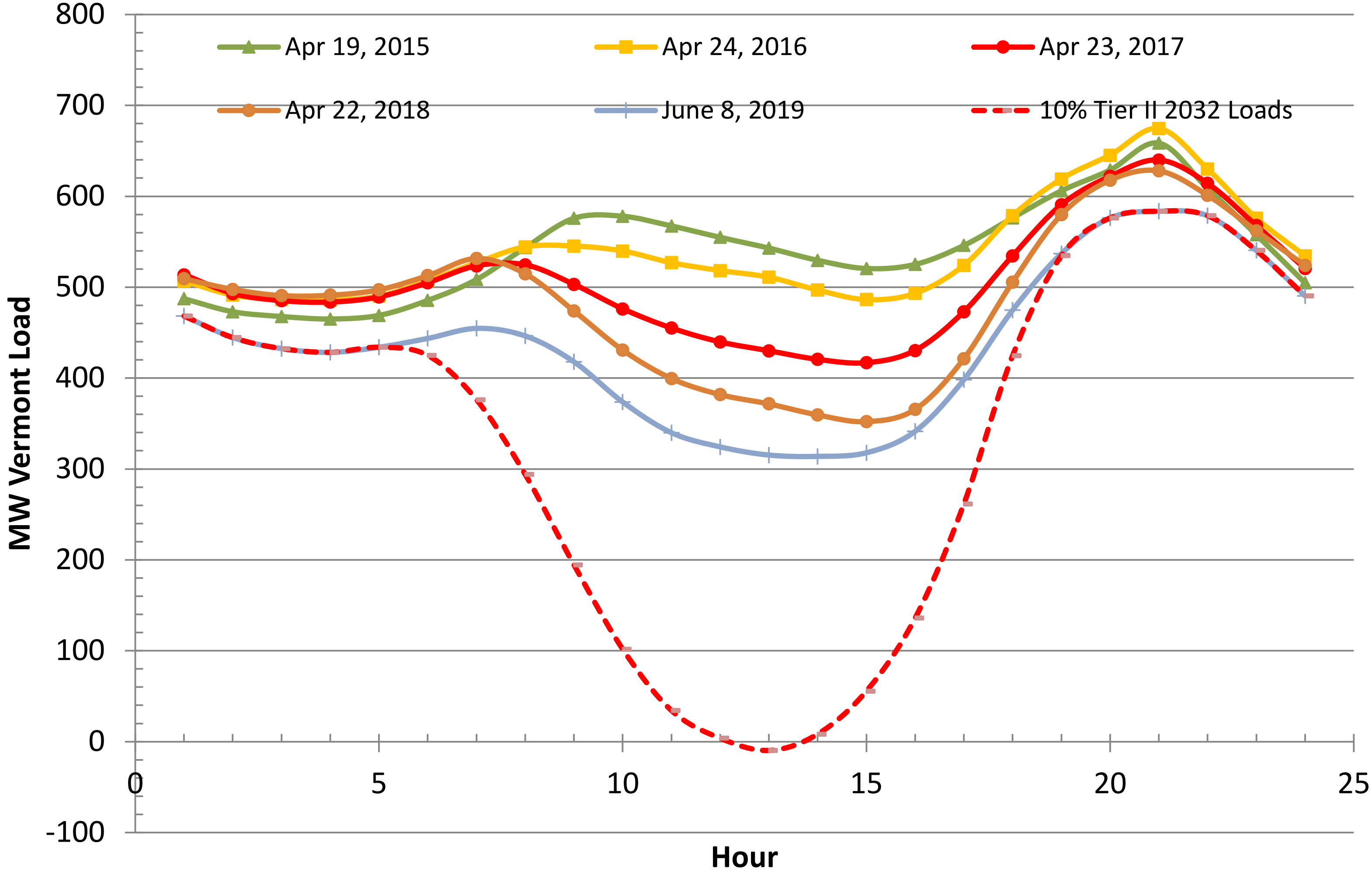
Policy and market forces are driving load

Year	Min Day load	Yearly load drop
2014	558	
2015	521	37
2016	486	35
2017	417	69
2018	352	65
2019	313	39
2020	288	25
2021	263	25
2022	238	25
2023	213	25
2024	188	25
2025	163	25
2026	138	25
2027	113	25
2028	88	25
2029	63	25
2030	38	25
2031	13	25
2032	-12	25



* https://www.iso-ne.com/static-assets/documents/2019/12/p2_dgfwg_vt2019.pdf

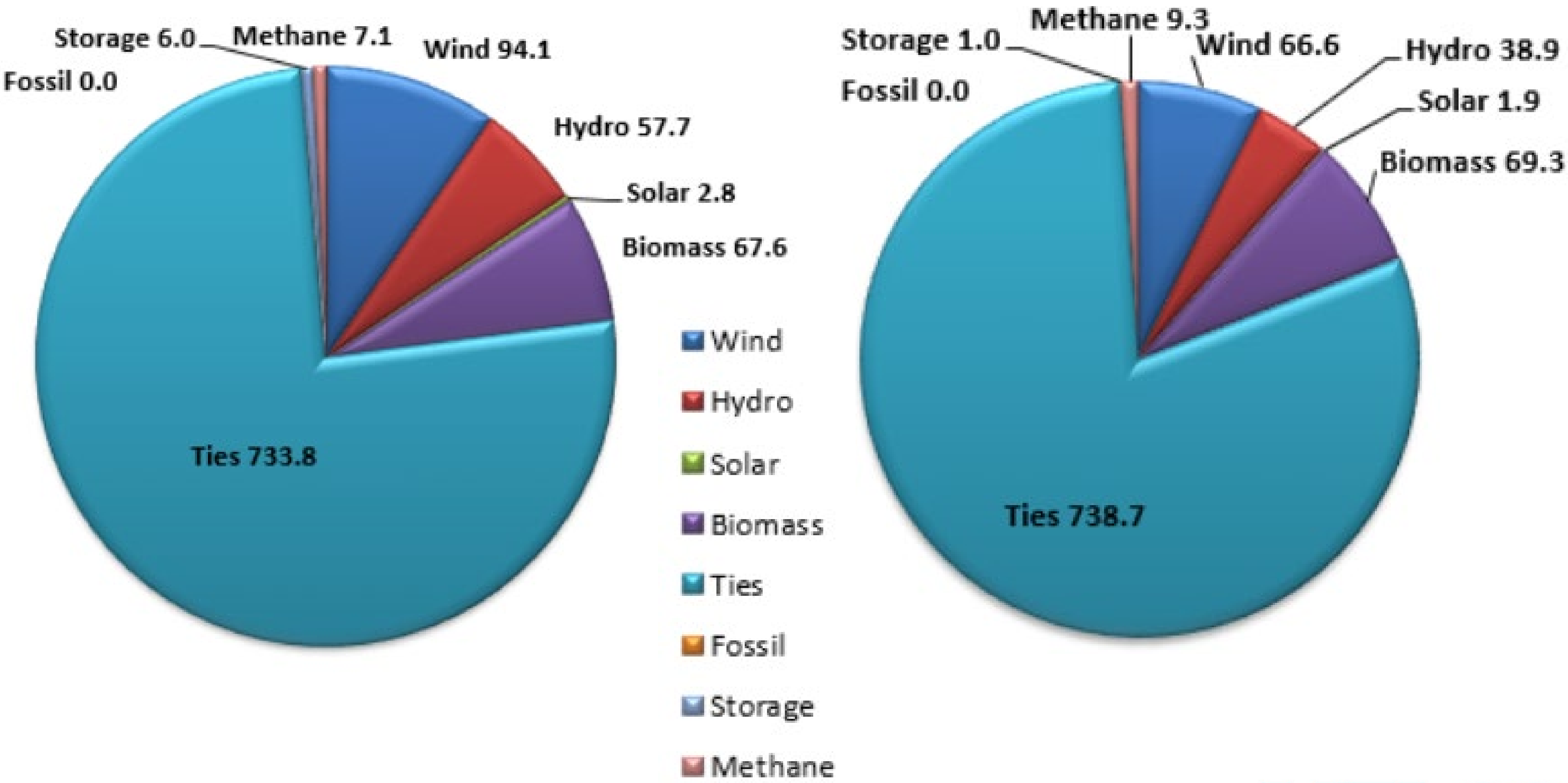
Incremental solar PV offers no incremental benefit at the daily peak hour



2019 Vermont power supply on peak days

- **Winter peak day (1/21/19, 18:00)**
- **Load was 969.2 MW**

- **Summer peak day (7/20/19, 21:00)**
- **Load was 925.7 MW**



2018 VT Long-Range Transmission Plan in short

- Vermont system reliability depends on an interconnected grid
- 2018-2028 no peak load growth expected
- No upgrades to serve peak load; some upgrades may be needed to meet renewable goals
- Requirements of implementing two scenarios: 500 MW existing requirement &1000MW Solar Pathways vision
  - Generation curtailments
  - Load management (e.g., shifting consumption)
  - Grid reinforcements
  - Optimized location of generation
  - Storage

2018 results of high-solar PV scenarios

- System impacts at 500 MW of solar PV
  - System losses increased by about 13 MW (snapshot)
  - Existing constraints aggravated (i.e., SHEI)
    - Voltage collapse in Northern VT
    - Additional overloads along Highgate-St Albans-Georgia line
    - Overloads south of Georgia depending on Plattsburgh-Sand Bar (PV20) tie flow
- System impacts at 1000 MW of solar PV
  - Much more severe impacts that are more widely distributed
  - Reviewed transmission system hosting capacity
  - Reviewed storage-only non-transmission alternative

Storage as transmission grid asset

- Storage does not always mean battery storage
- Storage can shift energy over a number of hours
  - Flatten daily load curve
    - Reduce system stresses and curtailments, decarbonize daily peaks when charged from renewable sources
  - Can provide market benefits (e.g., energy, capacity, regulation)
    - Rules for determining transmission system reliability benefit under FERC review
- Attributes needed for sufficiently beneficial storage
  - Significant drop in costs (installed, maintenance, repower)
  - Long term charging, i.e. at least four hours
  - Limited loss of life with frequent cycling and deep discharge
  - Grid support (voltage, frequency, inertia, orchestration)

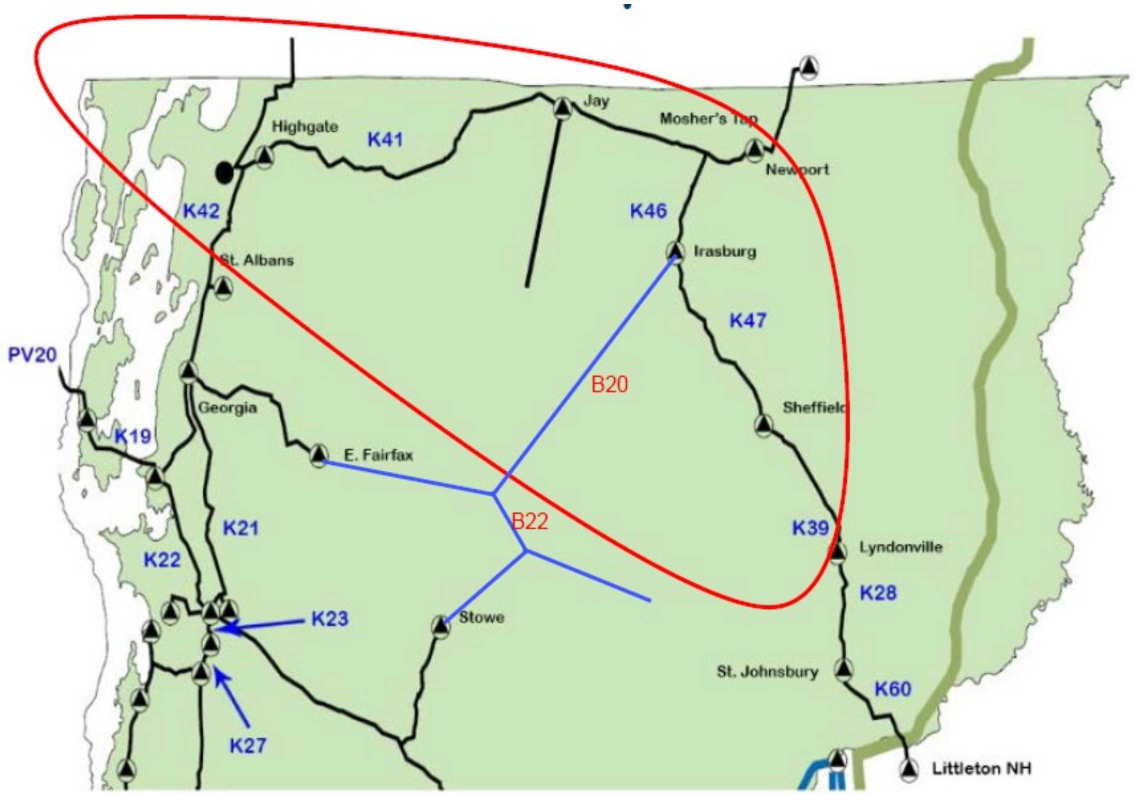
Minimum storage requirements to accommodate non-optimized solar PV distribution

Load zones →	Newport	Highgate	St Albans	BED	Burlington	Middlebury	Central
Energy (MWh)	103.5	111.4	30.5	99.0	497.3	160.0	254.8
Capacity (MW)	16.8	19.4	15.1	14.8	96.4	35.3	55.9
Installed cost ($M)	$72.7	$79.0	$26.6	$68.9	$357.5	$117.2	$186.5

- **Cost estimate exceeds $900M**
- Capacity and energy requirements are minimum values for several reasons (not limited to):
  - Depth of discharge management and other operational constraints
  - A reality that is different from study assumptions, mainly imports from other states and the installation of FERC regulated generation projects
- Cost estimate assumes lithium ion batteries
- Storage could be many things (other battery technologies, pumped hydro, load control…)
- Cost estimate did not include other cost drivers, such as contingencies reflecting cost of unknown risk, land, financing, O&M, battery replacement, nor potential cost declines and other cost reducing value streams
- Transmission or curtailments may be more appropriate than storage in some cases
- Cost estimate method from: http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/10018304_R-01-D_PacifiCorp_Battery_Energy_Storage_Study.pdf

Constraints = curtailment

- Sheffield-Highgate Export Interface created to monitor power flow reliability
- Export limits change dynamically
- ISO-NE controls flows by adjusting generation under operator
- Same outcome likely in more VT regions unless addressed in advance



Additional SHEI info at https://www.vermontspc.com/grid-planning/shei-info

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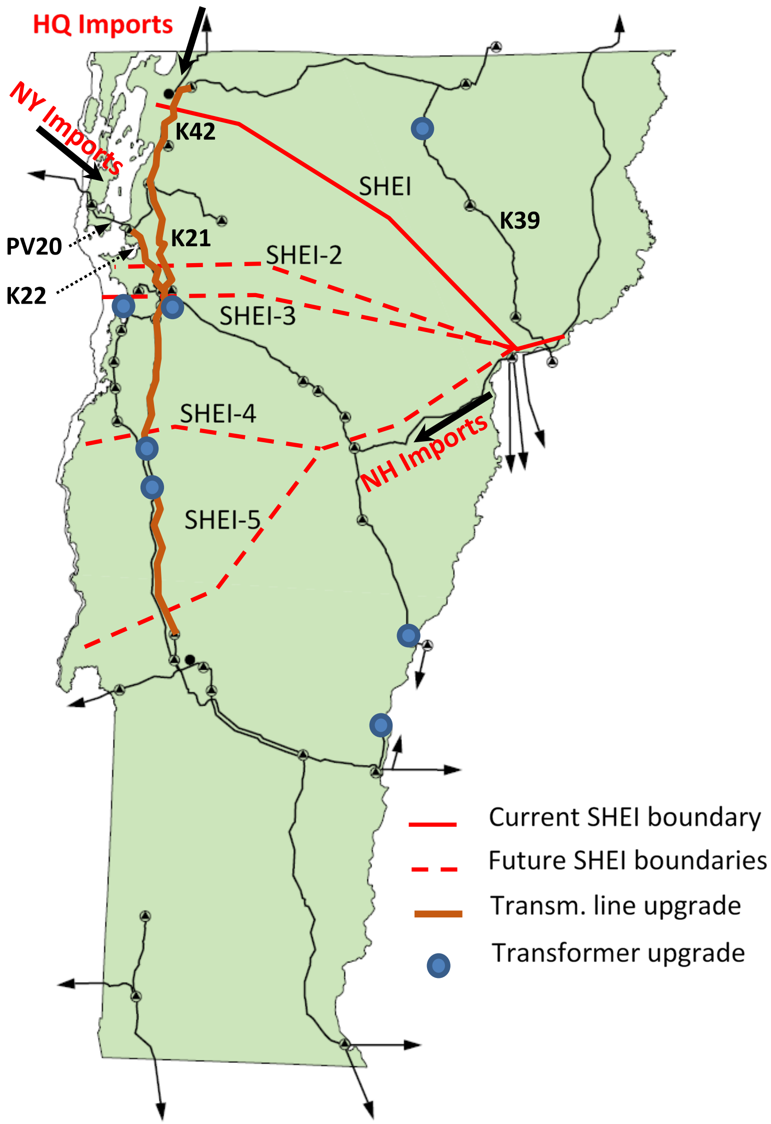
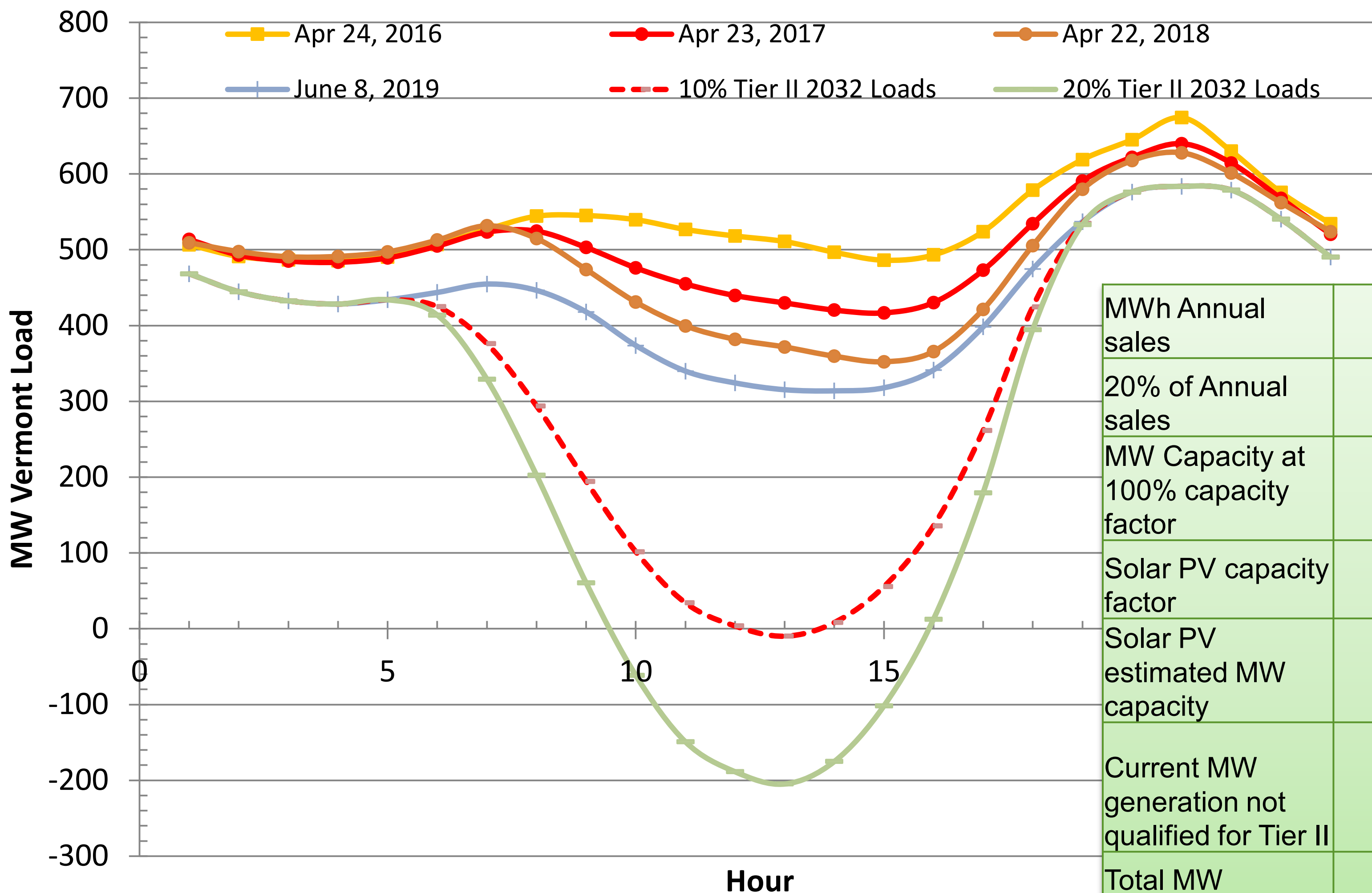
Impacts with high solar PV scenario



- **Exceeds $300M**
  (VT or developer cost)
- SHEI is current constraint interface
- SHEI-1 to SHEI-5 are expansions of constraint
- Timing of expansion is unknown
  - Depends on how quickly solar PV is installed in individual zones
  - Not necessarily sequential—e.g., SHEI-3 could occur before SHEI-2
  - Optimal solar PV distribution analysis gives some insights

Doubling Tier II - forecasted Vermont load shape

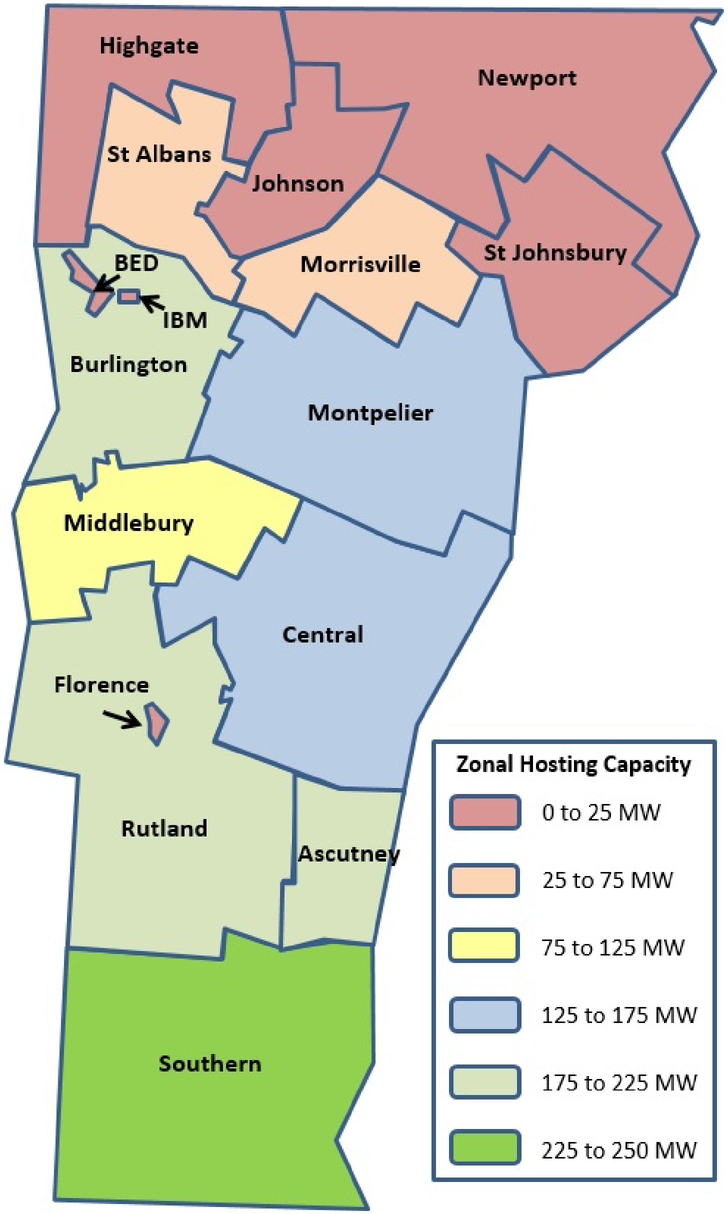


MWh Annual sales	6,000,000
20% of Annual sales	1,200,000
MW Capacity at 100% capacity factor	137
Solar PV capacity factor	0.15
Solar PV estimated MW capacity	913
Current MW generation not qualified for Tier II	210
Total MW generation	1123

“Perfect world” - Transmission system’s in-state generation hosting capacity

“All-optimistic” assumption scenario

Zone names	Gross MW loads	MW AC solar PV capacity	Net MW loads
Newport	19.8	10.3	9.5
Highgate	23.8	15.5	8.3
St Albans	39.7	42.9	-3.2
Johnson	6.6	16.4	-9.8
Morrisville	24.3	50.7	-26.4
Montpelier	48.6	104.9	-56.3
St Johnsbury	14.7	12.1	2.6
BED	39.8	5.6	34.2
IBM	60.6	20.0	40.6
Burlington	94.1	107.4	-13.3
Middlebury	19.7	57.7	-38.0
Central	37.6	91.2	-53.6
Florence	22.6	21.2	1.4
Rutland	61.7	164.6	-102.9
Ascutney	39.5	112.8	-73.3
Southern	65.6	224.9	-159.3
Total	618.7	1058.2	-439.5
Losses	33.6	N/A	53.4



"Perfect world" assumptions

- "Fortress Vermont" – AC tie line imports reduced to 0 MW – will not always be possible
- Voltage control installed – essential to maximize distributed generation
- Sub-transmission and distribution system reinforcements are completed – If not, these concerns may limit solar PV below levels indicated in analysis
- Storage contribution – allows for 5% thermal capacity overload
- Hosting capacity unclaimed by in-state projects driven by regional markets (e.g. NextEra's 20MW Coolidge Solar PV project is not included)
- Development blueprint – generation will be installed "exactly" as laid out in this optimized distribution – notwithstanding constraints, such as project economics, aesthetic impacts, public acceptance, etc.
  - Maximum zonal distributed generation levels are interdependent—amount of generation in one zone will affect amount that can be installed in other zones

The bottom line

- Reliably securing significant amounts of additional in-state, renewable generation requires:
  - Grid support from distributed resources
  - Generation curtailments
  - Load management
  - Locational alignment with grid capacity
  - Grid reinforcements
  - Storage
- VELCO will update our analyses to reflect new data (2021 LRTP)
- VELCO will work to ensure the transmission grid delivers value toward a sustainable Vermont whatever the legislative outcome