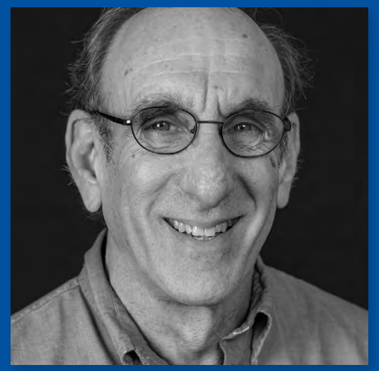
Facade Tectonics FORUM NEW YORK

CLEARLY CONTROVERSIAL

EXPLORING THE BENEFITS AND LIABILITIES OF HIGHLY GLAZED FACADES

SPEAKERS

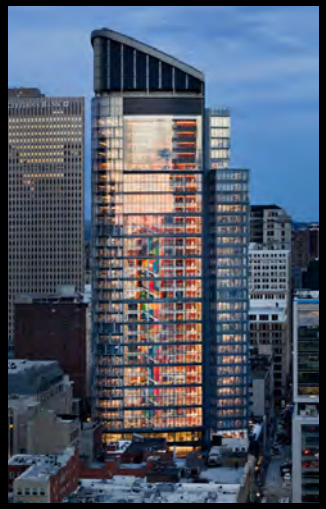


Steve Selkowitz
Senior Advisor
Lawrence Berkeley National Laboratory

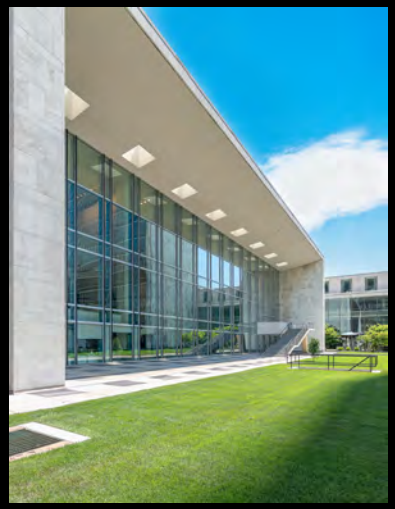
Gabrielle Brainard, AIA, CHPD
Professor
Rensselaer Polytechnic Institute, Columbia GSAPP, Pratt Institute

Areta Pawlynsky, AIA
Partner
Heintges

Mic Patterson, PhD, LEED AP+
Ambassador of Innovation & Collaboration
The Facade Tectonics Institute







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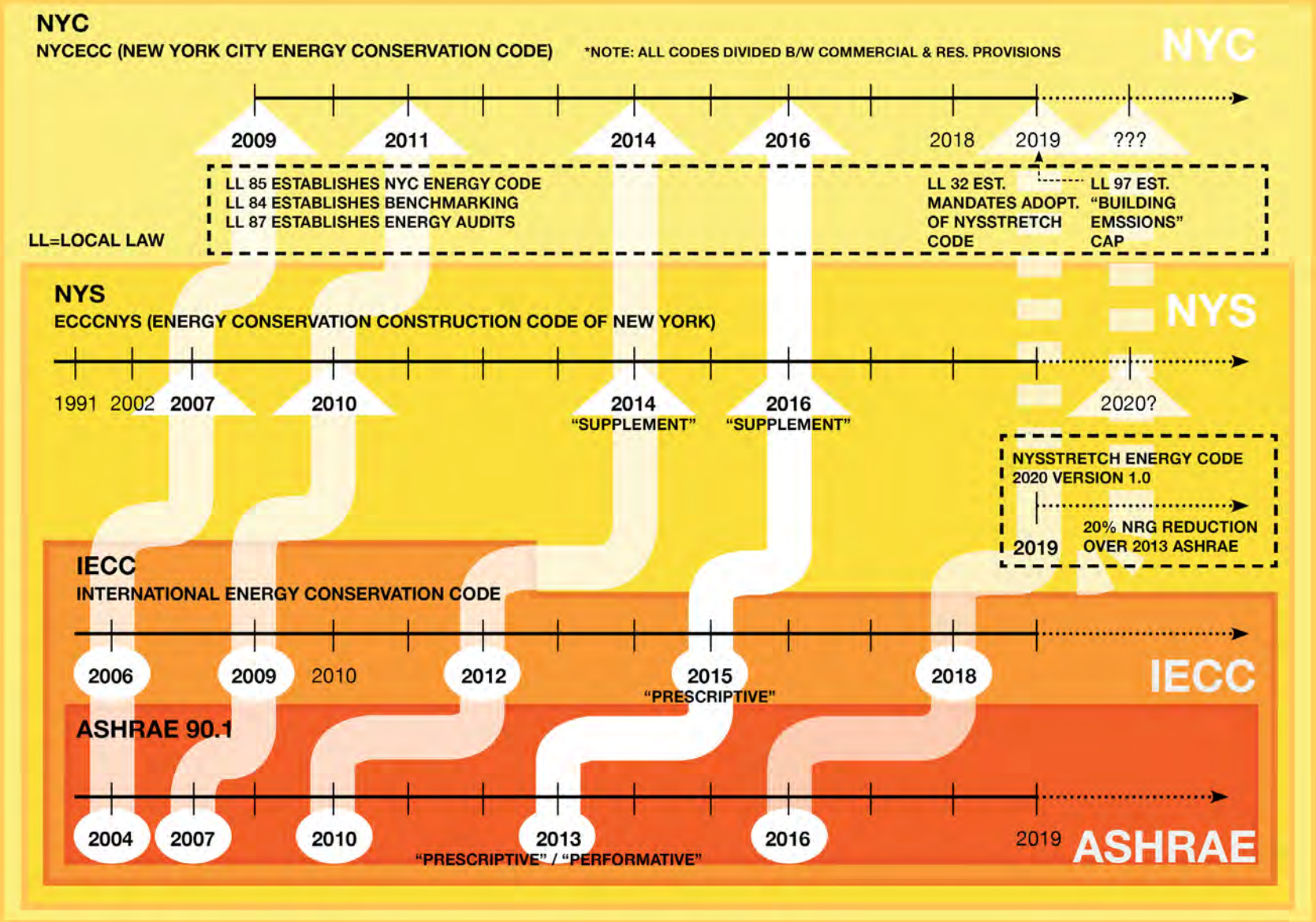
Building Envelope + Curtain Wall Consultants

“The tenuous position of federal climate change policy in the U.S. has necessitated a more market-driven, city-focused approach to energy efficiency in the building sector. Strategies and policy initiatives involve a combination of local regulations to improve efficiency standards coupled with incentives and market-based mechanisms to catalyze innovation in the marketplace and create value around building energy performance. Cities have taken the lead in this respect, with more than 50 U.S. cities adopting some form of green building policy since 2001...”

— Local Law 84 Energy Benchmarking Data Report [1]

1. Kontokosta, Constantine E. “Local Law 84 Energy Benchmarking Data: Report to the New York City Mayor’s Office of Long-Term Planning and Sustainability.” Local Law 84 Energy Benchmarking Data: Report to the New York City Mayor’s Office of Long-Term Planning and Sustainability. New York, NY, 2012.

Dissecting the Energy Code in NYC



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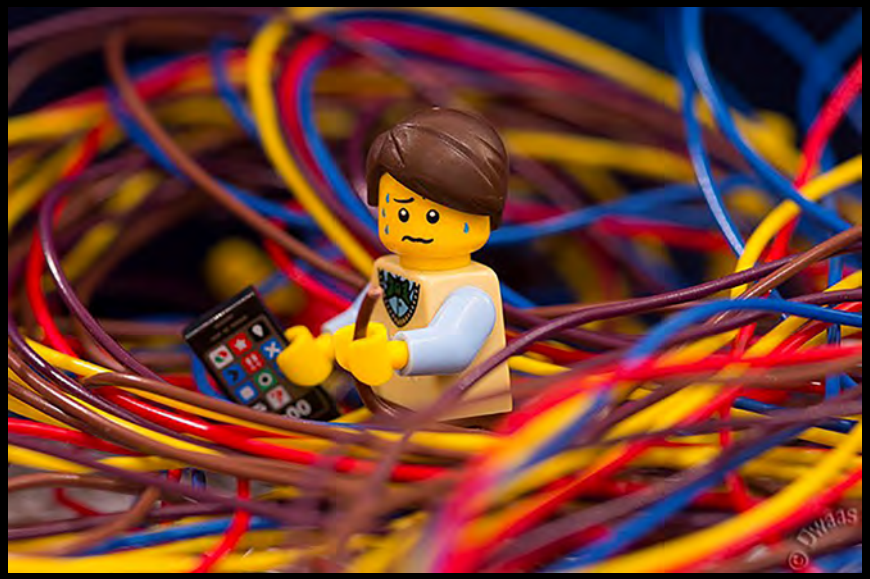

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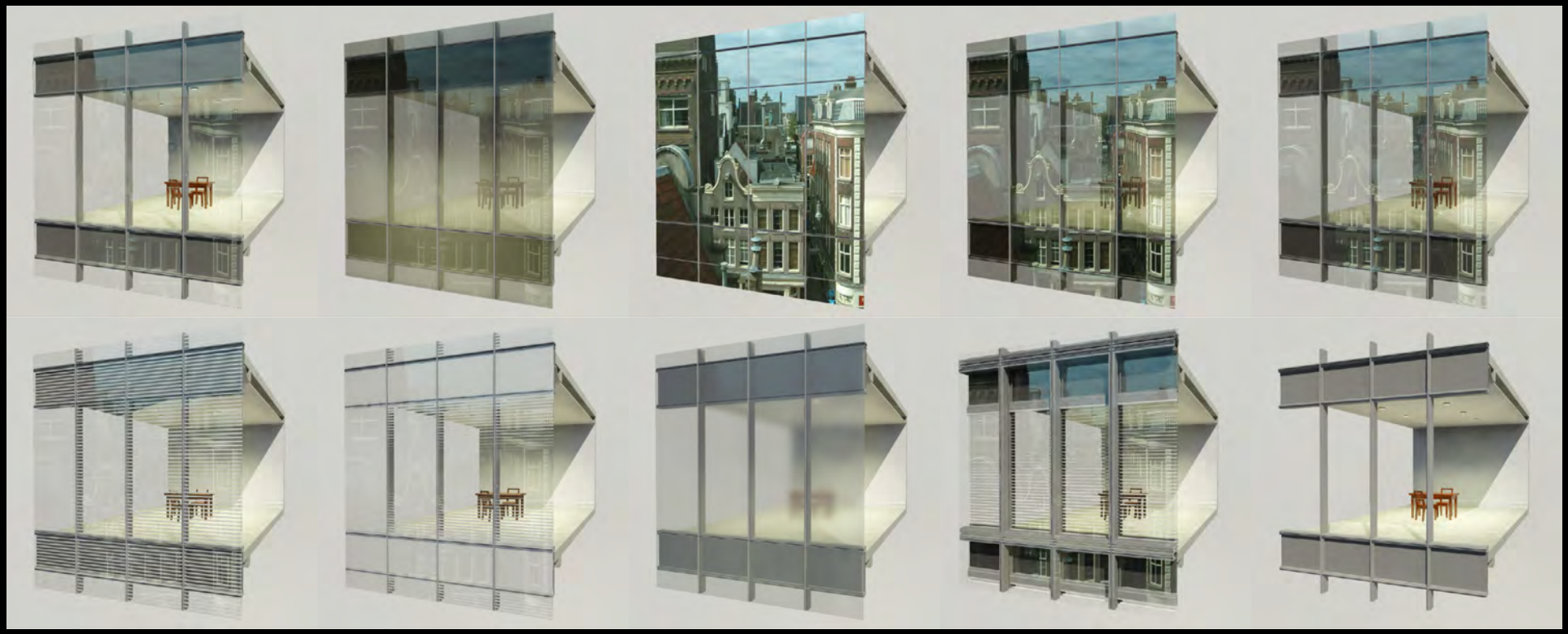
All Glass Facades?



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United Nations Headquarters Facade Renovation

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Le Corbusier, Wallace K. Harrison, Oscar Niemeyer, et al.

The Tower at PNC Plaza

Gensler

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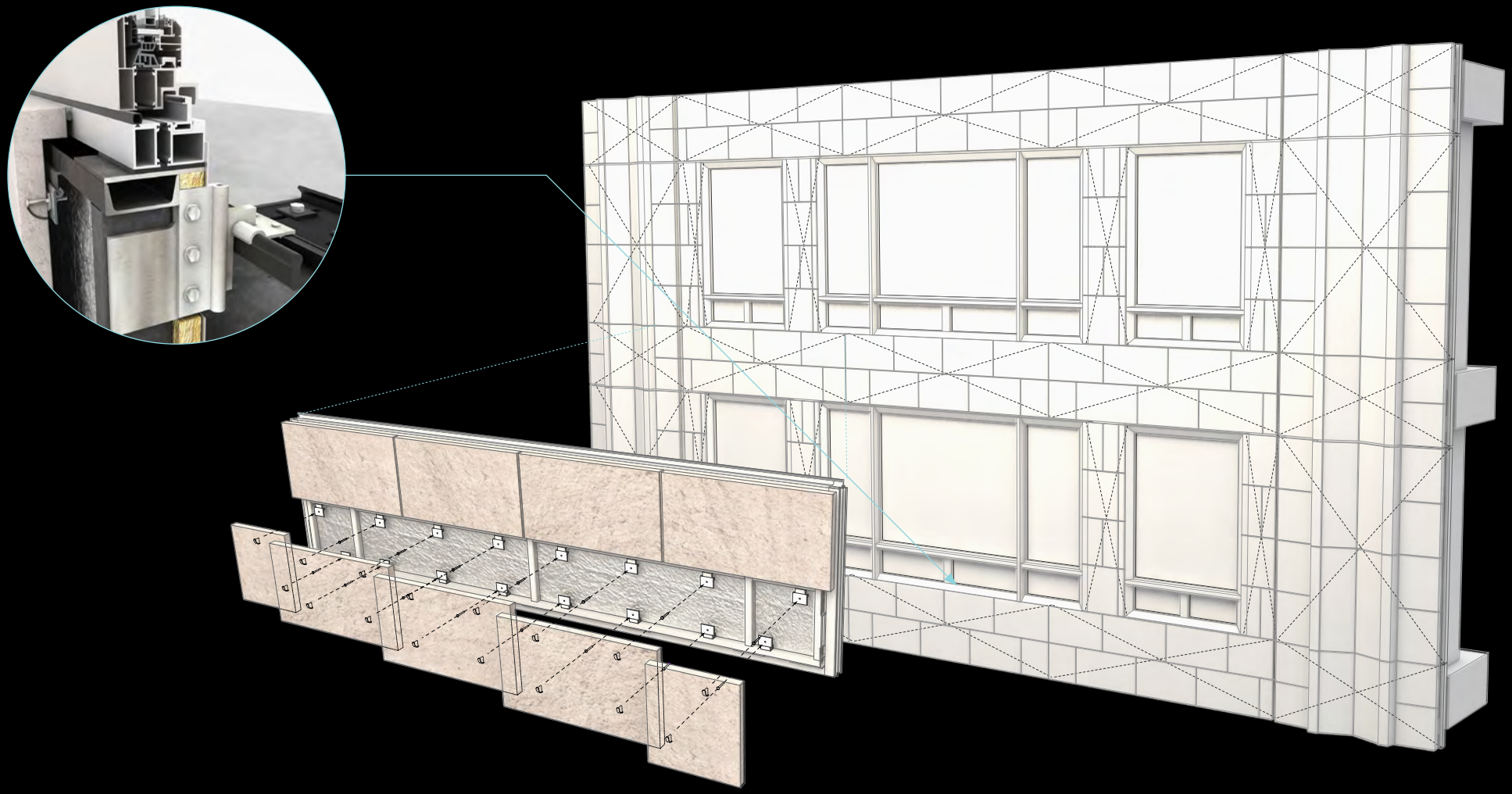
220 Central Park South

Robert A.M. Stern Architects

SLCE Architects



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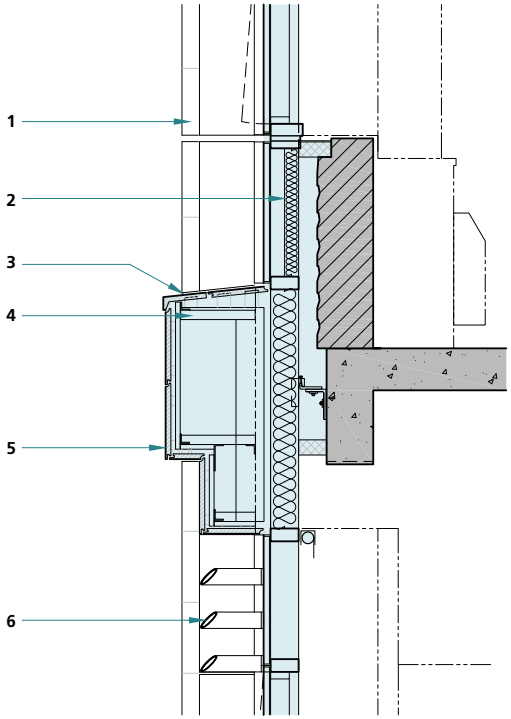
LaGuardia Community College Reclad

Mitchell Giurgola Architects

3rd Floor - Belt Course Wall Section



1 TERRACOTTA COLUMN COVER BEYOND
2 SHADOWBOX
3 TERRACOTTA SILL
4 ALUMINUM SUB-FRAMING
5 BELT COURSE
6 SUNSHADE

Drawing from Mitchell Giurgola Architects LLP

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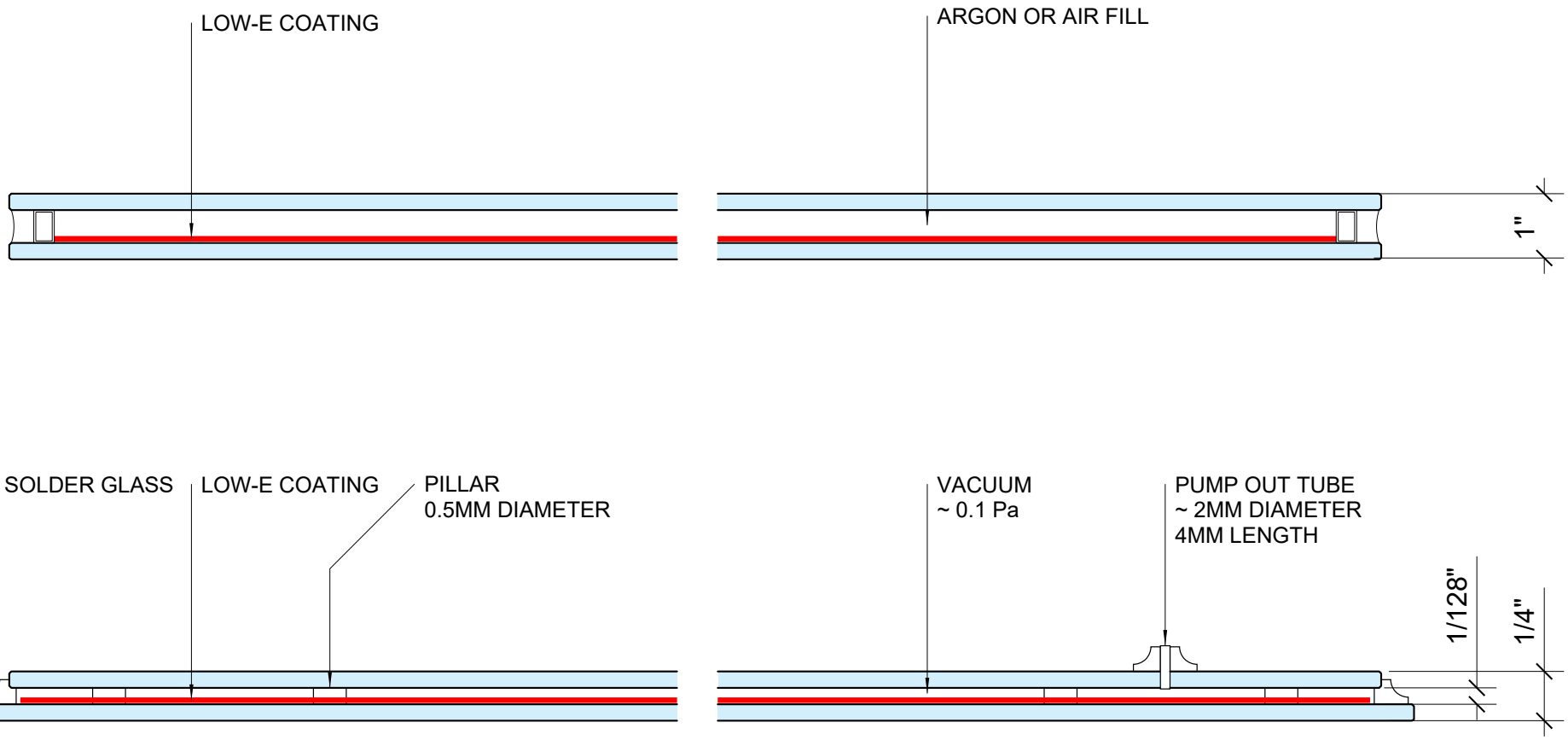
Low-e IGU vs. VIG



Information courtesy of Pilkington

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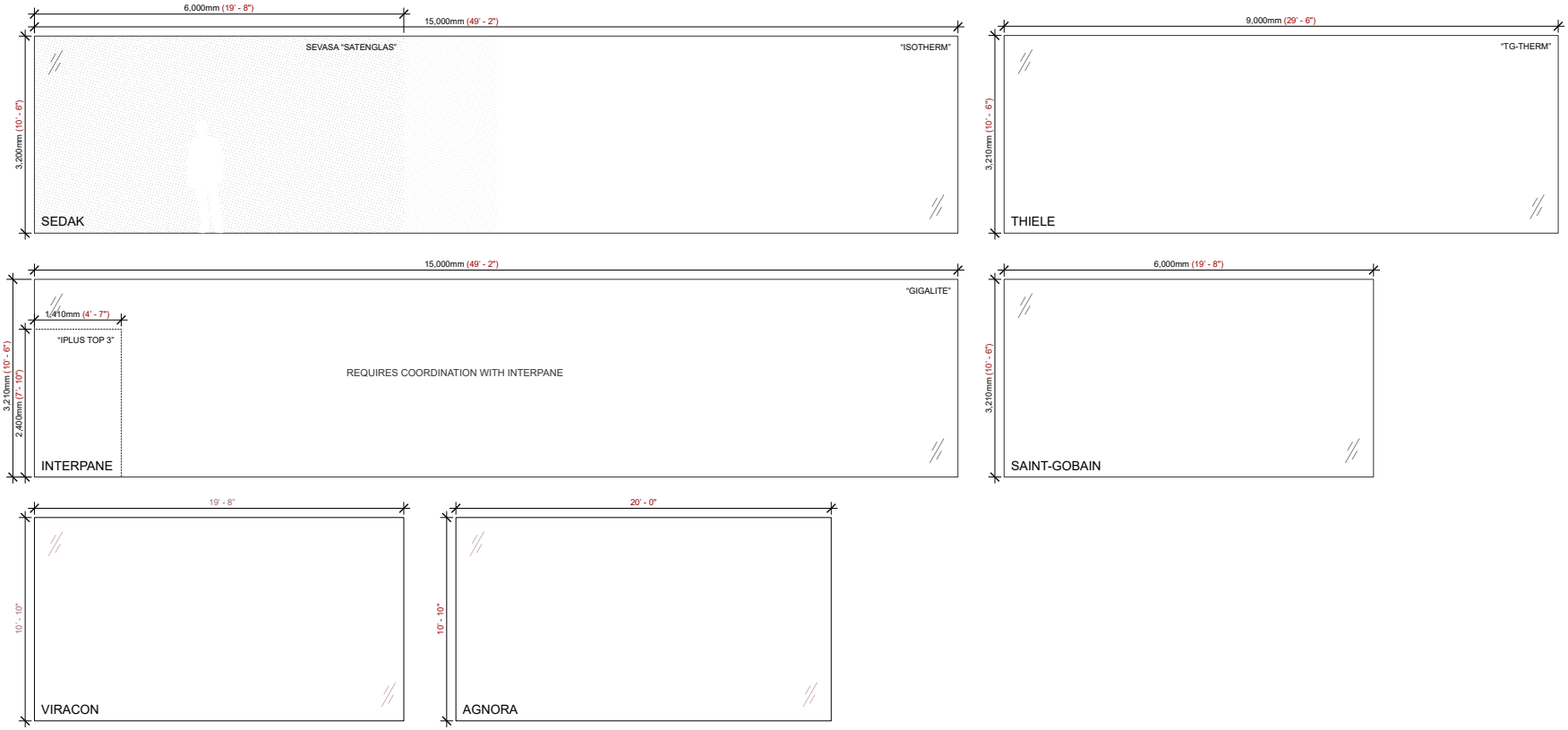
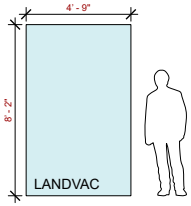
VIG vs. Triple IGU

TRIPLE GLAZED IGU MAXIMUM SIZES



VACUUM INUSLATED GLASS MAXIMUM SIZE



THERMAL PERFORMANCE

U-value for Triple IGU w/ double silver coating:
0.22 Btu/h ft2 F

U-value for Vacuum Insulated Glass:
0.14 Btu/h ft2 F

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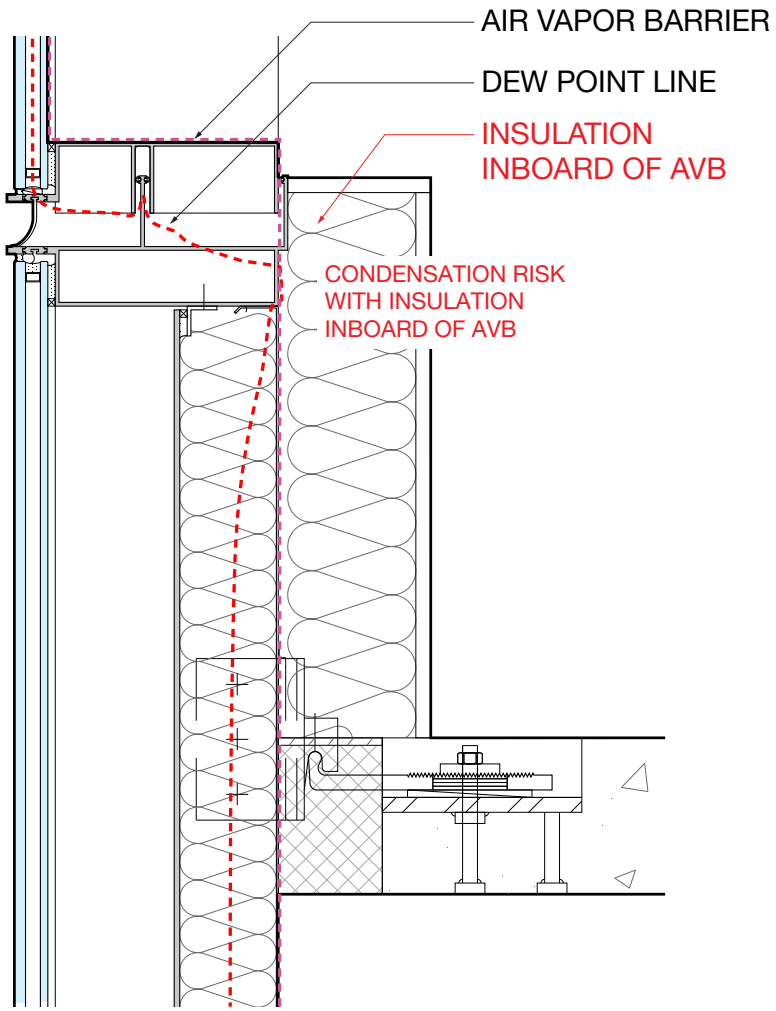
Challenges with Zone Green + Zone Greener



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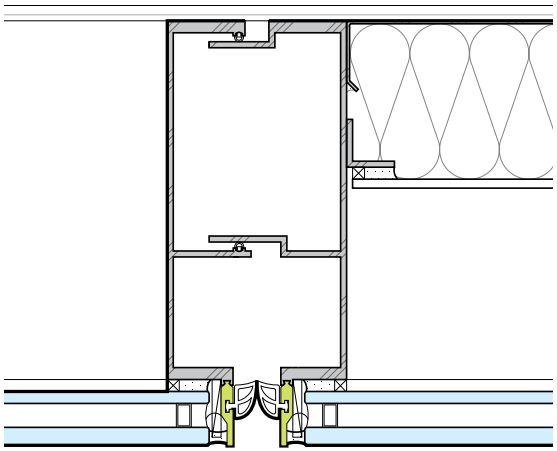
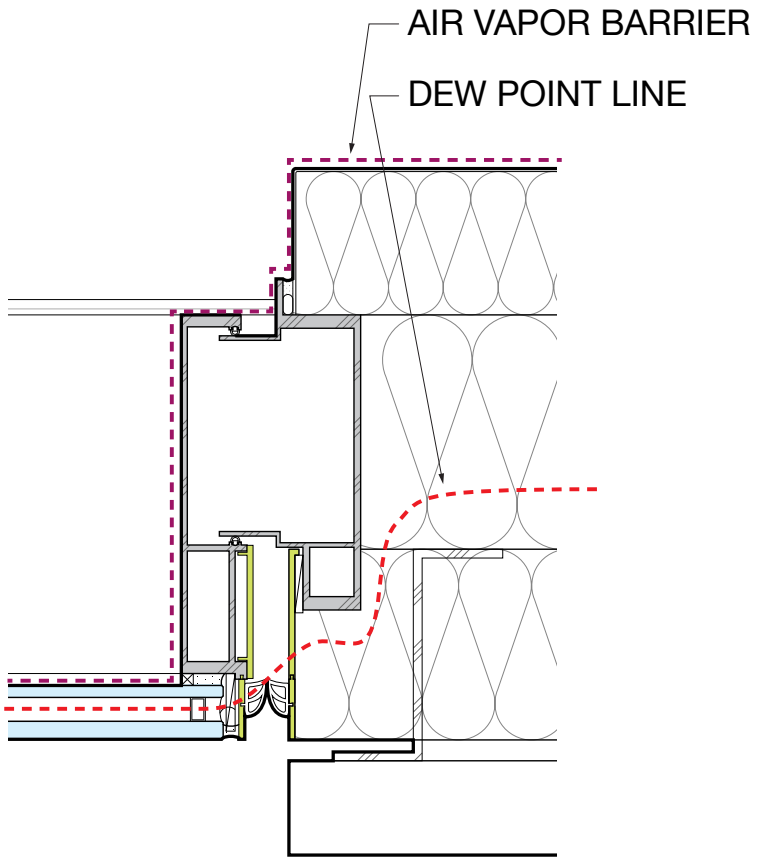
Advancements





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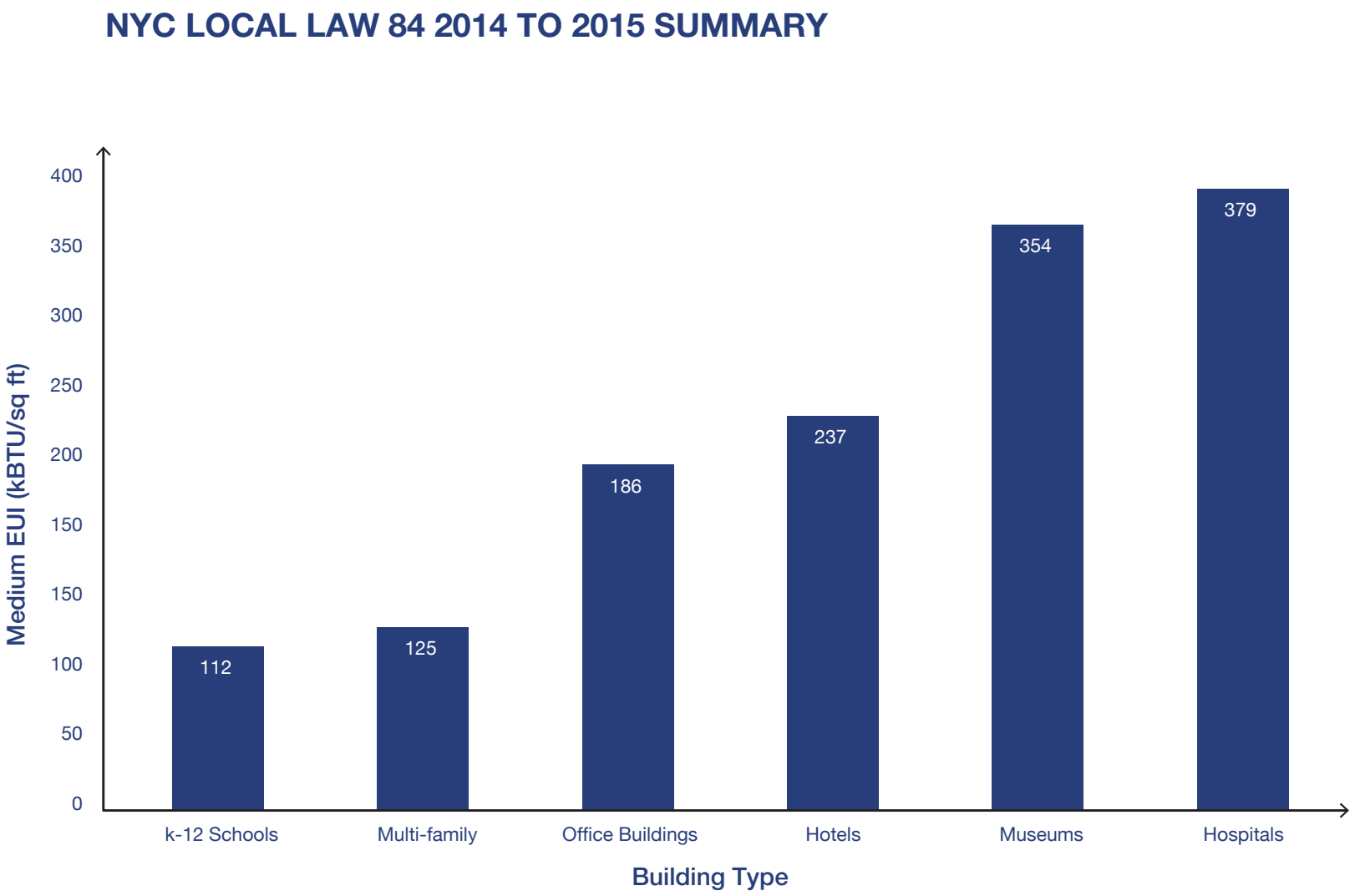
Data Collection



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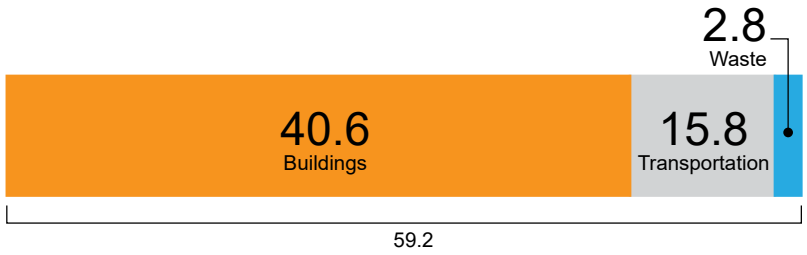
NYC Goals



2005
Baseline

40x30

40% reduction in greenhouse gasses by 20**30**

80x50

80% reduction in greenhouse gasses by 20**50**

Metric tons of carbon dioxide
tCO2e

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“Making steel and other materials—such as cement, plastic, glass, aluminum, and paper—is the third biggest contributor of greenhouse gases, behind agriculture and making electricity. It’s responsible for a fifth of all emissions. And these emissions will be some of the hardest to get rid of: these materials are everywhere in our lives, and we don’t yet have any proven breakthroughs that will give us affordable zero-carbon versions of them. If we’re going to get to zero carbon emissions overall, we have a lot of inventing to do.”

— Bill Gates [2]

2. Gates, Bill. “Here’s a Question You Should Ask about Every Climate Change Plan.” Gates Notes. The Gates Notes LLC , August 28, 2019. https://www.gatesnotes.com/Energy/A-question-to-ask-about-every-climate-plan.

The Case for Opacity

Gabrielle Brainard, AIA CHPD
Lecturer, Rensselaer Polytechnic Institute
braing@rpi.edu

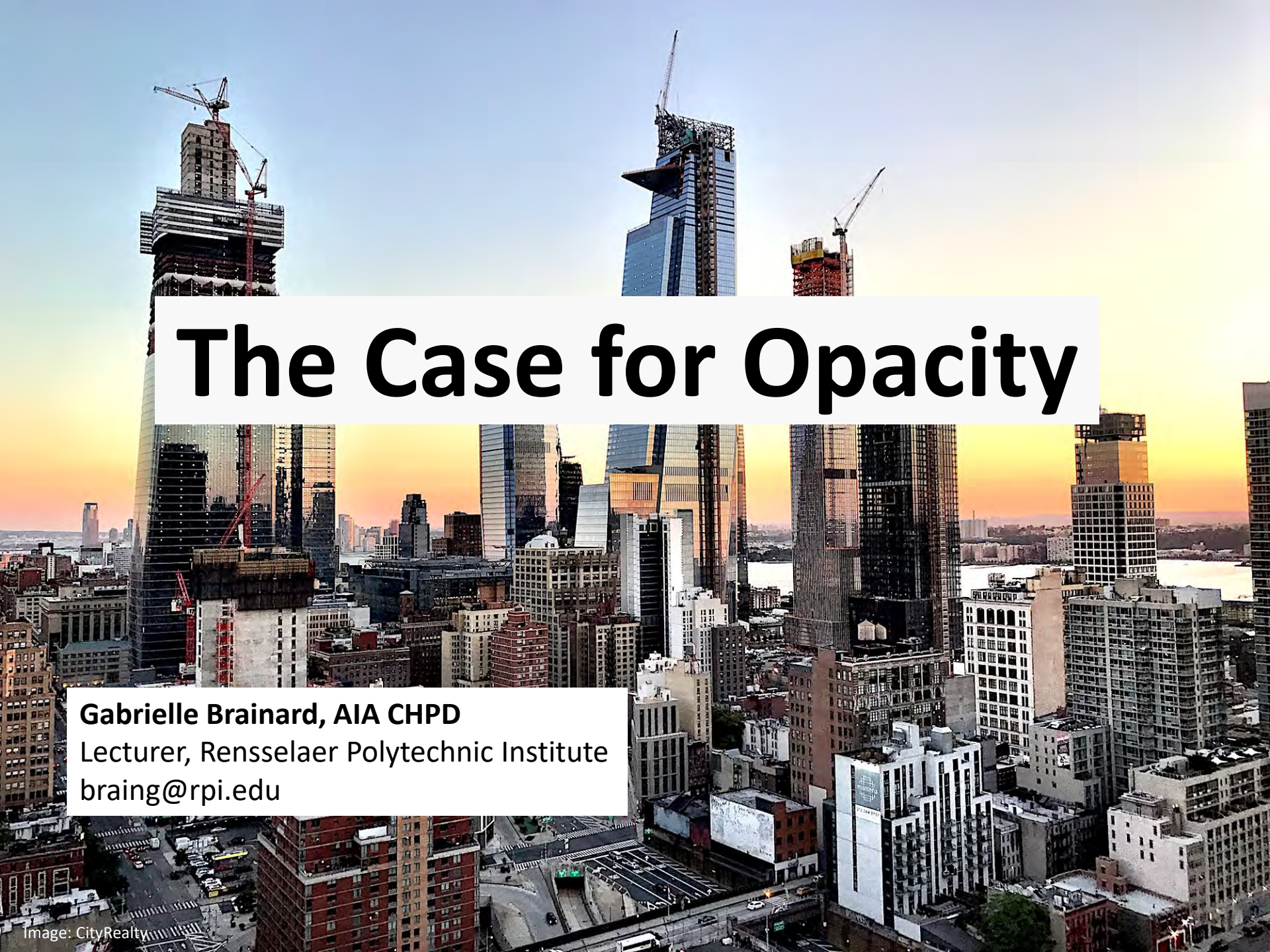
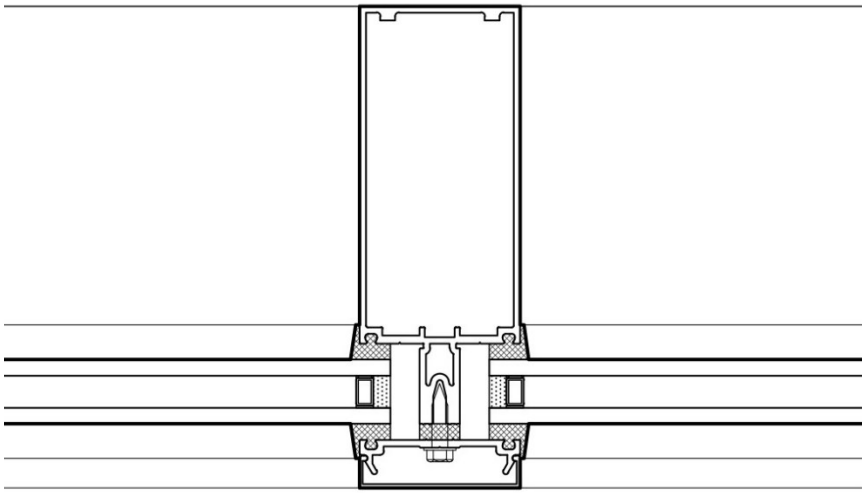
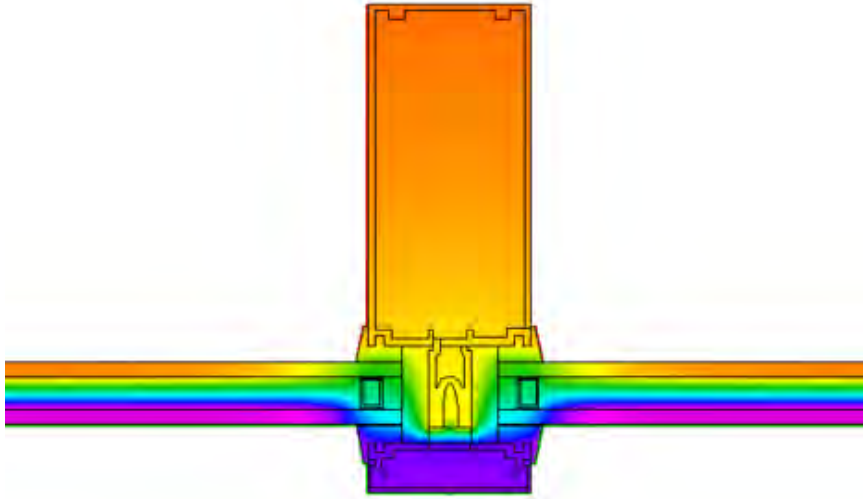


Image: CityRealty

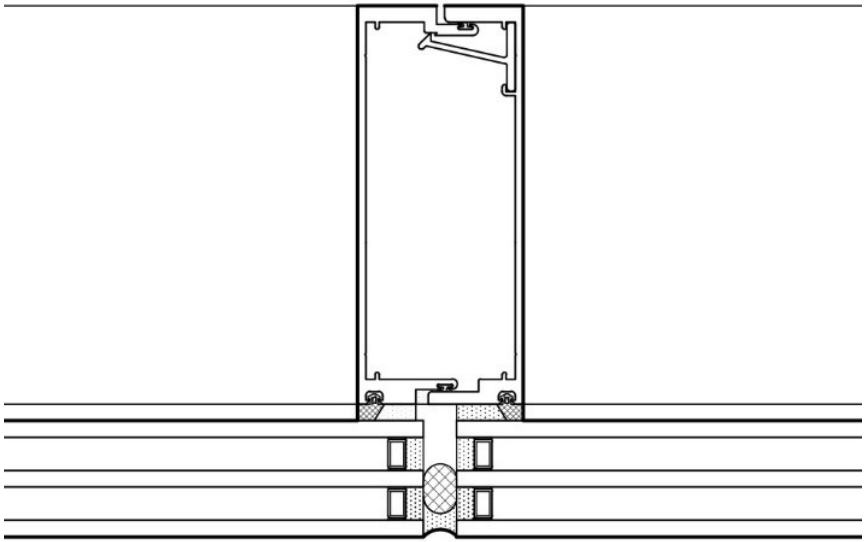
Image: CityRealty

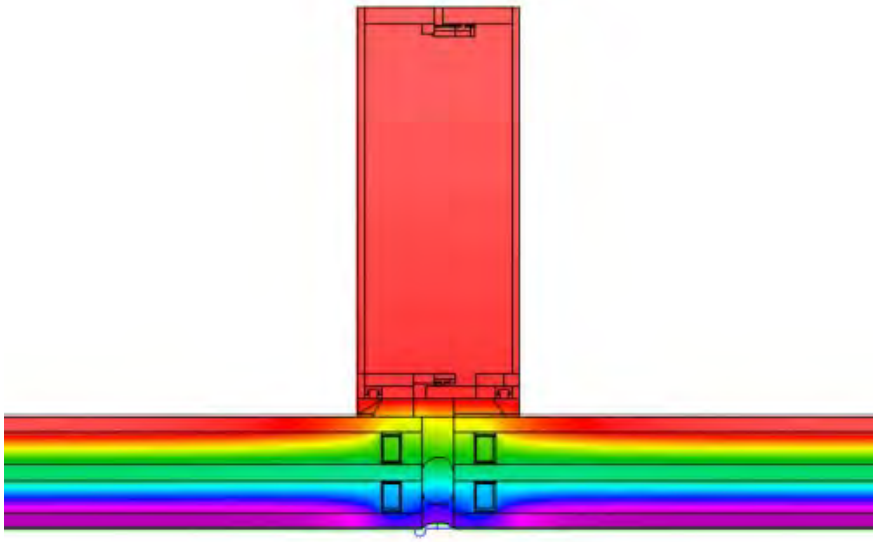




Typical Curtainwall (Vision): Thermally-improved frame; DGU with air, low-e on #2

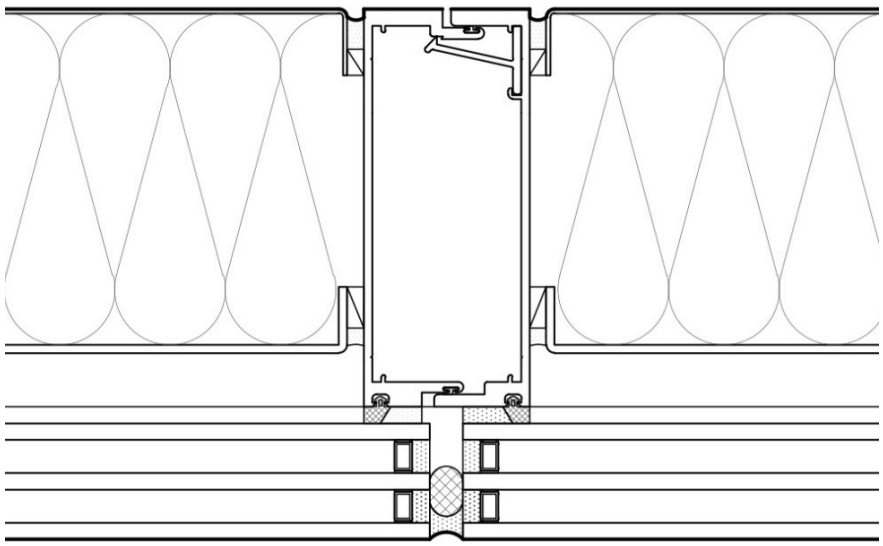
Center of Glass U-factor:	0.29
Overall U-factor (10’ x 5’ frame):	0.39 (code minimum: 0.42)
Overall R-value	2.56

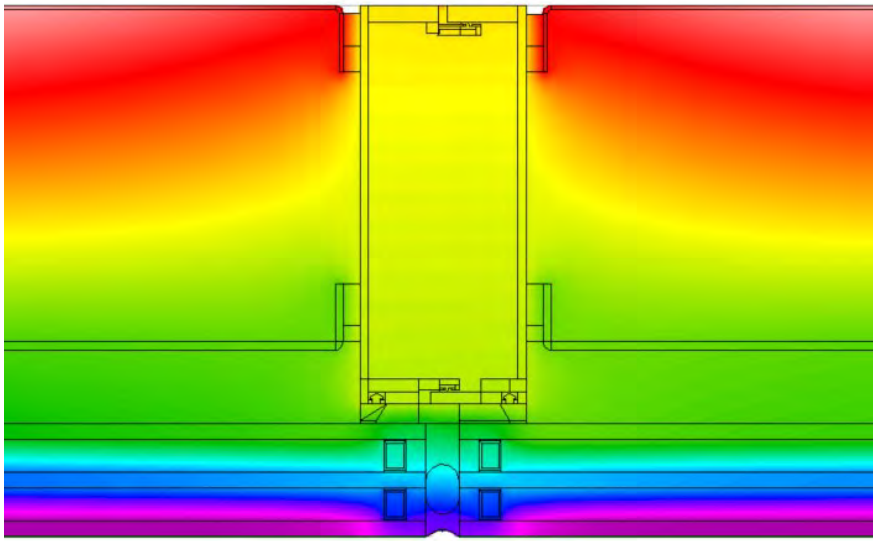




High-Performance Curtainwall (Vision): SSG frame; TGU with argon, (2) low-e coatings

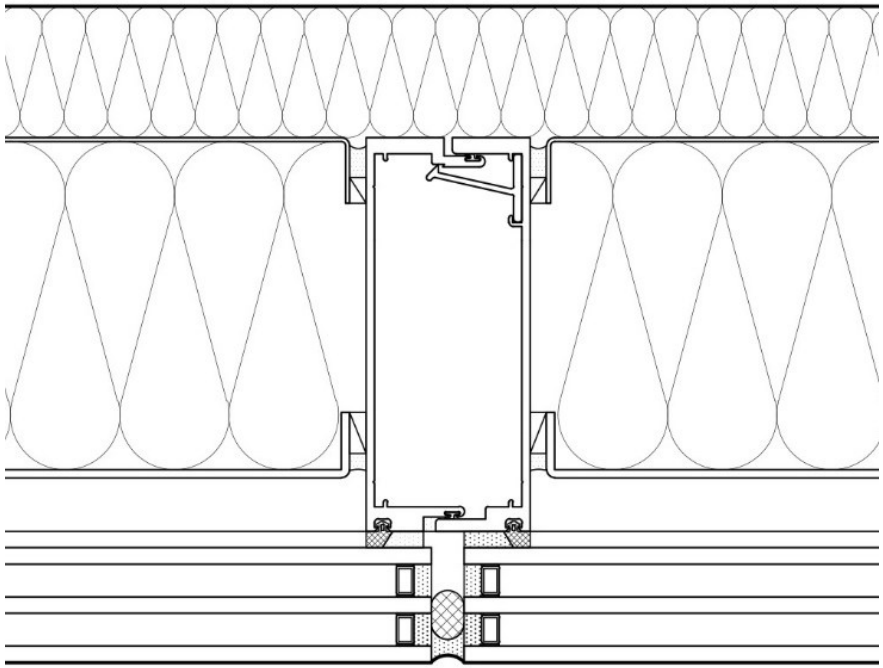
Center of Glass U-factor:	0.12
Overall U-factor (10’ x 5’ frame):	0.16
Overall R-value	6.25

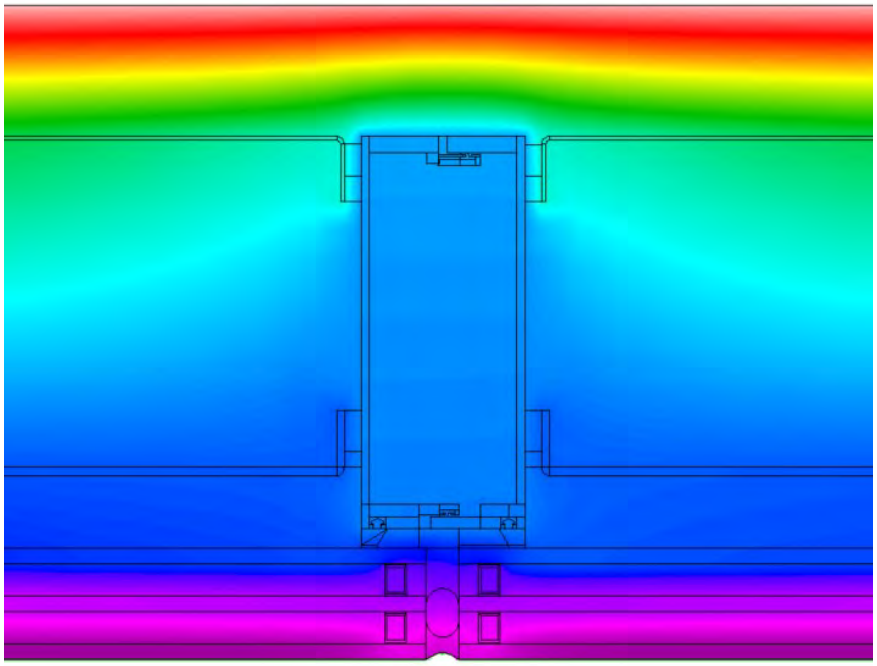




High-Performance Curtainwall (Spandrel): SSG frame, TGU, 5” cavity insulation

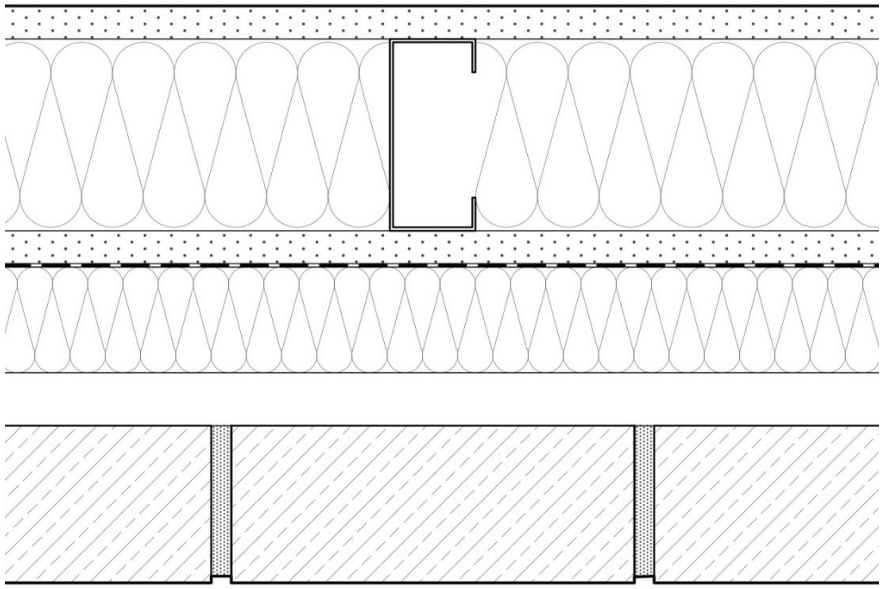
Overall U-factor (10’ x 5’ frame):	0.10
Overall R-value	10.25

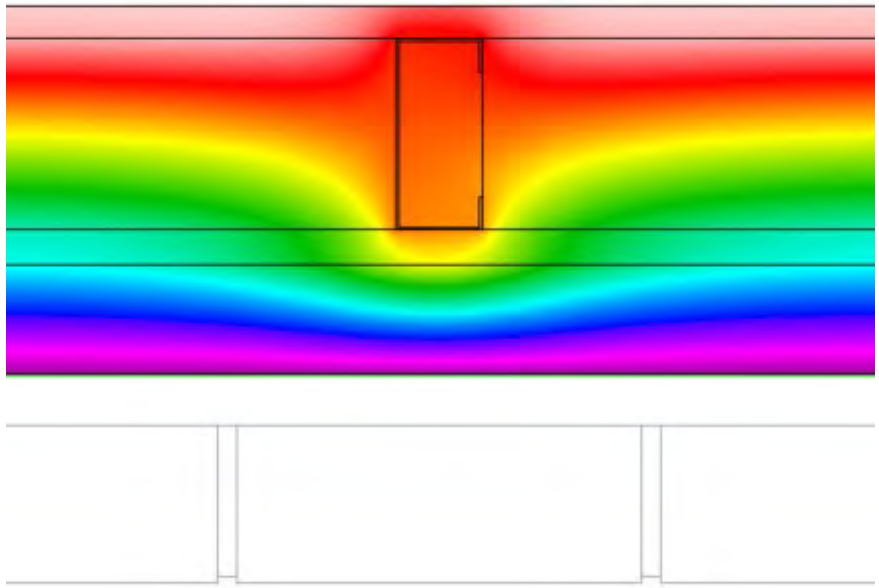




High-Performance Curtainwall (Spandrel): 5” cavity insulation, 2” mullion wrap

Overall U-factor (10’ x 5’ frame):	0.05
Overall R-value	21.11



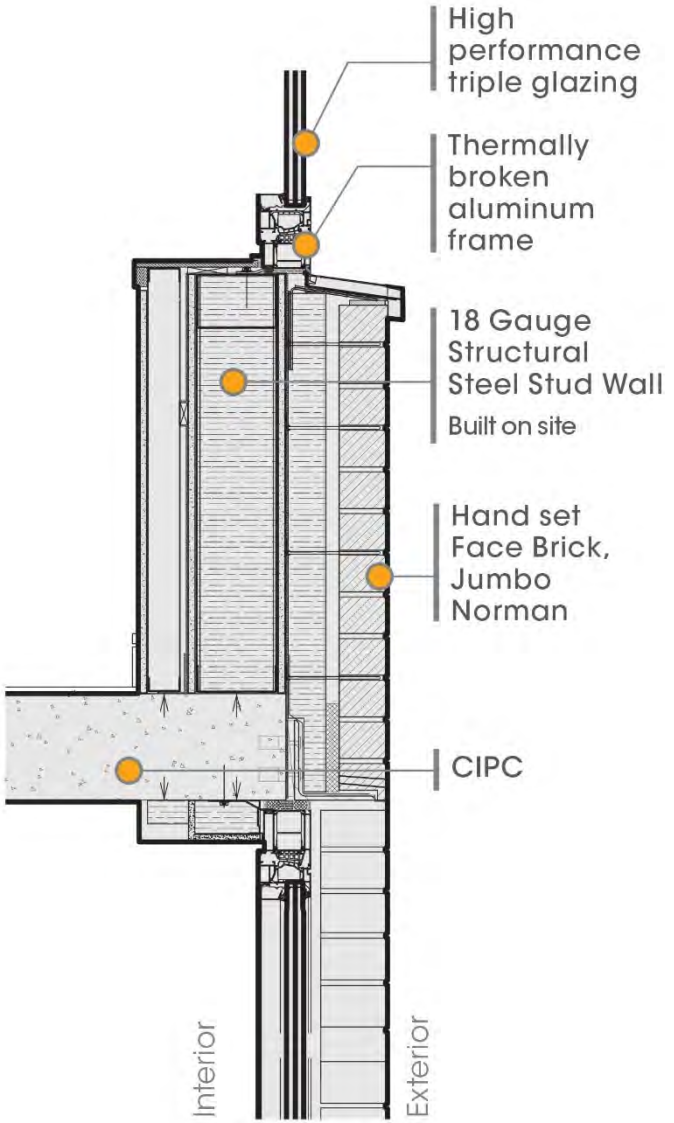


Masonry Cavity Wall: 3-5/8” metal stud @ 16” O.C., 3.5” cavity insul., 2” exterior insul.

Overall U-factor:	0.05 (Prescriptive code max: 0.064)
Overall R-value	18.42

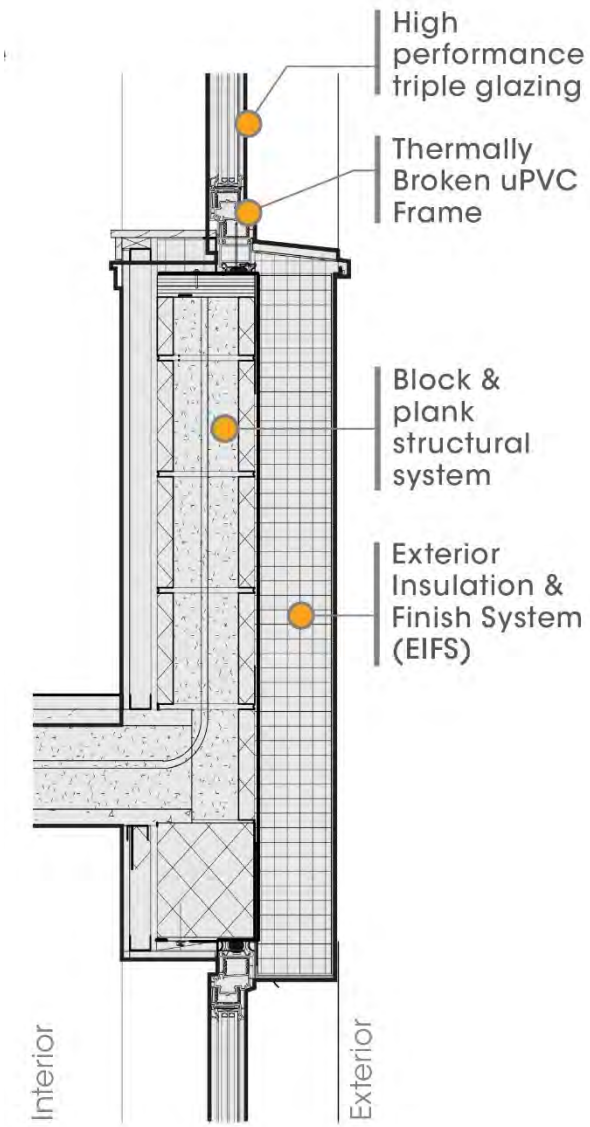
Sendero Verde, East Harlem
Handel Architects

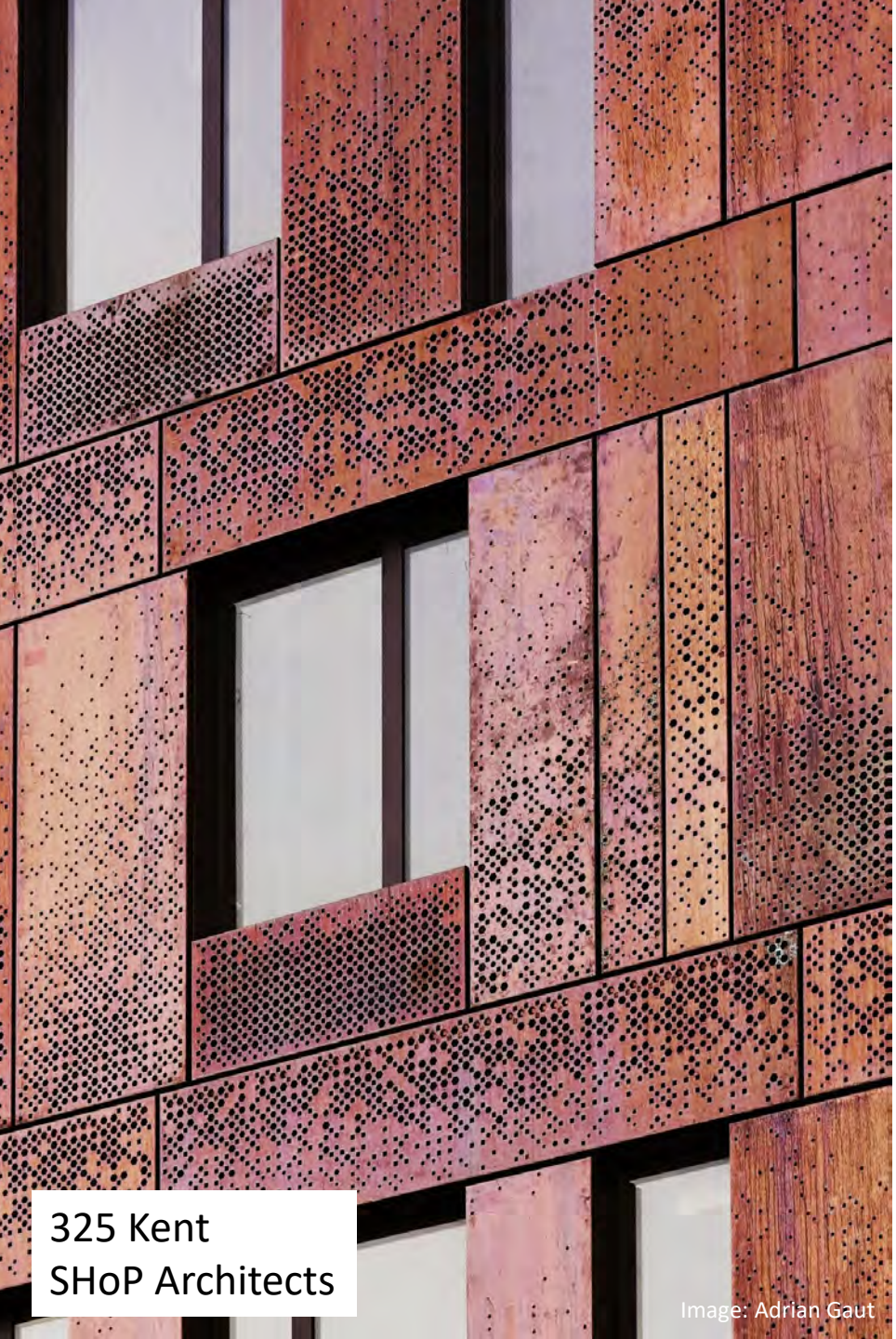
Masonry Cavity Wall



Sendero Verde, East Harlem
Handel Architects

EIFS

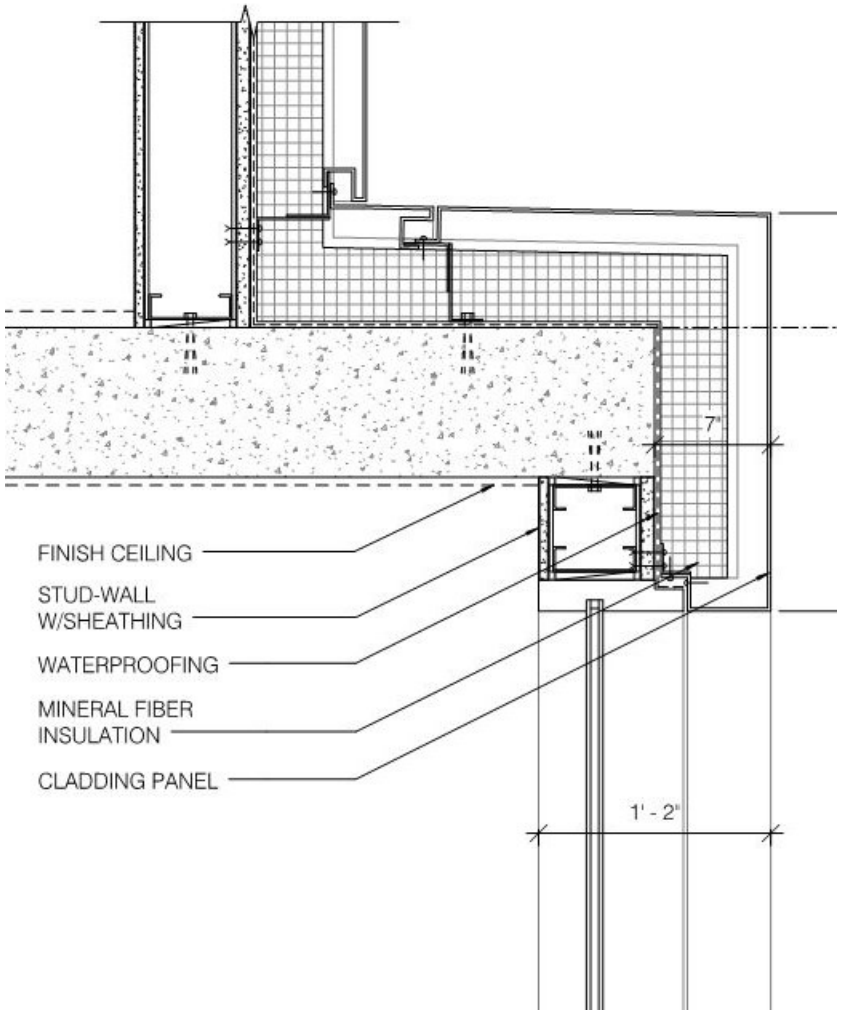


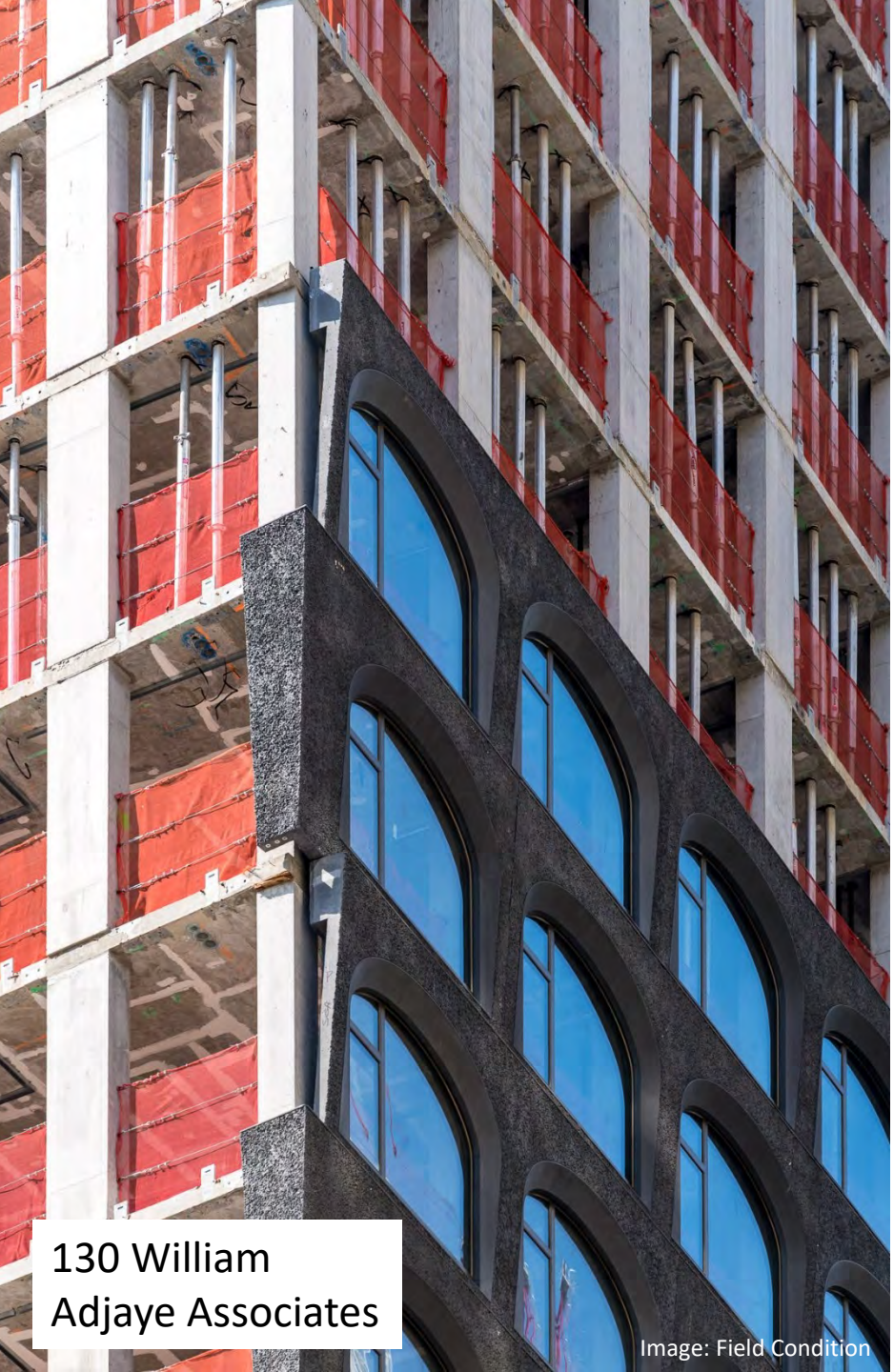


325 Kent
SHoP Architects

Image: Adrian Gaut

Site-built Rainscreen

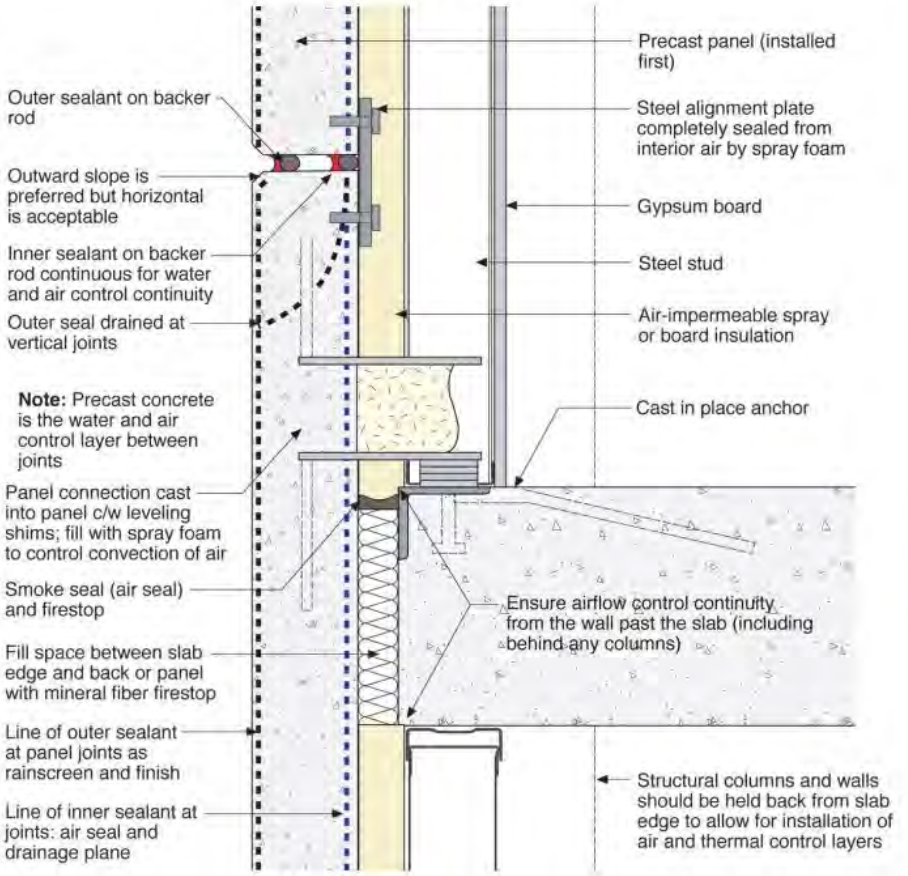




130 William
Adjaye Associates

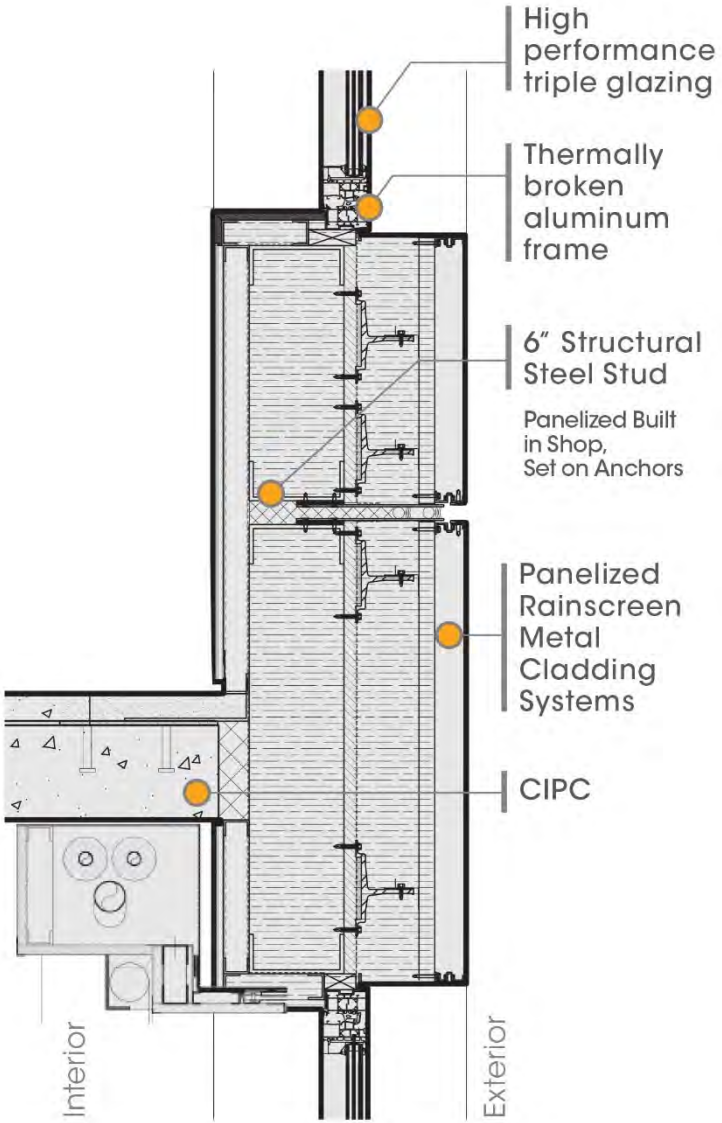
Image: Field Condition

Architectural Precast



The House at Cornell Tech
Handel Architects

Unitized Megapanel



Images: Related / Oxford

Session #2: **Clearly Controversial: Exploring the Benefits and Liabilities of Highly Glazed Facades**

High Performance Building Facades:
Solutions for People and for Sustainable Cities

AKA The Case for the All Glass Facade

Stephen Selkowitz

Retired: Group Leader, Windows and Envelope Materials

Department Head, Building Technologies

Senior Advisor, Building Technology and Urban Systems

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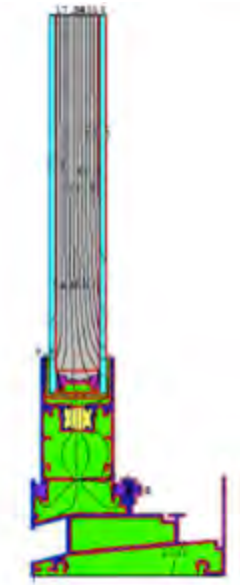
seselkowitz@lbl.gov



Energy Efficient Building in 2050 ??

The Edge
PLP architects
Amsterdam

How Do We Design with Glass/Windows/Facades…

When Energy and Carbon Matter?
…When People Matter?
…As We Decarbonize the Grid

Criteria, Metrics for Selecting Glass and Designing Optimal Facades

- Energy/Carbon
  - Operating
  - Embodied
- Comfort
- View/Privacy
- Productivity
- Daylight
- Health
- Grid Impact
- Recycled Materials

- Affordability
- Aesthetics
- Security
- Fire
- Acoustics
- Structure
- Weatherproof
- Maintenance
- Durability

My Façade Hypothesis:

- **It is "possible" to design a façade system that will "outperform" an insulated, opaque wall,**
  - For **"any climate"**
  - For **"any glass area"**

= Net Zero Envelope

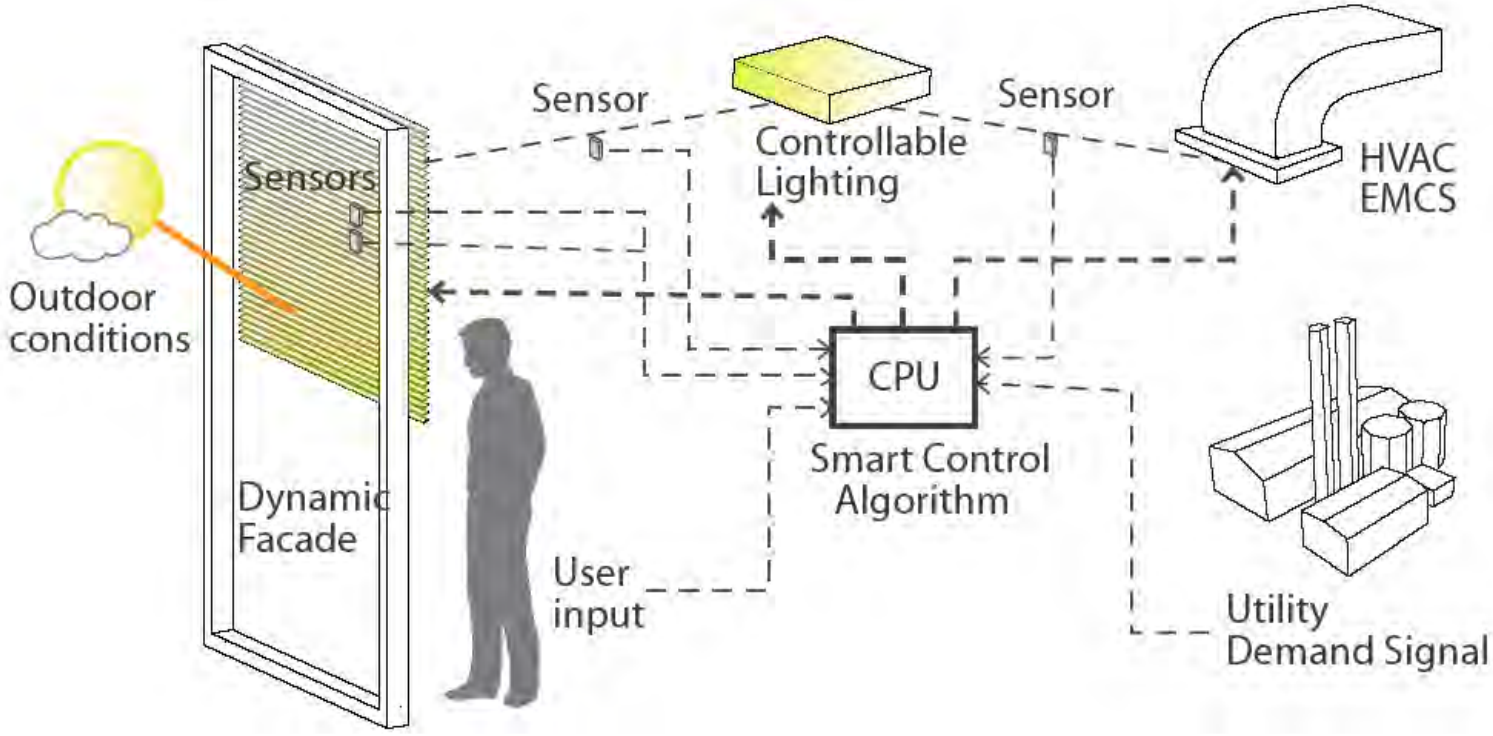
BUT

- **Not easy to design;**
- **Difficult to construct and commission**
- **A challenge to operate effectively**
- **May Cost More…**

- **Rethink everything, to do this at scale…**

An "Intelligent" Window/Façade can…..

- Manage **thermal loss and gain**
- Provide dynamic **solar control:**
- Provide glare-free **daylight**
- Provide **fresh air** to interior, minimize noise
- **Enhance occupant health, comfort**
- **Reduce demand** on utility/grid
- **Generate power** (photovoltaics)



3 Challenges

1. High Performance Components and Systems

- **Technology Kit of Parts**: heat loss, solar gain, daylight, air, moisture...

2. Static → Integrated, Responsive, Intelligent Systems

- Links to other building systems: lighting, HVAC
- Responsive to **occupant, owner, electric grid**
- "Smart": adaptive to changing needs, resilient

3. New Business and Delivery Models

- Cost, Reliable Performance

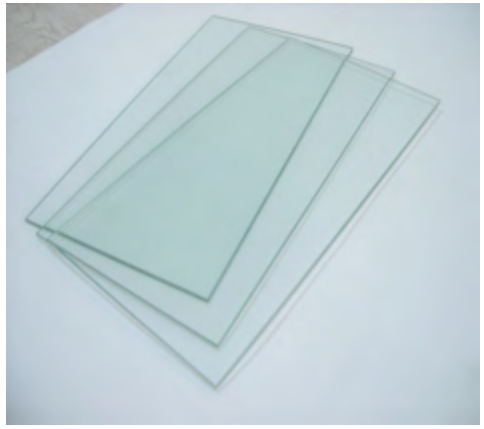
Glazing + Facade Technology Landscape:

Size/Scale: *Nano ← Micro ← Macro*

***Response**: Fixed – Passive – Active -- Intelligent*

***Who Controls?**: People – Building -- Grid*

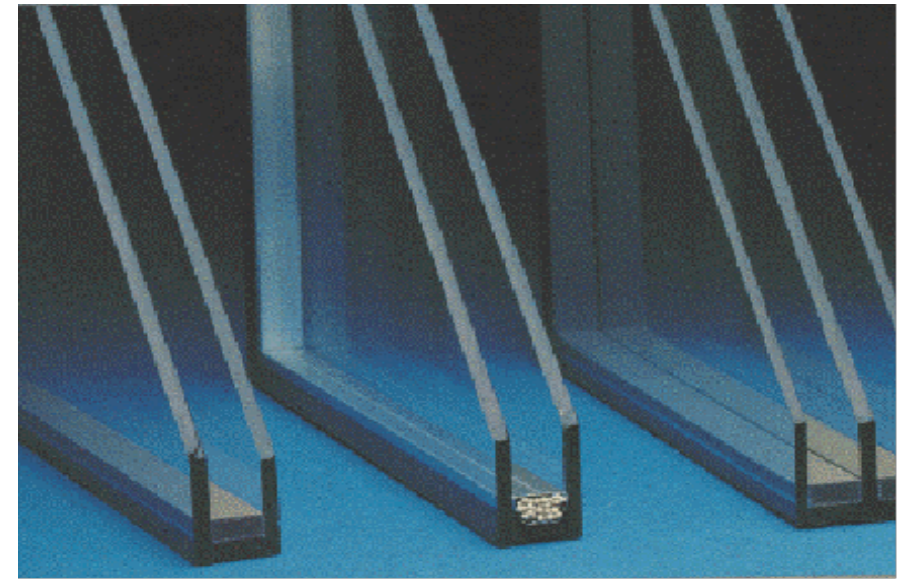
"1μ" coating → **"1mm" glass** → **"1m" Window, shading** → **"10-100m" Building**

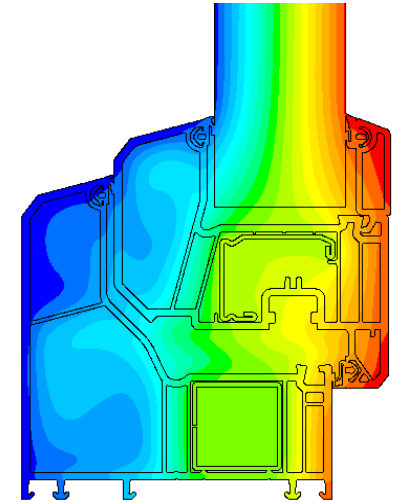


Highly insulating, low heat loss glazing

Approaches:

- **Low-Emissivity Coatings**
- Low Conductance Gas Fills
- Multiple Glazings -> Triple
- "Warm edge" low conductance spacers
- Insulated Frame Systems





Today: U-value ~ .3 - .5 BTU-sf-h/F

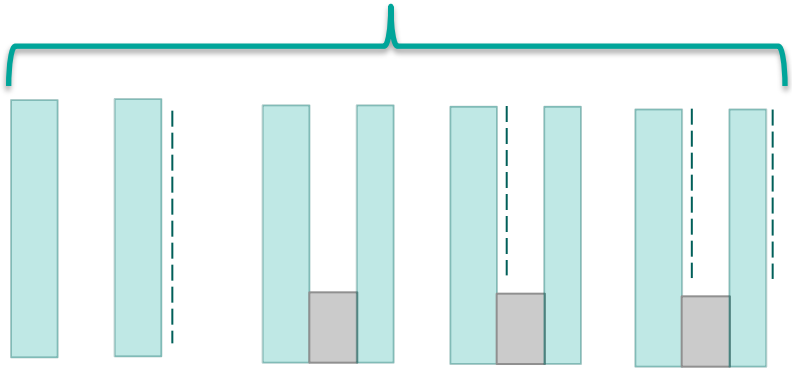
Nearer Term Objective: U-value ~0.2 BTU-sf-h/F

Longer Term Target: U-value < 0.1 BTU-sf-h/F

HIGHLY INSULATING GLAZING SOLUTIONS:

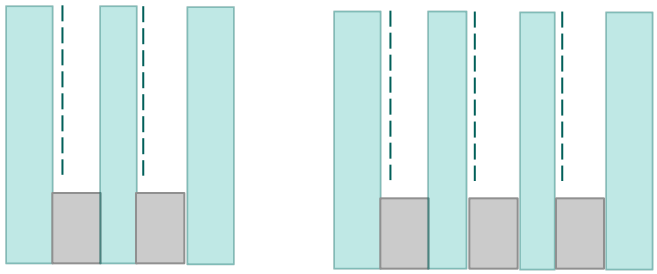
U ~ .1 Btu/sf-F-hr

Market Today



Single

Double



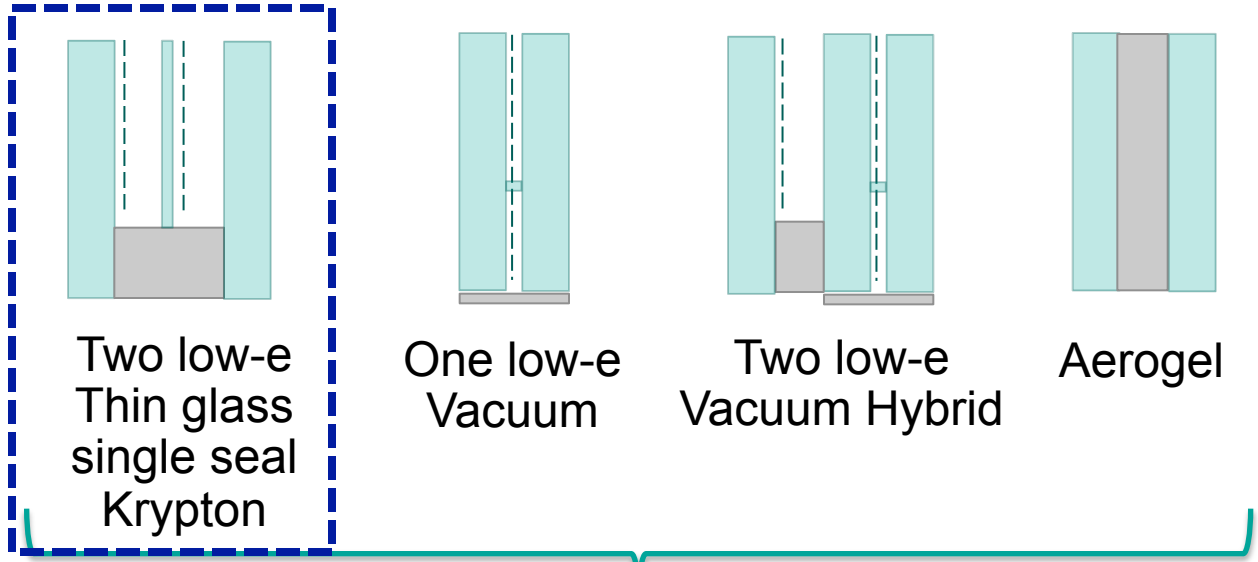
Two low-e

Three low-e

Note: low-E coated polyester film can be alternative middle glazing.

Emerging

Future

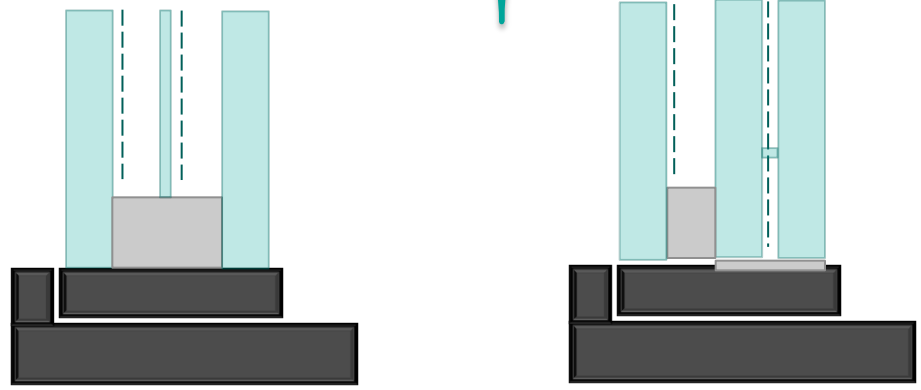


Two low-e
Thin glass
single seal
Krypton

One low-e
Vacuum

Two low-e
Vacuum Hybrid

Aerogel



Super-insulating frame with warm edge spacer

Triple and Quad Thin Glass Windows

Glazing Optics:

Transparency
Daylight
View

Solar Control? Glare?

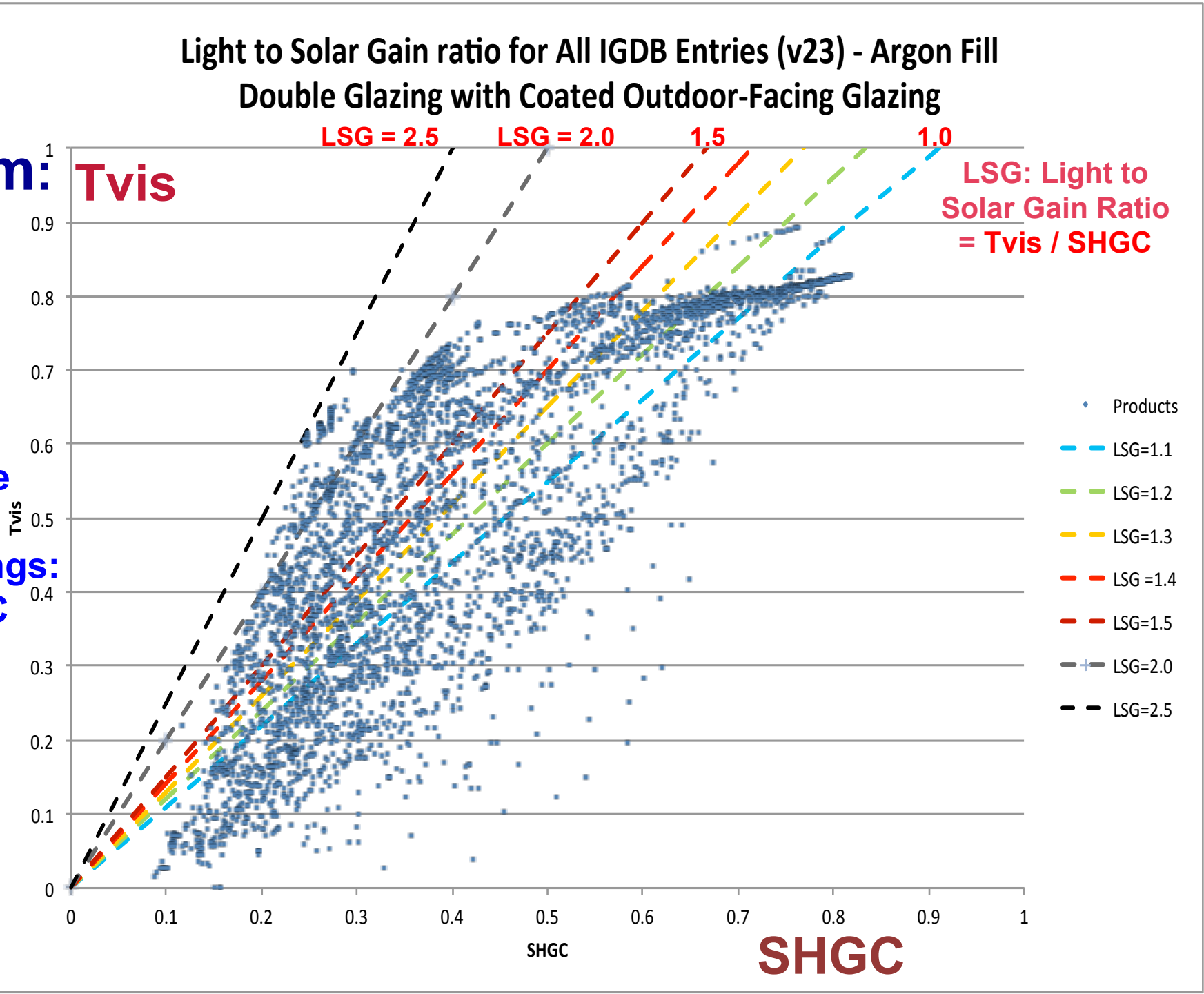
Glazing Ecosystem:

IGU Options

5000+ entries in LBNL Data Base

Selective Glazings: Tv = > 2 x SHGC

"



Glazing Ecosystem:

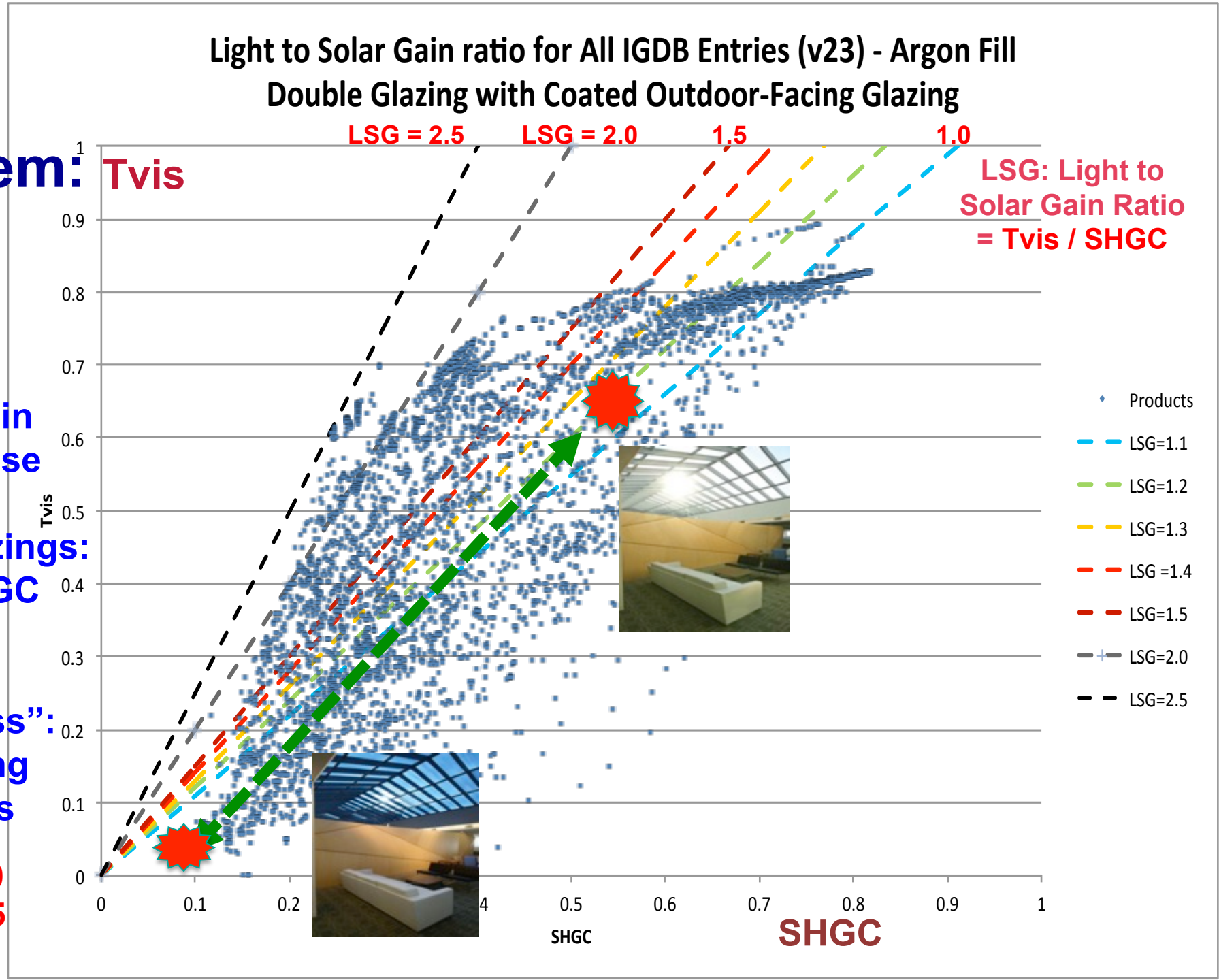
IGU Options

5000+ entries in LBNL Data Base

Selective Glazings: Tv = > 2 x SHGC

"Smart Glass": w/ Changing properties

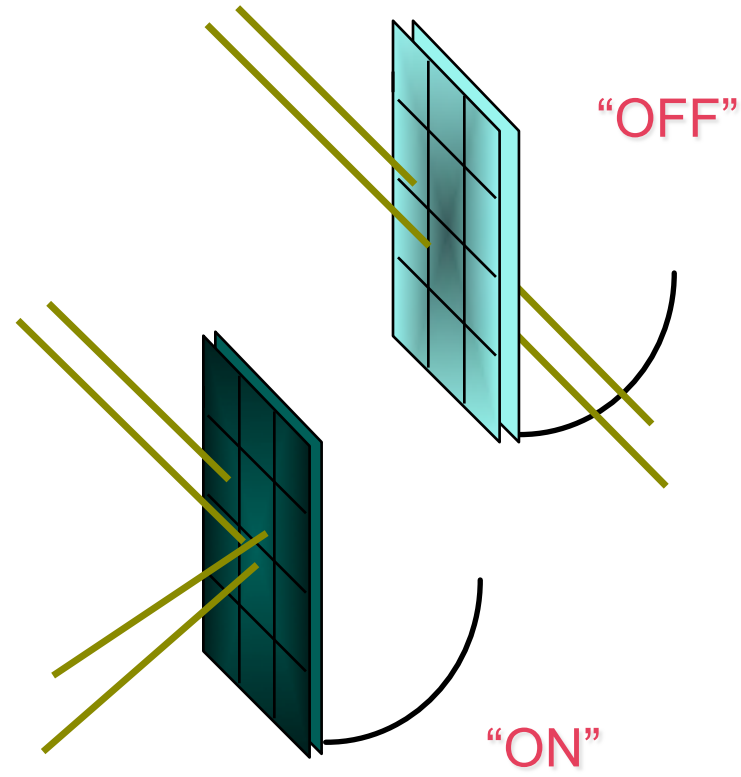
Tvis: .02 → .60
SHGC: .09 → .5



Dynamic Control of Façade Solar Gain, Daylight

Balancing Cooling <> Daylighting, View <> Glare
Optimized, Flexible control of solar gain, daylight

- **"Mechanical Shading"**
  - Interior, exterior, between-glass options
  - Manual or Automated
  - Functional and Aesthetic selections
- **Passive control - glass**
  - **Photochromic - light sensitive**
  - **Thermochromic - heat sensitive**
- **Active control - glass**
  - **Liquid Crystal (adds privacy)**
  - **Suspended particle display (SPD)**
  - **Electrochromic**



Large Scale EC Applications 2015+

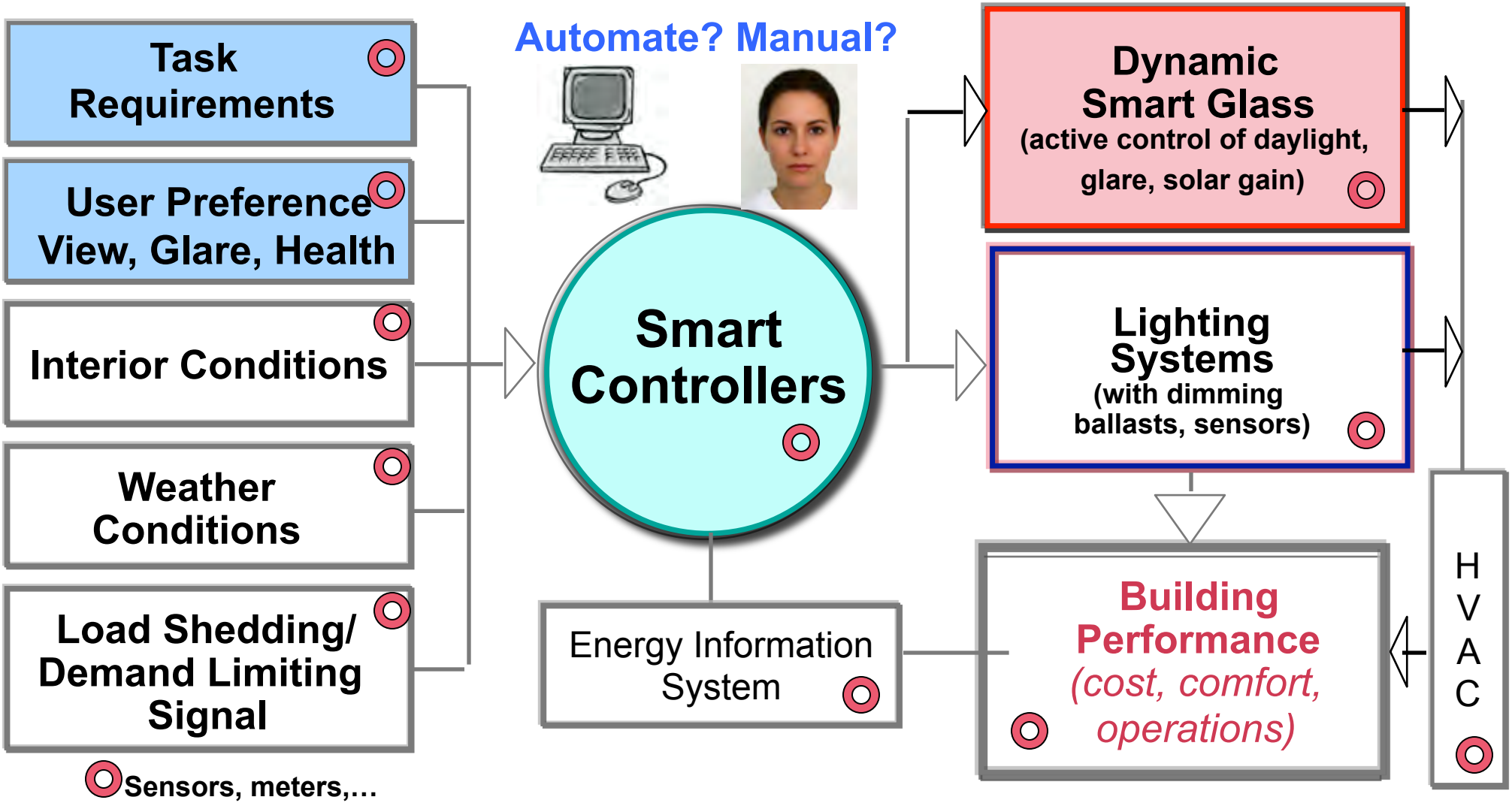
Second and third generation smart coatings emerging....

New Options: Gradient Light Control

Source: SageGlass Harmony

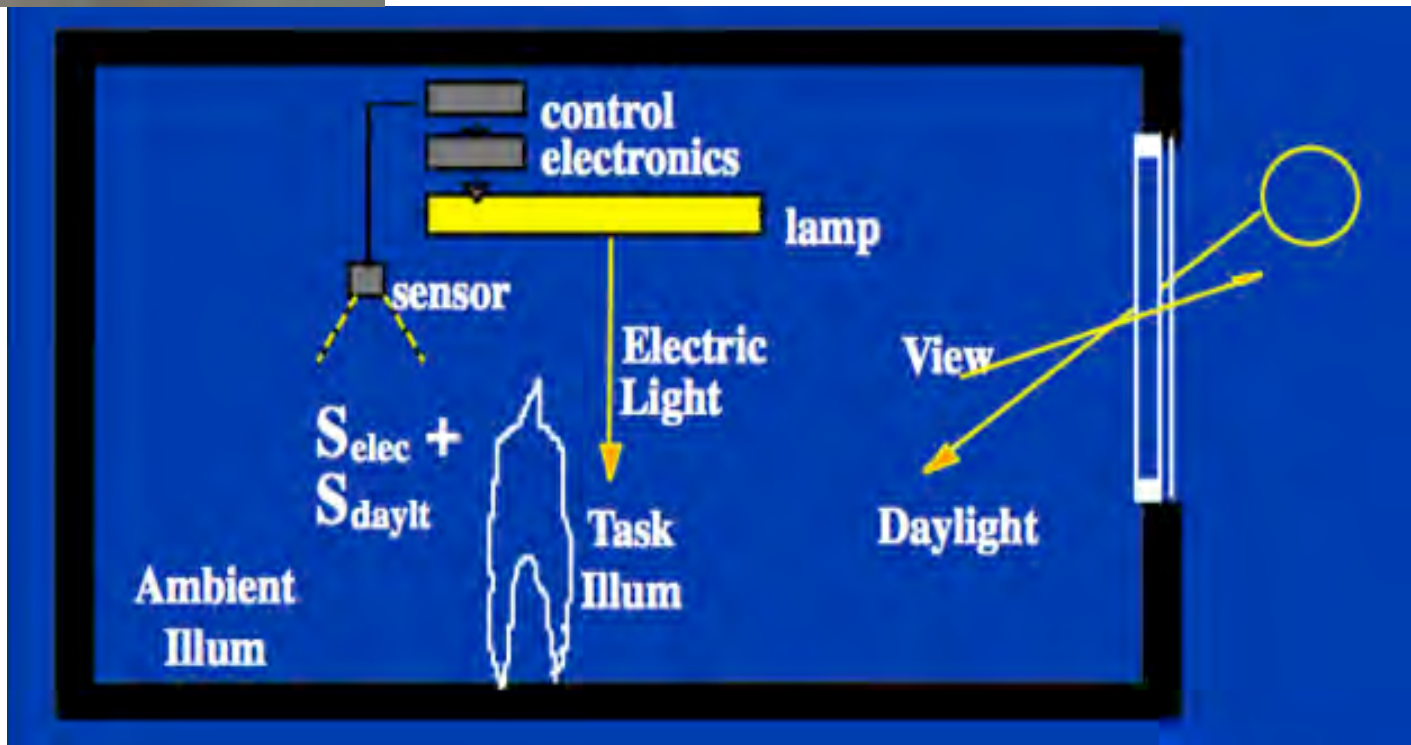
Exploring Intelligent Control Systems:

Optimal performance of dynamic windows requires full integration with building systems



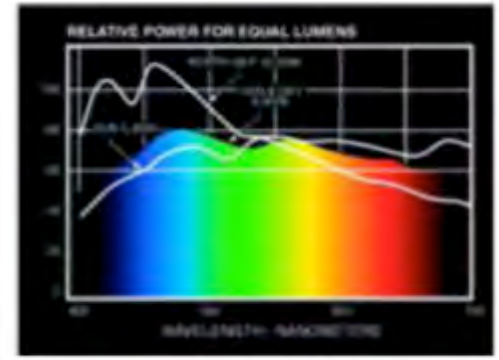
"Daylight" Remains a Defining Feature of Many Building Spaces

Daylighted Spaces vs (Day)Lighting Control Elements

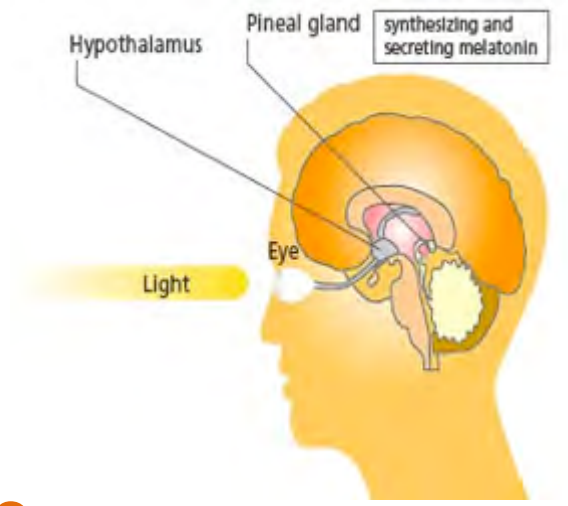


Daylight: What's New?
Human Factors/Wellness

- Glare and Visual Comfort
- Access to View (Footprint, Floorplate)
- Biophilic Effects
- Circadian Rhythm: Sleep, Alertness
- Health Effects
- Impact on Performance and Productivity
- These are clearly important, but…
- **Challenge: Very difficult to attribute a measurable impact to a design variable**
- Numerous studies underway globally
  - Stay tuned



Daylight



Occupants as Market Drivers (?)

Building Energy Use

vs

“local” occupant comfort, health, satisfaction, performance,….

LEED, others expanding to include “wellness”

What is the Most Costly “Building Component”?

Occupancy Costs = 100 x Energy Cost

Can a Well Designed Façade System Improve Satisfaction, Comfort and Productivity? By How Much?

Cost / Sq. Ft. Floor -Year

- **Energy Cost: $4.00**
- **Rent: $40.00**
- **“Productivity” $400.00+**

+ Added Useful Floor Space Benefits

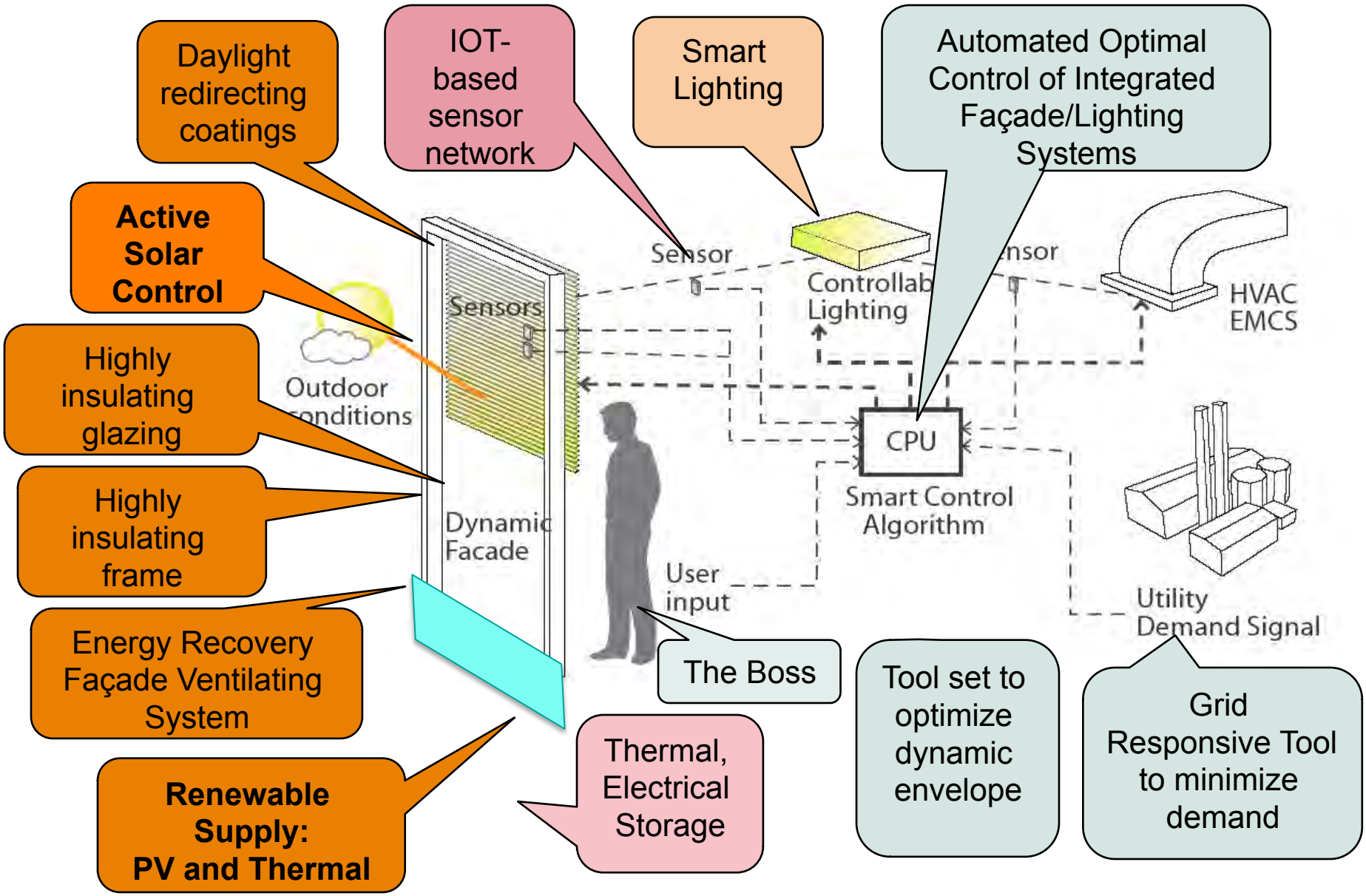
Components → Systems

Oldcastle

Facades are intrinsically "integrated systems" –

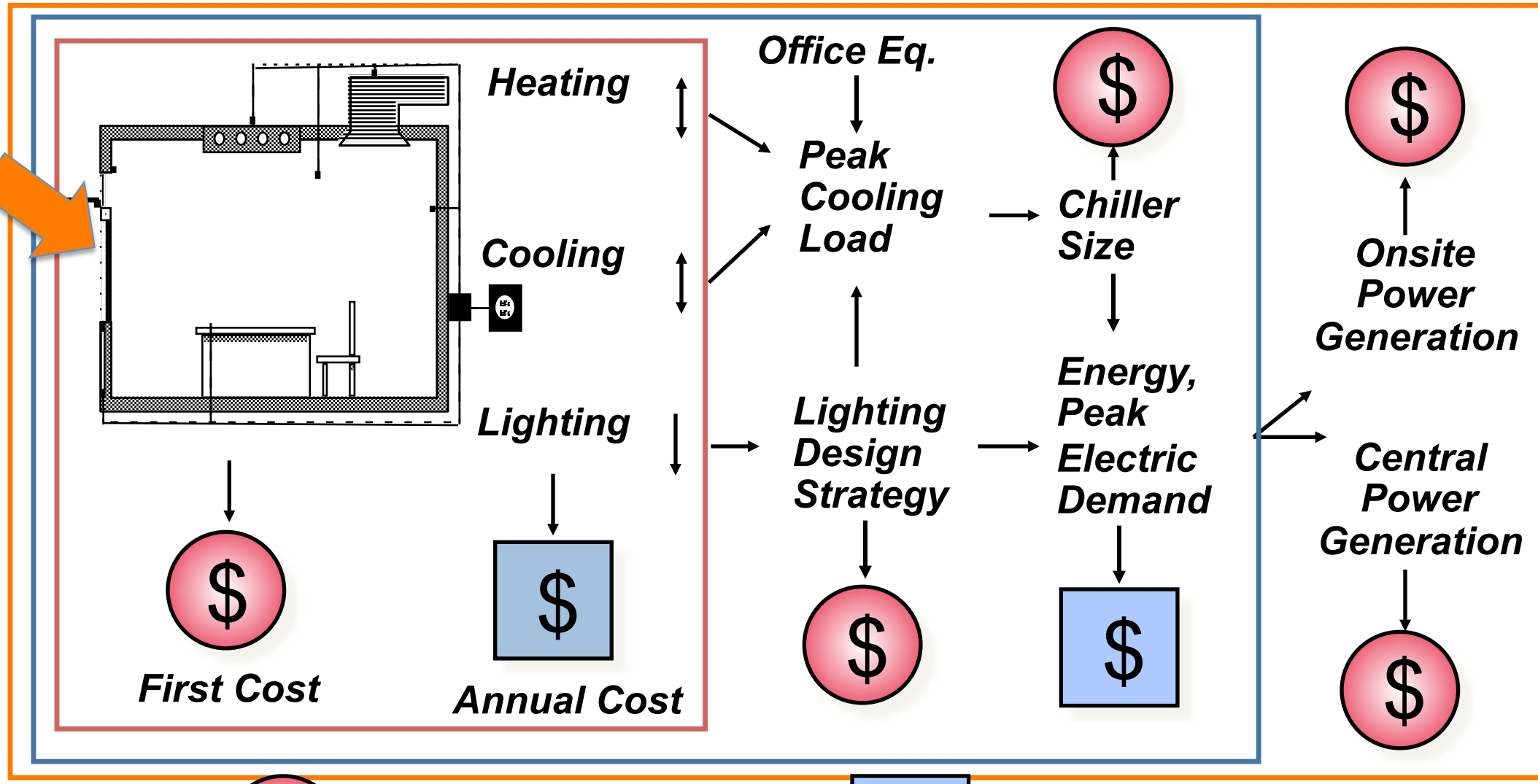
and are logically integrated into an overall Smart Building Control structure

managing light, glare, solar gain, heat transfer, ventilation, power generation, energy storage,..



Reliable System integration → First Cost tradeoffs

Improved Façade = Lower HVAC System Cost

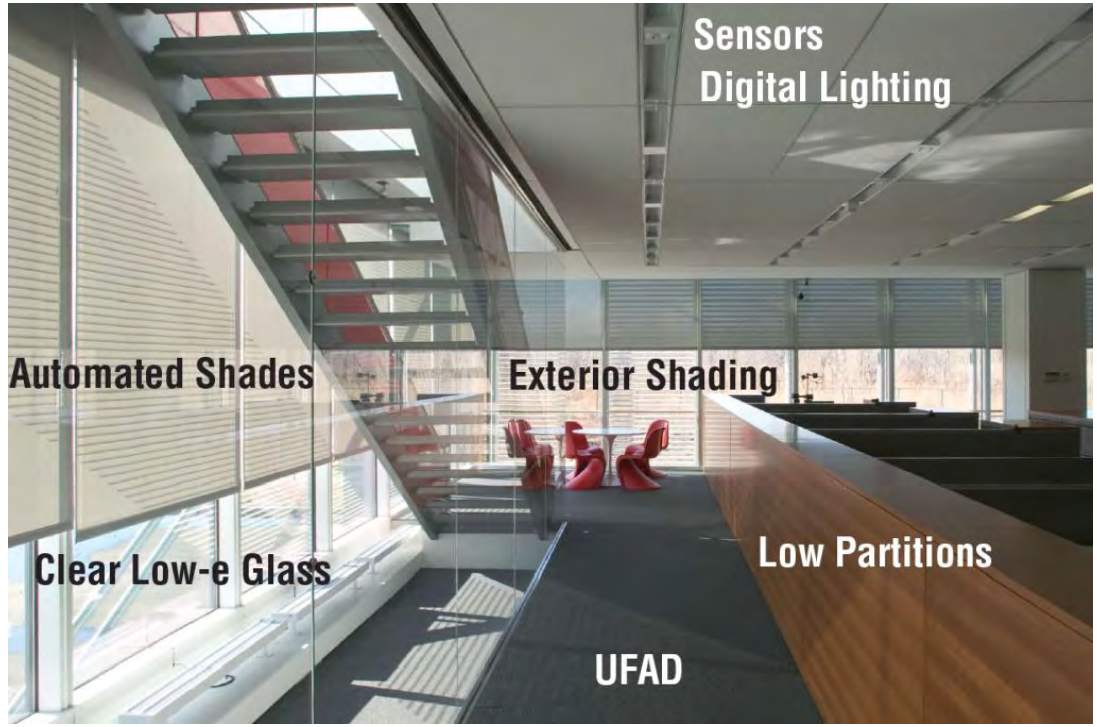


How Will We Build Confidence in these Systems Integration Challenges?

New York Times HQ, NYC 2007

Largest Installation of Automated Shading and Daylight Dimming in U.S.

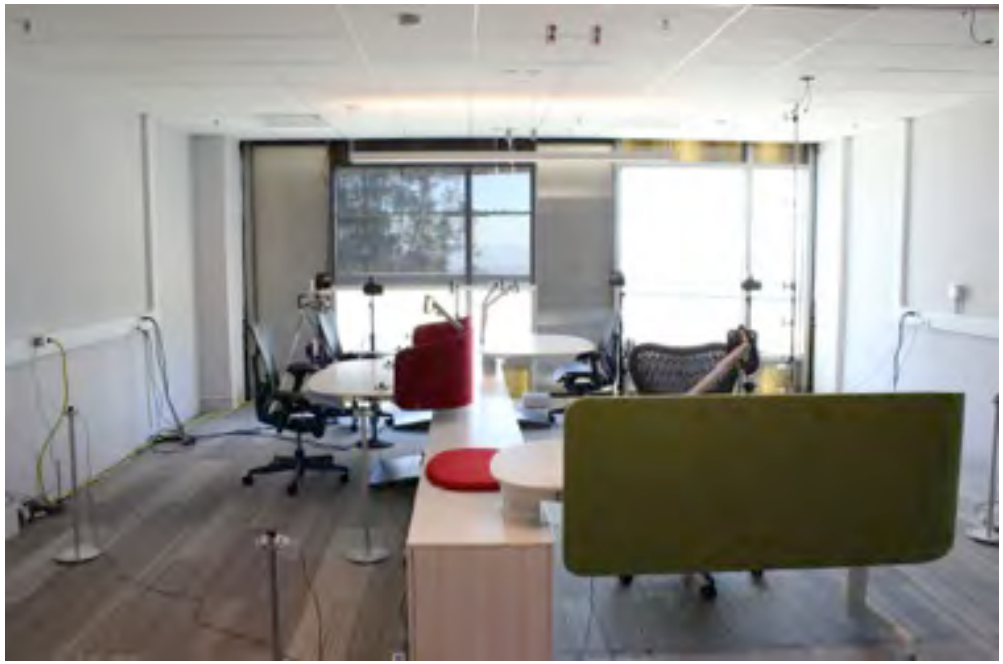
Renzo Piano, Gensler, F&K



2 years of LBNL testing in a 500 m^2 mockup was used to refine and spec the final design

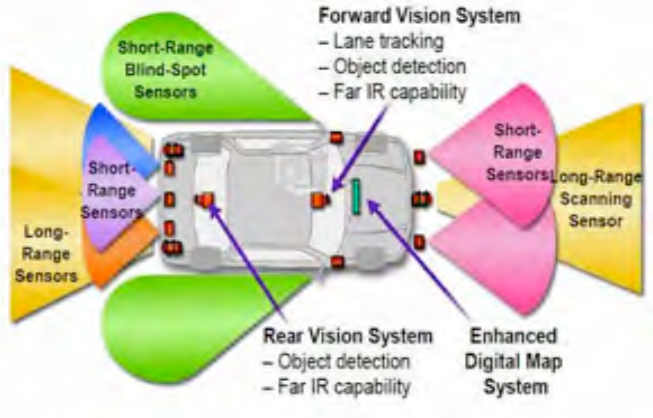
Outcomes: Energy, Demand, Occupant Satisfaction

Rapid Prototyping: Mockup in FLEXLAB Rotating Testbed



Relative Cost and Complexity?
A Story of Two $1T/yr Industries

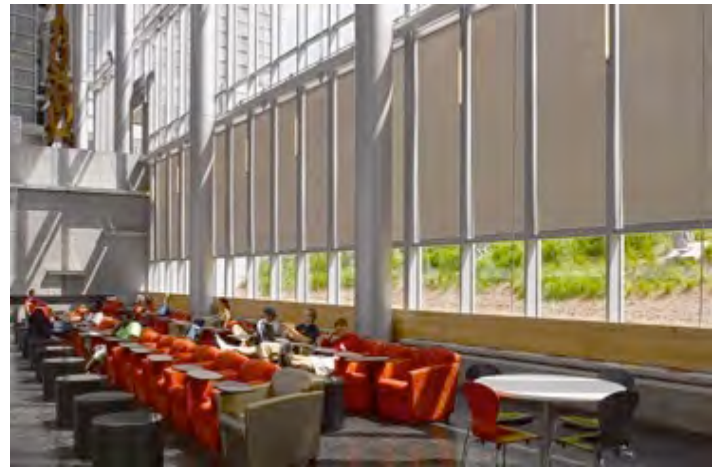
INDUSTRY "A"



***Integrated System*:**
Autonomous Car w/ Smart Sensors

VS

INDUSTRY "B"

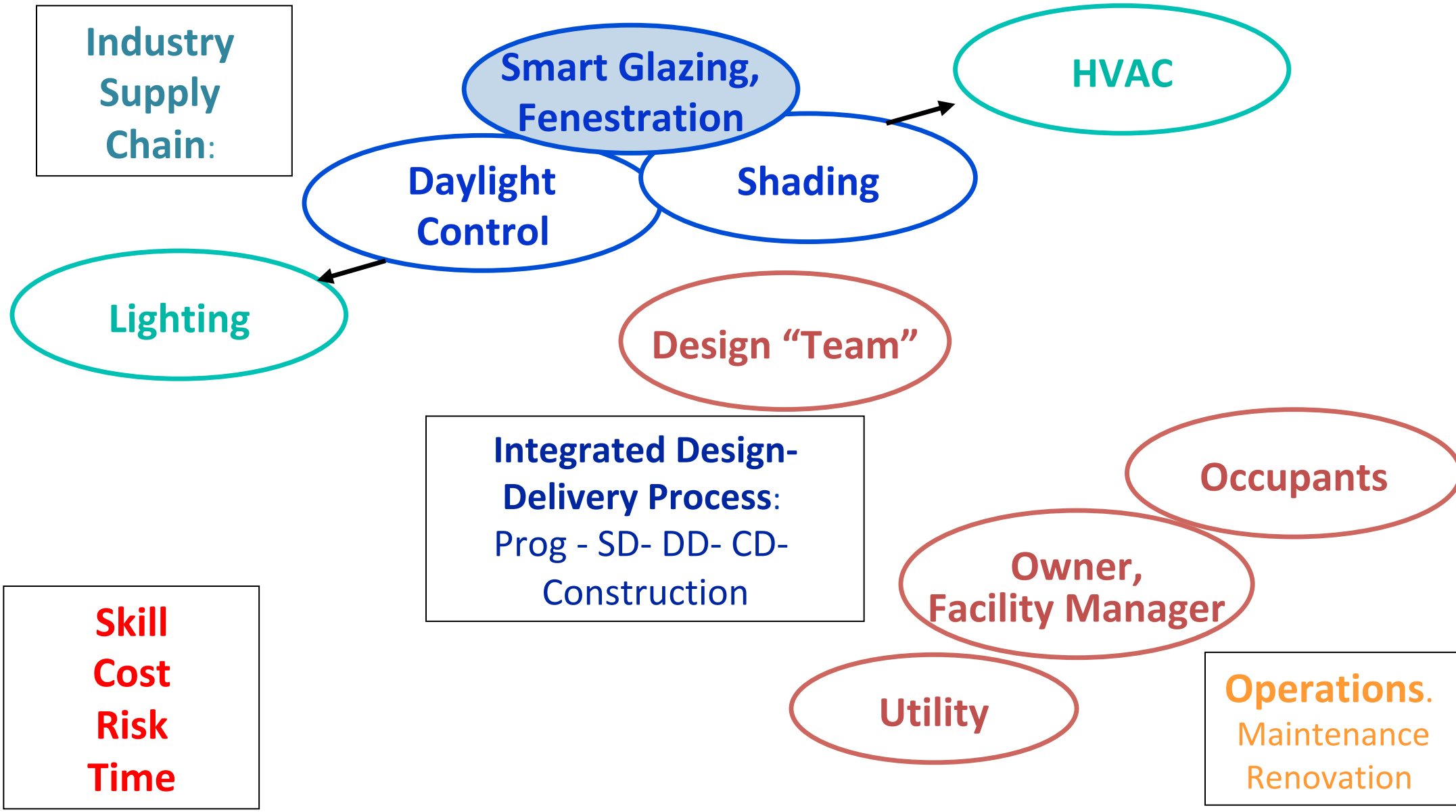


Integrated System:
Sensor-Driven
Automated Shade or EC
w/ Daylight Dimming

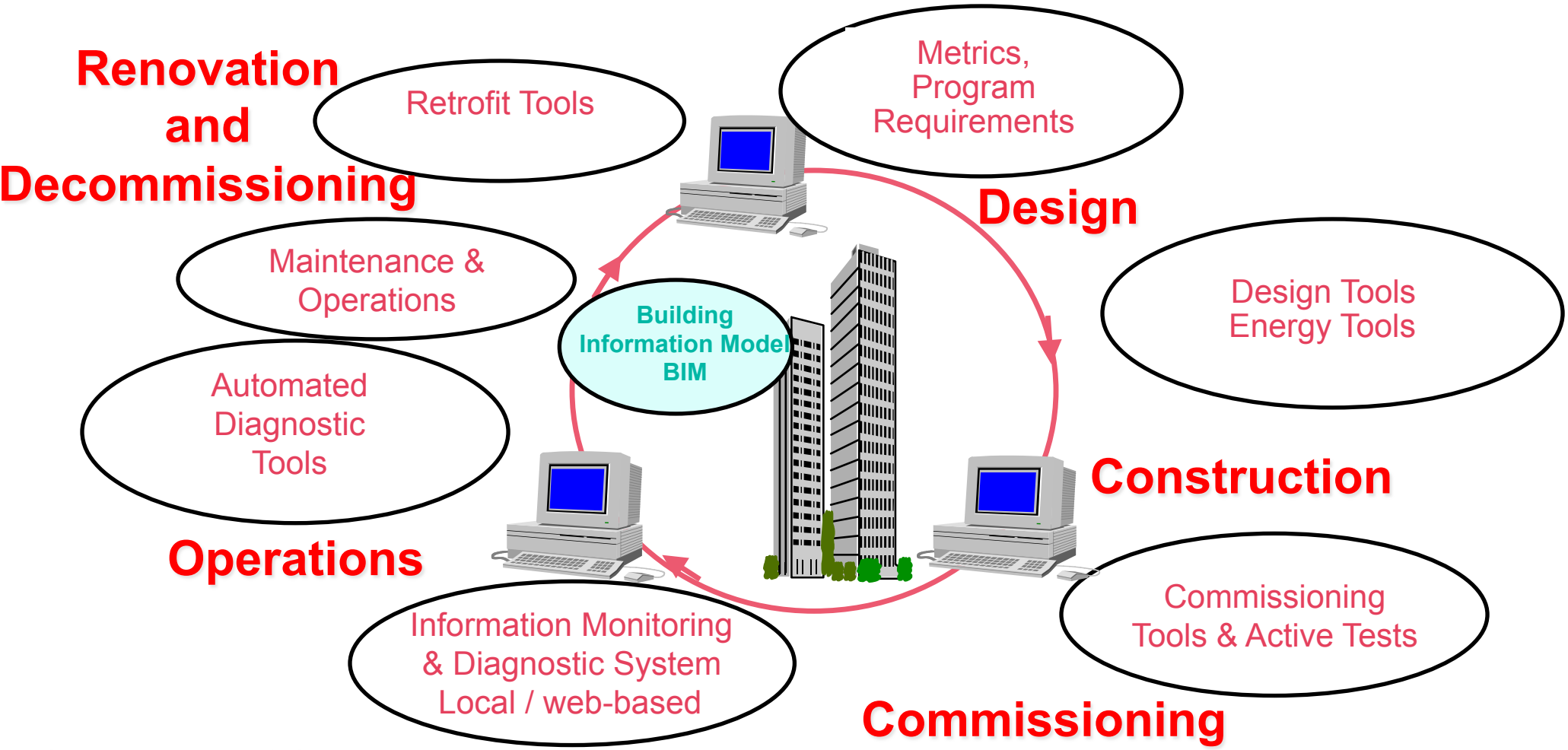
Why Can't Buildings Be as Smart as Cars??

Rethinking the Façade Design/Delivery Ecosystem

Window/Façade Design-Delivery Ecosystem

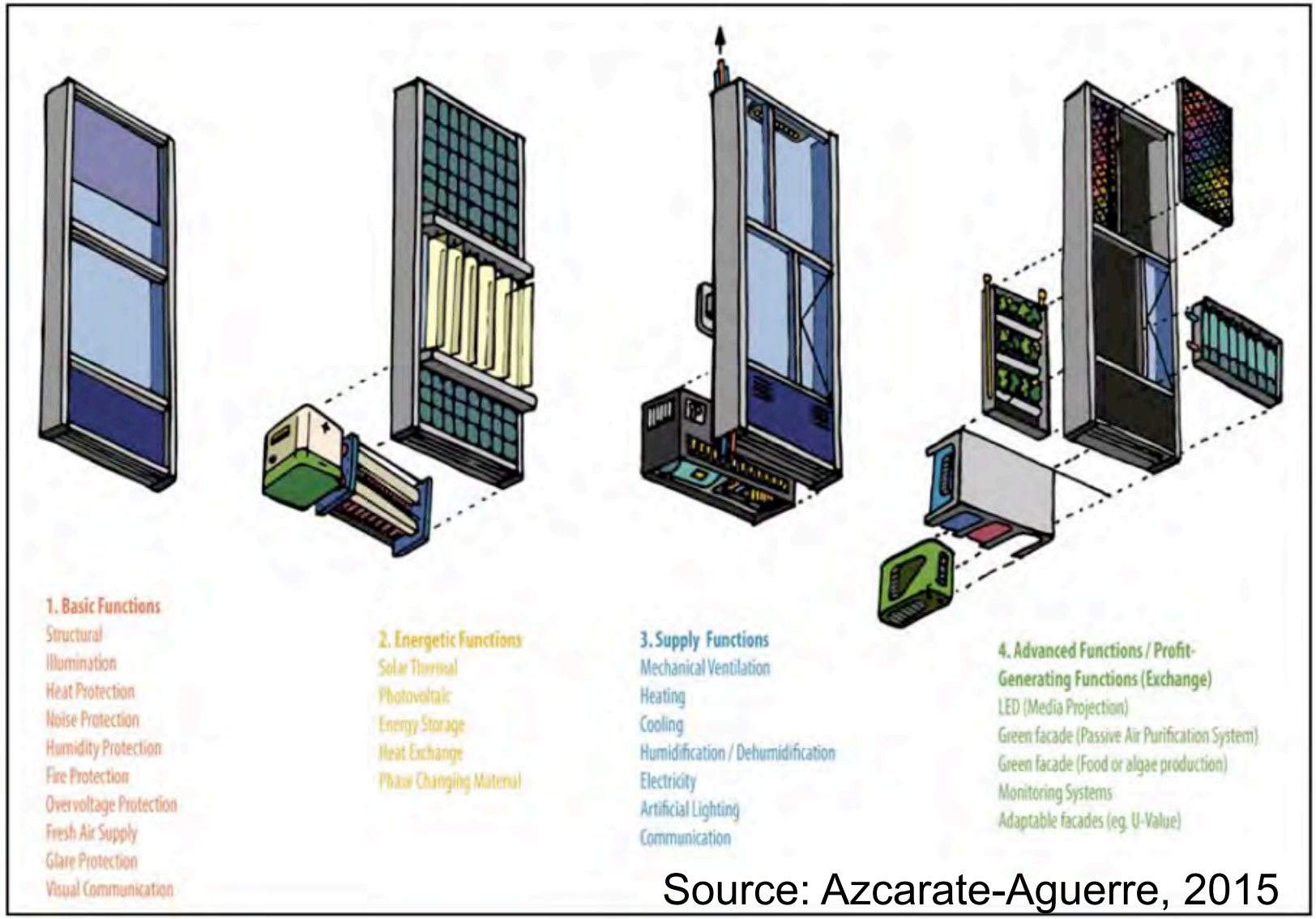


Operating Energy and Embodied Energy across Life-Cycle Boundaries



Interoperable BIM Data model

“Service Oriented” Façade Integrated Product (...it looks like a product but...)



Source: Azcarate-Aguerre, 2015

New Business Models: Product vs Service

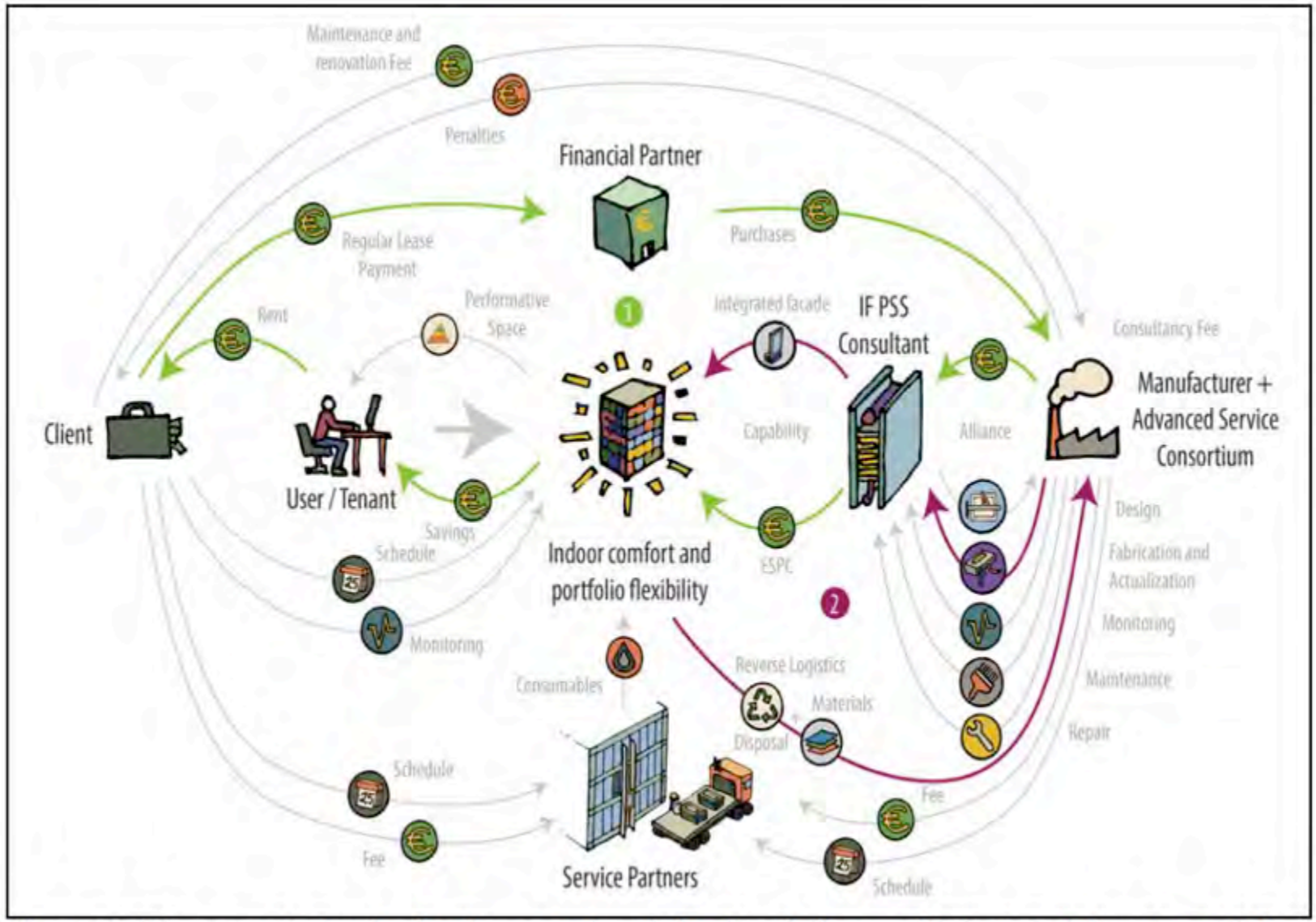
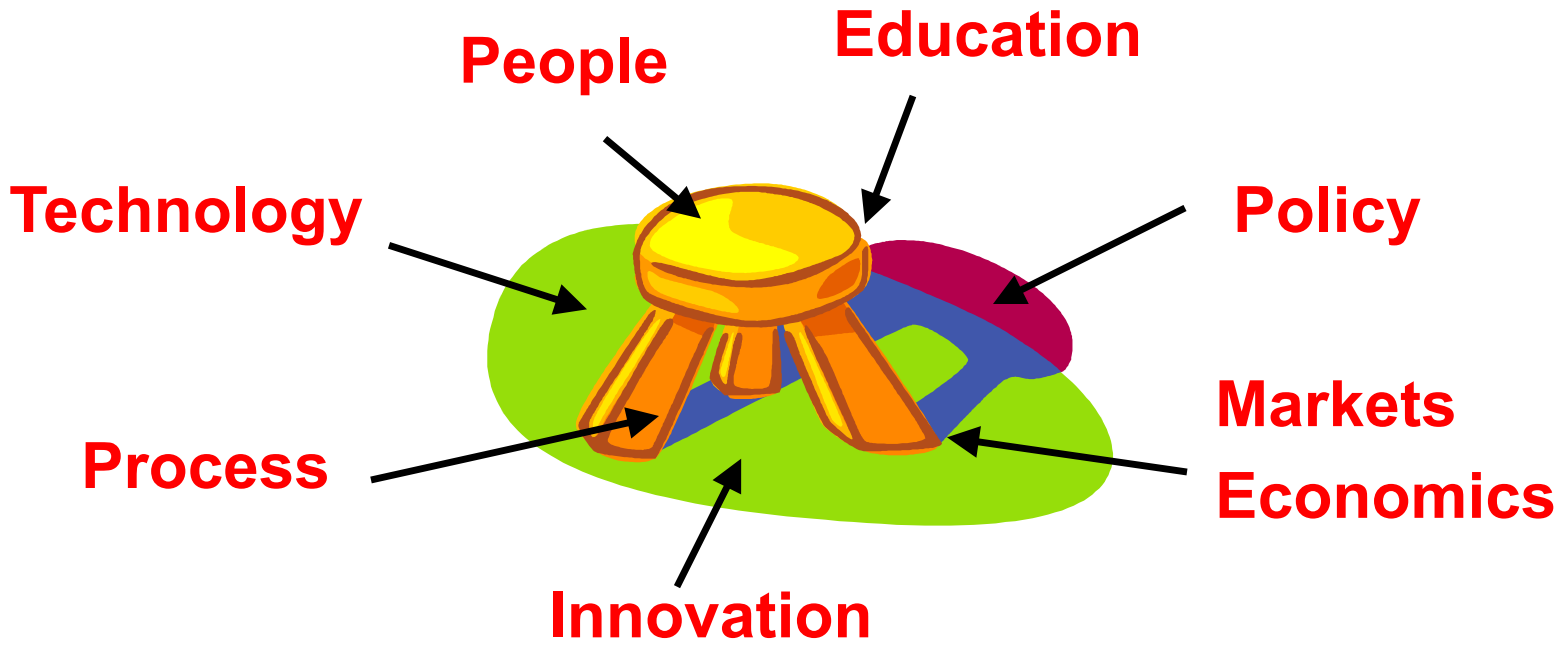


Figure 3. Diagram of circular business network for the delivery of integrated facades within a product-service system. *(1) Closed financial loop (2) Closed material loop*

Source: Azcarate-Aguerre, 2015

Significant Impact Comes Only from Comprehensive Balanced Approach

To routinely deliver high performance, low-energy buildings at scale we must find a balance between:



Solutions fail without this balance

Benefits of High Performance Facades

Improve Occupant Comfort, Satisfaction and Performance

Occupant

Add Value, Reduce Operating Costs

Building Owner

Reduce Energy, Greenhouse Gas Emissions

Planet

“In order to change an existing paradigm you do not struggle to try and change the problematic model. You create a new model and make the old one obsolete.”

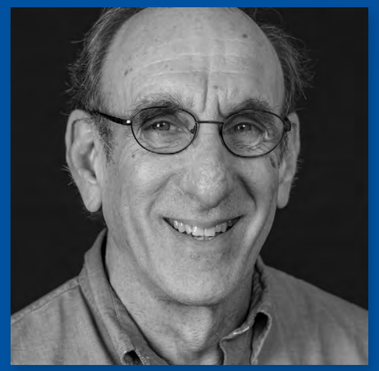
Buckminster Fuller

Facade Tectonics FORUM NEW YORK

CLEARLY CONTROVERSIAL

EXPLORING THE BENEFITS AND LIABILITIES OF HIGHLY GLAZED FACADES

SPEAKERS



Steve Selkowitz
Senior Advisor
Lawrence Berkeley National Laboratory

Gabrielle Brainard, AIA, CHPD
Professor
Rensselaer Polytechnic Institute, Columbia GSAPP, Pratt Institute

Areta Pawlynsky, AIA
Partner
Heintges

Mic Patterson, PhD, LEED AP+
Ambassador of Innovation & Collaboration
The Facade Tectonics Institute

OPENING REMARKS — **1:00 PM**

SESSION 1
DELEGATING DESIGN — **1:10 PM**

STEPHEN WEINRYB / HOK
ALBERTO FRANCESCHET / Permasteelisa North America
GREGORY CHERTOFF / Peckar & Abramson
CHRIS MCCARTIN / Tishman Speyer New York
CHARLES MURPHY / Turner Construction New York
ALEX COX / Permasteelisa North America

NETWORKING BREAK — **2:10 PM**

SESSION 2
CLEARLY CONTROVERSIAL — **2:30 PM**

STEPHEN SELKOWITZ / Lawrence Berkeley National Laboratory
GABRIELLE BRAINARD / Rensselaer Polytechnic Institute
ARETA PAWLYNSKY / Heintges
HELEN SANDERS / Technoform North America

NETWORKING BREAK — **3:30 PM**

SESSION 3
SKIN-DEEP RENOVATION — **3:50 PM**

DAVID BELLMAN / Vornado Realty Trust
DAN SHANNON / MdeAS Architects
MICHAEL HABER / W&W Glass
MIC PATTERSON / Facade Tectonics Institute

CLOSING REMARKS — **4:50 PM**

NETWORKING RECEPTION — **5:00 AM**

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