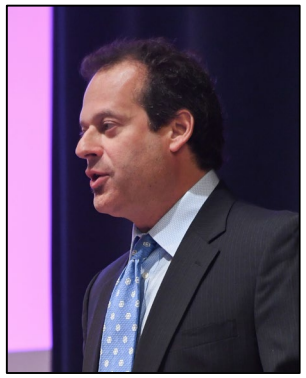

NASHVILLE, TN
BEC
CONFERENCE
MARCH 1-3,2020
NGA
NATIONAL GLASS ASSOCIATION with GANA

Glass in Architecture

a global perspective on design trends



Alex Bachrach
Architectural Record

Chuck Gannaway
Hastings Architecture

George Feathers
Terracon

Dan Piselli
FXCollaborative Architects

Session Objectives

- Summarize trends in architecture and design that utilize glass as a primary building material.
- Discuss a consensus-building approach among the design team.
- Explore challenges to complex building designs and solutions found using glass products.
- Describe the material selection process as it relates to the need to meet high-performing building code requirements.

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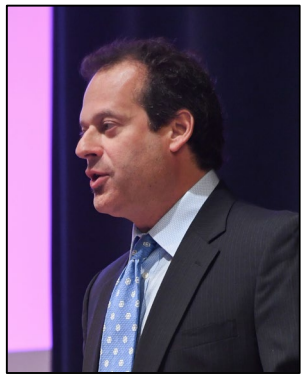

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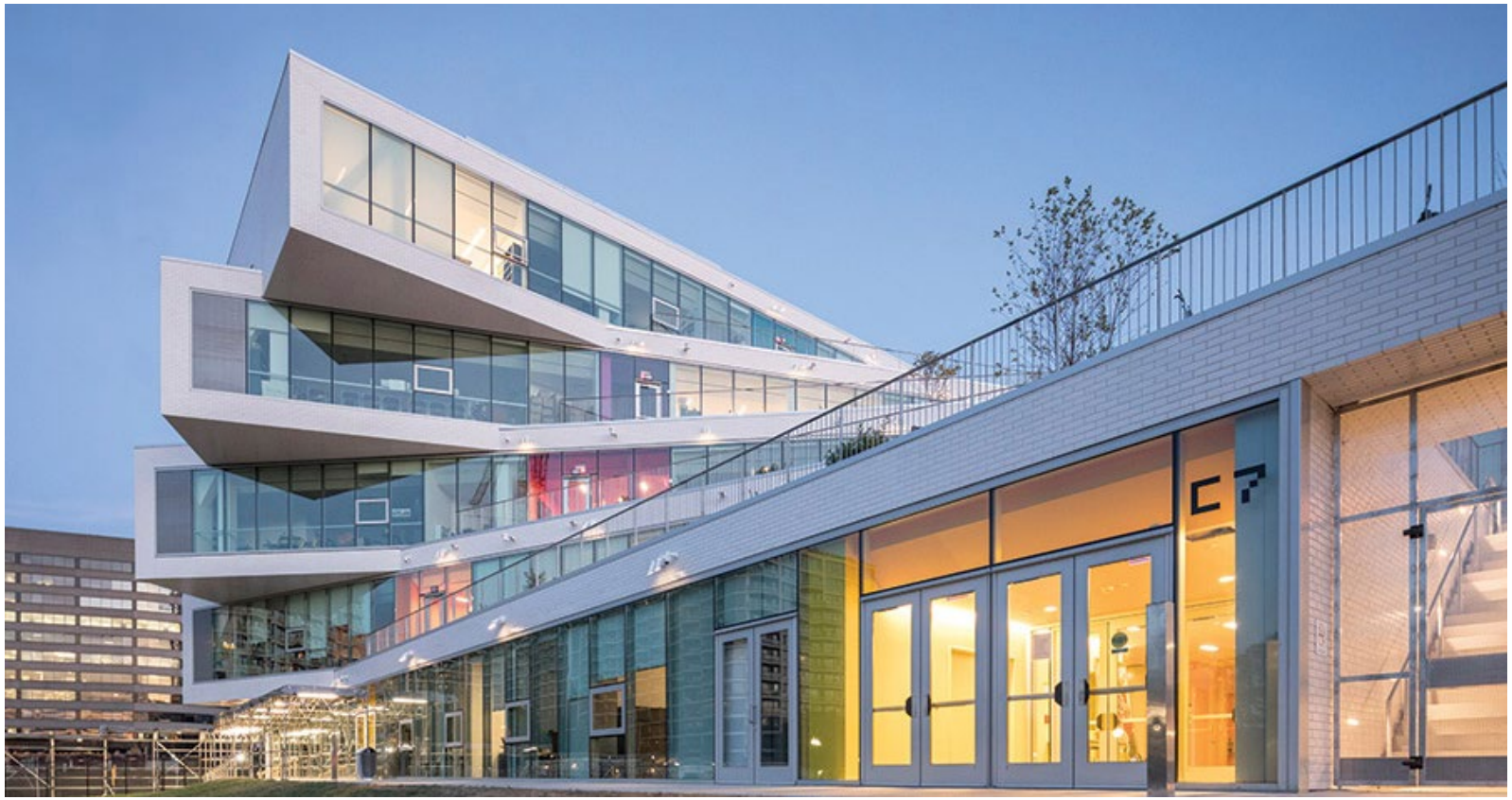
ARCHITECTURAL RECORD

Recent features: Glass in Architecture

225 Polk Avenue in Nashville
by Hastings Architecture
(Guardian + Oldcastle BuildingEnvelope)

The landmark building sits on a high point within the city, with a 15-foot grade change from the entrance on the east side, along the sloping Polk Avenue, to the west side, which offers panoramic views of downtown Nashville.

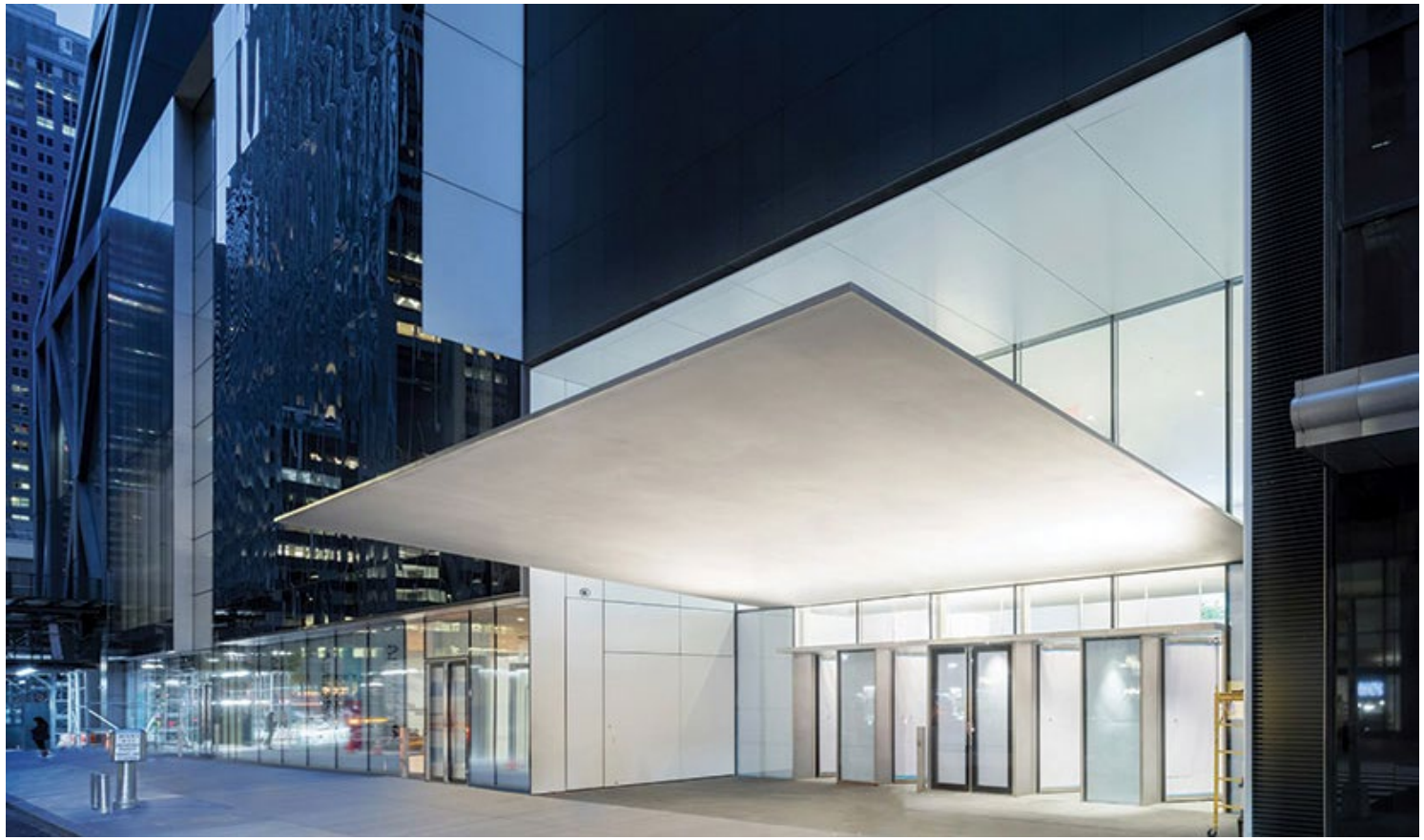
The Heights Building
by BIG with Leo Daly, Arlington, VA (Viracon)



Classroom bars fan out from an elongated base.

MOMA Addition

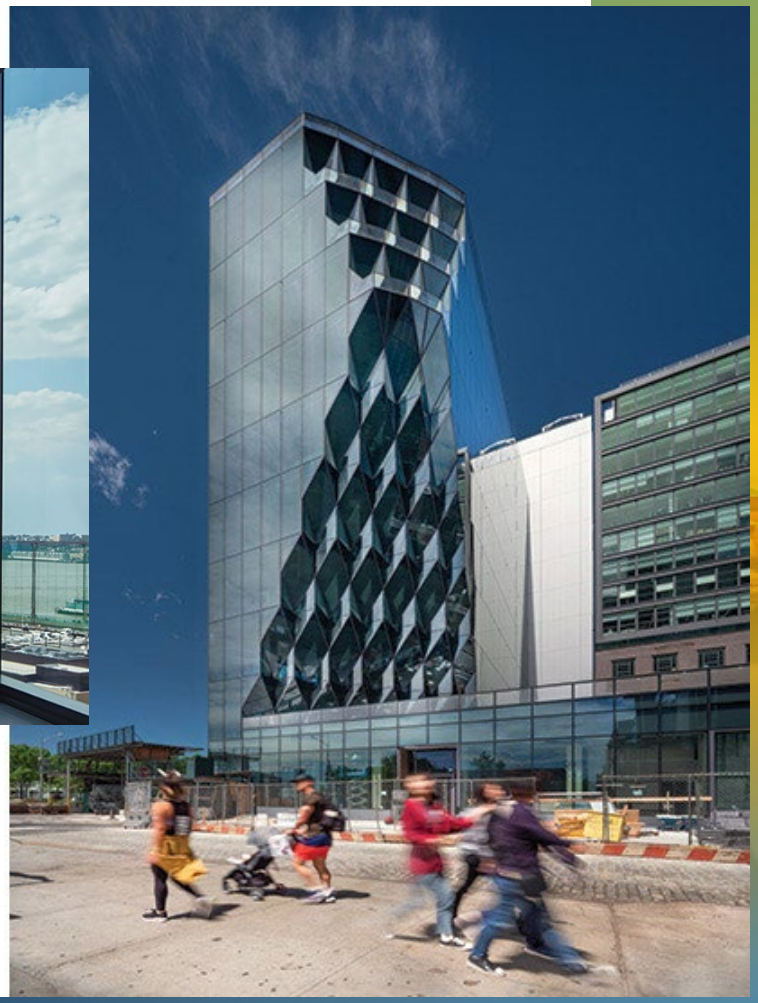
by Diller Scofidio + Renfro (DS+R) and Gensler (Sedak)



A cantilevered steel canopy calls out the double-height entrance lobby that replaces the 2004 one.

Solar Carve
by Studio Gang New York City (Interpane)

Solar Carve's design uses incident angels of the sun's rays to sculpt its form. The carved curtain wall mitigates glare and heat gain, and also creates dynamic corner work spaces.



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BUILDING ENVELOPE CONTRACTORS CONFERENCE 2020

NGA
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					Transmittance		Reflectance		U-Value				Compare All
Product Code	Configuration	Printing	Argon	Spandrel	Visible	UV	Exterior	Interior	Winter	Summer	SHGC	LSG	Actions
VS7-08	1" (25mm) Insulating	No Printing	No	No	6%	2%	29%	38%	0.38	0.39	0.13	0.46	Compare
VS13-08	1" (25mm) Insulating	No Printing	No	No	8%	4%	44%	40%	0.38	0.39	0.13	0.62	Compare
VS24-08	1" (25mm) Insulating	No Printing	No	No	8%	5%	44%	40%	0.38	0.39	0.13	0.62	Compare
VUE27-30	1" (25mm) Insulating	No Printing	No	No	15%	1%	8%	20%	0.29	0.26	0.13	1.15	Compare
VS34-08	1" (25mm) Insulating	No Printing	No	No	8%	4%	44%	39%	0.38	0.39	0.13	0.62	Compare
VS1-08	1" (25mm) Insulating	No Printing	No	No	8%	3%	42%	38%	0.38	0.39	0.14	0.57	Compare
VS2-08	1" (25mm) Insulating	No Printing	No	No	6%	2%	31%	38%	0.38	0.39	0.14	0.43	Compare
VS3-08	1" (25mm) Insulating	No Printing	No	No	4%	2%	14%	38%	0.38	0.39	0.14	0.29	Compare
VUE3-30	1" (25mm) Insulating	No Printing	No	No	15%	1%	8%	20%	0.29	0.26	0.14	1.07	Compare
VS4-08	1" (25mm) Insulating	No Printing	No	No	4%	1%	17%	38%	0.38	0.39	0.14	0.29	Compare
VUE4-30	1" (25mm) Insulating	No Printing	No	No	18%	1%	10%	20%	0.29	0.26	0.14	1.29	Compare
VS6-08	1" (25mm) Insulating	No Printing	No	No	6%	2%	31%	38%	0.38	0.39	0.14	0.43	Compare
VS18-08	1" (25mm) Insulating	No Printing	No	No	6%	2%	24%	38%	0.38	0.39	0.14	0.43	Compare
VS19-08	1" (25mm) Insulating	No Printing	No	No	6%	2%	24%	38%	0.38	0.39	0.14	0.43	Compare
VS26-08	1" (25mm) Insulating	No Printing	No	No	5%	1%	20%	33%	0.38	0.39	0.14	0.36	Compare
VS27-08	1" (25mm) Insulating	No Printing	No	No	4%	1%	13%	38%	0.38	0.39	0.14	0.29	Compare
VS30-08	1" (25mm) Insulating	No Printing	No	No	5%	2%	23%	38%	0.38	0.39	0.14	0.36	Compare
VS32-08	1" (25mm) Insulating	No Printing	No	No	5%	2%	20%	38%	0.38	0.39	0.14	0.36	Compare
VS33-08	1" (25mm) Insulating	No Printing	No	No	6%	2%	25%	38%	0.38	0.39	0.14	0.43	Compare
VZRE3-38	1" (25mm) Insulating	No Printing	No	No	16%	2%	14%	15%	0.29	0.25	0.15	1.07	Compare
VUE19-30	1" (25mm) Insulating	No Printing	No	No	22%	2%	12%	20%	0.29	0.26	0.15	1.47	Compare
VUE26-30	1" (25mm) Insulating	No Printing	No	No	20%	2%	11%	20%	0.29	0.26	0.15	1.33	Compare
VRE27-38	1" (25mm) Insulating	No Printing	No	No	17%	3%	14%	21%	0.30	0.26	0.15	1.13	Compare
VUE27-40	1" (25mm) Insulating	No Printing	No	No	19%	1%	7%	15%	0.29	0.26	0.15	1.27	Compare
VZRE27-38	1" (25mm) Insulating	No Printing	No	No	16%	1%	15%	16%	0.29	0.25	0.15	1.07	Compare
VUE30-30	1" (25mm) Insulating	No Printing	No	No	22%	2%	12%	20%	0.29	0.26	0.15	1.47	Compare
VUE32-30	1" (25mm) Insulating	No Printing	No	No	20%	2%	11%	20%	0.29	0.26	0.15	1.33	Compare
VUE2-30	1" (25mm) Insulating	No Printing	No	No	26%	1%	15%	20%	0.29	0.26	0.16	1.63	Compare
VNE3-53	1" (25mm) Insulating	No Printing	No	No	24%	1%	8%	20%	0.29	0.25	0.16	1.50	Compare
VRE3-43	1" (25mm) Insulating	No Printing	No	No	22%	3%	10%	19%	0.29	0.26	0.16	1.38	Compare
VUE3-40	1" (25mm) Insulating	No Printing	No	No	20%	2%	7%	15%	0.29	0.26	0.16	1.25	Compare
VZRE4-38	1" (25mm) Insulating	No Printing	No	No	19%	2%	19%	15%	0.29	0.25	0.16	1.19	Compare


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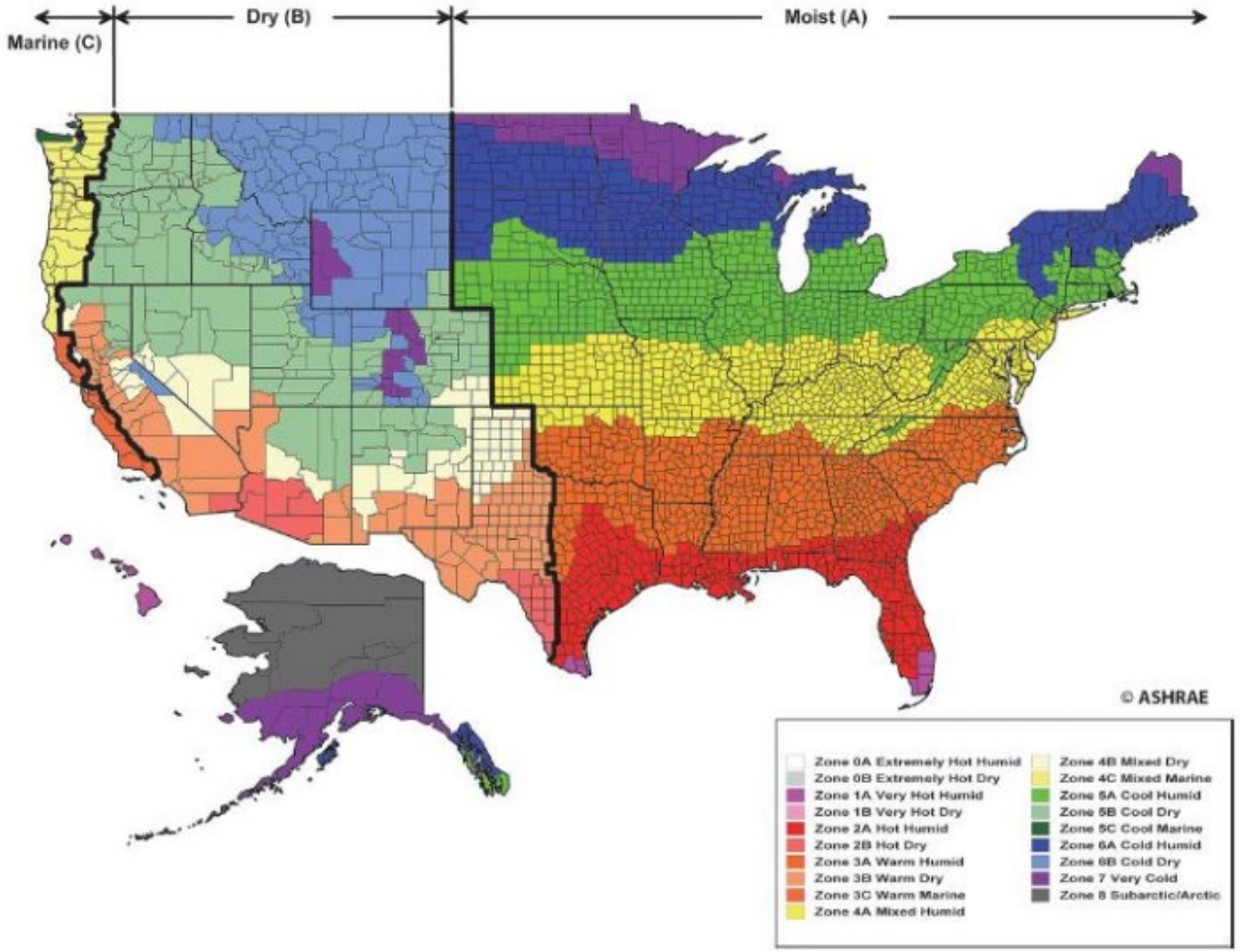
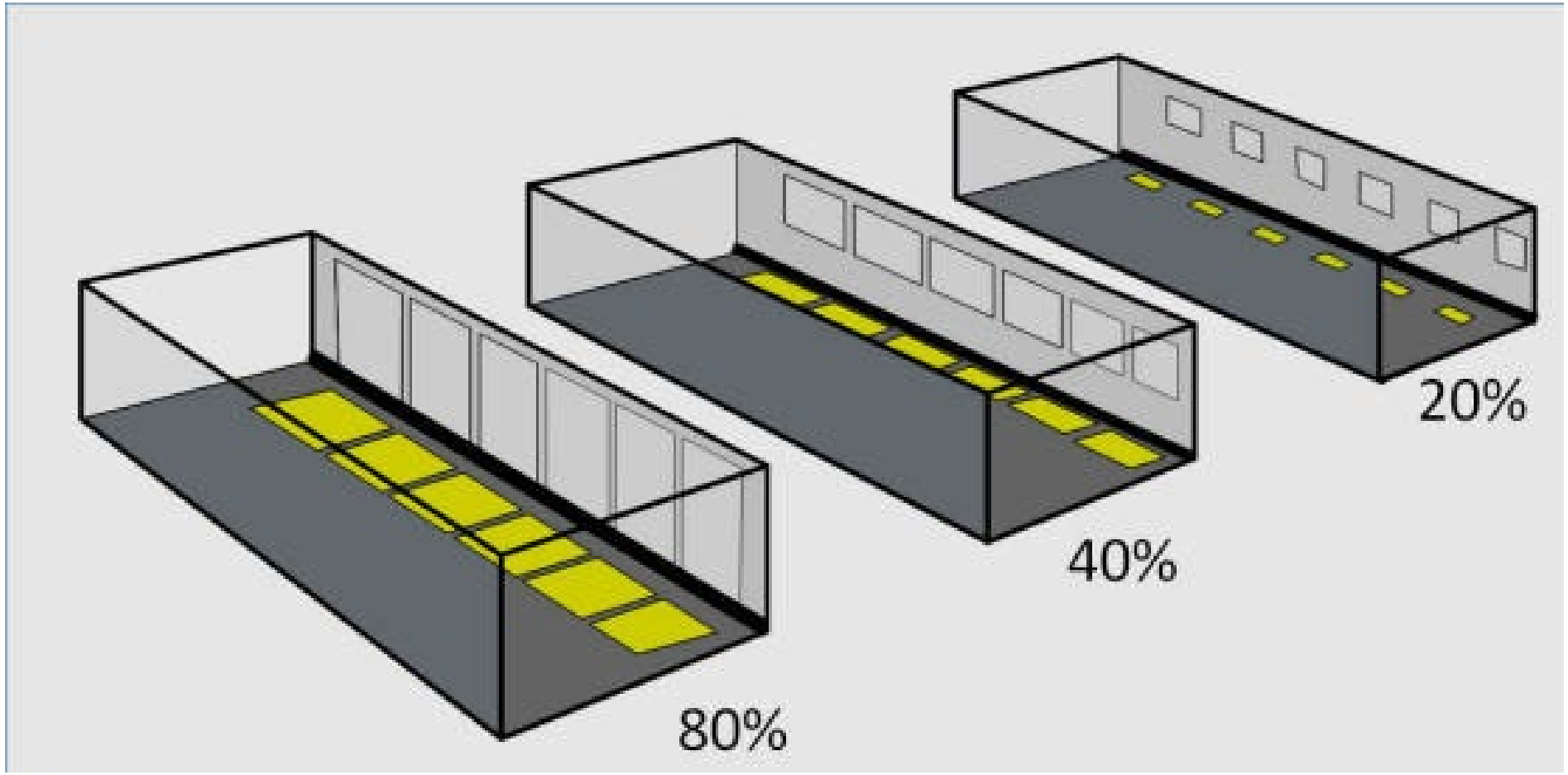
Climate Zone: 3A



Window to Wall Ratio

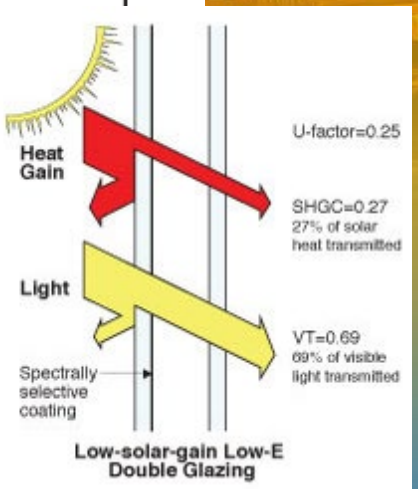


SHGC Matrix [2]

Glass SHGC [3]	Overall SHGC [4]
0.75	0.73
0.70	0.69
0.65	0.64
0.60	0.60
0.55	0.55
0.50	0.51
0.45	0.46
0.40	0.42
0.35	0.37
0.30	0.33
0.25	0.28
0.20	0.24
0.15	0.19
0.10	0.15
0.05	0.10

Visible Transmittance [2]

Glass VT [3]	Overall VT [4]
0.75	0.68
0.70	0.63
0.65	0.59
0.60	0.54
0.55	0.50
0.50	0.45
0.45	0.41
0.40	0.36
0.35	0.32
0.30	0.27
0.25	0.23
0.20	0.18
0.15	0.14
0.10	0.09
0.05	0.05



Glazing Assembly Comparison

COMPARISON						
OPTION	ENERGY (BTU^6/YR)	ANNUAL ENERGY COST $	ENERGY SAVINGS	% ENERGY SAVINGS	$ SAVINGS	% COST SAVINGS
ASHRAE MIN	13144.5	$ 429,784	0	0	0	0
BASE OPTION (Base) Assembly U-0.57 Assembly SHGC – 0.29	9977.9	$ 336,976	3166.6	24%	**$ 92,808**	22%
GLASS #1 Assembly U-0.55 Assembly SHGC – 0.29	9923.7	$ 334,824	3220.8	25%	$ 94,960	22%
GLASS #2 Assembly U-0.46 Assembly SHGC – 0.21	9356.2	$ 314,374	3788.3	29%	**$ 115,410**	27%
GLASS #3 Assembly U-0.49 Assembly SHGC – 0.27	9618.7	$ 324,124	3525.8	27%	$ 105,660	25%
					$ 22,602 ANNUAL SAVINGS	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STATE STREET

Ovation East End - Glass Selection Details

Location	Glass Name	Float Glass Manufacturer (Location)	Coating Manufacturer	Coating Application (Location)	IGU Fabricator (Location)	Cost Premium for this Project?	Glass Make-Up	VLT	Reflect (ext)	Reflect (int)	Winter U-Value	Summer U-Value	SHGC	LSG
1	PPG R100	PPG (USA)	PPG	PPG (USA)	Tecnoglass (Colombia)	NO	1/4" Solarban R100 #2 - 5/8" A.S. - 1/4" Clear	42%	32%	14%	0.30	0.24	0.23	1.83
2	Tecnoglass R36/23	PPG or Saint Gobain (USA) (Colombia)	Tecnoglass	Tecnoglass (Colombia)	Tecnoglass (Colombia)	NO	1/4" R36/23 #2 - 5/8" A.S. - 1/4" Clear	36%	46%	21%	0.30	0.24	0.24	1.50
3	Guardian SNR 43 (Tecnoglass)	Guardian (USA)	Guardian	Guardian (USA)	Tecnoglass (Colombia)	NO	1/4" SNR 43 #2 - 5/8" A.S. - 1/4" Clear	43%	28%	14%	0.29	0.27	0.23	1.87
4	Tecnoglass R43/28	PPG or Saint Gobain (USA) (Colombia)	Tecnoglass	Tecnoglass (Colombia)	Tecnoglass (Columbia)	NO	1/4" R43/28 #2 - 5/8" A.S. - 1/4" Clear	41%	35%	14%	0.30	0.24	0.28	1.46
5	AGC Energy Select 23	AGC (USA)	AGC	AGC (USA)	JEBerkowitz (New Jersey, USA)	NO	1/4" ES23 #2 - 5/8" A.S. - 1/4" Clear	50%	22%	22%	0.29	0.27	0.23	2.17
6	Guardian SNX 51/23	Guardian (USA)	Guardian	Guardian (USA)	Tecnoglass or JEBerkowitz (Colombia) (USA)	NO	1/4"SNX51/23 #2 - 5/8" A.S. - 1/4" Clear	51%	14%	14%	0.29	0.27	0.23	2.22
7	Viracon VRE1-43	Pilkington (Typically) (USA)	Viracon	Viracon (USA)	Viracon (Minnesota, USA)	NO	1/4" VRE1-43 #2 - 5/8" A.S. - 1/4" Clear	43%	25%	19%	0.30	0.23	0.22	1.95
8	Guardian SNR 43 (JEBerkowitz)	Guardian (USA)	Guardian	Guardian (USA)	JEBerkowitz (New Jersey, USA)	NO	1/4" SNR 43 #2 - 5/8" A.S. - 1/4" Clear	43%	28%	14%	0.29	0.27	0.23	1.87


DEERE

GLASS SELECTION KEY

VIRACON VE1-2M (SPANDREL)	GUARDIAN SNR43 (SPANDREL)	VIRACON VRE1-43 (SPANDREL)	VIRACON VRE1-46 #2 VZE-SC #3 (SPANDREL)	GUARDIAN AG43 #2 SN68 #3 (SPANDREL)	AGC ES23 (SPANDREL)
VIRACON VE1-2M (CLEAR)	GUARDIAN SNR43	VIRACON VRE1-43	VIRACON VRE1-46 #2 VZE-SC #3	GUARDIAN AG43 #2 SN68 #3	AGC ES23

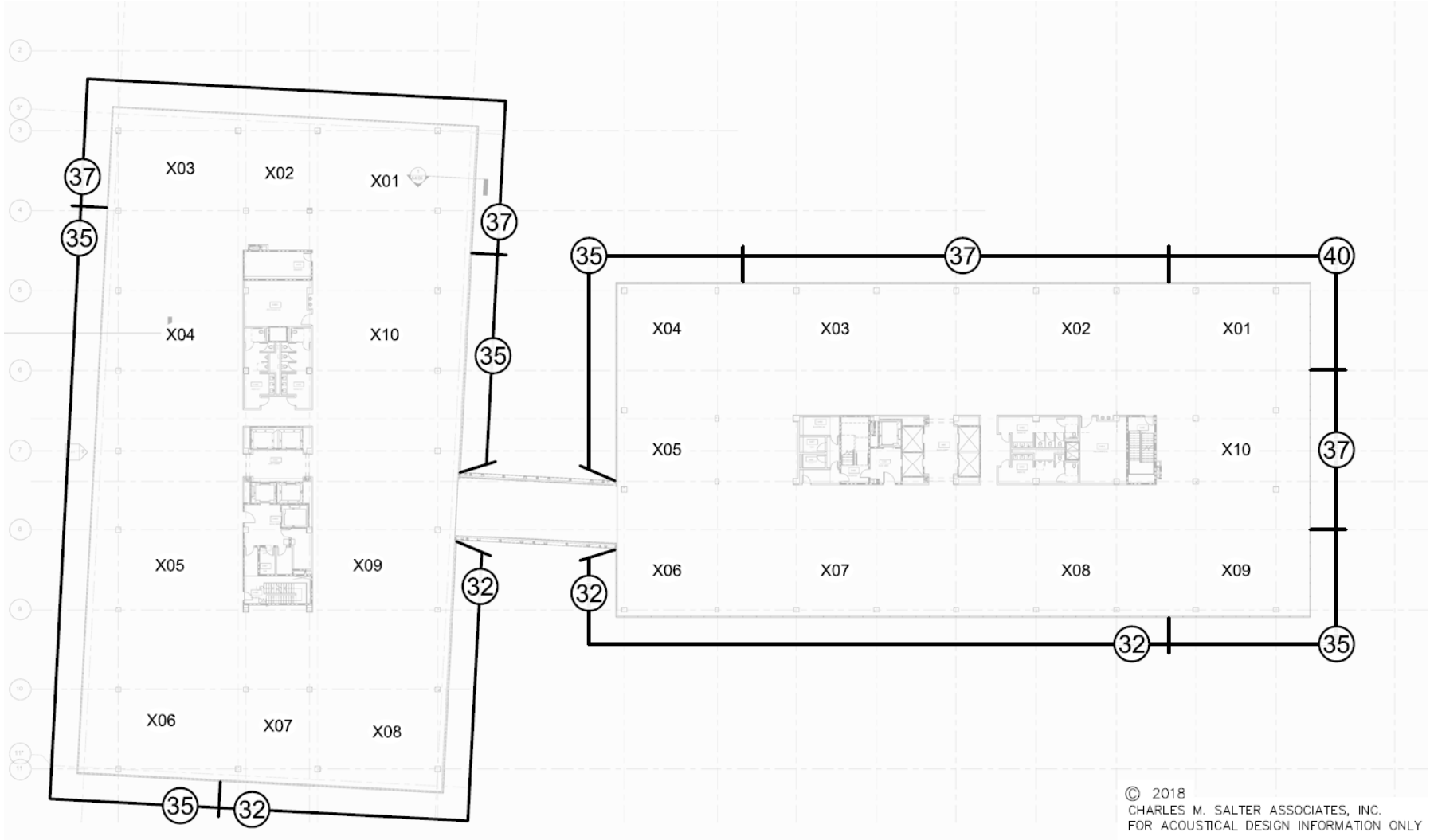

MEL-ROL
NO SMOKING

Case Study:
Asurion Headquarters

Site Plan

Noise Measurement Locations

Minimum STC Ratings as Required by California Green Building Standards



Sample Glazing and Assemblies with Associated STC Ratings

- STC 32: 1/4-inch glass + 1/2-inch airspace + 1/4-inch glass
- STC 35: 1/4-inch glass + 1/2-inch airspace + 1/4-inch laminated glass
- STC 37: 1/4-inch laminated glass + 1/2-inch airspace + 1/4-inch laminated glass
- STC 40: 3/8-inch glass + 3/4-inch airspace + 1/2-inch laminated glass
- STC 42: 3/8-inch laminated glass + 3/4-inch airspace + 1/2-inch laminated glass
- STC 44: STC 34 assembly + 4-inch airspace + 1/4-inch laminated glass
- STC 46: STC 37 assembly + 4-inch airspace + 1/4-inch laminated glass

Simulation Criteria

- Evaluated source noise transmission through window assembly “filters”
- STC is laboratory-tested metric
- STC rating of full window assemblies (glass and frame), derived from performance of glass only
- Adjusted for assumed room sizes and background noise levels
- Three assemblies evaluated: STC 31, STC 37, STC 40

Insulating Laminated Acoustical Data

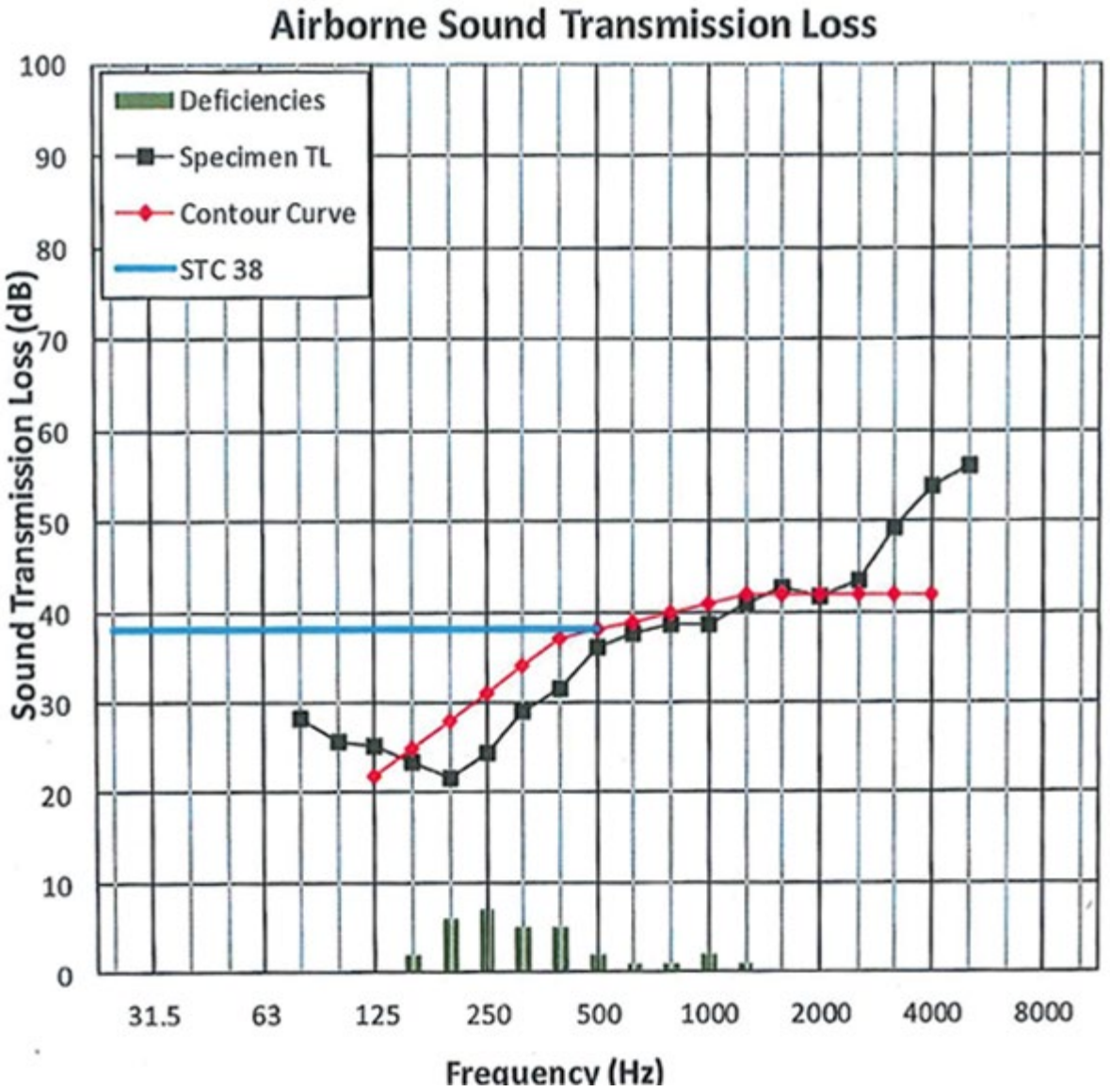
Insulating Laminated Glass Construction	STC	OITC*	Frequency (Hz)																	
			100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
			Sound Transmission Loss (dB)																	
13/16" overall - 3/16" glass, 3/8" airspace, 1/8" glass, .030" PVB, 1/8" glass	37	31	27	27	26	24	22	28	32	35	38	38	39	40	42	43	41	45	52	57
15/16" overall - 3/16" glass, 1/2" airspace, 1/8" glass, .030" PVB, 1/8" glass	39	31	26	23	25	23	27	31	34	36	38	39	41	43	45	46	43	49	55	55
1" overall - 1/4" glass, 1/2" airspace, 1/8" glass, .030" PVB, 1/8" glass	39	31	28	20	29	24	26	30	34	36	39	42	43	44	44	41	40	47	52	56
1-5/16" overall - 1/4" glass, 1/2" airspace, 1/4" glass, .075" Storm, 1/4" glass	39	34	29	25	30	27	31	34	35	34	36	38	40	41	42	43	44	47	50	49
1-5/16" overall - 1/4" glass, 1/2" airspace, 1/4" glass, .090" SGP, 1/4" glass	39	34	29	24	32	27	32	34	35	34	36	38	40	40	41	41	42	46	48	49
1-1/8" overall - 1/4" glass, 1/2" airspace, 1/4" glass, .030" PVB, 1/8" glass	40	30	28	17	28	29	33	34	38	40	40	41	41	41	41	40	43	49	54	58
1-1/16" overall - 1/4" glass, 7/16" airspace, 3/16" glass, .030" PVB, 3/16" glass	40	33	31	25	30	27	29	34	36	37	39	40	42	43	42	41	44	47	51	51
1-5/16" overall - 1/4" glass, 1/2" airspace, 1/4" glass, .100" Stormguard, 1/4" glass	40	34	28	23	30	28	32	35	36	36	37	39	41	43	43	43	45	48	50	49
1-5/8" overall - 1/4" glass, 1" airspace, 3/16" glass, .030" PVB, 3/16" glass	40	32	24	24	31	28	33	36	37	39	39	40	41	41	41	42	43	47	49	47
1-1/16" overall - 1/4" glass, 1/2" airspace, 1/8" glass, .060" PVB, 1/8" glass	41	32	24	23	28	26	28	33	36	37	39	42	44	46	46	43	44	50	53	55
1-1/8" overall - 1/4" glass, 1/2" airspace, 3/16" glass, .030" PVB, 3/16" glass	41	35	32	27	29	28	31	35	37	39	41	42	43	44	43	42	45	50	53	54
1-1/16" overall - 1/4" glass, 7/16" airspace, 3/16" glass, .030" AC, 3/16" glass	41	34	31	26	29	26	30	33	36	36	39	42	44	45	45	44	45	49	51	50
1-3/16" overall - 1/4" glass, 1/2" airspace, 3/16" glass, .060" PVB, 3/16" glass	42	35	30	29	31	28	31	34	37	39	41	42	44	46	45	44	47	52	55	60
1-5/16" overall - 1/4" glass, 1/2" airspace, 1/4" glass, .060" PVB, 1/4" glass	42	34	29	24	30	29	32	37	40	40	41	42	44	45	44	45	48	53	57	59
1-5/16" overall - 1/4" glass, 5/8" airspace, 3/16" glass, .060" PVB, 3/16" glass	42	35	29	24	30	29	32	37	40	40	41	42	44	45	44	45	48	53	57	59

Lab Testing of Glazing Assembly

Photo No. 1
Receive Room View of Installed Test Specimen

Photo No. 2
Source Room View of Installed Test Specimen

Test Results

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innovations
SOUTHEAST

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Aesthetics to Performance

- LEED 2007 Daylighting Impacts for Certification
- Daylighting and Views
- Visible Light Transmittance

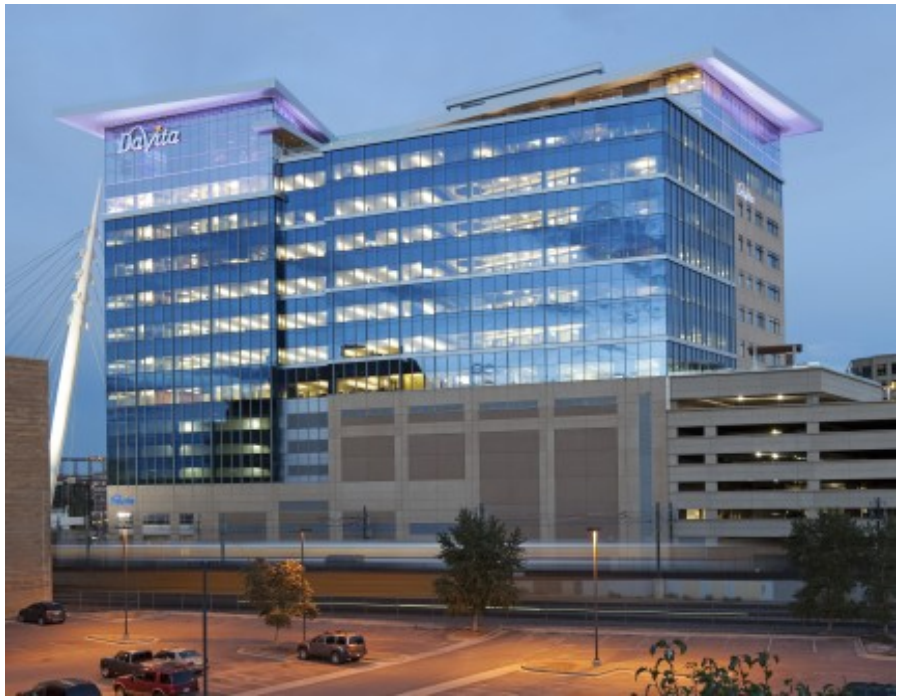
Aesthetics to Performance

- Solar Control Impacts Occupant Comfort

- Glare Impacts to Occupants
  - Blinding Glare
  - Disability Glare
  - Discomfort Glare

Aesthetics to Performance

- Controlling Glare
  - Exterior Envelope Components
- Glazing Performance
  - Visible Light Sweet Spot
  - Balancing Light and Glare
- Occupant Comfort as a Primary Goal



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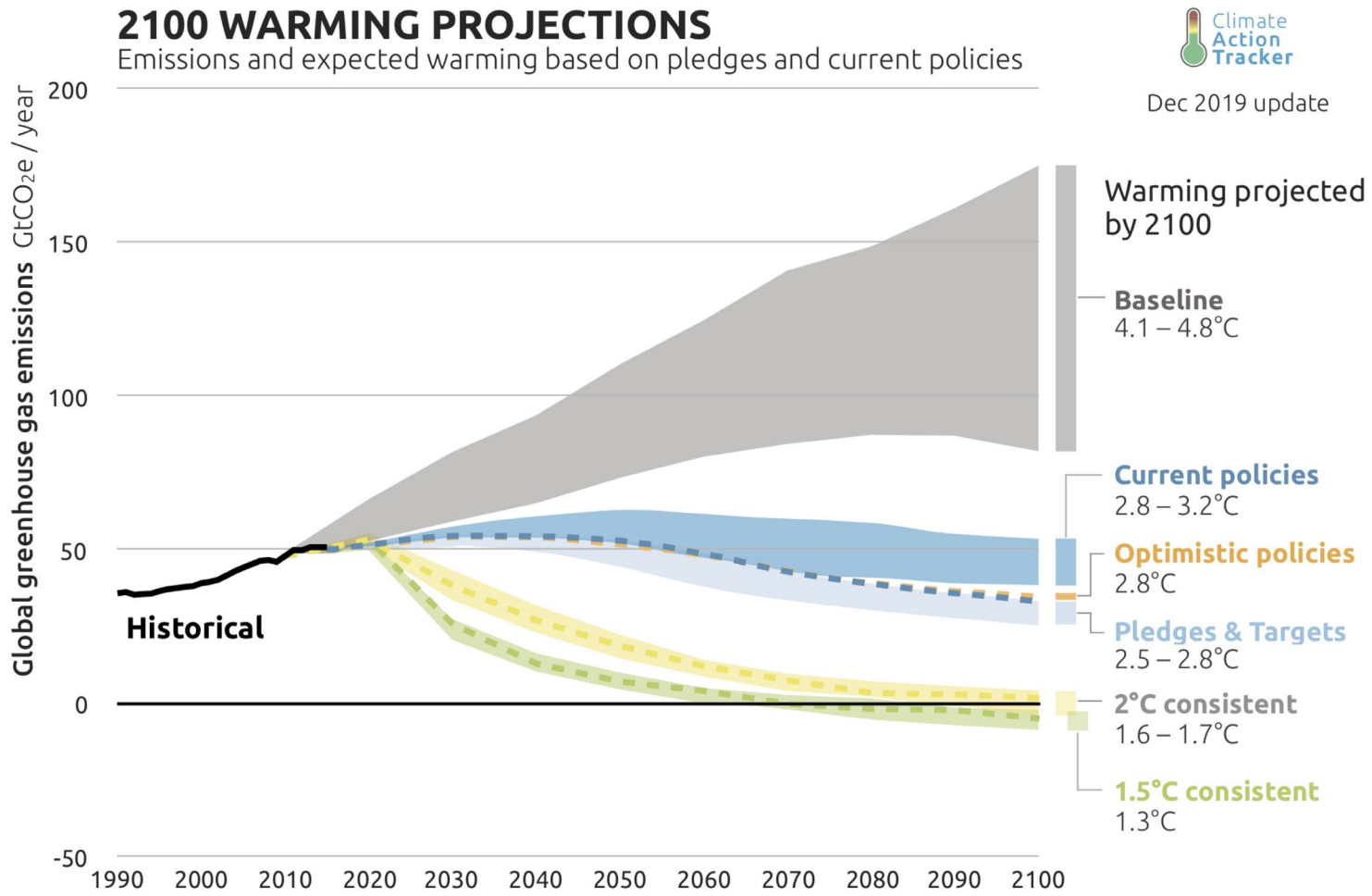
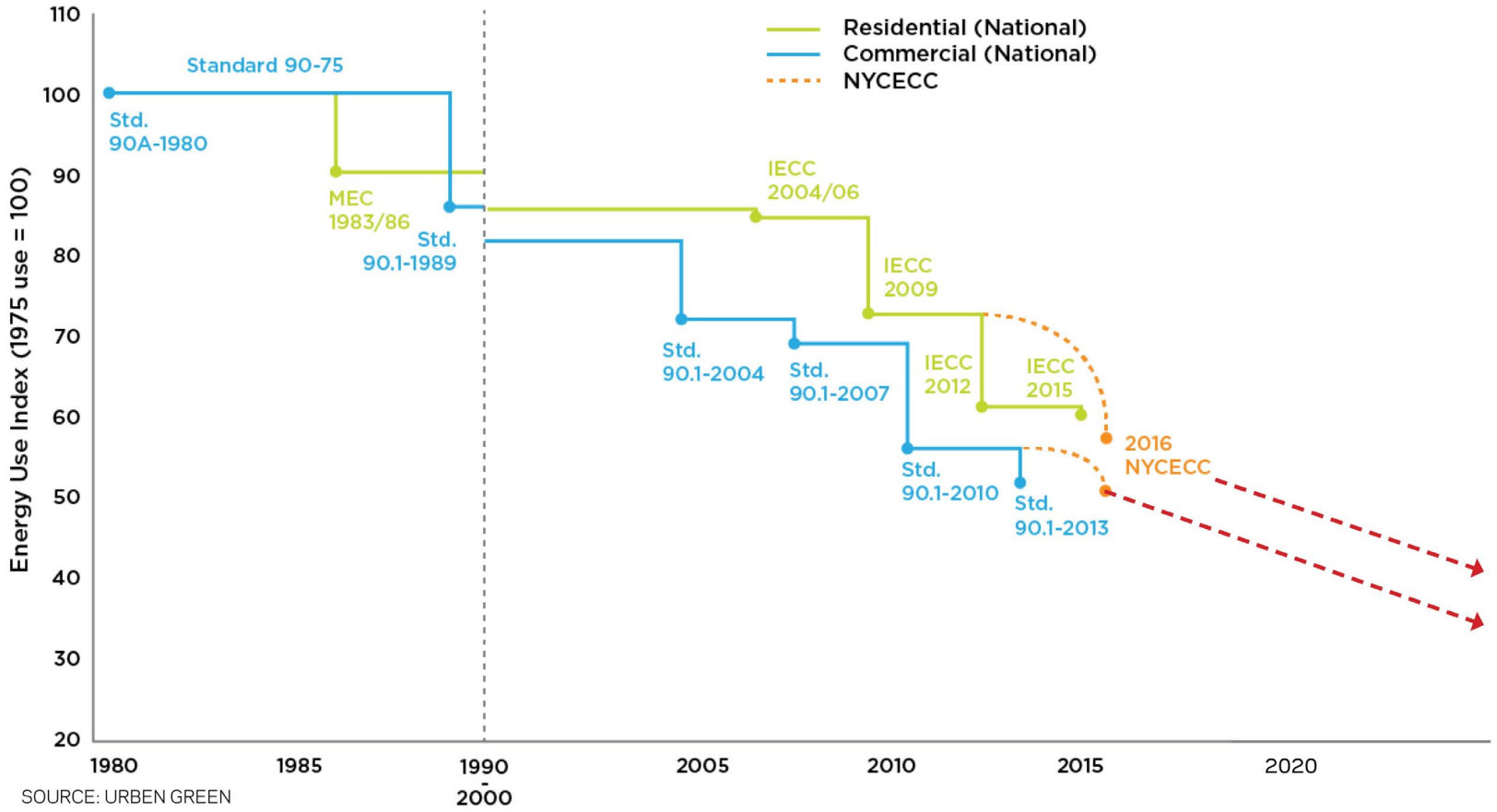
BETTER GLASS PERFORMANCE



BETTER GLASS PERFORMANCE

ENERGY CODE UPDATES OVER TIME



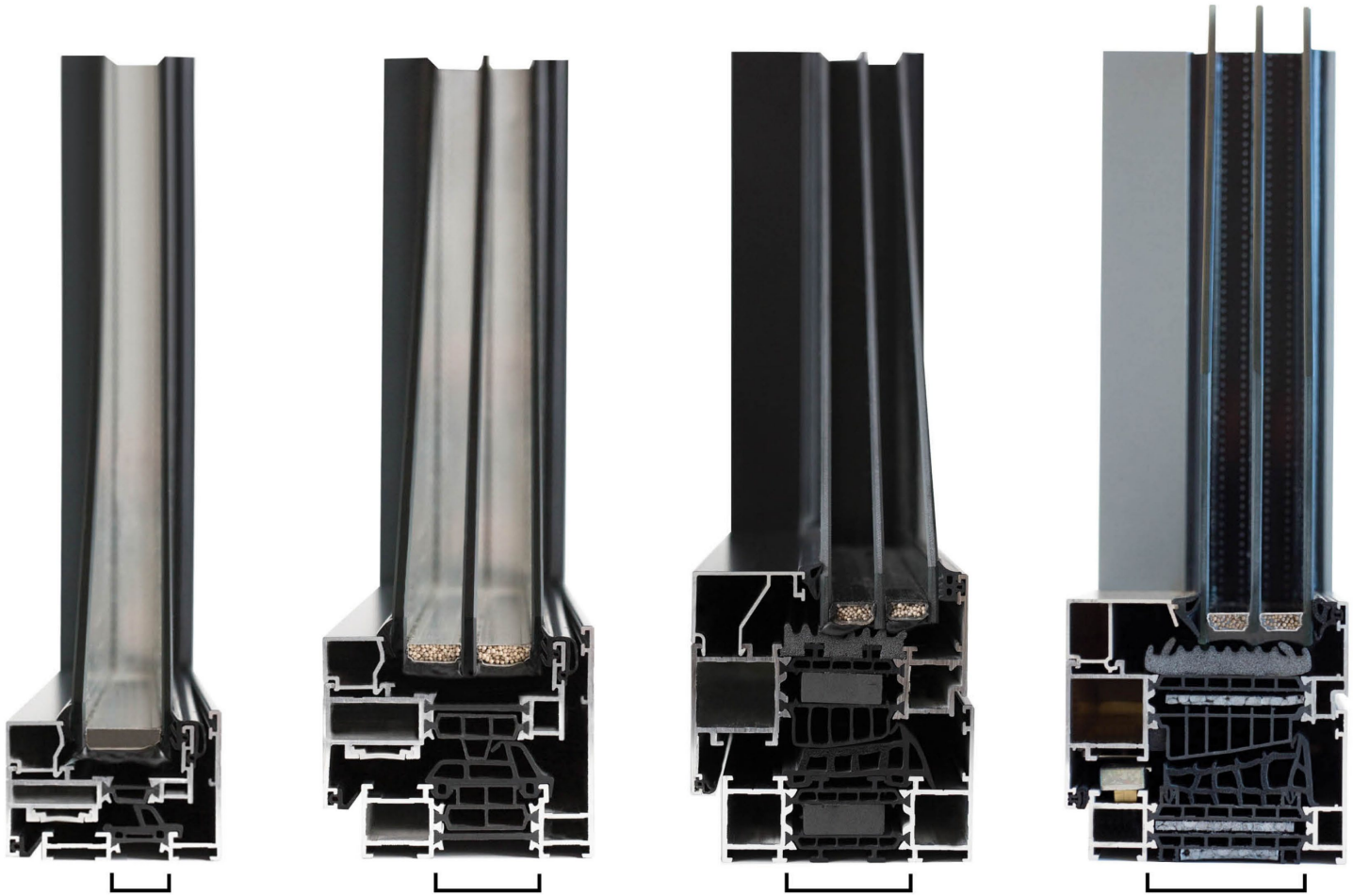
SOURCE: URBEN GREEN

BETTER GLASS PERFORMANCE

NYCECC 2020 - PRESCRIPTIVE FENESTRATION U-VALUES

Table C402.4 Building Envelope Fenestration Max. U-Factor & SHGC Requirements						
Climate Zone	**Units**	**4 Except Marine**				
		2016 NYCECC	**2020 NYCECC**			
			Below 95'	% change	**Above 95'**	% change
Vertical Fenestration						
U-Factor						
Vertical Fixed Fenestration	U	0.38				
Vertical Operable Fenestration	U	0.45				
Non-metal Framing, All	U		0.28	36%	0.28	36%
Metal Framing, Fixed	U		0.30	27%	0.36	6%
Metal Framing, Operable	U		0.40	13%	0.42	7%
Curtainwall, Fixed	U		0.36	6%	same as below 95'	
Entrance Doors	U	0.77	0.77	0%	same as below 95'	

BETTER GLASS PERFORMANCE



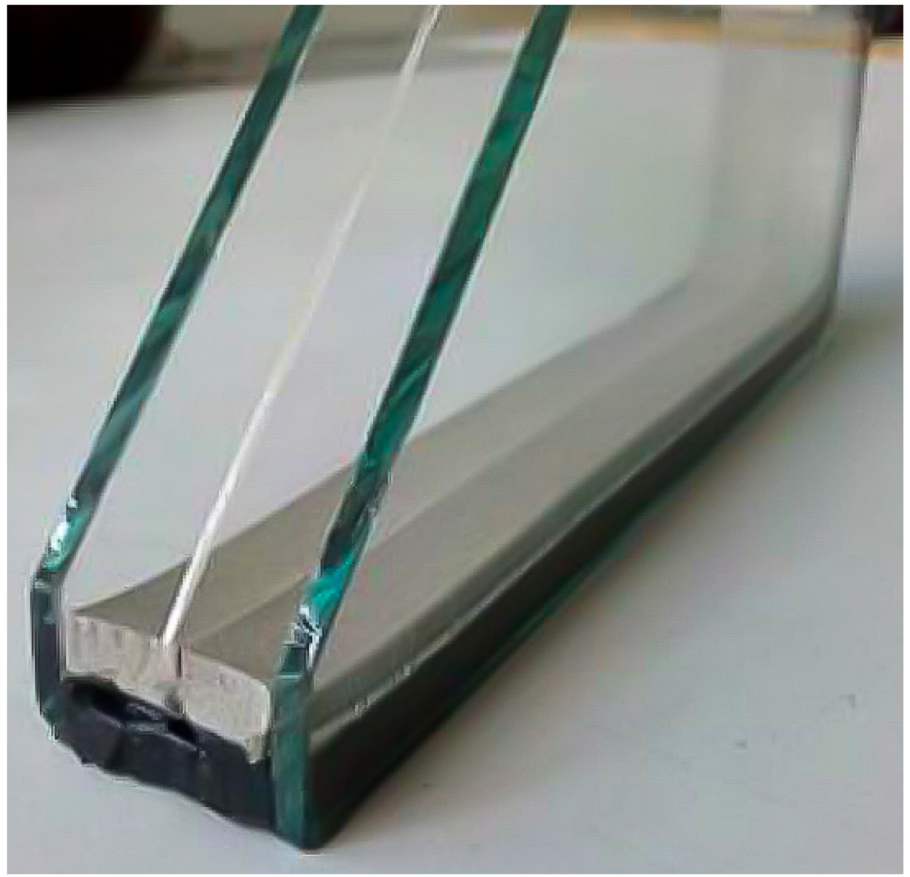
1/2" THERMAL BREAK
U-0.33

1 3/8" THERMAL BREAK
U-0.2

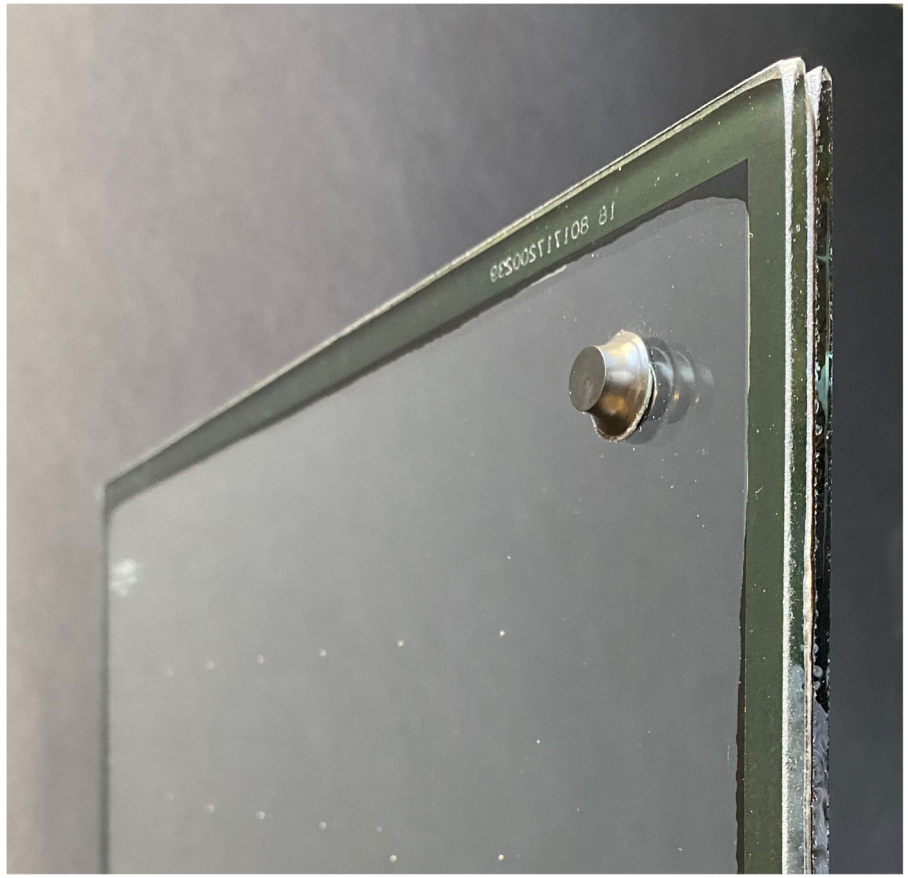
1 5/8" THERMAL BREAK
U-0.14

2 3/8" THERMAL BREAK
U-0.093

BETTER GLASS PERFORMANCE

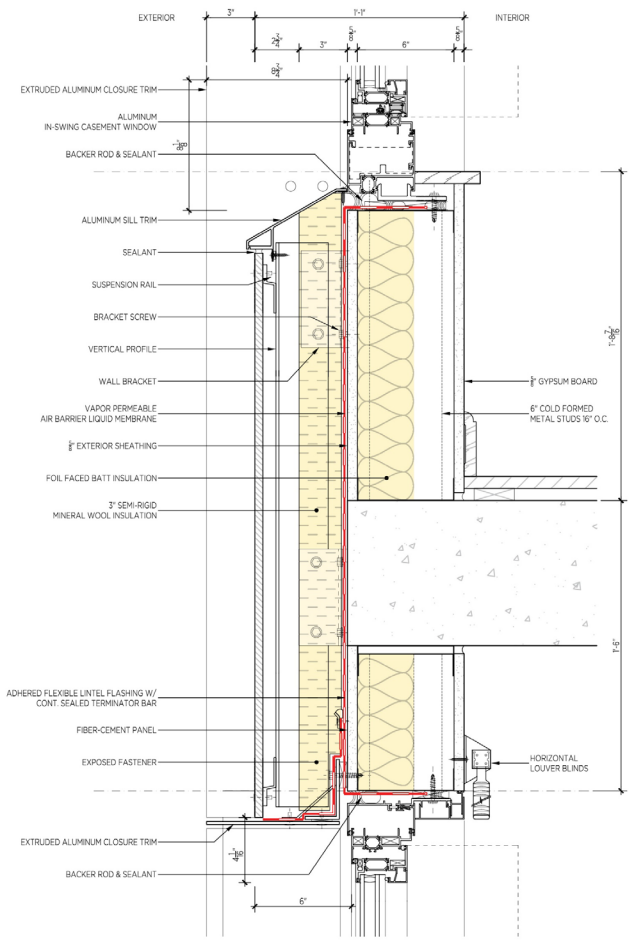


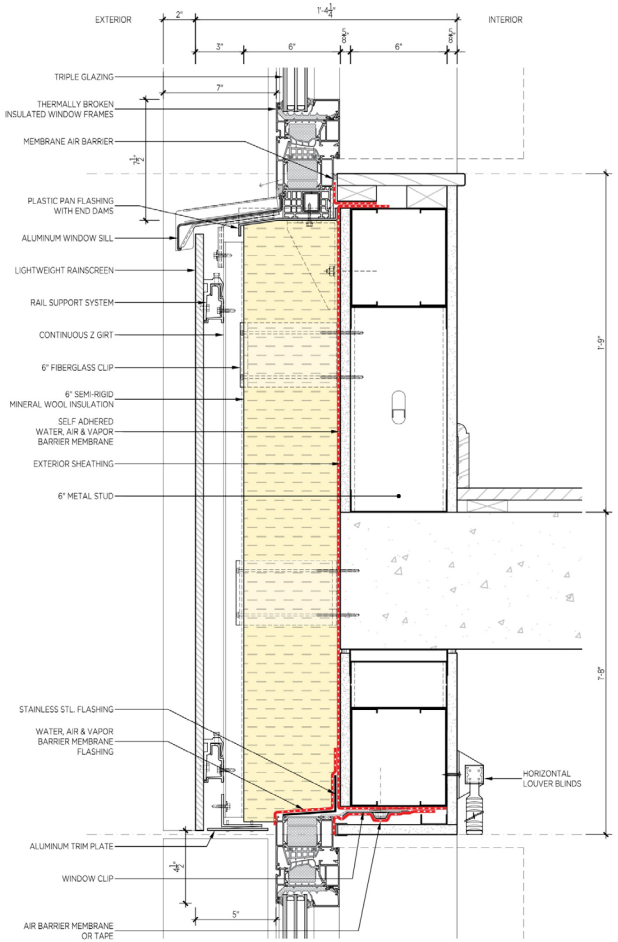
Thin Triple Glazing



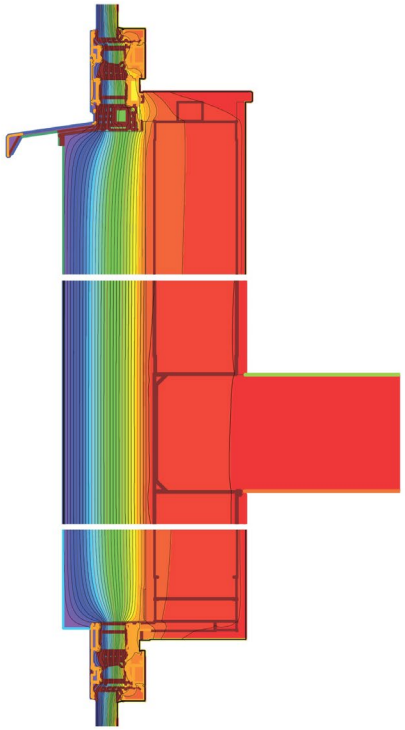
Vacuum Insulated Glazing

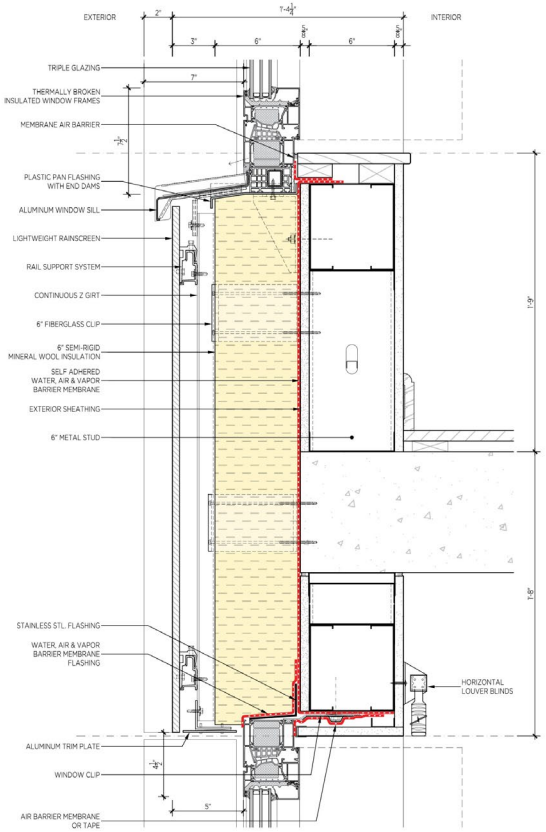
THERMAL BRIDGE MITIGATION & AIR-TIGHTNESS





THERMAL BRIDGE MITIGATION & AIR-TIGHTNESS





THERMAL BRIDGE MITIGATION & AIR-TIGHTNESS

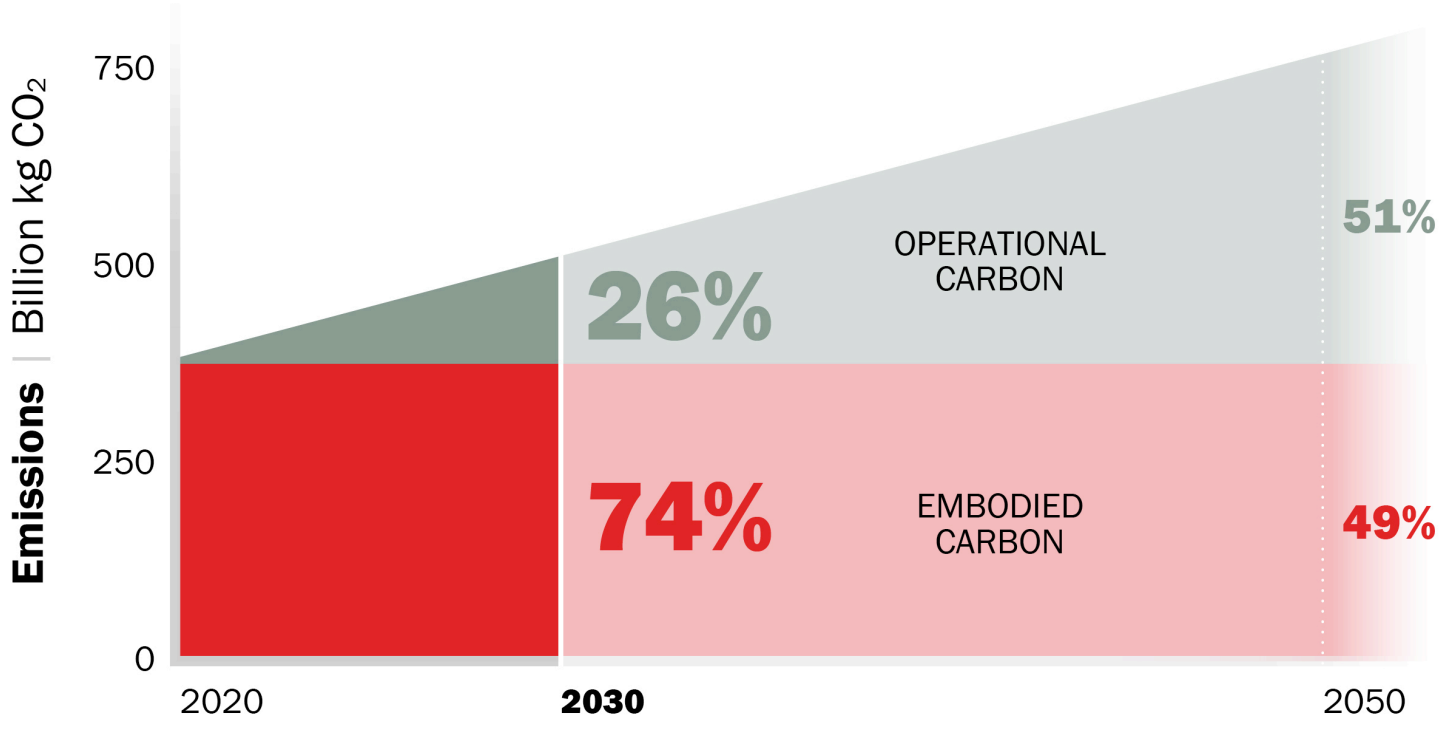
THERMAL BRIDGE MITIGATION & AIR-TIGHTNESS

Window Sealant Failure

Window With Air Barrier Tape

EMBODIED CARBON

Total Carbon Emissions of Global New Construction from 2020–2050



DATA SOURCE: ARCHITECTURE 2030

EMBODIED CARBON

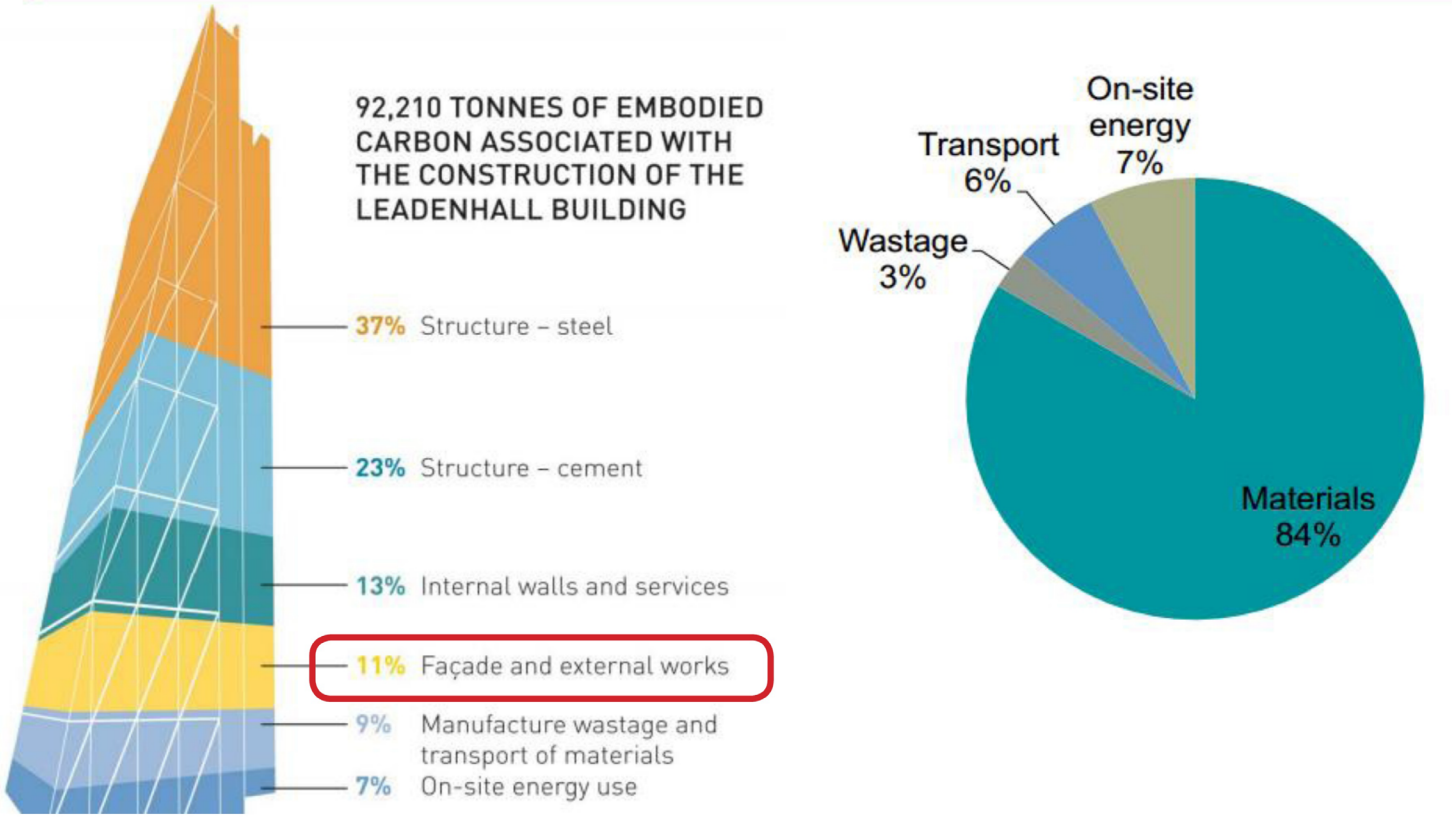
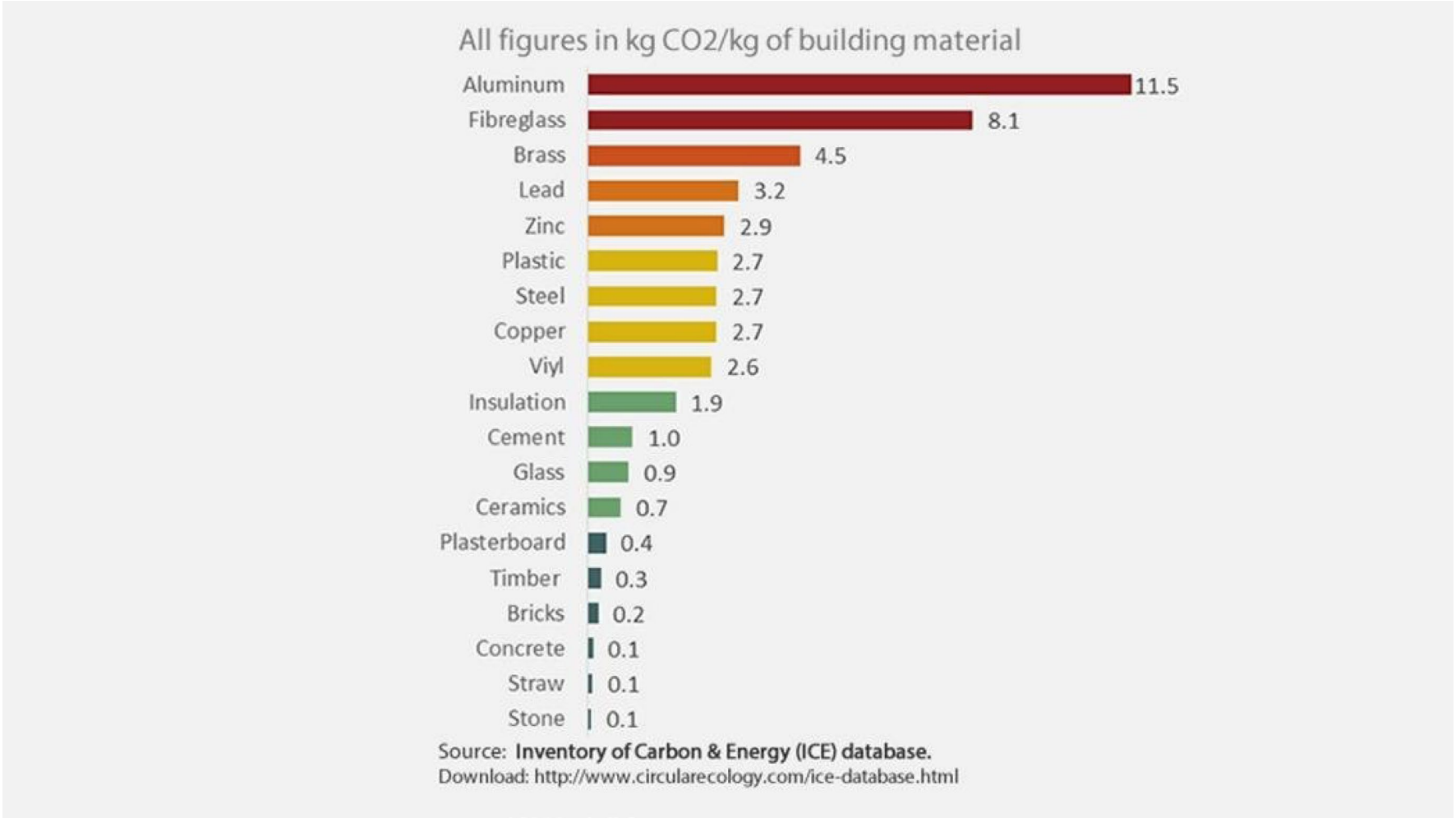


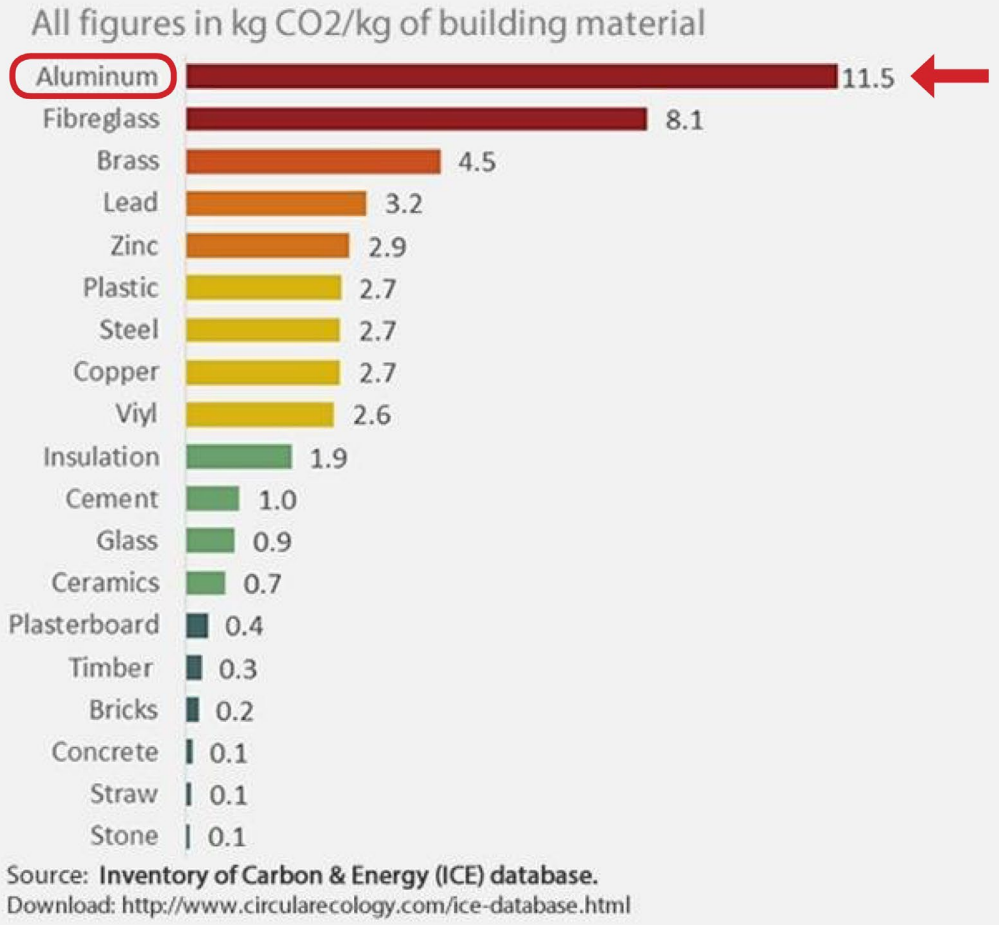
Figure 3: Proportions of embodied carbon in the different elements of the Leadenhall Building (courtesy of British Land)

EMBODIED CARBON



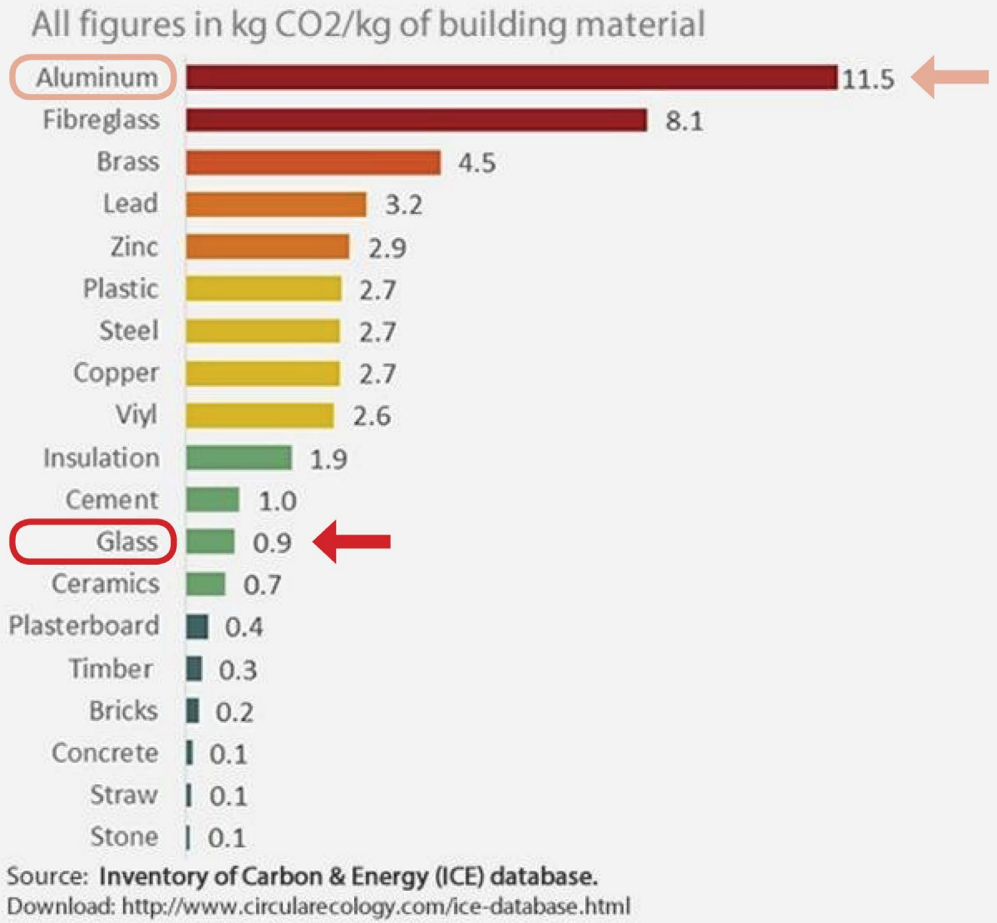
EMBODIED CARBON

Recycled Content



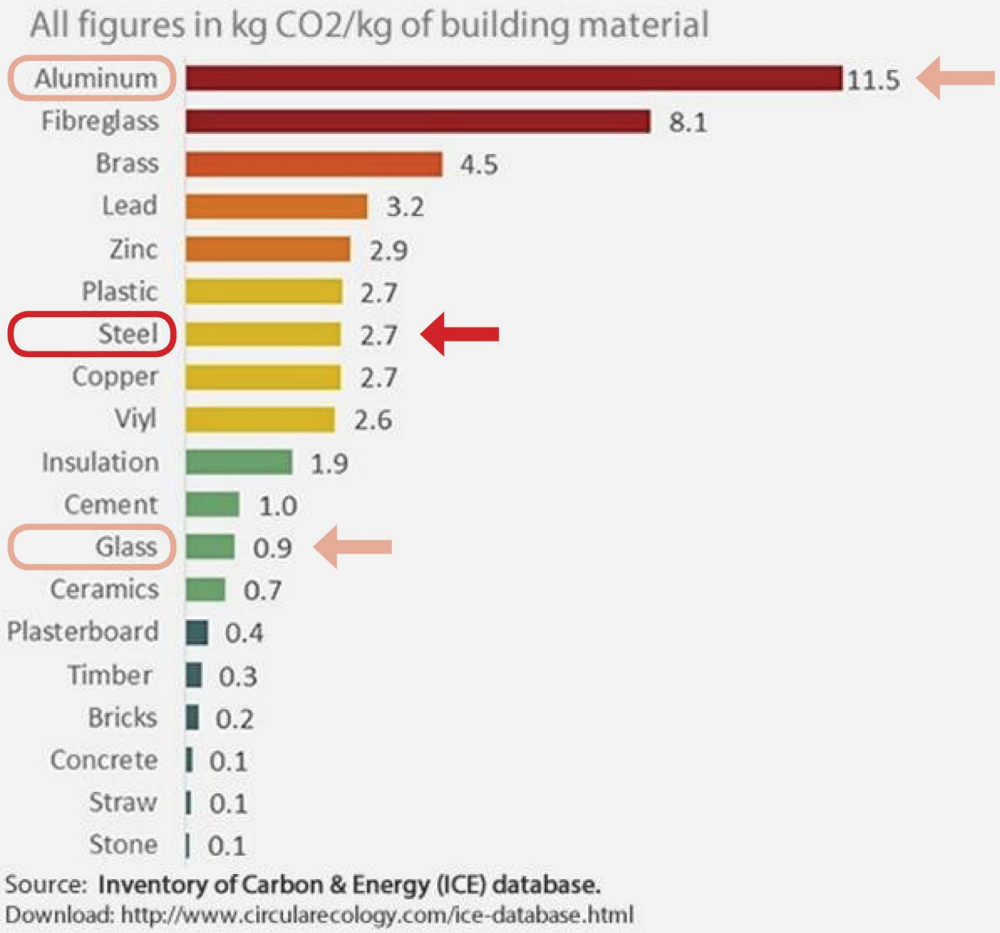
EMBODIED CARBON

Manufacturing



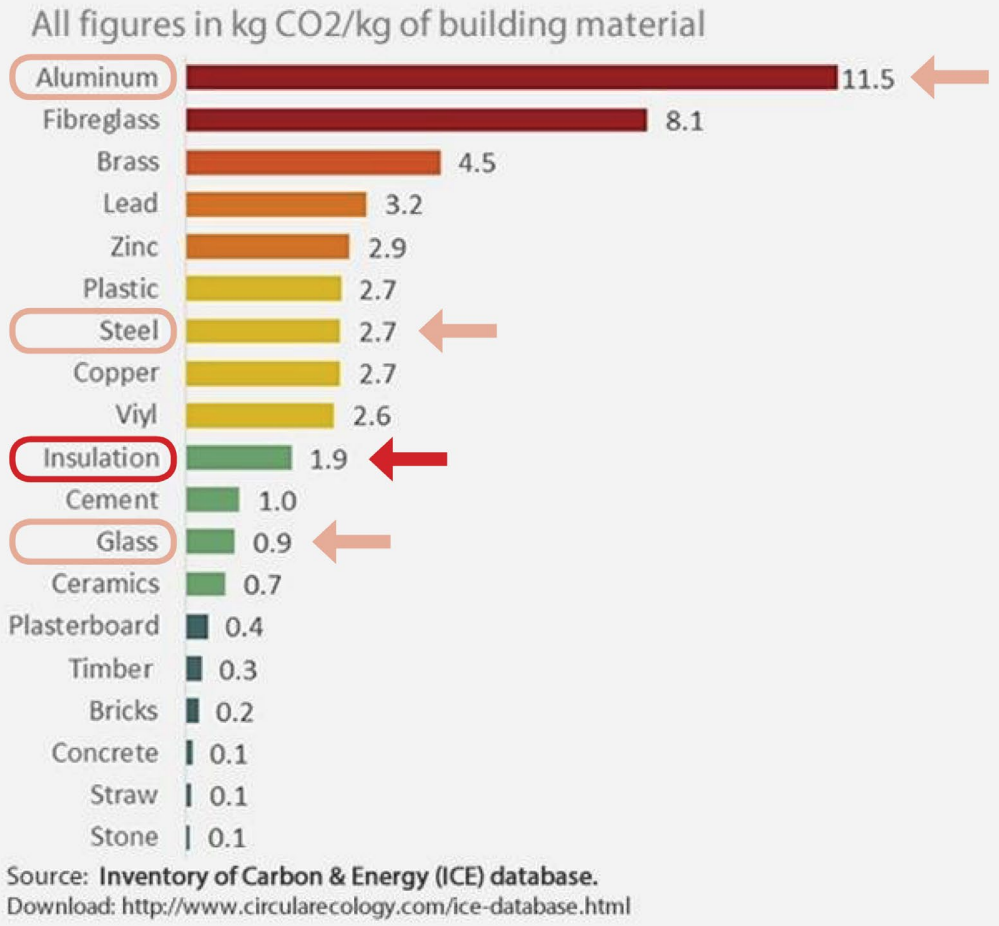
EMBODIED CARBON

Recycled Content & Manufacturing

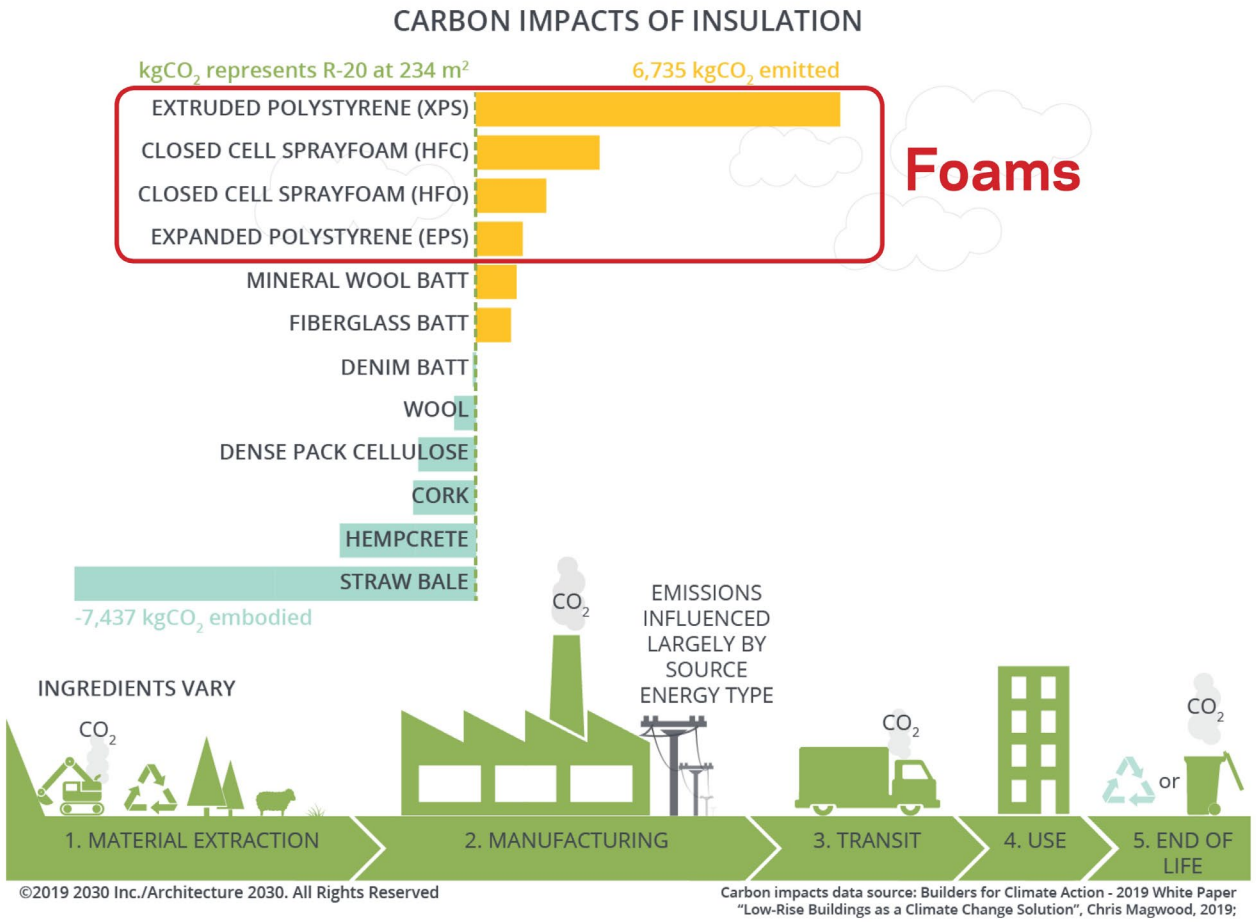


EMBODIED CARBON

Material Selection



EMBODIED CARBON



Carbon impacts data source: Builders for Climate Action - 2019 White Paper "Low-Rise Buildings as a Climate Change Solution", Chris Magwood, 2019;

NGA
NATIONAL GLASS ASSOCIATION with GANA

PANELIST DISCUSSION

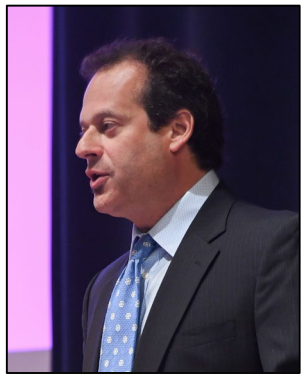
+

Q&A

THANK YOU

Glass in Architecture

a global perspective on design trends



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