TVA TENNESSEE VALLEY AUTHORITY

CONNECTED COMMUNITIES

Residential Demand Response Through Connecting MHA

Pilot Project Case Study

Contents

LOCATION

Murfreesboro, TN

PROJECT COSTS

$1M

Total Funding

FOCUS AREAS

Broadband and Digital Literacy

Energy and Environmental Justice

Project Summary

This pilot project expands and unites the "Connecting MHA" and "Home Energy Management System (HEMS)" pilot projects to offer connectivity and energy education to ensure residents benefit from smarter energy management and demand response (DR).

TOPICS

- ✓ Smart Energy Management
- ✓ Energy Conservation Education

TECHNOLOGY

- ✓ Fiber Optic Wi-Fi
- ✓ Smart Home Devices
- ✓ Mobile Application
- ✓ Open-Source Home Energy Management System (HEMS)

KEY PARTNERS

- Local Power Company
- Strategic Communications Firm
- Local Housing Authority
- Software Development Company
- National Laboratory
- Project Advisor

> It feels good to know that as TVA seeks to introduce new advanced energy management and grid technologies, they have a close eye on the customer experience. Our pilot has spotlighted areas where the operational and customer sides of the utility must come together, optimize the same data and improve communications so that utilities can respond to events holistically—from the grid to the customer.

JULIET SHAVIT | president and chief executive officer, SmartMark Communications

Challenge and Solution

Challenge

While affordable housing offers many benefits for limited-income residents, access to more advanced energy efficiency technologies and programs can be difficult or nonexistent, hindering meaningful energy burden relief.

Solution

By working together, the energy industry can explore more creative, innovative solutions to meet the increasing demands of electricity now and in the future. The architecture of communities—with homes, offices and factories spread throughout—provides ideal nodes for demand response programs in which electricity demand is voluntarily reduced as needed to optimize service.

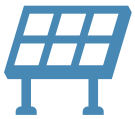
For utilities to invest more in necessary grid services, they will require meaningful and impactful examples that demonstrate these solutions' effectiveness without causing discomfort or inconvenience to residents, especially those who are underserved. This pilot project, although relatively small in scope with a maximum of 75 units, offers valuable insights into successful deployment strategies for the future. This pilot project helps illustrate how such deployments can be impactful and beneficial, paving the way for broader adoption and more extensive implementations in the future.

> **"The grid-edge presents a real challenge and opportunity for utilities to engage with consumers who own critical distributed energy resources. Our pilot is exploring the best way to educate and engage consumers around participation in programs that dually benefit themselves and the grid.**
>
> **JULIET SHAVIT** | president and chief executive officer, SmartMark Communications

Focus Areas Supported

Broadband and Digital Literacy

By integrating advanced energy management technologies within affordable housing, limited-income residents gain access to tools and knowledge that are often out of reach. By participating in an incentive-based demand response pilot project, residents may save money on energy bills and expand their understanding of digital energy solutions. The Open Home Energy Management System (HEMS) app, which is open source, and Wi-Fi-enabled devices facilitate this engagement, teaching residents how to effectively manage their energy use through digital platforms. Through active participation, they become more comfortable with technology, bridging the digital divide and fostering sustainable living in disadvantaged communities.



Energy & Environmental Justice

By participating in the demand response pilot project, residents of affordable housing are empowered to reduce their energy consumption and lower their utility bills, helping alleviate the energy burdens that affect limited-income households most. The pilot project not only provides immediate financial relief through monthly incentives but also fosters long-term energy literacy and self-sufficiency. By involving residents in demand response events, the project promotes equitable participation in sustainable energy practices, aiding in broader grid stability and environmental benefits. This inclusive approach ensures that all community members, regardless of income level, can benefit from cleaner, more efficient energy use.

Goals, Approach and Results

Project Goals

- Energy savings for residents
- Customer satisfaction
- Analysis of the pilot's impact on energy consumption patterns
- Value of Open HEMS and resident education in saving energy and managing peak demand
- Potential for expanding residential demand response programs across the Tennessee Valley Authority (TVA) service region

PILOT PROJECT GOAL

Improve quality of life through access to new services and opportunities to save energy and money.

> "The technologies deployed in this pilot can be used to optimize the internal environments of buildings at all times. It need not only be during certain events. We're starting with limited duration events for now, but the project team has created a technological solution capable of enabling more than just simple demand response, but something that I've become comfortable calling advanced demand management.
>
> **BILL MAGUIRE** | cofounder, ACE IoT Solutions, LLC

Goals, Approach and Results

Project Approach

Following the successful implementation of a previous pilot—Providing Wi-Fi Access & Education to New Affordable Housing Projects (Phase 1), TVA approached Middle Tennessee Electric (MTE), Murfreesboro Housing Authority (MHA) and SmartMark Communications about expanding the scope of the pilot project in one community by including residential demand response.

By expanding the scope of impact on the one affordable housing community at Murfreesboro Housing Authority (MHA) that received fiber optic Wi-Fi in the Phase 1 pilot, the project team assessed the viability of residential demand response in affordable housing neighborhoods to ensure residents' needs are met. Using a mobile app and smart technologies, the pilot team aimed to reduce the energy burden of MHA residents / MTE members, reduce system peak for MTE and speak to the mission of the MHA.

> **"We're a service organization, so it's providing a service for our residents. It's not so much benefiting us in particular, but it's benefiting our residents to be able to have Internet and then to be able to save on the utilities in the long run. Saving on their utilities helps us because then our allowances don't have to be so great.**
>
> **THOMAS ROWE** | executive director, MHA

Once the project team received the Connected Communities funding, they began planning through regular stakeholder meetings. Initial feedback from MTE and other local power companies emphasized the necessity of having a single, integrated app to use with customers; as many local power companies have preexisting mobile apps, this new energy-management component would need to fit seamlessly into existing applications. Recognizing this, TVA reengaged ACE IoT, which had developed an Open HEMS platform and mobile app as part of another Connected Communities initiative, to allow the thermostats and water heaters to be managed by MTE. The goal is to eventually integrate the software into their existing myMTE app.

Program participants allow MTE to adjust Wi-Fi-enabled thermostats and water heaters for opted-in members during system peak times. These demand response events can occur up to three times a month, and residents may opt-out of events at any time. The goal is to keep residents comfortable while helping them save money by reducing energy usage. Additionally, participants receive a $15 monthly incentive. By reducing the energy usage of participating residents during peak times through a demand response event, MTE can save on system demand charges.

Goals, Approach and Results

Project Approach (CONTINUED)

When scaled across the system, this can help positively impact the stability of rates for all members and help TVA delay building additional generation assets.

To prepare for initiative deployment, SmartMark consulted with MTE to collaboratively develop the resident communications cadence, providing a program orientation to new residents, including educational resources on energy savings and an introduction to the myMTE account platform.

Once the technology and Open HEMS app had been synced, key stakeholders from MTE, SmartMark and MHA were invited to Oak Ridge National Laboratory (ORNL) Yarnell Station Research House to experience the system firsthand before deployment and provide feedback.

> **The MTEs of the world aren't going to use software that they're not comfortable with because they have a really meaningful relationship with their customers. That's been baked into this project. It's certainly been a big part of the planning process, making sure that we respect and support the relationship that MTE has with their customers.**
>
> **BILL MAGUIRE** | cofounder, ACE IoT Solutions, LLC

Often, the app or interface isn't a priority in pilot projects, becoming the underfunded component. All parties felt that a critical piece to supporting this advanced demand management solution in the region is ensuring that customers have an interface that looks professional and feels intuitive to use. SmartMark and MTE worked closely with

> **We respect the residents. They can choose to opt-in or opt-out at any time they want, even if they agree to be part of this program, they can get out anytime they want to and they can choose to opt out of the events. It was very important to us that we gave our members options on how they will participate.**
>
> **ROBERT WHITE** | vice president, Community Relations and Member Services, MTE

Goals, Approach and Results

Project Approach (CONTINUED)

the app development team on the language for the app and to ensure it was consistent across all platforms and accessible for customers, focusing on ease of use and a positive experience.

This app, now available to local power companies, can be seamlessly integrated by their own developers, providing crucial functionality without requiring a separate application. Instead of settling for a minimally viable product, the developed app provides a comprehensive and realistic user experience. The app's design allows local power companies to incorporate its functionality into their existing apps, supporting grid services solutions without necessitating the use of a separate application. By developing the open-source software as a standalone component, local power companies can choose to integrate it into their own customer-facing app, maintaining a cohesive user experience while adopting new technological solutions. The team at ORNL developed the integrated optimization and now collect and process the data yielded by events to streamline the experience and identify optimization opportunities to support scaling.

In addition to the Open HEMS app, ACE IoT provided MTE with a web interface to enable the scheduling of events and access a dashboard with meter data and other key metrics produced during events.

WHAT IS AN "EVENT"?

Step 1: Initiate a period of precooling or preheating where the temperature in the residence is remotely adjusted by 3° for 30 minutes.

Step 2: After the residence has been precooled / preheated, the target temperature will be increased / decreased by 3° from the original setpoint depending on whether the pre-event included precooling or preheating.

Depending on outdoor temperature, inside temperature and other related factors, the indoor temperature will change as time passes until it hits the event's target temperature.

The goal is to curtail the heating, ventilation and air conditioning (HVAC) unit and water heaters during the three-hour peak load period for the local power company. Each event could potentially save participating customers money, which can compound over time and many events.

Step 3: The event ends and the thermostat and water heater temperature returns to original setpoint / state.

Sample summertime event temperatures:

- Starting indoor temp 72°
- Precool indoor temp 69° for 30 minutes
- Event target temp 75°
- Post-event indoor temp returns to 72°

Goals, Approach and Results

Project Approach (CONTINUED)

Once construction was complete, the smart water heaters and thermostats were installed into units and connected to the Open HEMS app. As with any new technology, especially a system with multiple components, there were connectivity issues with the smart home technology that required corrective action. SmartMark and MTE collaboratively developed a subsequent communications plan to address customer concerns and troubleshoot potential solutions. A hotline was established to facilitate direct communication with participating members experiencing issues, ensuring fast response times to rectify issues.

The first event was conducted in July 2024 with a single participating member, yielding positive results, and the project team scheduled three additional events to test the technology and manage participant flow.

> **I think in the future, one might imagine that this all happens in the background and that none of us ever notice, this kind of orchestration and optimization. But it's super important to make sure everyone's comfortable in their homes and feels like they have autonomy. If a user adjusts the thermostat or uses the app to adjust the temperature in any way, then that action completely overrides all of the optimizations and orchestrations that are in place.**
>
> **BILL MAGUIRE** | cofounder, ACE IoT Solutions, LLC

By fall 2024, the program is projected to include all enrolled participants, with MTE scheduling regular events based on predicted peak times, simulating a fully functional demand response program.

> **This technology benefits MTE by reducing our demand and helps us keep our rates stable, which benefits our members. Since TVA delivers our power, it's helping them reduce their generation needs. If this becomes a scalable solution and you look at what the aggregated demand reduction could be, then there could be some real impacts for everyone.**
>
> **GLENN HOLLANDSWORTH** | manager, Member Revenue & Programs, MTE

Goals, Approach and Results

Project Results

TVA and ORNL will provide technical support and statistical analysis for the data collected through mid-2025. The three user groups enable the analysis of the pilot project's impact on energy consumption patterns and peak demand. Extensive analysis of advanced metering infrastructure (AMI) data and survey results will help demonstrate the value of residential demand response and resident education in saving energy and managing peak demand and the potential for scaling residential demand response across TVA's service region.

FIRST EVENT: JULY 2024

95%
reduction in HVAC energy use*

$.30
savings for the member

SECOND EVENT: AUGUST 2024

94%
reduction in HVAC energy use*

$.26
savings for the member

*during the three-hour timeframe

Key Partners

- **ACE IoT**
  - **William Maguire**, cofounder
  - **Andrew Rodgers**, cofounder
- **Middle Tennessee Electric (MTE)**
  - **Avery Ashby,** manager, Electrical Engineering
  - **Glenn Hollandsworth**, manager, Member Revenue & Programs
  - **Robert White,** vice president, Community Relations & Member Services
- **Murfreesboro Housing Authority (MHA)**
  - **Thomas Rowe**, executive director
- **Oak Ridge National Laboratory (ORNL)**
  - **Borui Cui**, research and development staff, Grid-Interactive Controls Group
  - **Jin Dong**, research and development staff, Grid-Interactive Controls Group
  - **Teja Kuruganti**, section head, Advanced Computing Methods for Engineered Systems
  - **Melissa Lapsa**, program manager, Buildings Technology
  - **Helia Zandi**, research and development staff, Computational System Engineering Group
- **SmartMark Communications, LLC**
  - **Meredith Salefski Ponce**, associate vice president
  - **Juliet Shavit**, president and chief operating officer
- **Tennessee Valley Authority**
  - **Lisa Akins**, senior program manager
  - **Georgia Caruthers**, senior project lead
- **United Communications**
  - **Rick Jurosky**, chief technology officer
  - **Josh Lynch**, chief customer officer
  - **Jodie Miller**, director, Customer Operations

Lessons Learned

1

Communicate with Project Partners Strategically

Effective communication plans are vital to ensure timely decision-making and efficient alert systems for addressing hiccups or challenges, especially for complex project teams with multiple stakeholder groups. Establishing a strong communication plan from the start, with agreed points of contact, ensures streamlined coordination. This approach is essential for large-scale deployments, allowing teams to identify and address regional and individual challenges during pilot phases. Regular communication, such as weekly calls and real-time problem-solving, ensures all priorities are met, key individuals are always informed and updates to the resource hub are made.

Recommended Communications Activities:

- Conduct weekly project team calls to ensure alignment among all stakeholders
- Have a communications plan in place from the beginning, with key points of contact for each essential function
- Create a file system accessible to all team members with partner responsibility agreements, project objectives, detailed outcomes and any other important documentation

2

Plan for Contingencies

Construction delays at MHA and subsequent fiber optic installation issues forced a reevaluation of the deployment timeline. While not an option for this pilot project, considering alternate facilities that meet project objectives as backup options could have mitigated some delays. Planning for contingencies, including alternative deployment locations, is essential for managing unexpected setbacks. This ensures the project can continue progressing even if initial plans face obstacles.

Lessons Learned

3

Build a Diverse Project Team

Engaging consumers requires cross-functional teams during the planning phase. To ensure all perspectives are considered and addressed in the project planning process, include representatives from all stakeholder groups as soon as possible. This project team experienced minor delays when they uncovered a gap in their planning for device installation, recognizing that responsibility for that step had not been assigned; the project team enlisted United Communications, a partner from the Phase 1 pilot project and subsidiary of MTE, to complete the installations, which was outside of their original scope of work. Combining the expertise of communication teams, customer experience representatives and marketing teams with installation, technology and engineering experts in the initial planning phase ensures a holistic approach to program design and execution.

4

Consider the Perception of Your Customers

A core focus for the Connected Communities initiative is enabling energy equity, which means that many pilot projects will be deployed in underserved areas. The project team was mindful not to appear as though it was using limited-income residents as test subjects for new technology, instead leaning into familiar communications channels and in-person consultations. Limiting the number of events per month and placing parameters on the technology's use helped address this concern. Ensuring the right demographic is chosen for pilot projects and maintaining clear, respectful communication with participants builds trust and fosters positive relationships.

Lessons Learned

5

Thoroughly Test Technology Before Involving Customers

Pilot projects provide critical environments for the development and testing of technology, ensuring customer impact at scale is minimized. The project team experienced issues with smart technology support and integration, leading to additional customer visits for equipment troubleshooting and adjustments. Thoroughly testing the entire system using the finalized components and devices can better ensure sustainability and minimize disruptions for participants. For example, making sure that apps and devices work seamlessly and are user-friendly prevents confusion and enhances the overall experience. Future project teams may consider conducting a smaller test group composed of friendly individuals, such as utility employees, to test the technology ecosystem before customer deployment.

6

Set Attainable Goals

Setting realistic and attainable goals ensures clear outcomes that enable stakeholders to better measure the success of the holistic system. The initial goals of completely integrating the Open-HEMS with MTE's existing app were unmet by the end of the pilot project, due to the abbreviated timeline for technology testing and deployment. While a single app was an outcome outlined in the original project scope, the project has successfully developed and deployed software that is now available and viable at scale, should local power companies wish to adopt and integrate it into their existing interfaces.

Looking Ahead

With the connectivity and smart devices in place, the project team plans to continue demand response events and data collection through the end of the year to maximize impact and provide valuable insights for other communities.

Monthly data evaluations will be conducted to gather learnings, run events smoothly and collect comprehensive data and compile insights at the project's conclusion. These insights will inform future scaling efforts or potential modifications to the program.

The project's success could lead MTE or other local power companies to adopt the app, significantly lowering the cost and effort required to develop such technology independently. The open-source nature of the app ensures that any local power companies can utilize it without incurring additional expenses, providing a valuable resource built on the project's foundational work.

> **It would have cost a lot of money and a lot of time and energy for another organization to create something like this. But now we've got the building block there. And since it's open source, it can be used by any of the local power companies without any cost.**

BILL MAGUIRE | cofounder, ACE IoT Solutions, LLC

> **I'm so glad that we have participated because if there is anything that we can do to encourage curiosity around this space for any of the other local power companies, any other connected communities, it's worth it. I think that we'll probably be the ones who have made it a little easier for someone else in the future.**

ROBERT WHITE | vice president, Community Relations and Member Services, MTE

Looking Ahead

Next Steps: Exploring Viability at Scale

The project team will be conducting a scale-up analysis based on the pilot study results. This analysis will be invaluable for planning equipment purchases for other projects in the region. The focus will be on both retrofitting existing buildings and incorporating new construction, with a particular emphasis on limited-income housing. Cost efficiency is crucial, so the team is aiming to identify the minimal number of sensors and actuators needed to maintain an effective system.

This approach ensures the maintenance of efficient buildings, HVAC systems and water heaters while keeping costs low. This is particularly important as the industry moves towards greater electrification and needs scalable, cost-effective solutions applicable to a wide range of communities across the region.

> **"To have an impactful demand response program, broad participation is essential. This involves managing and orchestration of the power usage of various devices commonly found in buildings. A crucial aspect of this project is enabling seamless information exchange and determining the minimum data to understand the occupant behavior while offering benefits to both residents and utilities through integrated optimization. We are developing an approach that can be applied to a diverse range of building types.**

HELIA ZANDI | Research & Development, ORNL

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