Project Final Report

Vermont Regional Partnership Enabling the Use of DER (1.3.10)

Date: 8/15/2018

Section 1: Project Information

Project Information	
Project Control #	1.3.10
Project Title	Vermont Regional Partnership Enabling the Use of DER
Project PI	Robert Broderick (SNL)
Project team members	Mark Ruth (NREL)
DOE Project Manager/Sponsor	Merrill Smith Guohui Yuan
Period of Performance	4/1/2016 – 10/27/2017
Project Funds	$1M
Date Closed	4/30/2019

Section 2: Project Assessment and Checklist

Project Assessment and Checklist	Completion Date	Comments
Initiate Project Closeout (Date)	8/14/2018	Date contacted to close out
Have all quarterly reports been submitted?	9/30/2017	Last quarter of the project
Have all milestones been delivered	10/27/2017	Yes
Are all products finalized?	10/27/2017	Yes
Have all project products been presented and/or submitted to DOE Leadership Team and Project Managers	10/27/2017	Yes
Has the project team received feedback from all Project Stakeholders and project team members?	10/17/2017	Final meeting date
To the best of your knowledge, are there any open costs?	10/27/2017	None
Are there any open commitments?	10/27/2017	No
Project Closeout Concurrence with DOE Sponsor	4/30/2019	None

Project Final Report

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Section 3: Outcomes, Deliverables, Publications

1. **List of Outcomes:**

A. Advanced analysis and visualization of distribution feeders to determine their locational hosting capacity. Modeling of multiple distribution feeders for GMP and VEC that resulted in the ability to increase PV capacity by 100% or more in many cases, without adverse impacts.
B. Support siting decisions and control strategies to minimize the impact of new DER on feeders and utilize distributed storage for mitigation of impacts while optimizing it's use in peak shaving.
C. Improvements to existing solar forecasting tools that include accounting for total PV capacity, the design of utility-scale PV systems and clear vs cloudy days.

2. **List of Deliverables:**

• Ten distribution feeder models from 2 VT utilities converted and validated and hosting capacity analysis performed. Parameter estimation methodology developed using AMI data.
• Developed DR (Hot Water Heater) Simulation and control algorithms for DR and Storage
• Identified two large opportunities to improve the IBM PV forecast performance by using improved clear-sky models that accurately model the PV capacity and account for the tilt and azimuth of the PV modules.

   Produced a multifaceted approach to the integration of renewables that is technically sound, comprehensive and replicable. Areas of success:
   ➢ Modeling tools that identify the optimal placement of DER within a distribution network
   ➢ New control strategies for better managing demand resources.
   ➢ Improvements to weather forecasting programs to enable more efficient harvesting of power from renewables.

Project Final Report

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Date: 8/15/2018

3. List of Publications:

M. Lave, M. J. Reno and J. Peppanen, "Distribution System Parameter and Topology Estimation Applied to Resolve Low-Voltage Circuits on Three Real Distribution Feeders," in *IEEE Transactions on Sustainable Energy*, vol. 10, no. 3, pp. 1585-1592, July 2019.

M. J. Reno and R. J. Broderick, "Optimal Siting of PV on the Distribution System with Smart Inverters," *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, Waikoloa Village, HI, 2018, pp. 1468-1470.

M. Lave, R. J. Broderick and L. Burnham, "Targeted Evaluation of Utility-Scale and Distributed Solar Forecasting," *2017 IEEE 44th Photovoltaic Specialist Conference (PVSC)*, Washington, DC, 2017, pp. 1435-1440.

C. B. Jones, M. Lunacek, M. Lave, J. Johnson and R. Broderick, "Dynamic Setpoint Control of Electric Hot Water Heater Tanks for Increased Integration of Solar Photovoltaic Systems," *2017 IEEE 44th Photovoltaic Specialist Conference (PVSC)*, Washington, DC, 2017, pp. 3008-3013.

M. Lave, M. J. Reno, R. J. Broderick and J. Peppanen, "Full-Scale Demonstration of Distribution System Parameter Estimation to Improve Low-Voltage Circuit Models," *2017 IEEE 44th Photovoltaic Specialist Conference (PVSC)*, Washington, DC, 2017, pp. 3025-3030.

Mike Optis, George Scott, Caroline Draxl. 2018. *Evaluation of Wind Power Forecasts from the Vermont Weather Analytics Center and Identification of Improvements*. NREL/TP-5000-70313. https://www.nrel.gov/docs/fy18osti/70313.pdf.

Mark Ruth, Monte Lunacek, Birk Jones. 2017. *Impacts of Using Distributed Energy Resources to Reduce Peak Loads in Vermont*. DOE/GO-102017-5057. https://www.nrel.gov/docs/fy18osti/70312.pdf.

Monte Lunacek, Mark Ruth, Wes Jones, and Fei Ding. "Understanding the Impact of Electric Water Heater Control on the Grid" IEEE-Power and Energy Society General Meeting (August 6, 2018)

4. List of Awards or Recognition: Recognized by GMLC leadership as one of the "GMI Success Projects".
5. List any ROIs – None

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Section 5: Final Thoughts/Comments

Final Thoughts/Comments	Comments
Lessons Learned	Working with utilities that are implementing cutting edge technologies is a key step to improving the integration of DER on the distribution system.
Opportunities for Improvement	As always when working with utilities data was a major limiting factor. Both GMP and VEC did a great job getting us what they could but NDAs, privacy concerns etc. limited the speed we could progress with the project and the widespread dissemination of results. Therefore, we would suggest that DOE and GMLC develop a standard data sharing and dissemination guideline that is acceptable to the majority of utilities that could streamline the number of issues and simply the process. Perhaps modeling this after a standard CRADA process could be instructive.
Future Projects	None planned
Other	