Managing HVAC in High Performance Buildings

ABOUT US

Ultra-Aire is one of five brands manufactured in Madison, WI under Therma-Stor, LLC.

Our company, established in 1977, is considered the pioneer of whole-house dehumidification and premier manufacturer of dehumidifiers and heat reclaim products.

Ultra-Aire

Santa Fe

QUEST
DEHUMIDIFIERS

PHOENIX™
RESTORATION EQUIPMENT

Therma-Stor

Definitions and Terminology

Sensible Load is the temperature you feel on your body and measured with a thermometer. This is controlled with the HVAC thermostat.

Latent Load is the moisture in the air often referred to as relative humidity. This is more challenging to control with the HVAC thermostat.

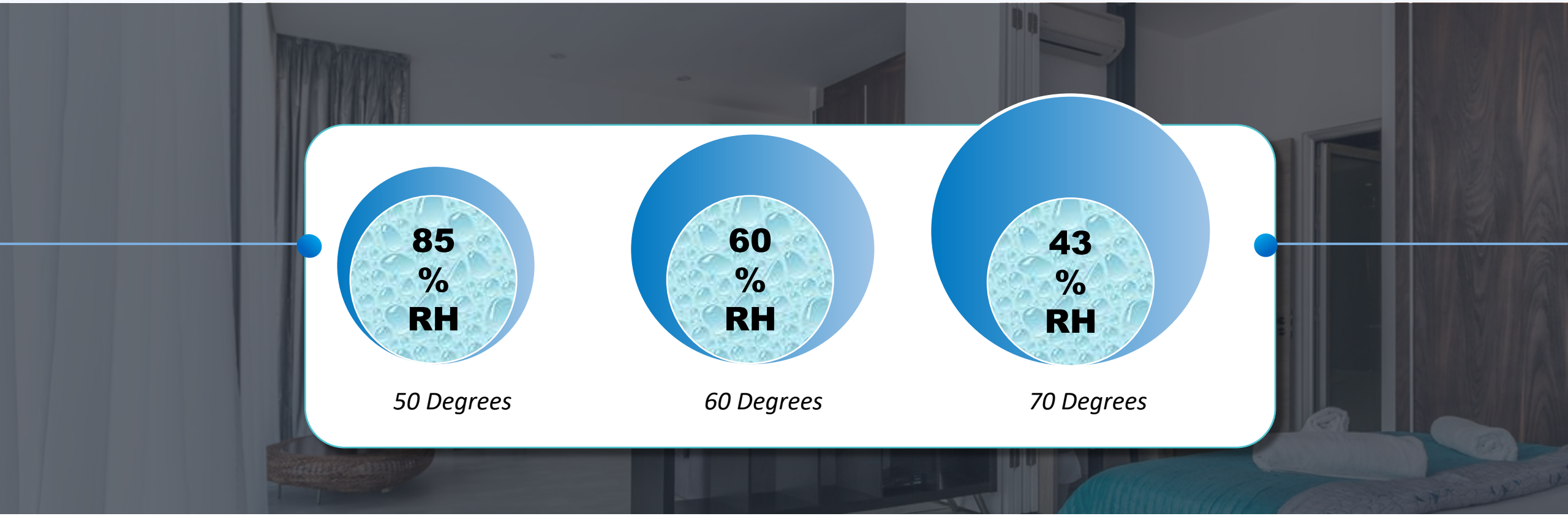
A pint is a pound the world around

It takes 1,000 btus to remove one pint of water

1 cfm in = 1 cfm out

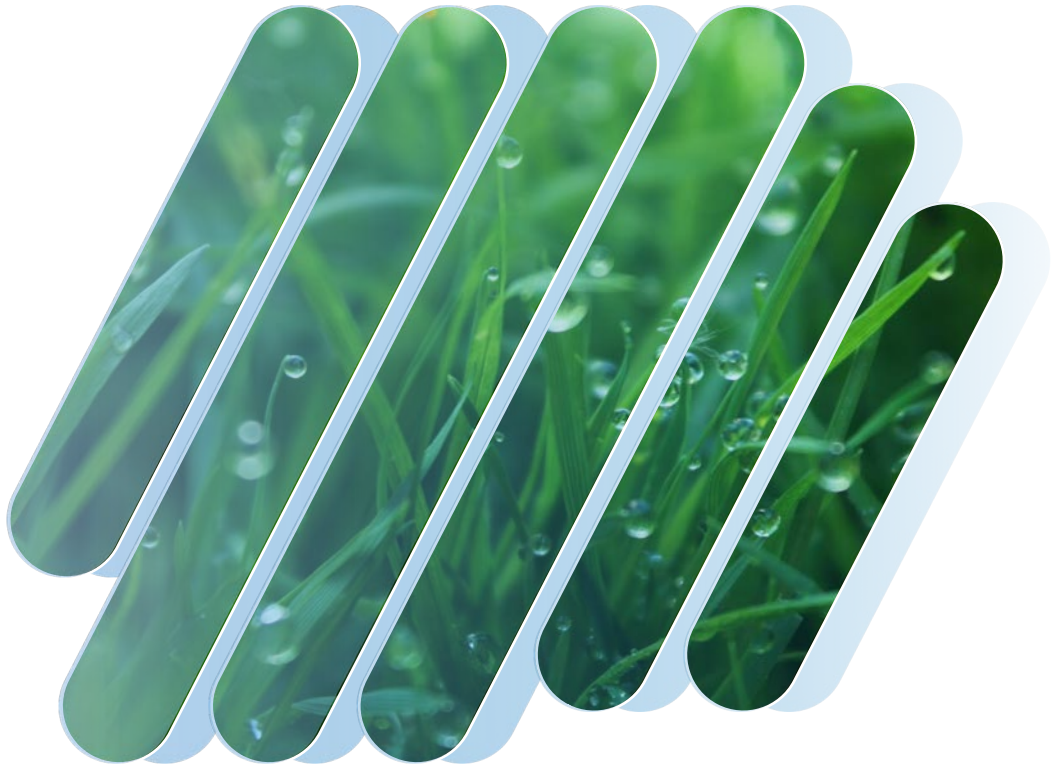
RELATIVE HUMIDITY

Humidity is relative to the temperature



While the amount of water in the air remains the same, the % of the air that the water occupies changes with the temperature; therefore, the amount of space that the water occupies is relative to the temperature of the air.

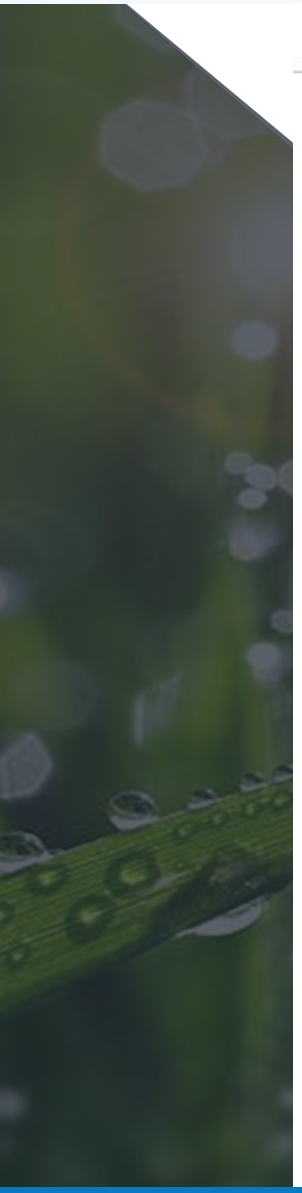
DEW POINT



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

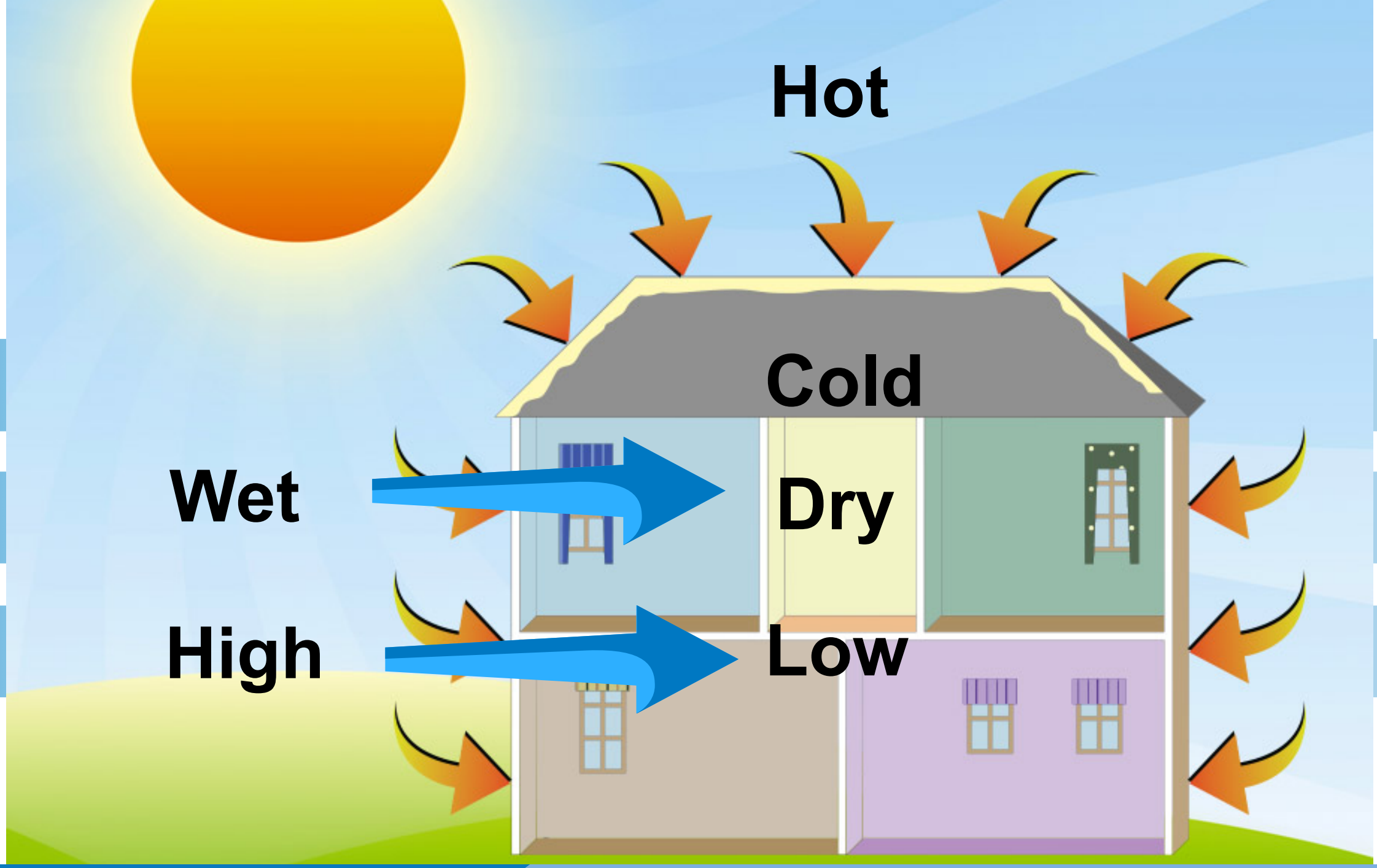
Unlike RH, the dew point does not change with air temperature. In that sense it is an “absolute” measurement of the amount of water vapor in the air.

DEW POINT'S ACROSS THE NATION

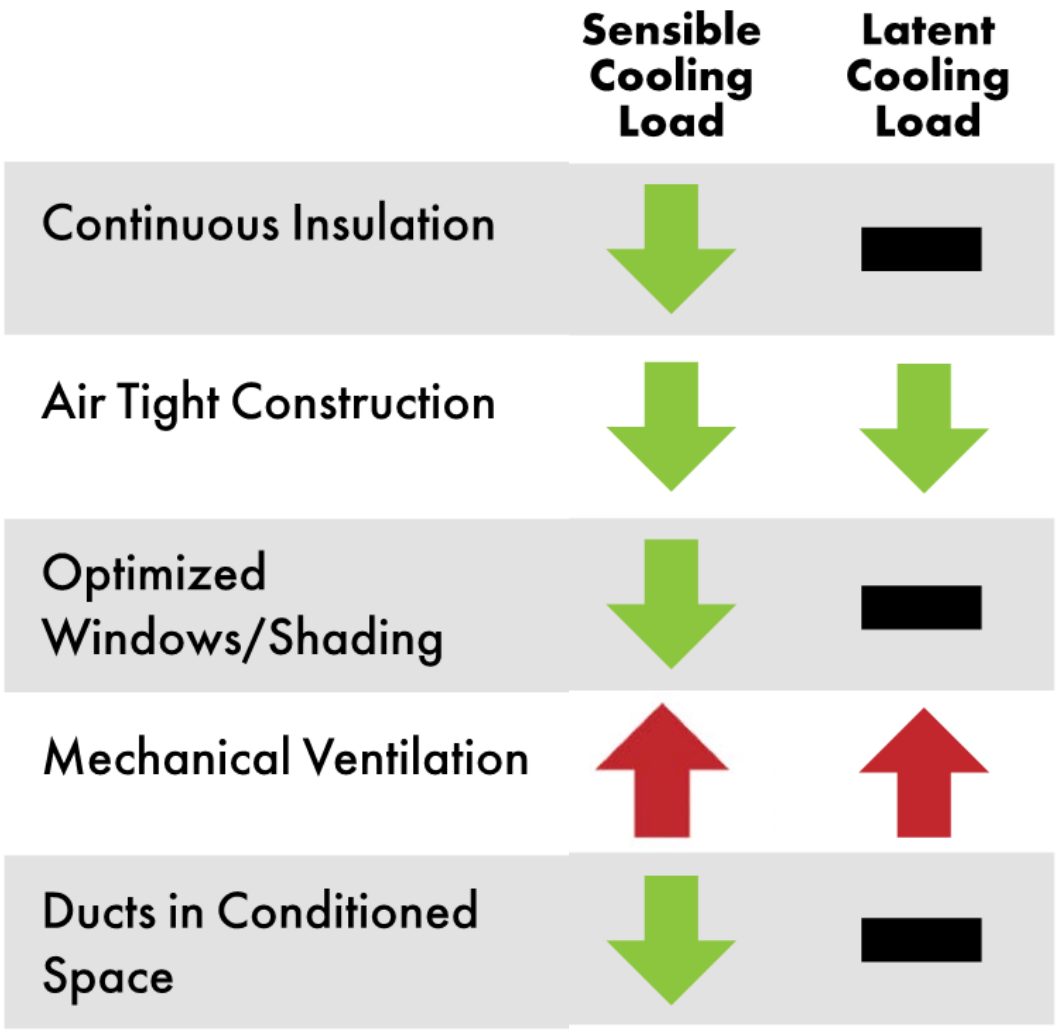


Dehumidification to maintain 75^F, 50%RH, 55^F dew point -- 0 1 3 6 Lbs. per hour per 100 CFM

Needs 1-6 pints/hour dehumidification per 100 cfm of fresh air @ 75^F, 50%RH 55^F dew point indoors


Hot
Cold
Wet
Dry
High
Low

Advances = Low-Sensible Load Houses

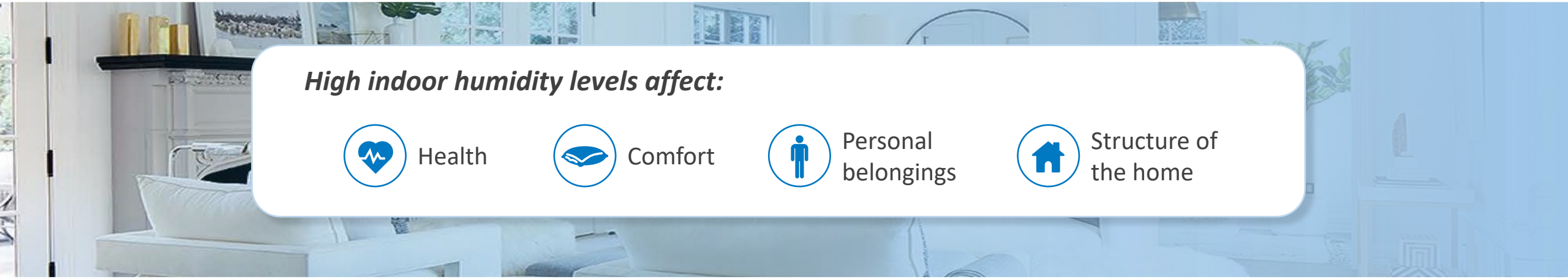


OCCUPANT BEHAVIOR INCREASES THE NEED FOR DEHUMIDIFICATION

One person adds about ¼ pint of moisture from breathing plus ¼ pint from activities to a home per hour.

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

THE NEED FOR DEHUMIDIFICATION IS SIGNIFICANT



High indoor humidity levels affect:

- Health
- Comfort
- Personal belongings
- Structure of the home

AMERICAN LUNG ASSOCIATION. Fighting for Air

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AMA AMERICAN MEDICAL ASSOCIATION

Less than 50% RH

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

Less Than 60% RH

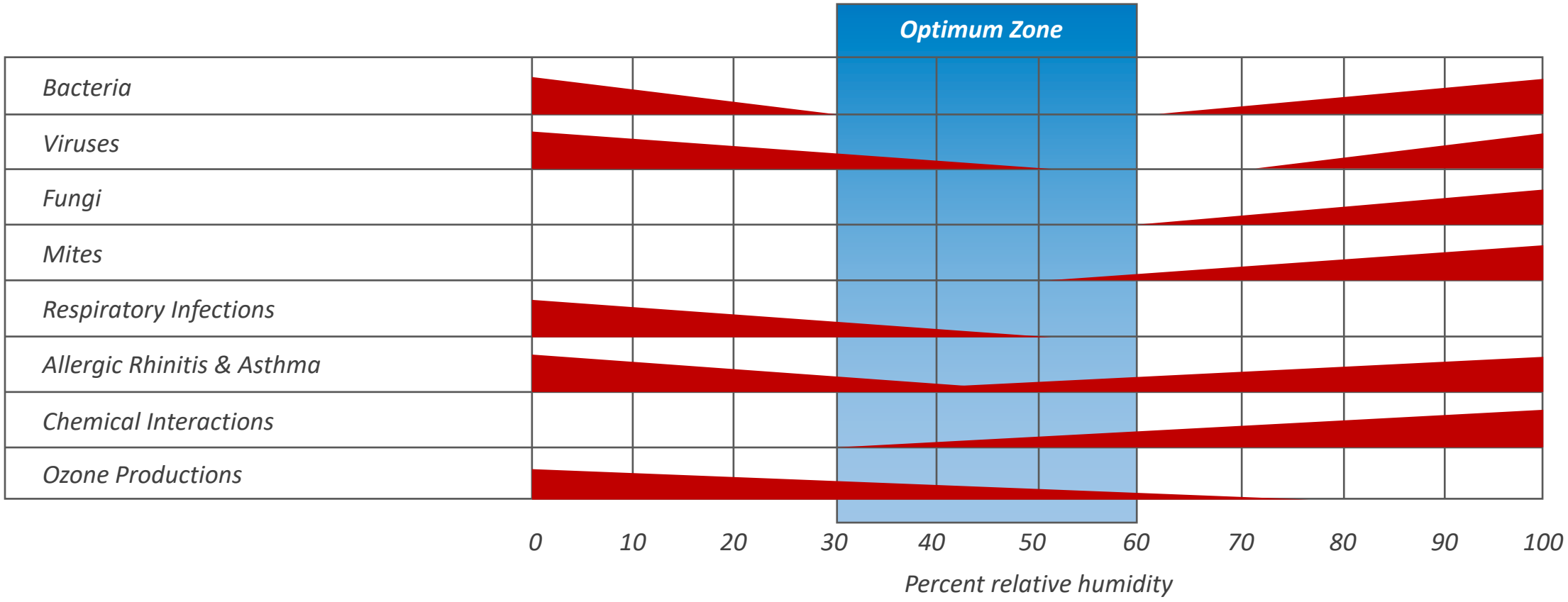
bsc Building Science Corporation

"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

BUILDING STRUCTURE | THE GOAL

The ultimate goal in every energy efficiency building standard program is to build a tight envelope to reduce the amount of run time on the HVAC system to save energy.

THE RESULT

- Higher Seasonal Energy Efficiency Ratio (SEER) equipment specified.
- Partial to no-load on the AC system, even in hot and humid climates.
- More efficient sensible cooling at the expense of latent removal capacity, resulting in (inefficient) overcooling to remove moisture.

DEHUMIDIFICATION STRATEGIES

AIR CONDITIONING

Designed to reach a temperature set-point (sensible)

New units have dehumidification set-points – still cooling

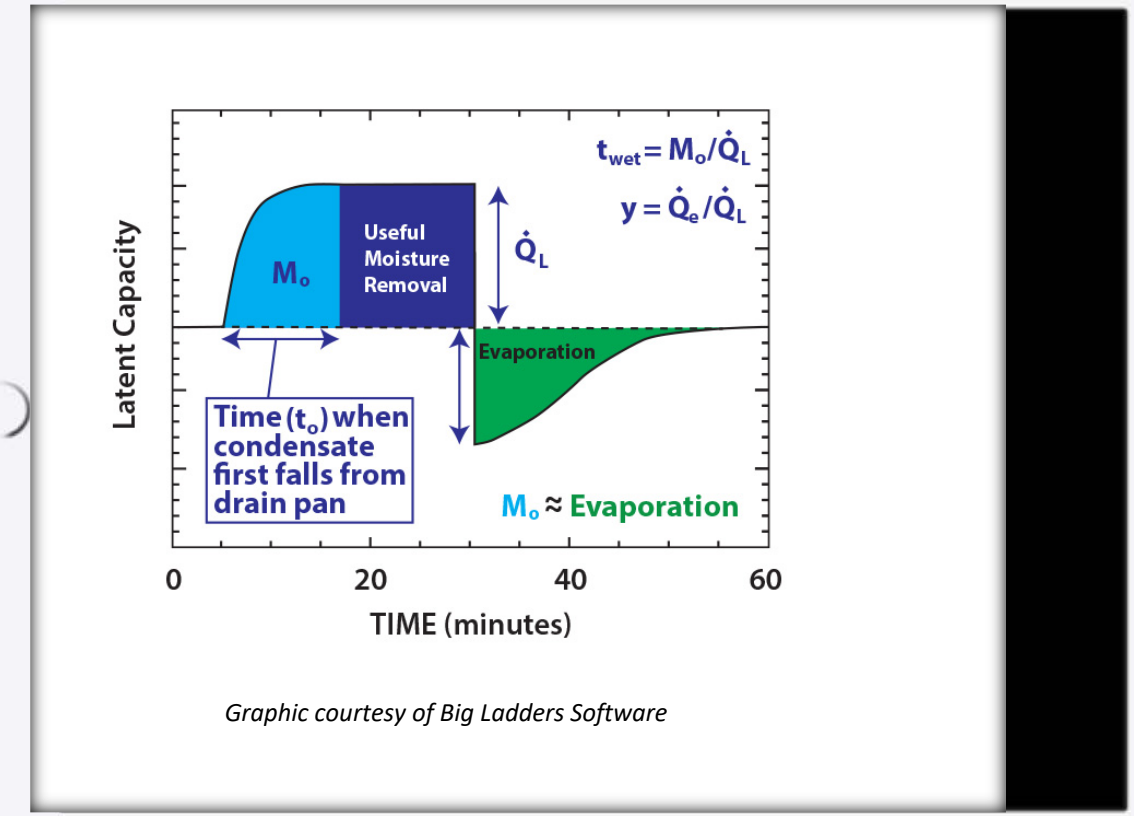
A common misperception is that hot, humid days are the most challenging days to control moisture in a home. But in these conditions, the air conditioner runs a lot in order to cool the home, which removes moisture in the process.

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

MECHANICAL SYSTEMS | WATER REMOVAL

Typical residential HVAC systems

need 14 minutes of run time to begin effective dehumidification.

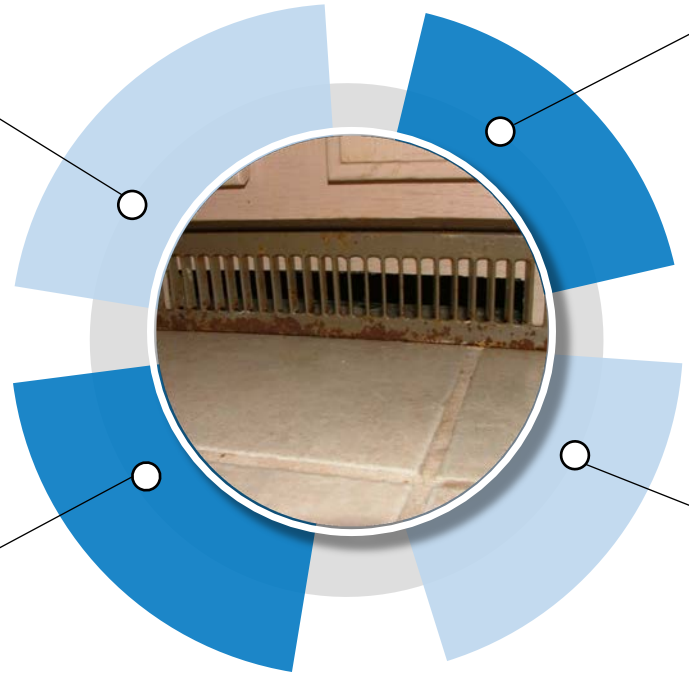


Graphic courtesy of Big Ladders Software

VARIABLE SPEED

Slows air conditioner fan down to remove more moisture

A/C makes a smaller amount of colder air



Doesn’t solve 70ºF/raining

Colder surfaces (ducts, registers, etc.) may result in condensation

DUCTLESS MINI-SPLIT

Only focuses on the space the unit is located in.

Cools the space very quickly, but often not enough run time to remove moisture in the space.

Dehumidification Mode is simply setting it to run in air cooling mode for a longer period of time, which leads to occupant discomfort and possible microbial growth due to materials reaching dew point.

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 means less run time. **Typical coil holds 1 pint of water per ton**

Coils do not get as cold as older AC systems.
Less water removed from air and going down the drain

High efficiency A/C runs 1-3 minute fan delays at end of cycle to increase SEER rating. **Increases the SEER rating by .5**

Can increase indoor RH by up to 10%

HVAC system has been sized according to industry best practices, is installed, and money collected. Some would consider this done – right?

WRONG!

Concern – the system has been sized for peak load conditions, but the house sees mostly partial and no-load conditions

BEST PRACTICES

Load-Calc

5/7/2016

Design Indoor Cooling Temp.: 78 °F
Design Outdoor Cooling Temp.: 93 °F
Temp. Difference Cooling: 15°F
Indoor Humidity: 50 ▼ Grains difference: 53

Chetan Mehta
4510 Colony Oaks Coart
Area: Houston Hobby Airport, TX
Front Door Orientation: South West ▼

Design Indoor Heating Temp.: 69 °F
Design Outdoor Heating Temp.: 34 °F
Temp. Difference Heating: 35°F

Whole House Load Calculator

TD:Cool:15°F Heat:35°F	Sq. ft. - types 1 and 2	shading	Sq. ft. - types 1 and 2	shading	Sq. ft. - types 1 and 2		Sq. ft.
Outside Wall: North	1: 2:	Windows x	1: 12.5 2: 12.5	Glass Doors x	1: 2:	Doors	
Outside Wall: South	1: 2:	Windows	1: 2:	Glass Doors	1: 2:	Doors	
Outside Wall: E & W	1: 2:	Windows	1: 12.5 2:	Glass Doors	1: 2:	Doors	
Outside Wall: NE & NW	1: 1500 2:	Windows x	1: 36 2: 110	Glass Doors x	1: 2:	Doors	
Outside Wall: SE & SW	1: 1440 2:	Windows	1: 75 2: 96	Glass Doors	1: 2:	Doors	
Sky Lights	N: S:	E-W:	NE-NW:	SE-SW:			
Floor - (linear ft. if slab)	1: 144 2:	Basement	Walls-above grade	below grade	Sq. ft.		
Ceiling	1: 170 2:	Basement	Floor --	width 23 ft. or ▼	feet below grade:	2 ft. ▼	
Number of Appliances	2 Fireplaces 1 ▼						
Number of People	4	Fresh Air	recommended:	71 CFM			
Conditioned - Sq. ft.:	2640	Cubic Ft.: 22440	Construction Average ▼		Duct System: Attic ▼	R-4 ▼	below av ▼

Calculate Load

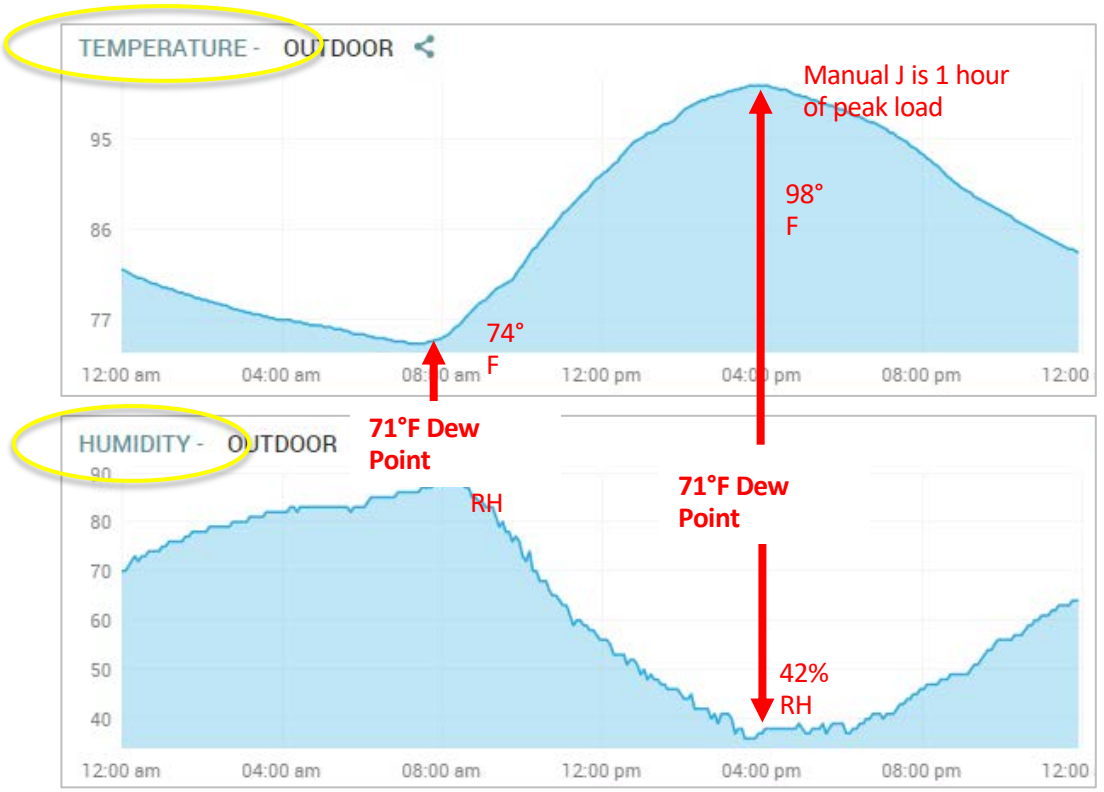
Total Btu's Cooling	Sensible Load	Latent Load	Total Btu's Heating
36577	29407	7170	42432

manual_s

Sizing Calculator based on Manual S

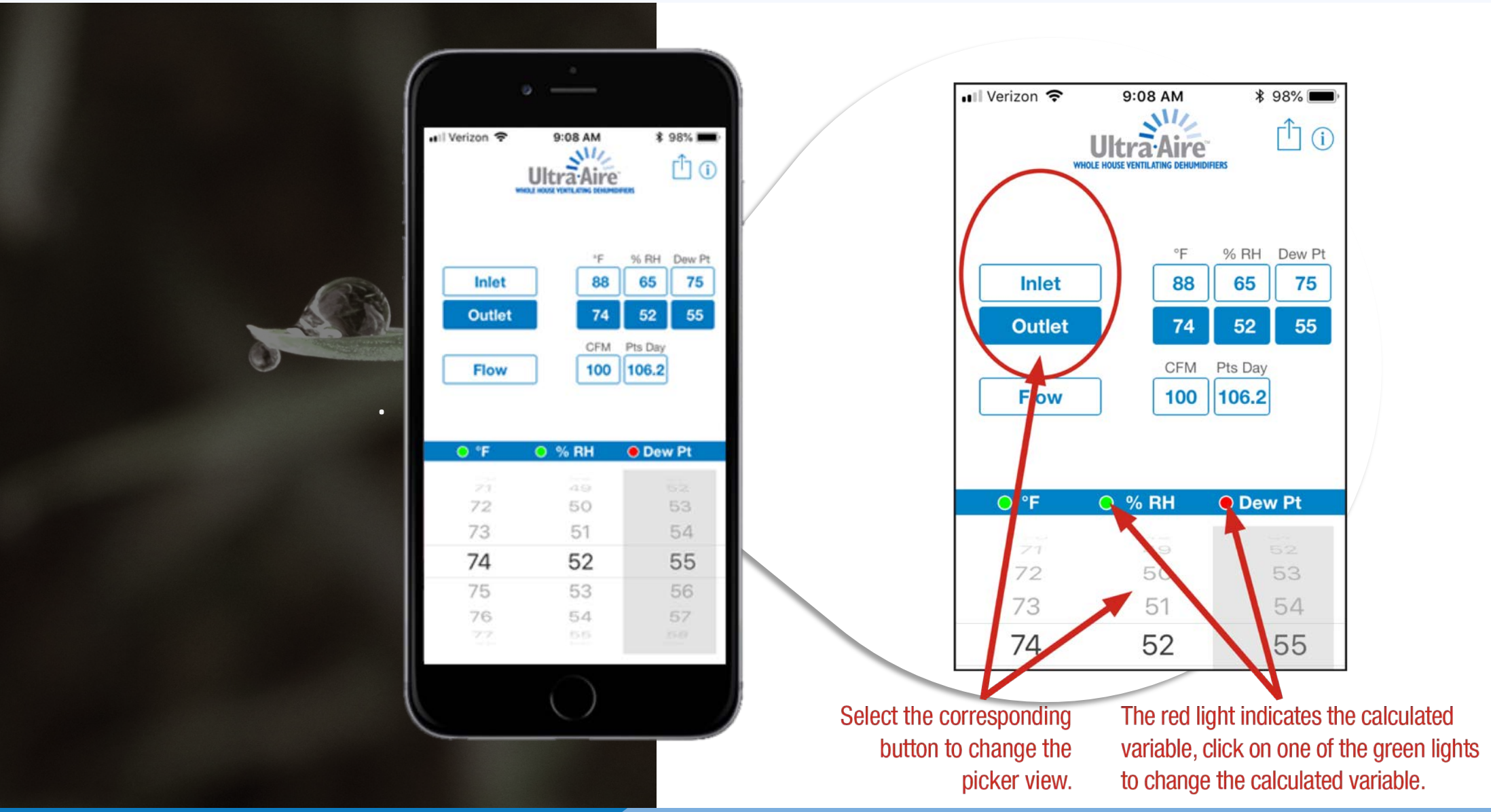
Sensible Loads Vary – Latent Loads Stay Uniform

Sensible Load
90% to near zero most days



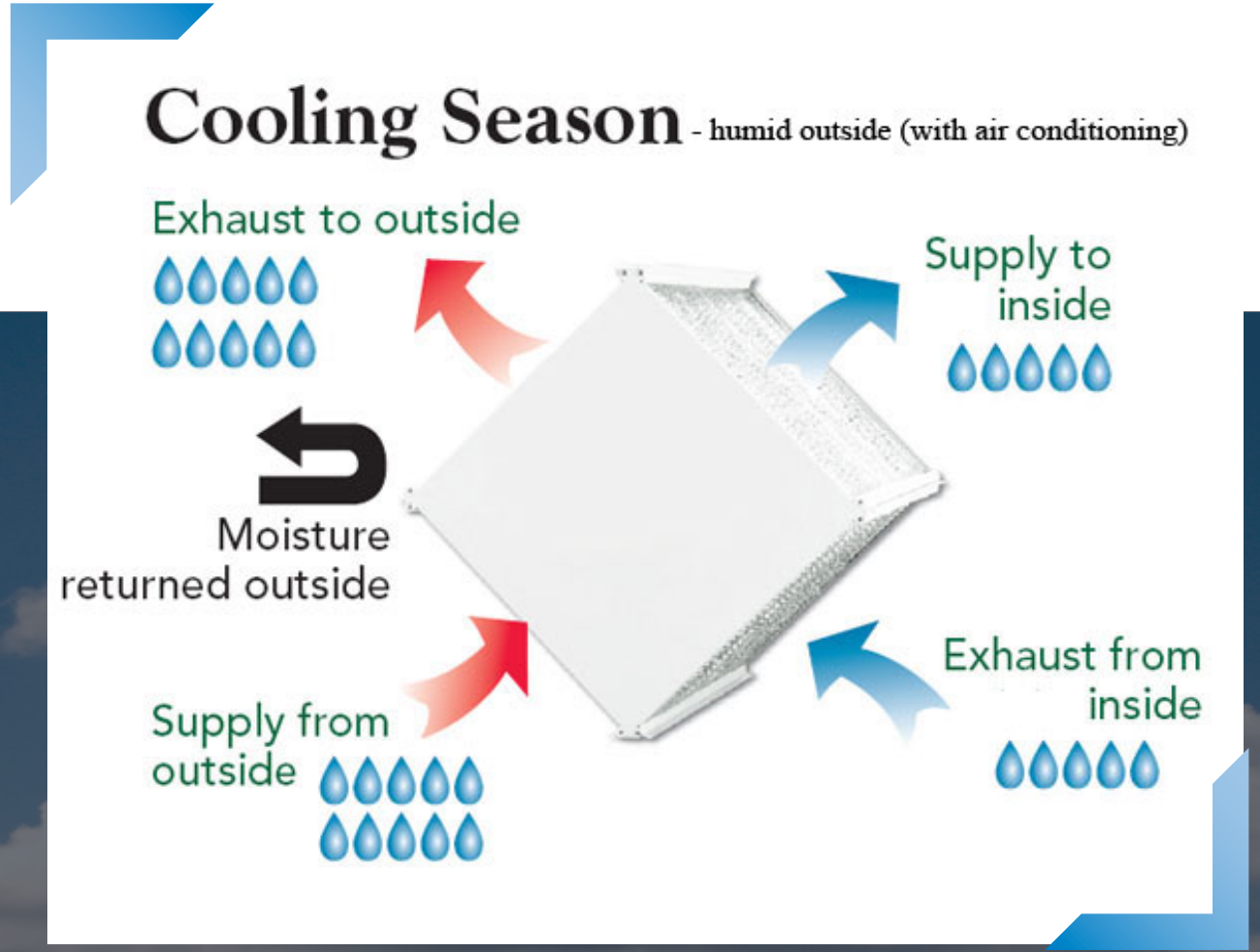
Latent load is fairly uniform throughout the day and night

HOW DO I KNOW HOW MUCH DEHUMIDIFICATION A HOME NEEDS?

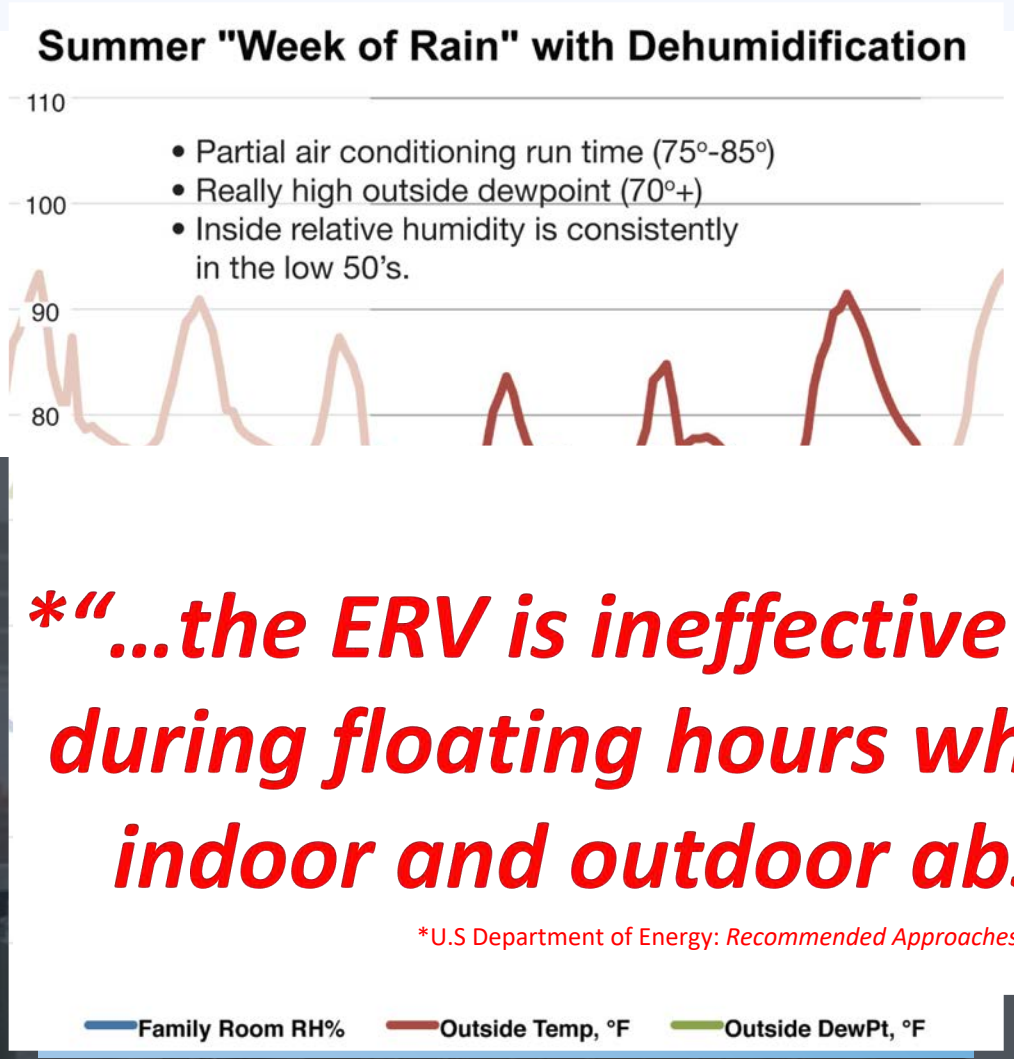


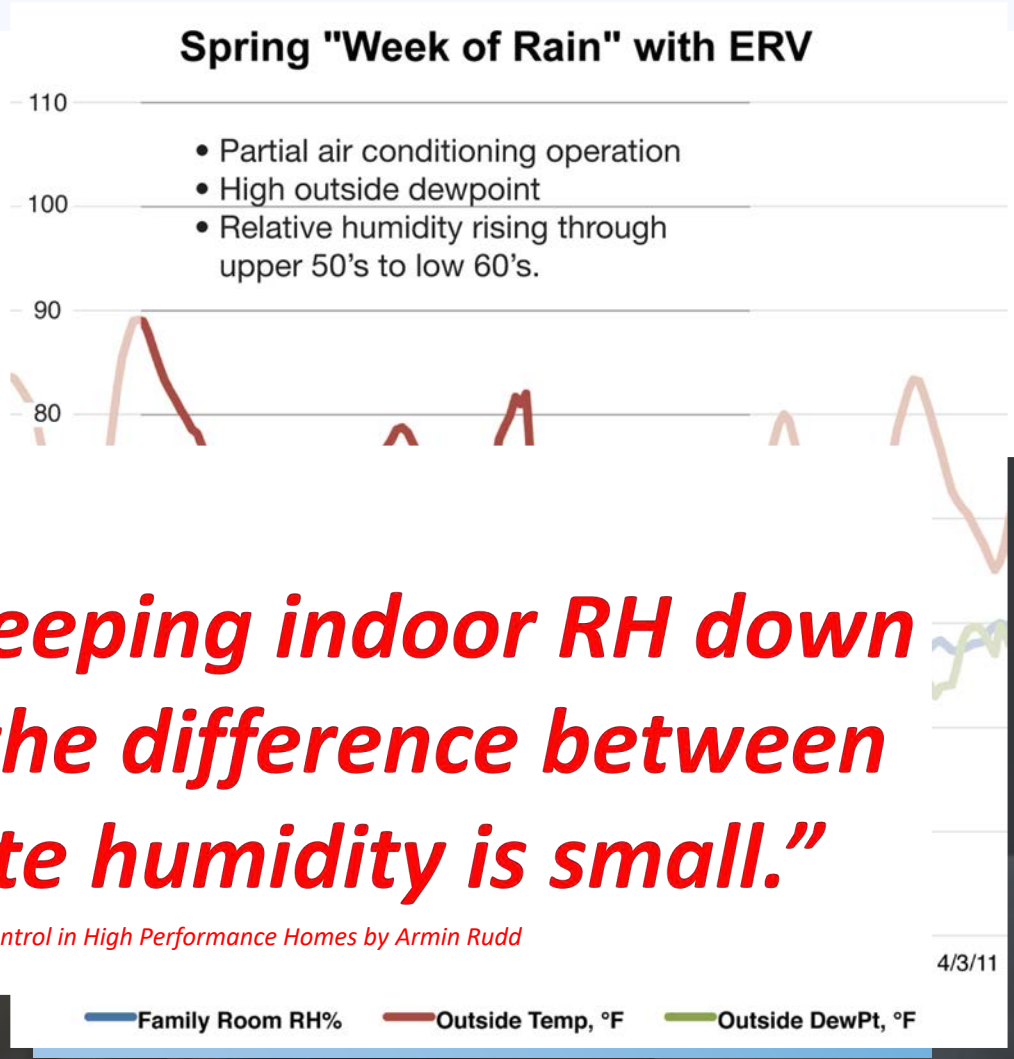
WHAT ABOUT USING AN ERV FOR VENTILATION?

ERVs and HRVs are balanced ventilation systems originally developed for northern climates. They bring air into the home and blow an equal amount of air out of the home. The ERV/HRV core transfers some heat, and in an ERV moisture (energy), between the two air streams.



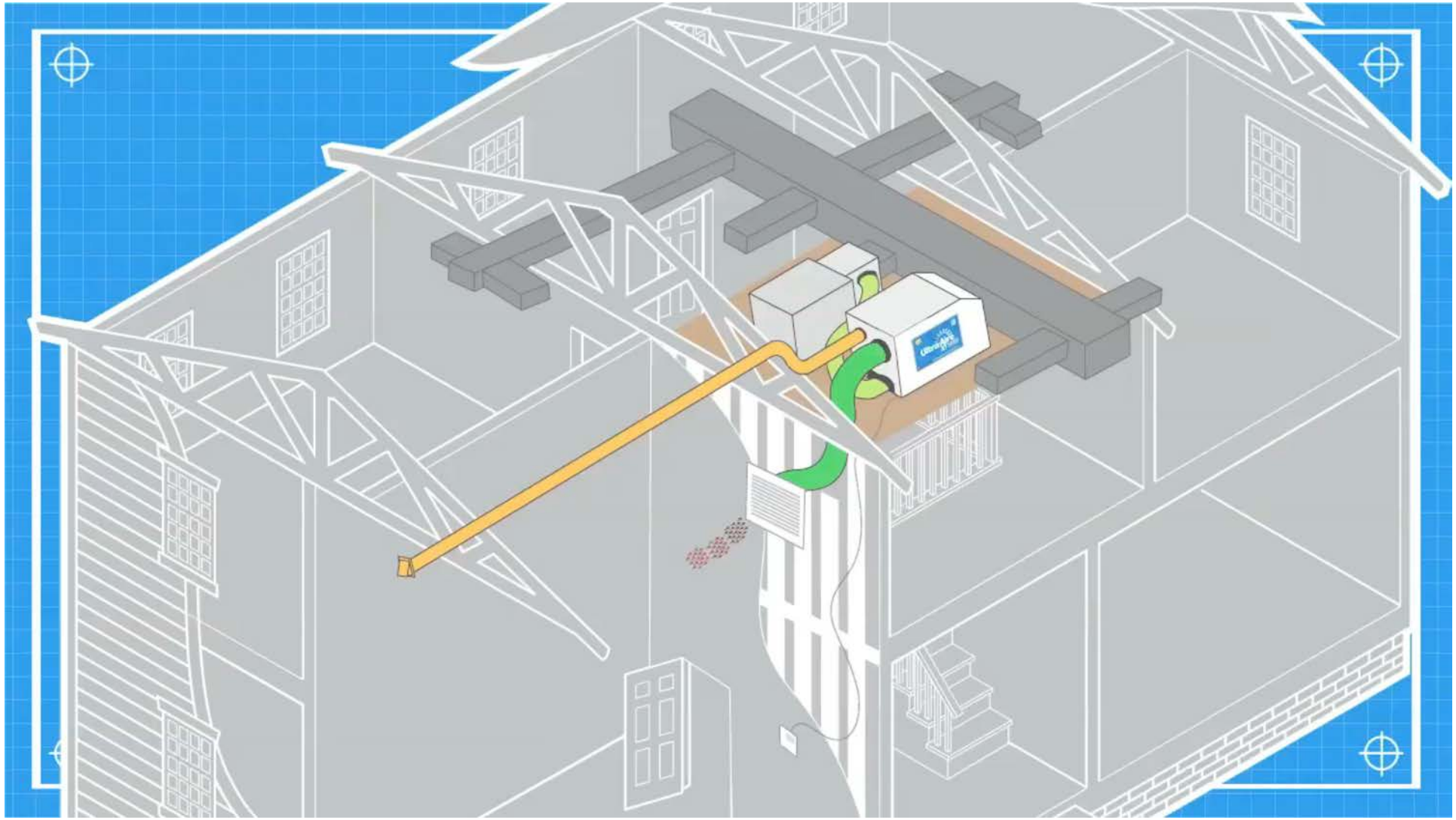
WHOLE HOUSE DEHUMIDIFICATION VS. ERV

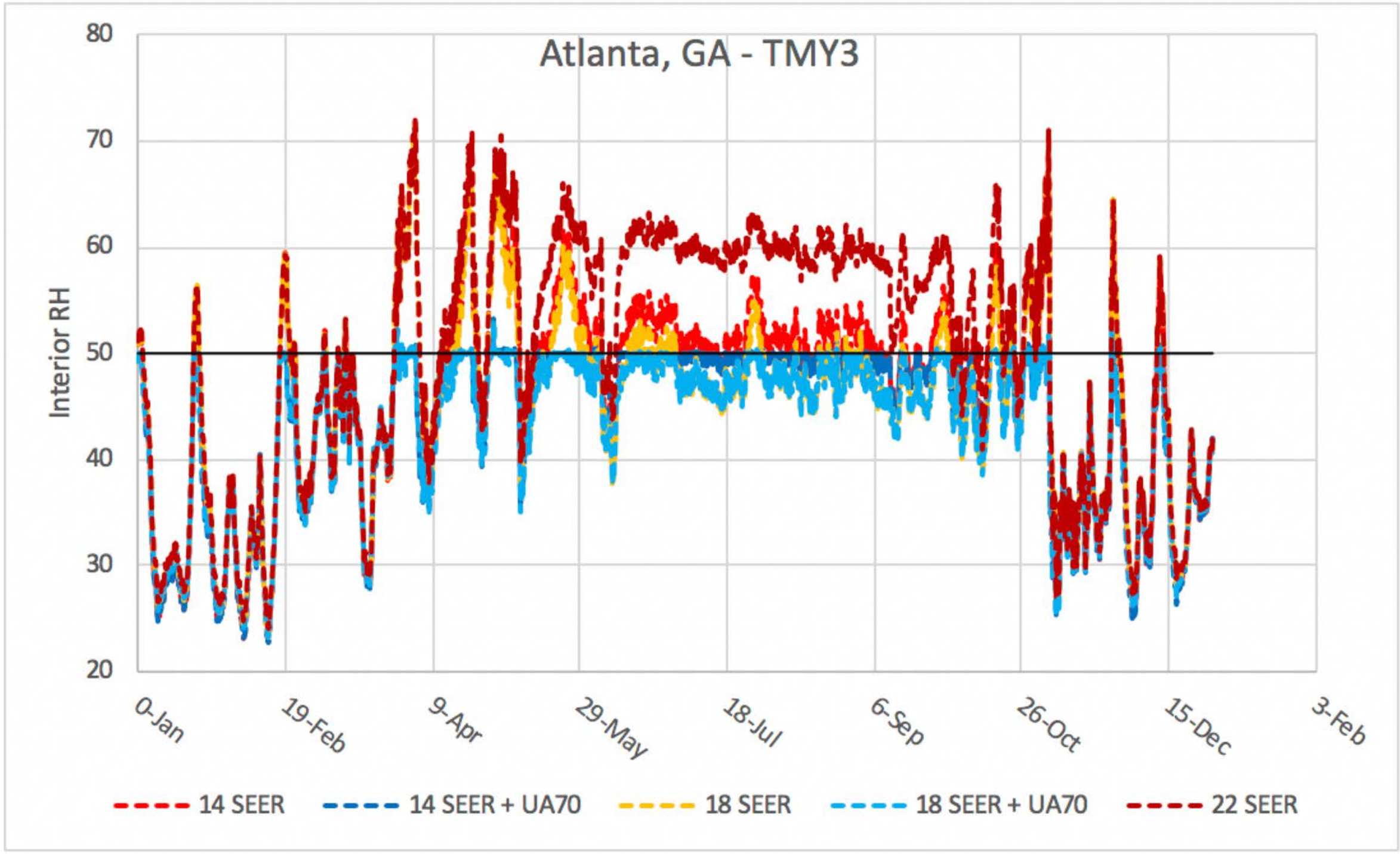




***"…the ERV is ineffective in keeping indoor RH down during floating hours when the difference between indoor and outdoor absolute humidity is small."**

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




Atlanta, GA - TMY3
Interior RH
80
70
60
50
40
30
20
0-Jan
19-Feb
9-Apr
29-May
18-Jul
6-Sep
26-Oct
15-Dec
3-Feb
14 SEER
14 SEER + UA70
18 SEER
18 SEER + UA70
22 SEER

CASE STUDY | AFFORDABLE MULTI-FAMILY HOUSING

Located in Climate Zone 4

Constructed in 2015

Two-stage cooling equipment installed

Significant mold issues caused by excessive humidity in several of the units during the summer of 2017

PROBLEM

Two-stage cooling equipment was installed with the understanding that the equipment would provide better moisture control. As it turned out, these two-ton condensing systems were grossly oversized for the one-bedroom units.

Reading taken in the apartment showed 74% RH and 66°F (above).

As a result, mold began to form on the walls (right).

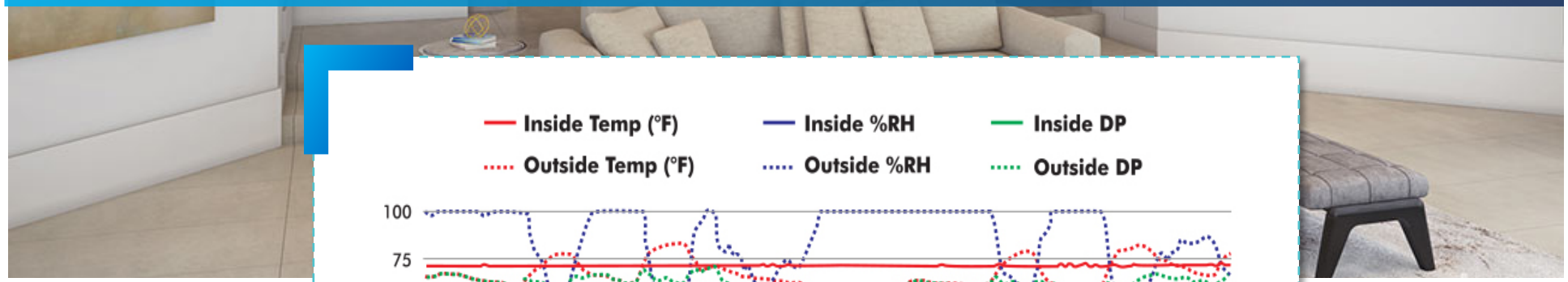
SOLUTION | HVACD

Heating, Ventilation, Air Conditioning & ***DEHUMIDIFICATION***

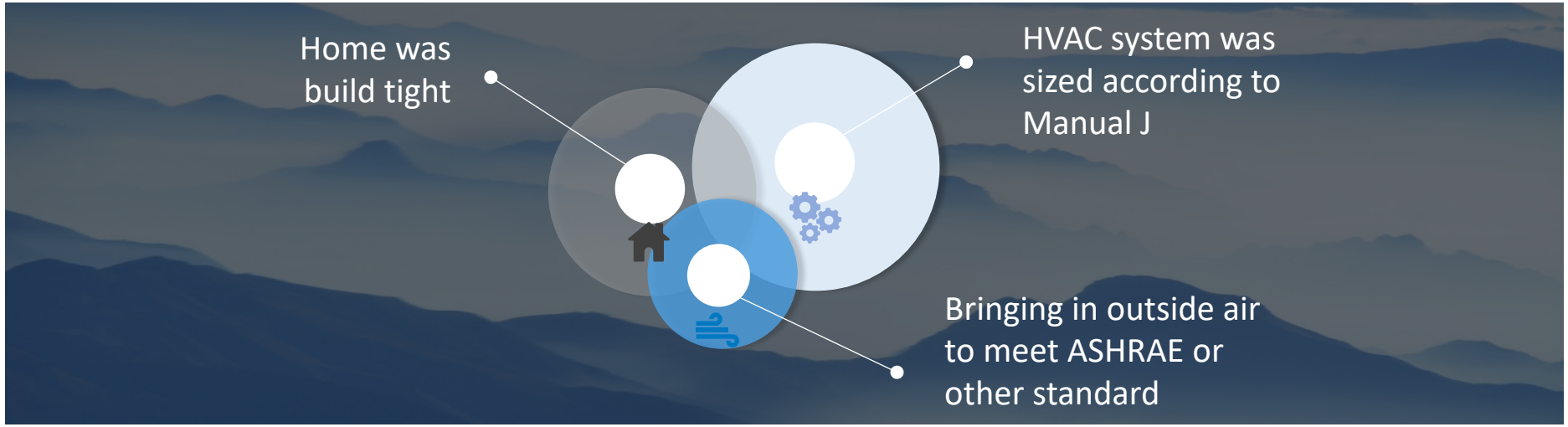
The tenant was temporarily relocated while the unit was remediated and an Ultra-Aire MD33 In-Wall Dehumidifier was installed.

Almost immediately, the RH stabilized in the 50% range, while the interior temperature was maintained at a comfortable and affordable 75°F.

The resident reported an immediate difference in the feel of her apartment with the sticky, clammy feeling now eliminated.



Conclusion…HVACD



- We have reduced the sensible loads on the home but the latent loads have not changed and possibly increased.
- High efficiency HVAC equipment can not always be counted on to keep homes dry, healthy and comfortable.

ACCA Manual LLH will look at:

- Resolving ventilation requirements (for occupant health and safety) while maintaining moisture control.
- Addressing ancillary dehumidification equipment for humid locations (e.g., DOE Type A climate zones require ancillary dehumidification).