

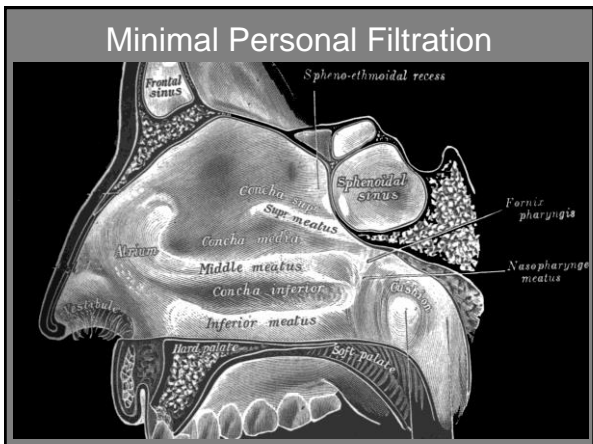


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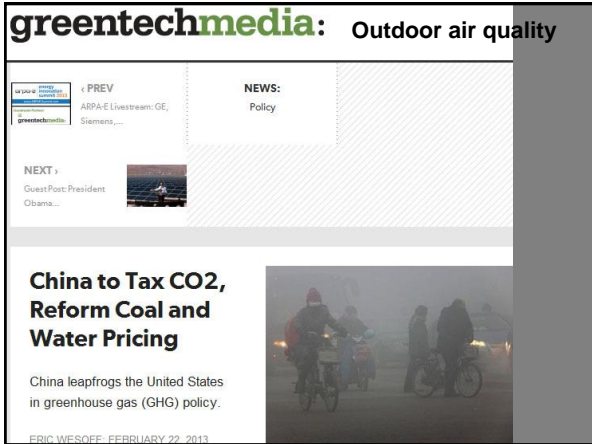
Air quality problems:

- A. Outdoor Air Pollution
- B. Ventilation Air
- C. Indoor Air Pollutants
 - VOCs
 - Toxins
 - Allergens
 - Radon
- D. Sick Building Syndrome

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PHOTOGRAPH BY STUART PALLET

An urgent question hangs over catastrophic wildfires: What's in that toxic smoke?

7



Beijing, Lima, Paris, & Spokane could use one:

EL PRIMER PANEL QUE PURIFICA EL AIRE MÁS QUE 1200 ARBOLES

ESTE PANEL PURIFICA EL AIRE COMO 1200 ARBOLES. ESO ES INGENIO EN ACCIÓN.

UTEC.EDU.PE

UTEC

Air-purifying billboard

A billboard to transform pollution into clean air

DESIGNED BY UNIVERSITY OF ENGINEERING AND TECHNOLOGY OF PERU (UTEC)

8



UTEC context and award-winning building by Grafton Architects

2016 RIBA International Prize

9

Air pollution diminishes with elevation above ground

STUDY: POLLUTANT ALTITUDE - OUTDOOR READINGS

Solution: Mine fresh air from top of building.

As did the 1905 Larkin Building by Wright

10

...maybe impossible in Suzhou,
while feasible in London

Suzhou Center, Wujiang by SOM Swiss Re aka the Gherkin - Foster

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Pittsburgh, PA, circa 1949
Clean Air & Water Act 1970s

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Indoor Air

90% of our day is spent indoors
(tightly sealed indoors)

- Rise in Asthma Rates

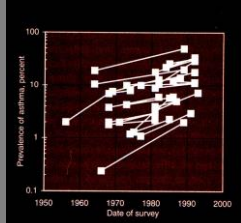
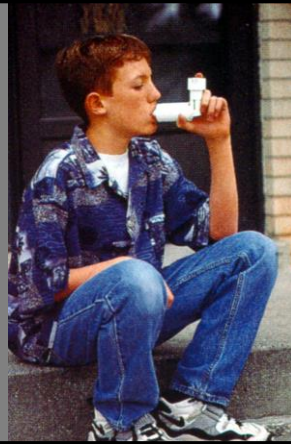


Figure 101 Changes in prevalence of asthma and wheeze, according to surveys conducted 1956-93

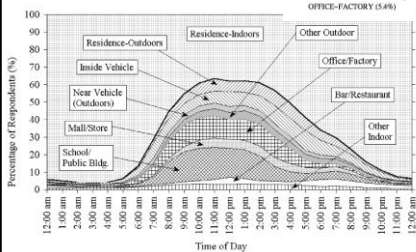
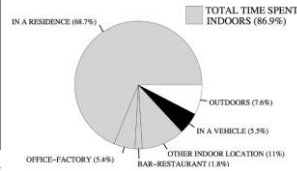


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How we spend our waking time!

NHAPS - Nation, Percentage Time Spent

Total n = 9,196



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Poor Quality Indoor Air is **High Concentrations** of:

- Volatile Organic Compounds (VOC's)
- Fungus
- Decomposing Insect Body Parts
- Pollen
- Turpentine
- Carbon-Based Products (Plastics)
- Formaldehyde in Glues
- Radon
- Carbon Dioxide
- Chlorine Gas
- Tobacco/Vape Smoke



Harvard University asserts, "People who work in well-ventilated offices with below-average levels of indoor pollutants and carbon dioxide (CO₂) have significantly higher cognitive functioning scores in crucial areas such as responding to a crisis or developing strategy than those who work in offices with typical levels"

www.hsph.harvard.edu/news/press-releases/...

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Filtration by Indoor Plants

- Produce Oxygen

Exceptional Filters:

- Boston Ferns
 - Formaldehyde

- English Ivy
 - Benzene

Spider Plants

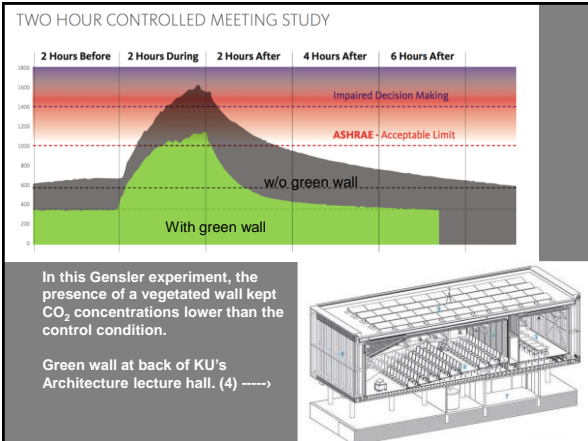
- Formaldehyde
- Carbon Monoxide

Watch for Mold Growth and Pollen Producing Plants

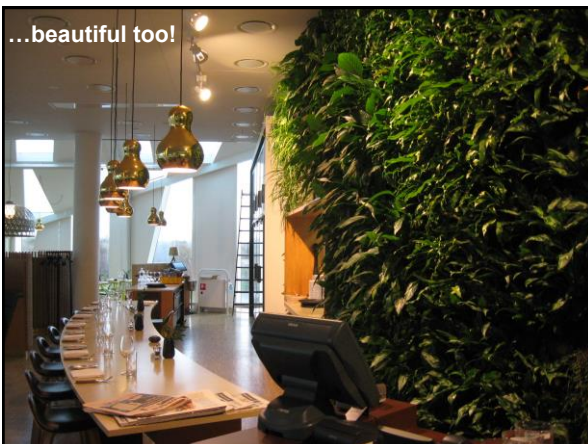


Library and Culture Center, Herfen Germany

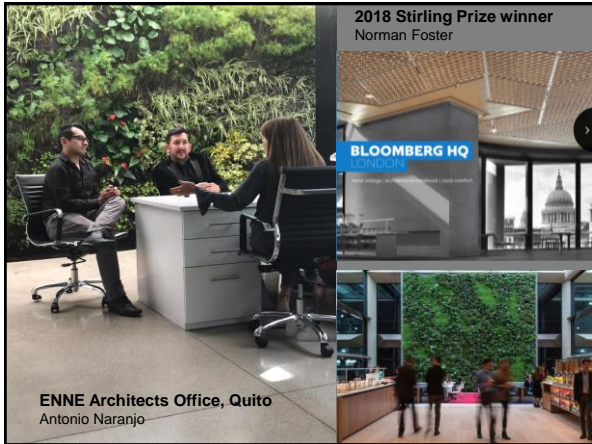
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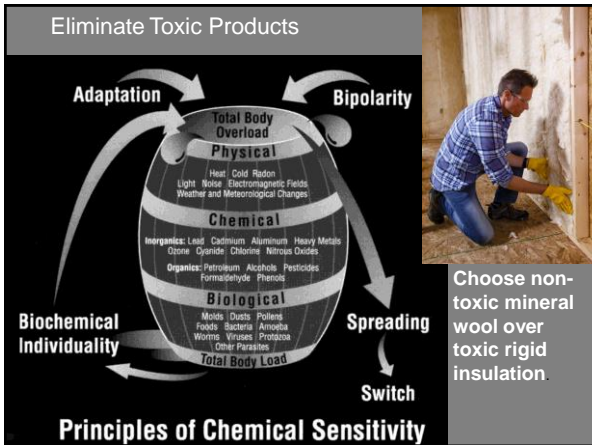
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LEED v4 Moves Green Building Toward Performance-Based Products

Building Product Disclosure and Optimization: Environmental Product Declarations (EPD) Credit.

The intent of this LEED credit is to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically and socially preferable life-cycle impacts. This credit also rewards project teams for selecting products from manufacturers who have verified improved environmental life-cycle impacts.

EPD "Nutrition" Label

Your Building Product

Amount per Unit	TOTAL
LCA IMACT MEASURES	
Primary Energy (MJ)	12.4
Global Warming Potential (kg CO ₂ eq)	0.96
Ozone Depletion (kg CFC-11 eq)	1.80E-08
Acidification Potential (mol H ⁺ eq)	0.93
Eutrophication Potential (kg N eq)	6.43E-04
Photo-Oxidant Creation Potential (kg O ₃ eq)	0.121

Your Product's Ingredients: Listed Here

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2. Building Product Disclosure and Optimization: Material Ingredients Credit.

This LEED credit also emphasizes the use of products and materials for which life-cycle information is available and that have environmentally, economically and socially preferable life-cycle impacts. But in addition, it rewards project teams for selecting:

- Products for which the chemical ingredients in the product are inventoried using an accepted methodology, e.g., HPDs.
- Products verified to minimize the use and generation of harmful substances.
- Raw material manufacturers who produce products verified to have improved life-cycle impacts.



HPDs are a 6-section inventory of material ingredients, summarized above.

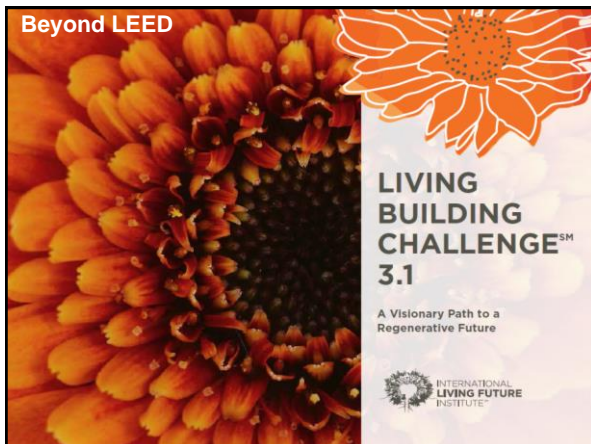
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3. Indoor Environmental Quality (EQ) Category: Low-Emitting Materials Credit.



The intent of this LEED credit is to reduce concentrations of chemical contaminants that can damage air quality, human health, productivity and the environment. This credit includes requirements for product manufacturing as well as project teams. It covers volatile organic compound (VOC) emissions in the indoor air and the VOC content of materials, as well as the testing methods by which indoor VOC emissions are determined. Different materials must meet different requirements to be considered compliant for this credit.

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HEALTHY INTERIOR ENVIRONMENT

HEALTH • HAPPINESS
IMPERATIVE 08

To promote good indoor air quality, a project must create a Healthy Interior Environment Plan that explains how the project will achieve an exemplary indoor environment, including the following:

- Compliance with the current version of ASHRAE 62, or international equivalent.
- Smoking must be prohibited within the project boundary.
- Results from an Indoor Air Quality test before, and nine months after, occupancy.¹⁸
- Compliance with the CDPH Standard Method v1-2010 (or international equivalent) for all interior building products that have the potential to emit volatile organic compounds (VOCs).¹⁹
- Dedicated exhaust systems for kitchens, bathrooms, and janitorial areas.²⁰
- An entry approach that reduces particulates tracked in through shoes.
- An outline of a cleaning protocol that uses cleaning products that comply with the EPA Design for the Environment label (or international equivalent).²¹

18 Testing protocols must be consistent with the United States Environmental Protection Agency Compendium of Methods for the Determination, or international equivalent. Refer to the v3.1 Health + Happiness Petal Handbook for the required Air Quality Conditions.
19 California Department of Public Health. Products not regulated by CDPH do not need to comply.
20 Refer to the v3.1 Health + Happiness Petal Handbook for the specifics of approved entry strategies, including vestibule requirements.
21 www.eia.gov/efc.

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MATERIALS RED LIST

IMPERATIVE 10

There are temporary exceptions for numerous Red List items due to current limitations in the materials economy. Refer to the v3.1 Materials Petal Handbook for complete and up-to-date listings.

The project cannot contain any of the following Red List materials or chemicals:²²

- Alkylphenols
- Asbestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethylene
- Chlorobenzenes
- Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)
- Chloroprene (Neoprene)
- Chromium VI
- Chlorinated Polyvinyl Chloride (CPVC)
- Formaldehyde (added)
- Halogenated Flame Retardants (HFRs)
- Lead (added)
- Mercury
- Polychlorinated Biphenyls (PCBs)
- Perfluorinated Compounds (PFCs)
- Phthalates
- Polyvinyl Chloride (PVC)
- Polyvinylidene Chloride (PVDC)
- Short Chain Chlorinated Paraffins
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
- Volatile Organic Compounds (VOCs) in wet-applied products²³

22 A link to the list of CAS registry numbers that correspond with each Red List item is available in the v3.1 Materials Petal Handbook.
23 Wet-applied products (concrete sealers, sealants) must not exceed specific VOC levels. Refer to the v3.1 Materials Petal Handbook for details.

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WELL Building Standard

1075 PROJECTS ENCOMPASSING OVER 214 MILLION SQUARE FEET ARE APPLYING WELL ACROSS 39 COUNTRIES.

EXPLORE THE PROJECTS

WELL fosters a holistic formula for better health and wellness outcomes, leading to improvements in things like employee productivity, engagement and retention. See: <https://www.wellcertified.com>

ASIS HQ: World's first (2018) / LEED Platinum & WELL Platinum



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Sick Building Syndrome

- Building Related Illness
- Mental Degradation
- Lower Work Performance



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Sick Building Prevention:

- Make Space for Maintenance
- Beware of Legionella
- Humidity Balance
- Practical Measures
- Commissioning & POE



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Make Space for Maintenance



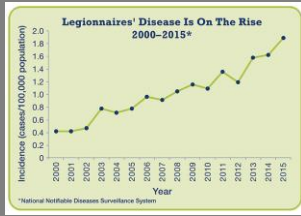
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Prevent Legionnaire's Disease

Caused by inhaling legionella bacteria in air-borne water droplets from:

- ❖ Cooling towers
- ❖ Bubbling hot tubs
- ❖ HVAC units
- ❖ Showerheads
- ❖ Decorative fountains

19,000 U.S. cases in 2015



Implement ASHRAE 188 Water Management Program to certify CDC compliance

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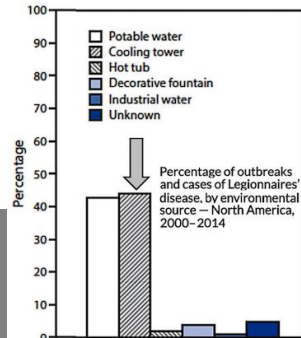
A Solution for Legionella Outbreaks in Cooling Towers; Eliminate Them

December 1, 2016

By Jay Egg and Billi Roberti

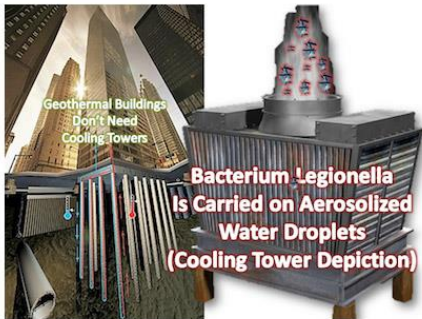


Cooling towers use evaporation to reject heat to atmosphere



35

In the summer of 2015, the largest outbreak of Legionnaires' disease in NYC history was traced to a cooling tower at a hotel in The Bronx. 128 people were infected and 12 of them died.



36



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WATER USED BY COOLING TOWERS...

8 BILLION SQ FT OF COMMERCIAL BUILDINGS IN THE US
COOLING TOWERS COOL BY EVAPORATION
THEY ARE THE 2ND GREATEST CONSUMER OF FRESH WATER IN COMMERCIAL BLDGS

USE AS MUCH FRESH WATER AS 50 MILLION US CITIZENS
WOULD FILL A SWIMMING POOL 1 MILE WIDE + 200 MILES LONG!

EVERY COOLING TOWER REPLACED WITH GEOTHERMAL SAVES DRINKING WATER

EVERY COOLING TOWER REPLACED WITH GEOTHERMAL REDUCES ENERGY CONSUMPTION AND CO2 EMISSIONS

2,000,000,000,000 GALLONS / YEAR THAT'S 2 TRILLION!!!

WE support GEO GeothermalDirect.com

CONVERTING FROM A COOLING TOWER TO A GEOTHERMAL BUILDING IS THIS EASY

Eliminate Cooling Tower
Add Geothermal Exchanger

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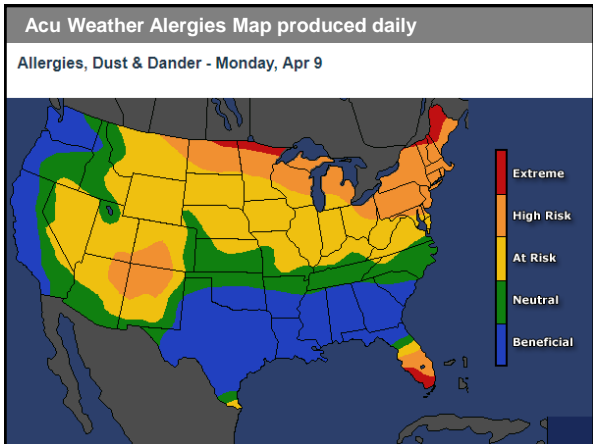
Attain Humidity Balance

Below 30%... Sinus Infections occur

Fungus Thrive Above 60% Humidity

Source: Gary Olip Architects

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Sick Building Prevention:

Four Actions

- Separate
- Eliminate
- Ventilate
- Filtrate

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Separate Fresh Air Intakes

- From Pollutants e.g. vehicle exhaust
- Pollinating Plants e.g., junipers

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Separate or Buffer

- Toxic Areas
 - Copy Machines
 - Cleaning Solutions
 - Car and Truck Waiting Areas
- Older Books and Bookcases for the Chemically Sensitive



Yale Rare Book Collection by SOM

43

Eliminate Dirt and Organic Build-up

Door Mats and Grates at entry or integrated into air lock keep dirt outside



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Eliminate Dirt and Organic Build-up

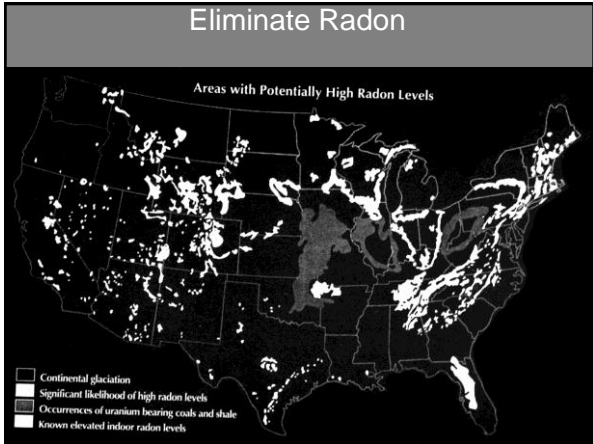
- Minimize Carpets
- Adopt Asian practice of removing shoes when entering home



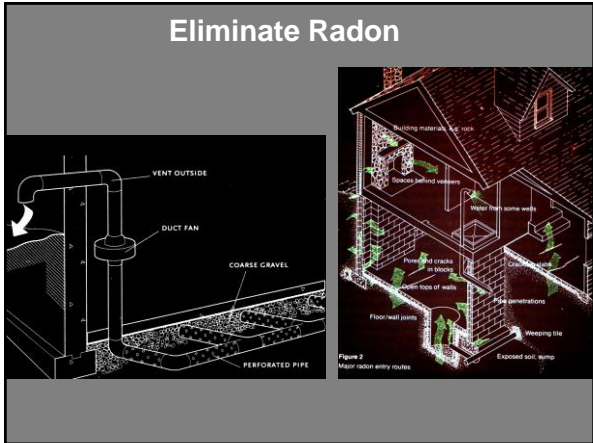
Genkan

(c) 1998 TTI

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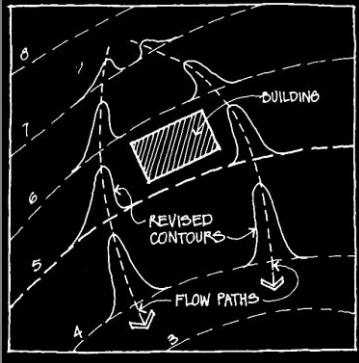


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Drain Ground Water Around Building



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Ventilate

- Outdoors is best ventilated space
- Fuzzy Space is second best
- Natural Ventilation is next best

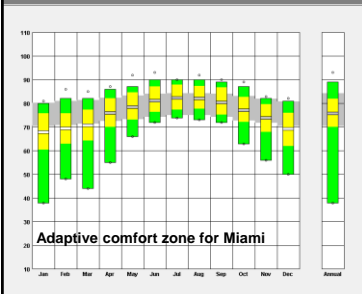


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Natural Ventilation vs. Mechanical Ventilation

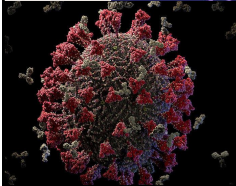
Occupants comfortable in a wider range of thermal conditions

Occupants twice as sensitive to temperature deviations than those in naturally vented buildings (Brager 2000)



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A breath of fresh air - how can we bring back natural ventilation?



COVID-19 shirkers say, "Yes, please do!"

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Ventilation Standard (typical)

Average of 20 cubic feet per minute (cfm) per person

Natural Ventilation through...

- Operable Windows
- Cross Ventilation
- Stack Ventilation
- Wind Cows

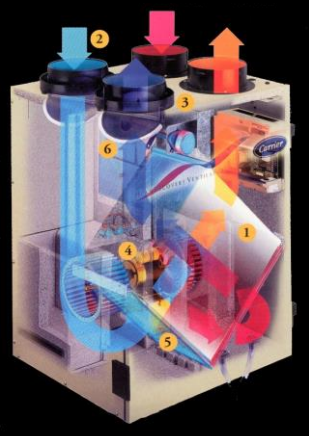


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Mechanical Ventilation through...

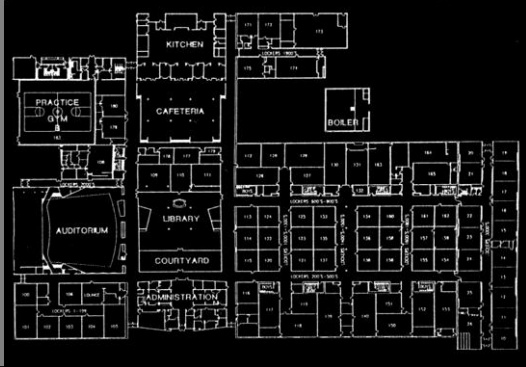
- Whole House or Building Fans
- Heat Recovery Ventilator

Ventilation can be Energy Intensive... or not



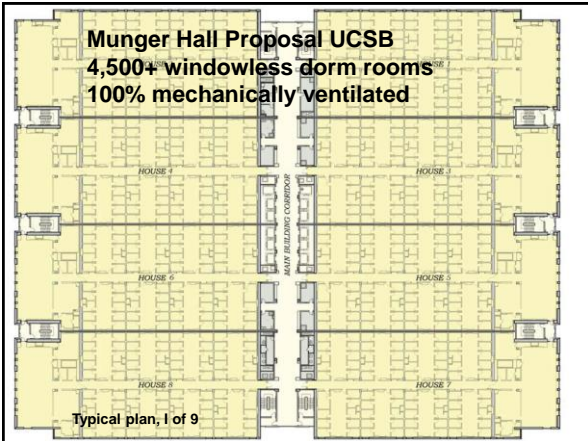
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Sick Building = Mechanical Ventilation Only?



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Munger Hall Proposal UCSB 4,500+ windowless dorm rooms 100% mechanically ventilated



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Rationale for Mechanical Ventilation

- Reduce CO2 levels
- Eliminate odor

Problem

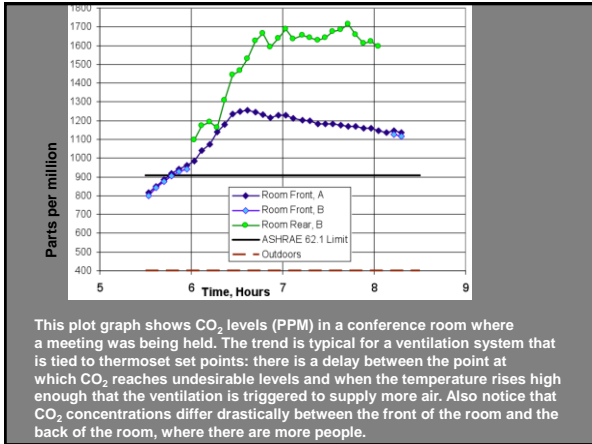
Most systems are actuated by the thermostat.

Most conventional mixing systems aim to uniformly dilute the concentrations of pollutants in a space. So fresh air may be brought in, but the air that people actually breath is mixed with the polluted indoor air, and thus never quite as fresh. **Displacement ventilation** systems do a better job of providing the freshest air at breathing height, but are less common in the US.

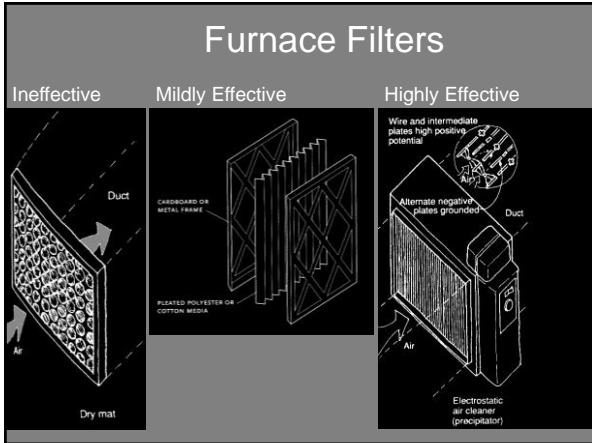
Solution

Demand controlled systems help to decouple ventilation from thermal conditioning needs using CO₂ sensors to better align ventilation set points with actual occupancy levels, but only go on when the level is too high!

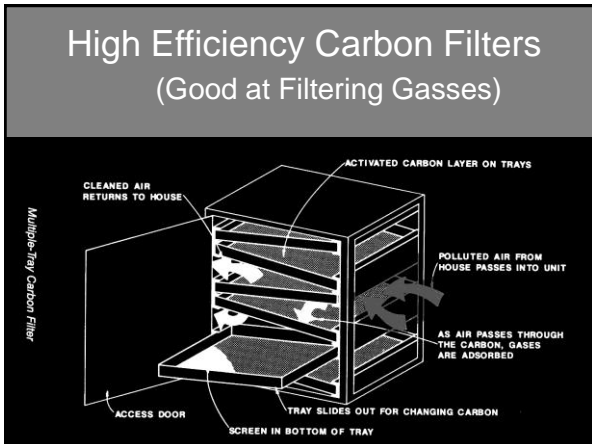
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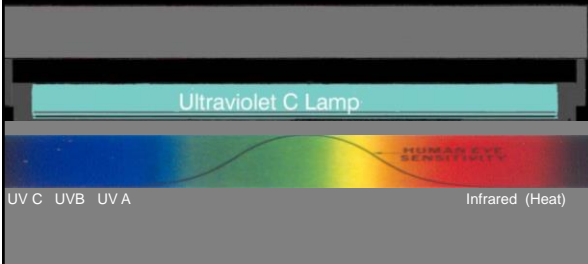
High Efficiency Electrostatic Filters



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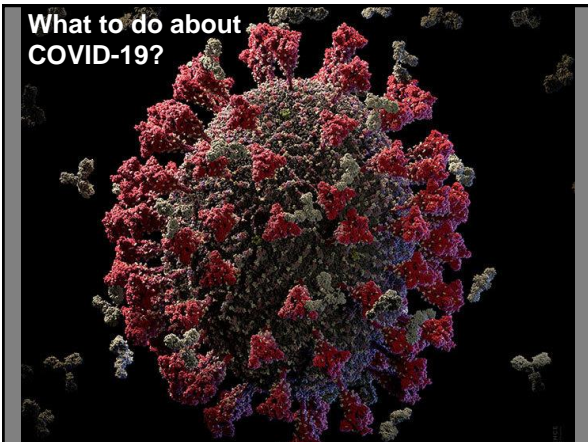
Ultraviolet C Lamps

- Hospitals Use in Ducts
- Kills All Viruses and Bacteria
- No Ozone
- Do Not Expose to Eyes or Skin

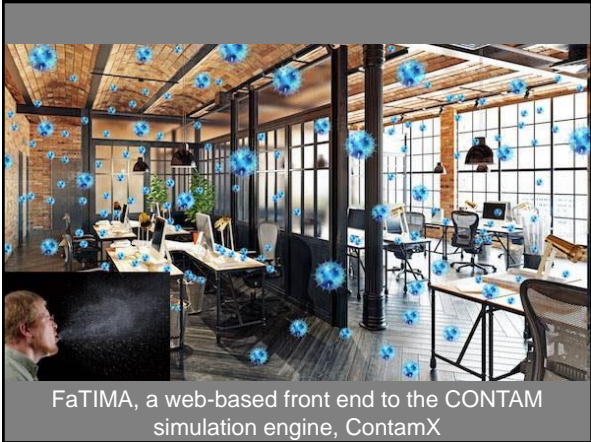


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What to do about COVID-19?



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