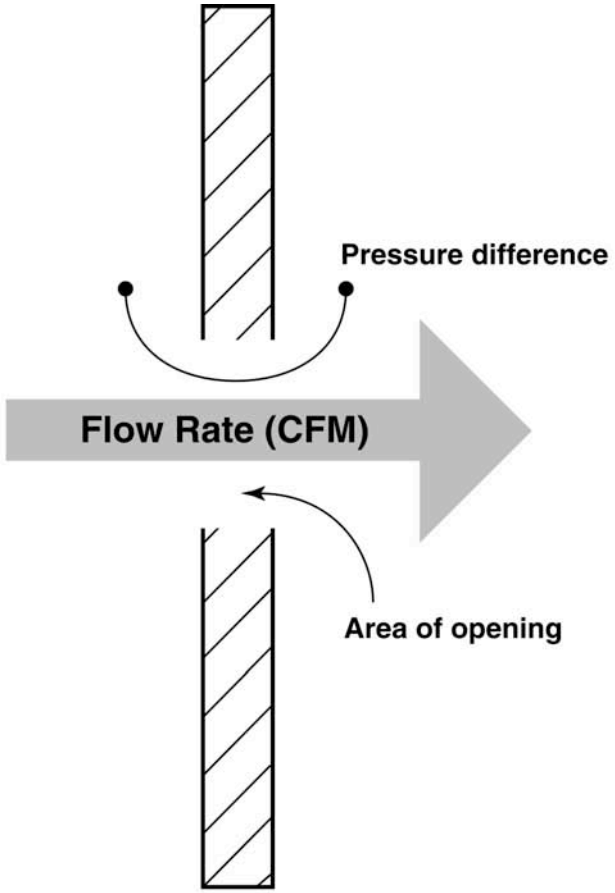
Well Ventilated Buildings and Ventilation Systems

A Well-Ventilated Building Provides:

- **Local Ventilation** to remove moisture, odors, and other pollutants at the source
- **Whole House Ventilation** for supplying fresh air to remove contaminants by dilution
- **Control of airflow** through building so crazy air flows can't carry contaminants into and around the house

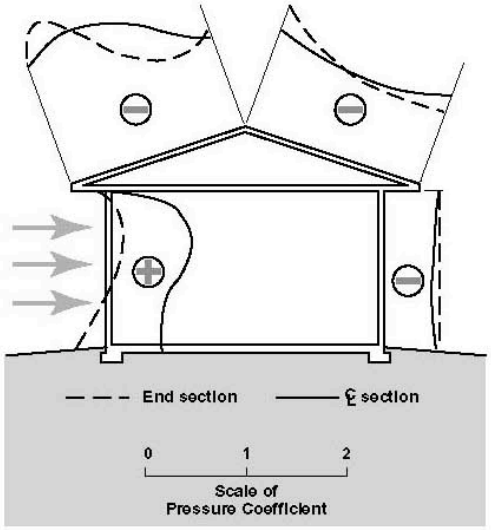
What powers air flow?



Air Flow

- Air flow depends on size of hole
- Air flow depends on pressure difference

  Flow ≅ Area x $\sqrt{\Delta P}$ x Coefficient
- Air flows from higher pressure to lower pressure



Distribution of pressures (+) and suctions (-) on a house with a low-sloped roof with wind perpendicular to eave

Figure 3.1
Exterior Air Pressure Field
(from Hutcheon & Handegord, 1983)

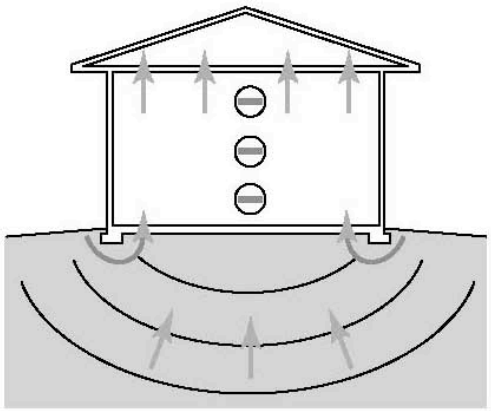
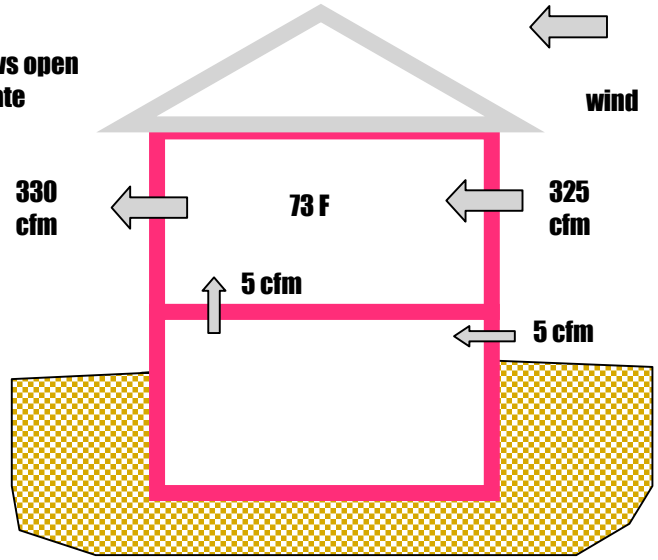


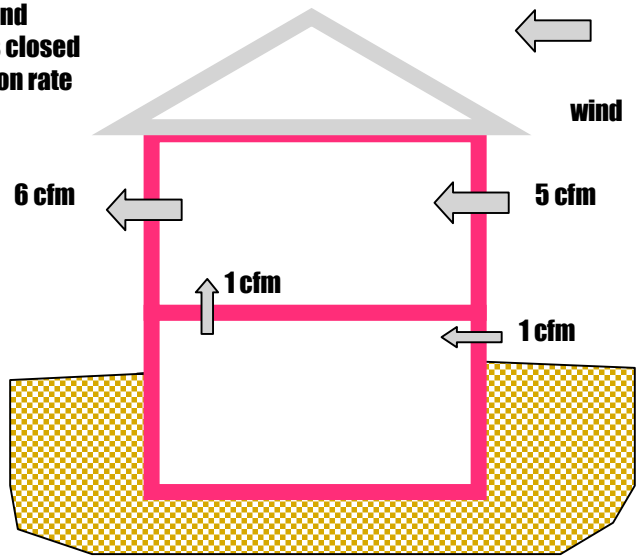
Figure 3.2
Exterior Air Pressure Field Extending Below Grade

It's 73 degrees out - how much air change occurs ?

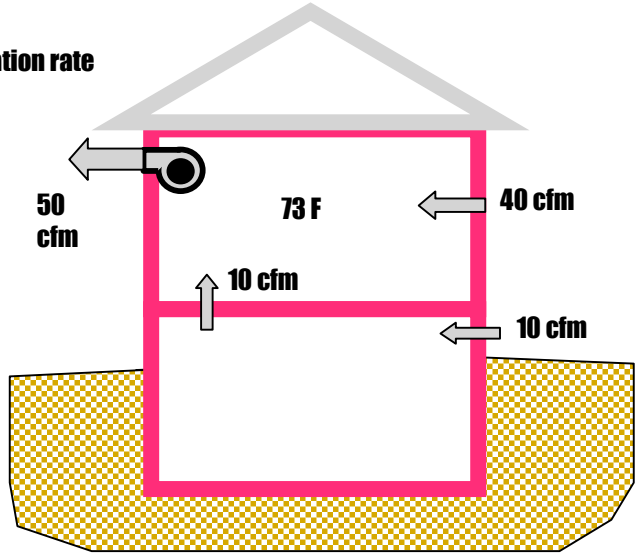
2 mph wind
24 ft2 windows open
Ventilation rate
330 cfm



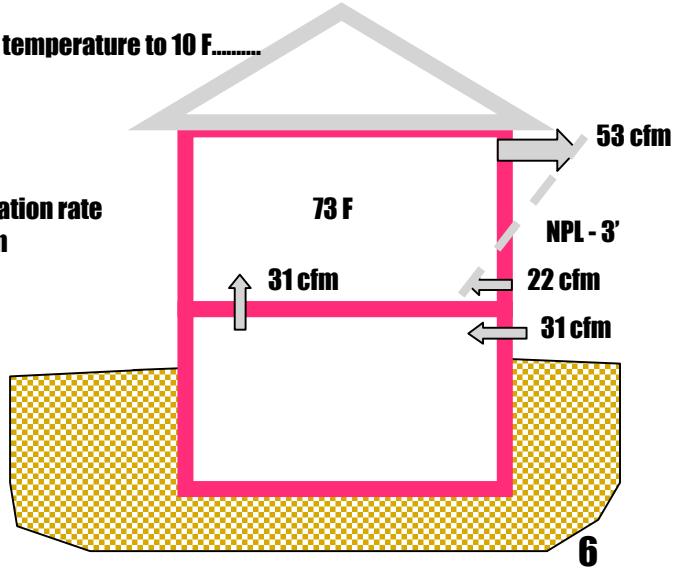
2 mph wind
windows closed
Ventilation rate
5 cfm



Ventilation rate
50 cfm



Decrease the temperature to 10 F.....



Purposes of Mechanical Ventilation

Point-source ventilation - Remove Pollutants

- exhaust fans: kitchen, bath, laundry, trash rooms

Whole-building ventilation - Dilute Pollutants

- supply, exhaust, or balanced fans distributing to all rooms

Standards and Codes?

- **State and Local codes**
- **IRC, IMC 2003**
  - 4 ft2window/100ft2 or 0.35 ach (not less than 15 cfm/person) mechanical
  - Bath 1.5 ft2 window(1/2operable) or 50 intermittent or 20 cfm continuous exhaust
  - Kitchens 100 intermittent, 25cfm continuous
  - Dryer must exhaust

- **ASHRAE 62.2P 2003**
  - 7.5 cfm/person+1cfm/100sq.ft. fan powered (<4500 infiltration degree day exclusion)
  - Exhaust: Intermittent 100cfm kitchen, 50 cfm bath, or continuous 5 ach kitchen , 20 cfm bath
  - Dryer must exhaust; range hood required if flow less than 5 ach
  - Some noise and installation requirements

According to ASHRAE 62.2

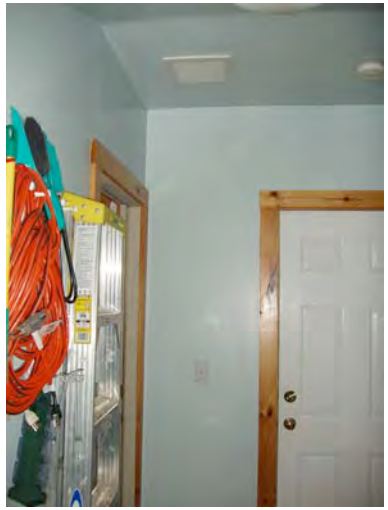
- **The same amount everywhere, every climate**
- **Big houses need more air than smaller houses**
- **Selecting materials does not affect the rates under current thinking**
  - This will change as we learn more in the future
- **We assume the enclosure are equally leaky everywhere regardless of age**

Local Ventilation
(Things That Need Exhaust Ventilation)

- Bathrooms
- Clothes dryers
- Kitchen ranges
- Boilers, furnaces, gas-fired hot water heaters
- Fireplaces, wood burning stoves

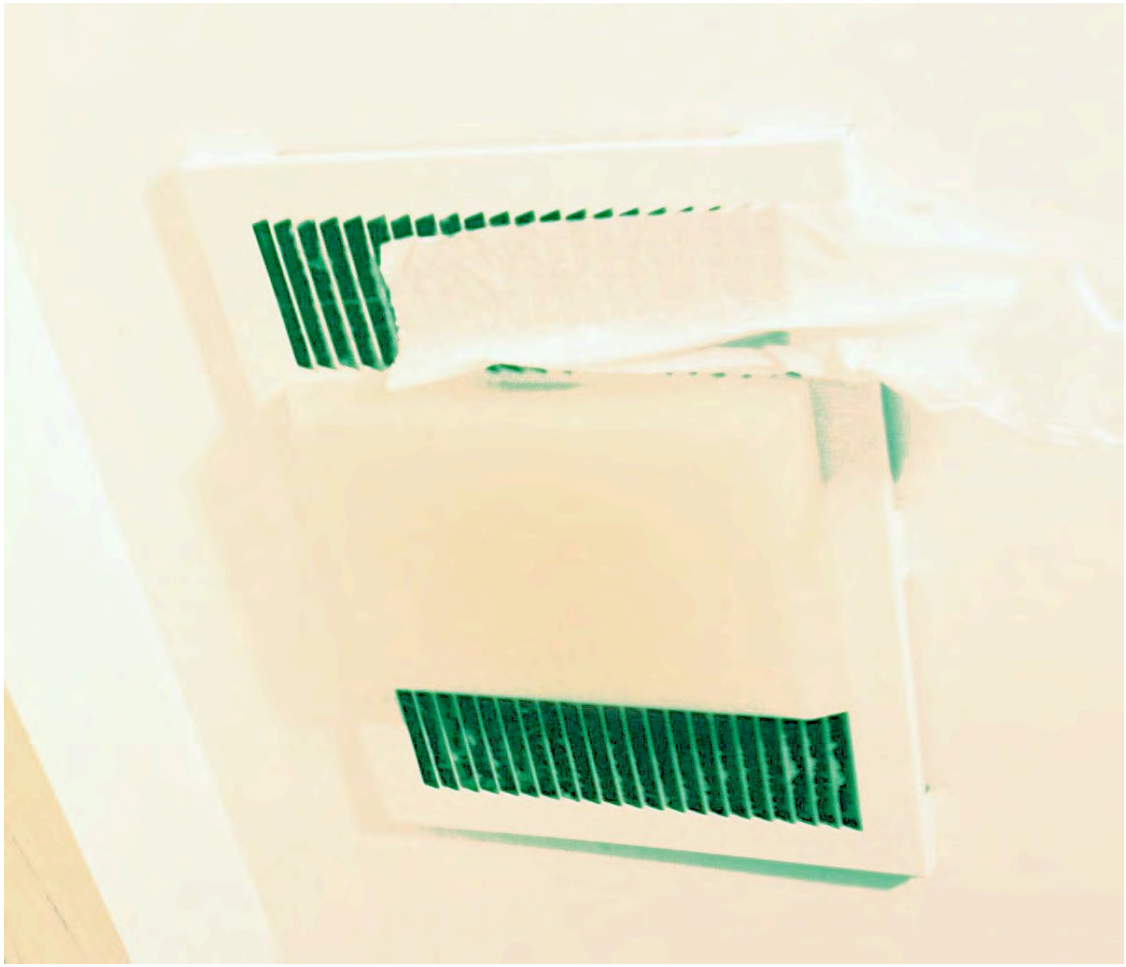
Dealing With Specific Pollutant Sources

- **Provide exhaust fans at pollutant generation location that can be run when required**
  - Example - Bathroom Fan
    - Kitchen exhaust hood
    - Fan in Trash room
- **These fans have off-on switches and/or timers**

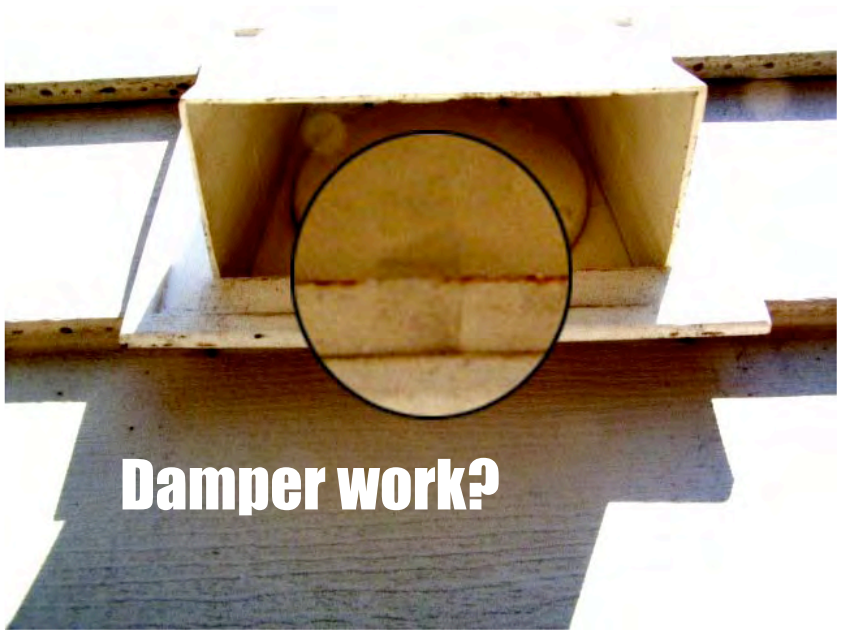


Exhausts in bathrooms? Does it work?

Testing Exhaust Fan: The Charmin Method



Testing Exhaust Fan: Flow Pan Method



New installation (above)

Retrofit bath fan (right)

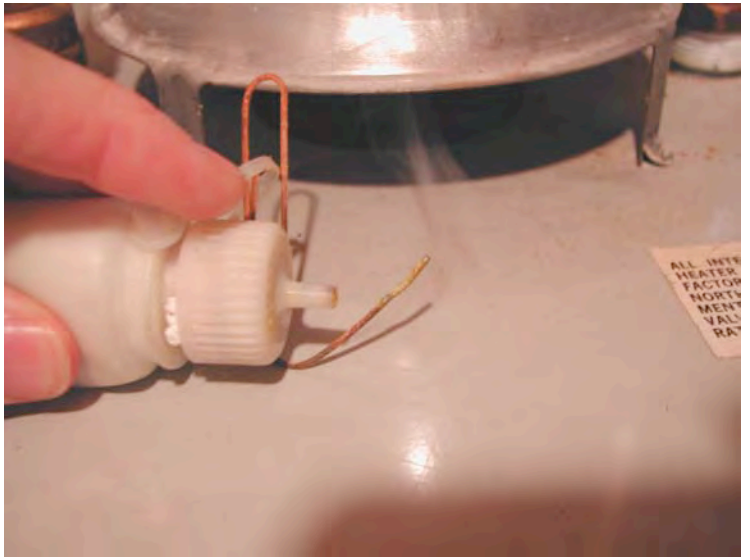
Local Ventilation: Kitchen

- Remove moisture, odors, grease
- If gas oven or range, remove products of combustion: moisture, CO, NOx
- Must be vented to the outside
- If it's not reasonably quiet, many people won't use it.

Some things on the exterior match-up with things on the interior

Local Ventilation: Combustion Appliances

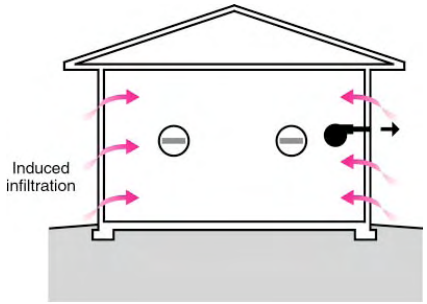
- Make sure all combustion appliances have adequate combustion and dilution air per manufacturers specs and code.
- Make sure gas ranges and ovens are exhausted to outside, even if manufacturer and code permit otherwise.
- Avoid negative (sucking) pressures in spaces with combustion appliances



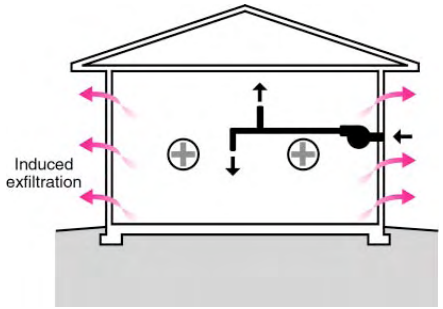
Whole House Ventilation - Options

Requires Airtight building envelope and ducts

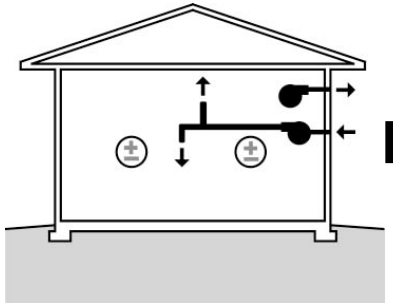
- **Exhaust ventilation**
  - single- or multi-point
- **Supply ventilation**
  - single- or multi-point
  - integrated with central system fan
- **Balanced ventilation**
  - single- or multi-point
  - integrated with central system fan
  - with or without heat or energy recovery



Exhaust



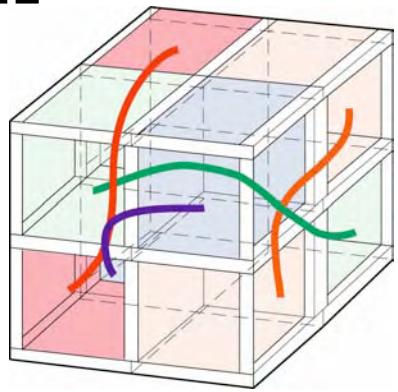
Supply

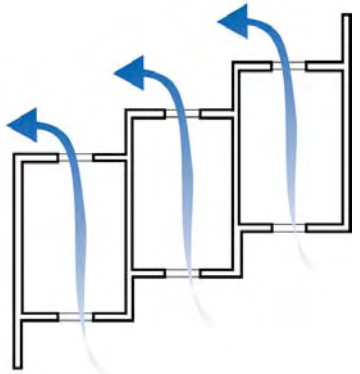


Balanced

In order to control the air, you must first enclose the air

- An enclosure is constructed
- This enclosure provides closure for all six sides of the cube
- Openings in the enclosure should be intentional
  - Doors, Windows, Exhaust vents, Outside Air Intake

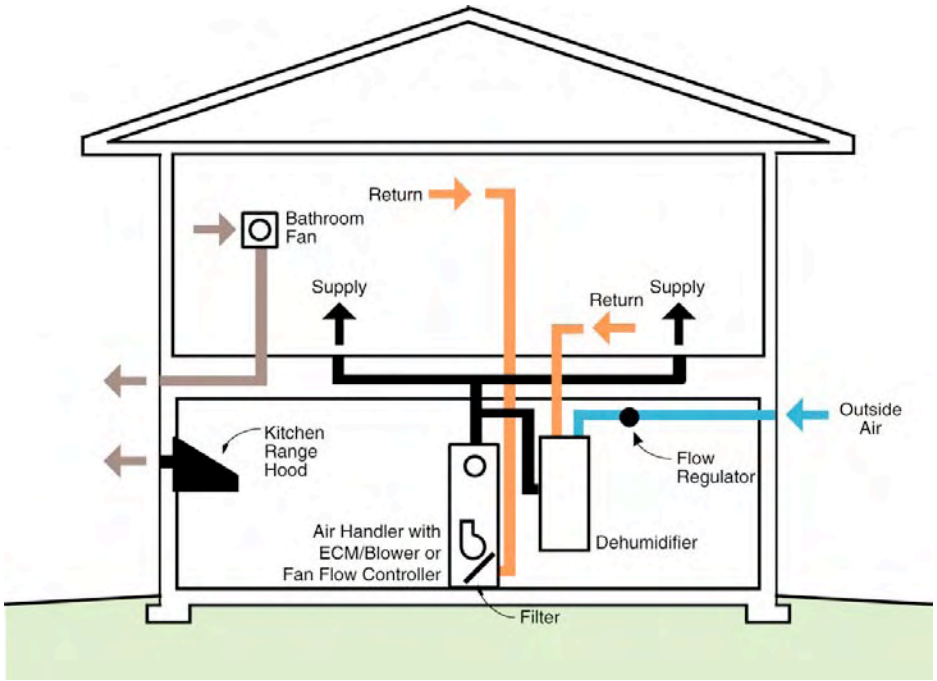




Staggering rooms or using wing walls increases ventilation through rooms oriented north to south

Air brought into the the home can then be.....

- Heated
- Cooled
- Humidified
- Dehumidified
- Cleaned, Filtered
- Distributed, Mixed



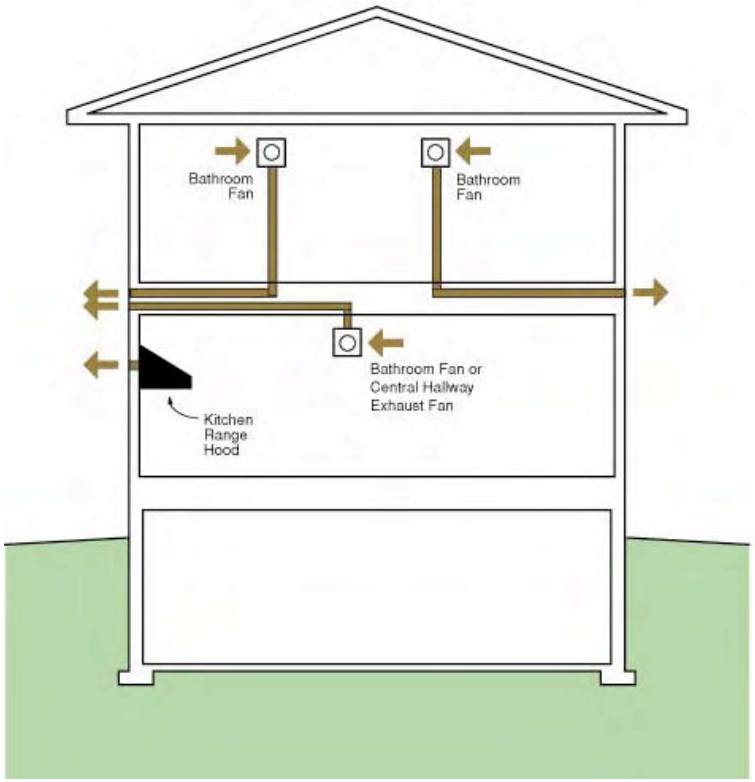
- Energy is spent in the process

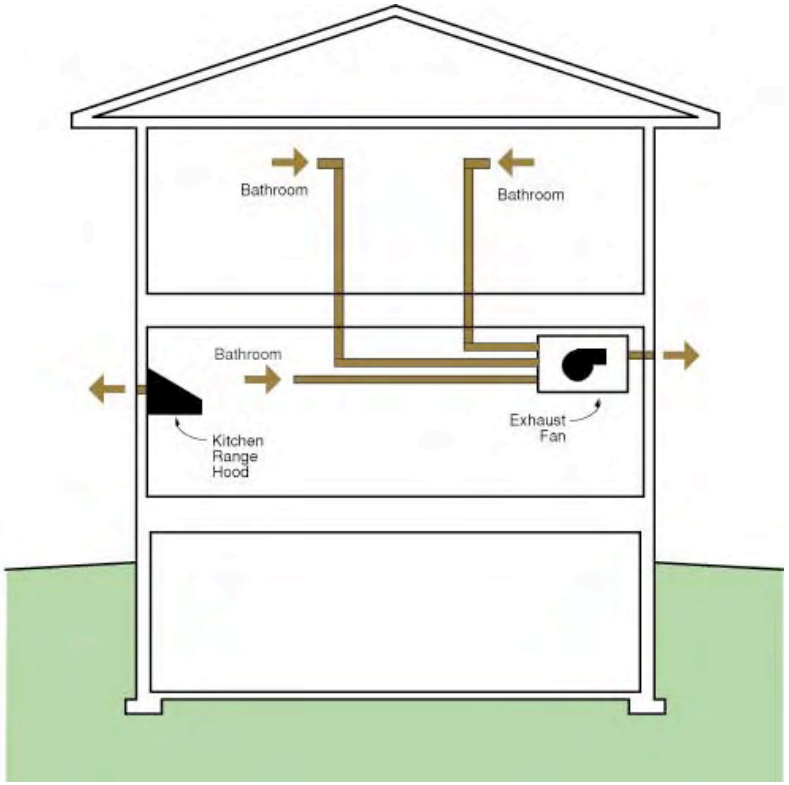
Bringing in Outside Air Can Be Expensive in Terms of Energy

- We do not want to bring in more than we need
- If we build a perfectly tight enclosure and eliminate uncontrolled air leakage,the above is possible

Bringing in Humid Air Can Be a Problem

- **Humidity is not a pollutant-but can create one**
  - It takes energy to dry air
  - This energy used to come from building inefficient enclosures and using inefficient equipment
  - Now with good glass, good insulation, good lights, good appliances, we don't have enough heat available to run the A/C to dehumidify





•Continuously operating exhaust with central fan recycling for distribution and mixing (sealed combustion space/DHW heating)

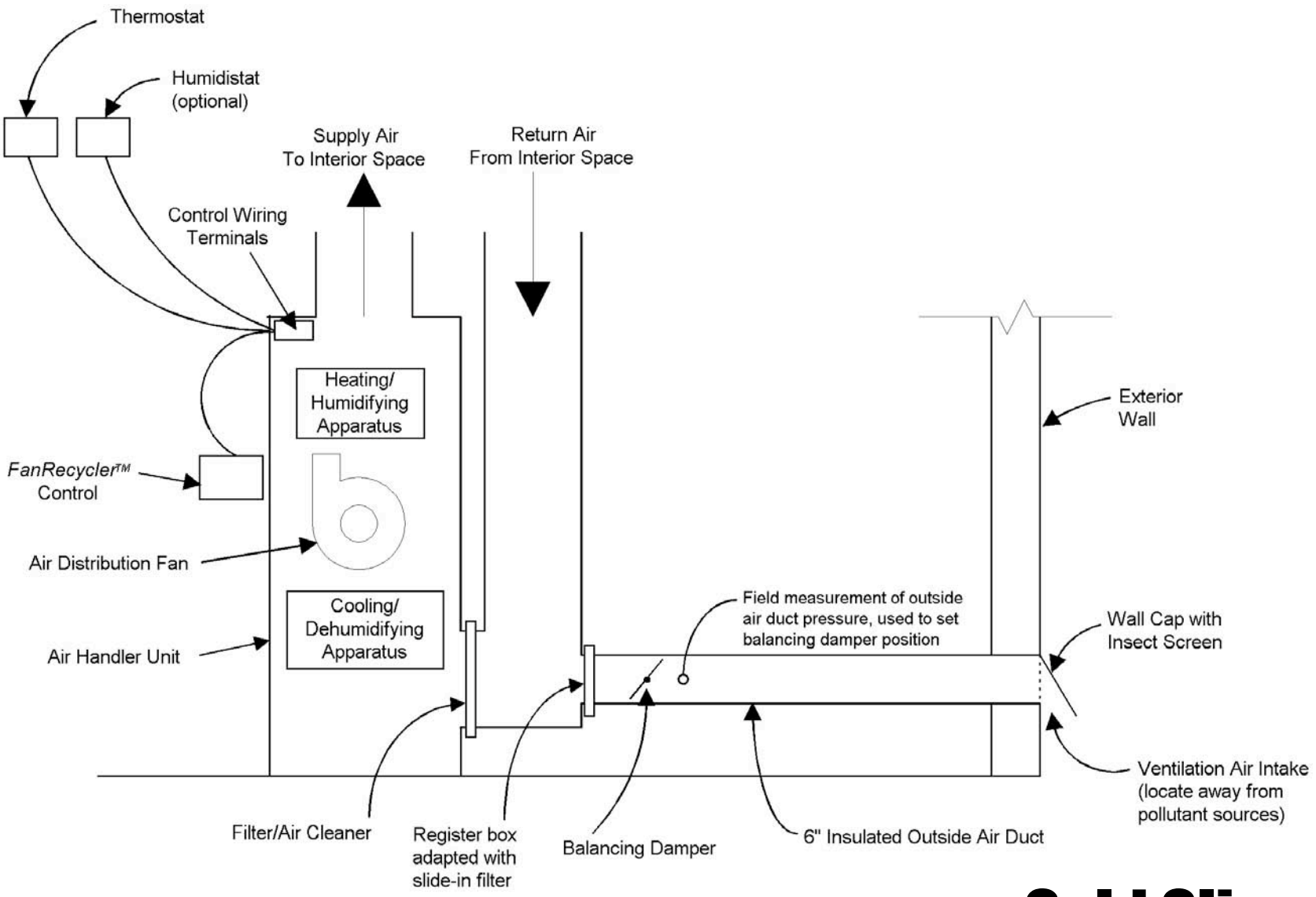
Exhaust Only

Exhaust Only

Inline fan ventilating house by drawing air from kitchen and 2 baths

Supply Only

- Can bring in outside air, mix it with inside air to temper it, and distribute it around the house.
- Can include filtration and/or dehumidification
- Moderate cost

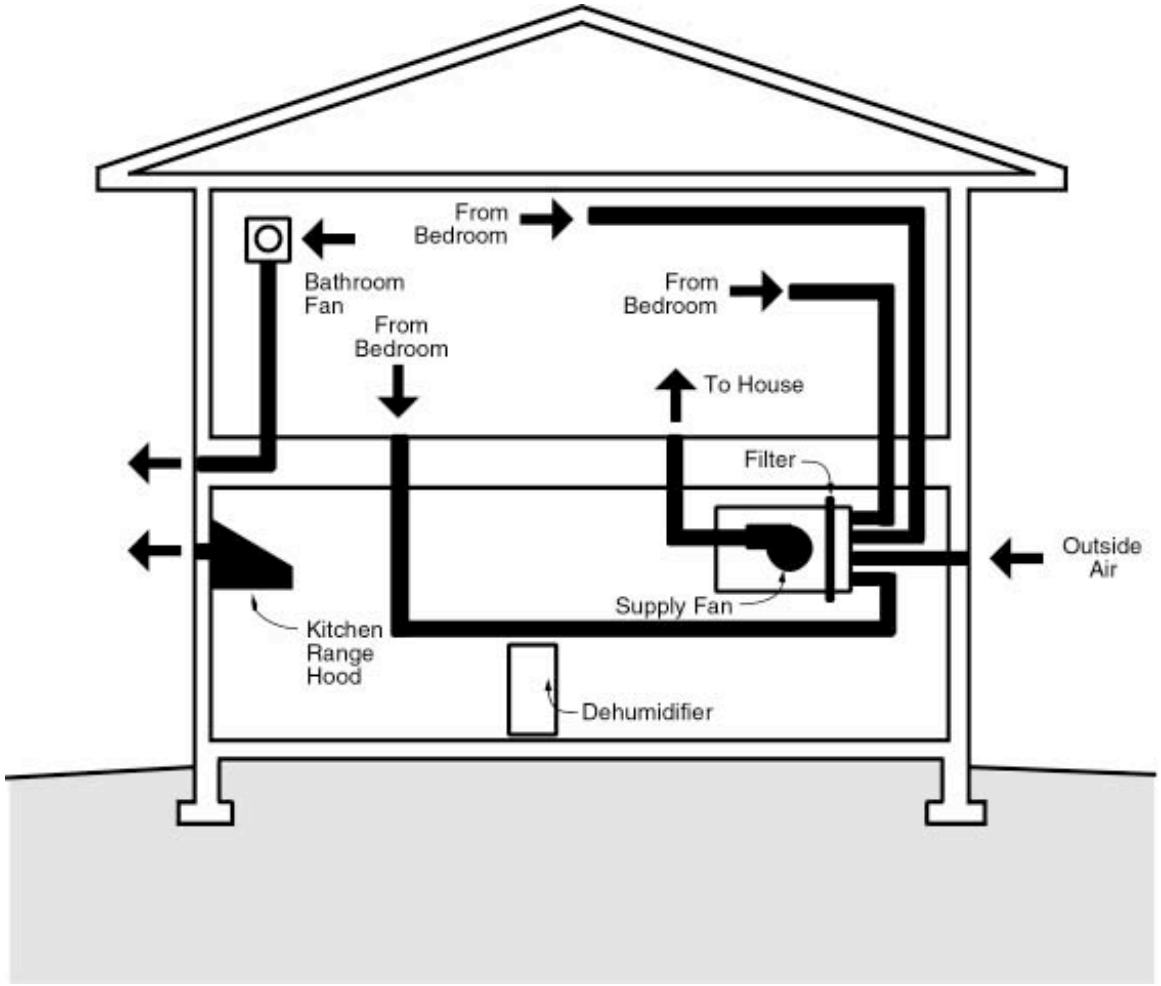


Cold Climate

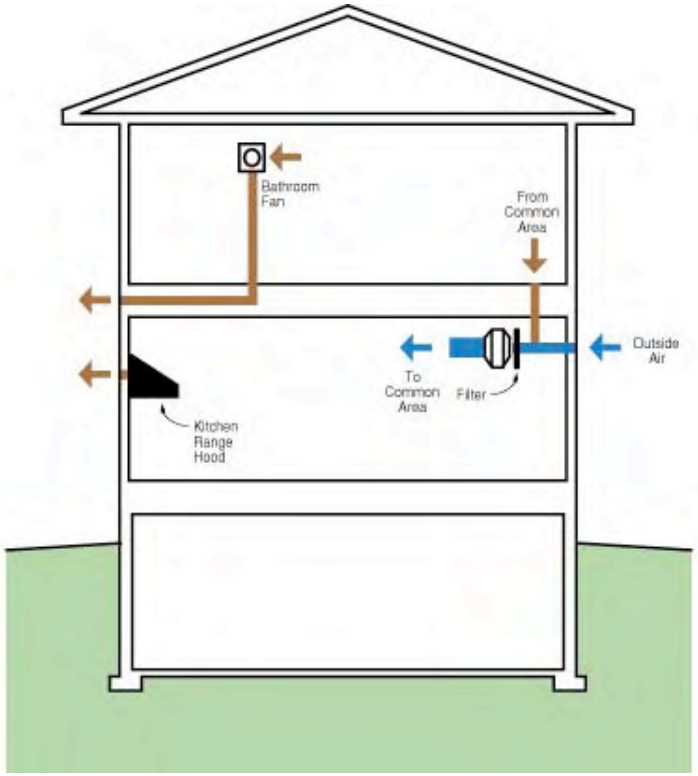
CENTRAL-FAN-INTEGRATED SUPPLY VENTILATION SYSTEM
Installation Configuration 1

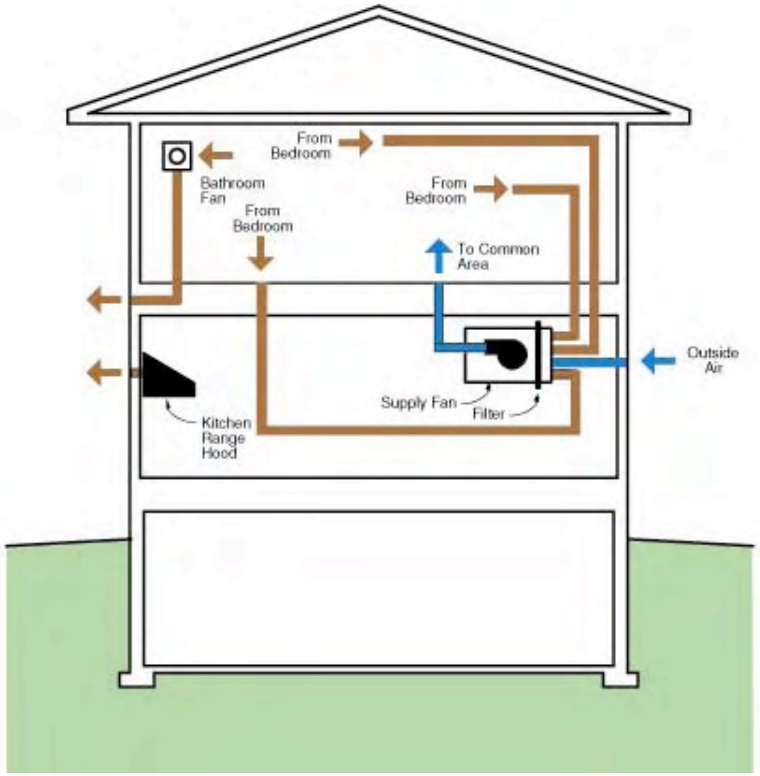
Fan Recycling Application

- **Activates the central system fan for a selectable ON time if it has been inactive for a selectable OFF time**
  - Improved comfort control by periodic mixing
  - Improved indoor air quality by periodic full distribution of ventilation air
  - Requires a central furnace or air handler



Non-Integrated Supply



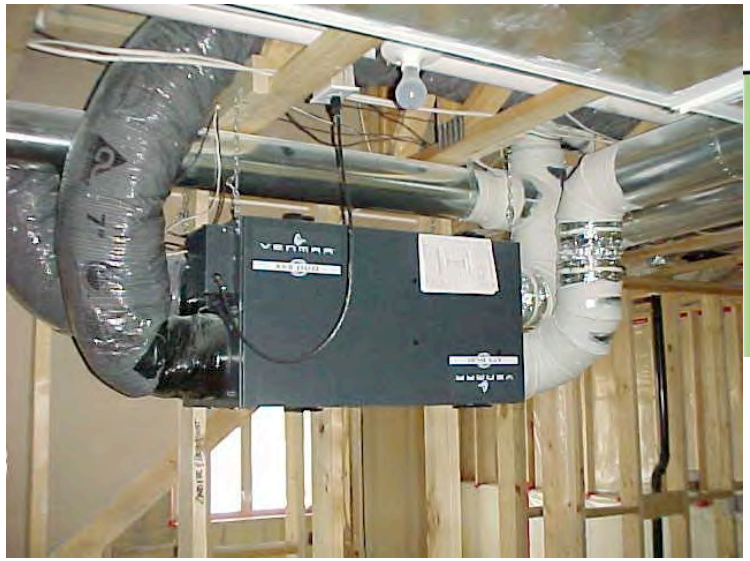


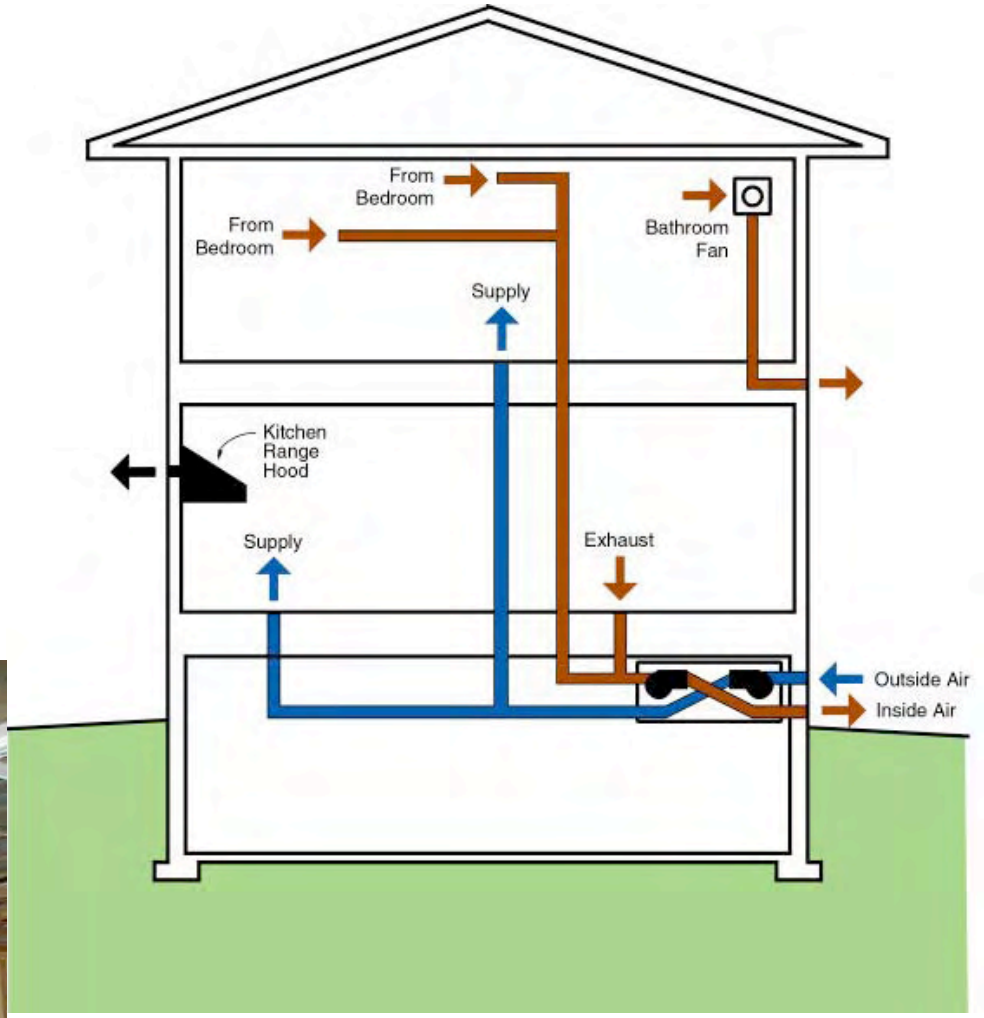
•Continuously operating supply with central fan recycling for distribution and mixing
•Limitations: Forgiving envelope, low interior RH

Supply Only

- Balanced heat recovery ventilation with central fan recycling for distribution and mixing or

- Fully-ducted multi-point HRV system





Balanced Cold Climates