Welcome

Powerful Facility Energy Conference

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Proven Technologies and Approaches for Healthy, Efficient Buildings

Powerful Facility
Energy Conference

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Northwest Energy Efficiency Alliance

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Professor of Architecture, University of Washington and Director of the Center for Integrated Design

Agenda

1) Introduction
2) Energy Saving Opportunities
3) Technology Deep Dives
    a) Pumps and Circulators
    b) Secondary Windows
    c) Advanced Lighting Controls
    d) High-performance HVAC
4) Conclusions

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Who is NEEA?

BETTERBRICKS
Powerful Energy Ideas. Delivered by NEEA.

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Bonneville Power Administration
Cascade Natural Gas Corporation
P.U.D. Chelan County
Clark Public Utilities
EnergyTrust of Oregon
Grant PUD
Idaho Power An IDACORP Company
NorthWestern Energy
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Pacific Power
PGE
PSE Puget Sound Energy
Seattle City Light
Snohomish County PUD Public Utility District No. 1
Tacoma Power Tacoma Public Utilities

What is BetterBricks?

>> Learn more at BetterBricks.com

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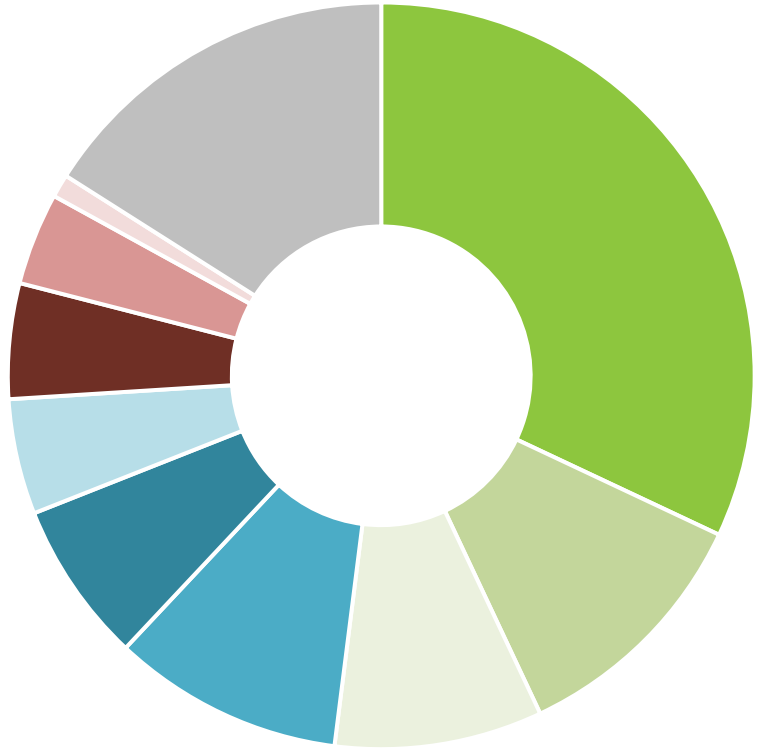
Where does a building's energy go?

Major fuels consumption by end use (2018)

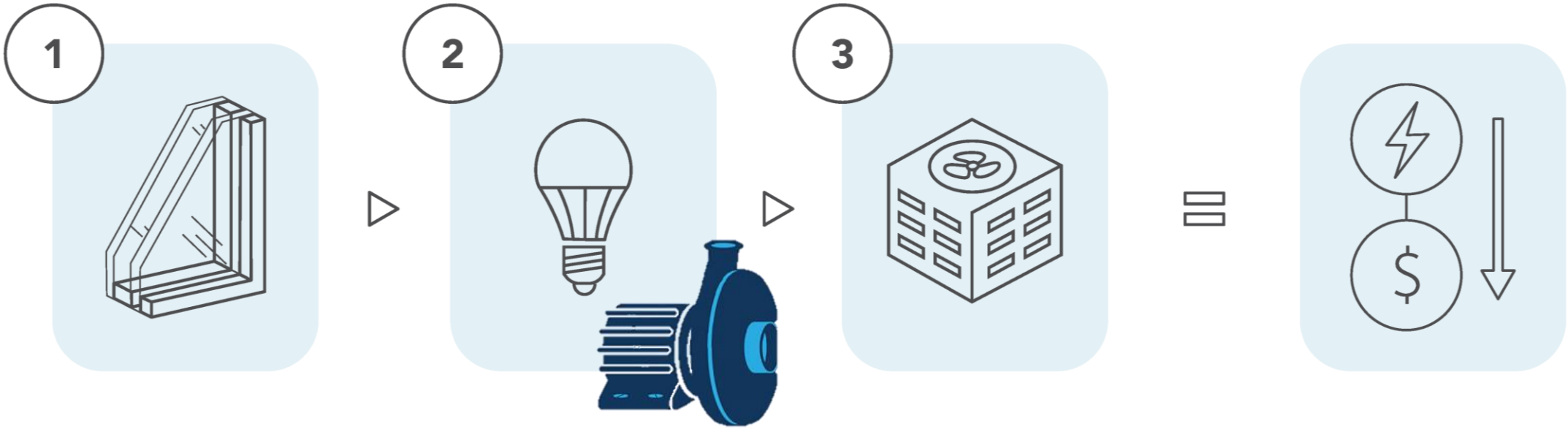


Source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*; Note: Btu = British Thermal Units

Advanced Technologies Are Available to Lower Energy Consumption

Technology	Overview
Pumps and Circulators	Pumps and circulators are the heartbeat of your building. Efficient equipment and smart controls can reduce overall energy consumption significantly.
Ventilation Air Systems	Your building needs fresh air to maintain a healthy and comfortable environment. Advanced equipment re-captures energy from exiting air, reducing heating and cooling equipment usage.
Advanced Lighting Controls	LLLC
Secondary Windows	Window Attachments

Sequencing upgrades



How can we piggyback on projects to make a bigger impact?

- In advance of a planned system replacement
- During periods of tenant turnover
- Buildings with comfort occupant issues
- Repositioning in the marketplace
- Saving historic buildings

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Smart Pumps

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Typical Pumping Systems in a Commercial Building

14

Target Products

Pumps



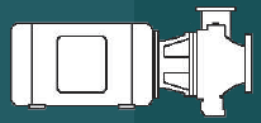


Circulators




THE RIGHT PUMPS MAKE A DIFFERENCE

End Suction Close Coupled
2020 Shipments: 197,474



Space-saving needs in water supply, HVAC, chemical and food/beverage processing.

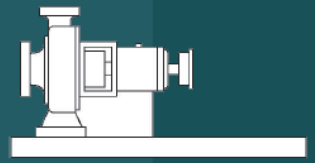
Annual Energy Saving Potential (kWh)
104,408,549

Annual Cost Savings ($0.09/kWh)
$9,396,769

Average Simple Payback (Years)
3.1

IRR
30%

End Suction Frame Mount
2020 Shipments: 50,725



Water supply, HVAC, chemical and food/beverage processing.

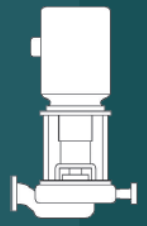
Annual Energy Saving Potential (kWh)
49,265,883

Annual Cost Savings ($0.09/kWh)
$4,433,930

Average Simple Payback (Years)
3.7

IRR
27%

In-Line
2020 Shipments: 58,075



Home and commercial building hydronic heating, domestic hot water circulation, and HVAC chilled water systems.

Annual Energy Saving Potential (kWh)
30,403,917

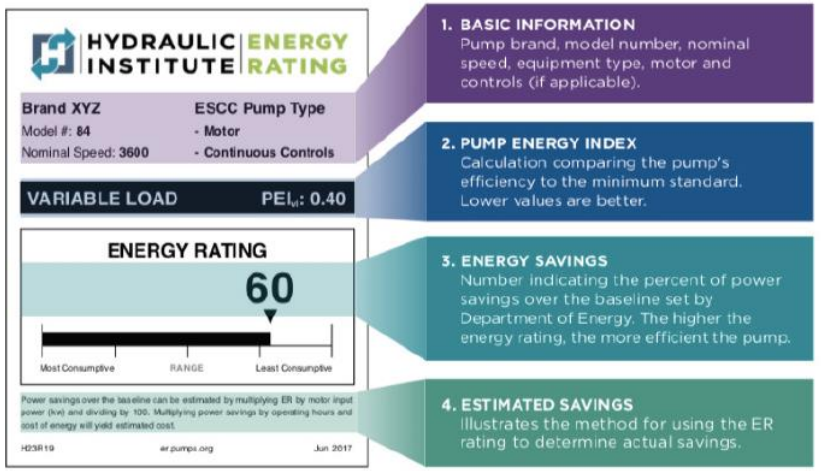
Annual Cost Savings ($0.09/kWh)
$2,736,353

Average Simple Payback (Years)
7.6

IRR
9%

FIND THE RIGHT SOLUTION

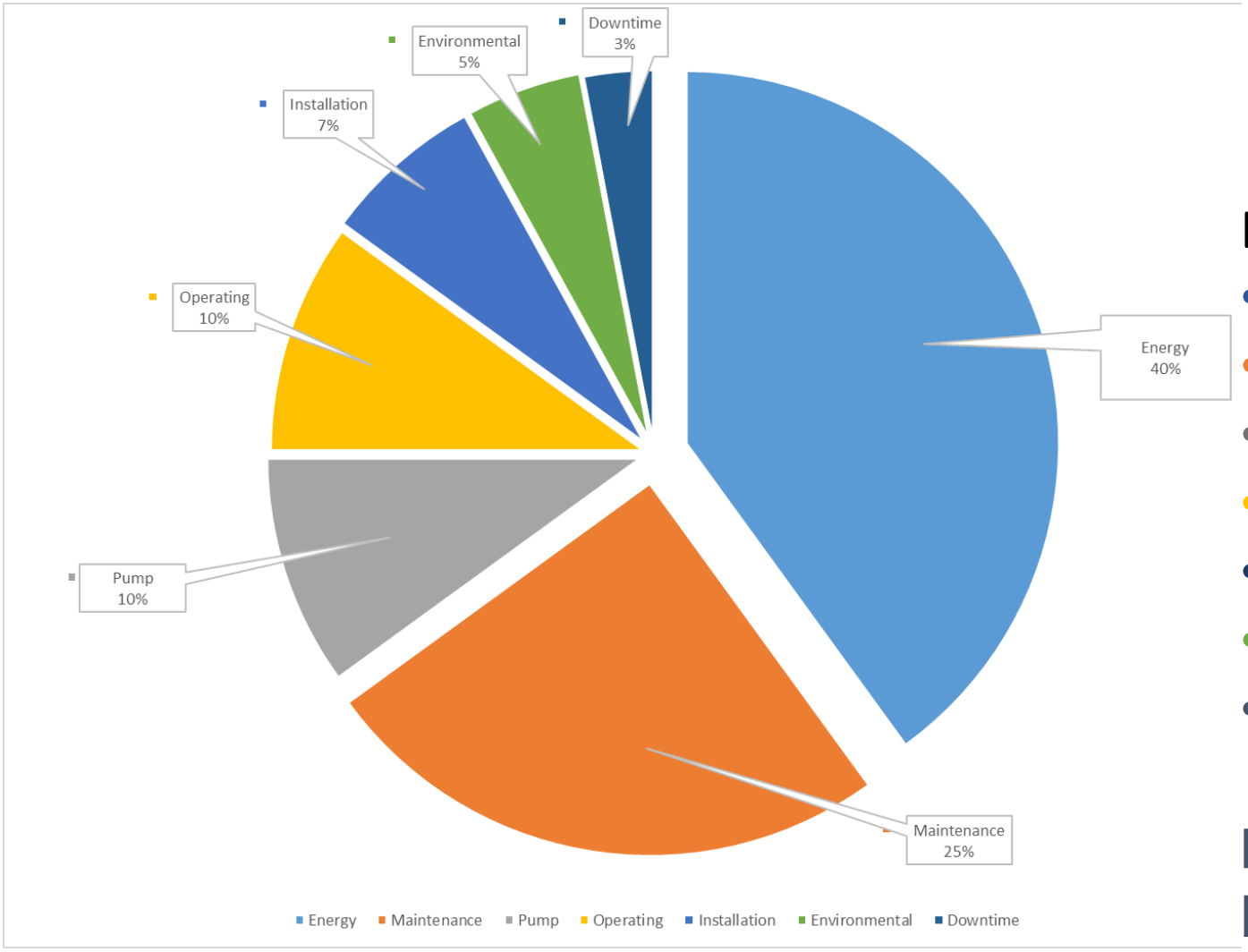
Visit pumps.org/energyefficiency to learn more about Hydraulic Institute'sEnergy Rating Program and Search the ER Database to find your solution



Annual Energy Savings Potential Total:
184,078,349 (kWh/year)

Annual Cost Savings Total:
$16,567,051

Life Cycle Cost of Typical Pumping System



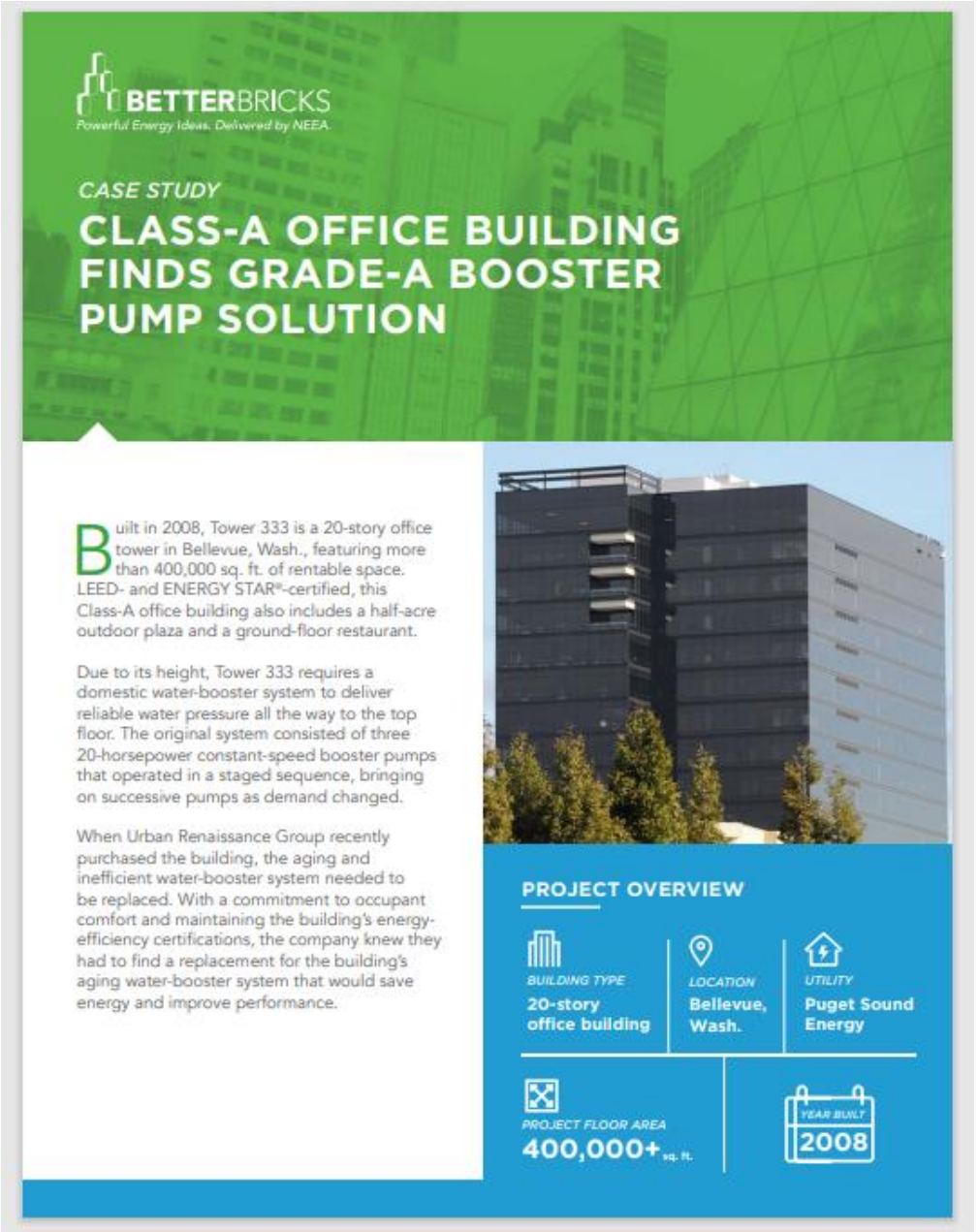
Energy & Maintenance is 65% of Life Cycle Cost

Elements of the LCC

- Energy – 40 %
- Maintenance – 25%
- Initial Purchase – 10%
- Operating – 10%
- Installation & Commissioning – 7%
- Environmental cost - 5%
- Downtime, Loss of Production – 3%

Focusing on initial cost misses the big picture

Case Study



- https://betterbricks.com/case-studies/class-a-office-building-finds-grade-a-booster-pump-solution

Case Study

NOISY, POORLY CONTROLLED AND OVERSIZED CONSTANT-SPEED PUMPS

Urban Renaissance Group's chief facilities engineer, Kidron Cobb, encountered a variety of issues caused by the original booster pumps, including:

- **Noise**: The basement-located pumps were so loud, they continually interrupted occupants of the conference room above.
- **Waste**: The flow of water was controlled by throttling valves, a common but wasteful control strategy in which the pumps always operate at full speed, rather than operating in proportion to demand.
- **Maintenance demands**: Due to their size and constant speed, the system created a pressure surge—also known as a water hammer—throughout the facility's piping whenever a pump was shut down. This water hammer effect caused frequent maintenance demands to replace the failed system components and rebuild the pumps.

SMART PUMPS REDUCE NOISE, WASTE AND MAINTENANCE NEEDS

After doing some research and consulting with Hurley Engineering, Cobb found his answer: a Grundfos HYDRO MPC-E smart-pump booster skid. Featuring four 5-horsepower Grundfos CRE pumps, the new skid is powered by highly efficient electronically commutated motors (ECMs). These variable-speed ECMs readily allow the system to meet fluctuating demand and, as a result, save energy.

The new smart-pump booster skid includes integrated sensors and smart controls that are performance-mapped to the specific operating characteristics of the pumps. The smart controls constantly analyze demand to determine when the pumps should turn on, and at what speed. The booster pumps no longer slam on and off, which eliminates noisy disturbances and prevents damage to plumbing components. And since smart pumps don't use throttling valves, this solution also saves energy improves system reliability, and reduces unnecessary pressure in the system.

Smart Pumps

More than just a drive, smart pumps feature advanced software and integrated, performance-mapped controls that operate the pump at peak efficiency without requiring pressure sensors in the system. On multi-pump systems, the software will run the most efficient combination of pumps to meet the load. And since the controls are built directly on the pump, installation costs are lower than those of a wall-mounted drive.

Existing System:

- *(3) 20-horsepower single-speed booster pumps*

New System:

- *(4) 5-horsepower variable-speed booster pumps*
- *Highly efficient ECMs*
- *Smart pump integrated controls*
- *Pumps can operate in lead/lag or staged*
- *Controls will duty-cycle all four pumps to wear equally*

Case Study: Smart Circulators Provide Convenience and Savings for Bellwether Housing

BEFORE

Four DHW Recirculation Loops served by a single speed circulator with an inefficient motor pulling 88 watts continuously 24 hours a day 7 days a week

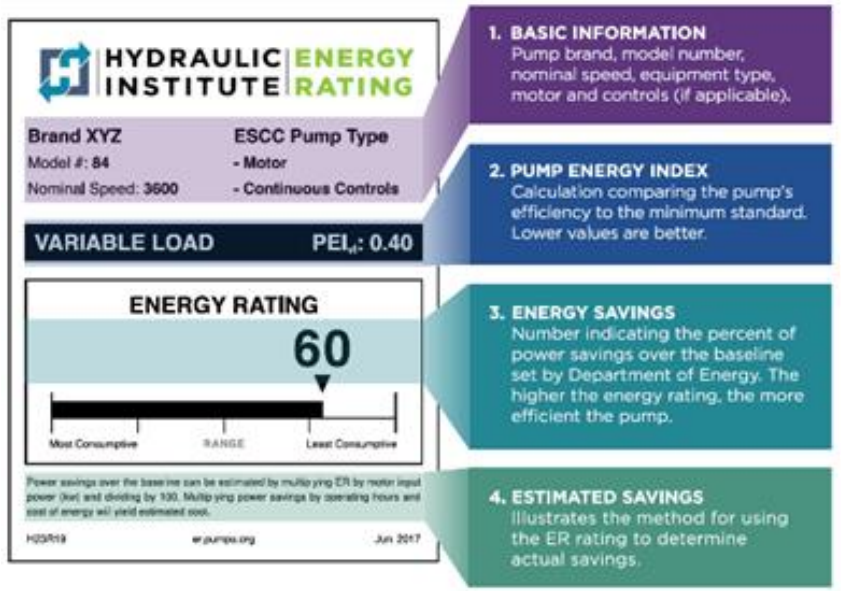
AFTER

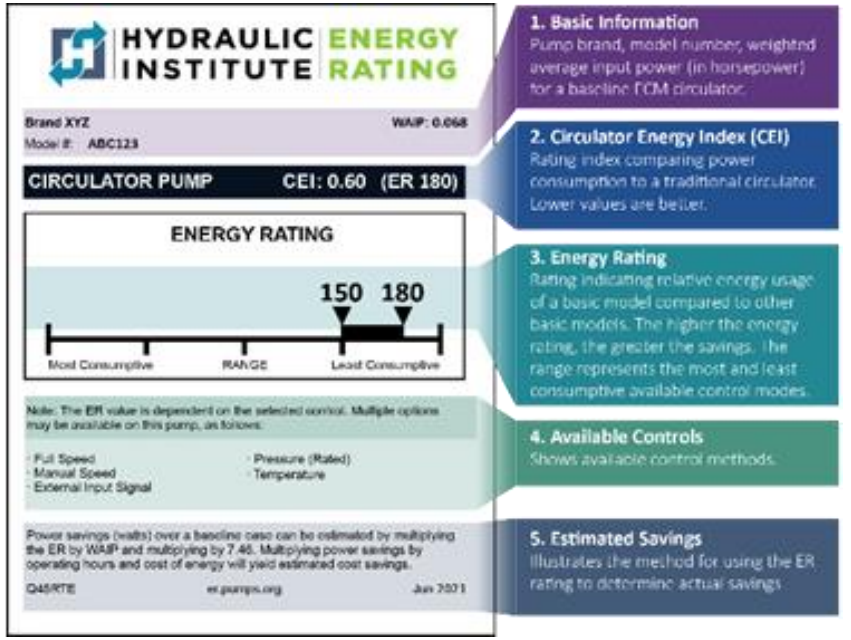
All four circulators were replaced with smart circulators equipped with ECMs and Advanced Speed controls, resulting in a 90% decrease in power consumption. Additional savings occur from the reduced demand placed on water heaters and boilers

MORE INFO

Energy Rating Label

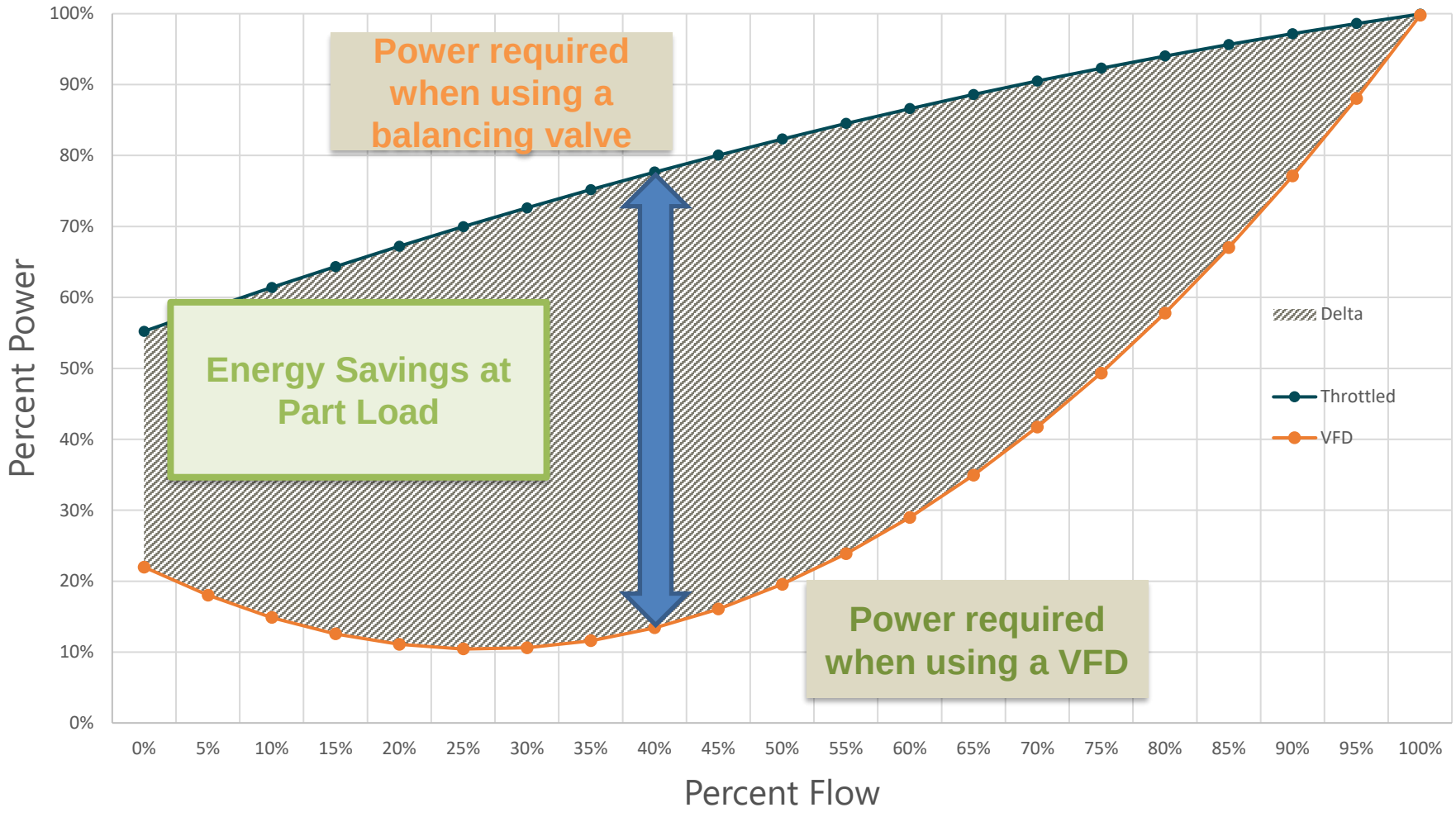
- ER Label = comparison tool similar to ENERGY STAR
- Efficiency % savings above baseline
- Use to estimate savings
- Choose pumps with higher ER values
- Found on pumps & circulators



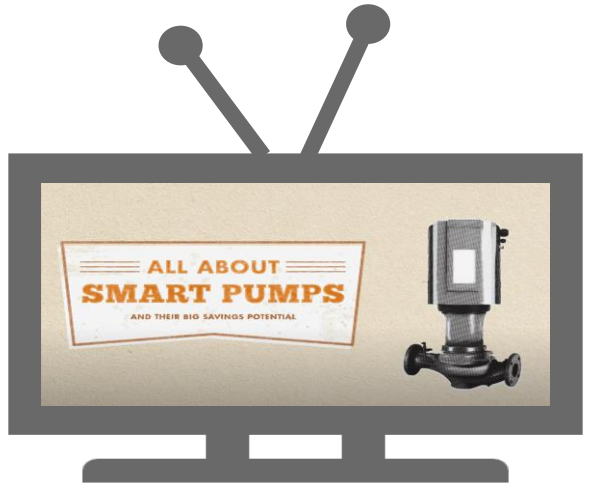


Speed Control is More Efficient than Valves

Pumps typically operate at a range of speeds throughout the year



Smart Pumps Eliminate Selection Guesswork and Simplify Installation



Integration of pump, motor, drive, and integral sensors into one streamlined package

Simplifies installation burden and reduces hardware costs

Pump-specific performance maps of pump curves that allow the drive to optimize operation

Simplified startup procedure reduces potential for errors in sensor installation and drive programming

Electronically-commutated motors (ECM), which further enhances efficiency benefits compared to standard NEMA Premium motors

Tools & Resources

HYDRAULIC INSTITUTE

- *https://www.pumps.org/resources/energy-efficiency*

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- *https://betterbricks.com/solutions/pumps-motors*

HYDRAULIC INSTITUTE

- Trainings
- Webinars (Live & On-Demand)
- Pump Savings Calculator
- Circulator Savings Calculator
- Pump System Assessment Professional
- (PSAP) Certification
- Motor & VFD Courses
- Videos
- Engineering Data Library

Hydraulic Institute Lifecycle Cost Calculator

- **Calculate total cost of ownership and compare between models**
- **Accounts for variables such as:**
  - Speed control
  - Efficiency
  - Equipment cost and installation
  - Maintenance
  - Other costs

Total Change in Life Cycle Costs ($)
The modeled pump replacement results in a savings of $43269.6 over the lifetime of the pump

Lifetime Energy Savings (kWh)	Lifetime Energy Savings ($)
963,370	$ 77,069.60

Incremental Increase in Equipment Cost ($)	Change in Installation/ Commissioning Cost ($)
$ 2,000.00	$ 800.00

Custom Project Incentives

- Involve your utility early in the process
- On-site metering to understand pre/post energy use
- Comprehensive approach, can include system optimization beyond just the pumps
- New construction or retrofit
- Nearly all pumps can benefit from a drive – even constant load pumps

Key Takeaways

1. Look for Smart Pumps with ECMs and Advanced Controls for ease of installation, operation and energy savings
2. Be aware of oversizing – how far away from your pump's Best Efficiency Point "BEP" are you operating?
3. Use a drive for system balancing (not valves)
4. Online resources: trainings, calculators, case studies, ER database
5. Utility incentives
6. Think about opportunities to replace pumps as part of preventative maintenance plans
7. Even though pumps are small, can result in big savings opportunities with attractive paybacks

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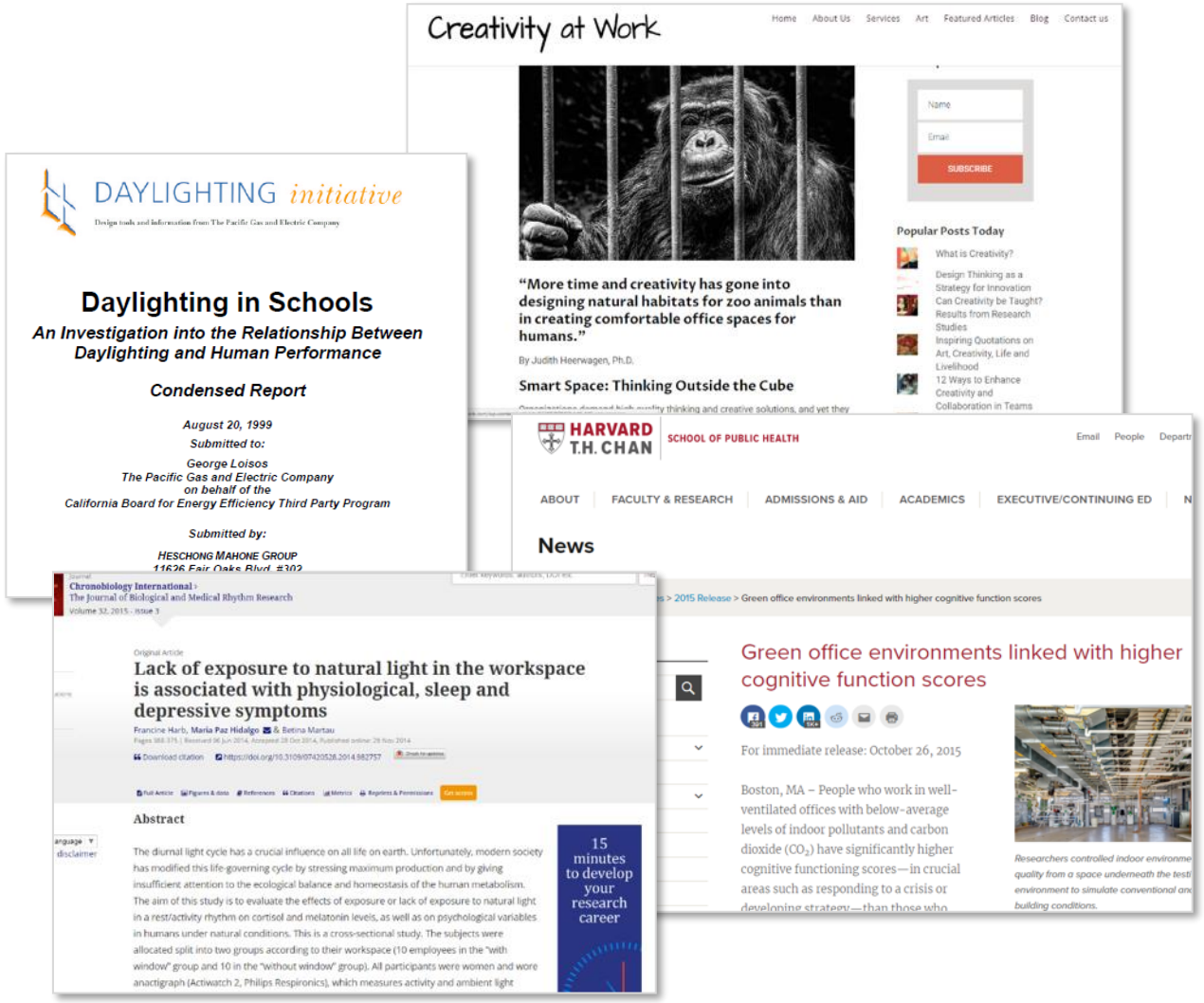
Why building performance matters:

- Connection to nature
- Environmental psychology
- Photobiology
- Productivity
- Health and wellness
  - Better sleep
  - Fewer sick days
  - Less depressive symptoms



Secondary Windows

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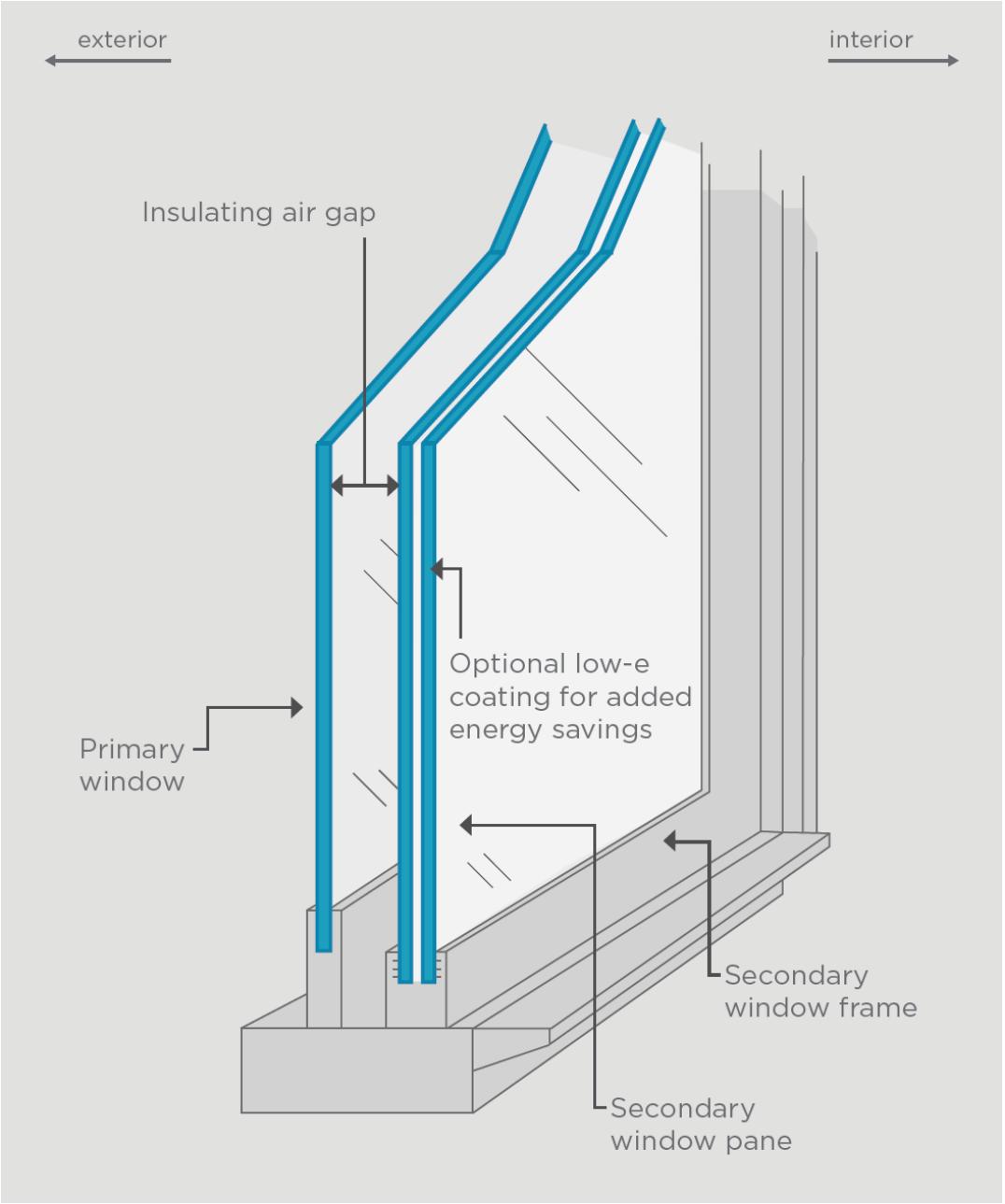
How it works

- Attaches to the interior or exterior of an existing window
- Creates an insulating air pocket between new and existing panes
- Improves comfort, daylighting, health and wellness, and reduces heating/cooling energy use



Why Secondary Windows?

Energy-Related Benefits

- Stabilize HVAC performance even under extreme conditions
- Reduce peak heating and cooling loads and energy costs
- Improve building resiliency

Non-Energy Benefits

- Improve occupant comfort
- Increase property value
- Exterior noise control
- Maintains natural daylighting, views and value of prime real estate near windows
- Maintains original exterior facade and windows (important for historic buildings)
- Installation is quick and non-invasive
- Improves occupant health and wellness

Ideal building characteristics

- Constructed before 1995 without low-e coating on windows (single-pane clear)
- Small, medium and large buildings with fixed or operable windows
- Retail, office, residential care, lodging and especially historic buildings
- All-electric buildings with single-pane, clear windows present largest savings opportunity

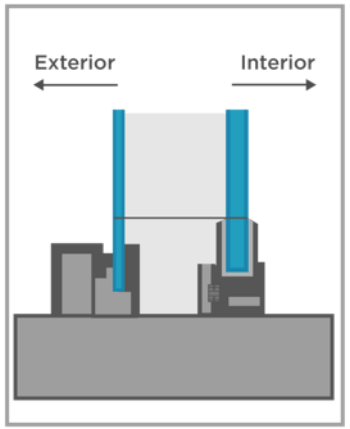
Technical potential

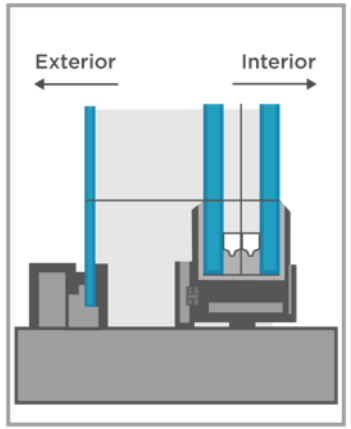
5-15%

reduction in heating / cooling energy use

~$32/sq. ft.

(~10-25% of the cost of window replacement)

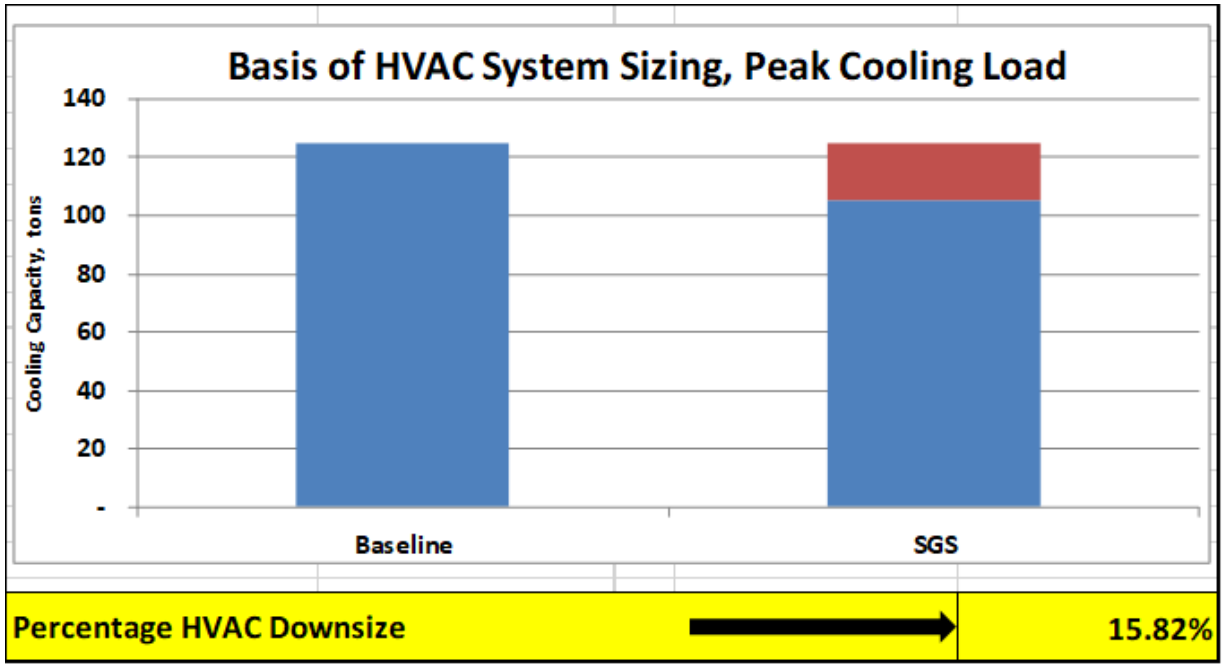




	Baseline Single-Pane Window	***Single-Pane Secondary Window***	***Double-Pane Secondary Window***
U-Value	1.12	0.53	0.27
SHGC	0.72	0.38	0.35
VT	0.77	0.51	0.51

Note: Average whole window (frame and glass) values

Lower peak heating and cooling demand

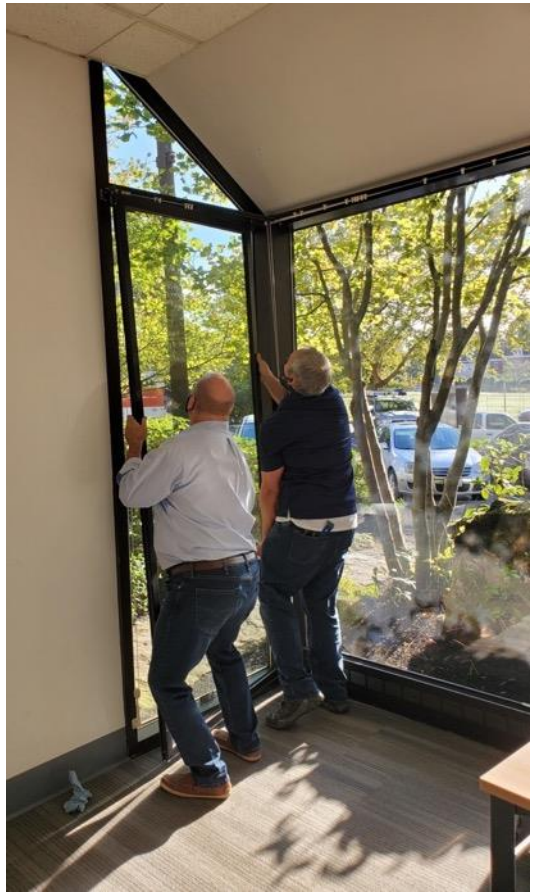


15%

average first-cost savings on HVAC downsizing for school buildings resulting from windows upgrade

CASE STUDY

915 Broadway



Office Building
Vancouver, WA

Built: 1975

Size: 4 stories / 36,000 SF

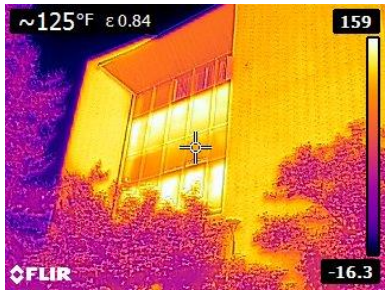
Projected savings:

$3,754/yr.

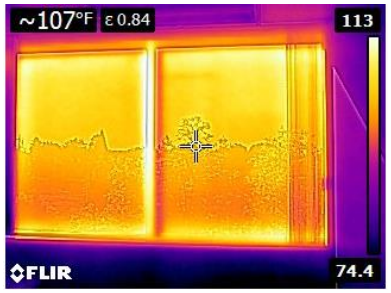
Product manuf.: Alpen

Problem:
Occupant Comfort & HVAC Performance

Thermal Comfort:
9/2/20 @ 8:00 am
Outside Ambient Temp: **63º F**



Exterior Window Surface:
125º F
(+ 62º F)



Interior Window Surface:
107º F
(+ 44º F)

Thermal comfort problems exist even in mild climates during mild weather

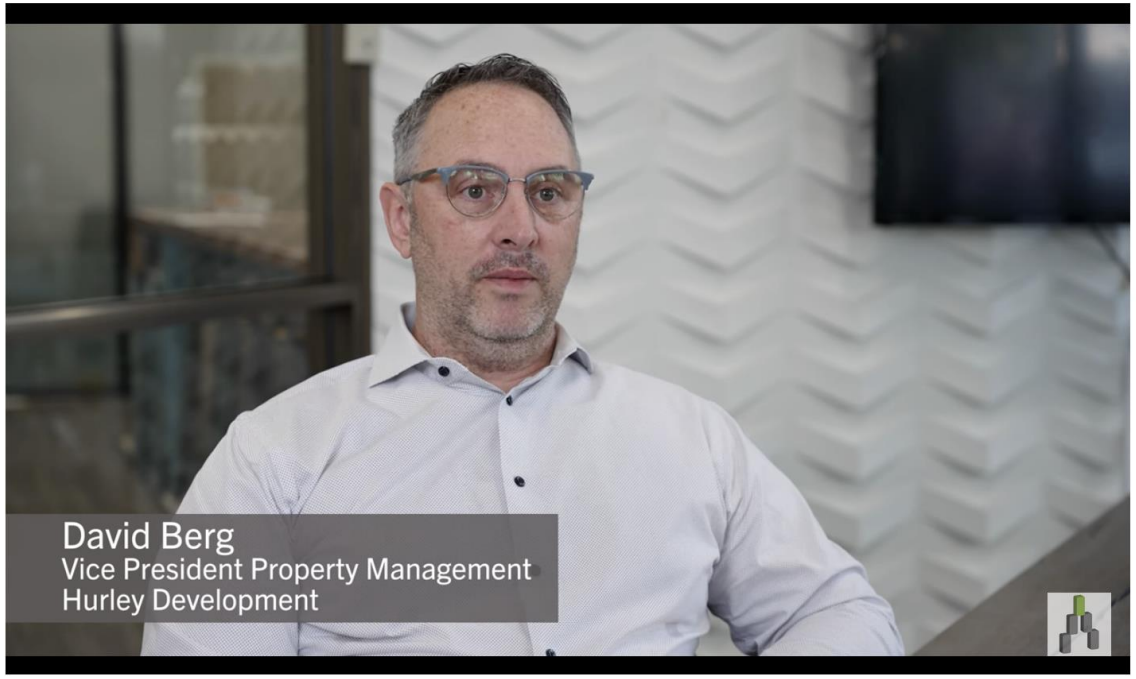
- Single pane glass absorbs energy and radiates it inward to occupied spaces.
- On a mild fall day, *interior* glass temperatures were 44 degrees warmer than *outside* air temperatures.
- During the summer, there were regular tenant comfort complaints, and many would be forced to go home early.

Outcome:
Improved Comfort & Savings

“When any building gets to 40 years old, systems start breaking down with age, weather and just natural deterioration…

We were blown away when we saw the energy-saving and comfort benefits provided by secondary windows.

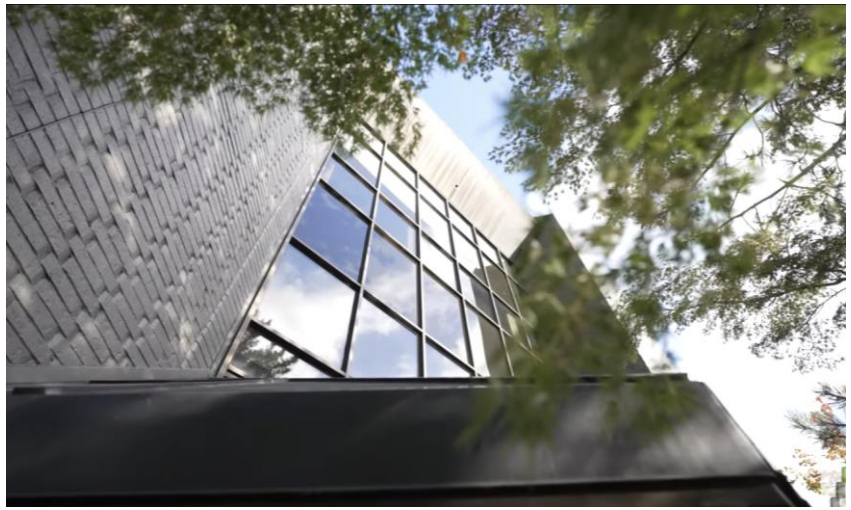
I don’t know why you wouldn’t want to consider this for your commercial building.”



See the full video case study at:
BetterBricks.com/case-studies/915-broadway

Outcome:
Secondary Windows Pass Historic Comfort Test

“We were very worried. In the past, even on a 90-degree day, we would receive tenant comfort complaints, and many would be forced to go home early. We watched the digital control system throughout the day. ***The temperature held at 72-74 F in every zone in the building. We were amazed.*** *We didn’t get a single complaint.”*



Attachments Energy Rating Council

Rates, labels and certifies the energy performance of window attachments

- Independent, public interest organization
- DOE-funded

Luminaire Level Lighting Controls (LLLC)

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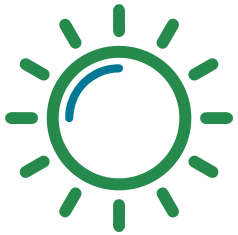
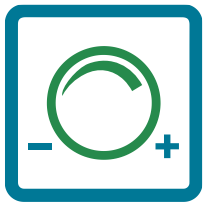
Luminaire Level Lighting Controls Benefits



Daylight harvesting

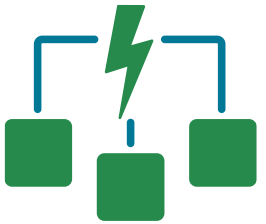
Occupancy sensing



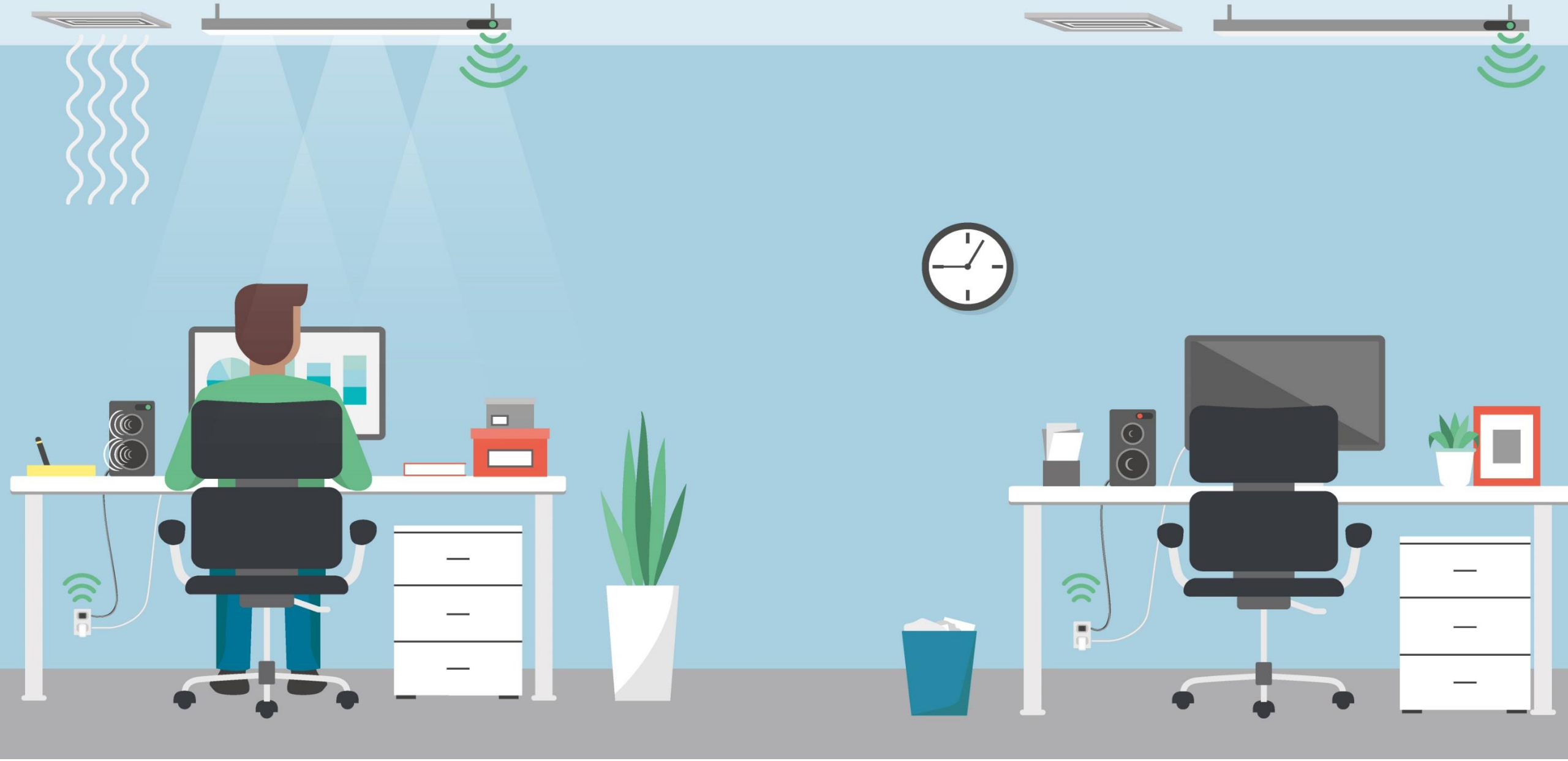
Continuous dimming

Controls persistence

High-end trim/Task tuning

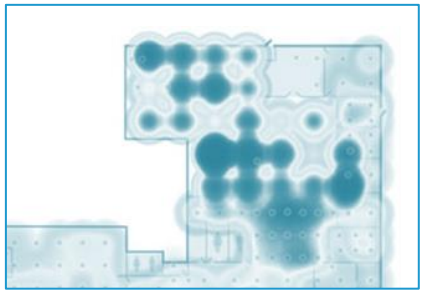


Demand response



LLLC Business Benefits Beyond Energy Savings

Asset Tracking



Space Utilization

Indoor Positioning

Diagnose & Report

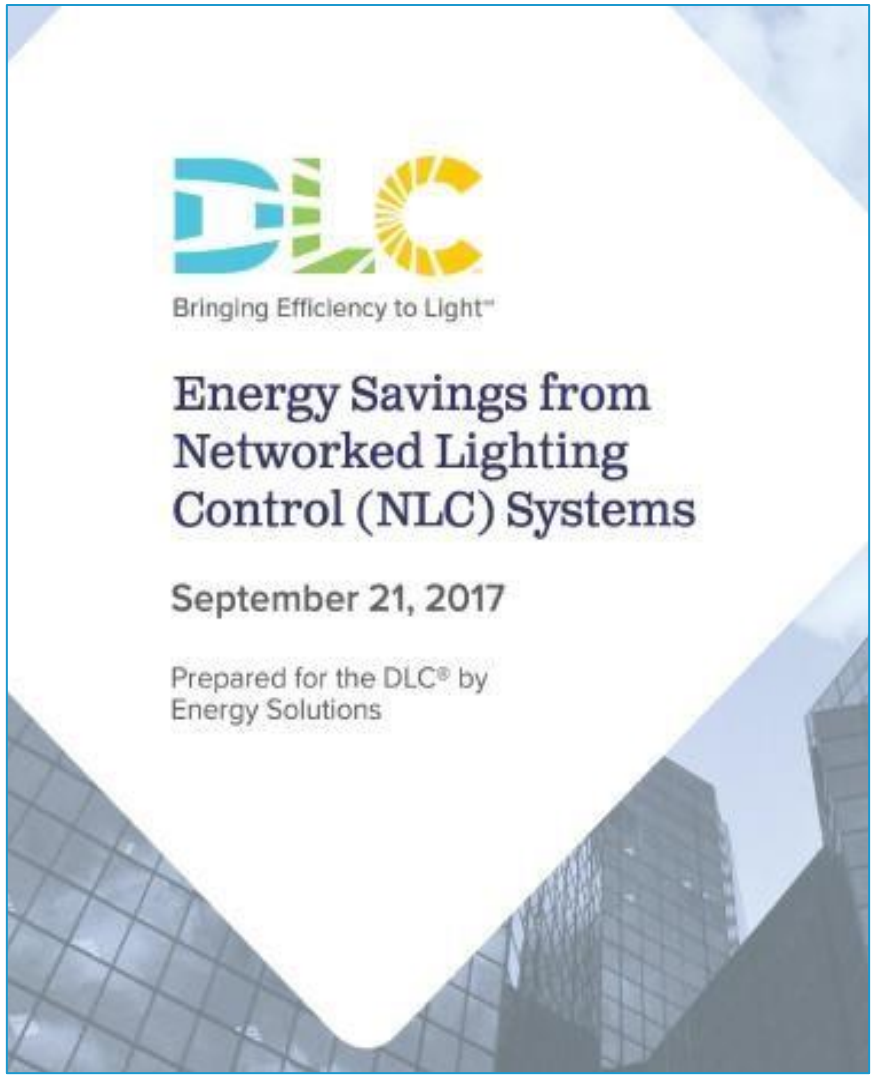
Conference Room Scheduling

Security

Energy Tracking

Integrate with BMS/HVAC

New Report Builds on Previoous 2017 Study



Finding #1: LLLC Showed Overall Higher Savings

Additional study needed to confirm correlation

- Need to control for potential confounding variables

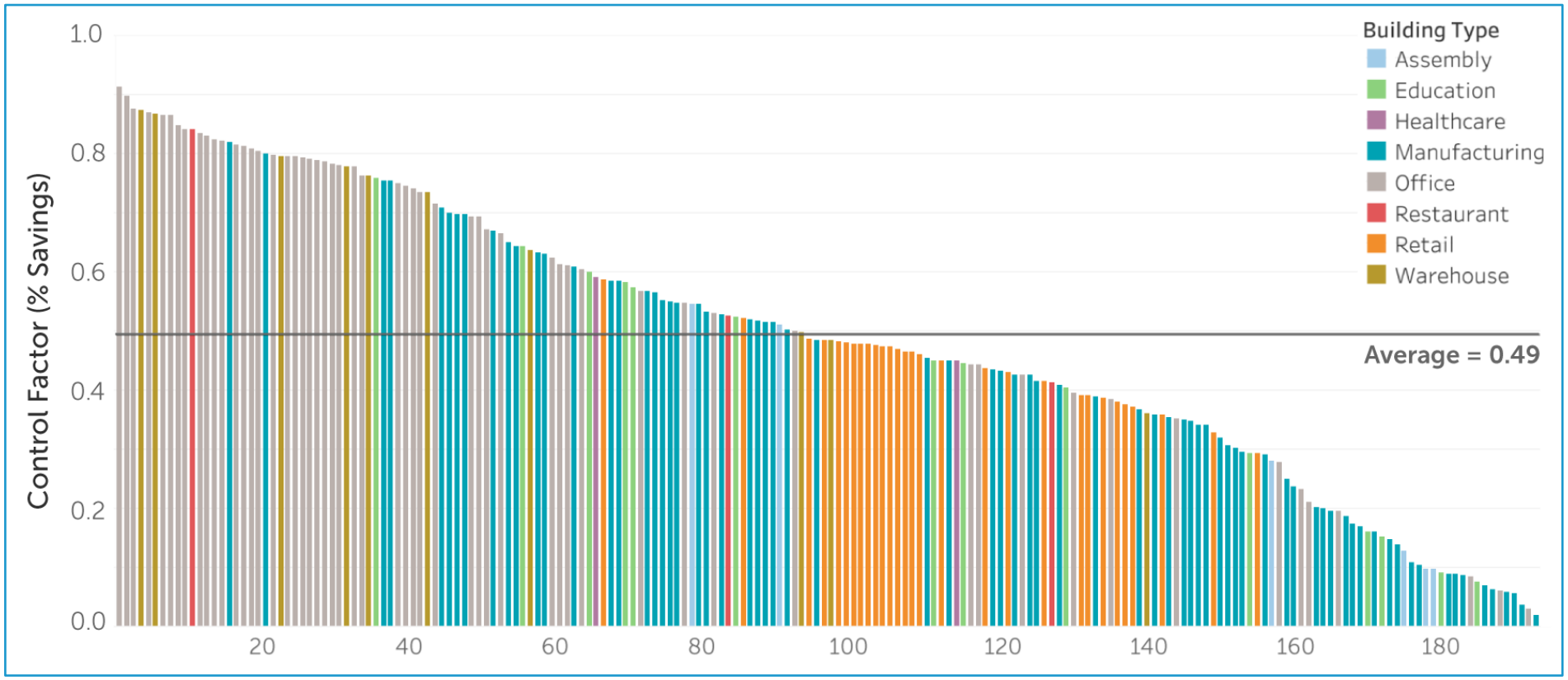
LLLC Presence	Total Buildings	Control Factor (% Savings)			
		Average	25th–75th Percentile	High-End Trim Contributions	Other Control Strategies
NLCs w/ LLLC	98	0.63	0.50 - 0.79	0.37	0.41
NLCs w/o LLLC	96	0.35	0.17 - 0.48	0.17	0.22
All NLCs	194	0.49	0.35 - 0.69	0.27	0.32

Note: The numbers provided in this table is meant to provide a high-level overview of average savings trends. Additional study is needed to control for potentially confounding variables, and thus at this time does not imply that LLLC is universally superior and applicable to all building types.

Finding #2: Average Energy Savings Was 49%

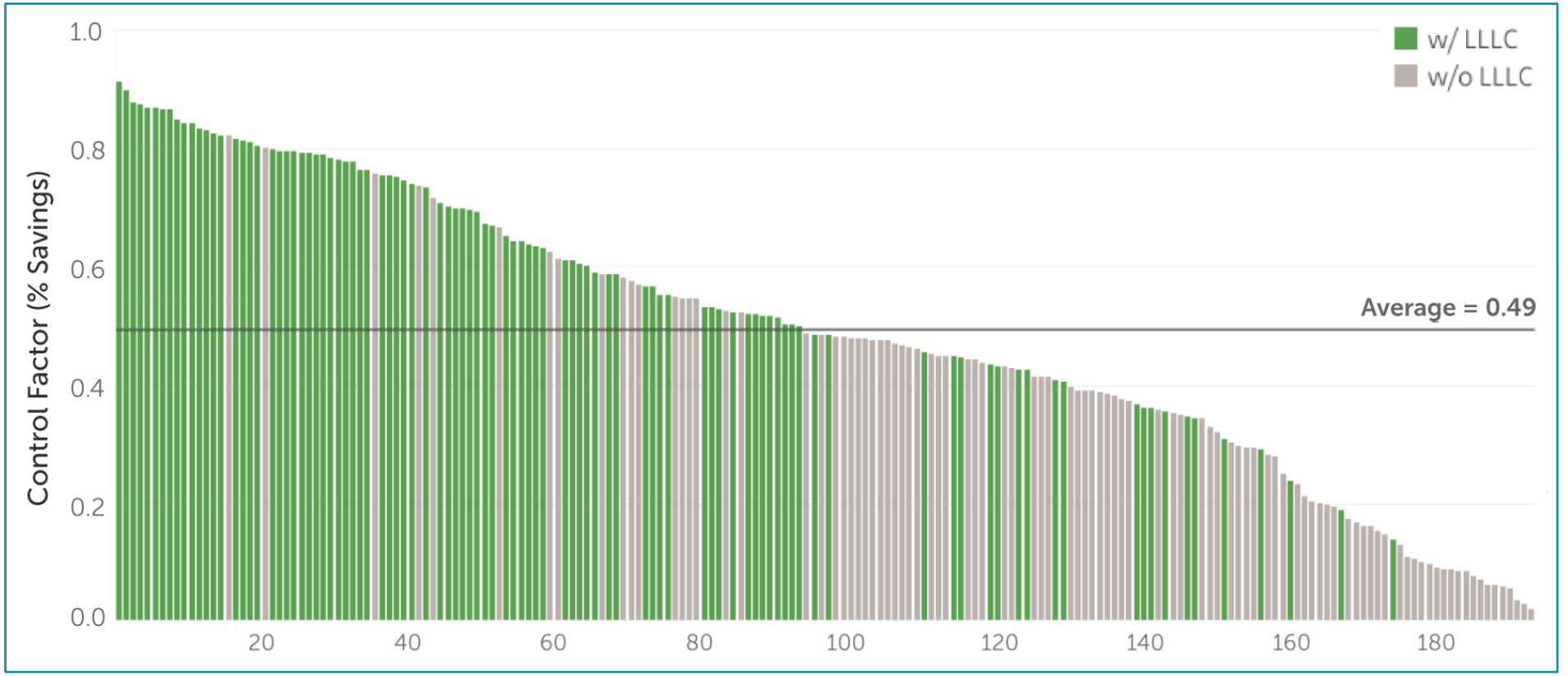
Site-specific variation is the largest driver of savings

- Control strategies used and the settings for those strategies
- Site characteristics, occupancy, user behavior



Savings for NLCs with LLLC

Average control factor for NLCs with LLLC is 0.63.



Existing Building Applications

- Aesthetic and ergonomic improvements
- Significant energy savings
- Non-invasive comprehensive controls upgrade (wireless control)
- Task tuning/fixture-level customization
- Future-flexibility
- Help meet WA or other Building Performance Standards

Very High Efficiency Dedicated Outdoor Air Systems (DOAS)

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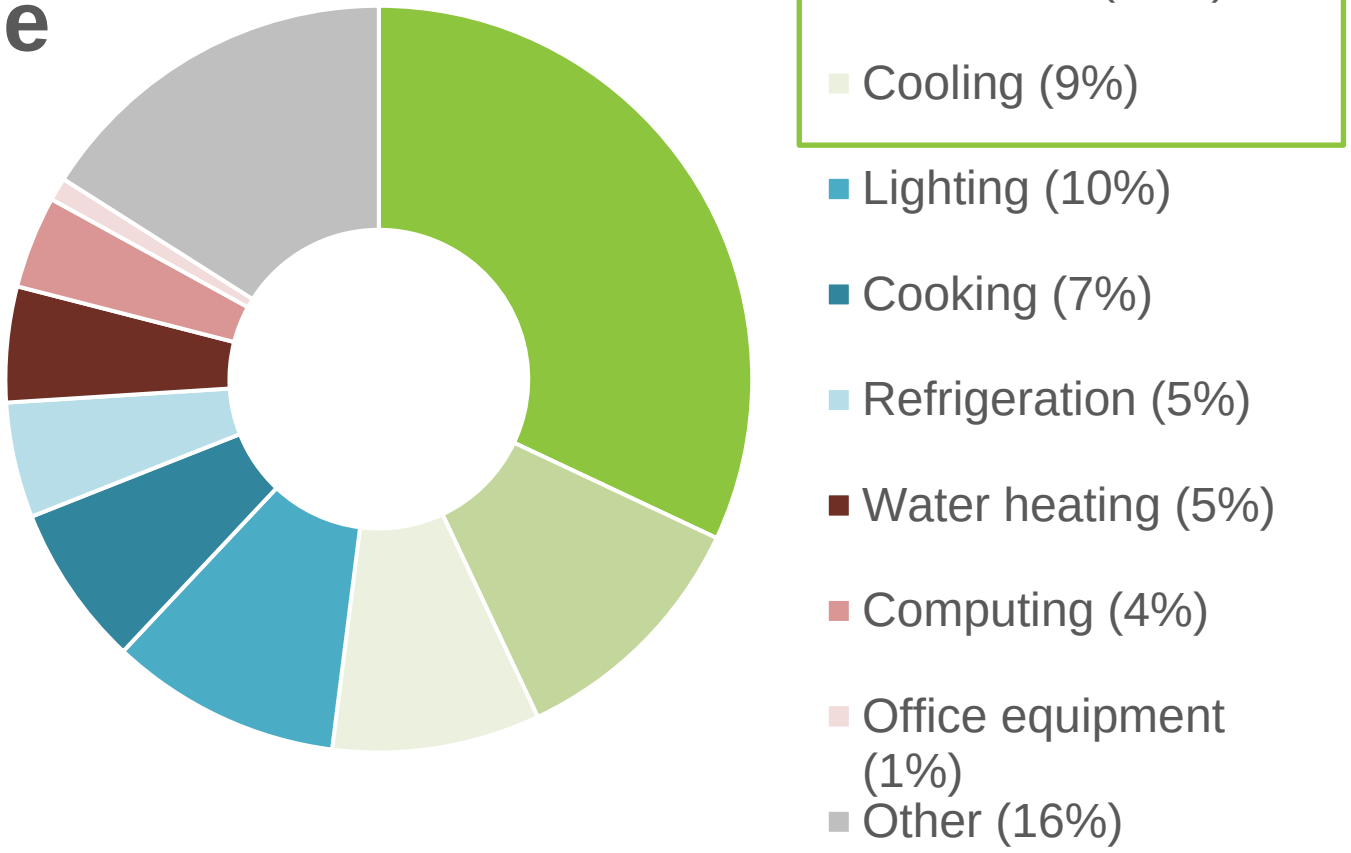
Powerful Energy Ideas. Delivered by NEEA.

The average building spends 52% of its energy and money operating the heating, cooling and ventilation systems

Major fuels consumption by end use (2018)



Source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*; Note: Btu = British Thermal Units

Ventilation and Indoor-Air Quality

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YOUR HEALTH

Scientists Probe Indoor Work Spaces for Clues to Better Health

Office buildings are used as labs to determine optimum environmental conditions

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

News

> News > Press Releases > 2021 Release > Office air quality may affect employees' cognition, productivity

NEWS

Office air quality may affect employees' cognition, productivity

For immediate release: Thursday, September 9, 2021

Boston, MA – The air quality within an office can have significant impa

NATIONAL GEOGRAPHIC

Natural light infuses Virginia's Manassas Park Elementary, described as a suburban school in the woods. A study showed that students in classrooms with more natural light scored 25 percent higher on standardized tests than other students in the same school district.
PHOTOGRAPH BY SAM KITTNER, NAT GEO IMAGE COLLECTION

SUSTAINABILITY SPOTLIGHT

5 Surprising Ways Buildings Can Improve Our Health

The latest trends in green design go far beyond energy and water efficiency to improve our daily lives.

Bloomberg Opinion

Improving Ventilation Will Stop More Than Covid-19

All airborne pathogens — including viruses that cause colds and flu — spread quickly in buildings without proper air circulation and filtration.

Science

POLICY FORUM

INFECTIOUS DISEASE

A paradigm shift to combat indoor respiratory infection

Building ventilation systems must get much better

By Lidia Morawska, Joseph Allen, William Bahnfleth, Philomena M. Bluyssen, Atze Boerstra, Giorgio Buonanno, Junji Cao, Stephanie J. Dancer, Andres Floto, Francesco Franchimon, Trisha Greenhalgh, Charles Haworth, Jaap Hogeling, Christina Isaxon, Jose L. Jimenez, Jarek Kurnitski, Yuguo Li, Marcel Loomans, Guy Marks, Linsey C. Marr, Livio Mazzarella, Arsen Krikor Melikov, Shelly Miller, Donald K. Milton, William Nazaroff, Peter V. Nielsen, Catherine Noakes, Jordan Peccia, Kim Prather, Xavier Querol, Chandra Sekhar, Olli Seppänen, Shin-ichi Tanabe, Julian W. Tang, Raymond Tellier, Kwok Wai Tham, Pawel Wargocki, Aneta Wierzbicka, Maosheng Yao

There is great disparity in the way we think about and address different sources of environmental infection. Governments have for decades promulgated a large amount of legislation and invested heavily in food safety, sanitation, and drinking water for public health purposes. By contrast, airborne pathogens and respiratory infections, whether seasonal influenza or COVID-19, are addressed fairly weakly, if at all, in terms of regulations, standards, and building design and operation, pertaining to the air we breathe. We suggest that the rapid growth in our understanding of the mechanisms behind respiratory infection transmission should drive a paradigm shift in how we view and address the transmission of respiratory infections to protect against unnecessary suffering and of pathogens, with morbidity and mortality risks now well established. By contrast, have been enacted for all aspects of food and water processing, as well as wastewater and sewage. Public health officials, environmental health officers, and local councils are trained in surveillance, sampling, and investigation of clusters of potential food and waterborne outbreaks, often alerted by local microbiology laboratories. There are published infection rates for a large range was on thermal comfort, odor control, perceived air quality, initial investment cost, energy use, and other performance issues, whereas infection control was neglected. This could in part be based on the lack of perceived risk or on the assumption that there are more important ways to control infectious disease, despite ample evidence that healthy indoor environments with a substantially reduced pathogen count are essential for public health.

"...healthy indoor environments with a substantially reduced pathogen count are essential for public health."

It is now known that respiratory infections are caused by pathogens emitted through the nose or mouth of an infected person and transported to a susceptible host. The pathogens are enclosed in fluid-based particles aerosolized from sites in the respiratory tract during respiratory activities such as breathing, speaking, sneezing, and coughing. The particles encompass a wide size range, with most in the range of submicrometers to a few micrometers (1).

Although the highest exposure for an individual is when they are in close proximity, community outbreaks for COVID-19 infection in particular most frequently occur at larger distances through inhalation of airborne virus-laden particles in indoor spaces shared with infected individuals (2). Such airborne transmission is potentially the dominant mode of transmission of numerous respiratory infections. There is also strong evidence on disease transmission—for example, in restaurants, ships, and schools—suggesting that the way buildings are designed, operated, and maintained influences transmission.

Yet, before COVID-19, to the best of our knowledge, almost no engineering-based measures to limit community respiratory infection transmission had been employed

Key Elements of Very High Efficiency DOAS

This optimized, high-performance approach to HVAC combines high-efficiency equipment with design best practices, including:

1

High efficiency heat / energy recovery ventilator (HRV/ERV)

That features 82% or greater sensible effectiveness.

2

High-performance heating and cooling

Using an electric heat pump system that meets ENERGY STAR performance standards.

3

Ventilation fully separated from the heating and cooling

4

Right-sized heating and cooling equipment

Why Very High Efficiency DOAS?

Improves indoor air quality

due to filtered 100% outside air being brought into the space, with little to no recirculation.

Saves energy and money

by reducing building energy use by an average of 48%, and HVAC energy use by an average of 69%.

Increases occupant comfort

through improved temperature stability and the ability to create zones with unique temperature controls.

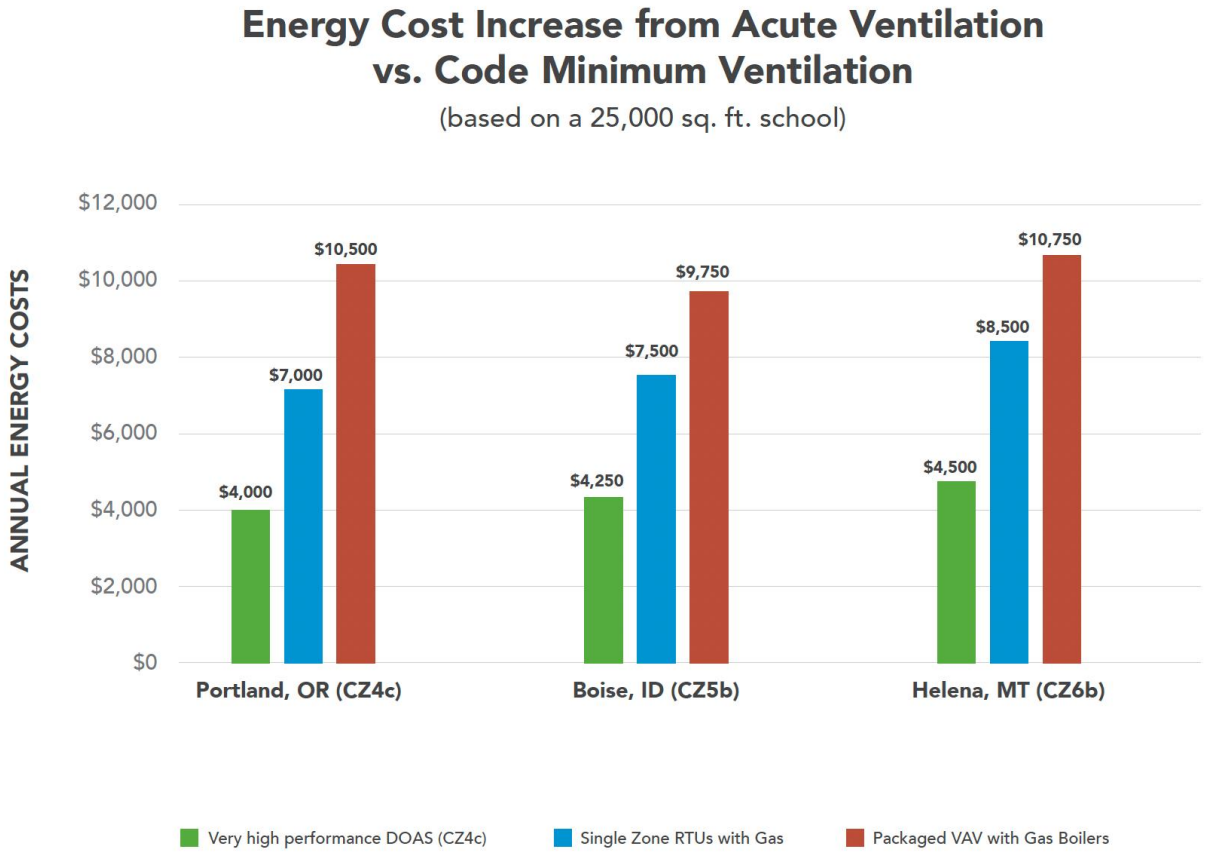
Meets/Exceeds 2018 WSEC

for DOAS in many building types.

Indoor Air Quality

Resilient HVAC doesn't have to cost so much to operate.

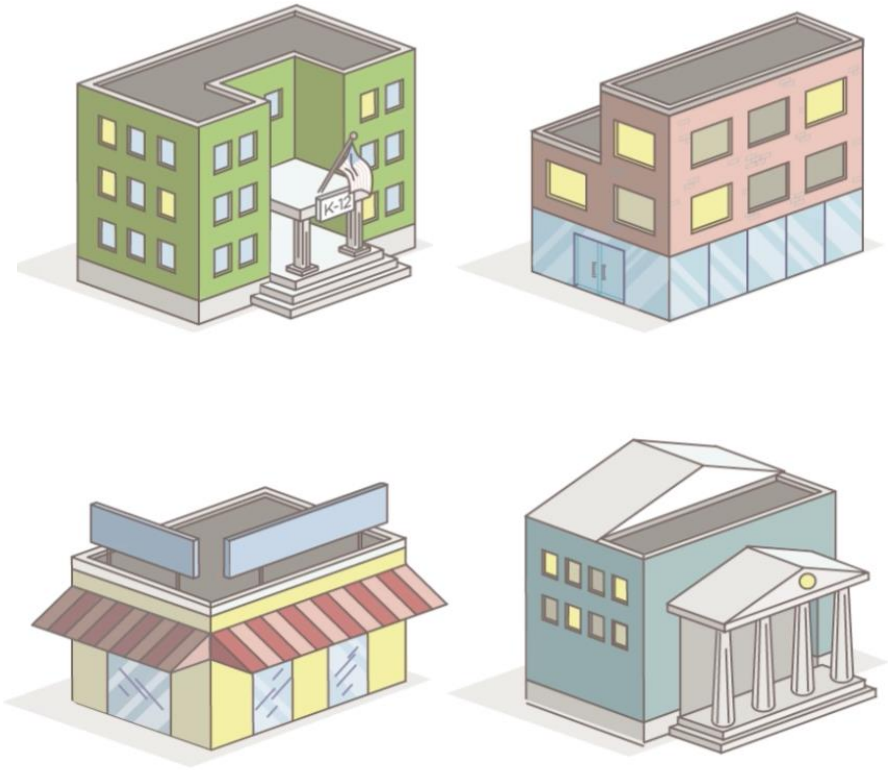
A recent study found that very high efficiency DOAS was able to significantly increase ventilation rates which can reduce viral risk while using **up to 37% less energy** than than a similar high-ventilation variable air volume (VAV) system.



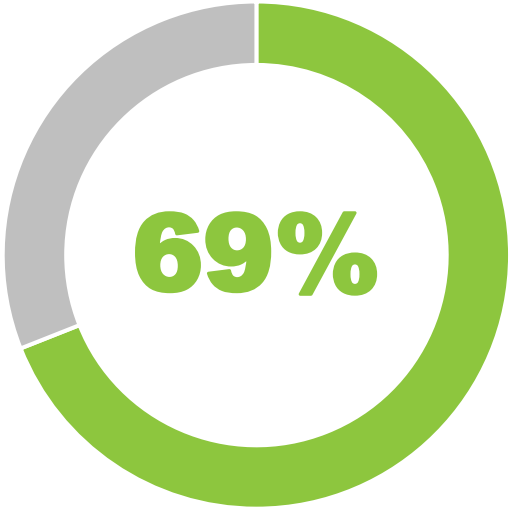
Source: betterbricks.com/resources/covid-19-hvac-risk-reduction-strategies

Ideal Building Types

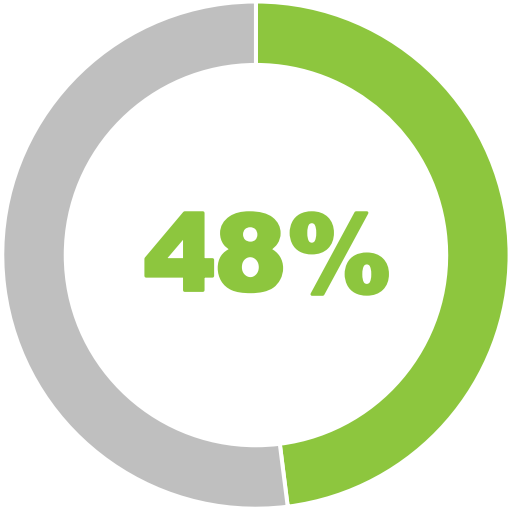
- Small-to-medium sized buildings, less than 50k sq. ft.
- Both new construction and major renovations
- Schools, office, government, retail and multifamily



A proven approach to high-performance HVAC



HVAC ENERGY SAVINGS*



WHOLE-BUILDING ENERGY SAVINGS*

12 pilots using the very high efficiency DOAS approach in small-to-medium commercial buildings across the NW proved significant average energy savings—based on if the building had started with standard code-minimum equipment.

**When compared to a code-minimum version of the existing equipment (often a packaged rooftop unit)*

CASE STUDY

Seattle Office Building [5,911 sq. ft.]

EXISTING SYSTEM:

VAV system: combined heating capacity, incl. re-heat coils in VAV distribution units

(16.4 tons heating, 14 tons cooling)

NEW SYSTEM:

1 Mitsubishi VRF
1 Ventacity Systems 1000RT HRV

(15.6 tons heating, 14 tons cooling)

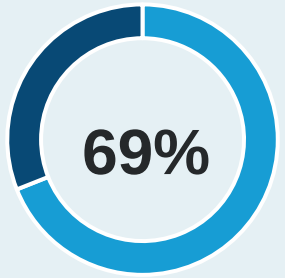
51.3
Existing Building EUI

29.7
New System Building EUI

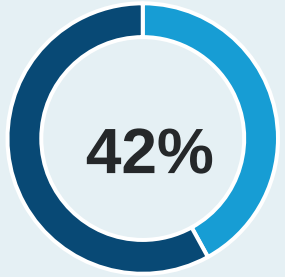
PEAK CHANGE:

-30 kW
Winter

-6 kW
Summer



reduction in total HVAC energy use

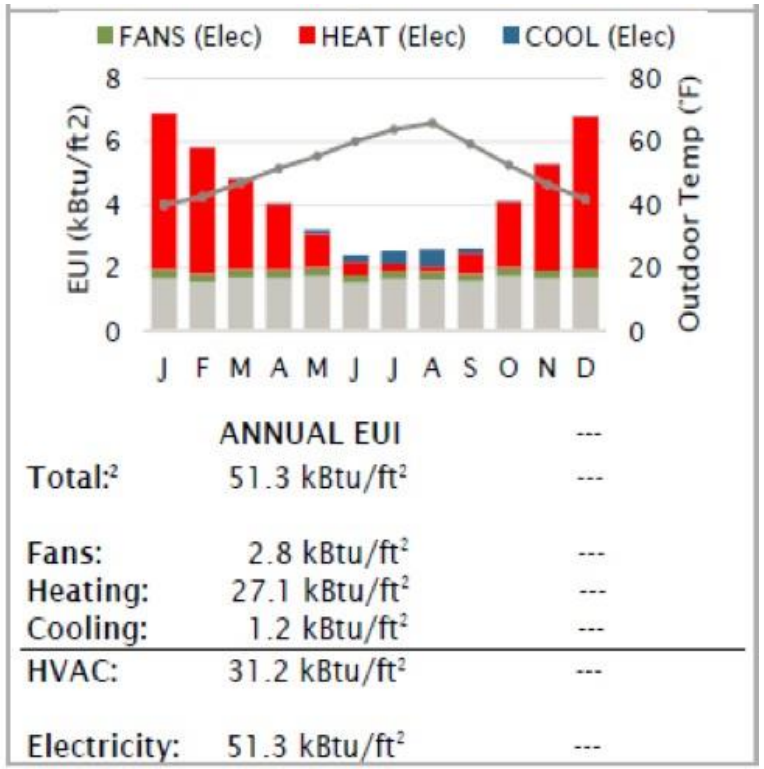


reduction in total building energy use

Seattle Office Building (cont'd)

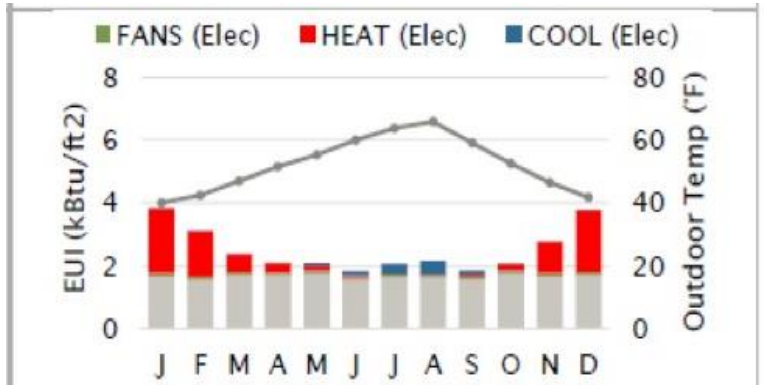
PRE-CONVERSION

BASELINE HVAC SYSTEM (new RTUs)



	ANNUAL EUI	---
Total:[2]	51.3 kBtu/ft²	---
Fans:	2.8 kBtu/ft²	---
Heating:	27.1 kBtu/ft²	---
Cooling:	1.2 kBtu/ft²	---
HVAC:	31.2 kBtu/ft²	---
Electricity:	51.3 kBtu/ft²	---

VHE DOAS CONVERSION SYSTEM



	ANNUAL EUI	ANNUAL SAVINGS	
Total:	29.7 kBtu/ft²	21.6 kBtu/ft²	- 42%
Fans:	0.9 kBtu/ft²	1.9 kBtu/ft²	- 68%
Heating:	7.9 kBtu/ft²	19.2 kBtu/ft²	- 70%
Cooling:	0.8 kBtu/ft²	0.5 kBtu/ft²	- 28%
HVAC:	9.6 kBtu/ft²	21.6 kBtu/ft²	- 69%
Electricity:	29.7 kBtu/ft²	21.6 kBtu/ft²	- 41%

POST-CONVERSION

→ Pre- and post-conversion energy consumption are based on a typical meteorological year (TMY)
→ Models updated based on several months of sub-metered energy end-use data and utility bills.

CASE STUDY

Seattle Airport Terminal [24,300 sq. ft.]

BUILT: 1930

EXISTING SYSTEM:

3 packaged RTUs
(95 tons)

NEW SYSTEM:

3 high-efficiency HRV,
VRF heat pump system
(32 tons)

122
Existing Building EUI

48.1
New System Building EUI

PEAK CHANGE:

0 kW
Winter

-79 kW
Summer

reduction in total HVAC energy use

reduction in total building energy use

Seattle Airport Terminal (cont'd)

(MODELED) PRE-CONVERSION HVAC SYSTEM W/NEW CODE MINIMUM EQUIPMENT

	ANNUAL EUI	---
Total:	122.0 kBtu/ft²	---
Fans:	33.9 kBtu/ft²	---
Heating:	45.5 kBtu/ft²	---
Cooling:	7.9 kBtu/ft²	---
HVAC:	87.3 kBtu/ft²	---
Electricity:	76.8 kBtu/ft²	---
Gas:	45.3 kBtu/ft²	---

1 Minor additive discrepancies are due to rounding.

(MODELED) POST-CONVERSION HVAC SYSTEM W/NEW DOAS HRV + VRF SYSTEM

	ANNUAL EUI	ANNUAL SAVINGS
Total:	48.1 kBtu/ft²	73.9 kBtu/ft²
Fans:	2.8 kBtu/ft²	31.2 kBtu/ft²
Heating:	8.1 kBtu/ft²	37.3 kBtu/ft²
Cooling:	2.4 kBtu/ft²	5.5 kBtu/ft²
HVAC:	13.3 kBtu/ft²	73.9 kBtu/ft²
Electricity:	47.4 kBtu/ft²	29.4 kBtu/ft²
Gas:	0.7 kBtu/ft²	44.6 kBtu/ft²

Seattle Airport Terminal (cont'd)

BEFORE

AFTER

Learn more

- Case studies
- Pilot report details and findings
- Design requirements and guidelines
- Qualifying ERV/HRV manufacturers and products
- Research, including economic and indoor air quality analyses

betterbricks.com/solutions/very-high-efficiency-doas

NEEA Research

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You are the voice of the market

To make energy efficiency available to everyone, we need to hear from the whole market, including you.

We frequently sponsor studies to:

- Understand and improve product performance
- Learn opinions about new green technologies
- Improve energy efficiency programs
- Understand installation and maintenance challenges
- Improve access to energy efficient technologies

If you are contacted by a research company to join a NEEA study, we hope you will participate.

We will only ever ask for your honest opinions, expertise, experiences, and ideas.

Sign-up to our newsletter to stay informed of our latest research: ***neea.org/subscribe***

Agenda

1) Introduction
2) Energy Saving Opportunities
3) Technology Deep Dives
    a) Pumps and Circulators
    b) Secondary Windows
    c) Advanced Lighting Controls
    d) High-performance HVAC
4) Q&A/Discussion

Thank You

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Visit us at:
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Appendix

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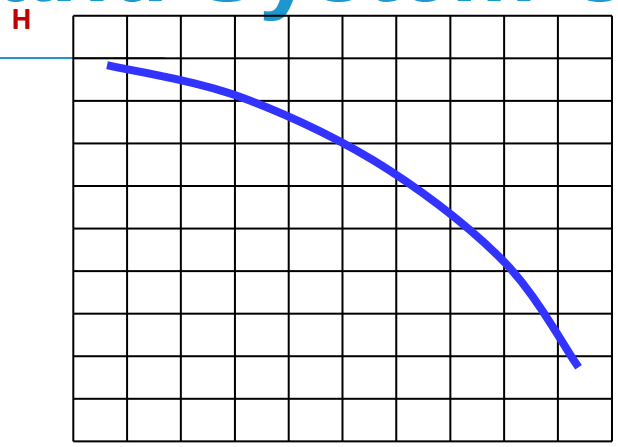
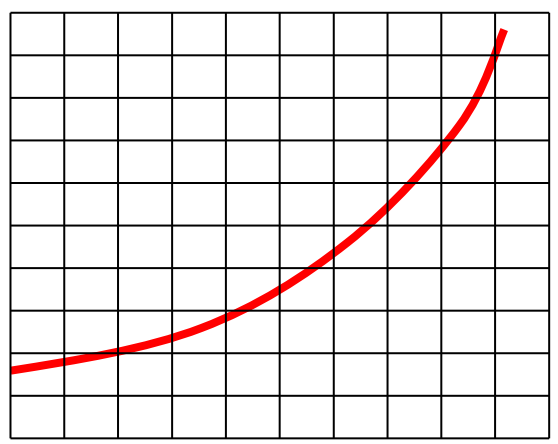
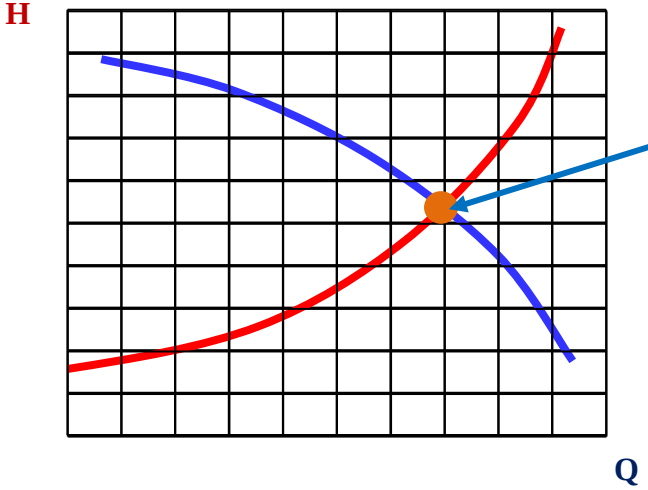
Pump and System Curves



Pump Curve
-Speed
-Impeller Dia.



System Curve
-Static Head
-Friction

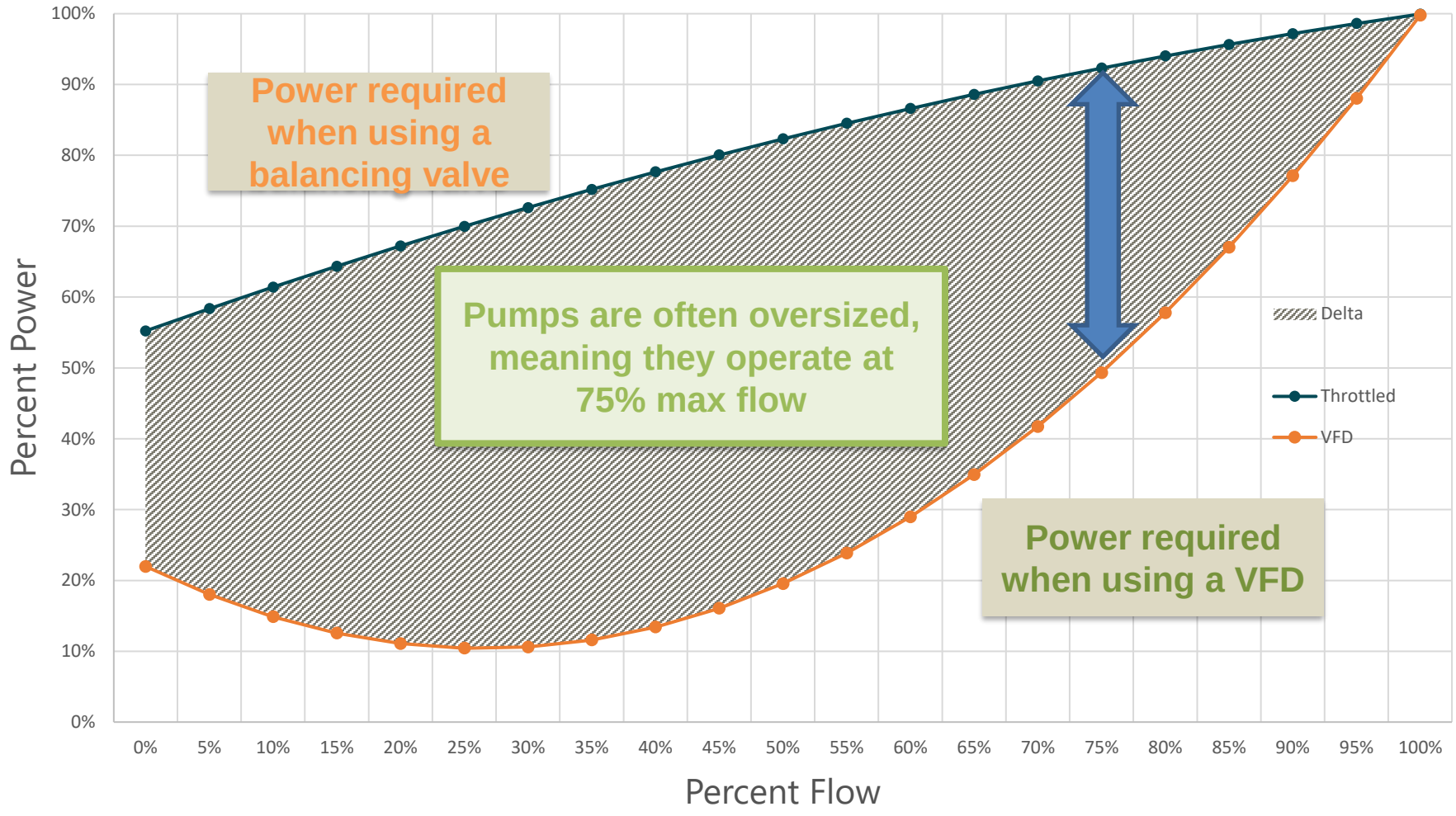


H = Head
Q = Flow
● = operating point

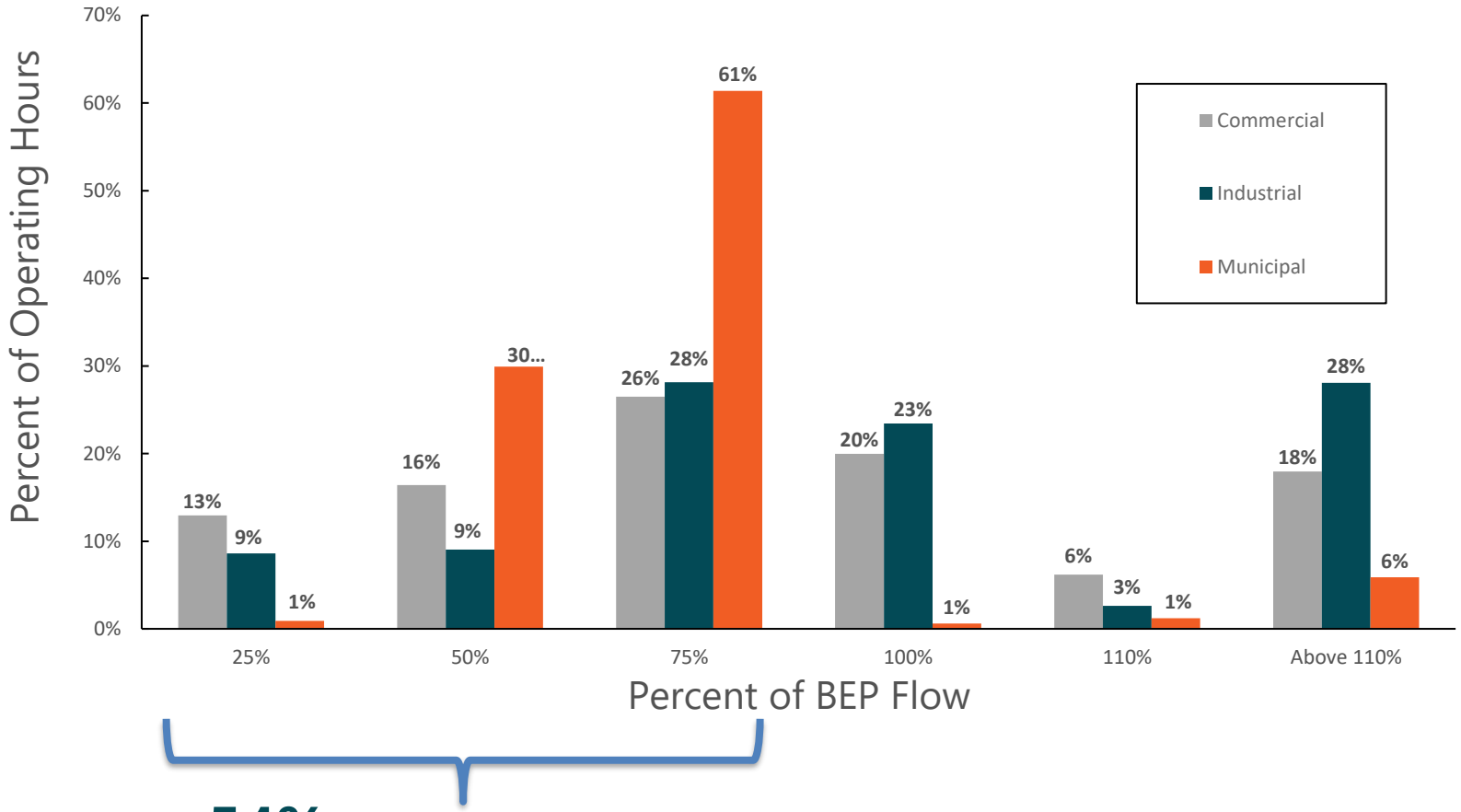
For fixed speed pumps, the operating point is located at the intersection of the pump and system curves.

Even Constant Load Systems can See Energy Savings

At 75% flow, 43% input power reduction



Constant load pumps are generally oversized



54%

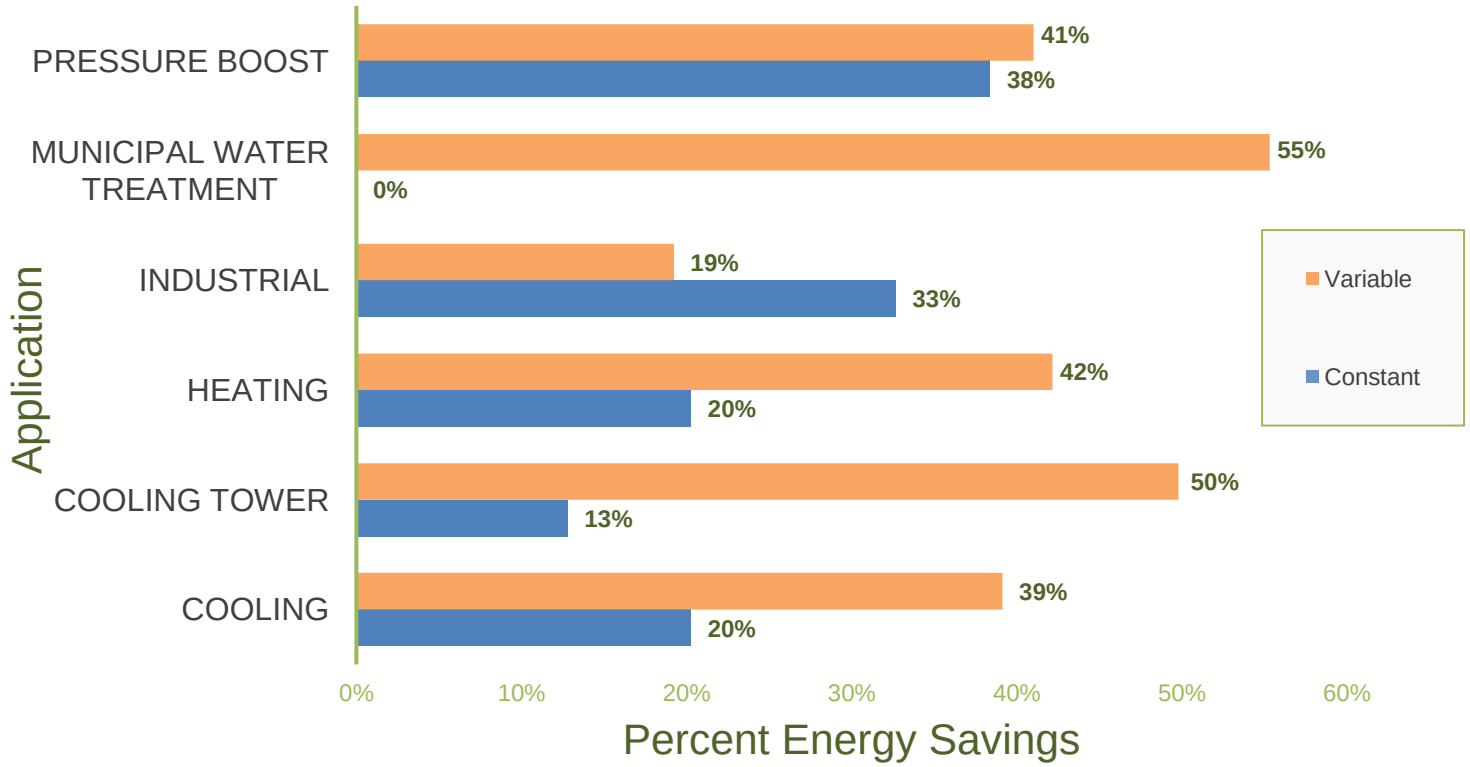
46%

92%

Source: 2019 NEEA Pumps research
https://neea.org/resources/extended-motor-products-savings-validation-research-on-clean-water-pumps-and-circulators

Savings Potential for Pumps

Load Type	Percent Energy Savings
Constant	23%
Variable	43%



neea

June 16, 2020

REPORT #E20-313

Power Drive Systems: Energy Savings and Non-Energy Benefits in Constant & Variable Load Applications

https://neea.org/resources/power-drive-systems-energy-savings-and-non-energy-benefits-in-constant-variable-load-applications

Operations & Maintenance Best Practices

- Unusual noise?
- Vibration?
- Leaks?
- Pressure gauges still working?
- Suction diffusors & pump strainers maintained?
- VFD operating correctly?
- Alignment?
- Mechanical seals correctly packed, sized, due for replacement?
- Operating per requirements in operating manual / retro-commissioning?

Technical Insights for Capital Projects

- Consider piping diameter. Larger diameter pipe means less friction loss, which leads to a more efficient pump system
- ER label gives you lab tested performance that highlights energy performance differences in one simple number
- Pump Savings Calculator – run your own numbers
- Skid systems using smart pumps in parallel with a control unit to dispatch the most efficient configuration to meet varying system demand

Thank You

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