

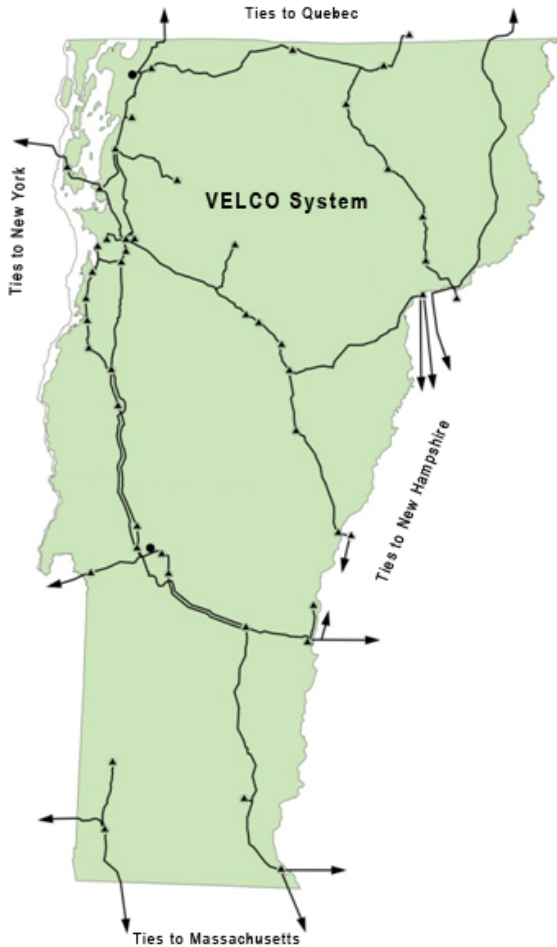
Northern VT Limits and Potential Solutions

vermont electric power company



Chris Root
April 21, 2016

Vermont now imports most of its power



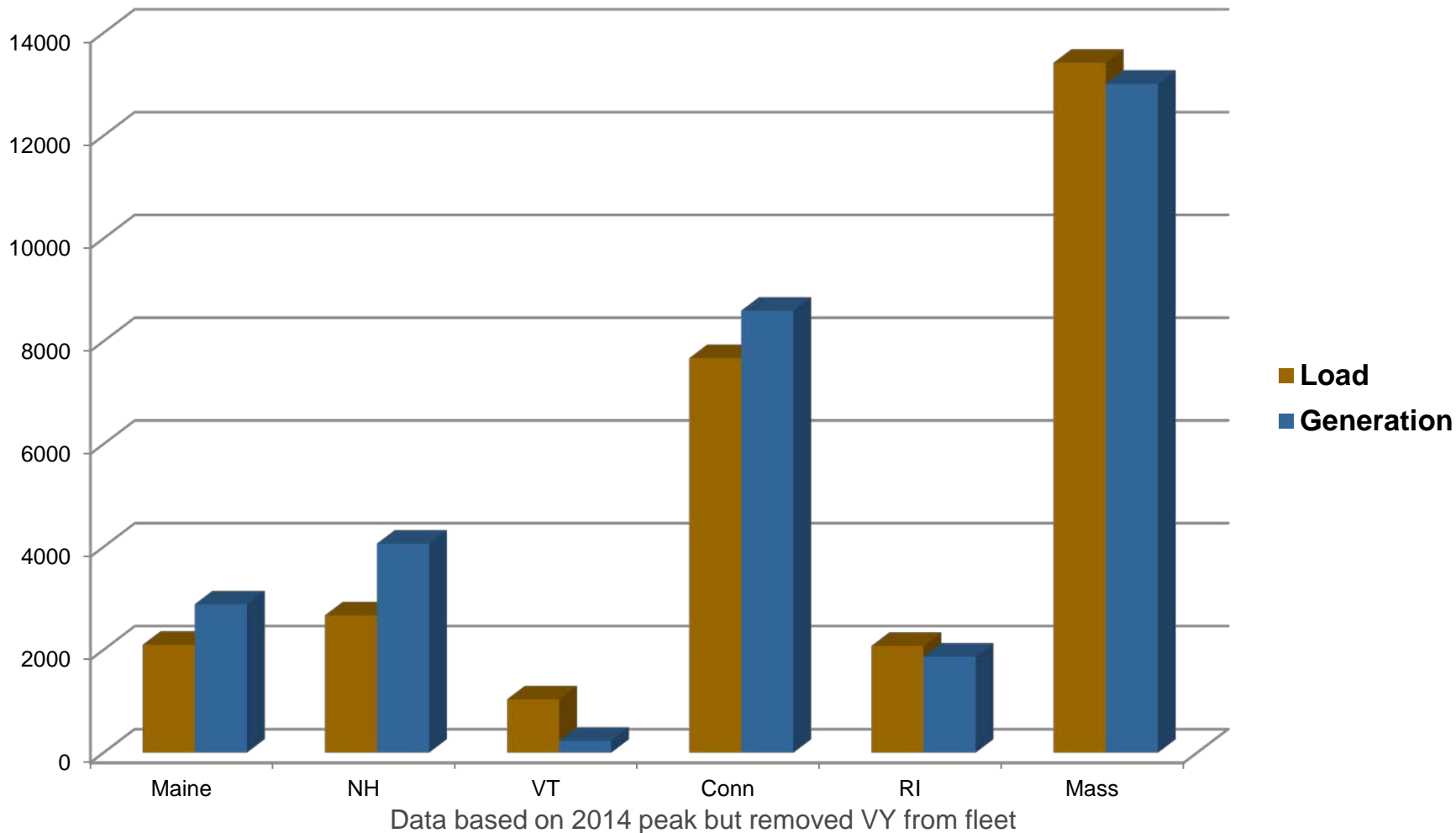
Type		MW 2014	MW 2015
Fossil (fast start units)	Winter	188	188
	Summer	138	138
Hydro		152	152
Wind		123	123
Landfill gas		9	9
Biomass (wood)		72	72
Nuclear		625	0
Solar and other, e.g. methane		~100 and growing	~100 and growing
TOTAL IN-STATE GENERATION		1265	640

73% of 2014 hours VT was exporting power

84% of 2015 hours VT imported >400 MWs

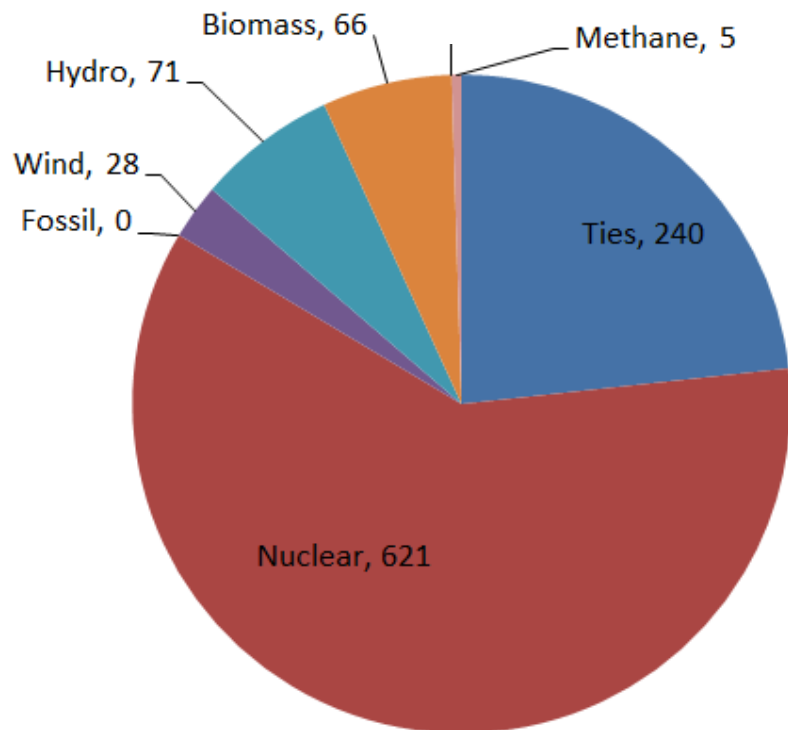
Generation and load by state (2015)

Vermont is the only New England state that has a major generation vs. load deficit

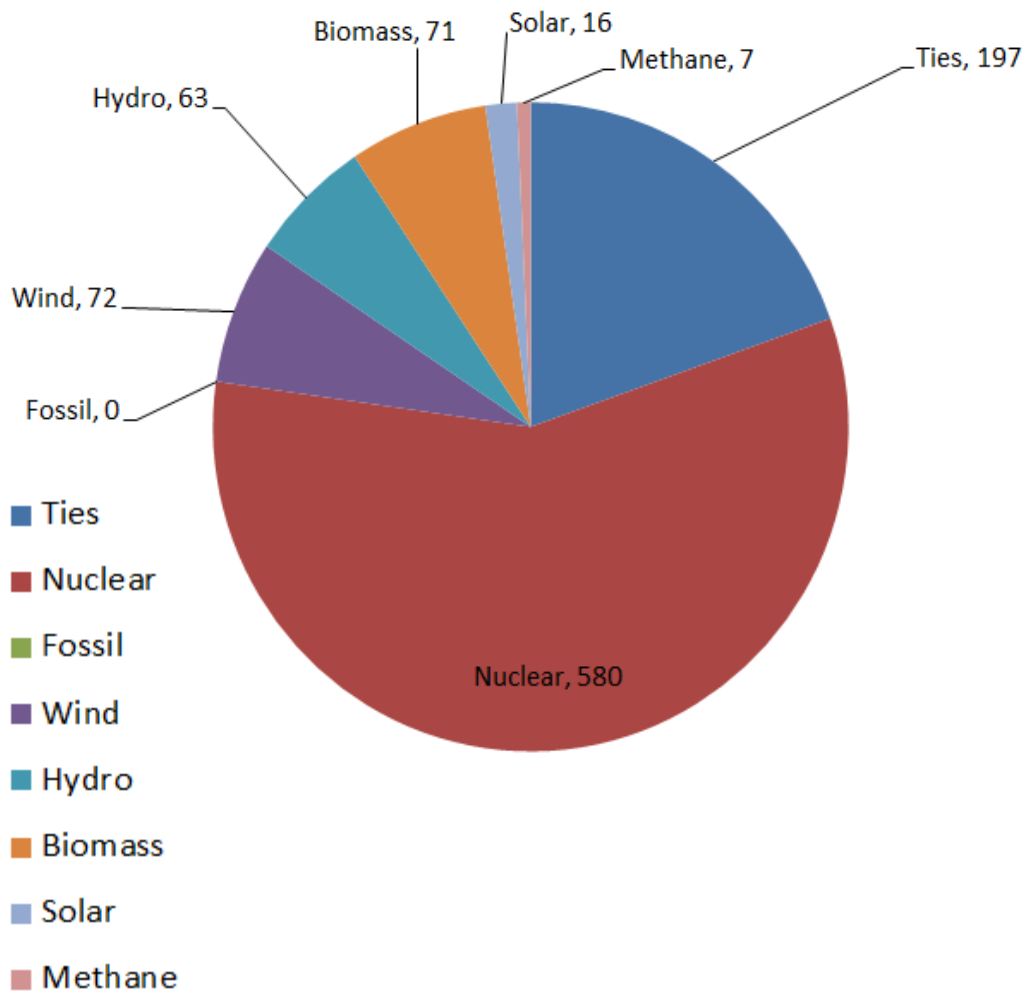


2014 Vermont peak days

- 2014 **winter** peak day (1/2/14 18:00)
- Load was 1,029 MW



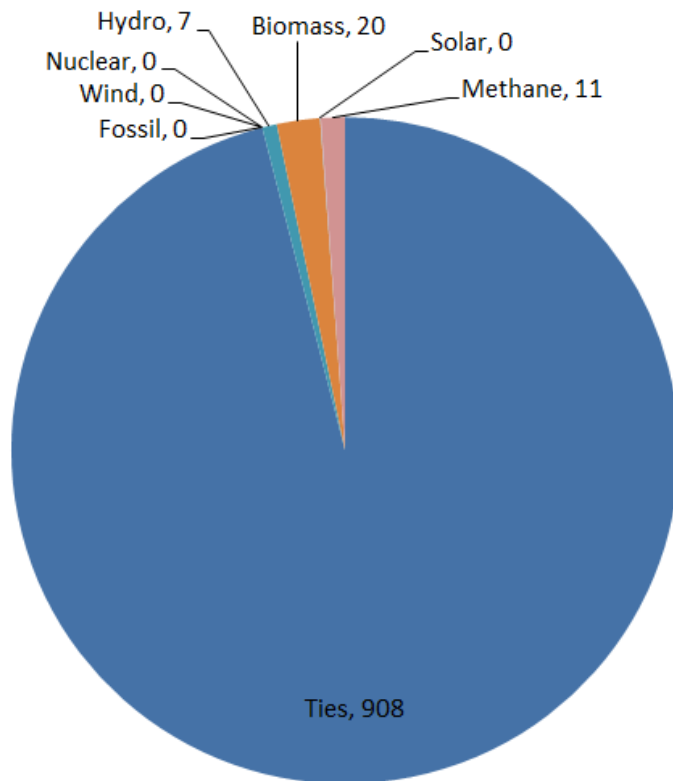
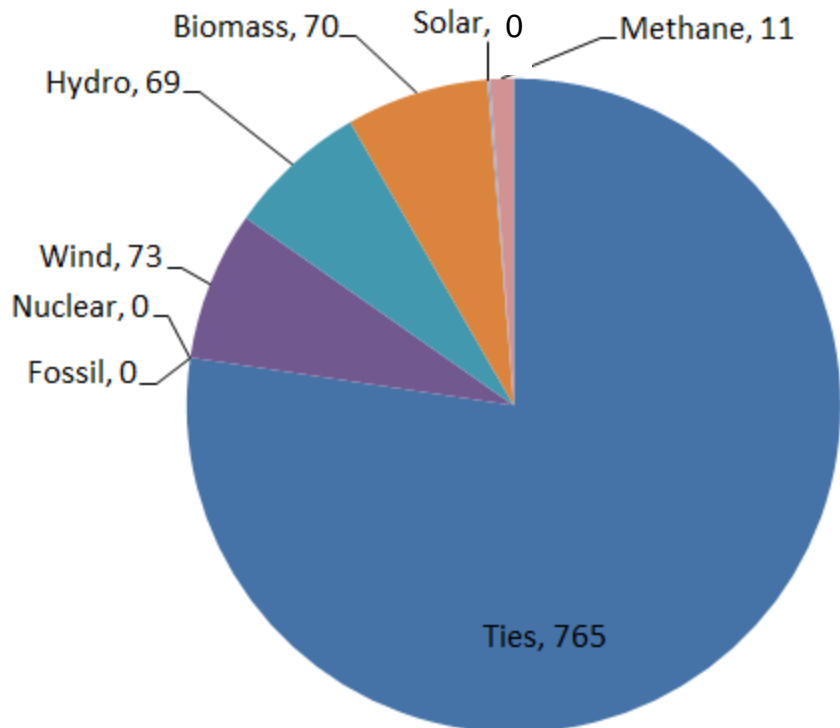
- 2014 **summer** peak day (7/2/14 12:00)
- Load was 1,006 MW



2015 Vermont peak days

- 2015 **winter** peak 1/8/15 18:00
- Load = 989.6 MW

- 2015 **summer** peak 9/8/15 20:00
- Load = 945.1 MW



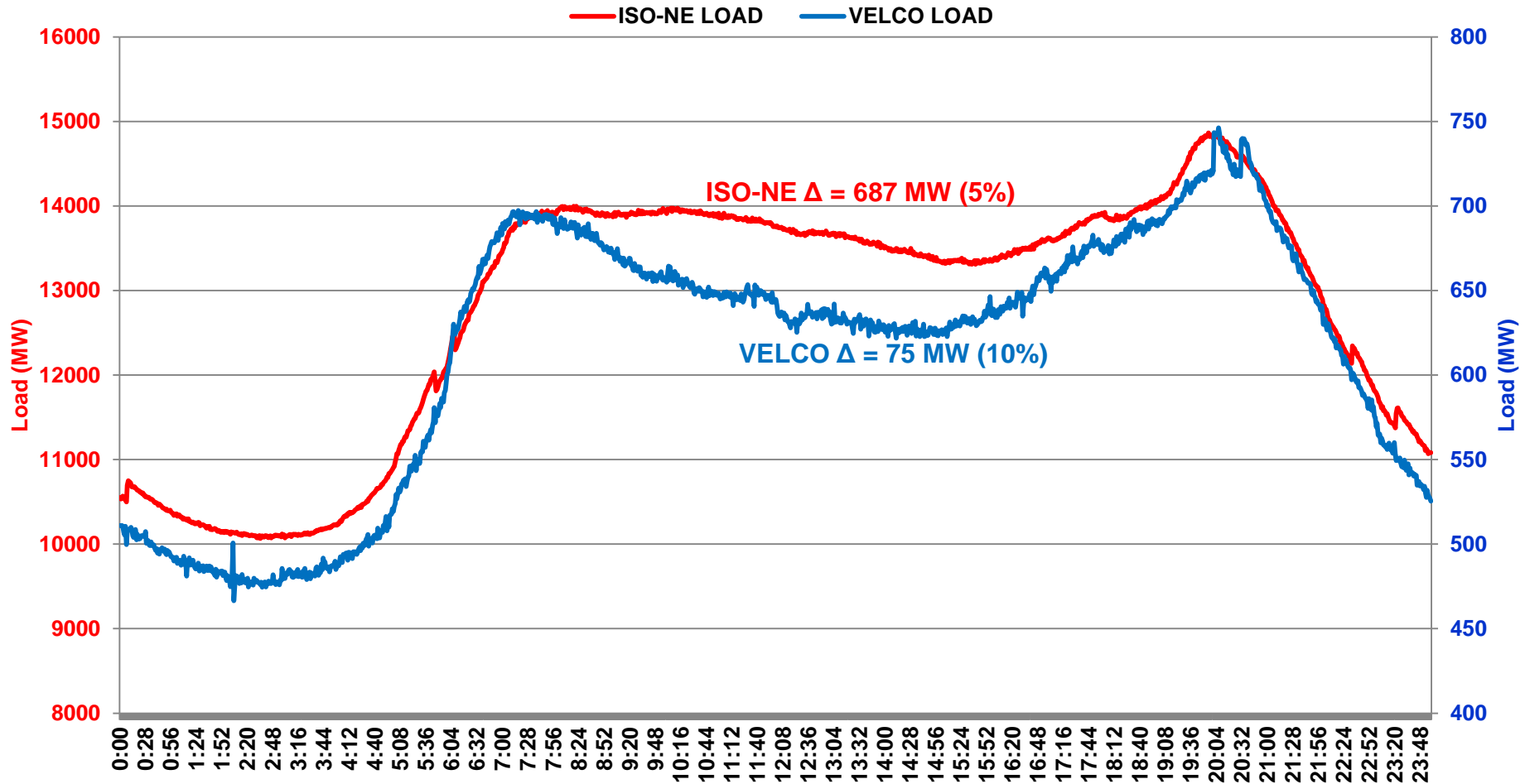
- Ties
- Nuclear
- Fossil
- Wind
- Hydro
- Biomass
- Solar
- Methane

Solar impact on New England vs Vermont

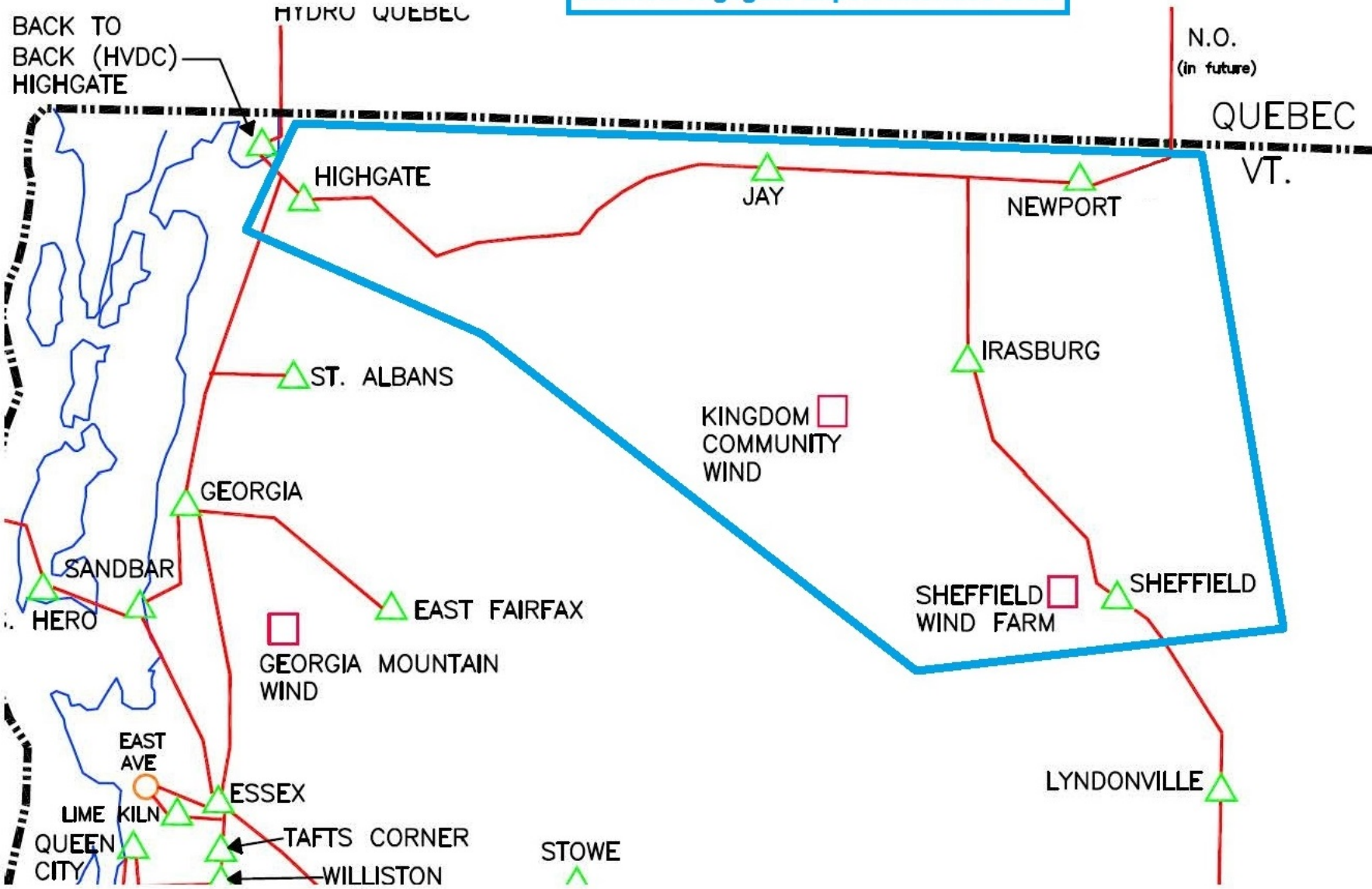
Case 1: Peak Solar Day (4/13)

Vermont's peak load reduction from solar is twice that of ISO-NE's

VELCO vs. ISO-NE Load Curve 4/13/2015 (Tuesday)



Sheffield Highgate Export Interface area

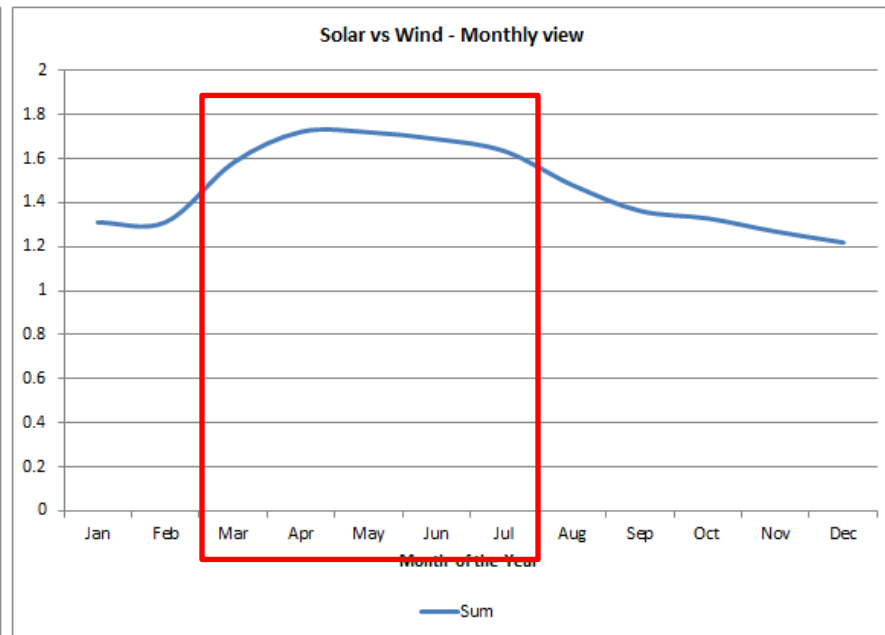
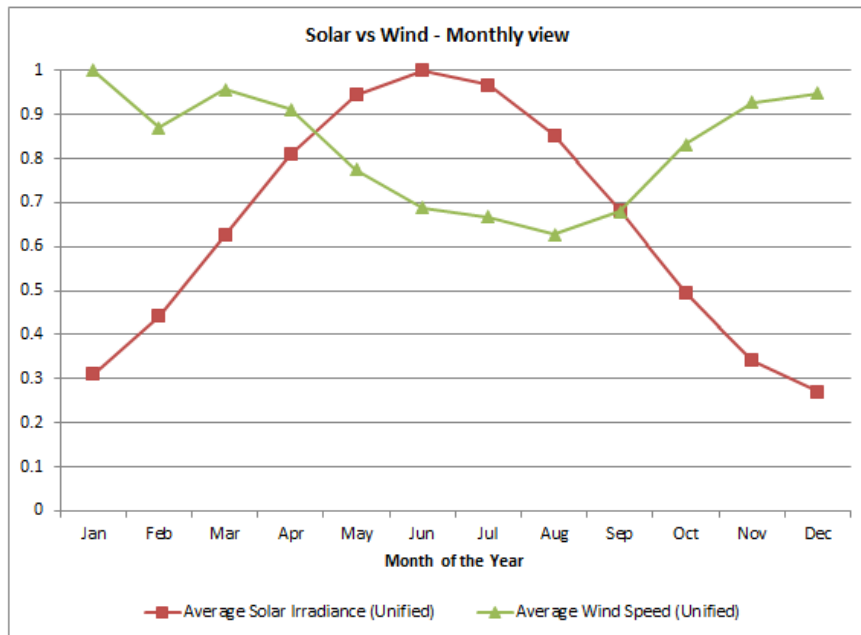


Implications of transmission constraints

- There are many constraints within Vermont
 - NW imports
 - NY/VT imports
 - Generally these are not an issue
- SHEI export constraint – is an issue in curtailing wind generation periodically
 - Reliability will always be maintained
 - 87% of generation limits relate to ISO-NE dispatch orders
 - Other limits relate to sound, weather, service
 - Curtailments: generation limits resulted in lost production 13% of the time

Quantifying curtailment

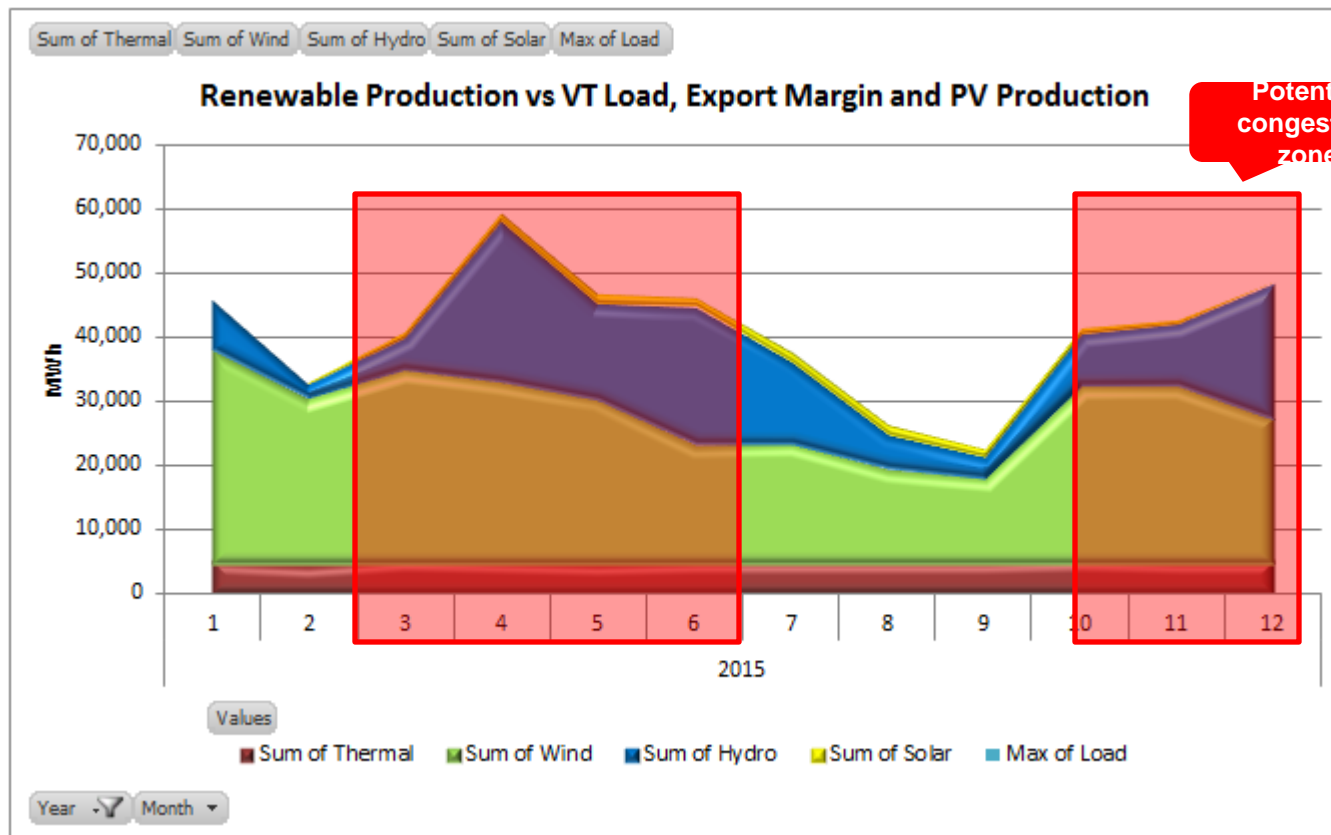
Solar versus Wind – Monthly view



In a capacity constrained system there is a higher likelihood of conflict in March to July

Quantifying curtailment

What other factors could be contributing to curtailment?



Independent transmission impacts

- Anbaric/National Grid VT Green Line—400 MW connecting at New Haven
 - ISO-NE study on-going
 - Potential upgrades to GMP and VELCO systems
 - Possible impact to VT generation dispatch
- TDI's NE Clean Power Link—1000 MW connecting at Coolidge
 - ISO-NE interconnection study started
 - Potential upgrades to GMP and VELCO systems
 - Interaction with VT Green Line reinforcements
 - Possible impact to VT generation dispatch

VELCO has been exploring solutions to SHEI constraint

- **Energy Storage**
 - Size and economics are still an issue
 - **Operational changes**
 - Utilization of reactive capability of existing machines
 - Removal of under-frequency load-shed scheme of Highgate (needs PSB approval)
 - Other small changes in multiple areas that can increase limit incrementally
 - **System upgrades**
 - Add a new 17-mile 115 kV line
 - Rebuild B20 (GMP)
- * *Note that these solutions are not related to system reliability
- Cost will be borne by beneficiaries (state, generators, DU's)
 - Who selects the solution and who pays?

Storage solution development

- Multiple technologies
 - Pumped storage hydro
 - Flywheels
 - Compressed air
 - Battery systems
- Different solutions for different problems
 - MW vs. MWh
- Many projects still in demonstration stages
- VELCO and other utilities studying storage options
- Storage is not viable if used only for congestion relief
 - Multiple revenue sources needed to improve economics
 - May be an effective solution for some distribution constraints
- Is storage generation, distribution or transmission?

Summary

- VT is very dependent on others for peak generation
- Solar is pushing peak hour to after dark
- Hydro not solar impacts wind generation
- There are some low-cost options to be explored by VELCO, DUs and ISO-NE to reduce constrained generation and potentially act as a long-term solution
- Independent transmission projects could lead to other constraints that could impact VT generation