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

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

VIEW OF COMMERCIAL KITCHENS

"BLACK HOLE"

Sucking Energy from Building
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 directly 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)
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
  - Minimize 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.

<table>
<thead>
<tr>
<th>Appliance status</th>
<th>Hood status</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOKING</td>
<td>Operates at <strong>Maximum design airflow</strong> (Exhaust CFM)</td>
</tr>
<tr>
<td>IDLE</td>
<td>Modulates <strong>BELOW</strong> Max. design airflow (reduced by 20-50%)</td>
</tr>
<tr>
<td>OFF</td>
<td><strong>Off</strong> (No hood airflow)</td>
</tr>
</tbody>
</table>
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)
- **Data Inputs**
  - 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
- **Report Calculates Annual Energy Savings**
  - 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!

<table>
<thead>
<tr>
<th>Energy Impacts</th>
<th>Estimated Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen Hood System w/ Single Roof Fan/Duct</td>
<td>Heating [Therms] $1.20/Therm</td>
</tr>
<tr>
<td>DCV w/ Dampers (Individual Hoods)</td>
<td>1,307</td>
</tr>
<tr>
<td>DCV w/o Dampers (All Hoods operate as Total System)</td>
<td>436</td>
</tr>
<tr>
<td><strong>Energy Difference</strong></td>
<td><strong>871</strong></td>
</tr>
<tr>
<td><strong>Energy Cost Savings/YEAR</strong></td>
<td><strong>$1045</strong></td>
</tr>
</tbody>
</table>
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 HUGE 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 NOT 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

<table>
<thead>
<tr>
<th>Dartmouth College*</th>
<th>Harvard GSE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Francis Tuttle –Culinary*</td>
<td>Univ. of Saint Thomas*</td>
</tr>
<tr>
<td>Oklahoma University*</td>
<td>University North Dakota*</td>
</tr>
<tr>
<td>Bellingham Technical College*</td>
<td>Western Kentucky Univ.*</td>
</tr>
<tr>
<td>Whitworth University*</td>
<td>SDCCD (Miramar College)*</td>
</tr>
</tbody>
</table>

* Real-time Internet Monitoring (including alarms sent to Facilities staff)
  * First Year Monitoring included with new MARVEL system
  * Requires Annual Energy Monitoring contract (HGS)

<table>
<thead>
<tr>
<th>Boston College</th>
<th>University of Wisconsin</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Colorado</td>
<td>Colorado College</td>
</tr>
<tr>
<td>UCSD-Stuart Commons</td>
<td>Oklahoma State Univ.</td>
</tr>
<tr>
<td>UCLA-South Campus</td>
<td>St. Johns University</td>
</tr>
<tr>
<td>Univ. of Hawaii -West Oahu</td>
<td>Berklee - College of Music</td>
</tr>
<tr>
<td>George Brown College</td>
<td>McMasters University</td>
</tr>
</tbody>
</table>
Questions?

David Reynolds
Business Development Manager

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