Residential Line Voltage Smart Thermostats: A Joint Action Approach

Final Report

WPPI ENERGY

OVERVIEW

The goal of the project was to provide utilities with a low-cost program for residential customers to control their baseboard electric resistance heat costs. In coordination with 17 of its member utilities, joint action agency WPPI Energy explored the energy efficiency potential of line voltage smart thermostats (LVSTs).

Electric resistance heat, while inexpensive to install, results in higher energy bills compared to natural gas furnaces or heat pumps. According to the 2015 Energy Information Association Residential Energy Consumption Survey, about 12% of households with income below $20,000 per year are primarily heated using built-in electric resistance heaters. Meanwhile, only 2% of households with income above $100,000 per year use electric heaters. LVSTs offer a cost-effective solution to help ease the energy burden of residents using electric resistance heat, who are more likely to be low income.

Locally owned municipal utilities are well positioned to assist lower income households pursue energy efficiency by implementing LVSTs.

WHAT IS AN LVST?

An LVST allows a customer to manage their electric resistance heat via a smart phone or tablet.

Some LVSTs also have learning capabilities and geolocation functionality. Geolocation monitors the proximity of a user's phone to determine whether or not the user is at home. If the user is not home, the LVST will automatically begin setting the temperature back. In order for a customer to utilize all of the functionality of an LVST, that customer must have both Wi-Fi and a smart device, such as a tablet or a smart phone.

The LVST pilot program provided incentives and support to assist customers with the installation of LVSTs in order to manage the costs associated with electric resistance heat. The program targeted residential customers for the installation of LVSTs through the following three steps:

1. First, customers most likely to use electric resistance heat were identified by examining their billing data.
2. Second, the pilot program was marketed to identified customers.
3. Third, for a small co-payment, residential customers were able to purchase LVSTs to control their electric resistance heat.
    - A group-buy was coordinated for the installation, using local electrical contractors.
    - The LVSTs were installed prior to the heating season of 2020/2021.

The results of this study will help inform the integration of LVSTs into energy efficiency programs throughout the United States.

Project Challenges

Multifamily housing

Most electric heat is located in multifamily units. Landlords and tenants can have differing goals when the landlord owns the property, but the tenant is paying the electric bill.

Some landlords were interested in the technology. However, not all tenants want smart technology even when their landlord is motivated. Additionally, when there is tenant changeover, the new tenants require education on the LVST.

Recycling used thermostats

Used thermostats may contain mercury, so the program creators searched for and found a free recycler in the area. This step would need to be repeated when other utilities promote LVSTs.

Varying installation costs

Installation costs varied in different service areas, making it more difficult to predict final expenses.

Coordinating installations across multiple areas

Joint action was valuable for this project in that it streamlined analysis and marketing. It also allowed participants to receive a deeply discounted price on equipment. However, it was challenging to work across many utility territories, as several different installers had to be brought in. Each installer had to be educated on the technology and the reporting requirements. In some cases, this led to missing or incomplete paperwork. It was a valuable benefit when proximity between utilities allowed a single installer to be used across several neighboring communities.

Thermostats not ENERGY STAR certified

We were unable to find line voltage smart thermostats that were ENERGY STAR Certified. Due to the lack of certification, it was more challenging to justify incentives through Focus on Energy, Wisconsin's statewide energy efficiency and renewable energy program.

Typically, an electric baseboard heater can be wired into a single-pole or double-pole breaker. This would determine whether the heat is wired 120V or 240V. It is not always easy for a resident to tell whether the existing wiring complies and upgrading wiring is costly.

Technology limitations

Some level of technical "know how" was required by the customer to understand whether the LVST would be compatible with their heating system. There were several cases where an electrician arrived onsite only to find that the existing wiring was not suited for an LVST.

Customer support

At the time of the pilot the thermostat vendor provided only chat support and did not have a phone number available. This was a source of frustration for some customers and installers. It's notable that since the pilot the company added a support number.

Global pandemic

The COVID-19 pandemic contributed additional obstacles. The program measurement and verification as originally proposed was not performed. The pandemic resulted in increased energy use for residential customers in winter 2020-2021 compared to winter 2019-2020. These increases can be attributed to customers spending more time at home due to restrictions. This resulted in an analysis based only on the program participants who saw reductions in energy use in 2020-2021 compared to 2019-2020.

Purpose

This study was undertaken to investigate the energy savings associated with LVSTs. Through this study, there is now a more comprehensive understanding of the benefits of LVSTs, with data to back their promotion and implementation.

Utility Name and Address

WPPI Energy
1425 Corporate Center Dr.
Sun Prairie, WI 53590

Utility Description

Member-owned, not-for-profit WPPI Energy serves 51 locally owned electric utilities. Together, WPPI members have built a diverse, competitive and responsible power supply. They share modern technologies and forward-thinking services, and they speak with a unified voice for effective energy policy advocacy.`

Key Personnel

Anna Stieve
SENIOR ENERGY SERVICES MANAGER
WPPI Energy
608-825-1758
astieve@wppienergy.org

Steve Lightbourn
MARKETING MANAGER
WPPI Energy
608-834-4519
slightbourn@wppienergy.org

Project Description

Engage member utility participation

The project began with the solicitation of participation from member utilities of WPPI Energy. 17 members chose to participate.

Identify a smart thermostat vendor

Three vendors were contacted, with Mysa being the selected firm.

Program design

Program financials had to be established. For example, customer co-pay, available rebates, grant expenses, and installation costs all had to be estimated and factored in.

WPPI worked with Focus on Energy to allow customers to obtain a "behind the scenes" rebate for LVSTs.

Customer marketing

The customer experience had to be considered, from designing the direct mail piece to creating utility branded landing pages for customer orders.

Billing data was used to identify customers who may have electric heat and those customers were targeted through the direct mail pieces. Broader marketing via social media was pursued by some utilities.

Customer ordering window

Customers were given a set window to order thermostats with a copay of $25 per thermostat. The thermostats were shipped to the utility offices.

Installations

A request for proposals was sent out to local electricians to quote the installations. The utilities hired the electricians, who then worked directly with customers to coordinate the installation of the thermostats.

Unused thermostats

In some cases, thermostats could not be installed. Those were returned and old thermostats were recycled.

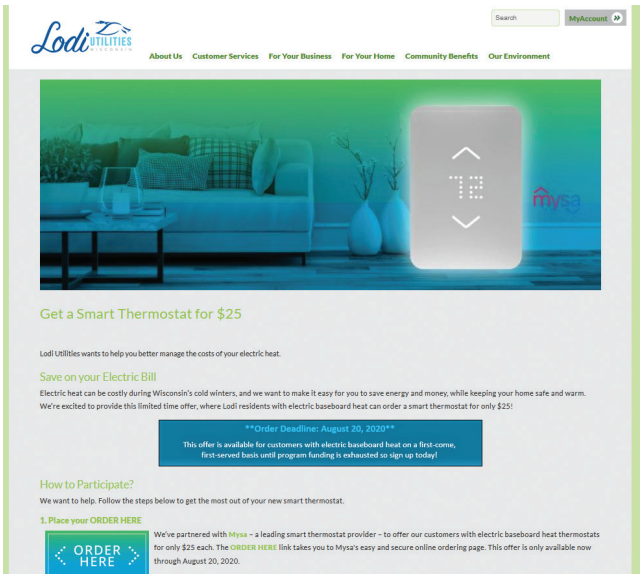
Measurement and verification

Energy savings for customers who did save energy was used in the analysis. Due to the timing of the pandemic, which began in spring 2020 while the project was taking place, it was assumed that if a customer used MORE energy after installing the thermostat, it was likely a result of the COVID-19 pandemic.

Tool Development

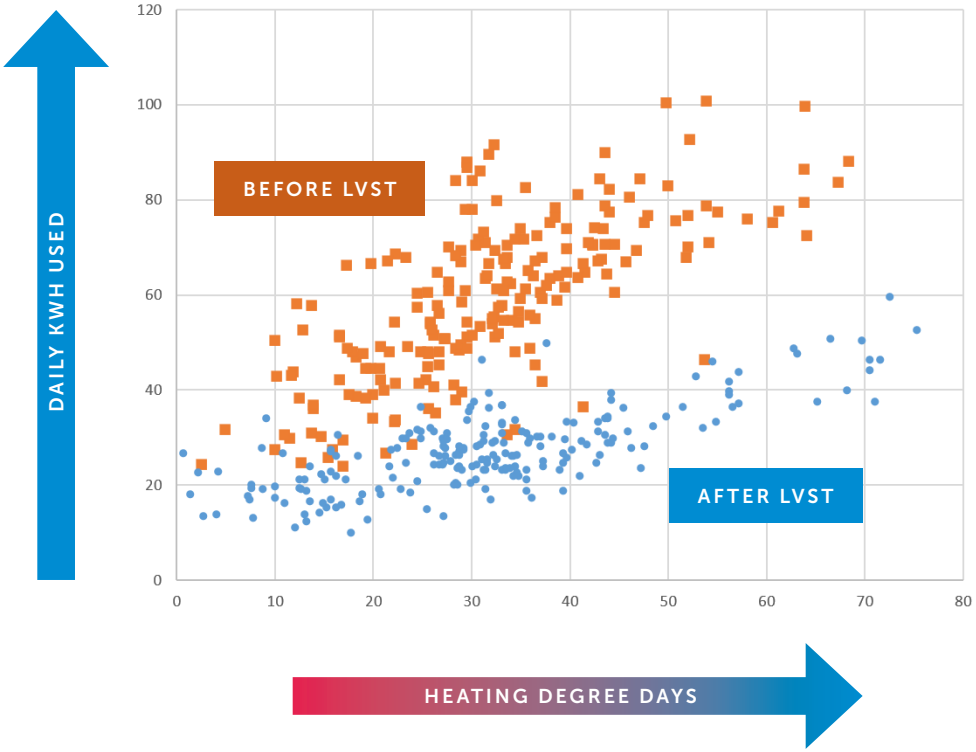
An in-house, MS Excel based tool was created to identify customers with electric heat. The tool was based on a data model within MS Excel, which crashed and broke by the end of the project.

Excess unused funds remain available. Approval was granted to use these funds and coordinate with an outside firm to develop a more robust MS Excel based tool. The new tool may be used in the future to identify electric heat customers across the entire WPPI Energy membership.



Diagram

Below is a graph from the measurement and verification process for a sample customer. The customer's daily energy use was plotted against heating degree days for each winter day. The installation of the LVST resulted in a significant reduction in energy use for this customer.



Dates

- DEED application – February 2020
- Program design – Summer 2020
- Thermostat installation – Fall 2020
- Data collection – 2021-2022
- Tool development 2022-2023
- Final report – 2023

Alternatives

For customers with electric baseboard heat, alternative solutions in place of the thermostat may include:

- Switch the fuel and install natural gas for heat
- Install a heat pump
- Install a simpler, programable line voltage thermostat
- Low/no cost options such as weatherization and manual thermostat adjustment

Alternative approaches to the program include:

- Provide rebates, but require customers to install themselves
- Many customers with electric heat had single-pole wiring serving their existing thermostat. The LVSTs used in this pilot are only compatible with double-pole wiring. There may be alternative LVST thermostats that work for customers with single pole wiring, which could be investigated

Results

Over the course of the project, 883 thermostats were installed with an average savings of 614 kilowatts per thermostat or around $70 per year per thermostat.

The measurement and verification results are not ideal due to the timing of the installations and the beginning of the 2020 pandemic. What is apparent, however, is that LVSTs are a great solution – for the right customers.

It is also clear that incentives will sometimes be necessary to make this technology viable for those customers. This is especially important because customers with electric heat typically have at least one thermostat in each room of their home. At the time of this report, the first cost of a Mysa thermostat is $129-149 per thermostat. LVSTs have great energy saving potential. But the first cost of upgrading an entire home will typically exceed $500.

Additionally, member utilities are now better equipped to offer customer programs that help residents more effectively manage their energy use and costs, particularly if those customers are using electric resistance heat.

Qualitative findings

The joint action approach was a great benefit to this project, allowing utilities to share resources and knowledge. This led to a better program and reduced overall costs.

WPPI Energy's member utilities share energy services managers. This project could not have been successful without them, as they dedicated a large amount of time and energy to supporting utilities, customers, and installers.

The program also led to increased benefits for customers outside of the participating utilities' territories. Focus on Energy is now considering incentives for LVSTs across all participants in the state of Wisconsin.

Customers with electric resistance heat benefited from the lower cost options the program provided compared to high-cost options like upgrading to a heat pump. Many customers enjoyed not only the energy savings, but also the increased convenience and peace of mind. Landlords who worked with the utilities formed better relationships with utility staff.

A good relationship with the thermostat vendor was also important. Ample support from Mysa in developing marking materials, hosting an online ordering site, coordinating a group purchase, answering customer questions, and orchestrating returns were all highly appreciated.

The direct mailing to customers (selected due to a high likelihood of using electric resistance heat based on utility analysis) worked well. However, program results suggest that future endeavors would benefit from online marketing. Some customers were not good candidates for LVSTs due to inexperience with technology, and online marketing may appeal more to customers more familiar with technology.

Two participating utilities chose to solely market through limited social media channels. There was very low participation in those communities. So, some form of direct marketing to customers with electric heat still has value. Utilities wishing to recreate this program may want to consider a direct email marketing campaign.

As with many direct installation programs, the installation was by far the most complicated piece. Using a single contractor would be beneficial in a more concentrated utility territory.

This program's designers worked on multiple approaches to identify customers with electric heat. Models using both monthly billing data and 15-minute electric use data, available through smart electric meters, were tried. Approximately 3,000 times more data was analyzed when using 15-minute electric data. However, the results were approximately the same. This suggests that billing data can be used to accurately predict if a customer has electric heat.

Status

The project has been completed to the satisfaction of the researchers and participating member utilities.

Applicability

Public power utilities across the United States are encouraged to consider promoting LVSTs to their residential customers who use electric resistance heat. Electric resistance heat takes longer to heat a space and costs more than other heating methods. It also disproportionally impacts customers with lower incomes. The new electric resistance heat identification tool can help utilities mine billing data to identify electric resistance heat users and promote LVSTs. Then, LVSTs can help those customers make their homes more energy efficient and lower their utility bills.

Future Plans

This project involved the development of a software tool that uses billing data to identify customers with electric resistance heat. The first list of customers relying on electric resistance heat was pulled for the 17 member utilities involved in the study. In 2023, a list of accounts likely heated with electricity is being created for all member utilities of WPPI Energy.

Potential uses of this information include:

- Market heat pumps or heat pump water heaters to identified homeowners
- Targeted outreach for energy assistance offerings
- Targeted communications regarding "energy saving tips for customers with electric heat" and other relevant educational materials

Meanwhile, member utilities may continue to offer LVSTs as a potential solution to customers with electric heat and high winter electric bills. Focus on Energy is collaborating with the thermostat provider to potentially offer incentives for LVSTs across the state of Wisconsin.

Equipment

Billing Software

A Microsoft Excel tool was used to identify residential customers with electric resistance heat. The software can be recreated by following the steps listed in the Electric Heat ID Tool Documentation at the end of this report.

Thermostats

Thermostats analyzed include:

- Sinope TH1500ZB
- Stelpro Maestro
- Mysa

Testing was performed in WPPI Energy employee homes in early 2020. After accounting for occupancy sensing abilities, price, customer/utility support, and location, the Mysa thermostat was the chosen winner.

Financials

Actual costs

	CONTRIBUTOR		
	WPPI/Member	DEED	Customer
Marketing	$3,500.00	$4,408.69	$0.00
Thermostats*	$44,150.00	$2,319.41	$22,075.00
Installation	$1,025.00	$36,609.61	$0.00
Tool Development	$0.00	$20,030.00	$0.00
Total	$48,675.00	$63,367.71	$22,075.00

*$3,270 credited to WPPI based on returns. Customers paid $25 per thermostat for 883 total thermostats.

Additional Notes

Full list of member utilities participating in the pilot study:

- Black River Falls Municipal Utilities
- Cedarburg Light & Water Utility
- Columbus Utilities
- Jefferson Utilities
- Kaukauna Utilities
- Lake Mills Light & Water
- Lodi Utilities
- Mount Horeb Utilities
- New Glarus Utilities
- New London Utilities
- Oconomowoc Utilities
- Plymouth Utilities
- Prairie du Sac Utilities
- River Falls Municipal Utilities
- Sturgeon Bay Utilities
- Sun Prairie Utilities
- Waunakee Utilities

References

Dear Mount Horeb Utilities Customer,

During this challenging year, we want to help you save energy and money while you keep your home safe and warm.

Get a Smart Thermostat for $25. Electric heat can be costly during Wisconsin's cold winters. We want to help. We've partnered with Mysa – a leading smart thermostat provider – to offer our customers with electric baseboard heat thermostats for only $25 each. Smart thermostats are proven to save up to 26% a year on your electric use.

To take full advantage, you should have the following:

- ✓ Electric baseboard heat *(required)*
- ✓ Wall mounted thermostat *(required)*
- ✓ WIFI network with router
- ✓ Smart device

To start managing your electric heat:

1. **Visit our website and place your order**
   mounthorebutilities.com/smart is where you can get complete program details and learn about all of the ways that using a smart thermostat can save you money. You can also link to our online ordering process that makes getting your $25 smart thermostat quick, easy and secure.
2. **FREE installation**
   We'll coordinate with a local electrician who will reach out to schedule your FREE installation this fall. Most installations can be completed in less than an hour.
3. **Download the Mysa app**
   Set schedules, define heating zones and access home energy reports! With the Mysa app, you can take control of your energy use and maintain the comfort of your home right from your mobile device. You can receive technical support directly from Mysa.
4. **Save energy and money; gain peace of mind**
   Not only can this thermostat save you big on your bill, it can also help you relax when you're away from home. Keeping an eye on your home's temperature is as easy as checking your phone.

****Order Deadline: August 20, 2020****
This offer is available for customers with electric baseboard heat on a first-come, first-served basis until program funding is exhausted so sign up today!
mounthorebutilities.com/smart

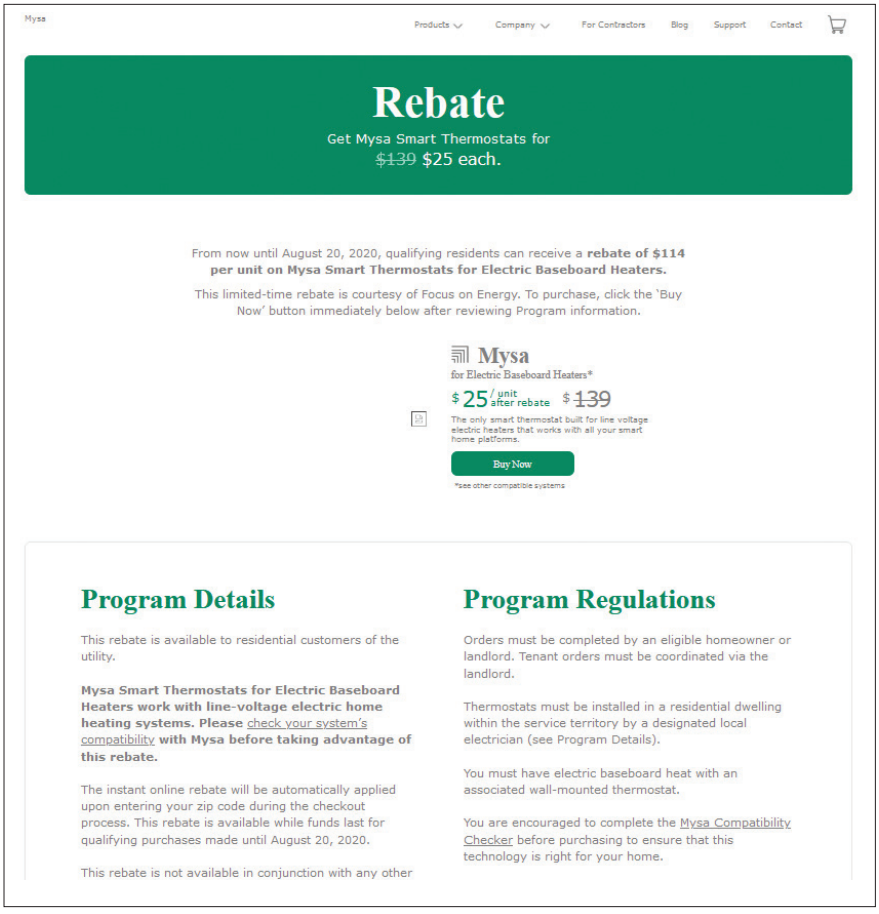
Tenants: Contact your landlords about this offer!

Please feel free to contact me with any questions at bcarlson@wppienergy.org or at 608.219.6763.

Sincerely,

Beth Carlson
Energy Services Representative

References (continued)



References (continued)

Electric Heat Identification Tool

Summary

The Electric Heat Identification Tool ("the tool") is an MS Excel Workbook that can be used to identify utility customers that use electricity for space heating. Users of the tool input electricity usage data for a set of customers, then the tool returns the list of customers ranked by a statistical metric that quantifies the degree to which electricity use is correlated with heating load. It is likely that customers ranked towards the top of the results table use electricity for space heating.

The purpose of this tool is not to derive unique information, but to help derive certain information more quickly and easily than by other means. Any results or output obtained from this tool are for convenience and information only, do not constitute advice, are provided as-is without warranty of any kind, and should not be exclusively relied upon for any particular purpose.