FOCUSED ENERGY. *For Life.*

Impact of Energy Codes on Exiting Homes

Improving Efficiency, Comfort, and Health

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Energy Code Resources

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Energy Code Resources

Missouri Residential Building Energy Code Construction Practices Study:
https://energy.mo.gov/energy-codes/missouri-residential-building-codes-study
For additional information on other DOE Field Studies and participating states, please visit https://www.energycodes.gov/compliance/energy-code-field-studies.
Additional education resources are available at www.southfaceonlinetraining.org.

www.southface.org => Resources => GA Energy Code Resources

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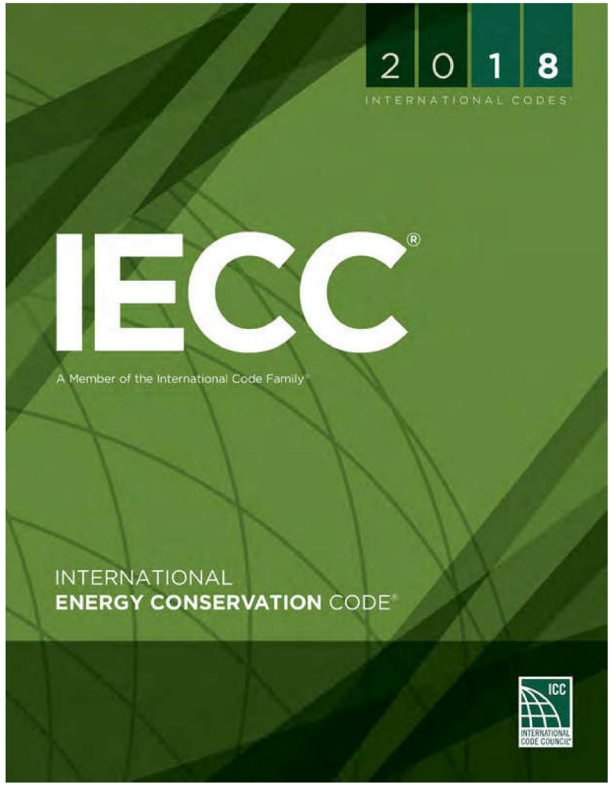
Learning Objectives

- Quick Building Science review
- Safety issues:
  Asbestos, Lead, Mold & moisture, Combustion Safety, Radon
- Using the Code: Correctly Air sealing and Insulating the house
- Ductwork
- Lighting

Importance of Energy Codes

- **Saves energy** - Buildings consume 40% of energy in U.S.
- **Saves money** - Energy costs continue to escalate, and energy codes help keep money within local economy
- **Additional benefits:**
  - Increases comfort, health and durability of homes
  - Increases value of homes in local community
  - Reduces liability for builders and subcontractors



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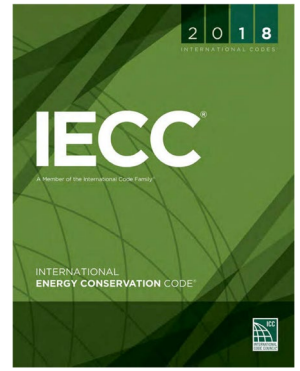
Scope of Residential Energy Code



- Focus is on building thermal envelope
  - Ceilings, walls, windows, floors, and foundations
  - Sets insulation and fenestration levels, and solar heat gain coefficients
  - Infiltration control – caulk and seal to prevent air leaks, and test
- Ducts, air handlers, filter boxes – seal, insulate, and test
- Limited space heating, air conditioning, and water heating requirements
- Federal law sets most mechanical equipment efficiency levels, not the I-codes (similar for appliances)
- Lighting equipment – 90% of lamps to be high-efficacy lamps or 90% of lighting fixtures to have only high-efficacy lamps

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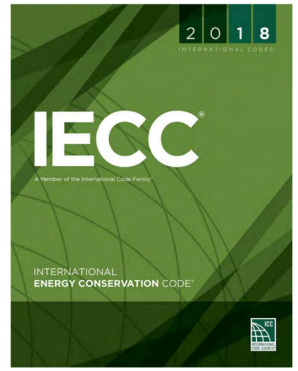
Residential Buildings

- New construction
- 1 and 2 family (R3)
- Multi-family, 3 stories and less (R2 and R4) – IECC 2015
- Additions, Alterations, Repairs



ALTERATION. Any construction, retrofit or renovation to an existing structure other than *repair* or *addition*. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

CONDITIONED SPACE. An area, room or space that is enclosed within the *building thermal envelope* and that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

Exempt Buildings

- Low energy < 1 w/sq.ft.
- No conditioning
- Log homes – ICC400
- Historic buildings (501.6)

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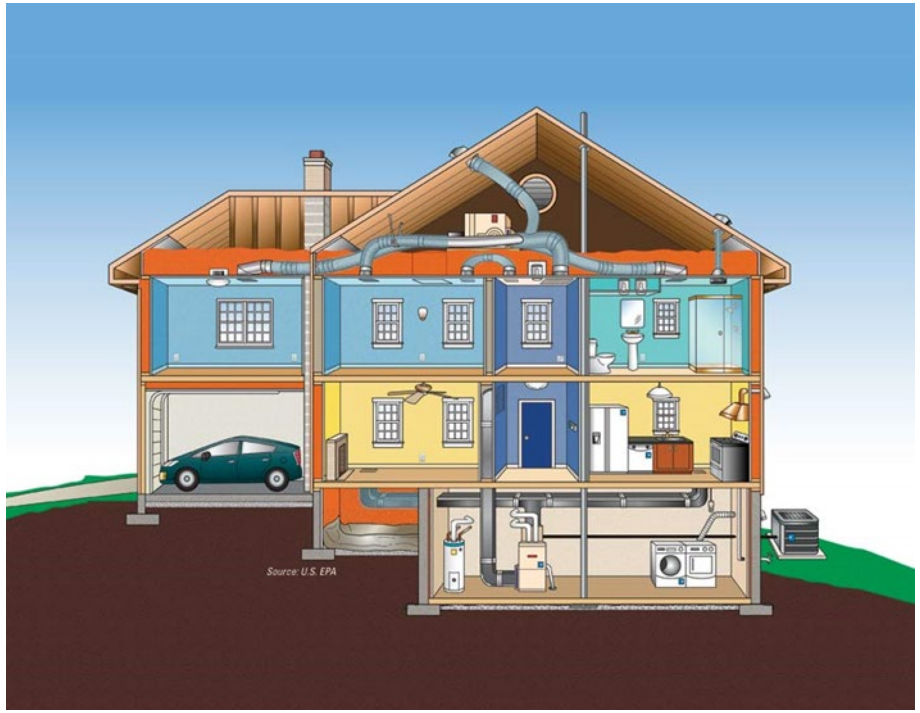
Building Science

Improving Efficiency, Comfort, and Health in Existing Homes

The house as a system

- A house is a system made up of interrelated parts:
  - Building thermal envelope
  - Space conditioning
  - Ventilation
  - Water heating & distribution
  - Lighting & appliances
- Building science represents a holistic view of a house and applies an understanding of the flow of:
  Heat, Air, and Moisture



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Section R402 – Building Thermal Envelope

- The building thermal envelope is the barrier that separates conditioned space from unconditioned space

- The envelope should consist of a **continuous** thermal boundary (insulation) and a **continuous** air barrier that are in complete contact

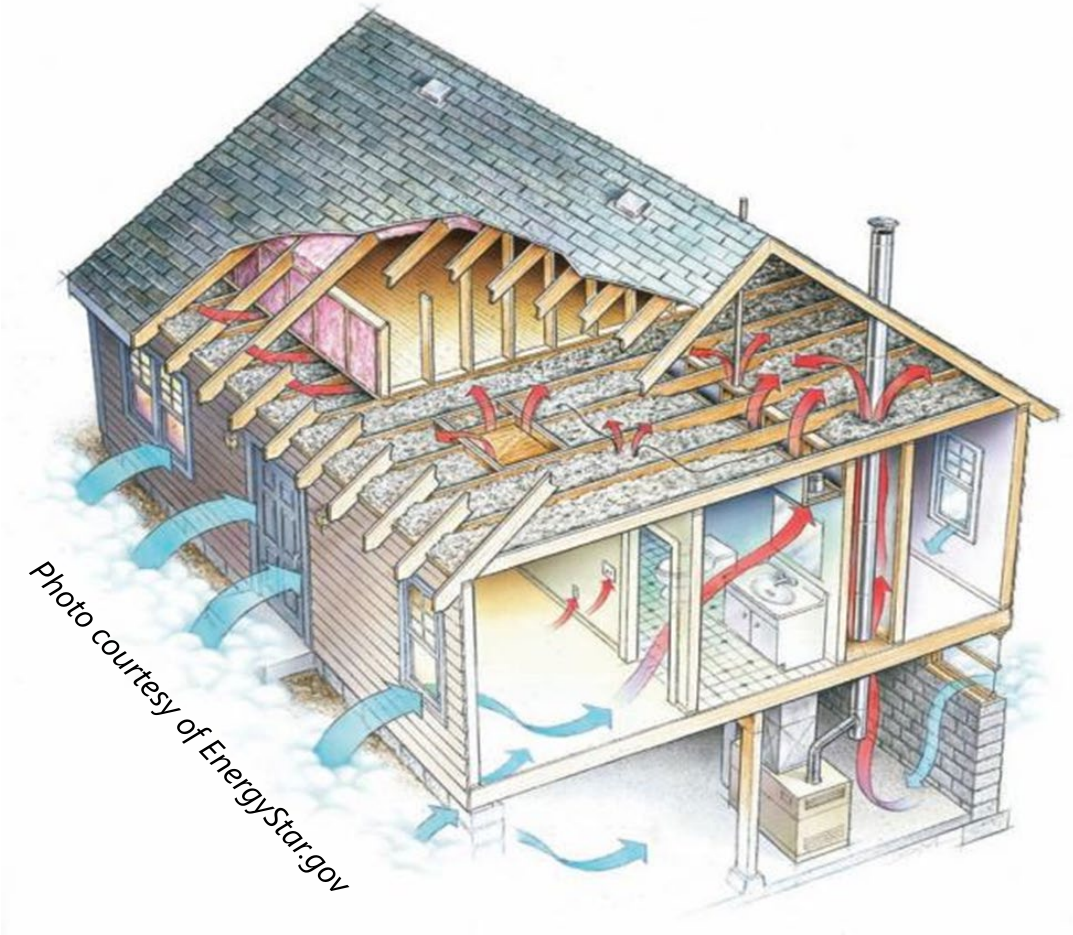
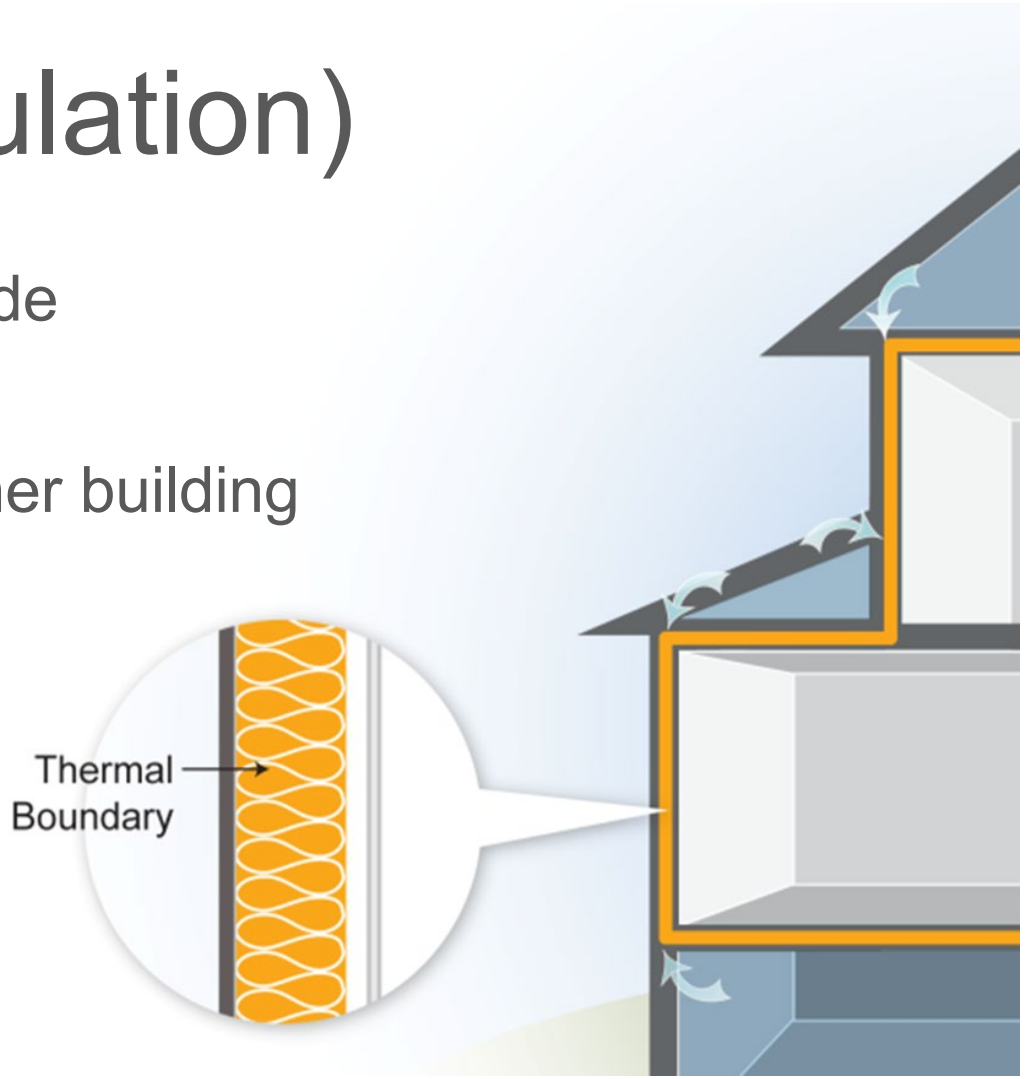


Photo courtesy of EnergyStar.gov

Thermal Boundary (Insulation)

- Limits heat flow between inside and outside
- Easy to identify by presence of insulation
- The location of insulation in relation to other building components is critical to its effectiveness
- Even small areas of missing insulation are critical
- Voids of 7% can reduce effective R-value by 50%



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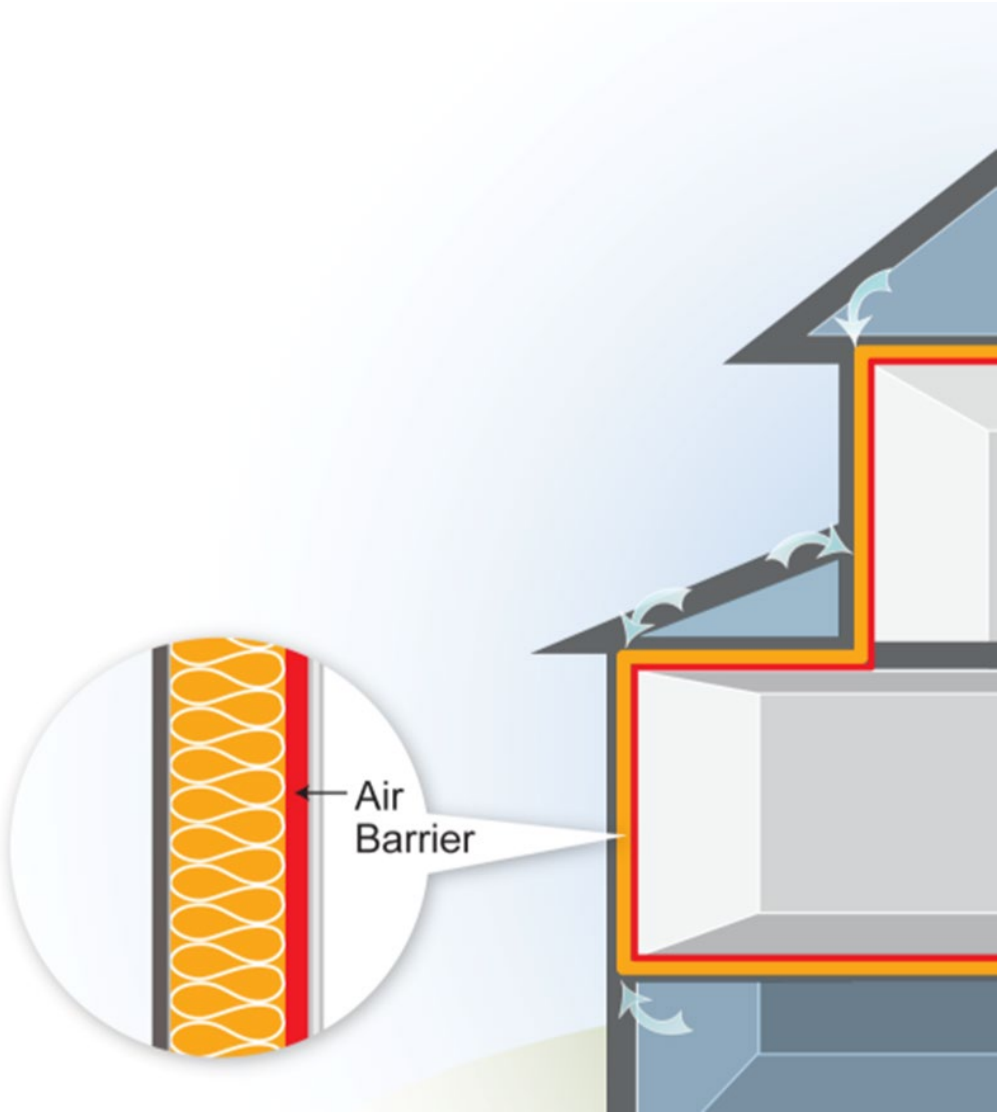
Air Barrier

- Limits airflow between inside and outside
- More difficult to identify
- Not always where you think it is
- Must be co-located with the thermal boundary
- Must be continuous
- Blower door is used to locate & verify air barrier



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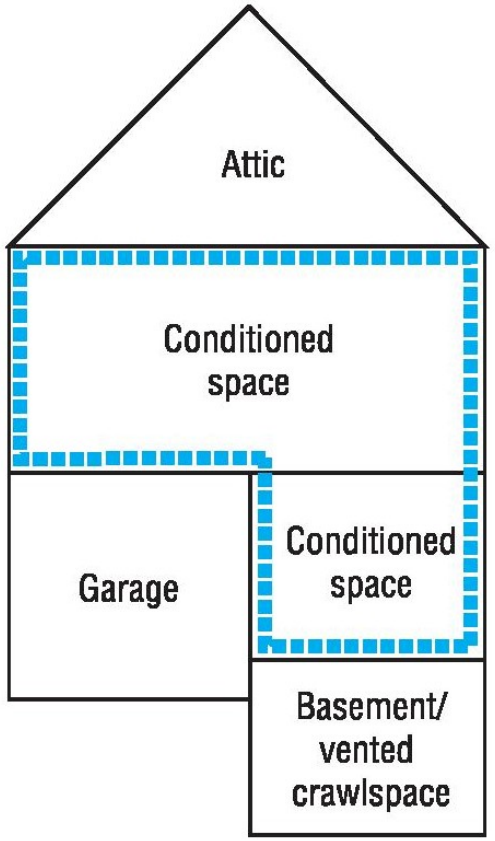
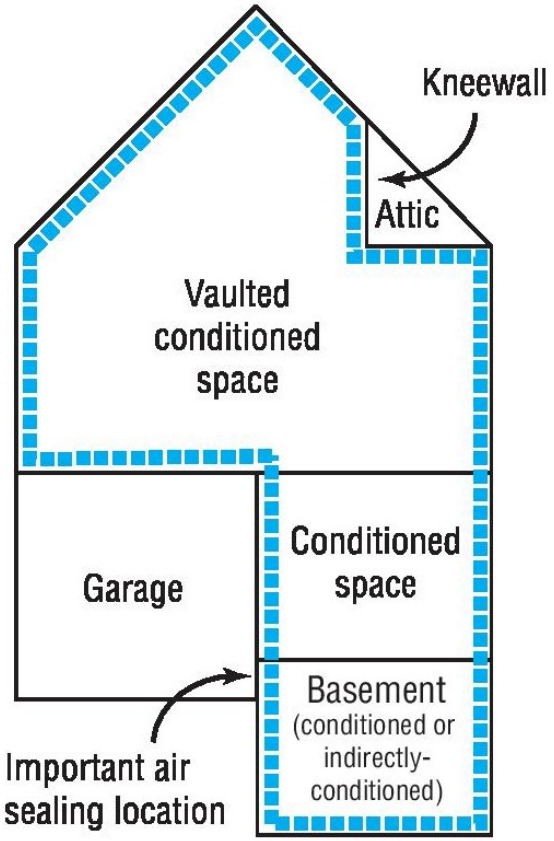
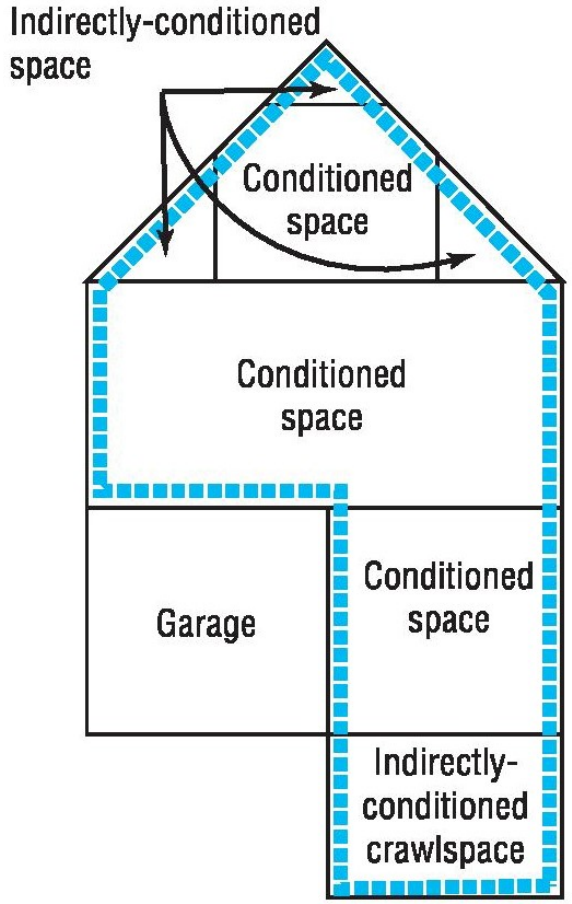
Thermal Envelope Example







*Although these three homes look identical from the outside, each has defined the building thermal envelope differently

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Heat Transfer

- Heat is a form of energy
- Heat moves from hot to cold
- 3 methods of heat transfer:
  - Conduction – heat moves through a material
  - Convection – heat energy carried by a fluid (including air)
  - Radiation – heat “emits” from a hot surface to a cooler surface

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Radiation

Radiation is the movement of heat from a hot surface to a cold surface with nothing solid or opaque in between (low-emitting surfaces slow radiation)

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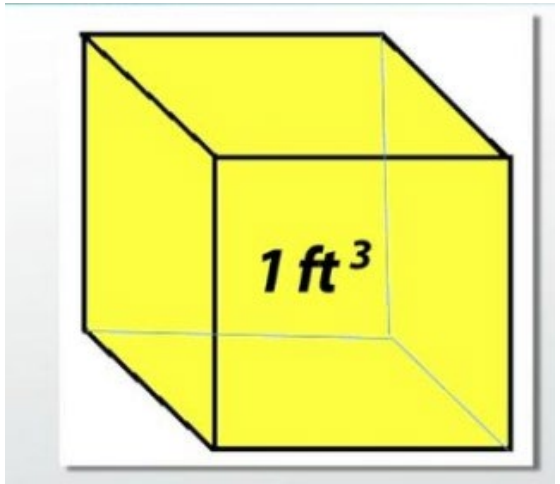
Convection

- Outdoor air of different temperature replacing indoor air
- Air moves from areas of higher pressure to areas of lower pressure
- Natural and man-made forces that can create pressure differences cause air to flow
- Whenever air moves out of a home, an equal amount of air enters the home

Conduction

- Heat moves through a material
- Insulation can slow down conduction
  - How well a material slows conduction is called resistance
  - Resistance is measure of R-value, inverse is U-value

Air Leakage



- Airflow is measured in cubic feet per minute, also written as ft^3/min, or CFM
- 1 CFM out = 1 CFM in
- Airflow takes the path of least resistance
- Air moves from high to low pressure areas
- Air usually moves from high to low temperature areas

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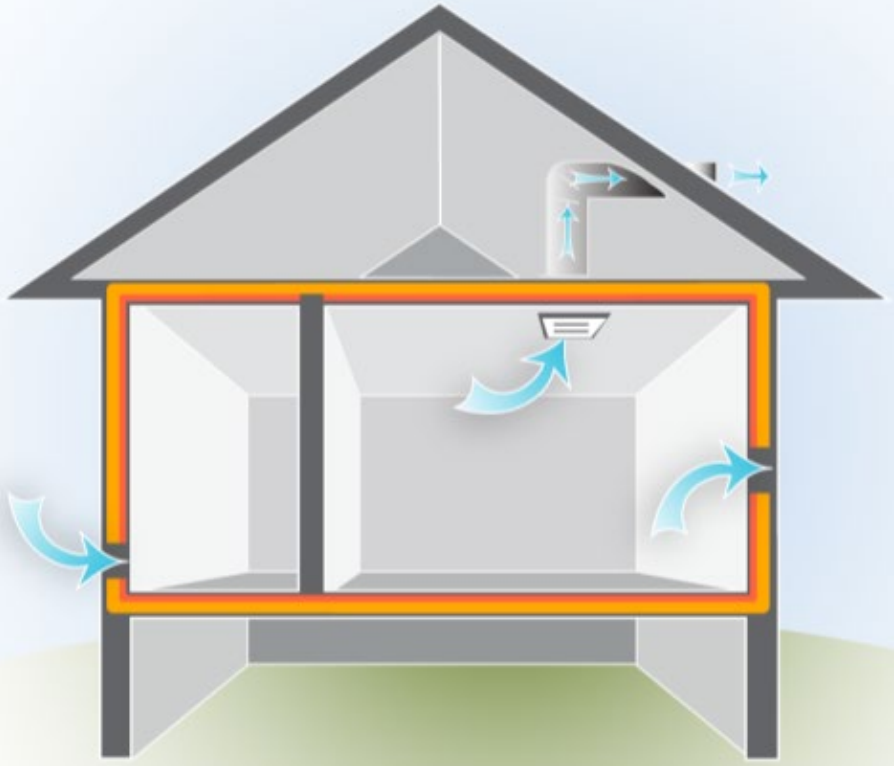
Air Leakage

Ventilation = Controlled air leakage



Infiltration =
Air leaking in

Exfiltration =
Air leaking out

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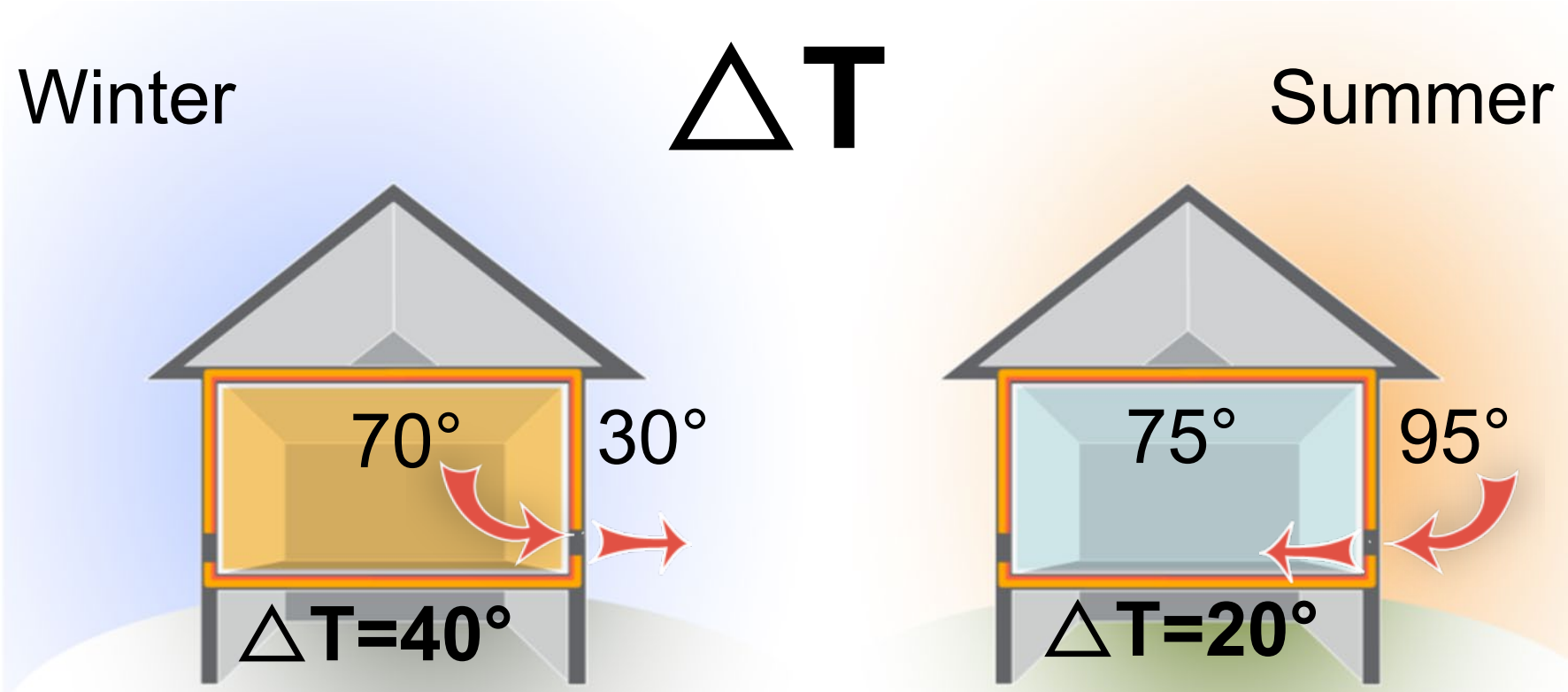
Heat Flow: Temperature Difference



Heat Flow is from _____ to _____

The higher the △T, the more heat and air will move

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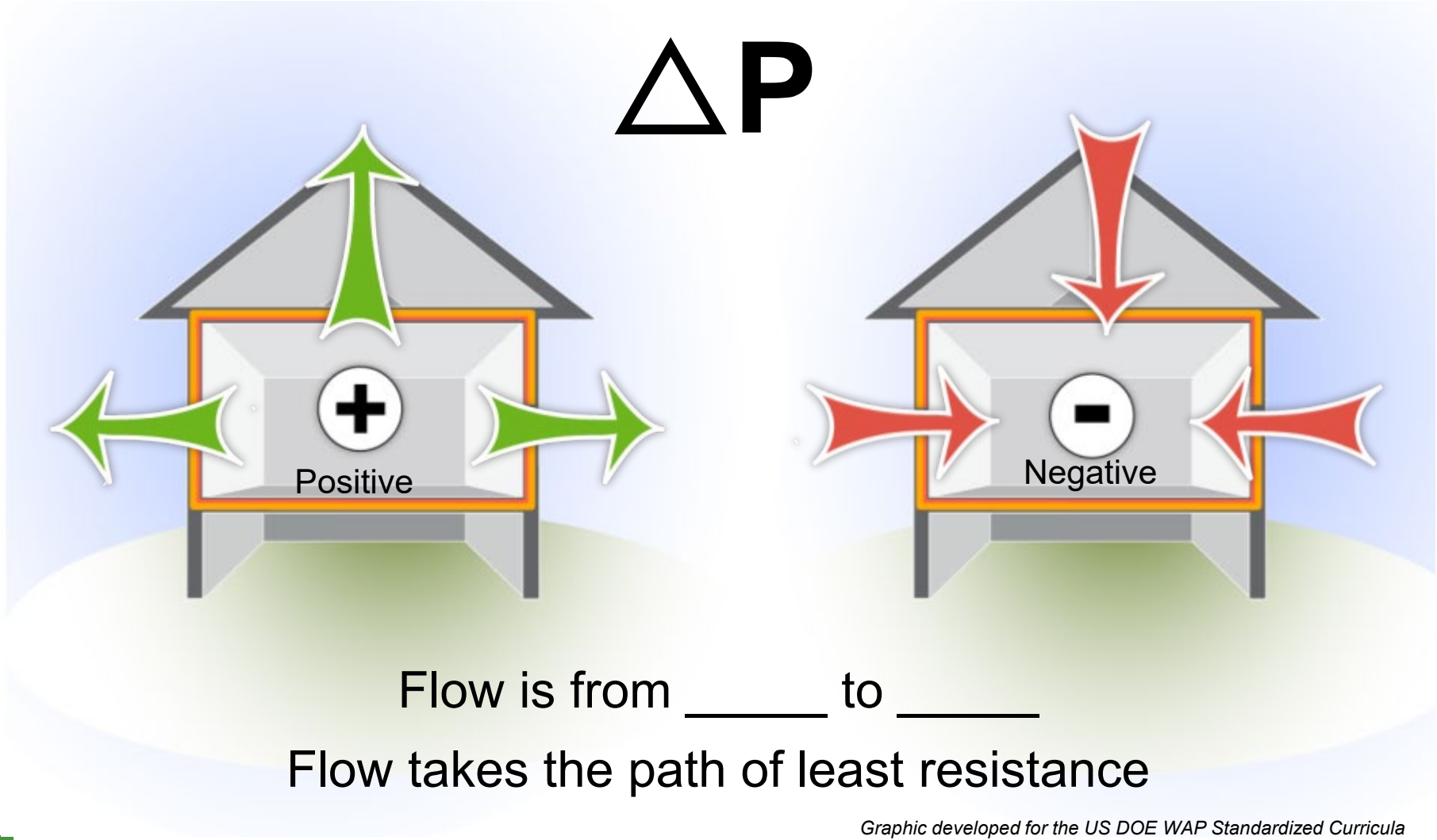
Air Leakage: Pressure



Flow is from _____ to _____

Flow takes the path of least resistance

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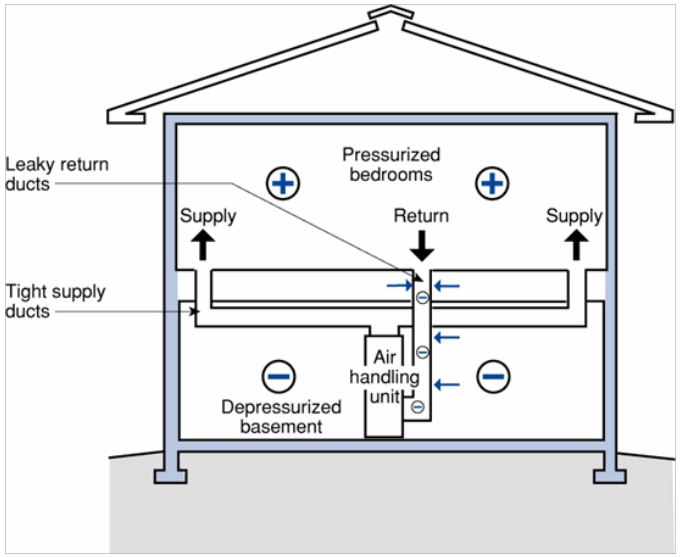
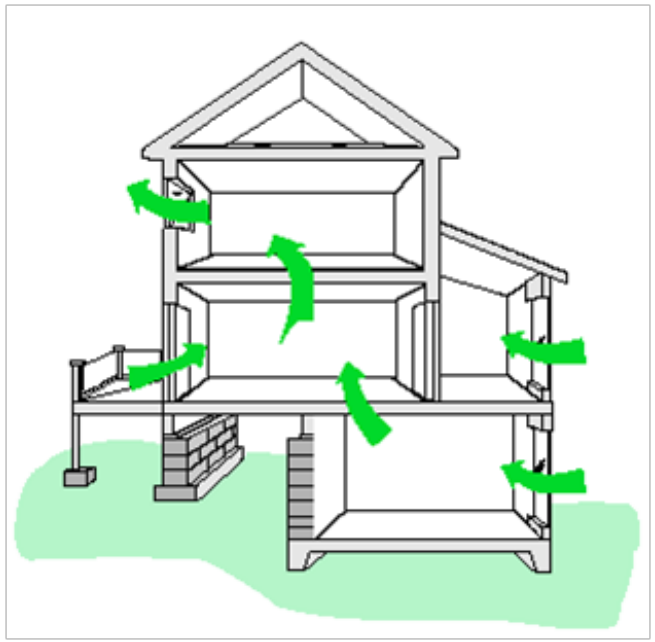
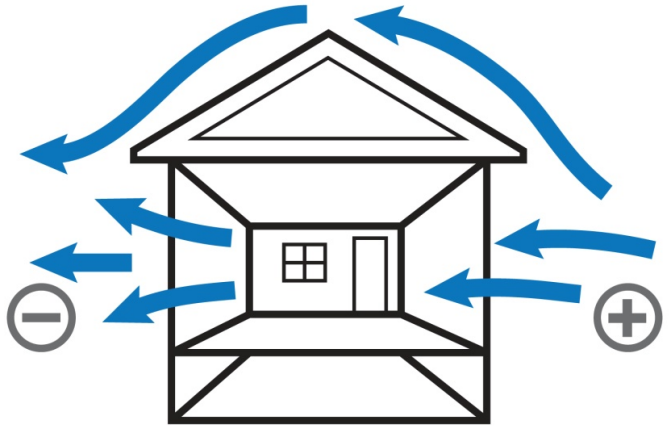
Air Leakage: Driving Forces

Three forces create pressure differences in a home:

- Wind
- Stack Effect
- Mechanical Fans







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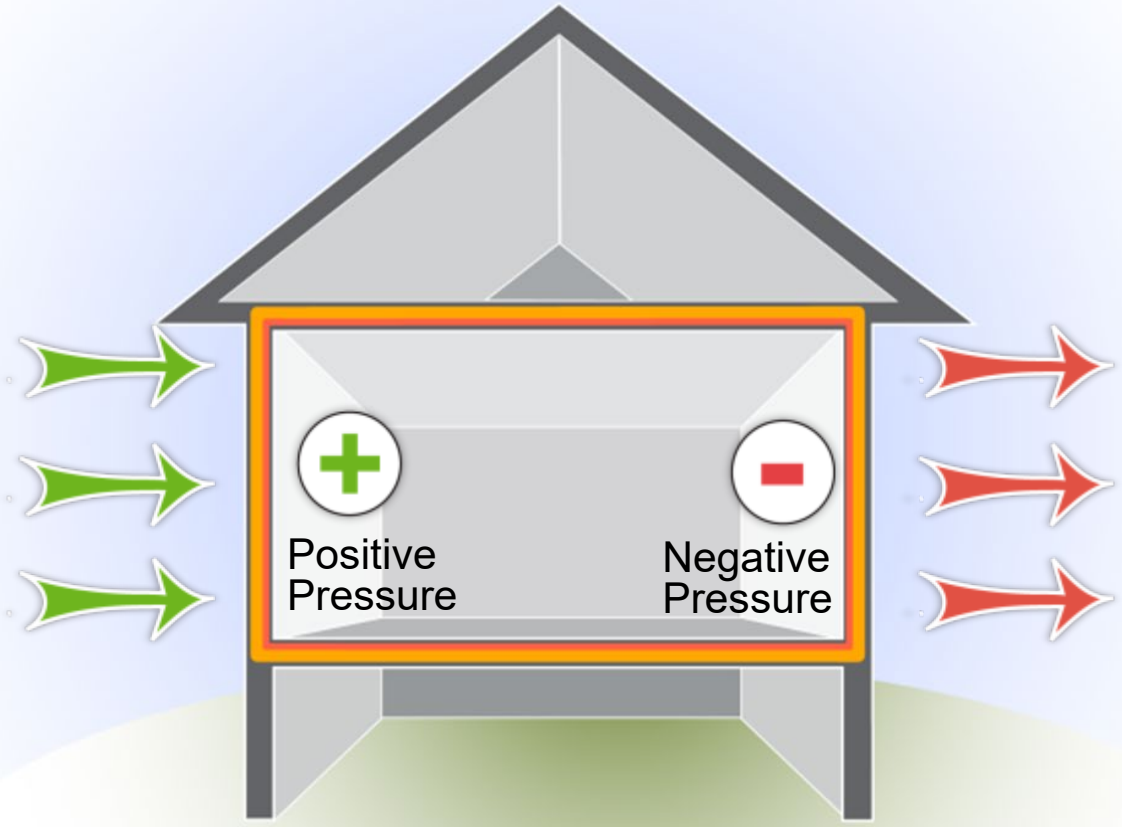
Driving Forces: Wind Effect

Wind creates a positive pressure on the windward side of the building



Which creates a negative pressure on the leeward side of the house

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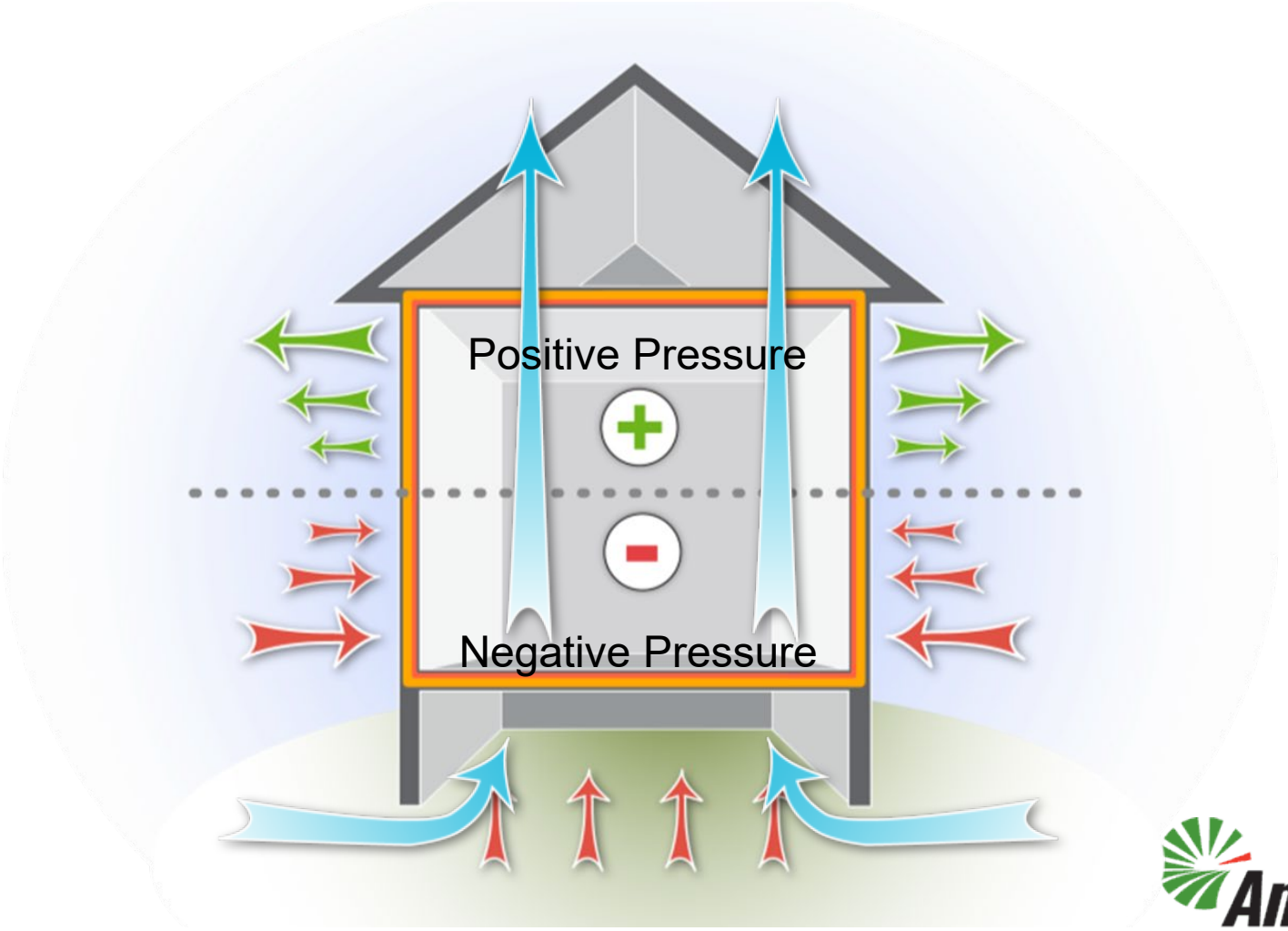
Driving Forces: Stack Effect

Warmer air rises and escapes out of the top of the house

Which creates a suction that pulls in outside air at the bottom of the house



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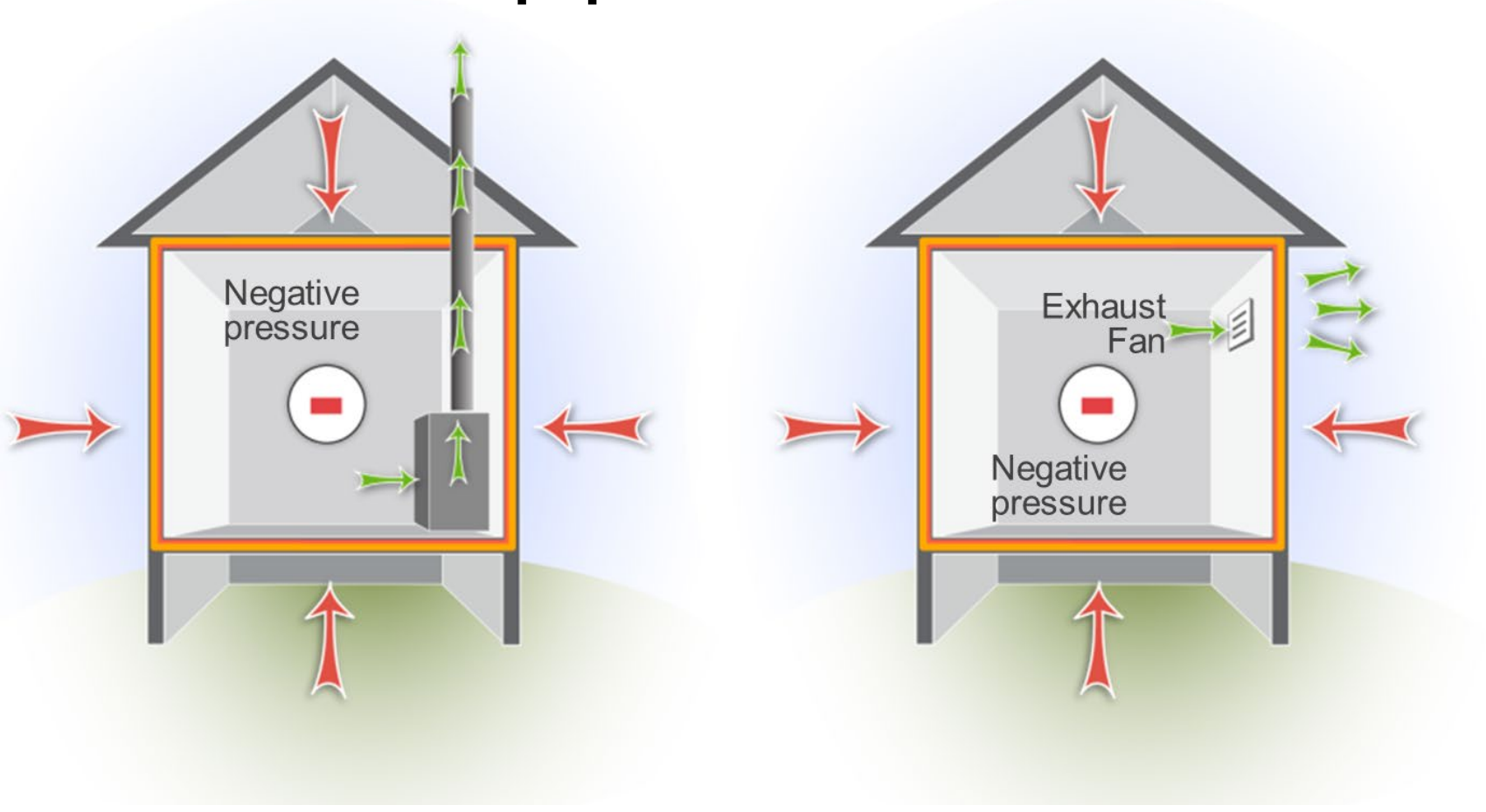
Driving Forces: Mechanical Effect

Combustion Equipment & Exhaust Fans



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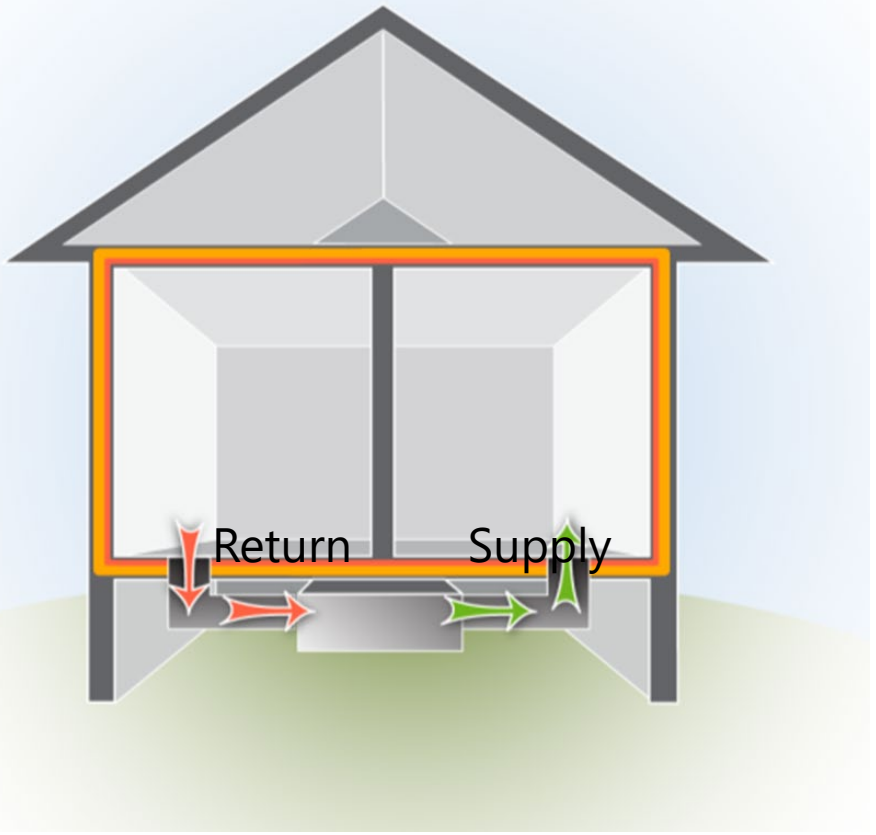
Driving Forces: Mechanical Effect

Duct Leakage

Duct leakage can create positive and negative pressures in different areas of the house

The pressures associated with duct leaks can be larger and more significant because the driving force is stronger



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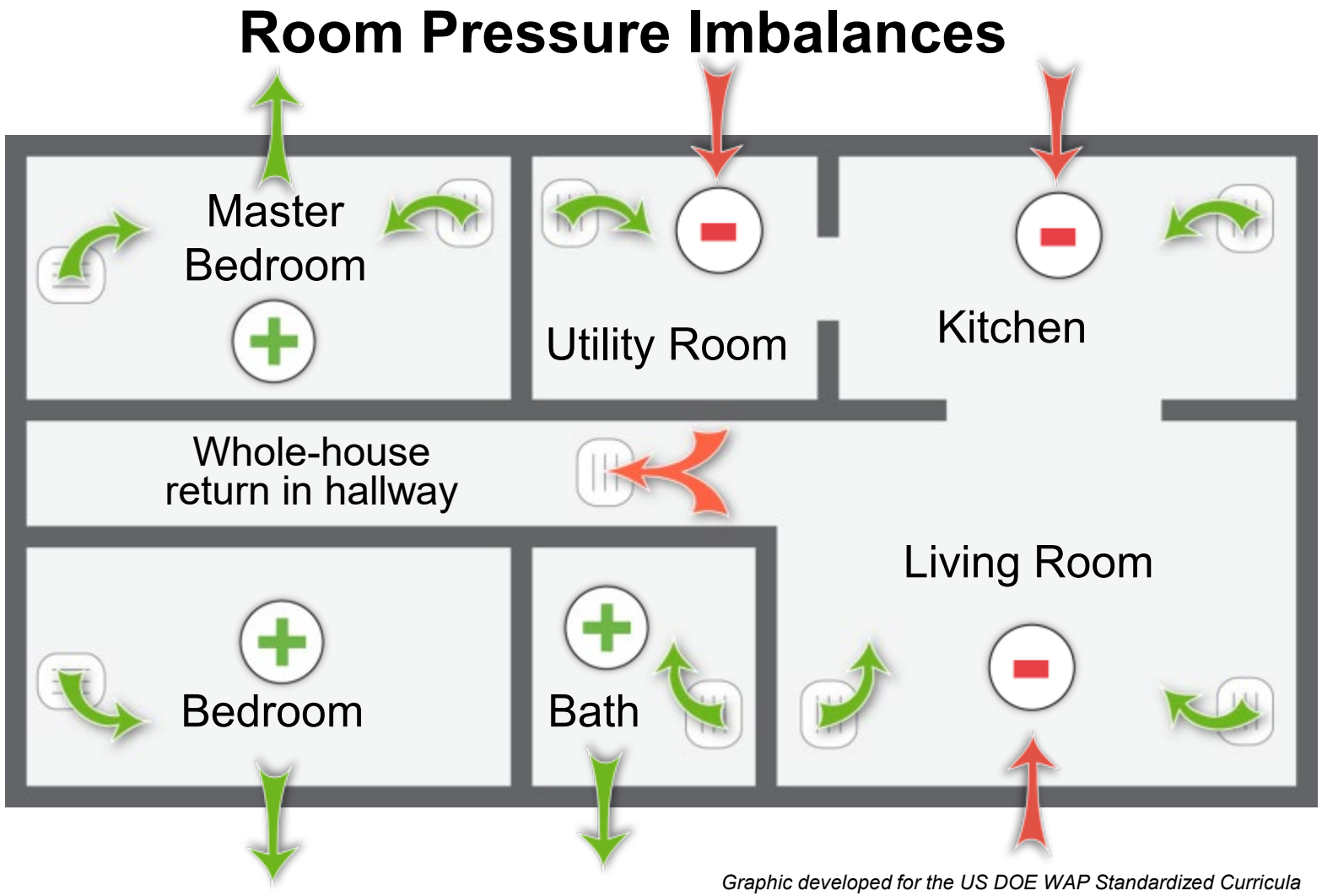
Driving Forces: Mechanical effect



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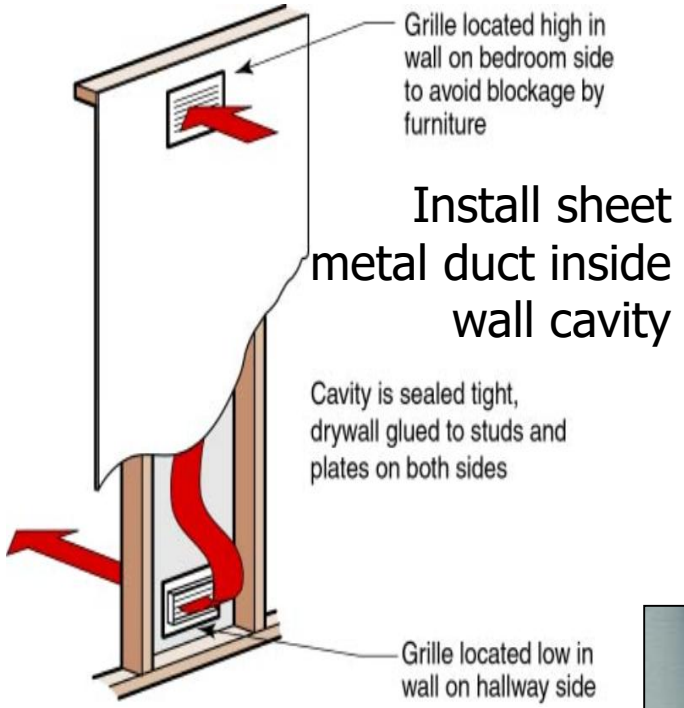
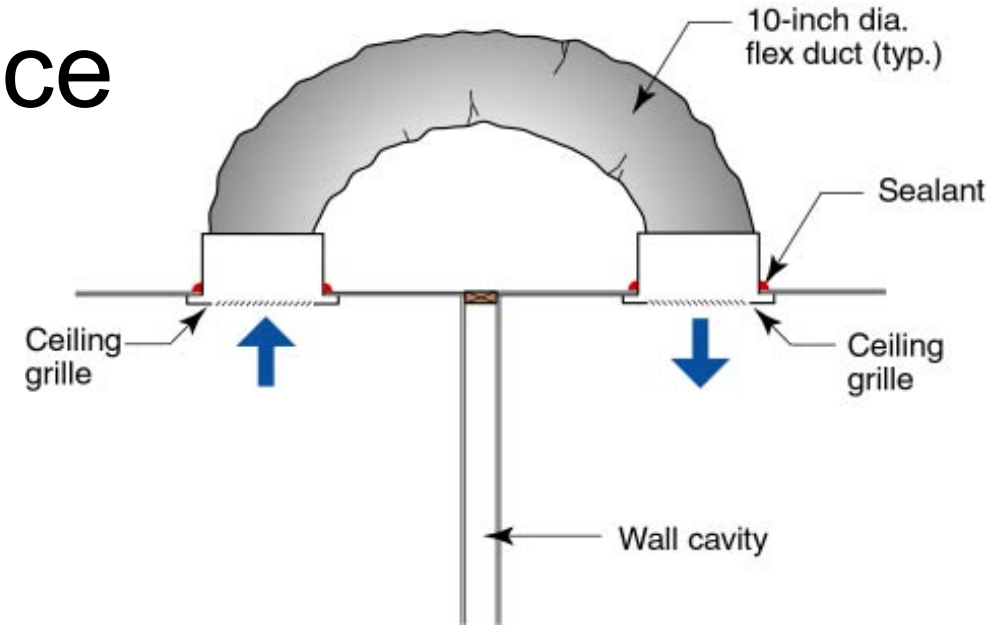
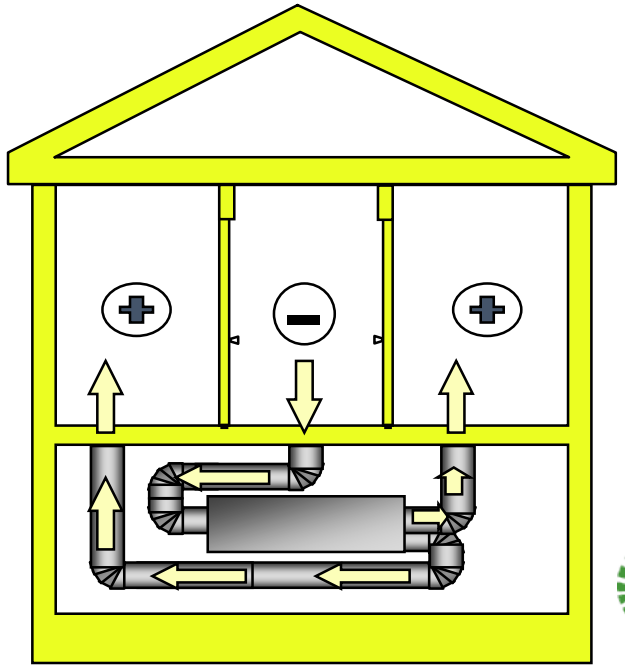
Correcting Pressure Imbalance with a Proper Return Path



Install sheet metal duct inside wall cavity

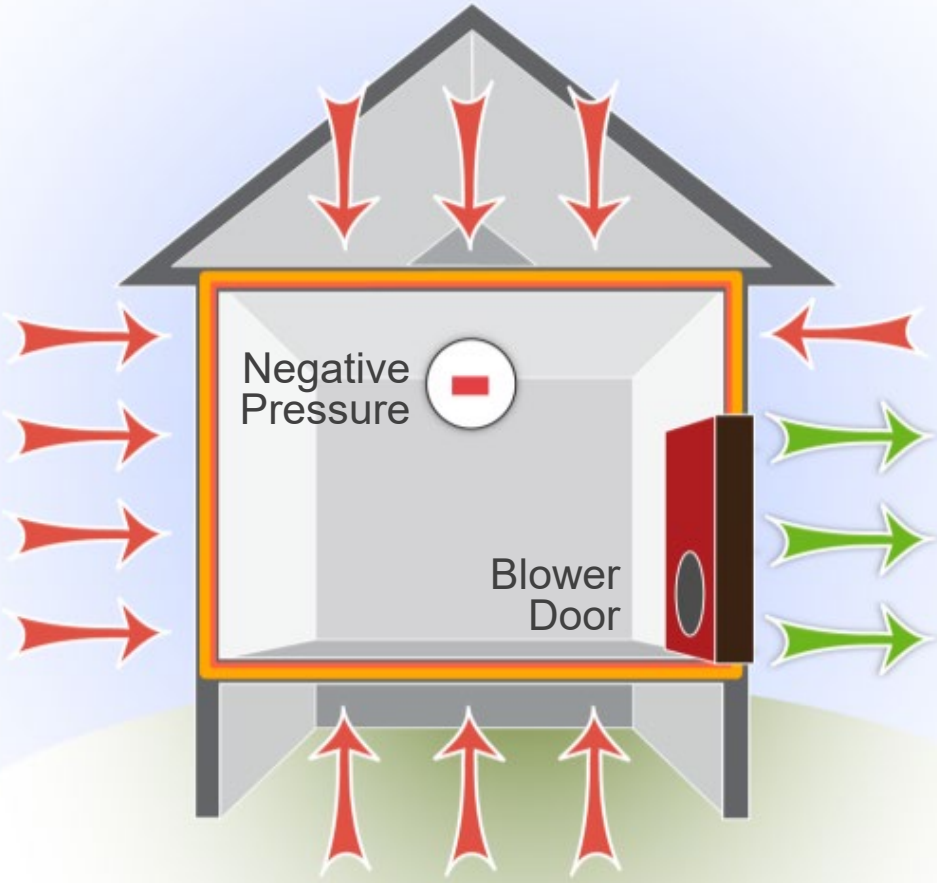




Driving Forces: Mechanical Effect

Use a Blower Door as a Controlled Driving Force

Using the blower door depressurizes the house, drawing air through all the holes between inside and outside



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MOISTURE TRANSPORT

Moisture moves…

…from wet to dry

- **Liquid** Water
  - Bulk (rain/drainage, plumbing)
  - Capillarity (wicking)
- Water **Vapor**
  - Diffusion (molecular)
  - Air Leakage (infiltration)

Geography matters!
What works in one region may not work in another

Appropriate measures for moisture control are essential!

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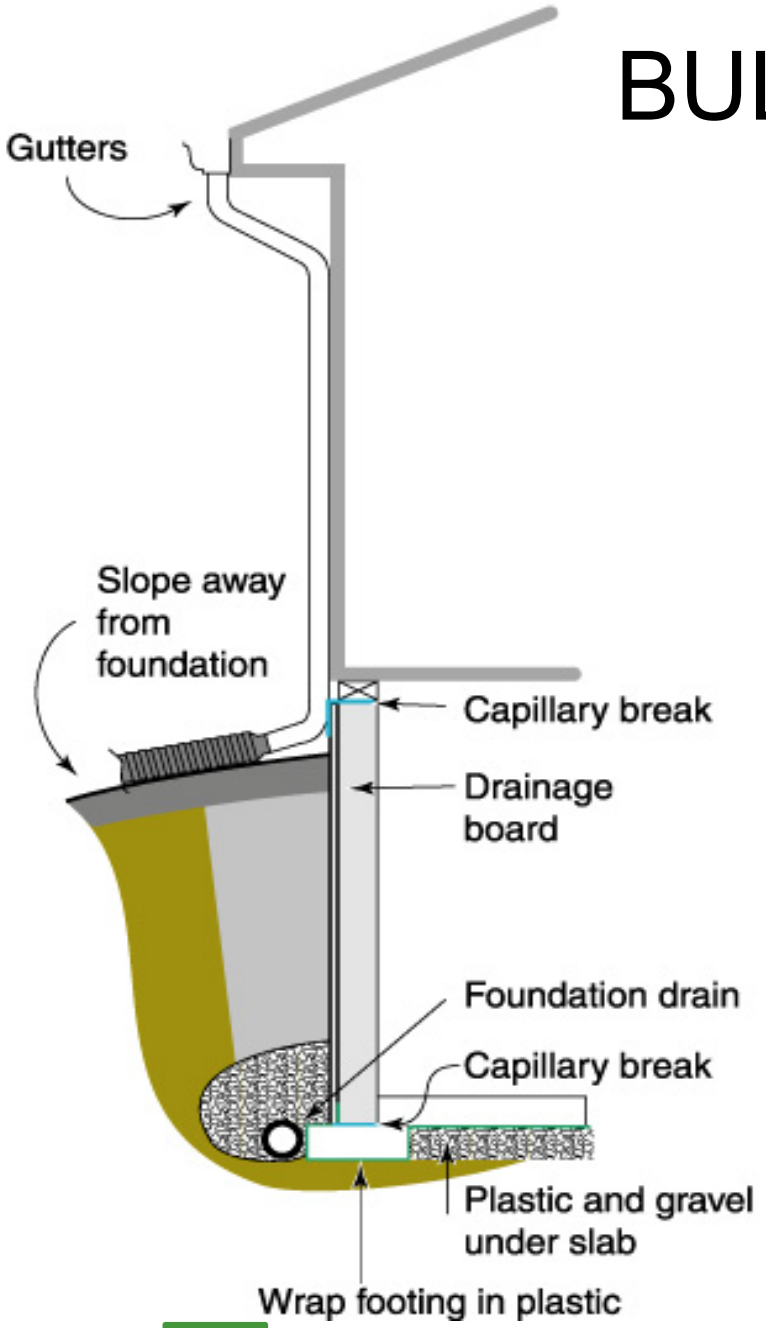
BULK MOISTURE CONTROL



- Proper site drainage
- Foundation waterproofing
- Plastic ground cover
- Gutters channel water away from foundation

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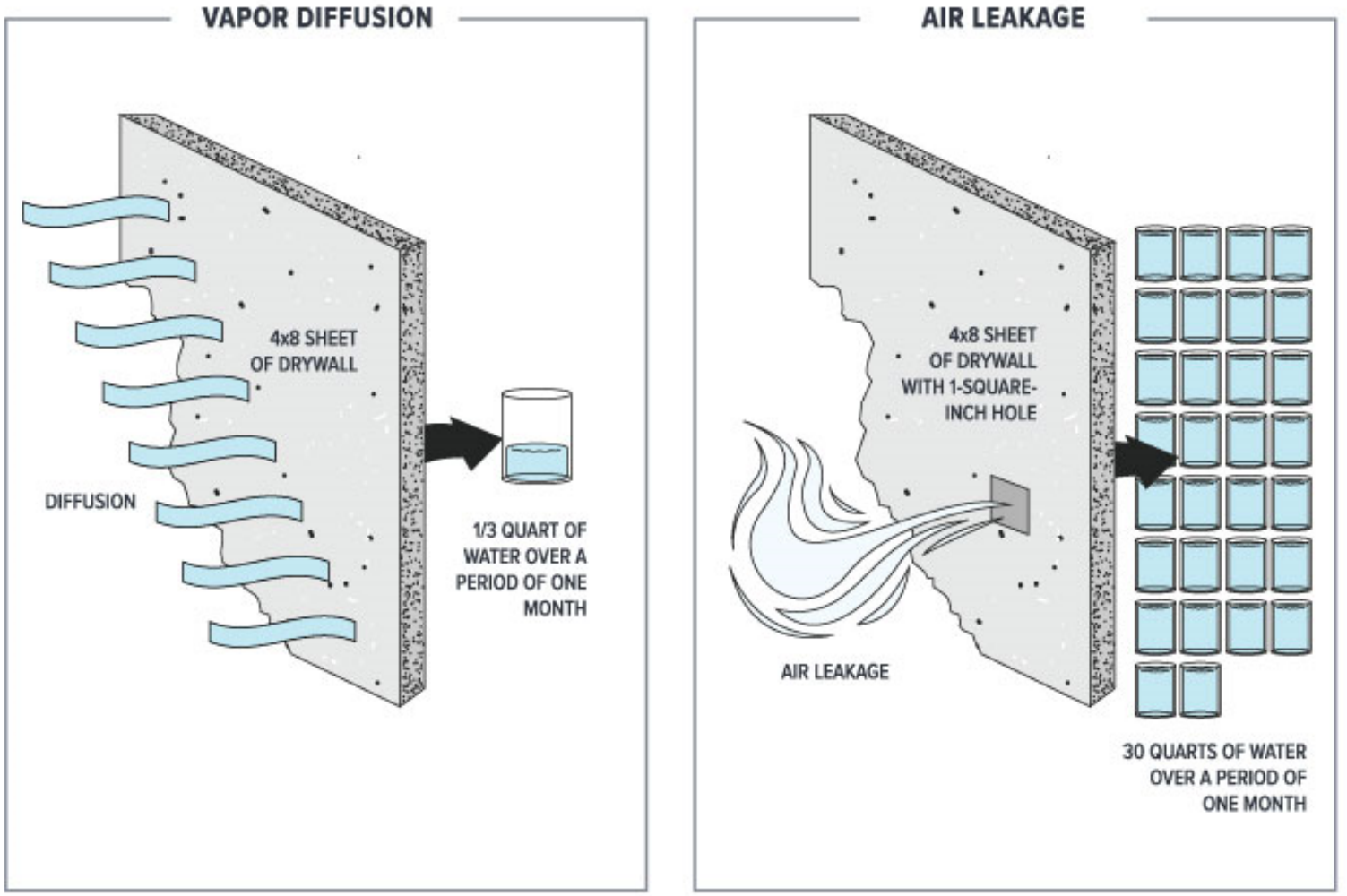
Moisture Vapor

Another reason to limit air flow in a home is to reduce moisture intrusion. Even a small hole can allow a large amount of water into the building.



VAPOR DIFFUSION VS. AIR LEAKAGE

INTERIOR TEMPERATURE = 70° F
RELATIVE HUMIDITY = 40%

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