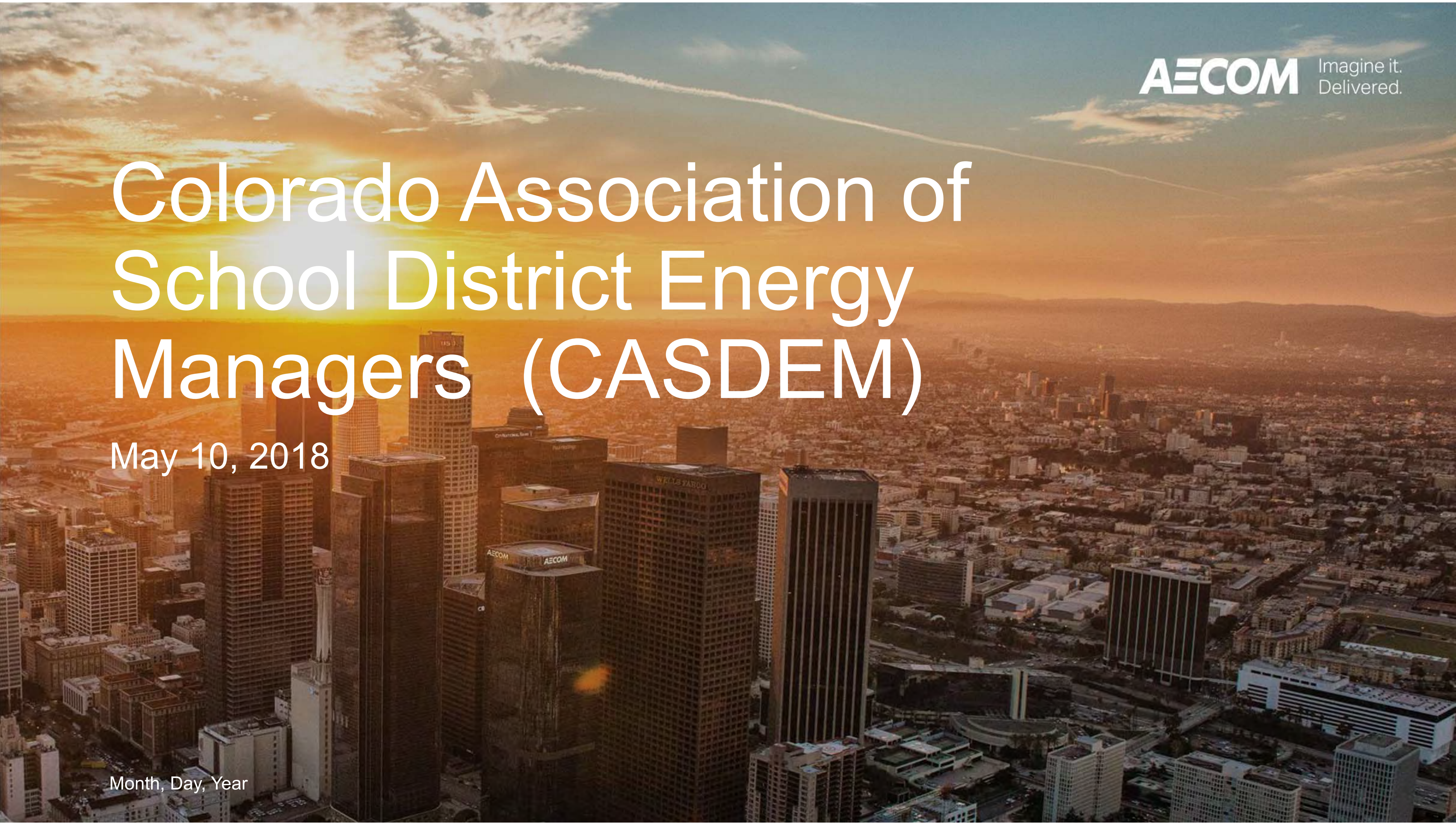


Colorado Association of School District Energy Managers (CASDEM)

May 10, 2018

Month, Day, Year

Introduction to AECOM Team

– Richard Kaselow
  - Associate Vice President
    - Asset Management

– Devin Boyce
  - Senior Project Manager
    - Asset Management

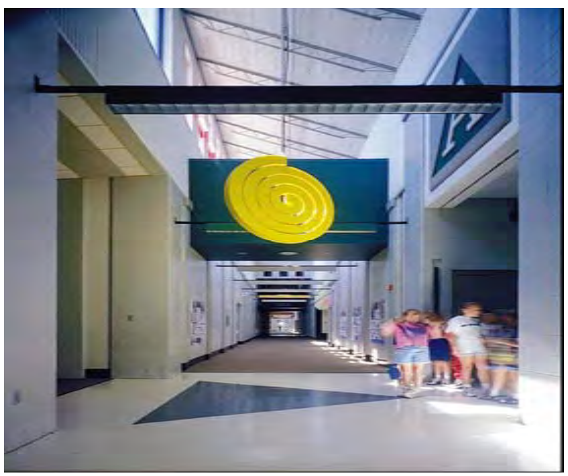
– Avilene Rodriguez
  - K-12 Facilities Planner
    - Asset Management

Overview

– Asset Management

– How Energy fits into the equation

Design Lessons Learned



- Include energy saving systems and design techniques in the district design guidelines, RFP's and design contracts.
  - These systems are not to impact the overall construction cost. This would be for MEP and for general building design.
- Have the district create a position for a champion for energy savings
  - This person would be responsible for design and construction review to insure all projects meet the energy savings goal
- Design new buildings to be renewable energy ready
  - This could allow for ease of adopting renewable energy in the future
- Have school districts make energy saving part of their curriculum, to make all users (teachers, students, and parents) aware of energy saving strategies
  - Create districtwide competitions for energy savings, reduced waste, etc.
- Put students in charge of monitoring energy savings and allow them to hold the school and district accountable
- Incorporate renewable energy!!

AECOM Energy Audits

– Overall Process
  - Coordination and Vision
    - o Client-driven
    - o Stakeholder investment
  - Site Audits
  - Facility Condition Assessments
  - Site Energy Use Modeling
  - Economic Analysis
    - o Energy savings
    - o Capital cost
    - o Life cycle cost
  - Incentive Procurement

Innovative Energy Management Systems

- Utilities Privatization
  - Fixed payments for maintenance and capital replacement
  - Regulated or unregulated
  - Electric
  - Gas
- Partnerships
  - Energy providers
- Community Hub
  - Clustered users

Case Study – Advances in Energy Storage and Alternative Project Delivery Models

Using a BESS for peak-shaving

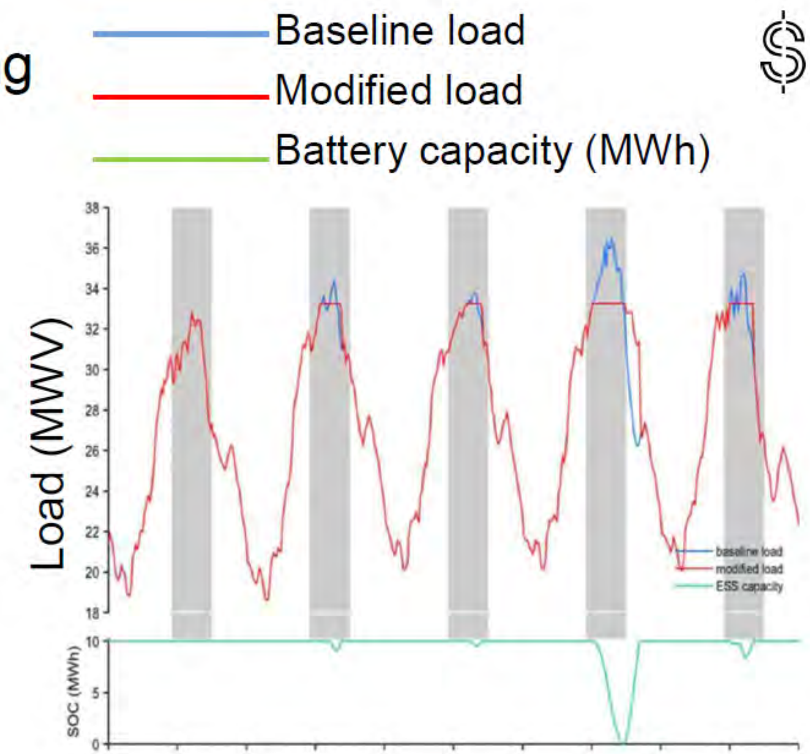
The maximum savings per month is maximum BESS discharge rate

With a smaller capacity battery

- Choice of discharge point determines savings
- Increase discharge rate to increase savings

Limiting factors

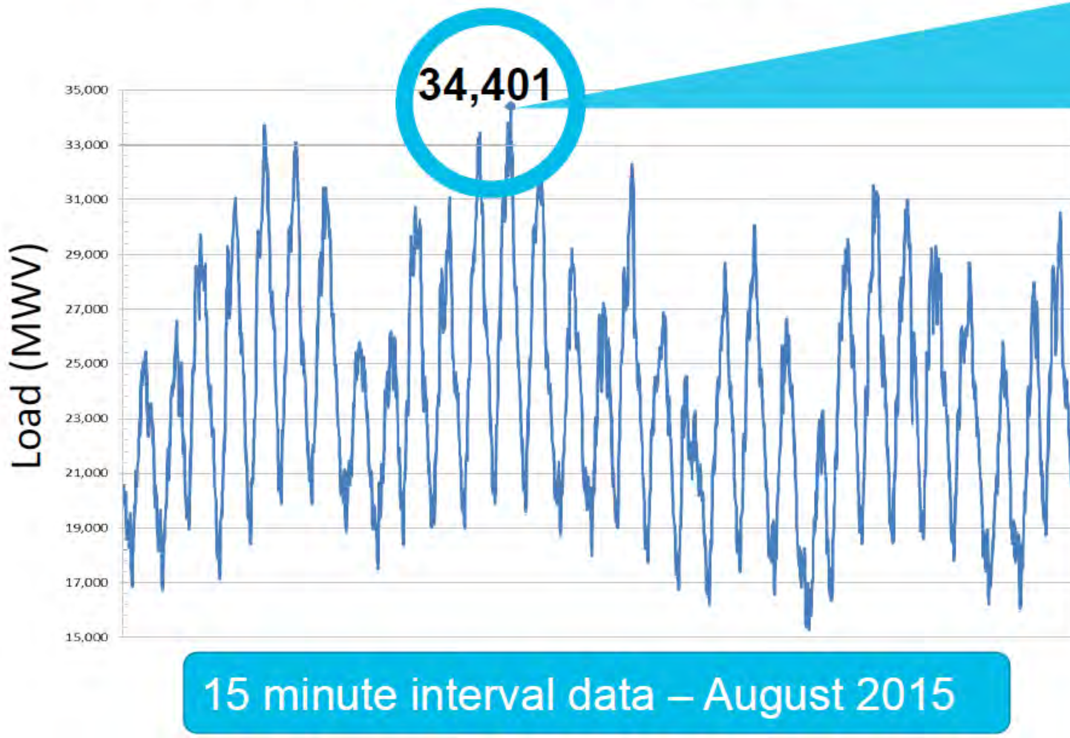
- Maximum discharge rate (MW)
- Total battery capacity (MWh)
- Accuracy or peak forecast



Five consecutive days in August 2015

Case Study – Advances in Energy Storage and Alternative Project Delivery Models

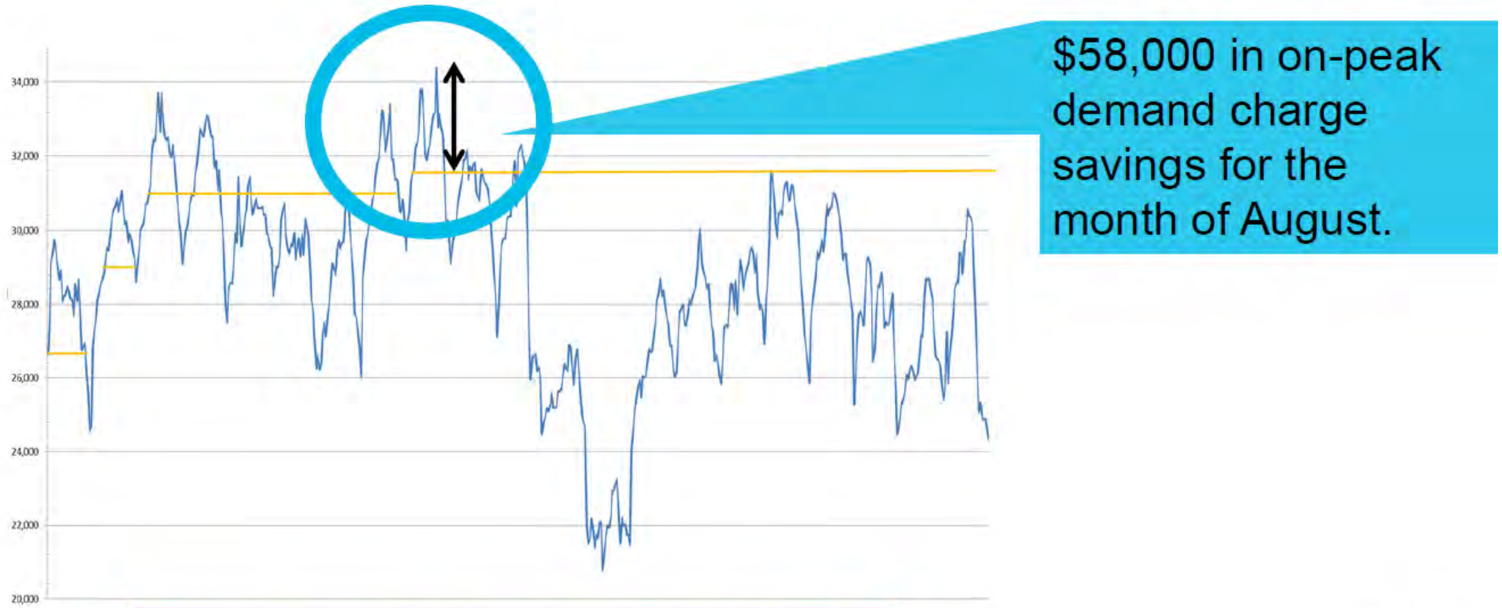
Fort Carson – load profile (August 2015)



Billing demand – the greatest fifteen minute load during on peak hours in the billing period

Case Study – Advances in Energy Storage and Alternative Project Delivery Models

Fort Carson – peak-shaving sequence



15 minute interval data – August 2015

27

AECOM

Case Study – Advances in Energy Storage and Alternative Project Delivery Models

BESS system summary

2017 GridStar – 300 kW/600 kwh

Power Rating
4,200 kW (14 modules)

Energy Rating
8,500 kWh (14 modules)

Voltage
480 VAC

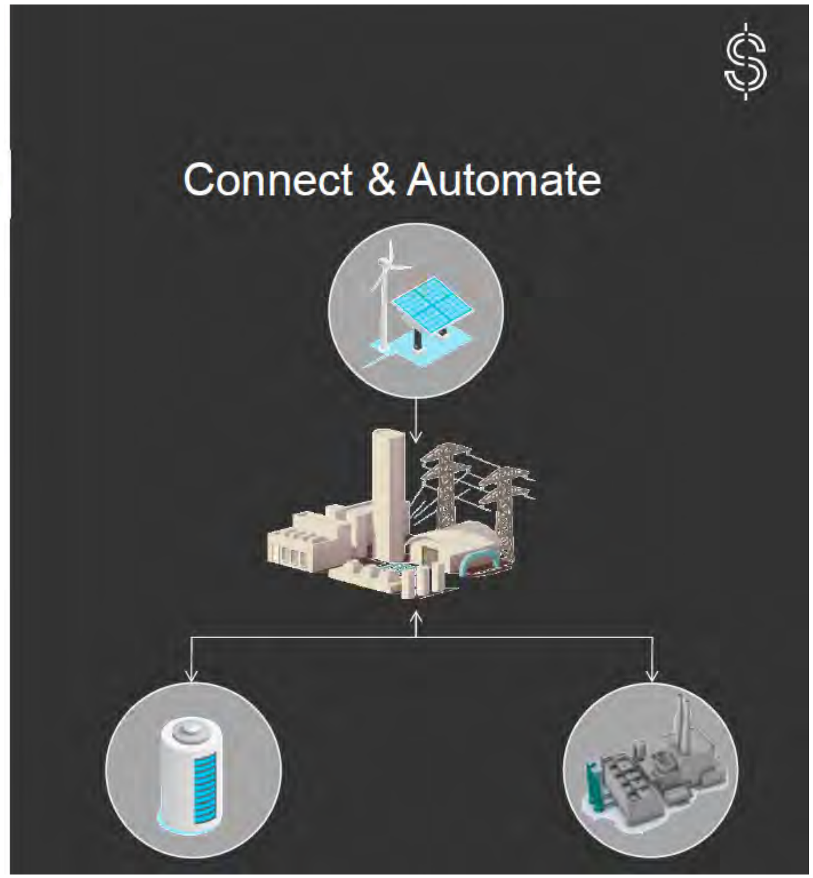
Round Trip %
~86%

Dimensions
144 x 60 x 96 inches/module

Control System
GELI - EOS

Operational Life Expectancy
21 years

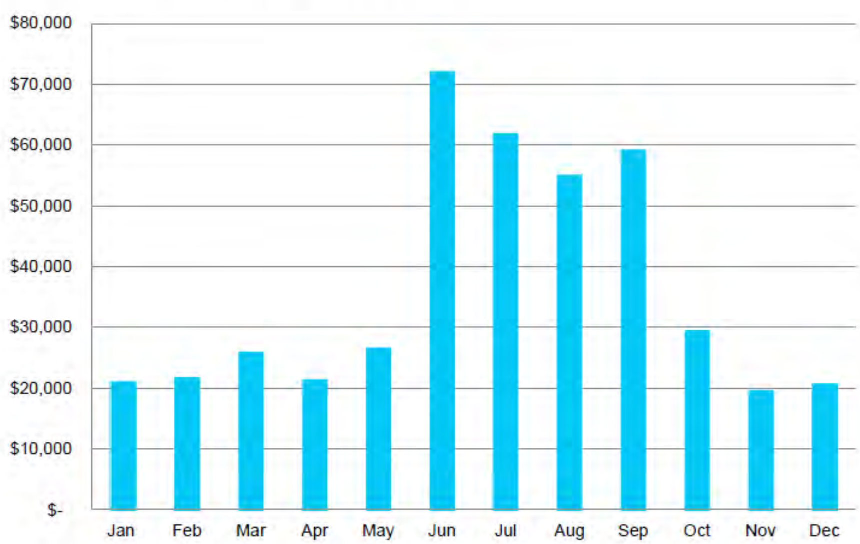
28



Case Study – Advances in Energy Storage and Alternative Project Delivery Models

Fort Carson ESPC – estimate of demand savings

Year 1 – Demand Charge Savings



$436,000
Year 1 savings

$713,000
Year 19 savings (Assumes 4% escalation rate)

Est. 83 full cycles/annum
Duty cycle

Case Study – Advances in Energy Storage and Alternative Project Delivery Models

Guarantee of performance – BESS in peak-shaving use case

- Guarantee by ESCO is based on maximum achievable savings (with perfect foreknowledge of demand)
- Guarantee recognizes a fair allocation of risk between ESCO and Govt.
- Guarantee predicated on BESS degradation; BESS degradation predicated on use-case operational profile

Case Study – Advances in Energy Storage and Alternative Project Delivery Models

Allocation of Risk – BESS in peak-shaving use case

Risk	ESCO	Government
■ Demand rate	Accepts reasonable escalation rate for demand charges.	Assumes manageable risk which is common and recommended approach in ESPC contracts.
■ Non-price change to tariff		Assumes manageable risk.
■ Load anomaly/grid performance	Compiles robust performance/context data IOT perform forensic analysis and support proposed M&V adjustments, if necessary.	Assumes risk.
■ ■ Load profile change	Continuously "trains" control system. Characterizes variability of benchmark profile IOT make M&V adjustments.	Assumes manageable risk.
■ ■ Weather	Implements cost-effective measures to adapt control strategy to possibility of adverse cloud cover.	Assumes risk.
■ BESS performance	Assumes manageable risk for battery system power and capacity, and for control system effectiveness.	Assumes risk of availability of savings, consistent with risks stated above.

31 ■ Risk inherent ■ Risk marginal ■ Risk shared

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Energy and Learning Environment

– Classroom Lighting
- Natural light is shown to benefit the health, concentration, and even test scores of students
- Alternative solutions such as daylight bulbs and tubes can be implemented to create the sensation and benefits of natural lighting as accurately as possible

– Bad Lighting
- Leads to discomfort and hyperactivity
- Teachers effectiveness

ACOUSTICS

Research has found that classrooms with less external noise are positively associated with greater student engagement and achievement compared to schools with classrooms that have noisier environments. Therefore, school buildings that buffer external noise from classrooms can improve student outcomes.

Proper Temperature and Control

- The ideal temperature range for effective learning in reading and in mathematics is between 68 and 74 degrees.
- Teachers need to be able to control the temperature in their own classroom

Air Quality

- Poor indoor air quality is a major contributor to absenteeism
- Indoor pollutants: office equipment, flooring materials, paints, adhesives, cleaning products, pesticides, and insects

How to get Involved

Organizations

– Colorado Renewal Energy Society
- Calendar with ongoing events and workshops

– Women in Sustainable Energy – WISE

– New Energy Colorado
- Colorado's solar & environmental communities that serves as an umbrella for several educational programs

– USGBC Colorado

Events

– Green Schools Summit

– Rocky Mountain Green Conference

– The Alliance Center – environment series

– Sustainability Expo

– Climate Leadership Conference

ENERGY EFFICIENCY IN SCHOOLS

Q&A

1. How do you achieve energy savings on new construction?
2. How do you achieve energy savings on existing construction?
3. What are the more typical energy saving projects?
4. What are the more innovative energy saving projects?

AECOM


AECOM
Imagine it.
Delivered.

Colorado Springs Utilities

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Preliminary Metrics for Energy Audits

Steve Doty PE / CEM

Energy Engineer

2018

Agenda

Metrics

- Part 1 – Why Metrics and Why Preliminary?
- Part 2 – Annual Use and Benchmarking
- Part 3 – Monthly and Daily Data
- Part 4 - Interval Data
- Part 5 – Case Examples

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Part 1 - Why Metrics and Why Preliminary?

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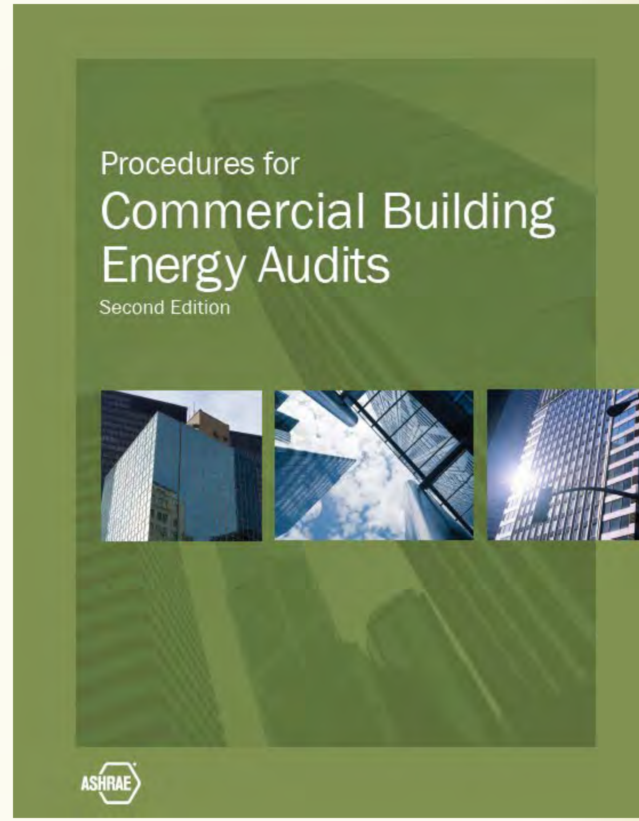
Information from Data

Why Metrics and Why Preliminary

- Get to know the building before wandering around
- Compare to similar buildings and uses
- Compare what you see to what you expect
- Patterns, or lack of patterns
- **Leads to Qs and ECMs**



ENERGY STAR® Portfolio Manager®

Why Metrics and Why Preliminary

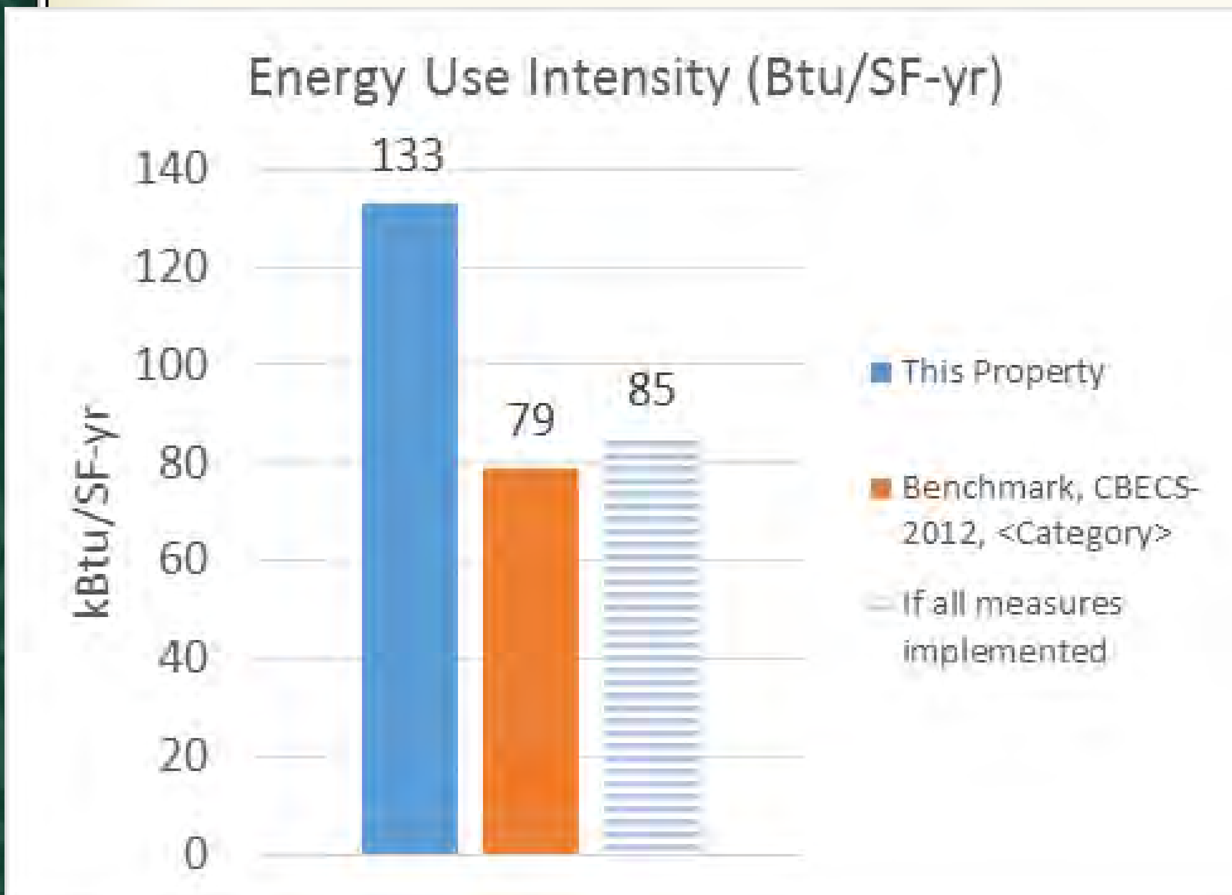
Better Results

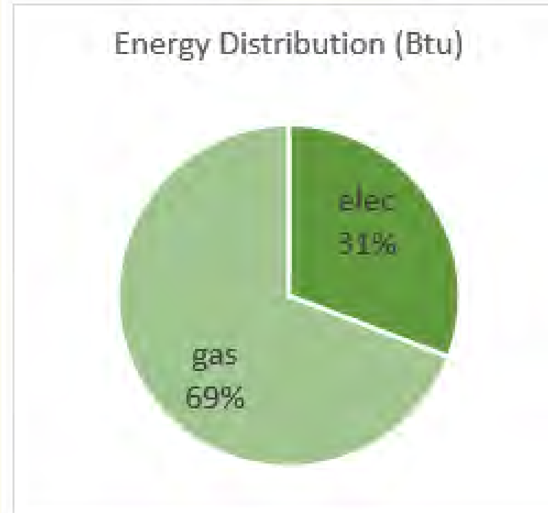
- Adds focus in the field work
- Look-for items, in addition to all the wandering around
- **Where to start. Where not to start. Clues. Questions. Things not to miss**
- Can establish a rough value of achievable savings (energy or demand)

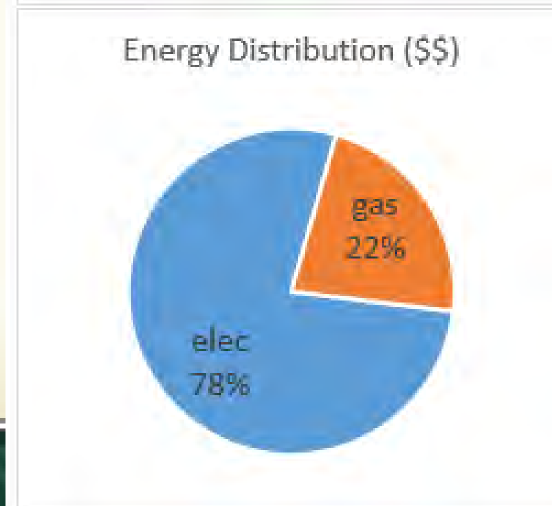
Start to Tune In

- **Is use for this type/size building normal or not?**
- Extent of weather dependence?
- Usage follow building hours?
- Persistent use after-hours?
- Ghost loads?
- Randomness?
- Poor load factor?
- Low power factor?
- Moving between rates?

Part 2 – Annual use and Benchmarking







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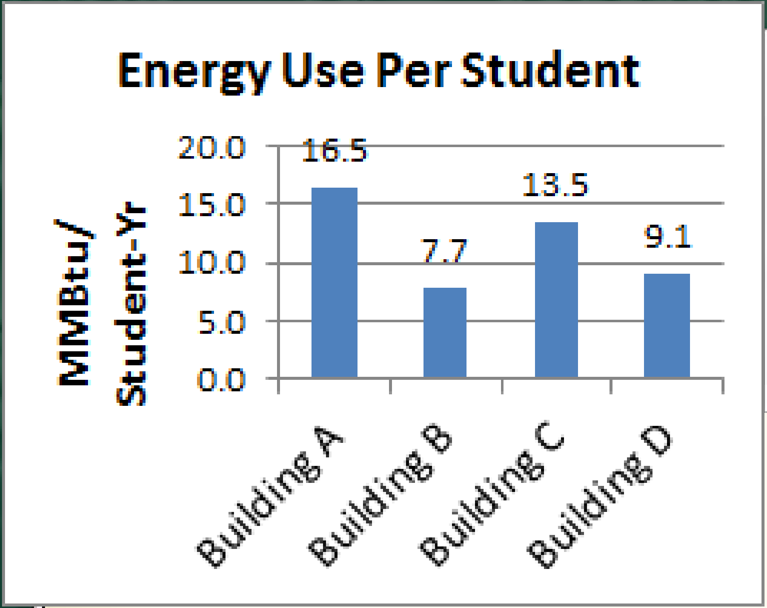
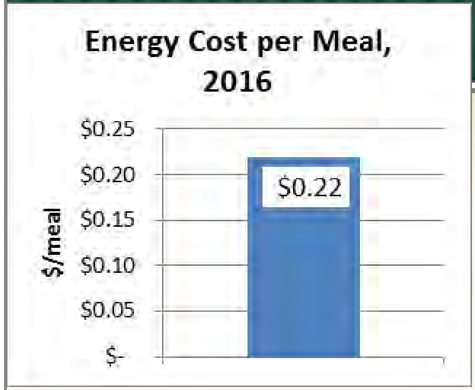
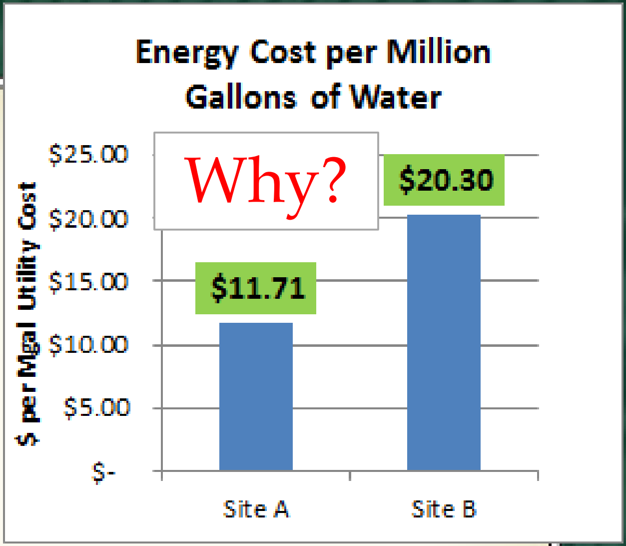
❖ A Sanity Check

- "Compared to…." similar use
- EUI (energy use intensity)
- kBtu/SF-year
- CBECs-2012, PBA (principal building activity)
- Blending PBAs is OK, proportion by area
- **Rough idea of achievable potential energy savings**, multiplying the overage by building SF
- (Gray: don't know at this point if it is electric or gas)







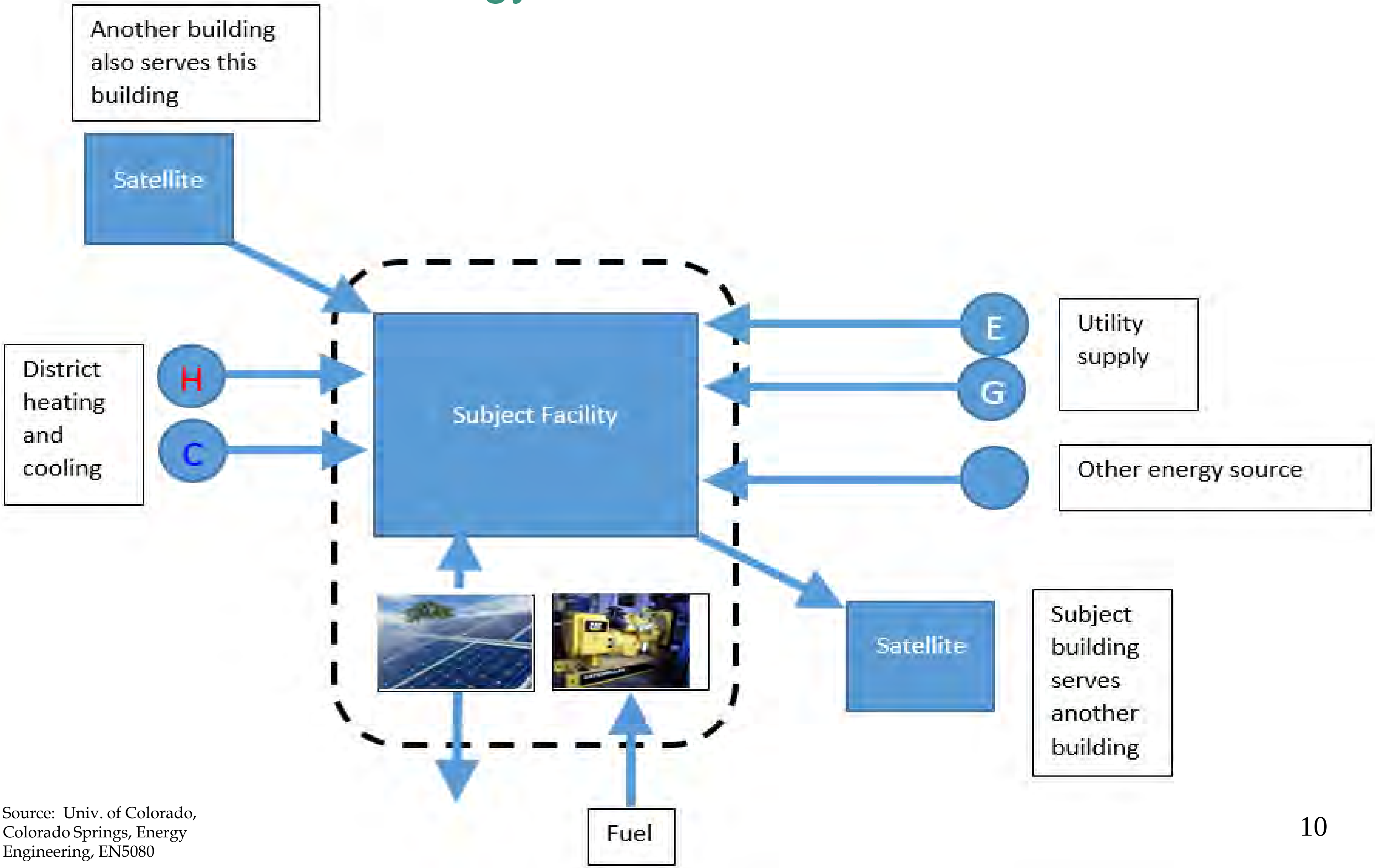
❖ Internal Benchmarks can make sense

- More clues…
- kBtu or $$ per student-year
- kBtu or $$ per meal-year
- kBtu or $$ per hotel night-year
- ……per million gallons treated water, per widget, per pound of steel, per ton of gravel, etc. as appropriate

Annual Use and Benchmarking

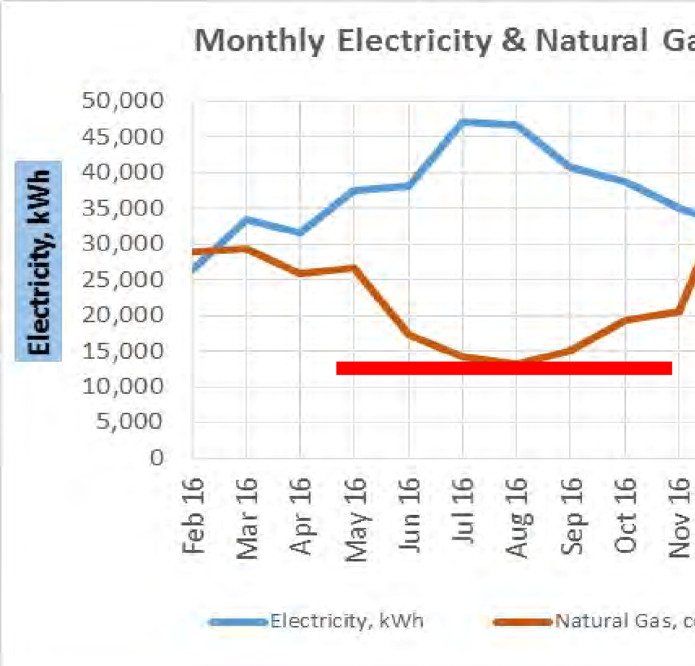
❖Control boundary concept

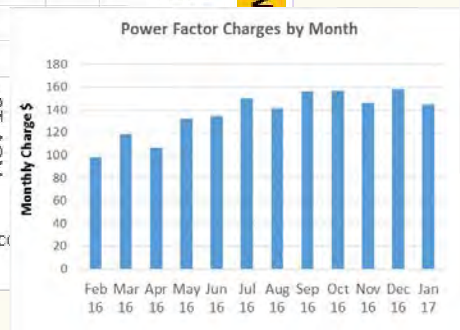
– Account for energy used 'inside the box'.

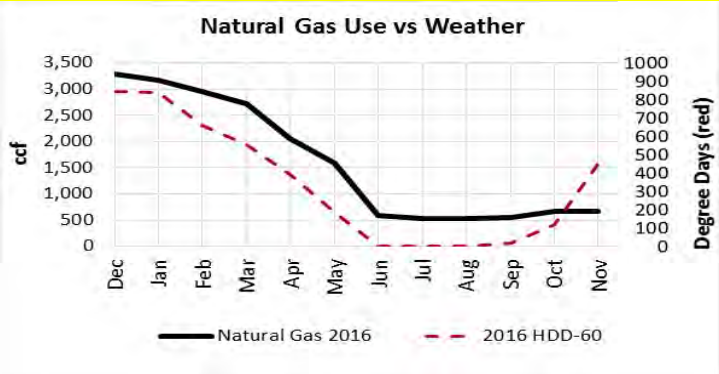


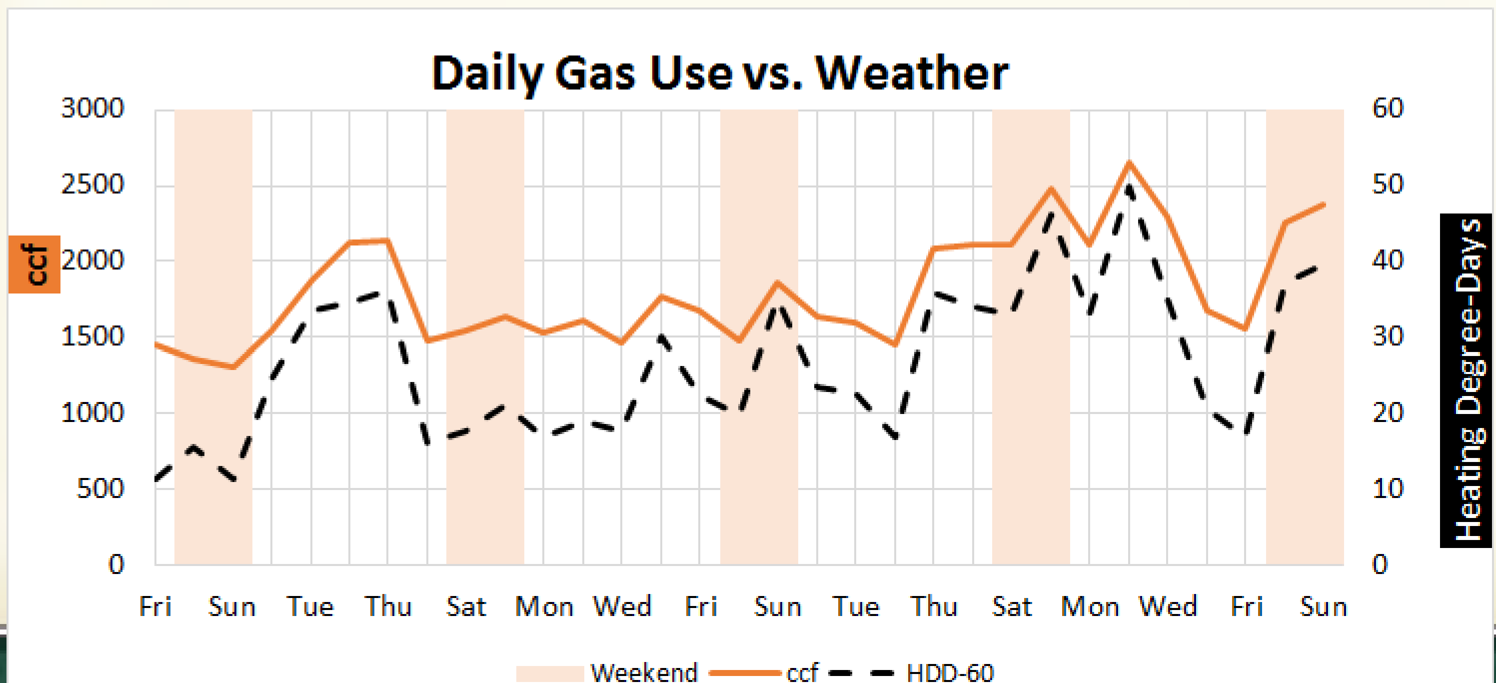
Source: Univ. of Colorado, Colorado Springs, Energy Engineering, EN5080

Part 3 – Monthly and Daily Data









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Monthly and Daily Data

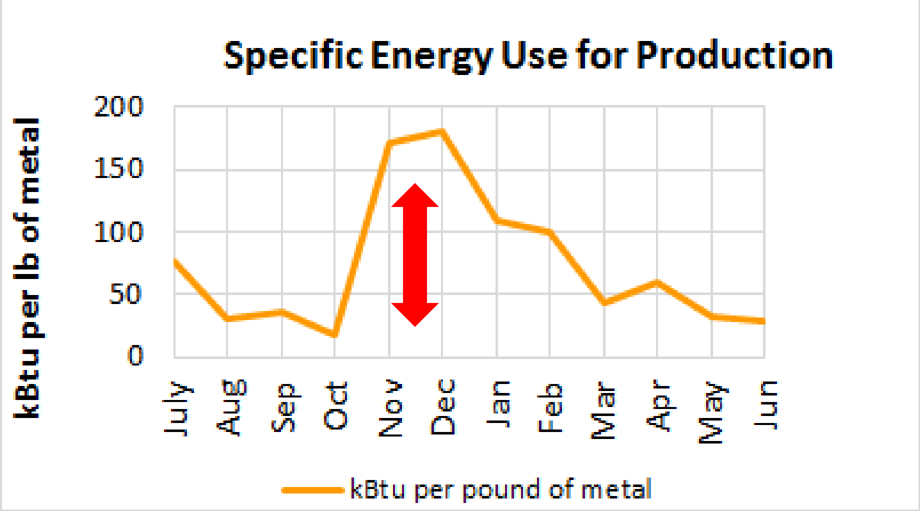
- Monthly
  - Energy use vs. degree-days
    - Accuracy improved if building balance temp. is known
  - Energy use vs. occupancy
  - Energy use vs. production (part load inefficiency)
  - First good indicator of weather dependence or lack of it (if energy follows degree-days)
- Daily
  - Confirms if set back controls are functioning
  - If gas is used for heating, and setback is working, correlation of gas use to degree-days will be weak. (prior slide shows this)

Monthly and Daily Data

Production and Internal Metrics

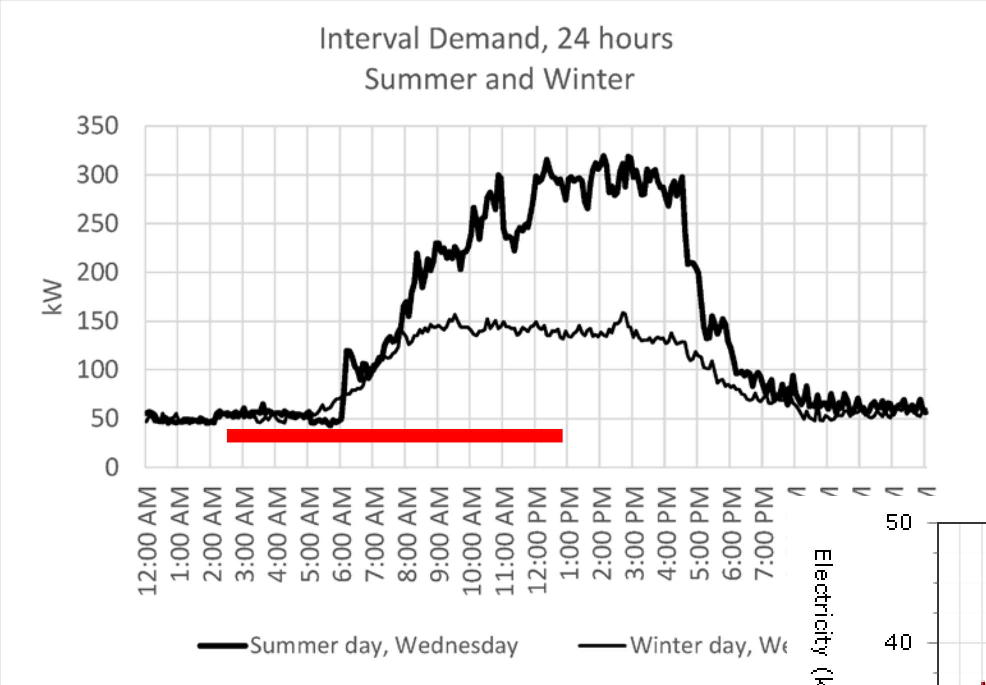
Variance in utility cost per unit of production by month indicates lack of load-following energy use

- Not turning things off
- Part load losses
- Oversized equipment
-
- May be unavoidable



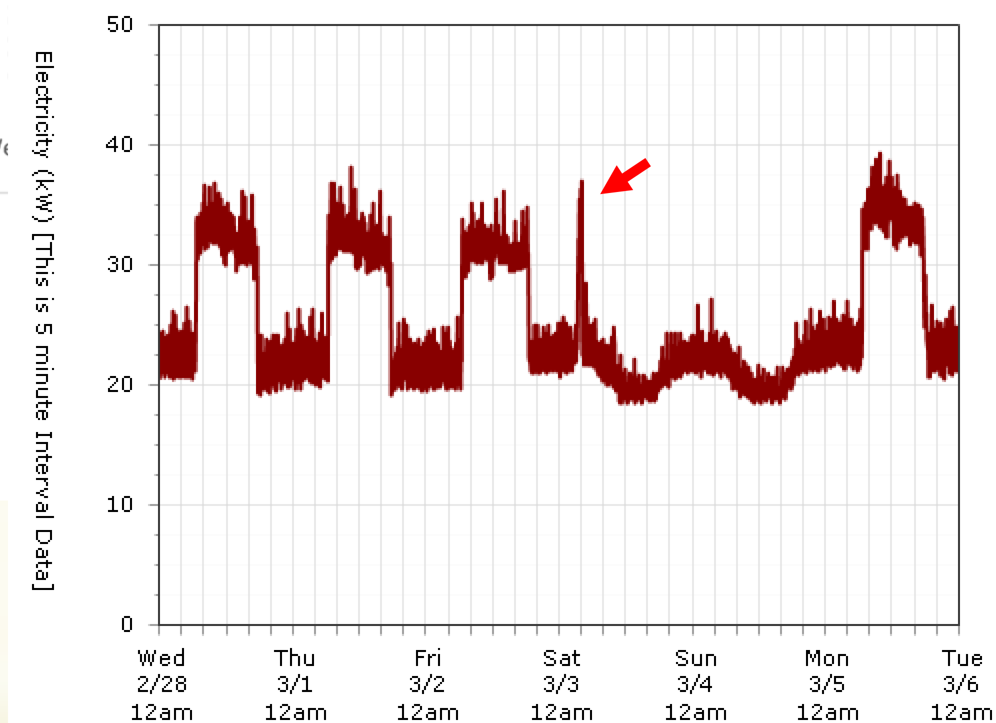
Why?

Part 4 – Interval Data



Ghost load accounting

5	emergency lighting
18	server rooms incl. dedicated cooling
1	parking lot lighting
5	misc plug loads
2	refrigeration
31	total



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My Usage

Interval Data

- Interval
  - Usually electric only
  - 5-15-60 minute
- Good applications
  - Correlate '**when**' something happened
  - Prompts useful questions: '**what is that?**'
  - Shows daily patterns, rhythms
  - Defines ghost loads (residual use, building unoccupied)
- Limitations
  - Not good for weather correlation (ENE response lags)
  - Can lead us astray if the day picked has some anomaly

Colorado Springs Utilities

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Part 5 – Case Examples

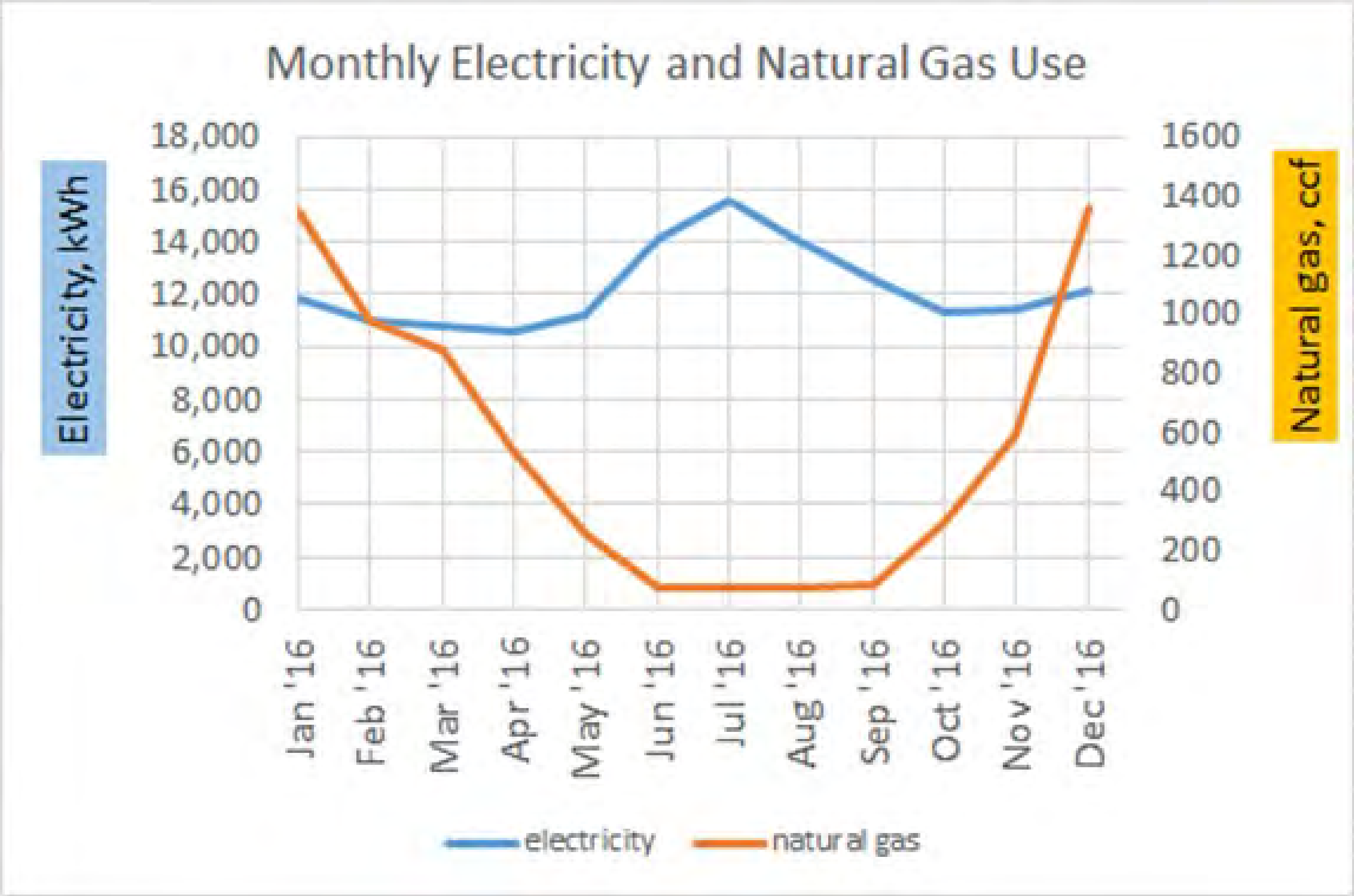
Case Examples

Not all metric reviews are as dramatic as these samples.

The method is the same as any troubleshooting:

Know the system involved, and what you expect to see.
Compare it to what you actually see
Start asking questions

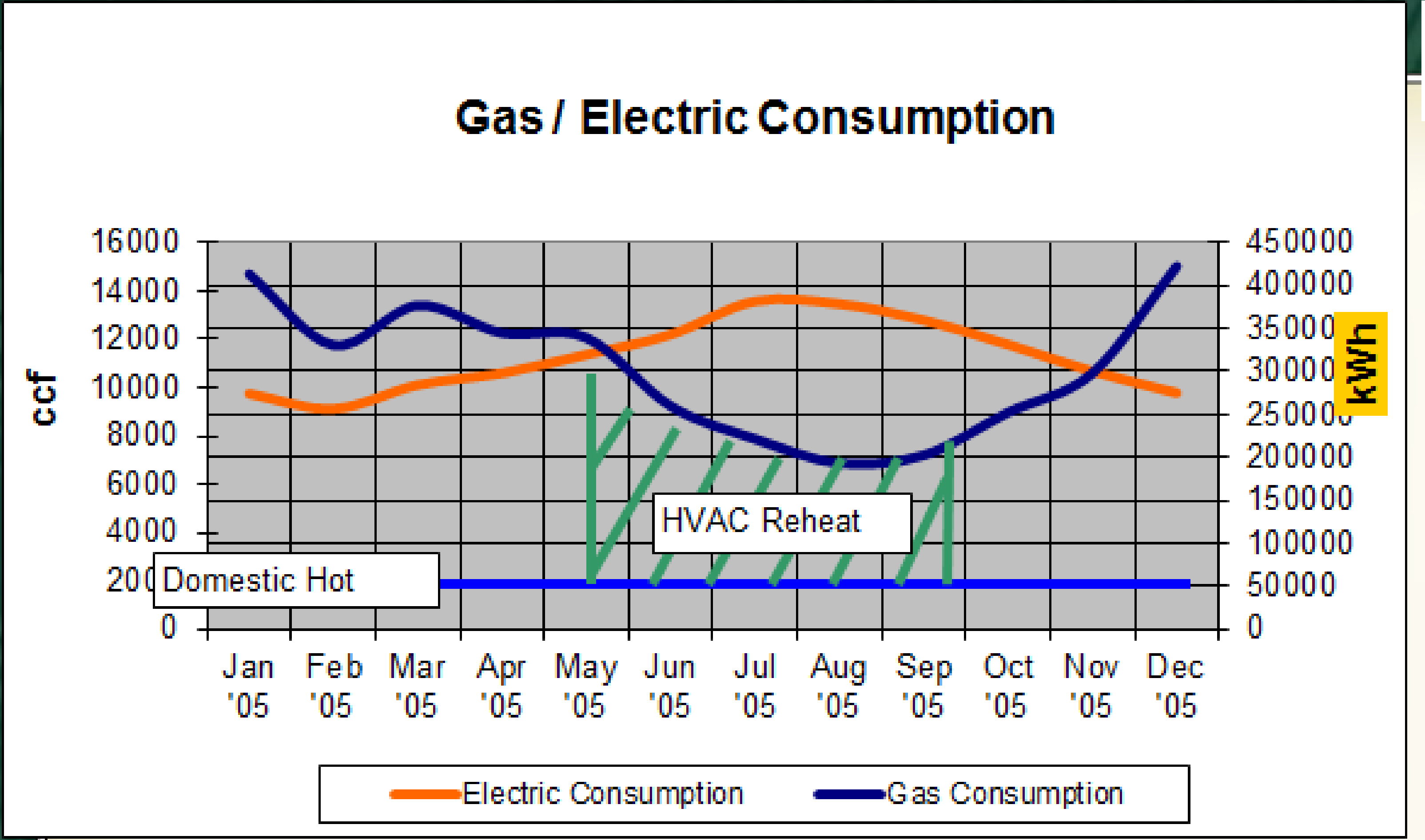
“Doing the homework” before surveying the site makes the work more focused and usually brings better results.



Normal

Gas is practically zero all summer, just some domestic hot water. Electricity is flat (lights, computers, appliances), with a hump in summer for cooling

Case Examples



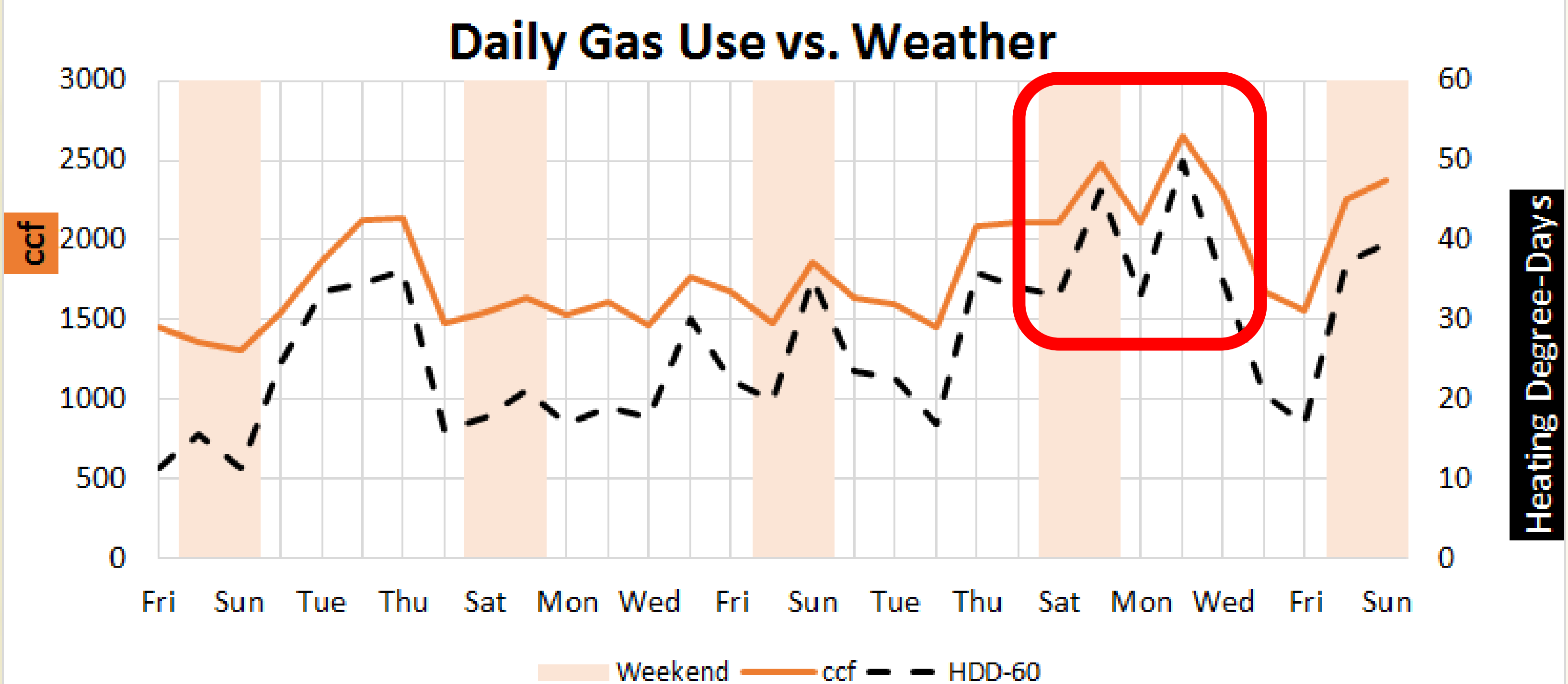
VAV box minimum air flow settings too high and boiler left on

Hot water reheat. Note the gas use does not come down in summer.

Case Examples

Colorado Springs Utilities

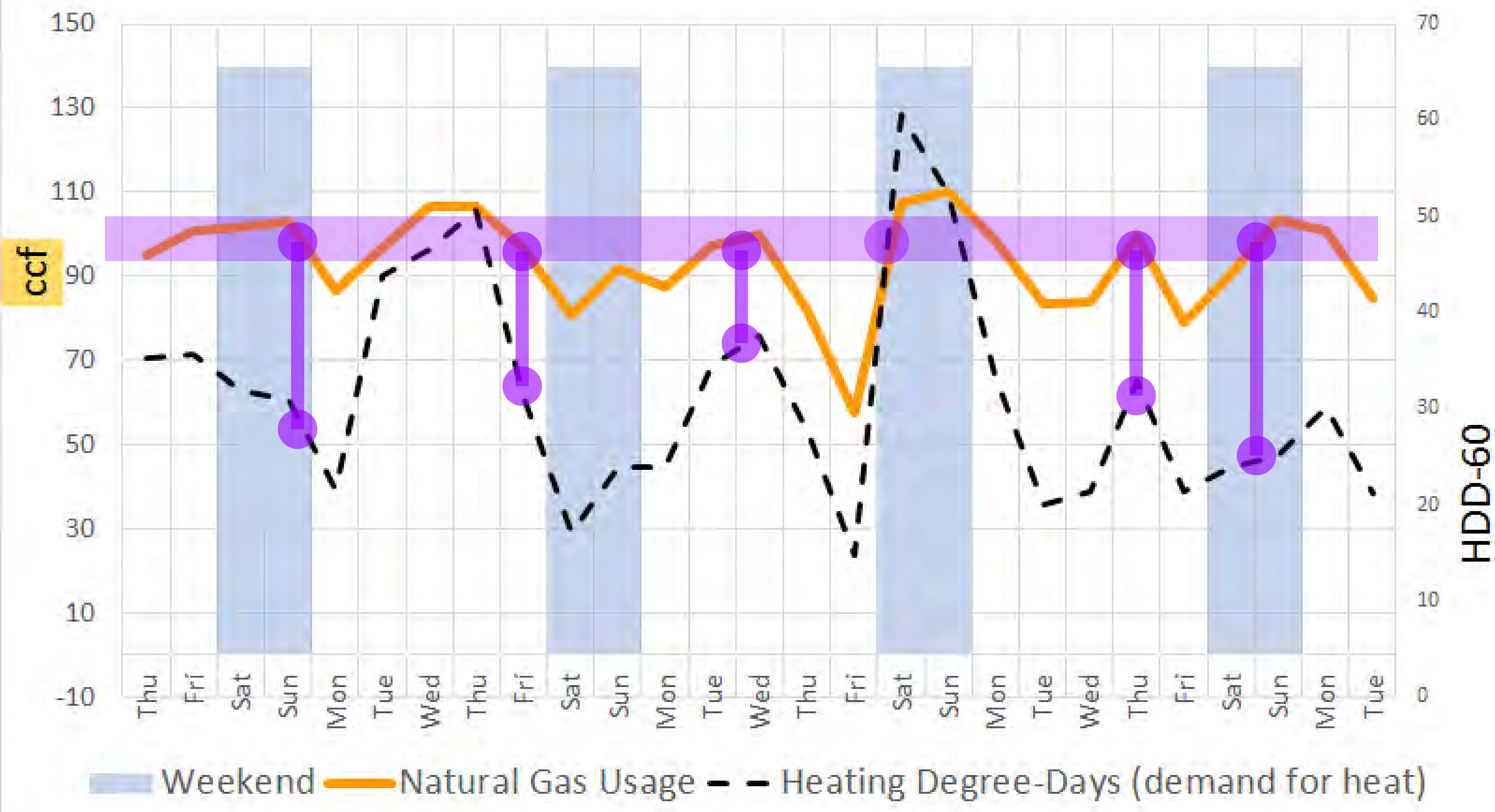
It's how we're all connected



Lack of setback control

Gas use follows degree-day demand in the week, normal.

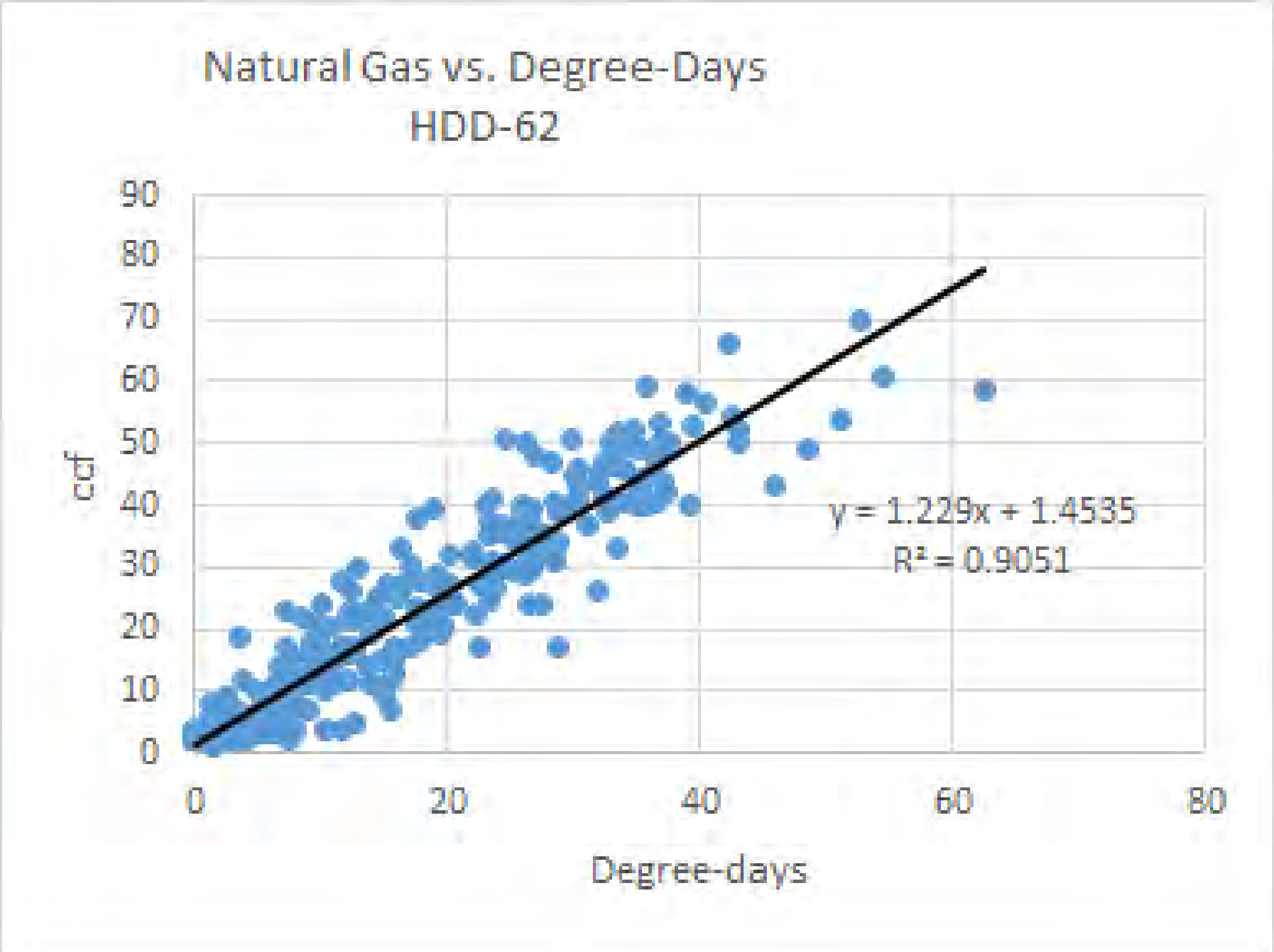
Gas use response on weekend should be less from reset, but it isn't. (Shaded bars are weekend)



Multi-zone false loading from blending

Random. Same gas usage response on days with much different weather, which makes no sense with gas used only for heating.

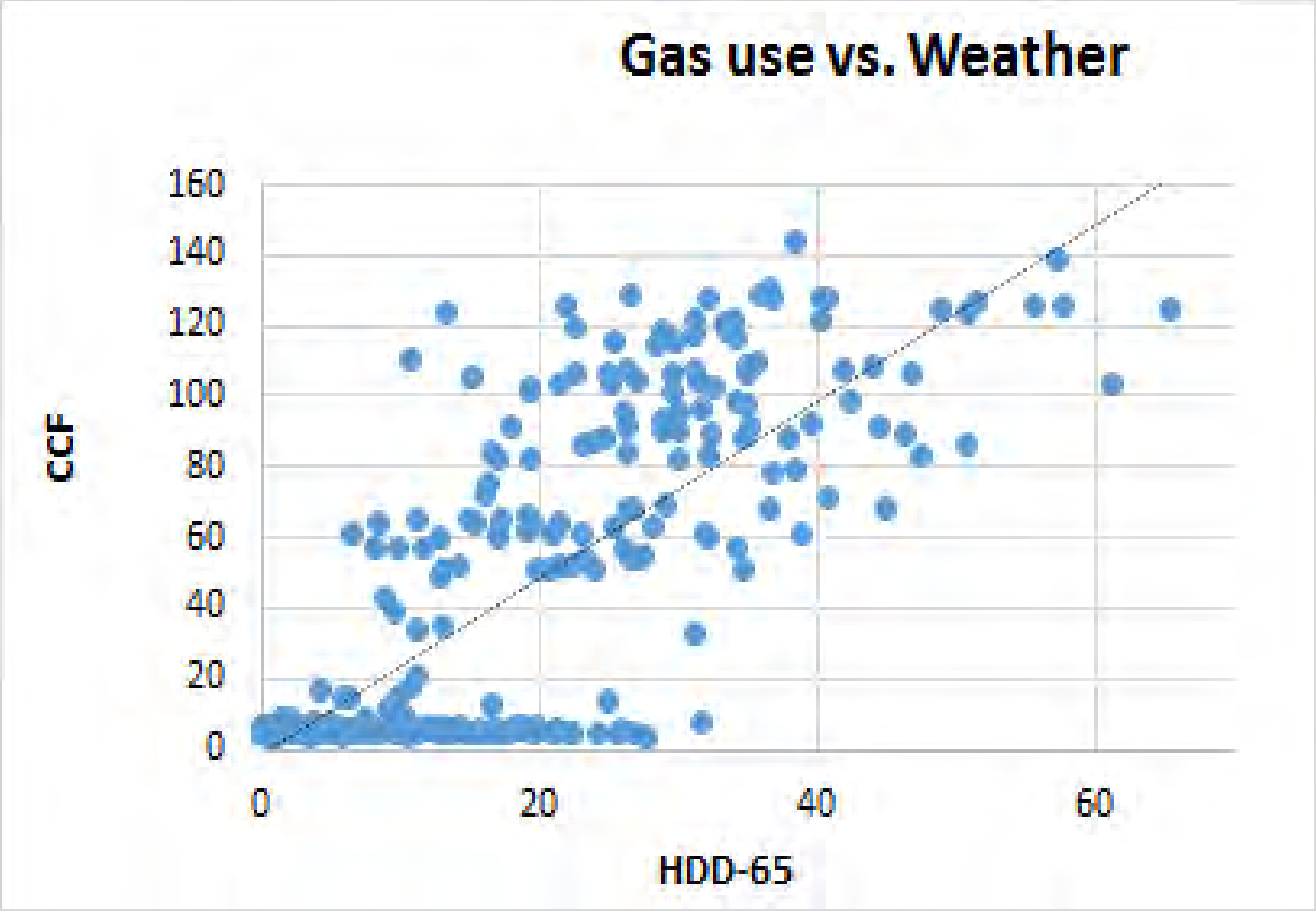
Case Examples



Normal response for gas heat

Strong correlation to weather

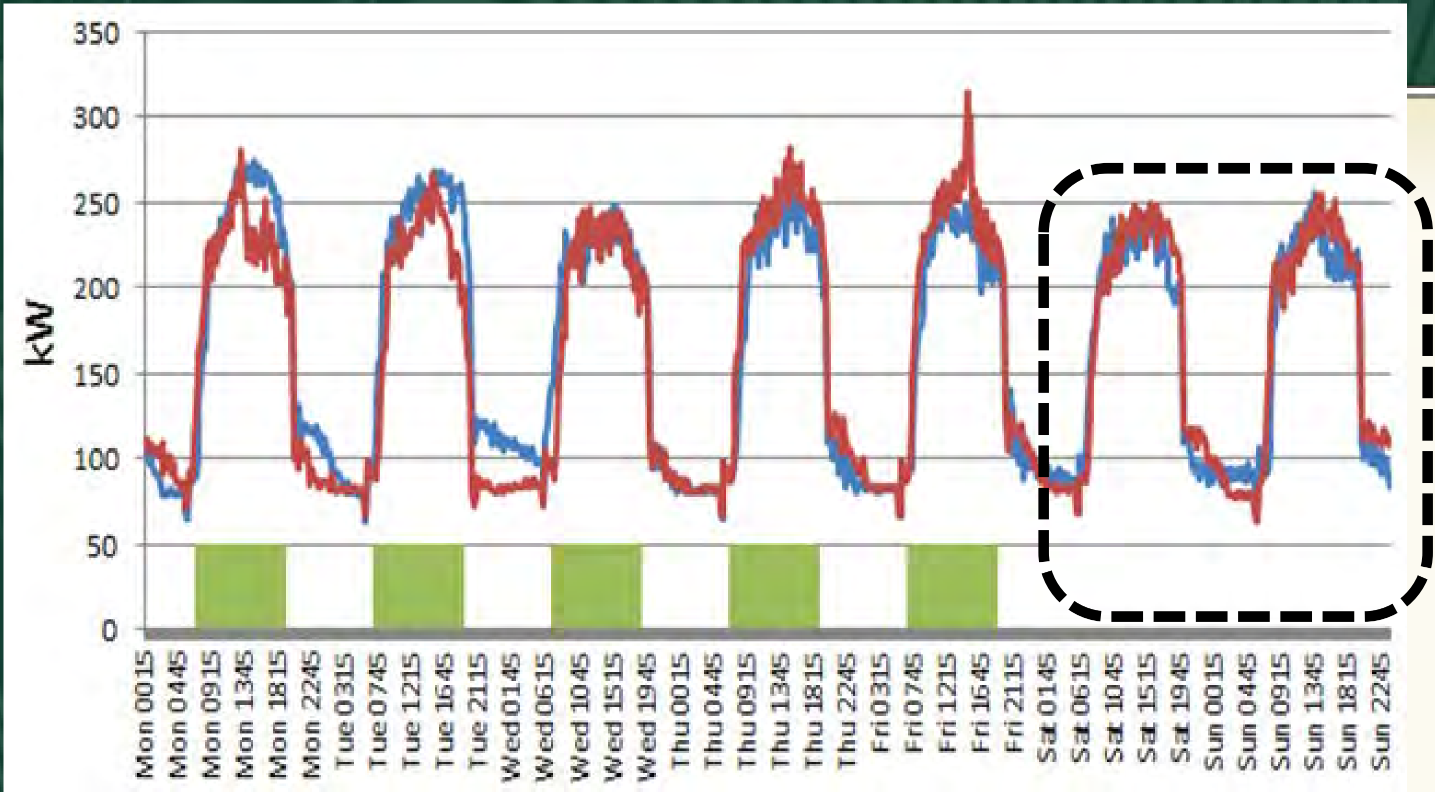
Case Examples



Broken controls

Note the randomness. Hand-operated control valves, boiler was started manually, sometimes forgot to turn it off. Weather independent usage (bottom) is kitchen

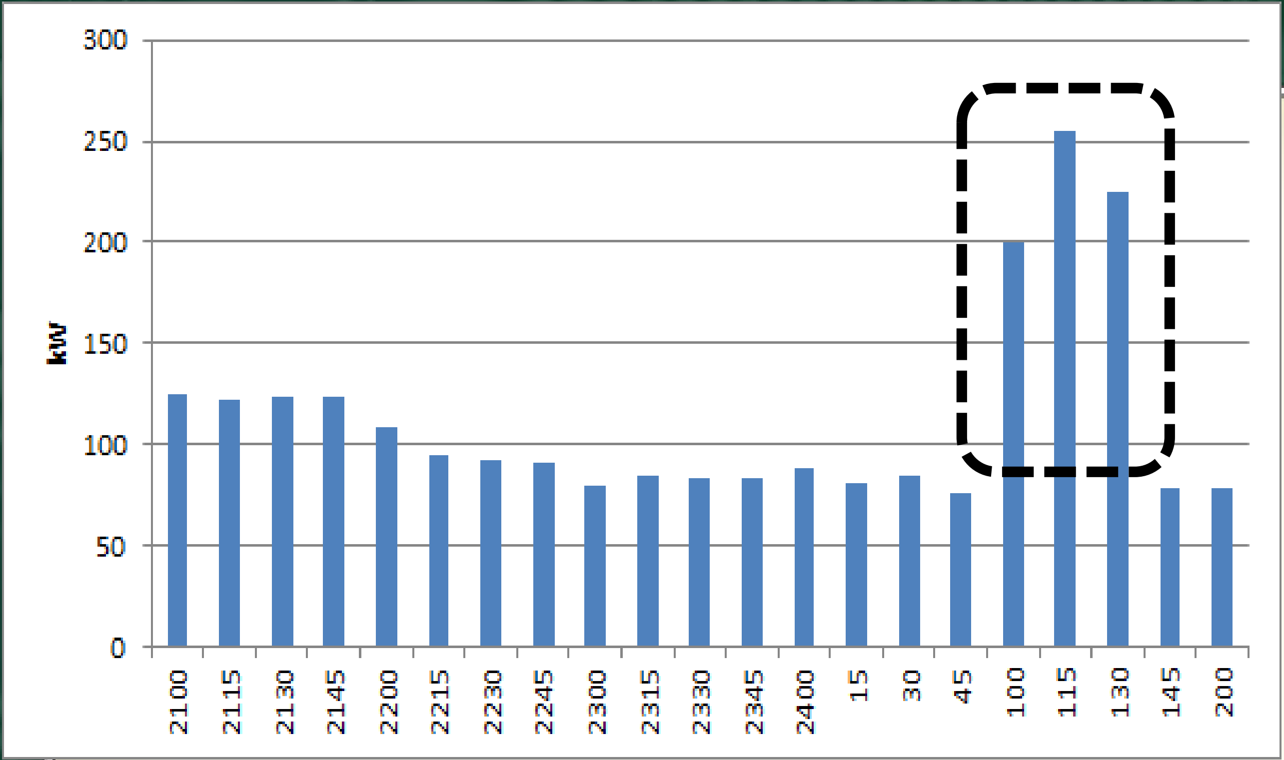
Case Examples



Control schedule error

Building is closed weekends, but the controls are keeping things running anyway. This is summer A/C

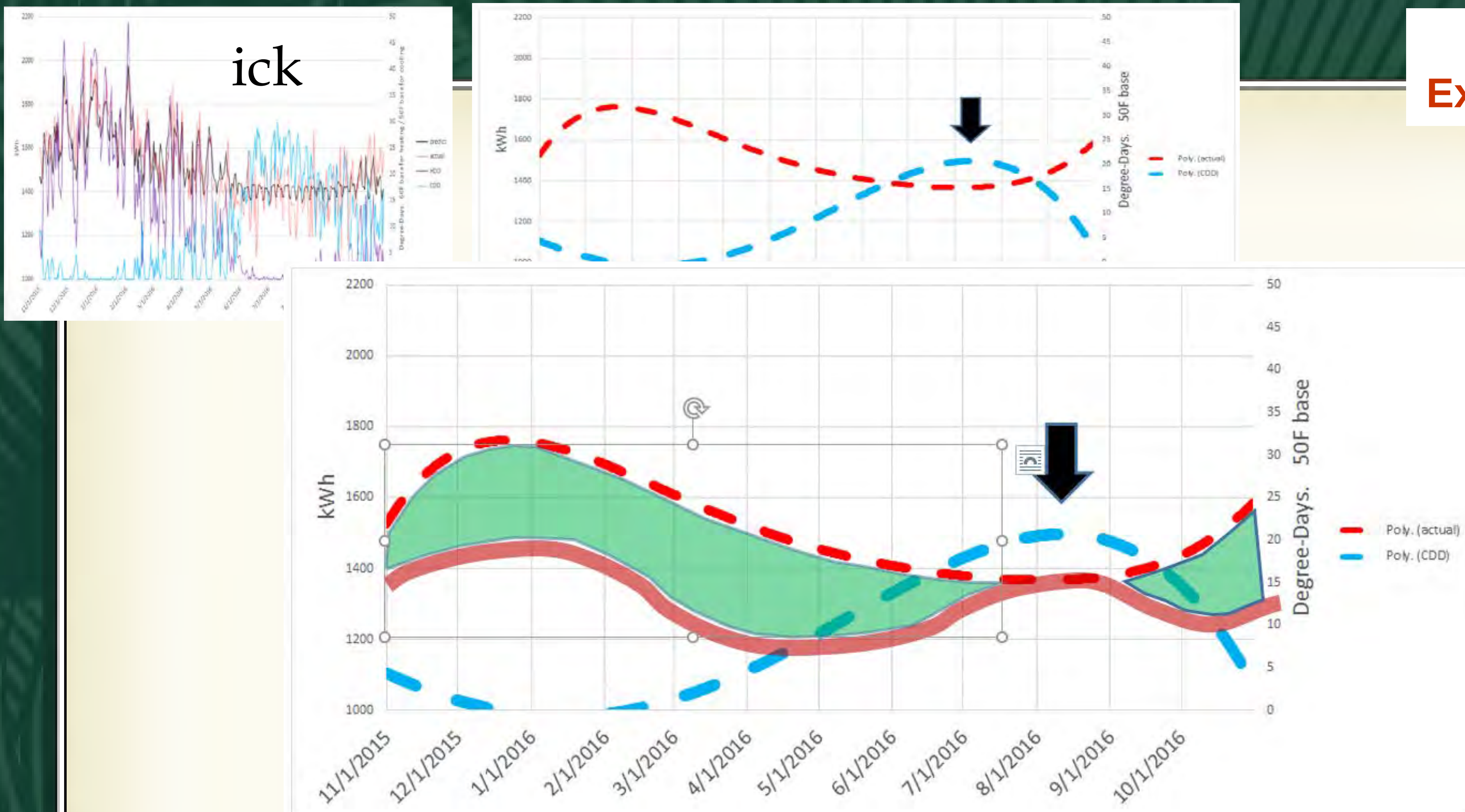
Green bars are occupied time



Ghost load

Unidentified load in the middle of the night, building closed. <u>These loads are invisible without interval data</u>

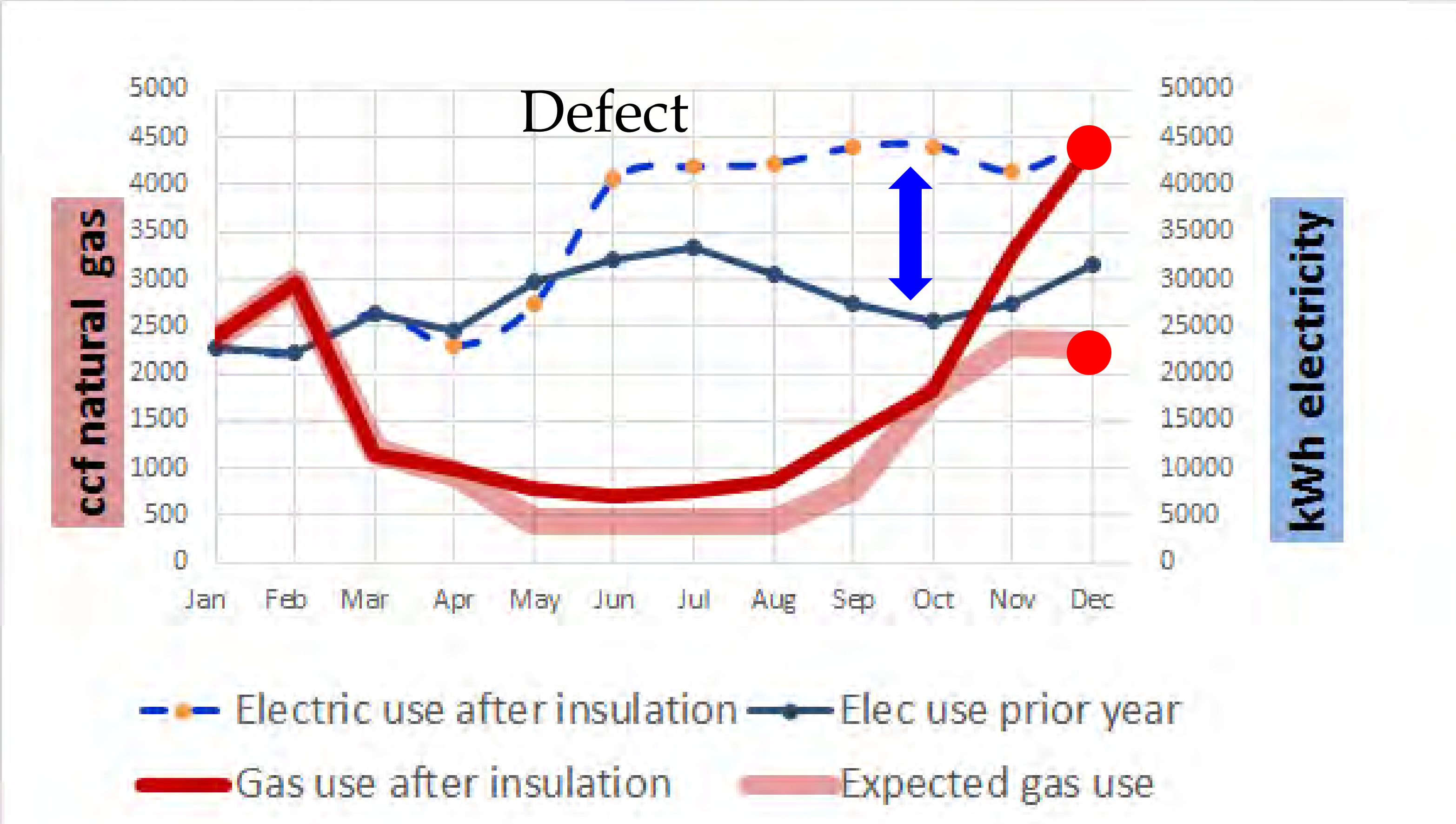
Case Examples



VAV minimums set to 100%

“Trend lines” were used to get past noise. Pointed to “energy use lowest when cooling demand is highest” which is the signature of constant volume reheat, which the VAV system became from changing the settings. Green is approx savings

Case Examples



Troubleshooting

Envelope improvements for high gas use. Then energy use goes up instead of down. Which makes no sense.

Defective control caused cooling to run, false loading the heating response

Thank You

Preliminary Metrics for Energy Audits

Questions / Comments

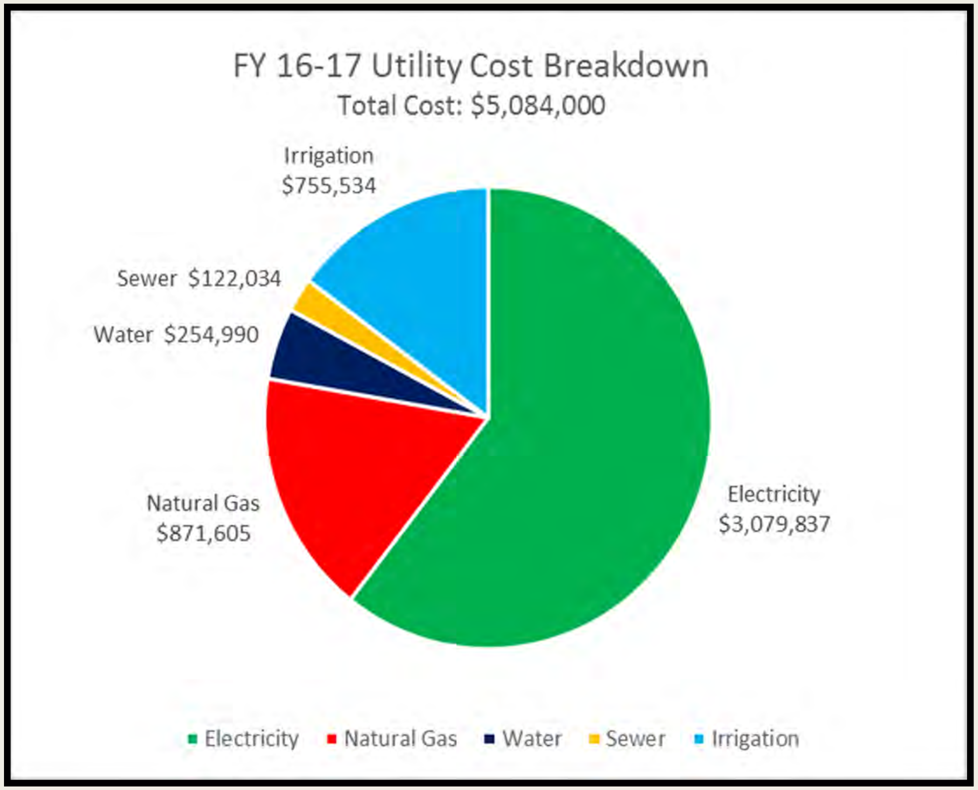
CASDEM MEETING

May 10, 2018

School District 11

Overview of School District 11:

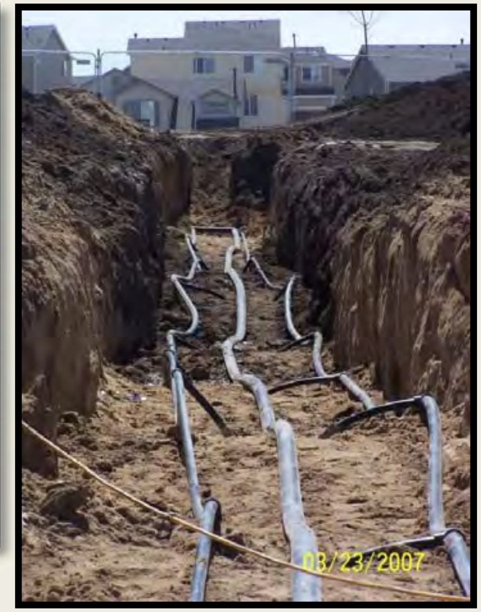
- Founded in 1872
- 72 Square Miles
- 26,665 students
- 46 Schools (5HS, 9MS, 32 ES)
- 3,903,954 Square Feet
- ~ $5 Million annual utility outlay

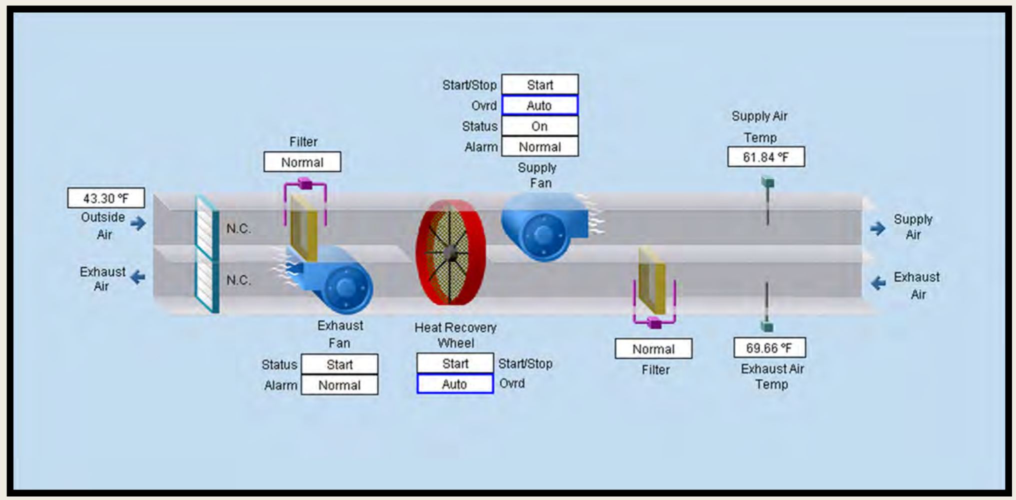


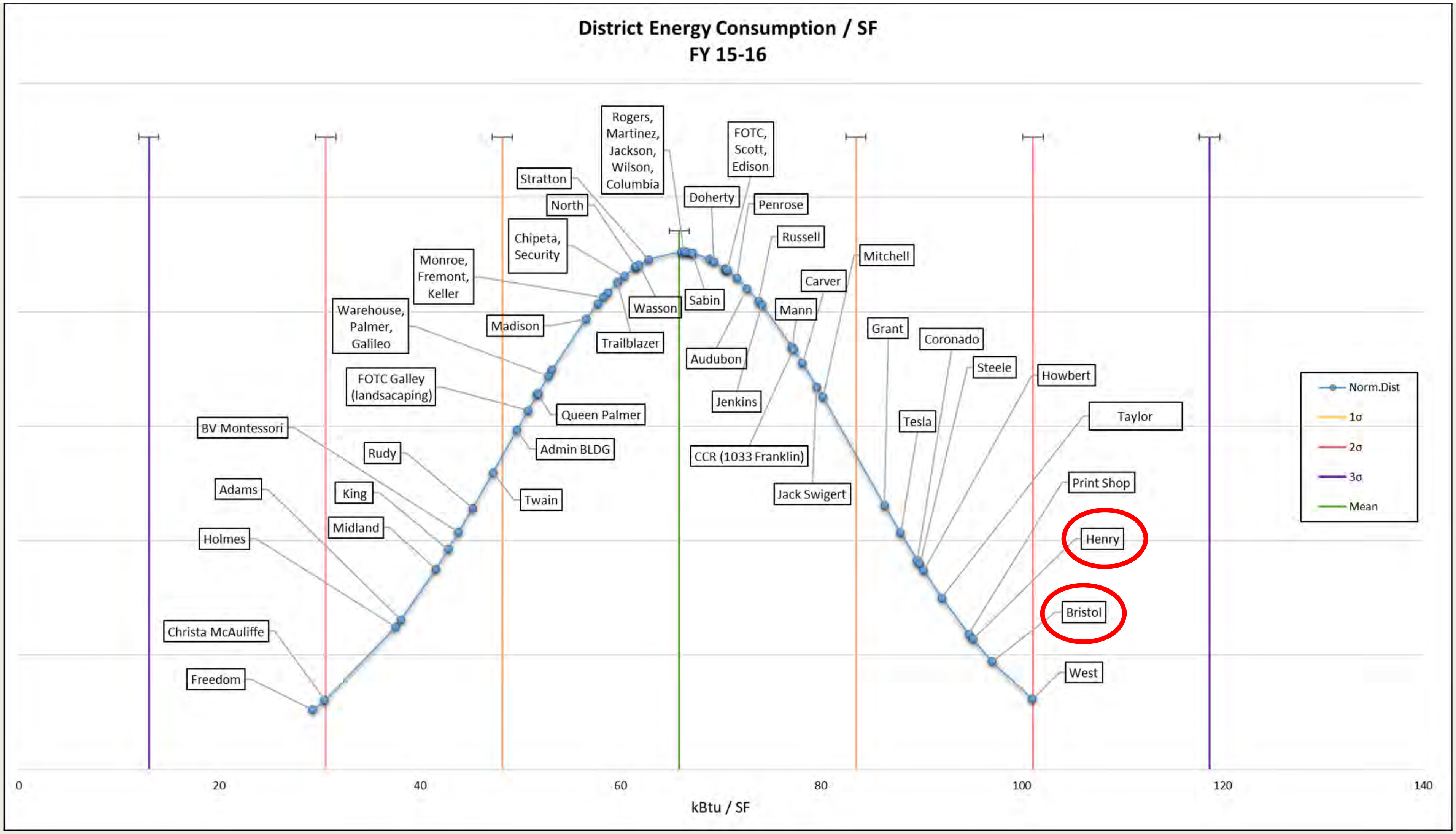
District 11 Energy Program Overview

- Program initiated in the late 1990s
- Active until 2012
- Program gap from 2012-2016
- 2016-2018 :
  - *Investigated the history of District 11 Energy Management Program*
  - *Determined status of the industry as a whole*
  - *Conducted pilot projects to determine viable strategies for water/energy management*
  - *Developed new goals and vision for this program*

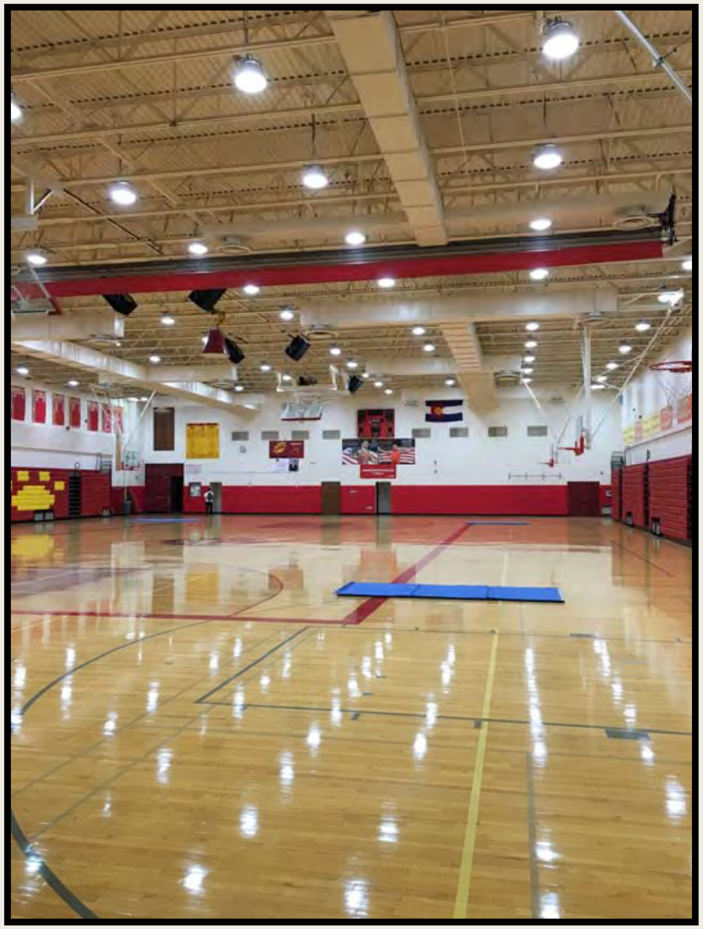
The History of Our Program:

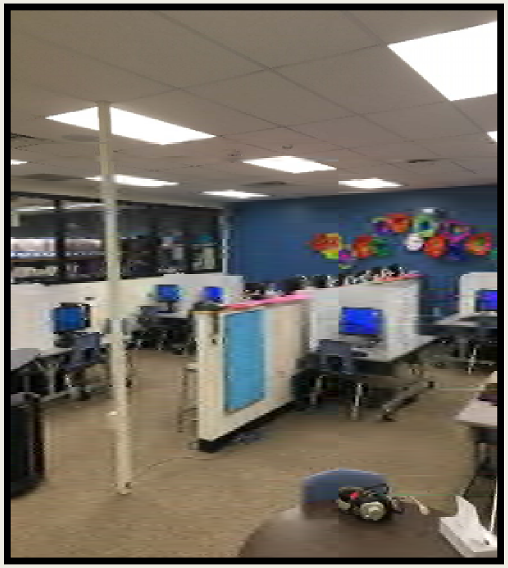




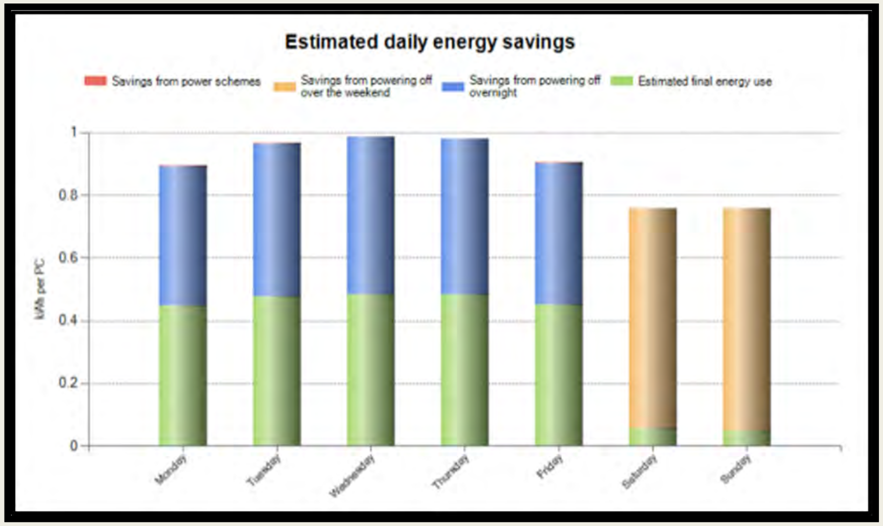

District Energy Consumption / SF
FY 15-16
Rogers, Martinez, Jackson, Wilson, Columbia
FOTC, Scott, Edison
Stratton
North
Doherty
Penrose
Chipeta, Security
Russell
Monroe, Fremont, Keller
Mitchell
Carver
Wasson
Sabin
Mann
Warehouse, Palmer, Galileo
Madison
Trailblazer
Grant
Coronado
Audubon
Steele
Howbert
FOTC Galley (landsacaping)
Jenkins
Queen Palmer
Taylor
BV Montessori
Tesla
Admin BLDG
CCR (1033 Franklin)
Rudy
Adams
King
Twain
Jack Swigert
Print Shop
Midland
Henry
Holmes
Bristol
Christa McAuliffe
Freedom
West
Norm.Dist
1σ
2σ
3σ
Mean
0
20
40
60
80
100
120
140
kBtu / SF

Recent Program Activity:



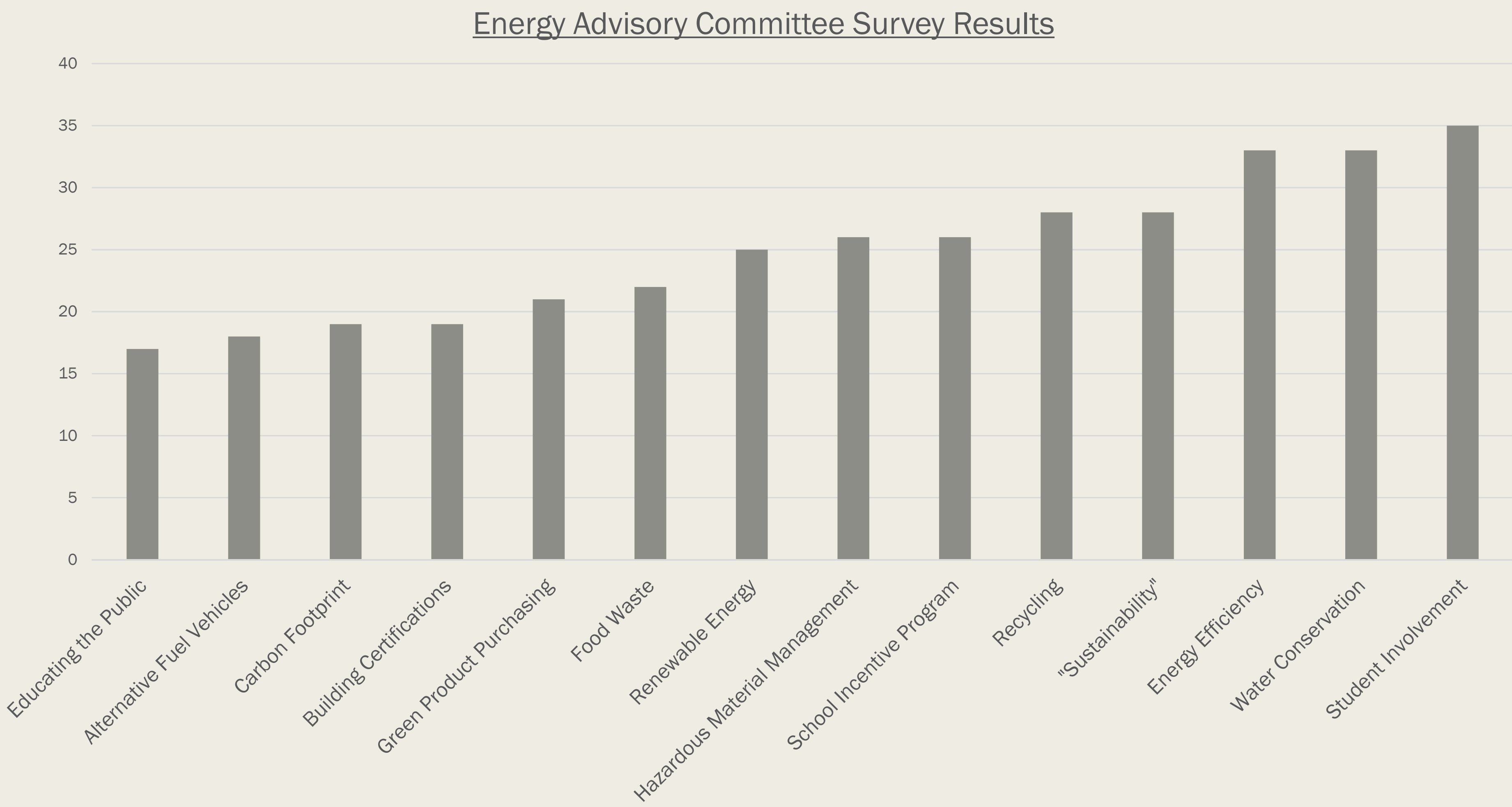


Recent Program Activity Continued:



Developing Goals & Vision:

- Market Research
- Input from The Energy Advisory Committee



Energy Advisory Committee Survey Results
40
35
30
25
20
15
10
5
0
Educating the Public
Alternative Fuel Vehicles
Carbon Footprint
Building Certifications
Green Product Purchasing
Food Waste
Renewable Energy
Hazardous Material Management
School Incentive Program
Recycling
"Sustainability"
Energy Efficiency
Water Conservation
Student Involvement

The Future of Our Program:

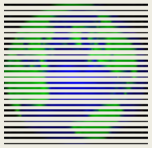
Discussion:

Energy Management

- Cost avoidance is the driver

Sustainability

- Carbon footprint
- Waste diversion
- Green product purchasing
- Alternative fuel vehicles
- Staff/student engagement



Building Envelope and Mechanical Insulation Energy Conservation Measures

Thursday May 10, 2018

Peter Boland, CIEA, BPI, LEED GA
Energy Conservation Specialist
I-Star Energy Solutions

BUILDING ENVELOPE

The **building envelope** is the physical separator between the interior and exterior of a **building.**

Components of the **envelope** are typically:

- Walls
- Floors
- Roofs
- Fenestrations - Windows
- Doors

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Is The Building Envelope Important?

"In Commercial and Residential buildings, 42 percent of energy is lost through the building envelope"

Former Energy Secretary Steven Chu

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Building Envelope Energy Losses

Air Infiltration/Exfiltration

Mitigated by

Air Barriers & Sealant and Weather-Stripping

Radiation & Conduction

Mitigated by

Insulation & Thermal Breaks

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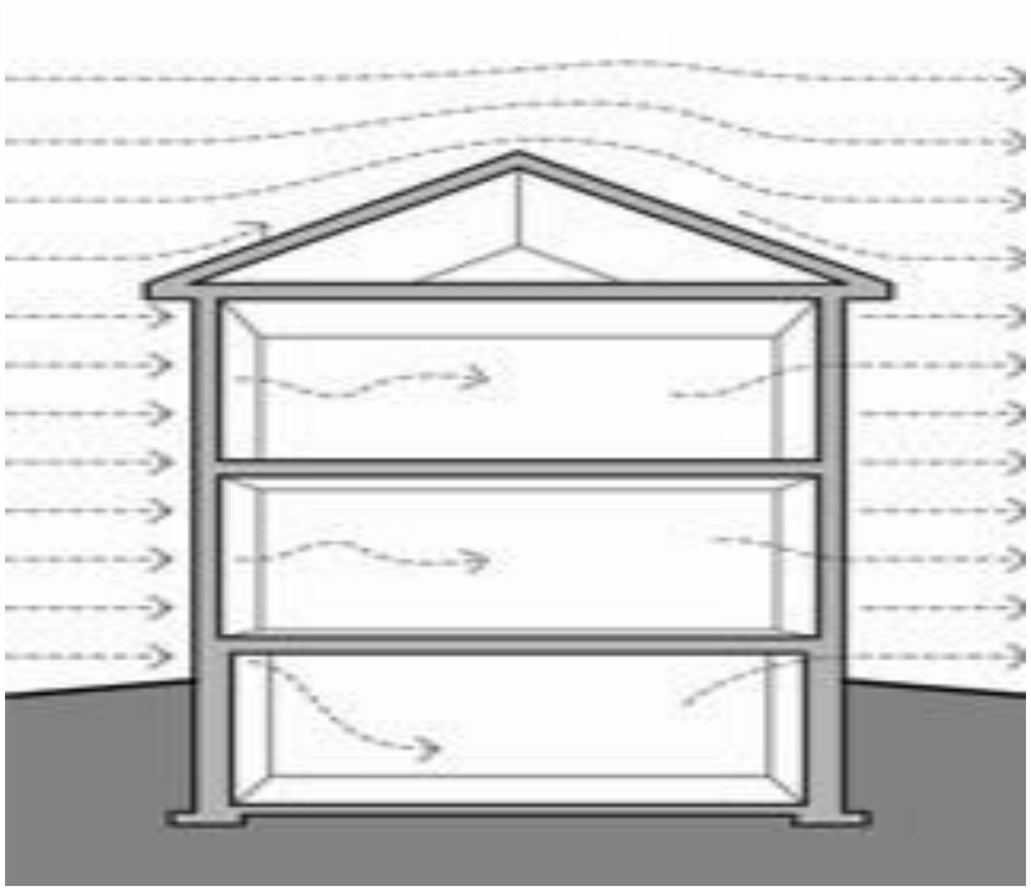
WIND LOAD



Positive Pressure

Negative Pressure

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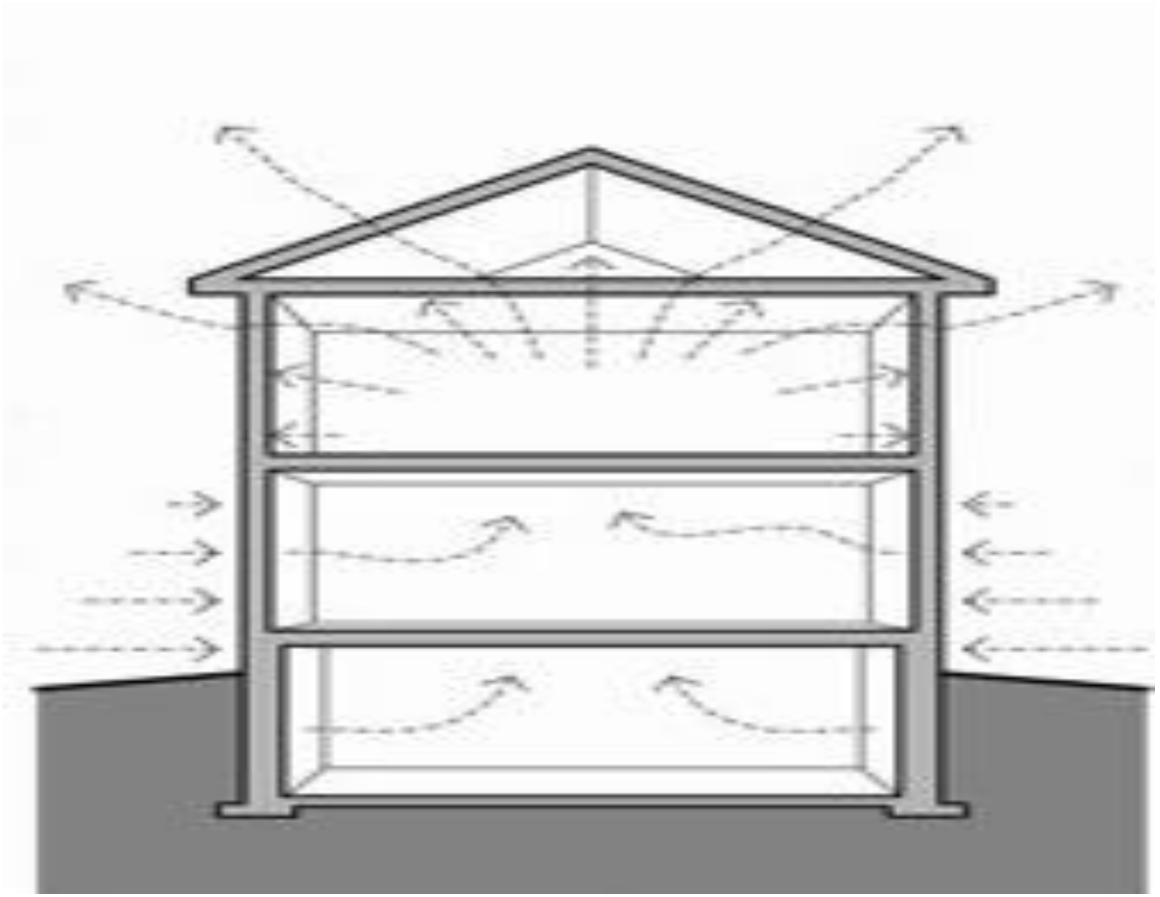
STACK EFFECT

And Ejected at the Roof



Air is drawn in at the Floor

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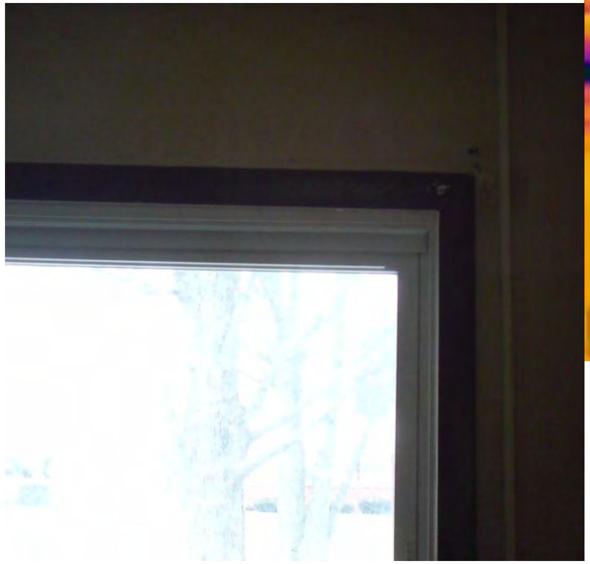
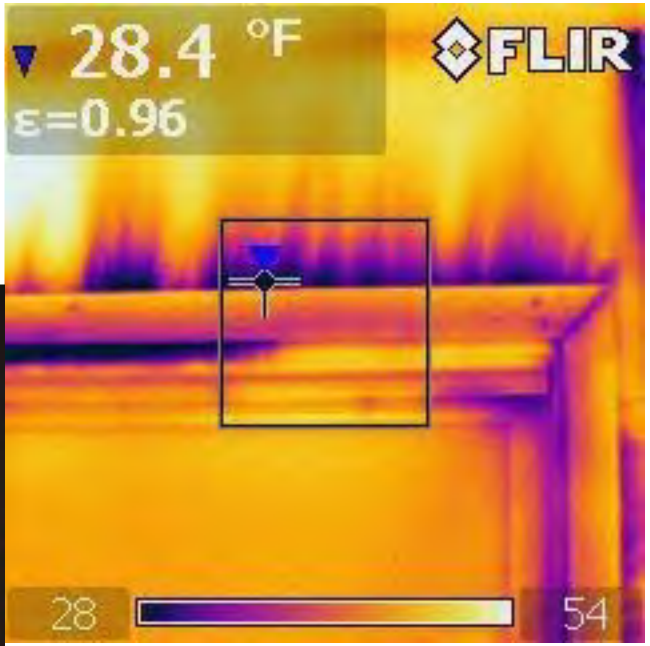
How is Air Leakage Measured?

ASHRAE 90.1 Crack Method - visually measuring cracks and openings in the envelope and calculating the amount of air moving through the cumulative opening

Blower Door Testing – using negative pressure to increase the visibility of leakage sources and measuring the actual amount of air entering through those sources

Blower Door Testing





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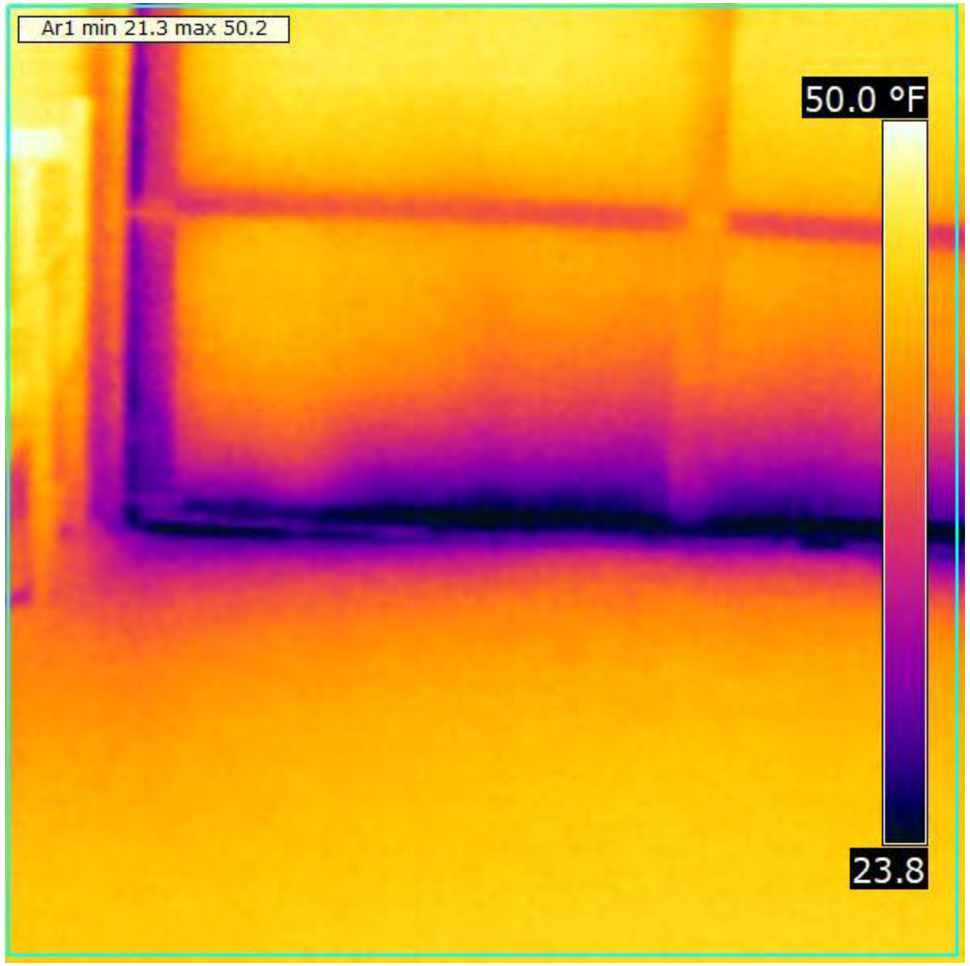
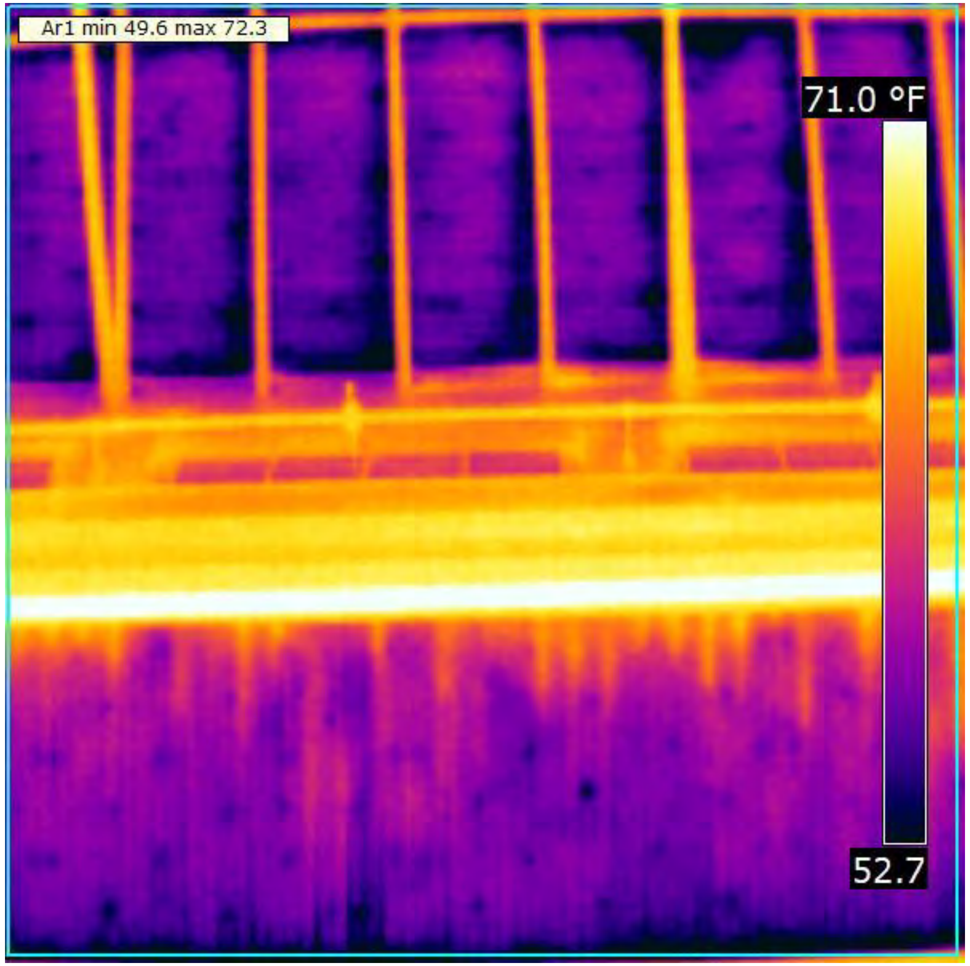
Infrared analysis can identify air leakage and missing insulation





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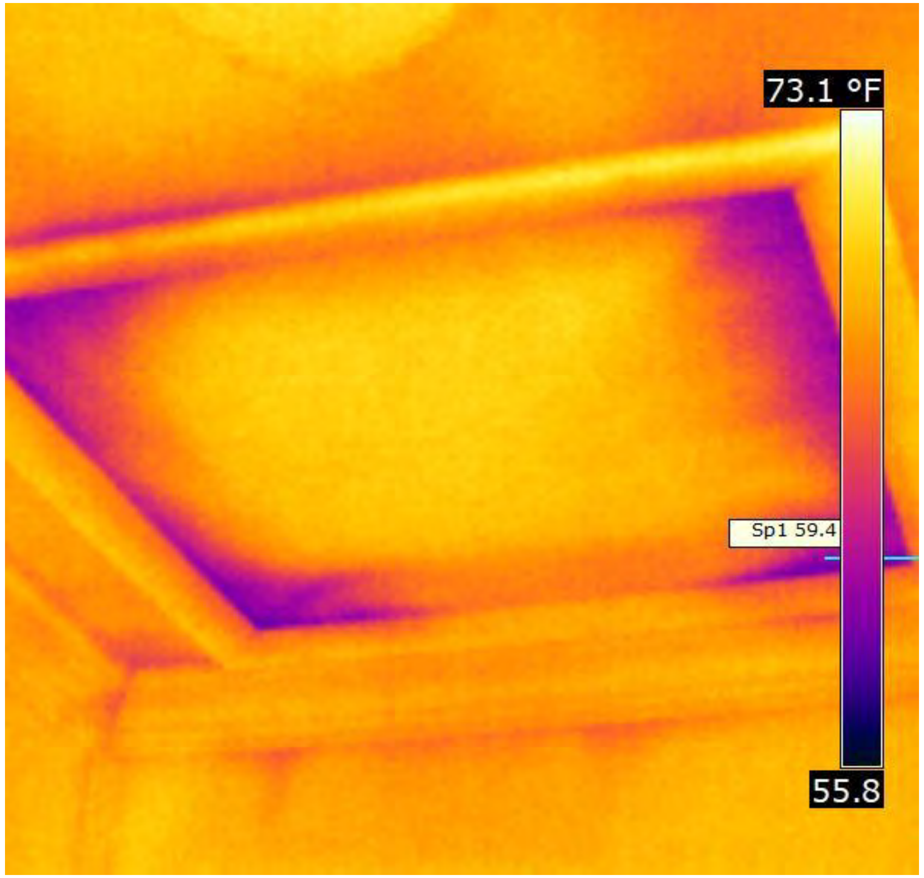
Air leakage under slight negative pressure



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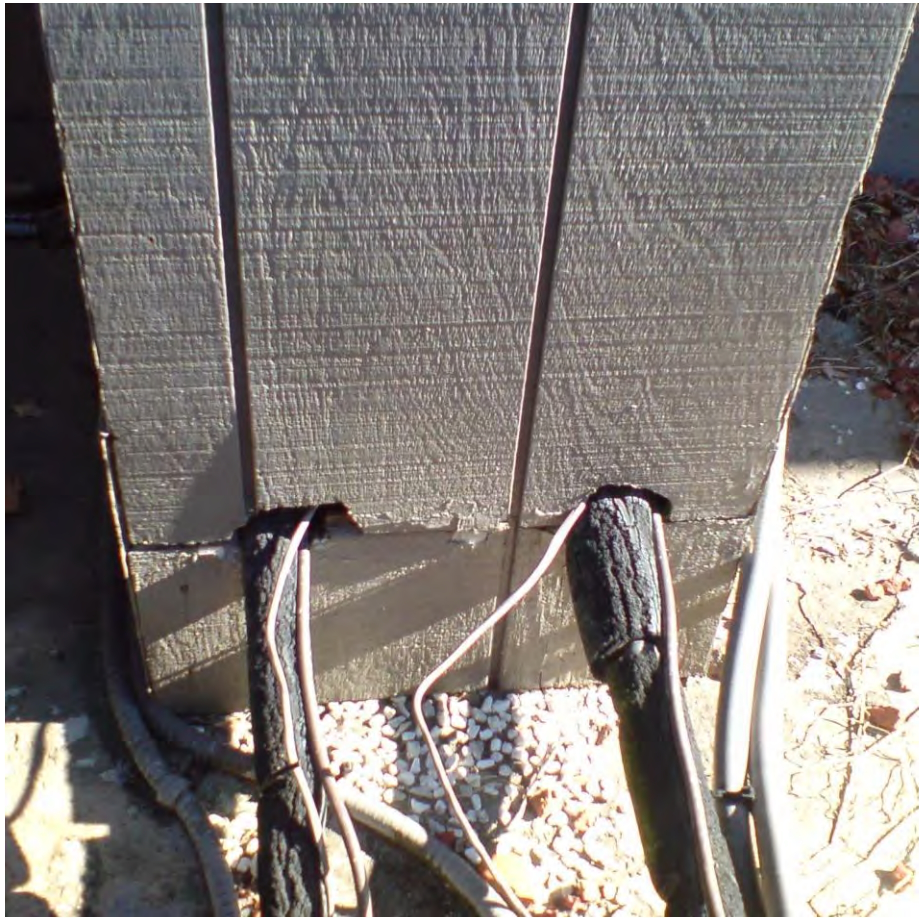
Wall penetrations – Some not so bad



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Wall penetrations – Some very bad

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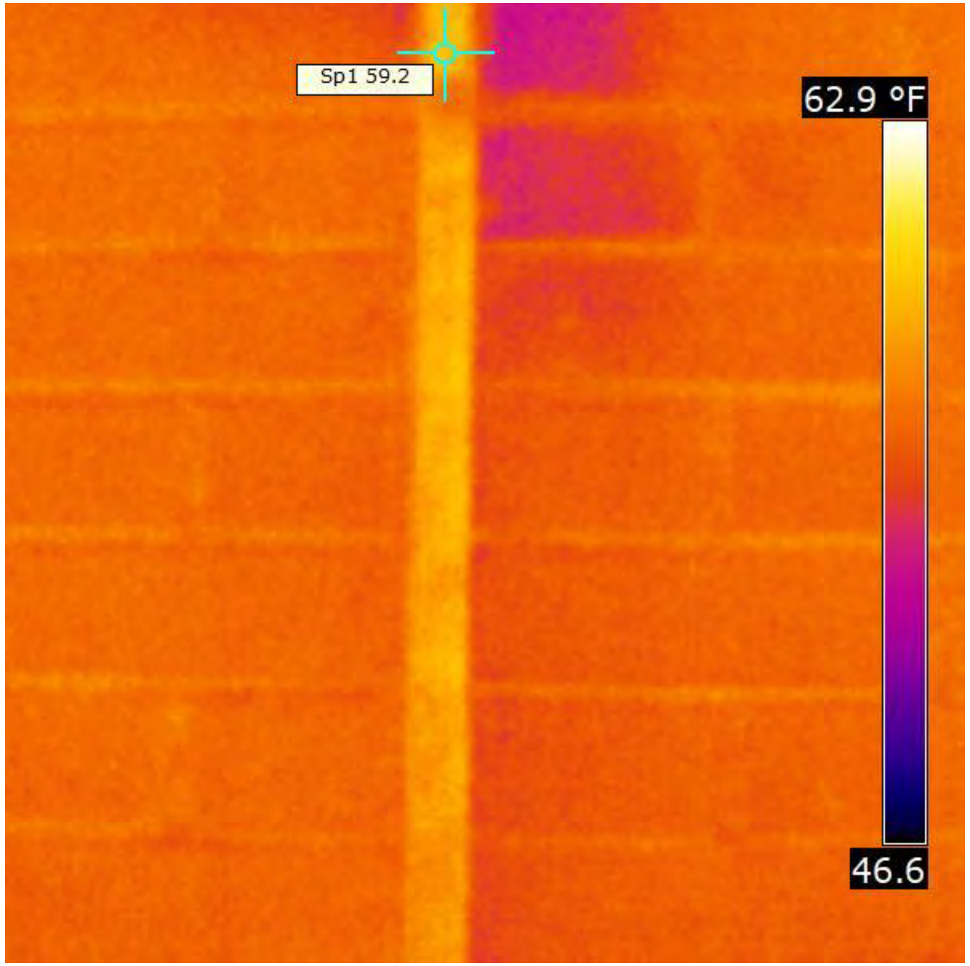
Wall cracks – Some are superficial



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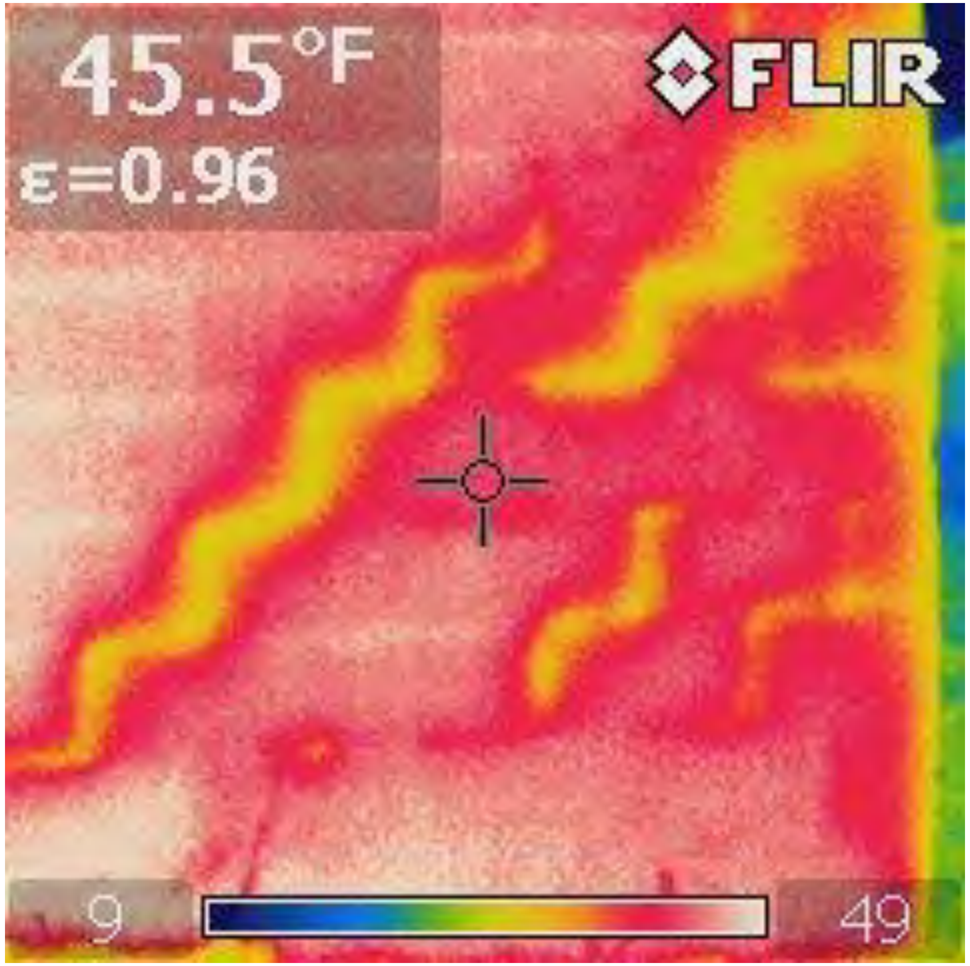
Wall cracks – Some not so superficial



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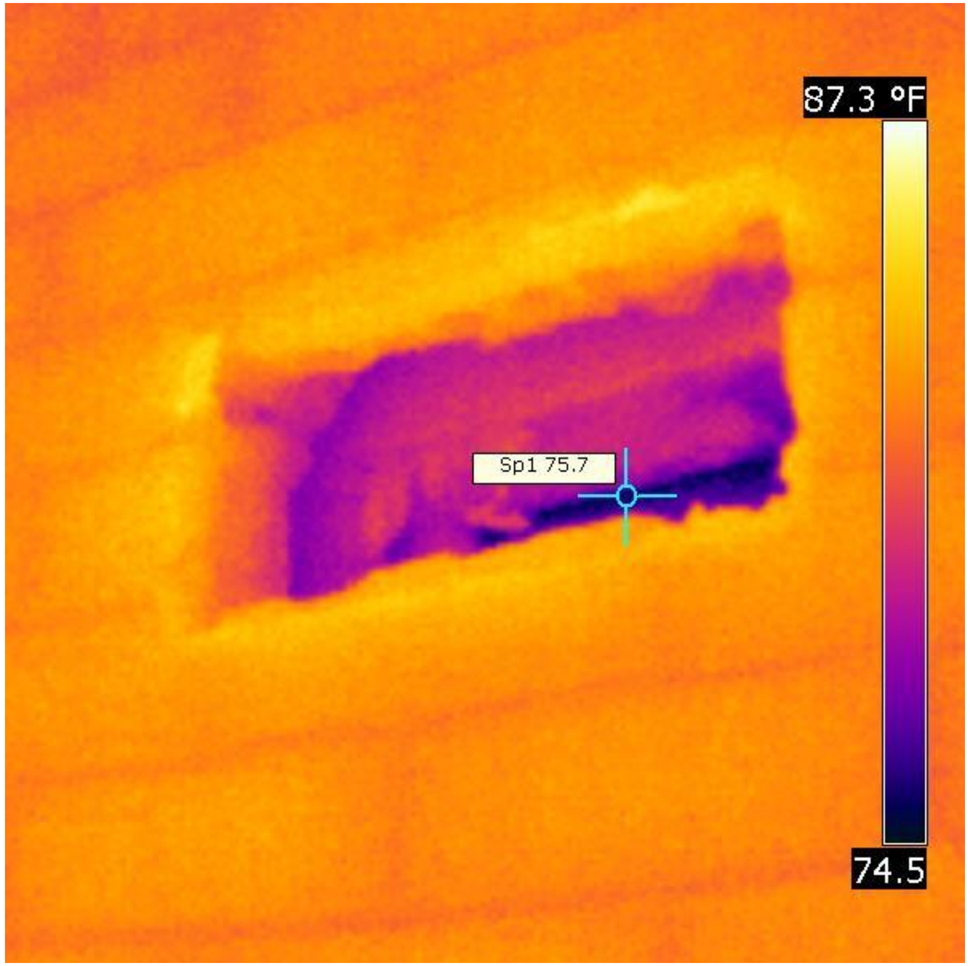
Wall openings



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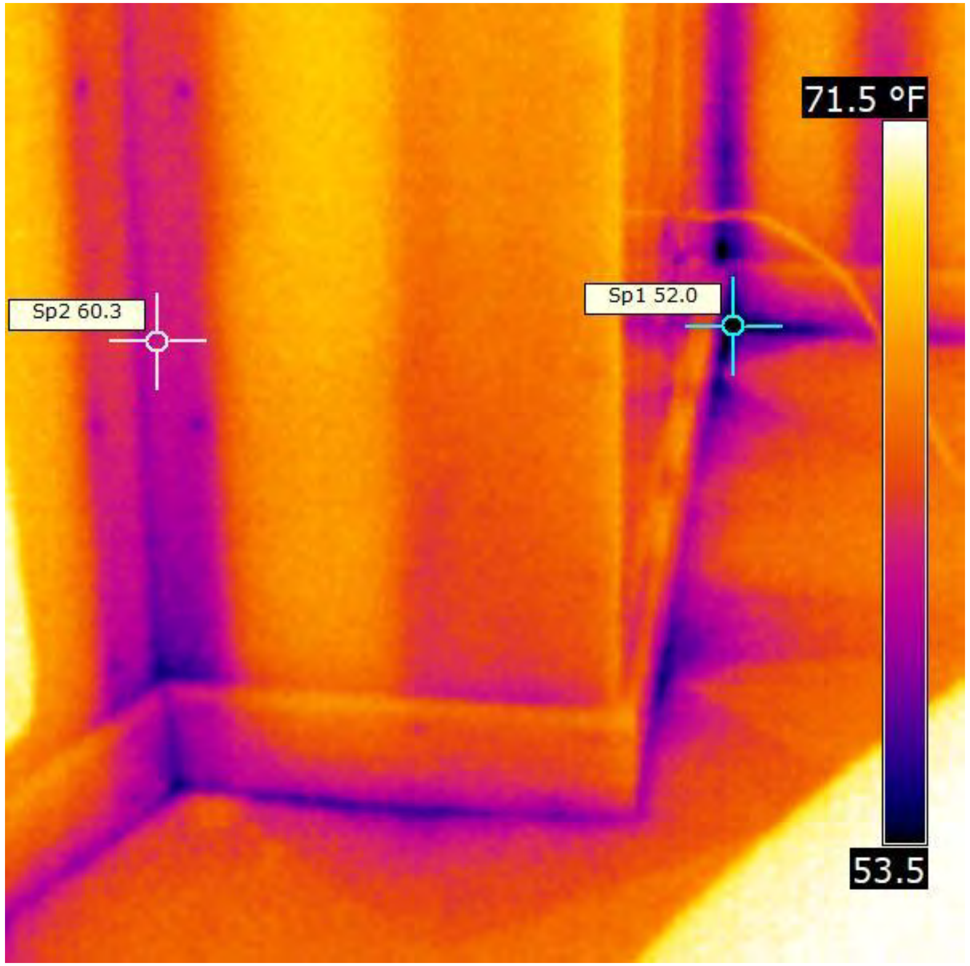
Walls – air infiltration at floor interface



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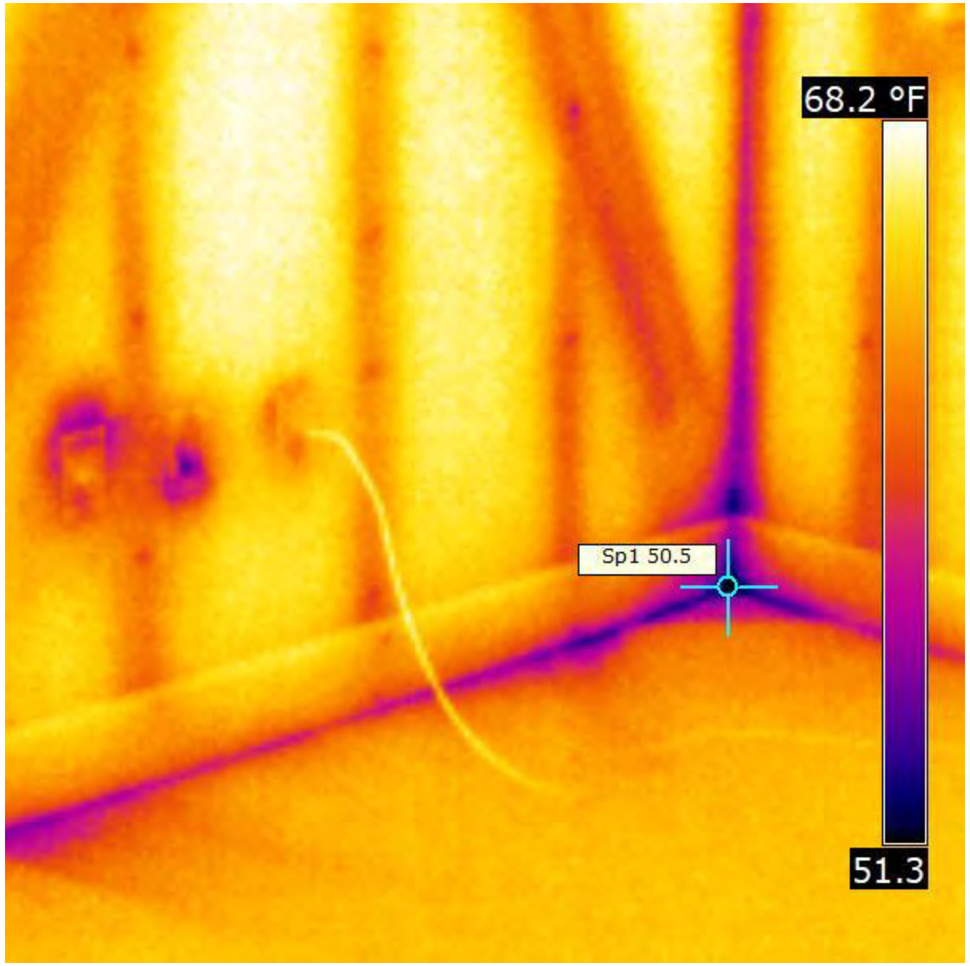
Walls – Thermal bridging



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Floors

Missing Insulation

Air Leakage

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Roofs

Missing Insulation

Roof hatches often leak

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Roof – Infiltration at roof wall

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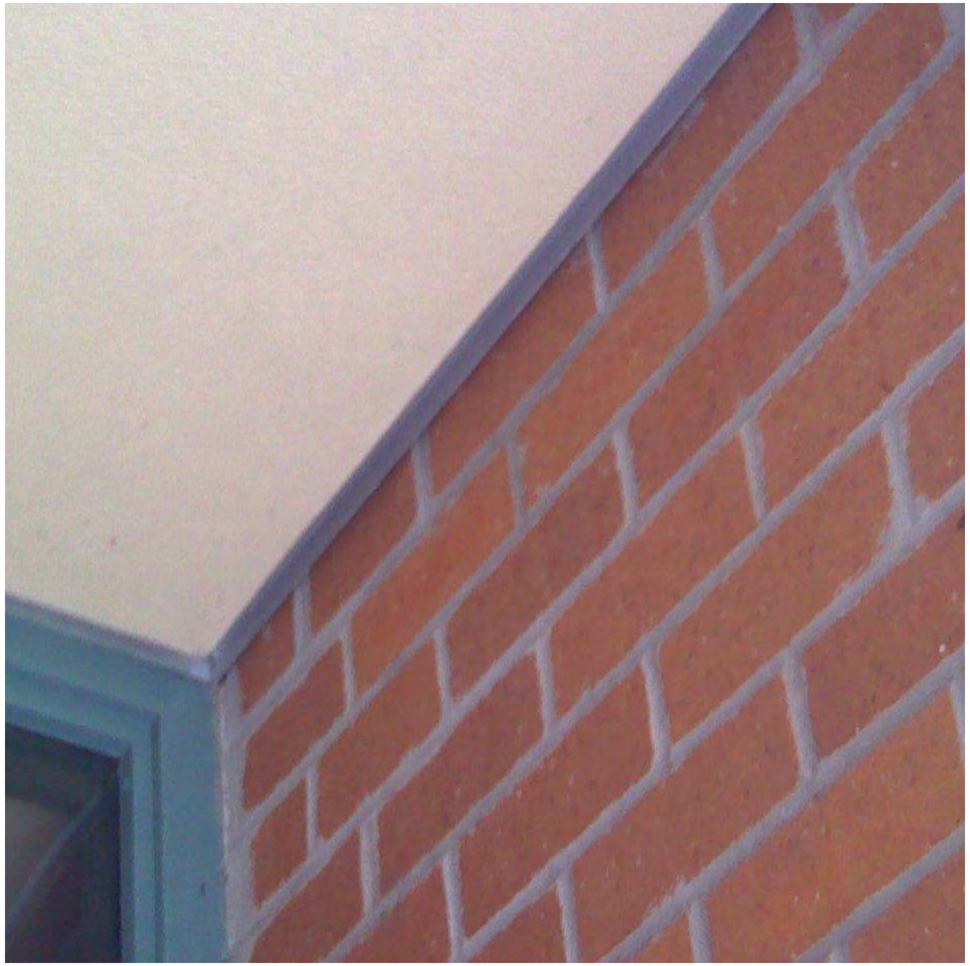
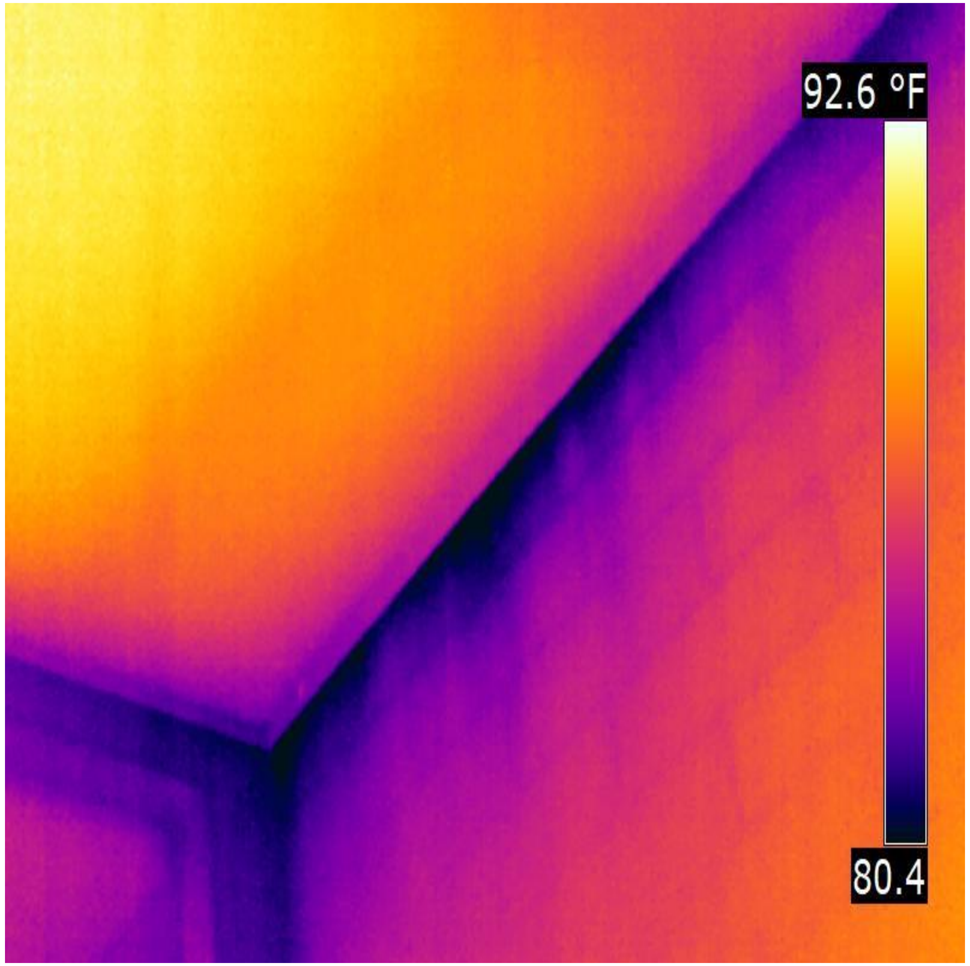
Soffit – Exfiltration





Hot Climate

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Roof – Campus IR image of roof issues

Doors

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Light is not a recognized method

But a very good indicator of Energy Savings Opportunities

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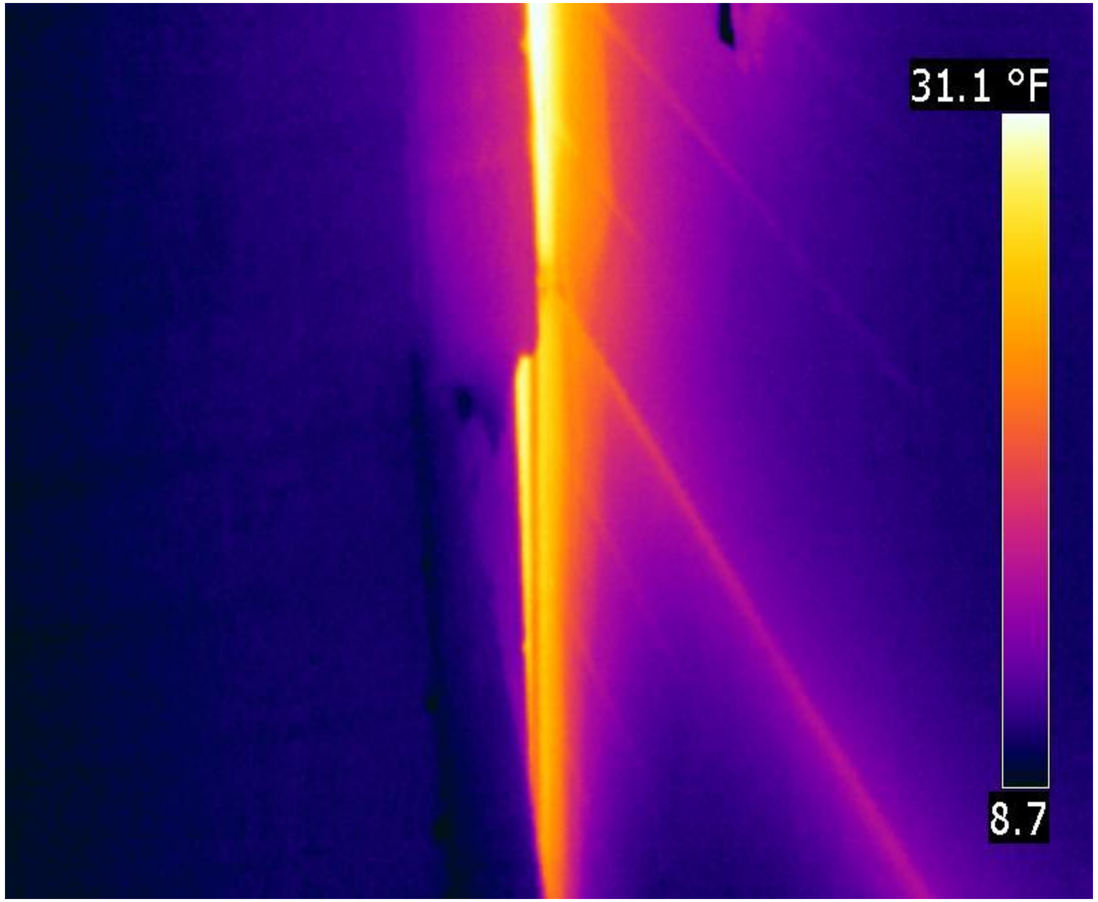
Door Leakage – Some Obvious



Missing weather-stripping

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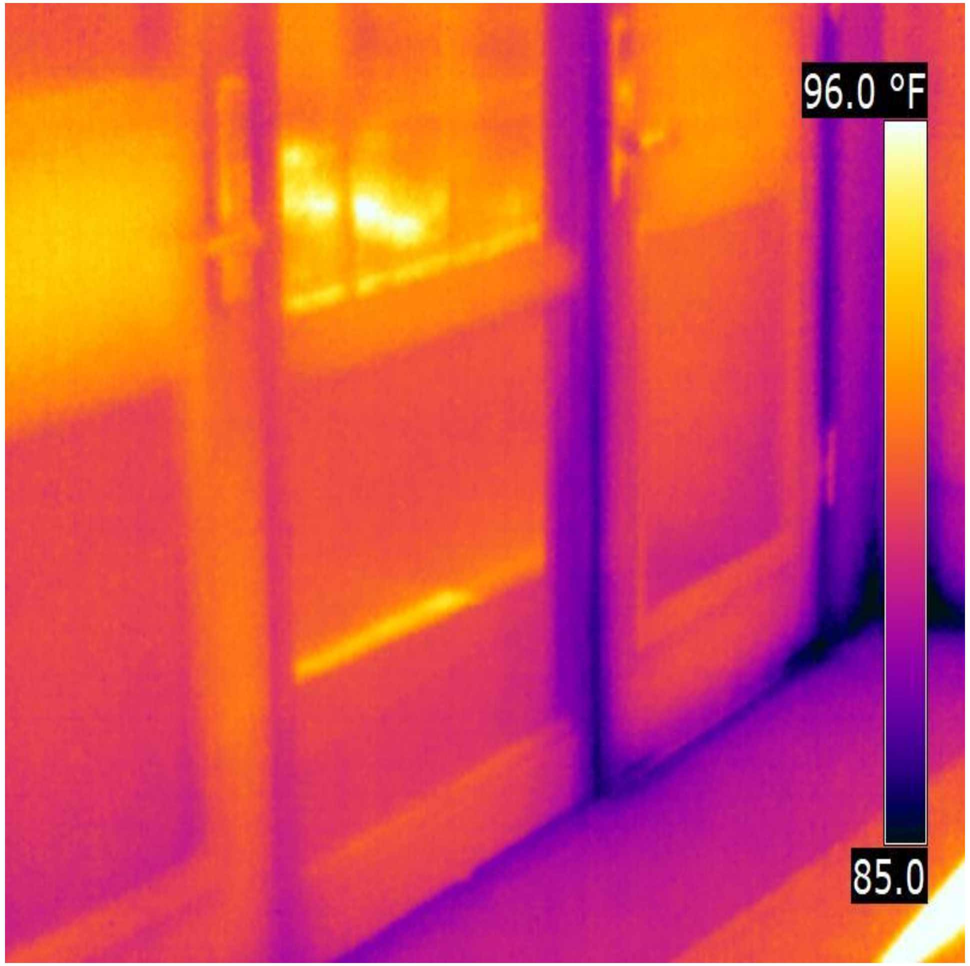
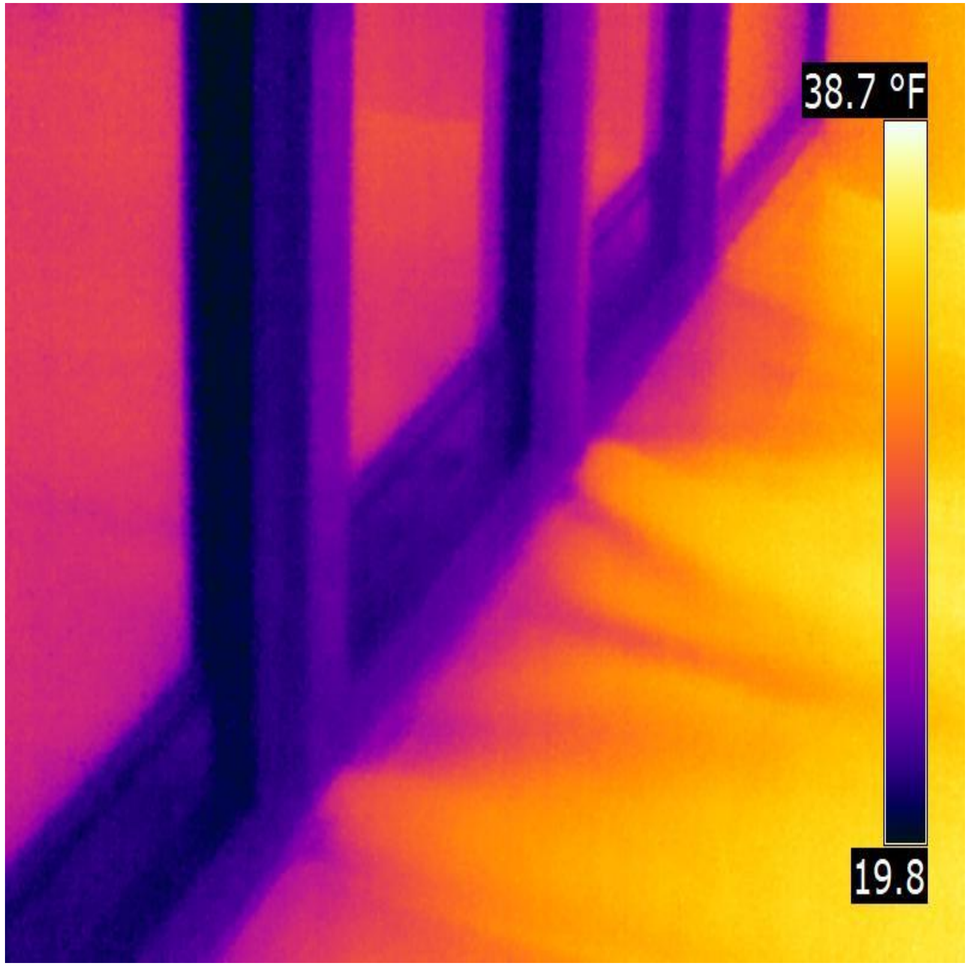
Door Leakage – Some not so Obvious





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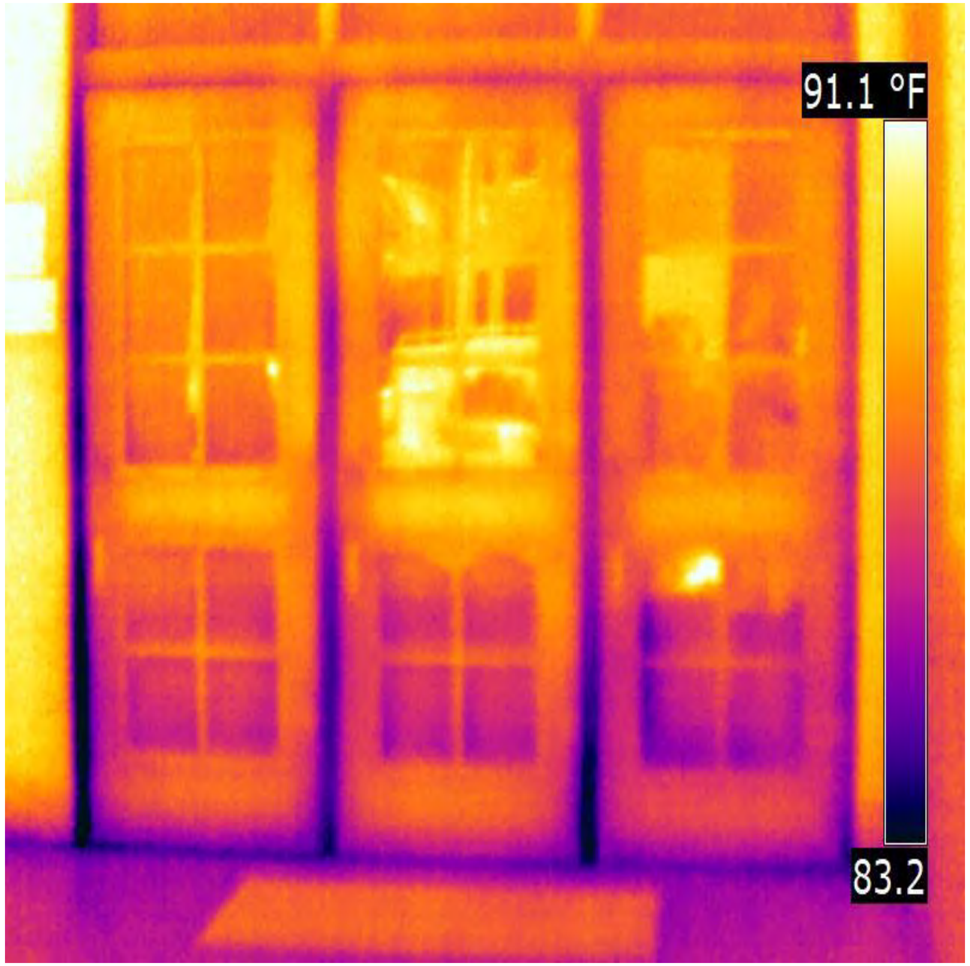
Doors – Ineffective weather-stripping



Hot Climate

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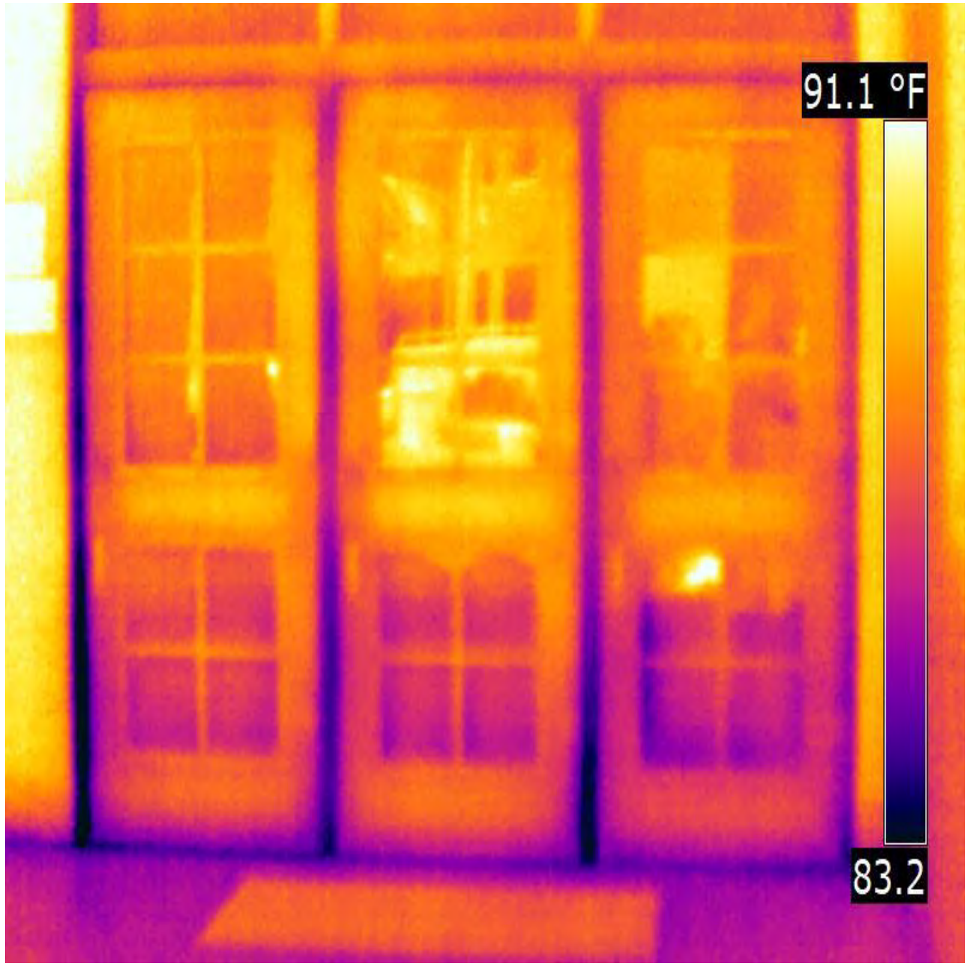
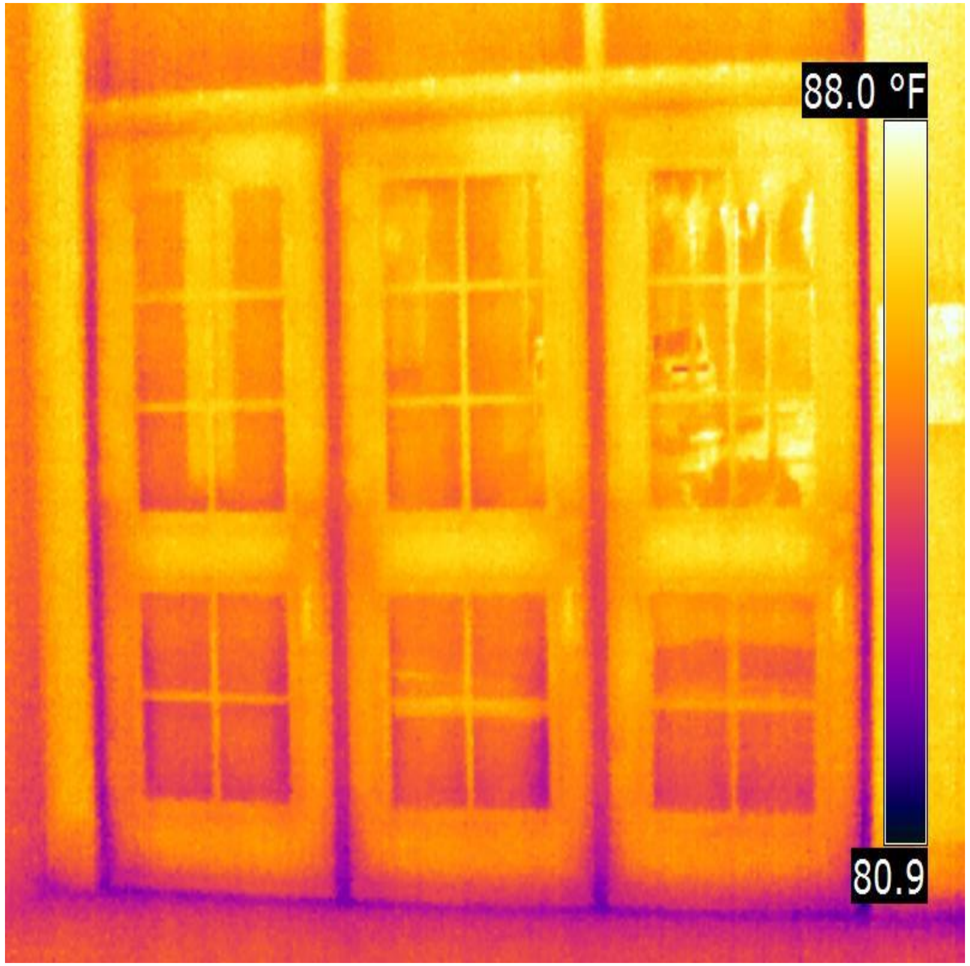
Doors – Effective weather-stripping



Before repair



After repair

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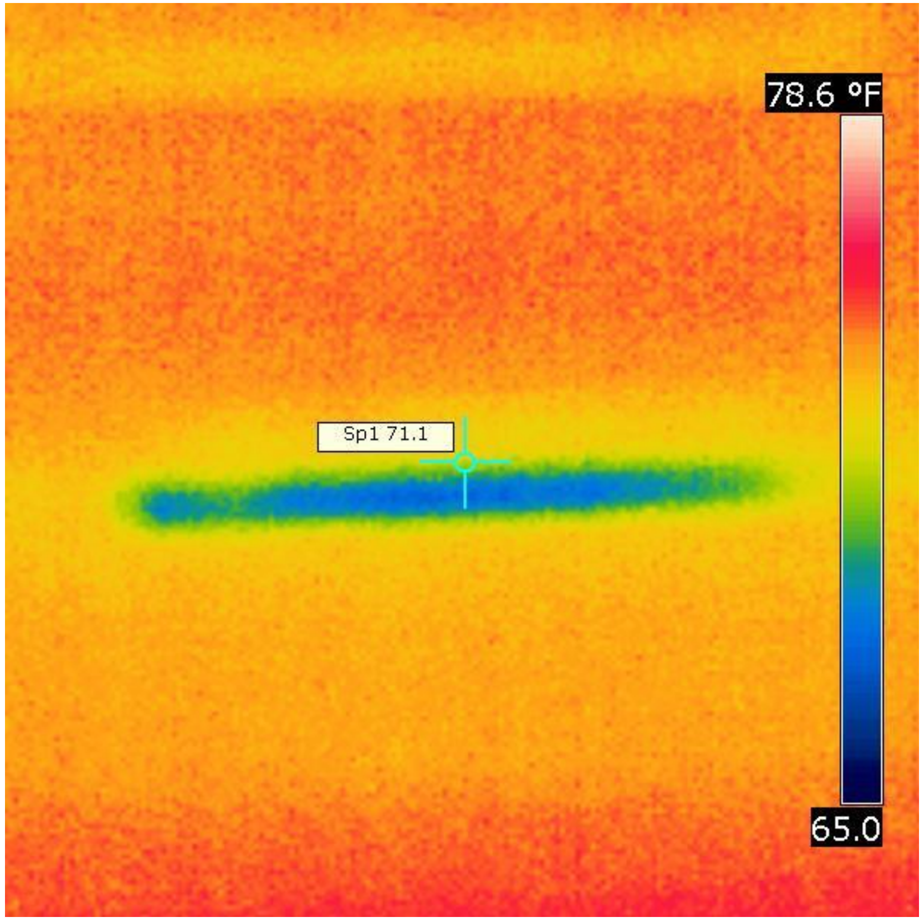
What do you think?



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Fenestrations

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Replacing Windows Challenges

In a study completed for Concord Municipal Light in the Boston area, it was determined that replacing 15 old windows would save $42 to $112 per year. Even at that higher number, it would take more than 62 years' worth of energy savings to pay for $7,000 worth of windows.

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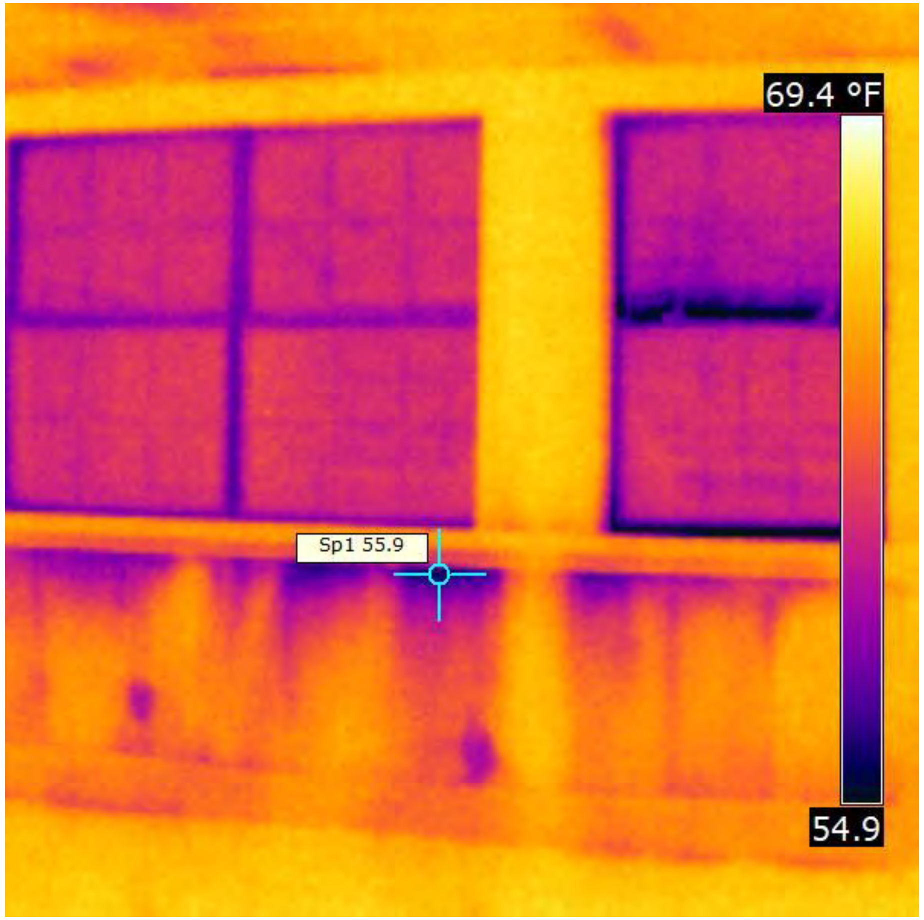
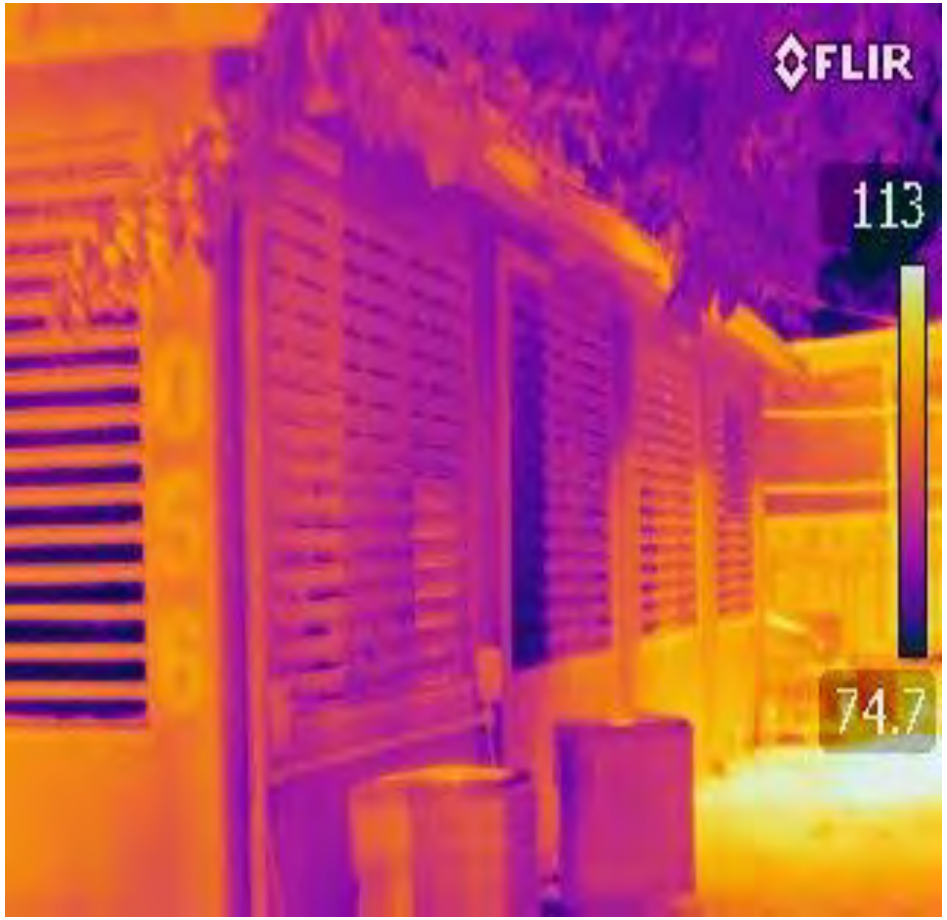
Windows can be in poor condition but rarely fit into an energy project budget





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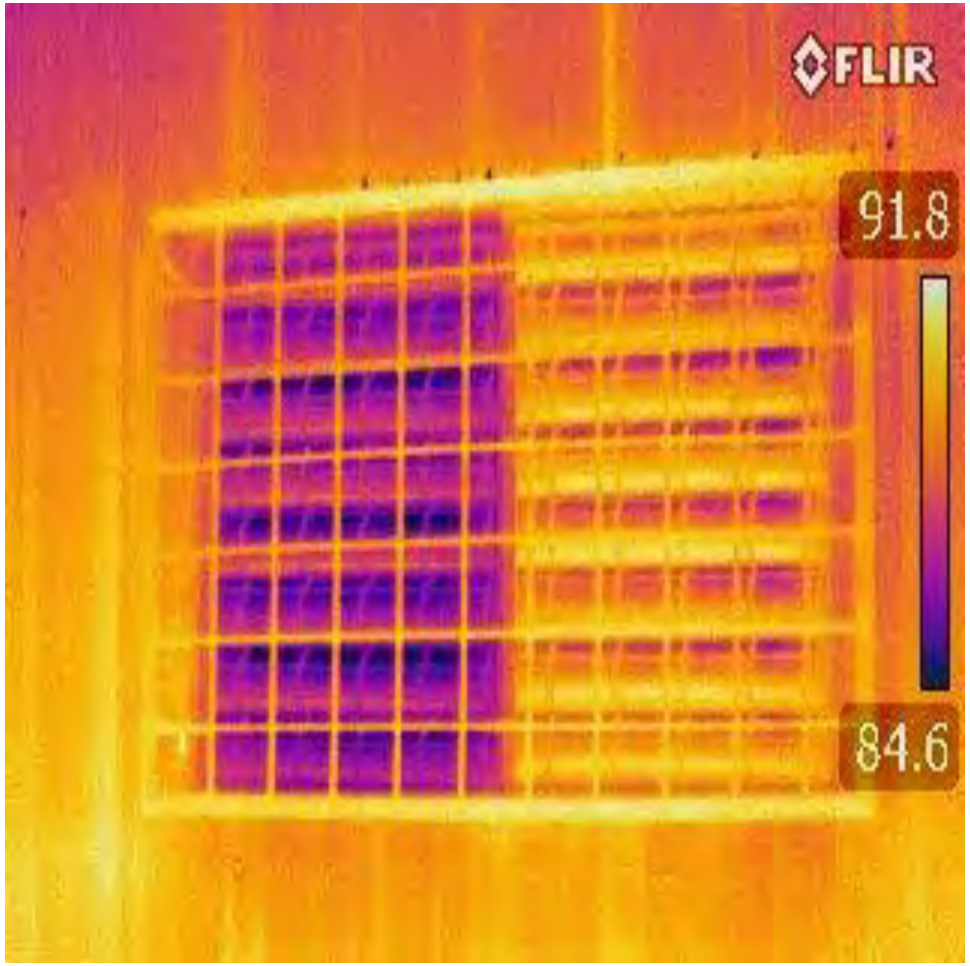
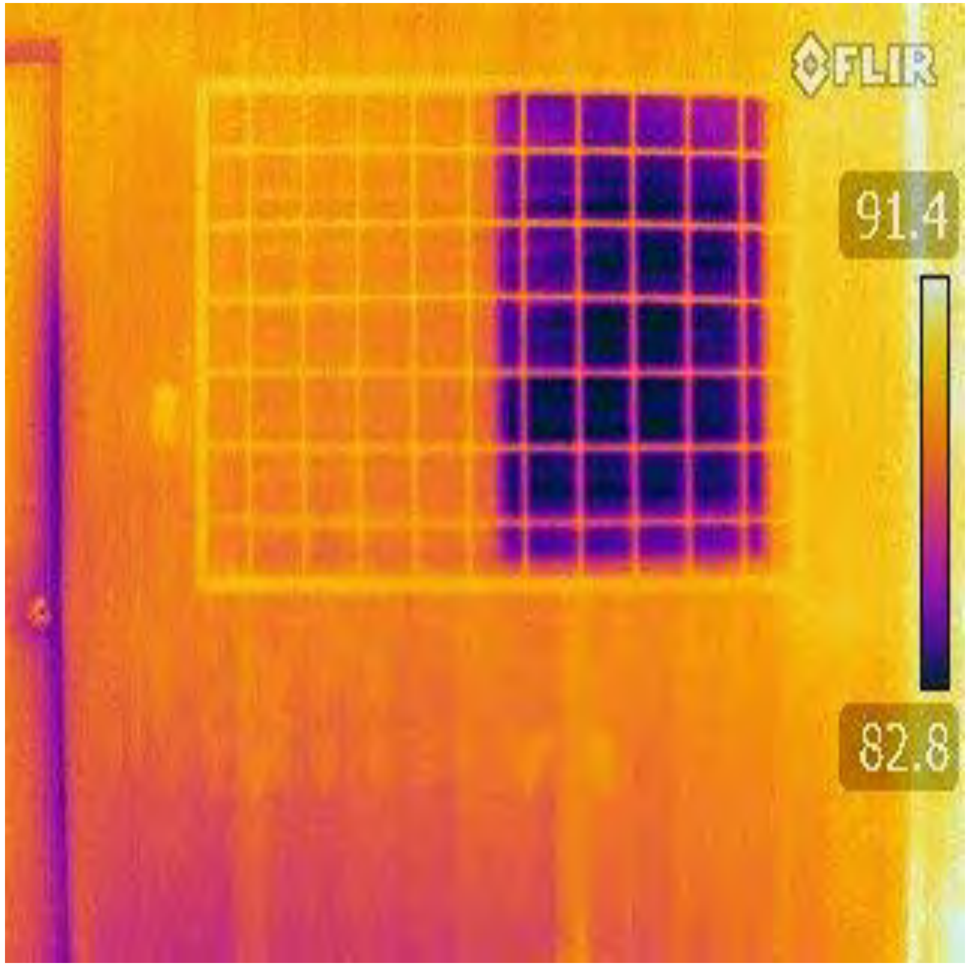
Window inserts can be very cost effective and energy efficient





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What Defines a Good Opportunity?

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Are the Buildings Old?

Historical?

In Overall Poor Condition?

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CAN YOU SEE DAYLIGHT?

There is Opportunity

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Comprehensive Building Envelope Reports

Envelope Improvement - Replacement Products and Manufacturer			
Replacement Product and Manufacturer	Warranty Information	Expected Failure rate	Website
DAP Premium Polyurethane Concrete & Masonry Sealant #18814	50 yrs	minimum 25 years	www.dap.com
3 M Polyurethane Sealant #535	n/a	minimum 25 years	http://solutions.3m.com
TremSeal D One Component Polyurethane Sealant	1 yr	minimum 25 years	http://www.tremcosealants.com
OSI Enhanced Polyurethane Sealant	1 yr	minimum 25 years	http://www.osipro.com
Dow Corning 790 Silicone Building Sealant	50 yrs	minimum 25 years	http://www.dowcorning.com
GE SCS200 SilPruf Silicone Sealant and Adhesive	n/a	minimum 20 years	http://www.siliconeforbuilding.com
Boss 312 RTV Industrial Silicone Sealant	1 yr	minimum 20 years	http://www.accumetricinc.com
Sikaflex®- 1a	1 yr	minimum 25 years	http://www.sika.com
Sonolastic® NP1™	1 yr	minimum 25 years	http://www.buildingsystems.basf.com
Tremco Sprectrem 2 High-Performance Silcone Sealant	n/a	minimum 20 years	http://www.tremcosealants.com
Sealeze Nylon Therm-L- Brush Door Sweep	n/a	1,500,000 cycle testing ANSI 156.4, 1980	www.sealeze.com
Sealeze Astra-Sweep Nylon T			
Sealeze Nylon Therm-L- Brush			

Office/Lab (1)			
Temperature Which Heating Begins		70	°F
Temperature Which Cooling Begins		72	°F
Day Operation Begins (Sunday is Day 1)		1	Sunday
Day Operation Ends (Sunday is Day 1)		7	Saturday
Hour Operation Begins (Hour 1 is Midnight to 1 AM)		1	Hour
Hour Operation Ends (Hour 1 is Midnight to 1 AM)		24	Hour
Directional Wind Infiltration/Exfiltration		80%	per cent
Occupied Cooling Temperature Setpoint		72	°F
Occupied Heating Temperature Setpoint		70	°F
Unoccupied Cooling Indoor Temperature Setpoint		80	°F
Unoccupied Heating Indoor Temperature Setpoint		60	°F
Cooling Plant Efficiency		0.4	kW/ton
Heating Plant Efficiency		80%	per cent
Energy Cost $/kWh	$	0.03950	per kWh
Fuel Energy Cost $/MMBtu	$	6.13000	per MMBtu
# of Floors in Building		2	
Local Shelter Class (see Table 5 below)		3	Typical shelter used by other
A_L = Effective Air Leakage Area from Survey, ft^2		4.64	ft^2

Doors								Windows					
Length (inches)	Height (inches)	Sealant Required (LF)	Door Weather-stripping (LF)	Door Sweeps (Ea)	Door Sweep-Crack Width	Door Astragal (Ea)	# of Doors (Ea)	Length (inches)	Height (inches)	Window (LF)	# of Windows (Ea)	Single Pane (Ea)	Cracked / Missing Panes (Ea)
36	84	20	34	2	1/8		2						
			0					20	68	14.66	2		1
32	80	18.66	32	2	1/4	1	2						
36	84	20	34				2						
36	84	20	34	2	1/8		2						
36	84	20	34										
48	84	22	18										
36	84	20	34										
			0										

Envelope Improvement - Environmental Emissions Reduction				
Bldg No.	Description	Annual CO2 Emissions (LBS/MMBTU)	Annual Nox Emissions (LBS/MMBTU)	Annual CE Emissions (LBS/MMBTU)
1	Office/Lab (1)	16,462	79	4,486
2	Cryogenic Research (2)	14,285	69	3,892
3	Liquefier (3)	10,112	48	2,755
4	Support Facilities/Offices (4)	9,194	44	2,505
5	Electromagnetics Lab(5)	625	3	170
6	Hydrogen Lab Control (8)	6,524	31	1,778
7	Vehicle Shop (21)	8,049	39	2,193
8	Warehouse (22)	4,250	20	1,158
9	Plasma Physics Research (24)	3,412	16	930
10	Maintenance Shops (25)	6,042	29	1,646
11	Daycare (26)	5,016	24	1,367
12	Central Utilities Plant (42)	11,646	56	3,173
	TOTALS:	95,617	458	26,054

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Why Perform an Envelope Assessment?

- Envelope improvements to save energy are simple and low cost
- Improvements often have reasonable simple paybacks 5-12 years
- Improving the overall performance of the envelope has impact on every other component of the buildings systems

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Envelope Improvement Benefits

- **Reduction in overall energy consumption**
- **Increased thermal comfort -** Reduction in space temperature fluctuations leading to improved occupant comfort
- **Infrastructure improvement**

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Mechanical Insulation

Benefits of Mechanical Insulation

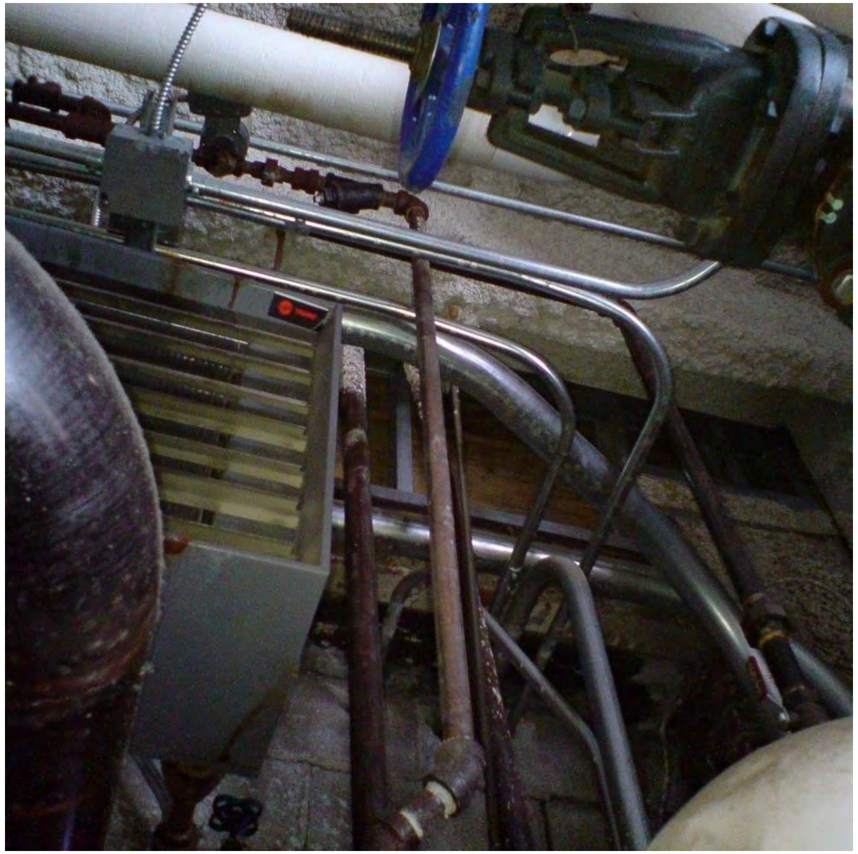
1. Reduces energy costs
2. Prevents moisture condensation
3. Reduces capacity and size of new mechanical equipment
4. Enhances process performance
5. Reduces emissions of pollutants
6. Safety and protection of personnel
7. Acoustical performance: reduces noise levels
8. Maximizes return on investment (ROI)
9. Improves Appearance
10. Fire Protection

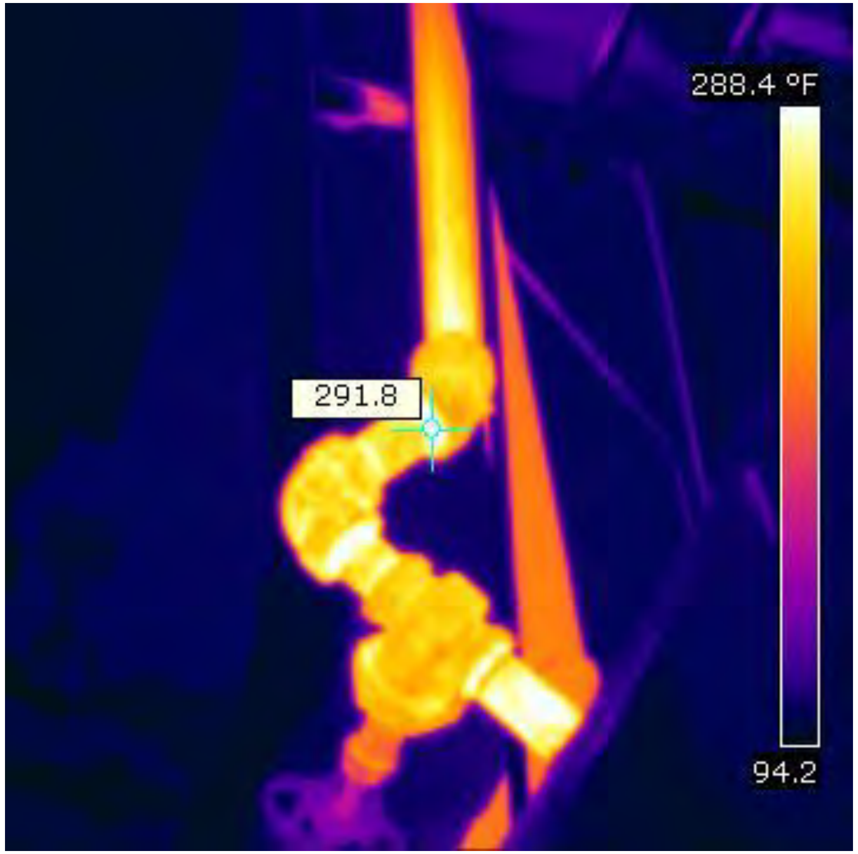
Mechanical Insulation Savings compared to Electrical Lighting

Energy Conservation Option	Energy Savings, MMBtu/yr (1)
1 ft of insulation on 350°F pipe	14.4
1 car, 5% increase in mpg	3.7
1 compact florescent light bulb	0.9
1 ft of insulation on 180°F pipe	0.9
1 ft of insulation on 42°F pipe	0.6

(1) Equivalent energy savings in Millions of Btu/yr (MMBtu/yr) of primary fuel.

Steam Piping





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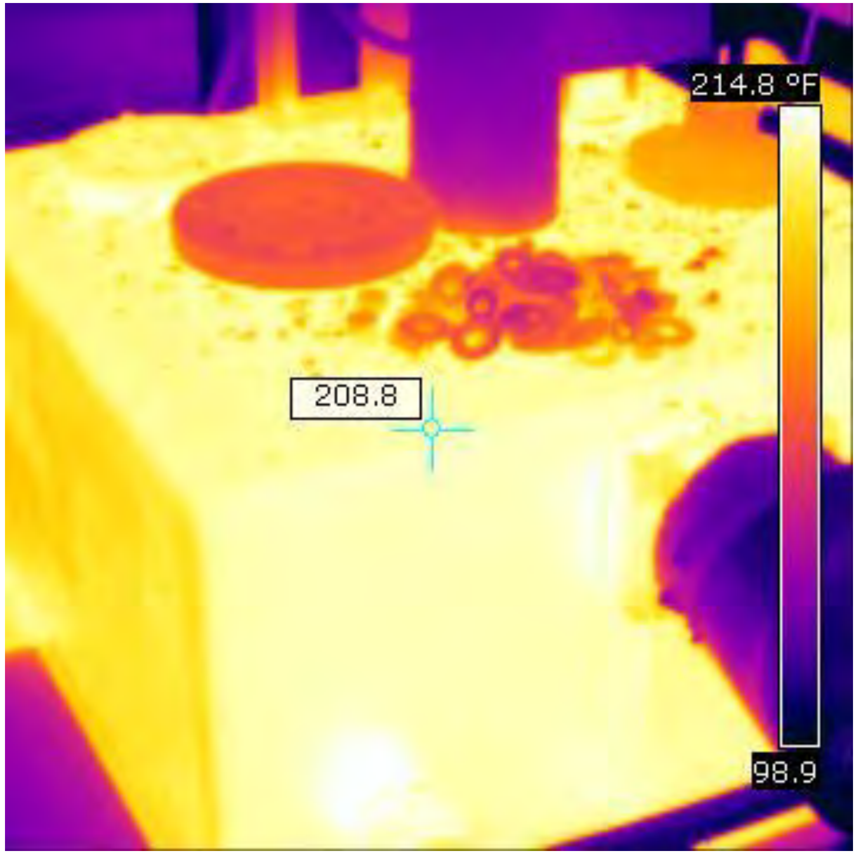
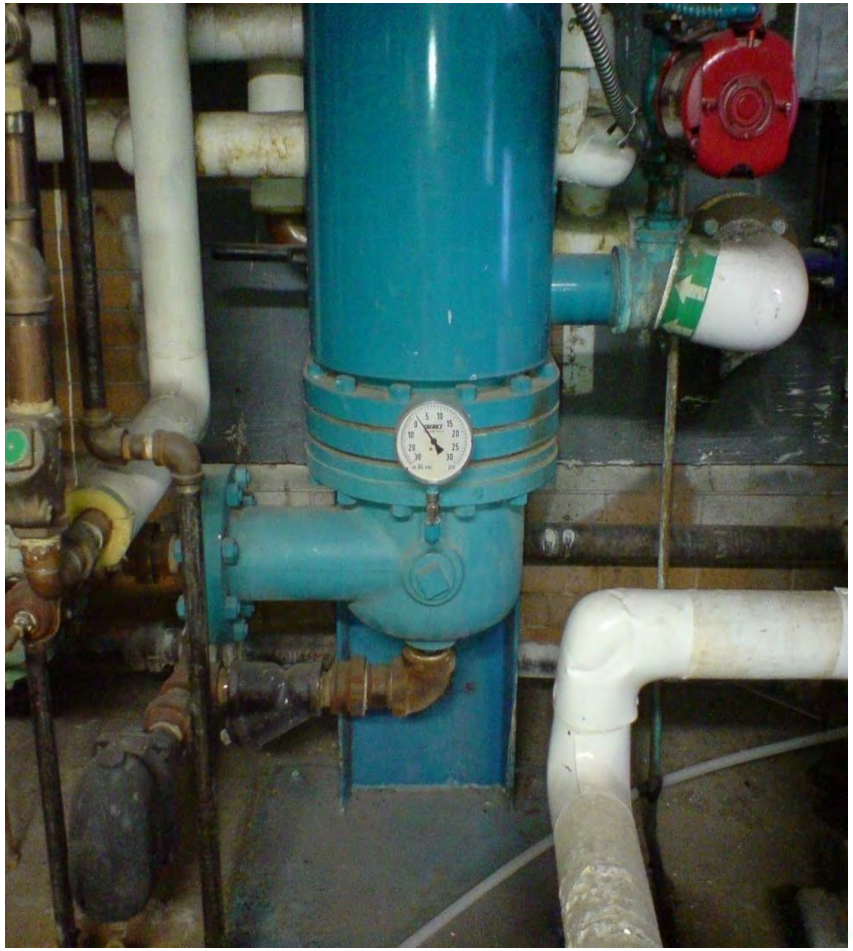
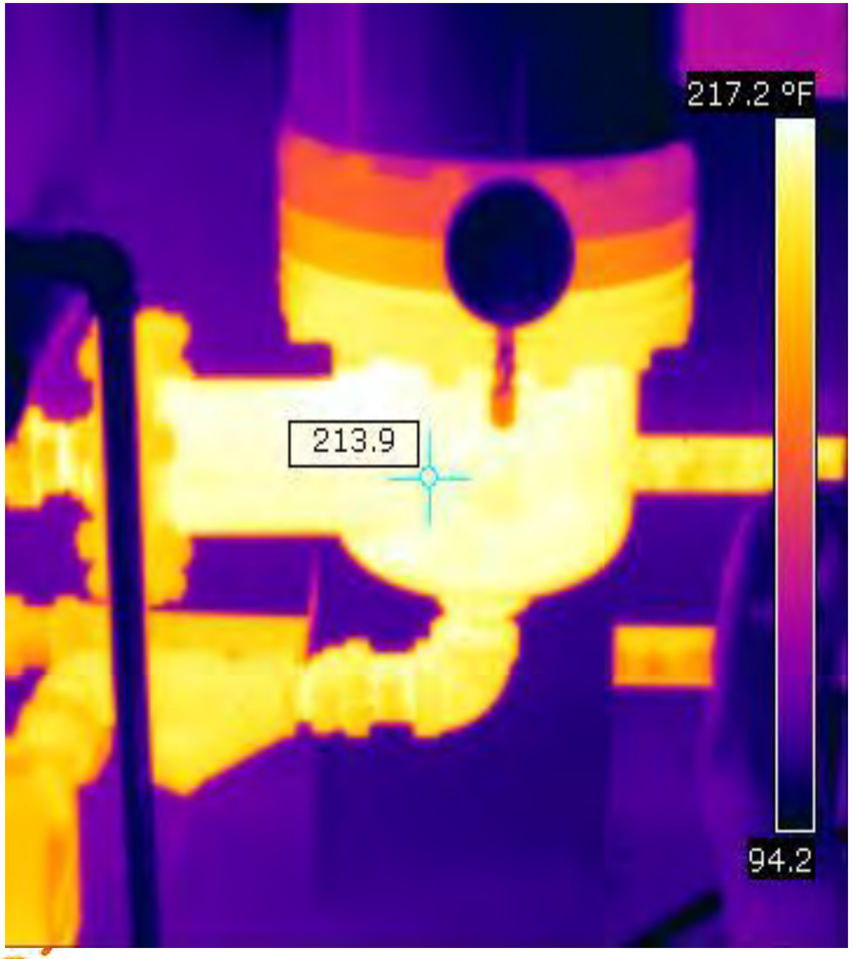
Condensate Receiver



Steam / Hot Water Heat Exchanger





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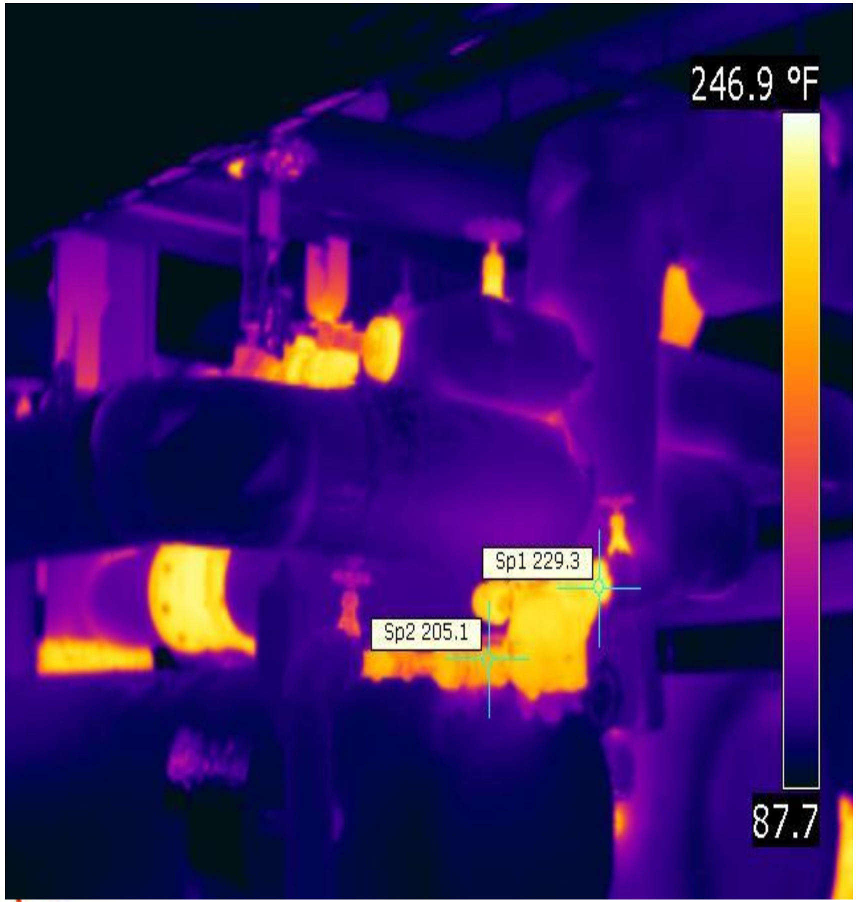
Hidden Opportunities



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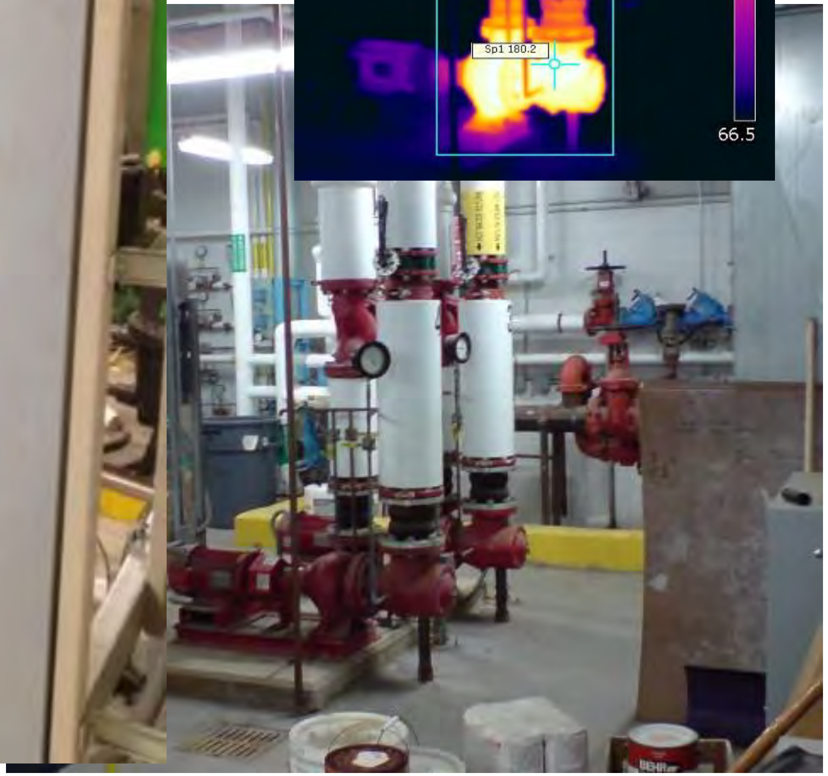
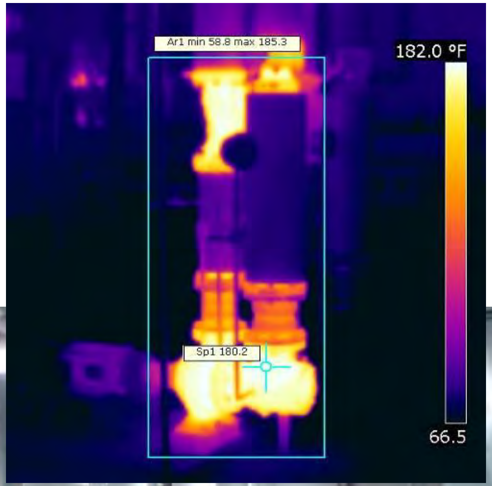
HYDRONIC HEATING PUMPS





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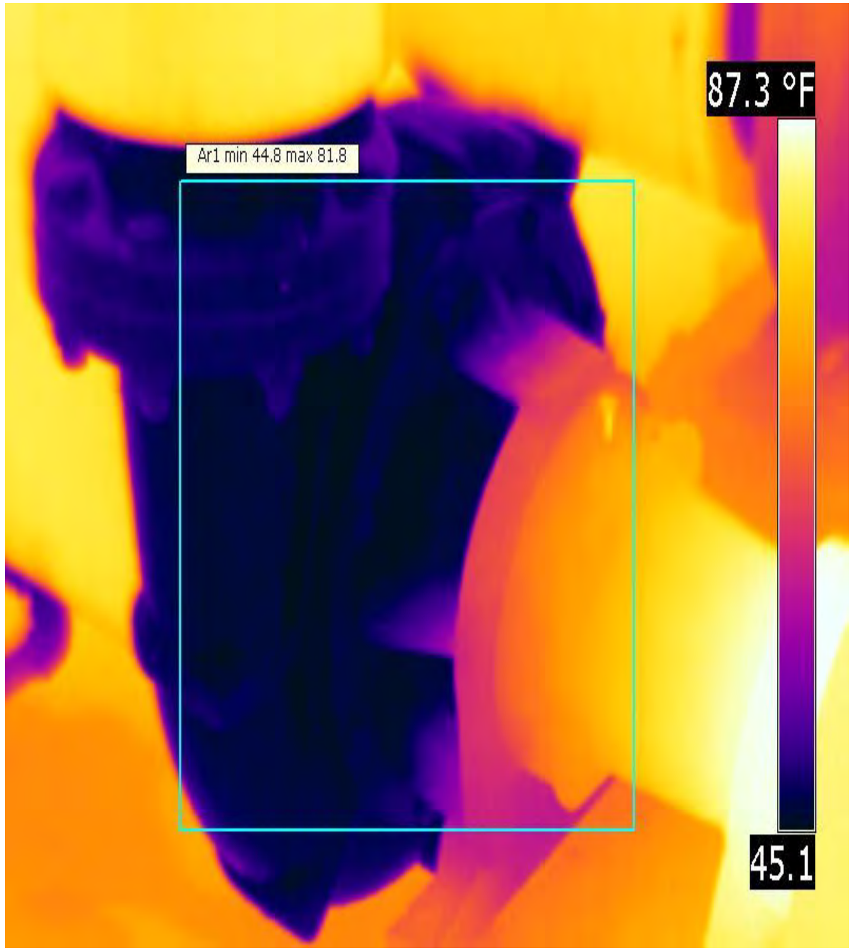
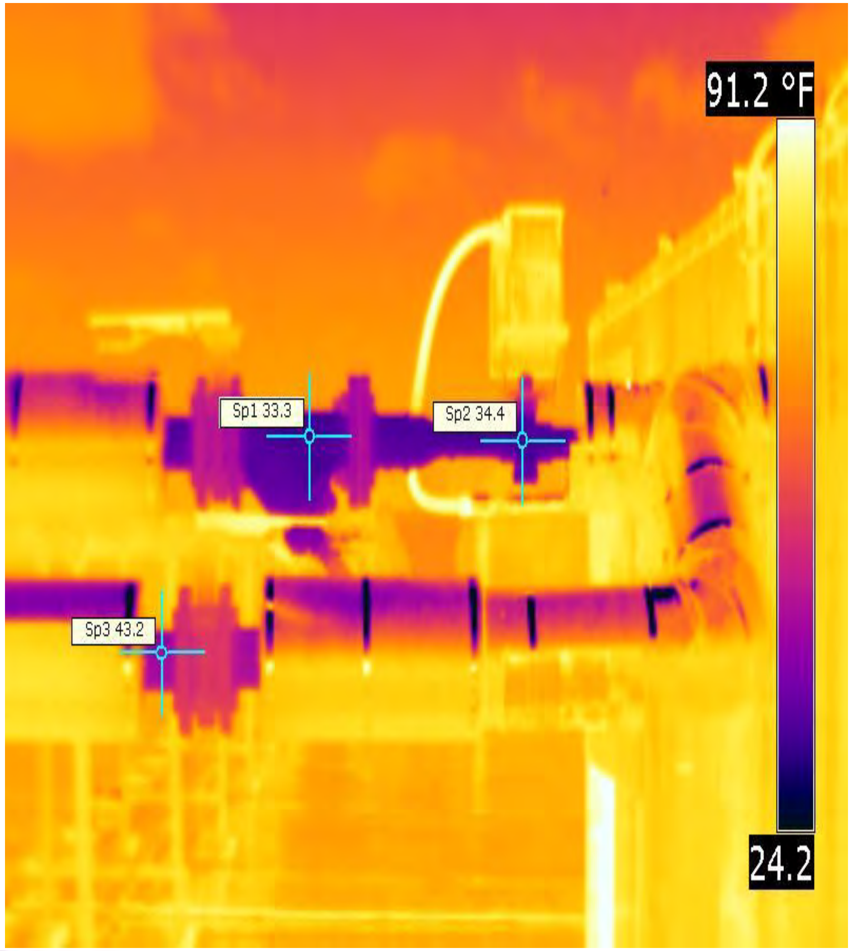
CHILLED PUMPS



OUTDOOR PIPING



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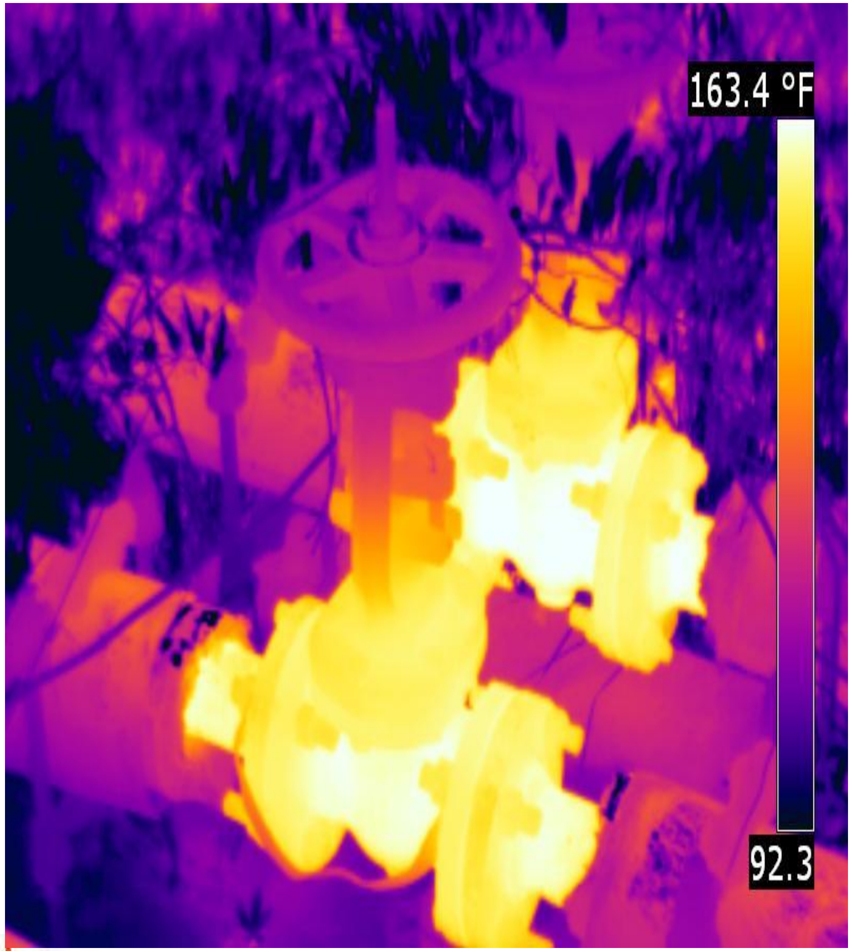
Out of Sight, Out of Mind



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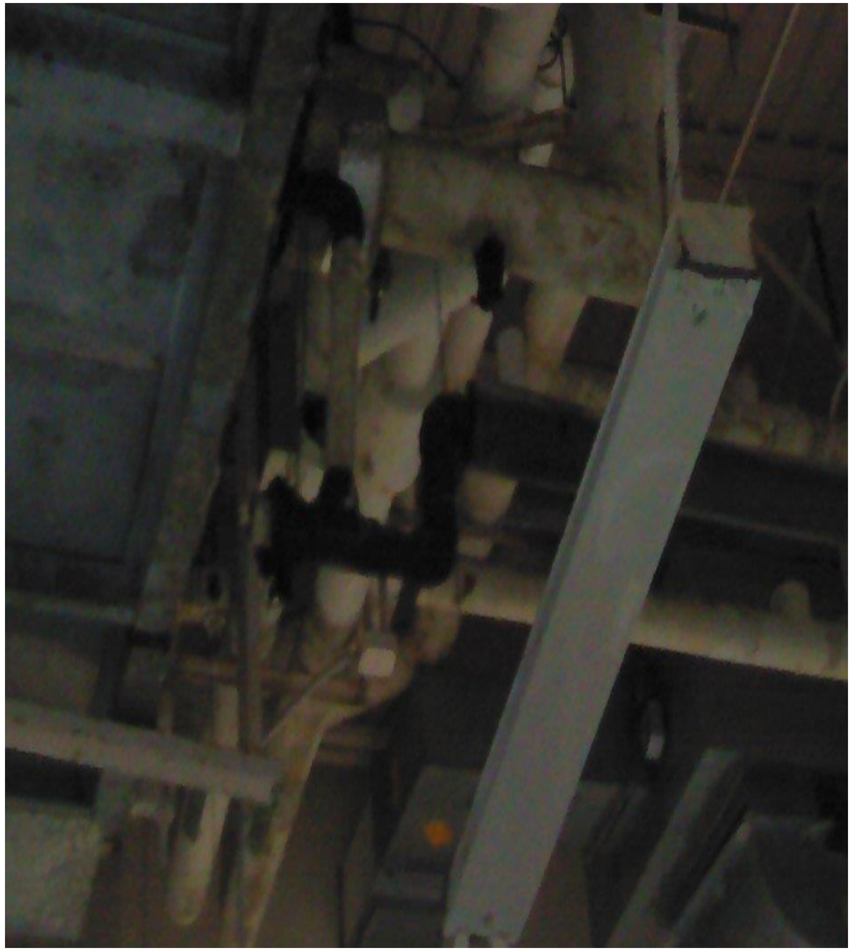
MOLD DAMAGE



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Insulated Blankets

Comprehensive Mechanical Insulation Reports

ENVIRONMENTAL EMISSIONS								
Annual CO_2 Emissions LBS Insulated	Annual CO_2 Emissions LBS Bare	Annual CO_2 Emission Reduction	Annual NO_x Emissions LBS Insulated	Annual NO_x Emissions LBS Bare	Annual NO_x Emission Reduction	Annual CE Emissions LBS Insulated	Annual CE Emissions LBS Bare	Annual CE Emission Reduction

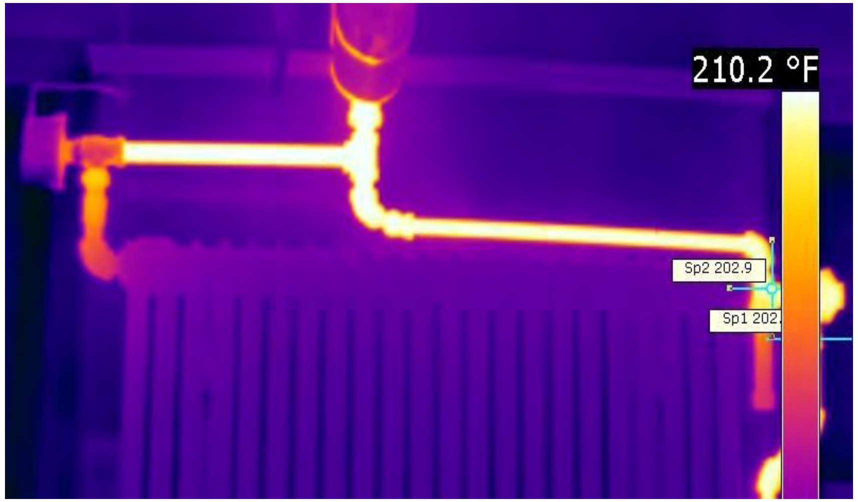
Scope of Work							
Pipe (LF)/Equip (sq/ft)	Fittings (#)	Valves (#)	Flange Pairs (#)	Bonnets (#)	In-Line Pumps (#)	Centrifugal Pumps (#)	Air Separaters (#)
913.0	193	135	34	7	0	1	0
505.4	115	15	1	0	0	0	0
173.7	43	9	0	0	0	0	0
3049.0	953	213	13	0	0	0	0

	NON-INSULATED		INSULATED	
Effective Lineal Footage (sq)	Total Bare Fuel Cost per Year	Total Bare Btu Heat Loss per Year	Total Insulated Fuel Cost per Year	Total Insulated Btu Heat Loss per Year
1,341.6	$ 31,124.86	4.115E+09	$ 2,953.64	3.899E+08
565.6	$ 5,501.77	7.270E+08	$ 818.72	1.079E+08
199.7	$ 2,148.38	2.841E+08	$ 288.98	3.811E+07
			5,643.99	7.447E+08
			833.39	1.100E+08
			269.48	3.550E+07
			2,593.81	3.421E+08
			2,727.30	3.601E+08
			5,287.91	6.975E+08
			680.15	8.982E+07
			1,416.90	1.867E+08
			23,514.27	3.102E+09

SYSTEM:	High Pressure Steam	FUEL NAME:	Natural Gas
BARE SURFACE EMITTANCE:	0.8	HEAT CONTENT:	1026 BTU per cuft
PROCESS TEMP:	324 deg F	FUEL COST:	6.6 US $ per Mcf
AMBIENT TEMP:	80 deg F	EFFICIENCY:	85%
WIND SPEED:	0 MPH	OUTER JACKET MATL:	All Service Jacket
INSULATION LAYER 1:	850F Mineral Fiber PIPE, Type I, C547-07	OUTER SURFACE EMITTANCE:	0.9
		HOURS OF OPERATION:	8760

PIPE SIZE	INSULATION THICKNESS: BARE	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
1/4													
1/2													
3/4	14.33	3.35	2.49	1.94	1.68	1.44	1.34	1.27	1.21	1.15	1.11	1.08	1.04
1													
1 1/4	21.68	4.89	3.33	2.35	2.16	1.9	1.74	1.61	1.52	1.43	1.37	1.31	1.26
1 1/2	24.54	5.51	3.36	2.66	2.1	1.9	1.75	1.64	1.54	1.47	1.41	1.34	1.3
2	30.17	6.07	3.94	3.04	2.55	2.26	2.06	1.9	1.77	1.67	1.59	1.51	1.46
2 1/2	36.04	7.09	4.53	3.11	2.69	2.4	2.2	2.02	1.89	1.79	1.69	1.62	1.56
3	43.34	9.06	5.36	4.02	3.34	2.91	2.61	2.36	2.19	2.06	1.93	1.84	1.76

Steam Trap Assessment



Steam Trap Evaluation Report

Trap Status Chart	
"OK"	18
"Failed Open"	86
"Blocked"	21
"Flooded"	0
"Out of Service"	0
"Not Tested"	59

Overall Trap Evaluation Chart	
Overall Total of Traps at Facility:	184
Total Traps Evaluated:	125
Number of Failed Traps:	107
Trap Failure Rate of Evaluated Traps:	85.60%

Input Data for Calculations		
Production of Steam Cost ($)	$ 10.44	$/1000 lbs
System Efficiency (%)	80%	%
Summary		
Estimated Steam Loss:	1.73E+06	lbs/yr
	2,010	MMBTu/yr
Estimated Cost Savings:	$ 18,041.65	$/yr

What is Involved?

Meeting with Facility Manager/Owner

Detailed accurate field takeoff quantities

Accurate calculations

Presentation of final report/remediation options

Remediation - Verified

CASDEM
Colorado Association of School District Energy Managers

Thank You

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Thank You!

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