Emerging Technologies

Saving Energy and Reducing Demand in Commercial & Industrial Facilities

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E Source

Efficiency Works

Outline

A new C&I lighting market

Cost-effective lighting controls

Energy-use disaggregation

Out-of-the-box building controls

Advanced retrofit HVAC controls

Key Takeaways

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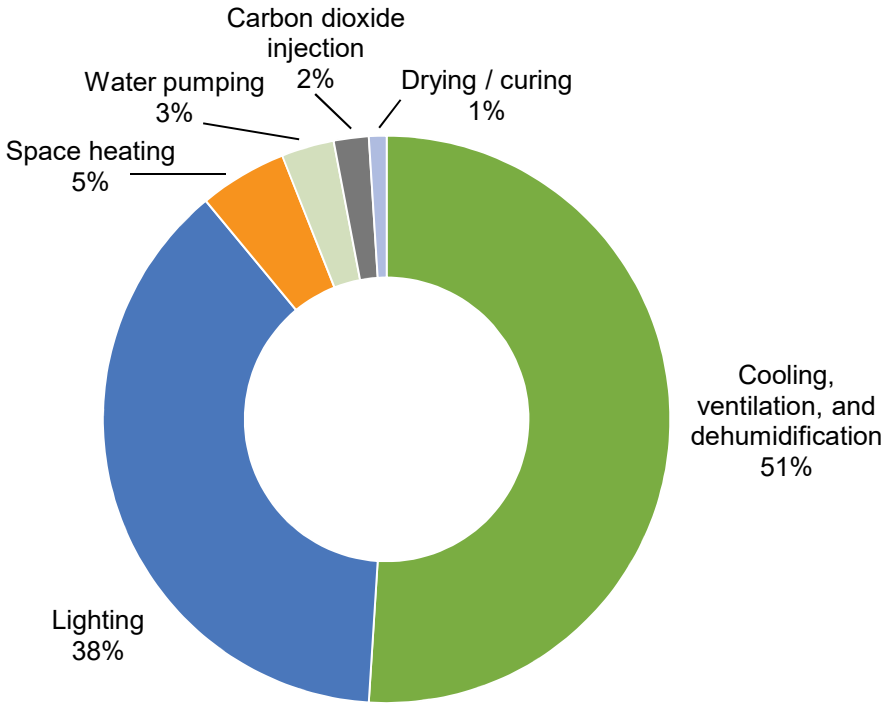
Headquartered
in Boulder, Colorado

EST.
1986

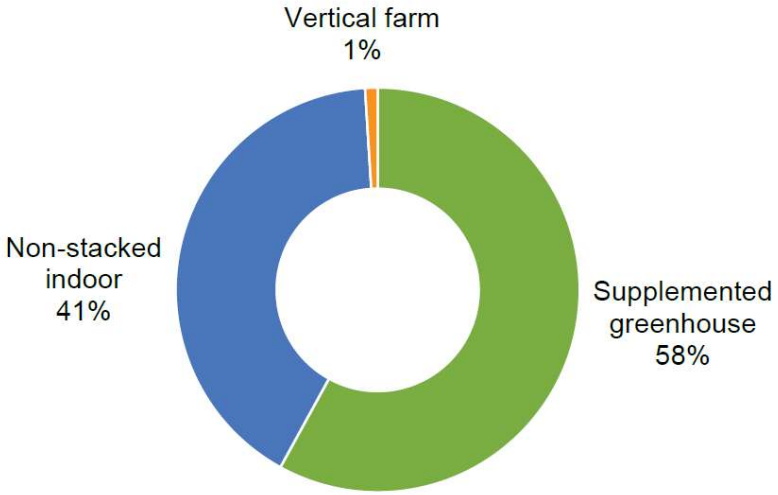
A new C&I lighting market: indoor ag



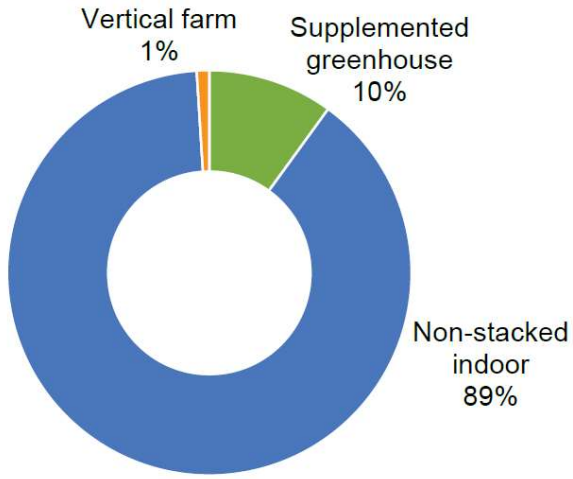
© E Source; data from A Budding Opportunity: Energy Efficiency Best Practices for Cannabis Grow Operations (PDF), Neil Kolwey, SWEEP (2017)

Indoor ag is large and growing

Size of indoor agriculture grow area by type
Total area = 46 million square feet



Energy consumption of indoor agriculture grow area by type
Total energy = 5.9 TWh



Source: Energy Savings Potential of SSL in Horticultural Applications, Stober et al., US DOE

Significant lighting savings potential

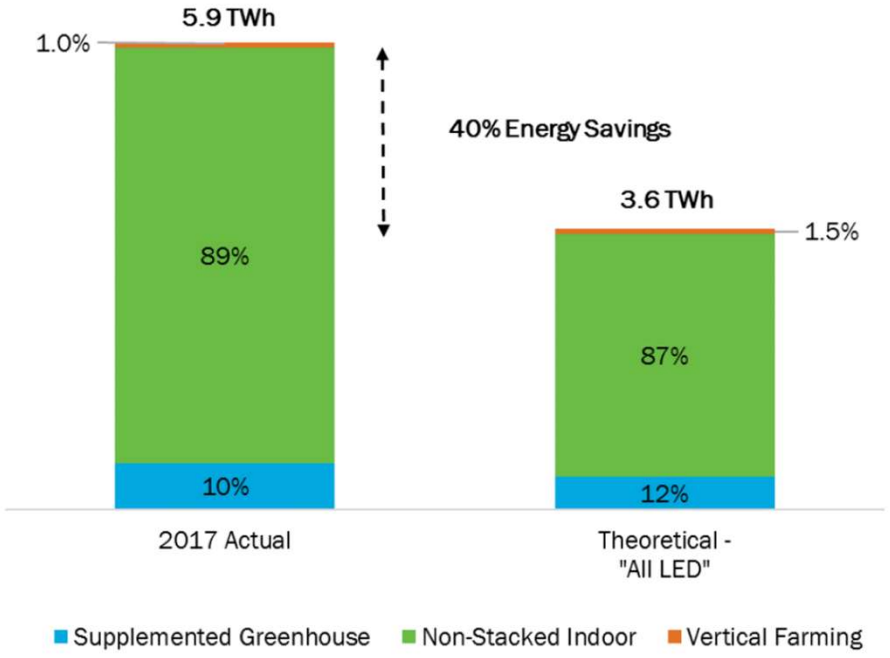


Figure E.2 2017 Annual Energy Consumption (TWh) of U.S. Horticultural Lighting

Courtesy: Stober et al., U.S. DOE

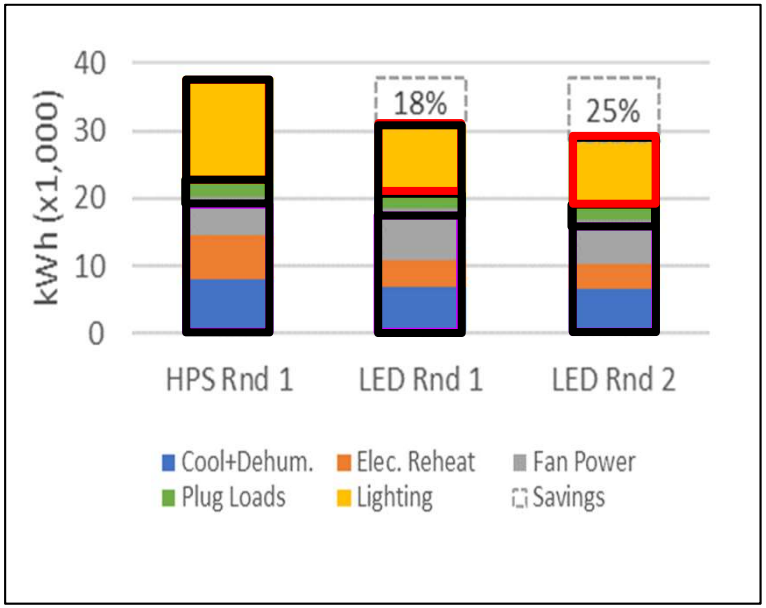
Baseline lighting tech for indoor ag

Luminaire	Brand	Source	Lamp	Rated Lamp Life (Hours)[35]	Lamp Cost	Rated Reflector Life (Hours)	Reflector Cost
1000 W HPS	Gavita	HPS	Gavita ProPlus 1000 W EL DE HPS	5,000	$135	10,000	$53
1000 W HPS	P.L. Light Systems	HPS	Ushio HiLux Gro Super HPS with optimized blue and red spectrum	10,000	$120	10,000	$40
1000 W MH	P.L. Light Systems	MH	Ushio HiLux Gro Super MH with optimized blue and red spectrum	10,000	$120	10,000	$110
600 W HPS[36]	P.L. Light Systems	HPS	SON-T PIA	12,000	$32	10,000[37]	$40

Source: Leora C. Tadetsky, Lighting Research Center

Independent testing shows real savings

- Lighting energy savings was an average of 34%
- Plug loads were 7% lower
- Total HVAC system usage was slightly lower (2%)
- Overall energy consumption was 18 to 25% lower



Source: Dave Bisbee, SMUD

Selecting quality lighting products

- Not all LEDs are created equal
  - Early adopters got burned
- Until very recently, no hort. LED qualified products list
- Off-the-shelf LEDs not suitable for indoor ag
  - "Lumens are for humans"
  - "PAR are for plants"
- Even in SMUD study, one LED product performed better
  - The other showed 35 – 40% reduction in yield

Testing and Reporting Requirements for LED-based Horticultural Lighting

Version 1.0

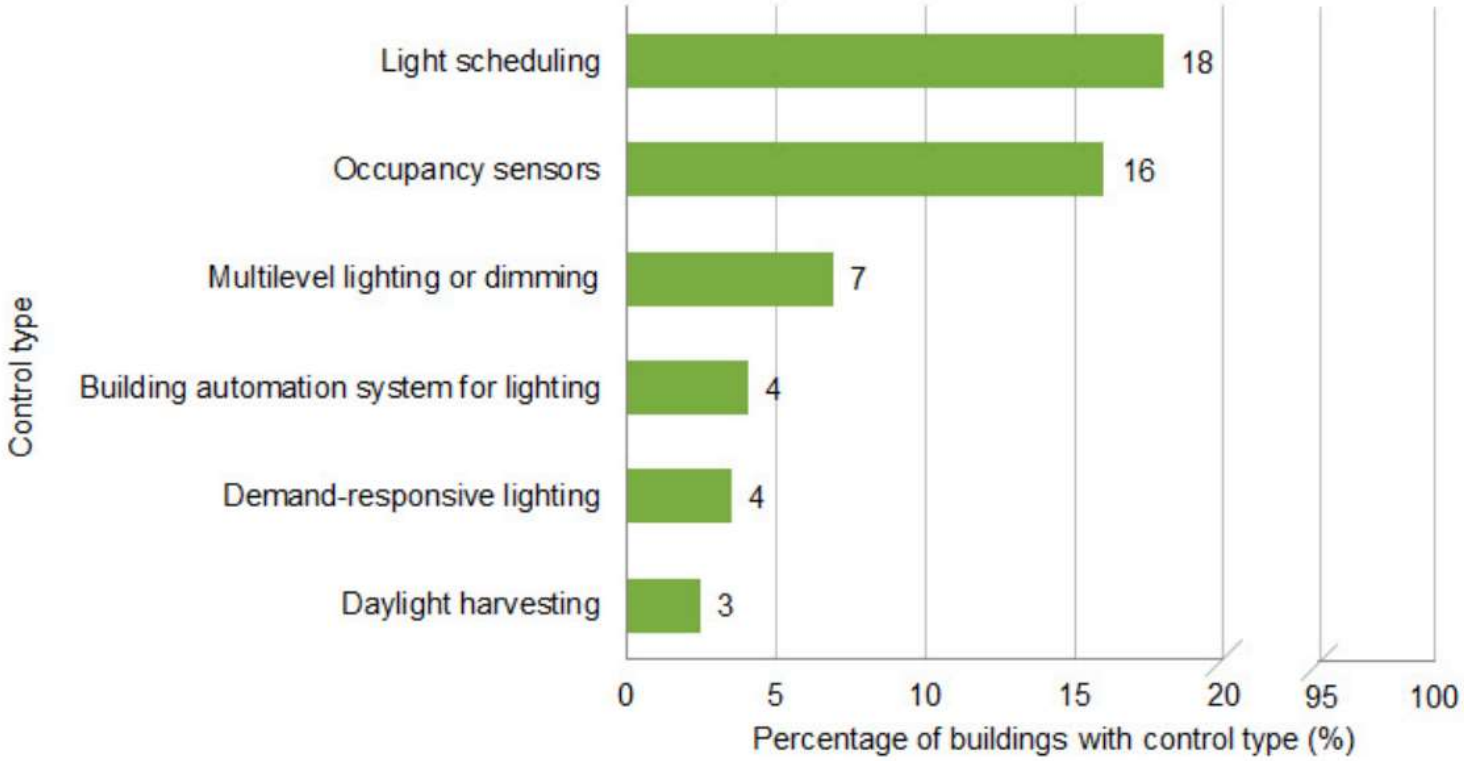
Effective October 18, 2018

Are there non-LED alternatives?

Plasma Lighting

Ceramic Metal Halide

Most buildings have no lighting controls



Saving energy with lighting controls

Control strategy	Description	Average lighting energy savings from Lawrence Berkeley National Laboratory meta-analysis (%)	Manufacturer-provided energy-savings estimates (%)
Scheduling	On/off/dimming based on operating schedules	Not available	10–40
Occupancy-based	On/off or dimming based on signals from an occupancy sensor, time clocks, or energy management system	24	20–60
Daylight harvesting	Light levels from electric lights adjusted based on photosensor signal indicating level of daylight	28	5–60
Personal tuning	Occupants control light levels	31	6–20
Task tuning	Dimmers and switches used to adjust light levels to suit tasks at hand	36	5–30
Combined strategies	Any combination of the above	38	Not available

© E Source; data from the Illuminating Engineering Society and the US Department of Energy

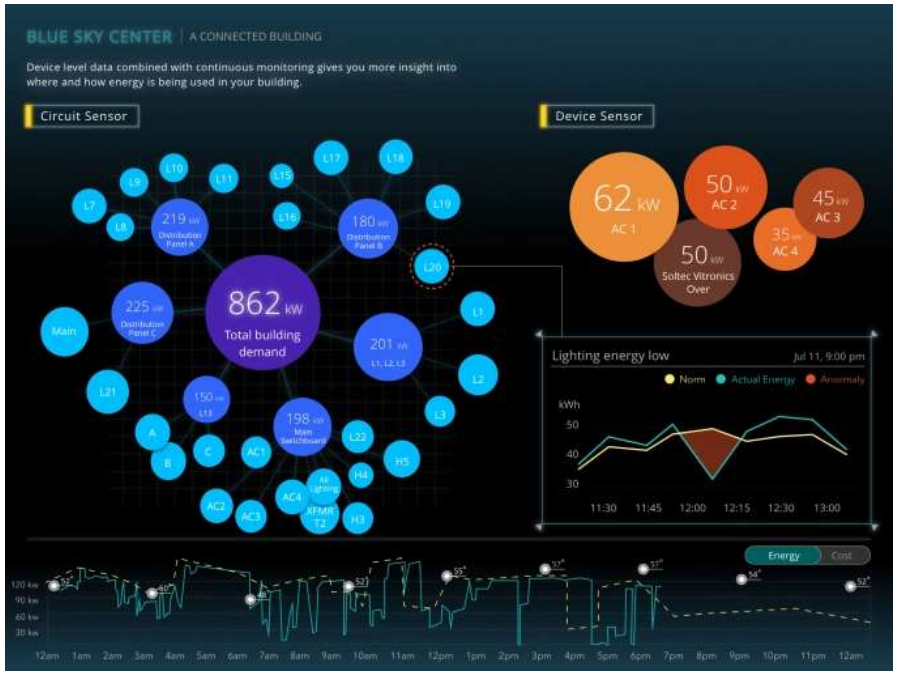
Adding controls to LEDs cost-effectively

Don’t trust, just verify (energy use)

System	Measurement type	Methodology	Sampling frequency	Average accuracy in energy consumption (%)
ACL1	Real (true) power	Current and voltage measured instantaneously	Every 60 seconds	98.6
ACL2	Real (true) power	Current and voltage measured instantaneously	Every 150 seconds	92.5
ACL3	Apparent power	Current is measured; voltage is assumed to be constant	User-defined	37.9

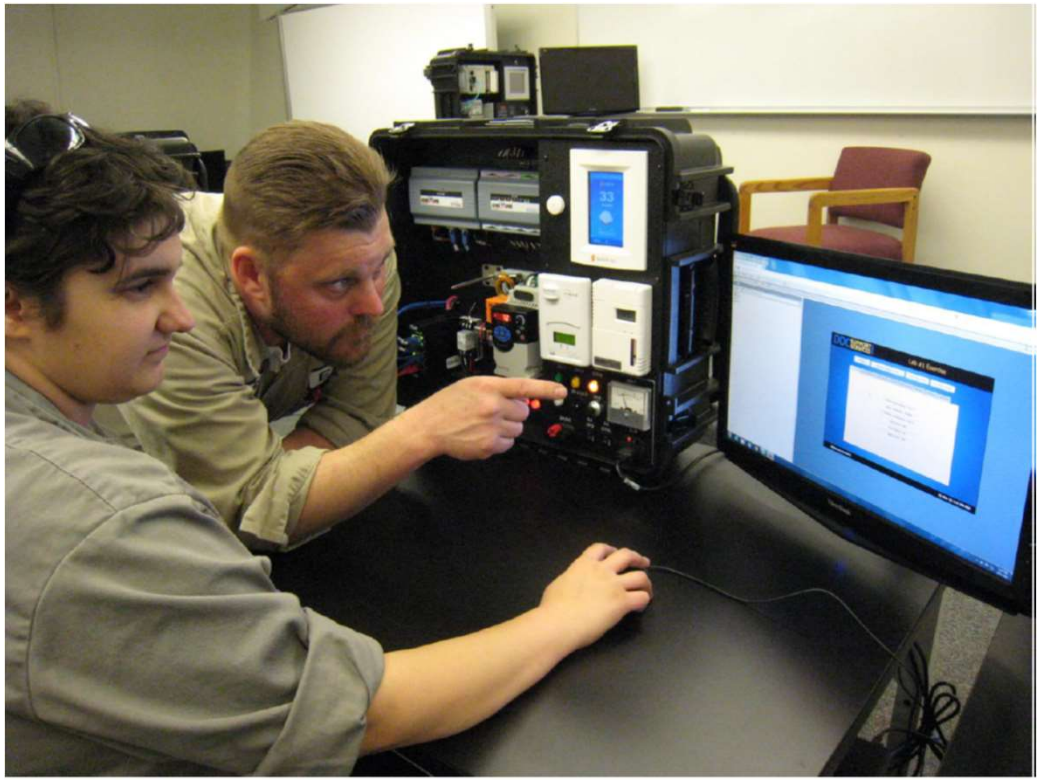
© E Source; data from the California Lighting Technology Center

Delivering better energy information



Sources: Verdigris

Building controls aren't obvious



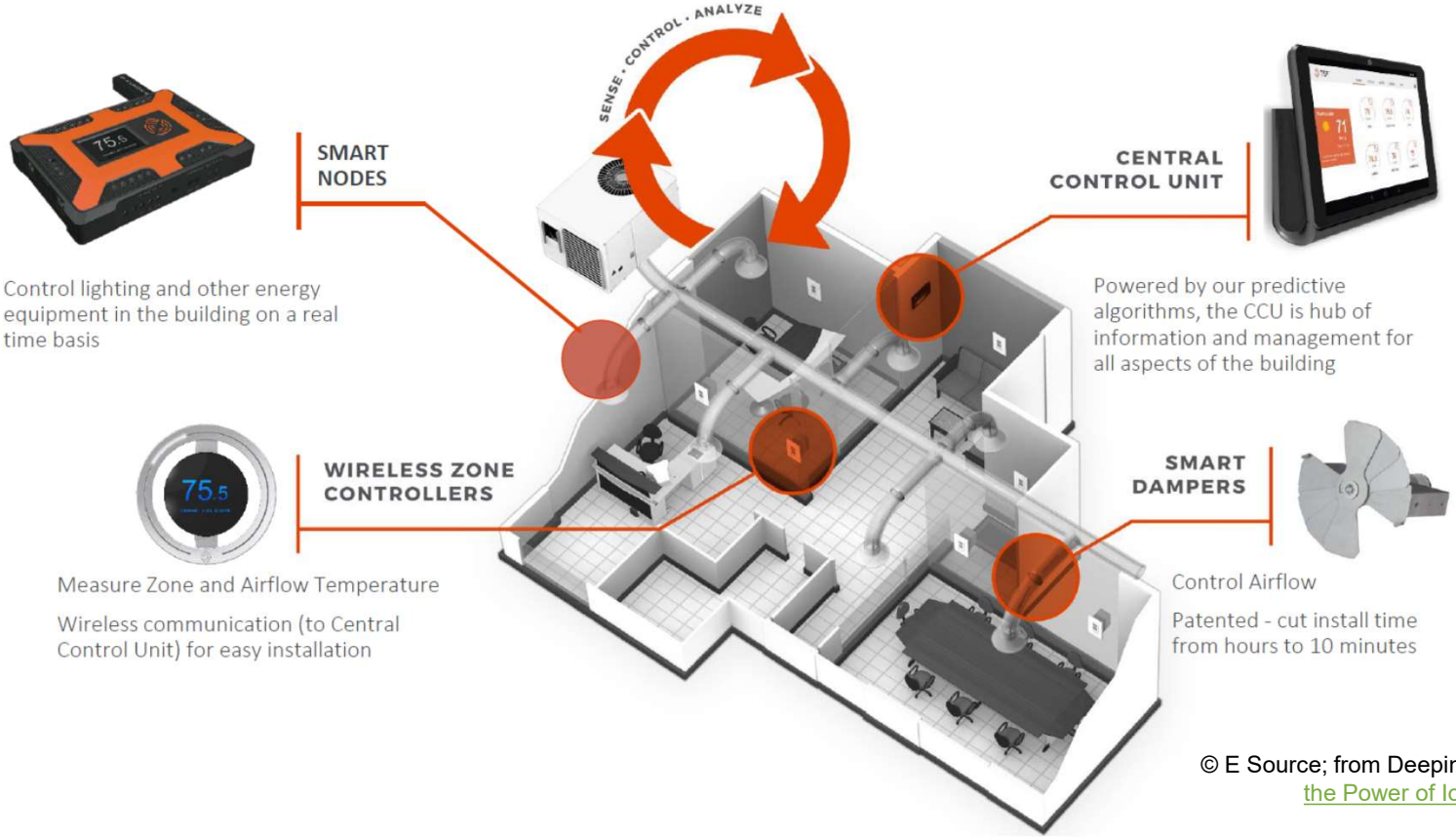
© E Source; from Deepinder Singh, 75F; Harnessing the Power of IoT& Cloud Computing (PDF)

We live in an age where technicians are more likely to understand computers than mechanical systems, but:

- Controls software skill sets are still widely lacking
- Software illiteracy is still common
- Major reliance on defaults and automated processes
- No QM process
- No commissioning

Traditional versus modernized building controls

Out-of-the-Box Building Controls



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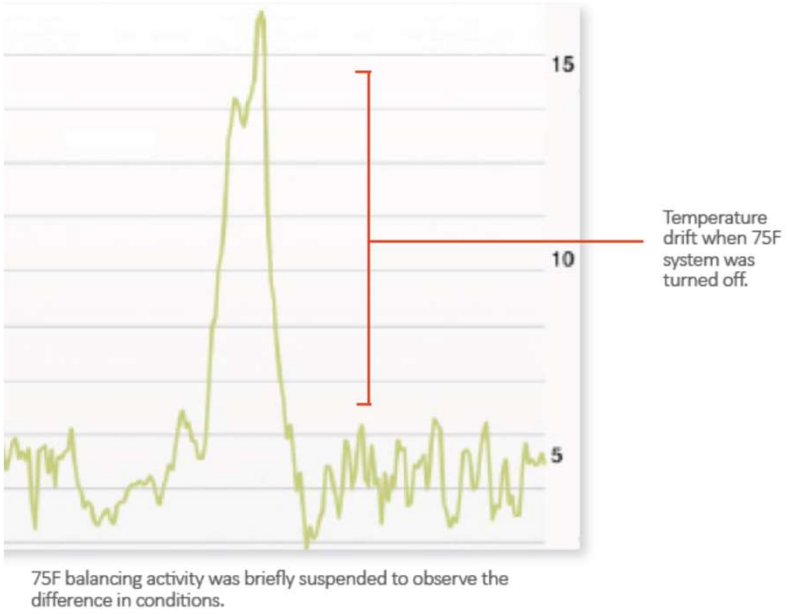
How 75F meets market needs



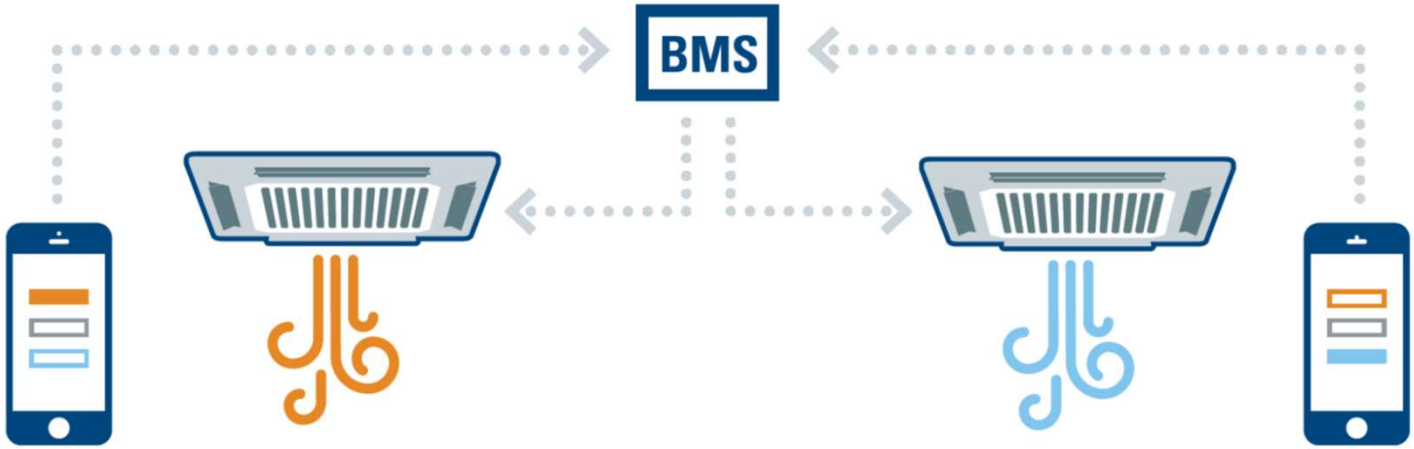
75F balancing activity was briefly suspended to observe the difference in conditions.

Employee comfort was improved
Pressure balance was improved
Energy was saved

Crowd-source building controls?

Source: Comfy

Socially driven optimization



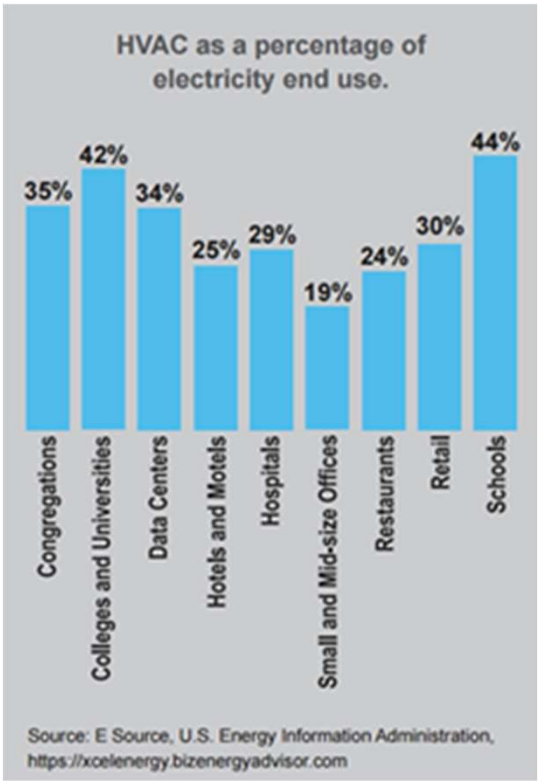
20% cooling energy savings
50% heating energy savings
60% reduction in hot/cold calls
80% of occupants more comfortable

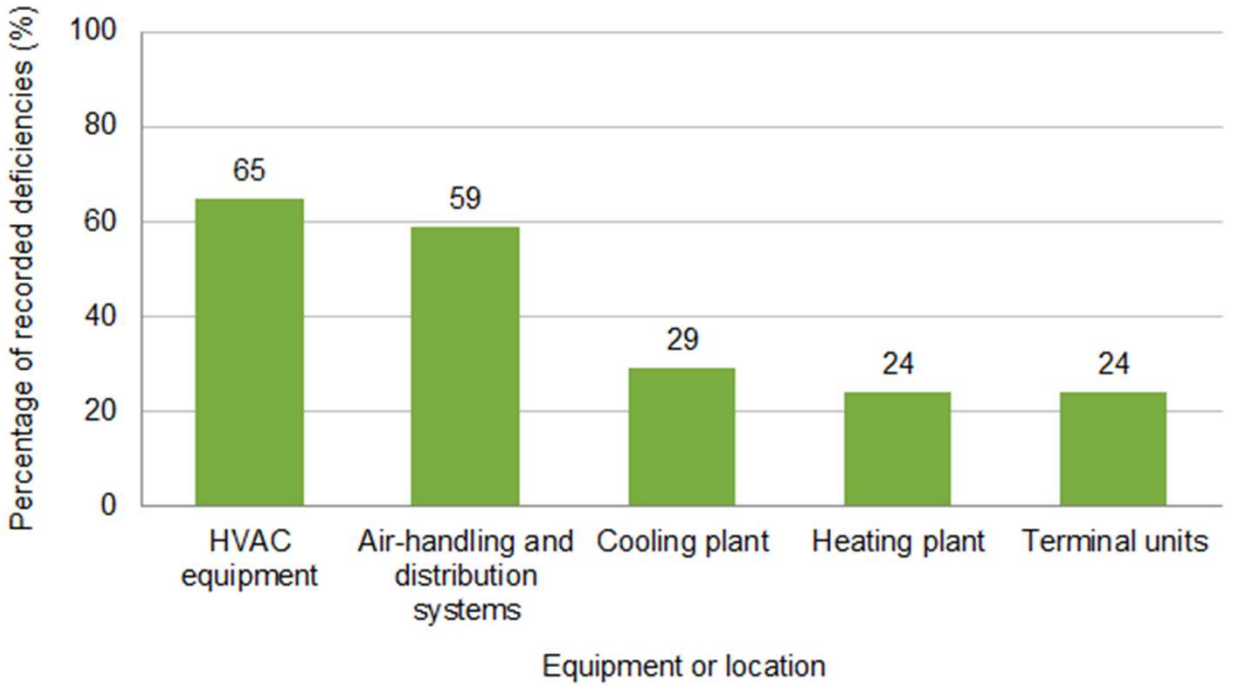
Source: GSA

Clean reporting for building operators

Source: Comfy

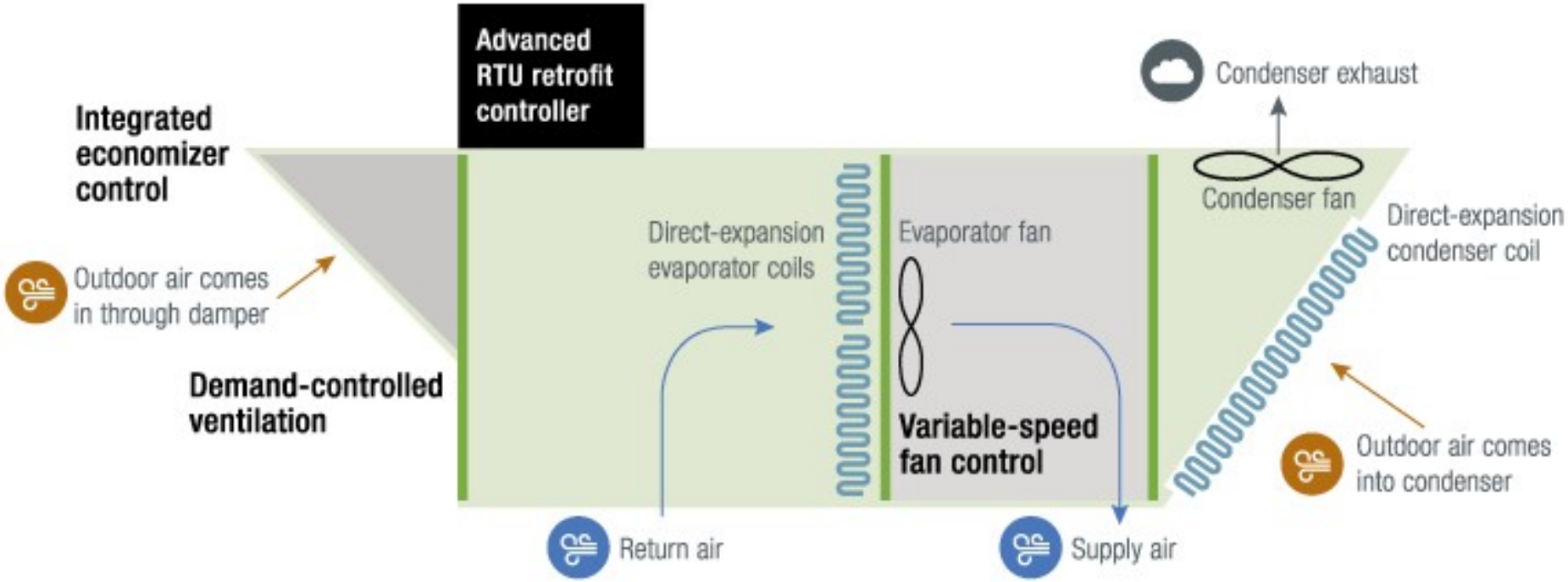
HVAC: the next big thing after lighting?





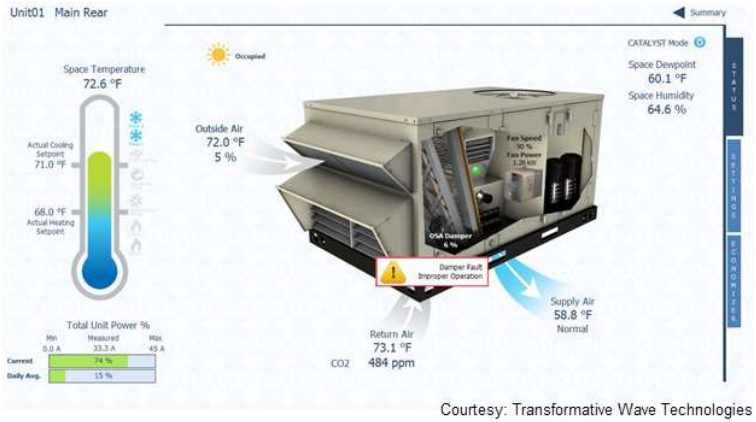
© E Source; data from Lawrence Berkeley National Laboratory

Packaged rooftop units: work hard, not smart



Source: E Source; adapted from National Renewable Energy Laboratory

Adding “smarts” to existing RTU equipment



Courtesy: Transformative Wave Technologies

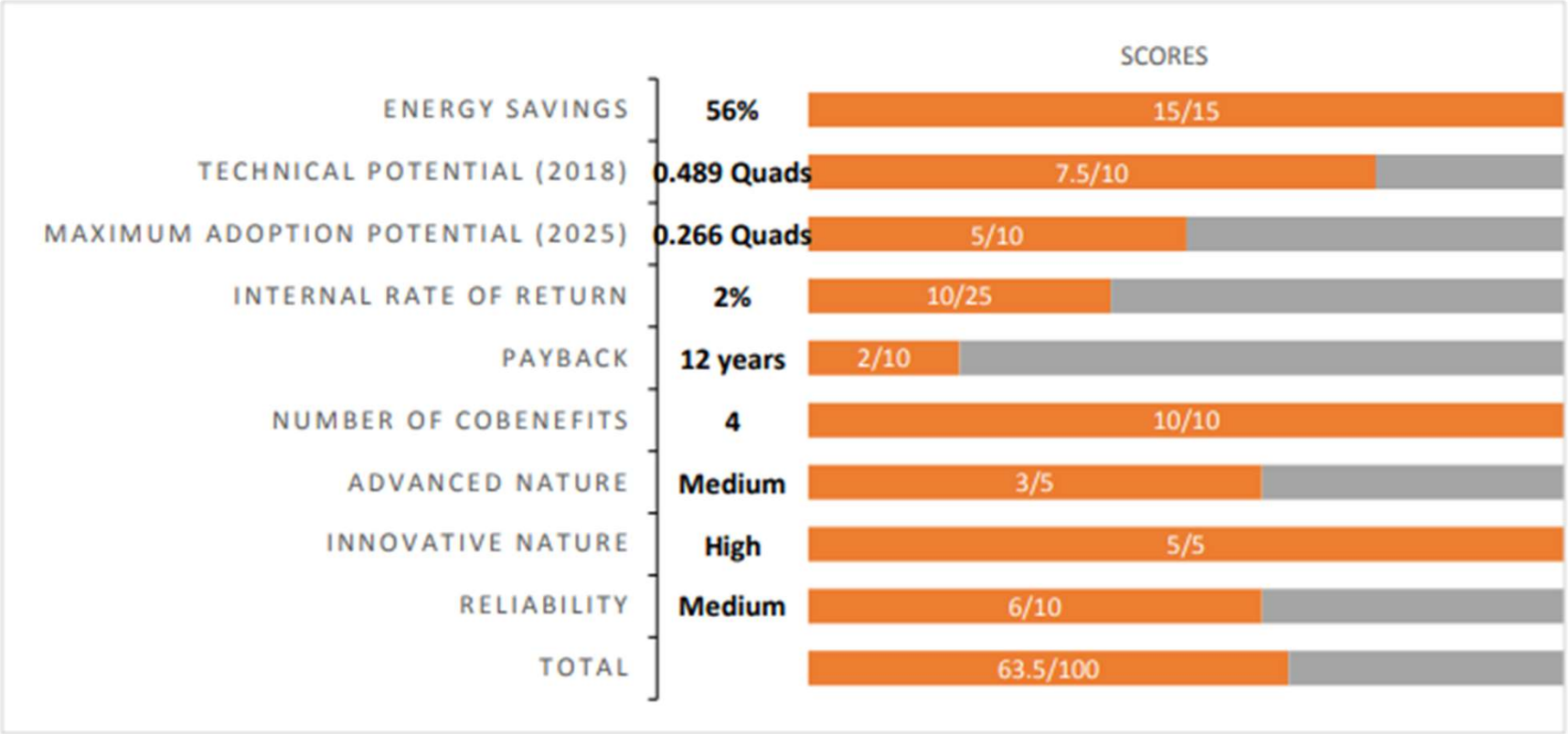
	Controller						
	Catalyst	Digi-RTU	DrivePak ARC	Enerfit V1	Jade Economizer	RTU Retrofit Pak	ZIP Economizer
Basic features[a]							
Evaporator fan control	x	x	x	x		x	x
Integrated economizer control	x	x	x		x		x
Demand-controlled ventilation	x	x	x		x		x
FDD	x	x	x	x	x	x	x
Desirable features[a]							
Remote monitoring	x	x		x		x	
Remote control	x	x					
Compressor control		x					
Condenser fan control		x					
Advanced features[a]							
Advanced thermostat control	x						
Advanced economizer control	x				x		x
Advanced FDD	x					x	
Demand-response capability	x	x					
Web-enabled user interface	x					x	
Bill analysis & savings EM&V	x						
BAS integration	x	x			x	x	
Stand-alone BAS	x						

Notes: BAS = building automation system; EM&V = evaluation, measurement, and verification; FDD = fault detection and diagnostics.
a. As designated by the US Department of Energy Advanced RTU Campaign.

© E Source

© E Source (Rooftop Unit Retrofit Controls Mature)

The DOE confirms that savings potential is huge



Source: Best Available Technologies in the US Buildings Sector (PDF)

Successful deployment requires cooperation

	Market factor	Barrier	Utility strategy
	Level of effort	Contractors lack sales experience, motivation	Refer interested customers to contractors for sales; offer midstream incentives
	Awareness, knowledge, and communication	Repair-or-replace approaches not conducive to retrofits	Help customers and contractors understand when it's best to retrofit
	Cost of adoption	Energy savings for smaller business customers are less compelling	Emphasize the value of non-energy benefits; demonstrate less-than-3-year payback
	Cost of adoption	Split incentives between building owner and occupants	Motivate occupants with evidence of demonstrated operational-cost savings
	Awareness, knowledge, and communication	Customers lack knowledge of efficiency and bill history and have limited context to aid in valuing future savings	Educate customers on likely costs and benefits with pamphlets, workshops, and account manager contact
	Technical performance	Regional contractor workforce has limited controls experience	Support contractor training and certification to help minimize their perceived financial risk
	Access to equipment	No regional access to products or services	Work with vendors to develop new market channels by region
	Cost of adoption	Contractors say their customers won't pay more to retrofit their existing equipment	Recruit contractors with experience in high-end, high-efficiency equipment and/or building automation

Source: Rooftop Retrofits Put HVAC Contractors in Control

Different solutions for different needs

CATALYST *LITE*

Smart VFD for those looking for supply fan control. Includes **CATALYST** ventilation and equipment protection features.

CATALYST

Full-featured **CATALYST** with Tridium BMS scheduling and comfort control of HVAC with optional lighting and portfolio asset management resources.

eIQ PLATFORM

Building Automation Solution with web-based visualization of RTU efficiency, system performance, fault detection & diagnostics, and energy accountability tools.

Courtesy: Joe Schmutzler, Transformative Wave Technologies

Evidence suggests scaling of ARCs has begun

Source: 2018 Campaign Award Winners

- The top seven organizations replaced or retrofitted over 10,000 RTUs combined
- They also installed a total of 5,800 automated fault detection and diagnostics (AFDD) systems
- Realized energy savings were over 50 million kilowatt-hours and $5 million annually

Human-assisted FDD: 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.

Thank you! Questions?

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