

Tackling the Giants: Applying Smart Labs Principles to Constant Air Volume Lab Buildings

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Introduction

- Laboratories typically consume **3 to 10 times** more energy that similarly sized commercial buildings
- **50% of energy** in labs is wasted by inefficient fume hood operations and ventilation systems[1]
- A challenge faced by older laboratory buildings is constant air volume (CAV) systems maintaining constant ventilation rates causing **excess airflow** and **inefficient energy use**

Photo Credit: Joe DelNero, NREL

Photo Credit: Rachel Romero, NREL

[1] Smart Labs Toolkit.2024. "Introduction to the Smart Labs Toolkit"

CAV vs. VAV

- It is estimated that 70,500 laboratories nationwide still obtain CAV systems[2]
- Variable air volume (VAV) systems works to solve the issues related to excess energy consumption and interior air quality from CAV systems
- Some opportunities in CAV upgrades can include energy recovery mechanisms and conversions to VAV systems

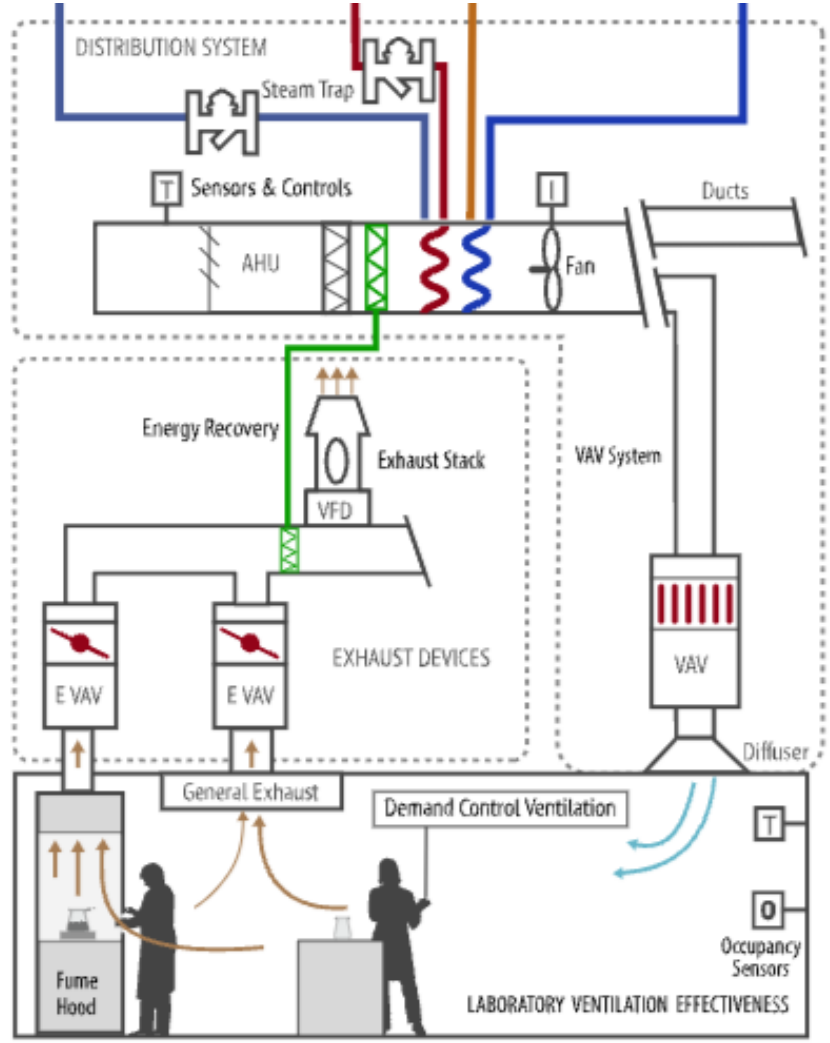


Photo Credit: Marjorie Schott, NREL

[2] EIA. 2012. "Commercial Buildings Energy Consumption Survey (CBECS)."

Background of Laboratory Building Stock

- HVAC systems represent nearly half of the overall energy consumption in commercial buildings, including laboratories
- CAV systems are often a simple design as well as low first cost
- Net present cost of VAV systems is lower than that of CAV systems.
- Payback periods of implementing a VAV system ranges from 4 - 10 years[3]

Implementing VAV controls may **disrupt** ongoing research

[3] Aktacir, Mehmet Azmi, Orhan Büyükalaca, and Tuncay Yılmaz. 2006. "Life-Cycle Cost Analysis for Constant-Air-Volume and Variable-Air-Volume Air-Conditioning Systems."

Photo Credit: Joe DelNero, NREL

A High-Performance HVAC System

HVAC Resource Map

HVAC design, operations, and maintenance best practices

Home | Commercial HVAC | **Lab HVAC** | Contributors | Contact Us

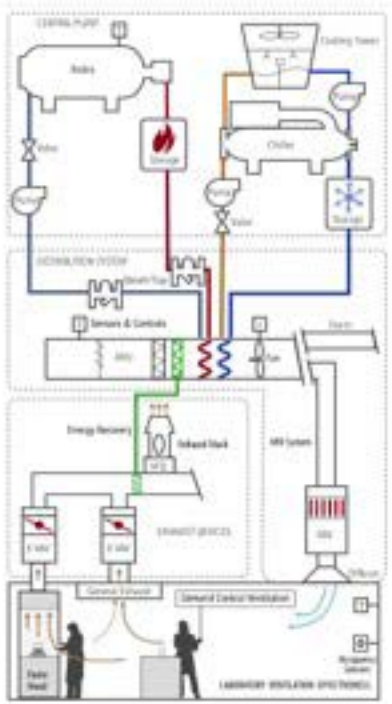
- LAB SPACE
- DISTRIBUTION
- LAB EXHAUST DEVICES
- CENTRAL PLANT

HVAC Resource Map for Laboratories

What is this resource?

The HVAC Resource Map for Laboratories is an intuitive graphical interface that provides quick access to a broad array of quality information on design, operations and maintenance best practices, and energy and water efficiency measures in single-pass HVAC systems that are 100% outside air and do not have return air.

The resources cover the central plant, distribution systems, and zone systems. The primary audiences are facility managers, operations staff, and design engineers who want to improve central plant and distribution efficiency.



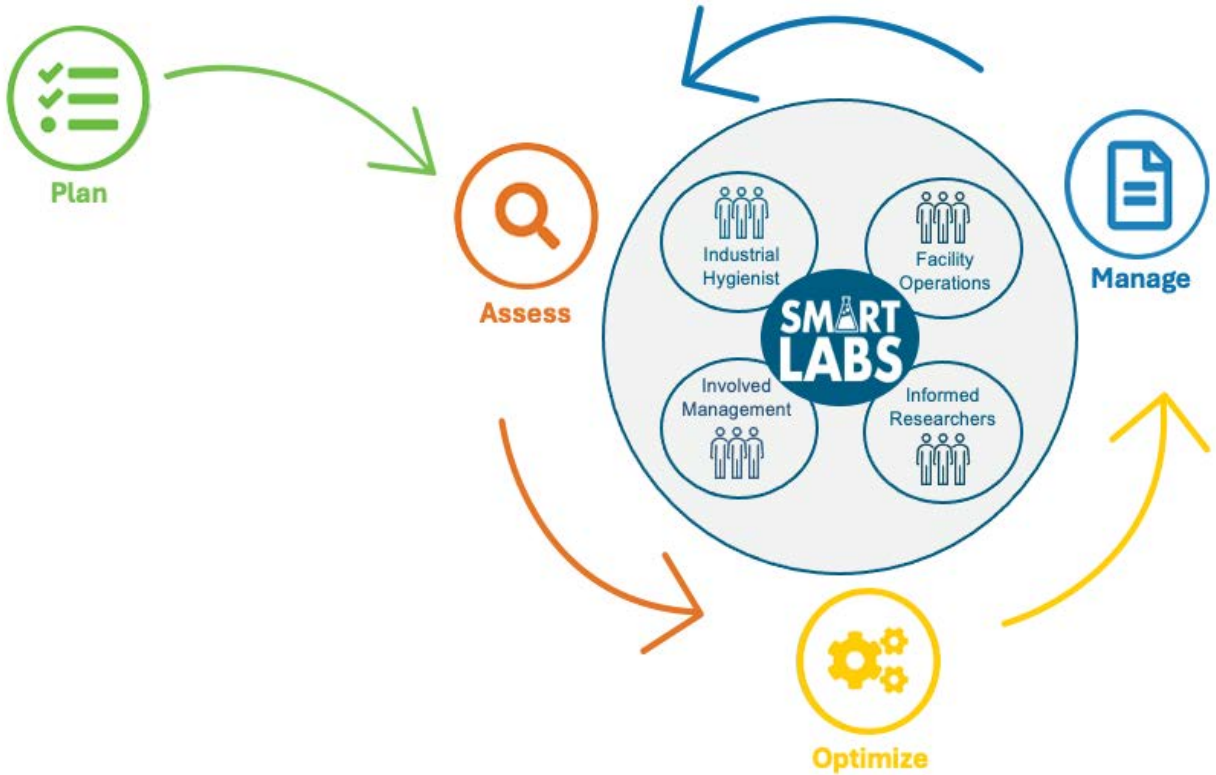
Explore HVAC Resources

Use the navigation on the left or the interactive diagram on the right to dive into resources on different HVAC components.

The interactive diagram will not be available on Internet Explorer. Please

The Role of Smart Labs

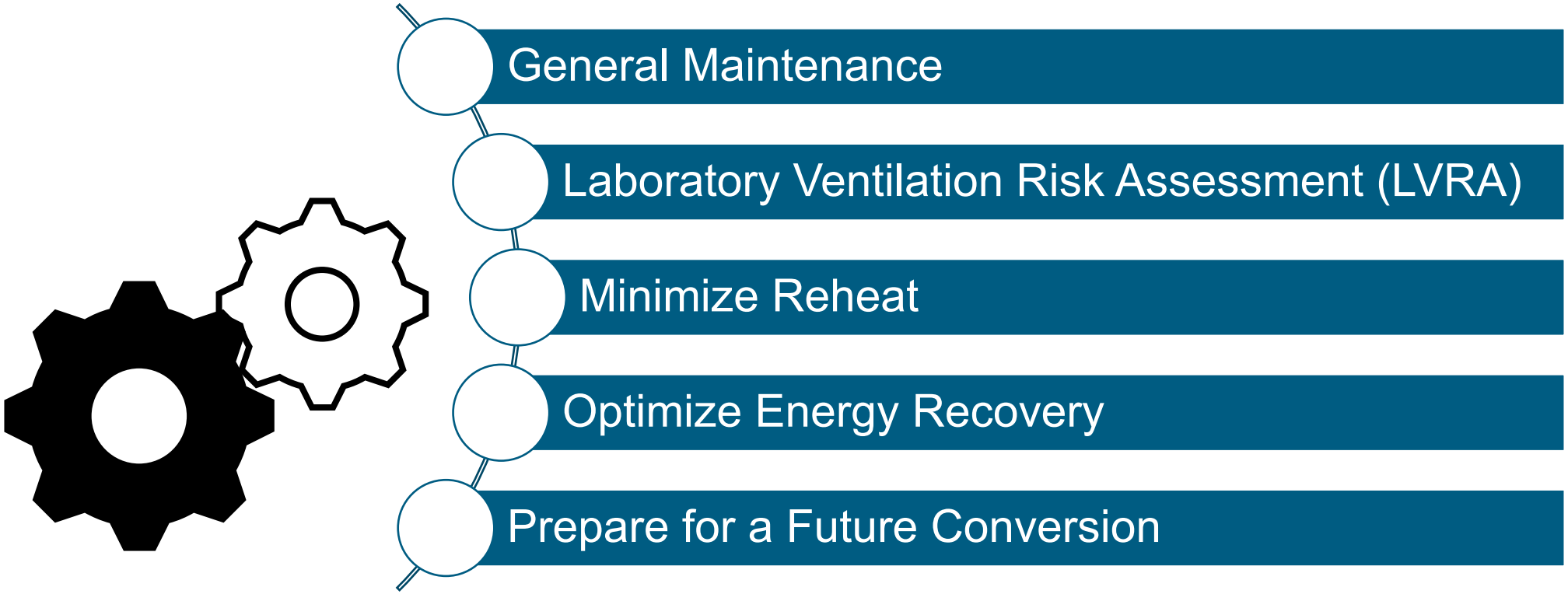
Smart Labs principles aims to support upgrading outdated laboratory buildings



- Incorporates planning, **assessment**, **optimization**, and **management** phases
- Each distinct phase includes specific tasks and resources proven to guide towards:
  - High-performance labs
  - Increase key stakeholder engagement
  - Enhance benefits for the organization

Opportunities for CAV Buildings for Smart Labs

- Assessing CAV laboratory buildings involves undertaking a renovation aligning with principles from the Smart Labs process aimed at transitioning to VAV systems including:



General Maintenance of CAV System

- Ensure proper functioning of coils, reheat/preheat valves, and dampers.
- Regularly clean coils to maintain airflow and heat transfer efficiency.
- Check and repair bypasses in reheat and preheat valves.
- Ensure proper operation of face and bypass dampers on steam preheat coils.
- Follow manufacturer’s maintenance instructions for comprehensive guidance

Laboratory Ventilation Risk Assessment

LVRA is a method to systematically **evaluate risks** associated with lab operations

- Labs should follow the ANSI/ASSP Z9.5-2022 standard
  - Establish minimum requirements and best practices for laboratory ventilation systems
- Utilizes risk control bands (RCBs) categorizing the risk for laboratory spaces
- In a building with CAV, the LVRA will determine the lowest safe ventilation rate for each laboratory space

Assessment Categories
✓ Type of hazards and procedures
✓ Generation characteristics of hazard
✓ Quantity of materials used or generated
✓ Frequency and duration of hazard generation
✓ Containment by exposure control devices

Photo Credit: Dennis Schroeder, NREL

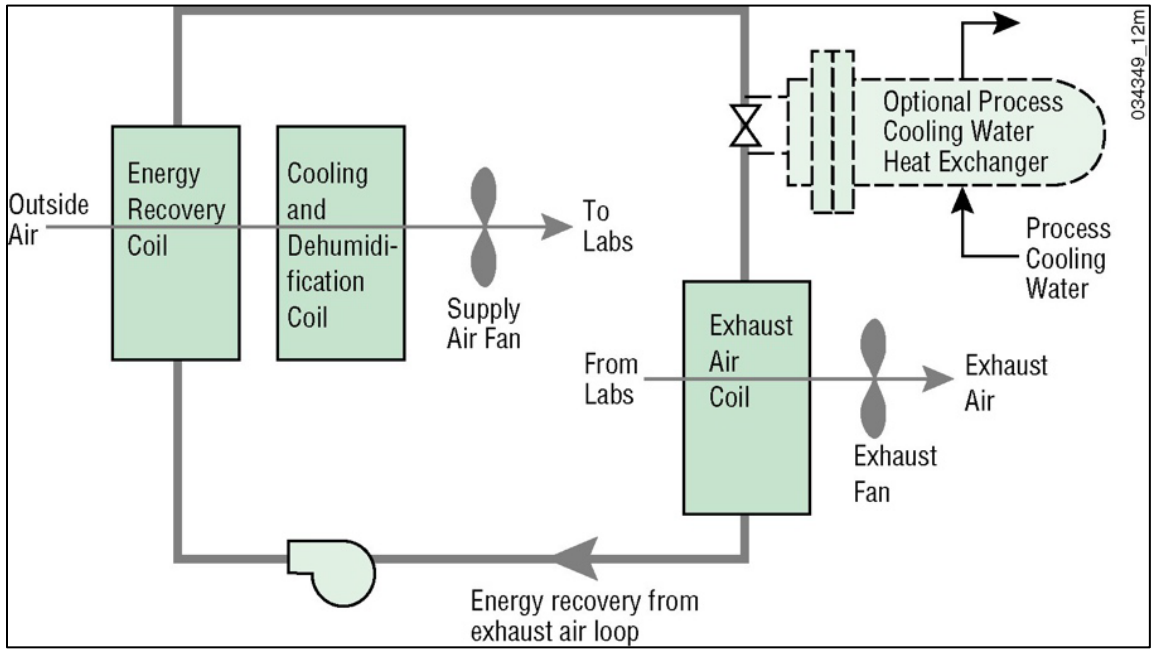
Minimize Reheat

Measure	Calculate	Consider
Measure actual plug loads to accurately estimate heat loads in laboratories	Base ventilation rates on measured heat loads, not assumptions	Consider auxiliary cooling options (fan coils, chilled beams, heat pumps) for high heat load labs to avoid overventilation

Photo Credit: Joe DelNero, NREL

Optimize Energy Recovery

- Energy recovery from exhaust air is crucial in CAV systems due to large, constant exhaust volumes
- Energy recovery may offer attractive payback and is easier to retrofit
- Runaround loops are a practical retrofitting option and do not require adjoining supply and exhaust



Runaround energy recovery loop with dehumidification

Photo Credit: NREL 2012

Prepare for a Conversion

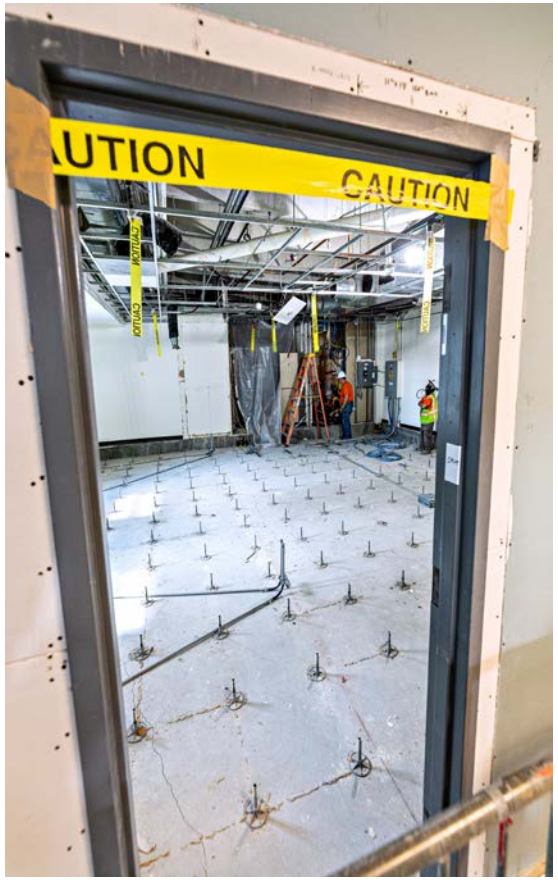


Photo Credit: Werner Slocum, NREL

- Add new VAV air valves and reheat coils during area renovations
- Phased approach limits one-time expense but requires phased lab shutdowns
- Optimal opportunity for retrofit during major lab renovations
- Plan system renovation when building has mostly VAV air valves to finalize VAV controls

Case Study: NREL's SERF Facility

- The NREL Solar Energy Research Facility (SERF) began operation in 1993
- 30,000 square feet of 100% outdoor air-ventilation laboratory space, housing research in advanced material synthesis and photovoltaics
- Pneumatically controlled CAV system

Photo credit: Werner Slocum, NREL

Case Study: NREL's SERF Facility

- Operating at 100% capacity, the ventilation flow rate is based on all ECDs being open
- Laboratory spaces have undergone extensive modification in the past 30 years
- Installing VAV valves on new or modified ventilated research areas in preparation for conversion to VAV
- HVAC system is "VAV ready" minimizing disruption and cost for future conversions

Photo Credit: Dennis Schroeder, NREL

Key Takeaways

Labs present opportunities to save energy and improve safety and performance of operations

Building owners must tackle CAV labs to align with and achieve the organization's energy management goals

- Increase safety
- Increase system capacity
- Improve energy efficiency

VAV system retrofits represent a modern and efficient HVAC solution

Commitment to Smart Labs principles ensures heightened effectiveness in ventilation and safety across laboratories settings

Thank you!

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