

Tech Roundup

Fall 2020



Customer Energy Solutions, E Source



E Source Technology Assessment Service

Unbiased data and analysis

Over 25 years of expertise

No hype, just unbiased analysis
instead of media headlines

Vendor-neutral recommendations

Emerging technology research

Latest developments in
efficiency and
demand-reduction technologies

Vetting of old, new, and
emerging technologies

Analysis that supports or
debunks "black-box"
technologies



Portfolio development support

Effective measures for
top-performing programs

Recommendations for
technology pilot programs

Recent and upcoming research



- [Commercialized vehicle-to-grid has arrived](#)
- [What can business customers do to manage HVAC energy use during COVID-19?](#)
- [What Ecobee's new research suggests about the future of integrated residential DSM](#)
- Getting the benefit out of batteries
- Meeting your energy goals with customer-centric smart home offerings (from the E Source Smart Home Residential Survey)
- Best practices for your emerging technology strategy

Tech Roundup ground rules

- This is a closed-door, vendor-neutral event for utilities
- We'll unmute the lines during the Q&A section
- Use Zoom's chat feature to ask questions and share comments
- We'll publish this presentation and an article with all the technologies included for all Technology Assessment Service members



Meet the techies!



Luke Beckett



Essie Snell



Jay Stein



Bryan Jungers



Clare Valentine



Miles Hayes

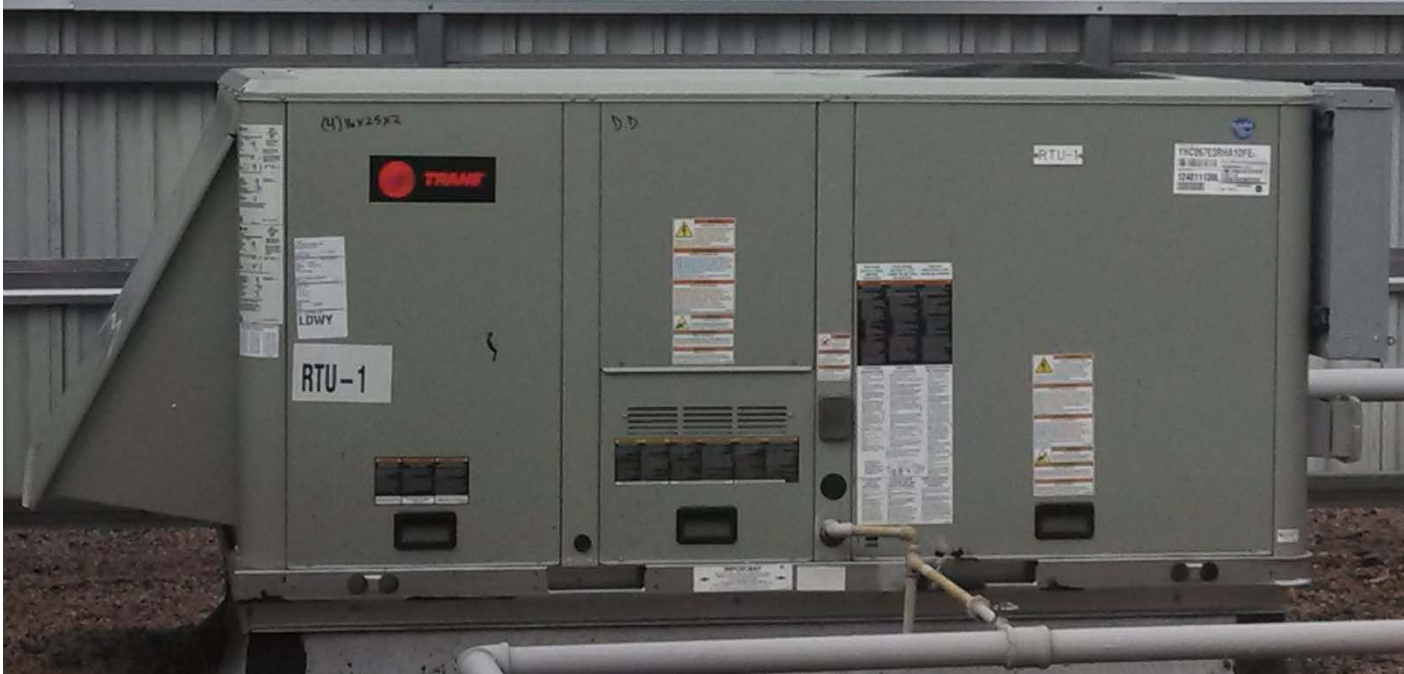
Agenda

- HVAC strategies for responding to COVID-19
- Update on an air-scrubbing technology for HVAC
- The latest on virtual energy audit performance
- Load control devices for frequency and voltage changes
- Smart window coverings
- Commercialized V2G
- DERMS take a leap forward
- Plasma lighting for indoor agriculture
- An update on smart thermostat optimization
- An update on 75F technology
- The latest on the HFC refrigerant phasedown

A nighttime aerial view of a city with illuminated buildings and a complex highway interchange. The top of the image has a dark blue gradient.

HVAC strategies for responding to COVID-19

Businesses struggle to upgrade HVAC in response to pandemic



© E Source

Filtration vs ventilation

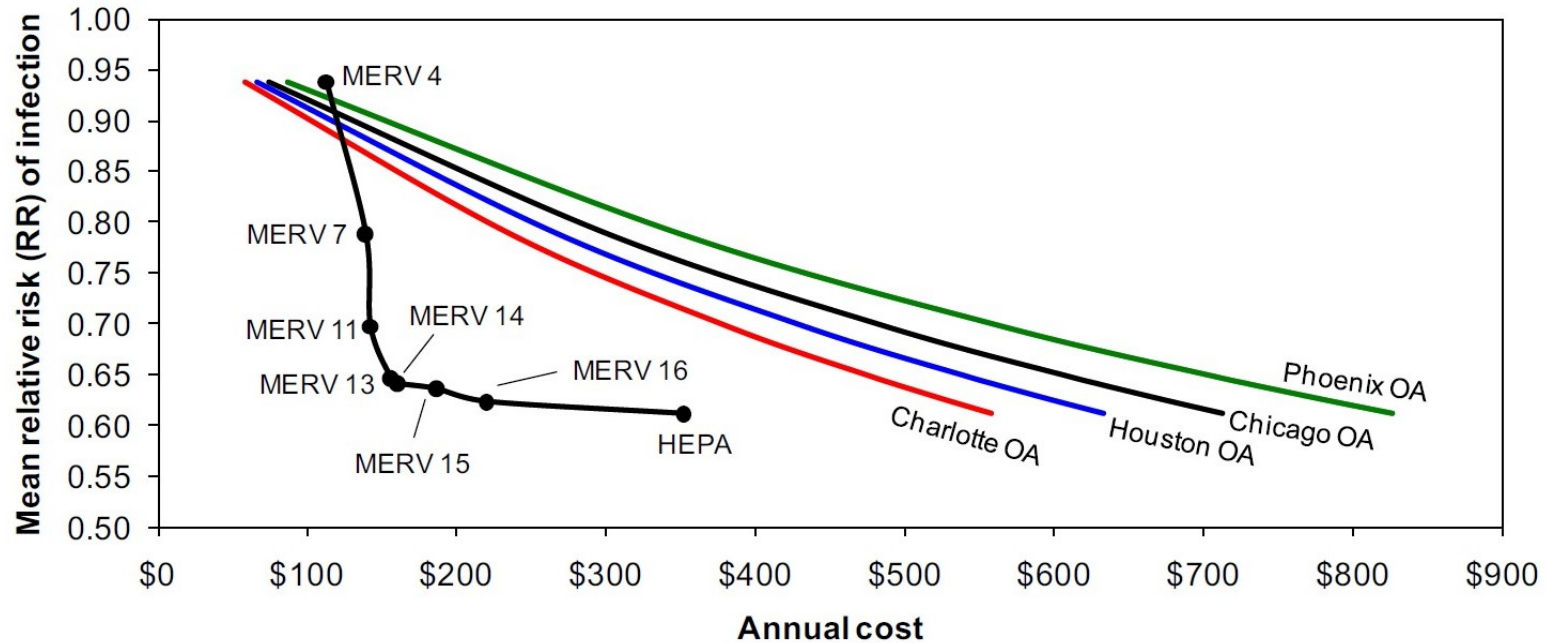


Illinois Tech researchers investigate



Source: Joe Ravi

Filtration reduces risk as much as ventilation but at much lower cost



Note: MERV = Minimum Efficiency Reporting Values; HEPA = high efficiency particulate air; OA = outdoor air. Source: Parham Azimi and Brent Stephens

Encourage trade allies to form integrated teams

- More complicated than swapping out filters
- Can involve measuring air flow, engineering, and modifying ductwork
- Form trade ally teams and help them with marketing



Source: US Air Force

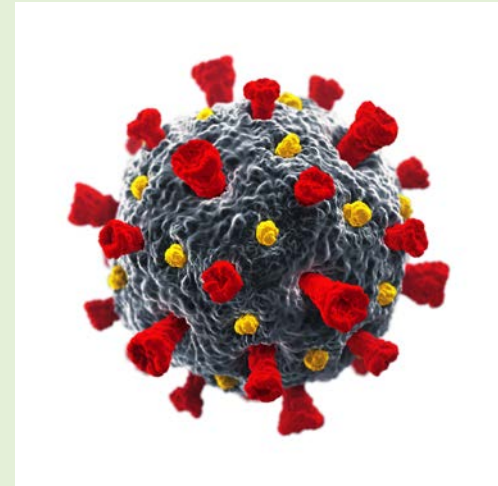


Update on an air- scrubbing technology for HVAC



Challenges in meeting indoor air standards

- Maintaining indoor air quality
- Conditioning outdoor air
- Infectious disease mitigation
- Occupant safety & comfort



enVerid offers new solutions to these challenges

HVAC Load Reduction

The enVerid HVAC Load Reduction (HLR) Modules save energy by cleaning the HVAC airstream and reducing required outdoor air intake.



Source: National Renewable Energy Laboratory

HVAC Load Reduction Module

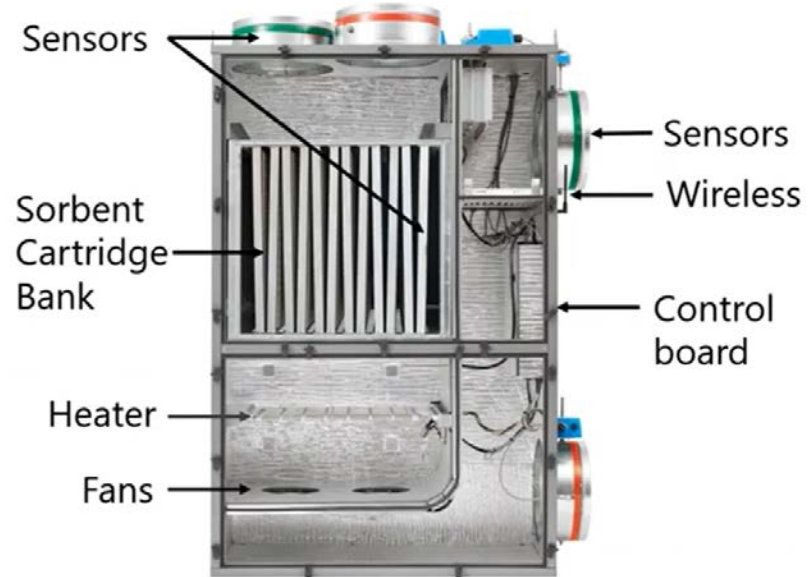
How it works

- Two models of HLRs

- Two operation modes

- Cloud dashboard

- Use cases



Source: National Renewable Energy Laboratory

HLR energy savings and cost offset

enVerid claimed savings

20% to 30% reduction in HVAC energy costs

60% to 80% reduction in outside air

0 to 3 years return on investment

Third-party studies

National Renewable Energy Laboratory study:

- University of Miami Wellness Center
- Morgan Stanley HQ in New York City
- ArcBest HQ in Fort Smith Arkansas


Results:

5% to 37% chilled water energy savings

What can you do?

Pilot the technology

Work with building owners to pilot air-scrubbing technologies to learn more about their potential to save energy and improve indoor air quality. Pilots will likely improve customer satisfaction and accelerate adoption.



The latest on virtual energy audit performance

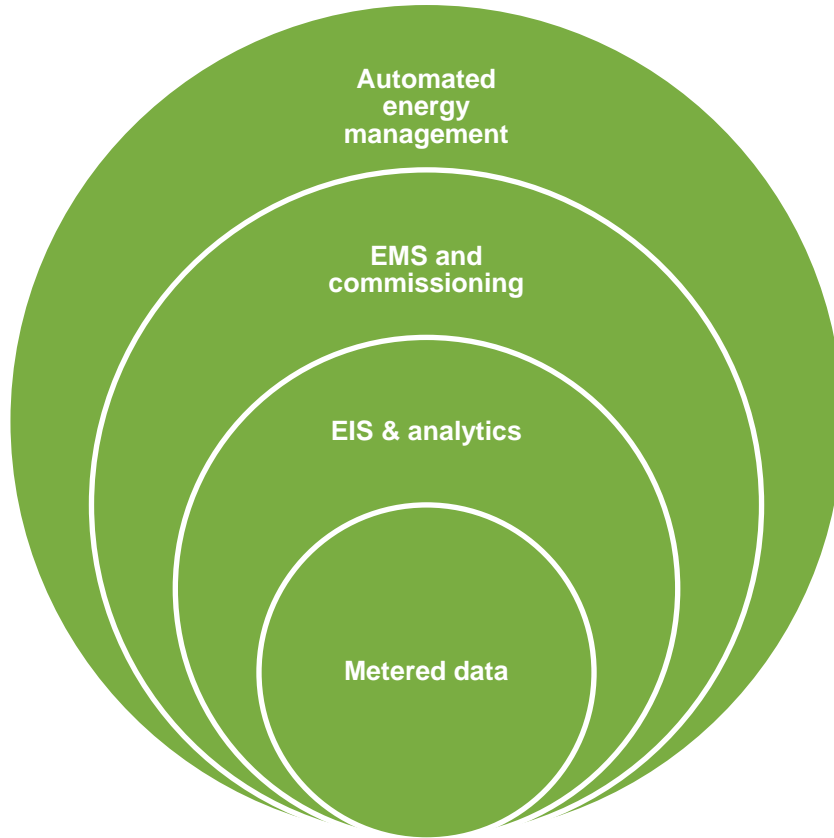


No-touch building energy management

- Terms that describe similar things:
 - Energy management system (EMS)
 - Energy information system (EIS)
 - Nonintrusive load monitoring (NILM)
 - Disaggregation
 - Remote monitoring
 - Real-time feedback
 - Automated systems
 - Analytics
- Often use advanced meter infrastructure (AMI) meter data to deliver energy services



A nested hierarchy of virtual solutions



- All virtual solutions rely on metered data inputs, either from AMI or submeters
- We used to refer to everything as “energy analytics” solutions
- Higher-order solutions build upon lower-order solutions to deliver more overall value
- The ultimate no-touch solution is an EMS that can run and recommission itself

A few virtual audit software solutions

Company	Software description
Agentis	Agentis develops business energy reports for utility business programs. Its software also helps implement virtual audits.
Buildee (formerly Simuwatt)	Buildee is a cloud-based mobile and desktop software solution. It's intended to reduce the time it takes to complete a commercial building energy audit, simultaneously lowering the cost.
Edifice Analytics	Edifice uses the Energy Diagnostics Investigator for Efficiency Savings (EDIFES) tool, originally developed by Case Western Reserve University. EDIFES gathers 15-minute interval utility meter data and basic building characteristics to produce estimates of energy-savings potential and measure opportunities. It doesn't require submeter data or independent building energy modeling.
EnergyX Solutions	EnergyX offers virtual auditing and other customer-engagement software.
Gridium	Gridium is a no-touch energy audit and building benchmarking software solution. It offers detailed advice and diagnostics support for building owners and operators.
ICwhatUC	ICwhatUC is an augmented-reality customer support application. It allows customer service reps to see what the customer sees, mark up video in real time, and provide improved virtual support.
Lucid	Through its BuildingOS tool, Lucid offers vendor-agnostic connectivity for building energy systems. It gathers data from: <ul style="list-style-type: none">Existing building automation systemsSubmetersLighting systemsPlug-load controlsOn-site generation systemsDemand-response aggregatorsElectric and gas utility meters
New Buildings Institute (NBI)	NBI developed FirstView , a tool to look at building energy performance. The tool creates a simplified building energy model that can identify opportunities for performance improvement and compare a building's performance against like buildings. Like EDIFES, FirstView uses only monthly utility bills and a few building characteristics as its data inputs.
WegoWise	WegoWise offers a sustainability and building performance benchmarking tool, which can conduct energy and water audits and estimate carbon-impact.

For more details about how utilities are incorporating these solutions into their commercial and industrial (C&I) efficiency programs, read our 2020 report [How are utilities doing virtual audits and inspections?](#)

Additional example

Power Takeoff

- Recently won an innovation award from Midwestern Energy Efficiency Alliance for ComEd's virtual commissioning program
- Evaluation is light on details, but big on evaluated energy savings



Additional example

Uplight

- Incorporates Energy Savvy and First Fuel technologies
- Not yet evaluated
- Showcased in Eversource's residential virtual audit program



Additional example

CLEAResult

- A relatively new offering in the market
- A software-assisted strategic energy management solution (like Power TakeOff)
- Check out our [Accelerating virtual assessment capabilities during COVID-19: Solution showcase series](#)

CLEAResult®

Additional example

Verdigris

- Been around for about 10 years—spun off from Stanford University
- Started with end-use disaggregation solution
- Evolved into automated EMS solution, e.g. for hospitality

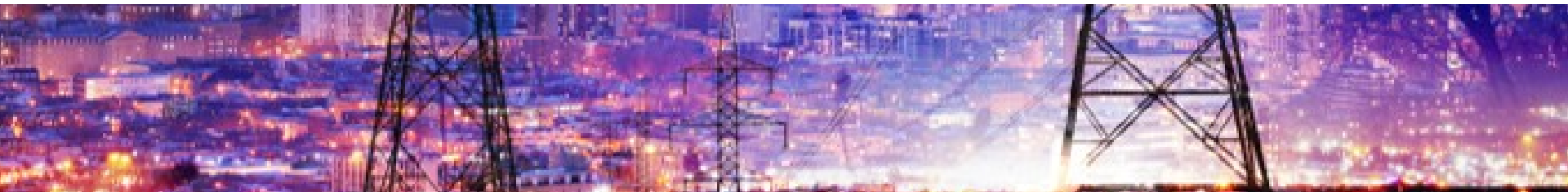


Call to action ...





Load control devices for frequency and voltage changes



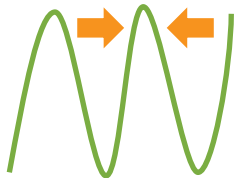
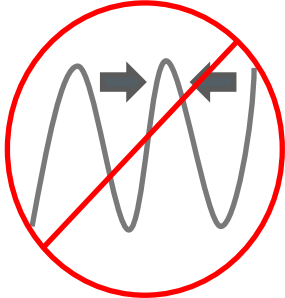
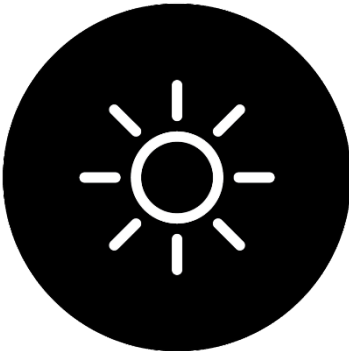
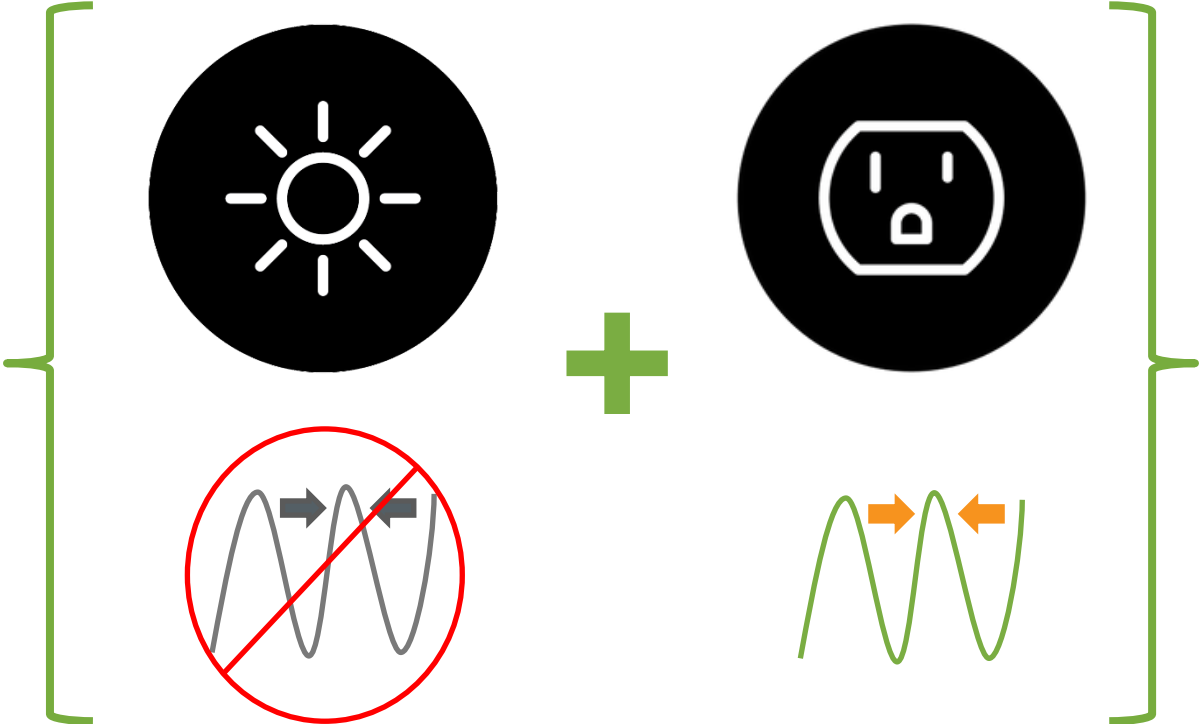
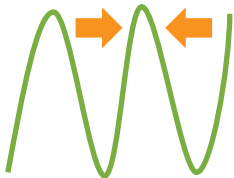
Mo' renewables, mo' problems

With frequency imbalances, that is

60 Hz

Mo' renewables, mo' problems

With frequency imbalances, that is



“

... **GridBallast technology** will monitor grid voltage and frequency and control the target load in order to address excursions from grid operating targets. The devices will operate **autonomously** to provide rapid local response, removing the need for costly infrastructure to communicate with a central controller.

—ARPA-E

”

Simulations demonstrated the value, while field studies validated the technology

The National Rural Electric Cooperative Association completed simulations to demonstrate effective operation of GridBallast controls.

- Simulated controls on three substations
- Assumed 50% penetration of GridBallast-controlled loads
- Set renewable generation levels to at least 50% of the energy in the simulated system

Performance metric	Target	Calculated
Initial response time	< 1 second	NA
Average reserve magnitude	NA	92.4%
Reserve magnitude target	> 5%	7.000 %
Reserve magnitude variability tolerance	< 2%	0.6%
Ramp time	< 2 seconds	NA
Off duration	> 10 minutes	11 minutes
Availability	> 95%	99.408%
Cascaded contingency support	2	NA
Recovery time	< 1 hour	0 hours

Note: NA = Not applicable

Simulations demonstrated the value, while field studies validated the technology

Eaton water heater controllers



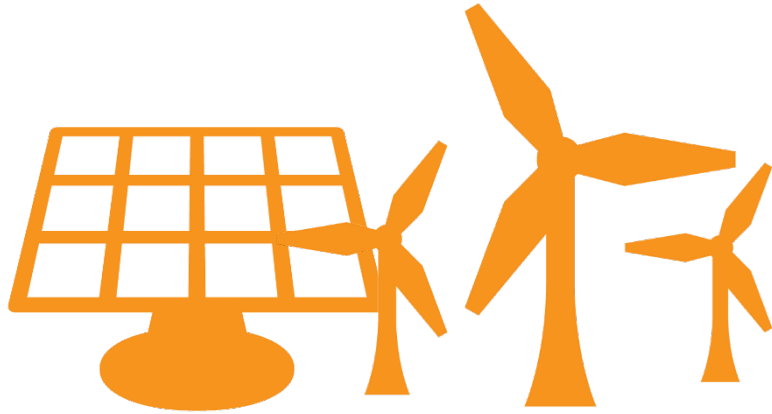
Source: National Rural Electric Cooperative Association

SparkMeter circuit controllers



Source: National Rural Electric Cooperative Association

But renewable penetration is still low, and retrofits are expensive



Should we assess or pilot this approach?

Utilities with a significant renewables portfolio or with CTA-2045 mandates may want to explore this approach to prepare for when load will need to participate as a grid stability resource.

A nighttime aerial view of a city with illuminated buildings and a complex highway interchange. The sky is a deep blue, and the city lights create a warm, golden glow.

Smart window coverings

Smart what?

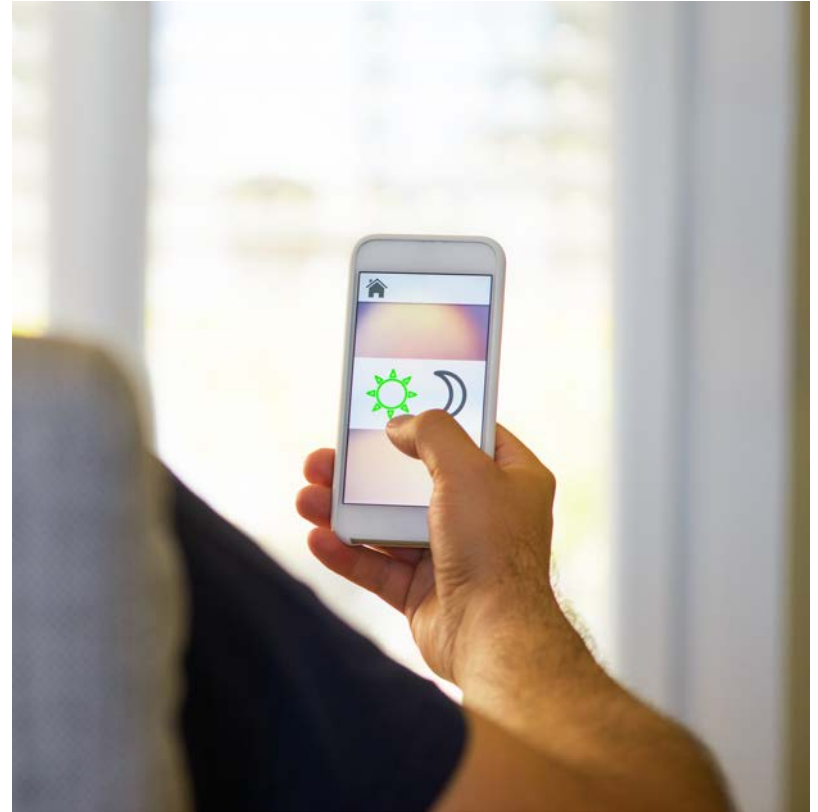
- Shades or blinds that users can control remotely and automate to open or close as needed
- Currently available, but ...
 - Typically paired with expensive systems
 - Frequently marketed as a convenience and security feature
 - Often don't include energy-based control algorithms



Source: Lutron and Budget Blinds

How they may help save energy

- Open window coverings to let light and heat in—close them to keep the space cool
- Automatically controlled based on current temperatures, light levels, or occupancy



Results so far

- No robust field studies, but modeling from Lawrence Berkeley National Laboratory suggests that automated shades could reduce overall home energy consumption by around 12% to 13%
- Research from Pacific Northwest National Laboratory (PNNL) suggests that even simple control strategies can save energy but those savings vary widely

Potential for demand management too!

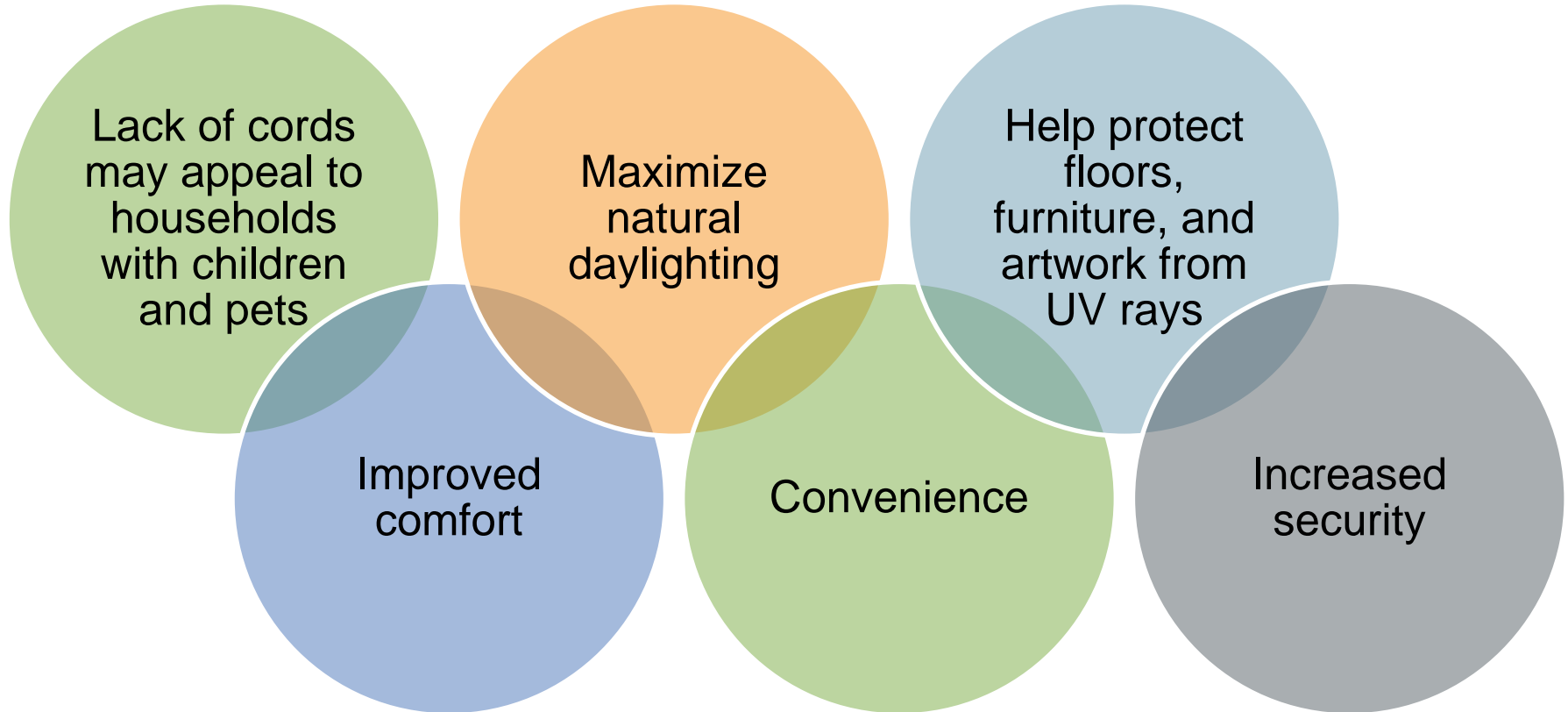
The good:

- PNNL found that when smart blinds were paired with thermostats and deployed for demand response (DR) events, homes saw increased energy savings and improved comfort compared with thermostat-only approaches

The not so good:

- Pairing smart blinds with smart thermostats could decrease predictability of dispatchable load given variable factors like cloud cover and user behavior
- It may be challenging to quantify and claim indirect load impacts

Non-energy benefits

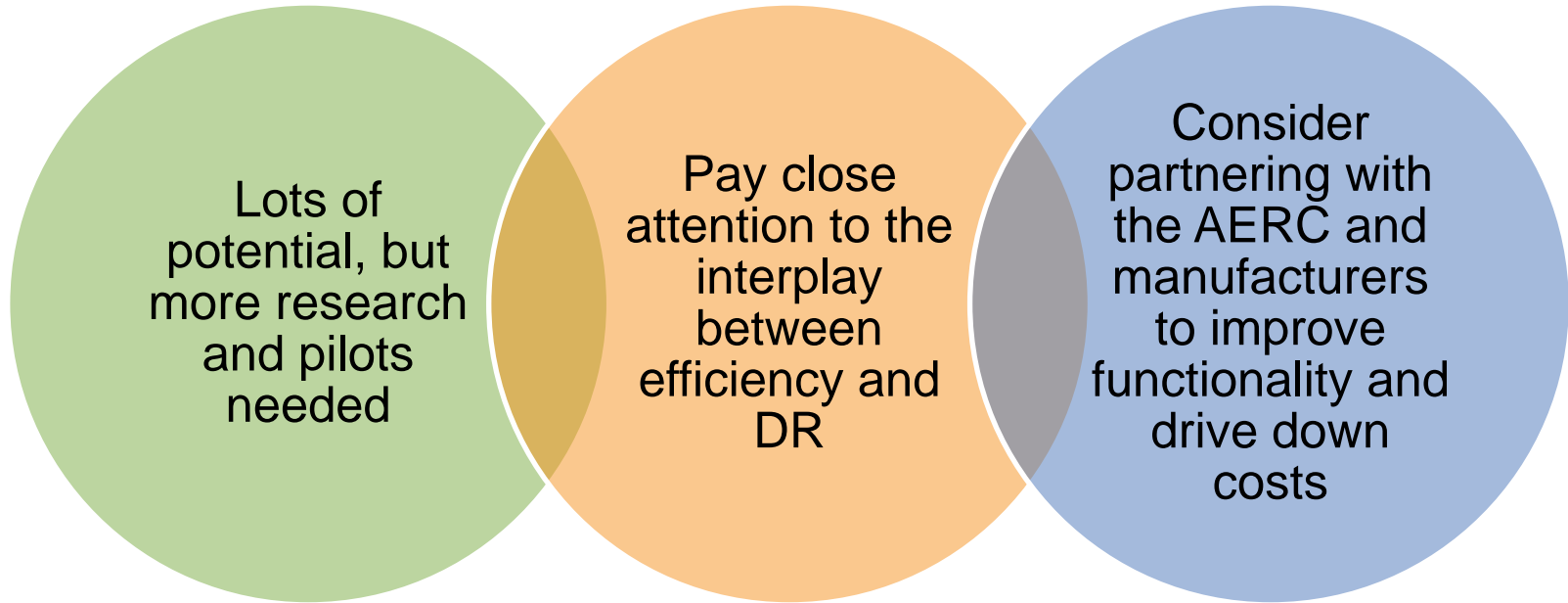


Introducing the Attachments Energy Rating Council (AERC)

- Created in 2018
- Nonprofit whose mission is to rate, label, and certify the performance of window attachments
- Working with many stakeholders to understand and quantify energy and demand impacts

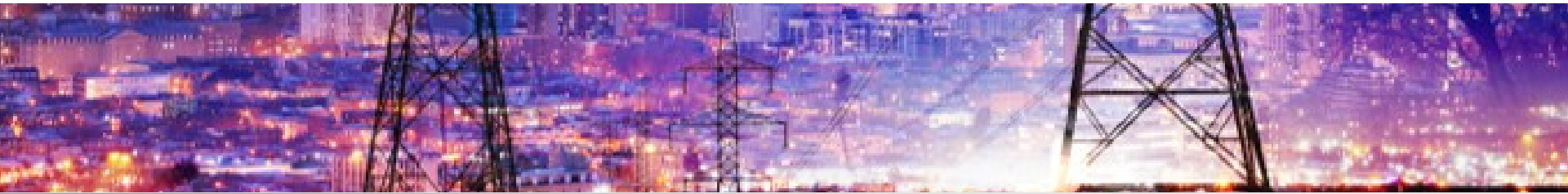


Next steps





Commercialized V2G





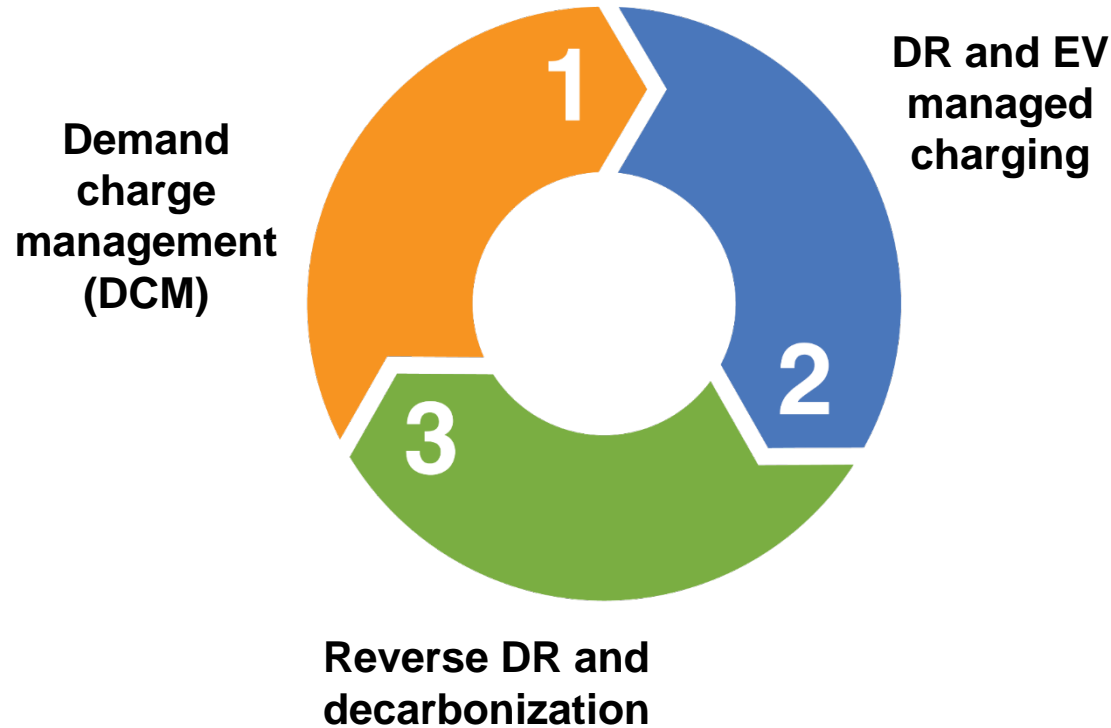
Though commonly considered a “long-term opportunity” for many years, vehicle-to-grid (V2G) solutions are being commercialized **now**. In this presentation, I’ll give some background on the technology potential, then discuss promising pilot results.

A big opportunity has arrived in the form of electric vehicles (EVs)

- There are about 1.6 million EVs on the road today, and that number grows every year
- Their combined available battery capacity is more than 23 gigawatts, or about the same as all pumped hydro in the US



Three ways utilities and customers can benefit



Is V2G worth the effort?

- An alternative solution: stationary batteries
- Batteries designed for stationary (not mobile) applications
- Includes bidirectional power electronics, but doesn't pull energy from EV batteries



Source: Intertie

“

We're kind of
philosophically
against V2G.

We think the
electricity is more
valuable in the car.

—*Richard Mrlik,
Intertie*

”

Which battery is best?

- Electric Power Research Institute estimated that 2.5 million V2G-capable EVs on the road in 2030 could deliver \$1 billion in grid benefits
- A fraction of EV battery capacity will deliver significant customer value



Fermata Energy case study

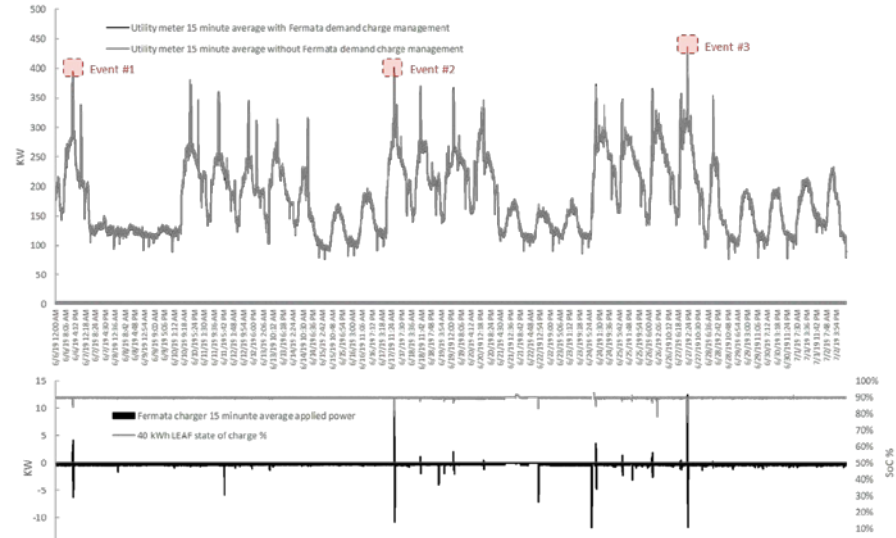
- In 2019, with permission from Danville Utilities, Fermata Energy tested its prototype bidirectional V2X system
- Over a 5-month period, the company successfully demonstrated DCM capabilities



Source: Fermata Energy

Demonstrating DCM capabilities of V2G

- Fermata's software successfully predicted monthly demand peaks at Electronic Instrumentation and Technology's facility
- Discharged Nissan LEAF at 12.5 kilowatts, up to about 10 kilowatt-hours



Source: Fermata Energy

Value of V2G for DCM

Cost of
electricity



\$4.50

Utility bill
savings
with DCM



\$187.50

TBD: Managed EV charging, DR, reverse DR

- Fermata Energy claims that its software-as-a-service includes managed EV charging
- Value stacking seems feasible with DR and reverse DR capabilities
- Best fit for customers who:
 - Are electrifying fleets
 - Have high demand charge
 - Have EV or carbon goals

E Source reports:

- [Commercialized vehicle-to-grid has arrived](#)
- [Mopping up the solar spill: Using optimized managed charging to absorb excess solar generation](#)



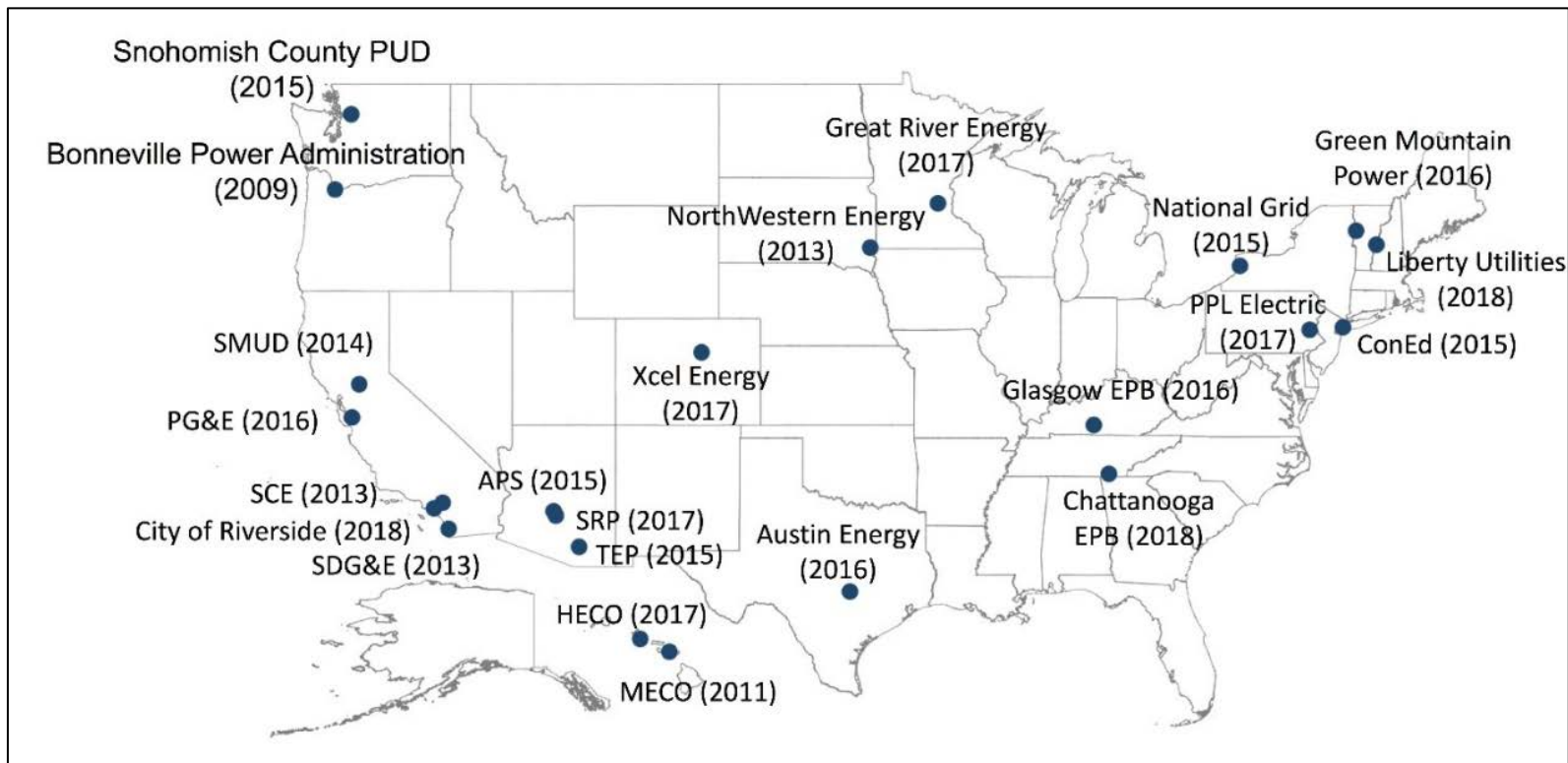
Your mileage may vary ...

- We're excited for this new development in V2G commercialization, but we're still in the early stages
 - No utility programs exist (yet)
 - May not work well for all customers
- Still, the future looks bright for utility V2G programs



A nighttime aerial view of a city with illuminated buildings and a complex highway interchange. The top of the image has a dark blue gradient.

DERMS take a leap forward



Source: National Renewable Energy Laboratory

“

A DERMS is a hardware and software platform to monitor and control distributed energy resources (DER) in a manner that maintains or improves the reliability, efficiency, and overall performance of the electric distribution system.

*–Smart Electric
Power Alliance*

”

A working concept for a distributed energy resource management system (DERMS)



Existing, industry making incremental improvements

Control and optimization of utility assets:

- Switches
- Reclosers
- Capacitors
- Voltage regulators

Net new and emerging, building from concepts from DMS and DRMS

Monitor, optimize, and dispatch DERs to meet grid and market needs:

- Energy storage
- Photovoltaics (PV) with smart inverters
- Future EV charging

Existing, industry making incremental improvements

Program management and control of DR portfolio:

- Smart air conditioning
- Aggregated DR

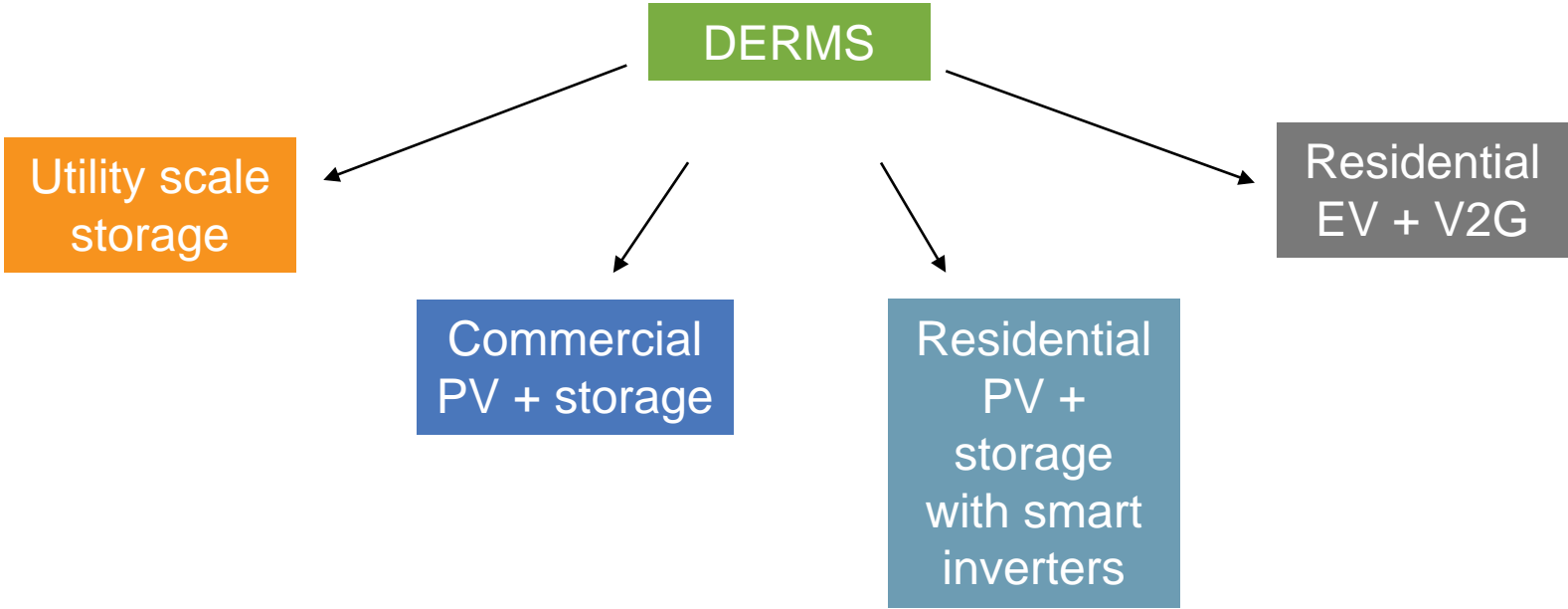
Notes: DERs = distributed energy resources; DRMS = demand-response management system. Source: PG&E



Key findings

- **DERMS + holistic controls** have lowest levelized cost of electricity (LCOE)
- **Real-time peak load control** is the most valuable utility application by far—enabled by holistic controls
- **Utility scale storage and load control** is most economic distributed energy resource (DER)—enhanced by holistic controls
- Total costs for DER deployments and integration are **higher than the potential value** they can generate at this time

Austin SHINES System

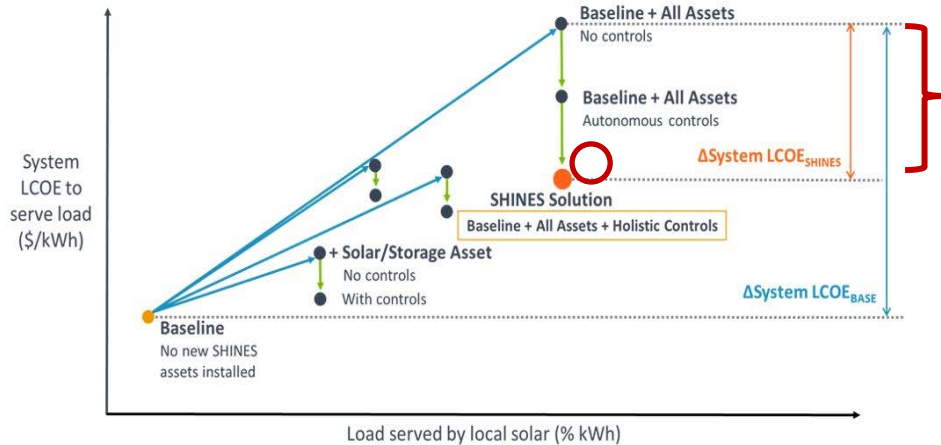


Three different controls scenarios (25% solar)

- **No controls**
(DERs)
- **Autonomous controls**
(local DER response)
- **Holistic controls**
(DER coordination)
- Baseline scenario without
SHINES assets (5% solar)



LCOE model targets



Source: [Final Deliverable 1: System Levelized Cost of Electricity \(System LCOE\) Methodology](#) (PDF)

1. **SHINES_{LCOE} < \$0.14 per kWh**
 - Met by all scenarios due to declining costs for DERs and low and stable Electric Reliability Council of Texas energy market prices
2. **SHINES_{LCOE} ÷ baseline_{LCOE} > 20%**
 - Met when holistic controls capture high wholesale market value
 - Met when no controls require significant system integration costs

Our takeaways and call to action

1. Austin SHINES offers **vital evaluation data** for DERMS and DER value streams
2. DERMS are **increasingly necessary** for cost-effective DER integration
 - Economic models highly sensitive to control responsiveness, grid reliability, and scale of adoption
3. Pursue modeling and field assessments, evaluate existing infrastructure and relationships, and develop roadmaps around key value streams and challenges

Resources

- [Austin SHINES: Innovations in Energy Storage](#) (Project overview)
- [Austin SHINES Final Deliverable 1: System Levelized Cost of Electricity \(System LCOE\) Methodology](#) (PDF)
- [Austin SHINES Final Deliverable 2: Software Platform Product Description](#) (PDF)
- [Austin SHINES Final Deliverable 3: Optimal Design Methodology](#) (PDF)
- [Austin SHINES Final Deliverable 5: Economic Modeling and Optimization](#) (PDF)



Plasma lighting for indoor agriculture



Common lighting options for indoor agriculture

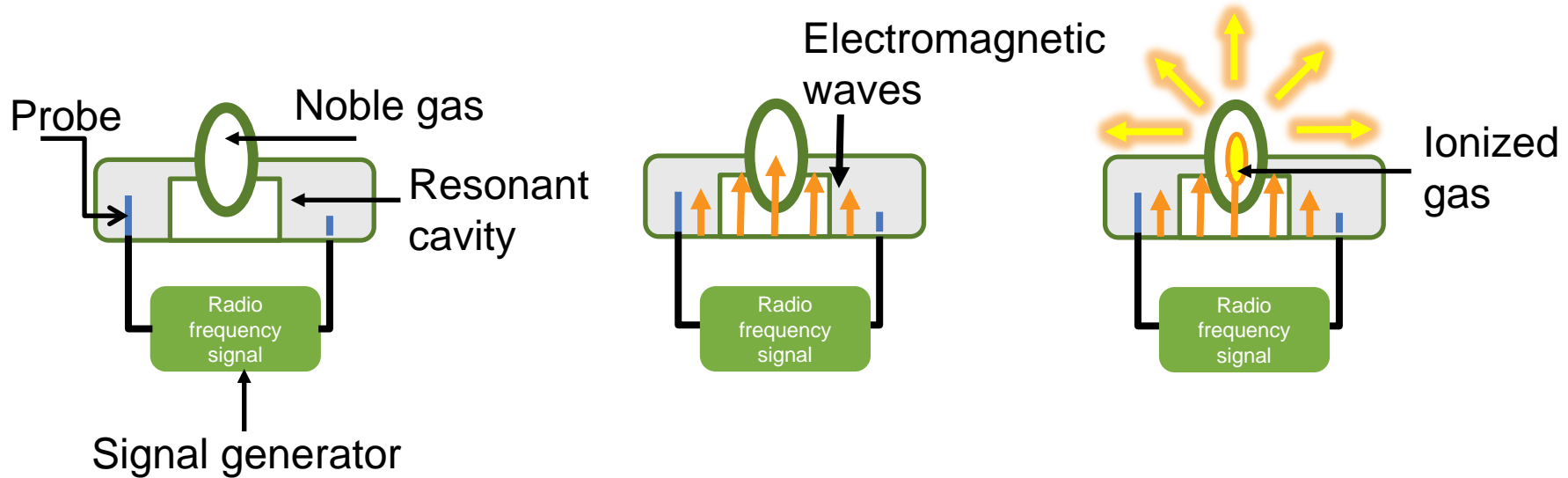


The new kid in town!

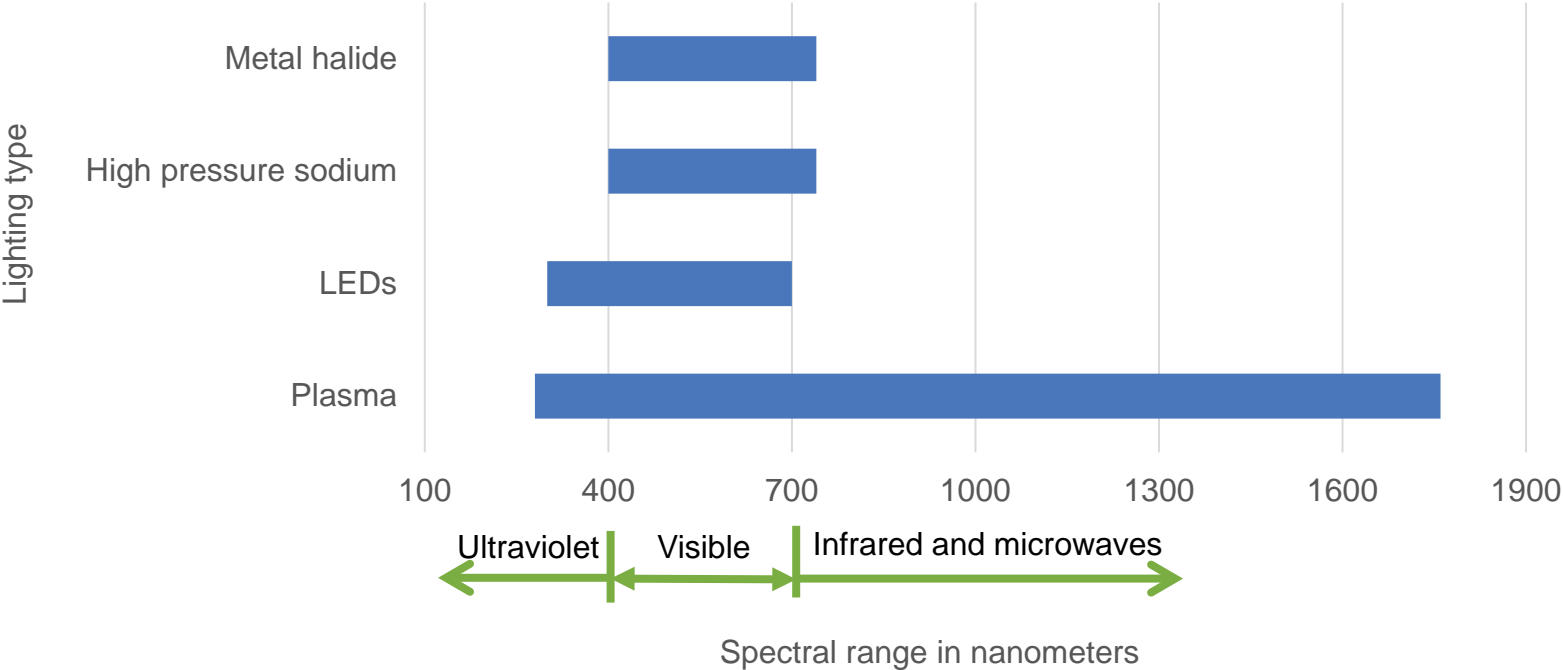


Source: Azentive

How does plasma lighting work?

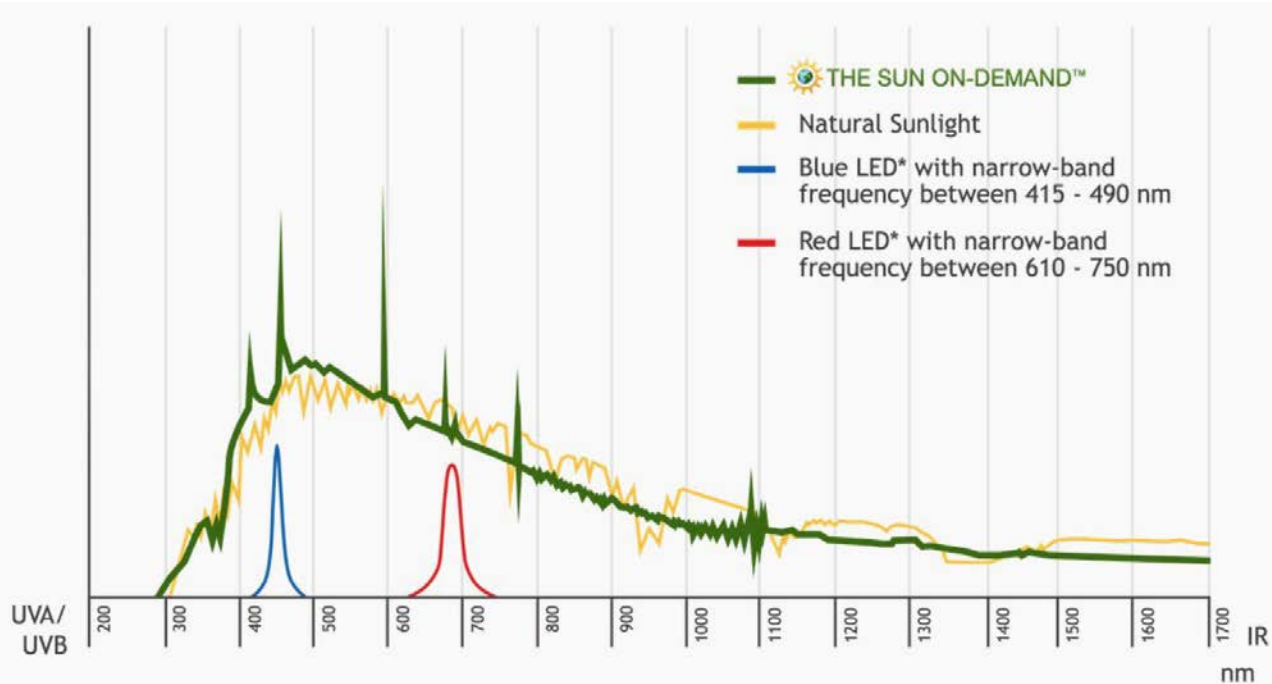


Plasma lighting can offer a wider, more-uniform spectrum that mimics the sun



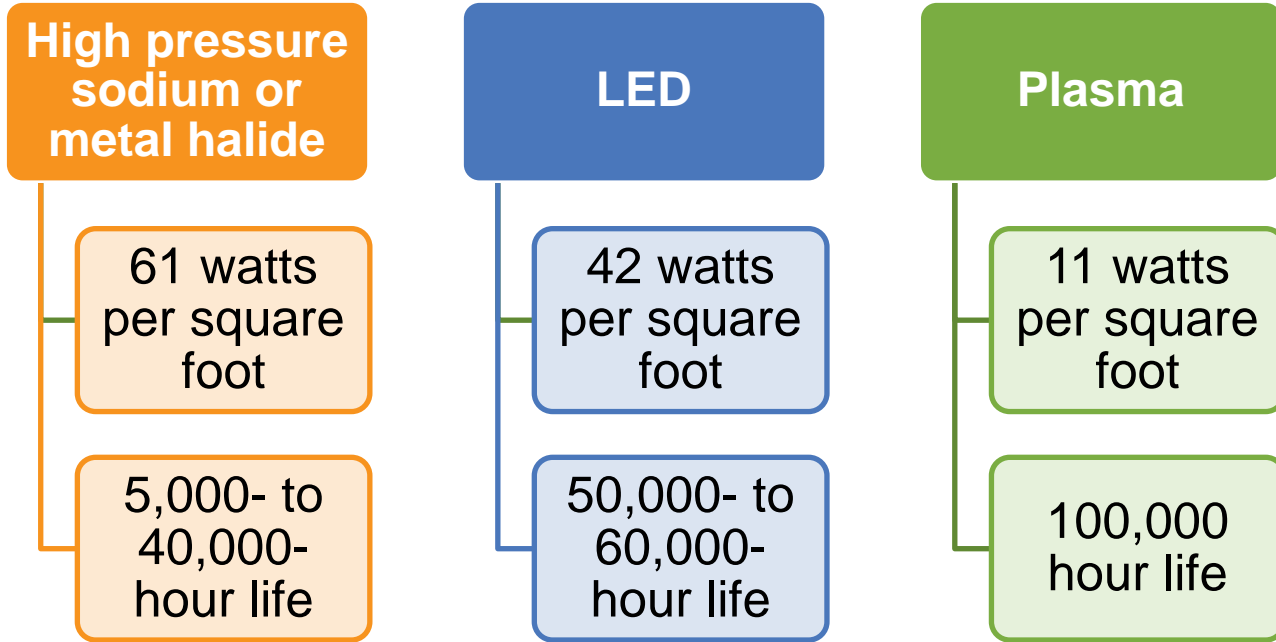
Source: E Source; data from DOE and Azentive

Plasma lighting can offer a wider, more-uniform spectrum that mimics the sun

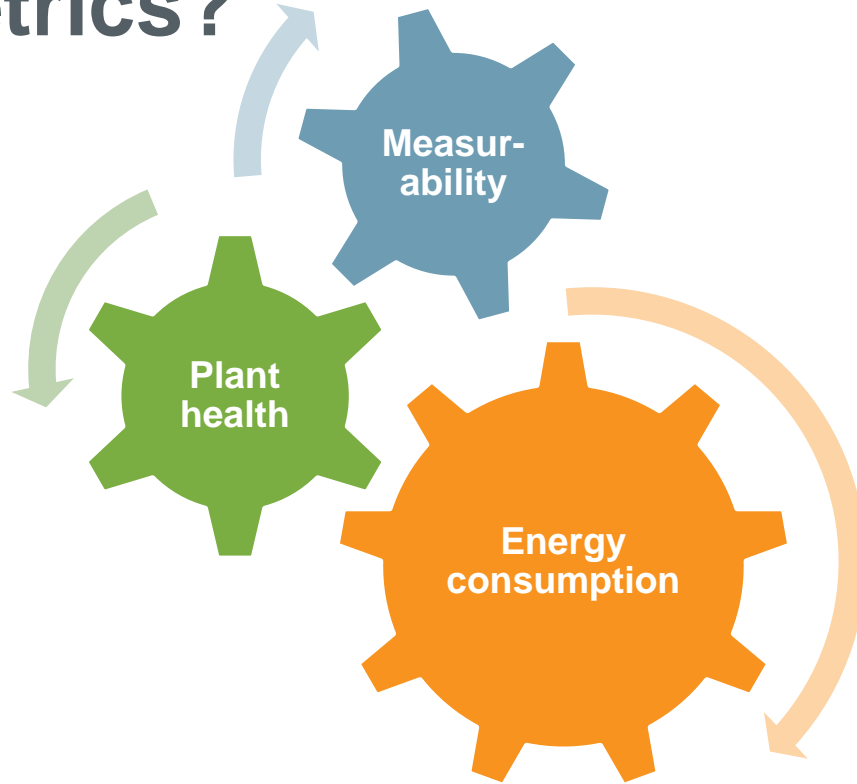


Source: Azentive

Claimed power and lifespan benefits



Are we using the right horticultural lighting metrics?



Multiple demonstrations underway



Source: University of California

Current vendors

North America



Europe





An update on smart thermostat optimization

What is smart thermostat optimization?

Typical smart thermostat

Common functionality:

- Online connectivity
- Automatic programming
- Mobile app
- Automatically switches between heating and cooling

Thermostat optimization

Setpoints adjusted based on additional criteria:

- HVAC runtime data
- Humidity sensing
- Local weather data

Some products construct thermal models of the home using machine learning.

What is smart thermostat optimization?

Nest's Seasonal Savings

- Adjusts scheduled setpoints by about 1 ° Fahrenheit during summer and winter, usually when the user is away.

Resideo's Connected Savings

- Uses HVAC runtime data and weather data to optimize the setpoint schedule and reduce system runtime at optimal times
- Can also integrate with DR and “energy scorecards”

Ecobee's Eco+

- Uses humidity sensing, schedule update suggestions, and faster occupancy adjustments to optimize setpoints
- Can also integrate with time-of-use and DR

Uplight's Orchestrated Energy

- Uses HVAC runtime to model the thermal characteristics of the home and produce an optimized setpoint schedule

What are the savings from smart thermostat optimization?

Product	Average savings	Evaluation
Ecobee's Eco+	Cooling savings ranged from 2.1% to 16.4% depending on the month and the climate region	Eco+ Thermostat Optimization Pilot Report (PDF)
Nest's Seasonal Savings	Cooling savings of 0.8% and heating savings of 4.8%	Energy Trust of Oregon Nest Thermostat Seasonal Savings Pilot Evaluation
	Average cooling savings of 6.4% for National Grid and 3.4% for Cape Light Compact	2018 Massachusetts Summer Thermostat Optimization Evaluation
	Cooling savings of 4.5%	ComEd Seasonal Savings Impact Evaluation Report
Resideo's Connected Savings	Cooling savings of 4.0% and heating savings of 6%	Energy Trust of Oregon Resideo Thermostat Optimization Pilot Report
	Cooling savings of 10.9%	PG&E Thermostat Optimization Evaluation (PDF)
Uplight's Orchestrated Energy	Cooling savings ranged from 9.8% to 34.2% depending on the region	Teaching a New Thermostat New Tricks: Results from Four Runtime Optimization Pilots (PDF)

The issue with smart thermostat optimization



Nest recently rolled out its Seasonal Savings product to all users



Utilities have a weakened case for savings attribution



Utilities must claim savings differently, whether through market transformation or product rebates

Should utilities include smart thermostat optimization in energy-efficiency portfolios?



Maybe!

The risk

- Needing to find new ways to claim savings
- Changes to products that could affect device eligibility and therefore overall savings

The reward

- Proven savings, beyond those from existing smart thermostats
- DR and load shifting benefits



An update on 75F technology



Advanced controls for small and medium businesses



Small and midsize businesses often can't afford costly building automation systems, which could reduce their energy use by 10% to 25% per building.

BC Hydro

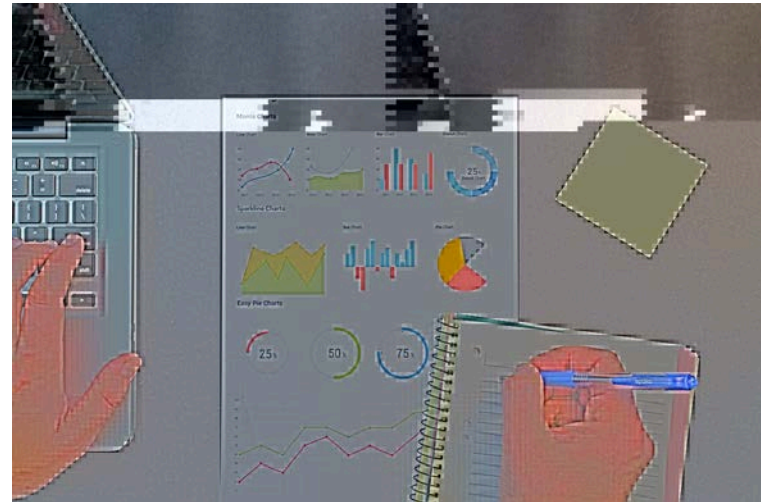
AEP Ohio

Mass Save

Green Mountain Power

PG&E

SDG&E—pilot study review in this presentation

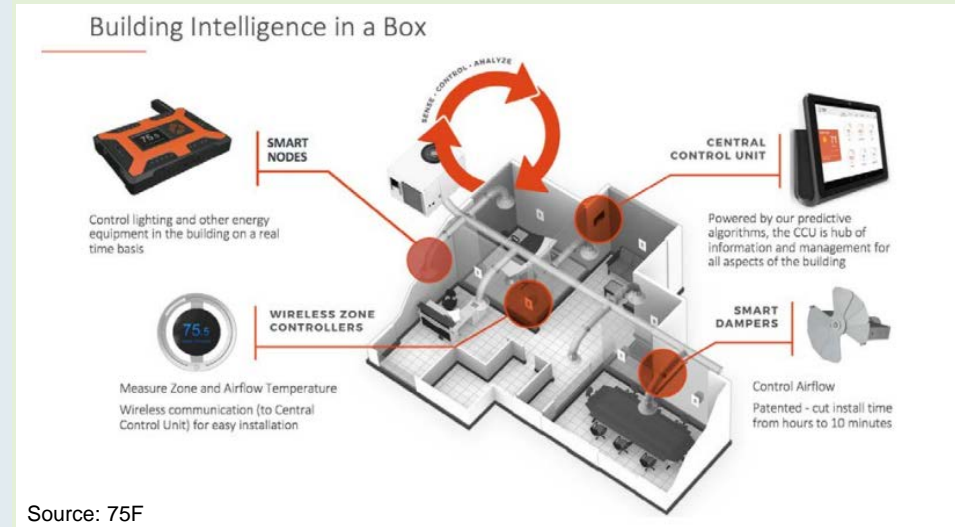


Introducing 75F

Technology

- Dynamic air balancing system
- Smart dampers
- Wireless zone control
- Rooftop unit (RTU) control strategies
- Occupancy sensing
- Setback scheduling
- Demand-controlled ventilation (DCV) and economizer operation
- User-friendly online portal

75F system schematic



SDG&E pilot study

- Baseline technology:
 - RTU operating at constant volume with no DCV



SDG&E pilot study host site

- Office space observed for one year (November 2017 to November 2018)
- Conditioned by nine packaged, constant volume RTUs that are 11 years old
- SDG&E chose four RTUs for 75F dynamic balancing technology pilot
 - RTU unit 1: 3 tons serving 5 zones
 - RTU unit 2: 3 tons serving 6 zones
 - RTU unit 3: 10 tons serving 8 zones
 - RTU unit 4: 10 tons serving 10 zones

SDG&E pilot study

Preliminary results

RTU units 1 and 2

Serving perimeter offices

- 45% natural gas savings during the monitoring period
- 44% electricity savings during the monitoring period



RTU units 3 and 4

Serving open office spaces

- No measurable gas savings
- No measurable electric savings
- The open office space provides natural air mixing that diminishes the benefits of zoning

75F epidemic mode

Pandemic building requirements:

- Operate properly
- Capable of monitoring all zones
- Able to use outside air economizers
- Keep temperatures above dew points



75F epidemic mode features:

- Monitors temperature, humidity, occupancy, and indoor air quality of each zone independently
- Dynamic air balancing
- 75F Smart Purge feature
- Maintaining space setback temperatures
- Provides granular occupancy data
- Remote control and alert capability
- Automatically updated as Center for Disease Control or ASHRAE guidelines change

What can you do?

Pilot the technology

Many small and midsize business owners don't have the building automation systems necessary to implement existing custom controls measures. If you pilot the technology with appropriate clients, you would likely improve customer satisfaction and create a new revenue stream for custom rebate measures while increasing the adoption of similar products.

A nighttime aerial view of a city with illuminated buildings and a complex highway interchange. The top of the image is a dark blue gradient.

The latest on the HFC refrigerant phasedown

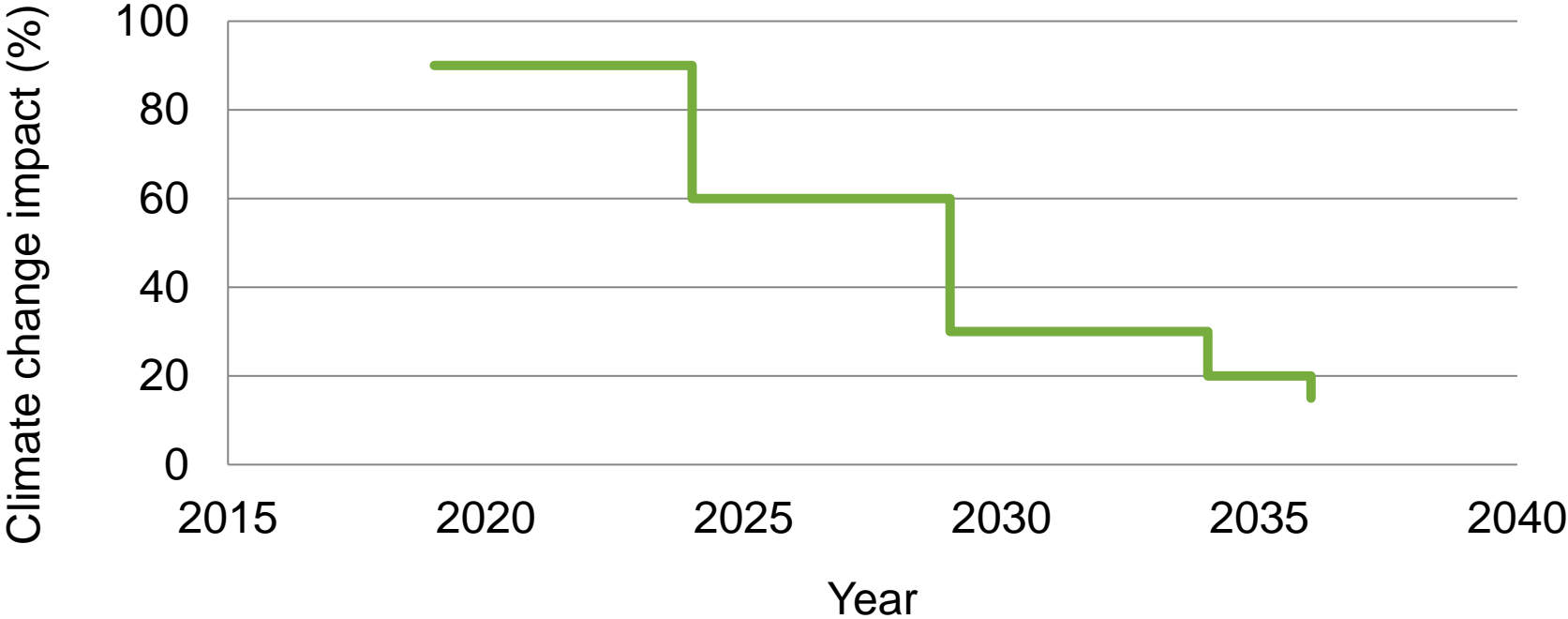
Get ready for the refrigerant revolution



Source: Wikimedia Commons

Kigali Amendment to the Montreal Protocol

Phasedown Schedule



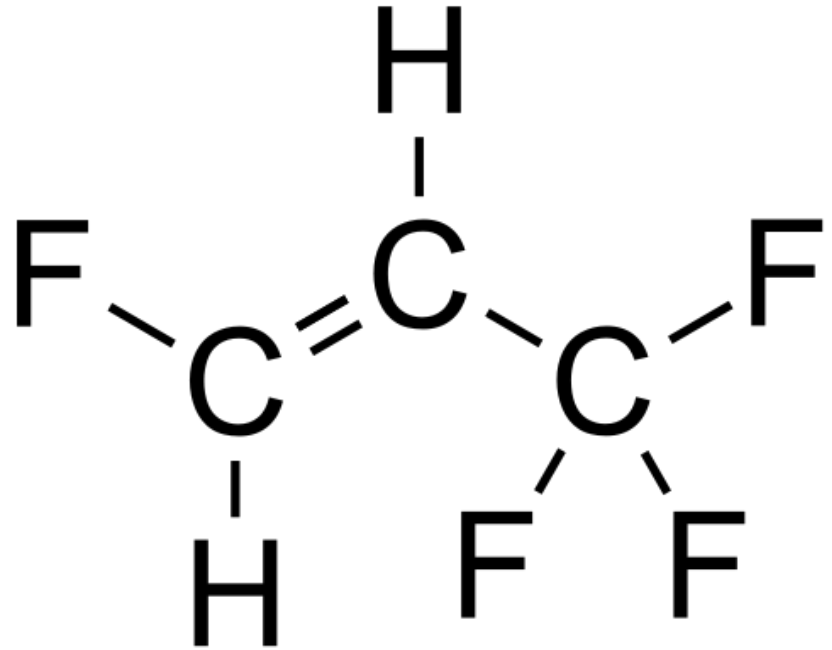
© E Source; data from Montreal Protocol Organization

Federal legislation expected in 2021



The HFOs are coming

- Hydrofluoroolefins (HFOs)
- Low to ultra-low global warming potential
- About as efficient as hydrofluorocarbons (HFCs)
- Cost 10 times HFCs
- Many are mildly flammable
- New safety standards



Cold facts on the chiller market

- Done deal in 6 states
- More on the way
- HFC-134a and R-410A banned
- Effective January 1, 2024
- Likely model for feds
- Incentivize low pressure



Source: Jay Stein

Your strategy

- Start preparing chiller program
- Get involved in legislative process
- Advocate for amended building codes



Source: Wikimedia Commons

Thank you! Questions?



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