



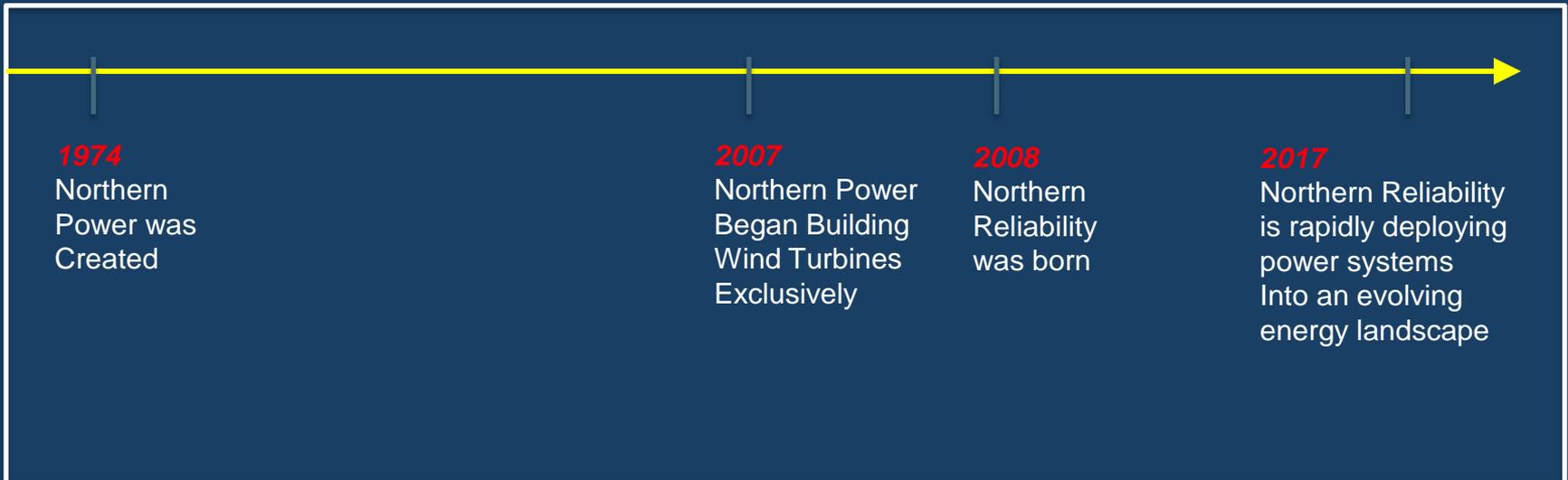
# Energy Storage Discussion

# Our Story



The NRI story begins over 40 years ago when Northern Power Systems was created. The NRI engineering team, while at Northern Power, built and installed over 1,000 power systems and Microgrids in 40 countries around the globe.

When Northern Power moved into exclusively large wind turbines, those engineers specializing in storage and renewable Micro-grid integration were dismissed, and **Northern Reliability** was born.



# Grid Impacts of High Solar Penetration



The forecast in 2011, was the higher the penetration of renewables, the larger the disruption to normal grid operation.

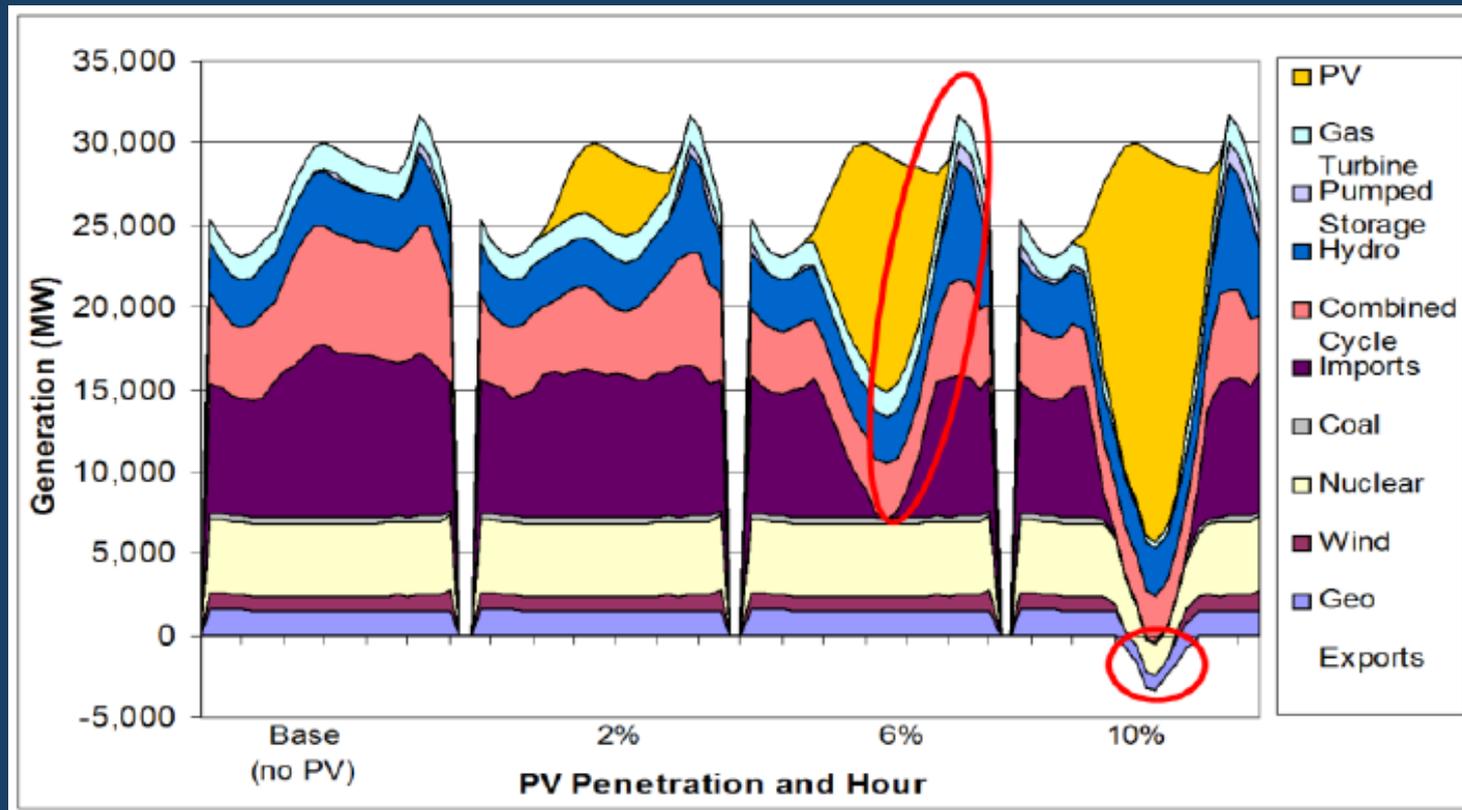


Chart Source: P. Denholm and M. Mehos, "Enabling Greater Penetration of Solar Power via the Use of CSP with Thermal Energy Storage," 28 pp. NREL Report No. TP-6A20-52978, 2011.

# A Regional View of the Grid Impacts of Solar

## Vermont Weather Analytics Center Renewable Integration

	3/30/2015 (Mon)	3/31/2015 (Tue)
Cloud Cover	Overcast	Sunny
High/Low (°F)	41/26	42/24
Max Radiation (w/m <sup>2</sup> )	241	965

2 weekdays with similar temperatures but large differences in cloud cover

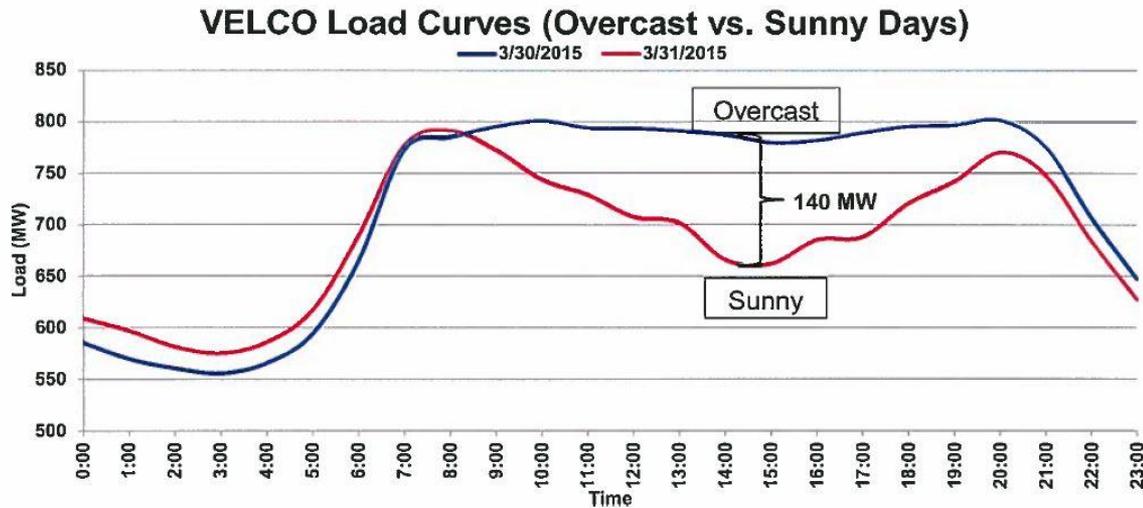


Chart Source: VT State of the Grid presentation by Chris Rot, Chief Operating Officer VELCO, to REV board 4/21/2016.

# 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)

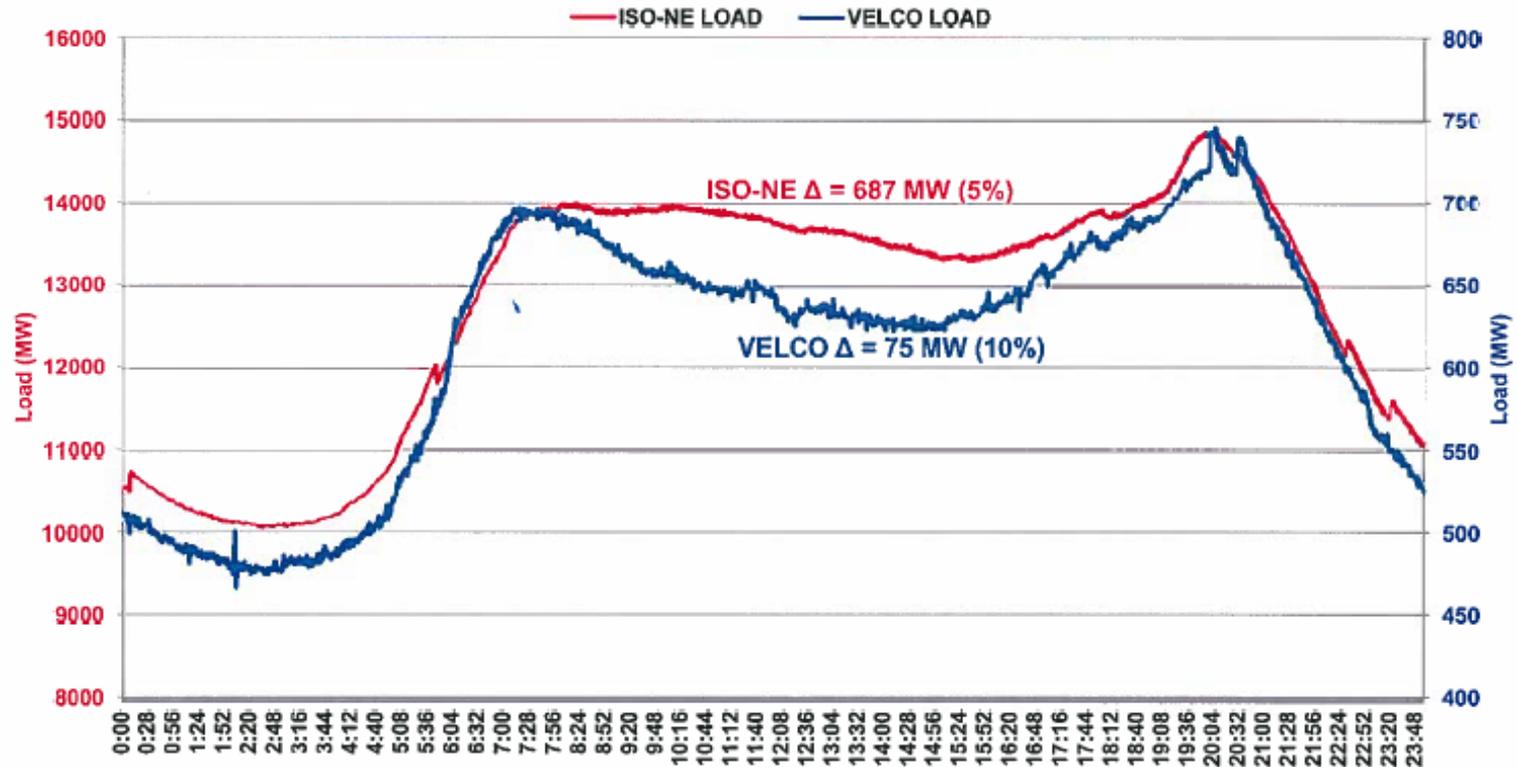


Chart Source: VT State of the Grid presentation by Chris Rot, Chief Operating Officer VELCO, to REV board 4/21/2016.

# Utility Scale Applications

## 500kWh – 10MWh+



- Generally installed adjacent to substation, at renewable generation site, or in proximity to large customer loads.
- NRI financial modeling
- Container or Structure housing depending on customer application and permitting
- Multiple modes of operation to allow a single system to capitalize on revenue stacking



# NRI System Controllers Modes of Operation



Northern  
Reliability

## Power Quality Management

- Frequency Regulation
- Voltage Regulation

## Peak Demand Reduction

- Utility Scale Monthly and Annual Capacity & Transmission Reduction
- Commercial application for removing large start-up loads and associated demand charges

## Energy Arbitrage

- Charges during low cost periods and discharges during high cost periods based on utility Rate schedule

## Islanding / Microgrid Operations

- Allows system to operate as a stand-alone power supply disconnected from the grid.

## Peak Shaving / Peak Shifting

- Eliminates “ratchet charges” for commercial customers
- Moves PV energy from the daytime generation peak to the late afternoon/evening consumption peak.

## Fleet Management

- Allows a multiple DES systems to function in unison to fulfill an objective



***For more information, please contact:***

Gregg R. Noble – Director of Sales  
802-496-2932  
[gnoble@northernreliability.com](mailto:gnoble@northernreliability.com)

Charles “Charlie” Van Winkle  
802-496-2927  
[cvanwinkle@northernreliability.com](mailto:cvanwinkle@northernreliability.com)