Vermont Solar Development Pathways

Vermont Systems Planning Committee

January 20th, 2016

Vermont Energy Investment Corporation

Overview and Objectives

- Project Overview
  - Solar and Distributed Resources as Key Elements in Meeting Vermont's *Comprehensive Energy Plan* Goals
  - Partners Vermont Department of Public Service and Regulatory Assistance Project
- Project Objectives
  - Convene and engage stakeholders to inform analytically based discussions and report on how Vermont can move from a developed to advanced saturation solar market in the coming decade

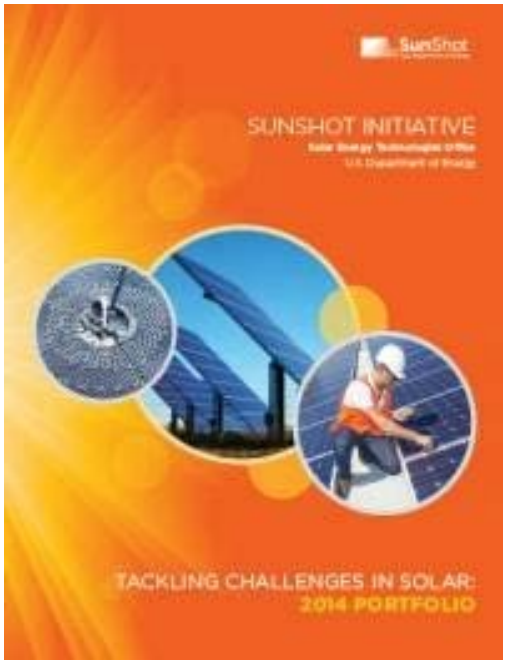
Sun Shot Initiative

- Launched 5 years ago

  More than $500 million for 350+ projects

  - PV
  - CSP
  - Balance of system (soft costs)
  - Systems integration
  - Tech to market

  Objectives to reduce costs of solar to $0.06 / kWh by 2020



“Developed to Advanced” Solar Market

- Solar growth: 10x in the coming decade
- By 2025, 20+% of total electric supply from solar
- Engineering, operational, regulatory, and business model challenges
- How does solar at these levels relate to Vermont’s total energy economy?
  - Costs/Benefits
  - Relation to CEP and other goals

Ferrisburgh Solar Farm, www.lwseddon.com

Accomplishments to Date

- Five Stakeholder meetings, group has grown over 70% through referrals (next meeting in March 2016)
- Created a model of the state's total energy system with different scenarios for the future
- Focus Area Briefs
- Integration and Barriers Brief
- Identification of Priority Analyses

Looking Forward

- Priority Analyses
- Cost/benefit analysis
- Final revised scenarios
- Solar Market Pathway Report
- Implementation support and further research (2017)

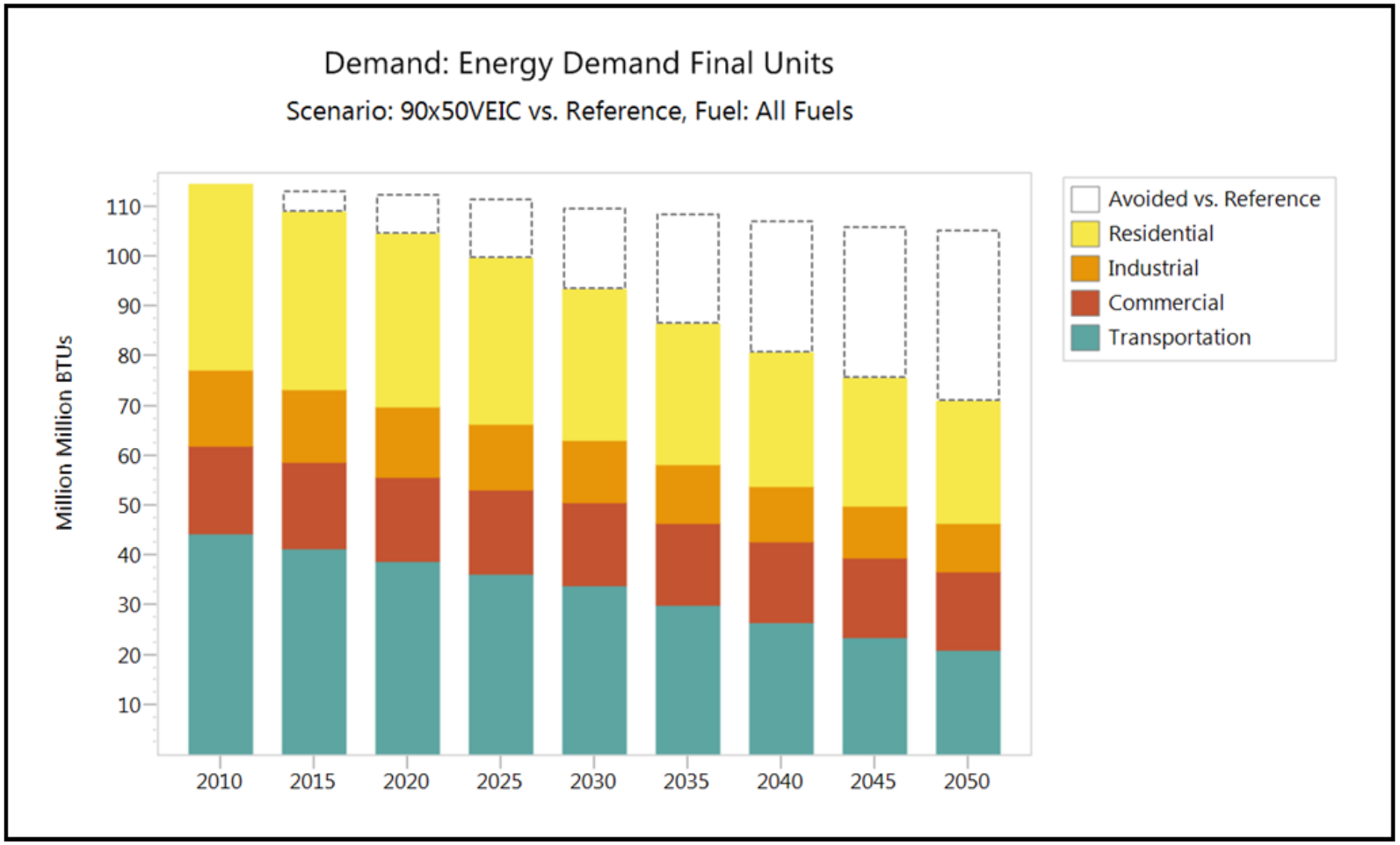
Our Vocabulary

1. Comprehensive Energy Plan Targets:
   - 90% of Vermont's Total Energy from renewables by 2050
2. Scenarios:
   - Current Accounts, Reference, 90x50$_{VEIC}$, SDPα
3. Focus Areas:

LEAP System

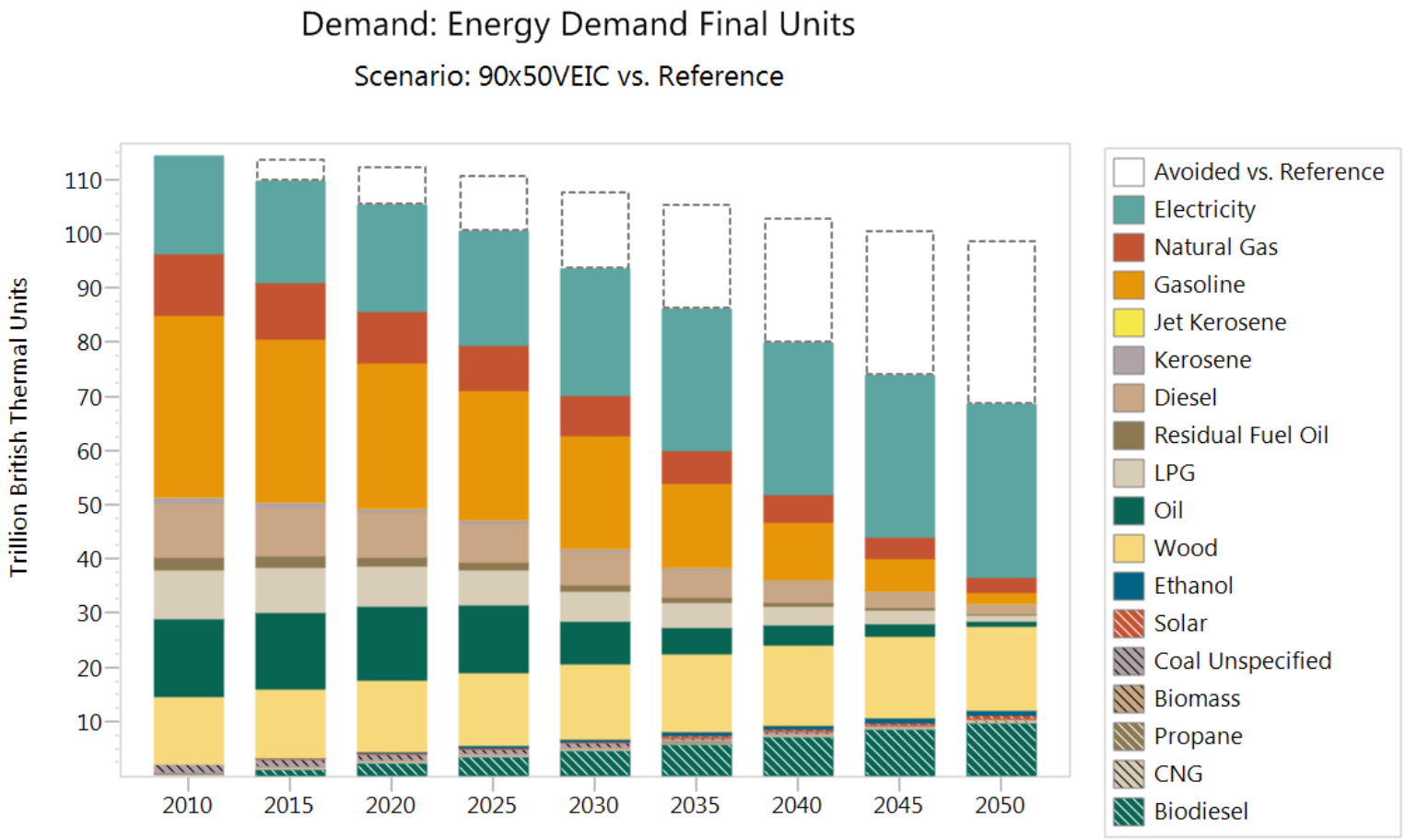
- **L**ong-range **E**nergy **A**lternatives **P**lanning System
- Developed / maintained by Stockholm Environment Institute
- Decades of application and development in > 190 countries worldwide
- Scenario based: “self-consistent story lines of how an energy system might evolve over time”; well suited for regional and targeted technology (Solar Development Pathways) analyses
- Transparent accounting framework

Efficiency Reduces Total Energy Across Sectors



Heaps, C.G., 2012. Long-range Energy Alternatives Planning (LEAP) system. [Software version 2014.0.1.20] Stockholm Environment Institute. Somerville, MA, USA. www.energycommunity.org

Share of Fossil Declines Significantly

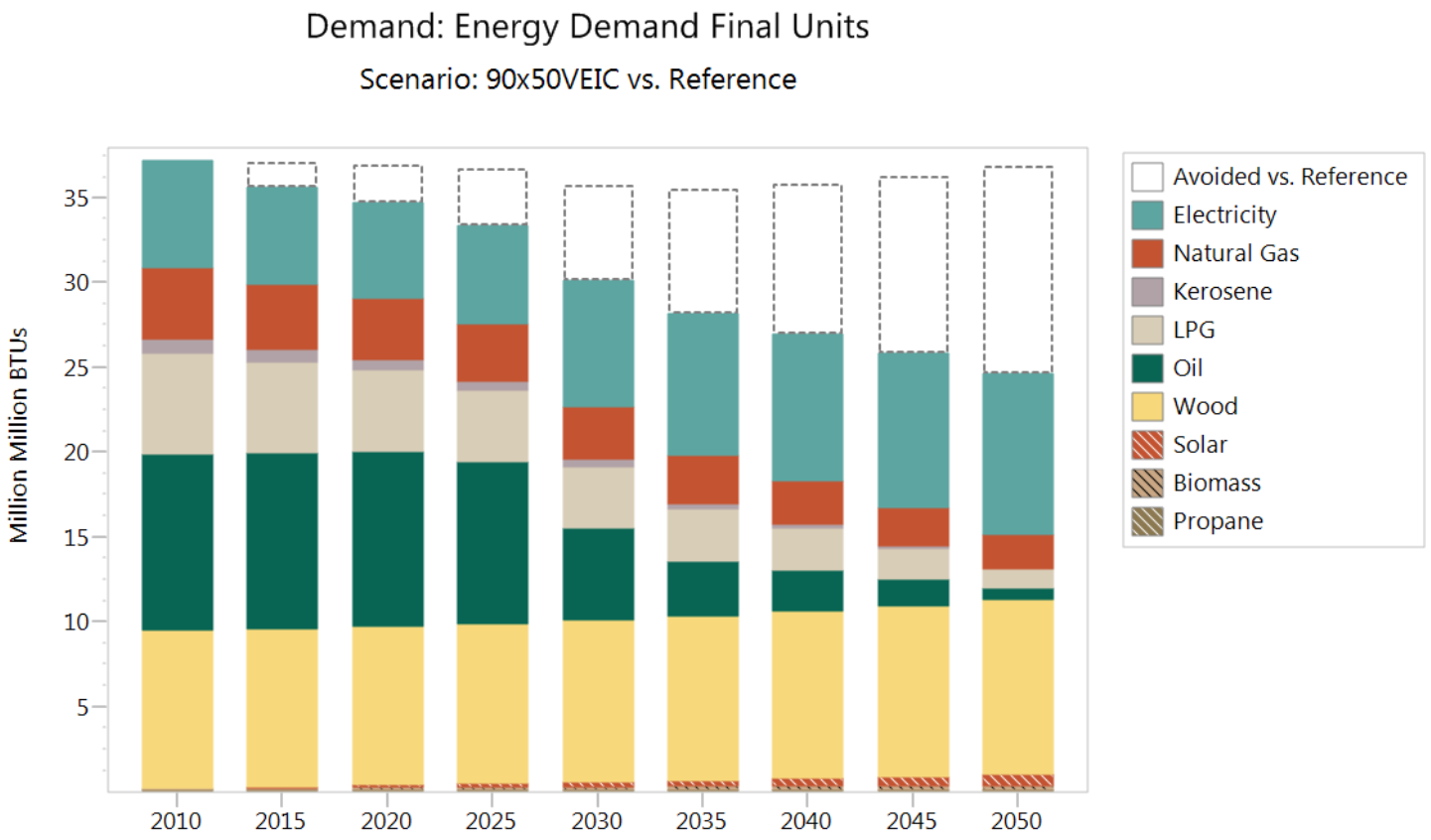


Vermont Energy Investment Corporation

Heaps, C.G., 2012. Long-range Energy Alternatives Planning (LEAP) system. [Software version 2014.0.1.20] Stockholm Environment Institute. Somerville, MA, USA. www.energycommunity.org

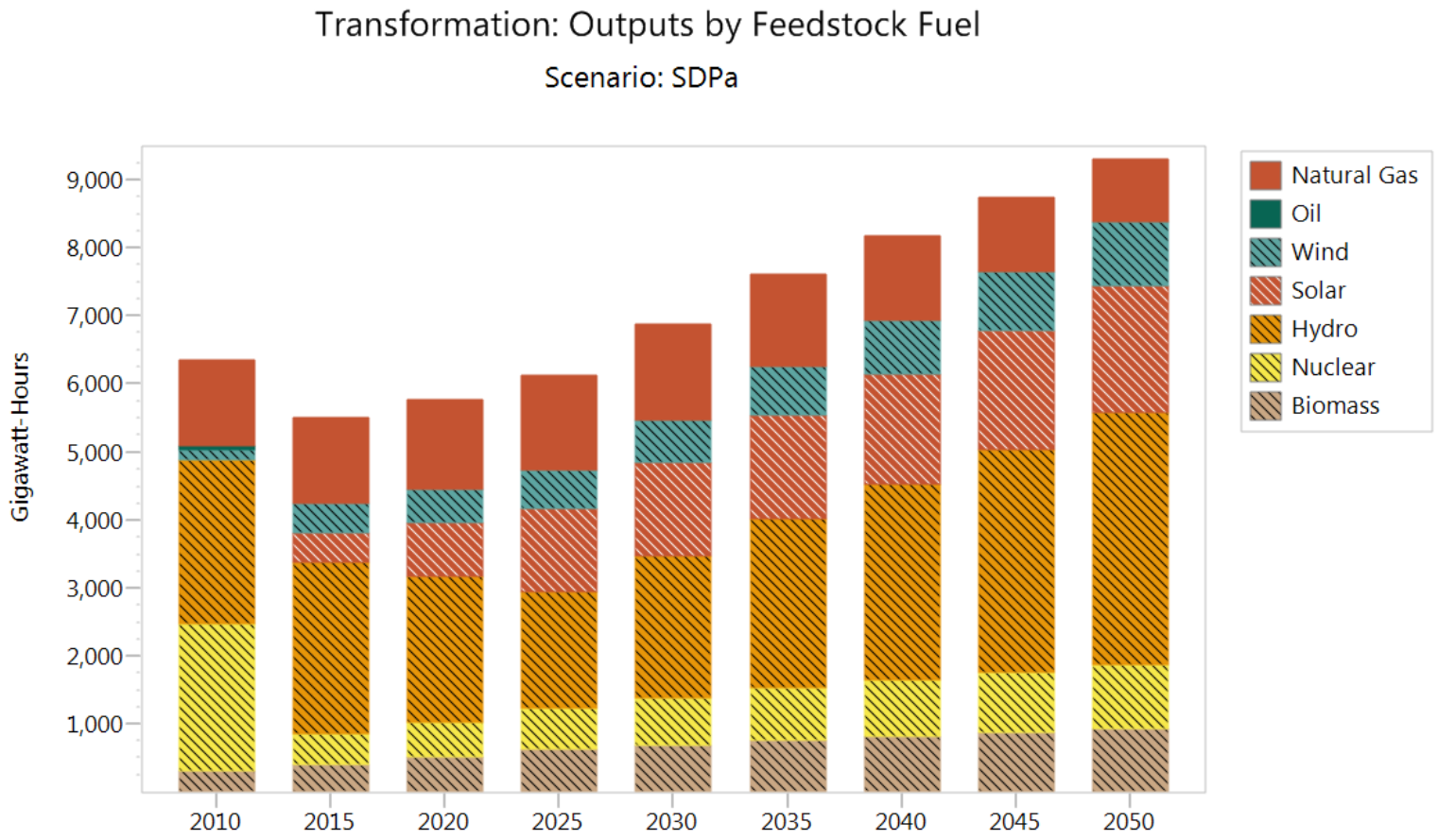
Powered by SunShot U.S. Department of Energy

Residential Demand – Efficiency and Electrification



Heaps, C.G., 2012. Long-range Energy Alternatives Planning (LEAP) system. [Software version 2014.0.1.20] Stockholm Environment Institute. Somerville, MA, USA. www.energycommunity.org

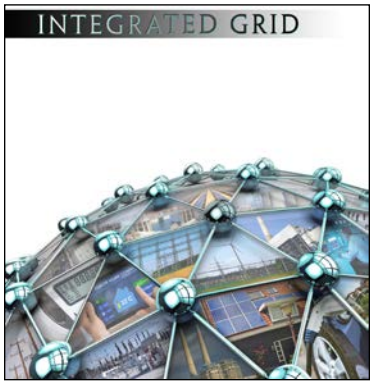
Growing Solar & Electric Consumption



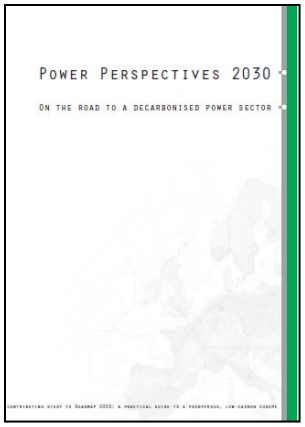
Heaps, C.G., 2012. Long-range Energy Alternatives Planning (LEAP) system. [Software version 2014.0.1.20] Stockholm Environment Institute. Somerville, MA, USA. www.energycommunity.org

Integration and Barrier Brief

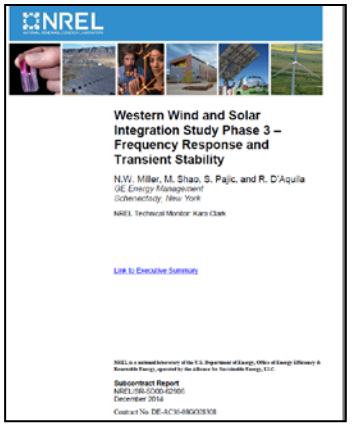
- Literature Review
- Technical
  - Distribution Hosting Capacity
  - Bulk Power System
  - Storage, Demand Response, Other Distributed Resources
- Policy and Regulatory
  - Siting
  - Allocation
  - Rates and Cost Recovery
- Business Models
  - Aggregation
  - Communications and Controls



EPRI, Integrated Grid Benefit Cost Framework February , 2015.



Power Perspectives 2030: On the Road to Decarbonized Power Sector



NREL Western Wind and Solar Integration Study

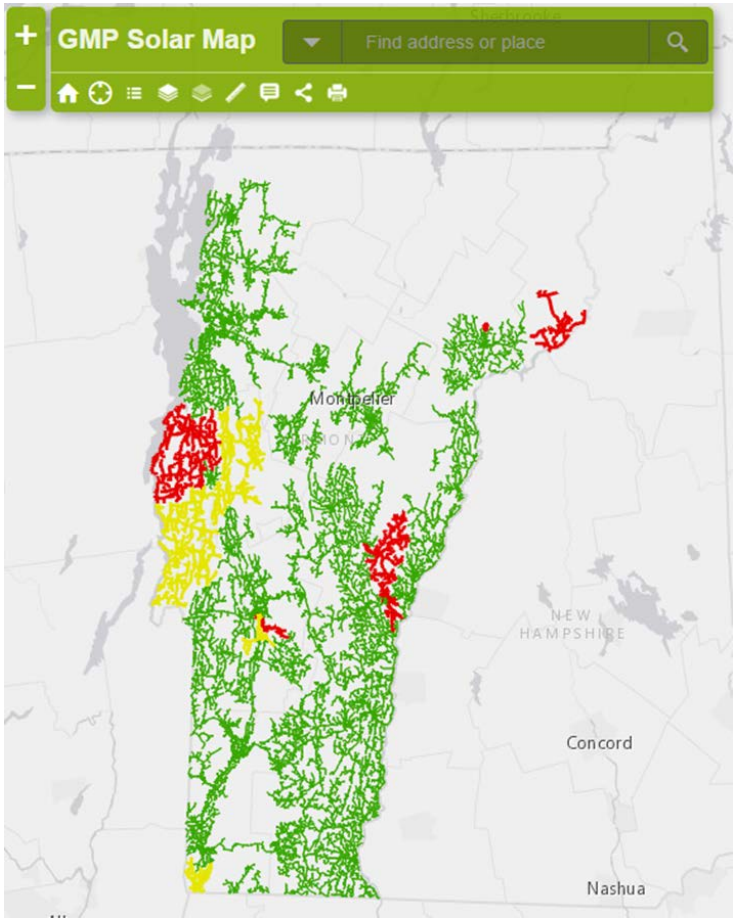
Priority Analyses

- Appreciate and complement the ongoing work and initiatives
- Contribute to enhanced understanding of challenges and opportunities for high saturation DER planning
- Not a replacement for detailed engineering analyses and processes (e.g. solar map)
- Used in report to provide insight into the nature, depth, process and outcomes of analyses
- Draw on literature and work by the DU's and VELCO
- Technical assistance through DOE and Labs may be available
- VEIC and team members are not electrical engineers

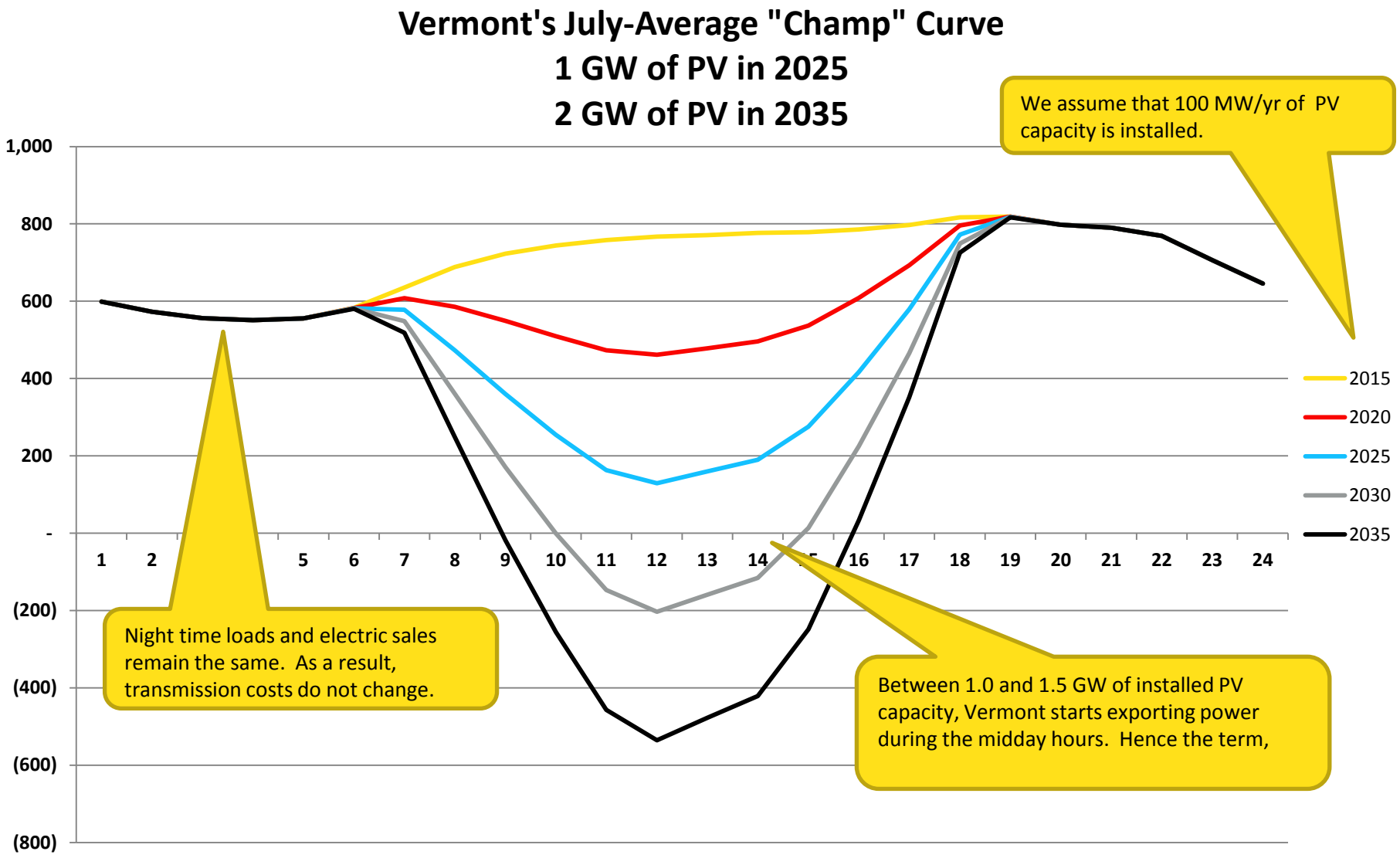
Scales of Analysis

- Distribution
  - System characteristics
  - Hosting capacity
  - Visibility and location of new DER
- Sub-transmission
  - Substations and hosting capacity
  - Dedicated Feeders to substations

- Bulk Power System:
  - Resource adequacy and expansion
  - Resource flexibility
  - Transmission expansion
  - Operational scheduling and balancing



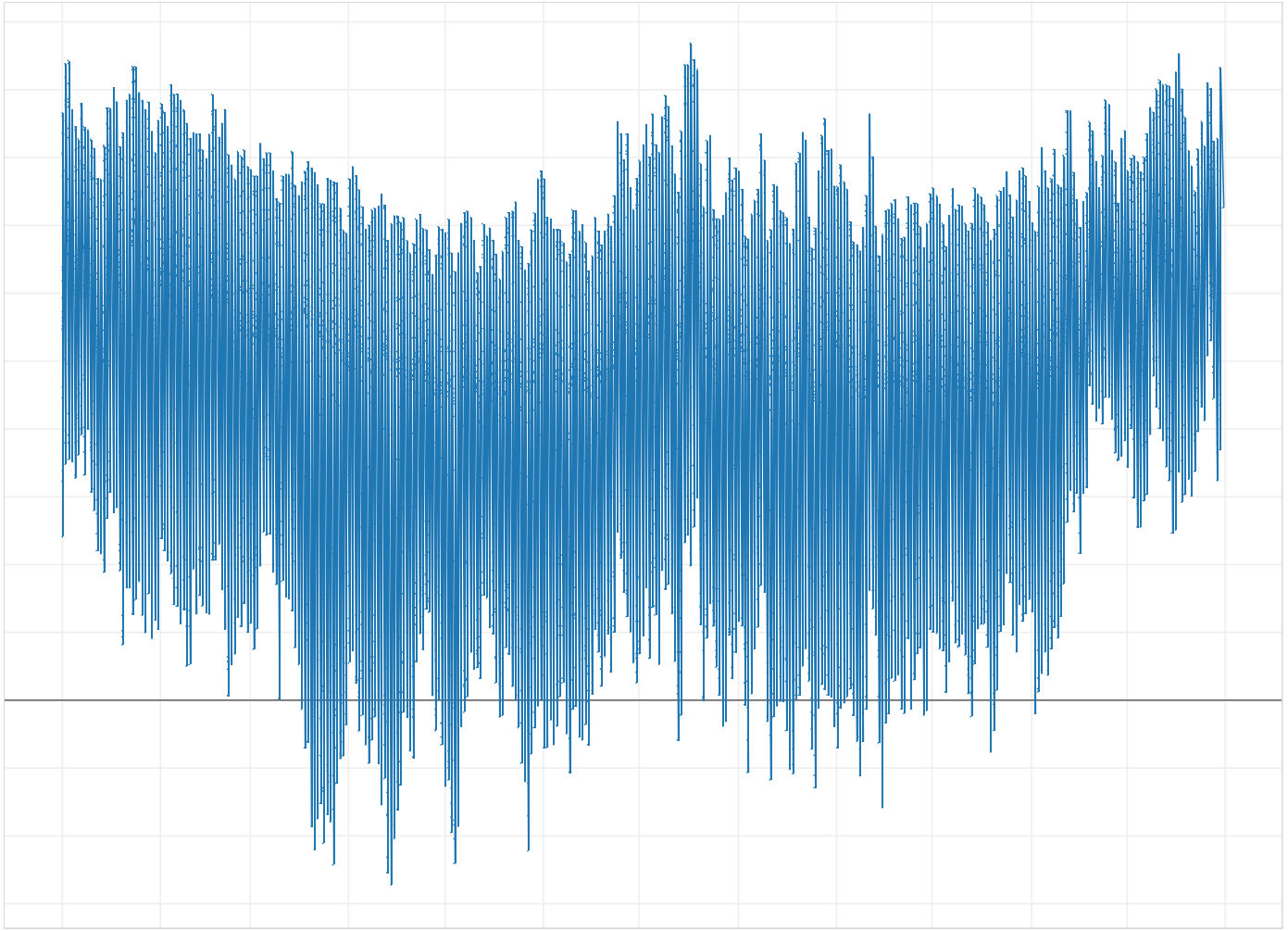
Vermont Champ Curve



Vermont Energy Investment Corporation

Powered by SunShot U.S. Department of Energy

Vermont Demand Net of Solar



Distribution Feeders Example

Feeder/Segment	Voltage -	Protection	Thermal Capacity	Analyses
A/1	Primary and Secondary limits	Increased fault currents	Transformer	Normal and contingency conditions
A/2	ANSI or CVR	Sympathetic tripping	Conductors	Probabilistic modeling
B/1	Fluctuations	Breaker reduction of reach		Connection to B/C analysis and models
C/1		Open phase		
C/2		Reverse Power flow		
C/3				
Etc				

- What are the most common hosting capacity violations (voltage, protection, thermal, other)?

Mitigation Options

- Activities Underway:
  1. AMI integrated volt/var control, advanced inverters
  2. Rutland grid innovation project
  3. Capacitor optimization studies
  4. Circuit reconfiguration/balancing
  5. Coordinate with needed/remaining planned voltage conversions
  6. Substation/transformer upgrades
  7. PSD transformer analysis tool
- DER Options

Follow up

- Review & engage proper VSPC committee(s) with priority analyses?
- Establish regular communications w VSPC
- March, 2016 Stakeholder meeting will review priority analysis status/results
- Draft Report mid – year 2016
- 2017: Implementation support and further analysis

For more Information:
https://portal.veic.org/sunshot

Discussion and Questions

David Hill
(802) 540-7734
Dhill@veic.org

Vermont Energy Investment Corporation