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Implementing Community Storage Programs

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ARTICLE SNAPSHOT:

What has changed in the industry?
Energy storage technologies can reduce an electric cooperative's need to purchase peak power, and provide greater flexibility for how co-ops can integrate increasingly available renewable energy resources. However, utility-scale energy storage solutions are still emerging, and most require significant capital investment or are not ready for full-scale implementation.

Fortunately, nearly all co-ops have existing distributed energy storage resources that can provide the same benefits as utility-scale storage. Electric water heaters are an example, and moving forward, co-ops will see additional new "flexible" loads that can double as storage resources, such as plug-in electric vehicles and home battery systems. These technologies can be coupled with other distributed energy resources (DER), such as home energy management, to build out a portfolio of energy services for members.

What is the impact on cooperatives?
Leveraging distributed "behind-the-meter" energy storage resources into a cohesive program can provide substantial energy storage benefits to co-ops, as well as benefits to co-op members, such as financial incentives, lower electric rates, and use of clean renewable energy. Programs that make use of these existing distributed energy storage resources are increasingly being referred to as community storage programs. Current experiences with community storage approaches will provide valuable insights and lessons learned for the co-op community.

What do cooperatives need to know or do about it?
This article explains the concept of community storage and describes how it can complement load management or renewable energy activities. It provides examples of community storage programs and highlights key steps that a co-op can take to launch a program.

COMMUNITY STORAGE PROGRAMS

Community *solar* programs are increasingly popular in cooperative territories, allowing members to contribute financially to a project that helps the cooperative use more renewable energy. Similarly, community storage programs give members the opportunity to contribute their distributed energy storage resources to help reduce peak power costs and allow the cooperative to better integrate renewable resources and ultimately other energy services.

There are a variety of strategies for integrating community storage into your electric cooperative's demand response, energy efficiency, and renewable energy programs. Table 1 displays examples that highlight key community storage strategies being implemented currently at cooperatives and utilities across the country. While this article primarily discusses "behind-the-meter" opportunities, larger-scale, utility-scale storage projects may also fit under the umbrella of community storage, such as battery storage at community solar sites and thermal storage at public facilities. More examples of projects can be found on the Community Storage Initiative's Supporters page: **www.communitystorageinitiative.com**.

TABLE 1: Types of Community Storage Programs

Program Type	Examples	Description
Peak Shave Water Heating	Palmetto Electric Cooperative	For more than 25 years, Palmetto Electric Cooperative has offered an off-peak electric water heating program. Currently over 35,000 large capacity water heaters are controlled, helping the co-op and members realize an annual savings of $3.4 million.
Peak Shave Space Heating	Northwestern REC	Northwestern REC has been involved in community storage since 1986 with its water heating and space heating programs. Over 600 members participate in the electric thermal storage (ETS) space heating peak shave program, in which these storage heaters are turned off during periods of peak demand. This program, in combination with the co-op's popular peak shave water heater program, has saved members over $20 million in avoided power costs.
Thermal Storage Water Heating	Great River Energy	Great River Energy, through its member distribution cooperatives, manages an ETS water heating program that is able to store nearly a gigawatt-hour of energy each night by controlling the electric water heaters of 65,000 members.
Thermal Storage Space Heating	Dairyland Power	Dairyland Power, through its member distribution cooperatives, offers a variety of load management programs, including daily control of ETS heating systems during winter months. Members participating in the program receive incentives in exchange for Dairyland turning off power to the ETS system for up to 14 hours per day.
Thermal Ice Storage	Ice Energy	Ice Energy is a supplier of a thermal energy storage systems that create and store ice, which then delivers space cooing during peak hours, eliminating peak air conditioning load. Eleven megawatts (MWs) have been installed, with another 41 MWs contracted to be delivered.
Grid-Interactive Water Heating	Steffes Corporation and Vaughn Thermal Corporation	These two companies offer grid-interactive water heaters, which allow finer controls on water heater load management for the benefit of the grid and the comfort of the consumer.
Community Storage Matched with Community Solar	Steele-Waseca Cooperative Electric	In 2015, Steele-Waseca Cooperative Electric, launched the SUNNA project, combining its community solar program with an ETS water heating program. If a member participates in the water heater program, they can receive a free water heater and purchase the first community solar panel at a substantial discount.
Plug-in Electric Vehicles Matched with Renewable Energy	Great River Energy	Great River Energy, through the ChargeWise and Revolt programs, offers plug-in electric vehicle drivers an off-peak rate for charging during overnight hours and the ability to fuel their vehicles with wind energy at no extra cost.

Continued

TABLE 1: Types of Community Storage Programs (cont.)

Program Type	Examples	Description
Residential Batteries	Green Mountain Power	Green Mountain Power, a Vermont utility, offers its members Tesla Powerwall battery systems, with an incentive to be able to share access with the system. With the ability to access these battery systems, Green Mountain Power can reduce peak power charges and manage future renewable energy overloads.
Public Transportation	Vermont Energy Investment Corporation	The Vermont Energy Investment Corporation (VEIC) has been a leader in grid-interactive vehicle policy development and the role of wholesale energy markets and the Renewable Fuel Standard commodity markets in supporting electrified transport. VEIC's focus is on developing equitable community storage, including aggregating electric light and heavy duty vehicles (transit and school buses) as a resource capable of participating in a number of markets with careful attention to consumer protection and equity issues.

Water heaters can be considered thermal batteries, providing both capacity value and energy efficiency benefits. (Brattle, 2016)

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Realizing Daily Benefits from Thermal Storage Programs

Over 40 percent of U.S. households have an electric water heater and electric water heating accounts for about a tenth of all household electricity consumption nationally. (Brattle, 2016) Because water can be heated at any time of day, remain hot for many hours, and be used at a later time, water heaters can be considered thermal batteries, providing both capacity value in the form of peak shaving and energy efficiency benefits by reducing overall energy use from water heating. (Brattle, 2016) More than 250 co-ops in 34 states have demand response programs for electric water heaters for thermal storage and peak shaving benefits. (NRECA, 2016) Programs that focus on peak shaving are discussed more in the next section.

Electric thermal storage (ETS) programs for water heaters curtail energy use from water heating on a daily basis during the highest priced hours of the day. Power to water heaters is paused until off-peak times, usually overnight. Programs interrupting power to water heaters typically install a load control device on the water heater that responds to a radio or power line carrier signal. As an incentive to participate in this kind of program, members receive a monthly bill credit, a free water heater, a rebate on the water heater, or other financial incentive to share in the direct benefits of their participation.

GridBallast: Research Addressing Barriers to Grid-Interactive Loads

The benefits of load control programs are many, but not every load can be easily controlled. Load control switches can be costly and require communications infrastructure to operate. New research funded by the Department of Energy's ARPA-E (Advanced Research Projects Agency-Energy), and executed by NRECA with partners Eaton, Carnegie Mellon University and SparkMeter, is working to address these challenges. The GridBallast project is developing super low-cost load control devices based on Eaton's considerable manufacturing capabilities and SparkMeter's experience developing affordable electric grid technology for the developing world. These devices will be designed to function without communications networks, greatly expanding the locations where they can be deployed. The initial controllers will be targeted at water heaters, taking advantage of their large thermal storage capacity, and the project team will be working to expand the devices' capabilities to work with emerging thermal and chemical storage hardware.

Bidirectional controls allow grid-interactive water heaters to be a flexible form of energy storage for real-time load control and demand response.

Some cooperatives are implementing thermal storage water heater programs now. For example, Great River Energy (GRE), a generation and transmission (G&T) cooperative supplying power to 28 member cooperatives in Minnesota, controls 65,000 water heaters through its ETS program, which began in 1979. The power to the water heaters is interrupted for 14 to 16 hours per day, depending on the season and whether it is the weekend. The water heaters "recharge" overnight. Each GRE distribution co-op markets and incents the program differently — some members receive a free water heater for participating, while other co-ops provide the water heater at a discount and with a reduced electric rate. The program allows GRE to store a gigawatt-hour of energy each night. (GRE, 2016/Webster, 2016)

Heating can also provide a similar thermal storage benefit. Heating technologies are available that use electricity to warm a storage medium that releases heat over extended periods of time when not receiving power. Examples include high-density ceramic bricks, electric radiant floor systems, and hydronic systems. Some electric cooperatives are promoting these ETS systems to their members. For example, Dairyland Power Cooperative, a G&T cooperative serving distribution cooperatives in Wisconsin, Iowa, Minnesota, and Illinois, has a load management program for ETS heating systems that distribution cooperatives can offer their members. An eligible member with an ETS system can enroll in a load management program through their cooperative. These programs typically provide a rebate for the heating system and/or places the ETS device on a separate meter that is charged at an off-peak rate. In exchange, the Dairyland is able to turn off the system for up to 14 hours a day, allowing it to recharge during lower cost times. (Dairyland, 2016)

Promoting Grid-Interactive Water Heaters

A new type of water heater emerging on the market is the *grid-interactive water heater* (GIWH). GIWHs are electric resistance water heaters outfitted with bidirectional controls that, in addition to allowing a utility to quickly turn the systems on and off, also allow the utility to view and adjust the temperature of the hot water, understand how much usable hot water is left in the tank, and to selectively control specific water heaters in the system. These bidirectional controls transform water heaters into a flexible form of energy storage that can be used for real-time load control and demand response, as well as for ancillary services like frequency regulation. Existing water heaters can be retrofitted to be GIWHs, but doing so requires a trained plumber and electrician to install the technology. (Steffes, 2016/E Source 2014) Current companies offering GIWHs include Steffes Corporation and Vaughn Thermal Corporation.

Some G&T co-ops are exploring how GIWHs can benefit their member cooperatives. For example, Dairyland Power Cooperative began studying GIWHs in 2010, in conjunction with one of its distribution cooperatives, Heartland Power Cooperative, and the Steffes Corporation. The G&T retrofitted ten water heaters with grid-interactive controls in the homes of members and studied how the technology worked, whether they could ensure sufficient hot water for members, and whether the GIWHs could accurately respond to market energy prices and frequency regulation signals. Dairyland has found that the systems can reliably respond to market signals while providing an overall positive member experience and, therefore, have the potential to provide ancillary services to a wholesale power market. However, the market rules for regulated wholesale markets are complicated and require a large capacity threshold for participation, and thus, an aggregation of many GIWHs.

The Midcontinent Independent System Operator (MISO Energy), which manages the wholesale energy market that Dairyland and other regional utilities participate in, requires an energy resource to be at least five megawatts (MW)

It is important to note that the many benefits of community storage technology do not necessarily require two-way communication.

to fully participate in the energy and ancillary services markets. MISO is currently considering whether to lower this participation threshold and/or allow for the aggregation of distribution load-based resources. At this time, Dairyland does not plan to expand its GIWH pilot until there is more clarity from MISO on the issues of minimum participation limits, aggregation, and metering and telemetry requirements for small-scale demand resources such as GIWHs. (Flege, 2016)

While community storage projects that make use of two-way communication provide innovative opportunities, it is important to note that many of the benefits of community storage technology, such as off-peak water heater and vehicle charging and peak load reduction, do not necessarily require two-way communication. Thus, co-ops without access to two-way communication technology have ample opportunity to participate in community storage projects.

Aligning community storage investments with renewable energy projects can help improve the economics of renewable energy projects by storing energy when renewable generation exceeds demand.

Marching in Step with Renewable Energy Projects

Nationwide, co-ops own or purchase nearly 6.4 gigawatts (GW) of renewable capacity. (NRECA, 2016b) Aligning community storage investments with renewable energy projects can help improve the economics of renewable energy projects by storing energy when renewable generation exceeds demand. In addition, bundling the two program ideas can help consumers connect the benefits between renewable energy and community storage.

A prime example of matching renewables investment with community storage is at Steele-Waseca Cooperative Electric, a distribution cooperative in Owatonna, MN. In 2015, the co-op launched the SUNNA project, an initiative combining its community solar program with the water heat storage program offered through its G&T, Great River Energy (described in more detail previously in this article). The 250-panel community solar project allows members to purchase a 410-watt panel for $1,225. However, if the member participates in the ETS water heater program, they can receive a free water heater and purchase the first solar panel for $170. Since Steele-Waseca began marketing the program in 2015, they have had almost 30 new water heaters enter the ETS program; about 20 other members were already enrolled in the ETS water heater program and decided to purchase a solar panel at the discounted price. The energy benefits from these new water heaters in the ETS program has covered about 70 percent of the cost of the community solar project: each electric water heater adds about 4,500 kWh per year in electricity sales. (Briggs, 2016/RE, 2015)

Plugging in Opportunities for Electric Vehicles

Plug-in electric vehicles (PEVs) are an emerging community storage resource for co-ops. The market for PEVs has grown exponentially in the last five years, and new models are on the market at a range of price points. Using a PEV can increase household's electricity consumption significantly — 13 to 40 percent, depending on how many miles the car is driven. (NRECA, 2015) However, the PEV's load is highly malleable: unlike lights or space heating, PEV drivers do not have a preference about when electricity is flowing to the car, as long as the battery in the car is fully charged by the time they need to use the vehicle. Co-ops can use time-of-use rates and controlled charging strategies to encourage drivers to store up energy during lower cost off-peak times.

GRE, for example, works with its member cooperatives to offer PEV drivers the ***ChargeWise*** program. The program provides enrolled members electricity at less than half the cost of normal

rates, if they only charge their PEVs during the off-peak period (generally 11:00 p.m. to 7:00 a.m.). Members who participate allow the co-op to control the flow of electricity to their charging equipment via radio- controlled equipment and a special ChargeWise outlet. In addition,

PEV drivers at GRE member cooperatives can take advantage of the new ***Revolt*** program, which offers PEV drivers the opportunity to power their vehicles with wind energy, at no additional cost until the end of 2016. All ChargeWise participants are currently participating in the Revolt program — together, these programs incentivize PEV drivers to recharge PEV batteries during overnight off-peak times and rewards them with low cost, renewable energy. (Webster, 2016)

Home batteries are currently less prevalent than other community storage resources, but are an emerging market for co-ops to consider.

Looking Forward: Home Batteries

When many people think of energy storage, batteries come to mind. Thanks to recent advancements and cost reductions in lithium-ion batteries, more homeowners are able to purchase home battery packs like the Tesla Powerwall, which is a 6.4 kWh lithium-ion battery system introduced in 2015. Home batteries can store cheaper off-peak energy that can be used during on-peak hours, or store power from on-site renewable energy systems — or they can be used for emergency back-up. Although home batteries are currently much less prevalent than other community storage resources, like electric water heaters or electric vehicles, they are an emerging market for co-ops to consider.

A recent example of a program using home battery packs as a distributed energy storage resource is at Green Mountain Power (GMP), a utility serving three quarters of Vermont. In 2015, the utility purchased 500 Tesla Powerwall battery systems and began offering them to customers for purchase or for rental. A customer can purchase the system with no further interaction with GMP, or can choose to purchase or rent the system with "shared access" for GMP. Customers who allow shared access give GMP the ability to discharge the battery to supplement energy demand. In return, a customer who has purchased the Powerwall receives a monthly bill credit (currently $31.76); a customer who rents the system does so at a low rate of $37.50 per mont.h (GMP, 2016) In April 2016, GMP started working with local contractors to install the Powerwall battery packs and inverters in the homes of members who have signed up for the program. Once the systems are in place, GMP will be able to use the batteries to supplement power needs during periods of peak demand, lowering costs for all, and in the future, absorb renewable energy overloads. GMP will be using microgrid controls to view the state of charge of batteries on the system, so that they, for example, do not fully discharge batteries when a storm is approaching, thus ensuring customers the back-up benefit of a Powerwall during a power outage. (Castonguay, 2016/GTM, 2015)

KEY STEPS FOR LAUNCHING A COMMUNITY STORAGE PROGRAM

The program examples provided earlier give a starting point for a co-op considering a community storage program. Community storage programs can provide value in the form of peak demand reductions, energy efficiency benefits, and better integration of renewable energy sources.

NRECA, in collaboration with the Natural Resources Defense Council (NRDC) and the Peak Load Management Alliance (PLMA), has launched the Community Storage Initiative (CSI) to assist cooperatives considering a

Community Storage Initiative

www.communitystorageinitiative.com

To Sign-up as a Supporter:

https://nreca.wufoo.com/forms/support-the-community-storage-initiative

distributed energy storage program. The CSI focuses on "collaborative information sharing and coordinated market development efforts in support of wide-scale implementation of energy storage technologies that are commonly located in communities across the country." (CSI, 2016) Co-ops that have implemented a community storage program, or are interested in beginning one, are encouraged to sign-up to the CSI as a charter supporter.

Understanding the amount of economic and energy value that community storage resources offer your co-op will help you determine the kind and level of incentive to provide participants.

Other key steps to launching a community storage program are below:

Learn more about utility-scale and community energy storage technologies: Understanding the different technologies and applications for both utility-scale and community storage is important for determining what will work best for your co-op's needs. NRECA has a number of resources available related to energy storage, including the **Electric Energy Storage Lexicon**; an **Energy Storage Handbook**, created in collaboration with EPRI and the U.S. DOE; and the ***Energy Storage Toolkit***. Use Case Studies will also be available soon; please refer to NRECA's **Energy Storage topic page** on cooperative.com. In addition, NRECA has resources available relevant to community storage technologies, including a report from the Brattle Group: ***The Hidden Battery: Opportunities in Electric Water Heating***; a **Technology Advisory** on water heaters; a **Technology Advisory on the Tesla Powerwall**; and a report on electric vehicle programs — ***Keys to Developing a PEV Program for Your Electric Cooperative.***

Collaborate and coordinate with the G&T and other co-ops: Tracking and controlling peak demand, energy use, and integrating renewable energy all benefit from close communication with your G&T, helping a distribution co-op realize the full value of energy storage resources. If you are considering starting a community storage program or focusing an existing program to take advantage of storage resources, your G&T may have information that can assist, and could help deploy a program across all member cooperatives in a G&T service territory.

Research the community storage assets in your service territory:

- Water heaters are an obvious starting point for co-ops considering a community storage program, though they are not prevalent everywhere. Research the saturation of water heaters in your service territory and whether many are beginning to reach their end of life.
- Electric vehicles are an emerging community storage resource. Is PEV ownership in your service territory high or increasing? Another *TechSurveillance* article, ***Keys to Developing a PEV Program for Your Electric Cooperative***, has information on how to understand local PEV markets.
- Home battery systems are still emerging, but are so far very popular, as evidenced by Tesla selling out of its Powerwall systems through 2016. Are your members asking questions about home battery systems? If so, a program similar to Green Mountain Power's could be an option to explore.

Determine the value of the community storage resources: Once your co-op has identified community storage resources, it is important to understand the economic and energy value that these resources can provide. For example, what benefit is gained by having water heaters in your system charge from 11:00 p.m. to 7:00 a.m.? This question requires some research to determine the load profile of existing water

heaters and to project the savings in wholesale power purchases that would be realized by shifting this load to the desired time.

Once the peak savings and overall energy savings are determined, the co-op can decide whether to provide participants in the program some kind of financial benefit. Most residential co-op members pay the same rate for a kilowatt-hour (kWh) during peak as they do off-peak. The co-op could decide to institute a time-of-use rate, or offer a rebate or annual incentive payment for community storage program participants.

A reduction in peak demand can have more value in areas of the service territory where the distribution system is near capacity, because it could defer investment in a distribution system upgrade. The amount of peak demand reduction would need to be substantial in order to realize this benefit, but it would not have to come solely as a result of community storage. The demand reduction could also be created by end use energy efficiency and distributed energy.

A community storage program that attracts significant participation could provide an additional benefit to the co-op, if it encouraged consumers to choose electricity for their end-uses instead of natural gas, propane, or fuel oil.

Find a vendor or partner who can help: Many of the programs described in this article worked with an external vendor or partner. For example, Dairyland Power Cooperative studied grid-interactive water heaters with the Steffes Corporation, and Green Mountain Power is working with local solar installers to market their home battery program.

Consider bundling with a renewable energy initiative: Associating a community storage program with a renewable energy program can help consumers better connect the reasons for participating in a community storage program with an environmental benefit. For example, Steele-Waseca Cooperative Electric's SUNNA program contributed to a large uptick in participation in their water heater storage program after they bundled it with their community solar program. "With the SUNNA program, we have helped our members be greener when adding to the co-op's load," said Syd Briggs, General Manager at Steele-Waseca.

Plan a pilot program: Pilot programs are a way to test consumer interest in the program, validate costs and benefits, try out different program approaches, and work out any logistical or communication problems.

Taking these steps can help a co-op launch and implement a successful community storage program that provides member benefits. The Community Storage Initiative discussed in this article will continue to track different programs, share successes, and distribute information for co-ops who are considering starting their own community storage programs.

CONCLUSION

The ability to store energy can help electric cooperatives avoid peak power purchases and better integrate intermittent renewable energy resources. However, utility-scale energy storage solutions are costly and still undergoing rapid technological improvements. Making use of existing distributed energy storage resources — such as electric water heaters, electric vehicles, and home battery systems — can provide similar benefits as utility-scale energy storage at a much lower cost. The idea of leveraging distributed "behind-the-meter" energy storage resources is commonly referred to as community storage. NRECA, in collaboration with the Natural Resources Defense Council (NRDC) and the Peak Load Management Alliance (PLMA), has launched the Community Storage Initiative (CSI) to assist cooperatives considering a distributed energy storage program. Co-ops that have implemented a community storage program, or are interested in beginning one, are encouraged to learn more about and engage with the CSI. ■

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