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forum

SEPTEMBER 25-28, 2018 THE SHERATON DENVER DOWNTOWN DENVER, COLORADO

Tech Roundup: Forum Edition

Moderator: Andrea Salazar



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Tech Roundup: Forum Edition

Technology Research Team



E Source

E Source Forum 2018

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- [Beyond Lighting: Next Generation DSM Programs and Technologies](#)
- [The Future of Farming: Current Developments in Indoor Agriculture](#)
- [Why Tech-Transfer Efforts Aren't Working, and What to Do About It](#)
- [Which Customers Are Interested in Smart Speakers, and How Do You Reach Them?](#)
- [Incorporating Emerging Technologies into Your Programs](#)
- [How Do Energy Pioneers Cook?](#)
- [Future of Farming: Lighting Up Indoor Agriculture](#)
- [Electrification Technologies Resource Center](#)
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 - Electric vehicles



Got a tech question?

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Andrea



Jay



Essie



Bryan



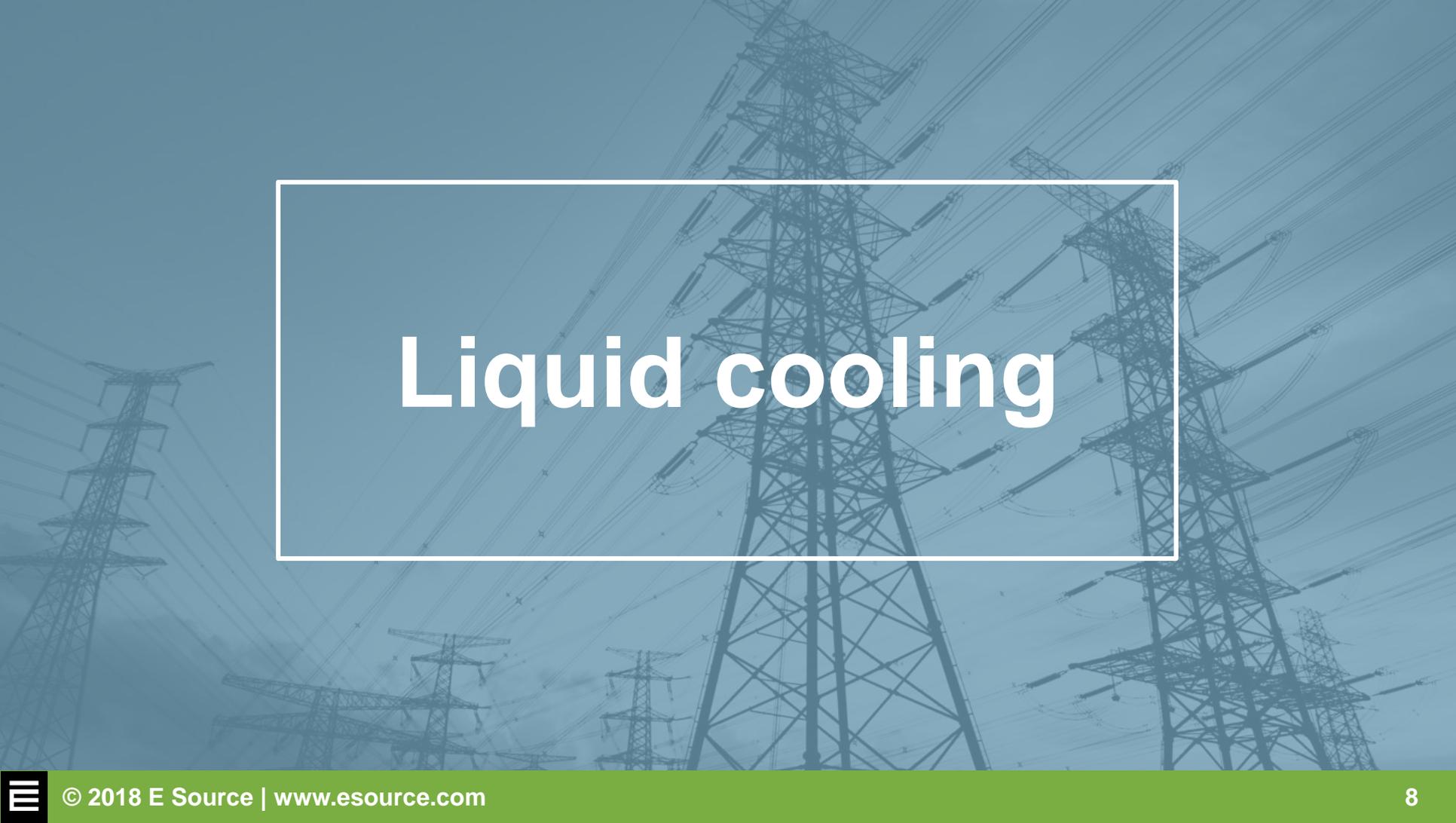
Logan



Zach

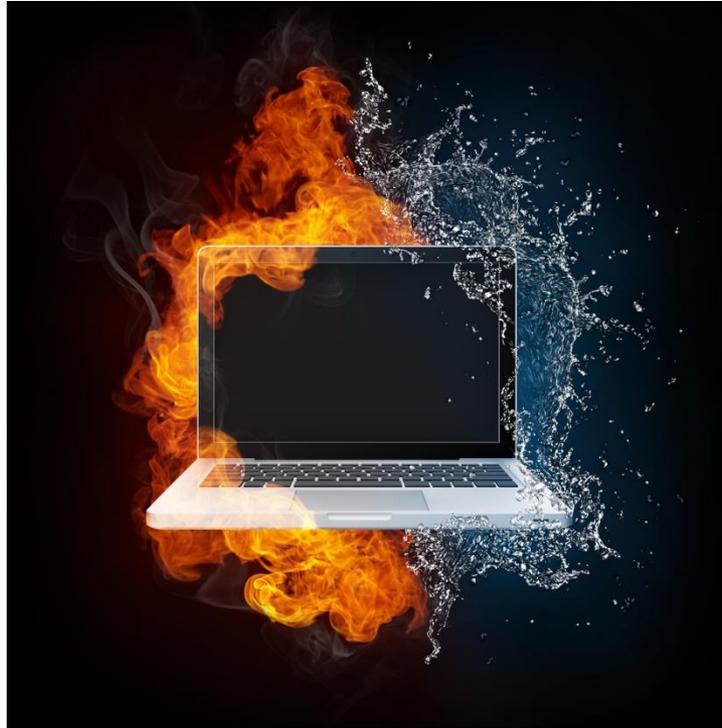


Monali

The background of the slide is a low-angle, blue-tinted photograph of several high-voltage electrical transmission towers and their associated power lines stretching across the sky. The towers are steel lattice structures, and the lines are thin and numerous, creating a complex web of lines against the light blue sky.

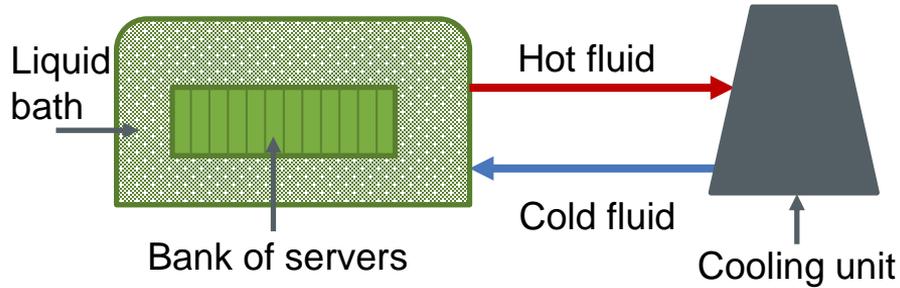
Liquid cooling

LiquidCool Solutions (LCS) Immersion Cooling Technology



Two types of immersion cooling

Single-phase



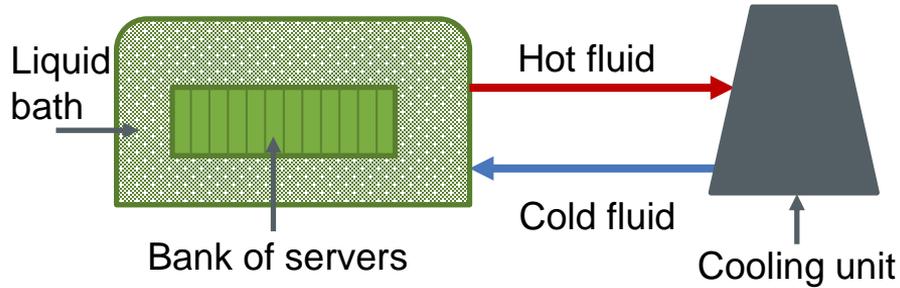
Vendors:

- [GRC](#)
- [Asperitas](#)
- [Engineered Fluids](#)
- [Fujitsu](#)
- [LiquidCool Solutions](#)
- [Submer](#)

© E Source; adapted from Submer

Two types of immersion cooling

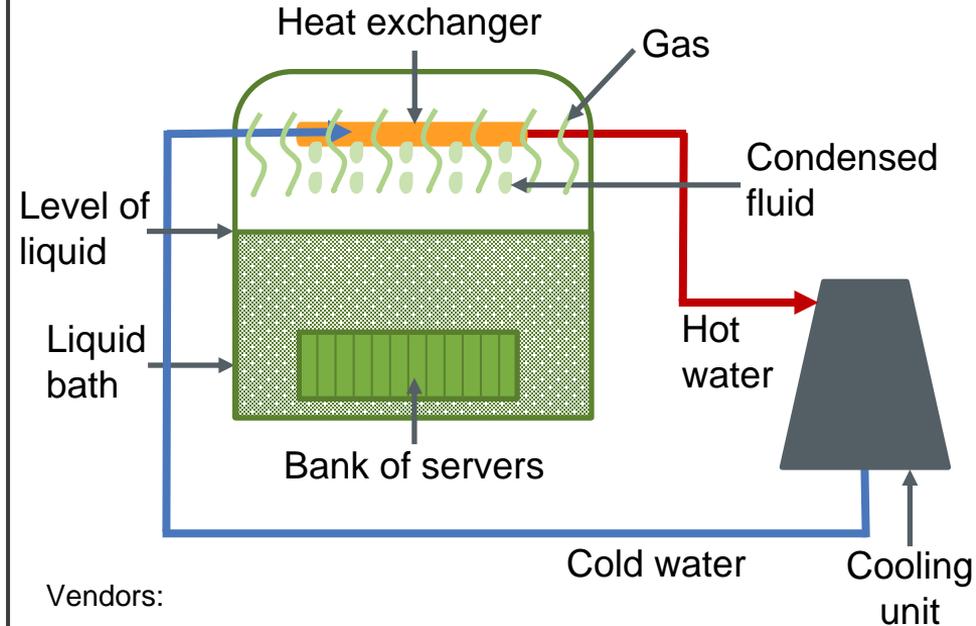
Single-phase



Vendors:

- [GRC](#)
- [Asperitas](#)
- [Engineered Fluids](#)
- [Fujitsu](#)
- [LiquidCool Solutions](#)
- [Submer](#)

Two-phase



Vendors:

- [Allied Control](#)
- [3M Novec](#)

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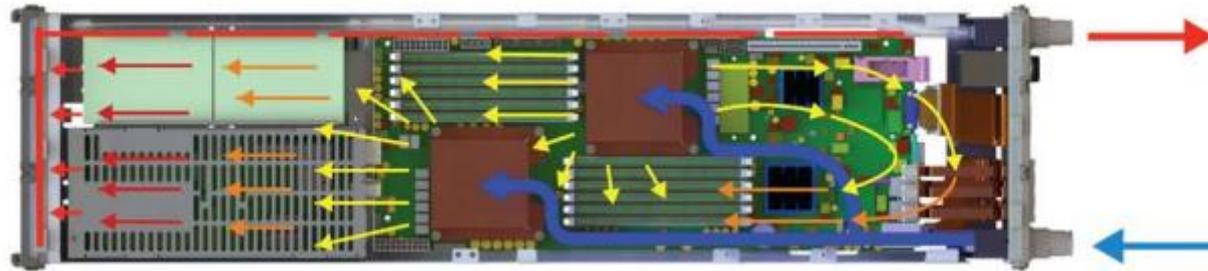
Some technologies work better than others

	Green Revolution Cooling CarnotJet	3M Novec
Conducted by	Pacific Gas and Electric Co. Submersion Cooling Evaluation (PDF) (2014)	Lawrence Berkeley National Laboratory Immersion Cooling of Electronics in DoD Installations (PDF) (2016)
Type	Single-phase	Two-phase
Cooling energy Savings (%)	80	72
Simple payback period (years)	4.86	33
Barriers	<ul style="list-style-type: none"> ▪ Suitable for solid-state drives only ▪ Need to remove some components such as fans 	<ul style="list-style-type: none"> ▪ Very expensive ▪ Volatile ▪ 13 IT equipment failures ▪ Safety and operational concerns
Conclusion	Suitable for utility programs	Not viable

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LiquidCool Solutions technology shows promise

- Single-phase type
- Separate enclosure for each server



Source: [Laboratory Study and Demonstration Results of a Directed-Flow, Liquid Submerged Server for High Efficiency Data Centers](#) (PDF), Eric Kozubal, National Renewable Energy Laboratory (2017)

NREL tests showed satisfactory performance

- Eight servers tested in a laboratory
- Eliminates parasitic cooling energy used by fans
- Higher temperature coolant effective in removing heat
- Heat can be rejected to ambient conditions or reused as heating source
- Energy savings by maintaining lower central processing unit temperatures (around 40%)
- Economics not determined

Minnesota Department of Commerce testing shows energy savings

- 12 servers installed in Mayo Clinic campus in Minnesota
- Air-cooled system as baseline
- Barriers at the site limited accurate power draw measurements
- Cooling energy savings: 37% to 75%
- Cost to install was higher
- Could not confirm vendor-specified simple payback of 1.5 years

Source: [Liquid Cooling of Data Center Servers](#) (PDF), Travis Hinck, GDS Associates (2017)

Promising technology, but needs more testing

Pros:

- Saves approximately 40% cooling energy
- Reduction in maintenance costs
- Increased life of equipment
- Heat removed from servers can be reused

Cons:

- Suitable for small-size data centers or with high utilization rates
- Cost-effectiveness not confirmed



New controls for hydronic heating

My war on dumb HVAC systems continues



Today's battle: water-heating systems in apartment buildings



New system from SHM Controls



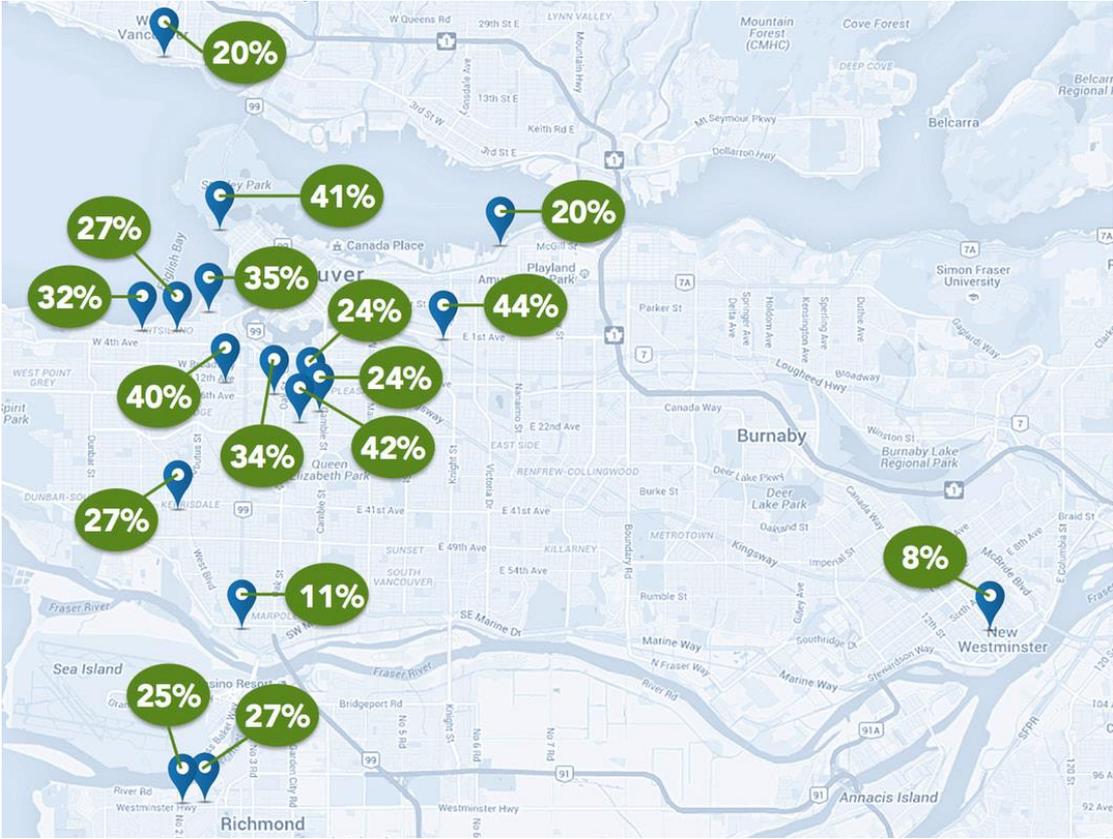
Source: SHM Controls

Graphic interface via the cloud



Source: SHM Controls

SHM does lots of utility bill analysis



Source: SHM Controls

SHM claims low costs

Capital and installation costs = \$3,000

Annual costs = \$2,400

The usual caveats

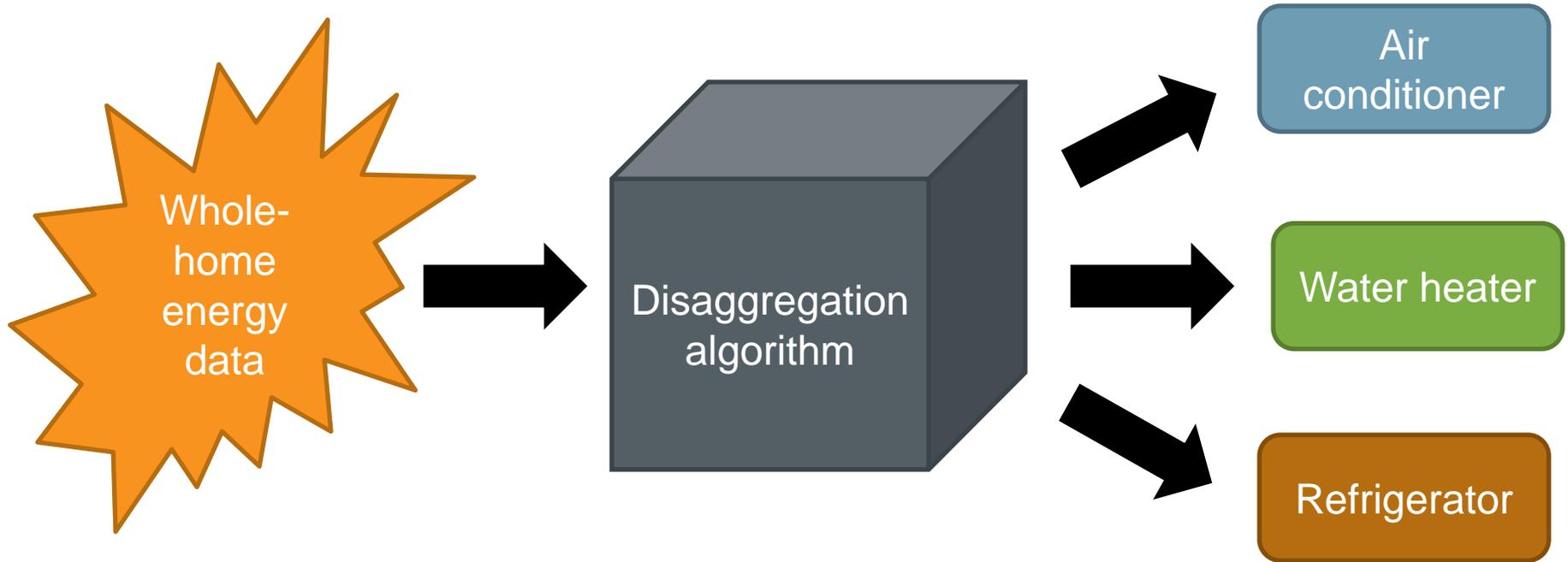
- Young company
- Ability to manage quality unverified
- Energy savings and economics unverified by third party



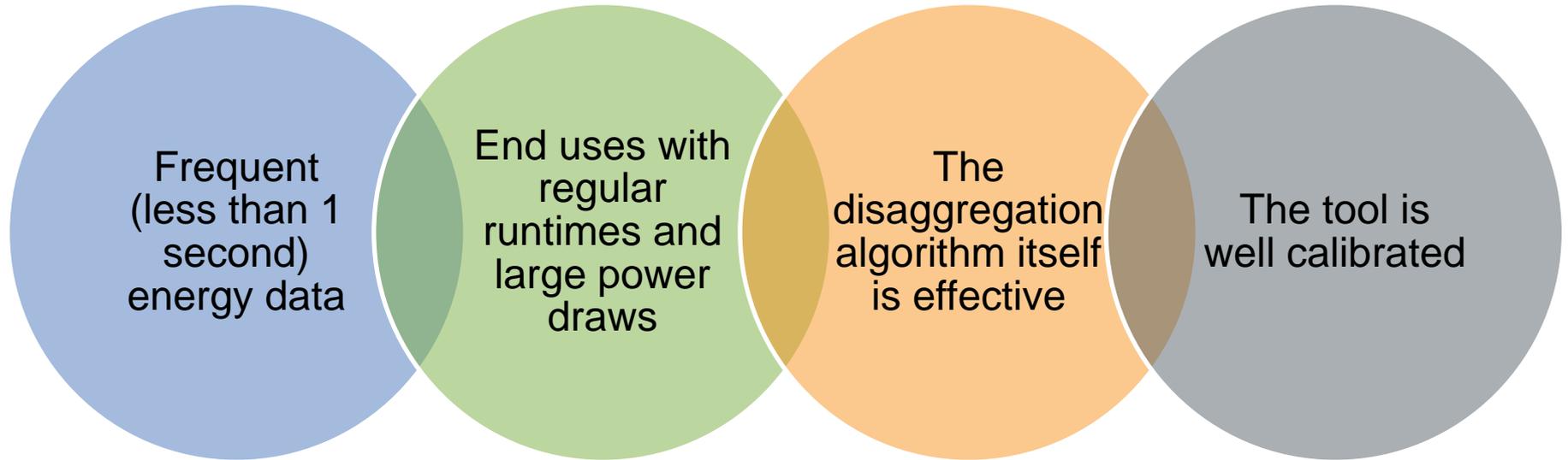


The challenges of disaggregation

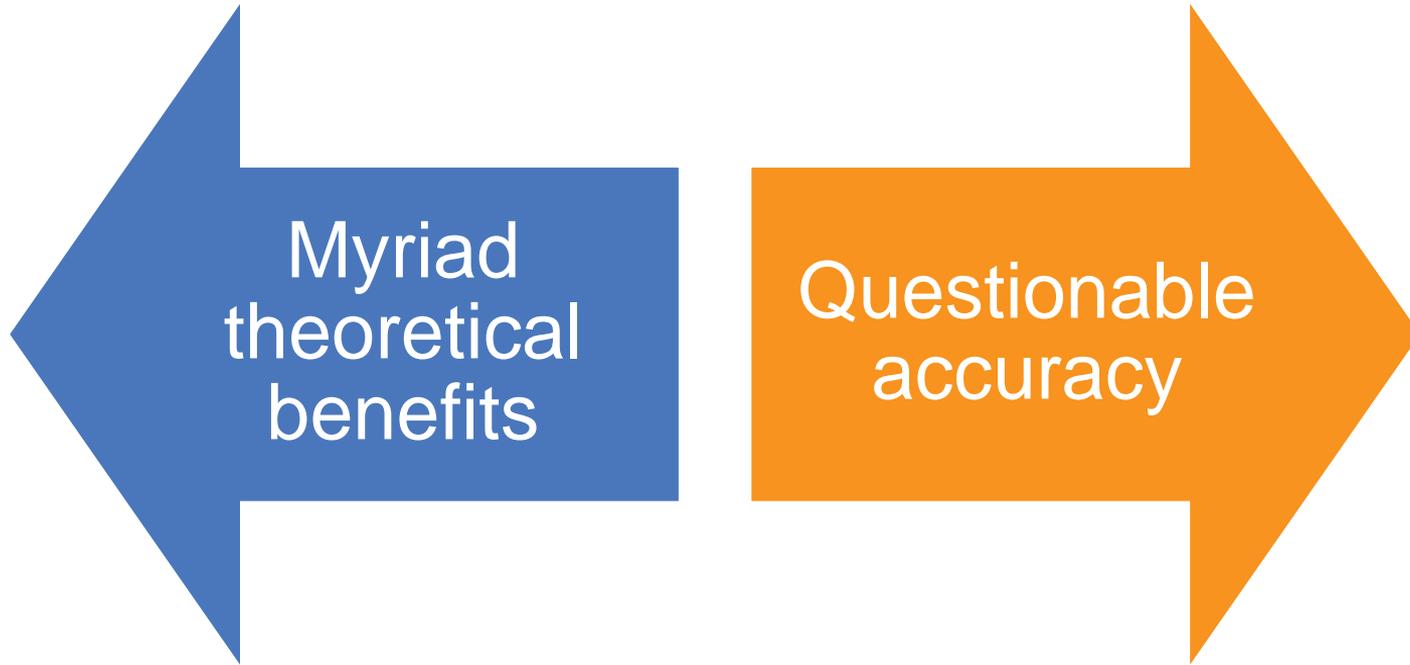
Let's talk about disaggregation!



When is disaggregation most accurate?

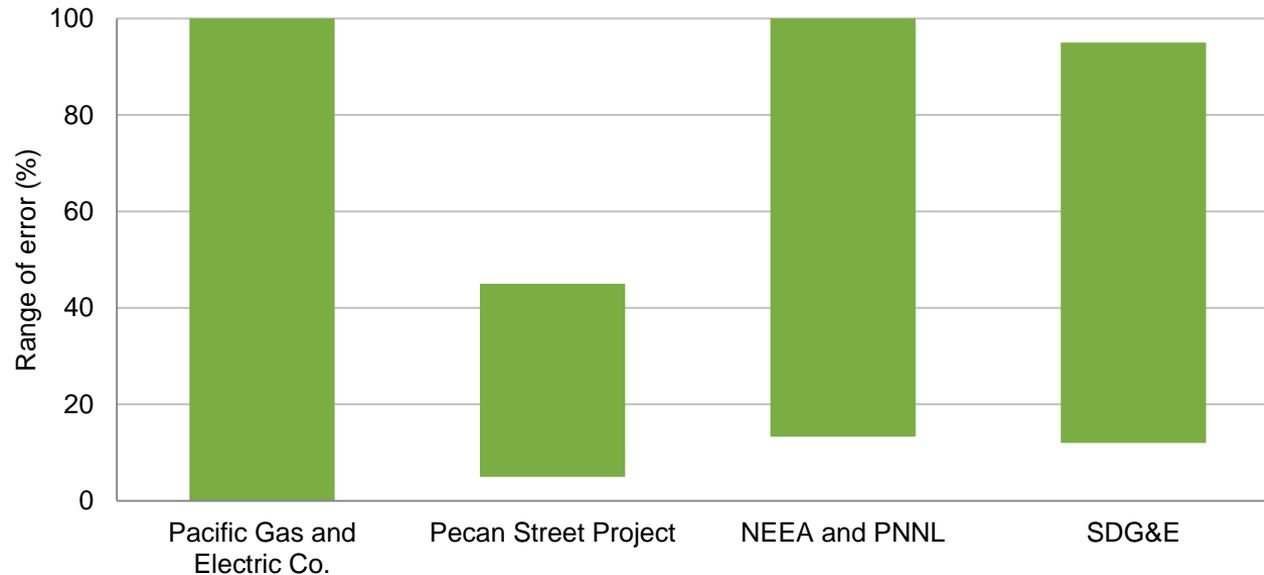


The disaggregation conundrum



Research has consistently shown that accuracy varies

Measured error of disaggregation tools in evaluating end uses



Notes: NEEA = Northwest Energy Efficiency Alliance; PNNL = Pacific Northwest National Laboratory.

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“Even with short interval data and limiting the disaggregation to vendor selected appliances ... the results were only acceptable for a few appliances.”

–Pacific Gas and Electric Co. (PG&E) research

**“Energy accuracy
was found to be less than 45% for all
appliances identified.”**

*–Pacific Northwest National Laboratory and
Northwest Energy Efficiency Alliance research*

What are the risks of low accuracy?

Customer education:

- Inaccurate data can lead to customer distrust
- Customers may miss out on potential savings opportunities

Savings estimation:

- Could yield incomplete or misleading data
- Incorrect savings/cost-effectiveness assumptions

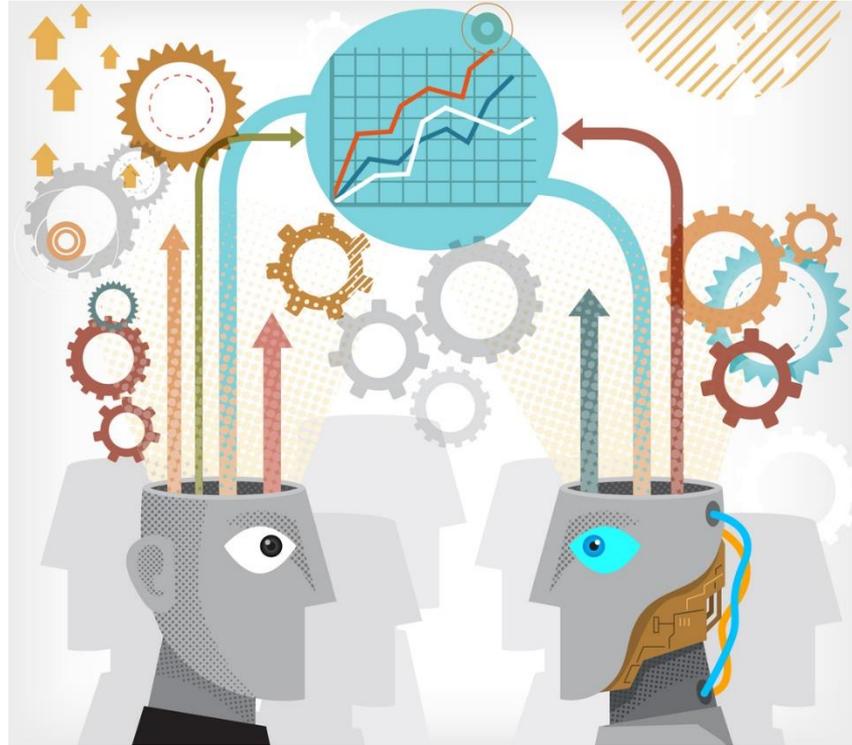
Targeted marketing:

- May miss out on potential demand-side management (DSM) opportunities
- May not be the most cost-effective way to target customers

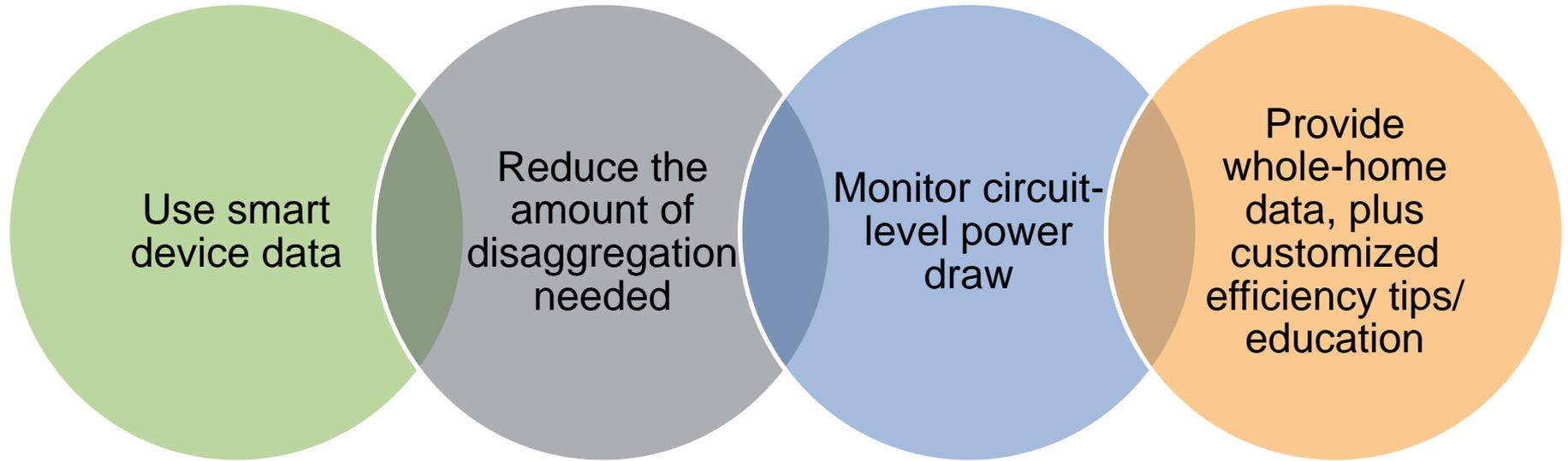
Appliance saturation:

- Data is only as accurate as the disaggregation tool

Can machine learning help? Maybe, maybe not



Other potential ways to overcome disaggregation's shortcomings



Want more info? Check out our reports

Is Accuracy the Achilles Heel of Residential Disaggregation?

Essie Snell

JUNE 1, 2016

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The idea behind energy disaggregation (also called non-intrusive load monitoring, or NILM) is a straightforward source of data on energy use—such as a smart meter—and use software algorithms to identify the constituent parts of their unique energy-use signatures. This breakdown of data can help utilities and end users learn where and how energy is being consumed at a much lower cost than would be incurred with submetering.

With myriad potential benefits ranging from customer education to measurement and verification (M&V), residential disaggregation could represent a true paradigm shift for utilities if it's proven to be reliable, and dozens of vendors have introduced a slew of unique products and proprietary disaggregation algorithms. Because we don't know yet just how accurate these products are when it comes to identifying the amount of energy consumed by specific end uses, it remains unclear how much potential of disaggregation can be realized without additional hardware improvements on the customer side. A wide range of applications, disaggregation may already be a viable option to pursue through pilot programs and field testing.

If it's successfully implemented—and sufficiently accurate—the end-use energy information provided by disaggregation can have multitudinous benefits for utilities. Unfortunately, there aren't yet any clear guidelines that will help utilities determine the accuracy needed when using disaggregation for a given application, and customers may not necessarily want to invest in marketing when deciding on a tool. With that in mind, **Table 1** summarizes a variety of potential benefits discussed in this report.

Top 20 Technologies and Trends of 2017

Jay Stein, Essie Snell, Bryan Jungers, Logan Jacobson, Monali Mujumdar, Andrea Salazar, Zach Hamber

JANUARY 26, 2018

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Sometimes in life, big changes creep up on us. They evolve so slowly, and so subtly, that one day we look around and realize those changes are here. For the energy world, that's an apt description of 2017.

For one example of an energy trend that crept up on us, it became evident in 2017 that the US utility industry has been decarbonizing at an impressive rate for a decade. We widely attribute this trend to closing coal plants, the influx of natural gas and renewable generation onto the grid, and the widespread diffusion of energy-efficiency technologies. And if they continue down this path, US utilities will decrease their carbon intensity by nearly 80% over the next 50 years. For an industry famous for its glacial pace, this would mark an impressive achievement.

Technologies that made headlines in 2017 include batteries and electric vehicles (EVs), which came onto the grid in higher numbers than ever before. Then there's the continued trend toward deeper market penetration of energy-efficient technologies, with one example being LEDs, a technology on the verge of becoming the baseline general-purpose lighting technology. Other technologies that made big advancements over the course of 2017 included switched-reluctance motors, automated savings verification, and voice-activated smart home systems.

We expect 2018 to continue advancing toward cleaner, smarter, more-efficient, and more-customer-responsive energy systems.

RELATED CONTENT

[5 Technologies and Trends That Caught Our Attention in 2017](#)

[Top 20 Technologies and Trends of 2016](#)

[Top Six Residential Technologies](#)

[Top Tech Trends of 2017](#)

[Top 20 Technologies and Trends of 2015](#)



Wireless energy monitoring

Copper Labs for home energy monitoring



Energy use information helps consumers make good choices



Energy-use data can help save 5% to 15%

Source: [Residential Feedback Devices and Programs: Opportunities for Natural Gas](#) (PDF), US Department of Energy (2012)

Manufacturers are using different approaches to provide data

	Submeters	Smart meter-based	Sensor-based
Vendor	Leviton, EKM Metering, Schneider, Inovonics, E-mon	Bidgely, Powerley, Blue Line Innovations, Copper Labs	Curb, Efergy, Ecoisme, mirubee, Sense, Neurio, Whisker Labs
Cost	\$\$\$	\$	\$\$
Disaggregation accuracy			
Difficulty of installation			

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Copper Labs making an entry

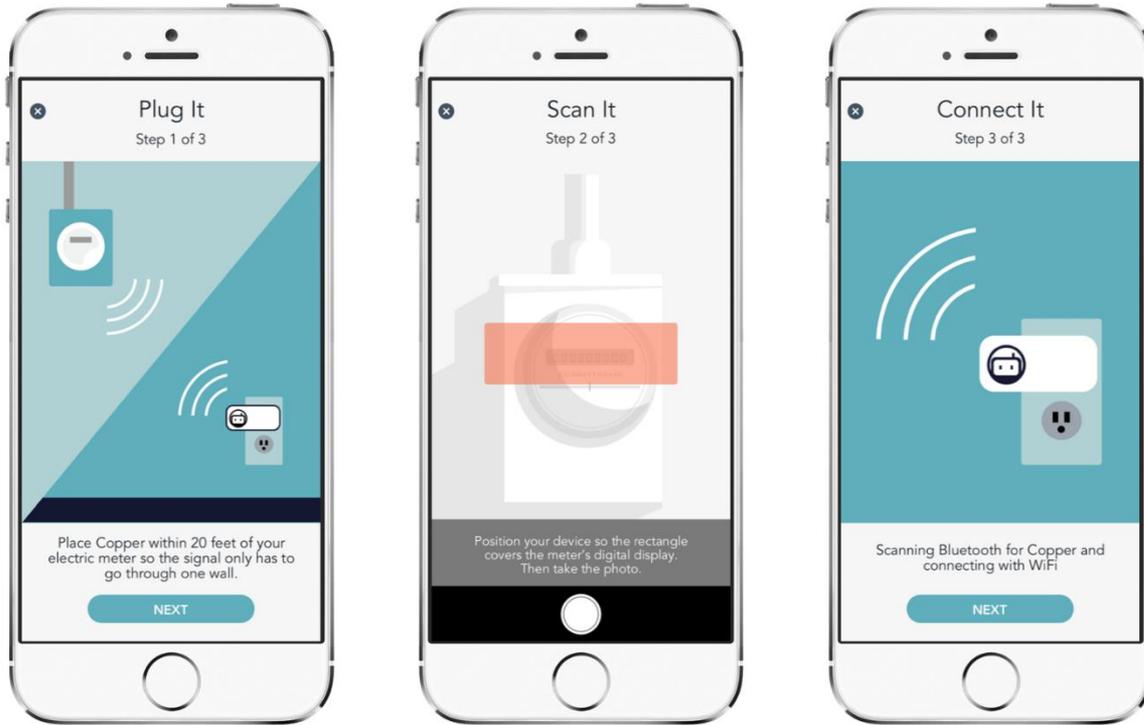
Works with
gas and
electric
meters!



Works with
AMR and
AMI
meters!

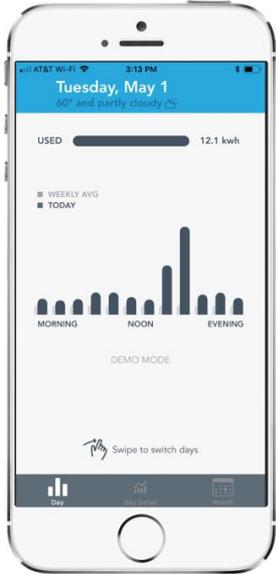
Source: Copper Labs

Installation is easy

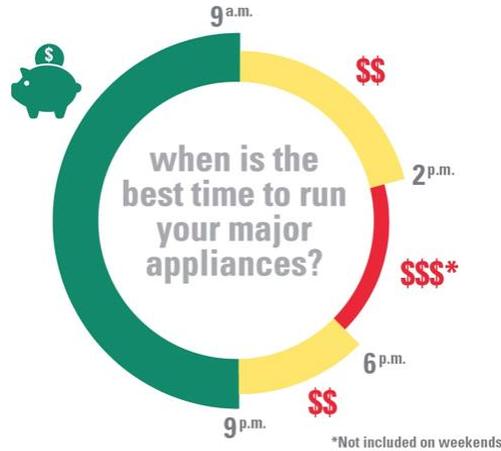


Source: Copper Labs

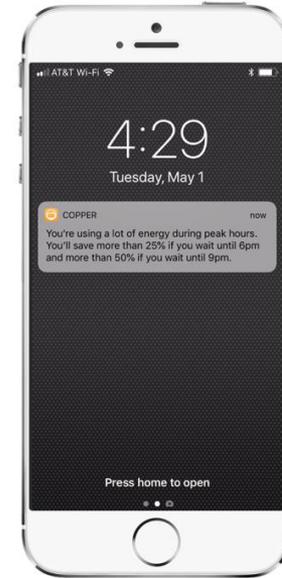
Alerts users with usage and time-of-use information



Actual usage + solar generation



Utility rate plan



Personalized alerts

Source: Copper Labs

Inexpensive technology available through utilities or solar installers only



\$99 +
\$1/month
service
charge

Pilots needed!





Heat-pump clothes dryers

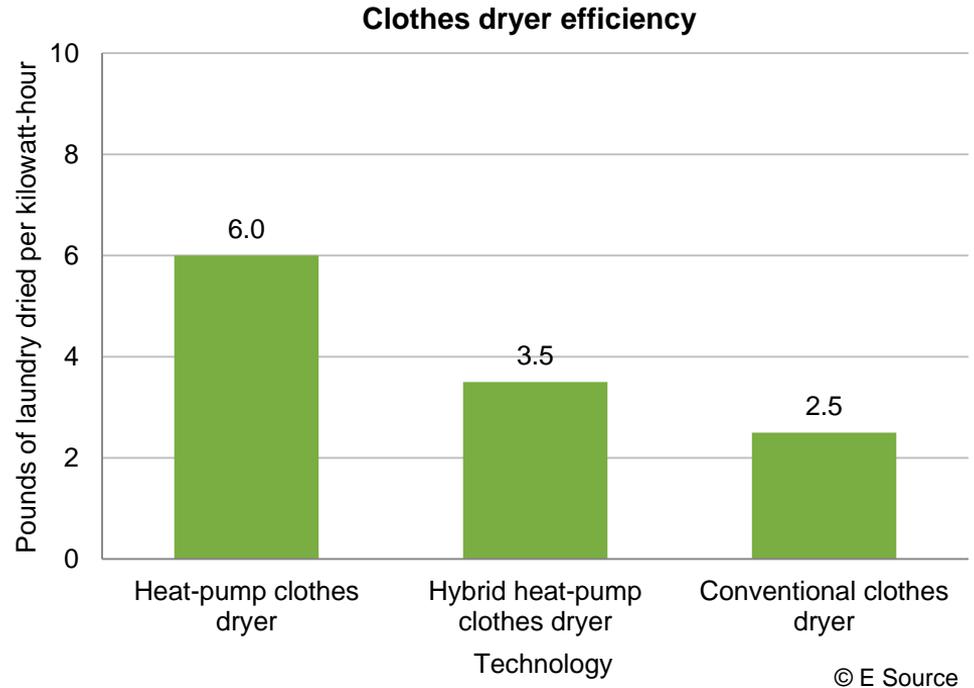
Drying technology hasn't changed

- Two major types of innovation:
 - Dry without heat
 - Dry with stolen heat
- Heat pumps are efficient, but barriers hinder adoption
- Strategic implementation can overcome barriers



Heat-pump dryers are efficient

- Saved 346 kilowatt-hours per year or 36% energy compared to conventional dryers in 2016 ACEEE study ([Measured Performance of Heat Pump Clothes Dryers](#) [PDF])
- Hybrid models increase convenience but decrease efficiency



Bad reviews reflect barriers to adoption

- Drying time
- Lack of customer understanding
- Lack of maintenance support
- Increased humidity in certain homes



Retailer partnerships address multiple barriers

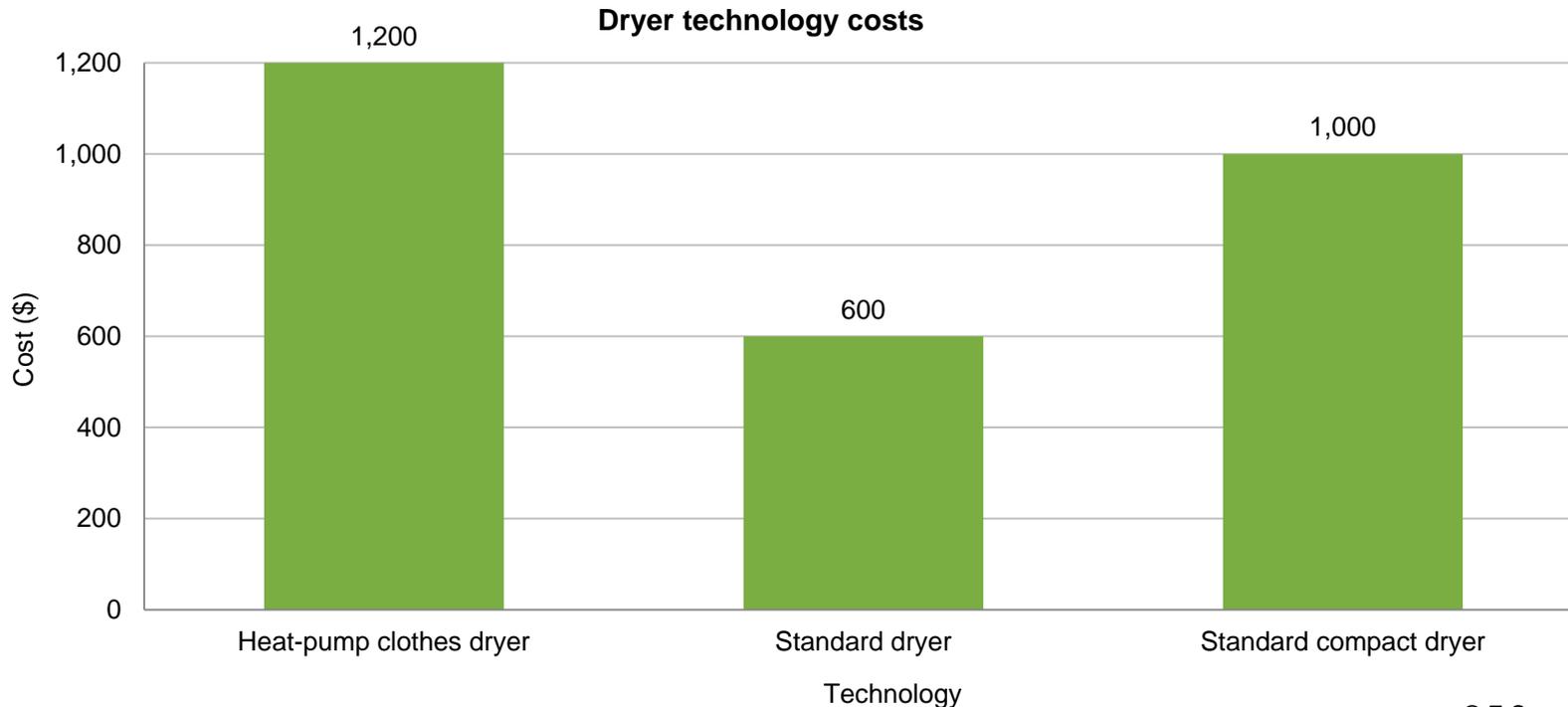
If sales people are more educated about products, they can sell to appropriate customers:

- Long cycles aren't a barrier for all
- They can increase customer understanding
- Certain homes will require vented design



Partnership tip:
Small retailers are better equipped than large chains to properly train sales staff

High cost is another barrier, but with a caveat



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Super-Efficient Clothes Dryers Initiative aims to transform market

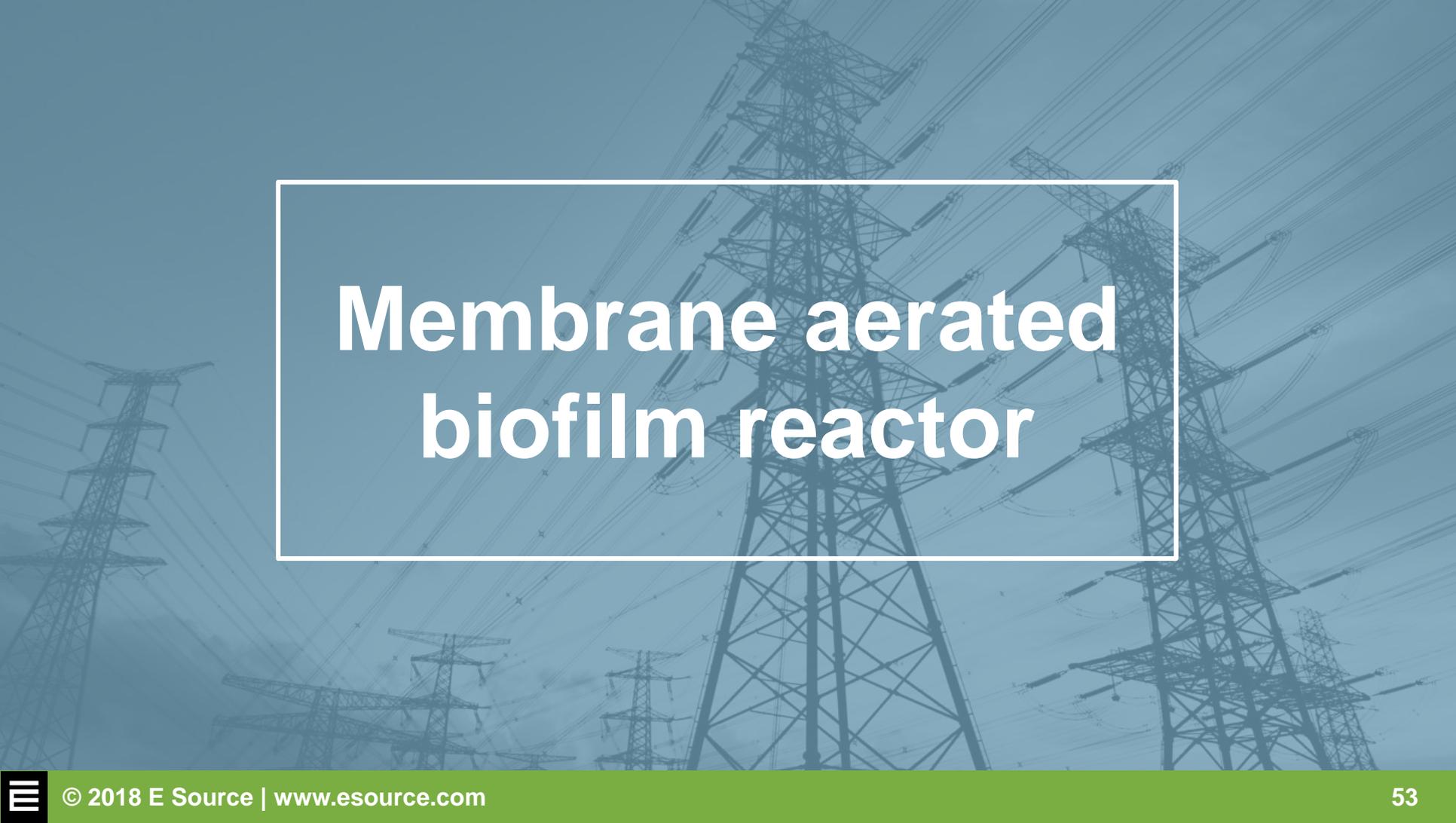
- Studies about customer preferences:
 - [Exploring the Consumer Value Proposition for Super-Efficient Dryers](#) (PDF)
 - [Marketing Message Testing for Super-Efficient-Dryers](#) (PDF)
 - [Gauging Consumer Appetite for Super Efficient \(Heat Pump\) Dryers](#) (PDF)
- Website for more information: [Clothes Dryers Industry Group](#)



Customers trust utility advice!

Focus group participants said that they trust utilities' advice, but don't think to go to their utility for information about clothes dryers



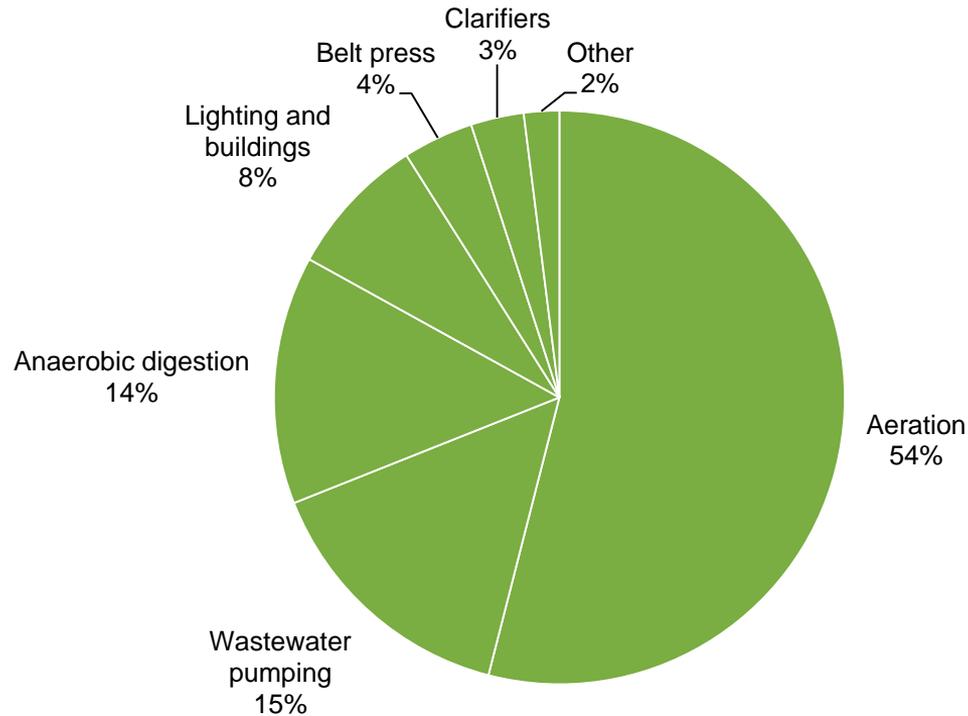


Membrane aerated biofilm reactor

Much energy wasted by wastewater treatment



Much of that energy used for aeration

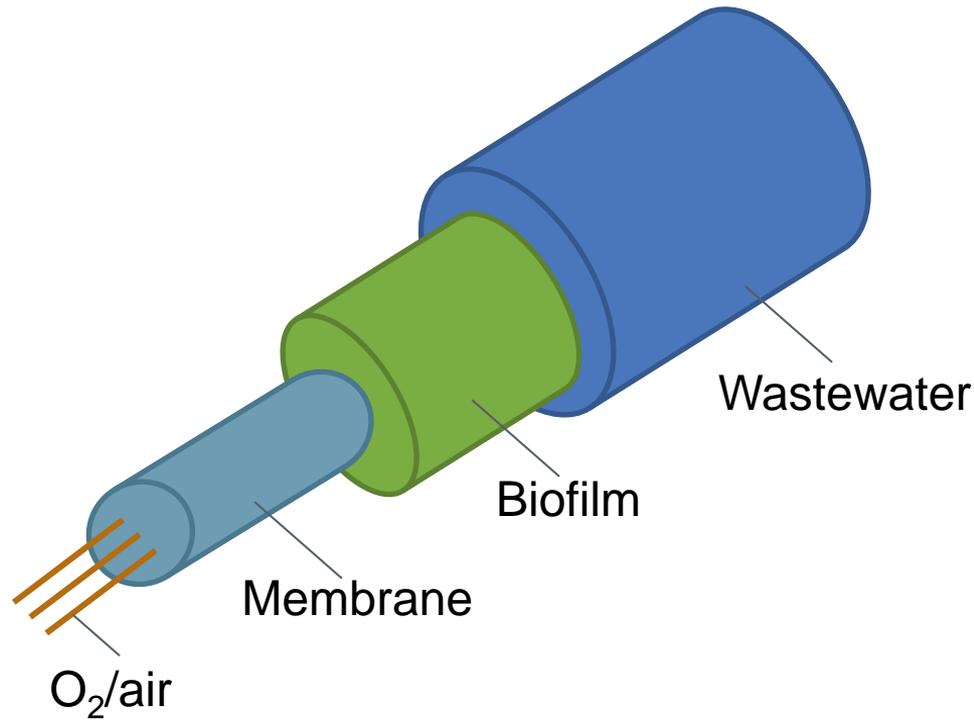


© E Source; data from Wisconsin Focus on Energy

You can see the energy waste



Membrane-aerated biofilm reactor



Tubes formed into bundles



Source: [The Benefits of Membrane Aerated Biofilm Reactor \(MABR\)](#), OxyMem (2016)

Fabricated into assemblies



Source: [OxyFILM - Membrane Aerated Biofilm Reactor](#), OxyMem (2018)

Benefits and costs

Benefits:

- 70% less energy consumption for aeration
- 50% less sludge production
- Less area, volume, and associated materials required

Costs:

- More expensive than bubble aerators
- Too expensive to pay for itself based on energy savings alone
- Lower overall costs in new construction and renovation

Final thoughts

- Well-established technology but apparently low market penetration
- Savings yet to be verified by third-party observation
- Costs still uncertain
- Programs may have to only pay incentives for design in new construction or capacity expansion projects



Solutions for heated dipper wells

Heated dipper wells



T&S B-2282-01 7" Dipper Well
Bowl and Faucet Set



Nemco 13" Wide Spadewell /
Dipperwell Ice Cream Dipper Station
(No Divider)

Common facilities



Health concerns: behavior versus energy savings



versus



What are the options?



HDW2 Water-Saver
Heated Disher Well



Server Products 87760
ConserveWell Drop-In
Utensil Holder

What are the options? (cont.)



Push-button faucets



Replace with efficient dishwasher

US Environmental Protection Agency WaterSense case study



Source: [Family Dining Chain Scoops Up a Big Dip in Water Use](#) (PDF), US Environmental Protection Agency

Wells heated-dipper well and push-button savings

Annual energy savings:
12% to 18%

Reduction in water use:
35%

Source: [Realizing Water Savings Through Dipper Well Replacement](#) (PDF), Michael Slater, Frontier Energy (2018)

Black Bear Diner case study



Source: [Black Bear Diner Secures Investment from PWP Growth Equity](#), Business Wire (2016)

ConserveWell case study results

	Existing	ConserveWell
Average flow rate (gallons per minute)	0.25	N/A
Operating time (hours)	24	24
Reduction in water use (%)	—	97
Reduction in energy use (%)	—	99

© E Source; data from [Realizing Water Savings Through Dipper Well Replacement](#) (PDF), Michael Slater, Frontier Energy (2018)

Cost information

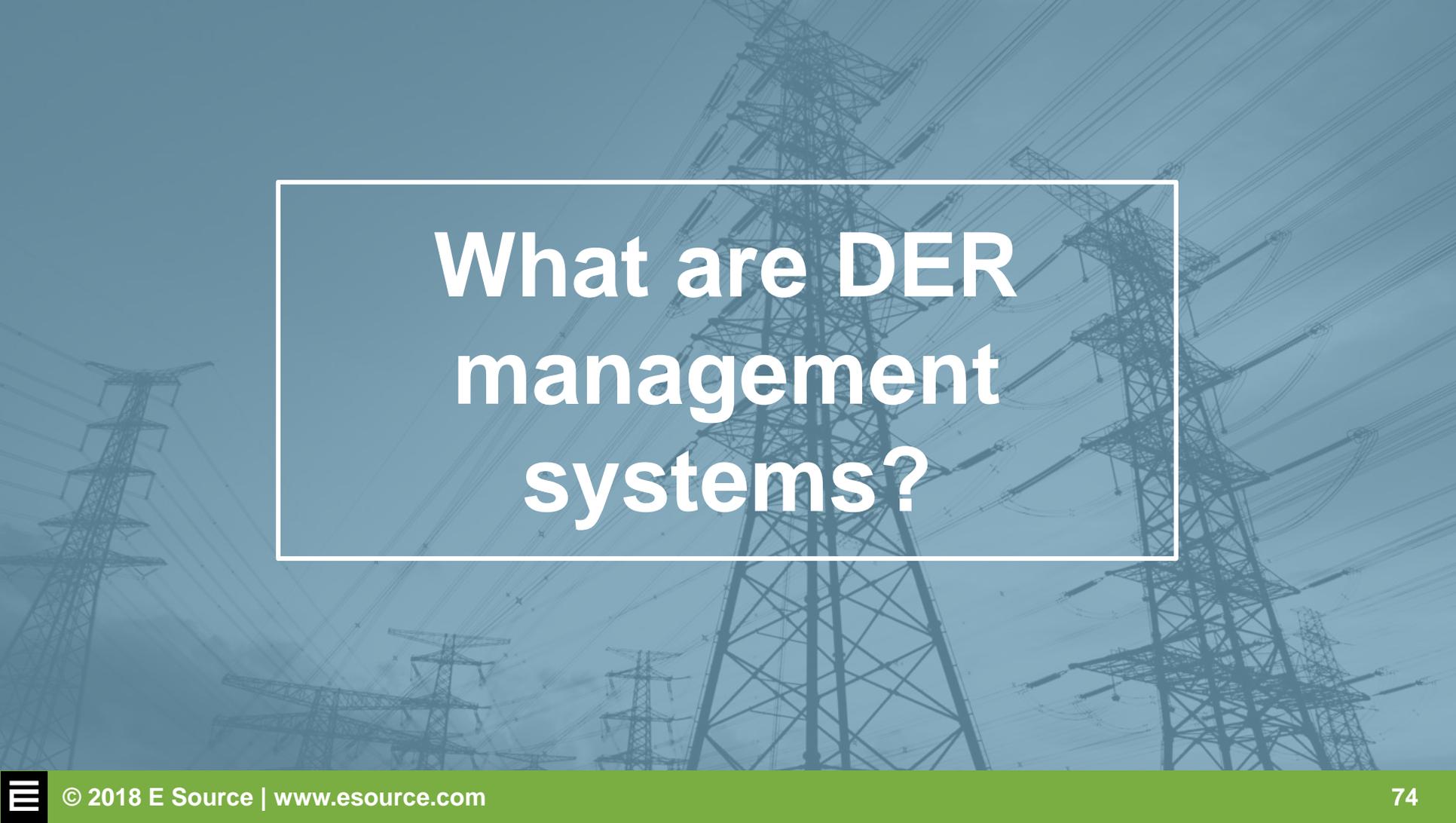
Sanitation method	Price (\$)
Standard dipper well (faucet and sink)	100
ConserveWell	500
Wells heated model	1,000
Push-button faucets	100 to 200

© E Source

Next steps

- Pilots
- Education
- Retrofits





What are DER management systems?

How do we define distributed energy resource management system (DERMS)?



Smart Electric Power Alliance (SEPA) published [Version 1.0 of DERMS Requirements](#) in November 2017: 37 pages of tech specifications, 6 pages of definitions

Which functional requirements are met by competing DERMS solutions?

How many of these requirements are being added to existing distribution management system (DMS) solutions?

A working concept for DERMS (by PG&E)



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 (with smart inverters)
- Future electric vehicle charging

Existing, industry making incremental improvements

Program management and control of DR portfolio:

- Smart air conditioning
- Aggregated DR

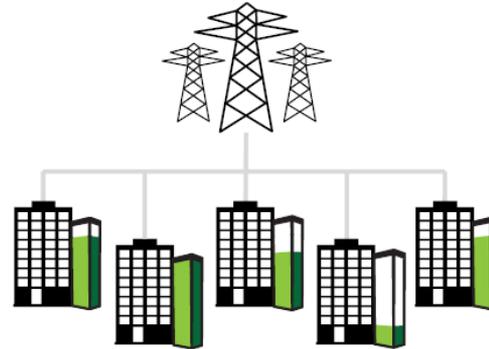
Notes: DERs = distributed energy resources;
DRMS = demand-response management system.

Source: [Distributed Energy Resource Management System \(DERMS\)](#) (PDF), Alex Portilla, Pacific Gas and Electric Co. (2016)

Example 1: STEM

Creating a stand-alone network:

- Single vendor
- One DER type
- Bidding into CAISO market
- Successful load shifting in California
- Automated artificial intelligence and cloud servers
- 800 sites, 200 megawatt-hours
- Additional 150 megawatt-hours contracted



Source: STEM

Example 2: AutoGrid

Expanding on DRMS capabilities:

- Single vendor
- Multiple DER/DR types
- Multiple customer classes
- 3 gigawatts of DERs managed globally
- Building our from DR platform
- Successful DR projects with Bonneville Power Administration, Marin Clean Energy

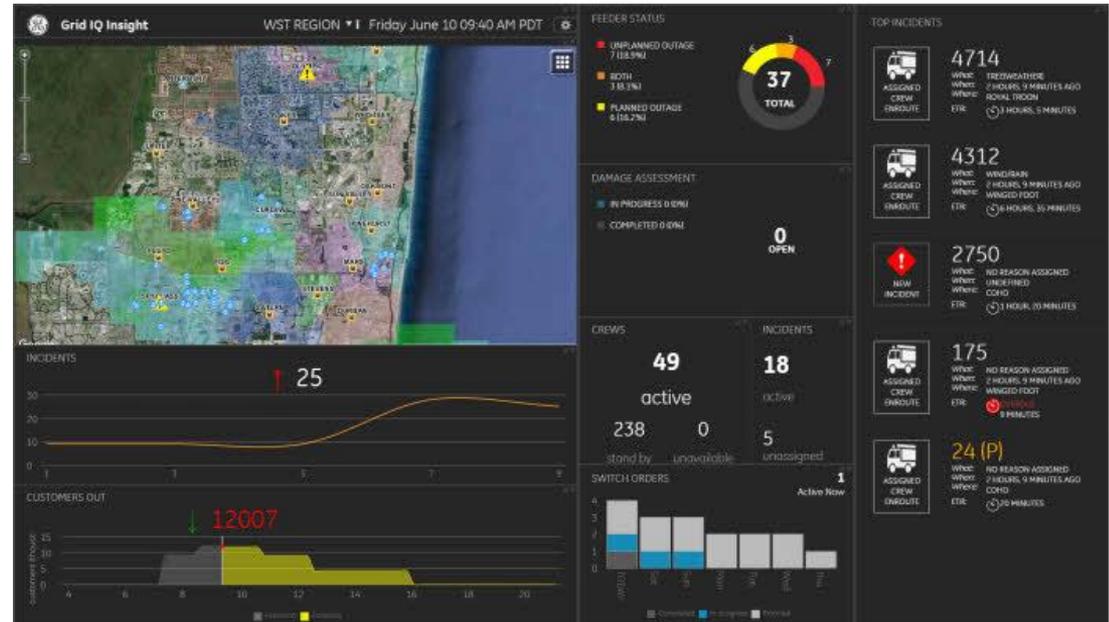


Source: AutoGrid

Example 3: GE and PG&E

Expanding on DMS capabilities:

- Three vendors
 - General Electric (GE)
 - Enphase Energy
 - SolarCity
- Testing smart inverters, storage
- Pilot is still under way

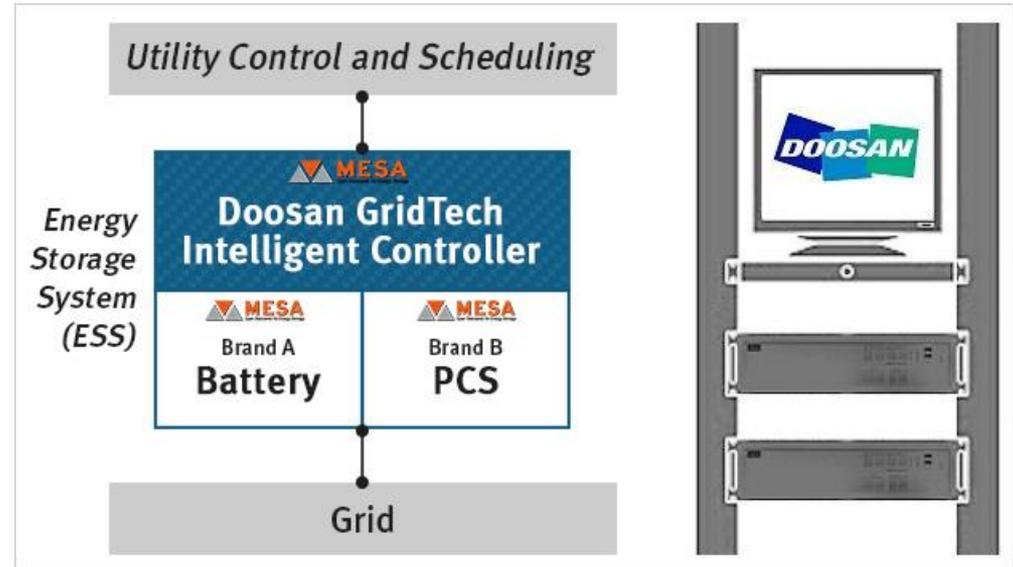


Source: [Grid IQ Insight](#), General Electric

Example 4: Doosan GridTech and Austin Energy

Building a customized solution:

- [Austin SHINES](#) (funded by the US Department of Energy)
- Austin Energy specifies platform
- DERMS with focus on batteries
- Brand/technology agnostic
- Tesla didn't play well with others
- C&I pilot under way, large battery systems being built now

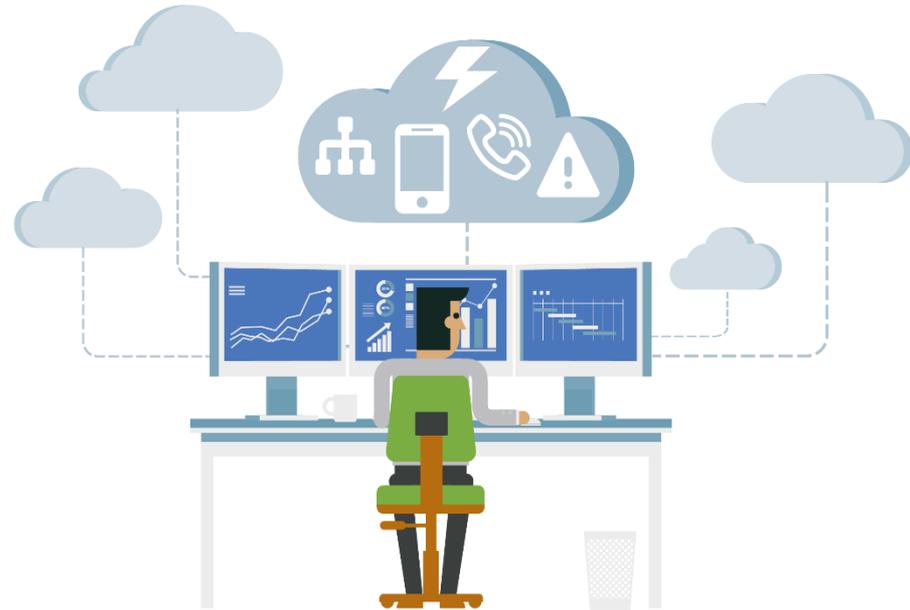


Source: Doosan GridTech

What you need to know about DERMs

An evolving concept and technology class:

- Many flavors, minimal standardization
- Vendor claims are not yet validated
- All utility projects are pilots (so far)
- Join or follow SEPA's [Grid Management Working Group](#) to stay up to date!





Advanced residential HVAC controls

The problem



3 million HVAC replacements annually



\$14 billion HVAC service/repair expenditures annually



Research indicates 50% to 70% of systems are improperly designed, installed, or maintained



Improper installations are estimated to be 10% to 50% less efficient than they should be

Source: US Department of Energy

A new solution: ComfortGuard



SMART SENSORS. STREAMING DATA.

Hardware and sensors are installed by a technician. The sensors gather vital information every time your system runs, sending the data to our monitoring center's secure cloud over your home's Wi-Fi network.



EXPERTS ON YOUR SIDE. AROUND THE CLOCK.

Our team carefully monitors your data around the clock. If your filter is clogged, a part is degrading or your equipment efficiency is declining, we'll see it before you realize you have a problem.



THE RIGHT INFORMATION. THE RIGHT TIME.

By sending you timely communications including system reports, alerts and repair verifications, the smart maintenance plan gives you the real-time insights you need to better manage your HVAC.

10 CUSTOM SENSORS

Sensors are professionally installed into your equipment to collect never-before-seen data and give unprecedented visibility into performance and efficiency.



Source: Emerson
Electric Co.

QA/QC of QI and QM programs



Another benefit for utilities

Demand-response potential estimation



Applicable to the small and midsize business market



Lots of folks are interested



Revenue generation opportunity?



The caveats

- No official pilot results available yet
- Contractor training and competency will be key to program success
- More pilots needed!



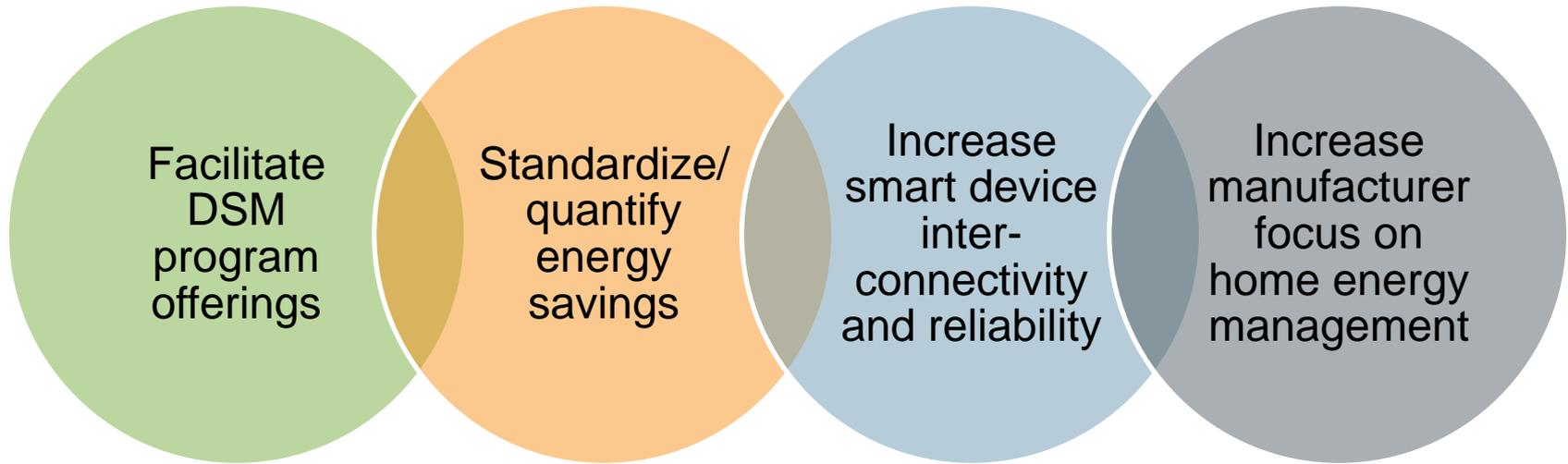


Energy Star smart home specification

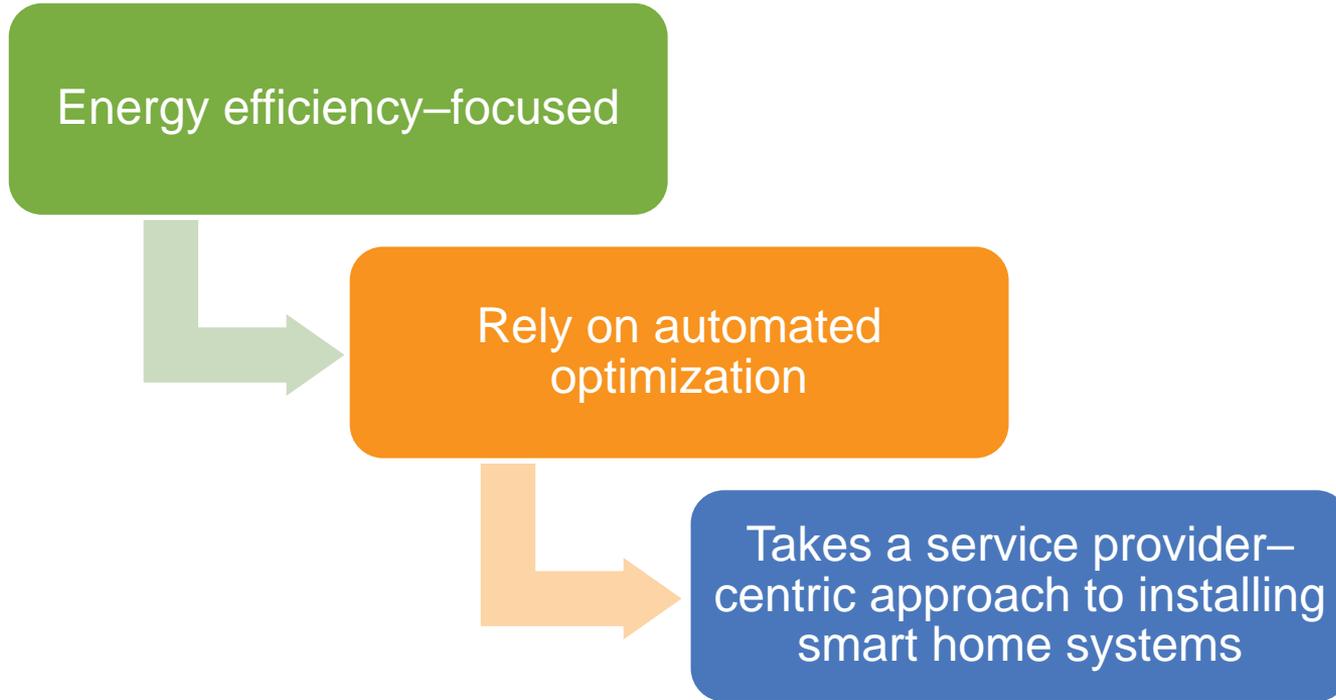
Coming soon: a new Energy Star specification for smart homes?



How could this help utilities?



The big picture



The current draft proposal

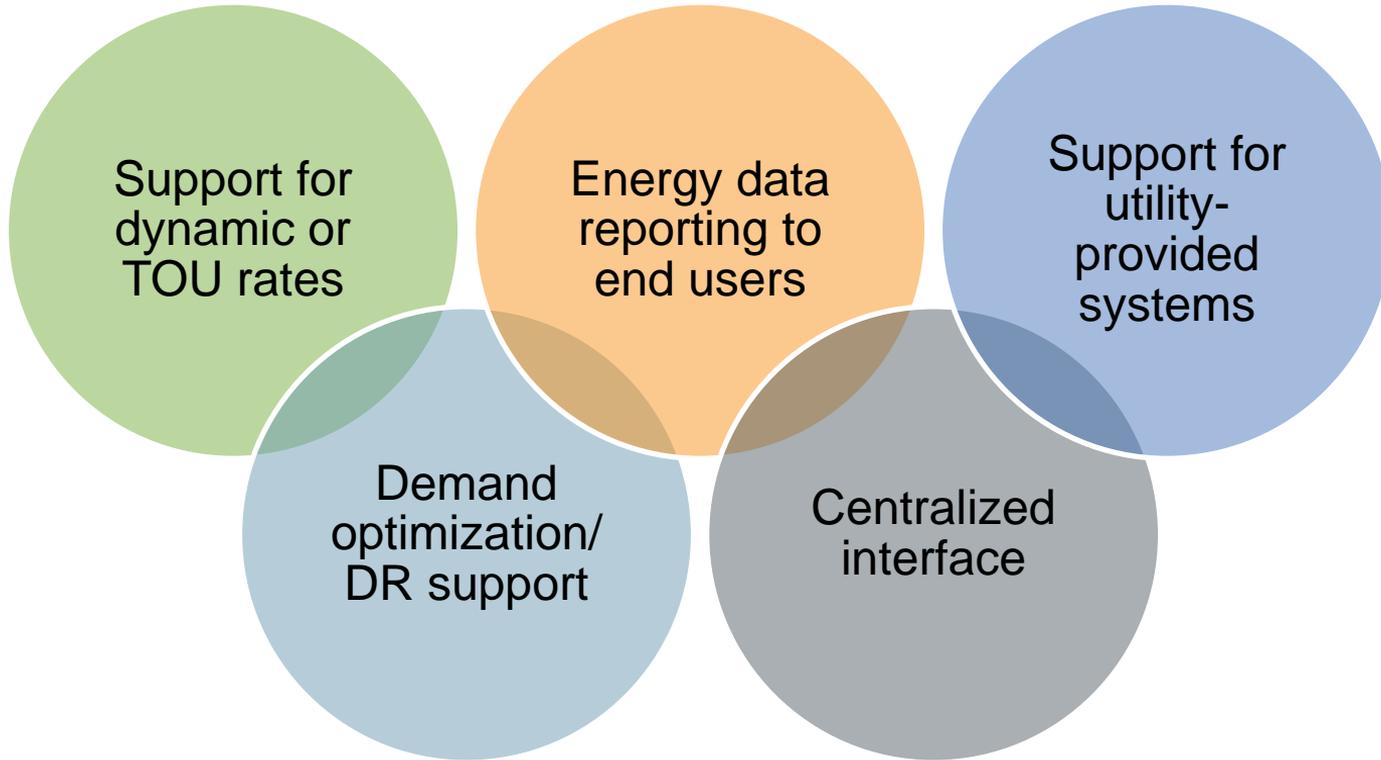
Required:

- 1+ smart thermostat
- 3+ connected light bulbs
- Devices/capabilities to control plug loads
- Occupancy sensing and automation
- Data collection
- Ability to connect to a water heater controller

Optional:

- Water heater controller
- Smart appliances
- Smart pool pumps
- In-home display/energy app
- Other smart home devices

What's not included (yet)



Want to get involved?

- Check out the [ENERGY STAR Smart Home Energy Management Systems Discussion Guide \(PDF\)](#)
- Follow the [ENERGY STAR certified products web page](#)
- Send your contact information to SmartHomeSystems@energystar.gov to be added to the distribution list for updates

For more information



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QUESTIONS



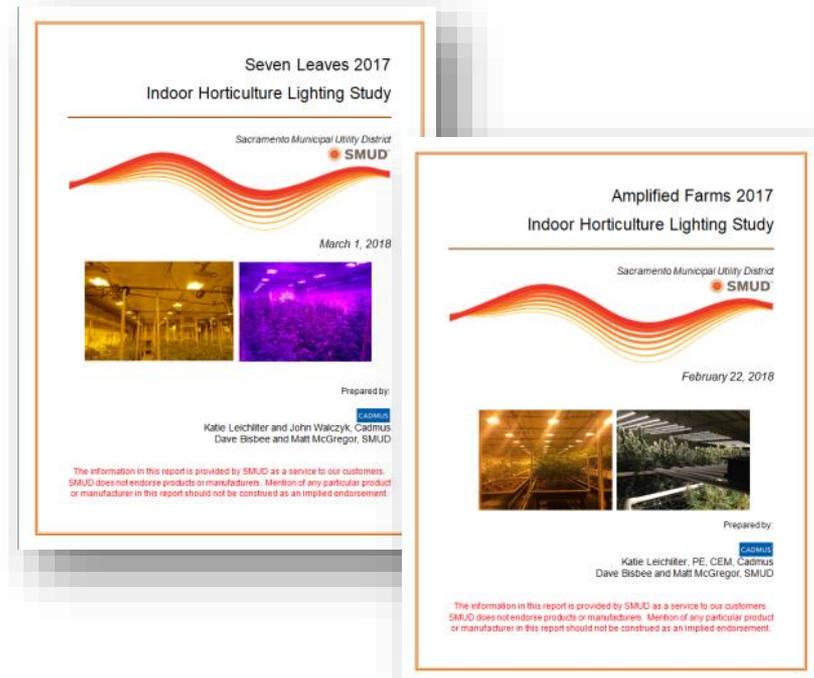
forum



Honorable mentions

SMUD evaluated cannabis lighting

- With high pressure sodium, yield was higher
- With LEDs, quality was better
- Difficult to control test setting:
 - Cultivation operations are dynamic
 - Adjusting grow conditions continuously
 - Security is a big concern (theft)
 - Mistakes can be costly
- Unexpected findings (grow media really matters)
- Read the reports [here!](#)



Source: SMUD

Glowing plants for streetlighting

- Developed by [MIT](#)
- Lighting principle same as fireflies
- Glow lasts 3.5 hours
- Method can be applied to any type of plants
- Can be used for indoor lighting as well



Source: [Engineers Create Plants That Glow](#), Anne Trafton, Massachusetts Institute of Technology (2017)

Thermochromic solar window

- Developed by [NREL](#)
- Look like ordinary windows
- Switchable layer allows change into dark color in high temperature
- Energy conversion efficiency 11.3% (color switches in three minutes)
- Cost-effective



Source: National Renewable Energy Laboratory

Conductive cow cooling

- Dairy farms use energy-intensive fans to cool cows in barns:
 - Healthier and happier animals
 - Increases milk production
- Mats with chilled water for cows to stand or lay on cools cows more efficiently

