Pacific Northwest NATIONAL LABORATORY

Accelerating Existing Building Tune-Ups in Seattle

Webinar

Thursday, March 26, 2020
12:00 PM – 1:00 PM ET

U.S. DEPARTMENT OF ENERGY BATTELLE

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Panelists

Nora Wang, Ph.D.
Pacific Northwest National Laboratory

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Office of Sustainability & Environment / City of Seattle

Dina Belon-Sayre
Pineapple Hospitality

Rina Fa'amoe-Cross
Seattle Public Schools

Holly Carr
Department of Energy

Agenda

- Intro – Nora (5 min)
- Overview of TUA – Nicole (25 min)
- Asset Score Results – Nora (5 min)
- Hospitality Case Study – Dina (5 min)
- Education Case Study – Rina (5 min)
- Conclusion – Nicole (5 min)
- Q&A – Holly (10 min)

Accelerating Existing Building Tune-Ups in Seattle, Washington

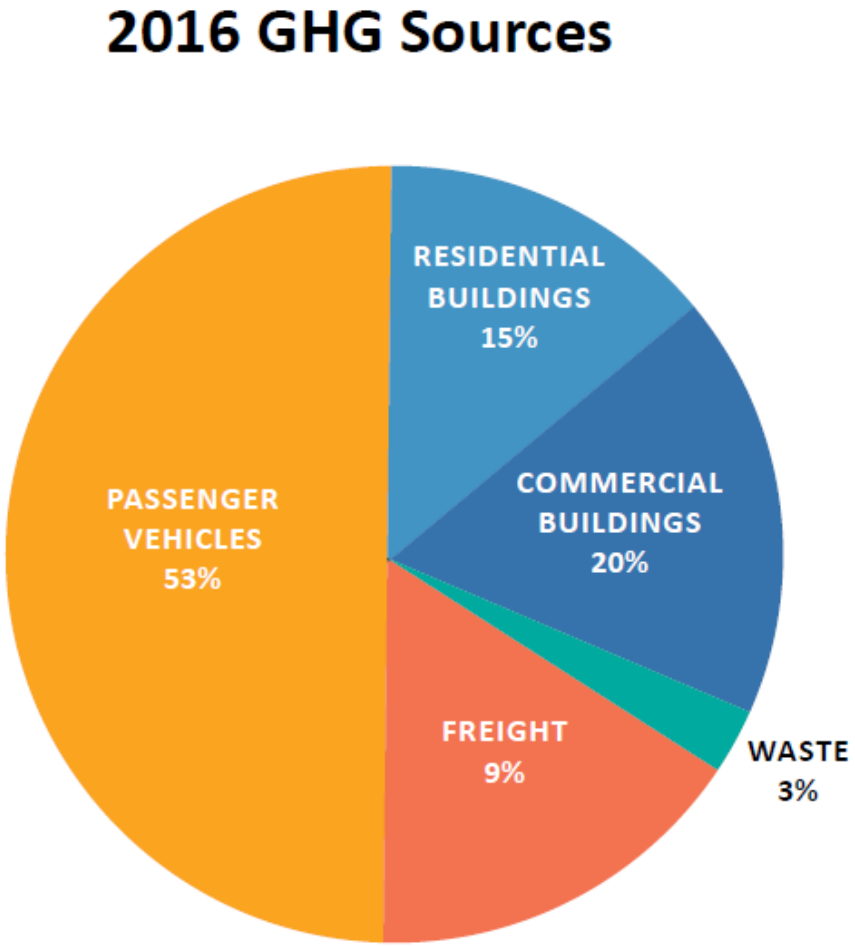
Nicole Ballinger
Tune-Up Accelerator Program Manager

Office of Sustainability & Environment
March 26, 2020

City of Seattle

Seattle Climate Action Plan

- Buildings make up over 1/3 of Seattle's core emissions
- Goal: Carbon neutral city by 2050
- 2030 Target: Buildings must reduce emissions by 39% from a 2008 baseline



Source: 2016 Seattle Community GHG Inventory

SEATTLE
building tune-ups

An energy efficiency mandate that helps building owners identify smart, responsible ways to reduce energy and water costs.

Like cars and bikes, all buildings need to be tuned regularly to keep them running as efficiently as possible.

Seattle
Office of Sustainability
& Environment

Tune-Up Requirements

Operating Protocols

- HVAC systems
- Lighting
- Water heating
- Water usage

Maintenance & Repair

- HVAC systems
- Lighting
- Water heating
- Water usage
- Envelope

Examples of Operating elements

"Review HVAC equipment schedules."

"Set schedules to optimize operations for actual building occupancy patterns."

Examples of Maintenance, Cleaning, and Repair elements

"Verify HVAC equipment is clean and adequately maintained."

"Clean where adversely impacting system performance."

SEATTLE building tune-ups

Elements of a Tune-Up

- **Conduct a Building Assessment**
  - of building systems to identify operational or maintenance issues
  - review benchmarking data and water bills
- **Identify Corrective Actions**
  - identify required operational and maintenance improvements
- **Implement Required Actions**
  - address all required corrective actions identified in the building assessment
- **Verify Changes & Report to City of Seattle**
  - confirm all corrected equipment and systems are functioning as intended

SEATTLE building tune-ups

TUNE-UP SCHEDULE

Ongoing, every five years

BUILDING SIZE*	WAIVER AND EXTENSION DUE DATE	TUNE-UP SUMMARY REPORT DUE DATE
200,000+ SF	September 4, 2018	March 1, 2019
100,000-199,999 SF	April 1, 2019	October 1, 2019
70,000-99,999 SF	April 1, 2020	October 1, 2020
50,000-69,999 SF	April 1, 2021	October 1, 2021

** Excluding parking*

SEATTLE building tune-ups

What is the Tune-Up Accelerator?

- Mid-Size buildings (approx. 100,000 SF or smaller) due 2020 or 2021
- Tune-up now to meet Seattle Building Tune-Ups requirements
- Financial incentives & enhanced technical support – offer sunset after 2018
- Goal of 20% average energy savings across at least 100 buildings or tenant spaces and 99.7 Million kBtu/year (~$1.5 million annual cost savings)

Program Partners & Funding

Partner	Primary Role
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy	Federal funding ($1.2 million) and project oversight
Seattle Office of Sustainability & Environment	Program management, enrollment, coord. w/ Building Tune-Ups, evaluation, reporting to DOE
SMART BUILDINGS CENTER	Provider training & curricula, tool lending library, project tracking, help desk
Pacific Northwest NATIONAL LABORATORY Proudly Operated by Battelle Since 1965	Building Re-Tuning training, Asset Score support & research on energy-savings from tune-ups
Seattle City Light	Tune-up and energy conservation measure incentives
INTEGRATED DESIGN LAB UNIVERSITY of WASHINGTON // W	Building Renewal strategic plan development and support, Spark Tool engagement

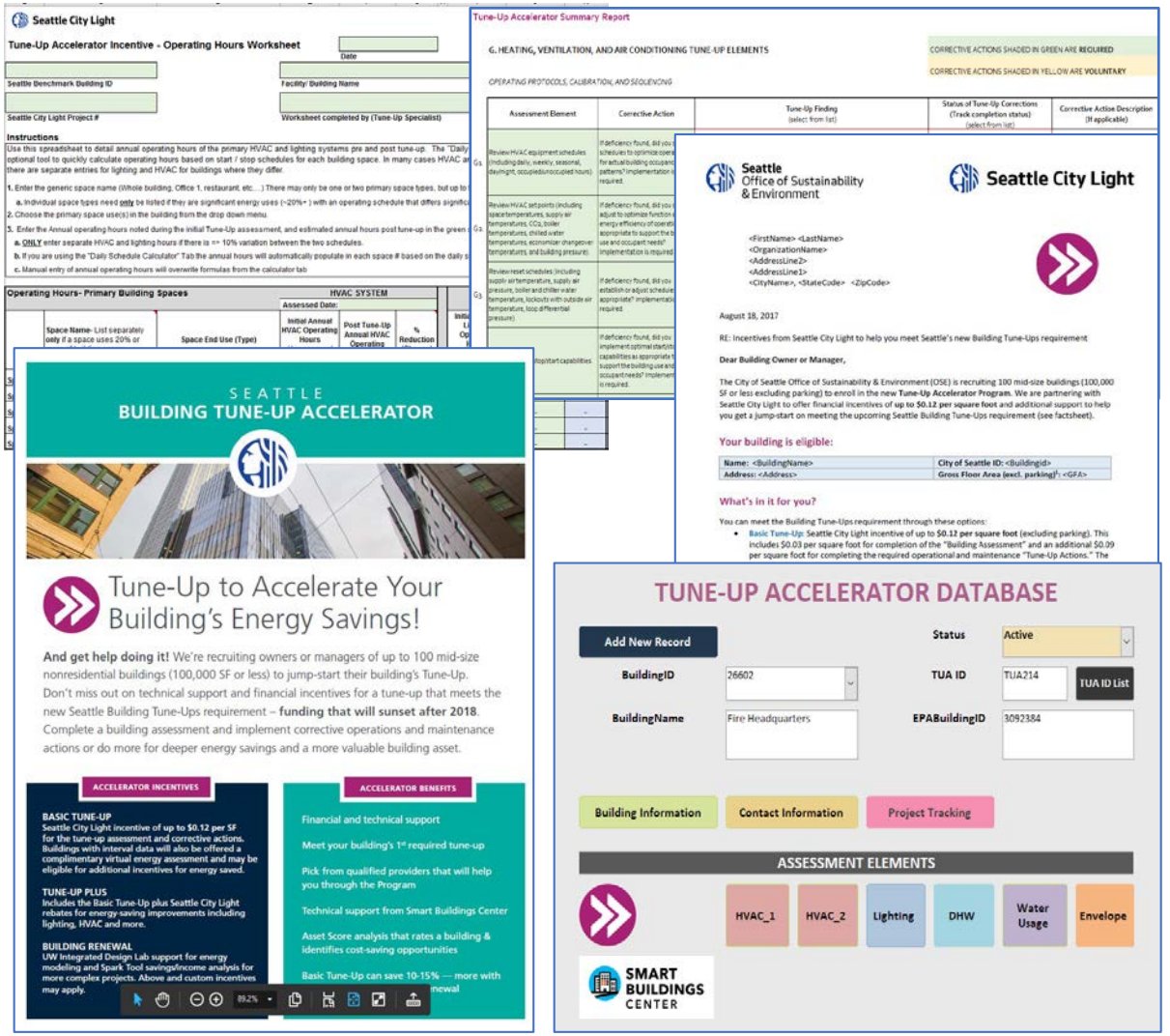
Program Approach

1. **Advance market expertise** to support building tune-ups
   >> Tune-Up Trainings
2. **Accelerate tune-ups** in mid-size buildings
   >> Incentives & Owner Engagement
3. **Generate voluntary** market action towards greater savings
   >> Building Assessments & Implementation – 20% Savings Goal
4. **Ensure the mandate** is effective for this market sector
   >> Evaluation & Refinement

2017 — **Q4 2019**

Program Development

- Create Incentive Program with Seattle City Light
  - Incentive Agreements
  - Reporting Forms
- Define Program Paths & Brand
- Plan, Prioritize & Recruit Buildings
- Program & Customer Tracking



Tune-Up Specialist Trainings

- ✓ 85 service providers attended trainings
- ✓ 30 firms on the "TUA" provider list
  - ✓ 16 firms participated in projects
  - ✓ Seattle Public Schools RCx /RCM staff
  - ✓ King County RCM staff

Tune-Up Accelerator Service Providers

Last Updated 6.6.18

Company Name & Address					Contact for Tune-Up Accelerator Inquiries			Website
ACCO Engineered Systems	5300 Denver Ave S	Seattle	WA	98108	Joseph	Bolducci	jbolducci@accoes.com	206-787-8525	www.accoes.com
Ameresco, Inc.	222 Williams Ave South, #300	Renton	WA	98057	Jason	Hite	jhite@ameresco.com	206-708-2952	www.ameresco.com
ArchEcology, LLC	1808 Bellevue Ave, Suite 202	Seattle	WA	98122	Katherine	Morgan	kjmorehome@archecology.com	206-717-2260	www.archecology.com
ATS Automation	450 Sherbeck Ave South	Renton	WA	98057	Pete	Segall	pete@atsinc.org	425-251-9680	www.atsinc.org
360 Analytics	710 2nd Ave, Suite 925	Seattle	WA	98104	Lukas	Hovee	lukas@360-analytics.com	206-557-4732 x202	www.360analytics.com
Ecotope, Inc	1917 1st Ave, Suite 100	Seattle	WA	98101	Morgan	Hester	morgan@ecotope.com	206-396-4709	www.ecotope.com
Elemental Commissioning Company	6440 35th Ave W	Seattle	WA	98199	Jessica	Sanborn	jessica@elementalcx.com	206-484-2403	www.elementalcx.com
Energy 350, Inc.	1031 SE Main St, Suite 1	Portland	OR	97214	Chris	Smith	chris@energy350.com	971-544-7211	www.energy350.com
Engineering Economics, Inc.	1201 Western Avenue, Suite 325	Seattle	WA	98101	Brandon	Mattis	brandon.mattis@eeiengineers.com	206.622.1001	www.eeiengineers.com
FSi consulting engineers	506 2nd Ave, Suite 700	Seattle	WA	98104	Ben	Roush	benr@fsi-engineers.com	206-622-1323 x236	www.fsi-engineers.com
Hargis Engineers, Inc.	1201 3rd Ave, suite 600	Seattle	WA	98101	Michael	Baranick	michael.baranick@hargis.biz	206-436-0448	www.hargis.biz
Hermanson Company	1221 2nd Ave N	Kent	WA	98032	Ken	Dykhman	kdykman@hermanson.com	206-917-6132	www.hermanson.com
Holaday Parks	6000 South 134th Place	Seattle	WA	98168	Edwing	Chang	engineer@holadayparks.com	206 248-9700	www.holadayparks.com
HughCx LLC	601 Union St, Ste 4200	Seattle	WA	98101	George	Amburn	gamburn@hughcx.com	206-321-9098	www.hughcx.com
Integrity Energy Solutions	14405 SE 36th St Suite 210	Bellevue	WA	98006	Matt	Montagner	matm@iesinnovates.com	206-413-7693	www.iesinnovates.com
Keithly Barber Associates	565 Andover Park West, Suite 101	Tukwila	WA	98188	Kent	Barber	kent@keithlybarber.com	206-947-8873	www.keithlybarber.com
MacDonald-Miller Facility Solutions	7717 Detroit Ave SW	Seattle	WA	98106	Greg	Noel	greg.noel@macmiller.com	206-768-4202	www.macmiller.com
McKinstry Essention LLC	5005 3rd Ave S	Seattle	WA	98134	Ric	Cochrane	ricc@mckinstry.com	206-832-8250	www.mckinstry.com
MENG Analysis	2001 Western Ave Suite 200	Seattle	WA	98121	Doug	Smith	doug@mengenalysis.com	206-587-3797	www.mengenalysis.com
Neudorfer Engineers, Inc.	5516 1st Ave S	Seattle	WA	98108	Jeff	Harding	jharding@neudorferengineers.com	206-683-1957	www.neudorferengineers.com
Northwest Engineering Service, Inc. (NWESI)	7080 SW Fredwood Lane	Tigard	OR	97224	John	Herborth	johnh@nwesi.com	503-701-9138	www.nwesi.com
Paladino and Company	1932 1st Avenue Suite 200	Seattle	WA	98101	Hanna	Swalstad	hannas@paladinoandco.com	206-957-8585	www.paladinoandco.com
PSR Mechanical	3132 NE 133rd St	Seattle	WA	98125	Neil	Bavins	neil.bavins@psrmechanical.com	206-367-2500 x139	www.psrmechanical.com
Siemens - PNW Energy Service	15900 SE Eastgate Way, Ste. 200	Bellevue	WA	98008	Andrew	Waymire	andrew.waymire@siemens.com	425-281-4706	www.siemens.com
Sazan Environmental Services	601 Stewart Street, #1400	Seattle	WA	98101	Kevin	David	kevind@sazan.com	206.267.1700	www.sazan.com
Solarc	1501 E Madison St., Suite 200	Seattle	WA	98122	Mike	Hatton	mikeh@solarcenergygroup.com	543-349-0966	www.solarcenergygroup.com
Sweek Consulting Engineers, LLC	7049 24th Ave NW	Seattle	WA	98117	Treasa	Sweek	treasa@sweekengineers.com	206-601-6681	www.sweekengineers.com
The Cadmus Group	720 SW Washington St., Suite 400	Portland	OR	97205	Katie	Leichliter	katrina.leichliter@cadmusgroup.com	503-467-7159	www.cadmusgroup.com
The Greenbusch Group, Inc.	1900 West Nickerson Street, Suite #200	Seattle	WA	98119	John	Greenlaw	johng@greenbusch.com	206-378-0569 x111	www.greenbusch.com
University Mechanical Contractors, Inc	11611 49th Place West	Mukilteo	WA	98275	Troy	Turpin	tturpin@umci.com	425-407-2153	www.umci.com

The firms listed above have staff that attended an Accelerator Program training and meet the requirements of the "Tune-Up Specialist"; however, this list is not intended by DNV or SCL to be a contractor recommendation. If you do not see your preferred provider listed, or would like to use qualified in-house facility engineering staff, please contact Mark.Zeifman@seattle.gov or 206-233-2184 for more information and prior to starting any work.

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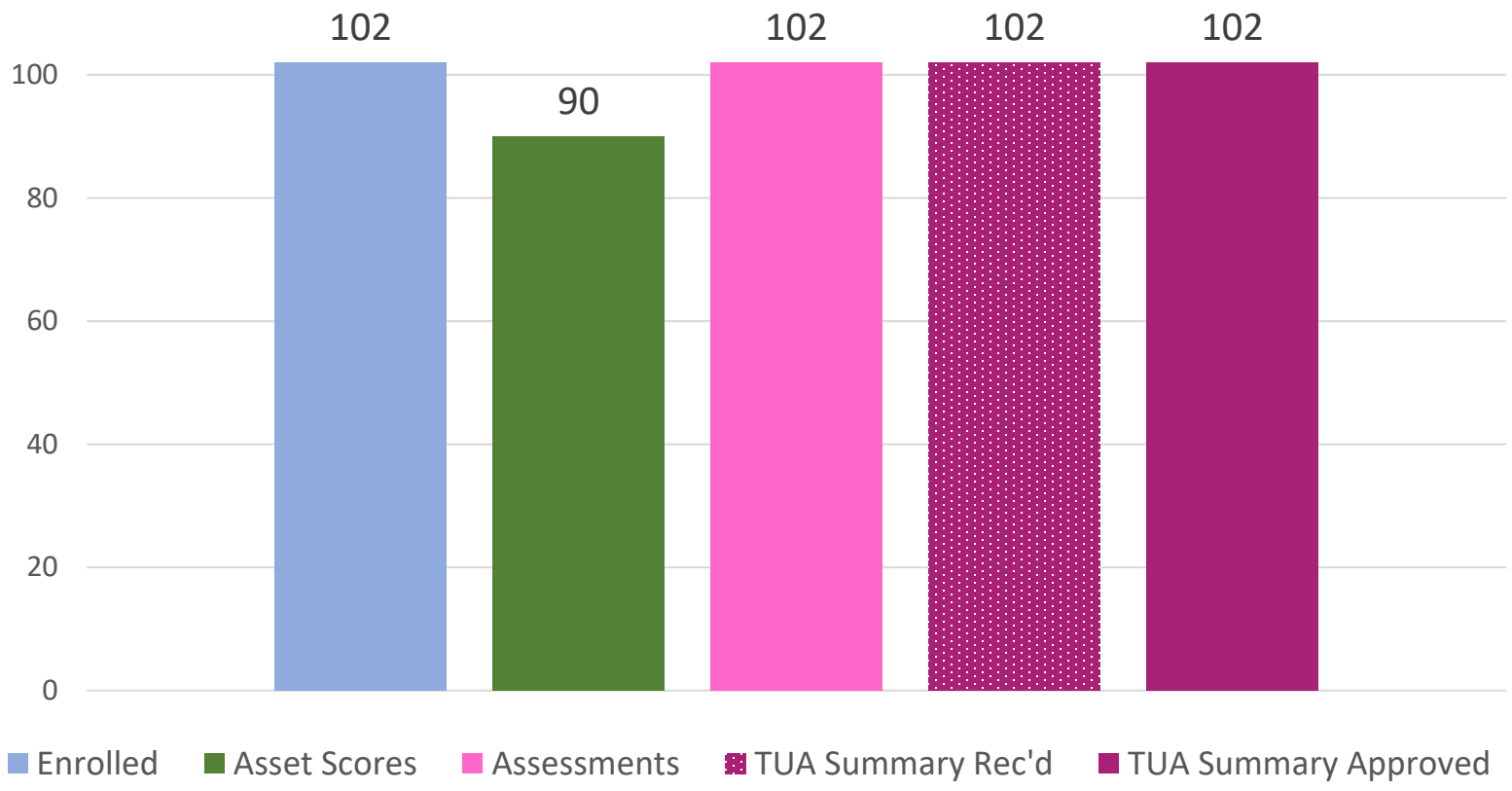
Incentives & Program Paths

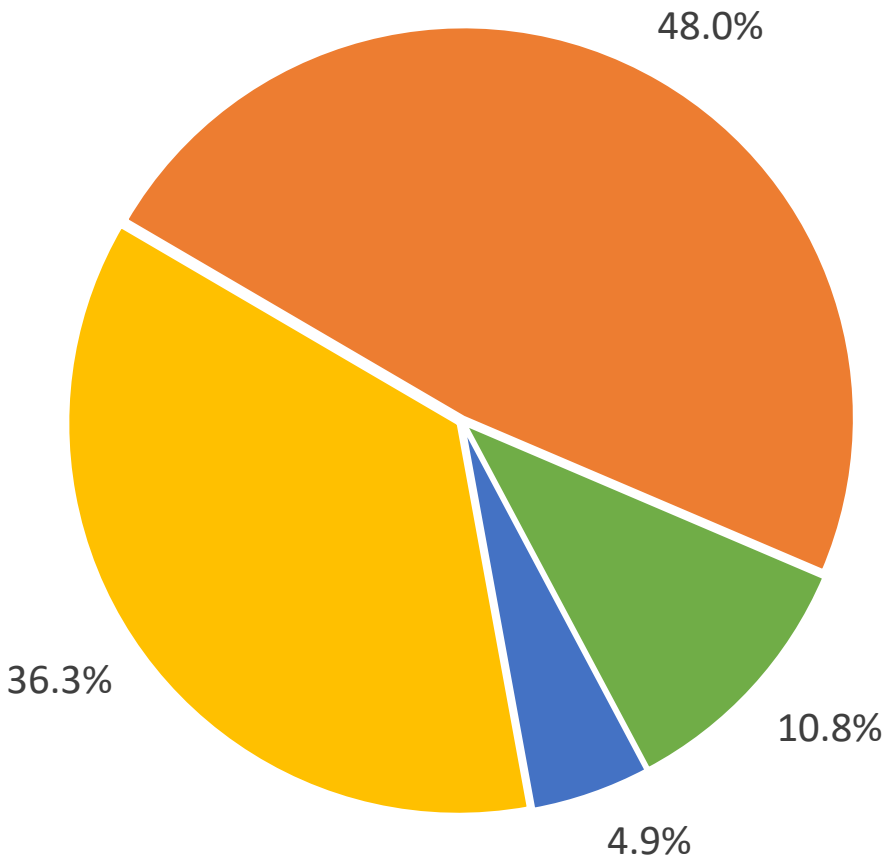
A. BASIC TUNE-UP	City Light incentive of up to **$0.12 per SF** for a tune-up that meets requirements
B. TUNE-UP PLUS	Plus incentives for energy-saving improvements like lighting, HVAC
C. BUILDING RENEWAL	Support for deeper investments like renovations or tenant improvements with 3 different levels of technical support

2017 — **Q4 2019**

Tune-Up Accelerator Project Status



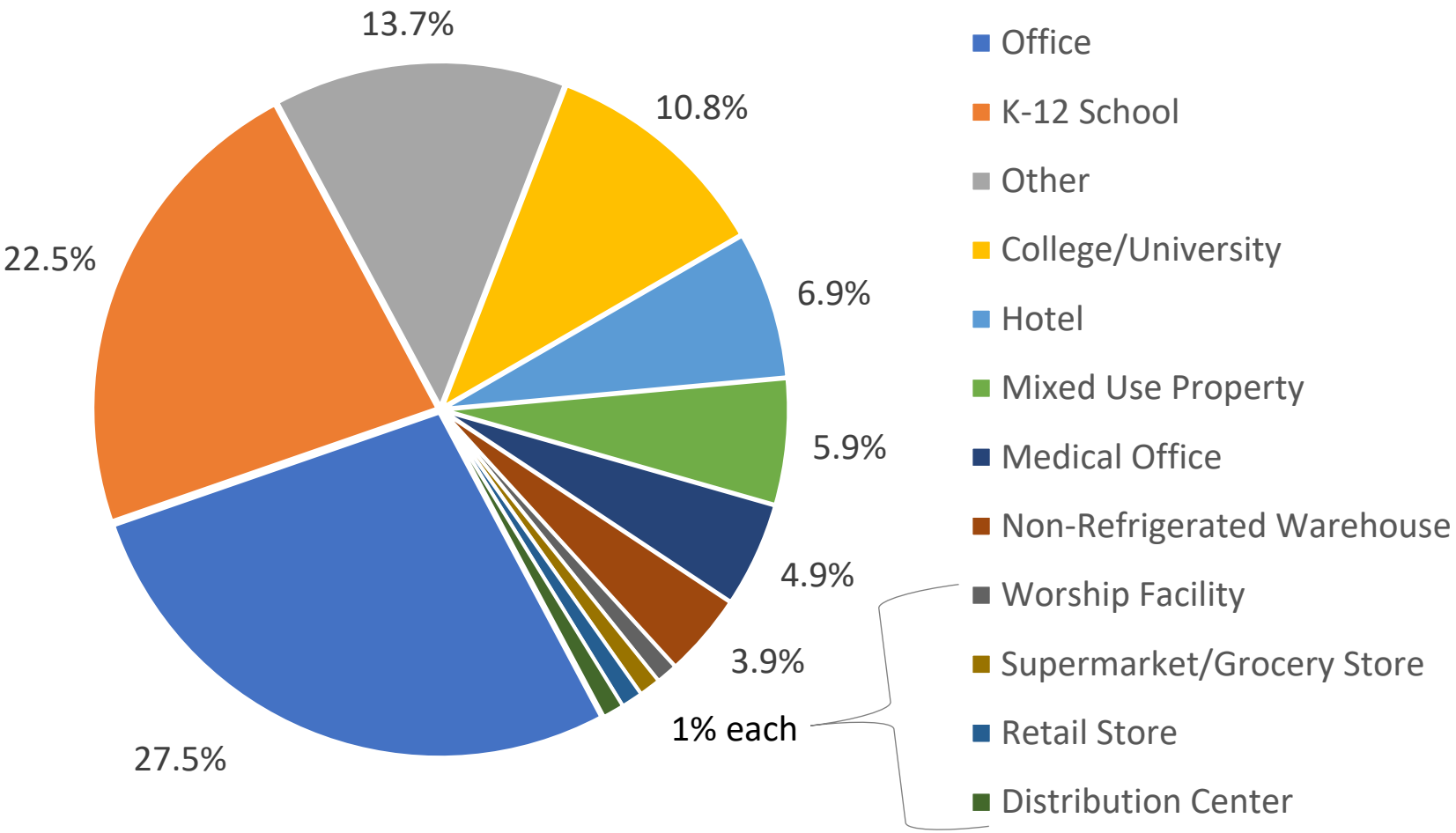
TUA Participant Buildings By Size



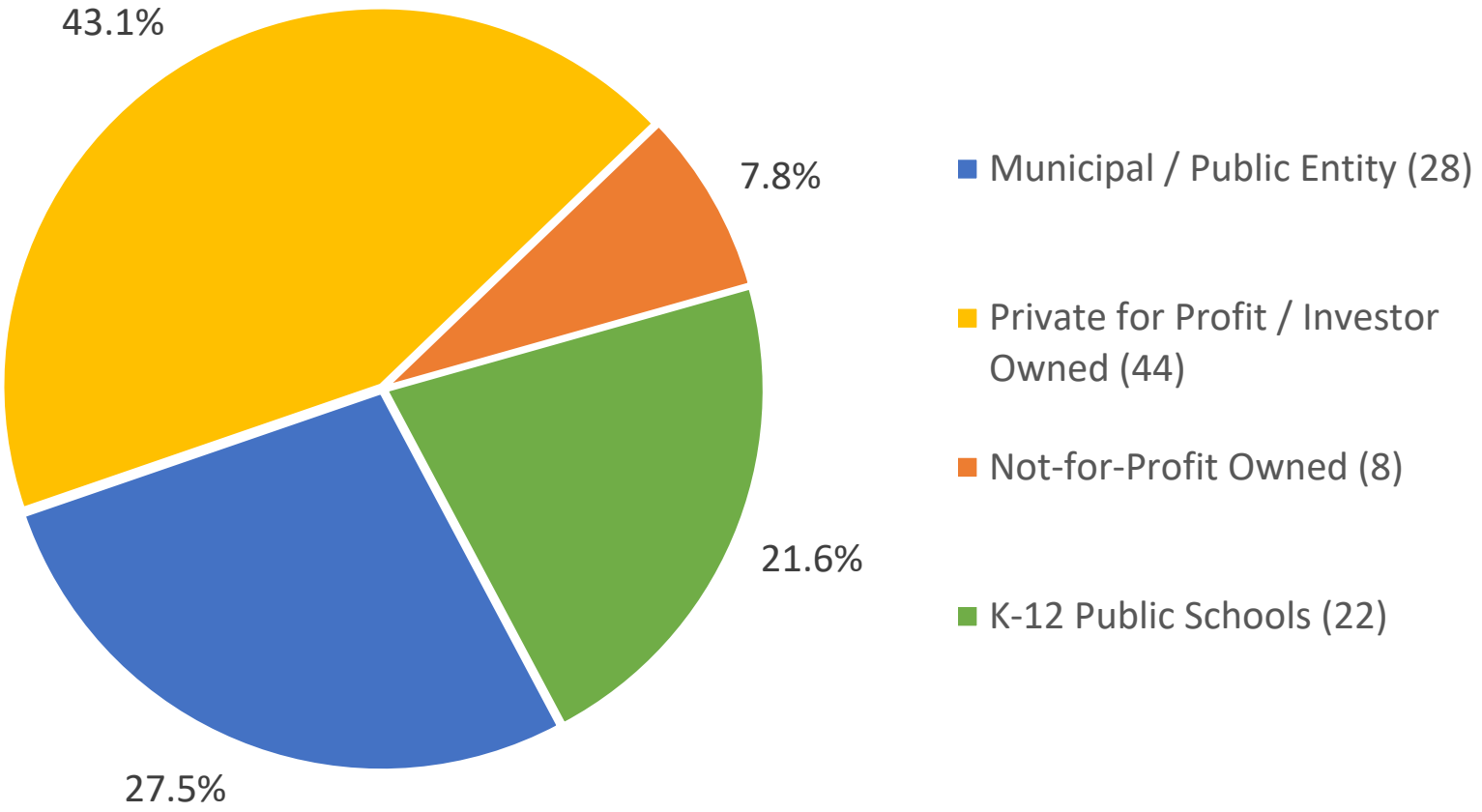
6.9 Million SF Total!
Average = 67,700 SF

- > 100 - 110K SF (5 Buildings)
- 70 - 99K SF (37 Buildings)
- 50 - 69K SF (49 Buildings)
- < 50K SF (11 Buildings)

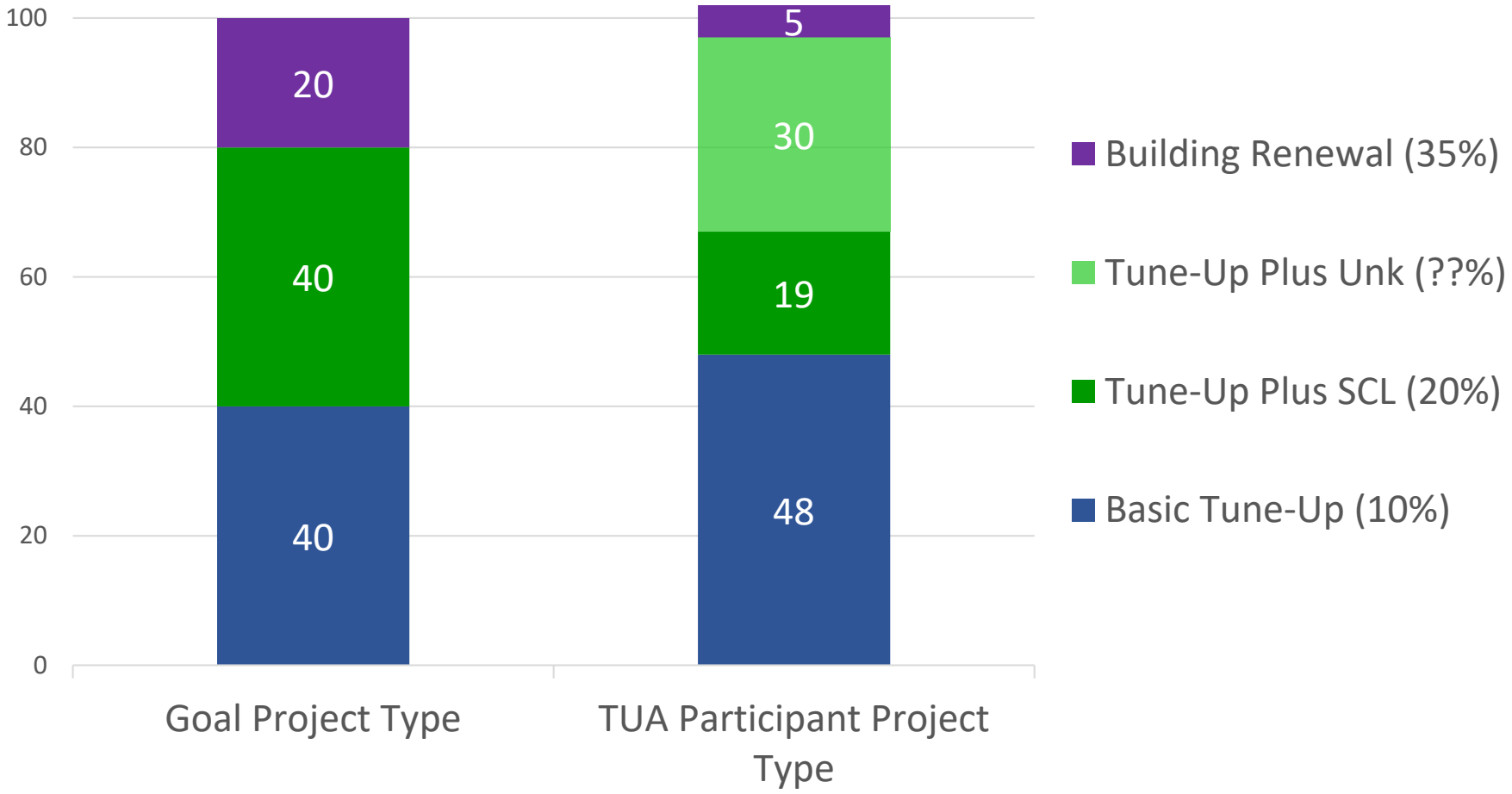
TUA Participant Buildings By Type



TUA Participant Ownership



Goal & Actual Project Types



Top Required Tune-Up Measures

Required Implementation Tune-Up Measure	Found & Corrected
G1 – Review **HVAC equipment schedules**	58%
G2 – Review **HVAC set points**	49%
G6 - Verify **HVAC controls** are functioning as intended	41%
G5 - Verify that **HVAC sensors** are functioning, calibrated, and in appropriate locations	40%
G17 – Check **valves and dampers** and adjust	36%
G11 – Verify **HVAC equipment maintenance**	34%

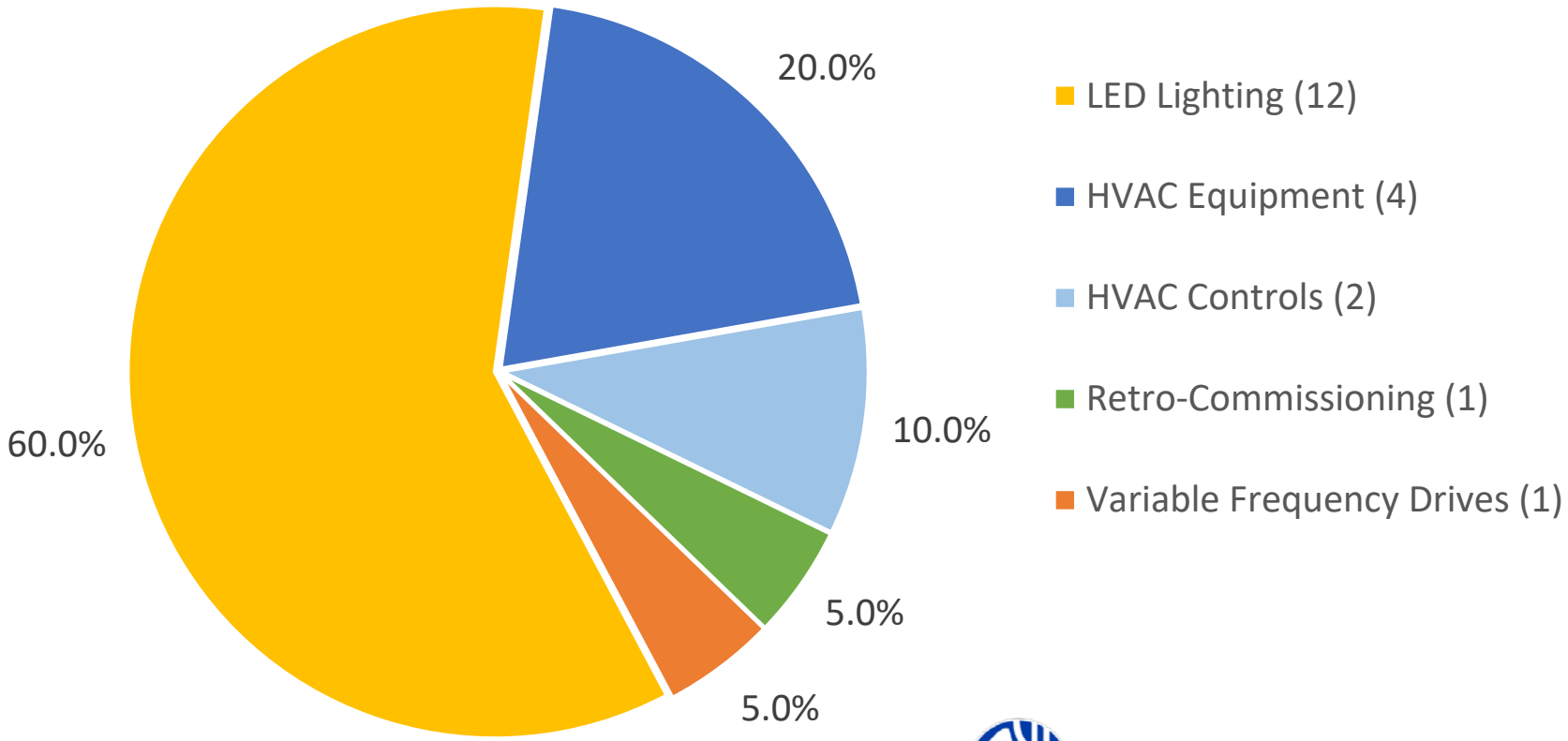
Top 6 out of 20 required measures in 102 TUA buildings.

Top Voluntary Tune-Up Measures

Voluntary Implementation Tune-Up Measure	Found	Corrected
H4 – Identify **inefficient lighting**	64%	20%
G18 - Identify **equipment approaching the end of its service life**, per ASHRAE	49%	10%
H2 – Verify **lighting sensors are working** and located appropriately	36%	17%
J12 – Check **water flow fixtures**	34%	10%
G9 – Identify areas with indications that **ventilation rates** may vary significantly from ASHRAE 62.1	33%	11%
G15 – Verify that **(HVAC) equipment observed** is in good working condition (such as motors, fans, pumps)	25%	12%

Top 6 out 19 voluntary measures in 102 TUA buildings.

Tune-Up Plus ECMs with City Light



Seattle City Light

Based on 20 ECMs in 19 TUA enrolled buildings.

Building Renewal with UW IDL

Level 1 Findings

- 38 “Spark” reports created using benchmarking, Asset Score and tune-up reports as inputs
- 11 reports with a positive net present value were sent to building owners
- **If all measures completed, the average EUI could be reduced 47%!**

Spark

Developed by NEEA BetterBricks

- Uses EnergyPlus seed models to simulate energy performance
- Incorporates business case
- Exports report and technical appendix
- https://buildingrenewal.org

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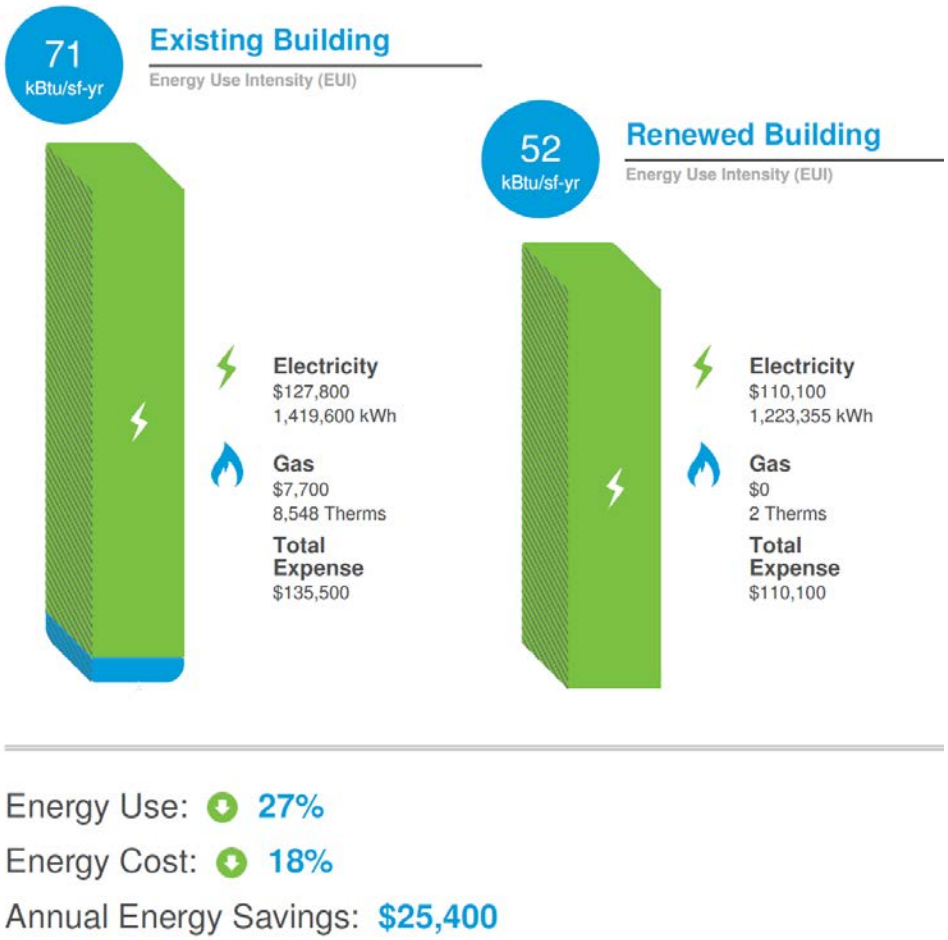
Spark Report Example



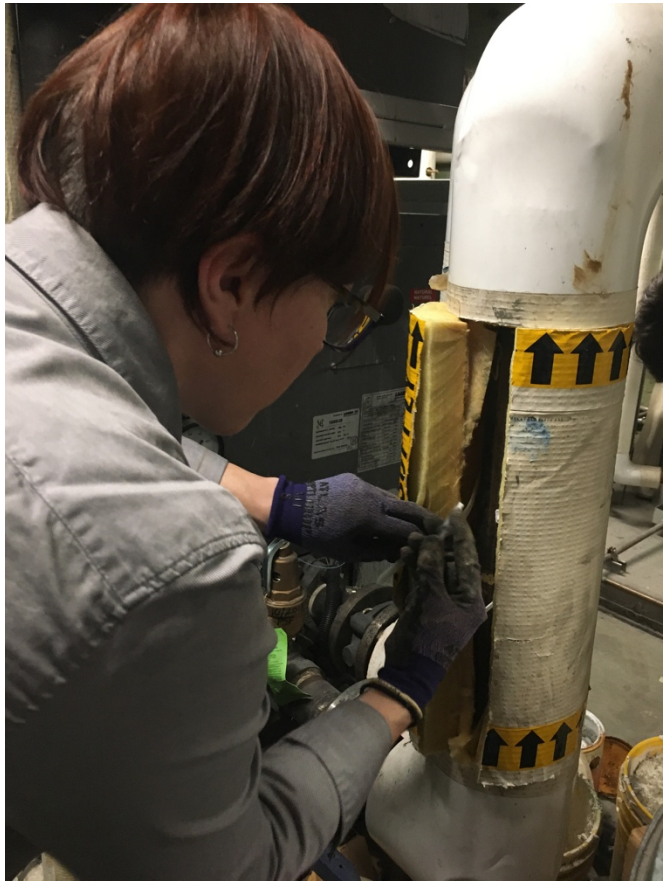
Level 3 Findings

Level 3 Building Renewal Potential

Measure Package	Description	Range of Savings in 5 Buildings	Average Savings	Average EUI
1	**O & M** - measures and a DDC expansion or complete DDC retrofit where needed	6% - 28%	**16%**	71
2	**Retrofit** - lighting, envelope, and plug load management	21% - 37%	**30%**	59
3	**Mechanicals** - improve the performance of selected or out of date HVAC systems.	30% - 49%	**38%**	55
4	**Electrification** - replace gas (space heating and/or DHW) and or process steam equipment with heat-pump-based systems	49% - 65%	**56%**	41

Total direct emissions savings of up to 900 MT CO2e

Evaluation: M & V Sample



- Evaluated 10 buildings
  - Mixed Use (1)
  - Hotel (1)
  - K-12 School (2)
  - Office (3)
  - Medical Office (1)
  - College/University (1)
  - Non-Refrigerated Warehouse (1)
- Site Visits
- Pre-Post Energy Data Analysis

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M & V: Site Visits

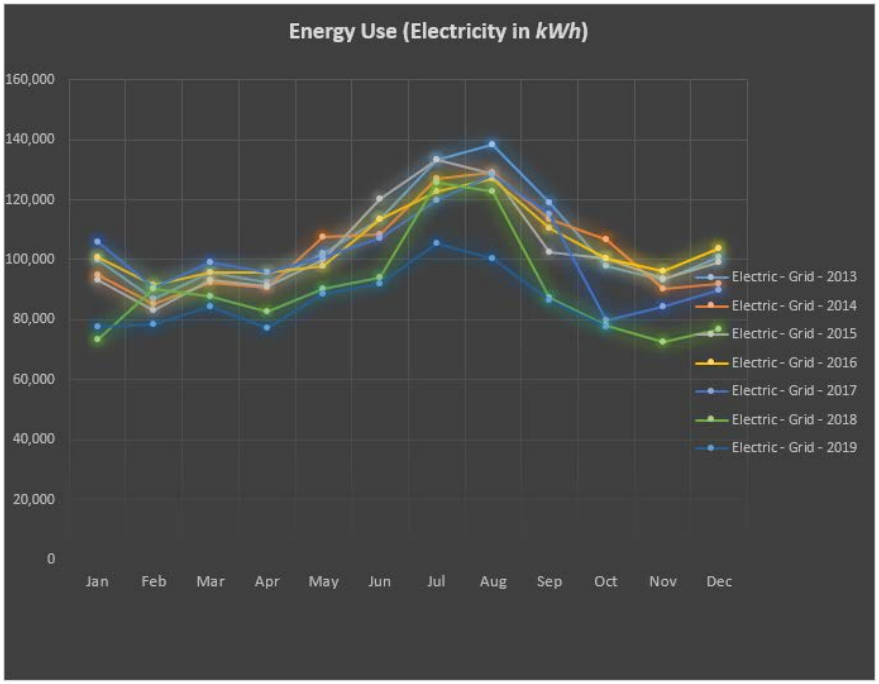
- Interviews with building owner/facility manager
- Visual verification of corrective actions reported to City
- Data loggers used to verify corrective actions requiring controls changes

Strong measure persistence!

SBC staff and building facility manager retrieve a HOBO UX90 motor runtime logger used to verify reduced parking garage exhaust fan schedule. It was confirmed.

M & V: Energy Data Analysis

- Monthly energy and emissions 1-year (2018) and 2-year (2017) gaps.
- 2017 baseline compared to 2019 using same pre and post months
- Emissions using Seattle GHG factors (carbon neutral utility)
- Challenges:
  - Unexplained data gaps & dips
  - Range of implementation timeline
  - Enough “post tune-up” data (range of 4 – 10 months available). Plan to update.
  - Not enough for weather normalization



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M & V: Post Tune-Up Savings

Building Energy Consumption & Emissions Savings Post-Tune-Up in M & V Sample Buildings 2017 vs. 2019 Non-Normalized. (##) = increase in energy or emissions.

Building	Electric %	Natural Gas %	Total Energy %	GHG Emissions %	Total Energy (kBtu)	Total Emissions (MT CO2e)	Months of Post Tune-Up Energy Data*
1	(3.81%)	0.51%	(1.84%)	0.14%	(65,924.91)	.13	6
2	12.69%	7.45%	12.32%	10.08%	344,344.47	2.13	10
3	4.92%	see note	4.92%	4.87%	102,520.81	.42	7
4	(7.13%)	see note	(7.13%)	(7.09%)	(97,216.68)	(0.4)	10
5	(3.16%)	17.57%	11.65%	16.95%	274,581.69	15.63	10
6	(1.18%)	see note	(1.18%)	(1.24%)	(23,041.24)	.01	4
7	20.38%	31.67%	27.17%	31.11%	749,318.72	28.84	5
8	16.73%	0.47%	14.42%	5.65%	597,868.71	2.6	10
9	5.65%	12.55%	8.59%	11.89%	282,930.94	9.8	7
10	11.31%	see note	11.31%	11.33%	371,639.58	1.54	7
Average Savings	**5.64%**	**11.70%**	**8.02%**	**8.37%**	**253,702.21**	**6.07**	

Building Notes:

3 - Gas wasn't analyzed because the tenant using gas left and service stopped on 6/30/18.

4 - Gas not analyzed because the meter was malfunctioning, and the management didn't realize it until M&V visit.

6 - Building is electric only with no natural gas use.

10 - Gas analysis was excluded due to unexplained high variability in usage trends.

** At the time of the evaluation, not all buildings had a full year of post tune-up data due to the implementation timing of the tune-up corrective actions, therefore these results should be considered preliminary.*

PNNL Re-Tuning Estimates

METHOD

- "Crosswalk" between TUA measure prevalence & Re-tuning prototype energy model
- 71 buildings matched to DOE/PNNL's 9 building types
- Eight ***required*** Seattle Tune-Up measures mapped to 18 different PNNL Re-tuning measures

FINDINGS

- Predicted savings ranged from 3.8% to 11.2% for building types.
- If extrapolated to all TUA buildings:
  - Electric 4.3%
  - Gas 3.1%
  - Steam .1% (1 bldg.)
  - **Total 7.5%**

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Asset Score Data Analysis

Nora Wang, Ph.D. AIA
Chief Engineer, Team Lead

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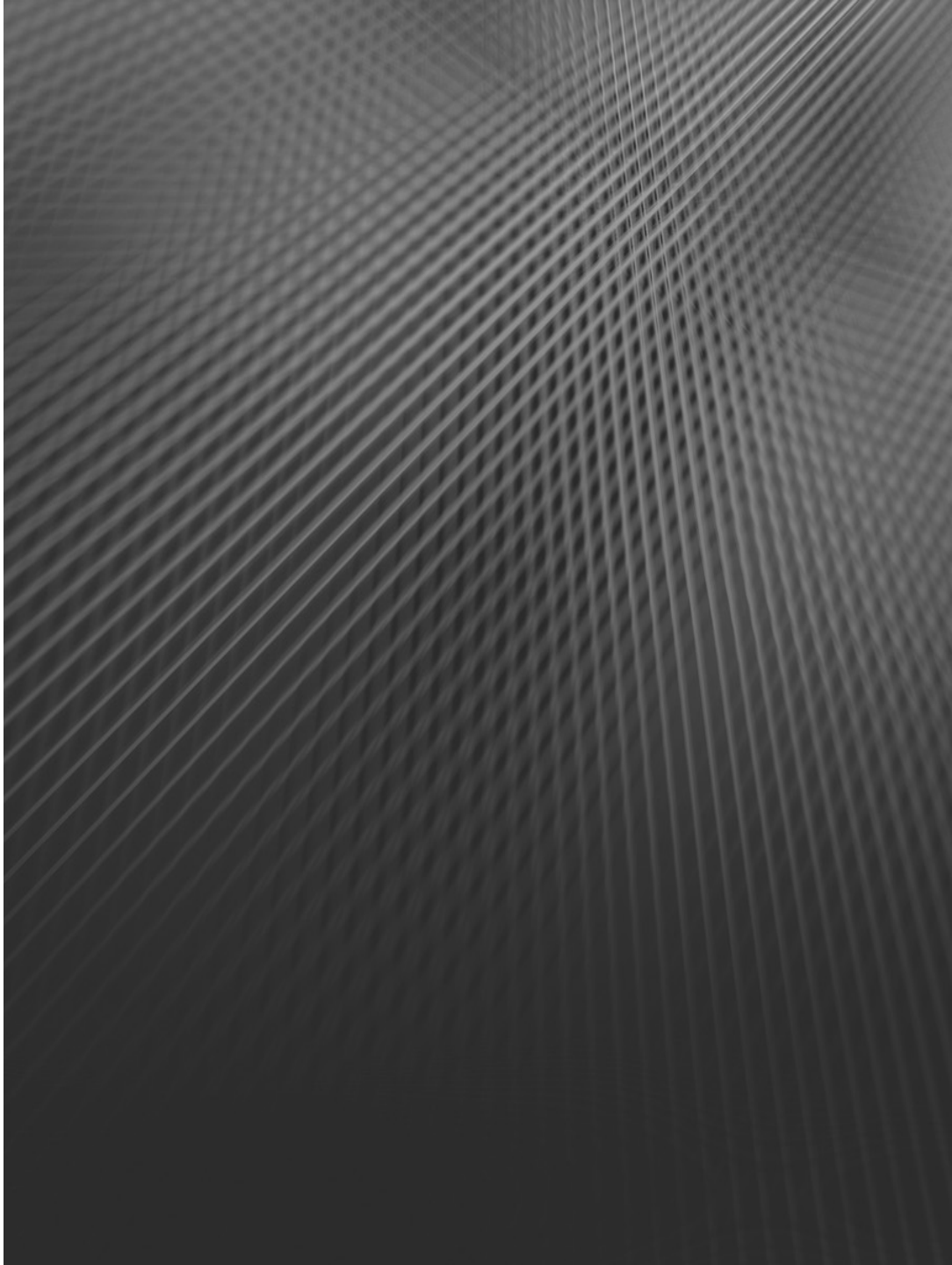
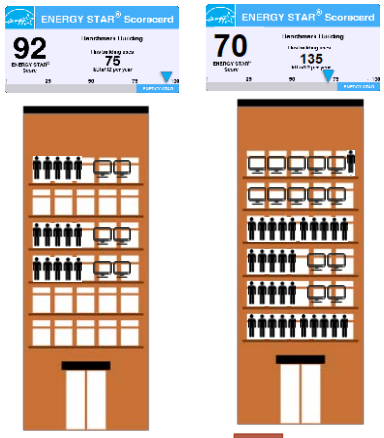
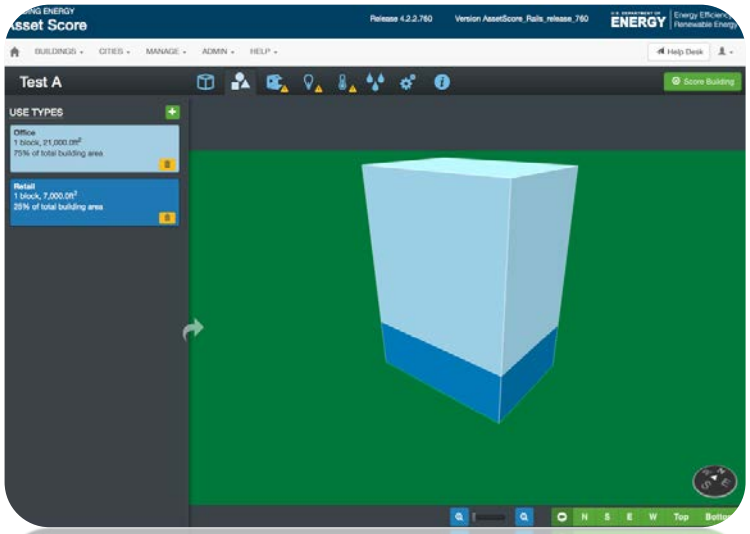
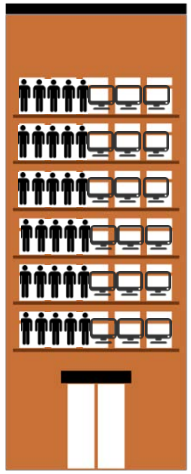


What is Asset Score

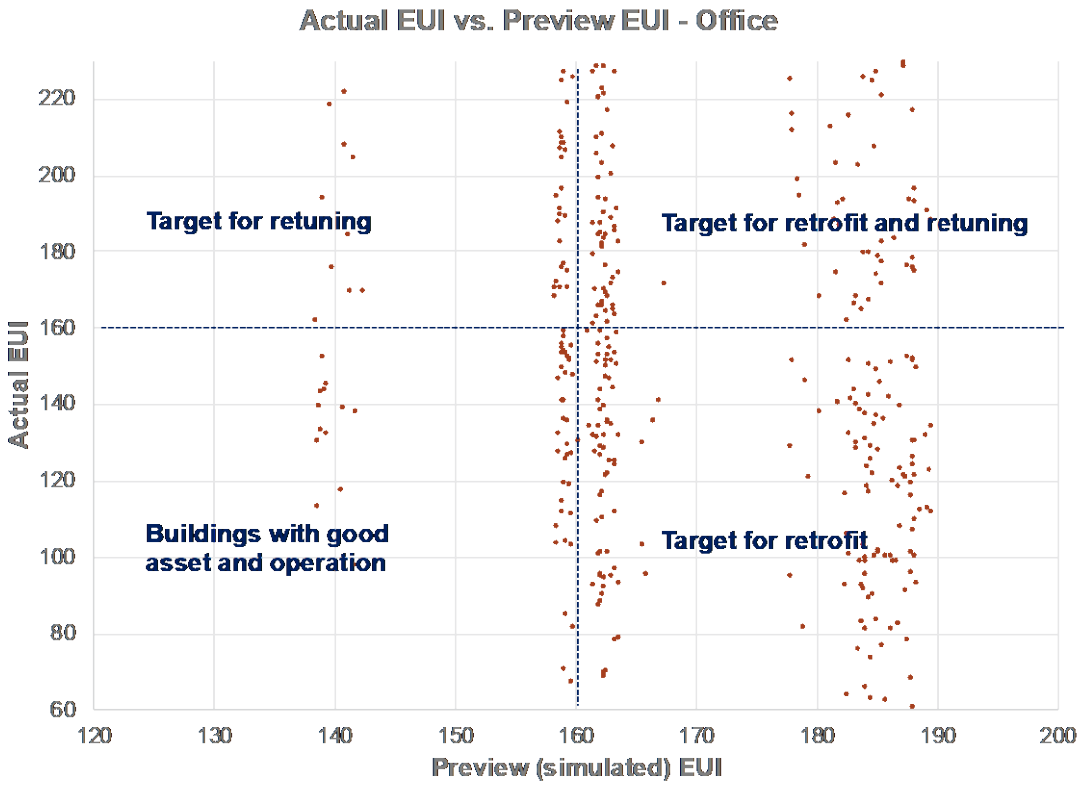


Asset Score runs an energy simulation using EnergyPlus through OpenStudio. The simulation normalizes for building operations, occupancy and tenant behavior. Users enter building characteristics through a web interface. A standard Asset Score report is then generated.





Asset Score Preview



In FY16, the City of Seattle identified over 2,600 small to medium size buildings (11,000-170,000 sq.ft.) from the energy benchmarking program. PNNL ran Preview Asset Score (AS) analysis based on their floor area, vintage, and use type. It was intended to help the City identify buildings with retuning or retrofit potentials with minimum inputs.

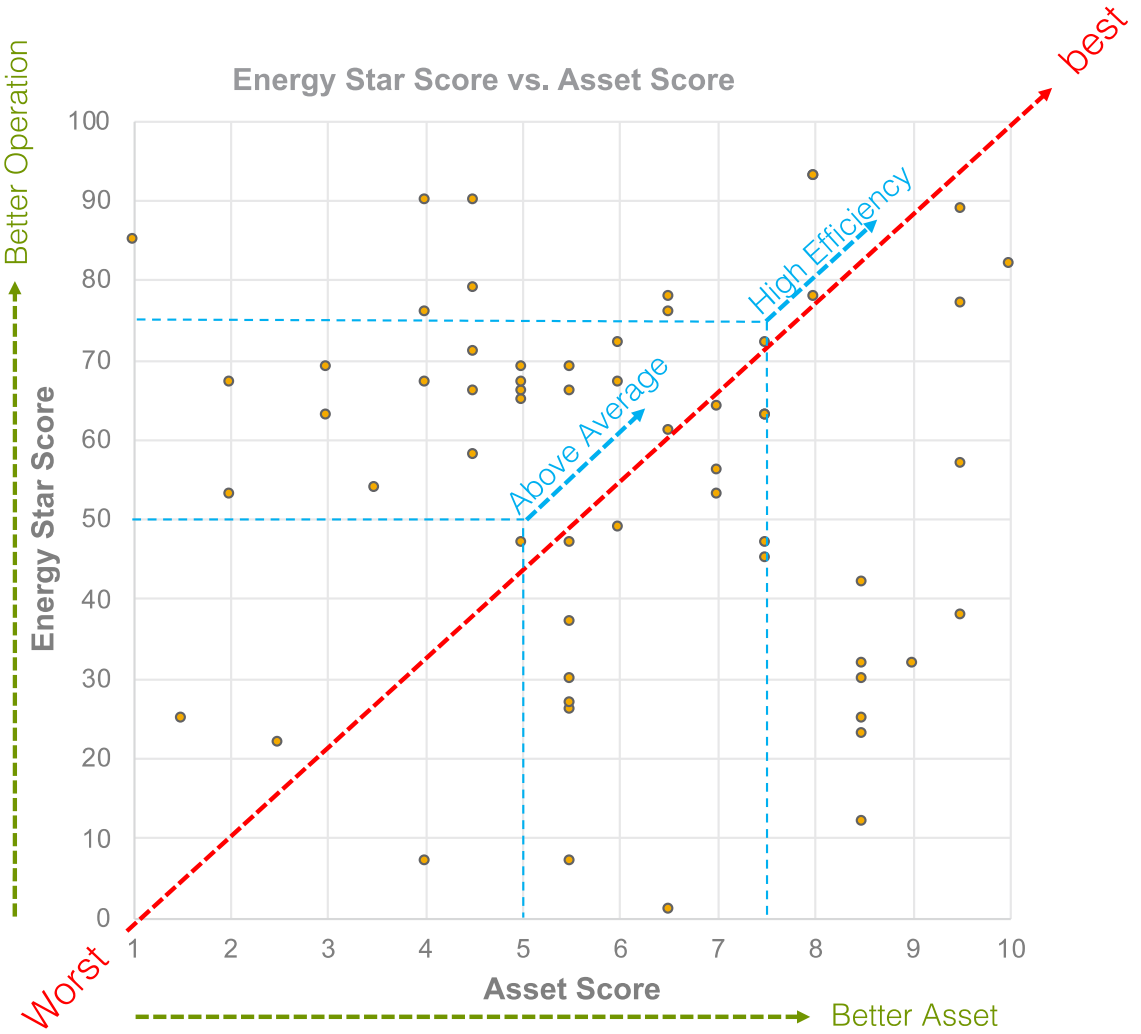
Example analysis of office buildings (total count 466)

- Actual EUI is measured from Portfolio Manager.
- Preview EUI is the medium EUI from the uncertainty analysis.

AS and ESPM as Complimentary Scores

60 out of the 90 TUA buildings have an ESPM Score.

Score comparison is less biased than EUI comparison because score normalizes weather and use type.



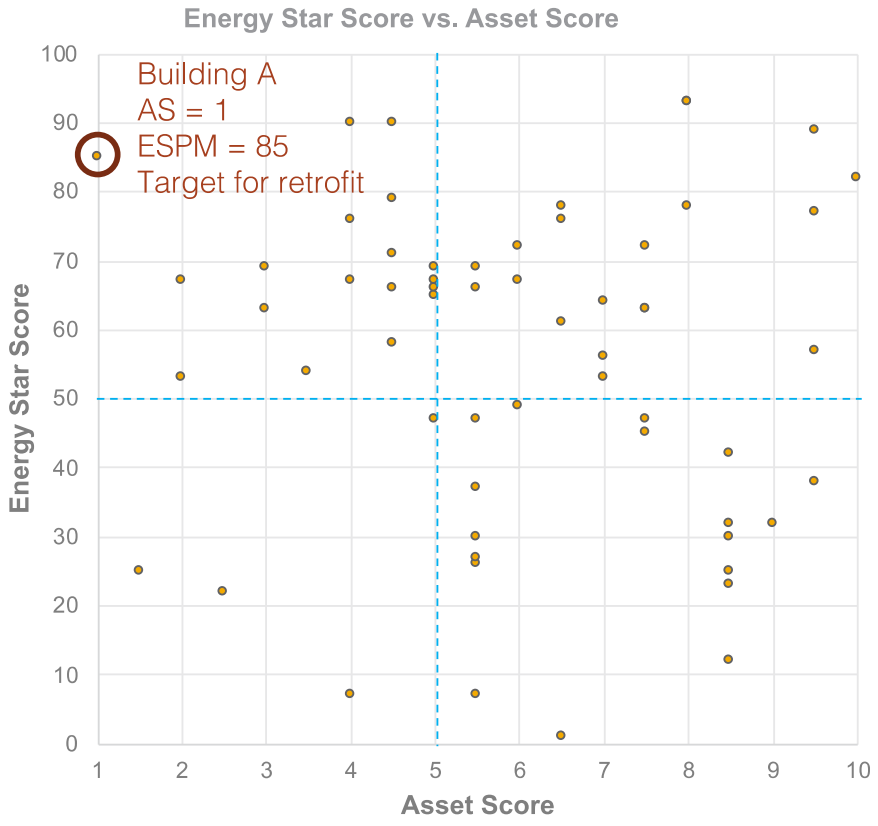
Case Study A

Field Assessment Report:

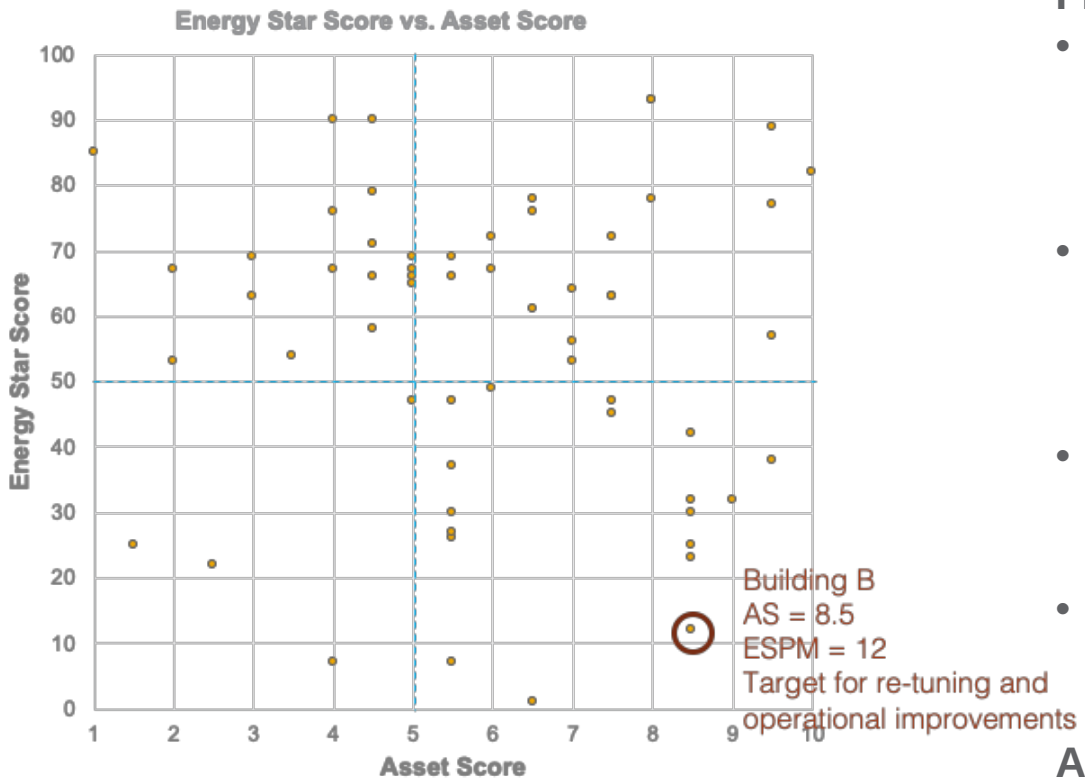
- Schedule exterior and interior lighting with energy management system.
- 30 years old water source heat pump units will need to be replaced.
- Upgrade all interior and exterior lighting.

Asset Score Recommendations:

- Replace all existing lights with LEDs.
- Install occupancy sensors.
- Upgrade heating system to natural gas boiler.
- Add variable frequency drives to cooling tower fan and condenser pumps.



Case Study B



Field Assessment Result:

- Replace valves on hot water loop and allow boilers and pumps to turn off when there is no heat demand.
- Install timer or aqua-stat control on domestic hot water recirculation pump to reduce 24/7 operation.
- Install occupancy sensors in storage room and the “back of house” spaces.
- Restaurant AHU nearing end of useful life.

Asset Score Recommendations:

- Replace T8-32 to LED lighting
- Add airside economizer
- Implement demand control ventilation

EEM Comparison with Assessor's Analysis

The Asset Score EEMs align with the assessor's evaluations, except that the tune-up assessors do not generally recommend envelope retrofits.

EEMs (for 56 buildings)	TUA	AS
Lighting - Retrofit	32	47
HVAC - Implement Controls	28	36
Lighting - Install Controls/Sensors	25	46
HVAC - Add Equipment	11	33
HVAC - System Upgrade	9	14
Envelope - Add Insulation	5	41
DHW - Install low flow faucets	4	34
Envelope - Upgrade Windows	3	24
DHW - System Upgrade	3	4
Total	120	279

HVAC EEM examples:

Add Equipment:

- add air-side economizer
- add variable frequency drive to supply fans

System Upgrade:

- upgrade heating system with high efficiency natural gas furnace
- upgrade cooling plant pumping system to constant primary - variable secondary pumping system

Implement Controls:

- implement chilled water temperature reset
- lower VAV box minimum flow set points

Owner / Manager Experience

"We participated in the Tune-Up Accelerator because it was a good business choice for us to get ahead of the game. The financial incentive helped; but more importantly, it allowed us to focus on energy efficiency and gave us a needed process, timeline and amazing support to get our necessary fixes done and create an informed plan for future capital upgrades."

DINA BELON-SAYRE
PINEAPPLE HOSPITALITY,
VICE PRESIDENT OF REAL ESTATE ASSETS

http://www.seattle.gov/Documents/Departments/OSE/Tune-Ups/OSE_BTU_CS_Hotel%20Five_Final.pdf

Owner / Manager Experience

"We were already doing a fair job managing the building, but we could only address the obvious things that were broken or not working right. The Tune-Up program gives us the opportunity to have our retro-commissioning staff dig in deep and find the source of a problem that isn't as obvious. That's the best thing about this program—finding the hidden opportunities is a big win."

RINA FA'AMOE-CROSS
SEATTLE PUBLIC SCHOOLS
RESOURCE CONSERVATION SPECIALIST

http://www.seattle.gov/Documents/Departments/OSE/Tune-Ups/OSE_BTU_CS_Concord_R7_final.pdf

Post-Participation Survey

✓ Positive Program Experience & Benefit to Building Operations

- **80% agreed to**: *Overall, participating in the Tune-Up Accelerator Program was beneficial to my building or organization.*

✓ Strong Satisfaction with the Tune-Up Specialist

- **75% agreed to**: *Service providers that want to conduct Seattle Building Tune-Ups should be required to attend a City of Seattle program training.*

✓ The Tune-Up Drives ECM Participation

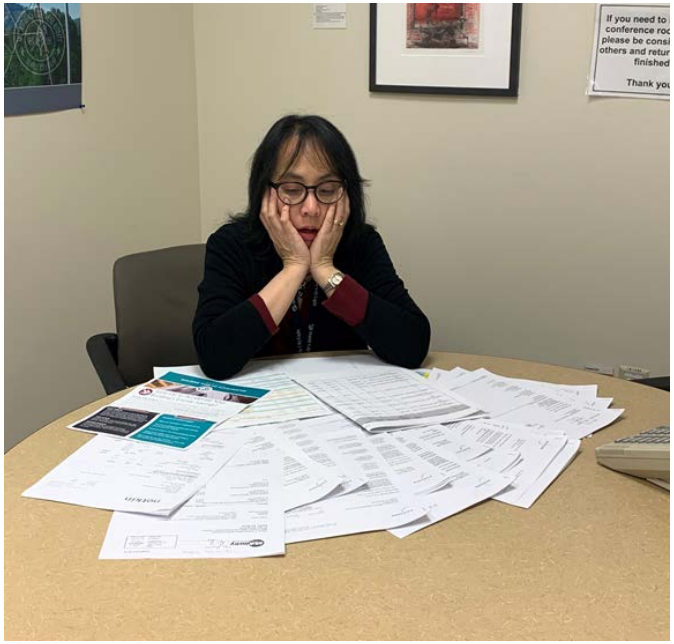
- **80% "Yes":** *After your participation, did you implement, or have you planned/budgeted for any voluntary ECM(s) beyond the required actions of the tune-up?"*

✓ Offering an Incentive & Technical Support for Early Compliance is Good Policy

- **93% "Yes" -** *The City should use incentives and extra technical support to engage building owners with early compliance.*

Tune-Up Costs

Primary Building Use	Number of Buildings	Avg. Tune-Up Cost/SF
College/University	11	$0.13
Hotel	7	$0.19
Office	27	$0.19
Medical Office	5	$0.20
Other	15	$0.21
Retail/Grocery Store	2	$0.21
Mixed Use Property	6	$0.24
Non-Refrigerated Warehouse / Distribution Center	4	$0.25
K-12 School	23	$0.27
Grand Total	**100**	**$0.21**



Seattle City Light

TUA Revised Savings Estimates

Basic Tune-Up: **10%** → **7%**

Tune-Up Plus: **20%** → **15%**

Building Renewal: **35%** → **35%**

Total Estimated: **20%** → **12%**

kBtu: **99** → **67.8 million**

Seattle GHG: **13.3%**

MT CO2e/Yr: **10,500**

Beyond Tune-Ups… Next Steps

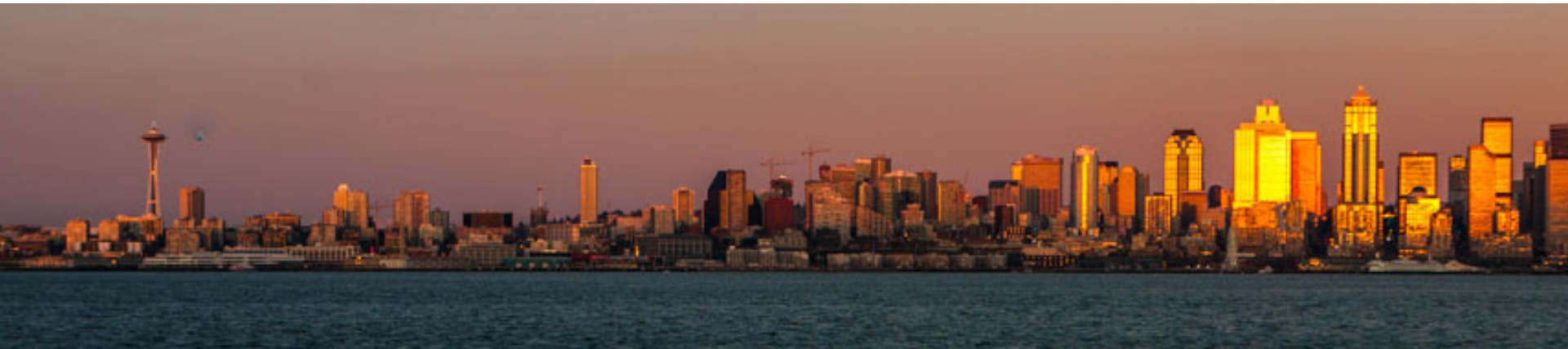
- WA State Building Performance Standards
- Future Seattle Building Performance Standards
- Green New Deal
- Increased Support: “Hubs”, Financing
- Pilot “Retrofit Accelerator”

Thank You!

Nicole Ballinger

nicole.ballinger@seattle.gov

www.seattle.gov/buildingtuneups



Pacific Northwest
NATIONAL LABORATORY

Questions

U.S. DEPARTMENT OF ENERGY BATTELLE

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