



Guidance on Demand- Controlled Kitchen Ventilation

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Introduction

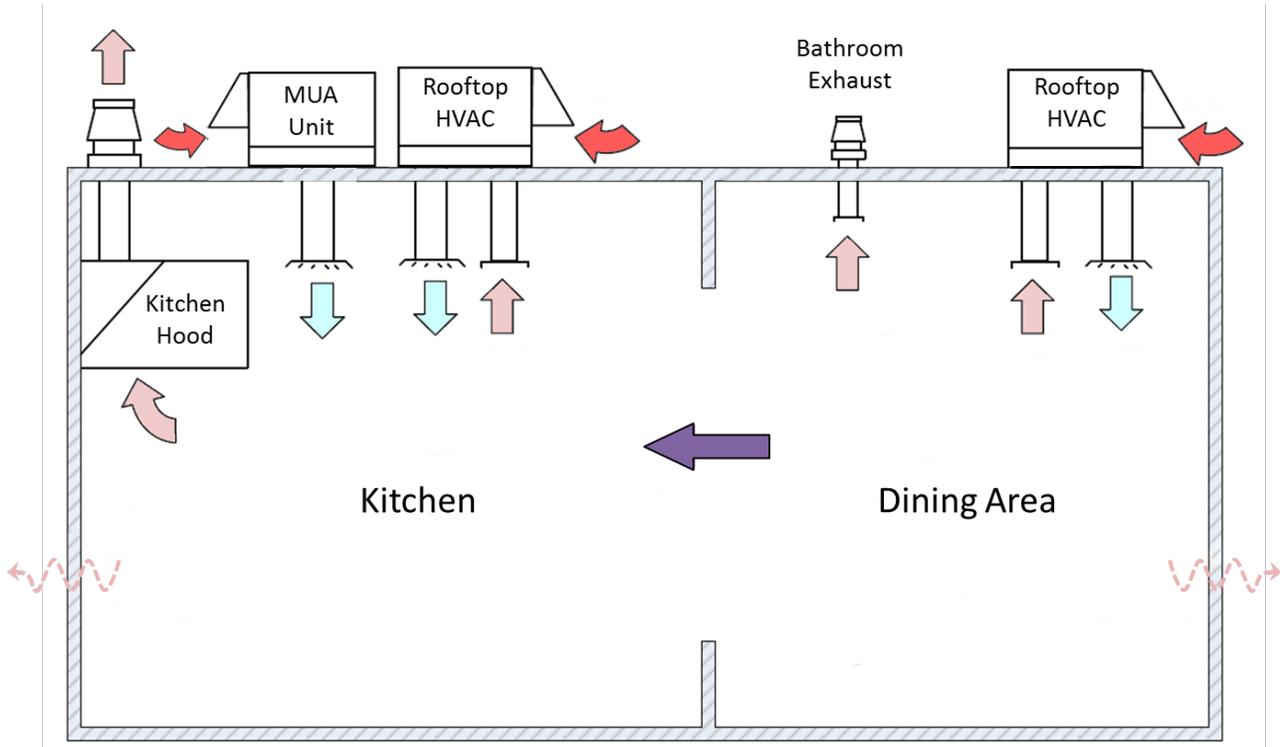
This report provides guidance on Demand Control Kitchen Ventilation (DCKV) systems in commercial food service facilities. The report explains how DCKV works and describes the components of a typical system. It also discusses important factors that affect the amount of benefit an owner and operator might get by installing a DCKV system. Finally, it provides helpful information about installation, project planning, and evaluating whether upgrading an existing exhaust system would be beneficial.

DCKV systems adjust the quantity of kitchen hood exhaust and incoming outdoor air, leading to energy and cost savings. Other benefits may include decreased heating and cooling energy and a reduction in HVAC and ventilation equipment deterioration. The energy and cost savings that can be achieved by installing DCKV varies between food service facilities due to site- and equipment-specific factors such as geographic location, operating hours, DCKV system features, and system cost.

Air Flow and Ventilation

Before discussing the specifics of DCKV, it is helpful to understand the basics of air flow and ventilation in a typical food service facility. Figure 1 is a schematic representation of how the air commonly flows in a quick-service restaurant. Rooftop HVAC units, often referred to as rooftop units or RTUs, supply conditioned air to the building. In this example RTUs bring in hot outside air (represented by red arrows), cool the hot air, and distribute it through supply vents (represented by blue arrows).

Figure 1: Schematic of a common commercial food service ventilation configuration ¹



Makeup Air

The amount of air flowing through a hood operating at normal capacity is substantial. Without adequate makeup air for the hood, problems such as suction on kitchen doors and inadequate containment of cooking effluents can occur. To make up for air exhausted through the kitchen hood, outside air must be brought into the building. The replacement air associated with the hood exhaust flow is known as makeup air, or MUA.

While makeup air can come from various sources, most food service facilities are designed with a dedicated makeup air unit to supply a major portion of this flow, as shown in Figure 1. Makeup air units may include heating, evaporative cooling, and dehumidification.

Introducing large volumes of makeup air into the kitchen can be complex. For example, it is important to avoid high air velocities in portions of a kitchen that can reduce hood effectiveness and cause employee discomfort. This can be especially important for large kitchens. ⁱⁱ

Air Balance

Refer again to Figure 1 and note the purple arrow that points from the dining area to the kitchen. That arrow shows that any air transfer between these two areas must flow towards the kitchen. This ensures that grease, smoke, fumes, heat, steam, and odors do not enter the dining area.

In addition, note the pink dotted-line arrows directed outward from both the kitchen and dining areas. Those indicate that the pressure in the building should be slightly higher than the pressure of outdoor air. This is realized by having the flow of outdoor air into the restaurant be greater than the total amount of air leaving the restaurant.

In summary, the implementation of a functional and efficient ventilation solution for an entire food service operation can be a complex matter, involving both air speed and flow balancing within and between building spaces.

Conserving Energy with Demand Controlled Kitchen Ventilation

Demand-controlled kitchen ventilation (DCKV) saves energy by adjusting the quantity of kitchen hood exhaust and incoming outdoor air to reflect the amount of cooking taking place under the hood. Periods of

Is DCKV right for you? Key Factors to Consider

- ▶ **The size of your kitchen ventilation system.** DCKV provides the best return on investment (ROI) in kitchens with exhaust flow rates of 5,000 CFM (cubic feet per minute) or higher. Exhaust flow rates below 3,000 CFM typically don't justify investment.
- ▶ **Hours of operation at reduced air flow.** A kitchen with short hours of operation and high levels of cooking will achieve less energy savings versus a kitchen with longer hours of operation and more opportunities for ramping down the hood.
- ▶ **The climate of your food service facility;** more specifically, the amount of heating and cooling of makeup air that occurs throughout the year. The greater the amount of air treatment (including both temperature and humidity), the greater the benefit from using DCKV.
- ▶ **Utility rebates available in your area.** These can vary widely, in some instances reducing the net cost significantly. It's worth contacting your local utility to learn what rebates are available.
- ▶ **Costs,** including purchase, installation, your local price of electricity, and upkeep of the system.
- ▶ **Indirect economic factors** such as the impact of installation and commissioning on your operations, increased kitchen comfort, and decreased noise.

reduced cooking activity are opportunities for ramping down the air flow to the exhaust hood. Owners or operators of commercial food service facilities can benefit from DCKV in two ways:

1. **Exhaust and makeup fan motors in commercial kitchens** are used less intensely and less often, resulting in energy and cost savings as well as reduced noise. In some cases it may reduce wear and tear on the equipment.
2. **Makeup air** that replaces the air that passes through the hood is often supplied by the building's heating, ventilation, and air conditioning (HVAC) system. When this occurs, lowering kitchen ventilation equipment also reduces HVAC heating and/or cooling usage. This generates similar energy and cost savings, and less equipment deterioration. When there is significant conditioning of air, this can provide the greatest cost savings from reducing kitchen ventilation.

Achievable Savings

Energy and cost savings depend on many factors, including the climate in which it is located. However, significant energy savings are to be achieved.

- ▶ Nationwide, HVAC systems account for about 30% of the total energy consumed in food service facilities. The average in different climates varies from 24-36%.ⁱⁱⁱ
- ▶ The portion of this HVAC-system energy expended on kitchen ventilation depends on many site-specific factors, but it can be quite substantial—as large as 75-95% in some cases.

How Demand-Controlled Kitchen Ventilation Works

To control a facility's ventilation and HVAC in response to changing cooking levels, DCKV does the following:

1. Detects cooking activity under the hood, using sensors
2. Analyzes the sensor signals to determine how much cooking is taking place, using a processor
3. Figures out the adjustment to be made to the ventilation system and sends signals to the ventilation system controls, using the processor
4. Makes adjustments to the exhaust hood fan and outdoor air HVAC equipment, using equipment controls

Figure 2 portrays this process for an illustrative DCKV system.

Panda Express

Location: Quartz Hill, California

Exhaust Flow: 6,000 CFM

Makeup Air Flow: 4,800 CFM

Daily Hours of Cooking: 13.1 hours

Average Fan Energy Reduction: 61%

Expected Payback Period: 3.5 years at \$0.15/kWh

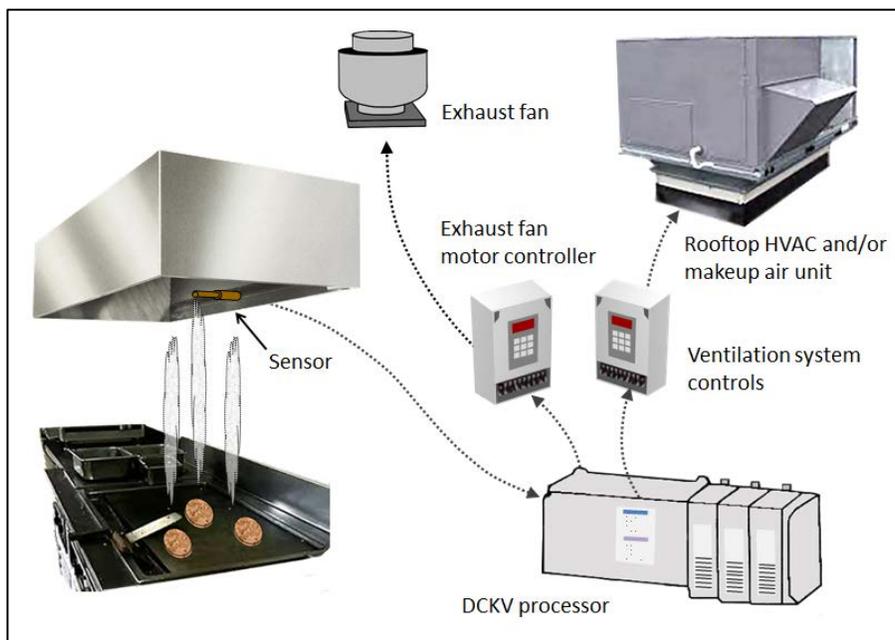
Date of Field Study: 2006

Panda Express is a quick-service restaurant serving Chinese food. Air flow is relatively high compared to a typical quick-service restaurant, due to heavy heat load from woks. At the time of the study, the restaurant had already installed DCKV in its two wall-mounted canopy exhaust hoods. The study did not measure savings from the HVAC portion of the makeup air unit. (Nearby LA has an average of about 1290 cooling degree days per year vs. 925 for Chicago).



Source: SoCal Edison (used with permission)

Figure 2: Schematic of an illustrative DCKV system



When significant heating and/or cooling of outdoor air is required, the energy used for conditioning can be much larger than the energy of the fans used to create air flow. Therefore, the greatest savings are typically found in locations with high heating and/or cooling requirements. This is important to keep in mind and will be discussed later in the document.

Note that DCKV will only yield such savings if your HVAC and ventilation equipment are in good working condition. Furthermore, with faulty HVAC and kitchen ventilation your facility is potentially at risk for safety, health, and comfort issues, especially in the kitchen. The equipment needs to be in good order prior to and after any retrofit or, in the case of new construction, after DCKV system installation.

Components of Demand-Controlled Kitchen Ventilation Systems

To perform its functions a DCKV system needs sensors, a processor, and equipment controls. Each of these components is described below.

Sensors

To determine the required hood exhaust flow, the DCKV equipment must detect cooking activity under the hood. This is accomplished with sensors that are typically located in the hood and/or ventilation duct. As food is prepared, smoke, steam, and hot air rise from the cooking equipment. The sensors detect these cooking byproducts and send the information to the DCKV processor to adjust the hood exhaust flow accordingly.

There are three main types of cooking level sensors used in DCKV systems: temperature, optic, and infrared. These sensors can be used separately or be combined to provide more accurate measurements. Below is a description of each sensor type and its typical placement:

- ▶ Temperature sensors are located in the hood or in the exhaust duct, often at its entrance. They measure and detect changes in air temperature due to cooking activity.
- ▶ Optical sensors are generally located on either end of the hood, facing each other. These sensors measure how transparent the air is between the sensors to determine the amount of smoke and/or vapor produced from cooking activity. They essentially act like an electronic eye. Optic sensors need periodic cleaning.
- ▶ Infrared sensors are located in the hood above the cooking equipment. These sensors measure the temperature of the cooking surface to detect cooking activity. Infrared sensors also require periodic cleaning.

Other sensors measure the energy input to the cooking appliances to determine when cooking is taking place, while other DCKV systems utilize direct communication from the cooking equipment controls to the DCKV processor.

Some systems also employ other sensors in addition to those that detect cooking activity. For example, at least one commercial product senses air pressure to ensure proper levels of pressurization in the space.

Some restaurants with very predictable cooking hours have utilized a time-based DCKV system. Time-based systems simply operate the exhaust and outdoor air equipment at full speed during cooking times. They reduce equipment speed based on pre-determined idle or non-cooking times.

Processor Unit

The sensors' signals are transmitted to the processor unit, which acts as the "brain" of the DCKV system. The processor uses these signals to determine how much cooking is taking place and computes the amount of air flow needed. Next, the processor sends signals to equipment controls (see below) that adjust fan speeds, damper positions, and other settings as applicable. The processor continuously monitors the sensors and adjusts the ventilation in real time.

The processor may also act as a user interface by displaying the DCKV system's current status. The interface allows adjustment of set points and other aspects of the system, but a technician usually performs these adjustments. Buttons or touchpads are commonly used for the customer interaction, for instance to control lights, manually increase exhaust volume, or otherwise override the system.

The processor unit may also serve to interface a DCKV with a system that manages building energy, if one is present and compatible. This might be an energy management system, another type of building management system, or a network-based monitoring system.

Equipment Controls

The processor can regulate a number of equipment components, including among others:

- ▶ Hood exhaust and makeup air fans. The system uses a controller known as a variable frequency drive (VFD) to adjust the motor speeds of the exhaust hood and makeup air unit fans.
- ▶ Ventilation dampers in the hood and HVAC system.
- ▶ HVAC economizer dampers, if any. (Economizers are automatically controlled dampers that can save energy by bringing in outside air during cooling. They do so when the outside air is sufficiently cool and dry that bringing it into the building would reduce HVAC cooling energy.)
- ▶ Cooking appliances, for example shutting them down when exhaust duct temperatures get too high.

The specific fan and damper adjustments will depend on the hoods involved, the cooking situation, the features and settings of the installed DCKV system, and other factors. Note that most DCKV systems control multiple exhaust hoods. Some systems vary the exhaust rate of each hood independently, while others apply the same change to all hoods at once.

Factors Affecting the Cost and Energy Savings of Demand-Controlled Kitchen Ventilation

The energy and cost savings of a DCKV system depend on many factors. Food service facilities are unique with respect to compatibility with DCKV, but there are a number of key factors to consider when evaluating DCKV for any facility. This section is focused on economic factors; savings in energy are strongly related to the project economics. Also, to be feasible and attractive, an energy efficiency measure must pay back its initial cost, do so sufficiently quickly, and provide further savings as well.

The economic performance of DCKV depends on many factors that fall primarily into the following categories:

- ▶ **First cost**, or the upfront cost of purchasing and installing the system
- ▶ **The amount of energy that can be saved** by coordinating exhaust and makeup air flow with cooking level
- ▶ **The cost of energy**

First Cost: Cost of Purchasing and Installing DCKV

As described above, DCKV is composed of similar basic components. Even so, each kitchen and building is unique – for example the number, size, and type of exhaust and makeup systems being controlled – so in effect DCKV installations are custom designed. As a result, purchase and installation cost will vary.

The first cost (or “installed cost”) of a DCKV includes both the capital cost of the equipment and the items discussed below.

Site Deficiency Corrections

To achieve the benefits of DCKV, hood ventilation and HVAC equipment must be in good working order:

- ▶ Hoods must properly capture and contain cooking exhaust when operating at full speed (that is, without reduction by DCKV). If hoods are not working properly, reducing their air flow will only release more smoke, steam, and heat.
- ▶ The HVAC components supplying the kitchen must be ventilating effectively and providing comfort to the space. Otherwise, reducing air flow could affect HVAC performance, with consequences for health and customer satisfaction.

You should have your hoods and HVAC equipment inspected and repaired as necessary prior to DCKV implementation. In some cases, physical modifications to the kitchen (layout or other aspects) may also be required for DCKV to be installed, for example to achieve adequate makeup air flow at reduced volume.

Pre-Installation Upgrades

A key component of DCKV is the variable frequency drive (VFD) that controls the speed of hood exhaust

and makeup air fan motors. Although your makeup air units might already have VFD incorporated, it is more likely that they do not. Installing a VFD may require an upgrade to the makeup air unit's motor as well, as not all motors are compatible with VFDs.

Also, some DCKV systems make use of an HVAC system's economizer, which is a dampered vent that brings in outdoor air. When a rooftop HVAC unit with an economizer is part of the DCKV solution, the economizer damper must be capable of being controlled by the DCKV system – this may require an upgrade. Many existing small rooftop HVAC units do not have an economizer. If your HVAC system does not have an economizer, check with the vendor to see if their DCKV system would work adequately in your facility.

Installation and Commissioning Costs

Installation of a DCKV includes many types of tasks: electrical, mechanical, HVAC, kitchen equipment, and in some cases IT. *Commissioning* is a process of ensuring that the system works as intended after installation in your facility. It includes initial testing, adjustment, and other activities. In some retrofits, site inspection may uncover building issues that may require general construction work before DCKV installation. (The [Retrofit Evaluation Criteria for Demand-Controlled Kitchen Ventilation](#) section of this report covers evaluation of retrofit situations to assess whether DCKV might be successful.)

DCKV installation will not impact food service operations and sales when it is part of construction of a new food service facility. For retrofits, careful planning is required to avoid impacting operations. Options include facility closure, although that will affect sales. Many owners and operators prefer to have installation take place during off-hours, requiring payment of a premium for off-hours labor.

Finally, rebalancing the site's air flow may be needed after DCKV installation, which is an additional expense that must be factored into the overall cost.

Note that the above-described activities must be performed by trained personnel with specific knowledge of the subject matter involved. Fortunately, many utilities offer incentives or rebates for installing DCKV in a commercial kitchen. This can substantially reduce the purchase and installation cost.

Intercontinental Mark Hopkins Hotel

Location: San Francisco, California

Exhaust Flow: 22,500 CFM

Makeup Air Flow: 19,500 CFM

Daily Hours of Cooking: Open 24/7 but idle for long periods

Average Fan Energy Reduction: 62%

Estimated Average Makeup Air HVAC Energy Reduction: 29%

Expected Payback Period: Less than 1 year

Date of Field Study: 2004

The kitchen at the Intercontinental Mark Hopkins Hotel never closes. In addition to catering large events, they prepare meals and room service at all times of day. However, much of the cooking equipment sits idle between tasks, which provides an opportunity to reduce the airflow to the hood. The exhaust system is a 30-foot double island canopy hood. The high exhaust flow and intermittent operating conditions are positive factors for good ROI from a DCKV system. DCKV was installed before the study began.



Source: PG&E Food Service Technology Center (used with permission)

Potential for Saving Energy Using DCKV

Clearly, the design of a DCKV system has a major impact on energy savings. Since the design is specific to the product purchased, we focus on non-design factors. The [PG&E Food Service Technology Center \(FSTC\)](#) has identified a number of key factors that determine the potential energy reduction from using DCKV. ^{iv}

Kitchen Exhaust Ventilation Rate

As with most equipment, DCKV has an “economy of scale.” While there is no hard-and-fast rule for minimum ventilation rate, given the cost for even a small system most experts believe that DCKV provides the best return on investment (ROI) in kitchens with exhaust flow rates of 5,000 CFM (cubic feet per minute) or higher. Exhaust flow rates below 3,000 CFM typically don’t justify investment. Generally, the higher the ventilation rate the faster the payback and the higher the ROI.

Geographic Location

Several location-related factors have an impact on energy savings:

- ▶ **Climate:** Locations with high heating and/or cooling requirements typically have the greatest energy savings. This is because the energy used by an HVAC for conditioning air can be much larger than energy used simply to create air flow. For example, using FSTC’s Outdoor Air Load Calculator, a restaurant in Boston with 5,000 CFM of ventilation would use 22 times as much energy in conditioning the air as ventilating it. The ratio for Sacramento is 13, and for Miami it is 30 (assuming dehumidification to 65% humidity, with no reheat).
- ▶ **Utility incentives and rebates:** Many utilities offer incentives and rebates for installing DCKV. ^v These can be a big help in offsetting purchase and installation costs. They are generally in the form of dollars per horsepower of exhaust fan or dollars per CFM of air flow.

Operating Hours

The energy consumed by a commercial food service facility’s ventilation and HVAC systems is strongly related to the daily hours of operation. Clearly, more energy can be saved if the DCKV is operated for 18 hours, as opposed to 14 hours, per day.

A related factor is the fraction of time during operating hours that cooking is performed at below-maximum levels. In order to save energy, a DCKV system must be able to lower exhaust rates, which is only possible when cooking levels are reduced below the hood design maximum. For example, a commercial kitchen that operates in a “factory” mode – constantly producing product at the highest possible rate – has little opportunity for reduced ventilation.

Static Pressure and Fan Efficiencies

These factors affect the energy use of the fans, and the greater the energy used by a fan, the greater the energy saved by reducing its air output. *Static pressure* in the ventilation system is positively correlated with fan energy use: the higher the static pressure, the greater the energy use. As for *efficiency*, high efficiency means that a fan normally uses less energy than a low-efficiency fan.

Other Energy Use Factors

Other factors affecting HVAC energy use at full ventilation, and thus the potential for energy savings, include the following:

- ▶ **Makeup air settings:** This refers to the heating, cooling, and dehumidification set points, which affect the energy used to condition the makeup air.
- ▶ **Appliances located under the hood:** In particular, this includes their heat release to the kitchen space. It can be difficult to estimate the size of this contribution to energy use and energy savings. For example, radiant heat release can play an important role in the comfort of the kitchen occupants, whereas much of the heat released into the air is captured by the hood.
- ▶ Note that facility conditions (such as heat load from cooking, the kitchen thermostat settings, and the state of the HVAC system) can result in the kitchen never reaching the thermostat temperature. This can waste a lot of energy. If your kitchen is generally hotter than the thermostat setting, you should check for this condition and correct it prior to installing DCKV. In addition to any equipment maintenance needed, consider the advice of some facility managers to set the kitchen thermostat to a temperature that the HVAC system can achieve, while still meeting worker safety and comfort requirements. This temperature may be somewhat higher than the dining room.

Putting It All Together

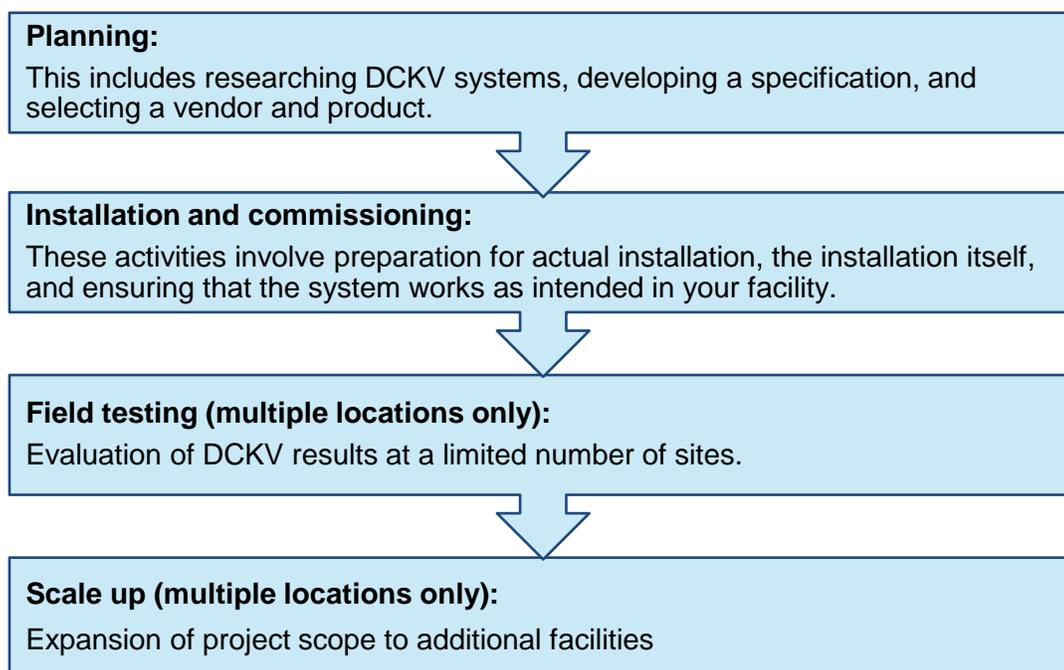
Knowing your heating and cooling loads and the price of electricity, you can estimate how much money can be saved per year for various assumed percentages of energy savings from DCKV.

As mentioned, FSTC offers a free Outdoor Air Load Calculator to help in estimating heating and cooling loads. The calculator is found at <http://www.fishnick.com/ventilation/oalc/oac.php>. The U.S. Energy Information Administration lists recent state-averaged retail electricity prices at the website http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_06_a, or you can simply look at your utility bills to see how much your energy costs.

Typical Stages of a Demand-Controlled Kitchen Ventilation Project

DCKV projects range in scope and complexity, depending on several factors. These include the number of locations involved, the desired capabilities and features of the system, and the nature of the installation (particularly, retrofit vs. installation in a new facility).

Most projects involve some or all of the following activities:



Stage 1: Planning

The first step in planning a DCKV project is deciding whether DCKV would be appropriate for your facility.

Researching DCKV Systems

Once you are familiar with DCKV, it is helpful to speak with one or several equipment vendors to learn more about available products, options, and services. Some companies may be willing to have their technical staff work with you to estimate the potential savings for your facility. If your organization does not have technical staff in-house, you may also wish to have an independent engineer or consultant help with savings estimates.

In considering adoption of DCKV, you will want to think about factors related to operations, required ongoing maintenance and repair, vendor support, and of course cost. An example of an operational factor is the integration of a new exhaust hood scheme – one that is now under automated control – into the day-to-day culture of the cooking staff.

“Required ongoing maintenance” refers to the need to keep the equipment in good operating order so that cost savings are not degraded over time due to performance issues. Depending on the vendor’s support infrastructure, and your own, either party might be chosen for this responsibility.

Choosing a Product and Vendor

If your organization concludes that one or more DCKV options is likely to result in attractive savings in your facility, you will need to choose a vendor and the product, features, and configuration that best meet your needs and goals. In the next section, [Demand Control Kitchen Ventilation Products, Vendors, and Contractors](#), we suggest a number of questions to get answered as you look into different products and companies and consider the choices available to you.

Stage 2: Pre-Installation, Installation, and Commissioning

As mentioned, it is critically important to have your HVAC and ventilation systems be in good working order prior to DCKV installation. Thus, pre-installation includes assessing the state of your systems, correcting deficiencies, and performing any upgrades necessary for compatibility with the DCKV product you are purchasing.

Installation begins after the DCKV unit and the installer have arrived at the facility. Note that a DCKV system is not a “drop-in” replacement for existing equipment. Rather, it is a component of the exhaust system. It is also interconnected with the makeup air or HVAC system. Check with your vendor or the installing contractor(s) to determine how much time installation and commissioning will require.

If the installation is a retrofit, you should also find out what specific steps will be taken during the installation and commissioning process. Depending on your facility’s characteristics, you may or may not be able to operate your business during DCKV installation. In either case, you’ll need to define for your installing contractor acceptable times for the installation to take place. Examples include overnight, on a day for which the restaurant is otherwise planned to be closed or, if possible, before opening.

DCKV installation and commissioning involve a number of different types of activities. These may be performed by a single party, either a contractor or the vendor, or by multiple parties. Activities include the following:

- ▶ **Installation of the DCKV components:** These include the sensor, processor unit, user interface (if separate from the processor) and, if needed, variable frequency drives.
- ▶ **Interconnection with a system that manages building energy, if one is present and compatible:** This refers to an energy management system, another type of building management system, or a network-based monitoring system.
- ▶ **Commissioning:** The process of ensuring that the system works as intended after installation. It includes initial testing, adjustment, and other activities.

Given how requirements vary among different facilities, no one set of installer skills can be defined that is correct for every site. Required skills may include, among others: electrical, kitchen ventilation equipment, HVAC, DCKV, building controls, kitchen design, and mechanical engineering.

Vendors should be open to discussing the parties they employ for installation and commissioning, including those who they anticipate are needed for your own facility or facilities.

Stage 3: Field Testing

Food service organizations with many locations usually field-test new equipment or technology in one or more selected sites prior to rolling it out to larger numbers of facilities. The goal is to validate that specific DCKV systems will meet the energy and cost savings goals you have set for them, and that they work well

in other respects. Testing might involve a single equipment model, perhaps with different configurations or in different climates. You might also use field testing to compare the performance of several models, from the same or different vendors.

In planning the field test, consider the following:

- ▶ **What climates** in your portfolio of stores look promising for implementing DCKV?
- ▶ **How will you measure the cost savings** that the DCKV system will achieve? Again, if you do not have in-house technical staff, you may want to have an independent engineer or consultant help with savings determinations. It is very difficult to identify energy savings from looking at total restaurant energy usage. Therefore, experts recommend taking actual measurements of the energy used by the hood and air supply components involved in DCKV. These measurements should be taken before and after DCKV installation and should be normalized for weather.
- ▶ **How will you capture information related to non-energy benefits**, such as employee feedback, operational or maintenance issues, vendor customer service, and kitchen comfort levels?

The last two items are key for *all* sites where DCKV is installed – whether they are involved in field testing or not!

Stage 4: Scale-Up

If field test results are successful, your organization may decide to expand the program to additional restaurants. The steps for doing so are similar to those of field testing. However, scale-up is generally a more strategic process than field testing because the timeframe can be much longer, usually spanning several years.

As mentioned above, ongoing maintenance is an important element in keeping cost savings high, so you will need to have procedures in place to ensure this. As more installations are added, your tracking and management of this program will need to grow as well.

You may decide to add vendors to your supply chain during scale-up, for example by performing further field testing as they get identified and considered for inclusion in the program.

Demand-Controlled Kitchen Ventilation Products, Vendors, and Contractors

Although they can be an excellent investment, DCKV systems are costly, a fair amount of pre-purchase research is highly recommended. In this section, we suggest a number of things for you to investigate as you look into different DCKV products and vendors and consider the choices available to you. The lists below are not exhaustive; however, they should help you to focus on many of the important elements that contribute to success with DCKV.

General Considerations

- ▶ Find out if there are utility rebates in your area. Be sure to research the rebate process well.
 - What types of rebates or incentives (custom, deemed savings, etc.) are available? ^{vi}
 - What are the measurement and verification requirements?

- What are the time frames for available funding, application deadlines, pre-installation inspections, etc.?

DCKV System Characteristics

- ▶ How far can the ventilation flow be turned down in response to cooking conditions?
- ▶ Does the system still capture and contain exhaust air at the lowest air flow level? What sort of testing has been done to verify this? Under what conditions (e.g., type of hood or appliances under hood) does this assurance hold?
- ▶ Does the system ensure that air is balanced throughout the facility regardless of hood air flow? In general terms, how does it do this?
- ▶ Can the user override the DCKV function? How is this done?
- ▶ What, if anything, is required on a daily basis for user interaction with the DCKV? How will that work with your kitchen, its staff, and its operating procedures?
- ▶ What is the user interface like?
- ▶ What sort of training may be required to operate the unit?
- ▶ What are the maintenance requirements?
 - What is needed for preventative maintenance, including sensors, the VFD, economizers, etc.?
 - How is system performance and equipment condition monitored? Is the monitoring ongoing, on a regular basis, or only when issues arise?
 - Can monitoring be done remotely by analysis of processor output (or some other method)? How, and by whom? Do you need to commit staff to monitor and respond to DCKV outputs?
- ▶ What does reducing and varying the volume of exhaust through the existing hood do to any hood certifications and ratings? Does this have an effect on insurance?

Vendor-Related Matters

- ▶ Has the vendor ever installed a DCKV system in your type and brand of exhaust hood(s)?
- ▶ What is the user manual like? Can you obtain a copy? Is it readable, complete, and aimed at the level of the staff that will use it?
- ▶ If the vendor provides performance monitoring, what is the charge, if any, for this service?
- ▶ Is training required to operate the unit? Who provides training?
- ▶ Does the vendor handle utility rebate paperwork? If not, will the vendor help with the application process? In any case, does the vendor charge extra for this service or assistance?
- ▶ What is the warranty for the system and what items are covered? What are the terms?
- ▶ What is the vendor's service and support infrastructure?
 - Service and support hours; methods of contact; response time for issues, including both service and support; technician network employed for service, or recommended, by the vendor
- ▶ What is the cost for the most commonly replaced parts? The most common types of service calls?
- ▶ Does the vendor support field tests? In what ways, and what is the cost for this service?

- ▶ Regarding quotes: What is the breakdown of costs and charges? Which features and services are essential for the DCKV and which are optional?
- ▶ Will the vendor supply client references? Can you contact companies for which case studies are available?
- ▶ Can you get access to a site which has the vendor's DCKV system installed, for a demonstration?
- ▶ Will the vendor supply a sample contract for review?

Pre-Installation, Installation, and Commissioning

- ▶ Does the vendor perform, or help perform, pre-installation activities? (See the earlier section for information on those activities.)
- ▶ If they are not directly involved, can they refer you to reliable parties?
- ▶ What is the installation process for a given DCKV system in your facility? What is the installation time frame?
- ▶ Will you need overnight and/or weekend installation? Would there be an additional cost for this? What will that cost be?
- ▶ In particular for retrofits: What parties will be involved in installation and commissioning? If contractors are involved, have they had prior experience with this DCKV system, the types and brands of hoods you have, and your type of food service operation?
- ▶ Will there be a project manager or general contractor for complex retrofits? Who takes that role, the vendor or a contractor? Whose responsibility will it be for the successful completion of the retrofit? Who follows up if an installation-related issue arises?
- ▶ What is the commissioning process and its time frame?
- ▶ What installation and commissioning documentation will you be given upon completion?

Retrofit Evaluation Criteria for Demand-Controlled Kitchen Ventilation

Many factors must be considered when deciding if a DCKV retrofit is a good option for a particular location. The following evaluation criteria were developed to assist food service owners and operators in determining if a DCKV retrofit may be appropriate for their facility. ^{vii}

Criterion	Significance
Do you know about DCKV and its energy savings potential?	If No, refer to this BBA guide on DCKV, as well as industry literature. Potential savings from retrofitting with DCKV can be significant and can result in relatively short payback periods. In addition to the BBA guides, listed at the end of this document, further information on DCKV can be found at http://www.fishnick.com/publications/ventilation/
Do you have more than 12 linear feet of exhaust hood or a hood system with more than 3000 cubic feet per minute (CFM)?	If No, be aware that your return on investment (ROI) may be constrained. Savings from DCKV are attributed directly to reduction in exhaust air. Larger capacity exhaust systems generally result in greater savings. A minimum of 12 linear feet and at least 3,000 CFM is estimated to be the threshold for a desirable return on investment. Though this is not always the case, having at least 12 linear feet of exhaust hood is a “ball park” criterion for retrofitting a DCKV system to make economic sense.
Are the exhaust hoods in your kitchen <i>backshelf</i>, or <i>proximity</i>, style (versus <i>canopy</i> style)?	If Yes, your backshelf hoods are relatively efficient so the ROI may be constrained. Backshelf and proximity hoods typically operate at lower air flow rates than canopy hoods. Generally speaking, less-efficient hoods operating at higher air flows offer greater savings with a DCKV system.
Do your exhaust hoods capture and contain heat and smoke effectively?	If No, consider a hood tune-up that fixes the problem before proceeding with the installation of a DCKV system. If exhaust hoods are not functioning properly at the outset, the performance of the DCKV system will be compromised.
Do you have single-island hoods over heavy-duty equipment?	If Yes, proceed with caution. Single-island hoods often fail to capture and contain smoke produced by heavy cooking equipment, such as charbroilers. They may perform even worse when a DCKV unit reduces the exhaust air flow.
Do you operate your exhaust hoods less than 8 hours per day?	If Yes, <i>note that ROI may be constrained</i> . Exhaust hoods that are used for longer periods each day have potential for greater energy savings using DCKV. While worthwhile savings may be achieved with hoods operated less than eight hours per day, further calculations and consideration of system specifications are recommended.

Criterion	Significance
Do you have multiple exhaust hoods connected to one exhaust fan?	If Yes, the ROI may be constrained. When multiple exhaust hoods serving different production roles are connected to one exhaust fan, it is difficult to reduce the exhaust air flow. (For example, if cooking is going on under one hood, then all hoods need to be operating at full speed.) An exception is when the DCKV system incorporates code-approved dampers to modulate air flow to the individual hoods. ROI may be constrained when the hood-to-fan ratio exceeds 4:1.
Are there times during the day when appliances are not actively cooking food and the hood is simultaneously operating?	If Yes, a DCKV system may return significant savings. DCKV requires periods of low or no cooking activity to save energy. If the cook line is always at full cooking capacity, there may not be significant energy reduction from a DCKV system.
Do you have a large underfired broiler (charbroiler) on your cook line?	If Yes, note that potential exhaust reduction for charbroilers is limited. A charbroiler needs almost as much exhaust in the “ready-to-cook” mode of operation as it does when cooking food products. Thus, the reduction in exhaust air may be limited and the ROI challenged. However, if a charbroiler is part of a much larger cook line, this issue may be less significant.
Is the noise from your current exhaust hoods excessive?	If Yes, then noise reduction is a supporting factor in your decision. Noise reduction can be a significant benefit of retrofitting DCKV
Do you heat your makeup air?	If Yes, then the ROI will be enhanced. Heating makeup air consumes a large amount of energy. Retrofitting with DCKV reduces the volume of makeup air, resulting in a smaller heating load.
Do you cool your makeup air?	If Yes, then the ROI will be enhanced. Cooling makeup air also consumes a significant amount of energy that is reduced by a DCKV system
Are the utility rates in your area considered high?	If Yes, the ROI will be enhanced. (Currently, the average U.S. commercial electricity rate is \$0.10/kWh, varying from \$0.07–\$0.17/kWh. ^[i] Average gas rates are presently \$0.83/therm, ranging from \$0.68–\$1.66/therm. ^[ii]) Higher utility rates result in a greater return on investment.
Do you know the total exhaust air flow rate (in CFM) of your exhaust hoods? Do you know the nameplate horsepower of the exhaust and makeup fans?	If No, engage an energy professional. If you know the air flow rate then proceed with a more detailed economic assessment. If you do not know these technical details, hiring an energy professional (a utility representative, food service consultant, mechanical engineer, contractor, etc.) to undertake an in-depth assessment of your current system is recommended.

[i] Excluding Hawaii. http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_b

[ii] Excluding Hawaii. http://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PCS_DMcf_m.htm, monthly commercial price. Price per therm is given price (i.e., per thousand cubic feet) divided by 10.25.

ⁱ Based on Figure 3.9 of "Technical Support Document: 50% Energy Savings for Quick-Service Restaurants," Zhang et al., Pacific Northwest National Laboratory document number PNNL-19809 (2010), found at http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19809.pdf.

ⁱⁱ "Improving Commercial Kitchen Ventilation System Performance – Optimizing Makeup Air," PG&E Food Service Technology Center (2004), see http://www.fishnick.com/ventilation/designguides/CKV_Design_Guide_2_031504.pdf.

ⁱⁱⁱ Based on data for food service in the 2003 Commercial Buildings Energy Consumption Survey (CBECS), U.S. Energy Information Agency, found at <http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=microdata>

^{iv} D. Fisher, R. Swierczyna and A. Karas (2013), "Future of DCV for Commercial Kitchens," ASHRAE Journal, pp. 48-54. For more details on some of these factors, see D. Fisher (2003), "Predicting Energy Consumption," ASHRAE Journal, pp. K8-K13. Both articles are available at: <http://www.fishnick.com/publications/ventilation/>.

^v The Consortium for Energy Efficiency (CEE) has summarized incentives and rebates offered by their members in a program summary at <http://library.cee1.org/content/commercial-kitchens-program-summary/>. See the column labeled "CKV DCV Offer" for information on DCKV offerings.

^{vi} The Consortium for Energy Efficiency (CEE) is a consortium of utility efficiency program administrators. They maintain a list of their members' DCKV incentive programs at <http://library.cee1.org/content/commercial-kitchens-program-summary/> (see columns AC-AE).

^{vii} These retrofit evaluation guide questions were developed by Don Fisher and Rich Swierczyna of the PG&E Food Service Technology Center (<http://www.fishnick.com/>).

