Customer Response to Demand Response

How Automated Emissions Reduction (AER) environmental messaging and traditional economic incentives influence customer reactions and program enrollment.

CONTACT

Henry Richardson, Senior Analyst, WattTime (henry@watttime.org)

CONTRIBUTORS

Peter Bronski (Inflection Point), Laura Corso, Geoff Hancock, Gavin McCormick, Henry Richardson, Katie Ryan

** Listed alphabetically by last name. All contributors from WattTime unless otherwise noted.*

ACKNOWLEDGMENTS

Special thanks to our project partners and especially the technical advisory committee members supporting this work, including:

Shaun Brown, Itron
Brandon Davis, JCI
Shannon Donley, GLPF
Scott Hackel, Slipstream
Jack Hays, OhmConnect
Justin Margolies, Slipstream
Don McPhail, Uplight
Jason Meyer, RMI
Asa Parker, VEIC
Doug Sansom, NRG
Luke Scheidler, Itron
Katie Siegner, RMI
Mark Silberg, RMI
Brittany Strumbel, CLEAResult
Marika Tomschin, OhmConnect

** Listed alphabetically by last name.*

ABOUT WATTTIME

WattTime is a nonprofit with a software tech startup DNA, dedicated to giving everyone everywhere the power to choose clean energy. We invented Automated Emissions Reduction (AER), which allows utilities, IoT device and energy storage companies, and any end user to effortlessly reduce emissions from energy, when and where they happen. Our cutting-edge insights and algorithms, coupled with machine learning, can shift the timing of flexible electricity use to sync with times of cleaner energy and avoid times of dirtier energy. We sell solutions that make it easy for anyone to achieve emissions reductions without compromising cost and user experience. WattTime was founded by PhD researchers from the University of California, Berkeley, and in 2017 became a subsidiary of Rocky Mountain Institute. WattTime is a founding member of Climate TRACE, a global coalition working together to monitor nearly all human-caused GHG emissions worldwide independently and in real time.

Great Lakes Protection Fund

ABOUT THE GREAT LAKES PROTECTION FUND

The Great Lakes Protection Fund's mission is to "identify, demonstrate, and promote regional action to improve the health of the Great Lakes ecosystem." The Fund is a permanent, private, not-for-profit corporation that launches innovative solutions to improve the health of the Great Lakes. Since 1989, the Fund has awarded more than $90 million in support to catalyze the continuous development of new technologies and practical regional actions to improve the health of the Great Lakes.

IMAGE CREDITS

Cover: Muzammil Soorma | Unsplash

Page 2: Max Bender | Unsplash

Page 5: Dan Price | Unsplash

Page 12: NOAA | Unsplash

Page 14: Lucas Ludwig | Unsplash

Page 16: Charlie Wollborg | Unsplash

Table of Contents

Executive summary

For decades, utilities have used traditional demand response to help manage the power grid in two important ways: 1) to support grid reliability, and 2) to reduce costs. Now increasingly, demand response is also being recognized for its potential environmental benefits, including reducing power grid emissions and absorbing surplus renewable energy.

Demand response program participation varies, but is generally low. Program structures typically rely on a financial incentive for participation. WattTime and our partners wanted to see if customer appetite would increase if presented with a compelling environmental impact message.

In this report, we analyze how different residential demand response offerings—financial incentive-based programs vs. an environmental-based demand response program using WattTime's Automated Emissions Reduction (AER)—influenced customer enrollment in demand response programs. The Great Lakes Protection Fund (GLPF) provided the funding for this pilot program.

The region's move away from fossil-fueled generation is an important vector for cleaning up the Great Lakes' legacy of mercury pollution. With an AER signal powering environmental demand response for even half of the smart devices in the region, it would be possible to eliminate 269 pounds per year of mercury emissions—more than 20% of the total atmospheric mercury deposition in Lake Erie each year.

For the pilot program, customers followed a three-step pathway: 1) see a social media ad, 2) visit a website landing page to learn more, 3) complete a sign-up form to enroll and then activate their thermostat. They were presented with one of three messages: 1) clean energy choice with AER-based environmental demand response, 2) traditional demand response with a financial reward, and 3) a combined message.

Key findings include:

- While all three scenarios had comparable clickthrough rates on the social media ads, **AER-based environmental demand response had a 12% stronger conversion rate for program sign-ups from the landing page**. This translated into a 5% lower cost per sign-up, in turn enabling marketing budgets to go further.
- **Customers that enrolled via the AER-based environmental message pathway showed significantly stronger engagement** with demand response programs. They were 2–3x more likely to connect and activate their thermostat. As a result, it costs 71% less for each demand response-enrolled thermostat in an AER-focused program.
- Our results suggest that 'free' AER-based environmental demand response unlocks massive program budget savings, since customers enroll without the expectation of financial incentive payments. **Taking into account 12 months of program participation, one-year utility costs for AER-based environmental demand response customers were 80% cheaper per sign-up** and 72% cheaper per device vs. financial incentive customers.

We see several 'no regrets' actions that utilities and demand response aggregators could begin implementing today:

- Offer AER to traditional residential customers with smart thermostats enrolled in existing automated demand response programs to realize environmental / emissions benefits immediately.
- When designing new demand response programs, implement AER and continuous optimization for emissions reductions from the start to take advantage of environmental outcomes.
- Incorporate environmental outcomes (e.g., GHG emissions reductions, local air quality improvements) into dashboards, utility billing, social media, and other customer-facing touch points to boost customer engagement and retention and bolster utilities' brand reputation and customer relationship.

Demand response aggregators and utilities both have roles to play advancing AER-based environmental benefits via demand response programs.

The successes—and challenges—with traditional demand response

For decades, utilities have tapped into traditional demand response—sometimes called DR 1.0—to help them manage the power grid in two important ways: 1) to support grid reliability (such as shaving load when peak demand threatens brown outs), and 2) to reduce costs (such as curtailing or shifting load to avoid price spikes during peak demand periods).

Demand response in the United States is a significant resource. By gigawatts of installed capacity, it is the country's largest category of distributed energy resources (DERs)—larger than rooftop solar, electric vehicle charging, and grid-connected batteries combined. According to SEPA's most-recent *Utility Demand Response Market Snapshot*, utilities representing 64% of U.S. electric customers reported 20.8 gigawatts (GW) of capacity enrolled in demand response programs; mass market demand response, which includes residential and small business customers, accounted for just over one-third of that capacity. The Brattle Group's 2019 report *The National Potential for Load Flexibility* estimates that nationwide demand response totals nearly 60 GW of capacity.[1]

Yet demand response could be an even greater resource. The SEPA report noted that less than 60% of the nearly 21 GW of demand response capacity was dispatched at any point during 2018. The Brattle Group report notes that the U.S. could have nearly 200 GW of cost-effective load flexibility available for demand response by 2030, yielding more than $15 billion per year in benefits. Plus increasingly, demand response is being recognized not just for its traditional benefits, but also for its potential environmental ones, including reducing power grid emissions and absorbing surplus renewable energy to reduce unnecessary curtailment.

However, whether for grid reliability, cost, or environmental considerations, the effectiveness of demand response directly correlates with the number of participating customers who opt-in to demand response programs and install the necessary equipment (such as smart thermostats that can respond to utility signals). Demand response program participation varies widely, but is generally low, difficult to achieve, and limited by the program administrator's acquisition and retention budget. For example, a 2019 FERC study on demand response tallied ~9.4 million customers enrolled in incentive-based retail demand response programs out of ~135 million residential electricity customers.

[1] Brattle Group's demand response estimate includes both retail and wholesale demand response, and could include some double counting.

Program structures typically rely on a financial incentive for participation (and sometimes, penalties for non-performance), which then places a continued financial weight on program costs into the future. Program structures without a recurring financial incentive for participation could free up budget to then be channeled elsewhere, such as toward attracting more participants, expanding program offerings, and launching new programs.

In this report, we analyze how different residential demand response offerings and their marketing messages—traditional financial incentive-based programs vs. an environmental-based program using WattTime's Automated Emissions Reduction (AER) as a specific form of environmental demand response—influenced customer enrollment in demand response programs. Our findings are intended to inform utility and demand response program manager design considerations to achieve more cost-effective, larger-scale demand response programs.

ABOUT AUTOMATED EMISSIONS REDUCTION (AER)

WattTime's Automated Emissions Reduction (AER) technology enables smart devices—from thermostats to appliances to electric vehicles—to automatically reduce emissions associated with their electricity use. Based on real-time grid data, cutting-edge algorithms, and machine learning, WattTime is able to "see" when, where, and how the grid is breathing. The AER software uses that insight to make smart devices even smarter. Powered by AER, smart devices can seamlessly optimize their energy use to seize moments of cleaner energy and avoid moments of dirtier energy, all without compromising cost and user experience.

Bringing behavioral economics to environmental demand response

In our experience and research, customers perceive two common residential energy offers very differently: renewable energy credit (REC) markets, where customers paid their utilities to source green energy such as wind or solar, and demand response markets, where utilities paid their customers to reduce or shift energy use at certain times (often to also achieve a beneficial environmental outcome).

Customers see RECs as a personal benefit, easy to understand, and an easy opt-in opportunity. Conversely, they tend to see demand response programs as only serving to benefit the utility and so consumers are doing the utility a favor—even though, like RECs, demand response programs can also yield environmental benefits (such as AER-based emissions reductions).

As a result, we believe most utilities and demand response aggregators have traditionally thought of such markets as very different animals. We've seen this manifest in the dominant perspective of the electricity industry, which assumes you have to pay people to participate in demand response programs. Other factors may come into play. For example, how much of this is a legacy issue (e.g., "We keep paying customers for demand response program participation because that's what we've always done.")? It could also be that issues related to flexible demand (e.g., the impacts of timing and location of energy consumption) are not well-communicated to customers, making demand response hard to understand.

WattTime and our partners wanted to test the hypothesis that customer appetite for demand response programs would increase if these programs also had a compelling environmental impact message. Like buying RECs, could demand response—by increasing its environmental benefits—become something customers wanted to do, rather than something their utility pays them to do?

In randomized surveys across 30 U.S states, initial WattTime studies found that customers expressed considerably higher willingness to participate in demand response programs when they were informed about the beneficial environmental impact of such programs, not about the financial incentive. However, these prior studies were hypothetical (where people tend to overstate their intended actions), not real-world programs. WattTime wanted to test whether the environmental features actually caused people to take action.

Pairing AER and demand response to fight mercury pollution in the Great Lakes from fossil-fueled electricity generation

The Great Lakes Protection Fund (GLPF) provided the funding for this pilot program. The governors of the Great Lakes states created GLPF in 1989 to collectively protect and restore their shared Great Lakes resources. This project's funding furthers that mission through a focused effort on minimizing the devastating pollution mercury brings to freshwater ecosystems.

Coal-fired power generation in the Great Lakes area is still fairly high, even as states make exciting clean energy commitments and major investor-owned utilities in the region have announced planned coal plant closures. Last year, 5 of the top 10 coal-consuming states in the U.S. were Great Lakes states: Indiana, Illinois, Pennsylvania, Ohio, and Michigan. For other Great Lakes states, coal still makes up a sizable portion of their electricity generation mix. For example, in 2019 coal-fired generation supplied 42% of Wisconsin's electricity. Nationwide, fossil fuels still supplied more than 60% of U.S. electricity generation last year.

Mercury emissions are released in the process of burning coal for electricity as well as in the 50 million tons of coal ash deposited per year into the region's surrounding bodies of water. In fact, coal-fired power plants remain the region's number one source of mercury pollution. Given its coal-heavy generation mix and abundance of freshwater, the Great Lakes region is acutely aware of the adverse impacts of mercury pollution and seeking solutions to mitigate those impacts. Every U.S. state and Canadian province in the Great Lakes has fish consumption advisories related to mercury contamination.

The region's move away from fossil-fueled generation and toward renewable energy is an important vector for cleaning up the Great Lakes' legacy of mercury pollution. But it is not the only one. WattTime's Automated Emissions Reduction (AER) software is also helping, with support from GLPF. AER leverages the flexible demand of smart devices such as thermostats and electric vehicles to shift their energy use to times of cleaner electricity generation based on a marginal emissions signal. In addition to supporting mercury emissions reductions, AER can also be deployed to reduce carbon and other GHG emissions, as well as criteria air pollutants.

With an AER signal powering environmental demand response for even half of the smart devices in the Great Lakes region, it would be possible to eliminate 269 pounds per year of mercury emissions. That is more than 20% of the total atmospheric mercury deposition in Lake Erie each year. As smart devices become more popular among customers and as more of those devices enroll in AER-based environmental demand response, the potential benefits are even greater.

While AER technology is simple, inexpensive, and highly effective, it still requires a pathway to widespread adoption. One obvious application is pairing AER with existing demand response programs, since both utilize load shifting—one to manage the handful of peak energy demand events each year and the other to continuously optimize for emissions reductions.

Numerous demand response programs in the Great Lakes region financially incentivize households and businesses to shift their electricity use away from times of peak electricity demand. We therefore sought to understand how pairing AER with demand response could unlock multiple potential benefits, from cheaper per-customer acquisition costs for demand response programs, to improved enrollment and retention in those programs, to mercury emissions reductions when adopted at scale.

GLPF provided funding to a team led by WattTime to evaluate offering AER as an alternative incentive to financial payouts in demand response program marketing. This work manifested in a 2019–2020 residential demand response pilot program in the greater Chicago area.

Methods and Approach

In this pilot, a joint working group (including a demand response aggregator, smart thermostat provider, and nonprofit cleantech organization) went further than past studies and actively tested multiple demand response program enrollment pathways in a randomized framework to empirically assess customer behavior. A technical advisory committee comprising energy utilities, retailers, consultants, and demand response providers also informed the pilot (see Acknowledgments).

PILOT FOCUS

The pilot program was set up to test the following question in a real-world environment:

> *How do program enrollments differ when customers are offered an AER-based clean energy demand response program vs. a business-as-usual financial incentive-based traditional demand response program?*

In general, customers followed a three-step pathway: 1) see a recruitment ad on social media, 2) visit a website landing page to learn more, 3) complete a sign-up form to enroll.

MARKETING DESIGN FOR CUSTOMER ACQUISITION

The customer acquisition marketing strategy focused on social media, and ran in the form of Facebook ads. Using Facebook's targeting criteria, the ads' demographic targeted residents of Chicago, IL, age 18 and up. (After the study was complete, Facebook analytics revealed a fairly even gender split between men and women, with most in the 25–55 age group.)

They were presented with 15-second Facebook video ads aligned to one of three possible messages: 1) clean energy choice with AER-based environmental demand response, 2) traditional demand response with a financial reward, and 3) a combined message that described both (see Figure 1). Each ad clicked through to a corresponding landing page with aligned messaging. From each landing page, customers could click a link to actually sign up for the program.

The marketing campaign ran for six weeks, from March 3 to April 15, 2020.

Regardless of which ad they saw, all customers were offered a free smart thermostat ($250 value). This was in part to ensure that all potential customers were eligible to enroll and wouldn't turn away because they didn't have a thermostat compatible with AER-based environmental demand response.

To encourage follow-through and actual device connection, customers paid a partial amount up front for the thermostat, which they were refunded upon device connection. Participants could also use their own smart thermostats (also known as bring-your-own / BYO programs). Upon signing up, customers either connected their existing smart thermostat or followed the process to receive a free thermostat to then connect to the program upon self-installation.

FIGURE 1
Facebooks Ads for Different Messaging Pathways

Here we show the financial vs. environmental messaging. A third hybrid ad showed a combined financial-environmental message.

DEMAND RESPONSE PROGRAM DESIGN

In practice, all customers were enrolled in the same demand response program: they all were offered a free smart thermostat, they all had AER-based environmental demand response enabled on their device, and they all received a $5 per month cash incentive. What differed was what they believed they were signing up for. Customers that saw AER environmental messages didn't know they'd be receiving the $5 per month financial incentive. Customers that saw financial incentive messages didn't know they'd get the added benefit of AER-based environmental demand response.

In order to ensure the environmental claims of the program are true, the program used WattTime's AER technology to shift participants' energy use towards times of cleaner generation. This particular program worked by optimizing smart thermostats to use energy generated by regional power plants with less mercury emissions. The thermostats were adjusted continuously (a couple degrees above or below the set point determined by the customer) to shift load into lower-emissions periods and/or reduce load during periods of high mercury emissions.

Results and Key Takeaways

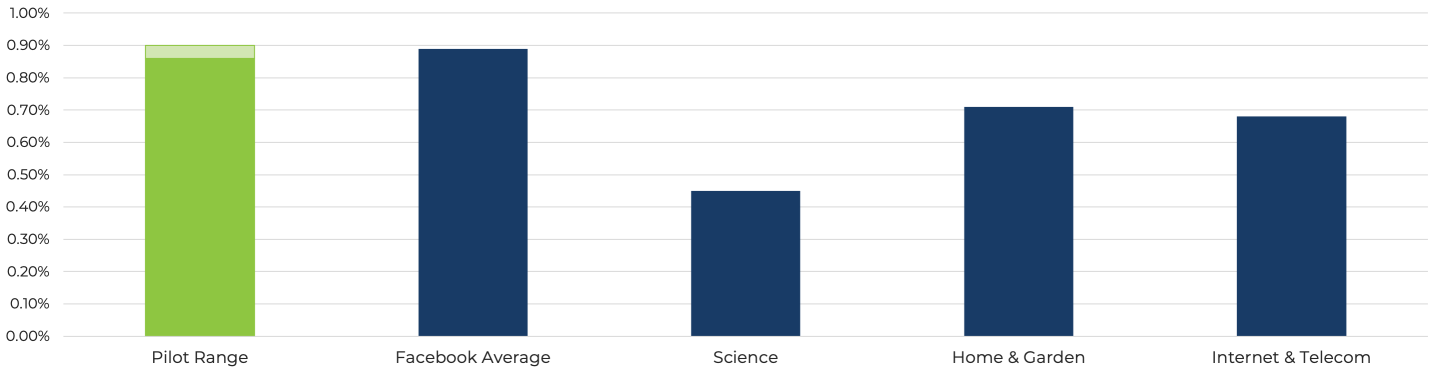
This pilot's Facebook ads received just over 1.2 million total impressions,[2] with a marketing budget split into equal thirds across the AER-based environmental message, traditional financial message, and the combined message. Those impressions translated into roughly 11,000 pageviews of the landing pages from nearly 10,000 unique users. Overall, the landing pages averaged a 12% conversion rate for demand response program signups.

All three scenarios had comparable clickthrough rates (CTRs) on the Facebooks ads (0.86–0.90%), driving similar amounts of traffic to their respective landing pages. The CTRs we observed are in line with overall CTRs for Facebook across industries (0.89%) and notably better than the average CTRs for relevant industries (0.45% for science, 0.68% for Internet and telecom, 0.71% for home and garden) (see Figure 2).

The traditional financial-based demand response had a lower cost per click. But as we'll see, superior performance from AER-based environmental demand response in areas such as conversion rate with landing page sign-ups and post-enrollment device connection strongly outweighed the financial program's cheaper cost per click, yielding significant demand response program benefits. For detailed results, see Table 1 on next page.

[2] 'Impressions' are the number of times a piece of content has been served in users' social media feeds.

FIGURE 2
Clickthrough rates for pilot ads vs. Facebook overall and category-specific averages



The environmental demand response pilot achieved clickthrough rates on par with Facebook's overall ad average and notably better than a number of comparable sector benchmarks.

TABLE 1

Full pilot results for Facebook ads, landing pages, program enrollment, device connections, one-year costs

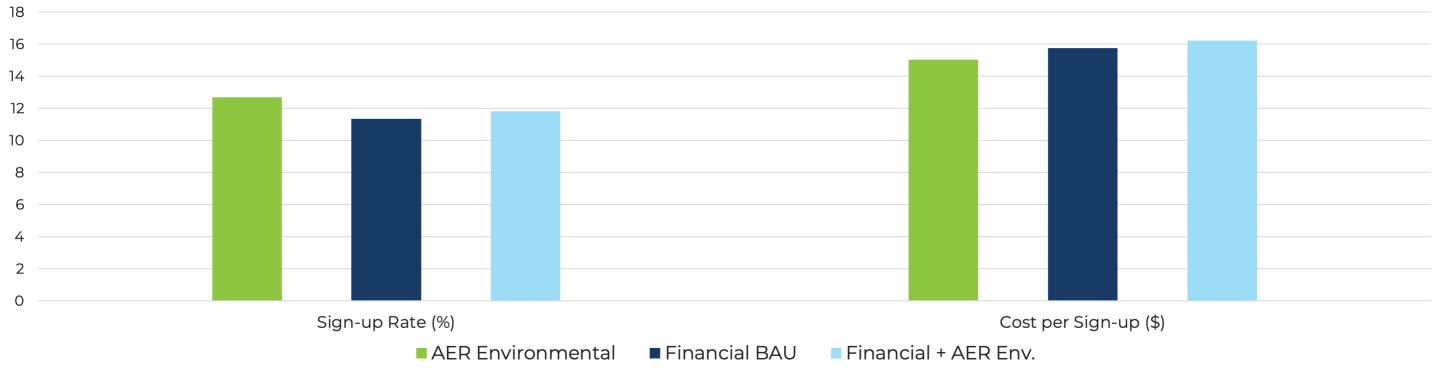
	SCENARIOS			
	AER Environmental	Financial BAU	Financial + AER Env.	TOTAL OR AVERAGE
FACEBOOK				
Impressions	397,337	411,707	403,265	**1,212,309**
Budget	$6,001.96	$6,001.96	$6,001.96	**$18,005.88**
Link Clicks	3,429	3,721	3,496	**10,646**
Clickthrough Rate	0.86%	0.90%	0.87%	**0.88%**
Cost per Link Click	$1.75	$1.61	$1.72	**$1.69**
LANDING PAGES & PROGRAM ENROLLMENT				
Pageviews	3,544	3,798	3,557	**10,899**
Unique Users	3,146	3,355	3,133	**9,634**
Sign-ups	399	381	370	**1,150**
Sign-up Rate	12.68%	11.36%	11.81%	**11.94%**
% Improvement vs. BAU	12%	–	4%	–
Cost per Sign-up	$15.04	$15.75	$16.22	**$15.66**
% Savings vs. BAU	5%	–	-3%	–
PROGRAM ACTIVATION & IMPACT				
# Device Connections	7	2	–	**9**
Connection : Sign-up Ratio	1.75%	0.52%	–	**0.78%**
% Improvement vs. BAU	234%	–	NA	
Cost per Connection	$857.42	$3,000.98	NA	**$18,005.88**
% Savings vs. BAU	71%	–	NA	
POTENTIAL ONE-YEAR COSTS				
Monthly DR Payment	$0.00	$5.00	$5.00	–
12-month Cost per Sign-up	$15.04	$75.75	$76.22	–
% Savings vs. BAU	80%	–	-1%	–
12-month Cost per Device	$857.42	$3,060.98	NA	–
% Savings vs. BAU	72%	–	NA	–

The data revealed several key takeaways:

AN AER-BASED ENVIRONMENTAL DEMAND RESPONSE PROGRAM ALLOWS MARKETING BUDGETS TO GO FURTHER.

Our data shows that utilities don't have to pay customers in order for them to enroll in a demand response program if important non-economic values—such as AER-based environmental benefits—are provided and clearly communicated to prospective participants. Moreover, AER-based environmental demand response had a stronger conversion rate for program sign-ups from the landing page (12% higher than the traditional financial message) (see Figure 3). This outweighed financial-based demand response's lower cost per click, such that **AER-based environmental demand response resulted in a 5% lower cost per sign-up.**

FIGURE 3
Landing Page Conversions



AER-based environmental demand response programs achieved a higher sign-up rate with lower costs per sign-up.

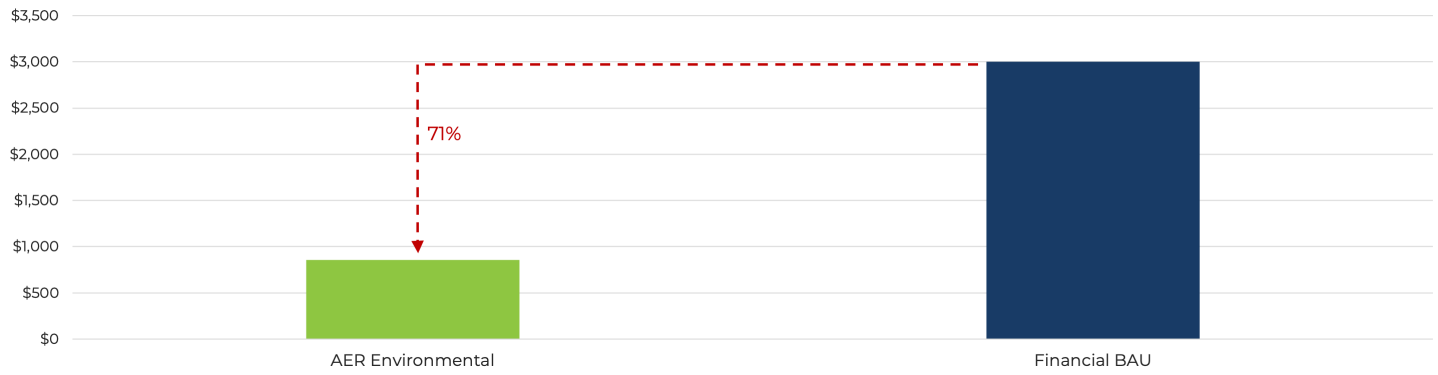
A lower cost per sign-up has important implications for demand response program marketing:

- Demand response programs can enroll more customers for the same marketing budget spend.
- Alternatively, demand response programs can spend less of their marketing budget to enroll the same number of customers, freeing up a portion of their marketing budget to be reallocated, such as for further boosting enrollment, improving program retention, or making program enhancements.

CUSTOMERS SHOW SIGNIFICANTLY STRONGER ENGAGEMENT WITH AER-BASED DEMAND RESPONSE PROGRAMS.

Once customers enrolled in the demand response program, those that did so via the AER-based environmental message pathway were significantly more likely (2–3x) to connect and activate their thermostat. This follow-through is an important component of successful demand response programs. Moreover, if we measure the effectiveness of demand response program marketing budgets by device connections rather than superficial customer enrollments (see previous finding), the implications become clear: **It costs 71% less for each demand response-enrolled thermostat in an AER-enabled demand response program (see Figure 4).** These savings stretch demand response marketing budgets even further.

FIGURE 4
Cost per Connection



Customers that enrolled in AER-based environmental demand response programs were significantly more likely to connect their thermostat upon sign-up, resulting in much lower per-device-connection acquisition costs.

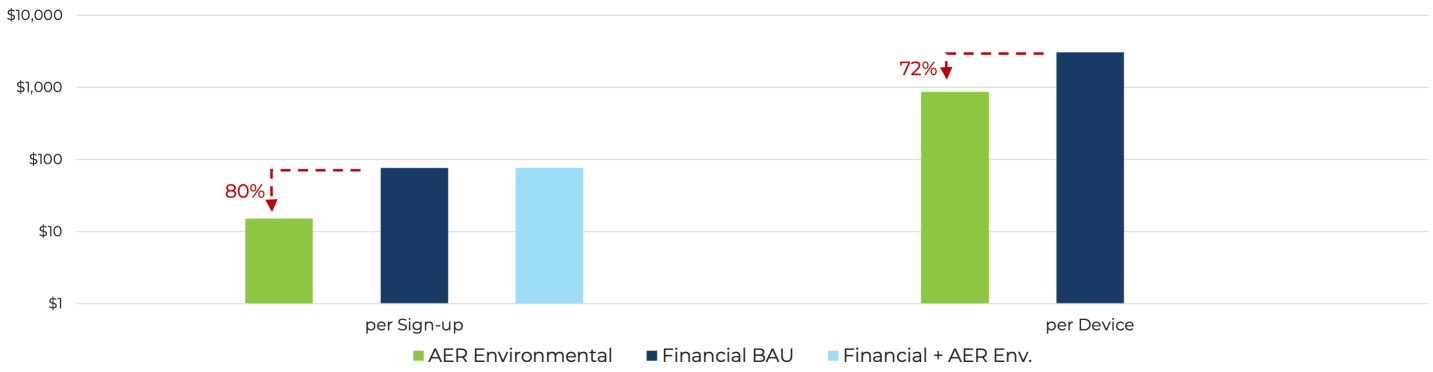
OUR RESULTS SUGGEST THAT 'FREE' AER-BASED ENVIRONMENTAL DEMAND RESPONSE UNLOCKS MASSIVE PROGRAM BUDGET SAVINGS, SINCE CUSTOMERS ENROLL WITHOUT THE EXPECTATION OF FINANCIAL INCENTIVE PAYMENTS.

Marketing budget savings with AER-based environmental messages are just the tip of the proverbial iceberg. Each year, utilities across the United States spend about ~$1 billion in demand response program costs. A big portion of that spend is financial incentive payments to customers. Because customers that enroll in AER-based environmental demand response programs are doing so 'for free,' without the expectation of financial incentive payments, this unlocks truly massive budget savings for utilities.[3]

For example, taking into account 12 months of program participation, **one-year utility costs for AER-based environmental demand response customers were 80% cheaper per sign-up and 72% cheaper per device vs. financial incentive customers (see Figure 5).** For the same total budget spend, utilities could translate that into 5x more customers enrolled. Or utilities could reallocate some or all of those budget savings in other ways, such as focusing on device connections for enrolled customers (a chronic challenge among demand response programs).

[3] These budget savings are even more important in the current era of the coronavirus pandemic, when many utilities are feeling the financial strain of bill nonpayment and disconnection moratoriums.

FIGURE 5
Potential 12-Month Cost



Because AER-based environmental demand response customers are signing up 'for free' vs. ongoing payments for traditional financial demand response, they have dramatically lower per-sign-up and per-device-connection costs after one year.

Discussion and Next Steps

Our findings are insightful and promising. We see several 'no regrets' actions that utilities and demand response aggregators could immediately begin implementing today:

- Offer AER to traditional residential customers with smart thermostats enrolled in existing automated demand response programs to realize environmental and emissions benefits immediately.
- When designing new demand response programs, implement AER and continuous optimization for emissions reductions from the start to take advantage of environmental outcomes.
- Incorporate environmental outcomes (e.g., GHG emissions reductions, local air quality improvements) into dashboards, utility billing, social media, and other customer-facing touch points to boost customer engagement and retention and bolster utilities' brand reputation and customer relationship.

Demand response aggregators and utilities both have roles to play advancing AER-based environmental benefits via demand response programs. Aggregators can proactively offer AER as part of their programs, while utilities can ask aggregates to include AER in their programs. This would create both demand pull and supply push.

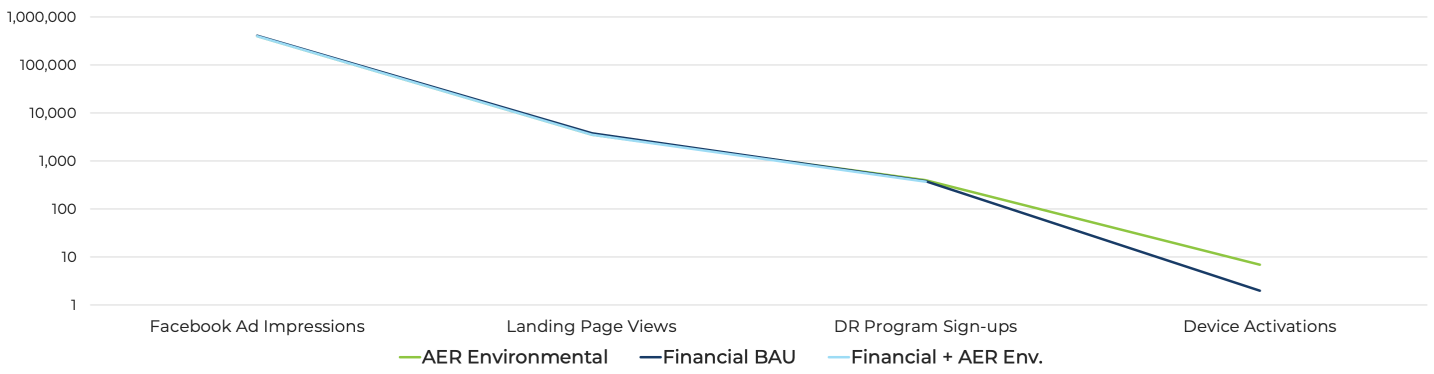
Appendix: For Further Consideration

In addition to the strong differences in customers' responses to the AER-based environmental message vs. traditional financial incentive message, the pilot revealed another important finding: **most customers did not follow through and install / connect their thermostats to the demand response program (see Figure 6)**. We've heard from a variety of partners involved in smart device programs that installation and device connection is a common challenge when the customer is responsible for their own setup.

Many factors could come into play. This could be because people are intimidated by electrical devices, fear that they will break or interfere with their heating and cooling system, a belief that finding the time to read and follow installation instructions are not worth the effort or benefit, or simply that this to-do item never makes it to the top of their list.

Thus, while the pilot provides good evidence of the positive relative effect of an AER-based environmental demand response program on sign-ups and engagement, it is also a reminder that programs requiring customers to install and connect a new thermostat face challenges. Demand response programs that incorporate environmental messaging should adopt best practices from programs that have a successful history of installations, including bring-your-own thermostat programs where customers already have a compatible, installed device.

FIGURE 6
Customer Acquisition Fall-Off



Despite strong differences between AER-based environmental demand response and traditional financial incentive-based demand response programs, all programs saw a scant few devices actually connect relative to earlier stages of the pipeline.

Other questions to consider when evaluating environmental demand response programs could include:

- How does the type of environmental choice influence customers' reaction (e.g., climate change, air quality, environmental justice, public health)?
- Do AER-based environmental demand response programs also improve customer retention, in addition to customer acquisition?
- How might a sample of residential customers with different demographics change the results? For example, this sample of customers came from an urban area. If marketing targeted customers in rural areas perhaps there would be different outcomes when emphasizing the variety of environmental messages such as "human health," "climate change," "clean energy." At a minimum, acknowledging any distinctive demographic traits of the sample in this pilot could help characterize the external validity of the results.
- Would on-bill financing of devices reduce the hurdle of device connections?
- How might AER-based environmental demand response be 'piggybacked' onto already-successful renewable energy programs, such as being offered as an optional adder when customers are signing up for 100% renewable energy with their utility?

For demand response program administrators, we also invite you to make a copy of this sandbox spreadsheet and input your own assumptions to experiment with potential outcomes.