The Need for Ventilation and Moisture Control for Health, Comfort and Sustainability

Nikki Kruger – Industry Manager

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Description

The need for fresh air in a home is nothing new. Every since man has brought fire inside we have recognized the need for ventilation. What is new is the charge to build a house built to codes that completely isolates the great outdoors from the indoors.

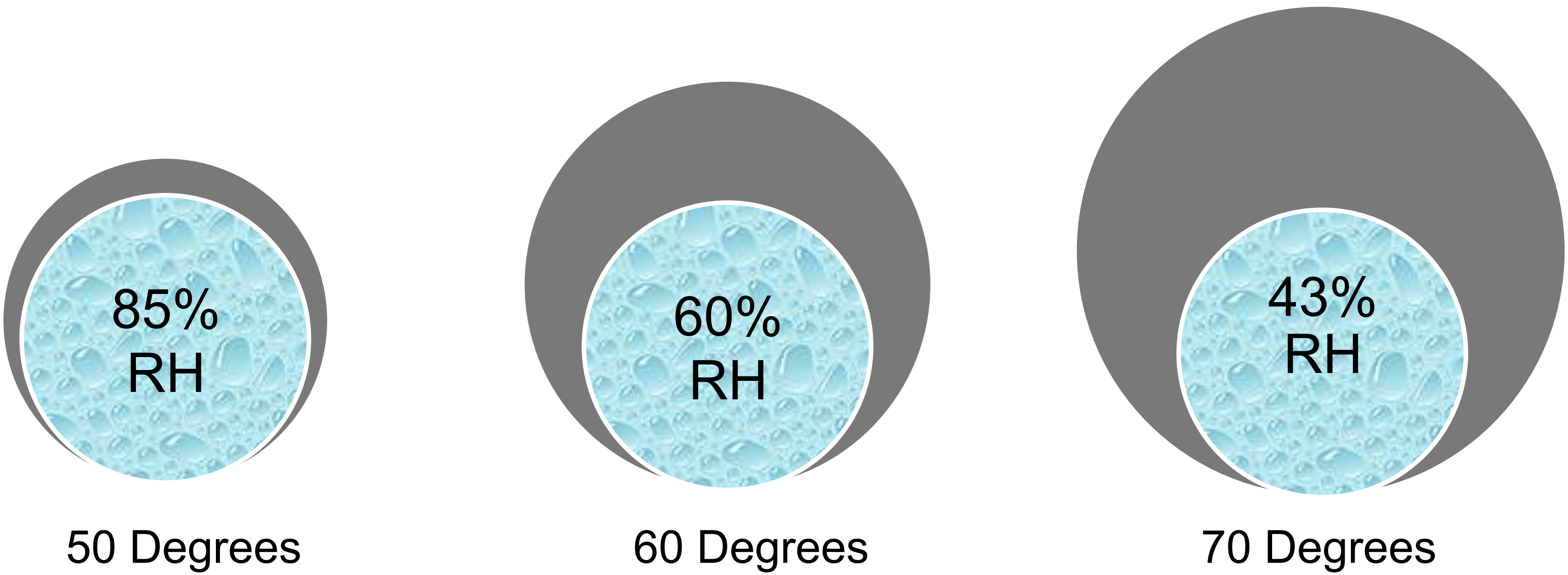
This session will address how building codes are driving the need for fresh air ventilation and how these codes can lead to moisture issues in homes. Discussed will be:

- Potential health, comfort and sustainability issues with the implementation of these building practices.
- The advantages and disadvantages of equipment options and control strategies
- Understanding the capabilities and limitations of the HVAC system
- Why dehumidification can be more cost effective than air conditioning
- The benefits of ventilation and dehumidification to the home and its occupants.

Dew Point & Relative Humidity

Relative Humidity

Humidity is relative to the temperature



The cooler the air, the less energy it has. By reducing the energy the molecules need to escape the liquid bonds and become a gas – condensation is created. Heating the air adds energy and encourages evaporation.

How Temperature Impacts RH

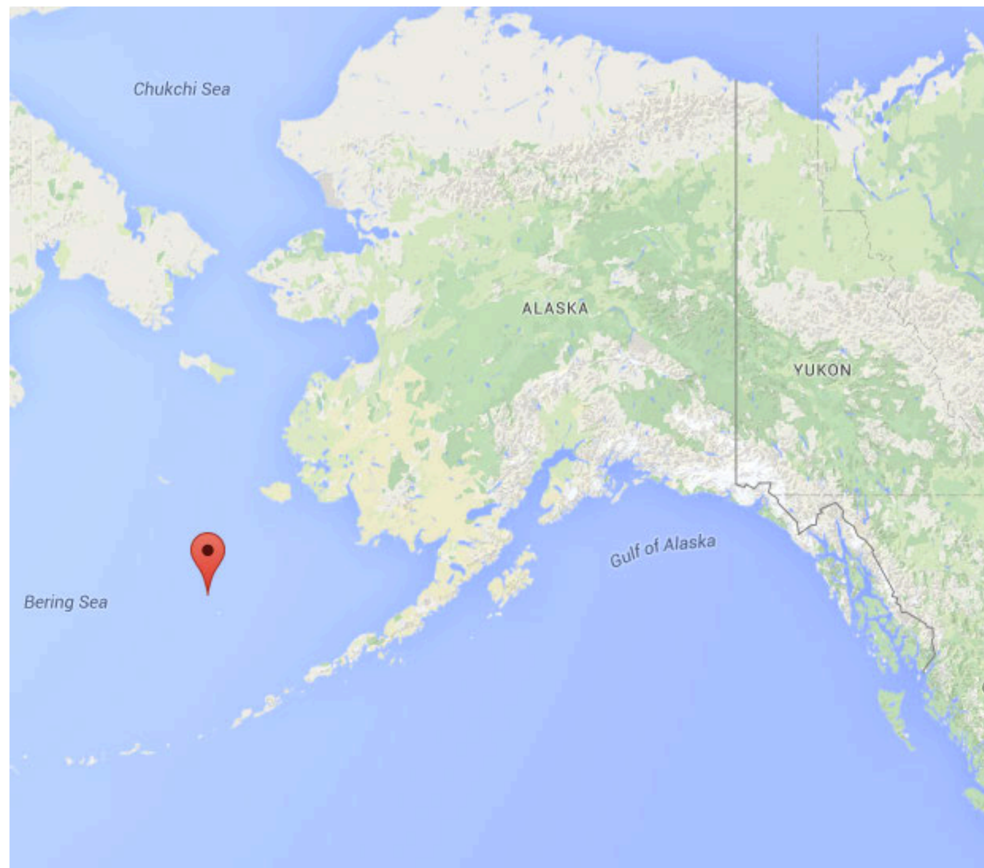
For each 1 degree the temperature increases

the relative humidity decreases 2%

Most Humid Location in the United States?

Due to their proximity to moisture and cool temperatures, island and coastal areas in Alaska are the most humid spots in the nation. Saint Paul Island, Alaska, has the highest average afternoon relative humidity (83%).

Average afternoon temperatures are 28° - 49° F



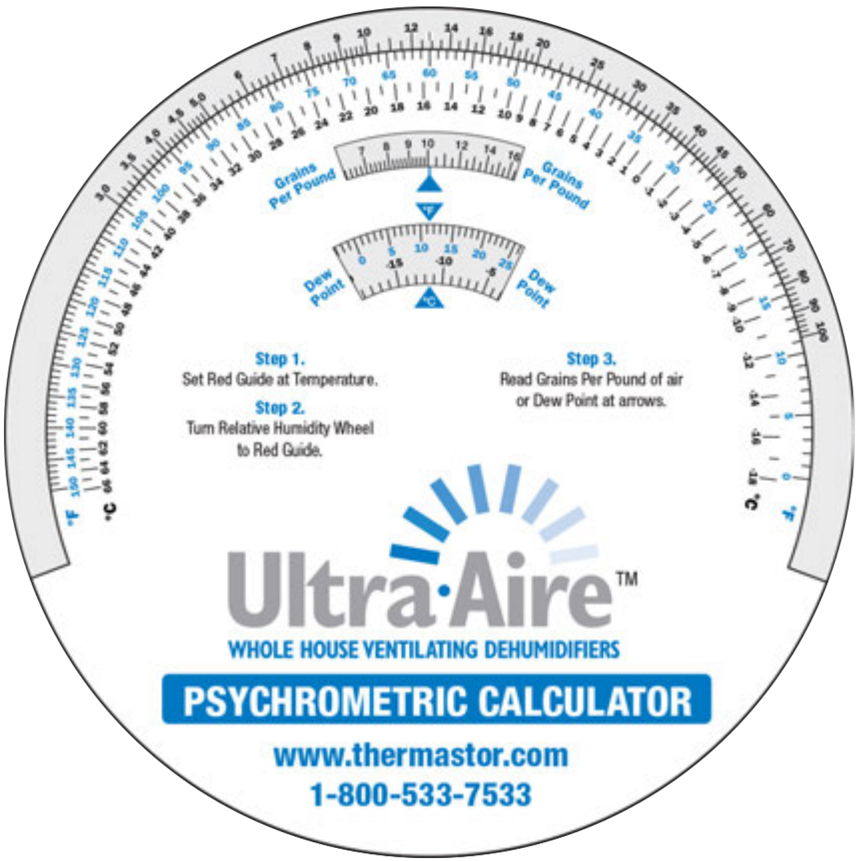
Dew Point

The dew point is what the air temperature would have to be for relative humidity to be at 100%.

Unlike RH, the dew point does not change with air temperature. In that sense it is an “absolute” measurement of the amount of water vapor in the air.

How Do I Calculate Dew Point?

If you know temperature and relative humidity,
you can calculate the dew point.



Dew Point

Degrees F	Relative Humidity	Dew Point
130° F	18% RH	73° F DP
120° F	24% RH	73° F DP
110° F	32% RH	73° F DP
100° F	42% RH	73 °F DP
90° F	57% RH	73° F DP
80° F	78% RH	73° F DP
73° F	100% RH	73° F DP

The glass of water is 73° F . All of the listed temperatures will produce condensation on a 73° F surface.

- A wet surface grows mold after 24 hours.
- Raising the temperature of the air does not stop condensation.
- Lowering the dew point of the air stops condensation.
- Warming the surface temperature above the dew point stops condensation.

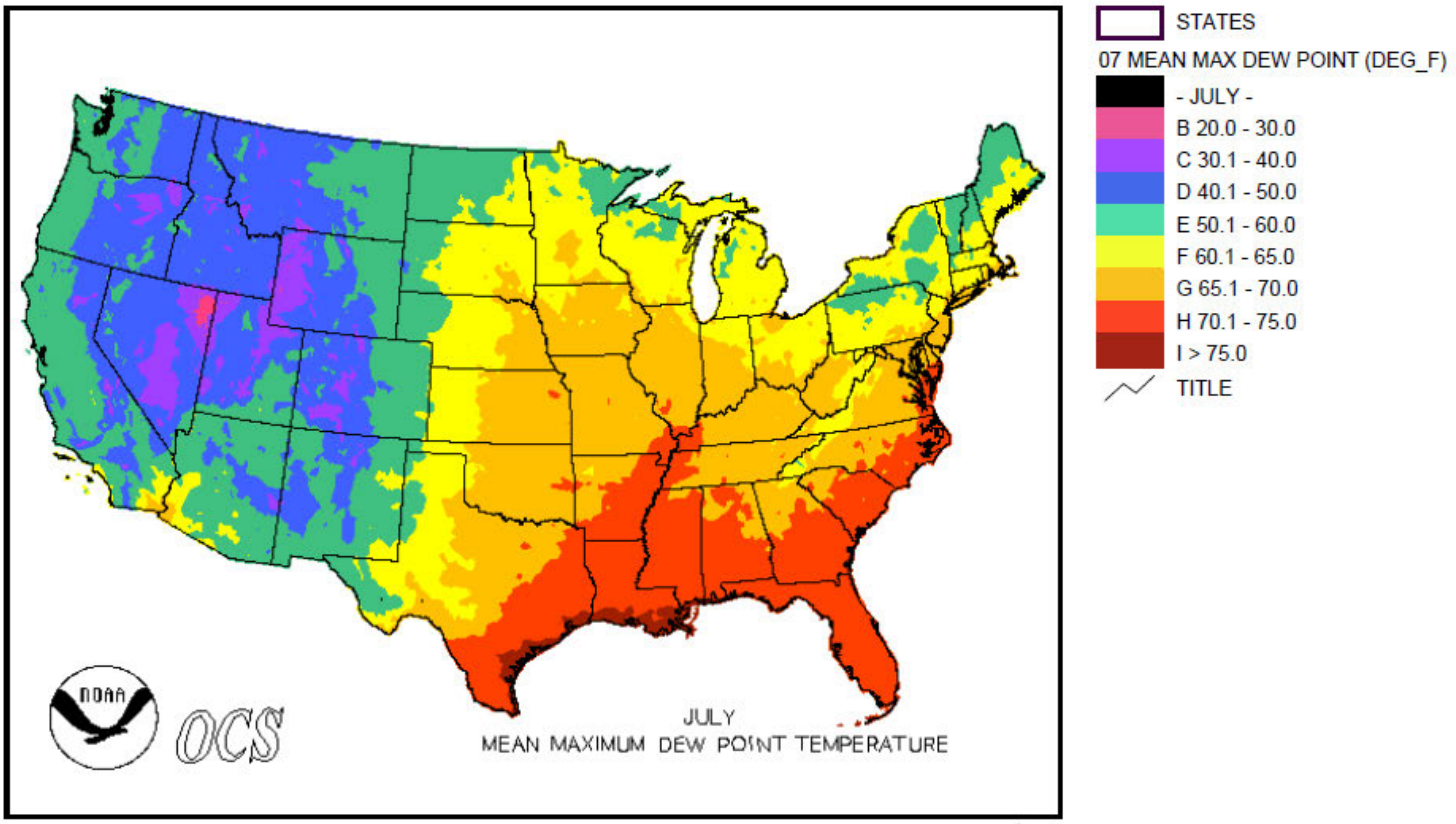
Why Do I Have Condensation?

If the dew point is above the surface temperature, condensation will occur

Surface Temperature

If the dew point is below the surface temperature, there will be no condensation

Dew Point's Across the Nation



24-hour Moisture Load: Hot, No Rain

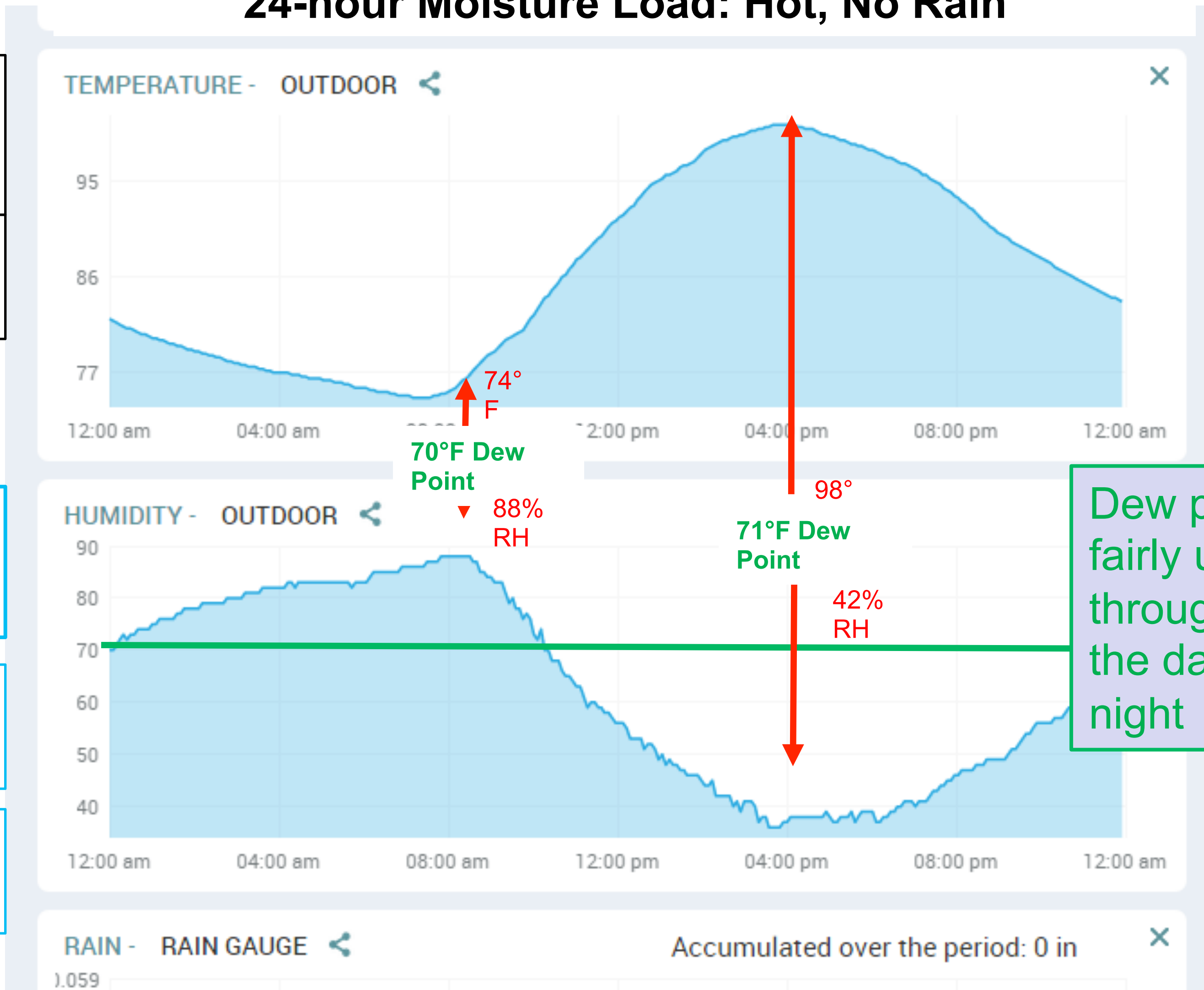
Sensible load — High most of the time

Latent load— High most of the time

A Rainy Day is Different

Sensible load — <u>Low</u>

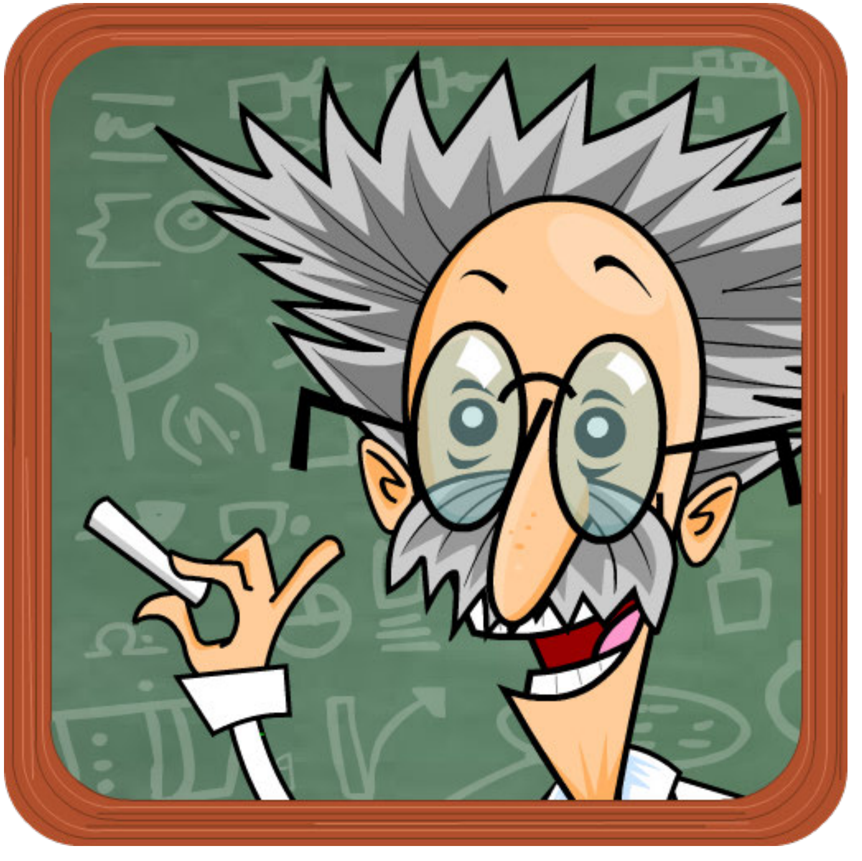
Latent load— High most of the time

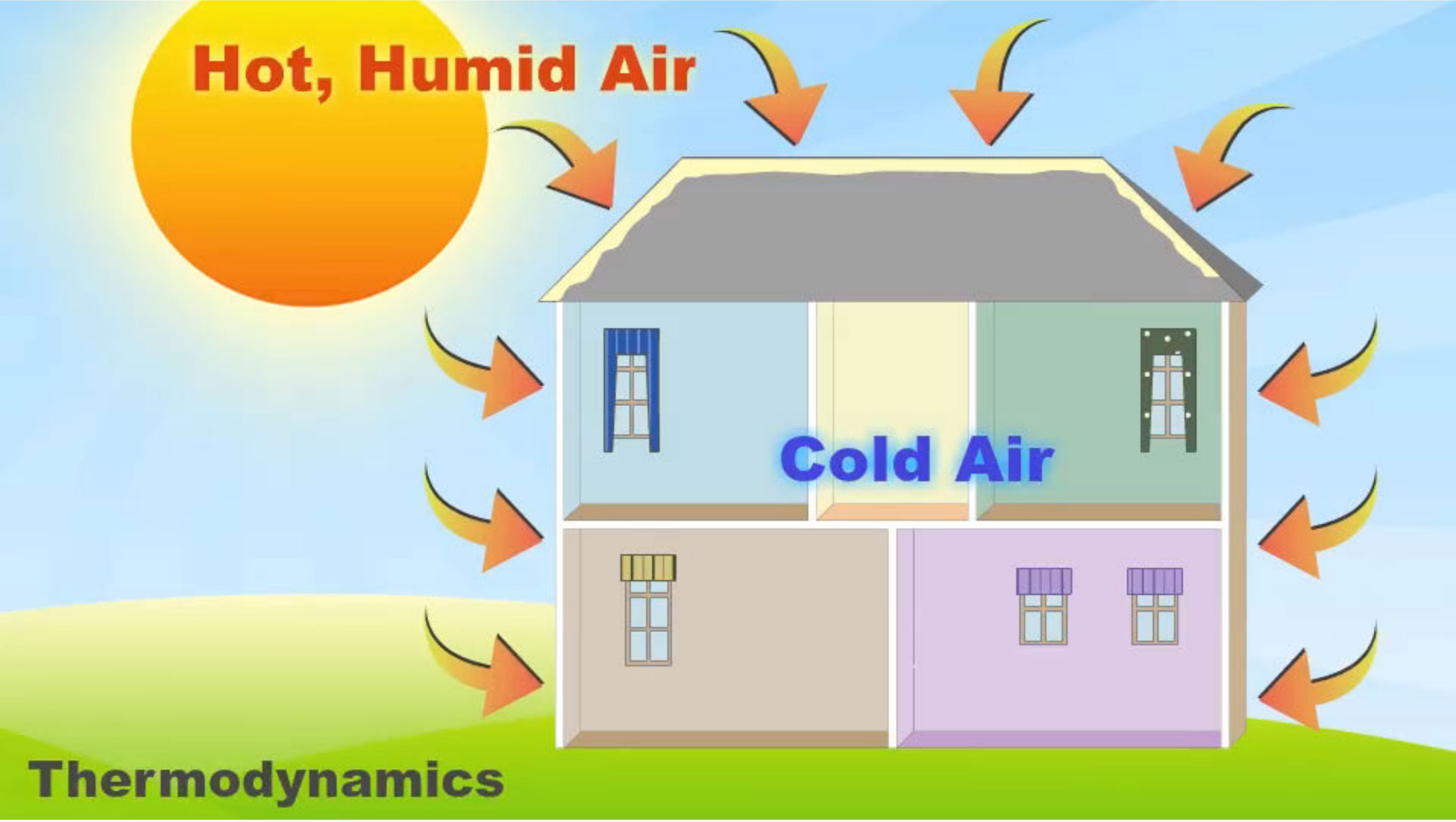


This is for a green grass climate region.

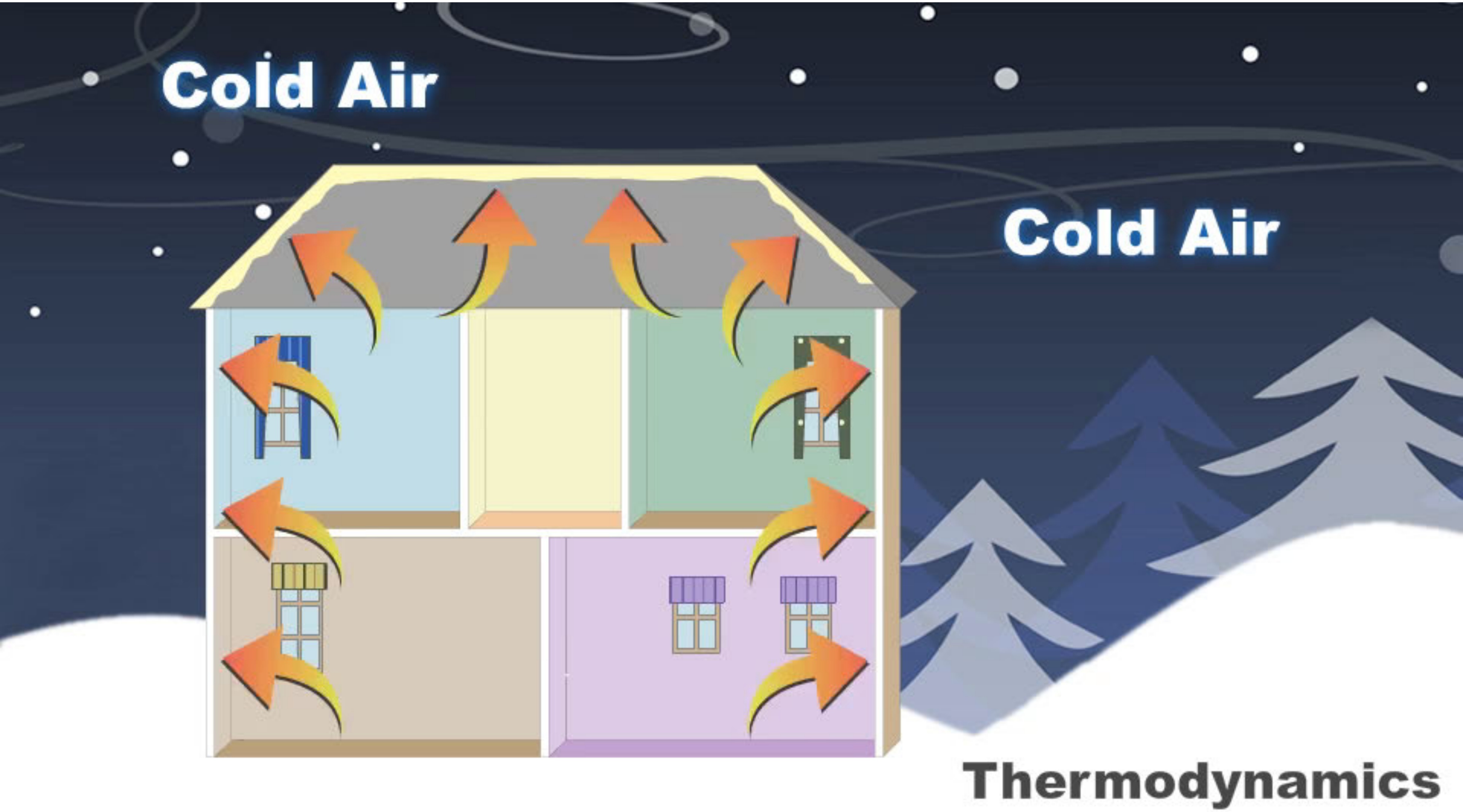
Dew point is fairly uniform throughout the day and night

Thermodynamics Basics



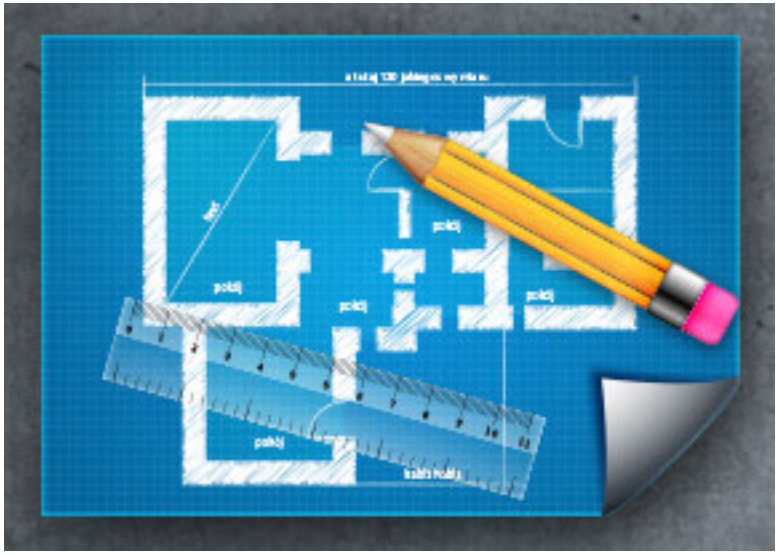


Hot, Humid Air
Cold Air
Thermodynamics

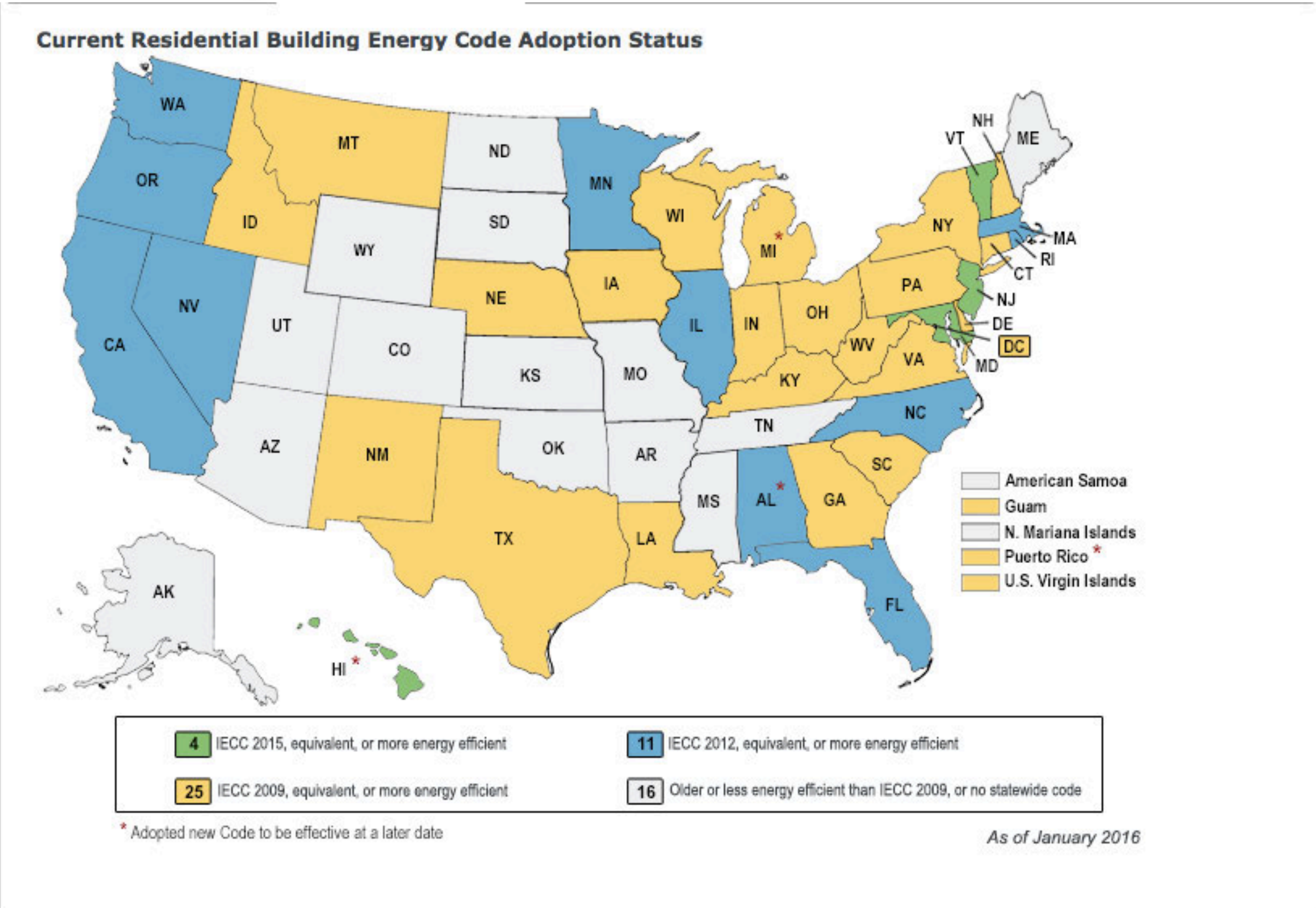

Cold Air
Cold Air
Thermodynamics

Today's Building Practices

Health, Comfort & Structure

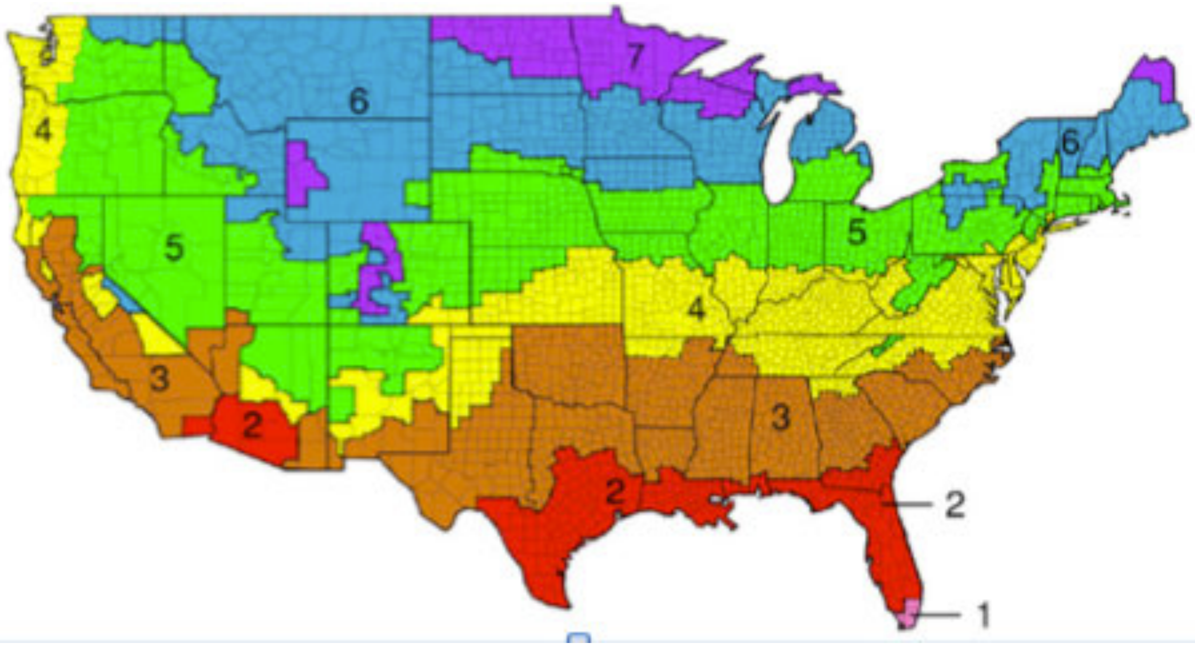


Building Codes



Source: Department of Energy

2012 IECC – Air Tightness



Climate Zone	2009 IECC	2012 IECC
1 - 2	< 7 ACH	≤ 5 ACH @ 50 pascals
3 - 8	< 7 ACH @ 50 pascals	≤ 3 ACH @ 50 pascals

Table 1: 2009 vs. 2012 IECC Comparisons

Source: Department of Energy

2012 IECC- Ventilation

IMC, Section 401.2 Ventilation Required

Where the air infiltration rate in a dwelling unit is less than 5 air changes per hour when tested with blower door at a pressure of 0.2-inch water column (to Pa) in accordance with Section 402.4.1.2 of the International Energy Conservation Code, the dwelling unit shall be ventilated by mechanical means in according with Section 403.

2,000 square ft. house will need approximately 90 CFM of fresh air according to the 2013 ASHRAE 62.2 Standard

This is up from 50 CFM in the 2010 ASHRAE 62.2 Standard

Source: Department of Energy

"Locating the air distribution system ducts inside conditioned space saves energy overall, but with the reduced sensible cooling load, also comes an increased need for supplemental dehumidification."

"…mechanical ventilation, operated at the ASHRAE 62.2-2010 addendum r rate, in a 3 ach50 house, raises the annual median indoor RH by almost 10% RH compared to a 7 ach50 house without mechanical ventilation in Orlando."

U.S Department of Energy: *Recommended Approaches to Humidity Control in High Performance Homes by Armin Rudd*

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Table 1: 2009 vs. 2012 IECC Comparisons

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The Need for Dehumidification is Significant

High indoor humidity levels affect:

- Health
- Comfort
- Personal belongings
- Structure of our homes

AMERICAN LUNG ASSOCIATION. Fighting for Air

AMA AMERICAN MEDICAL ASSOCIATION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Less than 50% RH

ASHRAE Advancing HVAC&R to serve humanity and promote a sustainable world

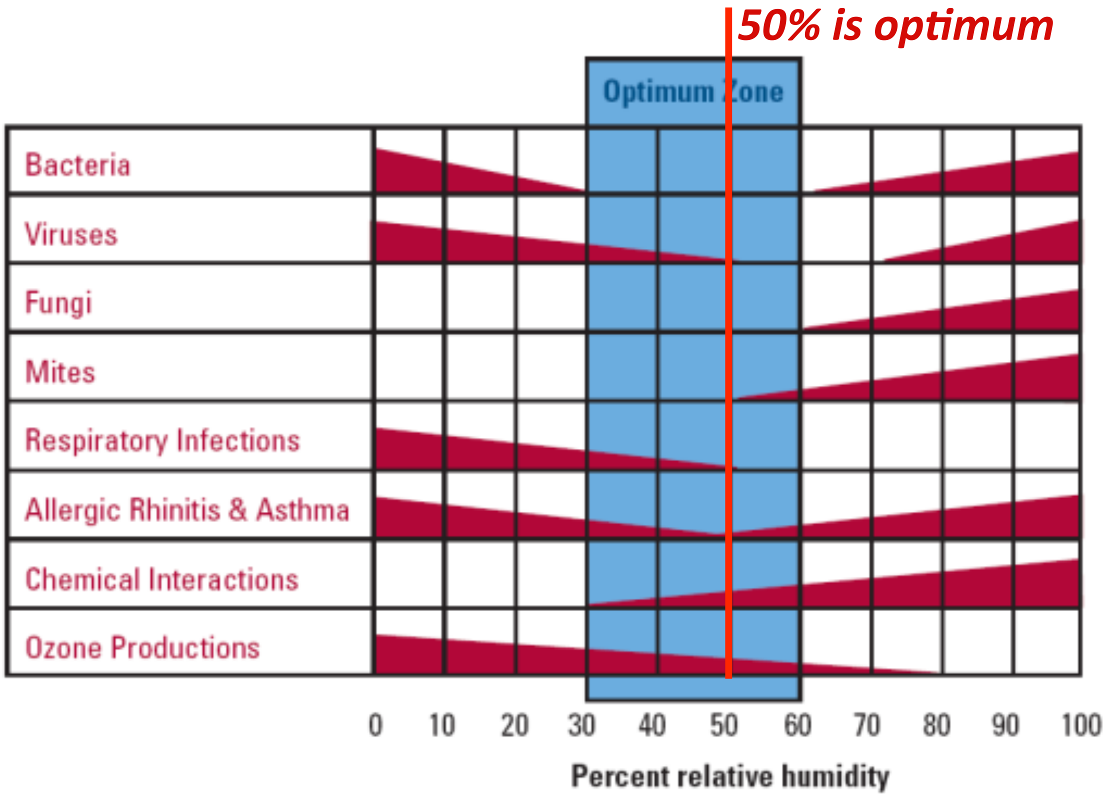
Less Than 60% RH

bsc Building Science Corporation

"Most comfortable when the relative humidity range is between 25-60%"

Health and Well Being

Optimum relative humidity range to minimize harmful contaminants*
(a decrease in bar height indicates a decrease in effect for each of the items)



*ASHRAE: American Society of Heating, Refrigeration & Air Conditioning Engineers

AIR CONDITIONING

- Designed to reach a temperature set-point (sensible)
- New units have dehumidification set-points – still cooling

A common misperception is that hot, humid days are the most challenging days to control moisture in a home. But in these conditions the air conditioner runs a lot in order to cool the home, and removes moisture in the process.

Days that you need to be most concerned about are when it is 70°F and raining.

1 Ton A/C Provides:

12,000 BTU per hour of cooling-

- 10,000 BTU of sensible cooling
- 2,000 BTU of latent cooling

2 lbs. per hour of dehumidification-

Uses the first 1 lb. of condensate per ton of coil to load the coil/pan

The typical A/C setup takes 30 minutes of runtime to wet the coil and drain pan.
This is before the first drop of condensate drains out.

Seasonal Energy Efficiency Ratio (SEER)

The SEER rating of a unit is the cooling output during a typical cooling-season divided by the total electric energy input during the same period. The higher the unit's SEER rating the more energy efficient it is.

High SEER AC

- Larger coils that are very efficient at getting to a cool temp quickly equals less run time.
  Typical coil holds 1 pound of water per ton
- Coils do not get as cold as older AC systems
  Less water removed from air and going down drain
- High efficiency A/C run 1-3 minutes fan delays at end of cycle to increase SEER rating.
  This increases the SEER rating by .5
- **Can increase indoor RH by up to 10%**

Variable Speed

Variable Speed

- Slows air conditioner fan down to remove more moisture
- A/C makes a smaller amount of colder air
- Colder surfaces (ducts, registers, etc.) may result in condensation
- Doesn’t solve 70ºF/raining

3 Ton Heat Pump Specs at Various Conditions

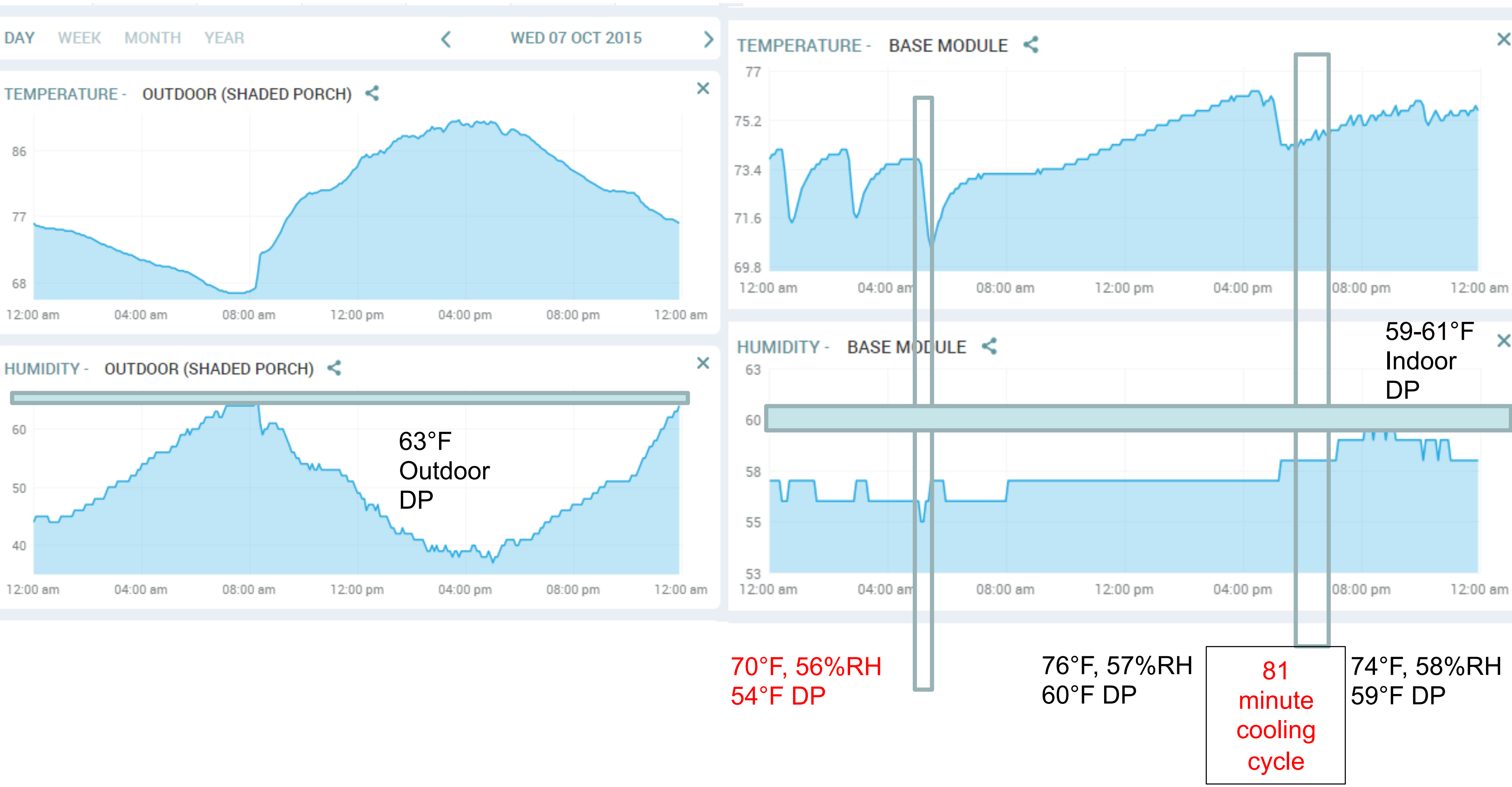
HPXA12-036 — CB30M-31 - CB30U-31 - CBX32M-030 COOLING CAPAC

Entering Wet Bulb Tempera-ture	Total Air Volume		Outdoor Air Temperature 85°F (29°C)						95°F (35°C)					
			Total Cooling Capacity		Comp Motor kW Input	Sensible To Total Ratio (S/T) Dry Bulb			Total Cooling Capacity		Comp Motor kW Input	Sensible To Total Ratio (S/T) Dry Bulb		
	cfm	L/s	kBtuh	kW		75°F 24°C	80°F 27°C	85°F 29°C	kBtuh	kW		75°F 24°C	80°F 27°C	85°F 29°C
63°F (17°C)	1050	495	34.8	10.2	2.44	.74	9 lbs. moisture per hour with 45°F coil with 55°F dew point return at 350 cfm per ton. Excellent setup							
	1300	615	35.9	10.5	2.36	.79	6 lbs. moisture per hour with 50°F coil with 55°F dew point return at 350 cfm per ton. Marginal							
	1600					.90	<3 lbs. moisture per hour with 52°F coil with 55°F dew point return at 530 cfm per ton. Wet home							

Raising the air flow from 350 to 530 cfm per ton increases the sensible ratio to .90 (thus decreasing the latent ratio to .10). This favors sensible cooling rather than humidity removal.

The increased airflow drops the dehumidification to <1 lb. of moisture removal per ton. More airflow forces the cold indoor coil to run warmer.

New Construction Energy Star Texas Home



The A/C is incapable of lowering the indoor dew point below 59°F. There is not enough sensible load.

Fresh Air Ventilation

The driving force for the development of ventilation standards is the fact that indoor air quality affects both comfort and health.

- Big debate is how much fresh air should be the standard
  - Everyone responds differently to pollutants
  - Bringing in fresh air costs $$$$

Fresh Air Ventilation

Balance - Balanced ventilation systems use one fan to bring fresh air into the home and another to exhaust an equal amount to the outdoors.

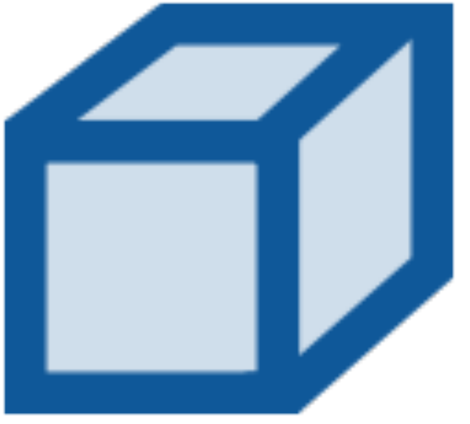
Supply - Supply ventilation systems push air into the home creating a slight positive pressure and provides make-up air for kitchen hoods and bathroom fans.

Exhaust - Exhaust ventilation systems pull stale air out of the home creating a negative pressure in the house and rely on make-up air leakage through the structure.

How Moisture, Temperatures and Wind Affect the Home

Lets start with one cubic foot of air. A typical home has 20,000 cubic feet inside the walls.

To be healthy, ASHRAE suggest an air change in 4-5 hours. This purges indoor pollutants and renews oxygen.

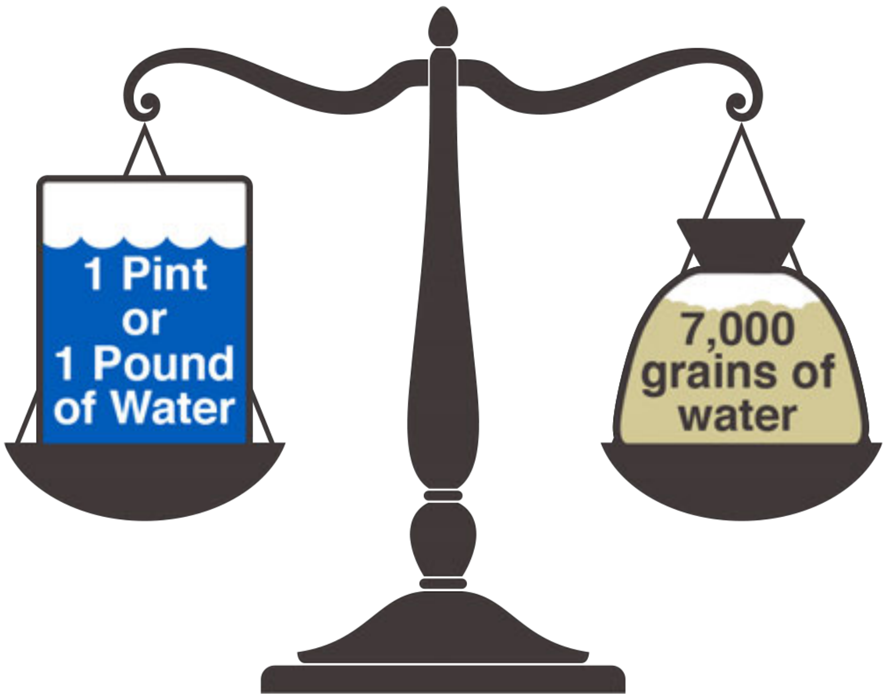


A Pint is a Pound the World Around

1. Let us focus on the amount of moisture in 1 cubic foot of air at specific temperatures and 100% relative humidity (RH).

2. There are 7,000 grains of moisture in a pint or lb. of water.

3. 1.4 drops of liquid water equals 1 grain of moisture vapor or 1 drop of water equals .7 grains. Call a grain of moisture a big drop.

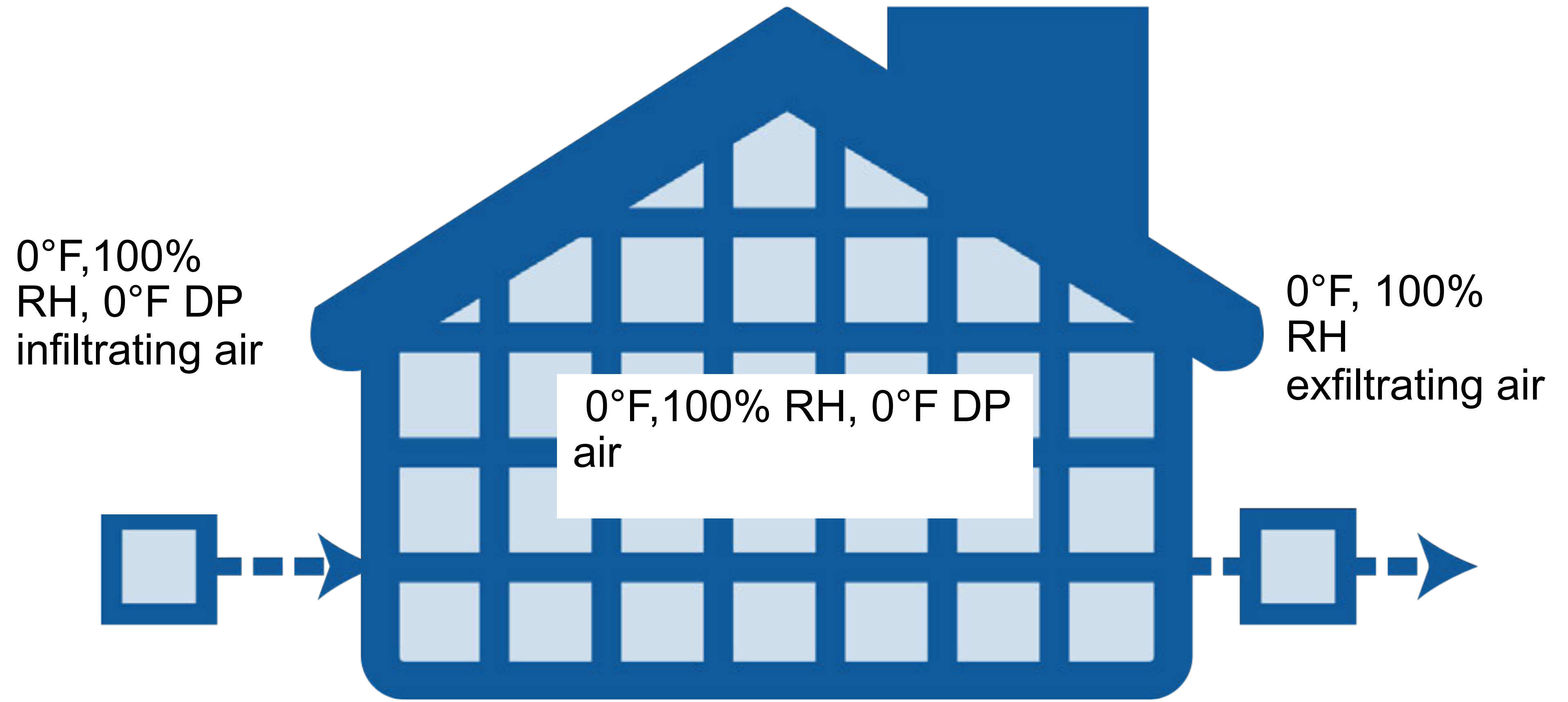


Homes imperfections allow air infiltration and exfiltration

1. Wind
2. Stack effect
3. Mechanical fans

Fresh Air Infiltration – Cold and Windy Climate

Unheated Home

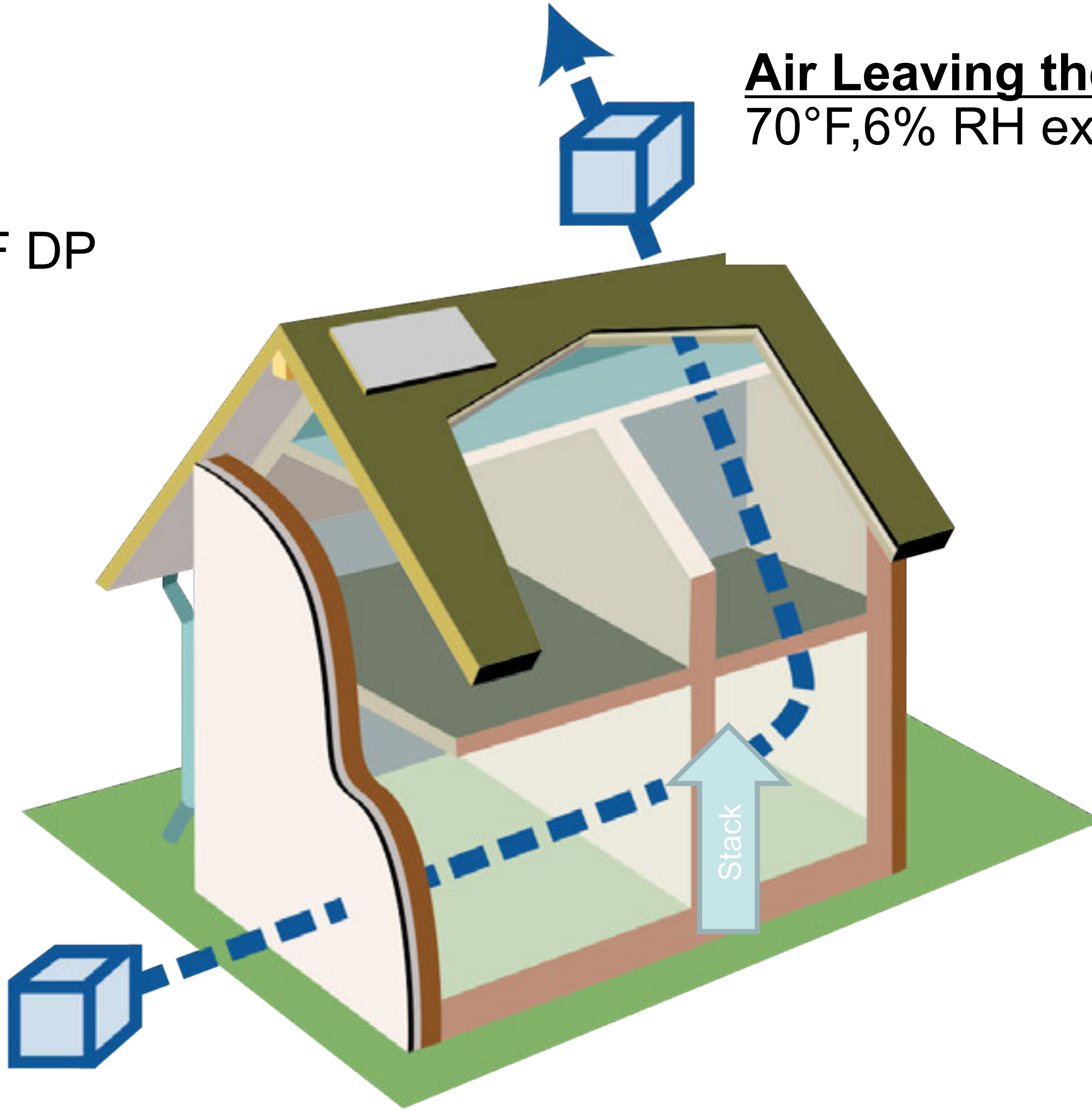


Fresh Air Infiltration – Cold and Windy Climate

Heated Home

Inside Home
70°F, 6% RH, 0°F DP

Air Leaving the Home
70°F,6% RH exfiltrating



Outside Air
0°F,100% RH, 0° DP infiltrating air

An occupant adds about ¼ lb of moisture (breathing) plus ¼ lb from activities to a home per hour.*

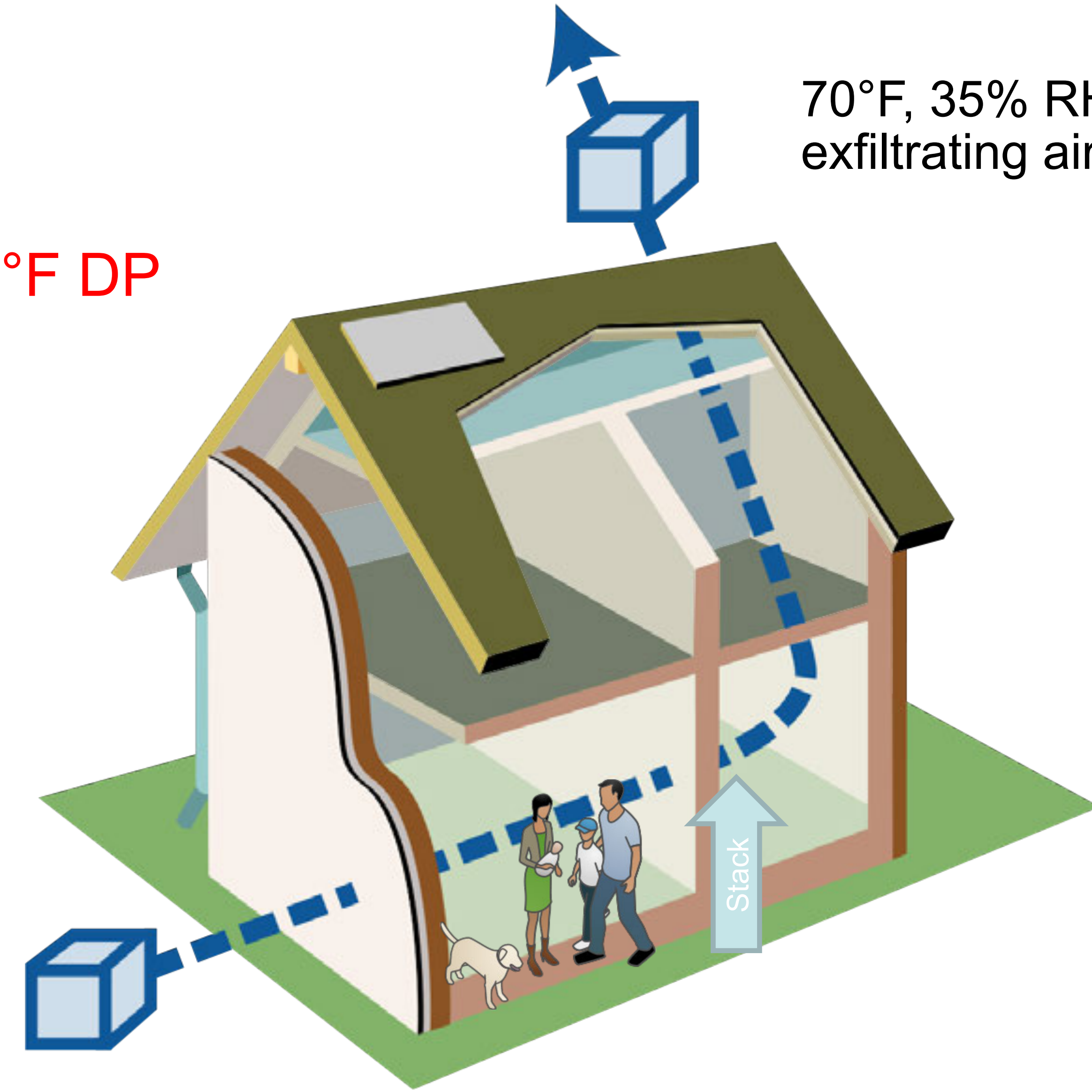
4 occupants add 2 lbs. (14,000 grains) per hour of moisture to the home.

*ASHRAE

Fresh Air Infiltration – Winter

Heated Home

Inside Home
70°F, 35% RH, 41°F DP

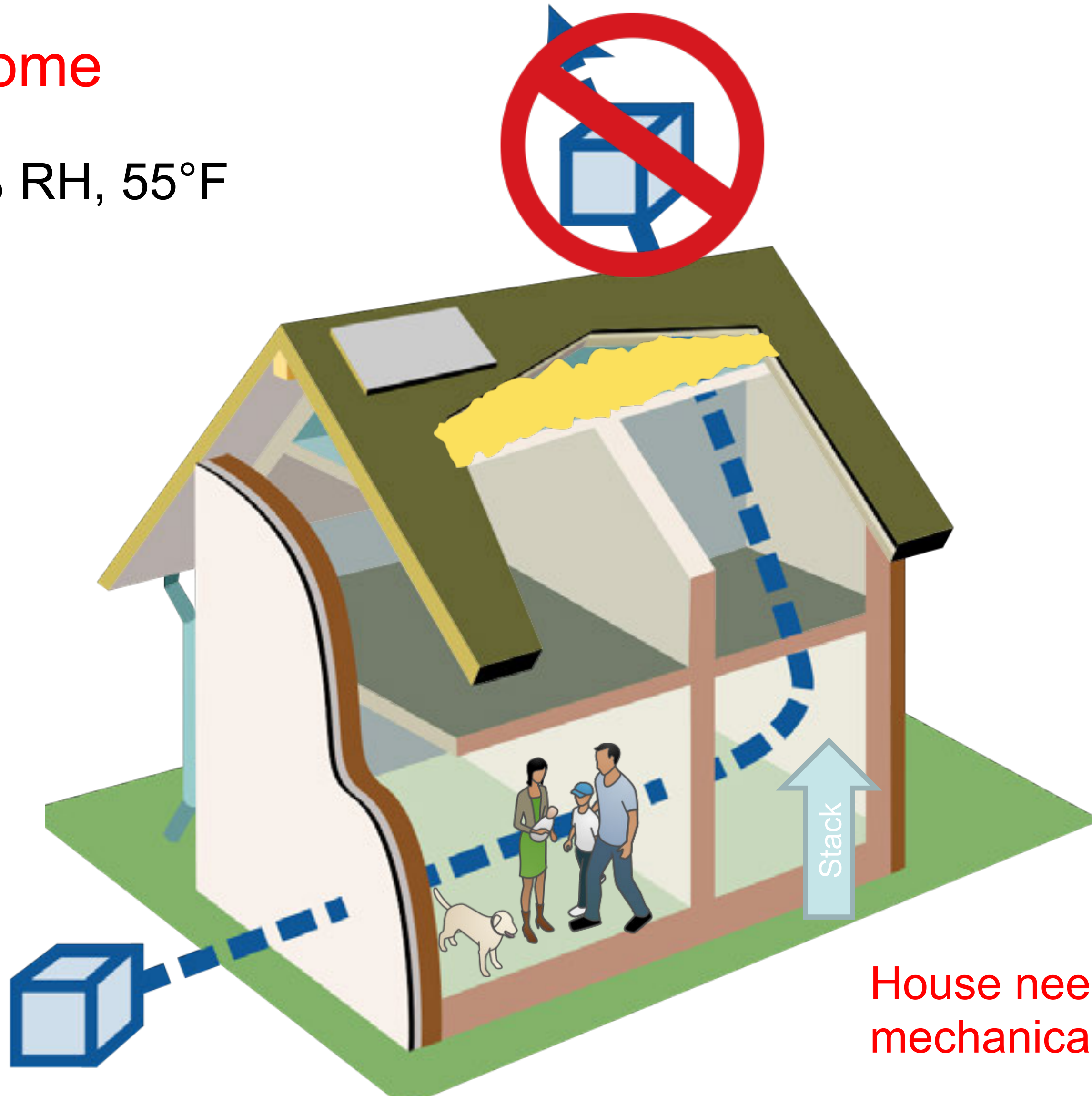


Home with Spray Foam & Mechanical Ventilation Fresh Air Infiltration – Winter

Heated Home

70°F, 60% RH, 55°F DP

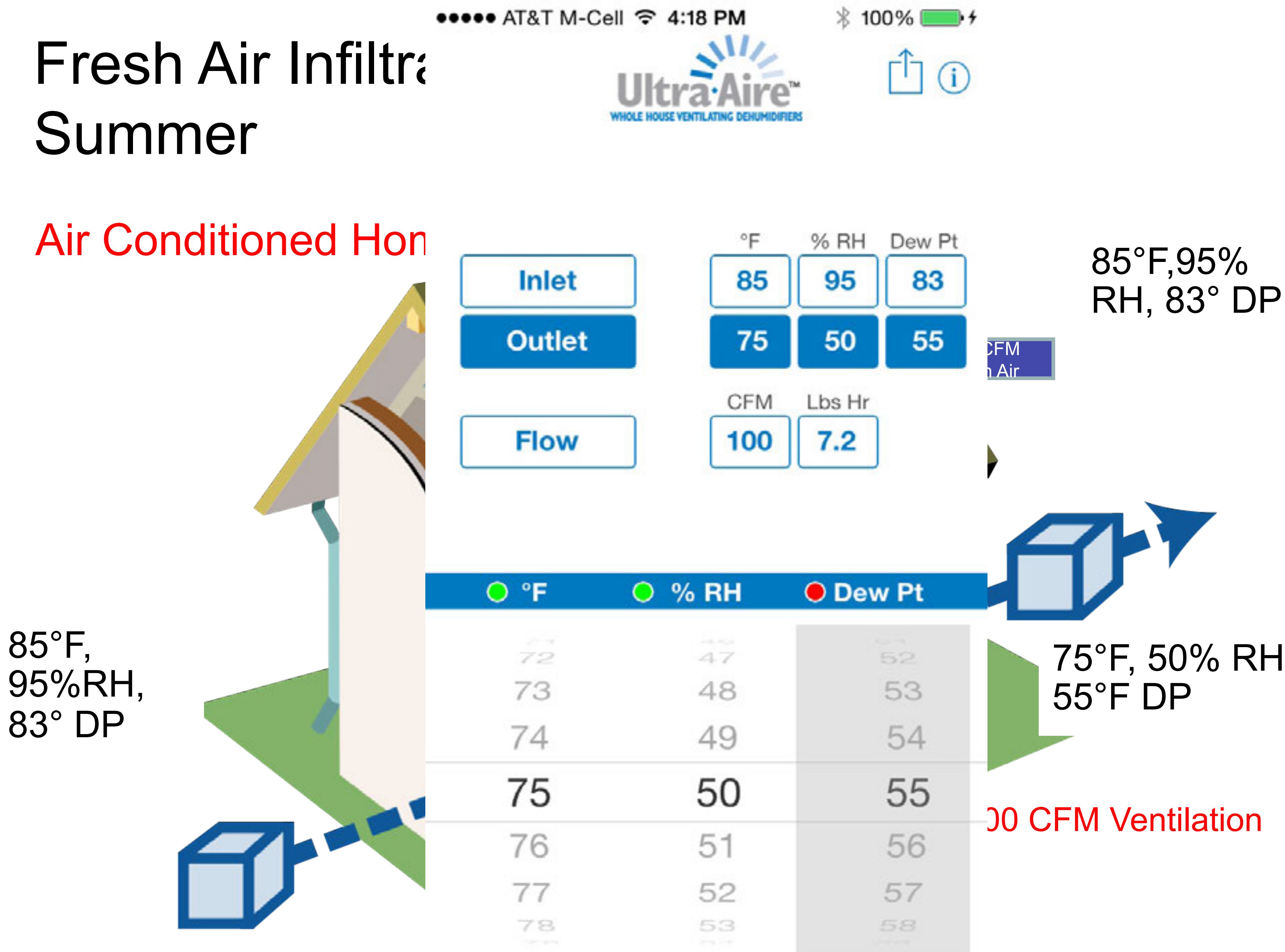
0°F,100% RH infiltrating air



House needs 100 CFM of mechanical ventilation

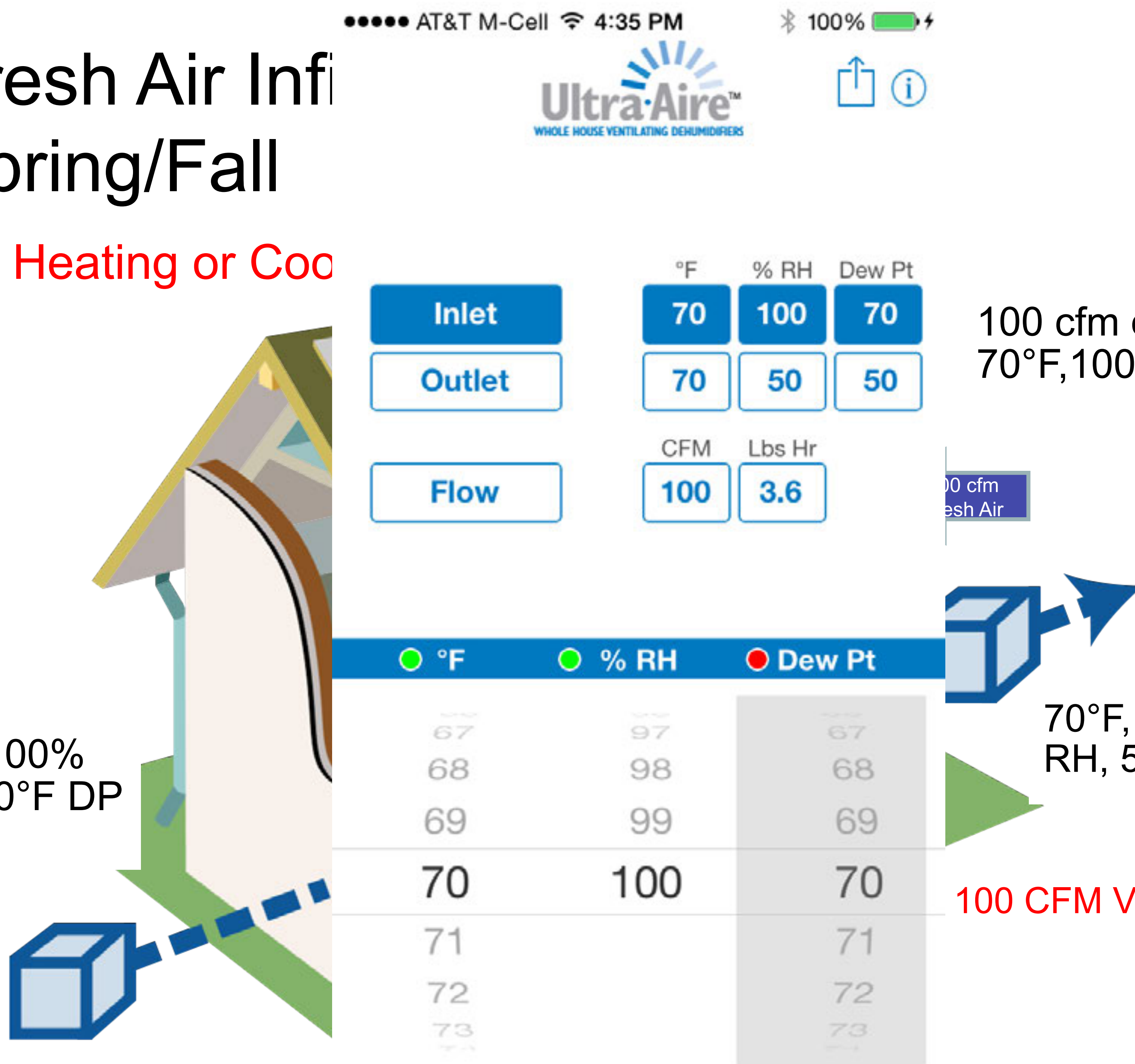
Fresh Air Infiltr
Summer

Air Conditioned Hon



Fresh Air Infi
Spring/Fall

No Heating or Coo



100 cfm of
70°F,100% RH

70°F,100%
RH, 70°F DP

70°F, 50%
RH, 50°F DP

100 CFM Ventilation

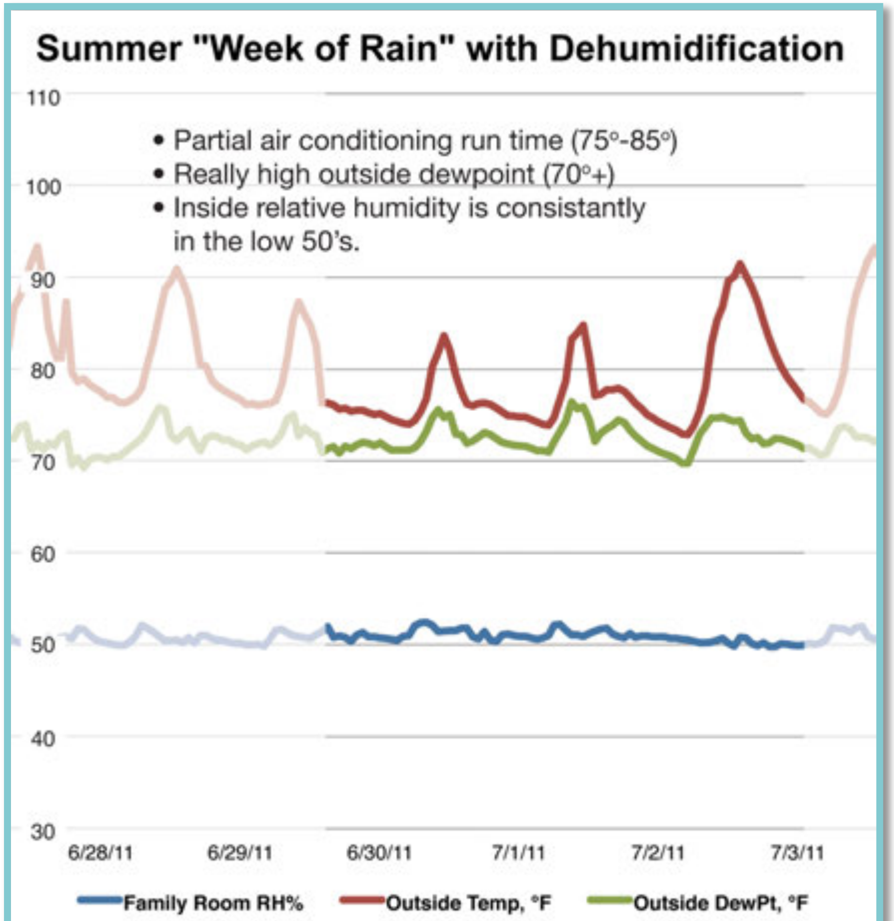
Moisture Removal Required per 100 cfm of Outdoor Air Infiltration

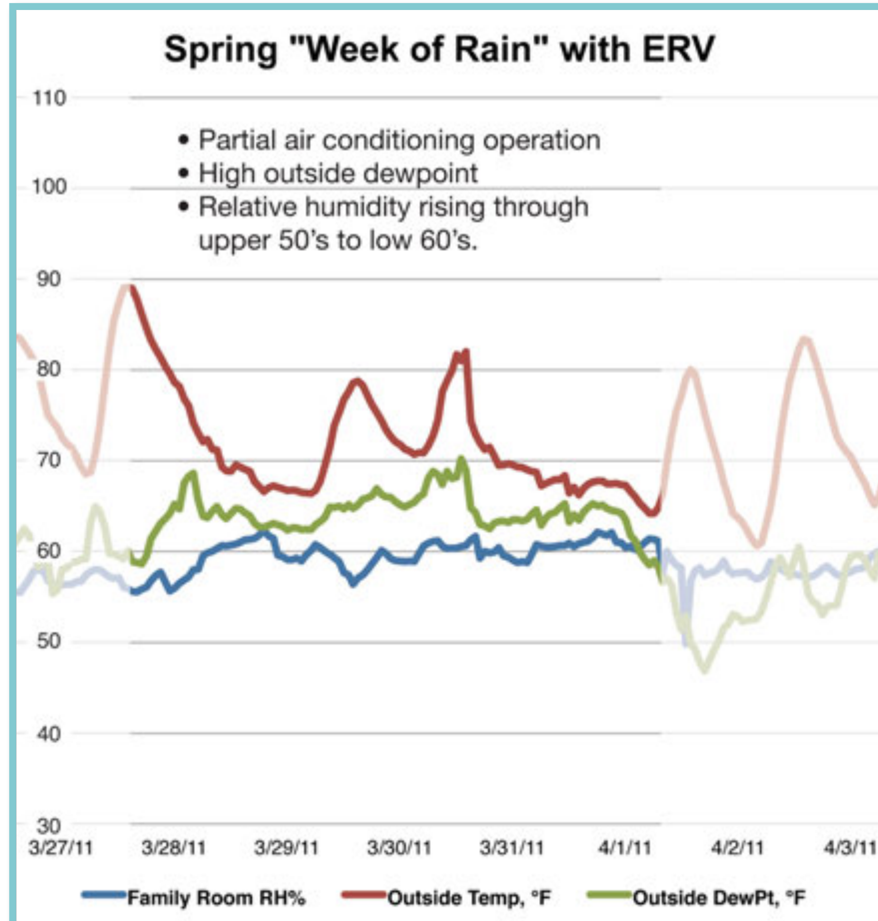
Indoor °F, %RH	Lbs. per hour Required Moisture Removal						
70°F, 45% RH, 48°F DP	.3	1	2	3	4	5.3	7
70°F, 50%RH, 50°F DP					3.6	5.1	
75°F, 60%RH, 52°F DP	0				3.3	4.8	
75°F, 50% RH, 55°F DP		0	1	2	3	4.3	6
80°F, 50%RH, 60°F DP			0	1	2	3.5	5
90°F, 50% RH, 69°F DP					.3	1.6	3.2
	50°F	55°F	60°F	65°F	70°F	75°F	80°F

Dew Point Temperature of Infiltrating Air

Rainy days, evenings, and design days (lbs. per hour, moisture)

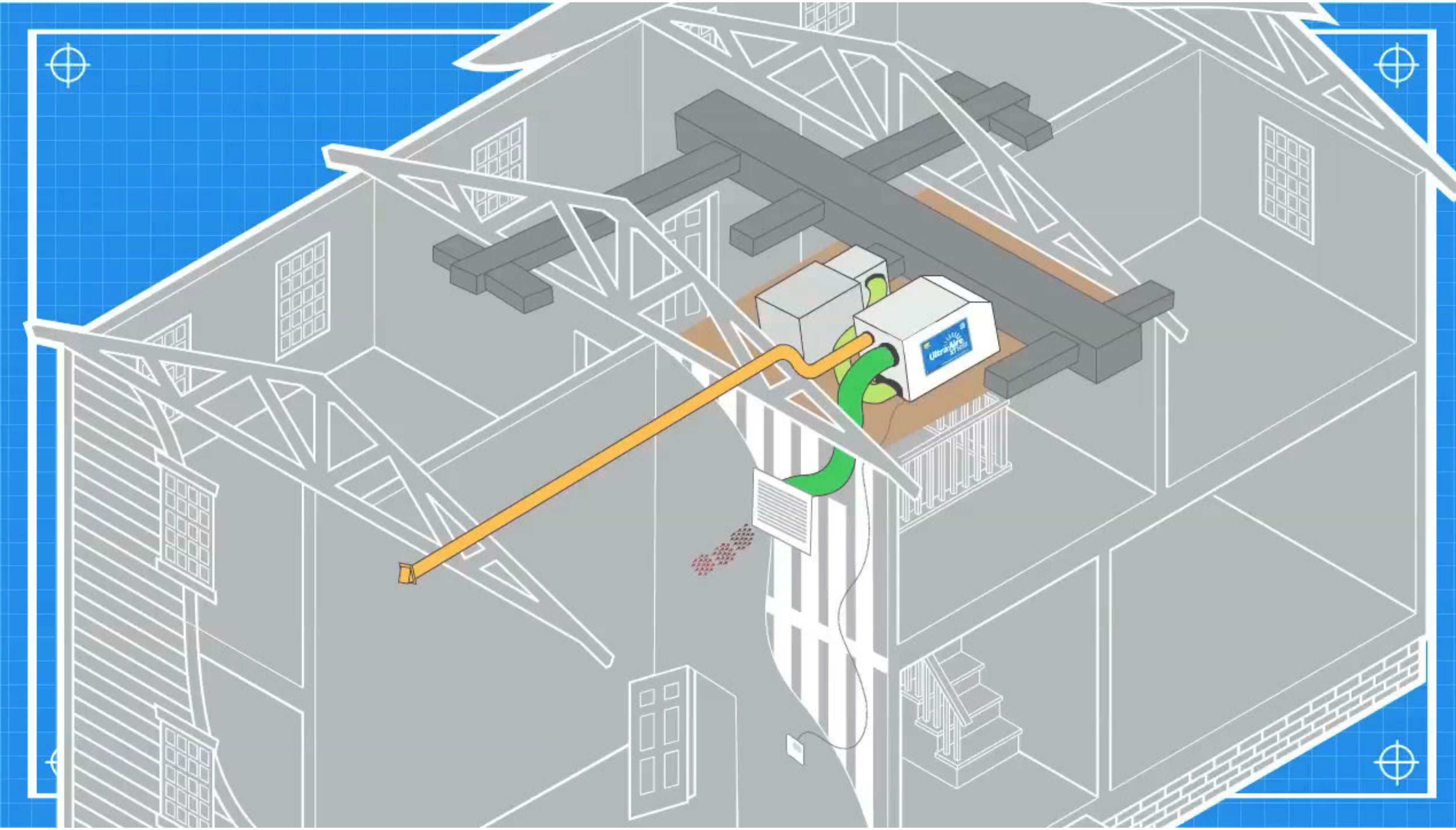
Whole House Dehumidification Vs. ERV

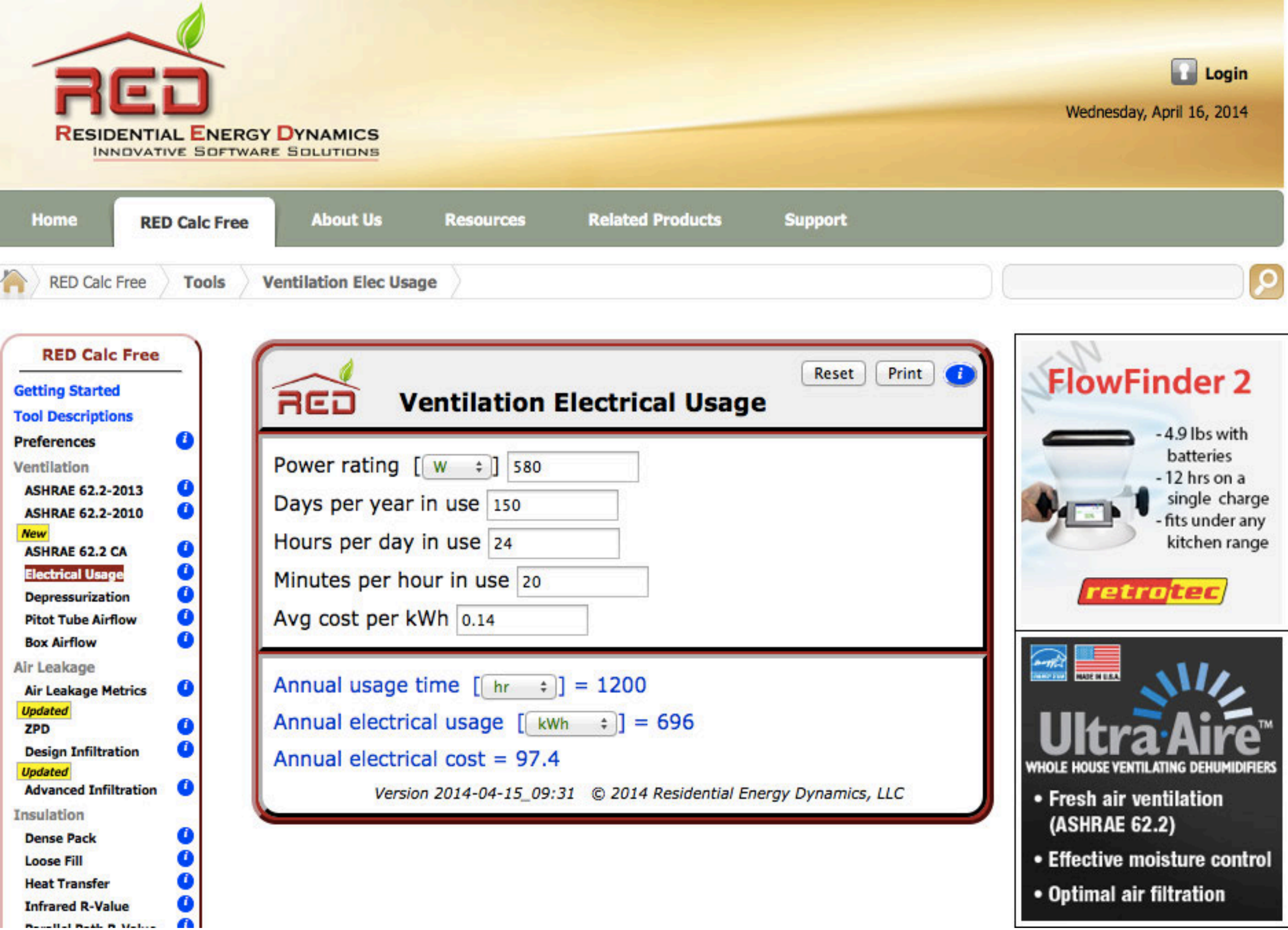




"…the ERV is ineffective in keeping indoor RH down during floating hours when the difference between indoor and outdoor absolute humidity is small."

*U.S Department of Energy: *Recommended Approaches to Humidity Control in High Performance Homes by Armin Rudd*


UltraAire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Heat Transfer
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Reset
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Ventilation Electrical Usage
Power rating [W] 580
Days per year in use 150
Hours per day in use 24
Minutes per hour in use 20
Avg cost per kWh 0.14
Annual usage time [hr] = 1200
Annual electrical usage [kWh] = 696
Annual electrical cost = 97.4
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NEW
FlowFinder 2
- 4.9 lbs with batteries
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MADE IN U.S.A.
Ultra-Aire™
WHOLE HOUSE VENTILATING DEHUMIDIFIERS
• Fresh air ventilation (ASHRAE 62.2)
• Effective moisture control
• Optimal air filtration

Best Ways to Decrease the Indoor Relative Humidity

1. Maintain ideal ventilation rate when occupied.
2. Add a correctly sized whole house dehumidifier
3. Setup a/c to provide air <45°F dew point air/cooling
4. Fix duct and building air leaks

Questions?