Deep Energy Cuts In Lab Buildings

Engineering & Science Building
Binghamton University

Hudson Hall
Plattsburgh University

Presenters:

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  Aircuity Channel & Implementation Partner

NYS Sustainability Conference
SUNY New Paltz
Energy Workshop Session 4
November 3, 2016

Goal of Workshop:

To help bridge the gap between current laboratory practices, updated guidelines, and solutions for more efficient operation.

Workshop Overview

Deep Energy Cuts In Lab Buildings

Agenda

I. Why is this important
II. Lab energy consumption
III. New guidelines & standards
IV. Demand Based Control – new air flow paradigm
V. Plattsburgh case study
VI. Binghamton case study
VII. Summary

Questions

Trivia Questions – Prizes!

WHY IS THIS IMPORTANT?

- **Labs are nearly 4X more energy intensive vs. a commercial building**
- **Labs account for up to 70% of campus energy footprint***

***Better Buildings Smart Labs Accelerator- US DOE**

WHY IS THIS IMPORTANT?

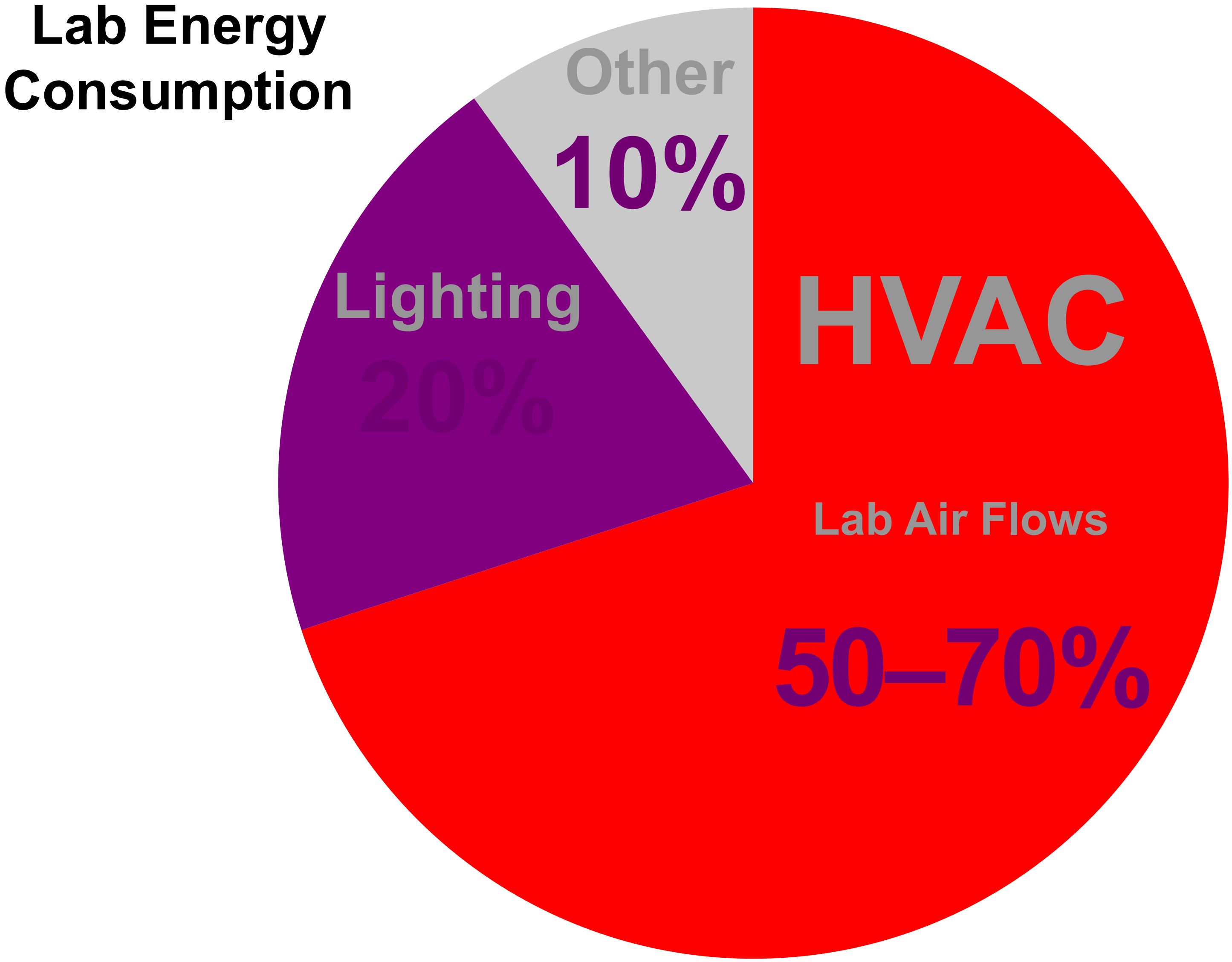
Drivers

- The planet – moving the needle on carbon reductions
- Executive Order 88 – NYS owned bldgs.
- Reforming the Energy Vision (REV)
- ACUPCC (college presidents' climate commitment)
- Financial – Excellent ROI. PB helps fund other ECMs.

Trivia Question #1:

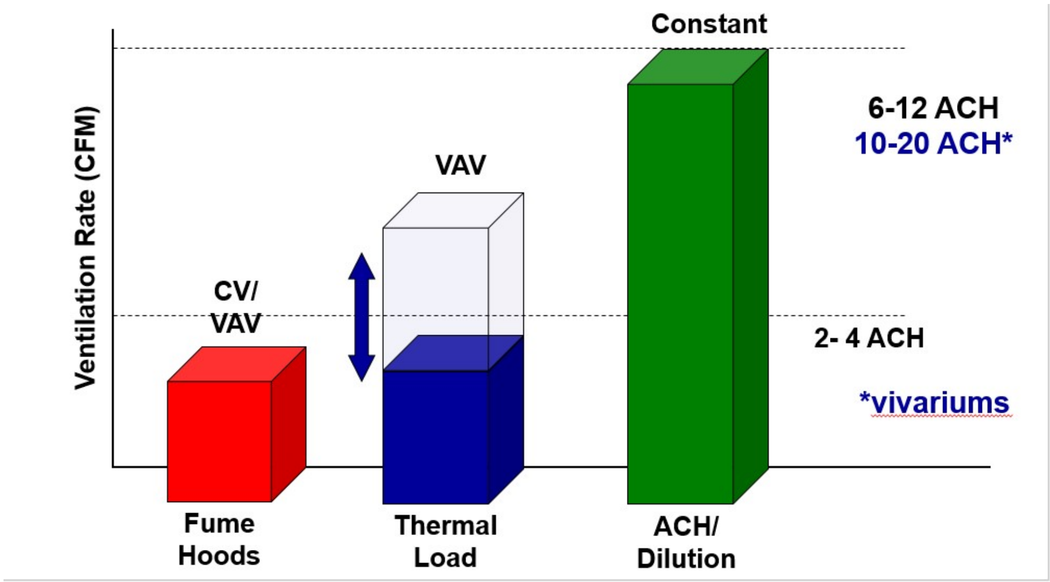
What is the single biggest factor effecting lab energy use?

Lab Energy Consumption

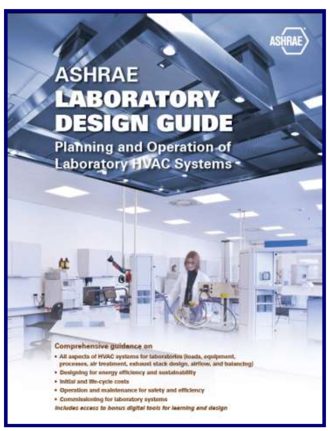


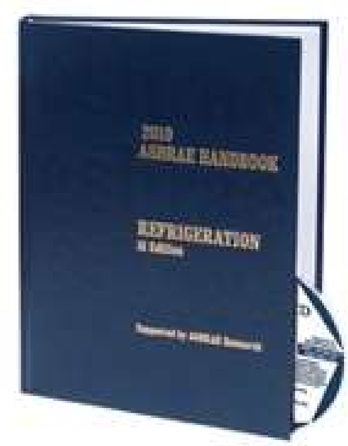
Can the Air Flow Rate (ACH) Be Reduced?

- **Of the factors effecting air flow- dilution air (ACH) is the greatest, and presents the biggest opportunity to conserve or lower…**
- **…But only if the lab air quality can be monitored to assure the air is 'clean'**



How are changes in codes, guidelines & standards effecting lab operations?





Trivia Question #2:

Who is the actor in this laboratory scene, playing what character, and from what movie?

Trivia Question #2:

Who is the actor in this laboratory scene, playing what character, and from what movie?

Just before Dr. Frederick Frankenstein (Gene Wilder) throws the switch, Transylvania Circa 1930's (note the good PPE)

ASHRAE LAB DESIGN GUIDE - 2015

Comprehensive guidance on

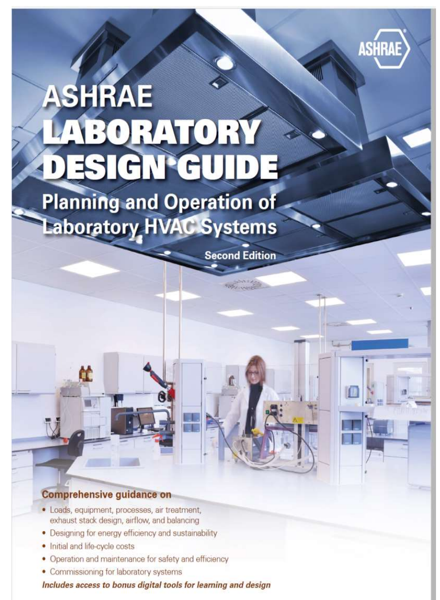
- Loads, equipment, processes, air treatment, exhaust stack design, airflow, and balancing
- * Designing for energy efficiency and sustainability
- Initial and life-cycle costs
- Operation and maintenance for safety and efficiency
- Commissioning for laboratory systems

Includes access to bonus digital tools for learning and design

*

- **Minimum ventilation rates (ACH)**
- **Occupied / unoccupied ACH**
- **Active Sensing aka Demand-Based Control (first appeared in 2011)**

www.greenbldgpartners.com/resources/



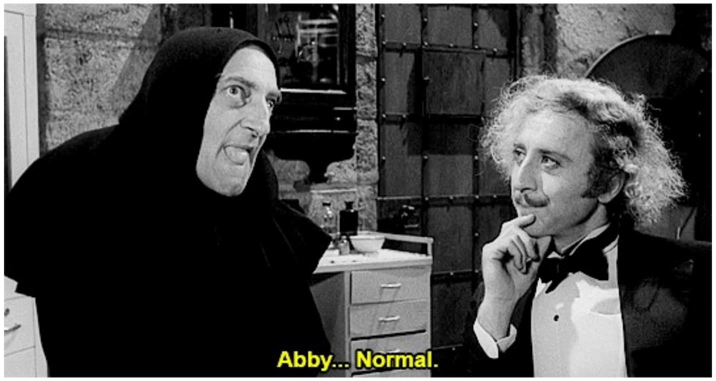
Industry Recommendations on ACH Rates

ASHRAE Lab Design Guide 2015:

Purpose of minimum ventilation rates (dilution air):

"Minimum ventilation rates should be established that provide a safe and healthy environment under *normal and expected operating conditions.*"

***"*The dilution ventilation provided by this airflow is no substitute for the containment performance of a laboratory fume hood or other primary containment device regardless of the room ventilation rate."**



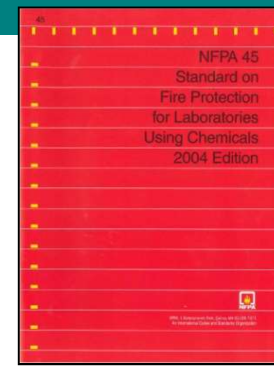
The "human factor"

Industry Recommendations on ACH Rates & DBC

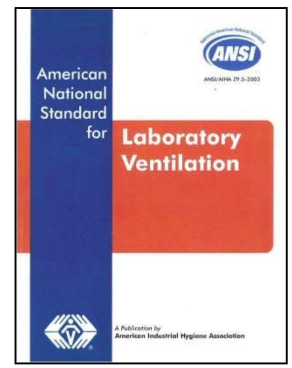
- **2015 ASHRAE Handbook, Lab chapter 16 excerpt:**
  - ✓ Fixed minimum airflow rates of 4 to 12 air changes per hour (ach) when the space is occupied have been used in the past.
  - ✓ Recent university research has shown a significant increase in dilution and clearing performance by increasing the air change rate from 6 to 8 ach with diminishing returns above 12 ach.
  - ✓ Similarly, CFD research found that increasing the lab's dilution ventilation rate from 4 to 8 ach reduced the background contaminant level by greater than a factor of 10.
  - ✓ This indicates that minimum ventilation rates at the lower end of the 4 to 12 ach range may not be appropriate for all laboratories.
  - ✓ Minimum ventilation rates should be established on a room-by-room basis considering the hazard level of materials expected to be used in the room and the operation and procedures to be performed.
  - ✓ As the operation, materials, and hazard level of a room change, evaluate increasing or decreasing the minimum ventilation rate.

Yale & RWDI research shows need for ACH rates > 6 ACH

Industry Recommendations on ACH Rates – Historical Persecptive



- Most fixed ACH values are being dropped:
  - ✓ NFPA 2011
  - ✓ ANSI Z9.5



- Occ/Unocc Control scope is being limited
  - ✓ 2011 ASHRAE Handbook
  - ✓ 2015 ASHRAE Laboratory Design Guide

- No codes other than ASHRAE 62.1

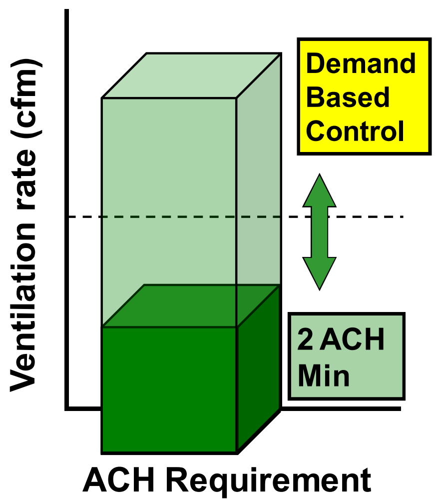
(~1.2 ACH fresh air or .18 cfm/sq. ft. area ventilation requirement)

What's the right answer?

Active Sensing (Demand- Based Control)

- **2015 ASHRAE Handbook, Lab chapter 16 excerpt:**
  - ✓ "Active sensing of air quality in individual laboratories is an alternative approach for dealing with the variability of appropriate ventilation rates, particularly when energy efficiency is important or when less may be known about the hazard level.
  - ✓ With this approach, the minimum airflow rate is varied based on sensing the laboratory's actual air quality level or 'air cleanliness'."

Active air quality sensing is a recommended approach for handling the variability of lab chemical use



ASHRAE Handbook Indicates When 2 ACH Can Be Used

- **New 2015 ASHRAE Handbook, Lab chapter 16:**
  - ✓ **Active Sensing – aka Demand-Based Control is recommended:**
    - – *"Reducing ventilation requirements in laboratories and vivariums based on real time sensing of contaminants in the room environment offers opportunities for energy conservation."*
    - – *"This approach can potentially reduce lab air change rates down safely to as low as 2 air changes per hour when the lab air is 'clean'..."*

Potential for significant energy saving to reduce ACH rates down to 2 ACH but only when a system is used to sense contaminants

Guidelines & Standards

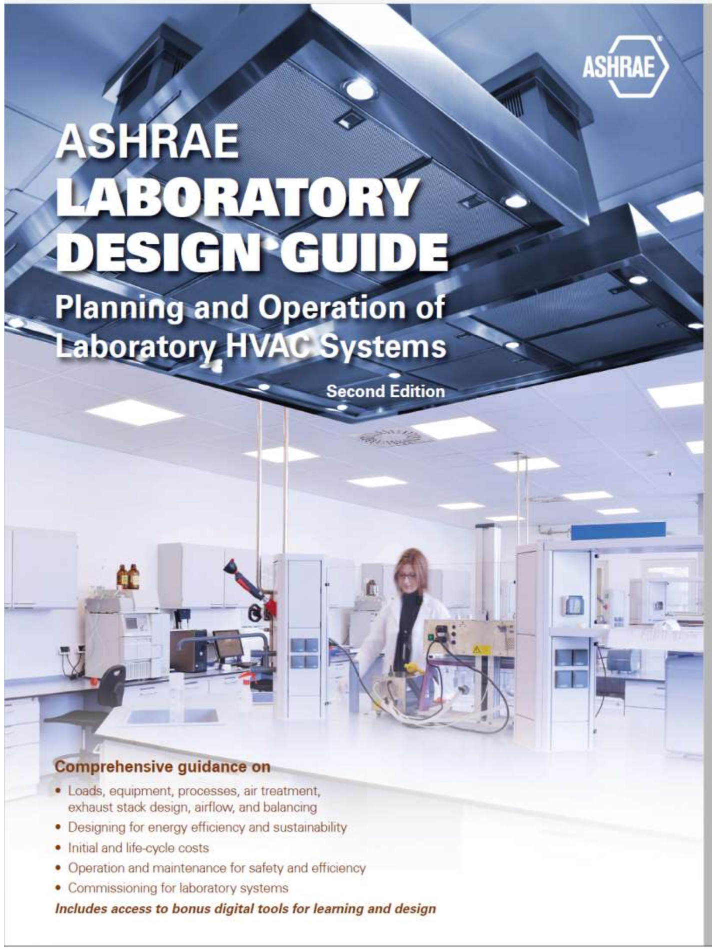
SUNY State University Construction Fund

SUCF
Laboratory Design
Program Directives
15H-8
Issue Date: October 2015

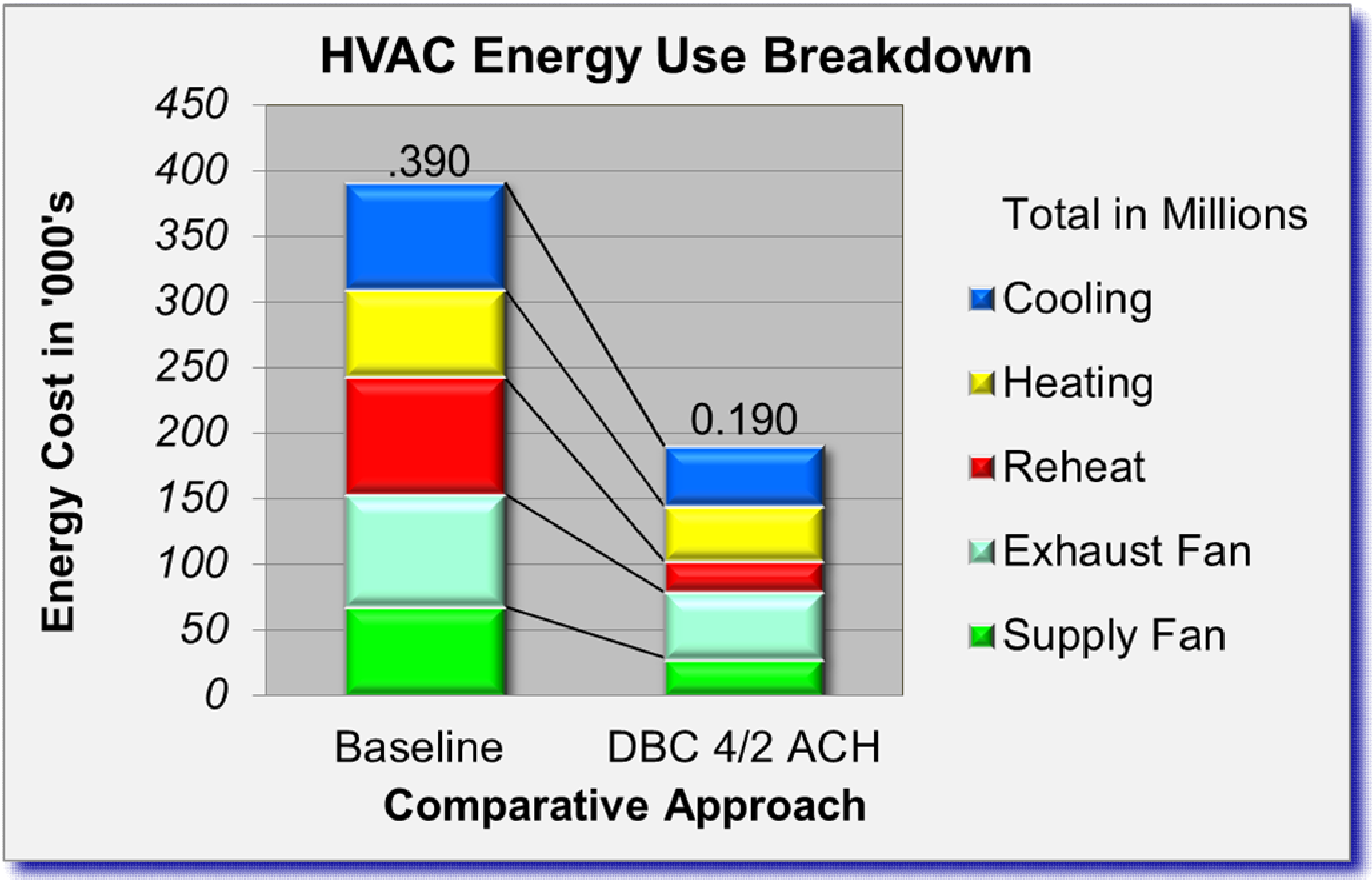
"Active air sampling for contaminants and alternate air change rates is an acceptable strategy but must be discussed and approved by the Fund."

ASHRAE LAB DESIGN GUIDE - 2015

- Demand Based Control
  - ✓ Lab air clean 98% of the time (3.5 hrs/ wk/ rm)
  - ✓ Single largest ECM
  - ✓ Typical lab – from 6 ACH without active sensing to 4/2 ACH = 51% savings.



DBC Energy Savings of 4 Day/2 Night ACH vs. 6 ACH

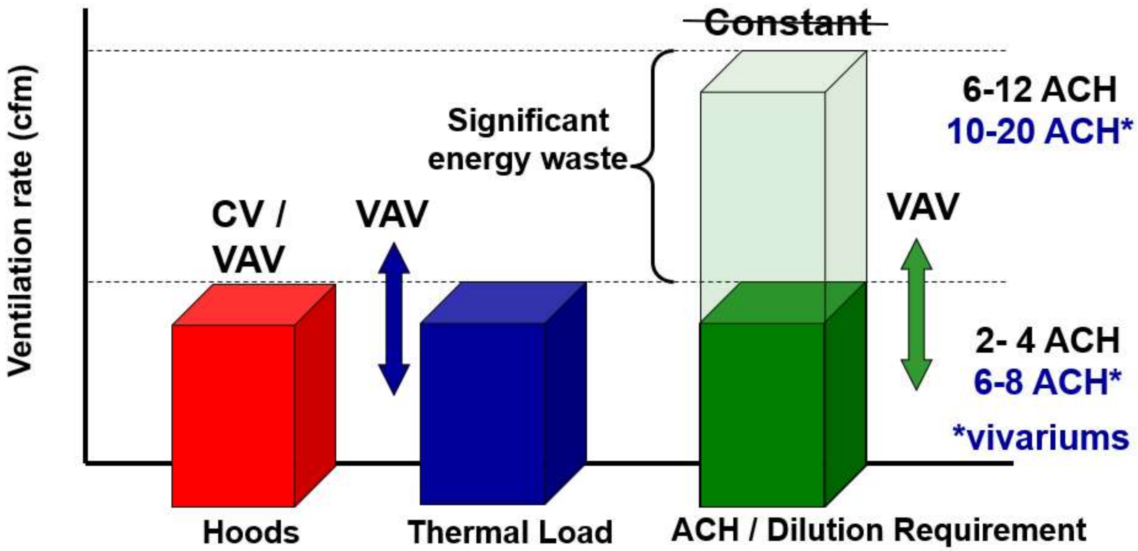


Demand Based Control reduces lab HVAC energy by 51% vs. 6 ACH. Typical payback is 2 to 3.5 years.

Reducing/Varying the Air Flow Rate (ACH)

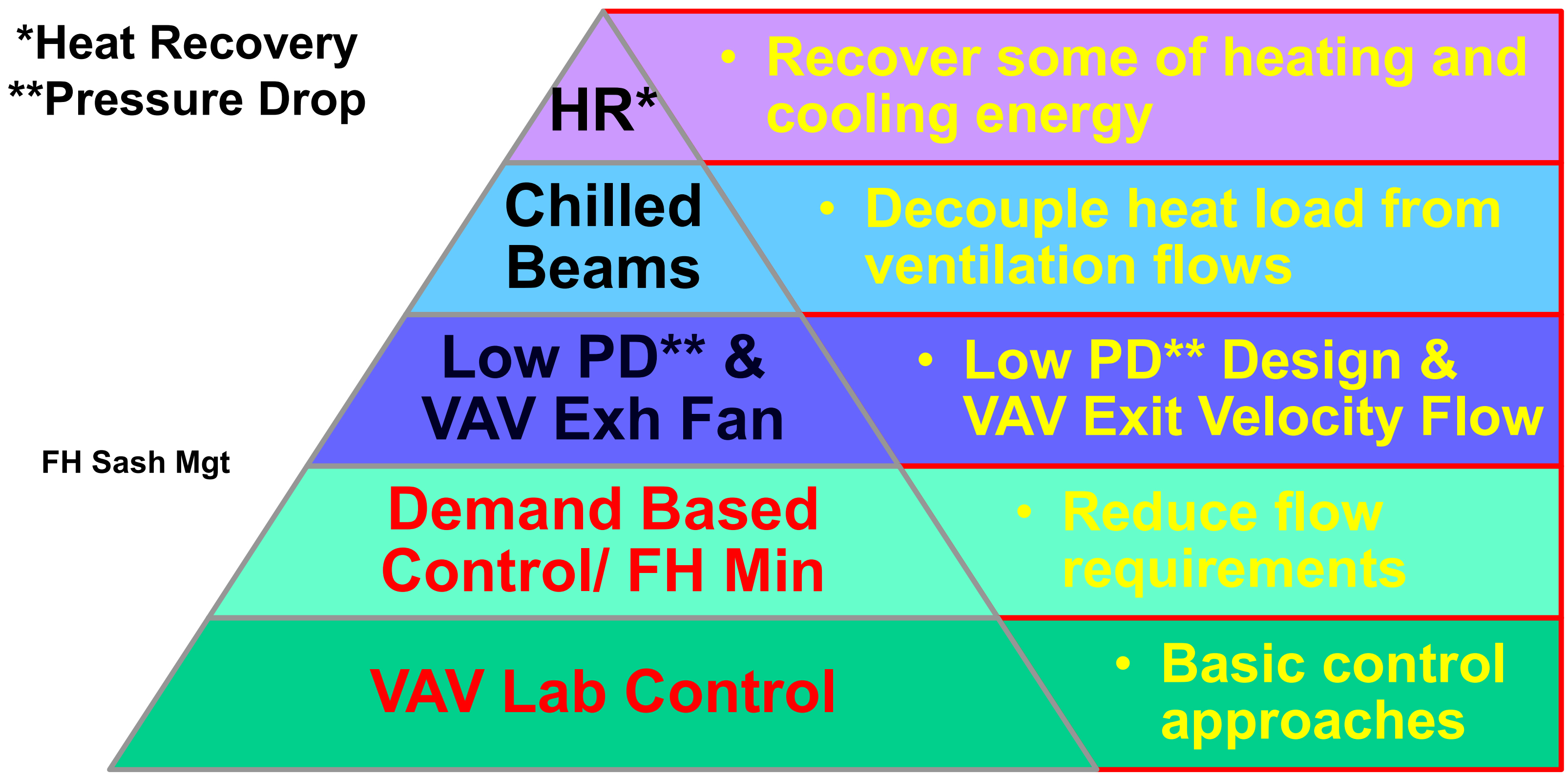
When "Active Sensing" or monitoring determines the air is 'clean' the dilution air can be reduced so it meets the highest demand of:

- ✓ **The fume hood(s)**
- ✓ **The thermal load, or**
- ✓ **The contaminants (dilution air)**



Holistic Strategies for Reducing Air Flows

- Demand Based Control is one of the technical strategies for reducing energy
- Must work with VAV lab controls (some labs are CV)
- Other strategies would follow
- Combining strategies systematically is best approach

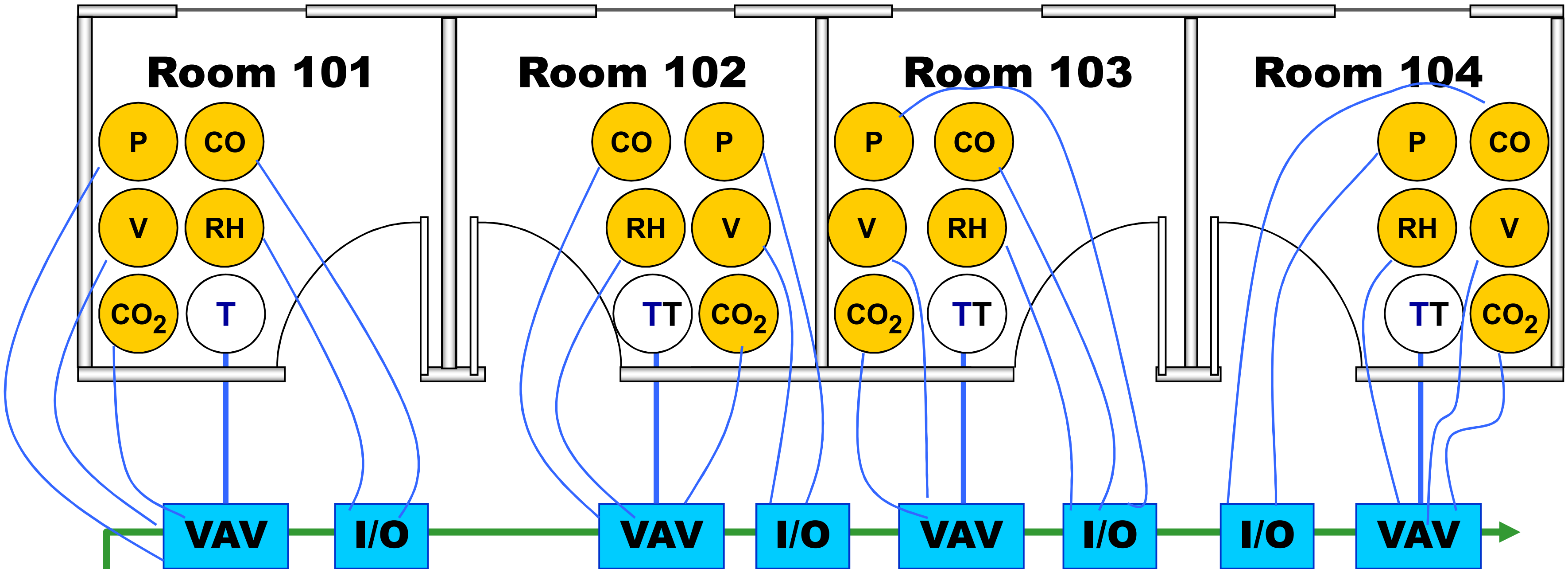


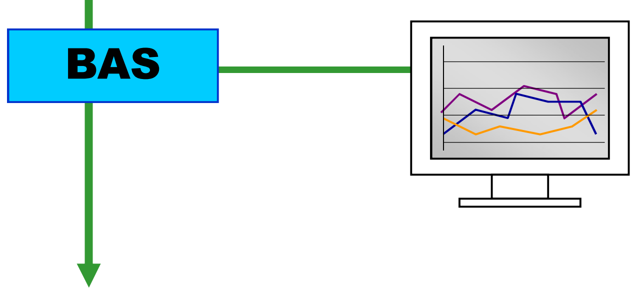
Applying Demand Based Control – Sensed Parameters

- **Air Cleanliness**
  - **Total Volatile Organic Compounds (TVOCs)**
    - *Photoionization Detector (PID) – broad range of organic as well as some inorganic compounds*
    - *Metal Oxide = other compounds of interest*
    - *Amonia – for animal facilities*
  - **Particles – laser based particle counter**
  - **CO2**

THE IMPACT OF GREEN BUILDINGS ON
COGNITIVE FUNCTION
STUDY 2: BUILDINGOMICS

DBC with conventional sensors

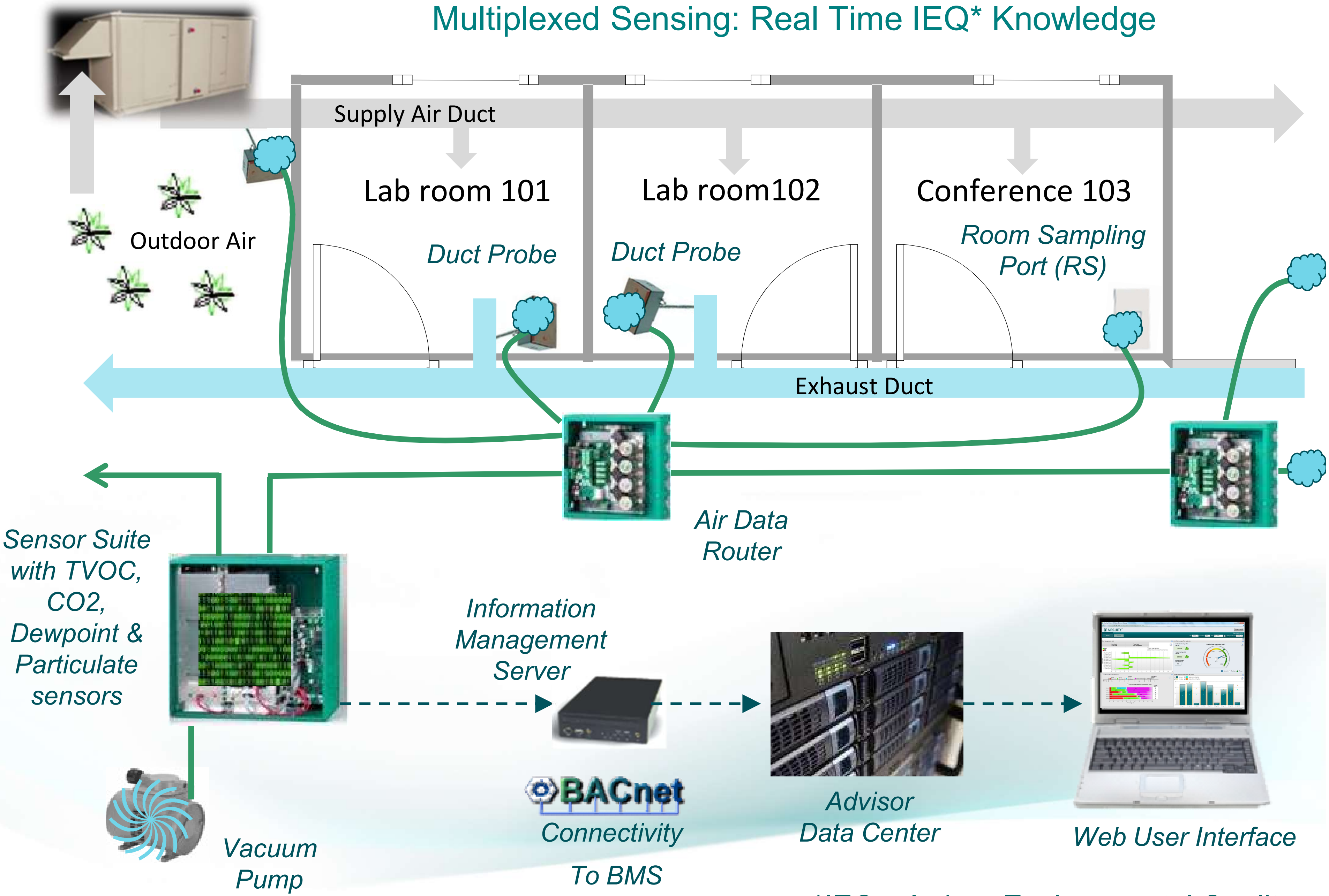




- **Concerns:**
  - ✓ **Sensor quality**
  - ✓ **Sensor quantity**
  - ✓ **Extra hard-wired points**
  - ✓ **Sensor maintenance & calibration**
  - ✓ **Differential errors**

First Cost (Sensor quality, Sensor quantity, Extra hard-wired points)

Multiplexed Sensing: Real Time IEQ* Knowledge



*IEQ = Indoor Environmental Quality

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Trivia Questions – Prizes!

AIRCUITY®

Guidelines & Standards

Trivia Question #3:

In addition to ASHRAE name another authority that recommends Demand-Based Control or "active sensing".

SUNY Experience

-SUNY Oneonta*
- **-Physical Science Bldg**

-SUNY Stony Brook*
- **-AERTC Lab**
- **-CMM**
- **-Bio Engineering**

-SUNY Oswego
- **-Park Hall**

- SUNY Plattsburgh
- **-Hudson Hall**

- SUNY Binghamton
- **- Engineering & Science**
- **- Center of Excellence**
- **- Energy R&D***

***in process of implementation**

Plattsburgh
STATE UNIVERSITY OF NEW YORK

Hudson Hall

- **Brief overview**
  - Chemistry & Physics Lab
  - Expansion in completed in 2013 (27k SF, LEED)
  - VAV / high efficiency FH
  - 7 ACH (no unocc set back)
  - Teaching tool for green practices
  - With DBC lowered to 3 ACH
  - 54% reduction
  - 2016 projected annual svgs ~$42K

Saving 223 metric tons of CO_2 emissions is equivalent to:

- ✓ 27,199 gallons of gasoline burned (43 average cars).
- ✓ 61 metric tons of carbon.
- ✓ The annual CO_2 emissions from 19 average American households.

Hudson Hall

Plattsburgh
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- **Always looking for best practices**
  - ASHRAE Chapter meeting introduced to DBC concept
- **EH&S concerns were answered**
  - Variable ACH better than one arbitrary rate
  - ACH > 7 if needed
  - Useful data to validate lab ops:
    - Air system performance
    - Fume hood management
- **Humidity issues**
  - High humidity levels – creating problems for microscopy
  - Chiller – not able to provide sufficient cooling

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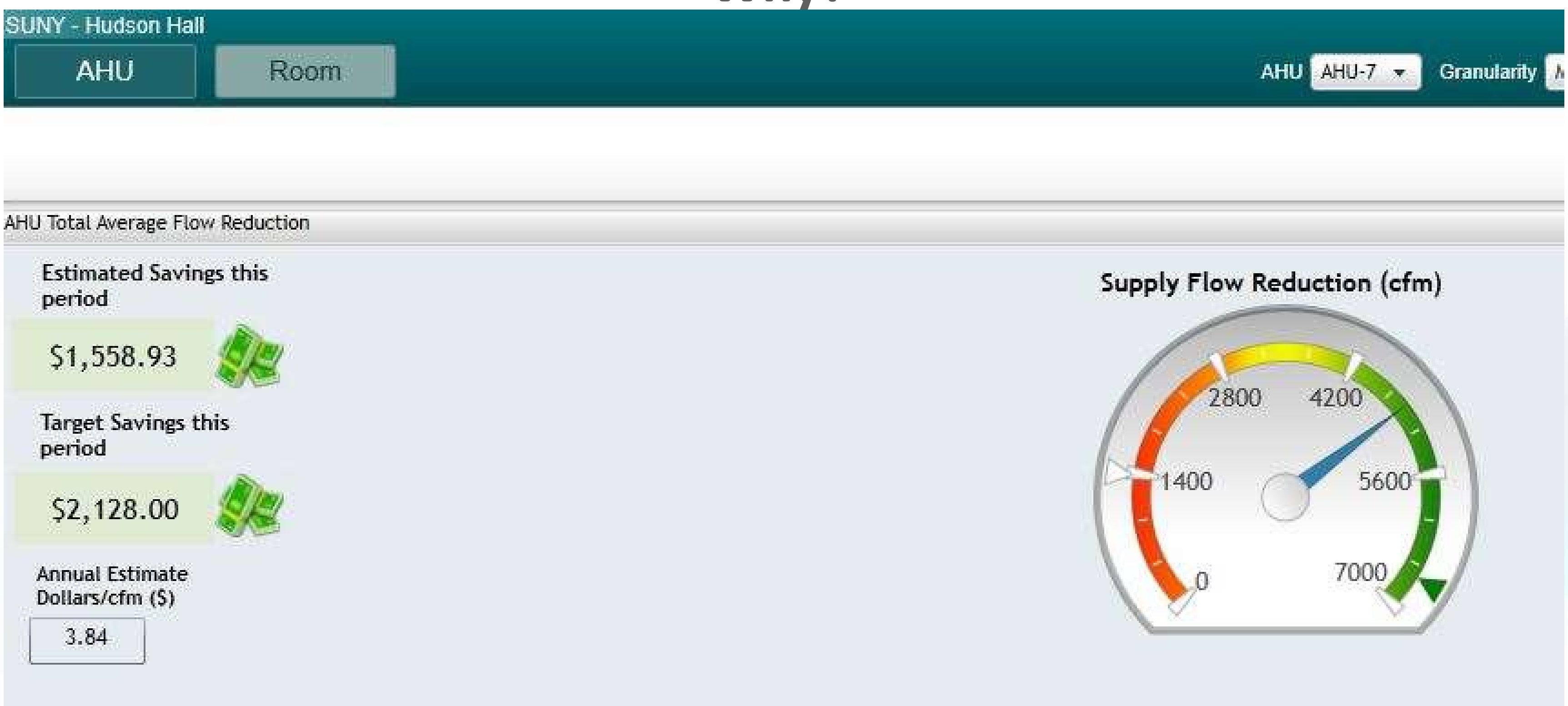
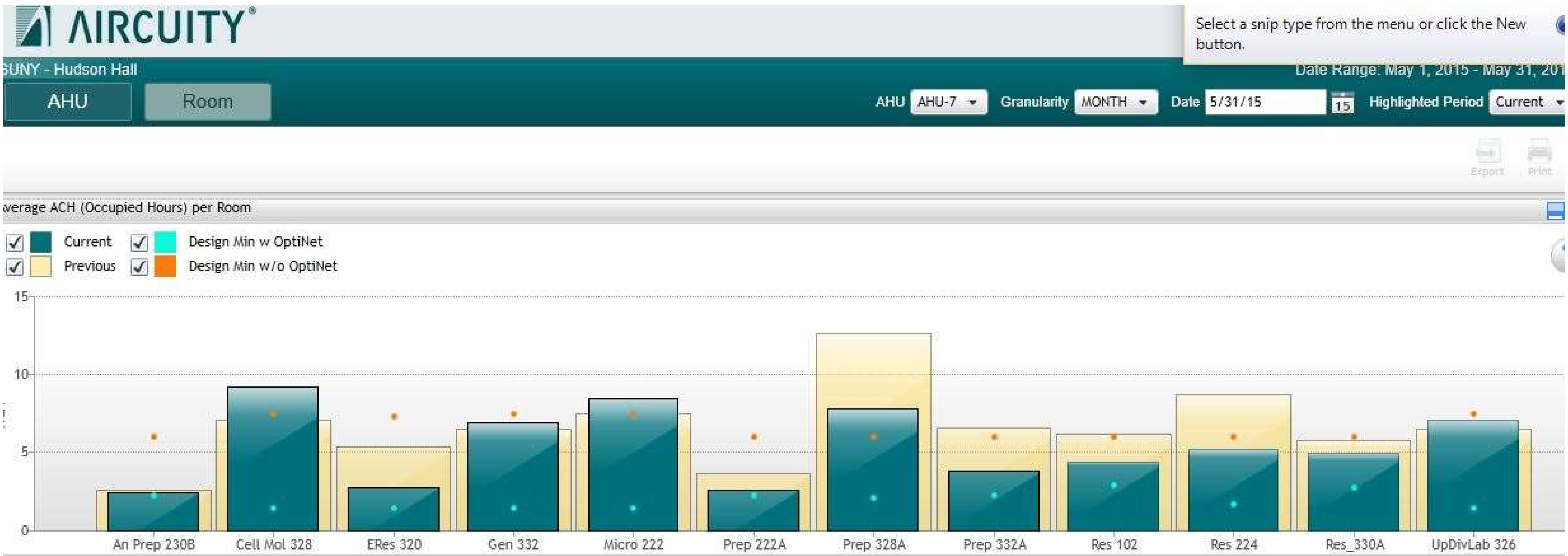
Validating Lab Operations

Supply Flow Reductions – not meeting target

Why?



Air Change Rates



CFM

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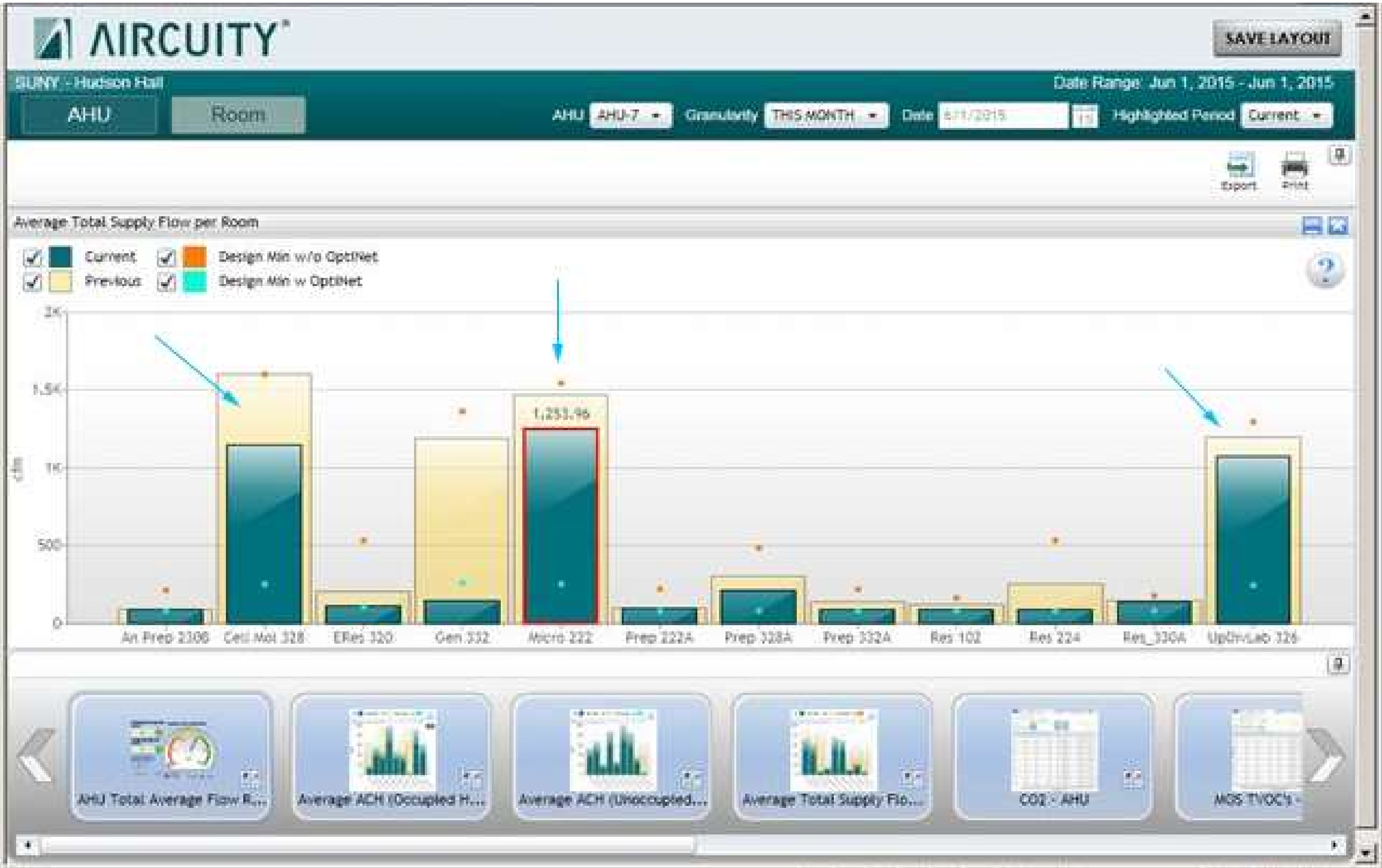
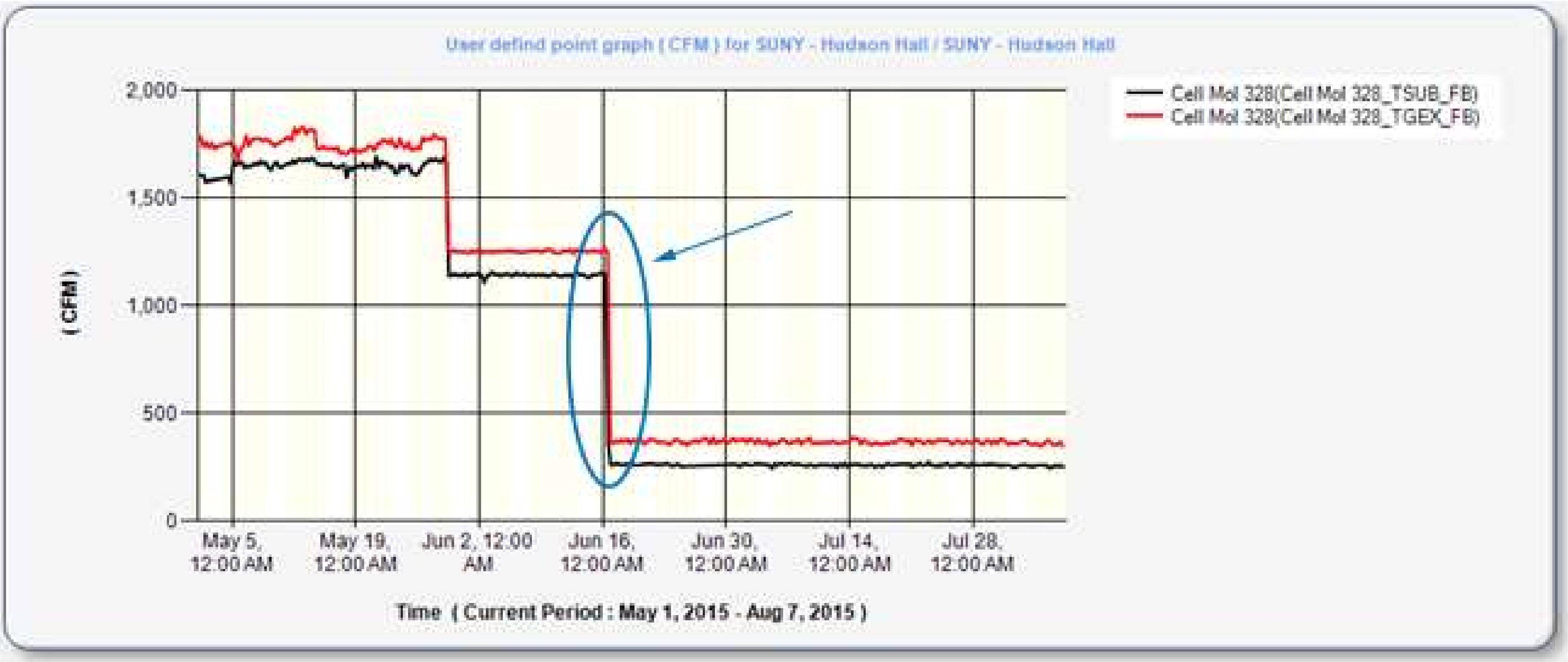
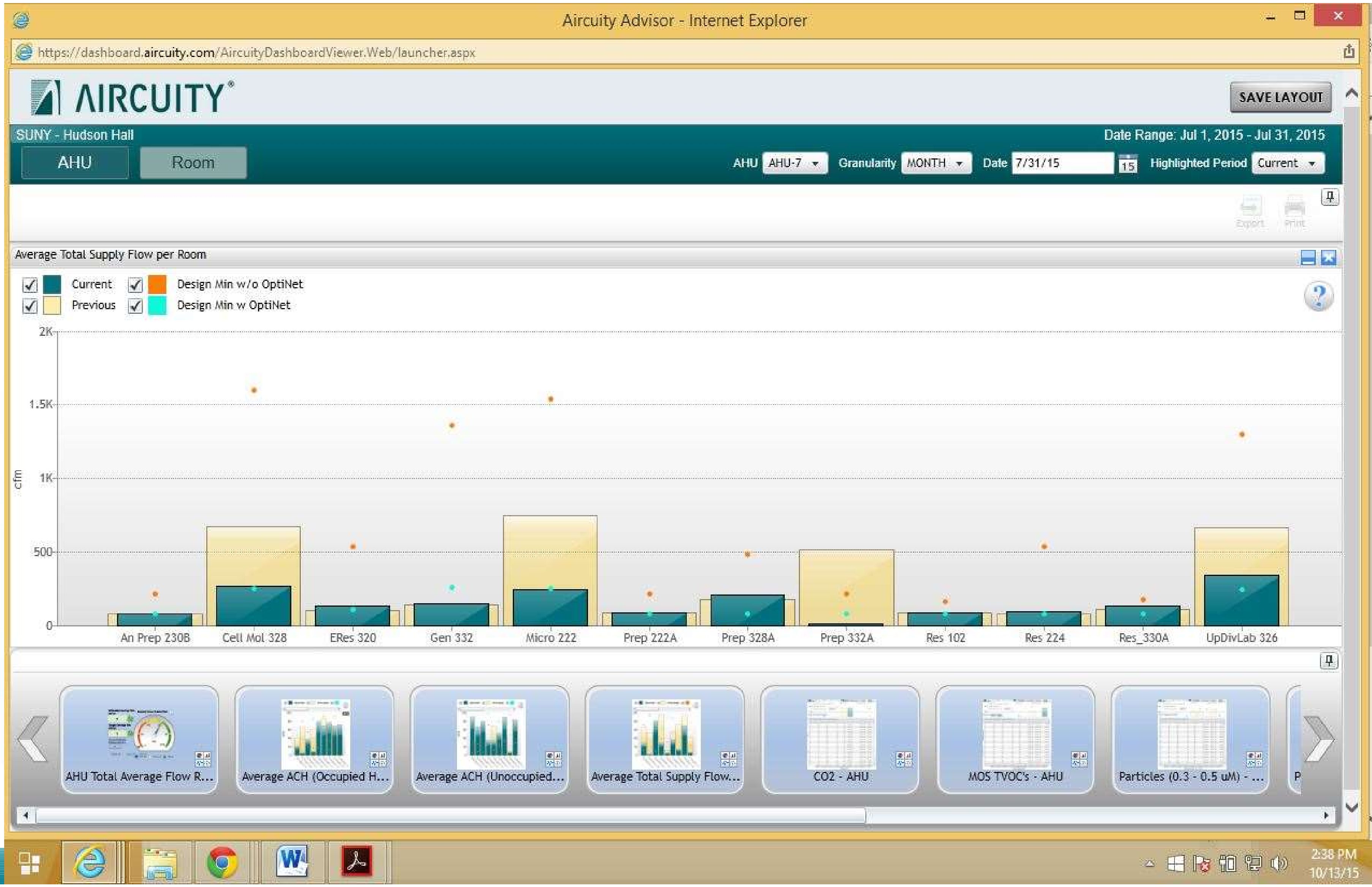


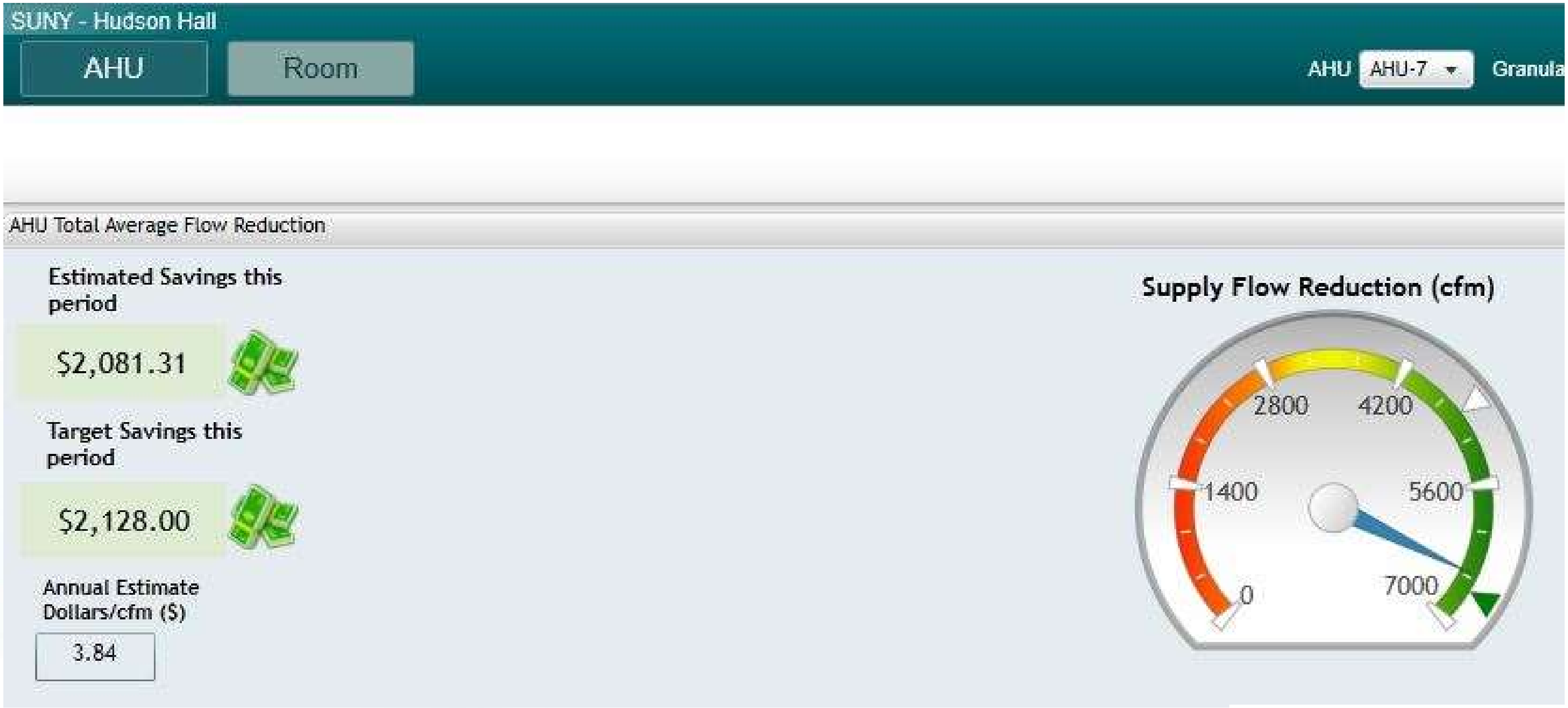
Broken Actuators



After Corrections



Hitting Target



Quarterly Target Reports

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Aircuity Quarterly Energy Savings Report

SUNY Plattsburgh - Hudson Hall

$32,086 Saved with Aircuity from Q1-Q3 2016

9 Month Target Savings: $34,043

Background Information

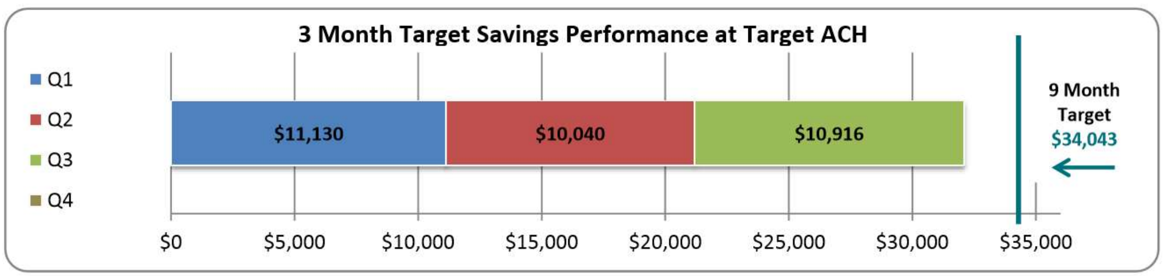
Client Name	**SUNY Plattsburgh**		
Building Name	**Hudson Hall**		
Report Start Date:	7/1/2016	Report End Date:	9/30/2016

Building Attributes

Monitored Zones	**19**		
Average ft^2 per Zone	**474**		
Total ft^2	**9,006**		
Target ACH with Aircuity	**2.4**		
Annual Cost per CFM	**$6.0**	Target Savings:	**$11,348**

Quarterly Results (Based on ALL data collected during occupied and unoccupied hours)

	ACH	CFM	Cost without Aircuity
Baseline Average Pre-Aircuity	8.00	10,807	$16,211
	ACH	**CFM**	**Cost with Aircuity**
Actual Average with Aircuity	2.61	3,530	$5,295
	ACH	**CFM**	**Savings with Aircuity**
Average Savings with Aircuity	5.39	7,277	$10,916



Fume Hood Behavior

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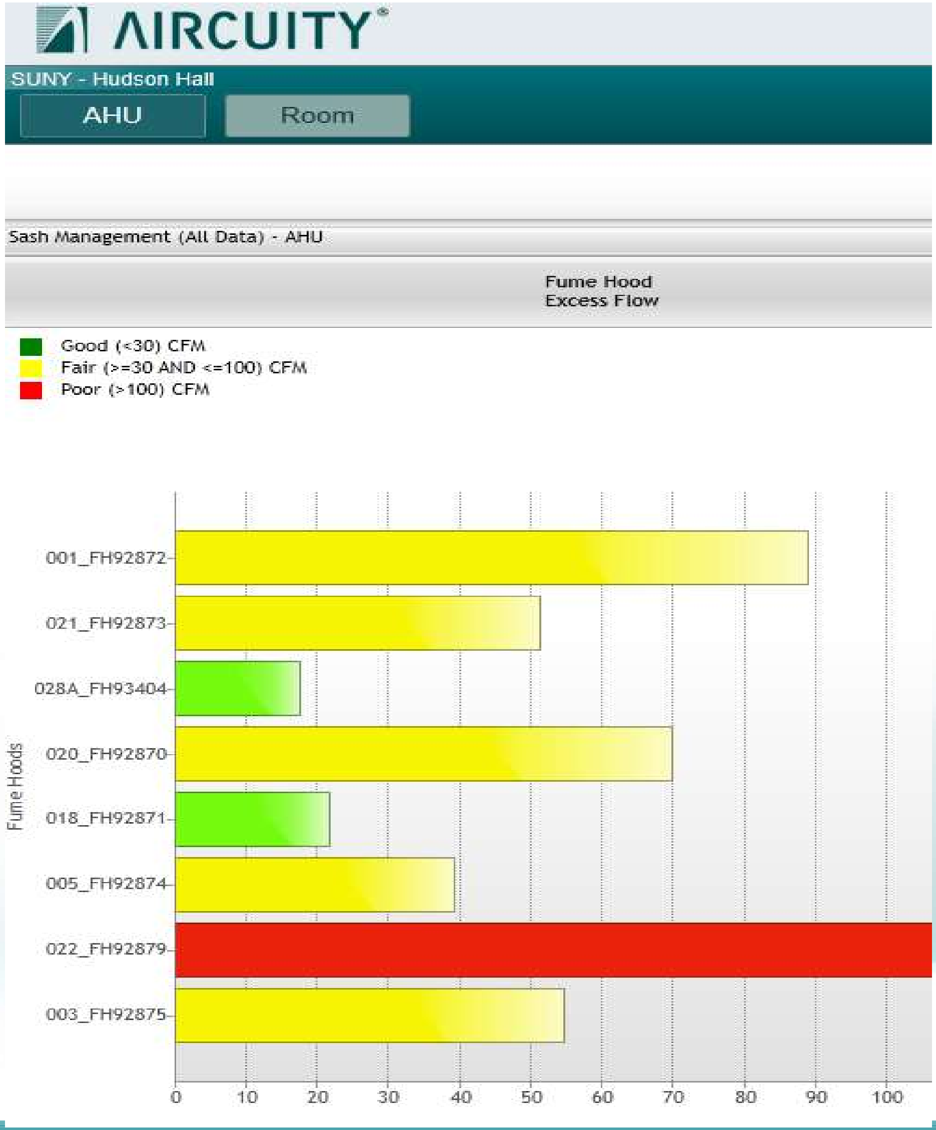


BINGHAMTON UNIVERSITY

State University of New York

Engineering & Science Building

- **Brief Overview**
  - Added to ITC in 2012
  - School of Engineering & Applied Sciences, electrical, computer, and mechanical engineering
  - LEED Platinum
  - 125,000 SF
  - High efficiency fume hoods
  - ACH 8 -12 (Pre DBC)
  - No unocc turndown

Lab Energy Focus

BINGHAMTON UNIVERSITY
State University of New York

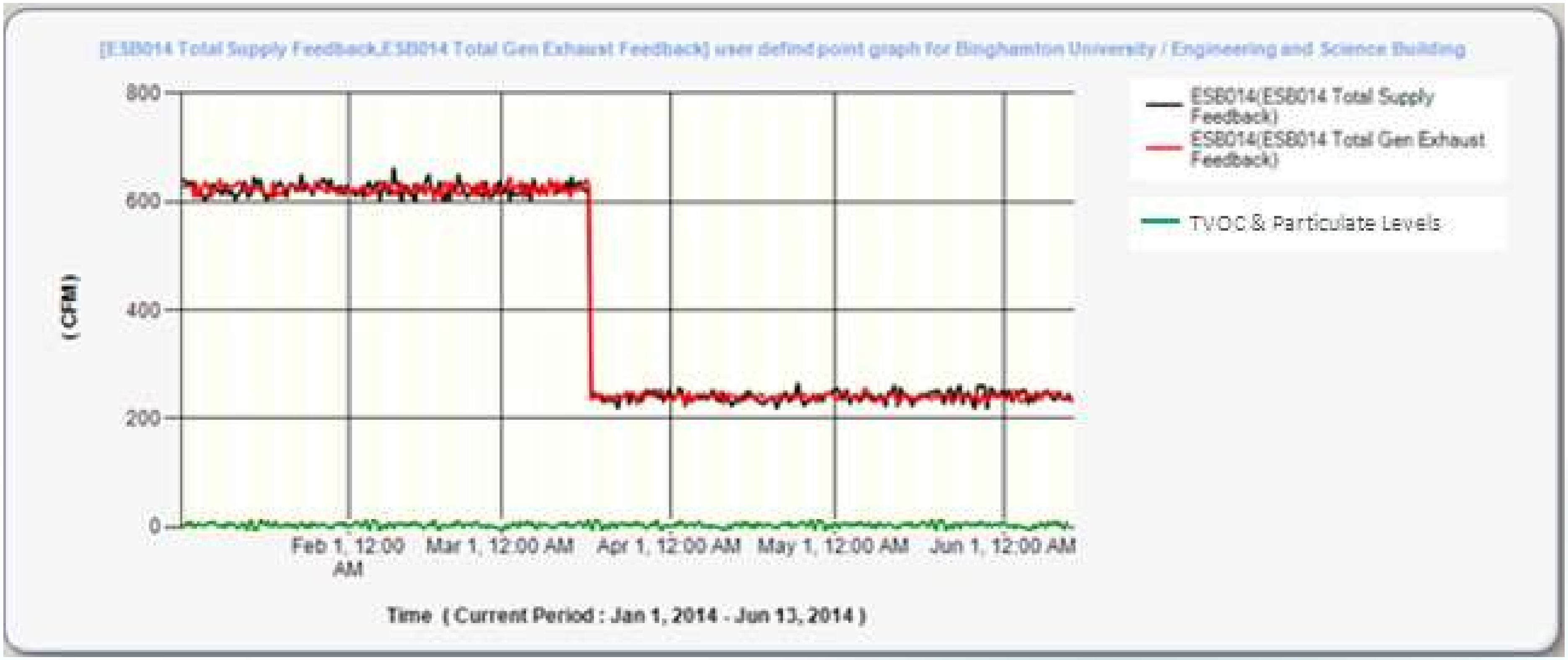
Center of Excellence Building 2015

Energy R&D Building - 2017

- **First implemented DBC in summer 2013**
  - Minimal disruption
  - NYSERDA PB Rebates
  - New air change rate: ~4 ACH
  - Found FH driven labs in excess of design flows
  - ~ 42% reduction
  - 2016 projected annual svgs: ~$30k

- **Two additional lab buildings**
  - Expansion of DBC into new lab buildings

Example Lab



Base	**10 ACH**	**(624 CFM)**
Target	**4 ACH**	**(238 CFM)**

Air Flow Performance

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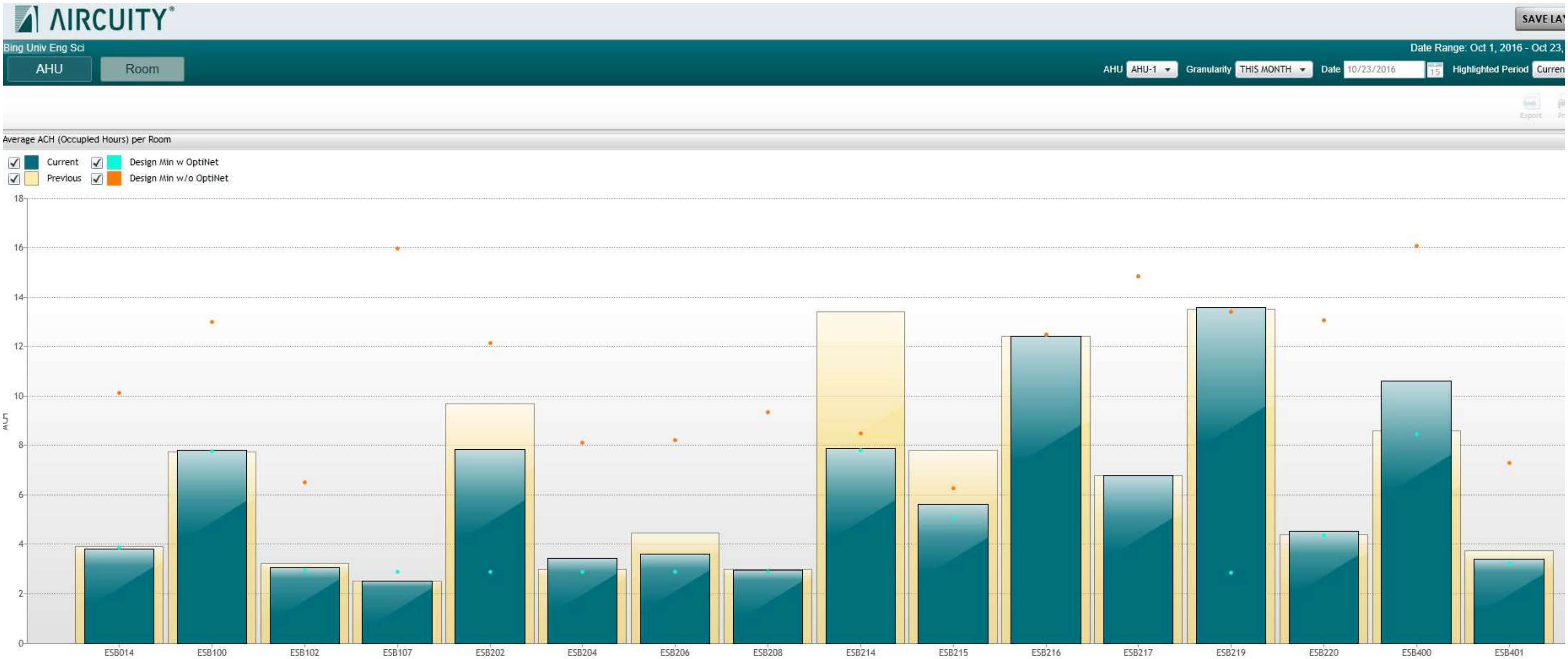
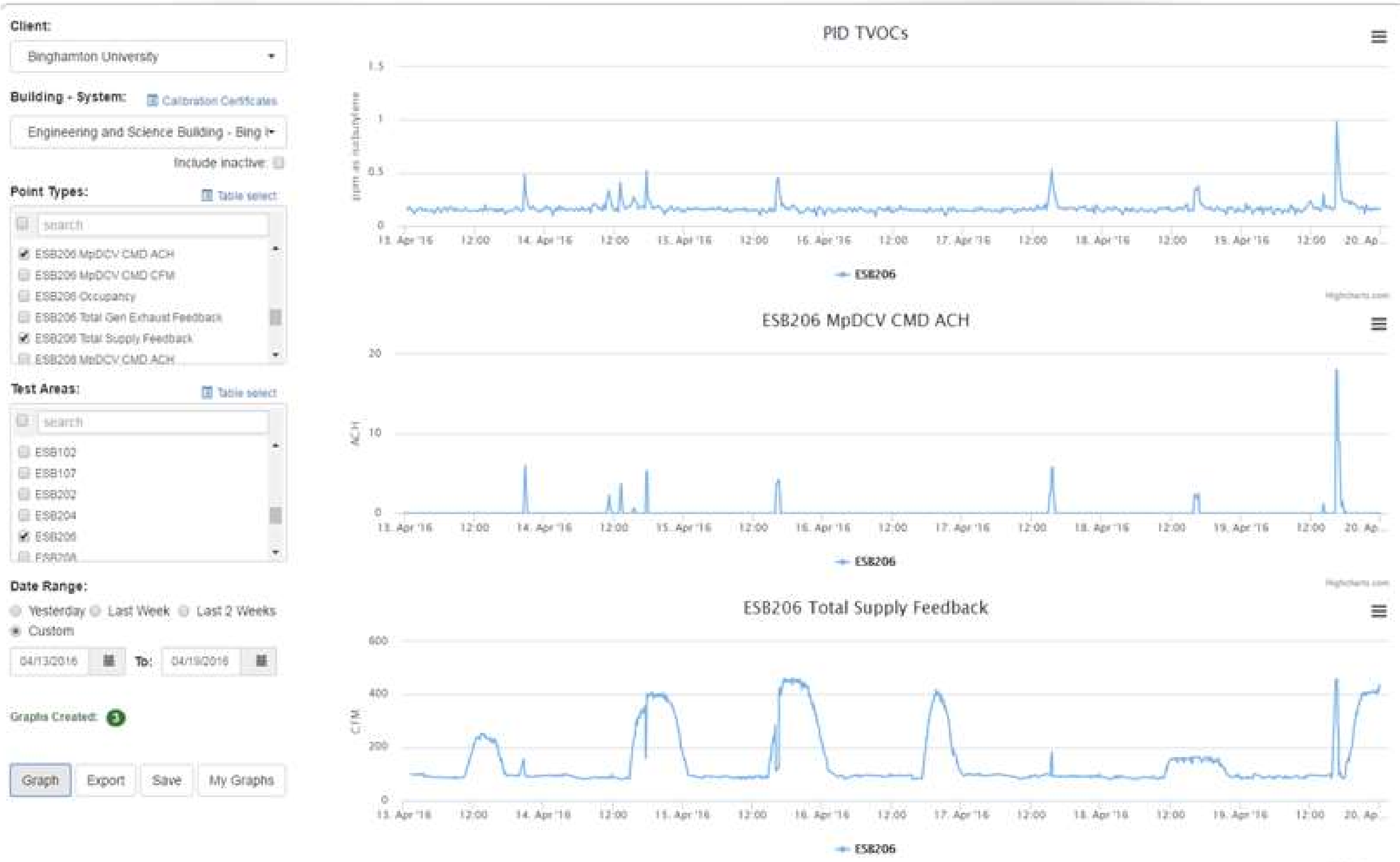
State University of New York



Problem Room

Binghamton University
State University of New York

- Room ESB 206 – TVOCs – April 15 - 20, 2016. Minor but frequent issues.



Goal: Dramatically Reduce Lab Building Energy Use

- **ASHRAE recommends DBC for optimal ach and greatest means to cut lab energy**
  - Lab HVAC energy can be cut by 40 to 70%
  - High ROI and fast payback support other ECMs
- **Sensor and flow analysis simplifies finding issues**
  - Provides quick “okay or not-okay” identification
- **Intelligent analysis can keep performance high**
  - Can provide real time commissioning automatically
  - Graphical analysis of data can solve problems

Questions?