SEATTLE

BUILDING TUNE-UP ACCELERATOR

Tune-Up Accelerator Provider Training

July 11 & 12, 2017

SMART BUILDINGS CENTER

WELCOME & INTRODUCTIONS

Program Partners

Seattle Office of Sustainability & Environment

SEATTLE building tune-ups

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Training Agenda at a Glance

Day 1

- Welcome & Introductions
- Seattle Building Tune-Ups Requirement
- Building Tune-Up Accelerator
- Asset Score
- Building Re-Tuning

Day 2

- On-Site Building Re-Tuning
- Tool Lending Library
- Building Renewal
- Utility Incentives

Definitions: Tune-Ups & Re-Tuning

Seattle Building Tune-Ups Mandate

- Seattle policy requiring owners of non-residential buildings 50K SF or greater to tune-up their buildings.
- Specific required O&M actions to assess and correct.
- No incentives.

Seattle Tune-Up Accelerator Program

- Voluntary, time-limited alternative compliance path to meet Building Tune-Ups mandate.
- Buildings 100K SF or less are eligible.
- Specific required O&M actions to assess and correct.
- Incentives available.

PNNL Building Re-Tuning™

- Method & training created by PNNL to detect and correct O&M problems in buildings.
- Methods and O&M actions overlap with Seattle Tune-Up programs.

SEATTLE building tune-ups

Tune-Up Accelerator: Provider Training

Seattle Building Tune-Ups Policy

TERRY SULLIVAN, Building Tune-Ups Program Associate
July 11, 2017

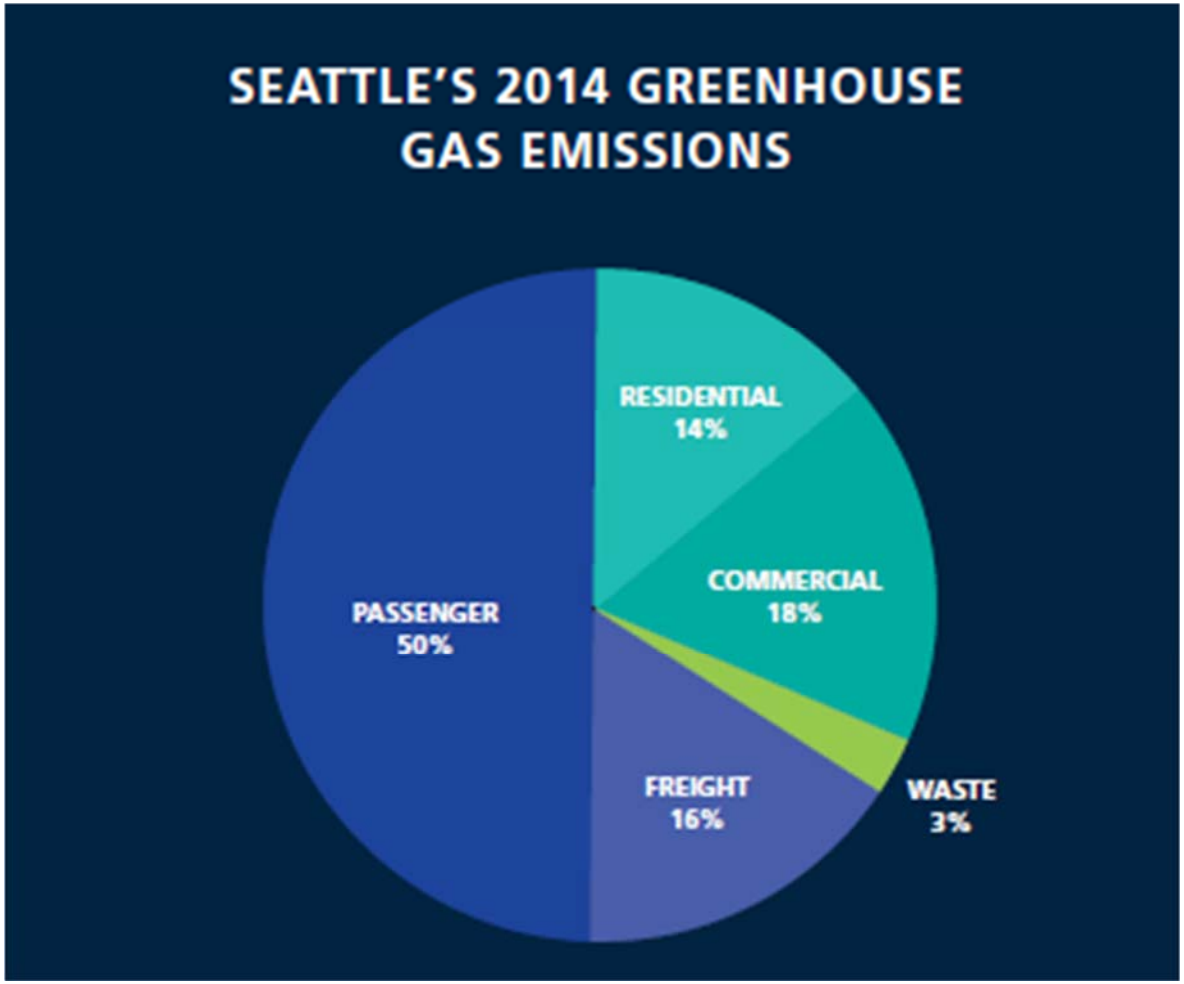
Seattle Office of Sustainability & Environment

What is a Tune-Up?

- RCx “lite”
- Operational improvements, not capital
- Generate energy and water savings through low to no-cost measures
- Currently a best practice for managing an energy efficient building

Why is the City mandating Building Tune-Ups?

Buildings are a significant contributor to carbon pollution

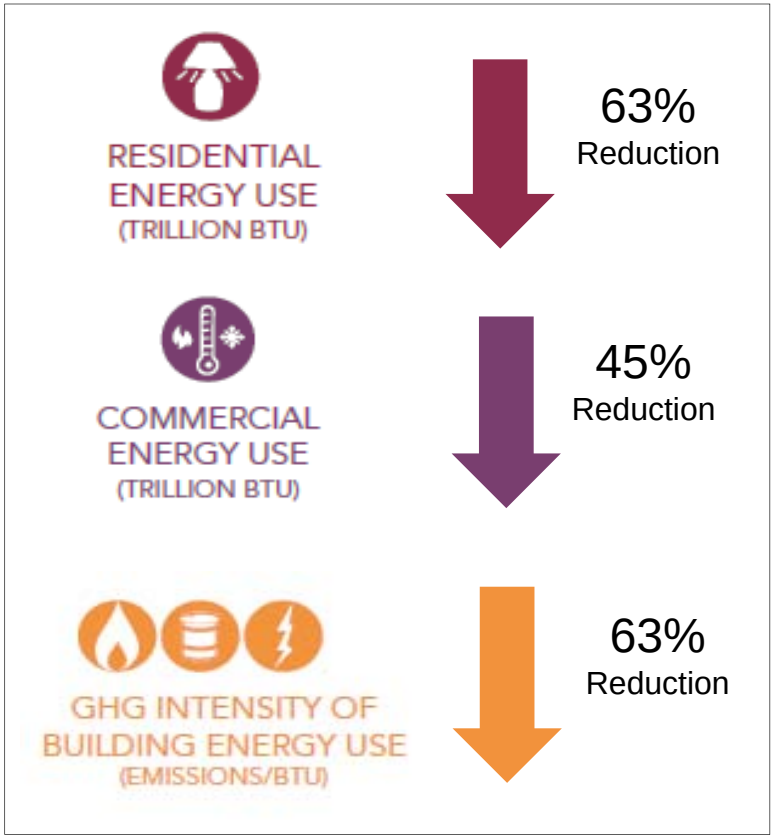


Source: 2014 Seattle Community GHG Inventory

Seattle has a bold mandate to achieve carbon goals

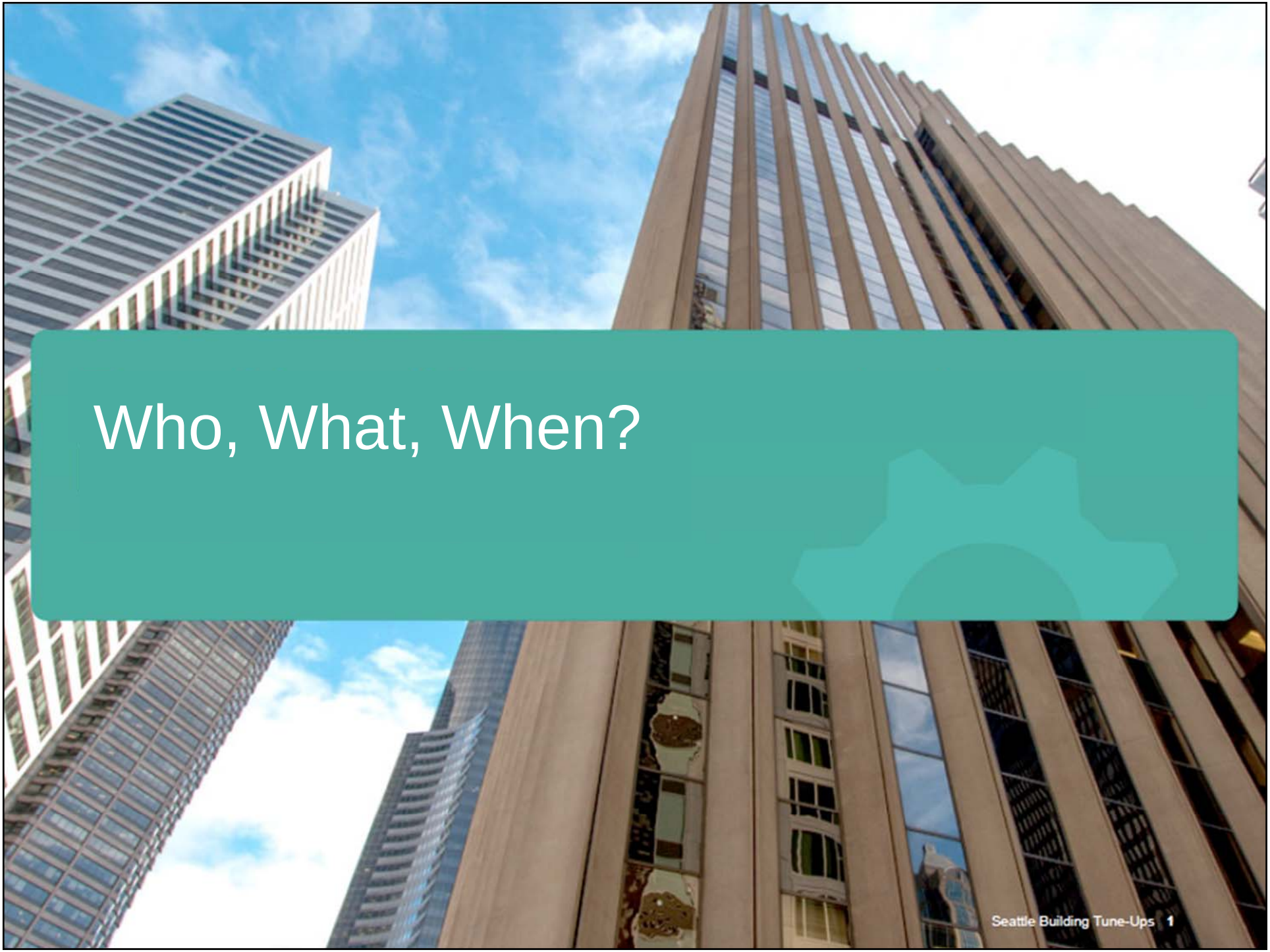
SEATTLE CLIMATE ACTION PLAN

2050 Energy & Carbon Goals



We have work to do…

- Wanted immediate savings for us and you
- A cost-effective approach (not a document on a shelf with no action)
- Practical, current best practice


Who, What, When?

Who does this mandate apply to? Who is excluded?

All non-residential buildings and commercial spaces > 50k SF (excluding parking)

Tune-up every 5 years

Excluded from mandate

- **Single-family** residential buildings
- **Multifamily** residential buildings
- **Mixed-use** buildings < 50k SF of nonresidential space
- Buildings used primarily for **manufacturing or industrial uses**
- **Buildings previously exempted** from the annual benchmarking requirement

Who can conduct the Tune-Ups?

Tune-Up Specialists must meet following qualifications

At least seven years experience ***plus*** one of the following:

- Professional Engineer
- Certified Energy Manager
- Existing Building Commissioning Professional
- Certified Commissioning Professional
- Commissioning Authority certification
- Level II Building Operator certification
- Bachelor in Sustainable Building Science Technology

TUNE-UP SCHEDULE

Ongoing, every five years

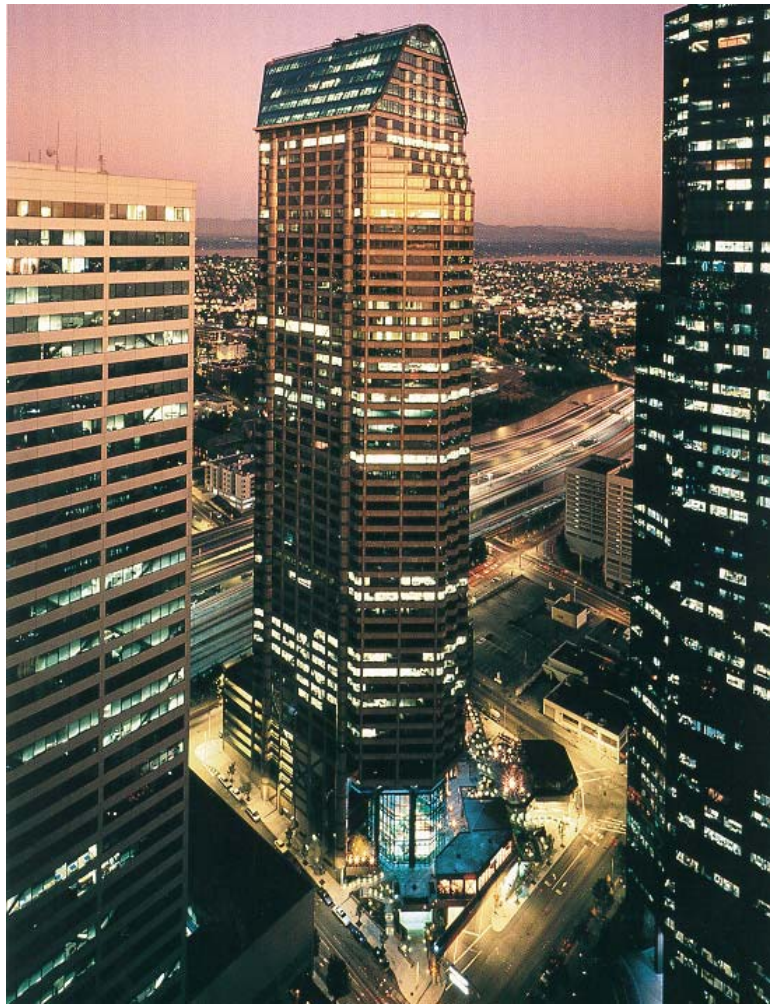
BUILDING SIZE*	DUE
200,000+ SF	10/01/2018
100,000-199,999 SF	10/01/2019
70,000-99,999 SF	10/01/2020
50,000-69,999 SF	10/01/2021

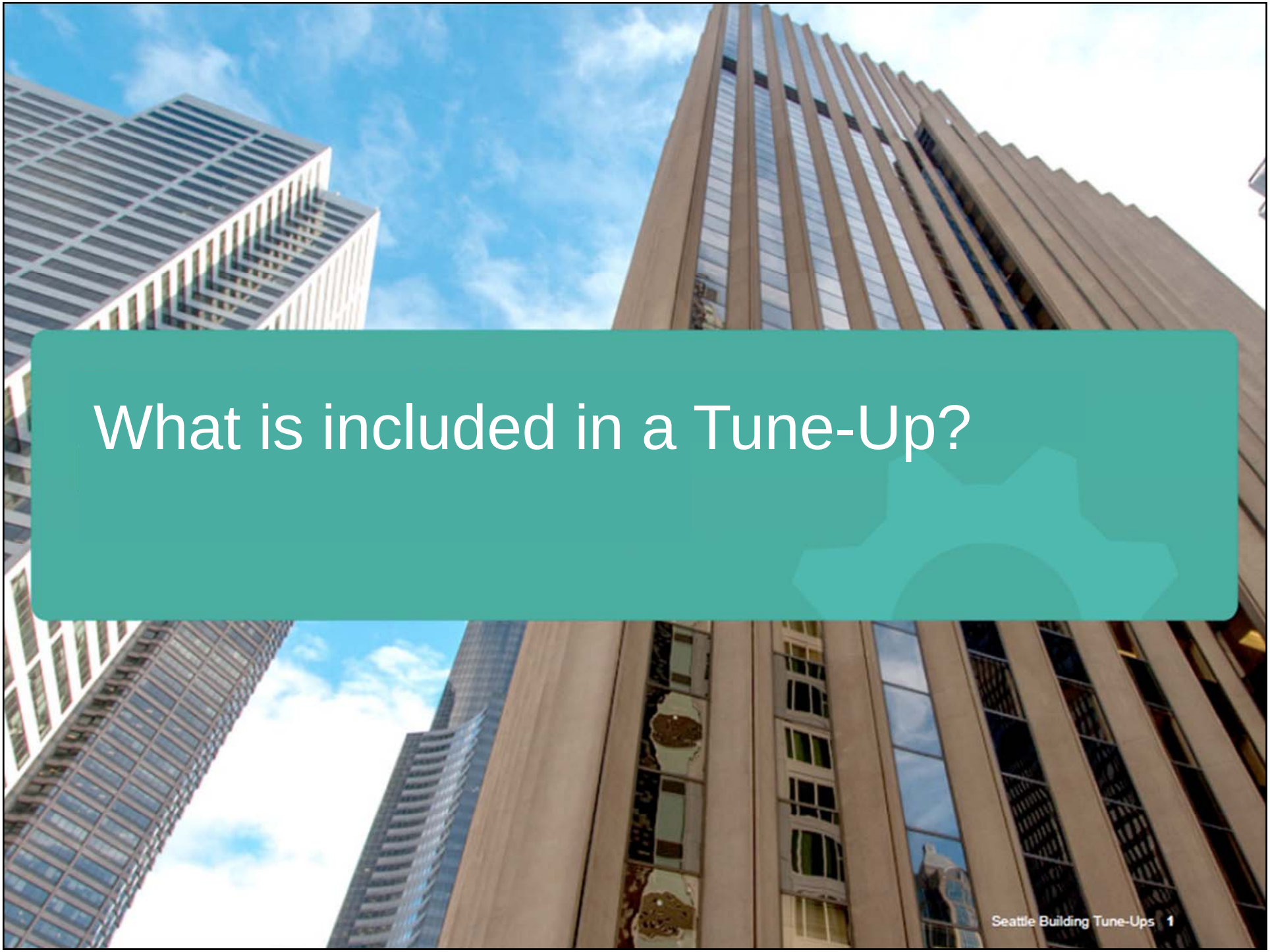
** Excluding parking*

Leading by Example

All municipal buildings must meet Building Tune-Ups deadlines one year ahead of privately-owned buildings.

Municipal Tune-Ups will save the City money and help us meet our energy reduction goals.





What is included in a Tune-Up?

The Tune-Up Process:

- An **ASSESSMENT** of building systems to identify operational or maintenance issues;
- **RECOMMENDATIONS** to building owner;
- **CORRECTIONS** to operational and maintenance issues identified in the inspection;
- **VERIFICATION** that corrections were made; and
- Submittal of a **SUMMARY REPORT** to OSE that notes the issues identified and actions taken.

The **ASSESSMENT** (by Tune-Up Specialist) includes:

- Review and verify ENERGY STAR Portfolio Manager account information.
- Review and evaluate monthly energy and water billing data.
- Documentation of basic building characteristics: HVAC systems, lighting, occupancy, space types, electric vehicle charging, other high use systems.
- On-site assessment of building systems.

Site Assessment: Energy & Water

(by Tune-Up Specialist)

Operational Protocols, Calibration, and Sequencing, e.g.

- Review HVAC equipment schedules
- Verify irrigation rain sensors are calibrated and functioning properly

Maintenance, Cleaning and Repair, e.g.

- Verify HVAC equipment is clean and adequately maintained
- Check water flow fixtures

Tune-Up Specialist Recommendations to Owner

- Identifies “Corrective Actions” required by Seattle Tune-Ups mandate, and
- Identifies voluntary measures included in the mandate.
- May also include recommendations for additional opportunities (other O&M, capital energy measures, etc.)

Format of report to owner per owner-provider contract and standard provider protocols.

Corrections: Energy & Water

(by Tune-Up Specialist, Contractor or Facilities Staff)

Operational Protocols, Calibration, and Sequencing, e.g.

- Set HVAC schedules to optimize for actual building occupancy patterns.
- Adjust calibrate or repair, as appropriate

Maintenance, Cleaning and Repair, e.g.

- Clean HVAC equipment where adversely impacting system performance
- Recommend low flow fixture of aerator replacements.

+

Additional measures requested by Owner

Verification & Report Submittal

The Tune-Up Specialist

- Verifies that corrective actions have been implemented, and
- Completes the Seattle Tune-Up Summary Report.
- Both Owner and Specialist confirm that report is accurate.

- Report is submitted by either the Owner or the Specialist on the Owner's behalf.

Building Tune-Ups Summary Report

C. BUILDING CHARACTERISTICS

C1. Total nonresidential gross floor area (excluding parking area)

C2. Parking garage area (per Portfolio Manager) if applicable

C3. Year built

C4. Year and description of any major building remodels (e.g. permitted as substantial alteration, major change of building use or function that would alter energy use)

C5. Primary building use (per Portfolio Manager)

C6. Was the building originally designed for the current use?

C7. Overall building occupancy

C8. Does the building have electric vehicle (EV) charging stations?

C9. Are they separately metered?

C11. Does the building have on-site renewables/self-generated energy?

C12. Average annual generation (if known) in kwh

C13. Provide information for the five most energy intensive space uses in the building.

Space Use (Up to five largest energy users)	Square Feet	Primary Heating System		Primary Cooling
		Type		Type
		Age		Age
		Condition		Condition

DRAFT

Building Tune-Ups Summary Report

Detailed Findings & Corrections

Assessment Element	Corrective Action	Tune-Up Finding	Status of Tune-Up Correction	Corrective Action Description	End Condition

1. HVAC
2. Lighting
3. Domestic Hot Water
4. Water Usage
5. Envelope

Alternative Compliance
Seattle Building Tune-Ups 1

Alternative Compliance Pathways

High Performance

- Certified ENERGY STAR Score
- LEED Gold for O&M
- Living Building, Petal, or Net Zero Energy
- Low Energy Consumption

Equivalent Process

- Active Monitoring & Continuous Cx
- Completed RCx
- Implemented ASHRAE L2 Audit Recs
- Reduced EUI
- New Construction or Substantial Alteration

Tune-Up Accelerator

- Program for buildings 100K SF or less
- Funding sunsets after 2018

Under Limited Circumstances

Single-Round Waiver	• Demolition • Major Renovation • Financial Distress
Extension Requests	• Change of Ownership • High Vacancy Rate • Existing Mechanical Improvements • Demonstrated 15% EUI Reduction

seattle.gov/buildingtuneups
BuildingTuneups@seattle.gov
206.727.TUNE (206.727.8863)
Seattle Building Tune-Ups 1

SEATTLE
BUILDING TUNE-UP ACCELERATOR

Tune-Up Accelerator Program Overview

PRESENTED BY:

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Seattle
Office of Sustainability
& Environment

Presentation Outline

TIME	TOPICS
10 min	Accelerator Background & Goals
5 min	Market Overview
15 min	Accelerator Overview – 3 Phases
5 min	Program Evaluation – M & V
10 min	Tune-Up Accelerator Summary Report Demo
10 min	Q & A

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BUILDING TUNE-UP ACCELERATOR

ACCELERATOR BACKGROUND & GOALS

Tune-Up Accelerator Program Goals

1. Accelerate tune-ups in small-medium buildings
2. Advance market expertise to support tune-ups
3. Generate voluntary market action towards even greater savings
4. Ensure that the mandate is effective for this market sector

Accelerator DOE Support

- Awarded to City of Seattle in 2016
- Small-Medium Commercial Buildings (100,000 SF or less)
- Implementing through August 2019

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SEATTLE building tune-ups

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Program Partner Roles

PARTNER	PRIMARY ROLES
Seattle OSE	Program Management, Enrollment, Coordination w/ Building Tune-Ups requirement, Reporting to DOE
SBC	Provider Training & Curricula, Tool Lending Library, Project Tracking, Help Desk
PNNL	Building Re-Tuning Training, Asset Score Support & Research on energy-savings from tune-ups
City Light	Tune-Up and Energy Conservation Incentives
UW IDL	Building Renewal Support, Spark Tool
US DOE EERE	Federal funding and project oversight

Accelerator Energy & Cost Savings Goals

✓Average 20% energy savings across 100 buildings or tenant spaces

✓Total Savings 99.7 Million kBtu/year

✓$1.5 Million annual cost savings

Getting to 20% Average Savings

A.	**Basic Tune-Up** Tune-Up Meets BTU Requirements	**+/- 10% Savings** (35-40 Buildings)
B.	**Tune-Up Plus** Meets Requirement + Energy Conservation Measures	**+/- 20% Savings** (+35-40 Buildings)
C.	**Building Renewal** Technical Support for Buildings Pursuing Deeper Upgrades	**+/- 35% Savings** (+20-30 Buildings)

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BUILDING TUNE-UP ACCELERATOR

SMALL – MEDIUM BUILDINGS

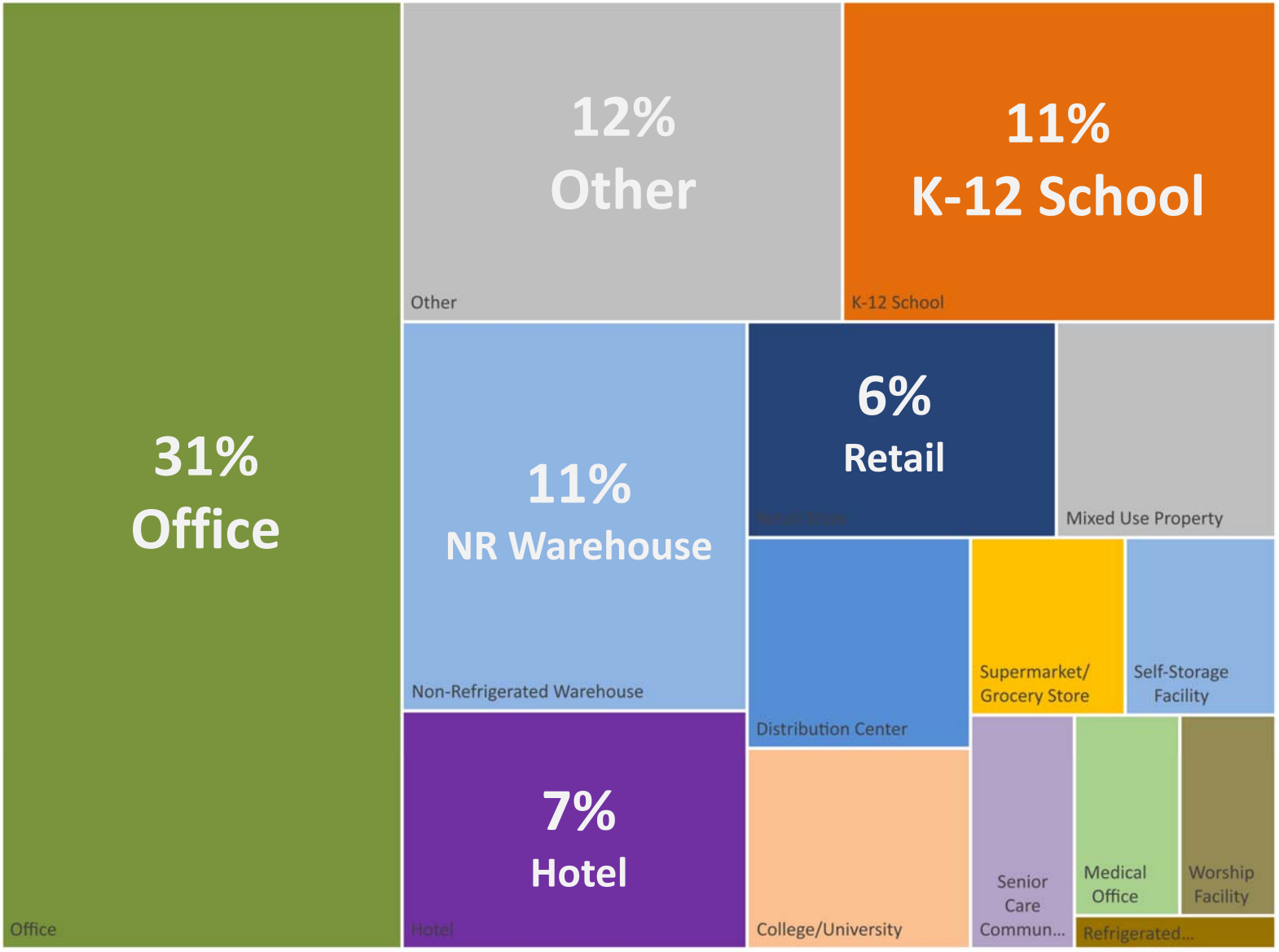
SEATTLE MARKET OVERVIEW

Seattle Market Overview

SMALL TO MEDIUM BUILDINGS			ALTERNATIVE COMPLIANCE PATH POTENTIAL		
Square Footage	**Tune-Up Compliance**	**Est. Number of Buildings**	**ENERGY STAR >=85**	**"Certified" >=85**	**EUI <=20**
70k-99,999	2020	160	45	4	14
50k-69,999	2021	230	31	4	26
20k-49,999	Optional	820	146	4	119
		1,210			

Source: 2015 Seattle Energy Benchmarking Data

Primary Use Type – Percent of Total SF, 50-100K SF (excl. parking)



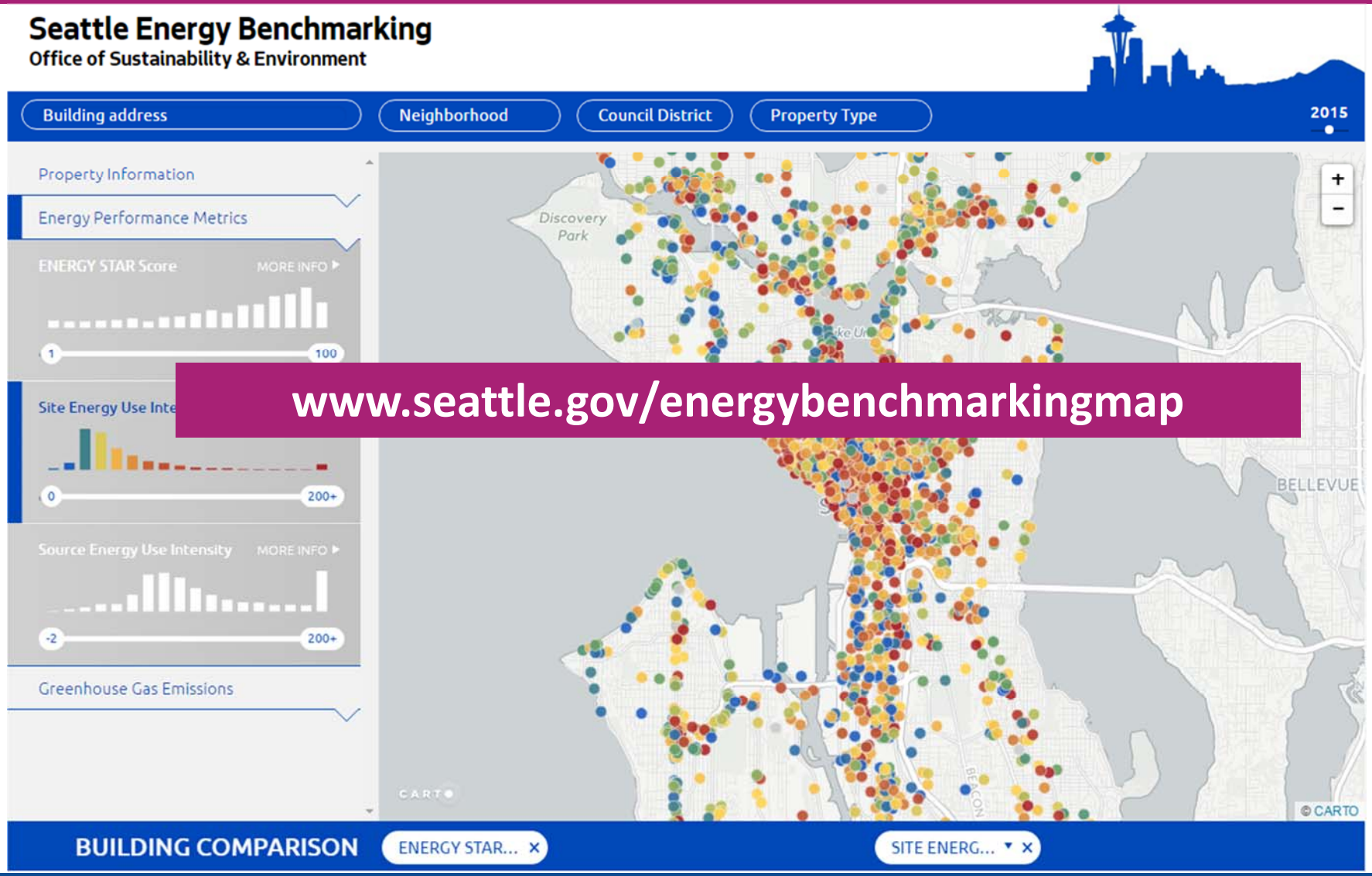
Source: 2015 Seattle Energy Benchmarking Data

Seattle Buildings 50K-100K (excl. parking)

	Est. Total #	Total SF	% SF	Total kBtu	% kBtu
Office	119	8,435,756	31%	565,944,283	30%
K-12 School	48	3,084,879	11%	97,929,277	5%
Other	47	3,134,608	12%	329,483,698	17%
Non-Ref. Warehouse	44	2,986,904	11%	96,202,490	5%
Hotel	25	1,825,005	7%	177,519,562	9%
Retail Store	22	1,484,968	6%	112,908,731	6%
Distribution Center	16	1,047,498	4%	32,877,322	2%
Mixed Use Property	16	1,053,418	4%	79,538,047	4%
College/University	14	995,990	4%	175,220,180	9%
Supermarket/Grocery Store	10	610,833	2%	106,865,395	6%
Self-Storage Facility	8	595,368	2%	8,414,018	0%
Senior Care Community	8	539,737	2%	69,802,929	4%
Medical Office	6	470,299	2%	48,294,149	3%
Worship Facility	6	428,535	2%	11,022,960	1%
Refrigerated Warehouse	2	148,072	1%	3,116,077	0%
	391	**26,841,870**	**100%**	**1,915,139,116**	**100%**

Source: 2015 Seattle Energy Benchmarking Data

Want More Building Information?



What's in it for Owners?

Incentives & support now

Tune-up early

Energy savings

SEATTLE

BUILDING TUNE-UP ACCELERATOR

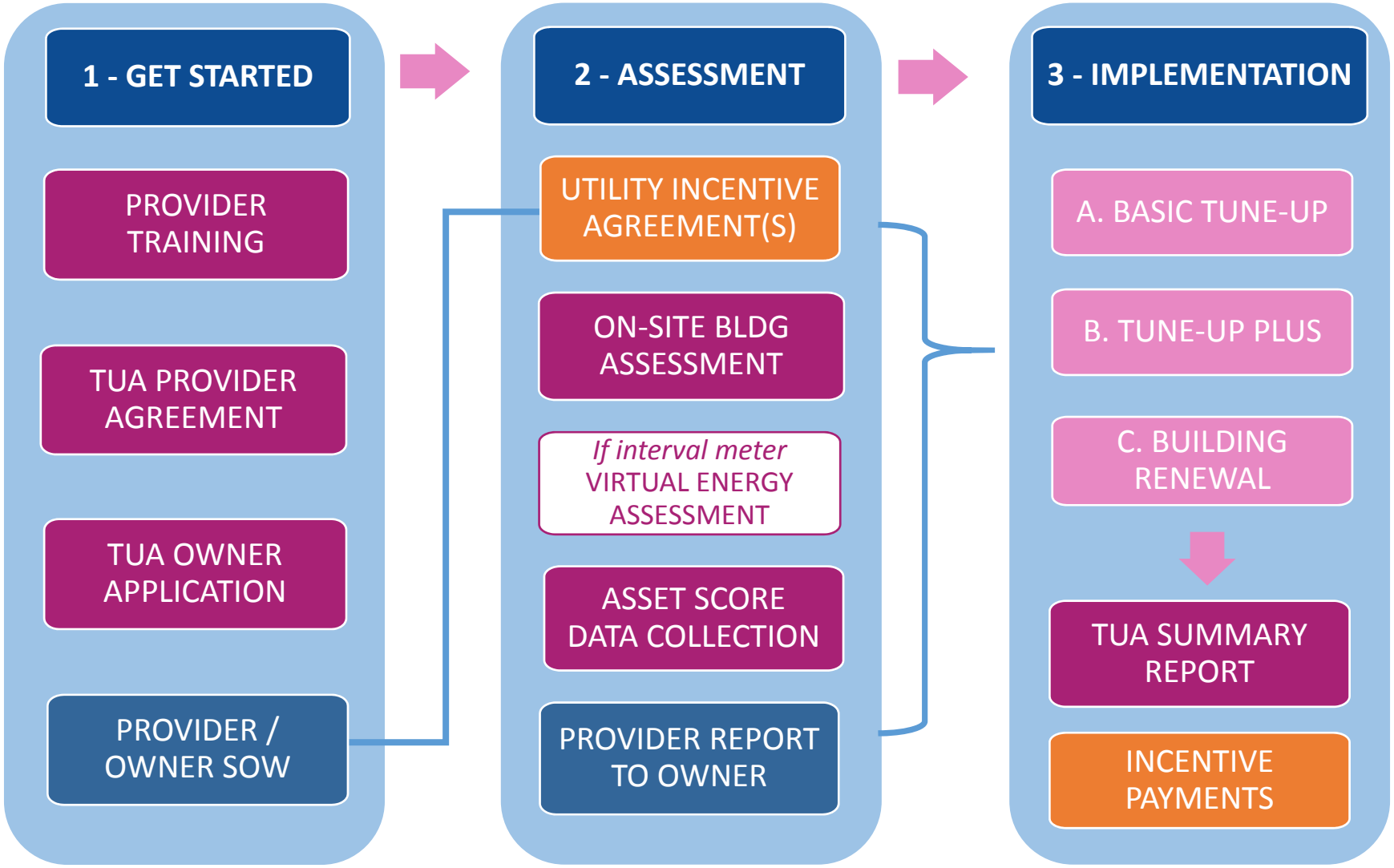
1
GET STARTED

2
BUILDING ASSESSMENT

3
IMPLEMENTATION

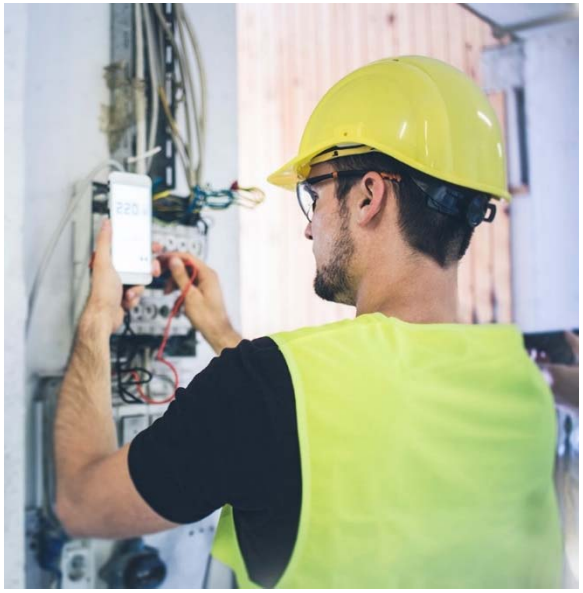
2017 → **Q2 2019**

Accelerator Overview – 3 Phases



GET STARTED: Training & Agreement

- Complete Provider Training
- Listed as participating service provider in Accelerator Program
- TUA Provider Agreement by September 30, 2017 or sooner



TUA PROVIDER AGREEMENT

PROVIDER TRAININGS

GET STARTED: Connect with Building Owner

- Contact your existing clients
- OSE is notifying building owner contacts
- Owner or Authorized Agent complete **TUA Owner Application** by December 01, 2017

TUA OWNER APPLICATION

GET STARTED: Develop Your Scope w/ Owner

- Your own contract with owner.
- SCL will also need for the incentive participation agreement.
- TUA considering a high level “market report” to provide after program completion.

PROVIDER / OWNER SOW

UTILITY INCENTIVE AGREEMENTS

GET STARTED: Explore Implementation Options

As part of SOW, consider options:

- *Client/owner just wants a tune-up that meets Seattle BTU?*
  - **Basic Tune-Up**
    SCL Incentives for Assessment & Corrective Actions
- *Considering other ECMs or RCx*?
  - **Tune-Up Plus**
    SCL or PSE Incentives, PSE CBTU Program
- *Needing comprehensive work or energy modeling support?*
  - **Building Renewal Options**
    SPARK analysis, energy modeling

GET STARTED: Working with an Owner?

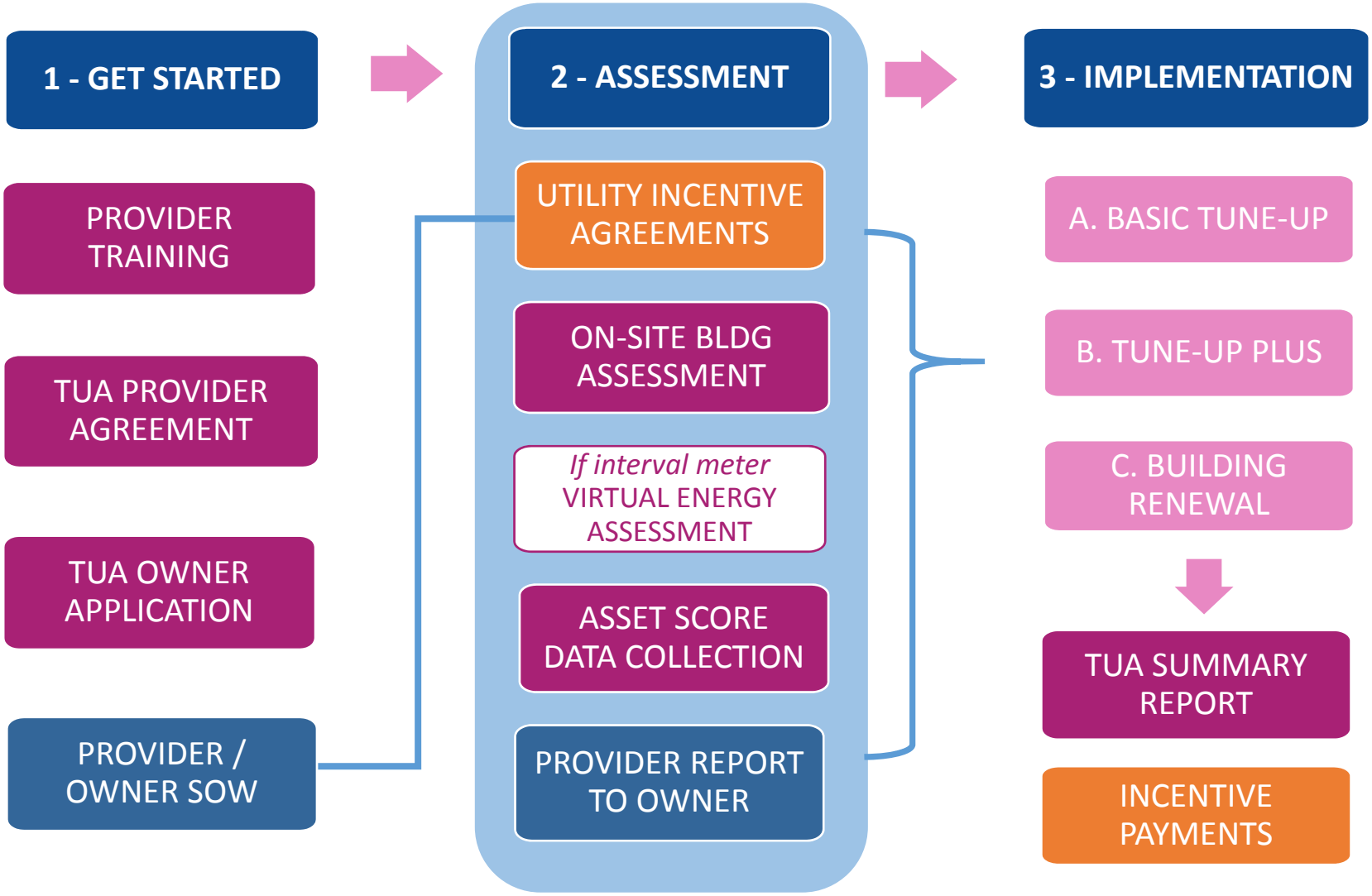
- Please let us know.
- OSE will send **TUA Summary Report Form**
- The Form will be prepopulated with some Portfolio Manager information.

OSE SENDS TUA SUMMARY REPORT FORM(S)

GET STARTED: Deliverables

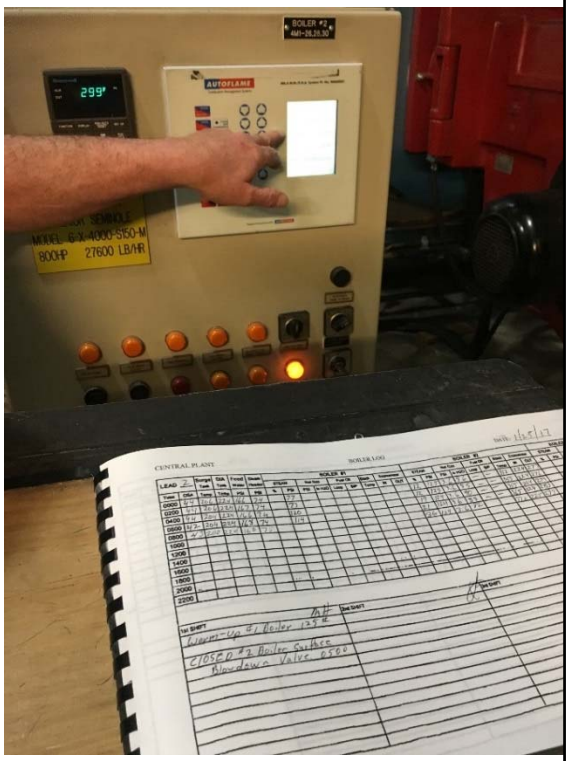
- ✓Tune-Up Accelerator Provider Agreement by 9/30/2017
- ✓Tune-Up Accelerator Owner Application by 12/1/2017
- ✓Service Provider SOW with Owner
- ✓Start work on utility incentive agreements

Accelerator Overview – Assessment Phase



ASSESSMENT: On-Site Building Assessment

- Get **Utility Agreements** in place!
- "Walkthrough"
- Trend data analysis from BAS / billing analysis
- Borrow tools from **SBC Tool Lending Library**
- Assess **Seattle Building Tune-Ups** elements (at minimum) & Benchmarking Verification
- Collect **Asset Score** required fields.



UTILITY AGREEMENTS

ON-SITE BLDG ASSESSMENT

ASSET SCORE DATA COLLECTION

ASSESSMENT: Got City Light Interval Data?

- About 50 downtown buildings in the 50K-100K range have 15-minute electric interval data
- City Light will provide a complimentary **Virtual Energy Assessment (VEA)** for these buildings to use with your Assessment.
- We will let owners know if **VEA** is an option.

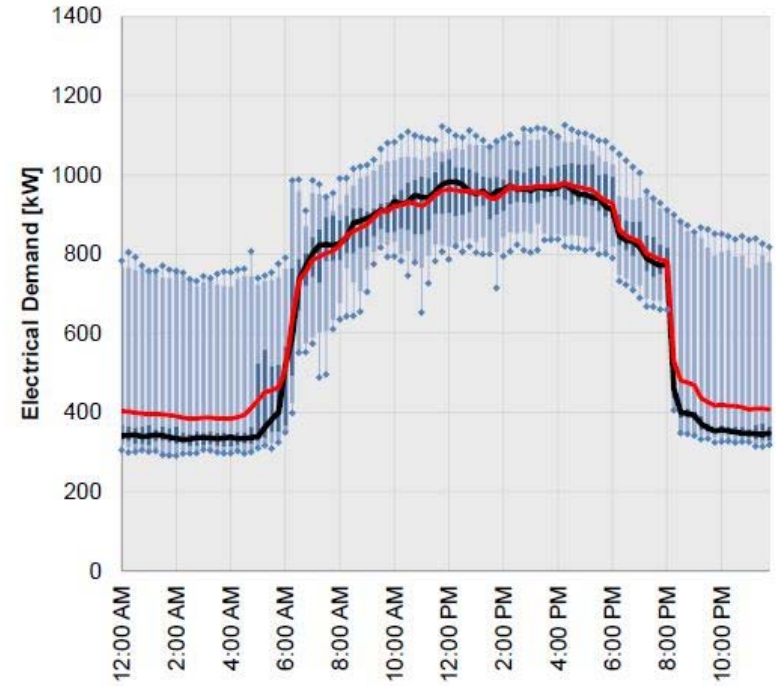


Image source: SBW

ASSESSMENT: Asset Score Data Collection

- Free web-based tool developed by that generates a “score” and suggest potential improvements.
- Accelerator Program is using to collect more building asset details to inform retrofit opportunities.
- Program wants to determine if this information helps motivate owners to take action beyond what is required by the tune-up.

https://buildingenergyscore.energy.gov

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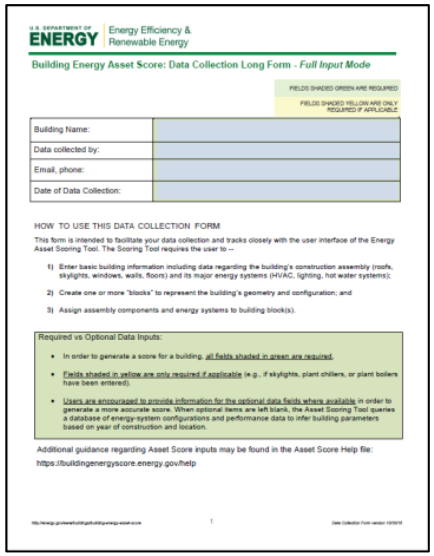
ASSESSMENT: Asset Score Incentive Options

A – $600 Incentive to Provider

- Return completed PDF form to OSE no later than 15 days after Assessment
- Provider sends invoice to OSE
- Asset Score Report provided to you and Owner.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Building Energy Asset Score: Data Collection Long Form - *Full Input Mode*

FIELDS SHADED GREEN ARE REQUIRED

FIELDS SHADED YELLOW ARE ONLY REQUIRED IF APPLICABLE

Building Name:	
Data collected by:	
Email, phone:	
Date of Data Collection:	

HOW TO USE THIS DATA COLLECTION FORM

This form is intended to facilitate your data collection and tracks closely with the user interface of the Energy Asset Scoring Tool. The Scoring Tool requires the user to --

1) Enter basic building information including data regarding the building's construction assembly (roofs, skylights, windows, walls, floors) and its major energy systems (HVAC, lighting, hot water systems);
2) Create one or more "blocks" to represent the building's geometry and configuration; and
3) Assign assembly components and energy systems to building block(s).

Required vs Optional Data Inputs:

- In order to generate a score for a building, all fields shaded in green are required.
- Fields shaded in yellow are only required if applicable (e.g., if skylights, plant chillers, or plant boilers have been entered).
- Users are encouraged to provide information for the optional data fields where available in order to generate a more accurate score. When optional items are left blank, the Asset Scoring Tool queries a database of energy-system configurations and performance data to infer building parameters based on year of construction and location.

Additional guidance regarding Asset Score inputs may be found in the Asset Score Help file:
https://buildingenergyscore.energy.gov/help

B – $1,000 Incentive to Provider

- Enter data into online tool, run report & provide to Owner
- Share online report with Accelerator (see handout)
- Provider sends invoice to OSE

https://buildingenergyscore.energy.gov

ASSESSMENT: Your Provider Report to Owner

- After Assessment is complete, your own report to Owner
  - Identifies “Corrective Actions” to meet BTU requirements
  - Recommendations additional opportunities (Capital ECMs, other O&M, Renewal, etc.)
  - Your firm, owner staff or other vendor might implement
- Report needed for SCL Basic Tune-Up incentive

PROVIDER REPORT TO OWNER

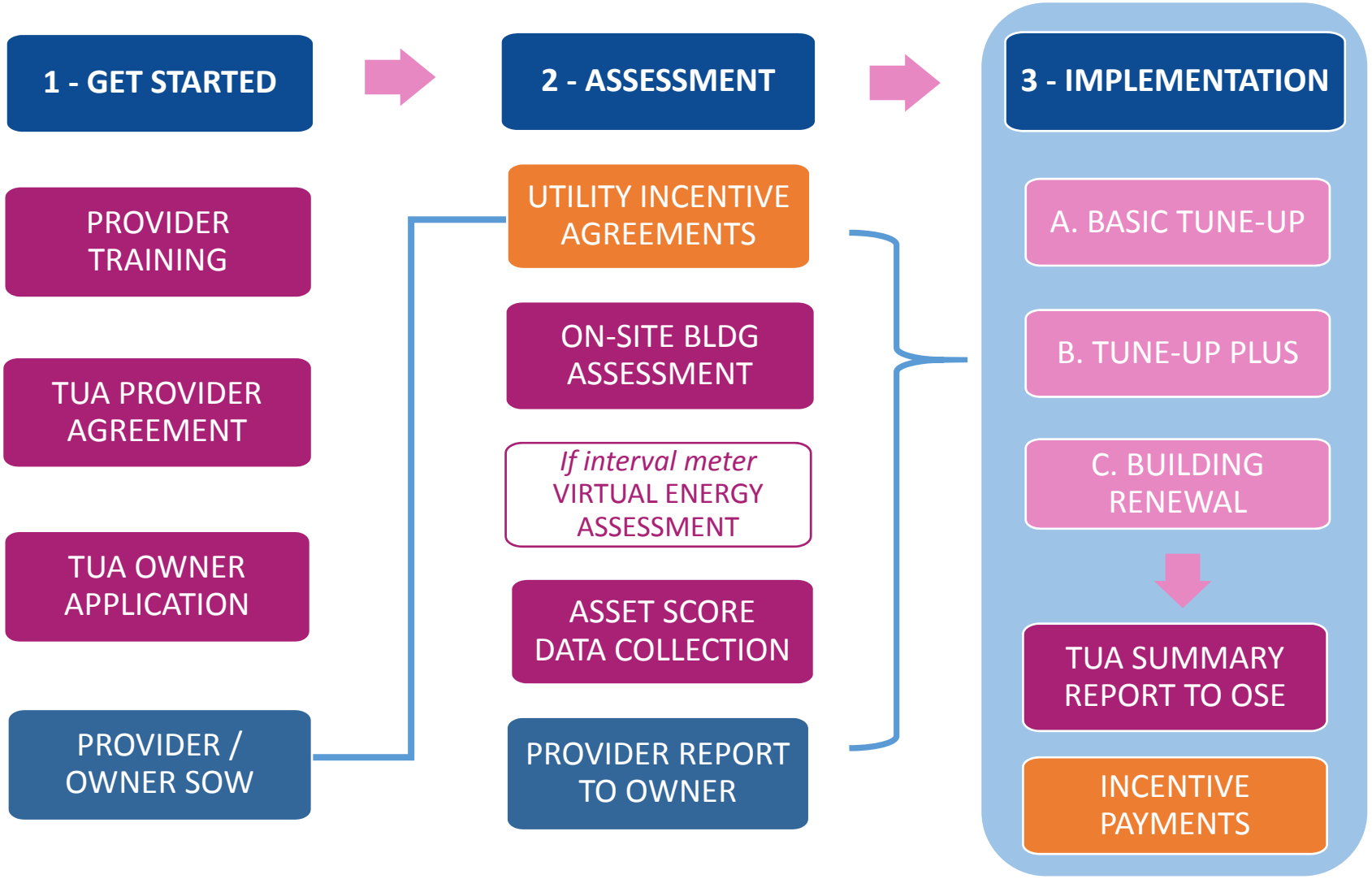
ASSESSMENT: Accelerator Deliverables

✓Building Assessment *by 8/30/2018*

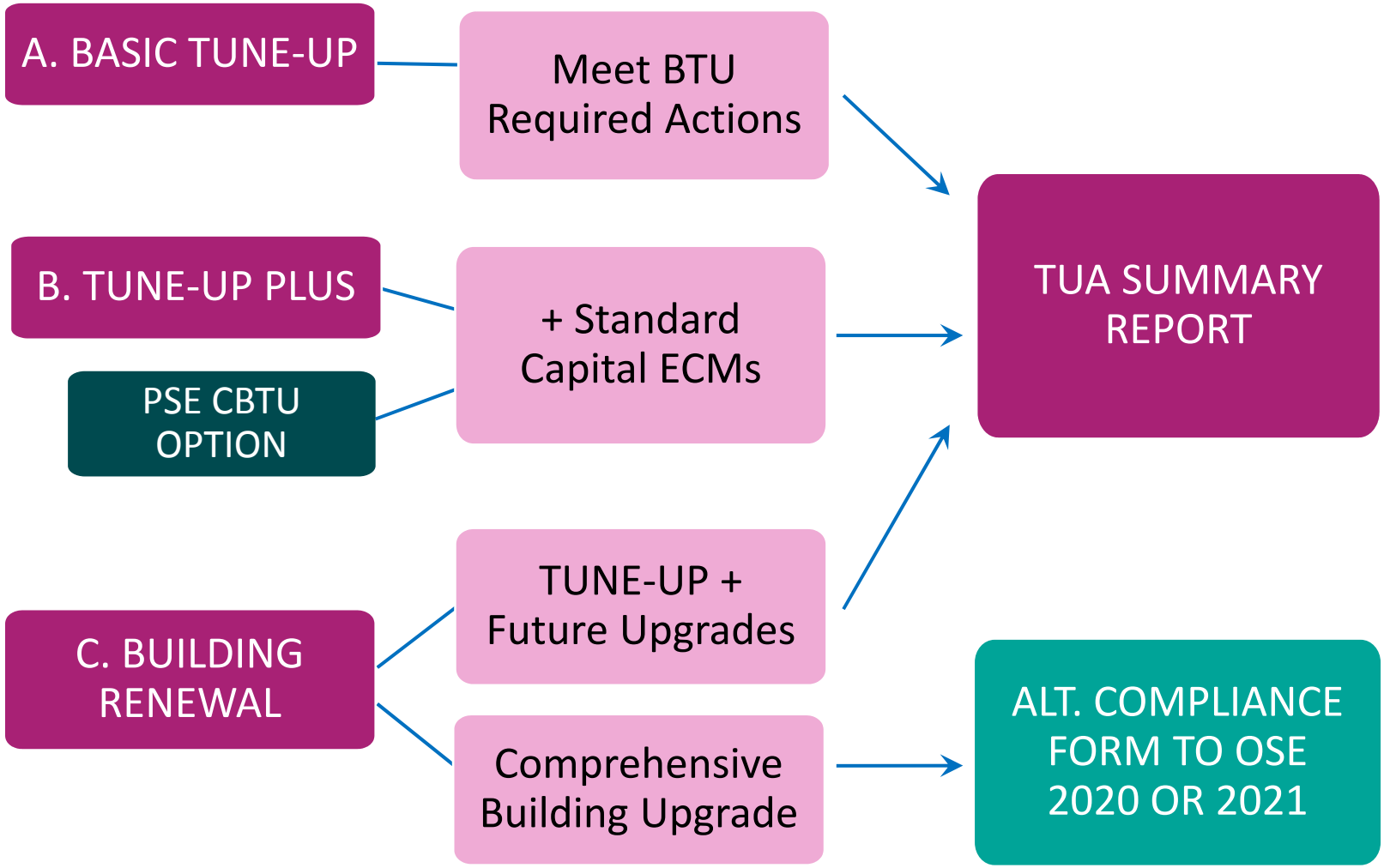
✓Complete Asset Score data collection

(15 days after assessment)

Accelerator Overview – Implementation Phase



IMPLEMENTATION: Options



A. BASIC TUNE-UP INCENTIVE

Incentives **per SF**

A. BASIC TUNE-UP

Seattle City Light

- ☐ For buildings w/ **monthly meter data**
- ☐ **$.03 per SF** City Light incentive for on-site Assessment
- ☐ **Complete all required corrective actions for Seattle Building Tune-Ups**
- ☐ **$.09 per SF** City Light incentive for required actions*

EXAMPLE:

75,000 SF Building

- Up to $9,000 Total
- $2,250 after assessment
- Up to $6,750 at completion

**Incentive capped at 70% of tune-up costs*

B. TUNE-UP PLUS INCENTIVE

Incentives **per SF**

B. TUNE-UP PLUS

Seattle City Light

- ☐ For buildings w/ monthly meter data
- ☐ **$.03 per SF** City Light incentive for on-site Assessment
- ☐ **Complete all required corrective actions that meet Seattle Building Tune-Ups**
- ☐ **$.09 per SF** City Light incentive for required actions
- ☐ **Capital ECMs (SCL or PSE)** with incentives based on standard programs
- ☐ PSE Comprehensive Building Tune-Up (CBTU) option – natural gas

EXAMPLE:

75,000 SF Building

- Up to $9,000 Total
- $2,250 after assessment
- Up to $6,750 at completion*

+ ECM Example

- Standard SCL lighting retrofit covers 40-70% of project cost

**Incentive capped at 70% of tune-up costs*

VIRTUAL ENERGY ASSESSMENT

Incentives **per SF**

A. BASIC TUNE-UP

B. TUNE-UP PLUS

Seattle City Light

- ☐ Complimentary **Virtual Energy Assessment** from City Light For buildings **w/ interval meter** data
- ☐ **$.03 per SF** City Light incentive for on-site Assessment
- ☐ **Complete all Seattle Building Tune-Ups required corrective actions**
- ☐ **$.09 per SF** City Light incentive for required actions
- ☐ May include PSE capital ECMs or PSE CBTU

EXAMPLE:

75,000 SF Building

- Up to $9,000 Total
- $2,250 after assessment
- Up to $6,750 at completion*

+ ECM Example

- Standard SCL lighting retrofit covers 40-70% of project cost

B. TUNE-UP PLUS – CBTU OPTION

- Building has significant heating and/or cooling natural gas use?
- Does owner wish to pursue a more comprehensive commissioning approach?
- Pre-approval by PSE & use of PSE approved provider required.
- Discuss first with PSE to see if gas use and potential savings qualifies – then work with City Light.

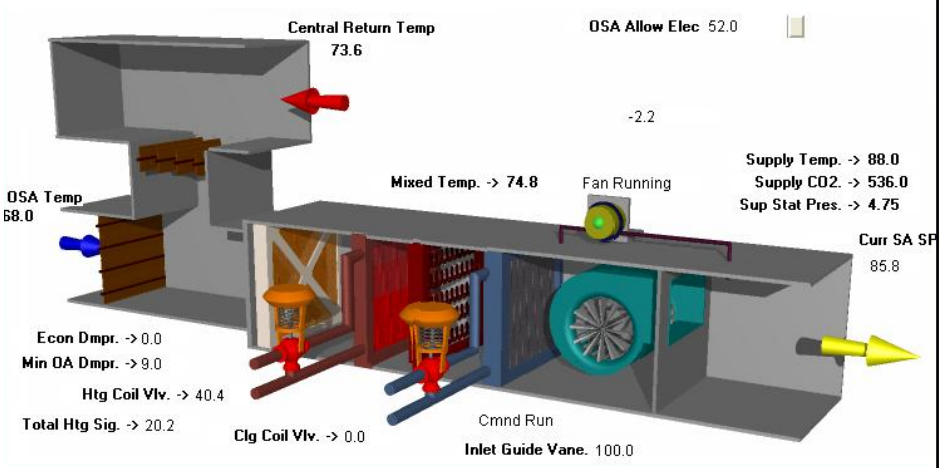
PSE PUGET SOUND ENERGY

PSE CBTU ASSESSMENT AGREEMENT

C. BUILDING RENEWAL – DEEPER SAVINGS

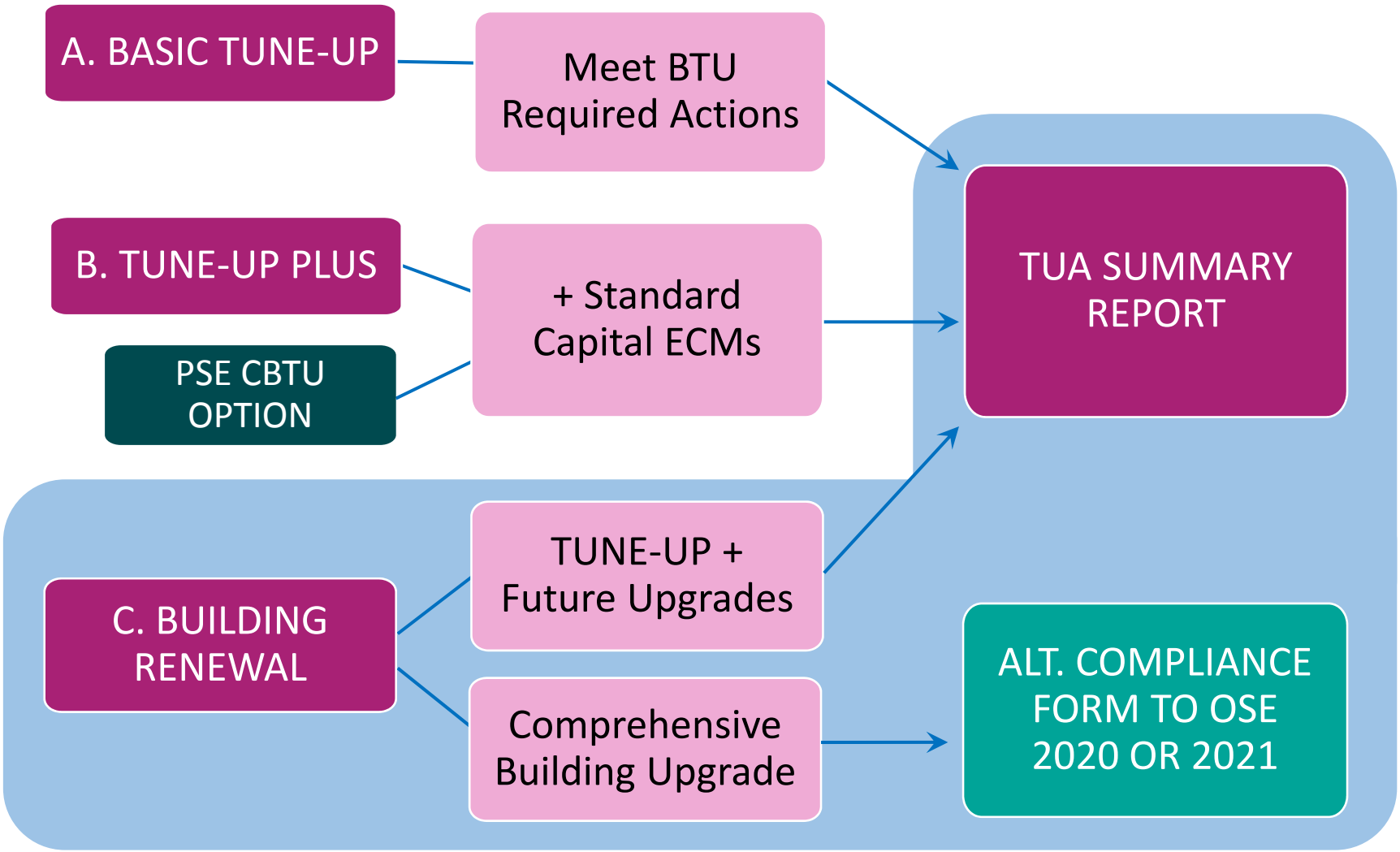
Resources for up to **25 participant buildings** pursuing deeper energy savings through building renewal at **three levels of project engagement**.

- SPARK Analysis
- Technical Assistance for Goal Setting/Lighting/Controls Retrofit Evaluation/Envelope upgrades
- Engineering Analyses
- SCL and PSE standard incentives could apply for deep retrofits



INTEGRATED DESIGN LAB
UNIVERSITY of WASHINGTON // W

IMPLEMENTATION: Options



IMPLEMENTATION: Accelerator Deliverables

- ✓Send complete **TUA Summary Report** to OSE by June 30, 2019 or sooner
- ✓Complete all utility deliverables needed for incentive payments

Accelerator M & V of Buildings

- About 10% of buildings will be asked to participate in Measurement and Verification (M & V)
- Goal is to look at projected vs. measured savings.
- May require one or more site visits to set up & retrieve data loggers.
- Results will not impact utility incentives.

Accelerator – Evaluation & Refinement

Program Final Report to DOE

- Energy and GHG savings analysis for program impact
- Pre and post tune-up energy use by fuel source (as available)
- Effectiveness of Asset Score as an analytic tool
- High level review of tune-up measures implemented
- Qualitative assessment of what motivated owners – tools, support, data, incentives.
- Case Studies

Program Refinement and Scalability

- Recommendation for establishing long-term owner assistance and engagement
- Recommendation to OSE for Building Tune-Ups Rule updates

Data Privacy

- All building data in public reports will be anonymized or in aggregate groupings.
- Building owner, service provider names and identifying project details will only be used with permission.
- Personal information is subject to Washington Public Records Act, and may be subject to disclosure to a third-party requestor.

Helpdesk Support from SBC

Help Desk Hotline

206-800-7211

Help Desk Email

accelerator@seattle.gov

SMART BUILDINGS CENTER A project of NEEC

Next Steps

- Financing options under development
- Service Provider agreement
- Sign-up buildings to participate!

QUESTIONS ?

TUNE-UP ACCELERATOR SUMMARY REPORT DEMO

SEATTLE
BUILDING TUNE-UP ACCELERATOR

15 Minute Break

SEATTLE
BUILDING TUNE-UP ACCELERATOR

DOE Building Energy Asset Score

PRESENTED BY:

Richard Fowler and Juan Gonzalez, PNNL
Energy Asset Score Technical Support
asset.score@pnnl.gov
buildingsenergyscore.energy.gov

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U.S. DEPARTMENT OF ENERGY

Learning Objectives and Course Outline

Learning Objectives

- Awareness of the Asset Score tool
- Understand basics of data collection, tool navigation, data entry, and score reports
- Insight into tool best practices
- Know where to go for help and additional resources

Course Outline

I. Introduction to Asset Score
II. Data Collection
III. Using Asset Score: Entering Data and Generating Score Reports

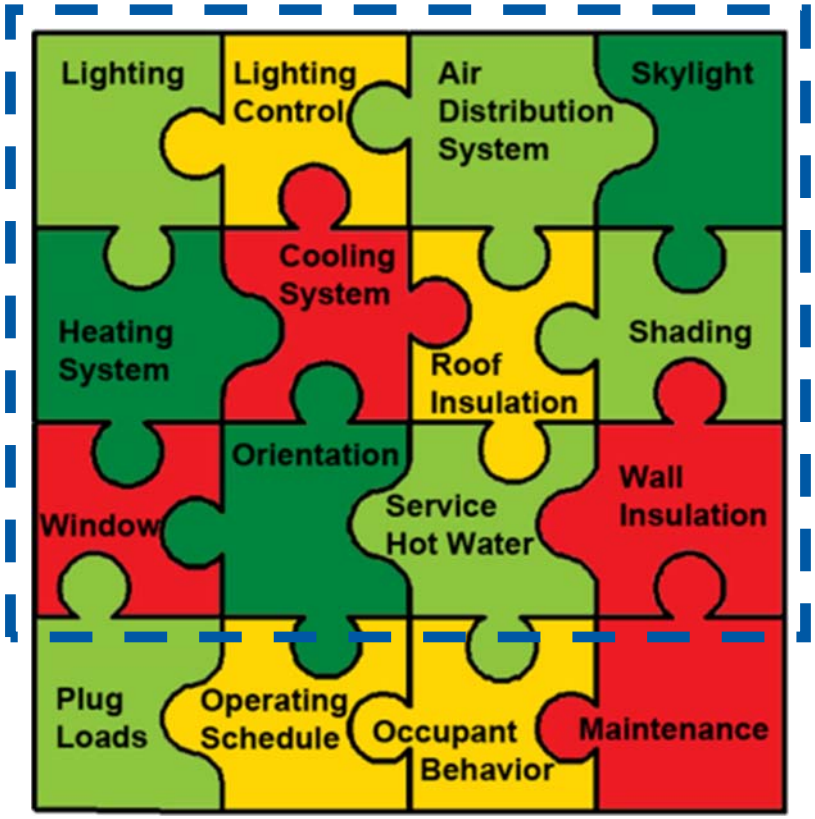
I. Introduction to Asset Score

- What is Building Energy Asset Score?
- What Does the Asset Score Tool Do?
- Asset Score vs. ENERGY STAR® Portfolio Manager
- Why was Asset Score Developed?
- Asset Score and the Tune-Up Accelerator Program
- How does the Asset Score Tool Work?
- What is the Asset Score Scale?
- How do I Score a Building?

BUILDING ENERGY ASSET SCORE

What is Building Energy Asset Score?

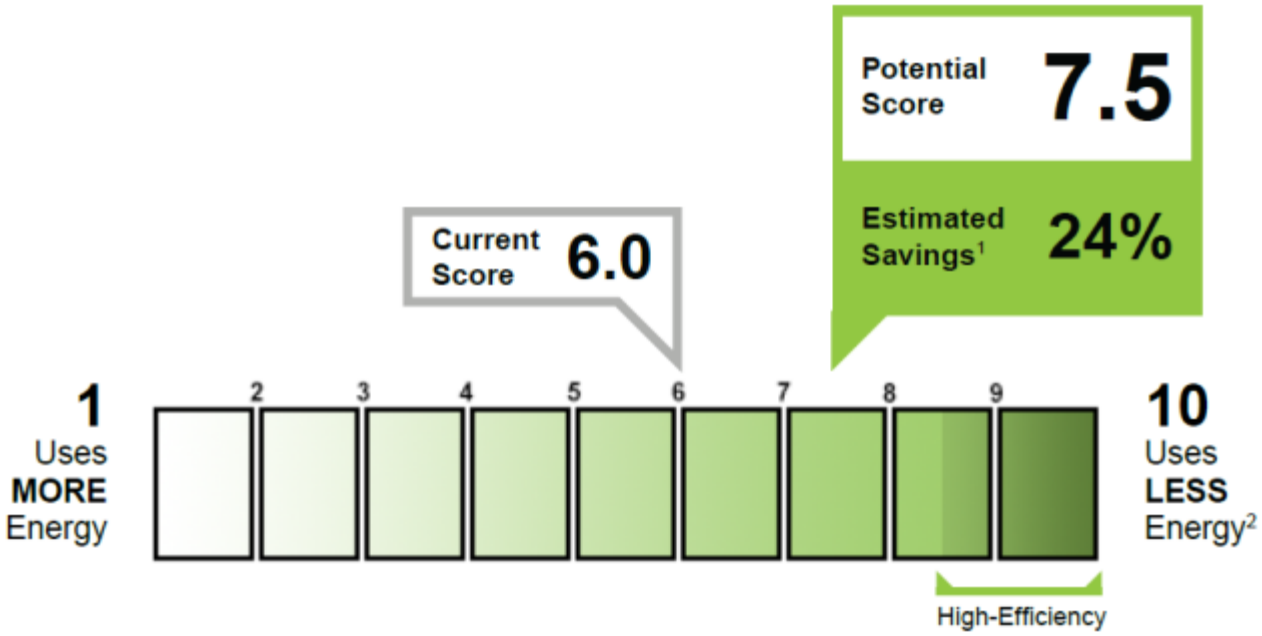
- Free web-based tool for assessing the physical and structural energy efficiency of commercial and multifamily residential buildings
- Evaluates building energy "assets": envelope and major energy-related systems and equipment
- Identifies opportunities for improvement



BUILDING ENERGY ASSET SCORE

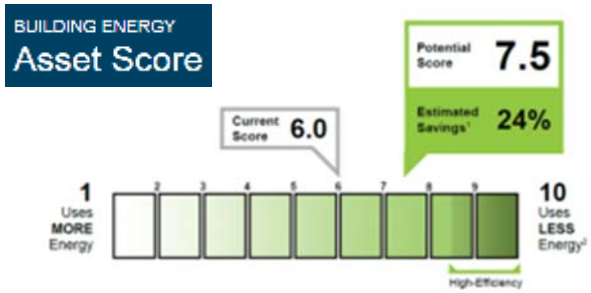
What Does the Asset Score Tool Do?

- Generates an energy **asset score** and produces an **asset score report**



BUILDING ENERGY ASSET SCORE

Asset Score vs. ENERGY STAR Portfolio Manager



What do the scores represent?

- **ESPM:** comparison of buildings based on their energy consumption, as indicated by actual energy bills; does the building need a tune-up?
- **Asset Score:** energy efficiency of a building based solely on its design, construction, and energy systems; does a building need new equipment?

Are the scores directly comparable? - No

- **ESPM:** reflect measured energy use under actual operating conditions.
- **Asset Score:** reflect modeled energy use under standard operating conditions

BUILDING ENERGY ASSET SCORE

Why was the Asset Score Tool Developed?

- Expand nationwide awareness of opportunities to invest in building energy upgrades.
- Quick, easy to use tool to help guide energy improvement decisions and investments.
- Not intended as a replacement for building energy usage benchmarking or building energy audits, but a complimentary tool
- Help make your job easier and faster
- Thousands in savings identified to date by users such as NOAA, Murphy & Miller, Inc., Missouri Department of Economic Development

BUILDING ENERGY ASSET SCORE

Asset Score and the Tune-Up Accelerator Program

- Why is Asset Score a part of the Tune-Up Accelerator Program?

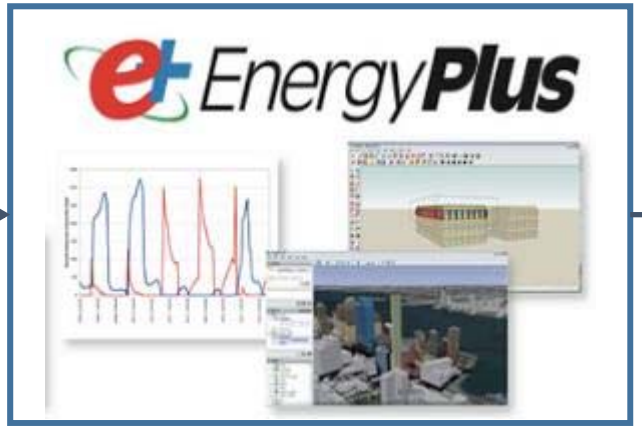
- What will DOE/OSE do with the collected data?

BUILDING ENERGY ASSET SCORE

How does Asset Score Work?

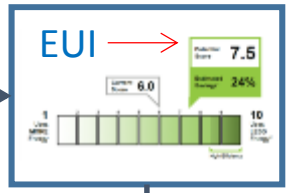
Collect data during Assessment

Web interface



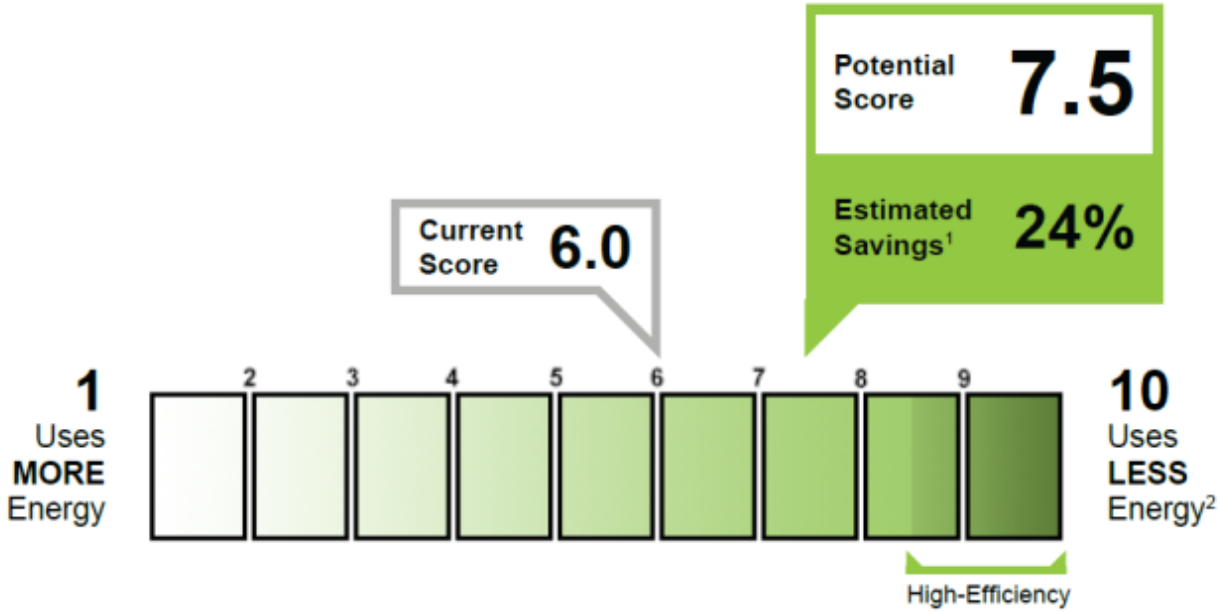
- Energy simulation using building energy modeling engine (EnergyPlus)
- Normalizes for building operations, occupancy and tenant behavior

Estimated EUI converted to Score



Outputs

Asset Score Scale



Key components:

- Shaded 10-point gradient represents a building's efficiency
- Current Score
- Potential Score
- Estimated savings

BUILDING ENERGY ASSET SCORE

How Do I Score a Building?

Three Steps:

1. Collect Building Data During “Assessment” Phase
2. Enter Data into the Asset Score Tool
3. Generate an Asset Score Report

BUILDING ENERGY ASSET SCORE

II. Data Collection

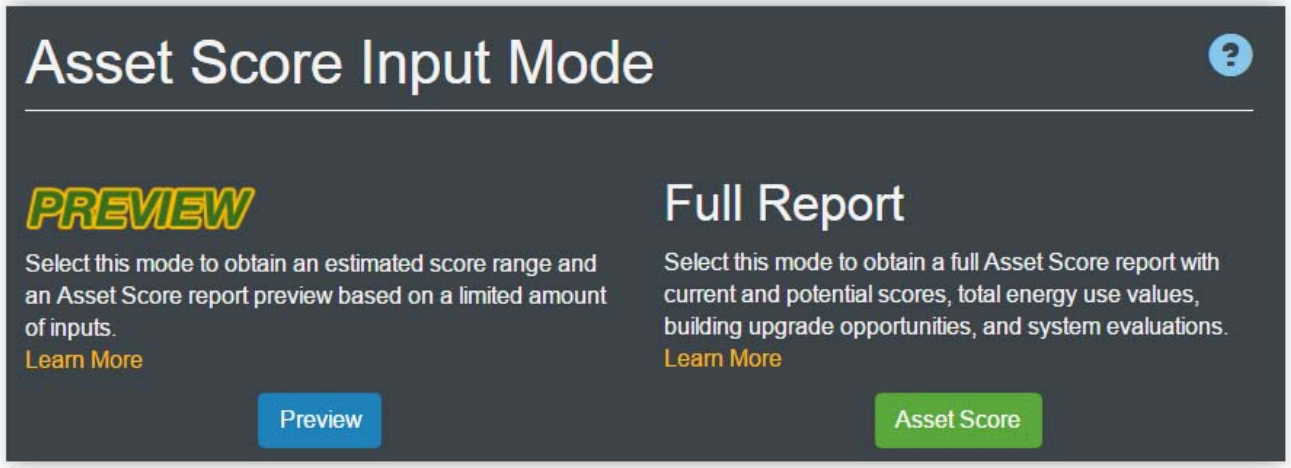
The first step in the Asset Score process is to collect baseline data on a building you want to evaluate and score. This section will focus on:

- Data collection methods and forms
- Required vs. optional fields
- Simplifying entries
- Data collection form walkthrough

Asset Score Input Modes

Asset Score offers an option to generate a score preview or a full score report depending on the type and amount of inputs entered:

- Preview mode
- Full report mode

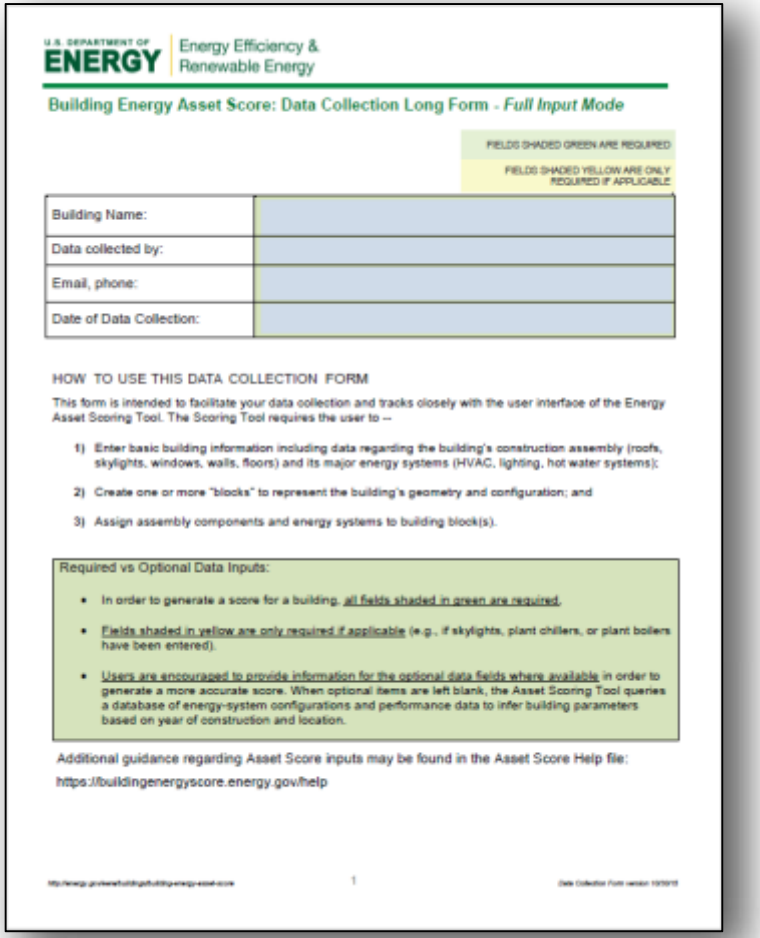


Data Collection Method and Forms

- Perform a building walkthrough
- Record data
- Asset Score Data Collection Form:

Short form: minimum required data fields necessary to generate an Asset Score; simple building and limited knowledge of asset details

Long form: all building shapes, mixed use types, complex HVAC systems, all tool input fields



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building Energy Asset Score: Data Collection Long Form - *Full Input Mode*

FIELDS SHADED GREEN ARE REQUIRED

FIELDS SHADED YELLOW ARE ONLY REQUIRED IF APPLICABLE

Building Name:	
Data collected by:	
Email, phone:	
Date of Data Collection:	

HOW TO USE THIS DATA COLLECTION FORM

This form is intended to facilitate your data collection and tracks closely with the user interface of the Energy Asset Scoring Tool. The Scoring Tool requires the user to --

1) Enter basic building information including data regarding the building's construction assembly (roofs, skylights, windows, walls, floors) and its major energy systems (HVAC, lighting, hot water systems);
2) Create one or more "blocks" to represent the building's geometry and configuration; and
3) Assign assembly components and energy systems to building block(s).

Required vs Optional Data Inputs:

- In order to generate a score for a building, all fields shaded in green are required.
- Fields shaded in yellow are only required if applicable (e.g., if skylights, plant chillers, or plant boilers have been entered).
- Users are encouraged to provide information for the optional data fields where available in order to generate a more accurate score. When optional items are left blank, the Asset Scoring Tool queries a database of energy-system configurations and performance data to infer building parameters based on year of construction and location.

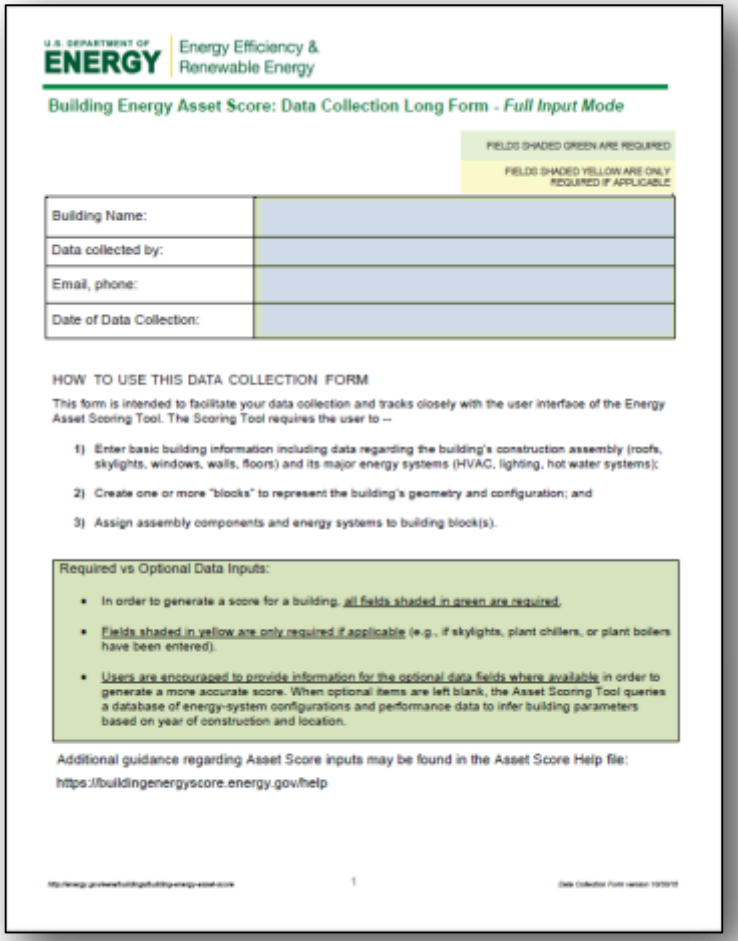
Additional guidance regarding Asset Score inputs may be found in the Asset Score Help file:
https://buildingenergyscore.energy.gov/help

https://buildingenergyscore.energy.gov/resources

BUILDING ENERGY ASSET SCORE

Data Collection Long Form

- Complete electronically or print out and complete manually
- Organized to match the data entry steps in the tool user interface
- **All fields shaded in green are required**
- Fields shaded in yellow are only required if applicable



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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https://buildingenergyscore.energy.gov/help

BUILDING ENERGY ASSET SCORE

Data Collection Form – Example Building

Example building:

Example Building - Mixed Use

2000 A Street

Chicago, IL 60601

BUILDING ENERGY ASSET SCORE

Data Collection Form - Required Fields

Required input fields for the following sections of the Data Collection Form and the Asset Score Tool include:

- **General Building Information:** Year of completion; gross floor area; location; building use type
- **Construction Properties (Envelope components):** Roof, exterior wall, and floor types; fenestration types and window to wall ratio
- **Lighting:** Fixture and mounting types, lamp wattage and lamps per fixture (to calculate lighting power density)
- **Heating and Cooling:** Heating and cooling source, distribution equipment type
- **Geometry:** Building ("block") footprint shape and dimensions, number of floors, floor-to-floor/ceiling height, orientation

BUILDING ENERGY ASSET SCORE

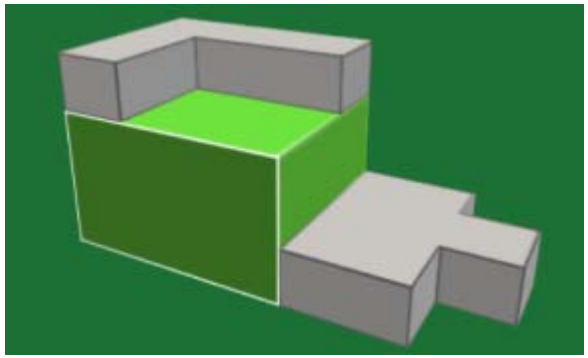
Data Collection Form - Optional Fields

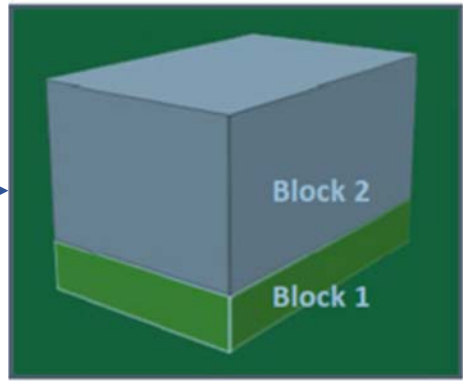
- Service Hot Water and Operations Inputs
- Unshaded data fields – encouraged for improved results
- Data Collection Priority Map available to download from the Asset Score Resources page:
  https://buildingenergyscore.energy.gov/resources
- Which are the most important recommended optional fields for Seattle buildings?
  - Envelope thermal property fields: roof, wall, and floor insulation, and window U-Value
  - Heating, cooling and water heating efficiency values are less important

BUILDING ENERGY ASSET SCORE

Building Blocks

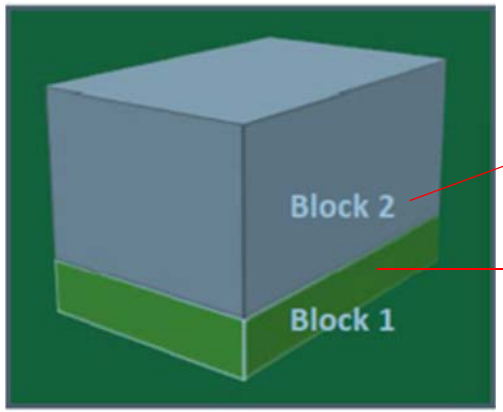
Graphical representations of your building's footprint and shape





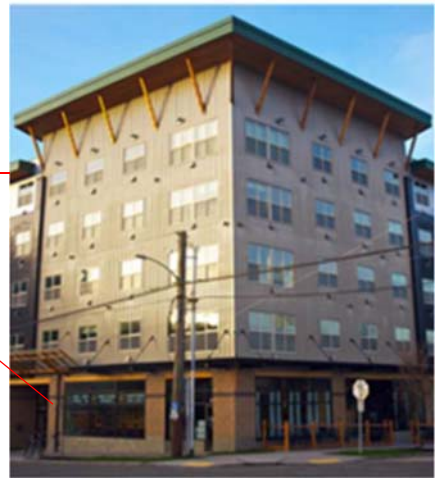
General Building Information

- Accounts for the age of the building, its size, location, and use
- Building use type
  - Select from the 19 available use types
  - Make note of the square feet for each use type
  - For mixed-use buildings, choose up to 5 use types. Each use type must be >2500 sq ft and >5% of the total building GFA
  - See Use Type handout to compare to Tune-Up selections



Office

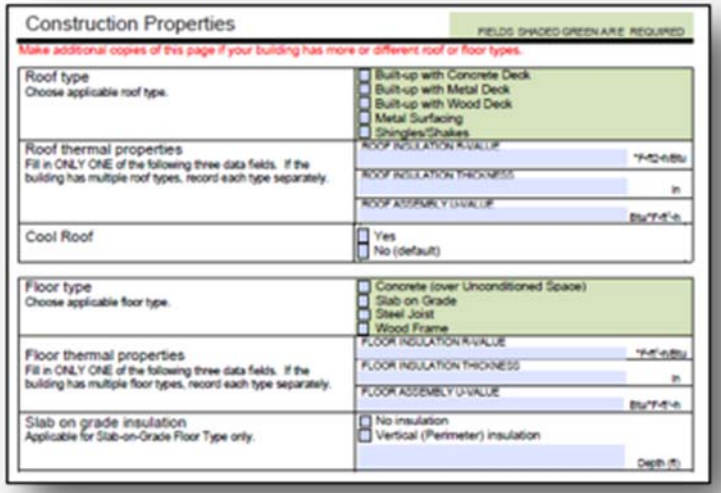
Retail



BUILDING ENERGY ASSET SCORE

Construction Properties

- Physical characteristics of the building envelope: roofs, floors, walls, fenestration types
- Thermal properties
- Surface entries for walls and windows
- Window to Wall Ratio: calculate manually (continuous), or have the tool calculate (discrete); may use estimates



Construction Properties

FIELDS SHADED GREEN ARE REQUIRED

Make additional copies of this page if your building has more or different roof or floor types.

Roof type Choose applicable roof type.	☐ Built-up with Concrete Deck ☐ Built-up with Metal Deck ☐ Built-up with Wood Deck ☐ Metal Surfacing ☐ Shingles/Shakes
Roof thermal properties Fill in ONLY ONE of the following three data fields. If the building has multiple roof types, record each type separately.	ROOF INSULATION R-VALUE ROOF INSULATION THICKNESS ROOF ASSEMBLY U-VALUE
Cool Roof	☐ Yes ☐ No (default)
Floor type Choose applicable floor type.	☐ Concrete (over Unconditioned Space) ☐ Slab on Grade ☐ Steel Joist ☐ Wood Frame
Floor thermal properties Fill in ONLY ONE of the following three data fields. If the building has multiple floor types, record each type separately.	FLOOR INSULATION R-VALUE FLOOR INSULATION THICKNESS FLOOR ASSEMBLY U-VALUE
Slab on grade insulation Applicable for Slab-on-Grade Floor Type only.	☐ No insulation ☐ Vertical (Perimeter) insulation Depth (ft)

BUILDING ENERGY ASSET SCORE

Lighting

- Asset Scoring Tool needs a lighting power density (watts per square foot) value for each block
- Lighting fixture types and numbers, lamps and wattage
- Total # of fixtures vs. % area served: percent served is simpler and quicker in most situations

Fixture	Lighting type	Total Number of Fixtures	% Area Served	Occupancy Controls (yes/no)
a.	Compact fluorescent			
b.	Fluorescent T5			
c.	Fluorescent T5 - High Output			
d.	Fluorescent T8			
e.	Fluorescent T8 - High Efficiency			
f.	Fluorescent T12			
g.	High-pressure sodium			
h.	Incandescent/Halogen			
i.	LED			
j.	Mercury vapor			
k.	Metal halide			

BUILDING ENERGY ASSET SCORE

HVAC Systems

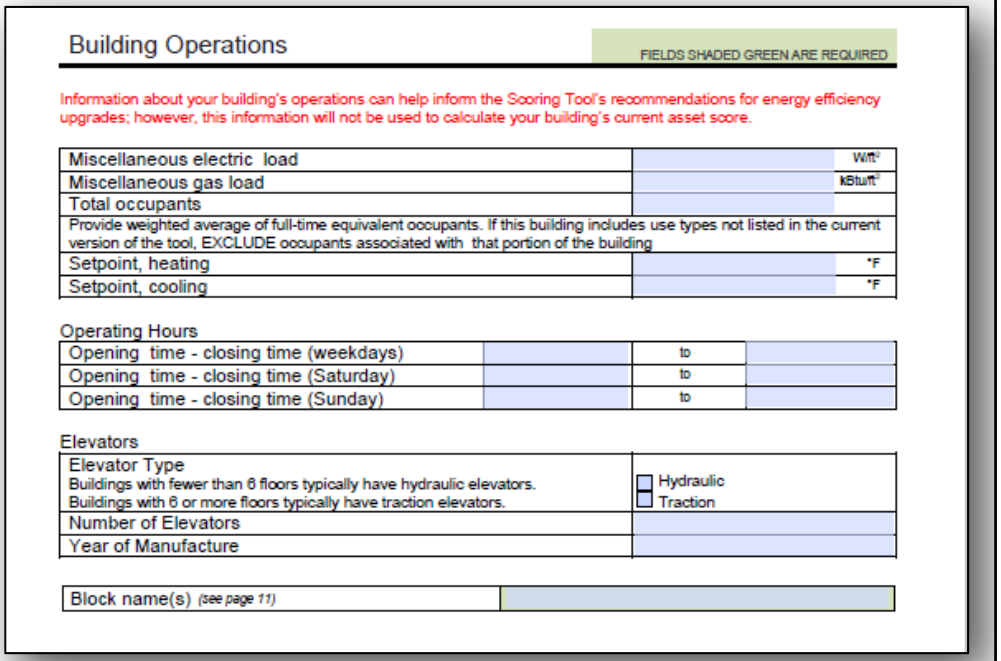
- HVAC System Types: helpful for data entry and/or if additional details are unknown
- Heating and Cooling Sources: Complete plant loop pages as necessary
- Equipment Details: Additional settings and options may be configured for quantity, capacity, efficiency
- Distribution Equipment (AHU vs. Zone Equipment): Additional settings and options may be configured for fan motors, controls, etc.
- Enter closest match if equipment or system is not listed, or see Users Guide or contact Help Desk for advice

https://help.buildingenergyscore.com

BUILDING ENERGY ASSET SCORE

Building Operations

- Optional: Inputs are not used to calculate the building's Asset Score
- Used to identify upgrade opportunities, which are considered in generating the potential score
- Operational and Equipment Sizing Assumptions:



Building Operations

FIELDS SHADED GREEN ARE REQUIRED

Information about your building's operations can help inform the Scoring Tool's recommendations for energy efficiency upgrades; however, this information will not be used to calculate your building's current asset score.

Miscellaneous electric load		W/ft²
Miscellaneous gas load		kBtu/ft²
Total occupants		
Provide weighted average of full-time equivalent occupants. If this building includes use types not listed in the current version of the tool, EXCLUDE occupants associated with that portion of the building		
Setpoint, heating		°F
Setpoint, cooling		°F

Operating Hours

Opening time - closing time (weekdays)		to	
Opening time - closing time (Saturday)		to	
Opening time - closing time (Sunday)		to	

Elevators

Elevator Type Buildings with fewer than 6 floors typically have hydraulic elevators. Buildings with 6 or more floors typically have traction elevators.	☐ Hydraulic ☐ Traction
Number of Elevators	
Year of Manufacture	

Block name(s) *(see page 11)*	

https://buildingenergyscore.energy.gov/assets/energy_asset_score_assumptions.pdf

III. Using Asset Score

- Creating and Scoring Buildings
- Using Asset Score with the Accelerator Program
- Additional Resources

How Do I Score a Building?

Three Steps:

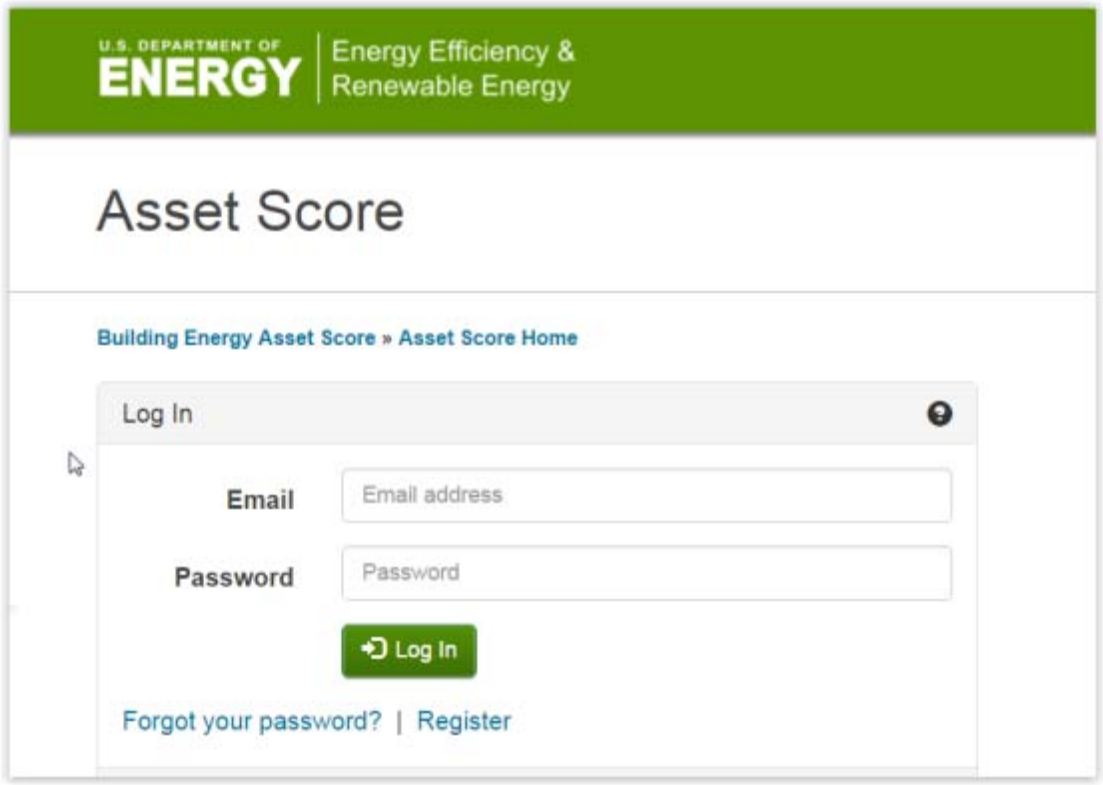
1. *Collect Building Data During "Assessment" Phase*
2. Enter Data into the Asset Score Tool
3. Generate an Asset Score Report

BUILDING ENERGY ASSET SCORE

Asset Score Tool

Create an account, register, log in:

https://buildingenergyscore.energy.gov



BUILDING ENERGY ASSET SCORE

Create a Building

Quick Start Guide -- 6-Step Process

https://buildingenergyscore.energy.gov/assets/asset_score_quick_start_guide.pdf

Step 1: Input Basic Building Information

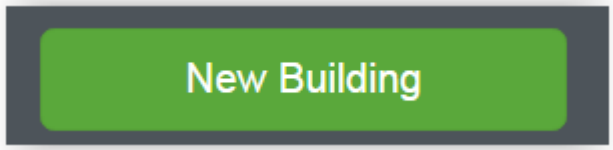
Step 2: Identify Building Use Types

Step 3: Create Inventory of Building Features

Step 4: Create a 3-D Image of the Building

Step 5: Assign Use Types and Components

Step 6: Score your Building and Review Asset Score Report



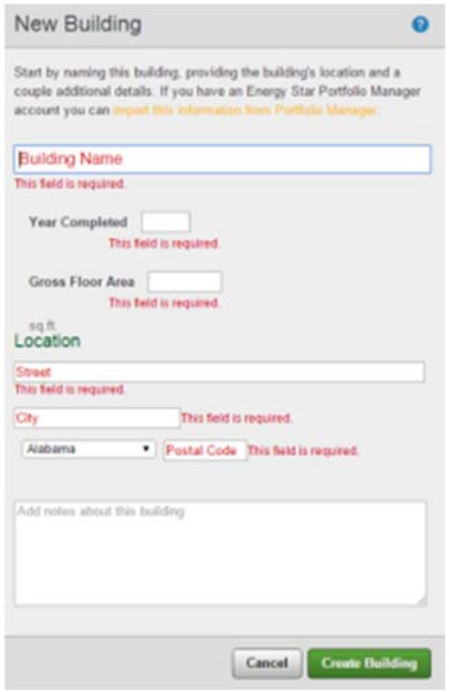
BUILDING ENERGY ASSET SCORE

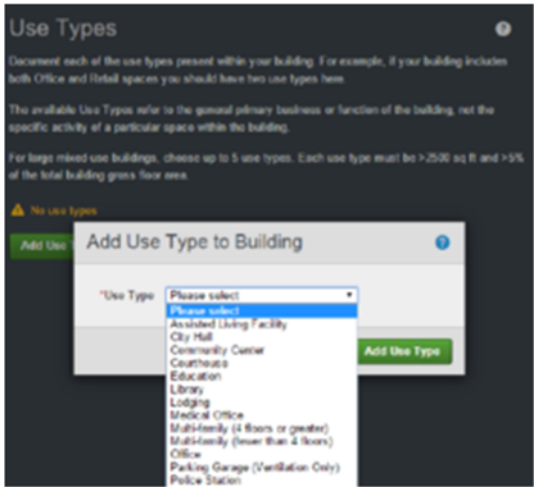
Steps 1-3: Input Data

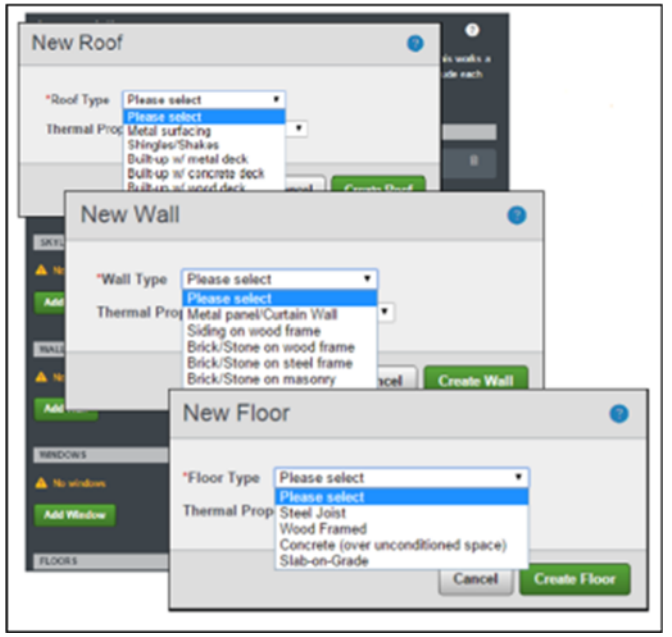
Step 1: Input Basic Building Information *(Optional: may import from ESPM)*

Step 2: Identify Building Use Types

Step 3: Create Inventory of Building Features

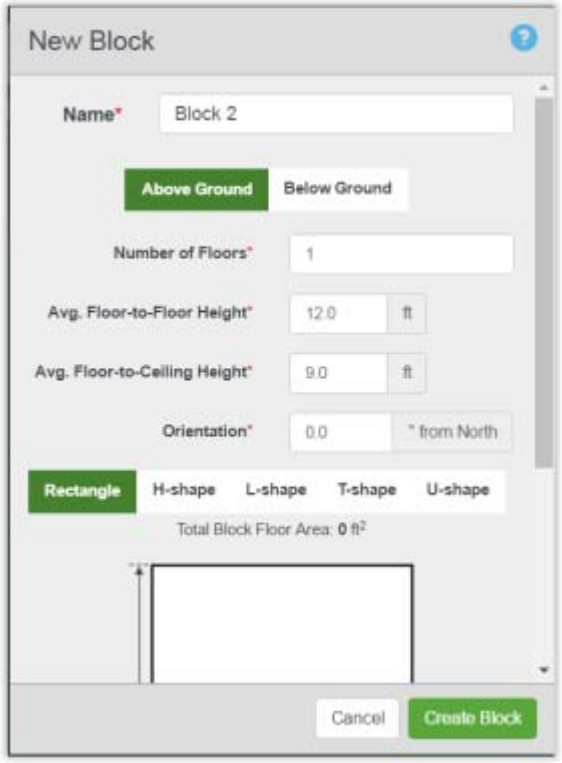


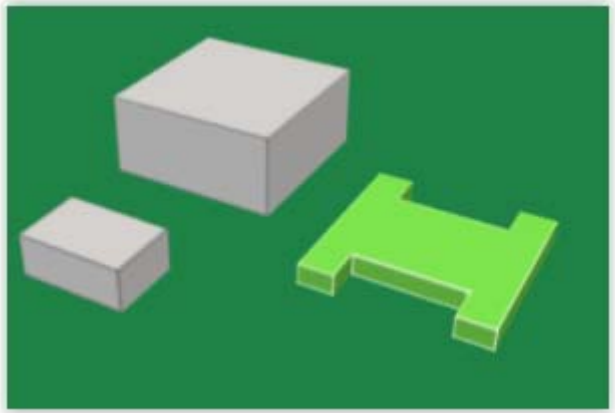


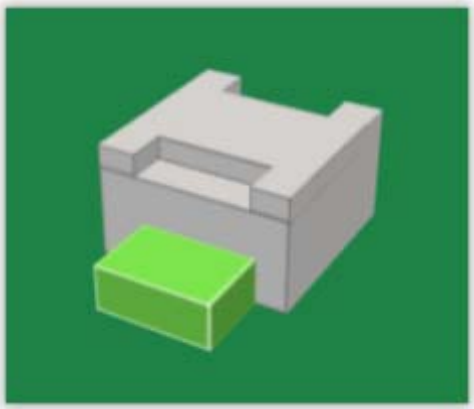


BUILDING ENERGY ASSET SCORE

Step 4: Create a 3-D Image of the Building



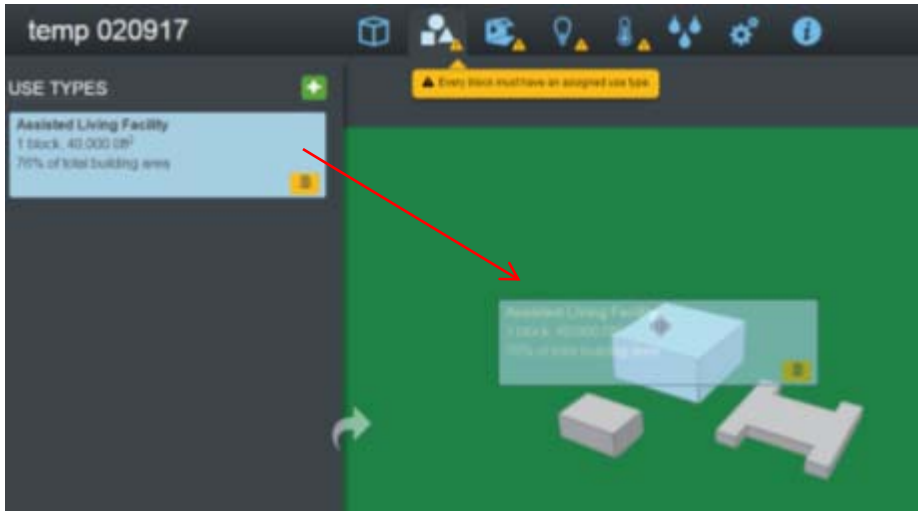


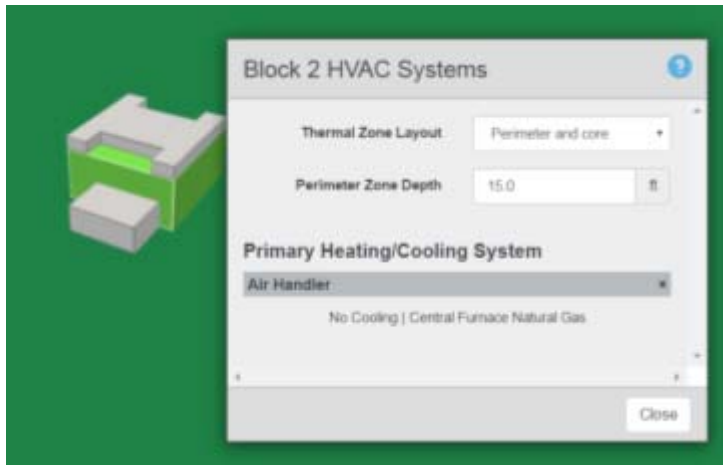


BUILDING ENERGY ASSET SCORE

Step 5: Assign Use Types and Components

- Drag and drop assets onto blocks
- Click blocks to add details for surfaces, lighting, HVAC, water heaters





BUILDING ENERGY ASSET SCORE

Step 6: Score Building and Review Score Report

- Review inputs
- Select Score button
- Wait for Email notification
- My Buildings page status icons
- Download report
- Return to edit mode
- Duplicate buildings

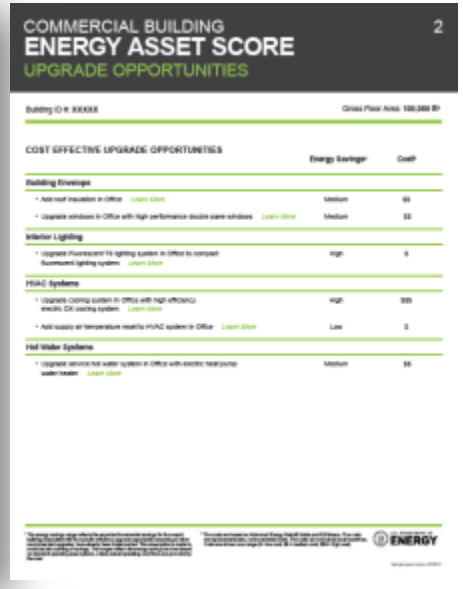
BUILDING ENERGY ASSET SCORE

Asset Score Report

- Review score results and report sections
- See score report and building upgrade guides for details – available from the Resources page

Overall Building Score

Upgrade Opportunities



Structure and Systems

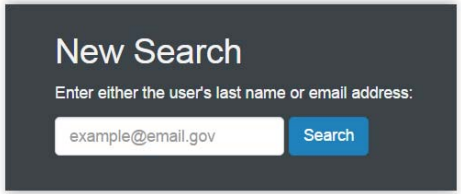
Building Assets

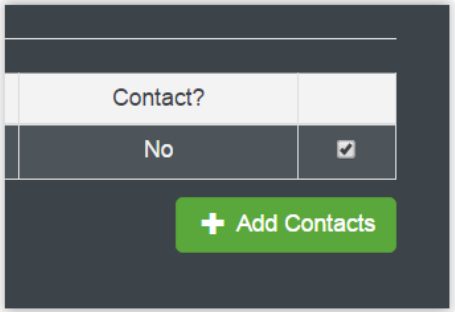
BUILDING ENERGY ASSET SCORE

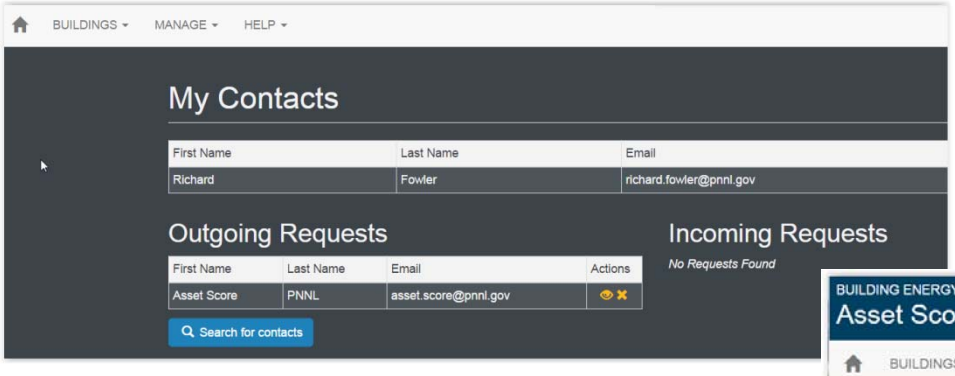
Creating Contacts and Sharing Buildings

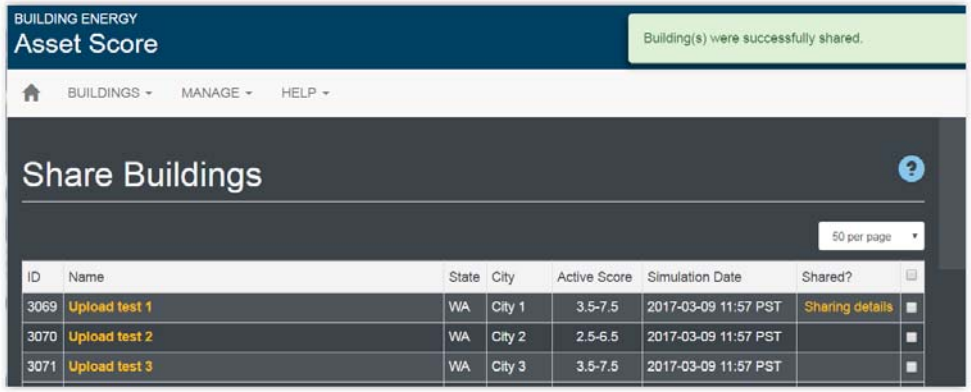
Share buildings with contacts:

- Add Contacts
- Share Buildings









Using Asset Score with the Accelerator Program

- Share building entries with the Tune-Up Accelerator Program: see handout for instructions
- Options for help with entering data: contact Nicole Ballinger, Building Tune-Up Accelerator Program Manager

- Where to go from here?
  - Take action on recommended upgrades
  - Identify opportunities for deeper energy savings analysis and goal setting
  - Building Renewal - University of Washington Integrated Design Lab

Seattle
Office of Sustainability
& Environment

BUILDING ENERGY
ASSET SCORE 2
UPGRADE OPPORTUNITIES

Building Name: Example Building - Single Use — Gross Floor Area: 100,000 ft²

Cost Effective Upgrade Opportunities	Energy Savings [3]	Cost[4]
Building Envelope		
• Add roof insulation in Office Block - *Learn More*	High	$ - $$
• Install high performance triple pane windows in Office Block - *Learn More*	High	$$ - $$$
• Add floor insulation in Office Block - *Learn More*	Low	$$
Interior Lighting		
• Upgrade T8 fluorescent lighting in Office Block with LED lighting - *Learn More*	Medium	$$
HVAC Systems		
• Add air-side economizer in Office Block - *Learn More*	Medium	$-$$
• Implement demand controlled ventilation (DCV) in Office Block - *Learn More*	Medium	$$
• Add variable frequency drive to supply fans in Office Block - *Learn More*	Medium	$$
Hot Water Systems		
• Add low flow faucets in Office Block - *Learn More*	Low	$$

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BUILDING ENERGY
ASSET SCORE

Additional Resources

- Resources page

  https://buildingenergyscore.energy.gov/resources
- Asset Score Help Desk

  https://help.buildingenergyscore.com/
- DOE FAQ page

  https://energy.gov/eere/buildings/building-energy-asset-score-frequently-asked-questions
- Handouts
- PNNL and OSE staff

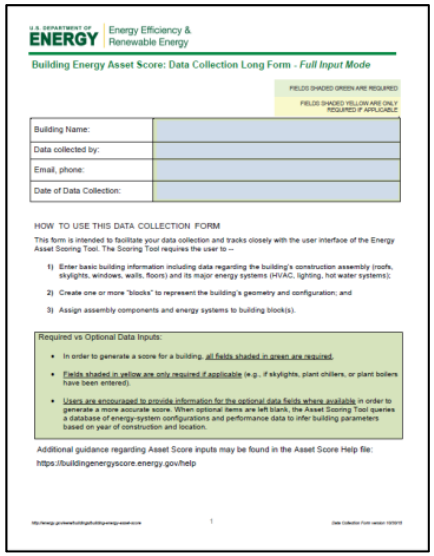
Conclusion

- Review objectives
- Thank you!
- Questions?

ASSESSMENT: Asset Score Incentive Options

A – $600 Incentive to Provider

- Return completed PDF form to OSE no later than 15 days after Assessment
- Provider sends invoice to OSE
- Asset Score Report provided to you and Owner.


U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building Energy Asset Score: Data Collection Long Form - *Full Input Mode*

FIELDS SHADED GREEN ARE REQUIRED

FIELDS SHADED YELLOW ARE ONLY REQUIRED IF APPLICABLE

Building Name:	
Data collected by:	
Email, phone:	
Date of Data Collection:	

HOW TO USE THIS DATA COLLECTION FORM

This form is intended to facilitate your data collection and tracks closely with the user interface of the Energy Asset Scoring Tool. The Scoring Tool requires the user to --

1) Enter basic building information including data regarding the building's construction assembly (roofs, skylights, windows, walls, floors) and its major energy systems (HVAC, lighting, hot water systems);
2) Create one or more "blocks" to represent the building's geometry and configuration; and
3) Assign assembly components and energy systems to building block(s).

Required vs Optional Data Inputs:

- In order to generate a score for a building, all fields shaded in green are required.
- Fields shaded in yellow are only required if applicable (e.g., if skylights, plant chillers, or plant boilers have been entered).
- Users are encouraged to provide information for the optional data fields where available in order to generate a more accurate score. When optional items are left blank, the Asset Scoring Tool queries a database of energy-system configurations and performance data to infer building parameters based on year of construction and location.

Additional guidance regarding Asset Score inputs may be found in the Asset Score Help file:
https://buildingenergyscore.energy.gov/help

B – $1,000 Incentive to Provider

- Enter data into online tool, run report & provide to Owner
- Share online report with Accelerator (see handout)
- Provider sends invoice to OSE

https://buildingenergyscore.energy.gov

QUESTIONS ?

SEATTLE

BUILDING TUNE-UP ACCELERATOR

LUNCH BREAK

Program Partners

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building
tune-ups

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Pacific Northwest
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Seattle City Light

U.S. DEPARTMENT OF
ENERGY
Energy Efficiency &
Renewable Energy

SEATTLE
BUILDING TUNE-UP ACCELERATOR

Observation-Driven Building Re-Tuning Training

PRESENTED BY:
Ron Underhill and
Duane Lewellen

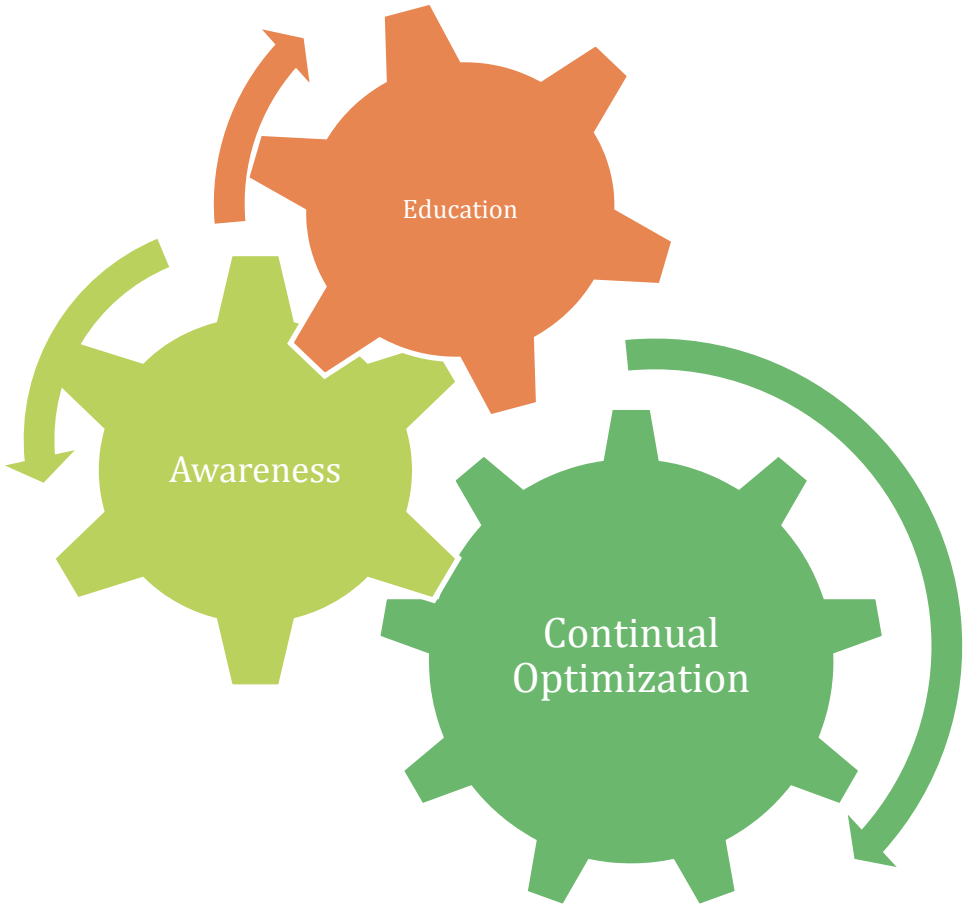
Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Goals for this portion of training

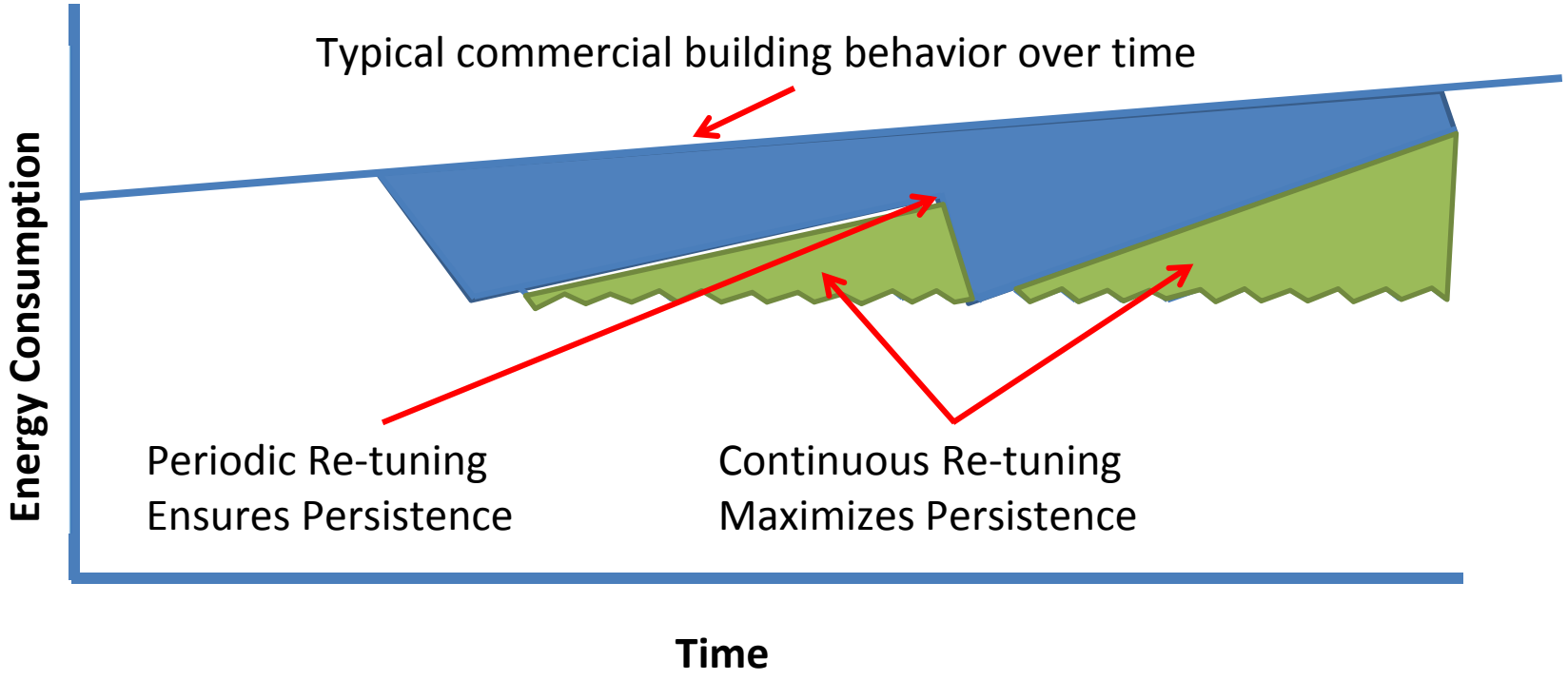
- Review building Re-tuning best practices for non-BAS and BAS applications
- Discuss applicability to buildings in the City of Seattle
  - as requirement for buildings >50K SF
  - encouraging re-tuning as a best practice in buildings <50K SF
- Provide opportunities for attendees to ask questions and get clarification on the re-tuning process and the SBTU requirement

Observation-Driven Building Re-tuning Training: Definition

Re-Tuning Is Going Back To the Basics



Life Cycle of Retro-Commissioning/Re-Tuning



Summary of Meta-Data Results Relevant to Small- and Medium-Size Buildings without Building Automation Systems

	Small Office	Medium Office	Strip Mall	StandAlone Retail	Primary School	Supermarket
EEM01: Re-calibrate Faulty Sensors	1%	0%	1%	1%	0%	0%
EEM04: Shorten HVAC Schedules	**6%**	**12%**	**9%**	**12%**	**8%**	**10%**
EEM05: Supply Air Temperature Reset		11%			4%	
EEM07: Exhaust Fan Control	3%	1%		2%	1%	
EEM08: Static Pressure Reset		4%			0%	
EEM14: Hot Water Temperature Reset					5%	
EEM15: Minimum VAV Terminal Box Damper Flow Reductions		19%			6%	
EEM16: Wider Deadbands and Night Setbacks	**12%**	**10%**	**11%**	**13%**	**16%**	**12%**
EEM27: Optimal Start	**6%**	**8%**	**10%**	**12%**	**6%**	
EEM28: Optimal Stop		0%	1%	2%	1%	

Summary of Meta-Data Results Relevant to Large Buildings with Building Automation System

	Large Office	Large Hotel	Secondary School
EEM01: Re-calibrate Faulty Sensors	1%	0%	0%
EEM04: Shorten HVAC Schedules	**14%**		**16%**
EEM05: Supply Air Temperature Reset	**10%**	**11%**	**2%**
EEM07: Exhaust Fan Control	1%		1%
EEM08: Static Pressure Reset	**4%**	**2%**	**0%**
EEM10: Chilled Water Differential Pressure Reset	0%	0%	0%
EEM11: Chilled Water Temperature Reset	1%	0%	0%
EEM13: Hot Water Differential Pressure Reset	0%	0%	0%
EEM14: Hot Water Temperature Reset	1%	0%	1%
EEM15: Minimum VAV Terminal Box Damper Flow Reductions	**18%**	**0%**	**3%**
EEM16: Wider Deadbands and Night Setbacks	**10%**	**8%**	**12%**
EEM27: Optimal Start	**10%**		**14%**
EEM28: Optimal Stop	3%		2%

Observation-Driven Building Re-tuning Training: Definition

Building re-tuning is a systematic process to identify and correct no/low cost operational problems that lead to energy waste

- Many of the recommendations for efficiency improvements will be prescriptive

Observation-Driven Building Re-tuning Training: Approach

It will use a **four step approach**

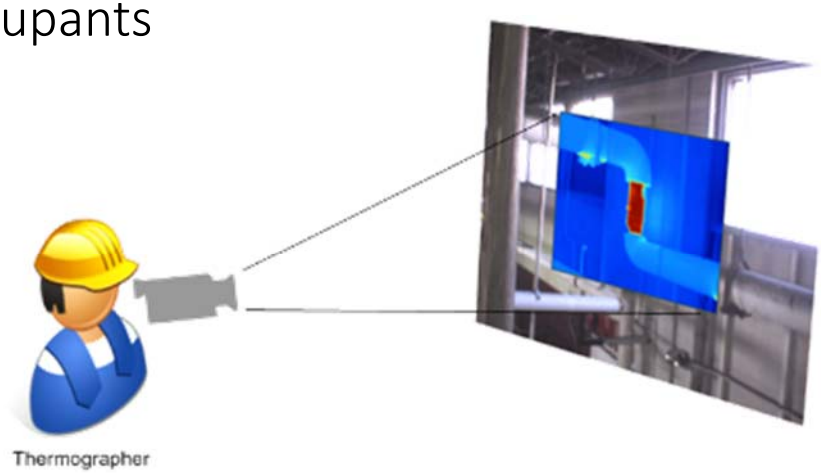
1. **Initial data collection phase:** Collection of information about the building
2. **Investigation phase:** Building walk down to identify and characterize the building operations
3. **Implementation phase:** Application of prescriptive re-tuning measures
4. **Documentation phase:** Reporting of measures implemented and calculation of energy savings

Small/Medium-Sized Building Re-tuning Training: Major Focus Areas

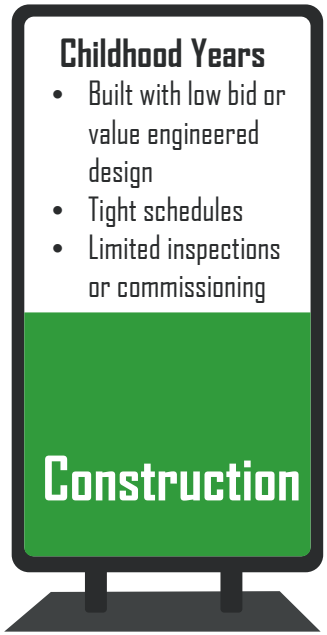
- Heating, Ventilation and Air-Conditioning Systems and Controls
- Lighting System and Controls
- Hot Water
- Building Envelope
- Miscellaneous Electric Loads
- Air distribution systems
- Meter Profile
- Air Compressors

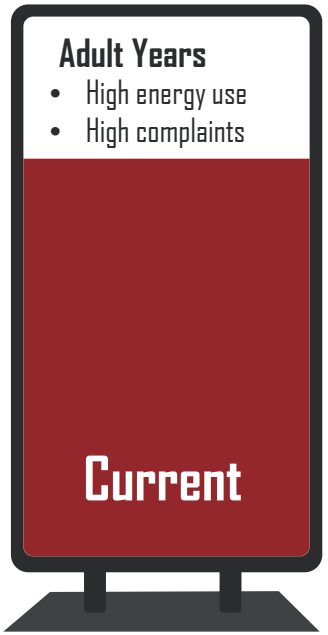
Observation-Driven Building Re-tuning Training: Basic Energy Management Principles

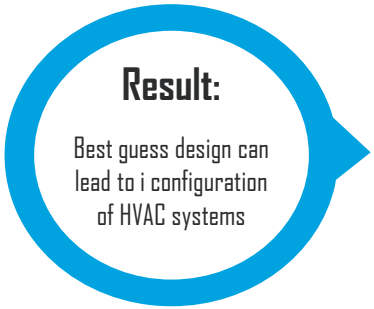
- If you don't need it, turn it off
- If you don't need it at full power, turn it down
- Make "smart" energy decisions when adjusting systems to the real building needs
- Save energy without negatively impacting the comfort of the occupants

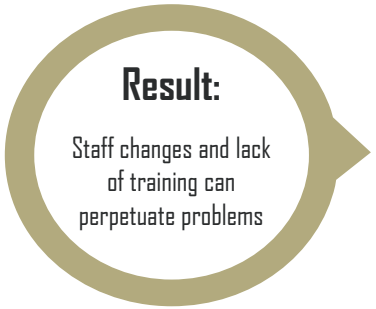


Observation-Driven Building Re-tuning Training: Basic Energy Management Principles









Get to Know the Building:
What is the Building's Personality?

- How does it act or respond to changing internal conditions?
- How does it respond to weather changes?
- What is its balance point, a point where no heating or cooling is required to maintain comfort in the building?
- If the building is lightly occupied on weekends, how does it behave?
- How does it react at night with setbacks?

If it is status quo, ask why?

Questions

- Why is the temperature set at this level?
- Why is equipment turned on at 6:00 am (or earlier)?
- Who made that decision?
- Do the conditions that drove this still exist?
- Have the occupant hours increased to meet short-term or long-term needs?

Results

- If conditions have improved, try new settings
- If people who made the decision are gone, re-evaluate their decision
- Consider trying new re-tuning ideas and see what happens
- Evaluate occupancy hours to ensure HVAC operations match.

Collection of Basic Building Information: Initial Data Collection Phase

- This is the first step in the building re-tuning process
- Information collected in this step is used to plan the building walk down or the Investigation Phase

Collection of Basic Building Information

- Size, age and type of building
- As-built and construction documents
- O&M Manuals, Sequence of Operations (SOO)
- Types of equipment, recent repairs
- Equipment maintenance schedules
- Review logs (e.g. tenant complaints, etc.)
- Construction or changes to the building
- Building occupancy/equipment schedules
- Use/mission of the building
- Meter data (Utility for Electric, Gas, Oil, etc…)

Collection of Basic Building Information: Building Information Log Example

Building Survey

- When was the building constructed?
- When was the building most recently renovated?
- How many floors are there?
- What is the approximate gross square footage of the building?
- What is the general shape of the building?
- What are the different uses of the building?
  - Offices: _____
  - Classrooms: _____
  - Data Center: _____
  - Warehouse/Storage: _____
- What is your buildings monthly energy consumption in kWh for January through December?
  - January: _____
  - February: _____
  - March: _____
  - April: _____
  - May: _____
  - June: _____
  - July: _____
  - August: _____
  - September: _____
  - October: _____
  - November: _____
  - December: _____

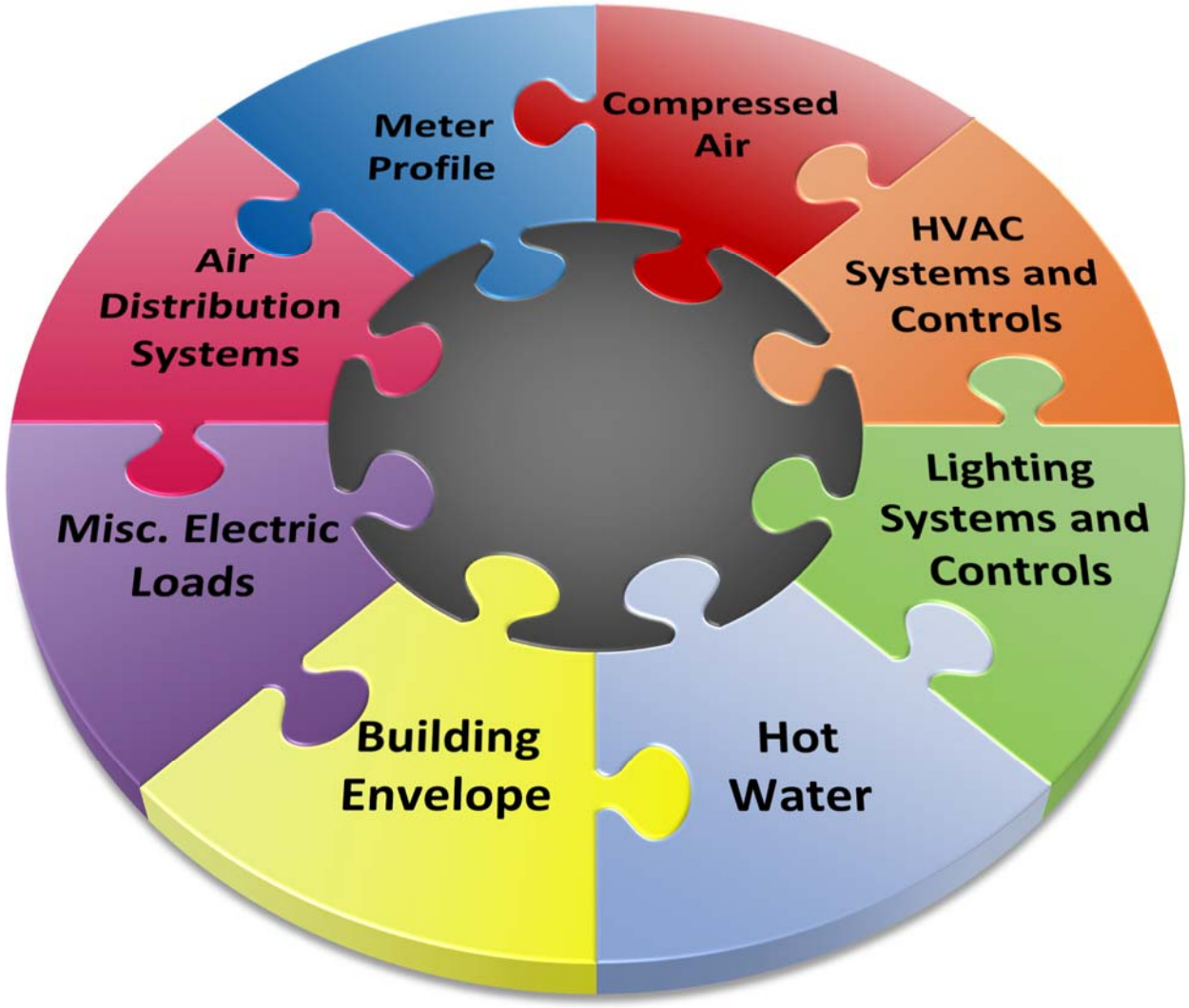
Building Walk Down: Investigation Phase

- This is the second step in the building re-tuning process – the Investigation Phase
- Information collected in this step is used to identify the operational problems and energy saving opportunities that are fed into the plan for implementation of re-tuning measures

Reminder: Sample Size "Tune-up" Mandate

- In buildings where there are multiple pieces of similar equipment, the City's mandate requires:
  - Minimum sample size of at 12%
  - But no fewer than a sample size of 10 for buildings <100,000 sf and no fewer than 20 for buildings >=100,000 sf

Building Walk Down: Focus Areas



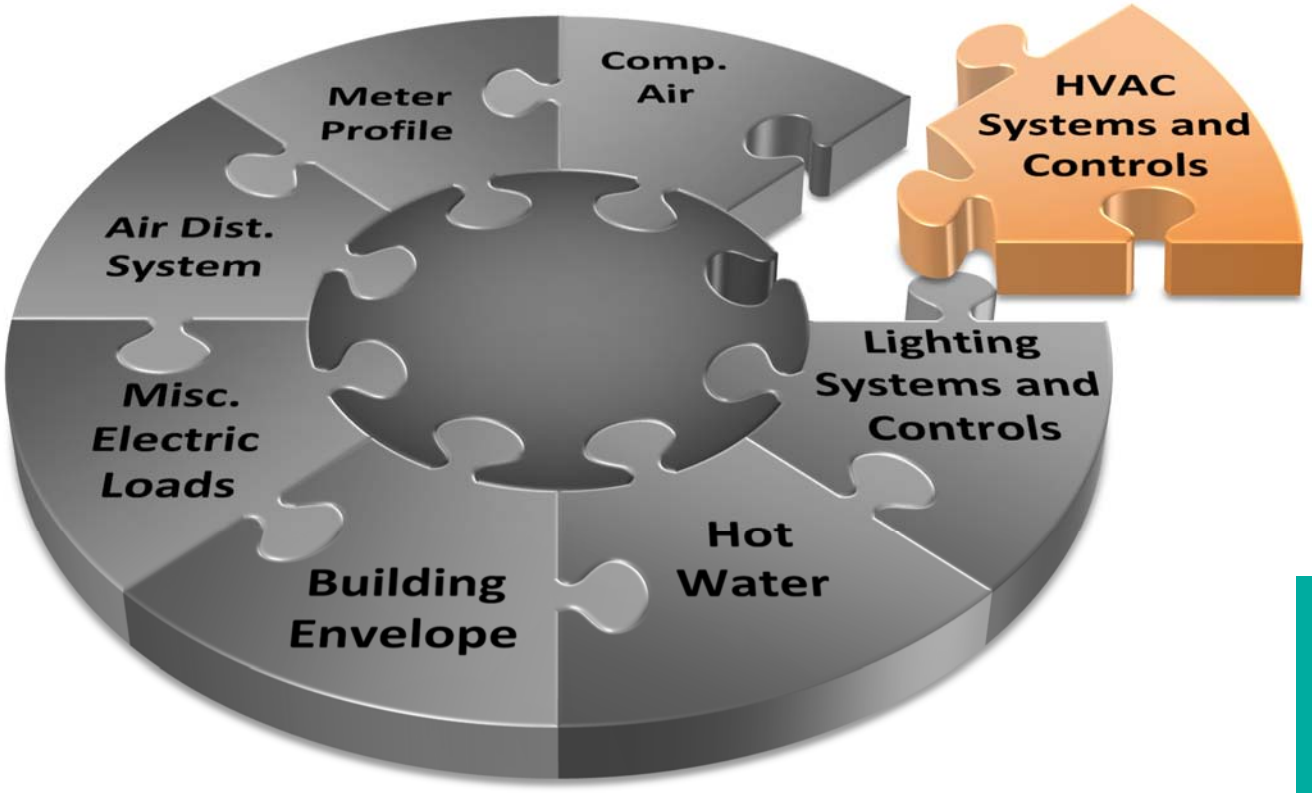
Building Walk Down: Guidance

- While walking down to investigate the building's condition and operations, be vigilant, use your senses – look, listen, smell and touch (be careful!)
- If possible, perform the walk down during both occupied hours and unoccupied hours
- A lot of energy waste typically occurs during unoccupied periods and holidays
- **Walk down at least once during the heating season and the cooling season**
- Log all information on the log sheets – this will help you calculate energy savings

"You can observe a lot by just watching."
—Yogi Berra

Building Walk Down:
Tools to Carry

Building Walk Down: **HVAC Systems and Controls**



HVAC

- HVAC Systems & Controls
- Economizers
- Air distribution systems
- Pumps
- Thermostats

Seattle Building Tune-Ups Rule:
Table 1: 1.a-g & 1.j
Table 2: 1.a-c & 1.e

Building Walk Down:
HVAC Systems and Controls

- Small/medium-sized buildings typically have **packaged air conditioners** with gas furnaces or heat pumps with either gas furnace or auxiliary electric strip heating
- Gas-Fired Equipment
  - Verify that the combustion-air intake is properly configured with **no blockages**
  - Verify that the gas pressure regulator is set correctly (trained technician)
- Packaged units are typically **controlled by wall mounted thermostats** with varying functionality
- Many of these units are not properly maintained
- Count how many units are serving the building
- Note the rated tonnage of the units

Building Walk Down:
HVAC Systems and Controls

While examining the HVAC equipment, look for:

- Missing panels/access doors or leaking panels/access doors
- Outdoor-air dampers wide open or fully closed (when not appropriate)
- Missing condenser fans
- Poor maintenance (oil leakage at refrigerant connections, etc.)
- Other conditions that might affect performance

Building Walk Down:
HVAC Systems – Visual Inspection

What to look for:

- Missing or damaged panels/access doors or seals for them Damaged/Dirty indoor or outdoor coils
- Missing or damaged mechanical items (fan motors/blades/belts)
- Use cogged V-belts & high-efficiency motors for better performance
- Ice-filled condenser/outdoor coil

1 or 2% efficiency improvement by tightening belt

Building Walk Down:
HVAC Systems–Visual, Audible & Sensory Inspection

What to look, listen and feel for:

- Oil leaks or drips from the refrigeration system or components of the unit. This type of problem may require training on how to properly handle refrigerant & should be done by an authorized person
- Coil condition – deteriorating due to corrosive air (salt water, etc.)
- Feel and listen for air leaks around exposed ductwork or the roof curb for a rooftop unit. This may be hard to fix, but it is wasting energy and should be identified
- Refrigerant line sets should be adequately protected on split systems and packaged rooftop units
- Low pressure suction lines should be adequately insulated for efficiency

Building Walk Down:
HVAC Systems – Visual Inspection

Check the P-trap on the cooling coil

- P-trap should have water in it if the equipment is located in a mechanical space that does not freeze
- P-traps that are located outside need to have water in them when the cooling is running and emptied when the weather changes to fall or winter (blow them out or the pipe may freeze and break)

For good drainage of the evaporator cabinet (negative pressure across evap. coils)

Building Walk Down:
HVAC Systems – Visual Inspection of Motor-Driven Fans

Visually Inspect:

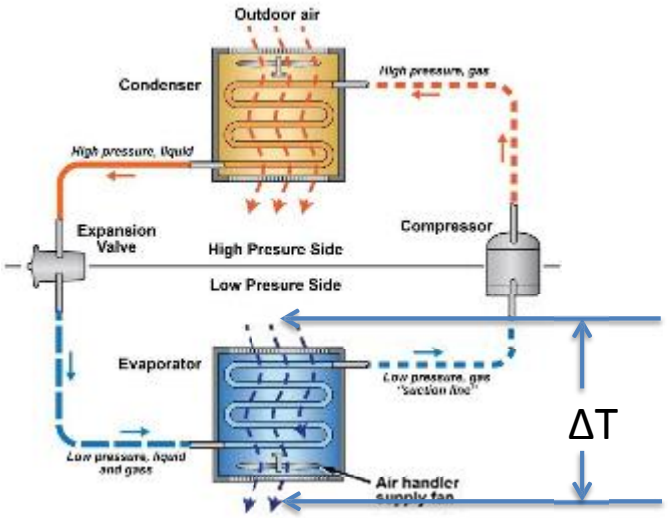
- Fan motor
- Fan Wheel
- Fan Housing
- Fan Belts
- Pulley/sheave are in good condition

- Check fan mounts
- Check fan bearings for tightness
- Ensure that the fan is rotating in the correct direction
- Check pulley alignment
- Listen for unusual noises or vibrations

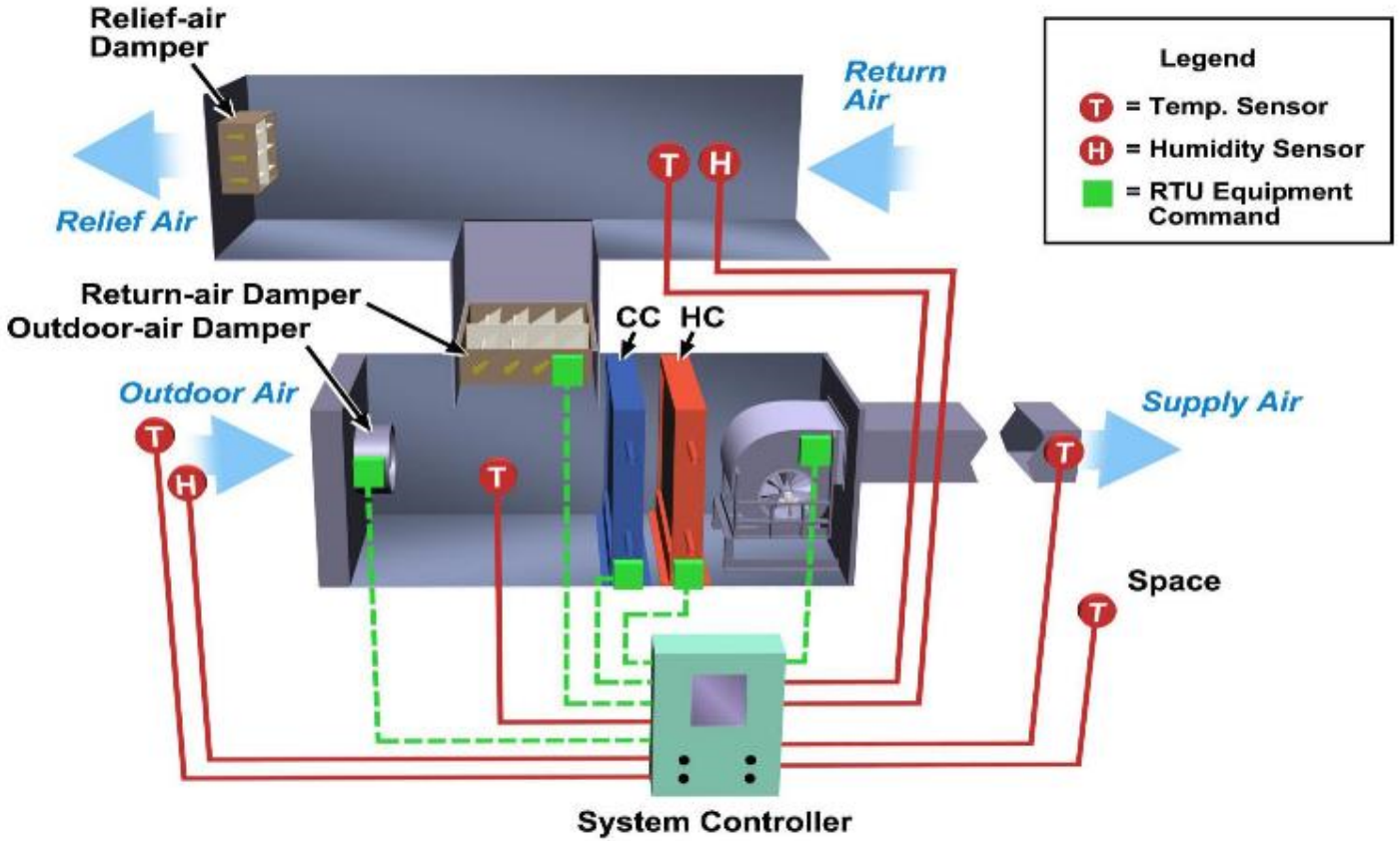
Building Walk Down:
HVAC Systems – Visual Inspection of Coil Section

- Are the indoor/outdoor coils and fins dirty? Is the coil damaged or leaking?
- Is the drain pan and drain line clean and clear of debris?
- In cooling mode, measure the temperature difference across the evaporator coil when the compressor is on
- Should be 18 to 22°F for a single compressor unit or multi-compressor unit that is fully loaded

Clean any coils that are dirty to increase efficiency of the unit



HVAC Economizer Fundamentals: The Basics of Air-side Economizers



Air-side Economizer: "A duct-and-damper arrangement and automatic control system that, together, allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather." (*ASHRAE Standard 90.1-2004*)

HVAC Economizer Fundamentals: Common Types of Controls

- Fixed dry-bulb temperature, also referred to as a change over – 65F to 70F outdoor air temperature
- Fixed enthalpy – between 26 and 28 Btu/lb
- Differential dry-bulb temperature (outdoor air comparison with return air)
- Differential enthalpy **(outdoor air comparison with return air)**
- Enthalpy-based economizers typically have a lot of maintenance problem, therefore, should be avoided

HVAC Economizer Fundamentals: Common Component Problems

What are some common Component Problems?

- Jammed or frozen outdoor-air damper
- Broken and/or disconnected linkages
- Nonfunctioning actuator or disconnected wires
- Malfunctioning outdoor-air/return-air temperature and relative humidity sensors
- Malfunctioning controller
- Faulty control settings
- Installed wrong or wired incorrectly

Jammed/Frozen Damper

Disconnected Damper

Wired poorly

Building Walk Down: Pumps

- Determine and record whether each pump is running, leaking, hot, or vibrating unusually
  - If you can't hold your hand on the pump, it's too hot.
  - Isolation valves on running pumps and pumps that are in service should be wide open and not used for "balancing" or trimming of water flow

Building Walk Down:
HVAC System Controls - Thermostats

- Small/medium-sized commercial buildings typically lack central controls
- Typically have wall mounted thermostats to control both heating and cooling systems
- While surveying the thermostats and their capabilities, check:
  - Type of thermostat?
  - Mechanical or digital?
  - If digital, is it programmable?
  - If mechanical, replacing it with a programmable digital thermostat will save energy, if it is properly programmed

Building Walk Down:
HVAC System Controls - Thermostats

1. Where are the thermostats located?
   - What is the optimal location?
2. Are the thermostats sensing the temperature of the area they serve, and are they controlling the right piece of equipment in the area they serve?
3. Is there a draft of air coming from behind the thermostat that will affect the temperature that the thermostat is sensing?
4. Are there any overrides on the thermostat?
5. How might you address scheduling of HVAC systems with irregular occupancy?

Building Walk Down:
HVAC System Controls - Thermostats

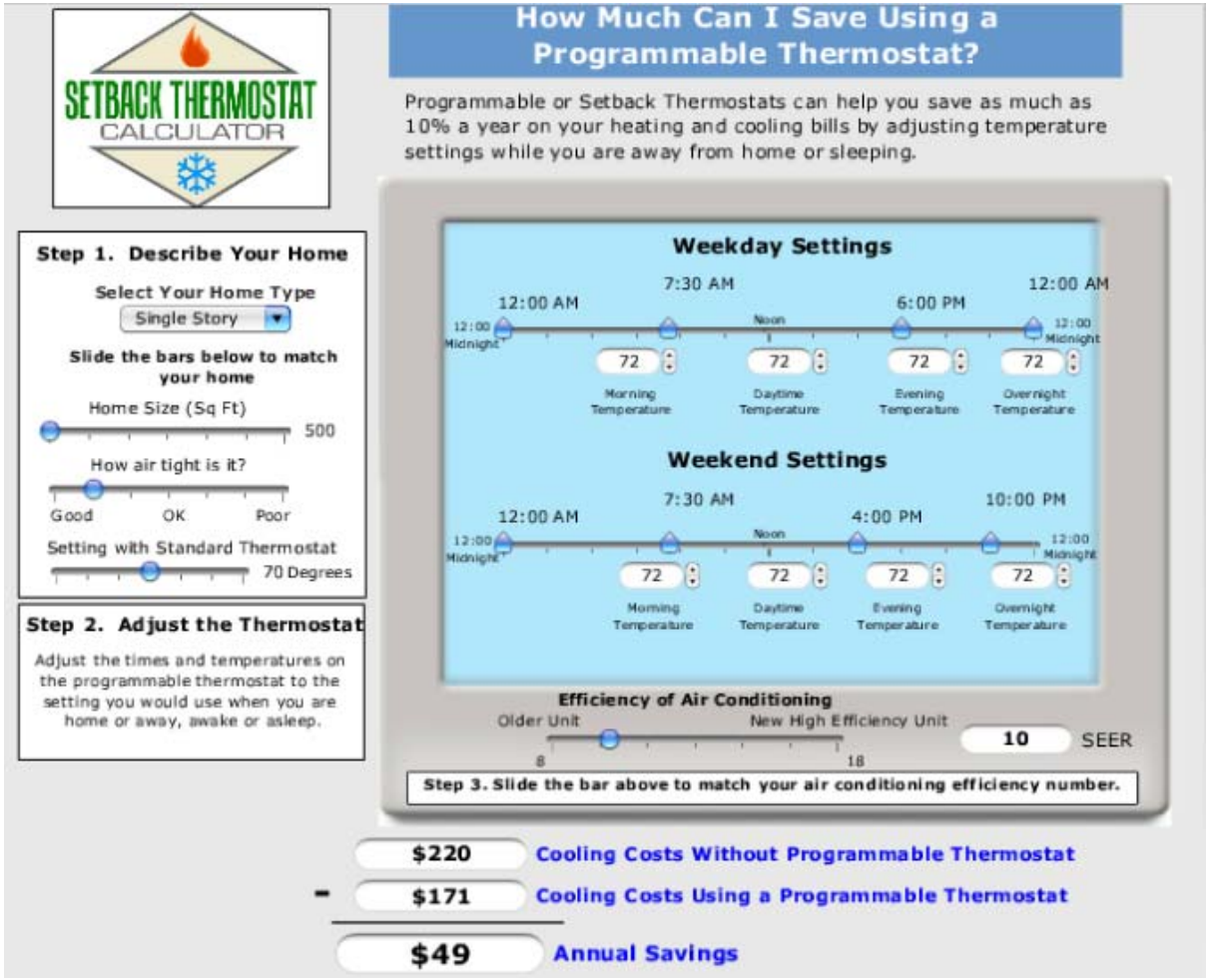
What is wrong in this picture with the thermostat?

Thermostat too close to window and on an exterior wall

What are some Re-tuning Ideas Related to Thermostats?

1. Digital thermostats that are programmable
2. Scheduling that matches the building occupancy
3. Set points that are reasonable
4. Fan operation
5. Thermostat location (interior wall away from false heat sources – what is on the other side of that wall?)
6. Remote sensors
7. Motion sensor-based occupancy

Building Walk Down:
HVAC System Controls – Thermostats Schedules



Building Walk Down:
HVAC System Controls – Learning Activity

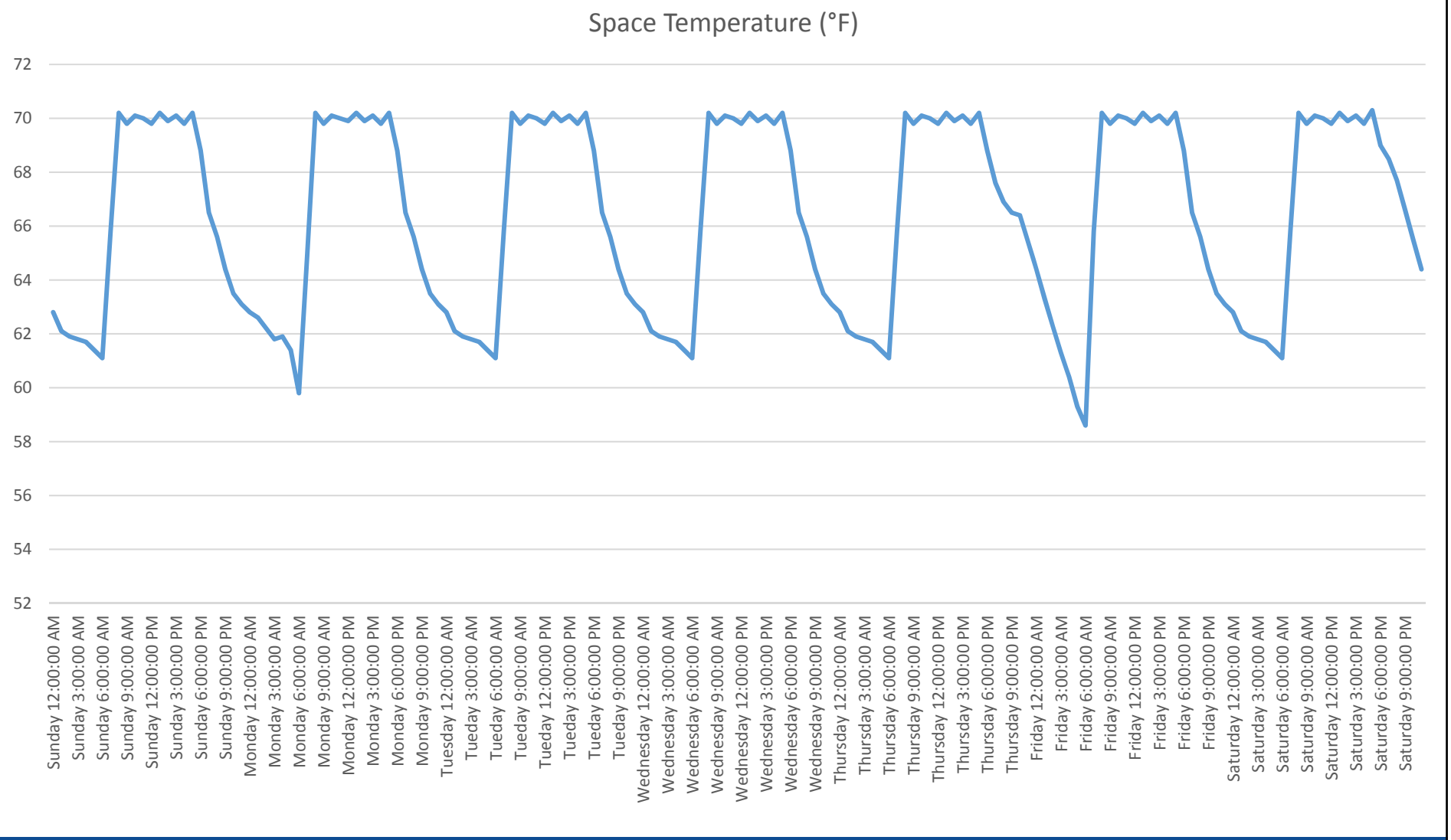
If available, it might be useful to look at past trends/temperature data to ensure thermostats are properly programmed and system is performing as intended.

Assumptions: Space is Heated and Cooled by a packaged rooftop A/C unit with natural gas heat.

The Building Operations Plan calls for:

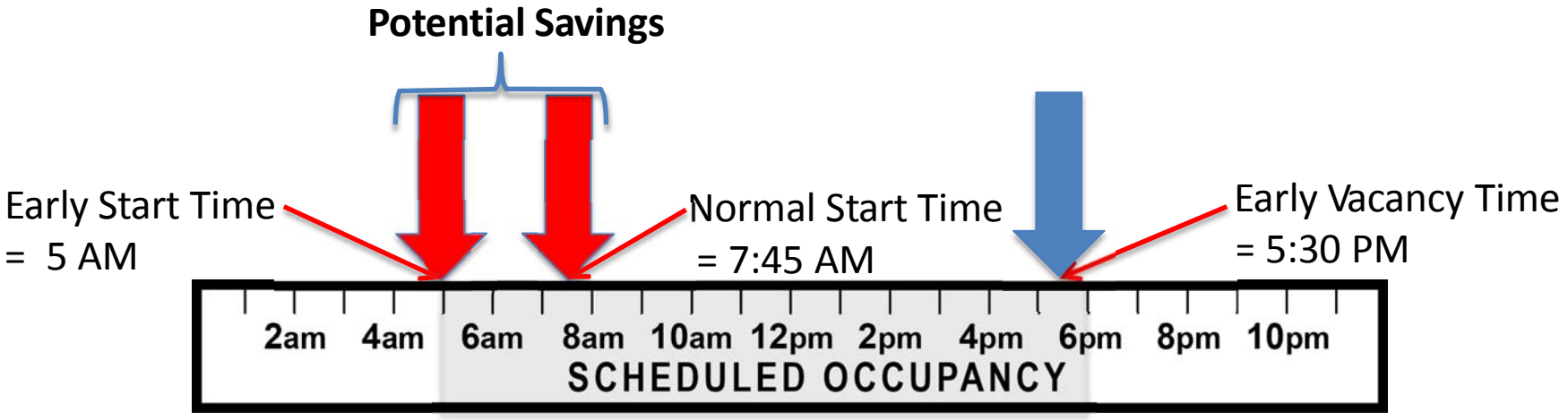
- Heating Set Points: 70F while occupied
  55F while unoccupied.
- Cooling Set Points: 72F while Occupied
  80F while Unoccupied
- Space is Occupied: M-F from 7 AM to 5 PM
  Unoccupied all other times

Building Walk Down:
HVAC System Controls – Learning Activity

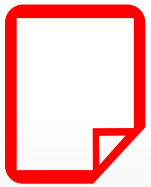


Building Walk Down:
HVAC System Controls – Thermostats Optimal Start

- Optimal Start (OS) is a feature that can save energy over traditional scheduling programs
- Most schedules are configured to start the HVAC system at the time it would take to heat or cool the space under worst case conditions
- OS will automatically "learn" over time, the optimum time to start the HVAC system to bring space temperatures within 1 to 2°F of occupied requirements at the start of the occupied time period



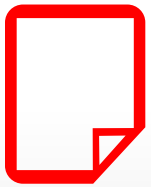
HVAC Thermostats: Discussion Question



If you have a conference room or an auditorium or other spaces with irregular schedules, what should you do?

Answer: A thermostat with a motion sensor (these are also referred to as hotel sensors) that resets set points based on sensed occupancy might be a good option to consider.

HVAC Thermostats: Discussion Question



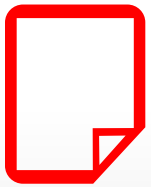
Which thermostat has a better chance of saving energy, a programmable thermostat or a mechanical thermostat?

Answer: A programmable thermostat as long as it is configured properly.

Building Walk Down:
HVAC System Controls – Thermostats Fan Control

- Is the programmable thermostat in “Fan- Auto,” which means that the fan is cycling with the cooling compressor and/or furnace?
- If the thermostat is in “Auto” (instead of “On” or “Run” in Occupied Mode) it can lead to lower ventilation rates than required, especially during spring and fall seasons, when cooling/heating needs are at a minimum
- Commercial building codes may require the RTU supply fans be running continuously to provide adequate ventilation during occupied modes
- Ensure that the space is considered an “occupied space” and not a mechanical or electrical space where continuous ventilation may not be required – fan cycling may be acceptable

HVAC Systems:
Discussion Question



List three reasons economizers fail or don't work property.

Answers:

1. Installed wrong
2. Broken linkage or frozen dampers
3. Controller or sensor failure

Building Walk Down:
Lighting Systems and Controls

Part of the Indoor and Outdoor Building Walk Down

Building Walk Down: **Lighting**

Lighting

- Interior Lighting Systems and Controls
- Exterior Lighting Systems and Controls

Seattle Building Tune-Ups Rule:
Table 1: 2.a-c
Table 2: 2.a

Building Walk Down:
Interior Lighting Systems and Controls

Interior Lighting Details

- Do they have any lighting controls – manual switches, dimmers or time clocks?
- **Type of lights** (Fluorescent [T12, T8, T5], CFL, LED, Incandescent?)
- Are proper light levels being maintained or over lighted? Is there opportunity to re-evaluate?
  - Use light meter to verify that light levels meet IES (Illuminating Engineer Society of North America) recommendations and/or user needs for the spaces. Take many measurements around the space.
  - Day lighting opportunities?
  - Are lamps and fixtures clean?

Building Walk Down:
Interior Lighting Systems and Controls

Although T-12 lighting replacement is only a recommendation in the City's mandate, replacing them with more efficient lighting will result in significant savings

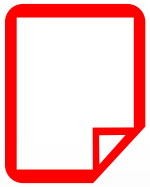
Convert magnetic ballasts to electronic

Excessive lighting in unoccupied areas

Building Walk Down:
Interior Lighting Recommended Illumination

Activity	Space Types	Recommended Illumination (lux)	Foot Candles (FC)
Public areas with dark surroundings	Parking garage	20 - 50	2-5
Simple orientation for short visits	Lobbies, storage areas, corridors	50 - 100	5-10
Working areas where visual tasks are only occasionally performed	Waiting areas, auditoriums	50 - 150	5-15
Easy Office Work, Classes	Certain offices and classrooms	200-300	20-30
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	Certain offices, classrooms, libraries	350-500	35-50
Retail	Supermarkets, Mechanical Workshops	300-800	30-80

Lighting Systems: Discussion Question



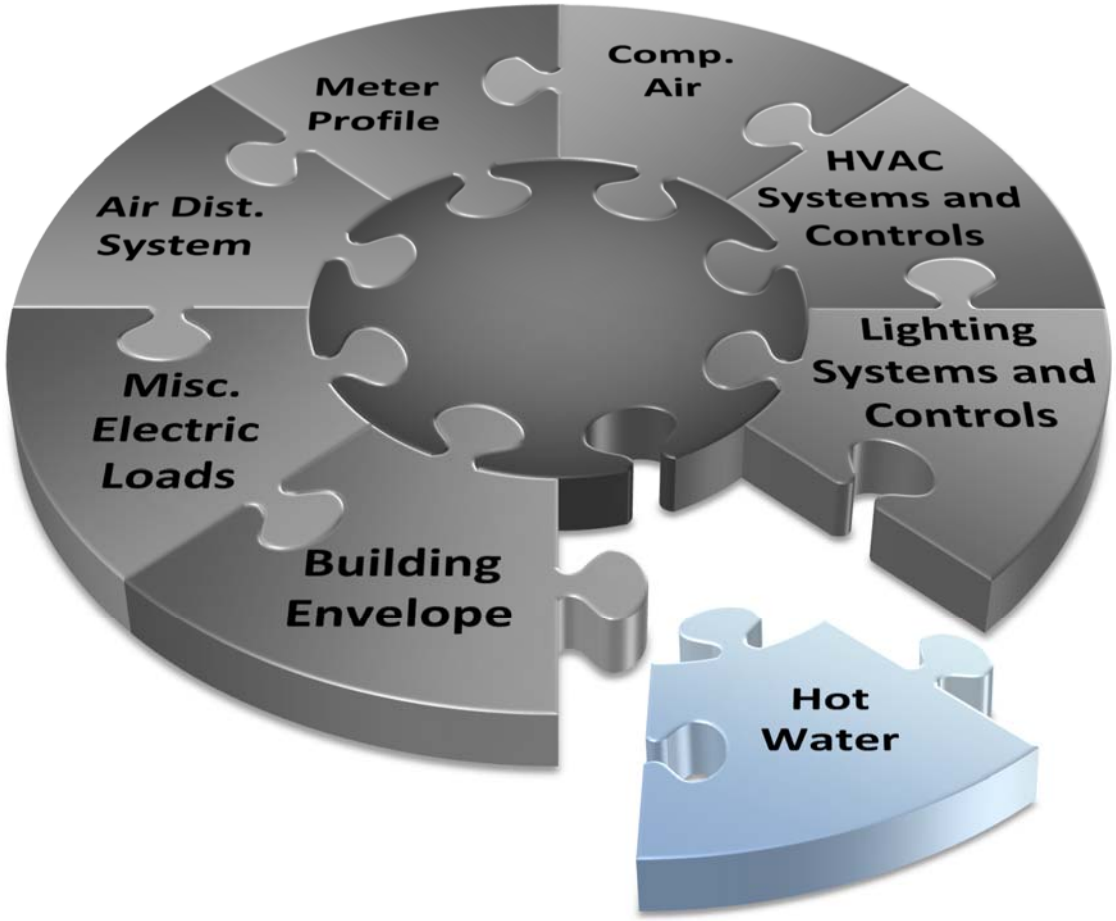
True or False:

1. Posting signs to promote turning lights off helps lower energy usage.
2. T-5 lamps use the most power.
3. When replacing T-12 lamps with T-8 lamps, the existing ballast can be left in place.
4. Dirty fixtures reduce the effectiveness of the light fixtures.

Answers:

1. True, 2. False, 3. False, 4. True

Building Walk Down: Hot Water Systems



Hot Water

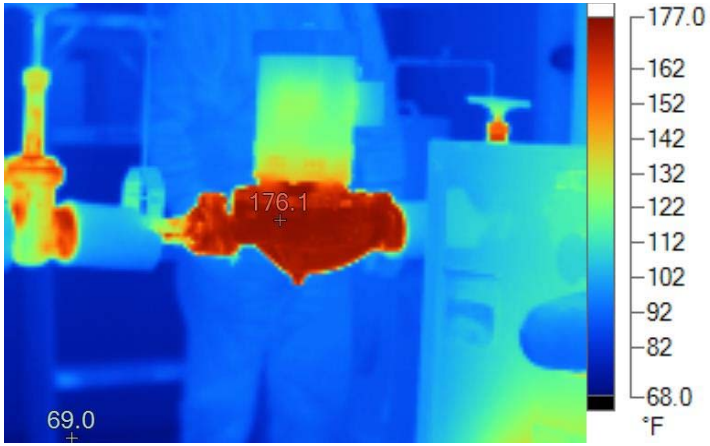
- **Hot Water Systems and Steam**
- **Domestic hot water temperature**
- **Insulation**
- **Leaks**

Seattle Building Tune-Ups Rule:
Table 1: 3.a-b
Table 2: 1.d

Building Walk Down:
Hot Water Systems

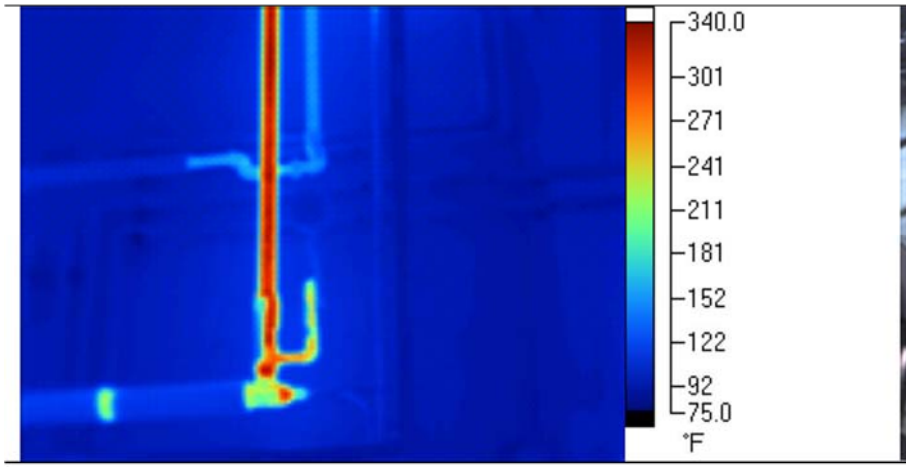
- Type of hot water system – domestic hot water or heating hot water or both?
- Energy Star rated appliances?
- Domestic hot water temperature?
- Are the tanks insulated?
- Are the plumbing lines insulated?
- Are there any observable leaks?
- Faucets leaking?
- Relief Valves leaking?
- Zone heating controls in place and working?
- Set back controls in place and working?
- Circulation pump with time clock?
- Solar HW system (panels and pumps)?

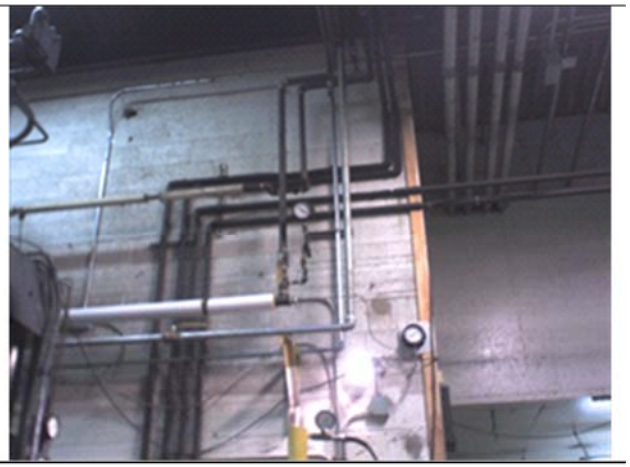
Building Walk Down:
Hot Water Systems and Steam



Use Thermal Camera to Identify Uninsulated Pipes

Pipes that aren't insulated give off a great deal of heat, making the system less efficient



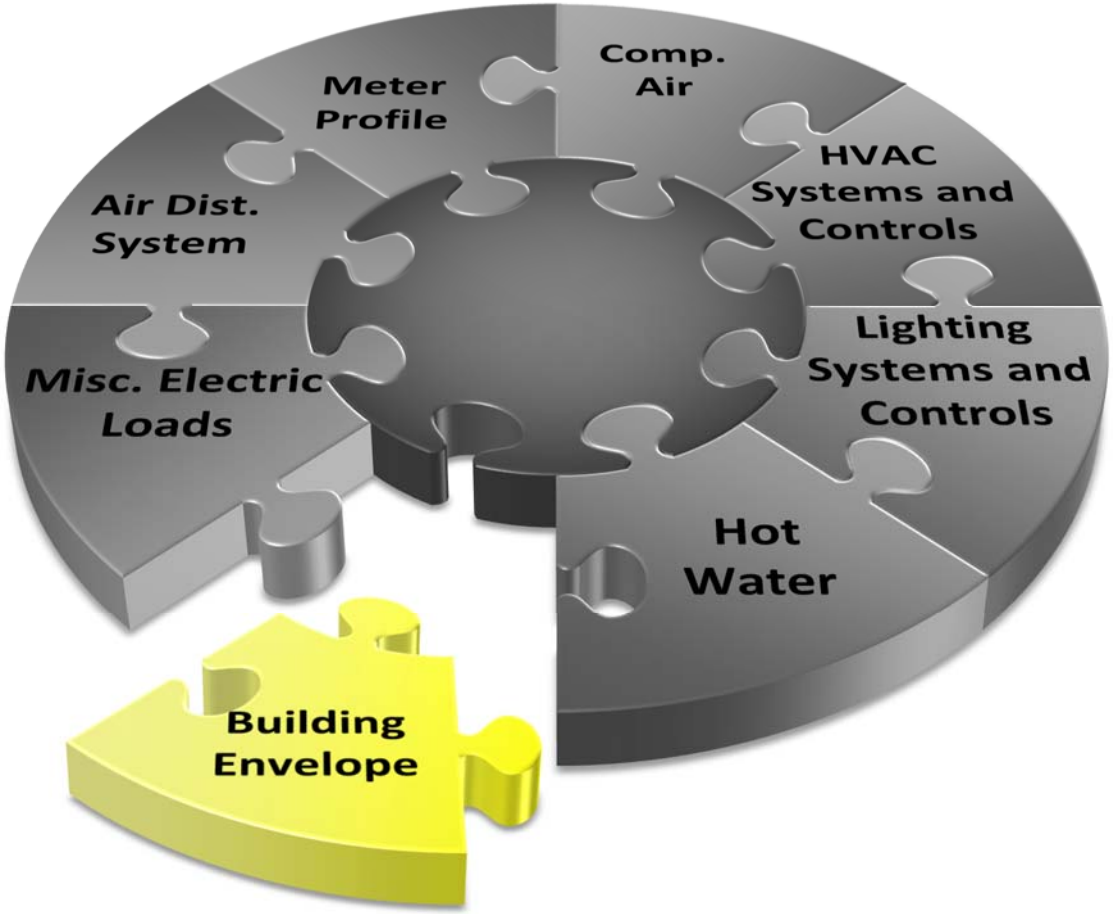


Hot Water Systems: Discussion Question

Heating hot water systems can typically be turned off above what outside air temperature?

Answer: 50-60°

Building Walk Down: Envelope



Envelope

- Walking down the outside and inside the building
- Doors
- Windows
- Openings
- Shades
- Exterior Plug Loads
- Insulation
- Roof
- Attic and Crawl Spaces
- Seal un-used penetrations in envelope (piping, duct work, etc.)

Seattle Building Tune-Ups Rule:
Table 2: 1.d, 4.a, 4.c

Building Envelope Walk Down: Doors and Windows

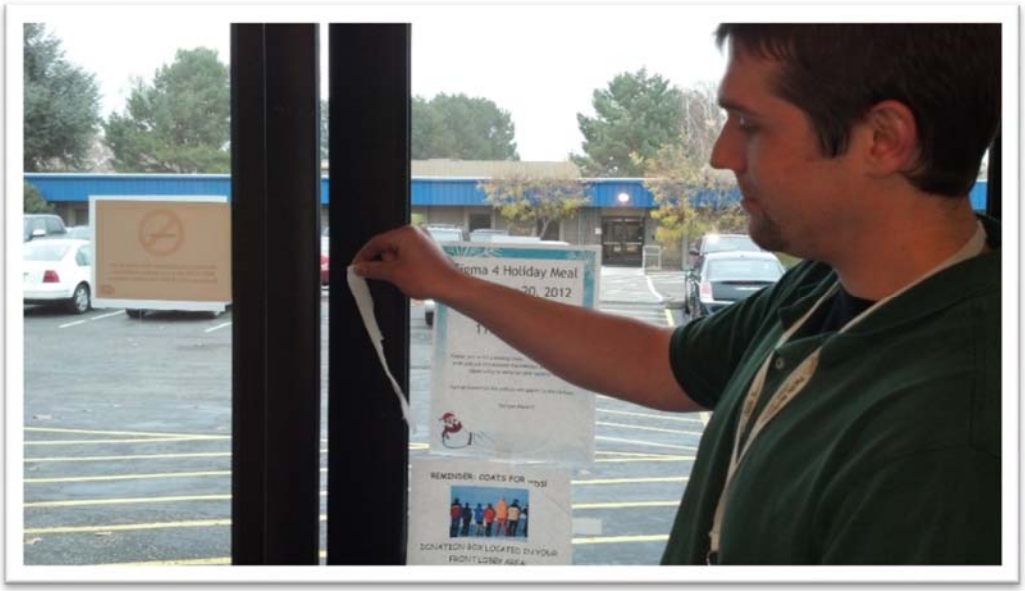
Focus on the exterior conditions of the building

Door and window type:

- Are the windows operable?
- Are the windows single, double or triple pane?
- Are any windows and outside doors open during the walk down?
- If windows and doors are open, this could indicate a problem related to heating, cooling or ventilation

Building Envelope Walk Down: Doors and Windows

A small strip of tissue paper is being pulled inward near a gap in the door (or slight opening)

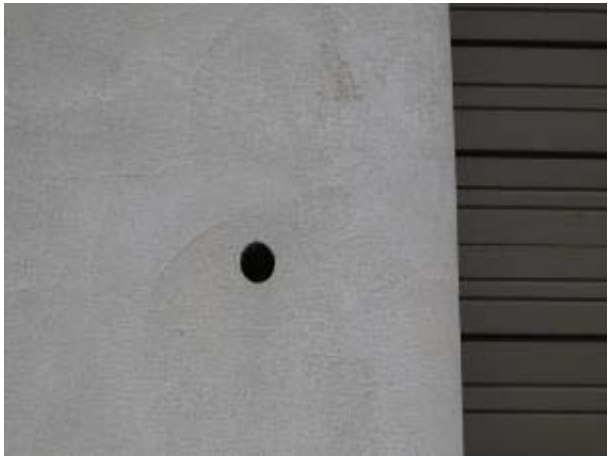


- Buildings should be pressurized to be slightly positive to eliminate unconditioned air from infiltrating into the building. This building seems to be negatively pressurized
- Side Note: Door gaps indicate a lack of proper door seals and should be fixed

Building Envelope Walk Down: Unsealed Penetrations in the Envelope

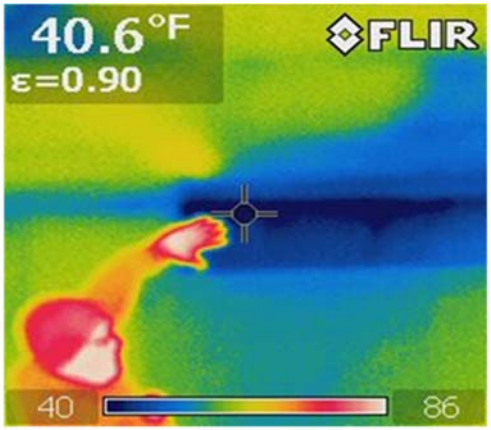
Are there unsealed penetrations in the building?

- Look for penetrations around seams or pipe penetrations in the building envelope
- Improperly sealed holes will allow for increased infiltration into the building, which will lead to increased heating and cooling loads on the HVAC equipment
- Have there been any problems or indication of vermin (mice or rats) entering the building? **This could be a health safety issue**

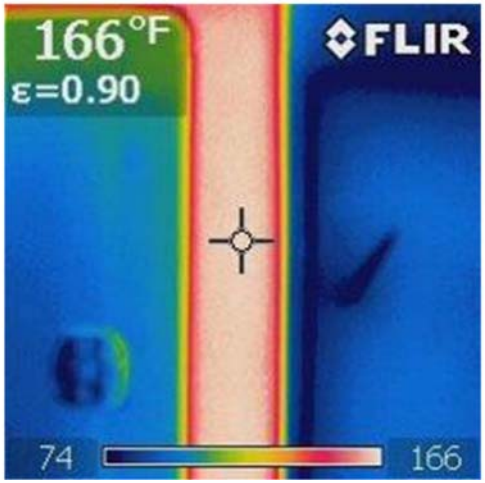


Building Envelope Walk Down: Insulation

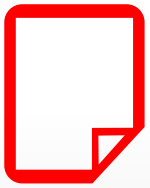
- Use a temperature gun (or infrared camera) and take temperature readings of the walls and the ceiling
- Missing insulation will contribute to energy costs and is a low cost fix



Heat loss in thermal envelope



Building Envelope Walk Down: Discussion Question



There can be as much as a 3°F of improvement in surface temperature for a clean roof compared to a dirty roof.

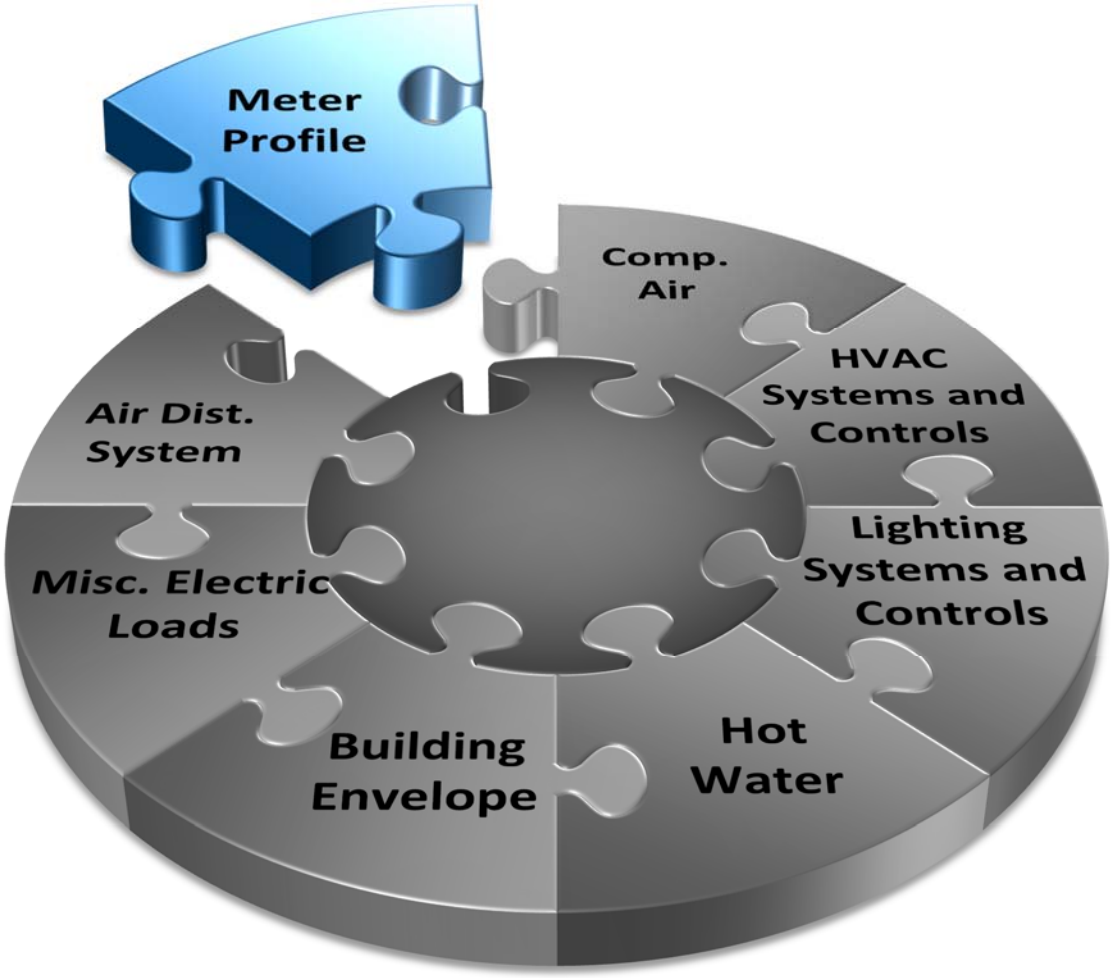
True or False?

Answer: True

Building Envelope Walk Down: Attic and Crawl Spaces

- Ventilation of attic and crawl spaces
  - Look for crawl space vents and attic vents that are closed or plugged
- Look for powered exhaust fans in attics
  - Do they have backdraft dampers?
  - Check if the temperature controls for the exhaust fan(s) are working
- Look for missing or damaged insulation in attic or crawl spaces
  - Damaged by water or animals?
  - Hanging loose from roof deck?
- Look for abandoned vents in lunchrooms (that were used to exhaust stove heat)
  - These abandoned legacy vents can let outdoor air into the building if not properly sealed.

Building Walk Down: Meter Profile



Meter Profile

- Demand for Services
- Utilities
- Smart Meters

Building Walk Down:
Meter Profile

- Meter Profiles are like a heartbeat
- Will show a variation as the building consumption goes up and down in response to demand for services
- Photo Voltaic (PV) renewable power on site?

Building Walk Down: Meter Profile

- Periodic review of the meter profile will reveal inconsistent usage
- Utilities in many regions are installing interval meters that provide high resolution interval data
- Data from the utilities can be downloaded from the utilities' website
- Smart meters may also be installed on the building
- Review Electric, Gas and Water meters
- Multiple meters for larger buildings or campus with multiple buildings may exist (check)
- Net metering for PV/renewable power?

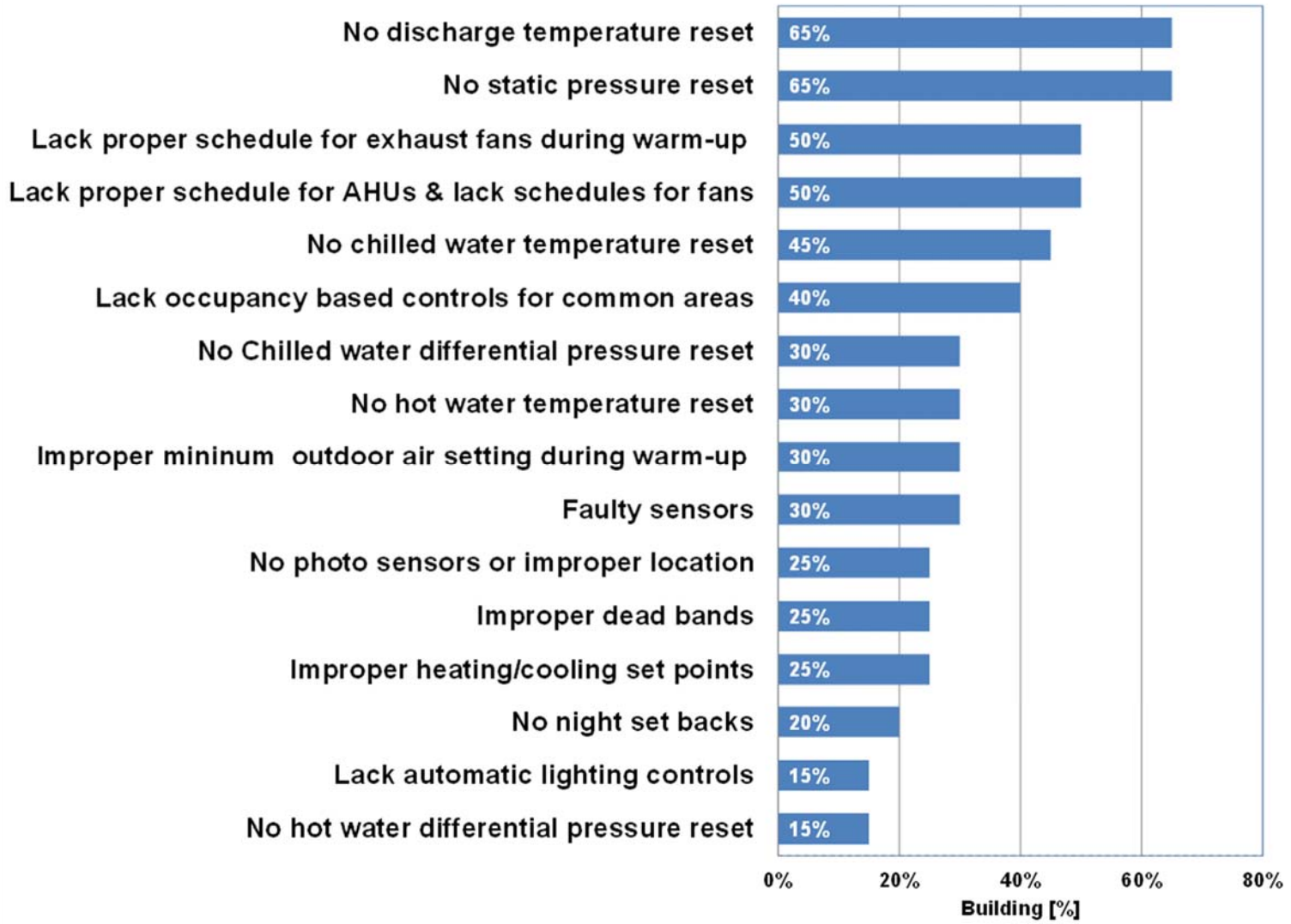
Building Automation Systems, Data-driven Analysis:

The following material is relevant for buildings that have a building automation system

Data-driven Re-tuning

- Approach: use the building's building automation system (BAS) to identify and correct building operational problems that lead to energy waste
- For buildings with BAS
  - Typically 100,000 square feet or more
  - Front-end data drives re-tuning process

Common Re-tuning Measures: PNNL Meta Analysis of 100 Building



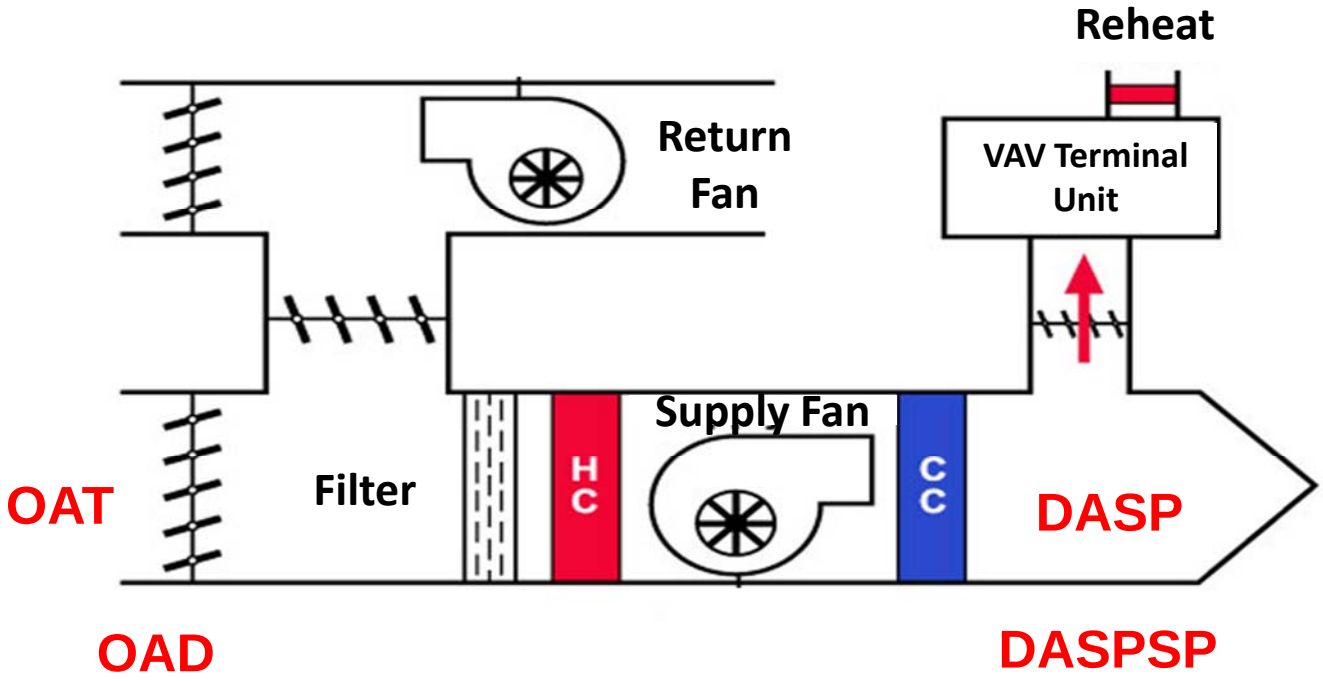
Building Tune-Up Focus Areas

- **Occupancy Scheduling**
- AHU Discharge Air Temperature Control
- **AHU Discharge Air Static Pressure Control**
- AHU Heating and Cooling Control
- AHU Outdoor Air Operation
- **AHU Economizer Operation**
- **Zone Conditioning**
- Heating Plant
- Cooling Plant
- Meter Profiles

Tune-Up Occupancy Scheduling

Seattle Building Tune-Ups Rule:
Table 1: 1.a, 1d., 1e., 1f.

Data Points Being Used: Occupancy Scheduling

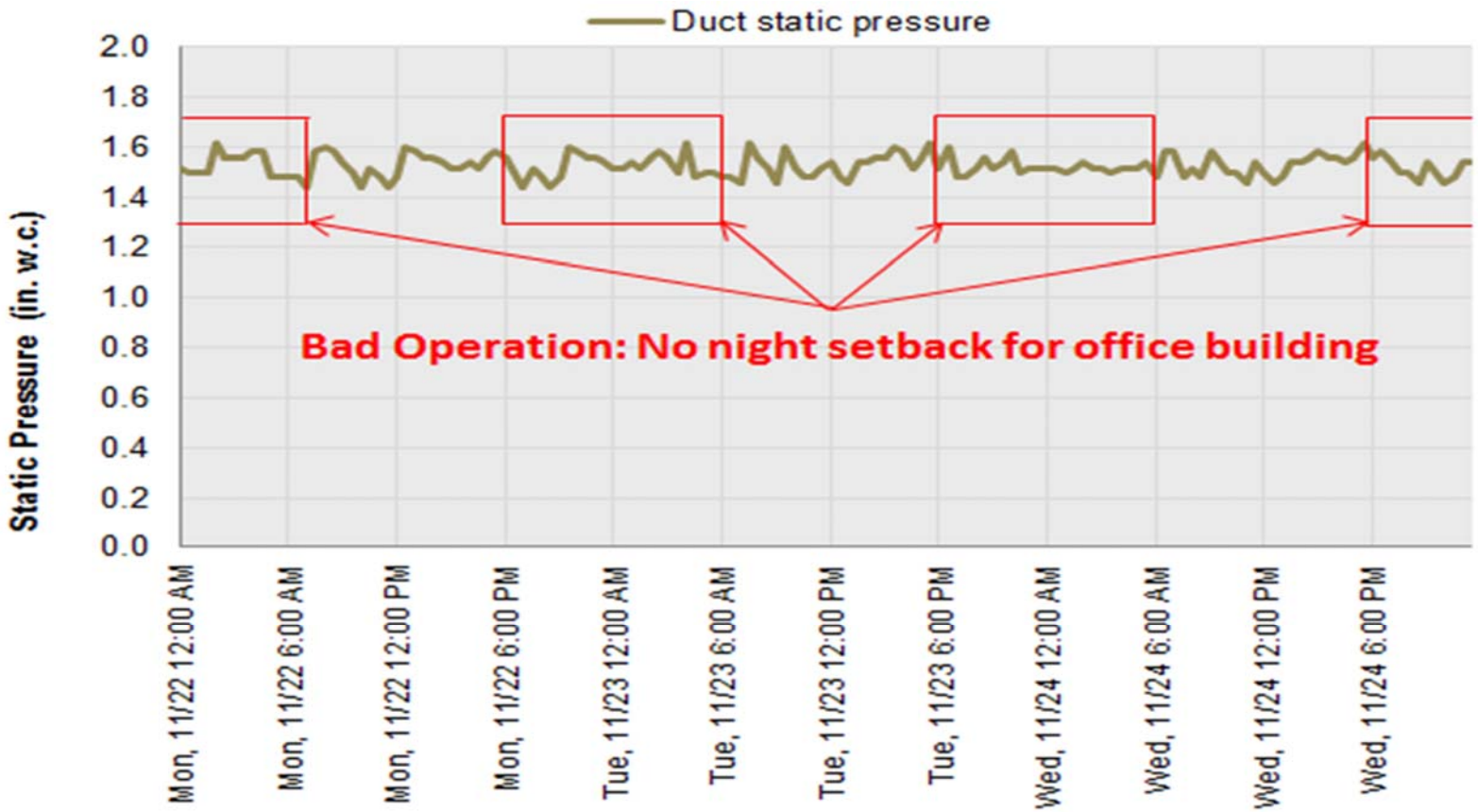


- Outdoor-air temperature (OAT)
- Outdoor-air damper position signal (OAD)
- Supply fan status
- Discharge-air static pressure set point (DASPSP)
- Discharge air static pressure (DASP)

Trends to Look for: Occupancy Scheduling

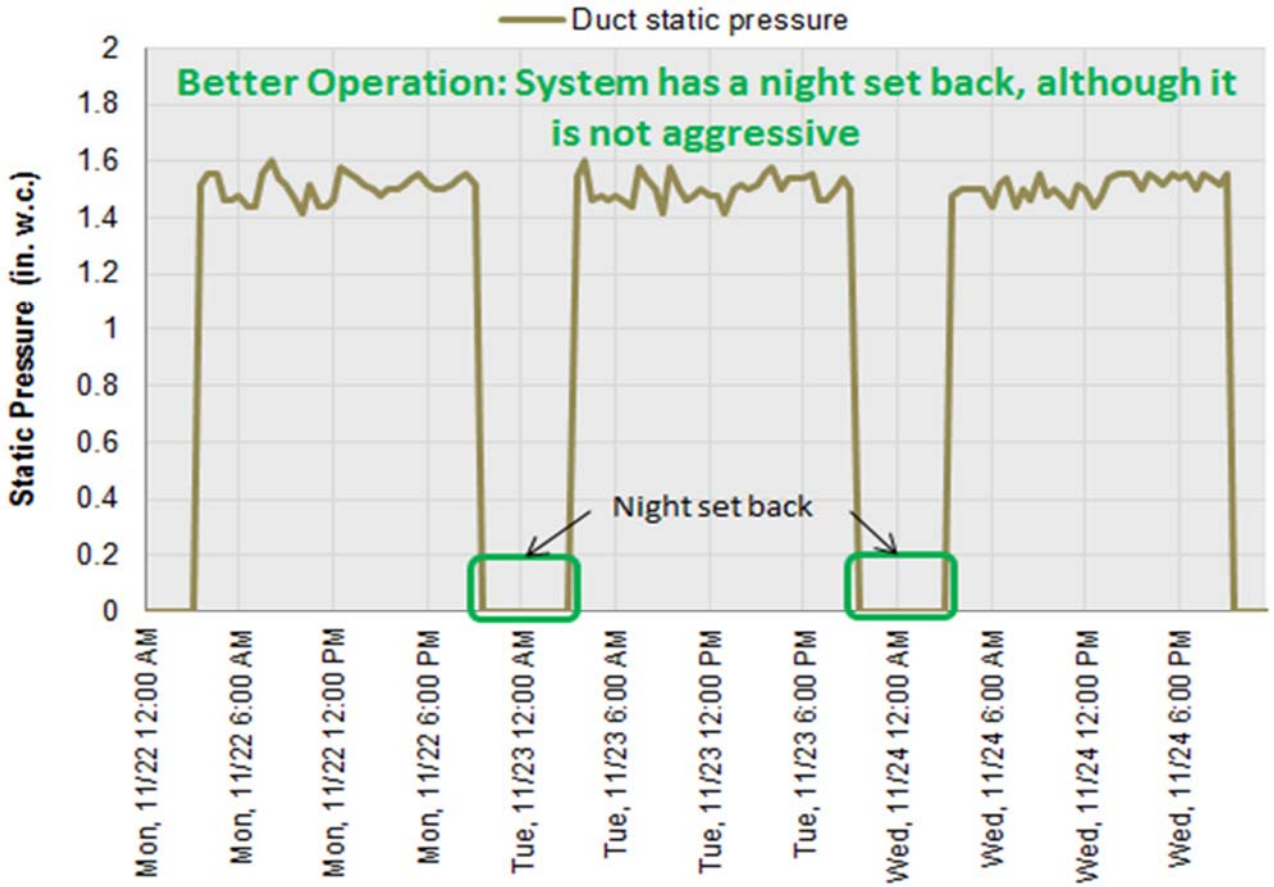
- Is there night setback for unoccupied hours?
- Is there weekend setback if the building is unoccupied on the weekends?
- Does the supply fan cycle frequently during unoccupied hours?
- Does the outdoor-air damper open during unoccupied hours or when the building is in warm-up/cool-down mode?
- Are miscellaneous support systems, ancillary systems also shutting down at night?
- Specialized systems – lighting, exhaust fans, etc.

Occupancy Scheduling: Set back for Unoccupied Hours?

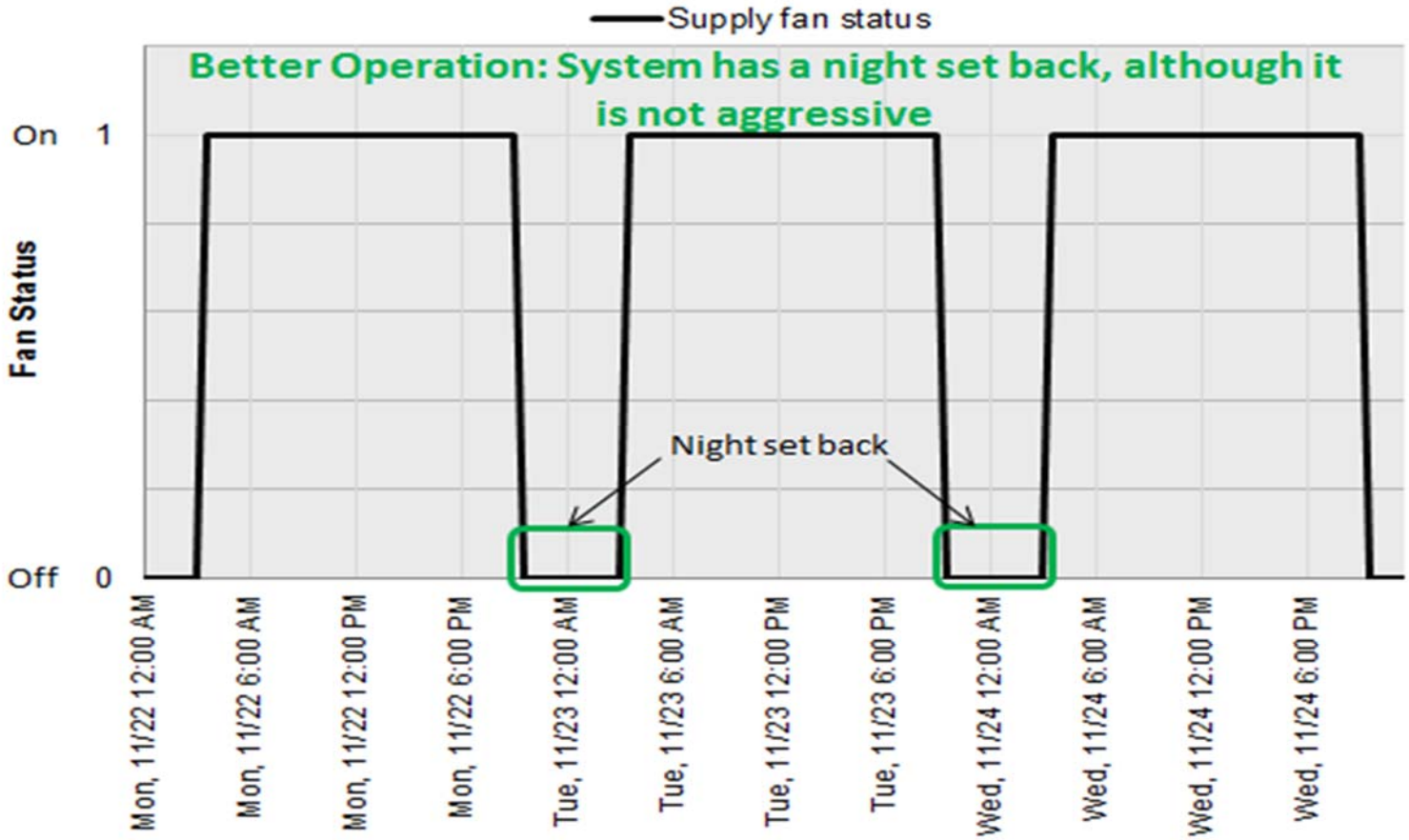


During unoccupied hours, the system should be set back so that the system does not continue to operate

Occupancy Scheduling: Set back for Unoccupied Hours?

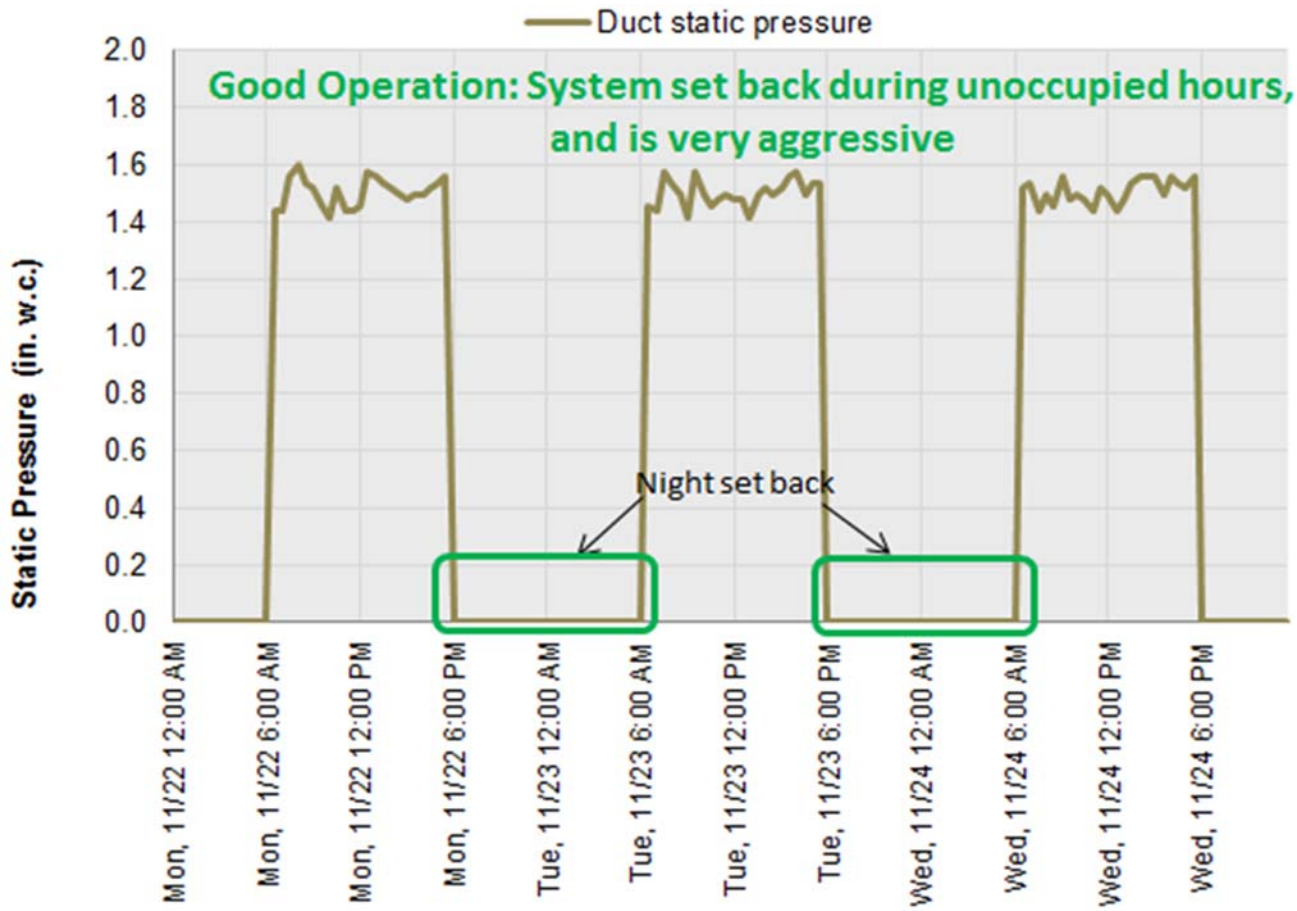


Occupancy Scheduling: Set back for Unoccupied Hours?

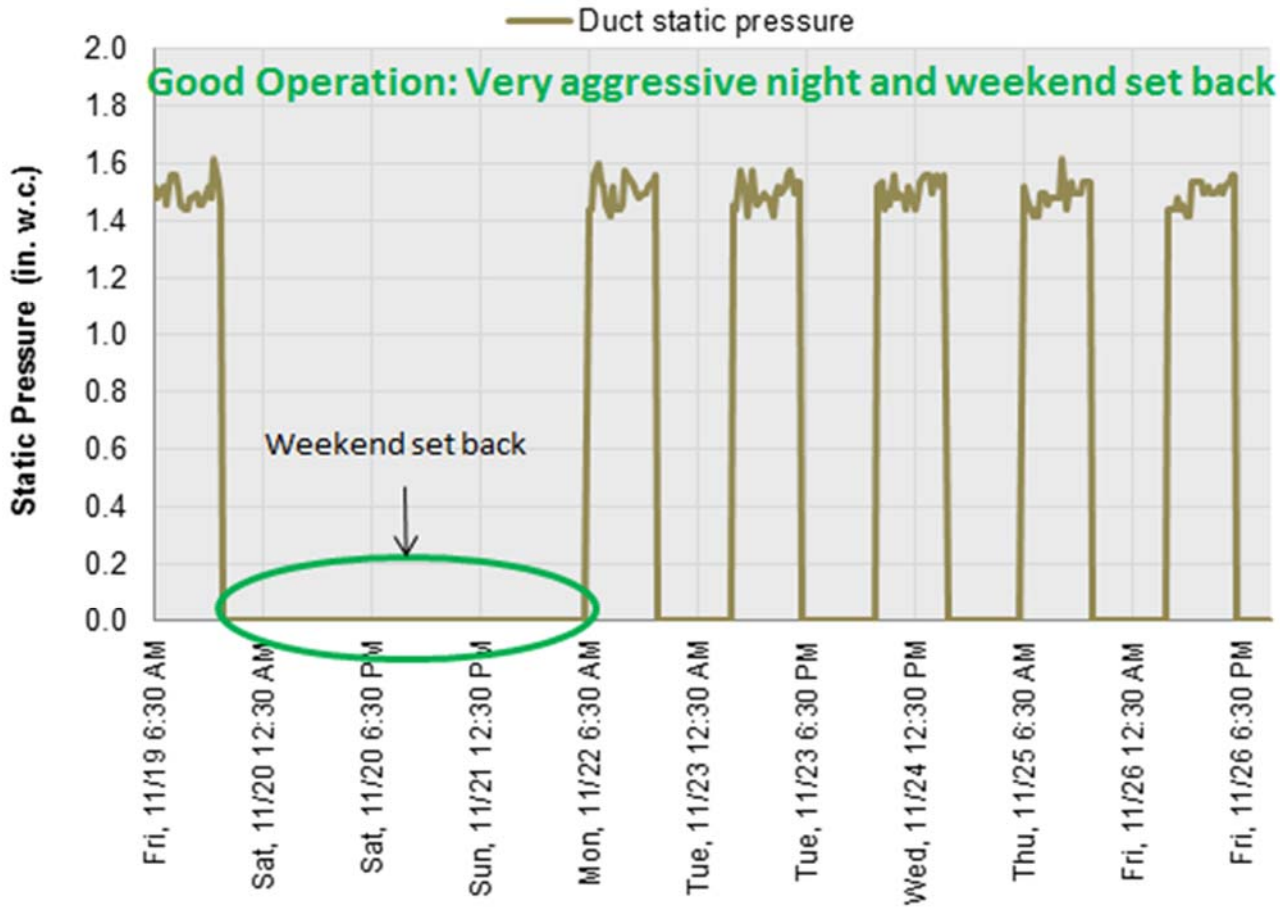


You can also look at supply fan status but it is not as reliable as the static pressure. It is easier to see if a static pressure sensor is giving faulty readings than an on/off status sensor.

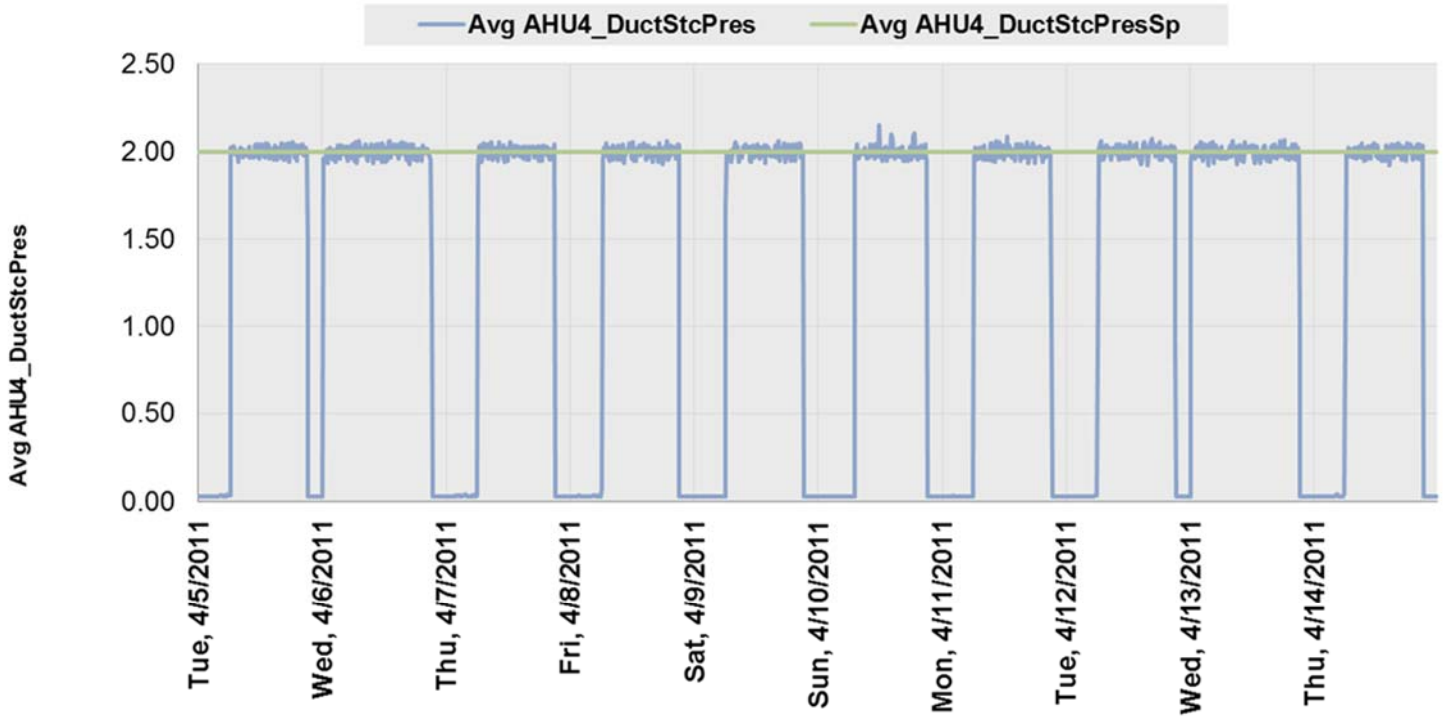
Occupancy Scheduling: Set back for Unoccupied Hours?



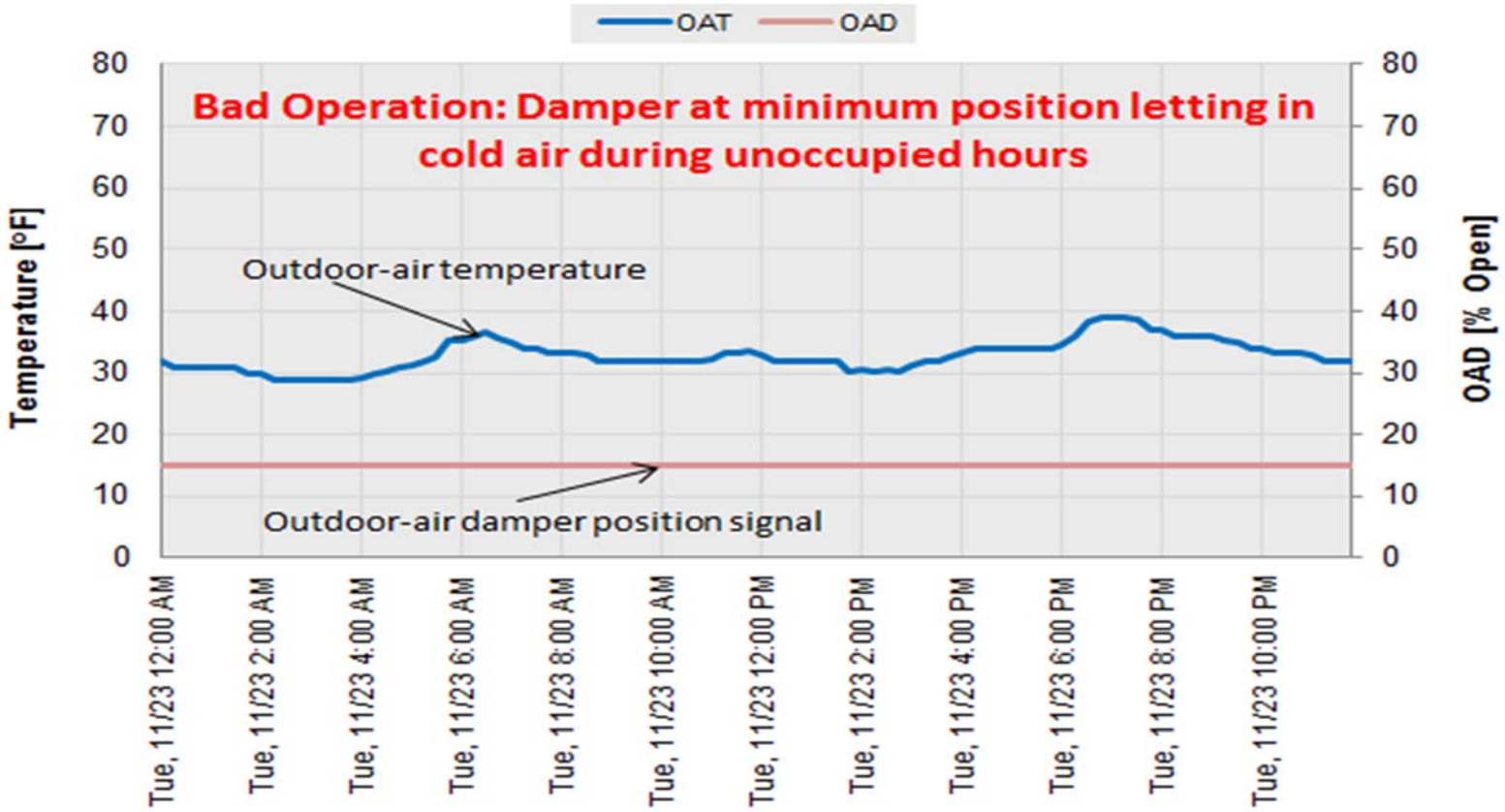
Occupancy Scheduling: Set back for Weekend Hours?



Occupancy Scheduling: Setback Opportunities?

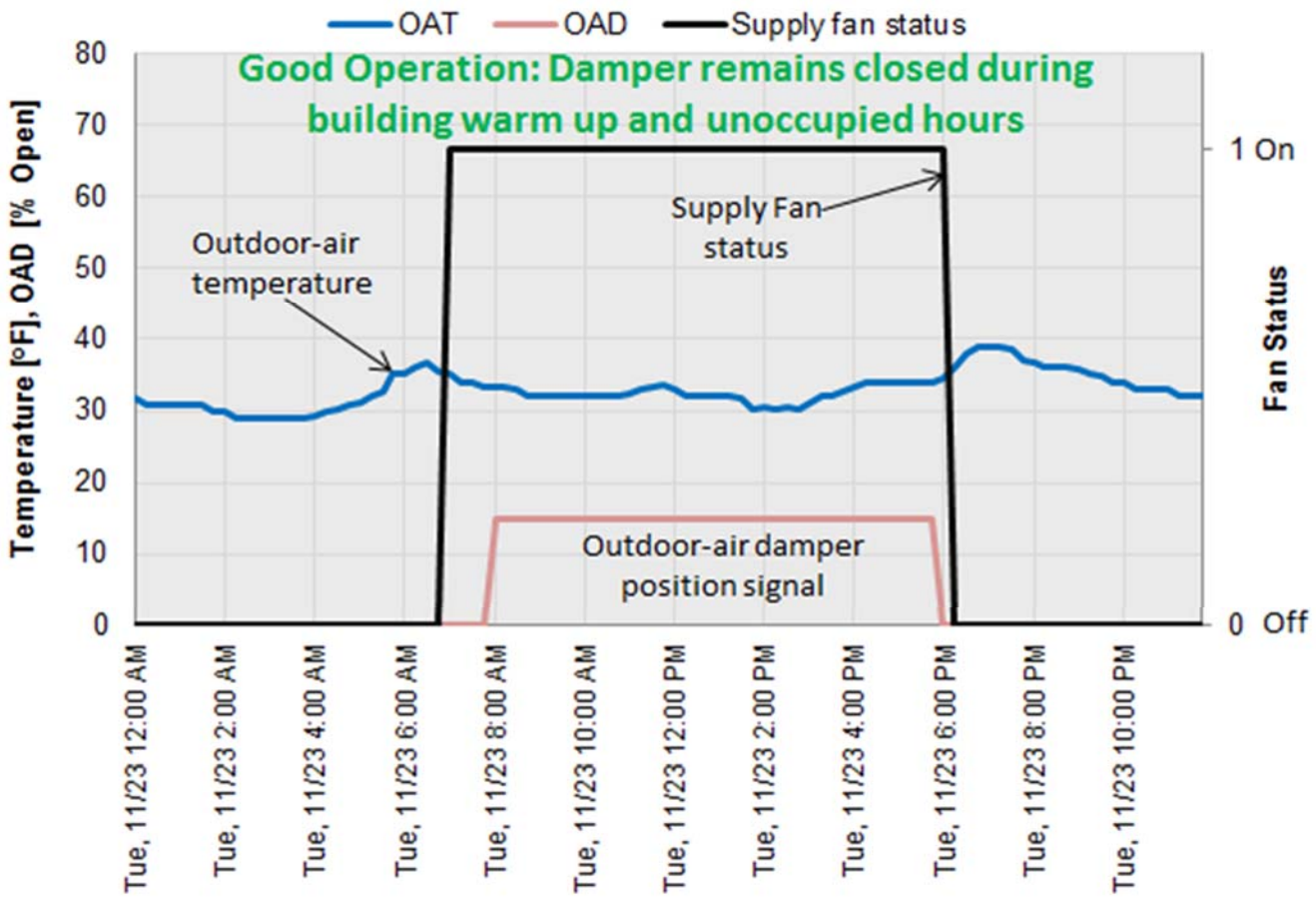


Occupancy Scheduling: Outdoor Air Damper during Unoccupied Hours



The outdoor-air damper should not open up during morning warm-up/cool-down (unless the weather is appropriate for economizing), and then it should open 30 minutes prior occupancy to flush the building. It should close at the end of the occupied time, and stay closed overnight.

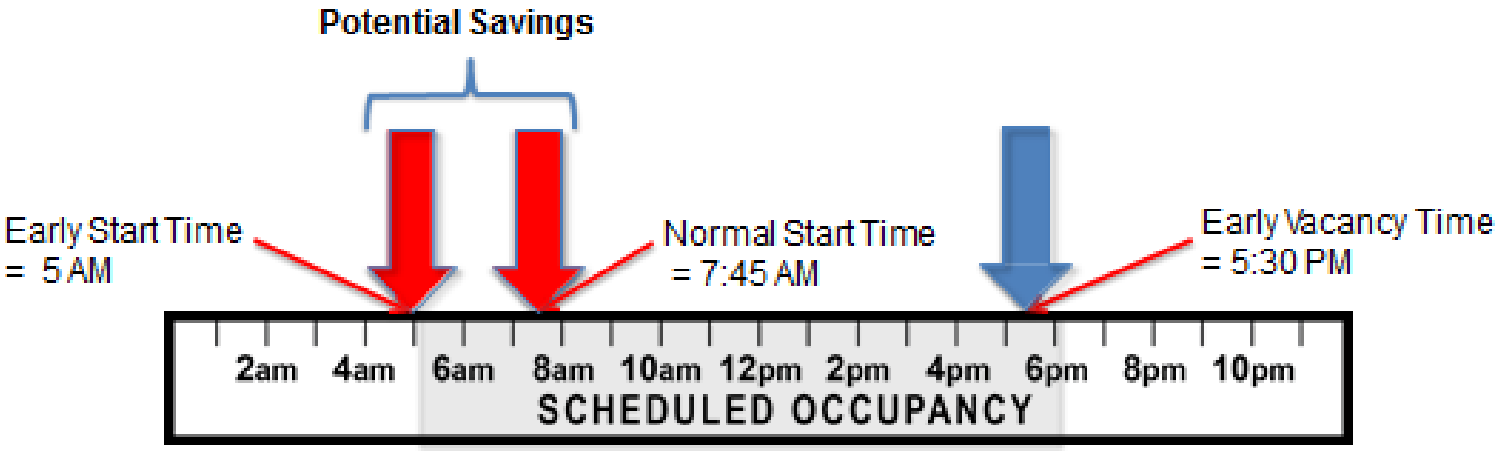
Occupancy Scheduling: Outdoor Air Damper during Unoccupied Hours



The OAD remains closed during ramp up times to prevent the system from having to fight against that increased load from the cold outdoor air.

Occupancy Scheduling: Optimal Start

- Optimal Start will automatically "learn" over time the optimum time to start the HVAC system to bring space temperatures within 1 to 2°F of occupied requirements at the start of the occupied time period



Recommendations and Actions: Occupancy Scheduling

- Look for Re-tuning opportunities during night, weekend, and holiday unoccupied schedules.
- If your organization has moved to a four-day work week, make sure systems aren't running at full capacity on the fifth day.
- Look for Re-tuning opportunities during workday no- or low-use schedules (auditorium, classrooms, conference rooms).
- Do not restart too early - use a startup schedule based on building needs (employ ***optimal start***, if possible).
- Do not use outside air during warmup except the last 30 minutes for flushing the building.
- Enable unoccupied mode and night setback control.
- Shut off units at night and on weekends.
- Turn off systems during unoccupied hours.
- Slow down systems during unoccupied and lightly occupied hours.

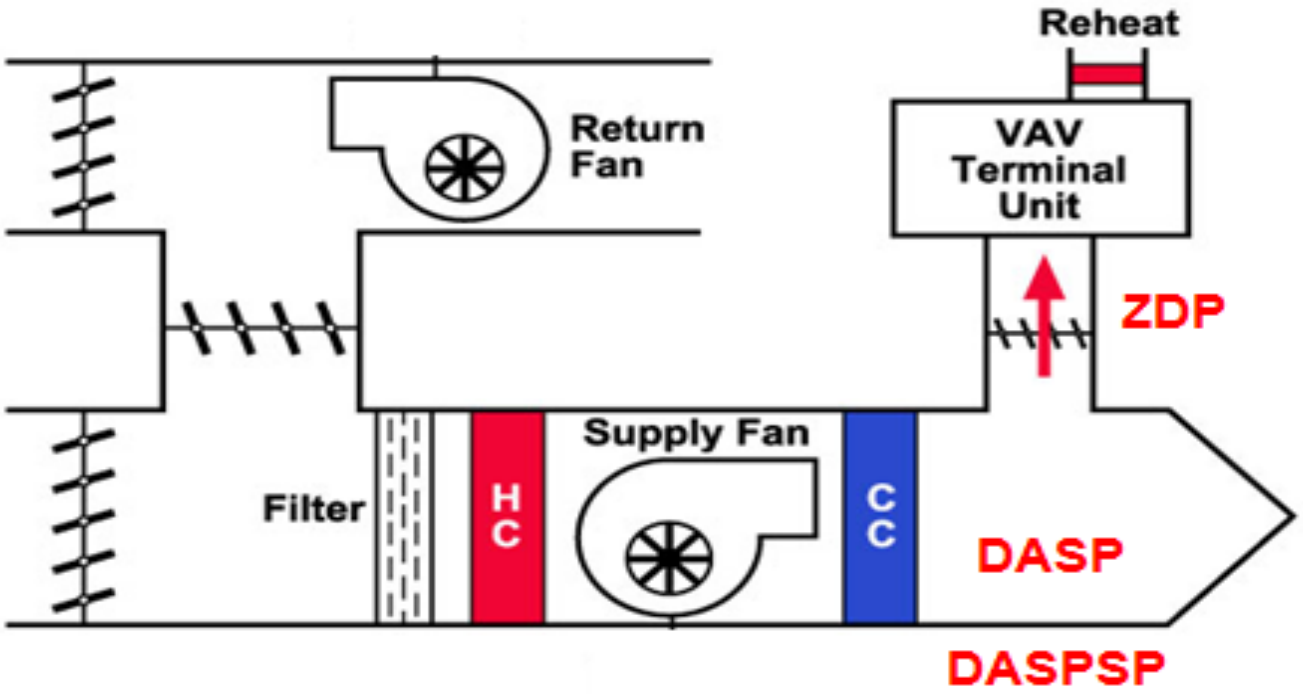
Recommendations and Actions: Occupancy Scheduling

- Refrain from starting up a system for the occasional nighttime or weekend user.
  - Use bypass/override buttons for occasional night or weekend users (set for no more than 2 - 4 hours).
- Do not make radical changes. Instead, make small changes and observe how they work, and then readjust as needed.
- Notify occupants that you are implementing changes and let them know who to contact if the changes are not working for them.
- Consider switching to smaller-capacity equipment, if available, for early evening loads.

Tune-Up
AHU Discharge-Air Static Pressure Control

Seattle Building Tune-Ups Rule:
Table 1: 1.b, 1.c, 1.f

Data Points Being Used: AHU Discharge-Air Static Pressure Control



- Discharge-air static pressure (DASP)
- Discharge-air static pressure set point (DASPSP)
- Zone damper position signal (ZDP)

Trends to Look for: AHU Discharge-Air Static Pressure Control

- Is there a reset-schedule for the discharge-air static pressure?
- Is the discharge-air static pressure set point too high or too low?
  - Review trends of damper positions of variable air volume (VAV) boxes vs. time
  - If most dampers are nearly closed during cooling - static pressure is too high
  - If several (>25%) dampers are fully open during cooling - static pressure is too low (starved boxes)
- Look for dampers that aren't modulating with changing conditions, and VAV boxes that are not being controlled or not responding to control signals.

Issues: AHU Discharge-Air Static Pressure Control

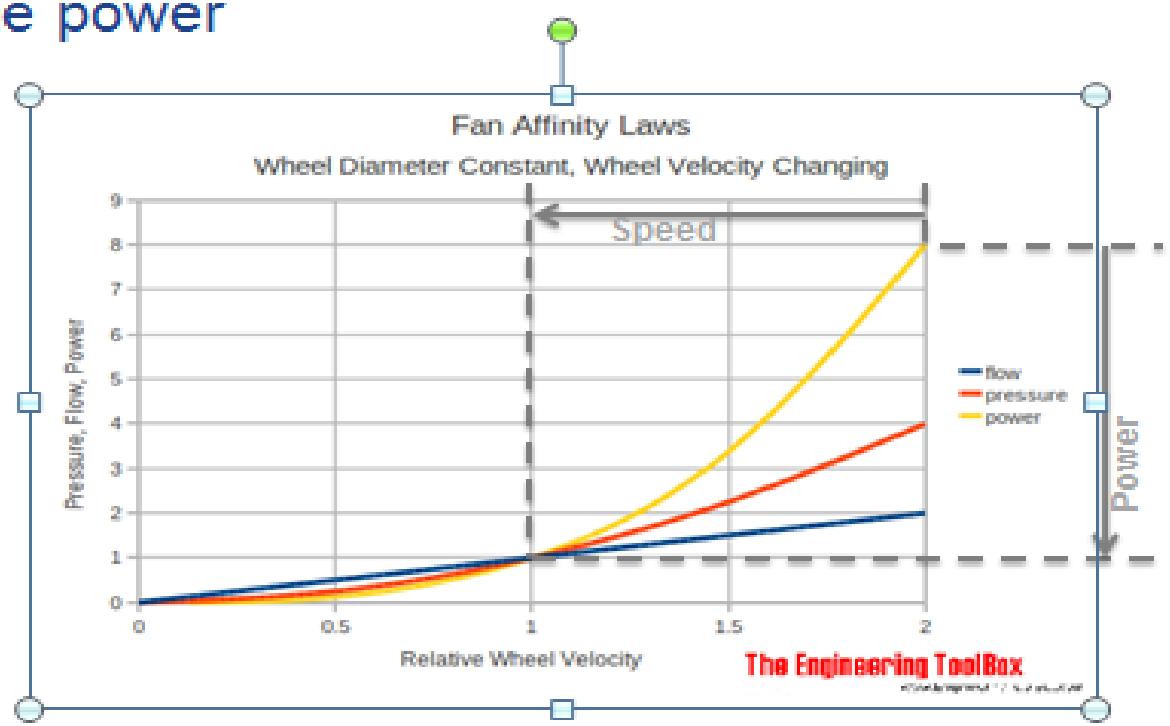
- Like discharge-air temperature, discharge-air static pressure should follow the real load conditions
- Ideally, VAV dampers should run in the 50% to 75% range (non-design conditions)
- When many VAV dampers are down at 20% open (or less), the static pressure is too high

When should someone expect several VAV box damper to be fully open?

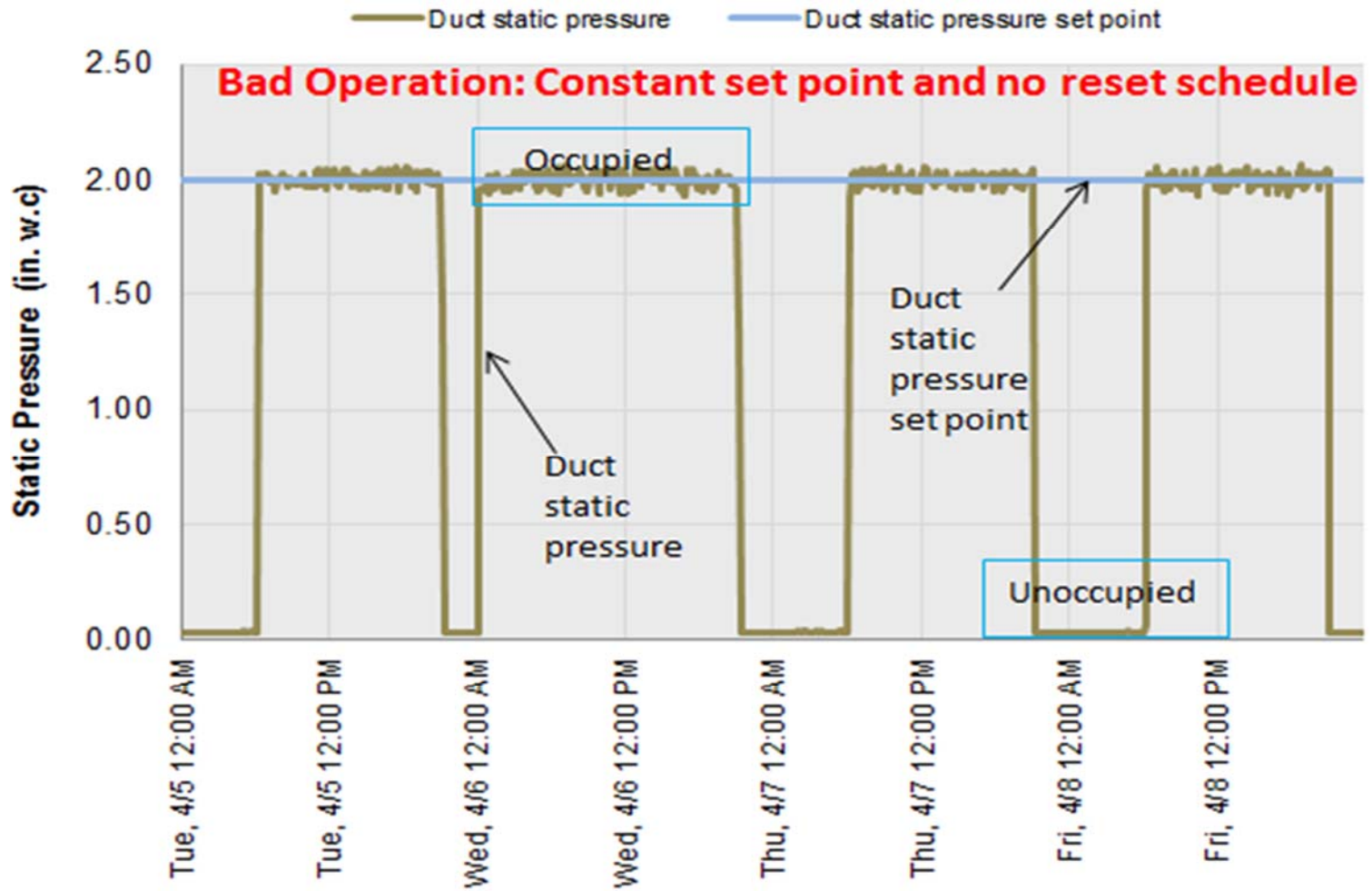
- During the morning cool down period (if the night setback was properly implemented, the building should have warmed up overnight, during warm weather)
- If the building warmed up overnight during cold weather, the building heating system is not being controlled correctly
- Overheating a building in the winter is a huge **RED FLAG**

Big Savings Potential: AHU Discharge-Air Static Pressure Control

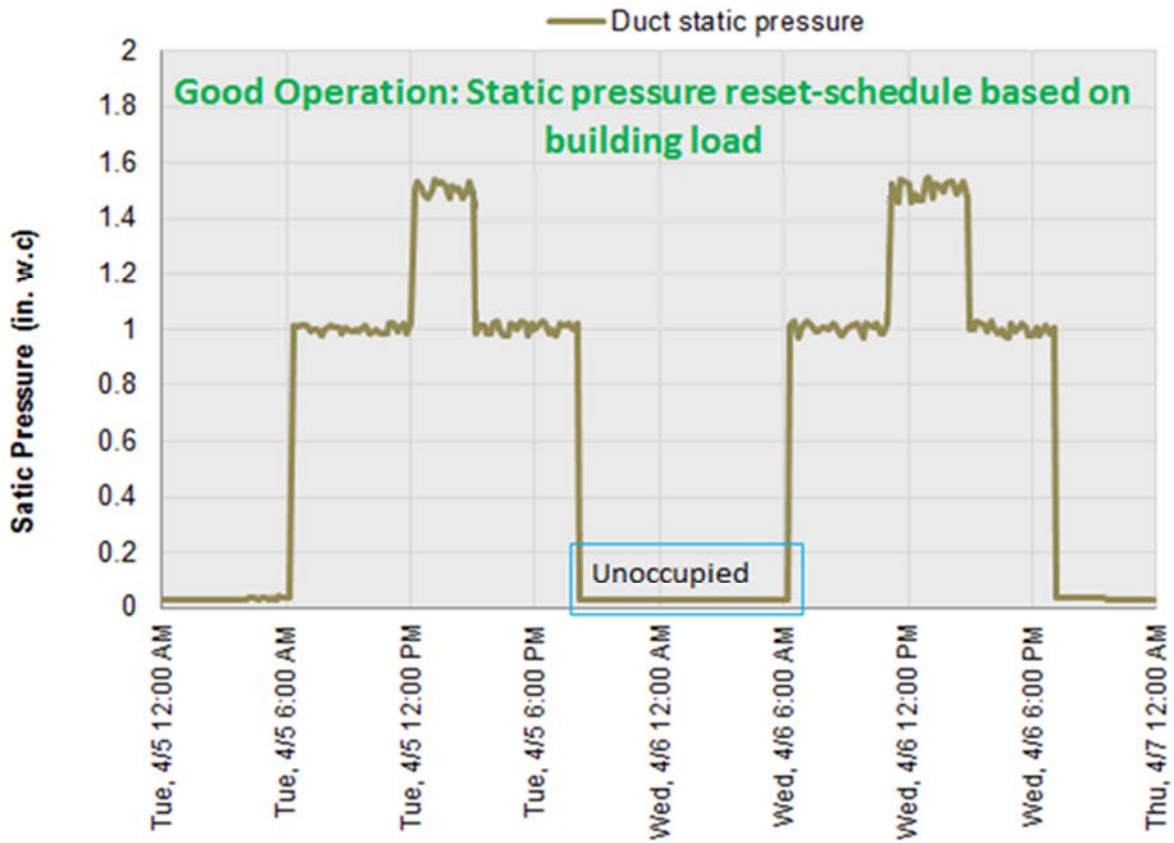
Fan Affinity Laws: reducing fan speed by 1/2 uses about 1/8th the power



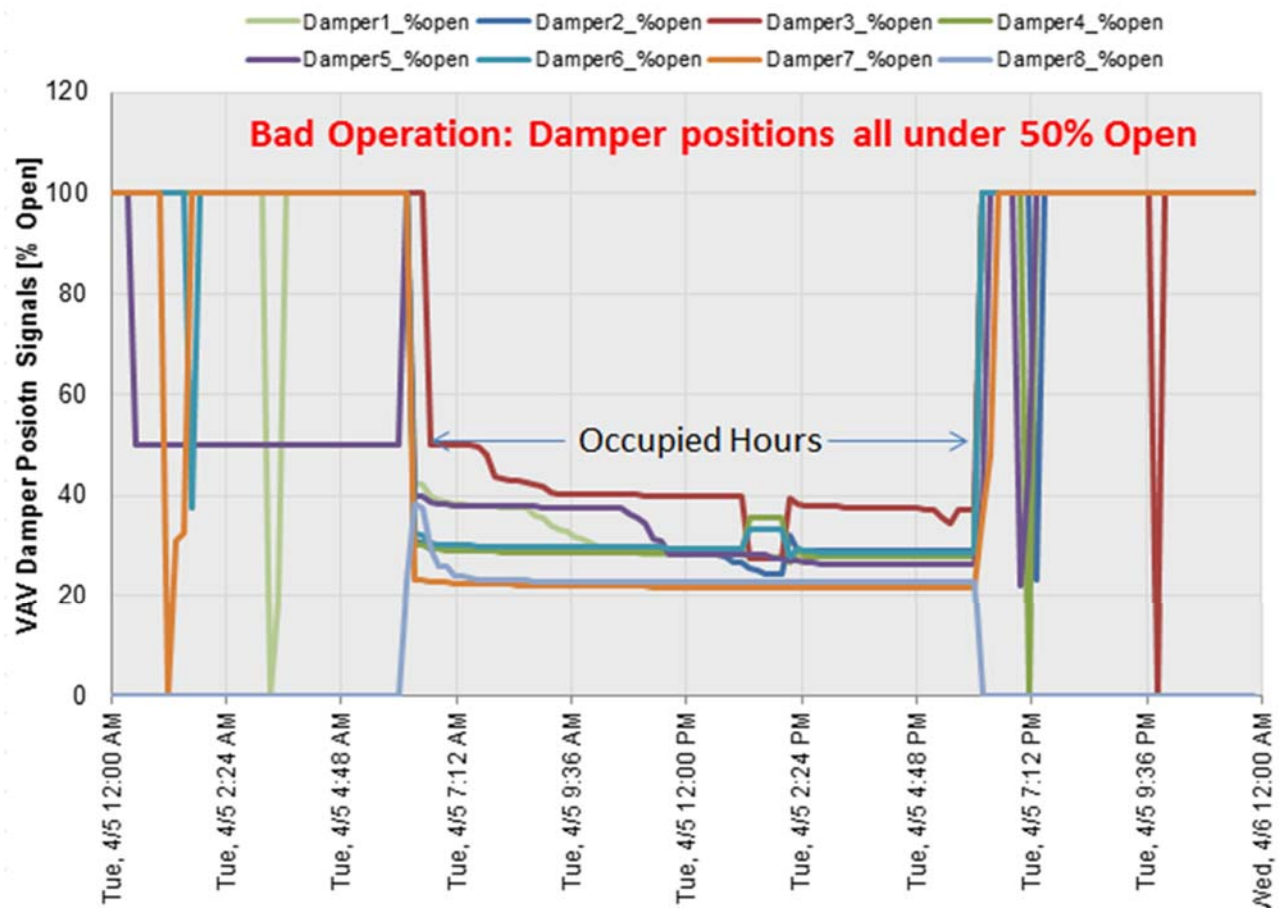
AHU Discharge-Air Static Pressure Control



AHU Discharge-Air Static Pressure Control



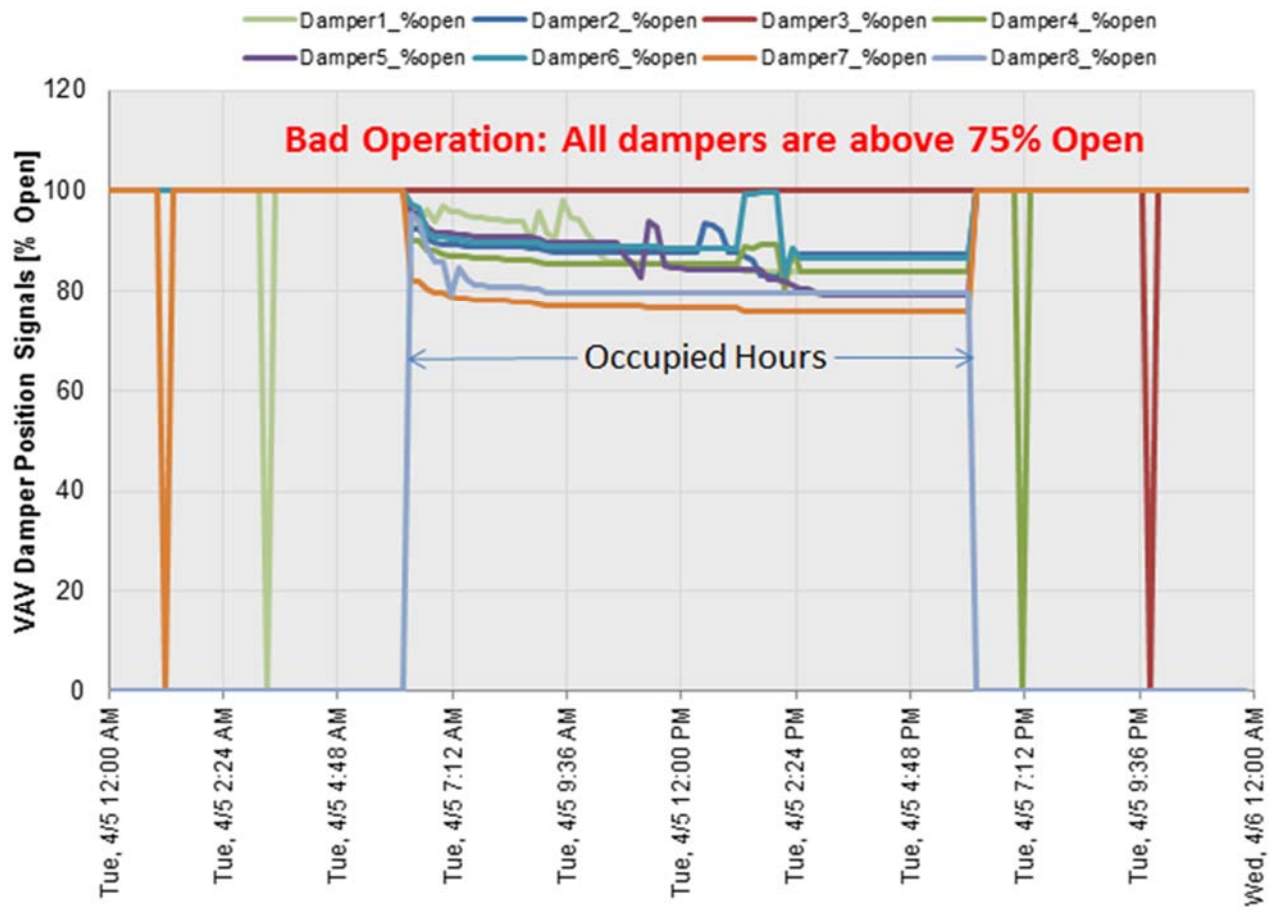
Discussion: AHU Discharge-Air Static Pressure Control



Too much static pressure, most of the VAV boxes are less than 50% open

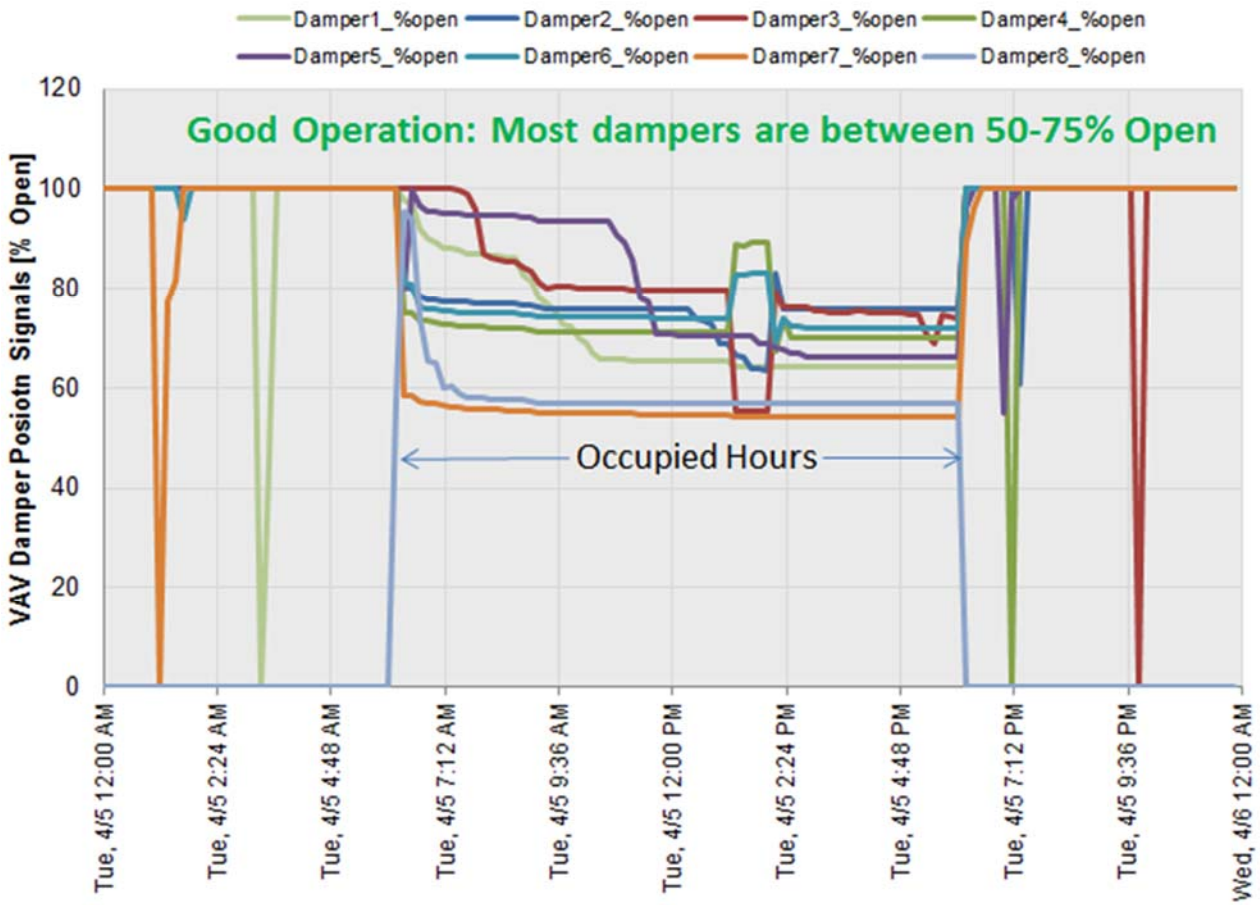
"Pushing the gas and the brakes at the same time"

Discussion (continued): AHU Discharge-Air Static Pressure Control



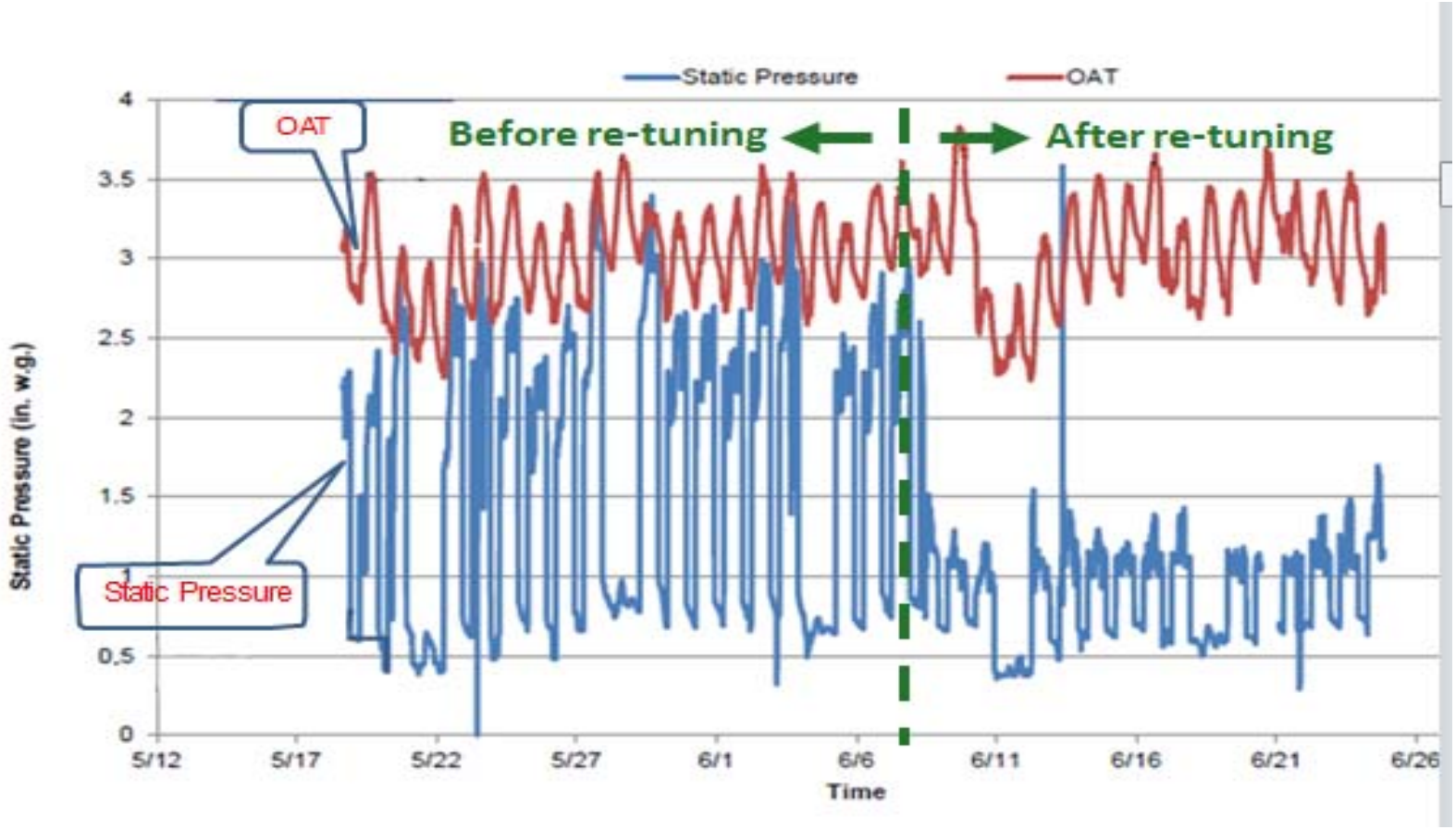
Not enough static pressure, most of the VAV boxes are close to fully open

Discussion (continued): AHU Discharge-Air Static Pressure Control



Just right!

Before and after Re-tuning: AHU Discharge-Air Static Pressure Control



You can see how the discharge-air static pressure changes dramatically before and after Re-tuning

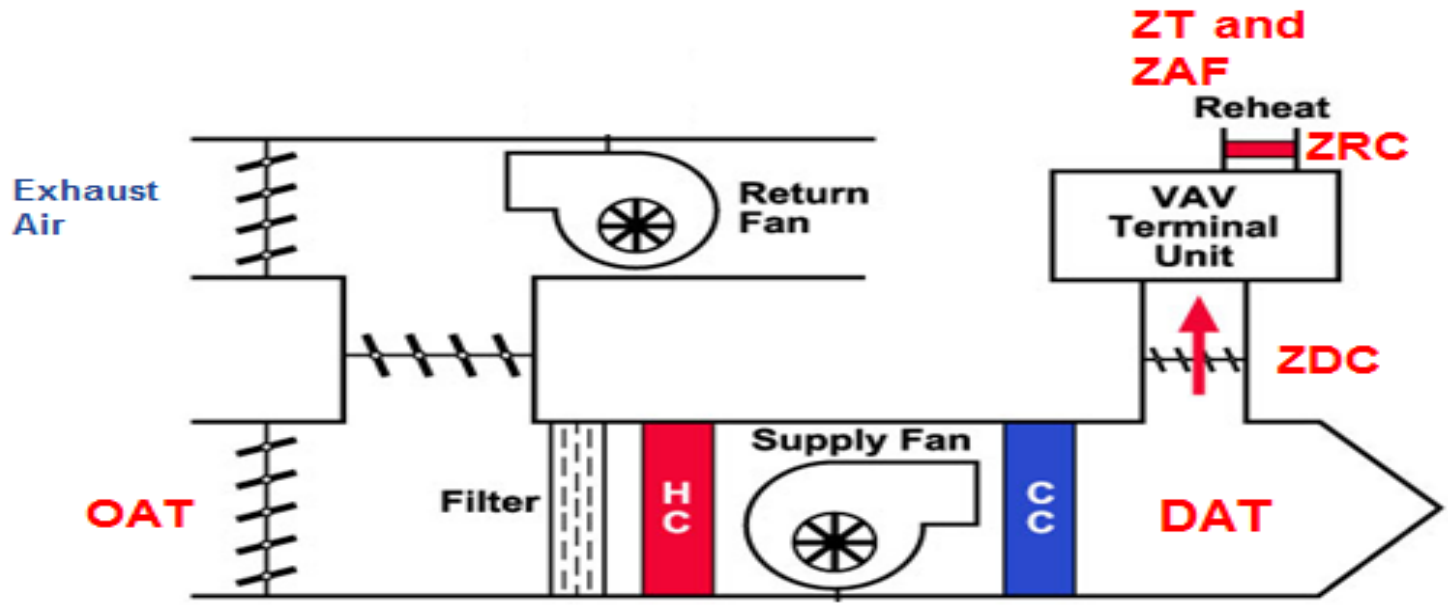
Recommendations and Actions: AHU Discharge-Air Static Pressure Control

- Ideally, VAV box dampers should trend in the 50%-75% range (or lower).
- Match the discharge-air static pressure set point to actual need - an example is systems that run at 0.5" in the morning and 1.5" in the afternoon when cooling loads are greater (solar gain, weather, occupant loading, etc.).
- Numerous occupant complaints may indicate an improperly working discharge-air static pressure control scheme. Note that hot and/or stuffy complaints occur when discharge-air static pressure is too low, not when it's too high.
- Excess static pressure can result in excessive air delivery, cold drafts and high noise levels in offices (diffuser noise)
- Trended data for discharge-air static pressure control that is working should show varied static pressure over time.

Tune-Up
Zone Conditioning

Seattle Building Tune-Ups Rule:
Table 1: 1.a, 1f, 1.g

Data Points Being Used: Zone Conditioning



- Outdoor-air temperature (OAT)
- Discharge-air temperature (DAT)
- Zone reheat command (ZRC)
- Zone temperature (ZT)
- Zone occupancy mode
- Zone damper command (ZDC)
- Zone air flow (ZAF)

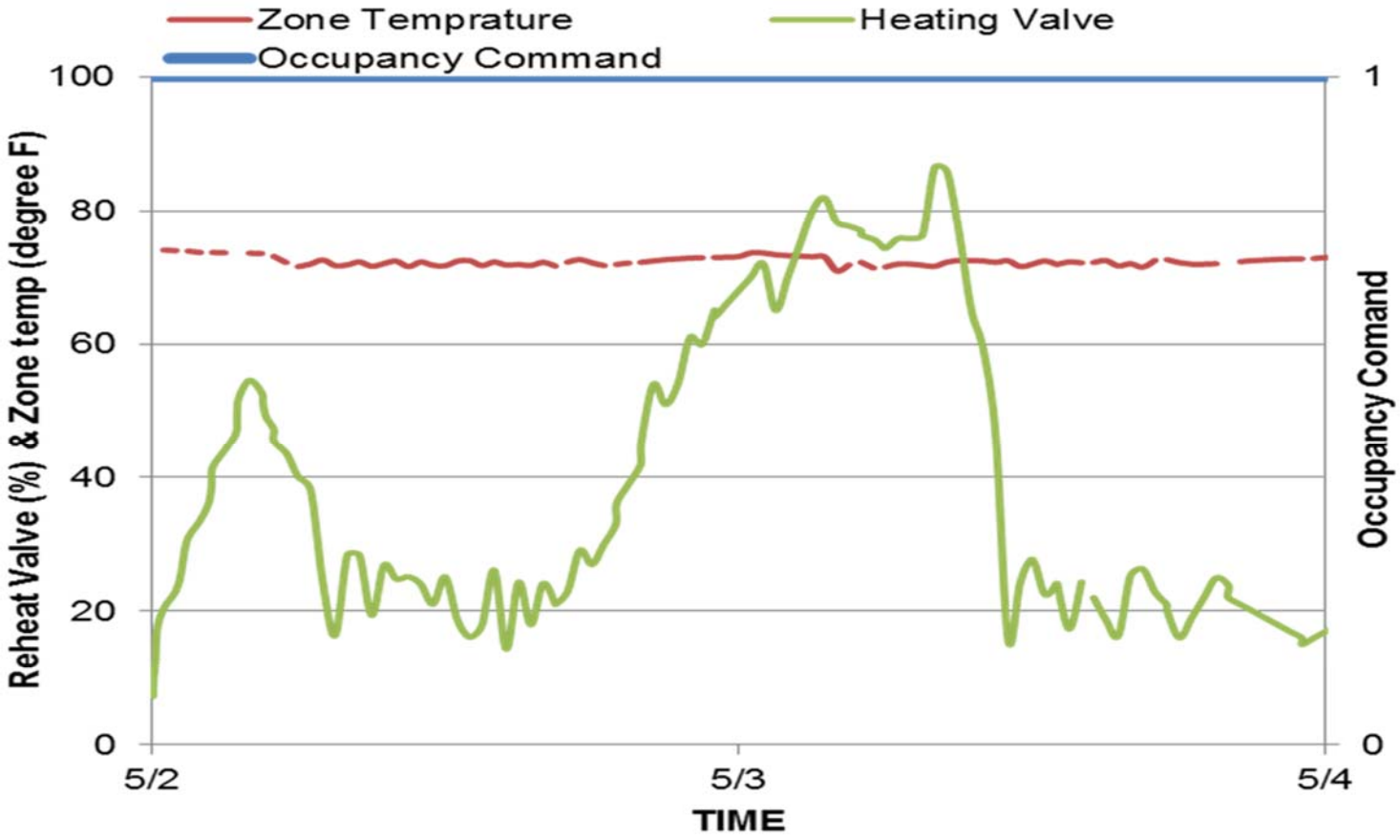
Trends to Look for: Zone Conditioning

- Is there night-time set back/unoccupied mode at the zone level?
- Is there significant reheat occurring at the zones, especially interior zones or during summer (cooling) seasonal periods?
- Excessively high minimum air flow rates for VAV terminal boxes may result in significant reheat, especially if the primary air temperature is extremely low
- Compare minimum airflow set points to maximum airflow set points (ratio). If the minimum is more than 50% of the maximum, this could indicate excessive ventilation and/or terminal box airflow rates when the space is trying to heat.
- How many zones are in heating mode and how many are in cooling mode?
- Occupant complaints (temperature or indoor air quality) may be related to the zone conditioning.
- Cold complaints may indicate AHU primary air temperatures that are too cold (does the AHU reset the discharge-air temperature set point?) and/or may indicate terminal box minimum airflow rates that are too high.

Equipment Configurations to Look for: Zone Conditioning

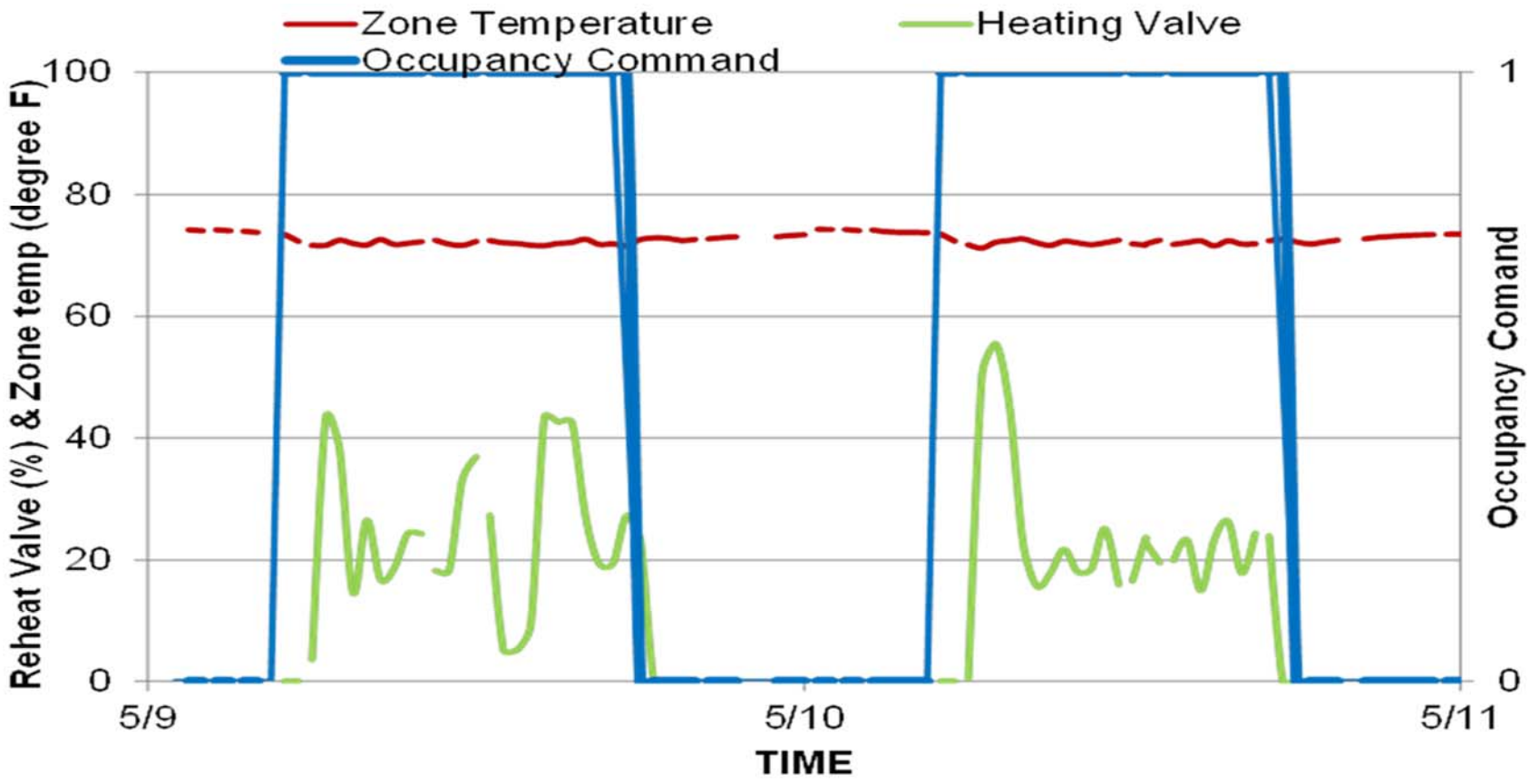
- Terminal boxes are major building HVAC components and directly impact occupant comfort and energy costs
- Single duct variable air volume (SDVAV) terminal box
  - With reheat (hot water reheat/electrical reheat; typically used in perimeter zones)
  - Without reheat (typically used in interior zones)
- Fan powered VAV boxes (Note: the fan section adds another filter that must be maintained periodically – replaced)
  - Parallel type (typically found in perimeter zones)
  - Series type (may be found in interior or perimeter zones)
- Dual duct terminal box
  - Dual duct constant air volume (DDCAV)
  - Dual duct variable air volume (DDVAV)
- Induction units (2 pipe/4 pipe)
- Fan coil units (2 pipe/4 pipe)
- Cabinet and Unit Heaters

Zone Conditioning: Continuous Reheat and No Schedule



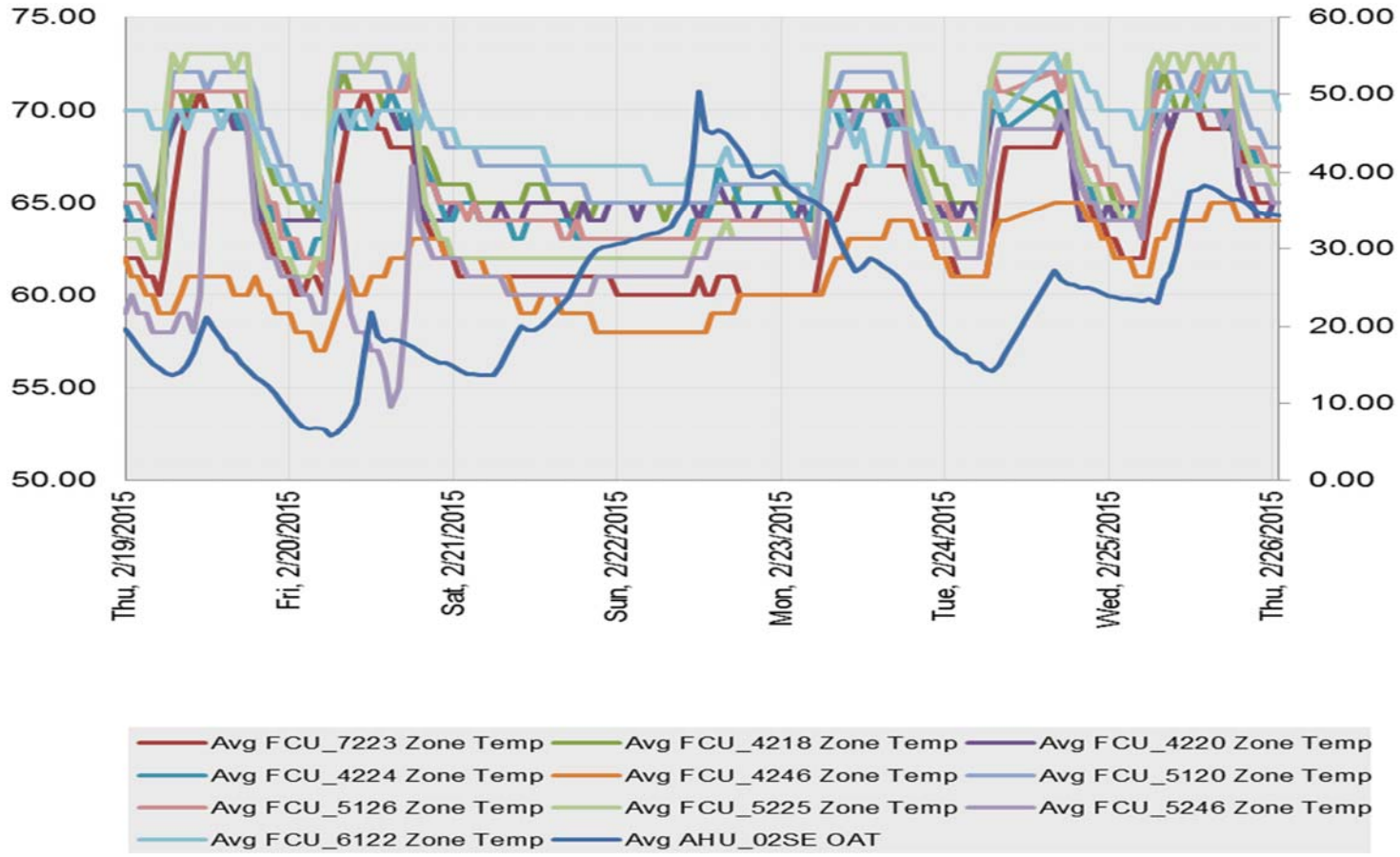
- Zone occupancy schedule – missing?
- Reheat valve is active all the time (during unoccupied (night) periods)

Zone Conditioning: Scheduled Occupancy with Reheat



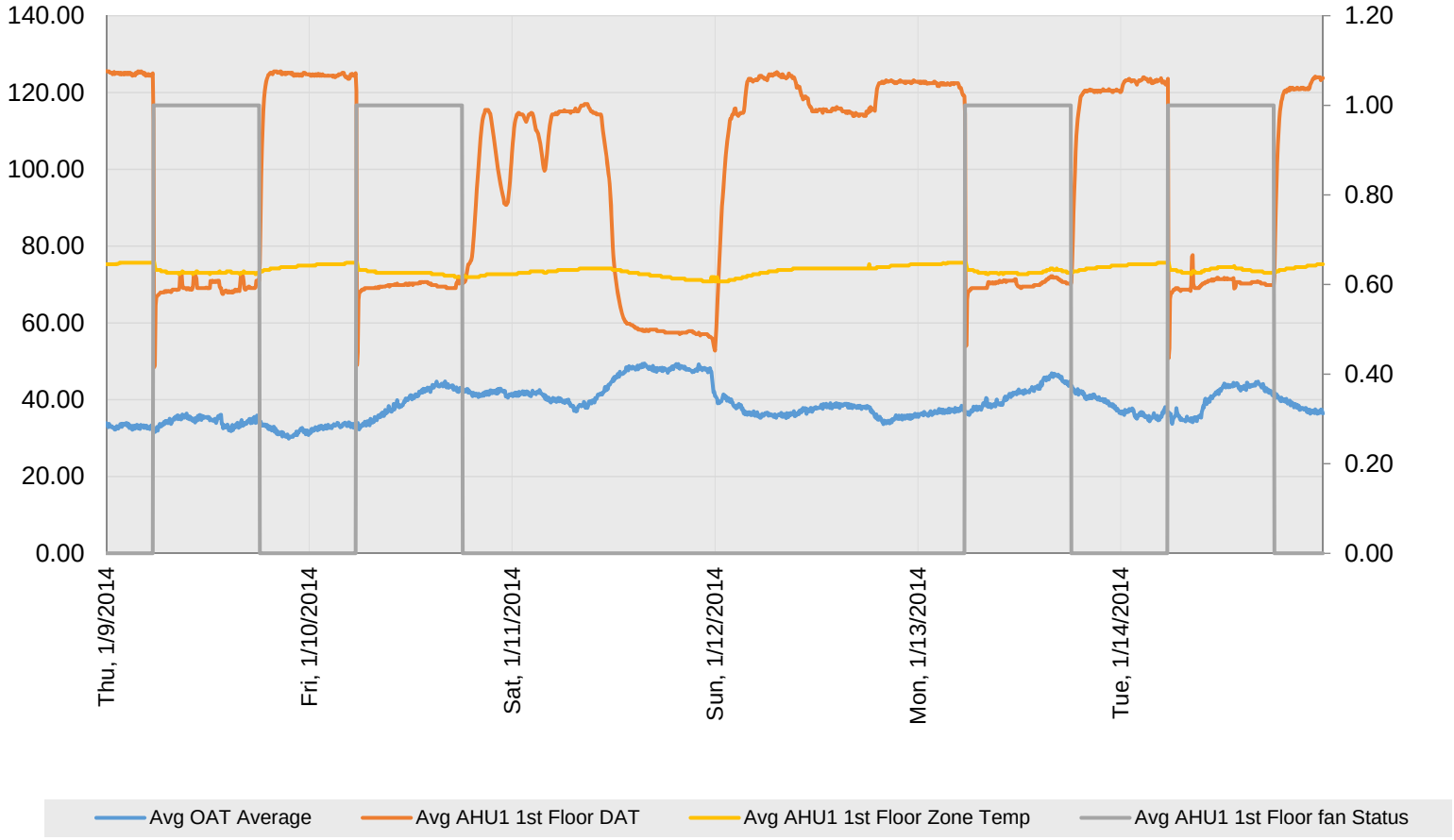
- Zone occupancy schedule used
- Reheat valve closes during vacancy/unoccupied period

Zone Conditioning: Scheduled Occupancy with Reheat



- **Are there any opportunities for holiday scheduling in the data?**

Zone Conditioning: Scheduled Occupancy with Reheat

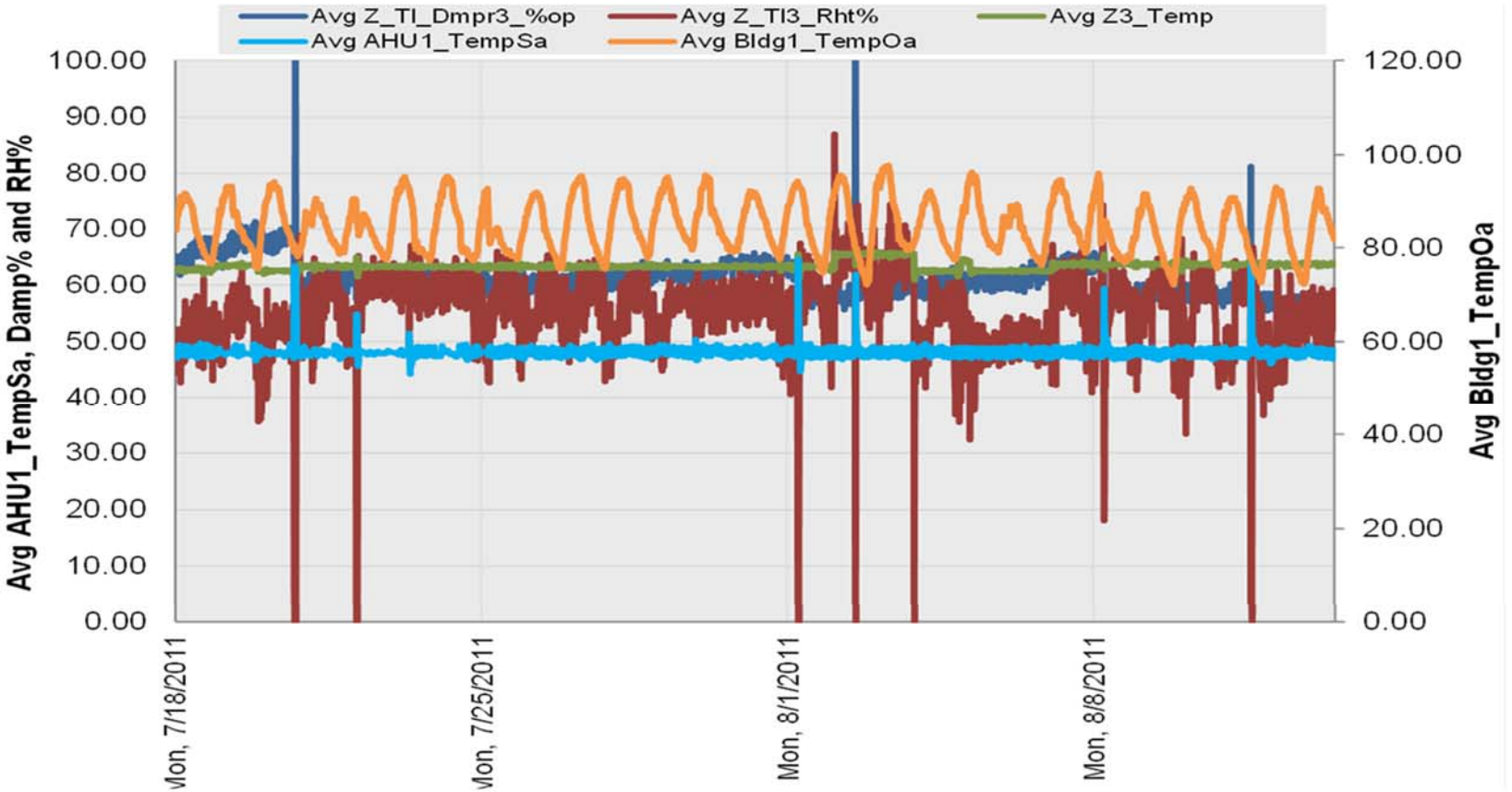


Zone Conditioning: Discussion Question

In which zones should heating be disabled/minimized during the summer?

Answer:
Interior zones

Zone Conditioning: Continuous Zone Conditioning – Reheat and Airflow



- Very cold primary AHU supply air temperature results in continuous reheat
- The zone damper command is always greater than 60% open, which may indicate excessively high minimum airflow rates – especially given the high reheat requirements

Recommendations and Actions: Zone Conditioning

- VAV damper trend data will indicate opportunities for optimized AHU discharge-air static pressure control. VAV boxes with zone dampers that are running more than 75% open all the time should be evaluated (high AHU discharge-air temperatures, low AHU discharge-static pressures, failed zone terminal box damper actuators, failed airflow sensors, excessively high minimum airflow set points or incorrectly configured controls).
- Reduce the perimeter zone terminal box cooling minimum air flow setting by 25-50% of the cooling maximum air flow set point and trend data. Otherwise, excessively high perimeter zone terminal box cooling minimum air flow set points may require reheat – year round.
- If multiple zones are calling for reheat (indicating over-cooling), increase the AHU discharge-air temperature by a few degrees and trend new data. Ensure automatic AHU discharge-air temperature reset is in place and configured properly to respond to cold zones.

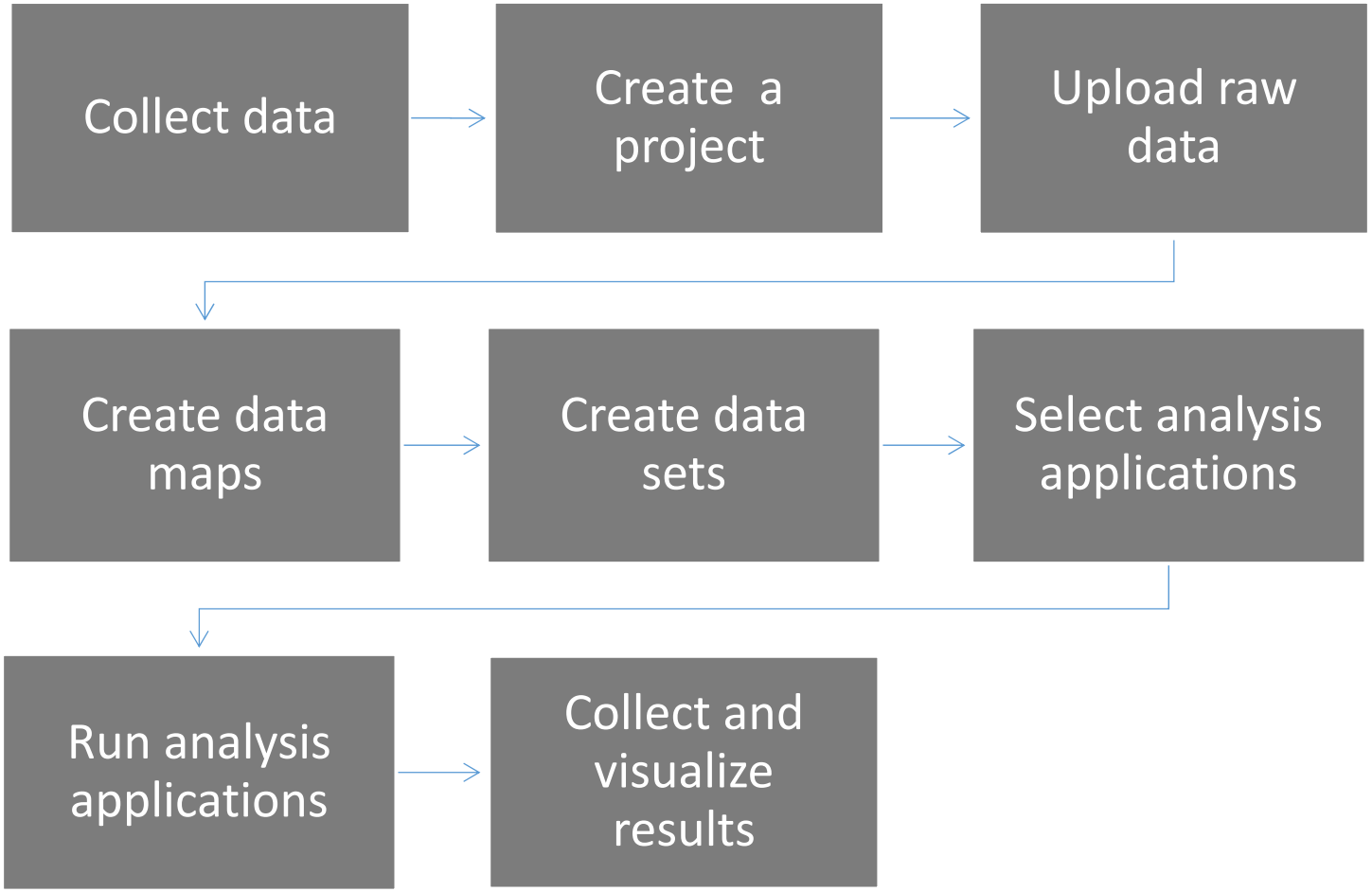
Recommendations and Actions (continued): Zone Conditioning

- Evaluate zone terminal boxes with fans (fan-powered boxes) to ensure they are configured properly – failure to configure fan powered boxes correctly will compound problems at the zone.
- Make sure fan powered box filters are replaced periodically as they will plug with dust – reducing the fan powered box effectiveness
- Enable unoccupied mode and night-time set back control, and develop a schedule for each zone
- Reduce the interior zone terminal box heating minimum air flow setting by 25-50% of the heating maximum air flow set point and trend new data.
- Disable heating in summer months (OAT >70°F, for example) to eliminate heating and allow for summer boiler shutdown. This action must be coordinated with the AHU discharge-air temperature reset to ensure optimal cooling (without overcooling as the reheat system will not function with boilers shut down)

OpenEIS: Open Energy Information System

- Cloud and desktop versions identical
- Desktop version will run on Windows 7 and 10, Mac or Linux operating systems
  - Currently have Windows installer
  - Mac installer coming soon
- Functionality implemented as web services
  - Simplifies replacing/customizing UI
  - Interaction with the system can skip UI completely (programs/scripts)
- Users can create an account before using the tool; especially important for Cloud version where multiple users will be using the same service

OpenEIS UI Workflow



OpenEIS Features: Importing

- Importing performance data
  - Loggers, automated meters (interval data), Green Button XML, building automation systems, etc.
  - Data can be either be comma or space delimited – may work with other forms of delimiters
- Date and timestamp can be in any number of formats
- Green Button XML
  - Importing process “automatically” coverts Green Button XML data to CSV “on the fly”, so the application can readily use the data
  - Once converted to CSV, workflow identical to the other data
- Imported data file can be
  - Renamed
  - Deleted
  - Re-exported or downloaded – useful to export XML data that is converted to CSV
- Other Features:
  - Merging raw data files into datasets
  - Merging mismatched time stamps (off a by few minutes)
  - Merging raw data from multiple files for analysis
  - Filling missing data
  - Time zone can be assigned
  - Data can be previewed

OpenEIS Applications

- **Heat Map**
- **Load Profile**
- **Load Profile – RCx**
- **Energy Savings – M&V**
- **Temperature Set Point Detection**
- **Compressor Cycling Detection**
- **Schedule Detection**
- AHU/RTU Economizer Diagnostics
- AHU/RTU Performance Diagnostics
- Auto-RCx: AHU Static Pressure Performance
- Auto-RCx: AHU Supply Temperature Control
- Auto-RCx: AHU/RTU Operation Schedule
- Hot Water Distribution System Performance
- Auto-RCx: Hot Water Distribution System Diagnostics
- Auto-RCx: AHU-VAV Zone Diagnostics

Where can you download the OpenEIS tool

- https://github.com/VOLTTRON/openeis/releases
- Get the setup file and not the source code files
- When the OpenEIS software is installed, an user guide is also installed. The guide can also be download separately from the same location.
- Set point, cycling and schedule detection algorithm report - http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-25996.pdf

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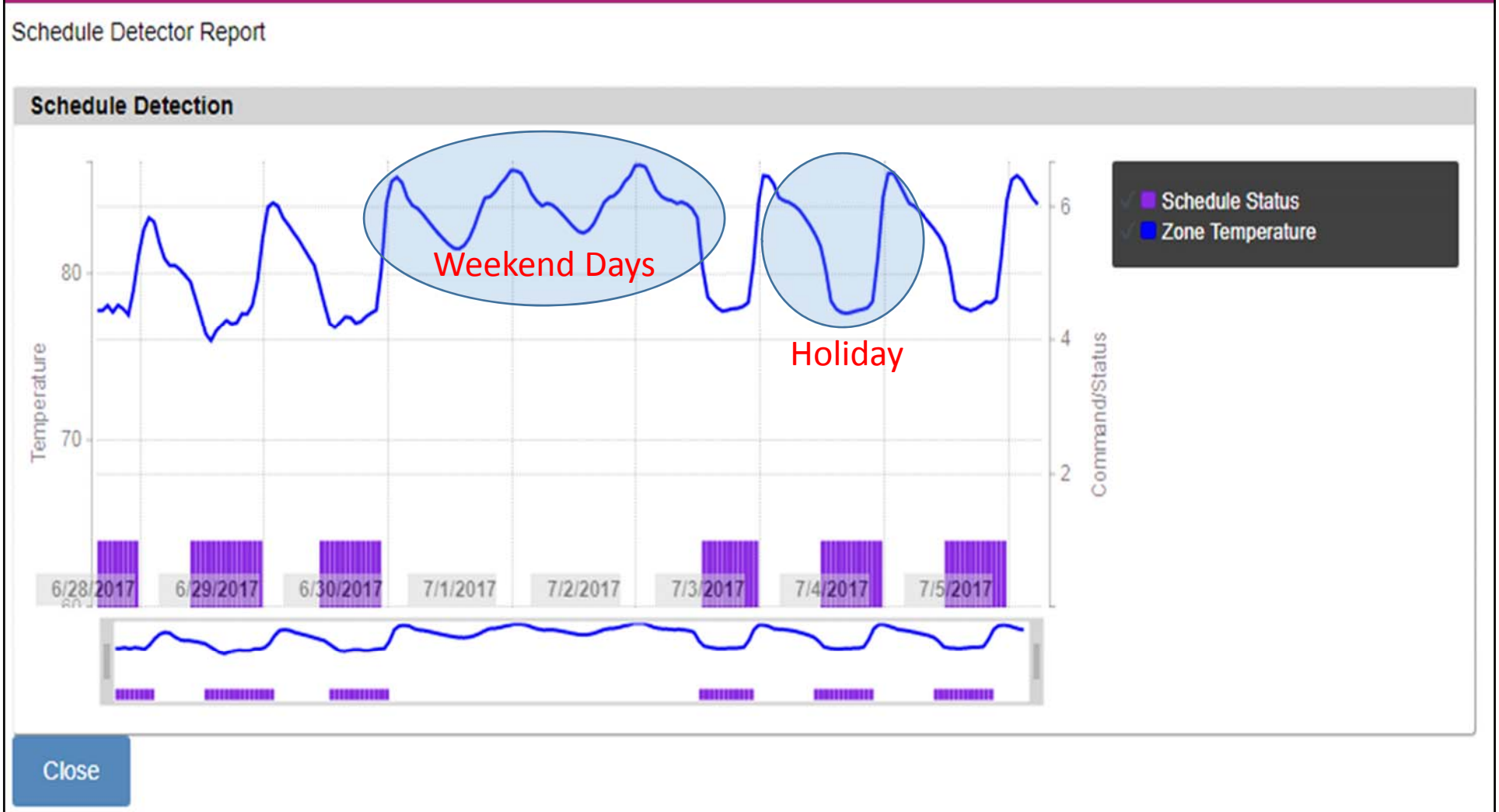
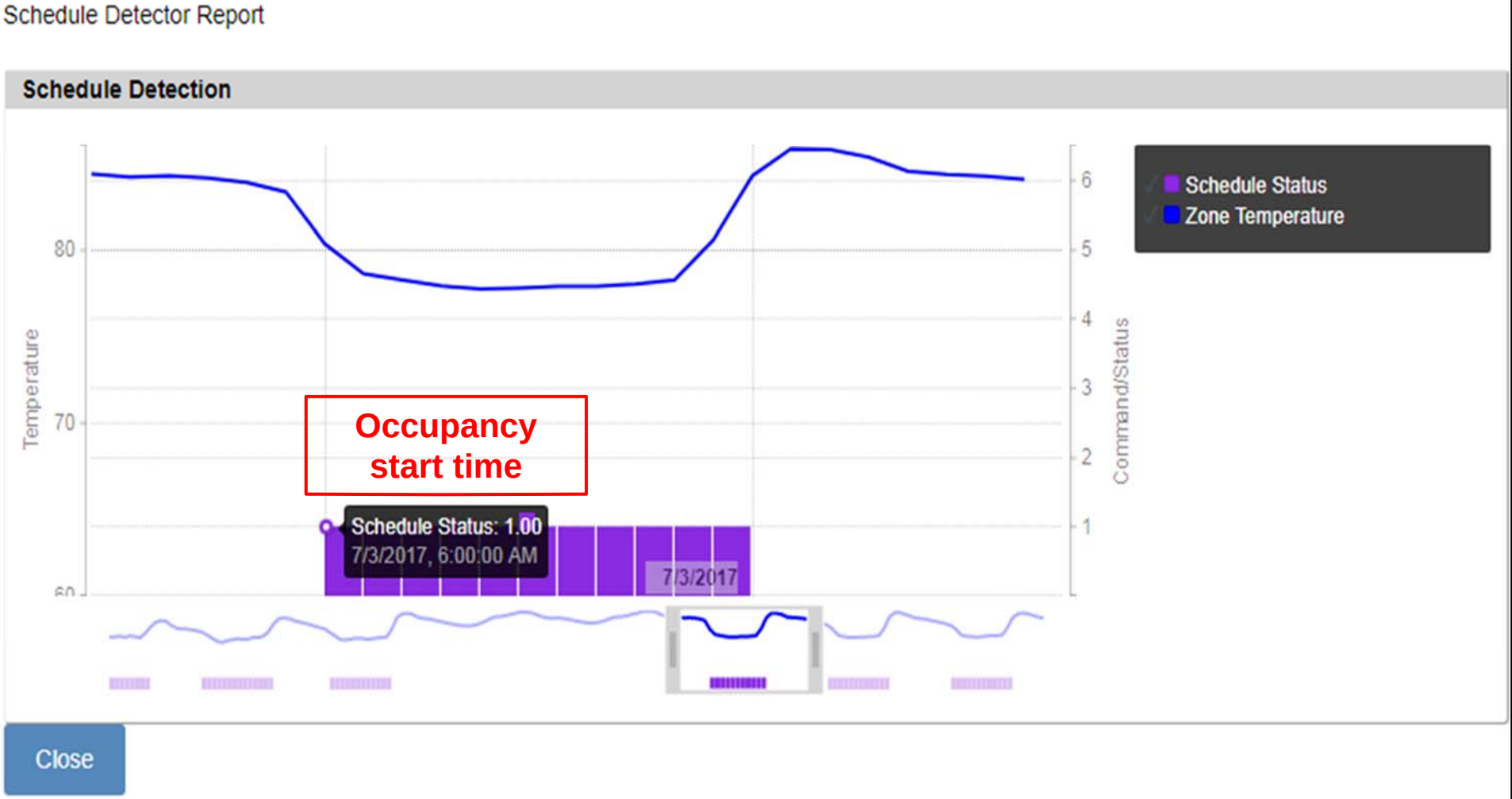
OpenEIS Use Case Detecting Set point, Rooftop Unit Cycling and Schedule Using Data from Tool Lending Library Temperature Logger

Schedule Detection Output (8 days)



- 6/28/2017 through 7/6/2017

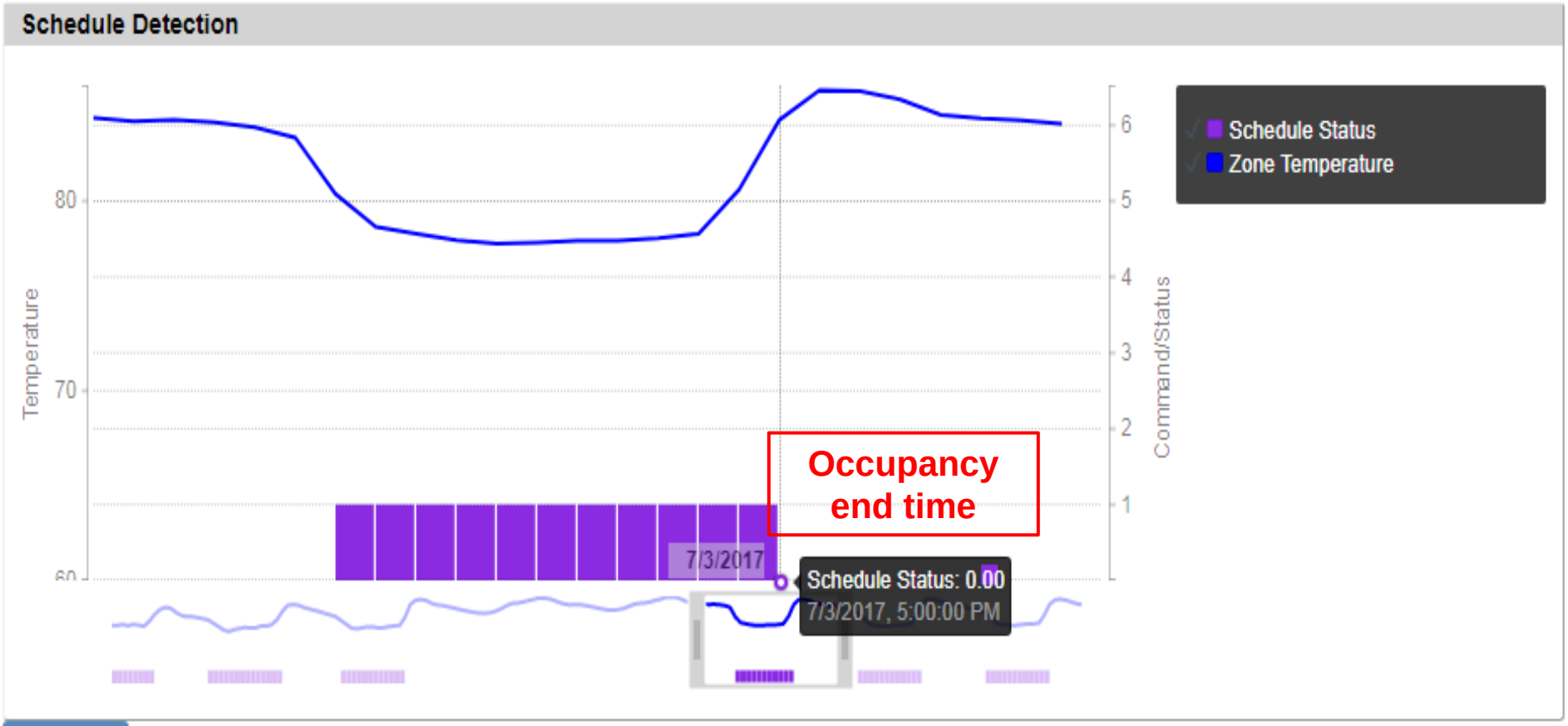
Schedule Detection (Occupancy start time)



- 7/3/2017

Schedule Detection (Occupancy end time)

Schedule Detector Report

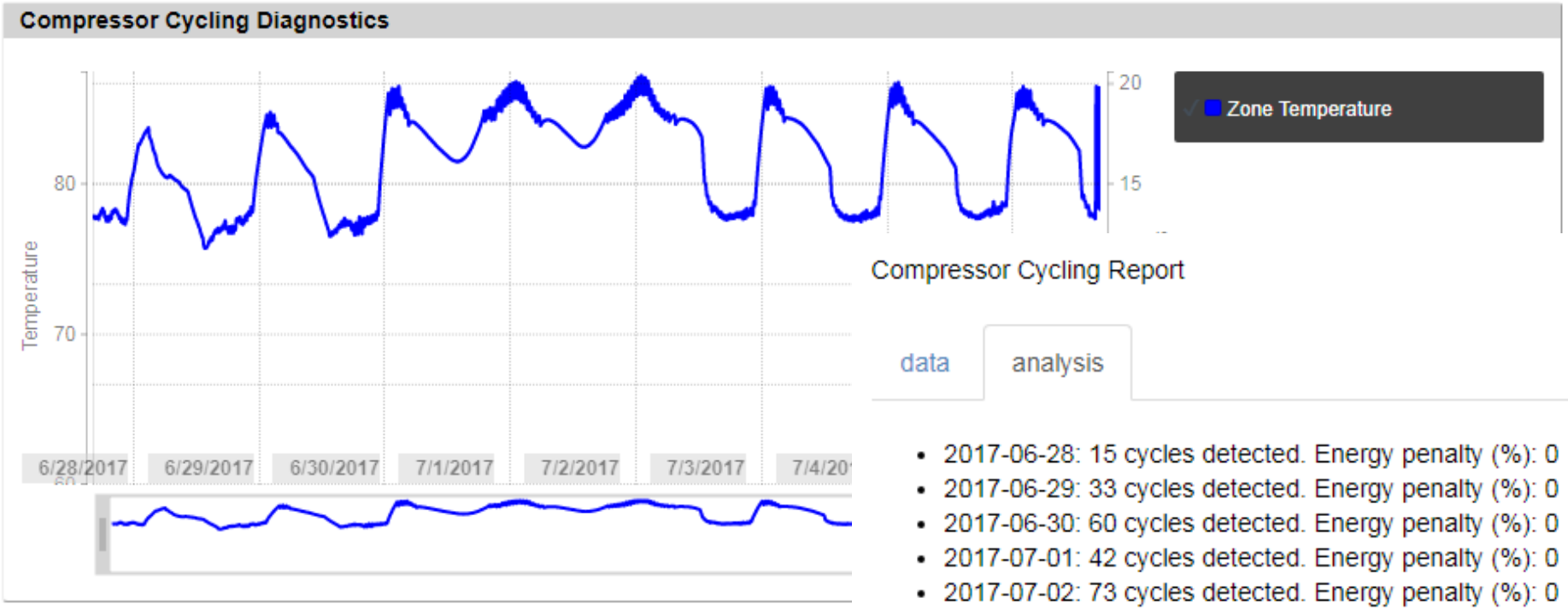


- 7/3/2017

Compressor Cycling Detection Output

Compressor Cycling Report

data analysis



Compressor Cycling Report

data analysis

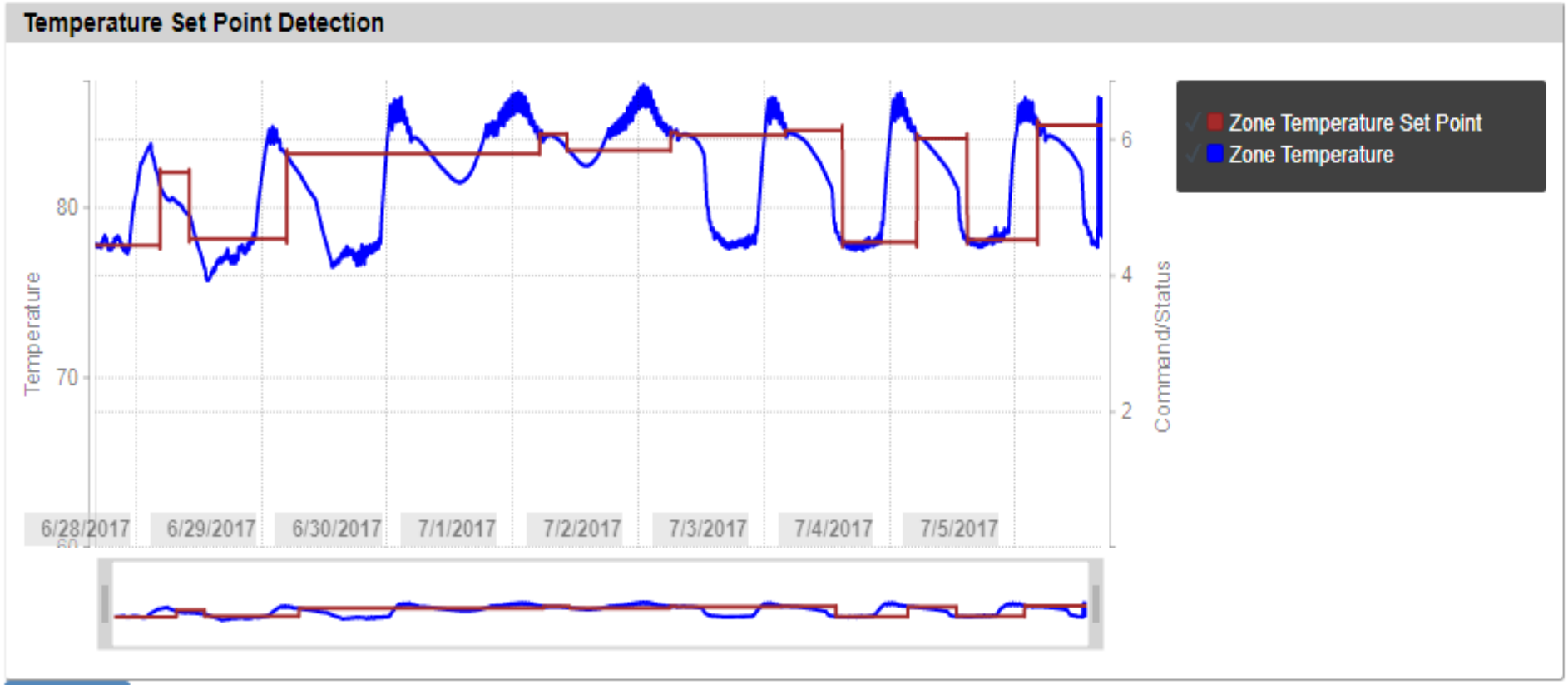
- 2017-06-28: 15 cycles detected. Energy penalty (%): 0
- 2017-06-29: 33 cycles detected. Energy penalty (%): 0
- 2017-06-30: 60 cycles detected. Energy penalty (%): 0
- 2017-07-01: 42 cycles detected. Energy penalty (%): 0
- 2017-07-02: 73 cycles detected. Energy penalty (%): 0
- 2017-07-03: 91 cycles detected. Energy penalty (%): 0
- 2017-07-04: 89 cycles detected. Energy penalty (%): 0
- 2017-07-05: 58 cycles detected. Energy penalty (%): 0
- 2017-07-06: 14 cycles detected. Energy penalty (%): 0

Close

- 6/28/2017 through 7/6/2017

Set Point Detection Output

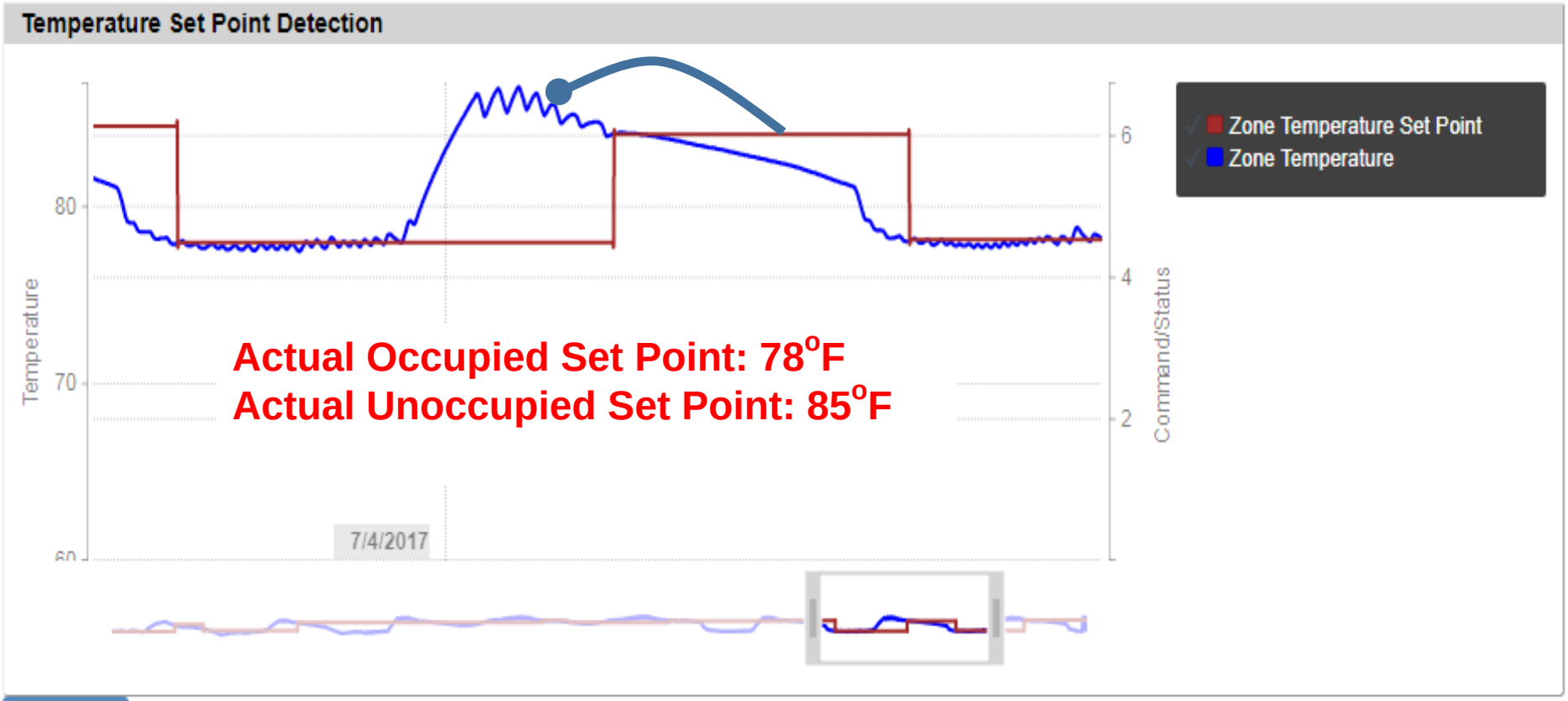
Setpoint Detector Report



- 6/28/2017 through 7/6/2017

Set Point Detection Output: 1-Day

Setpoint Detector Report



- 7/3/2017

Day 1 Review

- Seattle Building Tune Up Requirements
- Seattle Tune Up Accelerator Program
- Asset Score Tool
- Building Re-tuning

QUESTIONS ?

Day 2: Walk Down Logistics

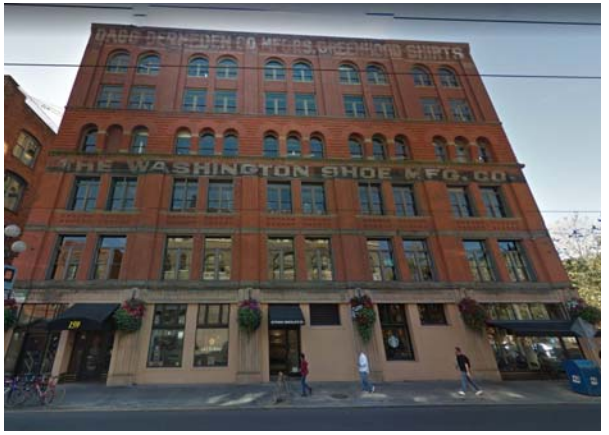
8:30 am - Gather for the onsite building walk down practice. Bring clip board or writing pad for notes, Asset Score and any other tools for observing building conditions

10:30am - Reconvene at the Smart Buildings Center

Day 2 Site Locations & Addresses

- **Group A:**
  Charles Street Engineering
  714 S Charles St
  City Facilities Office
  20,424 SF, Built in 1972

- **Group B:**
  Washington Shoe Building
  159 S Jackson St
  Leased Office
  79,920 SF, Built in 1890



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BUILDING TUNE-UP ACCELERATOR

THANK YOU & SEE YOU TOMORROW!