Draft 2021 Vermont Long-Range Transmission Plan

Operating Committee

April 15, 2021

vermont electric power company

VELCO

What's important to remember

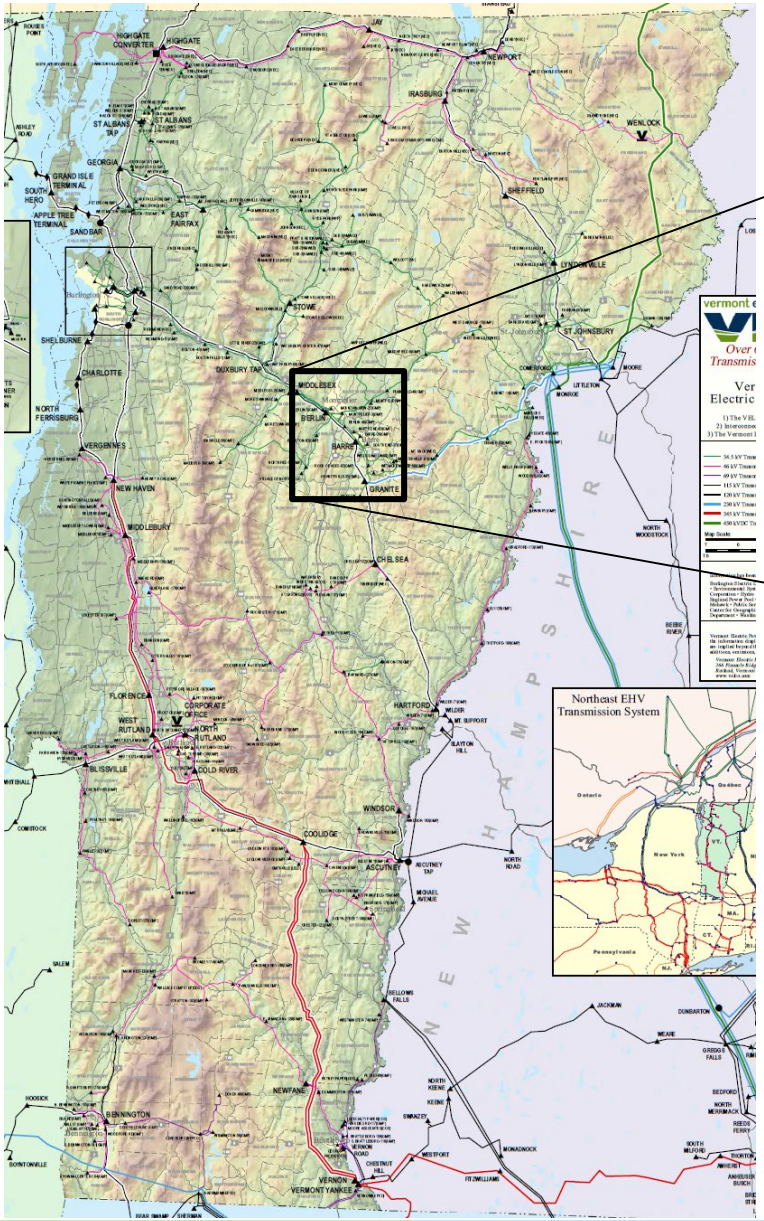
- System reliability will be maintained
- Vermont is a transmission-dependent state
- Significant load growth expected – winter peaking
- No major upgrades needed to serve load within the 10-year horizon
  - Presumes additional load management capability
  - Does not resolve all local concerns
- Incremental solar does not reduce load at peak hour
  - Efficiency and solar PV have provided great value
- VT utilities continue to implement innovative programs
- Further collaboration and innovation needed to achieve renewable and climate-driven requirements

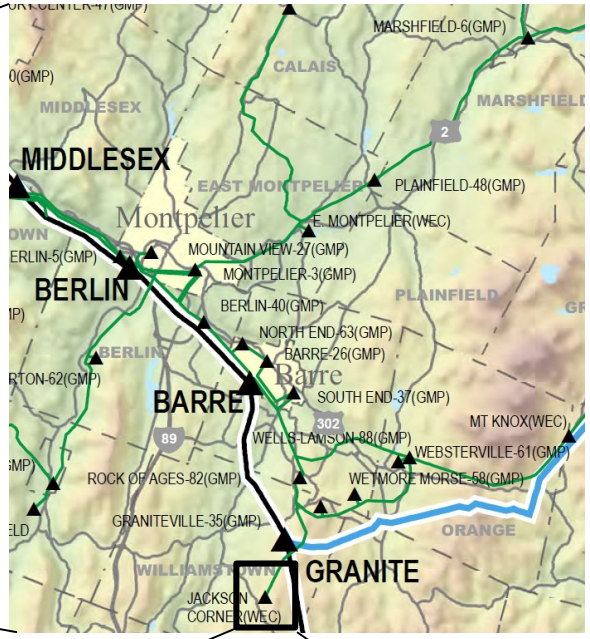
Recommendations

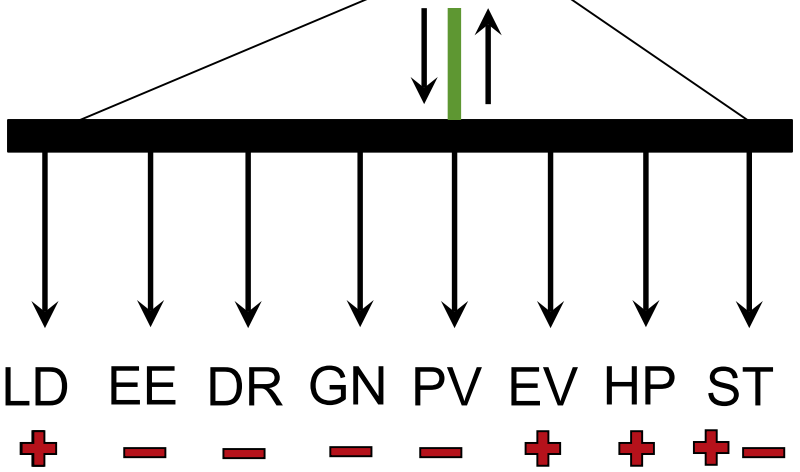
- Give greater weight to grid impacts when siting generation
- Bring to scale flexible load management
  - Enable inverter grid support functionality, i.e., voltage control and ride through capability
  - Enable utility management of distributed generation
  - Continue to evolve with storage
  - Establish data organizational architecture
  - Deepen/broaden fiber communications network
- Grid reinforcements (e.g., transmission, subtransmission and distribution investments)

THE FORECASTS

Load modeling (state, zone, substation)

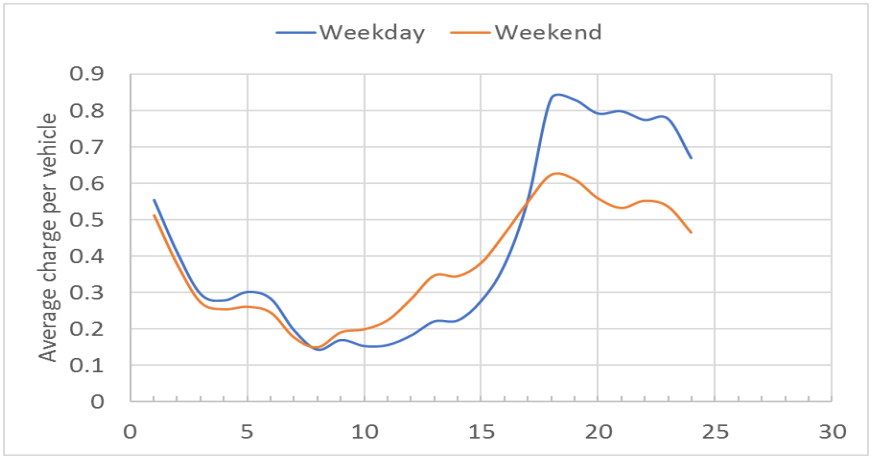




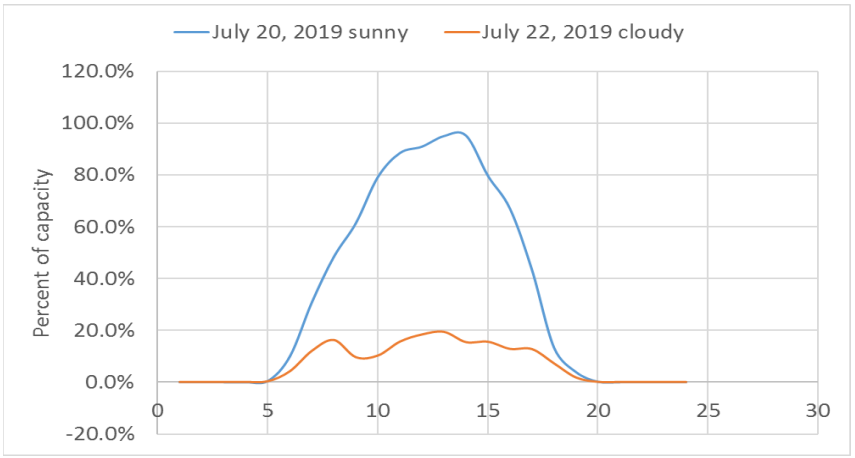


Net load calculation involves adding shapes

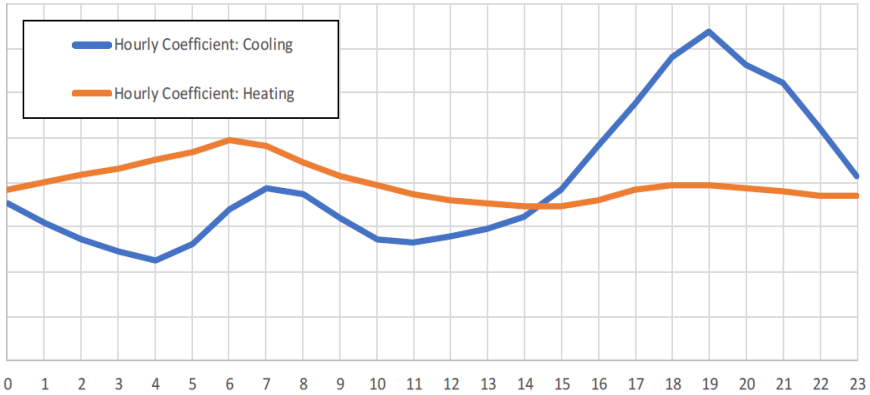
EV load shapes



Solar PV shapes

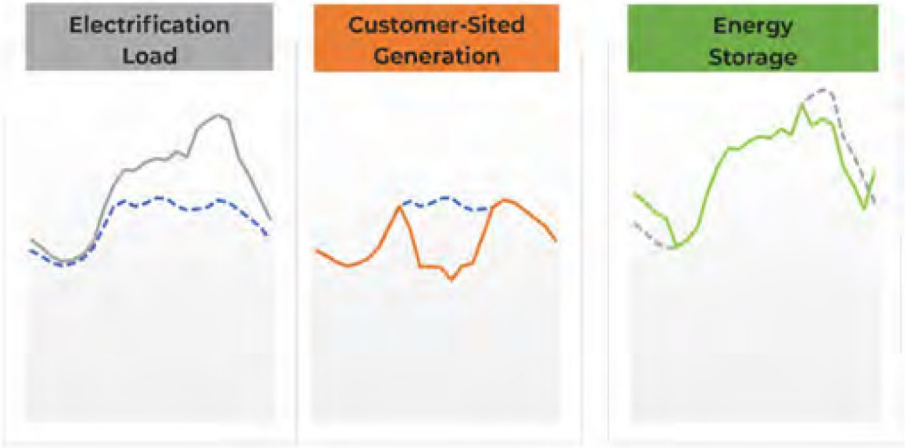


Heat Pump load shapes



2017 Evaluation of Cold Climate Heat Pumps in Vermont

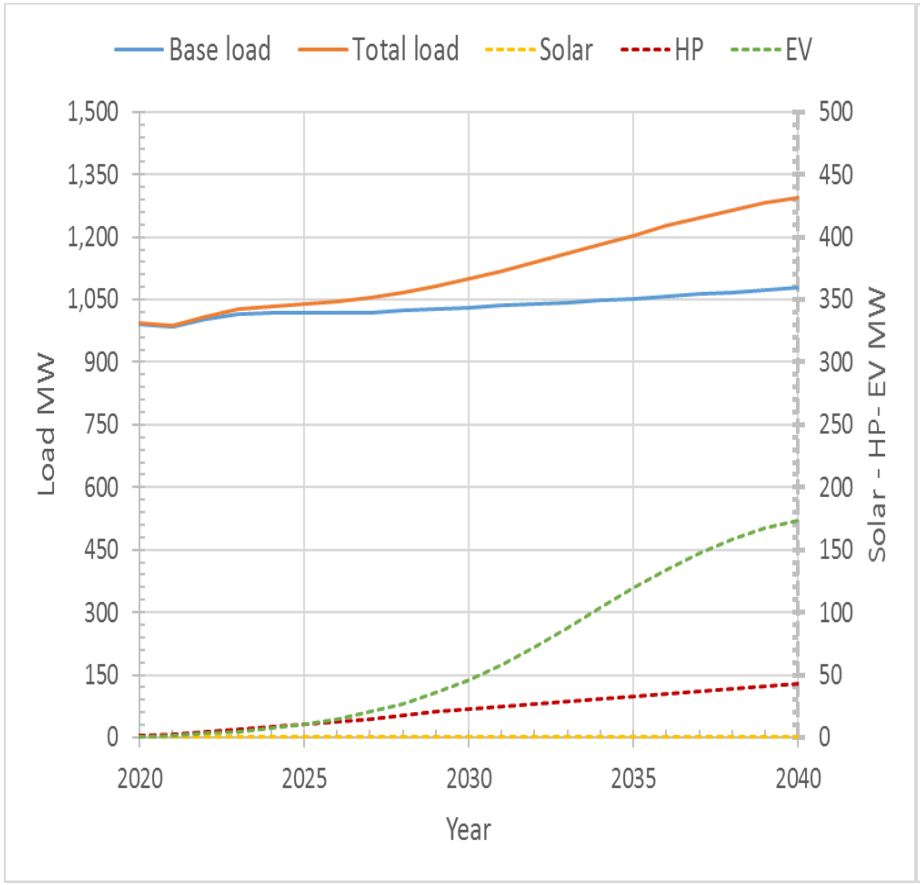
Optimistic convergence



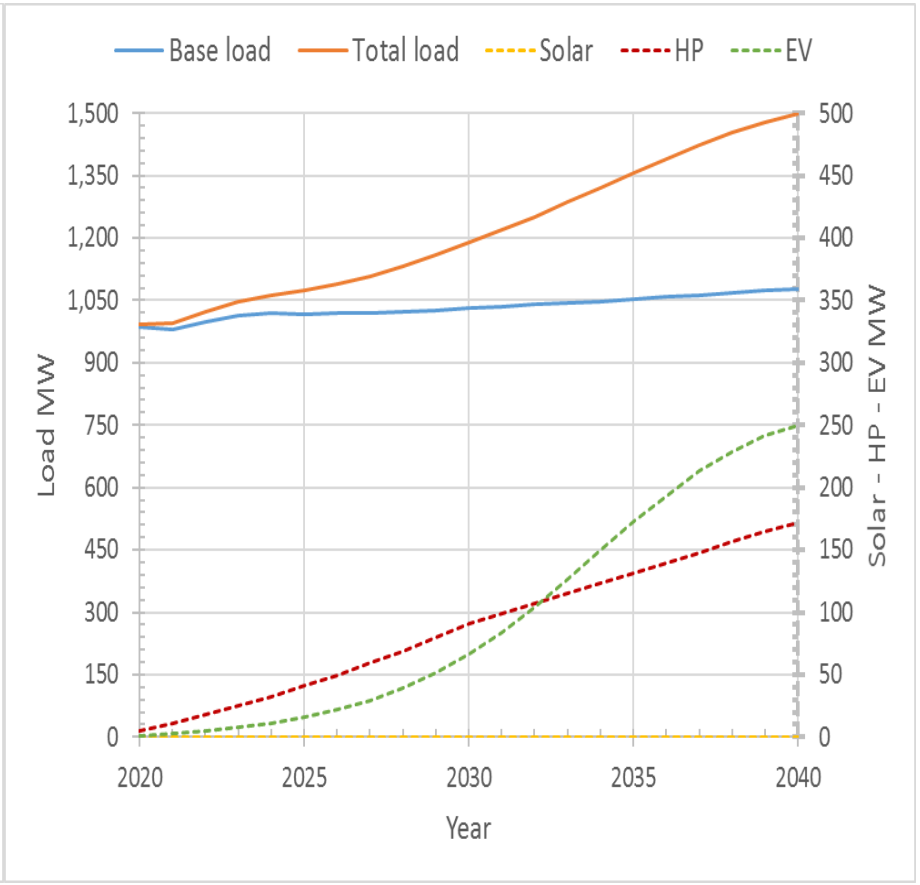
VT DPS Innovative Rate Design Study

Summer and Winter Medium Peak Load Forecast Components

Summer Peak Load Forecast

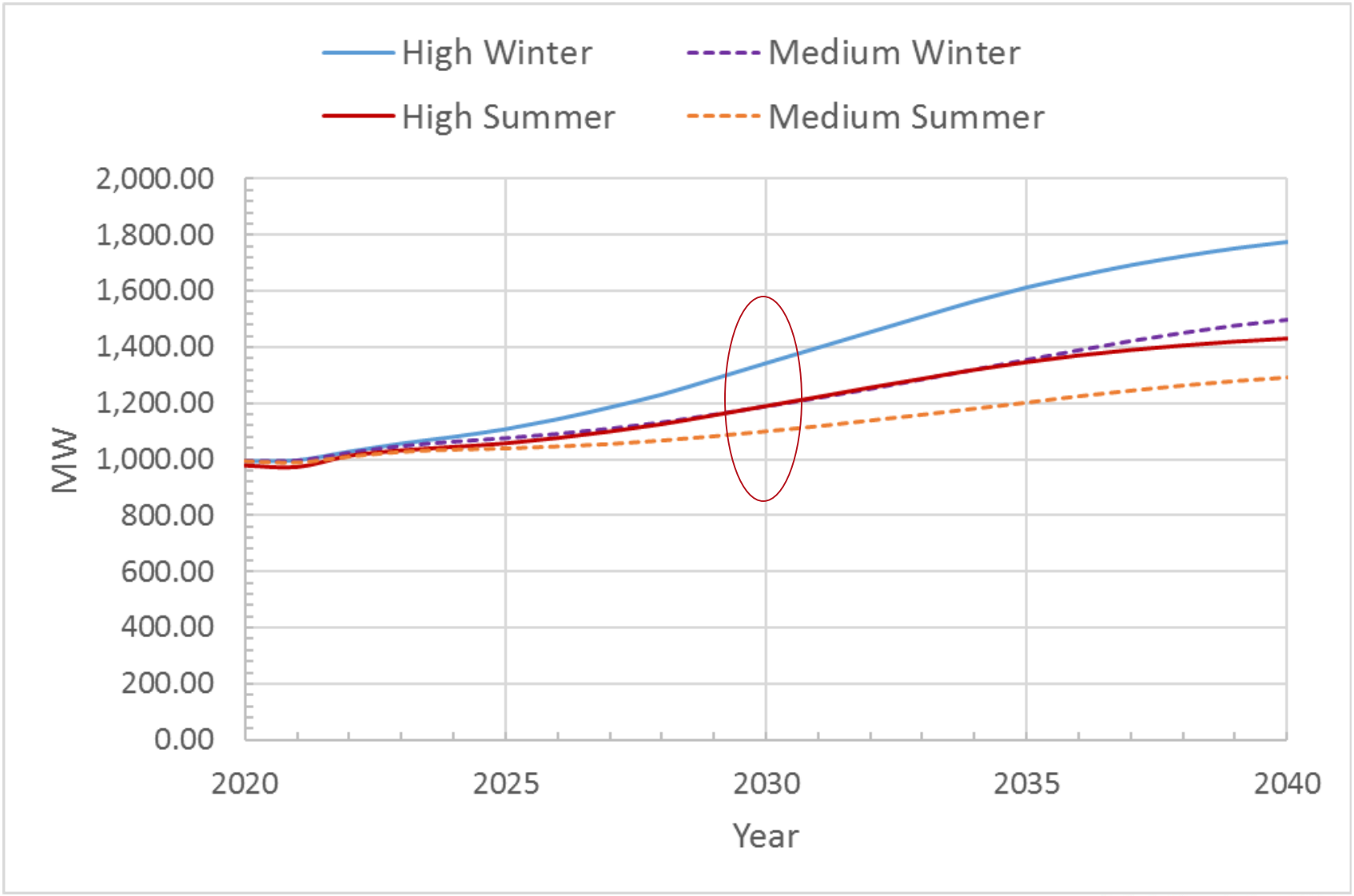


Winter Peak Load Forecast



Technology forecasts do not include effect of load control

Load forecast scenarios



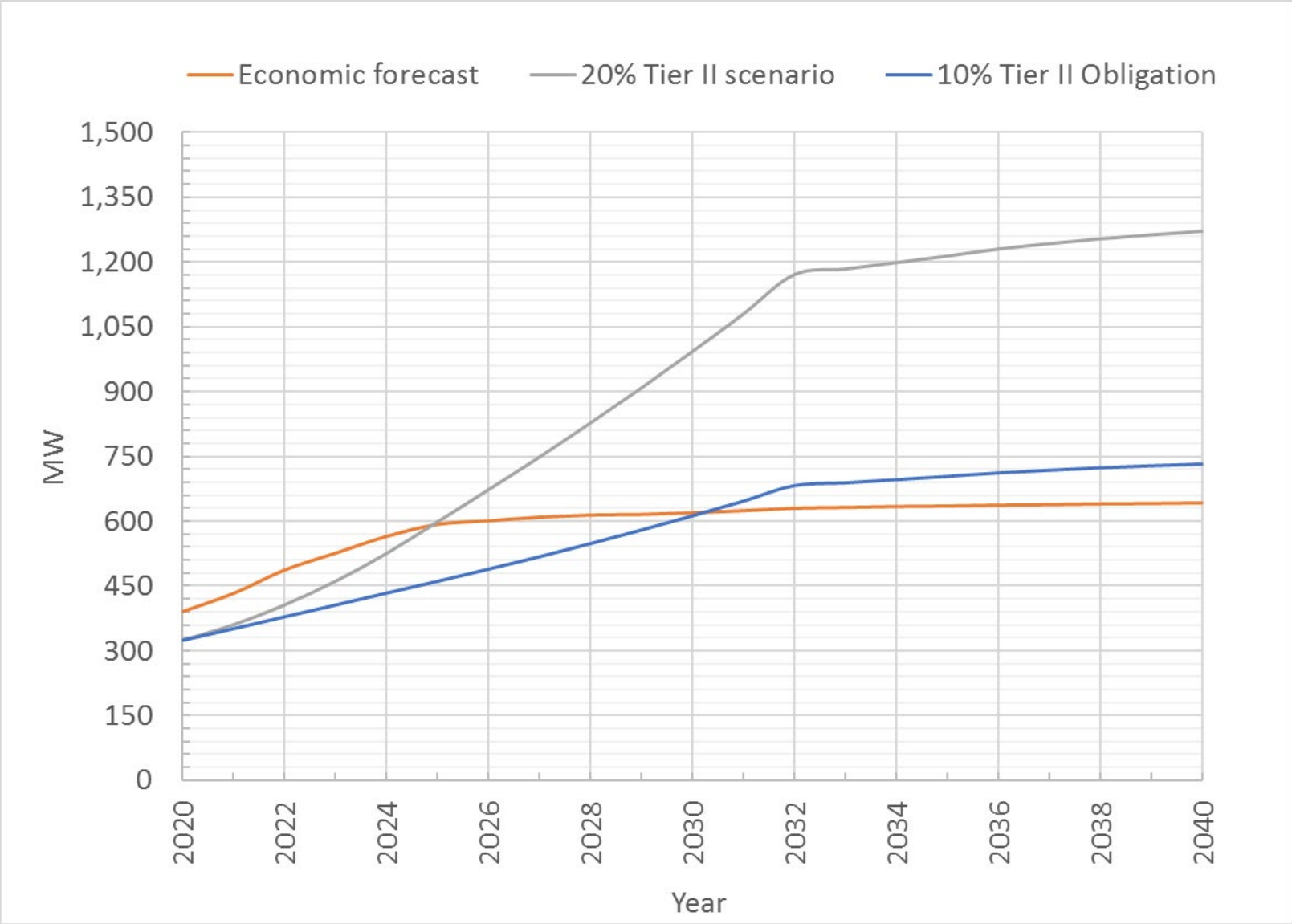
Load forecast scenarios

	Low forecast scenario		Medium forecast scenario		High forecast scenario		All-time peak (year)	Historical 5-yr average
Year	2030	2040	2030	2040	2030	2040		
Summer	1071 MW	1185 MW	1119 MW	1294 MW	1189 MW	1430 MW	1118 MW (2006)	950 MW
Winter	1135 MW	1292 MW	1219 MW	1499 MW	1342 MW	1774 MW	1086 MW (2004/05)	970 MW

	Actual	Low forecast scenario		Medium forecast scenario		High forecast scenario	
Year	2020	2030	2040	2030	2040	2030	2040
Electric Vehicles	3912	36080	126184	71624	256417	190125	412689
Heat Pumps	4611	61185	80141	77685	149141	110185	254141

450,000 light-duty vehicles today – did not forecast trucks, buses, etc.
320,000 residential customers today

Solar PV growth scenarios



RESULTS

ABILITY TO SERVE PEAK LOADS

No major upgrades needed to serve load within the 10-year horizon

Bulk system	• No peak load concerns. Issues addressed with tie line adjustments
Predominantly bulk system	• No peak load concerns. Issues addressed by tie line adjustments and operator actions • Acceptable loss of load (5-150 MW). As a direct consequence of outage and operator actions.
Subtransmission issues	• Flagged some issues to be evaluated by distribution utilities
High-load scenario	• Minimal effect within 10 years • After 10 years, requires non-transmission solutions to avoid transmission upgrades: load management, energy efficiency, storage, generation, …

RESULTS

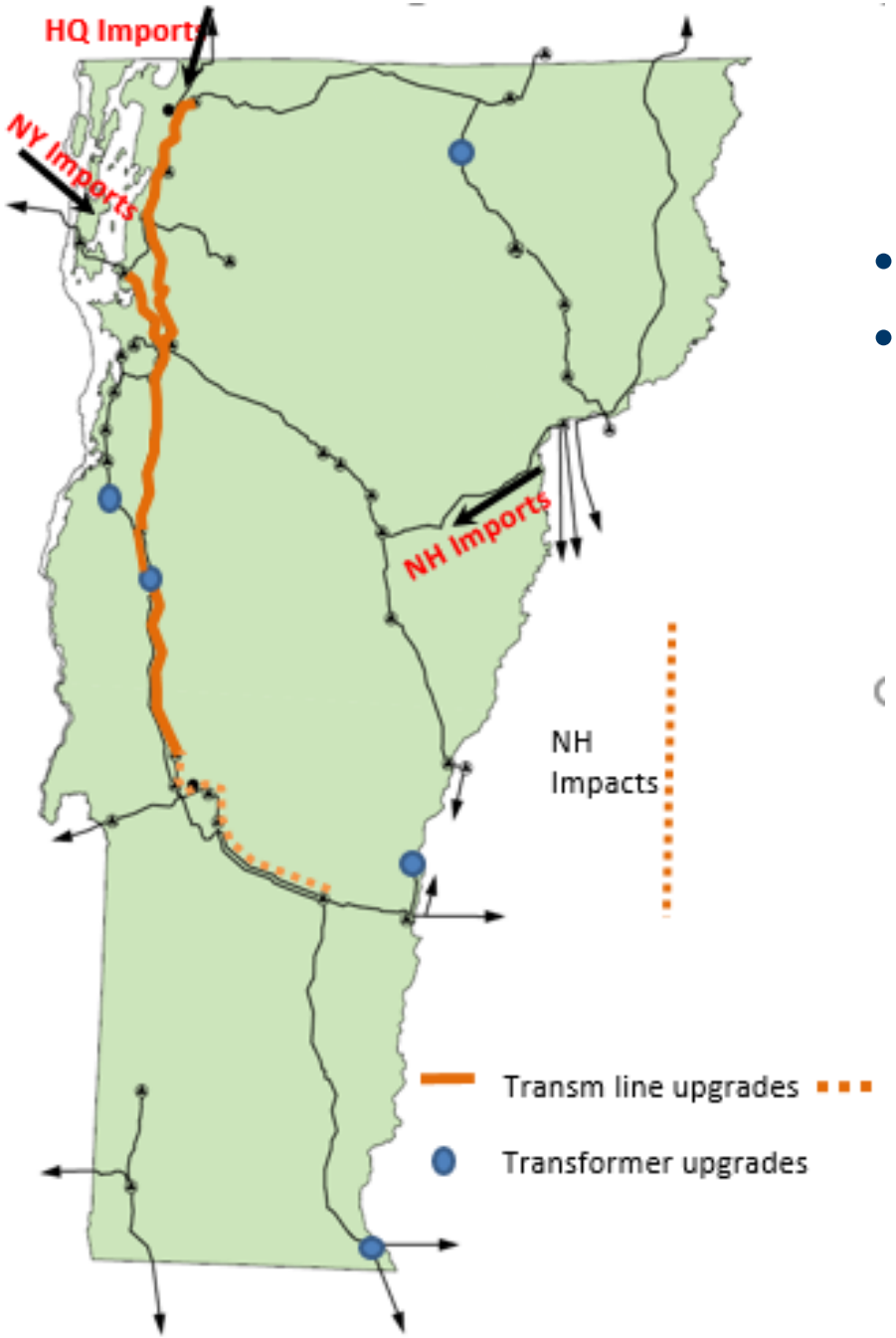
ABILITY TO ACCOMMODATE DISTRIBUTED GENERATION (DG)

Location matters

- Current geographical distribution will cause additional overloads and voltage concerns
- Optimizing DG distribution avoids major upgrades
  - New information from sensitivity analysis
    - DG hosting capacity affected by controllable tie lines
      - Additional PV20 flows decrease hosting capacity by nearly 1-to-1
      - F206 flows have similar impacts but less than 1-to-1
    - Queued Projects (20 MW or greater) may alter the limiting elements, restricting DG locally and changing an optimized solution
    - Distribution transformer ratings not particularly restrictive

Tier II Doubled

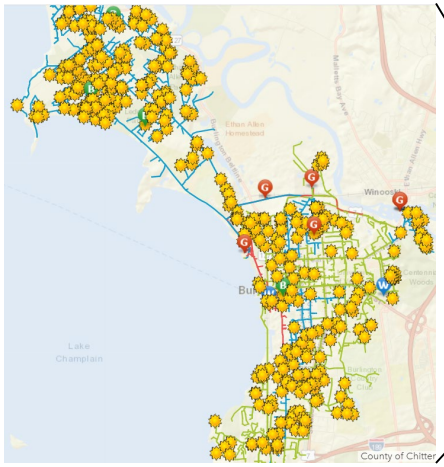
- Transmission overloads
- No optimization

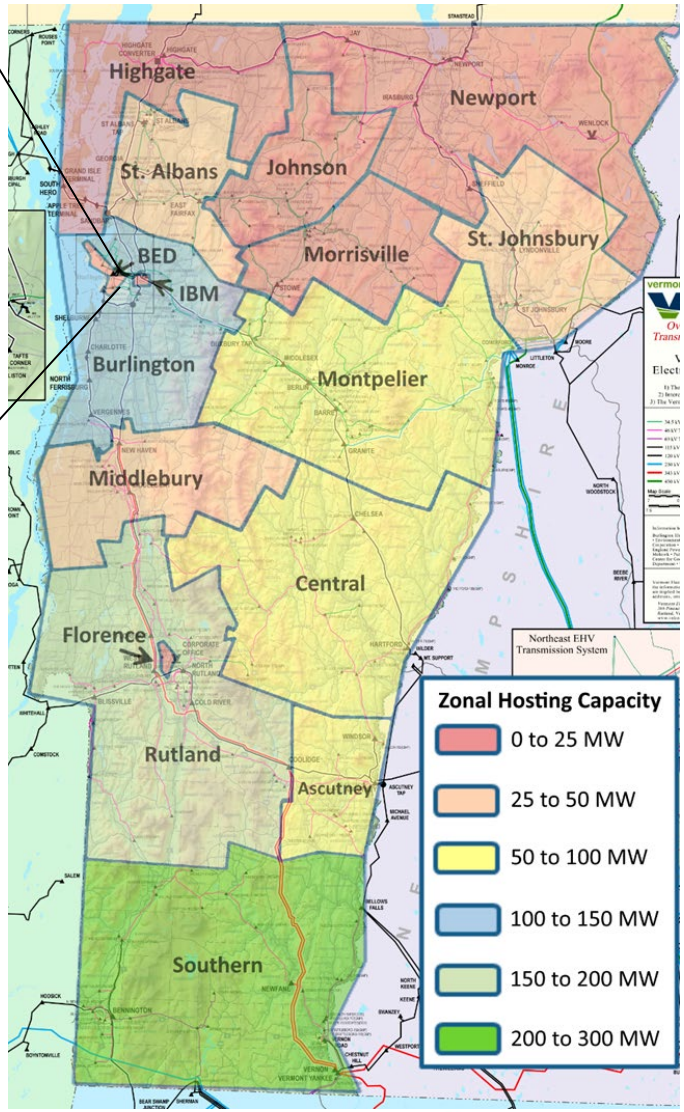


Represents newly observed overloads in 2021 analysis

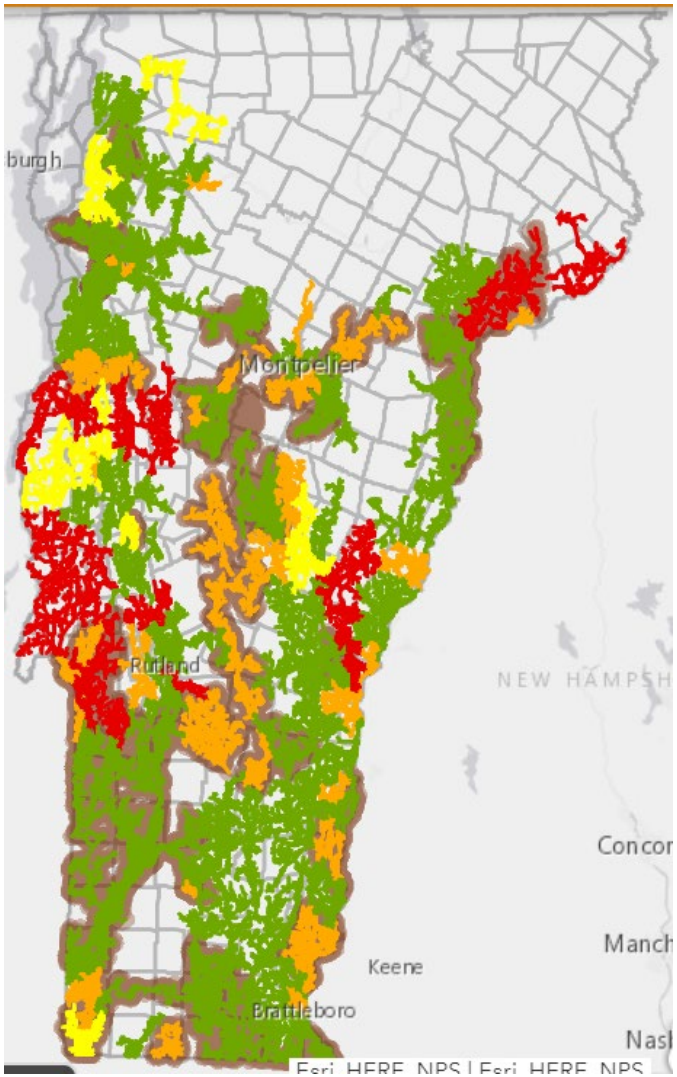
Transmission total DG zonal limits

BED additional solar PV Map





GMP additional solar PV Map

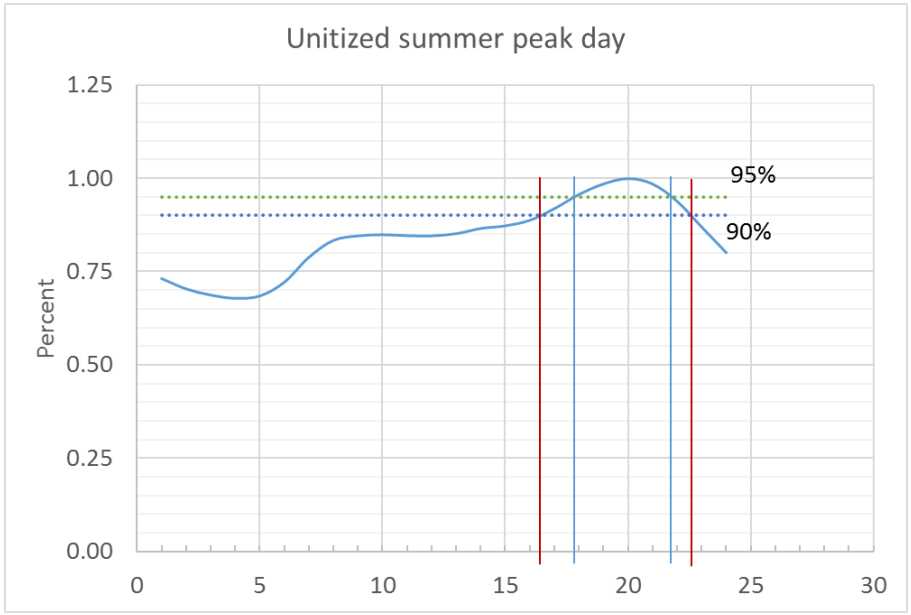


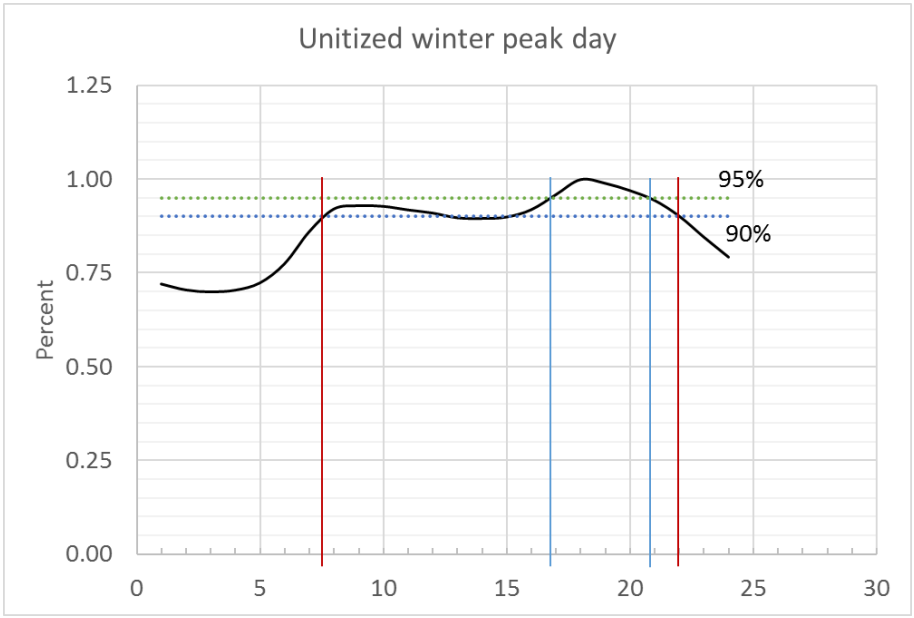
Controls to address non-optimized system concerns

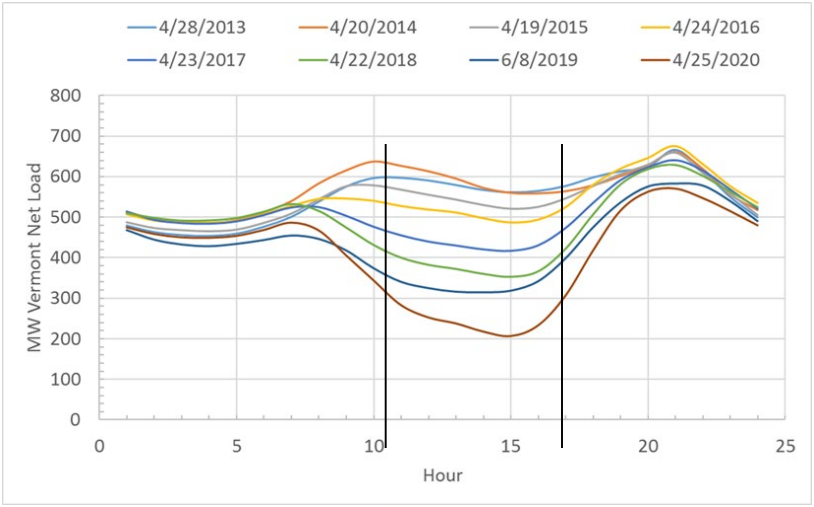
Names	Non-optimized	Optimized, no FERC projects	Excess
St Johnsbury	35.6	30	5.6
Newport	17.2	5.4	11.8
Highgate	57.9	19.8	38.1
Johnson	12.2	20	
Burlington	247.8	126.2	121.6
BED	23.7	7.5	16.2
Montpelier	90.3	76.8	13.5
Morrisville	39.9	25	14.9
Middlebury	91	50	41
Rutland	134.6	151.9	
Ascutney	59.8	73	
Southern	148.6	251.5	
St Albans	95.9	40	55.9
Central	126.9	98.7	28.2
Florence	0.6	20	
GblFoundries	0	0	
Zonal Totals	1182	995.8	**346.8**

- Estimate of storage, curtailment or load management
  - 350MW for at least 4 hours (1400 MWh)

Load shape affects storage MWh need

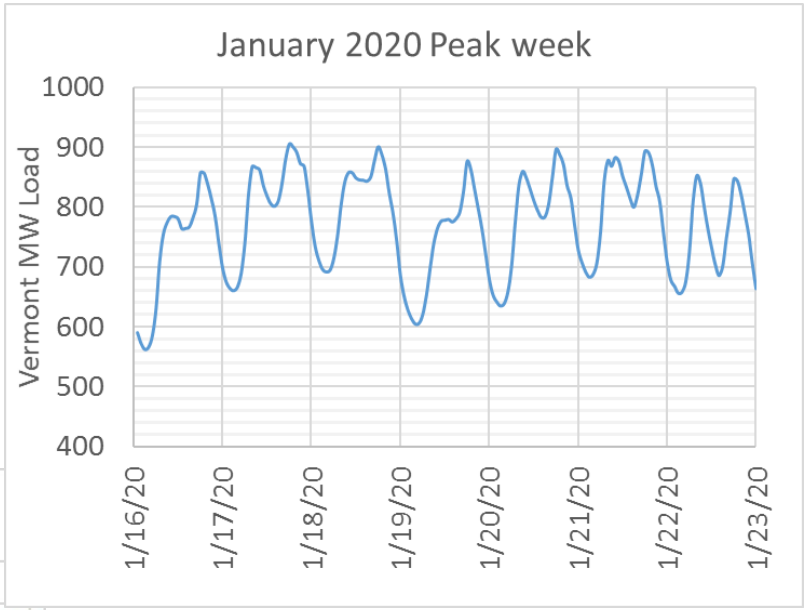


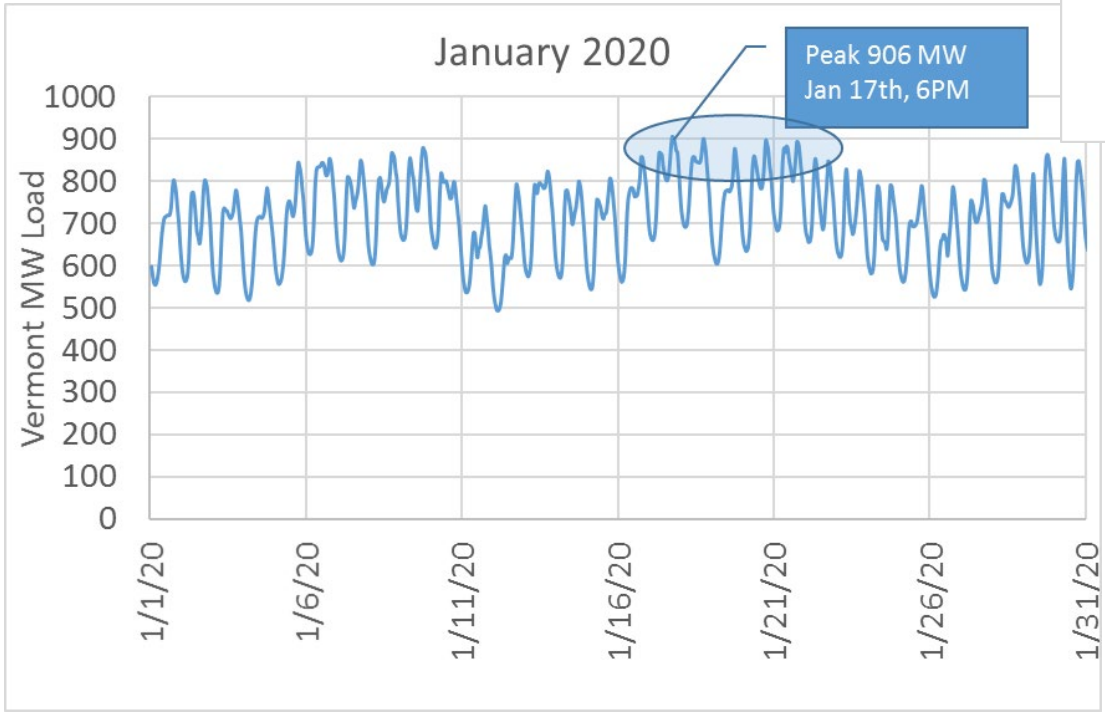




Many days and hours near the “peak”

Load level	Number of hours
At peak	1
Within 5 MW of peak	3
Within 25 MW of peak	10
Within 50 MW of peak	37
Within 100 MW of peak	132





Dark calm: an extended period of highly limited or no energy production - how long are these dark calms for Vermont solar potentially?

Dark calm examples - Vermont Solar Energy (includes snow shading)

Date	Total Daily PV Power Generation (MW)
8-Jan-19	0
9-Jan-19	0
10-Jan-19	0
11-Jan-19	0
12-Jan-19	0
13-Jan-19	0
14-Jan-19	33
15-Jan-19	28
16-Jan-19	23
Total Power	84 MW over 9 days

Date	Total Daily PV Power Generation (MW)
30-Dec-19	11
31-Dec-19	0
1-Jan-20	0
2-Jan-20	80
3-Jan-20	55
4-Jan-20	58
5-Jan-20	45
6-Jan-20	0
7-Jan-20	0
8-Jan-20	0
9-Jan-20	0
10-Jan-20	0
Total Power	248 MW over 12 days

Date	Total Daily PV Power Generation (MW)
16-Jan-20	14
17-Jan-20	0
18-Jan-20	27
19-Jan-20	63
20-Jan-20	0
21-Jan-20	0
22-Jan-20	0
23-Jan-20	60
Total Power	164 MW over 8 days

Conclusion: Solar and winter don't go together well - dark calms are often 7-14 days in duration during mid-winter. Significant implications for storage duration.

From Dr. Jay Shafer – Northview Weather

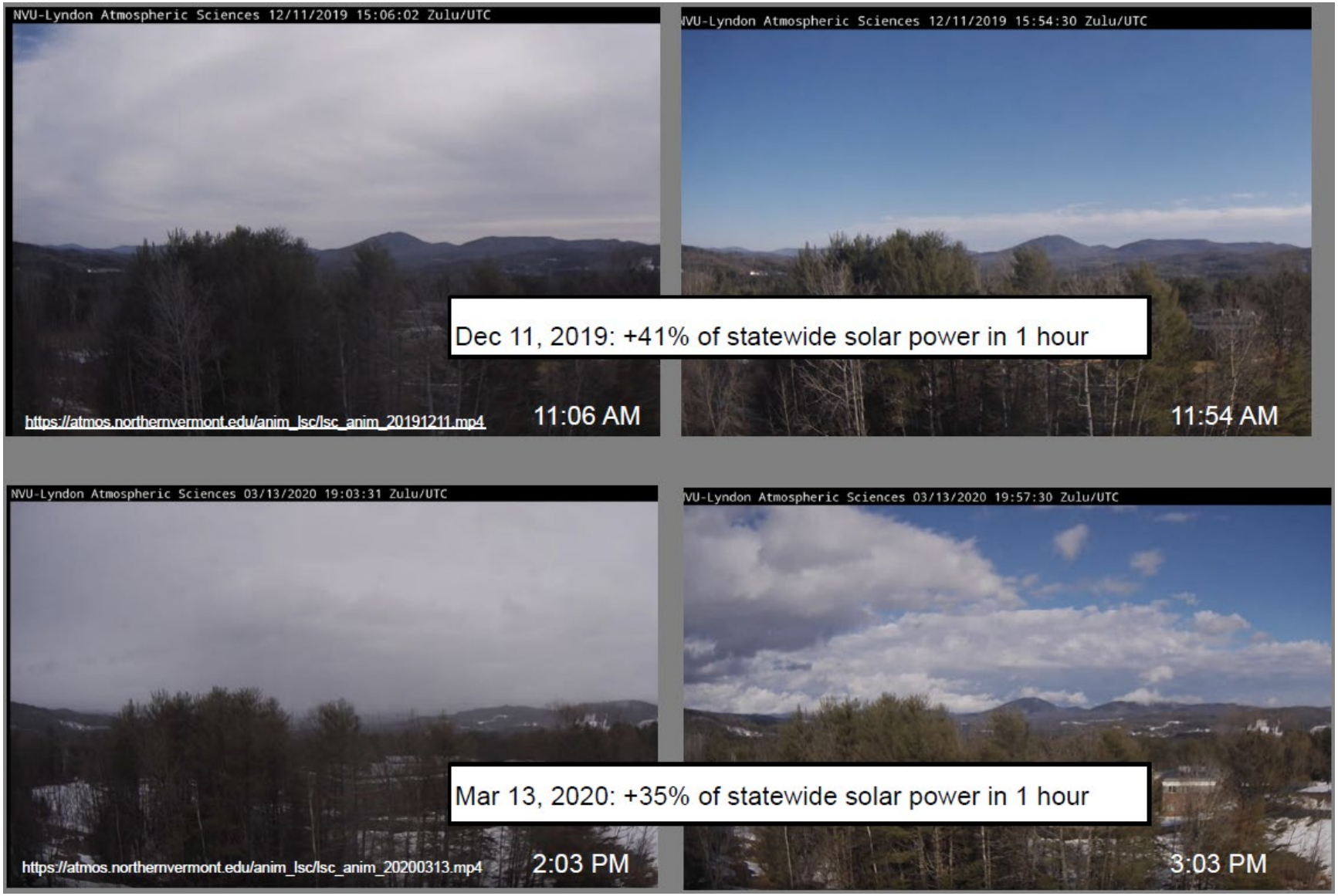
Solar Ramp: a rapid change in solar power generation, in this case most likely as a result of a fast change in cloud cover conditions.

Maximum Hourly Solar Power Generation Change as a Percentage of Overall Statewide PV Generation Capacity (2018-2020)

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Max/Min
Local Standard Time	5:00					3%	3%	1%							3%
	6:00				8%	10%	10%	9%	6%	2%					10%
	7:00		3%	16%	15%	16%	15%	15%	15%	13%	7%	1%			16%
	8:00	6%	18%	30%	29%	27%	25%	21%	24%	27%	29%	15%	5%		30%
	9:00	29%	32%	30%	30%	30%	25%	27%	26%	31%	36%	34%	23%		36%
	10:00	29%	29%	28%	35%	29%	31%	23%	30%	32%	32%	29%	31%		35%
	11:00	28%	33%	33%	25%	-29%	33%	24%	20%	31%	27%	23%	41%		41%
	12:00	25%	33%	32%	-49%	-27%	-32%	-21%	30%	27%	-20%	25%	22%		-49%
	13:00	-19%	-23%	25%	-30%	-23%	-20%	-28%	28%	23%	-25%	26%	22%		-30%
	14:00	-35%	-27%	-26%	-29%	-17%	-21%	-27%	-25%	-27%	-32%	-32%	-21%		-35%
	15:00	-31%	-36%	35%	-26%	-22%	-40%	-34%	-33%	-33%	-34%	-33%	-31%		-40%
	16:00	-40%	-32%	-30%	-32%	-35%	-28%	-25%	-29%	-29%	-28%	-29%	-26%		-40%
	17:00	-22%	-32%	-30%	-31%	-22%	-20%	-21%	-25%	-20%	-21%	-16%			-32%
	18:00		-15%	-15%	-17%	-15%	-14%	-15%	-14%	-14%	-5%				-17%
	19:00				-5%	-7%	-8%	-8%	-8%	-2%					-8%
	20:00					-2%	-3%	-3%							-3%
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Annual
	Max	29%	33%	35%	35%	30%	33%	27%	30%	32%	36%	34%	41%		41%
	Min	-40%	-36%	-30%	-49%	-35%	-40%	-34%	-33%	-33%	-34%	-33%	-31%		-49%

These percentages would scale with rated system size. Thus, 1000 MW would result in hourly PV generation up to 400-500 MW per hour when spatially aggregated across Vermont.

From Dr. Jay Shafer – Northview Weather



From Dr. Jay Shafer – Northview Weather

Next outreach steps

- Continue direct, key stakeholder discussions
- Two virtual public meetings
  - Wednesday, April 28, 11am – 1pm
  - Wednesday, May 5, 5pm – 7pm
- Incorporate public comments in report
- Submit report to VT Public Utility Commission by July 1, 2021