Energy Management in Academic Foodservice using Demand-Controlled Ventilation (DCV)

David Reynolds,
Business Development Manager
Halton Group - Foodservice Division
www.haltoncompany.com

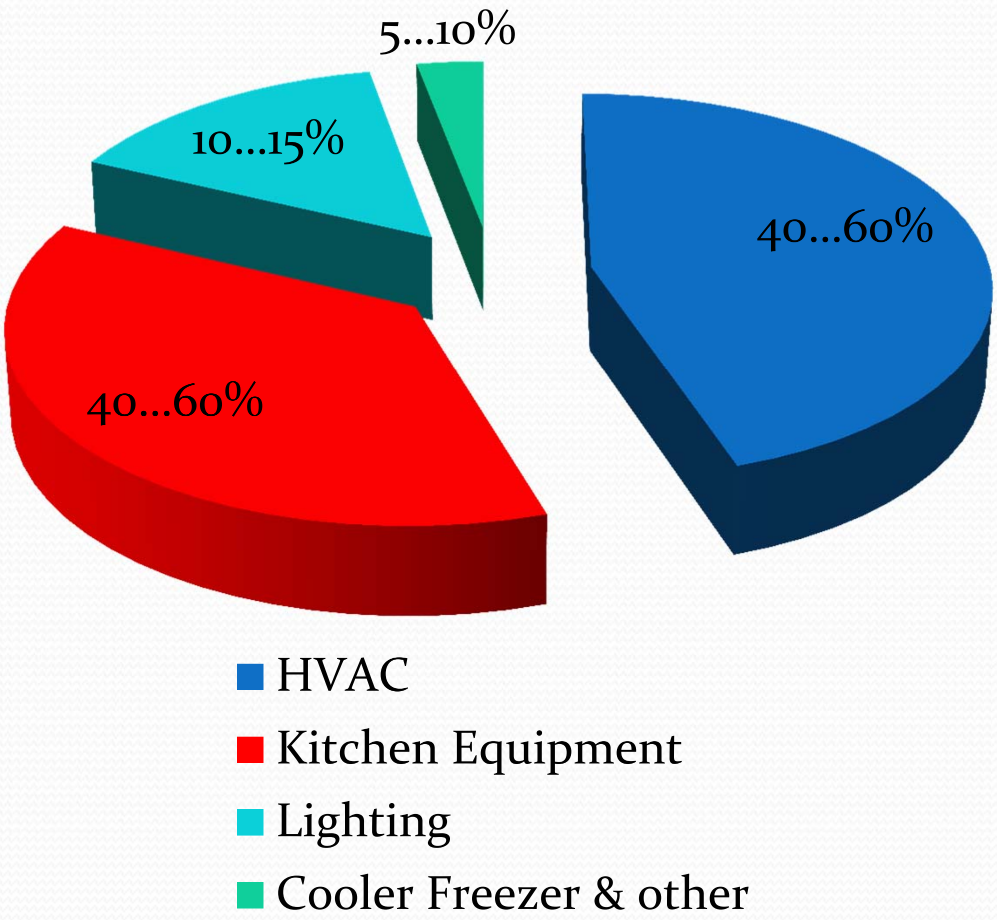
Why are Campus Kitchens Overlooked for Energy Efficiency?

- Not always the **Facility Manager's responsibility** ?
  - Is Kitchen area managed by Foodservice Contractor?
- **Excess (Wasted) air is "invisible"**
  - Usually not monitored or managed because it is undetected loss
  - Can reduce both Electric & Gas bills – WHY?
    - Make-up Air (MUA) usually heated or cooled (Costly air replacement !!!)
  - Kitchens: Negative pressure" designs (Pulls bldg. air to kitchen)
    - Additional MUA supplied from Office/ Open area HVAC system
- Kitchen energy isn't <u>directly</u> monitored or separated on bill
  - **Implement sub-metering** to define actual usage in space
  - **Less Exhaust air = Less Make-Up Air** (MUA) required
    - If excess Exhaust CFM controlled, then Supply (MUA) reduced to match

Kitchen Energy - Overproduction !

- **Existing kitchen hoods** used much higher design exhaust CFM/per lineal ft. standards
  - Estimate: 20% higher CFM's (very inefficient vs. current day !!!)
  - More efficient kitchen hood design parameters are used today
  - **Retrofit kits** can reduce existing overall kitchen exhaust CFM's
- M.E. firms generally **add a "safety factor"** to roof fan H.P. sizing assuring good ventilation in kitchen space (no smoke)
  - Estimate: 10 – 25% depending on the project/ application
  - Be Aware: New **ASHRAE 90.1 (2010) code standards** will limit/ reduce the CKV – Exhaust CFM's allowed in new facilities
    - Won't affect existing kitchens, but shows importance on energy focus
    - For New Construction/ Renovation Kitchens (over 5,000 CFM)
      - CKV "energy saving options" will be required (e.g. choice of DCV)

"Typical" Commercial Kitchen energy consumption footprint



- Buildings with commercial kitchens are one of the **highest energy consumers** of all building types
- HVAC (CKV) & kitchen equipment contribute up to **80% of total dining service building energy consumption**

How to reduce Kitchen Energy Consumption in Campus Dining

- Utilize “**Whole Building Design**” approach
- Design efficient **HVAC (CKV) system**
  - <u>Minimize</u> kitchen hoods exhaust airflow
    - Use High Efficiency Kitchen exhaust hoods
    - **Use Demand Controlled Ventilation (DCV)**
- Select efficient **Kitchen equipment**
  - Energy efficient cooking equipment is available
    - “Energy Star” models
      - Both Gas and Electric models
      - Lower BTU or KW inputs

DCV - Adaptable to most Kitchens

- DCV (Demand Controlled Ventilation) is an **automatic** control system that regulates (and balances) the kitchen hood exhaust and make-up airflow **based on demand from cooking process**
- Supplies the right **amount of energy**, at the right **time**, and right **when and where** it's needed
- Kitchens > 5,000 CFM: DCV usually has effective ROI

Appliance status	Hood status
COOKING →	Operates at **Maximum design airflow** (Exhaust CFM)
IDLE →	Modulates **BELOW** Max. design airflow (reduced by 20-50%)
OFF →	**Off** (No hood airflow)

DCV – System Models

- **Exhaust Temperature + Cooking Activity Sensor**
- Two types of DCV cooking activity sensors available
  - 1) Infrared **light beam** across the hood to **detect visible smoke or steam** associated with the beginning of cooking process
  - 2) Infrared array **temperature sensors** continuously **monitor surface temperature** of appliances under the hood
  - Minimum exhaust fan speed default = **60% of design** exhaust airflow
  - Option: **Single Hood VS. Multiple Hood** on Common Fan/ Ductwork
- **Temperature Only**
  - Minimum exhaust fan speed default = **80% of design** exhaust airflow for systems with constant exhaust temperature set-point
  - **Delayed responsiveness** with temperature sensor only at duct collar and **no secondary activity-sensor** capability
    - If DCV has constant Exhaust Temperature Set-point (Variable)
      - **Settings must be adjusted** from Winter to Summer months

DCV - Control Systems types

- **Energy Management Control Systems (EMS)**
  - Energy controls monitoring a specific area/ function
  - Sub-metering required for optimal energy management
- **“Building Automated System” (BAS)**
  - **Integrated systems approach** for multiple EMS control systems in the building
  - **DCV systems** can usually be integrated easily
    - BACnet, Modbus, and LonWorks are common protocols used
  - List of monitored “Control Points” (Metrics) supplied to Architect (Design Team) in design process assures BAS control wiring diagrams are complete

DCV Systems = Calculation Data

- **HEAT Example (Energy Savings Analysis Software)**
- **<u>Data Inputs</u>**
  - Weather City
  - Hours of Operation: Hrs/Day - Days/Wk - Wks/Year
  - Energy Costs: Electric and Gas
  - CKV System: Design CFM Exhaust/ Make-up Air requirements
  - Costs: Ventilation System (Kitchen Hoods & DCV system control)
  - Energy Modeling Schedules – by Market
- **<u>Report Calculates Annual Energy Savings</u>**
  - Electric Energy Reduction (kWh/ per year) = $$$
  - Gas Energy Reduction (Therm/ per year) = $$$
  - Greenhouse Gas Reduction (Lbs. of CO_2) = $$$
  - TOTAL PAYBACK SAVINGS (ROI) = $$$
- Used as Utility Energy Rebate Submission support documents

DCV Case Study

- Evaluated Site Configuration
  - Four canopy hoods attached to single exhaust fan
  - Demand control ventilation (DCV) installed
  - Design Exhaust Airflow = 11,290 CFM
  - Balancing dampers installed on each hood to independently regulate exhaust proportional to “actual” cooking demand

DCV CONTROLS YIELD BIG SAVINGS !

Energy Impacts Kitchen Hood System w/ Single Roof Fan/Duct	Estimated Savings			
	Heating [Therms] $1.20/Therm	Cooling [kWh] $0.12/kWh	Exhaust Fan [kWh]	Supply Fan [kWh]
DCV w/ Dampers (Individual Hoods)	1,307	7,425	38,075	12,692
DCV w/o Dampers (All Hoods operate as Total System)	436	2,475	15,705	5,235
Energy Difference	**871**	**4,950**	**22,370**	**7,457**
Energy Cost Savings/YEAR	**$1045**	**$594**	**$2684**	**$895**

Energy Systems require Routine Preventative Maintenance

- After installation, HVAC/ CKV systems should be "**optimized**" by DCV manufacturer and/or BAS - Controls contractor
  - **Start-up:** Assures installation per M.E. design specification
- Energy management system (EMS) monitor/control sensors require occasional "system" checks to assure proper operation
  - **Operation: "Monitoring" does not equate to "Control"**
  - Routine calibration is recommended to assure maximum energy savings and comfortable working/dining conditions all day
- Automatic DCV controls **detect system "weakness**" in HVAC
  - Reduces overall costs because "Emergency Fixes" cost more than "Preventative Maintenance" solutions
  - Examples: Roof fan issues, Ducts, Space Temp. "spikes", etc.

Summary of Key Points

- **MOST CAMPUS KITCHENS AREN'T MONITORED**
  - COMMERCIAL KITCHENS ARE <u>HUGE</u> ENERGY CONSUMERS
  - **"SUB-METERING"** ALLOWS SPACE ENERGY MONITORING
- **"DEMAND CONTROLLED VENTILATION (DCV)**
  - **MATCHES ENERGY USAGE = ENERGY REQUIRED**
- ENERGY MANAGEMENT: EMS & BMS/BAS SYSTEMS
  - **ENERGY MONITORING IS <u>NOT</u> ENERGY MGMT.**
    - SET "CONTROL" POINTS FOR BMS/BAS SYSTEM (METRICS)
- SAVE BOTH MONEY & TIME OVER TIME
  - **ROUTINE PREVENTATIVE MAINTENANCE A "MUST"**
  - TURNS "EMERGENCIES" INTO "SCHEDULED" MAINTENANCE

COLLEGE & UNIVERSITY – DCV SITES

- Dartmouth College*
- Francis Tuttle –Culinary*
- Oklahoma University*
- Bellingham Technical College*
- Whitworth University*

Harvard GSE*
Univ. of Saint Thomas*
University North Dakota*
Western Kentucky Univ.*
SDCCD (Miramar College)*

* Real-time Internet Monitoring (including alarms sent to Facilities staff)

* First Year Monitoring included with new MARVEL system

* Requires Annual Energy Monitoring contract (HGS)

- Boston College
- University of Colorado
- UCSD-Stuart Commons
- UCLA-South Campus
- Univ. of Hawaii -West Oahu
- George Brown College

University of Wisconsin
Colorado College
Oklahoma State Univ.
St. Johns University
Berklee - College of Music
McMasters University

Questions?

David Reynolds
Business Development Manager

www.haltoncompany.com
dave.reynolds@halton.com

Halton