GARAGE

VENTILATION

Airing out how new technologies and systems can spell big savings.

By Frank Nagle

When it comes to capturing energy savings in commercial garages, lighting retrofits have become the first go-to action. That's for good reason: Lighting retrofits provide an effective means to reduce energy consumption. But, another big savings generator comes in another area that's also worth serious consideration: retrofitting a garage ventilation system.

All enclosed parking garages in North America are subject to ventilation standards established by the International Mechanical Code (IMC) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). The IMC and ASHRAE stipulate that garage ventilation systems run continuously during building-occupied hours, with an exception made for those that deploy carbon monoxide (CO) sensor-based, demand-controlled ventilation (DCV) systems.

For a garage adhering to IMC/ASHRAE code requirements and not utilizing sensor-based DCV, depending on the type of lighting system in the garage, that means as much as two thirds of the monthly/annual utility bill can be attributed to ventilating the space.

Oceanview Village

Oceanview Village, San Francisco, is an expansive, mixed-used development consisting of condominiums, apartments, and retail shops. The property houses a two-level, 145,000-square-foot, enclosed parking garage for its residents and visitors, as well as an adjacent, single-level, 18,000-square-foot, enclosed garage that serves retail shoppers and other guests. The garage can accommodate more than 450 vehicles.

When the property was constructed in 2002, building designers did not incorporate a CO sensor system in the garage ventilation strategy, so applicable code required the garage ventilation system to operate at its maximum design ventilation rate during building-occupied hours. In this case, that meant running the garage fans at full speed 24 hours a day, seven days a week.

Detailed power measurements (quantified as kilowatts or kW) prior to retrofit revealed that the garage ventilation system, with four 10-horsepower (HP) exhaust fans, two 7.5-HP supply fans ventilating the residential garage, and two 3-HP exhaust fans supplying fresh air to the adjacent retail garage, consumed nearly 400,000 kilowatt hours (kWh) a year.

At a utility rate of $0.1556/kWh, and taking into account additional charges incurred by running the fans during peak demand periods each day, the annual cost to ventilate Oceanview Village's garages amounted to nearly $62,200. The owners were stunned to learn that figure represented approximately 30 percent of the

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entire property's prior 12 months of electricity spending.

Fortunately, CO sensor-based DCV technology has taken a quantum leap in the past few years, as it converges with stricter energy efficiency and health and safety standards at the local and state levels. As a result, it now provides a real and significant means to generate energy savings in a cost-effective manner.

CO sensor systems have been readily available for quite some time. The prototype that has served for years as the industry standard is commonly known as an on/off or start/stop system, and while it might outdo many lighting retrofits in terms of savings, it has its drawbacks.

An on/off system switches garage fan motors on (to ventilate the garage) only when increased CO levels require it, with the typical CO trip point set at 35 parts per million (ppm). Otherwise, it leaves fan motors in the off mode.

Based on market research and field experience, it's safe to say approximately 80 to 90 percent of the installed base of CO sensor systems nationwide fall under the category of on/off. It's credited by some regional utilities, including Pacific Gas & Electric (PG&E), with the ability to reduce up to 95 percent of the power (kW) consumed by garage fan motors. But beyond the fundamental question of how energy not being consumed (the motor is off, after all) can be reduced, deployment of on/off CO systems in many environments creates as many issues as it does solutions.

For example, subterranean garages with office, retail, or residential spaces located above have mechanical systems (exhaust and supply motor/fan units, ventilation shafts, etc.) designed to enable the substructure to maintain negative to neutral air pressure in relation to the property above. Why? Two reasons:

- It prevents the property's primary HVAC system—the one heating and cooling the office/living/shopping spaces above the garage—from having to work beyond its design capacity and ventilate the garage, too. Anytime you've tried to open the door of, say, an office building and had to pull hard due to a suction-like feel, you've experienced what engineers call the stack effect. The property's primary HVAC system is sucking up the available air in the garage and basically sealing the building.
- When the HVAC system seals the building, it enables potentially harmful gases—not just CO, but also radon and other fumes—to be sucked up through elevator and ventilation shafts into the building, creating an unnecessary health and safety risk for building occupants and visitors.

The irony is that, while on/off systems are given credit for saving a lot of energy, they cause other building HVAC systems to consume greater amounts of energy ventilating spaces they're not designed to support. They also completely disregard some basic engineering designs for proper building operation and ensuring the health and safety of its occupants.

It gets worse: On/off CO sensor systems are subject to peak demand charges imposed by most regional utilities because the time they are most likely to start garage fan motors is in the midst of peak demand periods (roughly from noon to 6 p.m., depending on the region). That's when most folks leave work, and it's when cars emit the highest concentration(s) of CO. It takes five minutes of operation before a automobile's catalytic converter has warmed up sufficiently to be effective.

Energy Use	Pre-Installation	Post-Installation	Savings	Savings %
Total kWh	399,620	18,554	381,066	85.4%
Total Cost	$62,166	$2,783	$59,384	95.5%
Total kW Demand	46.76	2.12	44.65	95.5%

All you need is a fair amount of cars starting simultaneously for CO levels to exceed the sensors' trip point and ramp the garage fan motors to full speed. When those fan motors stay on for just 15 minutes, the property owner is hit with prohibitively high peak-demand charges not only for that day but the entire month in some utility districts.

This brings us back to Oceanview Village and the recent technological advances in sensor-based, demand-control ventilation for commercial garages.

Choosing a System

The owners of Oceanview Village were pitched various on/off CO systems by a number of vendors, but ultimately chose to install what's referred to as a variable flow DCV system. As the name implies, the system is designed to keep the garage fans running continuously and vary motor speeds based on CO concentrations in the garage.

A proven effective variable flow CO system is one that designs in or syncs variable frequency drive (VFD) technology with a control strategy that:

- Enables the motors to run continuously at low speeds—when CO levels are *de minimis*—while adhering to code/design ventilation rate requirements.
- Creates a reservoir of fresh air in the garage so CO concentrations are prevented from exceeding predefined sensor trip points for an extended period of time, minimizing the number of times the motors must ramp to flush out the garage.
- Incrementally increases fan motor speeds, (the ventilation rate) whenever CO concentrations near pre-set trip points. Said another way, the motors don't instantly ramp from low to high speeds, but rise proportionally (in speed) to counter CO concentrations with an equivalent amount of fresh air.

The result is that property owners can continuously ventilate their garages in an energy-efficient manner while ensuring the health and safety of building occupants and visitors.

VFDs are used to vary the speed of an electric motor by changing the frequency of the electric power going to the motor. In doing so, they capture significant energy savings. In fact, the engineering law of affinity confirms that a VFD running a three-phase motor at 50 percent of its full load capacity reduces the energy (kW) consumed by that motor by 80 percent.

The percentage of motor speed is relevant because a good portion of the nation's garages were built before catalytic converter technology became a standard item in vehicles. Prior to the 1990s, the IMC mandated a design ventilation rate of 1.5 cubic feet per minute (cfm) per square foot for commercial garages, so fan motors were sized to meet that ventilation rate at 100 percent motor capacity.

Oceanview Village found substantial savings in a new ventilation system.

Thanks primarily to catalytic converter technology, the IMC cut the design ventilation rate in half, to .75 cfm/sq. ft. That means older garages not using a variable flow ventilation strategy—including those deploying on/off systems—waste a lot of energy by running their motors at twice the rate or capacity now required.

VFD-driven variable flow systems make it possible to set and manage motor speeds in a manner that captures truly exceptional energy/cost savings. Indeed, it's not uncommon for a property that runs its garage fans on the same schedule pre- and post-installation to realize kWh savings amounting to 95 percent while reducing peak kW demand by as much as 96 percent.

I also can cite several examples in which garage fan run times were substantially increased—even quadrupled—and the VFD-driven variable flow system reduced energy consumption by 90 percent or more.

Post-installation measurements at Oceanview Village showed this type of system reduced the garage fan motors' combined consumption by 381,000 kWh—a 95.4 percent savings—with peak kW demand reduced by 95.5 percent.

The annual cost savings amounted to 95.5 percent, lowering the property's garage ventilation bill by approximately $59,400 a year—from more than $5,200 to just $230 per month. Not including a $30,500 rebate, the system paid for itself in just 12 months!

When considering what's best for your garage, keep in mind that an industry trick of the trade—simply shutting off garage fans to avoid expensive energy bills—is expressly prohibited in an increasing number of cities and states. Moreover, if you happen to be in a region where on/off ventilation strategies are still permissible, I would recommend heeding the words of the unknown author who said, "The bitterness of poor quality remains long after the sweetness of low price is forgotten."

The benefits derived from recent innovations in garage ventilation are too compelling to be ignored.

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