Tracy Steward & Mark K. Lee AIA

CREATING HUMAN COMFORT BY DEMYSTIFYING HIGH-PERFORMANCE BUILDING DESIGN

Learning Objectives

1. **Value of early coordination** between architect and HVAC engineers to acheive human comfort.
2. **Importance of a robust air barrier** to control costs and acheive and exceed energy conservation goals.
3. **Create a healthy environment** with high quality indoor air.
4. **HVAC design and facade are interactive**, acting as a holistic environmental control system.

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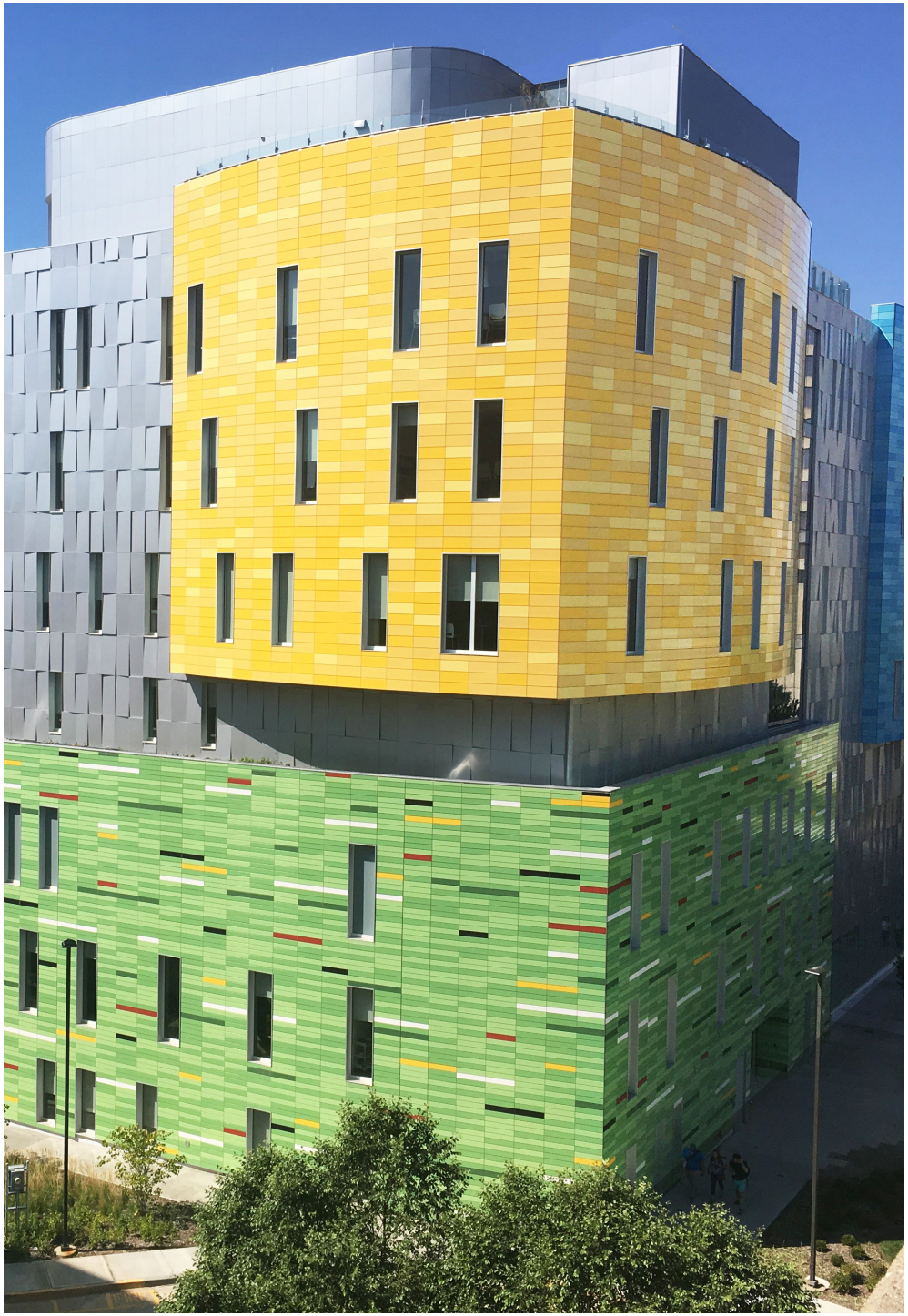
Agenda

1. Introduction
2. Criteria
3. Design Strategies
4. Questions



Introduction

Novack Center for Children's Health, *Louisville, Kentucky, USA*

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Introduction

Introduction

1. Urban site at Health Science Center Campus
2. Opened July 2018
3. First new healthcare facility constructed in the Louisville Medical Center in nearly a decade
4. 140,000 SF
   (includes 140-ft pedestrian bridge)
5. Construction cost: $56.3M ($320/SF)
6. Home to general, specialty and subspecialty pediatric practices at University of Louisville
7. 500 staff, residents and students will utilize facility
8. 120,000 patient visits annually

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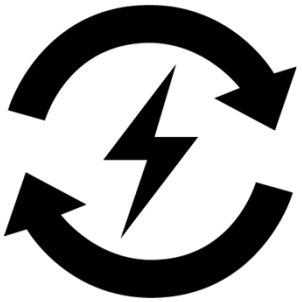
Criteria

HUMAN EXPERIENCE



ENERGY CONSERVATION

DURABILITY

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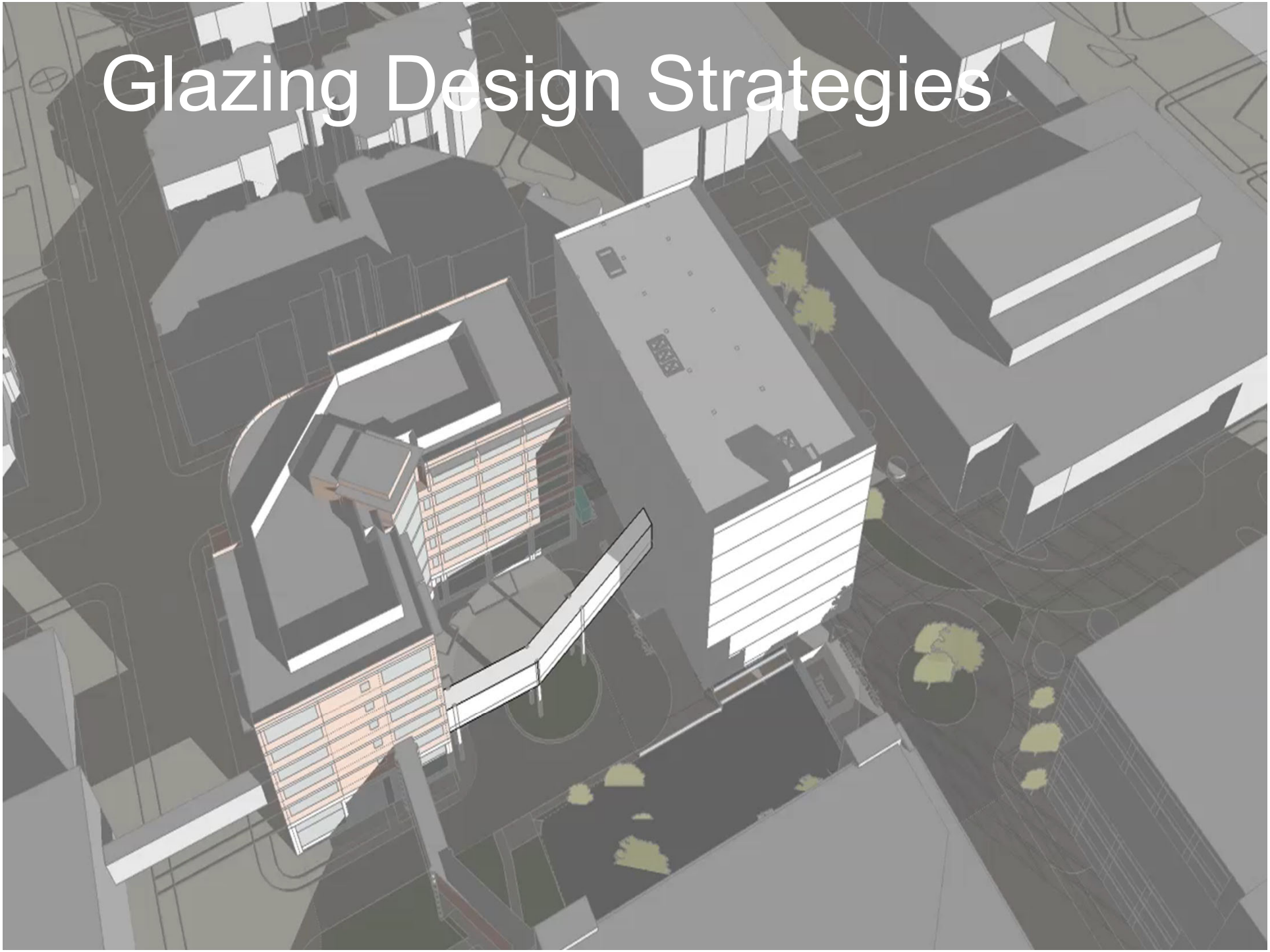
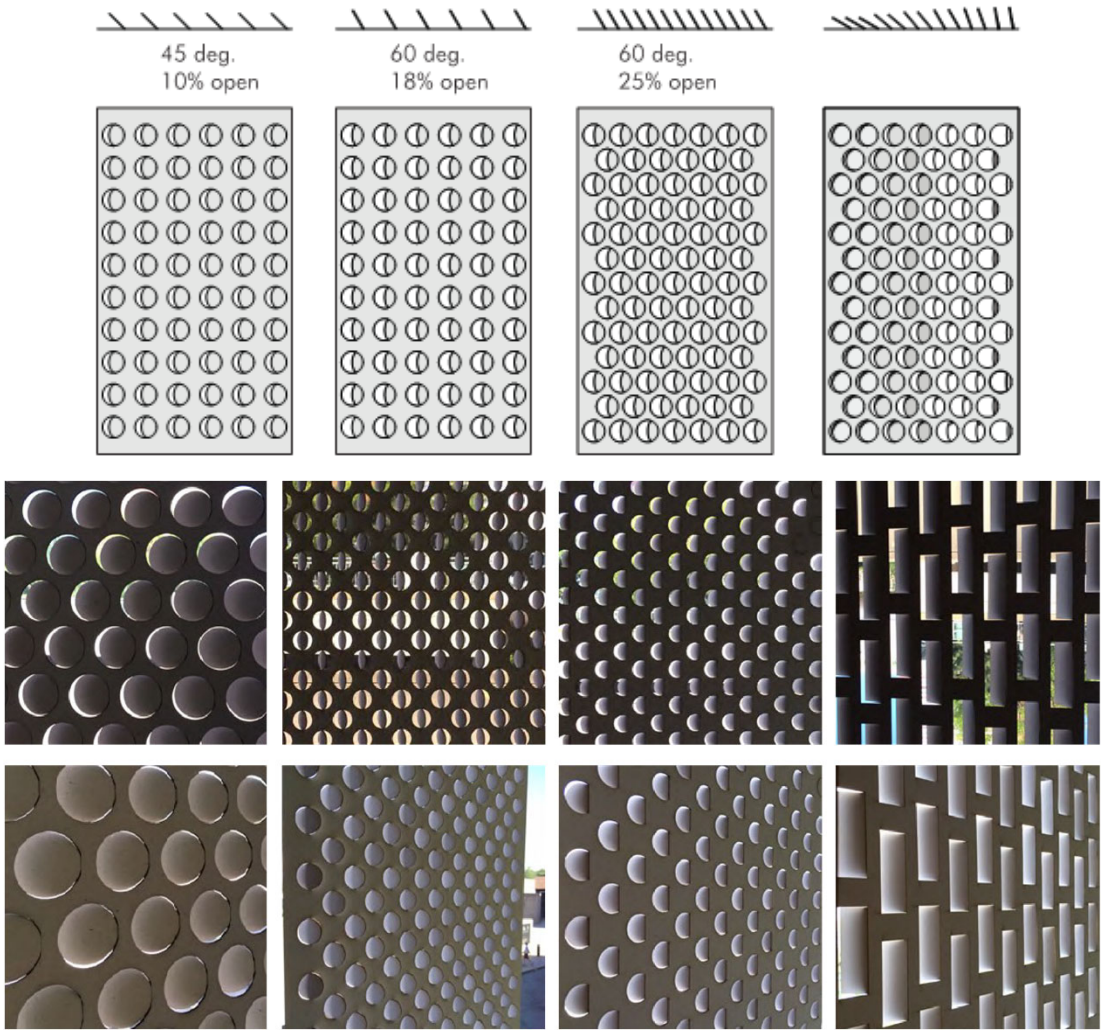
Criteria

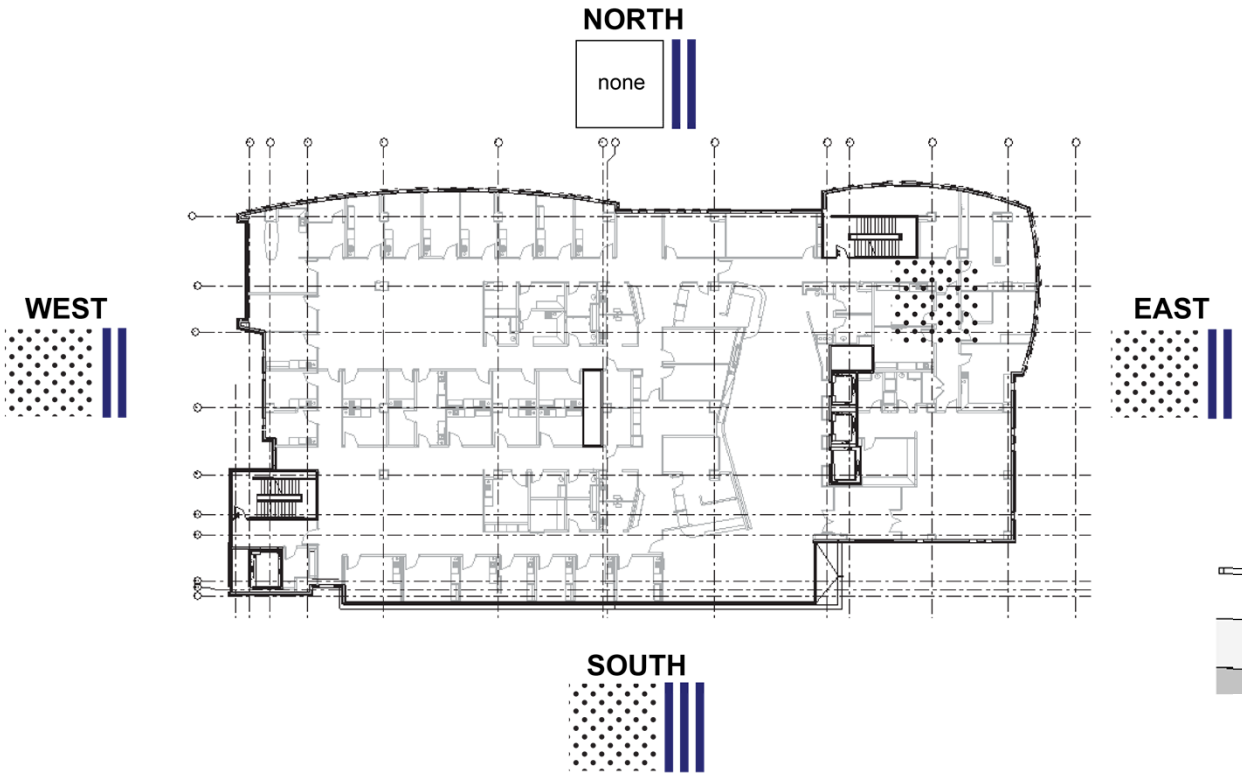
Glazing Design Strategies



Glazing Design Strategies



Glazing Design Strategies



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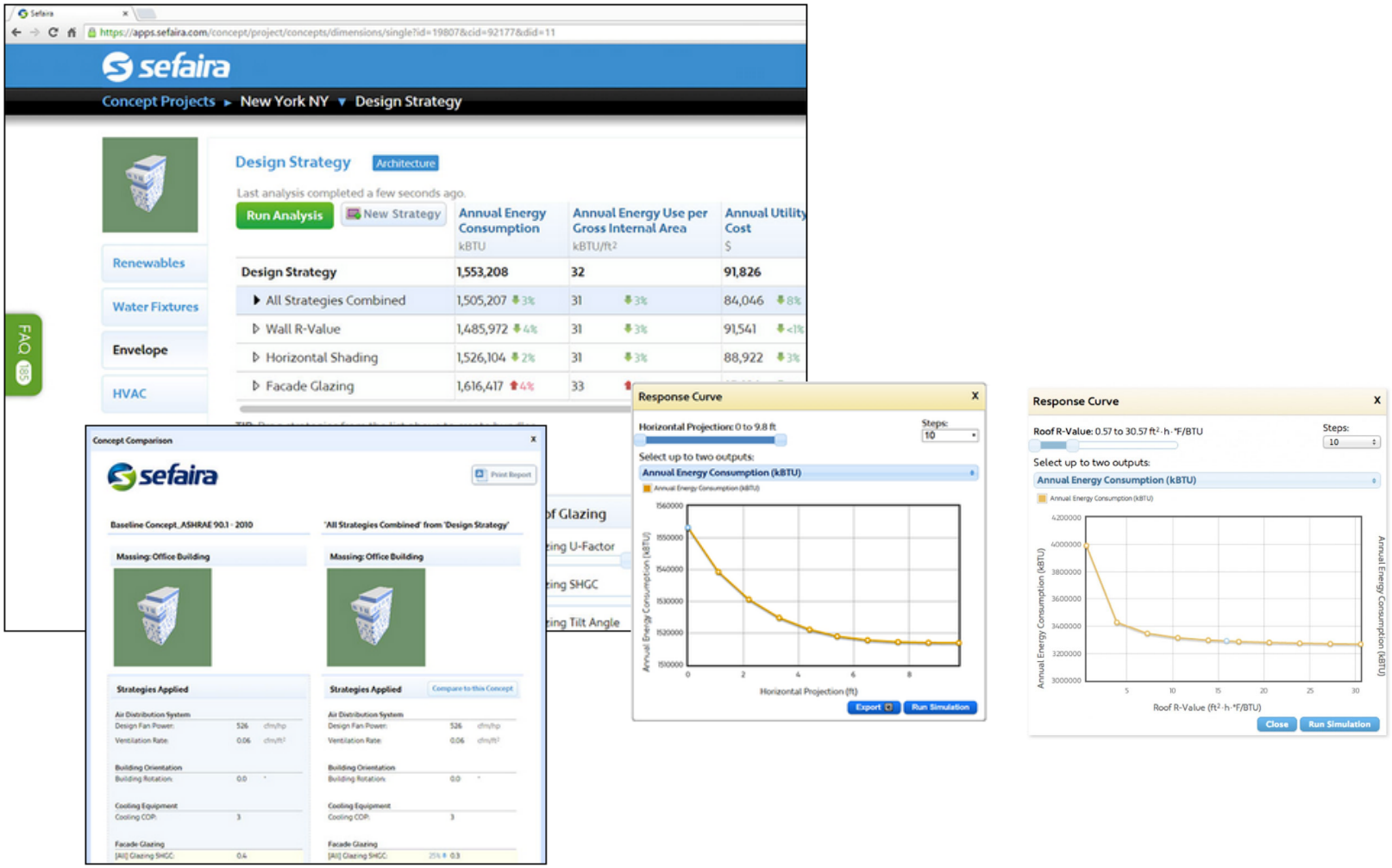
Performance Studies



Design Strategies

Sefaira Concept Analysis
U of L PCACC | Optimization
23-6-2015

Monthly Heat Gain (kBTU)
Louisville US

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar	42821	46037	40334	48727	64827	67885	66734	55377	46581	40458	42310	31434
Conduction	0	96	264	3784	17490	30690	27481	32267	10977	1964	146	0
Ventilation	0	551	501	10261	91344	143329	183477	155105	63565	23392	3394	0
Infiltration	0	226	157	3191	17421	18131	28712	22134	7222	3390	795	0
Occupant	112593	102419	116692	104484	116443	111935	108992	116692	108334	112593	111935	109241
Lighting	117801	107089	122013	109173	121827	117039	113962	122013	113199	117801	117039	114148
Equipment	117801	107089	122013	109173	121827	117039	113962	122013	113199	117801	117039	114148

Monthly Heat Loss (kBTU)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar	0	0	0	0	0	0	0	0	0	0	0	0
Conduction	250462	163592	133539	71821	30052	16805	9970	10233	40221	101652	124604	217865
Ventilation	257739	168658	134675	69442	26991	13049	6098	6687	34499	95584	120065	218502
Infiltration	66486	34577	27550	15330	4370	1217	655	426	3566	14622	30331	46105
Occupant	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	0	0	0	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0	0	0	0

HEAT GAIN - HEAT LOSS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Solar	42821	46037	40334	48727	64827	67885	66734	55377	46581	40458	42310	31434
Conduction	-250462	-163496	-133275	-68037	-12562	**13885**	**17511**	**22034**	-29244	-99688	-124458	-217865
Ventilation	-257739	-168107	-134174	-59181	64353	130280	177379	148418	29066	-72192	-116671	-218502
Infiltration	-66486	-34351	-27393	-12139	13051	16914	28057	21708	3656	-11232	-29536	-46105
Occupant	112593	102419	116692	104484	116443	111935	108992	116692	108334	112593	111935	109241
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SEFAIRA CONCEPT ANALYSIS

Optimization | Architecture

Last analysis completed a minute ago.

Run Analysis | New Strategy

	Annual Energy Consumption kBTU	Annual Energy Use per Gross Internal Area kBTU/ft²	Annual Space Cooling kBTU	Annual Space Heating kBTU
Optimization	**4,832,009**	**34**	**1,520,082**	**319,135**
▽ Roof R-Value	4,819,660 ↓<1%	34 0%	1,528,660 ↑<1%	298,207 ↓7%
Roof R-Value (40.00 ft²·h·°F/BTU)				
▽ South Horizontal Shading	4,755,257 ↓2%	33 ↓3%	1,411,391 ↓7%	351,073 ↑10%
[C] Orientation (Vertical)				
[C] Angle (0.0 °)				
[C] Separation (3.0 ft)				
[C] Depth (3.0 ft)				
▽ South Vertical Shading	4,755,257 ↓2%	33 ↓3%	1,411,391 ↓7%	351,073 ↑10%
[C] Orientation (Vertical)				
[C] Angle (0.0 °)				
[C] Separation (3.0 ft)				
[C] Depth (3.0 ft)				
▽ Wall R-Value	4,805,235 ↓<1%	34 0%	1,527,226 ↑<1%	285,216 ↓11%
[All] Wall R-Value (22.00 ft²·h·°F/BTU)				

R-14 to R-22 at roof has most effect in heating.

R-25 to R-40 at roof has little effect.

Based on WWR:
North = 30%
East = 20%
South = 50%
West = 10%

Vertical or horizontal shading has the same positive effect.

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Cladding Design

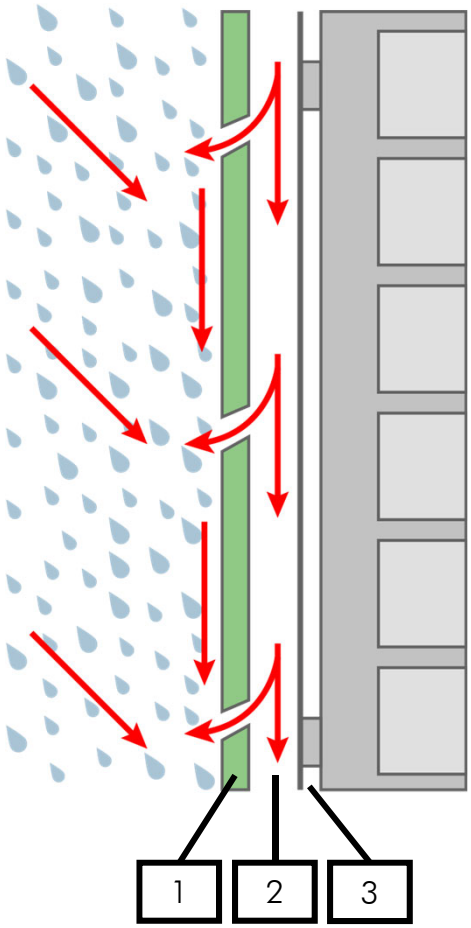
Ventilated (Rain Screen)

Multiple layers of defense

1. **Cladding**
   Defends against 4 of 5 water forces

2. **Air Cavity Venting**
   - Defends against air pressure Δ
   - Defect in AMB will not convey water

3. **Air Barrier Drainage Plane**
   - Residual moisture drained and dried
   - Open joints allow for ventilation and differential movement



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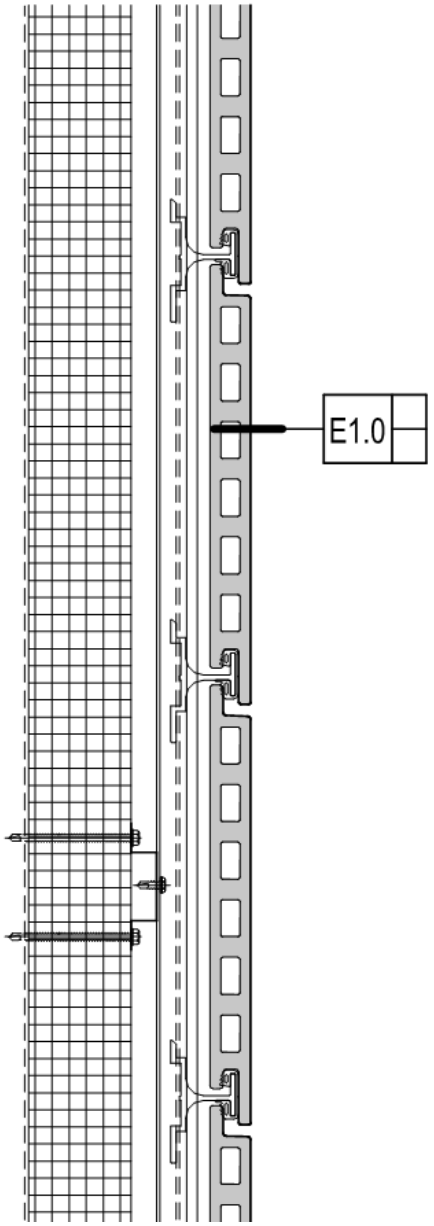
Cladding Design



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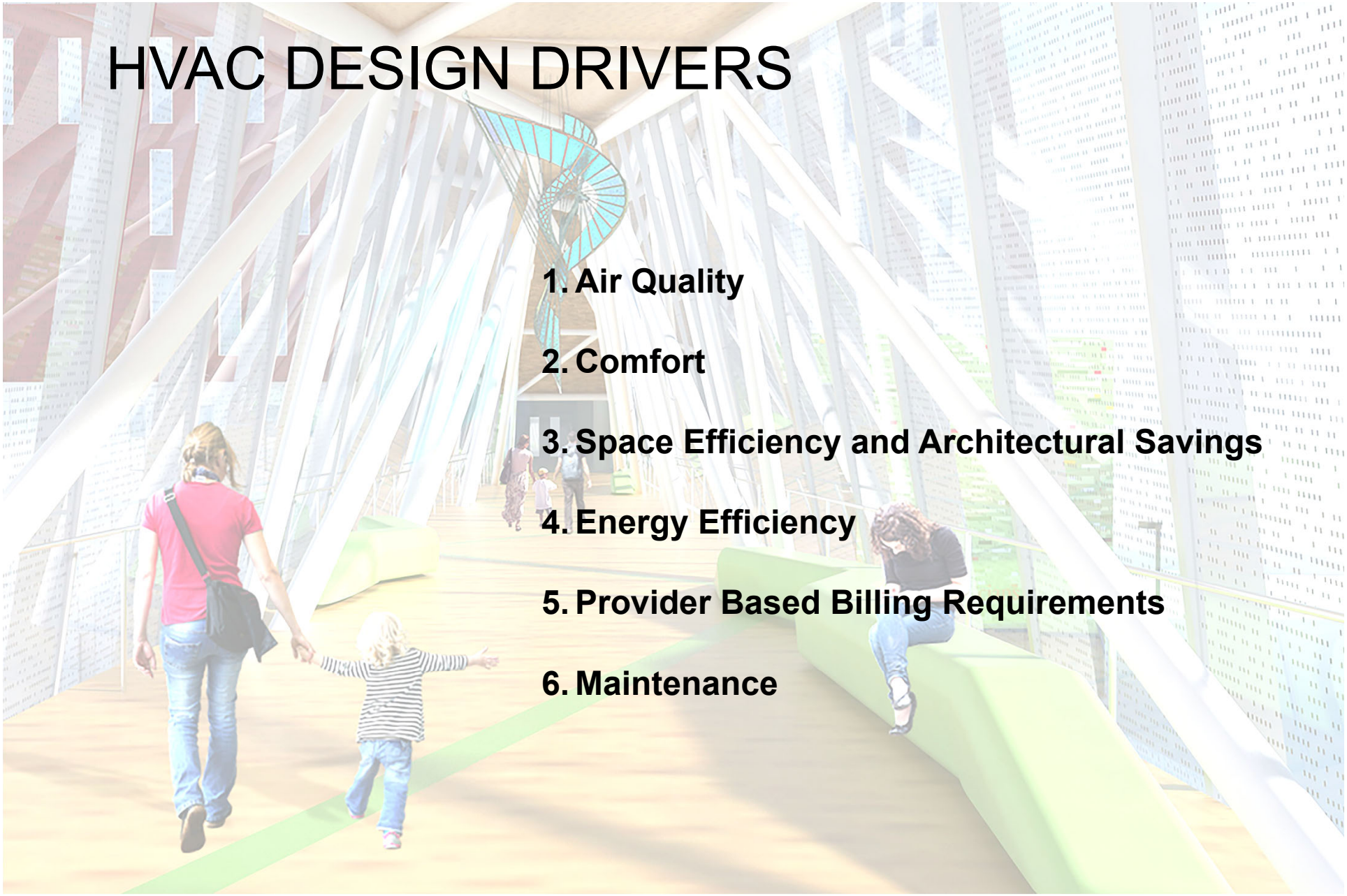
HVAC DESIGN DRIVERS



1. Air Quality
2. Comfort
3. Space Efficiency and Architectural Savings
4. Energy Efficiency
5. Provider Based Billing Requirements
6. Maintenance

INNOVATION REQUIRES

1. **Project Champion**
2. **Team Work**
3. **Persistance**
4. **Patience**

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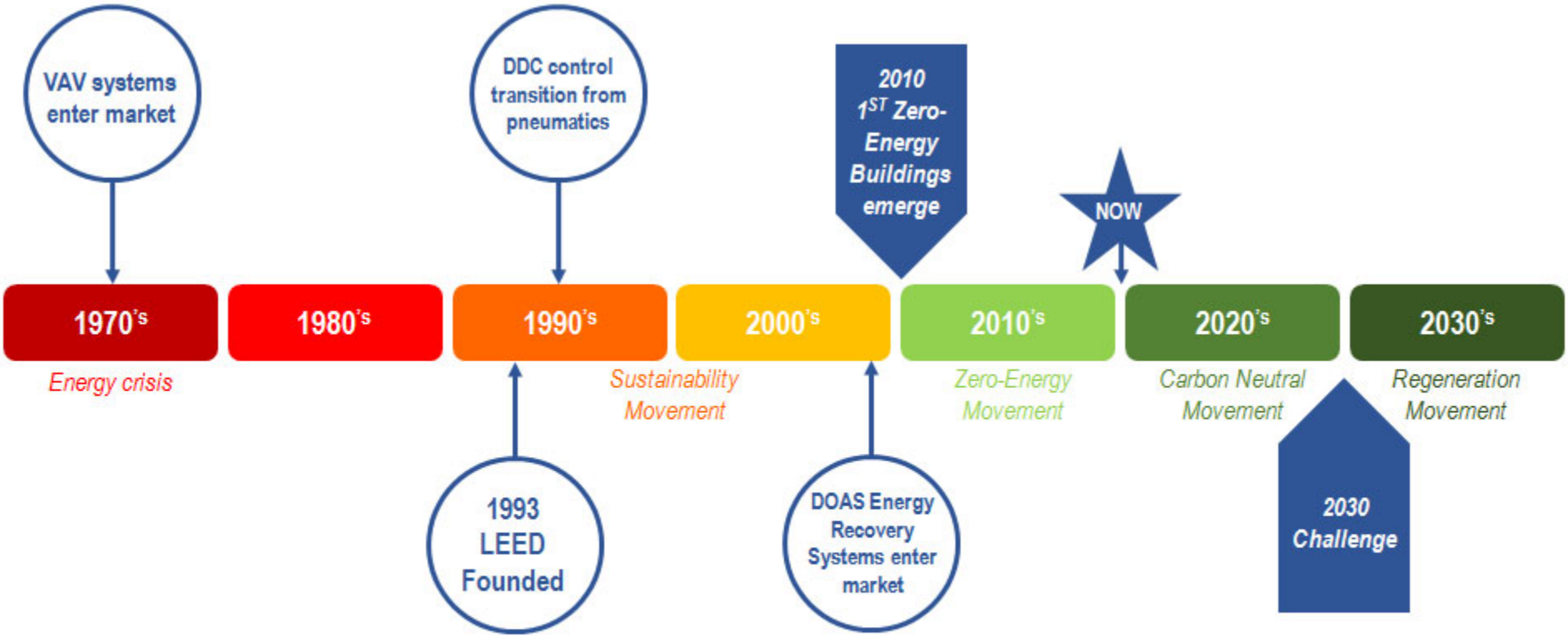
Have no fear of perfection - you'll never reach it.

Salvador Dali



VAV systems were the approach in the 1970's...

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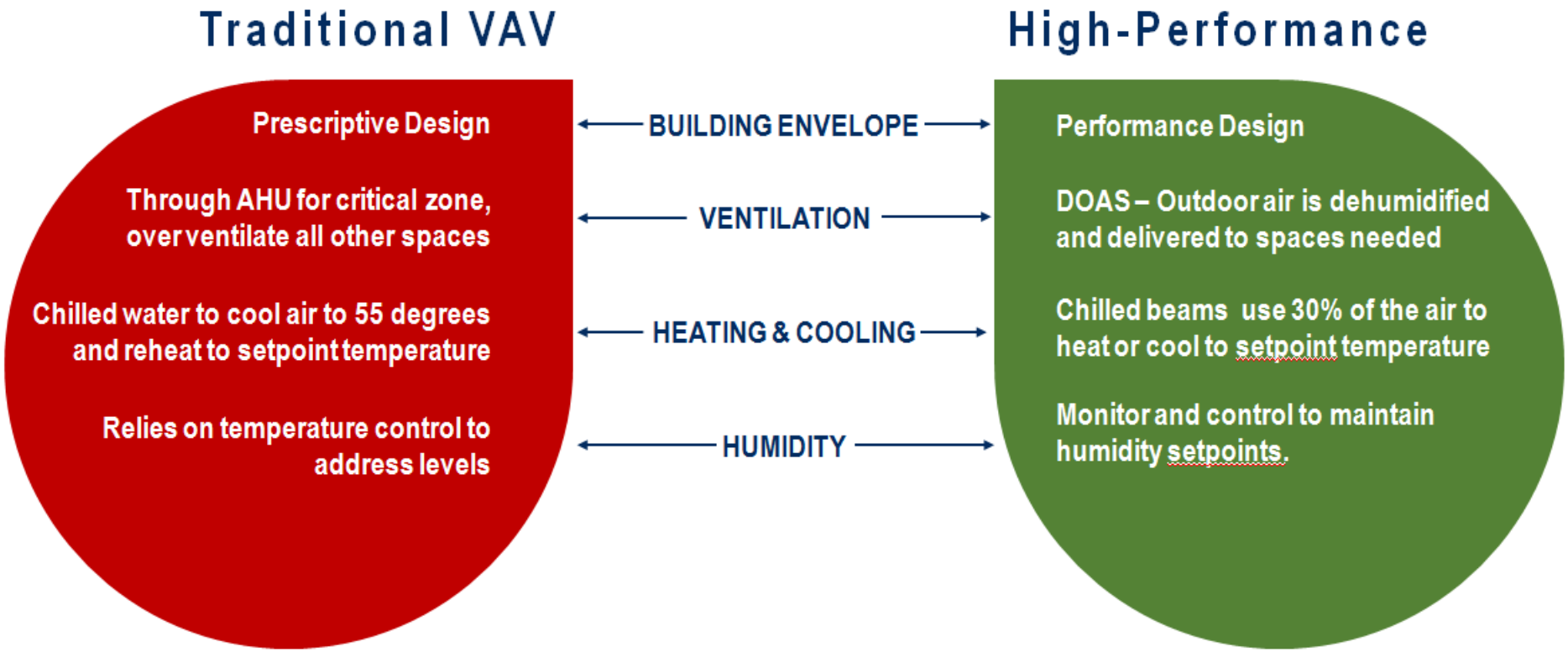

MECHANICAL SYSTEM DESIGN CRITERIA

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CHILLED BEAM SYSTEM SELECTION

Project eliminated the concept that the MEP budgets are independent of the architectural budget

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Estimated Tradeoff Costs

VAV with Reheat (baseline) **HVAC Budget** $35/SF

Chilled Beam HVAC Budget
- $38/SF = $450,000 premium

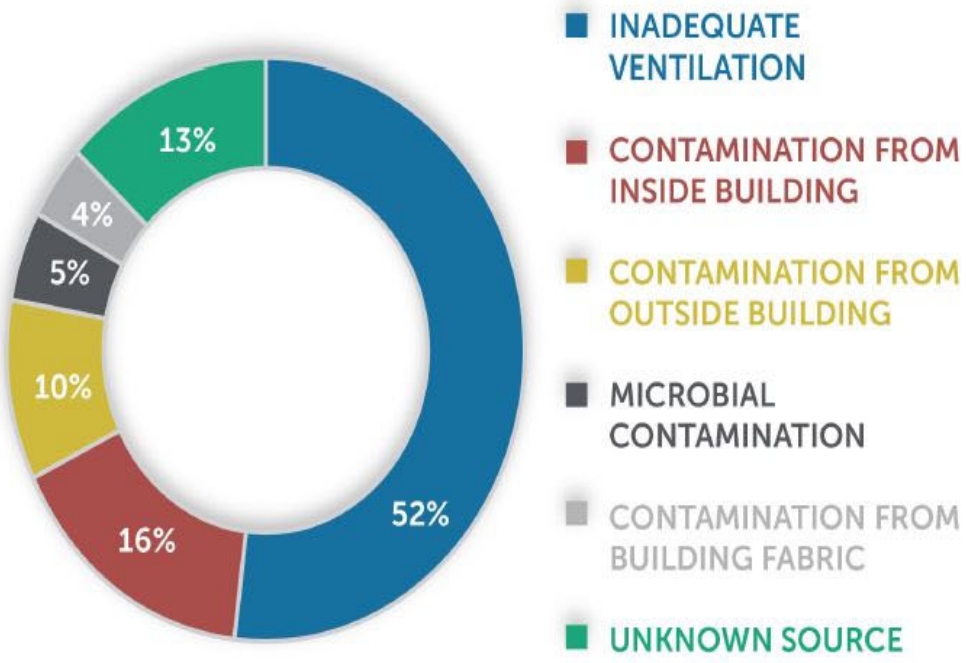
Tradeoff costs for Chilled beam:
Mechanical penthouse vs interstitial space:
5,000 SF x $252/SF = $1,260,000 (interstitial floor)
5,000 SF x $132/SF = $660,000 (penthouse)
$600,00 savings

Reduce floor to floor heights:
Remove 1’ from floor to floor for 7 floors (ducts are smaller with chilled beam)
7’ x 600 LF x $70/SF = $294,000 savings

Construction savings	$894,000
Premium for Chilled Beam	$450,000
Overall estimated savings	$444,000

AIR QUALITY PERFORMANCE

SOURCES OF INDOOR AIR QUALITY CONCERN



Occupational Safety and Health Administration. OSHA Technical Manual. Washington, DC: Department of Labor, 1999. TED 01-00-015.

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AIR QUALITY PERFORMANCE

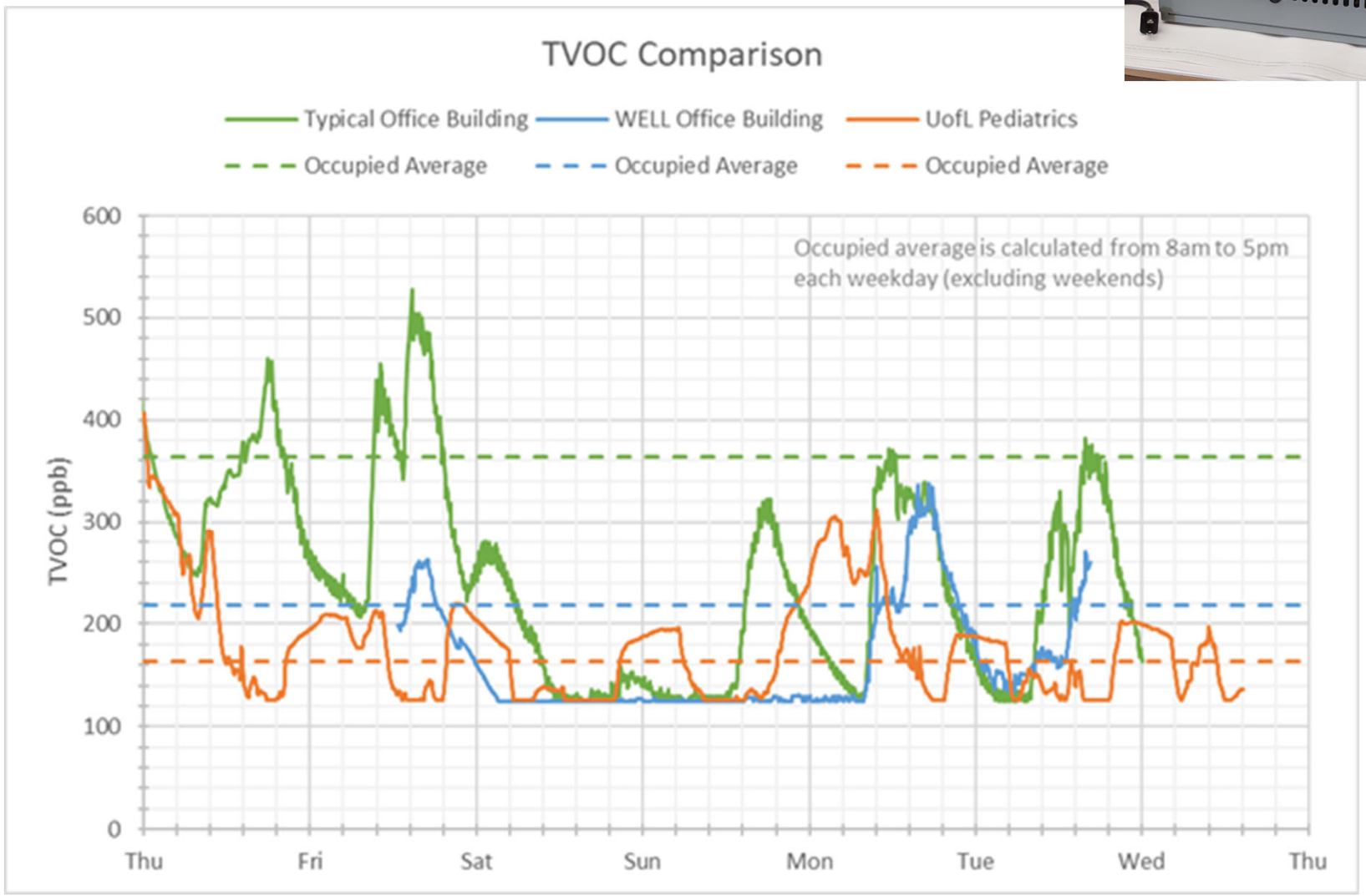
DOAS VENTILATION – CHILLED BEAM SYSTEM – ENVELOPE

Ventilation
Filters ventilation and Re-circulated air
Final Filters
Removes Humidity

Beam Induction Fans Filter
Re-circulated Air

Envelope Locks out Infiltration

AIR QUALITY PERFORMANCE



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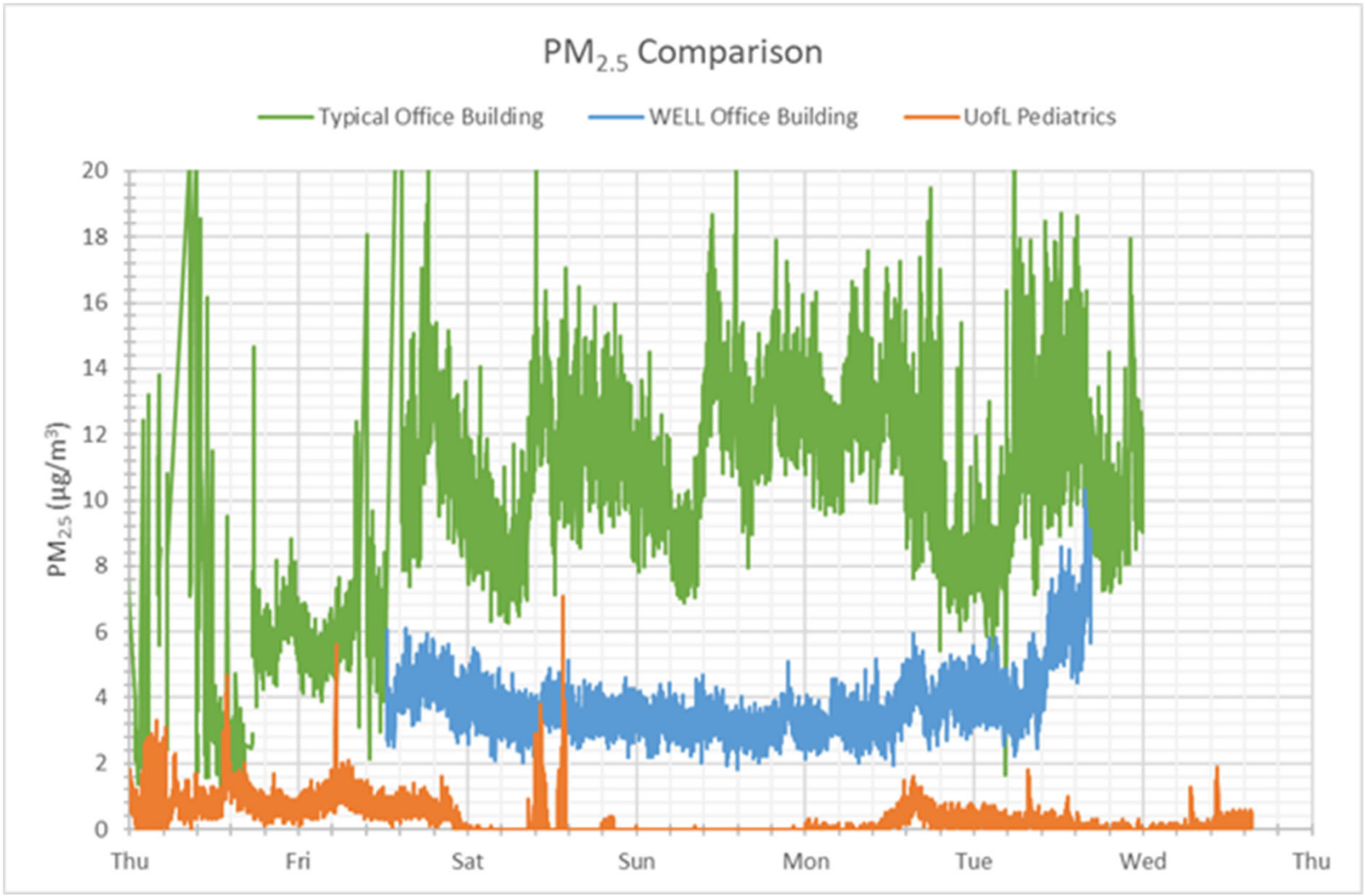
AIR QUALITY PERFORMANCE



HIGH PERFORMANCE BUILDINGS

Building Performance

Mechanical System Sizing

As Building Performance goes up

Chilled water system sized ~25%-30% smaller tonnage than a typical MOB

“Shift Costs – Not Add Cost”

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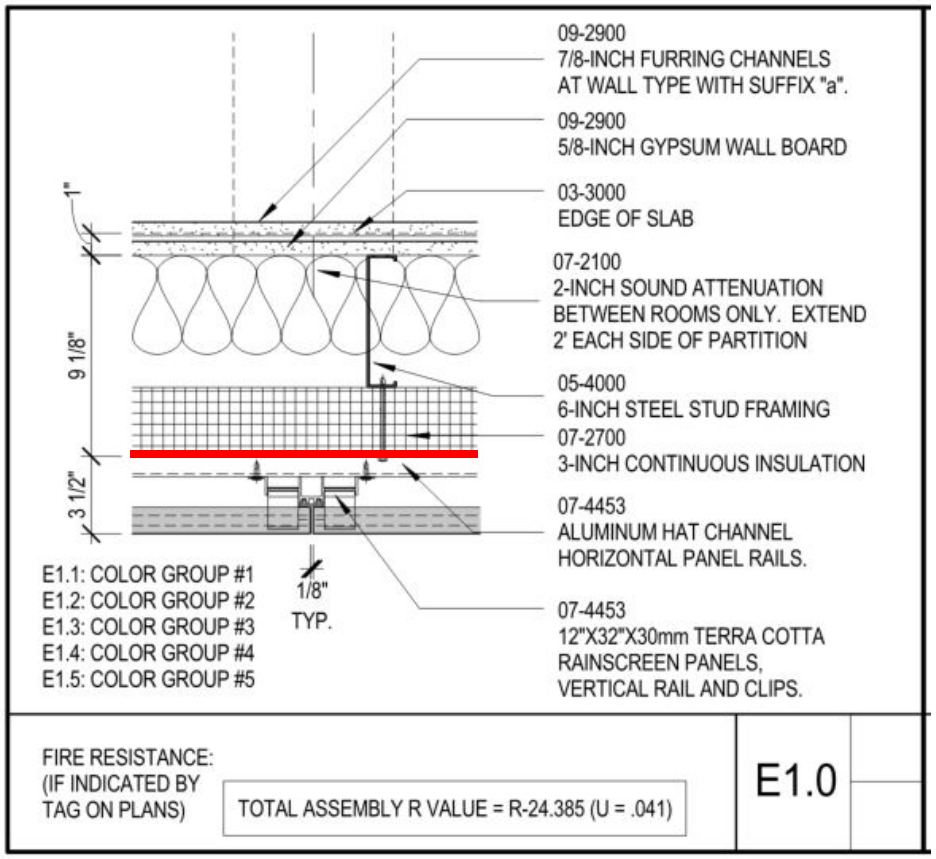
CMTA

Cladding Design & HVAC Coordination



Air/vapor barrier integral with continuous insulation

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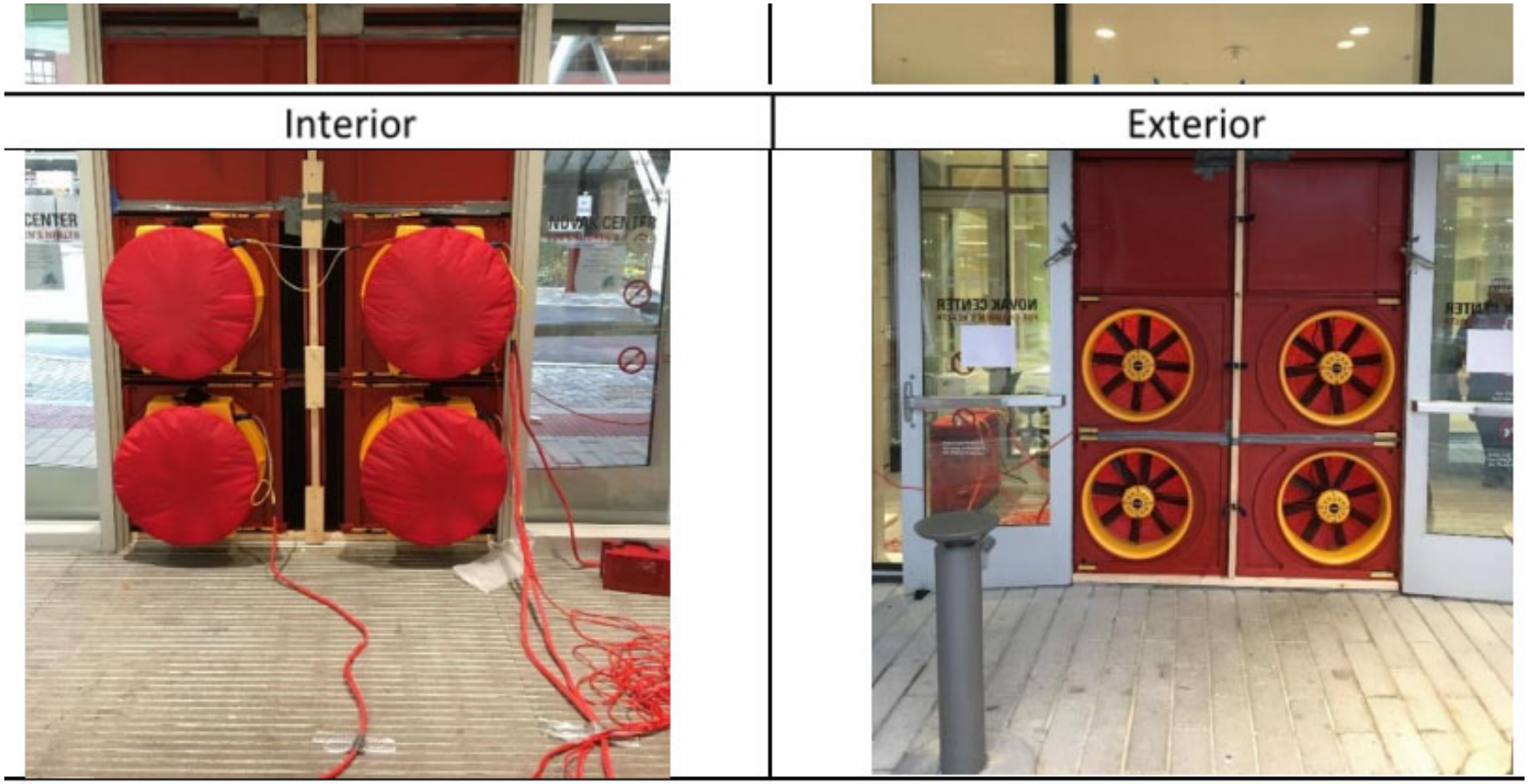
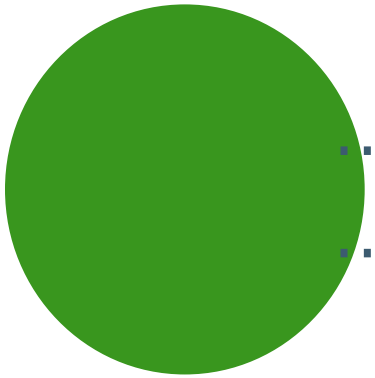
Building Pressure Testing & HVAC Sizing



Energy Use Intensity (EUI)

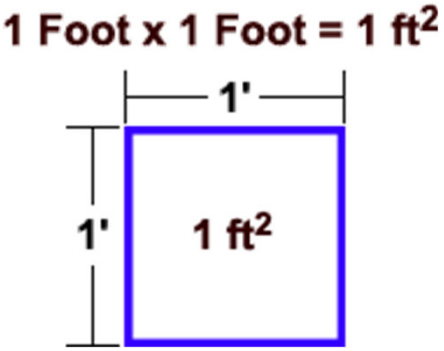


...the lower the number

...the lower the energy use

Energy Use Index (EUI) =

Energy use per square foot over one year



kBTU / s.f. / yr.

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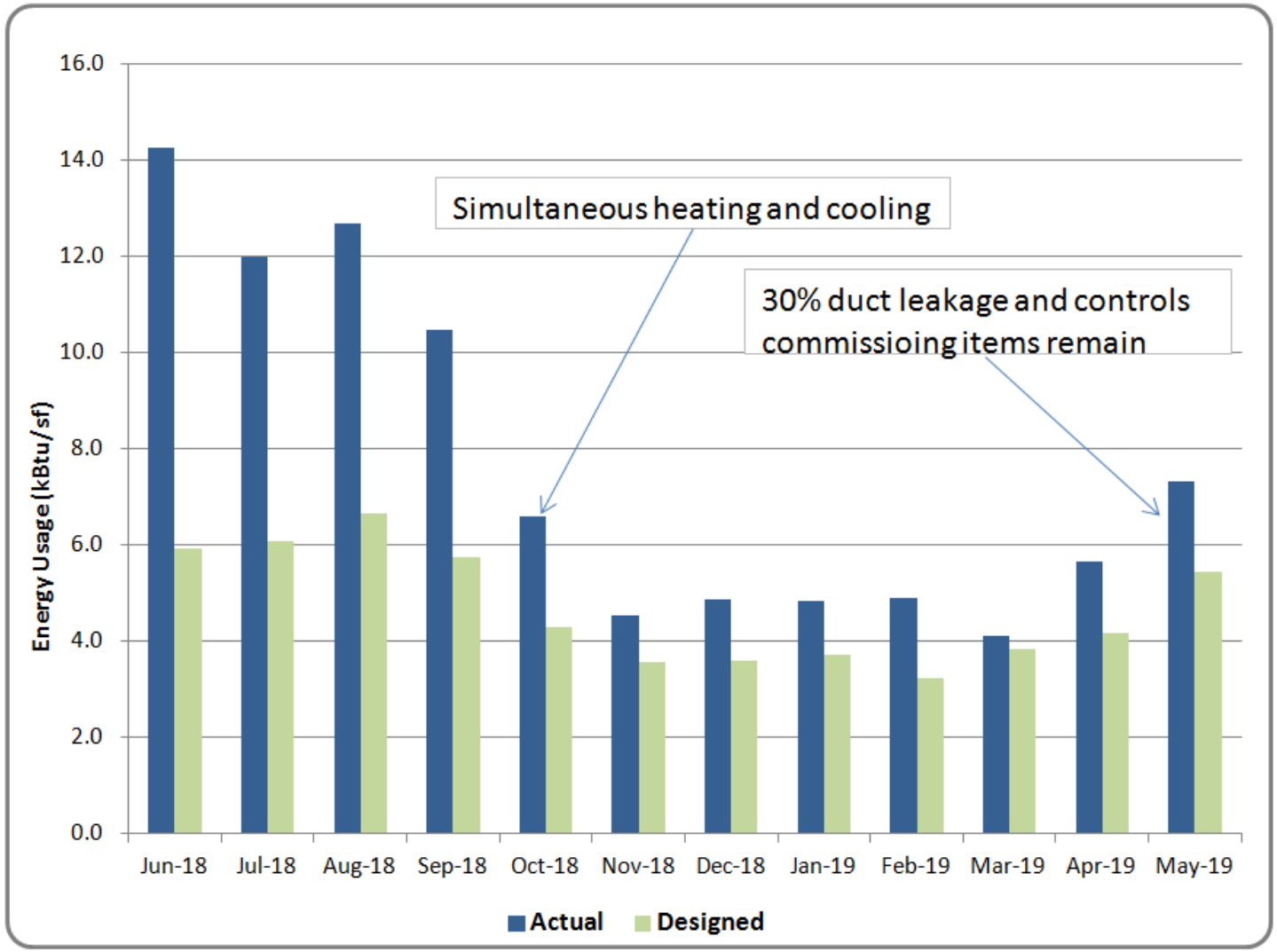
CMTA

Cladding Design & HVAC Coordination



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Project completed in collaboration with:
Stanley Beaman & Sears/EYP, Uzun + Case, Carman, CMTA