E Source

Black Box and Emerging Technologies

Essie Snell, Research Manager

Logan Jacobson, Associate Analyst

E Source

Efficiency Works Training

Who Is E Source?

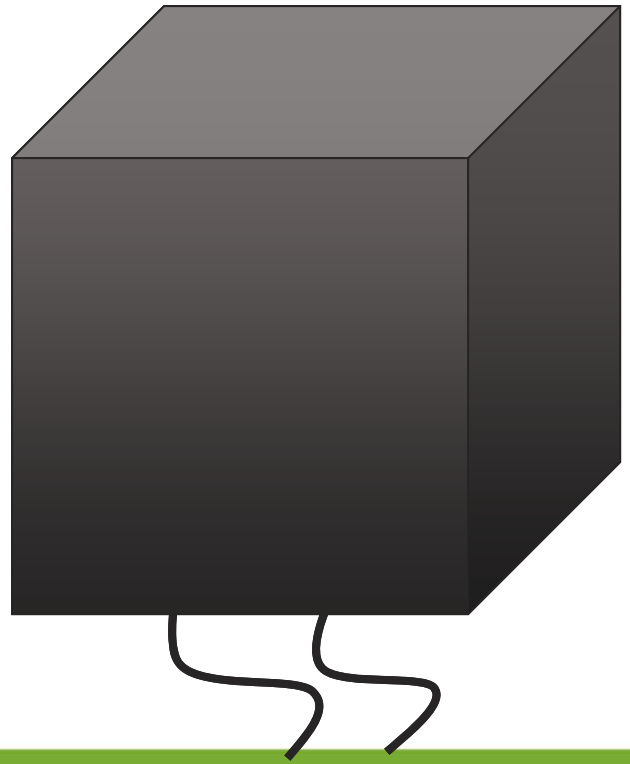
- Membership-based energy research, advising, and consulting services
  - Focused on electric and gas utilities across the US and Canada
- How to manage, sell, and use energy effectively
- Unbiased research and analysis
  - Fuel neutral
  - Product neutral
  - Vendor neutral

Agenda

- Evaluating unfamiliar “black box” products
  - Our general approach
  - Technical fallacies
  - Psychological manipulation
- Cool new technologies for commercial applications
  - Lighting
  - HVAC
  - Motors
  - Plug loads
  - Techs for data centers, laundries, ice rinks, and more!

What Is A Black Box?

- We say it's something that is bolted on, wired in, or otherwise added to an existing technology with the goal of providing energy savings.



Why Care?

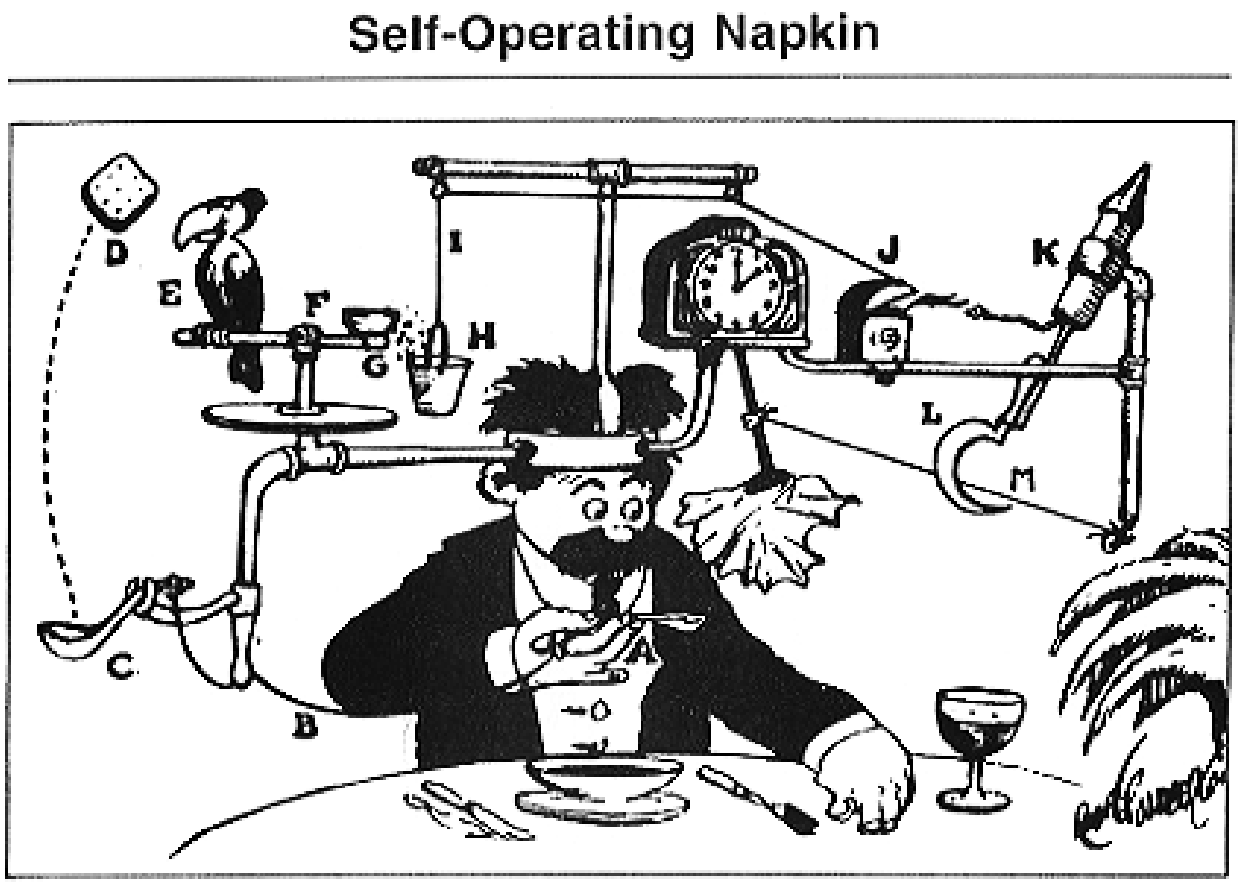
- You've all probably been approached by an enthusiastic representative of a black box vendor!
- Having a strategy in place to quickly gauge the likely energy-saving potential of a given product can be helpful.

Source: Tomwsulcer

A Different Approach

- E Source relies on secondary research and doesn't have a laboratory
- We've developed a unique process to evaluate unfamiliar technologies

What's the Theory of Operation?



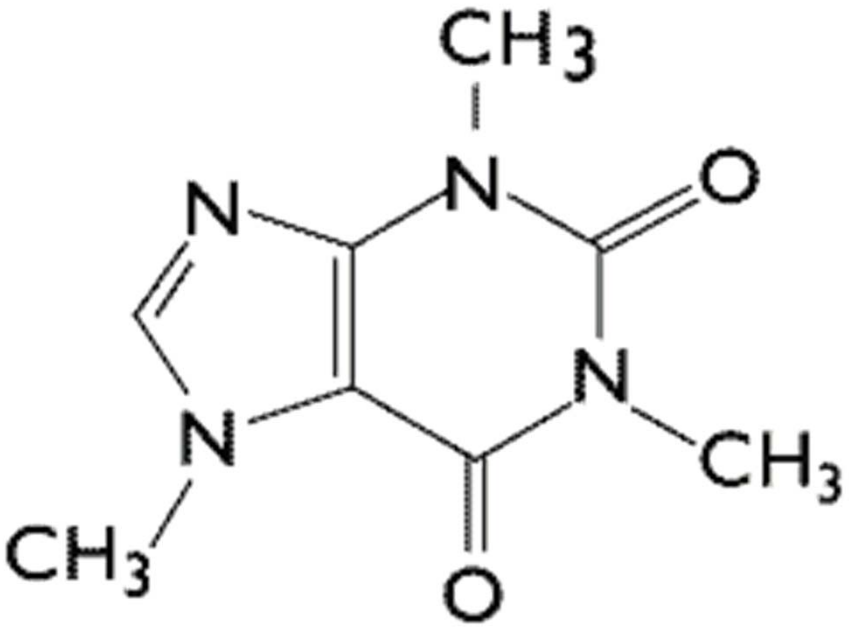
Source: Rube Goldberg

Does Test Data Substantiate Vendor Claims?

Source: Roger Dudley

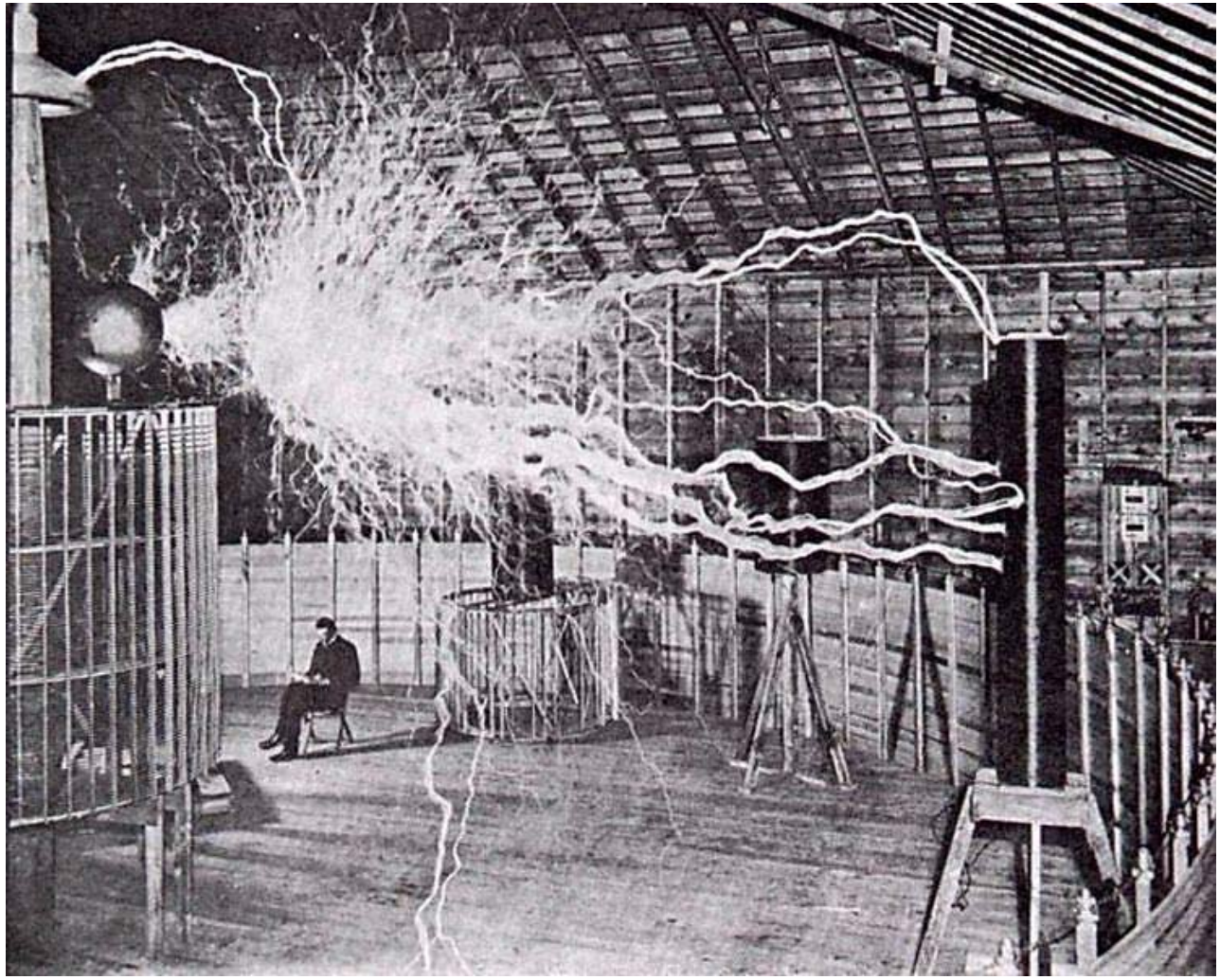
Technical Fallacies

- Laws of physics
  - Basic thermodynamics
  - Heat transfer methods
  - Magnetic monopoles
- Unit consistency
- Statistical analysis
- Big picture



Source: Jeanot

Does It Obey the Laws of Physics?

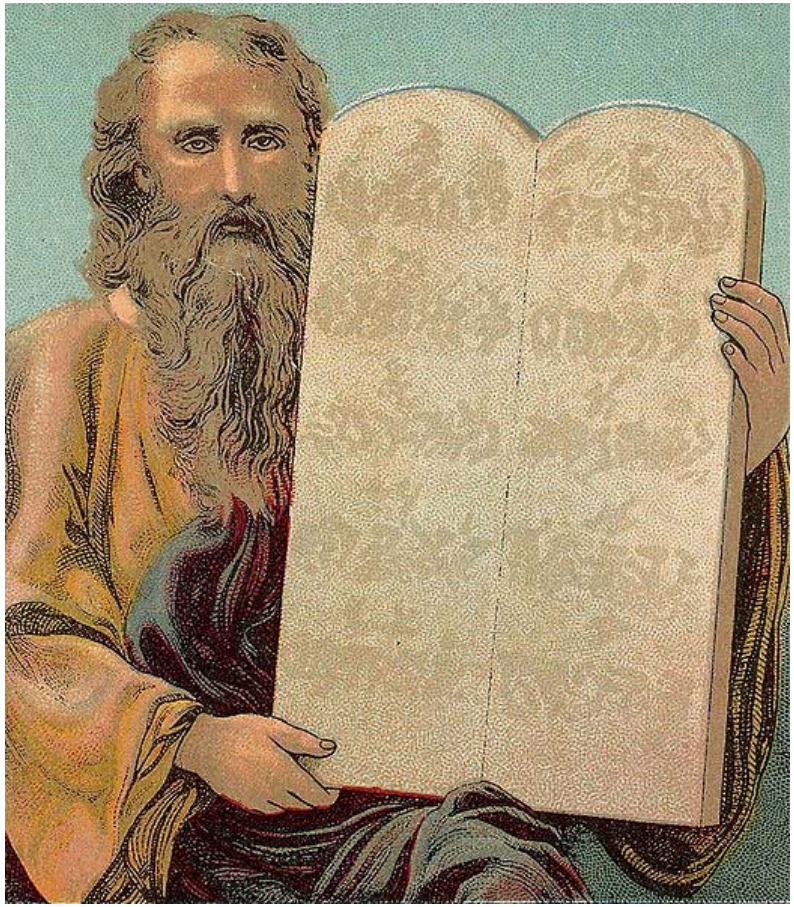


Source: Yelm

Laws of Thermodynamics

- The four laws of thermodynamics are fundamental to modern physics

- They establish (among other things) that energy can't be created or destroyed, and that the entropy of a system tends to increase over time.



Source: the Providence Lithograph Company

Breaking the Law(s)

"Once the heater has reached its operating temperature, every photon creates another photon with the same characteristics (energy and wavelength), without requiring additional energy."

"Independent testing revealed that: 'the output is greater than the input'."

Heat Transfer 101

- Radiation
  - Via the emission or absorption of electromagnetic radiation (e.g. warming yourself by a fire)

- Conduction
  - Via physical contact (e.g. burning yourself by touching a hot kettle)

- Convection
  - Via motion of a fluid (e.g. movement of warming tea in the kettle)

Source: Aih.

A Common Heat Transfer Mistake

"Our nanocoating reflects over 95% of radiation from the sun, replacing 8 inches of traditional insulation."

≠

Sources: Everaldo Coelho and Radomil.

Unit Consistency

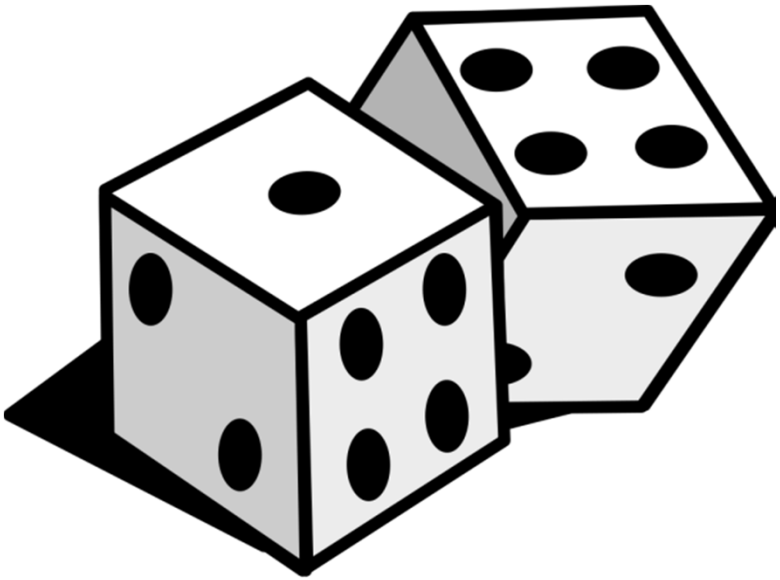
"To calculate R value, we take the inverse of conductivity (measured in meter-Kelvin/watt) and multiply by a conversion factor to convert the value to hour-foot-°F/BTU."

Wrong Units for R-value!!

"The result? R-200 per inch of thickness!"

Statistical Error Analysis

Rarely available (though it should be), but can be invaluable in establishing whether performance claims actually mean anything



Source: Personeoneste

Big Picture

- Does it make sense?
  - What does existing research say?
  - What do experts think?
- Are savings claims even in the right order of magnitude?

Source: Namazu-tron

Psychological Manipulation

- Red herrings
  - Testimonials/case studies
  - “Phantom” test data
  - Number of installations
  - Deferral to authority figures
- Obfuscation
- Poor inventor archetype
- Guarantees
- Sense of urgency

Source: FiachraByrne

Red Herrings

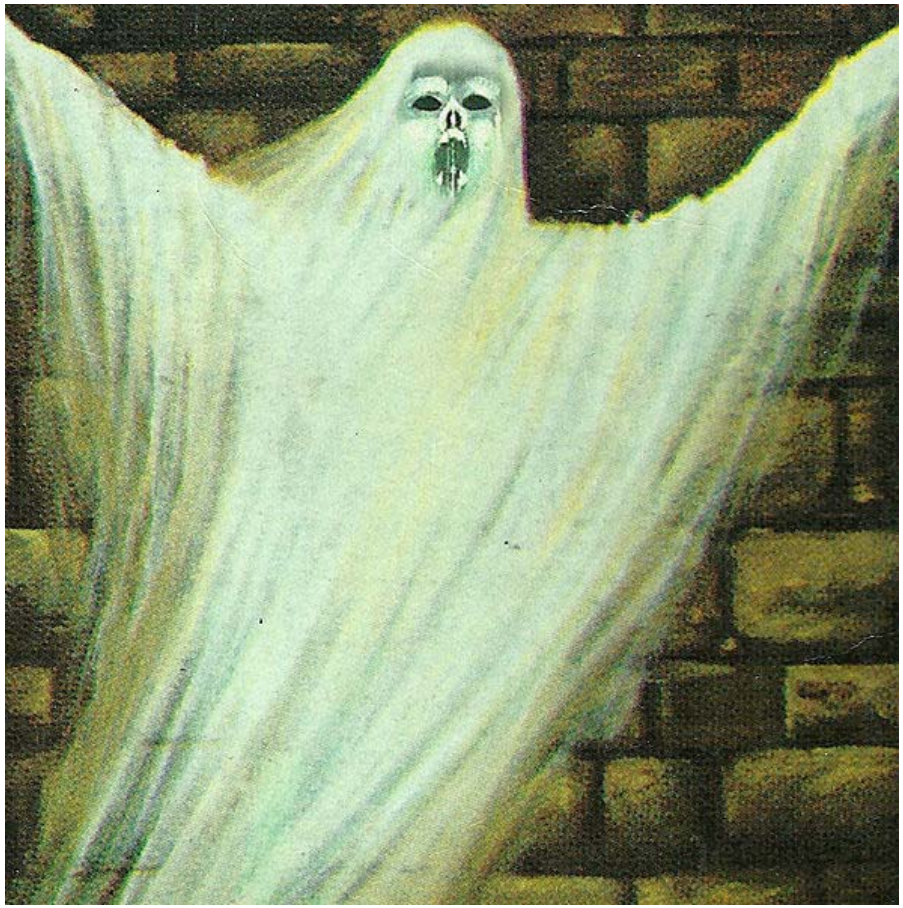
- Any piece of information that:
  - Sounds credible and convincing
  - Isn't independently verifiable or doesn't directly address the claims that a vendor is making.

Source: Nordisk familjebok

Testimonials or Case Studies

Source: Regionalista por Chile

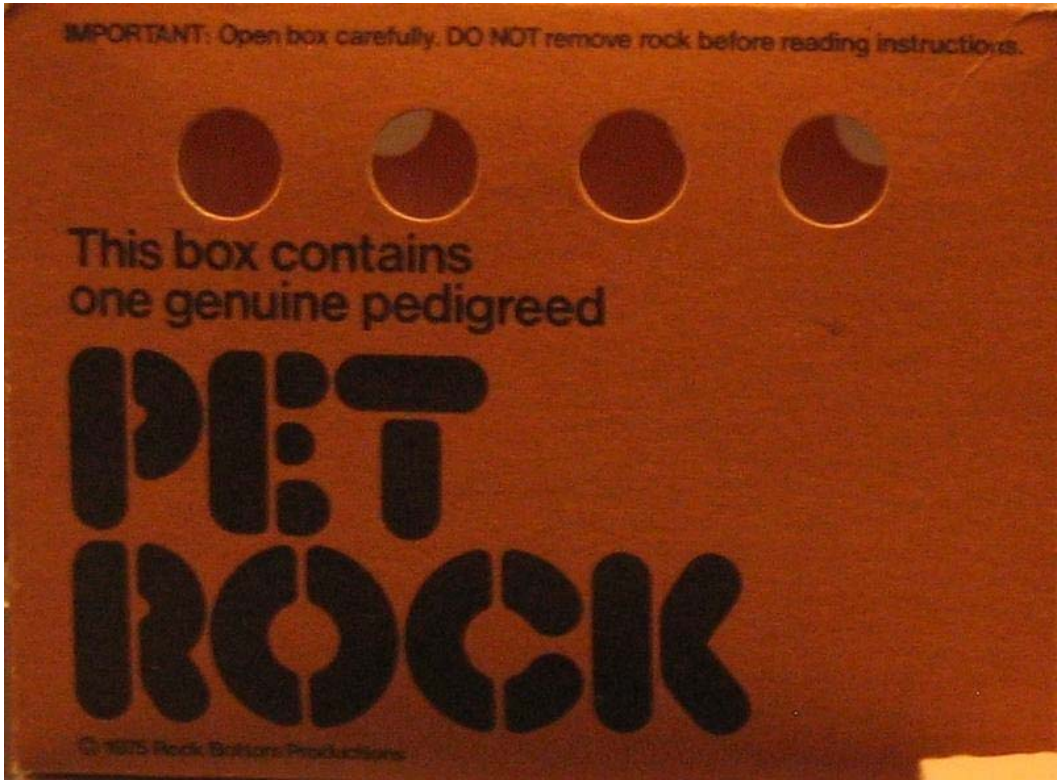
“Phantom” Test Data



Source: Gallowglass

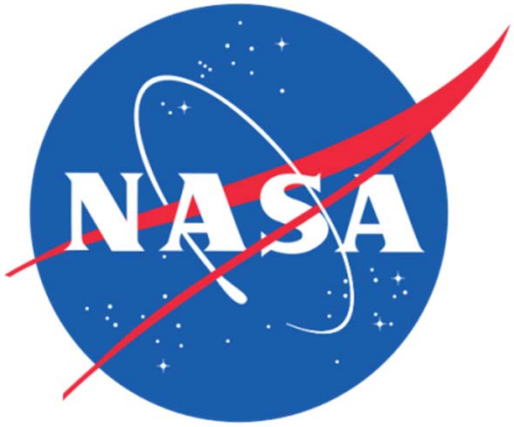
Number of Installations or Sales Data

"Over 1.5 million sold!"



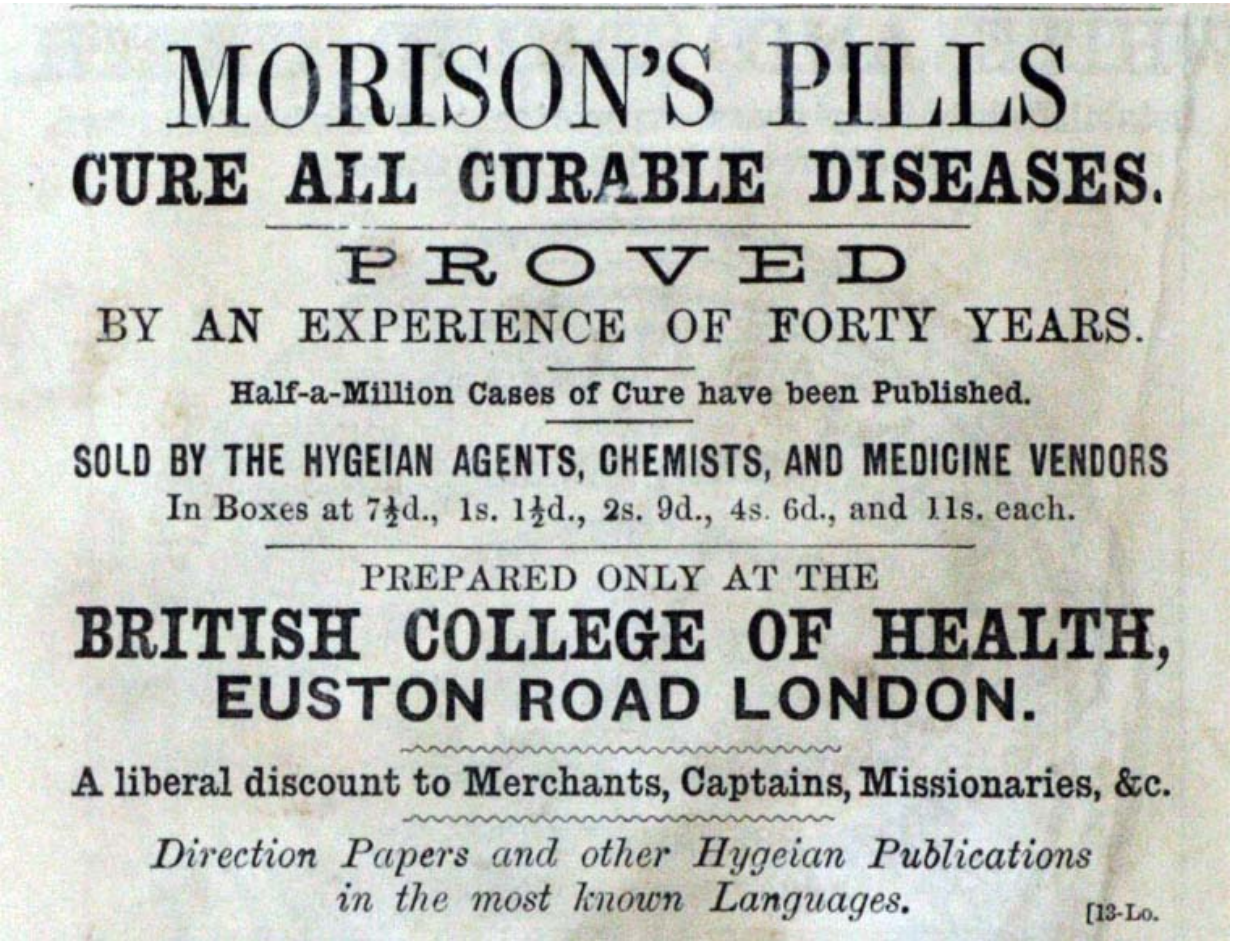
Source: Hempdiddy

Deferral to Authority Figures



Courtesy (left to right): United States Department of Energy, National Aeronautics and Space Administration, Underwriters Laboratories, United States Environmental Protection Agency

These Strategies Have Been Used For Centuries



MORISON'S PILLS

CURE ALL CURABLE DISEASES.

PROVED

BY AN EXPERIENCE OF FORTY YEARS.

Half-a-Million Cases of Cure have been Published.

SOLD BY THE HYGEIAN AGENTS, CHEMISTS, AND MEDICINE VENDORS

In Boxes at 7½d., 1s. 1½d., 2s. 9d., 4s. 6d., and 11s. each.

PREPARED ONLY AT THE

BRITISH COLLEGE OF HEALTH,

EUSTON ROAD LONDON.

A liberal discount to Merchants, Captains, Missionaries, &c.

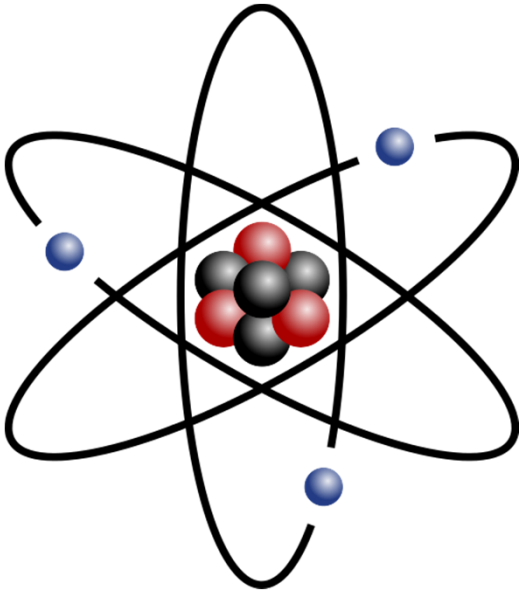
Direction Papers and other Hygeian Publications in the most known Languages.

[13-Lo.

Source: Grace's Guide

Obfuscation

"The secret of this savings comes from the magic of nanotechnology, the changing of the molecular structure of natural gas to release never-before tapped power."



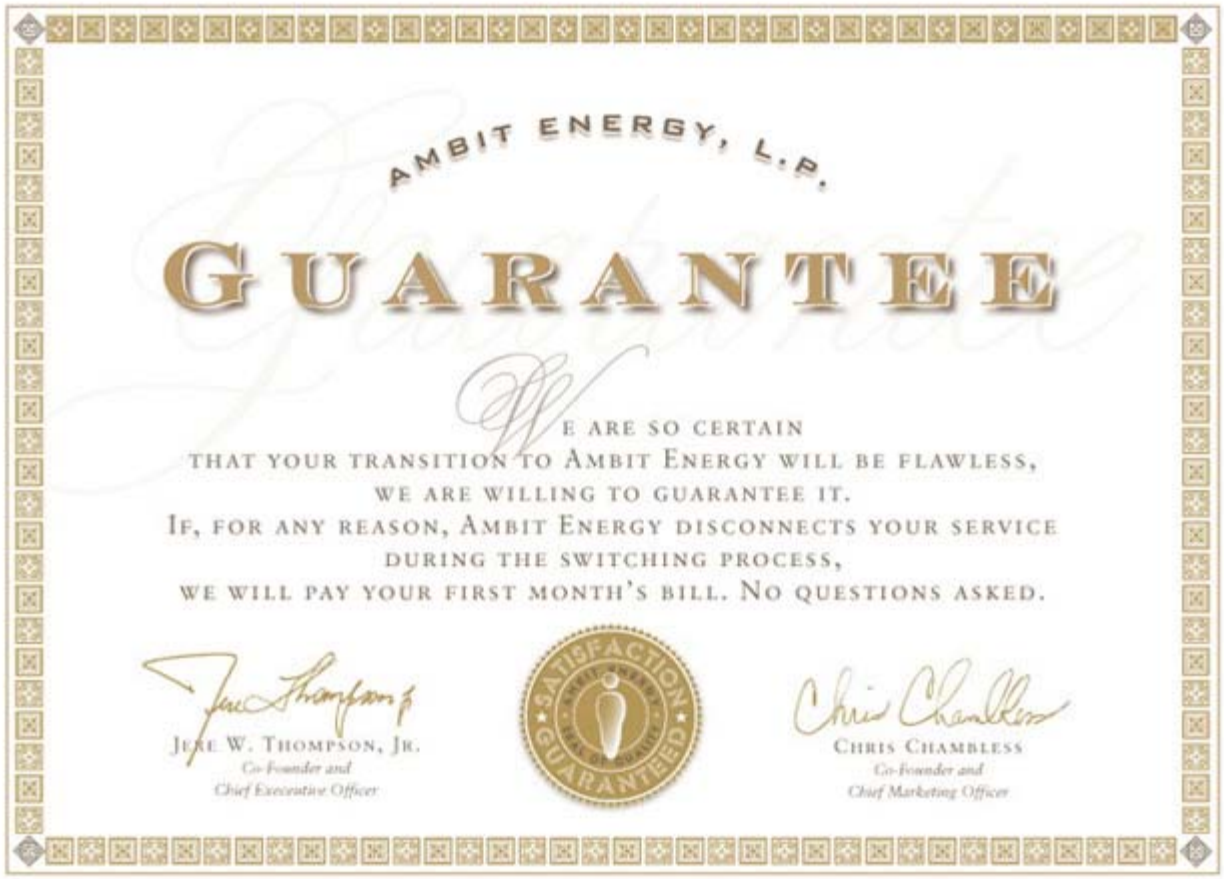
Source: Rainer Klute.

The Poor Inventor Archetype

"We're a very small organization that offers a wholly unique product which could change the world, but we currently have limited resources available for testing."

Source: Tetra Pak

Guarantees



AMBIT ENERGY, L.P.

GUARANTEE

WE ARE SO CERTAIN
THAT YOUR TRANSITION TO AMBIT ENERGY WILL BE FLAWLESS,
WE ARE WILLING TO GUARANTEE IT.
IF, FOR ANY REASON, AMBIT ENERGY DISCONNECTS YOUR SERVICE
DURING THE SWITCHING PROCESS,
WE WILL PAY YOUR FIRST MONTH'S BILL. NO QUESTIONS ASKED.

SATISFACTION GUARANTEED

JERE W. THOMPSON, JR.
Co-Founder and
Chief Executive Officer

CHRIS CHAMBLESS
Co-Founder and
Chief Marketing Officer

Source: Ambitibo

Strategies for Avoiding Refunds: Vendor Provides Proof of Savings

"We installed our product at your facility in March. Having reviewed your energy data, it turns out that your overall consumption in April was several thousand kWh lower than in January! Clearly, our product is responsible for saving you energy and money."

Strategies for Avoiding Refunds: Burden of Proof On the Customer

*"To prove that our product **isn't** saving you energy, you'll need to provide us with weather data and utility bills for six months before and after installation, along with service invoices, occupancy records, sales data, and complete records and documentation of any changes in your facility that could have affected your energy use. Please provide this information within the next two months."*

Strategies for Avoiding Refunds: Fine Print

"The guarantee is not valid unless received by customer through the US Postal Service directly from the manufacturer."

Sense of urgency

"We're very excited at the prospect of working with you! Please let me know what your decision is as soon as possible."

Source: penubag

A Quick Review

- Two overarching questions
  - What's the theory of operation?
  - Does test data support that theory?
- Technical Considerations
  - Laws of physics
  - Unit consistency
  - Statistical analysis
  - Big picture
- Psychological considerations
  - Red herrings
  - Obfuscation
  - Poor inventor archetype
  - Guarantees
  - Sense of urgency

Questions?

Cool New Technologies for Commercial Applications

Source: Guy Sie

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

For Commercial Refrigeration Fans

Courtesy: N-Lange.de

The New Kid on the Block

- The Q-Sync motor from QM Power
- Permanent magnets
- New circuit for start-up and control
- 20% more efficient than an electronically commutated motor (ECM)
- Being tested in a DOE demonstration project

Courtesy: QM Power

Impressive Economics

Estimated energy savings from replacing a less efficient evaporator fan motor with a Q-Sync motor

Motor type	Efficiency (%)	Annual energy use (kWh)	Annual savings ($)
Shaded pole	18	876	80
PSC	35	451	29
ECM	63	250	5
Q-Sync	75	210	–

Note: kWh = kilowatt-hours.

© E Source, some data from QM Power

Cost to retrofit ≈ $100/motor

Cost for original equipment manufacturers to upgrade from ECM to Q-Sync = $0

Interesting Slant

Courtesy: FridgeWize

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

Efficiency Opportunities on Ice!

Estimated annual ice rink energy use (in Canada):
897,000 kWh
35,940 therms
Equivalent to 162 single-family homes

Operate around
100 hours/week
8 months/year

Ice resurfaced
approximately
65 times/week

Domestic hot water and resurfacing account for nearly **7%** of total facility energy use

Source: MorgueFile

Data: "Improving Efficiency In Ice Hockey Arenas," *ASHRAE Journal* (June 2009)

Maintaining the "Smooth"

Source: Wikimedia Commons

Source: Ximeg, Wikimedia Commons

Surface maintenance:

- "Snow" removed
- 1 millimeter of ice shaved off
- Warm water flood
- Scars eliminated

Resurfaced ice:

- Smooth
- Hard
- No discontinuities

Zamboni: Hot Water Energy Hog

Source: Myrabella, Wikimedia Commons

Air bubbles in water cause an uneven ice surface:

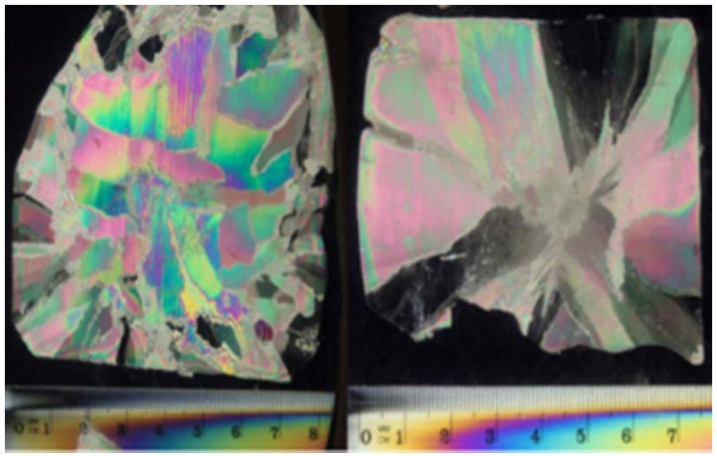
- Heat resurfacing water to approximately 130°F
- Annual energy use: approximately 4,436 therms
- Requires hot water storage tanks because daily demand varies

Vortex Water Treatment Approach

- Removes air bubbles by:
  - Creating a vortex
  - Isolating bubbles in low-pressure zone
  - "Degassing" process
- End result:
  - Ice crystals are larger
  - Ice is harder (higher density)
  - Ice is smoother (fewer discontinuities)

Courtesy: Realice

Ice crystals



Before **After**

Courtesy: Realice

Water-Treatment Benefits

- Dual energy savings:
  - Natural gas
    - Reduced heating of resurfacing water (approximately 60°F)
  - Electricity
    - Lower-temperature flood water reduces the refrigeration load
    - Increased ice slab temperature reduces the refrigeration load
- Ice quality:
  - Improved ice strength
  - Better uniformity of hardness

Results So Far

Utility	Energy	Verified annual savings	Savings percentage
FortisBC	Thermal	3,128 therms	79.0%
	Refrigeration	22,500 kWh	29.0%
SCE	Thermal	3,731 therms	NA
	Refrigeration	21,476 kWh	4.6%

© E Source

After the FortisBC pilot, 90% of participants intended to keep using the vortex water treatment system

SCE test: 42% average increase in ice hardness, plus improved ice uniformity

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

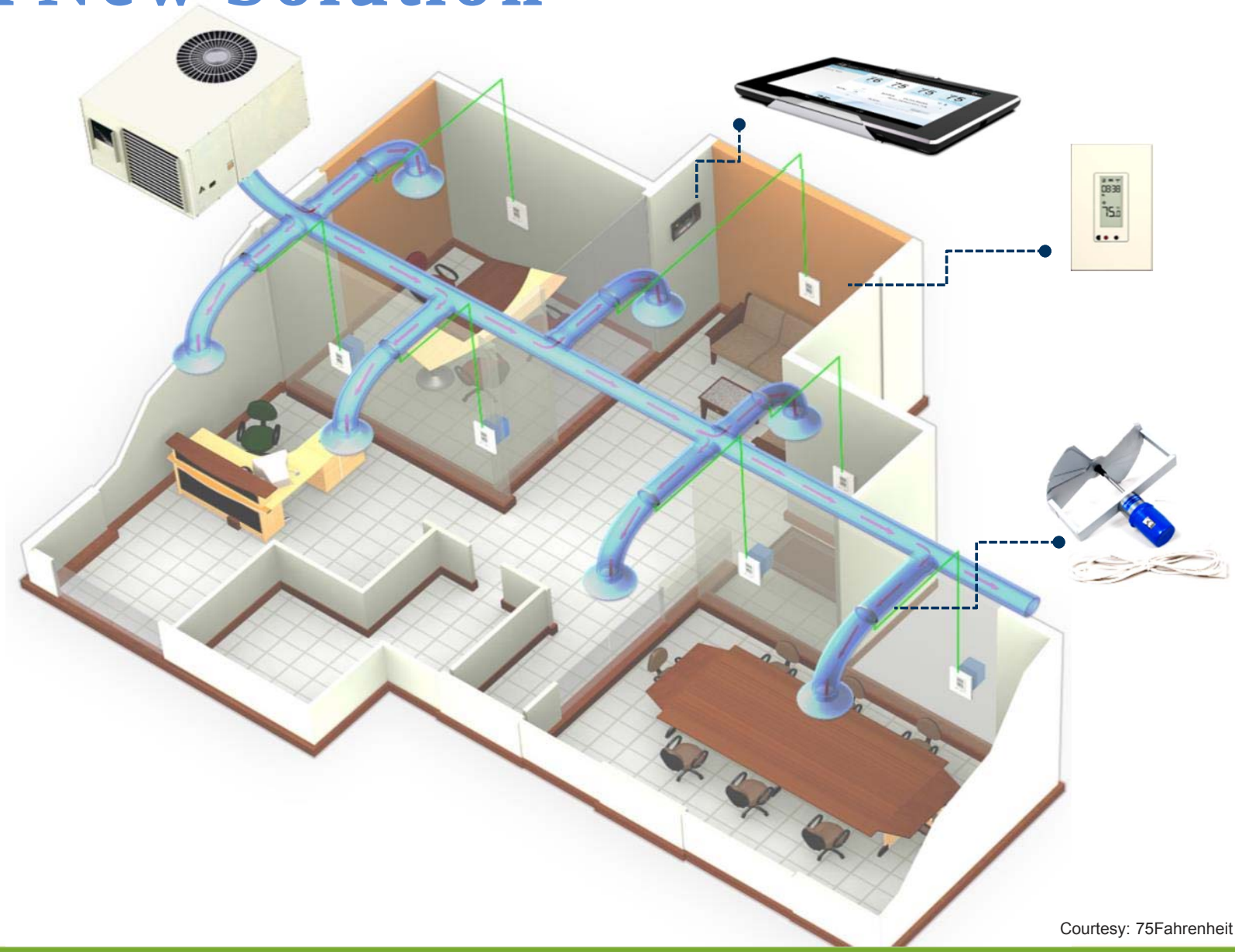
Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

The Problem

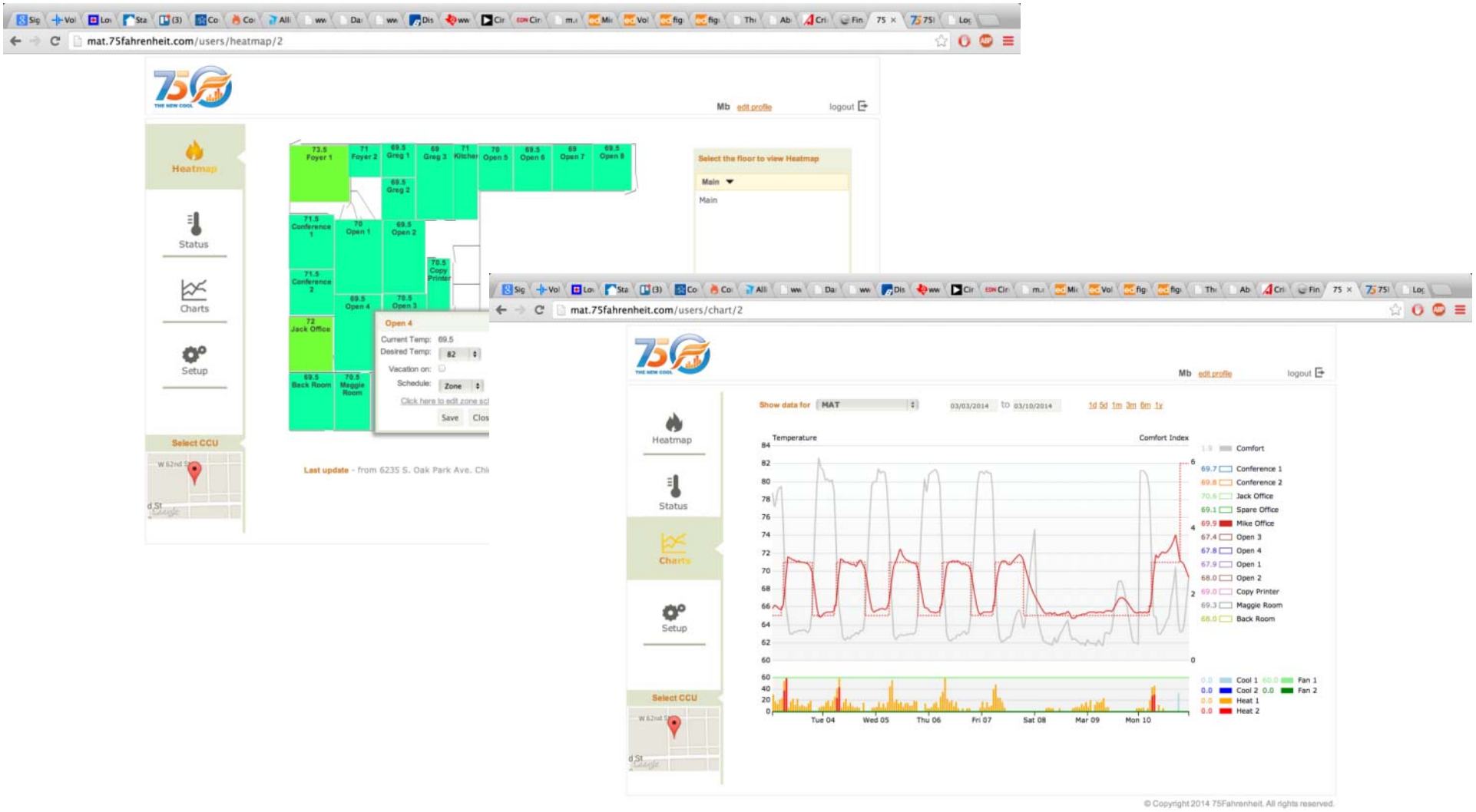
Source: Cartoonaday.com

A New Solution



Courtesy: 75Fahrenheit

Real Time Reporting



BUT, It's Still Very Emerging

Source: CKSinfo.com

- Energy savings are undetermined
- Young company
- Reliability and quality control are undetermined

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

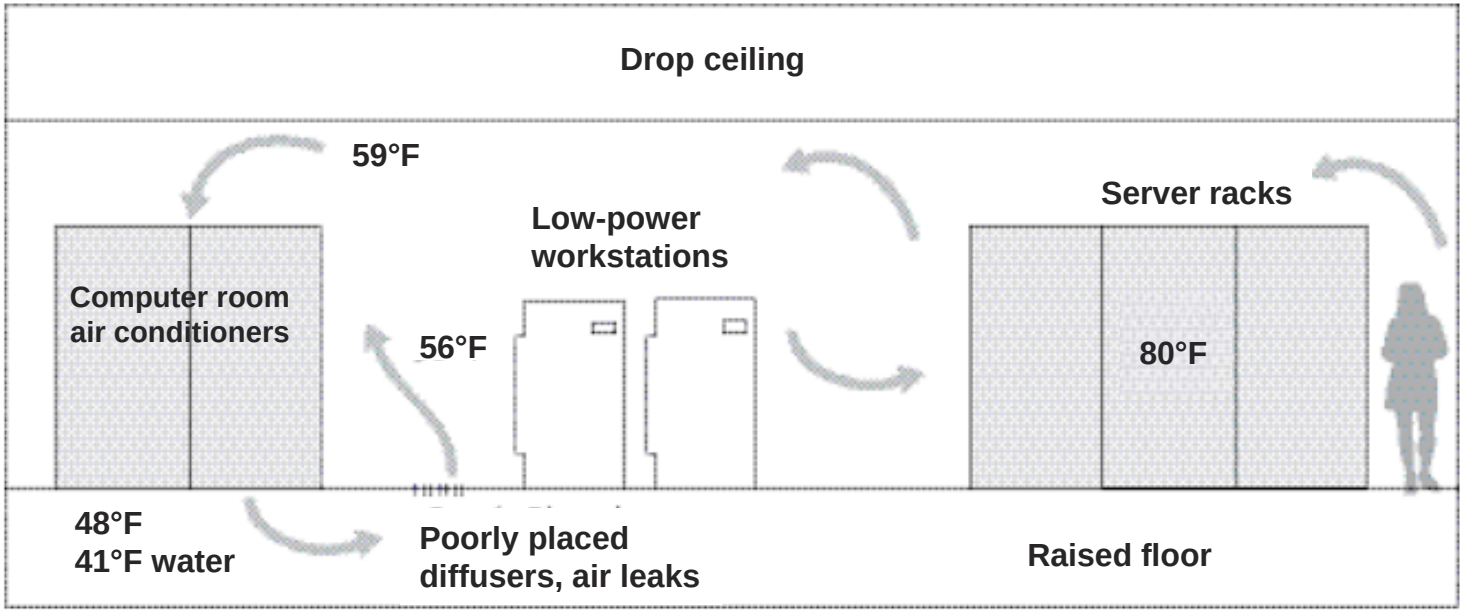
Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

Is This the Data Center of the Future?

Courtesy: Green Revolution Cooling

Data Center Cooling Is Frequently Complicated and Inefficient



Courtesy: Lawrence Berkeley National Laboratory

Why Not Submerge Servers in Liquid?

- Liquid is a much better heat transfer medium
  - Can use readily available non-conducting mineral oil
  - 1,000 times higher heat capacity
- Pull heat directly off hot components
- Massive energy-savings potential in data centers
  - Up to 90 percent claimed cooling energy savings
  - Up to 50 percent claimed overall data center energy savings

Courtesy: Green Revolution Cooling

Potential Non-Energy Benefits

Existing buildings

- Increase computing power density of servers
  - Potential to get server densities up to 40 kilowatts (kW) per rack
- Run existing servers faster

Courtesy: Green Revolution Cooling

New construction

- Eliminates the need for:
  - Air-handling equipment
  - Chillers
  - Computer room air conditioners (CRACs)/computer room air handlers (CRAHs)
  - Raised flooring
  - Hot/cold aisles
- Faster, less-expensive construction and installation
- Uses servers with simplified architecture (e.g. no fans)
- No needless conditioning of space around servers

Promising Test Results from PG&E

- Evaluated four CarnotJet tanks from Green Revolution Cooling
  - Compared to a large data center with:
    - Level II air management
    - Hot and cold aisle containment
    - Ducted return
    - A constant-speed CRAH fan
- Results: 82 percent energy and demand savings
  - Savings of 81,030 kilowatt-hours/year and 9.25 kW

Courtesy: Green Revolution Cooling

- All demand savings are 100 percent coincident with peak demand
  - HVAC equipment runs at full duty cycle 24/7

Some Caveats to Consider

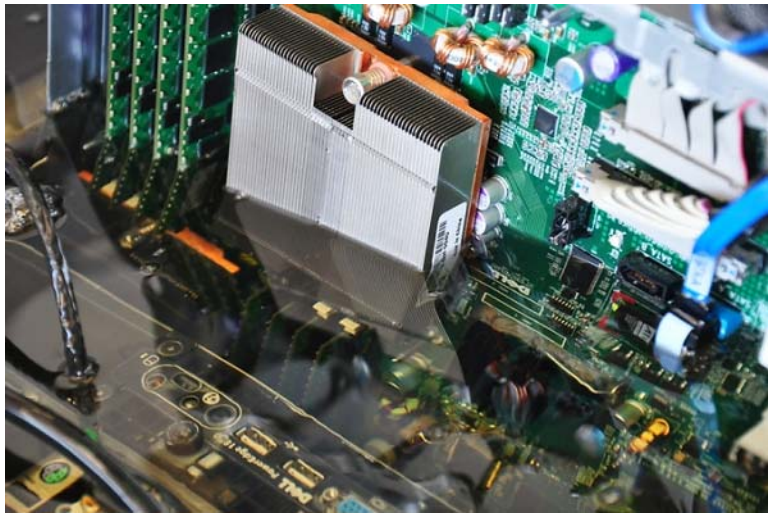
- Need the right type of servers
  - Need to remove fans and thermal paste
  - Requires solid-state drives
    - Standard magnetic hard drives aren't hermetically sealed
  - Manufacturers don't yet offer off-the-shelf servers to submerge into mineral oil
- May need to ensure that warranties are honored

- Servers may require additional time to service
  - Have to be removed from the oil bath and dried

Courtesy: Redline

What Options Are Out There?

- Green Revolution Cooling is currently the only vendor with a modular tank-style full-submersion system



Courtesy: Green Revolution Cooling

- Other vendors have similar offerings:
  - 3M
  - Asetek
  - Coolcentric
  - Iceotope
  - LiquidCool Solutions
- BUT each vendor offers a different approach
  - Different types of liquid cooling
  - Highly variable costs

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

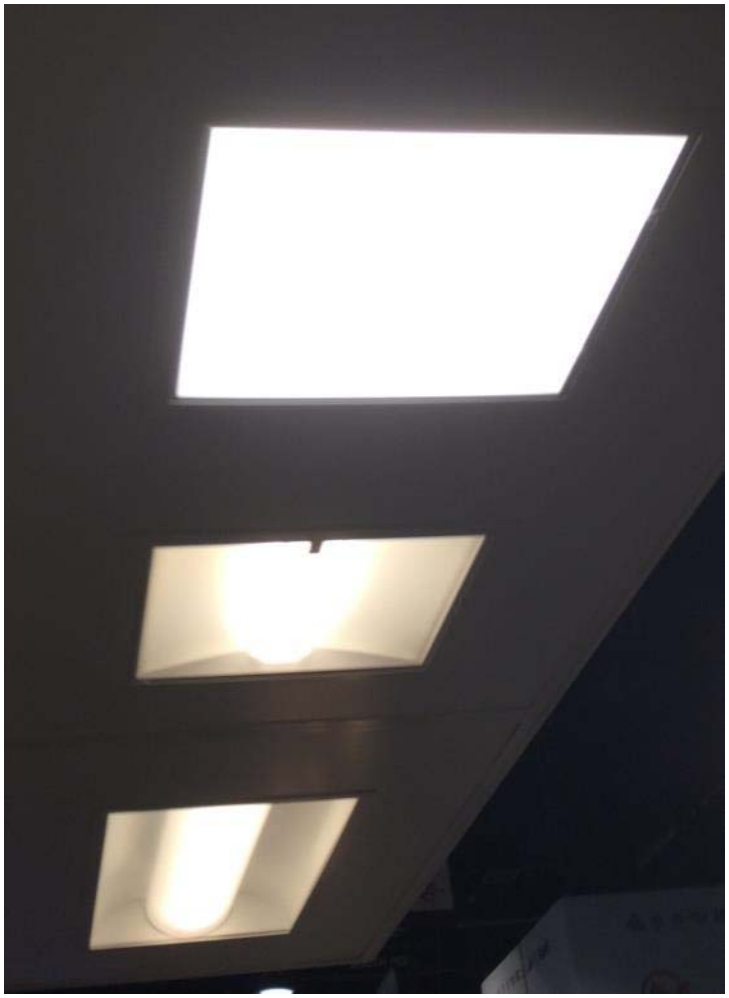
Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

Troffers Are Ubiquitous

The most common fluorescent fixture:

- Operates 10.5 hours/day
- Draws 25 to 113 watts
- Contributes to peak load
- 1 billion fluorescent luminaires (troffers, pendants, etc.)
- 42 percent of lighting energy
- Converting all to LEDs would save the equivalent of 27 million homes



© E Source

Source:
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_21_t8.pdf

LED Troffer Options and Rebates

- Options
  - Tubes (ballast and driver options)
  - Kits (use existing housing, may include lenses)
  - Fixtures

Courtesy: LG Electronics

DOE Recommendations for LED Tubes

- Choose carefully—there are good and bad products out there
  - www1.eere.energy.gov/buildings/ssl/application-troffer.html
- Consider retrofit kits, high-performance fluorescents
- LED T8s may be cost-effective: high electric rates, long hours, and low installation costs
- Do a mock-up

LED T8s: Getting Better, But …

	CRI	Life (hours)	Efficacy (lm/W)	Cost ($)	Dimmable	Ballast compatibility
High-performance T8	80s (R9~10)	24,000 to 75,000	98	5	Yes	All
Philips InstantFit LED	85 (R9~20)	40,000	100 (95 to 116)	24 to 39	No	IS, some PS, no dimming (yet)
Cree T8 series	90 (R9~50)	50,000	100	30	Yes	90% of IS, PS, dimmable
LG retrofit kit	82	50,000	130	130 to 175	Yes	NA

Notes: LEDs and fluorescents use different definitions of "life.
CRI = color rendering index; IS = instant start; lm = lumens;
NA = not applicable; PS = programmed start; W = watt.

© E Source

Courtesy: Cree

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

LEDs in Stadiums

- Metal halide fumbles:
  - Long delay during the 2013 Super Bowl due to long restrike and warm-up times
- LEDs have previously been ineligible to play
  - High cost
  - Lack of “throw”
  - Insufficient color quality for TV broadcasts

- LEDs score
  - Instant on (no delays)
  - Better controllability
  - Long life
  - Better lumen and color maintenance
  - High efficiency
  - Good color

Source: Ephesus Lighting

A Winning Technology!

University of Phoenix Stadium

- Hosted the 2015 Super Bowl
- 1.24 megawatts (MW) of metal halide translates to 0.31 MW LED
- Brighter, more uniform, better color, lower maintenance
- Suitable for HDTV, digital photography, slow-motion

NRG Stadium in Houston

- Cut 60% of lighting energy (down to 337 kW)
- Dimming and instant-on capabilities useful for rodeos and concerts

Source: Mucsco Lighting

Outline

Q-Sync Motors for Evaporator Fans

Gas and Electricity Savings in Ice Rinks

Dynamic Airzone Balancing

Liquid-Submerged Cooling for Servers

LED Troffers and Tubes

LED Stadium Lighting

OLEDs

Polymer Bead Commercial Laundry

CO2 Commercial Laundry

Single-Zone RTU Retrofit Controllers

Wireless Plug Load Controllers

OLEDs Are Coming on Strong…

- Organic LED (OLED) features:
  - Thin, flat, flexible, diffuse, no hazardous materials, cool to the touch
  - New forms: flexible substrates, illuminated wallpaper, faux windows
- A few years behind LEDs
  - Current products: up to 60 lumens/watt (lm/W); color rendering index (CRI) >90; tunable color; 15,000-hour life; prototype at 131 lm/W

Source: Acuity

And You Can Buy 'Em at Home Depot

- Aedan
  - $199
  - 5 W, 136 lm (27 lm/W)
- Chalina
  - $299
  - 8 W, 345 lm (44 lm/W)
- General
  - 40,000-hour, 3-year warranty
  - 89 CRI
  - Dimmable

Source: Home Depot

Source: Home Depot

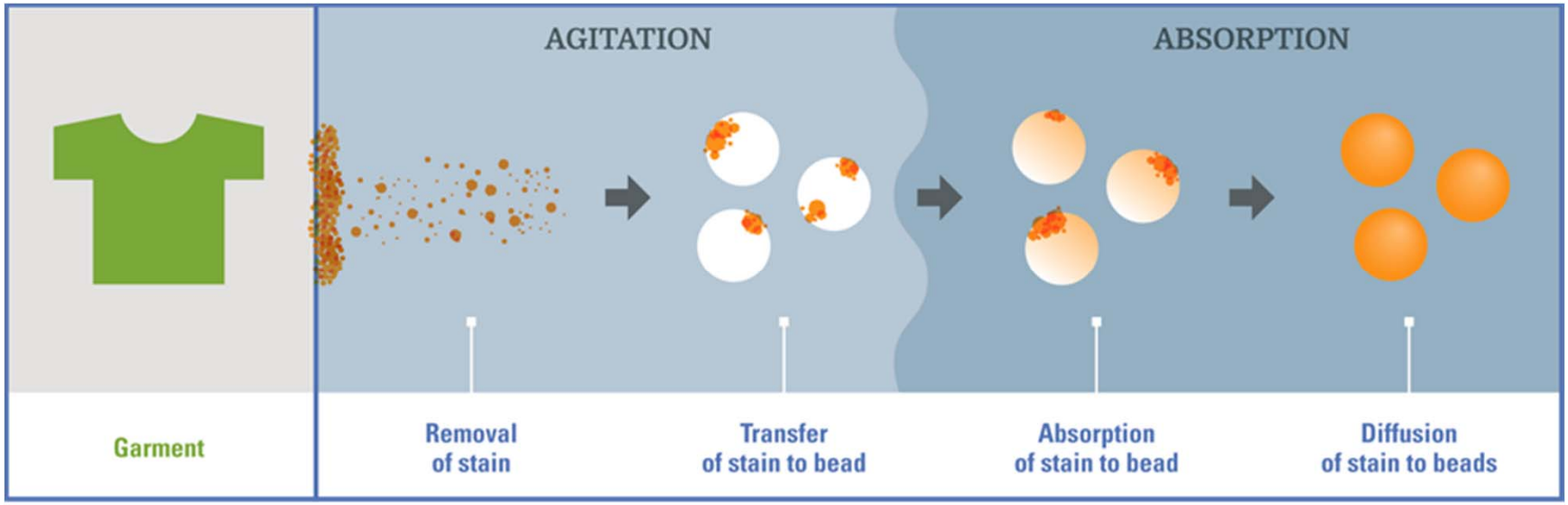
The OLED Future

- DOE estimate of OLED energy-savings potential:
  - 73% in corridors, 52% in retail, 50% in reception areas
- Early markets: architectural, hospitality, retail, automotive
- Market predictions vary widely:
  - $26 million by 2020 (HIS)
  - $200 million by 2019; $1.9 billion by 2025 (IDTechEX)
  - $4.7 billion by 2020 (UBI Research)
- Resource: 2014 OLED Stakeholder Meeting Report (PDF), DOE

Outline

Q-Sync Motors for Evaporator Fans
Gas and Electricity Savings in Ice Rinks
Dynamic Airzone Balancing
Liquid-Submerged Cooling for Servers
LED Troffers and Tubes
LED Stadium Lighting
OLEDs
Polymer Bead Commercial Laundry
CO2 Commercial Laundry
Single-Zone RTU Retrofit Controllers
Wireless Plug Load Controllers

How It Works



© E Source

Polymer beads:

- Spheroidal
- The size of BBs
- 1:2 mass ratio of laundry to beads
- Expand with moisture

The Process:

- Beads enter drum in specially made machine
- Agitate with fabrics
- Lift and absorb stains
- Beads exit drum for re-use
- No treatment of beads necessary

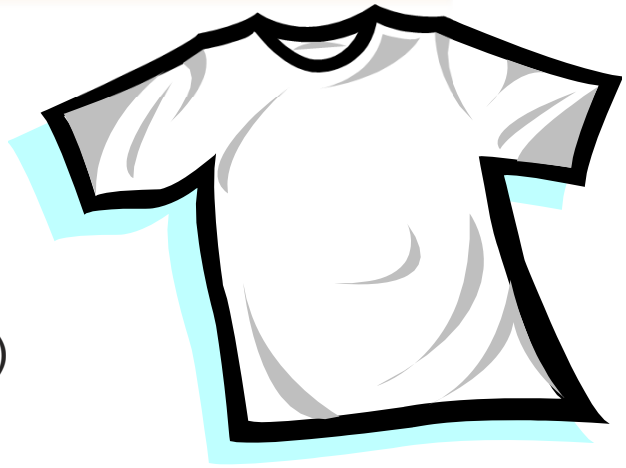
Standard Machines Waste Resources

Courtesy: BrokenSphere

For use in hotels, fitness centers, commercial laundry services…

not hospitals or correctional facilities

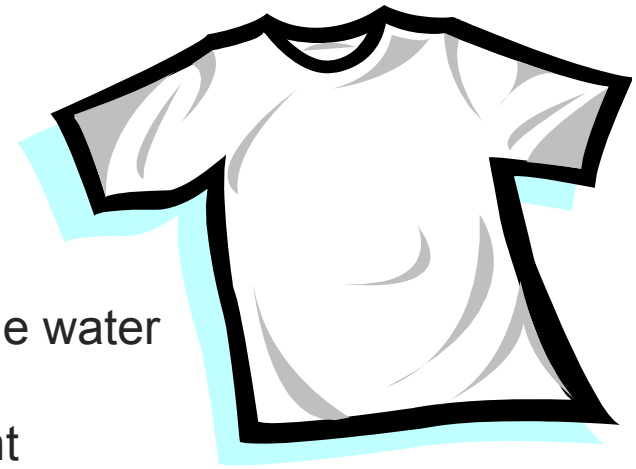
- Water (about 140 gallons per load)
- Heat (1 to 2 therms)
- Detergent
- Time (about 1 hour)



Source: MS Clipart

Why Polymer Bead Is Better

Courtesy: Liberty Utilities



Source: MS Clipart

- One-quarter of the water
- ~~Heat~~
- Half the detergent
- Less time
- Reduced drying*

Big Savings, and Substantial Non-Energy Benefits

Per load	Milnor (baseline)	Xeros (polymer bead)	Savings
Time (minutes)	54 to 78	50 to 51	4 to 26
Water (gallons)	134 to 156	35 to 37	80%
Therms	1.02 to 1.59	0	100%
Electricity	2 kWh	3 kWh	–4,600 kWh[a]

Notes: kWh = kilowatt-hours.
a. total additional electricity use in a year (compared to baseline).

© E Source

- Gentler on fabrics
- No sorting colors
- Improved cleaning
- No bleach

Outline

Q-Sync Motors for Evaporator Fans
Gas and Electricity Savings in Ice Rinks
Dynamic Airzone Balancing
Liquid-Submerged Cooling for Servers
LED Troffers and Tubes
LED Stadium Lighting
OLEDs
Polymer Bead Commercial Laundry
CO2 Commercial Laundry
Single-Zone RTU Retrofit Controllers
Wireless Plug Load Controllers

How Does Liquid CO_2 Clean?

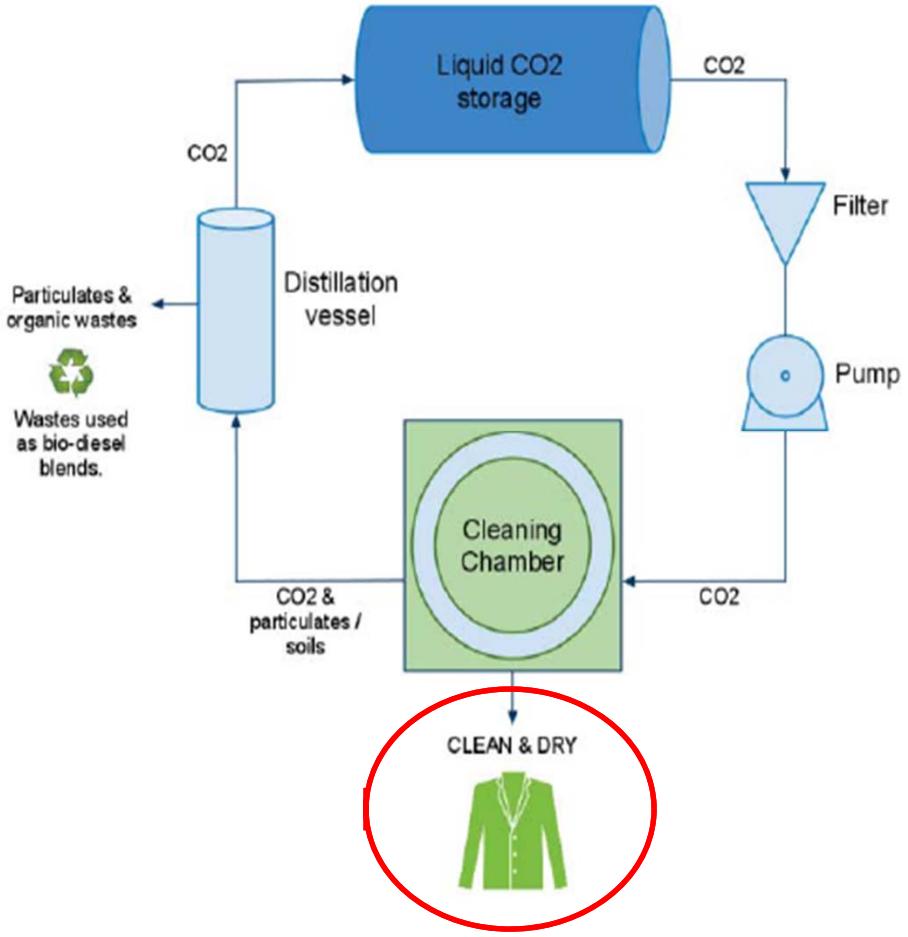
Gas at room temperature	Liquid at higher pressures	Solid at atmospheric pressure and below (-)109° F
		
Carbonation	Liquid	Dry ice

Courtesy (left to right): Quinn Dombrowski, Mr. Thomas, and Michael Melgar

Carbon-dioxide (CO_2) solvent properties compared to water:

- Lower viscosity and surface tension
- Improved small pore penetration
- **Cleans better and more quickly**

How the Process Works



Courtesy: CO_2Nexus

1. The cleaning chamber is purged of air
2. Liquid CO_2 (at ~ 60° F and 700 psi) is pumped into the cleaning chamber
3. Wash: CO_2 is recirculated
4. Distillation: residual body oils, detergent, and other soils are captured and removed
5. Clean liquid is moved back to storage and is ready for the next cycle

Savings Versus Incumbent Water-Based System

Process consumption

	Water-based system	CO_2-based system	Percentage reduction
Water (gallons)	4 million	0	100%
Electric energy (megawatt-hours)	444	200	33%
Natural gas energy (megawatt-hours)	667	300	22%
Chemicals (pounds)	30,000 (disposed of in municipal water system)	9,000	70%
Garment life	50+ cycles	2 to 3 times longer life	NA

Note: Based on 1.2 million pounds of garments throughput per year.

© E Source; data from CO_2Nexus

Economics and Potential Applications

Simple payback period target of 2 to 4 years

- Application- or market-specific
- Water and energy costs vary geographically
- Minimal biological contamination

Potential applications

- Hospitality
- Upstream textile processing
- Oil and gas
- Healthcare
- Dry cleaning
- Clean rooms

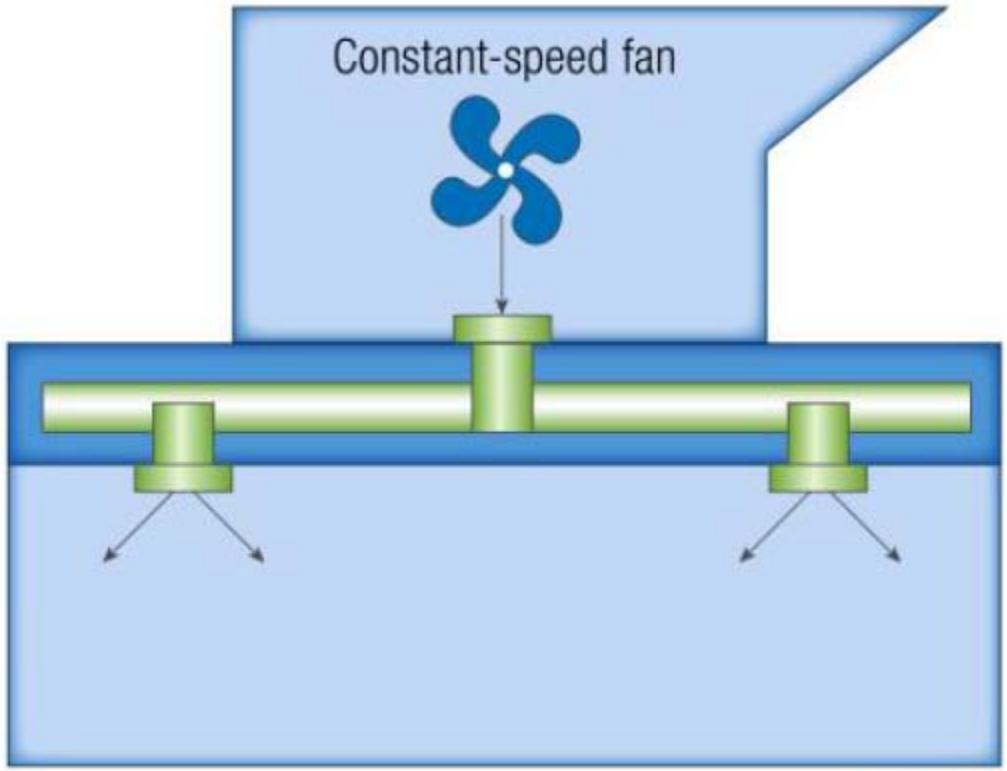
Courtesy: CO_2Nexus

Outline

Q-Sync Motors for Evaporator Fans
Gas and Electricity Savings in Ice Rinks
Dynamic Airzone Balancing
Liquid-Submerged Cooling for Servers
LED Troffers and Tubes
LED Stadium Lighting
OLEDs
Polymer Bead Commercial Laundry
CO2 Commercial Laundry
Single-Zone RTU Retrofit Controllers
Wireless Plug Load Controllers

Single-Zone RTUs Are UNINTELLIGENT Machines

- One zone
- Fixed fan speed
- Fan is either on or off
- Ventilation is kept at 100 percent when the building is occupied



© E Source

Single-Zone Rooftop Units Are EVERYWHERE

- About 50 percent of all commercial buildings have RTUs installed
- If half of those were retrofitted, it would be equivalent to removing 70 coal-fired power plants

Source: Wikimedia Commons

Variable-Frequency Drive (VFD) Retrofit Devices for RTUs: What's Under the Hood

Product	Variable-speed evaporator fan	Variable-speed compressor	Demand-controlled ventilation	Economizer controls	Fault detection and diagnostics
Catalyst	✓		✓	✓	Some
Enerfit	✓		✓	✓	Some
Digi-RTU	✓	✓	In progress	In progress	In progress

© E Source

Results Continue to Be Positive: PNNL Study

- Pacific Northwest National Laboratory (PNNL) study published July 2013:
  - 66 Catalyst units
  - 8 different buildings (retail, shopping mall, office, food sales, healthcare)
  - 4 climate zones (warm coastal, mixed humid, mixed marine, cool moist)
- Average savings of 57 percent!
- Mostly due to fan energy savings when in ventilation-only mode
- Average simple payback of 3 years at $0.10/kWh

Newest Results Continue to Be Positive: SDG&E Study

- San Diego Gas & Electric (SDG&E) study published November 2013:
  - 2 different manufacturers (kept anonymous)
  - 1 installation per manufacturer
  - 1 building in San Diego, California

Device	Variable-speed evaporator fan	Variable-speed compressor	Demand-controlled ventilation	Economizer controls	Fault detection and diagnostics	Savings (%)
Unit 1	✓	✓				27
Unit 2	✓		✓	✓	Some	26

© E Source

Outline

Q-Sync Motors for Evaporator Fans
Gas and Electricity Savings in Ice Rinks
Dynamic Airzone Balancing
Liquid-Submerged Cooling for Servers
LED Troffers and Tubes
LED Stadium Lighting
OLEDs
Polymer Bead Commercial Laundry
CO2 Commercial Laundry
Single-Zone RTU Retrofit Controllers
Wireless Plug Load Controllers

Wireless Plug Load Controls

- Several new smart plugs/ strips on the market
  - Available for residential and commercial applications
  - Can simplify installation and set-up
  - Offer customized load management strategies
- Wireless functionality
  - Centralized web portal
  - Straightforward monitoring and reporting
  - Finally feasible for a single person to manage many different plug loads

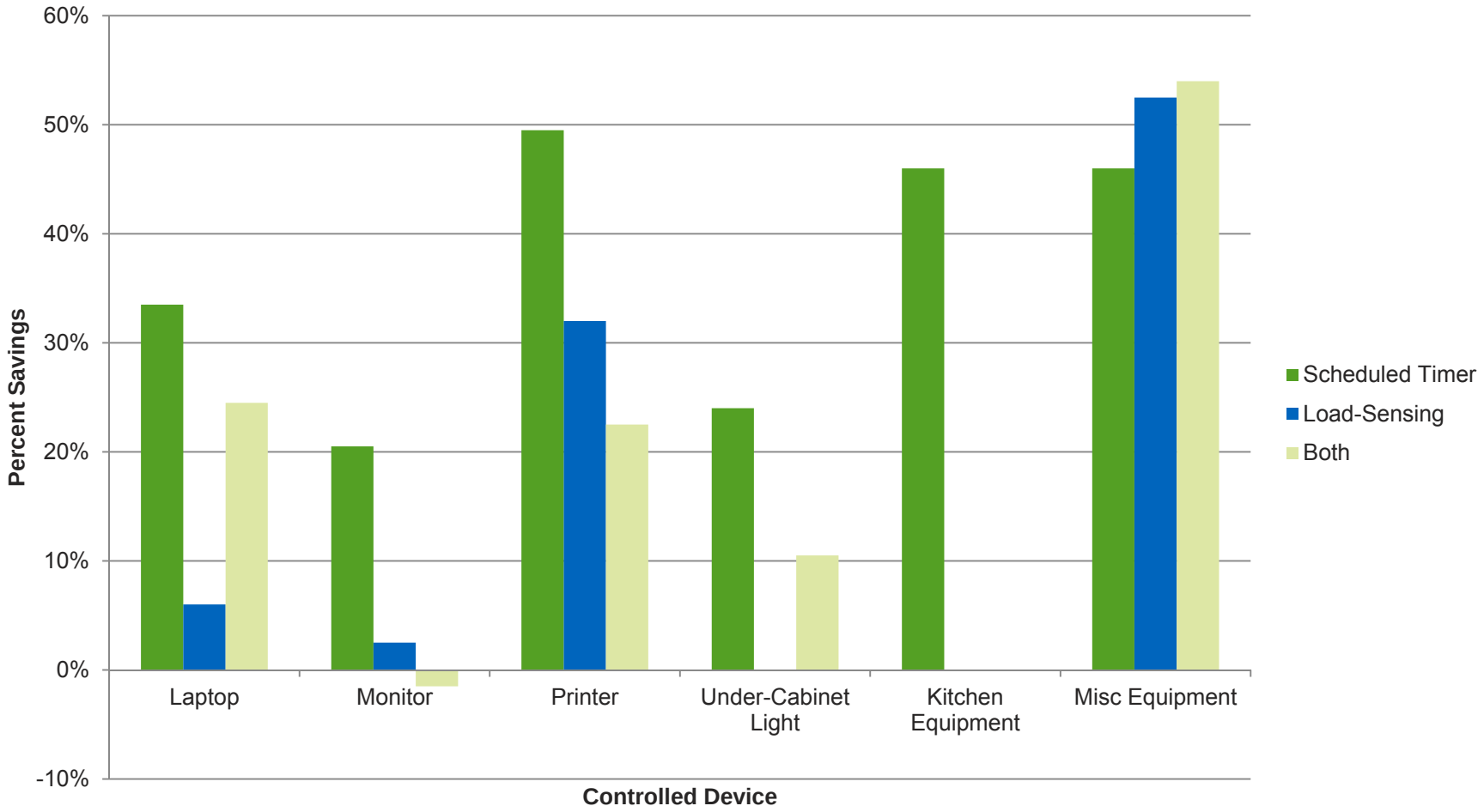
Image courtesy Enmetric Systems

How Well Do They Work?

- NREL tested Enmetric smart strips in 8 office buildings
  - Baseline was a standard “dumb” power strip
  - Studied nearly 300 devices
- Control strategies used included:
  - Submetering only
  - Schedule timer
  - Load-sensing
  - Schedule timer and load-sensing

Image Courtesy Everaldo Coelho and YellowIcon

Savings Vary Based on Device, Control Strategy Used



Small Business Pilot with NYSERDA

- 10 small businesses in New York City
- 250 ThinkEco Modlets installed
  - Comprised 500 individual plug-level meters + controls

Courtesy: Petiatil

- 3 phases
  - "Blind"—establishing a baseline
  - Automated savings
  - Interoffice competition (the "Modlympics")

Courtesy: ThinkEco Inc.

Automated Savings

- Plug loads accounted for 10 to 40 percent of all the electricity consumed
  - This was in energy-conscious offices!
- Automatic controls have enormous potential
  - Shutting off equipment after hours can reduce *overall* electricity bills by up to 10 percent in small offices

Courtesy: S Sepp

Individualized Feedback

- Surprise! People don't know what to focus their efforts on
  - Worried about small things like cell phone chargers
  - Often miss "obvious" opportunities (such as the many energy hogs that are left on 24/7)
- Data can quickly dispel common misconceptions
  - People can see how they actually consume energy

Courtesy: McKinley

For More Information

Essie Snell
Research Manager, Technology Assessment, E Source
303-345-9140 essie_snell@esource.com

Logan Jacobson
Associate Analyst, Technology Assessment, E Source
303-345-9181 logan_jacobson@esource.com

CONTACT US

1-800-ESOURCE (1-800-376-8723)
customer_service@esource.com
www.esource.com