Resilient Retrofits - DRAFT

Why We Need Passive to Get Aggressive

Presenters

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Existing Buildings – Enclosure Focus

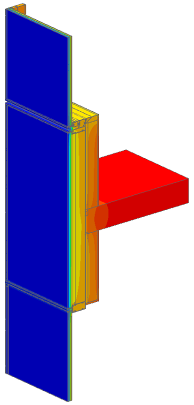
https://www.iea.org/reports

Renovating the existing building stock to a zero-carbon-ready level is a key priority for achieving the sector's decarbonization targets for 2030 and 2050. However, the retrofitting of buildings is a significant challenge since at least 40% of buildings floor area in developed economies was built before 1980, when the first thermal regulations came into force**. Retrofitting 20% of the existing building stock to a zero-carbon-ready level by 2030 is an ambitious but necessary milestone** toward the Net Zero Emissions by 2050 Scenario (NZE Scenario). To achieve this goal, an annual deep renovation rate of over 2% is needed from now to 2030 and beyond.

In buildings, energy is used for a wide array of applications, including heating, ventilation and air conditioning systems (HVAC), domestic hot water (DHW), lighting, household appliances, and electronics. Older, existing buildings are on average inefficient compared to newer buildings. While appliances can be replaced with ones that have greater energy efficiency due to their shorter lifespans, **the building envelope (walls, roof, and windows), as well as technical and mechanical equipment systems, are rarely upgraded since they are high-cost and done on an as-needed basis.** These components also have a longer shelf life at 40-plus years for building envelopes and 15-plus years for technical systems. Nonetheless, these are the building elements whose performance improvement can bring the most significant benefits in reducing CO_2 emissions, especially in regions with very cold or hot climates.

Finding the optimal cost-effective combinations of building envelope renovation solutions with high-efficiency technical systems using renewable and low-emissions energy sources is the main challenge and the focus of numerous research projects. **One of the most significant factors influencing the decision-making process is the initial investment required, which can be very high and often with long payback periods.**

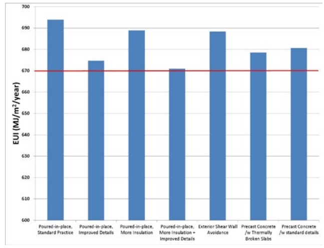
Prescriptive vs Project Specific



Performance

Whole Building Analysis

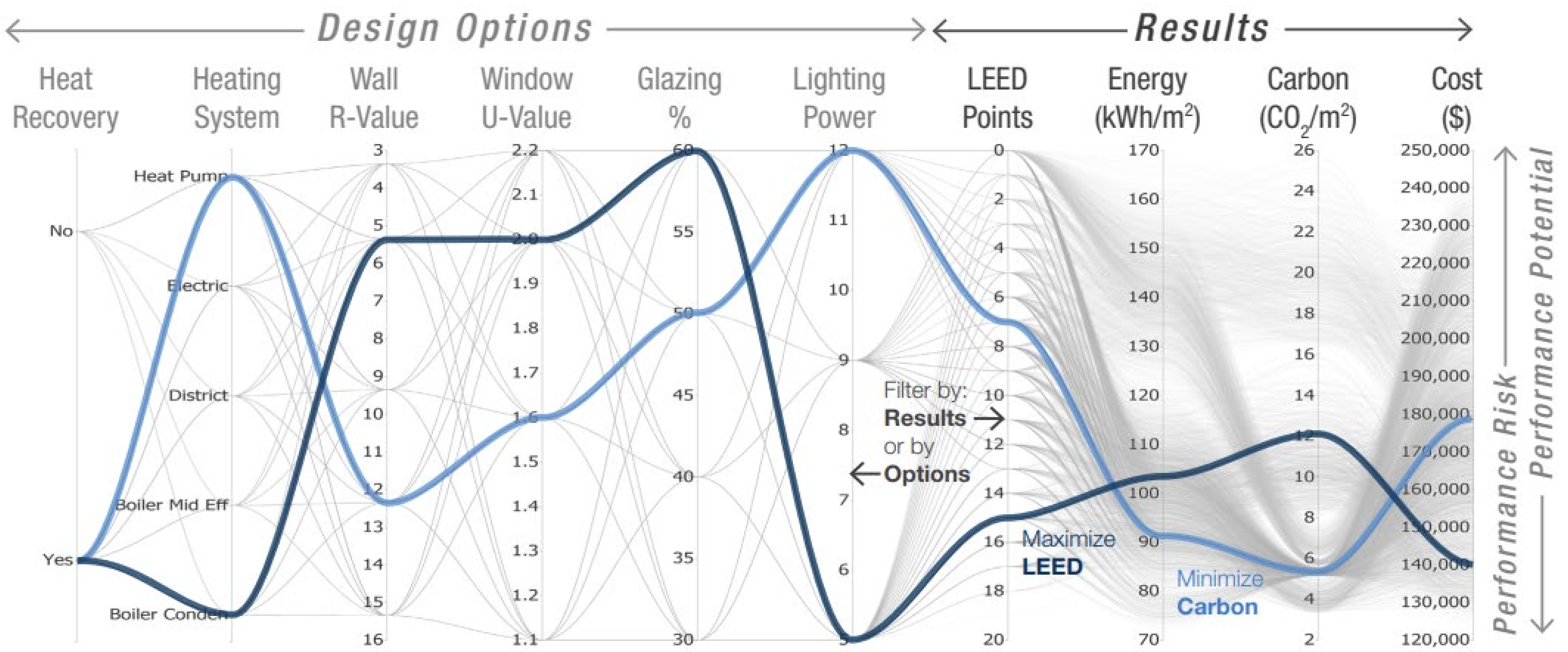
Costs



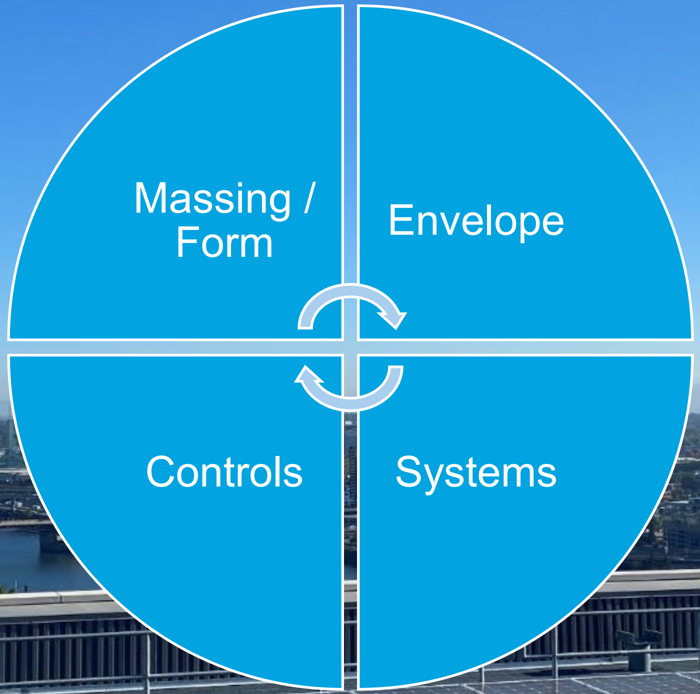
Cost-Benefit Analysis

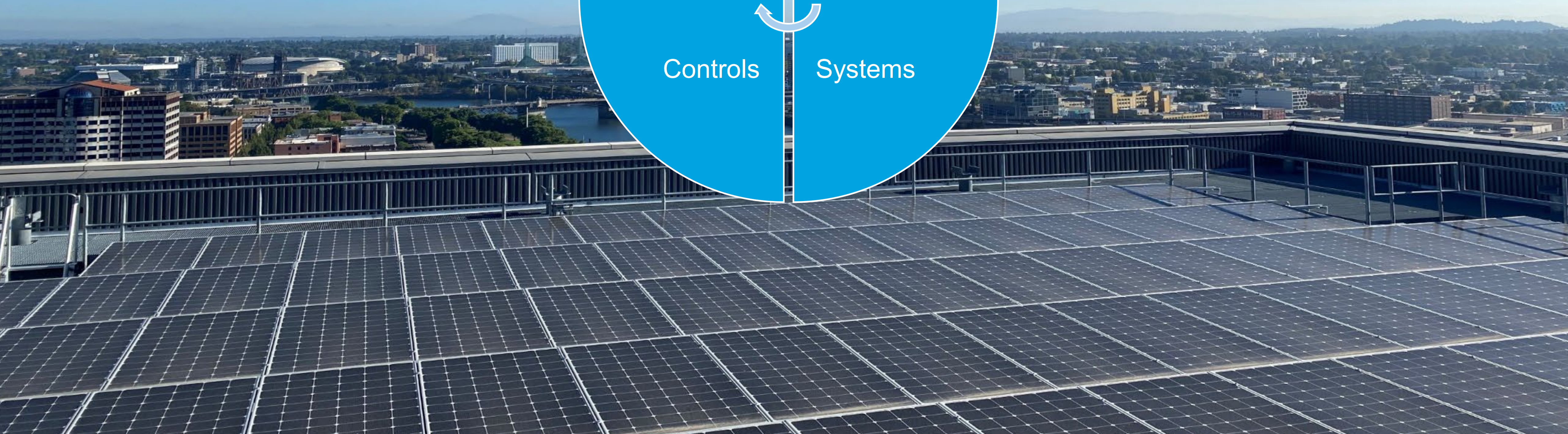
Maintenance

Project Specific Approach



New Construction





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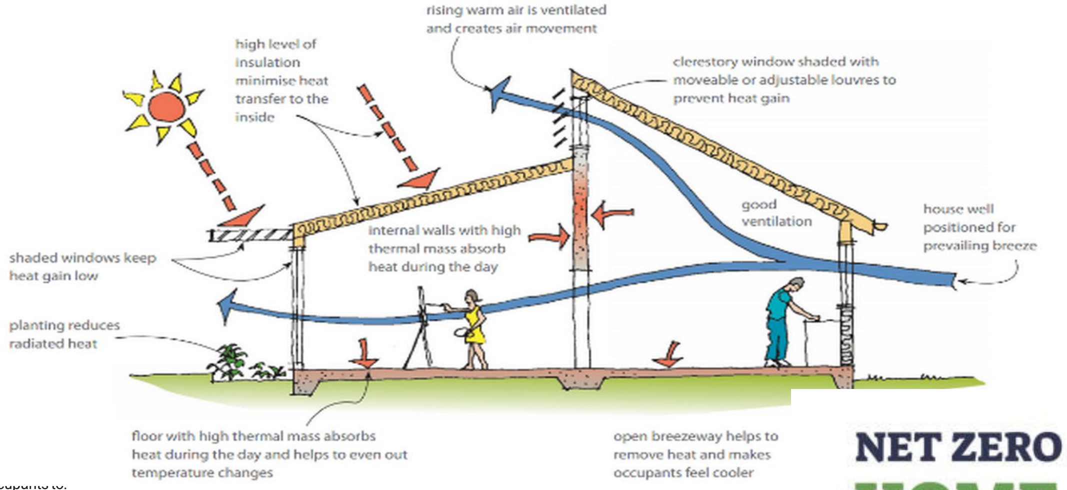
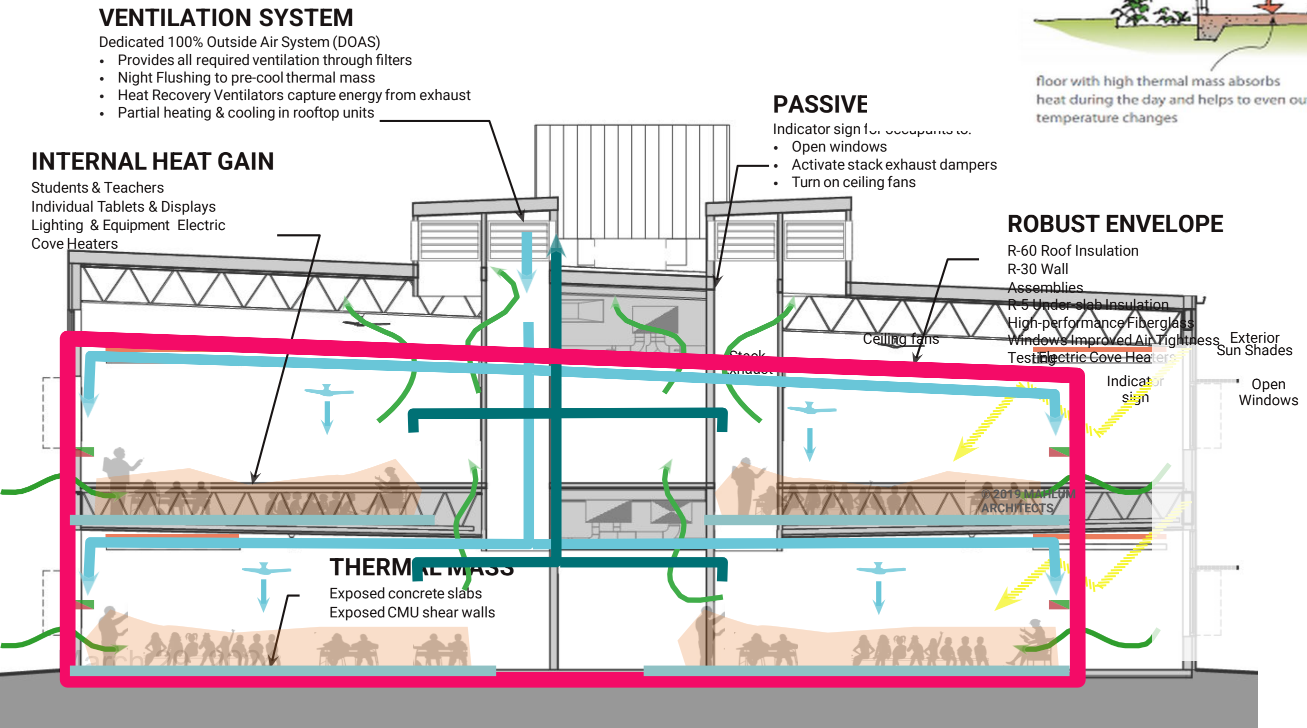
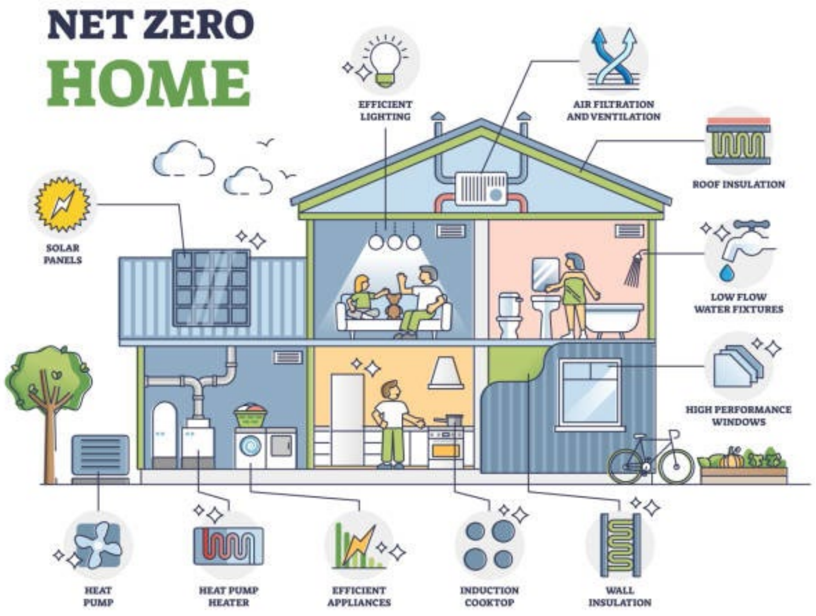






Existing Buildings

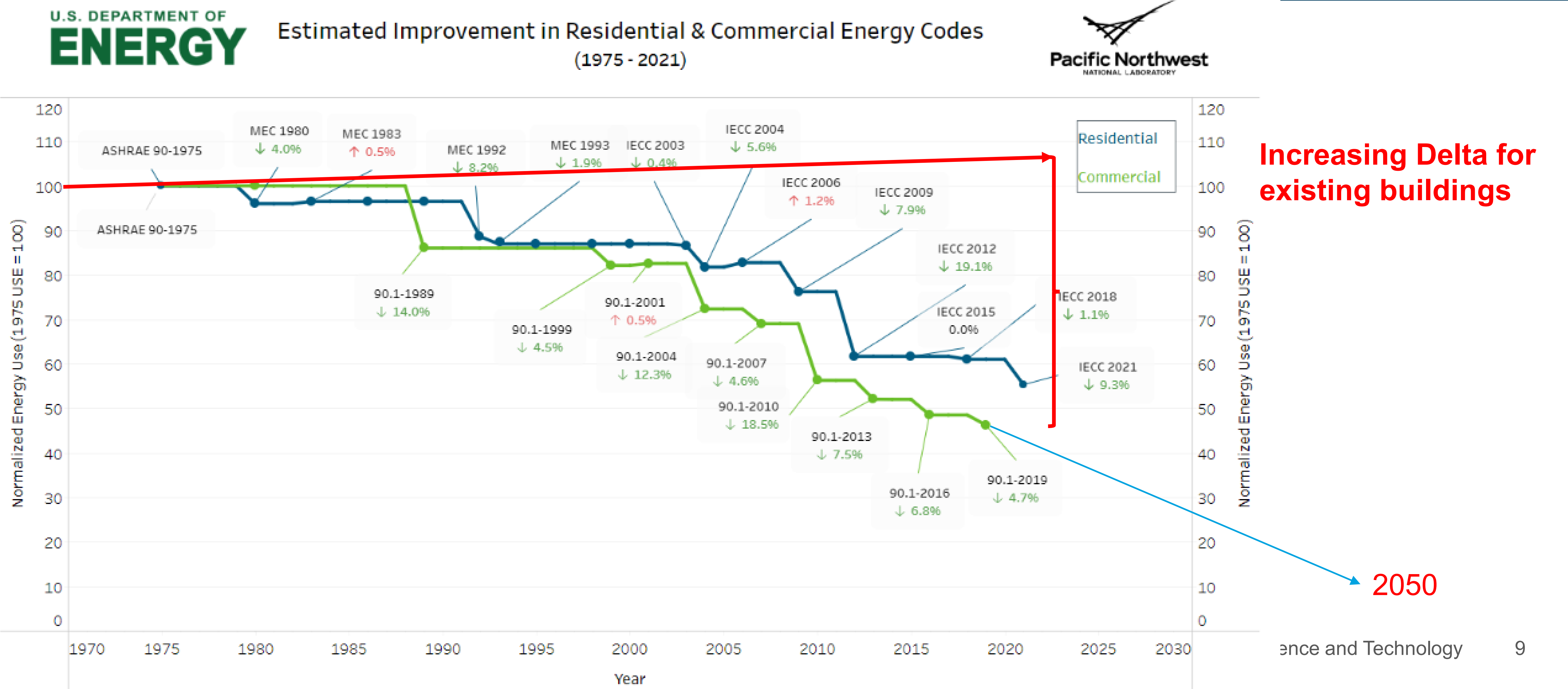
Performance will be based on project needs. What is the scope of the renovation?

The process is non-linear

Must be flexible and adaptable

Requires more integrative thinking. The potential of net zero / low energy is always there – the circumstances (scope/budget) will dictate the development of the overall project performance

Changing Code Requirements (for Existing Buildings)

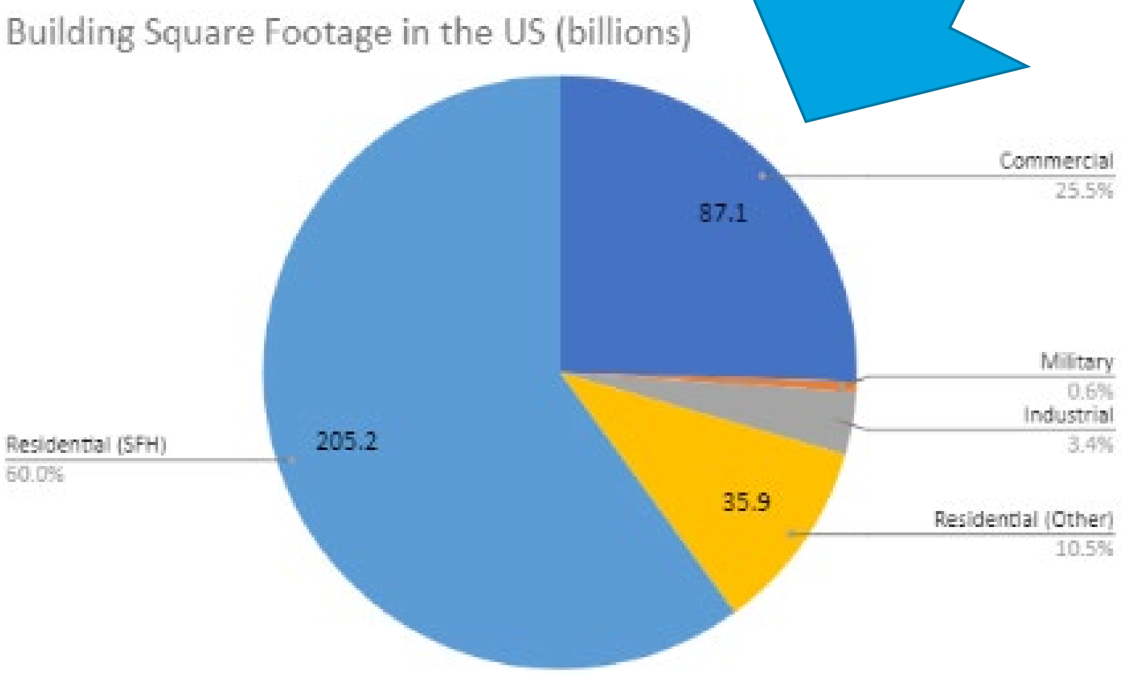


Changing Code Requirements

Context for Existing Buildings

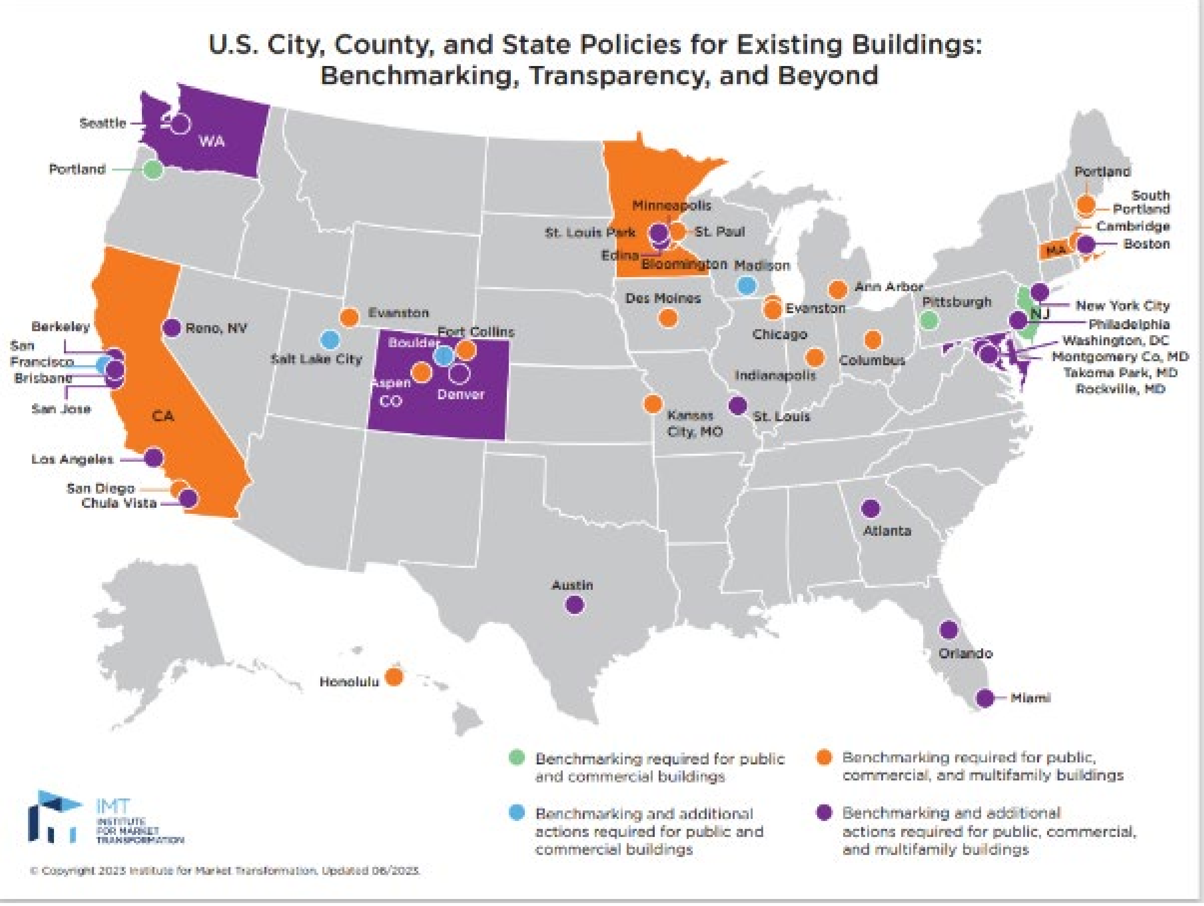
Number of Buildings (thousand)			
	2012 (2019 for AHS)	1979 (1989 AHS)	Growth rate
Commercial	5557	3995	1.01%
Industrial	345	243	1.07%
Residential (SFH+Mobile)	95641	70468	1.02%

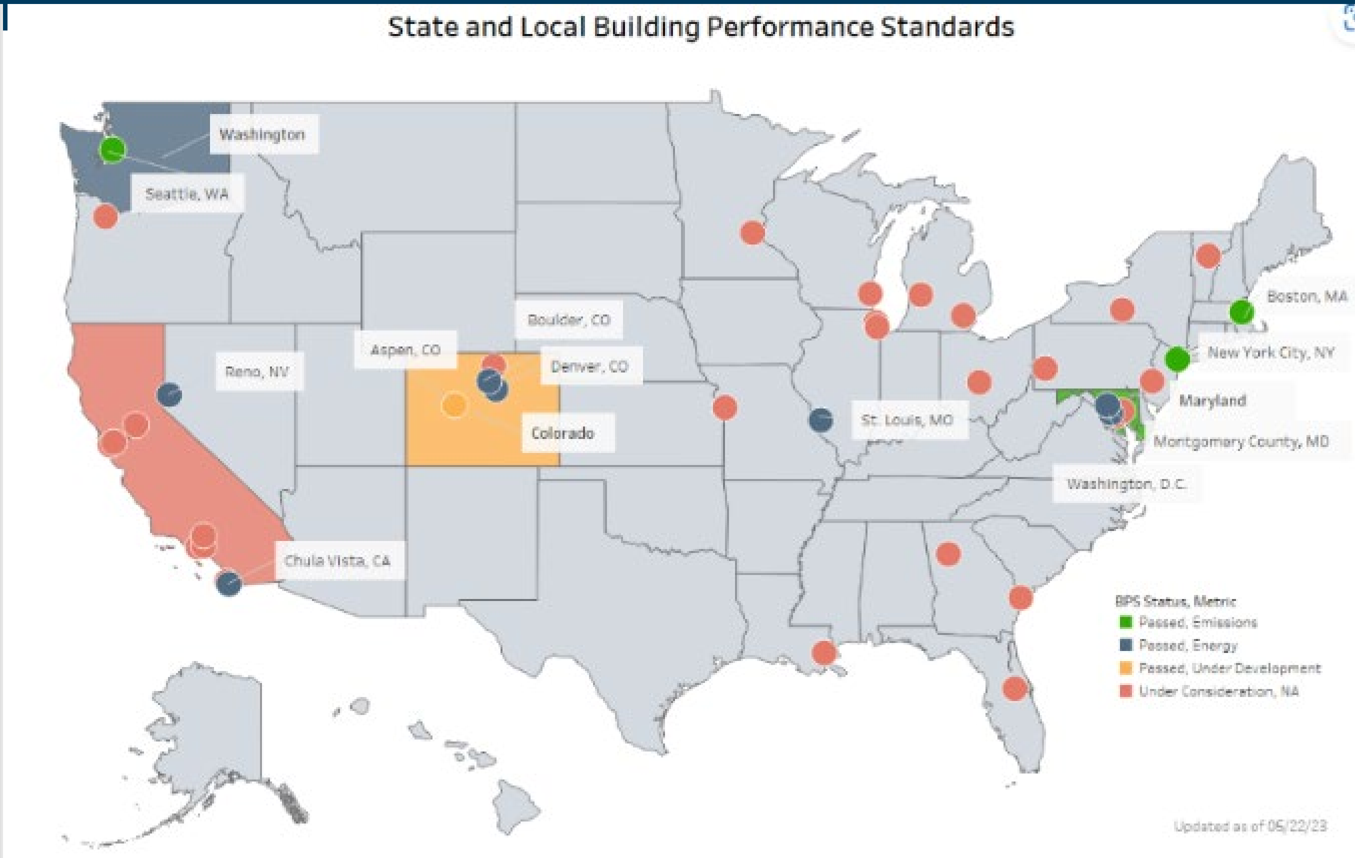
context



www.energycodes.gov/

U.S. Existing Building Benchmarking





DOE Building Performance Standard (BPS) for Existing Buildings

www.energycodes.gov/

LEED v5 (Existing Buildings- BETA Version)

Prerequisite: Assessment for Climate Resilience
Required

Intent
To promote comprehensive assessment for climate resilience, aiming to increase awareness of reduced vulnerability, while striving to ensure long-term safety and sustainability.

Requirements
Identify observed and projected natural hazards and assess relevant effects to the project site and building function. Identified hazards may be currently affecting the project or may affect it in the future. Qualifying hazards are site-specific natural hazards that include, but are not limited to:

- Sea Level Rise and Storm Surge
- Flooding
- Hurricane and High Winds
- Earthquakes and Tsunami
- Wildfire and Smoke
- Drought
- Landslides
- Extreme Heat
- Winter Storms
- Other (Specify)

The assessment shall demonstrate the relationships between the most impactful hazard(s) and the planning, operations, and maintenance of the project to potentially enhance the project's resilience to natural hazards and extreme environmental stressors, including acute and chronic changing climate conditions.

Building Envelope will play a key part of achieving project Resilience

LEED v5 (Existing Buildings

Path 2. Envelope and Ventilation Strategies.

Apply one or more of the following peak reduction strategies for a maximum of 2 points:

Strategy 1. Air tightness (1 point)

Perform leakage testing to demonstrate whole building infiltration meeting the criteria below. Buildings smaller than 25,000 ft^2 (2322 square meters) must use whole building air leakage testing.

A. **Low Measured Leakage Rates**

- For buildings smaller than 5,000 square feet (465 square meters):

  Demonstrate whole building infiltration less than or equal to three Air changes per hour (ACH) at 50 Pascal (0.2 in H20), as confirmed by an air leakage test.

- For buildings 5,000 square feet (465 square meters) or greater:

  Demonstrate through an air leakage test a measured air leakage of the building envelope less than or equal to 0.4 cfm/ft^2 (2,0 L/s·m^2) at 75 Pascal (0.3 in H20) (0.3 cfm/ft2 (1.6 L/s·m2) of building envelope area at a pressure difference of 50 Pascal (0.2 in H20))

OR

B. **Reduction of Measured Leakage Rates**

- Implement measures to reduce building envelope leakage.
  - For buildings with initial leakage greater than 2.0 cfm/ft^2 (10 L/s·m^2) at 75 Pa (1.5 cfm/ft^2 (7.6 L/s·m^2) at 50 Pa), reduce air leakage to less than or equal to 1.0 cfm/ft^2 (5 L/s·m^2) at 75 Pa (0.77 cfm/ft^2 (3,9 L/s·m^2) at 50 Pa).
  - For all other buildings, demonstrate at least a 50% reduction in the measured air leakage rate.

The same test conditions and air leakage testing standard must be applied for the current air leakage and the historical leakage testing (occurring no more than three years prior to project registration).

Strategy 3. Envelope Thermal Conductance (1 point)

A. **Low thermal conductance**
Demonstrate that the total building envelope UA (the sum of U-factor times assembly area) is no more than 125% of the total building envelope UA meeting the ASHRAE 90.1-2019 prescriptive building envelope criteria.

B. **Improvement in thermal conductance**
Implement measures to improve the total building envelope UA.

- Demonstrate a minimum 30% improvement in total building envelope UA for the current building design versus historical total building envelope UA (no more than three years prior to project registration), AND
- Demonstrate that the total building envelope UA is no more than 200% of the conductance of a total building envelope UA meeting the ASHRAE 90.1- 2019 prescriptive building envelope criteria.

ASHRAE 227P (for new and existing buildings)

Standard provides requirements for the design of buildings that have exceptionally low energy usage and that are durable, resilient, comfortable and healthy.

Provides requirements for the building envelope

- Reduced thermal bridging
- Increased air tightness
- Moisture risk

PHIUS – REVIVE Retrofit Standard for Buildings

Therefore, building enclosure improvements and equipment efficiency improvements are designed such that the building can function using locally-generated renewable energy. This is true in both normal operation, maintaining comfortable conditions, and for some degree of reduced function but still habitable conditions during utility outages, summer or winter. The outage-resilience consideration is a key factor determining the design of the envelope improvements. We also view it as a characteristic that every building should have, as a matter of fairness or equity.

6.1.4 Accounting for thermal bridges

Account for thermal bridges in accordance with ASHRAE Standard 227P - *Passive Building Design, Advisory Public Review Draft*, sections 5.2.2 through 5.2.5.
Exceptions:

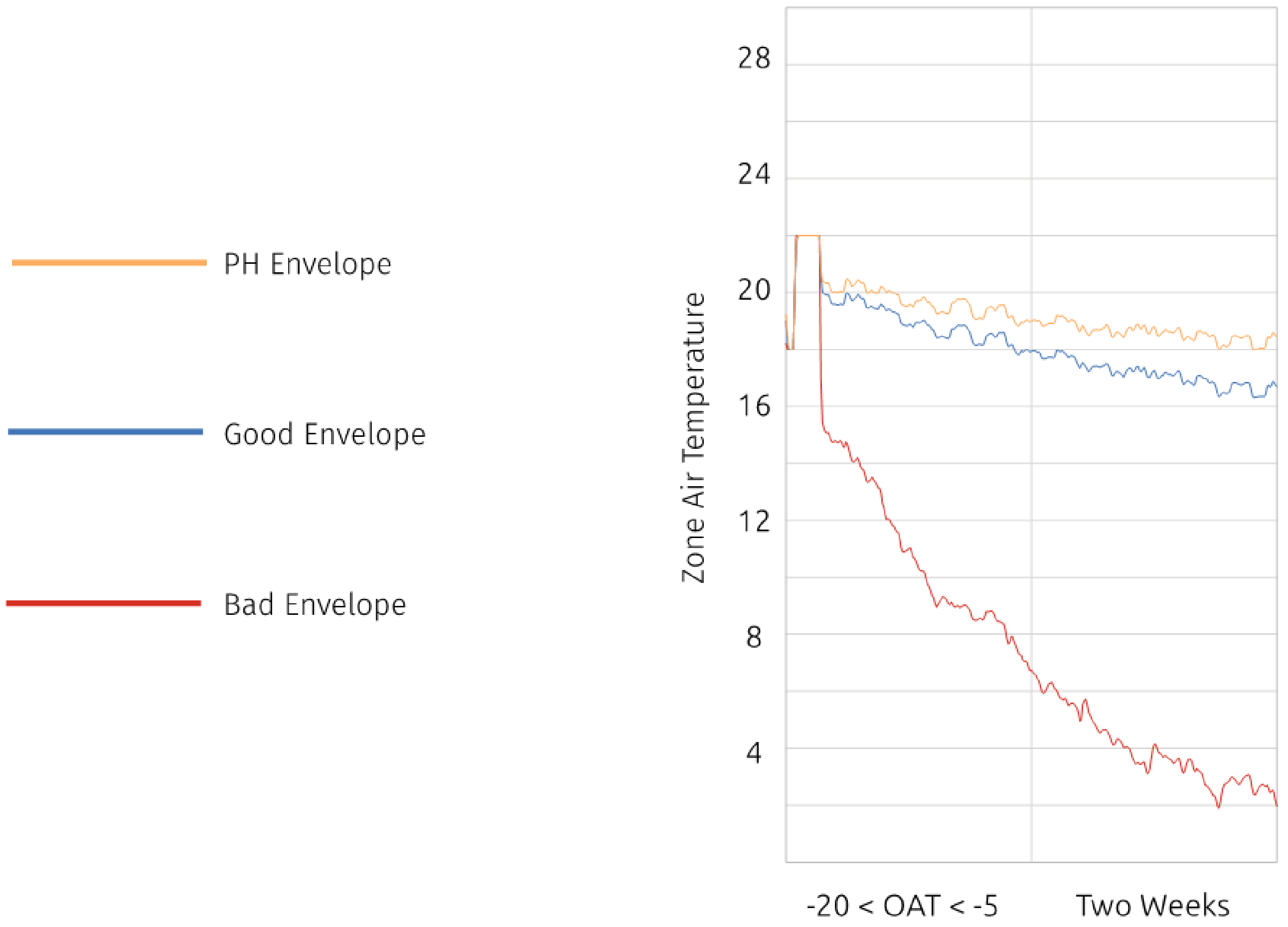
- Skinny assemblies may be used to represent weakly-insulated sills and top plates.
- Point thermal bridges may be represented by a small area of weakly-insulated assembly.

- *To account for linear thermal bridges in EnergyPlus, an object could be created for psi-value-based linear thermal bridging. This can be accounted for by using an EnergyManagementSystem:Program to calculate a conduction heat transfer based on the temperature delta, and applying that gain or loss to an OtherEquiptment object.*
- *To account for window installation thermal bridges in EnergyPlus, a WindowProperty:FrameAndDivider object could be used.*

Improvements lead to Resilience

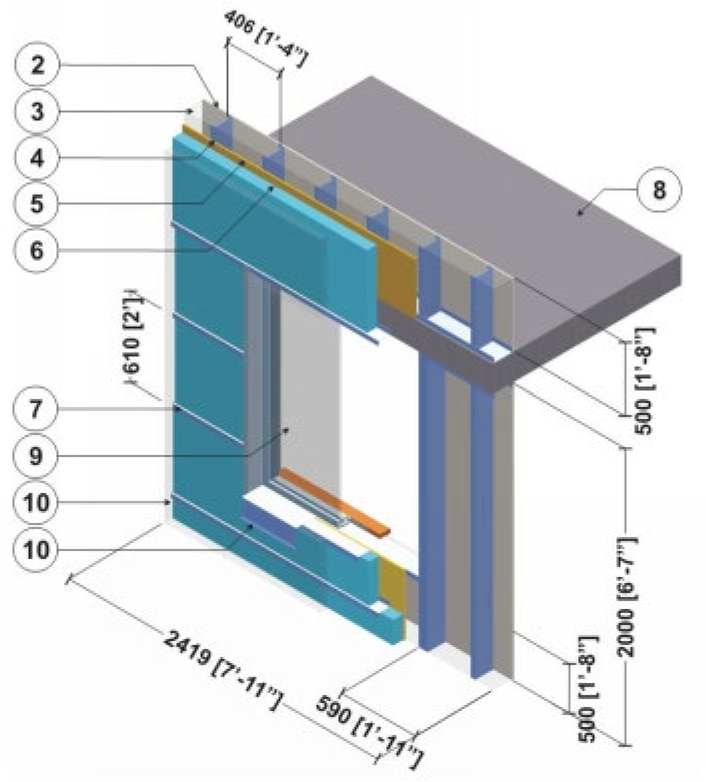
Standard	Leakage Rate
2018 IECC Maximum Air Leakage	0.40 cfm/ft2
State of Utah High Performance Building Standard	0.10 cfm/ft2
US Army Corps of Engineers	0.25 cfm/ft2
ASHRAE - Leaky	0.60 cfm/ft2
ASHRAE - Average	0.30 cfm/ft2
ASHRAE - Tight	0.10 cfm/ft2

Test	Envelope Area (ft^2)	Air Leakage (cfm/ ft^2 @75Pa)
Depressurization	**52,684 ft^2**	**0.214**
Pressurization	**52,684 ft^2**	**0.235**
Combined, Average	**52,684 ft^2**	**0.224**



Improving the Details

Transmittance Type	Exterior Insulated Steel Stud	
	Heat Loss (BTU/hr °F)	% of Total
Clear Wall	98	67 %
Slab	24	17 %
Parapet	4	3 %
Window transition	19	13 %
Total	**145**	**100 %**



Thank You