Webinar - April 14, 2022

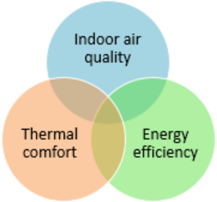
Workshop 2. Comfort, Air Quality and Lighting

HAWAII STATE Energy Office | Building Energy Education fundamentals | SEDAC ILLINOIS

Presentation Collaborators

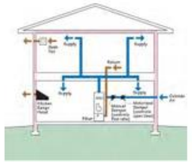
Hawai'i Energy | AIA Honolulu | ASHRAE Hawaii Chapter | HAWAII | BOMA HAWAII

Section 1
Introduction



Section 2
Indoor Air Quality

Section 3
Ventilation



Section 4
Thermal Comfort Strategies

Section 5
Air Conditioning - System Sizing

Section 6
Air Conditioning - Ducts

Section 7
Hawaii Energy – Water Heating

Hawai'i Energy

Section 8
Lighting

Section 9
Wrap Up

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Building Energy Education fundamentals

SEDAC SMART ENERGY DESIGN ASSISTANCE CENTER

ILLINOIS

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Hawai'i Energy

AIA Honolulu

ASHRAE Hawaii Chapter

U.S. GREEN BUILDING COUNCIL USGBC HAWAII

BOMA HAWAII Building Owners and Managers Association

Welcome

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Building
Energy
Education
fundamentals

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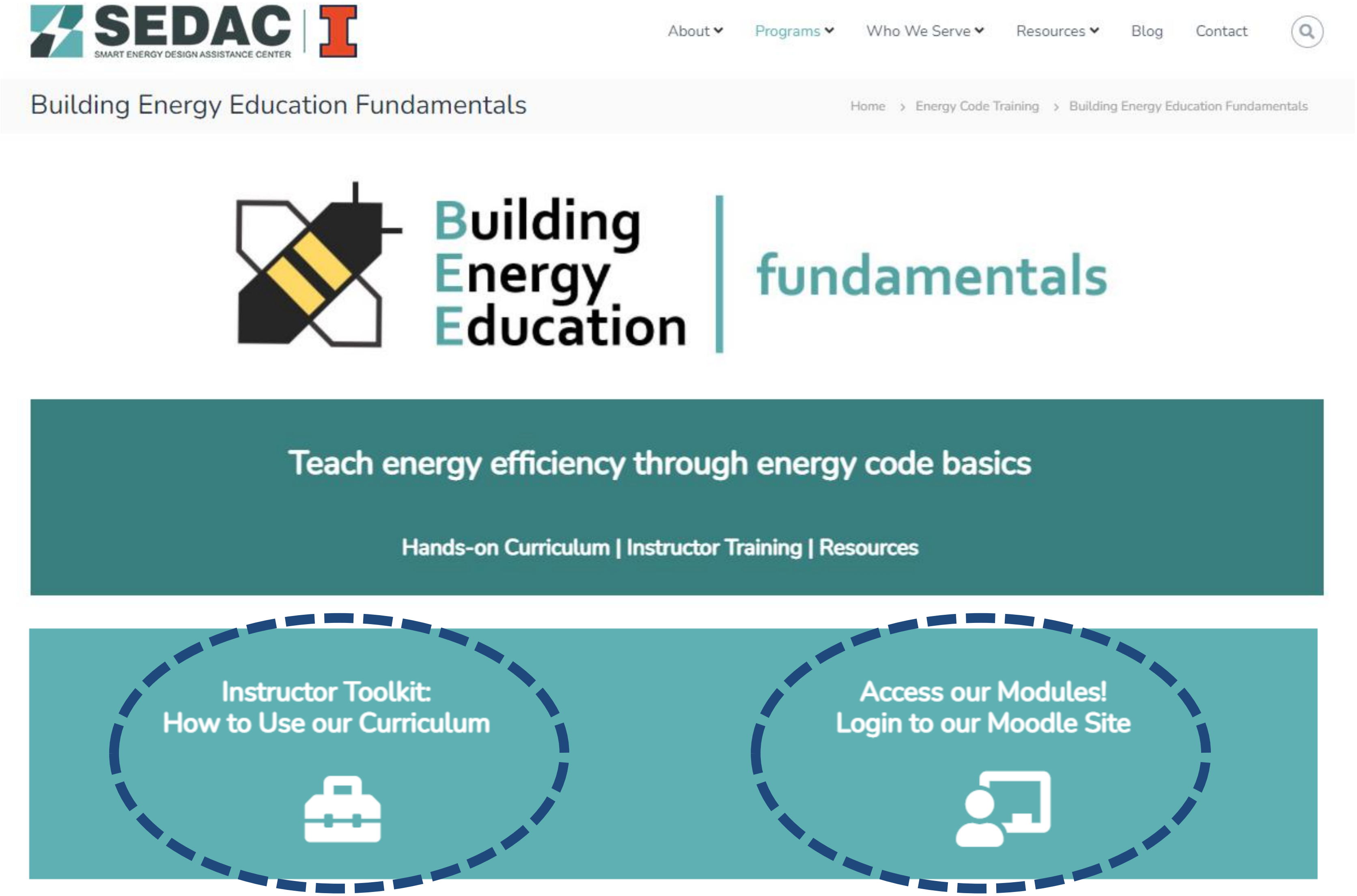
SMART ENERGY DESIGN ASSISTANCE CENTER
ILLINOIS

BEE Fundamentals Program Webpage

https://smartenergy.illinois.edu/bee_fundamentals/



Instructor Toolkit

https://smartenergy.illinois.edu/instructor-toolkit

Instructor Toolkit: How to Use our Curriculum

ABOUT OUR PROGRAM

- What is this training program about? +
- Why all the focus on energy codes? +
- Who should use this program? +
- Will this training prepare students for a job or certification exam? +
- Who created this training program? +
- How can I be involved and get updates? +

USING OUR CURRICULUM

- Are the modules free to use? +
- Do I need to use all of the modules? +
- How should I select which curriculum to use? +
- How do my students and I access the modules? +
- Can my students work through the material on their own? +
- How can I provide feedback? +

INTRO MODULES

Community College Energy Code Training Program: ...

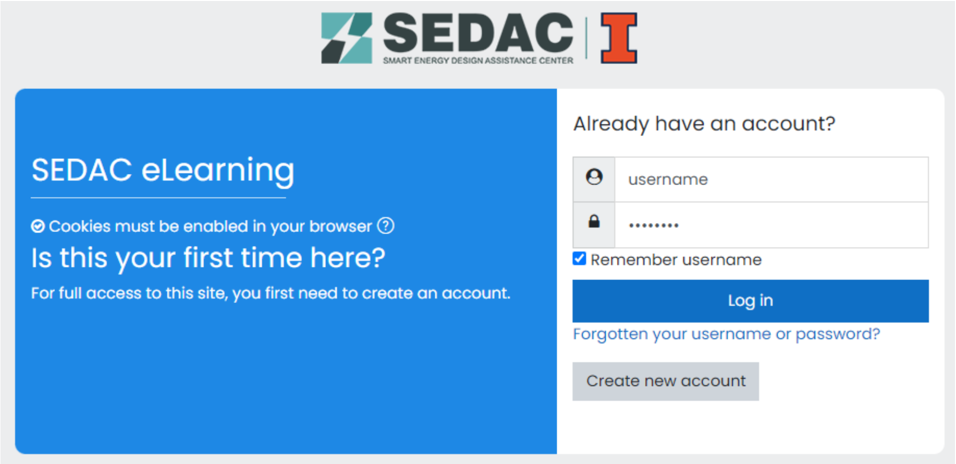
Copy link

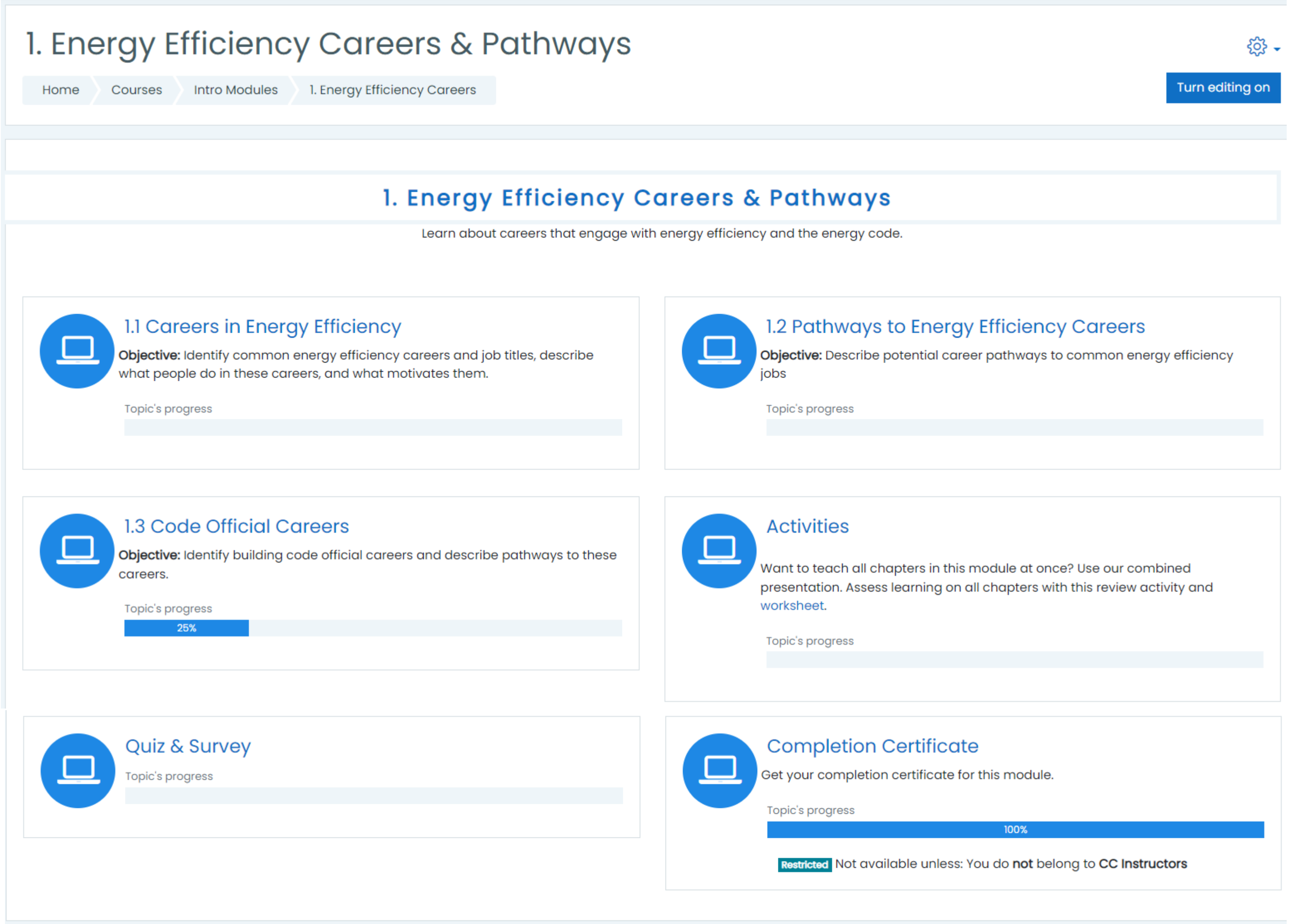
- 3. Introduction to Energy Codes & Standards +
- 4. Navigating Energy Codes & Standards –

1. Accessing the Codes: Presentation
2. Looking up Requirements: Presentation
3. Energy Code Compliance Paths: Presentation
4. The Approval and Permit Process: Presentation
5. Combined presentation, in-class exercise, review worksheet, and Jeopardy activity

Moodle

https://learn.smartenergy.illinois.edu/





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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

COURSE DESCRIPTION

This is the second in a series of three webinars covering building energy efficiency and the energy code in Hawaii. This session focuses on thermal comfort and indoor air quality and will cover fundamentals of building systems, including lighting, air conditioning, ventilation and air filtration. The emphasis will be residential building systems.

LEARNING OBJECTIVES

At the end of this course, participants will be able to:

1. Identify thermal comfort design strategies
2. Identify design strategies to improve indoor air quality
3. Describe the comfort and air quality impacts of AC system oversizing
4. Identify energy efficiency strategies for AC systems

Introductions

Presenters

- Howard Wiig, State Energy Office
- Sumi Han, Smart Energy Design Assistance Center
- Erik Kolderup, Kolderup Consulting
- Justin Bizer, Hawaii Energy

Acknowledgments

- Karen Shishido, Hawaii Energy
- Gail Suzuki-Jones, State Energy Office
- Kiera Williams, State Energy Office
- Alan Okimoto, State Energy Office
- Elena Arinaga, State Energy Office

Now online

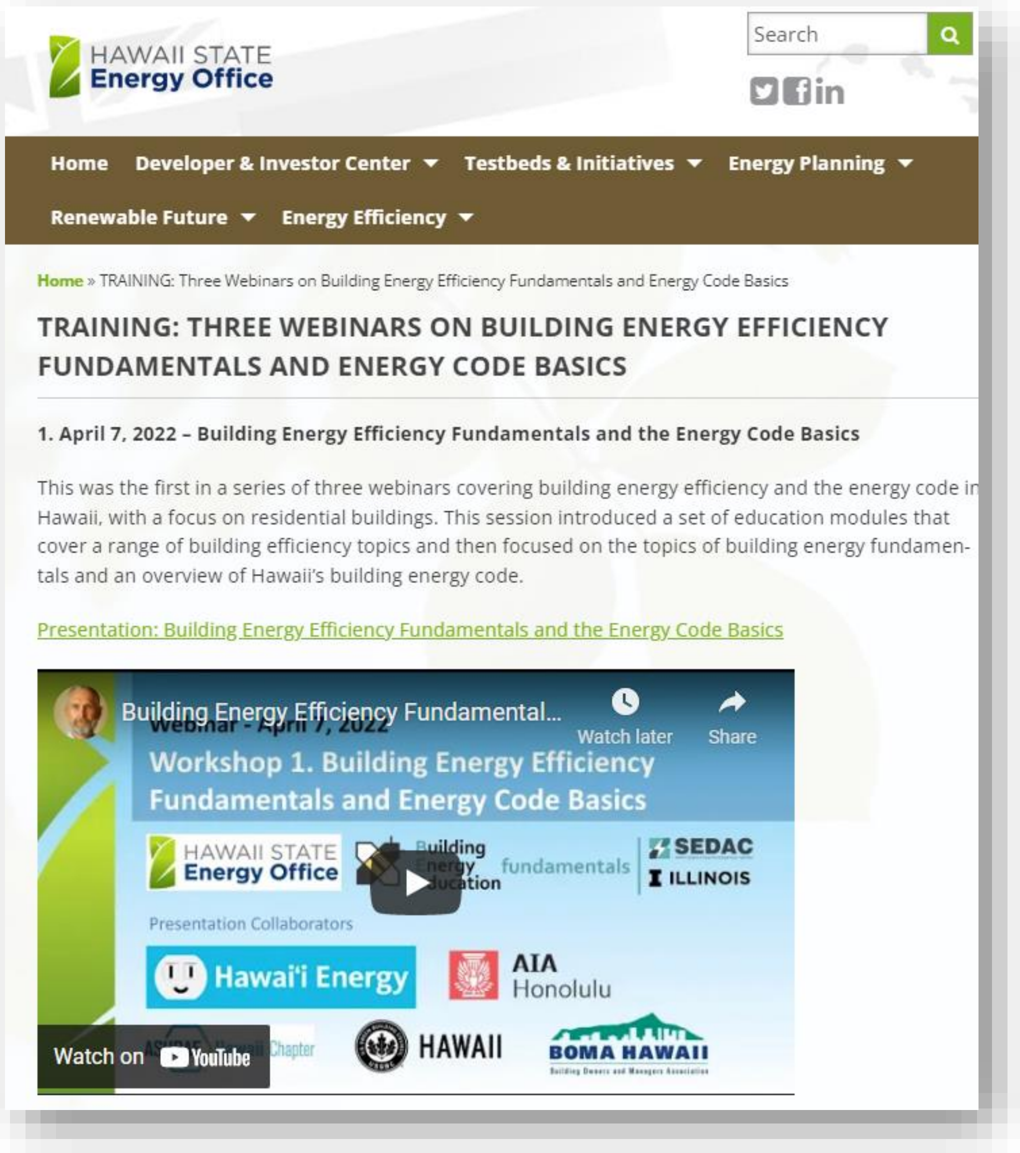
Workshop 1

Building Energy Education Fundamentals and Energy Code Basics

4/7/2022

PDF & video recording

https://energy.hawaii.gov/building-energy-efficiency-and-energy-code



Coming up

Workshop 3

Beyond Code, Net Zero Energy and Existing Buildings

Thursday, 4/21/2022, 12:00 – 1:30 pm HST

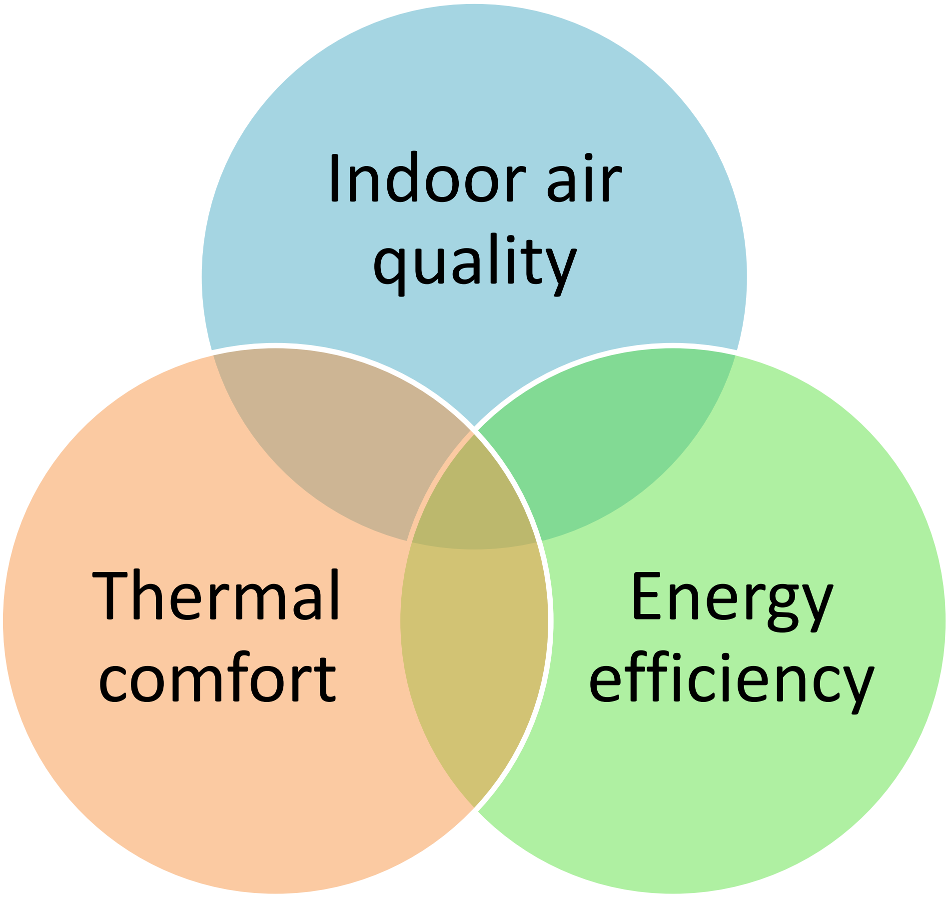
Train the Trainer

BEE Fundamentals: Train-the-Trainer Workshop

Friday, 4/29/2022 9:00 – 11:00am HST

https://smartenergy.illinois.edu/bee_fundamentals/

Section 1
Introduction



Introduction

Indoor air quality (IAQ)

- Fundamentals
- Ventilation

Thermal comfort

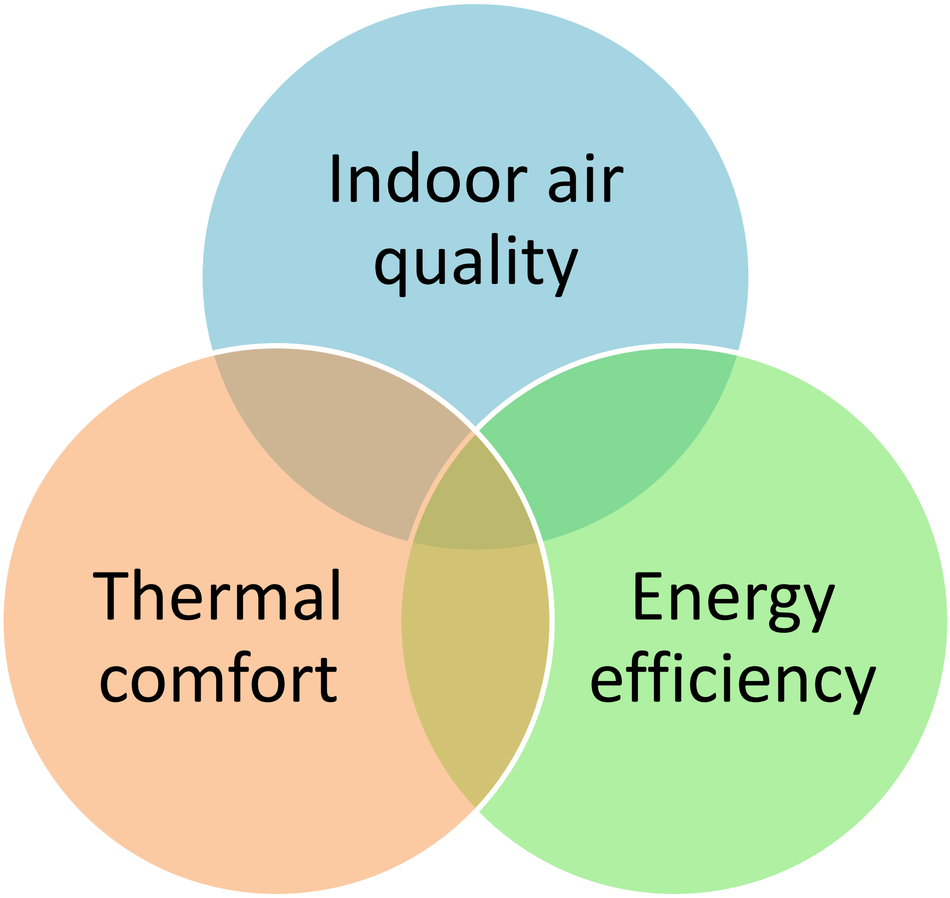
Air conditioning

- System sizing
- Duct design and installation

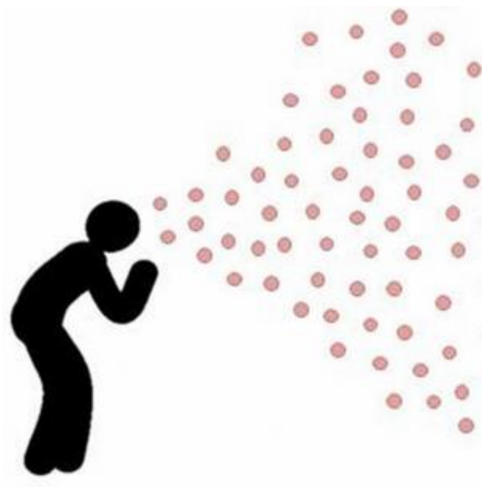
Water heating

Lighting

Zippy's gift cards!



Section 2
Indoor Air Quality



https://iaqscience.lbl.gov/vent-summary

BEE Modules

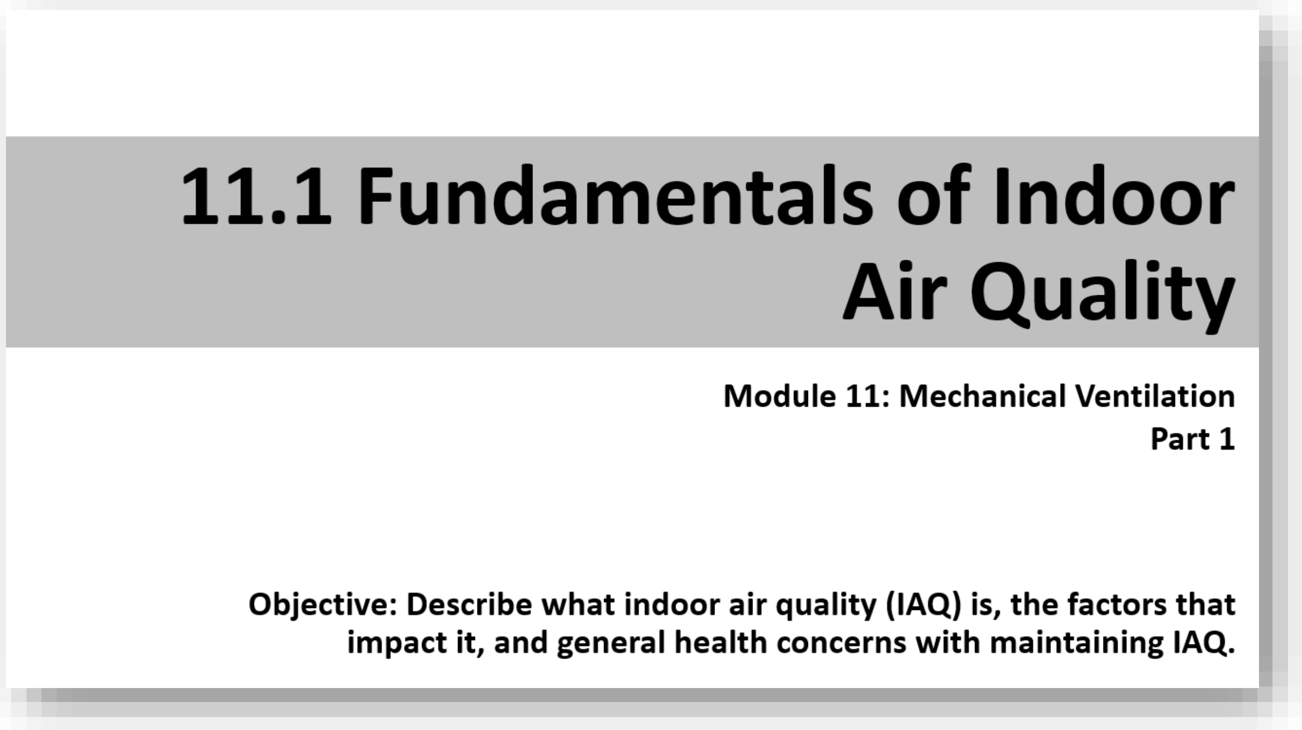
11. Mechanical Ventilation

- 11.1 Fundamentals of Indoor Air Quality
- 11.2 Fundamentals of Building Ventilation
- 11.3 Minimum Ventilation Standards
- 11.4 Energy Code Ventilation Requirements

Plus

- Volcanic smog (Vog)
- Covid-19

Building Energy Education fundamentals



11.1 Fundamentals of Indoor Air Quality

Module 11: Mechanical Ventilation
Part 1

Objective: Describe what indoor air quality (IAQ) is, the factors that impact it, and general health concerns with maintaining IAQ.

Indoor air quality (IAQ) overview

IAQ is created by interaction of several components:

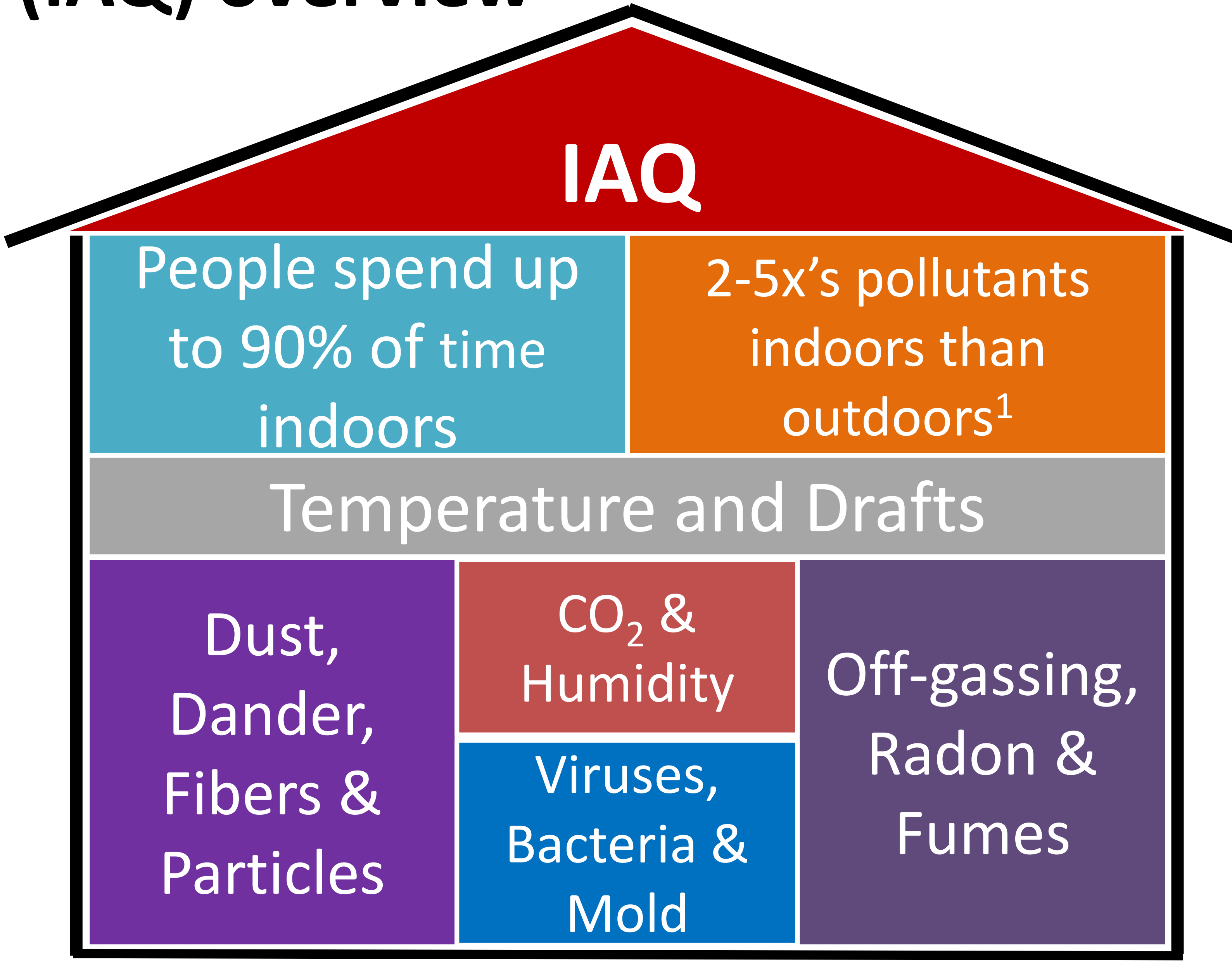
Outdoor environment

Building materials and envelope tightness

Ventilation systems

Occupant activities

https://www.epa.gov/report-environment/indoor-air-quality



Common indoor air pollutants

Chemical Pollutants

CO/CO2 AND OFFGASSING


HOUSEHOLD CLEANERS

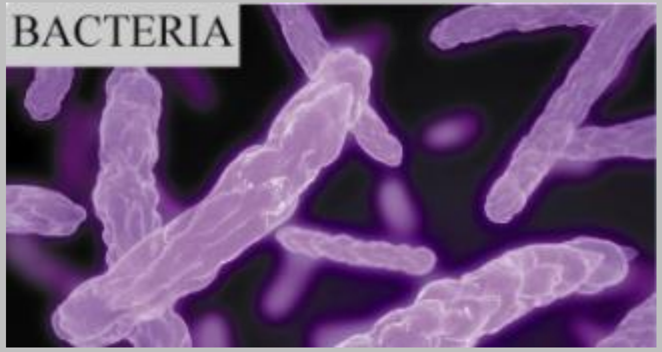
Dust and Particulates


FIBERS/DANDER


POLLEN


DUST MITES

Microbes and Mold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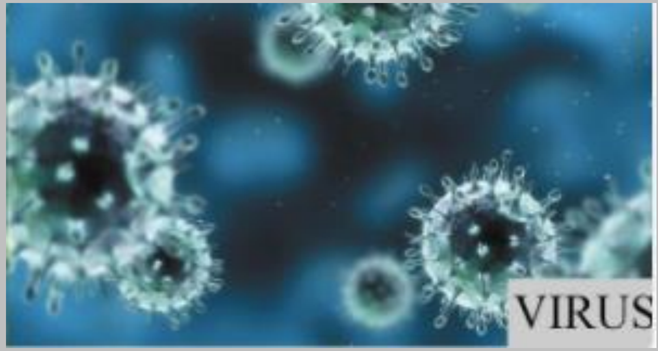

VIRUS


MOLD

Particulate sources

Fibers come from:

- Carpet
- Clothing
- Furniture
- Insulation

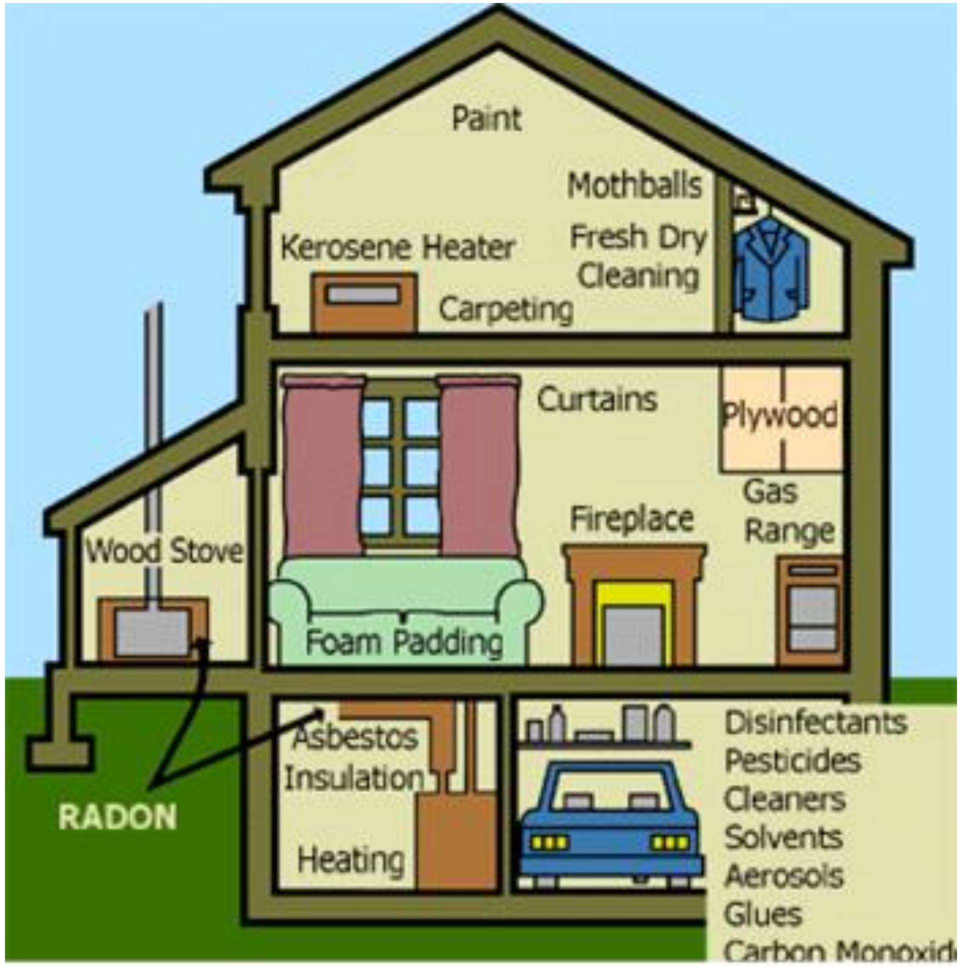
Dust

- Skin cells
- Pollen
- Dirt/Soil
- Food Debris
- Pet Dander
- Dust Mites

https://www.shutterstock.com/search/cleaning+dust

Sources of chemical contaminants

Construction By-products
Glue, paint, and wood finish off-gas volatile organic compounds (VOCs).
Wood and some insulation preservatives off-gas formaldehyde.
Foam insulation & synthetic material off-gas VOCs.
Environmental Contaminants
Ozone from surrounding atmosphere
Radon from soils
Combustion by-products/wildfire smoke
Cigarette smoke
Cleaning Products
Ammonia
VOCs from cleaners
Personal care products
Scent generators



http://nbrienvis.nic.in/Database/IndoorAirPollutants_2048.aspx?format=Print

Avoiding indoor chemical pollution sources

- Properly vent combustion appliances and cooking surfaces to outdoors.
- Select low VOC building products
  - Can find resources at: https://www.epa.gov/saferchoice
- Ensure foundation vented to remove radon and other soil contaminants.
- Avoid smoking indoors.
- Control moisture levels.

Tight envelope controls humidity

Openings in building shell

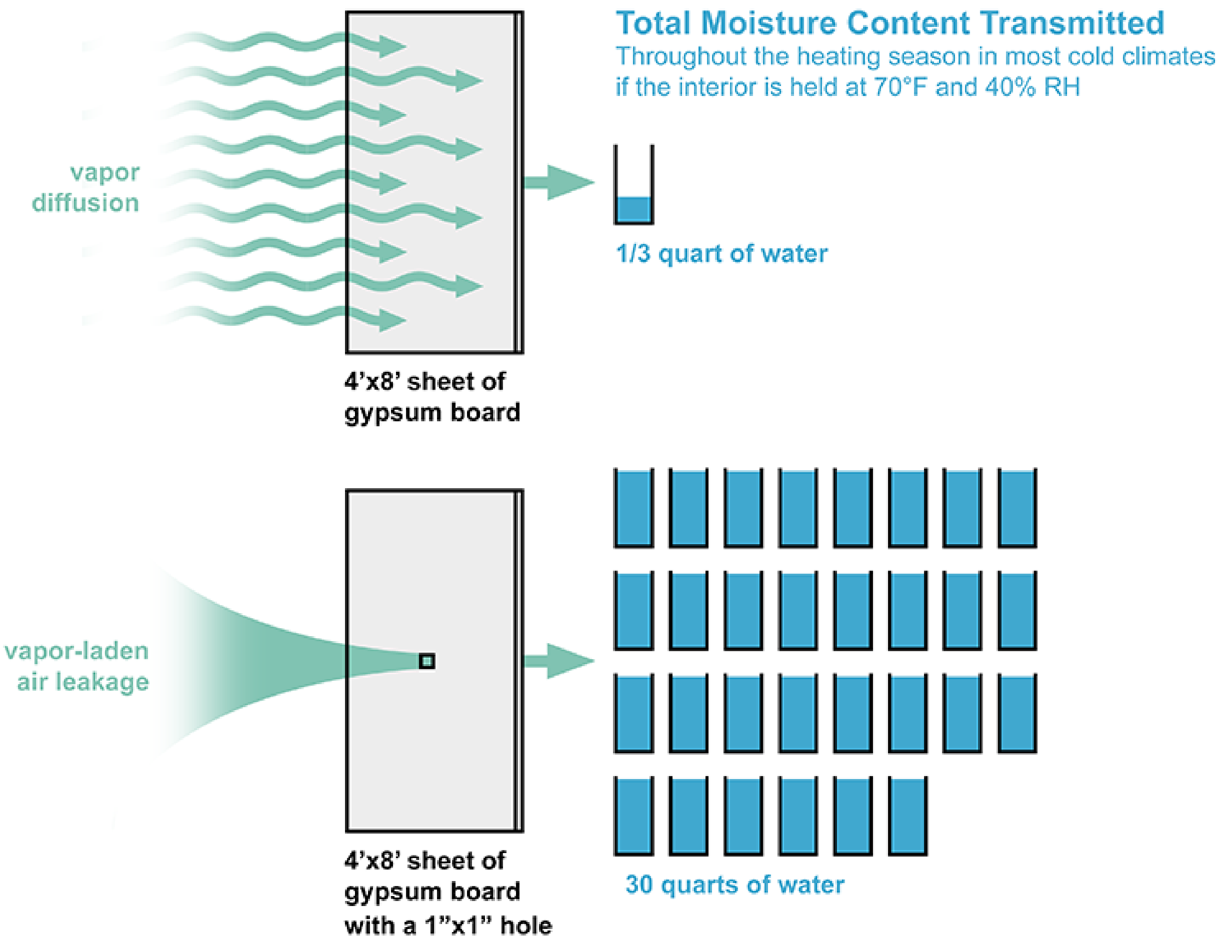
Allow large humidity transfer, leading to a variety of problems.

Air-conditioned Buildings

Humidity leaking in causes…
- condensation
- mold & mildew
- water damage

Heated Buildings

Leakage outward causes…
- condensation freezing
- similar water damage and mold/mildew risks as above



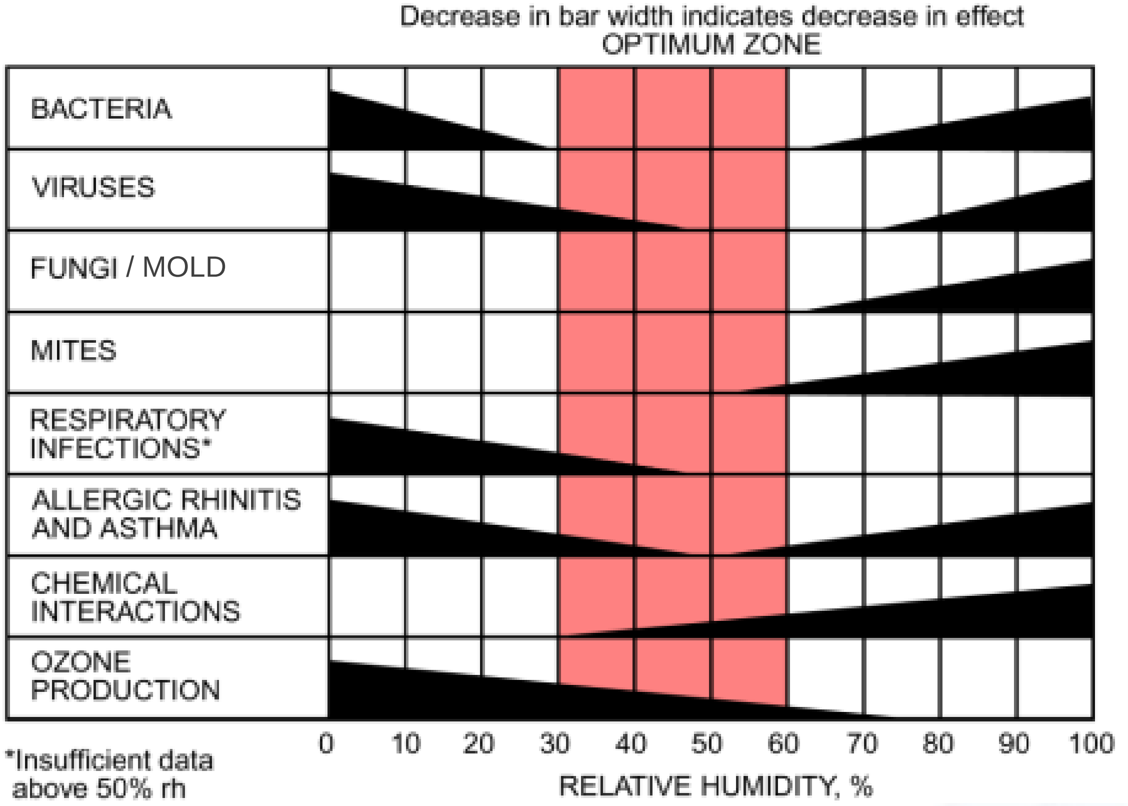
https://www.buildingenclosureonline.com/blogs/14-the-be-blog/post/88242-the-moisture-threat-of-infiltration-to-the-building-envelope

Humidity control important for pollutant control

Too dry, mucous membranes dry out, making occupants more susceptible to pathogens, as well as pollutant increases.

Too high can result in condensation damage to walls/windows and other cool surfaces.

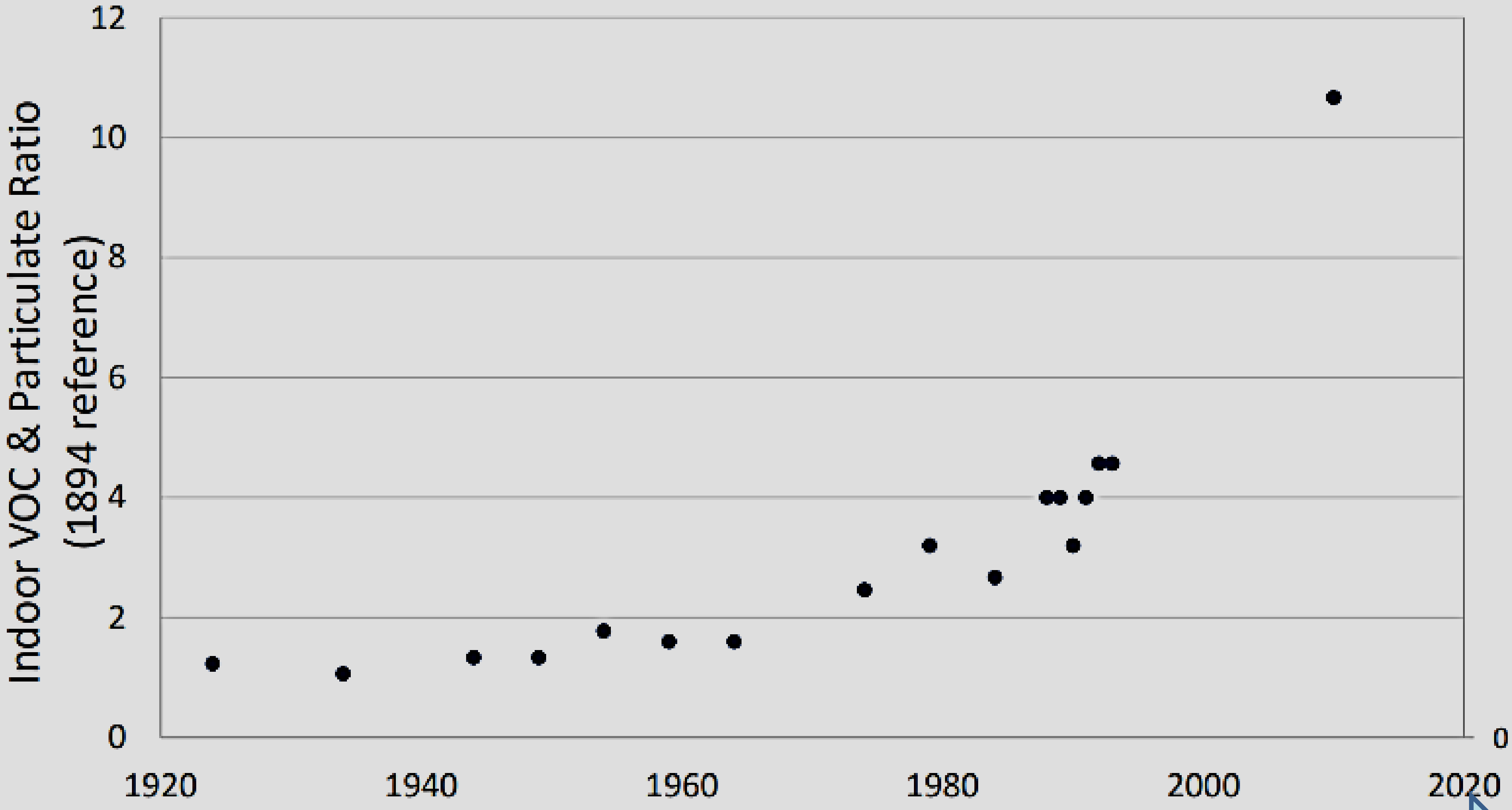
Both too high and too low decrease occupant comfort as well.



[2]2016 ASHRAE HVAC Systems and Equipment Handbook – Ch 22

Tight buildings need ventilation

More VOCs and particulates become trapped in the indoor air.



Building envelopes have become increasingly tight

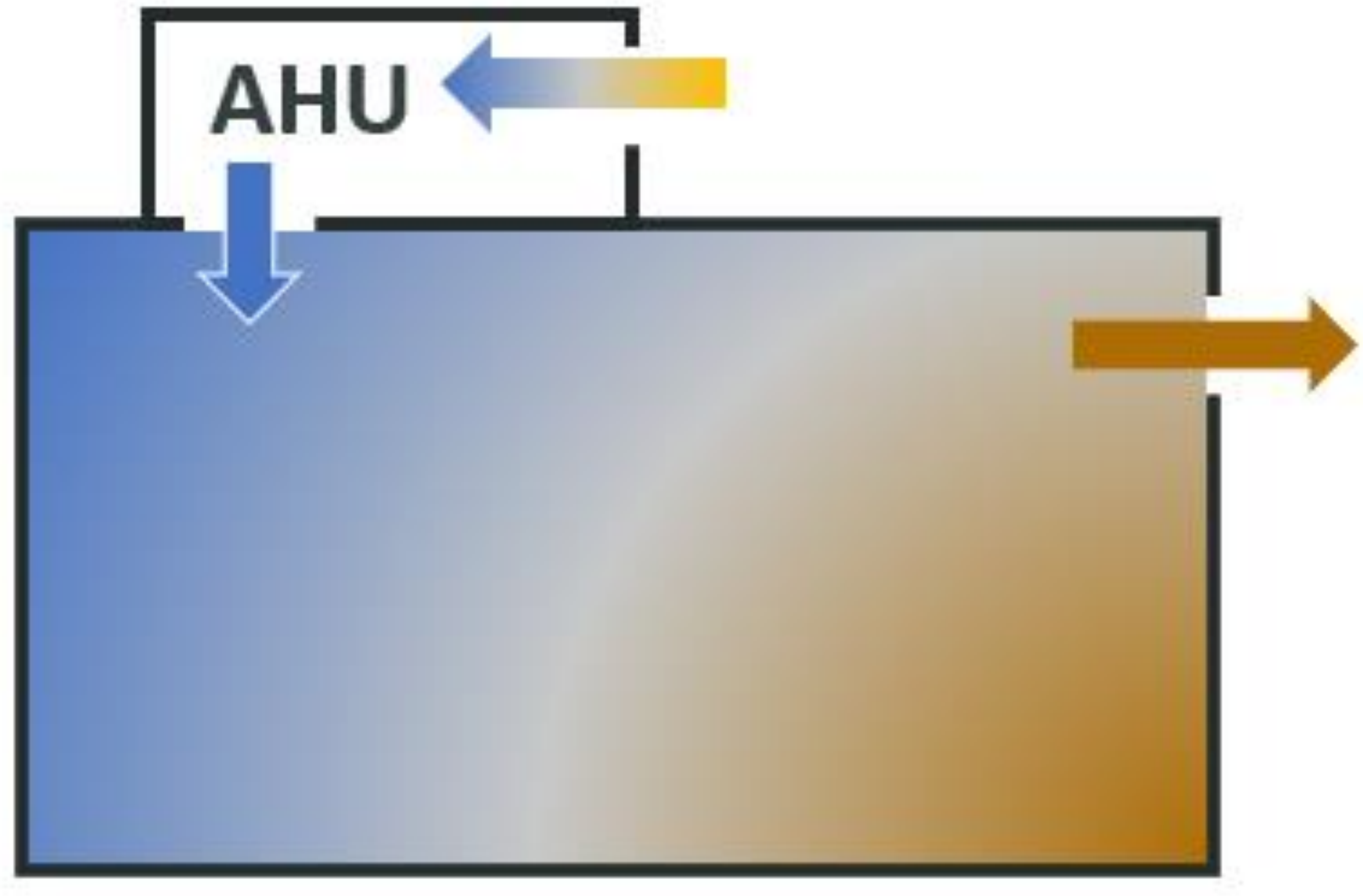
www.buildequinox.com

Seal tight – ventilate right

Ventilation is critical with a tight envelope.

Outdoor air, in combination with exhaust from spaces, dilutes and removes odors, VOCs, and other unfilterable pollutants.

Controlled ventilation air removes humidity, pollen, dust, and other outdoor and indoor pollutants.



Particulates impact health

- Big Idea 1 -
Particulates in indoor air have adverse effects on health.

- Asthma triggers
- Nose / throat / eye irritation
- Virus and bacteria carriers

- Big Idea 2 -
Finer particulates are of greater concern.

- Deeper lung penetration
- Greater impact on respiratory health
- Also impact cardiovascular health

https://www.flickr.com/photos/ihatefog/3867981181

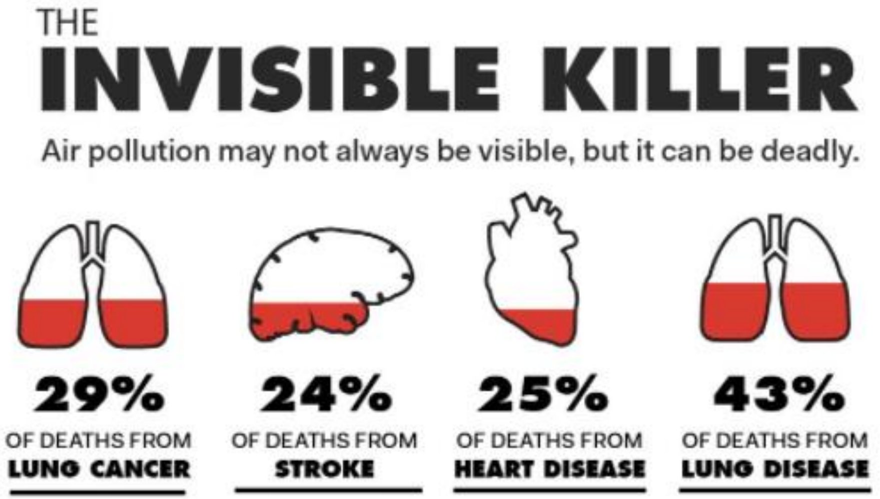
Particulate size affects health impact

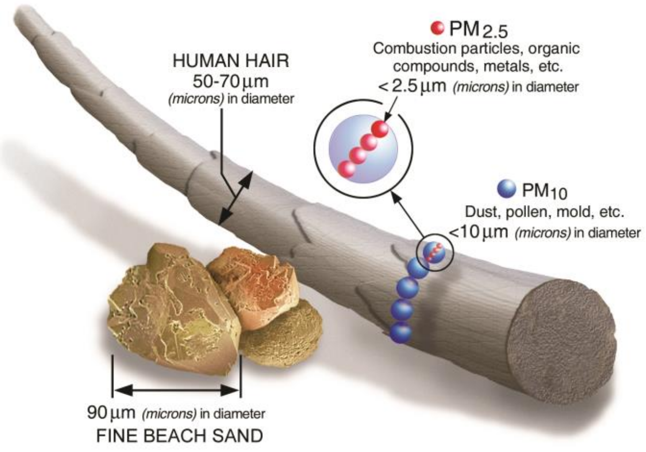
10 µm and smaller cause irritation of eyes, nose, throat

- Penetrate deep into lungs.

2.5 µm penetrate deep into lungs

- Smaller particles (<0.1 µm) have been shown to enter blood.
- Can increase risk of asthma and coronary disease.
- Can affect other organs





https://www.epa.gov/indoor-air-quality-iaq/indoor-particulate-matter

https://world-heart-federation.org/news/air-pollution-and-cardiovascular-disease-a-window-of-opportunity/

https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

Chemical contaminants and occupant health

Known Detriments

- Reduced cognition from high CO_2
- CO can cause oxygen deprivation – stronger effect than CO2
- Asthma triggers/ respiratory irritants
- Carcinogens

https://luxafor.com/7-best-co2-sensors-and-air-quality-monitors-for-home-and-office/

Vog (Volcanic Smog)

What is vog?

Sulfur dioxide (SO_2) gas + fine particles (acid) created when SO_2 reacts with atmosphere

Health effects

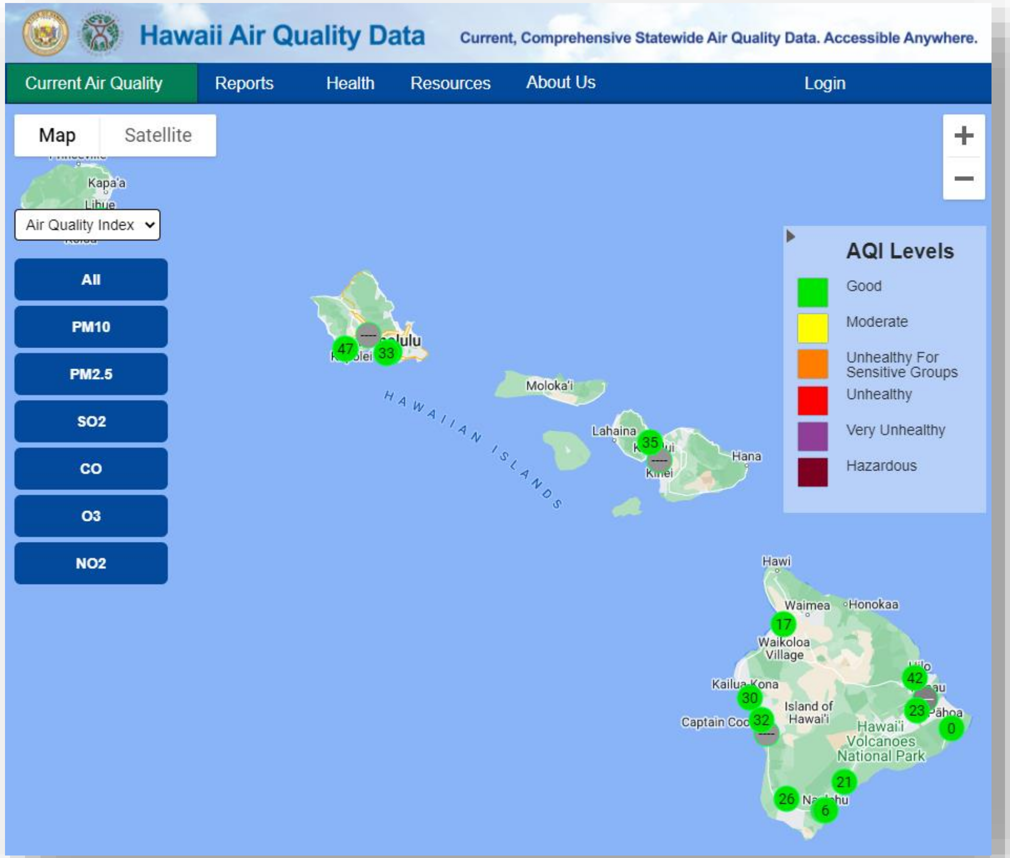
- Eye, nose, throat, and/or skin irritation
- Coughing and/or phlegm
- Chest tightness and/or shortness of breath
- Headache
- Increased susceptibility to respiratory ailments
- Some people also report fatigue and/or dizziness

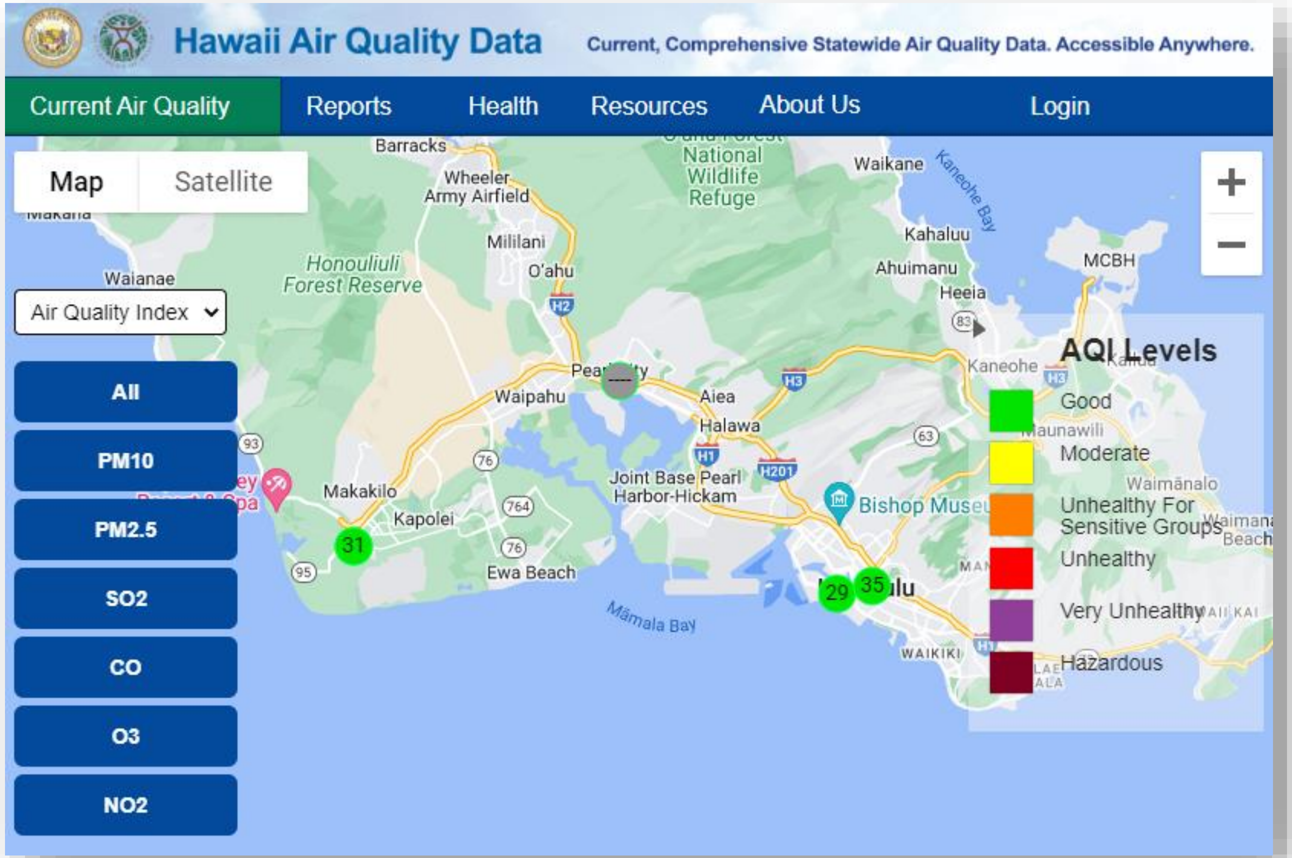
https://en.wikipedia.org/wiki/Vog#/media/File:Vog_from_Sulfur_dioxide_emissions.jpg

➡ https://vog.ivhhn.org/what-vog

Vog (Volcanic Smog)

https://air.doh.hawaii.gov/home/map





Vog (Volcanic Smog)

AQI Basics for Ozone and Particle Pollution

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

https://www.airnow.gov/aqi/aqi-basics/

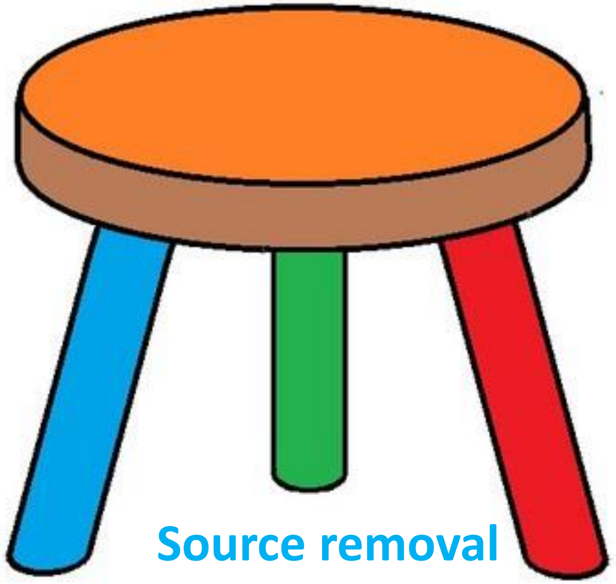
Vog (Volcanic Smog)

DOH Guidance on Short-term Sulfur Dioxide (SO_2) Advisory Levels

SO_2 Conc. (ppm)[1]	Color Code & Air Quality Condition	Air Quality Description	Recommended Action/Activity[2]		
			Sensitive Groups[3]	People Experiencing Health Effects[3]	Everyone Else
0 – 0.10	Green *(Good)*	Considered satisfactory & poses little or no risk	Highly sensitive individuals may be affected at these levels		Potential health effects not expected
0.11-0.20	Yellow *(Moderate)*	Acceptable, however, may be moderate health concern for small number of people	Be aware that levels are slightly elevated	If you experience breathing difficulties, such as chest tightness or wheezing, stop activities, use a rescue inhaler and find a place to sit down and rest.	Potential health effects not expected, however actions to reduce exposure to vog may be useful
0.21–1.00	Orange *(Unhealthy for Sensitive Groups)*	Members in sensitive groups, including healthy individuals with mild asthma, may experience health effects. They may be affected at lower levels than general public. Toward the upper end of this range, most asthmatics who are active outdoors are likely to experience some breathing difficulties. General public not expected to be affected in this range.	Avoid outdoor activities that cause heavy breathing or breathing through the mouth[4]	If you experience breathing difficulties, such as chest tightness or wheezing, stop activities, use a rescue inhaler and find a place to sit down and rest.	Potential health effects not expected, however actions to reduce exposure to vog may be useful
1.01–3.00	Red *(Unhealthy)*	Everyone may begin to experience health effects. Members of sensitive groups may experience more serious health effects.	Avoid outdoor activities & remain indoors	Consider leaving the area	Avoid outdoor activities that cause heavy breathing or breathing through the mouth[4]
3.01–5.00	Purple *(Very Unhealthy)*	Triggers health alert, meaning everyone may experience more serious health effects.	Avoid outdoor activities & remain indoors	Leave the area & seek medical help	Avoid outdoor activities & remain indoors
> 5.01	Maroon *(Hazardous)*	Triggers health warnings of emergency conditions. Entire population is more likely to be affected.	Avoid outdoor activities & remain indoors. Leave the area if directed by Civil Defense	Leave the area & seek medical help	Avoid outdoor activities & remain indoors. Leave the area if directed by Civil Defense

http://www.hiso2index.info/assets/FinalSO2Exposurelevels.pdf

Covid-19



Source control

Masks
Isolation

Source removal

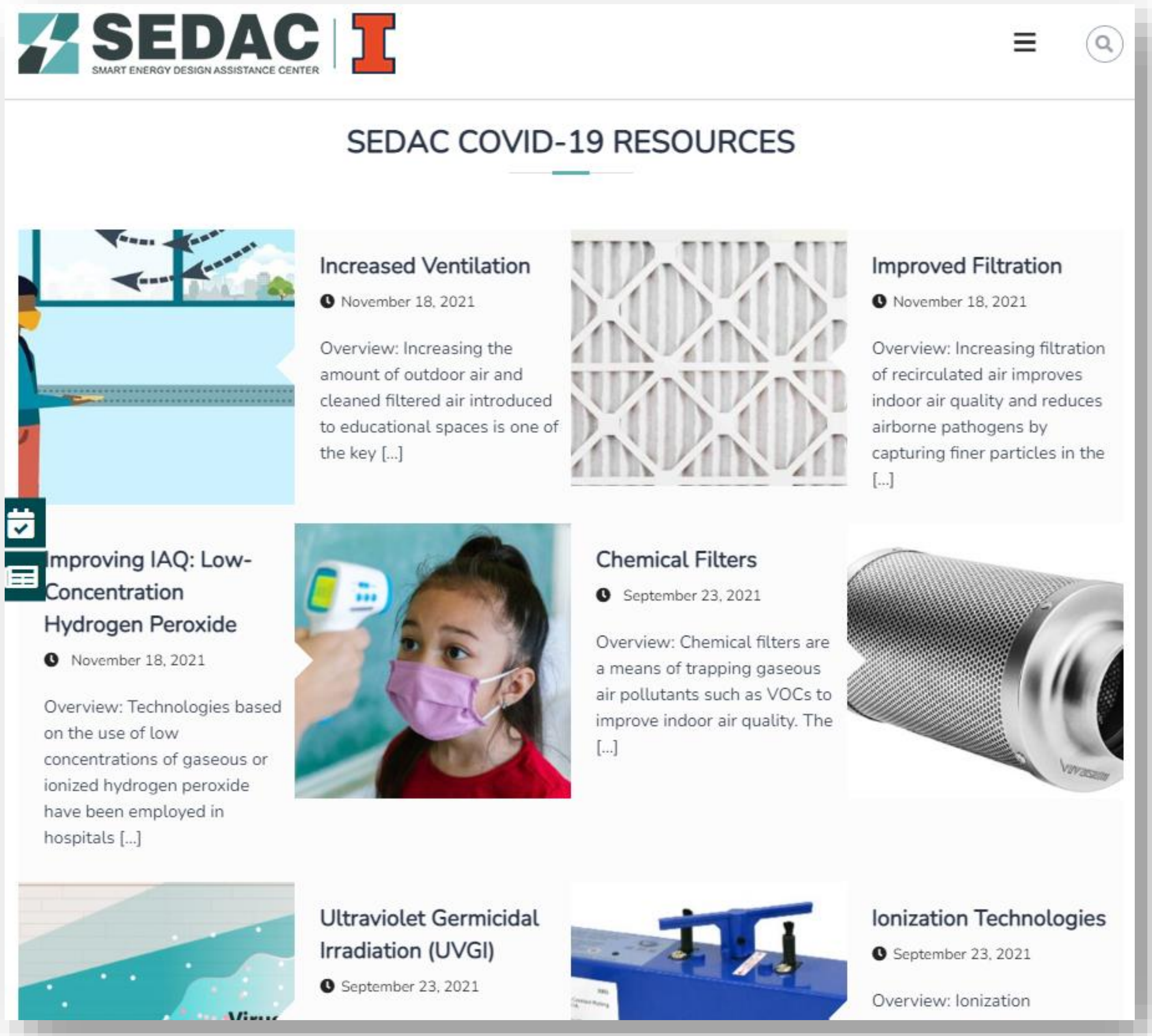
Filtration
Disinfection

Dilution

Ventilation

Covid-19

Resources from the Smart Energy Design Assistance Center

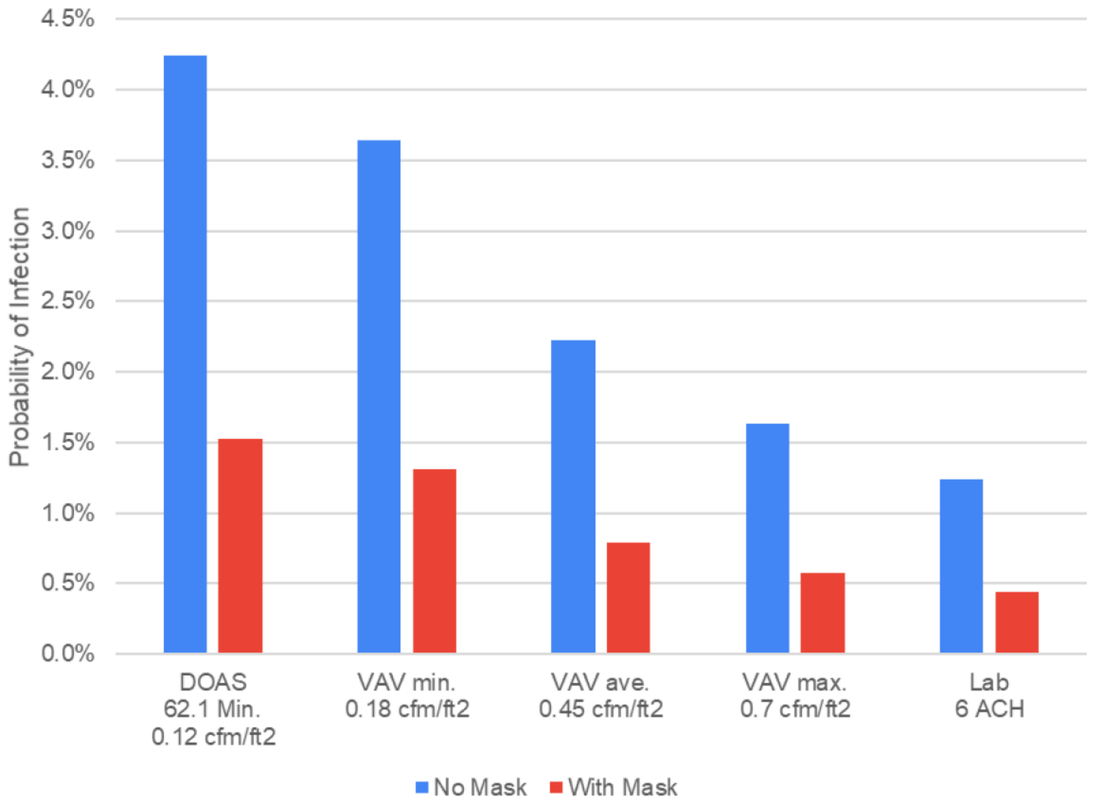


https://smartenergy.illinois.edu/covid-19-resources

Covid-19

White Paper from Taylor Engineering

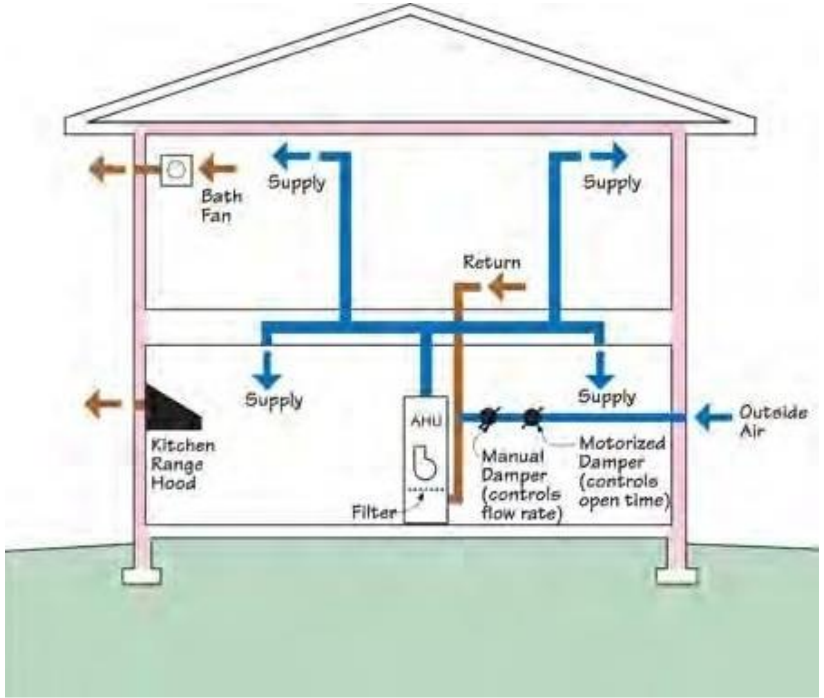
Measure	Effectiveness in Mitigation COVID-19 Transmission	First Cost Impact	Energy/ Environmental Impact
Require masks be worn at all times indoors in areas where more than one person can gather	★★★★★	$	–
Maintain social distancing	★★★★★	$$$ (note 1)	-
Require and pay for employees to be regularly tested	★★★★★	$$	–
Require employees with symptoms or diagnosed to stay home	★★★★★	–	–
Conduct meetings via computer video, not in-person	★★★★★	–	-
Work from home as often as possible	★★★★★	$$ (note 2)	–
Implement flexible paid sick leave policies so sick employees stay home	★★★★	$$$ (note 3)	–
Reduce office workstation density and install plexiglass guards	★★★★	$$$$$	–
Frequently wash hands	★★★★	–	-
Ensure HVAC systems are providing at least Standard 62.1 and code minimum ventilation rates	★★★	$	-



https://taylorengineers.com/taylor-engineering-covid-19-whitepaper

Section 3

Ventilation



BEE Modules

11. Mechanical Ventilation

- 11.1 Fundamentals of Indoor Air Quality
- ➡ 11.2 Fundamentals of Building Ventilation
- ➡ 11.3 Minimum Ventilation Standards
- 11.4 Energy Code Ventilation Requirements

Plus

- Hawaii residential ventilation requirements
- Air purifiers

Building Energy Education fundamentals

11.2 Fundamentals of Building Ventilation

Module 11: Mechanical Ventilation
Part 2

Objective: Describe and understand the basic methods to achieve fresh air ventilation in buildings.

11.2 Fundamentals of Building Ventilation

Module 11: Mechanical Ventilation
Part 2

Objective: Describe and understand the basic methods to achieve fresh air ventilation in buildings.

Uncontrolled air exchange is detrimental

Air drawn inward through the envelope is called infiltration

Bring in unfiltered outdoor air

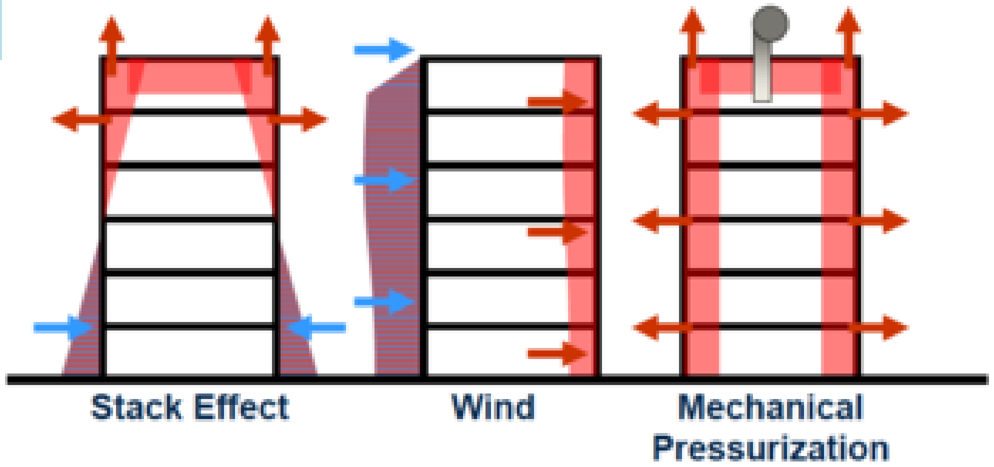
- Limited amount beneficial for free ventilation
- Too much causes discomfort
- Brings humidity into building

Air **pushed out** through the envelope is called **exfiltration**

Lose conditioned air to outdoors

- Limited amount beneficial for preventing infiltration
- Too much wastes energy
- Carries humidity out of building

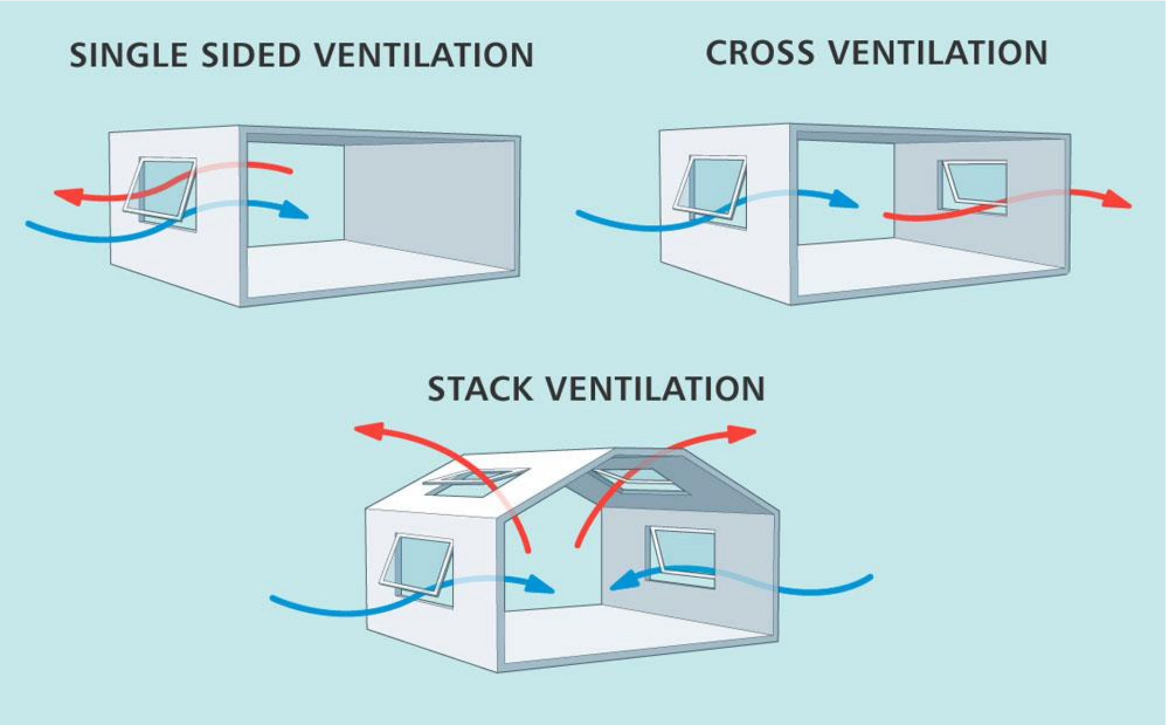
Sources of infiltration and exfiltration



https://energyeducation.ca/encyclopedia/Air_infiltration_and_exfiltration

Natural ventilation reduces fan energy

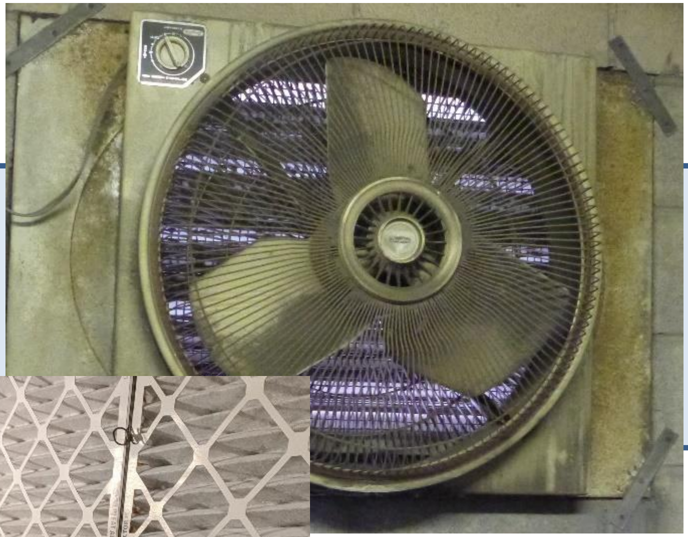
- Green buildings incorporate envelope designs to maximize natural ventilation where/when climatically appropriate.
- Orient long wall to primary wind direction.
- Best ventilation from cross-flows
- Open windows on both sides of building to allow air to flow straight through.



https://www.tealproducts.com/natural-ventilation-control

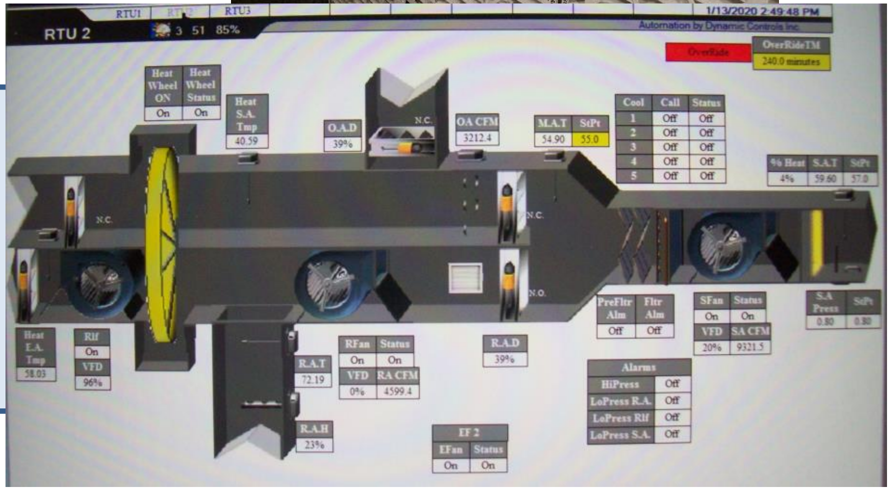
Mechanical ventilation

- **Ventilation.** Remove or dilute pollutants.



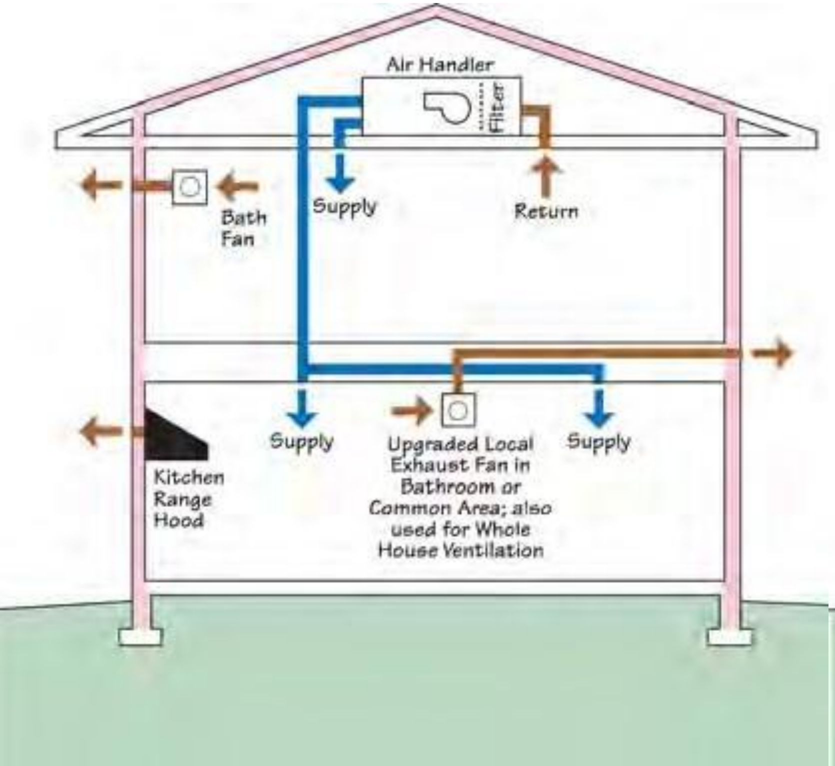
- **Filter.** Remove particulates.

- **Control.** Maximize efficiency.

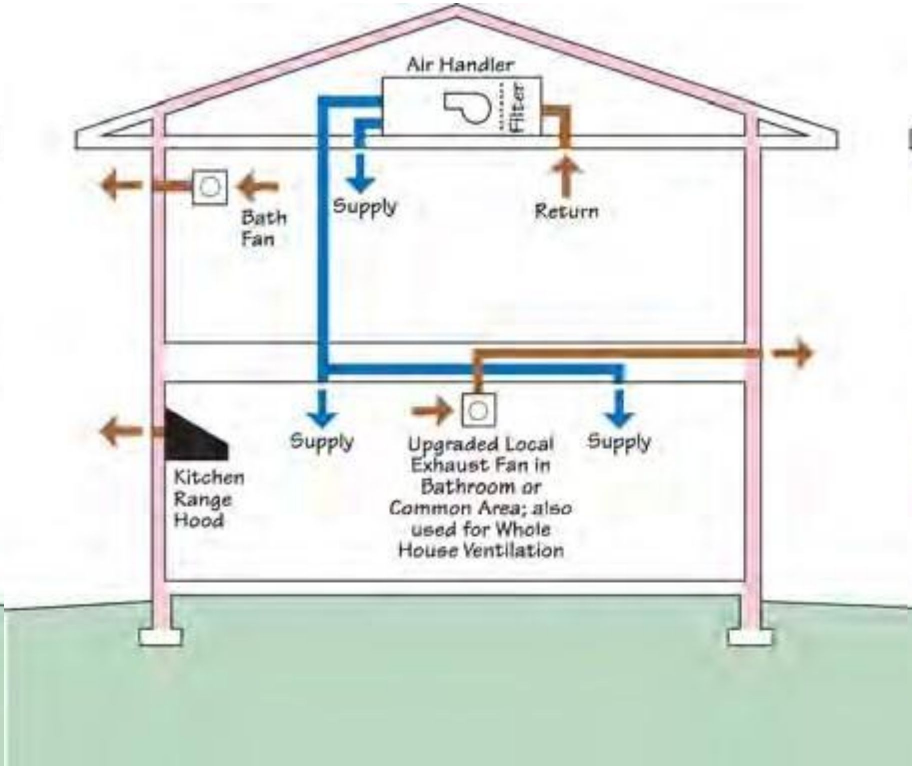


Residential mechanical ventilation options

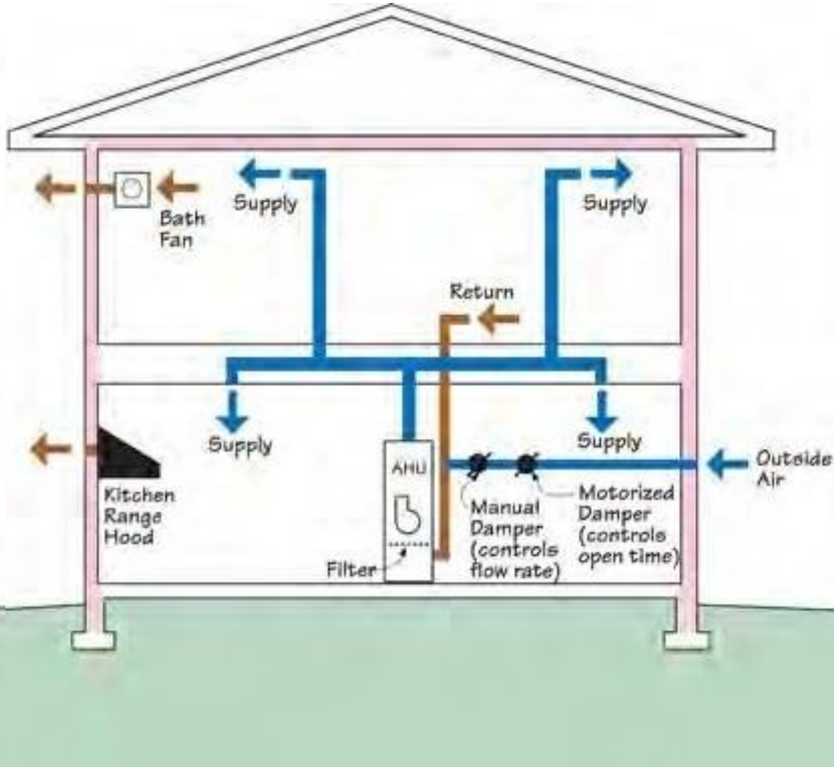
Exhaust Only



Supply Only



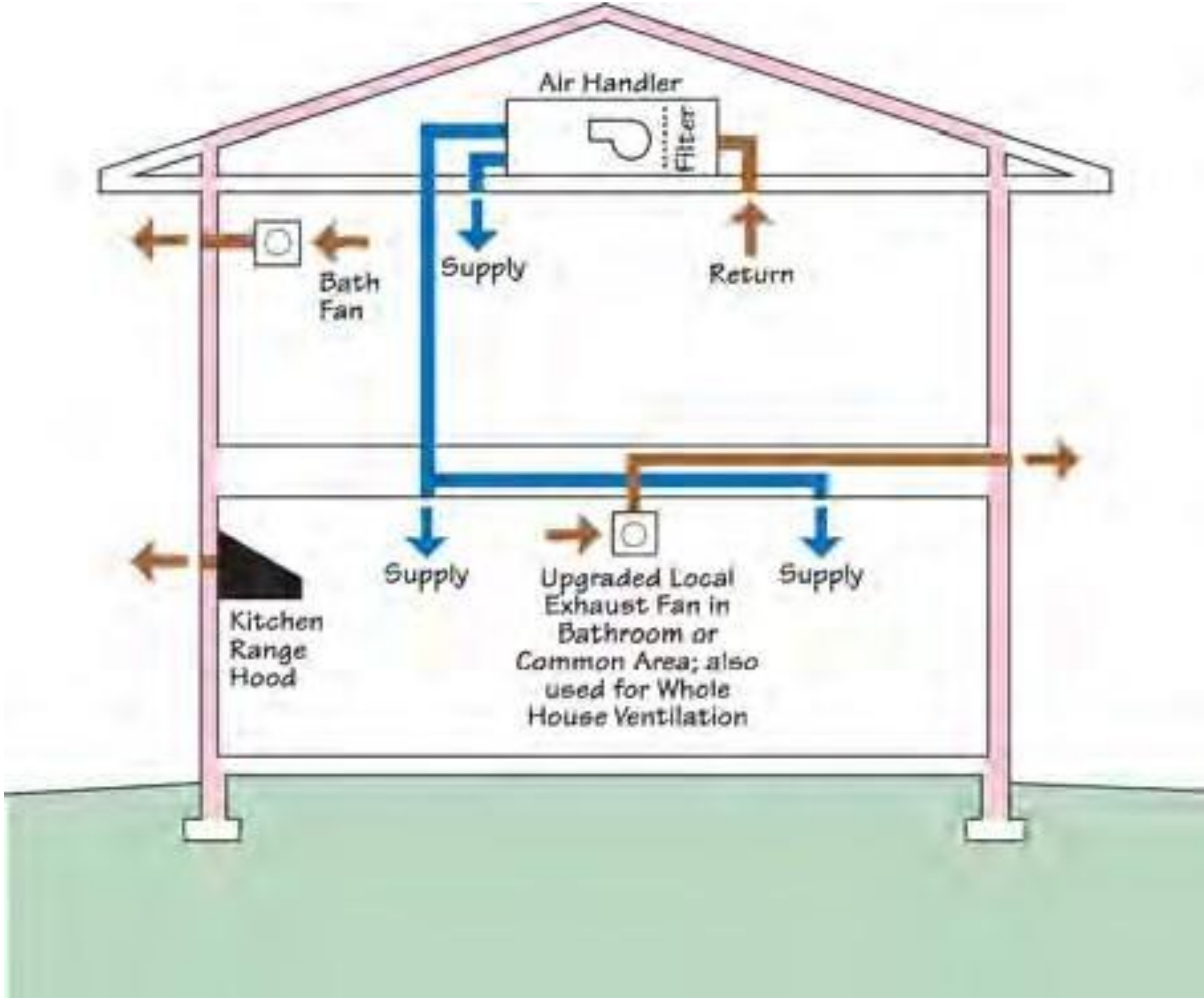
Balanced



Residential negative-pressure ventilation

Negative ventilation

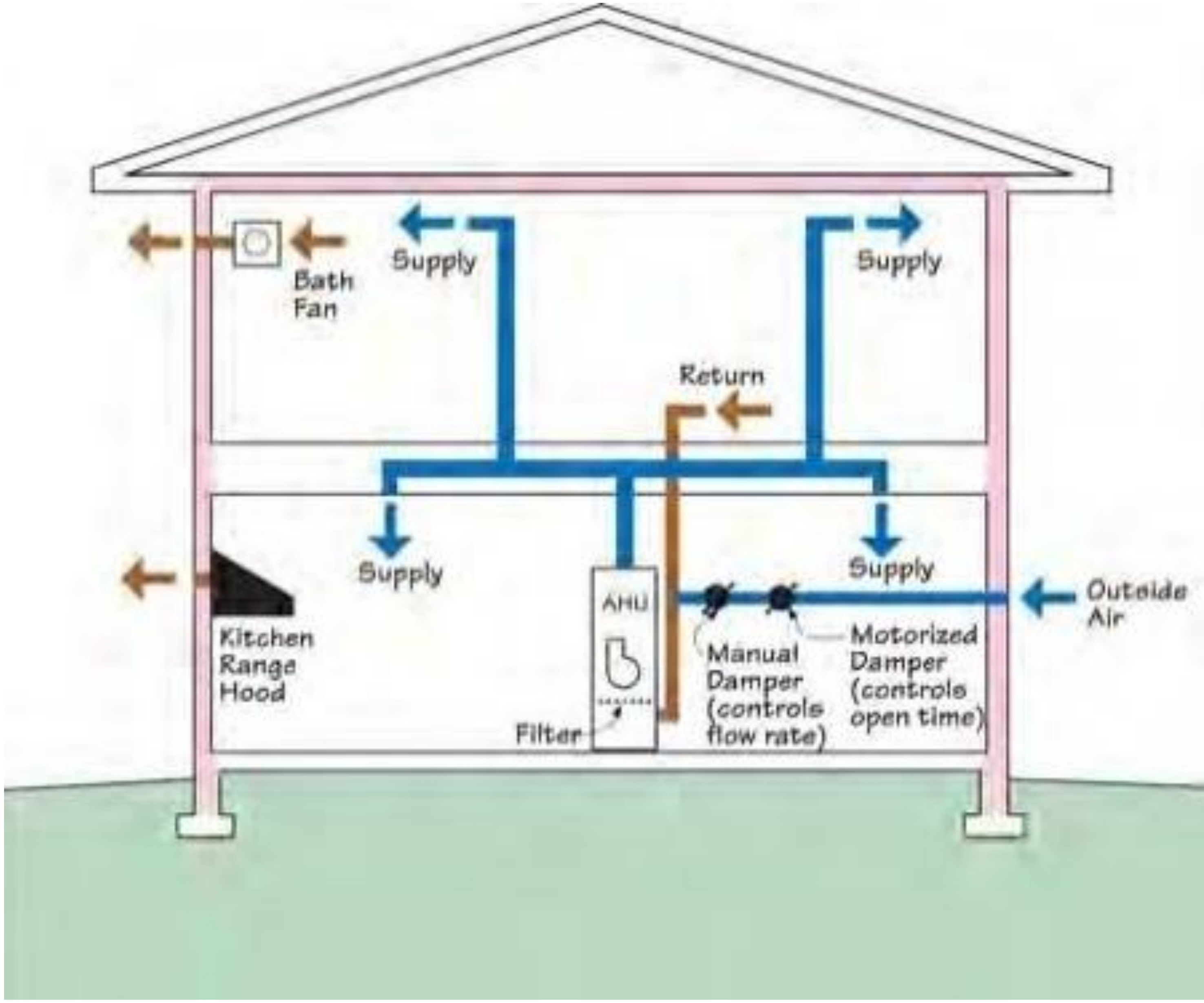
- Relies on infiltration for make up air
- Worst design for IAQ
- Negative air pressure can draw in contaminants and humidity
- Cost effective and simple



Residential positive-pressure ventilation

Positive ventilation

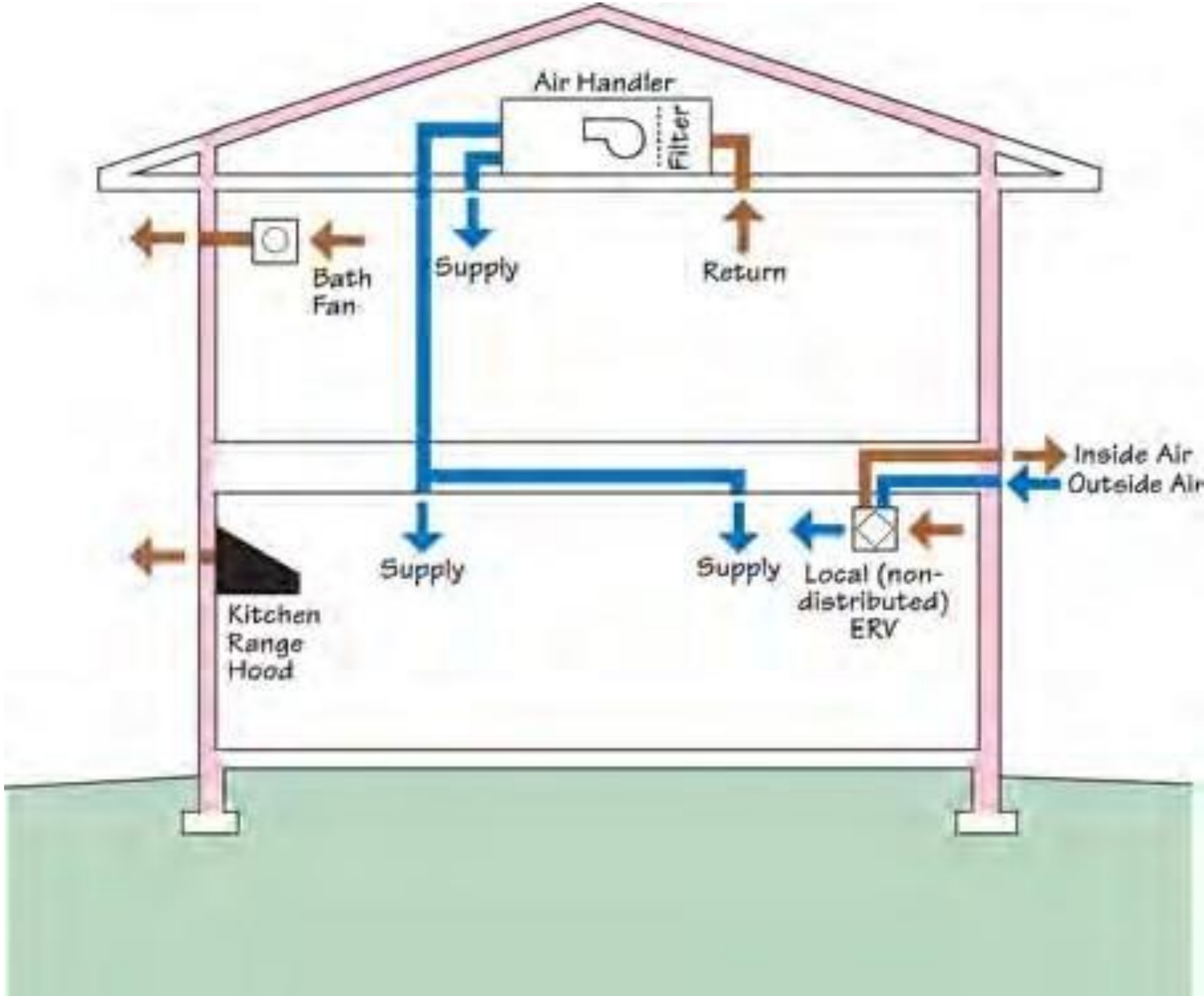
- Relies on exfiltration for make up air
- Better design for IAQ
- Outdoor air is filtered and conditioned.
- Forcing humidity out through envelope can cause moisture issues.



Residential balanced-pressure ventilation

Balanced ventilation

- Has dedicated intake and exhaust
- Does not rely on infiltration or exfiltration
- Outdoor air is filtered and conditioned.
- Best design for IAQ
- Can be paired with energy recovery



11.3 Minimum Ventilation Standards

Module 11: Mechanical Ventilation
Part 3

Objective: Identify the methods to design for adequate IAQ and identify why going beyond minimum ventilation is beneficial.

ASHRAE 62.1/62.2-2019 current standard

ASHRAE 62.1: Commercial Ventilation Standard

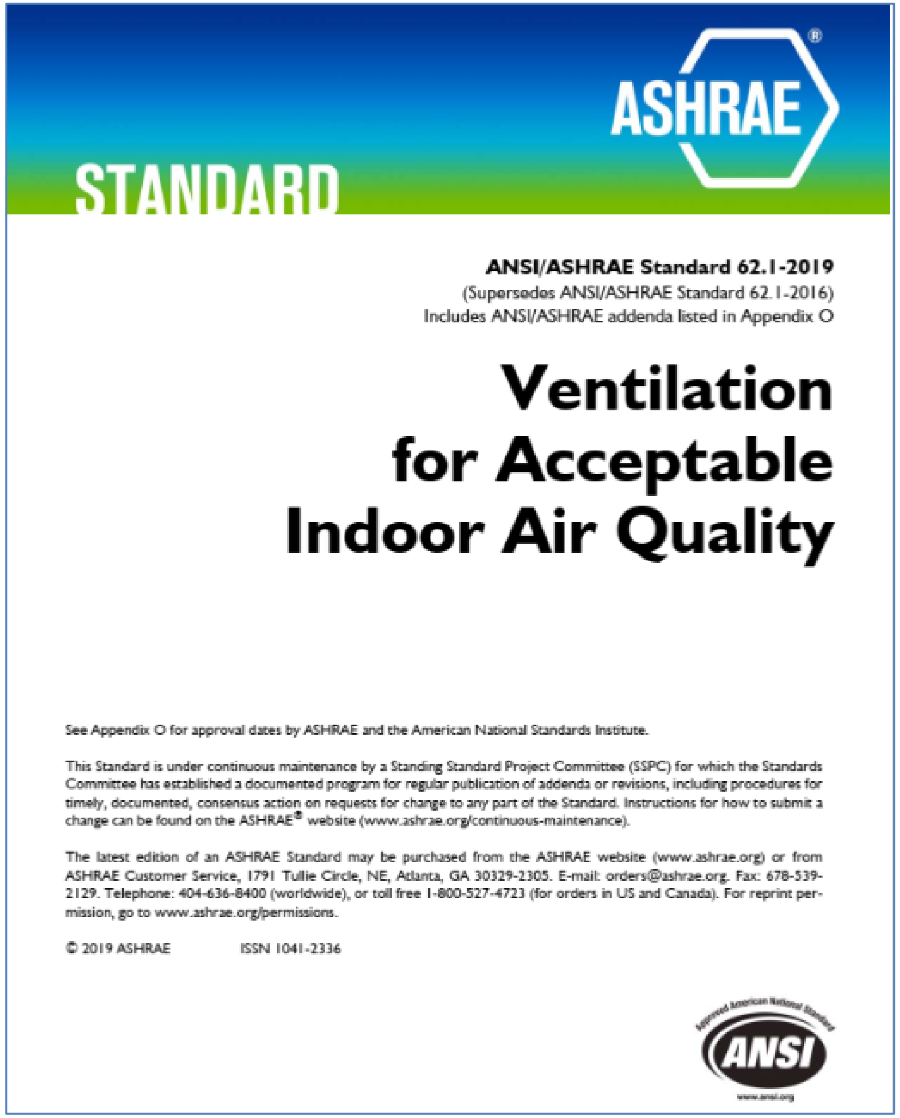
ASHRAE 62.2: Residential Ventilation Standard

3 Compliance Options in 62.1, two in 62.2

- Ventilation Rate Procedure - Both
- Indoor Air Quality Procedure – Both
- Natural Ventilation Procedure – 62.1 only

Prescriptive ventilation based on combined square footage and per occupant values.

- Accounts for generation of VOCs and other non-occupant indoor pollutants.


STANDARD

ASHRAE

ANSI/ASHRAE Standard 62.1-2019
(Supersedes ANSI/ASHRAE Standard 62.1-2016)
Includes ANSI/ASHRAE addenda listed in Appendix O

Ventilation for Acceptable Indoor Air Quality

See Appendix O for approval dates by ASHRAE and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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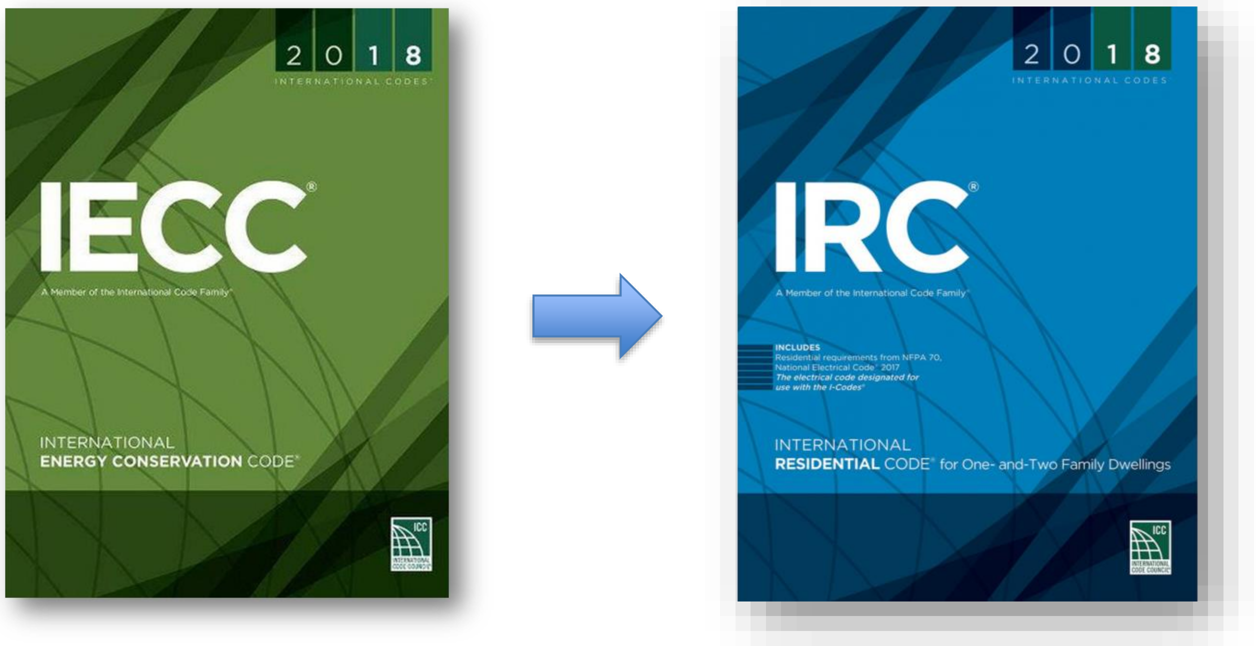
ANSI

Image source: ashrae.org

Hawaii Residential Ventilation Requirements



Energy code points to the International Residential Code (IRC) or International Mechanical Code (IMC)

Not required for homes following the "Tropical Zone" energy code compliance path

Ventilation rate

$$CFM = 0.01 \times \text{floor area } (ft^2) + 7.5 \times (\text{\# bedrooms} + 1)$$

Delivery

1. Continuous, or
2. ≥25% of each 4 hours

International Residential Code (IRC)

TABLE M1505.4.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 – 1	2 – 3	4 – 5	6 – 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 – 3,000	45	60	75	90	105
3,001 – 4,500	60	75	90	105	120
4,501 – 6,000	75	90	105	120	135
6,001 – 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

For SI: 1 square foot = 0.0929 m^2, 1 cubic foot per minute = 0.0004719 m^3/s.

TABLE M1505.4.3(2)
INTERMITTENT WHOLE-HOUSE MECHANICAL VENTILATION RATE FACTORS[a, b]

RUN-TIME PERCENTAGE IN EACH 4-HOUR SEGMENT	25%	33%	50%	66%	75%	100%
Factor[a]	4	3	2	1.5	1.3	1.0

a. For ventilation system run time values between those given, the factors are permitted to be determined by interpolation.
b. Extrapolation beyond the table is prohibited.

Example

2,500 ft^2, 4 bedrooms

Continuous ventilation

75 cfm

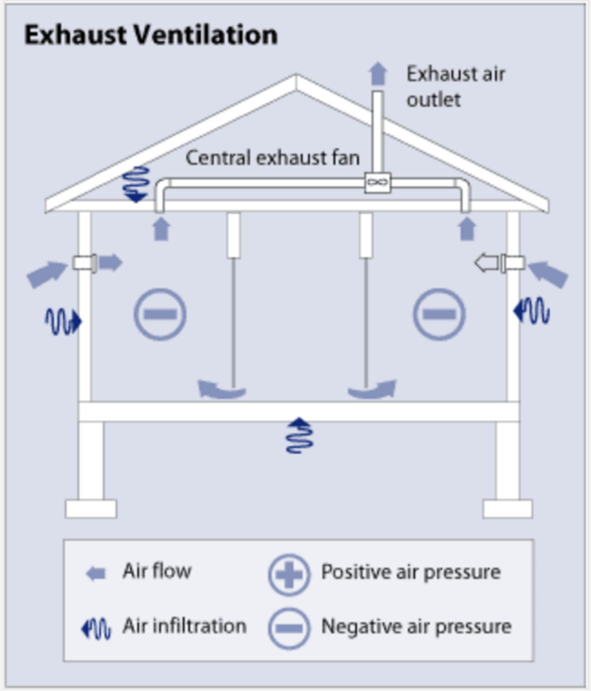
15 minutes of every hour

4×75 cfm = 300 cfm

Hawaii Residential Ventilation Requirements

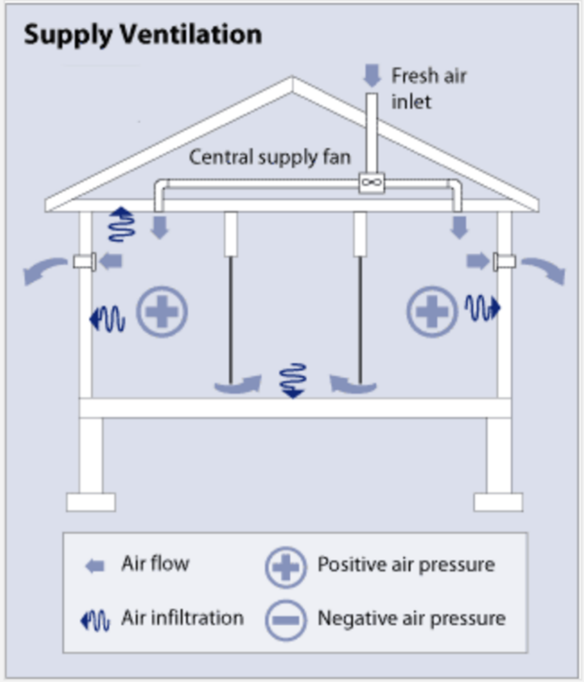
Ventilation method: exhaust, supply or balance allowed

Humidity consideration: avoid warm humid air delivered to cool space



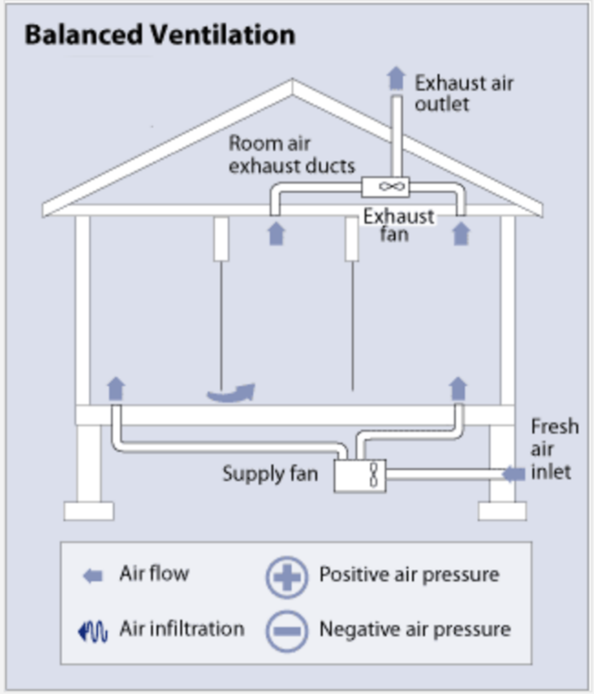
DOE

Exhaust Ventilation System



DOE

Supply Ventilation System



DOE

Balanced Ventilation System

Air purifiers

Filters air for single room

1. Particles – High Efficiency Particulate Air (HEPA) filter
2. Gasses – activated carbon or other sorbent
3. Both

Performance

Clean air delivery rate (CADR)

Energy efficiency – CADR/watt

For vog

Close to eruption – particulates + gas

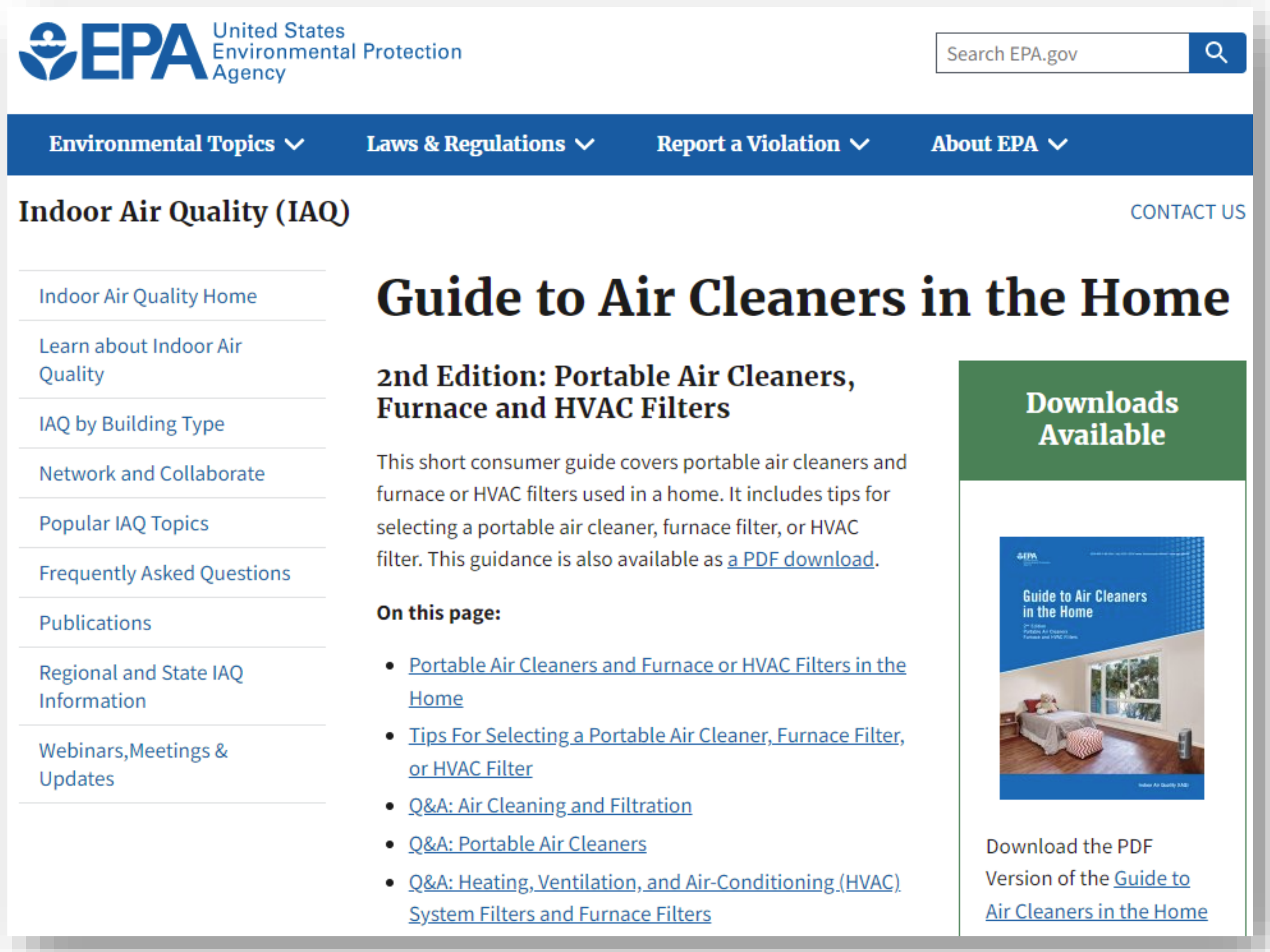
Otherwise - particulates

https://www.epa.gov/indoor-air-quality-iaq/guide-air-cleaners-home

International Volcanic Health Hazard Network (IVHHN)
https://vog.ivhhn.org/air-purifier-information

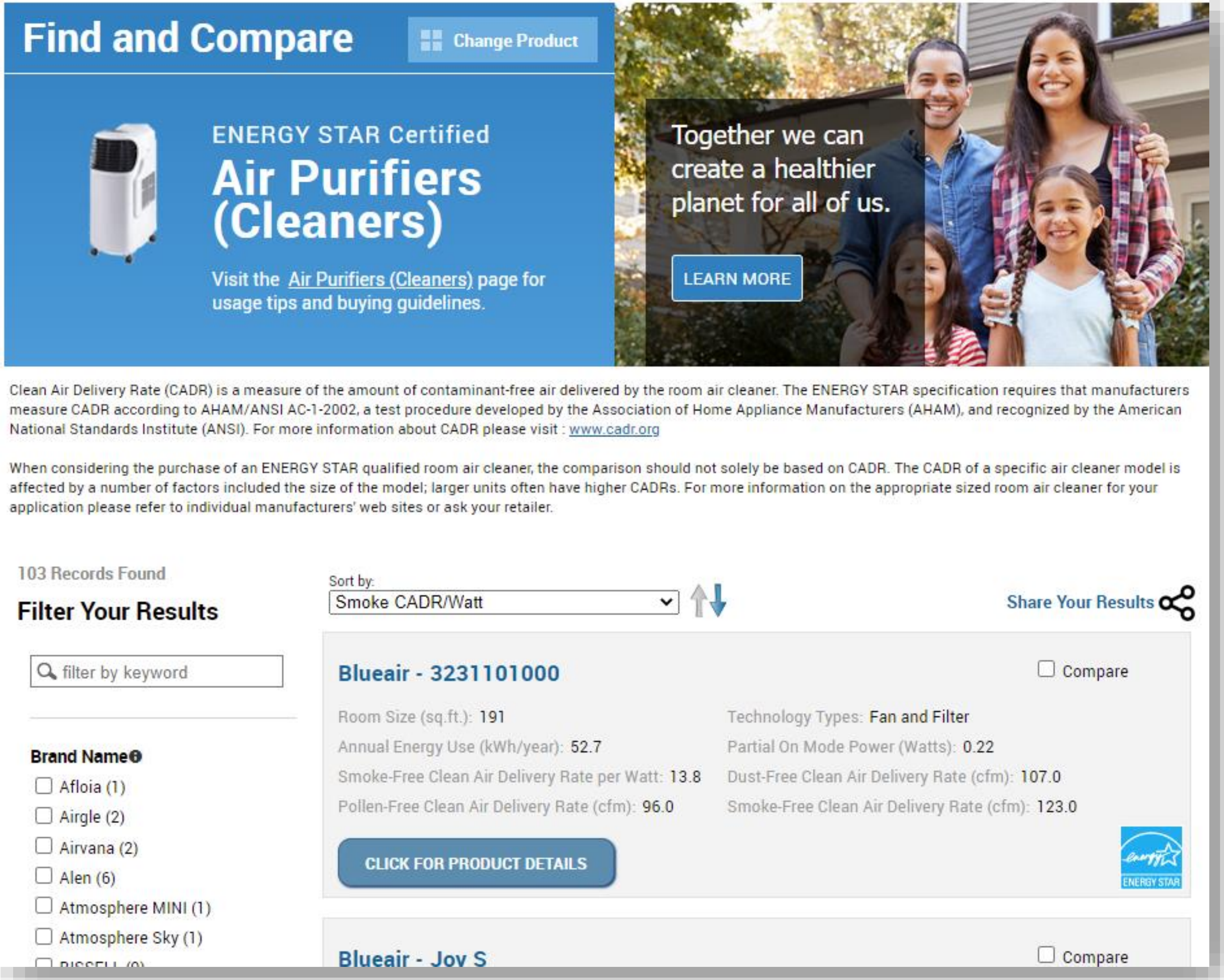
Air purifiers

Room area (ft^2)	Minimum CADR (cfm)
100	65
200	130
300	195
400	260
500	325
600	390



https://www.epa.gov/indoor-air-quality-iaq/guide-air-cleaners-home

Air purifiers

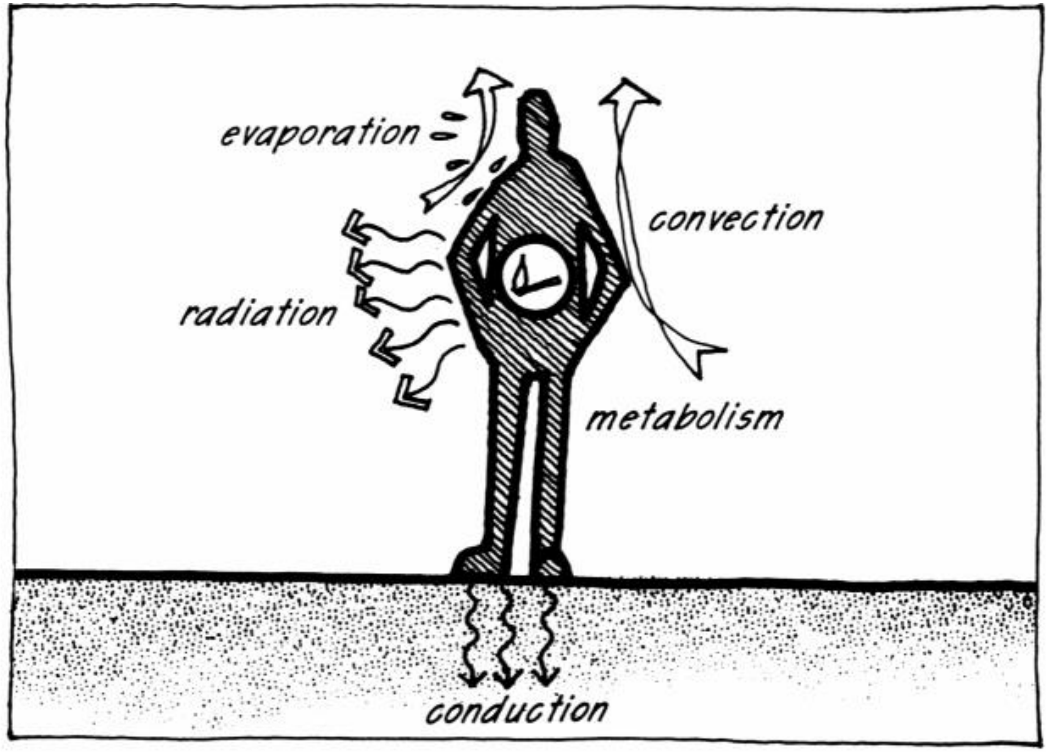


https://www.energystar.gov/products/air_purifiers_cleaners

Section 4

Thermal Comfort Strategies

Thermal Comfort Factors



Heat balance

Heat generated within body ≈ **Heat loss from body**

- Activity level (metabolic rate)
- Gender
- Age

- Clothing
- Air temperature
- Relative humidity
- Air velocity
- Mean radiant temperature (MRT)

Thermal Comfort Factors

Air temperature

Relative humidity

Air velocity

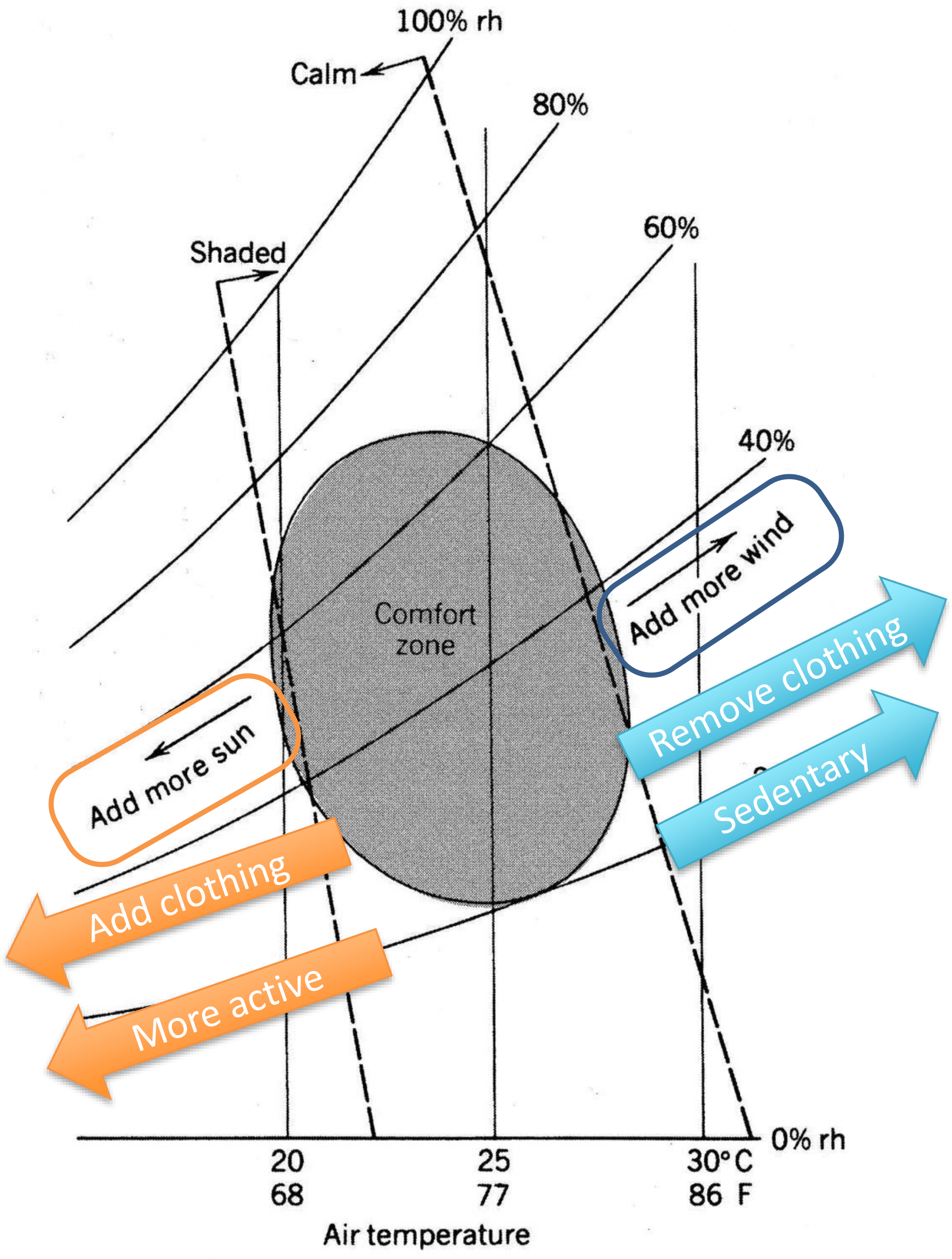
Mean radiant temperature (MRT)

Comfort Zone Concept

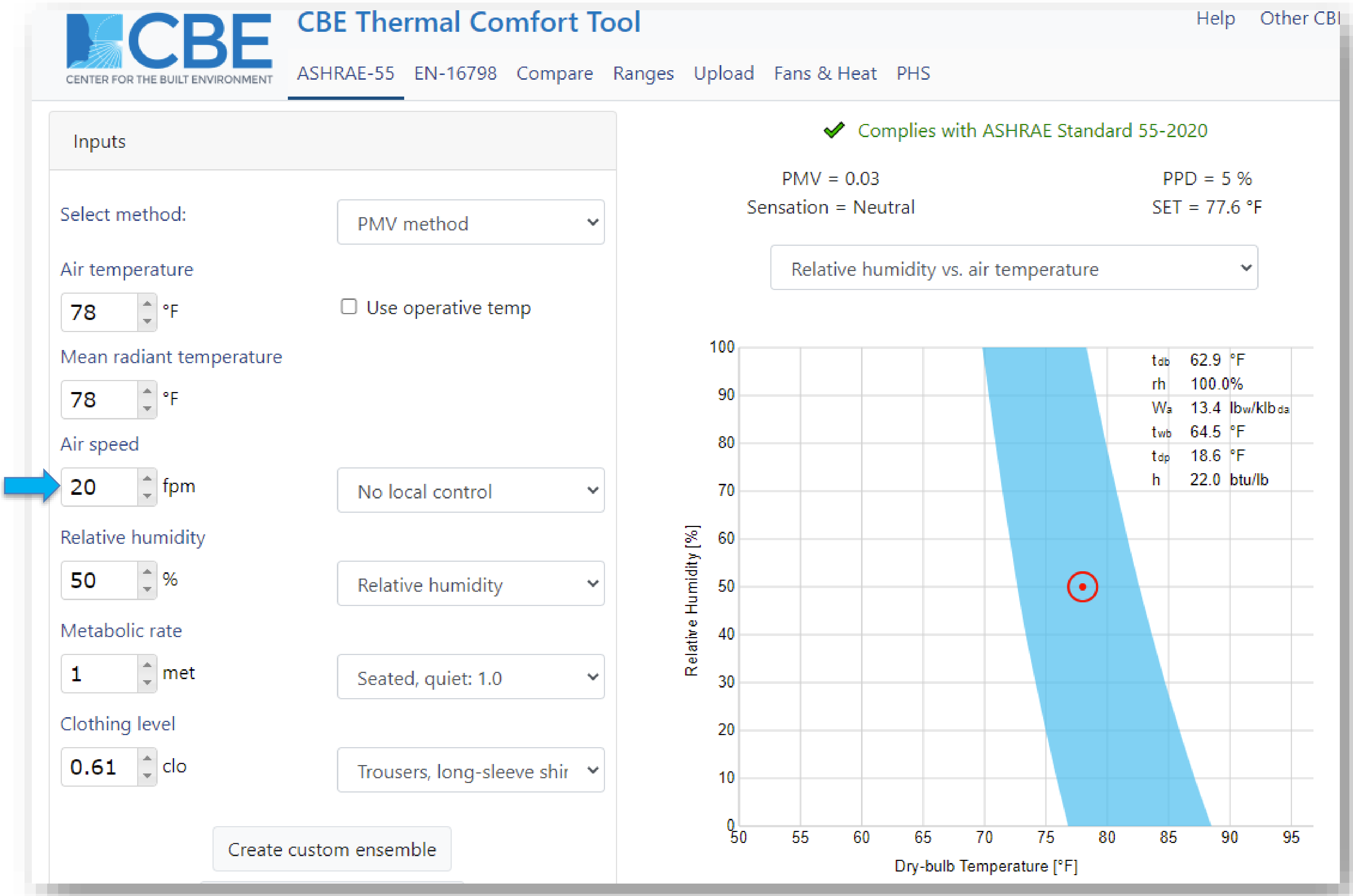
Range of conditions where people feel comfortable

Shifts to left with more radiant heat (e.g. sun)

Shifts to right with air movement

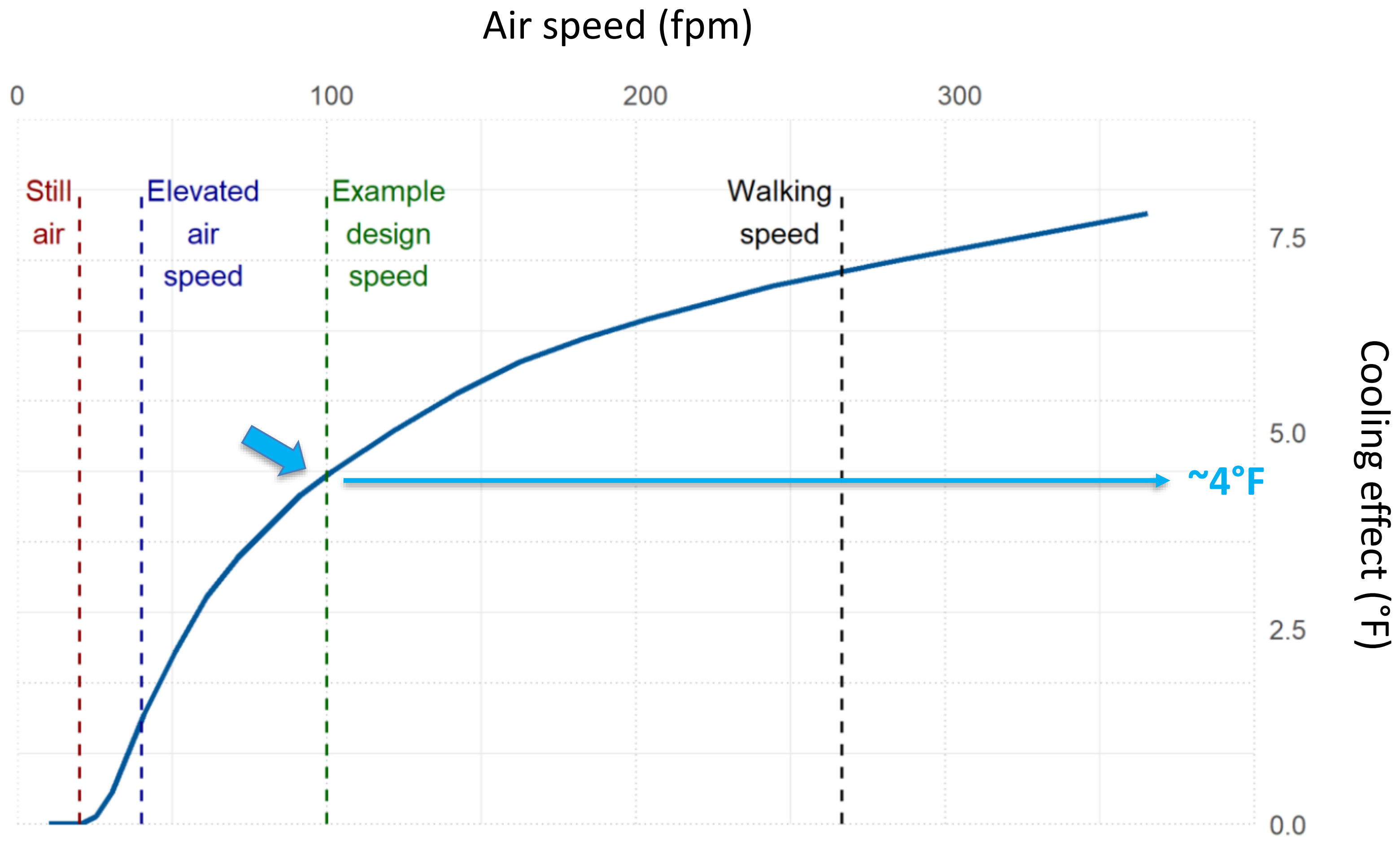


Source: Mechanical and Electrical Equipment in Buildings



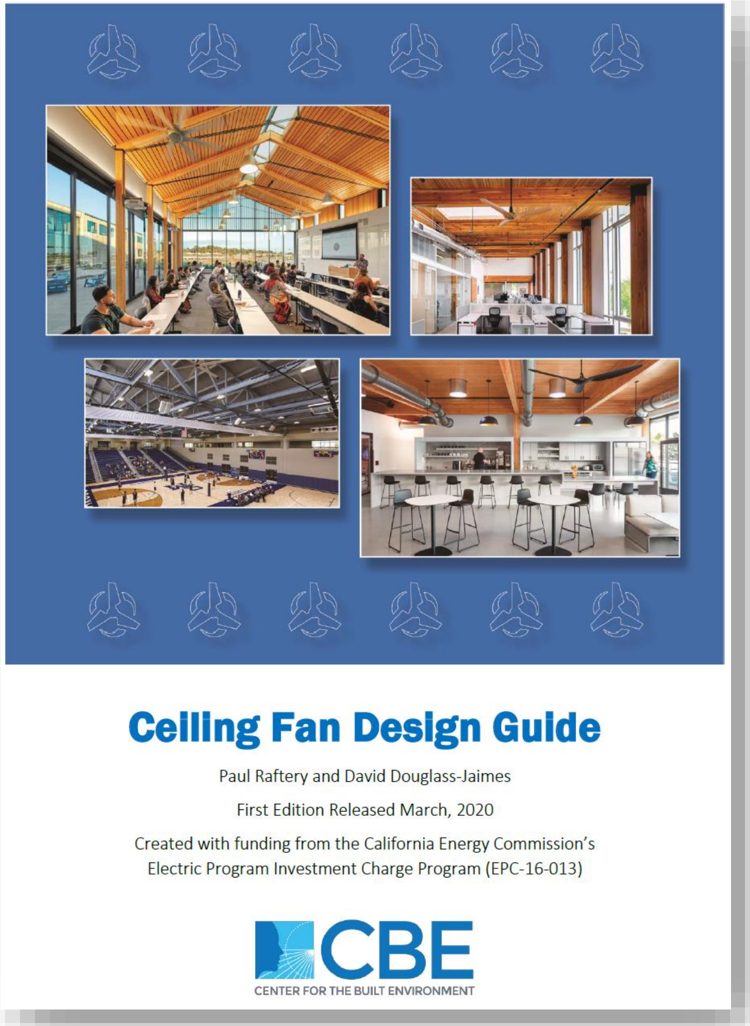
https://comfort.cbe.berkeley.edu/

Ceiling fans

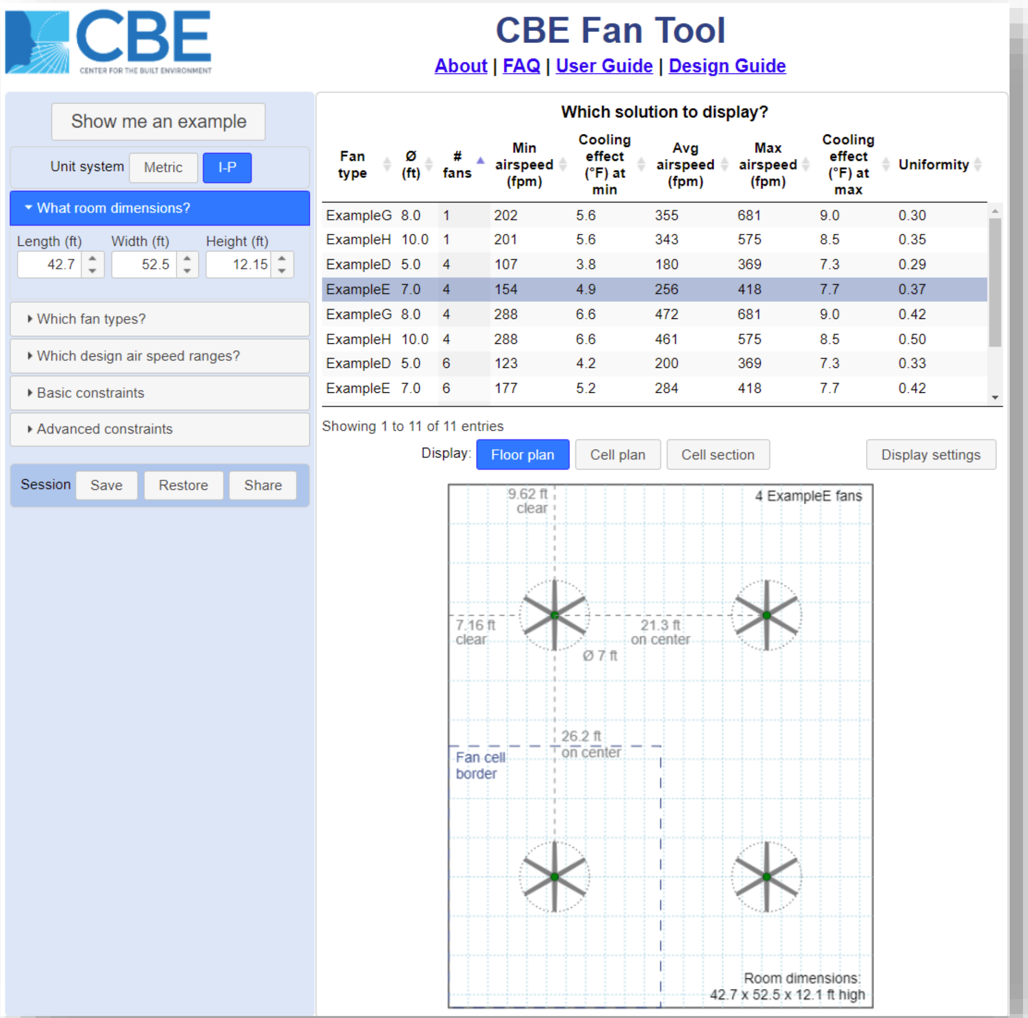


Source: Ceiling Fan Design Guide
https://cbe.berkeley.edu/wp-content/uploads/2020/04/CBE-Ceiling-Fan-Design-Guide-V0.pdf

Ceiling fans

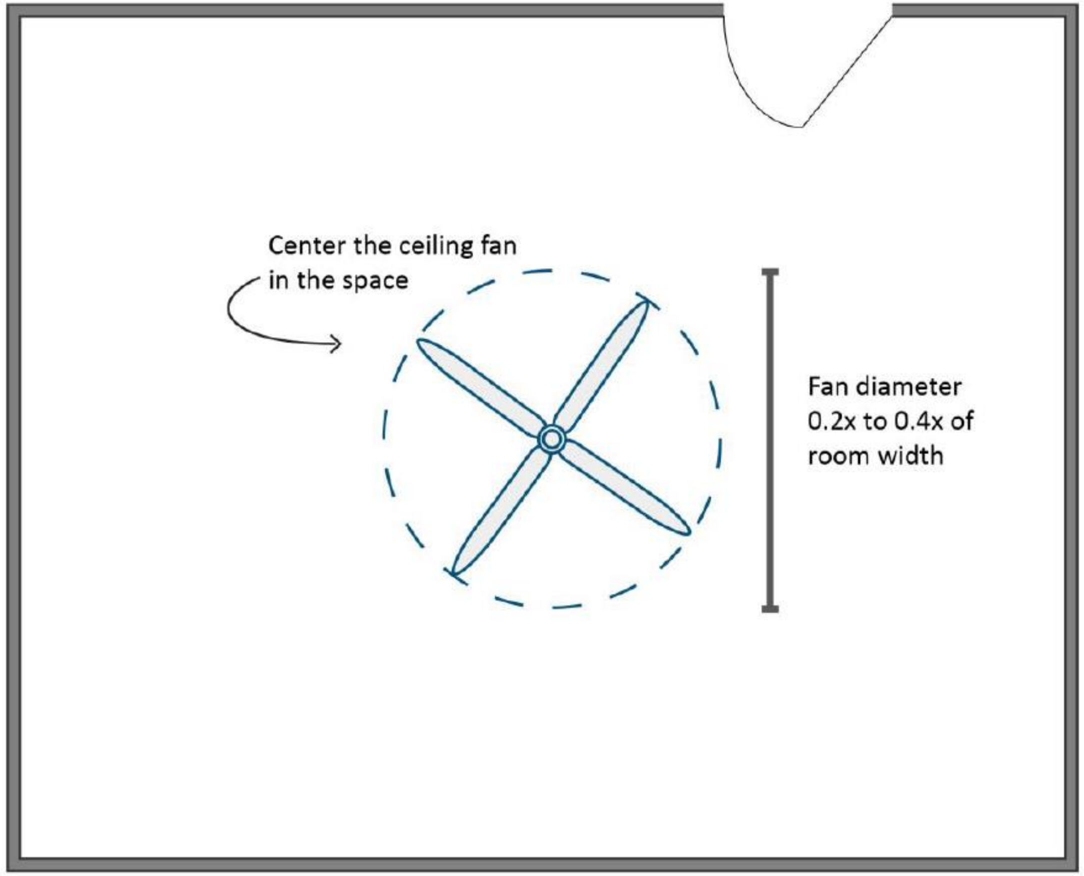


https://cbe.berkeley.edu/wp-content/uploads/2020/04/CBE-Ceiling-Fan-Design-Guide-V0.pdf

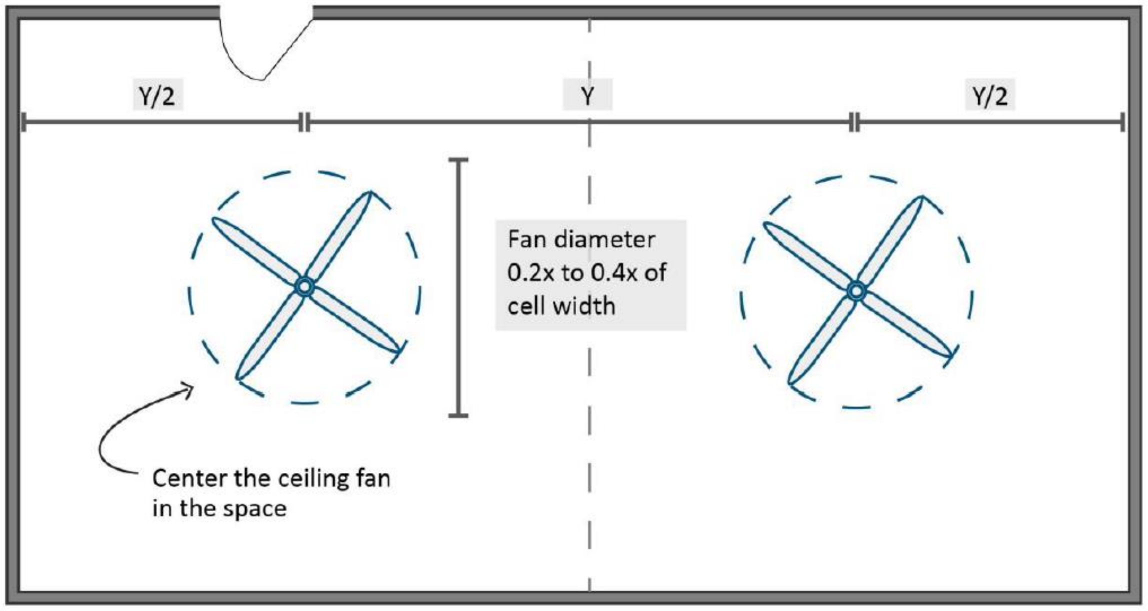


https://centerforthebuiltenvironment.github.io/fan-tool

Ceiling fans



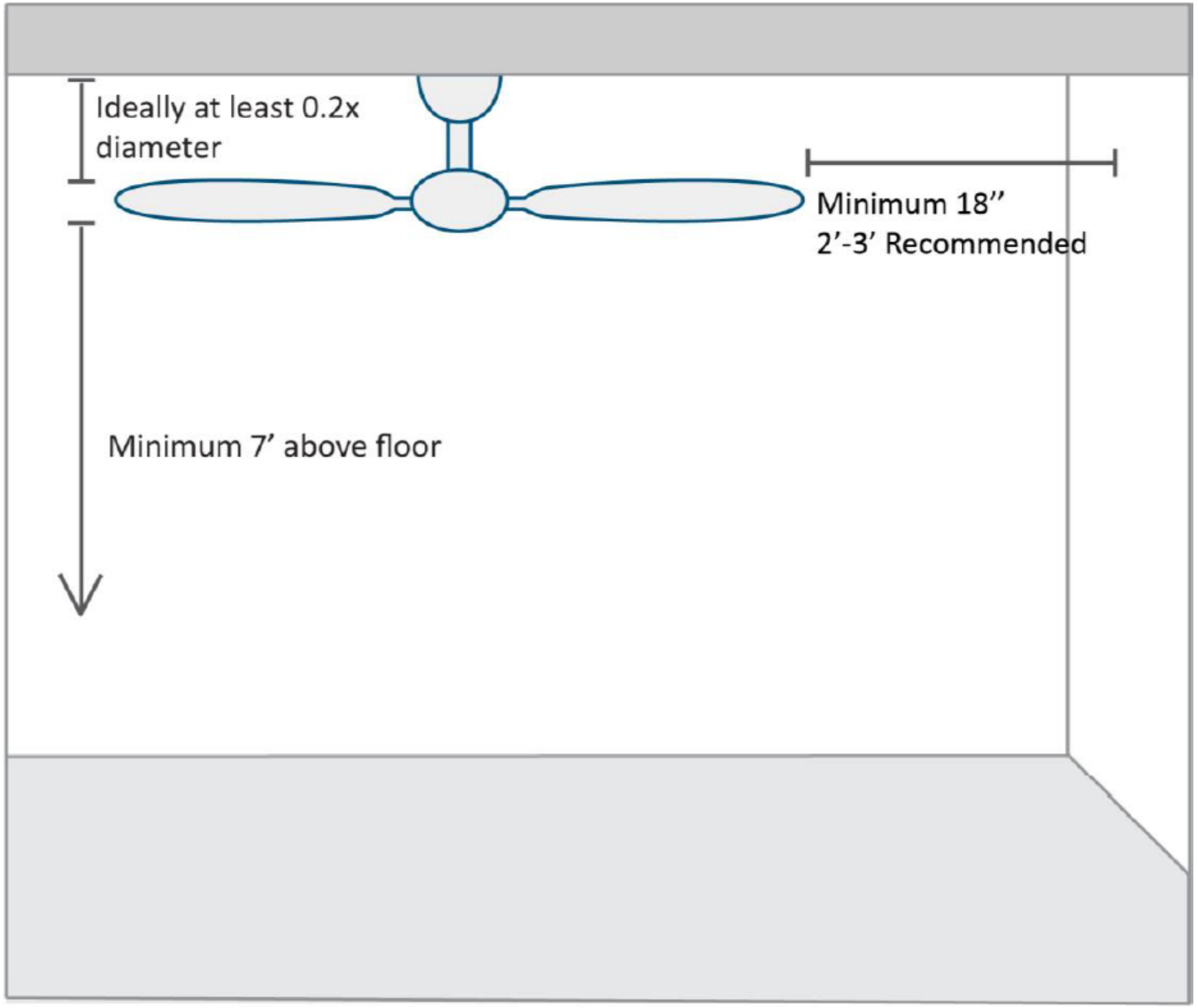
Maximum Room Aspect Ratio 1.5:1 for effective single ceiling fan use.



For larger spaces with multiple fans, divide the space into equal, roughly square (maximum 1.5:1 aspect ratio) cells and center the fans in each cell.

Source: Ceiling Fan Design Guide
https://cbe.berkeley.edu/wp-content/uploads/2020/04/CBE-Ceiling-Fan-Design-Guide-V0.pdf

Ceiling fans

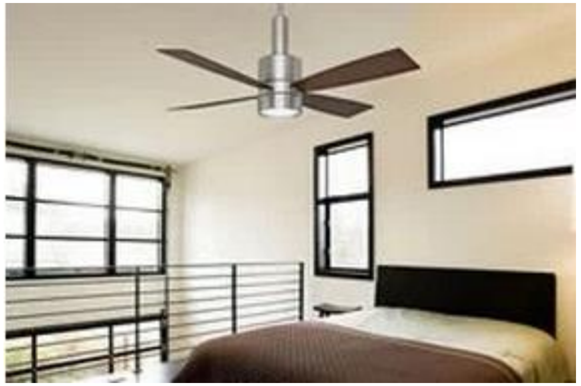


Source: Ceiling Fan Design Guide
https://cbe.berkeley.edu/wp-content/uploads/2020/04/CBE-Ceiling-Fan-Design-Guide-V0.pdf

Ceiling Fans

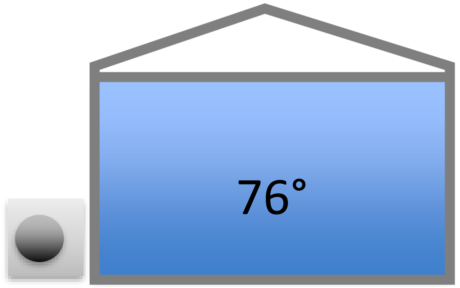
Energy code residential requirement

R404.2 Ceiling Fans (Mandatory). A ceiling fan, ceiling fan rough-in or whole house fan is provided for bedrooms and the largest space that is not used as bedroom.

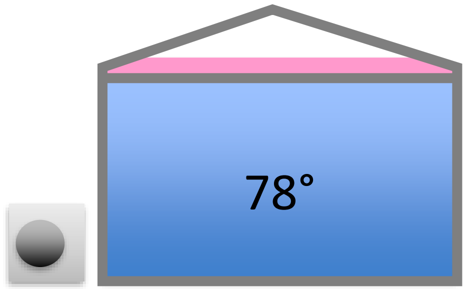


Thermal comfort strategies

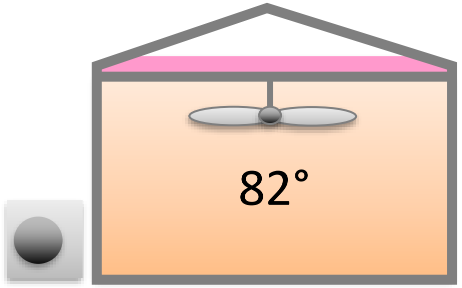
Air temperatures for equal thermal comfort



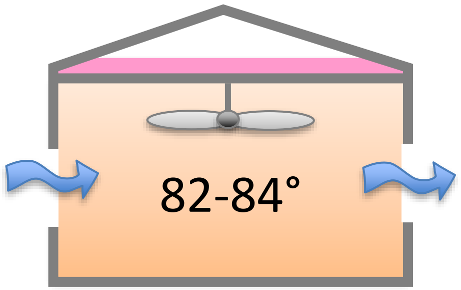
AC



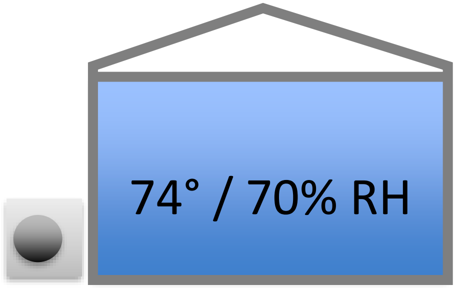
+ insulated ceiling



+ ceiling fan

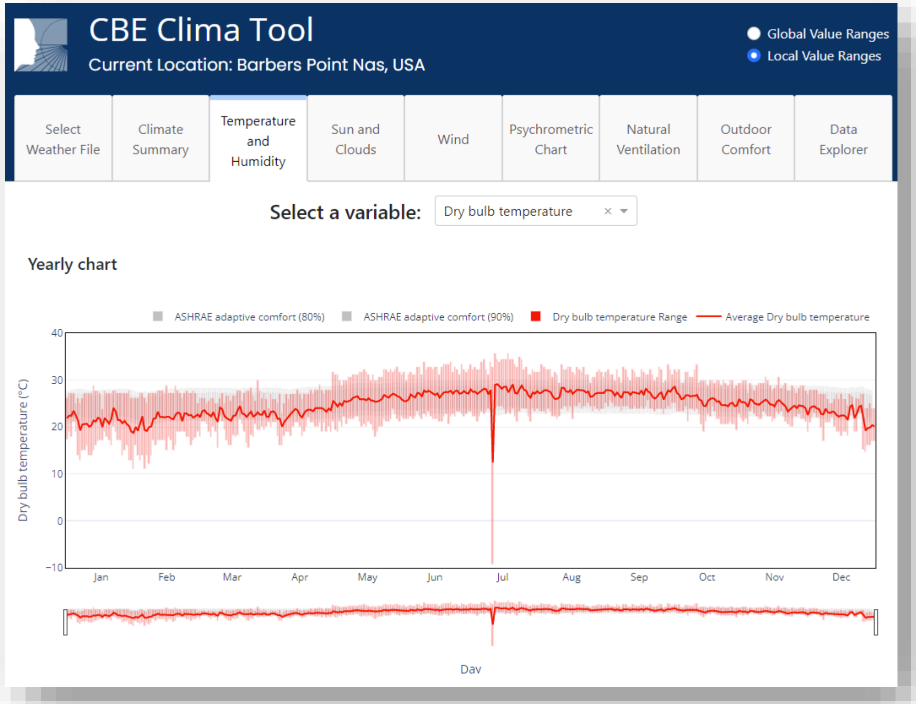


- AC
+ natural ventilation



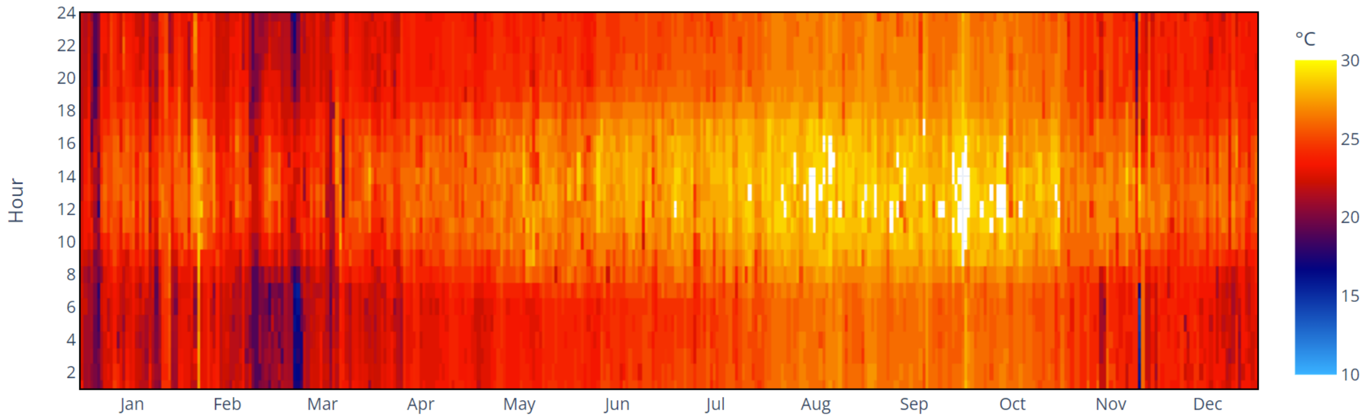
AC (poor humidity control)

Natural ventilation feasibility

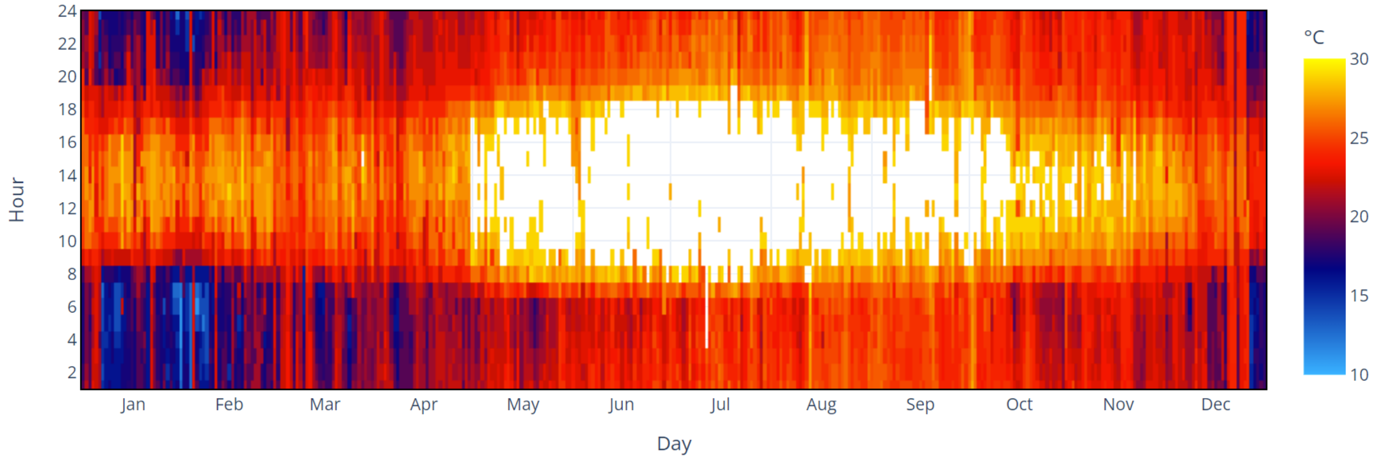


https://clima.cbe.berkeley.edu/

Kaneohe Bay



Barber's Point



White = hours above 84° outdoor temperature

Cost of air conditioning in Hawaii

Type	kWh/year	$/year (at $0.30/kWh)
Central AC	4,700 - 6,500	$1400 - $2000
Mini-split AC	3,400 - 4,700	$1000 - $1400
Room AC	2,800 - 3,900	$800 - $1200

Based on Market Potential Study
https://hawaiienergy.com/images/about/information-and-reports/market-potential-study/mps_appendix-A-results.xlsx

Section 5

Air Conditioning - System Sizing

BEE Modules

9. Mechanical Equipment Sizing

- 9.1 Introduction to Mechanical Equipment Sizing
- 9.2 Sizing Residential Equipment – Manual J & S
- 9.3 Using Manual J
- 9.4 Using Manual S

Building Energy Education fundamentals

9.1 Introduction to Mechanical Equipment Sizing

Module 9: Mechanical Equipment Sizing
Part 1

Objective: List the energy, economic, and sustainability impacts of proper equipment sizing on building performance, and broadly describe the different methods of sizing residential and commercial equipment.

9.1 Introduction to Mechanical Equipment Sizing

Module 9: Mechanical Equipment Sizing
Part 1

Objective: List the energy, economic, and sustainability impacts of proper equipment sizing on building performance, and broadly describe the different methods of sizing residential and commercial equipment.

Reasons to size mechanical equipment

Energy Use

According to NREL,* one Florida study showed a 9% increase in annual space cooling cost for units that are 50% oversized.

Comfort

Oversized fans are louder than needed; short run times distribute air poorly, potentially leaving cold and hot pockets in the home.

Equipment Life

In addition to using energy inefficiently, short cycling equipment on and off increases wear and tear on the equipment and increases maintenance costs.

De-humidification

In humid climates, one of the important roles played by air conditioning is pulling moisture out of the air. This needs time to occur.

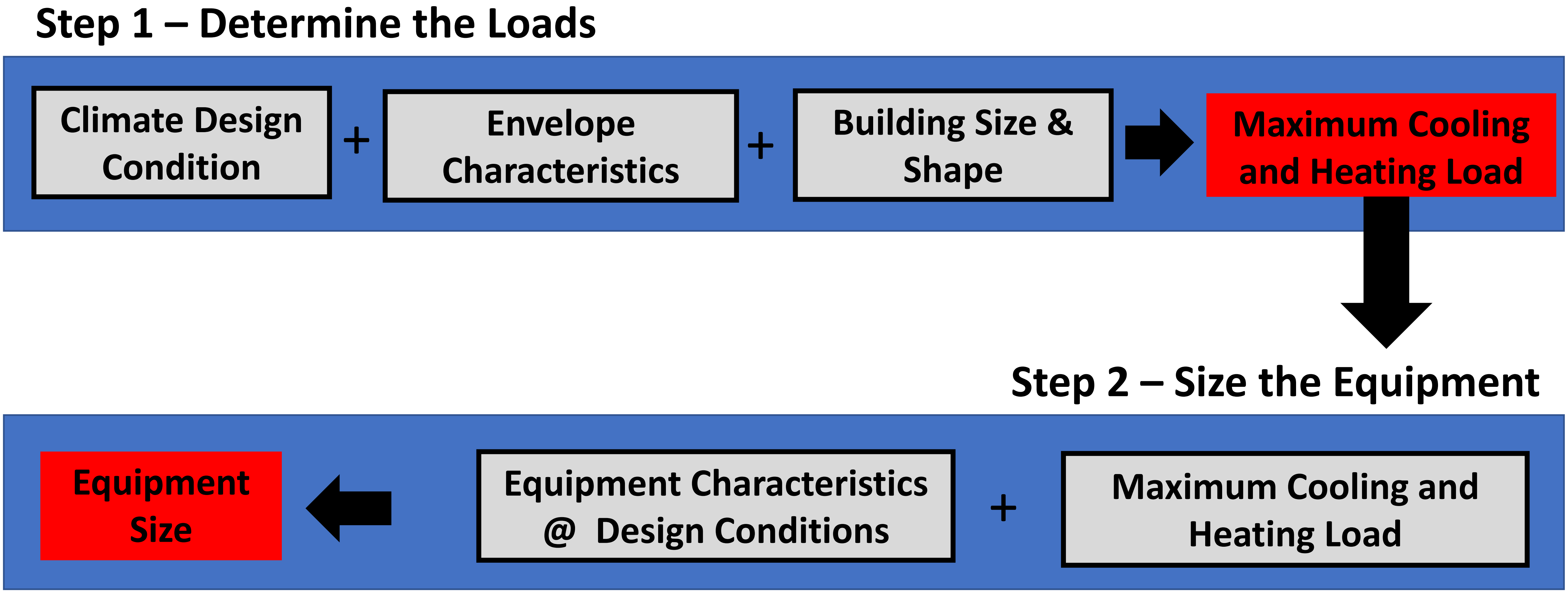
Electric Peak Demand

Oversized cooling equipment contributes to peak demand issues in the summer increasing costs for building owners and utility companies.

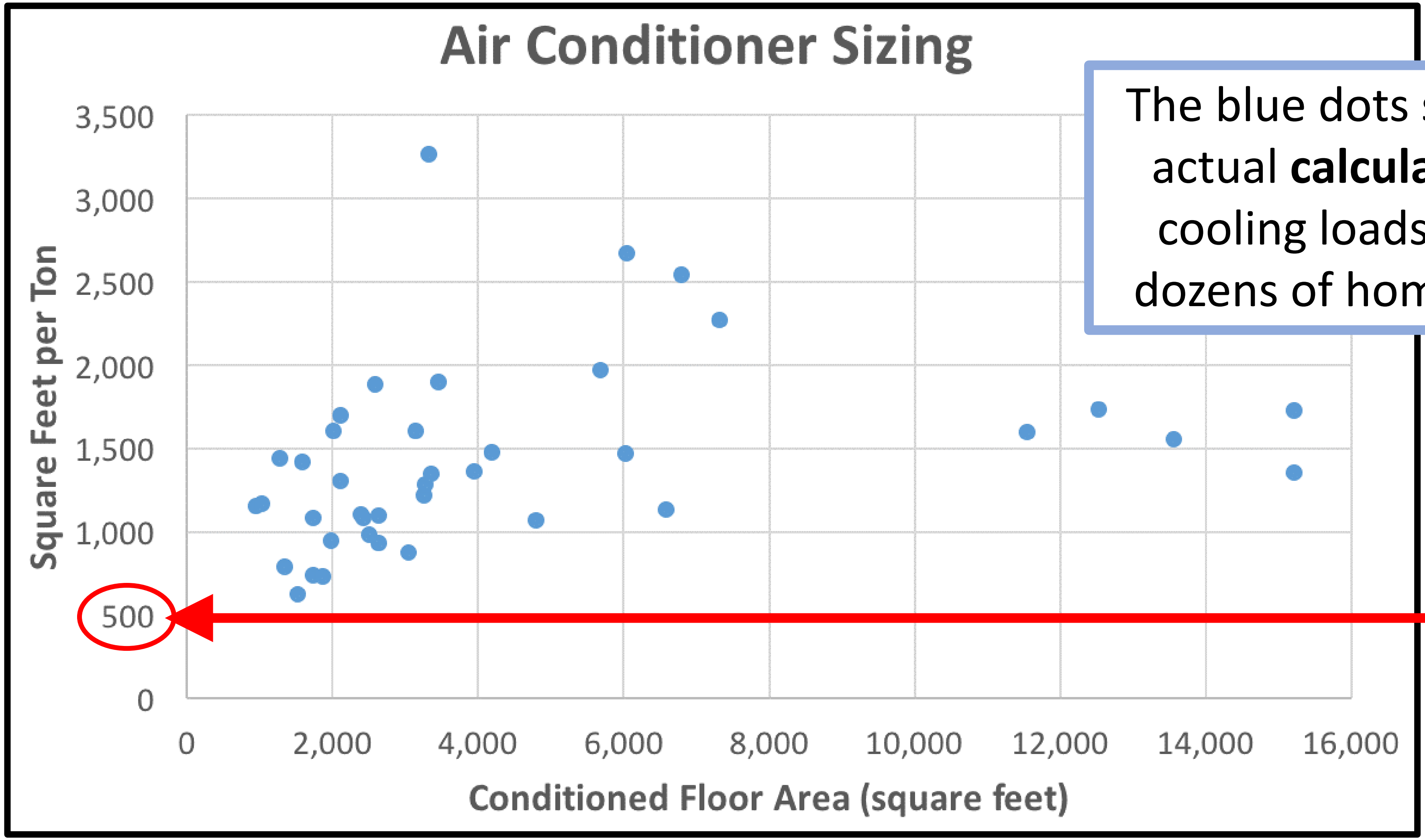
First Costs

Larger equipment is more expensive to purchase and install.

How is equipment sized correctly?



How is equipment incorrectly sized?



The blue dots show actual **calculated** cooling loads for dozens of homes.*

The traditional industry standard of 500 square feet per ton is inaccurate and massively over-sizes equipment.

standard practice

actually needed

note, images not to scale

https://www.energyvanguard.com/blog/air-conditioner-sizing-rules-of-thumb-must-die

Methods for sizing equipment

Less common

Manual

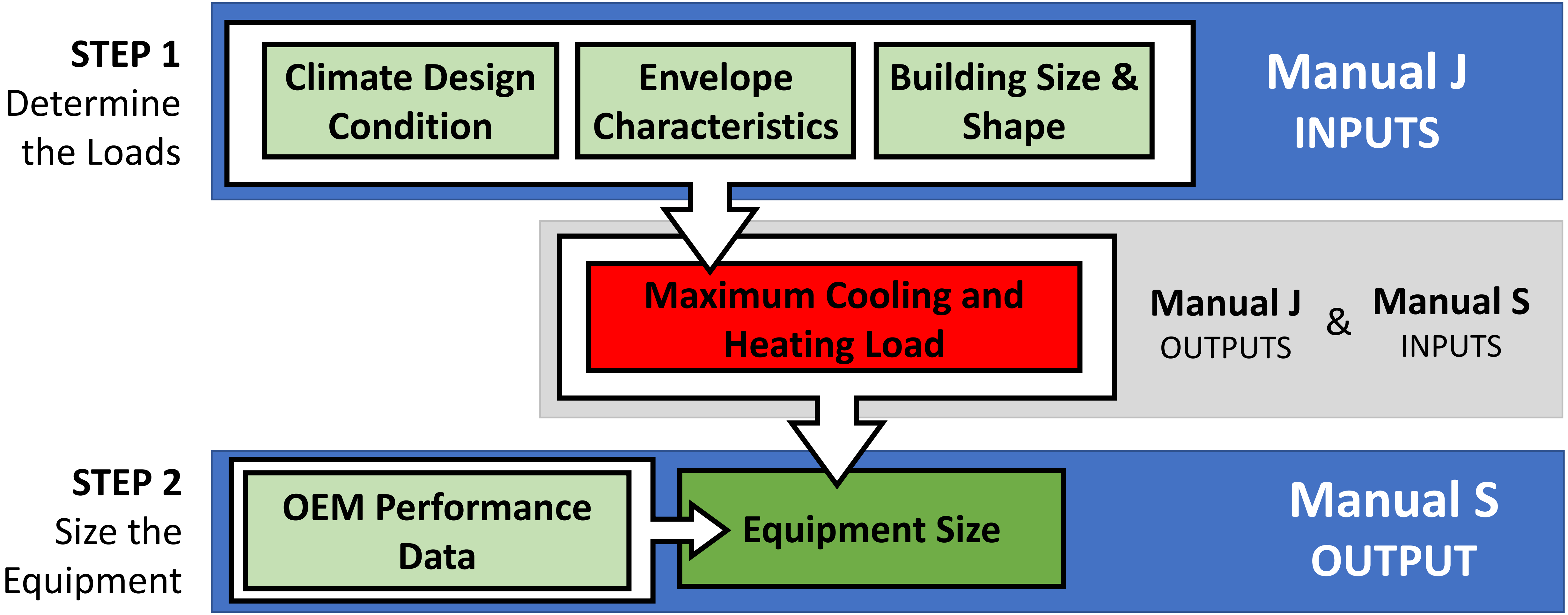
The Air Conditioning Contractors of America (ACCA) publishes Manuals that guide a designer through calculating the load and equipment size using tables and manual calculations. The ACCA Manuals J and S are most common, but equivalents can also be used as applicable.

More common

Software

Software programs allow the designer to input the required information and have the computer calculate the heating and cooling loads and equipment sizing.

The Manuals J and S are used to size residential mechanical equipment for IECC compliance.



Right sized equipment pays back!

Costs

- Reduced First Costs
- Lower Energy Costs
- Less Maintenance and Longer Equipment Life

Comfort

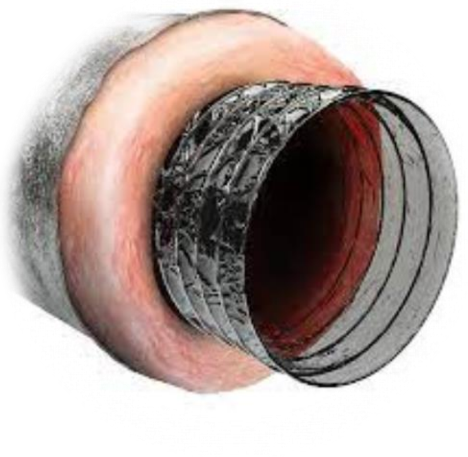
- Dehumidification
- Noise reduction
- Even temperatures
- Appropriate Air Circulation
- Indoor Air Quality

Sustainability

- Reduced Energy Use
- Minimize Peak Demand
- Increased Usable Life of Equipment

Section 6

Air Conditioning - Ducts



BEE Modules

10. Duct Design & Installation

- ➡ 10.1 Ductwork Fundamentals
- ➡ 10.2 Friction Loss
- ➡ 10.3 Air & Temperature Loss
- ➡ 10.4 Residential Duct Pressure Testing
- 10.5 Manual D Duct Sizing Calculation

Building Energy Education fundamentals

10.1 Ductwork Fundamentals

Module 10: Duct Design & Installation
Part 1

Objective: Describe fundamentals of ductwork energy and the effects of friction and air and temperature loss in ductwork.

10.1 Ductwork Fundamentals

Module 10: Duct Design & Installation
Part 1

Objective: Describe fundamentals of ductwork energy and the effects of friction and air and temperature loss in ductwork.

Types of system energy loss

Friction Loss

Friction inside ducts makes it harder to move air.

Fan energy is lost to overcome the friction of air against duct walls.

Temperature & Air Loss

Heat and air transfer out of ducts can waste heating and cooling energy.

Ducts often deliver air through unconditioned spaces so insulating and sealing is important.

https://www.energycodes.gov/sites/default/files/documents/cn_commercial_duct_insulation_sealing.pdf

https://www.nrel.gov/docs/fy12osti/5349.pdf

Factors impacting friction loss

Material & Length

Friction occurs all along the ductwork.

- ✓ **Reduce the roughness** with material selection and proper installation**.**
- ✓ **Reduce the length** to reduce the system friction loss.

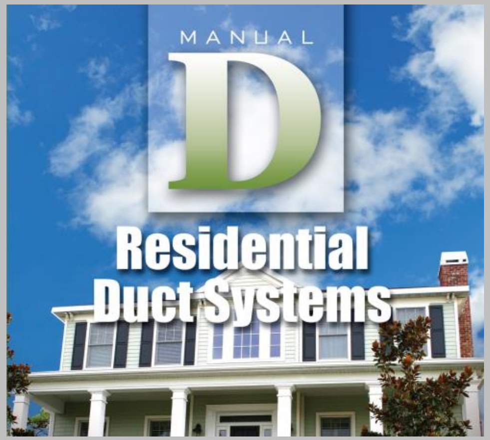
Layout & Bends

Fittings can increase friction by restricting airflow. Design to minimize friction loss.

Proper installation is also a factor!

Sizing

During design, appropriate sizing impacts energy by reducing excess friction and ensuring efficient equipment operation and appropriate airflow.



https://www.nrel.gov/docs/fy12osti/53494.pdf and ACCA

Factors impacting air and temperature loss

Seal

Seal ducts to minimize loss and comply with the IECC.
Air leaks waste heating, cooling, and fan energy while reducing comfort and equipment life.

Insulate

When ductwork passes through unconditioned spaces, it must be insulated to prevent heat transfer through the wall of the duct.

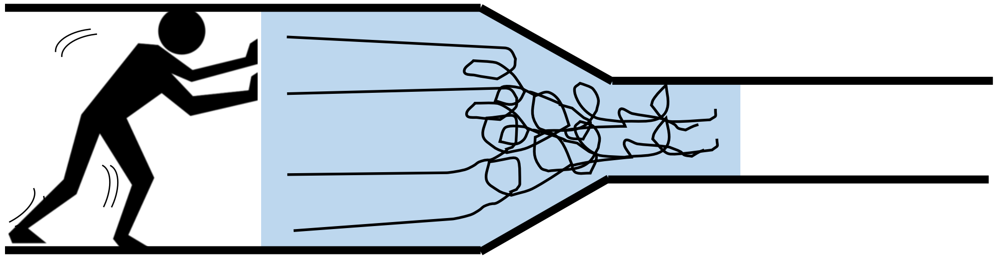
https://www.energy.gov/eere/buildings/ and www.basc.pnnl.gov

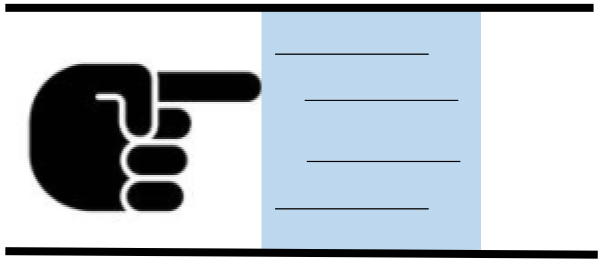
10.2 Friction Loss

Module 10: Duct Design & Installation
Part 2

Objective: Describe the sources of duct friction and importance of limiting friction in duct design & installation.

Friction loss causes – duct characteristics





MORE FRICTION LOSS	LESS FRICTION LOSS
Rougher duct textures	Smoother duct textures
Extra, unnecessary surface area (non-circular ducts, flex duct)	Appropriately sized ducts, shaped and fitted to minimize surface area within duct system
Undersized, restrictive ductwork, or ducts with tight bends	Ductwork with gentle bends or flow straightening where sharp bends are necessary
SUMMARY – Frictional resistance increases pressure and decreases flow.	**SUMMARY – The lower the frictional resistance, the higher the flow.**

TAKEAWAY – Make duct systems shorter and straighter whenever possible to minimize resistance and use round duct as much as possible.

Friction loss sources - fittings

MORE FRICTION LOSS	LESS FRICTION LOSS
More fittings = more resistance	fewer fittings = less resistance
More turns in fittings = more resistance	fewer turns in fittings = less resistance
Tighter bends = more resistance	Long radius bends = less resistance
SUMMARY – Adding excessive resistance by selecting tight bends causes more friction loss.	**SUMMARY – Reducing resistance by selecting long-radius bends causes less friction loss.**

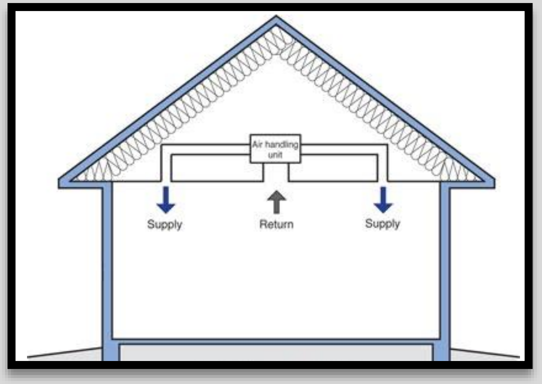
TAKEAWAY – Choose fittings that minimize air turbulence to minimize friction loss.

10.3 Air & Temperature Loss

Module 10: Duct Design & Installation
Part 3

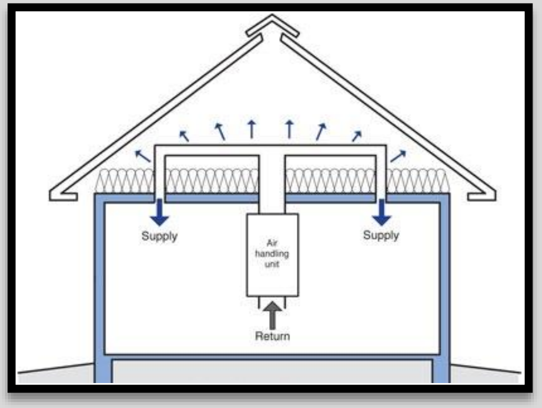
Objective: Explain causes of air and temperature loss, describe duct leakage testing methods, and summarize code requirements.

Duct location impacts on energy loss



Ducts in conditioned space

- Reduced conduction through duct wall to environment
- Less risk of drawing humidity/dust into return ducts
- Little to no risk of condensation causing moisture damage and air quality concerns
- Downsized ducts and mechanical systems due to reduced loss



Ducts in unconditioned space

- Increased conduction through duct walls to environment
- Long runs may lose ability to condition far spaces due to temperature loss/gain
- Ducts can condense water, leading to moisture and air quality problems.
- Can draw in contaminants such as dust, humidity, and fumes from unconditioned space into ducts.

Insulating ductwork

If ducts must be in unconditioned space – must insulate to reduce loss.

Crawlspaces are usually **humid**, and somewhere between ground temperature and outdoor air temperature.

Attics are usually **120-130°F** at peak summer temperatures and **humid**, or close to outdoor temperatures in winter.

Ducts can be wrapped in insulation or buried in attic/floor insulation to reduce loss.

- Important to **include air/vapor barrier** around duct insulation to prevent condensation risk.

Insulated crawlspace ducts.
https://www.energyvanguard.com/blog/the-invisible-problem-with-duct-insulation/

Buried attic ducts
https://www.greenbuildingadvisor.com/article/burying-ducts-in-attic-insulation

Duct leakage locations

Highest pressure parts of ductwork should be the focus: i.e., supply and return plenums near the air handler.

Openings in the air handler cabinet for piping, sensors, electrical, etc…

Any unsealed/ungasketed seams, except longitudinal seams on low-pressure (<2 in. w.g.) ducts.

Connecting boots to floor/ceiling vents

Ducts in unconditioned spaces

Methods for sealing properly

- UL-181 duct sealing tapes
- Paint on duct mastic
- Polyurethane caulking
- Gasketed duct joints
- Aerosol sealants

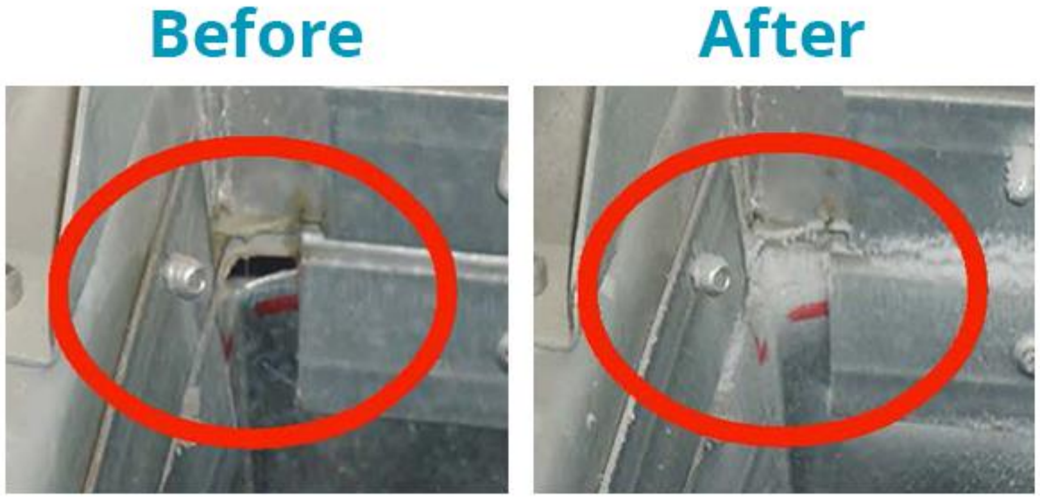


Image courtesy: www.aeroseal.com

https://www.greenbuildingadvisor.com/article/sealing-ducts-whats-better-tape-or-mastic

10.4 Residential Duct Pressure Testing

Module 10: Duct Design & Installation
Part 4

Objective: Describe duct leakage testing methods and code requirements.

Residential duct testing is required!

As noted in basics, if ducts are *outside* the conditioned envelope, must conduct a total leakage test.

Energy Code Requires Leakage Testing for Residential Ducts

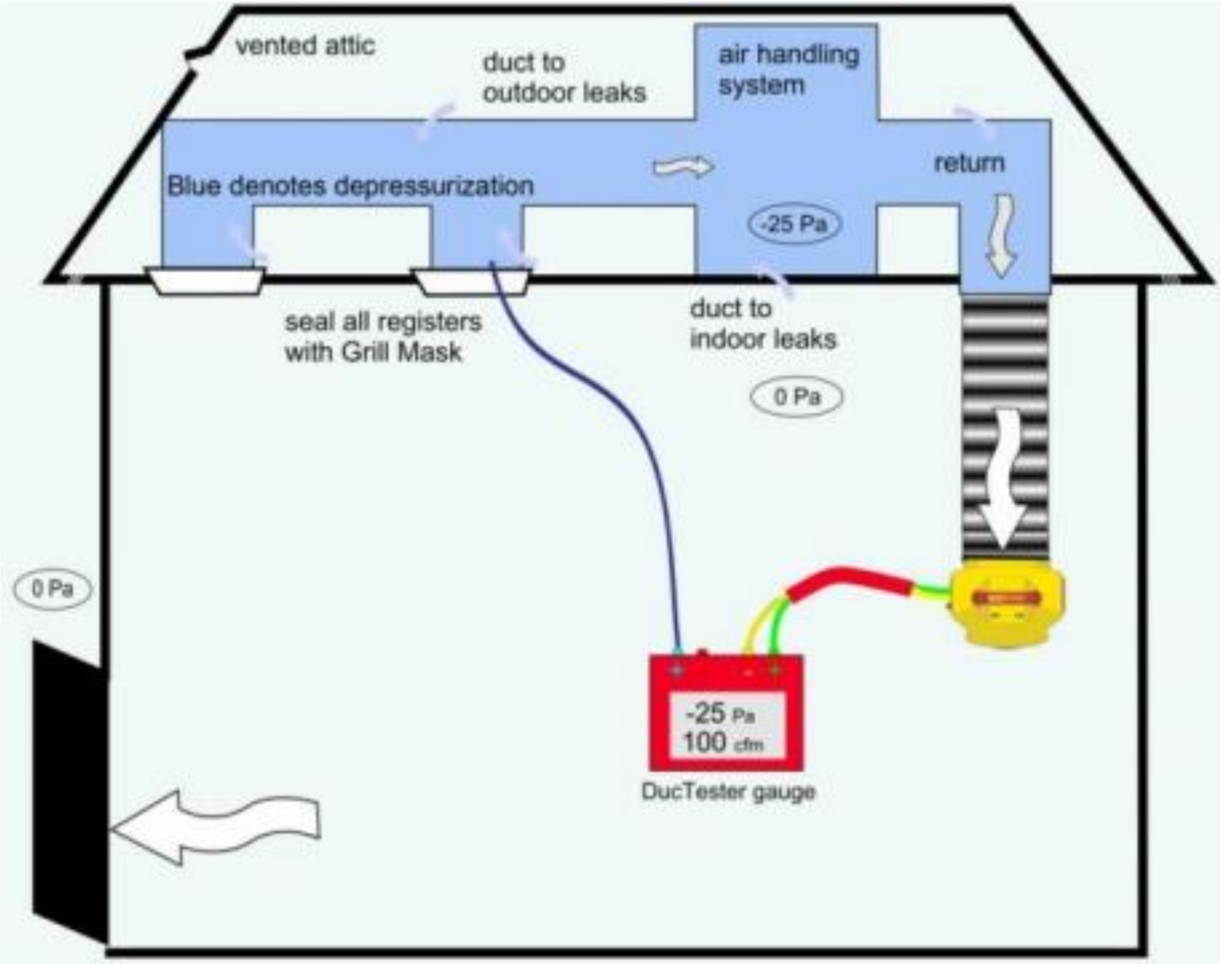
2018 IECC and ASHRAE 90.1 require duct leakage <4 cfm/100 sf floor area if furnace installed at time of test, or <3 cfm/100 sf of floor area if furnace is not installed.

Leakage to outdoor test can be used to comply if ducts are buried in attic insulation.

Total loss and loss to outdoors tests are also used in Home Energy Rating System (HERS) score, a common home efficiency rating program.

Set-up for total leakage test

1. Locate and seal all supply and return vents in home.
   - If conditioned crawl, there are likely vents hiding in that space!
2. Open a door or window of house so interior pressure is balanced with outdoor pressure.
   - Test will obtain an incorrect value if interior of the home is at different pressure than attic/crawl with ducts.
3. Connect calibrated fan with gauges to duct system
   - Best to depressurize to ensure seals stay in place!



Example: duct total leakage test

Section 7

Hawaii Energy – Water Heating

Hawaiʻi Energy

Heat Pump Water Heaters, HVAC & Air Quality

Justin Bizer

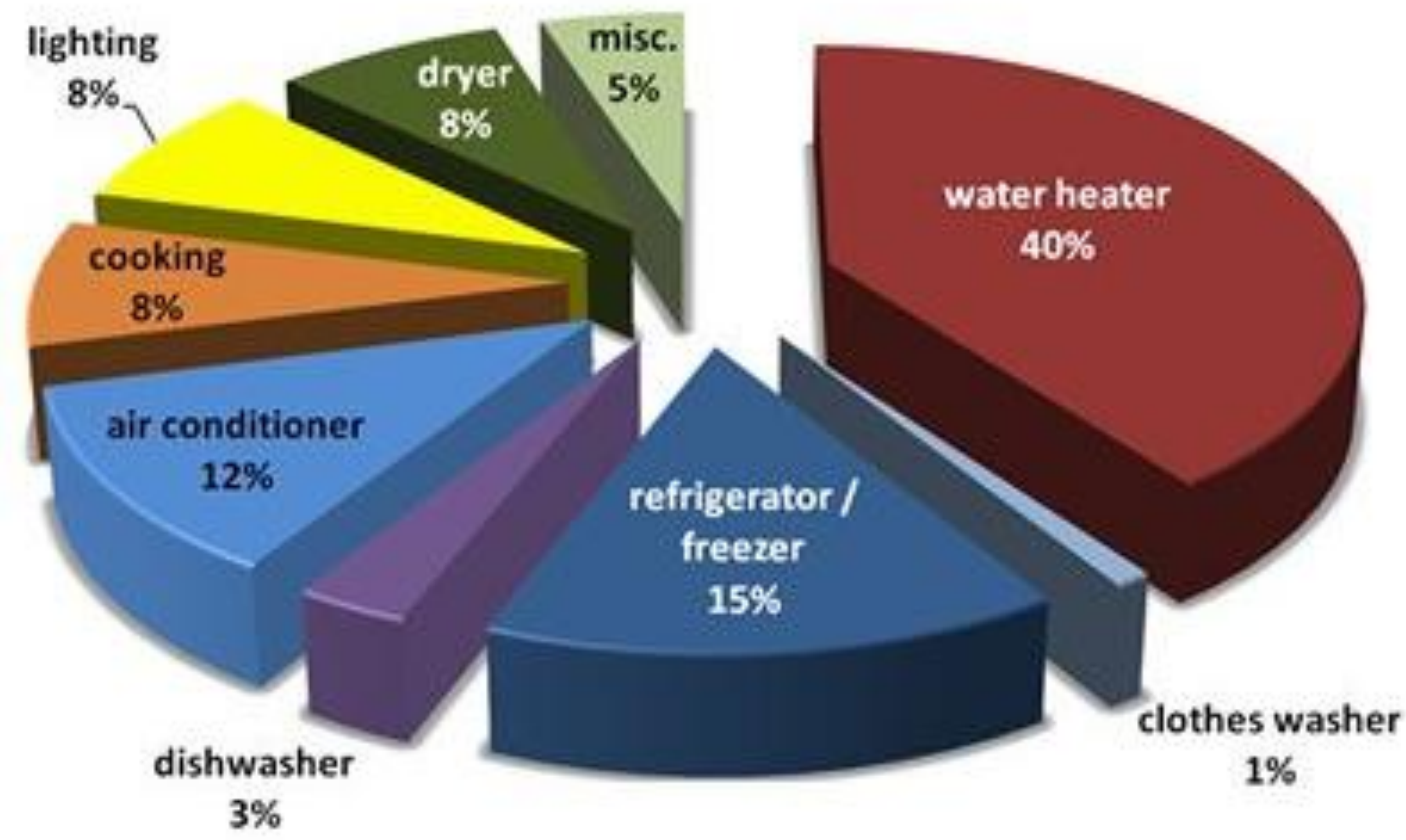
Affordability & Accessibility Program Specialist

Residential Programs Overview

(New & Existing)
COMMUNITY-BASED
ENERGY EFFICIENCY

Typical Electrical Energy Demand

Hawaii Households With Electric Water Heating



Household of Four Persons

Source:
Hawaiian Electric

Local Factors

Average Price of Electricity

U.S. average retail price per kWh is 10.48 cents per kWh

Source: U.S. Energy Information Administration (eia.gov)

11¢

Hawai'i's electricity prices are *more than double* the U.S. average

Source: energy.Hawaii.gov

Oah'u 31¢ — Maui, Hawai'i, Moloka'i — Lana'i 42¢

"R" Residential Rate Schedule ranges from 31 cents per kWh (O'ahu) to 42 cents per kWh (Lana'i)

Source: Hawaiian Electric

Electric Water Heating

Nationwide

18%

- 'water heating accounts for about 18% of a home's energy use.'

Source: energy.gov

Hawai'i

40%

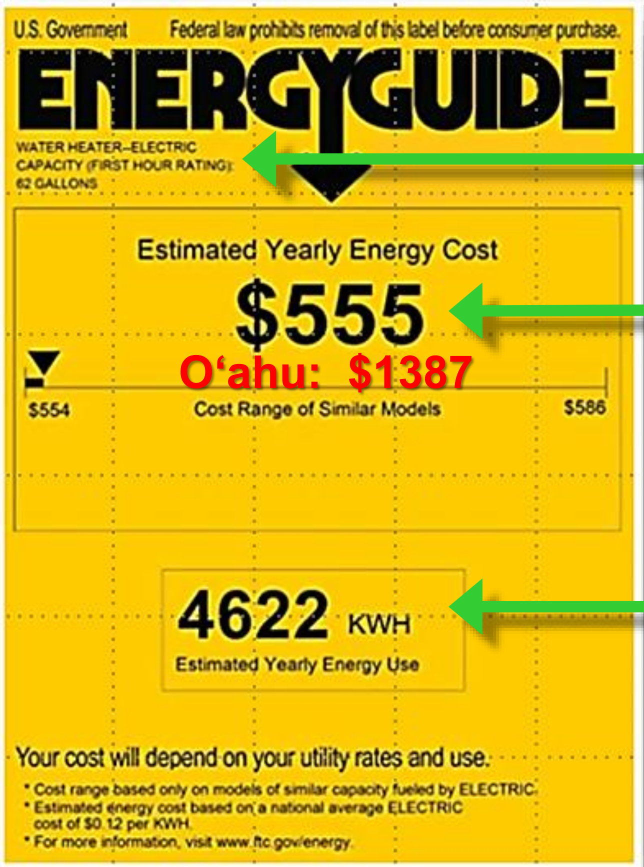
- Locally, electric water heating demand can be as much as 40% of electricity use for homes.

Source: dashboard.Hawaii.gov

Household Energy Demand

Estimated Savings Comparison

Electric Resistance WH



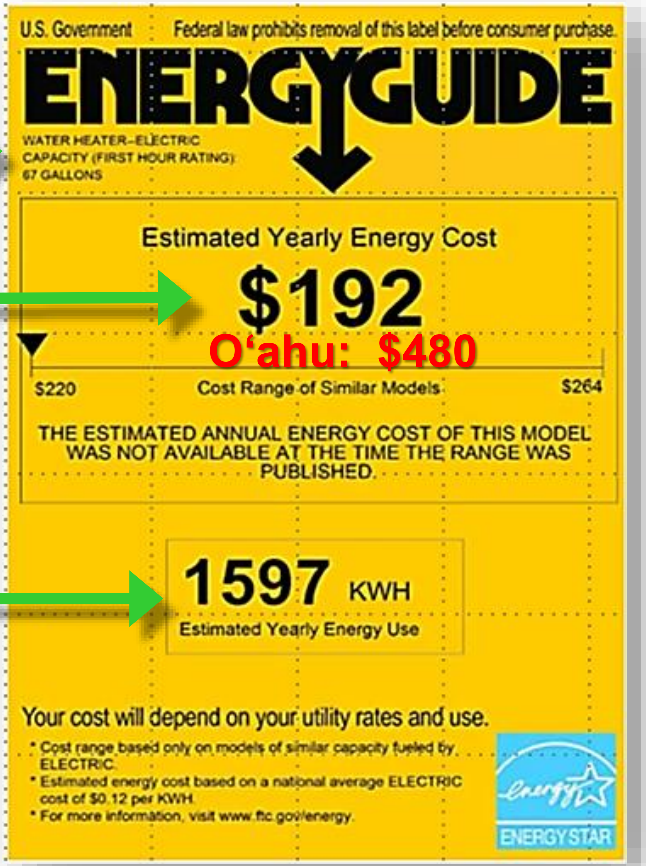
similar tank capacities

annual operating cost based on $0.12/kWh

"Heat pump water heaters can use up to ***63% less energy*** *than traditional electric water heaters"*

-- Sarah Widder
U.S. Department of Energy,
Pacific Northwest National Laboratory.

Heat Pump WH



Average Water Heating Cost in Hawaii



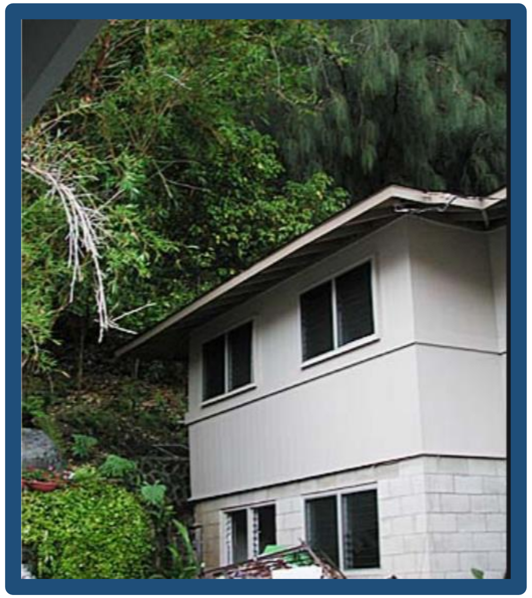


Water Heater Type	Heat Pump	Tankless Gas	Tankless Electric	Tank Electric	Tank Gas
Efficiency	4	0.93	0.99	0.93	0.58
Annual Operational Cost	**$190**	**$420**	**$768**	**$817**	**$674**

Electric Rate	$0.310	per kwh	
Gas Rate	$4.670	per therm	
Gallons Per Day	64	**64 gal per day is National Avg.*	
Desired Temperature	120		
Incoming Ground Water	77		

Heat Pump Technology: A Viable Water Heating Option

- Consider heat pump technology as an alternative to solar thermal water heaters:
  - ✓ When exposure to sunlight is limited



Nu'uanu, Oahu

<< Examples >>

Waimanalo, southeast Oahu

Heat Pump Technology: A Practical Water Heating Solution

- Consider heat pump technology as an alternative to solar thermal water heaters:
  - When rooftop location is subject to shading or limited sunshine
    - Example: Neighboring tall buildings or high trees/shrubbery

Heat Pump Technology: A Logical Choice

- Consider heat pump technology as an alternative to solar thermal water heaters:
  - When rooftop location is subject to shading or limited sunshine

✓ Homes in deep interior valleys

Example: Kalihi Valley

Heat Pump Technology: A Practical Water Heating Solution

- Consider heat pump technology as an alternative to solar thermal water heaters:
  - ✓ In situations where roof type not conducive for situating solar collector panels

Examples:

tile roofs

'older' roofs

Recent Custom, Direct-Install Project

The Project	
Who:	Hawaii Agricultural Research Center (HARC)
Where:	Kunia Village, central Oah‘u
What:	Affordable rental housing, 501(c)(3) Non-Profit, Residents pay no more than 30% of Household Income.

Scope:

Direct-Installation of 43 HPWHs for renovated or new construction SFRs, FULLY-FUNDED by Hawai‘i Energy

Customized, Direct-Install Residential Projects

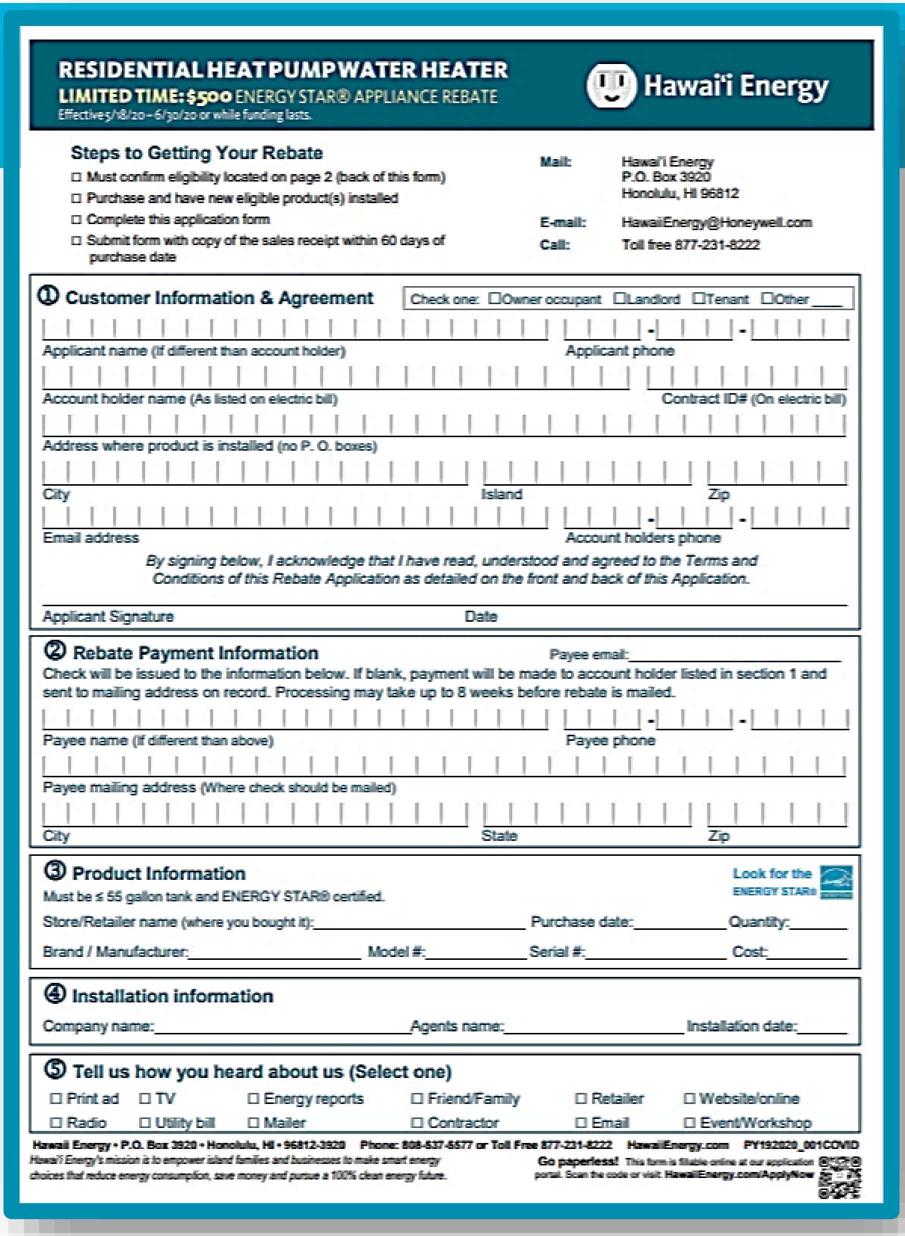
For retrofit projects at eligible properties:

- Direct-installation custom projects possibilities available for affordable residential communities.
- Major factors include projected energy savings.
- Projects are evaluated on a case-by-case basis and must be pre-approved by Hawaiʻi Energy.
- Contact the Residential Team at HawaiiEnergy@Honeywell.com on how we may be able to subsidize a project for your property and for eligibility information.

Residential Consumer Incentive

Retail Purchase = $500 Rebate

- ❑ Confirm product eligibility at:
  - EnergyStar.gov/PRODUCTFINDER
  - ENERGY STAR certified
  - Less than 55 gallon capacity
- ❑ Purchase & install new eligible water heater
- ❑ Customer applies for rebate*
  - Online or,
  - Downloadable application
- ❑ Within 60 days of purchase date:
  - Submit application and receipt (copy)



RESIDENTIAL HEAT PUMP WATER HEATER
LIMITED TIME: $500 ENERGY STAR® APPLIANCE REBATE
Effective 5/18/20 – 6/30/20 or while funding lasts.

Hawai'i Energy

Steps to Getting Your Rebate
- ☐ Must confirm eligibility located on page 2 (back of this form)
- ☐ Purchase and have new eligible product(s) installed
- ☐ Complete this application form
- ☐ Submit form with copy of the sales receipt within 60 days of purchase date

Mail: Hawai'i Energy, P.O. Box 3920, Honolulu, HI 96812
E-mail: HawaiiEnergy@Honeywell.com
Call: Toll free 877-231-8222

① Customer Information & Agreement Check one: ☐Owner occupant ☐Landlord ☐Tenant ☐Other ____

Applicant name (If different than account holder) | Applicant phone
Account holder name (As listed on electric bill) | Contract ID# (On electric bill)
Address where product is installed (no P. O. boxes)
City | Island | Zip
Email address | Account holders phone

By signing below, I acknowledge that I have read, understood and agreed to the Terms and Conditions of this Rebate Application as detailed on the front and back of this Application.

Applicant Signature | Date

② Rebate Payment Information Payee email: ____

Check will be issued to the information below. If blank, payment will be made to account holder listed in section 1 and sent to mailing address on record. Processing may take up to 8 weeks before rebate is mailed.

Payee name (If different than above) | Payee phone
Payee mailing address (Where check should be mailed)
City | State | Zip

③ Product Information Look for the ENERGY STAR®

Must be ≤ 55 gallon tank and ENERGY STAR® certified.

Store/Retailer name (where you bought it): ____ Purchase date: ____ Quantity: ____
Brand / Manufacturer: ____ Model #: ____ Serial #: ____ Cost: ____

④ Installation information

Company name: ____ Agents name: ____ Installation date: ____

⑤ Tell us how you heard about us (Select one)

☐ Print ad ☐ TV ☐ Energy reports ☐ Friend/Family ☐ Retailer ☐ Website/online
☐ Radio ☐ Utility bill ☐ Mailer ☐ Contractor ☐ Email ☐ Event/Workshop

Hawaii Energy • P.O. Box 3920 • Honolulu, HI • 96812-3920 Phone: 808-537-5577 or Toll Free 877-231-8222 HawaiiEnergy.com PY192020_001COVID
Hawai'i Energy's mission is to empower island families and businesses to make smart energy choices that reduce energy consumption, save money and pursue a 100% clean energy future.
Go paperless! This form is fillable online at our application portal. Scan the code or visit HawaiiEnergy.com/ApplyNow

https://hawaiienergy.com/for-homes/water-heating/heat-pump

HVAC & AIR QUALITY REBATES

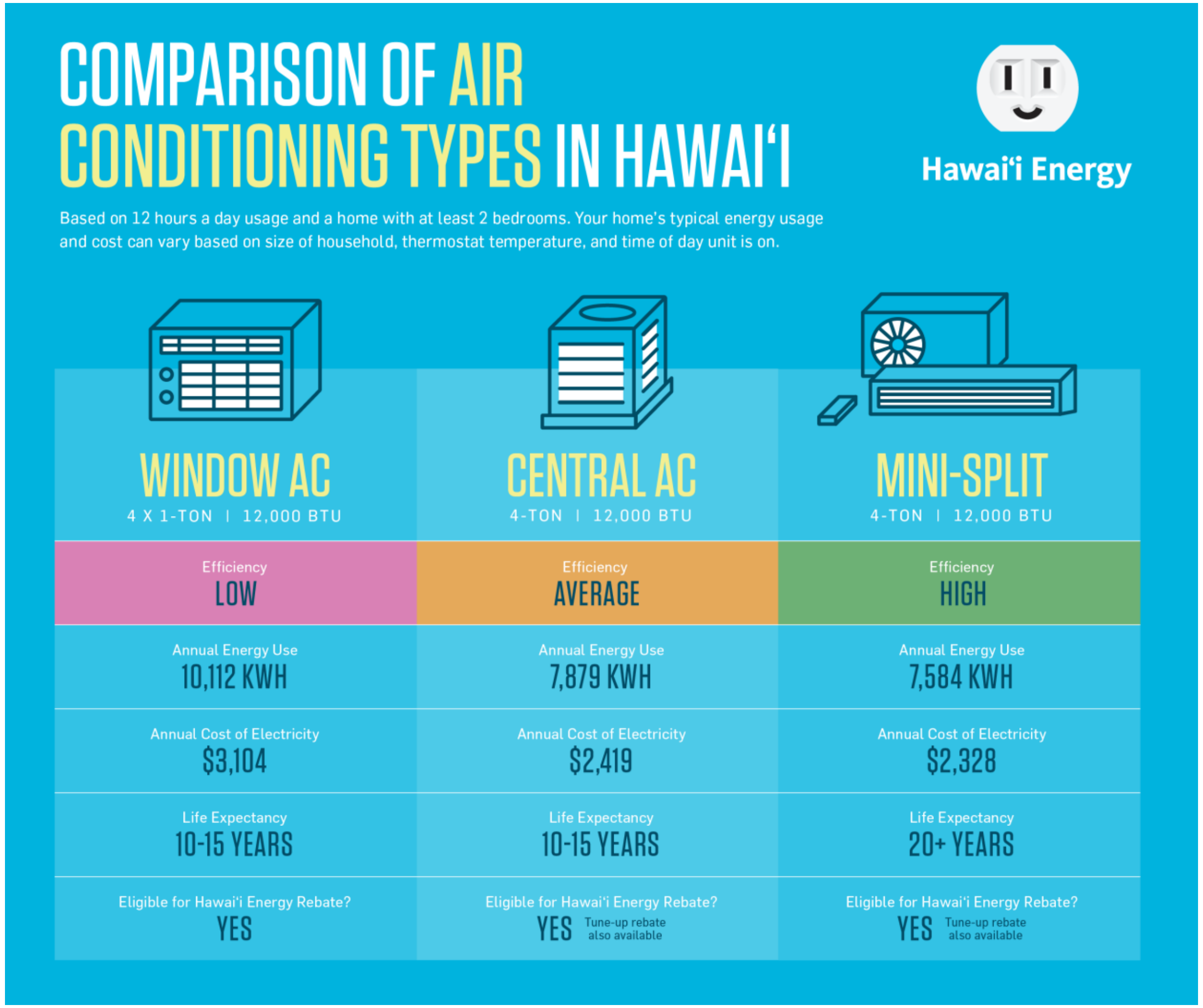
Window Air Conditioner — UP TO $45 INSTANT REBATE

Air Conditioner Tune-Up — $75 INSTANT REBATE

Central Air Conditioner Retrofit — $750 INSTANT

Mini-Split VRF Air Conditioner — UP TO $350 INSTANT

UNITY CAPACITY BY BTU	SEER	REBATE
≥8,000 BTU to <20,000 BTU	18	$250
≥14,000 BTU to <20,000 BTU	16	$200
≥20,000 BTU to <30,000 BTU	16	$250
≥20,000 BTU to <30,000 BTU	18	$300
≥30,000 BTU to <65,000 BTU	18	$350



HVAC & AIR QUALITY REBATES

Solar Attic Fan $50 REBATE

A solar attic fan uses the power of the sun to cool hot attics by drawing in cooler outside air from attic vents (soffit and gable) and pushing hot air to the outside. It can also cool your roof and reduce the load on your air conditioning system saving energy. Get a rebate when you purchase a qualifying solar attic fan model.

Whole House Fan $75 REBATE

A whole house fan draws cooler, outside air through your living space by pushing the hot air out of the home and out of the attic vents, creating a cooling breeze and using less energy than air conditioners. Get a rebate when you purchase a qualifying model. For more information about whole house fans, click here.

Room Air Purifiers and Cleaners

ENERGY STAR® certified room air purifiers are 40% more energy-efficient than standard models, saving consumers about 225 kWh/year, that's up to $30 annually on utility bills. These savings could add up to $220 over its lifetime! Look for the ENERGY STAR logo on products at your local retailers for models with the best savings.

AMERICAN LUNG ASSOCIATION® IN HAWAII

HVAC & AIR QUALITY REBATES

AMERICAN LUNG ASSOCIATION IN HAWAII

Hawai'i Energy

Our Mission: To save lives by improving lung health and preventing lung disease.

Our Vision: A world free of lung disease.

Our Strategic Imperatives:

- Defeat lung cancer.
- Champion clean air for all.
- Improve the quality of life for those with lung disease and their families.
- Create a tobacco-free future.

TOTAL UNITS: <u>50 x WINIX A230 AIR PURIFIERS</u>

ESTIMATED LIFETIME SAVINGS: <u>175,725 (kWh)</u>

COST TO AMERICAN LUNG ASSOCIATION: <u>$0.00</u>

MAHALO!

Justin Bizer

Residential New Construction and A&A Program Specialist

Justin.V.Bizer@leidos.com | 808-848-8534

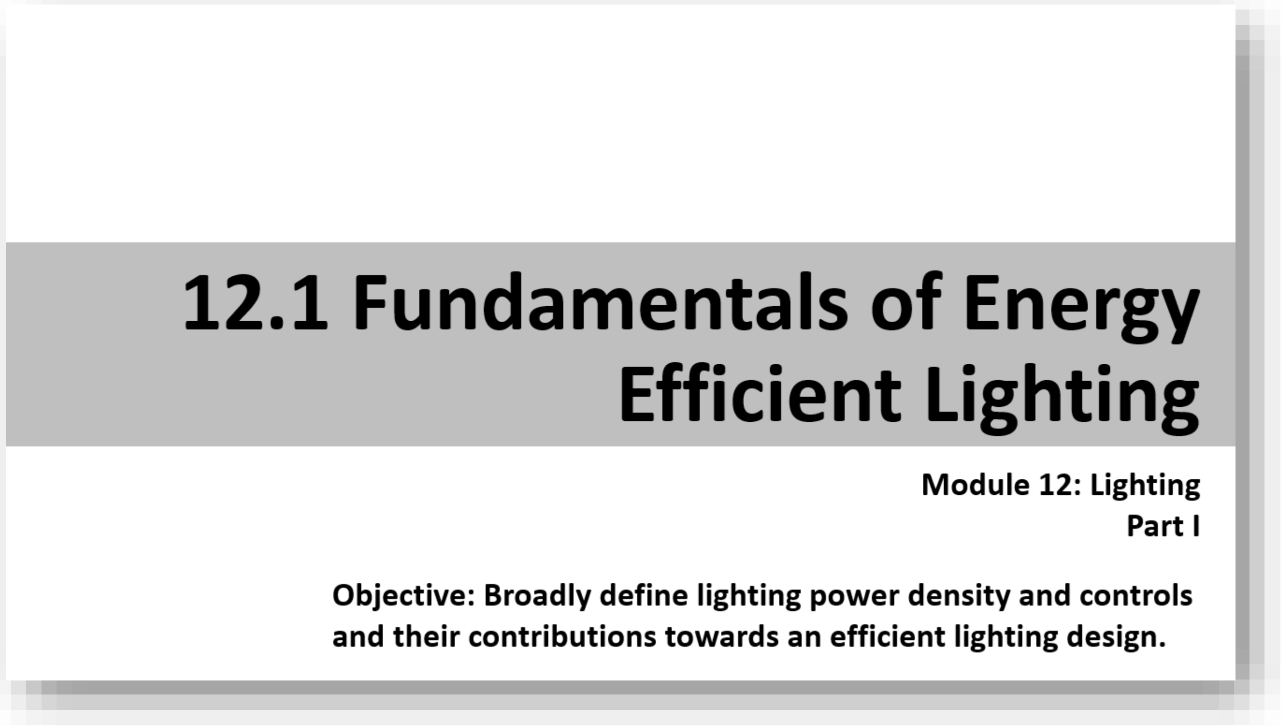
Section 8
Lighting

BEE Modules

12. Lighting

- 12.1 Fundamentals of Energy Efficient Lighting
- 12.2 Lighting Power Density
- 12.3 Lighting Controls

Building Energy Education fundamentals



12.1 Fundamentals of Energy Efficient Lighting

Module 12: Lighting
Part I

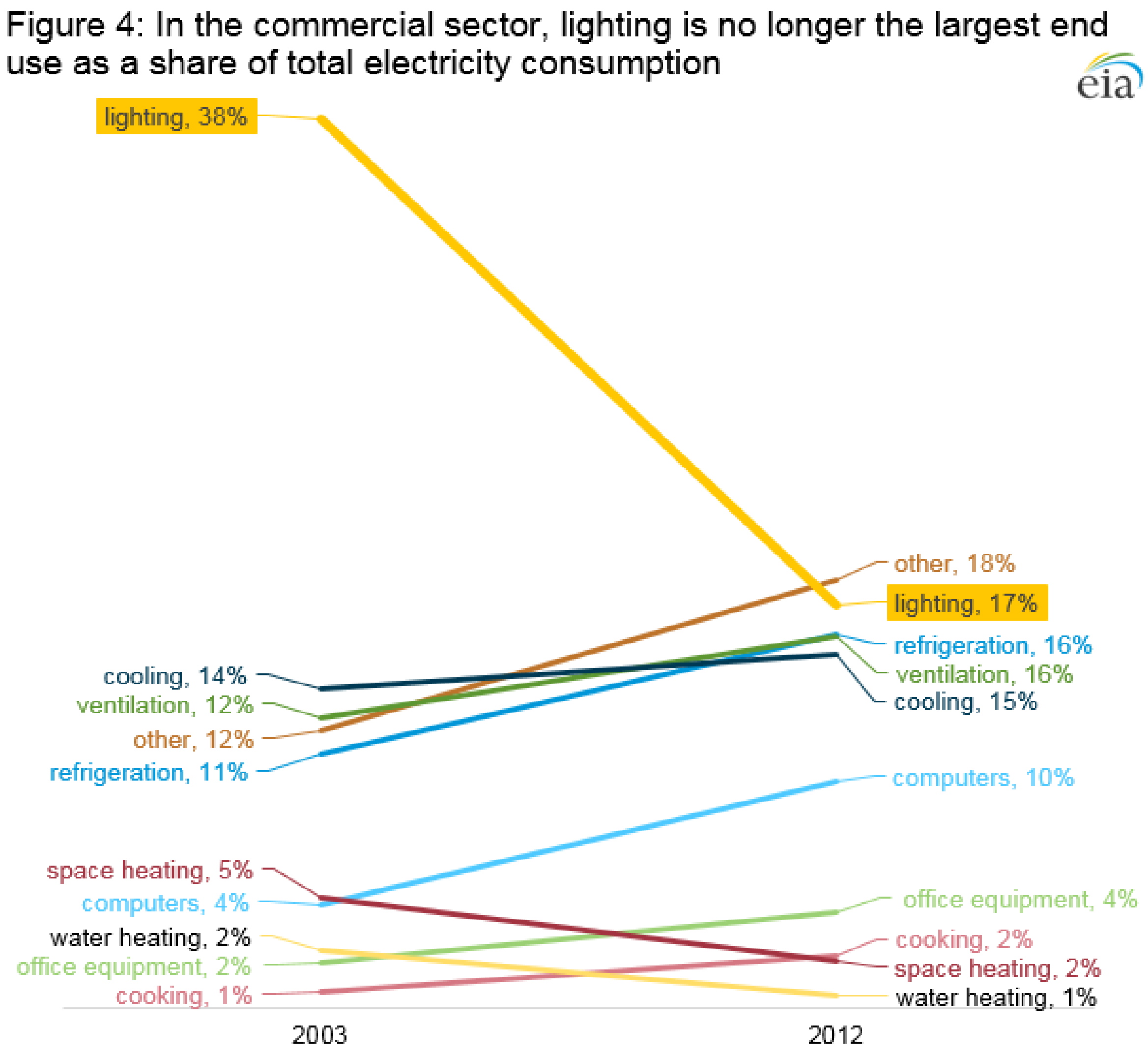
Objective: Broadly define lighting power density and controls and their contributions towards an efficient lighting design.

12.1 Fundamentals of Energy Efficient Lighting

Module 12: Lighting
Part I

Objective: Broadly define lighting power density and controls and their contributions towards an efficient lighting design.

Why is energy efficient lighting important?



Lighting efficiency has greatly improved but still makes up a significant share in **electricity** use.

https://www.eia.gov/consumption/commercial/

3 Components for efficient lighting:
1) Illuminance level

Appropriate light level is key

Provide the appropriate amount of light needed for tasks and occupants. For reference to appropriate illuminance level, refer to the Illuminating Engineering Society (IES) recommendations.

About 30fc of Illuminance level is recommended for offices.

3 Components for efficient lighting:
1) Illuminance level

Recommended Illuminance

- **10-20 foot-candles:** Working spaces where visual tasks are only occasionally performed
- **20-50 foot-candles:** Performance of visual tasks of high contrast or large size
- **50-100 foot-candles:** Performance of visual tasks of medium contrast or small size

https://unsplash.com/photos/HAwA1N2gjo8; https://waypointlighting.com/uploads/2/6/8/4/26847904/ies_recommended_light_levels.pdf

3 Components for efficient lighting:
1) Illuminance level

Lumens

The amount of light produced by a source

Target **Illuminance** (Foot-candles) =

$$\frac{\text{Lumens}}{\text{Square Feet}}$$

Square Feet

Where the task will be performed

3 Components for efficient lighting:
2) Efficient lighting technologies

Use high-efficacy (Lumen/Watt) lamps and high efficiency fixtures.

LED lamps use less power (9W) to produce the same lumens with 43W halogen lamps.

https://basc.pnnl.gov/resource-guides/high-efficacy-lighting#edit-group-description

3 Components for efficient lighting:
3) Proper controls

Control lighting to be on only when it is necessary and dim electric lights when daylight is available.

An example of Luminaire Level Lighting Controls

https://www.bpa.gov/EE/Technology/EE-emerging-technologies/Projects-Reports-Archives/Pages/Easily-commissioned-Lighting-Controls-.aspx

12.2 Lighting Power Density (LPD)

Module 12: Lighting
Part 2

Objective: Calculate the allowable lighting power budget for a commercial building and explain why lighting power density is important and how it can be reduced.

What is the building area method?

- LPD is determined by using each appropriate building area type per the energy code.

(2018 IECC)

Building Area Type	LPD (w/ft^2)
Hospital	1.05
Library	0.78
Office	0.79
Religious Building	0.94
Warehouse	0.48

Calculating the lighting power allowance using the Building Area Method is simpler compared to the Space-by-space Method.

What is the space-by-space method?

- LPD is determined by using each appropriate space type per the energy code.

(2018 IECC)

Space Type (healthcare)	LPD (w/ft^2)
Exam room	1.68
Imaging room	1.06
Medical supply	0.54
Operating room	2.17
Patient room	0.62

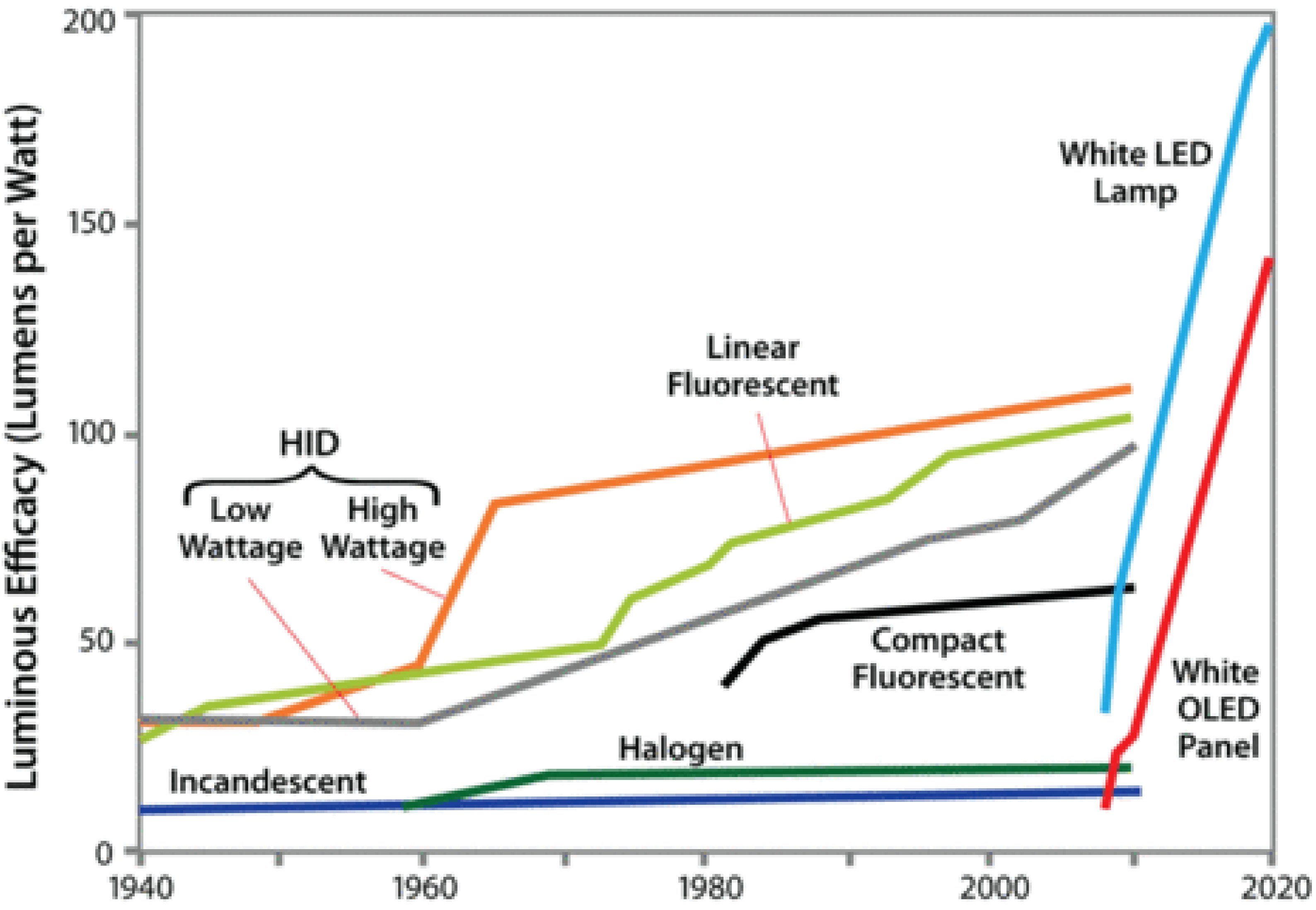
Calculating lighting power allowance using the Space-by-space Method is complicated, but flexible compared to the Building Area Method.
In general, the Space-by-space Method might allow slightly higher lighting power allowance.

Provide light as efficiently as possible

Incandescent = 800 Lumens/ **60 watts**

LED = 800 Lumens/ **9 watts**

Daylight = **infinite** Lumens/watt



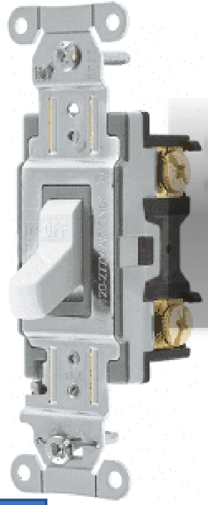
12.3 Lighting Controls

Module 12: Lighting
Part 3

Objective: Identify different lighting control techniques, describe the similarities and differences between occupant controls and daylight controls, and identify the applicable code requirements.

What makes an efficient lighting design?

First, reduce the LPD, and then **Utilize Controls.**



Switches & Dimmers

Daylight Sensor

Controls

Turn Off or Dim Lights When Not Needed

Occupant Sensors

Timers

Digital Lighting Control

Lighting controls in energy code

3 Controls Types

1. Occupant Controls

OR

2. Timers and Manual Controls

AND

3. Daylight Controls

Are occupants present to benefit from the electric light?

Is light present without additional electric light?

Occupancy sensor control technologies

- Passive Infrared Sensor (PIR) – picks up heat patterns – *good for areas with a direct line of sight*
- Ultrasonic Sensor (US) – uses ultrasonic monitoring to detect motion – *work without a line of sight*
- Dual-technology Sensor (DT) – integrates both PIR and US – reduces *false tripping*

http://lightingcontrolsassociation.org/2011/11/16/lighting-controls-association-updates-occupancy-sensor-course/

Applications for occupancy controls

Occupancy (vacancy) Controls Required Spaces (2018 IECC)

- Classrooms/lecture/training rooms
- Conference/meeting/multi-purpose rooms
- Copy/print rooms
- Lounges/breakrooms
- Enclosed offices
- Open plan offices*
- Restrooms
- Storage rooms
- Locker rooms
- Other spaces 300 sf or less
- Warehouse storage areas*

Time-switch control technologies

- A time switch (also called a timer switch, or timer) is a timer that operates electric lighting controlled by the timing mechanism.

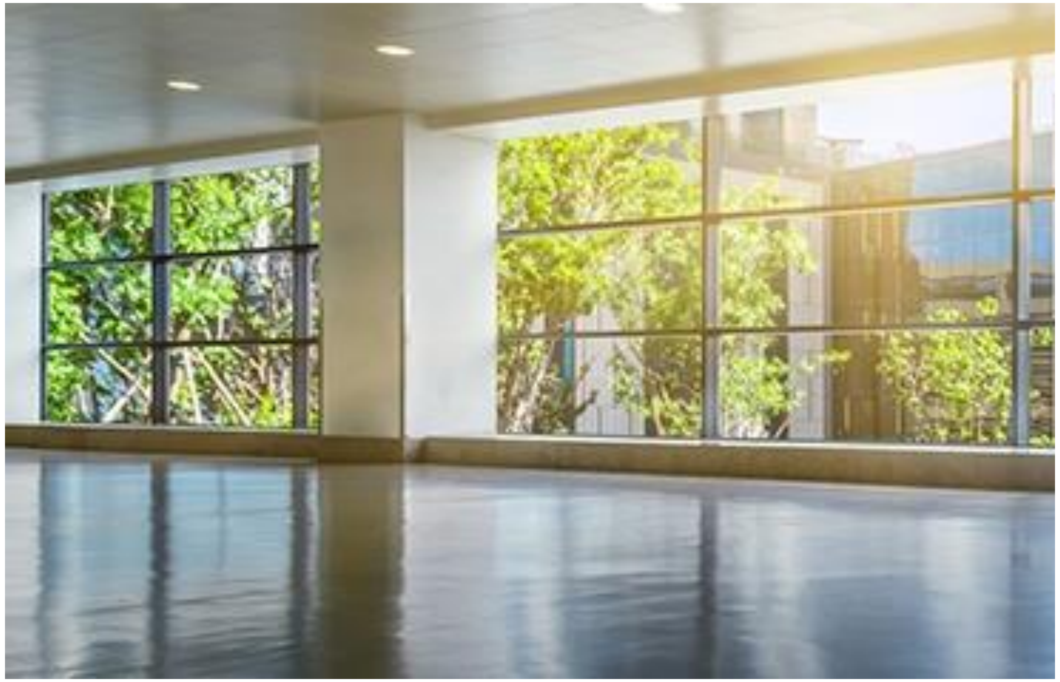
- Astronomical timers calculate dawn and dusk times for each day of the year based on location, which are typically used for exterior lighting.

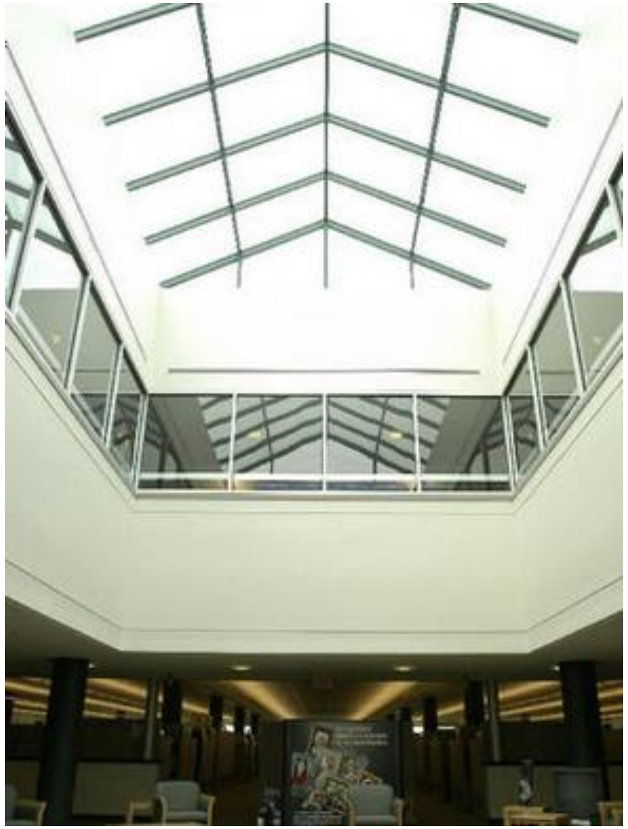
Applications for time-switch controls

Time-switch Controls Required Spaces (2018 IECC)

- Spaces that are ***not*** equipped with occupant sensors.
- Time switches areas must ***also*** have manual controls
- Exceptions: (these must have Manual Lighting Controls):
    1. Spaces where patient care is directly provided
    2. Spaces where an automatic shutoff would endanger occupant safety or security
    3. Lighting intended for continuous operation
    4. Shop and laboratory classrooms

Daylight areas





Areas adjacent to significant windows (Sidelit Zones) and skylights (Toplit Zones) are identified as **daylighting zones** in the energy code.

https://windows.lbl.gov/daylight-systems

Lighting (R404.1)

High efficacy
≥ 90% of lamps

Lamp Wattage	Efficacy (lumens/watt)
> 40 watts	60
15-40 watts	50
< 15 watts	40

High efficacy examples

Compact fluorescent

Source: DOE/NREL PIX17458

Full-size fluorescent

Source: DOE/NREL PIX20307

LED

Section 9

Wrap Up

Q&A

Howard Wiig, State Energy Office

Erik Kolderup, Kolderup Consulting

Justin Bizer, Hawaii Energy

Zippy's gift cards

Hawaiʻi Energy

https://www.zippys.com/

Now online

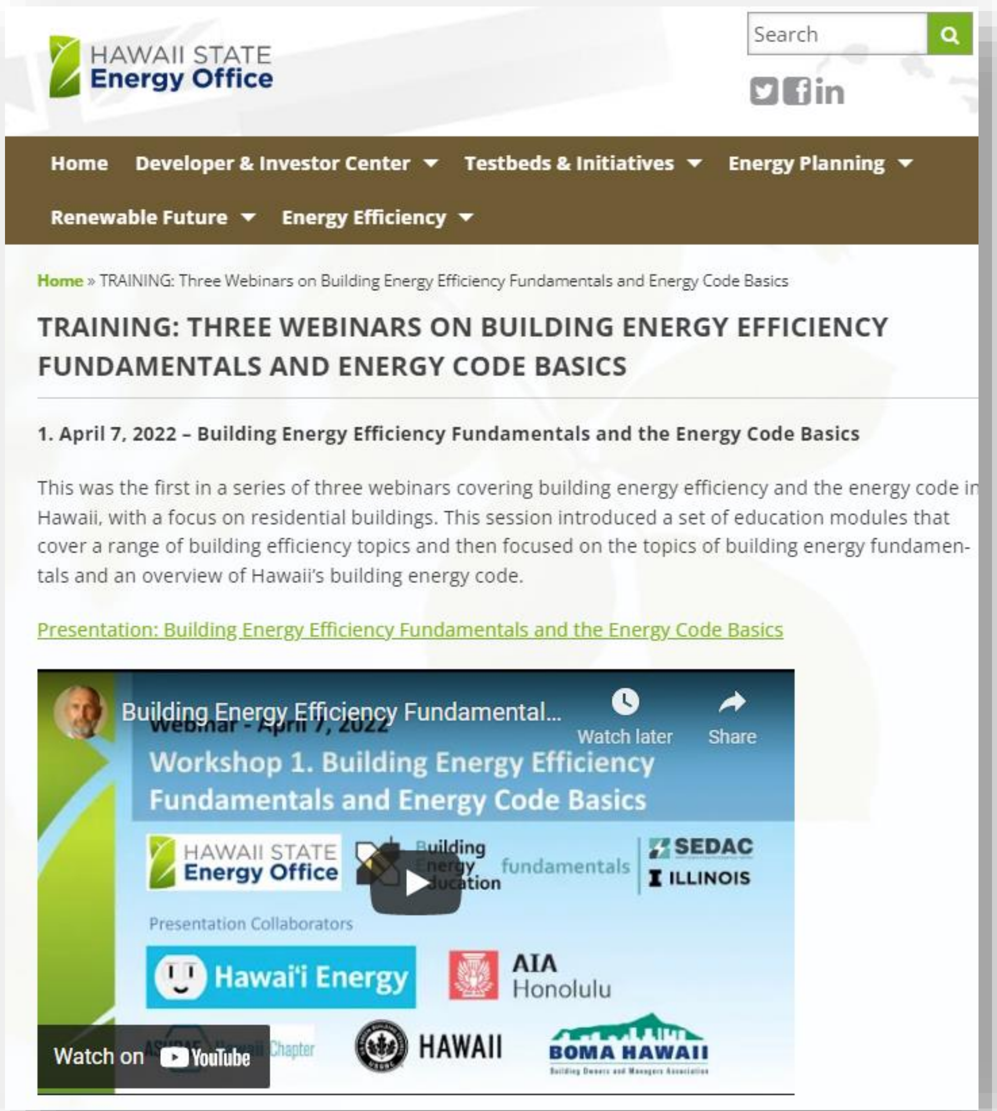
Workshop 1

Building Energy Education Fundamentals and Energy Code Basics

4/7/2022

PDF & video recording

https://energy.hawaii.gov/building-energy-efficiency-and-energy-code



Coming up

Workshop 3

Beyond Code, Net Zero Energy and Existing Buildings

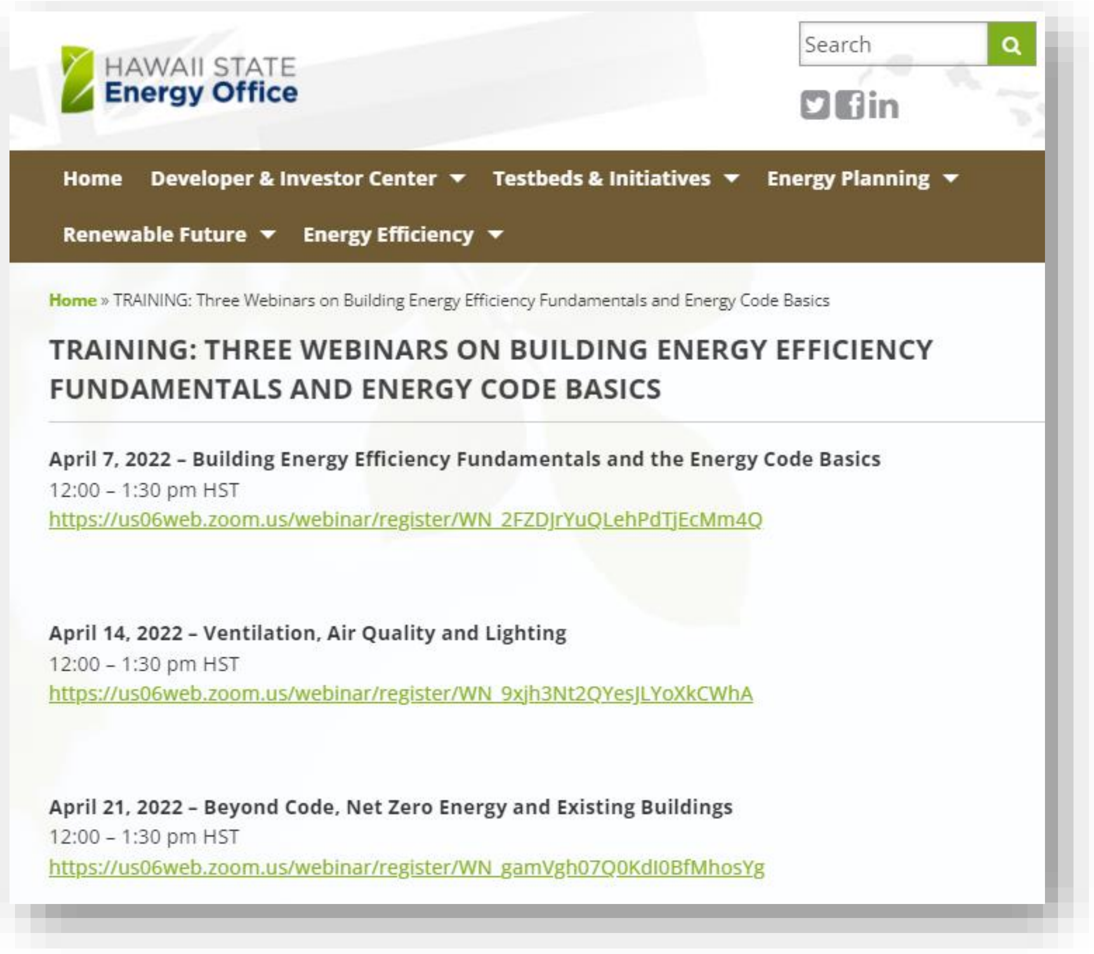
Thursday, 4/21/2022, 12:00 – 1:30 pm HST

Train the Trainer

BEE Fundamentals: Train-the-Trainer Workshop

Friday, 4/29/2022 9:00 – 11:00am HST

https://smartenergy.illinois.edu/bee_fundamentals/



Evaluation Survey

https://www.surveymonkey.com/r/F2QJHGR

Attendee Feedback Survey - IAQ, Comfort, AC and Lighting Webinar - April 14, 2022

1. My role

- ☐ Student
- ☐ Educator
- ☐ Contractor
- ☐ Architect or designer
- ☐ Engineer
- ☐ Vendor
- ☐ Government
- ☐ Other (please specify)

For more energy information

Howard C. Wiig

Hawaii State Energy Office

Office (808) 590-9555

Howard.c.wiig@Hawaii.gov

Building Energy Education Fundamentals

- https://smartenergy.illinois.edu/bee_fundamentals/

2018 IECC available

- http://iccsafe.org/publications
- https://codes.iccsafe.org/content/iecc2018

State Energy Code Website

- http://energy.hawaii.gov/hawaii-energy-building-code

Hawaii Energy Code Website

- https://hawaiienergy.com/codes