Catalyzing the Market for Automated Emissions Reduction

Post-Charette Report

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Transforming global energy use to create a clean, prosperous, and secure low-carbon future.

Background and overview

Project Overview: The project team, led by WattTime.org and comprised of other diverse nonprofit organizations, undertook a pilot project in Chicago, IL and organized a related workshop in order to (i) quantify the opportunity for *automated emissions reduction* (AER) to reduce mercury and carbon emissions in the Great Lakes Region, and (ii) engage with industry and identify paths to scale this opportunity.

Workshop Description: March 6–7, 2017, RMI and partners convened a diverse set of stakeholders in Chicago to review the potential for AER and identify opportunities to scale its adoption. This charrette divided participants into groups, which discussed the business case from different perspectives:

- Residential customer value proposition
- Institutional customer value proposition
- Utility program integration
- Policy perspectives

Automated emissions reduction defined:
An emerging software-based technology that modulates the electricity consumption of internet-connected, energy-using devices (e.g., air conditioning, water heaters, or electric vehicles) in response to the time-varying pattern of grid emissions, reducing these loads' energy consumption during hours when dirtier power plants will decrease output in response to the load reduction. This approach can thus minimize emissions associated with meeting individual loads, often using imperceptible shifts in energy-use timing.

Overview of this Document: This document reviews RMI's analysis of AER opportunity, summarizes the discussions and key themes from the charrette, and presents initiatives that participants identified as priorities for near-term action.

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Executive Summary (1/2)

The project team, consisting of diverse nonprofit organizations, launched a pilot deployment and workshop in Chicago to test the value of—and customer demand for—an emerging technology: *automated emissions reduction.*

What is "automated emissions reduction?"

Automated emissions reduction (AER) combines:

- real-time grid data on power plant emissions, and
- internet-enabled control of energy-using devices,

allowing customers to seamlessly reduce the emissions associated with their use of electricity

Technology trends and customer demand create an emerging opportunity

- Both residential and institutional customers are increasingly demanding both "green" and "smart" attributes from their major electricity loads
- The increasing prevalence of Internet-connected devices and building systems provide an opportunity to easily accomplish both goals

AER can create value across multiple sectors

- For both residential and institutional customers, AER provides environmental benefits at a low cost
- For utilities, AER can lower customer acquisition costs for traditional demand-side management programs

Executive Summary (2/2)

Using input from the workshop, the project team identified five priority initiatives to pursue in the near-term in order to further test the value proposition of AER, and rapidly scale the potential benefits it can provide.

Initiative	Details
Institutional customer pilots	• Launching pilot projects to test reporting and technical integration needs for institutional buyers of AER products and services
Residential customer pilots	• Testing potential of AER to lower customer acquisition costs for existing utility demand response programs
Device certification	• Creating a recognized brand for AER-enabled devices to simplify customer buying decisions
Emissions protocol integration	• Validating AER impacts by integrating into existing greenhouse gas emissions accounting protocols
Open tools and infrastructure for AER	• Creating open-source, transparent tools to facilitate connections between devices and emissions data

Context:
Project background

Funded by a grant from the Great Lakes Protection Fund, the project team launched a pilot project in Chicago to test customer preferences for AER, and convened a workshop to identify a path to scale this emerging opportunity.

This project aims to achieve the ambitious goals of significantly reducing emissions, and kick-starting a self-scaling market for automated emissions reduction

Project goals	Details
Achieve significant mercury emissions reductions in the Great Lakes region	• Achieve a **near-term reduction of 2 tons of mercury** across the Great Lakes region • Identify potential to achieve **41 tons of mercury emissions reduction by 2020**
Catalyze a self-scaling market for AER	• Solidify automated emissions reduction as a **differentiating feature in the $7 billion/year market** for smart devices and utility demand-side management programs

The project team is comprised of a broad range of nonprofit organizations with complimentary emissions reduction goals

Organization	Role
Great Lakes Protection Fund	• Project sponsor
WattTime	• Project lead and coordinator of ongoing initiatives • Cloud infrastructure host for connected devices
LEEM Locational Emissions Estimation Methodology	• Technology provider • Mercury emissions intensity estimates
delta institute	• Pilot-project implementation partner • Customer outreach and engagement
National Wildlife Federation	• Data analysis and ecosystem research • Mercury impact analysis technology
Rocky Mountain Institute	• Data analysis and market research • Workshop organization and facilitation

The overall project is designed to pilot AER solutions, and generate new ideas on how to scale the opportunity using a workshop to solicit industry input

Project timeline overview:

	Mid-2016	Early 2017	Mid-2017
Customer preference testing	**Site deployment** 38 residential and 3 commercial sites; customer engagement tests	**Controlled operation** Operation of connected devices to minimize emissions	**Analysis** Assessment of effectiveness and impact
Market scaling	**Market research** Interviews, market sizing, barrier identification	**Innovation workshop** Structured problem-solving, value identification, and brainstorming	**Industry report** Synthesized insights and roadmap to scale

Workshop details:

- March 6–7, 2017
- Chicago, IL, hosted by McKinsey & Company
- 63 participants from diverse industry groups

Charrette attendees represented a range of participants from key stakeholder groups (1/2)

Device and/or Service Providers

Troy Anatra, Enbala
Joey Barr, Whisker Labs
Matt Carlson, Aquanta
Daniel Chiotos, Mosaic
Vince Cushing, QCoefficient
Shaun Dentice, CLEAResult
Daniel Frey, THG
Darren Gronewald, Energate
Bill Hosken, AO Smith
Marissa Hummon, Tendril
Audrey Lee, Advanced Microgrid Solutions
Ian Monk, Shell Tech Works
Greg Overholt, Ecobee
Evan Pittman, Comverge
Emmett Romine, Powerley
Charles Russell, Eos Energy Storage
Louis Szablya, Energate
Shannon Weigel, Edison Energy
Jim Westover, THG
Yeye Zhang, Nest

Consultants & Independent Participants

Annette Beitel, Future Energy Enterprises, LLC
Ann McCabe, Ann McCabe & Associates, Inc.
Bud Sambasivam, McKinsey & Company
Jeff Wolfe, Independent

Project Execution Team

Chiel Borenstein, WattTime
Kevin Dick, Delta Institute
Loch McCabe, Energy Emissions Intelligence
Gavin McCormick, WattTime
Stephen Miller, Energy Emissions Intelligence
Eric Nguyen, WattTime
Ben Shorofsky, Delta Institute

Charrette attendees represented a range of participants from key stakeholder groups (2/2)

Institutional Energy Managers
Bob Best, JLL
Eddie Corwin, Google
Mike Foley, Cuyahoga County
Jack Higgins, Sears Retail
Keith Klug, Sears Holding Corporation
Mandy LaBrier, City of Chicago
Michael Macrae, Harvard University
Ryan Tinus, Tishman Speyer

RMI Facilitation Team
Steve Abbott (Manager)
Paul Bodnar (Managing Director)
Dan Cross-Call (Manager)
Mark Dyson (Manager)
Gautham Krishnadas (Fellow)
Jamie Mandel (Principal)
Margaret McCall (Sr. Associate)

Nonprofit Organizations
Ellen Bell, Environmental Defense Fund
Clare Butterfield, Illinois Science & Energy Innovation Foundation
Shannon Donley, Great Lakes Protection Fund
Scott Hackel, Seventhwave
David Kolata, Citizens Utility Board
Kristin Munsch, Citizens Utility Board
Jamie Ponce, Environmental Law & Policy Center
David Rankin, Great Lakes Protection Fund
David Rosenheim, The Climate Registry
Nikhil Vijaykar, Midwest Energy Efficiency Alliance
Karen Weigert, Chicago Council on Global Affairs

Utilities
Dolf Joekes, Innogy
Teri Lewand, ComEd
Chris Rosso, ComEd
Kevin Schwain, Xcel Energy
Rick Tonielli, ComEd
Tim Webster, Exelon

Context:
Evolving customer demand presents an emerging opportunity

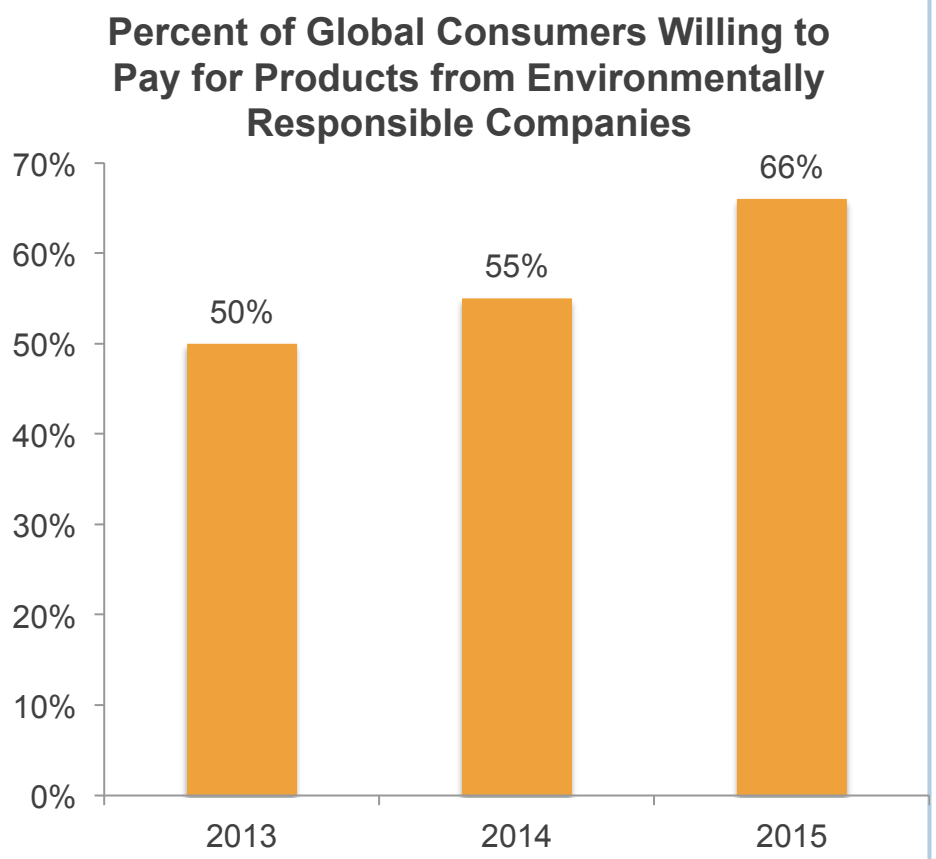
Both residential and institutional customers are increasingly demanding sustainable products and services, as well as products that are connected and “smart.” These products and services can take advantage of the evolving nature of the electricity grid to lower emissions associated with providing energy to end-use devices.

Individual consumers are expecting more environmentally friendly options, and are willing to pay for them

Consumers in America want and expect more sustainable solutions

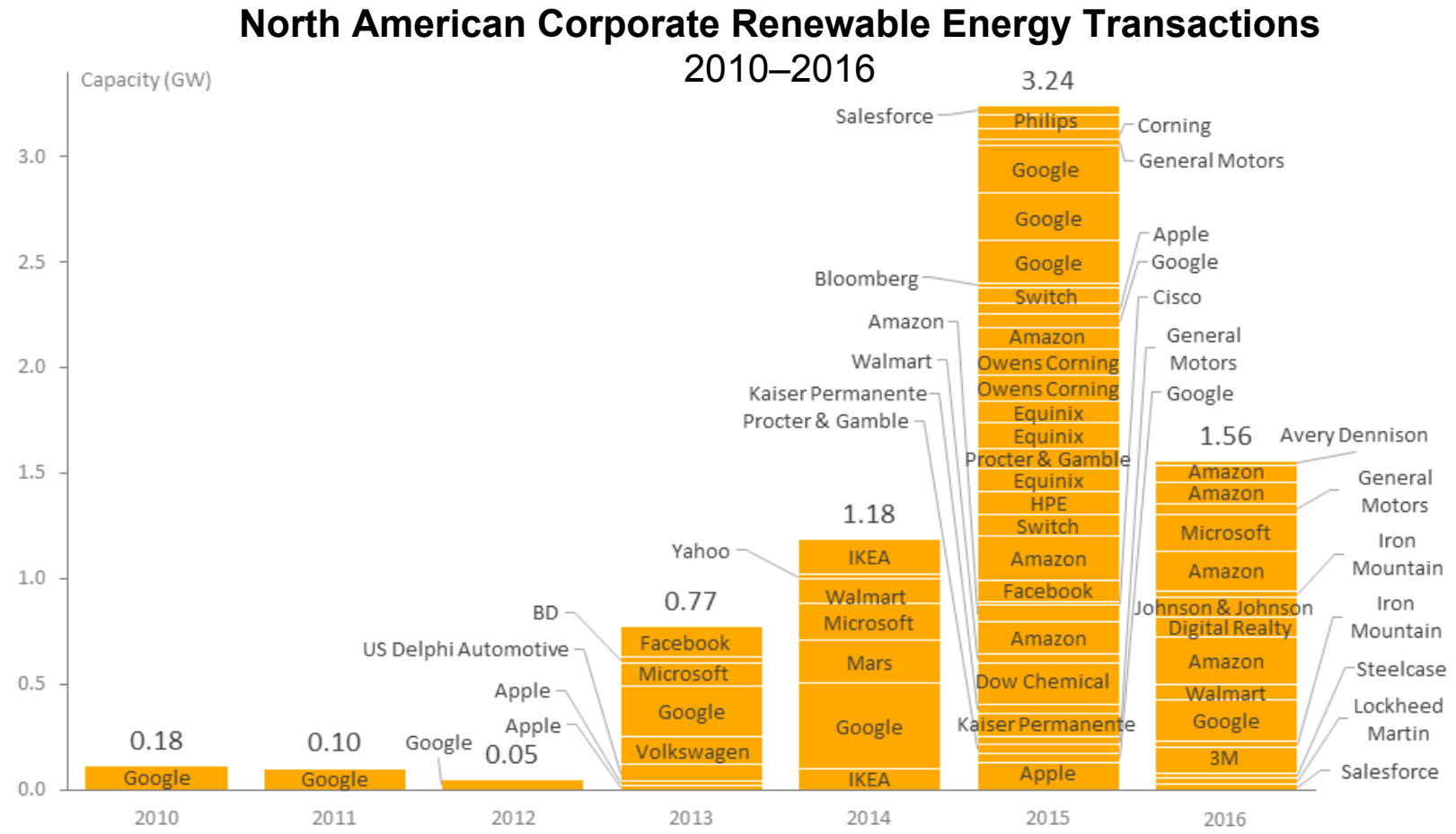
- A survey of 1,500 customers conducted by SmartEnergy IP found that 32% expect their utility to adopt automation technologies to save energy[1]
- A 2016 Gallup poll revealed that 73% of Americans want to emphasize alternative energy instead of oil and gas production[2]

Consumers are increasingly willing to pay for environmentally conscious brands[3]



Source: [1] Navigant Research; [2] Gallup; [3] Nielsen.

Sustainability drives purchasing behavior of companies, universities, and other large customers



Publicly announced contracted capacity of corporate Power Purchase Agreements, Green Power Purchases, Green Tariffs, and Outright Project Ownership in the US and Mexico, 2012 – 2016. Excludes on-site generation (e.g., rooftop solar PV) and deals with operating plants. Last updated: January 12, 2017.

For more information, please visit http://www.businessrenewables.org/ or contact BRC@RMI.org

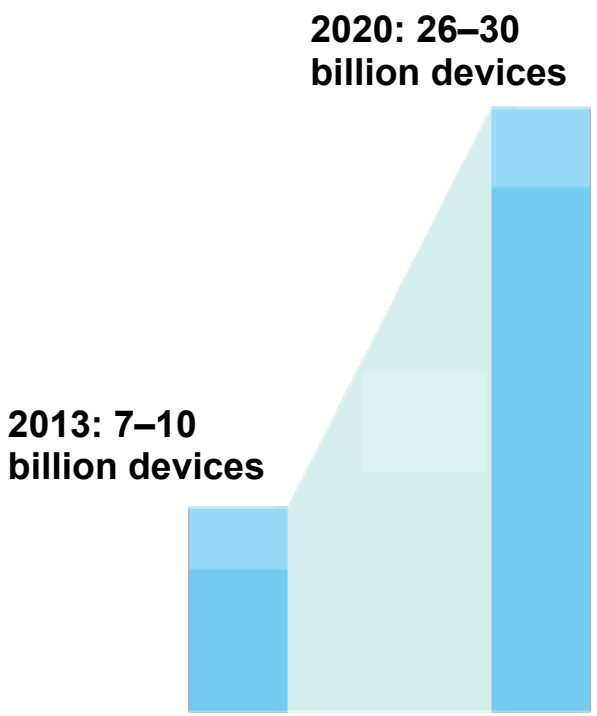
Source: RMI Business Renewables Center

Customers are also increasingly demanding communicating, controllable, and "smart" devices and control systems

Smart devices, appliances, and controls are growing in availability and popularity

- The smart thermostat market is projected to quadruple in size, reaching a $4.4 billion dollar industry by 2025.[1]
- Large consumer technology companies are now competing for market share in the growing "smart home" space.
- In institutional, commercial, and industrial facilities, business priorities are driving customers to demand connected, intelligent control systems to manage loads.

Some 30 billion devices may be connected to the Internet of Things (IoT) by 2020[2]



Source: [1] Navigant Consulting; [2] McKinsey, December 2014

As the IoT expands, greater connectivity will offer new opportunities to capture value from connected devices

	Connectivity and control allow energy-using devices to be optimized against several criteria. Devices can be programmed to:
Existing capabilities	• **Reduce peak demand** by shifting the timing of electricity usage to non-peak hours. Existing programs in the United States are already capable of reducing peak loads by up to 32 GW. • **Lower energy costs** by scheduling load to take advantage of relatively low-cost electricity at different times of day. U.S. utilities currently have over 7.5 million customers enrolled in some form of dynamic pricing program, which directly incentivize this temporal flexibility.
Emerging opportunity	• **Reduce emissions** by shifting load to coincide with renewable energy production, or cleaner, more-efficient conventional generators.

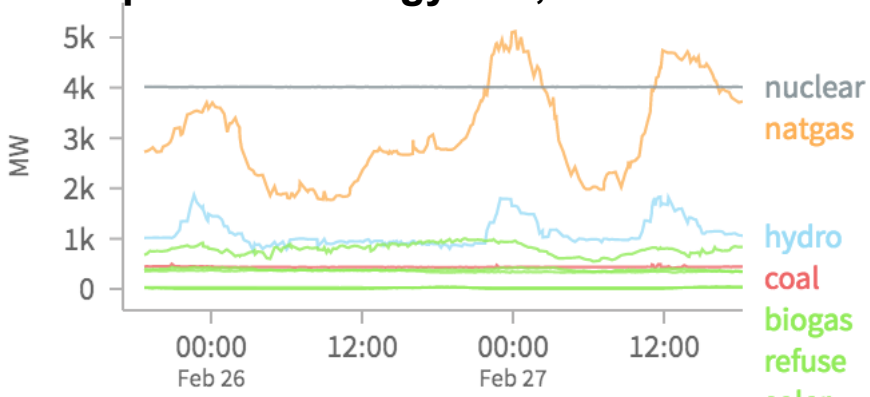
Using current technology, **it is possible to stack the value of these use cases**, achieving both cost reductions for capacity and energy, as well as emissions reductions.

Source: EIA

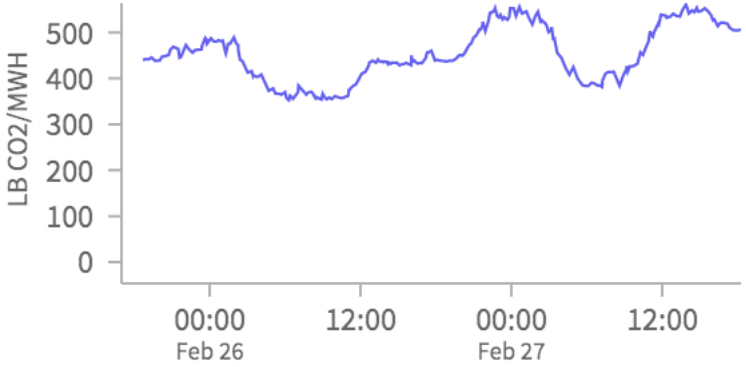
New software tools can monitor grid operations in real-time, allowing users to identify variations in marginal emissions

The fuel mix and emissions factors in regional grids can be calculated every 5 minutes

Example: Grid energy mix, NYISO



Average carbon intensity, NYISO



Marginal emissions provide detailed insight into a user's actual impact

Average emissions: Average emissions are calculated by dividing total emissions by total energy output, and are generally used today to measure carbon footprints.

However, if a user turns on or off a particular device, in reality only one or two power plants would increase or decrease production; thus the average value is not the most accurate or relevant figure.

Marginal emissions: In contrast, software tools can now calculate the marginal emissions, which more precisely represent the change in overall emissions if load increases or decreases at any given time.

Source: WattTIme.org

Real-time emissions signals enable load shifting for seamless, cheap, and measurable emissions reductions

Loads with flexibility or energy storage mechanisms can moderate their electricity usage with little or no impact on performance

- **HVAC and refrigeration systems** can slightly pre-cool or temporarily delay running in order to reduce energy-related emissions.
- **Electric water heaters** can use their storage tank like a battery, enabling flexible operation.
- **Electric vehicles** charging overnight can fluctuate the timing of their to take advantage of low-emissions periods.

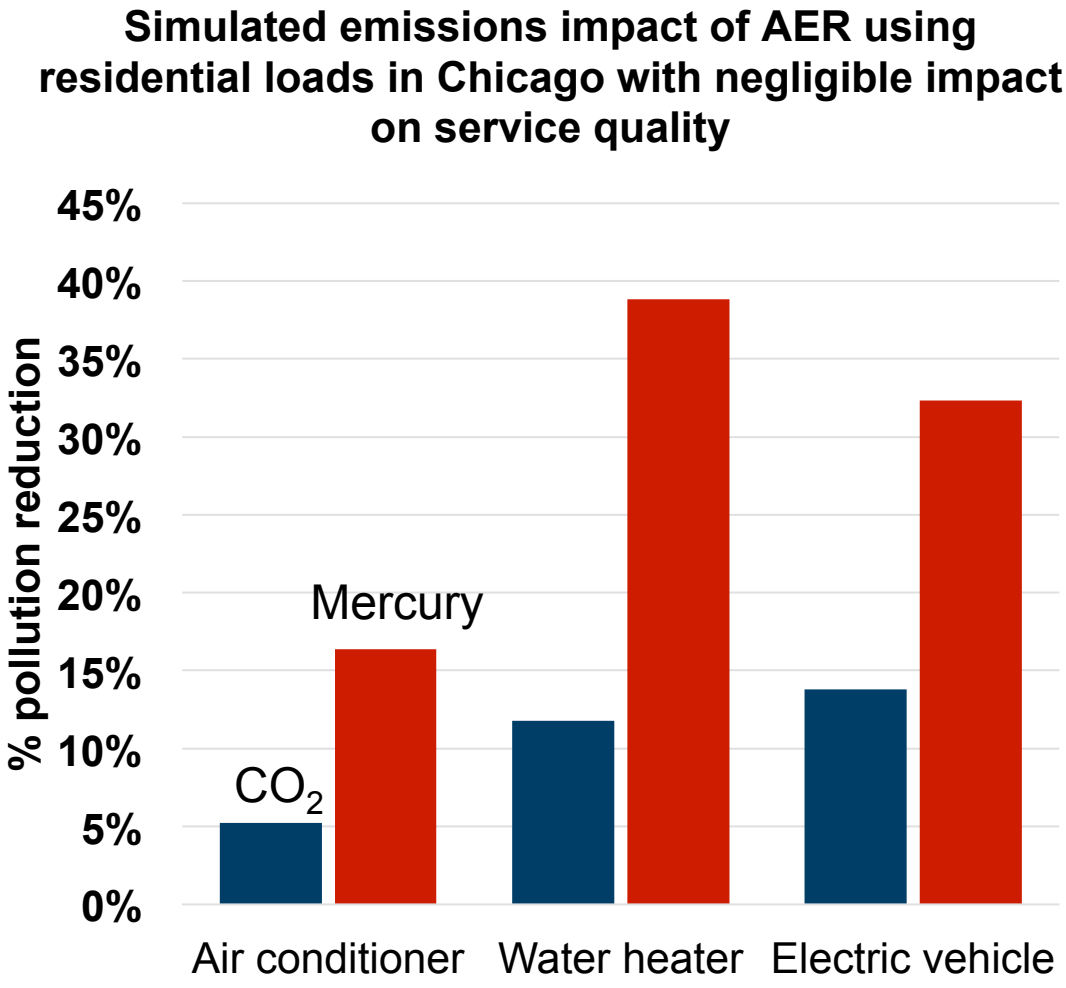
Providers can take advantage of the flexible nature of loads and the scalable nature of software to enable programs that are:

- **Seamless:** Program operators can take advantage of natural flexibility to reduce emissions without impacting customer satisfaction.
- **Low cost:** Programs can offer these benefits at minimal incremental cost, given that control capability is often already present.
- **Measurable:** The environmental benefits gained can be quantified using widely accepted methodologies.

Pre-charrette work: Analysis of scale of the opportunity

In the short term, AER can help customers reduce the emissions associated with a given load or appliance from 5–40% per year. Over time, the technology could be scaled to dramatically reduce emissions across the U.S.

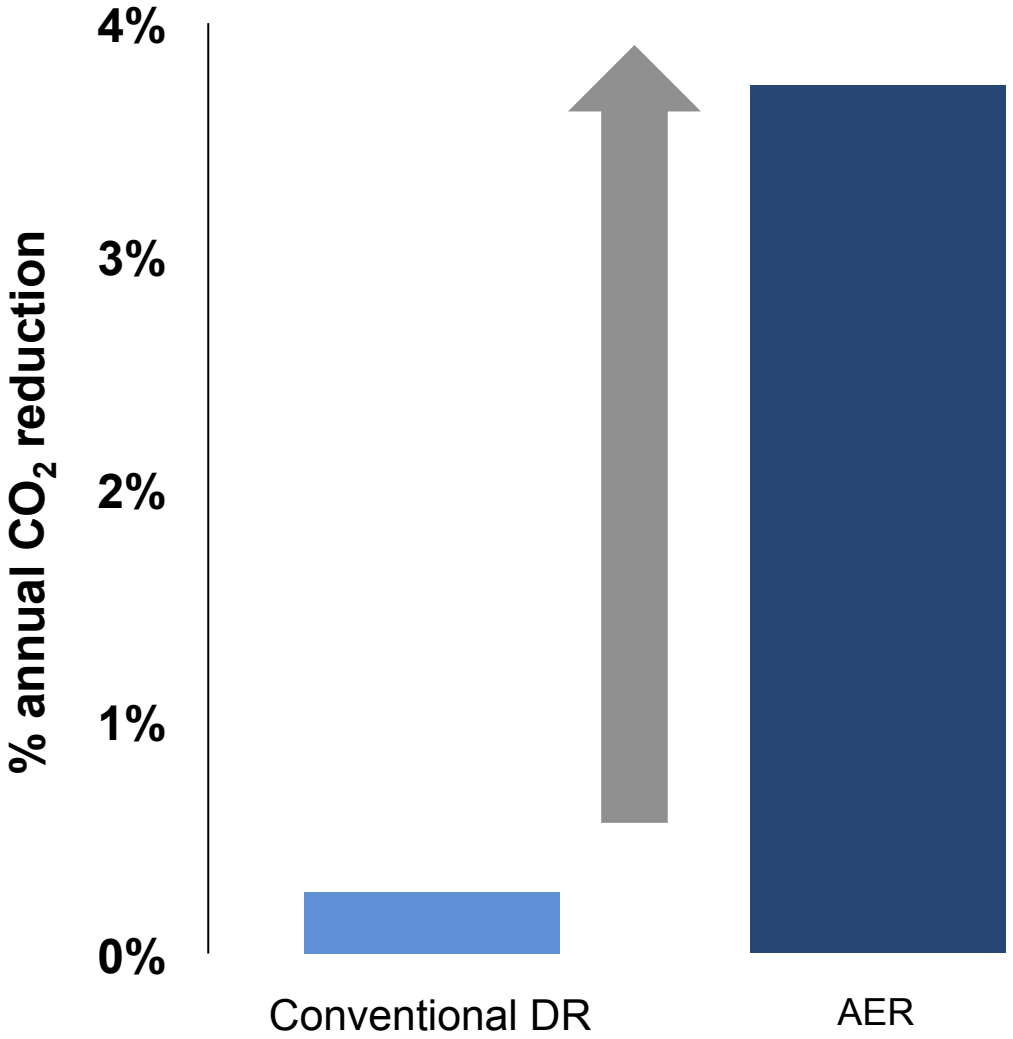
Adjusting loads to minimize CO_2 and mercury emissions can reduce pollution by 5–40%, using current generation data



- Strategies to reduce emissions rely on flexibility and/or physical storage inherent in end-use loads.
- Electric water heaters and electric vehicles have flexibility over longer time scales, and thus greater emissions savings potential than air conditioning loads.

Source: WattTime.org, E2i, RMI simulation

AER can amplify the emissions benefits of traditional demand response (DR) in large buildings

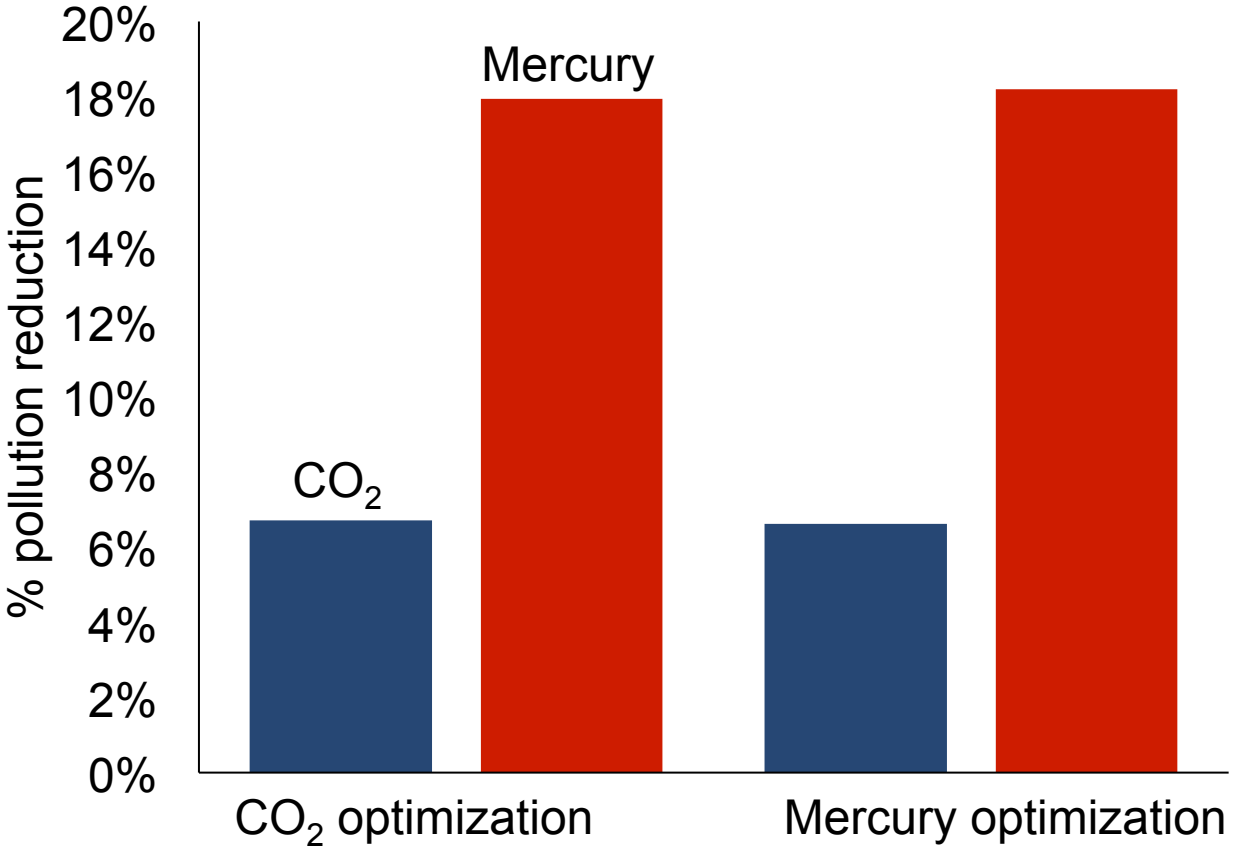


- AER can use existing DR controls to optimize emissions outside of DR event hours.
- During AER control, even 5–10% of the curtailment associated with DR events can enable further emissions reduction.
- AER during more hours may also unlock energy savings associated with advanced demand response.

Source: RMI analysis, WattTime.org, THG. Ranges shown are median savings across 6 facilities participating in a range of traditional DR programs, with simulated participation for increased hours in emissions-focused demand response.

Mercury and CO_2 reduction goals are complementary

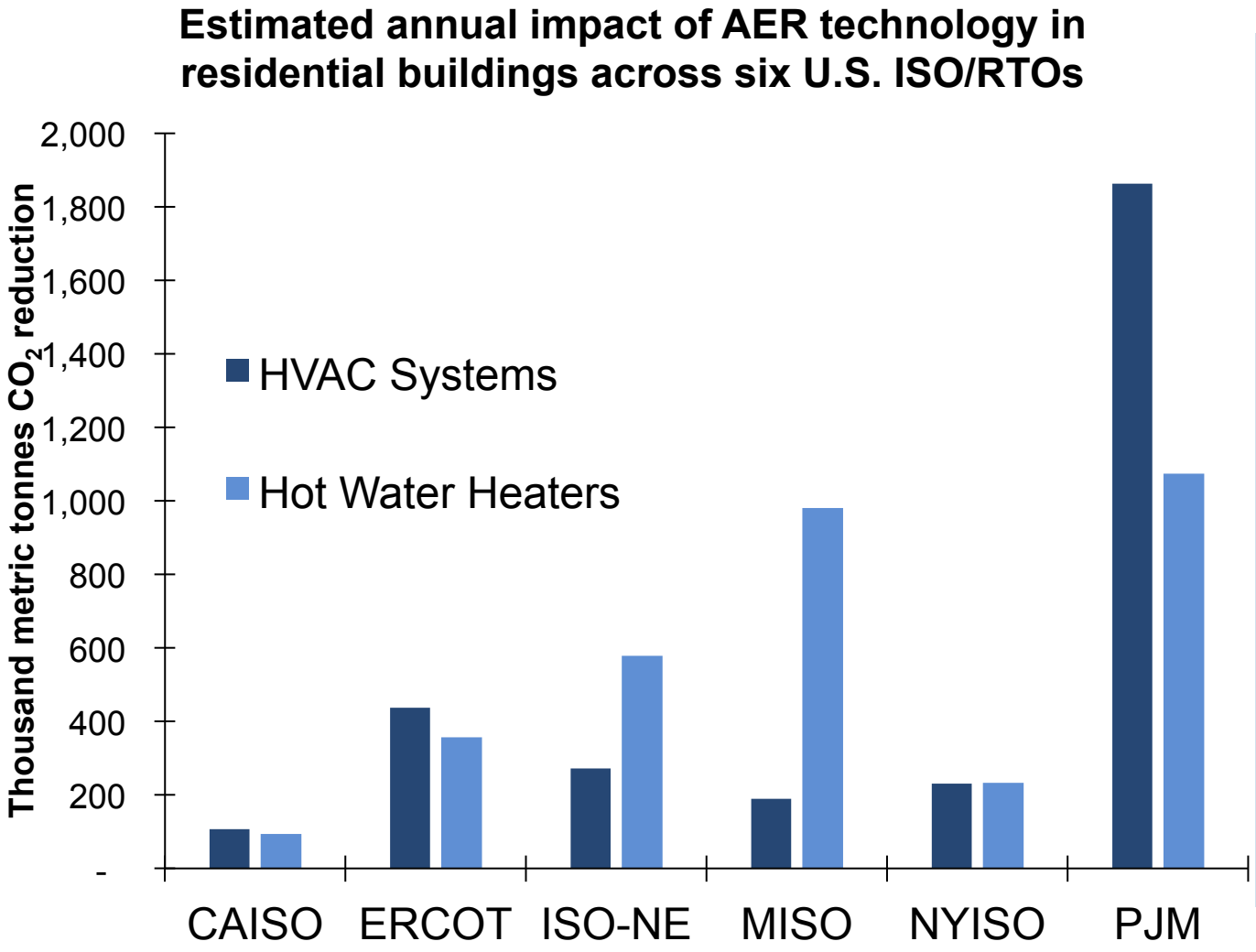
Emissions savings results from optimizing for either mercury or CO_2 for water heaters in Chicago



- Optimizing for CO_2 emissions reduction leads to significant mercury pollution reduction, and vice versa.
- Both strategies reduce energy production from coal plants, and thus use nearly identical control signals.

Source: RMI analysis, WattTime.org, E2i.

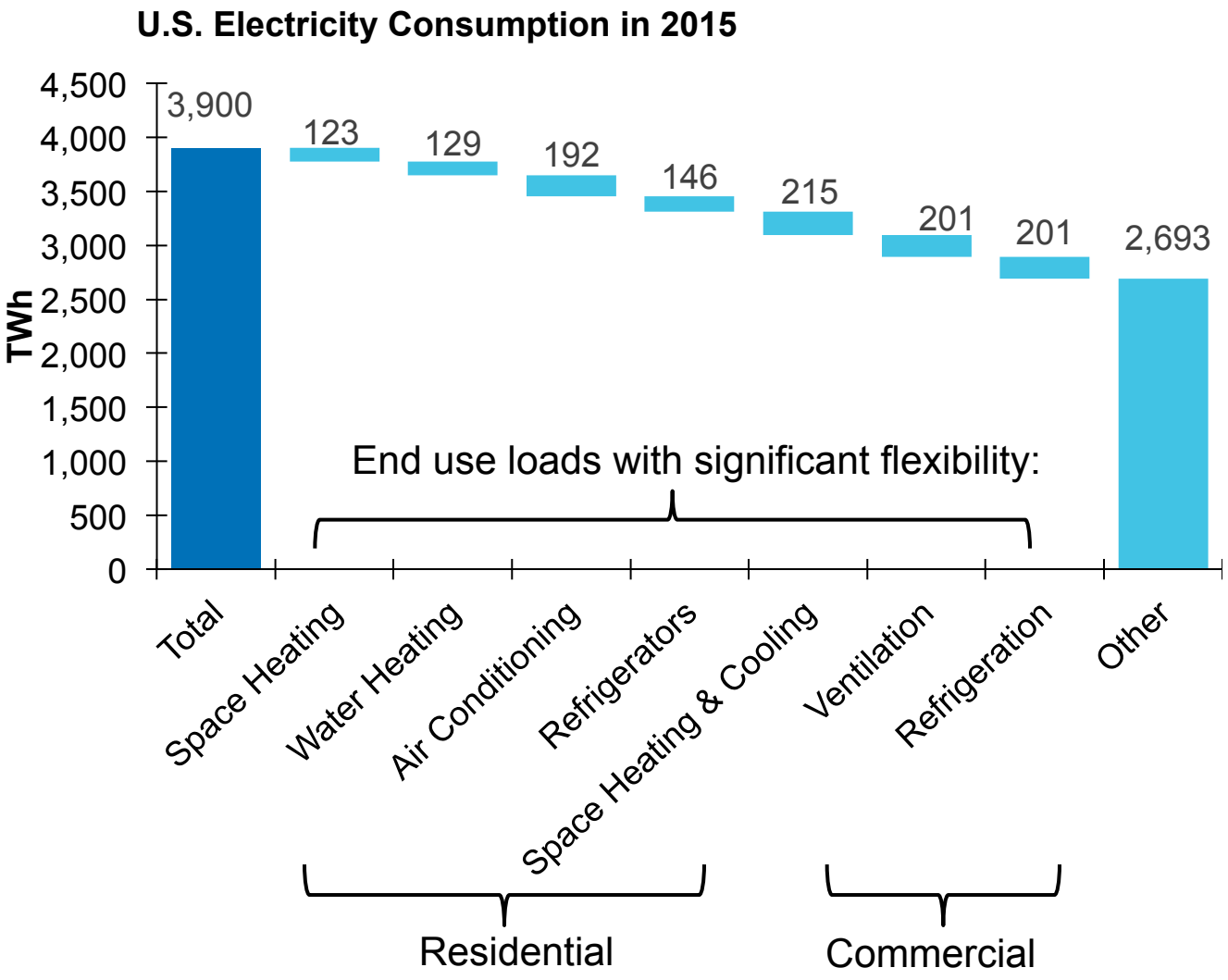
Residential AC and water heating in six markets in the U.S. can reduce emissions by the equivalent of 1 million autos



- Savings potential depends on both the patterns of marginal carbon intensity in regional grids, and the number of flexible devices in each region.
- Non-wholesale market regions and non-residential loads would lead to greater savings potential.

Source: RMI analysis; WattTime and E2i emissions data; EPA; EIA

Naturally flexible residential and commercial loads account for at least 30% of U.S. electricity consumption



- RMI modeling of residential AC and water heating represents only 8% of the U.S. load.
- At least 30% of total U.S. load has significant inherent flexibility appropriate for AER
- Additional flexibility is likely present in remaining 70% of load (e.g. industrial processes, pumping, etc.).

Source: EIA; RMI analysis

Emissions reduction potential from all flexible loads can improve with two key enablers

Improved data in near-term

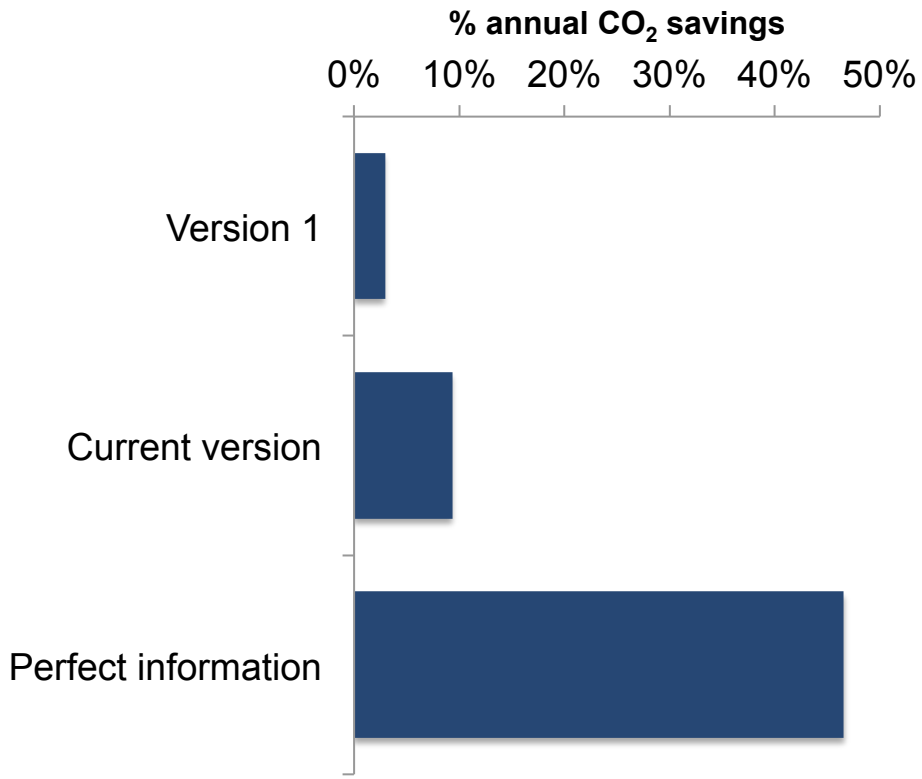
- Grid operators can provide direct data streams.
- This can help AER providers and customers identify and capture larger swings in marginal emissions intensity.

Higher volatility in medium-term

- Renewables are already on the margin many hours of the year in certain regions (e.g. wind in TX, solar in CA).
- The number of these hours are likely to increase as more renewable capacity is built.

Emerging data sources can lead to more dramatic emissions reductions

Comparison of emissions savings possible for water heaters in MISO using different generations of marginal emissions data



- The first generation of marginal emissions data allowed a 3% CO_2 reduction.
- Current-generation models, using more and different data sources, increase savings potential to ~10%.
- With future data sources (e.g. directly from the system operator), it may be possible to precisely identify marginal CO_2 and reduce annual emissions by over 40%.

Source: WattTime.org, E2i, MISO, RMI simulation

The impact of small changes on the margin today can add up to major emissions reductions over time

Planning for next kilowatt-hour…

- Using current technology and data about marginal emissions, individual customers are **empowered to make informed decisions about their next unit of energy consumption.**
- These immediate emissions savings are verifiable, easily demonstrated, and simple to quantify.

... leads to grid operational changes …

- As more customers make incremental changes to their usage, there will be an **emerging opportunity to adjust the control signals and directly impact power plant operational decisions** (i.e., unit commitment).
- While harder to quantify, these savings can be much greater (e.g., targeted shifting to eliminate the need for coal plant operation).

… and eventually impacts resource investment

- As these operational impacts are reflected in system operations, spot prices, and forward capacity prices, **emissions-aware load shifting can drive emissions-reducing investment decisions.**
- These impacts are difficult to forecast, but could materially increase investment in renewable energy resources.

Pre-charrette work:

Ingoing hypotheses on segment value propositions

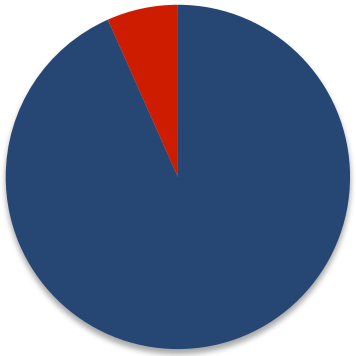
Residential customers, institutional customers, and utilities have demonstrated unmet needs that could be addressed by AER.

Residential customers prefer automated emissions reduction technology when it is offered to them, allowing companies that offer AER to differentiate themselves

2015-2016 Chicago pilot project findings:

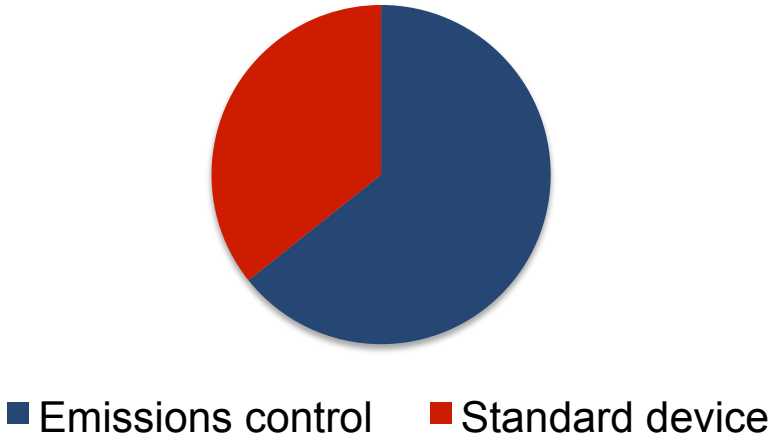
Customers overwhelmingly chose to opt in to an AER program after hearing details from program representatives

Opt-in rate for AER service



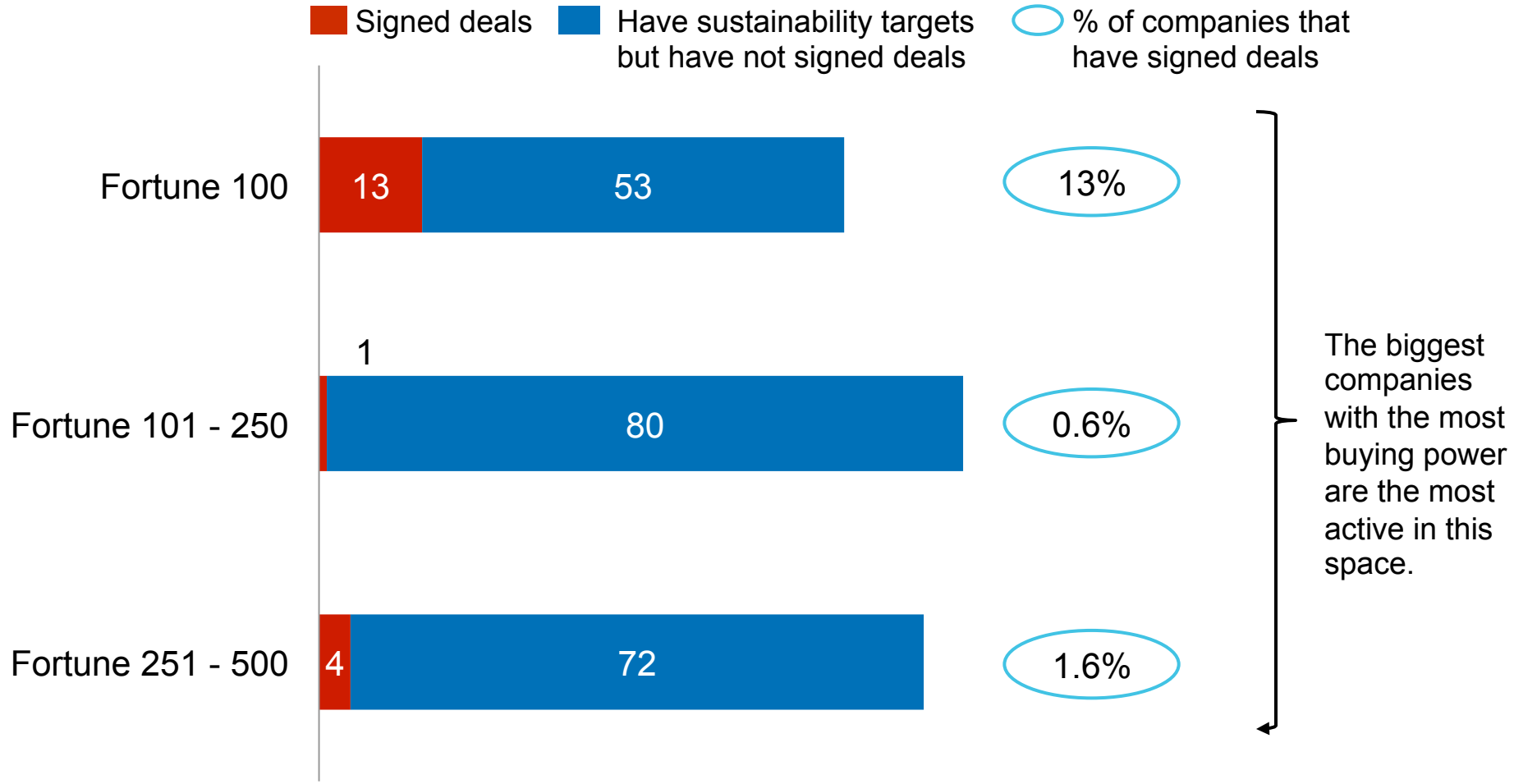
Customers chose AER over a non-AER device when entering a raffle for a smart thermostat

Customer choice in raffle entry



Source: WattTime.org, Delta Institute

Corporations and other institutional customers have acted on sustainability goals by signing billions of dollars in renewable power purchase agreements in recent years



Source: RMI Business Renewables Center; data current as of December, 2016

For institutional customers, accurate emissions data and AER can help lower costs of reaching sustainability targets, and helps achieve other cost-saving goals

Identifying least-cost options

- Marginal grid emissions data can differ dramatically from regional average emissions factors often used to benchmark emissions, which can re-prioritize investment choices.

Adding a new, low-cost option

- Automated emissions reduction itself can be a near-zero cost option for emissions savings when integrated with existing demand response or building controls.

Integration with energy cost goals

- The controls required for automated emissions reduction are the same as those required for demand charge management and other utility bill reduction efforts.

Source: Company interviews

Utilities are rolling out new products and services to bolster customer engagement, especially for “green” programs

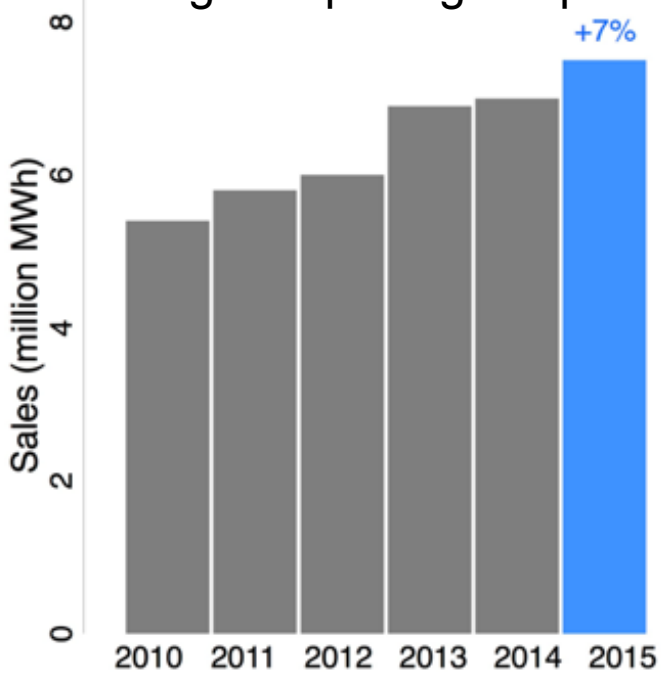
Expanded utility customer programs can boost engagement and revenue

In a 2016 Utility Dive poll, respondents reported pursuing many new types of programs:

- **66% will pursue new energy management** and efficiency program opportunities
- **47% will pursue expanded green pricing** programs

Customer uptake of green pricing is growing

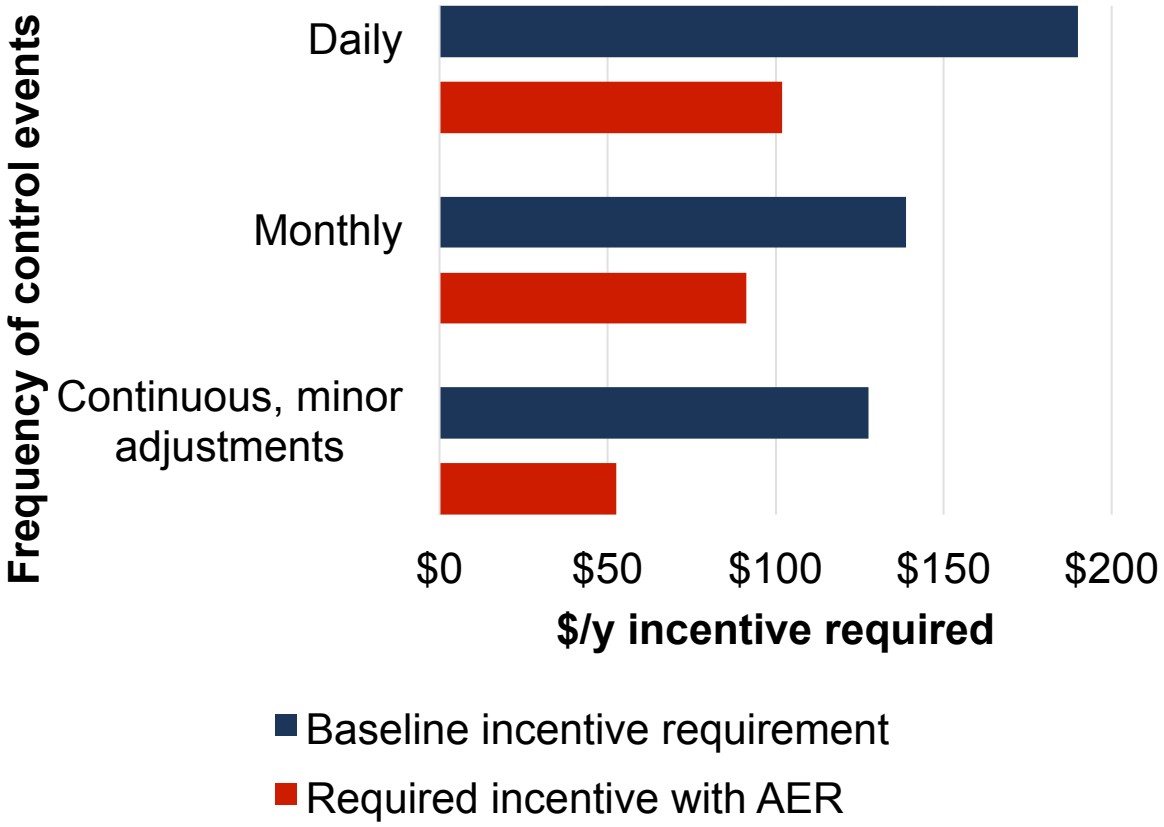
A 2016 NREL study found a steady increase in green pricing adoption:



Source: Utility Dive; NREL: O'Shaughnessy, Liu, and Heeter. (2016)

Emissions management features can lower customer acquisition costs and drive program adoption

Impact of emissions control feature on survey respondents' stated required incentive to participate in a utility demand response program

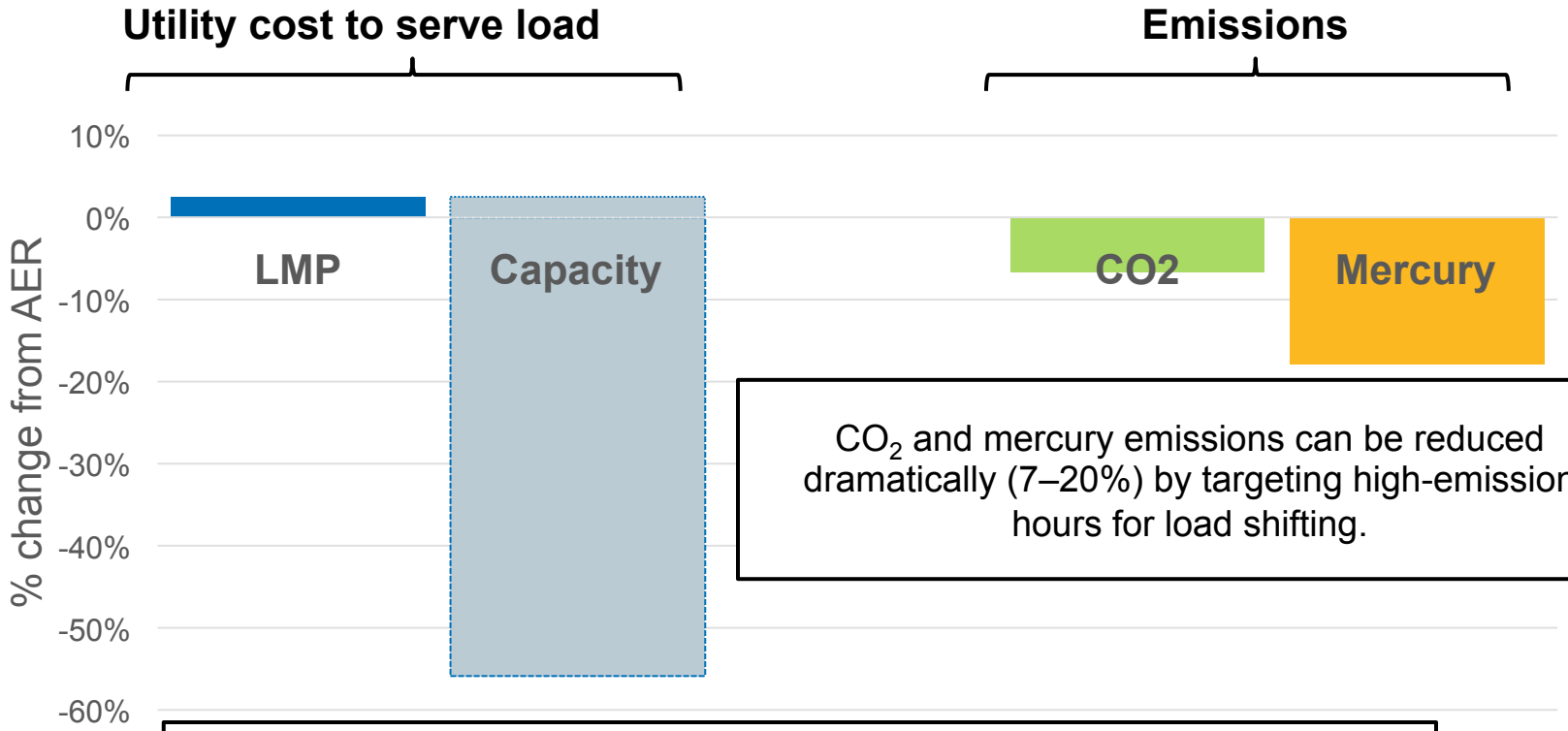


- Survey data reveals that offering an AER feature to customers in a utility DR program reduces the required incentive by 30–60%.
- The relative change in incentive requirement grows the more frequent the program's control events.

Source: WattTime.org

Utilities can incorporate AER into demand-side management programs to reduce both costs and emissions

Simulated impacts of emissions-based control signal for residential electric water heater in ComEd territory



CO_2 and mercury emissions can be reduced dramatically (7–20%) by targeting high-emission hours for load shifting.

When emissions are optimized, energy cost (i.e., locational marginal price) may increase slightly, but by targeting peak hours for reduction, and total cost to serve can decrease by >50%. End-user costs are typically unaffected by AER, unless a utility passes along the savings via a dynamic rate structure.

Source: RMI analysis; E2i emissions data

Companies are already deploying products to harness latent consumer demand and reduce emissions

Category	Examples	Activities
Technology providers	WattTime, LEEM Locational Emissions Estimation Methodology	• Pioneering new products for real-time marginal emissions estimates
Consumer device manufacturers	HōlHōm powered by ENERGATE, eMotorWerks SMART [GRID] EV CHARGING	• Integrating data and control streams into consumer products and services
Corporate solution providers	THG Energy Solutions, LLC, Business Renewables Center, Advanced Microgrid Solutions, building clouds	• Providing differentiated services by better tracking and managing emissions
Emissions accounting standard bodies	The Climate Registry, SCSglobal SERVICES	• Incorporating more-granular emissions data into verified protocol

Workshop overview and outcomes

The Chicago workshop, March 6–7 2017, included 63 participants from 47 organizations representing stakeholders across the U.S. electricity industry. Attendees identified and prioritized sources of value, use cases, and near-term initiatives for AER across multiple sectors.

Workshop summary

The AER workshop in Chicago brought together stakeholders from different companies and industries well-positioned to shape the emerging AER market.

The workshop provided a fact-base to begin the discussion

- Pre-event calls, a workshop pre-read, and content presentations provided attendees with context for—and analysis of—the opportunities presented by AER.
- Participants with early presence in AER space shared their experiences to ground the discussion.

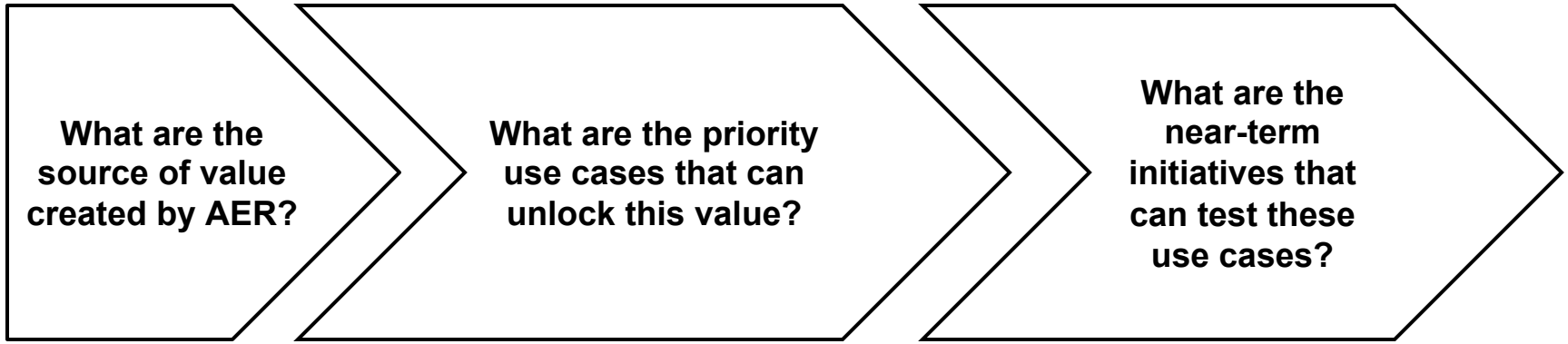
Facilitated sessions allowed participants to drive toward outcomes

- Following content sessions, participants joined facilitated breakout tracks that fostered new ideas and critical thinking about the path forward for AER.
- Feedback sessions in plenary and between paired groups allowed for broad input to emerging themes.

Workshop flow and process

The workshop was organized around three questions, allowing attendees to explore different value propositions, use cases, and priority initiatives for AER.

Day 1 Day 2



Breakout tracks:

Example topics:

Residential customers:
- Marketing
- Integration with existing programs

Institutional customers:
- Emissions accounting
- Technology integration

Utility programs:
- Customer acquisition
- New revenue streams

Policy perspectives:
- Existing policy targets
- New policy levers

The AER project team, using input from workshop attendees, identified five high-priority projects for near-term action

Participant-identified initiatives fell into five general topics

Topics

1) Pilot projects to test business case for institutional customers
2) Pilot projects to test integration into utility DR programs
3) Device-level certification
4) Integration of AER into emissions accounting protocols
5) Creating standard, open infrastructure for AER deployment

The project team will take forward specific projects in these areas

Roles

- WattTime, as the leader of the overall effort, will coordinate participant contributions to collaborative projects
- RMI will provide topical facilitation support to initiatives (e.g. organize conference calls) and analytical assistance as needed

Workshop attendees will help test criteria for success of these projects

- Project participants will test specific AER value propositions for their individual organizations
- Participation in these projects will ground the work in real-world use cases and value propositions, and can demonstrate early success for this emerging opportunity

Project 1: Pilots to test AER business case for institutional customers

What is the need?	Workshop participants identified a need to perform pilot studies that can **test and quantify AER's value to large customers**. Successful case studies and pilot programs will help justify the business case for AER.

How will this project address it?	The project will facilitate connections between large energy consumers (such as large companies or municipalities), and device manufacturers that could integrate AER capabilities in order to help jump start these pilot projects. Specific topics may include reporting needs for executives, and technical integration of AER signals with facility management systems.

Who should participate?	**(i) Device OEMs or energy management firms** interested in providing AER services **(ii) Large energy consumers,** such as corporates and municipalities, that are interested in additional emissions savings

Project 2: Pilots to test value of AER for residential DR program customer acquisition

What is the need?	A pilot program with a DR provider could test if **integrating AER into DR programs lowers customer acquisition costs**. AER is a natural extension of existing residential demand response programs, but the value for DR program providers has not yet been proven in the field.
How will this project address it?	The project team will work with utilities and demand response providers to develop and run pilot programs to confirm (i) to what extent residential customers value AER features, and (ii) that DR providers are able to leverage this to enroll more customers in their programs and/or enroll customers at lower costs.
Who should participate?	**(i)** **Demand response providers** with two-way communication capabilities that can integrate an AER feature **(ii)** **Utilities** with active DR program recruitment that can serve as an opportunity for A/B testing

Project 3: Device-level certification

What is the need?	Building on the success of programs like Energy Star, a device-level certification program would **simplify the buying decision for consumers**, helping them obtain the benefits of AER without having to fully dive into all of the technical details.

How will this project address it?	WattTime and partners are currently developing a certification system for devices that verifies appropriate device response to an AER signal, and are interested in partnering with other organizations to make it broadly accessible.

Who should participate?	**(i)** **Certification entities** or regulatory bodies with interest in supporting certification **(ii)** **NGOs** who can provide input on scaling the reach and impact of the certification

Project 4: Integration of AER with existing greenhouse gas (GHG) accounting frameworks

What is the need?	For this nascent industry to gain significant adoption, it will be important for the GHG savings to be **validated by external parties** and incorporated into existing carbon accounting frameworks.
How will this project address it?	WattTime has applied with Verified Carbon Standard (VCS) to incorporate AER into a standard GHG accounting framework. VCS will soon be initiating a public comment period to gather feedback and generate awareness. Other initiatives, such as a technically-focused conference on data and model development, are also planned, pending funding and interest.
Who should participate?	**(i) Large organizations** that have sustainability targets; **(ii) NGOs** interested in providing feedback; **(iii) any other** interested parties.

Project 5: Creating standard, open infrastructure for AER deployment

What is the need?	For AER to scale, it is necessary to have **software infrastructure that is transparent and easy to use** in order to lower barriers to entry for broad AER participation. This can facilitate making more devices "AER-ready" and allow verification of data and device response.
How will this project address it?	The project team will coordinate several developers of IoT software (e.g. If This Then That) who are developing tools to facilitate AER and making them publicly available, often with open source.
Who should participate?	**(i) IoT** software companies **(ii) Device manufacturers** who make IoT devices **(iii) Building managers** who use IoT-enabled systems

Appendix: Detailed workshop outputs

Participants in workshop breakout groups created detailed outlines of value sources, use cases, and near-term initiatives for AER. Team discussions and final presentations of initiatives informed the next steps to be prioritized by the project team.

Sources of value and potential barriers, by sector

Participants in breakout groups identified what value AER could provide in their sector, and what potential barriers stood in the way of that value.

Residential buyers: Sources of value

Enables customers to go green	Green marketing tool	Renewable energy integration
• Allows customers to take action to reduce mercury/carbon emissions • Solution to help reach personal/community/ city goals	• Support/expand market for smart appliances (e.g., smart thermostats) • Can enhance existing demand response programs	• AER can act as a control signal for renewable integration • Enables higher penetration of renewable energy and closure of fossil-fueled power plants

Residential buyers: Potential barriers

1. **Who pays?** Deciding who should bear the cost of integrating AER into programs and devices for residential customers was a primary point of concern.

2. **Inertia among customers and original equipment manufacturers (OEMs):** Customers are seen as being fairly content with their current range of green options and smart home devices. There is some skepticism around whether customers adequately take advantage of existing opportunities to go green. Barriers to OEM integration are also seen as significant—from the manufacturing process to uptake among distributors.

3. **Lack of knowledge:** Residential customers are seen as having very limited understanding of electricity as a whole, making the concept of automated emissions reductions potentially complicated or out of reach.

Institutional buyers: Sources of value

Financial savings	Public relations and marketing benefits	Simplified and improved GHG accounting
• Offsets need for energy efficiency investments and/or carbon offsets • Software could enable lower energy bills as well as reduced emissions	• *Internal:* Improves employee health and happiness • *External:* Company can publicize corporate stewardship effort	• Simplifies GHG emissions data collection • Helps companies understand where their emissions are coming from

Institutional buyers: Potential barriers

1. **Complexity:** AER is non-intuitive and can be difficult to explain. This could limit the appeal of using AER as a marketing tool. Further, it could hinder efforts to explain the tool to key stakeholders and decision makers within an organization.

2. **Risk vs. reward:** Enabling AER throughout an organization could pose a number of risks to an organization's cyber security and building operations. AER's modest impacts, when compared to the perceived large risks, might deter some from adopting the technology if those risks are not adequately addressed.

3. **Lack of internal incentives:** Although many companies have set sustainability targets, employees are often solely judged based on more traditional metrics. Particularly when combined with the first two barriers listed above, the lack of proper incentives could lead to internal resistance to AER programs.

Utilities: Sources of value and barriers

Improving customer engagement	Meeting utility-level sustainability objectives	Adding value to new utility programs
• Lower customer acquisition costs • Increase satisfaction • Increase scale of demand side management programs	• Sell emissions credits • Mitigate operational challenges • Avoid renewable energy curtailment	• Provide new revenue through new customer programs • Utility can provide validated marginal data

Barriers to success:

• Uncertain customer response to messaging • Uncertain customer trust in utility savings assertions • Uncertain value prop for mass-market	• Undeveloped emissions trading markets • Lack of credit certification methodology • No CO_2 targets for most utilities	• Uncertain business model and revenue source for new programs • Privacy concerns and other data sensitivities

Policy: Sources of value and barriers

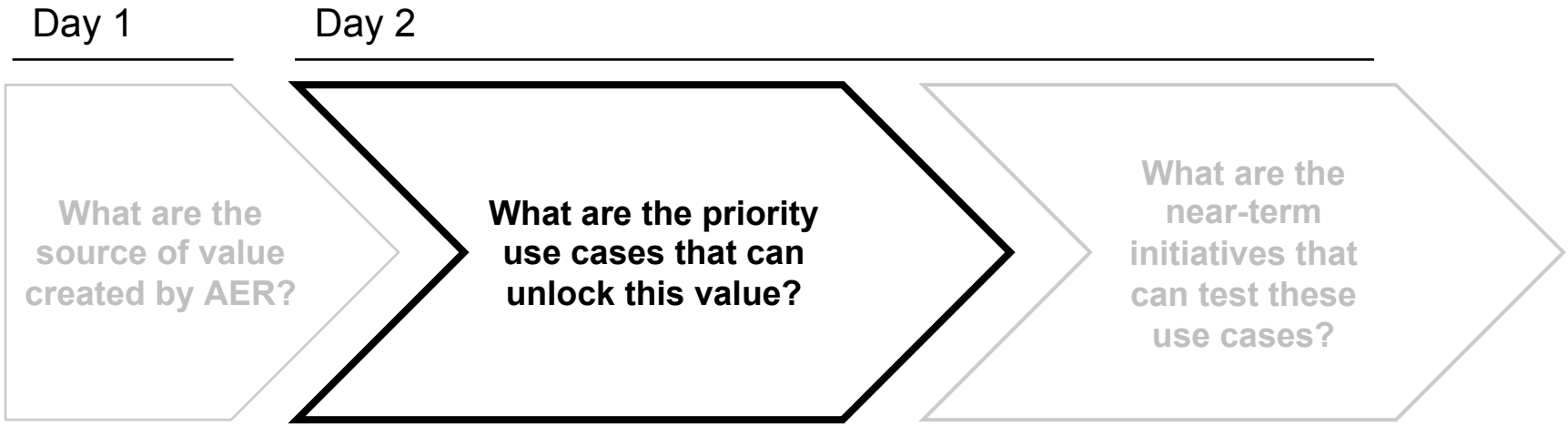
Achieving existing policy goals	Ability to target emissions savings regionally	Protocols and standards
• AER can be a low-cost lever to reach goals of existing policy, e.g. state-level renewable portfolio standards.	• AER can be used to prioritize emissions-reduction investment toward sources of greatest pollution (e.g. the ~40% of mercury emissions that come from local sources).	• Policy can help spur a standardized protocol for AER and consumer-level transparency, e.g. similar to existing programs like ENERGY STAR, or new standards opportunities.

Barriers to success:

- Policy levers relying on AER drive demand for emissions reduction in indirect way
- Uncertainty in magnitude of potential for AER to reduce emissions
- Requires policy change at state and/or federal levels
- Consensus that customer adoption will likely lead policy

Priority use cases, by sector

Participants in breakout groups prioritized use cases for AER for each sector, including the value at stake, key stakeholders, unresolved questions, and opportunities for integration with existing efforts.



Residential buyers: Priority use case #1

Drive system operations with AER

What is the opportunity?	Drive system operations with AER to integrate renewables into a more efficient grid, embed “carbon cost” into market, and avoid load-following peakers or expensive storage.

What value would it unlock?	Using AER to drive system operations should decrease customers’ energy costs and drive a cleaner power system (a societal benefit).

What major questions exist around this opportunity?	• Who pays the upfront costs of this approach? • How will the utility find value in this regime? • How can we motivate residential customers to demand this transformation?

Residential buyers: Priority use case #2

AER: Technical Integration

What is the opportunity?	Facilitate the technical integration of AER into programs and devices.

What value would it unlock?	• To vendor: differentiation, branding • To utility: PUC mandate, customer satisfaction, branding/stickiness • To customer: “Prius effect,” incentives

What major questions exist around this opportunity?	• How can we create a common integration/signaling protocol (e.g., “OpenADR for AER”)? • How can we mitigate impact on customers (i.e., comfort, appliance function)? • How should we incorporate common technical/data nomenclature (e.g., “Green Button,” credit score)?

Residential buyers: Priority use case #3

Standardized rating system for devices

What is the opportunity?	Create a standardized rating system for devices/appliances (e.g., Energy Star).
What value would it unlock?	Having a standardized rating system would unlock value for AER companies, device manufacturers, and retailers by providing a recognizable brand-name that customers can trust. This could drive incremental sales to firms that adopt this rating system.
What major questions exist around this opportunity?	• How can manufacturers manage risk? • What is the appropriateness/adequacy of having one national label? • Who markets and pays for this rating system? • How can we integrate this label with other labels like Energy Star; should this label should be a standalone AER label or integrated with efficiency?

Institutional buyers: Priority use case #1

Create a business case which quantifies the potential savings

What is the opportunity?	Utilize AER in locations where electricity price is correlated with emissions in order to reduce both; or, quantify the value of generated carbon offsets.
What value would it unlock?	Quantifying the savings would help convince companies to implement AER, thereby unlocking value for the organizations, AER providers, and society.
What is the current situation?	Currently, companies are not implementing AER because they are (i) unaware of its capabilities, and (ii) not convinced of its value.
Who are the key stakeholders?	The customer (including the financial decision makers and sustainability officers), the AER providers, and the regulators.
What available programs could be leveraged?	Utility or government energy management programs, smart building programs, DR programs, etc.

Institutional buyers: Priority use case #2

Provide integrated offerings

What is the opportunity?	Integrate AER into ”smart” devices and DR programs through bundles and OEM collaboration.
What value would it unlock?	Bundling AER would help (i) OEMs differentiate their product, (ii) customers meet their goals, and (iii) society reduce emissions.
What is the current situation?	Given the lack of a broad-based CO_2 market, customers don’t have a large incentive to seek this technology out on their own. Bundling would align the product with the customer purchase decisions to maximize participation.
Who are the key stakeholders?	OEMs, corporate procurement and facility managers, energy program designers, and environmental advocates.
What available programs could be leveraged?	Demand response programs, building certification programs, code and standards organizations, eco/smart procurement programs (e.g. Energy Star), or facility operator training sessions.

Institutional buyers: Priority use case #3

Energy smart buildings

What is the opportunity?	Integrate the AER technology into buildings to enable emissions reductions. To achieve this, it may be useful to rebrand the technology as “smart”.
What value would it unlock?	This approach emphasizes simplicity, cost savings, and an automated carbon management and reporting approach to appeal to building managers. It would also enable AER and emissions reductions within buildings.
What is the current situation?	Building managers are not incentivized to care about emissions reductions and are constantly approached with new approaches. To get their attention, AER will need to provide clear emissions accounting or cost savings benefits.
Who are the key stakeholders?	General managers, facility engineers, and building tenants and owners.
What available programs could be leveraged?	Energy Star, USGBC, GRESB, CDP.

Utility programs: Priority use case #1

Integrate AER with existing residential thermostat DR program

What is the opportunity?	Utilities already have significant DR capacity deployed, and are constantly recruiting new customers. This presents an opportunity to do a lightweight pilot project for AER integration into an existing process.
What value would it unlock?	Integration into existing program would limit overhead costs of setting up a dedicated project. Testing with a subset of newly recruited customers would provide a natural opportunity to statistically test marketing value.
What is the current situation?	Utilities have difficulty recruiting customers into DR programs, and/or suffer from attrition in recruited customers.
Who are the key stakeholders?	Utility DR program managers and their vendors need to design the specific integration with existing program recruitment efforts and demand response management systems (DRMS).
What available programs could be leveraged?	Demand response programs that employ two-way communication are the most natural targets for AER integration.

Utility programs: Priority use case #2

Launch a utility affinity program for residential customers

What is the opportunity?	AER can be integrated into a utility affinity program—where customers can earn points through certain actions and redeem them for chosen rewards—by letting customer accrue points for emissions savings.
What value would it unlock?	Allowing customers to earn points for emissions savings could increase marketing value of utility programs to the environmental customer segment, and provide customer-specific rewards to participants.
What is the current situation?	Due to relatively low monetary rewards or other incentives to participate, utility programs lack appeal to some customer segments.
Who are the key stakeholders?	Utility product developers would need to work with environmental stakeholders and regulators to agree on the cost allocation, cost-effectiveness metrics to use, and emissions savings validation.
What available programs could be leveraged?	Existing utility affinity programs could provide a low-cost starting point to test integration.

Utility programs: Priority use case #3

Utility-sponsored program for commercial and industrial (C&I) customer emissions management

What is the opportunity?	Utilities can provide AER to institutional customers interested in more easily managing their emissions footprints, integrated with other load management use cases to provide utility value.
What value would it unlock?	Customers get a turn-key service from a trusted provider to benchmark and seamlessly reduce their emissions. Utilities may earn new revenue and/or lower the costs (e.g. customer acquisition) for traditional DR / energy trading.
What is the current situation?	Utility-sponsored C&I demand response programs provide relatively minor monetary incentives to participate, leading to low participation.
Who are the key stakeholders?	Utilities need to design this as a new program and/or integrate with existing C&I DR. Customer groups need to define their requirements.
What available programs could be leveraged?	Existing utility affinity programs could provide a low-cost starting point to test integration.

Policy: Priority use case #1

Targeted regional incentives to reduce emissions

What is the opportunity?	Low levels of adoption (e.g. 1-2%) of AER technology, if targeted correctly, could enable a large degree (e.g. 40%) of mercury emissions savings that affect local environmental quality.
What value would it unlock?	Policy efforts could help prioritize program spending on the highest-value emissions-reduction opportunities for specific local benefit, and avoid less-impactful program spending.
What is the current situation?	Policy instruments to encourage emissions savings are often applied in a broad geographic area without consideration of variability in local impacts.
Who are the key stakeholders?	Market operators (ISOs/RTOs), federal- and state-level regulators, environmental science researchers, and utilities.
What available programs could be leveraged?	Existing air quality and emissions programs.

Policy: Priority use case #2

Protocols to support AER integration into existing emissions reduction policy

What is the opportunity?	Numerous existing policies aim to reduce emissions of mercury, CO_2, and other pollutants. AER may be a low-cost lever to do so, if underpinned by protocols that provided a common basis for estimating its impact.
What value would it unlock?	Protocols that help policy-makers assess the likely impacts of AER on existing pollution reduction targets could obviate higher-cost measures that are currently used to achieve the same goals.
What is the current situation?	Lacking a common protocol for AER impact estimation, existing policy levers do not allow for it to be prioritized in compliance efforts.
Who are the key stakeholders?	Policy-makers, market operators, environmental compliance regulators.
What available programs could be leveraged?	Existing air quality and emissions programs.

Priority initiatives

Participants in breakout groups designed near-term initiatives that could test the priority use cases they identified, including key outcomes and milestones. All participants then offered feedback and support for each of the proposed initiatives.

Initiative #1: Create AER Protocol

What is the approach?

This initiative would create a protocol for measuring and reporting the avoided emissions from AER and other interventions including energy efficiency, renewable energy projects, etc.

Key features include:

- A definition of the scope and boundaries for avoided emissions measurement and reporting.
- Verification and certification approaches for AER and other interventions.
- A distinction between project-level and corporate-level accounting.

Proposed milestones

- 6 months: Concept paper or executive summary; stakeholder identification.
- 12 months: Scope setting and published draft for comment.
- 24 months: Published protocol.

Comments and questions

”Include price-based approaches”

”A delay until the protocol is 100% ready will be costly and could reduce momentum”

”Will paper be peer-reviewed?”

“How to account for procurement vs. load market?”

“Who can participate? How is it approved and rolled out?”

“What is value proposition to help develop?”

“Need to generate demand for this protocol”

“Does this need to be national, or can we do regionally?”

Initiative #2: Enviro star rating system

What is the approach?
This initiative will create a rating system called “Enviro Star,” modeled after Energy Star, which acts as an AER-based rating system. The rating will drive competition and sales among device and appliance manufacturers; it will also drive customer awareness and support environmental preferences and trust. Key features include: • Rewarding specific features including flexibility and emissions reduction. • Marketing options include “Enviro Star Inside”. • Enviro Star could integrate with Energy Star efficiency ratings.

Proposed milestones
• 6 months: Stakeholders are assembled (RMI, WattTime, manufacturers, retailers); pilots begin. • 12 months: CES rollout. • 24 months: Wide presence in retailers.

Comments and questions

“Love the concept”

“What type of connectivity/security concerns exist for consumers to enable/utilize their devices for AER?”

“Who has the credibility to develop the rating system?”

“Would this be available for retrofits to existing appliances? (Ex. load controller added to water heater)”

Initiative #3: Ecosync

What is the approach?
This utility-sponsored program would integrate AER into a automated demand response (ADR) to create a compelling product for C&I customers reduce costs and emissions. Key features include: • Improved utility / retailer branding through customer engagement. • Simple implementation, with no incremental cost. • Affiliate program for multiple providers (e.g. ENERGY STAR). • Real-time measurement and verification of emissions savings.

Proposed milestones
• 6 months: Define standard marginal emissions data feed and integrate into GHG reporting protocols. • 12 months: Utility tools to report customer GHG savings are deployed. • 24 months: Top 100 utilities and 50% of existing ADR customers are Ecosync partners.

Comments and questions

"Great name!"

"Fits with LEEM and E2i objectives"

"What is it? Software?"

"Getting the data feed sounds awesome and is crucial"

"What must happen to create 'eco-button?'"

"AMS provides similar service with WattTime feed"

Initiative #4: Incremental AER pilot

What is the approach?
Develop a pilot with a large institutional customer who already has the necessary hardware to implement AER to prove the value. Key features include: • The program must impose zero incremental cost on the buyer or offer net savings. • The program must be implemented using existing technology in order to ensure low friction and low impact with operations.

Proposed milestones
• 3 months: Identify the customer and complete preliminary economic and emissions models. • 6-9 months: Allow buildings to operate as normal, but gather information from the sensors in order to simulate what cost and emissions savings would have occurred given various settings. • 12 months: Once complete, work with the customer to implement the approach that best meets their operational, financial, and sustainability needs.

Comments and questions

"Simple! Seems so easy!"

"What is the best jurisdiction to do a pilot?"

"Like it!"

Initiative #5: Open-source AER data

What is the approach?
Make emissions data underlying AER standardized and widely accessible. Parties involved would be FERC, ISOs, vendors, NGOs, big energy consumers, and DOE/EPA Key features include: • Developing common standards (e.g., Green Button). • Create a clearinghouse for real-time data.

Proposed milestones
• 6 months: Legal review, organize project sponsors, find project manager/champion, bring stakeholders together. • 12 months: Conduct workshops, develop initial concepts, draft standards (15 months). • 24 months: Develop standard set, lay foundation for clearinghouse.

Comments and questions

"Good idea!"

"Interested in this approach. Key issue is sustainability"

"How could this improve upon / how is this different from (nonprofit) WattTime's AER data feed?"

Initiative #6: Commercial buildings smart emissions program

What is the approach?

By 2020, get 5% of commercial buildings over 50,000 square feet into the "Smart Emissions" program.

1) Target building managers and engineers. Capitalize on existing channels (e.g. Energy Star, GRSB, CDP), and select the best geographies (i.e. "green cities").
2) Use a good PR firm to design a simple, clear message which connects to dollar savings and ease of emissions reporting.
3) Develop case studies and recruit advocates.
4) Make signing up simple, and provide training to users.

Proposed milestones

- 6 months: Develop a target list of individuals and companies; run focus groups including practitioners to create an effective communications plan, and initiate pilot programs.
- 12 months: Finalize marketing materials, wrap up case studies, and host a number of events to promote the campaign.
- 24 months: Buildings are signing up for the program, there is demonstrated value, and the program has plenty of good PR.

Comments and questions

"Opportunity to play in college / university space, many program opportunities to deploy?"

"Find companies [with] a focus on [environmental] issues or existing utilities and see if they themselves do building management."

"I like K.I.S.S. mindset and leasing value adds BOMA = good idea. Nice!"

"I like! BOMA/Chicago members have sophistication to accomplish. Consider Atlanta as ally. I'd like to help."

"ComEd as ally [with] muscle?"

"AER Data – offer [with] secure ID code to free up links […]"

Initiative #7: Increase DR with AER

What is the approach?
Using one of the several existing utility programs with two-way communications technology already enabled, pilot AER as an add-on to test customer (i) engagement and (ii) acquisition cost impacts. Key features include: • Integrated with existing utility program as an A/B test. • Seek program with active recruitment and two-way communication. • Testing of DRMS integration for AER control signal.

Proposed milestones
• 6 months: Build DR manager pitch, develop customer messaging. • 12 months: Roll out pilot project. • 24 months: Review results and evaluate expansion.

Comments and questions

"Is this mature enough to present to ISO-NE / NEPOOL in context of e.g. IMAPP?"

"Project team could solicit a grant to seed customers necessary to pitch utility"

"A/B testing a great focus"

"Message as 'always-on' DR"

"Does 2-way communication introduce additional security issues?"

Initiative #8: Clean energy counts

What is the approach?

This initiative would provide an "early adopter package" to companies interested in leading the market for AER, thus demonstrating success of and demand for AER and helping to drive and shape any subsequent policy.

Key features include:

- Enables credits for quantified emissions reduction.
- Enables streamlining of implementation for facility managers.
- Can go through various channels, e.g. OEMs, trade groups.
- Offers choice for managers to save dollars, kWh, and emissions.

Proposed milestones

- 6 months: Roll out concept and prototype of package.
- 12 months: Perform small pilot of the technology.
- 24 months: Large scale pilots, case studies, and demonstrated trade group ally buy-in (e.g. USGBC, BOMA).

Comments and questions

"Consider BOMA Chicago and Atlanta as potential allies"

"Can combine with [Initiative #6] to achieve scale"

"Is this implementation faster than policy?"

"Is this adding new metrics?"

Initiative #9: Energy rewards

What is the approach?
Create a utility-sponsored affinity program where participating customers earn redeemable points for emissions reductions. Key features include: • Integrate with existing program and regulatory framework. • AER hardware rate-based as in traditional DSM programs. • Points earned based on diverse activities in addition to emissions reduction, e.g. energy and peak demand savings.

Proposed milestones
• 6 months: Identify utility to pilot and begin program design. • 12 months: Launch pilot program. • 24 months: Regulatory approval of tariffs.

Comments and questions

”I’d like to stay involved”

”Similar to Just Energy Rewards program”

“Many third party vendors can provide this service”

“Could charitable donation of points be a utility tax benefit?”

“Where does capital come from?”

“Large number of partners needed”

Initiative #10: Advanced DR readiness platform

What is the approach?
(1) Make integrated, branded advanced demand response (ADR) capabilities standard for energy-intensive commercial building hardware. (2) Create a competitive ecosystem of software companies and service providers ready to activate ADR services that allow customers to prioritize and customize cost and emissions savings. Key features include: 1. Equipment must conform to pre-defined standards. 2. Required capabilities must be built-in for new equipment. 3. There should be an after-market option for existing equipment.

Proposed milestones
• 6 months: Create the product standards and define the branding. • 12 months: Build out the ecosystem, including analysis software and utility programs. Moreover, create the aftermarket hardware option for existing equipment. • 24 months: Mainstream rollout.

Comments and questions

"I need to know why I want this feature."

"What policy drivers can help? -i.e. energy commission appliance standards."

"Where do [the] algorithms live?"

"You may not have bought the smart TV for Neflix (or if you had to buy Netflix up-front), but you're much more likely to take that net step when your TV is Netflix-ready."

"We manage energy storage systems on a platform that is integrated [with] WattTime and Open-ADR compatible."

Initiative #11: Carbon drop co

What is the approach?
System operations dispatches load and generation with a three-part optimization based on reliability, cost, and emissions. Change in dispatch process incorporated in utility IRP. Key features include: • Reduces cost for consumer. • Minimizes infrastructure investment. • Lowers barriers to renewable generation adoption.

Proposed milestones
• 6 months: Initiative business plan; select pilot partner. • 12 months: Launch pilot; M&V, results, and learnings. • 24 months: Pilot partner IRP submission, playbook for IRP and guidance for utility implementation.

Comments and questions

"What regulations will need to be changed?"

"Could Green Mountain Power 'self-define' their own marginal on an interconnected unit? Makes sense with HECO, but harder on an interconnected grid?"

"I like that you 'flipped the script.' Sounds simple…too simple?"

"How do you get RTO/ISO/FERC buy-in? Which states would put in an IRP?""