Technology Advisory

Demand Response Program Planning With "VirtualBatteries" Software

What has changed?

While representing only 12 percent of consumers, rural electric cooperatives account for 27 percent of all reported peak demand savings – more per consumer than any other utility class.[1] Nonetheless, co-ops are always interested in improving or expanding their existing programs. To help with this goal, NRECA was recently funded by the Pacific Northwest National Laboratory (PNNL) to work with them in building and testing a demand response planning software application called the "VirtualBatteries" evaluation tool. It uses detailed models of electricity loads for common appliances and equipment (water heaters, air conditioners, refrigerators, and resistance heaters) to determine the ability of a large group of these resources to store and release energy like a battery energy storage system, and hence, to manage energy consumption and peak load. This evaluation tool also simulates the economic impacts of dispatching a group of these loads. The tool is now available to the co-ops, and in this advisory, we describe this tool and how it has been tested and can be used.

What is the impact on cooperatives?

VirtualBatteries will allow co-ops to better evaluate and simulate their peak shaving potential. The tool will enable its users to see the impact both financially and on their demand for co-ops not currently using a demand response program, as well as those equipped with a demand response program who wish to compare their program to VirtualBatteries.

Cooperatives are encouraged to try the tool, send NRECA and PNNL feedback, and consider using it when you plan your next demand response program expansion. Your feedback will provide us with useful insights with which to make updates to the tool to better serve cooperatives.

Cooperative Demonstrators

This simulation tool was tested and developed with the cooperation of Washington Electric Co-op, Blue Ridge Energy, Black Hills Electric Cooperative, Flathead Electric Cooperative, Oklahoma Electric Cooperative, Allegheny Electric Cooperative, and Central Alabama Electric Cooperative. With their help, we were able to validate results and improve our interface, as well as implement new features to better serve co-ops.

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[1] Form EIA-861 Electric power sales, revenue, and energy efficiency. Can be found here https://www.eia.gov/electricity/data/eia861/.

How the Model Works

The VirtualBatteries algorithm operates by comparing the outside temperature to a desired temperature threshold for the thermostatically controlled device to determine when the device is operating. By strategically operating these devices to "charge" them before the peak consumption of the day, it can then "discharge" them to shave the peak of the given day. This potential is calculated and treated like a battery, which is only dispatched on peak consumption days. When a forecast predicts a high consumption day that will exceed the current month's peak, the virtual battery is dispatched as optimally as possible to shave that month's peak.

What do cooperatives need to know or do about it?

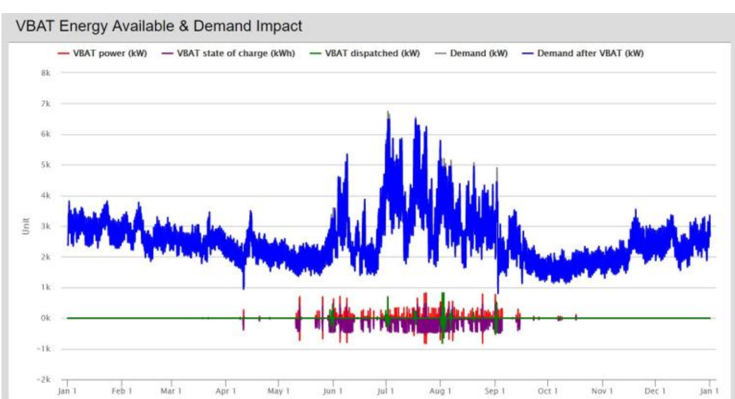
The VirtualBatteries evaluation tool is hosted on NRECA's Open Modeling Framework (OMF) website. To access the OMF, go to omf.coop, log in (create a free account if you do not have one), and select vbatDispatch from the "New Model" drop down menu.

The OMF is a website developed by NRECA. It is comprised of a set of Python libraries for simulating power systems behavior with an emphasis on cost-benefit analysis of emerging technologies: distributed generation, storage, networked controls, etc.

To run a VirtualBatteries simulation, a few things are required:

- A .csv file containing 8760 hourly demand values in kW in a single column.
- A .csv file with 8760 hourly temperature measurements in Celsius in a single column of the same year as the demand data. (A good source of historical weather data is https://mesonet.agron.iastate.edu/request/download.phtml).
- The specifications of the devices to be modeled (common default values exist), including the rated power, thermal capacitance, thermal resistance, coefficient of power (COP).

Once these parameters and files are loaded, the simulation can be run and will return the following results as follows:



This graph displays the hourly demand, virtual battery state of charge, and the impact of the virtual battery on the demand.

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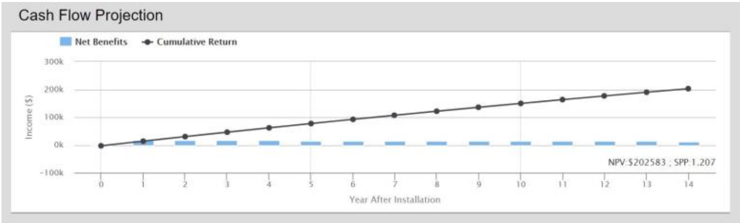

This graph shows an overview of the financial benefits of using virtual batteries over multiple years.

The model outputs also include a table with detailed monthly power, energy, and cost data with and without the virtual batteries impact. Additional details about the model can be found at https://github.com/dpinney/omf/wiki/Models-~-vbatDispatch.

Related model

For cooperatives who are interested in time-of-use pricing, critical peak pricing, or peak time rebates, the OMF also includes an econometric model for demand response programs. It uses the PRISM economic model, first developed and published by the Brattle Group, to estimate the impact of changes in energy rates on consumption. The full documentation for that model is available at: https://github.com/dpinney/omf/wiki/Models-~-demandResponse.

Additional Resources

- Try out the model: https://www.omf.coop/newModel/vbatDispatch/vbatTechAdvisory2018
- Documentation for the model: https://github.com/dpinney/omf/wiki/Models-~-vbatDispatch
- Open Modeling Framework (OMF): https://www.omf.coop
- More information about the OMF: https://www.cooperative.com/programs-services/bts/open-modeling-framework/Pages/default.aspx

Contacts for Questions

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