



Clean Buildings—Getting to Efficiency Webinar 2

Tune-Ups for Clean Buildings

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WSU Energy Program

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Tune-Ups for Clean Buildings

Your Participation

Join audio:

- Choose “Telephone” and dial using the information provided
- OR
- Choose “Mic & Speakers” to use VoIP

Questions/comments:

- Submit questions and comments via the Questions Panel throughout the webinar
- Q&A will be held after the presentation

Recording

- This webinar is being recorded and will appear within a few days at





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Building Operator Certification Program
Project Manager, Tune-up Specialist
ArchEcology



Thank you to Neil Bavins for developing the webinar series!



Clean Buildings – Getting to Efficiency Webinar Series

- Efficiency Through the Clean Buildings Performance Standard (CBPS)
 - 3/30/21
- **Tune-ups for Clean Buildings**
 - **4/21/21, 11:30 am**
- Energy Management Plans for Clean Buildings
 - 5/19/21, 11:30 am
- Operations & Maintenance for Clean Buildings
 - 6/9/21, 11:30 am

registration and past webinars:
<http://www.energy.wsu.edu/PublicFacilitiesSupport/ResourceConservation.aspx>



What is **not** Covered in this Webinar Series

- Compliance Path Details
- Early Adopter Incentive Program

Please keep your questions to the topic
of this webinar



Requirements of the Clean Buildings Performance Standard

- Energy Management Plan (EMP)
- Operations & Maintenance (O&M) Program
- Compliance through one of these performance metrics:
 - Meet energy use intensity target (EUI_t)
 - Implement all cost-effective energy efficiency measures



WA State Dept of Commerce Clean Buildings Web Page

<https://www.commerce.wa.gov/growing-the-economy/energy/buildings/>

- Links to legislation and reference standards
- Early Adopter Incentive Program
- Determining if your building must comply
- Steps to comply
- Personnel roles
- Resources and support links
- Links to ENERGY STAR Portfolio Manager and other trainings
- Building owner portal (to come)
- **Clean Buildings Live Q&A Session:**
 - **May 4 at noon**
 - **Go to Commerce webpage for link**

Contact your utility – they may have resources and incentives to help comply with the Standard



Learning Objectives

- Why a building tune-up is a great starting point for CBPS compliance
- Components of a tune-up
- Strategies for an effective tune-up
- Energy efficiency measures in a tune-up

Q & A: Please submit questions in the question box – we'll answer after the presentation



City of Seattle Tune-up Objectives

- Gather building and system data (characteristics)
- Validate data in Energy Star Portfolio Manager
- Analyze energy use
- Identify and implement O&M energy conservation measures
- Recommend potential energy efficiency projects



Tune-Up for Clean Buildings Objectives

- Gather building and system data (characteristics)
- Validate data in Energy Star Portfolio Manager
- Analyze energy use
- Identify and implement O&M energy efficiency measures
- Recommend potential energy efficiency projects
- Calculate EUI target
- Document Energy Management Plan
- Document O&M tasking and program plan
- Implement and document O&M program for at least a year



Tune-Up for Clean Buildings Objectives

- **Document and Implement Energy Management Plan**
 - Gather building and system data (characteristics)
 - **Identify O&M tasking and program plan**
 - **Calculate EUI target**
 - Validate data in Energy Star Portfolio Manager to generate WNEUI
 - Analyze energy use
 - Identify and implement O&M energy conservation measures
 - Recommend potential energy efficiency projects
- **Implement and Document O&M Program for at least a year**

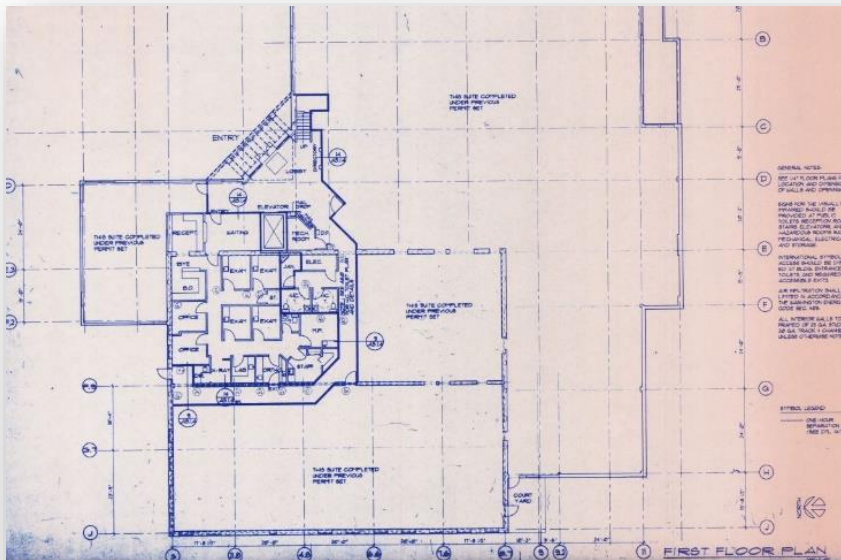


Strategies for a Successful Tune-up

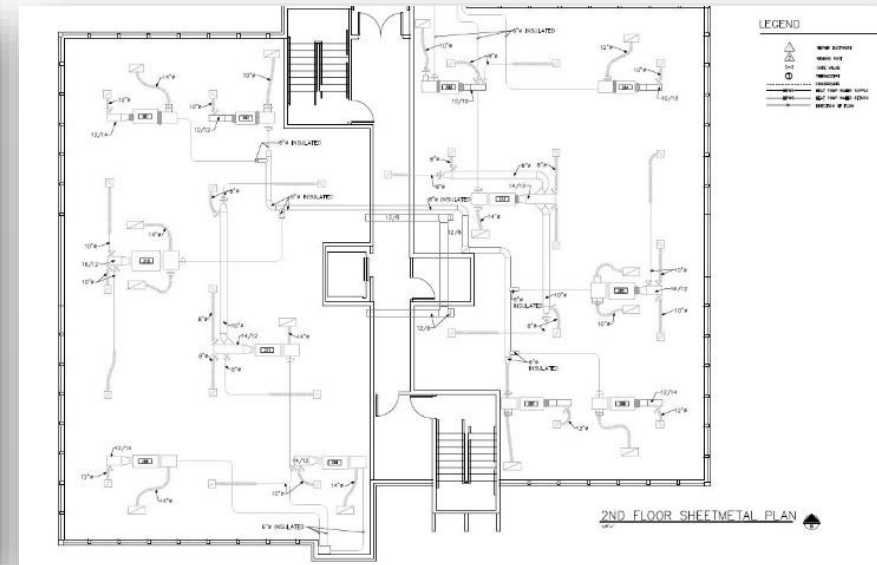
Start by Gathering Data

- Age, construction type and insulation
- Space use and square
- Occupancy and occupant schedules
- Operating schedules and set points
- Heating, cooling and ventilation systems
- Lighting systems
- Domestic hot water systems
- On site renewables
- Other significant energy uses

Gather documentation and review prior to site assessment



Building plans



Mechanical, Electrical and Plumbing plans



Space Name	CO2	Thermostat Type	Optimum Start	Occ HSP	Unocc HSP	Occ CSP	Unocc CSP	Occ Days	Occ Start	Unocc Start	Space Pressure issues	Air Balance Issues	Notes
Suite 102	556	Vision Pro	<input checked="" type="checkbox"/>	70	62	73	78	7 Days	6am	7pm	N/A	N/A	8am-3pm Sa-Su, unoccupied changed to 60/85, unoccupied on Sa-Su
Suite 103c	549	Vision Pro	<input checked="" type="checkbox"/>	73	65	76	74	7 Days	730ar	630pr	N/A	N/A	set occ 72/76, unoccupied 60/85, currently vacant, set to unocc
104a	565	Vision Pro	<input checked="" type="checkbox"/>	70	62	73	78	7 Days	6am	7pm	N/A	N/A	set unoccupied 60/85, set to unoccupied on weekends
lobby	651	Vision Pro	<input checked="" type="checkbox"/>	68	60	73	78	7 Days	545ar	830pr	N/A	N/A	set unoccupied to 60/85
vida 106	646	Vision Pro	<input checked="" type="checkbox"/>	68	<60	72	80	M-F	6am	8pm	N/A	N/A	7am to 6pm business hours m-f, set hvac to 6am-8pm, front thermostat, unoccupied 55/85

- Tenant spaces and building zones
- Tenant schedules and set points
- Document key performance indicators (KPI's)



Exhibit One - Equipment Inventory

The responsibilities of the Company shall not be limited to the major components of the equipment listed, but shall include all appurtenant devices and systems that are related to the equipment (e.g. controls, sensors, compressors, pumps, fans, etc.)

Qty.	System/Components ¹	Manufacturer	Model Number	Location
1	Hydronic Heat Pump 101	Climate Master	HS012G5DMR8GCSC	Ste 100 Back Laundry Room
1	Hydronic Heat Pump 102	Climate Master	N/A	Ste 103 Lunch Room
1	Hydronic Heat Pump 103	Climate Master	GRH019BGC30CLB5	Ste 103 In Open Work Area
1	Hydronic Heat Pump 104	Climate Master	GRH012BGC30CLB5	Ste 103 Lobby
1	Hydronic Heat Pump 105	Climate Master	GRH024AGD30CLB5	Ste 102
1	Hydronic Heat Pump 106	Climate Master	HS019G585LSGC5A	Ste 103 E
1	Hydronic Heat Pump 107	Climate Master	HS036G525LSGC5B	Lunch Room
1	Hydronic Heat Pump 201	Enercon	HW19A	Ste 200 D. Warren's Office
1	Hydronic Heat Pump 202	Climate Master	GRH012AGD30CLB5	Ste 200 Receptionist Area
1	Hydronic Heat Pump 204	Climate Master	GRH012AGD30CLB5	Ste 201 N

- HVAC equipment list



AIR BALANCE DATA SHEET								
PROJECT: Crown Point 4010 suite 204				PROJECT #: P5356				
ROOM #	OPENING	SIZE	ZONE	REQUIRED CFM	TEST 1 CFM	TEST 2 CFM	TEST 3 CFM	FINAL CFM
VAV 208								
Office 1	10x10	8		220	240	230	230	230
Office 2	10x10	8		220	140	220	220	220
VAV 209								
Diffuser 1	10x10	8		100	130	200	105	105
Kitchen 2	10x10	8		100	250	100	95	95
VAV 210								
Diffuser 1	10x10	8		200	250	230	200	200
Diffuser 2	10x10	8		200	180	190	200	200
VAV 211								
Diffuser 1	10x10	8		230	220	240	200	200
Diffuser 2	10x10	8		170	190	240	200	200

- Air balance
- Commissioning reports



EQUIPMENT HP103 W/S HEAT PUMP
 :
 CONTRACT YEAR: 7/1/2020 - 6/30/2021

Task Code	Task Description	Tech ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2160000000	HEAT PUMP/WATER SOURCE	DYLAN D							✓					
2160000004	HEAT PUMP/WATER SOURCE	D SOUTH	✓			✓						✓		
2160030000	EVAPORATOR COIL	DYLAN D							✓					
2160030004	EVAPORATOR COIL	D SOUTH										✓		
2160030504	__INSPECT COIL, CLEAN COIL	D SOUTH										✓		
2160030510	__CHECK AND RECORD RETURN AIR TEMPERATURE	DYLAN D							✓					
2160030520	__CHECK AND RECORD SUPPLY AIR TEMPERATURE	DYLAN D							✓					
2160030554	__CLEAN CONDENSATE PANS AND DRAINS	D SOUTH										✓		
2160050000	CONTROL PANEL	DYLAN D							✓					
2160050700	__INSPECT AND TIGHTEN ALL ELECTRICAL CONNECTIONS	DYLAN D							✓					
2160060000	COMPRESSOR	DYLAN D							✓					
2160060110	__OBSERVE SURFACE TEMPERATURES	DYLAN D							✓					
2160060120	__INSPECT FOR REFRIGERANT AND OIL LEAKS	DYLAN D							✓					
2160060130	__CHECK REVERSING VALVE	DYLAN D							✓					

- Maintenance tasking or vendor maintenance agreements
- Does the building have service logs? Will indicate current O&M program effectiveness and documentation



Validate ESPM Data

- Verify Space use type, area
- Verify utility meters
- Verify data download from utilities



Summary
Details
Energy
Water
Waste & Materials
Goals
Design

Meter Summary

1 Energy Meters Total

1 - Used to Compute Metrics

[Add A Meter](#)

Current Energy Date
Dec 31, 2020

[Enter Your Bills](#)

i Five Ways to Enter Bill Data

1. Manual ([Instructions here](#))
2. Use our [simple spreadsheet](#) (on the bottom of each meter's Manage Bills page) to upload or Copy/Paste
3. Use our [complex spreadsheet](#) (multiple meters + multiple properties)
4. Hire an organization to electronically enter your data
5. See if your [utility offers this service](#)

Energy Use by Calendar Month (Not Weather Normalized)

[Export Data by Calendar Month](#)

Meters - Used to Compute Metrics (1) [Add A Meter](#)

[Change Meter Selections](#)

[View as a Diagram](#)

Name Meter ID	Energy Type	Most Recent Bill Date	In Use? (Inactive Date)
	Electric - Grid	12/31/2020	Yes

18



Validate ESPM Data

- Run Data Quality Checker tool in ESPM
- Use ESPM Metrics to benchmark building (CBPS sec. 5)

Weather Normalized Site EUI Trend (kBtu/ft²)
[Change Metric](#)

Metric	Oct 2019 (Other)	Jan 2021 (Energy Current)	Change
ENERGY STAR Score (1-100)	Not Available	77	N/A
Source EUI (kBtu/ft ²)	39.5	36.5	-3.00 (-7.60%)
Site EUI (kBtu/ft ²)	18.9	21.5	2.60 (13.80%)
Energy Cost (\$)	48,739.15	47,041.95	-1,697.20 (-3.50%)
Water Use (All Water Sources) (kgal)	661.7	485.7	-176.00 (-26.60%)
Total GHG Emissions (Metric tons CO ₂ e)	170.3	174.0	3.70 (2.20%)
Weather Normalized Site EUI (kBtu/ft ²)	19.3	22.5	3.20 (16.60%)

Data Quality Checker
 Run a check for any 12-month time period to see if there are any possible errors found with your data.
[Check for Possible Errors](#)



Use ESPM Goals to Identify Financial Benefits and Evaluate Metrics

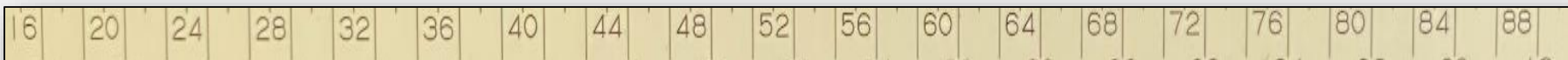
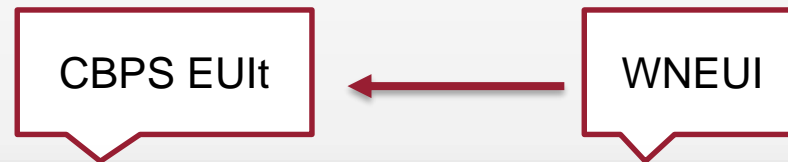
Water Waste & Materials **Goals** Design

Metrics Comparison for Your Property & Your Target [Change Time Period](#)

Metric	Dec 31 2019 (Energy Baseline)	Dec 31 2020 (Energy Current)	Target*	Median Property*
ENERGY STAR score(1-100)	53	65	80	50
Source EUI(kBtu/ft²)	184.7	155.5	121.3	192.2
Site EUI(kBtu/ft²)	105.3	81.8	63.8	101.1
Source Energy Use(kBtu)	7671033.3	6458493.0	5039149.2	7982783.3
Site Energy Use(kBtu)	4374951.7	3398485.3	2651621.0	4200573.3
Energy Cost(\$)	66042.08	65689.60	51253.42	81193.20
Total GHG Emissions(Metric Tons CO2e)	289.4	234.0	182.6	289.3

Calculate CBPS Energy Target

- Energy Use Intensity Target (EUI_t) method in CBPS Section 7 and Annex Z
- Compare current Weather Normalized Energy Use Intensity (WNEUI) with EUI_t



- WNEUI at or below EUI_t: develop EMP and O&M Program documentation
- WNEUI above EUI_t: pursue O&M efficiency measures
- WNEUI 10 to 15 above EUI_t: likely need some capital projects, Asset Score or audit might help identify priorities
- WNEUI more than 15 above EUI_t: qualifies for Early Adoption Incentive Program



Energy Analysis–High Level

- Look for anomalies-such as high month
- Look for seasonal use-heating or cooling dominated
- Estimate fraction for space heating
 - Use lowest monthly readings to approximate baseline
- Estimate fraction for space cooling



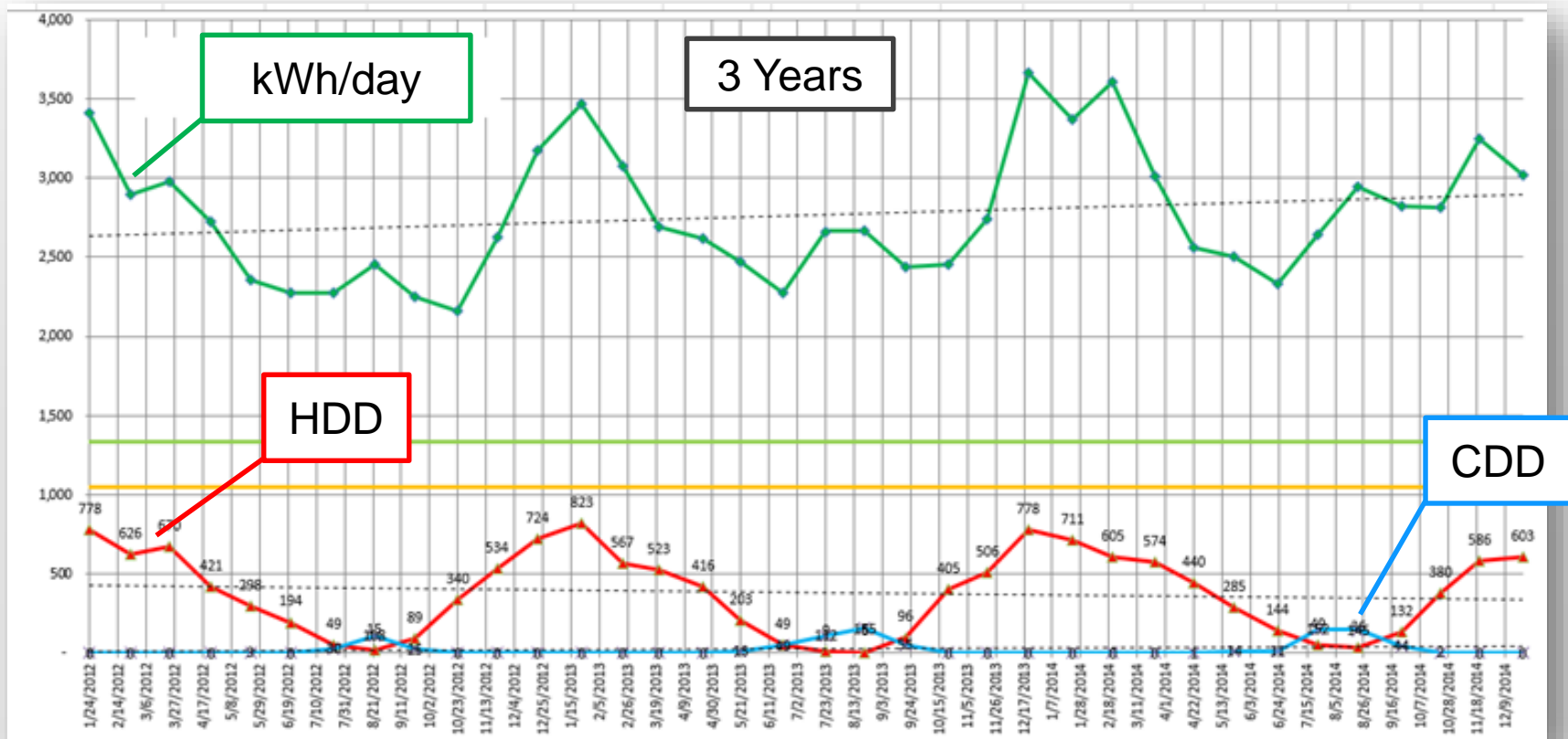
Energy Analysis

- Consider annual water use
 - Domestic hot water
 - Cooling towers
 - Plumbing leaks
- Irrigation or water features
 - Not energy savings, but savings may help offset cost of other measures
 - Water cost savings may also result in sewer cost savings



Energy Analysis

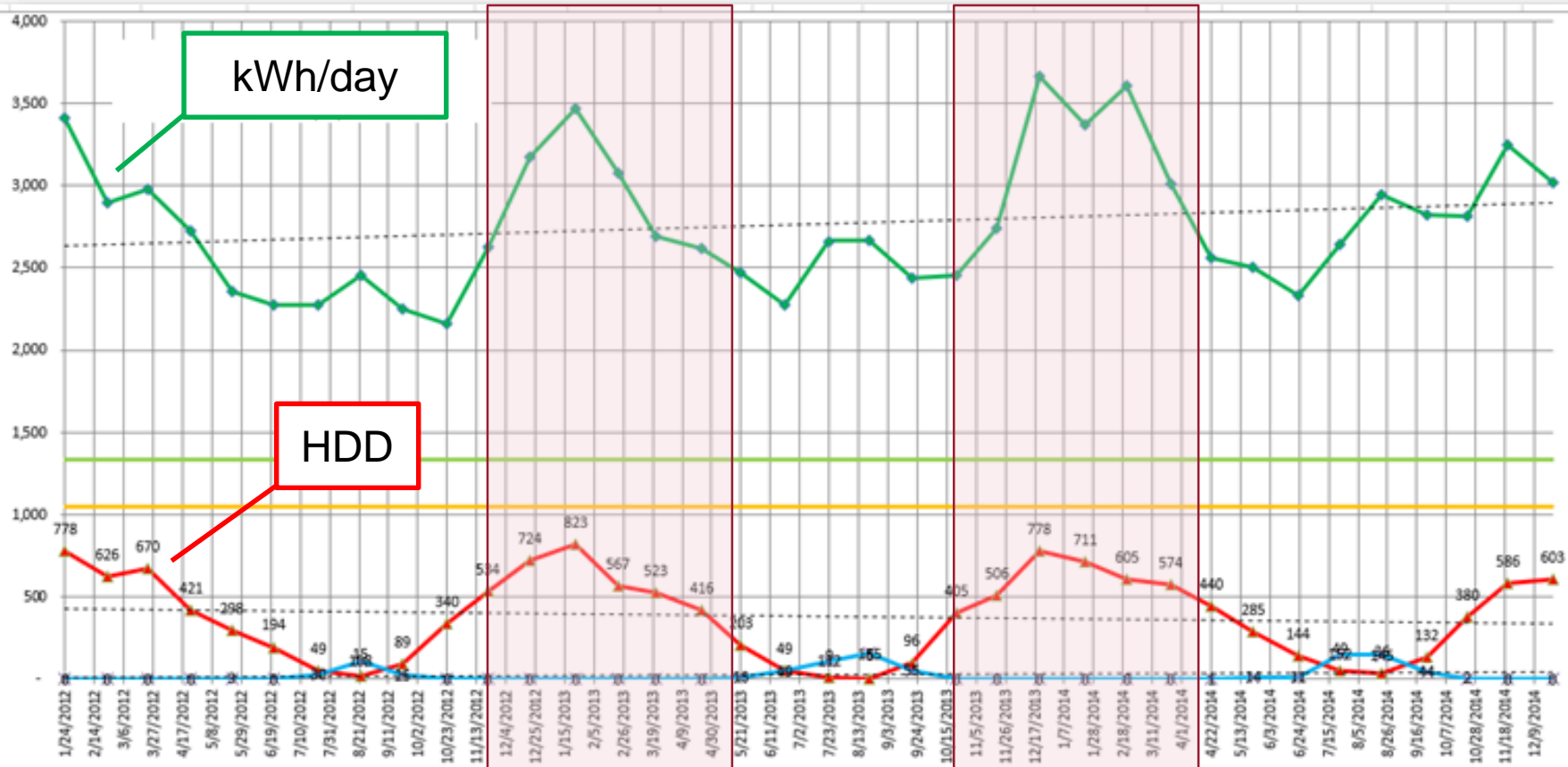
- Plot kWh/day (and Therms/day) against HDD and CDD
- Degreedays.net





Energy Analysis

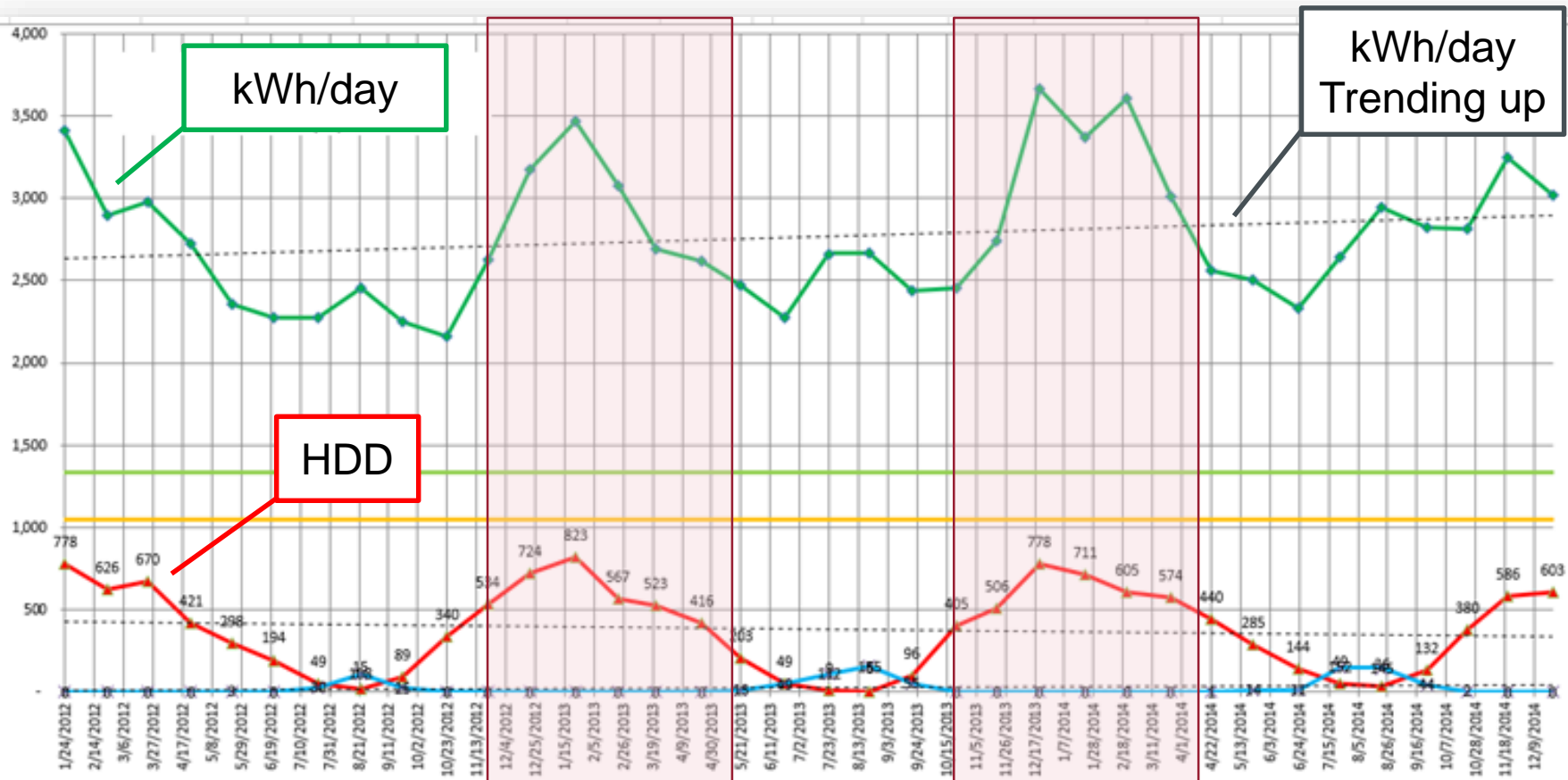
- Identify magnitude of seasonal effects





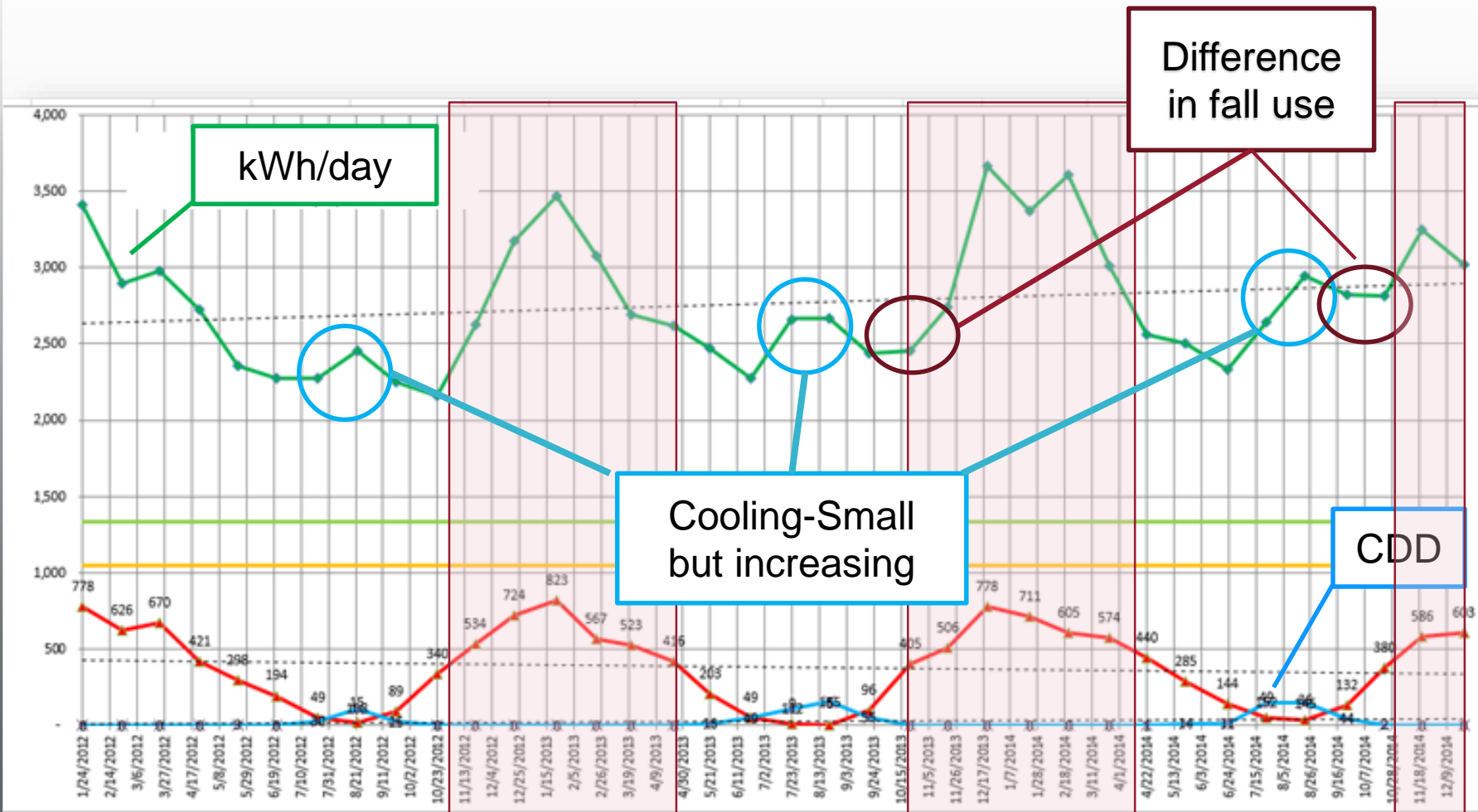
Energy Analysis

- Trendlines help interpret direction and need to identify factors





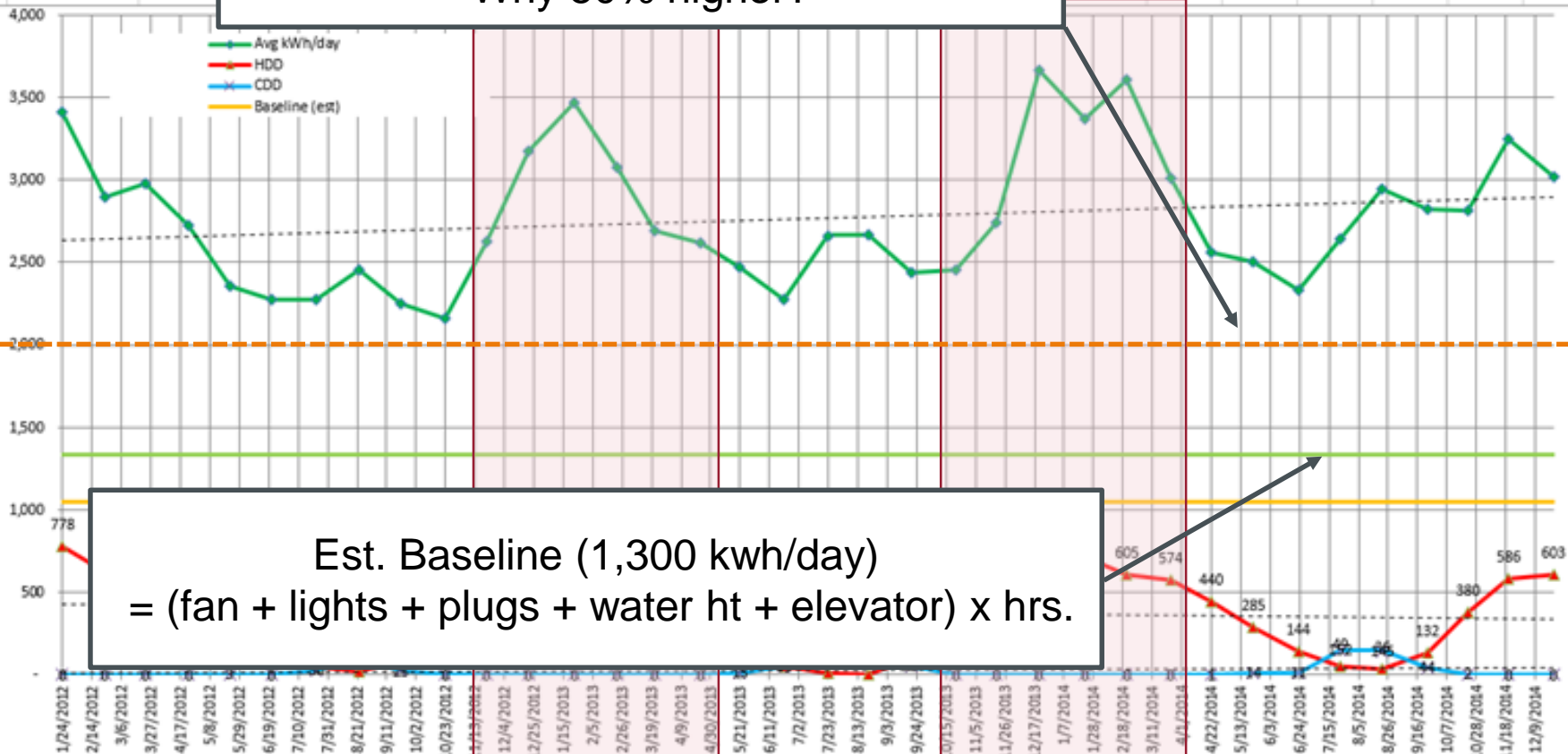
Energy Analysis

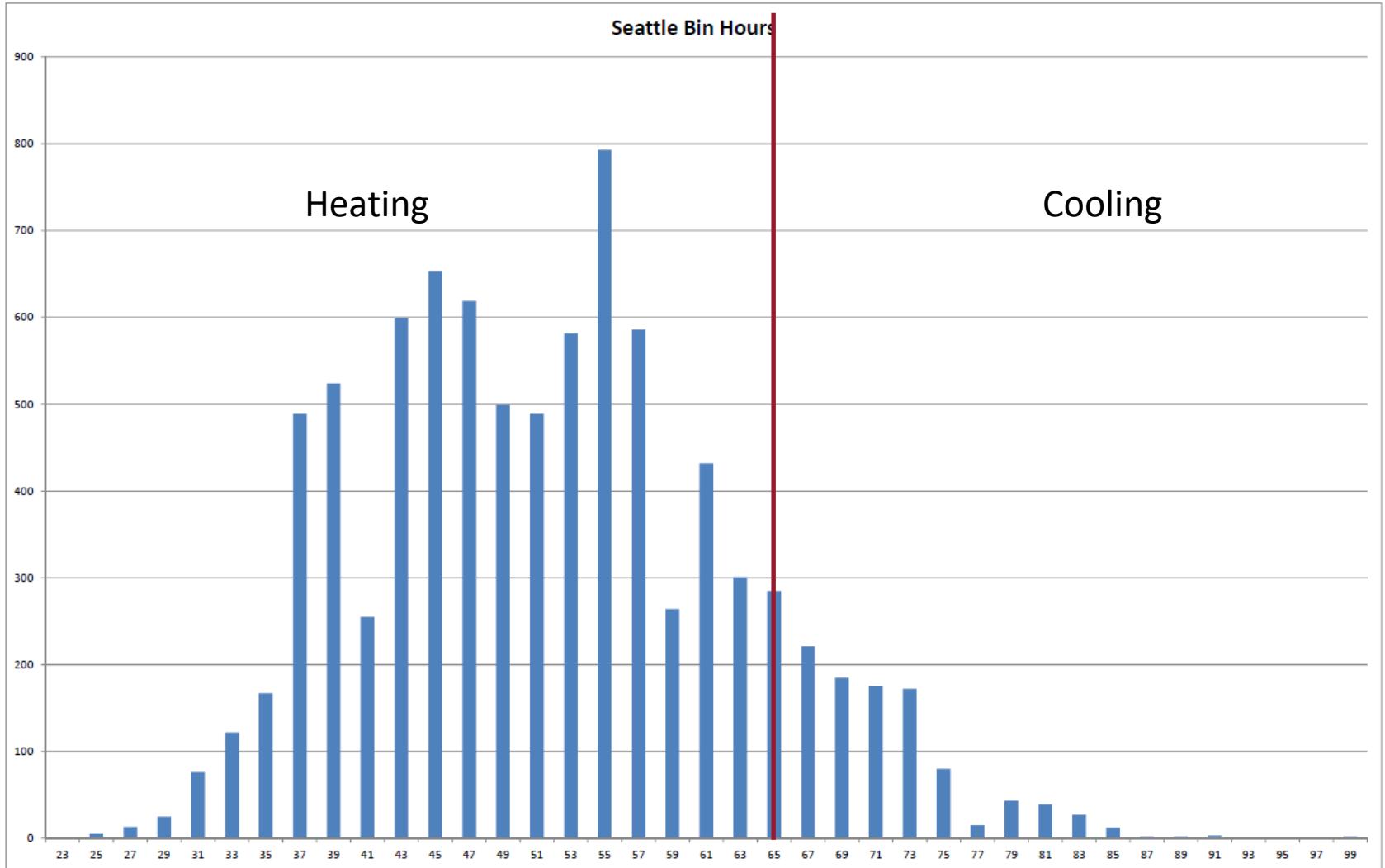




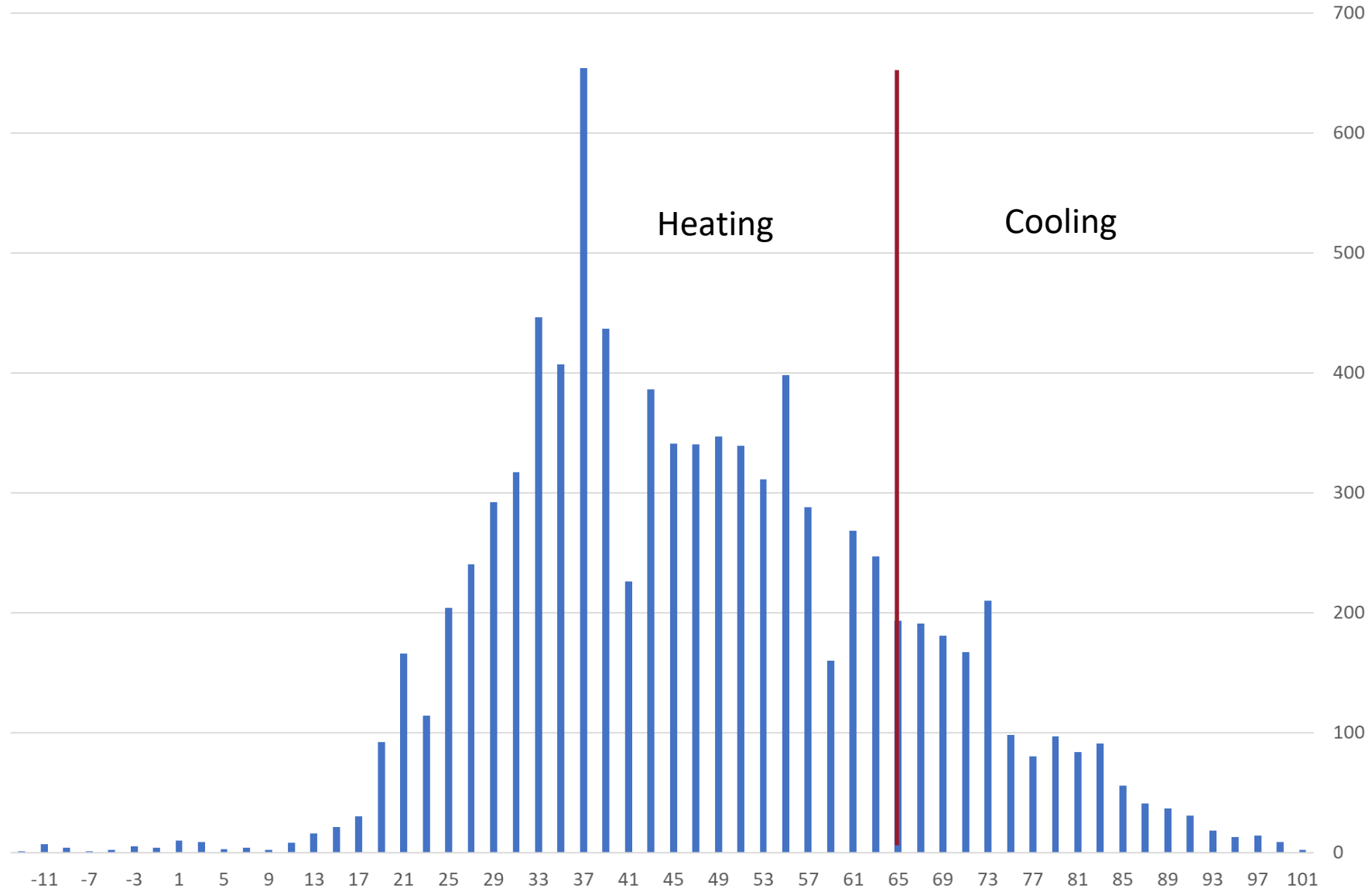
Energy Analysis

Meter Baseline (approx. 2,000 kWh/day)
Why 50% higher?





Spokane Bin Hours



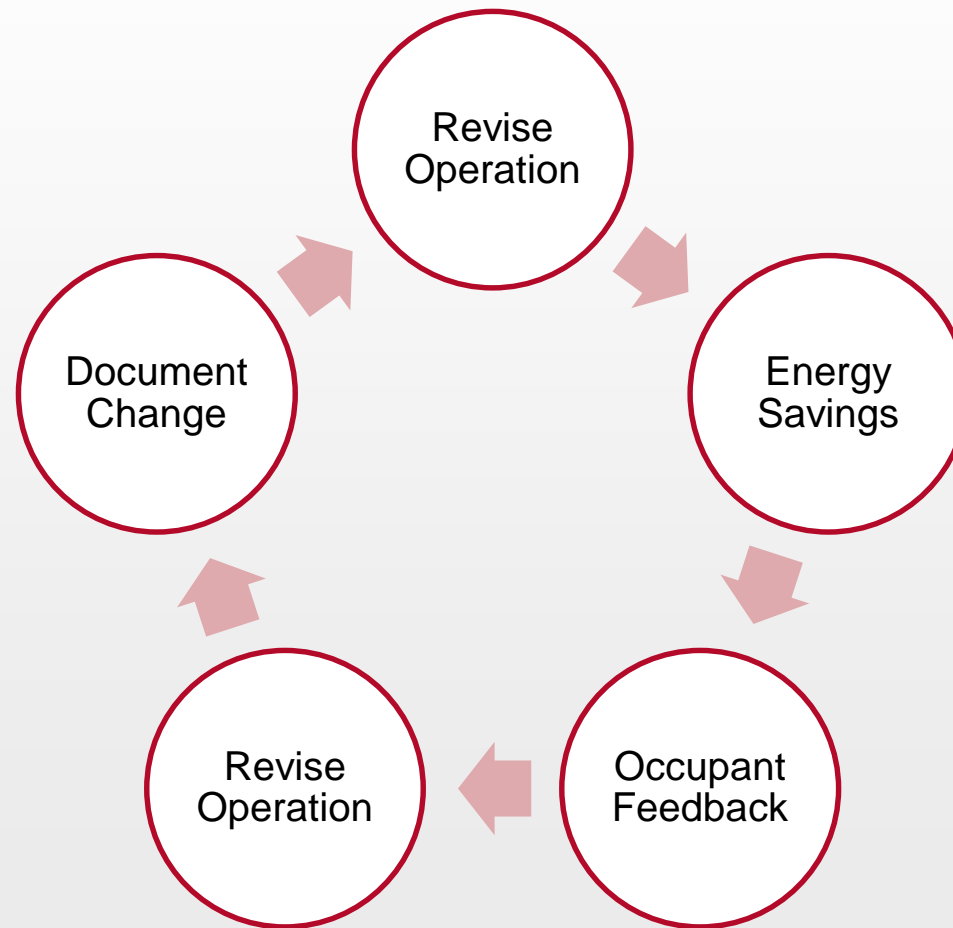


Additional Energy Analysis

- If available, review interval data for several weeks to see load throughout the day and night
- Compare Electric Load Factor (ELF) to Occupancy Factor (OF)
 - $ELF = \text{Lowest avg. daily use (kWh)} / \text{lowest daily demand (kW)} \times 24 \text{ (h)}$
 - $OF = \text{Weekly occupied hrs.} / 24 \times 7$
 - Higher ELF indicates high after hours use
- Commercial analysis software may also be useful
 - Energy Management Information Systems: A Selection Guide for Resource Conservation Managers
http://www.energy.wsu.edu/Portals/0/Documents/SelectionGuide_for_RC_Ms-WSUEP19.pdf



Tune-ups Are Often an Iterative Process





Strategies for a Successful Tune-up

- Tune-up is a great process to get familiar with the building occupants, systems and operation
- Consider a team approach
 - Divide work by system type
- Assume it may take several rounds
 - Adjustments to get maximum savings from the Tune-up
 - To complete documentation for Energy Management Plan and O&M Program



Strategies for a Successful Tune-up

Interview engineer or property manager before walk thru:

- Current deficiencies?
- Deferred maintenance?
- Recurring comfort complaints?
- Design problems?
- Document details



Strategies for a Successful Tune-up

- Once onsite continue data collection needed for Energy Management Plan (section 5) and O&M Program (section 4)
 - Confirm HVAC equipment list or create new
 - Lighting schedule
 - Current O&M activity and effectiveness. Document deficiencies
- Document Current Conditions for Key Performance Indicators:
 - Temp range-by space use/tenant
 - Lighting levels
 - Ventilation rates for different spaces: Office, restrooms, conference rooms











Strategies for the Site Assessment Walk Thru

- Escort by someone familiar with the facility
 - HVAC tech than maintains is ideal
- Confirm equipment can be shut down for safe inspection
 - Don't forget to turn back on!
- Documents to have with you
 - Building plan with room numbers (small copy) to document lighting levels and other issues
 - HVAC and DHW equipment lists with locations
 - Targeted EEM list by system type: HVAC, lighting, domestic hot water, etc.



Strategies for the Site Assessment Walk Thru

- Worksheet for each system type to document findings:

HVAC Unit #	Type	Model #	Serial #	Heating Op	Cooling Op	Economizer Op	Coils	Filters	Repairs	Duct insulation	Pipe insulation	Valves/dampers	Age
RTU-1	Pack Gas/AC			OK	OK	OK	Dirty	End of life	N/A	N/A	N/A	N/A	9
RTU-2	Pack Gas/AC			OK	Problem-add note	OK	Dirty	End of life	Minor-add note	N/A	N/A	N/A	9
RTU-3	Pack Gas/AC			OK	OK	OK	Dirty	End of life	N/A	N/A	N/A	N/A	9
RTU-4	Pack Gas/AC			Unable to test-add note	Unable to test-add note	Unable to test-add note	Clean	Clean	Major-add note	N/A	N/A	N/A	9



Strategies for the Site Assessment Walk Thru

- Worksheet for each system type to document findings:

Space Name	DHW setpo...	Lav Flow	Hands Free	Urinal Flow	Toilet Flow	Shower Flow	Circ Pump Sched.	Plumbing Leaks	Notes
Water Heater - Lochinvar HST 18-120, Janitor Room P1	114						NA	None observed	Circ pump is installed, controls. On 24/7. Ele water heater.
103c womens locker room	110	2+	N/A	N/A	1.2	Low flow	na	None observed	electric wh
106 Vida	95	1.2	N/A		1.2		na	None observed	electric wh
107 Bathroom	103	1.2	N/A	N/A	1.6	N/A	NA	None observed	
107 Patient Area Sinks (5)		1.5						None observed	
107 Staff Bathroom	107	1.2	N/A	N/A	1.6	N/A	NA	None observed	
107 Staff Lounge		1.5						None observed	
101 magforce	92	1.2	N/A						break room sink, point water htr

Tools for the Site Assessment Walk Thru

- Light meter to check lighting levels





Tools for the Site Assessment Walk Thru

- Water flow test bag - Seattle Public Utilities (free)

1701 Charleston Regional Parkway • Charleston, SC 29492
Customer Toll Free: 800.GOOD.BUY or 800.777.5655
For more water and energy saving products visit www.amconservationgroup.com

AM Conservation Group

How Much Can You Save?

Save water and energy (energy used to heat your hot water) and money with high efficiency, lower flow shower heads and aerators.

Determine the flow at showers and sinks.
Flow is measured as volume per minute. This handy tool will show you the flow in gallons and liters per minute, and help guide you to saving water, energy and money.

Easy instructions on how to test your showers and faucets.

- 1) Turn on the fixture to be tested - shower head, faucet, or hose. Adjust the flow to how you would normally use the fixture.
- 2) Hold the bag open and place under the fixture for exactly FIVE seconds.
- 3) Remove from the flow, hold the bag up and read the flow rate measurement on the bag. Pour water out and repeat. It is important to get the FIVE seconds correct. Practice counting with a watch. Repeat the test to check your results.
- 4) Below we have indicated efficient shower head, kitchen aerator and bathroom aerator guidelines. NOTE: These are maximum recommendations. You can always go lower if you are comfortable with the performance at the lower flow. The lower the flow, the more water, energy and money you will save.

Showerheads
Compare the water level for your shower heads to the efficient one. Look in the Potential Savings Column to see how much you can save by installing a new shower head.

Faucets
(Bathroom and Kitchen)
Compare the water level for faucet to the efficient one. Look in the Potential Savings column to see how much you can save with a new faucet aerator.

Water Level	Flow Rate		Potential Savings on your utility bills	Water Level	Flow Rate		Potential Savings on your utility bills
	Gallons (US)	Liters			Gallons (US)	Liters	
—	5 GPM	19 LPM	\$262/year	—	5 GPM	19 LPM	\$29/year
—	4 GPM	15.2 LPM	\$180/year	—	4 GPM	15.2 LPM	\$21/year

Tools for the Site Assessment Walk Thru

- IR/probe thermometer

Smart Buildings Center
has a tool lending library!

<https://www.smartbuildingscenter.org/tool-library/>



Tools for the Site Assessment Walk Thru

- Handheld CO2 meter to spot check ventilation rates
 - Confirm economizer position or if DOAS!
 - Lots of buildings are over ventilated
 - Look for 700-1,000 ppm
 - Lower than 700 ppm may indicate over-ventilation
- If occupancy varies demand control ventilation using CO² sensors may be a good small project efficiency measure



<https://www.smartbuildingscenter.org/tool-library/>

HVAC Maintenance Efficiency Measures



- Indoor and outdoor coil cleaning



- Air Filters: Check if clean, fit well, note type and MERV rating

HVAC Maintenance Efficiency Measures



- Heat exchangers
 - Shell and tube
 - Plate and frame



- Cooling towers and fluid coolers

HVAC Maintenance Efficiency Measures



- Dirty air-cooled motors
- Worn belts and sheaves

HVAC Maintenance Efficiency Measures



Economizer Intake Screen



Economizer dampers and actuators

HVAC Maintenance Efficiency Measures

- Duct and pipe leakage
- Duct and pipe insulation and vapor barriers



Valve Insulation Jacket Removed



Pipe Insulation Not Replaced After
Expansion Tank Replacement

HVAC Maintenance Efficiency Measures



- Boiler Tune-up/combustion efficiency

HVAC Operations Efficiency Measures

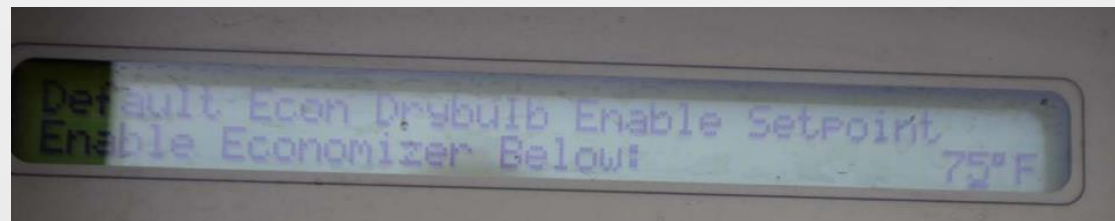
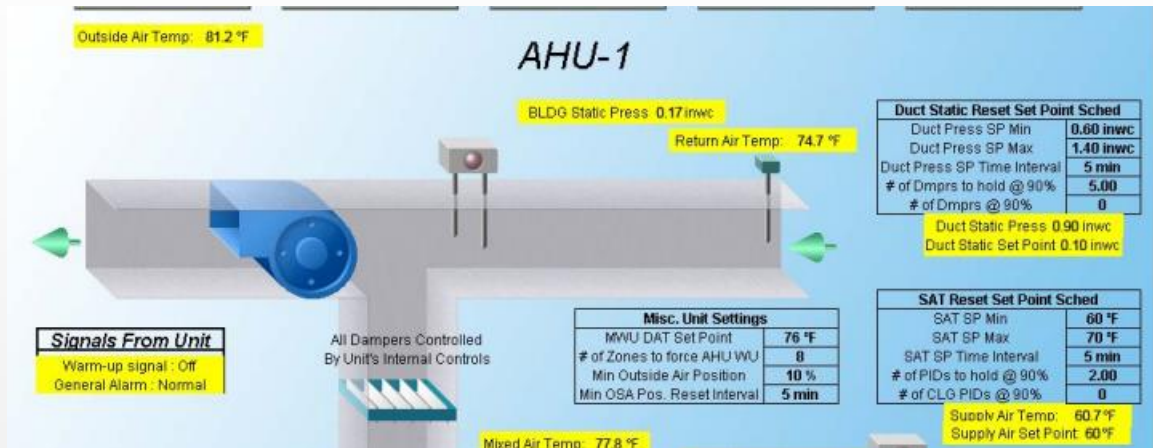
- HVAC schedule
- Use of intelligent recovery and shut down (coasting)
 - Including lockout of OSA during warm up
- HVAC occupied and unoccupied set points and dead band



- HVAC sensor calibration
 - Space and supply air and water temperature
 - CO² sensors
- Outdoor temperature lockout for boiler and chillers

HVAC Operations Efficiency Measures

- HVAC reset schedules
- Boiler supply water temp. reset
- Chiller supply water temp. reset
- VAV discharge air temp. reset
- Economizer operation
 - Sensible vs enthalpy
 - Integrated operation



Lighting Conservation Measures

- Are Lighting levels appropriate for space use?
 - Lighting Design Lab lighting levels reference:
https://www.lightingdesignlab.com/sites/default/files/pdf/Footcandle_Lighting%20Guide_Rev.072013.pdf
- Occupancy sensor operation
- Daylight sensor operation
- Outdoor lighting control
- Lighting schedule controls & time clocks
- ID/document inefficient lighting for replacement:
 - Incandescent
 - Higher wattage fluorescent
 - Metal Halide
 - Low Pressure Sodium



Domestic Hot Water Efficiency Measures



- DHW set point
 - 120 F recommended in most applications
- DHW circulation pump timer settings



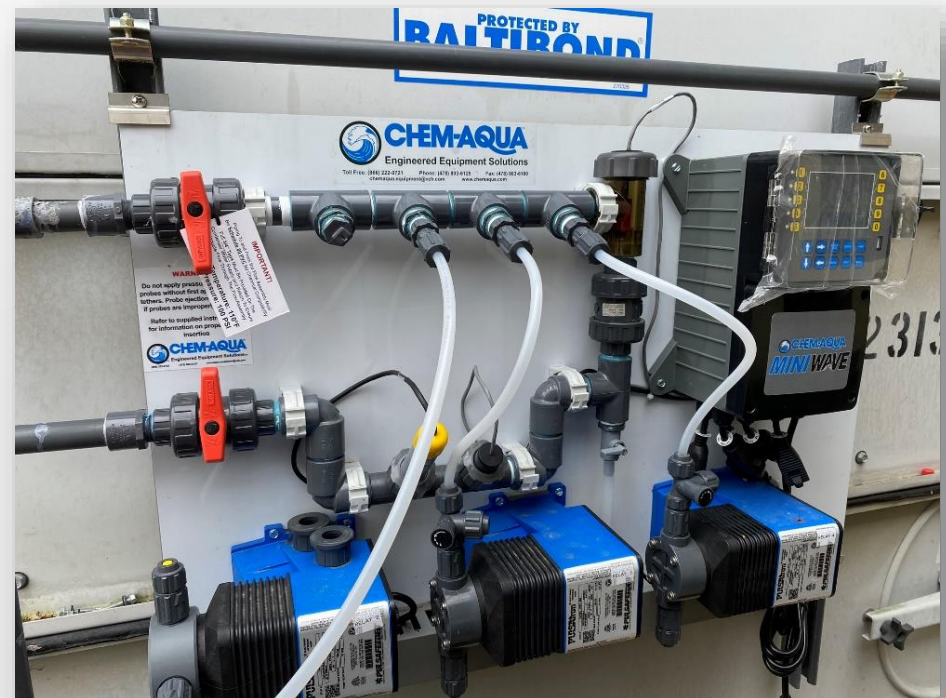
Water Efficiency Measures

- Low flow faucet aerators
 - 0.5 gpm
- Low flow shower aerators
 - 1.5 gpm
- Water leaks:
 - Under sinks
 - Pumps
 - Pipe fittings
 - Equipment connection

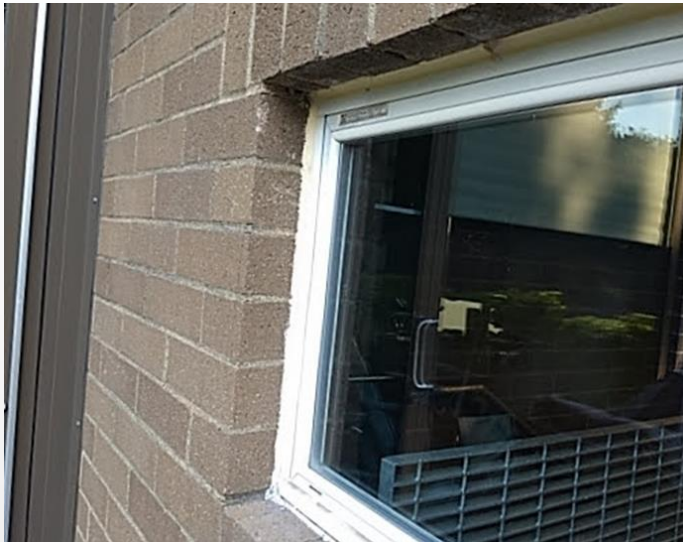


Water Efficiency Measures

- Boiler blowdown
- Cooling tower conductivity meter and blowdown



Building Envelope Efficiency Measures



Weather-stripping for windows and doors

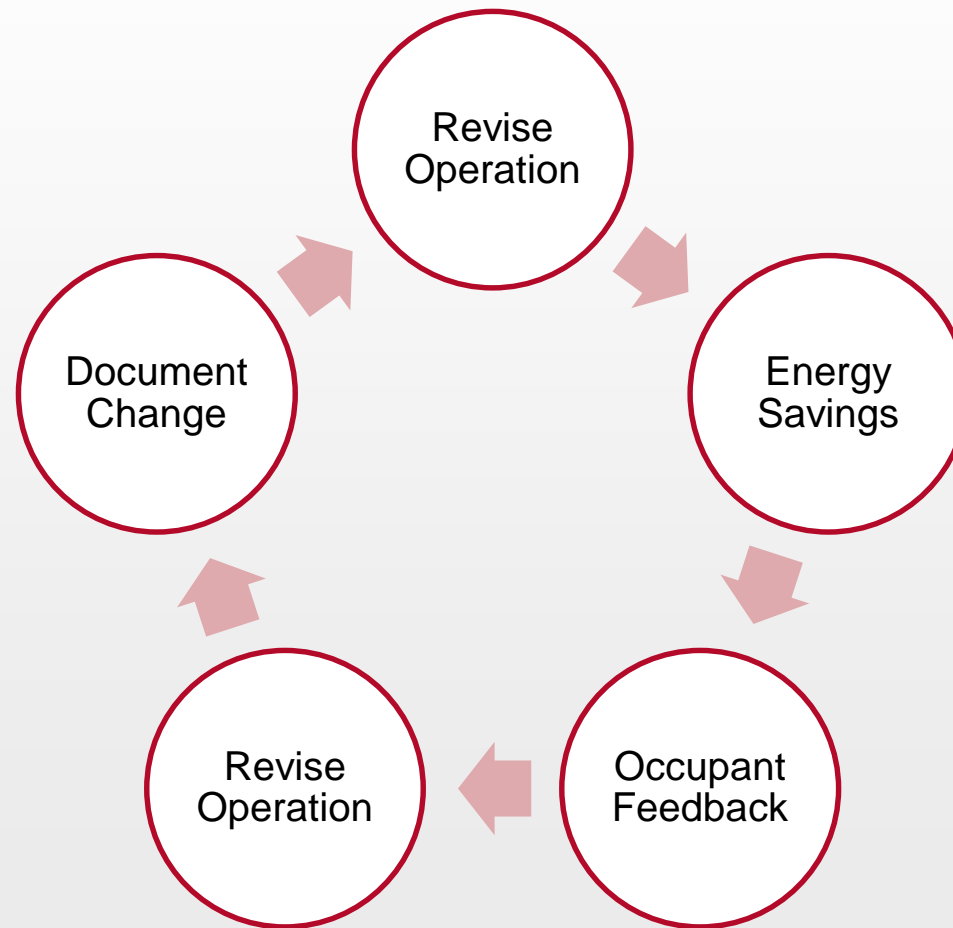


Ceiling or roof insulation

- Repair disturbed
- Look for opportunities to increase (re-roofing)
- Disturbed or missing insulation on ceiling between parking and floor above



Tune-ups Are Often an Iterative Process





Review

A clean building tune-up is a great way to get started

- Establish, update and validate Energy Star profile
- Analyze energy use to identify trends and areas for investigation
- Gather O&M documentation and verify during site visit(s)
- Interview staff and gain better understanding of building operations
- Prepare for and carry out on-site assessment(s)
- Implement O&M-related energy conservation measures
- Develop a list of potential energy saving projects
- Begin building the Energy Management Plan and O&M Program



30 minute Q&A starting now

Please submit your questions to the question box

Next webinar:

Energy Management Plans for Clean Buildings

5/19/21, 11:30am



Thank You

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