



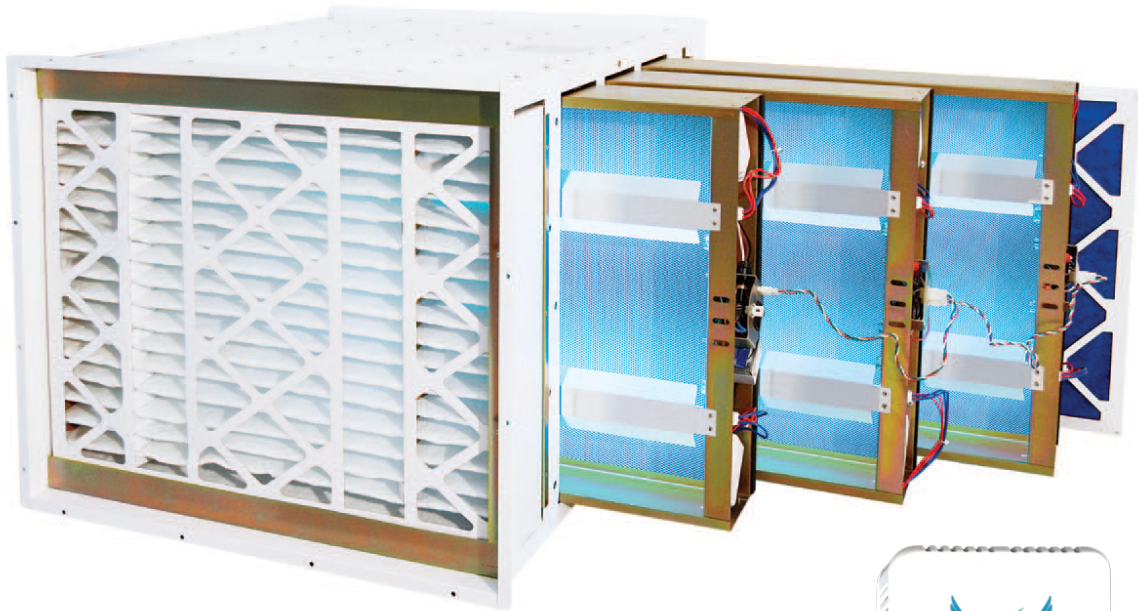
Deactivates 99.5+%
SARS-CoV2/COVID-19*



with
Air Vaccine™

hummingbird™ EQ

HVAC in Perfect Balance™



Cloud Enabled.
View on any Computer / smart device

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<https://www.energycloudinc.com>

Patent
Pending

*Tested at Keck School of Medicine at the University of Southern California BSL Level 3 Biosafety Lab.
single-pass tests of hummingbird models: EQ30000 / AP30000 / EQ10000 / AP10000 / CP800 Portable / EL / WC HDAZ models

7.1.21 V1.06



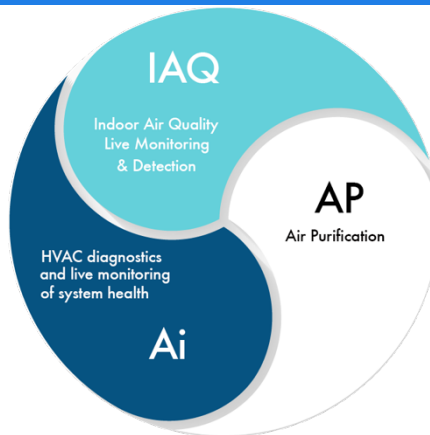
hummingbird EQ

HVAC in Perfect Balance™

The Ultimate Commercial HVAC Management & Air Purification System

The hummingbird EQ (Equilibrium) is a complete HVAC management and air purification system which helps engineering, facility directors and asset managers manage their HVAC systems to deliver heating, cooling and superior air quality while saving energy and extending the life of the equipment investment. EQ keeps your HVAC and air environment in perfect equilibrium.

Hummingbird EQ utilizes Ai, IOT and real-time data collection along with the latest in indoor air quality monitoring and air purification technology. Scales to any size HVAC unit.



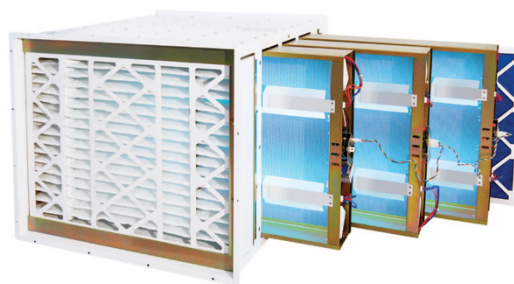
INDOOR AIR QUALITY

AIR PURIFICATION

HVAC MANAGEMENT



Indoor Air Quality Live Monitoring
Continual Air Certification
VOC's, Particulates, CO2



Premium Air Purification
Photocatalytic Oxidation
Kills Viruses, VOCs, Particulates



HVAC Remote Monitoring
Cloud Enabled. View on any
Computer / Smart Device





hummingbird™ EQ

INDOOR AIR QUALITY CERTIFICATION

Hummingbird™ EQ's Indoor Air Quality monitoring and certification's first year comes standard with all EQ models. Air quality is essential to building occupants health. Businesses that wish to show that they invest in their customer and employees' health can now show that visibly on their front door and online marketing and public relations efforts.

The most important aspect of this feature is that Energy Cloud can certify that the air is continually kept clean and pure by solid data which we capture as part of the system. All

certifications grades are linked to actual data for these core IAQ areas: VOC's (volatile organic compounds, particulates, and CO₂ levels.) An A+ is not guaranteed, only if the data backs up the grade. A QR Code is also provided that will link directly to the customer's certified air quality webpage on Energy Cloud®.

In addition to the sticker is a dedicated webpage for each customer which shows their air quality score and recent certification date. This can be linked to off of the customer's website.



A webpage with live certification is provided for each customer.



INDOOR AIR QUALITY

IAQ: Indoor Air Quality is essential to human health. More time is spent indoors than outdoors and the air that we breath indoors directly impacts our health and productivity.

¹Concentrations of some pollutants are often 2 to 5 times higher than typical outdoor concentrations. Approximately 9 million people died prematurely from pollution-related diseases in 2015, accounting for 16% of all deaths worldwide. To put this in perspective, pollution is killing more people than wars, obesity, smoking and malnutrition. Poor indoor air quality is linked to sick building syndrome, reduced productivity, and impaired learning in schools. Indoor Air Quality needs to be measured and proven to be healthy for the benefit of the building occupants. Most harmful VOC's (volatile organic compounds), and other gases such as Ozone, CO or large CO2 concentrations are all invisible and dramatically affect human health. The EPA defines several categories of pollution including Particulate Matter and VOCs.

Particulate matter (PM) particles are a complex combination of pollutants as dust, pollen, smoke and mist. Protective masks rated N95 and N99 are

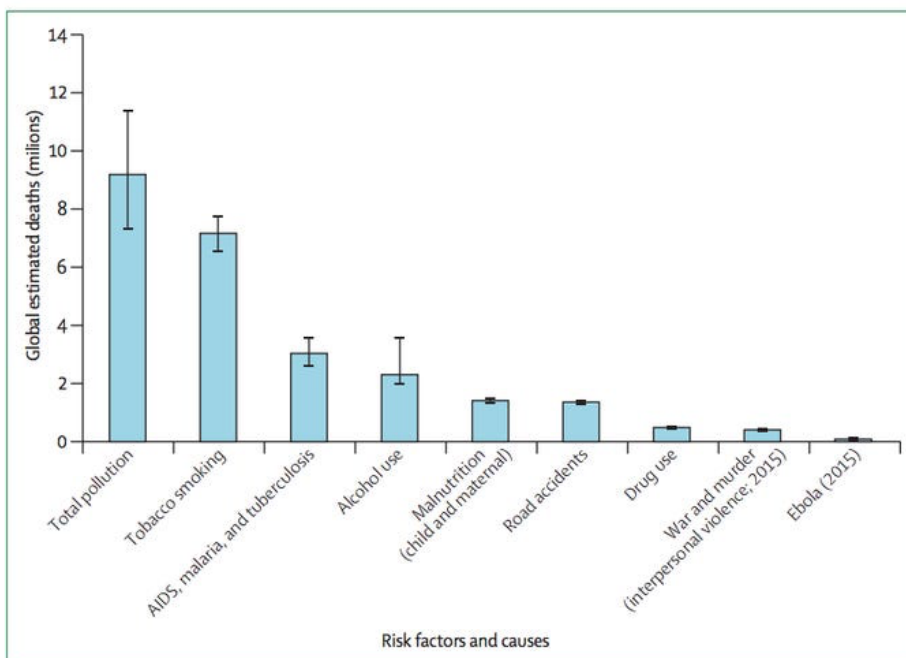
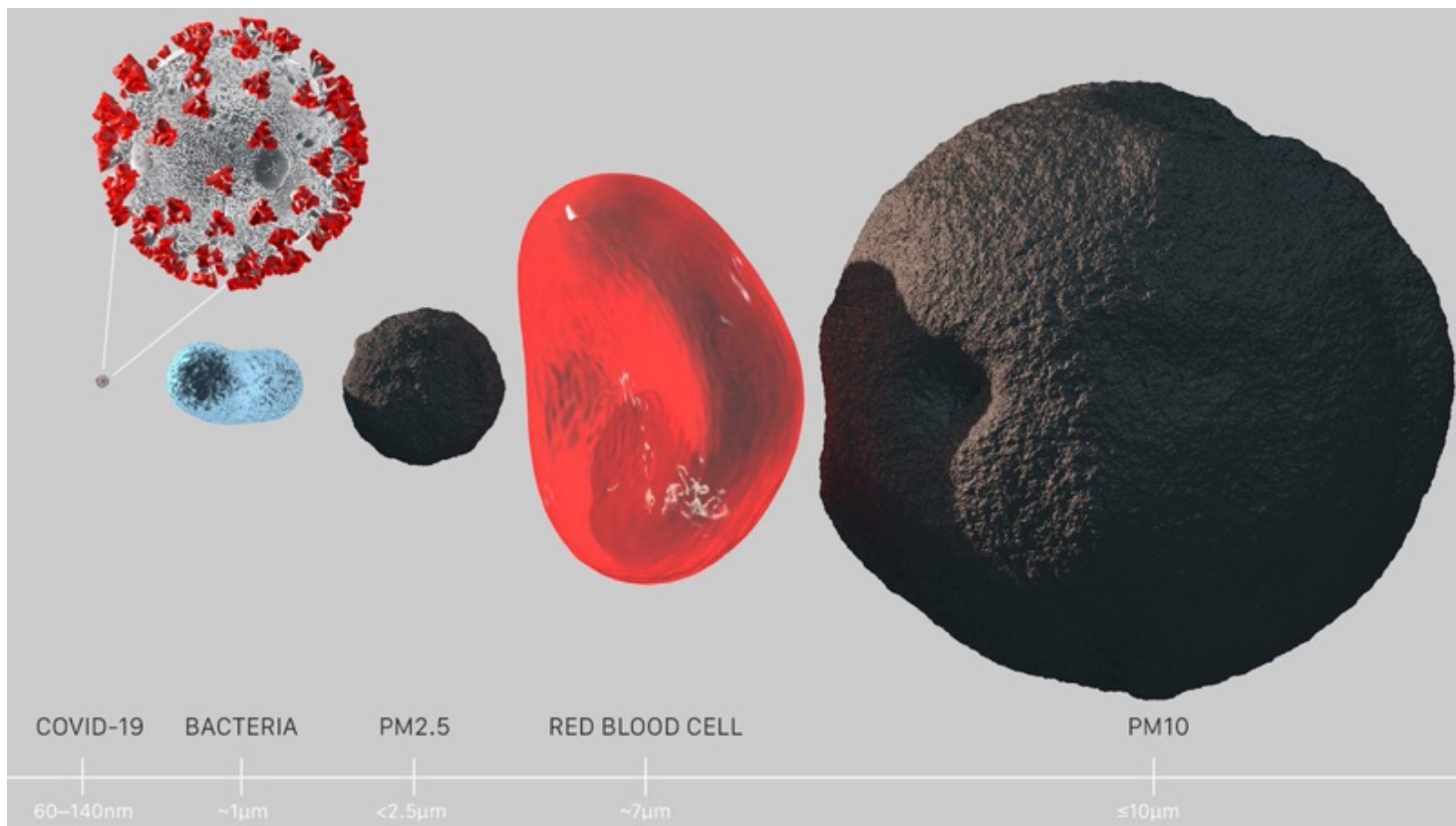
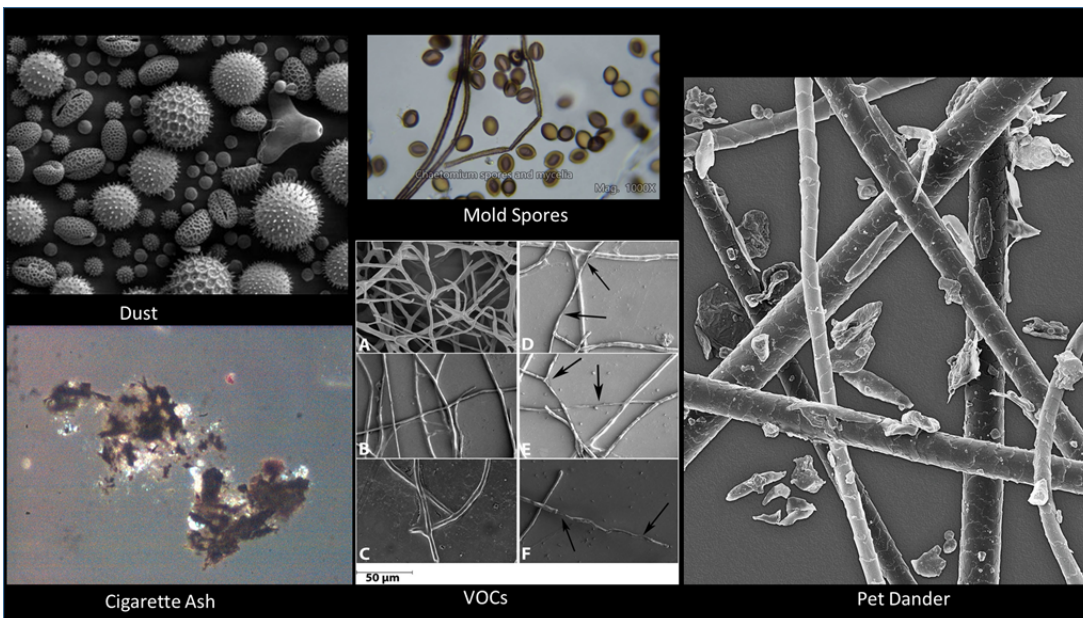


Figure 5: Global estimated deaths by major risk factor and cause, 2015
Using data from the GBD Study, 2016.⁴¹

supposed to block 95% and 99% of PM2.5 – particulate matter of 2.5 micro-meters (μm) or less in diameter. Our hummingbird™ Particulate Laser Diode type sensor was designed to detect the presence of dust particles as small as 0.3 μm micrometers in size which is substantially smaller than current mask protection.





is not. Air purification products should deliver on the results that they promise. While the premise of measurement is good, the quality and the longevity of the sensors is just as important. Our IAQ **Particulate (PM)** sensors are extremely accurate and durable. While most particulate sensors only last four years, our sensors lasts 10 years running 24 hours / day with advanced technology to keep its internal fan and measurement chamber clean and operational.

A study reported last year by Dept. of Family Medicine, Inje Univ., South Korea, [Oct. 20, 2019.] showed the effect of fine **dust concentrations in the air** on the incidence of viral respiratory infections. Results showed that as the weekly average concentration of fine dust increased, the incidence of HAdV (adenovirus), **HCoV (human-coronavirus)**, HBoV (human bocavirus), HPIV (parainfluenza virus), HMPV (human metapneumovirus and IFV (influenza virus) increased. Exposure to such particles can affect both the lungs and heart.

The particulate sensor includes advanced particle size binning including 4 mass concentration ranges of PM1, PM2.5, PM4 and PM10 where-as most sensors only can sense one or two ranges.

Energy Cloud® as a data driven organization believes we should not assume our Indoor air quality is good, it often

Our **VOC sensor** is a MOX based multi-pixel gas sensor which can measure TVOC's. Our sensor can output TVOC's in a color-coded chart similar to the one prescribed by the German Federal Environmental Agency tracking air quality over time and sending alerts when the air falls into poor and unhealthy levels. Our **C02 sensor** is based on NDIR C02 technology with integrated temperature and humidity sensing. Carbon Dioxide is a key indicator for indoor air quality. With our sensor you can help ensure your building is maintaining healthy quality air along with maintaining and adhering to local and state codes and standards.

Level	Hygienic Rating	Recommendation	Exposure Limit	TVOC [ppm]
Unhealthy	Situation not acceptable	Use only if unavoidable / Intense ventilation necessary	hours	2.2 - 5.5
Poor	Major objections	Intensified ventilation / airing necessary Search for sources	< 1 month	0.66 - 2.2
Moderate	Some objections	Intensified ventilation / airing recommended Search for sources	< 12 months	0.22 - 0.66
Good	No relevant objections	Ventilation / airing recommended	no limit	0.065 - 0.22
Excellent	No objections	Target value	no limit	0 - 0.065

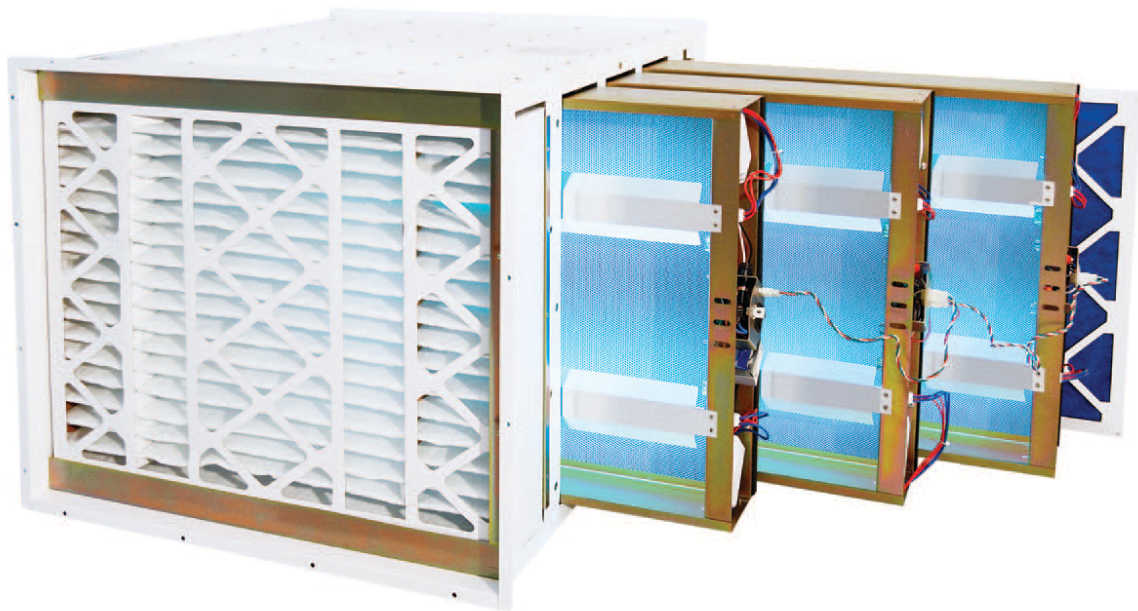
Chart: Bundesgesundheitsblatt–Gesundheitsforschung
Gesundheitsschutz 2007, 50:990–1005

¹. U.S. Environmental Protection Agency. 1987. The total exposure assessment methodology (TEAM) study: Summary and analysis.



hummingbird™ AP

Photocatalytic Oxidation Air Purifier



COMMERCIAL AIR QUALITY SOLUTIONS

The Ultimate Commercial Air Purification System

The hummingbird™ AP commercial air purifier is designed for applications or work environments where superior air quality is essential. High efficiency particle filtration is combined with up to three stages of PCO-Cell™ odor and VOC reduction. This multi-stage treatment effectively and efficiently cleans the air in a single pass for systems up to 6.0 tons. The hummingbird™ AP is designed for use in any environment where harmful odors, volatile organics, viruses or other airborne contaminants are a concern. The hummingbird™ AP's effectiveness is multiplied in recirculating HVAC systems where the air quality improves with each pass.

System Options

Recirculating systems can be outfitted with an optional post filter to trap targeted gases or with an all-purpose charcoal filter to further control odors.

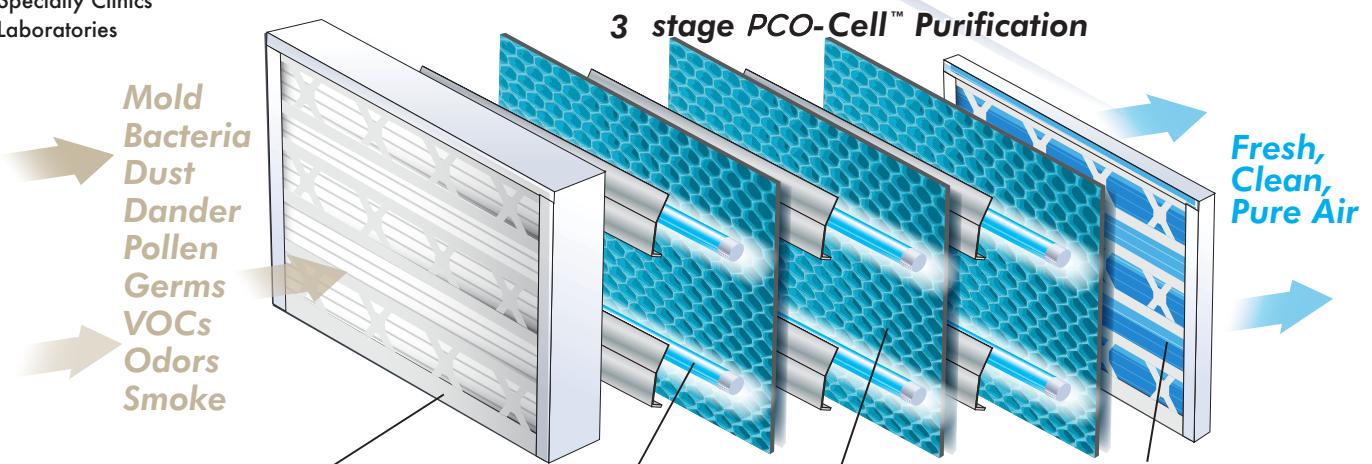
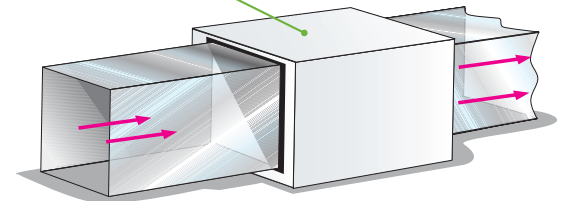
Exhausting systems can be outfitted with a third PCO-Cell™ module with specialized output to completely eliminate odors from being emitted outside the building.

Typical commercial applications include:

- Schools
 - Grocery
 - Nail & Hair Salons
 - Clean Rooms
 - Printing Companies
 - Specialty Clinics
 - Laboratories
- Hospitals
 - Medical Clinics
 - Vet Hospitals
 - Furniture, Fabric, Carpet Stores
- Gym / Health Clubs
 - Retail
 - All Environments with Inks, Solvents, and VOC-Generating Chemicals



hummingbird™ Commercial PCO



- 1 High Efficiency Filter**
- MERV 13 high efficiency 4" pleated pre-filter
 - Traps particles as small as .3 micron including mold, bacteria, dust, dander, and pollen

- 2 UVC Germicidal Lamps**
- Two high output UVC germicidal lamps per module
 - Three ultraviolet germicidal treatment zones are standard
 - Neutralizes airborne microbes such as bacteria, viruses, mold, and fungi
 - UVC magnifies PRO-Cell™ performance up to 200%

- 3 PCO-Cell™**
- Patented PCO-Cell™ panels that clear the air of smoke, odors, and VOCs
 - Transforms odors, smoke, and volatile organic compounds (VOCs) into harmless, odorless water vapor and carbon dioxide
 - Maintenance free PCO-Cell™ core

- 4 Potassium Permanganate Filter**
- Optional**
Carbon Filter



ENERGY CLOUD®

Hummingbird™ AP

Model	PCO-Cell™ Surface Area (sq. in.)	Sizing (tons)	Voltage	Lamp Wattage	MERV 13 Filter (inches)	MERV 13 Efficiency Particulate Reduction at .30 microns	Dimensions (inches)	Lamp Life Efficiency
AP30000	30,240	6.0	120	6 at 25	20 H x 25 W x 4 D	92.30%	23 H x 31 W x 29 D	2 years



hummingbird™ AP

Bundled Package Solutions

CUSTOM AP MODULES WITH FILTRATION

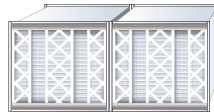
The custom AP bundled configuration

A single hummingbird™ AP 30000 is capable of total air purification up to six tons. AP's can be stacked or bundled together to handle up to 54 ton capacity by bundling 9 units.

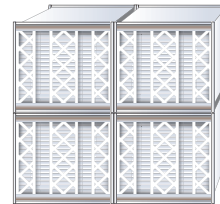


Two units were bundled to purify the air in this IVF lab in Chapel Hill, NC.

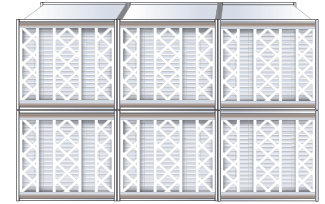
Bundled Configuration Examples



Two



Four



Six

Scalable & customizable

up to 6 ton capacity

up to 6 ton capacity

up to 6 ton capacity

up to 6 ton capacity

MERV 13 High Efficiency filtration in each module

Serviceable from end panel

120,960 sq. in. of PCO-Cell surface area

Optional Post-Filter

6 powerful UVC lamps in each Cube

PCO-Cell magnifies the power of the UV

Maintenance-free PCO-Cell

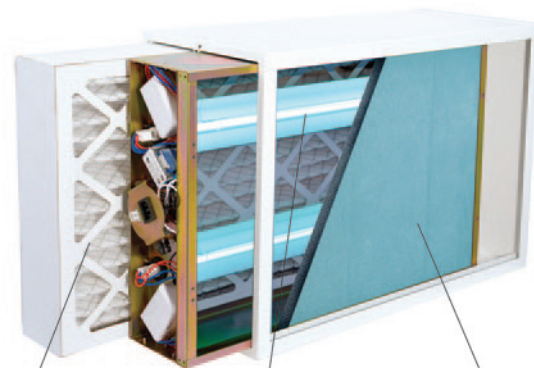
Example
24 ton capacity scalable package shown

Bundled Package Solutions

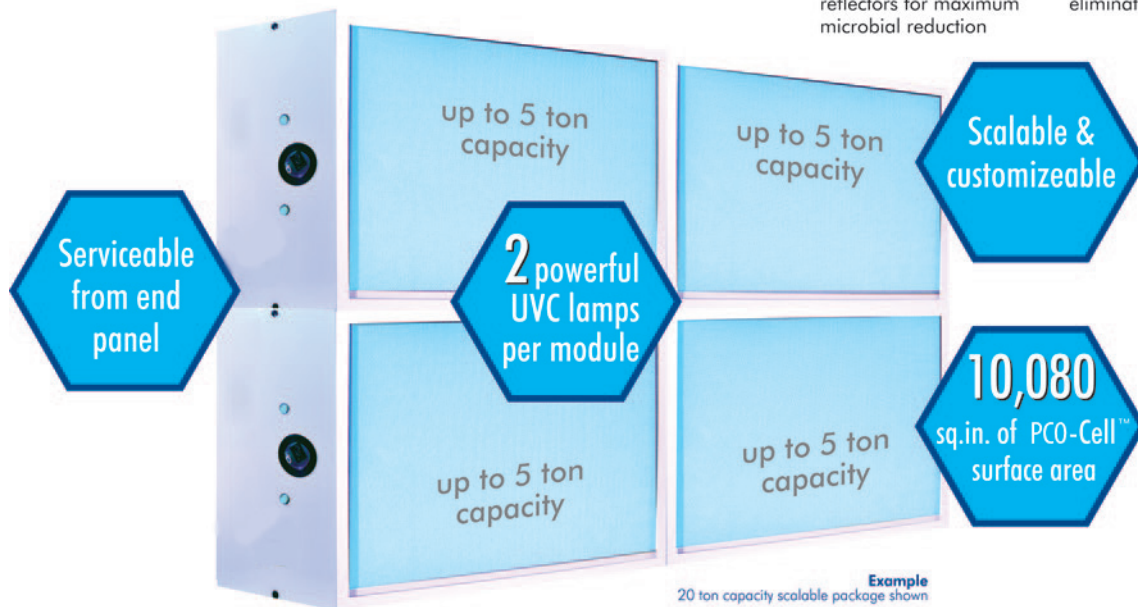
CUSTOM AP MODELS WITH FILTRATION

The custom AP commercial air purification system with PCO technology and filtration

The AP 10000 is a 3-in-1 package that is scalable and customizable for commercial applications up to 20 tons. Each AP 10000 module contains a four inch MERV 13 high efficiency filter, two 22 inch UVC germicidal lamps, and 10,080 square inches of our patented PCO-Cell honeycomb. Each module is sized for a typical 5 ton installation. The units can be paired and bundled as illustrated below for increased air cleaning power.



- 1 MERV 13 high efficiency filter
- 2 Two UVC germicidal lamps and magnifying reflectors for maximum microbial reduction
- 3 Maintenance-free PCO-Cell panel eliminates toxic VOCs



AP10000 / AP8000

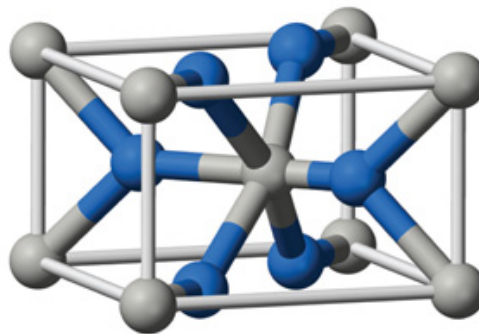
Model	PCO-Cell™ Surface Area (sq. in.)	Sizing (tons)	Voltage	Lamp Wattage (μ W/cm ² @1m)	Lamp Intensity (μ W/cm ² @1m)	Static Pressure Performance	MERV 13 Filter	MERV 13 Efficiency Particulate Reduction at .30 microns	Dimensions (inches)	Lamp Life Efficiency
AP-8000	8,065	1.5 to 3.0	120	2 at 25	2 at 70	.30 in WC @ 1,200 cfm	16 H x 25 W x 4 D	92.30%	17 H x 25 W x 10 D	2 years
AP-10000	10,080	2.5 to 5.0	120	2 at 25	2 at 70	.32 in WC @ 1,600 cfm	20 H x 25 W x 4 D	92.30%	21 H x 25 W x 10 D	2 years

Photocatalytic Oxidation

Photocatalytic Oxidation (PCO) is a reaction that occurs when Titanium Dioxide (TiO₂) is exposed to ultraviolet (UV) light rays. When VOCs (Volatile Organic Compound) gaseous contaminants and odors come into contact with the PCO-Cell™ surface, they are converted to odorless, harmless water vapor and Carbon Dioxide. The titanium dioxide catalyst is activated by UV light which neutralizes biological contaminants such as bacteria, viruses, mold and fungi. When used properly, Photocatalytic Oxidation is a powerful air sanitizer ideal for controlling air quality.



+



● Titanium atoms
● Oxygen atoms

Titanium Dioxide (TiO₂)

=

Photocatalytic Oxidation

Deactivates

Biologicals

- Bacteria
- Viruses
- Fungi
- Fungi

Eliminates

VOCs

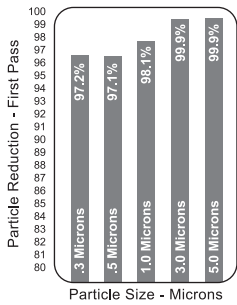
- Paint
- Pesticides
- Chemicals
- Solvents

Reduces

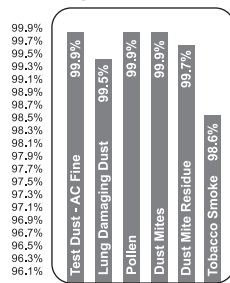
Odors

- Cigarettes
- Garbage
- Kitchens
- Bathrooms

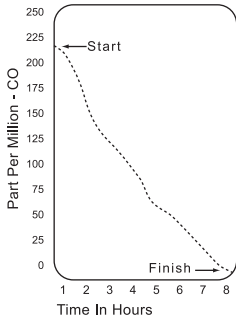
Particulate Filter



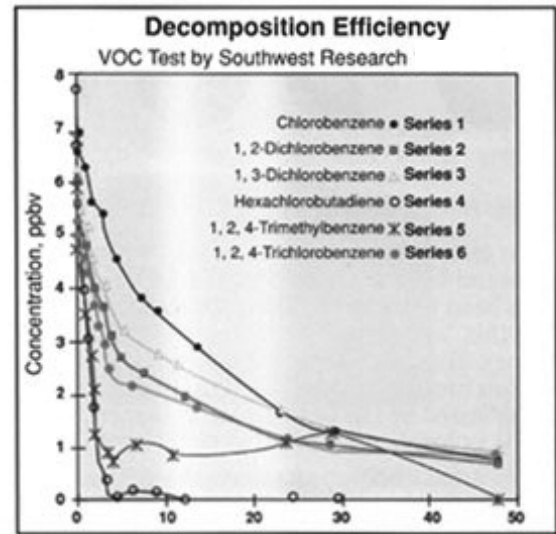
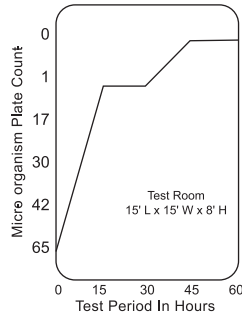
Allergen Reduction



Carbon Monoxide Reduction



Bacteria Reduction



Electrical Testing Laboratories
United States



Electrical Testing Laboratories
Canada

Air Flow & Resistance Data:	Air Flow (cfm)	Resistance (in w.g.)	Air Velocity (fpm)
	1250	0.18	360
	1500	0.20	432
	1750	0.25	504
	2000	0.35	576
	2250	0.42	648
	2500	0.55	720

Safe Air Purification – Does not create harmful Ozone!



hummingbird™ does not generate ozone. The fact is, hummingbird™ germicidal lamps convert ozone back into safe, healthy oxygen.

Ozone is a toxic gas which can damage the lungs when inhaled. Even low amounts can cause chest pain, coughing, shortness of breath, and throat irritation. Ozone may also worsen chronic respiratory diseases such as asthma and compromise the ability of the body to fight respiratory infections. Visit the EPA's website for more information at www.epa.gov/iaq/pubs/ozonegen.html.

Beware of other manufacturers advertising ozone generating devices as air quality products. They often use misleading terms to disguise ozone such as "energized oxygen", "plasma", "activated oxygen", and "ionization". No matter what it is called, ozone is a known carcinogen and can be harmful to your health.

Tested and approved by:

- Electrical Testing Laboratories
- Sandia Laboratory & National Renewable Energy Laboratory
- Chalmers University of Technology, Gothenburg Sweden
- Hong Kong Polytechnic University Department of IAQ
- Alpha, Scientists in Reproductive Medicine, Istanbul, Turkey

Test Results

- 97.2% Particle Reduction (.3 Micron) in (1st Pass)
- 99.9% Particle Reduction (>=3.0 Microns)(1st Pass)
- VOC Reduction down to 1 ppb
- Viral and Bacterial Reduction
- Destroys Ozone, CO and Formaldehydes



Through Duct Test Chamber - State of the art computerized monitoring allows for adjustable airflow, scheduled monitoring of CO₂, VOCs, ozone, and more.



Featured Installations

APPLICATIONS

Airports

"When one plane uses its engine to back away from the gate, the fumes from jet fuel can destroy the air quality in that concourse within seconds. We installed PCO-Cell technology to eliminate that danger."

*-Airport Manager
Southern California*

Jet engine exhaust, VOCs, and toxic gases are in the air in every airport in the world. In the past, airport managers have used exhaust fans and filters to try to stabilize the air. They are now adding PCO-Cell technology as a more efficient and effective method of mitigating these challenges. As with casinos, PCO-Cell panels and UV-C light banks are added to new or existing air handling units to clean the air of jet fuel fumes, VOCs, and other toxins.



In Vitro Fertilization Labs

"The air in our IVF lab has to be pristine...completely free of odors, VOCs, germs, and dust. It is truly a life or death situation."

*-In vitro fertilization Lab Manager
Chapel Hill, NC*

The In vitro fertilization process is a delicate one and requires ultra-clean air. The presence of VOCs or germs can prevent the successful fertilization of an egg. IVF labs turn to **photocatalytic oxidation** to filter and purify the air in their facility. A single **hummingbird™ AP** is capable of purifying the air handled by a six ton system. Up to **eight AP's** can be bundled together to handle up to **48 ton** capacity. In Chapel Hill, North Carolina, we combined two units for twelve ton capacity in a new 6,000 square foot IVF lab. Each module contains one MERV 13 high efficiency filter to capture particulates and three PCO-Cell modules that contain two UV-C germicidal lamps and 10,080 square inches of active photocatalytic activated surface area. Since the lab only operates during regular business hours, the **AP** is dormant at night. It is activated in the morning when the staff arrives. Within 30 minutes, the air is quickly cleaned and the lab is ready for business.



Casinos

"Our air quality has dramatically improved since installing the PCO System. Our customers have noticed the difference."

*-Casino Manager
San Diego, California*

Heavy concentrations of VOCs such as cigarette smoke produce a serious challenge for casino managers. Studies have shown that casino patrons stay longer and play more when the air quality in the casino is fresh and clean.

Leading casino operators are adding PCO-Cell technology to their existing air conditioning system to efficiently eliminate VOCs, smoke and cooking odors as well as microbial contaminants. PCO-Cell panels, typically 24" x 24", are configured into a one inch thick PCO "wall" inside each roof-top air handling unit. A bank of UV-C germicidal lamps are positioned before and/or after the PCO-Cell panels. Together, the lights and PCO-Cell panels work to clean the air of odor causing compounds as airborne mold, bacteria and viruses. The entire configuration can be installed in a space as narrow as ten inches. Six such systems were used to purify the air in a 250,000 square foot casino in California.





hummingbird™ AP

Packaged & Custom Solutions APPLICATIONS

Commercial Applications

Airports, hospitals, specialty medical clinics, grocery stores, shipping and supply chain warehouses, labs, nail salons, veterinarian clinics, manufacturing plants, casinos, and more. Each has special air quality needs and challenges. Energy Cloud's hummingbird Ai & AP offers a comprehensive solution that is scalable, customizable, and robust. Our advanced, patented PCO-Cell™ technology combines high output UVC germicidal irradiation with a state-of-the-art photocatalytic oxidation process that reduces VOCs and odors. When combined with high efficiency filtration, you have a complete solution for clean, pure, odor-free air and a healthier environment.

FRESH, CLEAN, PURE AIR

Hospitals

Reduces germs, viruses, VOCs, and spread of airborne diseases



Casinos

Reduces smoke & odors



Photocatalytic Oxidation

PCO-Cell™ honeycomb reduces odors and gases, and destroys ozone and formaldehyde.

Commercial Offices

Reduces absenteeism caused by VOCs and germs



In Vitro Fertilization labs

Keeps environment safe for embryos



UVC Germicidal Lamp

UVC germicidal lights neutralize airborne microbes such as bacteria, viruses, mold, and fungi.

Medical Facilities

Reduces germs



Airports

Removes jet fuel fumes, VOCs



High Efficiency Filtration

Traps tiny particles including mold, bacteria, dust, dander, and pollen.

Manufacturing Process

Manage odor pollutants



Retail Stores

Removes VOCs





Ai Module



DESCRIPTION

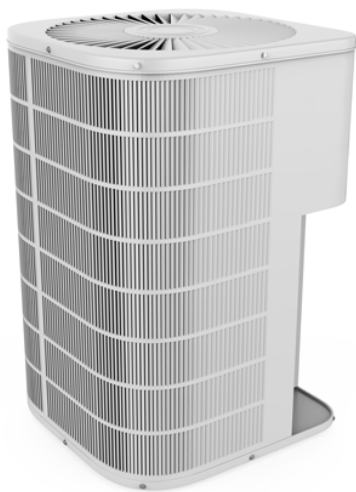
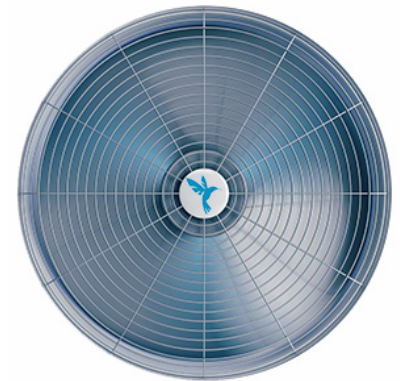
Hummingbird™ Ai is a complete HVAC live monitoring system that keeps your Air Conditioning unit ‘humming’ with optimum efficiency. The system measures and monitors all of the HVAC unit’s vitals including temperatures, humidity, air flow and refrigerant charge. **Hummingbird™ Ai** then continually checks the HVAC system with this data to make sure it’s running efficiently and alerts the customer and customer’s HVAC contractor with text or email alerts when a system is failing to run properly. This helps the Customer save energy, money, and extend the unit to its full useful life by making sure it’s running to its proper manufacturer specifications.

Most commercial HVAC systems only operate at 65% of their intended efficiency and residential systems only to 57%¹. The hummingbird AI will help identify the inefficiency as soon as there is an issue, so that your HVAC contractor can immediately help correct issues. By bringing your system up to it’s intended operating efficiency, substantial energy savings can be realized.

Hummingbird™ Ai is suitable for both existing and new systems. The Charge & Air Pro model will even measure the actual BTU output to make sure the HVAC system is delivering the heating and cooling that the HVAC unit is rated for.

BENEFITS

- Detect HVAC issues in real-time
- Save energy & money by ensuring efficiency
- Avoid down-time and emergency repairs
- Energy Cloud® portal access to view HVAC systems real-time* data
- Text and Email alerts on system performance/ issues
- Benchmark and Report on each HVAC system
- Continuous Monitoring instead of snapshot in time
- Extend Equipment life to its full potential



hummingbird™ Ai Model				Sensor	Type	Unit
Charge & Air Pro	Charge Pro	Pro	Light	Filter Replacement Detection	Air Flow	Yes / No
				Ambient Air Temperature	Temperature	°F or °C
				Return Air Temperature	Temperature	°F or °C
				Return Air Humidity	Humidity	RH%
				Return Air Wetbulb Temperature	Temperature	°F or °C
				Supply Air Temperature	Temperature	°F or °C
				Supply Air Humidity	Humidity	RH%
				Refrigerant Liquid Line Temperature	Temperature	°F or °C
				Refrigerant Suction Line Temperature	Temperature	°F or °C
				Refrigerant Liquid Line Pressure	Static Pressure	WC" & psi
Refrigerant Suction Line Pressure	Static Pressure	WC" & psi				
			Air Flow Total Static Pressure	Static Pressure	WC" & psi	

* Different data capture plans available

¹ National Comfort Institute
Document Rev. 1.0

Product Data Sheet

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REPORTING

Hummingbird™ Ai has the ability to report on many facets of your HVAC system from temperature split, SuperHeat / SubCool, Static Pressure, CFM, filter status, and BTU's of delivered performance depending on the model. All reports and live data can be viewed from any Internet accessible computer, smart phone or tablet.



COMMUNICATIONS

Hummingbird™ Ai system includes several wireless clusters of sensors which are long range with up to 1200 meters or .75 miles from the main sensor hub. In addition to the long range, the cluster sensors have the ability to buffer data in the event of a communication issue to the main sensor hub so there is no loss of data. Once data reaches the hub, there are several options to send the data over the internet to Energy Cloud® including accessing the building's Internet connectivity by ethernet or wifi or to be completely separate from the buildings network via a cellular gateway.

The sensor clusters are battery powered with standard 1.5V AA form factors, so they are easy to replace. An upgraded Lithium battery option is also available for colder climates.

Due to having multiple wireless sensor clusters, the system is more flexible than a system based on one monolithic board. For instance, the Return Sensor cluster could easily be installed down at the Return Vent instead of ducts by the main HVAC unit.

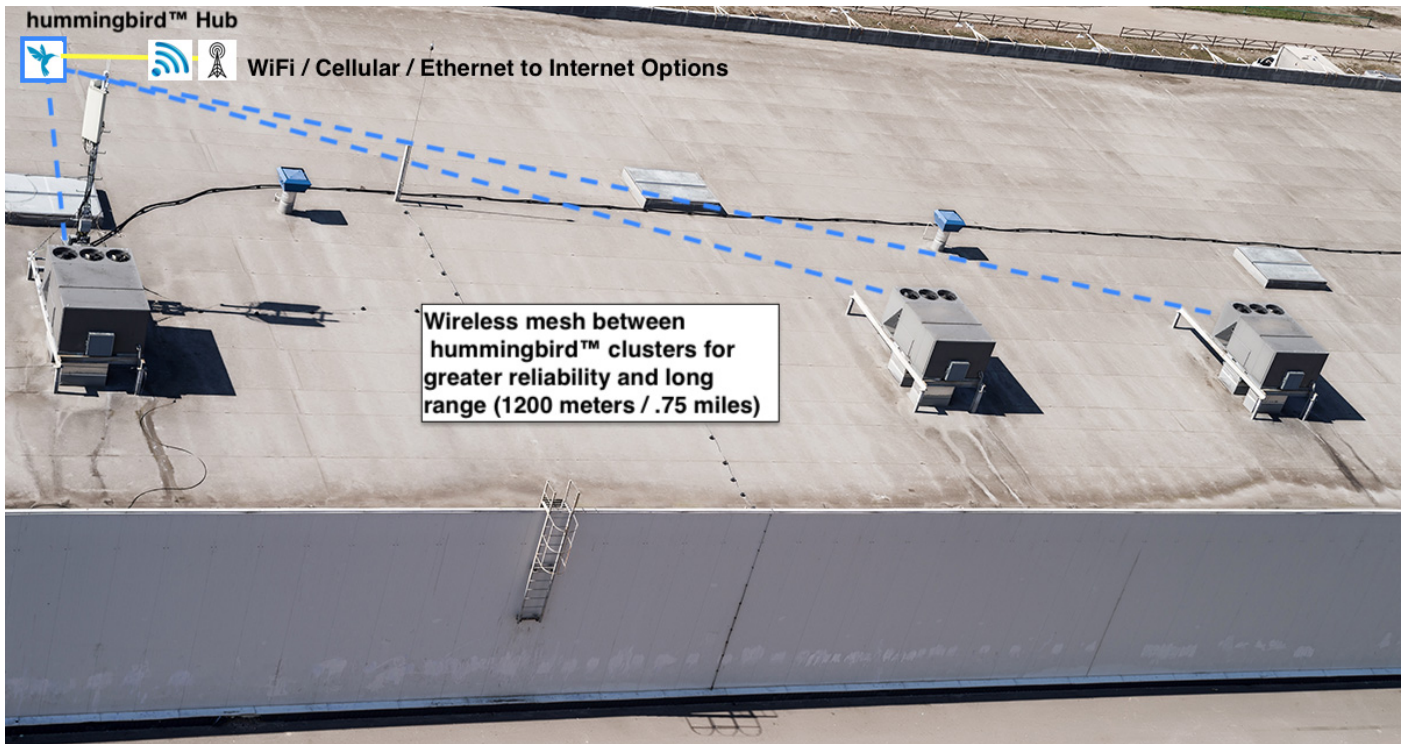
Internet Communication Options

Wi-Fi
Cellular 4G LTE
Ethernet

Local Communications

Local Communications	Range
Wireless Mesh	1200m/.75 Miles

Battery Options	Included	Expected Life*	Operating Temp.
2 x 1.5V AA Alkaline	Standard	2 Years	-20°C to 54°C (-4°F to 130°F)
2 x 1.5V AA Lithium	Upgrade	4 Years	-40°C to 60°C (-40°F to 140°F)



Due to continuous research, product improvements and enhancements, Energy Cloud reserves the right to change product or system specifications without notice, except to the extent an outstanding contractual obligation exists. ©2020 Energy Cloud, Inc. All rights reserved.

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Competitive Air Purification Technologies Discussion.

There are many different types of air purification technologies and methodologies to clean air. In evaluating all of the different technologies, we looked at what technology or multiple technologies could be deployed to provide the best solution to accomplish:

- A. Neutralizing VOC's (volatile organic compounds)
- B. Reduce and Capture Particulates
- C. Neutralize Viruses & Bacteria

AP: The hummingbird™ AP air purification technology combines the power and effectiveness of Photocatalytic oxidation with a 5 stage filtration process including a high performance pre-filter, three chambers of photocatalytic oxidation and a post filter of Potassium Permanganate or other filter options such as Carbon, depending on the application.

Here is a basic overview of the top deployed technologies.

Photocatalytic Oxidation is the best technology for killing viruses and bacteria as well as neutralizing VOC's and it achieves this without producing Ozone. There are ample studies proving the efficacy of the technology UV and TiO₂ as the substrate. The technology is so effective that it has been used in fertility labs IVF for years due to their incredibly stringent air standards.

A study was conducted in Japan photocatalysis by TiO₂ covering a wide variety viruses and bacteria. *"We have demonstrated broad-spectrum biocide efficacy of photocatalysis against both bacteria (GPC and GNR, including drug-resistant bacteria) and viruses (enveloped and non-enveloped virus). Photocatalysis has broad-spectrum microbicidal activity ... TiO₂ is a potential, environmentally friendly microbicidal agent. Furthermore, because of the high level and broad-spectrum biocide efficacy of photocatalysis, it is considered a valuable biocide method for use in various areas, e.g., sewage disposal treatment systems and air purification systems [54]."*¹

¹. Broad Spectrum Microbicidal Activity of Photocatalysis by TiO₂ (2013) Japan

². California Air Resource Board

Ionization based systems have been around since the late 1800's. They were later named Plasma tubes. They are also marketed as corona discharge tubes (CDT), ionization systems, bipolar ionization systems, dielectric barrier discharge (DBD) systems or Cold Plasma. Whatever their type, the philosophy is aimed at charging ions in the air which will adhere to other molecules and affect them one way or another. What is known about these based systems is they produce ozone which is extremely harmful and toxic to humans. It causes headaches, throat dryness and damage to mucous membranes at levels as low as 0.1 – 1 ppm and can be life - threatening at levels higher than this (Mills et al. 2003).

The California Air Resources Board maintains a list of over 40 different such products that produce Ozone.

"Indoor "air purifiers" or air cleaners that intentionally emit ozone are often called "ozone generators." Manufacturers sometimes inappropriately refer to ozone as "activated oxygen," "super oxygenated" or "energized oxygen," which implies that ozone is a healthy kind of oxygen. Because ozone reacts with some other molecules, manufacturers claim that the ozone produced by these devices can purify the air and remove airborne particles, chemicals, mold, viruses, bacteria, and odors. However, ozone is only partially effective at cleaning the air when it is used at extremely high, unsafe levels that pose a serious health risk."¹

Another aspect of ionization systems is the ions only last 60 seconds. This means they have very little time to treat the entirety of air in a building from individual rooms to the duct system. There is no central control point to ensure that particulates can be captured. This is why they will often use a general term about particulate reduction without actual measurement data or any discussion about Air Changes per Hour (ACH) and how many times it might take to completely clean the air.

Ultra-Violet Light Only

Ultra-violet light is known to be effective against viruses and bacteria, but the challenges are deploying the technology without the light exposing humans which can be detrimental. Also, the technology by itself, does not take care of particulates, VOC's or CO. When deployed within a duct based system, fast moving air flow means that the technology has little time to affect the air requiring many more air exchanges to affectively treat the air.



hummingbird™ EQ

SPECIFICATIONS



Patent Pending

hummingbird™ Specifications

EQ 30000

EQ 10000

EQ 8000

AP 30000

AP 10000

AP 8000

AIR PURIFICATION

- Photocatalytic Oxidation Chambers
- Surface Area of TiO₂ cells (Sq. Inches)
- Tonnage Range
- UVC germicidal lamps
- MERV 13 High Performance Filter
- In-Duct Install
- Neutralizes Viruses
- Neutralizes Bacteria
- Neutralizes Fungi
- Eliminates VOC's
- Eliminates Ozone (O₃)
- Eliminates Carbon Monoxide (CO)
- Eliminates Formaldehydes
- Reduces Particulates (PM .3 / PM1 / PM 2.5+)
- Reduces Allergens: Pollen
- Reduces Allergens: Dust Mites & Residue
- Reduces Allergens: Tobacco Smoke
- Reduces Allergens: Lung Damaging Dust
- Does not produce Ozone

3	1	1	3	1	1
30,240	10,080	8,065	30,240	10,080	8,065
5 - 6	2.5 - 5	1.5 - 3	5 - 6	2.5 - 5	1.5 - 3
6	2	2	6	2	2
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
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INDOOR AIR QUALITY MONITORING

- Live TVOC monitoring / data collection
- Live Particulate monitoring / data collection
- Live CO₂ monitoring / data collection
- Air Quality Certification based on data
- Air Quality Certification (Live / Up to Minute)
- Air Quality Certification web page
- Air Quality Certification QR code
- Wireless Sensor Modules

✓	✓	✓			
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REMOTE MANAGEMENT & AI

- Remote Diagnostics Detect Issues Real-time
- Energy Savings (Average 5 - 20%)*
- HVAC Performance Scoring
- Text & Email Alerts
- Monitor Return Air Temperature (dry bulb)
- Monitor Return Air Temperature (wet bulb)
- Monitor Return Air Humidity
- Monitor Supply Air Temperature (dry bulb)
- Monitor Supply Air Humidity
- Monitor Refrigerant Liquid Line Pressure
- Monitor Refrigerant Liquid Line Temperature
- Monitor Refrigerant Suction Line Pressure
- Monitor Refrigerant Suction Line Temp.
- Monitor Total Static Pressure
- Monitor Filter Status

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ADDITIONAL SPECIFICATIONS

- Warranty (Main Air Purification Unit)
- Warranty (UVC Lamps)
- Dimensions (Inches)
- Weight
- Static Pressure Performance
- Power (Main Air Purification Unit)
- Country of Origin

5 years	5 years	5 years	5 years	5 years	5 years
1 Year	1 Year	1 Year	1 Year	1 Year	1 Year
23H x 31W x 29D	21H x 25W x 10D	17H x 25W x 10D	23H x 31W x 29D	21H x 25W x 10D	17H x 25W x 10D
92 lbs. / 41.7 kg	26 lbs / 11.8 kg	23 lbs / 10.4 kg	92 lbs. / 41.7 kg	26 lbs / 11.8 kg	23 lbs / 10.4 kg
.26WC @ 1600 cfm	.32WC @ 1600 cfm	.30WC @ 1200 cfm	.26WC @ 1600 cfm	.32WC @ 1600 cfm	.30WC @ 1200 cfm
120V / 150 watts	120V / 50 watts	120V / 50 watts	120V / 150 watts	120V / 50 watts	120V / 50 watts
USA	USA	USA	USA	USA	USA

*Based on average of two or more systems.