Challenges Associated with High RSI Value Building Envelope Retrofits

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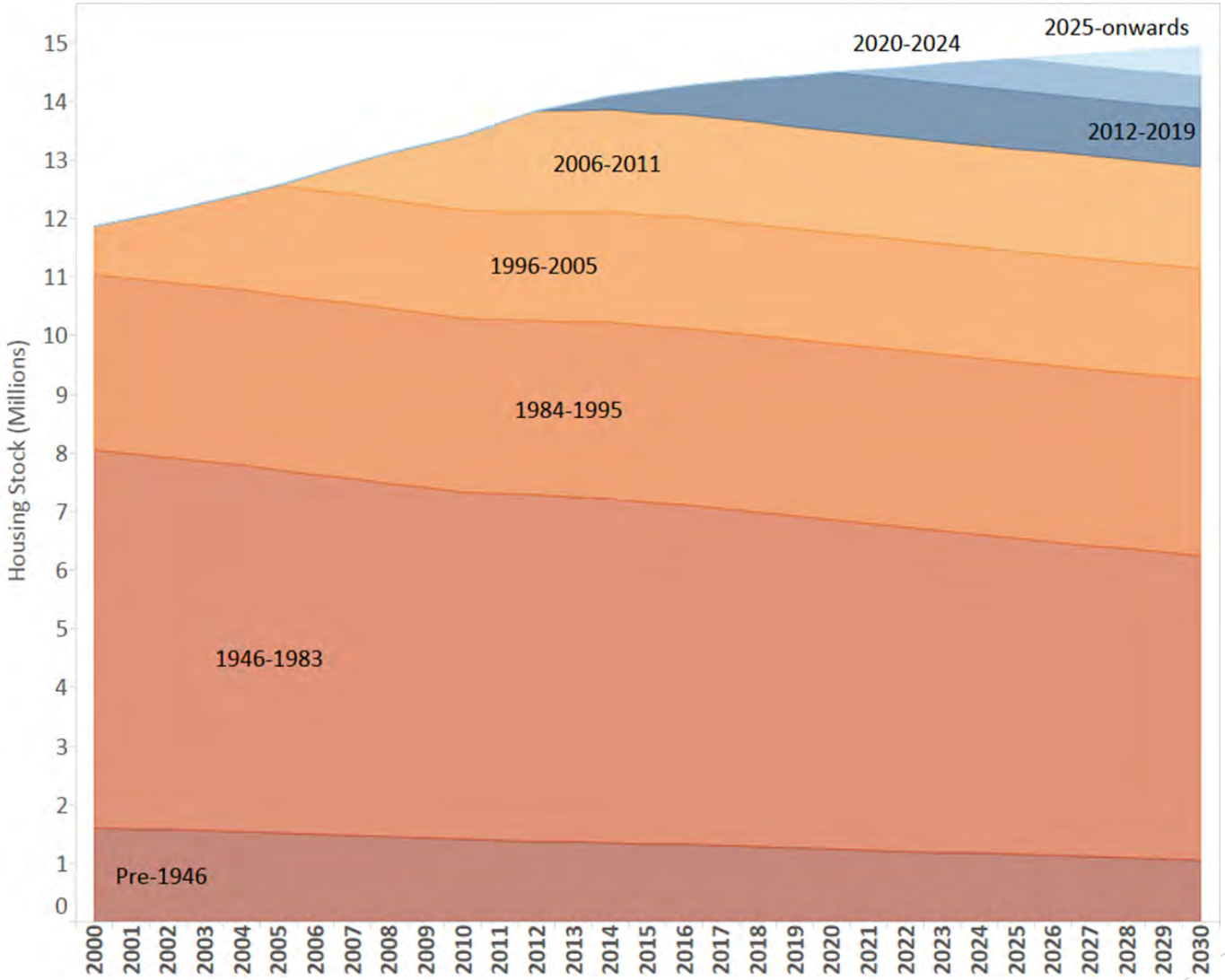
Overview

- Envelope Retrofit Opportunity
- Challenges with Implementation
- VIP Solution
- CE-BETH Facility
- Updated Results
- Conclusions and Future Work

Research Question and Motivation

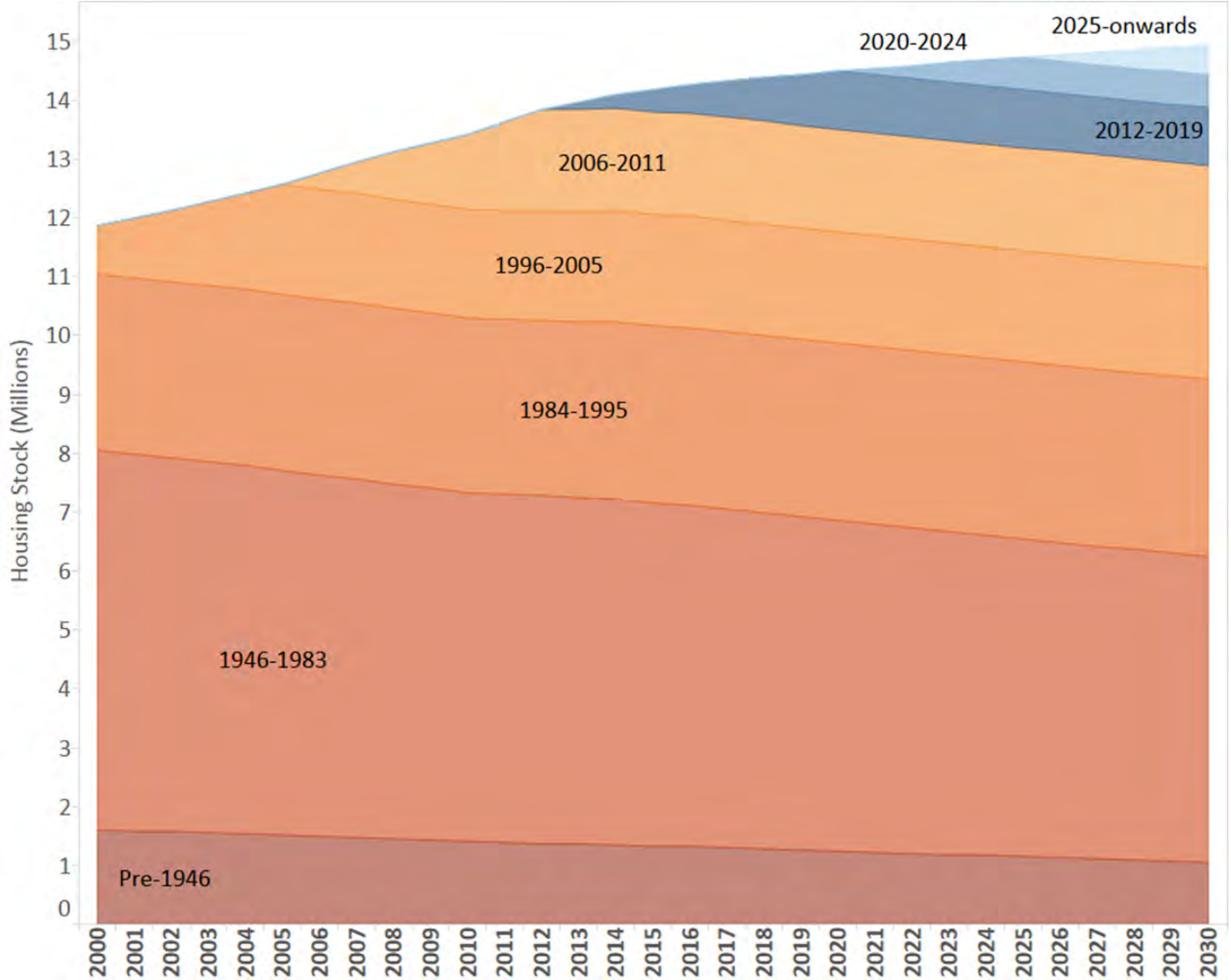
- How can high-R retrofits be achieved with thin assemblies in cold, humid climates?
- How does moisture move through these assemblies?
- Is there sufficient moisture resiliency in such retrofitted assemblies?

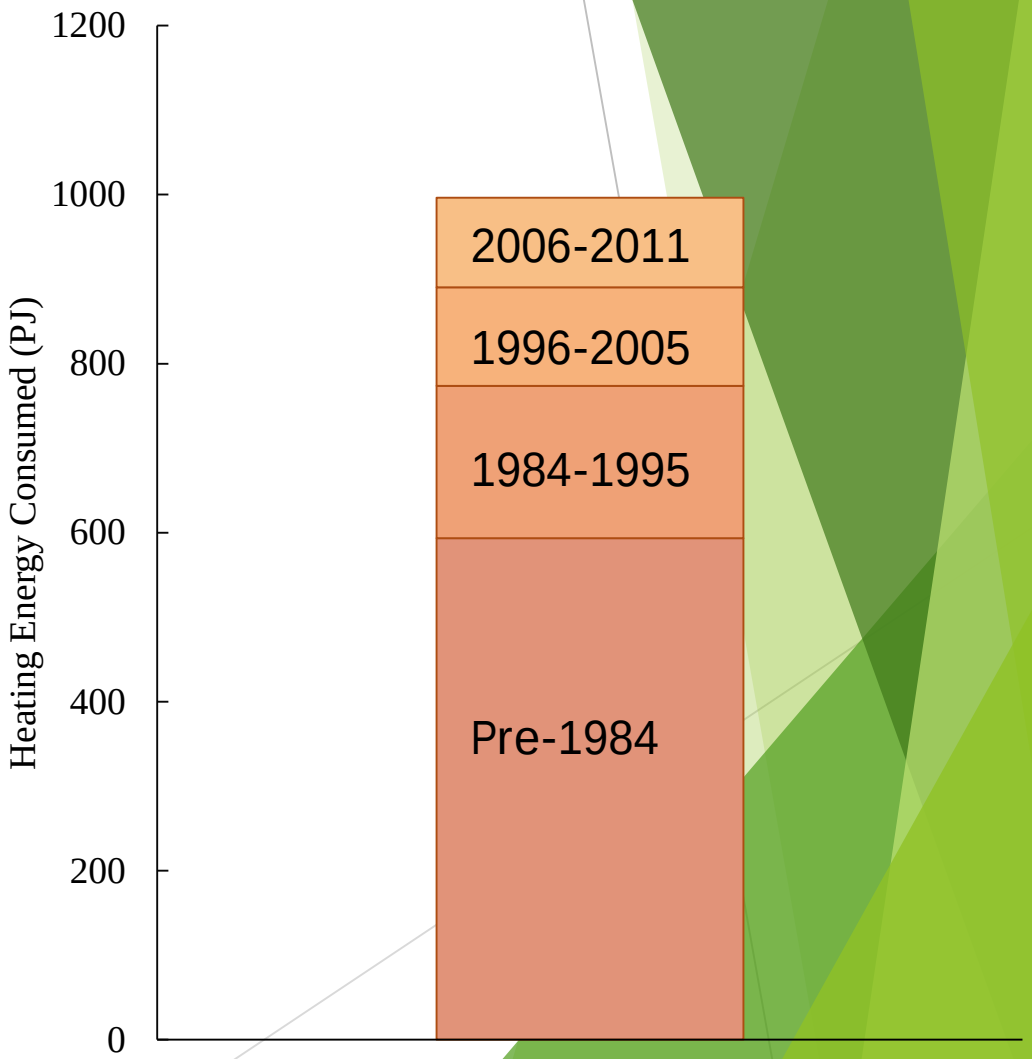
Historical and Projected Housing Stock in Canada



Source: Carver, Mark. 2016. "Envelopes Gaps and Drivers." Workshop, Ottawa, Ontario.

Heating Energy Consumed by Vintage





Interior Retrofit

Pros

- Does not affect building footprint
- Exterior finish left intact

Cons

- Disruptive to occupant during installation
- Decreases interior floor area

Exterior Retrofit

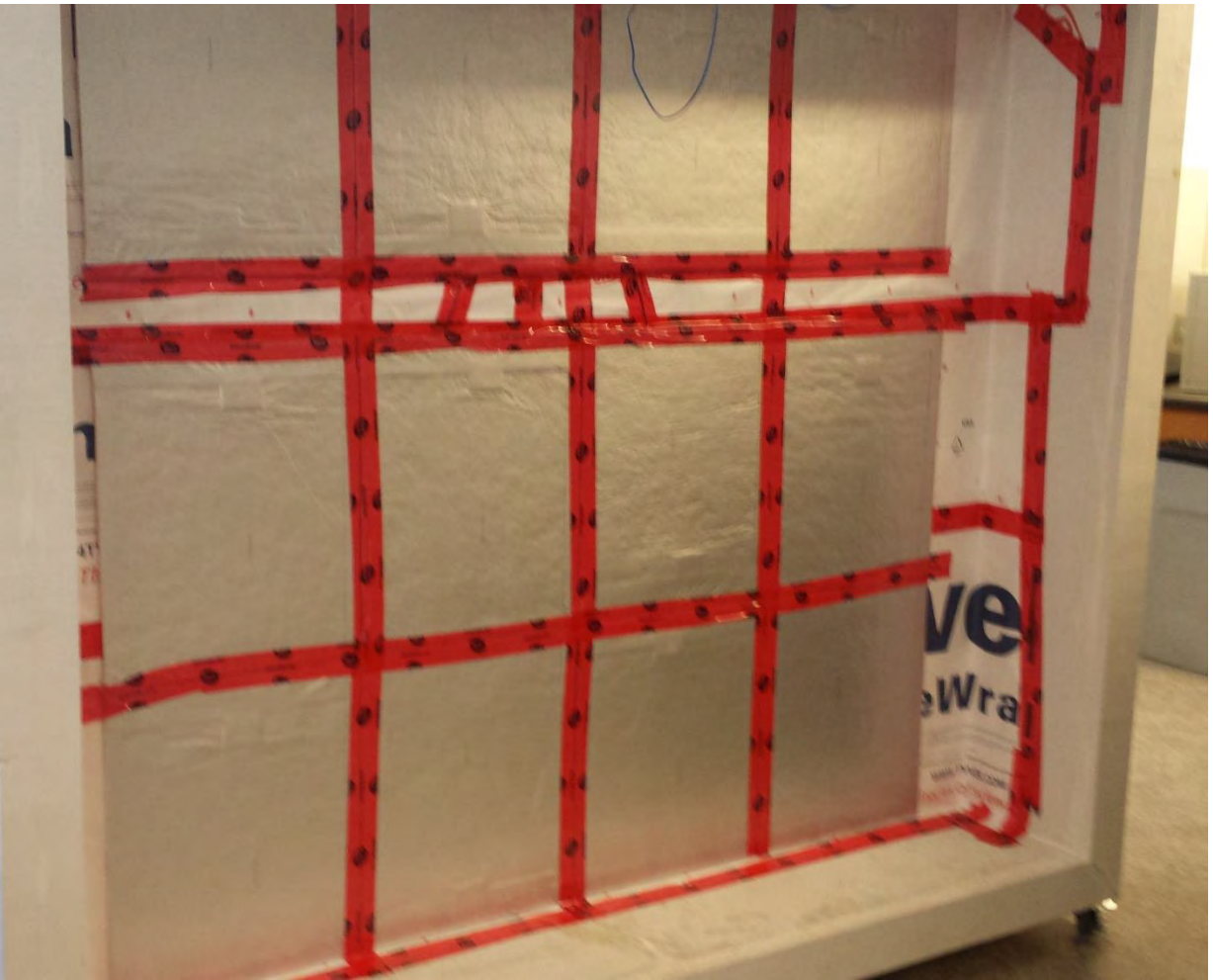
Pros

- Minimal disruption to interior of building
- Maintain interior floor area
- Warmer sheathing temperature

Cons

- Limited by distance to property lines and zoning setbacks
- Heritage Designation or masonry exterior
- Exterior demolition and surface preparation labour required

Vacuum Insulation Panels



- Vacuum contained in a metallic envelope with a porous core
- Provides a high thermal resistance per unit thickness (RSI per inch 6.2 to 10.5)

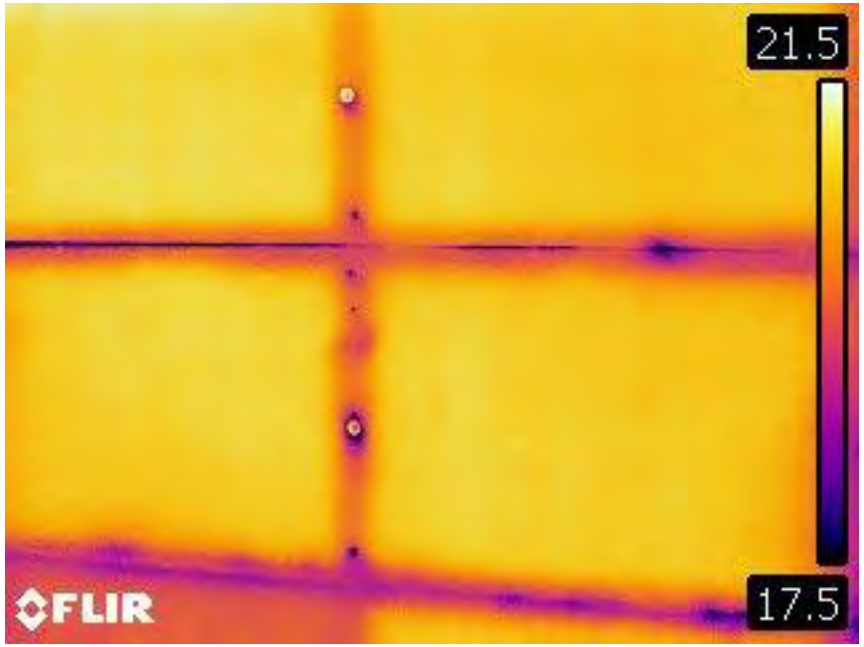
Issues:

- Thermal bridge along the perimeter
- Fragile and risk of loss of vacuum
- Unknown lifespan
- High cost
- Limited flexibility

What is a VIP sandwich panel

- VIP added within rigid foam insulation
- Maintains high thermal performance
- Improved “buildability” for VIPs

VIP Sandwich Solution



Factors In Thermal Performance

- Coverage of VIP
- VIP Thickness
- VIP Size and Edge Effects

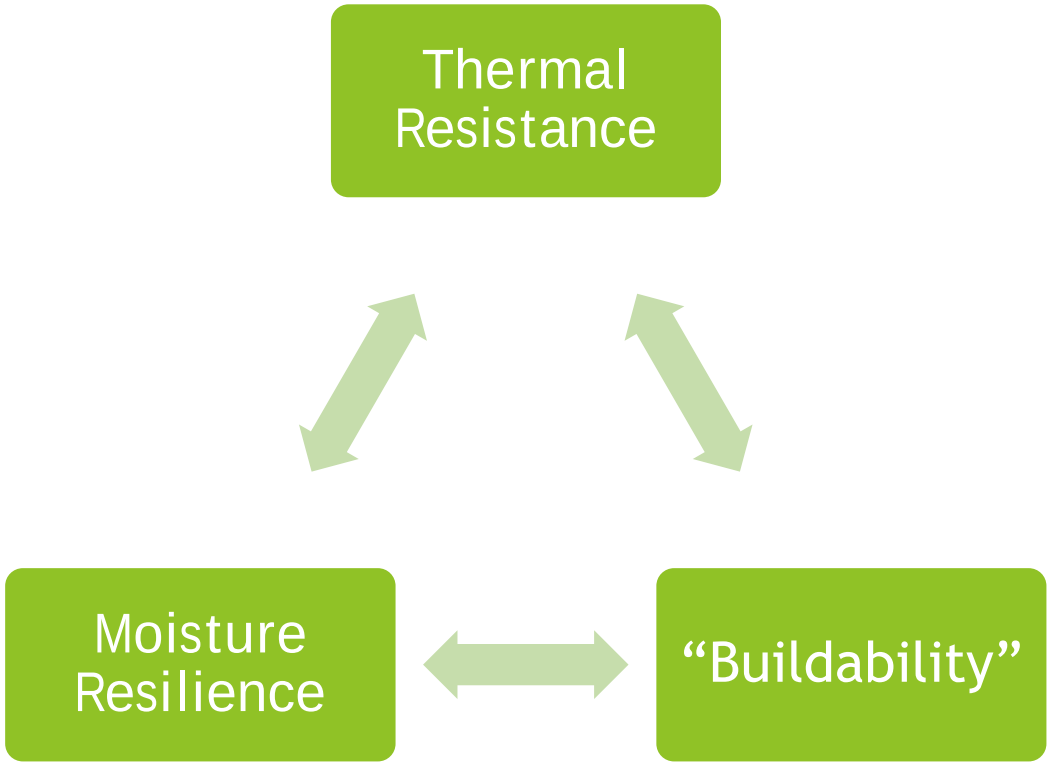
1” VIP, 87% coverage in 2” panel

- RSI 6.4 (R36)

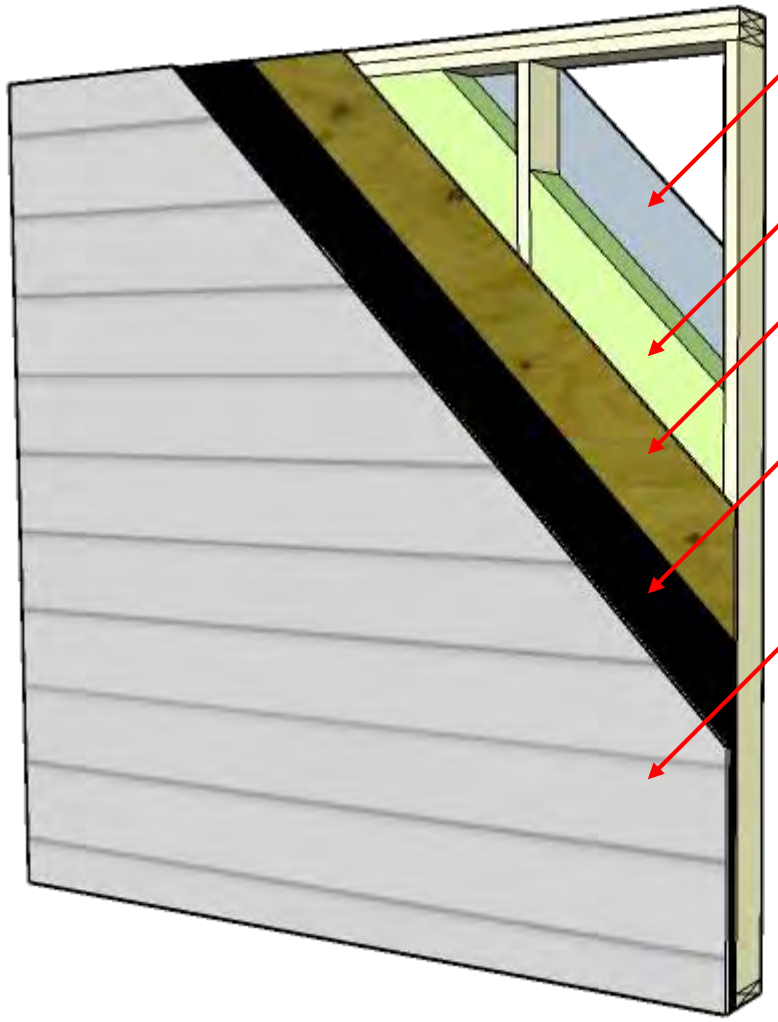
3/4” VIP, 50% coverage in 2” panel

- RSI 3.2 (R18)

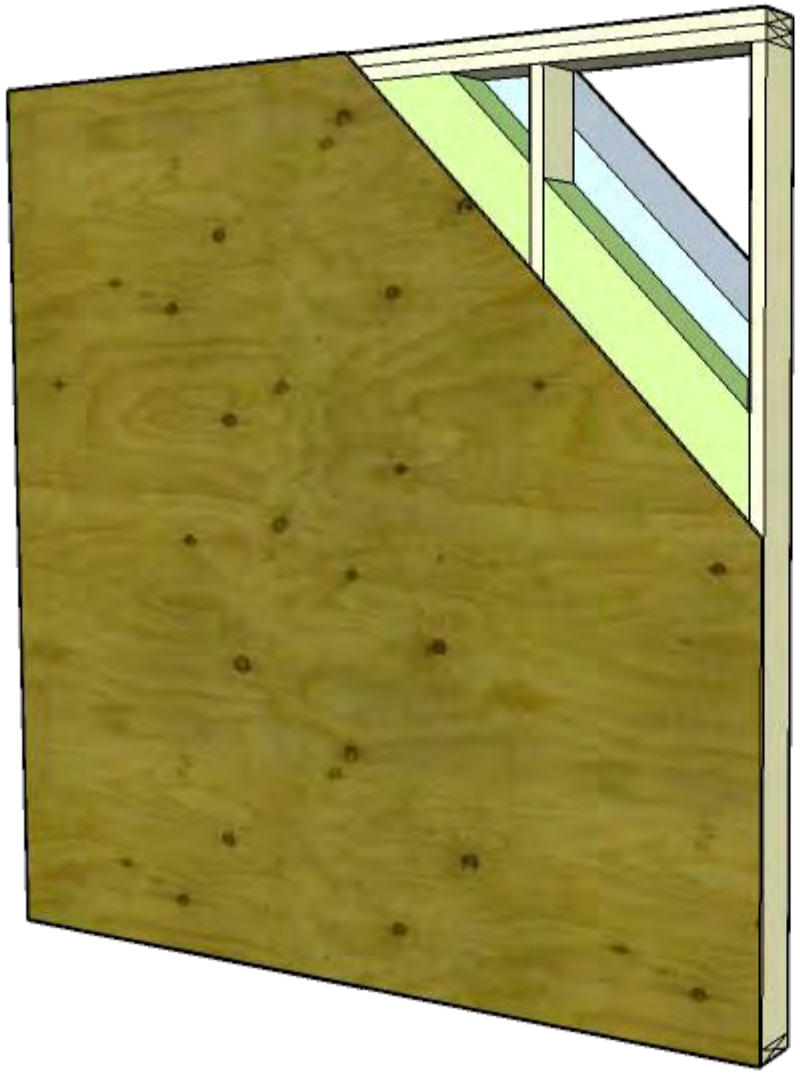
Design Trade Off for VIP Sandwich



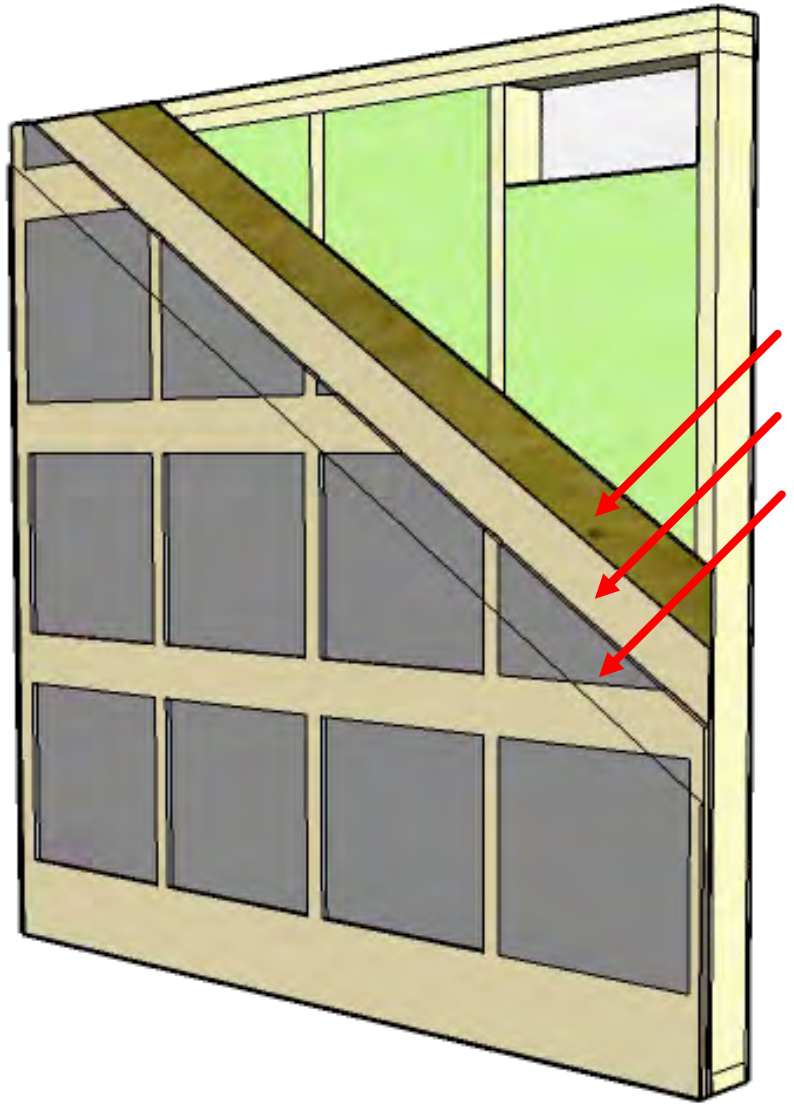
Typical Existing Wall Assembly



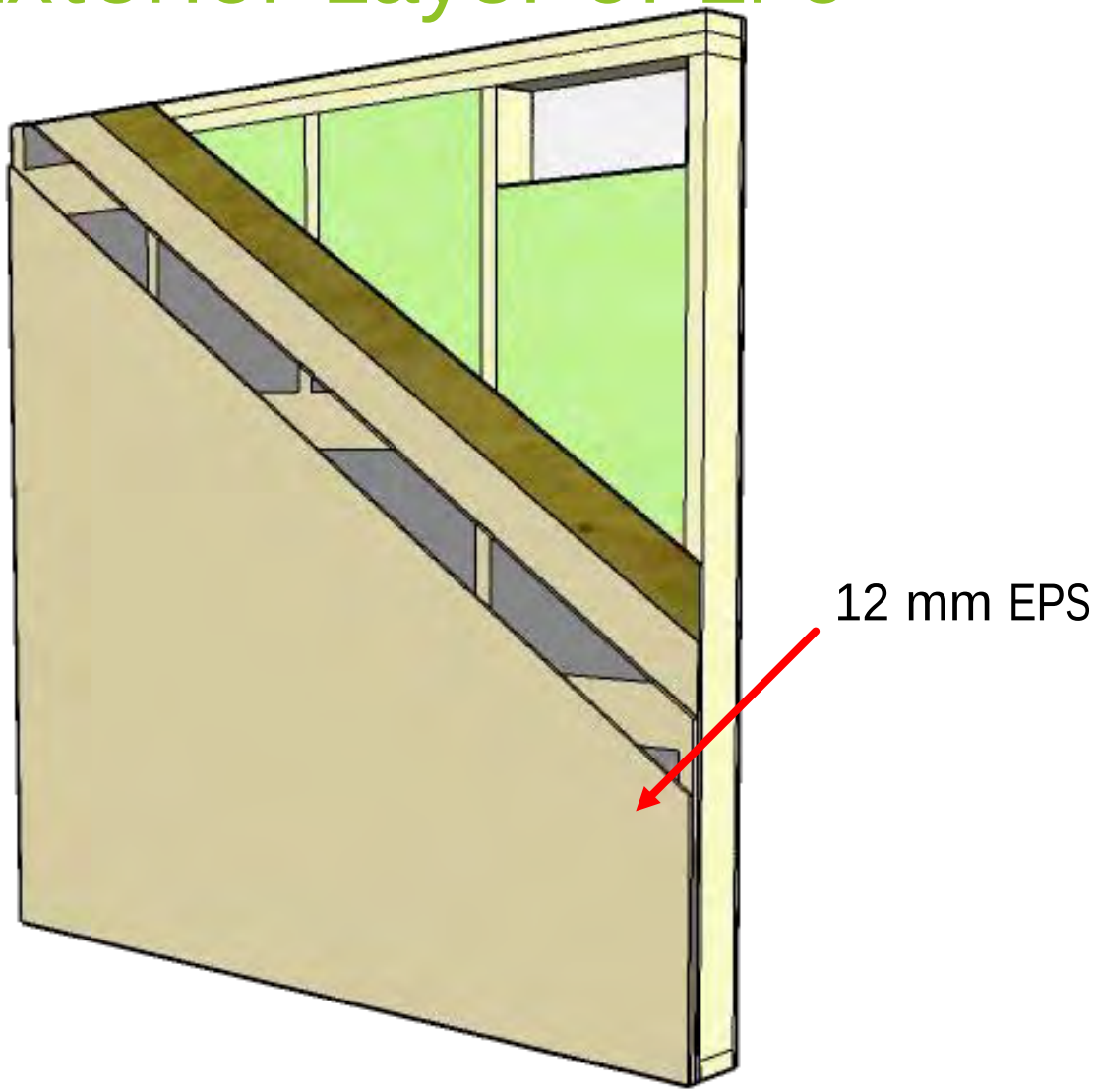
Remove cladding to expose sheathing



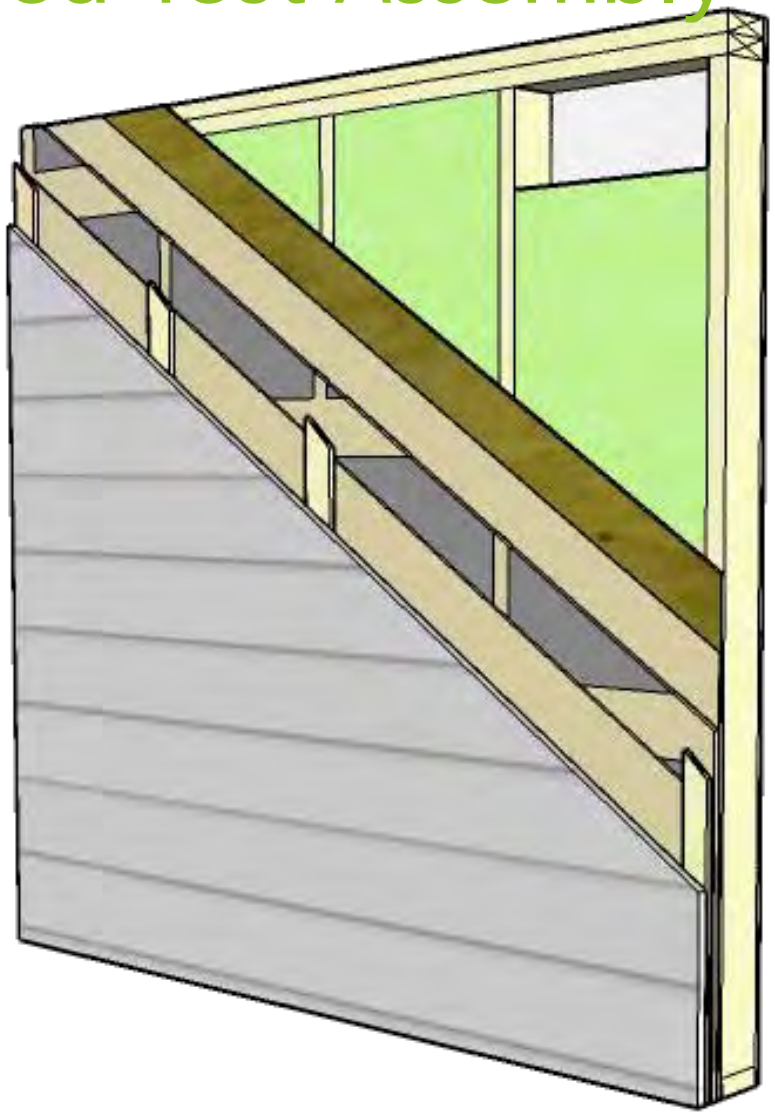
Adding VIP Sandwich Assembly



Adding Exterior Layer of EPS



Completed Test Assembly



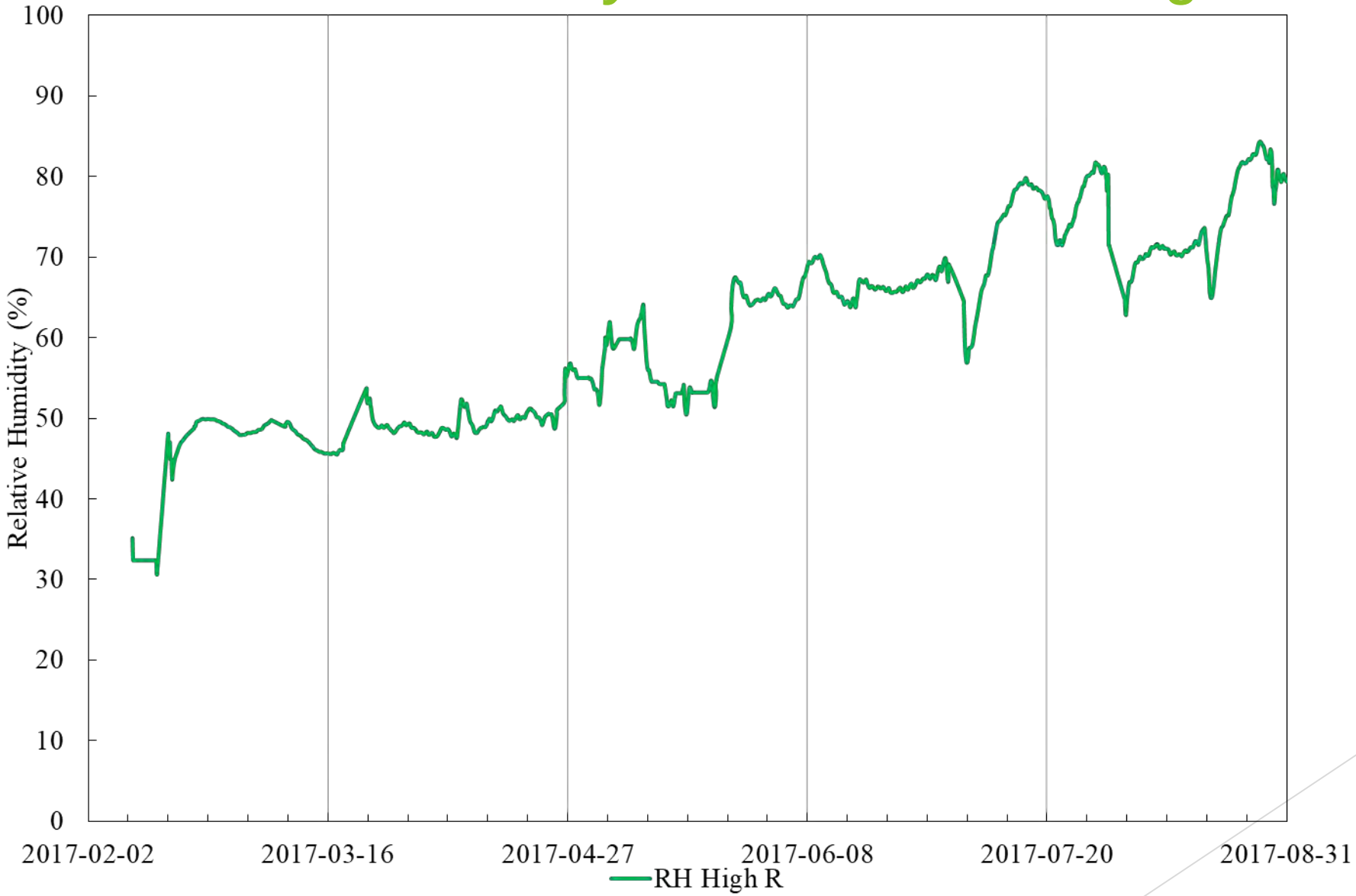
CanmetENERGY Building Envelope Test Hut (CE-BETH)

Moisture Risk Assessment Criteria

1. Does the RH and moisture content in the framing and sheathing of the experimental walls exceed those of the baseline assembly?
2. To minimize the potential for mold growth:
   a. 30-day running average surface RH should be < 80%
   b. 7-day running average surface RH should be < 98%
   c. 24-h running average surface RH should be < 100% .
3. To avoid rot, moisture content of wood should remain <28%

ASHRAE 160-2009

Relative Humidity at the Sheathing



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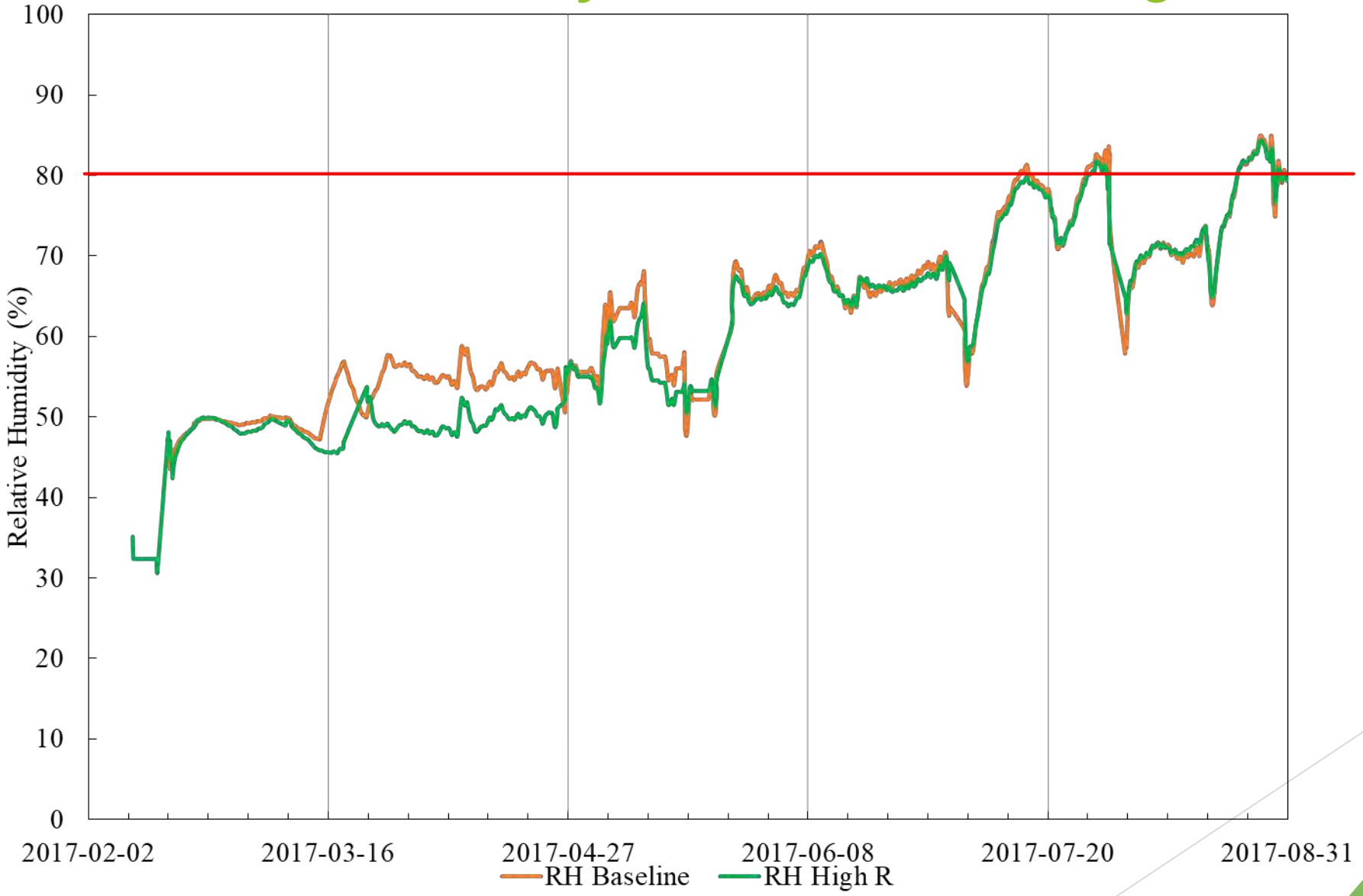

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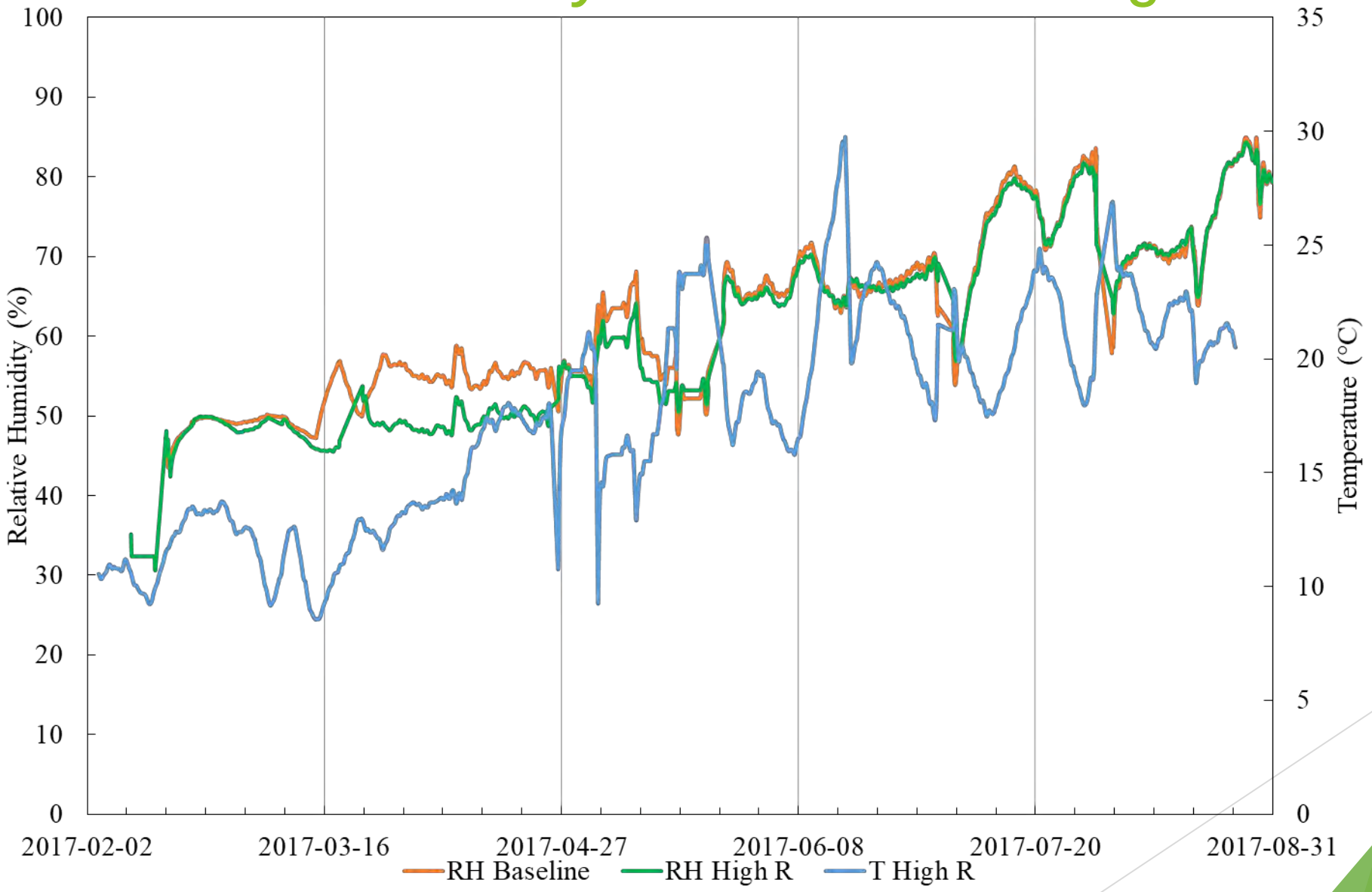

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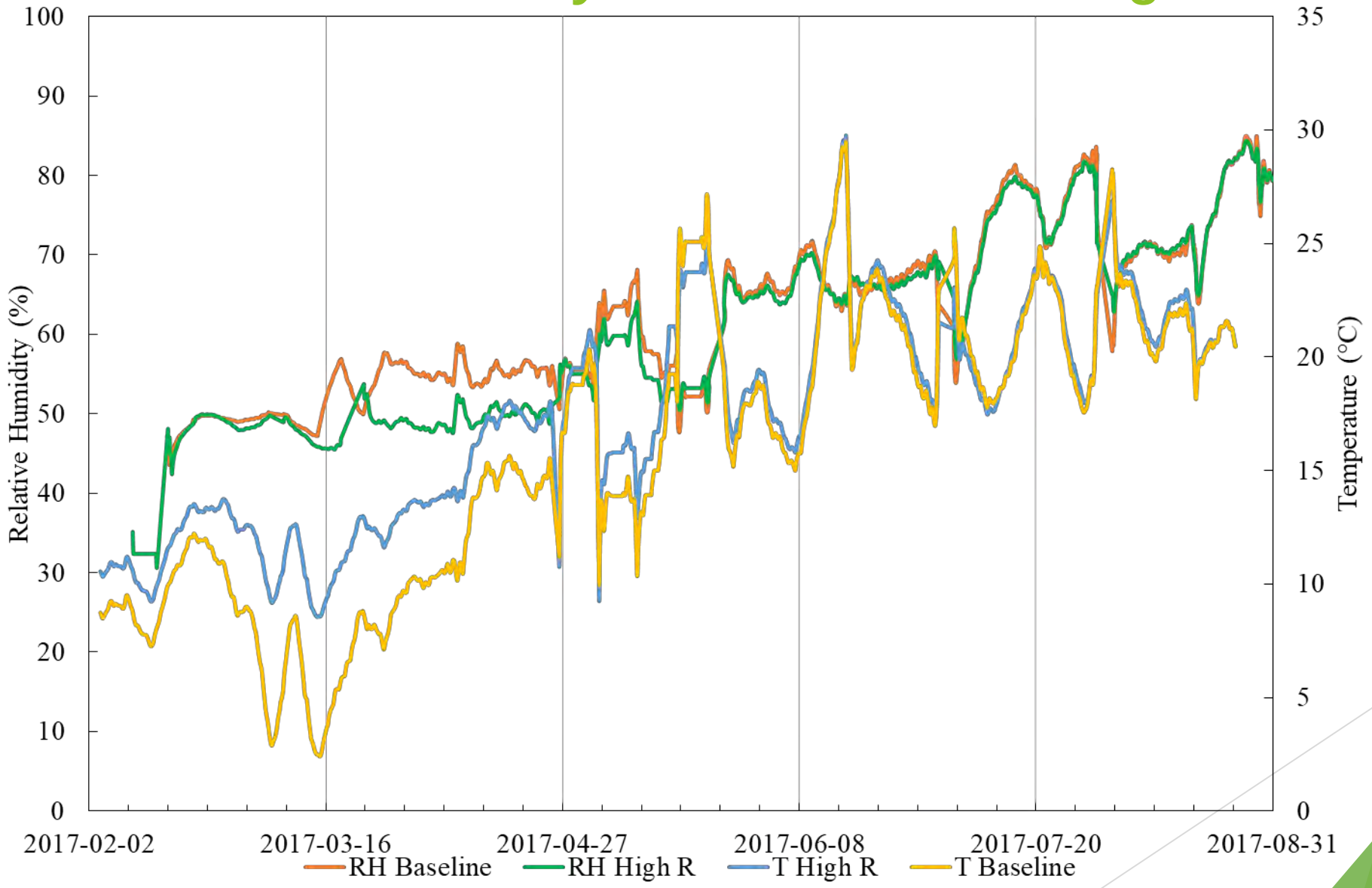
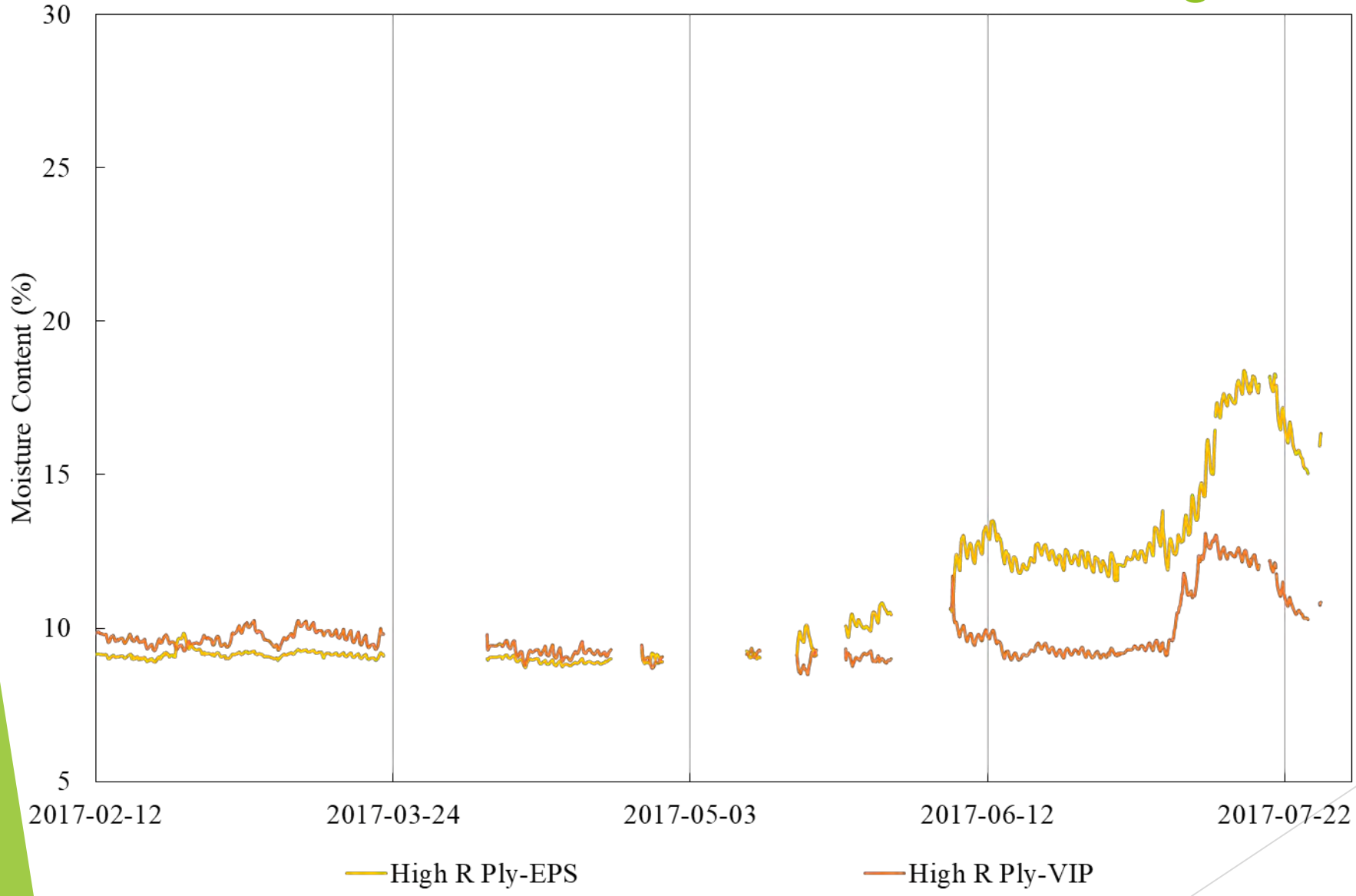


Moisture Content in the Sheathing



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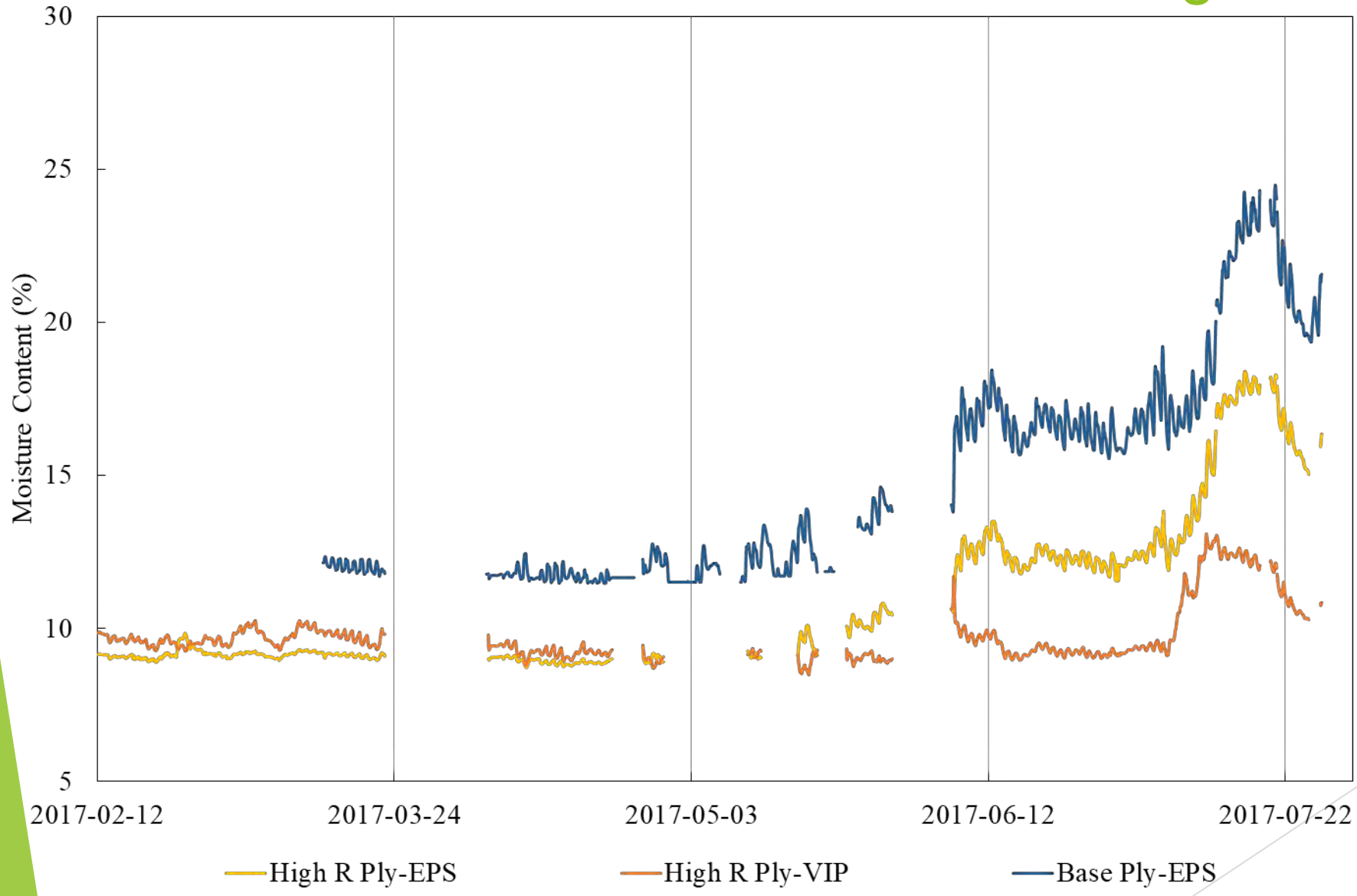

Conclusions

- Elevated relative humidity at sheathing observed for short periods of time
- VIP maintains warmer sheathing temperature, lower moisture content
- Baseline sheathing experiences high moisture content during summer months
- Another heating season needed to determine the moisture resiliency of assembly

Thank You

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