



# BUILDING ENERGY 15

MARCH 3-5, 2015 AT THE SEAPORT WORLD TRADE CENTER

AIA Provider: Northeast Sustainable Energy Association

Provider Number: G338

Beyond Utility Bills: Energy Data Collection  
Course Number

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Wednesday March 4, 2015



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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

# Course Description

The use of utility bills to benchmark building performance is a critical first step in any approach to energy conservation. However, utility bills can only tell you so much about how to improve building performance. Five multifamily buildings received circuit level electricity, temperature, and CO2 monitoring equipment. The data identified inefficient mechanical designs, incorrect installations, poor maintenance and individual apartments with high energy use. We will review what we measured and what we learned, including energy savings as a result of this monitoring strategy.

# Learning Objectives

## **At the end of the this course, participants will be able to:**

1. Be able to evaluate if a building warrants an investment in equipment that provides data beyond that which is available via utility bills.
2. Be able to formulate a scope of work for energy monitoring and determine what information will be most valuable in their conservation efforts.
3. Know some standard approaches to evaluating the data available through energy monitoring systems.
4. Understand some of the obstacles to installing and maintaining energy monitoring equipment in the multifamily setting.

# Agenda

- POAH Utility Data Collection
- Individual Unit Monitoring
- Expanding Energy Metering
  - Technology
  - Lessons Learned
  - Case Studies

# Non-Profit Developer and Owner



# Utility Bill Data

wegowise

Dashboard Properties Reports Help tastpoah

All Deve

Welcome POAHENERGY: [Account Settings](#) | [Contacts](#) | [Help](#) | [Sign Out](#)



MyPortfolio Sharing Planning Reporting Recognition

Properties (12)

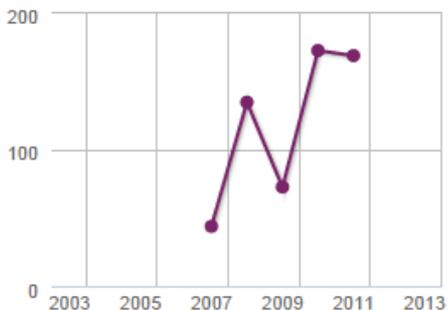
Add a Property

Notifications (1)

You are connected to [Barry Poage](#).

Clear

Source EUI Trend (kBtu/ft<sup>2</sup>)



Properties (12)

Add a Property

Filter by: View All Properties (12)

Search

Search

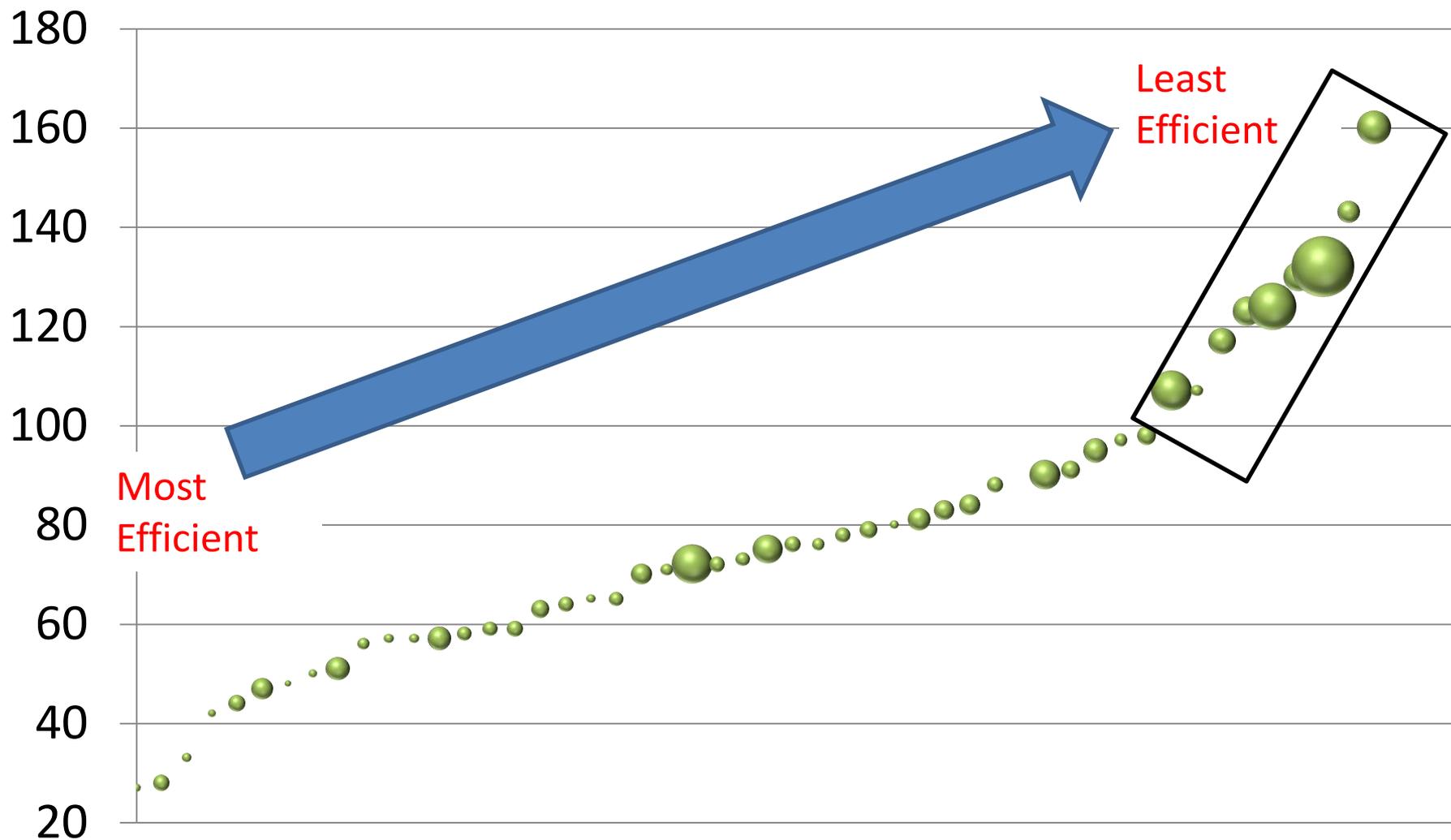
[Create Group](#) | [Manage Groups](#)

Name	Action
<a href="#">8330 On the River</a>	I want to...
<a href="#">920 On the Park</a>	I want to...
<a href="#">Blackstone</a>	I want to...
<a href="#">Colony Plaza</a>	I want to...
<a href="#">Fairweather Beverly</a>	I want to...

Total GHG Emissions Trend (Metric Tons CO<sub>2</sub>e)

# Prioritization is Key

kBtu/SqFt



# Barr Foundation Grant



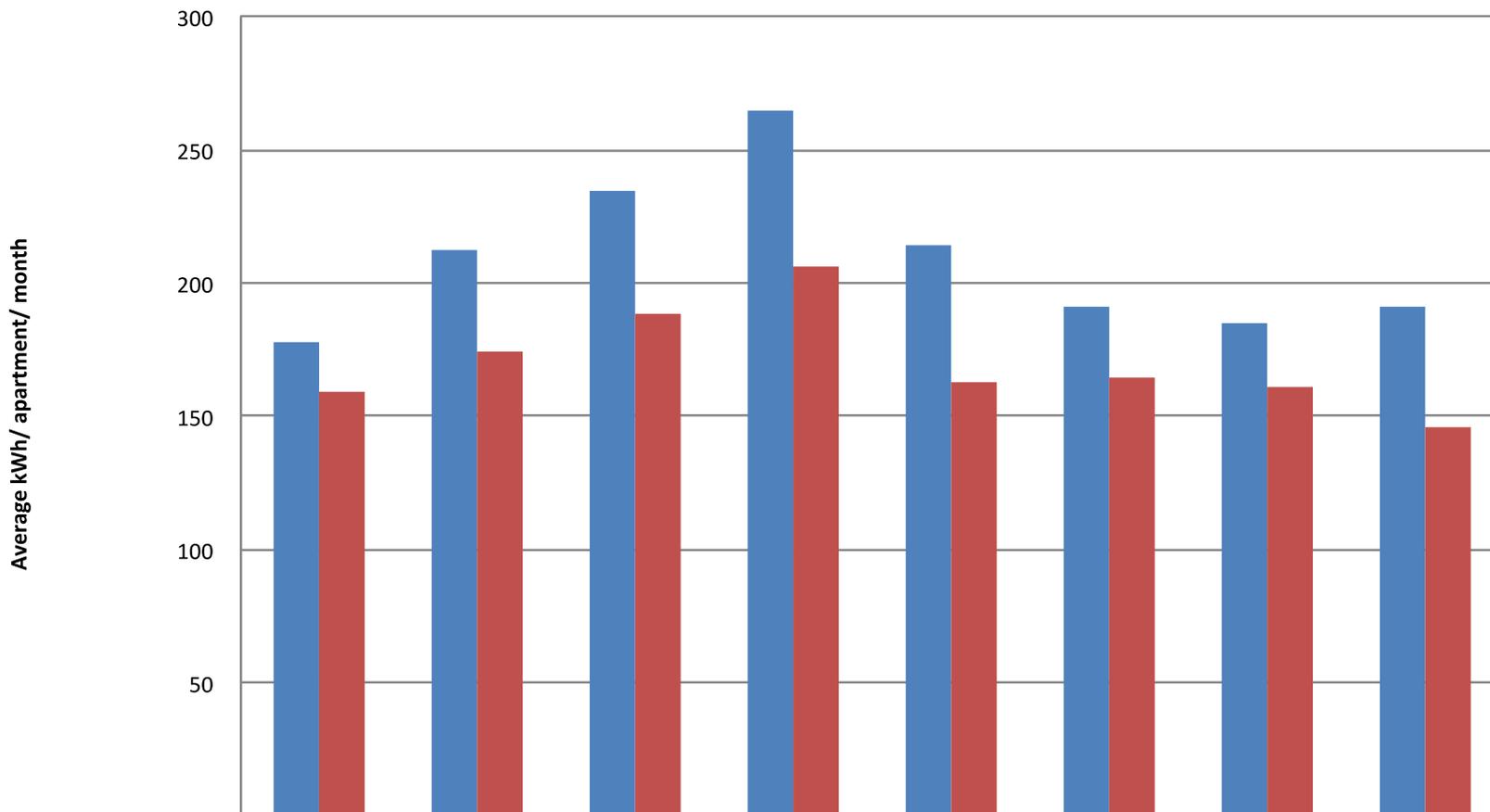
**Fairweather Peabody  
Peabody, MA**

## Grant Objectives

- submeter residential unit electric and gas use
- share data with residents to encourage reduction
- Analyze data to inform building performance upgrades

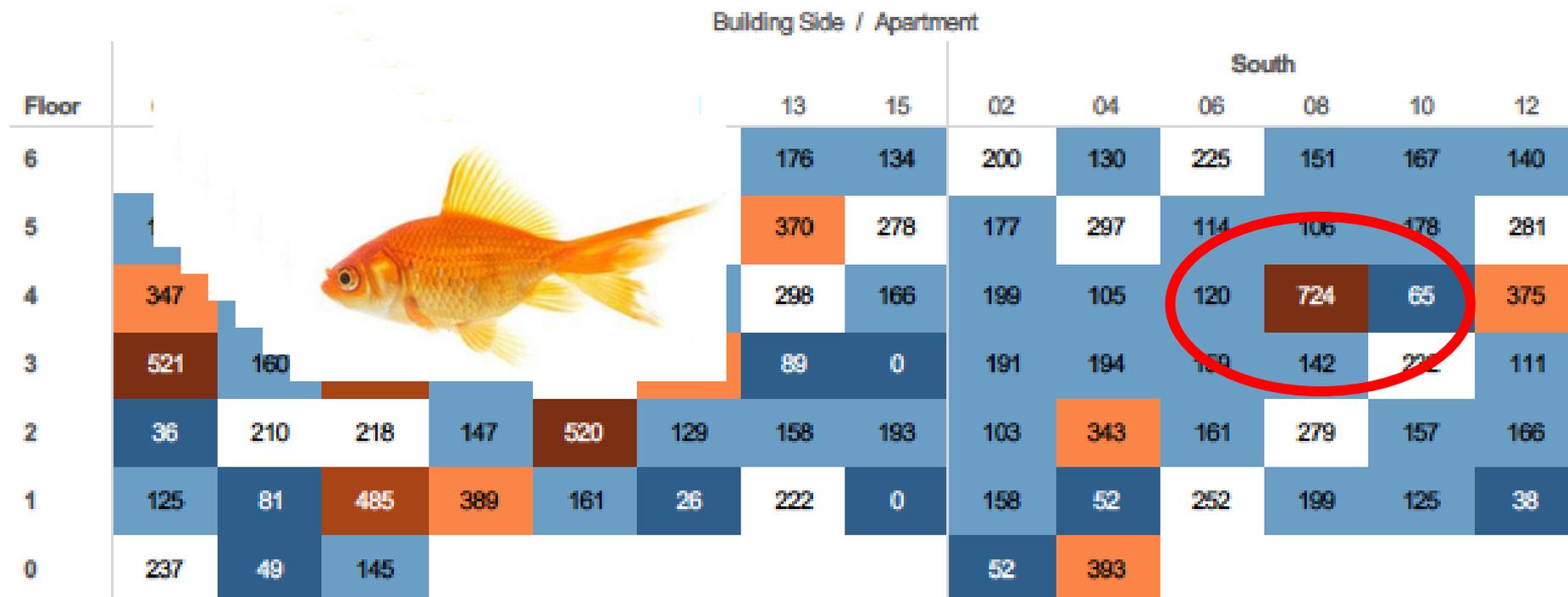
# Preaching to the Choir?

**Residents Who Attended Meetings  
Average kWh per Apartment Savings**



■ Did not attend meetings	178	212	234	264	214	191	185	191
■ Attended meetings	159	175	188	207	163	165	161	146

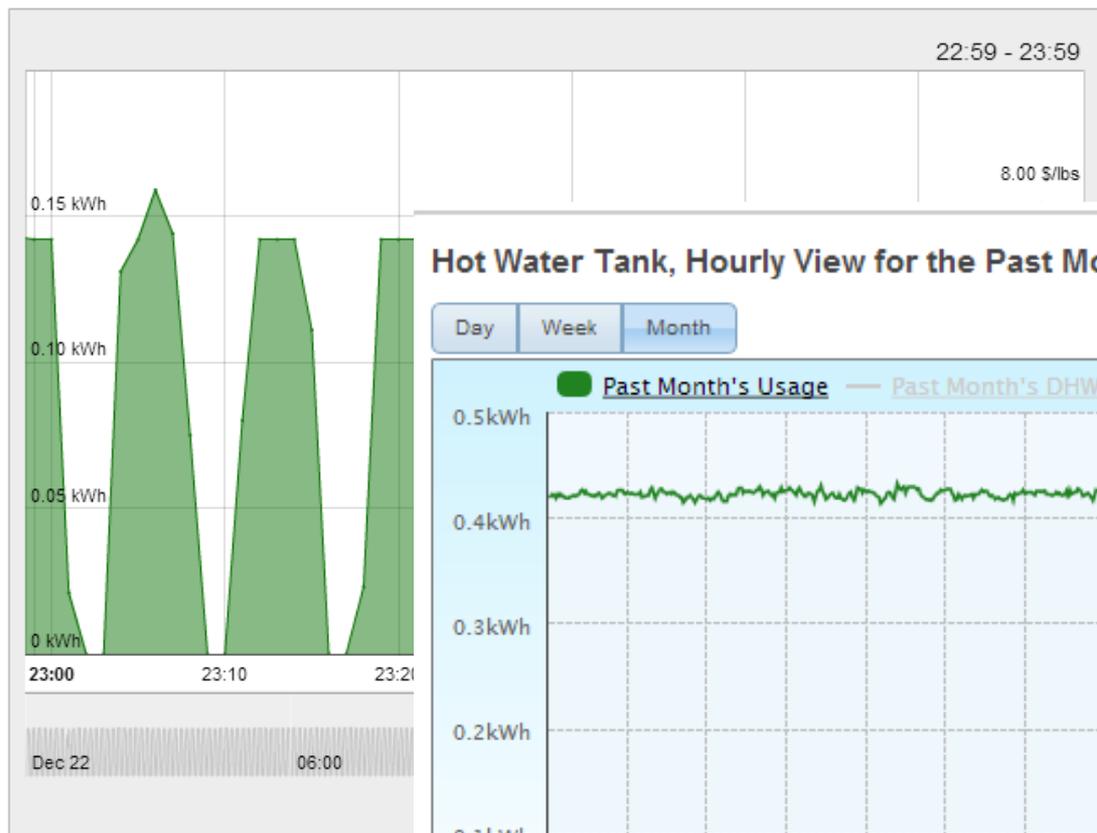
# Search for the Outliers



# Building Performance

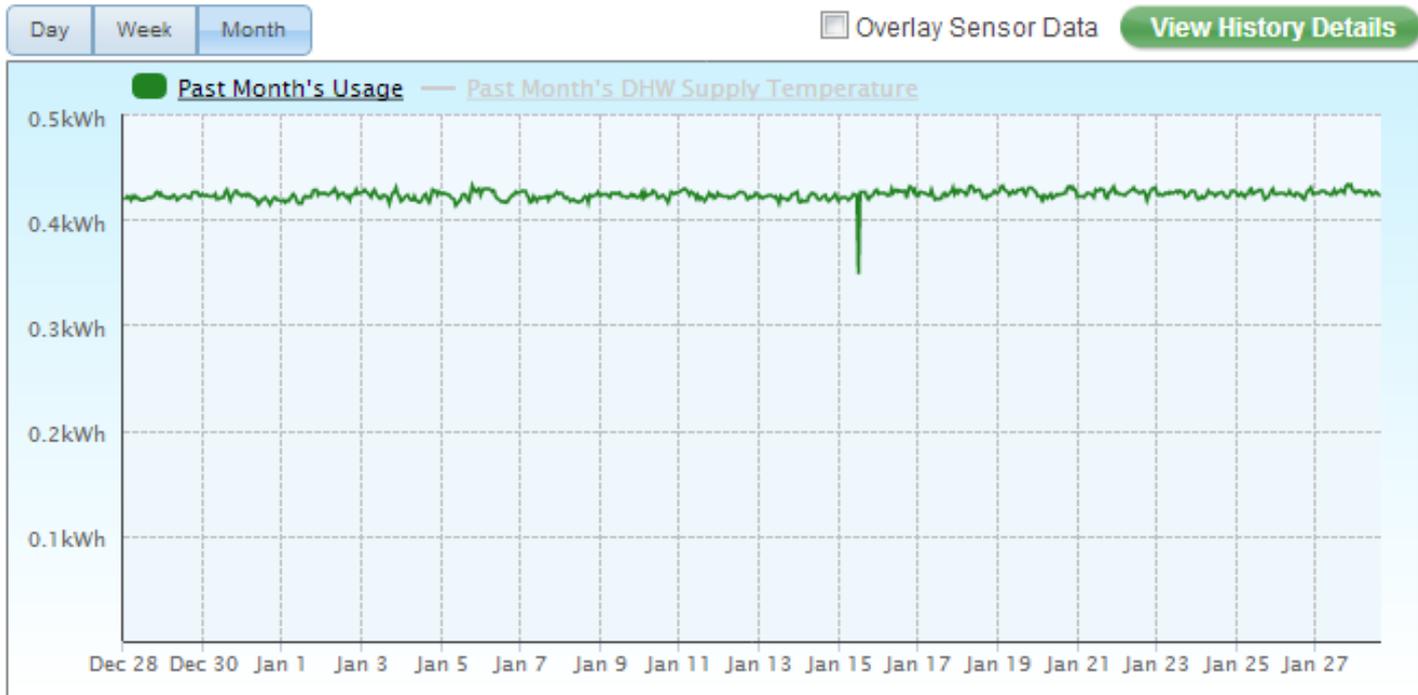
## Boiler Short Cycling

2012 ▶ December ▶ 22



### Making Hot Water 24/7

### Hot Water Tank, Hourly View for the Past Month

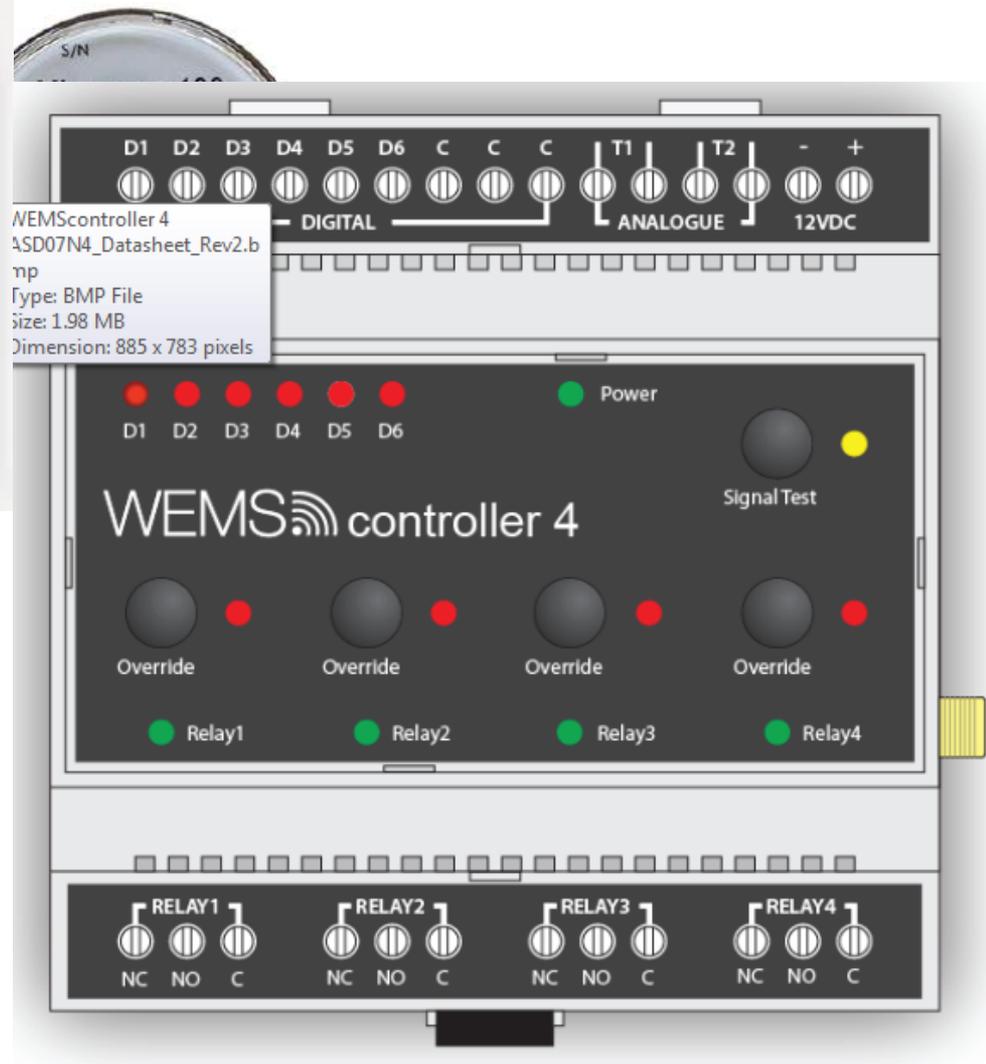




# Individual Metering Costs

Property	Units	Types of Submeters	Installed Cost	Cost/Unit	Cost/Unit/Month
Fairweather Peabody	88	Electric, Heat	\$57,963	\$659	\$1.50
The Grant	33	Electric, Gas, Water	\$22,176	\$672	\$4.00
The Jackson	67	Gas	\$30,150	\$450	\$3.00

# Submetering for Unit Data



# Expanding to other POAH Developments



Kenmore Abbey  
(199 apts)



Franklin Square  
(193 apts)



Blackstone  
(145 apts)

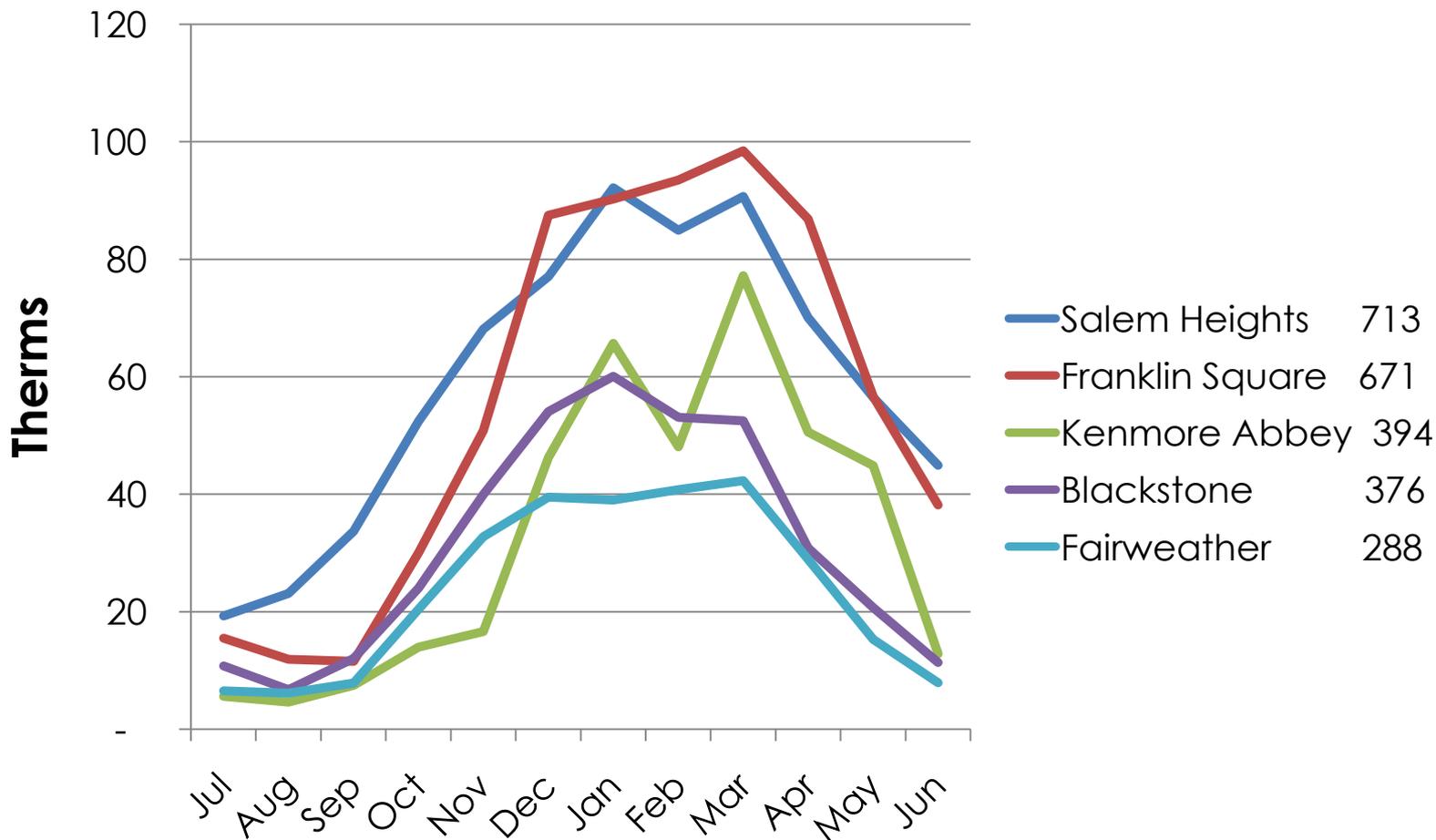
Fairweather  
(88 apts)



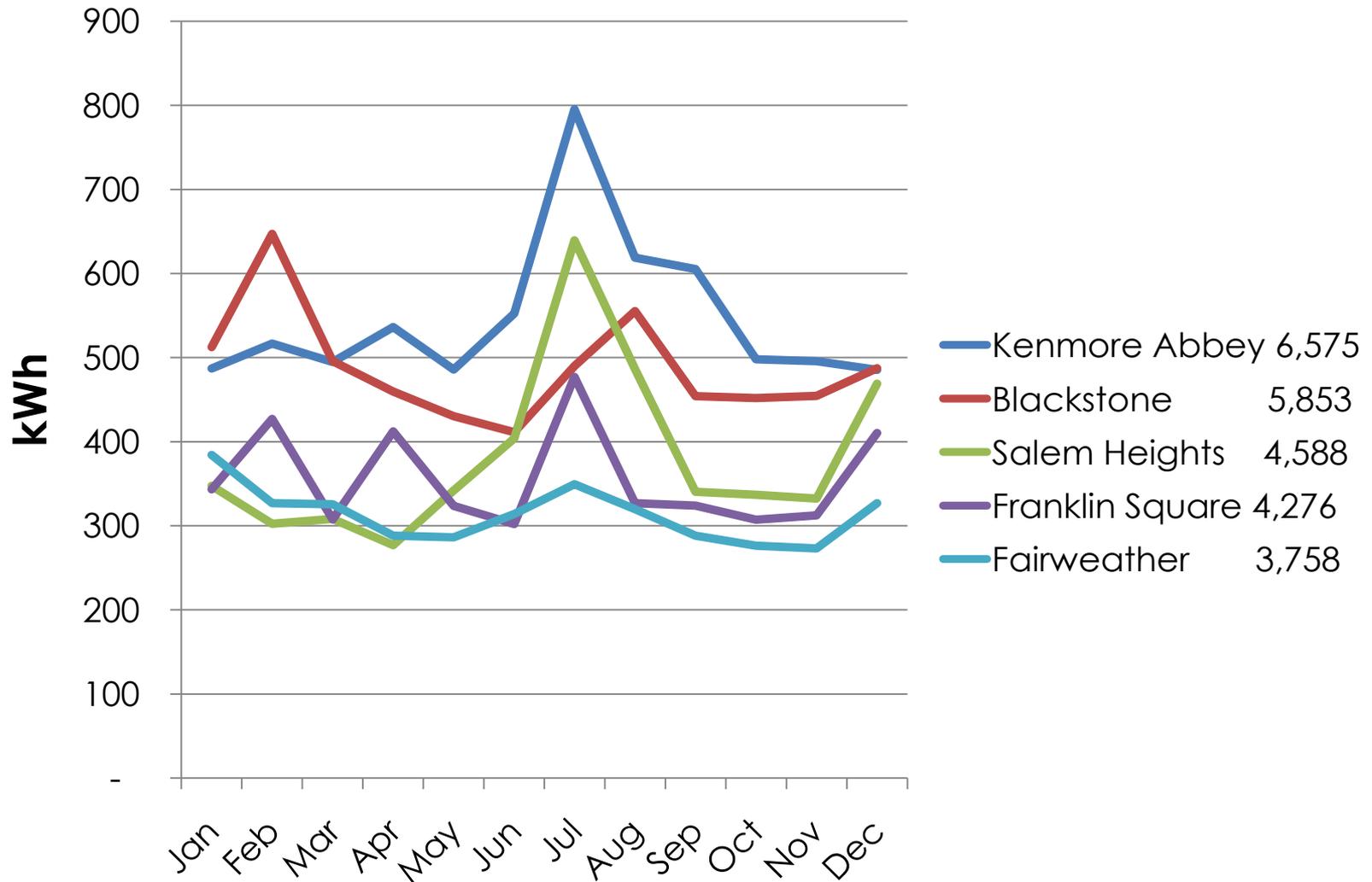
Salem Heights  
(283 apts)



# Gas Use per Apartment



# Electricity Use per Apartment



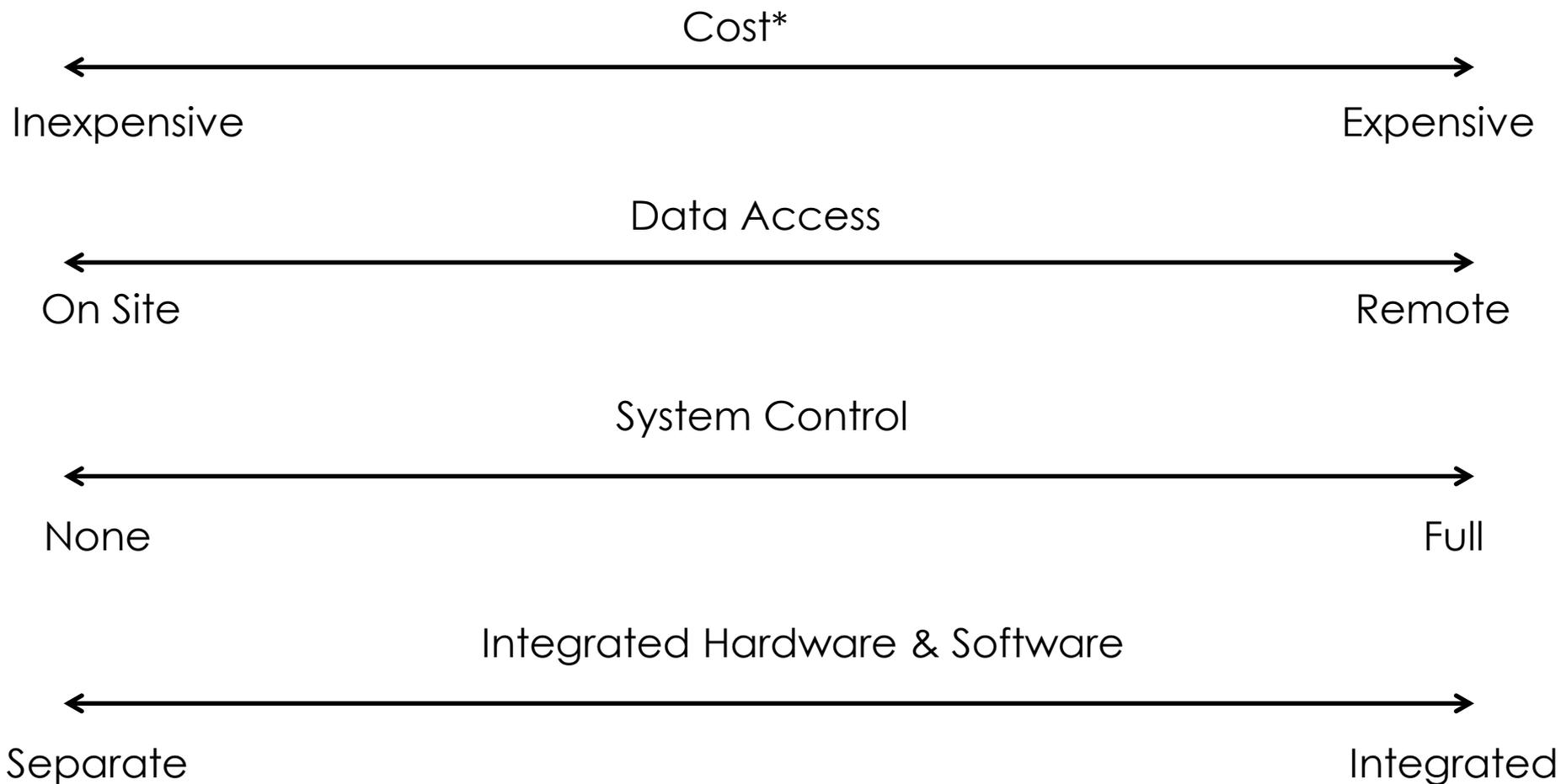
# Increasing Array of Options



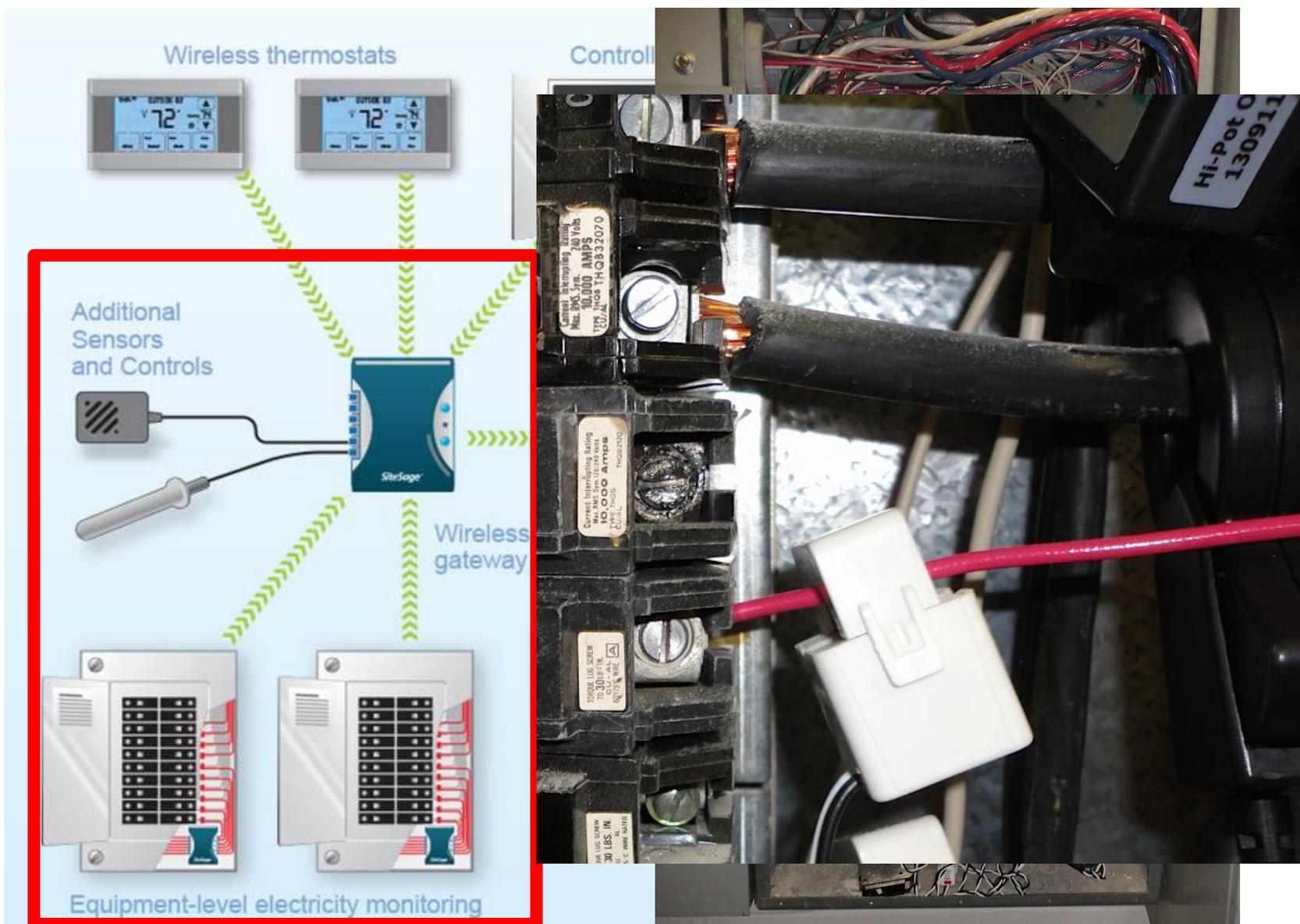
Improve

bandingos

# How do we get more data?



# Building Monitoring: Site Sage



# Site Sage: Targeted Buildings

<b>Property</b>	<b>Units</b>	<b>2014 Utility Spend</b>
Blackstone Apartments	145	\$197,499
Fairweather Peabody	88	\$94,395
Franklin Apartments	193	\$348,775
Kenmore Abbey	199	\$346,439
Salem Heights	283	\$611,482

# Real Time: Building Level Data

SiteSage Status: ●  Current use: 84.96 kW | \$13.18/hr Current voltage: 123v Outside Temp: 73°F Enterprise

### Measured Power *i*



### Top Circuits On Now

- Chiller 2 (37433w)
- Panel 1st floor HPL (8119w)
- ERU #2 (8103w)
- ERU #1 (5934w)
- AC 6 (5511w)
- Chiller 1 (5019w)
- ERU #3 (4143w)
- Spare (1274w)
- Fan coil boiler room 12 (1029w)
- Hall light 2-8 & hall (847w)
- 2 (838w)

### 30-Day Carbon Footprint *i*

Last 30 Days	Prev 30 Days	% Change
53,487 lbs.	60,523 lbs.	 -13.2%

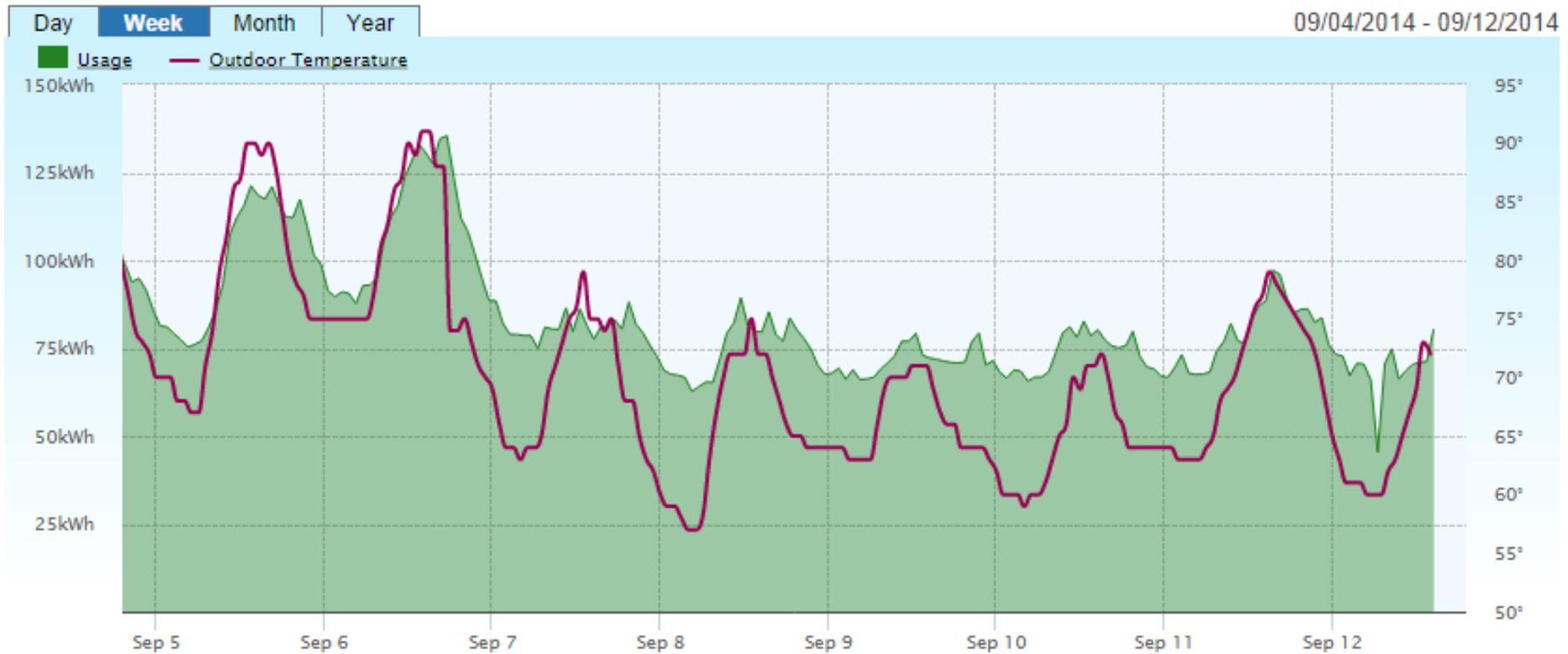
30-Day  \$8 *i*

### Sensors



● Boiler return	53°F
● Boiler supply	52°F
● Chiller return	68°F
● Chiller supply	54°F
● CO2	434 ppm

# Building Level History



# Circuit Level Data

+ All Circuits

- Heating & Cooling

- AC 1
- AC 4
- AC 5
- AC 6
- AC Computer room
- Boiler 1
- Boiler 2
- Boiler 3
- Boiler 4
- Chiller 1
- Chiller 2
- Electric heat panel
- fan coil 6 computer room
- Fan coil 6 rehab room
- Fan coil 8 mechanical room
- Fan coil boiler room 12
- Fan coil boiler room 14
- Fan coil conference room
- Fan coil conference room heater
- Fire pump heater
- Heat - security guard
- Temp heat

+ Ventilation

+ Lighting

+ Food Prep

+ Laundry

+ Process Equipment

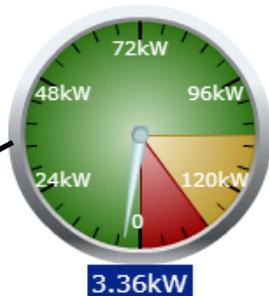
+ Safety

+ Water & Irrigation

## Chiller 1

Circuit Details

[Edit Channel Settings](#)



Now	
Usage	3,361 w
Power Factor	0.67
% Breaker Capacity	7%

Past 30 Days	
Energy	15,288 kWh
Power Factor	0.64
Cost	\$1,566
CO2	lbs

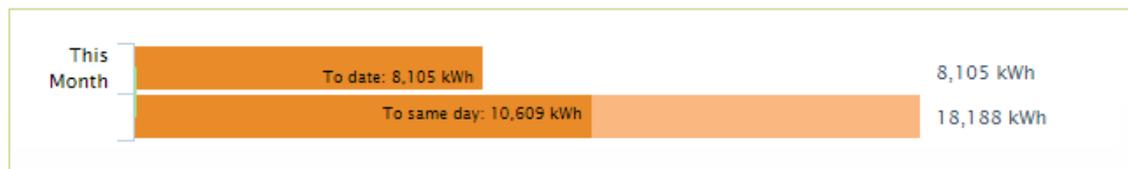
Runtime Information

Show Detail

90 Day Alert History Beta (0 - 0)

Show Detail

Projected Usage in kWh vs Previous Period  kWh  Cost

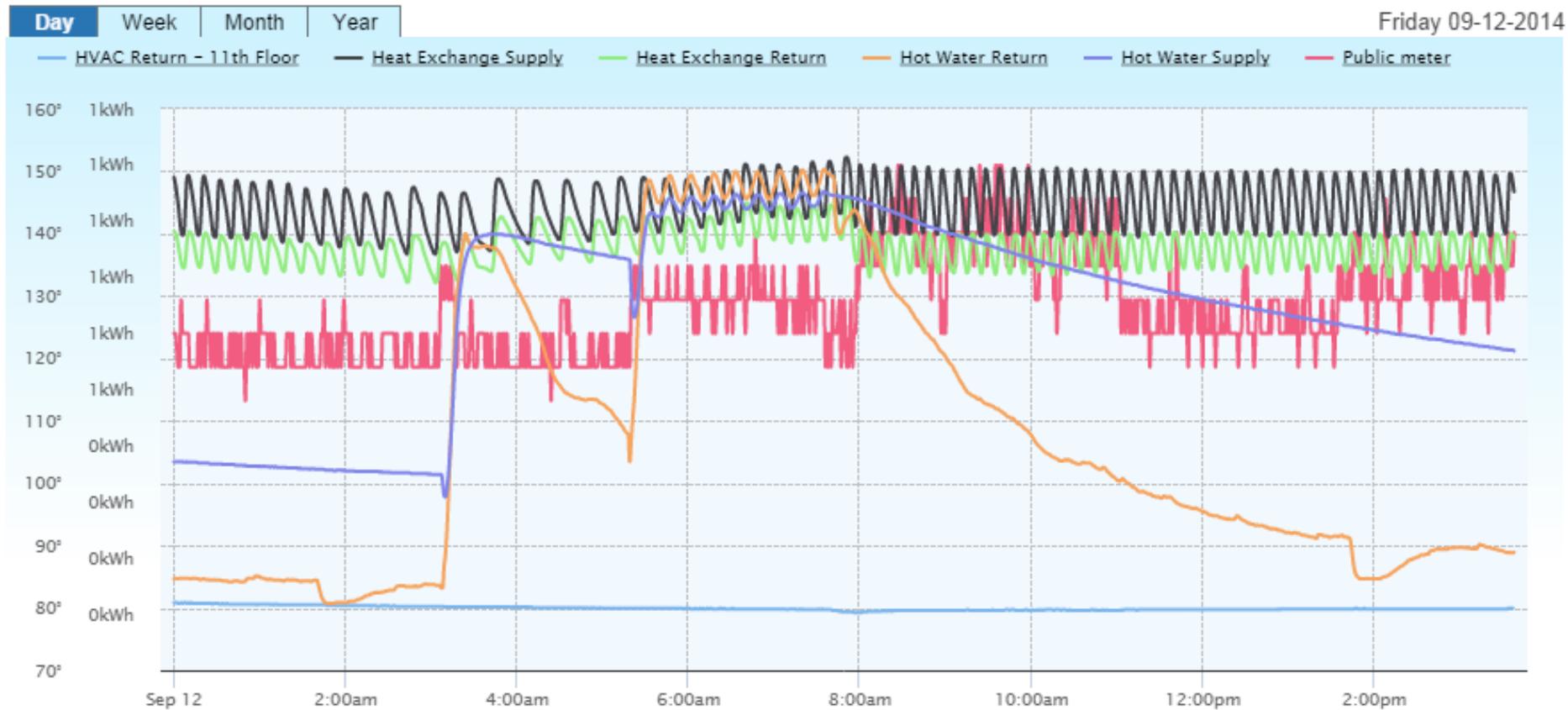


## Chiller 1



# Sensors Available

## Sensors



# Set Alerts

## Savings Opportunity Alerts

### Select Circuits On To Long

Select the time of day when the alert is active, or leave From and To blank for all day

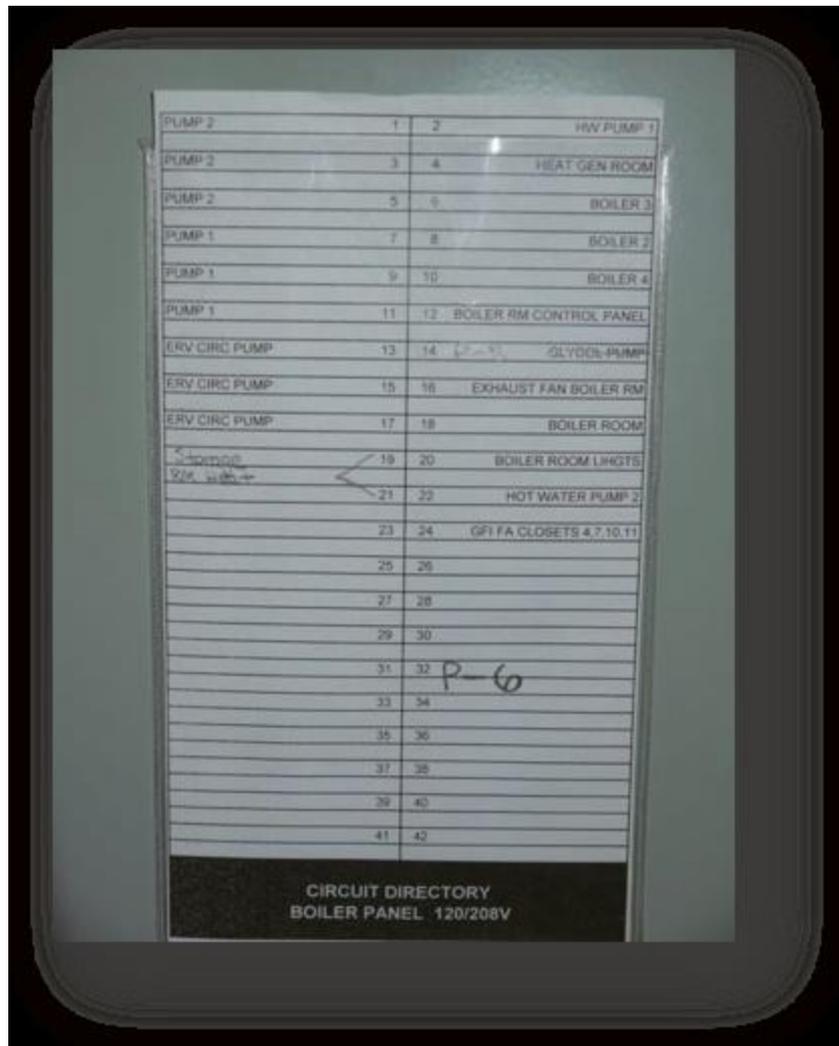
Circuit	Threshold (in Minutes)	From:	To:
<input type="checkbox"/> Fan #8			
<input type="checkbox"/> Fan #9			
<b>Lighting</b>			
<input checked="" type="checkbox"/> Basement Lights	<input type="text" value="30"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Class Rm and Art Room Lights			
<input type="checkbox"/> Hall & Library Lights			
<input type="checkbox"/> Laundry and Game Room Lights			
<input type="checkbox"/> Lobby and Outside Lights			
<input type="checkbox"/> Multipurpose Room Lights			
<input type="checkbox"/> Multipurpose Room Lights			
<input type="checkbox"/> Multipurpose Room Lights			
<input type="checkbox"/> Multipurpose Room Lights			
<input type="checkbox"/> Mutlipurpose Room & Office Lights			
<input type="checkbox"/> Pool Room & Lav Lights			

# Lessons Learned from the Process

# Lesson Learned: How will you get data?



# Lesson Learned: Electrical Panel Labels



## Lesson Learned: Who will look at data?

Blackstone Data:

107 Circuits

X 60 Readings an hour per circuit

X 24 hours a day

= 154,080 data points per day

X 365 days

= shitload of data points per year

# What is the data telling us?

Monitoring entire buildings is expensive. So...

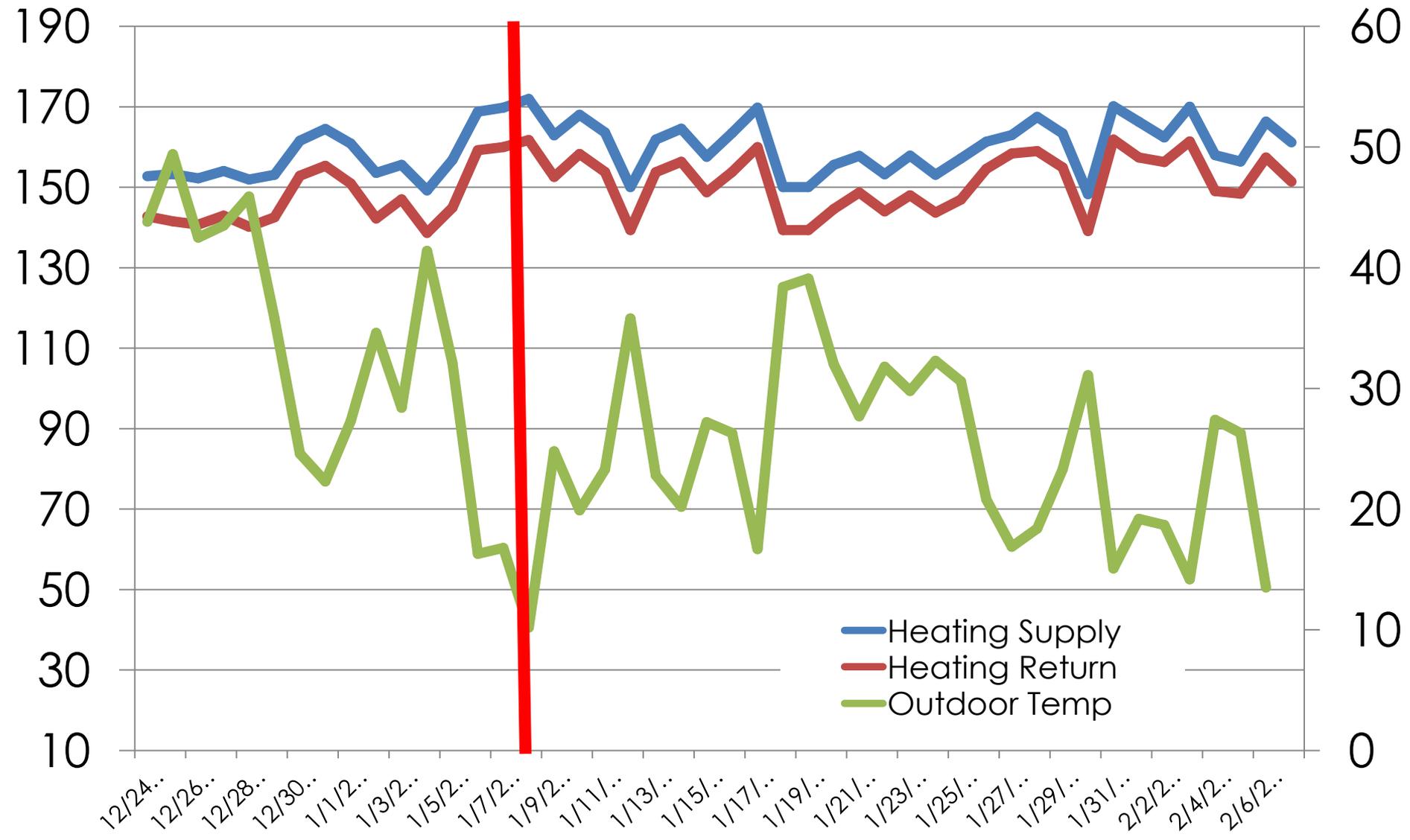
Based on monitoring an entire building at Fairweather, we identified the four monitoring priorities:

1. Troubleshooting
2. Air conditioning
3. Heating
4. Ventilation

# Salem Heights Pumping



# Salem Heights Pumping



# Pumping Savings

<b>Pumps</b>	<b>kWh Saved</b>	<b>Rate</b>	<b>Savings</b>
Heating Loop	2400	\$0.20	\$480
Primary Boiler Loop	3000	\$0.20	\$600
DHW Indirect Loop	800	\$0.20	\$160
<b>Total:</b>	<b>6200</b>		<b>\$1240</b>

# DHW Issue

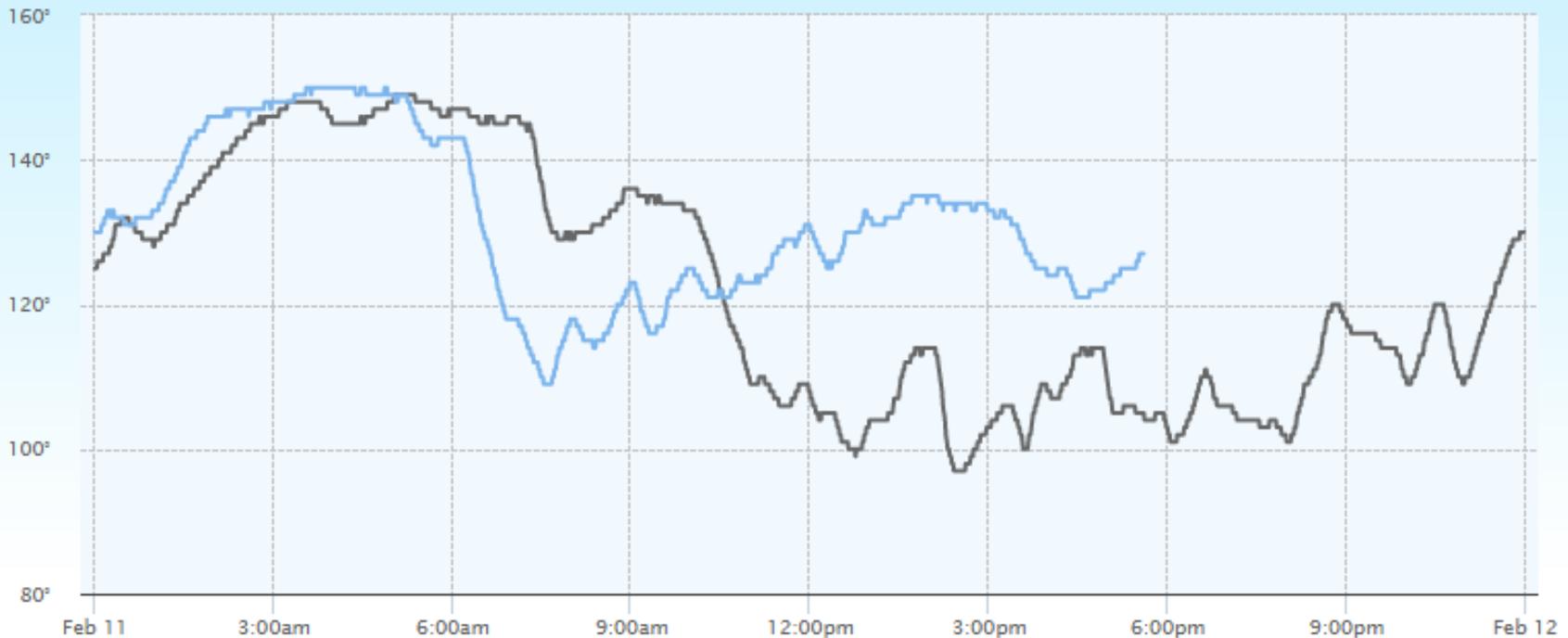
## Domestic Hot Water Supply



Day | Week | Month | Year

Wednesday 02-11-2015

— Domestic Hot Water Supply (Yesterday)    — Domestic Hot Water Supply (Today)



OK

# Air Conditioning



Kenmore Abbey  
(Direct Expansion)



Fairweather  
(Through-the-wall)



Franklin Square  
(Window)



Blackstone  
(Through-the-wall)



Salem Heights  
(Through-the-wall)

# Measurement Approach

<b>location_name</b>	<b>timestamp</b>	<b>kwh</b>
<b>Blackstone</b>	<b>Jan-13</b>	<b>46815</b>
<b>Blackstone</b>	<b>Feb-13</b>	<b>65392</b>
<b>Blackstone</b>	<b>Mar-13</b>	<b>43009</b>
<b>Blackstone</b>	<b>Apr-13</b>	<b>38321</b>
<b>Blackstone</b>	<b>May-13</b>	<b>36252</b>
<b>Blackstone</b>	<b>Jun-13</b>	<b>33321</b>
<b>Blackstone</b>	<b>Jul-13</b>	<b>36105</b>
<b>Blackstone</b>	<b>Aug-13</b>	<b>35039</b>
<b>Blackstone</b>	<b>Sep-13</b>	<b>34509</b>
<b>Blackstone</b>	<b>Oct-13</b>	<b>37722</b>
<b>Blackstone</b>	<b>Nov-13</b>	<b>37755</b>
<b>Blackstone</b>	<b>Dec-13</b>	<b>40572</b>

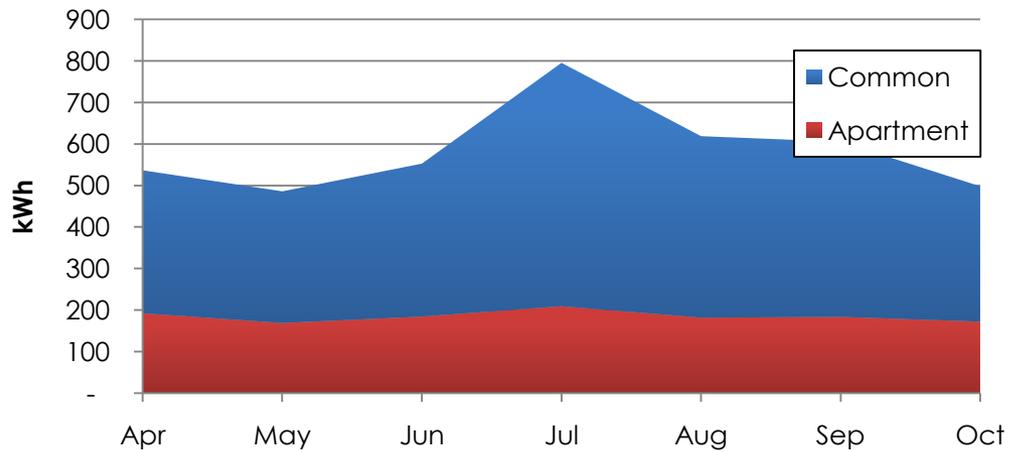
1. Calculate total apartment use per month
2. Add common area electricity use per month

Equipment cost:

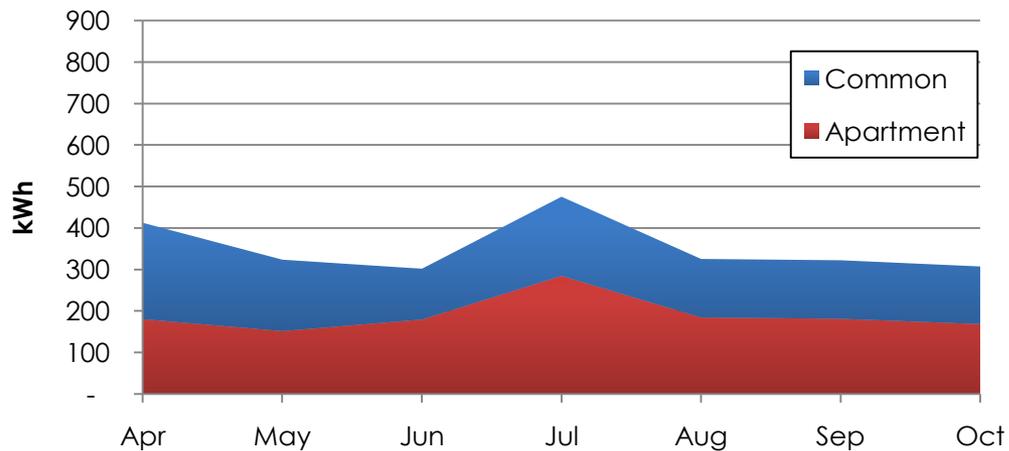
– \$0

# Air Conditioner Use (kWh/ Apt)

## Kenmore Abbey



## Franklin Square



# Heating -Boilers



**Kenmore Abbey  
(2-Stage 85% efficient)**



**Fairweather  
(Modulating  
85% efficient)**



**Blackstone  
(Modulating 93% efficient)**



**Franklin Square  
(Modulating 85% efficient)**



**Salem Heights  
(2-Stage 85% efficient)**

# Heating - Apartments

## Whalen fan-coils



Blackstone  
Franklin Square  
Kenmore Abbey

## Fin-tube radiators



Fairweather  
Salem Heights

# Measurement Approach



Install sensors:

- Supply and return water temperature

Install circuit transformers:

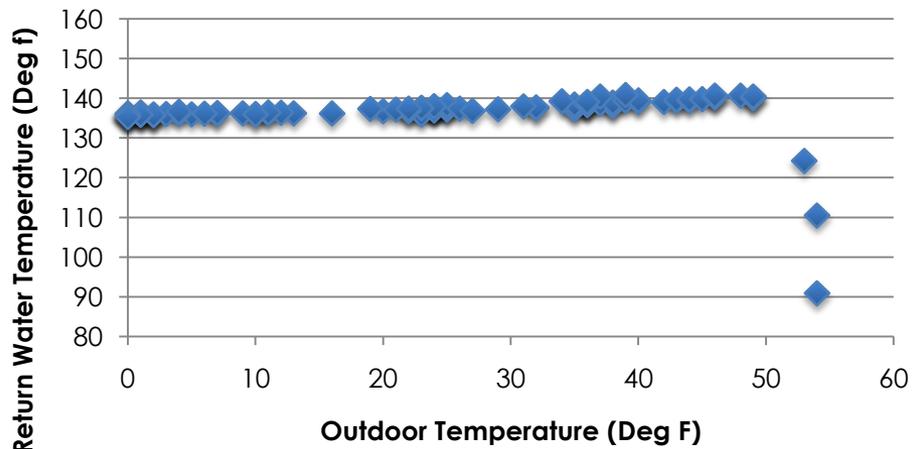
- Boilers and pumps

Equipment cost:

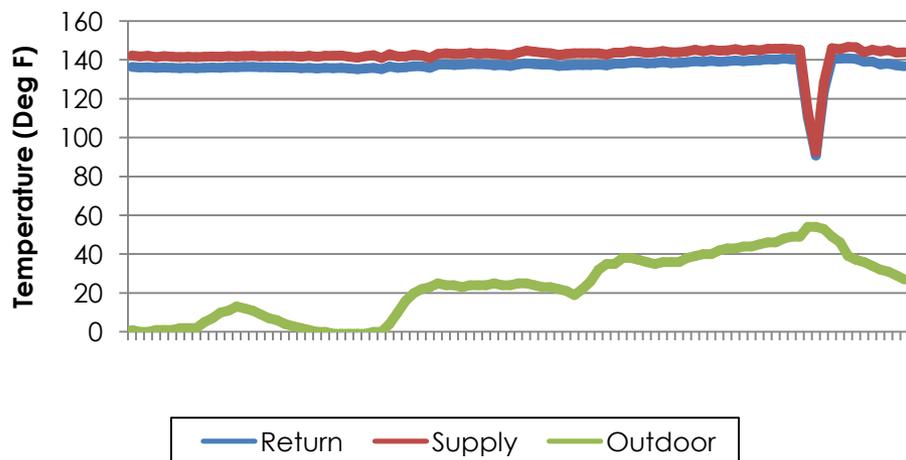
- Monitor \$439
- Gateway \$140
- Sensors \$39 each
- 2 yr. license \$576

# Fairweather Peabody

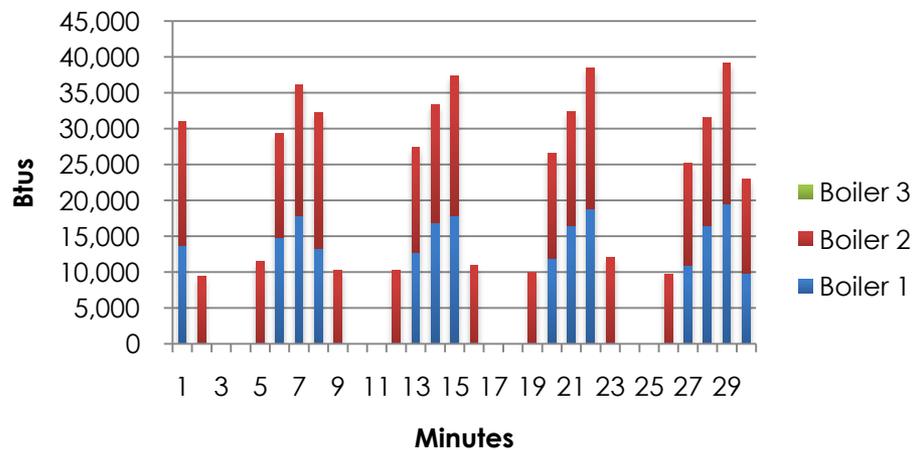
## Outdoor Reset (4 days)



## Supply & Return Water (4 days)

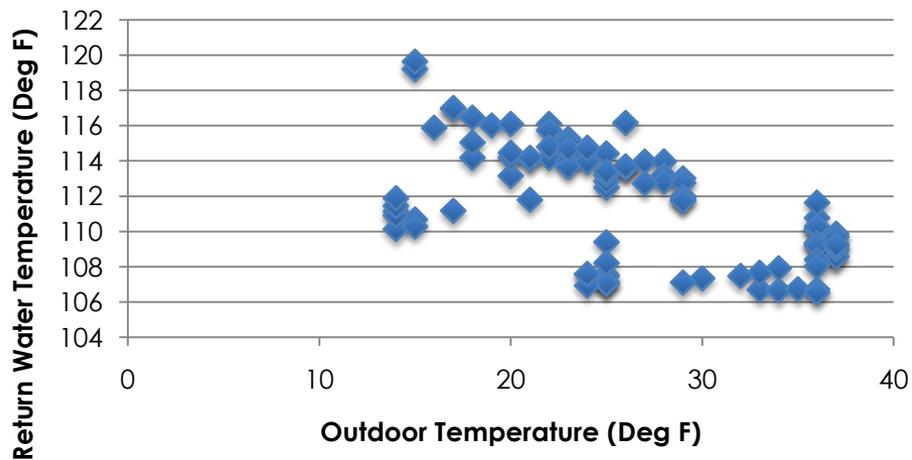


## Boiler Sequencing (30 minutes)

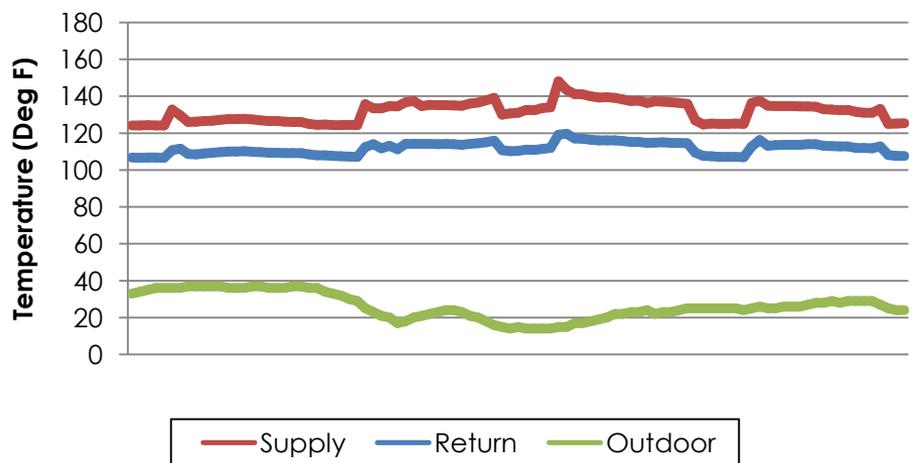


# Franklin Square

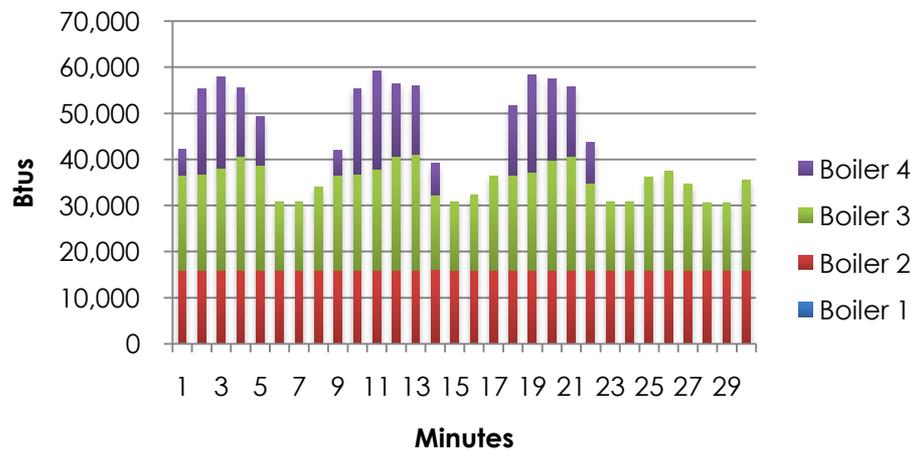
## Outdoor Reset (4 days)



## Supply & Return Water (4 days)

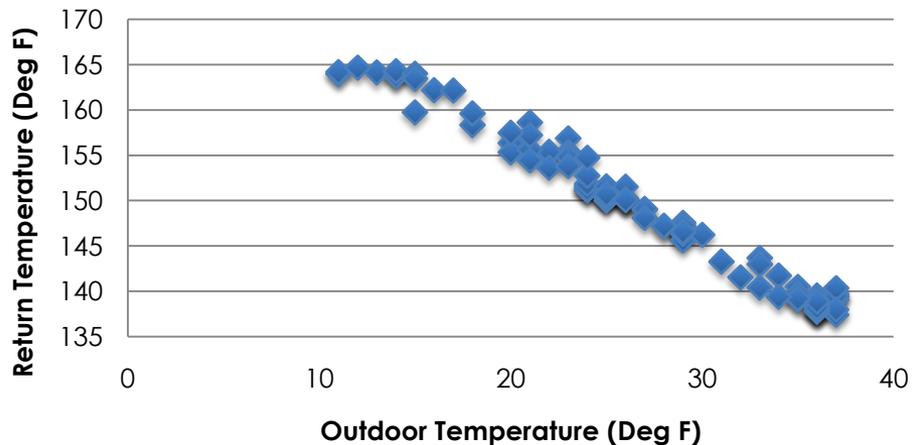


## Boiler Sequencing (30 minutes)

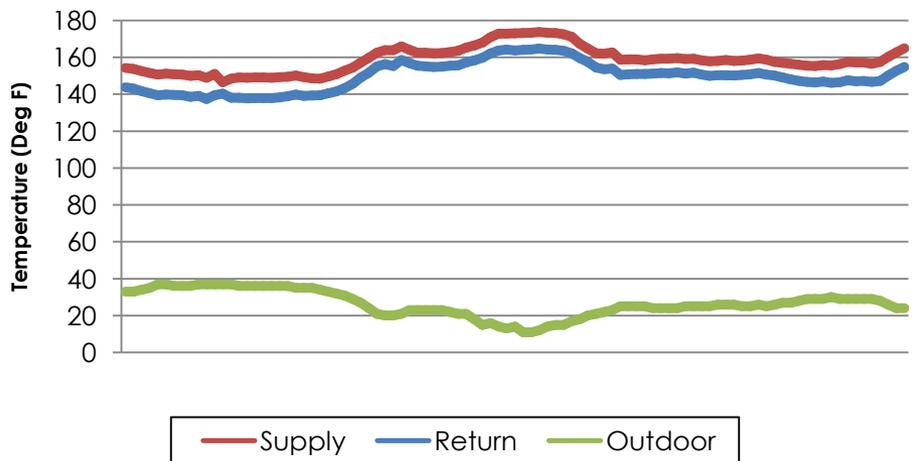


# Salem Heights

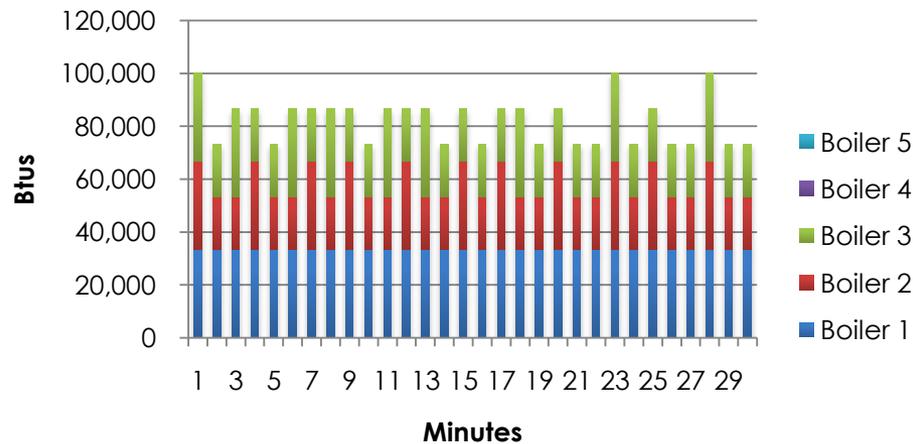
## Outdoor Reset (4 days)



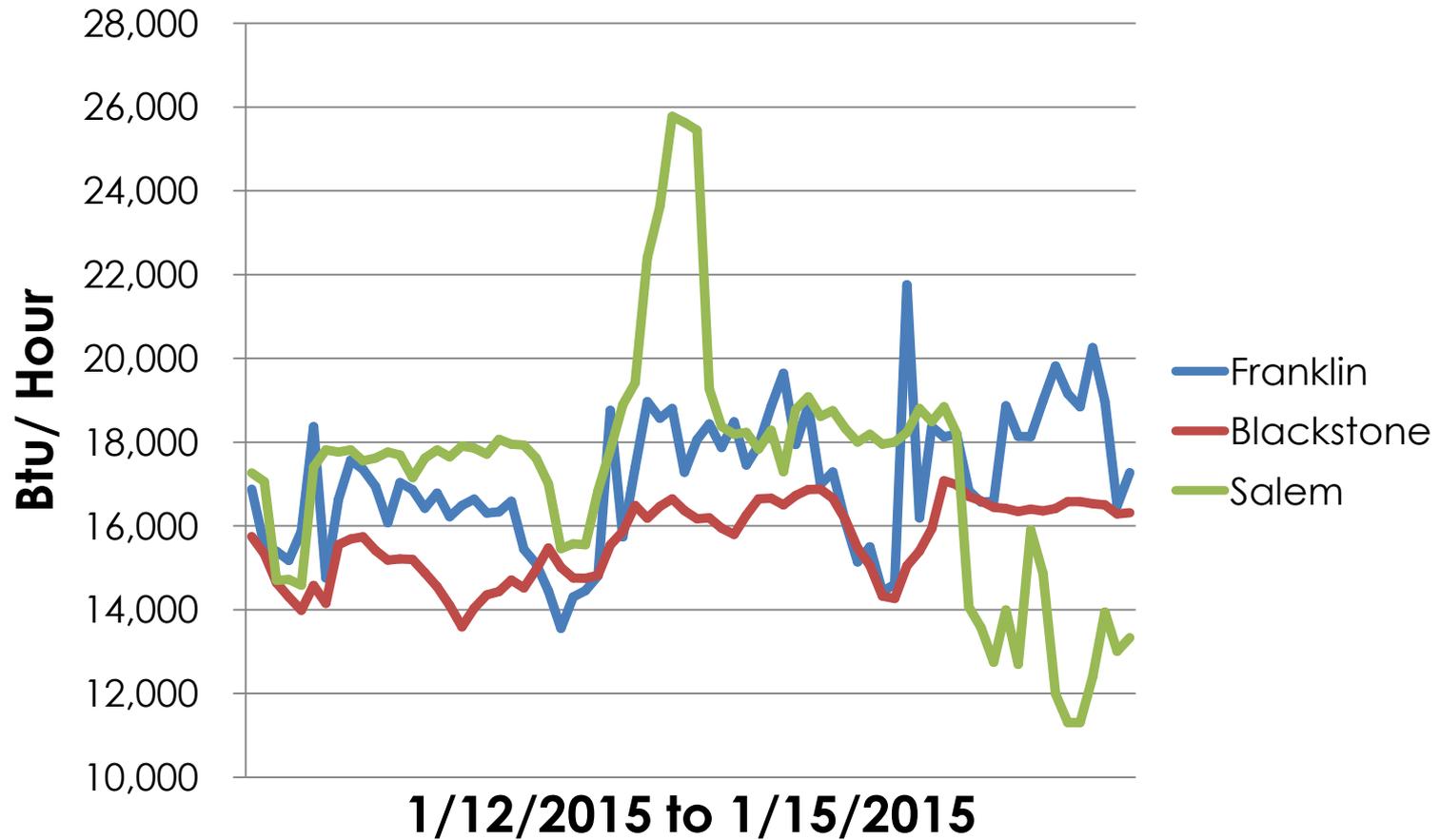
## Supply & Return Water (4 days)



## Boiler Sequencing (30 minutes)



# Btu per Hour per Apartment



# Ventilation



Kenmore Abbey  
(6,200 watts)



Blackstone  
(9,000 watts)



Franklin Square  
(2,200 watts)



Fairweather  
(25-150 watts)



Salem Heights  
(2,200 watts +)

# Measurement Approach



Add CTs for Fans:

- \$13 per CT

Add CO2 sensor:

- CO2
- Temperature
- Relative Humidity

Equipment cost:

- \$630

# Mechanical Ventilation Rated CFM & Cost

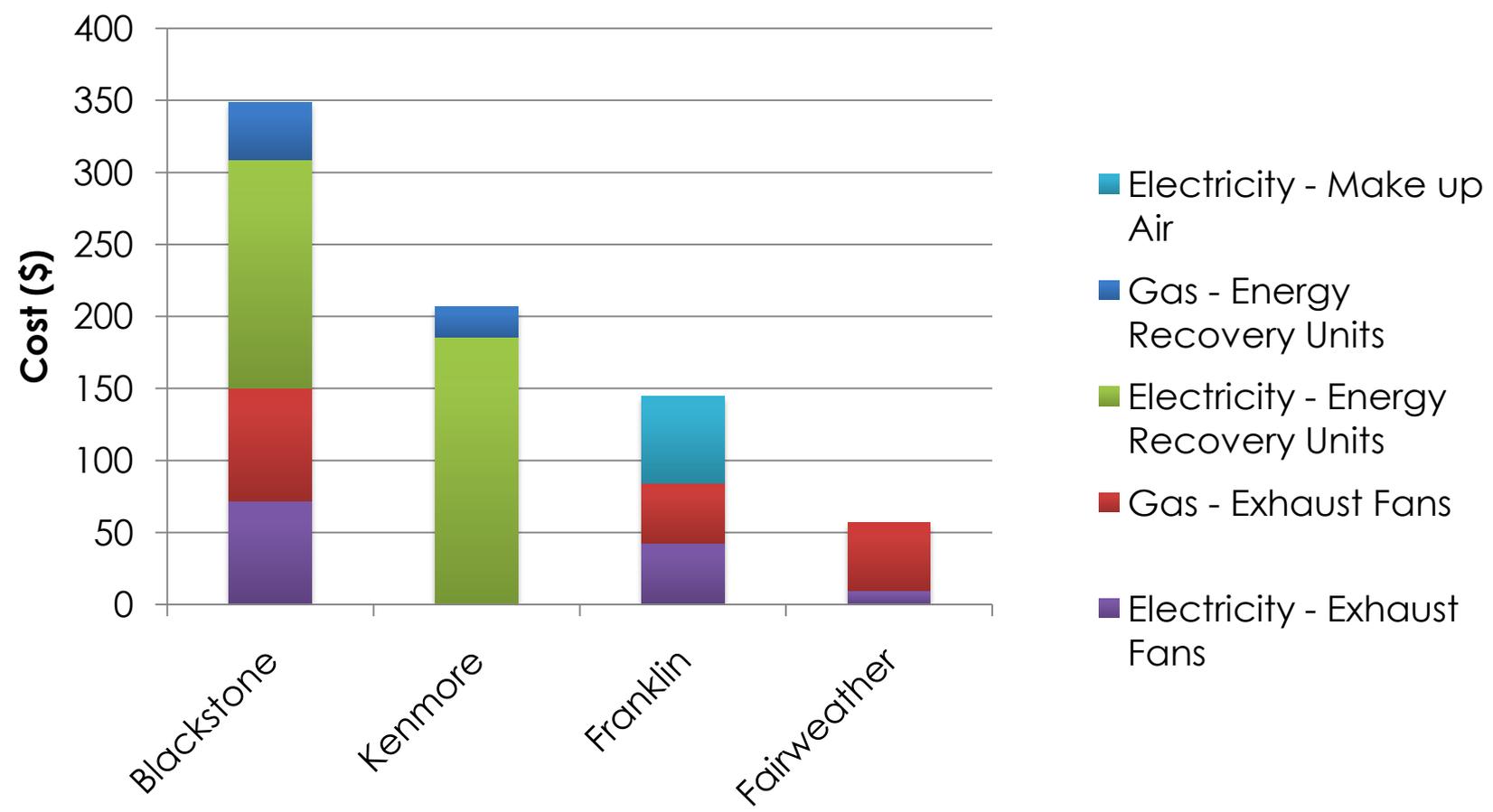
Ventilation Type	Blackstone CFM/ Apt	Kenmore CFM/ Apt	Franklin CFM/ Apt	Fairweather CFM/ Apt
Energy Recovery Unit CFM per apartment	69	73		
Exhaust fan CFM per apartment	135		72	40
Make up air fan CFM per apartment			71	

## Notes:

- Peabody ERU and exhaust fans run 24/7 at 100%
- Kenmore ERU fan runs 24/7 at 100%
- Fairweather exhaust fans run 12/7 at 100% and make up air is off
- Franklin exhaust and make up air fans run 24/7 at 100%
- Blackstone, Franklin, and Fairweather fan kWh is measured
- Kenmore exhaust fan ventilation kWh is estimated
- Actual CFM and associated gas cost is estimated
- Electricity cost @ \$.20/kWh
- Gas cost @ \$1.00/therm



# Estimated Ventilation Electricity and Gas Cost per Apartment



Note: Gas cost assumes exhaust fans deliver 50% of rated CFM output

# Corridor CO<sub>2</sub>, Temperature, & RH



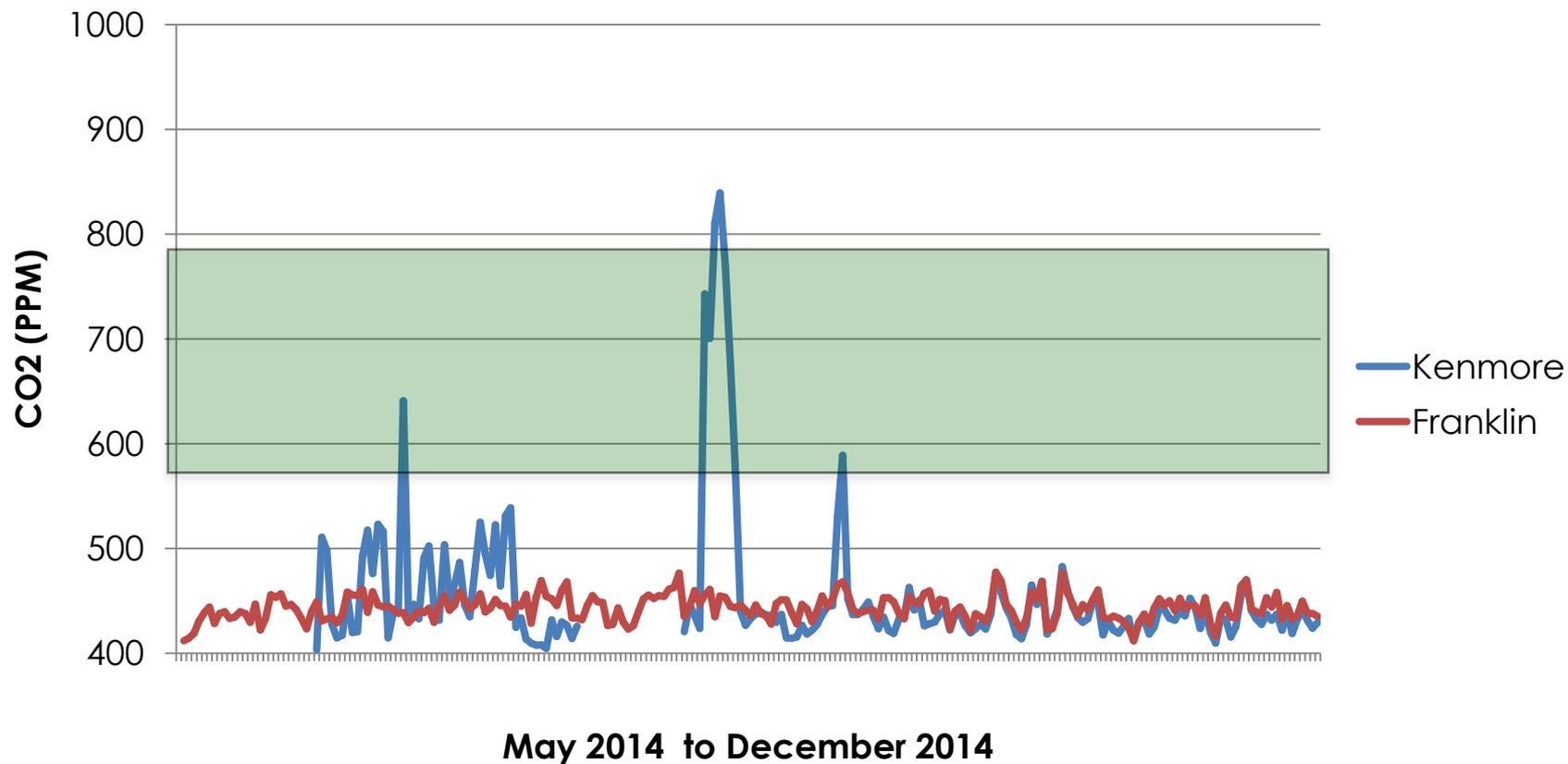
**Kenmore Abbey**  
100% Ventilation from  
3 Energy Recovery Units  
73 CFM/ Apt

**Franklin Square**  
100% ventilation from  
3 Make up air units &  
8 Exhaust Fans  
72 CFM/ Apt



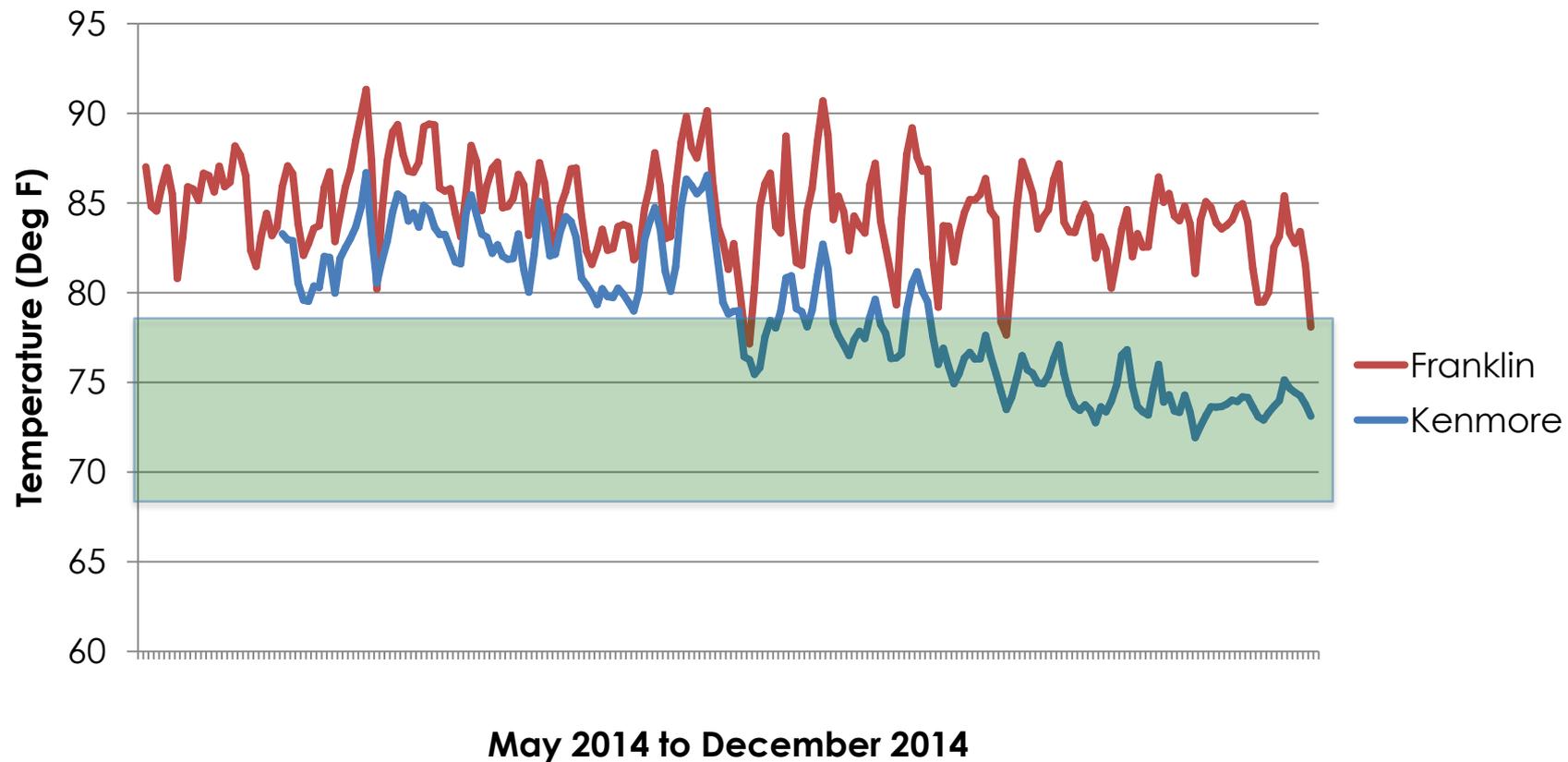
# Ventilation Impact – CO<sub>2</sub>

## Corridor CO<sub>2</sub> Levels Kenmore and Franklin



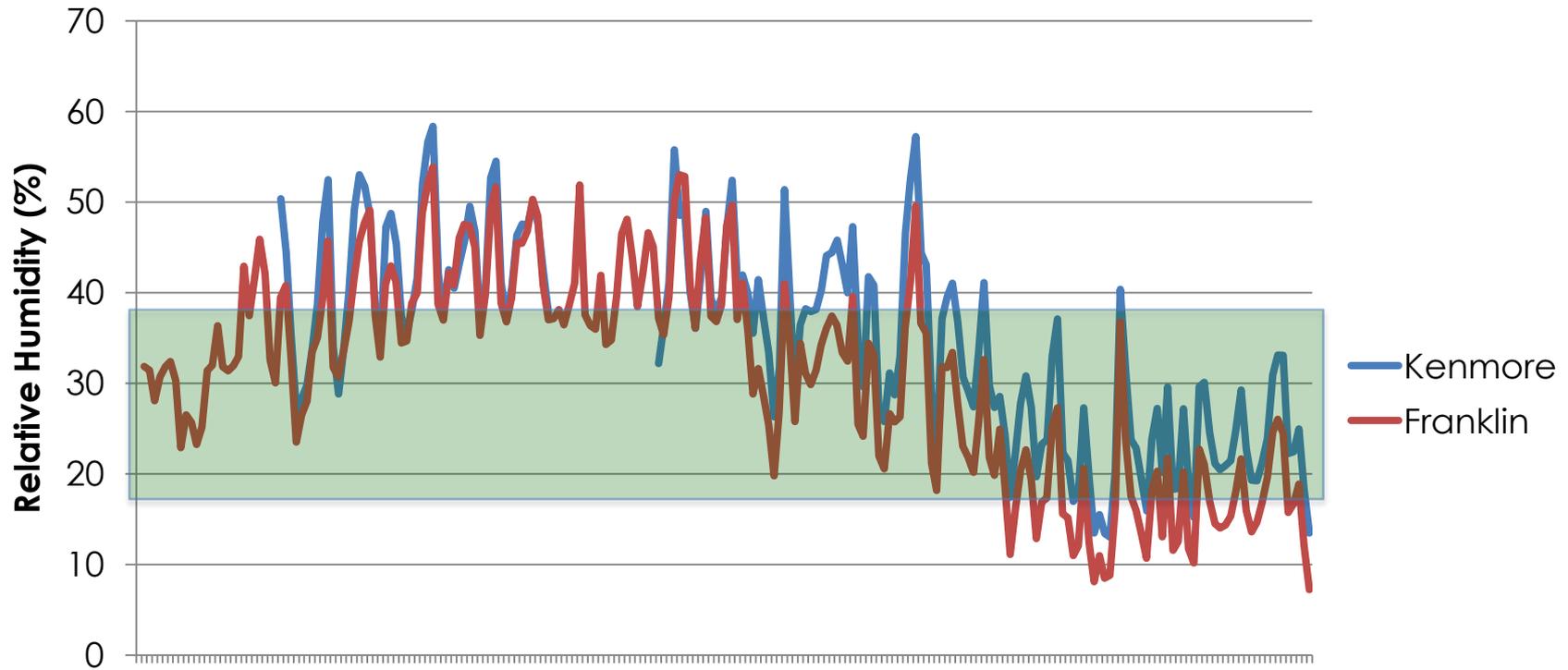
# Ventilation Impact – Temperature

## Corridor Temperature Kenmore and Franklin



# Ventilation Impact – Relative Humidity

## Corridor Relative Humidity Kenmore and Franklin



May 2014 to December 2014

## Proposed Actions

### **Troubleshooting**

- Continue to investigate and monitor odd readings and resident complaints

### **Air Conditioning**

- Monitor Kenmore chiller operation

### **Heating**

- Continue to adjust controls

### **Ventilation**

- Test apartment-level CO<sub>2</sub> measurement and ventilation control

# Thank You

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This concludes The American Institute of  
Architects Continuing Education Systems Course

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