AIM for Success with Advanced Exhaust System Controls

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LEARNING OBJECTIVES:

- Get a brief introduction into the I2SL Labs2Zero AIM Report
- Understand how different AIM measure may impact your EUI and Energy Score
- How to take the results of the AIM report and develop a business case for implementing VAV lab exhaust control
- Learn the process involved in designing and implementing VAV lab exhaust control

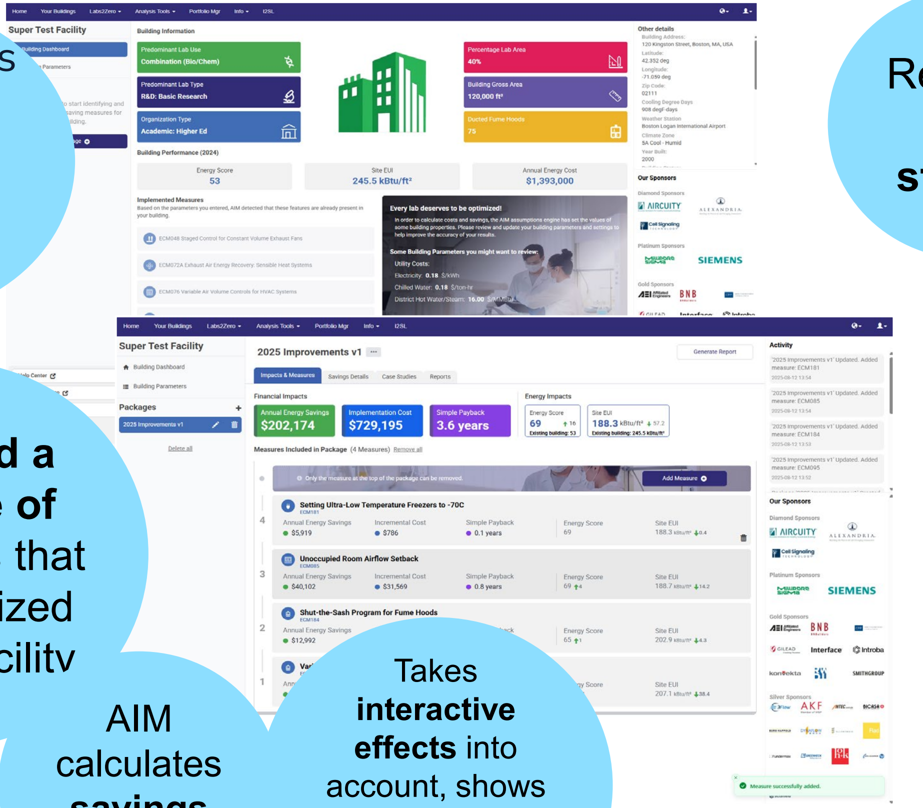
Labs2Zero

- An Energy and Carbon Emission Score Card for Lab Buildings that encompass both operational and embodied emissions, as well as a way to set targets for new lab building scores
- An Actionable Insights and Measures (AIM) Report that suggests ways to improve a lab's Energy and Emissions Scores
- A Design2Zero Tool which suggests ways to achieve energy and emissions goals in new lab construction (*Future*)
- A Certification Program to independently verify lab energy and emissions performance (*Future*)
- Training and Accreditation to support the certification program (*Future*)

AIM Report

AIM is an automated energy audit for lab buildings!

AIM imports your **building data** from lbt.i2sl.org

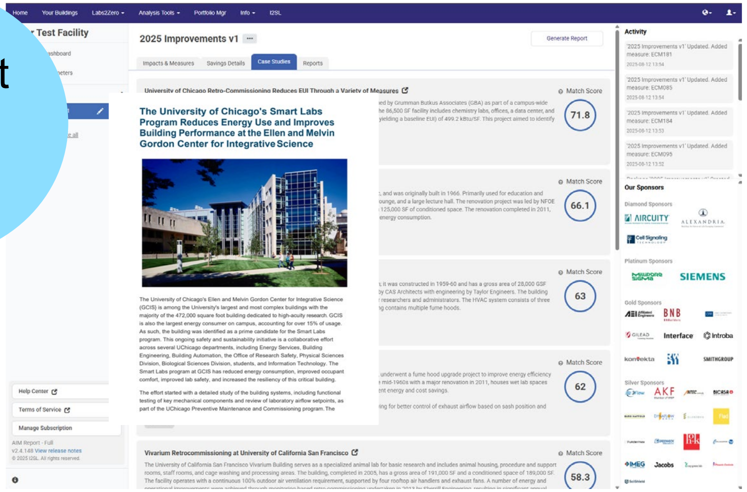


You **build a package of measures** that is customized to your facility

AIM calculates **savings and costs**

Takes **interactive effects** into account, shows **next steps,** stakeholders to involve

Relevant case studies



PDF AIM Report to share

AIMReport™
Actionable Insights and Measures

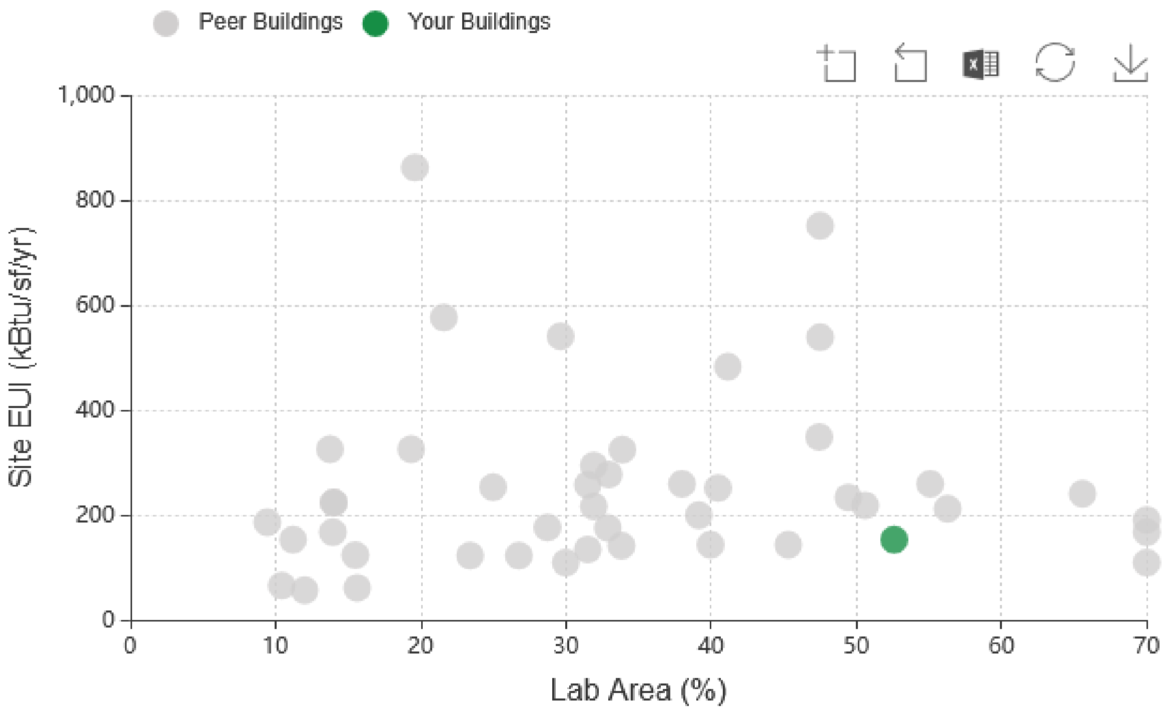
Example – CPP Wind Engineering Laboratory

Labs2Zero Scorecard

— Labs2Zero Scorecard

Labs2Zero Pilot Scores for: 2024

78	50
Energy Score	**Operational Emissions Score (Location-Based)**



AIM Report

Building Information

Predominant Lab Use	Other
Predominant Lab Type	Testing / Quality Control
Organization Type	Commercial: Other
Percentage Lab Area	53%
Building Gross Area	38,000 ft²
Ducted Fume Hoods	20

Building Performance (2024)

Energy Score	Site EUI	Annual Energy Cost
78	153.1 kBtu/ft²	$245,503

Home | Your Buildings | Labs2Zero | Analysis Tools | Portfolio Mgr | Info | I2SL

Add Measure

	Annual Energy Savings	Incremental Cost	Simple Payback	Energy Score	Site EUI
Enhanced Exhaust Fan System Controls ECM045	$19,141	$130,600	6.8 years	82 ↑4	143.5 kBtu/ft² ↓9.5
Exhaust Duct Static Pressure Setpoint Reset ECM204	$8,712	$3,704	0.4 years	80 ↑2	148.7 kBtu/ft² ↓4.3
Supply Duct Static Pressure Setpoint Reset ECM203	$7,682	$3,704	0.5 years	79 ↑1	150.4 kBtu/ft² ↓2.7
Frequent Filter Replacement for Air Handlers ECM059A	$5,489	$3,795	0.7 years	79 ↑1	151.2 kBtu/ft² ↓1.9
Low Pressure-Drop Filters for Air Handlers ECM059B	$5,489	$14,266	2.6 years	79 ↑1	151.2 kBtu/ft² ↓1.9

AIM Report

Enhanced Exhaust Fan System Controls

ECM045

Add Measure to Package

Already in Building

Financial information

Annual Energy Savings $19,141	Package $19,141	Incremental Cost $130,600	Package $130,600
Simple Payback 6.8 years	Package 6.8 years		

Energy Impacts

Energy Score	Site EUI
82 ↑ 4	143.5 kBtu/ft2 ↓ 9.5
Current Package: 78	Current Package: 153.1kBtu/ft²

Description

This measure involves enhancing the building's exhaust fan systems in order to reduce the amount of energy consumed without adversely impacting downwind exposure levels to lab exhaust emissions.

Many lab exhaust systems operate in a constant air volume (CAV) mode to maintain a prescriptive exit velocity. This prescribed exit velocity is either defined using rule of thumb values (typically 3000 fpm / 15.2 m/s) or through dispersion modeling. If dispersion modeling is used, the exit velocity is defined by assuming the worst-case emission scenario and the worst-case wind conditions that result in the highest concentration at a location of concern.

With these CAV systems, if the ventilation exhaust demand within the laboratory is reduced, for example through the use of variable airflow controls, then bypass air, which is outside air bled into the exhaust ductwork just prior to the fans, is used to make up the difference between the total airflow exhausted out of the building and the total airflow (out of the stack) that is needed to maintain the prescribed exit velocity. This can result in an exhaust system that operates under full load conditions continuously and that may be responsible for perhaps 30% of the entire electrical power consumption of the building. Note that some CAV exhaust systems use staged fan controls, where each fan on a given exhaust plenum operates at constant speed but individual fans are de-energized when conditions permit; this control method results in some energy savings versus the fully CAV approach.

With enhanced controls, the exhaust fan systems can be converted to variable air volume (VAV) control, which reduces or even eliminates the need for bypass air. Enhanced controls can potentially save significant energy while also maintaining acceptable exposure levels downwind of the exhaust stack.

AIM Report

CPP Windsor

Generate Report

Impacts & Measures | Savings Details | Case Studies | Reports

Financial Impacts

Annual Energy Savings	Implementation Cost	Simple Payback
$78,857	$190,214	2.4 years

Energy Impacts

Energy Score	Site EUI
95 ↑17	87.8 kBtu/ft² ↓65.3
Existing building: 78	Existing building: 153.1 kBtu/ft²

Measures Included in Package (3 Measures) Remove all

Only the measure at the top of the package can be removed.

Add Measure

#	Measure	Annual Energy Savings	Incremental Cost	Simple Payback	Energy Score	Site EUI
3	**Risk-Based Airflow Optimization** ECM083	$53,131	$57,800	1.1 years	95 ↑11	87.8 kBtu/ft² ↓52.5
2	**Exhaust Duct Static Pressure Setpoint Reset** ECM204	$6,585	$1,814	0.3 years	84 ↑2	140.3 kBtu/ft² ↓3.3
1	**Enhanced Exhaust Fan System Controls** ECM045	$19,141	$130,600	6.8 years	82 ↑4	143.5 kBtu/ft² ↓9.5

AIM Report

CPP Windsor

CPP Windsor

7365 Greendale Road, Windsor, CO, USA

Genentech Labs Save Energy, Operating Costs in Exhaust Systems by Converting to VAV

Match Score

60.8

Genentech implemented a site laboratory energy optimization program implemented in 2010 at their South San Francisco campus. The project aimed to reduce energy consumption in 24 laboratory exhaust systems across 16 research lab buildings on the south, central, and north campuses by converting constant volume manifolded laboratory exhaust fans to VAV control. CPP Wind Engineering Consultants conducted extensive plume dispersion modeling for each exhaust system in order to implement a wind-responsive laboratory exhaust control system.

CPP designed and constructed three separate 1:240 scale models of the campus and placed them in their Atmospheric Boundary Layer Wind Tunnels. Tracer gases were released from each exhaust stack, and downwind concentration measurements were obtained at various critical locations under a full range of wind directions and simulated wind speeds. Based on the modeling results, a wind-responsive control system was implemented, where an anemometer was installed on each of the three campuses. The building automation system (BAS) read average wind speeds and directions, and a look-up table defined the minimum allowable volume flow rate for the current wind conditions. A new sequence of operation was developed to control fan speeds to meet duct static setpoints, ensuring fans operated at or above the minimum allowable flow rate based on wind conditions.

After implementing the wind-responsive systems, one month of trend data was collected to verify system performance. Energy consumption data were trended and compared to pre-implementation measurements. Results indicated over $1.2 million per year in energy savings across the Genentech campus. Total energy savings amounted to 9,428,210 kWh/year, reducing annual energy consumption from 17,586,252 kWh/year to 8,158,042 kWh/year. The total annual cost savings were over $1.2 million, with the annual cost decreasing from $2.3 million to $1.1 million. The payback period, after rebates, was less than one year. Detailed energy consumption and cost savings for individual buildings and exhaust systems show the specific reductions achieved at each location.

This project emphasizes the effectiveness of wind-responsive control systems for laboratory exhaust, highlighting significant energy and cost savings. A key lesson learned is that detailed plume dispersion modeling is crucial for determining minimum flow rates and ensuring compliance with air quality standards. The successful implementation was verified with extensive data collection and monitoring. The use of scale models in wind tunnels allowed for accurate prediction of exhaust plume behavior under various wind conditions, which was important for designing an effective wind-responsive control strategy.

List of Measures Used in this Case Study:
1. Enhanced Exhaust Fan System Controls (ECM045)

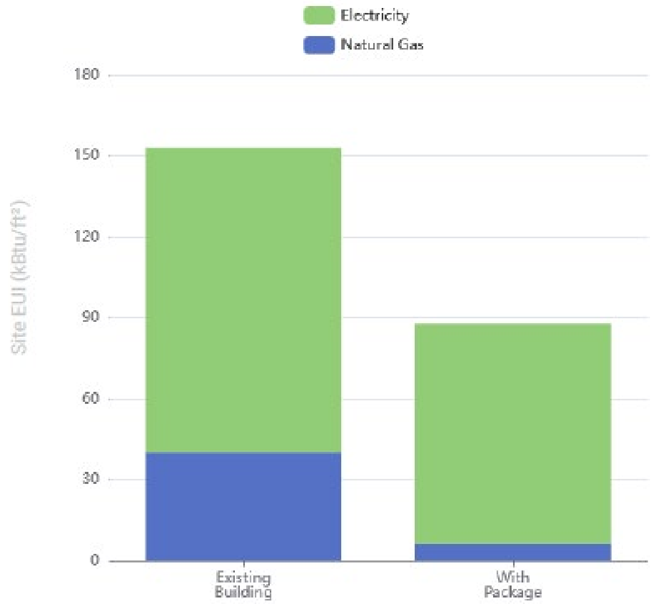
Executive Summary

Laboratory facilities often present significant opportunities for energy savings and emissions reductions. This report reveals the potential energy cost savings and implementation costs of a package of energy-saving measures applicable to CPP Windsor

Annual Energy Cost Savings	Package Implementation Cost	Simple Payback
$78,857	**$190,214**	**2.4 years**

Building Performance (2024 data)

	Existing Building		Building With Package
Annual Energy Cost	$245,503	→	$166,645
Labs2Zero Energy Score	78	→	95
Site EUI	153.1 kBtu/ft²	→	87.8 kBtu/ft²



Next Steps – Site Specific Feasibility Assessment

Defining Opportunities – Advanced Exhaust System Controls

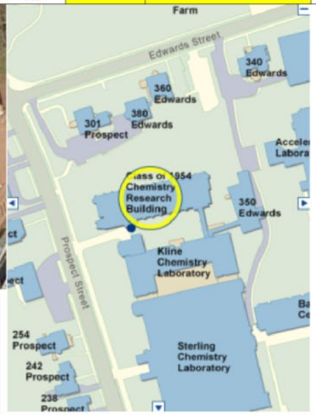
Gather Exhaust System Information

- Fan make
- Fan model
- RPM
- Volume flow rate
- VFDs installed
- Bypass dampers

Chemistry Research Building

Total Lab Exhaust Flow (cfm): 126,000
Lab Equipped with Building Automation System?____________
Hourly Load Profiles Available?____________
Drawings indicating how the fans are manifolded available? Yes

Fan Name	Exhaust Volume Flow (cfm)[1]	Exhaust Velocity (fpm)[1]	Fan Make/ Model	Fan Curve Available?	Static Pressure (In WG)	By-pass on Manifold ?	By-pass cfm or louver position	Sequence of Operation (i.e., CV w/ N+1 Redundancy, Staged CV, or VAV)	VFDs?	Stack Height Above Local Roof (ft)
EAHU-1a,b	31,500	2,766			3 to 7.5	Yes			Yes	7.4
EAHU-2a,b	31,500	2,766			3 to 7.5	Yes			Yes	7.4



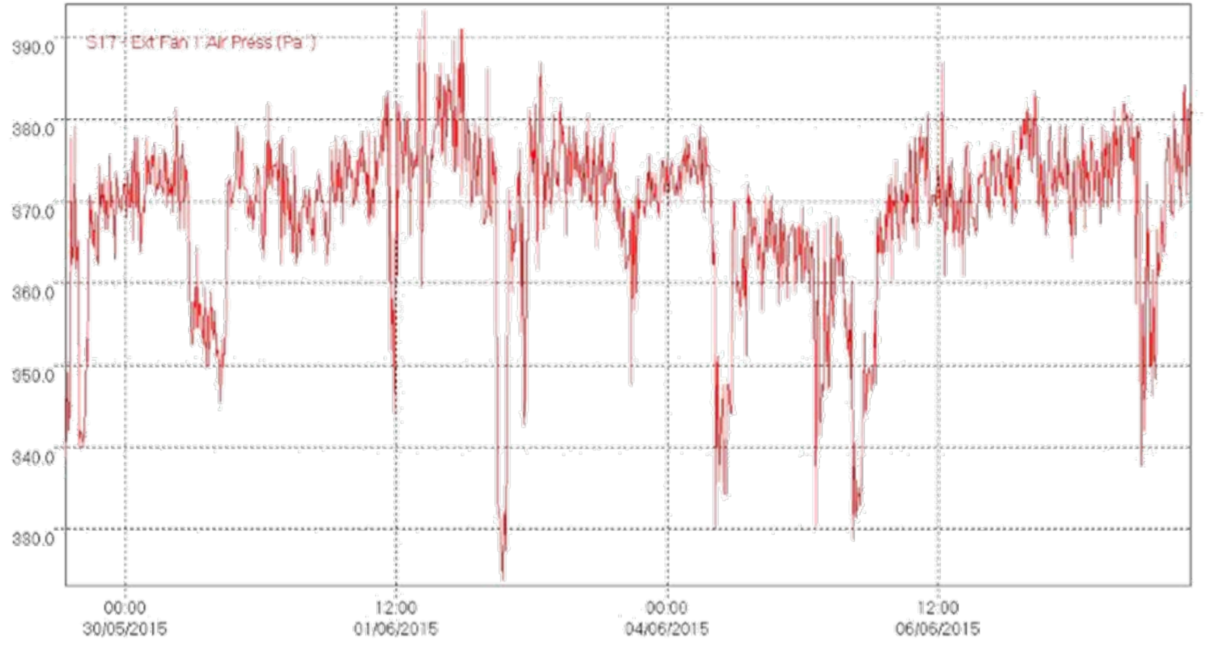
[1] Per "as-built" documents

Next Steps – Site Specific Feasibility Assessment

Defining Opportunities – Advanced Exhaust System Controls

Collect Trend Data

- Fan status
- Fan speed (with VFD)
- Duct static pressure
- Bypass damper position and/or AHU cfm



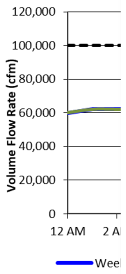
Next Steps – Site Specific Feasibility Assessment

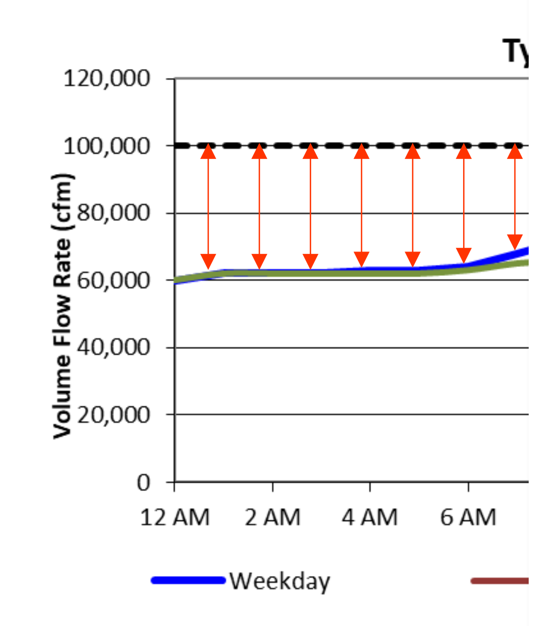
Defining Opportunities – Advanced Exhaust System Controls

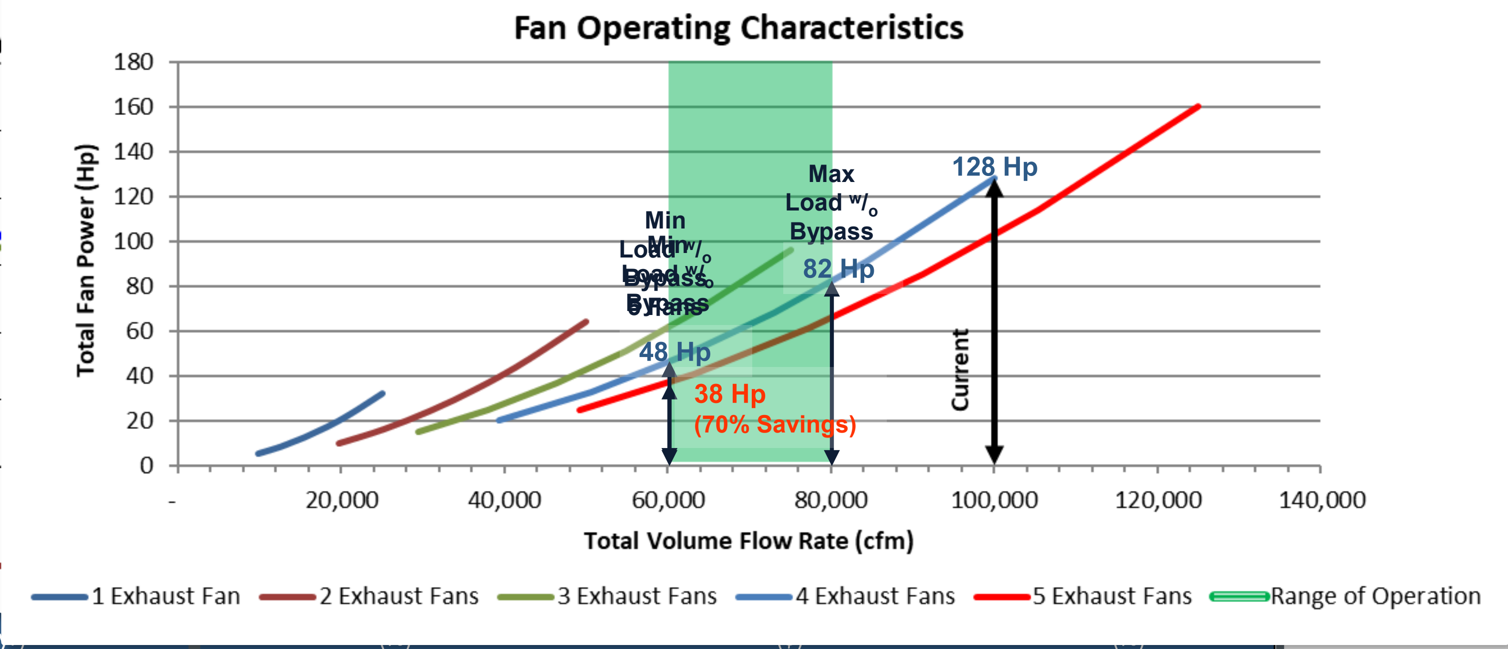
Baseline

Mode of Operation: Constant Volume 4 of 5 Fans Operating at Full Load

Fan	Make	Model	Hp	Volume Flow Rate (cfm)	Annual Energy Consumption (kW-hr/year)	($)
EF-1	ACME	48-CEN	32.0	25,000	209,119	31,368
EF-2	ACME	48-CEN	32.0	25,000	209,119	31,368
EF-3	ACME	48-CEN	32.0	25,000	209,119	31,368
EF-4	ACME	48-CEN	32.0	25,000	209,119	31,368
EF-5	ACME	48-CEN	32.0	Stand-By		







Optimized

Mode of Operation: Variable Air Vol

Optimal # of F
5

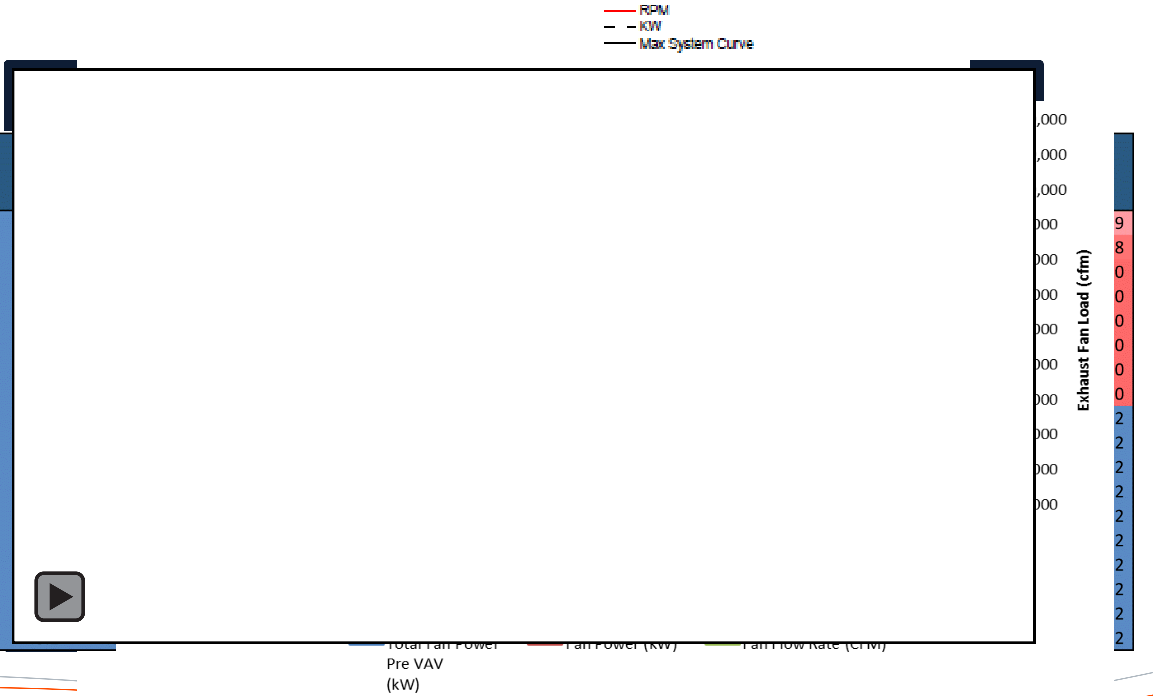
ENERGY REDUCTION SUMM

Annual kW-hr/year	($)	(y			
509,497	76,424	1.09	82.1%	$484,189	1162%

Next Steps – Fan Energy Optimization Assessment

- ✓ Conduct a Dispersion Modeling Study to Define Minimum Acceptable Volume Flow Rates/Exit Velocities
- ✓ Perform Pre-Functional Testing to Identify Exactly How the Systems are Currently Operating and Define any Critical Operational Deficiencies
- ✓ Update the Sequence of Operation for VAV Control
- ✓ Implement the Updated Control Code
- ✓ Commission VAV Control System
- ✓ SAVE ENERGY – REDUCE CARBON EMIS
  - Reduce External Noise Generation
  - Extend the Life of the Equipment
  - Maintain Better Static Pressure Cont

Wind Direction Min	Max
350	10
10	30
30	50
50	70
70	90
90	110
110	130
130	150
150	170
170	190
190	210
210	230
230	250
250	270
270	290
290	310
310	330
330	350



SUMMARY:

- The I2SL Labs2Zero AIM Report is a great tool to identify possible energy savings/carbon reduction measures for your laboratory facility
- Energy Savings Predictions are fairly generic and your results may vary
- If a measure, such as the Advanced Exhaust System Control appears viable, then a site specific feasibility assessment should be conducted to build a business case.
- If the business case looks good. Then carry out a fan energy optimization assessment.

QUESTIONS?

For More Information

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