Smart Energy Home Case Study

An Historic Feat: The Barden Seidman Residence

GENERAL INFORMATION

Residence Name: The Barden Seidman Residence

Location: Southwestern Vermont

Year Built: 1850

Square Footage: 3,000 sq. ft.

Home Characteristics: 5 bedrooms, 2 baths, 2 floors + basement

Retrofit Technologies: 4 heat pumps, efficient windows, appliances and systems, programmable thermostat

Renewables: 8.5 kW solar PV system (2 arrays), two leased Powerwall's (combined back up around 25 kWh), batteries are "dispatched" by Green Mountain Power

Retrofit Team: The project team consisted of almost all local contractors with jobs going to local masons, carpenters, spray foam technicians, plumbers, electricians - many of whom are neighbors!

PROJECT OVERVIEW

In a picturesque New England region snuggled in the Southwestern corner of Vermont lies an historic stretch of charming, small towns full of rich history and beautiful landscapes.

Spoiled with natural outdoor beauty and an abundance of many fresh foods – like maple syrup, apples, and of course, cheese – residents endure long, cold, snowy winters and hot, muggy summers. Average low temperatures in the winter range from 2°F to 12°F while average high temperatures in the summer range from 75°F to 82°F.

Figure 1: Barden Seidman Residence, August 2021

Across the region, especially during very hot summer days, residents ramp up their energy needs. As utilities and customers continue to devise behind- and in-front- of the meter interventions to deal with these sweltering summer days, the state continues to focus on changing the way Vermont residents use and produce energy.

Back in 2009, Vermont was awarded funds through Smart Grid Investment Grants (SGIG) to support the state's electric utilities in deploying smart grid measures. This helped jumpstart utilities in leveraging funds to start developing and deploying smart energy home technologies including smart meters, home energy management systems (HEMS), battery storage and EV plug-ins. By making smarter investments, residents can save money, increase comfort and health, and reduce their carbon footprint while the state can grow the workforce and simultaneously meet the needs of the grid.

The Barden Seidman Family lives north of Bennington, Vermont in an historic retrofit farm house originally built in 1850. It includes over 3,000 square feet of living space with five bedrooms, a kitchen, dining room, living room, bathrooms on both floors, and a basement.

In 2014, this residence suffered the unfortunate fate of a chimney fire. The extensive damage led to substantial portions of the home getting torn down. When it came to rebuilding, the homeowners wondered "What should we do with our 1850s farmhouse that suffered damage to most of the home?" As environmentally conscious citizens, the Barden Seidmans decided to gut the home and retrofit it in the most sustainable and energy efficient manner.

At the onset of their home's retrofit project, the idea of achieving a smart energy farm-home lifestyle seemed a bit ambitious for the Barden Seidmans – especially for a home built way before modern energy codes and standards were enforced. But embedded in their challenge was an opportunity that they could not resist.

Aligning Smart Energy Homes and Grid-Interactive Efficient Buildings (GEBs) Characteristics

"I love our PV system, Powerwalls, and the data we get to see through the app."

The Barden Seidmans were able to take their misfortune as an opportunity to lower their carbon footprint through energy efficiency and the installation of solar PV and heat pumps. With efficiency in mind, the Barden Seidmans knew that the benefits of having a home equipped with smart, efficient features would allow them to save money and reduce their energy use, all with greater control over their home's energy systems.

Through the integration of high-performance features, energy efficient systems and appliances, and connected solutions, the Barden Seidmans achieved a smart energy farm-home lifestyle simply through a traditional retrofit project process. Making more energy-conscious choices, encompassing energy efficiency, solar PV, and load flexibility, the Barden Seidmans created a home with huge impacts on reduced energy use and increased savings while also delivering benefits to the grid.

Figure 2: Barden Seidman Residence near Complete Renovation, 2017

Before the chimney fire, the farm home was fueled only by wood heat, consisted of outdated and inefficient cooking technologies, and leaked heat throughout the home. Retrofit work included whole-home spray foamed interior walls, roofs, and attic, installation of a programmable thermostat, and a plethora of efficiency upgrades including efficient windows, electric hot water system, electric dryer electric oven, all new efficient appliances, dual flush toilets, and all efficient LED lighting fixtures. Currently, the only appliance fueled by propane is the range top stove and the backup heating system, which is only used when temperatures hit below 20 degrees Fahrenheit.

Why lease the Tesla Powerwalls?

"We leased the Powerwalls because it worked out better in terms of financial feasibility and long-term practicality with future upgrades. Green Mountain Power (GMP) then offered another part of the program for voltage regulation which gave a discount on the lease rate." In this case, GMP controls the batteries and the Barden Seidmans would have full control only during power outages. Currently, GMP uses the batteries almost four days a week for some type of grid support program.

The renovated farm home also has four heat pumps, 8.5 kW of solar PV tied to two leased Tesla Powerwalls provided through Green Mountain Power's Bring Your Own Device Program. Through this program, the Barden Seidmans selected the battery, installer, and amount of energy they were willing to enroll. The Barden Seidman's stored energy, along with hundreds of other GMP customers' stored energy, helps offset what is needed to power Vermont's grid during peak demand hours. As a result, GMP customers are helping each other save money, reduce emissions and stress on the grid, and ensure a more flexible grid that can allow for continued renewable generation growth.

Through the Barden Seidman's Tesla Powerwall app and Green Mountain Power app, they stay connected to their utility and are able to see both their energy usage and GMP's power draw. The homeowners also use the ISO-New England app to see the region's demand and to check for forecasted peak demands. This allows smart energy products and systems to combine with the smart grid to create opportunities to leverage two-way communication from the utility to its customers. By making energy performance easier to understand and control, homeowners can cut energy costs and create healthier, comfortable, and more efficient homes at the push of a few buttons.

Lessons Learned

"We did not get good advice on where to site our heat pumps; I wish we were more educated at the time."

A comprehensive retrofit like the one performed on the Barden Seidman's residence may not be the easiest or simplest process, especially when having to select multiple contractors for different work and having to select the right type of systems and appliances. Even with homeowners interested in reducing air pollution and energy, these choices proved to be tough. The residents stated, "The job we have ahead of us is huge to reduce carbon emissions in homes and if we don't have the knowledgeable contractors to educate the consumers and make this process easier for us, then it's going to be a long road ahead."

What worked well?
The solar PV systems are performing very well. The initial estimated solar payback period was around 6-7 years and the farmhouse is currently on track to achieve that. Additionally, they are generating just about enough energy on an annual basis to offset what they use. On a daily basis, the Barden Seidmans generate 30 percent of the energy themselves through their solar PV system. The Barden Seidmans asked for even more granular, real-time data to better understand their energy usage and regional demand.

What could have worked better?
Currently, three of the four heat pumps are working well, but the location of the fourth heat pump is in an area of the home that is largely unused. The heat pump would have been better placed in another bedroom on the second floor. Due to this poor placement, and how the bathroom is laid out, the residents have to use a supplemental heater in the upstairs bathroom.

The home originally had historic arch top windows that the homeowners did not want to replace. Working with Efficiency Vermont, the Barden Seidmans preserved their older wooden storm windows on the first floor, but upgraded the storm windows made for the arch top windows on the second floor.

NEEP's Air Source Heat Pump Buying Guide

If you are a homeowner looking into air source heat pumps, check out NEEP's Air Source Heat Pump Buying Guide. The guide offers both introductory and intermediate information on air source heat pumps, how to select one, and provides a checklist of questions to ask potential installers

Final Outlook

"Something we are very proud of!"

Since occupying the retrofitted farm home in 2015, the Barden Seidmans have been thoroughly enjoying their smart, flexible, connected, highly efficient and comfortable home. On average, the Energy Information Administration (EIA) reported a typical 3,000 sq. ft. home uses around 14,214 kWh annually, or 1,185 kWh per month. Since the Barden Seidmans have been able to track their usage over the past two years, they report that their 3,000 sq. ft. home used 8,600 kWh and 8,400 kWh annually in 2019 and 2020, respectively.

What's Next?
The Barden Seidmans continue to look for opportunities for more improvements. On the upgrade wish list, they hope to replace their current hot water heater with a heat pump water heater. They would also like to move the improperly-placed heat pump to a more appropriate location. Additionally, they are working on water conservation efforts including landscaping and introducing pollinating plants to their yard.

The need for achieving deeper energy savings through increased energy performance is a vital part in reaching the state's carbon reductions goals. The Barden Seidmans have done a tremendous amount of work to assist in that effort and can do a few more things to achieve a fully-optimized smart energy home. While the farm home is equipped with efficient appliances, smart features and renewables, the Barden Seidmans can consider introducing a Home Energy Management System (HEMS) to provide the opportunity for the household to more effectively manage smart technologies and systems including HVAC, water heating, and plug loads. Additionally, the residence can consider an electric vehicle with an accompanying EV charging station. Lastly, security camera systems, smart hubs and speakers, and even electric lawn mowers/leaf blowers can contribute to achieving more carbon reduction.

Reach out to NEEP's Smart Energy Homes and Buildings Team for more information and guidance on integrating energy efficiency, smart and connected systems and technologies, and demand flexibility into your home.