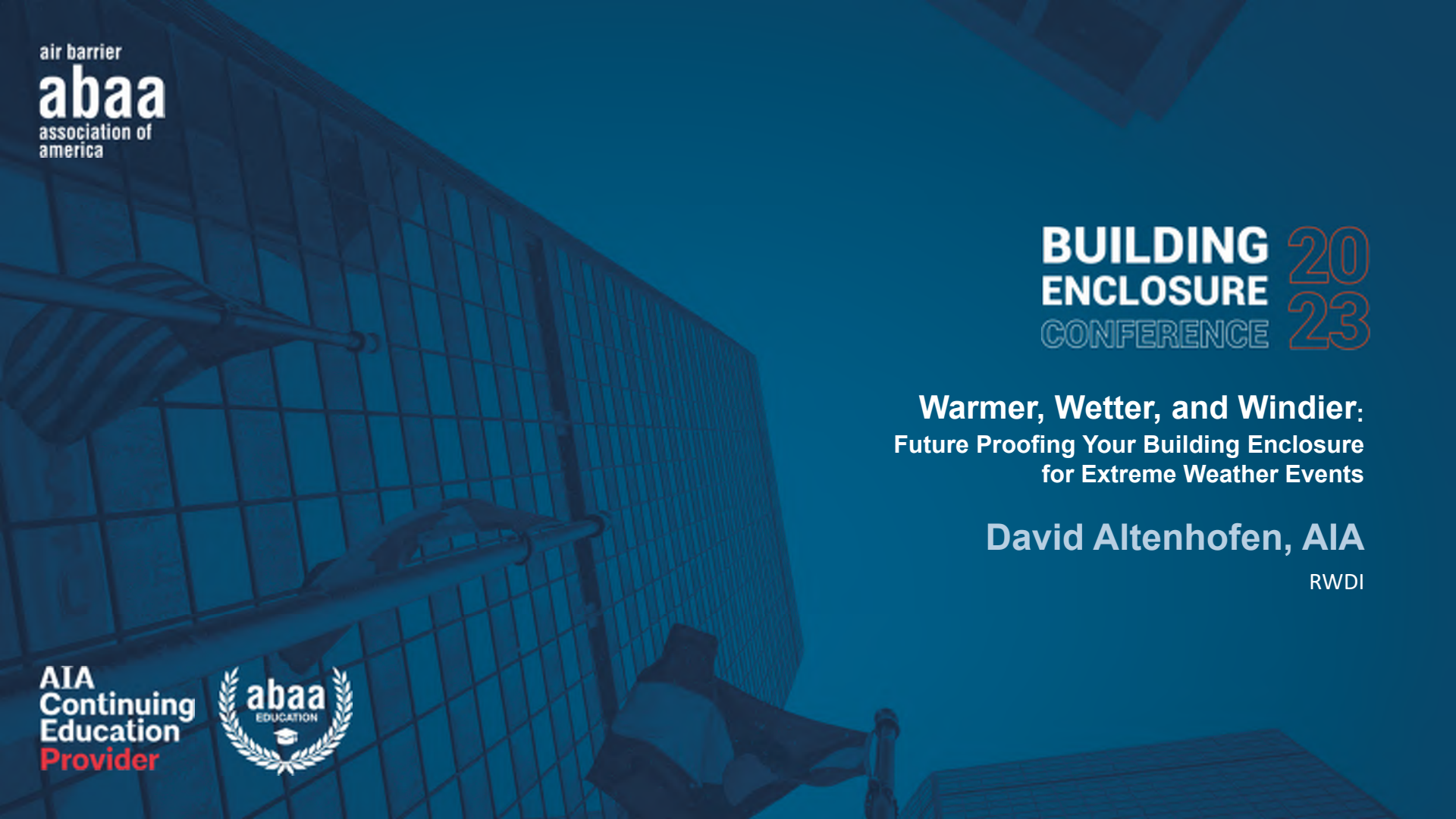


Warmer, Wetter, and Windier:

Future Proofing Your Building Enclosure for Extreme Weather Events

David Altenhofen, AIA

RWDI

Warmer, Wetter, and Windier:

Future Proofing Your Building Enclosure for Extreme Weather

It's getting wilder for building enclosures. Climate change is causing warming temperatures with climate zone boundaries moving north, longer periods of more intense rain between droughts, and increased high wind occurrences sometimes reaching tornadic or hurricane forces. Such changes will challenge the performance of building enclosures and will require altered design strategies to reliably perform. Furthermore, extended utility outages which accompany the extreme events will place even more demands on performance of buildings during the most catastrophic of situations.

David Altenhofen, AIA
Senior Technical Director
Building Enclosures
RWDI

Learning Objectives

1. Identify changing climatic conditions that influence building enclosure design and performance.
2. Identify how some enclosure design strategies that have performed adequately in the past may no longer be acceptable due to climate change and review enhancements to accommodate the new conditions.
3. Investigate the impact of climate change on the performance of existing building enclosures and how some previously acceptable buildings will "tip over" into problem structures.
4. Understand the interrelationship of enclosure design for weather extremes with resilient design for passive performance and sustainability.

Thank You Exhibitors and Sponsors!

Thank You Sponsors!

BOARD MEMBER
MEET & GREET

air barrier
abaa
association of
america

The Peaks Lounge
On the 27th Floor

BUILDING
ENCLOSURE
CONFERENCE

6:00 PM - 8:00 PM

Use Your Phone's Camera to Scan the Barcode. Search Code: DENVER2023

Connect with me after the presentation at the Fireside Chat area, next to the stage.

CLIMATE CHANGE

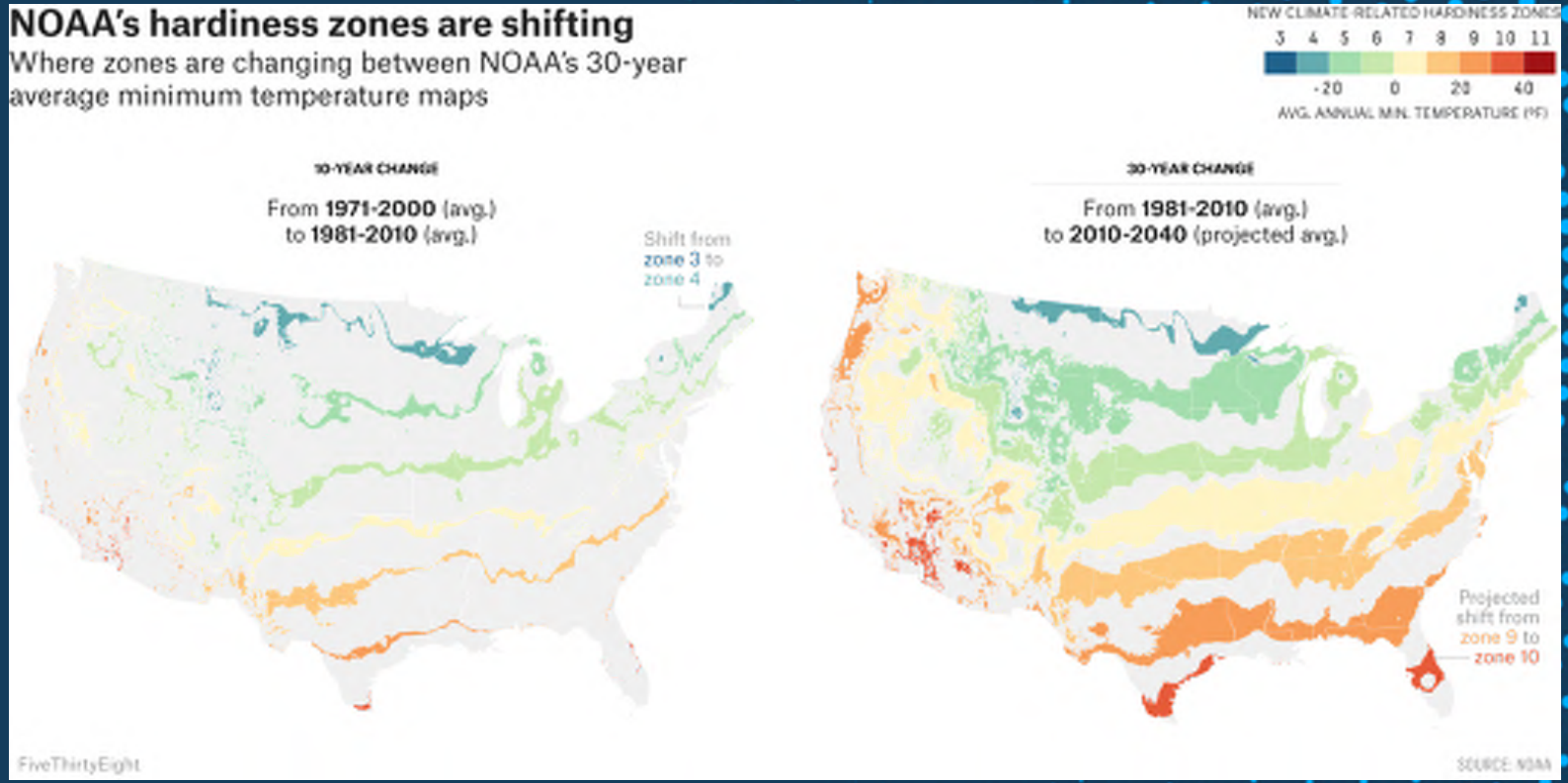
A significant variation of average weather conditions

– National Resourses Defense Council

- Warmer
- Wetter or Drier
- Windier

WILDER

GENERALLY WARMER

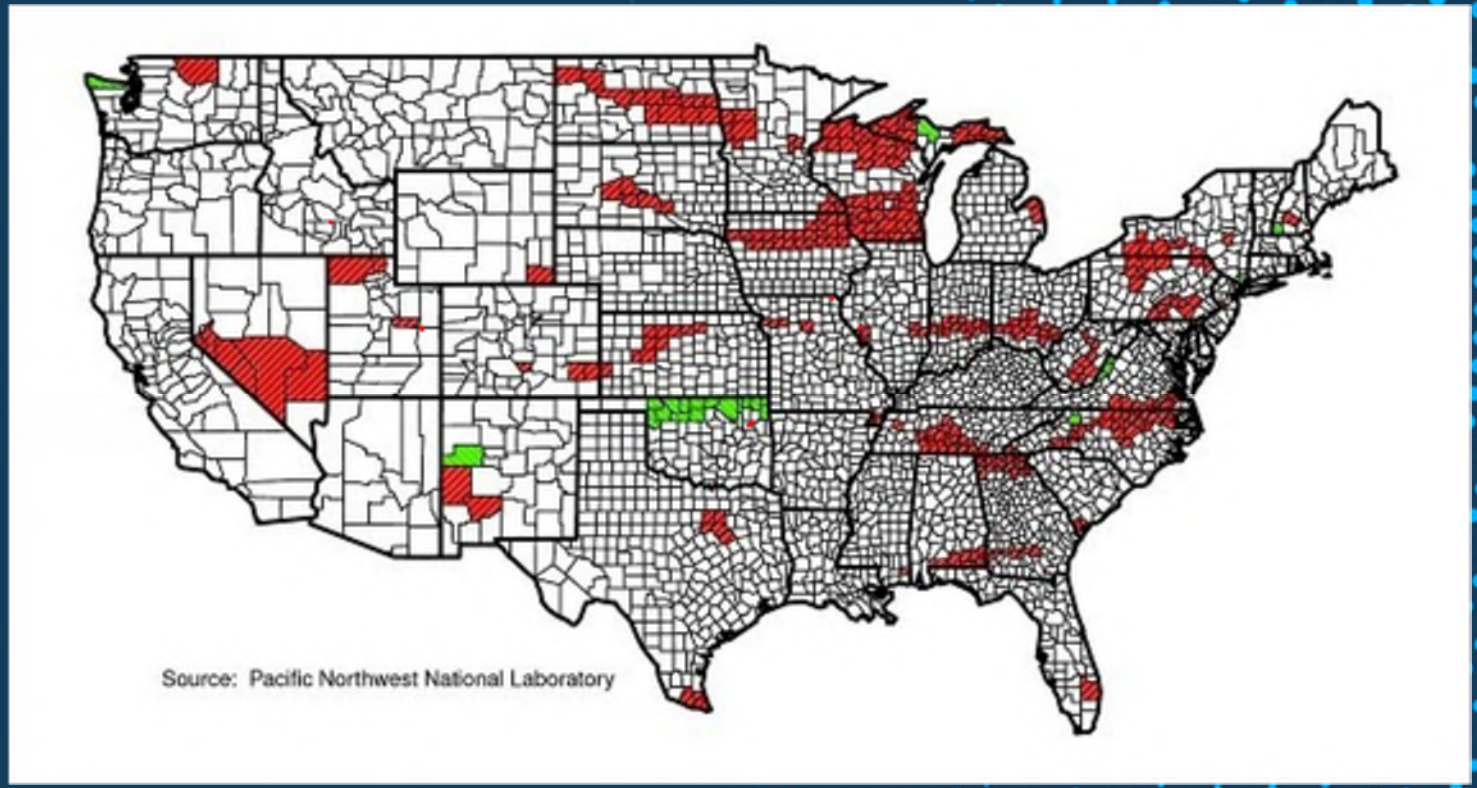


Slide 9

JB1 Jillian Burgess, 9/14/2020

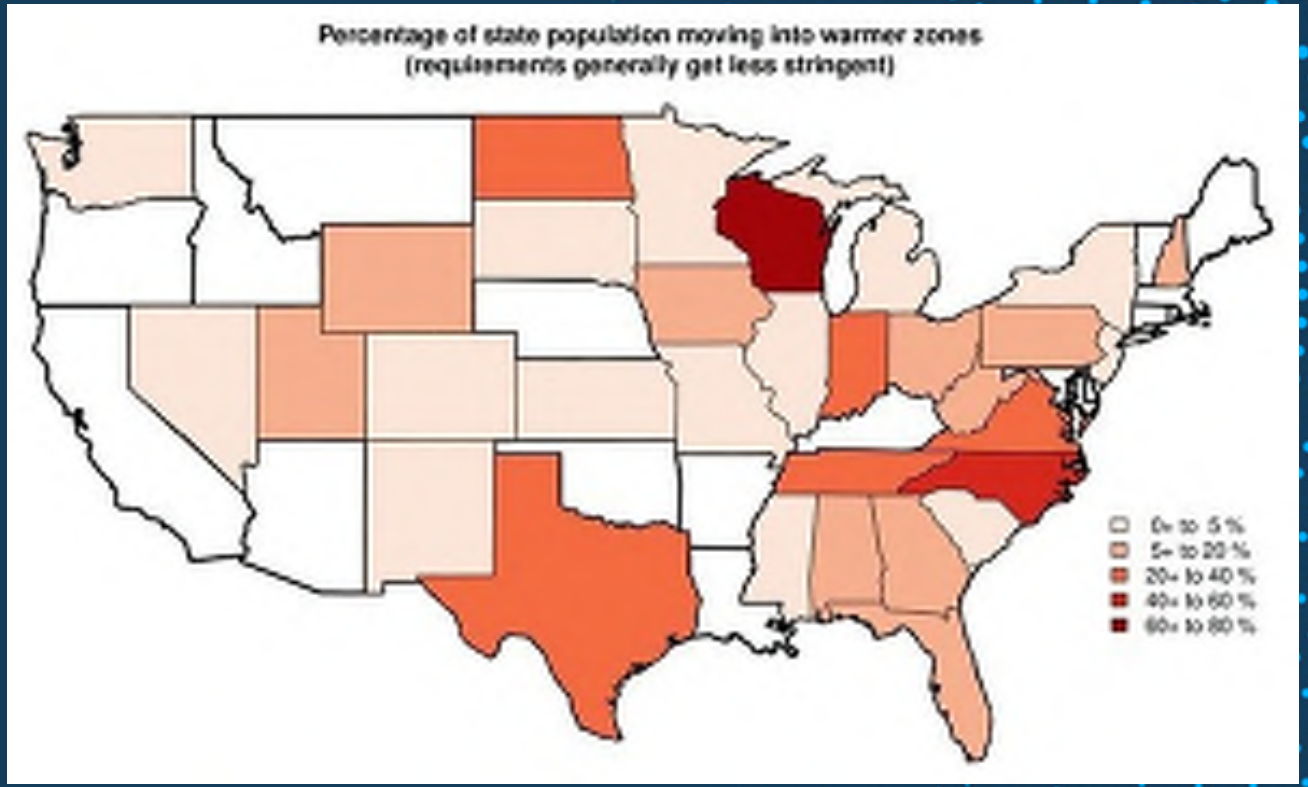
GENERALLY WARMER

Changes IECC climate zones 2018 to 2021



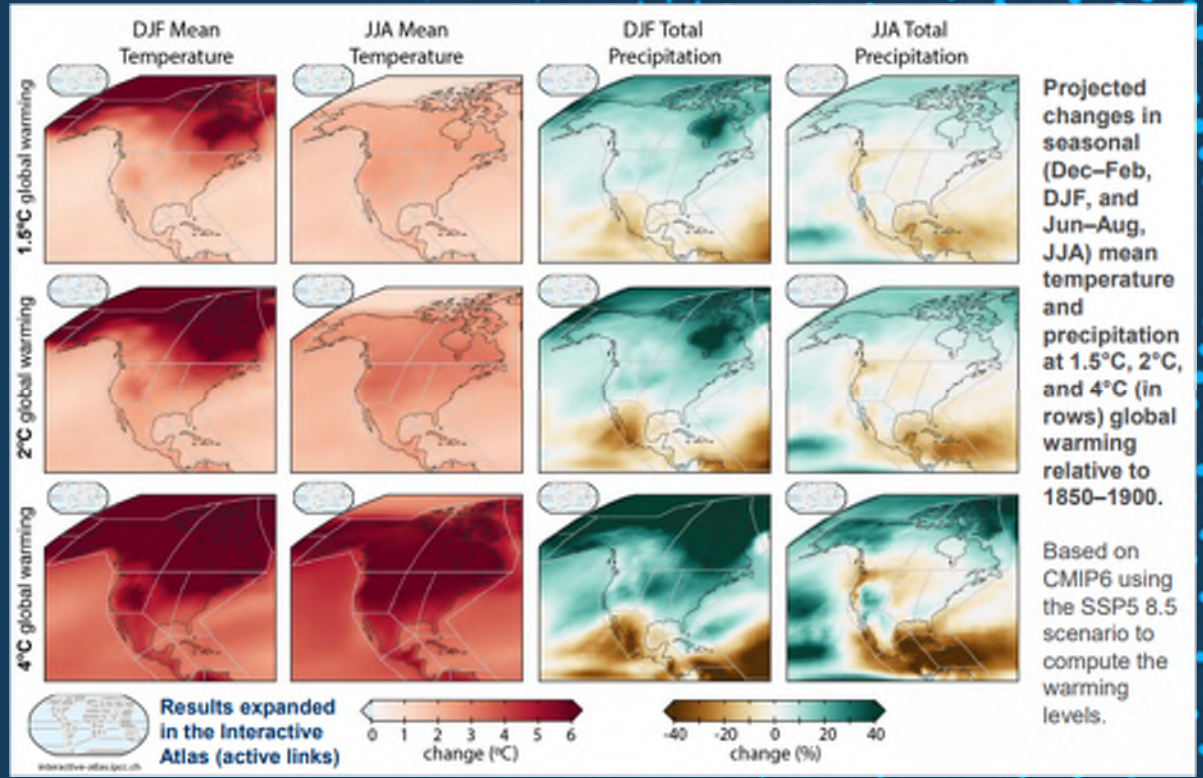
GENERALLY WARMER

PNNL

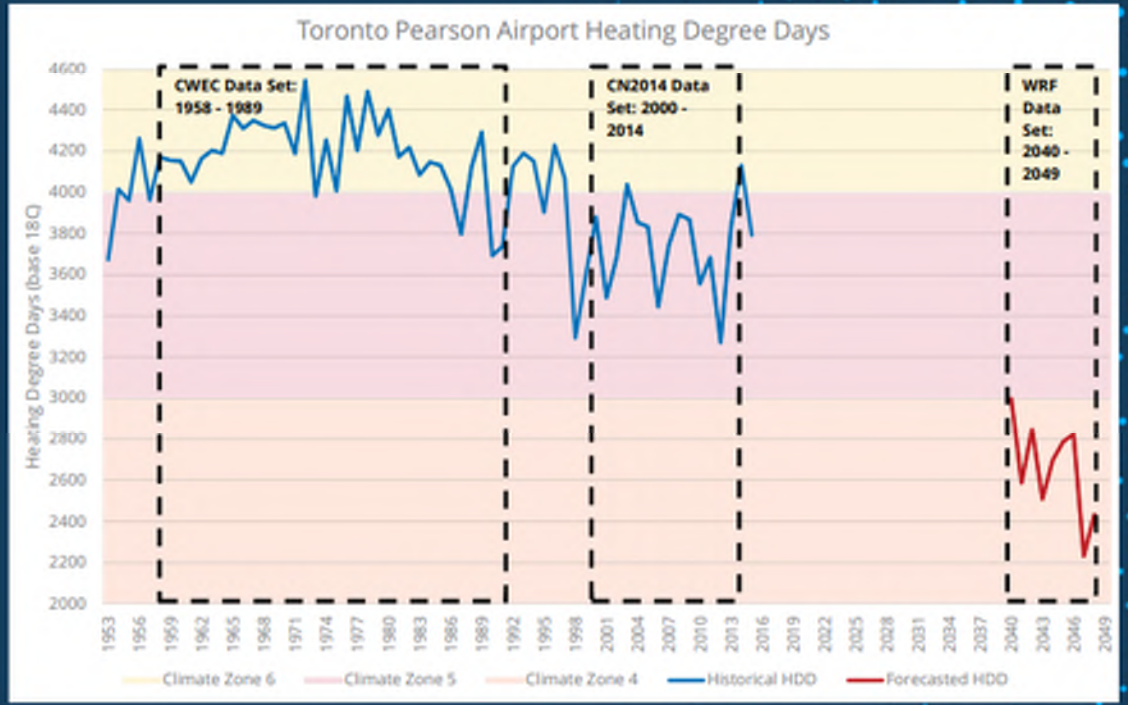


Extreme Conditions

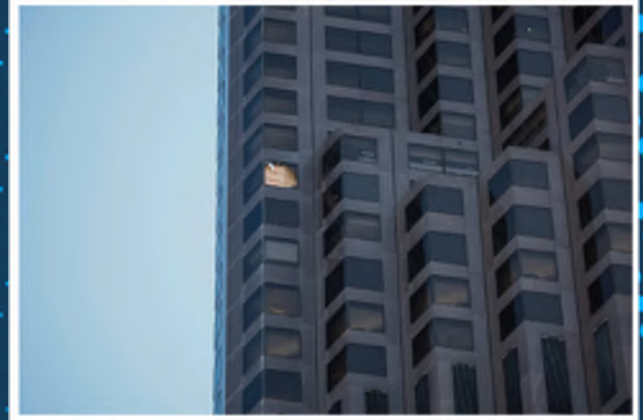
UN IPCC Report on Climate Change, 2021



Modeling Weather Futures



HIGH WINDS
RECORD SNOW



Glass from the 43rd floor (boarded up at left) fell on Kearny Street during a severe wind storm on Tuesday, March 14, in San Francisco. | Paul Kuroda for The Standard

Extreme Conditions

- Extreme Temperatures

- Extreme Precipitation

- Increased Wind Speeds

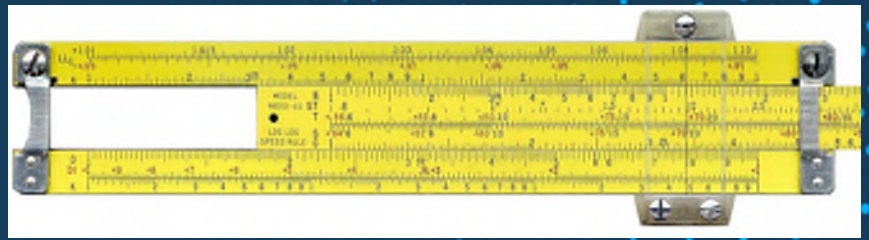
INCREASED FREQUENCY of EXTREME EVENTS

Slide 15

JB1 Jillian Burgess, 9/14/2020

CLIMATE IS CHANGING FASTER THAN WE CAN KEEP UP

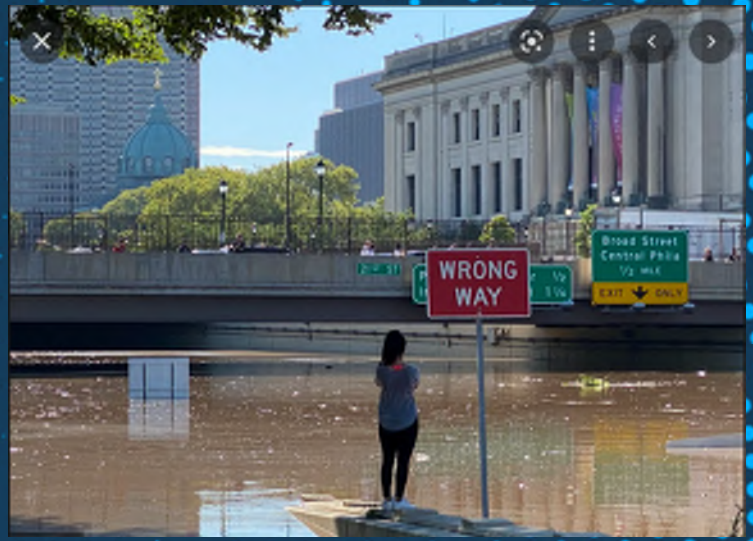
WHAT USED TO WORK MIGHT NOT ANYMORE?



CHANGES TO THE ENCLOSURE

FLOODING

Hurricane Ida – Philadelphia PA

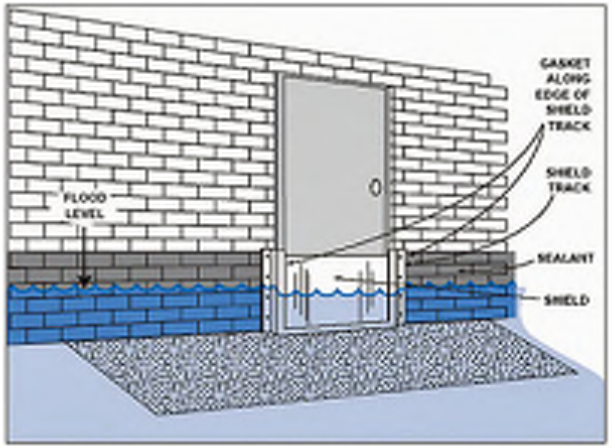


PRIMARY MEP EQUIPMENT

CRITICAL EQUIPMENT MOVED OUT OF BASEMENTS!

Or

Design for flood protection



Temporary Flood Shield Held in Place by Permanent Metal Track

Source: FEMA

SNOW DRIFTS AND LOUVERS

SNOW DRIFTS AND HVAC

WINDOW SILLS

Higher winds and more rain create even larger challenges for window installation

Especially at sills

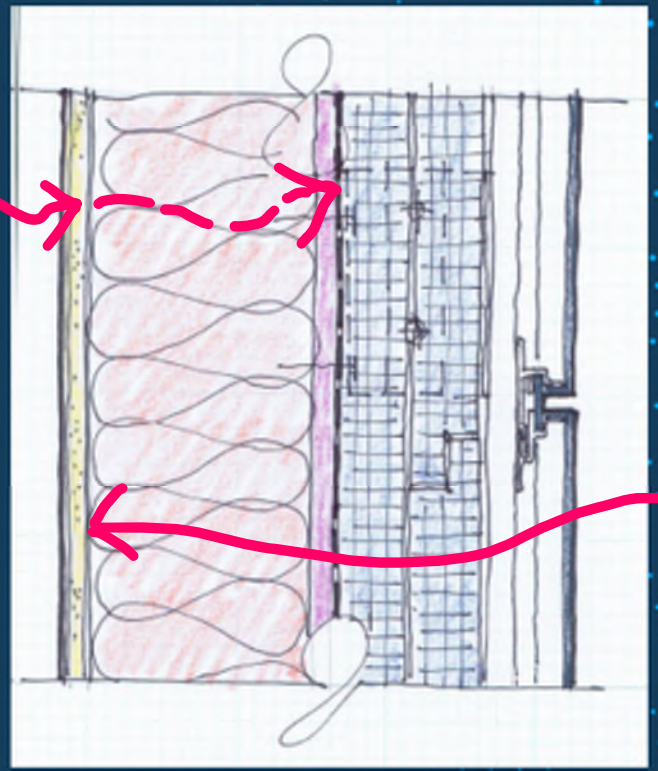
WINDOW SILLS

Water*proo*f sub-sills become more important

REVERSING VAPOR DRIVE

Longer and hotter summers and less cold winters changes the duration of reversing vapor drives

Winter int:
72 deg F
and 35%RH



Winter ext:
10 deg F
and 0% RH

Summer int:
74 deg F
and 40% RH

Summer Ext:
95 deg F and
80% RH

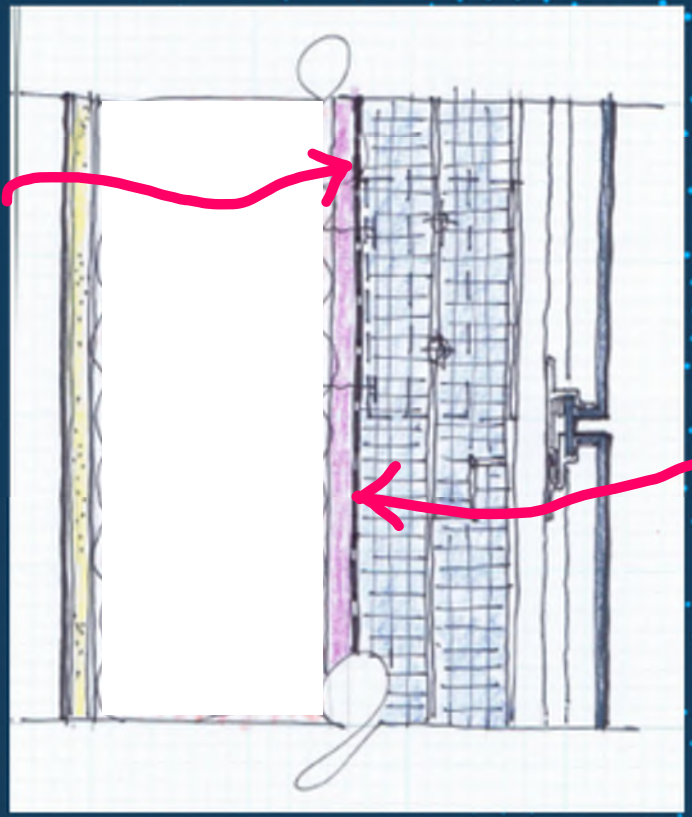
REVERSING VAPOR DRIVE

Eliminate the interior batt insulation

Make AB vapor impermeable

Winter int:
72 deg F
and 35%RH

Summer int:
74 deg F
and 40% RH



Winter ext:
10 deg F
and 0% RH

Summer Ext:
95 deg F and
80% RH

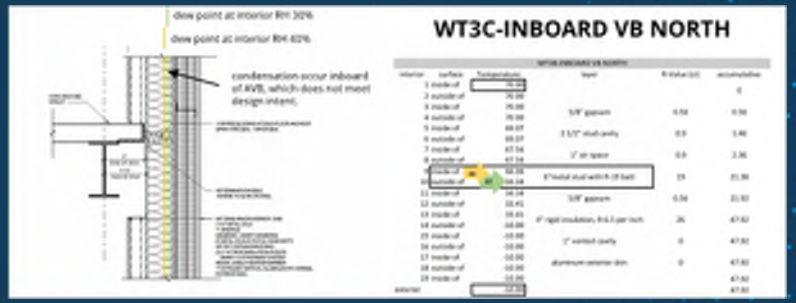
CONDENSATION ANALYSIS

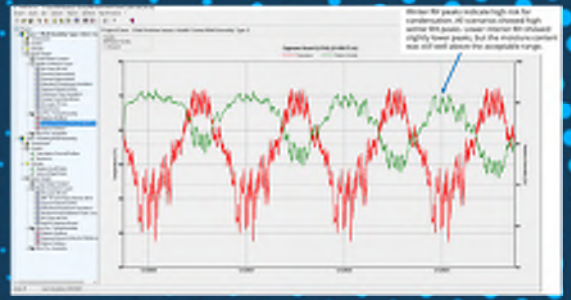
Calculated

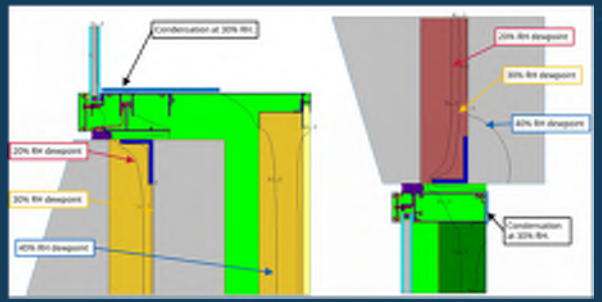
WUFI

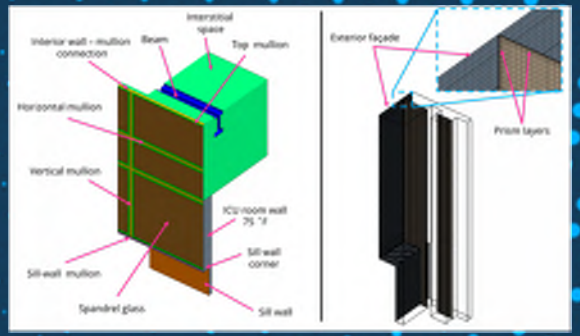
THERM

CFD



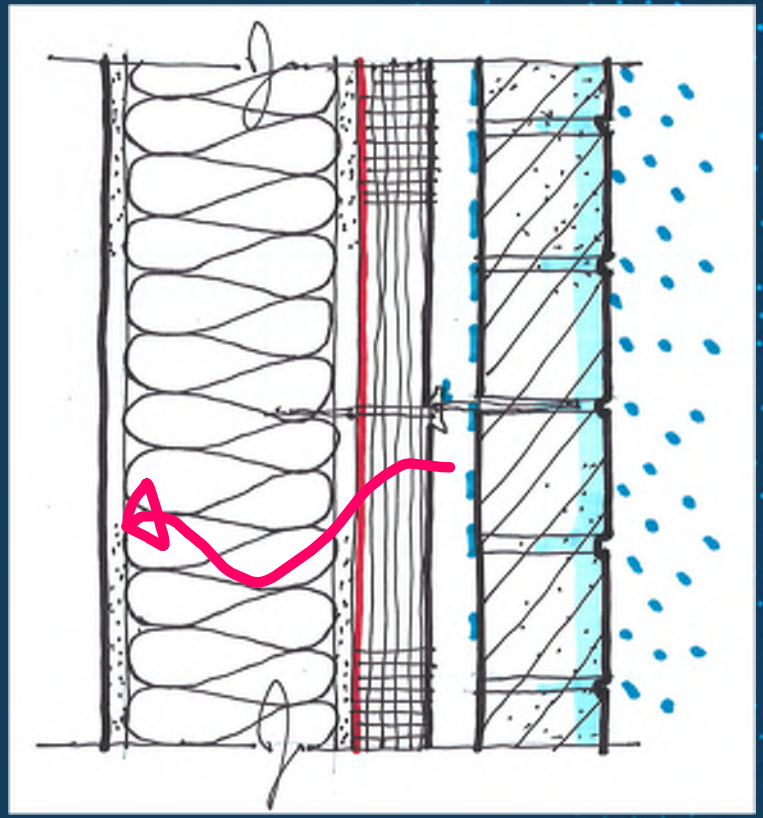






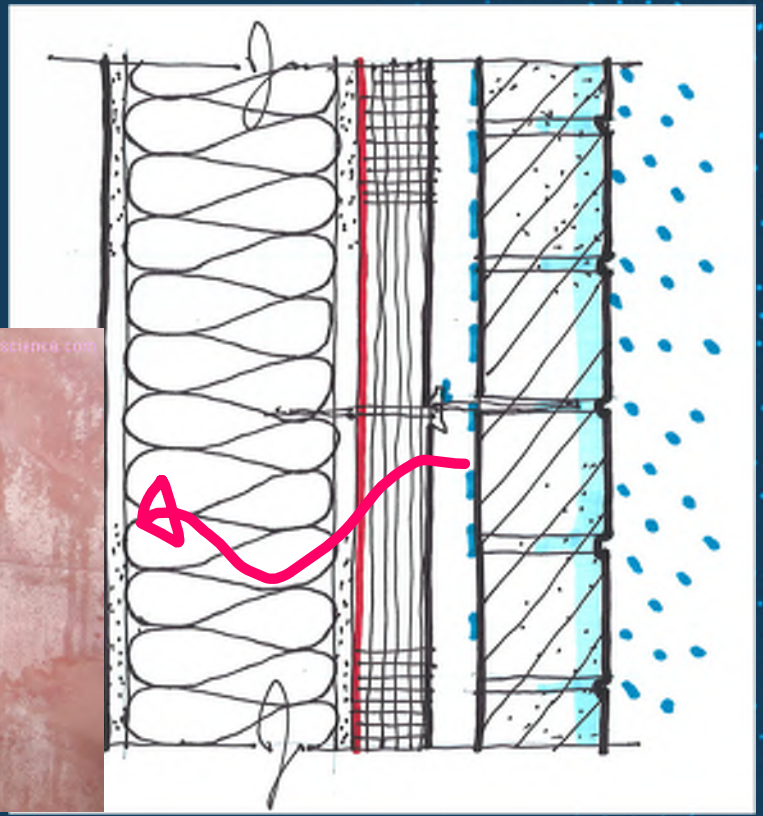
MASONRY RESERVOIR CLADDING

More rain followed by longer periods of higher temps creates prolonged inward vapor drives



MASONRY RESERVOIR CLADDING

Condensation on vapor barrier

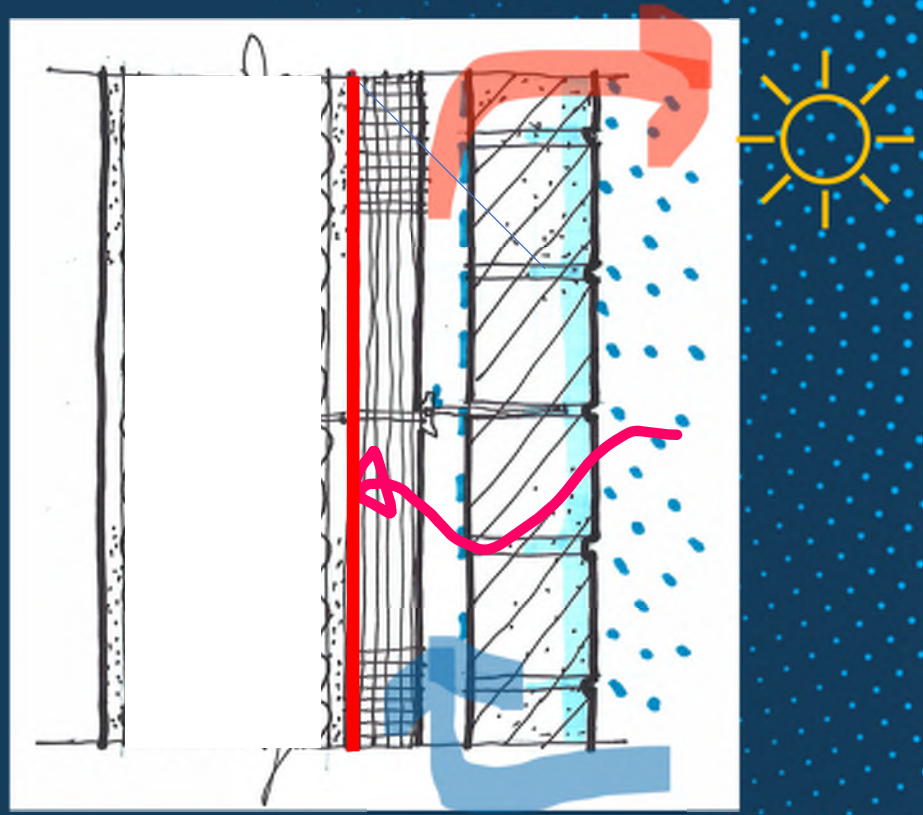


MASONRY RESERVOIR CLADDING

Change Air Barrier to vapor impermeable

Eliminate interior batt insulation.

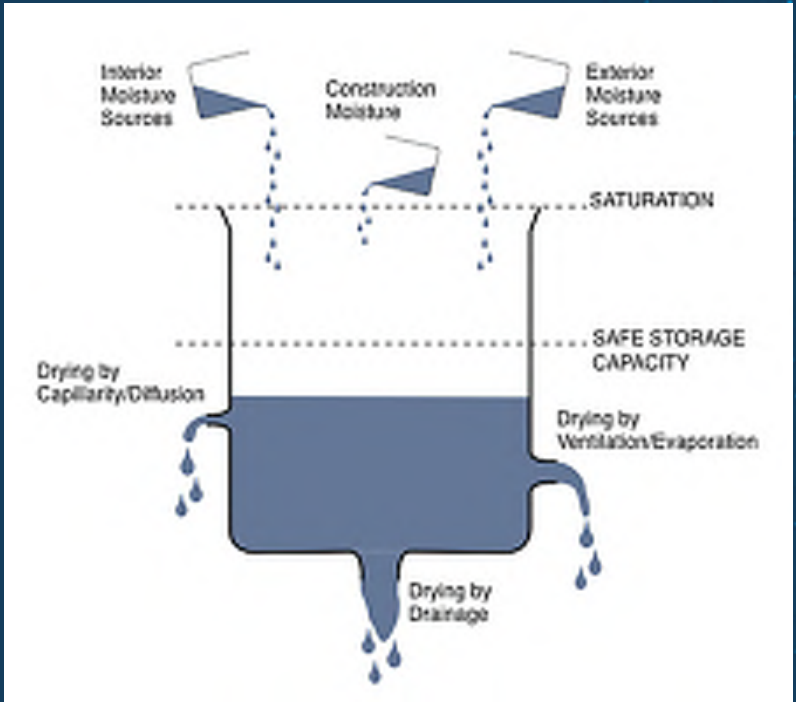
Ventilate cavity.

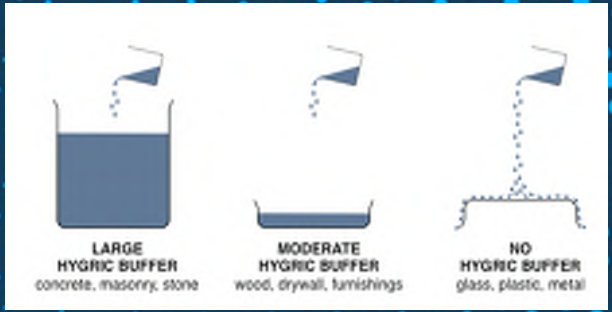


WETTING/DRYING CYCLES

All enclosure materials go thorough cycles

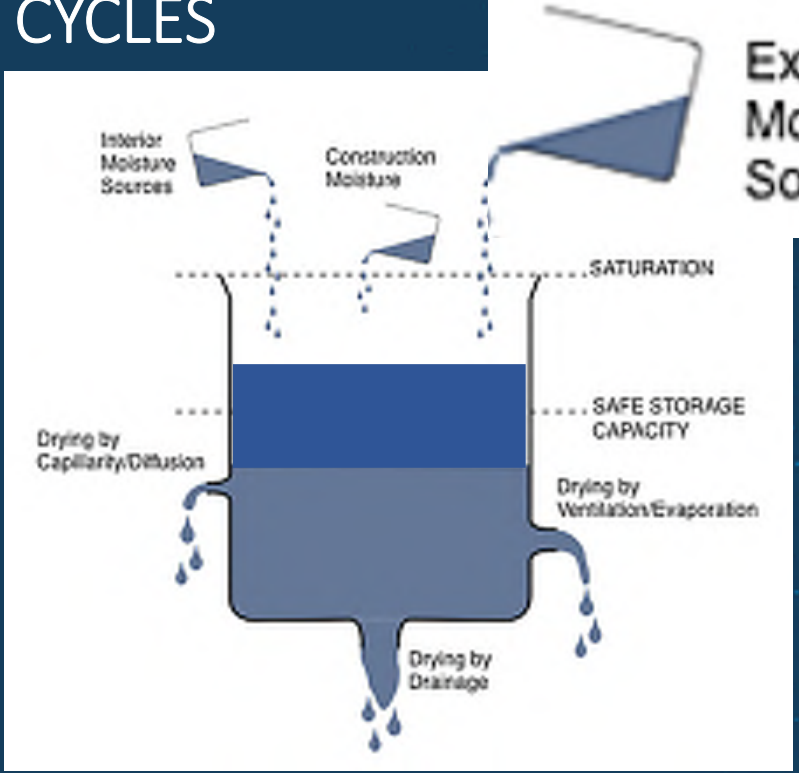
Materials have different hygric buffers





WETTING/ DRYING CYCLES

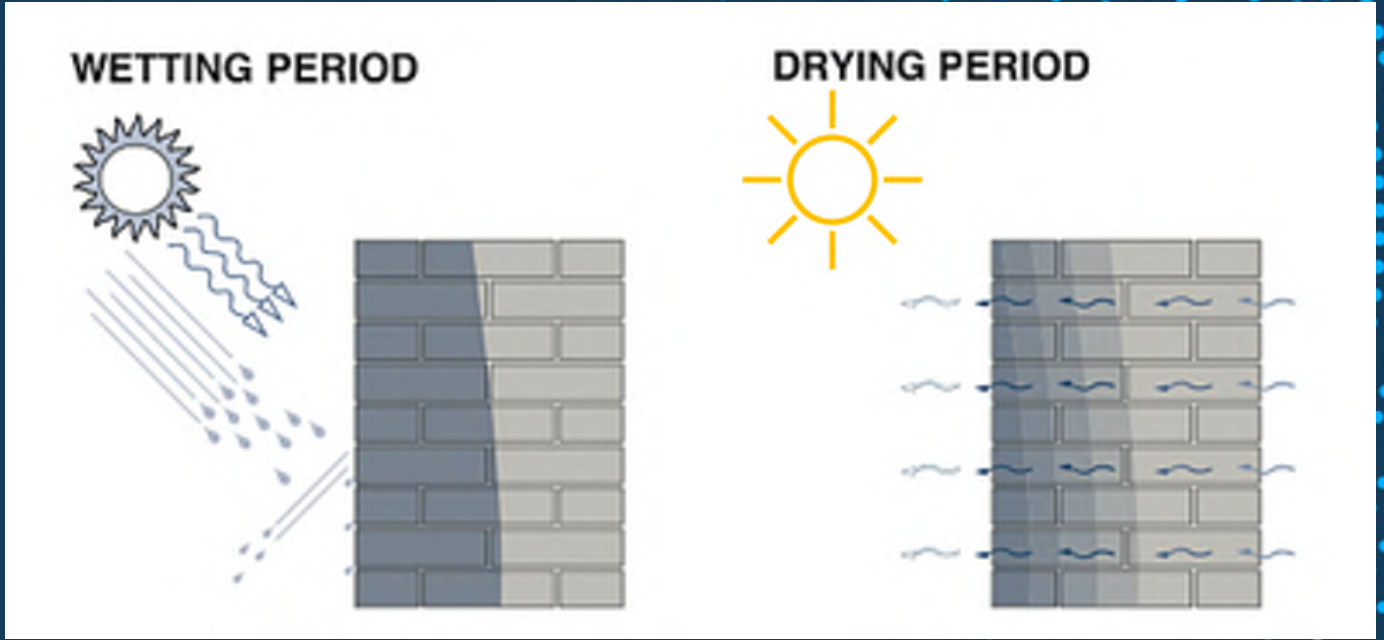
Increased exterior moisture may tip the balance past safe storage capacity



Exterior Moisture Sources

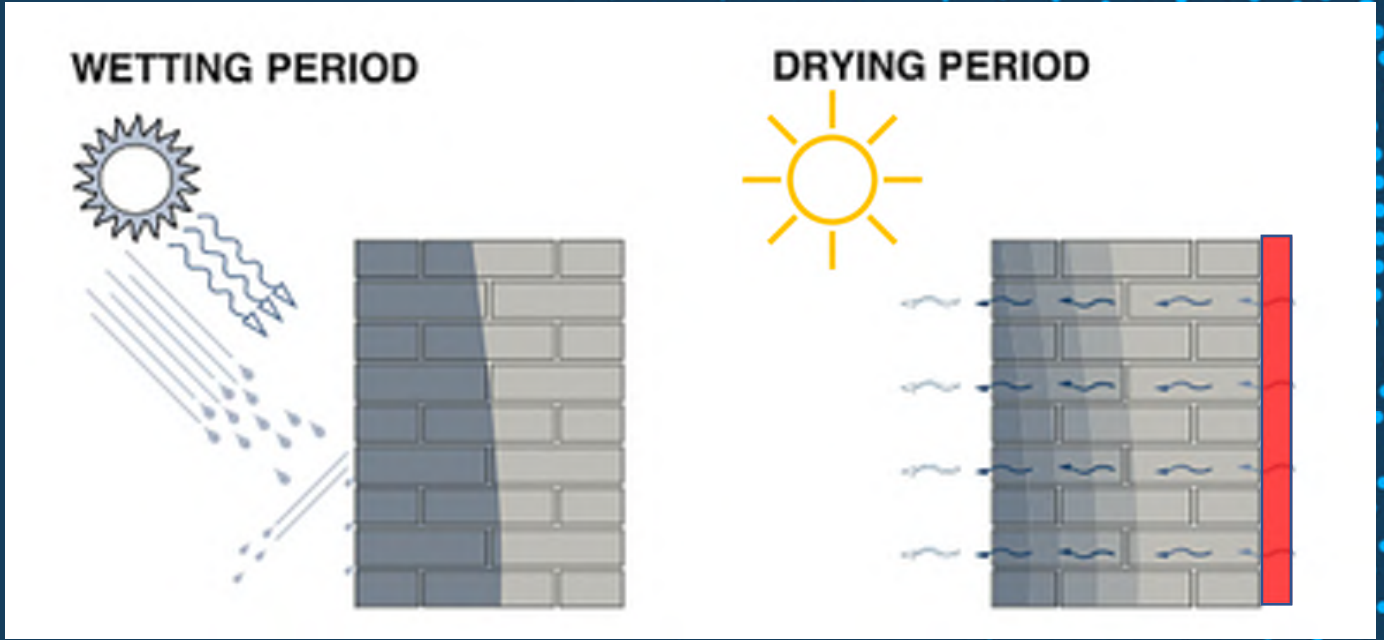
OLDER MASS MASONRY BLDGS

Longer wetting periods may force older buildings past the tipping point.



OLDER MASS MASONRY BLDGS

Adding air barrier and insulation further slows drying



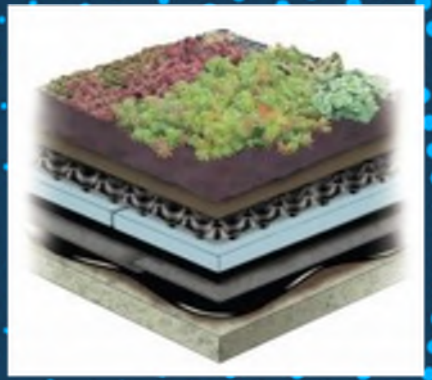
INCREASED RAINFALL – MORE ROOFTOP RETENTION

BLUE ROOFS
GREEN ROOFS

Typical roofing systems

ARE NOT

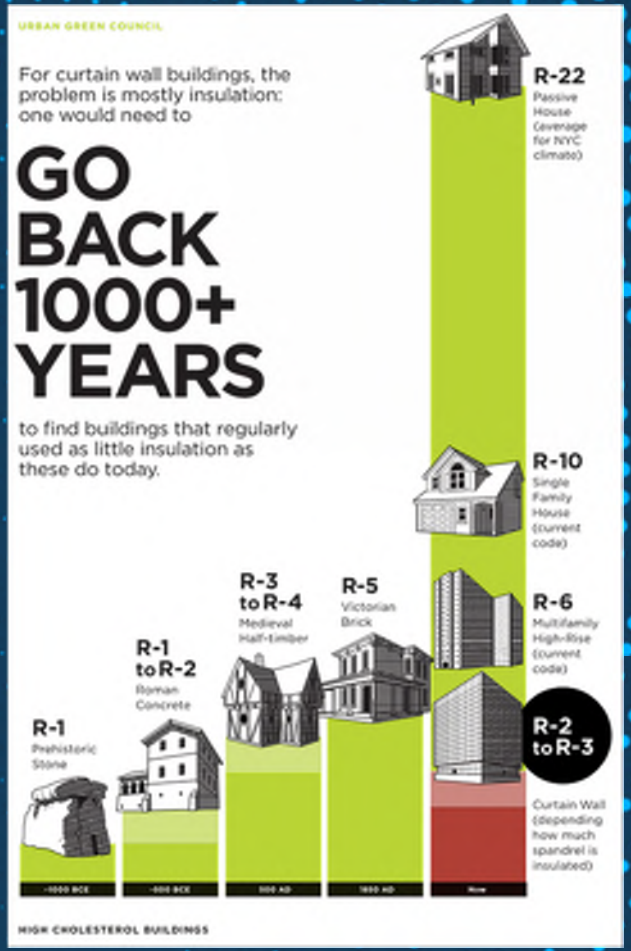
designed for standing water.



ENERGY REDUCTION in a CHANGING CLIMATE

BUILDINGS ENCLOSURE AND ENERGY

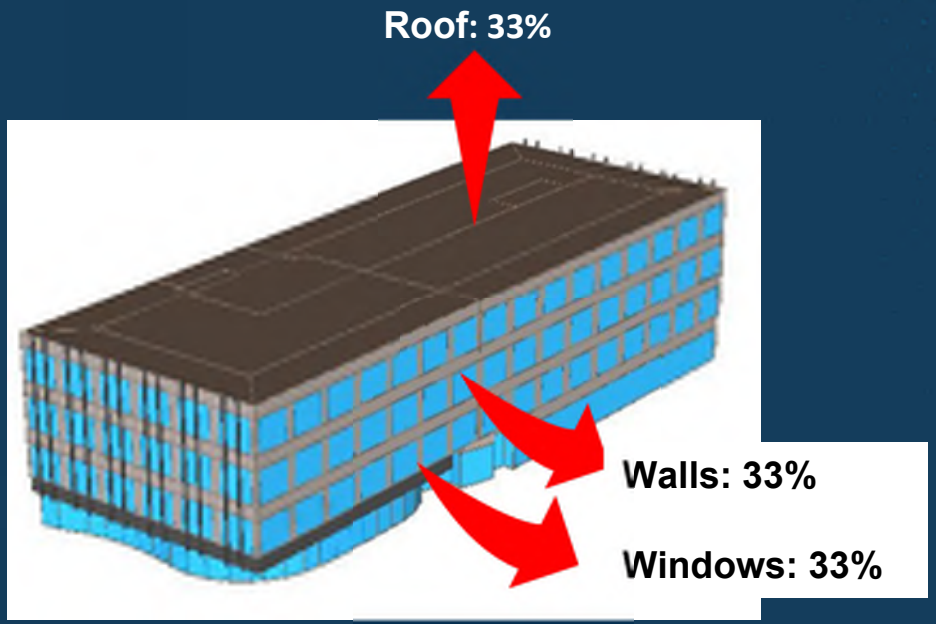
- Behind on performance goals
- Codes will get much stricter about energy.
- We should be doing better.
- Increased insulation affects the drying potential for assemblies.
- Tighter buildings require better control of ventilation



- Source: High Cholesterol Buildings, 2014 Urban Green Council, NY Chapter of the USGBC

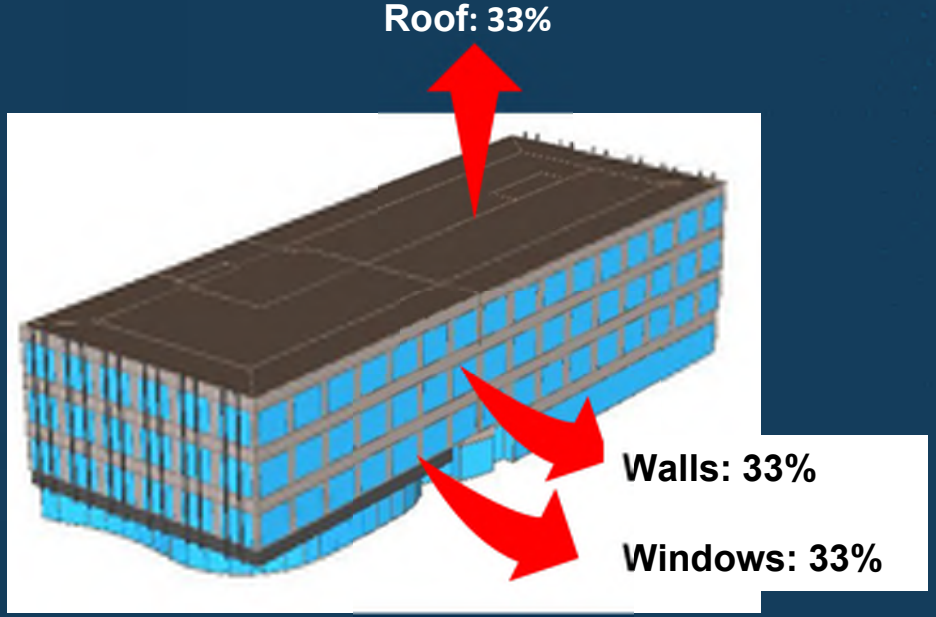
SOLAR HEAT GAIN INCREASES

SURFACE AREA

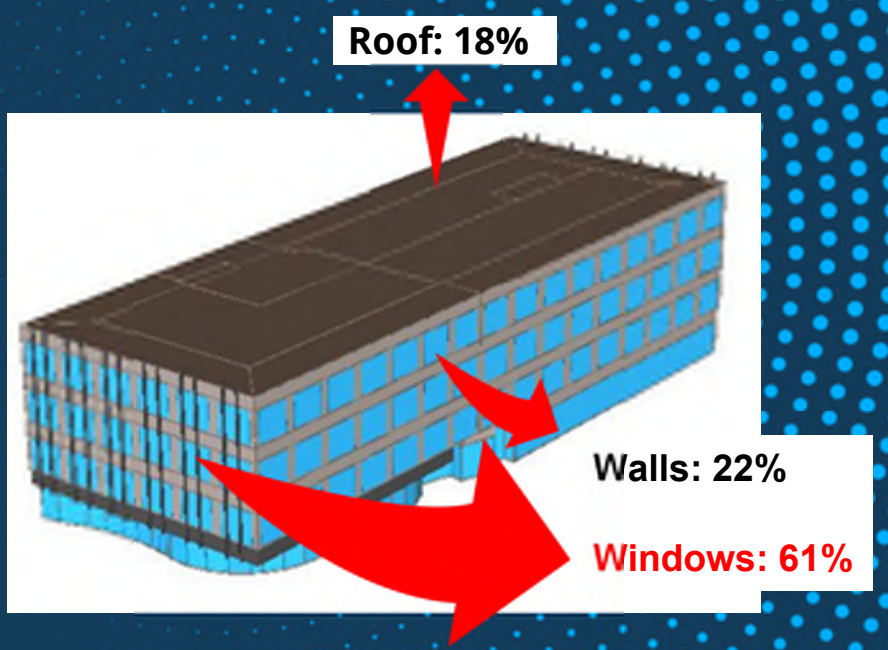


Case Study: 50% WWR

SURFACE AREA



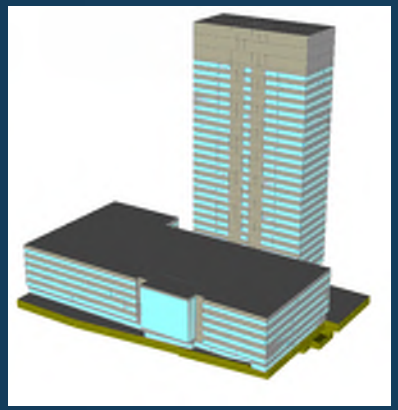
HEAT LOSS

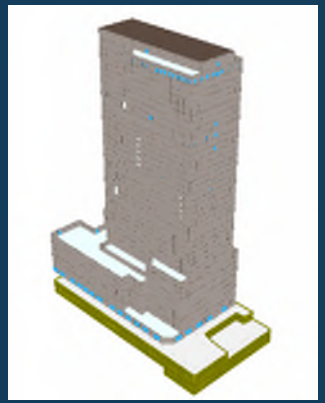


Types of Modeling

Comparative

Understand relative value of various options

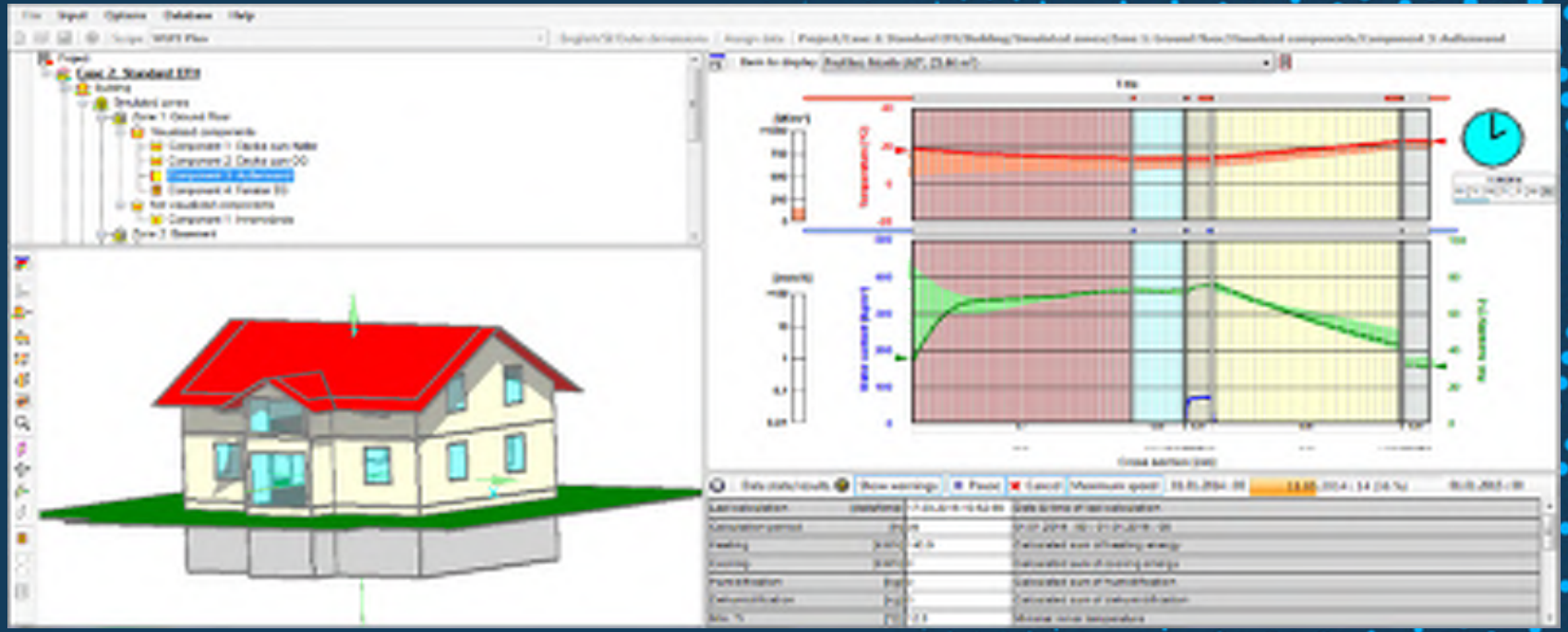




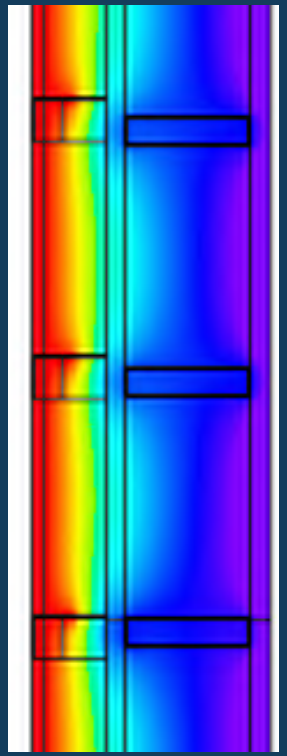
Predictive

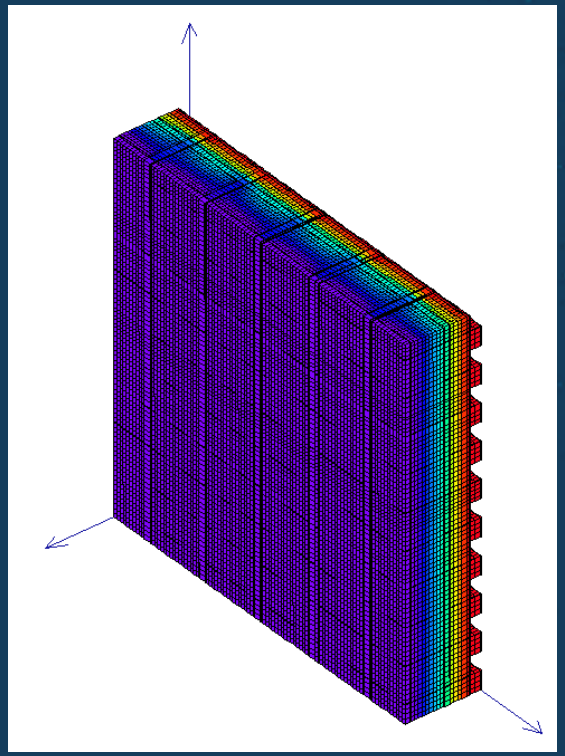
Establish expectations for actual consumption

Accurately Predicting Hygrothermal Performance



Accurately Predicting Thermal Performance





1D Series	U- 0.030
1D ASHRAE	U - 0.047
2D Modeled	U - 0.044
2D Zones	U – 0.053
3D Modeled	**U – 0.057**

RESILIENCY

RESILIENCY

Durability Environmental Impact Future Casting

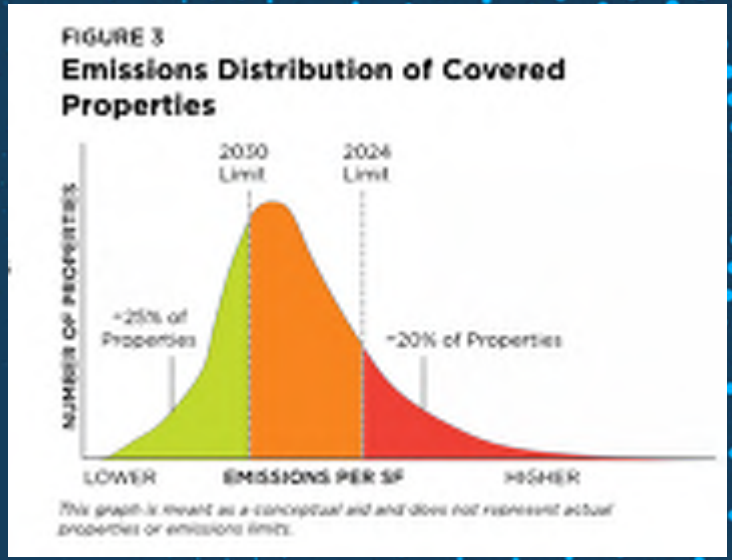
	Energy Use	Carbon Emissions Flexibility
	Catastrophic Event Function	Longevity of Occupancy Loss of Functionality
	Security Requirements and Risks	Ballistics Chemical Attack Internal Isolation
	Maintenance and Reliability	Embodied Carbon Disruption of Use

Carbon Emission Limits: NYC

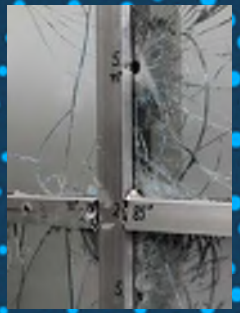
- The worst ~20% must do something by 2024
- By 2030, ~75% of buildings are affected

DESIGN FOR FUTURE CLIMATE, NOT CURRENT

	2024-29 (Kg Co2/sf)	2030-34 (Kg Co2/sf)
Occupancy Type H (Laboratories)	23.8	11.9
Occupancy Type B (Offices)	8.5	4.5
Occupancy Type E (Educational)	7.6	3.4
Occupancy Type S (Storage)	4.3	1.1



ROBUSTNESS

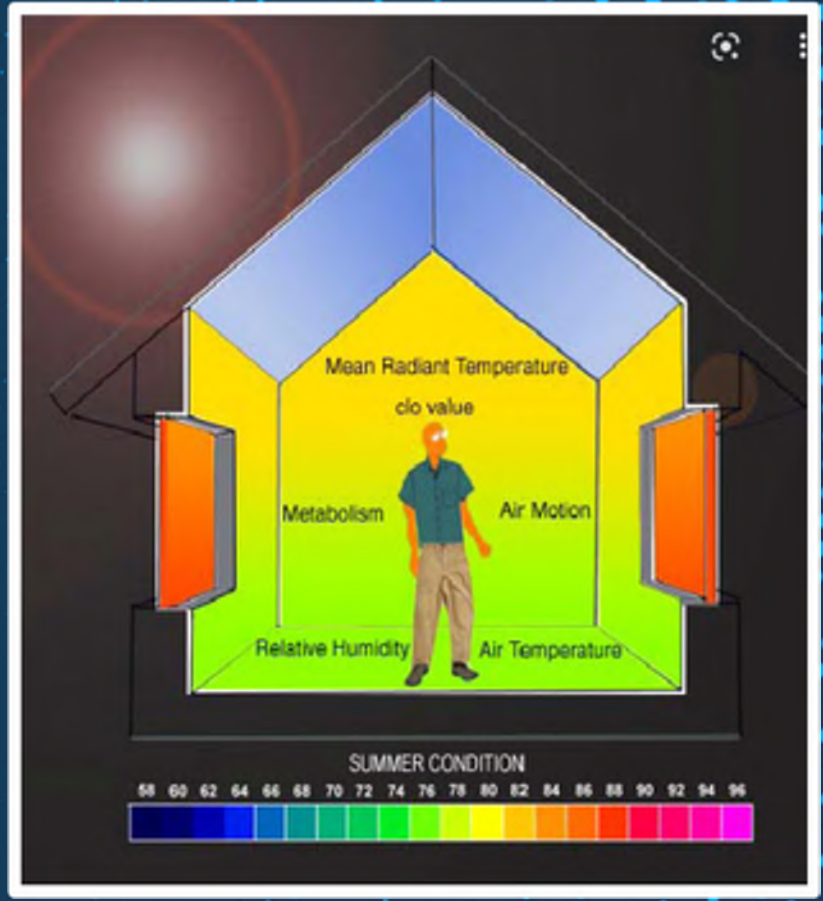


OCCUPANT COMFORT

Mechanical ventilation is preferred for better control of indoor environment

But

Operable windows are better for resiliency



AIR QUALITY

Double Trouble

Newer buildings are more and more airtight

Higher moisture and heat due to climate change

PASSIVE SURVIVABILITY

Highly insulated

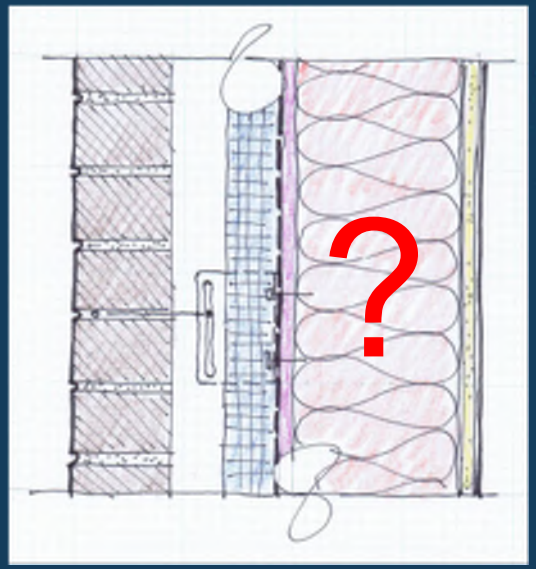
Natural Ventilation

Appropriate Glazing

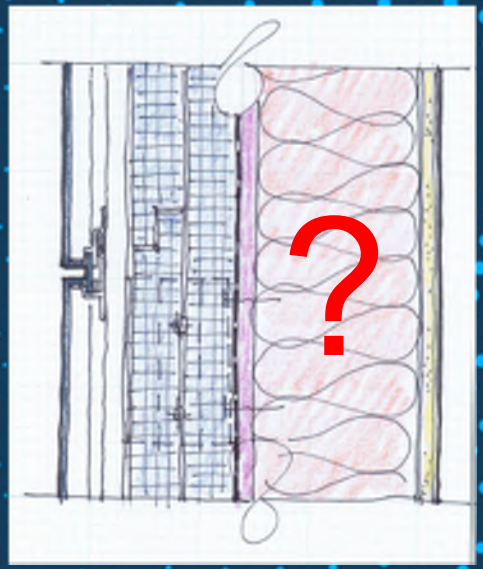
On-site Energy Generation

High Reliability

Drained Cavity Wall

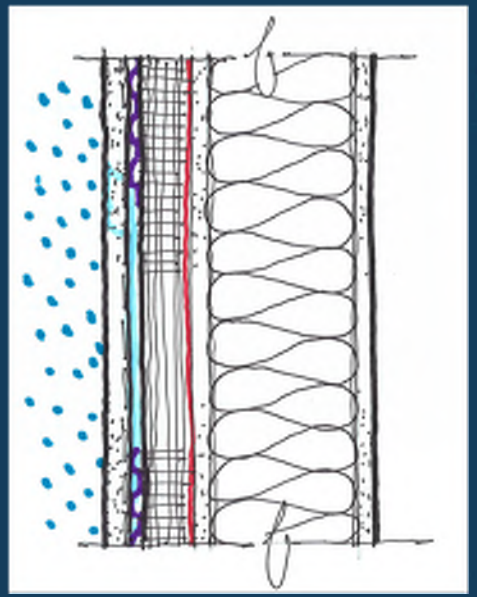


Rainscreens

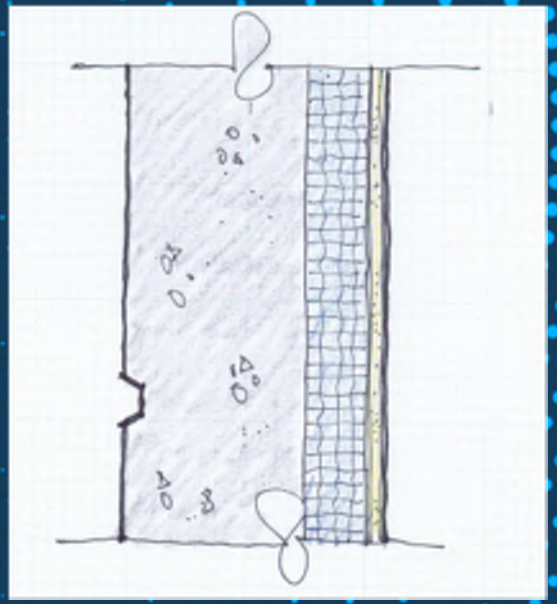


Reliability?

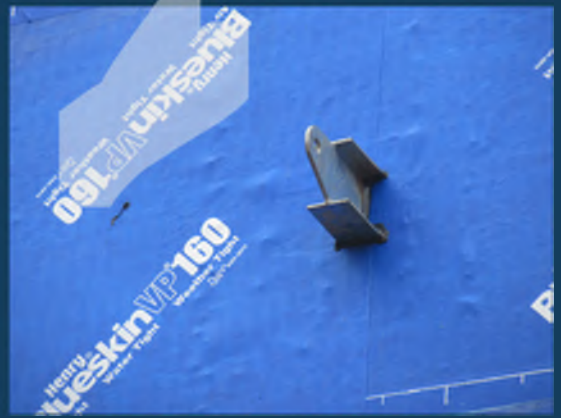
Drainage Plane Walls

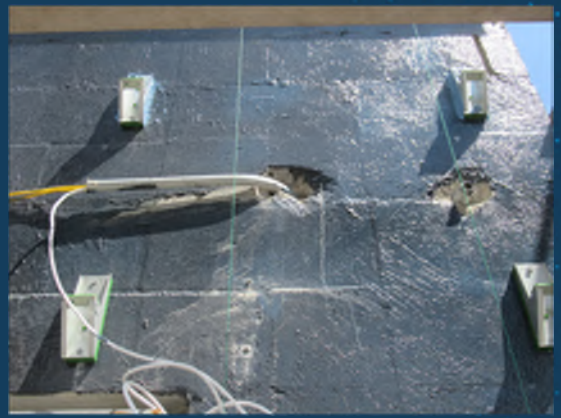


Mass walls



RELIABLE PENETRATIONS





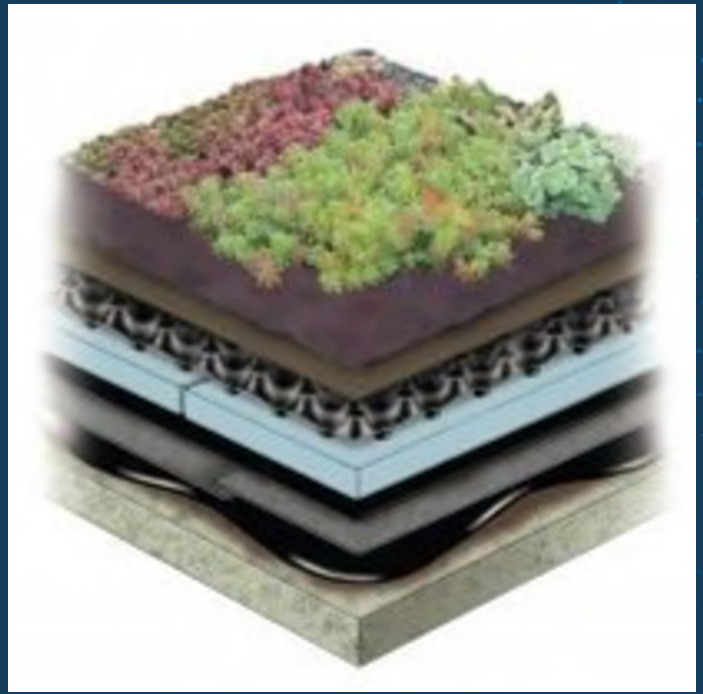
Reliable Roofs

Design for reliability, maintenance, and continuity

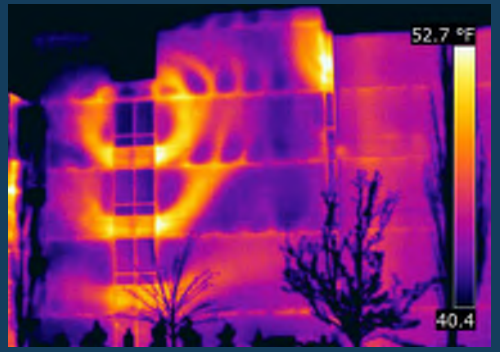
Recommend an IRMA assembly with highly reliable waterproofing membrane

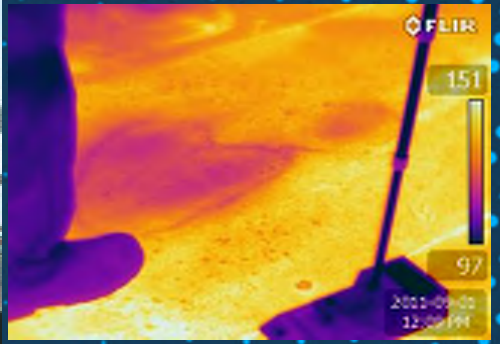
Evaluate higher wind uplift pressures

Evaluate Hail Risk



Validation and Testing





INTER-RELATIONSHIP

- Energy and passive survivability
- Heat/Air/Moisture control and air quality
- Air leakage control and Energy
- High quality daylighting and energy
- Durability and Robustness

QUESTIONS

David Altenhofen, AIA
Senior Technical Director
RWDI, Philadelphia

1 CHANGES TO THE ENCLOUSRE

2 ENERGY

3 RESILIENCY

DURABILITY

4 Q and A