Benchmarking, BEPS, and the Big Apple:

Lessons Learned from NYC's Local Law 97 for St. Louis Laboratories

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Grumman|Butkus Associates

St. Louis I²SL Chapter

Webinar

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12-1 p.m. CT

GRUMMAN|BUTKUS

ENERGY EFFICIENCY CONSULTANTS AND SUSTAINABLE DESIGN ENGINEERS

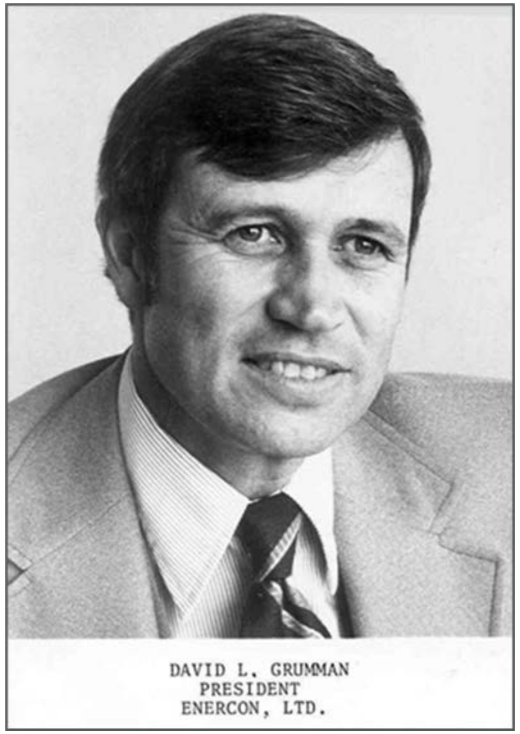
Presentation Agenda

Introductions

Who is GBA, and what is a BEPS or BPS?

Who Is GBA?

- Founded by Dave Grumman in 1973
- Energy efficiency consultants
- Original firm name: ENERCON Ltd.
  - Short for energy conservation
- Today ...
  - Full-service MEP consulting firm
  - 130 employees in four offices
  - **New York regional office founded in 2013; our clientele and services have evolved along with the passage of NYC sustainability laws**
  - Practice spans the USA, with some clients in Canada and Mexico



What GBA Is …

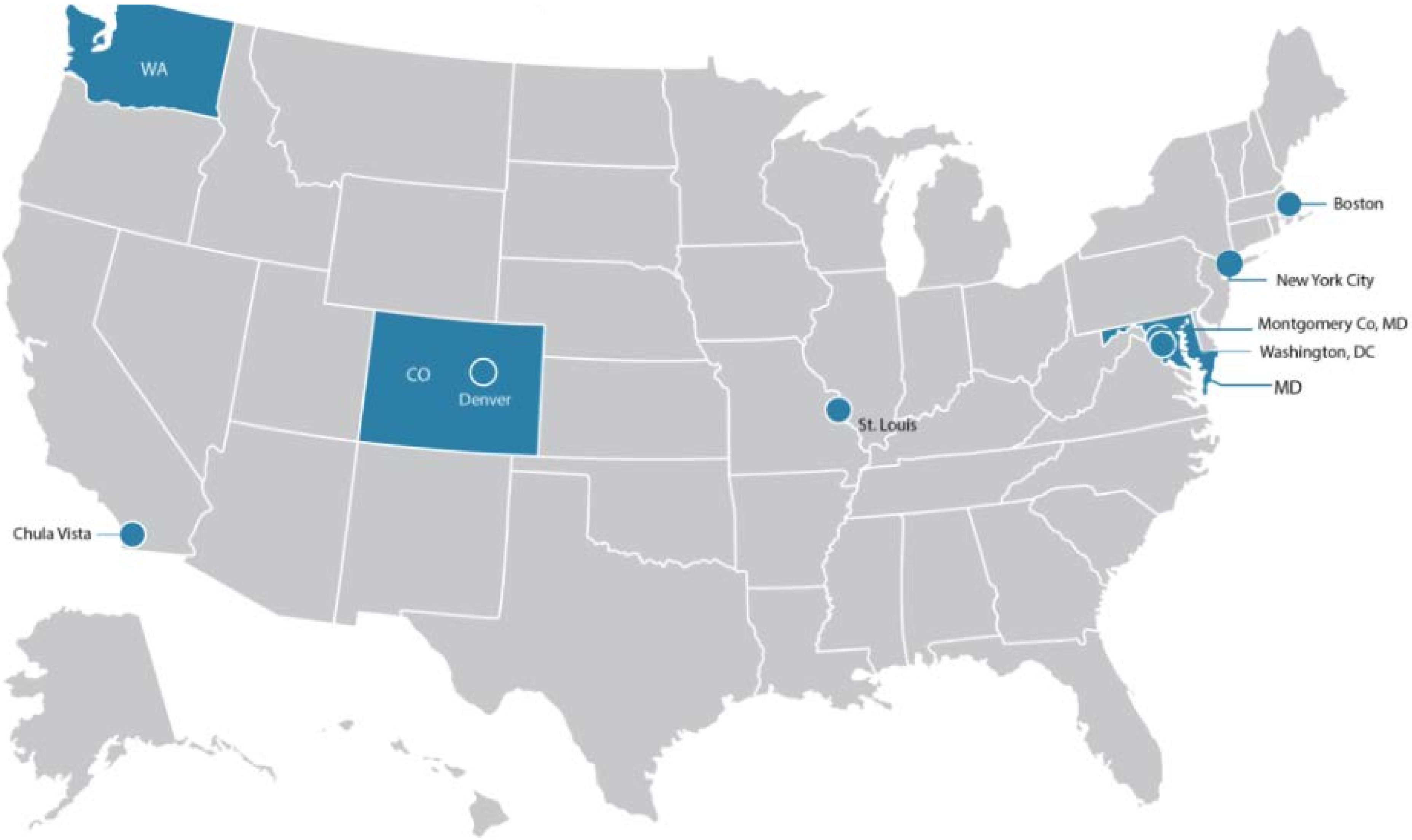
- Focus on energy management, sustainability, decarbonization and electrification
- Emphasis on the most energy-intensive, mission-critical buildings
    - Laboratories, hospitals, pharma, cleanrooms, data centers, central plants
- Emphasis on MEP infrastructure upgrades, which will be a necessary part of deep energy retrofits

What Is BEPS and Who Is Using One?

Building Energy Performance Standard (BEPS) or Building Performance Standard (BPS) are outcome-based policies or laws used to encourage reductions in energy use and/or carbon emissions from buildings in a jurisdiction.

- IMT (Institute for Market Transformation) currently shows 10 programs nationwide
- **It isn't enough to require good components like chillers, boiler burners, and wind turbines**

BEPS Nationwide



St. Louis and…

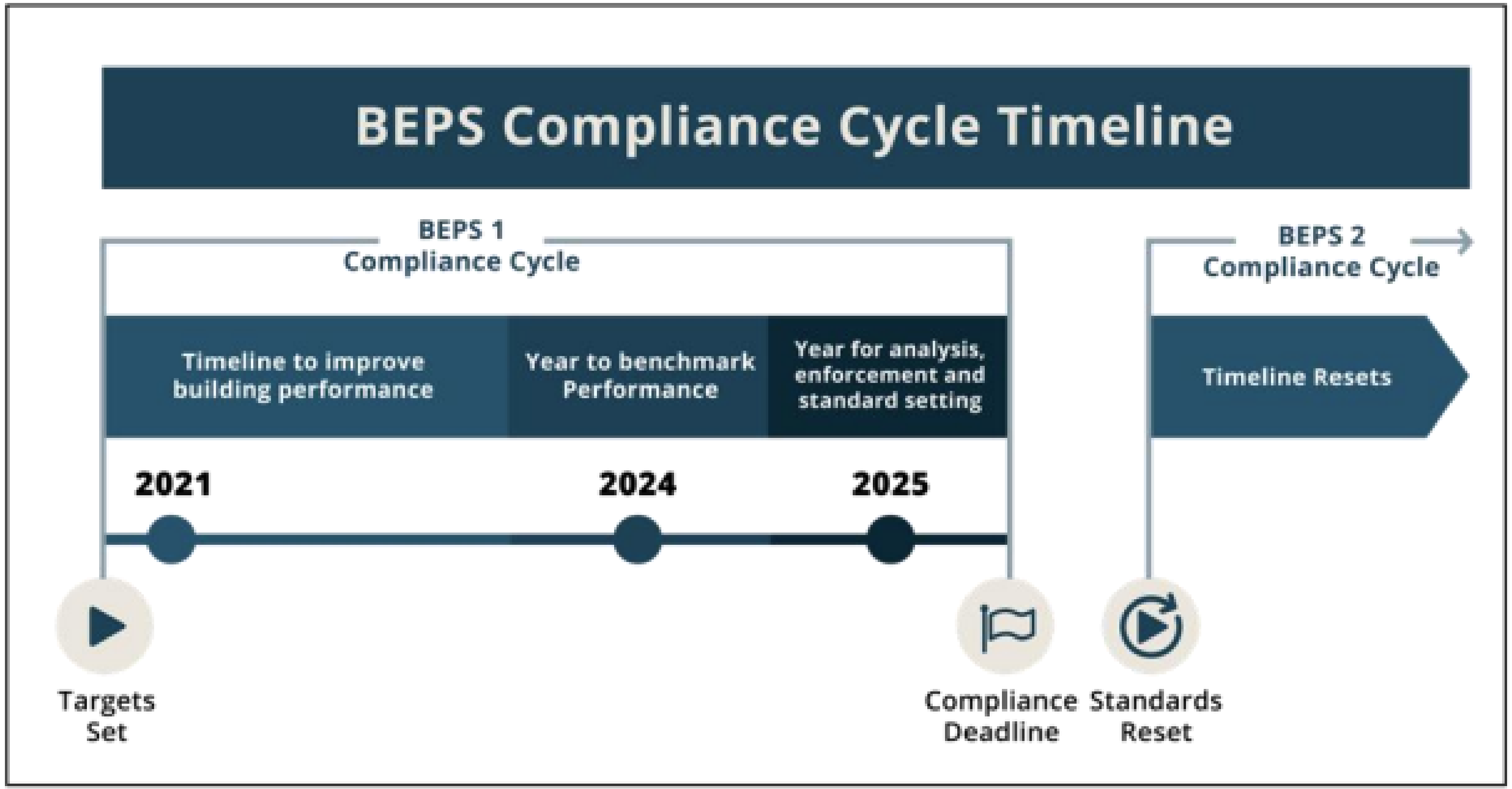
- NYC
- Boston
- Washington DC
- Montgomery County, MD
- State of MD
- Denver, CO
- State of CO
- State of WA
- Chula Vista, CA

Source: IMT, 4/2022

Comparison of St. Louis Ordinance to NYC and Other BEPS and BPS Programs

Program Characteristic	St. Louis	NYC	Boston	State of Washington	District of Columbia
Performance metric	Site EUI	Carbon emissions	Carbon emissions	Site EUI	ENERGY STAR Score
Potential fines	$500/day BEPS ($182,500)	$268/ton	$234/ton or $1,000/day large bldgs $300/day	$5,000 + $1/sf/day	$10/sf maximum sliding scale (capped @ $7.5M!)
Affected facilities	>50,000 sf	>25,000 sf	>35,000 sf then down to 20,000 sf	>220,000 sf then down to 50,000 sf	>50,000 sf then down to10,000 sf
Date for first compliance cycle	CY 2024	CY 2024	CY 2025	CY 2026/2029	CY 2021/2033

Targets and Timeline



Property Type	Target (EUI in kBtu/ft^2/yr.)
Adult Education	80.1
Automobile Dealership	79.3
Bar/Nightclub	77.3
College/University	113.8
Courthouse	112.3
Data Center	Exempt
Distribution Center	17.6
Financial Office	71.7
Fitness Center/Health Club/Gym	77.3
Food Service	181.9
Hospital (general medical and surgical)	259.9
Hotel	89.4
Indoor Arena	77.3
K-12 School	63.5
Laboratory	219.2
Library	57
Manufacturing/Industrial Plant	Exempt
Medical Office	105.9
Multifamily Housing	42.5
Museum	118.4
Non-Refrigerated Warehouse	17.6
Office	71.7

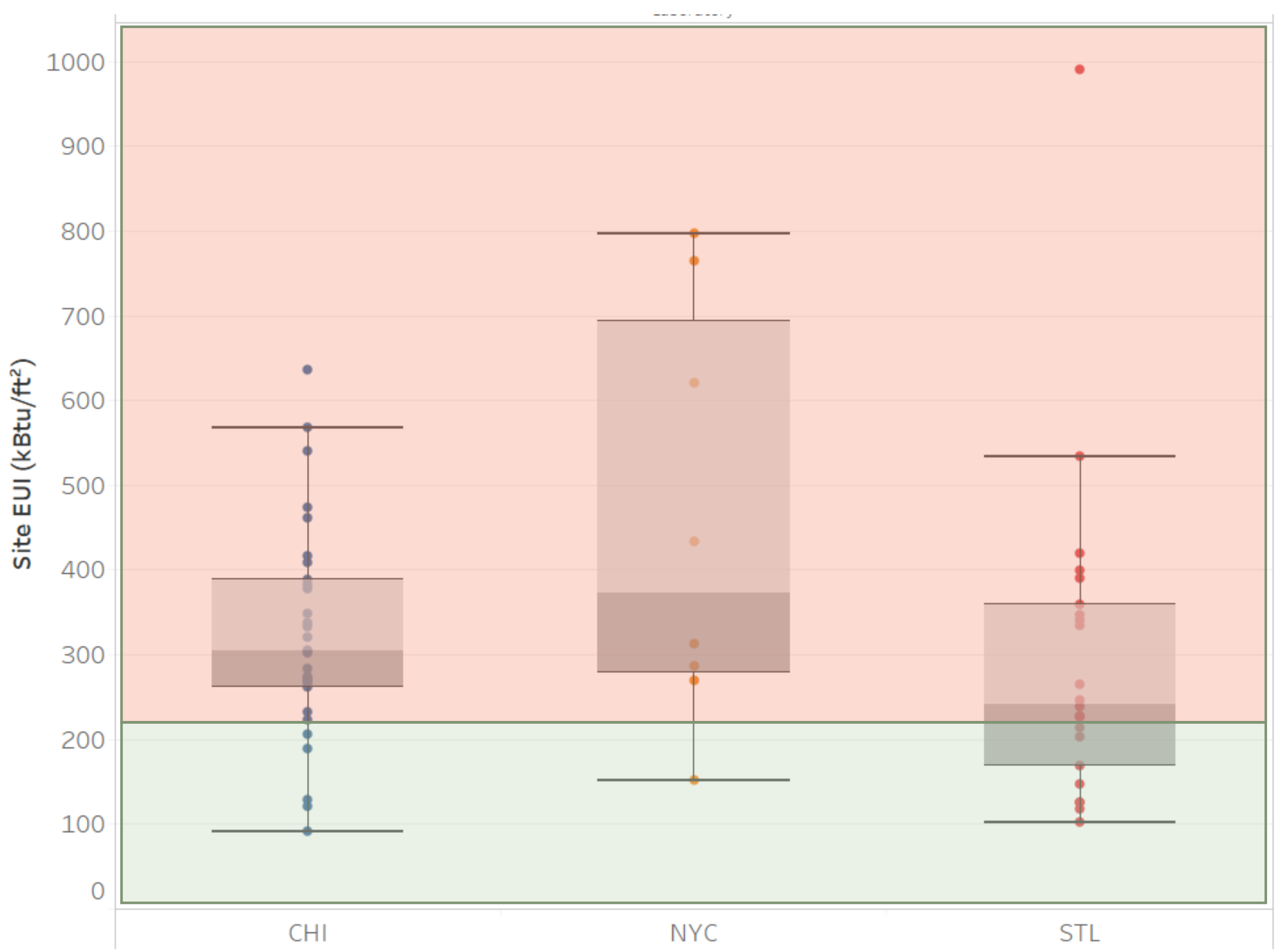
Background of St. Louis BEPS

What are the approaches used by St. Louis' BEPS ordinance, and how will these approaches affect laboratory facilities in the City?

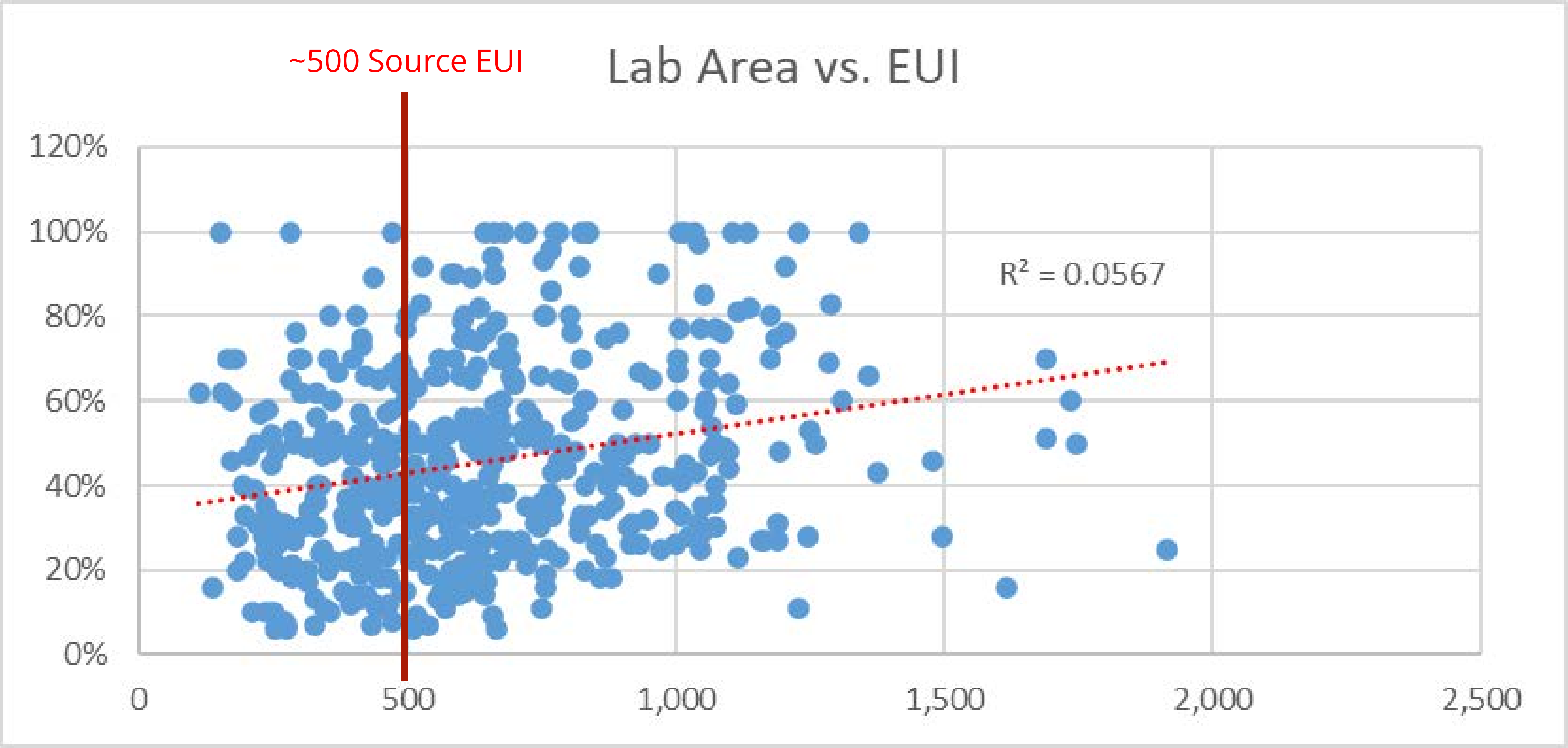
St. Louis Benchmarking vs. NYC (and Chicago)

EUI shown for sites with less than 1,000 kBtu/sf/year

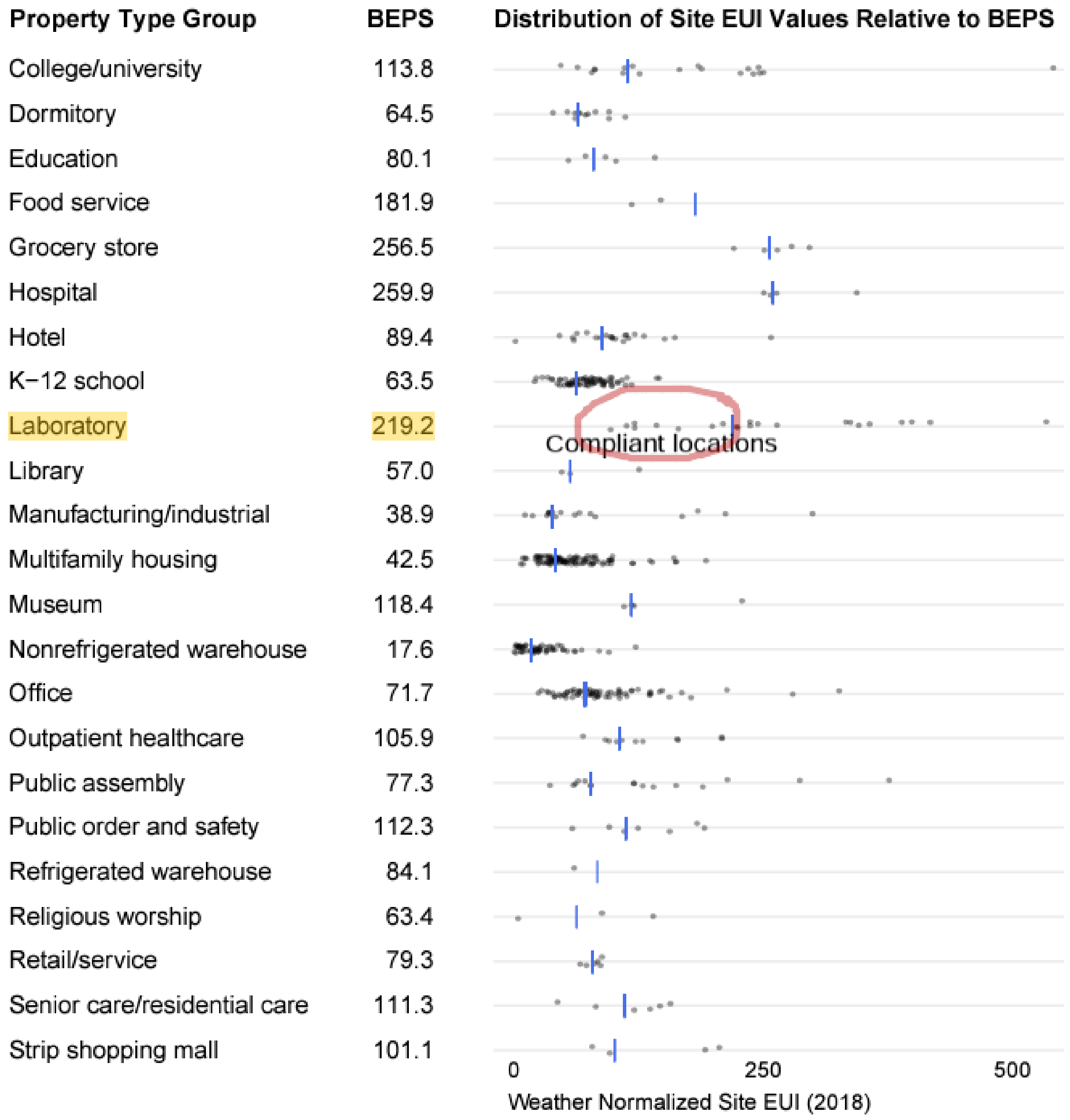
- Knocked out several outliers in NYC and Chicago data for campus buildings with central plants
- St. Louis Compliance Target is 219.2 kBtu/sf/year
- Red-shaded area is non-compliant according to St. Louis BEPS; green area is compliant
- Potential under-reporting in the benchmarking data for high energy users or “masking” as part of college/university or hospital types



Lab Benchmarking From I²SL Database



http:// lbt.i2sl.org



Compliance Path #1

EUI Below 219.2 kBtu/sf/year

- 65th percentile is 219.2 kBtu/sf/year
- One site is 1,000 kBtu/sf/year — not feasible to operate at 219.2 kBtu/sf/year by 2025
- Several locations at 250 kBtu/sf/year or below could use energy audits and implement measures in time for the performance period
- Sites embedded in college/university or healthcare settings may be “masked”

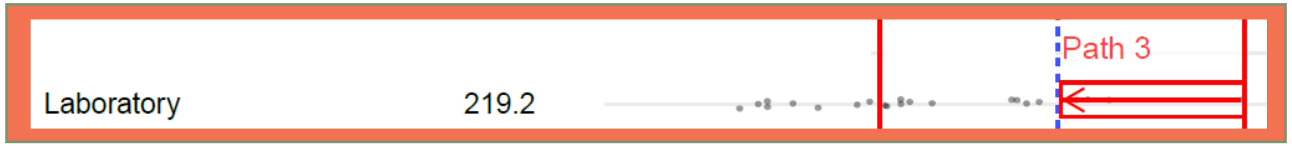
Compliance Path #2

Early Adopter by EUI and 20% Reduction

- Achieving EUI targets as well as demonstrating a 20% improvement from 2018 baseline earns compliance for cycles 1 and 2
- Achieving the same with a 50% reduction earns compliance through cycles 1, 2, & 3
- Labs with older airflow controls and older lighting might be able to achieve 20% to 30% savings
- “Exotic” approach such as heat pumps may be needed for 50% reductions

Compliance Path #3
Narrow the Gap

- Reduce EUI to the midpoint between 2018 baseline and the standard target
- For example, the St. Louis site reporting just over 500 kBtu/sf/year would need to achieve an EUI 359.6 kBtu/sf/year after retrofits (a 28.1% reduction)
    - Wouldn't qualify for extended compliance since the EUI target wasn't met
    - Energy audit is recommended to identify that large of a savings



Compliance Path #4

Custom Alternative Compliance With Audit

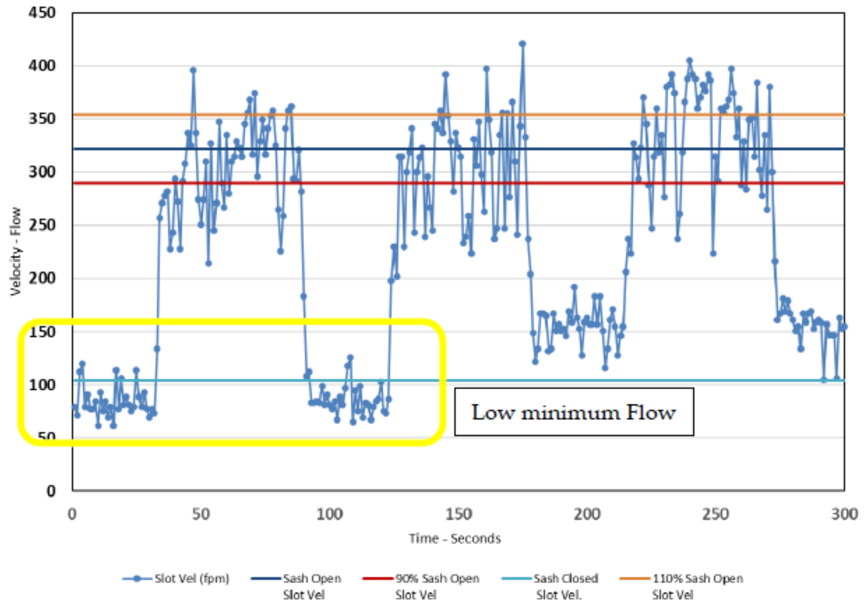
- Similar to Path #3 but may not achieve the midpoint while demonstrating pursuit of feasible measures from the Level 2 energy audit
- **Must meet the requirements of an ASHRAE Standard 211 Level 2 report**
- For example, the 500 kBtu/sf/year site may find only 100 kBtu/sf/year reduction is possible at a 10-year payback while maintaining safety of people and research

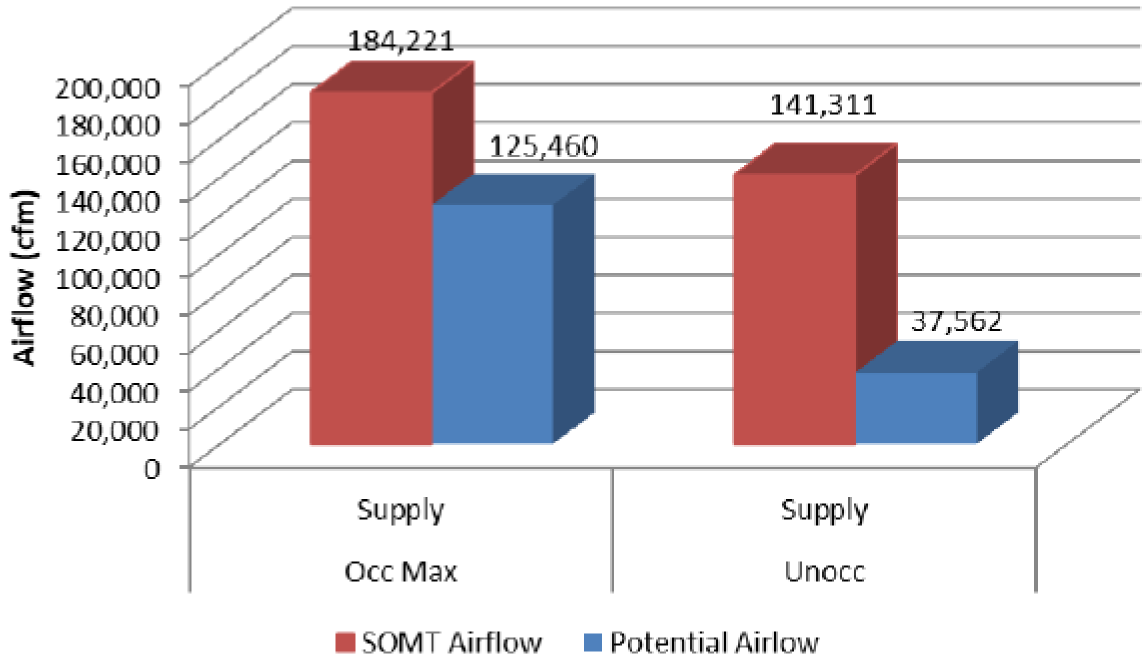
Strategies To Improve Performance

How can St. Louis laboratory facilities comply?

Assess the Facility

1. Infrastructure Report Card
2. Lab Ventilation Risk Assessment (LVRA) fist – determine risks in collaboration with the facilities staff **and researchers**
3. Demand Ventilation Assessment (DVA) second – evaluate at minimum flow and maximum flow by lab and system for stability and meeting minimum requirements
4. Retro-commissioning next, to bring systems to current HVAC requirements while maintaining safety levels from LVRA and DVA
5. Energy audits to develop capital measures for implementation as part of energy efficiency and/or carbon master planning

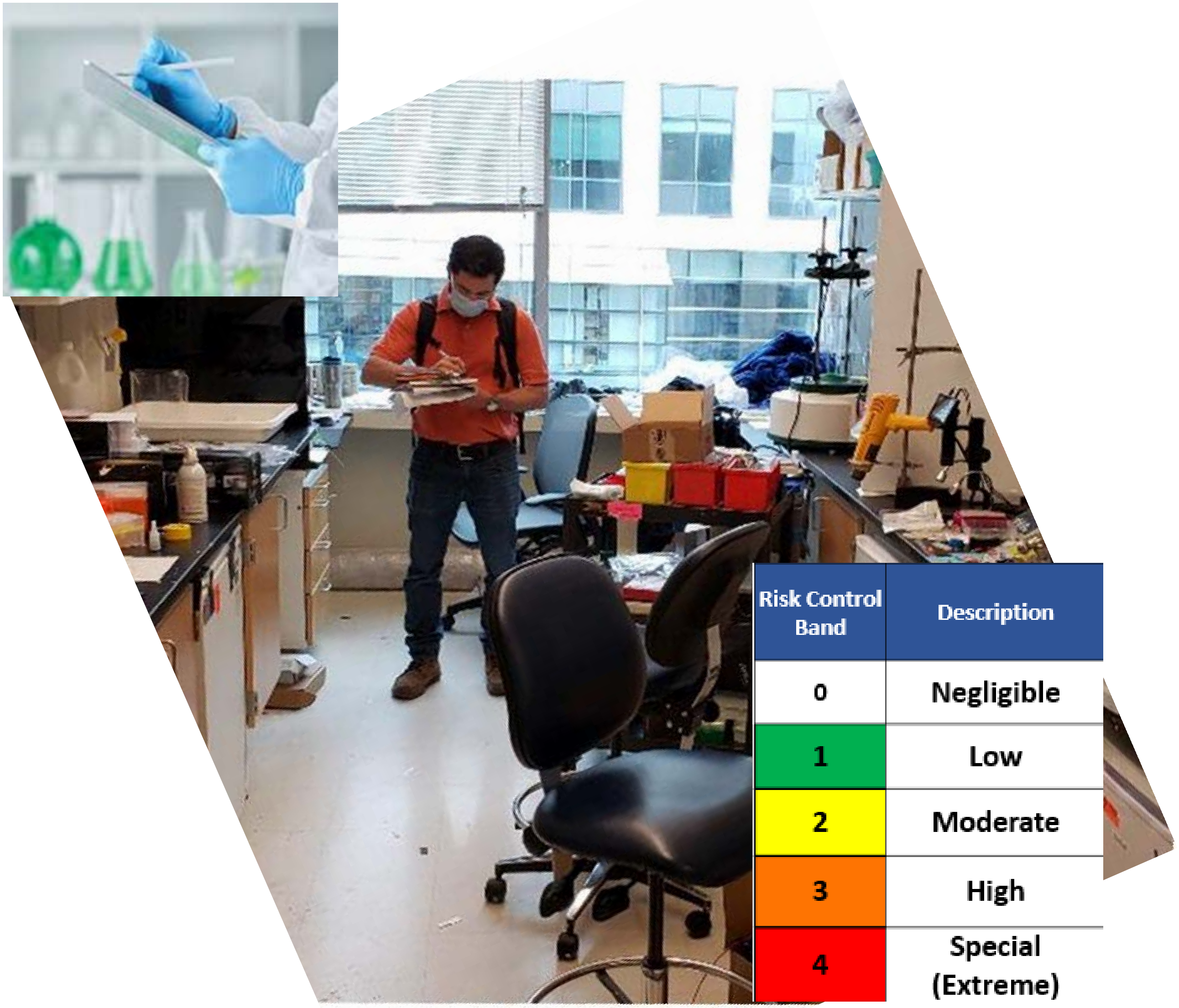




1. Infrastructure Report Card (Assessment)

Facility	Air Handlers			Boilers/Steam			Chillers/Cooling Towers			Electrical			Fire Protection			Plumbing		
MoMA 2021 Infrastructure Report Card - Tables	37	64	2	4	4	3	1	12	4	27	20	1	1	4	0	10	6	7
Percent of Total	36%	62%	2%	36%	36%	27%	6%	71%	24%	56%	42%	2%	20%	80%	0%	35%	26%	39%
TOTAL	**103**			**11**			**17**			**48**			**5**			**23**		

- Determine the starting point
- Conduct an infrastructure assessment and report card to clearly identify the current health of the facility, systems, and equipment
- Includes MEP and building envelope



Risk Control Band	Description
0	Negligible
1	Low
2	Moderate
3	High
4	Special (Extreme)

2. LVRA

The Laboratory Ventilation Risk Assessment™ (LVRA) is a focused risk assessment

- Surveys of lab environments and associated exposure control devices
    - “Below-the-ceiling” study
- Relative risk is determined using weighted algorithm method that establishes a control band representing a range of hazard emission scenarios
- Control banding techniques correlate with risk band values with minimum operating specifications
- Developed to assess risk and associated ventilation demand in critical environments

3. Demand-Side Ventilation Strategies

AMEREN Incentives

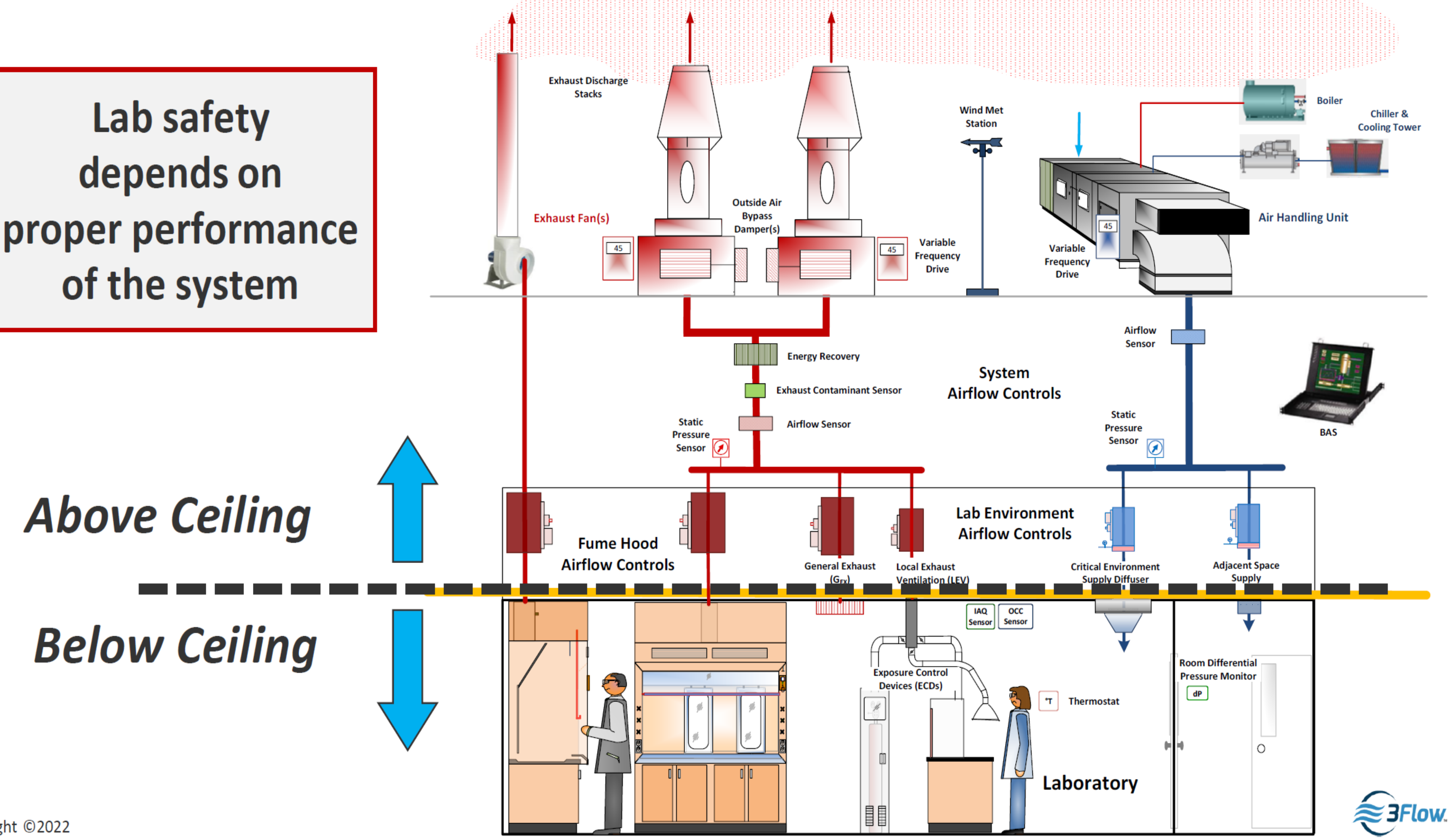
End Use (Savings Type)	Unit of Measure	Incentive Per Unit
Cooling	kWh reduced	18¢
HVAC	kWh reduced	12¢
Building Shell	kWh reduced	12¢
Cooking	kWh reduced	9¢
Water Heating	kWh reduced	9¢
Interior Lighting (Existing Equipment Baseline)	kWh reduced	8¢
Interior Lighting (Applicable Code Baseline)	Watt reduced	40¢
Compressed Air	kWh reduced	8¢
Miscellaneous	kWh reduced	7¢
Motors	kWh reduced	7¢
Process	kWh reduced	7¢
Refrigeration	kWh reduced	6¢

ComEd Incentives

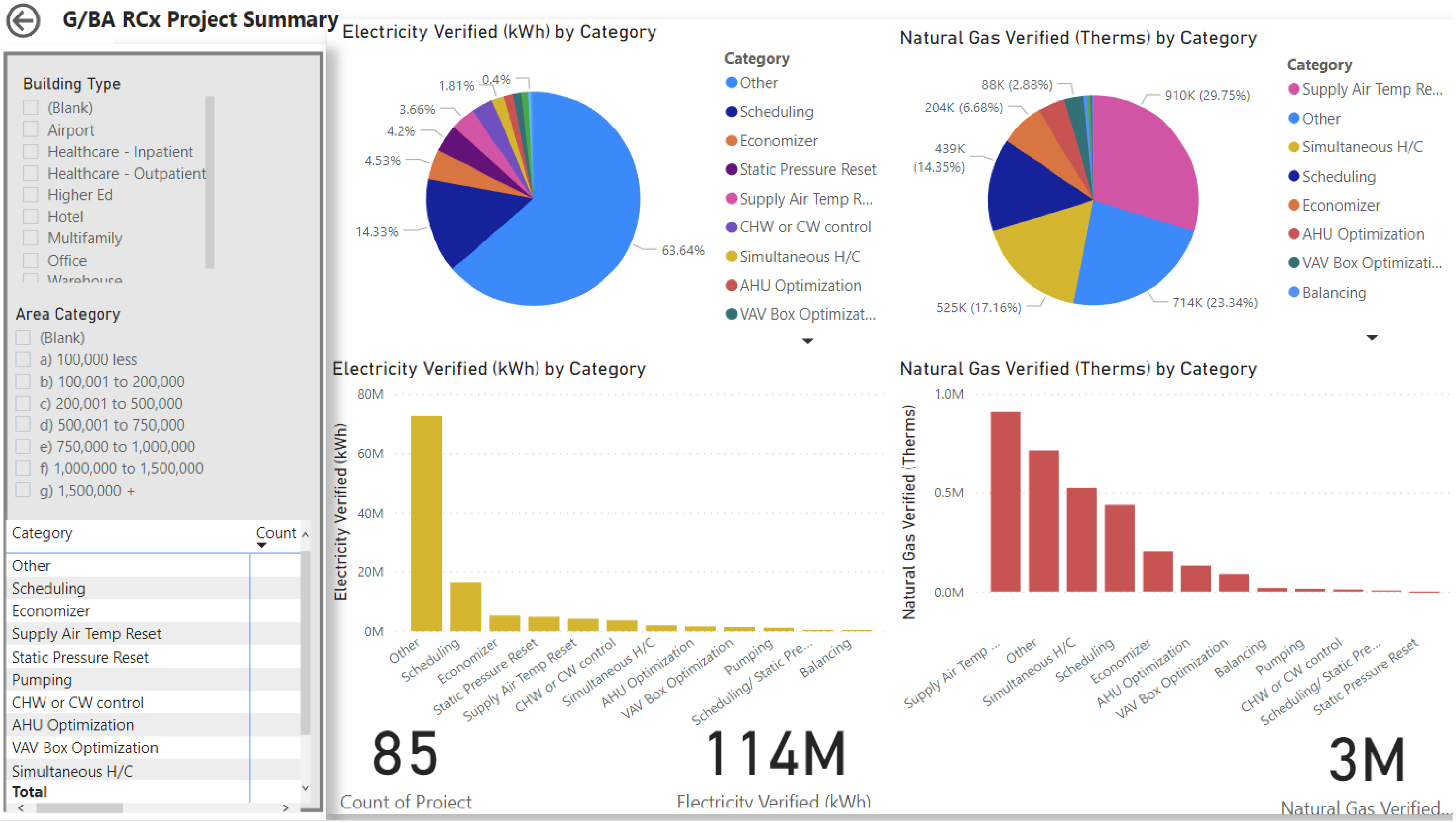
LABORATORY	
High performance low flow fume hood	$400 per linear ft.
Variable air volume fume hood	$250 per linear ft.
Fume hood occupancy control	$100 per linear ft.
Automatic fume hood sash closer	$150 per linear ft.
Sash stops	$5 per linear ft.
Low pressure drop HEPA filters	$50 per 1,000 CFM
Low pressure drop high efficiency (non-HEPA) air filters	$15 per 1,000 CFM
Reduce/optimize air changes per hour (ACH) in laboratory space	$0.75 per CFM

Proper ventilation requires a systems approach

Lab safety depends on proper performance of the system

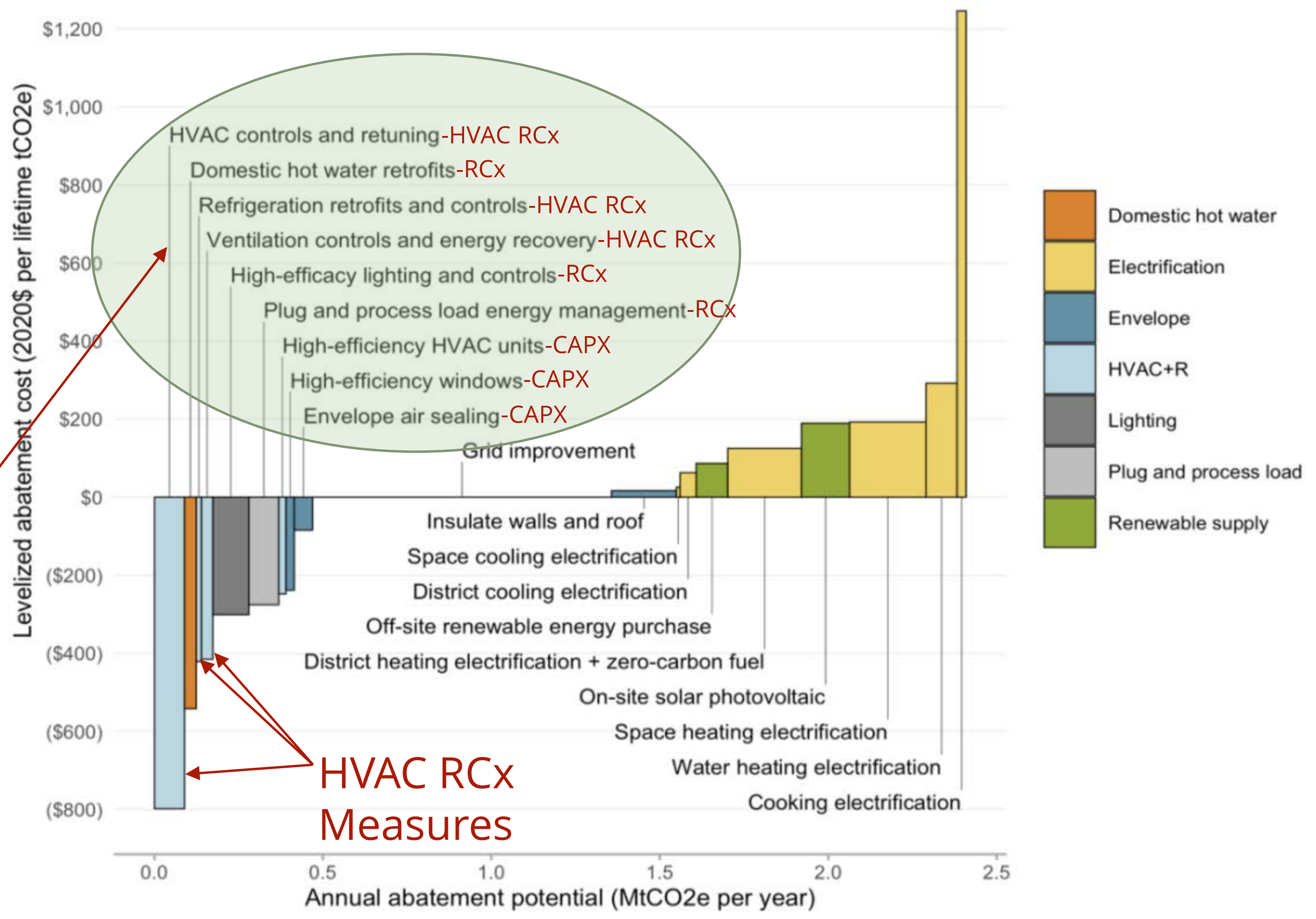


4. Retro-commissioning Results and Savings



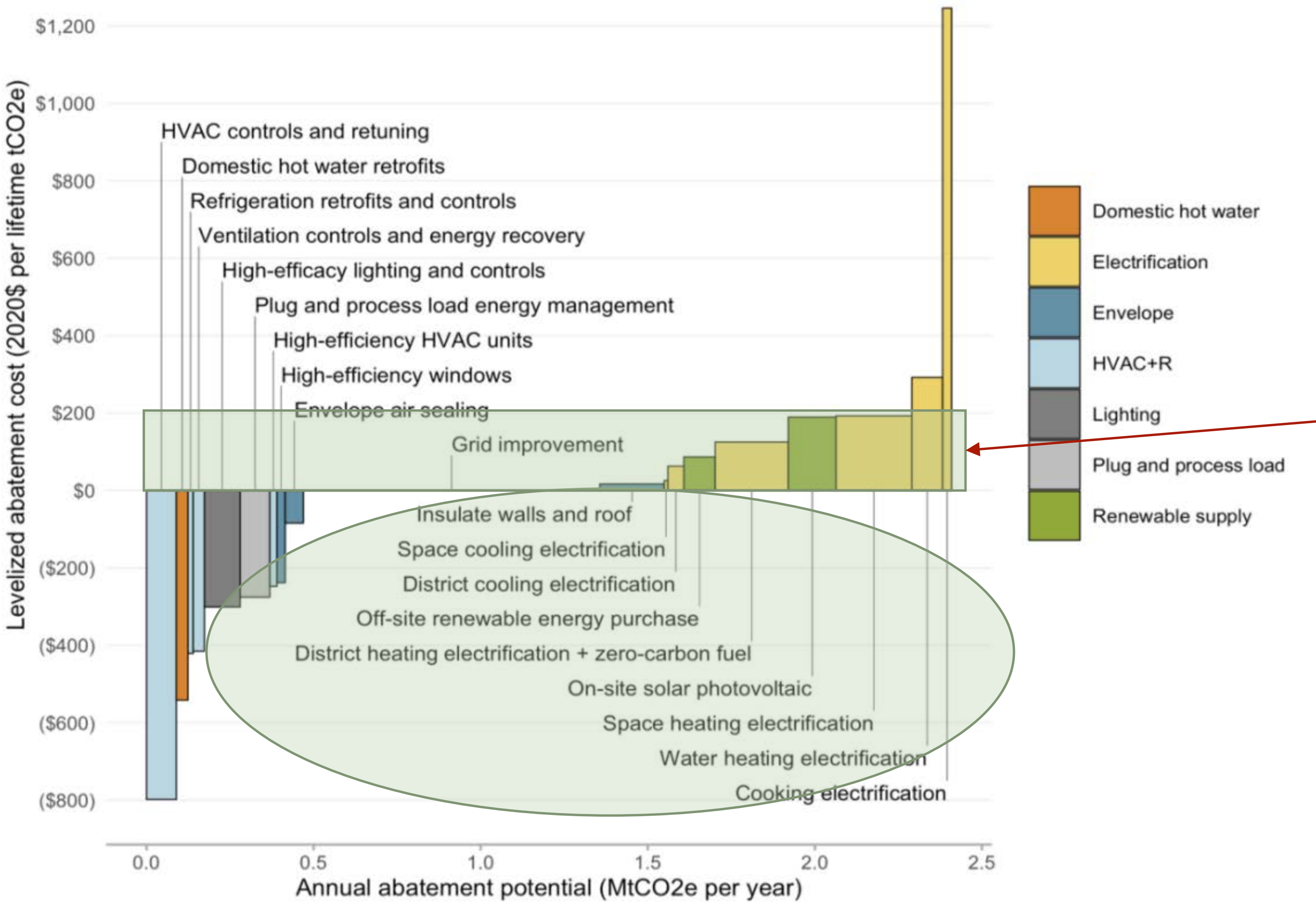
5. Assessment and Capital Approach for Carbon Abatement

Measures that "pay back" over their lifetime from energy cost savings that also reduce carbon emissions



Source: Synapse model.

5. Assessment and Capital Approach for Carbon Abatement



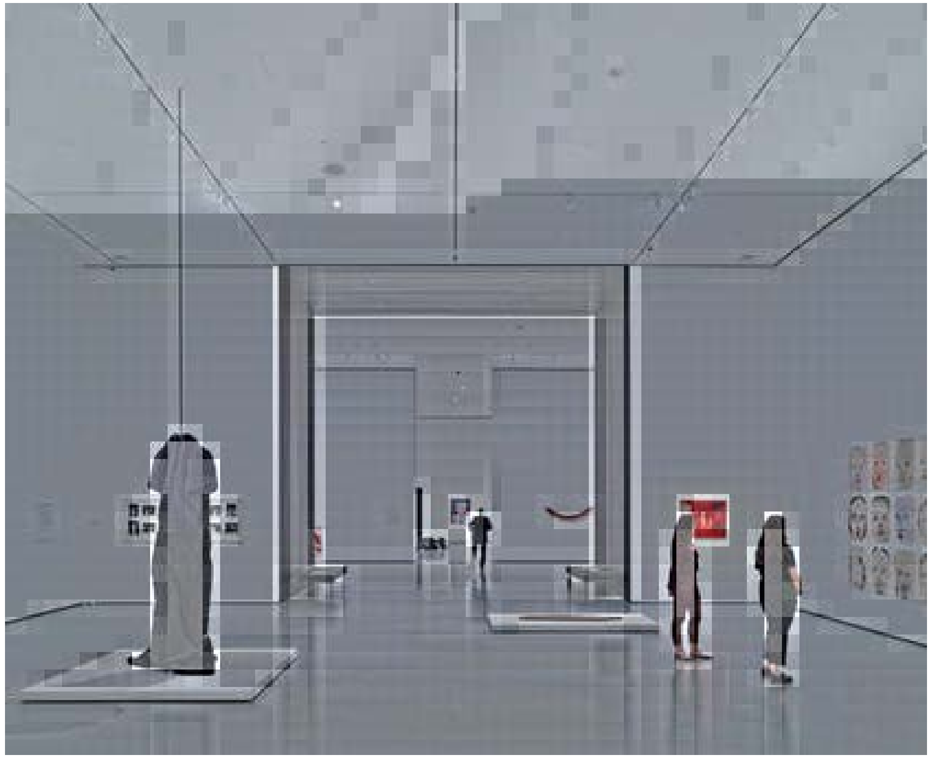
Source: Synapse model.

Measures wouldn't pay back until \$268/MTCO2 penalty is applied; these may be implemented primarily to achieve carbon reduction or mandated EUIs

Case Study

NY Mission Critical Institutional Facility With Laboratory Spaces

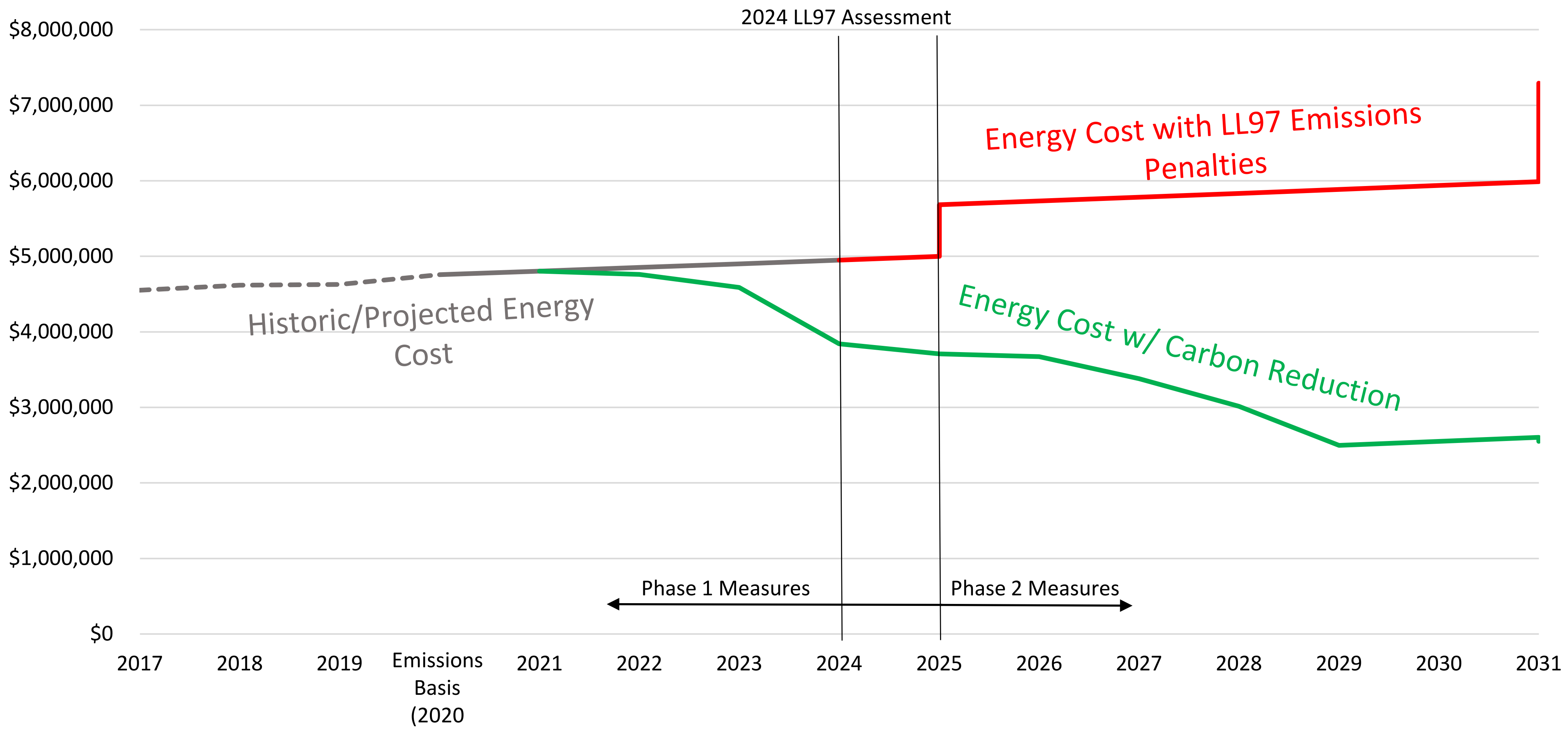
Case Study: Major NY Facility



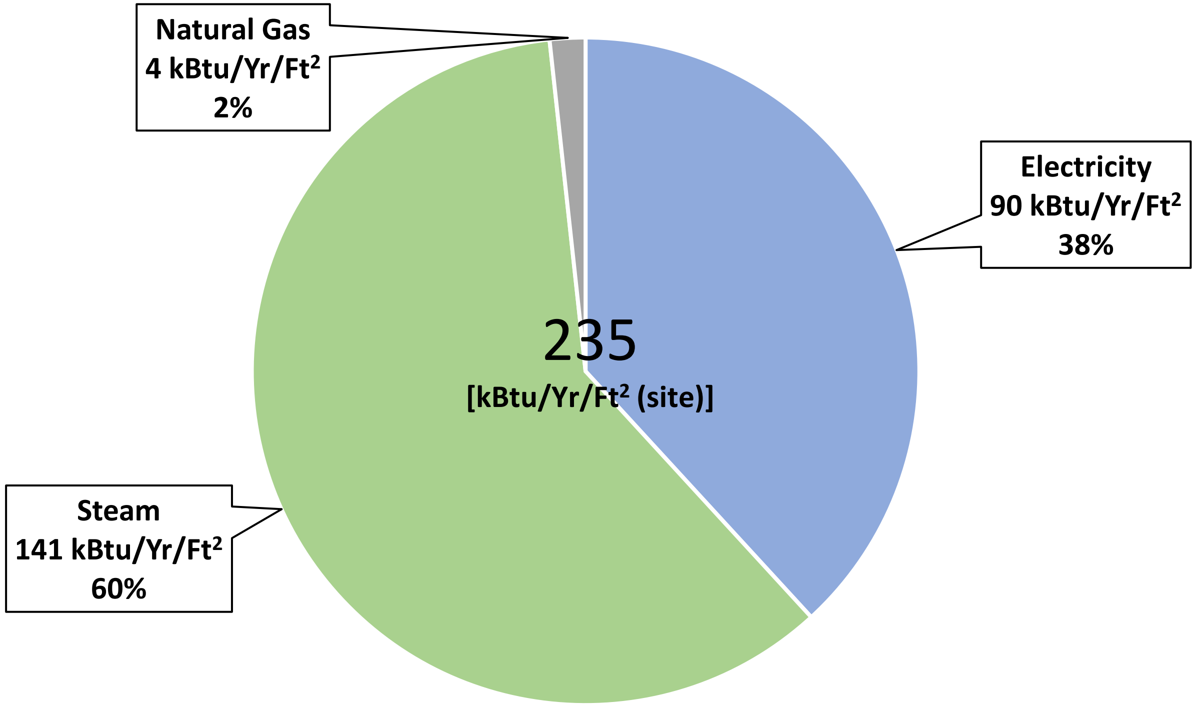
Multi-year program for Local Law compliance and environmental responsibility

- Comprehensive assessment of energy-using systems and RCx of building HVAC systems
- **Lab ventilation risk assessment program**
- Collection of documentation; benchmarking and calculation of LL metrics; evaluation of potential BAS upgrades; development of energy efficiency measures; implementation recommendations and support (NYSERDA FlexTech incentives)
- Ongoing monitoring-based Cx program
- Typical RCx measures + capital upgrades

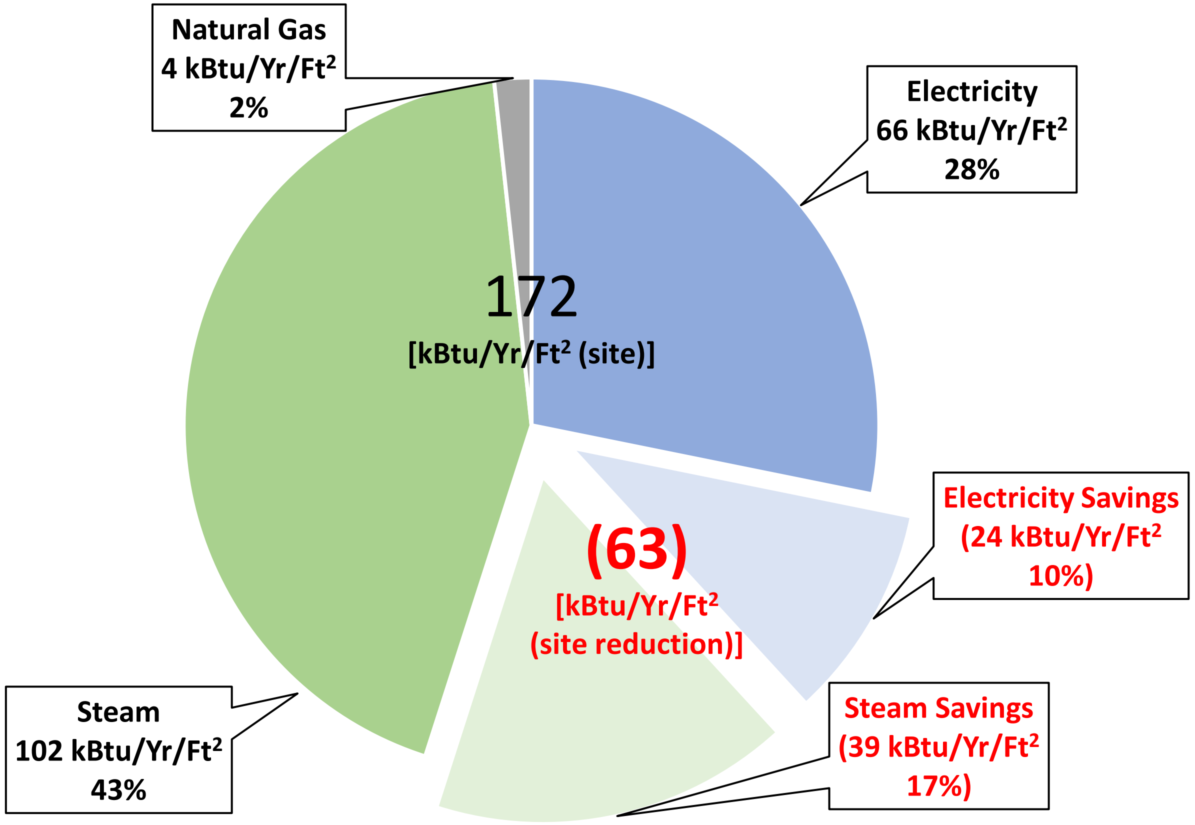
Energy Performance and Projected Financial Implications



Energy Sourcing Comparison: BAU vs. Carbon Reduction Plan

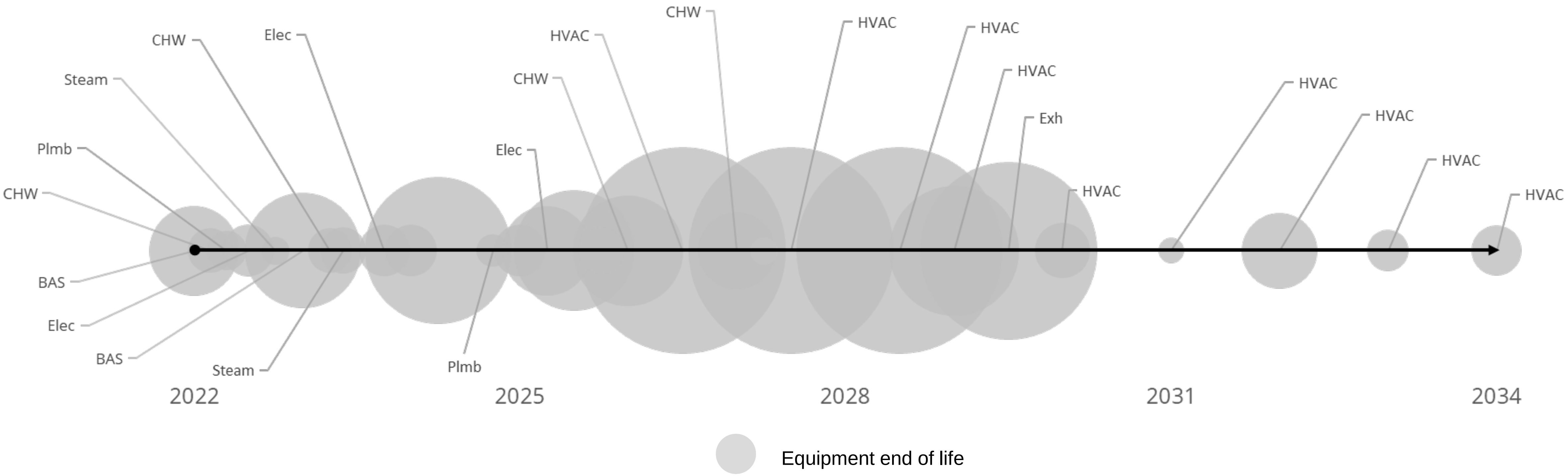


Current BAU Energy Use Profile

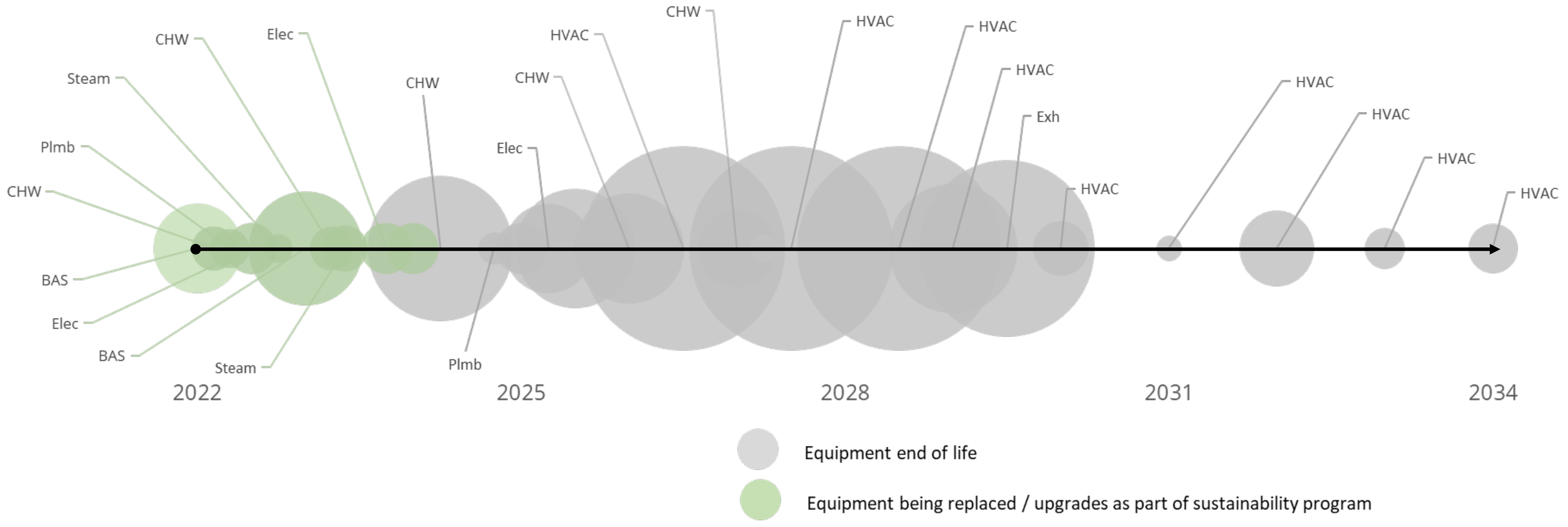


2024 Carbon Reduction Plan Energy Use Profile

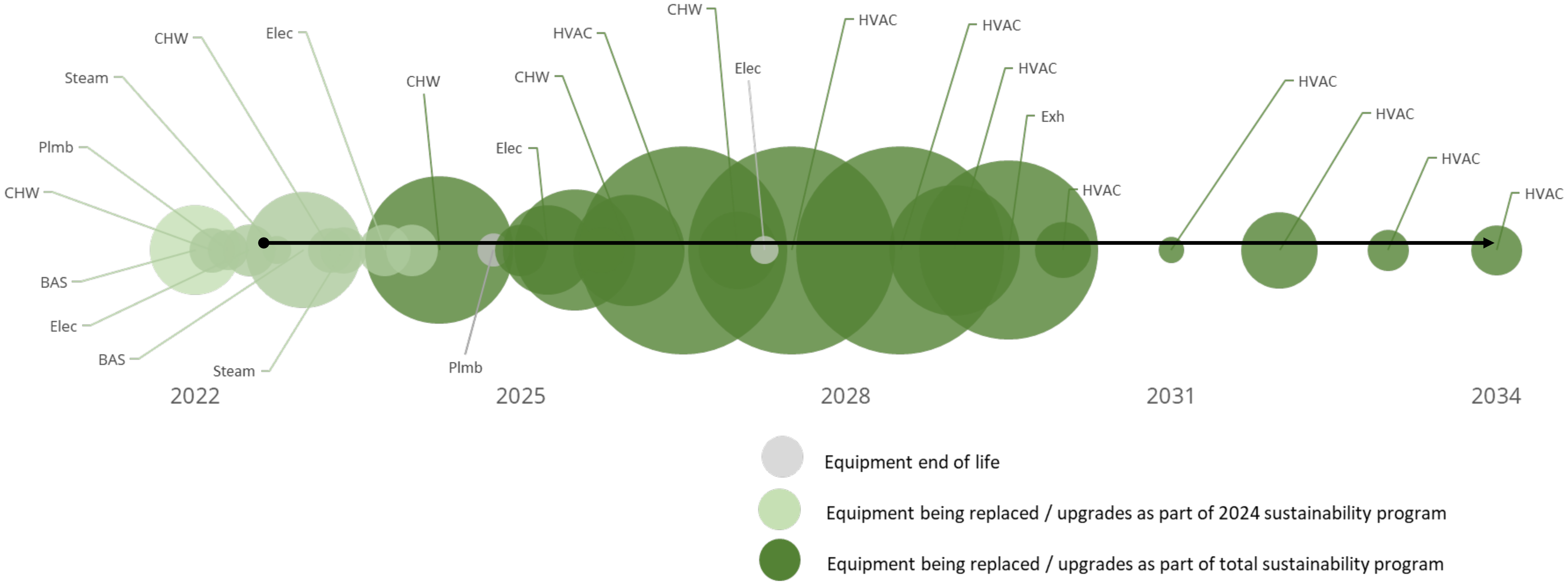
Existing Equipment End-of-life Timeline and Projected Replacement Costs



Existing Equipment End-of-life Timeline and Projected Replacement Costs – PHASE 1



Existing Equipment End-of-life Timeline and Projected Replacement Costs PHASE 1 & 2



Phase 1 Sustainability Measures

- HVAC air delivery and exhaust system enhancements, repairs and upgrades
- New BAS with FDD and new sequences of operations
- Steam system Upgrades: traps, piping, and insulation repairs.

  Heat Pump Heat Recovery System
- Chilled Water Plant Optimization and Metering
- Reheat heating system optimization setpoint optimization
- Domestic and heating hot water upgrades and M&V
- Lighting and controls upgrade to LED
- Electrical metering and M&V
- Building envelope assessment and repairs

Museum Sustainability EUI analysis

- 2018 EUI 271 kBtu/sf/year from 2018 baseline
- Proposed EUI after all retrofits and renovations is 198 kBtu/sf/year with all measures implemented
- **27% reduction in EUI**
- **Achieves laboratory target EUI 219.2**
- Would be a Path 2 early compliance (if the museum was in the laboratory group) and completes all measures by 2024

How Can St. Louis Lab Facilities Best Prepare for Complying with BEPS?

Based on GBA's LL97 Experience, How Can St. Louis Lab Facilities Best Prepare for Complying With BEPS?

- START NOW!! Only quick implementing measures will be feasible in the timeframe still available – think assessment, retro-commissioning, steam, lighting
- Leverage experienced and pre-qualified energy / RCx service providers
- Utilize custom approach in Path 3 or 4 based on science-based targets from an ASHRAE Level 2 or 3 energy audit for St Louis which also has some of the same categorization issues

Based on GBA's LL97 Experience, How Can St. Louis Lab Facilities Best Prepare for Complying With BEPS?

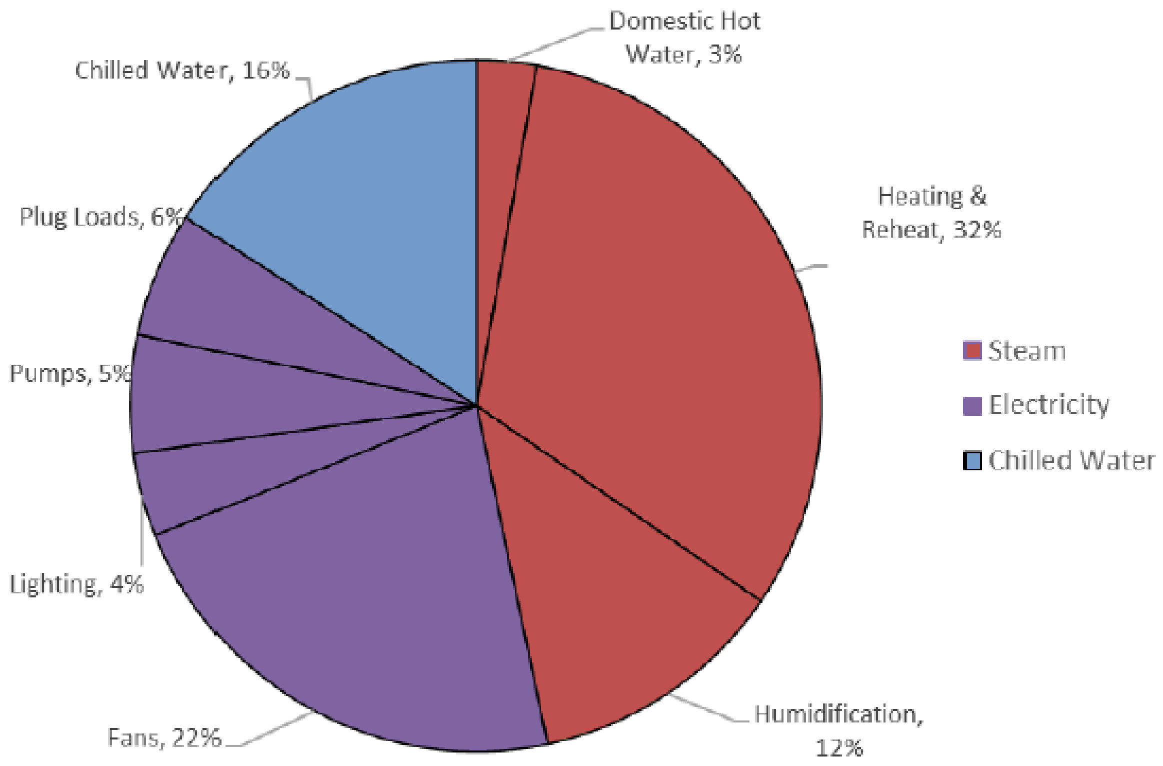
- Implementing all of these efficiency projects will cost a lot of money
  - Investigate alternative financing options for energy efficiency and renewable energy projects
    - PACE, ESCOs, EEaaS, GRFs, PPAs, etc.

Case Study

Laboratory LVRA, DVA, RCx, Capital

Case Study: University Lab

- Five-story, 288,000 sf providing pharmaceutical research and academic spaces
- Ten (10) air-handling units grouped on separate headers for labs, vivarium, and academic areas with exhaust systems for lab and vivarium
- 100% OA with heat recovery for labs and vivarium AHUs/EAHUs
- 203 exhaust control devices, including 85 variable volume fume hoods
- Campus CHW and steam; modern building automation system



Case Study: University Lab Approach

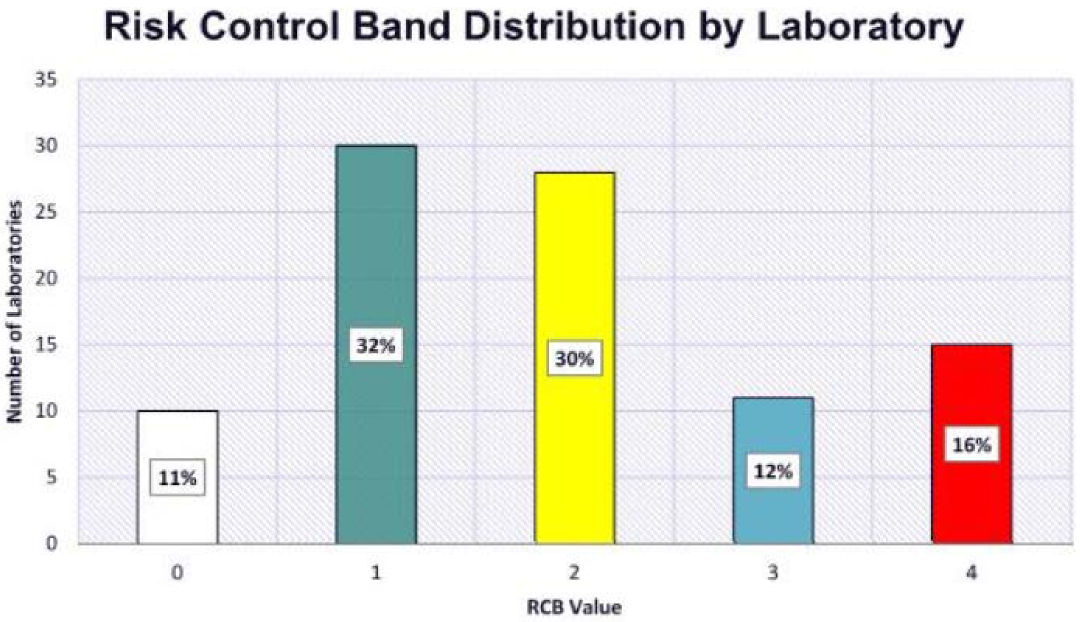
- Energy efficiency and laboratory facility optimization effort
- Laboratory Ventilation Risk Assessment (LVRA)
- Retro-commissioning (RCx)
- Demand Ventilation Assessment (DVA)
- Implementation
- M&V
- *Capital projects not included in this phase*

- Existing building started at 318 kBtu/sf/year
  - o 45% over the St. Louis Laboratory target EUI
  - o Need to calculate this for NYC LL97, can't use the default calculator with district chilled water

ENERGY TYPE	ANNUAL FACILITY USE (FY18)	SAVINGS AS A PERCENT OF FY18 ANNUAL USE (%)	SAVINGS EQUIVALENT IN TONS OF CO2*
Electricity	9,582,179 (kWh)	9%	1,252
Chilled Water	27,751 (MMBtu)	16%	272
Steam Savings	59,054 (MMBtu)	24%	942
Total	119,499 (MMBtu)	18%	2,466

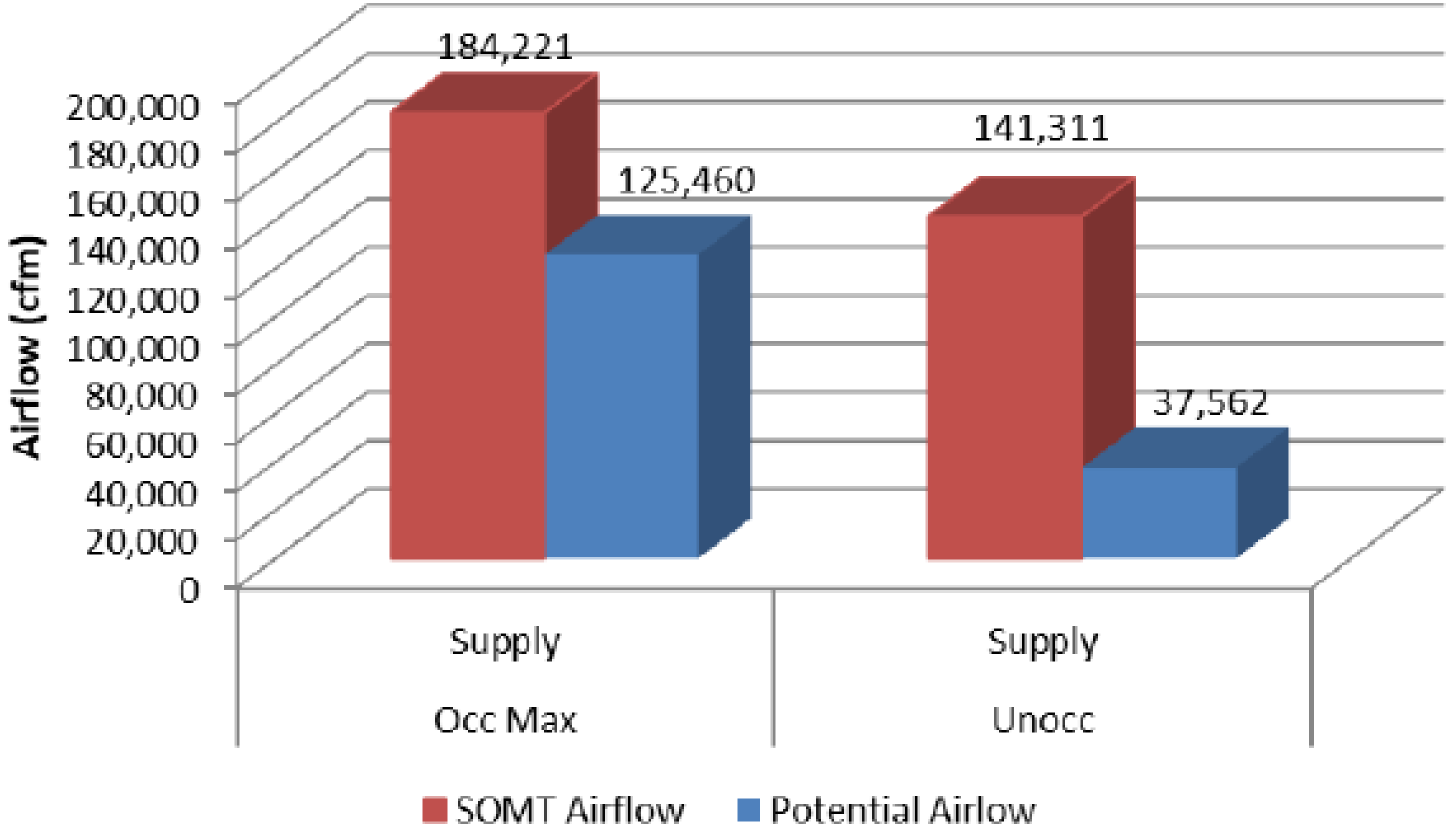
318 kbtu/sf/year => reduced to 260 kbtu/sf/year

Case Study: University Lab LVRA



System Feature	Parameter	Risk Control Band 0	1	2	3	4
Fume Hood	ASHRAE 11 Tracer Gas Control Level	n/a	4 lpm AU < 0.1 ppm	4 lpm AU < 0.1 ppm	4 lpm AU < 0.05 ppm	<8 lpm AU < 0.01 ppm
	Fume Hood Face Velocity (1)	n/a	60 fpm	60 fpm	60 fpm	>80 fpm
	Cross Draft Velocity	n/a	< 30 fpm	< 30 fpm	< 30 fpm	<30 fpm
	Minimum Fume Hood Exhaust Flow w/Sash Closed (2)	Turn off or Hibernate	> 150 ACH_{FH}^2	> 250 ACH_{FH}^2	> 375 ACH_{FH}^2	CAV
	VAV Response Time	n/a	< 5 sec	< 5 sec	< 5 sec	< 5 sec
	VAV Stability (% Variation)	n/a	< 20%	< 20%	< 20%	< 20%
	Monitor	n/a	Yes	Yes	Yes	Yes
Lab Environment	Minimum Effective ACH	n/a	4	6	8	10+
	Recirculation of Lab Air	Yes	Filtered	Internal	Internal	No
	Lab Pressurization	Neutral	< -0.005 iwg	< -0.01 iwg	< -0.05 iwg	≥ -0.05 iwg
	Room Monitor	n/a	n/a	Review	Yes	Yes
	Airlock/Vestibule	n/a	n/a	n/a	n/a	Yes
	Flow Setback (DCV)	Yes	Yes	Yes	Review	No
	Energy Purge Mode	No	No	No	Review	Yes
	Future Capacity for ECD	n/a	4-ft LFH	6-ft LFH	8-ft LFH	6-ft LFH 2x
	Additional Flow Capacity	n/a	480 cfm	780 cfm	1080 cfm	1560 cfm
	Ventilation Effectiveness (3)	<= 2	< =1.5	<= 1	< 1	<< 1
System	Duct Velocity	< 200 fpm	200 fpm	300 fpm	500 fpm	>500 fpm
	VAV Controls Accuracy/Precision	+/- 10%	+/- 10%	+/- 5%	+/- 5%	+/- 5%
	Enthalpy Wheels	Yes	Review	No	No	No
	Stack Discharge	N/A	Review	Review Min. 10 ft, 3000 fpm	Wind Wake Model	Wind Wake Model

Case Study: University Lab DVA



Case Study: University Lab RCx Findings

RCM	DESCRIPTION	ELECTRIC ENERGY SAVINGS (KwH)	ELECTRIC SAVINGS	CHILLED WATER SAVINGS (MMBtu)	CHILLED WATER SAVINGS	STEAM SAVINGS (MMBtu/yr)	STEAM SAVINGS	EQUIVALENT TONS OF CO_2 SAVINGS (TONS)	ANNUAL SAVINGS	COST	SIMPLE PAYBACK (yrs)
1	Classroom AHU Scheduling	277,000	$19,000	900	$14,000	500	$8,000	498.7	$41,000	$,000	0.1
2	Static Pressure Reset/Reduction	207,000	$14,000	0	$0	0	$0	305.4	!14,000	$12,000	0.9
3	Chilled Water Pump Optimization	7,000	$500	0	$0	0	$0	10.3	$500	$3,000	6.0
4	Heating Hot Water Differential Pressure Reset	7,000	$500	0	$0	0	$0	10.3	$500	$4,700	9.4
5	Correct Building Overpressurization	0	$0	0	$0	1,000	$16,000	67.6	$16,000	$31,000	1.9
6	Apothecary Café Setpoint Adjustment	28,000	$2,000	200	$3,200	0	$0	53.8	$5,200	$4,000	0.8
7	Humidity Sensor Calibration	0	$0	0	$0	3,400	$54,400	229.7	$54,400	$8,000	0.1
8	Correct VAV Reheat Valve Leakby	0	$0	200	$3,200	700	$11,200	59.8	$14,400	$25,000	1.7
9	Zone CO2 Sensor Optimization	121,000	$8,500	700	$11,200	4,900	$78,400	553.3	$98,100	$34,000	0.3
10	Preheat Coil Pump Optimization	6,000	$4000	0	$0	0	$0	8.9	$400	$2,500	6.3
11	Heating and Cooling Valve Hunting	0	$0	50	$800	40	$600	5.8	$1,400	$3,200	2.3
12	Lab Rebalancing and Minimum Airflow Reduction	196,000	$14,000	2,300	$37,000	3,400	$54,000	662.6	$105,000	$240,000	2.3
	MBCx 2-Year Contract – 12 Reviews	—	—	—	—	—	—	—	—	$24,960	—
TOTAL	—	849,000	$58,900	4,350	$69,400	13,940	$222,600	2,466.3	$350,900	$397,360	1.1

BEPS Examples

Examples applied to St. Louis BEPS

Sample Laboratories, NYC LL97 vs. St. Louis BEPS

Example university labs with ECMs, LL97 calculation, and St. Louis BEPS in a single table

LAB	START EUI	ENDING EUI	LL97 CALC CARBON EMISSION (KG/1000 – METRIC TON)	LL97 CARBON LIMIT	ENDING % OF LL97	ENDING % OF ST. LOUIS	ST. LOUIS CALCULATION
A	460	394	2,810	2,169	129.6%	179.9%	Path 3
B	372	257	4,958	4,117	120.4%	117.4%	Path 3
C	378	378	4,031	3,488	115.6%	172.7%	Path 3. Path 1
D	208	208	730	940	77.7%	95.0%	EUI Path 1
E	196	196	10,284	18,419	55.8%	89.3%	EUI
F	303	303	9,545	9,972	95.7%	138.1%	Path 3
G	318	265	4,572	6,857	66.7%	120.8%	Path 3

Thank You and Questions

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