DEMAND CONTROL KITCHEN VENTILATION

Demand ventilation fan speed controller installed at the kitchen of the Carrillo Dining Commons, University of California, Santa Barbara

AVERAGE ELECTRICAL ENERGY SAVINGS
62%

AVERAGE HEATING SAVINGS
25%

AVERAGE CO_2 SAVINGS
39%

AVERAGE INTERNAL RATE OF RETURN
27%

Multiple campus case studies have already been performed using this technology (demand control kitchen ventilation) and the savings are well proven. This study is a summarized compilation of select SPEED case studies to demonstrate the efficacy of the technology in different environments ranging from 7 to 40 horsepower. Installations have been performed for combined hood and make-up air motor nameplate ratings up to 90 horsepower.

PROBLEM

Ventilation in commercial kitchens can account for half of the HVAC energy use in restaurants and dining facilities. Conventionally, kitchen exhaust fans and the associated makeup air handlers are switched manually and left to run at full speed for all operating hours. The power needed to exhaust air in a exhaust hood increase by a cube factor with respect to air flow. This means that even a relatively modest reduction in air flow can result in large energy savings. In addition to direct savings due to reduced fan energy, every cubic foot of air exhausted from the building must be replaced by another cubic foot of unconditioned outside air. By reducing the amount of air exhausted the energy that would have been required to condition this air is saved.

"Melink works well in our kitchen—it saves energy, reduces hood noise and helped secure our certification as a Green Building."

—Ken Guerra, General Manager, Clark Kerr Dining, UC Berkeley

SOLUTION

The Melink Intelli-Hood Controls package is a demand ventilation based energy management system for commercial kitchen exhaust hoods. Its processor controls the speed of the exhaust and make-up air fans through variable frequency drives (VFDs) based on input signals from temperature probes placed within the exhaust duct collars as well as infrared (IR) beams that cross the length of the fume hood. The Melink system will automatically manage fan operation and speed to provide an appropriate degree of ventilation according to temperature and effluent sensed in each kitchen hood. Demand control kitchen ventilation often **reduces fan energy by more than 60%**, and may additionally reduce conditioning loads for these spaces by 20% or more. Simple paybacks range from 4.2 to 7.8 years without incentives.

UCSB CARILLO DINING COMMONS

Climate Zone	Total Motor Power	Rated Exhaust	Cost/IRR*
6	25HP	16,200 CFM	$33k/ 41%

UCB CLARK KERR CAMPUS DINING CENTER

Climate Zone	Total Motor Power	Rated Exhaust	Cost/IRR*
3	17HP	12,200 CFM	$27k/ 40%

UCLA COVELL COMMONS

Climate Zone	Total Motor Power	Rated Exhaust	Cost/IRR*
9	40HP	28,000 CFM	$53k/ 18%

SACRAMENTO CITY COLLEGE

Climate Zone	Total Motor Power	Rated Exhaust	Cost/IRR*
12	30HP	18,500 CFM	$30k/ 30%

BUTTE COLLEGE

Climate Zone	Total Motor Power	Rated Exhaust	Cost/IRR*
12	7HP	10,200 CFM	$20k/ 14%

**Includes utility incentives*

DEMONSTRATION RESULTS

UCSB Carillo Dining Commons

A single demand ventilation fan speed controller was installed at the kitchen of the Carillo Dining Commons replacing a manual switch. The single controller operates four fans in two separate hood systems. The first area operates a 7,000 CFM exhaust fan with a gas heated makeup unit. The second area has two back to back 17ft. hoods tied into a single 9,200 CFM exhaust fan, also with a gas-fired makeup unit. The fans total nameplate power for this demonstration is 25 horsepower.

UCB Clark Kerr Campus Dining Center

The Clark Kerr Campus dining center utilizes two separate demand ventilation fan speed controllers: one for the front server cook line exhaust and supply fans and the other for the back cooking area exhaust and supply fans. The front line uses a single 4,800 CFM, 10-ft. exhaust hood and a 6,800 CFM supply fan with hydronic heating and cooling. The rear cooking area has four separate 8-ft. hoods tied to a single 7,400 CFM exhaust fan and uses a 3,740 CFM supply fan with hydronic heating and cooling. The fans total nameplate power for this demonstration is 17 horsepower.

UCLA Covell Commons

At UCLA four variable frequency fan motor drives and associated MeLink controls were installed at the kitchen of Covell Commons to control three exhaust hood fans and a makeup air unit. The makeup air unit supplies about 22,200 CFM of heated only air to the kitchen. These four fans total 40 nameplate horsepower (35 kW actual load).

Sacramento City College

At Sacramento City College, two controllers operate eleven exhaust hoods and eight exhaust fans. The total system exhaust air volume is 18,500 CFM; the motors total 15HP. A 15 HP make-up air unit introduces 10,000 CFM.

Butte College

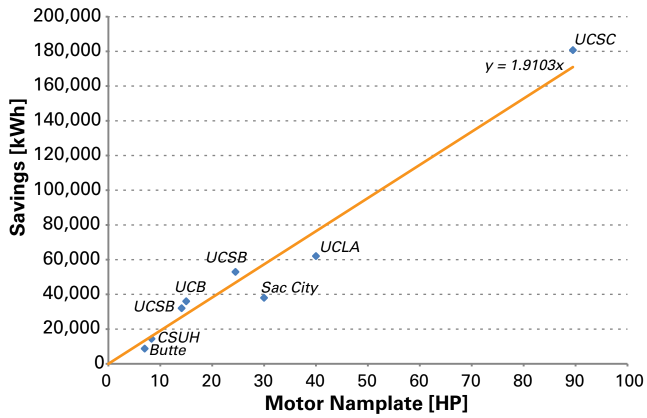
At Butte College, a single demand ventilation fan speed controller was installed at the kitchen of the main dining facility. This one controller operates three exhaust fans, each serving a separate, hood and a make-up air unit. The fans total only 7 HP, and the hoods remove 10,200 CXFM of exhaust from the kitchen. There is about 8,100 CFM of make-up air.

FIGURE 1 & 2: FAN ENERGY SAVINGS

Examining a regression of savings achieved for all these installations shows direct hood fan electrical savings proportional to the total motor power being replaced. Using this information and some estimates regarding the operating hours of the hoods in these studies the annual fan savings model was calculated.

This model can be used to estimate the savings that can be expected from fan motors. This is only one part of the savings that can be expected.

FAN SAVINGS VS. MOTOR NAMEPLATE HORSEPOWER



ANNUAL FAN SAVINGS

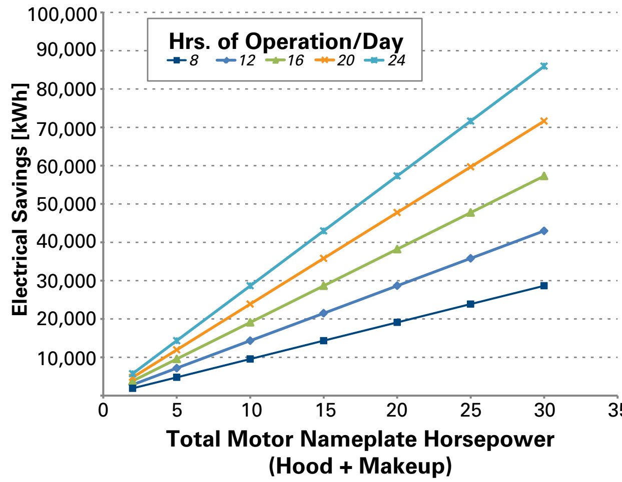
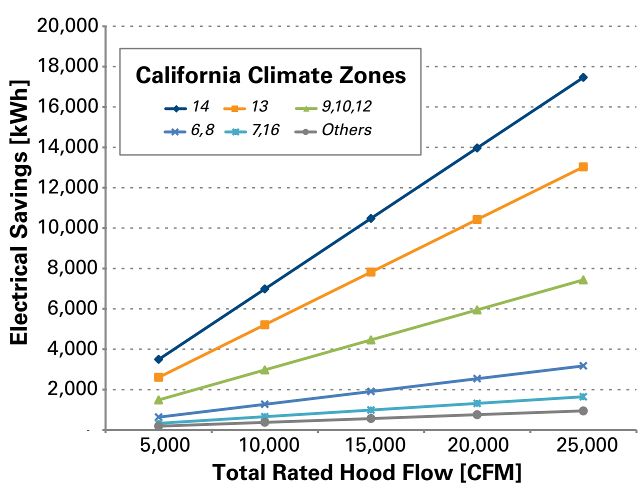


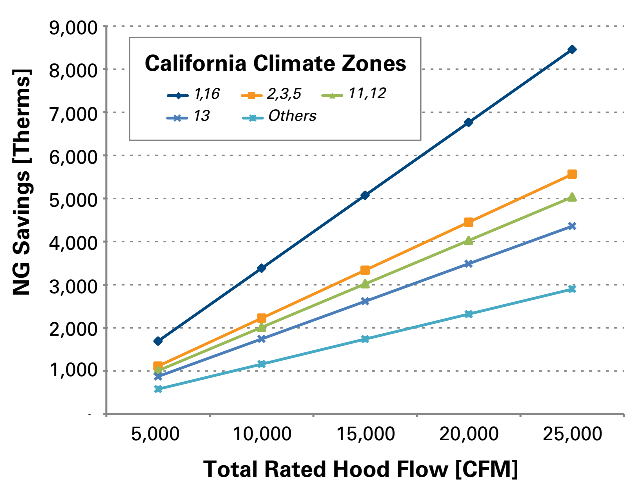
FIGURE 3 & 4: COOLING AND HEATING SAVINGS

Additional savings can be achieved by examining the amount of heating and cooling energy saved by exhausting less conditioned air from the building. For every cubic foot of air exhausted from the kitchen hood, another cubic foot of outdoor air needs to be conditioned and supplied to the building. Heating and cooling savings were not directly measured in each case study, however, an estimation of expected savings can be made based on the expected reduction in exhaust air and some information about which climate zone the proposed project lies in. As would be expected, in hot climates, energy associated with cooling air will be saved, and in cooler climates energy for heating is saved.

ANNUAL COOLING SAVINGS



ANNUAL HEATING SAVINGS



INSTALLATION CONSIDERATIONS

Since kitchen exhaust fans will operate at full speed only when required, the system allows for a higher exhaust rate safety factor in the design without sacrificing the reduced energy consumption of the lower average exhaust rate. Optimized performance and savings can be achieved by effective controller programming tailored for each equipment line and accompanying hood during system commissioning.

Each Intelli-hood processor can receive inputs from up to four separate hoods and then control the VFDs for each hood's accompanying exhaust and supply fans. Cost-effectiveness increases proportionally to the ventilation system size and airflow rates. Aside from the incremental cost difference for larger VFDs, the installed DCKV system cost per hood is relatively independent of exhaust capacity. Furthermore, an estimated $2,000 per system can be saved if installed during new construction or remodel as opposed to retrofit.

Care must be taken to integrate MeLink with the main building HVAC system and make-up air units to maintain proper kitchen pressure. Make-up air supplied to the kitchen should always be somewhat less than that exhausted, with the remainder being made up by "transfer air" from areas outside the kitchen. This assures that a slightly negative kitchen pressure is maintained to make sure that odors from the kitchen do not enter the exterior areas. In some cases, the exhaust fan and the associated make-up air fan can be tied to a single VFD. The result is that reductions in exhaust flow are matched by proportional reductions in make-up air flow, while keeping costs low by utilizing a single VFD.

ECONOMIC EVALUATION

An estimate of total annual savings can be achieved based on expected savings for fan energy, heating and cooling energy and the cost of electricity and natural gas. This can then be coupled with the expected system cost to determine your payback. The installed cost of the MeLink Intelli-hood Controls package at any particular kitchen facility depends on how many control systems the kitchen needs – there is a step up in cost every four hoods.

Typical costs range from $14,000 to $32,000 per system, depending on the number of hoods and fans, and whether the work is new or retrofit. Costs for new construction cases are typically lower because installation complexity is reduced. Energy savings depend on the fan motor loads at full speed, the variability of the kitchen operation during the day, and the number of operating hours in the year. It should be noted that T-24 standards, starting January 1, 2014, requires demand control kitchen ventilation for any hood with a rated flow greater than 5,000 CFM.

The UC/CSU/IOU Energy Efficiency Partnership Incentives program can be used to pay for up to 80% of the project costs. Multiple projects have already been funded and accepted modeling methods exist for estimating the savings and the incentive funding that each project will receive. The 2013 Title 24 requirements will reset the baseline for utility incentives for kitchen hoods over 5,000 CFM and essentially eliminate them. For more information, visit their website at **http://www.uccsuiouee.org.**

PG&E offers a $350 / HP rebate for DCKV installations in its service territory. Information about this program can be found by contacting the Food Service Technology Center at **http://www.fishnick.com**.

ADDITIONAL RESOURCES

The Food Service Technology Center has further resources for calculating savings and planning for the integration of your Demand Control Kitchen Ventilation project. Project resources include design guides, a publication library, and an outdoor air load calculator.

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.

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