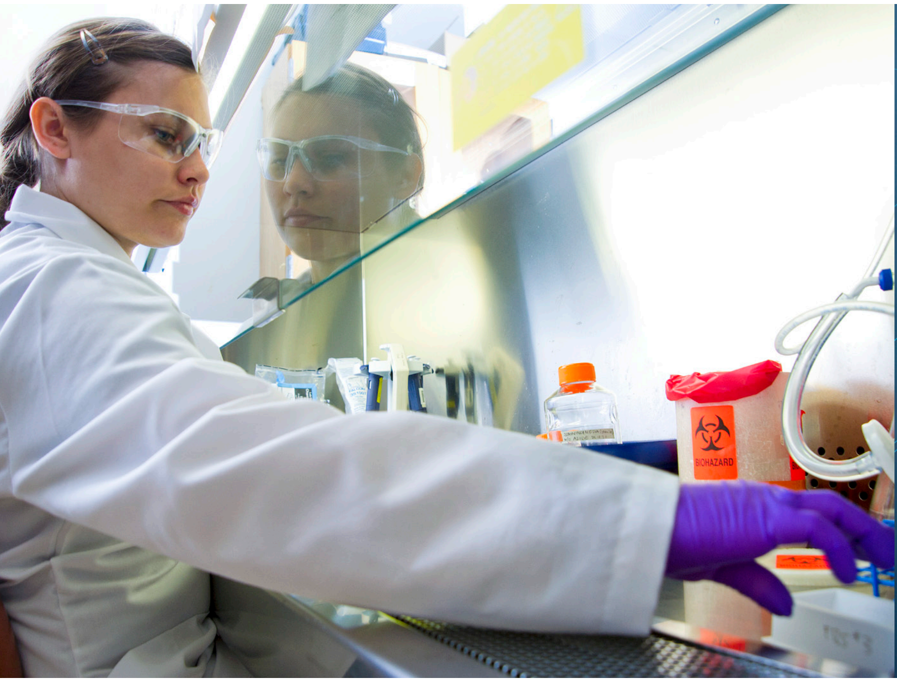


SHUT THE SASH: FUME HOOD VENTILATION IN LABORATORIES

UC Berkeley & UCLA

Destanie Cummings, a graduate student, works under a fume hood at the Center for Comparative Medicine, UC Davis

SHUT THE SASH SASH HEIGHT REDUCTION

50%-76%

PROBLEM

In addition to high equipment loads, Laboratory buildings require large amounts of fresh air ventilation and therefore consume much more energy than other building types. These buildings consume 3 – 8 times the amount of energy as the average office building and can account for as much as 40 – 50% of the total energy use for a university campus, even though they may constitute less than 20% of the total floor space. Once commissioned, fume hoods must operate continuously to provide a safe working environment. Energy is not only expended due to the operation of the ventilation fan and motor, but also due to the fact that the air that is exhausted must be replaced with fresh air that requires conditioning. Thermal conditioning is an obvious consumer of energy, but energy use can be even higher in humid or cold climates when humidity control also becomes important.

SOLUTION

One of the simplest ways to reduce the energy required by operating fume hoods is to ensure that the sash—the moveable pane in front of the fume hood that controls the exhaust flow from an experiment—is always in the lowest possible operating position. This simple action can in some circumstances lower the amount of energy used substantially and will in all cases provide for the safest working environment, even in cases where energy use is not reduced. Behavioral change programs to promote being mindful of sash heights have been dubbed "Shut-the-sash" (STS). The STS is a collaborative project with SPEED, Alliance to Save Energy (ASE), Lawrence Berkeley National Laboratory (LBNL) and the participating campuses. Shut-the-sash campaigns use various educational methods, posted materials, and rewards to encourage lab users to lower fume hood sashes when not in use. Estimating the energy that can be saved by closing the fume hood depends on many factors, including the type of fume hood being used, fume hood face velocity, the number of hoods in a particular ventilation zone, the building ventilation rate, and local climate.

> *"If four interns and a modest $300 budget can save $35,000 in energy, just imagine the potential savings for future shut the sash campaigns."*
>
> *—Molly Uyeda, ASE Green Campus Intern, UCLA*

ENERGY SAVINGS

The energy savings from STS is achieved by two main methods. First, fan energy consumption can be lowered by reducing the amount of air that is exhausted through the fume hood exhaust system. By reducing flow through the exhaust system, the fan can operate at a lower speed and the pressure drop under which it operates is lowered. Additional savings come from reducing the load on the heating and cooling system because less conditioned air is exhausted from the building. For every cubic foot of air exhausted from a fume hood, another cubic foot of outdoor air needs to be conditioned and supplied to the building. Typically it costs between $3-$5/CFM annually to condition air, the exact cost is determined by the climate zone and other factors.

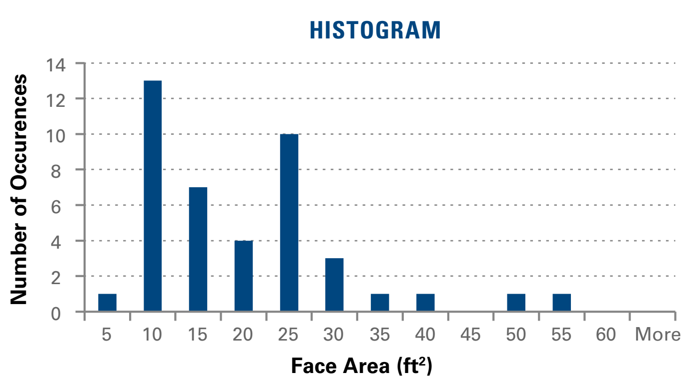
It should be noted that both mechanisms for saving energy are only realized when fume hood exhaust systems take advantage of variable flow design elements. Older fume hoods are often constant volume (CV) designs that exhaust a constant volume of air regardless of the position of the fume hood. Newer laboratory designs utilize variable frequency drive (VFD) fan motors, variable air volume (VAV) fume hood exhaust dampers, manifold exhaust systems and stepped fan operating control schemes. In these cases, sash height reduction will reduce the amount of air that flows through the fume hood exhaust and save energy.

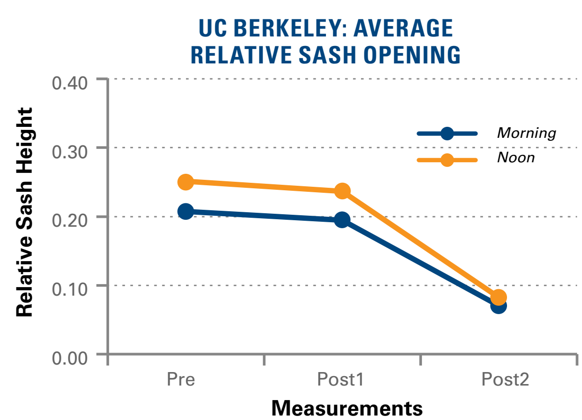
Another complicating factor in determining true energy savings is the fume hoods interaction with the laboratory general exhaust. All buildings, and laboratories, have a total exhaust requirement. This is usually expressed in Air Changes per Hour (ACH) and is typically 6 ACH for laboratory spaces during occupied hours. With advanced controls, this rate can be reduced further when the space is unoccupied. A well designed building will utilize fume hood exhaust to offset the total exhaust requirement and only exhaust additional air through the general exhaust system when the fume hood exhaust is not meeting the zone's exhaust requirement. Typically a laboratory may have 10 ft tall ceilings and require 6 ACH of general ventilation, which is equivalent to 1 CFM/SF (cubic feet per minute/square foot) of floor space. Typical fume hood face velocity is 100 LFM (linear feet per minute) by code in California, which is equivalent to 100 CFM/SF of open hood area. Fume hood savings may only be achieved in zones that have open fume hoods, and are "fume hood dominated". In the "general exhaust dominated" scenario, shutting fume hoods may do little to save energy but users will still have the benefit of increased safety. As a rough rule of thumb, fume hood dominated spaces would be ones where the floor area to cumulative fume hood face area ratio is less than 100:1. Further illustration of this can be seen in the diagram of laboratory scenarios.

CASE STUDIES

In cooperation with the Alliance to Save Energy and Lawrence Berkeley National Laboratory two Shut-the-sash efforts were monitored at University of California Los Angeles and University of California Berkeley. A standard protocol for running the energy competitions and data collection was established by the working group and implemented at each campus. The campaigns were designed and run by Alliance to Save Energy interns at each respective campus and the methods used were left to the organizers at each campus.

UC Berkeley	Site: Tan Hall	Fume Hoods: 109	Rooms: 43	Avg. Face Area: 6.5 SF





At UC Berkeley, the Shut the Sash competition was conducted at Tan Hall. This building is a chemistry research building that serves multiple departments. The fume hoods at Tan Hall are primarily used for research and some are used as part of teaching classrooms. The study observed all 109 fume hoods in 43 rooms of the building.

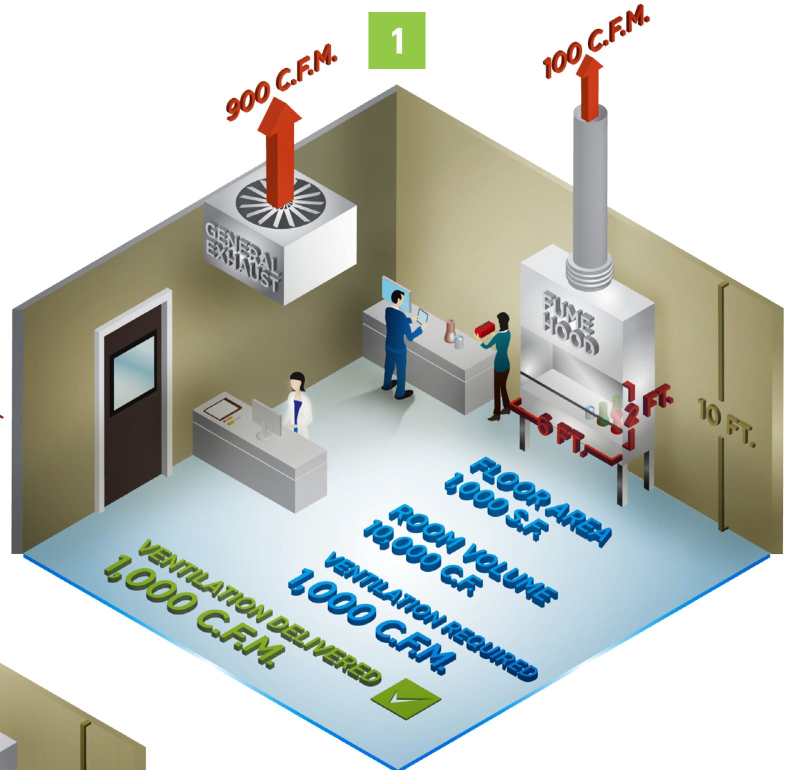
The competition ran for 2 weeks from October 29 to November 16, 2012. The competition was advertised through email listservs to laboratory users, informational flyers, "meme" themed flyers, and tabling before and during the campaign. Additionally, fume hood stickers were designed and printed to replace older "shut the sash" stickers on the fume hoods. At the end of the competition, the floor that showed the most improved average sash height and behavior change won several energy efficiency tools and gadgets.

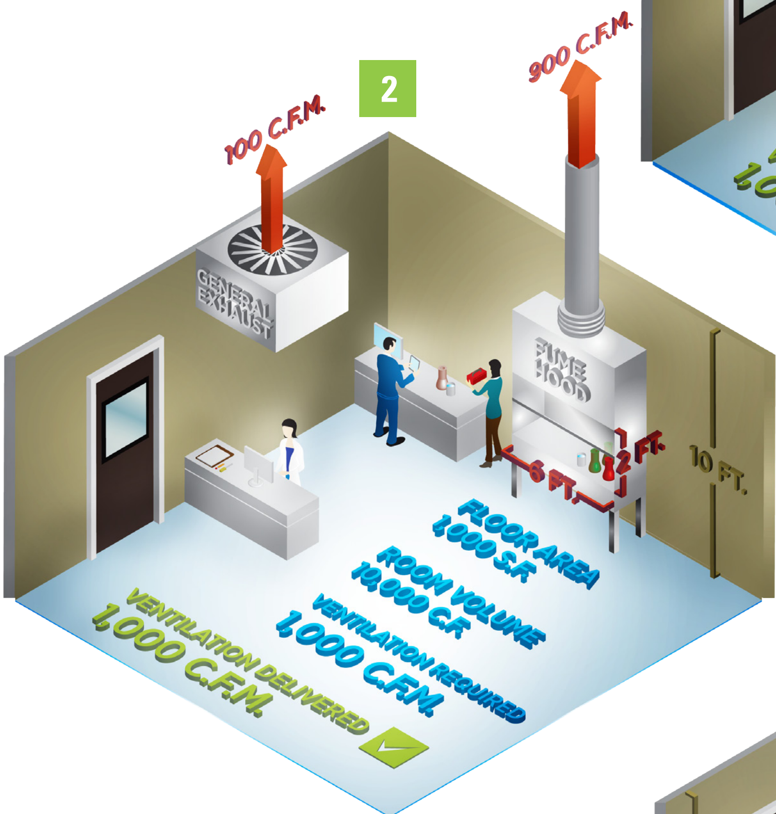
3 EXAMPLE SCENARIOS OF LABORATORY VENTILATION

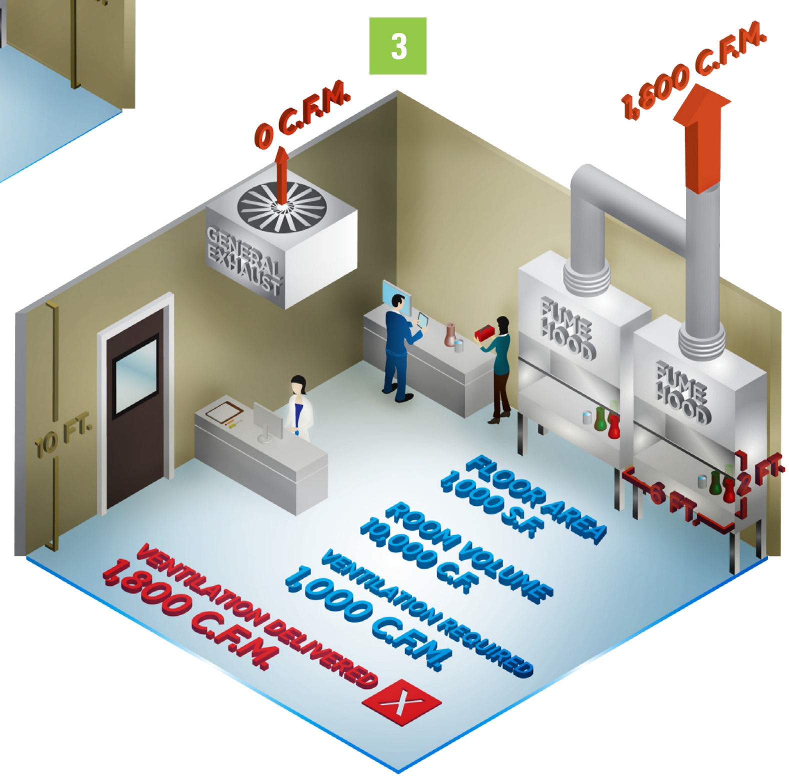
1 ***General Exhaust Dominant, Fume Hood Closed:***
Scenario where the general exhaust is handling the majority of ventilation for a given lab room.

2 ***General Exhaust Dominant, Fume Hood Open:***
Scenario where the Fume hood's ventilation is dominant, but still within the specified room requirements.

3 ***Fume Hood Dominant, Fume Hood Open:***
Scenario where the fume hoods are over-ventilating the space and wasting energy.





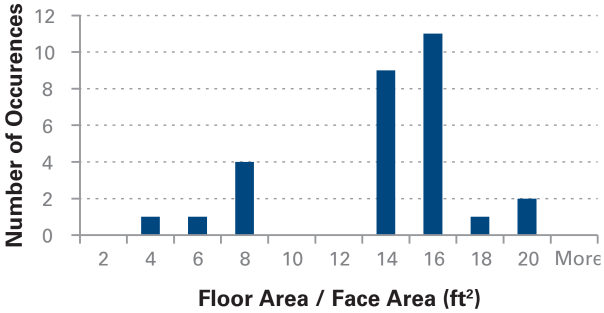


EQUATIONS
Ventilation Required:
10,000 Cu. Ft. x 6 Air-Changes-per-Hour = 1,000 CFM

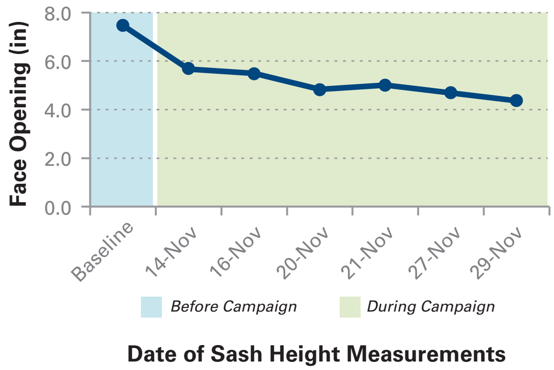
Ventilation Delivered:
General Exhaust + Fume Hood Exhaust

UCLA	Site: Molecular Science Building	Fume Hoods: 163	Rooms: 30	Avg. Face Area: 6.1 SF

HISTOGRAM



UCLA: AVERAGE SASH OPENING



UCLA's fume hood competition took place in the Molecular Science Building from November 11th to November 30th in 2012. The competition included 163 fume hoods in thirty inorganic and organic chemistry laboratories. The competition itself consisted of bi-weekly fume hood sash height measurements, which were later compared to a baseline sash height taken a week before the competition began. Weekly food prizes were given to the labs that reduced their sash heights the most and a grand prize was awarded to the lab that had the lowest overall sash height regardless of baseline and the lab with the largest sash height reduction. The first week's winner had the majority of their sashes shut and the ones that were open were lower than four inches. The second week's winner reduced its overall sash height by 76% compared to the baseline. The lab that won the overall fume hood competition reduced their overall sash height by 68%.

CONCLUSION

Encouraging environmentally sound laboratory behavior can have an impact on energy consumption and can be implemented without excessive cost. The result of even a few inches of reduction of average sash height in fume hood dominated laboratories can yield significant savings. The two STS collaborative campus demonstrations validate the energy savings potential and effectiveness of behavioral changes in fume hood management over a relatively short period. Long-term persistent energy savings will depend upon the continuation of the reduced fume hood sash height which typically requires persistent communications, encouragement, and monitoring. Even in constant volume or general exhaust dominated fume hood areas that are not good candidates for energy saving through reductions in sash height, a closed hood will always be the safest fume hood position.

ADDITIONAL RESOURCES

The Alliance to Save Energy is a nonprofit organization that promotes energy efficiency worldwide through research, education and advocacy. In support of this mission the Alliance maintains a presence on University campuses throughout the country.
http://www.ase.org/

Lawrence Berkeley National laboratory has built a tool that calculates the energy that can be saved by changing fume hood sash height, as well as a multitude of other parameters. The tool can be used in conjunction with room size and general exhaust requirements to calculate expected savings .
http://fumehoodcalculator.lbl.gov/

The Labs 21 group is dedicated to improving the environmental performance of US laboratories. Their website contains links to information on current efforts as well as case studies, best practice guides, and other information related to laboratory efficiency.
http://www.labs21century.gov/

ABOUT THE STATE PARTNERSHIP FOR ENERGY EFFICIENT DEMONSTRATIONS (SPEED) PROGRAM: The SPEED program is supported by the California Energy Commission and managed through the California Institute for Energy and Environment (CIEE). SPEED demonstrations are coordinated by the CIEE in partnership with the California Lighting Technology Center and the Western Cooling Efficiency Center, both at the University of California, Davis.

Any questions about this project, including technology costs, can be directed to:

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For more resources and information, including technology catalogs, business case studies and demonstration maps, visit PARTNERSHIPDEMONSTRATIONS.ORG.