



## Identifying underused fume hoods as candidates for hibernation at Stanford University

### Highlights

- An asset efficiency audit was conducted across 16 fume hoods in the Green Earth Sciences research building.
- Sashimi sensors tracked utilization and sash movement over a continuous 5-month period to distinguish between underused, semi-underused, and active fume hoods.
- Identified that 56% of the monitored infrastructure was underutilized or semi-underutilized.

### Abstract

While fume hood energy management often focuses on user behavior (closing the sash), a significant source of waste arises from "underutilized" equipment—hoods that remain fully operational and connected to building exhaust systems despite rare usage. This case study details an asset efficiency audit conducted within a Green Earth Sciences building at a large private research university. Over a continuous five-month period, Sashimi IoT sensors monitored 16 VAV fume hoods to quantify utilization rates based on sash movement frequency. Although baseline sash behavior in the facility was satisfactory, the granular data revealed a structural inefficiency: 25% of the units were "underused" (used once or fewer), and 31% were "semi-underused" (used fewer than 10 times). In total, 56% of the monitored infrastructure was identified as viable candidates for mechanical hibernation or equipment sharing. By identifying these opportunities to decommission unnecessary airflow capacity, the study demonstrates that rightsizing infrastructure to match actual research demand is a critical strategy for decarbonization.

### Introduction

On a per-square-foot basis, research facilities consume five times more energy than typical commercial buildings, with heating, ventilation, and air conditioning (HVAC) systems accounting for approximately 60% of this demand. At the heart of this energy intensity is the chemical fume hood. Designed

to protect researchers from hazardous vapors, these ventilated enclosures continuously exhaust conditioned air to the exterior, necessitating massive amounts of energy to heat, cool, and filter replacement air. While modern facilities increasingly utilize variable air volume (VAV) systems to reduce airflow when the hood's sash is closed, the base operational cost of maintaining even a closed hood remains significant.

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A critical, often overlooked inefficiency in laboratory management is the prevalence of "underutilized" fume hoods—units that remain fully operational and connected to the building's exhaust system despite being rarely or never used for active research. Because safety standards dictate that all active hoods maintain a minimum airflow volume to ensure containment, these idle units continue to drive substantial energy consumption and carbon emissions purely by existing.

Historically, identifying these candidates for "hibernation", which is the process of mechanically decommissioning a hood to stop airflow, has been a logistical challenge. Facilities managers often lack the granular usage data required to confidently determine if a hood is truly abandoned or simply used intermittently. Without reliable metrics, the risk of disrupting potential research prevents action, leaving significant energy savings on the table.

To address this gap, this case study explores a data-driven approach to identifying hibernation candidates at Stanford University. By deploying Sashimi monitoring sensors, facilities teams were able to audit usage patterns across 16 fume hoods in the Green Earth Sciences building and reveal that a significant number of their fume hoods were underused. This suggests a significant portion of laboratory energy waste can be eliminated within fume hood dense spaces not just by changing how scientists use hoods, but by questioning whether those hoods need to be running at all.

### Methods

#### *Site Selection and Sensor Deployment*

A total of 16 fume hoods distributed across 14 distinct laboratory rooms were selected for monitoring in the Green Earth Sciences building at Stanford University, which contains VAV infrastructure (**Figure 1**).

The audit utilized "Sashimi" sensors, a retrofit Internet of Things (IoT) solution designed to track sash position and user occupancy. These units were installed on the exterior of the fume hoods using a non-intrusive mounting system, allowing for rapid deployment (approximately 15-20 minutes per unit) without disrupting ongoing research operations. The sensors utilize near-infrared photodetectors to read a grayscale optical strip on the sash, providing real-time height data.

#### *Data Collection and Utilization Analysis*

Following an initial behavioral intervention period, sash data was monitored for a continuous duration of five months. This extended longitudinal time frame was

critical to distinguish between hoods that were temporarily idle due to project gaps and those that were structurally underutilized. Data regarding sash height, movement frequency, and duration of openness was transmitted via Wi-Fi to a centralized server for analysis.

To categorize asset efficiency, the study established specific, quantifiable thresholds for utilization. "Significant sash movement" was defined as any change in height greater than 10%, a threshold set to filter out minor sensor fluctuations or incidental contact. Based on this metric, hoods were classified into two categories:

- Underused: Hoods with significant sash movement occurring one time or fewer over the 5-month study period.
- Semi-underused: Hoods with significant sash movement occurring between 1 and 10 times over the 5-month study period.



**Figure 1. Installed Sashimi Sensors that Monitor Fume Hood Sash Height.** Examples of the physical placement of the sensor unit on the fume hood exterior and the corresponding gradient strip.

#### *Hibernation Energy Modeling*

To quantify the potential savings from decommissioning these identified units, the team utilized a comparative computational model. This algorithm simulates two scenarios for every timestamp in the data set: a "Baseline" iteration, where hoods operate at standard VAV setpoints (e.g., 25 FPM closed, 100 FPM open), and a "Hibernation" iteration, where the airflow for candidate hoods is set to zero (or a hibernation setpoint).

This model accounts for the complex interaction between fume hood exhaust and the building's general exhaust requirements. It classifies rooms as "Fume Hood-Driven," "General Exhaust-Driven," or "Intermediate" based on whether the aggregate hood airflow exceeds the room's minimum air change rate

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(ACH). The algorithm ensures that energy savings are only claimed when hibernating a hood actually lowers the total supply air required for the room; if the general exhaust system must ramp up to meet the room's minimum ACH despite the hood being off, the model caps the realizable savings to reflect this physical reality.

### Results

#### *Baseline Usage and Behavioral Intervention*

The initial audit revealed a counter-intuitive finding regarding sash compliance. Unlike typical facilities where user behavior is the primary variable for energy waste, baseline data indicated that sash management practices among the researchers were already satisfactory. Consequently, the project scope pivoted from a behavioral intervention (e.g., "Shut the Sash" competitions) to an asset efficiency audit. The granular data collected by the sensors uncovered a different, structural inefficiency: a significant number of fume hoods continued to run and exhaust air despite being infrequently used by active researchers.

#### *Identifying Hibernation and Consolidation Candidates*

Using the longitudinal telemetry from the Sashimi sensors, the team applied rigorous utilization thresholds to the 16 monitored fume hoods. The audit identified that 4 hoods (25%) were "underused," defined as having significant sash movement one time or fewer over the entire five-month study period.

Furthermore, an additional 5 hoods (31%) were classified as "semi-underused," showing only sporadic activity (between 1 and 10 movements).

Aggregating these findings, the study concluded that 9 of the 16 fume hoods (56%)—over half of the monitored infrastructure—were viable candidates for hibernation or equipment sharing programs. This revealed a significant inefficiency in space and energy allocation, suggesting that researchers could easily consolidate their work onto fewer active units, allowing the remaining infrastructure to be decommissioned.

#### *Quantifying the Structural Energy Opportunity*

The identification of these 9 candidates could represent a substantial financial and environmental opportunity. By applying the study's energy model, which accounts for room-level ventilation dynamics, the team determined that hibernating these units could generate annual cost reductions.

The deployment estimates suggest that identifying and hibernating such units can yield savings of approximately \$400 annually. While modest, this figure reflects the specific ventilation profile of the Green

Earth Sciences building, where the monitored hoods were located in rooms driven primarily by the general exhaust. In these types of spaces, the building's general ventilation requirements often override the savings achieved by turning off a single hood. However, these results are highly translatable to other facilities; the methodology used to identify underutilization remains constant. Implementing this same audit in "Fume Hood-Driven" rooms—where the hood dictates the room's total airflow—would yield significantly higher financial returns per unit.

### Discussion

This case study illuminates a critical but often overlooked dimension of laboratory sustainability: the inefficiency of the infrastructure itself, independent of user behavior. By shifting the focus from "how scientists use hoods" to "whether hoods are used at all," this project successfully demonstrated that a significant portion of laboratory energy waste can be addressed through asset optimization and hibernation.

The most striking finding of the audit in The Green Earth Sciences building was the high prevalence of underutilized equipment. Despite being fully operational and consuming significant energy to exhaust conditioned air, 56% of the monitored fume hoods were identified as candidates for hibernation or consolidation. This suggests that research facilities often operate with a surplus of ventilation capacity that does not align with actual research needs. In these scenarios, traditional behavioral interventions—such as "Shut the Sash" competitions—are fundamentally limited; even a closed sash consumes energy if the hood is running unnecessarily. The data indicates that the most effective strategy for these units is mechanical decommissioning.

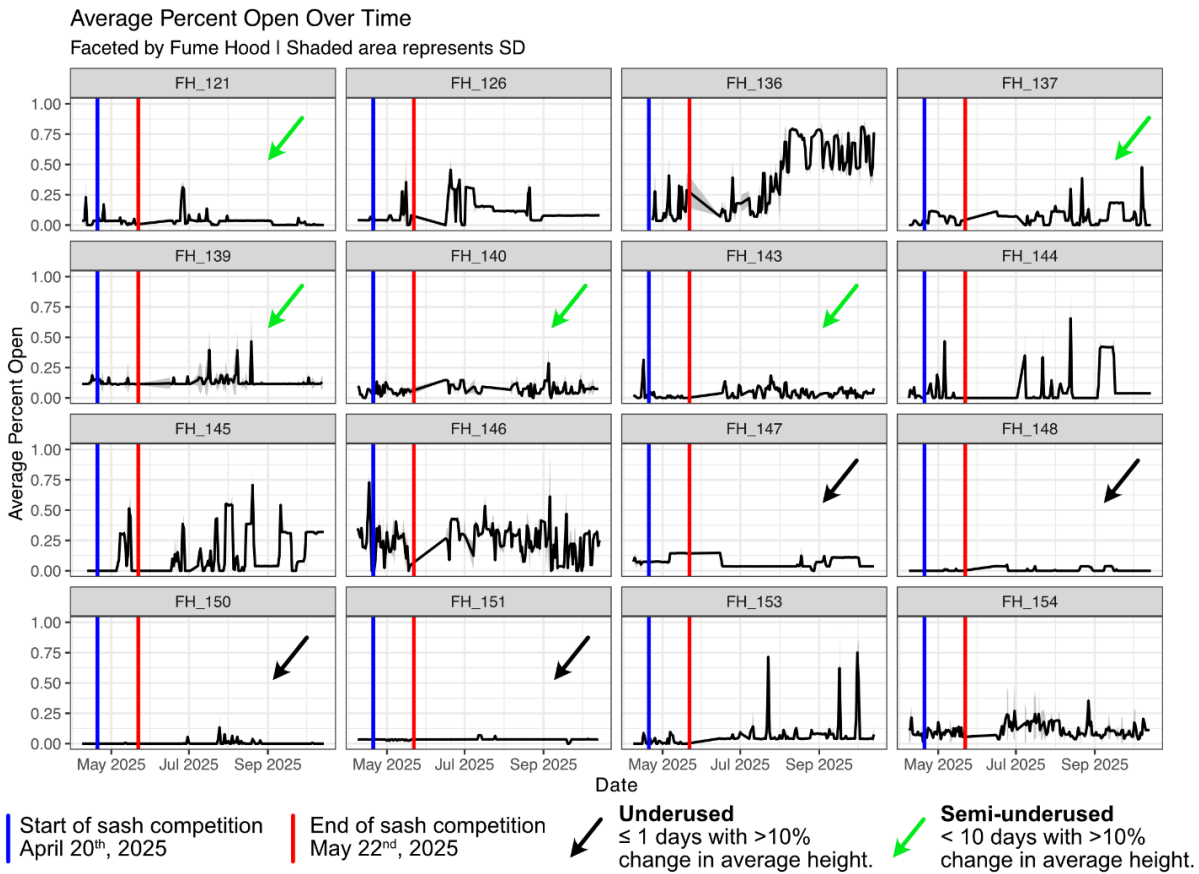
Historically, facilities managers have been hesitant to hibernate fume hoods due to the risk of disrupting potential research and the complexity of identifying true candidates. This study demonstrates that granular, longitudinal data is the key to overcoming these barriers. By defining rigorous utilization thresholds, combined with in-person checks with individual labs, the team was able to provide actionable, evidence-based recommendations. This data-driven approach allows institutions to consolidate research activities onto fewer active units without compromising scientific output.

The findings from this pilot have broad implications for institutional decarbonization strategies. However, the study also highlights that these savings are dependent on room-level physics; hibernation is most effective in "Fume Hood-Driven" rooms where the hood dictates the ventilation rate. In "General

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Exhaust-Driven" rooms, hibernating a hood may simply shift the load to the building's general supply valves, yielding no net energy reduction. Therefore, future hibernation programs must pair utilization data with room-level ventilation audits to target efforts where they will yield the highest return on investment.

In conclusion, by leveraging fume hood monitoring technology such as Sashimi to identify and hibernate underutilized assets, universities can unlock energy savings by rightsizing their infrastructure to match actual research demand



**Figure 2. Sashimi identifies underutilized fume hoods for hibernation and their energy saving potential.** (A) Sash-height traces of 16 fume hoods in an Earth Sciences research building at University B. Fume hoods identified with a black arrow were identified as underused, and thus candidates for hibernation. Fume hoods identified with a green arrow were identified as semi-underused, and thus candidates for sharing or hibernation. Shaded areas represent standard deviation in sash height measurements.