The Role of Building Maintenance in Energy Efficiency and Building Operations

Energy Audits of Alaska

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Unhappy occupants

High vacancy

Lost revenue

Increased & unplanned capital expenses

Reduced profit

The Role of Building Operations in Energy Efficiency

Operating schedules & strategies – Lighting, HVAC, occupancy, vacancy management

Temperature & ventilation set points

Heating and cooling reset schedules

Lock outs

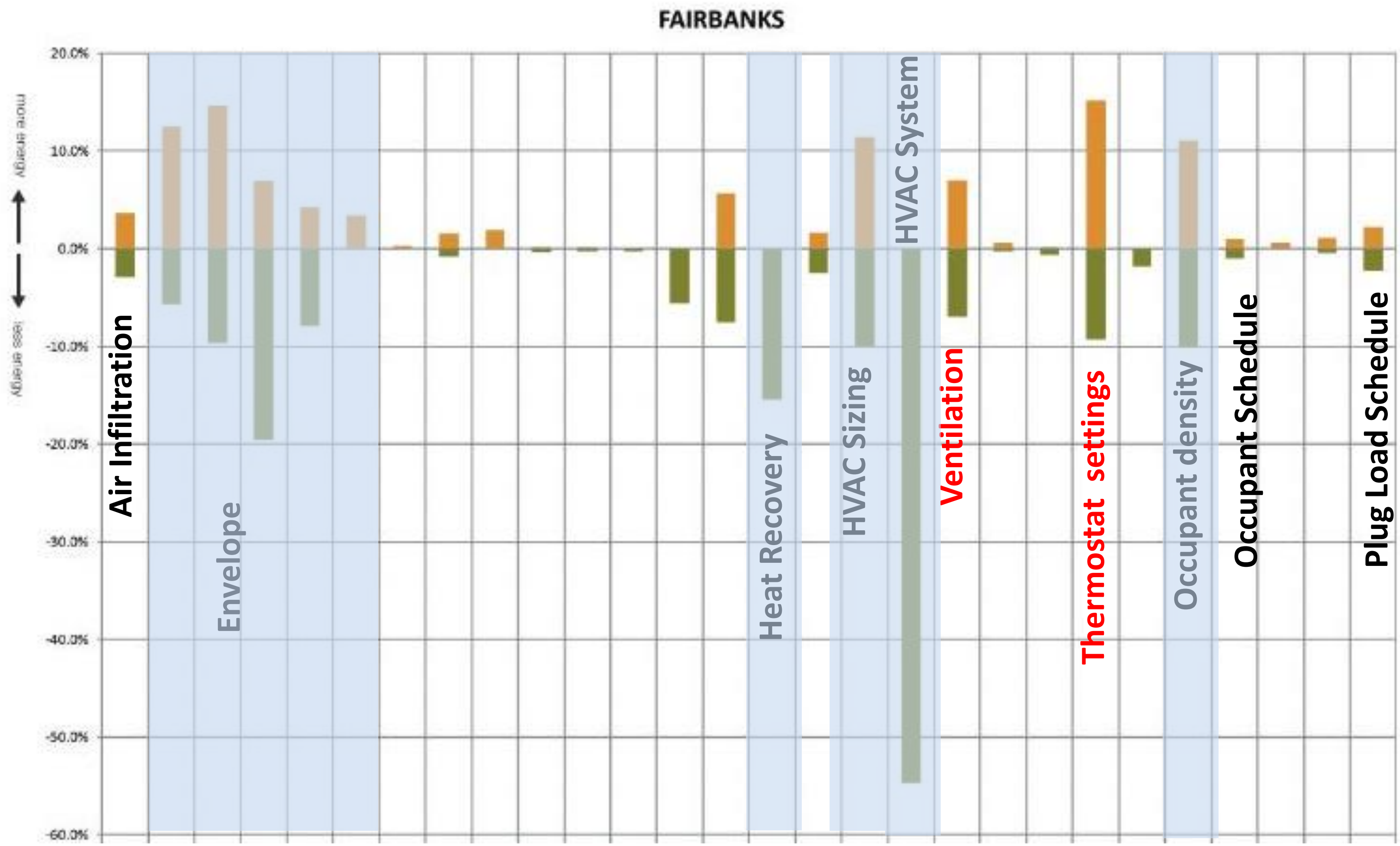
Seasonal shut downs

Optimum start/stop strategies

Building Maintenance and Energy Efficiency

"A sound operation and maintenance program for a facility not only includes maintenance plans and activities but also emphasizes operating equipment in the most energy-efficient manner."

Putting the "O" back in O & M; Portland Energy Conservation, Inc., R. Mosier



Sensitivity Analysis (for Fairbanks): Comparing the Impact of Design, Operation, and Tenant Behavior on Building Energy Performance.

New Buildings Institute, 2011, Heller, Heater & Frankel

Commercial, Industrial and Municipal Energy Audits

Building Maintenance and Energy Efficiency

5,000 public buildings *
SWAG 8,000+ non-residential buildings

* A White Paper on Energy Use in Alaska's Public Facilities; AHFC, Armstrong, et. al. 2012

Building Maintenance and Energy Efficiency

5,000 public buildings
SWAG 8,000+ non-residential buildings

How many have integrated maintenance and operations with energy efficiency?

Building Maintenance and Energy Efficiency

5,000 public buildings

SWAG 8,000+ non-residential buildings

2-3%


maintenance
efficiency

Today

- Who cares…and who should care…
- What's in the way
- Examples
- Plan of action & Best Practices

Who should care?

Owner/operator
Maintenance team/group/individual

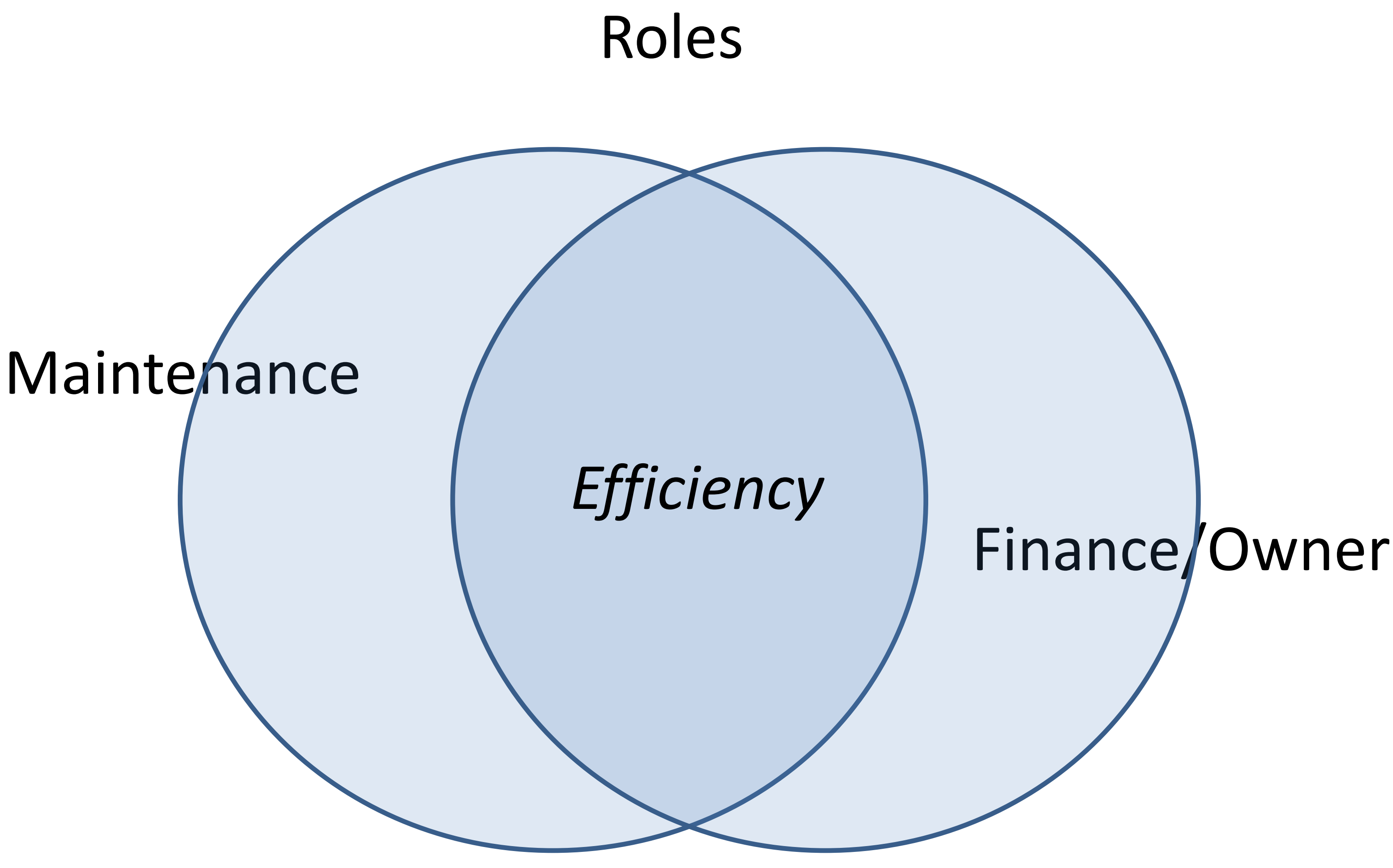
Organizational Level

Roles

Maintenance
- Repair broken equipment (like for like)
- Maintain existing systems
- Respond to comfort complaints
- Preventative maintenance procedures

Finance/Owner
- Watch bottom line
- Cost increases
- Variance based
- Writes checks
- Budget management

Organizational Level



good maintenance ≠ high efficiency

poor maintenance = low efficiency

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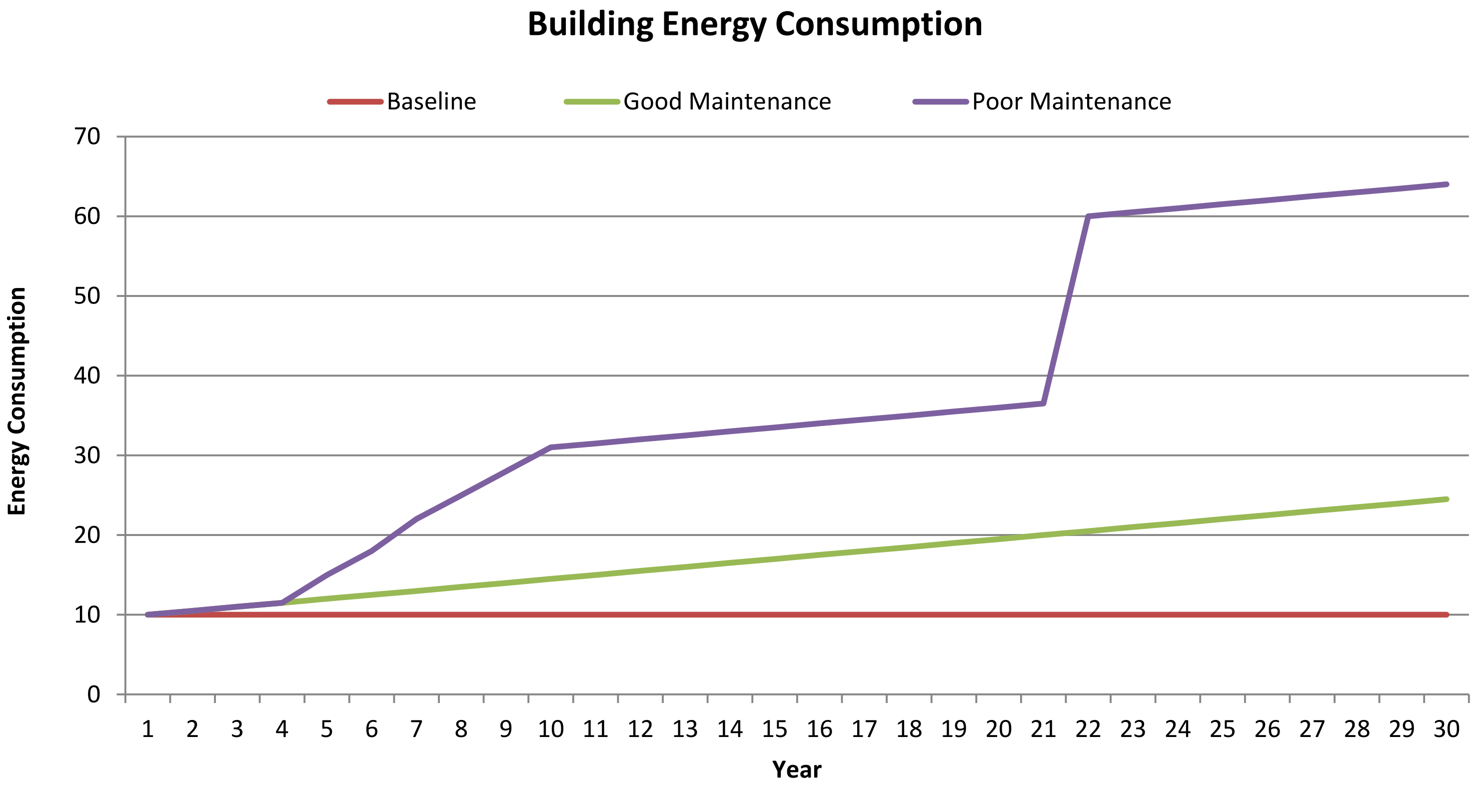
poor maintenance = low efficiency



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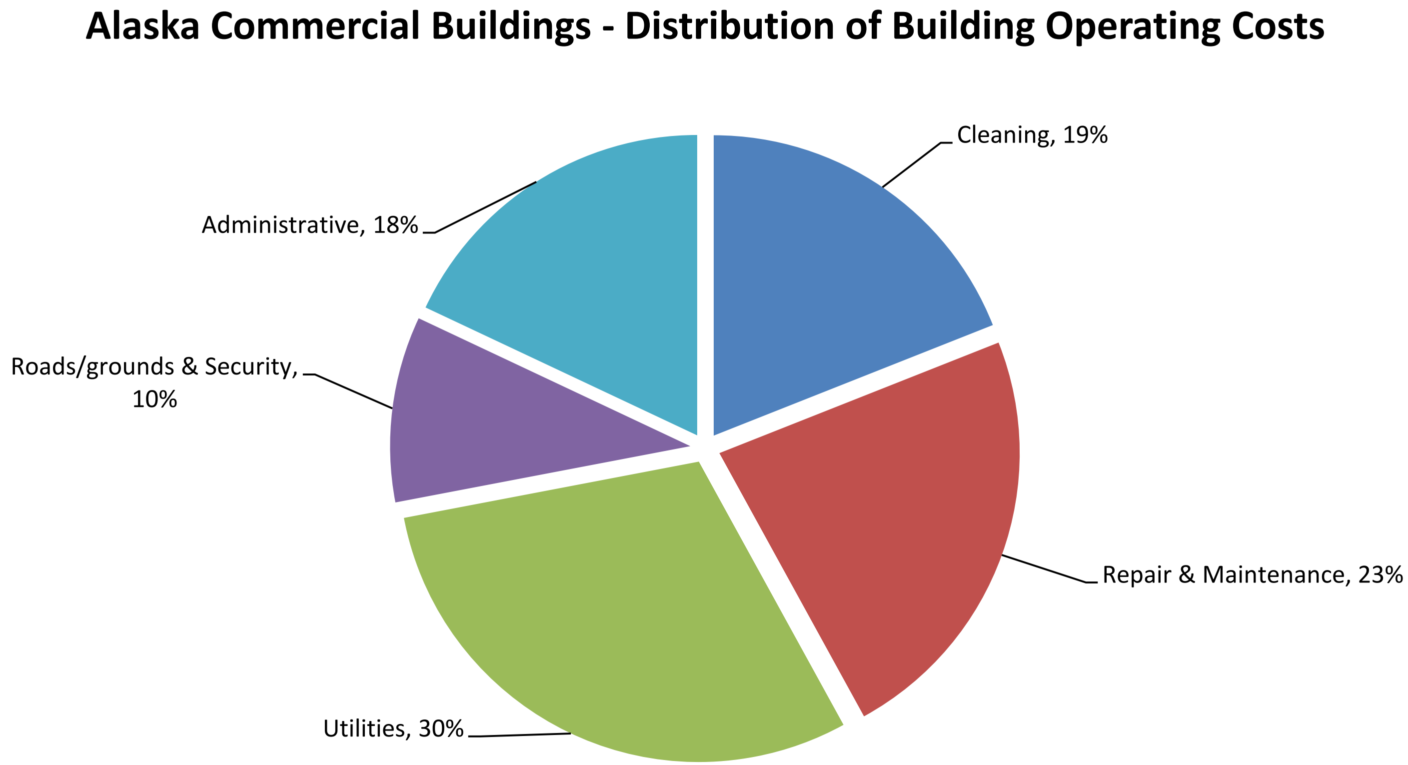
Why they should care…



Source: BOMA Experience Exchange Report – based on continental US average; data adjusted for +50% higher use of energy in Alaska buildings

Why they should care…

“Building operation and maintenance programs specifically designed to enhance operating efficiency of HVAC and lighting systems can save 5 to 20 percent of the energy bills without significant capital investment.”

“15 Best O & M Practices”, Portland Energy Conservation, Inc., Tudi Haasl; funded by US EPA, Climate Protection Division, 1999

Why they should care…

- 10% of 30% = 3% to bottom line
- More budget to organization's mission
- Higher profits
- Economic expansion
- Offset budgetary cuts

- Stop wasting energy

Why they should care…

"Buildings are responsible for 30 to 40 percent of global energy use. In 2009, commercial buildings in particular consumed 28 percent of the total energy used by the built environment…"

Energy Information Administration, 2010

US Energy Information Administration (EIA)

State Energy Efficiency Scorecard – 8 years

"…measures the progress of state policies and programs that save energy while also benefiting the environment and promoting economic growth…"

How is Alaska doing?

US Energy Information Administration (EIA)

State Energy Efficiency Scorecard – 8 years

Top 4:
Massachusetts
California
Rhode Island
Oregon

"…measures the progress of state policies and programs that save energy while also benefiting the environment and promoting economic growth…"

US Energy Information Administration (EIA)

State Energy Efficiency Scorecard – 8 years

Top 4:
Massachusetts
California
Rhode Island
Oregon

Bottom 4:
Alaska
North Dakota
Wyoming
Minnesota

"…measures the progress of state policies and programs that save energy while also benefiting the environment and promoting economic growth…"

US Energy Information Administration (EIA)

State Energy Efficiency Scorecard – 8 years

Top 4:
Massachusetts, $.142
California, $.147
Rhode Island, $.135
Oregon, $.085

Bottom 4:
Alaska, $.165
North Dakota, $.808
Wyoming, $.088
Minnesota, $.092

Average retail price of electricity, commercial end use sector, compiled by ElectricChoice.com, Eisenbach Consulting, LLC, 2013

US Energy Information Administration (EIA)

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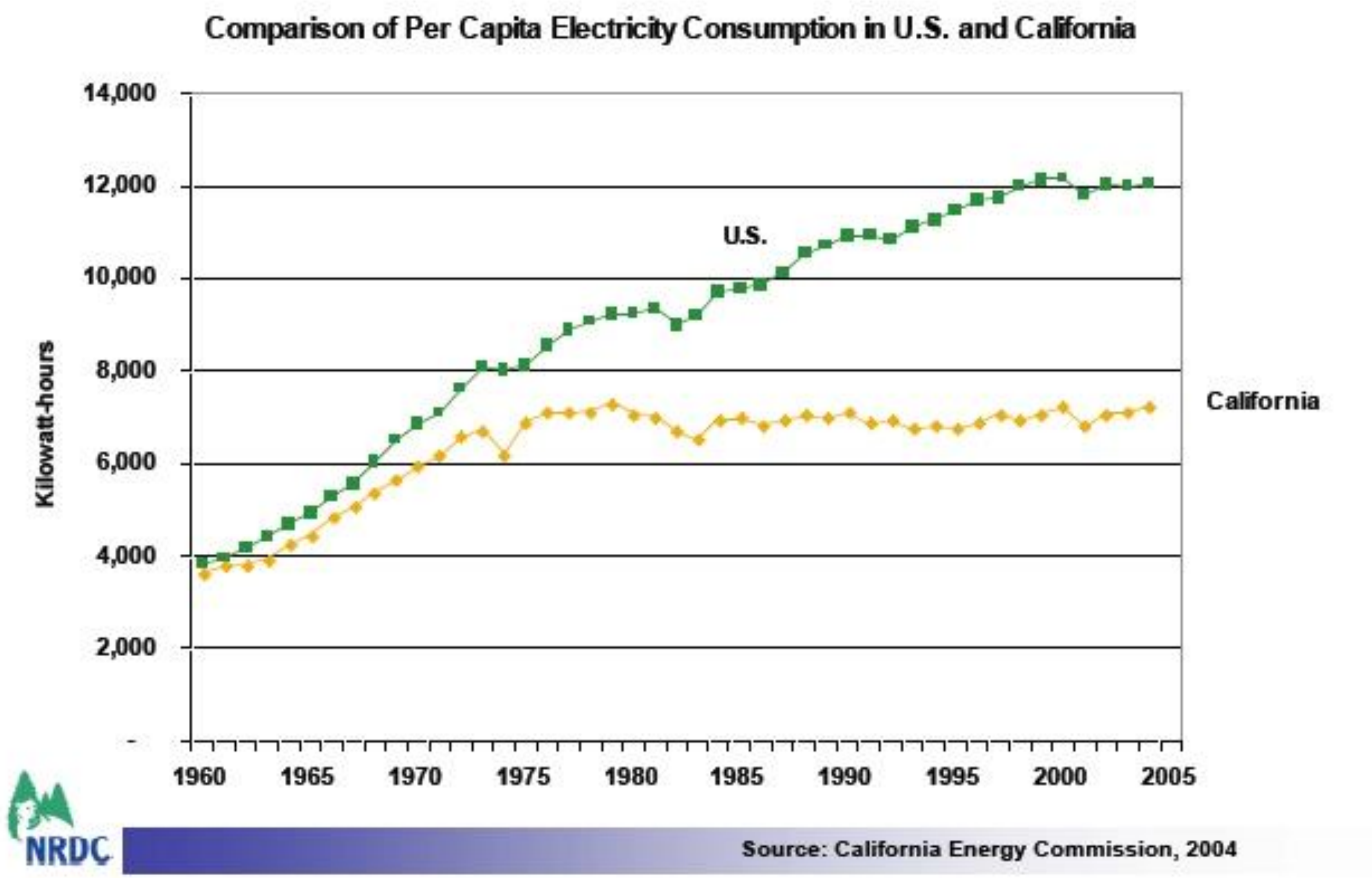
Hawaii, $.346/kWh

Average retail price of electricity, commercial end use sector, compiled by ElectricChoice.com, Eisenbach Consulting, LLC, 2013



The impact of State policies and programs

What's in the way…

What's in the way…

New buildings versus existing buildings

Architects

Engineers

Contractors

What's in the way…

Owners

The design process: Committee based, historically non-collaborative process

Owner:

Operations/Maintenance not involved from beginning
Cost savings
Utilization per square foot
Lack of energy awareness

What's in the way…

The design process: Committee based, historically non-collaborative process

Owner:

Operations/Maintenance not involved from beginning
Cost savings
Utilization per square foot
Lack of energy awareness

Architect:

Training – 30-40 yr building operating life not considered
Code minimums
No energy focus
Don't ask for operator input
Box engineer in from before they start

Building maintenance and Energy Efficiency

Not so nice…

Nice…

Building maintenance and Energy Efficiency

What's in the way…

Engineer:

Lack of arctic experience

Code minimums

No energy focus

Field experience lacking

Dictated their space allocation

Changing building usage and occupancy

What's in the way…

Engineer:

Lack of arctic experience
Code minimums
No energy focus
Field experience lacking
Dictated their space allocation
Changing building usage and occupancy

"The Clevenger and Haymaker (2006) study on the impact of building occupancy on energy simulation models showed that estimated energy consumption can change by more than 150 percent when occupants with different energy consumption rates were considered."

An Agent Based approach to Model the Effect of Occupants' Energy Use…Azar & Menassa

What’s in the way…

“…research at Texas A&M University has found that in almost all older buildings, and even in many new buildings, the use of the building is quite different from the original plan…”

Claridge, et al. 1998

What's in the way…

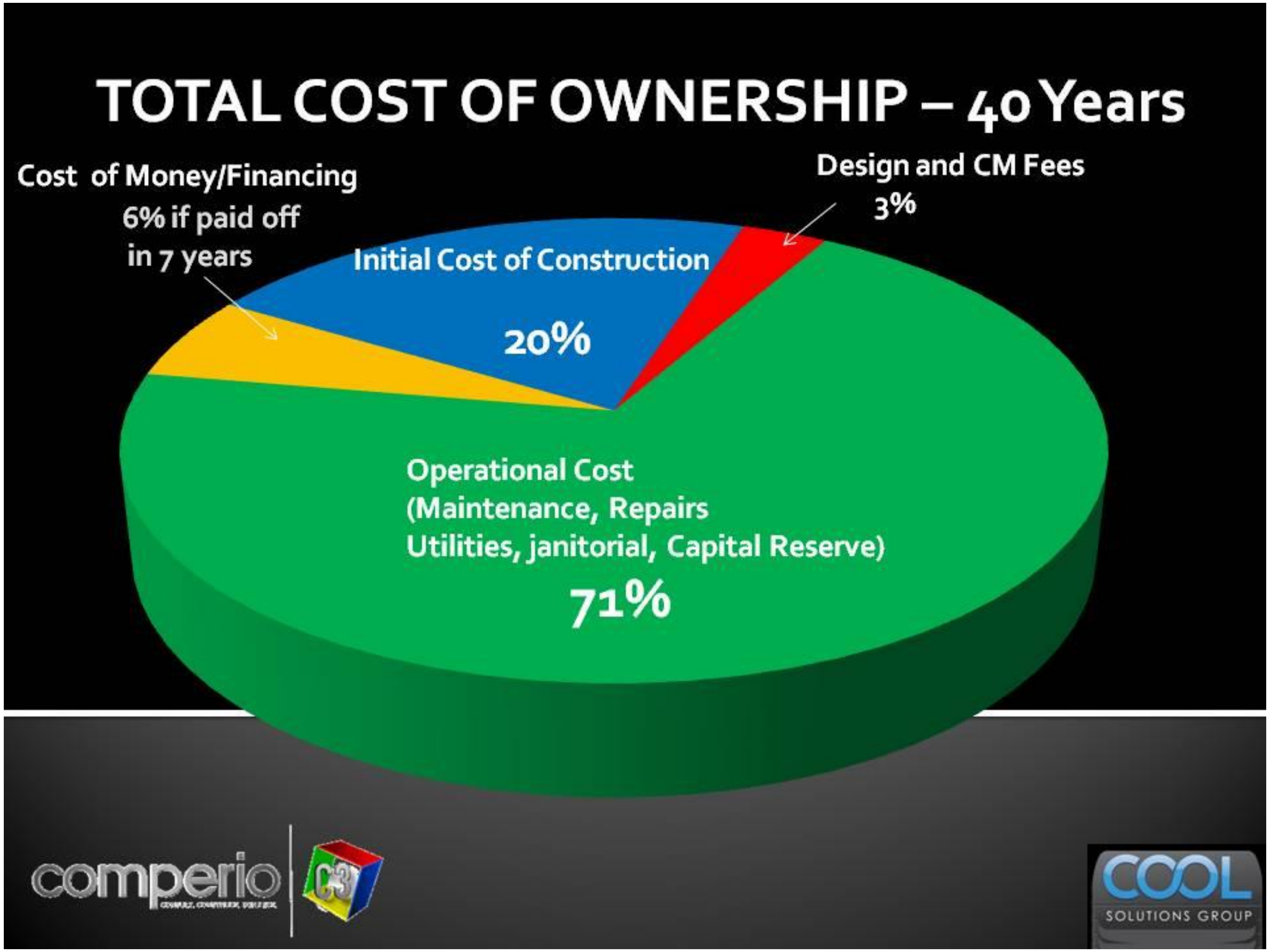
Engineer:

Lack of arctic experience
Code minimums
No energy focus
Field experience lacking
Dictated their space allocation
Changing building usage and occupancy

Contractor:

Easier to change it/move it/delete it
Poor or no commissioning
Doesn't understand the equipment
I've always done it this way…

Low cost design and engineering is very costly…



Source: Teamway Integrated Solutions, Greenville, SC

good maintenance ≠ high efficiency

poor maintenance = low efficiency

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poor maintenance = low efficiency

good operations & good maintenance = high efficiency

Building maintenance and Energy Efficiency

Building maintenance and Energy Efficiency

$1015/yr

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34,240 gallons DWH, $921/yr

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.5”wc SP
1760w
$594/yr ANC
$2,150/yr YAK

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$252/yr

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"The continual flow of waste heat into the school is causing the school to be over-heated much of the year. Often the occupants leave windows open during the day in order to attain some degree of cooling…caused by the pump in the generator shed being left on throughout the year…" Central Alaska Engineering Co., Slana K-12, Copper River SD

Yakutat K-6 + offices

January 2014, 37F

February 2015, 34F

Building maintenance and Energy Efficiency

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$169/yr

Building maintenance and Energy Efficiency

"There appears to be very little incentive to contain the cost of energy for facility operation because that energy cost is subsidized or completely paid for by others."

Richard S. Armstrong, PE, LLC

Building maintenance and Energy Efficiency

"There appears to be very little incentive to contain the cost of energy for facility operation because that energy cost is subsidized or completely paid for by others."

Richard S. Armstrong, PE, LLC

$14,935/yr

Objectives

- Operate building as efficiently as possible
- Operate existing equipment as efficiently as possible
- Maintain existing equipment, delay capital outlay (cost trade off)
- Replace old equipment with higher efficiency units at EOL
- Purchase reliable energy at lowest cost

Key Requirements

- Policy and Training - An energy management plan with metrics & training
- Business Systems - Energy accounting
- Staff - Energy Champion
- Hardware/software - Building Monitoring

Best Practices

Process – Policies and Activities

- Establish energy management plan and goals – collaboratively - initiated from top down, include:
  - comprehensive energy audit and prioritized recommendations
  - establish baselines
  - O & M assessment
  - operating budget
  - capital budget & equipment EOL replacement
  - catch up and tune up maintenance
  - measurement and verification plan – must include monitoring
- Incentivize efficiency at all levels
- Develop and refine customized metrics
- Require life cycle cost analysis for all new equipment
- Create embedded Energy Champion inside maintenance and operations staff
- Investigate spikes and anomalies quickly
- At least monthly monitoring (weekly and daily is better) and reporting to ownership or management
- Post dashboards for all stakeholders

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Best Practices

IF YOU DON'T MEASURE IT, YOU CAN'T MANAGE IT

Walmart: "…each month, the benchmarking analyst identifies the 20 poorest performing sites, and refers them for further investigation at the operations and maintenance level…"

University of California, Berkeley: "…Each day 8 person hours are dedicated to building by building HVAC equipment checks across 61 buildings. Appropriate on/off status and set-points are verified, and when problems are detected, the staff delves further into it…"

Microsoft: "We not only find the faults but monetize them"

Proctor & Gamble: …after an initial pilot project involving more than 3 million square feet of office, laboratory and research and development space, shaved 4.4 million kW off energy use just by optimizing building systems already in place.

Building Monitoring

Study of 60 buildings by LBNL*

- 40% had HVAC equipment problems
- 15% had missing equipment
- 50% were experiencing controls problems
- 25% had energy management systems, economizers and/or variable speed drives which were not functioning properly

* Lawrence Berkeley National Lab; Piette, et al, 1994

Building Monitoring

“Monitoring and Continuous Commissioning”

MCx

Building Monitoring

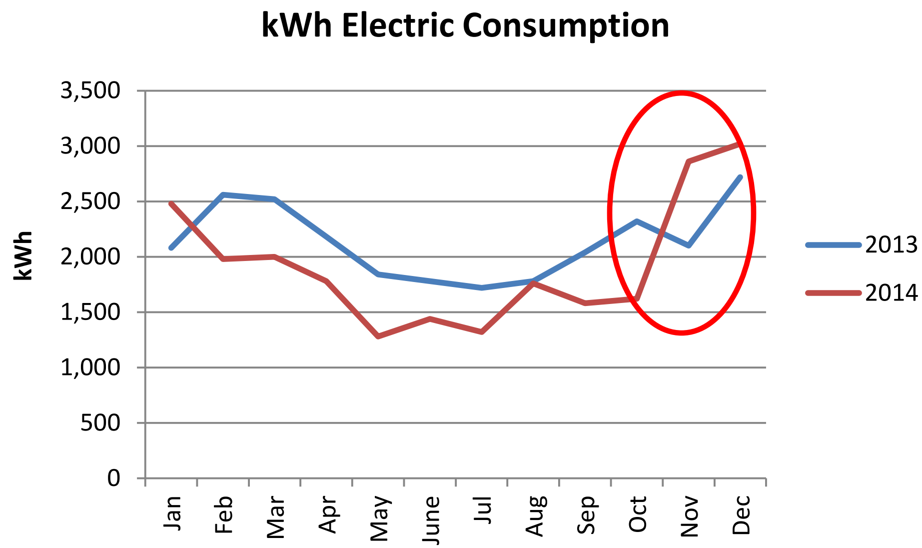
"Monitoring and Continuous Commissioning"

HVAC System Performance Drift, 10%-20%

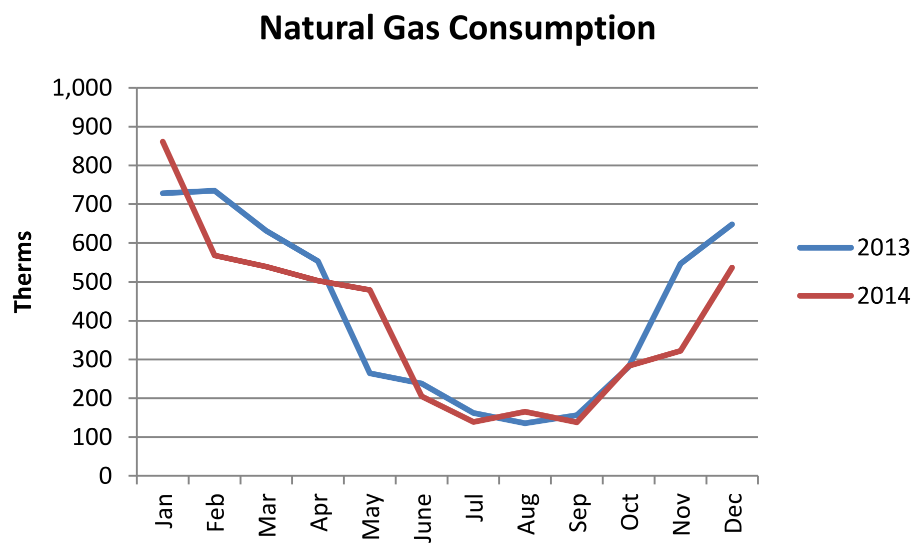
• Variable frequency drive functionality disabled
• Time clocks not used or circumvented
• Simultaneous heating & cooling
• Duct or valve leakage
• Pumps, fans, actuators or dampers malfunctioning
• Airflow not balanced
• Scheduling & resets do not match specs or actual building usage requirements
• Software programming errors
• Improper controls hardware installation, failure or degradation
• HVAC system not right-sized for facility

Source: Lawrence Berkeley National Lab; Monitoring Based Commissioning: Benchmarking Analysis of 24 UC/CSU/IOU Projects; June 2009

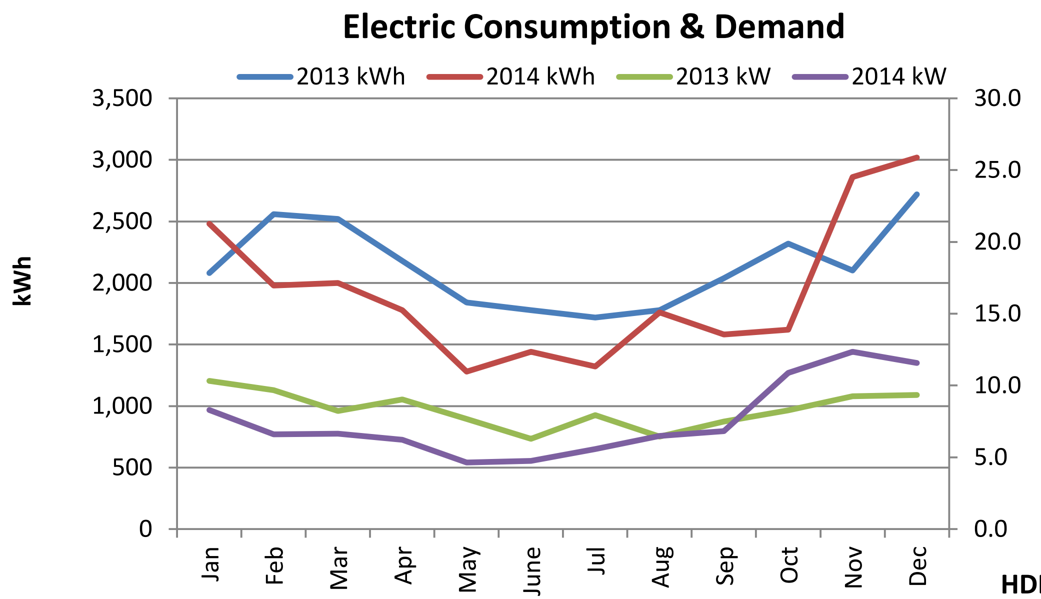
Building Monitoring



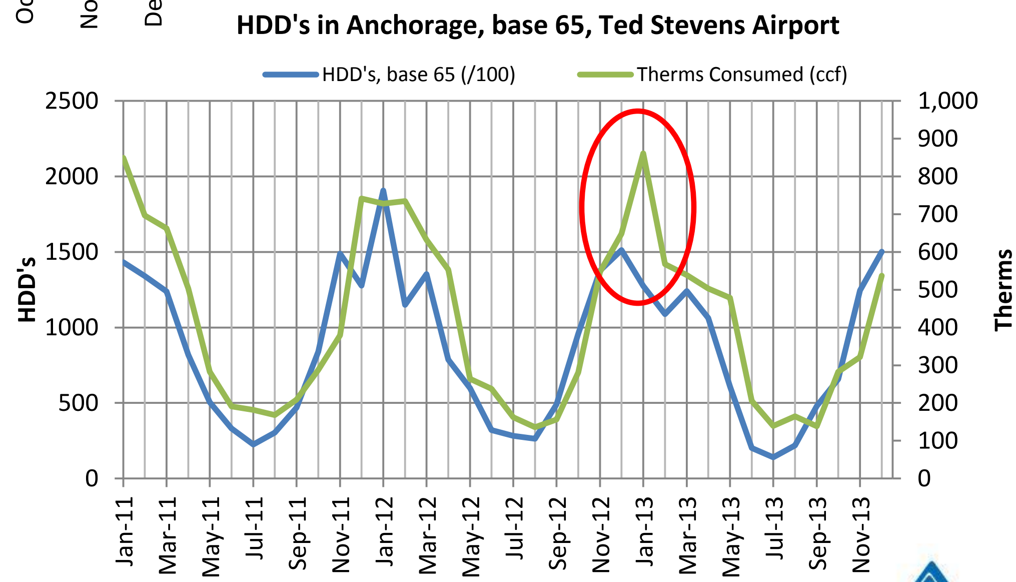
Simple homegrown



Building Monitoring



Complex homegrown



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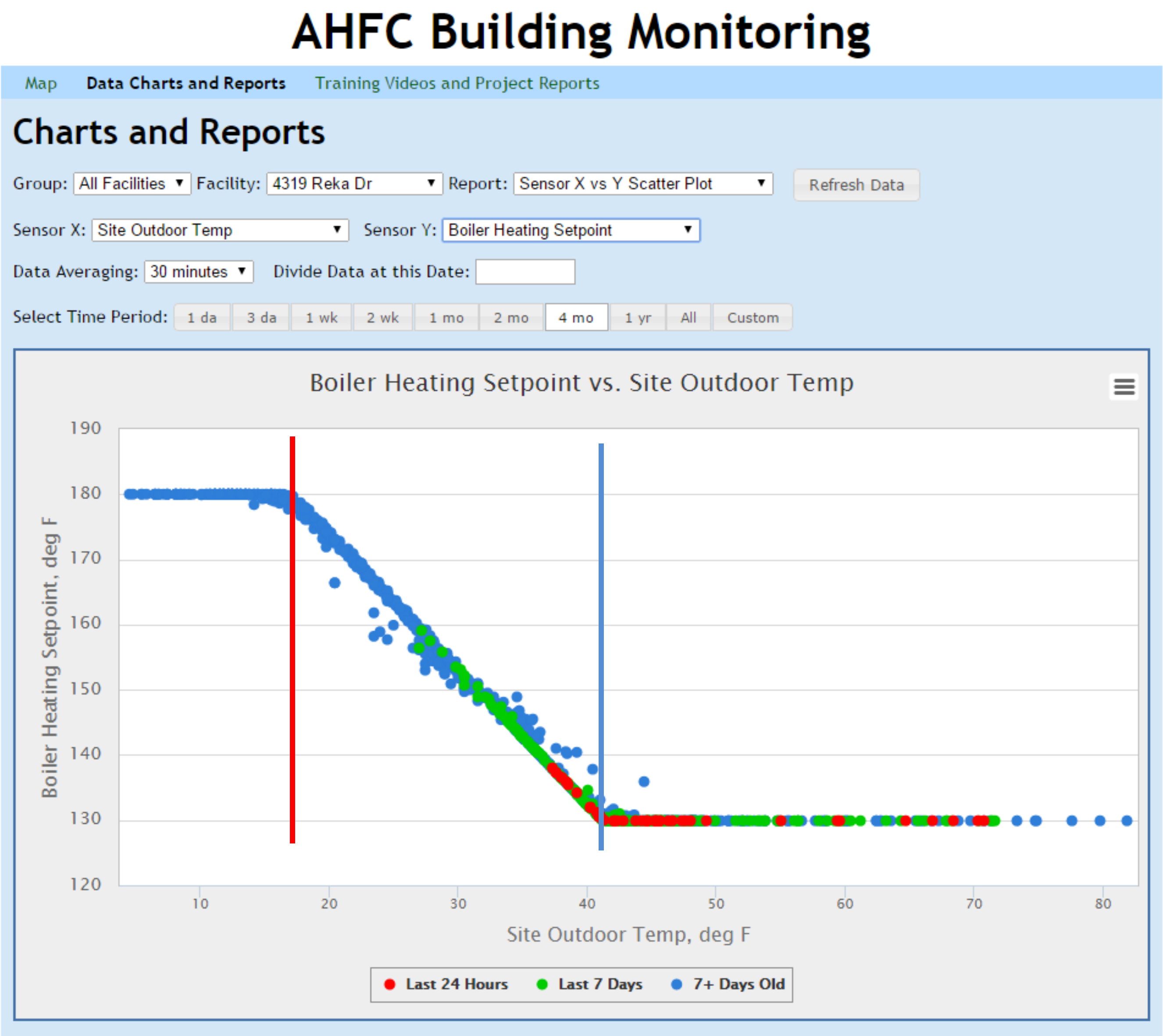

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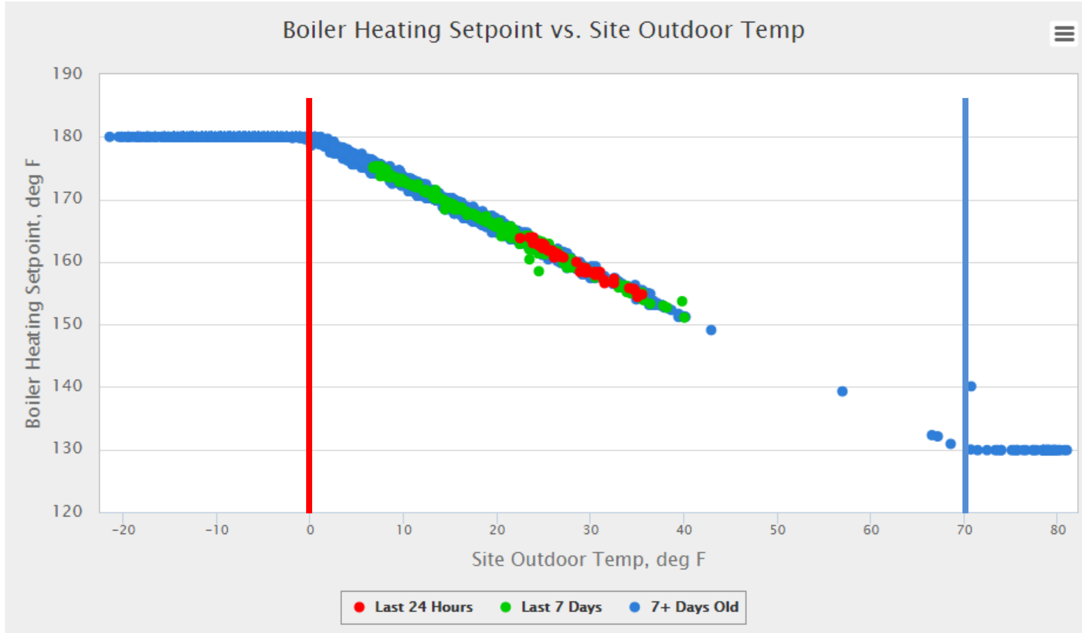
Building Monitoring

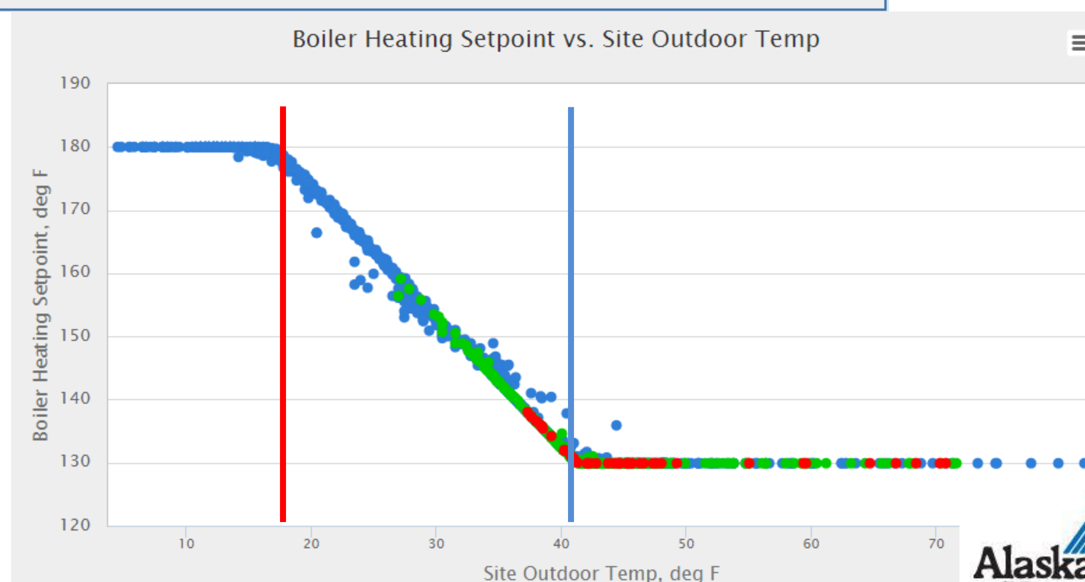
180F at
OSA=0F

130F at
OSA=70



180F at
OSA=18F

130F at
OSA=40F



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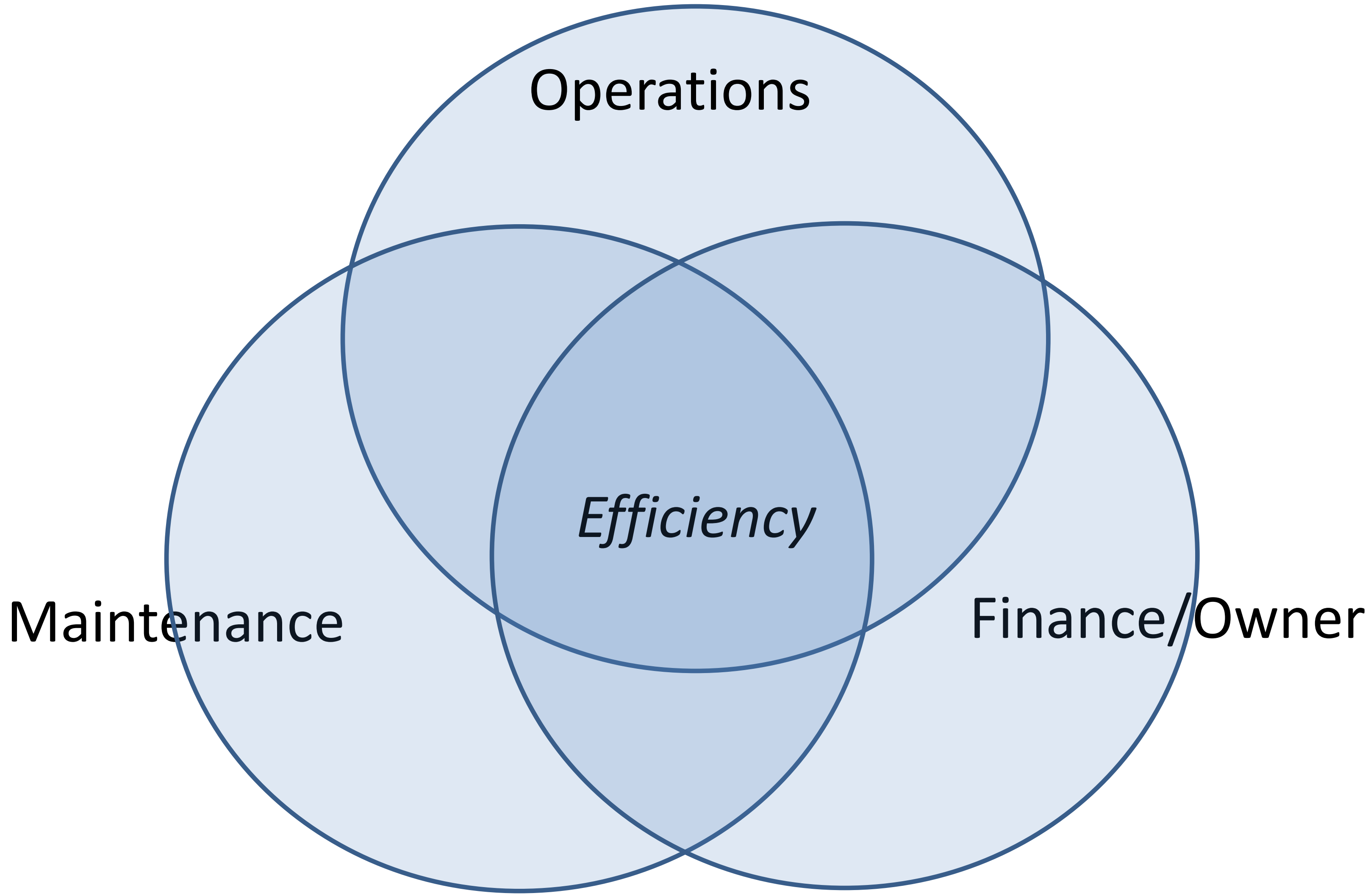
Operations
Efficiency
Maintenance
Finance/Owner

Thank you!

Jim Fowler
907-269-4350
jim@jim-fowler.com
www.energyauditsofalaska.com

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Alaska Housing Finance Corporation