# Bi-Polar Ionization Technology Overview

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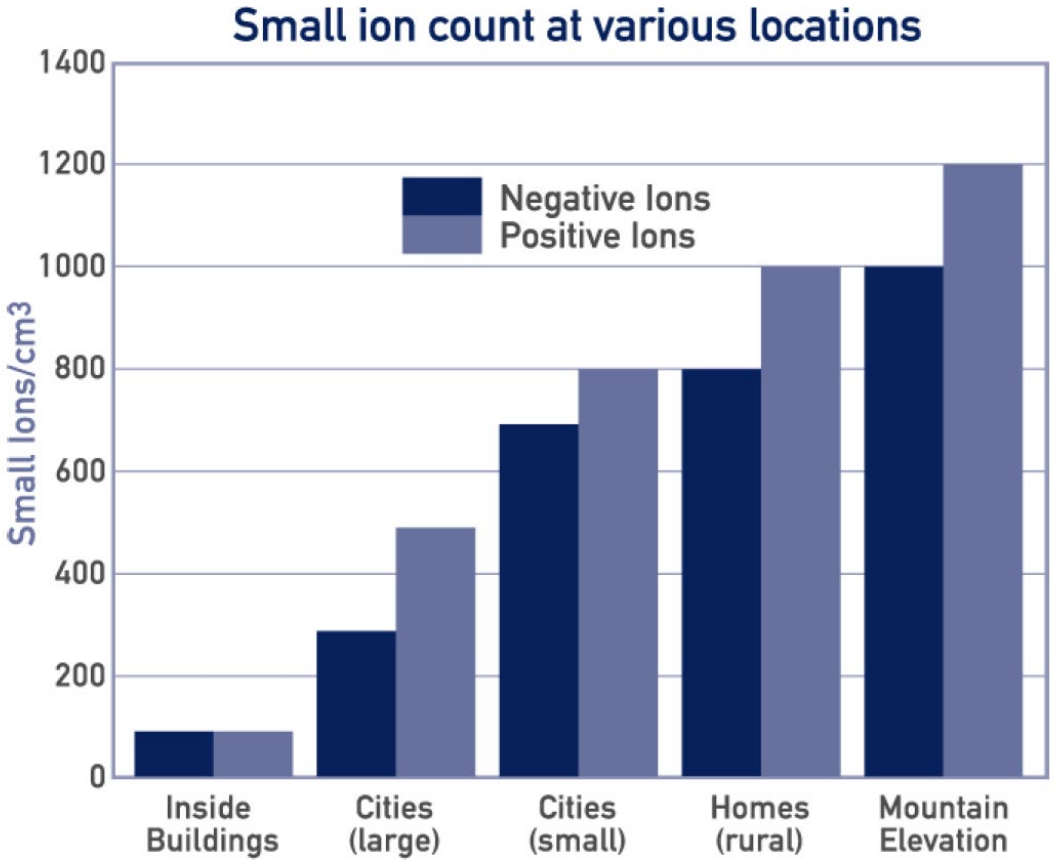
# Agenda

- What are Ions?
- Why are Ions Beneficial to Indoor Air Quality (IAQ)?
- How Does Bi-Polar Ionization Technology Work?
- What are the Benefits of Bi-Polar Ionization?
- Bi-Polar Ionization Performance Validation
- How is Bi-Polar Ionization Technology Implemented?
- Creative Financing for Bi-Polar Technology Implementation

# What are Ions?

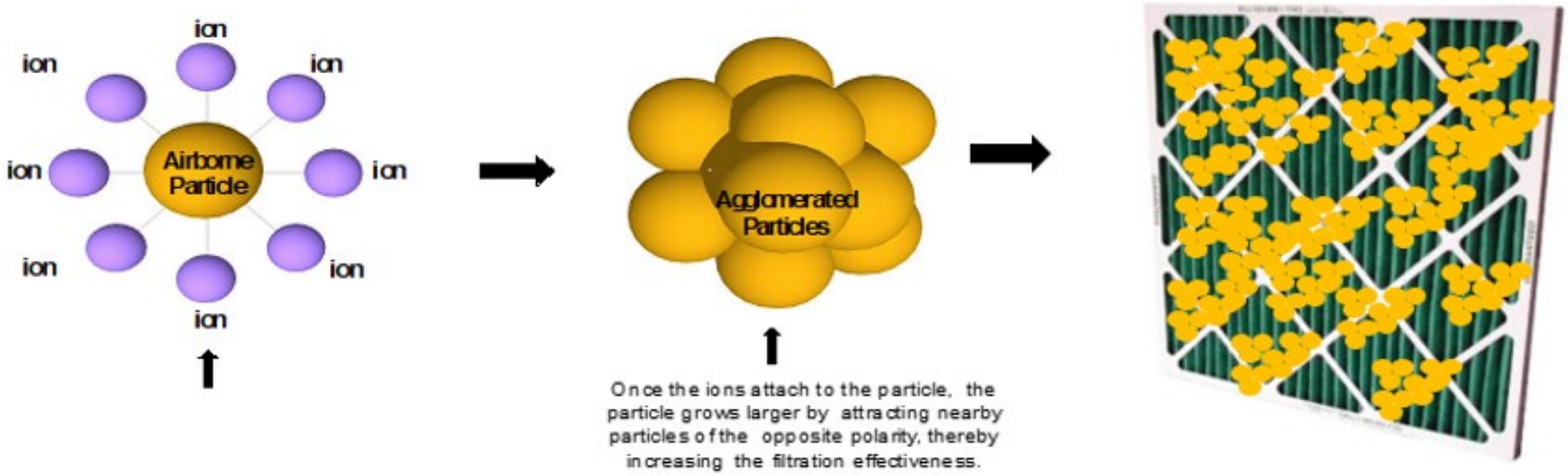
Ion: An atom or molecule with a net electric charge due to the loss or gain of one or more electrons.

- Ions exist naturally in our environment
- Ions have a finite lifespan – typically 5-60 seconds
- Natural ion count is reduced as elevation is reduced
- Natural ion count is reduced as population activity/density is increased
- Lowest ion count is typically inside of buildings



# Why are Ions Beneficial to IAQ?

- Due to the attractive forces of positively/negatively charged ions, airborne particles will stick together (agglomeration)
- As airborne particles agglomerate, they:
  - Become larger - larger particles increase the effectiveness of traditional filtration media
  - Become heavier – heavier particles fall out of the breathing zone faster; thereby increasing the effectiveness of surface cleaning



# Why are Ions Beneficial to IAQ?

## Size Distribution of Typical Atmospheric Contaminants*

| Range of Particle Size (Micron) | Average Particle Size (Micron) | Number of Particles | Percent by Particle Count | Percent by Weight |
|---|---|---|---|---|
| 10 - 30 | 20 | 1,000 | 0.005 | 28 |
| 5 - 10 | 7.5 | 35,000 | 0.175 | 53 |
| 3 - 5 | 4 | 50,000 | 0.25 | 11 |
| 1 - 3 | 2 | 214,000 | 1.07 | 5 |
| 0 - 1 | 0.5 | 19,632,000 | 98.5 | 3 |
| | | 19,932,000 | 100 | 100 |

* University of Minnesota

**Conclusion:** 99.8% of all airborne particles pass through a typical filter. Agglomerating smaller particles into larger ones using bi-polar ionization improves filter efficiencies.

## Summary of Frank Chart

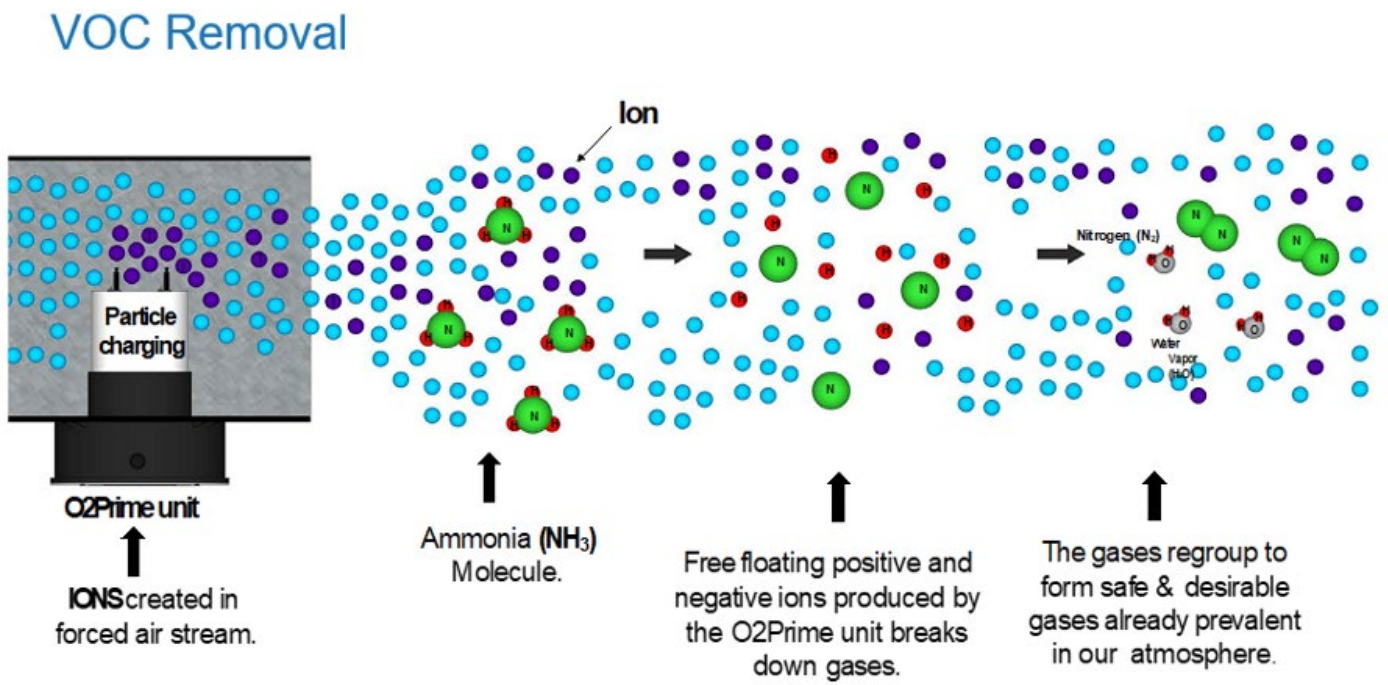
| Particle Diameter (Microns) | Number of Particles per $ft^3$ of Air [1] | Settling Rate for Spheres (FPM) [2] | Time Required to Settle 8 Ft. |
|---|---|---|---|
| 100 | 75 | 59.2 | 8.1 Sec |
| 10 | $75 \times 10^3$ | 0.592 | 13.5 Min |
| 1 | $75 \times 10^6$ | 0.007 | 19 Hours |
| 0.1 | $75 \times 10^9$ | 0.00007 | 79 Days |
| 0.01 | $75 \times 10^{12}$ | 0 (Brownian) | Never |

1. Based on air containing 0.00006 grains of impurities per $ft^3$
2. In still air 70° F, density = 1 (S-C factors included)

**Conclusion:** Particles 1 micron and smaller (98.5% of all particles) stay airborne. Particles are typically the vehicle that transmit bacteria and virus from person to person. Agglomerating these small particles into larger ones essentially reduces airborne pollutants as they are caught by the filter

# *Why are Ions Beneficial to IAQ?*

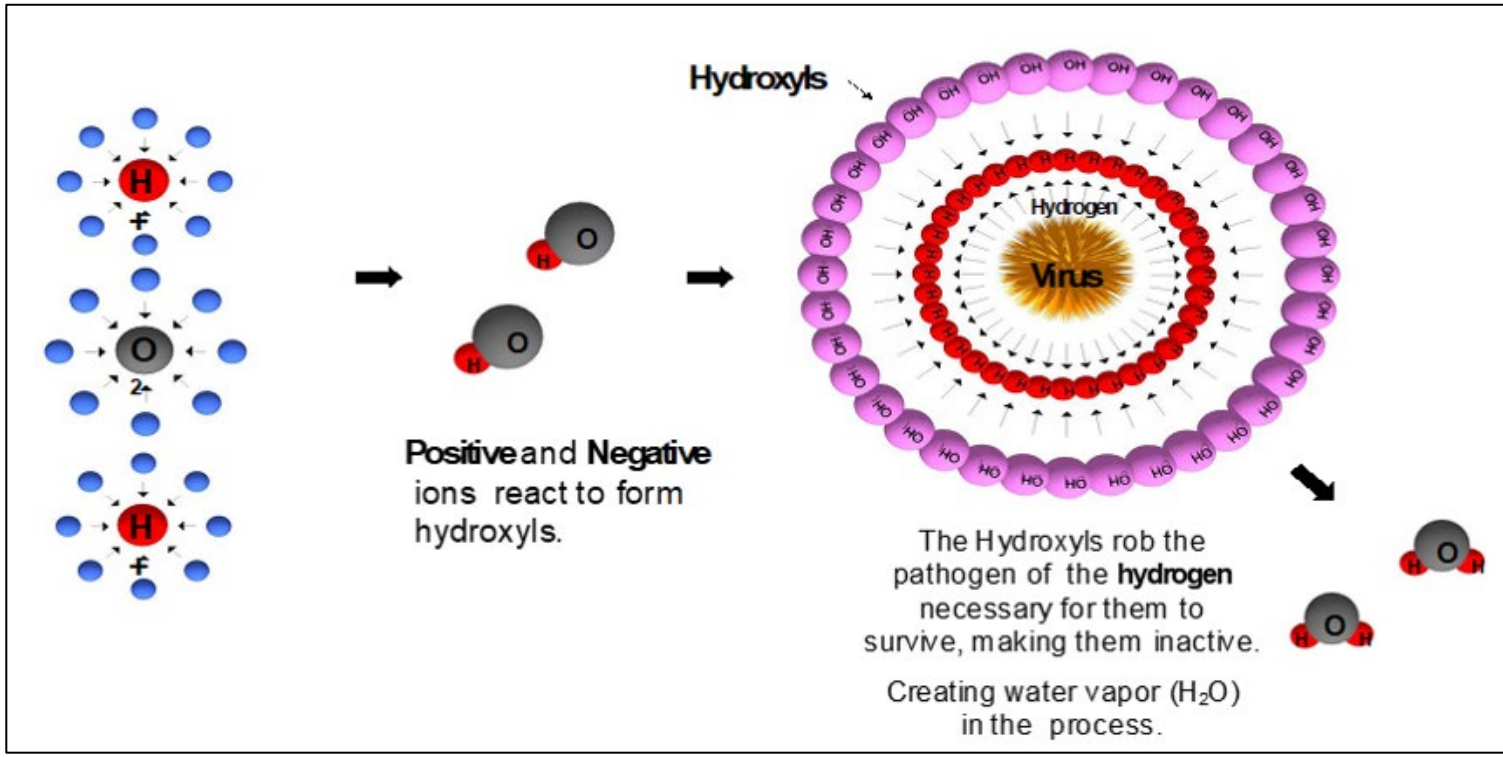
- Due to the attractive forces of positively/negatively charged ions, they will strip weakly bound atoms off VOC's (oxidation)
- As atoms are stripped off by the ions, VOC's are broken-down/removed
- The remaining ions foster the formation of new safe & desirable gases



# Why are Ions Beneficial to IAQ?

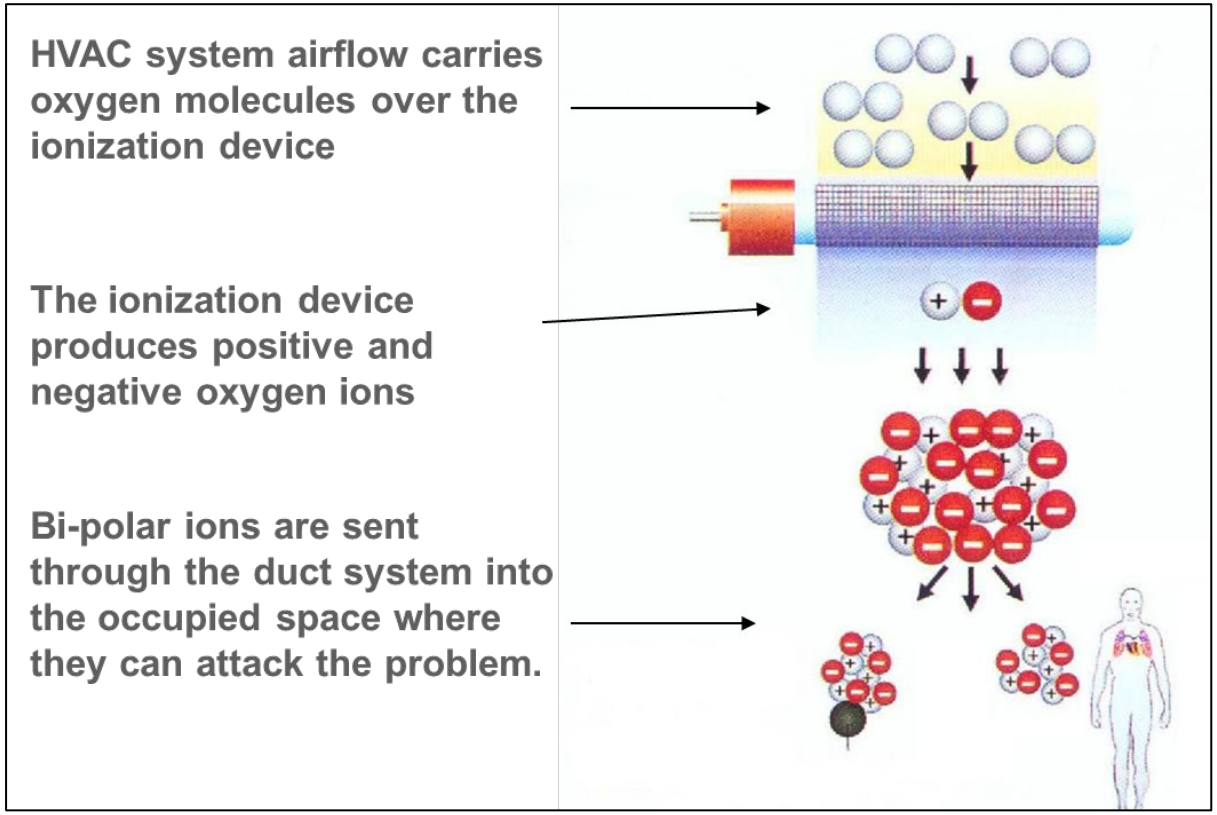
- Due to the attractive forces of positively/negatively charged ions, they will react with ambient air to form hydroxyls
- Hydroxyls rob hydrogen atoms from bacteria & pathogens making them inactive (sterilization)
- The hydroxyls combine with the hydrogen atoms to form water vapor

## Bacteria & Pathogen Removal

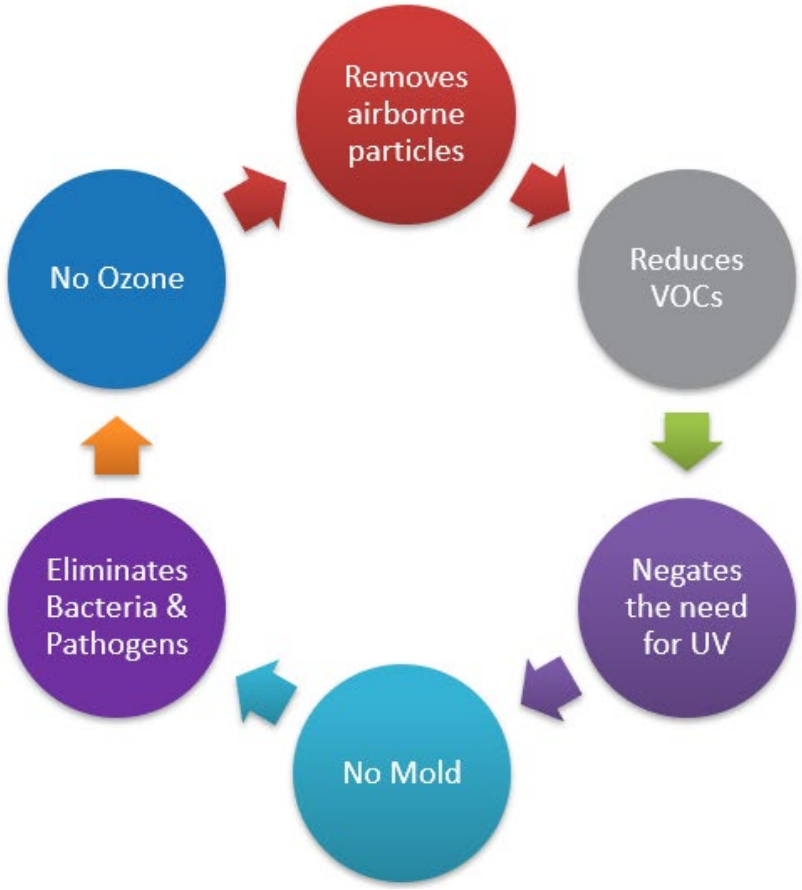


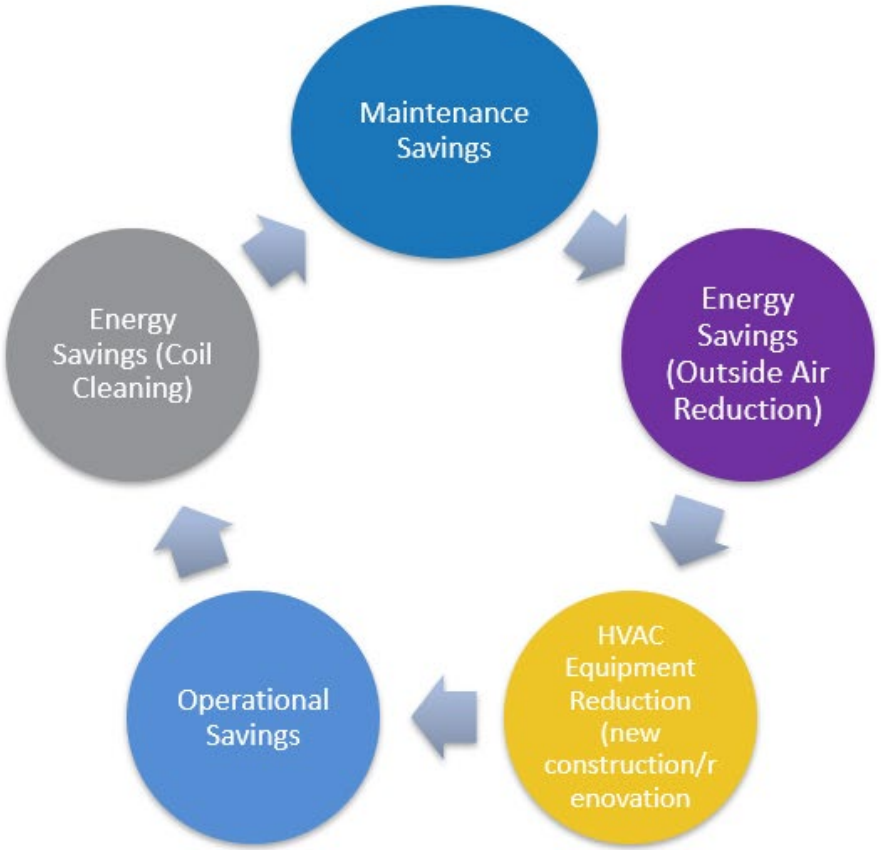
# How Does Bi-Polar Ionization Technology Work?

- Bi-Polar ionization technology utilizes the HVAC system/ductwork to deliver ions to the occupied space
- Ions are generated in a compact, low energy consuming, low/zero maintenance ionization device
- There are (2) pre-dominant technologies in the marketplace
  - Tube technology: Generates the most ions – typically applied in industrial/heavy odor remediation applications
  - Needlepoint technology: Generates fewer ions – typically applied in commercial applications



# What are the Benefits of Bi-Polar Ionization?



# What are the Benefits of Bi-Polar Ionization?

IN ADDITION TO IMPROVING A FACILITY'S INDOOR AIR QUALITY (IAQ), BI-POLAR IONIZATION CAN PROVIDE SUBSTANTIAL REDUCTIONS IN HVAC SYSTEM ENERGY CONSUMPTION & FIRST COST

## Energy Savings

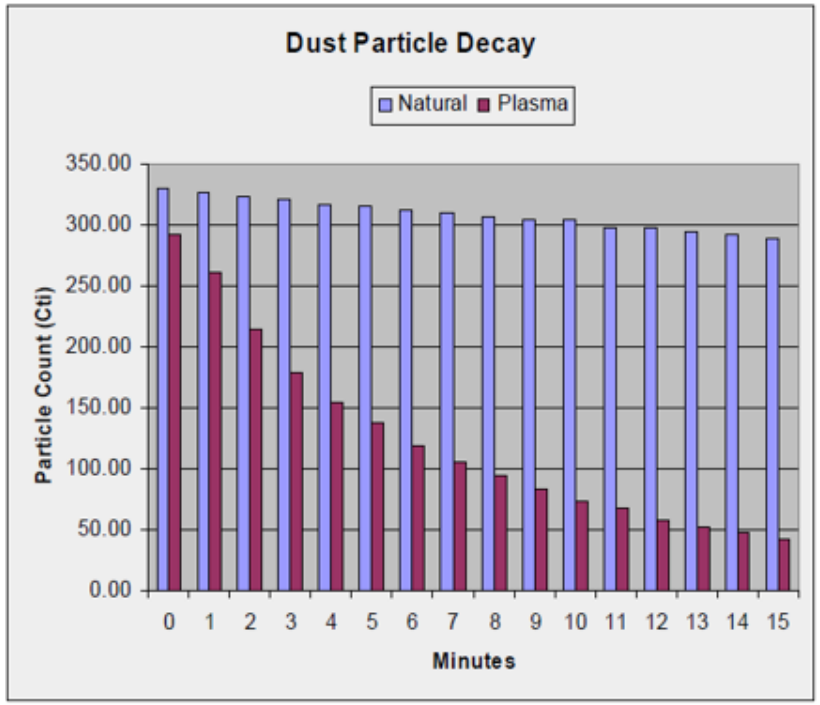
O2Prime Saves Energy using ASHRAE 62.1

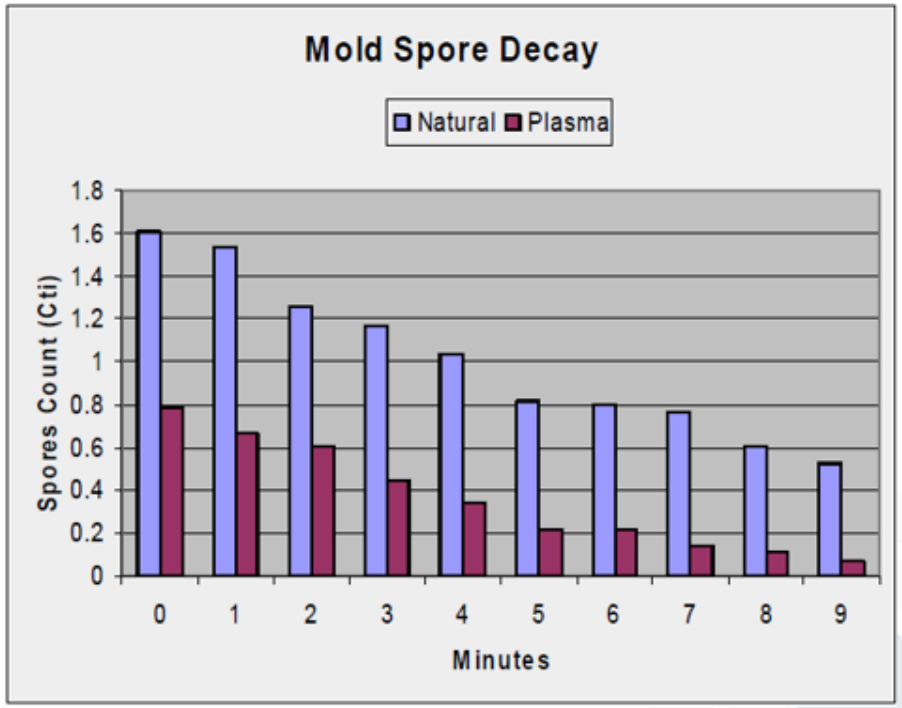
| Ventilation Rate Procedure (VRP) | | Indoor Air Quality Procedure (IAQP) | |
|---|---|---|---|
| **Retrofit** | | **Retrofit** | |
|  | ✓ By using ASHRAE Mass balance analysis on existing HVAC system we can reduce the amount of outside air, consequently reducing the energy demand for cooling/heating the building. |  |   |
| 15.5 cfm per person 25 ton air handler | | 3.5 cfm per person 25 ton air handler | $8-$10K (using 1,800 run hours) (Estimated) |
| **New Construction** | | | |
|  | ✓ By using ASHRAE Mass balance analysis on new HVAC systems, we can reduce the amount of outside air, consequently reducing the energy demand for cooling/heating the building.<br>✓ And in addition also reduction of HVAC equipment size. |  |     |
| 15.5 cfm per person 25 ton air handler | | 3.5 cfm per person 15 ton air handler | $5-$6K (Estimated) $6-$7K (Estimated) O2 PRIME |

MOST FACILTIES ARE VENTILATED ACCORDING THE VENTILATION RATE PROCEDURE (VRP) OUTLINED IN ASHRAE STANDARD 62.1

HOWEVER BOTH ASHRAE & IMC ALLOW FOR THE REDUCTION OF REQUIRED OUTDOOR AIR CFM BY UTILIZING THE INDOOR AIR QUALITY PROCEDURE (IAQP)

# Effectiveness on Airborne Particles



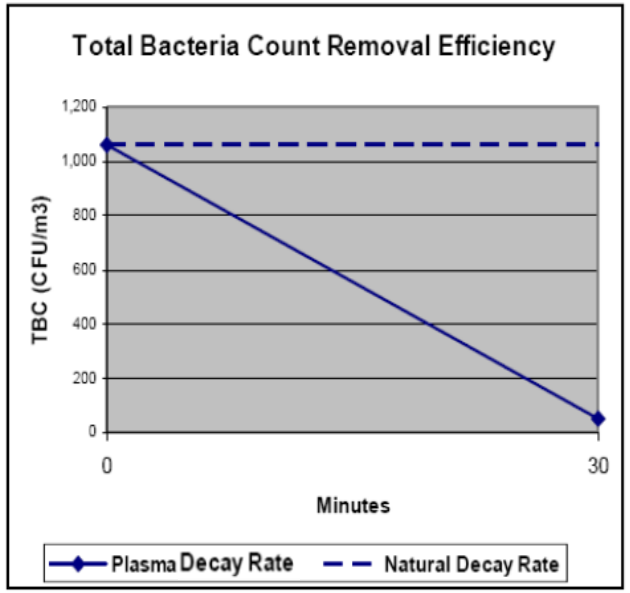

**Natural Decay 12.8%** **Bi-Polar Ionization 85.8%** **Natural Decay 67.1%** **Bi-Polar Ionization 91.1%**

**REPORT**
**INTERTEK, ETL SEMKO**
3933 US ROUTE 11 CORTLAND, NEW YORK 13045

# Bi-Polar Ionization Performance Validation

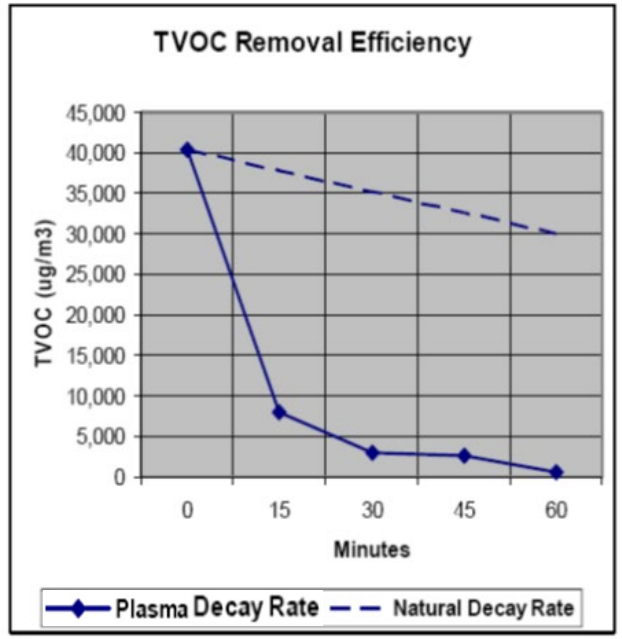
## Effectiveness on Airborne Bacteria

| Parameters | | Airborne Bacteria |
|---|---|---|
| Unit | | CFU/m$^3$ |
| Sampling description | Survey Date | |
| Step 1 | 31/10/08 | 1,063 |
| Step 2 (after 15 min) | 31/10/08 | - |
| Removal rate at 15 min (%) | | |
| Step 2 (after 30 min) | 31/10/08 | 49 |
| Removal rate at 30 min (%) | | 95.3% |
| Step 2 (after 45 min) | 31/10/08 | - |
| Removal rate at 45 min (%) | | |
| Step 2 (after 1 hour) | 31/10/08 | - |
| Removal rate at 1 hour (%) | | **95.3%** |




## Effectiveness on TVOC

| Parameters | | TVOC |
|---|---|---|
| Unit | | µg/m$^3$ |
| Sampling description | Survey Date | |
| Step 1 | 31/10/08 | 40,400 |
| Step 2 (after 15 min) | 31/10/08 | 7,901 |
| Removal rate at 15 min (%) | | 80.4% |
| Step 2 (after 30 min) | 31/10/08 | 3,002 |
| Removal rate at 30 min (%) | | 92.6% |
| Step 2 (after 45 min) | 31/10/08 | 2,514 |
| Removal rate at 45 min (%) | | 93.8% |
| Step 2 (after 1 hour) | 31/10/08 | 580 |
| Removal rate at 1 hour (%) | | **98.6%** |



# Bi-Polar Ionization Performance Validation

| Pathogen | Time in Chamber | Kill Rate | Test Agency |
|---|---|---|---|
| Clostridium Difficile (C Diff) | 30 min. | 86.87% | EMSL |
| E.coli | 15 min. | 99.68% | EMSL |
| Legionella | 30 min. | 99.71% | EMSL |
| Mold Spores | 24 hrs | 99.50% | GCA |
| MRSA | 30 min. | 96.24% | EMSL |
| Norovirus | 30 min. | 93.50% | ATS Labs |
| SARS-coronavirus | 3.3 sec. | 73.40% | hVIVO |
| Staphylococcus (Staph) | 30 min. | 96.24% | EMSL |
| Tuberculosis | 60 min | 69.09% | EMSL |

VIRUSES FALL INTO (3) CATEGORIES:

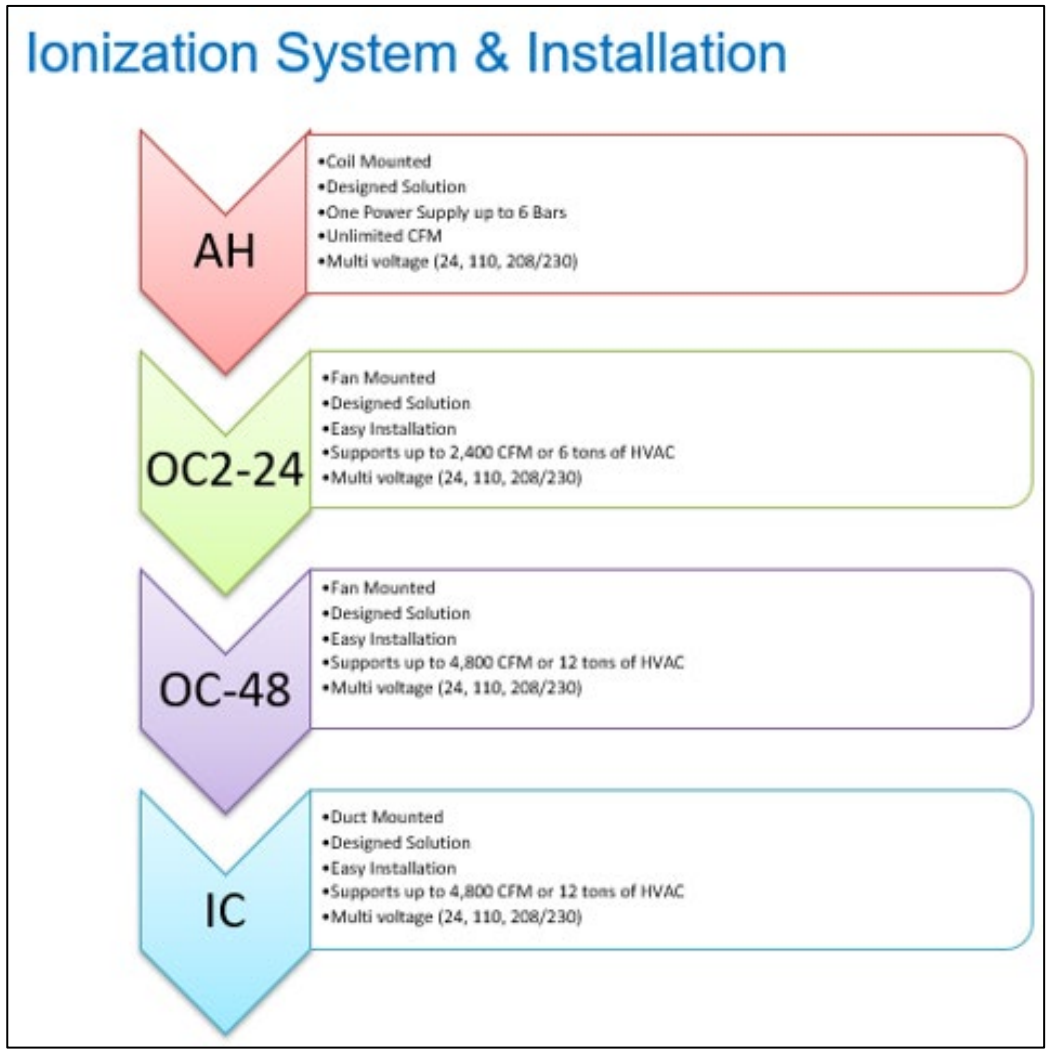
- Enveloped: Influenza A, Coronavirus, et al. (EASIEST TO KILL)
- Large, non-enveloped: Rotavirus, et al.
- Small, non-enveloped: Rhinovirus, Norovirus, et al. (HARDEST TO KILL)

Bi-polar ionization has a documented kill rate of 93.5%, within 30 minutes, for Norovirus (most difficult to kill)

# How is Bi-Polar Ionization Technology Implemented?

- Bi-polar ionization devices are easily installed into new & existing HVAC duct work
- Bi-polar ionization devices are easily installed into new & existing HVAC units
  - Packaged Rooftop Units
  - VRF Indoor Units
  - Fan Coil Units
  - Air Handling Units
  - Unit Ventilators
  - Furnaces
- Operation is typically interlocked with the supply fan's operation

  FAN ON = IONIZATION ON
- The number & size of the device(s) is dependent on supply CFM (higher CFM = need for more ions)
- Multiple voltages are available to suit all applications (24v, 120v, 208-230v)



# ripKurrent ASSESSMENT & IMPLEMENTATION PROCESS

1. Gather information on Verde Solutions' PIF including HVAC equipment (model #, CFM, etc.)
2. Determine end-user objectives (improved IAQ, odor mitigation, energy savings, etc.)
3. Educate, consult & advocate approach to ensure the correct technology is applied
4. Provide a turn-key proposal including engineering, procurement, rebates, and installation
5. Measure & verify the result to ensure objectives are met and ion count is acceptable

# C-PACE FINANCING CAN BE LEVERAGED TO COVER 100% OF THE UPFRONT COST OF IMPLEMENTATION

***Property Assessed Clean Energy (PACE)***

- PACE is a Public / Private partnership which allows property owners to finance projects through voluntary assessments placed on the property by a state economic development agency.
- PACE programs finance 100% of the energy efficiency, renewable energy, water conservation, resiliency improvements and the related costs, covering retrofits to ground-up construction.
- The financing is collected with regular local real estate taxes and assessment payments are amortized over the useful life of the project, usually 15- 25 years.

# Creative Financing for Bi-Polar Ionization Technology

## C-PACE Eligible Improvements

**Doors and Windows (Energy Efficiency or Wind Resistant*)**
Examples include: Impact resistant doors, impact-resistant windows, applied window film

**Roof (Energy Efficiency or Wind Resistant*)**
Examples include: Wind resistant re-roof, solar reflective cool roof, Fluid Applied Silicon Coating System

**HVAC (Energy Efficiency)**
Examples include: Heat Pumps, Water Heaters, Chillers, Building automation, Central air conditioner, furnace, energy efficient thermostat

**Lighting (Energy Efficiency)**
Examples include: Indoor and outdoor lighting fixtures, lighting controls

**Pool (Energy Efficiency)**
Examples include: Pool pumps, pool heaters, automatic pool covers

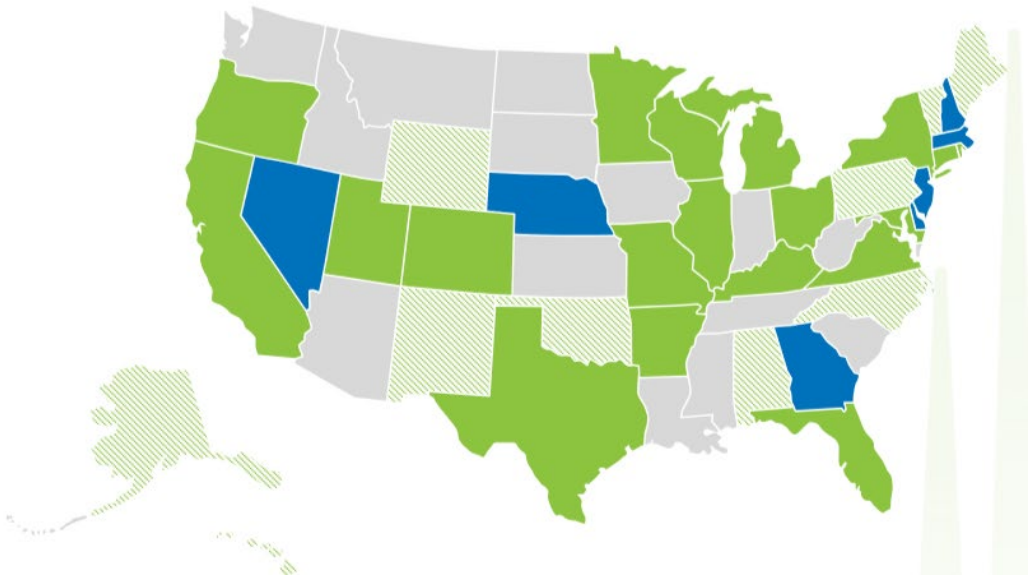
**Building Envelope (Energy Efficiency)**
Examples include: Insulation, radiant barriers, air sealing, cool wall coating

## C-PACE Market Coverage

Commercial PACE is legislated in 36 states and D.C.

Of that total, C-PACE programs are now launched and operating in **20 states** and the number of eligible states continues to grow.

Although some states, such as NJ and NH are legislated, those states have limited PACE financing availability due to the rate PACE is adopted at the city/county level and other jurisdiction specific issues.

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# Creative Financing for Bi-Polar Ionization Technology

## ASSUMPTIONS

- 100% of total implementation cost is financed
- 6% interest rate
- 15-year life expectancy/loan term
- 25% minimum OA to the facility per ASHRAE 62.1 VRP method (8,300 CFM)
- 15% reduction in VRP method minimum OA CFM to the facility (7,055 CFM)
- $4.00 per OA CFM annual energy consumption cost

| TAG | TONS | CFM | TOTAL IMPLEMENTATION BUDGET PRICE |
|---|---|---|---|
| RTU-1 | 8000 | 20 | **$18,330 (~$0.55/CFM)** Includes: Engineering, product procurement, installation, and M&V |
| RTU-2 | 8000 | 20 | |
| RTU-3 | 4000 | 10 | |
| RTU-4 | 1200 | 3 | |
| RTU-5 | 3000 | 7.5 | |
| RTU-6 | 3000 | 7.5 | |
| RTU-7 | 3000 | 7.5 | |
| RTU-8 | 3000 | 7.5 | |

## FINANCIAL RESULTS

- $1,860 per year in PACE assessed loan payments
- $4,980 in annual energy savings due to reduced OA CFM
- $3,120 per year in positive cash flow based on energy savings

For zero upfront investment, *Verde Solutions powered by ripkurrent* can provide a turnkey solution that helps your clients protect their employees, customers, and provides cash flow to their business.