HOME PERFORMANCE STAKEHOLDER COUNCIL | CLEAResult®

House-as-a-System Webinar

JUNE 26th, 2019

Home Performance Stakeholder Council

The Home Performance Stakeholder Council (HPSC) is composed of key industry players tasked with amalgamating and addressing the fragmented interests, opportunities, and challenges that exist in the home performance industry, which is evolving and growing.

HOME PERFORMANCE STAKEHOLDER COUNCIL

STEERING COMMITTEE | **EXECUTIVE GROUP**

SECTOR COUNCILS

RENOVATORS

HEATING & HVAC

INSULATION & AIR SEALING

FENESTRATION

ENERGY ADVISORS

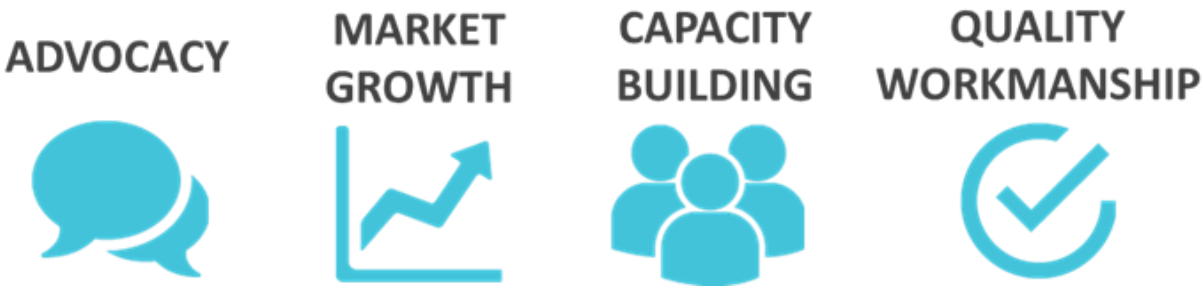
UTILITIES & GOVERNMENT

COUNCIL PARTICIPANTS

CONTRACTORS & SUB TRADES | TRADE SUPPLIERS | MANUFACTURERS & SUPPLIERS | SECTOR LEADERS

Where does the HPSC focus?

- The HPSC exists to help companies operating in home performance succeed and believe industry input is critical to developing effective long-term policies and programs that support home performance.
- HPSC acting as a facilitator for industry to provide an impactful voice on the unique needs of sectors operating in BC's home performance industry.

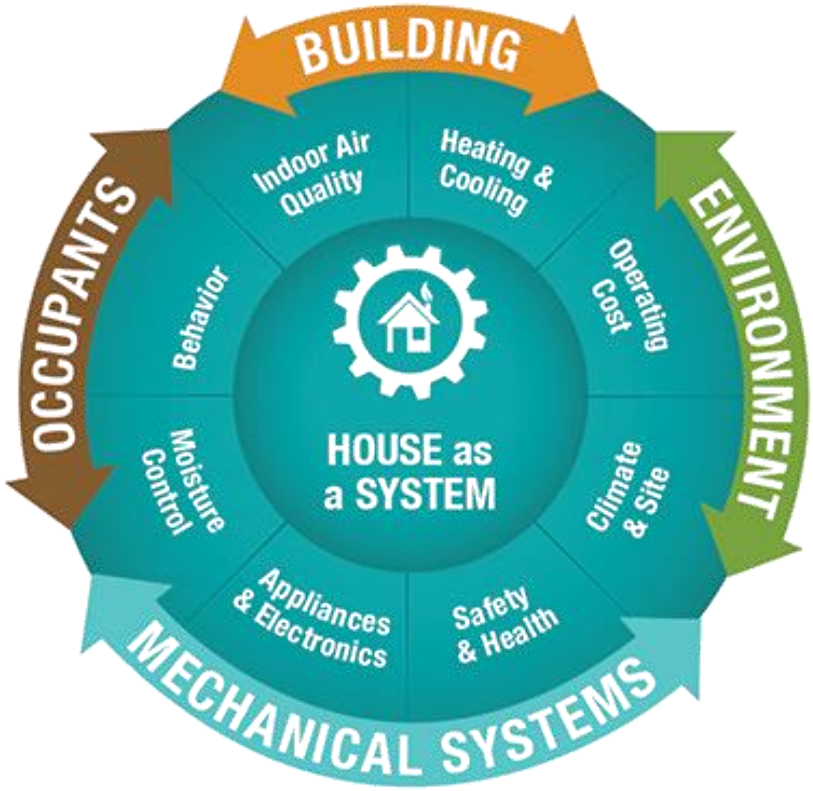


Funding Partner Acknowledgement

We gratefully acknowledge the financial support of BC Hydro, Fortis BC, and the Province of British Columbia.

Our Presenter: Bruce Manclark

The House is a System: Interacting Relationships



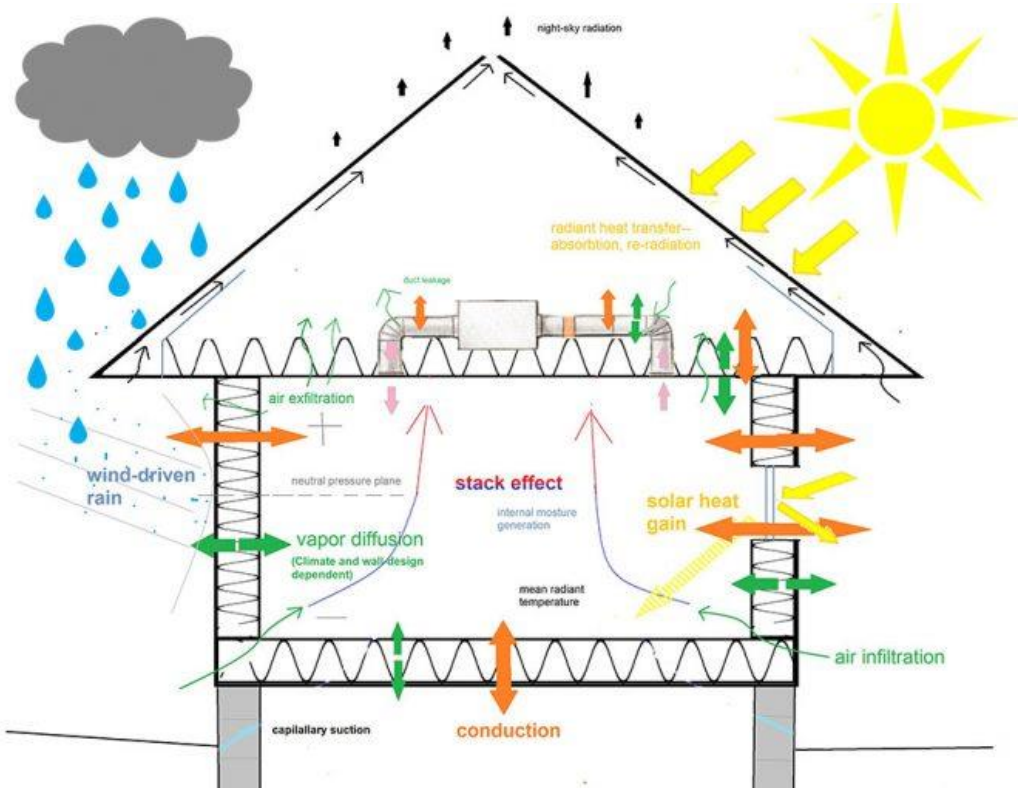
Building Science

The Study Of:

- Heat Flow
- Moisture Flow
- Air Flow

Their interactions & how they impact:

- Comfort
- Health
- Energy Use
- Building durability



It's Really About Comfort:

Six Factors Determining Thermal Comfort

1. Air temperature
2. Mean radiant temperature
    - Humans are highly responsive to changes in mean radiant temperature
3. Air movement / velocity
4. Relative humidity
5. Clothing
6. Activity levels

House-as-a-System

- A house is a system of interdependent parts:
  - Mechanical components
  - Construction components
- The operation of one part affects many others
- When they all work together, the house is comfortable, safe, efficient, and durable.
- Older homes the system is out of balance
- When remolding part of the home what does that do to the overall system

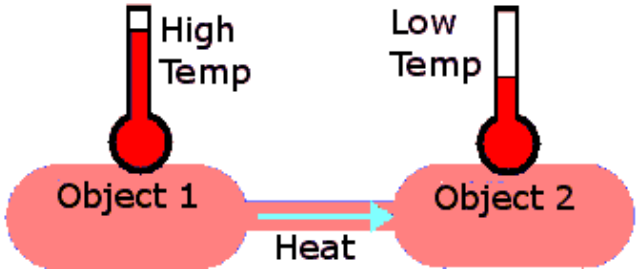
What Happens?

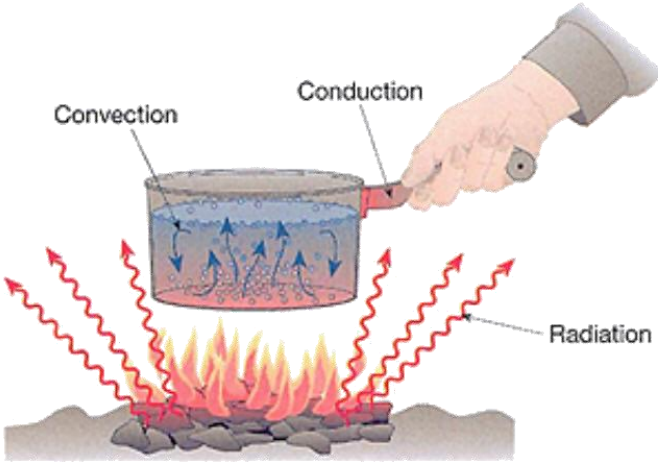
- When the system is out of balance or not maintained?
- Gets a partial upgrade?

System failure
and
Building failure

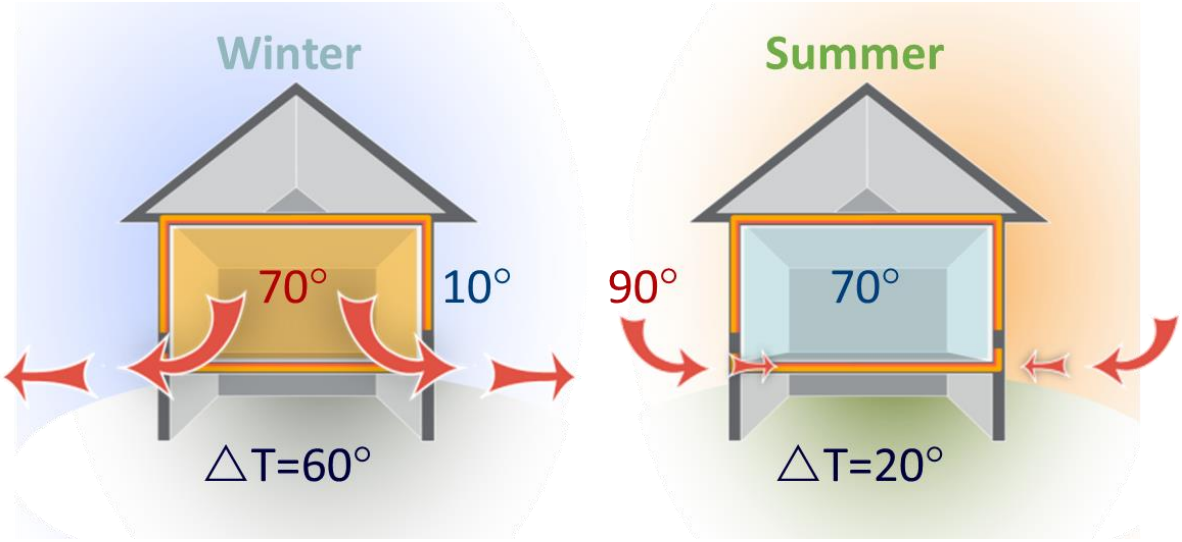
Heat Transfer

- Heat flows from hot to cold.
- Three types of heat transfer:
  - Conduction through a solid
  - Convection through a fluid
  - Radiation from surface to surface





ΔT = Temperature Difference

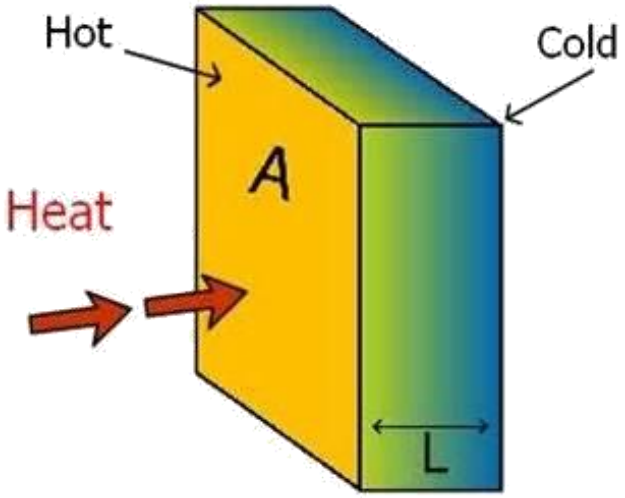


Flow is from **hot** to **cold**

The higher the △T, the **more** heat and air want to escape or enter the building

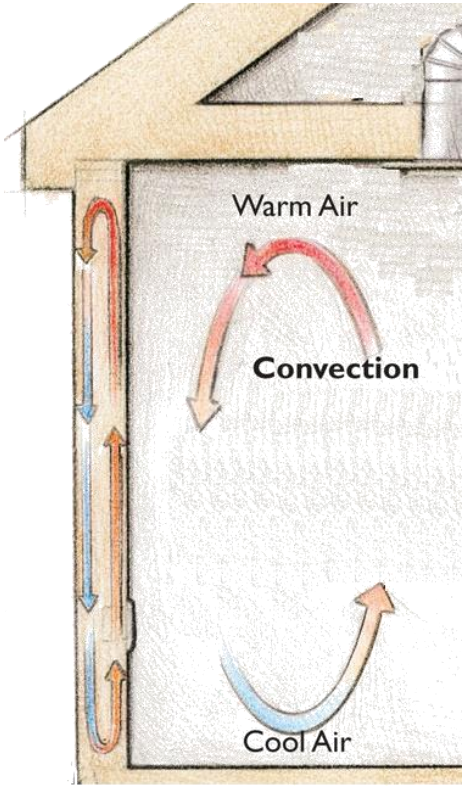
Conduction

- Conduction requires a solid, liquid or gas medium.
- Energy is transferred directly from one molecule to the next when they come in contact.
- Insulation reduces conduction.
- R-value indicates resistance to heat flow.



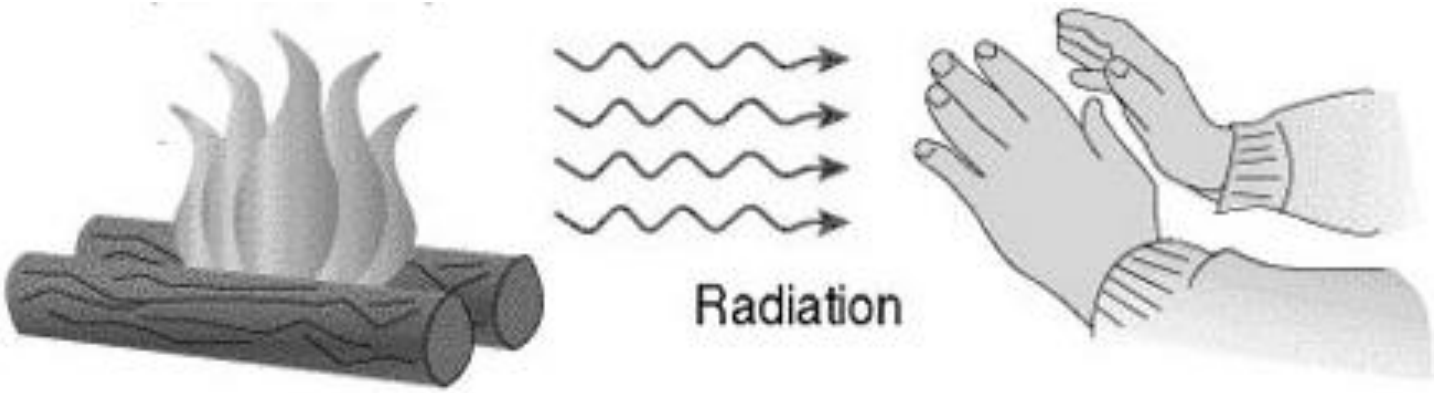
Convection

- Convection is the transfer of heat by circulation or movement of a fluid medium (a liquid or a gas).
- Caused by density differences between warmer and cooler parts of a fluid medium.
  - Warm air is lighter and rises.
  - Cool air is denser and falls.
- Heat travels along with the fluid medium, so reducing the flow reduces convection.



Radiation

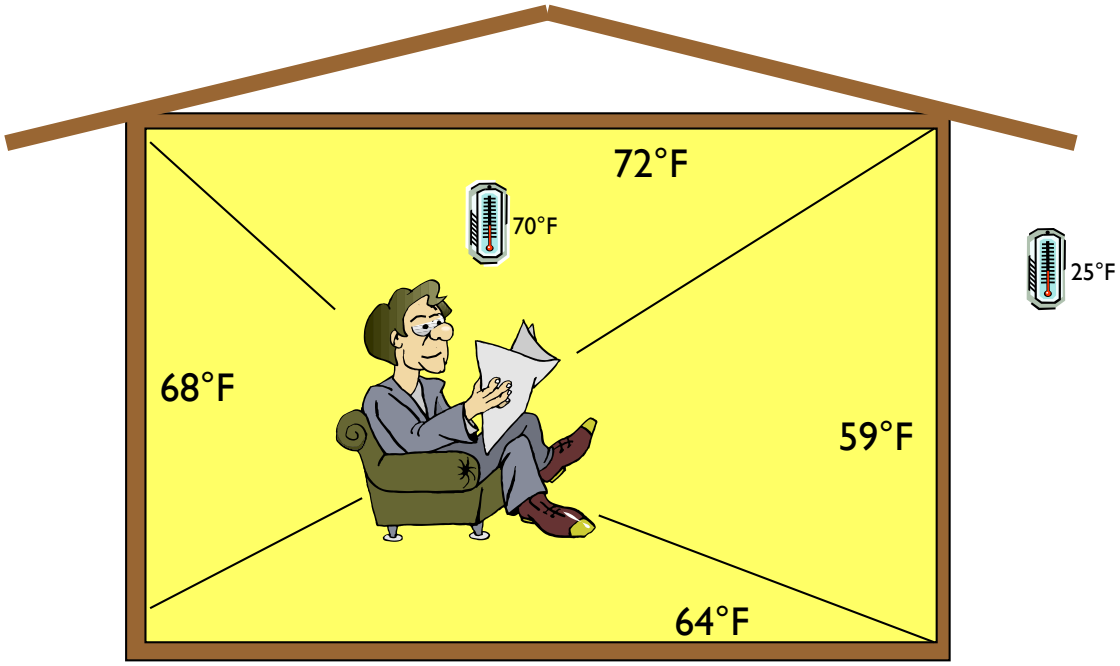
- Radiation transfers heat from a warm object to a cold object that are not in contact with each other
- The objects must be in sight of one another.



Hot Surfaces Warm You

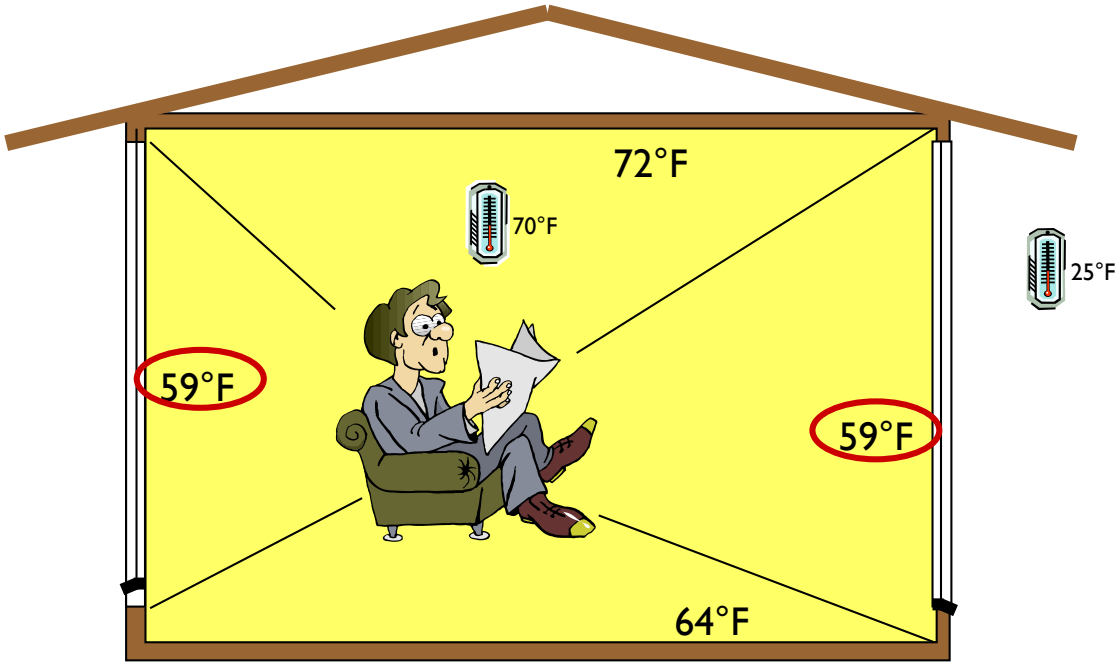
- **Radiation**
  - You feel heat through space, even if the air is cold.
  - You feel cold surfaces the same way.
- Function of temperature difference and area

Mean Radiant Temperature



Mean Radiant Temperature: = 67°F

Mean Radiant Temperature



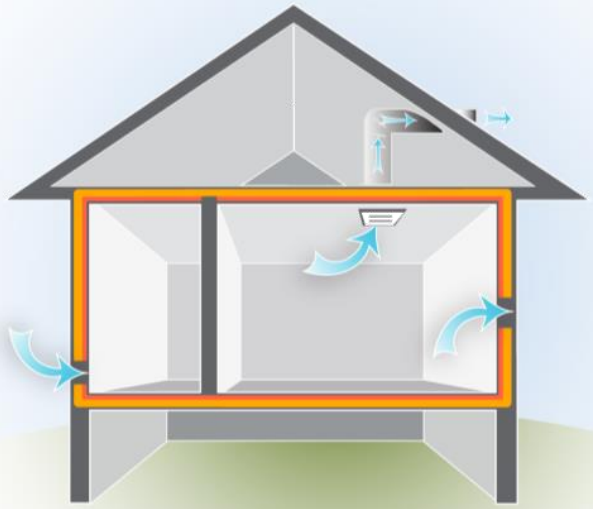
Mean Radiant Temperature: = 63°F

Air Movement

Principles of Air Movement

Ventilation = Controlled air leakage

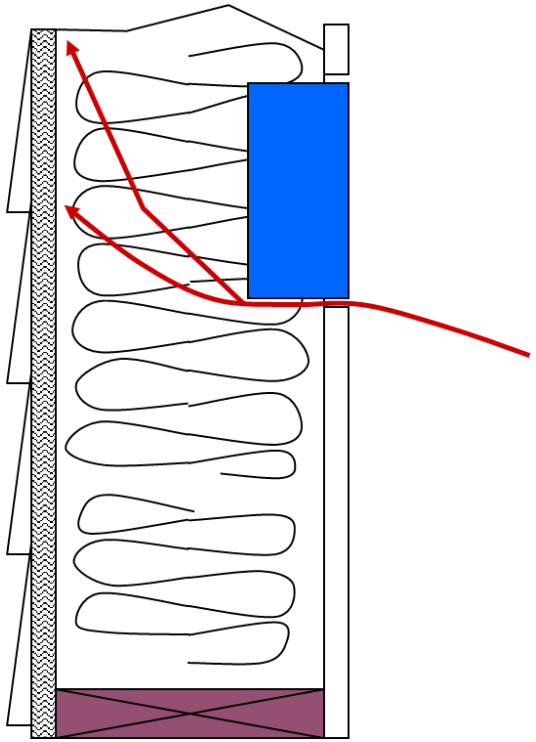
Infiltration = Air leaking in



Exfiltration = Air leaking out

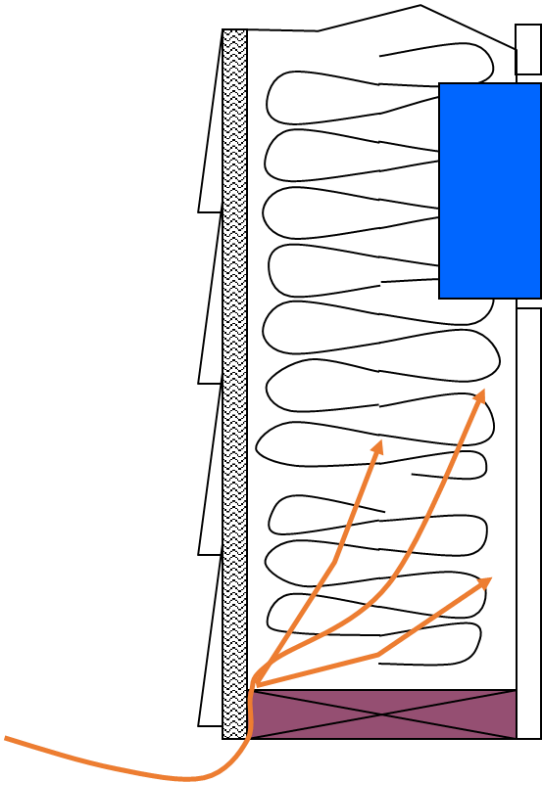
Exfiltration

- Interior air leaks allow warm humid air to reach the exterior sheathing

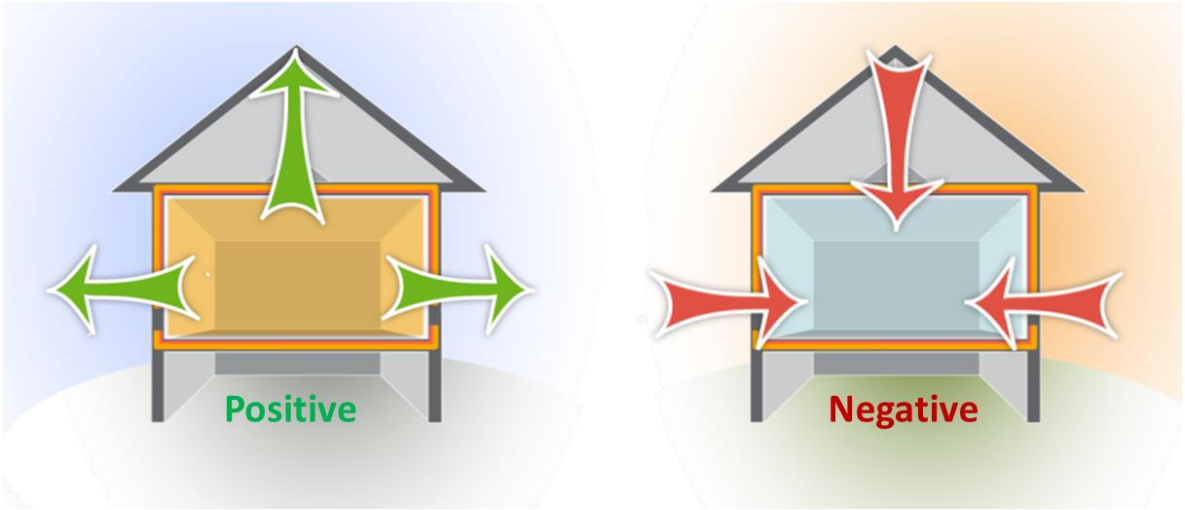


Infiltration

- Exterior air leaks allow wind washing and chilling of interior vapor barrier



△P = Pressure Difference



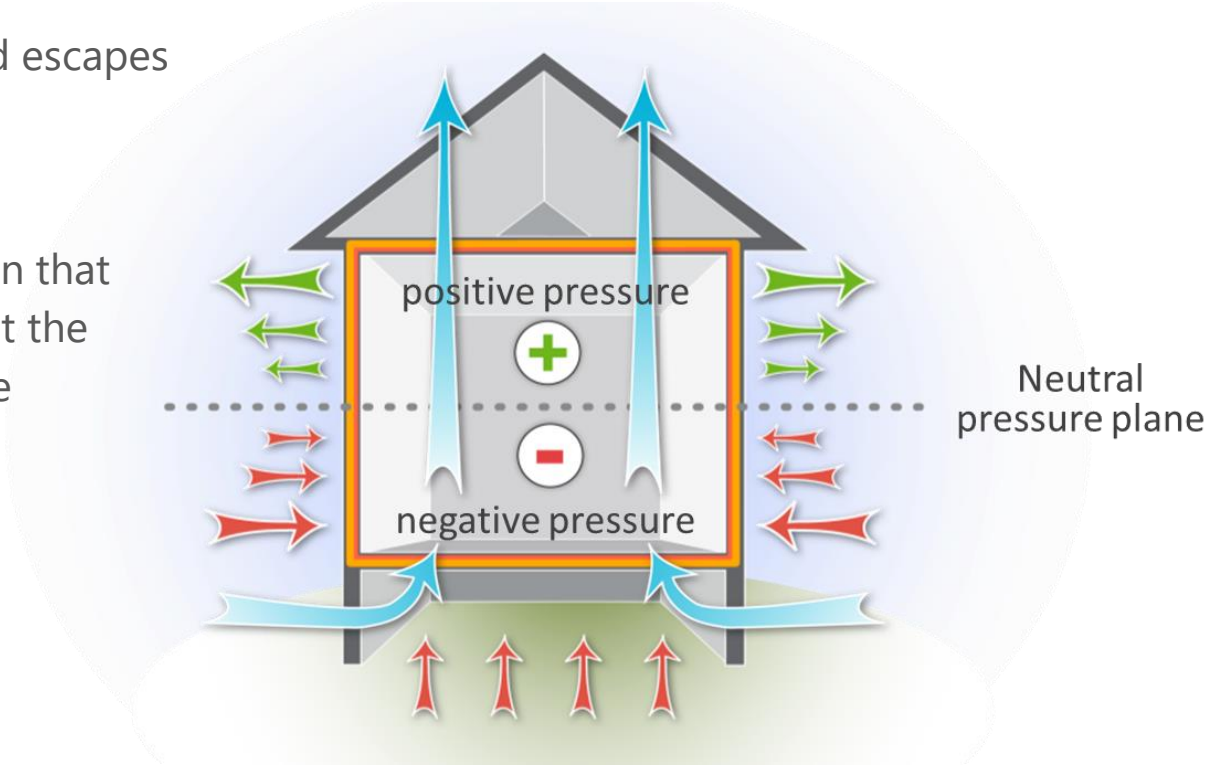
Flow is from **positive (high)** to **negative (low)** pressure

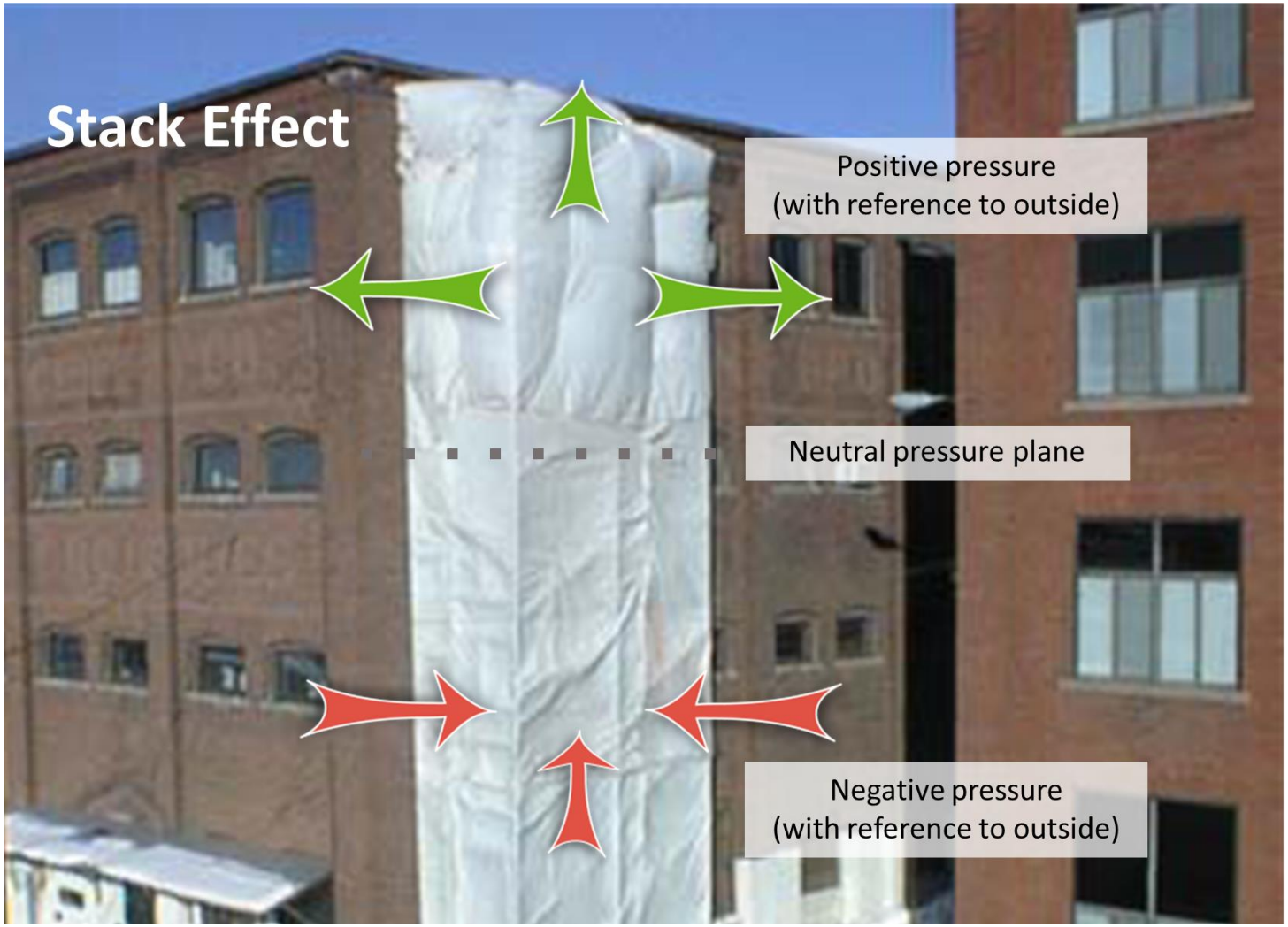
For every CFM that **enters**, one CFM **exits**

Flow takes the path of **least** resistance

Stack Effect

- Warmer air rises and escapes out of the top of the house
- This creates a suction that pulls in outside air at the bottom of the house





Source: David Keefe, Vermont Energy Investment Corp.

Moisture

Moisture

- Moisture in Buildings
- Relative Humidity
- Moisture Transport
- Controlling Moisture Transport
  - Vapor Barrier
  - Air Barrier

Moisture In Buildings

Bulk (Liquid) Moisture

- Rain and ground water through basement walls and floors
- Clogged gutters or storm drains
- Leaky pipes
- Roof leaks
- Ice dams

Water Vapor

- Cooking
- Cleaning
- Respiration
- Plants

Condensate

- Water vapor that condenses (changes back into liquid)

Moisture in Buildings

- Moisture accumulation in homes can be a problem because it can:
  - Lead to building deterioration by pests (pests, in turn, are a health threat)
  - Corrode metal, dissolve glue, warp wood, weaken mortar
  - Reduce thermal resistance of insulation and may permanently damage it
  - Contribute to mold growth and health related issues

Relative Humidity

- Relative humidity is a measurement of the amount of moisture in a sample of air, compared to the total amount of moisture the air could hold at a given temperature, expressed as a percentage
- Air that is at 100% RH is said to be “saturated”

Relative Humidity

- Warm air can hold more moisture than colder air before becoming saturated
- Relative humidity depends on the temperature of the air sample
  - What happens to the relative humidity of a sample of air as it is heated?
  - What happens to the total amount of moisture in a sample of air as it is heated?

Dew Point

- The temperature to which air must be cooled, at a given water vapor content, for it to become saturated.
- Any colder and the air must give some of its moisture up as condensation.

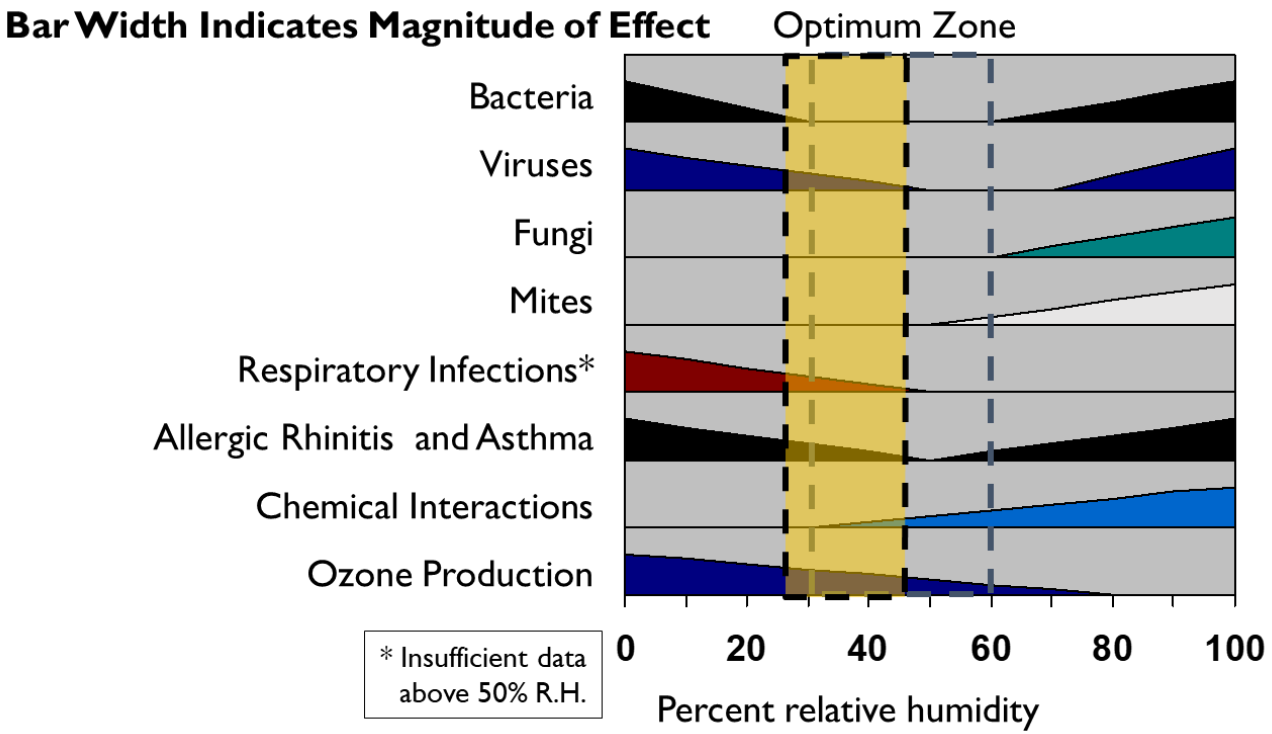
Moisture Control Overview

- Control bulk water penetration
- Control capillary action
- Control water vapor
  - Air leakage
  - Diffusion
- Keep indoor relative humidity around 50%
- Keep condensing surfaces warm

What to Control?

- **Source** – Can the source be controlled?
- **Path** – If the source can not be controlled, can the path be controlled or managed?
- **Driving Force** – If the path can not be controlled, then the driving force must be controlled.

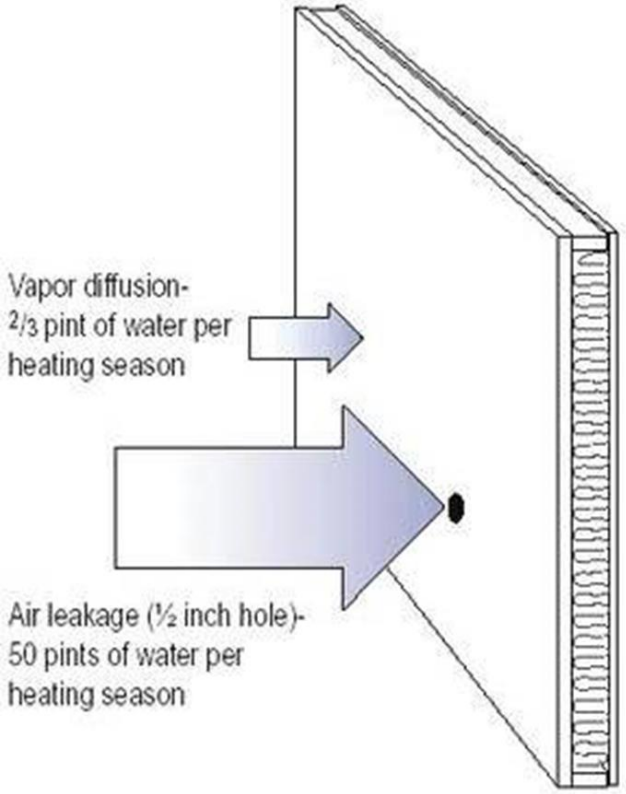
Health effects



Source: ASHRAE Systems and Equipment Handbook, 2000

Diffusion vs. Air Leakage

- Air carries 75 times more water than diffusion



How Much Water Vapor

Daily water vapor produced by family of 4:

- Respiration/perspiration 14 lb.
- Showers & bathing 3 lb.
- Cooking 2 lb.
- Other activities 2 lb.

Total **21 lb. = 2.5 gallons**

It’s not a 3-minute solution

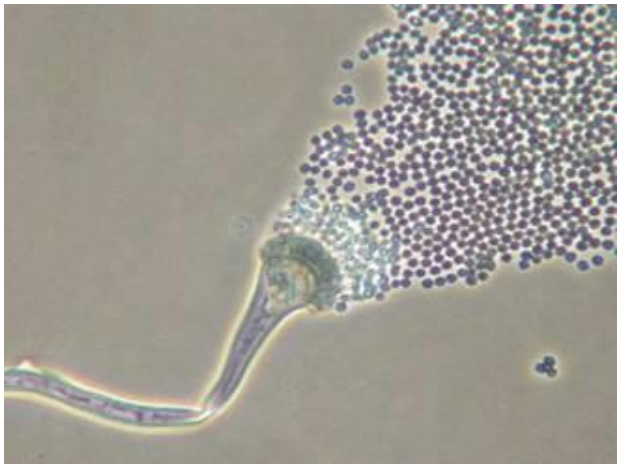
- How do we fix the problem?
- Or, how do we avoid it in the first place?
- How do we clean up mold?
- What is mold?
- And, how did this water get inside?

What is Mold?

- **Mold is a type of fungi**
  - The same as mushrooms or yeast
- **Without mold, the world we know would not exist…**
  - Decay is a natural thing
  - We cannot stop it, but we can avoid it in our buildings

Mold Types

- **Most common "household" mold types:**
  - Cladosporium
  - Penicillium
  - Alternaria
  - Aspergillus
  - Mucor



- **Stachybotrys and Fusarium species are types that can decay not only sugars and starches, but also breakdown cellulose walls**

Photo: EPA Mold Remediation in Schools and Commercial Buildings Guide 2001

Forget the Latin…

- "If you see mold or smell mold, you have mold."
  - Yost, Lstiburek, Brennan
- Identifying the type is not very important
- Mold testing is not usually needed
- If mold is visible or odor is detectible, there is too much mold!

Mold Food

It just so happens:

- Most of our buildings are made up of a substantial amount of organic matter.
- The ideal temperature for mold growth is the same ideal temperature for humans.

You have three choices:

- Don’t build with organic materials
- Freeze our buildings
- Burn our buildings

Not so practical…

How it Works

- **Mold cannot survive without water or oxygen**
- **Mold only grows in materials:**
  - At temperatures between 40°F – 100°F, and 20% moisture content

Before Any Work

- **Consult a health professional** before work begins if anyone involved has allergies to mold
- **Seek guidance from:**
  - Environmental Protection Agency (EPA) at www.EPA.gov/mold
  - EPA's A Brief Guide to Mold, Moisture and Your Home
  - EPA's Mold Remediation in Schools and Commercial Buildings
  - American Conference of Governmental Industrial Hygienists

Can a House be Too Tight?

No! A leaky house has problems:

- Wastes energy
- Moldy, dusty, dirty and moist air
- Uncontrolled air movement
- Uncomfortable to live in

House-As-A-System Solutions

Air Movement and Control

Seal it Tight & Ventilate it Right

Goals of Air Sealing:

- Save energy and money
- Avoid moisture problems
- Control air flow & indoor air quality
- Allow the insulation to work
- Increase occupant comfort

Don’t Ignore CO

Pay Attention to:

- CO - carbon monoxide concerns
- Combustion appliances
- Unvented space heaters (bad idea)

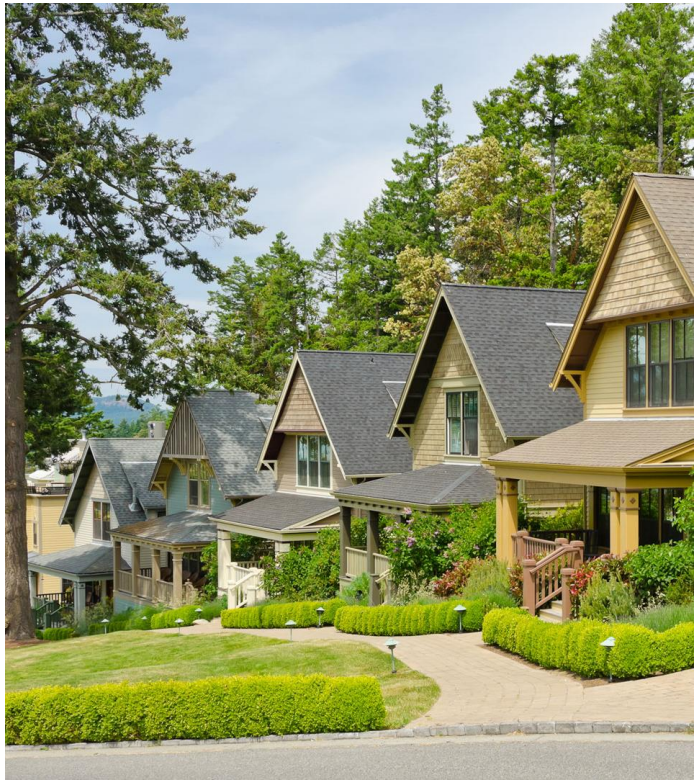
Building Enclosure (Defining the Air Barrier)

Define the building enclosure:

- Ceiling
- Exterior walls
- Floor
- Other special zones
  (i.e. garage, basement, kneewalls)

Separate the Inside from the Outside

- Conditioned vs. Un-Conditioned



The 80 / 20 Method

- **Treat 80% of the house leakage with 20% of the work effort**
  - Prioritize = make the big gains
  - Don't waste time with small stuff
  - Don't overwork or kill yourself

High Priority Areas

- Attic and crawlspace hatch
- Plumbing chase & penetrations
- Chimney chaseway
- Recessed can lighting
- Exhaust fan housing
- Wall to ceiling connections
  - Both exterior and interior walls
  - Framing transitions
  - Drop soffit

Air Sealing Materials

- **Caulk**
- **Spray foam**
- **Air barrier materials:**
  - Plywood / drywall
  - Galvanized steel
  - Foam board
  - House-wrap
  - Backer rod
  - Weatherstripping / gaskets


DAP

Insulation DOES NOT stop Airflow!


R-13
R-13

Ventilation

What is ventilation?

- A controlled exchange of air
- Stale indoor-air for fresh outside-air
- Introduction of oxygen
- Dilution is the solution to pollution

Natural Air Exchange

Unreliable, due to:

- Dependency on outdoor conditions
- Temperature, wind, etc.
- Lack of occupant control
- When, where, and how much?
- Draws air from contaminated spaces

Why Ventilation?

Source control / durability:

- Protect the building & systems from moisture issues.

Health:

- Mold / dust mites / volatile organic compounds.
- Combustion products
- Soil gases / radon
- Pesticides / cleaning products

Comfort:

- Stale air / stuffiness / odors

Improving Indoor Air Quality

- Eliminate pollution sources
- Minimize unavoidable pollution sources
- Separate pollutants from occupants
- Ventilate:
  - Exhaust known pollutants at their source
  - Supply fresh (cleaner) air to dilute remaining pollutants

How to Ventilate?

Strategies for ventilation:

- Local or point source exhaust
  - *Moisture & pollutant removal*
  - *Exhaust fans*

- Whole house ventilation
  - *Dilution for the balance of pollutants*
  - *Whole house fan / heat recovery ventilation*

Mechanical Air Exchange

- Reliable
- Occupant has control of when, where, and how much
- Outdoor air can be treated as it enters the house (heat, cool, filter)
- Allows houses to be built tighter by providing fresh air and controlling moisture

Types of Ventilation

Supply only:

- Introduces outdoor air
- Treat the air (filter and/or condition)
- Minimize back-drafting of combustion appliances

Exhaust only:

- Expel inside air to outdoors
- Depressurize interior space
- Draws air from leaks in building envelope
- No filtration or conditioning

Quiet Bath Exhaust Fans

Photos: © Conservation Services Group

Types of Ventilation

- **Balanced systems:**
  - Exhaust and supply are equal
  - Should not affect interior pressures
  - Introduces fresh filtered air
- **Heat Recovery Ventilator** (HRV)
- **Energy Recovery Ventilator** (ERV)

Insulation Familiar Types

Fiber Insulations:

- Fiberglass (batt & blown)
- Cellulose (blown & dense pack)

Foam Insulations:

- Spray-in Cavity:
  - *Closed Cell (high density - 6.8)*
  - *Open Cell (low density - 3.8)*
- Foam Board
  - *Poly-Iso (7) / XPS (5) / EPS (4)*

Building Envelope
How Insulation Works

- Insulation slows heat loss/gain by trapping still air in small pockets within the insulating material.
- The trapped air within the material is actually the insulator.
- If air moves through insulation, the rate of heat gain/loss increases!
  - The effective R-value decreases.
- Remember! Most insulation does not stop air movement.

R-Value and U-Value

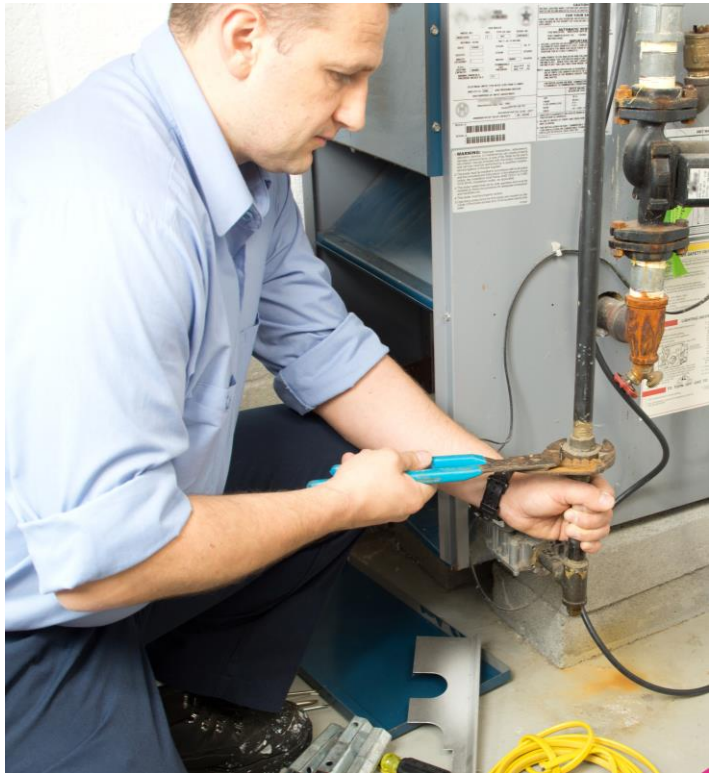
- R-Value: The measured resistance of a material to heat transfer
- U-Value: A measure of thermal transmittance (how fast heat moves through a material)
- You can convert between R and U:
  - R = 1/U and U = 1/R
- R values can be added (in thermal path)
  - But can't be averaged over areas


The
nergy


PROPINK
Comple
Fabric for
Enclosed
Cavity
Insulation

Heating and Cooling of Buildings

- Heating Load in buildings are expressed in Btus.
- The typical method of expressing loads of a building is in Btu/Hour.
- This is the number of Btus need to maintain a particular temperature in the building at a given Temperature Difference (Delta T) between indoors and outdoors during one hour.



BTU's & Efficiency

- Although a heating system may be capable of burning 100,000 btu/hr, the amount of that heat energy available for distribution to the space depends on the efficiency of the system.
- We usually see this expressed as a percentage.
- The input of the equipment is the btu/hr of energy entering the equipment (potential energy of fuel), the output of the system is the heat energy available to distribute once the losses are accounted for (what goes up the chimney)
- A 100,000 btu/hr furnace has an input of 100,000 btu/hr and if it is 80% efficient has an output of 80,000 btu/hr of heat energy available for distribution

Annual Fuel Utilization Efficiency (AFUE)

Annual Fuel Utilization Efficiency- tells us how much of the potential energy in the fuel makes it into the heating distribution system.

- AFUE accounts for fuel burning losses, chimney losses, cycling loss, and heat losses through the heaters cabinet.
- If a Furnace is rated at 100,000 btus, and has an AFUE of 80%, this means on 80% of the total rating is available to heat the space- in this case, 80,000 btus

Co-Efficient Of Performance (COP)

- Energy output per unit of energy input
- Electric resistance COP = 1.0 = 100%
- Geo-thermal heat pumps are rated this way as well as air source heat pumps
- COP range from 1.6 to as high as 5

Heating Seasonal Performance Factor (HSPF)

- This account for the addition of electric resistance heat during heat pump operation.
- In some climates when the air temperature is too cold to extract usable heat, back-up electric heat engages. This less efficient heat is factored into the overall performance and a seasonal efficiency is assigned.
- BTUS moved/watt hous

Seasonal Energy Efficiency Ratio (SEER) & Energy Efficiency Ratio (EER)

- Seasonal Energy Efficiency Ratio measures the ratio of btu of cooling provided, divided by the electrical energy input.
- SEER ratings from 9 to about 19 currently exist although the standard for all newly manufactured air conditioning equipment is now 13 SEER

  13 SEER is 30% more efficient than 9 SEER

  1-(9/13)=30

  Rating Conditions: 82 outside, 80Fdry bulb, 67F wet bulb

  EER is usually given at 95F

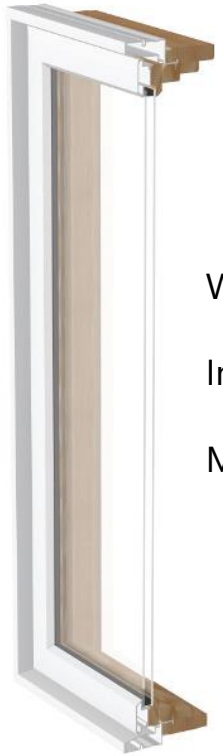
Energy Factor (EF)

- Energy Factor describes the fraction of the water heaters energy that actually remains in the water leaving the unit. Factors range from .50 - .93, current federal minimum is .59EF
- Energy Factor takes into account:
  - Use- assumes 64 gallons a day is used
  - Energy loss during heating
  - Pilot light loss (if gas)
  - Thermal loss through the tank

Ductless Heat Pump Efficiencies

- **7.7 – 12 HSPF**
  - 200 – 400% efficiency
    - *At 47 degrees*
    - *Reduced efficiency as outdoor temperature falls*
- **Don't buy cheap units**
- **Inverter driven**

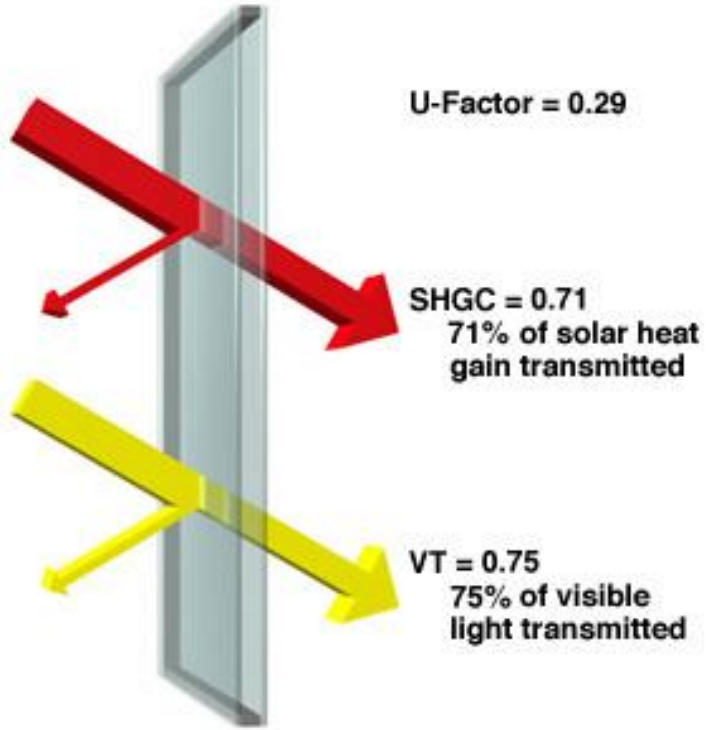
Windows: New Technology



Warm Edge spacers

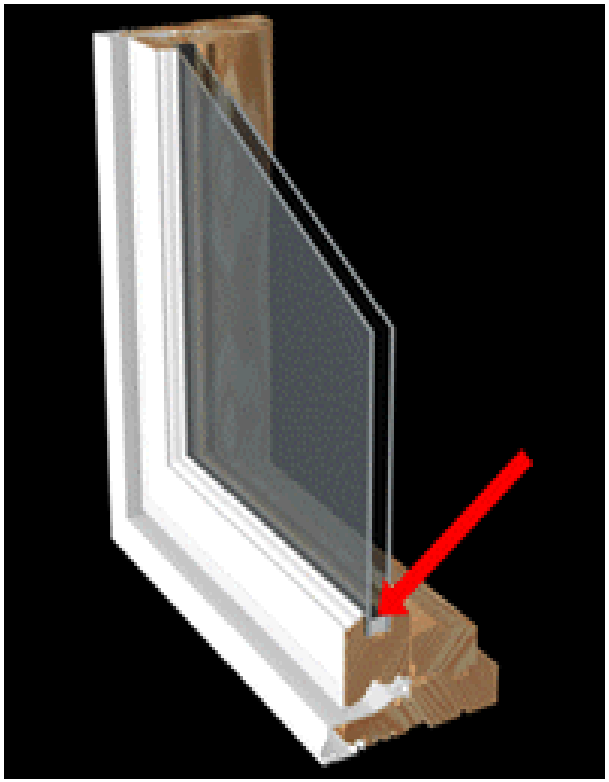
Inert Gas fills –Argon/Krypton

Metallic coatings (Low E)



Warm Edge Spacers

- Thermally improved edge spaces isolate panes of glass the appropriate distance apart.
- Accommodate stress induced by thermal expansion and pressure differences
- Overall U-Value is improved by reduced heat loss at glass pane edges
- Provide gas tight seals

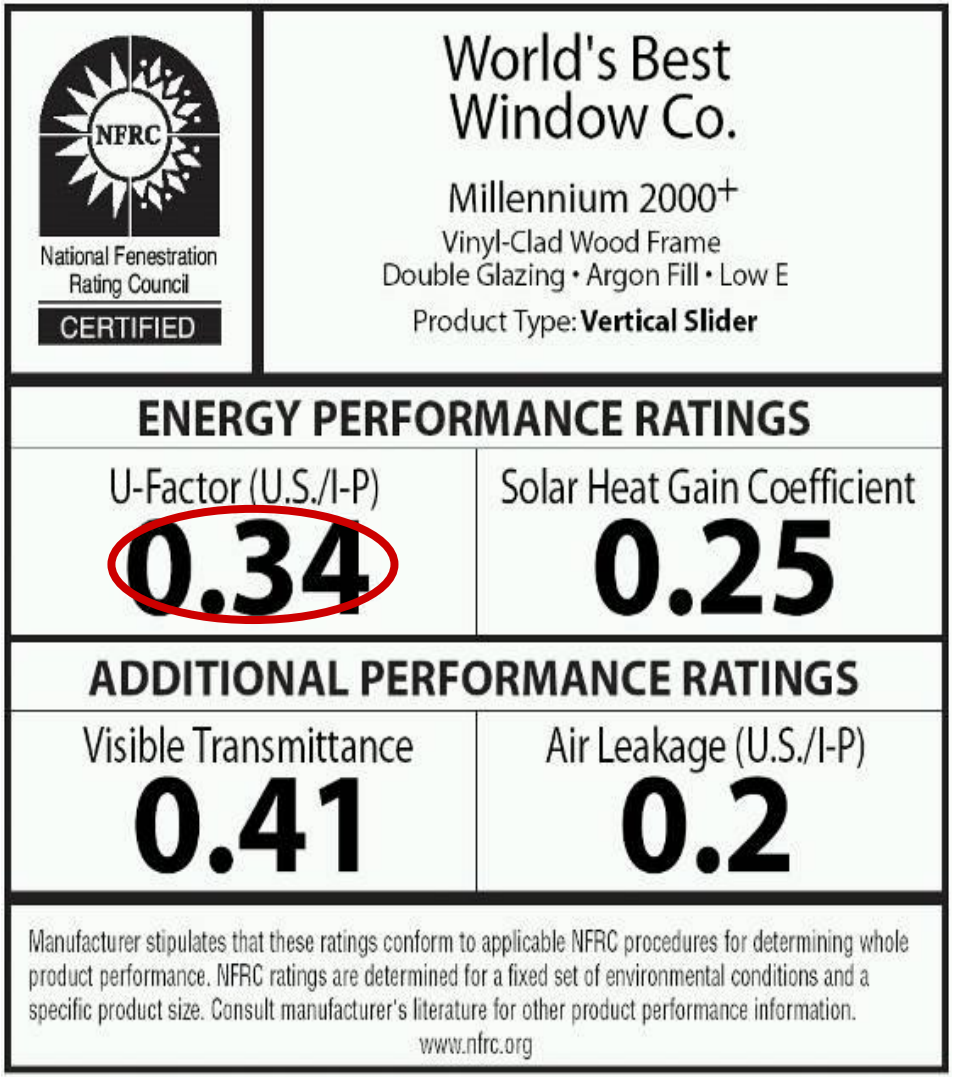


Argon or Krypton Gas

- Thermal resistance is increase with gas fills, reducing winter heat loss and summer heat gain through conduction
- Higher temperatures in winter on interior glass surface contribute to greater comfort and less condensation
- Visual transmittance is not effected

Low E Coatings

- Long-wave radiant heat is reflected, giving an improved U-factor and reduced winter heat loss
- Higher temperatures on interior glass surface increase comfort and reduce condensation
- Slight affect in visible transmittance
- Coatings can allow solar transmittance or reflection



www.efficientwindows.org

Window Trends

- U-.10? Is it possible

- Technologies being studies now are creating “smart” windows.
- Skinny Triple with Foam

Photo © Kevin Kennefick 2001

Home Performance Opportunities

What Is Home Performance?

- **More than one tool in the tool box**
  - HVAC
  - Insulation
  - Windows
  - Air sealing
  - Ventilation

The Changing Consumer

- For better or worse, they are internet educated
- On line “yelping” can help or hurt
- Expect to be part of the solution
- May have a desire for “smart products”

Home Retrofit Drivers

1. The desire for a healthy home
2. Home equity
3. Comfort
4. Climate related goals
5. Utility Goals

The Basic Approach

Focus on the root cause of the problem, not the symptoms

Indoor air quality

Indoor air quality

Energy Savings

Environmentally sensitive

ICE Damning

Old School

- Blame the roofer
- Blame the gutter guy
- Install more attic ventilation

Home Performance

- Air sealing attic plane (limits heated air and moisture movement)
- Vent out all fans
- Limit indoor RH
- Seal and insulate attic duct work
- Insulate attic and kneewalls

Problems You Can Solve with a little BS Knowledge

IAQ issues, health, asthma, etc.

High energy costs

Ice Dams

Moisture Problems

Comfort

Widget Sales to Consultative Sales

Don’t Let Your Existing Offerings Be Your Blinders When Offering Customers Solutions

Putting Tools In The Tool Box!

Or how one company can install insulation, windows, HVAC and create value.

Option One

Partnerships with other contractors

- Referrals
- Bidding others work

Option Two

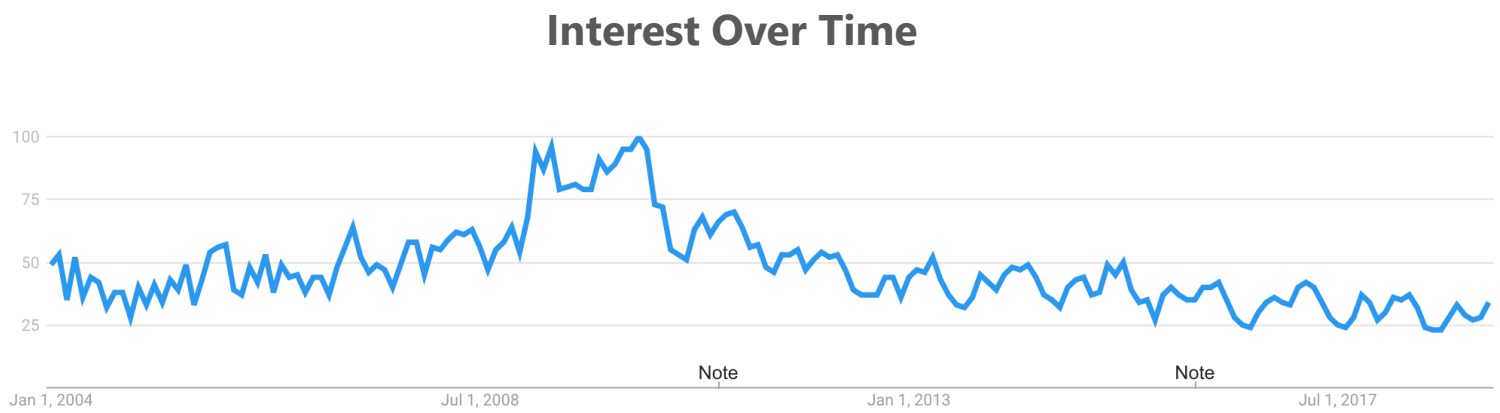
GROW internally!

- The most successful option in the Northwest
- Typically its been an HVAC contractor acquiring the skills
- Saves the customer from multiple contractors and multiple bid

Mother Google

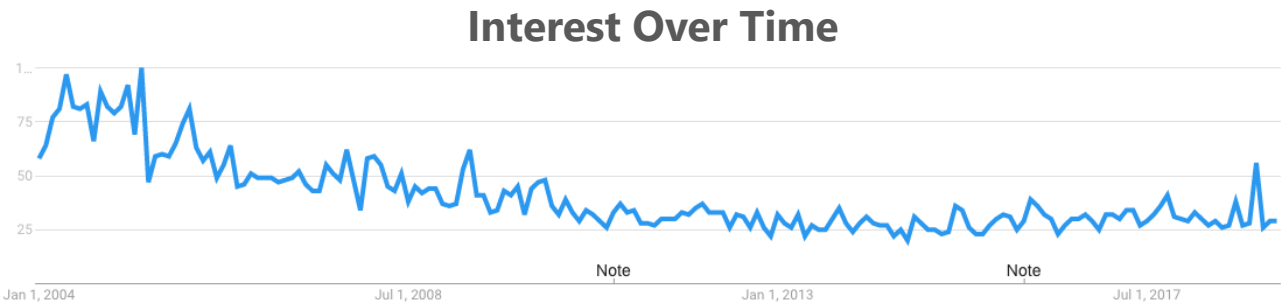
- Google Trends shows how often a particular search-term is entered relative to the total search-volume across a region.

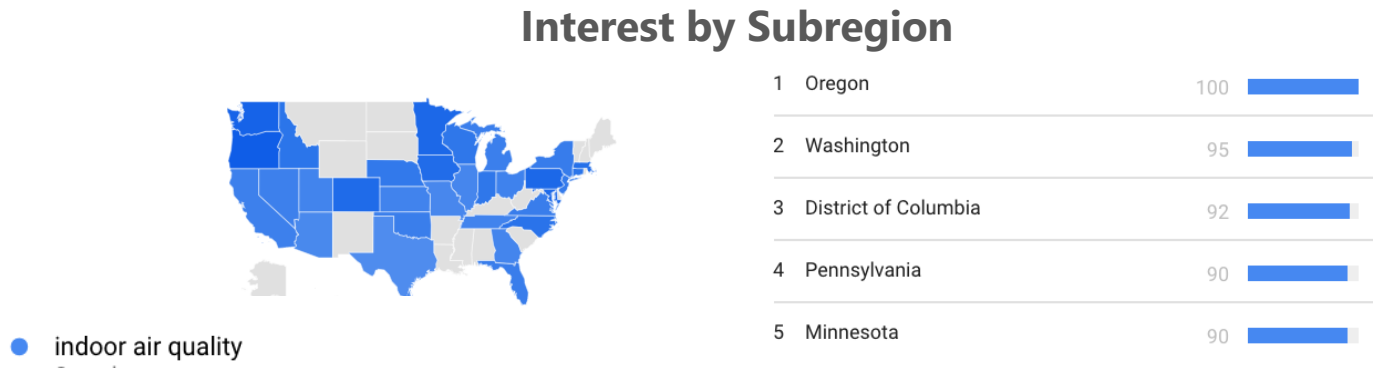
Energy Efficiency



Google Trends, February 12, 2019

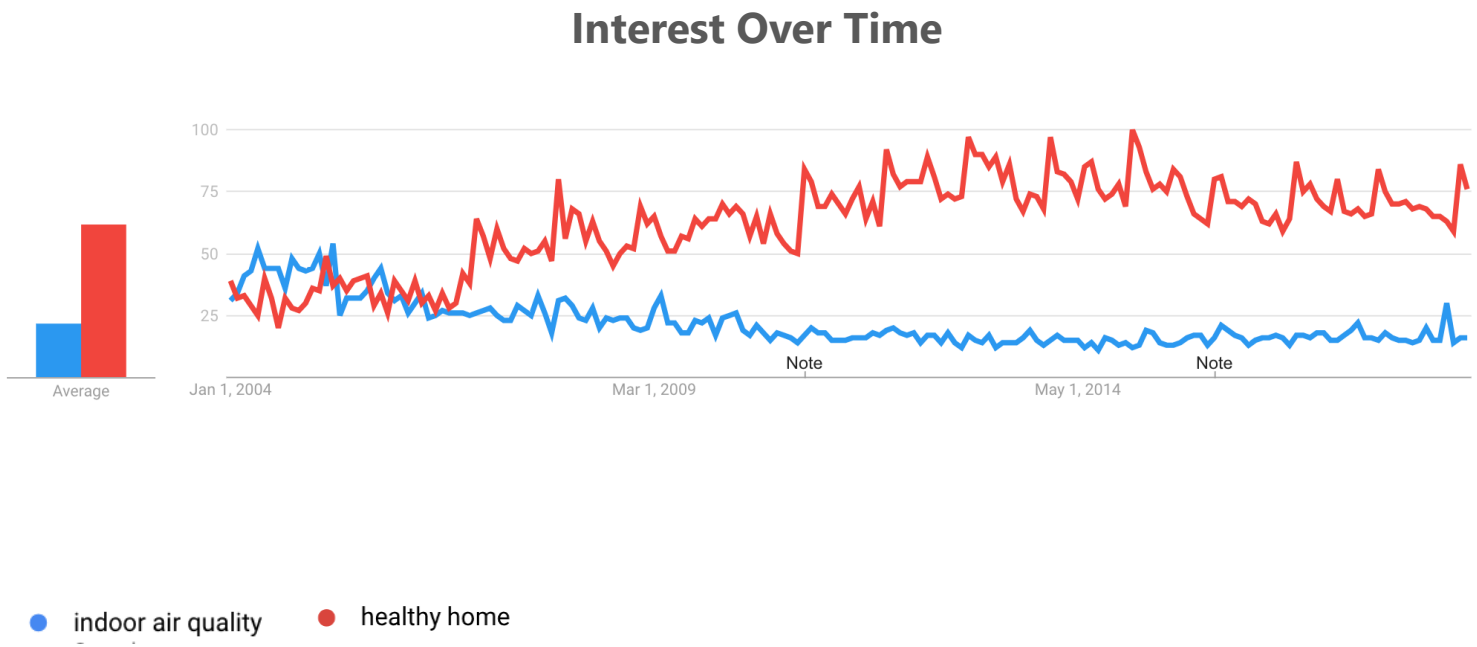
Indoor Air Quality





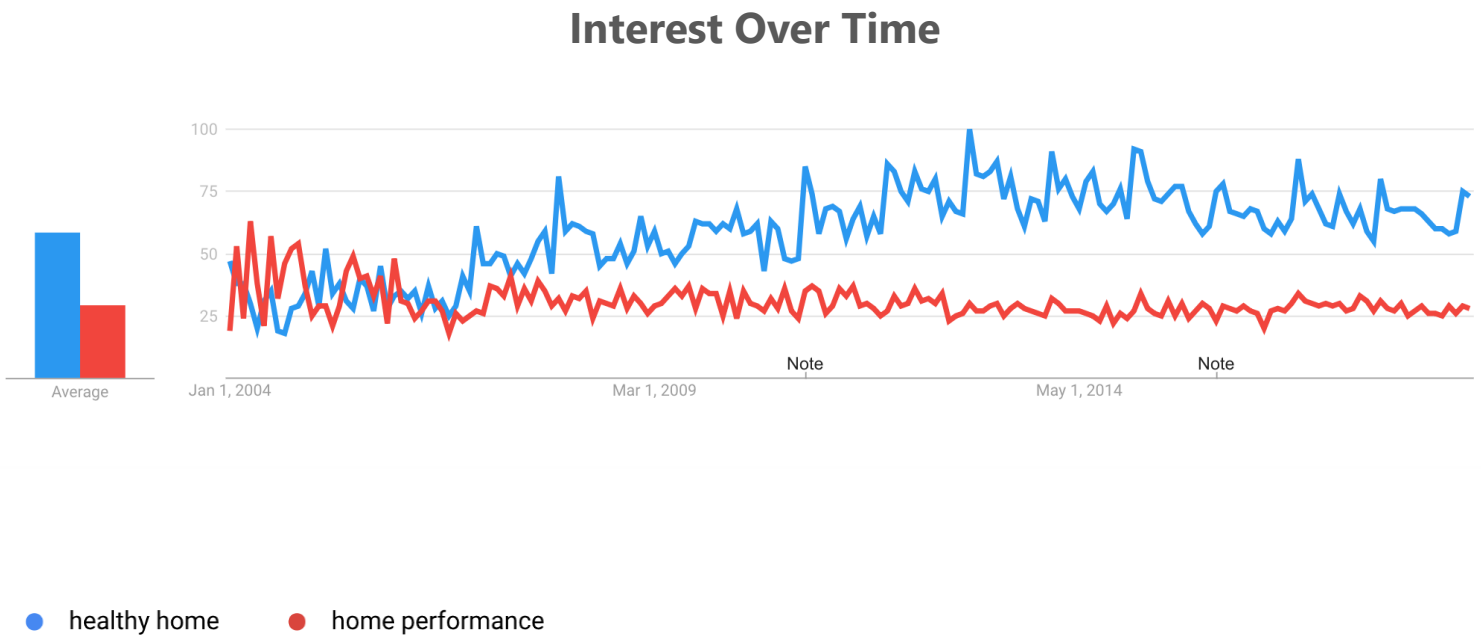
Google Trends, February 12, 2019

Healthy Home vs. Indoor Air Quality



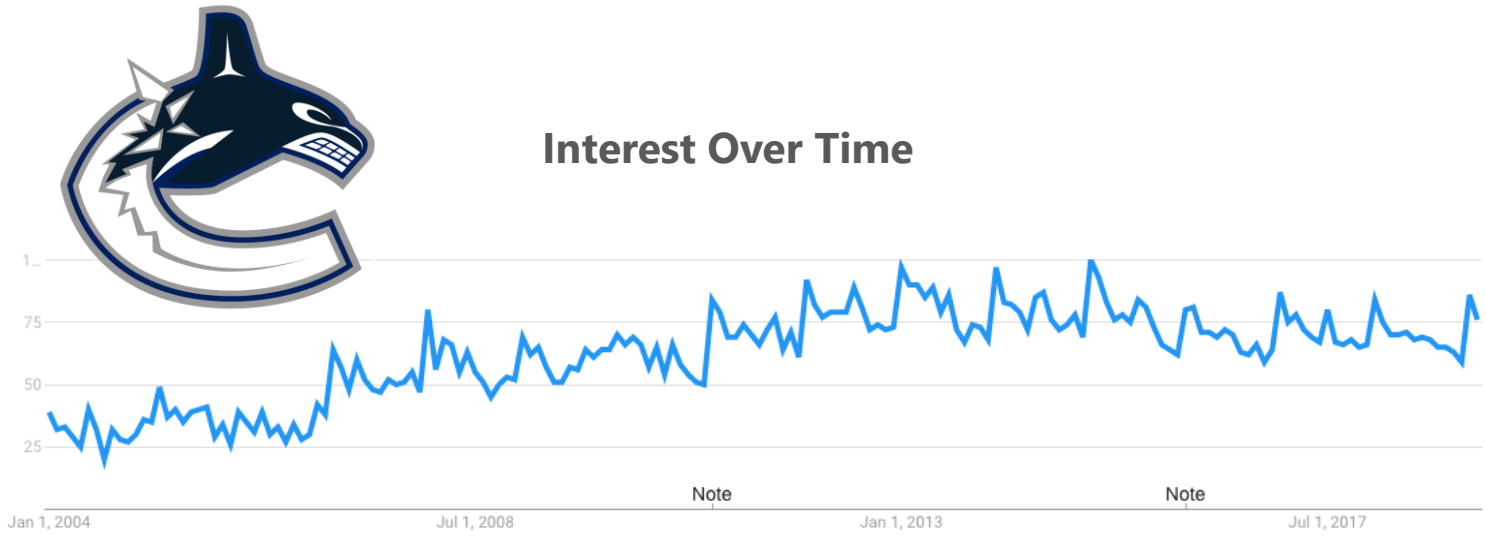
Google Trends, February 12, 2019

Healthy Home vs. Home Performance



Google Trends, February 12, 2019

“Skate to where the puck is going to be!”



Google Trends, February 12, 2019

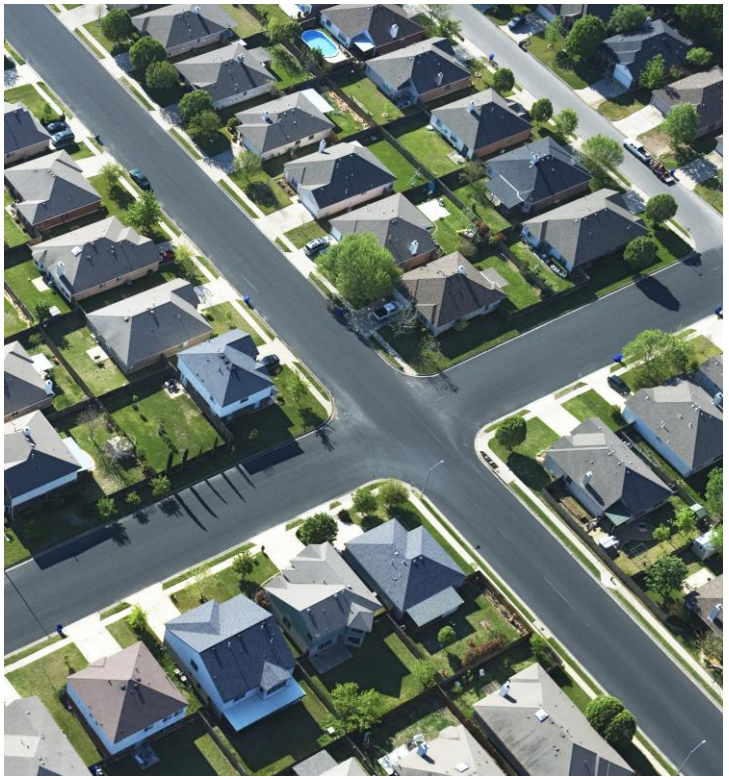
Where Will the Puck Be?

- Educated consumer
- Problem solving not one tool to rule them all
- Environmental / climate programs
- Healthy homes

Takeaways

Treating the house as a system is the best way to:

- ✓ Solve problems, not create them
- ✓ Meet the needs of the modern consumer
- ✓ Increase the total revenue per job



Resources & Getting Involved

House-As-A-System Resources

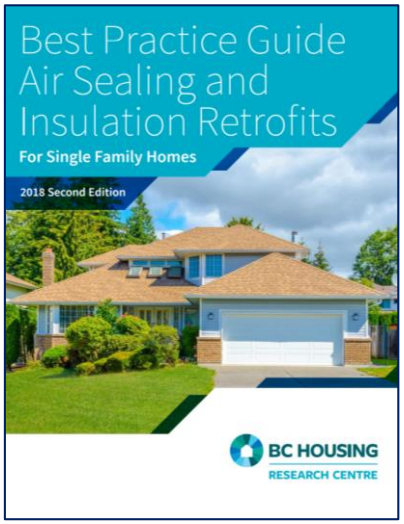
Industry Training

Canadian Home Builders' Association

FORTIS BC™ Energy at work

BCIT

Industry Tools



Next Webinar

SELLING ENERGY EFFICIENCY!

Coming in Fall 2019

Thank You

- To get involved with the HPSC, write to **info@homeperformance.ca**
- Or visit **www.homeperformance.ca**