

Equatorial Adventures

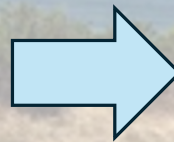
Kimberly Llewellyn, Building Science Symposium 2026



From Chasing Unicorns to Going Down Rabbit Holes

At Blue Rabbit and in collaboration with our sister companies, Kalos Services, HVAC School and GRIT Foundation, we aim to shift a societal mindset related to how intelligence is valued, one project at a time.

- The founders of Blue Rabbit view responsible resource stewardship as foundational to our moral code. We consider people, finances, time, air, water and energy to be the most fundamental of resources. Our built environment has profound and comprehensive impact on all of these resources and therefore presents both the opportunity and the obligation to focus our minds and hearts.
- We believe that buildings should function as assets for owners, occupants and the communities within which they are located.



Our Team



Bryan Orr, Bob Orr, Me



Peter Marciano



Alan Yanik



Pamela Arra



Roman Baugh



Tony Amadio



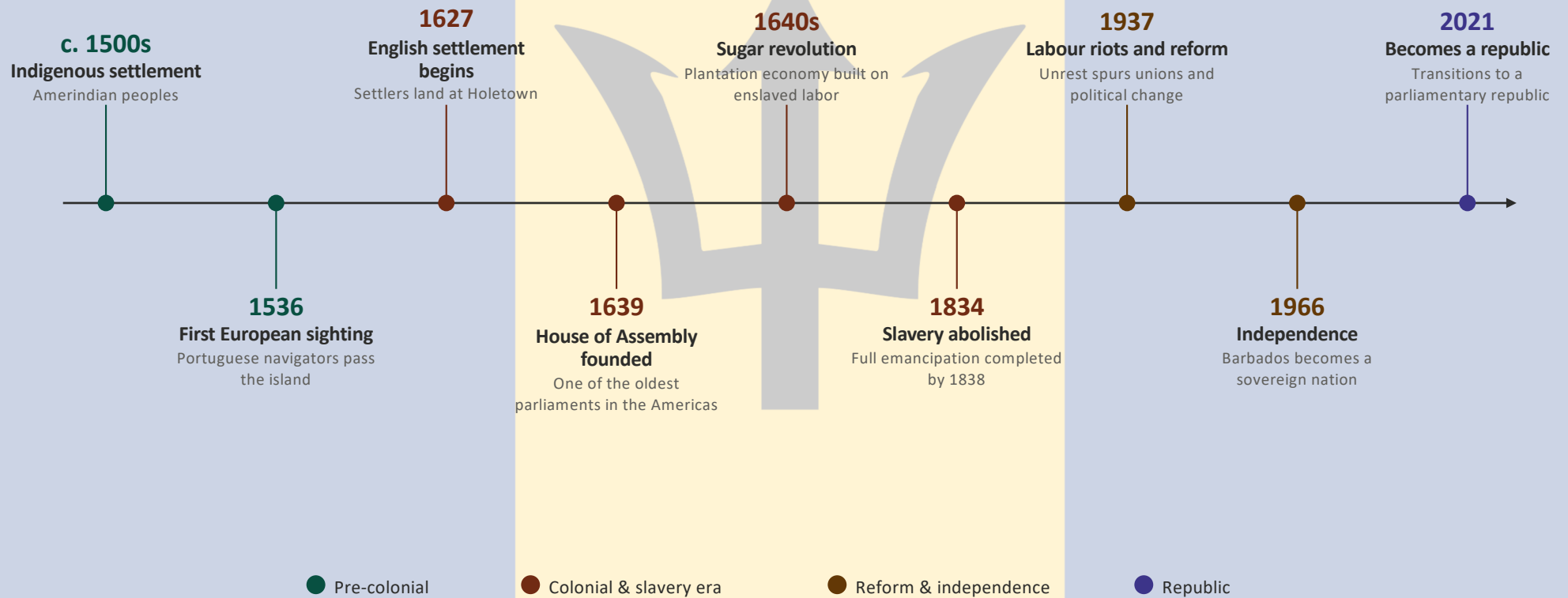
Al Mitchell

Thank You...



History of Barbados

A timeline of key events, 1500s to 2021



Barbados – Seal Replaced by Flag & Coat of Arms 1966



Grantley W. Prescod



Mr. Neville C. Connell

Where is it and what's it made of?

- Barbados is the most eastern of the Caribbean Islands
- It receives constant trade winds
- Not a volcanic island
- Coral reef limestone covers about 85% of the island's surface, up to roughly 70–100 meters thick, dating to the Pleistocene. So that where ground hasn't been covered, the drainage is very good*.

**This has implications on the need for robust waterproofing of subgrade building elements.*



Climate Stats

RAINFALL

Short, intense rain

Top 1% of highest intensity rainfall (87 hours) accounts for 24% of the year's total.

WIND PATTERN

90% from the East

Only 16 hrs/yr are calm!

SOLAR

4.9-6.5 kWh/m²/yr

Small range but high operating Temps

DRY BULB

75-86 °F [24-30 °C]

87% hours/yr

DEW POINT

68-79 °F [20-26 °C]

95% hours/yr

Traditional Bajan: Exteriors

Coral Block, Chattle, Metal



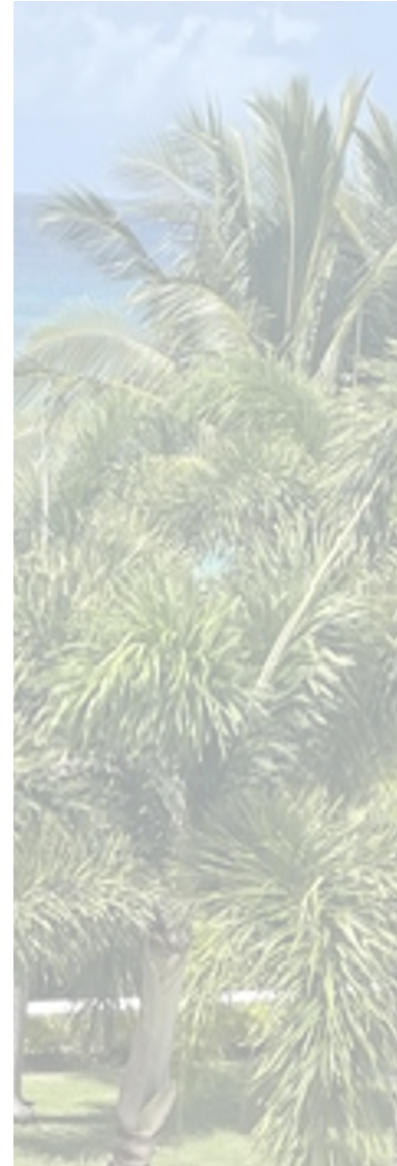
Traditional Bajan Design

Cheryl's House



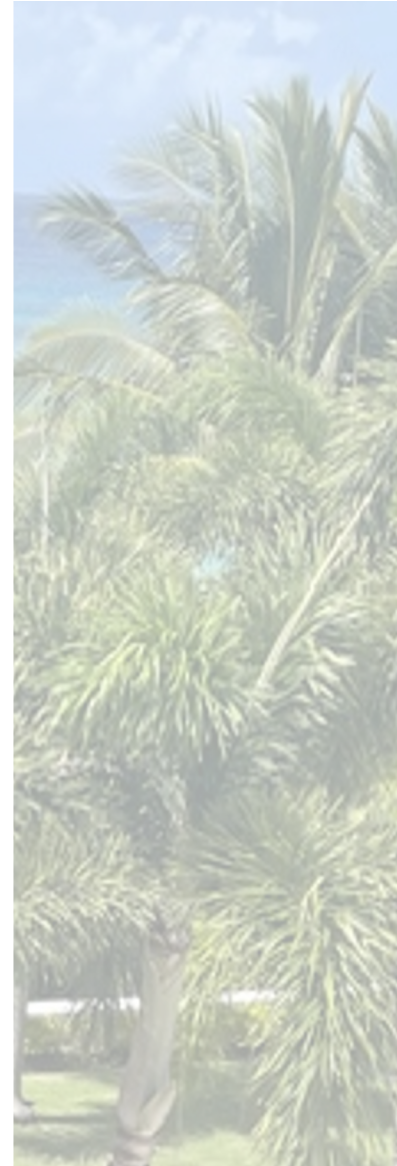
Traditional Bajan Design

Lots of Windows with Shutter and Deep Overhangs



Traditional Bajan Design

Openings in Walls for Cross Breeze



Barbados – Wind Speed & Direction

Annual wind speed summary and direction distribution (IP units, mph)

Mean Wind Speed

16.3 mph

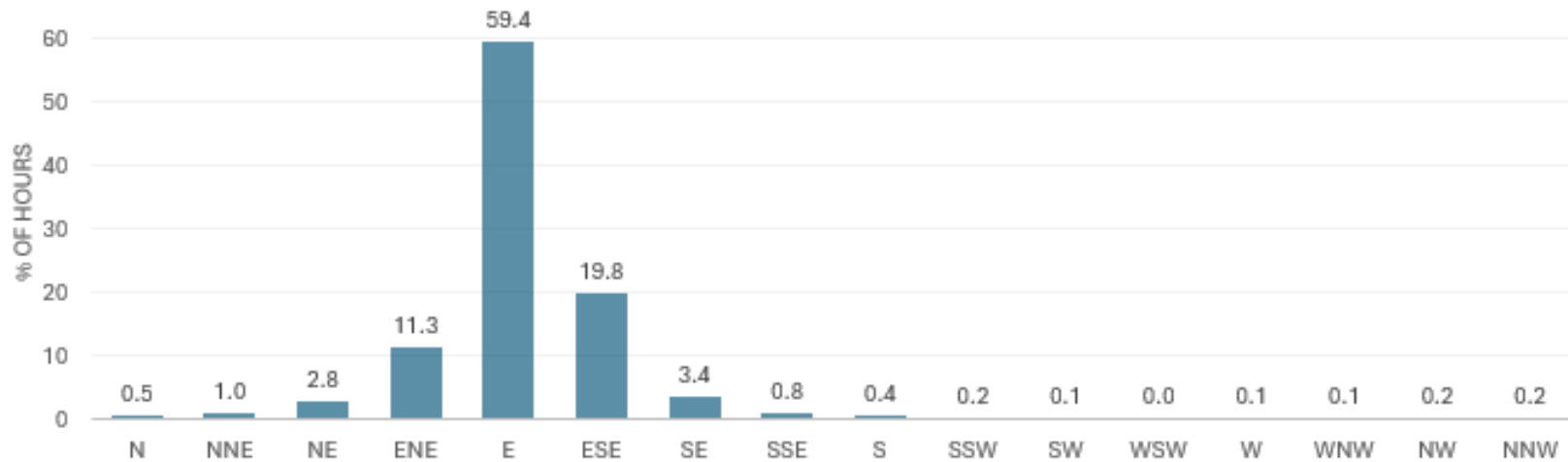
Max Wind Speed

55.3 mph

Calm Hours (≤ 0.5 m/s)

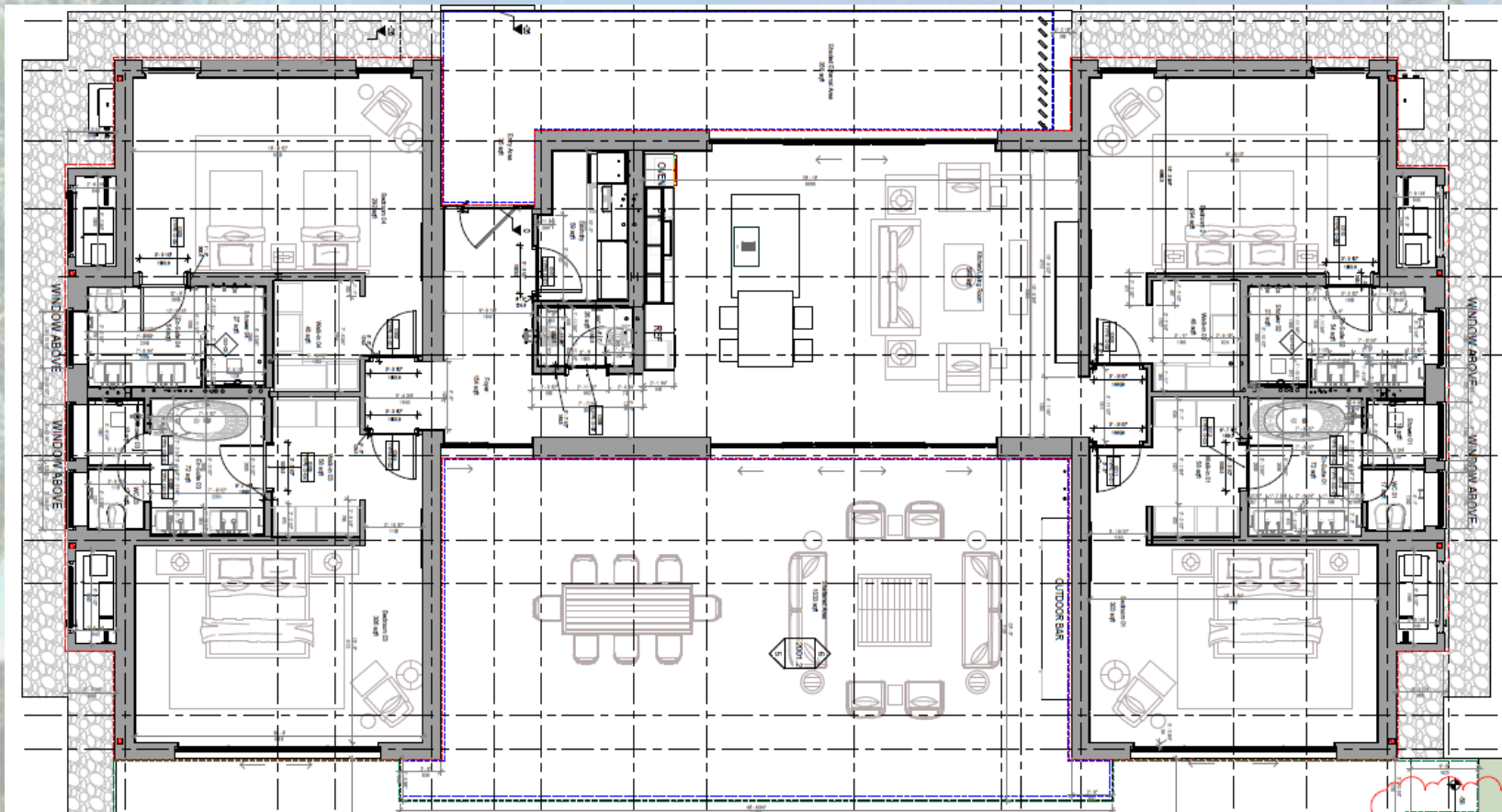
16 of 8,760 hrs/yr

Wind direction distribution (% of hours, compass order)



Source: Climate.OneBuilding.org TMYx 2011-2025, Seawell/Grantley Adams Intl Airport, Barbados (WMO 789540)

Typical Layout with Unconditioned Central Living



Every Job Has a Beginning

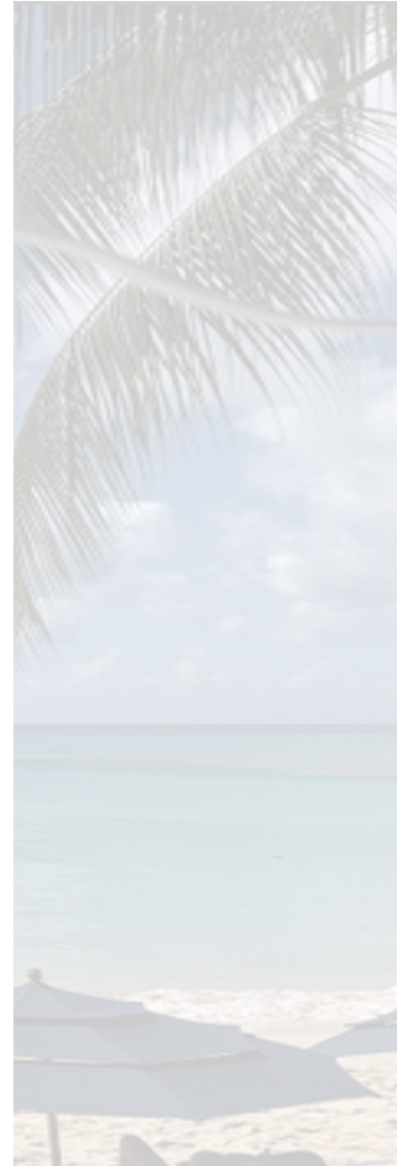
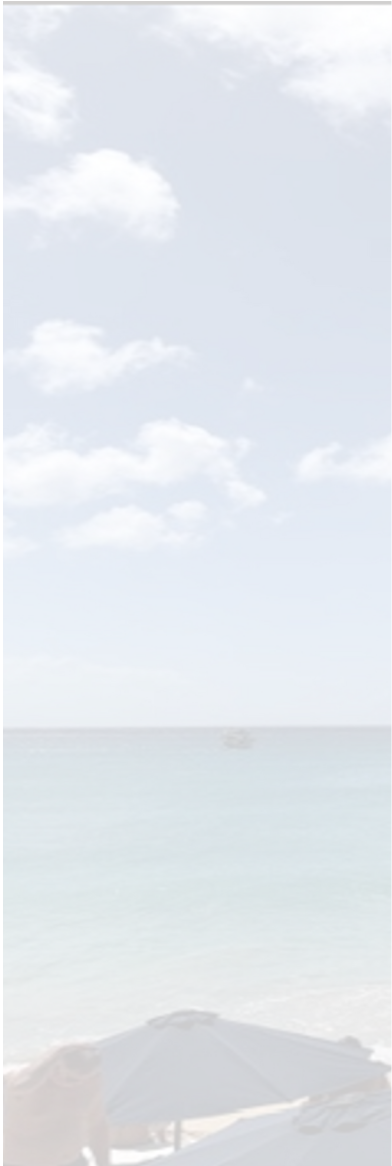


“We think we have a humidity problem.”



HVAC is an obvious culprit

- Extreme Humid Climate
- ~500 ft² Bedroom Suites
- 2 and 3 Tons ASHP's
- 4" outdoor air duct to return
- No dehumidification

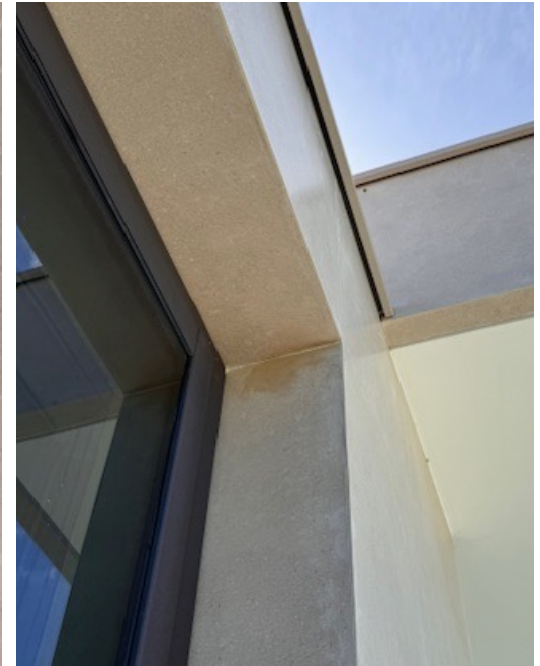
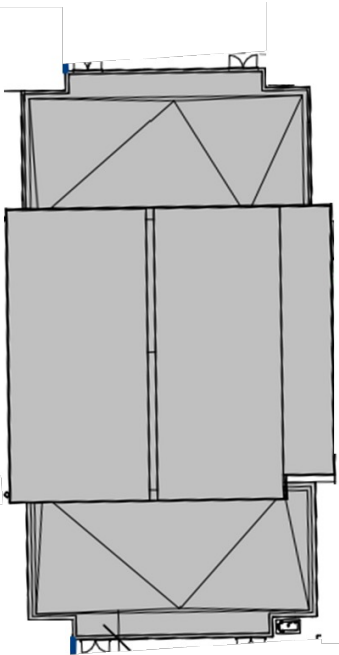


We were already suspecting envelope issues

Now they've got the only set of TEC equipment on the island.



What became obvious: Building was Taking on Water



A Lot of Water



Barbados – Rainfall Intensity Distribution

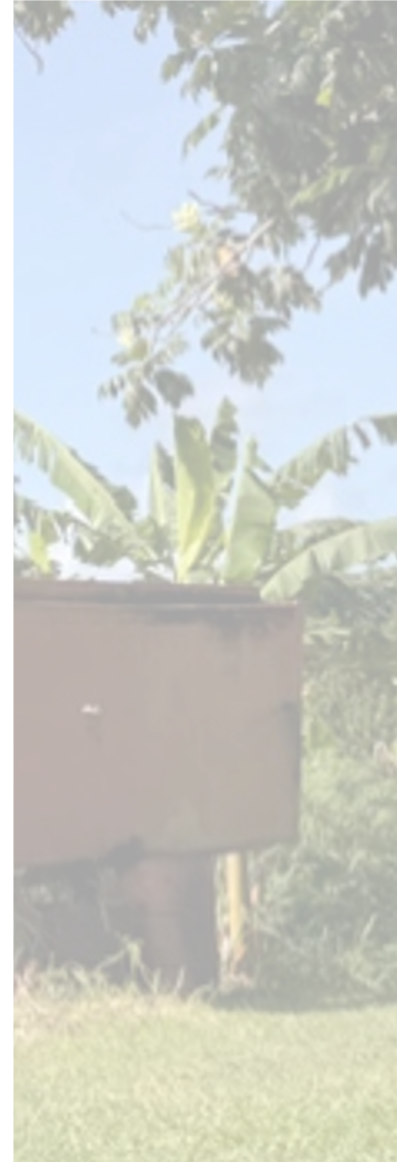
Hourly rain rate among rainy hours (TMYx representative year)

RATE (MM/HR)	HOURS	% RAINY HOURS	% ANNUAL RAIN
0–1	3,497	94.4%	61.2%
1–2	149	4.0%	19.2%
2–5	50	1.3%	13.4%
5–10	8	0.2%	5.1%
10–15	1	0.03%	1.1%
The bottom band (0–1 mm/hr) is 94% of rainy hours but only 61% of the rain — mostly light drizzle. The heaviest hours (5+ mm/hr) are under 0.3% of rainy hours yet still deliver over 6% of the year's rainfall.			

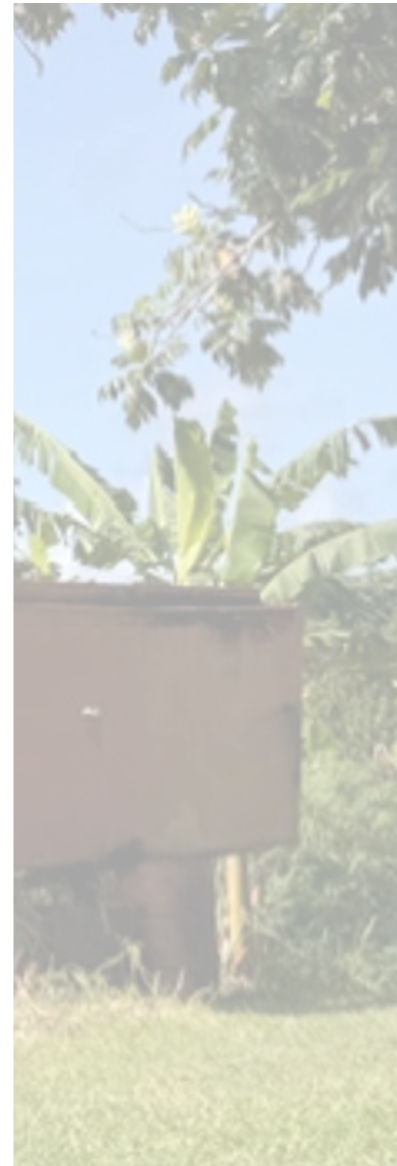
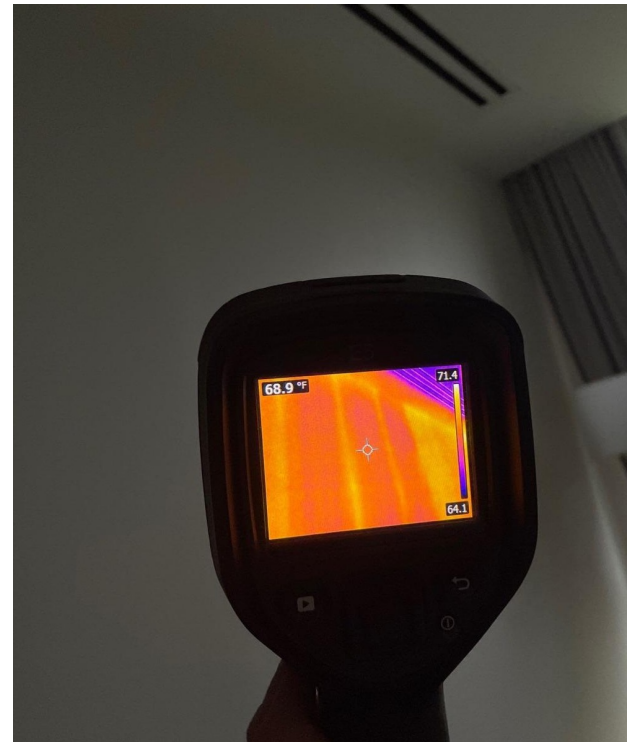
Source: Climate.OneBuilding.org TMYx 2011-2025, Seawell/Grantley Adams Intl Airport, Barbados (WMO 789540)

Roofs Weren't Draining Properly

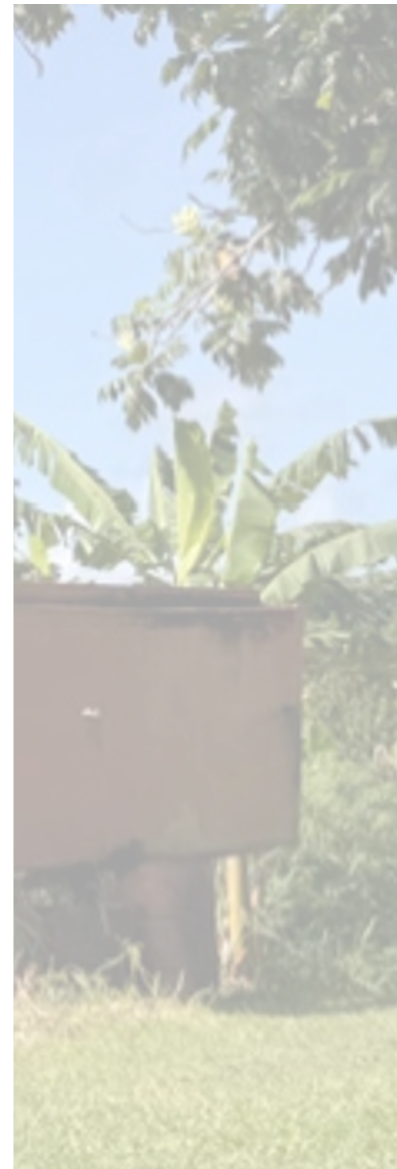
Gloeocapsa Magma?



What became obvious: There was a lot going on



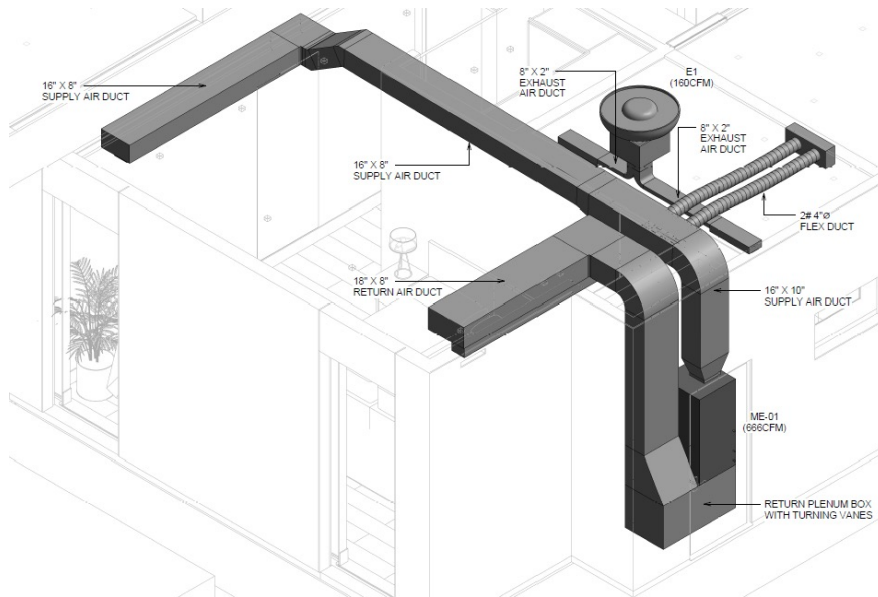
The Framing Part of the Problem



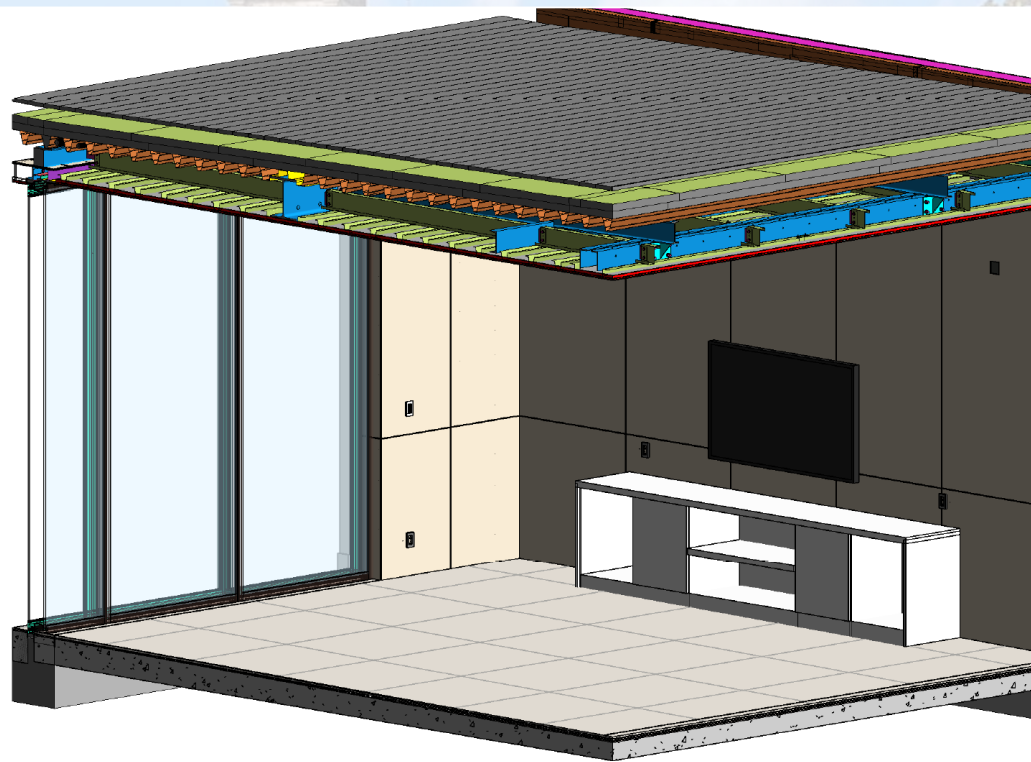
How Much Surface Area?



Problem: HVAC + Building Enclosure



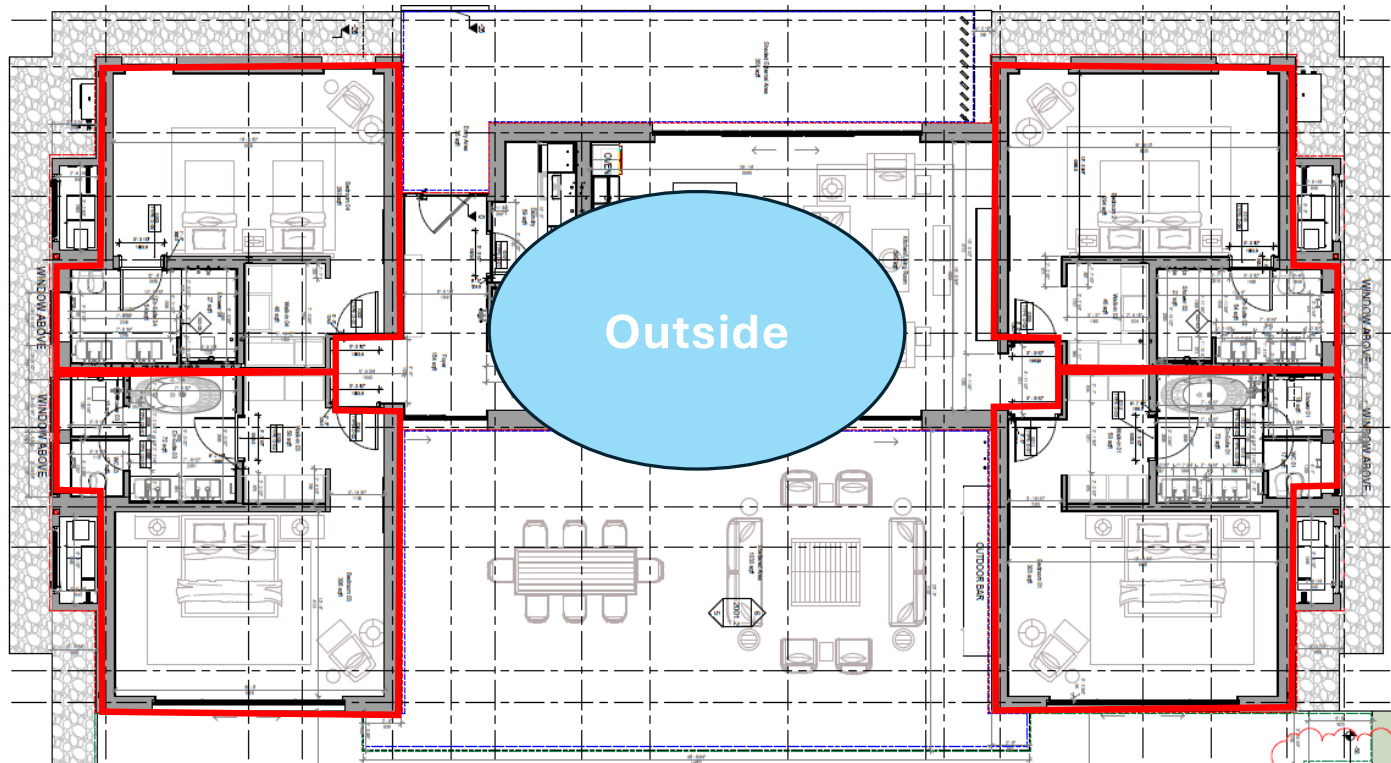
The Entire Roof Cavity Was Connected = Wind Tunnel



Complicated Structure = No Continuous Planes



Why This Layout is Difficult: Compartmentalizing



Clash of Cultures

Architects, Designers and Trades are Used to...

- Fresh Air= Good. More is better.
- Open assembly construction
- Built for cross-breezes
- Unconditioned or only bedrooms
- Deep overhangs
- Shutters

Owners, Investors and Overseas Architects are Used to...

- Want it COLD!
- Drywall Level V finished
- Metal framing prevalent
- Modern is in = no overhangs
- No building code
- House will be unoccupied for months at a time

Barbados: Dry-Bulb Temperature Bin Data

Seawell / Grantley Adams Intl Airport (WMO 789540) — TMYx 2011-2025, 8,760 hours

Dry-Bulb Range (°C)	Dry-Bulb Range (°F)	Hours	% of Year	Cumulative Hours	Cumulative %
18–20	64–68	0	0.0%	0	0.0%
20–22	68–72	11	0.1%	11	0.1%
22–24	72–75	111	1.3%	122	1.4%
24–26	75–79	1384	15.8%	1506	17.2%
26–28	79–82	3701	42.2%	5207	59.4%
28–30	82–86	2534	28.9%	7741	88.4%
30–32	86–90	1009	11.5%	8750	99.9%
32–34	90–93	10	0.1%	8760	100.0%
Total		8760	100.0%		

Source: Climate.OneBuilding.org TMYx 2011-2025 dataset for Seawell/Grantley Adams Intl Airport, Barbados (WMO 789540), derived from NOAA NCEI ISD observations and ERA5 reanalysis. Bins are left-inclusive, right-exclusive (e.g. 26-28°C includes 26.0 up to but not including 28.0°C).

Barbados: Dew-Point Temperature Bin Data

Seawell / Grantley Adams Intl Airport (WMO 789540) — TMYx 2011-2025, 8,760 hours

Dew-Point Range (°C)	Dew-Point Range (°F)	Hours	% of Year	Cumulative Hours	Cumulative %
14–16	57–61	7	0.1%	7	0.1%
16–18	61–64	27	0.3%	34	0.4%
18–20	64–68	171	2.0%	205	2.3%
20–22	68–72	1218	13.9%	1423	16.2%
22–24	72–75	4059	46.3%	5482	62.6%
24–26	75–79	3105	35.4%	8587	98.0%
26–28	79–82	164	1.9%	8751	99.9%
28–30	82–86	9	0.1%	8760	100.0%
Total		8760	100.0%		

Source: Climate.OneBuilding.org TMYx 2011-2025 dataset for Seawell/Grantley Adams Intl Airport, Barbados (WMO 789540), derived from NOAA NCEI ISD observations and ERA5 reanalysis. Bins are left-inclusive, right-exclusive (e.g. 26-28°C includes 26.0 up to but not including 28.0°C).

Barbados: Dry-Bulb x Dew-Point Bin Matrix

Hours per year by dry-bulb x dew-point combination (IP units, °F)

DRY-BULB x DEW-POINT	55-60	60-65	65-70	70-75	75-80	80-85	85-90
65-70	5	2					
70-75	1	16	49	40			
75-80		27	754	1677	494		
80-85		7	299	2208	2039	7	
85-90			4	319	795	14	2
90-95					1		

Source: Climate.OneBuilding.org TMYx 2011-2025, Seawell/Grantley Adams Intl Airport, Barbados (WMO 789540)



Strategy

Understand the Structure

Stop Bulk Water

Air Seal

Create Thermal Break

Check It

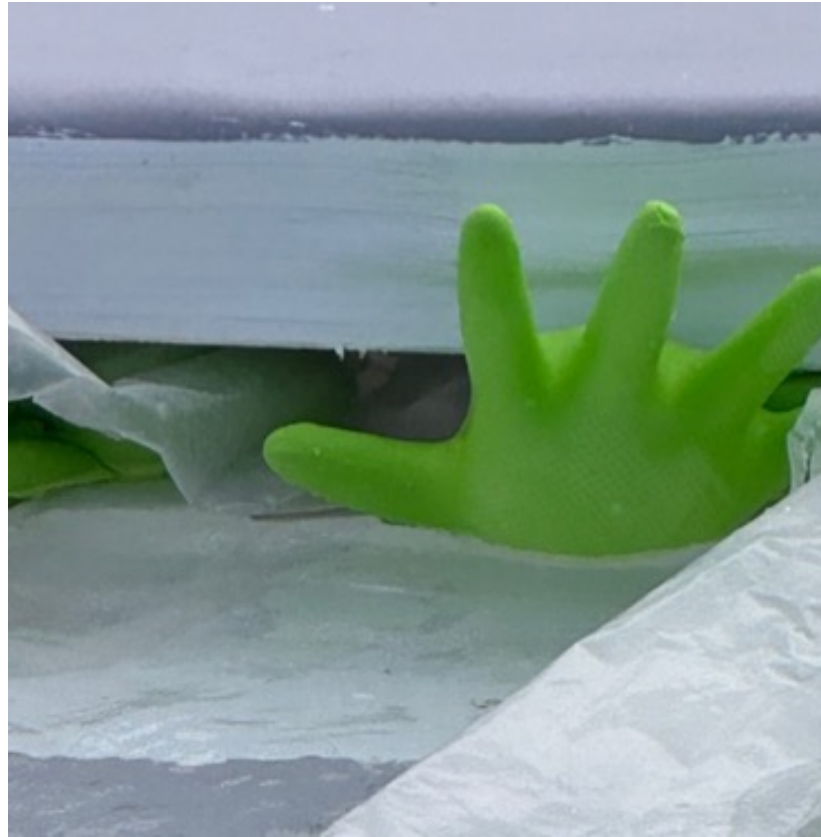
Less Obvious Challenges

- Understanding of climate/materials
- No codes – No safety
- Limited materials

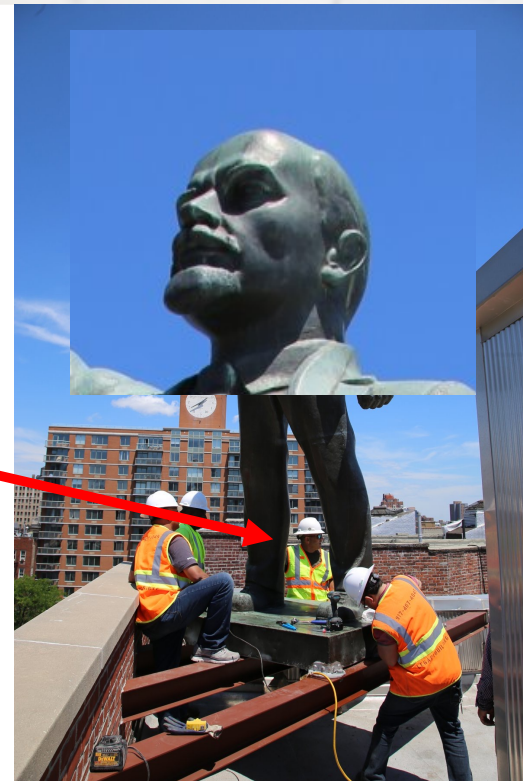
Wrote the Spec, Trained the Crew and Fixed the Roof



And Water Tested the Roof



Quick Side Story...



95% of Hours/yr DP >68°F

Humid Air

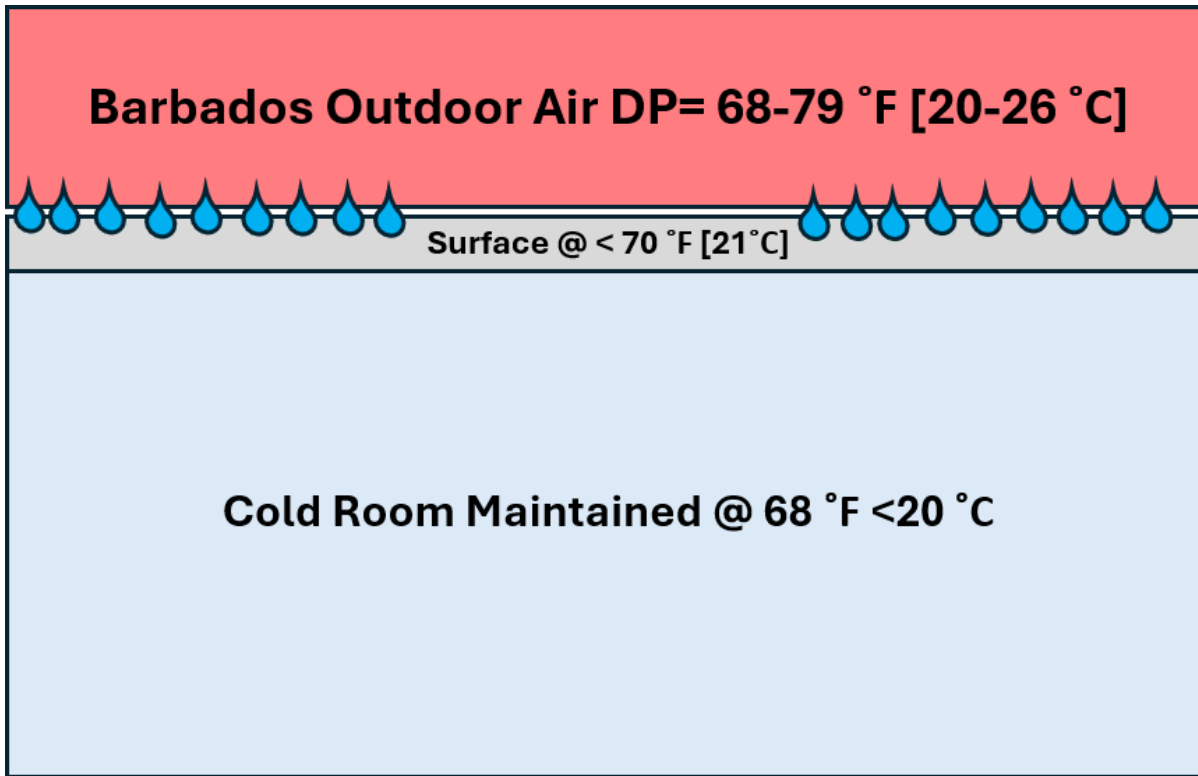
Cold Surface

Cold Room

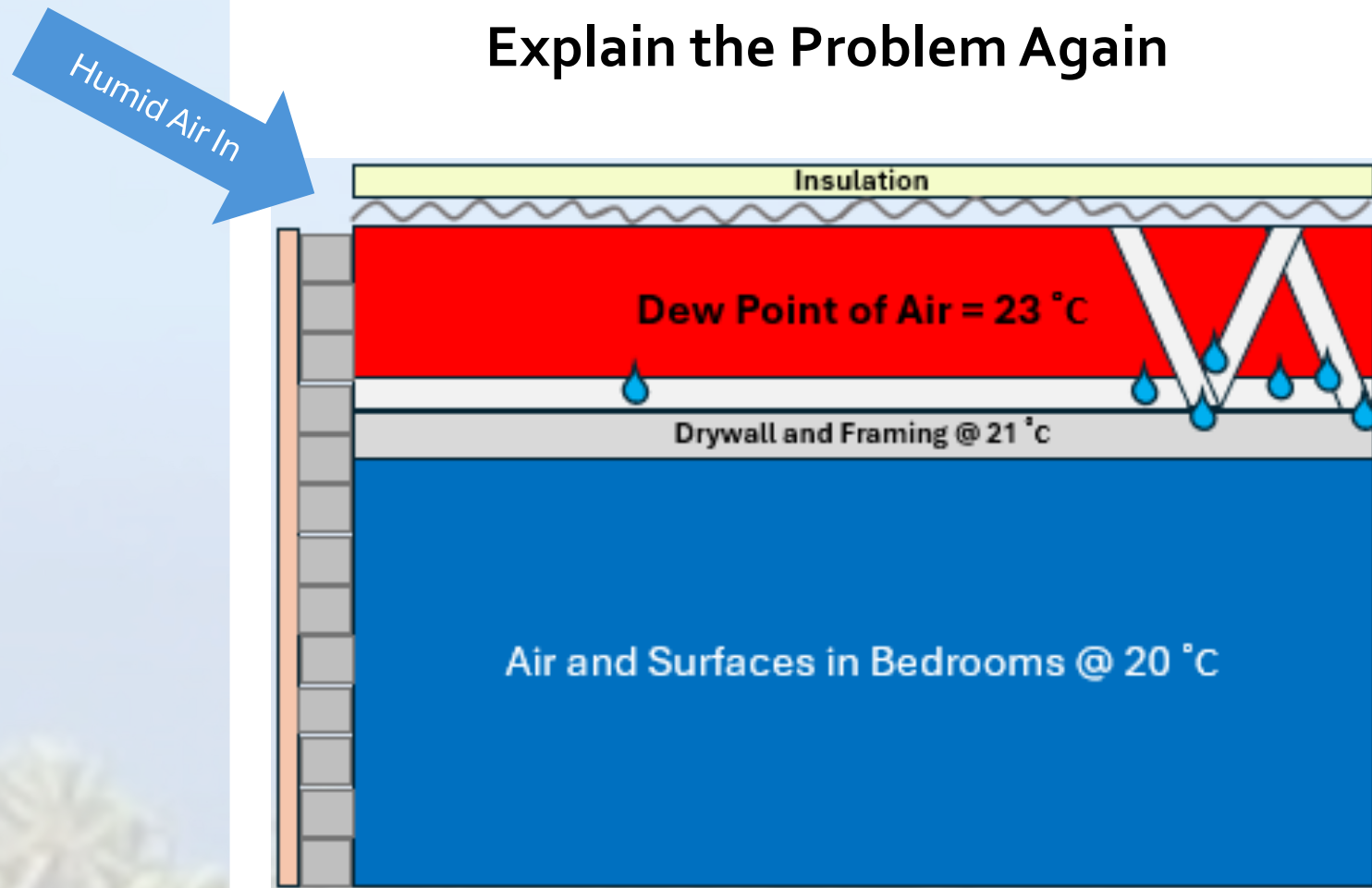
Barbados Outdoor Air DP= 68-79 °F [20-26 °C]

Surface @ < 70 °F [21°C]

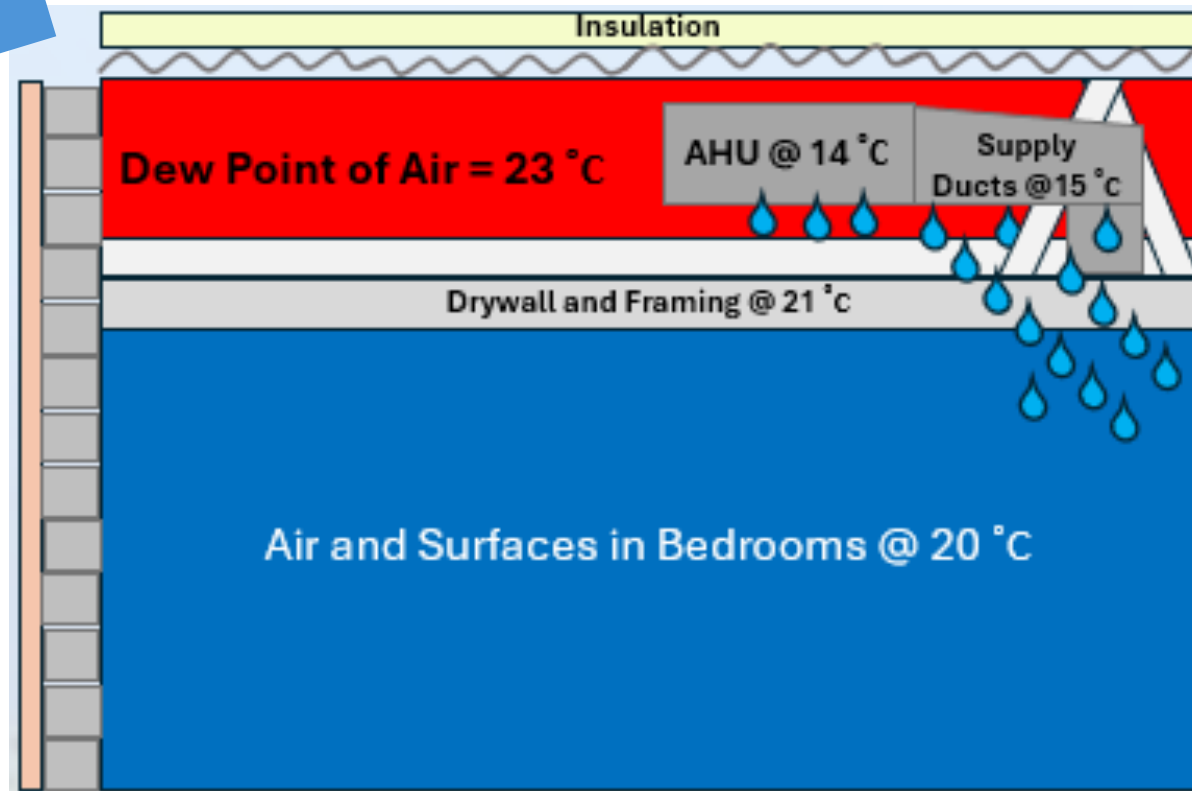
Cold Room Maintained @ 68 °F <20 °C



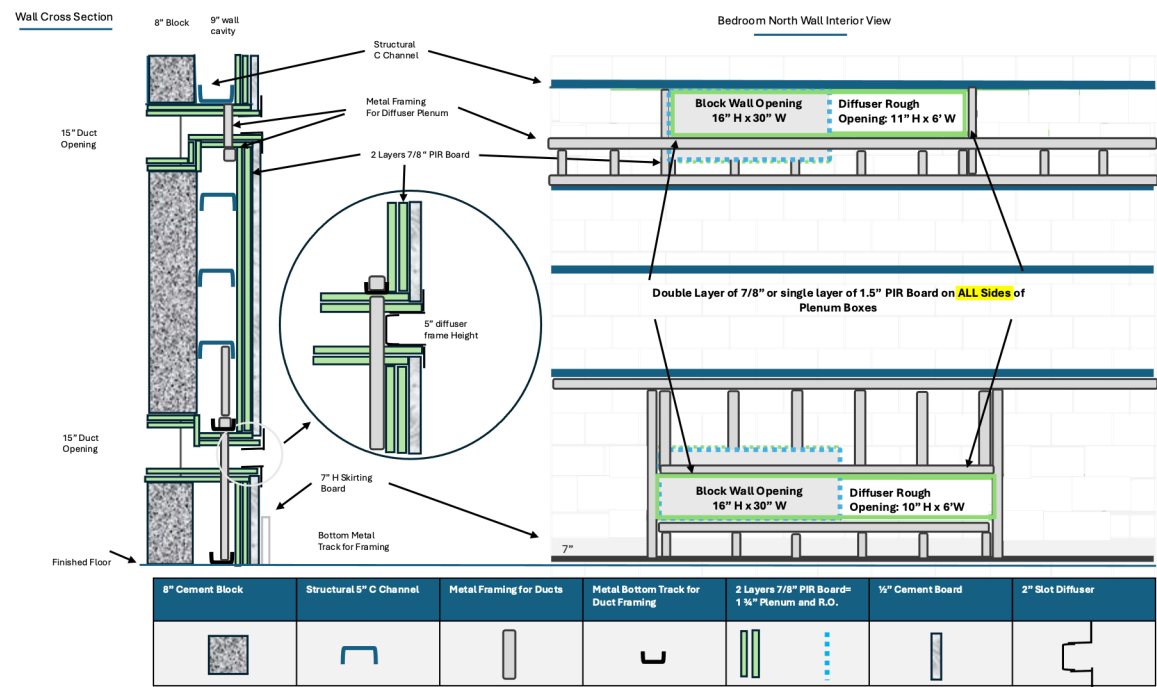
Explain the Problem Again



And Again



Compartmentalization: Was a Dream and a Prayer



Deconstruction: Behind the Walls



Reconstruction: New Ducts, Grouting, Air-Sealing

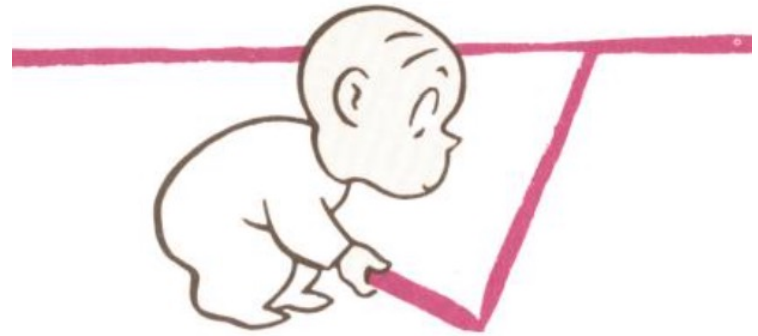


Reconstruction: Air-Sealing



Construction as Performance Art

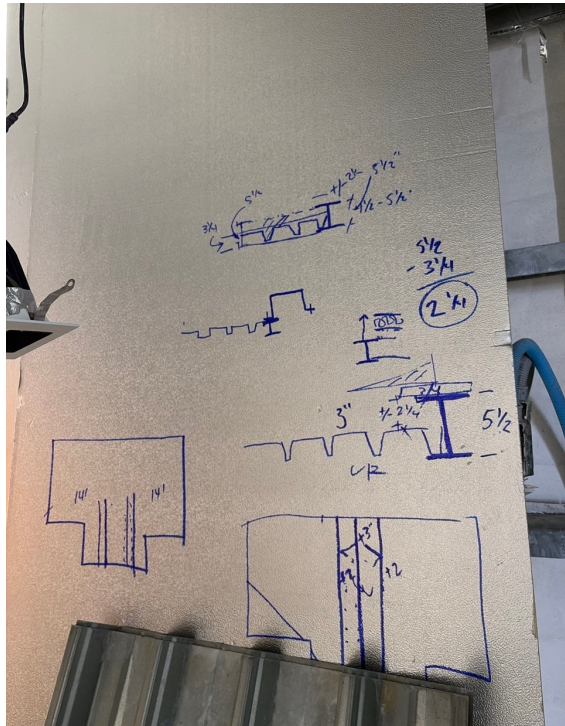




How do you say Rockwool in Bajan?



Beginning of Blocking the Wind Tunnel



“Might be a Good Idea to Check...”



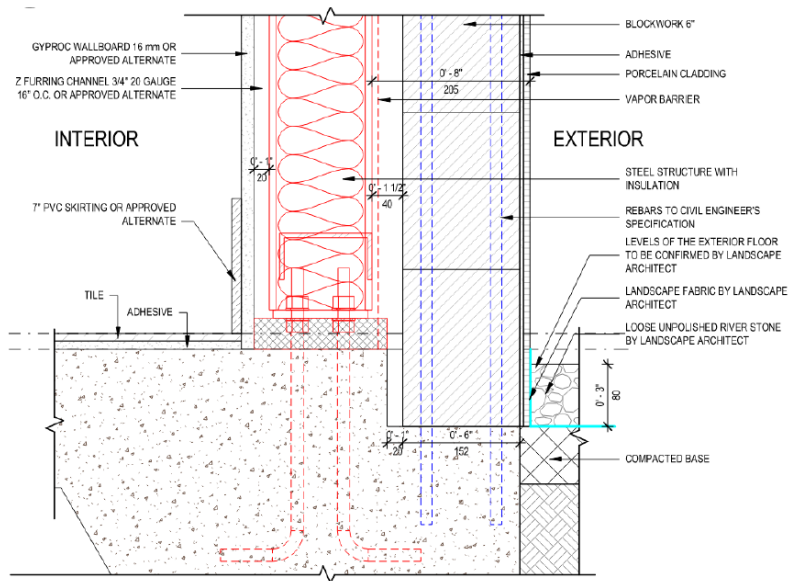
Reframing for Future New Roof, Wall Framing, Window Sealing



Cement Board Installed



Might be a Good Idea to Check...



2.1.1 Baseline Wall

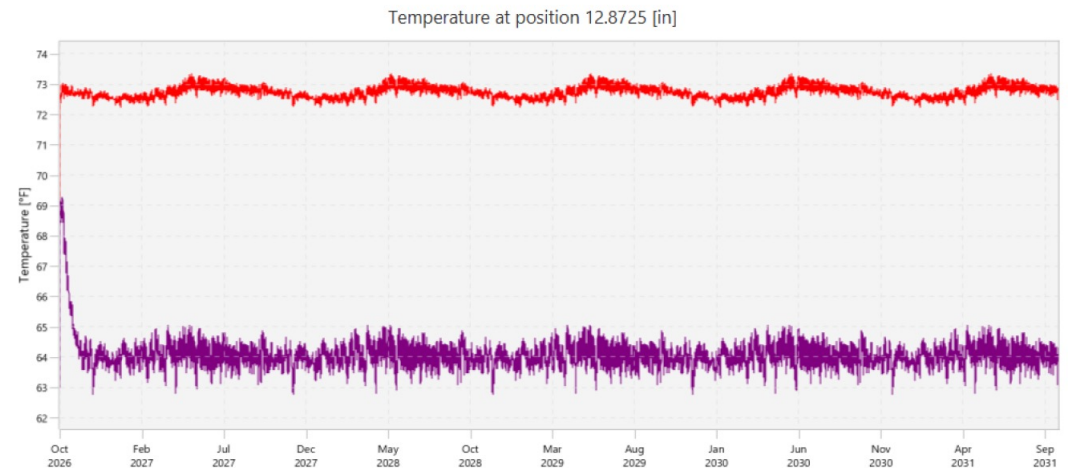
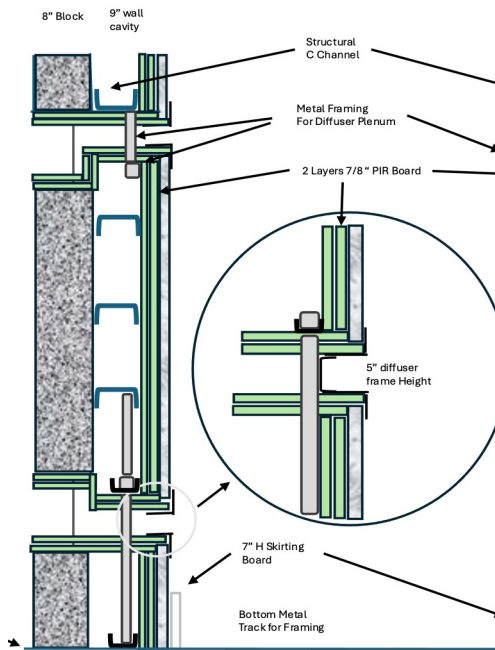


Figure 3: A plot showing the dry bulb and dew point temperatures outboard of the gypsum wall board in the baseline wall assembly.

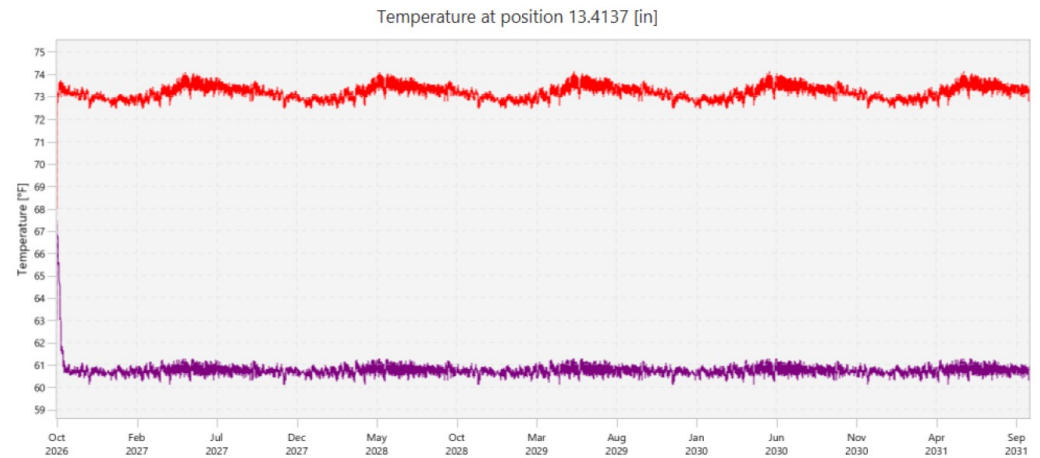
WUFI Analysis by Al Mitchell.

Moving in the Right Direction...



2.1.2 Proposed Wall

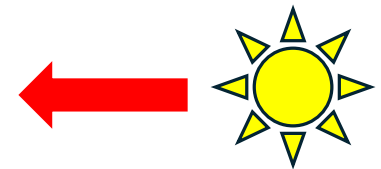
A proposed variation to the wall assembly was also tested, where the stud cavities were left uninsulated, and 1.5 in of polyisocyanurate insulation was applied inboard of the stud cavity. In these assemblies, the key areas tested for condensation risk are behind the GWB and in the stud cavity. Please see Figs. 5 and 6. The average dew point behind the GWB in the proposed variant is slightly lower, 61°F vs 64°F, than the baseline wall assembly, indicating a more moisture resistant wall assembly.



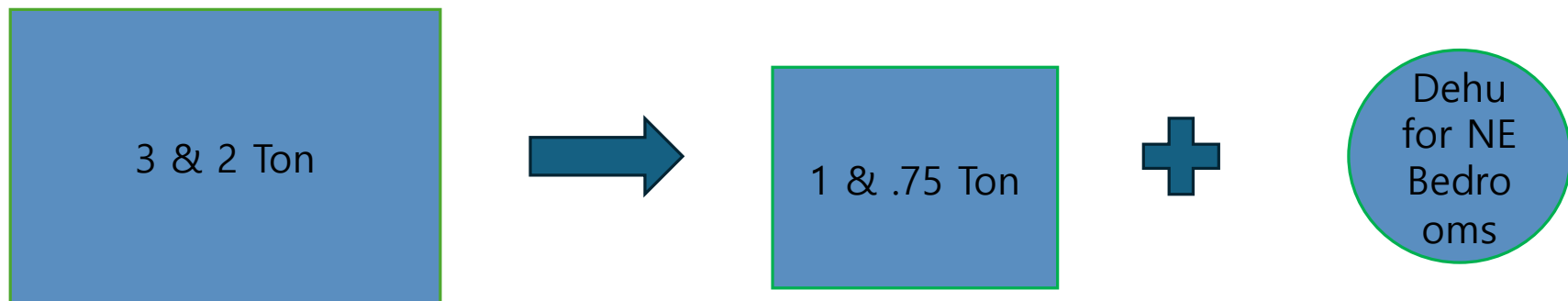
WUFI Analysis by Al Mitchell.

HVAC Load Summary

	AREA (ft ²)	TOTAL (Btu/h)	LATENT (Btu/h)	SENSIBLE (Btu/h)	SHF
NW Bedroom	570	15,191	3,430	11,761	0.77
NE Bedroom	506	10,061	2,917	7,144	0.71



Design Conditions: 74°F(23 ° C)/55%RH, Ventilation ~50cfm, Infiltration ~35cfm



HVAC: 5 → 1.75 Tons

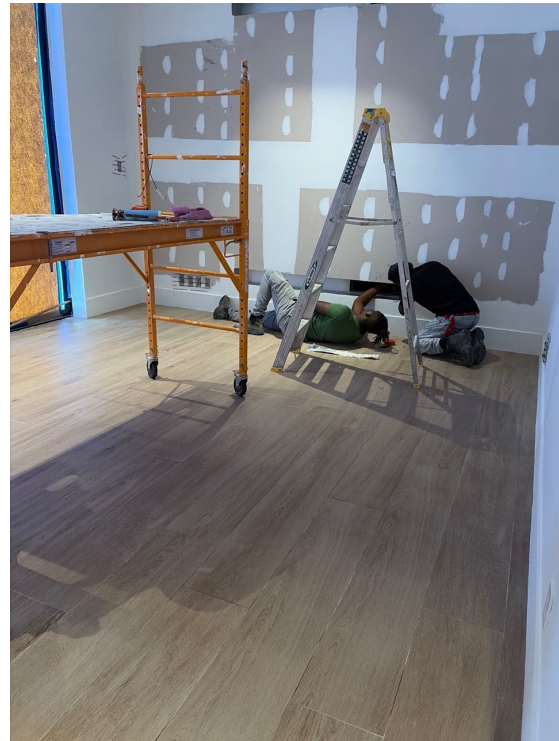
WHERE WE STARTED	WHAT WE TESTED	FINAL SYSTEM
Outdoor Unit Mini-VRF 5-Ton Midea MDV-V160W/DHN1	Outdoor Unit Mini-VRV 3-Ton Hitachi RAS-4.0HNSKQ	Outdoor Unit Mini-VRV 2.3-Ton Hitachi RAS-3.0HNSKQ
Outdoor Unit Mini-VRF 5-Ton Midea MDV-D36VVN1	Multi-position AHU 1.5-Ton Hitachi TIAH018B22M	Slim Compact Ducted 1-Ton Hitachi RPIZ-1.3HNDTSQ
Multi-position AHU 2-Ton Midea MDV-D24VVN1	Multi-position AHU 1-Ton Hitachi TIAH012B22M	Slim Compact Ducted .75-Ton Hitachi RPIZ-1.0HNDTSQ
Wired Controllers Midea KJR-86C-E	Wired Controllers Hitachi PC-ARFG2	Wired Controllers Hitachi PC-ARFG2
Total Capacity = 5 Tons	Total Capacity = 2.5 Tons	Total Capacity = 1.75 Tons

Blower Door Before & After

ACH50 8 → 5



They Didn't Believe Me When I Said the Ducts Were Leaking

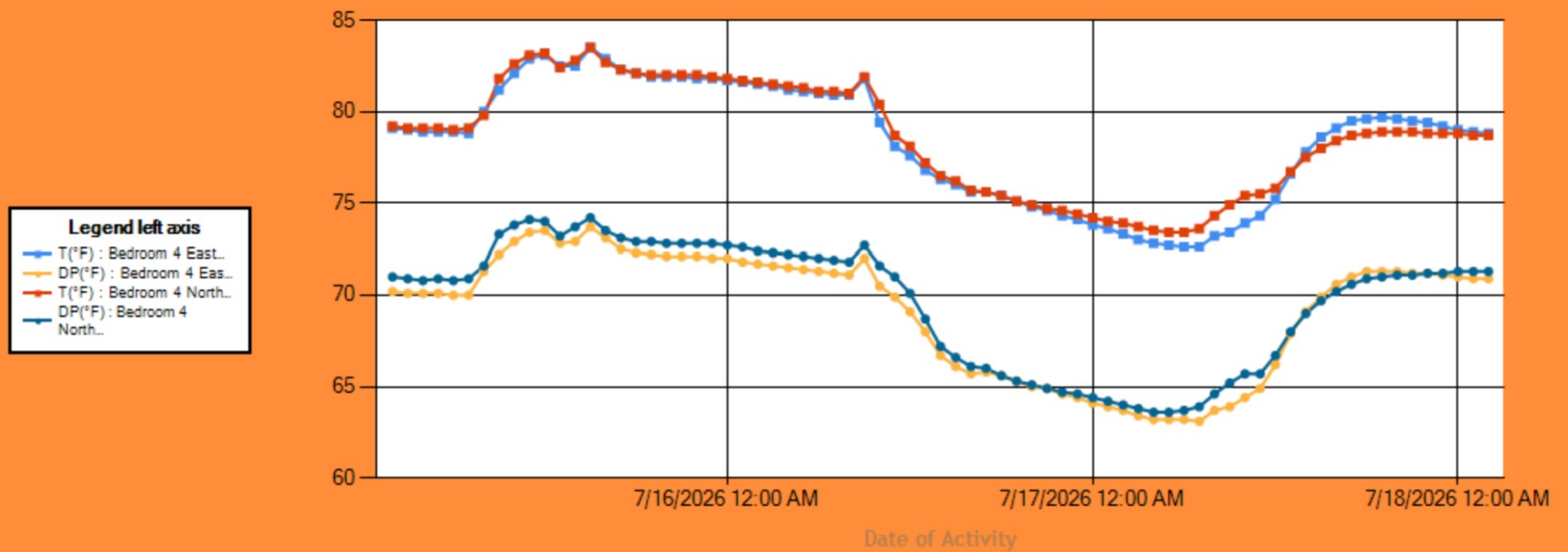


Opened the Walls After 2 Months- They Were Dry



Sensor Data

Average Sensor Values from 7/15/2026 2:16:00 AM to 7/18/2026 2:16:00 AM using hourly averages



Take Aways



Best Advertising



*Two Great Products
—
Same Ingredients?*



Fundamental

If this number is

bigger than

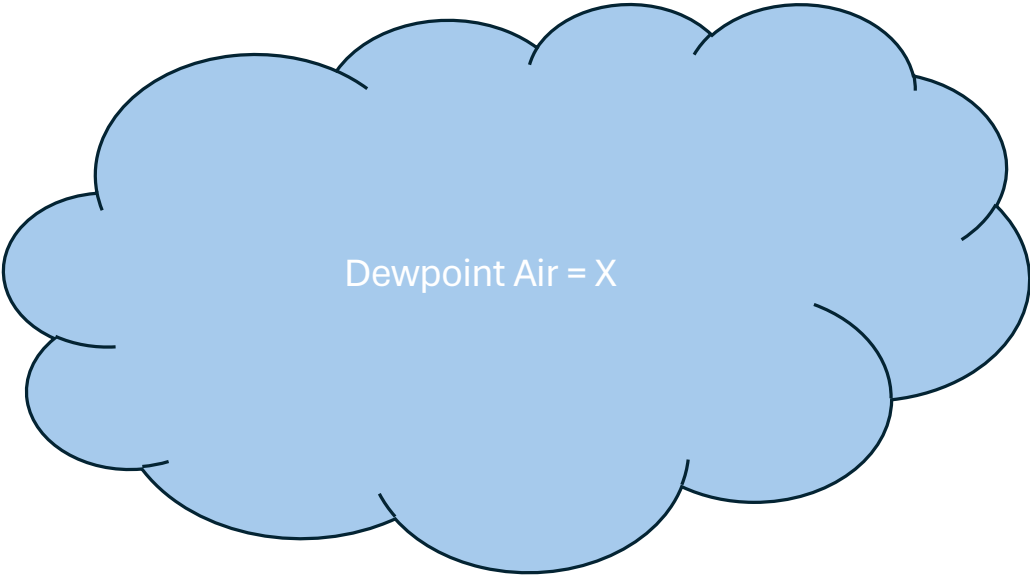
than this number

Dewpoint

**Surface
Temperature**

Humidity Control for Comfort $\neq$ for Mold Prevention

*For Humid Design Conditions: Keep Surface and Framing Temps $>10^{\circ}\text{F}$ Dewpoint of Air in Room or Interstitial Spaces.
This keeps you at $>75\%$ surface RH in most cases.*



Dewpoint Air = X

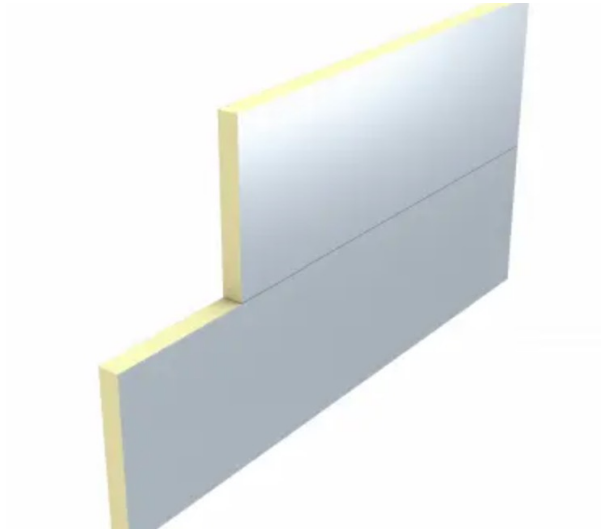
Surface DB $> X + 10^{\circ}\text{F}$ [5.5°C]

Materials Are Limited and Lead Times Long



MATERIAL	LEAD TIME
Foam Board	2-Months
Fiberglass Faced Gypsum	2-Months
Sealants	4-Weeks
HVAC Systems	8-10 Weeks

PIR Board = I like it



POLY-ISO DUAL FOIL FACED

1.5" = R10

Foil facing can be cleaned

Lightweight

Fabrication is similar to duct board

Much cheaper than metal

Paper Faced Drywall = NO

From a
Manufacturer's
"Limitations" on
Submittal

Moisture and Mold Resistant drywall panels should not be used in areas which will be continuously wet or subjected to high humidity such as saunas, steam rooms, gang showers or indoor pools.

- 
- Even Moisture Resistant drywall is not designed for continuous exposure to humidity.
 - Alternatives = Fiberglass faced gypsum and cement board or traditional block and render with chases for services.

Metal Framing + Drywall = Major Red Flag

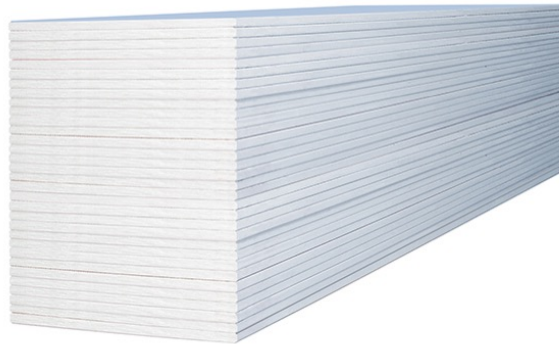


This is the Triple Whammy

Metal Framing



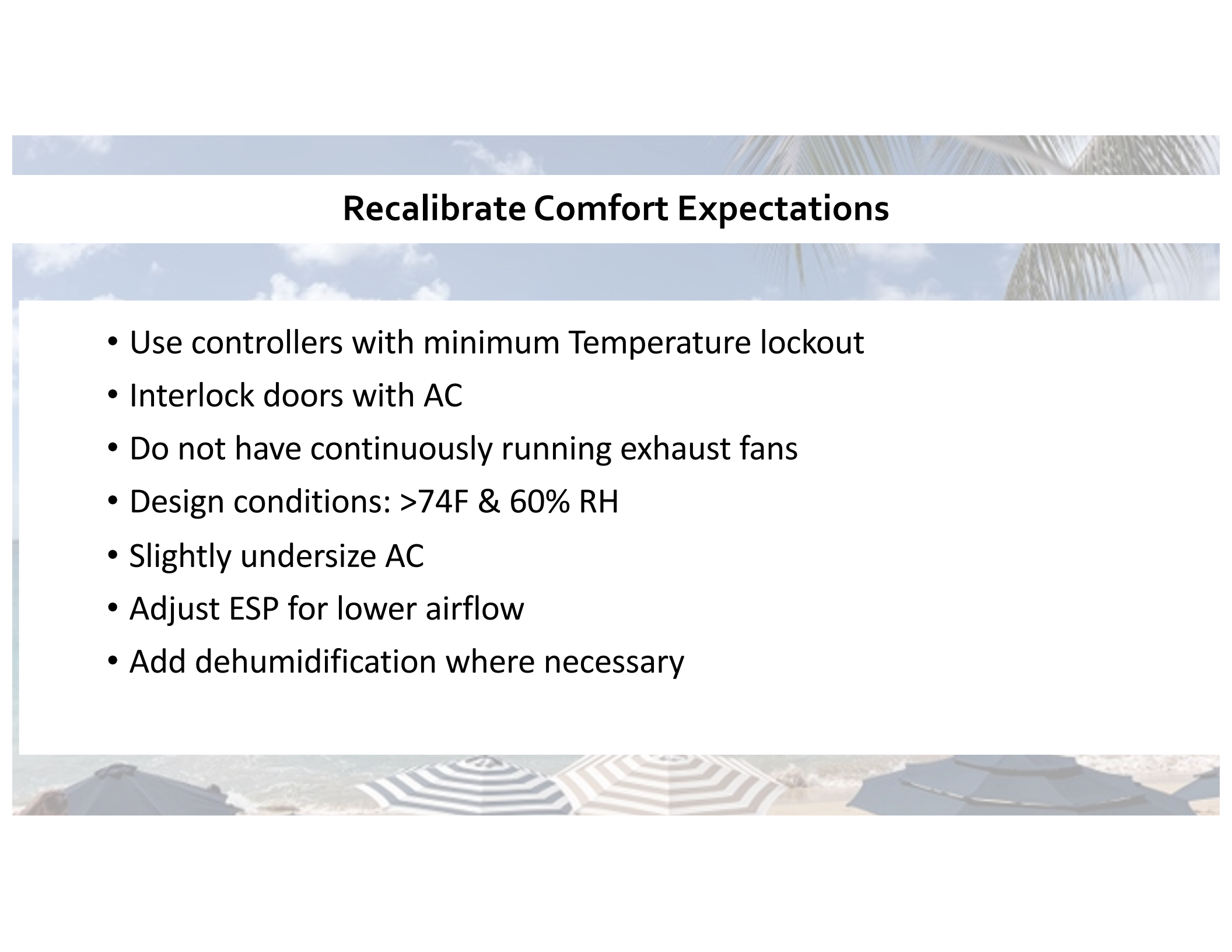
Paper Faced Drywall



Level V Wall Finish



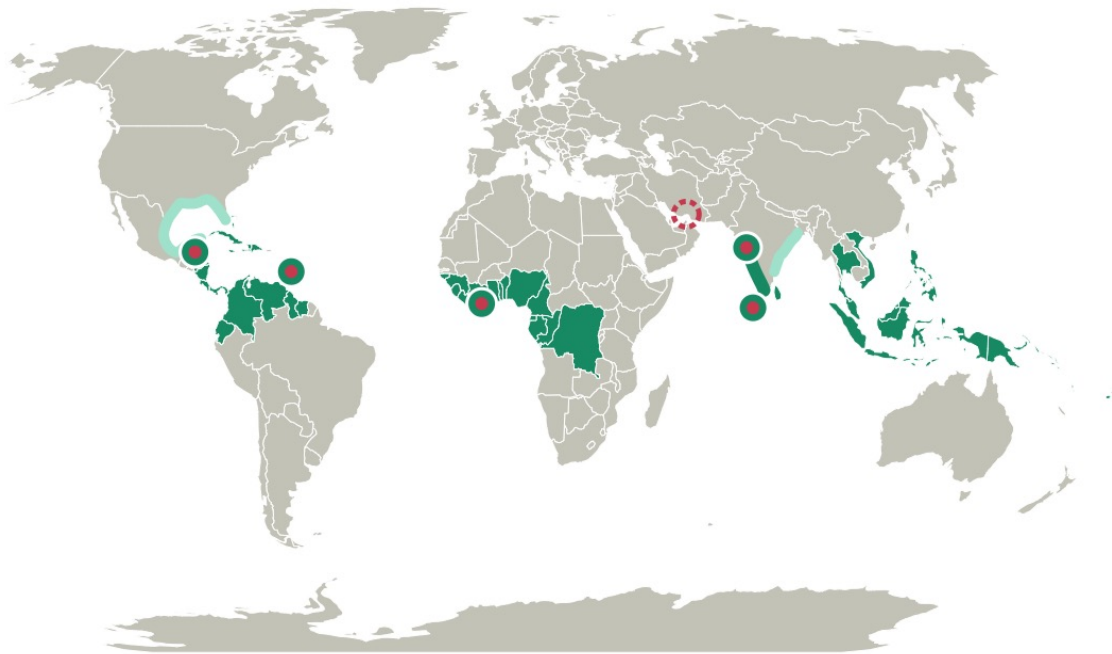
Guarantees the Wall Will be >80% Surface RH for 48 Hours

The background of the slide is a composite image. The top portion shows a clear blue sky with a few wispy white clouds and the fronds of palm trees. The bottom portion shows a sandy beach with several large beach umbrellas in various colors (blue, white, and brown) and the ocean waves in the distance.

Recalibrate Comfort Expectations

- Use controllers with minimum Temperature lockout
- Interlock doors with AC
- Do not have continuously running exhaust fans
- Design conditions: >74F & 60% RH
- Slightly undersize AC
- Adjust ESP for lower airflow
- Add dehumidification where necessary

Why This is Important: $>72^{\circ}\text{F}$ DP over 50% hours/yr



 Indicates regions with Dewpoints $>72^{\circ}\text{F}$ [21°C] $>50\%$ hours/year

 Indicates regions with Dewpoints $>75^{\circ}\text{F}$ [24°C] $>30\%$ hours/year

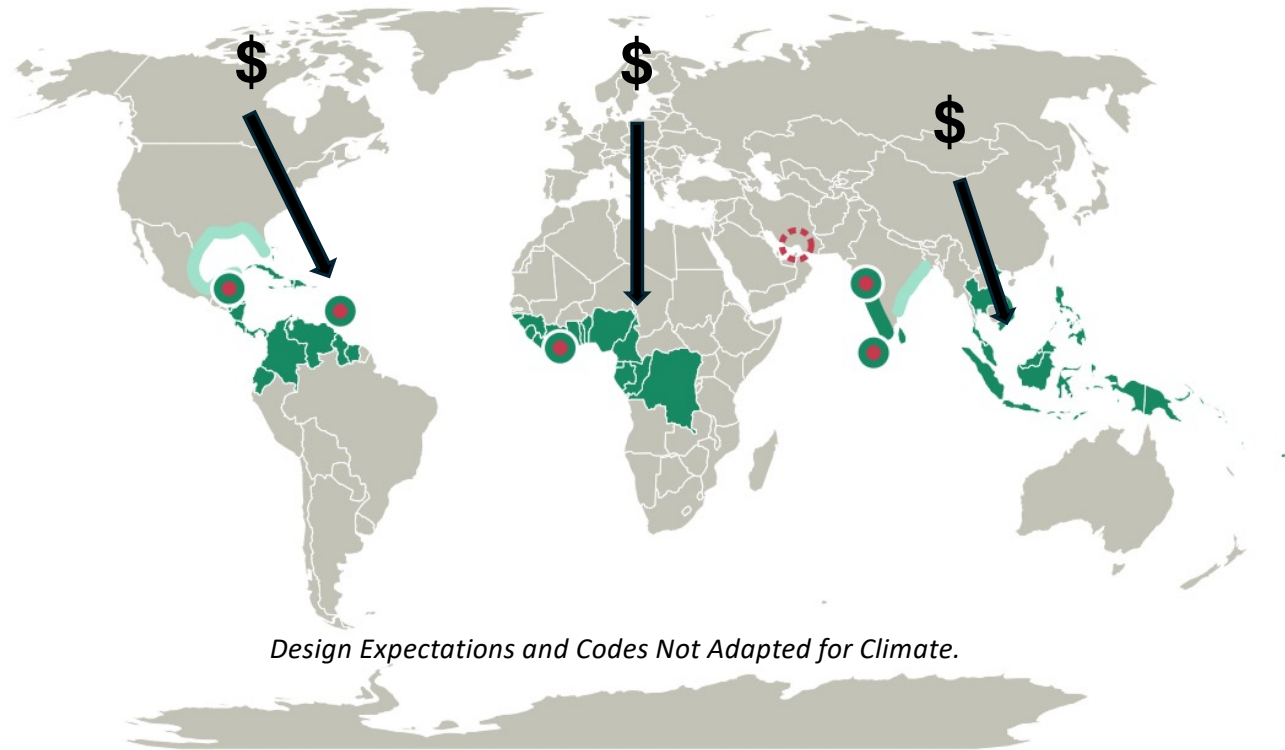
Why This is Important: Designers are Using 62.2 in Good Faith!



$$Q = (\# \text{ people} * 7.5 \text{ cfm}) + \frac{0.03 \text{ cfm}}{100} \text{ ft}^2$$

No dehumidification and more is better.

Why This is Important: \$ Being Invested by Northern Climate Countries



Design Expectations and Codes Not Adapted for Climate.

You may not know it, but you need this.

Great reports and information on paper
will only get you so far.



A serene sunset scene over a body of water. The sun is low on the horizon, casting a warm, golden glow across the sky and reflecting on the water's surface. A sailboat's mast is visible in the foreground on the right side. The text "Until the Next Chapter" and "Thank You!" is overlaid in white.

Until the Next Chapter
Thank You!