Tackling the Big Challenges of Commercial Kitchens Energy Efficiency and the Role of Ventilation Hoods

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FCSI ACCELERATE

Today's Session

- Identify issues surrounding ventilation of cooking processes;
- Review the latest guidelines on vented vs. ventless installations;
- Examine impact of unhooded equipment;
- Examine opportunities to optimize designs; and
- Provide guidance on application of demand-controlled ventilation.

Energy Efficiency for Commercial Foodservice

FRONTIER energy

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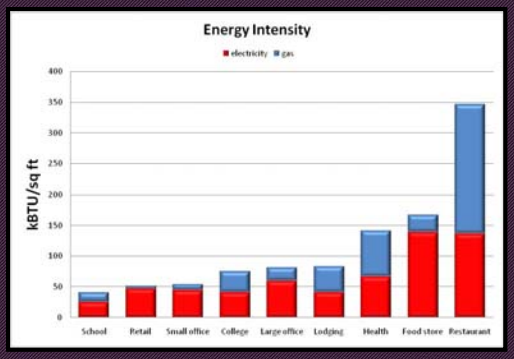
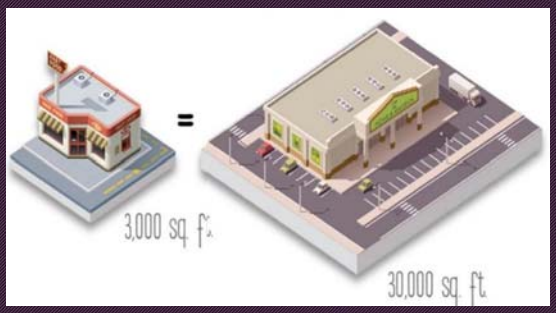
Foodservice is Energy Intensive!



A 3,000 ft² restaurant can have the same energy bill as a 30,000 ft² store



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How current food trends might impact kitchen design?

- Broilers are still in demand
- There could be more refrigeration
- And fewer freezers
- Fried foods are still popular – Can ovens fill in?
- Menu diversity = combination ovens
- Menu diversity + need for speed = rapid cook
- Flexibility + speed = induction

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How Does the Process Impact Ventilation?

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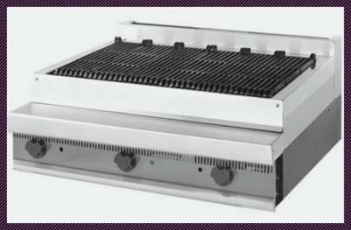
Ventilation Rates Depend on Appliances…



vs.

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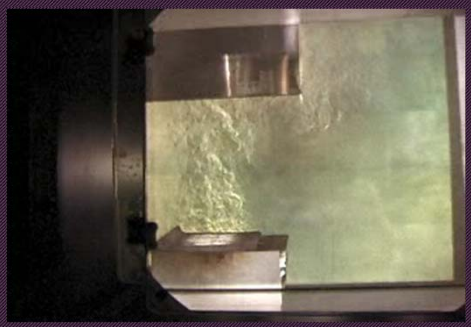
What About Fuel Choice…

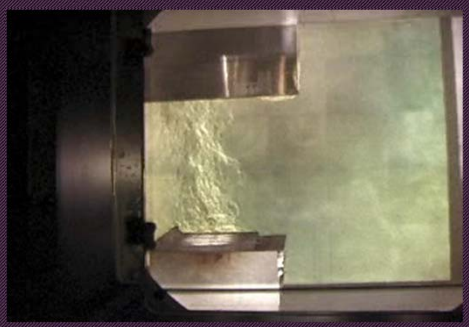
- Does it matter if an appliance is powered with…
- **Natural Gas** or **Electricity**?

Flow Visualization in Action

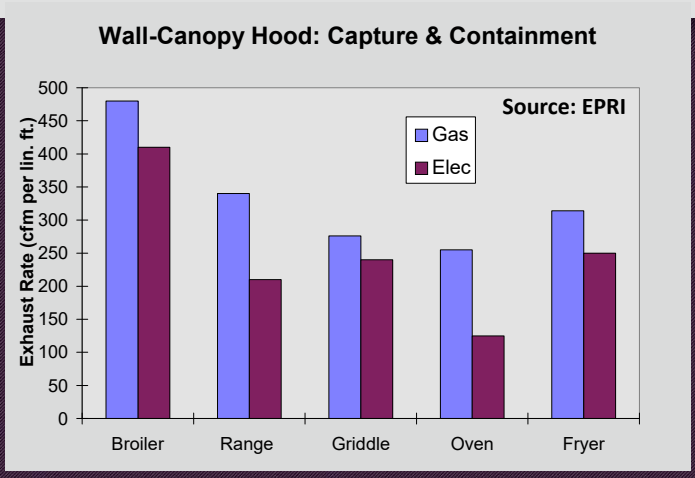
Hood Failure = Spillage



Capture and Containment



Wall Canopy Hood: Capture & Containment



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ASHRAE 154: Light Duty Appliances

- Gas and electric ovens (including standard, bake, roasting, revolving, retherm, convection, combination convection./steamer, conveyor, deck or deck-style pizza and pastry)
- Electric and gas steam jacked kettles
- Electric and gas compartment steamers
- Electric and gas cheesemelters
- Electric and gas rethermalizers

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ASHRAE 154: Medium Duty Appliances

- Electric discrete element ranges (with or without oven)
- Electric and gas hot top ranges
- Electric and gas griddles
- Electric and gas double-sided griddles
- Electric and gas fryers (including open deep-fat fryers, donut fryers, kettle fryers and pressure fryers)
- Electric and gas pasta cookers
- Electric and gas conveyor (pizza) ovens
- Electric and gas tilting skillets/braising pas
- Electric and gas rotisseries

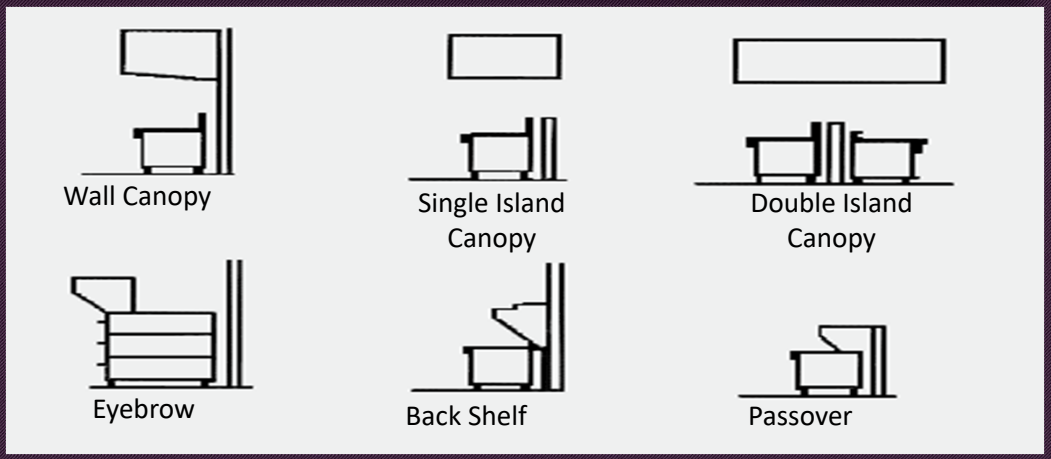
ASHRAE 154: Heavy Duty Appliances

- Electric and gas underfired broilers
- Electric and gas chain (conveyor) broilers
- Gas open-burner ranges (with or without oven)
- Electric and gas wok ranges
- Electric and gas overfired (upright) broilers
- Salamanders

ASHRAE 154: Extra-Heavy Duty Appliances

- Appliances using solid fuel such as wood, charcoal, briquettes, and mesquite to provide *all or part* of the heat source for cooking.

Ventilation Rates Depend on Hood Style:



…and Whether the Hood is

Listed
or
Unlisted

Example: (Both UMC and IMC)

Listed exhaust hoods are to be installed in accordance with the terms of their listing and the manufacture's installation instructions.

Underwriters Laboratories (UL) Standard 710 Exhaust hoods for commercial cooking equipment.

- Part of this UL Standard is a *"cooking smoke and flare up"* test. This test is essentially a capture and containment (C&C) test where "no evidence of smoke or flame escaping outside the exhaust hood" must be observed.
- Hoods bearing a recognized laboratory mark are called listed hoods, while those constructed to the prescriptive requirements of the building code are called unlisted hoods. Generally, a listed hood can be operated at a lower exhaust rate than an unlisted hood of comparable style and size over the same cook line.

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Underwriters Laboratories (UL) Standard 710 Exhaust hoods for commercial cooking equipment.

UL clearly states that under the application of UL 710 *"air flow rates are established under draft free laboratory conditions with the appliance cooking surface temperatures as noted. Greater exhaust and/or lesser supply air flow rates may be required for each specific installation to obtain complete vapor and smoke removal."*

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Typical Minimum Exhaust Flow Rates for Listed Hoods by Cooking Equipment Type*

Type of Hood	Minimum Exhaust Flow Rate (cfm per linear foot of hood) Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-mounted canopy	150 - 200	200 - 300	200 - 400	350+
Single island canopy	250 - 300	300 - 400	300 - 600	550+
Double island canopy	150 - 200	200 - 300	250 - 400	500+
Eyebrow	150 - 250	150 - 250	N/A	N/A
Backshelf/Passover	100 - 200	200 - 300	300 - 400	not recommended

* ASHRAE Applications Handbook

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Size Matters! (or at lease overhang does)

6 inches of Front Overhang

18 inches of Front Overhang

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Not Enough Overhang!

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Free CKV Design Guides Available


Design Guide 1
Improving Commercial Kitchen Ventilation System Performance
Exhaust Hood Selection & Sizing


Design Guide 2
Commercial Kitchen Ventilation
Optimizing Makeup Air

Download @
www.CAenergywise.com

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When is a hood *not* required?

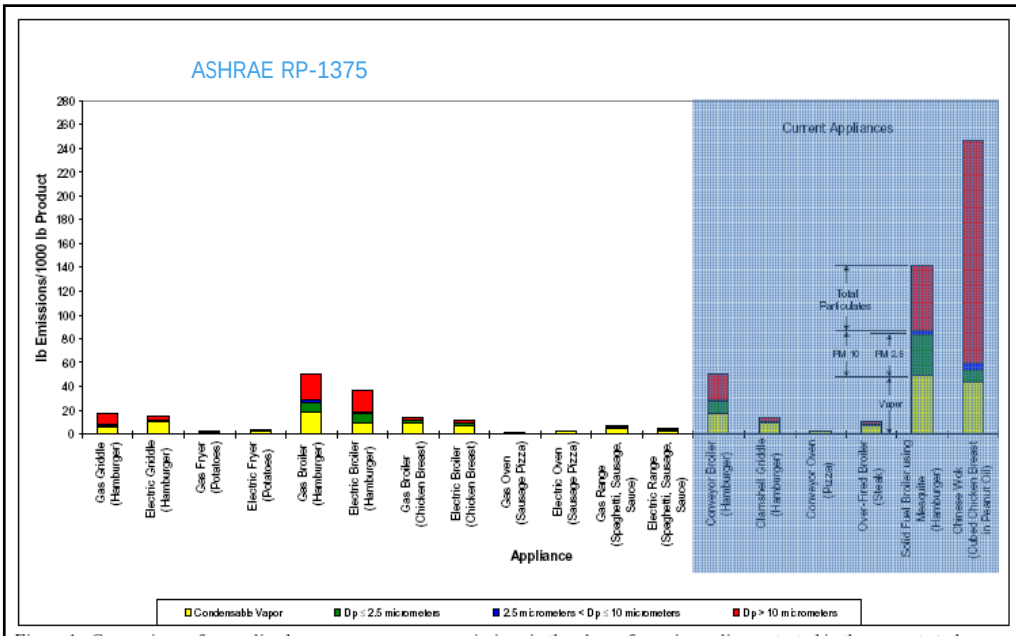

Figure 1. Comparison of normalized average grease mass emissions in the plume from six appliances tested in the present study compared with the emissions measured in ASHRAE 745-RP.

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Ductless Hoods - a Reference Point

UL 710B: UL tests to determine the actual emissions from recirculating hoods and list hoods that meet the NFPA 96 standard

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How Is Ventless Cooking Determined?

- Mechanical and regional Health and Safety Codes require that all cooking equipment in food facilities be vented for the removal of toxic gases, heat, odors, steam, and grease laden vapors
- The *critical* determination is when the concentration of grease laden vapors in the discharge air are **greater than 5 mg/m^3**
- Anything less is not considered a hazard in the breathing zone

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Where did 5 mg/m³ come from?

- This concentration originally came from industrial hygienists regulating oil droplets concentration from metals machining process
- NFPA 96: In response to the development of recirculating hoods and the hood industry asking, what the threshold for emissions should be, the NFPA adopted the 5 mg/m³ TLV concentration level at the discharge end of the recirculating hood

How about Unhooded Appliances?

- ASHRAE Standard 154-Ventilation of Commercial Cooking Processes: Takes into account the effect of the cooking appliance on the ventilation system of the building and classifies according to a "duty" rating
- ASHRAE adopted a concentration level as part of a use requirement to where you use a hood. They expanded the conversation from recirculation hoods to hood exemptions for certain cooking equipment

There is No Uniformity!

- Emission limit of 5 mg/m3 for ductless hoods (UL 710B) may be recognized by the Authority Having Jurisdiction (AHJ).
- UL now lists appliances in accordance with UL KNLZ for use without a hood – but recognition by the AHJ is not consistent across the country.
- The AHJ can limit the quantity of unhooded equipment allowed in a commercial space.

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Typical Unhooded Appliances

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Potential for big savings from small loads?

- California Energy Commission EPIC Research Project EPC-15-027
- Electric Plug Load Savings Potential Commercial Foodservice Equipment (www.Fishnick.com/cecplug)
- Appliance Plug Loads can be substantial, considering that there are approximately 1 Million commercial food service (CFS) facilities operating nationwide.

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Unhooded Equipment on a Typical Prep-line

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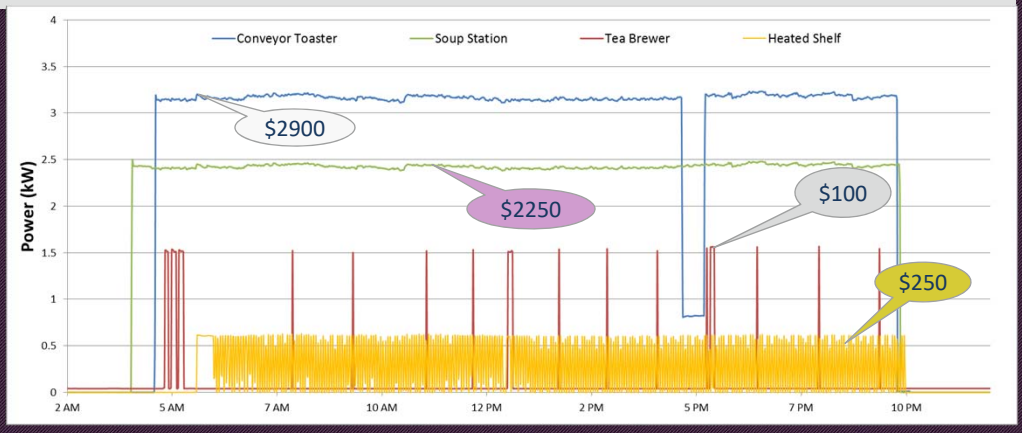
Small Appliances…Big Energy



@ $0.15/kwh

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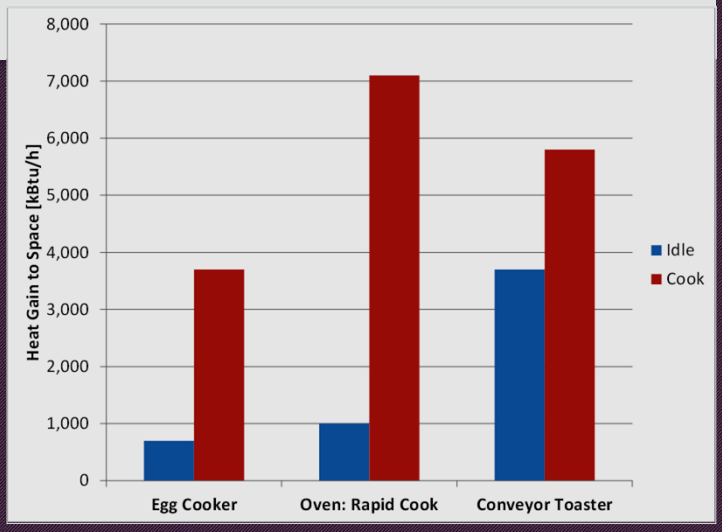
Unhooded Counter Top Appliance Heat Gain from RP-1631



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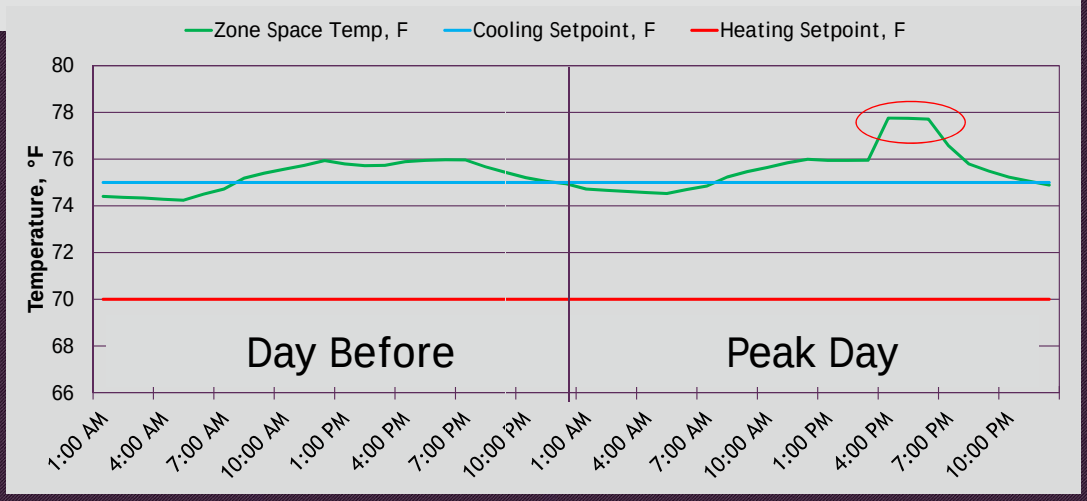
What Happens if We Add a 5 kW Rated, 2 kW Peak Load (40% diversity) Thermostatically Controlled *Unhooded Load*?

Kitchen Space Temperature and Setpoints



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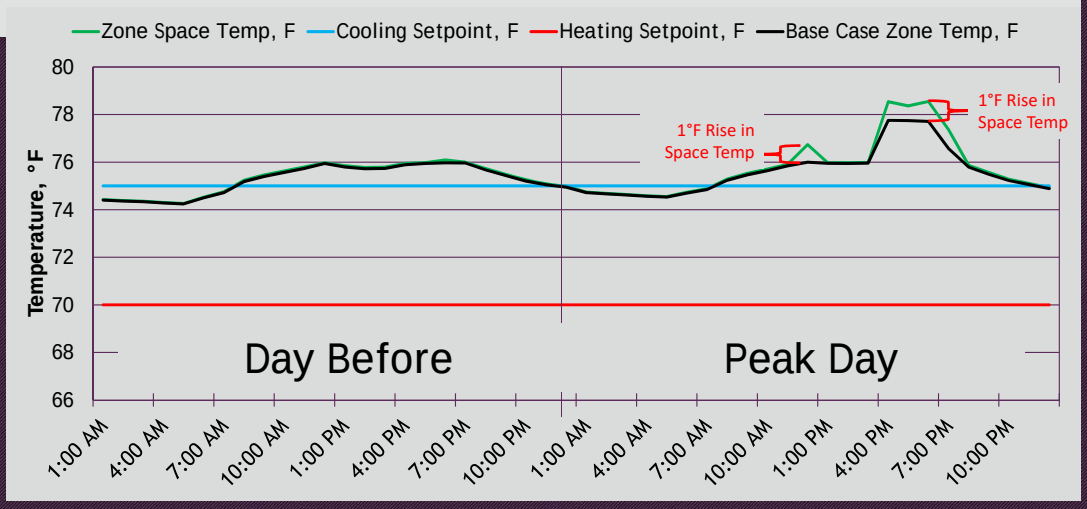
Kitchen Space Temperature and Setpoints



Impact of Adding a 5 kW Rated/2 kW Peak Unhooded Appliance

- Total unmet (above setpoint) load hours increased from 3 to 6 hours
- This is an example of a restaurant with HVAC that meets loads most of the time, but it is at the margin

"Ventless" Dishwashers

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School Kitchen Case Study:

	Water Use (gal/d)	Electricity Use (kWh/d)	Gas Use (thm/d)	Total Utility Cost ($/d)
Original 108" Rack Conveyor Dishwasher	1372	21	30.2	$57
Replacement 86" Rack Conveyor Dishwasher	628	276	3.2	$52
Savings Percentage	54%	-92%	89%	9%

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Back to the Main Kitchen Ventilation System

More than 3 Billion CFM…

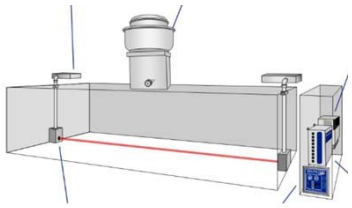
…exhausted from Commercial Kitchens in the U.S.

A Ventilation Problem:

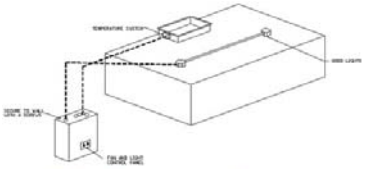
- The kitchen exhaust hood operates at 100%.
- All day long. (And sometimes all night as well.)

- **Whether you are cooking or not!**

Solution: Demand-Controlled Ventilation



Duct Temperature Sensor & Vapor Detection



Duct Temperature Sensor

Duct Temperature Sensor & Infrared Sensors

Emerging Technology Award

IN THIS SECTION

- 2016 Innovative Refrigerant Systems
- 2015-2016 Demand Control Kitchen Ventilation
  - Criteria Development Process Documents
- 2014 Advanced Clothes Dryers
- 2013 Advanced Clothes Dryers
- 2011-2012 Micro Combined Heat and Power

2015 – 2016 Demand Control Kitchen Ventilation

The U.S. Environmental Protection Agency (EPA) is pleased to recognize Demand Control Kitchen Ventilation (DCKV) with the ENERGY STAR® Emerging Technology Award for 2015 – 2016. DCKV technologies employ advanced sensors and variable speed controls to offer end users significant reductions in energy use and CO_2 emissions compared to standard kitchen ventilation systems. Field studies suggest that energy savings could be 60% or more depending on the facility and type of operation.

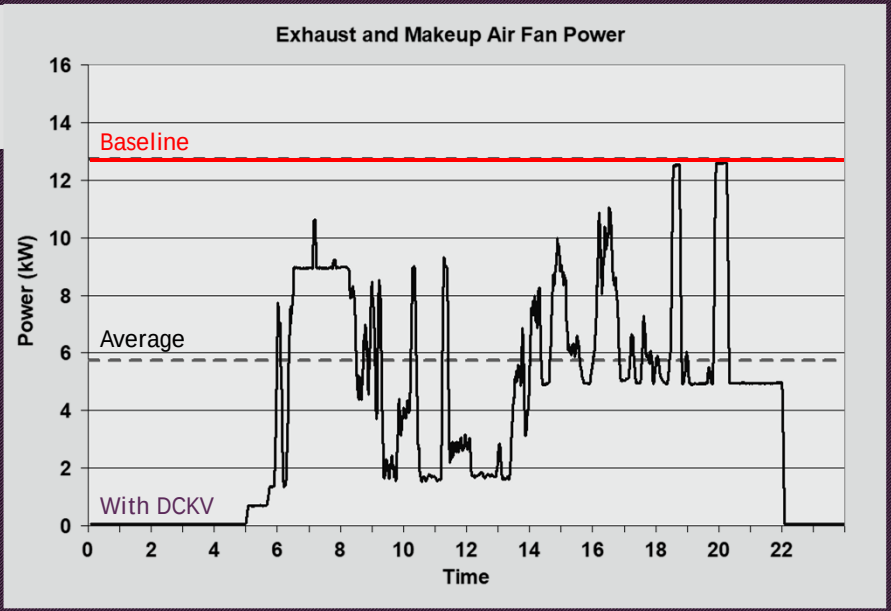
Systems that meet the performance criteria for DCKV will be listed on this webpage once it is determined that all Award criteria have been satisfied. Manufacturers can submit documentation for eligible DCKV systems to emergingtech@energystar.gov.

2015 Emerging Technology Award-Winning Demand Control Kitchen Ventilation Systems

- List of 2015 Emerging Technology Award Systems (PDF, 204 KB)

DCKV Case Study: University Dining Hall

Exhaust Fans:



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DCKV Savings Analysis

Design Exhaust Ventilation Rate	**12,000 cfm**
Average Fan Speed Reduction	**23%**
Average Fan Power Reduction	**6.98 kW**
Fan Energy Savings*	**$4,100**
Estimated Heating/Cooling Energy Reduction*	**$2,350**
Total Operating Cost Savings*	**$6,450**
Estimated Payback	**2.5 years**
*Based on 300 days/yr, $1.000/thm and 11.5¢/kWh	

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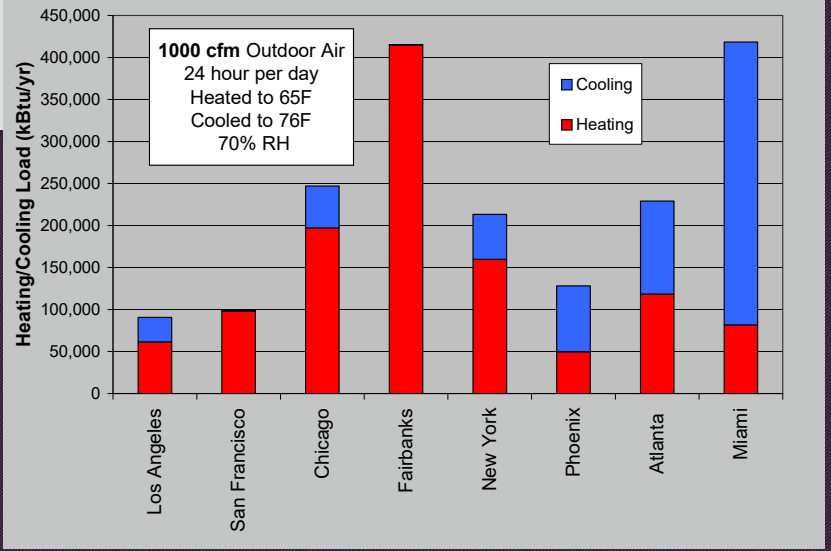
Climate Effect



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Ideal Candidates for DCKV

- Large exhaust hoods (more cfm = More HP = More $Savings)
- Dedicated fans for individual hoods
- Long operating hours (8+ hours/day)
- Diverse appliance lines
- Light to Medium duty appliances
  Ovens, Steamers, Fryers & Griddles)
- Minimal Charbroiling

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on the economic incentives of saving energy
before they will **act**

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Thanks!

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Resources for Evaluation of Cooking Equipment for Exemption

- **UL 710B**: UL tests to determine the actual emissions from recirculating hoods and list hoods that meet the NFPA 96 standard
- **UL710B/UL 197**: Electrical cooking appliances rated at 600 volts or less. If its listed, it is exempted
- **UL KNLZ**: Cooking equipment with integral systems for limiting the amount of grease laden air including the use of catalytic combustion technology

ASHRAE Research

- RP-1362 -- Revised Heat Gain and Capture and Containment Exhaust Rates from Typical Commercial Cooking Appliances (2008)
- RP-1469 -- Thermal Comfort in Commercial Kitchens (2013)
- RP-1631 -- Countertop Commercial Appliance Emissions (2016)
- Talbert S.G. et al., CH-2260 -- An Experimental Study of Ventilation Requirements of Commercial Electric Kitchens (1973)