Efficiency Vermont

Taking Control to Get to Net Zero

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Taking Control to Get to Net Zero
Part I – Concepts & New Technologies

I. Controls & Net Zero Energy Goals

II. Wireless Controls –Good Option for Smaller Businesses

III. Communications – within the Controls

IV. Communications – with the Facility Owner

V. Options for Hardware Components

VI. Analytics – Managing Data, Getting to & Staying at Net Zero

VII. Vermont Case Study - Vermont Public Radio

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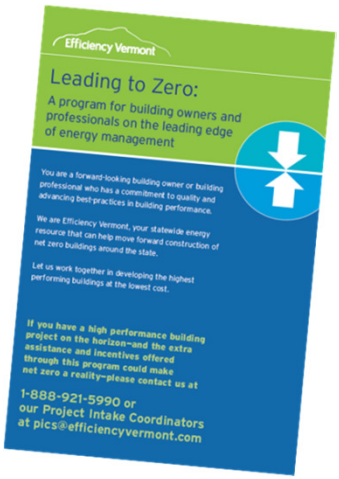
Taking Control to Get to What?

Net Zero Energy =

"Residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies."

National Renewable Energy Laboratory, US Dept. of Energy



Controls are Vital to Net Zero Energy Success!

nbi new buildings institute

Technologies

Passive systems, high performance building envelopes and **the evolution of technologies for monitoring and controlling energy systems are key developments toward extremely low energy buildings.**

New Buildings Institute "2014 Getting to Zero Status Update," page 25

Controlling a Net Zero Energy Building

All lighting on occupancy and daylight sensor controls

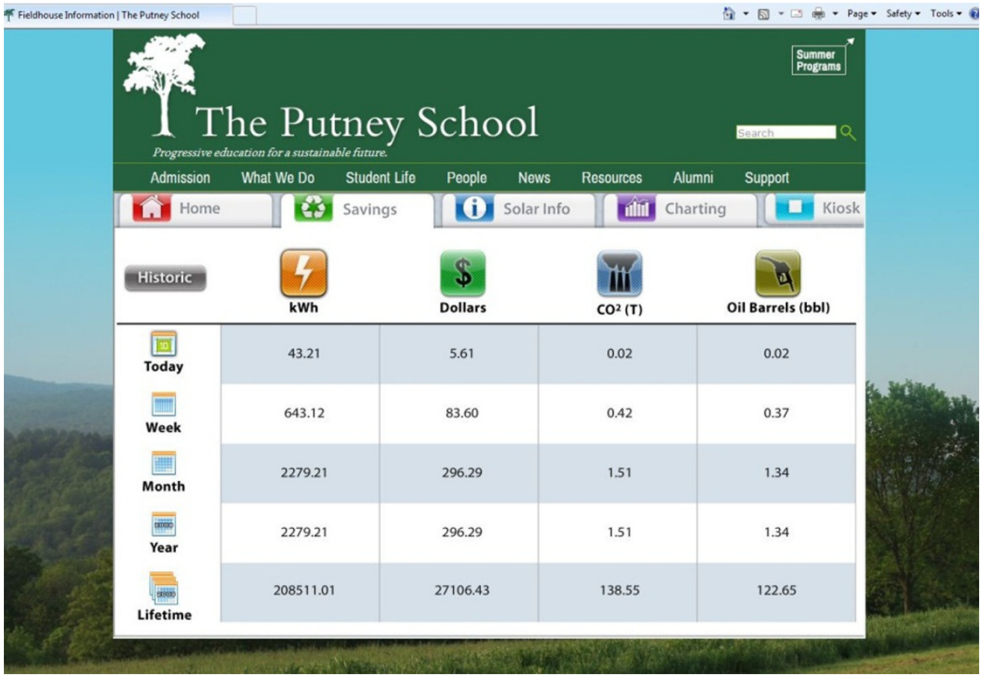
Automatic window controls flush building at night

All ventilation on occupancy and carbon dioxide sensor controls

Photo courtesy of Putney School
Design Information by Maclay Architects

Energy Monitoring Important

Energy monitoring and tracking at a Net Zero Energy Building



http://www.putneyschool.org/content/fieldhouse-information

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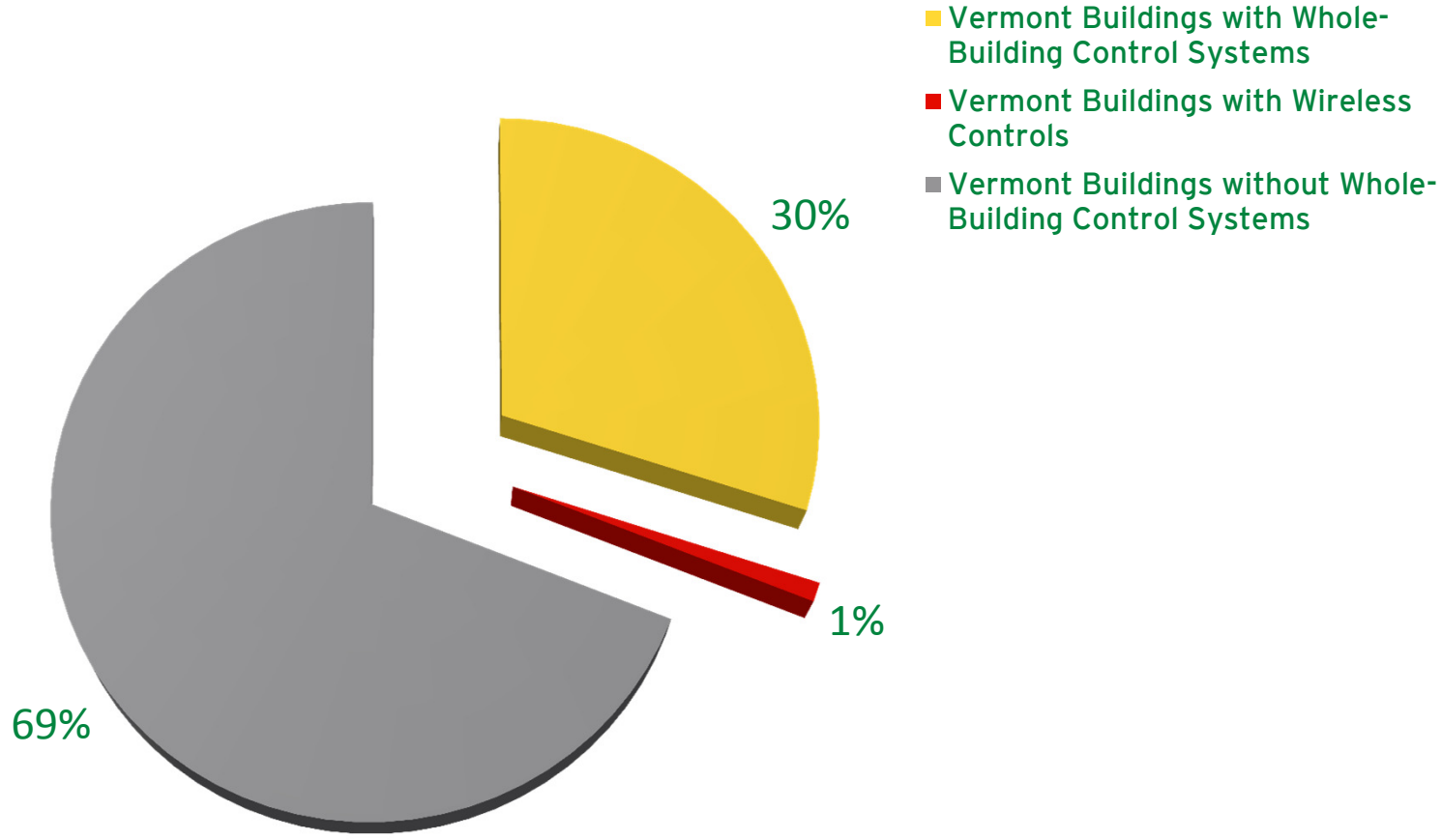
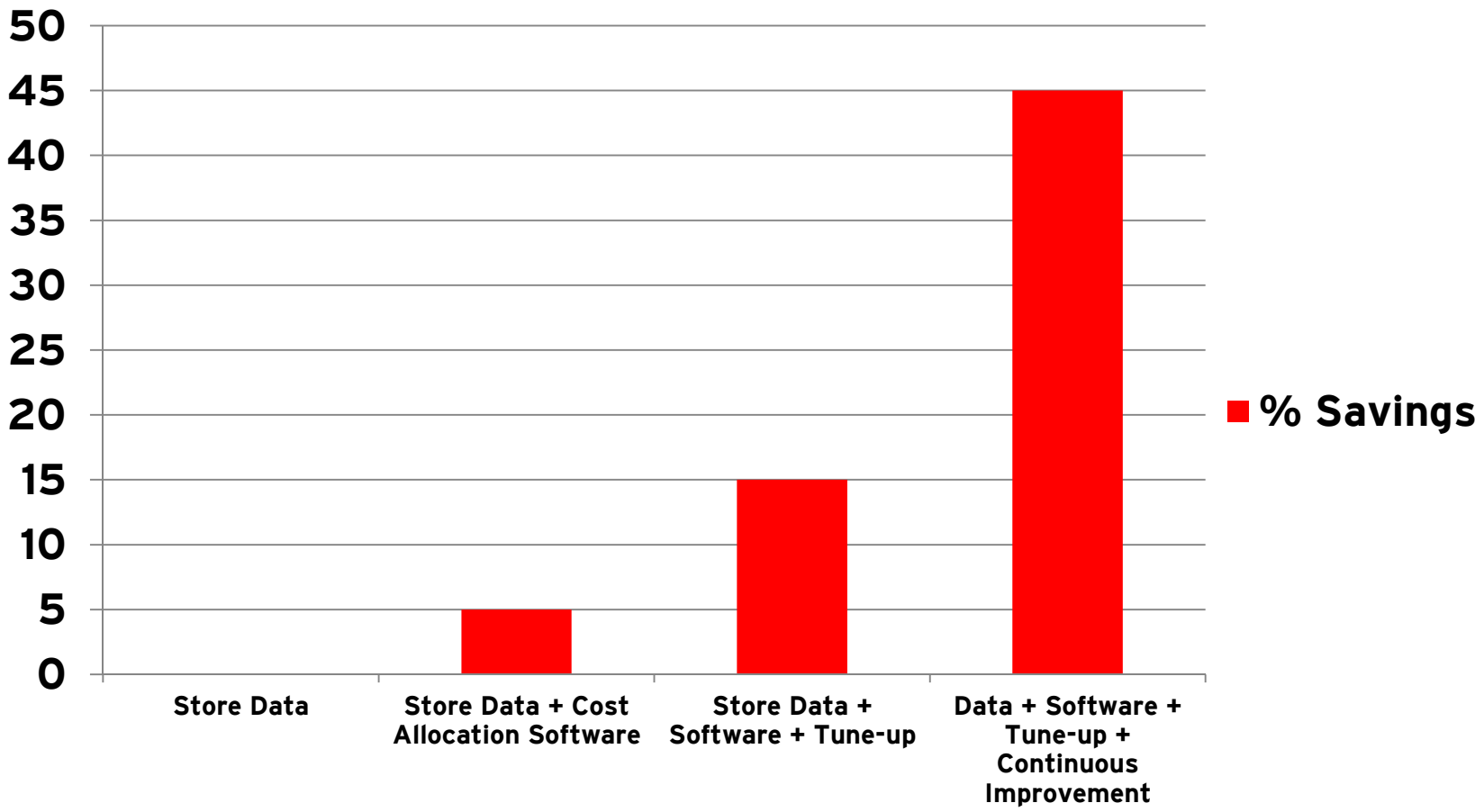
Vermont Existing Commercial Building Market



Source: Navigant Consulting 2012. *2011 Vermont Energy Management Systems – Market Actor Report – Business Sector (Commercial and Industrial)*

Potential Controls-Related Savings



Source FEMP Fact Sheet: "Facility Metering for Improved Operations, Maintenance & Efficiency" January 2005

What Does This Mean?

Controls can be used to:

- Commission
- Re-commission
- Monitor
- Operate building

Help you achieve net zero

Net Zero Office Building, Courtesy MMM Group

There is Benefit for Any Budget

Controls – Related Improvement	Cost	Savings
Retuning or Optimizing Existing Controls	$	$
Whole Building Energy Monitoring	$	$
Add Stand-Alone Control	$	$
Demand-Limiting – Demand Savings	$$	$
Retuning & Automated Data Analytics	$$	$$
Add Web-based Control w/Graphical User Interface to Existing DDC System	$$$	$$$
Extensive Energy Monitoring with Continuous Controls Optimization	$$$	$$$
Stand-Alone to Web-based User Interface	$ to $$$$	$ to $$$
Energy Management Services Provider w/Extensive Energy Monitoring	$$ to $$$$	$$$$

No matter where your building falls on the controls spectrum, there are control improvements to fit your budget and goals!

Wireless Controls
Inexpensive & Good for Smaller Businesses

I. Wireless Controllers

II. Communication

III. Mesh Networks

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Classic Honeywell T87 came out in 1953 with setback available in the1960s

7-day Programmable thermostats came out in the 1970s

First wireless thermostats become available in the 2000s

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More Wireless Controls Becoming Available Every Year

Wireless Valve and Damper Actuators

2012 AHR Expo® INNOVATION AWARDS Value Impact Application HONORABLE MENTION

Wireless Temperature and Humidity Sensors

Wireless Hotel Room HVAC Controls

Wireless Terminal Equipment Controllers

2013 AHR Expo® INNOVATION AWARDS Value Impact Application HONORABLE MENTION

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Hampton Inn

GEM Link® Wireless by Lodging Technology

$17,000/yr Estimated Energy Savings

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Why use wireless controls in existing buildings rather than wired controls?

- Faster installation
- Lower labor cost
- No extensive demolition or re-wiring
- Flexible redeployment when the building space changes
- Good option for historic buildings

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Wireless Controls – How do they Work?

They transmit information on radio waves similar to devices that we're all familiar with: laptops, smartphones, and garage door openers, for example.

Wireless Controls
Inexpensive & Good for Smaller Businesses

I. Wireless Controllers

II. Communication

III. Mesh Networks

Wireless Controls – How do they communicate?

Wired controls have communication protocols or standards like BACnet, Modbus, or IP/Ethernet, but what protocols do wireless controls use to communicate?

- They use protocols like ZigBee Alliance or EnOcean.
- ZigBee is common in the U.S. Unfortunately, it operates in the crowded Wi-Fi frequency range and needs to have batteries replaced periodically.
- EnOcean is the popular choice in Europe. It doesn't need batteries since it uses very low power and harvests its own energy for operation.

Wireless Communication Protocols

Table 1: Comparison of BAS wireless protocols and common non-BAS wireless technology.

Common Name	ZigBee	EnOcean	Z-Wave	RedLINK	Wi-Fi
Standard	802.15.4	ISO/IEC 14543-3-10	IEEE 802.15.4	N/A	IEEE 802.11 a/b/g/n/ac
Operating Frequency	868.0-868.6 MHz[1], 902 - 928 MHz[2], 2400 - 2483.5 MHz[4]	315 MHz[3], 868 MHz[1]	902 - 928 MHz[2]	902 - 928 MHz[2]	2,400 - 2,483.5 MHz[3]
Industry Application	BAS Controls & Automation	BAS Controls & Automation	Home, Security, and Entertainment	Home, Security, and Entertainment	PC Wireless Peripherals
Battery Life (days)	100 - 1,000+	No Battery	100 - 1,000+	N/A	0.5 - 5
Network Size	65,536	N/A	232	N/A	32
Max Data Rate (kb/sec)	20 - 250	125	9.6	N/A	11,000+
Transmission Range (ft)	approx. 300 ft	90 ft (indoors) 900 ft (outdoors)	90 ft (indoors) 300 ft (outdoors)	90 ft (indoors) 300 ft (outdoors)	Approx. 300 ft

[1]Europe, Canada **[2]North America** **[3]United States Only** **[4]Worldwide**

Wireless Controls
Inexpensive & Good for Smaller Businesses

I. Wireless Controllers

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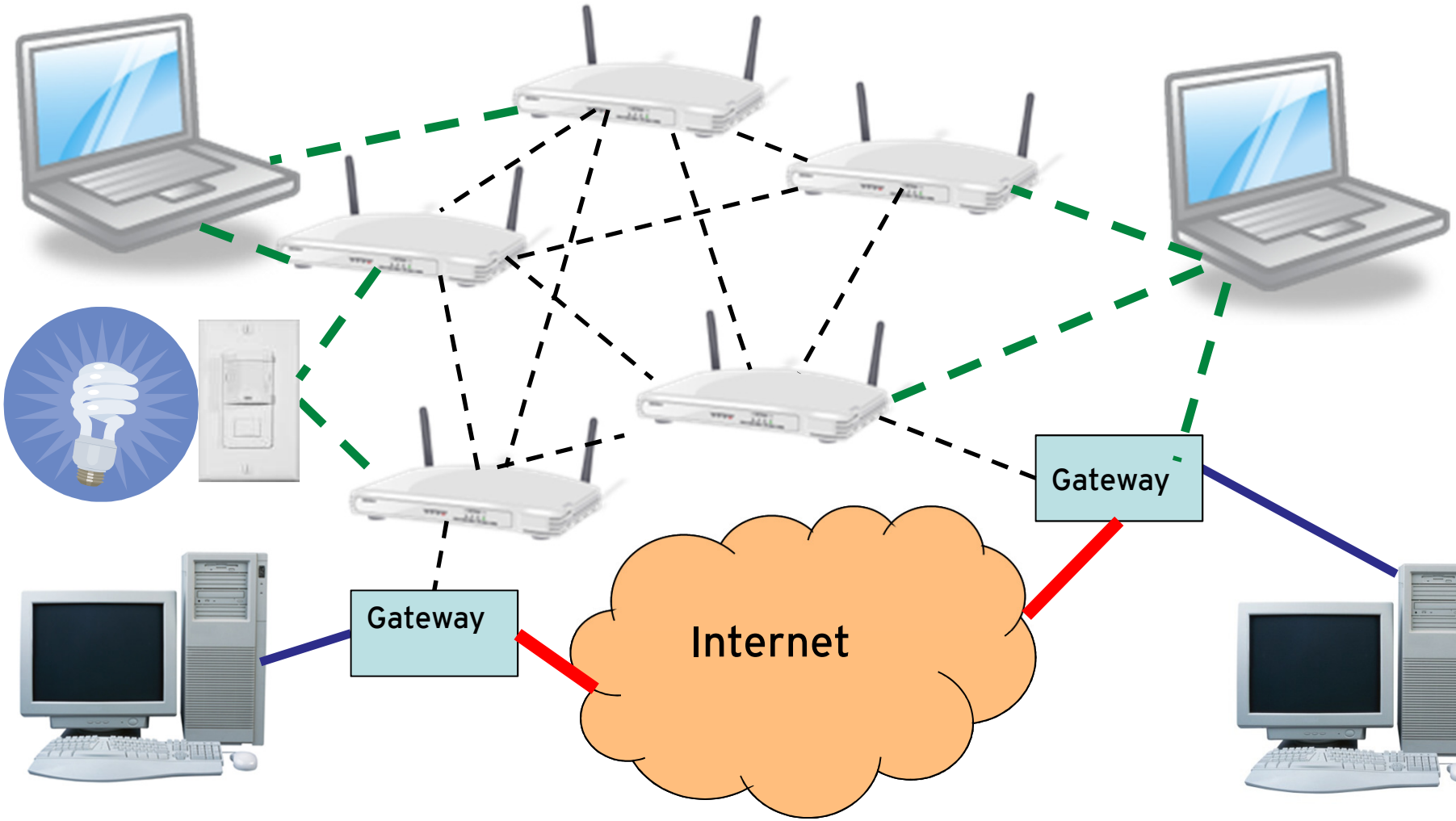
Wireless Mesh Network (WMN)



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Benefits of Mesh Networks

- Cost effective approach to deploying a sensor network.
- Technology is easy to install and maintain.
- Mesh networks automatically adjust to changes in the network structure.
- Nodes can be added, removed, replaced or relocated without the need for traditional network administration.
- Mesh networks can optimize or increase visibility into dynamic systems such as temperature and humidity inside a commercial building without the cost of a wired network.

Courtesy AutomatedBuildings.com and Mark Pacelle, VP Marketing, Millennial Net

Communications
Within the Controls

I. Wired Protocols

II. Security

Communication Protocol Summary – Direct Digital Control (DDC) Systems

- BACnet – Established by ASHRAE in 1995 to promote "interoperability"
- Lon – LonWorks is the overall technology & LonTalk is the protocol
- Proprietary
- TCP/IP

Which is Better For Your Business?

Open System

Advantages:
- Freedom of choice
- Cost benefits
- Potential for Easy Integration

Disadvantages:
- Multi-vendor system may be more complex to operate & maintain
- Staff considerations – may need more technical expertise

Proprietary System

Advantages:
- One-stop shopping
- Single source responsibility
- Proven performance

Disadvantages:
- Cost of Service & Upgrades
- Less Choice

If You Want Open Systems - Are they?

Building owners beware! Just because a building automation system can speak Lon or BACnet, does not mean that the system is truly open.

1. Can multiple factory trained contractors work on the system?

2. Are controller programming tools available to the building owner and service contractors?

3. Does the building owner have access to the same training as the staff that the control manufacturer's technicians receive?

The BAS is only open if the answer is yes to all 3 questions!

Source: www.controltrends.org

Communications
Within the Controls

I. Wired Protocols

II. Security

Concerned about Security?

Cyber security is of paramount important to building owners, property management firms, and facility managers.

Include the IT experts in your building's controls system architecture and controls purchases, if possible.

Don't rely on promises from vendors that their products are "secure."

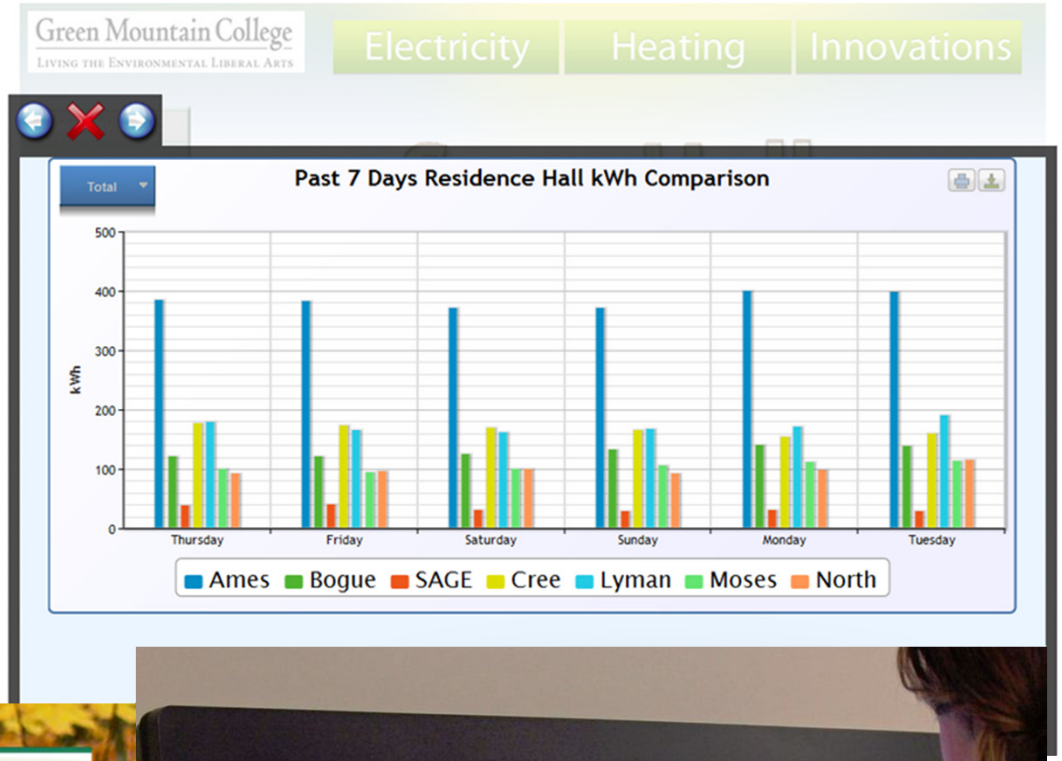
Communications
With the Facility Owner

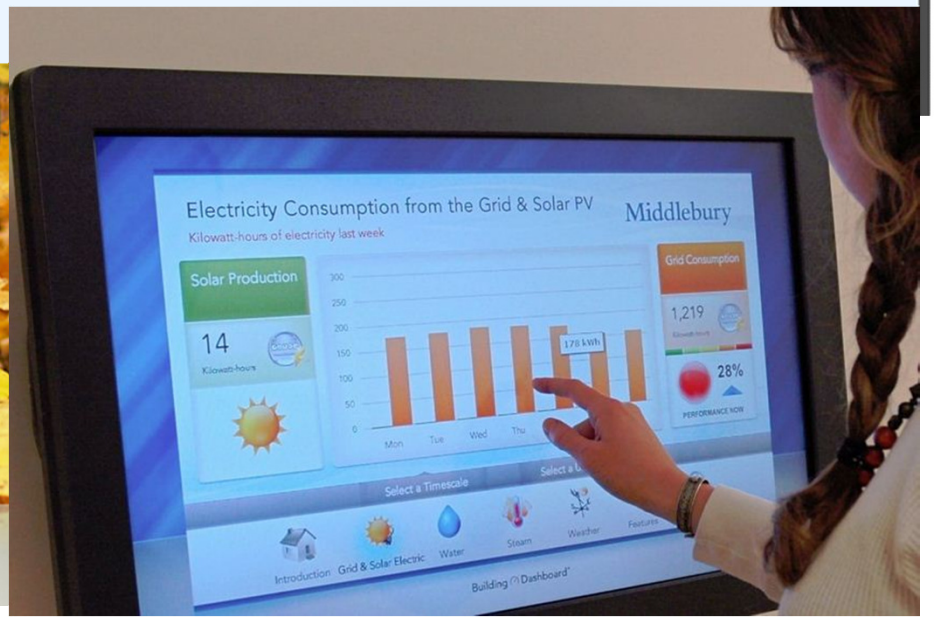
I. Dashboards

II. Web-based User Interfaces

Energy Dashboards

Show real-time energy data on computers and/or displays located on site & can motivate building users to conserve energy





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Communications
With the Facility Owner

I. Dashboards

II. Web-based Controls with User Interfaces

Web-based Graphical User Interface

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More Web-based Graphical User Interface

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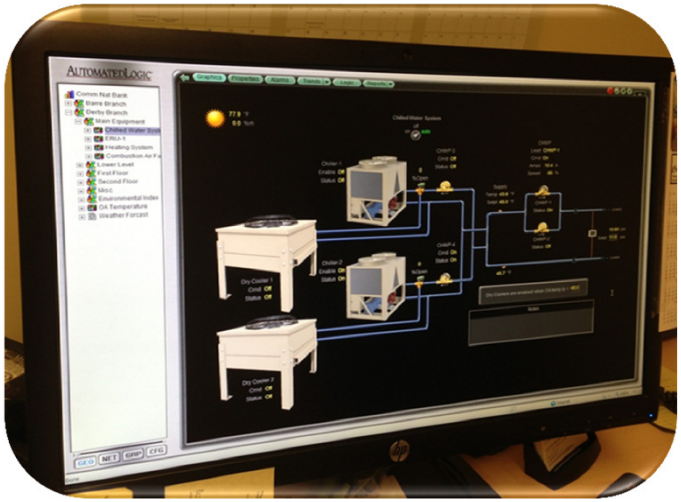
Controls + HVAC Improvements

$7,000/yr Estimated Savings

Community National Bank
DERBY, VERMONT



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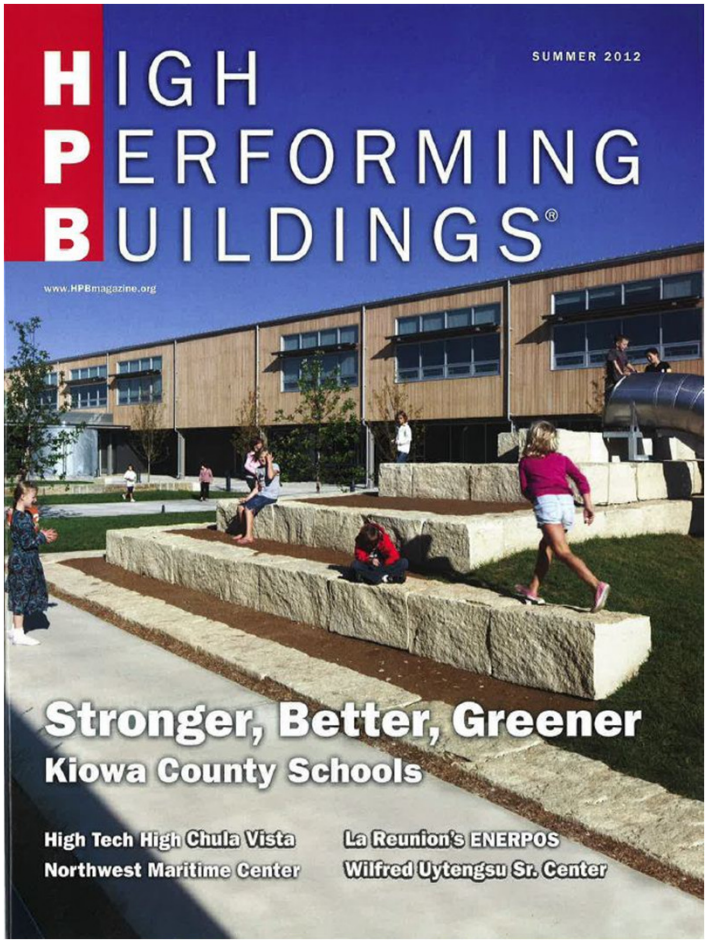
Web-Based Control for Multiple Systems



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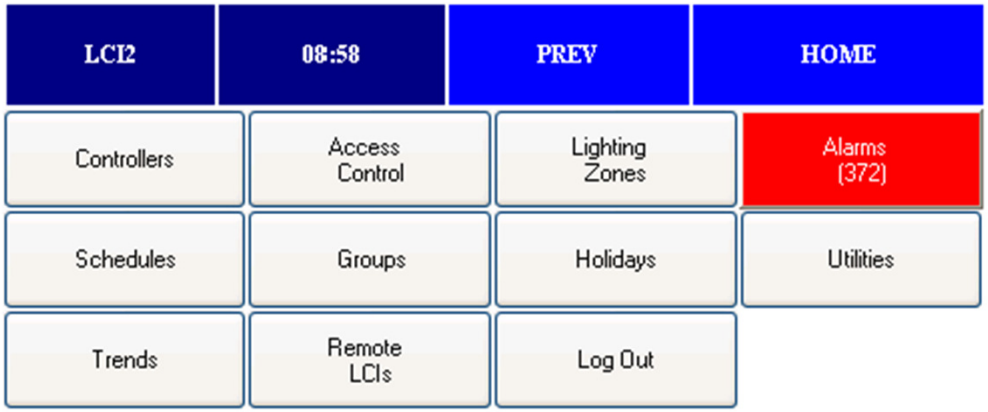
Web-based Control - continued

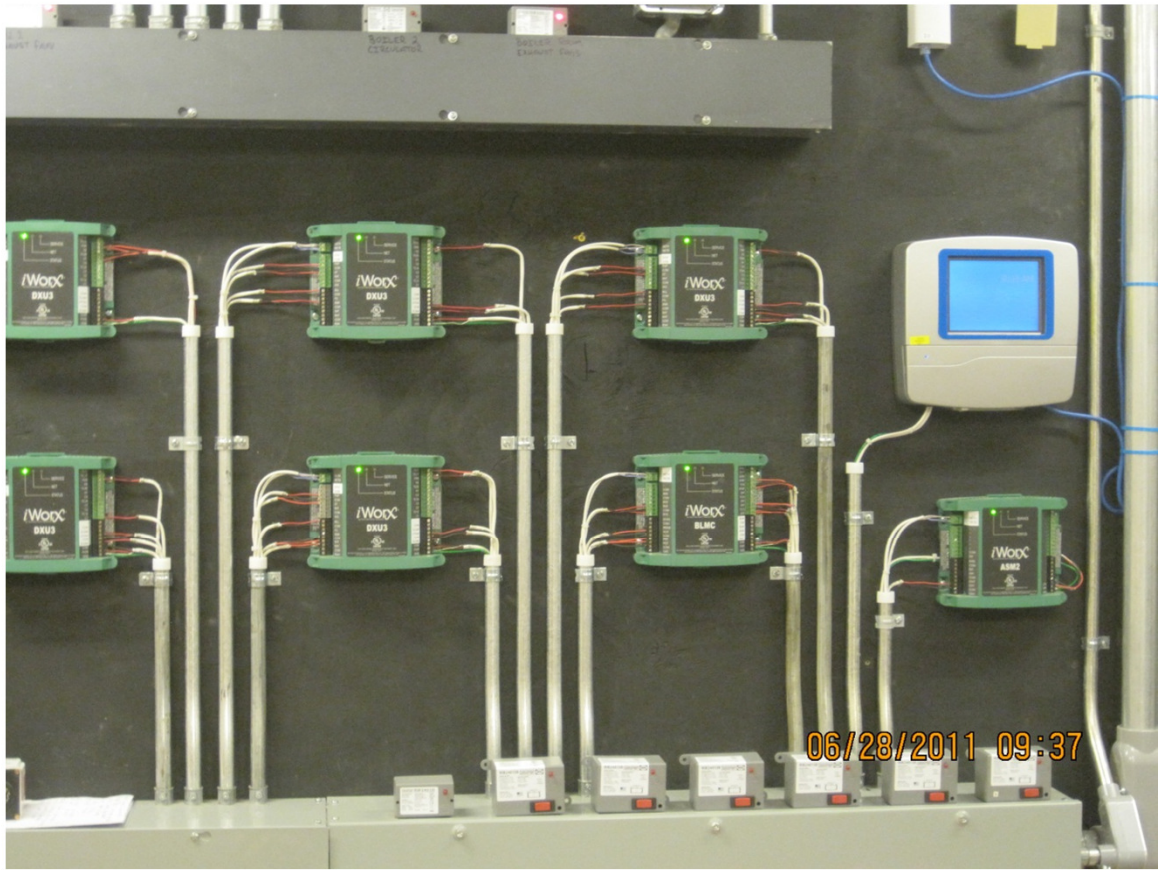
Home screen sample for simple web-based controller:



Coventry Village School

Scheduling Made Easier

Estimated Controls & Boiler Energy Savings = $12,000 per year



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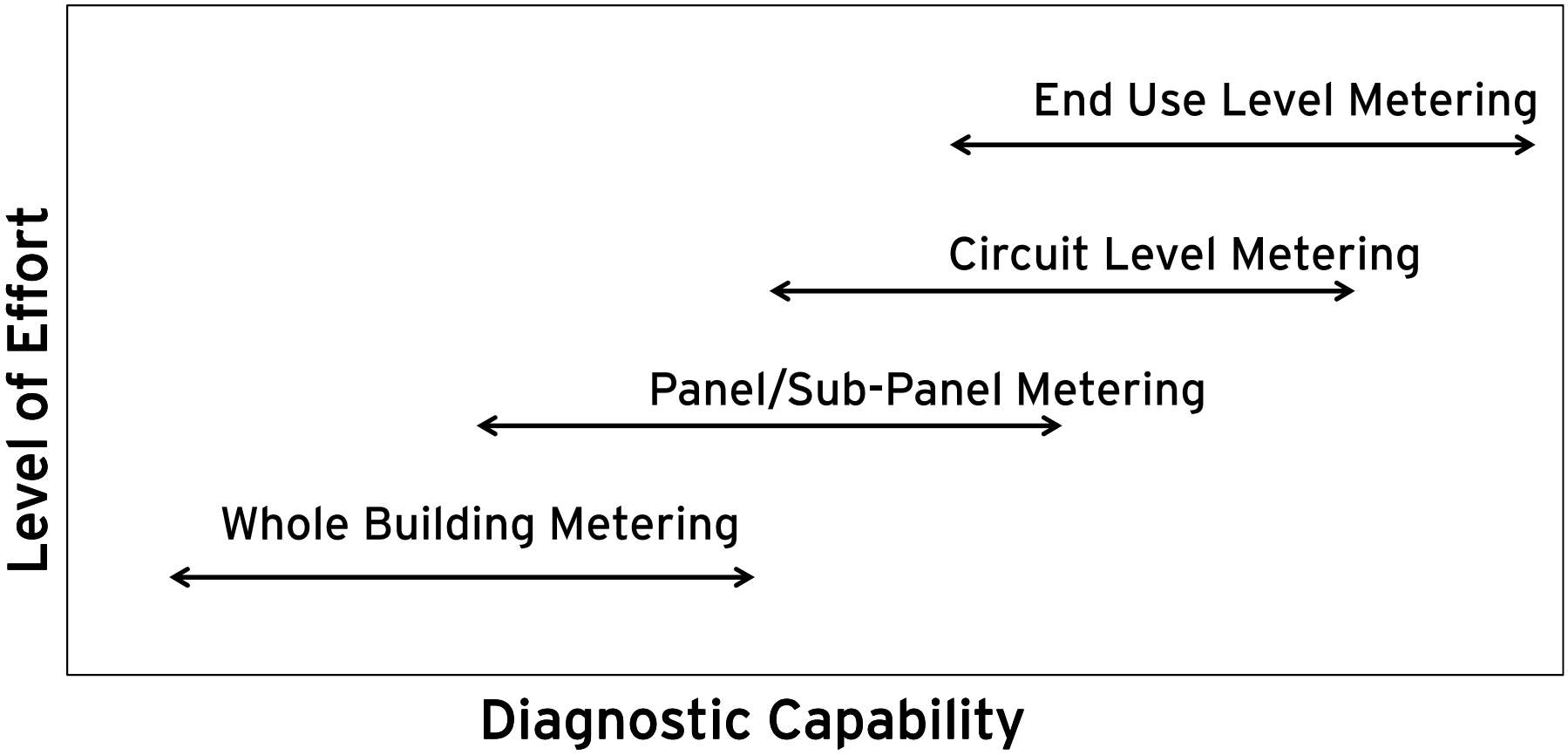
Options for Hardware Components

I. Whole Building vs. Sub-Metering

II. Stand alone vs. Integrated

Electric Metering Hierarchy

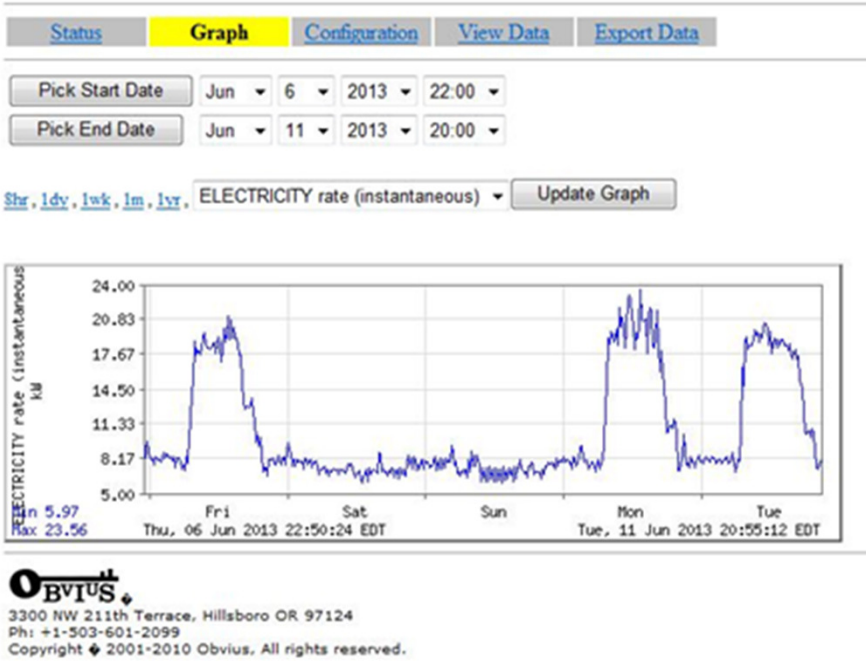


Source FEMP 2010 Operations & Maintenance Best Practices Guide 3.0

Whole Building Energy Monitoring

Price range for material and labor:

$3,800 to $4,900 plus $110/yr for Obvius on-line service



ENERCEPT® H804X

4-20mA Output kW Transducers

US Patent No. 6,3

Whole building Instantaneous Electricity & Propane Use

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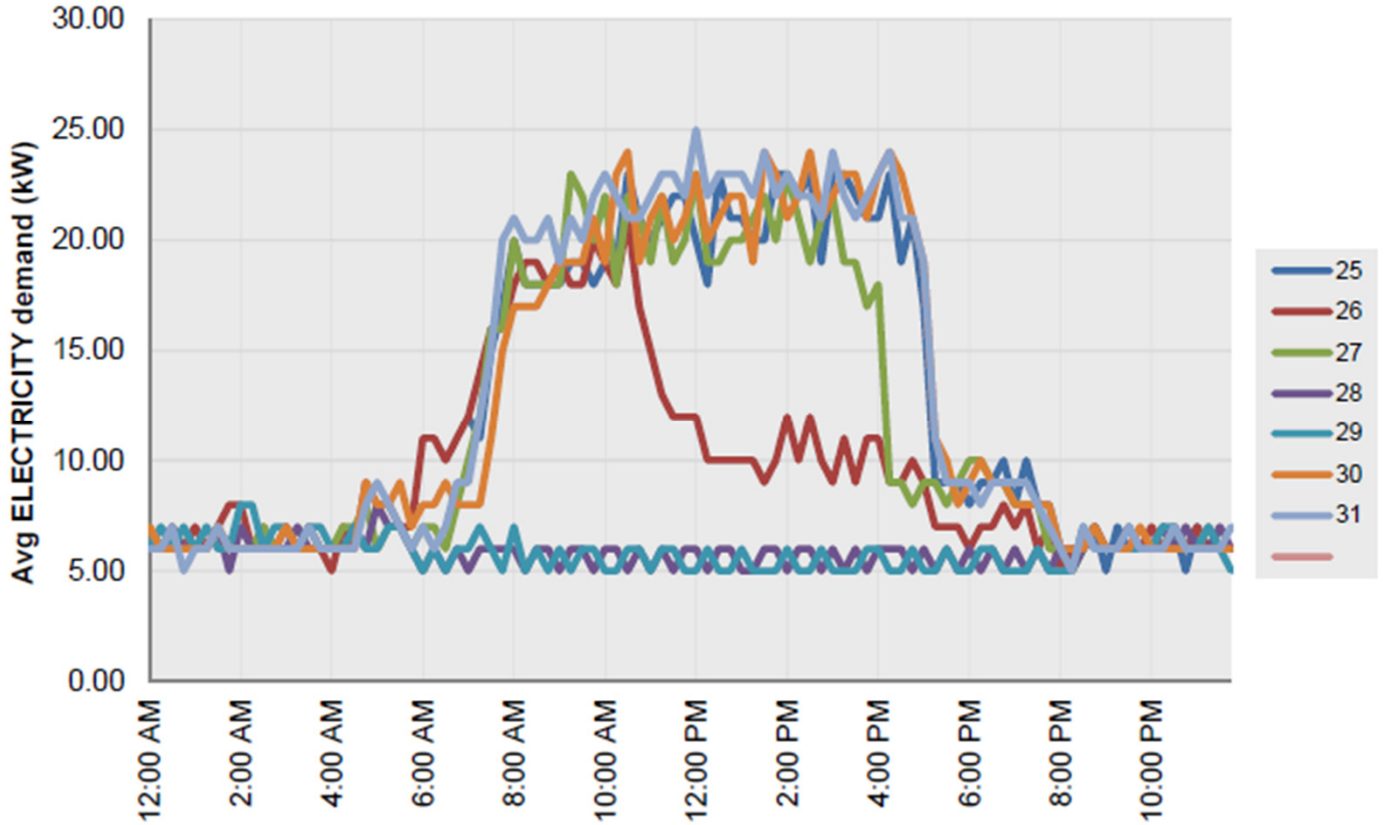
Free Energy Charting and Metrics Tool from Pacific Northwest National Laboratory

http://buildingretuning.pnnl.gov/ecam.stm



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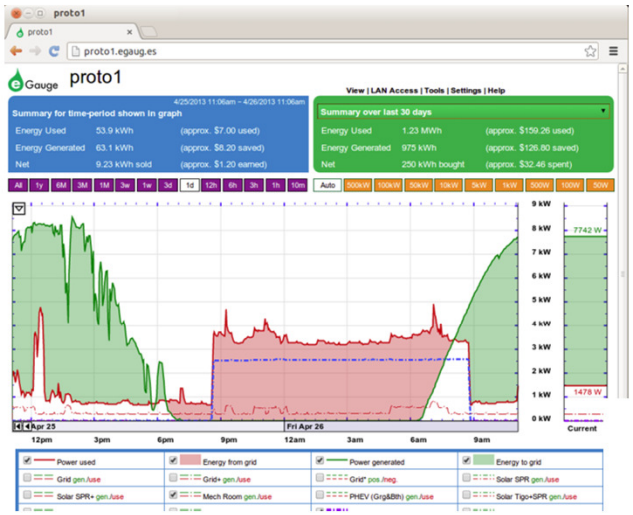
Sub-Metering Yields More Data

- Sub-metering with web-based user interface
- Scheduling of lighting and mechanical at the zone level
- Alarm and energy monitoring and trending capabilities
- Set-point and setback controllable
- FEMP "Operations and Maintenance Best Practices: A Guide to Achieving Operational Efficiency" Release 3.0, August 2010, Chapter 8 Metering for Operations & Maintenance

  http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf



E-Mon
Energy Monitoring Products

eGauge
capture your footprint [tread lightly]

VERIS INDUSTRIES

obvius

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Options for Hardware Components

I. Whole Building vs. Sub-Metering

II. Stand-alone vs. Integrated

Stand-alone Controls

- Low cost
- User friendly
- High energy efficiency & cost savings due to pre-programmed energy saving functions
- Flexible – oftentimes can be expanded

Zone Controller (ZC)

Roof Top Controller (RTC)

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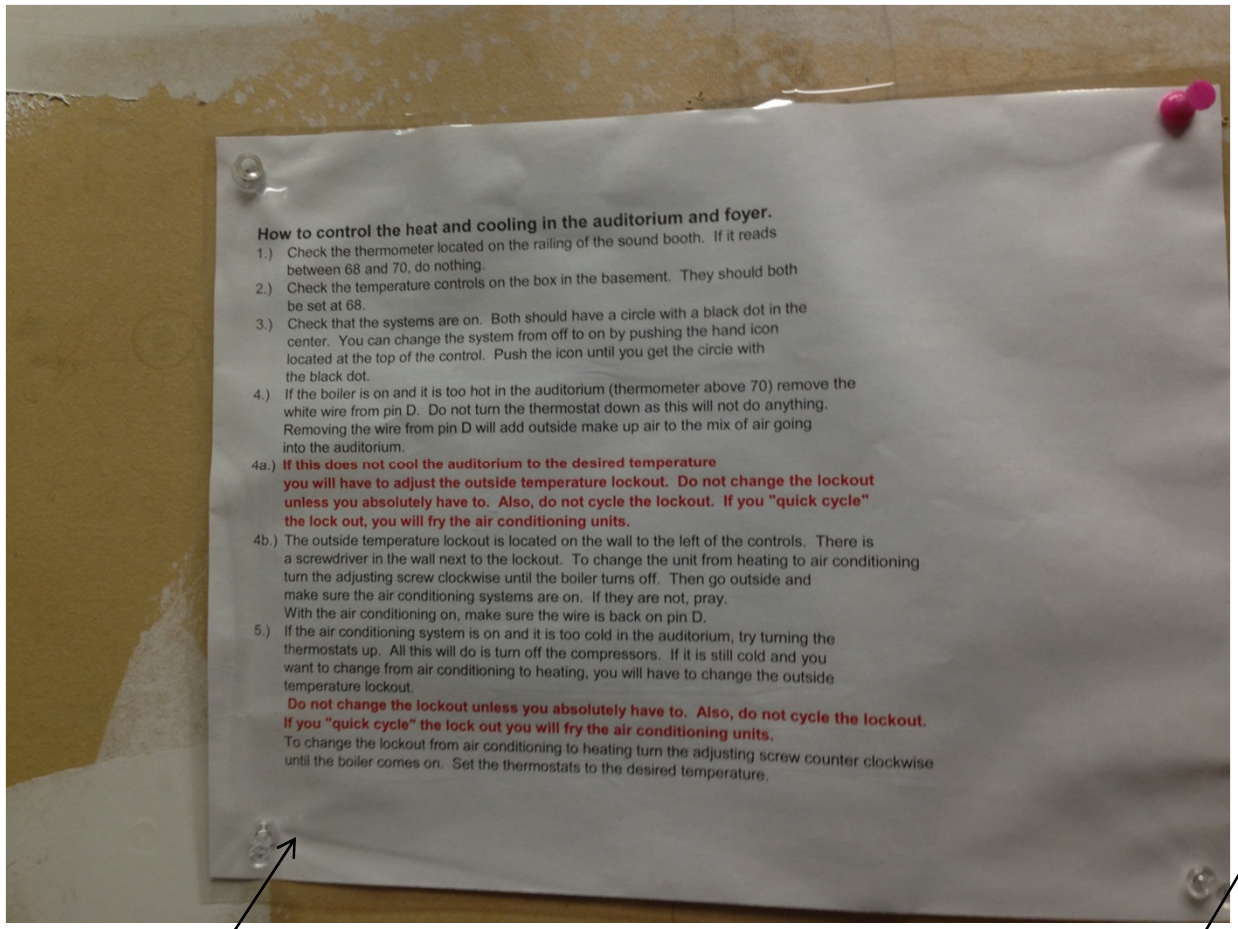
Essex Alliance Church



How to control the heat and cooling in the auditorium and foyer.

1.) Check the thermometer located on the railing of the sound booth. If it reads between 68 and 70, do nothing.

2.) Check the temperature controls on the box in the basement. They should both be set at 68.

3.) Check that the systems are on. Both should have a circle with a black dot in the center. You can change the system from off to on by pushing the hand icon located at the top of the control. Push the icon until you get the circle with the black dot.

4.) If the boiler is on and it is too hot in the auditorium (thermometer above 70) remove the white wire from pin D. Do not turn the thermostat down as this will not do anything. Removing the wire from pin D will add outside make up air to the mix of air going into the auditorium.

4a.) **If this does not cool the auditorium to the desired temperature you will have to adjust the outside temperature lockout. Do not change the lockout unless you absolutely have to. Also, do not cycle the lockout. If you "quick cycle" the lock out, you will fry the air conditioning units.**

4b.) The outside temperature lockout is located on the wall to the left of the controls. There is a screwdriver in the wall next to the lockout. To change the unit from heating to air conditioning turn the adjusting screw clockwise until the boiler turns off. Then go outside and make sure the air conditioning systems are on. If they are not, pray. With the air conditioning on, make sure the wire is back on pin D.

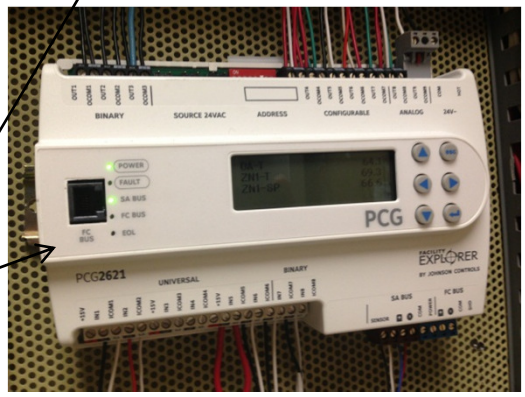
5.) If the air conditioning system is on and it is too cold in the auditorium, try turning the thermostats up. All this will do is turn off the compressors. If it is still cold and you want to change from air conditioning to heating, you will have to change the outside temperature lockout.

Do not change the lockout unless you absolutely have to. Also, do not cycle the lockout. If you "quick cycle" the lock out you will fry the air conditioning units.

To change the lockout from air conditioning to heating turn the adjusting screw counter clockwise until the boiler comes on. Set the thermostats to the desired temperature.

Before

$4,000 /yr
Estimated Savings



After
+ CO_2 Controls

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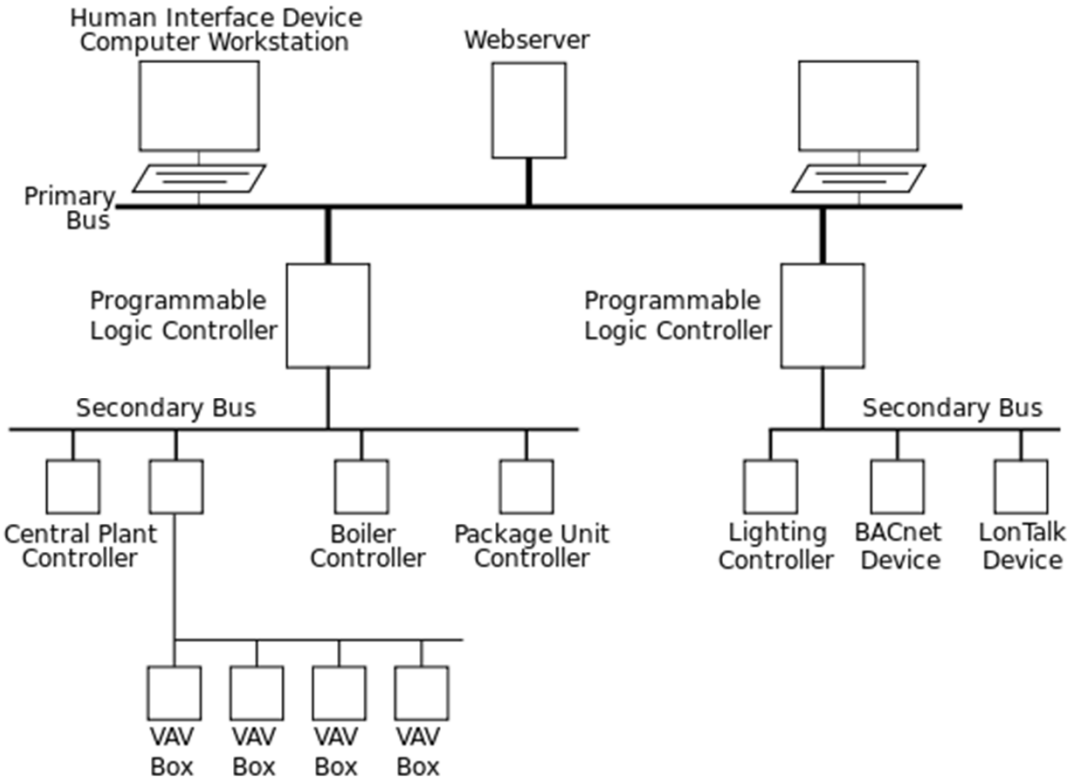
Integrated Controls



- Monitoring and control capabilities from a single point
- Depending on security requirements, may be accessed on the local area network or remotely
- Typically more expensive than stand-alone control
- High energy saving potential

Demand-Limiting at Stowe Middle/High School

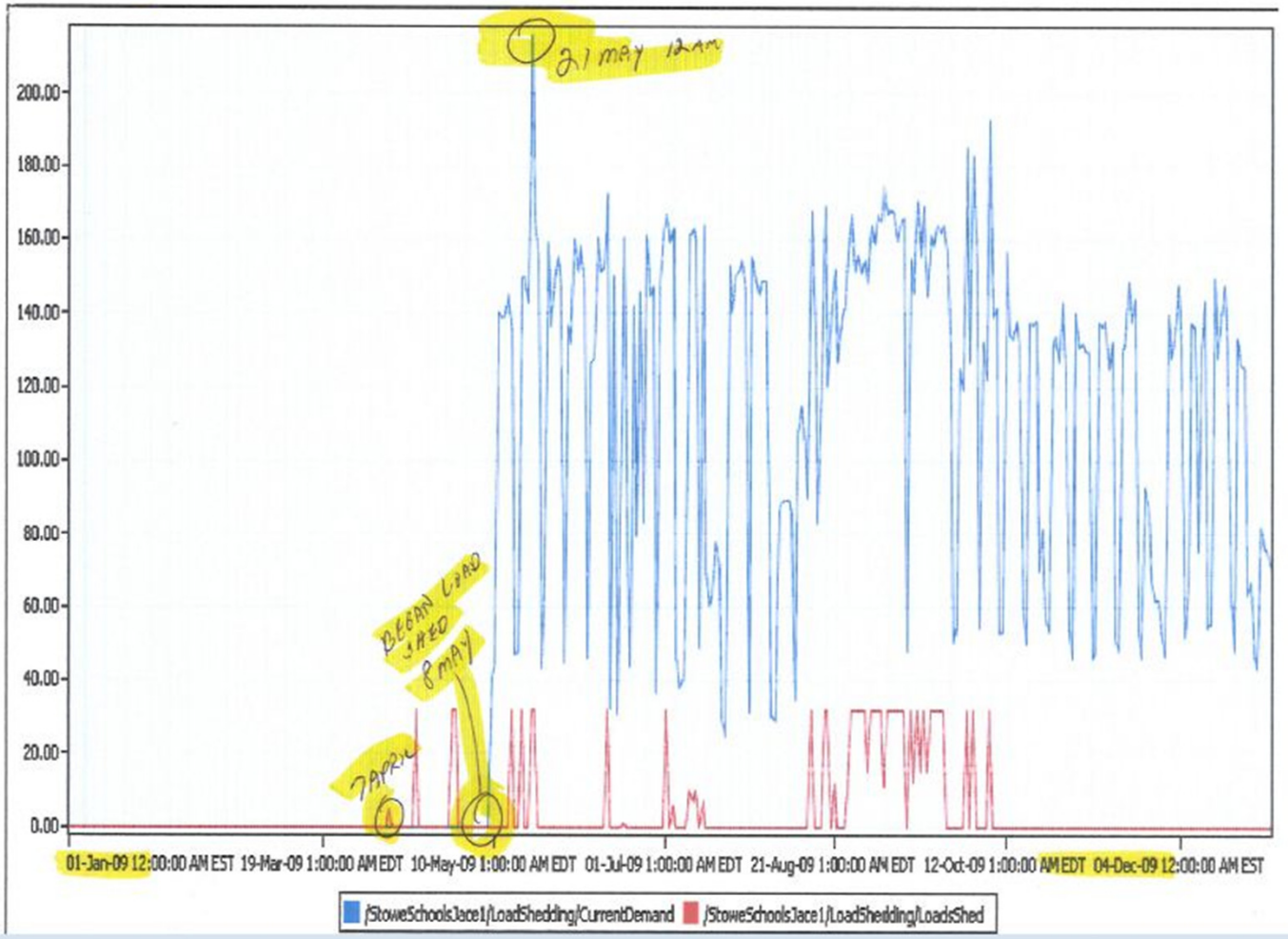


Chart courtesy of Tom Mailhoit, Facility Director, Stowe HSMS

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Don't Forget About the Plug Loads!

- Consider installing computer power management to help control plug load energy consumption
- Choose ENERGY STAR® IT Equipment

BUDDERFLY

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Analytics

Managing the Information & Getting to and Staying at Net Zero

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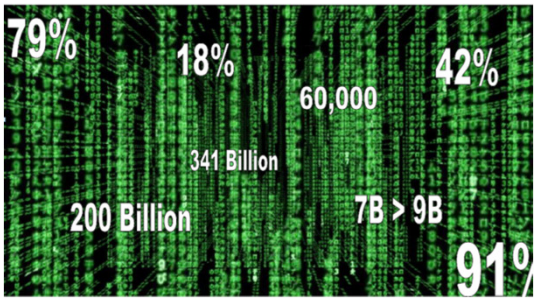
Now you can see it, but how do you manage it to help get to net zero?

Automated Fault Detection Data Analytics has arrived!

Data analytic software is being developed by small and large companies alike to handle high velocity, large volume, varied data



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Automated Fault Detection Data Analytics

SkySpark by SkyFoundry offers alerts to notify facility manager or Owner of energy consumption, equipment alarms, or energy savings.

Local vendors include Control Technologies & Temperature Controls of Vermont.

Coppertree Analytics is commonly used in Canada. Vendors include Delta Controls.

COPPERTREE ANALYTICS

OPOWER

pulse energy

Retroficiency and **Energy Ai** data analytics with reports are actively being investigated currently by Efficiency Vermont for possible benefits for Vermont customers.

FIRSTFUEL BUILDING ENERGY ANALYTICS

Retroficiency

Efficiency Vermont

Data Analytics - Brattleboro Union High School

SkySpark by SkyFoundry

Site Spark

Targets | Apr-2013

All | Brattleboro UHS

Group	Rules	dur	energy	Timelines	Targets
Brattleboro UHS Annex Building Loop 2 sparks	Pump Savings (VFD)	23.53hr	53.911 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	
Brattleboro UHS Heat Exchanger 1 81 sparks	Pump Savings (Constant Speed)	653.15hr	1,529 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	
Brattleboro UHS Heat Exchanger 2 172 sparks	Pump Savings (Constant Speed)	1551.93hr	1,480 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	
Brattleboro UHS Heat Exchanger 3 67 sparks	Pump Savings (Constant Speed)	629.61hr	971.467 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	
Brattleboro UHS Heat Exchanger 4 28 sparks	Pump Savings (Constant Speed)	211.51hr	245.022 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	
Brattleboro UHS Heat Exchanger 5 40 sparks	Pump Savings (Constant Speed)	441.72hr	723.065 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	
Brattleboro UHS Heat Exchanger 7 29 sparks	Pump Savings (Constant Speed)	317.72hr	247.822 kWh	1st 3rd 5th 7th 9th 11th 13th 15th 17th 19th 21st 23rd 25th 27th 29th	

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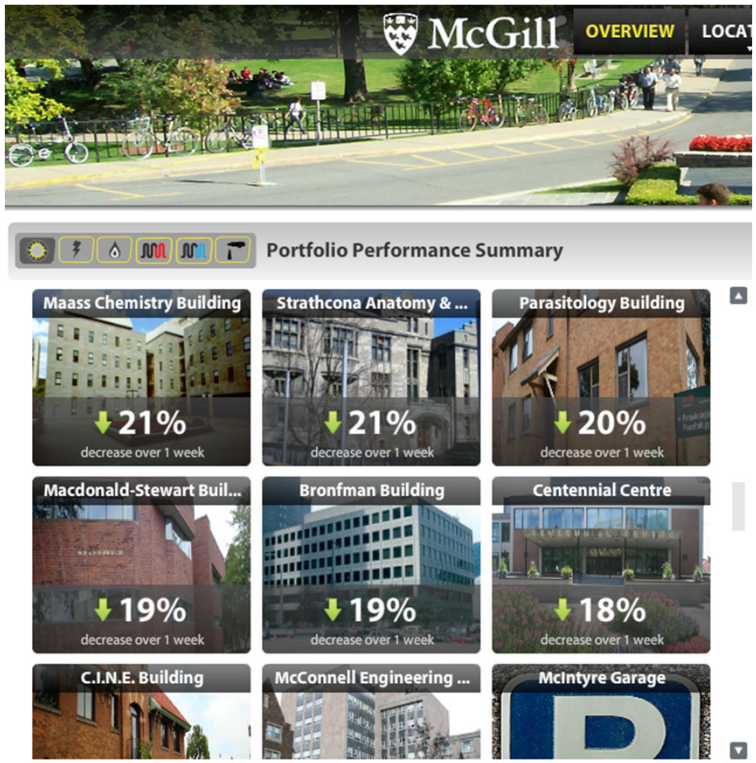
Newest Energy Dashboards

Public Energy Dashboard



+

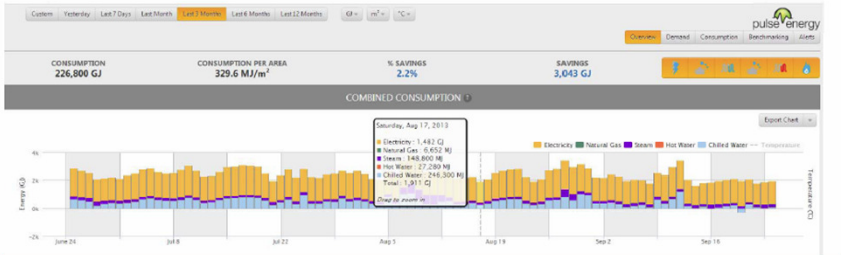
Energy Management Module w/ Automated Fault Detection Data Analytics Software

McGill

the project

Software

- **Collect and organize data**
- **Plot energy demand in real time** against external factors T_{out}, RH_{out}, wind speed and direction, net solar radiation
- **Generate reports** to follow trends in long-term energy use
- **Train "typical curves"** to benchmark buildings against themselves and detect anomalies
- **Engage building occupants**



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Energy Management Service Providers

Vermont Public Radio

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Vermont Public Radio

- Radio station in Colchester, Vermont
- 14,000 square foot with mix of one and two stories
- Late 19th century building renovated ~1993
- Stand alone controls
- Existing HVAC System:
  - DX cooled split systems
  - Air handlers
  - Natural gas-fired boiler
  - Propane-fired furnaces

VPR Challenges

- Extremely uncomfortable for staff in some areas
- High HVAC energy costs
- High maintenance costs
- Early HVAC equipment failure

VPR First Step

Vermont Public Radio hired a local energy management company, to help them with a solution.

They specified reconfiguration of the control structure to allow for energy and environment optimization.

Wireless controls one part of the hardware component specified to meet control plan.

Project Scope

1. Capability for auto start/stop of boiler & pumps from multiple HVAC control modules
2. Auto start/stop air handlers
3. Integrated control of studios from one command module
4. Integrated control of air handlers & their heating coils, perimeter heat loops, separate cooling coil and multiple location temperature sensing.

VPR Results

- Building comfort improved and complaints stopped
- No unscheduled maintenance on HVAC equipment was necessary between July 2011 and April 2012
- 16% drop in electric energy consumption
- 29% drop in natural gas consumption
- 27% drop in propane consumption
- Incentives provided by Efficiency Vermont

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What does a Poem and Controls have in common?

VAV Control Sequence & Schedule

VAV shall maintain room temperature at

- 72+/- 2.5F during occupied times Min. Occupied CFM 1,000
- During unoccupied times, the airflow shall be reduced to 100 cfm. Heat only at temperatures below 65F and cool only at temperatures above 78F.

Device	Design cfm	Min. cfm	Temp spec
VAV-1	1,200	1,000	72+/-2.5F

Controls have Energy to Save
All complex and expensive things

Understand them
And you'll find they're worth
The cost

"Taking Control to get to Net Zero"
Part II

I. Energy Savings Initiative (ESI)

II. Data Analytics

III. Advance Energy Design Guide

IV. Case Study: Bond Auto

V. Data Center, The Energy Valve, Hybrid Boiler Controls (Time Permitting)

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Central Vermont Medical Center

CONTROL TECHNOLOGIES
DEFINING BUILDING PERFORMANCE

Efficiency Vermont

Liebert Engineering Incorporated

The ESI Team

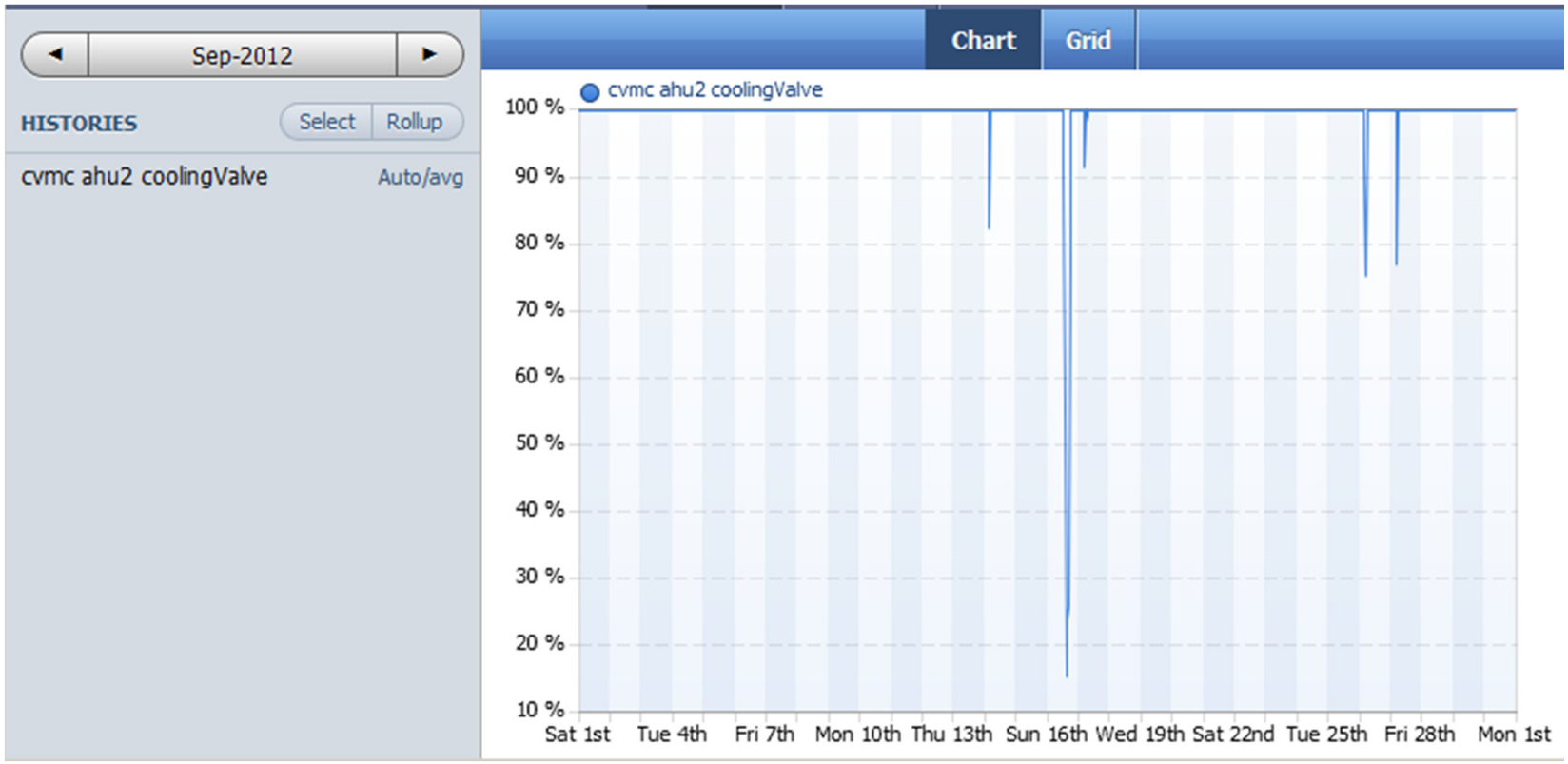
Delivered!
Reducing energy consumption by over 18% and Improving the Energy Star Score by 30 points

Control Measures Implemented by ESI

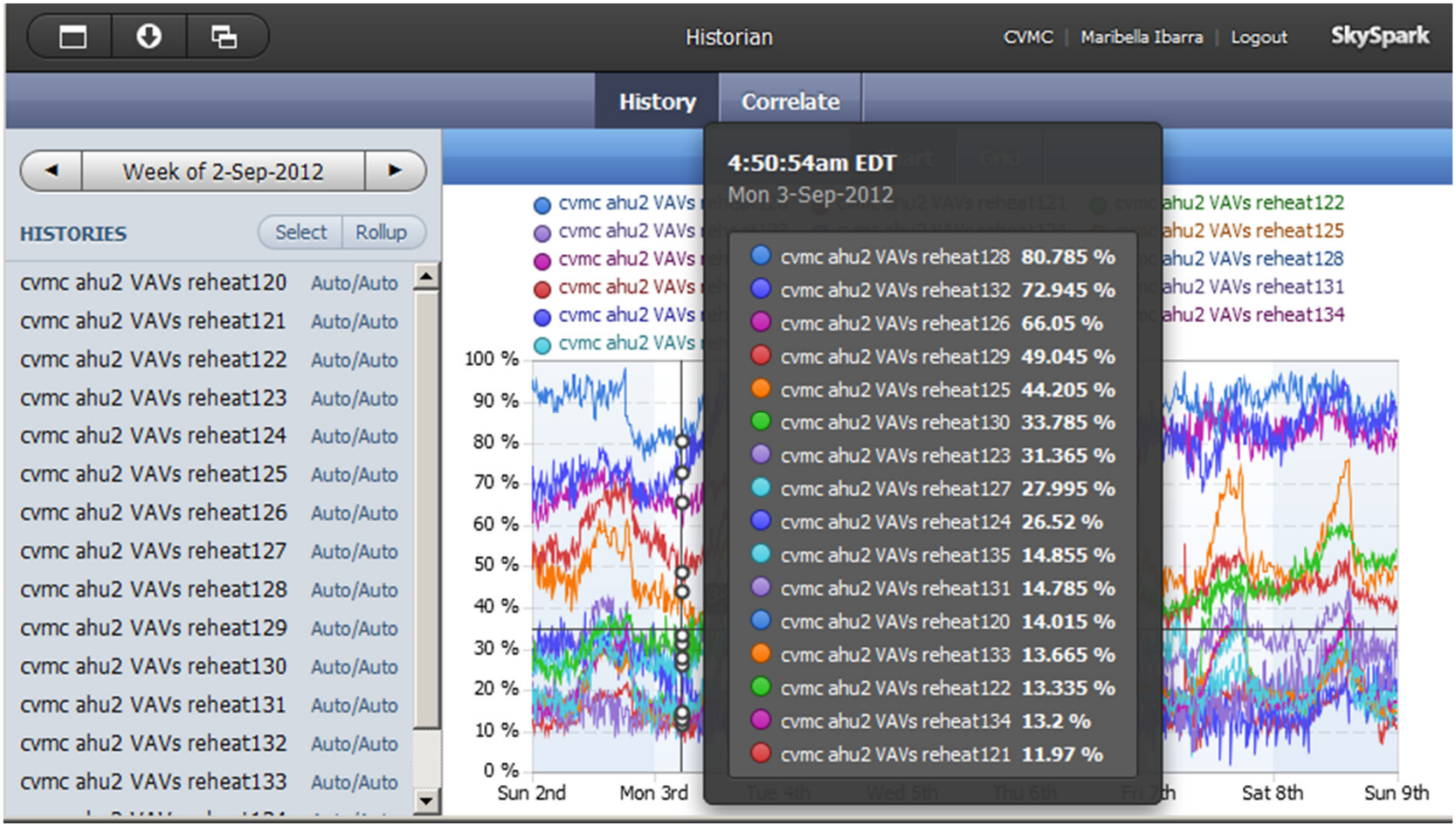
- Replaced faulty sensors
- Occupancy Controls
- Calibration and scheduling of VAV boxes
- Min O/A reduction (meeting ASHRAE Ventilation requirements)
- Demand Control Ventilation in Cafeteria and select conference rooms
- Replacement of VFD (existing VFD near EOL)
- Static Pressure Reset and Supply Air Reset
- Dual Enthalpy Economizers
- Changed Dew Point Spec (One unit)
- What is the next Step? Continuous Energy Improvement

Efficiency Vermont

>8% control energy savings; Payback <2 years

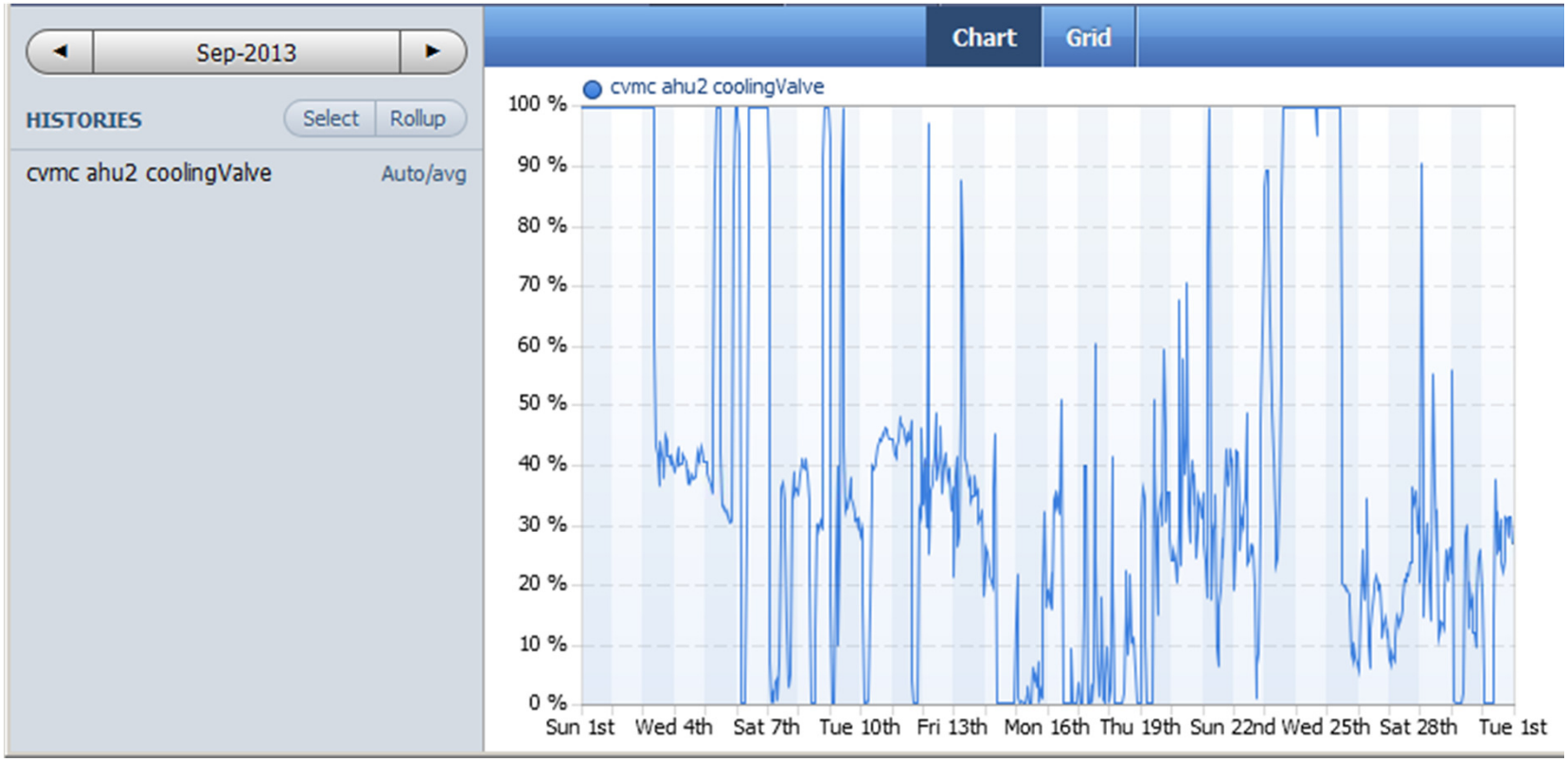

Sep-2012
HISTORIES
Select
Rollup
cvmc ahu2 coolingValve
Auto/avg
Chart
Grid
cvmc ahu2 coolingValve
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
Sat 1st
Tue 4th
Fri 7th
Mon 10th
Thu 13th
Sun 16th
Wed 19th
Sat 22nd
Tue 25th
Fri 28th
Mon 1st

Is the room calling for cooling?



Efficiency Vermont

After sequence change 2013



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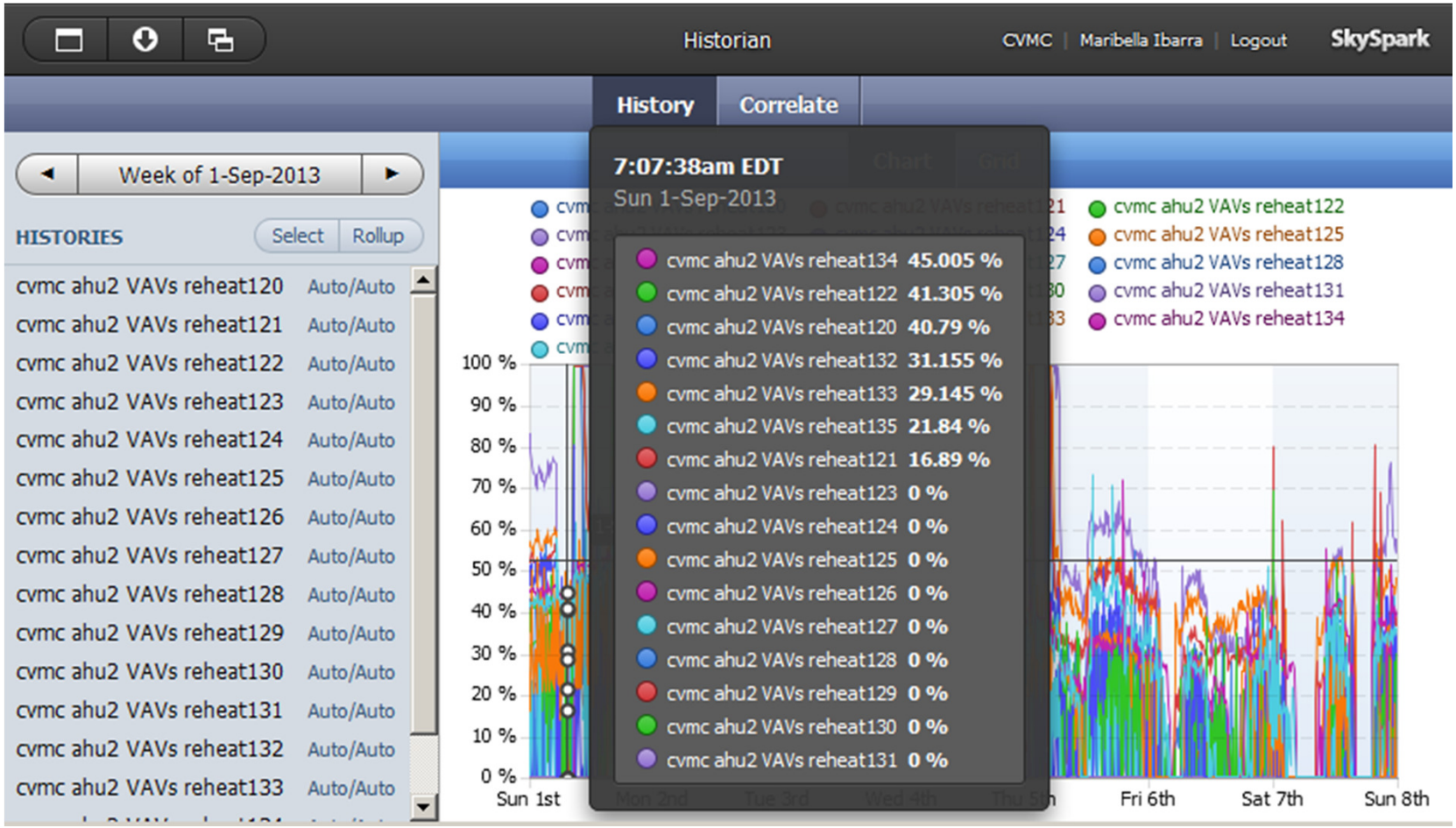
Historian
CVMC | Maribella Ibarra | Logout
SkySpark
History
Correlate
Week of 1-Sep-2013
HISTORIES
Select
Rollup
cvmc ahu2 VAVs reheat120 Auto/Auto
cvmc ahu2 VAVs reheat121 Auto/Auto
cvmc ahu2 VAVs reheat122 Auto/Auto
cvmc ahu2 VAVs reheat123 Auto/Auto
cvmc ahu2 VAVs reheat124 Auto/Auto
cvmc ahu2 VAVs reheat125 Auto/Auto
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cvmc ahu2 VAVs reheat131 Auto/Auto
cvmc ahu2 VAVs reheat132 Auto/Auto
cvmc ahu2 VAVs reheat133 Auto/Auto
7:07:38am EDT
Sun 1-Sep-2013
cvmc ahu2 VAVs reheat134 45.005 %
cvmc ahu2 VAVs reheat122 41.305 %
cvmc ahu2 VAVs reheat120 40.79 %
cvmc ahu2 VAVs reheat132 31.155 %
cvmc ahu2 VAVs reheat133 29.145 %
cvmc ahu2 VAVs reheat135 21.84 %
cvmc ahu2 VAVs reheat121 16.89 %
cvmc ahu2 VAVs reheat123 0 %
cvmc ahu2 VAVs reheat124 0 %
cvmc ahu2 VAVs reheat125 0 %
cvmc ahu2 VAVs reheat126 0 %
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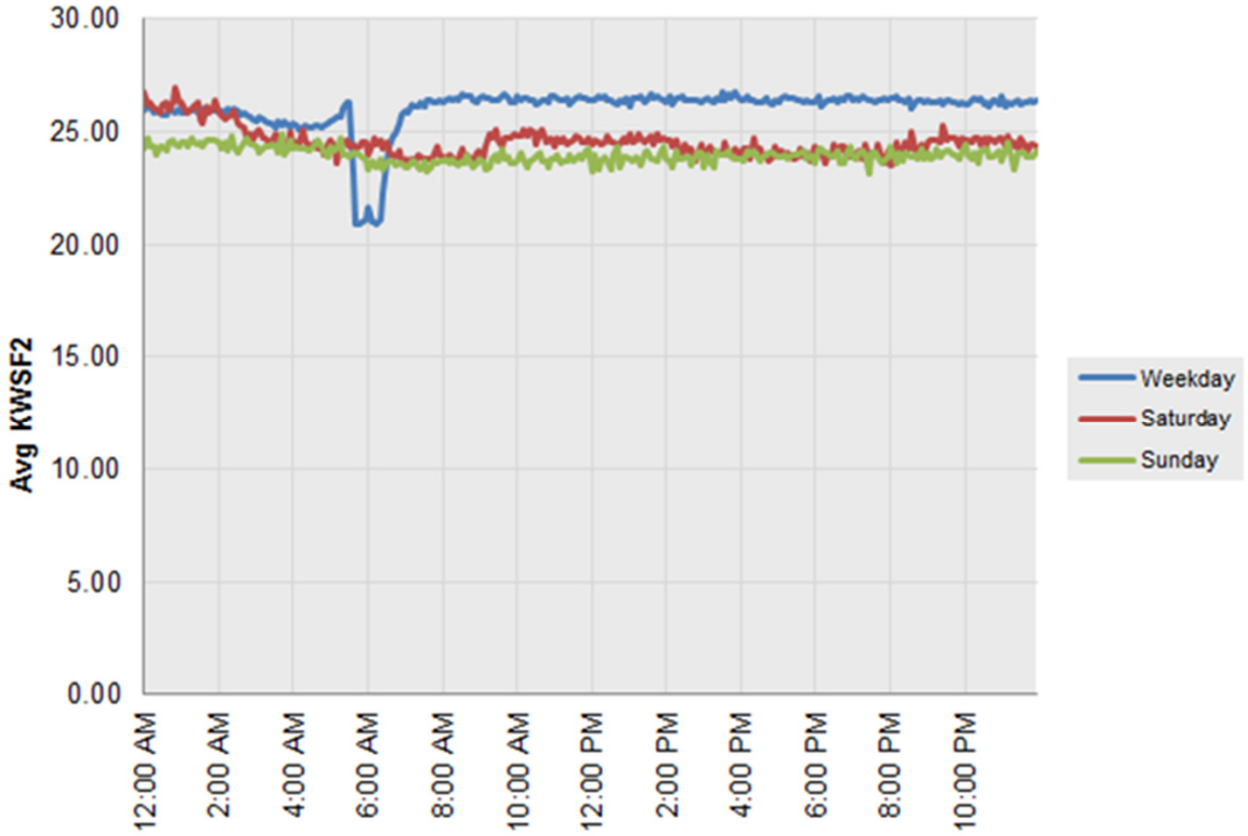
cvmc ahu2 VAVs reheat128
cvmc ahu2 VAVs reheat131
cvmc ahu2 VAVs reheat134
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
Sun 1st
Fri 6th
Sat 7th
Sun 8th

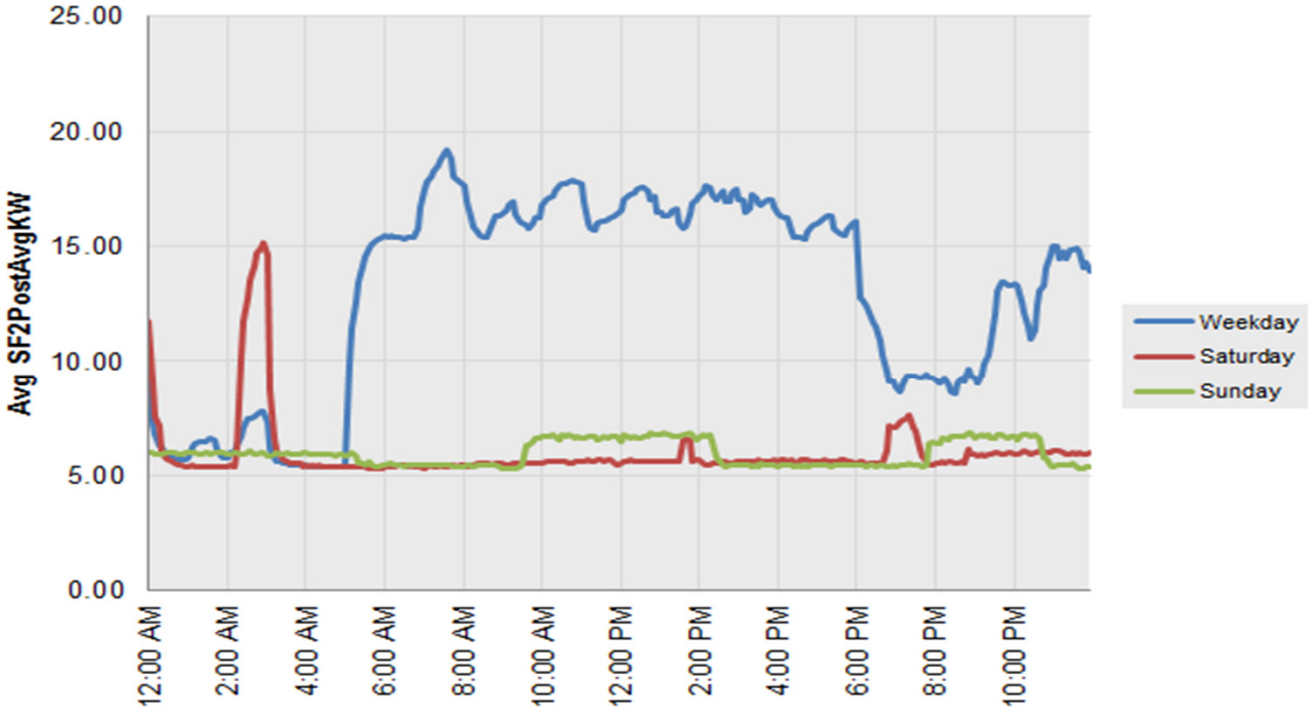
Efficiency Vermont

Pre- Occupancy Control

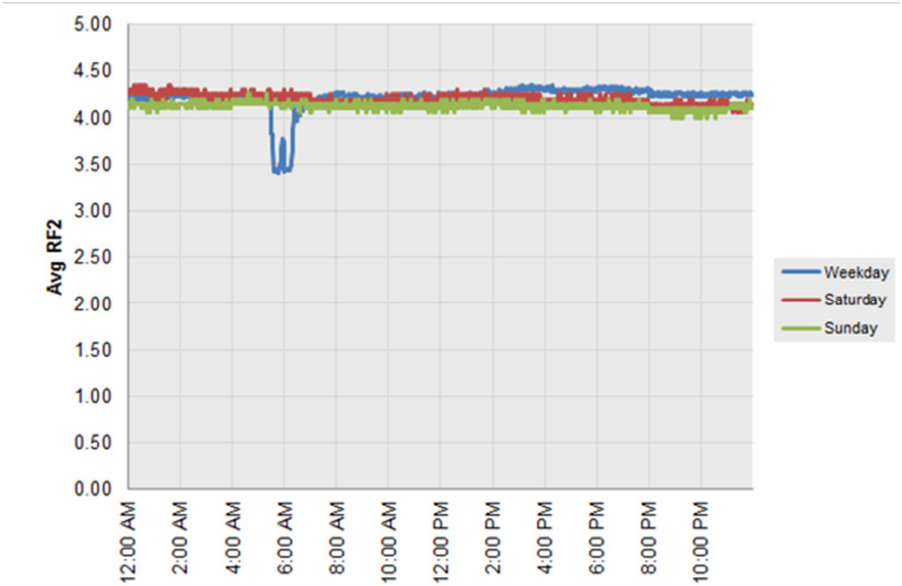


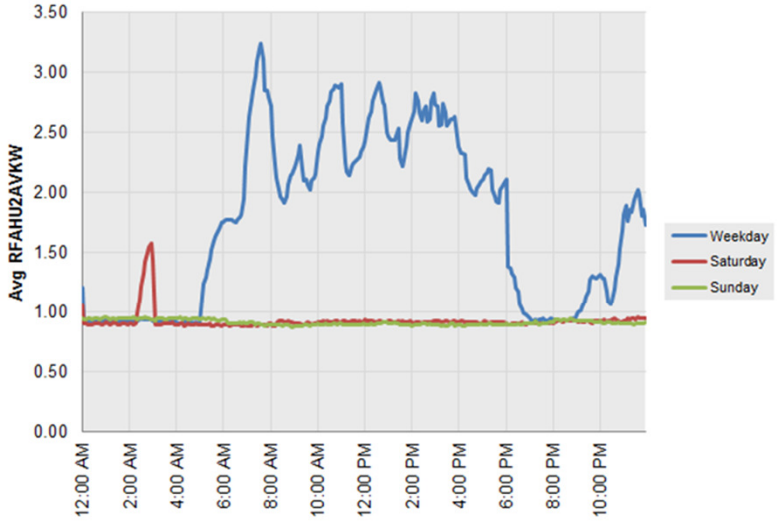
Efficiency Vermont

Post- Occupancy Controls



Return Fan Pre and Post





Return Fan Amps (Post)

VAV Calibration and Scheduling SF4&2 (M&V)

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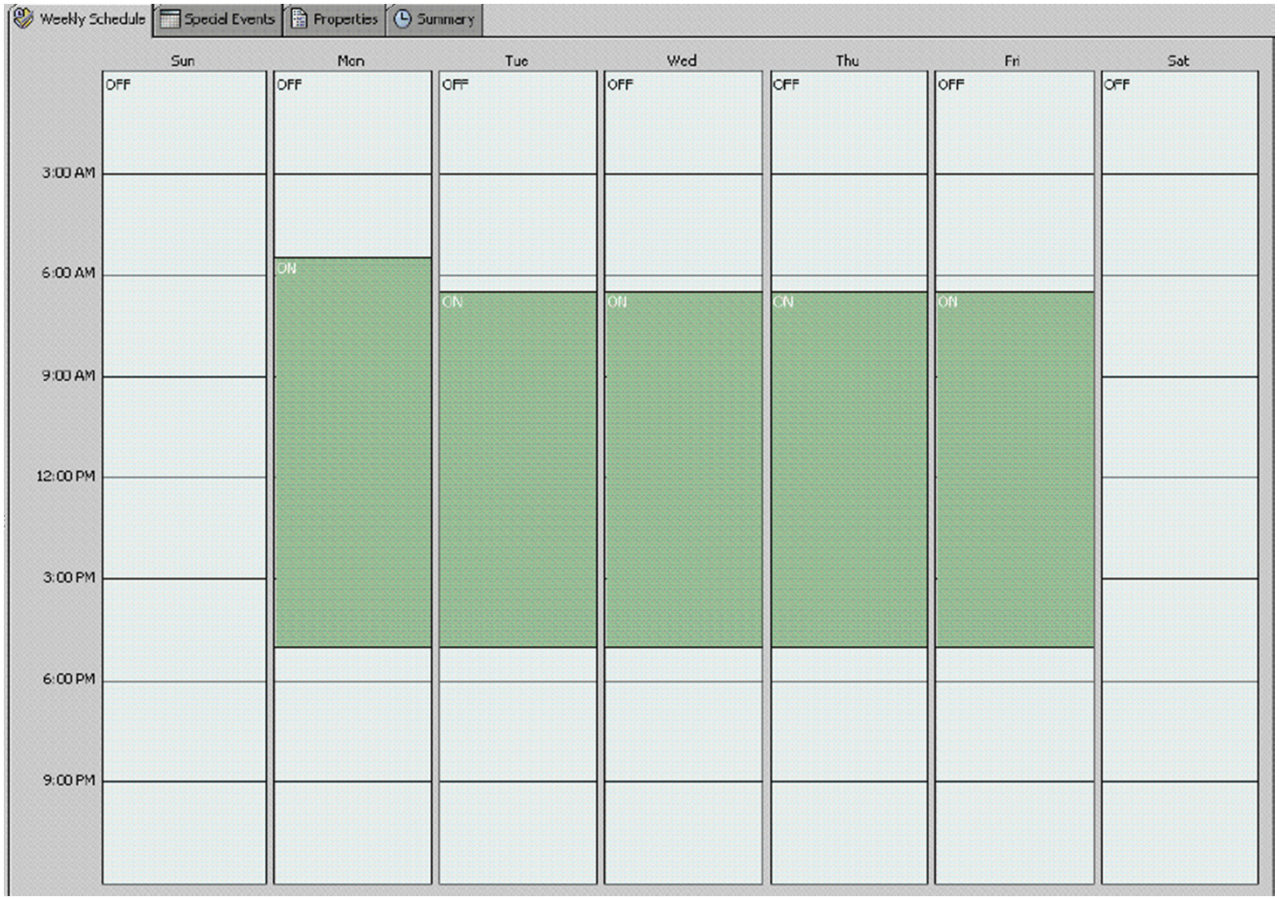
Office AHU Schedule (example)



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Vermont has great weather for economizers

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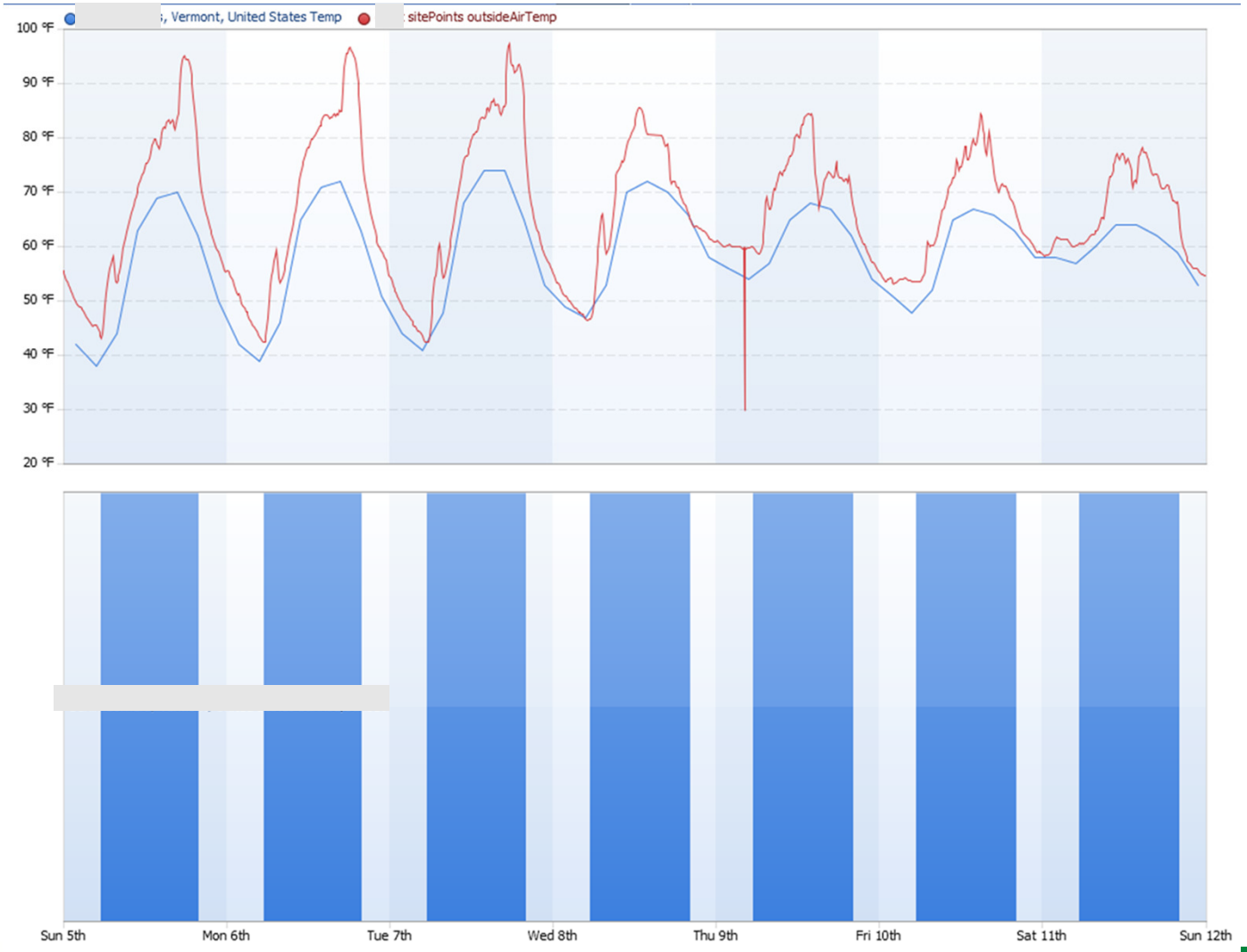
Sensor Accuracy



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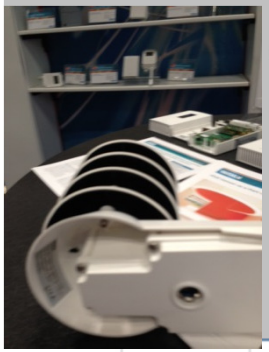
Get an accurate o/a weather station

Basement 1st Floor 2nd Floor 3rd Floor Penthouse Facilities Equipment Misc. Sites Utilities

[redacted] WEATHER STATION

OA DRY BULB	53.8
OA WET BULB	50.0 °F
OA HUMIDITY	77 %RH
OA ENTHALPY	20.26 btu/lb
OA DEWPOINT	47 °F
OA DRY BULB SP	-5.00 °F

TODAY'S HIGH TEMP	55 °F
TIME OF HIGH TEMP	
YESTERDAY'S HIGH TEMP	
TIME OF HIGH TEMP	
SEASONAL CLG. DEG. DAYS	CDD
TODAY'S LOW TEMP	50 °F
TIME OF LOW TEMP	
YESTERDAY'S LOW TEMP	
TIME OF LOW TEMP	
SEASONAL HTG. DEG. DAYS	HDD



AHUs S21 and S22 OA DAMPERS AT MINIMUM POSITION
OR OA TEMP IS BELOW SETPOINT

Off
AHU S21 AND S22
SET BACK TIMER
CLICK ON DATA BOX
AND PERFORM OVERRIDE

Current Conditions

Share

Overcast
53°F
12°C

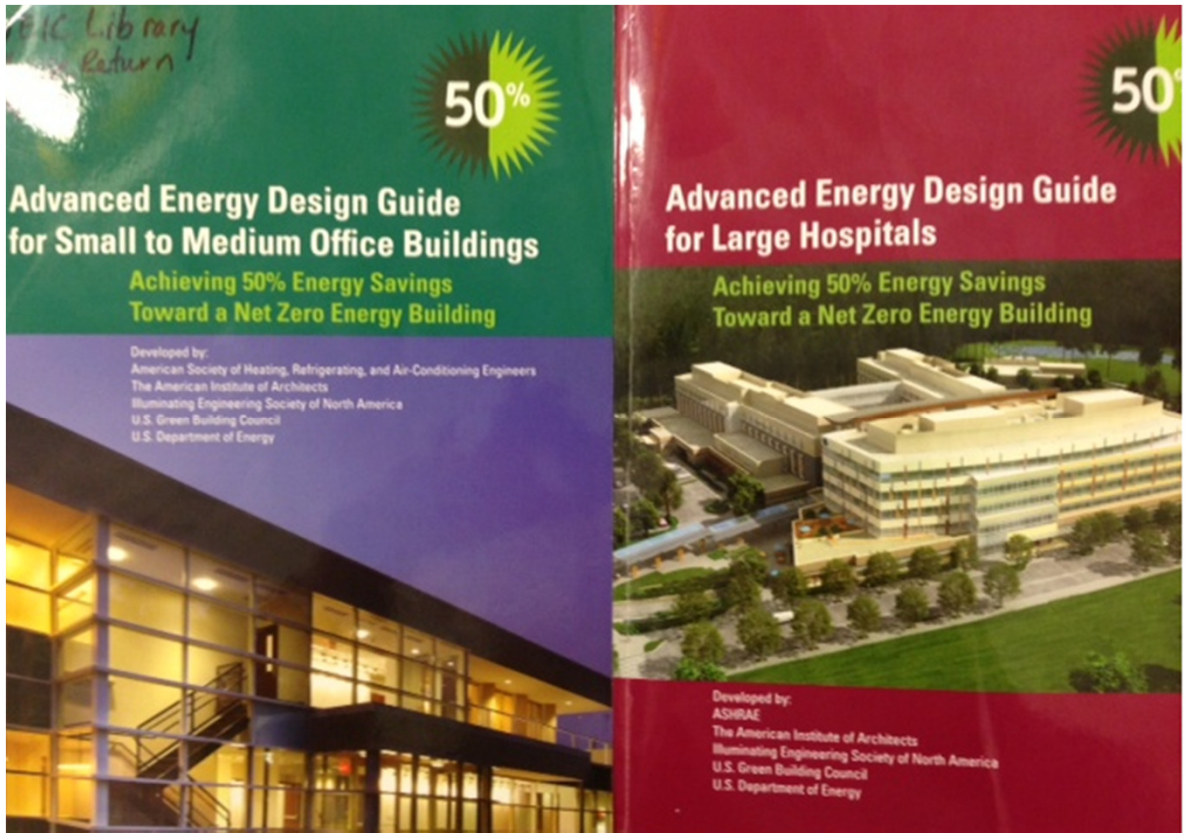
Humidity 80%
Wind Speed W 8 mph
Barometer 30.00 in (1016.4 mb)
Dewpoint 47°F (8°C)
Visibility 10.00 mi
Wind Chill 50°F (10°C)
Last Update on 14 Sep 11:51 am EDT

Current conditions at [redacted]
Lat: 44.21 Lon: -72.57 Elev: 1126ft.

More Local Wx | 3 Day History | Mobile Weather

Efficiency Vermont

Toward Net Zero
What should I do?



Free download: https://www.ashrae.org/standards-research--technology/advanced-energy-design-guides

Not in the Picture: Advance Design Guide for K-12, Advance Design Guide for Retail

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Advanced Energy Design Guide

- Recommendations to Achieve 50% savings from ASHRAE 2004. Free download from ASHRAE's website
  - Lighting
  - HVAC and Service Water
  - Envelope
  - Plug Loads

Advanced Energy Design Guide

- Example: kbtu Target to achieve 50% savings for Climate Zone 6A Hospital

  -125 kbtu/sqft. Year

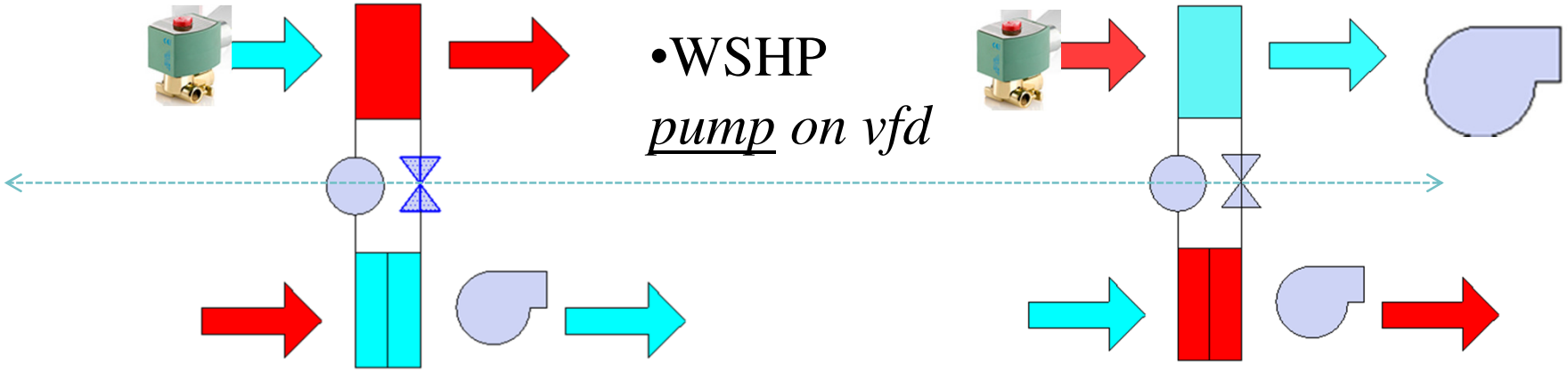
  -Plug/process 38 kbtu/sqft.

  -Lighting 18 kbtu/sqft.

  -HVAC 69 kbtu/sqft.

AEDG Water Source Heat Pump HV-4

reset loop temperature



•WSHP

pump on vfd

EER 17.6/15.0

Lower wT, Higher EER, Higher efficiency

COP 5.7/5.0

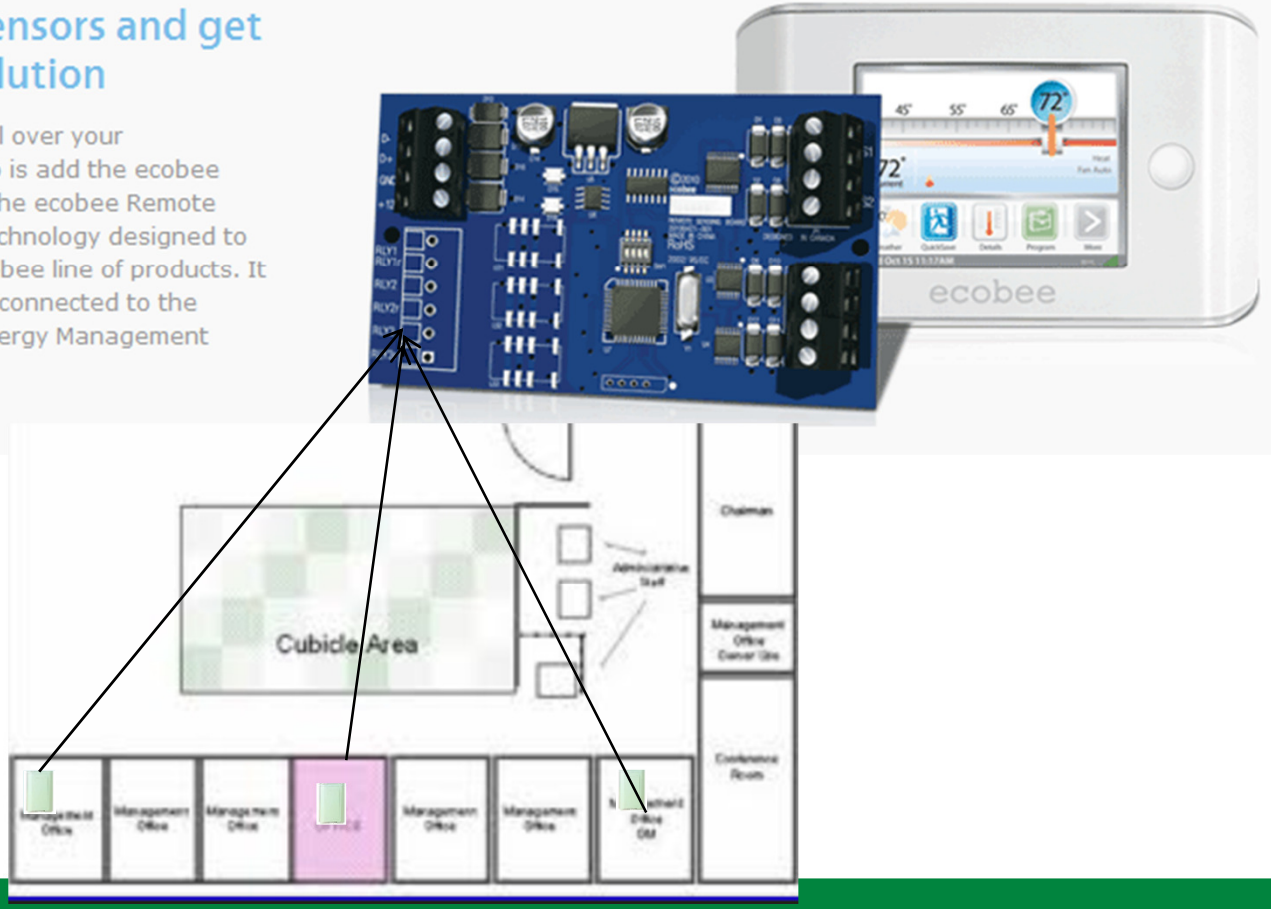
Higher wT, Higher COP, Higher Efficiency

WSHP unit should incorporate a solenoid valve to shut off flow of circulating loop water when the compressors are off.

A "newer" way for small commercial, retail, and institutional

Attach additional sensors and get more out of your Solution

Want to have even more control over your environment? All you have to do is add the ecobee Remote Sensor Module (RSM). The ecobee Remote Sensor Module is the newest technology designed to support the award- winning ecobee line of products. It allows additional sensors to be connected to the ecobee Smart Thermostat or Energy Management System.



With Averaging Capability

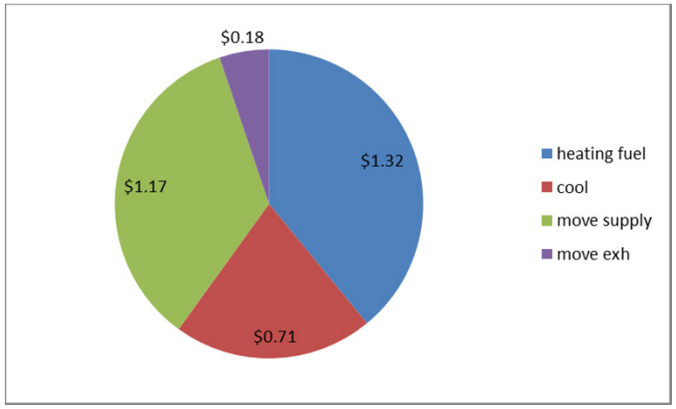
Efficiency Vermont

Supply Air Reset

- **Supply air reset**
- **50F-58F AEDG Office CLZ 1,2,3**
- **50 - 61F on other climate zones**
  - Disable reset if the space exceeds 60%

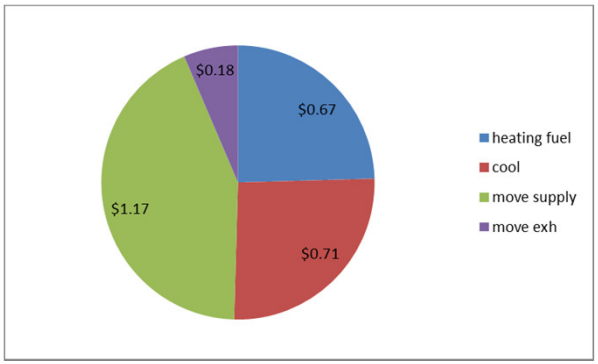
O/A is not always "free"
Est. Cost of o/a (24x7)

About $3.38/CFM a year



BTU/unit of fuel	138000
Cost of fuel	$3.26
cost of electric	$0.14

About $2.73/CFM a year



BTU/unit of fuel	100000	BTU/therm
Cost of fuel	$1.20	
cost of electric	$0.14	

Space at 35% rh winter; 55DP summer; using tmy3 weather 8760; heating when To/a <40F

TMY3= Typical Meteorological Year

(and About $1.20 for ng + electric if 12hr/day 5 days a week using HDMakeup Handsdown software company)

Efficiency Vermont

AEDG Office HV19- Exhaust Air Systems

- **"Central exhaust systems for restrooms, janitorial closets, and break rooms should be interlocked to operate with air conditioning systems" "During unoccupied period the system should remain off"**

Delivery of Outdoor Air to The Space

ASHRAE 62.2007

Example:

Conference room O/A rate **5 cfm/person + .06 cfm/sqft ;**

Occupancy 50 people/1000 sqft

(1000 *.06 + 50*5)= 310 cfm Vbz (Breathing Zone)

Plus adjustments for the effectiveness of air delivery

Areas that could be good candidates for DCV

- Area >500sqft
- And occupancy >40 people/1000 sqft

Check areas that meet DCV requirements

"Dynamic Reset of Outdoor Air" Reference: ASHRAE 62.1-2007 6.2.7

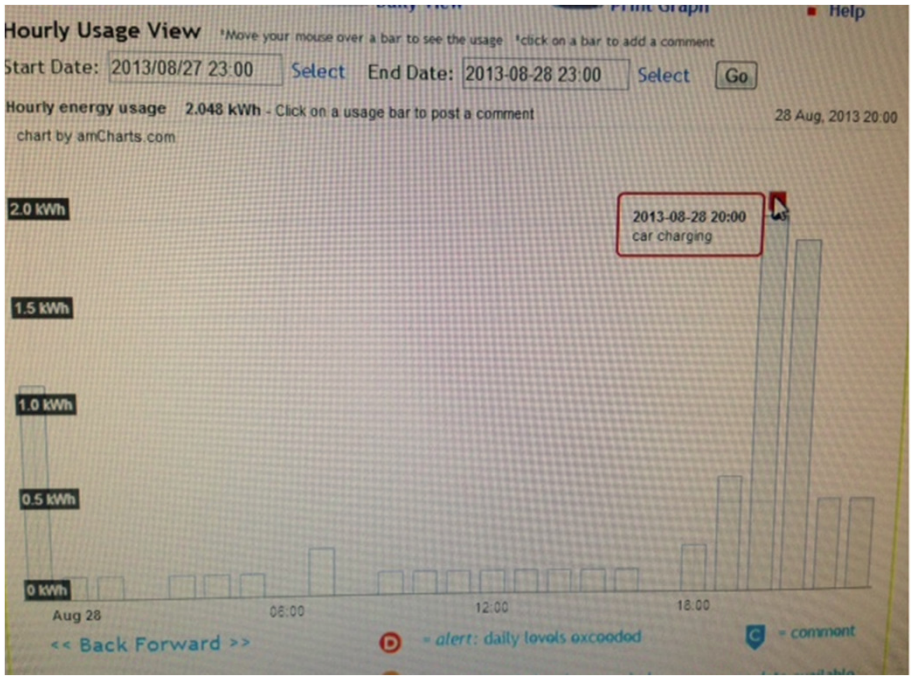
1. **Variations in Occupancy**
   - Occupancy scheduled by time of day
   - Occupancy sensors
   - Estimate of occupancy using CO2
2. **Variation in the efficiency of the delivery of air into space**
3. **"A higher fraction of o/a in the supply due to intake of additional outdoor air for free cooling or exhaust makeup"**

CO2 Sensors

- AEDG: accuracy of +/- 50 PPM at 1,000 ppm
- ASHRAE 189.1- 2011 – install 3-6 ft. above floor.
- Ca. Title 24 specifies a sensor that requires calibration no more frequently than once every 5 years.
- Ca. Title 24 also requires a calibration certificate with sensor.
- MI Recommendation- Field test for accuracy

Why Energy Monitoring?

Saving
$90/month



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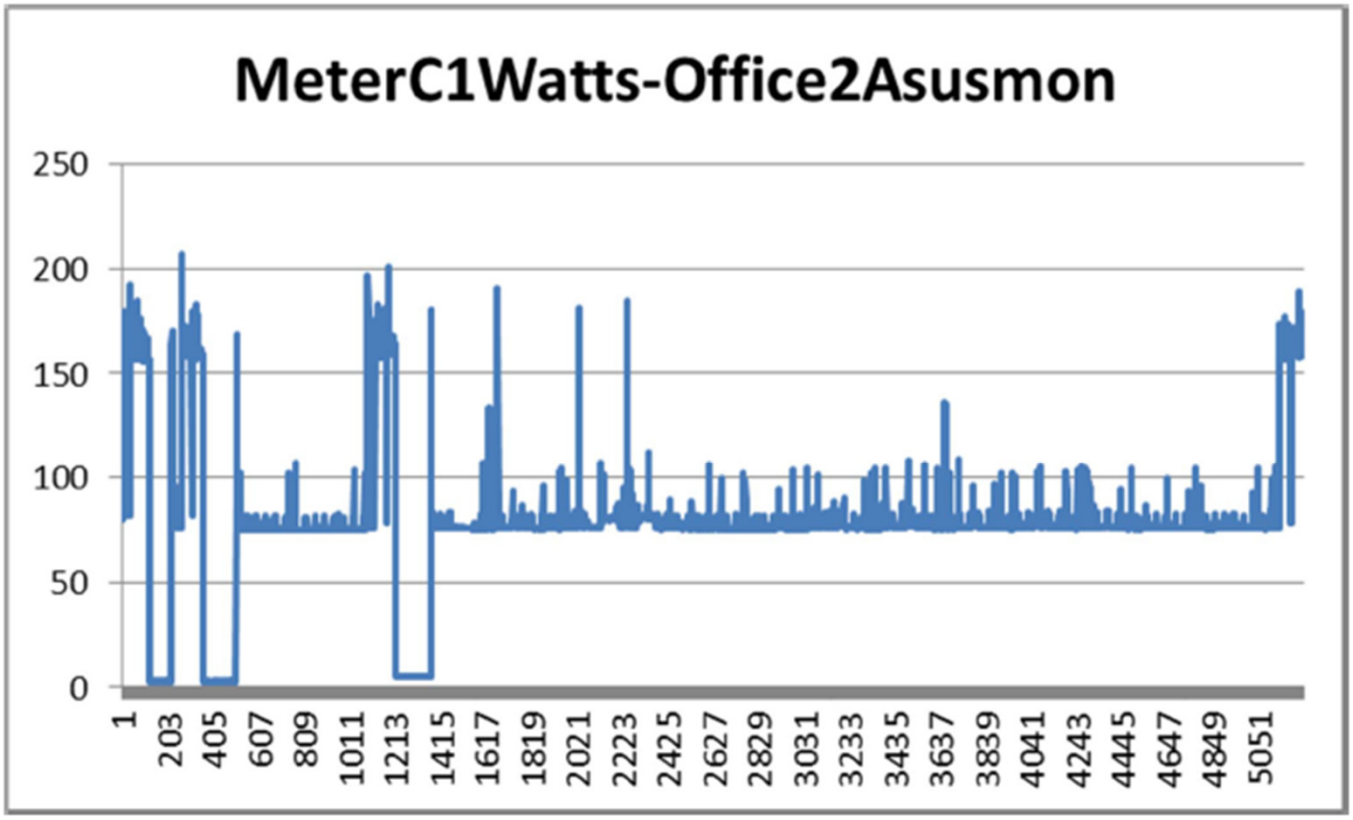
Metering plug load

Watts up? PRO

Computer Metering Example



Office 313J

Efficiency Vermont

Employee was on vacation part of the time

eGauge and ECAM

Re-tuning Commercial Buildings

Re-tuning Commercial Buildings Resources

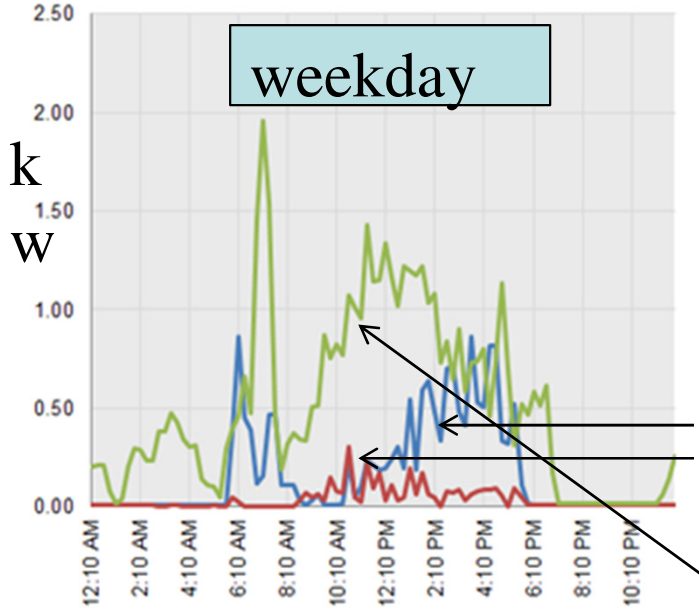
Researchers at the Pacific Northwest National Laboratory (PNNL) have developed a number of useful resources to help re-tune commercial buildings:

Energy Charting and Metrics Tool plus Building Re-tuning and Measurement and Verification (ECAM+)

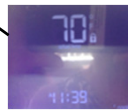
Note that the Microsoft Excel™ file is an Excel add-on file, please refer to the user guide for instructions on how to use it.

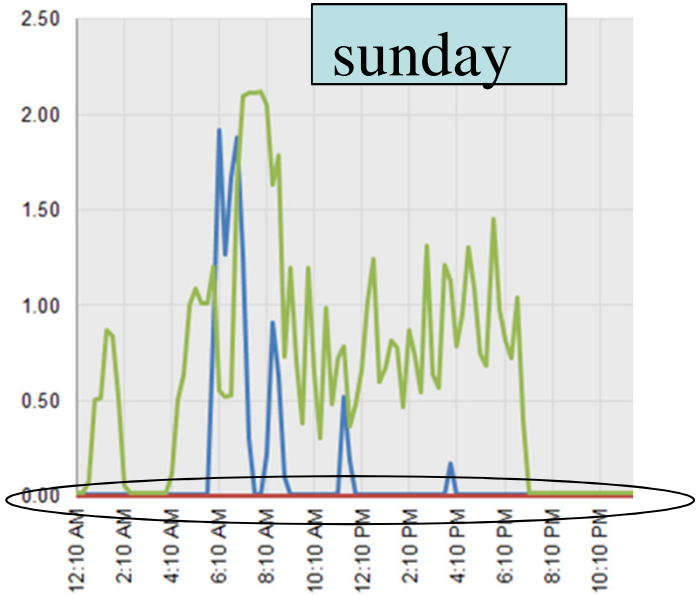
The Energy Charting and Metrics Tool is an add-on for Microsoft Excel® which was developed to facilitate analysis of data from building (energy and other data). The tool makes extensive use of Excel pivot tables. Some key features of ECAM+ include: creation of charts to help re-tuning, creation of schedules and day-type information to time series data; filtering data from months, years, days, day-type, day of week, day of month, occupancy, temperature binned weather data, pre/post comparisons after retrofits or retro-commissioning; normalizing data and creating metrics based on consumption or equipment; creation of various load profiles or scatter charts for data selected by the user; new additions to the PNNL re-tuning charts; and new modeling and verification (M&V) for meter data.

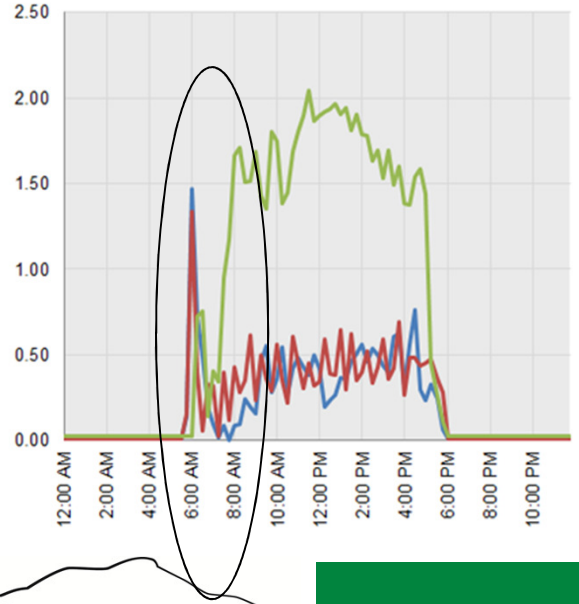
Energy Charting and Metrics Tool (ECAM) Webinar Series Content



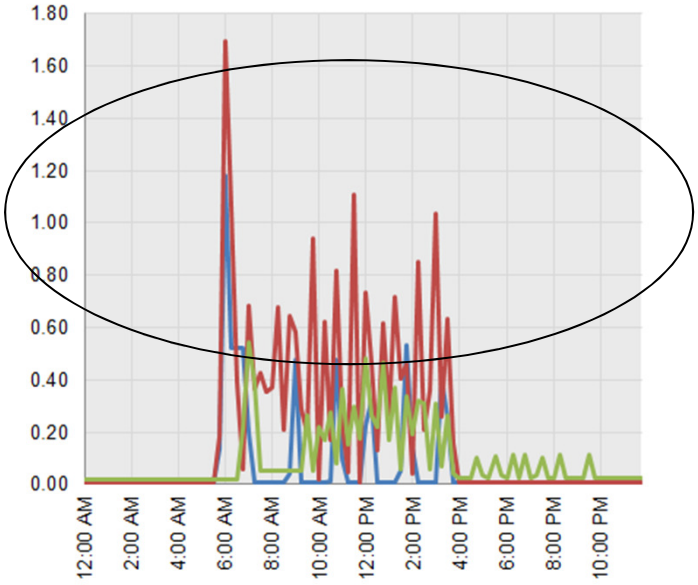
Cooler
11/18
2weeks







Warmer
8/29
2 weeks



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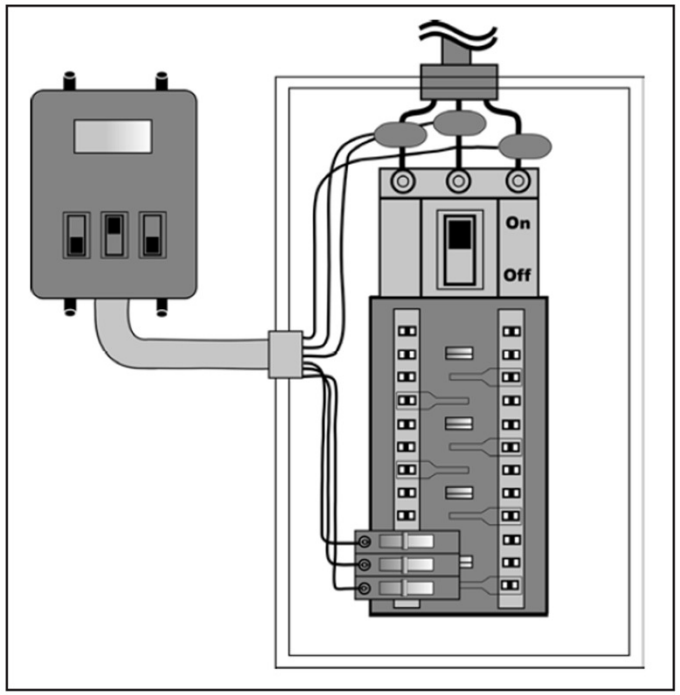
Source: FEMP Fact Sheet "Facility Metering for Improved Operation, Maintenance and Efficiency" (2005)

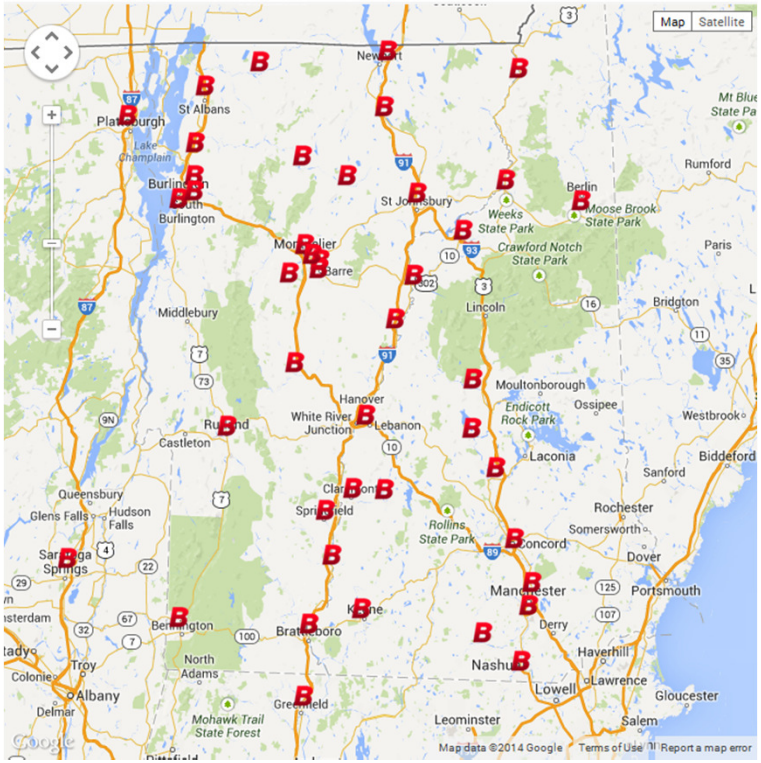


Typical electrical sub-meters (box on left) used in long-term monitoring.

5%-15% Savings

- Cost Allocation Software
- Fine Tuning of Controls
- Monthly Reports

Bond Auto is Taking Control with the help of TRIADD Electric and ENTOUCH Controls



VERMONT

- BARRE
- BARTON
- BELLOWS FALLS
- BENNINGTON
- BERLIN
- BETHEL
- BRADFORD
- BRATTLEBORO
- DERBY
- ENOSBURG FALLS
- ESSEX JCT.
- HARDWICK
- MILTON
- MONTPELIER
- MORRISVILLE
- NORTHFIELD
- RUTLAND
- SO. BARRE
- SOUTH BURLINGTON
- SPRINGFIELD
- ST. ALBANS
- ST. JOHNSBURY
- WILLISTON

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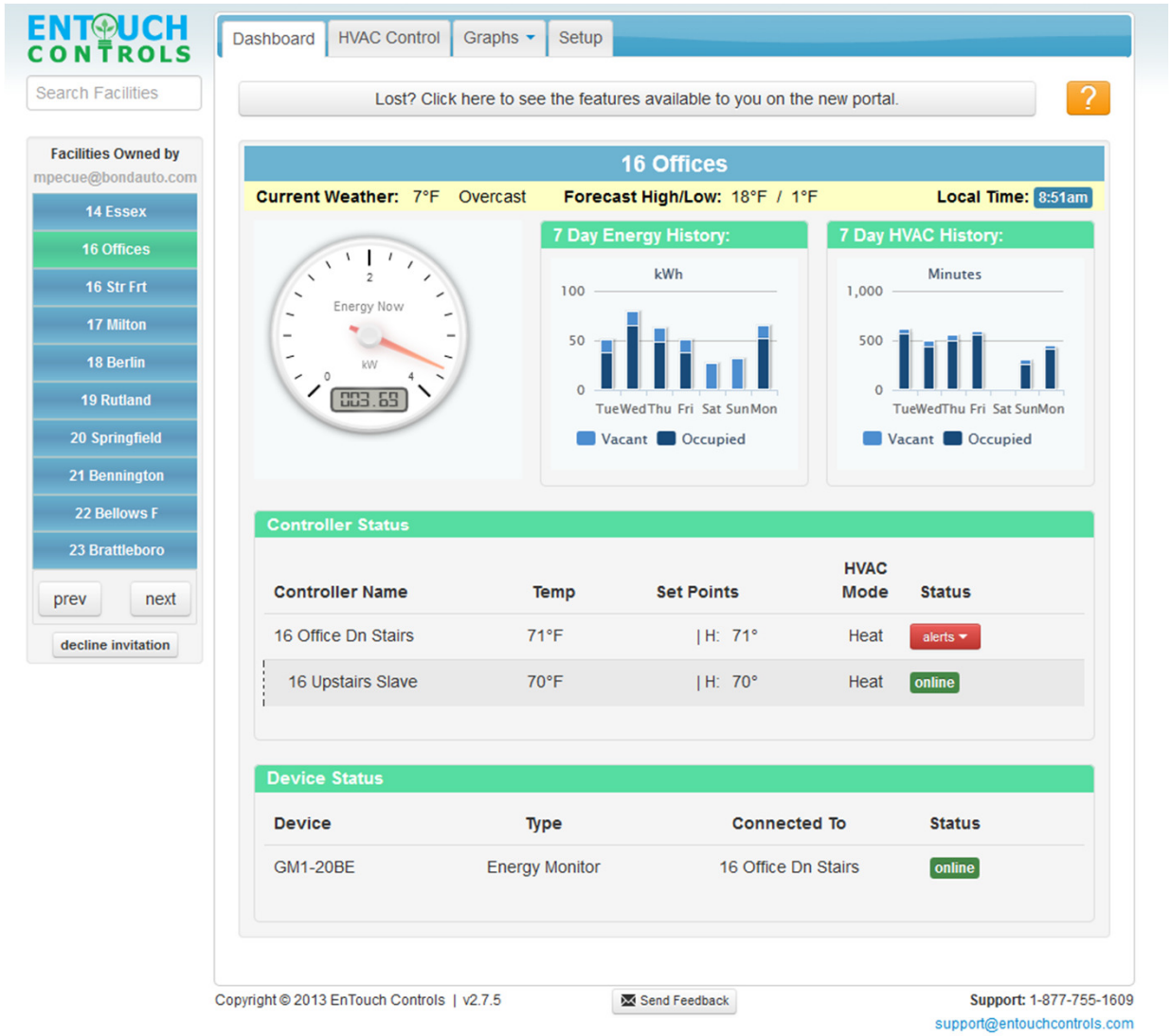
ENTOUCH CONTROLS
Search Facilities
Facilities Owned by
mpecue@bondauto.com
14 Essex
16 Offices
16 Str Frt
17 Milton
18 Berlin
19 Rutland
20 Springfield
21 Bennington
22 Bellows F
23 Brattleboro
prev
next
decline invitation
Dashboard
HVAC Control
Graphs
Setup
Lost? Click here to see the features available to you on the new portal.
16 Offices
Current Weather: 7°F Overcast
Forecast High/Low: 18°F / 1°F
Local Time: 8:51am
Energy Now
kW
003.69
7 Day Energy History:
kWh
100
50
0
Tue Wed Thu Fri Sat Sun Mon
Vacant
Occupied
7 Day HVAC History:
Minutes
1,000
500
0
Tue Wed Thu Fri Sat Sun Mon
Vacant
Occupied
Controller Status
Controller Name
Temp
Set Points
HVAC Mode
Status
16 Office Dn Stairs
71°F
| H: 71°
Heat
alerts
16 Upstairs Slave
70°F
| H: 70°
Heat
online
Device Status
Device
Type
Connected To
Status
GM1-20BE
Energy Monitor
16 Office Dn Stairs
online
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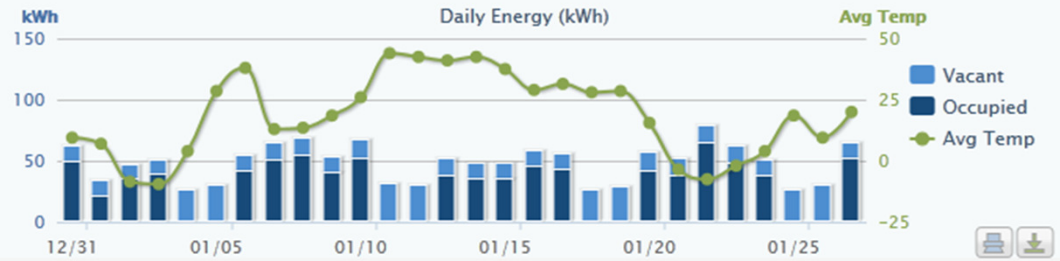
Support: 1-877-755-1609
support@entouchcontrols.com

16 Offices

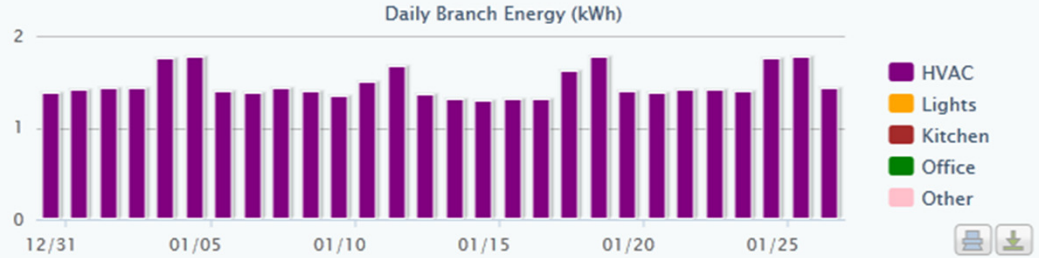
Last 28 Days — **Energy Usage** — Advanced Graphs »

Daily Average: 49 kWh **Vacancy Average:** 18 kWh (37%)

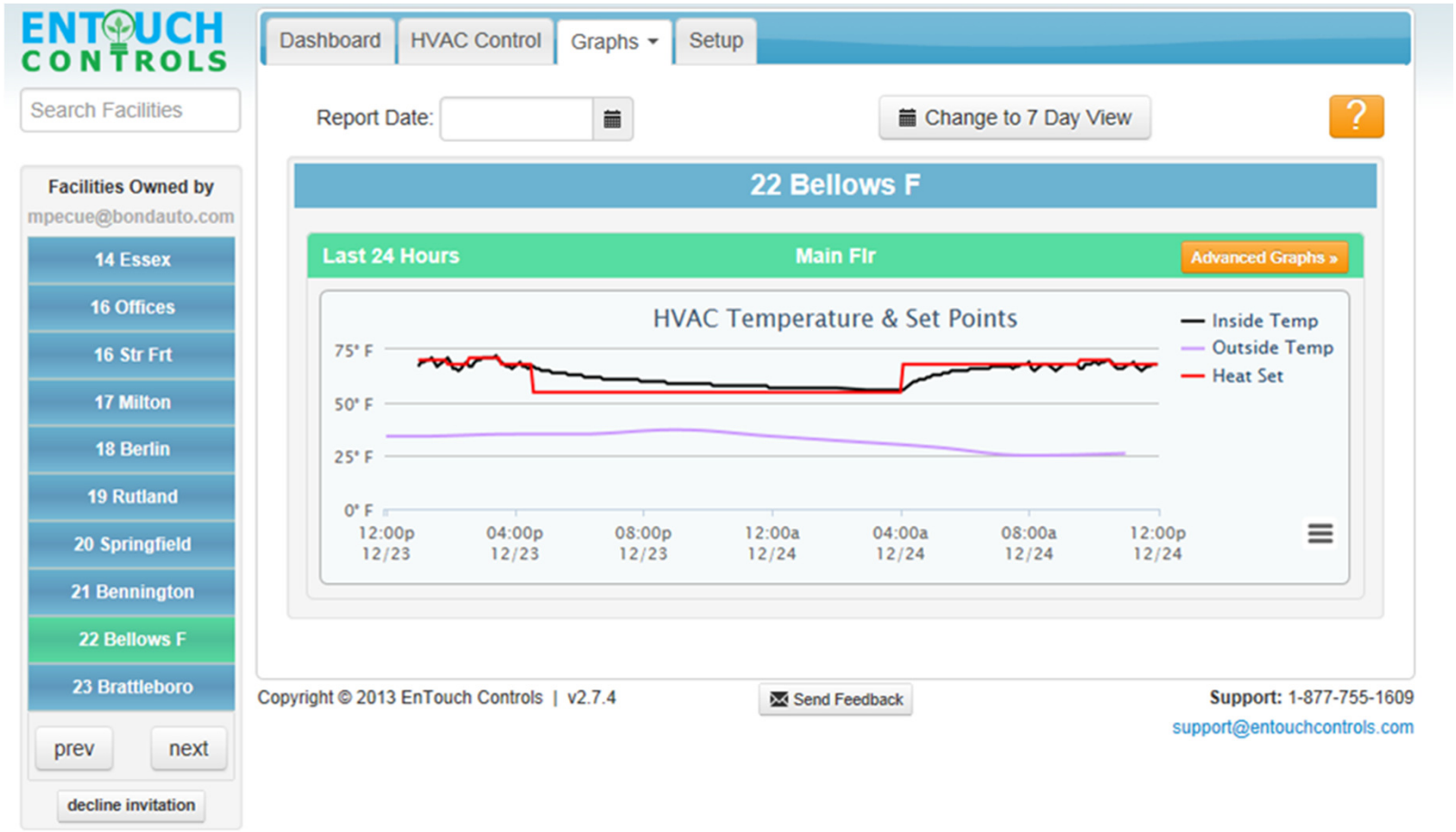


Last 28 Days — **Branch Energy Usage**

Daily Averages - HVAC 1 kWh **Lights** 0 kWh **Kitchen** 0 kWh **Office** 0 kWh **Other** 0 kWh



Last 28 Days — **Heating and Cooling Usage** — Advanced Graphs »


ENTOUCH CONTROLS
Search Facilities
Facilities Owned by
mpecue@bondauto.com
14 Essex
16 Offices
16 Str Frt
17 Milton
18 Berlin
19 Rutland
20 Springfield
21 Bennington
22 Bellows F
23 Brattleboro
prev
next
decline invitation
Dashboard
HVAC Control
Graphs
Setup
Report Date:
Change to 7 Day View
22 Bellows F
Last 24 Hours
Main Flr
Advanced Graphs »
HVAC Temperature & Set Points
Inside Temp
Outside Temp
Heat Set
75° F
50° F
25° F
0° F
12:00p 12/23
04:00p 12/23
08:00p 12/23
12:00a 12/24
04:00a 12/24
08:00a 12/24
12:00p 12/24
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Send Feedback
Support: 1-877-755-1609
support@entouchcontrols.com

The Next Step for EVT & Bond Auto?

Enter data into the Energy Star Portfolio Manager

Conclusion

There are many energy saving opportunities
by understanding how the control systems in your facility
are operating

By using metering and data analytics you can

- Identify measures
- Calculate energy savings
- Have the tools available to ensure the persistence of the energy reduction measures

Traditional data center

	kW	PUE	$/kW	
System 1	51	2.14	$ 2,432.00	1/9-1/26
System 2	37	2.1	$ 1,743.00	10/13-11/3
System 3	20	2.5	$ 2,115.00	10/13-11/3
System 4	41	1.8	$ 1,397	4/14/-6/7

Containment +VFD + Economizer

$10,000 Savings/Year for a 30KW data center

Efficiency Vermont

QUESTIONS?

What is New

- **Intelligent Control Valve**
- **Hybrid Boiler Control Systems**

The Intelligent Valve

- **Before the Intelligent Valve**
  - PID valve (Proportional Integral and Derivative)
    - Pressure dependent

- **System Optimization since PID**
  - Temperature Reset
  - Delta P reset in the water loop

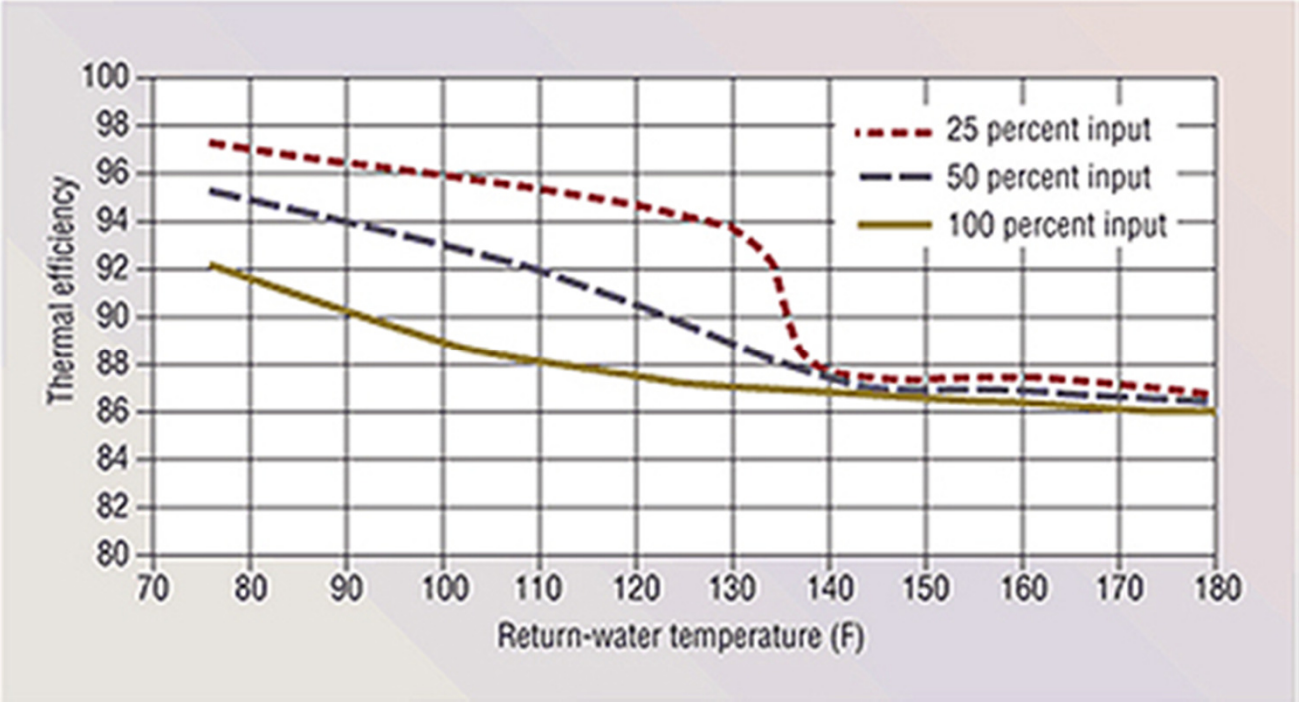
2014 AHR EXPO Winners
Innovation Award
Automation and Controls

Belimo Air Controls (USA) BAS Data logging Energy Valve

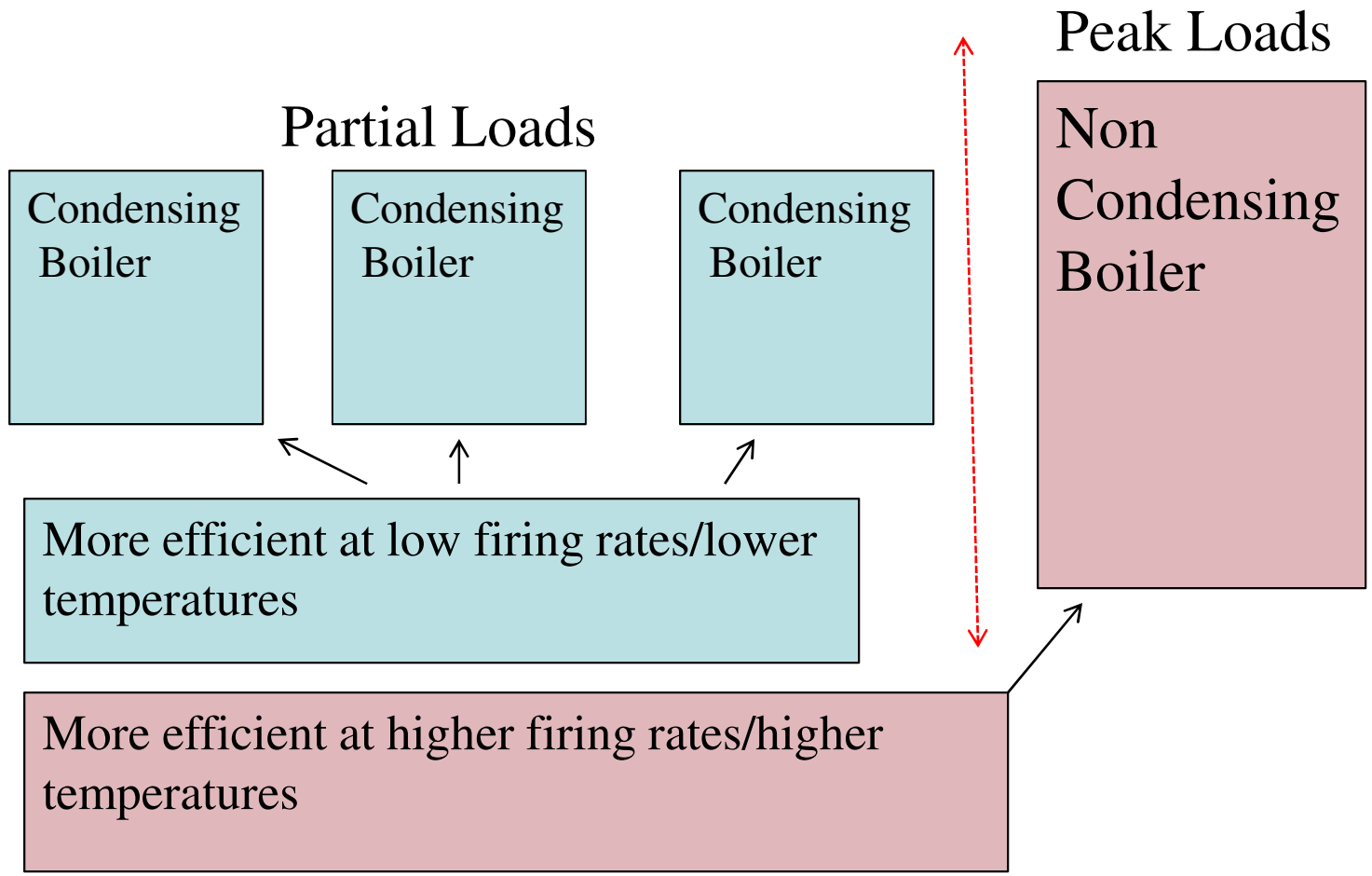
- DT Management, Measures Flow, Pressure Independent

- Communicates (BACNet) and Web

Example- Condensing boiler efficiency



"Hybrid Boiler Controller"



Efficiency Vermont

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