



It's Time to Swap Tradition for Impact.

Why decarbonization and electrification require real-time, app-based energy efficiency

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As utilities contemplate ways to manage the transition to a more distributed, electrified and decarbonized future, one thing remains the same: energy efficiency will be critical.

However, the traditional set of energy efficiency programs will not be sufficient. Demand Side Management (DSM) portfolios will need to find new, cost-effective sources of energy savings. Program planners will need to get serious about time and location specific measurement of their impacts. And customer program teams will need to learn how to balance electrification with both energy efficiency and reliability goals.

In pursuit of these objectives, behavioral energy efficiency (BEE) holds immense promise. Unfortunately, legacy BEE programs like Home Energy Reports (HERs) are still far too reliant on low engagement channels and outdated data. Further, there's concerning evidence of degrading savings in mature programs. It is time to seize upon innovation that brings together real-time home energy monitoring and next generation smart meters in a way that embraces customer preferences while enabling the utility to multiply gains from energy savings and achieve greater demand flexibility.



Yesterday's Solutions Can't Meet Today's Challenges

Measures to address climate change will drive a surge in electrification in the coming decades and, in turn, put new demands on utility energy efficiency programs. Market analysts predict that EV sales will capture 32% of total light vehicle sales by 2030.¹ The infrastructure bill, which has allotted \$7.5 billion for EV charging infrastructure,² could push consumer adoption of EVs even further. With it will come a surge of electricity use related to residential EV charging.

Buildings will become more electrified, too. Analysts expect heat pump sales in the U.S. to dominate the market.³ Already, leading states like Massachusetts and New York have issued executive orders with aggressive goals aimed at electrifying residential homes.

What Does This Mean for Utilities?

The role of demand side management (DSM) will become even more critical to the success of the utility. DSM programs like Behavioral Energy Efficiency (BEE) will see their importance elevated further and, along with it, the expectation to deliver greater energy savings and to do so more cost effectively.

Home Energy Reports (HERs) have been an important part of addressing energy efficiency awareness and have made significant impacts in delivering overall reductions in energy use, but they have major drawbacks as we view them against these new challenges:

- Customer engagement is too low
- Data and insights have high latencies
- Integration is complicated
- Cost effectiveness is waning as savings plateau or erode

These problems are aggravated by the way HER programs have been siloed, as if those communications with customers don't connect with other energy efficiency programs and the utility's ability to achieve greater demand flexibility.



Lifting engagement

Today many utilities are relying on regular mail or email as primary communication tools. Direct mail is expensive and nearly two-thirds is discarded and never read.⁴ Email delivery reduces costs, but with an average open rate between 30-35%, it still falls short. Low engagement numbers lead to stagnant energy savings. Studies have shown that most of the savings in large BEE programs are driven by a small number of customers. When the research firm Opinion Dynamics examined results from a HER program run by a large California investor-owned utility, it found that fewer than one in five participants (19%) could be called positive or very positive electricity savers after receiving their HERs.

Consumers now average 4.2 hours per day engaged with mobile apps.

Today, 85% of Americans have a smartphone and 97% have a cellphone, according to Pew Research.⁵ A report

from App Annie found that consumers now average 4.2 hours per day engaged with mobile apps. High adoption has changed customer preferences. A study conducted in the Netherlands offered participants a choice of energy feedback systems that included a smartphone or tablet app, a desktop (Windows) application or an online application. Most participants (84%) picked the smartphone app as their feedback method of choice.⁶

Simply providing mobile reports isn't enough. To lift engagement, utilities need to offer a combination of mobile delivery and real-time insights that are far more compelling to customers. This is important because real-time, mobile data is more actionable, insightful and accessible than conventional approaches to BEE.

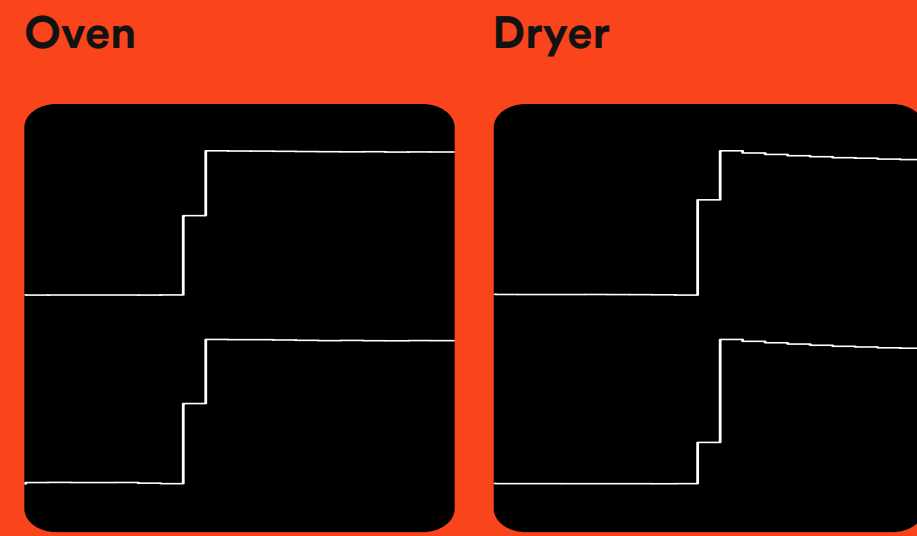
Changing behavior in an instant

Real-time data is more actionable.

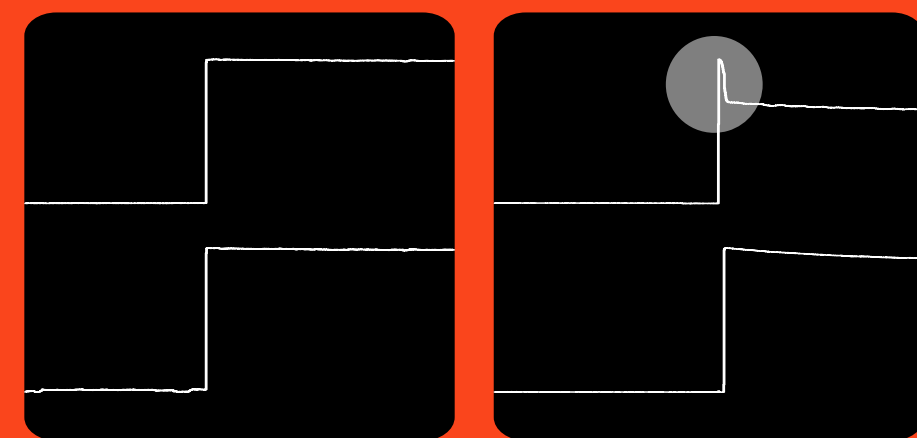
Historical, whole house energy usage data common to traditional HER programs is not engaging for the average customer and doesn't allow consumers to connect what they see in the report to what is happening in their homes. Participants in the Netherlands study wanted "more actionable insights that are applicable to their own situations," the researchers wrote.

While HER programs have incrementally adopted low resolution disaggregation (insights such as "air conditioning was 60% of your usage last month"), customers have lacked access to a real-time view of how their actions are impacting their energy usage and costs at the moment. Rather than drawing broad conclusions about a customer's energy usage in retrospect, next generation behavior programs should aim to influence customer behavior at the moment when it is most impactful to the grid and to the customer's bottom line.

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One sample per second



60 cycles per second

Figure 1.0 Shows the electronic signatures of two common household appliances: an oven and a dryer. The top images in this graphic show one-second interval data for an oven and a dryer. At this level of data resolution, while there are some differences in the energy tracks, the two appliances cannot be reliably distinguished by a disaggregation algorithm. In the bottom two images, power is displayed every cycle – 60 times per second – and there are now reliable clues. The electric dryer has a 120V motor on one power leg that starts 300 milliseconds before the 240V heating element and machine learning algorithms are able to use this to distinguish these two appliances in a home.

Interval AMI data (commonly sampled in 60-minute, 15-minute or rarely 5-minute increments), backhauled through utility meter networks every 24 hours is not sufficient for this experience. Customers seeking it have often turned to home energy management devices and in-home displays, but these lack end-use specific monitoring and they are costly to deploy at scale. These devices typically tell customers how much electricity the household is using, not how much power any single appliance is using.

Real-time Data + AI = Device level insights.

According to the IEA, about half of the average home's energy is dedicated to heating and air conditioning. Of course, this means that the other half is used by a wide variety of appliances and devices turning on and off in the home, with their energy usage going mostly unnoticed by the residents. It's now possible to capture device level activity and analyze it with AI to distinguish and track household appliances and devices in real time, but it requires far higher data resolution.

In the example (left), cycle-level data was sufficient to distinguish an electric oven from an electric dryer. For other devices in a home, even higher resolution is needed. For example, identifying the difference between an incandescent light bulb and some other resistive element can be seen in the first 30 milliseconds of the waveform - as the tungsten filament of the light bulb heats up, the

electrical resistance increases. Unless customers have an energy monitoring device that can capture data with high enough resolution that these millisecond-level changes are visible, people do not see a complete and dynamic view of their home. This results in lower engagement rates, which limits energy savings potential.

Mobile apps can share real-time data.

It isn't just the lack of high resolution data that hurts traditional BEE and HERs. It's the delay in sharing data, too.

Typically, customers who receive HERs see how their homes performed last month. The reports are outdated before they ever reach a customer's mailbox or email account. In today's world, customers need to know how a winter freeze or summer heat wave is impacting their energy bill while it's happening — right now — to be motivated to adjust their thermostat, schedule HVAC maintenance or invest in more efficient systems. This real-time feedback loop becomes the foundation for behavioral demand response as well as new time varied rates.

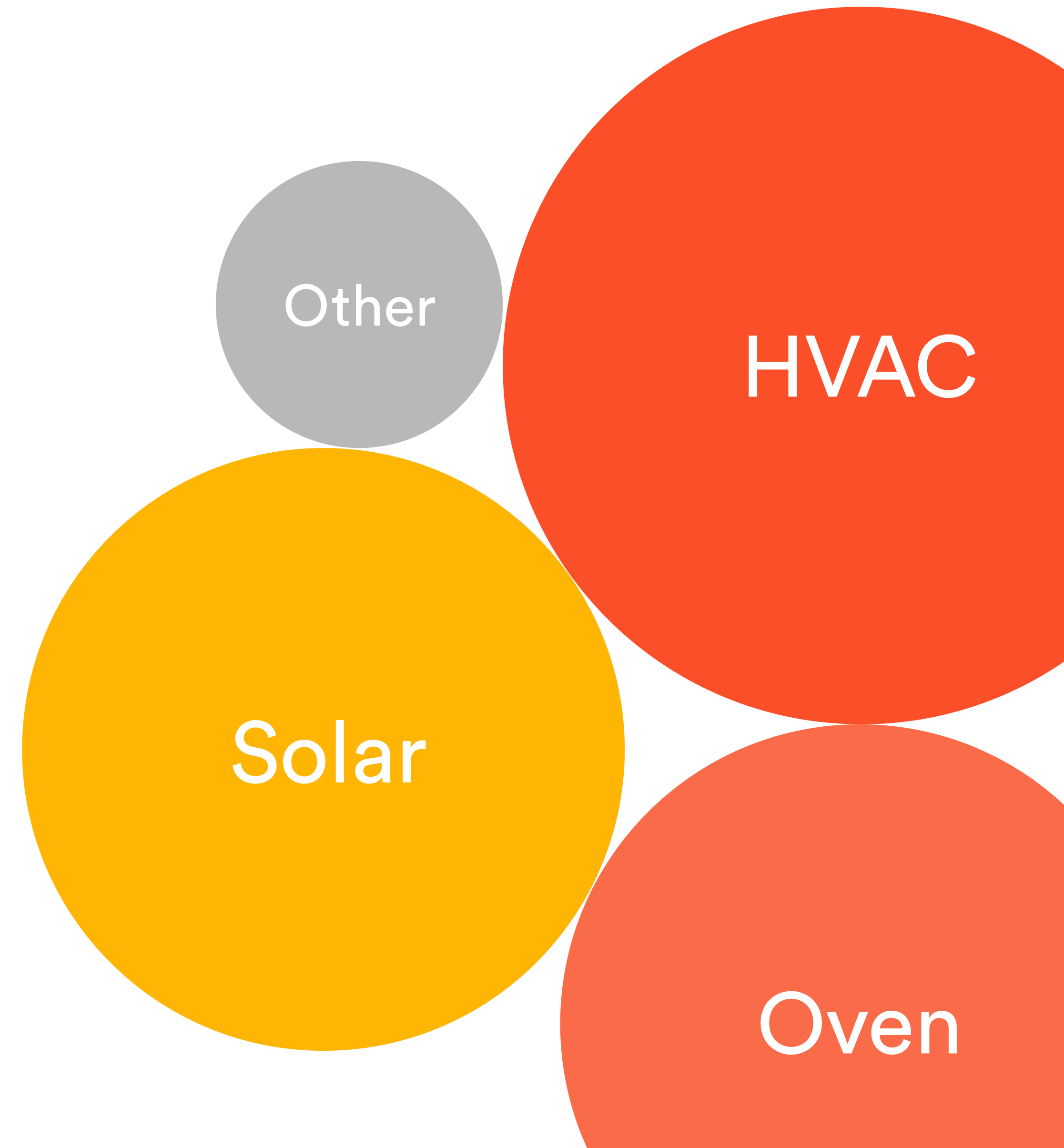


Sense: Home Energy Intelligence for Today's Challenges

Sense's waveform technology and edge computing embedded in the Revelo™ meter from Landis+Gyr, coupled with our award-winning customer facing mobile app, can help improve customer participation in energy efficiency and demand response behavior programs, resulting in higher achievement of energy reduction targets by utilities and lower bills for customers.

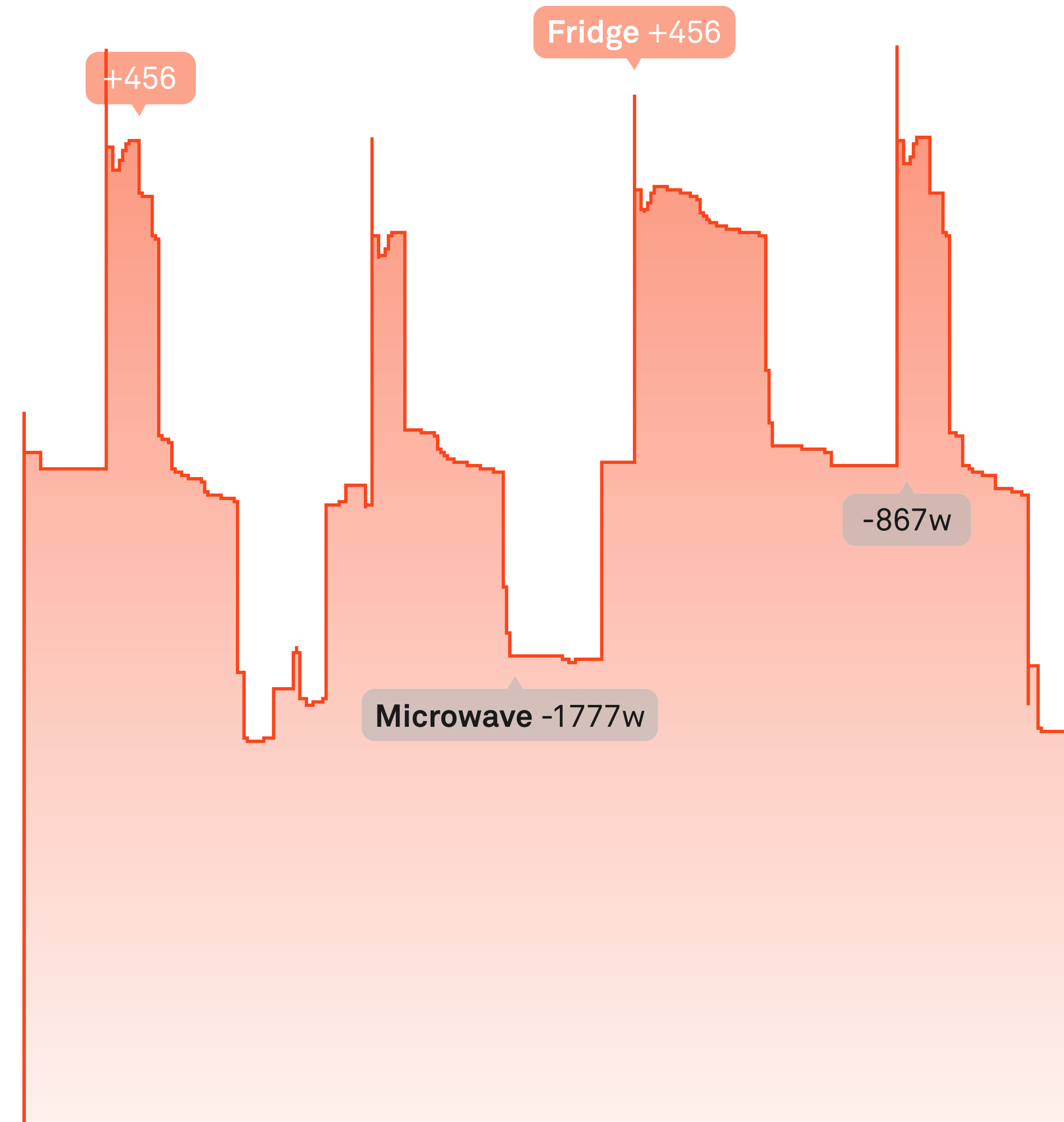
Sense offers: High-resolution data

The Sense-enabled Revelo meter samples current more than 10,000 times per second. This level of data resolution enables machine learning algorithms to correctly identify even small household loads, giving customers a comprehensive view of what is happening in their homes. Combined with edge computing and high bandwidth/low latency networking, this data is delivered in real time, so customers get disaggregated consumption insights on their smartphones and computers at the same time the electric power is being used.



An app-based solution

Given the amount of time people spend on apps now – 4.2 hours per day – it makes sense to offer home energy information via a full mobile app experience. In the Sense app, customers can see total power usage in the home in real time, along with a timeline of device activity in the home. They receive instantaneous, specific insight into what's on and how much power each device is using.



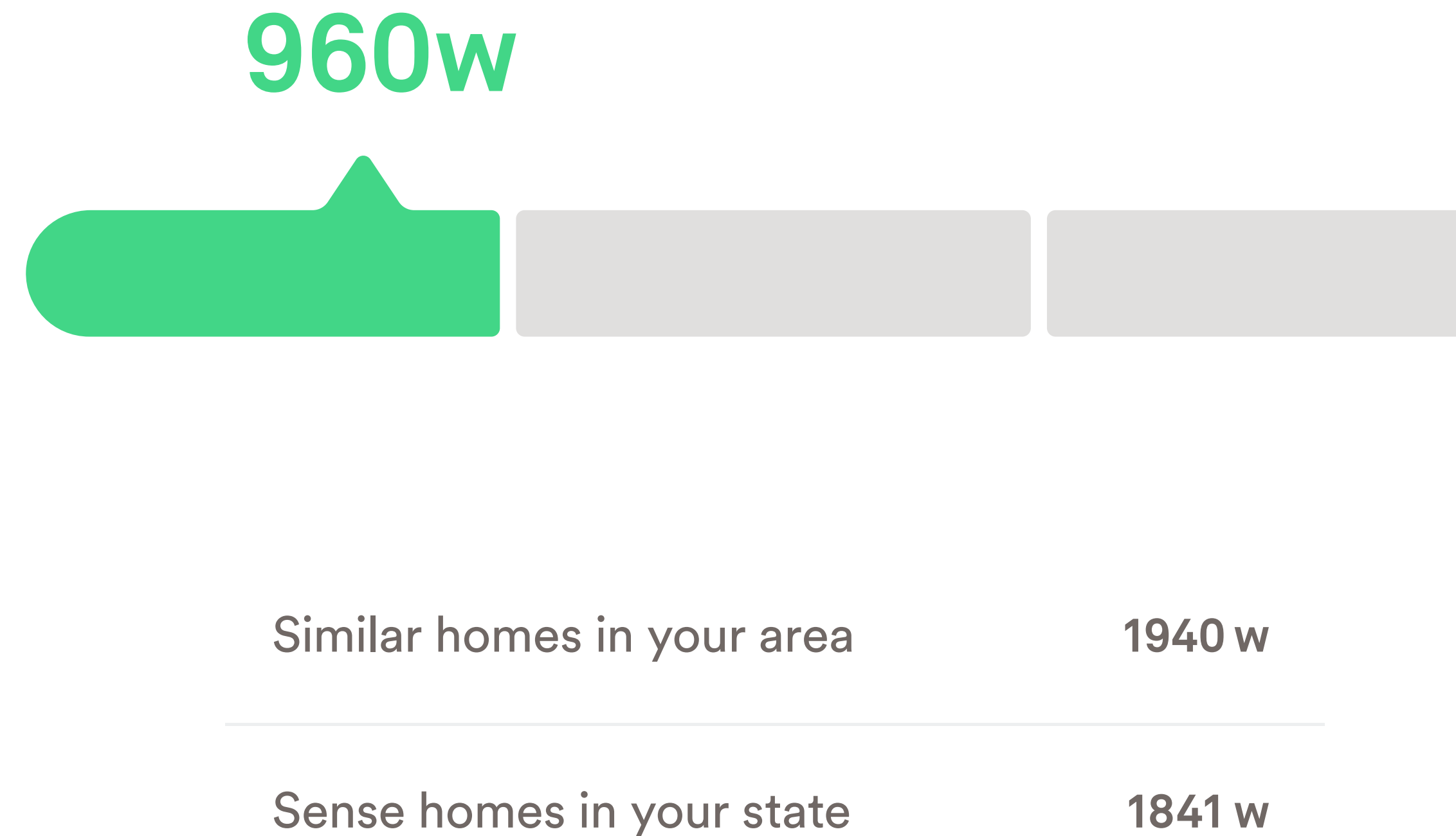
Comprehensive information at a customer's fingertips

Customers should be able to observe historical trends at the whole home level and device level. For customers, the Sense app delivers whole home consumption and, for those with rooftop solar arrays, it shows generation and solar power use. For people with electric vehicles, it enables them to track charger consumption, peak usage and runtime. For utilities, the monitor delivers high-resolution power quality data to support deeper analyses.



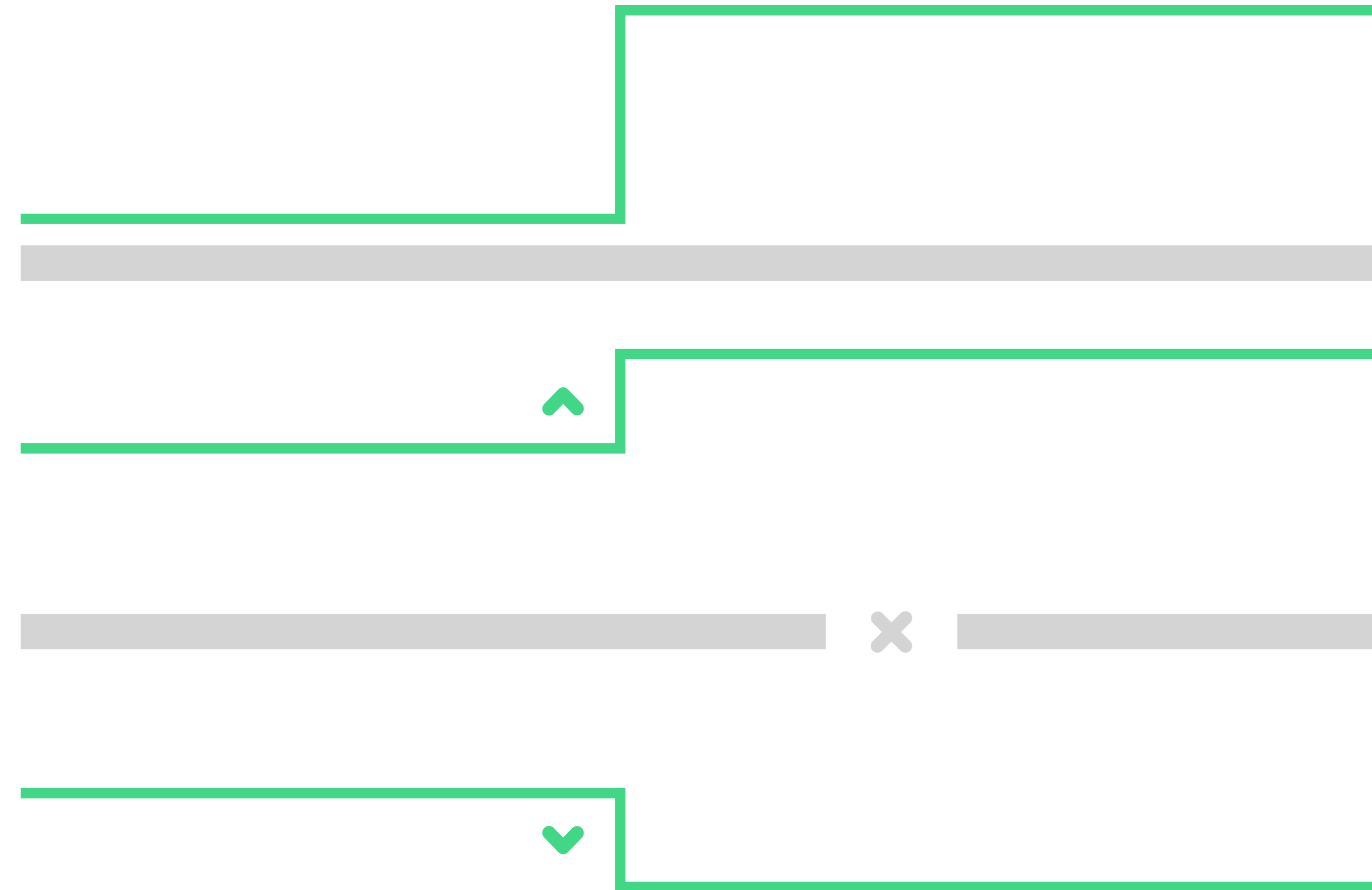
More meaningful benchmarks

Peer-related comparisons are a time-tested motivator. In the Sense app, customers go beyond the standard whole home comparisons to a series of benchmarks that motivate more kinds of savings. For instance, in the Sense app, customers with AC can compare their AC usage to similar sized, nearby homes. Customers can also live their values by seeing carbon reduction from the energy savings they achieve. Users can also set specific goals for energy usage or budgets and get alerts to track their progress.



Home safety information and alerts

The same high-resolution data that enables device-specific disaggregation on even small loads can also give customers access to power quality, AC compressor failures and floating neutral analytics. These insights help customers find electrical problems within the home and to fully consider remedies that could also lower energy use before disaster strikes.



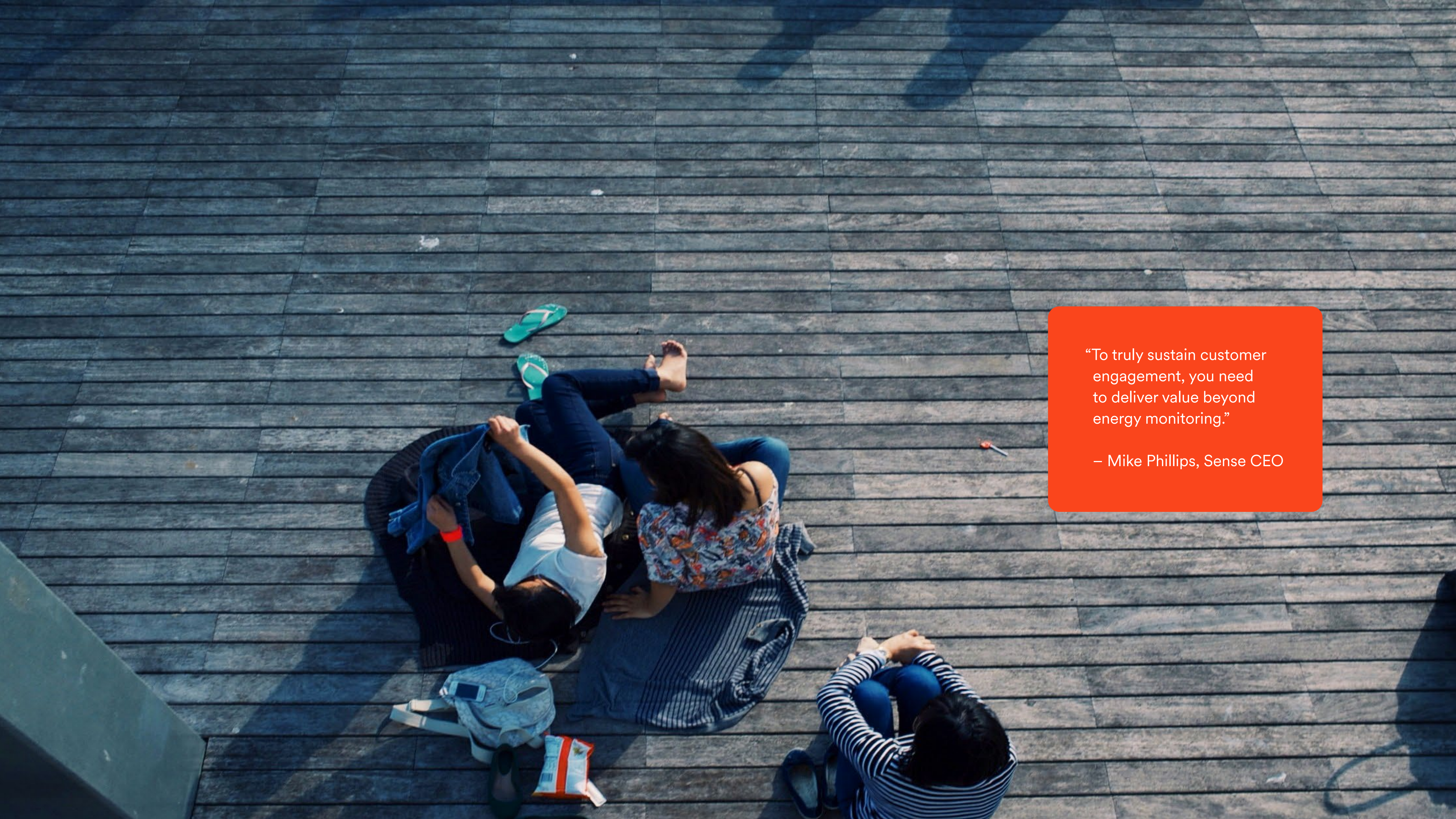


Improving Outcomes for Utilities and Customers

Delivering greater savings

Many traditional HER programs have been running for a decade now. Savings persistence is an issue and there is documented erosion of savings. One study conducted by The Cadmus Group found that response to HERs deliver their highest rate of energy efficiency savings during program year one and continue to grow at a lower rate during program year two, but then levels off in subsequent years.

Traditional behavioral energy efficiency programs deliver annual per-customer energy savings in the range of 1% to 2.5%. At that rate, utilities won't succeed in delivering the scale of energy efficiency that is required to meet climate change goals. BEE programs must do better.



“To truly sustain customer engagement, you need to deliver value beyond energy monitoring.”

– Mike Phillips, Sense CEO

Alliant Energy Case Study

Alliant Energy, a Midwest utility serving 960,000 electricity customers, piloted the app-based Sense Home Energy Monitor to study how the disaggregation of energy consumption and a real-time customer experience with the Sense app could impact behavior and inform the development of new energy-saving programs.

Billing analysis by The Cadmus Group revealed participants shaved between 6%-8% off their annual utility bill, often without making costly appliance upgrades. Detailed analysis of device consumption during MISO peak days revealed that after air conditioners, “always on” loads, refrigerators, and dryers were the highest contributors to peak load. The study also found:

8–9%

Potential savings per home from “Always On” load

57%

Had improved opinion of Alliant Energy

58%

Purchased at least one new energy-efficient device

Energy savings is the driver for BEE programs, and with Sense home energy intelligence, it’s just the beginning of the benefits utilities can achieve. Real-time, app-based home energy insight creates a much more compelling experience for customers, and it shows in their engagement with the Sense app. **Nearly 60% of Sense users remain long-term active users. Approximately half of those users open the app on any given week with an average of 6.5 app sessions per week.**

One reason is that customers use the Sense app for more than energy efficiency. The Sense app tracks activity across the home such as the garage door opening and closing or a microwave turning on when a teenager comes home from school and heats up a snack. These insights can be even more compelling when they apply to electrical safety, such as checking to make sure an appliance is off after leaving the home. These lifestyle insights keep users engaged over time.

Simplifying integration and roll-out

For most utilities, putting together customer analytics based on utility AMI data is a multi-step process that requires integration with third party software. To protect customer privacy and ensure security, the integration alone can turn into a complex, multi-month data IT project that many utilities don’t have the resources to manage.

Because Sense intelligence runs on next generation smart meters like Landis+Gyr’s Revelo™, the entire program is simplified. There’s no reason utility operations or customers should have to install additional hardware in homes to deliver monitoring capabilities. The Sense enabled Revelo meter makes it as simple as downloading the Sense app from Google Play or the Apple Store. The accessibility of the Sense app, which is offered at no cost to customers, ensures that utilities are achieving their goal of equitably serving all customers, delivering important tools to manage their home and control energy use.

And because utilities don’t roll out such technology every day, Sense offers a comprehensive roll-out plan and simple onboarding processes with step-by-step instructions for customers to easily follow.

Sense has built its leadership in the consumer market. Sense’s program team works with utilities, leveraging our market research and proven messaging to educate and activate utility customers. We understand customer attitudes, needs, motivations, and concerns as it relates to energy savings and technology. Our experience informs our user segmentation and messaging development and enables us to execute a multi-channel program to activate the right customers to meet utility goals.



Getting to More Automation

In addition to a lack of data granularity and timeliness, traditional home energy reports don't support dynamic energy control because they haven't been tied into a whole-home energy management system (HEMS) or even device-specific controls, such as some smart thermostats or EV chargers.

Set-and-forget energy efficiency delivers a more powerful punch than voluntary programs where customers have to do things manually to respond to price signals from the utility. An app-based approach like Sense will enable customers to easily program their own response preferences into home-automation tools to effectively manage household energy, optimizing cost savings or carbon reduction impact.

OhmConnect Case Study

Sense recently collaborated with OhmConnect to assess the impact of customer access to real time, appliance specific energy use and notification of peak event savings. Through a combination of OhmHour rewards and high engagement with the Sense app, Sense participants increased savings over a typical Ohm customer by 160%.

18%

Reduction in home energy usage

74%

Rated Sense notifications as important

4X

More likely to delay high-energy tasks like laundry

In a recent study, Sense found that automating EV charging when carbon intensity from the grid was lowest could lead to reductions in carbon emissions up to 14% on average across the U.S. and up to 43% in California.⁷ This kind of automation could make a big impact both on reducing carbon emissions and balancing demand.

A Platform for Growth

When customers engage more actively, it opens the door to a variety of additional opportunities. Programs for behavioral demand response, EV charging, solar integration and time varying rate schedules can all benefit from higher customer engagement which flows from real-time experiences and continuous energy monitoring.

Supporting demand flexibility

Mid-cycle or day-ahead notification of critical peak rates are simply not an effective tool to provide flexible demand for the utility. The energy monitoring technology must be a real-time resource to support effective demand response efforts.

The high engagement that app-based BEE can deliver is important, and it will become even more so as electrification of home heating and transportation increases, which will likely require more grid flexibility. Demand response can

deliver that flexibility, but only if customers are willing to partner with utilities and participate in time-based rates and load control. When a utility gains high customer engagement from the Sense app, customers have more favorable opinions of the utility, enrollments and program effectiveness rise and program costs drop.

Delivering enhanced customer service across the customer journey

Data and insights from Sense enable customers to troubleshoot power issues around their homes on their own. All relevant data can also be integrated with other key utility systems. When they do need to call customer service, CSRs can see the same information a customer sees and deliver more insight for the customer. Data from high-resolution disaggregation can also help utility system operators see issues on the grid and troubleshoot issues before bigger problems arise.



Customers are Key to a Resilient, Clean-Energy Future

To meet climate change goals, utilities are modernizing and digitizing the grid with significant technology investments. However, it should not go overlooked how customer behaviors will impact the success of these efforts. A strong vision of the customer experience was notably absent in the early days of smart meter selection. The result; many of the promised customer benefits and related utility goals have fallen far short of expectations.

DSM portfolio managers and customer experience stakeholders must have a seat at the table from the project's inception when selecting new technology. When these teams collaborate with grid modernization leaders, they select next generation smart meters that support edge-computing with access to high resolution waveform data needed for real-time customer experiences like Sense.

Sense innovation delivers better results for energy efficiency and demand response programs. And utilities will be able to track EV charging, discover power quality issues, run analytics on the highly granular data

they pull back from the grid, monitor system voltage for Volt/VAR optimization and more.

The grid gets more and more complex each day, and a high-resolution, app-based approach to BEE can help utilities not only manage energy resources more effectively, but at a lower cost for utilities and their customers. In the end, traditional BEE programs are a peek at the past, while technology like Sense and the Sense app are powerful tools for the future.

About Sense

Sense's mission is to reduce global carbon emissions by making homes smart and efficient. We empower people to care for their homes and families while contributing to a cleaner, more resilient future.

To learn more, visit sense.com/utilities.





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