Clean Buildings—Getting to Efficiency Webinar 2

Tune-Ups for Clean Buildings

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Karen Janowitz, WSU Energy Program

WSU Energy Program
April 21, 2021
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

http://www.energy.wsu.edu/PublicFacilitiesSupport/ResourceConservation
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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:
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 (EUIt)
  - 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
Clean Buildings: Tune-Ups

- 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.).

<table>
<thead>
<tr>
<th>Qty.</th>
<th>System/Components</th>
<th>Manufacturer</th>
<th>Model Number</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Hydronic Heat Pump 101</td>
<td>Climate Master</td>
<td>HS012G5DMR8GCSC</td>
<td>Ste 100 Back Laundry Room</td>
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<td>Ste 103 Lunch Room</td>
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<td>Climate Master</td>
<td>GRH019BG30CLBS</td>
<td>Ste 103 In Open Work Area</td>
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<td>Hydronic Heat Pump 104</td>
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<td>GRH012BG30CLBS</td>
<td>Ste 103 Lobby</td>
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<td>Enercon</td>
<td>HW19A</td>
<td>Ste 200 D. Warren's Office</td>
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<tr>
<td>1</td>
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<td>GRH012AGD30CLBS</td>
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<td>Ste 201 N</td>
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- HVAC equipment list
Clean Buildings: Tune-Ups

**AIR BALANCE DATA SHEET**

<table>
<thead>
<tr>
<th>ROOM #</th>
<th>OPENING</th>
<th>SIZE</th>
<th>ZONE</th>
<th>REQUIRED CFM</th>
<th>TEST 1 CFM</th>
<th>TEST 2 CFM</th>
<th>TEST 3 CFM</th>
<th>FINAL CFM</th>
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<td>170</td>
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<td>200</td>
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</table>

- Air balance
- Commissioning reports
**Clean Buildings: Tune-Ups**

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

---

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

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<th>Task Code</th>
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<th>Jun</th>
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</tr>
</tbody>
</table>
Validate ESPM Data

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

- Run Data Quality Checker tool in ESPM
- Use ESPM Metrics to benchmark building (CBPS sec. 5)
Clean Buildings: Tune-Ups

Use ESPM Goals to Identify Financial Benefits and Evaluate Metrics

---

**Metrics Comparison for Your Property & Your Target**

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

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

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

DIAGRAM:
- kWh/day
- 3 Years
- HDD
- CDD
Energy Analysis

- Identify magnitude of seasonal effects
Energy Analysis

- Trendlines help interpret direction and need to identify factors.
Energy Analysis

- **kWh/day**
- **Cooling-Small but increasing**
- **Difference in fall use**
- **CDD**
Energy Analysis

Est. Baseline (1,300 kWh/day)
= (fan + lights + plugs + water ht + elevator) x hrs.

Meter Baseline (approx. 2,000 kWh/day)
Why 50% higher?
Clean Buildings: Tune-Ups

Seattle Bin Hours

Heating

Cooling
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 = Lowest avg. daily use (kWh)/lowest daily demand (kW) x 24 (h)
  - OF = Weekly occupied hrs./24 x 7
  - Higher ELF indicates high after hours use.

- Commercial analysis software may also be useful:
Tune-ups Are Often an Iterative Process

- Revise Operation
- Energy Savings
- Revise Operation
- Occupant Feedback
- Document Change

An iterative process involving revising operation, analyzing energy savings, receiving feedback from occupants, reviewing documents, and revising operations again.
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:

<table>
<thead>
<tr>
<th>HVAC Unit #</th>
<th>Type</th>
<th>Model #</th>
<th>Serial #</th>
<th>Heating Op</th>
<th>Cooling Op</th>
<th>Economizer Op</th>
<th>Coils</th>
<th>Filters</th>
<th>Repairs</th>
<th>Duct insulation</th>
<th>Pipe insulation</th>
<th>Valves/ dampers</th>
<th>Age</th>
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<td>Dirty</td>
<td>End of life</td>
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<td>RTU-2</td>
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<td>End of life</td>
<td>Minor-add note</td>
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<td>N/A</td>
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<td>RTU-3</td>
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<td>End of life</td>
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</table>
Strategies for the Site Assessment Walk Thru

- Worksheet for each system type to document findings:

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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Heater - Lochinvar HST 18-120, Janitor Room P1</td>
<td>114</td>
<td></td>
<td></td>
<td>N/A</td>
<td>1.2</td>
<td>NA</td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>103c womens locker room</td>
<td>110</td>
<td>2+</td>
<td>N/A</td>
<td>N/A</td>
<td>Low flow</td>
<td>na</td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>106 Vida</td>
<td>95</td>
<td>1.2</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td>na</td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>107 Bathroom</td>
<td>103</td>
<td>1.2</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td>N/A</td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>107 Patient Area Sinks (5)</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>107 Staff Bathroom</td>
<td>107</td>
<td>1.2</td>
<td>N/A</td>
<td>N/A</td>
<td>1.6</td>
<td>N/A</td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>107 Staff Lounge</td>
<td>107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>None observed</td>
<td>Electric water heater.</td>
<td></td>
</tr>
<tr>
<td>101 Magforce</td>
<td>92</td>
<td>1.2</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td>None observed</td>
<td>Break room sink, points, bathroom sink</td>
<td></td>
</tr>
</tbody>
</table>

The table outlines various systems with their DHW setpoints, lavatory flow rates, and toilet flows, all documented to assess and improve the site's energy efficiency.
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)
Clean Buildings: Tune-Ups

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 CO$_2$ 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
Clean Buildings: Tune-Ups

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: [link]

• 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
Clean Buildings: Tune-Ups

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

1. Document Change
2. Revise Operation
3. Energy Savings
4. Revise Operation
5. Occupant Feedback

The process is iterative, involving document changes, revision of operations, energy savings, further revisions, and occupant feedback, which then loops back to document changes.
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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