Ventilation and Indoor Air Quality

Funding

Funding for this class was provided by the Alaska Housing Finance Corporation (AHFC).

This course is designed to empower homeowners with the knowledge to live in and maintain a safe, energy efficient home.

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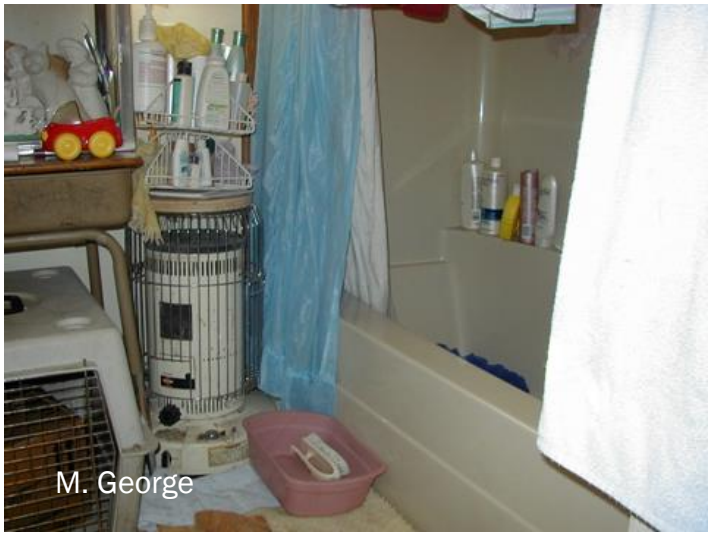
Topics for today:

- AHFC programs
- Reasons for ventilation
- Indoor pollutants
- Ventilation Strategies

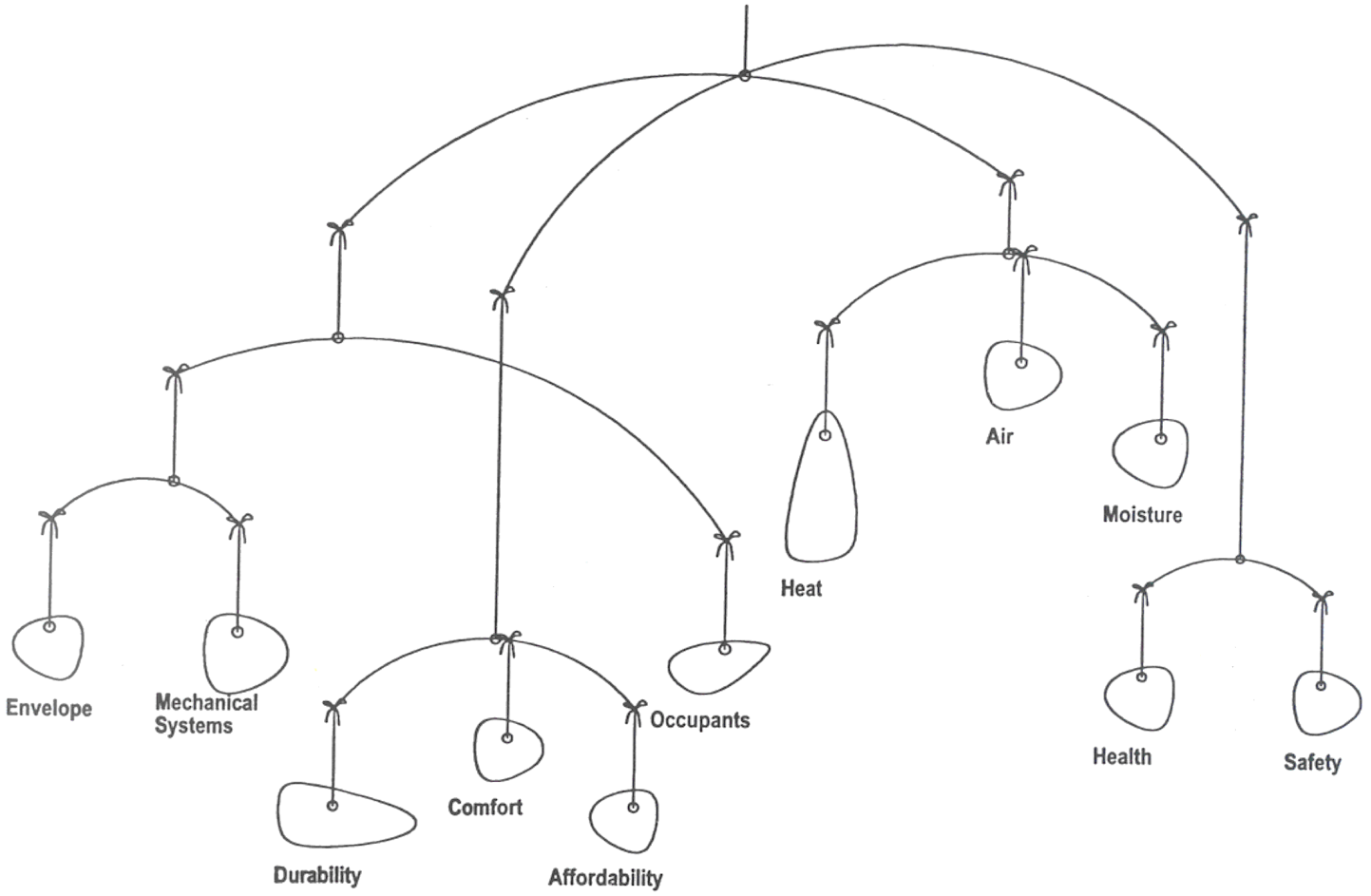
AHFC Energy Efficiency Programs:

- Home Energy Rebate Program
  - www.akrebate.com
- Weatherization Assistance Program
- New Home Rebate
- Second Mortgage for Energy Conservation
- Energy Efficiency Rate Reduction Mortgage
- www.ahfc.us

Ventilation and Indoor Air Quality



The house is a system



Generally, we desire…

- Air perceived as fresh/pleasant
- No negative impact on our health
- No negative impact on productivity
- No negative impact on durability

"I am certain that no air is so unwholesome as air in a closed room that has been often breathed and not changed."

– Benjamin Franklin

Smithsonian National Portrait Gallery

Which houses have air quality problems ?

- Tight homes? OR Leaky Homes?

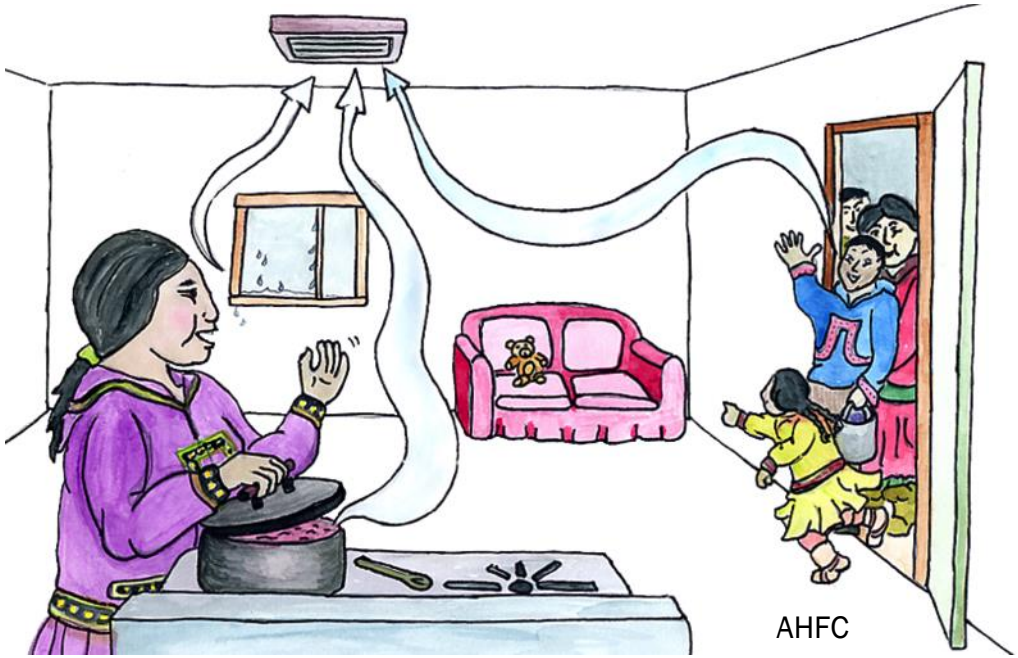
- Low indoor air quality affects who/what?

IAQ is about

- Source control
- Pressure management
- Moisture management
- **Ventilation**

Why do we ventilate?

- Occupants
- Building
- Moisture



- Pressure management
- Indoor Air Quality (IAQ)

Ventilate with Fans and Ducts

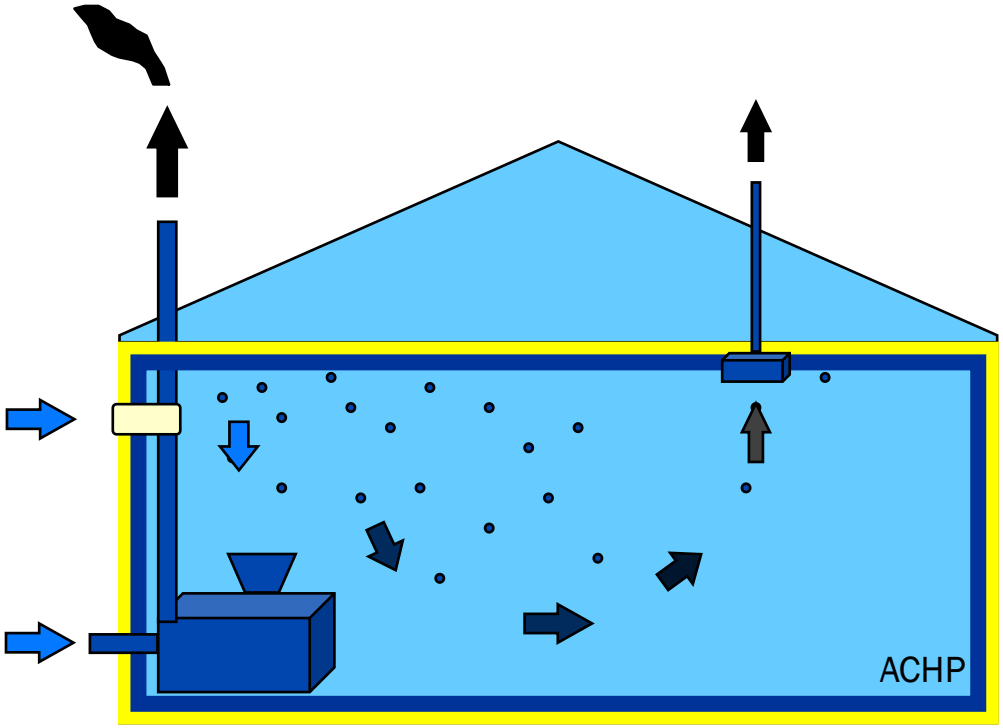

P. Cotter


P. Cotter


ACHP

Goals of Ventilation

- Fresh air IN
- Stale air OUT
- Manage Pressure

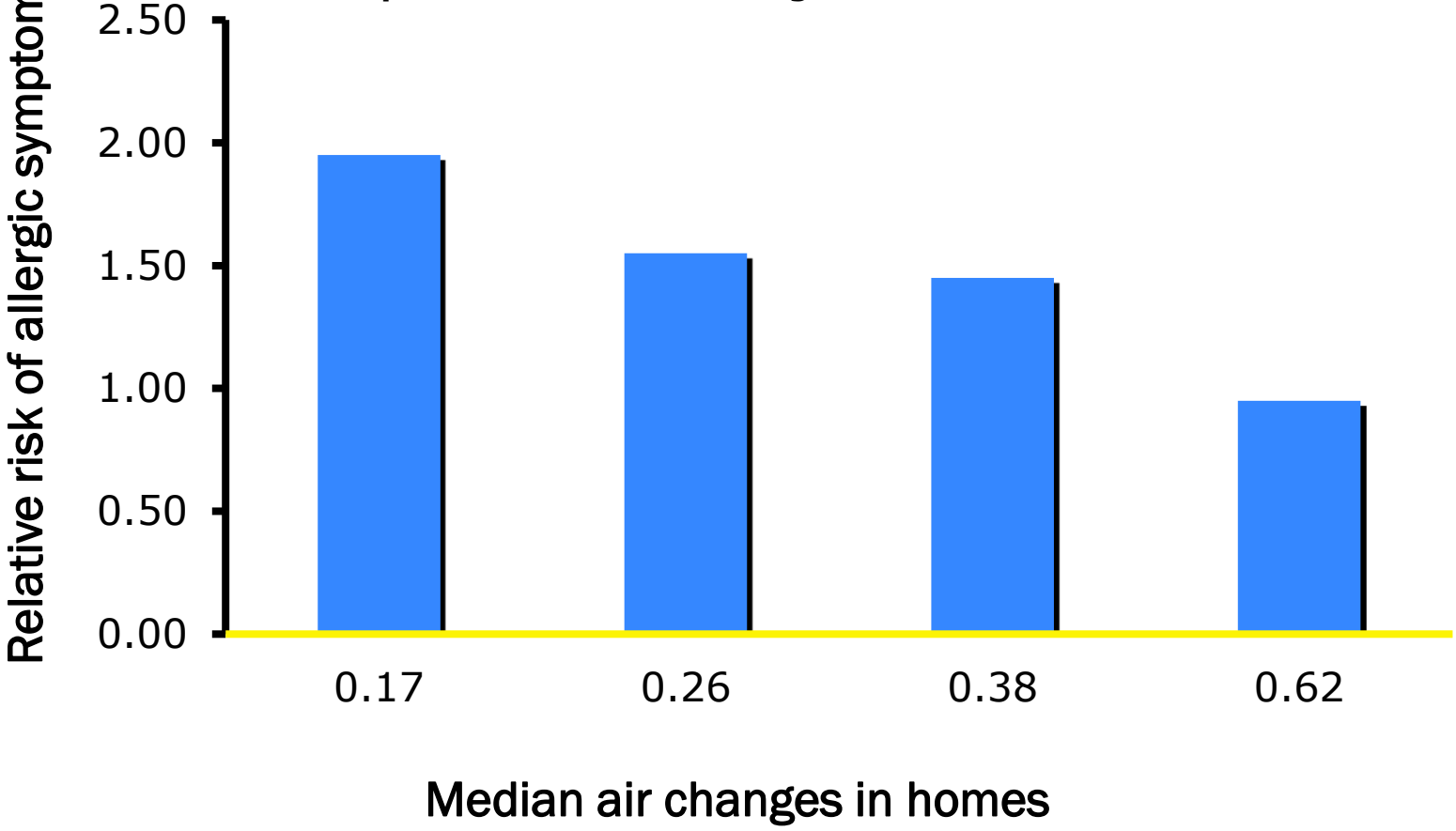


Not from garage, attic, etc...

Air needs a route to escape

Low Ventilation = Higher Allergy Risk?

Adapted from from Bornehag et al 2005



Toxin Exposure

- Inhalation
  - Lung
- Ingest
  - Mouth
  - Gut
- Absorb
  - Skin

P. Kaluza

Toxin Removal

- Exhalation (major pathway)
  - Lung
- Excretion (major pathway)
  - Urine, feces
- Sweat (minor pathway)
  - skin

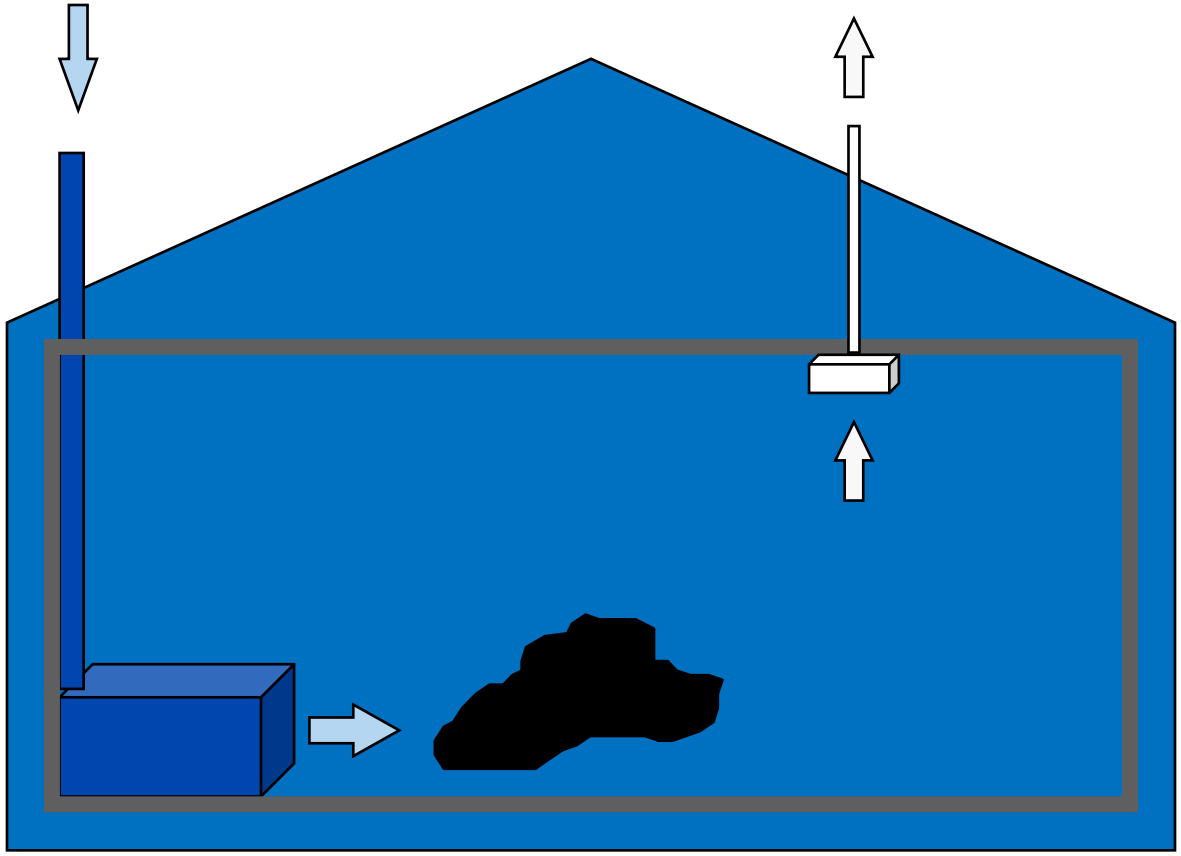
Indoor Pollutants

Classes of Pollutants

- Combustion exhaust gases
- Volatile Organic Compounds (VOC)
- Biologicals
- Particulates
- Water
- Others (phthalate esters, PVC…)

Combustion and IAQ

Combustion gases and tight homes: Be careful of backdrafting

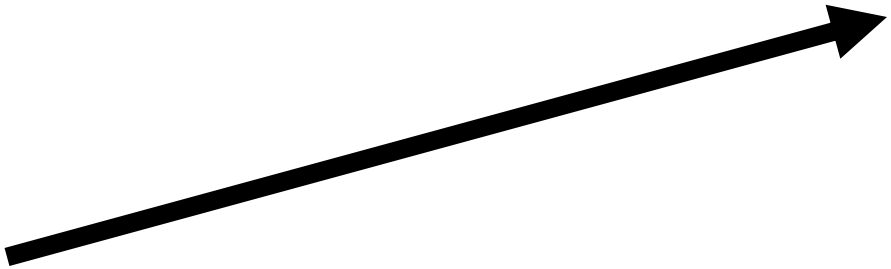


Some Combustion Gases

- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Nitrogen dioxide (NO_2)
- Others

CO is formed from incomplete combustion

$$C_3H_8 + O_2 \rightarrow H_2O + CO_2 + CO$$



Toxic (and lethal?)!!

Acceptable level = as low as possible

Combustion gases come from

Anything with a flame

Health and Safety

Cars in attached garages

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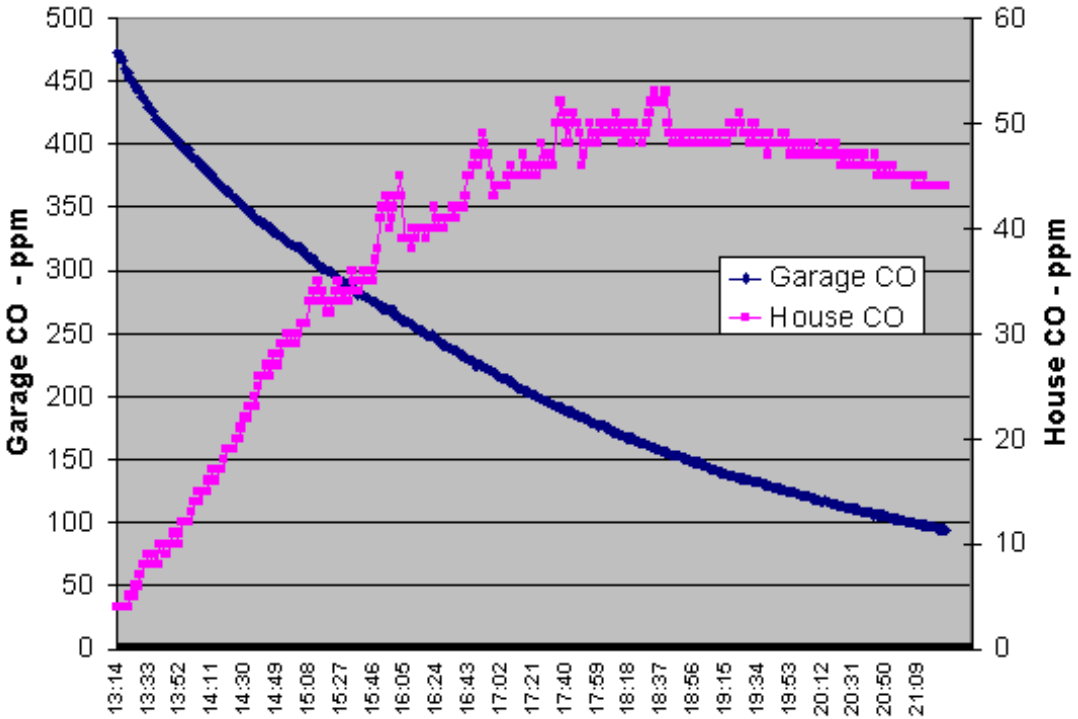
GARAGE FAN & HRV OFF



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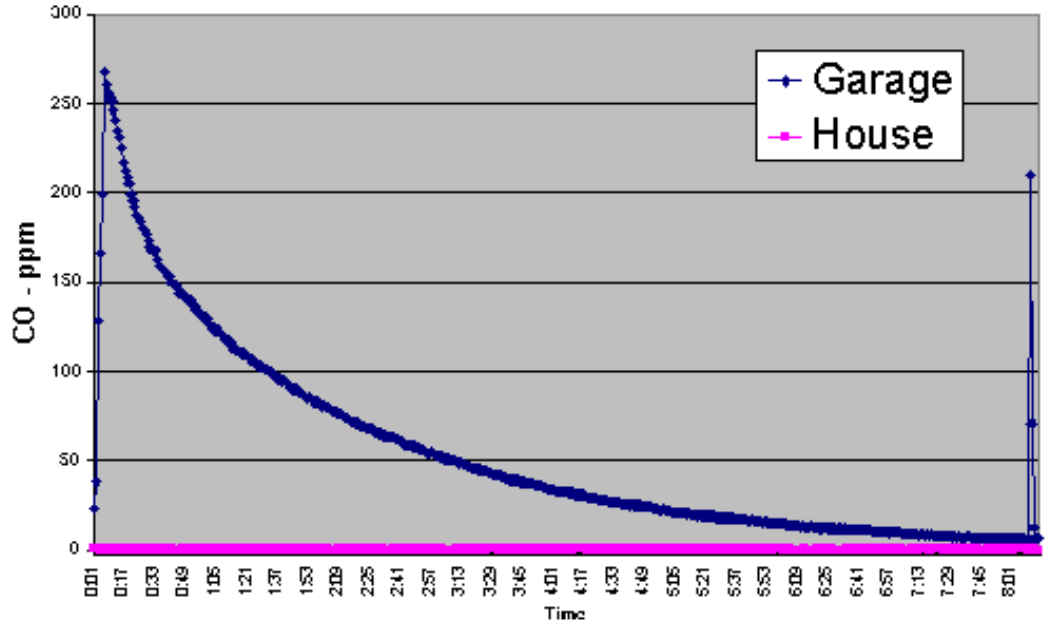
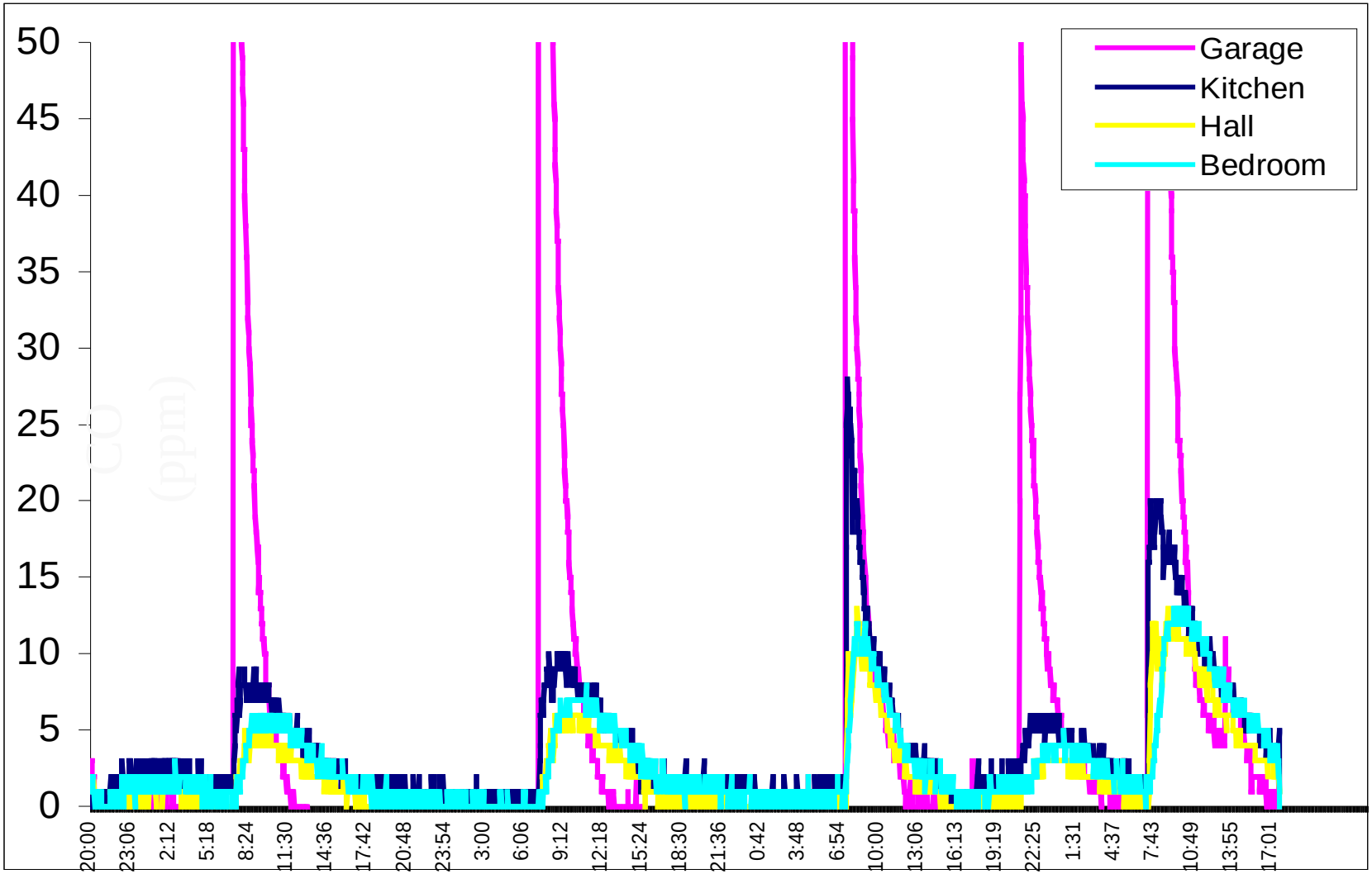
GARAGE FAN & HRV ON



CO profile in Alaska home w/attached garage



J. Freeman

VOCs

(Volatile Organic Compounds)

Some VOCs

- Formaldehyde –
- Benzene –
- Toluene –
- Ketones –
- Pinene/ Limonene –
- Others

Minimizing VOCs in Existing Homes

- Source Control
  - product selection, solvent storage, carpets, pressure management, moisture management,
- Ventilation
- Combination of above

Solvent Storage

Solvents in the living space

Solvents in living space, but notice exhaust ports

Best practice is to remove solvents from home

Benzene in Alaska homes

- Highest in homes with tuck-under garages and no centralized ventilation
- Homes with garage furnaces = high benzene
- Homes with detached garages = low benzene

Particulates

Particulate concentrations depend on

- What comes in
- What is generated inside
- What goes out
- What is left behind

Particulates Are Hard To See

150 microns	Human Hair
25 microns	Visible Particles
10 microns	Atmospheric Dust
3-10 microns	Molds & Pollens
1-5 microns	Bacteria, Dander
0.3-1 microns	Carbon, Particles, Tobacco Smoke

Filters

- Clogged filters
  - Collect more particulates
  - Source of VOCs
  - May be an energy penalty
- New filters
  - May not catch as much stuff
  - Contribute little to home VOCs
- Filters require diligence and maintenance
- In practice: Not real effective

Moisture

Where does water come from?

- Us: breathing, evaporating, sweating…
- Cooking
- Showers, baths
- Plumbing leaks

Relative Humidity

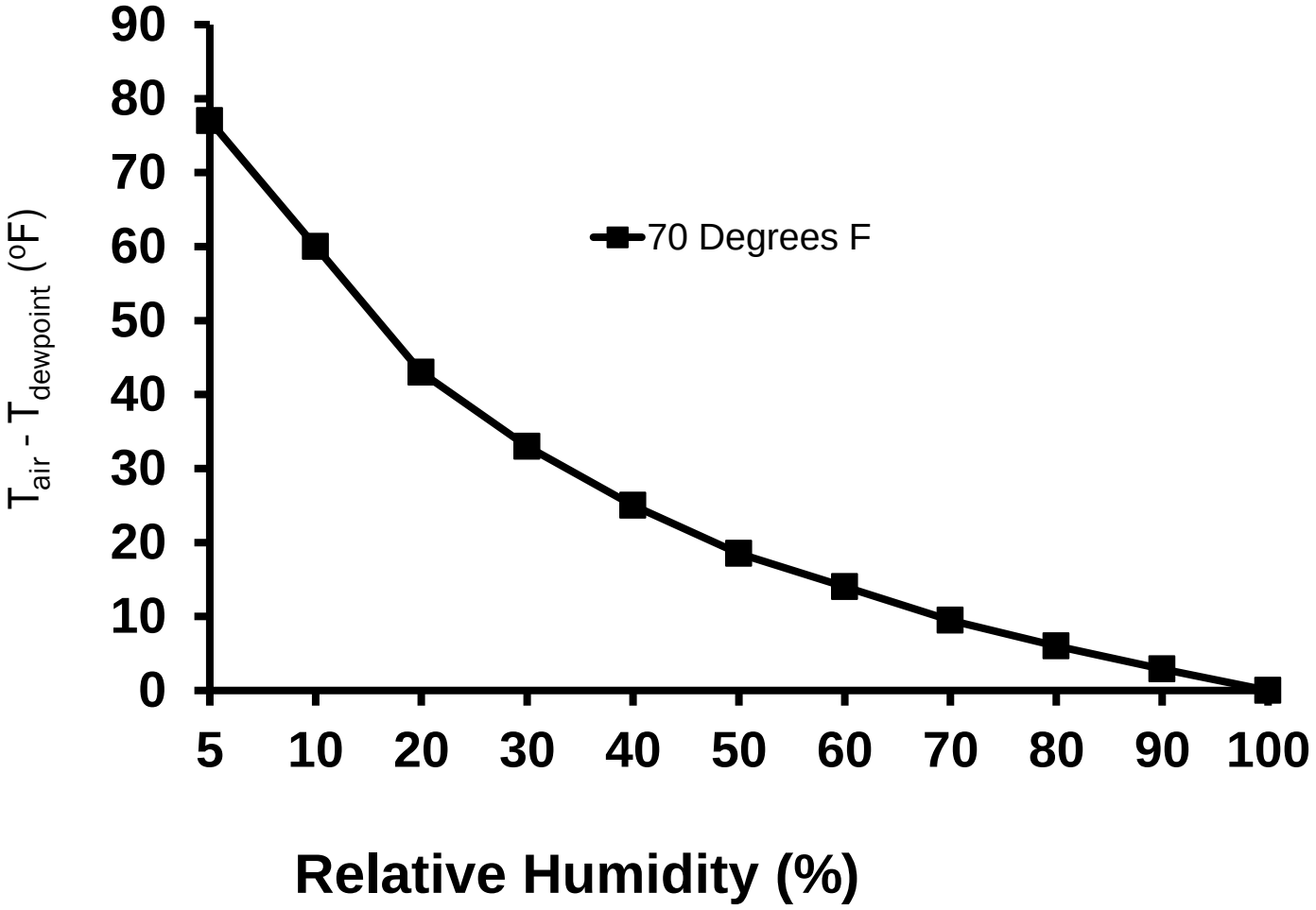
- Amount of water vapor in air RELATIVE to how much water vapor that air can hold
- Depends on TEMPERATURE
- Should be controlled
  - Ventilation is one part of a control strategy

Dewpoint Temperature

- The temperature at which water vapor changes to liquid

- Dependent on temperature and amount of moisture in the air

When warm wet air cools, water vapor ➔ liquid



Dew point on interior glass surface

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Double Pane

Triple Pane

Why RH matters...

If warm air holds more water than cold air,

AND

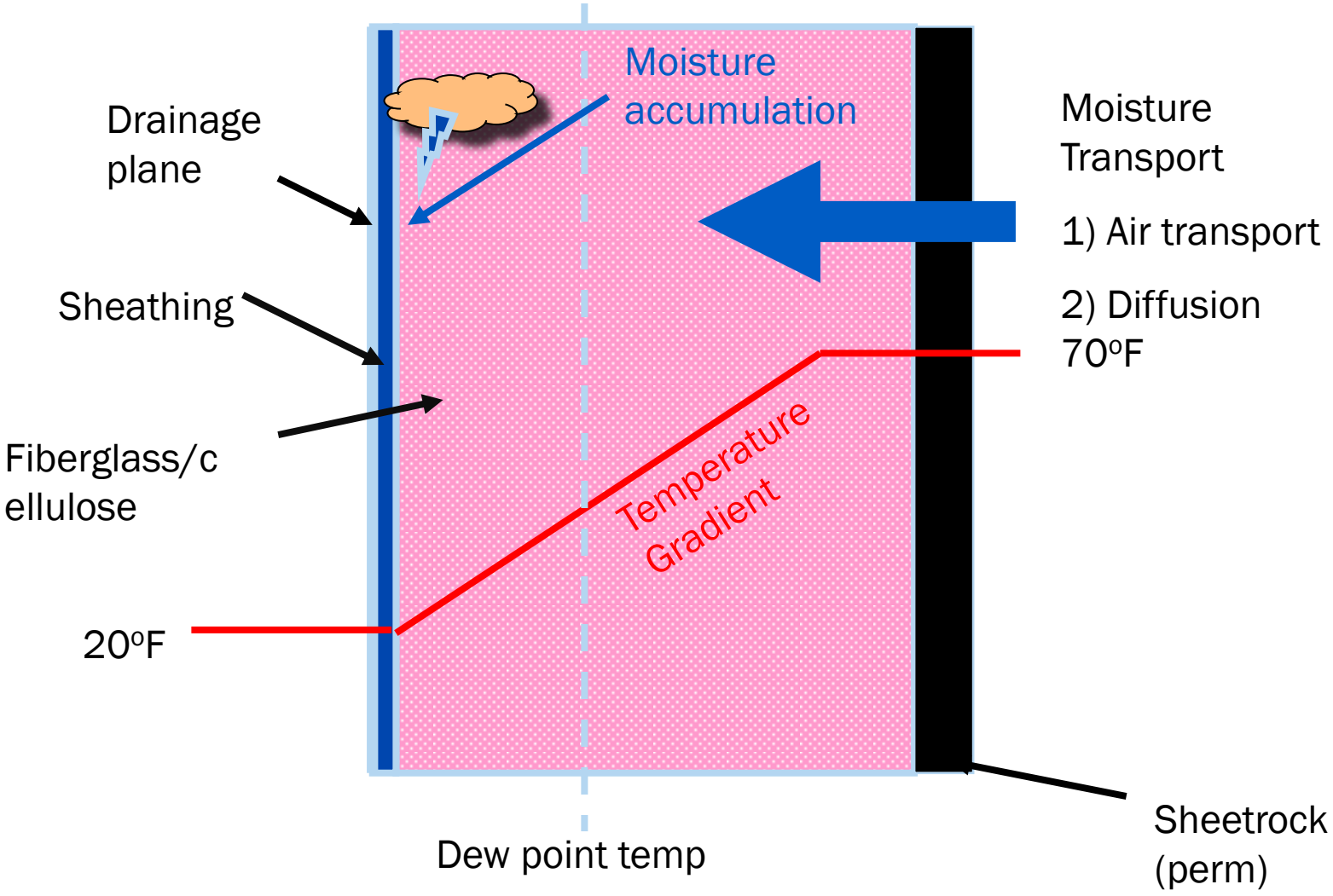
This warm air leaks through building assemblies,

AND

It meets a cold surface,

THEN

There will be a moisture problem


Moisture accumulation
Drainage plane
Moisture Transport
1) Air transport
Sheathing
2) Diffusion
70°F
Fiberglass/cellulose
Temperature Gradient
20°F
Sheetrock (perm)
Dew point temp

Moisture problems can lead to

- Mold growth
- Other biological contaminates
- Increased release of VOCs by building products
- Decreased building durability
- Occupant health issues

What should winter RH be in the home?

Depends on who you ask, but

30 – 45%

is a good target.

Ventilation

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You must consider ventilation during weatherization/retrofitting

Size and Flow

- Fans are sized by their flow rate in cubic feet per minute (cfm)
  - Ex. Bath fan might be 50cfm
- Many fans have adjustable flow rates to meet different needs and situations
- True flow depends on other factors, too

How much ventilation?

- Alaska's Building Energy Efficiency Standard (BEES) addresses this

- Use the following equation/table to help you determine your ventilation needs

- For best results, consult an energy rater or building diagnostics professional or enroll in an Alaska BEES course

Ventilation in Alaska homes

$$cfm = 0.01A + 10(\#\ Bedrooms + 1)$$

.01(floor area) + 10(# bedrooms +1)

.01(2000) = 20 + 10(3+1)

20+40 = 60 CFM

OR

Ventilation in Alaska homes

Number of Bedrooms	0-1	2-3	4-5	6-7	>7
<1500 ft²	35	55	75	95	115
1501-3000	50	70	90	110	125
3001-4500	65	85	105	125	145
4501-6000	80	100	120	140	160
6001-7500	95	115	135	155	175
>7500 ft²	110	130	150	170	190

Measured flow to meet standard

Ventilation Strategies

- Exhaust Only
  - Usually 1 or 2 bath fans

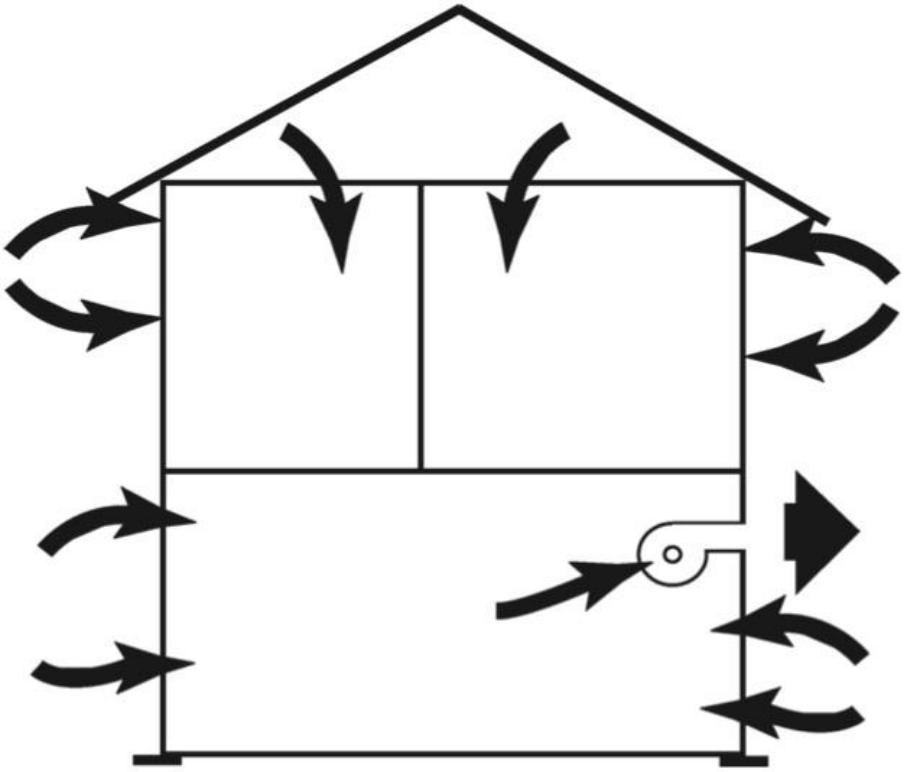
- Balanced
  - Usually a heat recovery ventilation (HRV) system

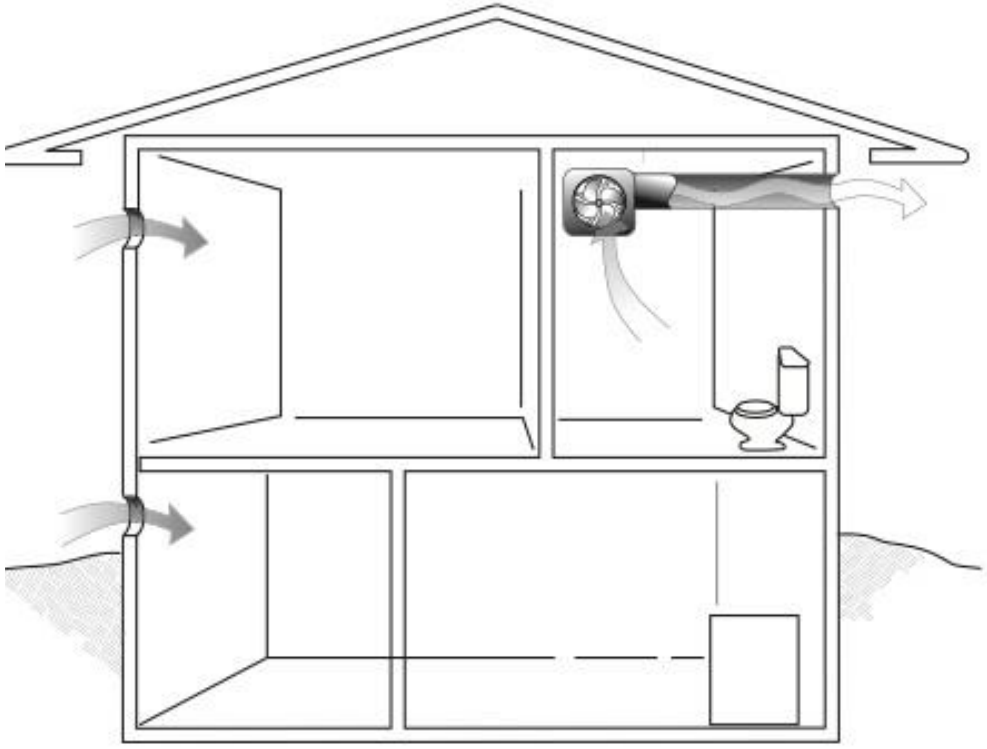
Exhaust Only Ventilation

- Bath fans and range hoods
- Local or Remote Fans
  - Single or multiport pickups
- May be run intermittently or continuously

P. Cotter

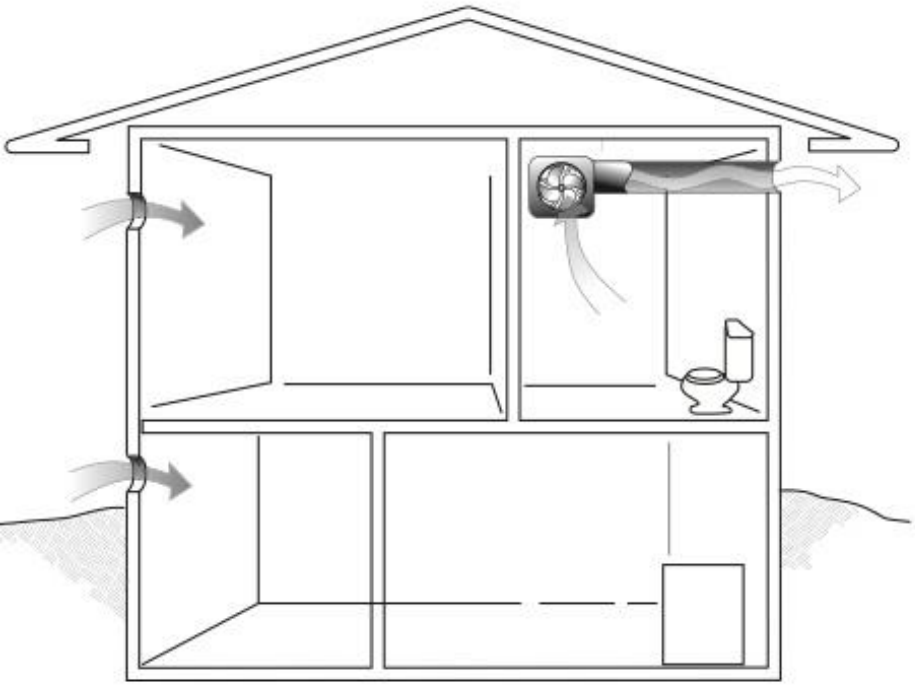
Exhaust Only Ventilation



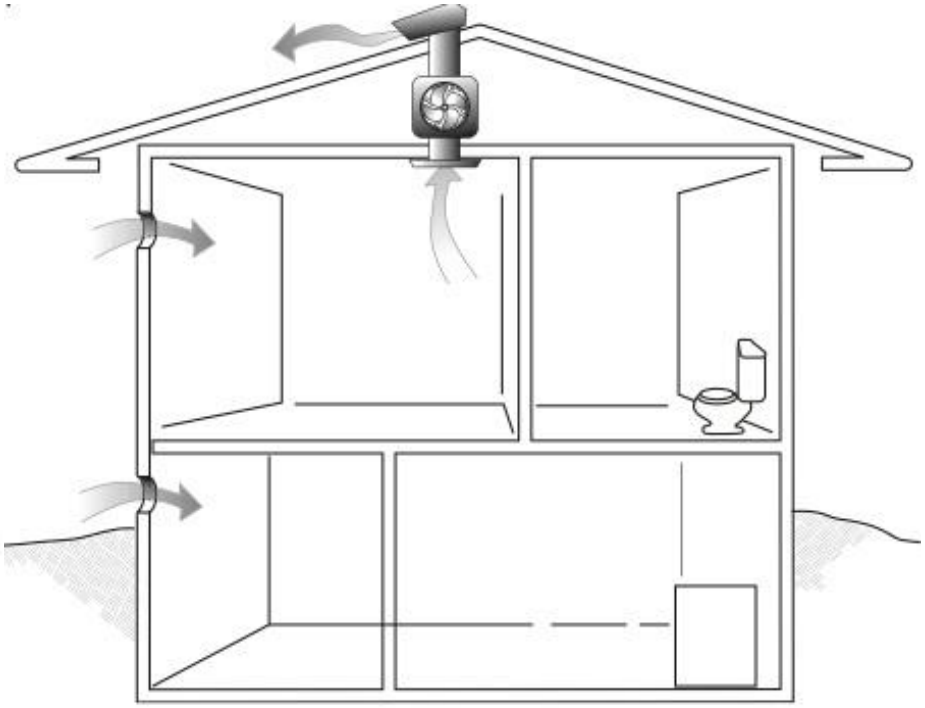


Can use dedicated air intakes

Single port exhaust fan

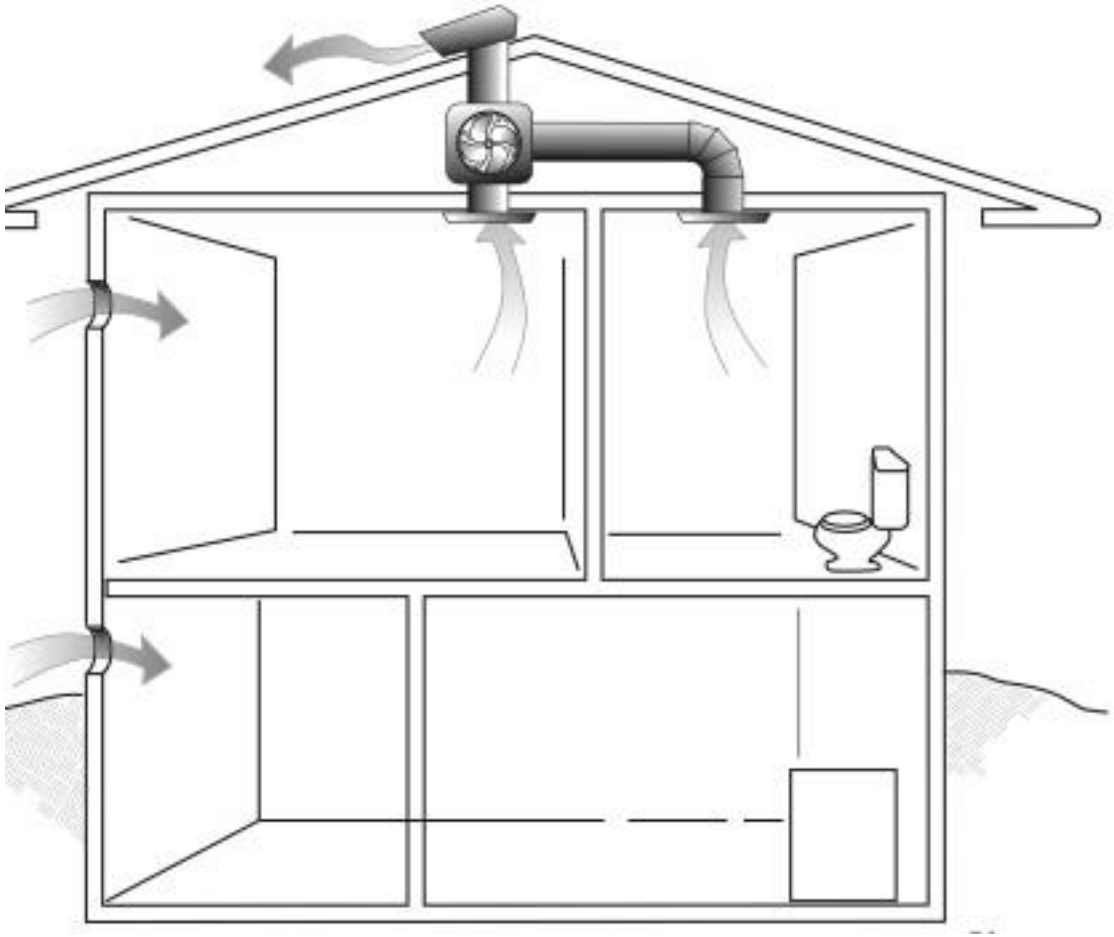


Surface mounted fan



Remote fan

Multiport exhaust fan

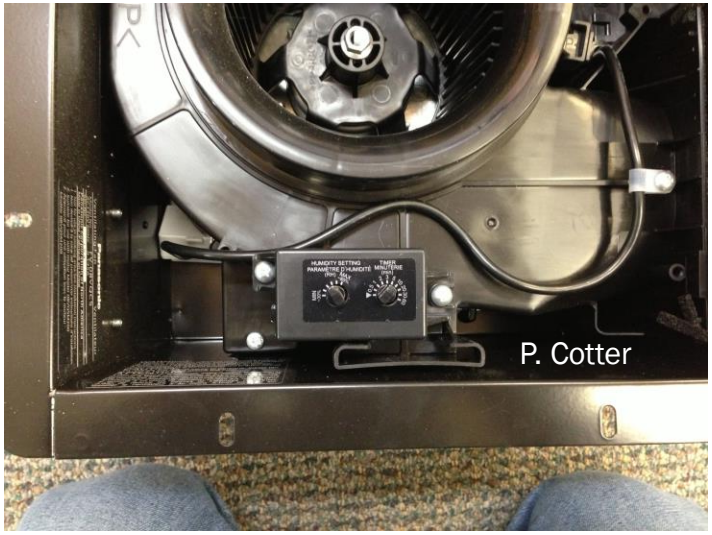


Exhaust Only Ventilation - Controls

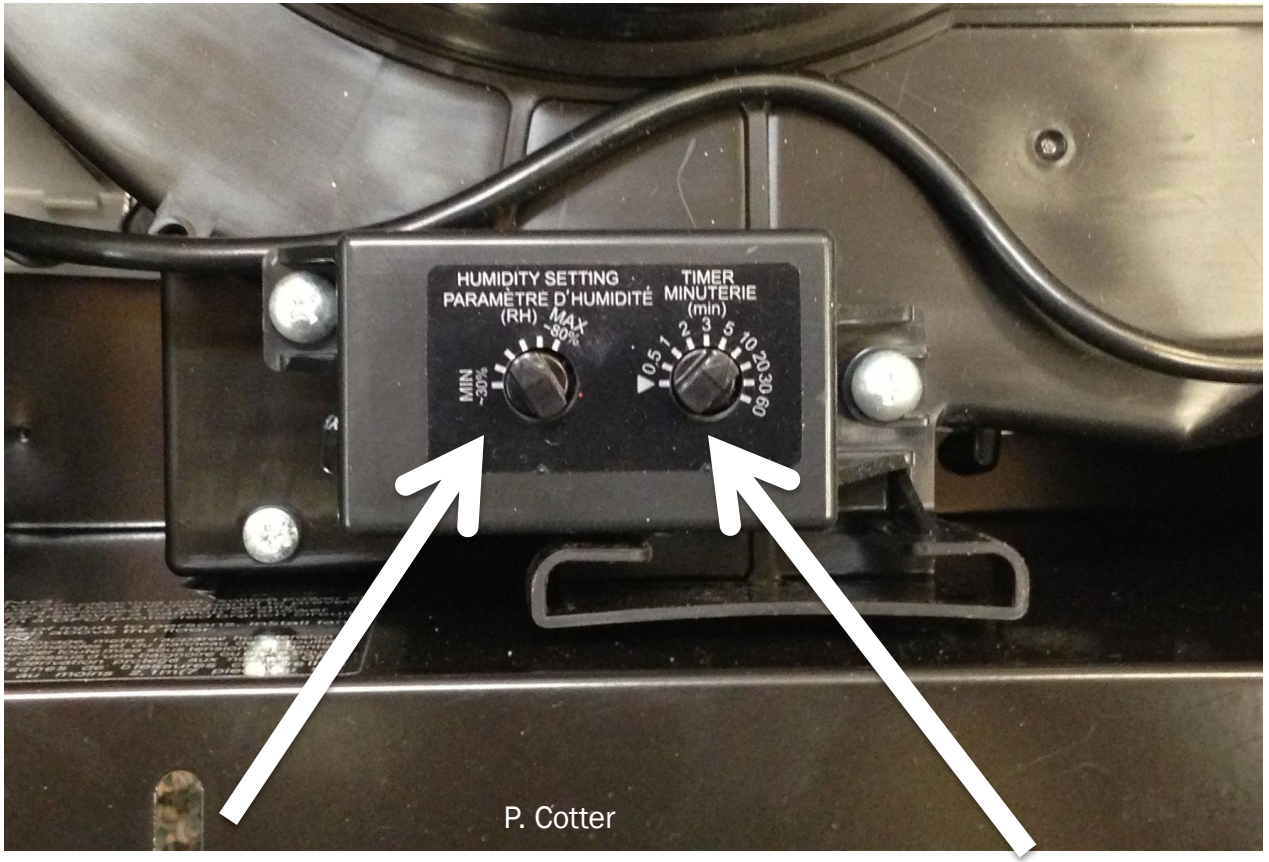
- timers
- occupancy sensors
- Humidity sensors, etc.
- Manual control

Fan Controls

A look inside…



Reveals controls



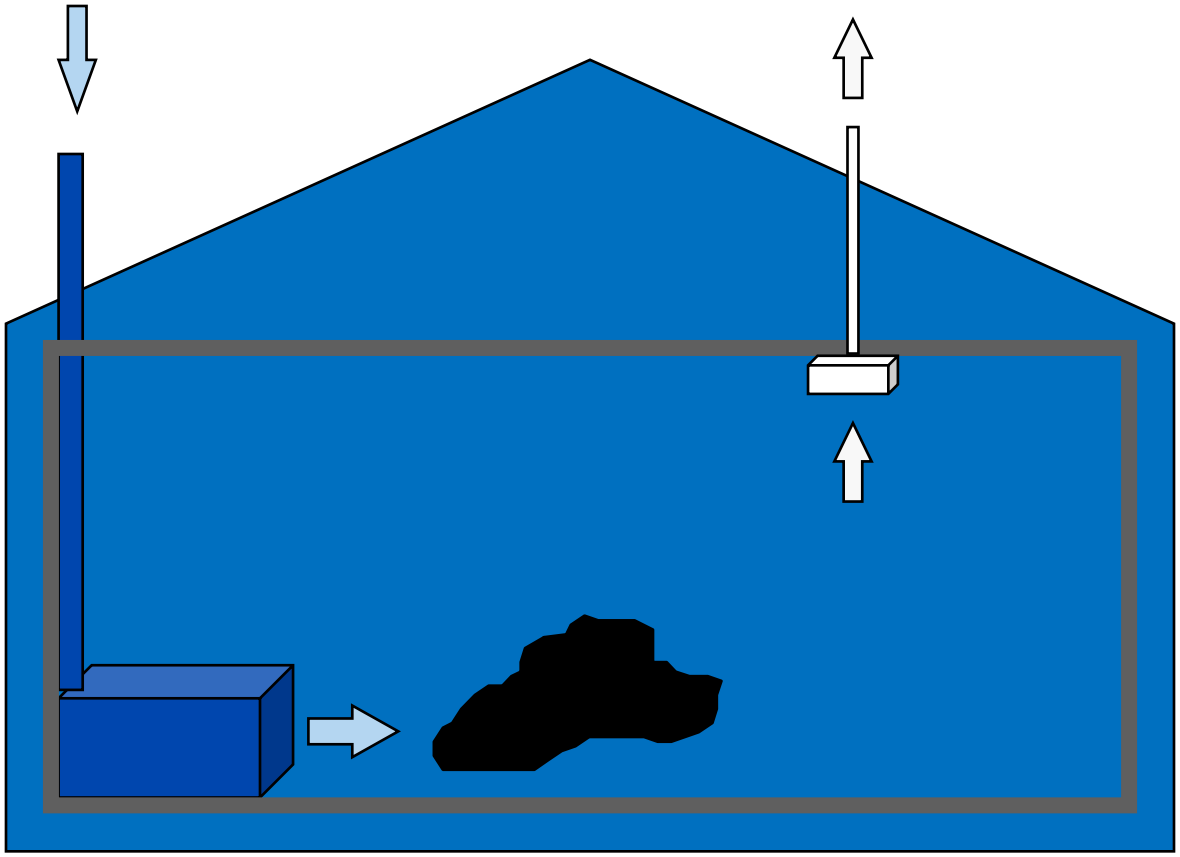
Humidity

Time

Exhaust Only – Pros/Cons

- Pros
  - Low initial cost
  - Simple, generally
  - Low maintenance
  - Many controls
- Cons
  - Potential for dangerous depressurization
  - No heat recovery
  - Incoming air may get contaminated

Back-drafting and Depressurization



Balanced Ventilation

- Move equal amounts of air IN and OUT
- In our climate, this is done with a Heat Recovery Ventilator*
  - Heat from outgoing air transferred to incoming air
  - Minimizes heat loss
- May be run intermittently or continuously

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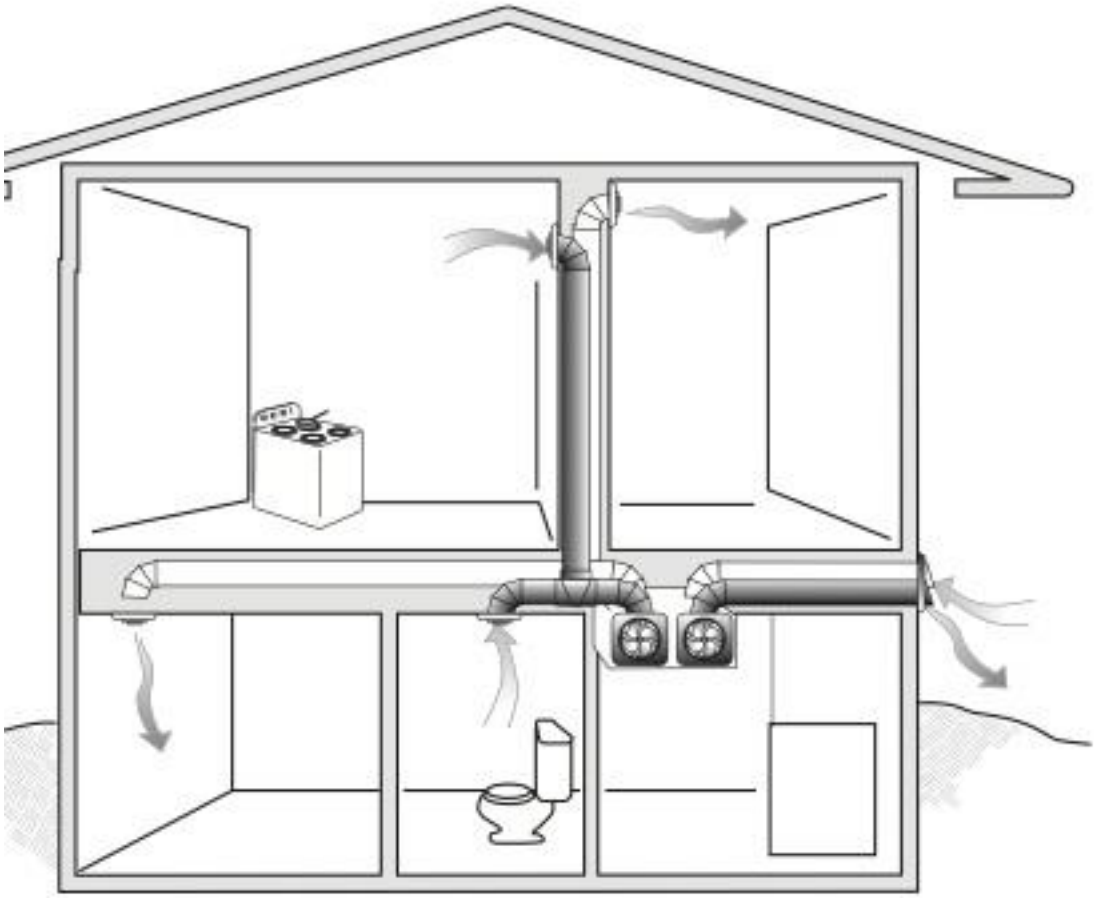
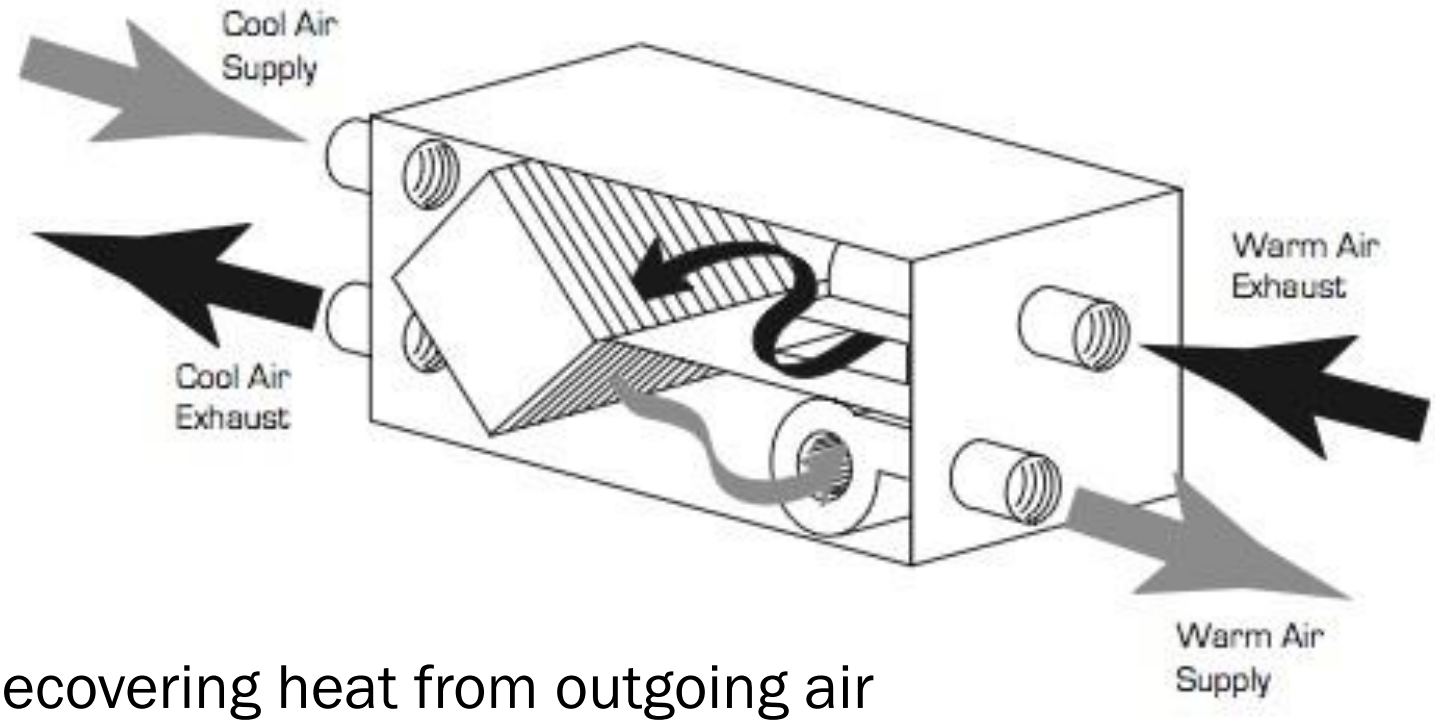
HRV Strategy



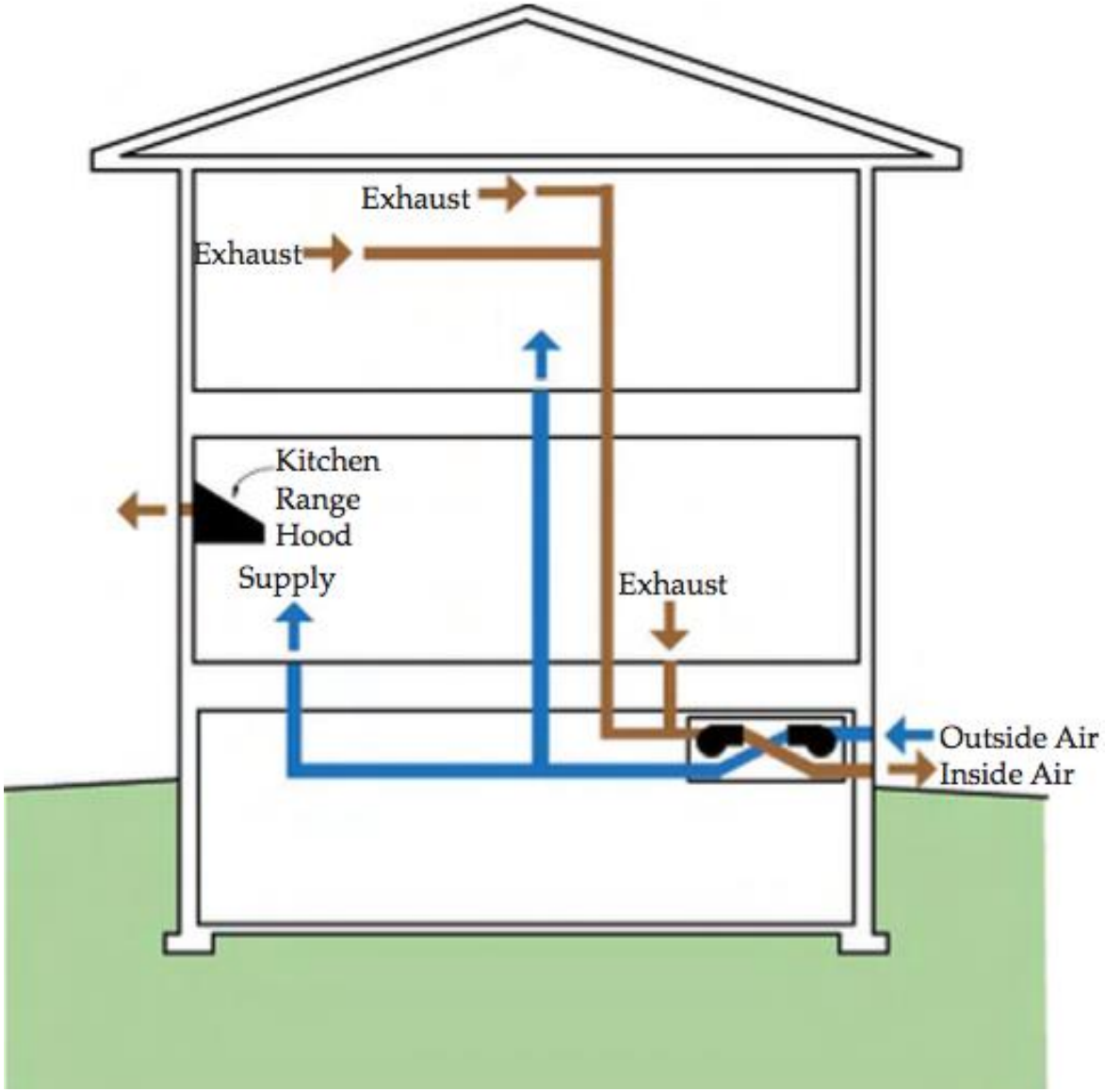
HRV – Heat Recovery Ventilation



Recovering heat from outgoing air

HRV Strategy

Balanced with multiple supply and exhaust



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HRV air temperature tempering

P. Cotter

P. Cotter

Small residential HRV

HRVs require ducting

HRV – Pros/Cons

- Pros
  - Continuous
  - Heat recovery for efficiency
  - Balanced (installed properly)
  - Many controls
- Cons
  - High initial cost
  - Some maintenance required
  - Retrofits can be challenging

Summary

- Minimize pollutants in the home
  - Source control, ventilation
- Avoid bringing combustion gases into the living space
- Ventilation must be considered when tightening a home
- Ventilate with exhaust only or balanced strategies

Resources

- AHFC - Research Information Center
- Alaska Residential Building Manual
  www.ahfc.us
- Cold Climate Housing Research Center
  www.cchrc.org
- One stop shop for AK Energy Efficiency information
  www.akenergyefficiency.org