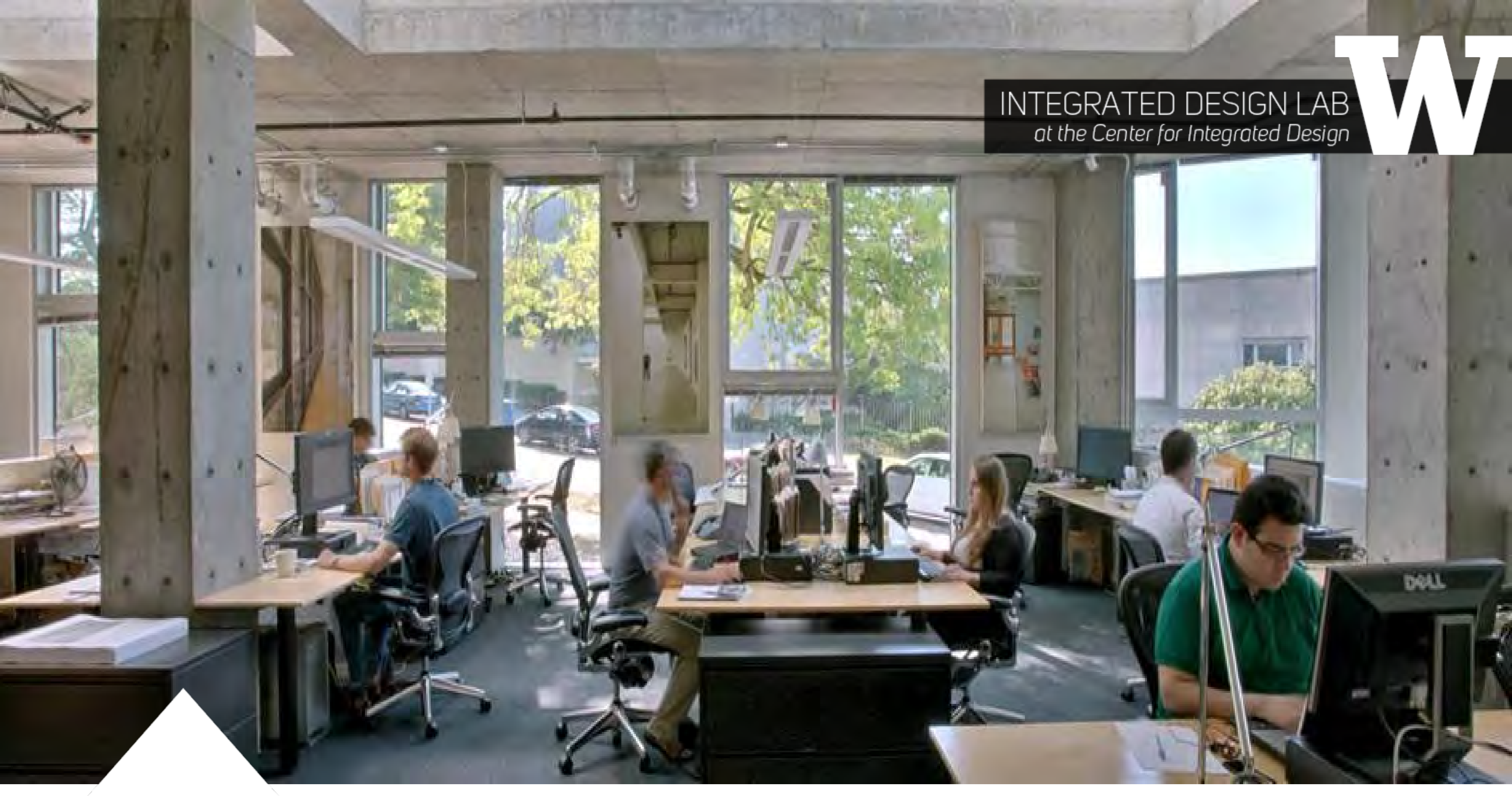

INTEGRATED DESIGN LAB
at the Center for Integrated Design

NEEA Product Council: UW Integrated Design Lab

Christopher Meek
Professor and
Director
University of Washington
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Research Associate Professor and
Director of Education & Outreach
University of Washington
burpeeh@uw.edu

INTEGRATED DESIGN LAB

Annual Report 2021–2022

UW Center for Integrated Design
1501 E. Madison Street, Suite 200
Seattle, WA 98122

206-616-6566
https://idl.be.uw.edu/

IDL at a GLANCE

WHO WE ARE

The IDL is operated by the **Department of Architecture** in the **College of Built Environments** at the **University of Washington** in the **Center for Integrated Design**. We are a self-sustaining organization of interdisciplinary faculty, staff, students, professional collaborators, and partner organizations working together to push the boundary on what's possible in sustainable building design. Our shared mission is to discover solutions that overcome the most difficult building performance barriers, and to meet the building industry's goals of moving towards radically higher performing buildings and healthy urban environments.

OUR WORK

The Integrated Design Lab's mission is underpinned by three service streams that work in tandem to promote an energy efficient, healthy built environment:

Knowledge Transfer through Education and Outreach – We share technical knowledge and lessons learned with our commercial clients and industry partners through professional education programs and public tours of the Bullitt Center.

Discovery through Research – We perform targeted research projects on high performance buildings in order to discover new technologies and strategies for healthy, energy efficient buildings.

Guidance through Technical Assistance – We apply our research findings by providing technical design assistance that translates new strategies and technologies to building project teams and industry partners.

The outcomes of our work intersect with people, policies, cities and buildings, and markets. Work examples are highlighted throughout this report. **In the past decade the Integrated Design Lab has produced:**

144 PAPERS PUBLISHED & JOURNAL ARTICLES, AND **437 CONFERENCE PRESENTATIONS**

DIRECT PROJECT INFLUENCE ON OVER **65,000,000 SQUARE FEET** OF COMMERCIAL BUILDINGS

OVER **94,830 HOURS** OF PAID GRADUATE STUDENT RESEARCH ENGAGEMENT AND MENTORSHIP

OVER **1,900 TOURS** SERVING OVER **36,500 PEOPLE VISITING** THE BULLITT CENTER

CONTACT

The UW Integrated Design Lab
1501 E. Madison Street, Suite 200
Seattle, WA 98122

206-616-6566
https://idl.be.uw.edu/

SPONSORSHIP

Interested in collaborating with the IDL? Contact us to learn more, [illegible] to support the lab's mission, or to create student research internships.

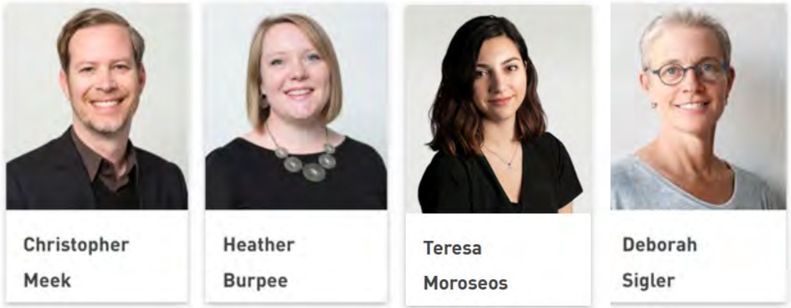
https://idl.be.uw.edu/

Agenda

- Introductions
- IDL Operating Framework
- Motivation and Awareness Building
    - Rosetta Stone: Research-informed design
    - ROI for High Performance Design
- Technical Pathways and Tools
    - Co-Optimization of operational and embodied carbon
    - Building retrofit pathways for Seattle Housing Authority: EEM tool for energy and cost measure
- Progress Tracking: AIA Energy in Design Award
- Discussion

About the UW IDL

Senior Staff



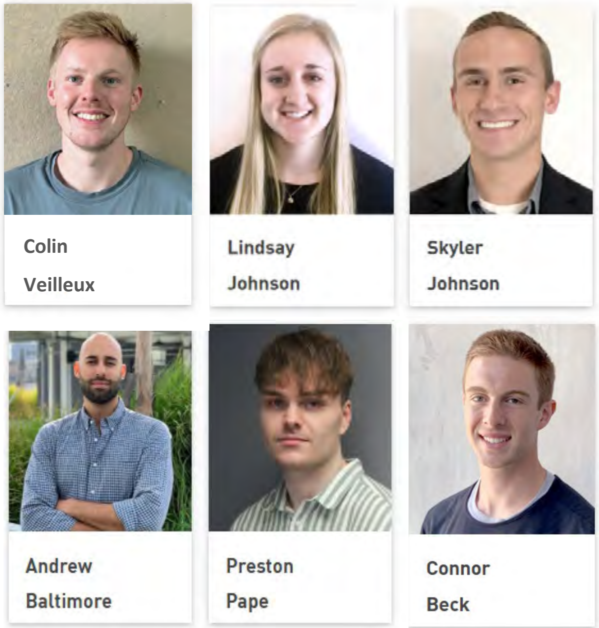
Christopher Meek

Heather Burpee

Teresa Moroseos

Deborah Sigler

Graduate Research Staff



Colin Veilleux

Lindsay Johnson

Skyler Johnson

Andrew Baltimore

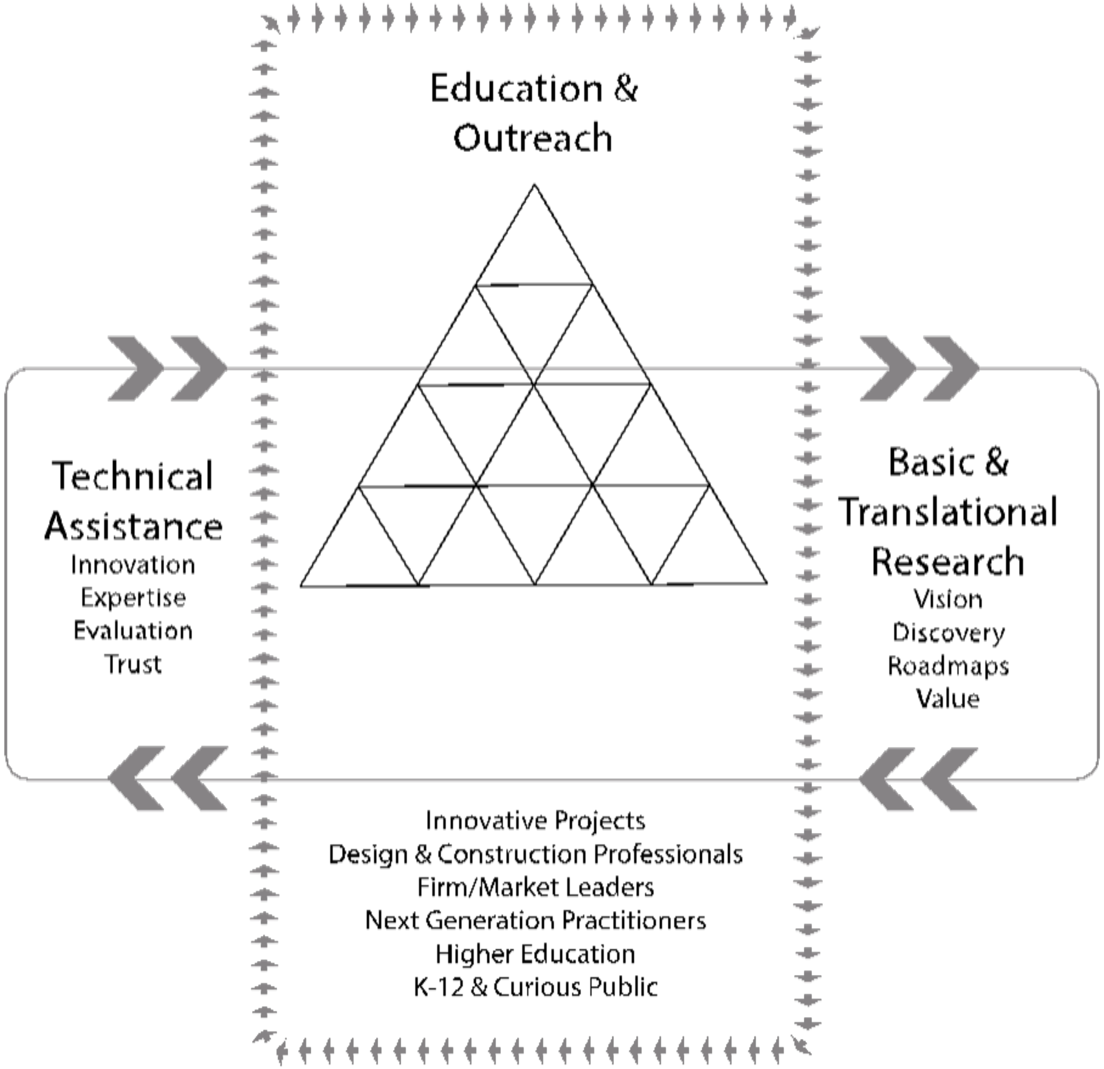
Preston Pape

Connor Beck

University of Washington
College of Built Environments
Department of Architecture
Integrated Design Lab
at the Bullitt Center

UW IDL's Mission

Market Transformation



Education & Outreach

Technical Assistance
Innovation
Expertise
Evaluation
Trust

Basic & Translational Research
Vision
Discovery
Roadmaps
Value

Innovative Projects
Design & Construction Professionals
Firm/Market Leaders
Next Generation Practitioners
Higher Education
K-12 & Curious Public

UW CENTER FOR INTEGRATED DESIGN
PARTNERSHIP INITIATIVE

Steadfast in our work to advance the highest performing built environment through research, technical assistance, education and outreach, the Center for Integrated Design is uniquely positioned to transform a rapidly evolving energy efficiency space in Seattle, the Pacific Northwest, and beyond. As a technical resource for design practitioners, and a collaborative research space for addressing the most challenging obstacles facing the built environment, we serve as a critical connection between emerging research and real-world implementation of innovative design methods. In order to strengthen our impact on sustainable design and rapidly accelerate carbon reduction in the built environment, we require increased support from the design and construction industry—the core benefactors of our work. Through participating in our Partnership Initiative, you support the Center for Integrated Design and Integrated Design Lab to shape future design leaders, and drive meaningful and timely change in the built environment.

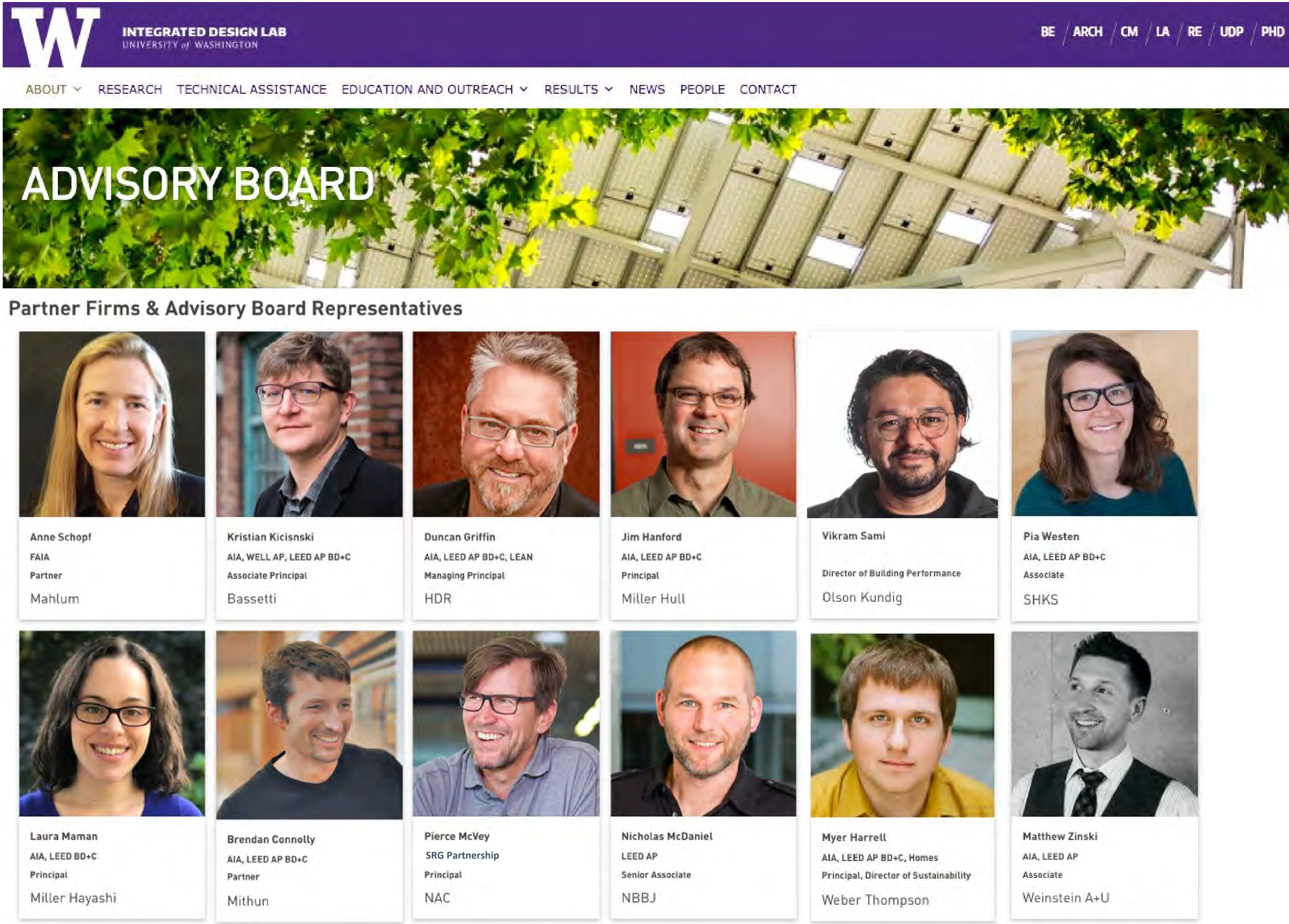
BRIDGE ACADEMIA AND PRACTICE

EDUCATE AND DVOCATE FOR SUSTAINABILITY

STRENGTHEN INDUST COLLABORATION

ADVANCE PIVOTAL RESEARCH

CULTIVATE THE NEXT DESIGN LEADERS



ADVISORY BOARD

Partner Firms & Advisory Board Representatives

Anne Schopf
FAIA
Partner
Mahlum

Kristian Kicisnski
AIA, WELL AP, LEED AP BD+C
Associate Principal
Bassetti

Duncan Griffin
AIA, LEED AP BD+C, LEAN
Managing Principal
HDR

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AIA, LEED AP BD+C, Homes
Principal, Director of Sustainability
Weber Thompson

Matthew Zinski
AIA, LEED AP
Associate
Weinstein A+U

Selected Goals of Partnership

- Connect like-minded practitioners & cultivate leaders in high performance design practice
- Maintain UW IDL's engagement in emerging needs across practice and ability to collect and analyze strategic market intelligence
- Bridge academic research to application in practice
- Provide knowledge to practitioners to improve practice
- Share IDL projects, initiatives, and learnings with leading practitioners to advance energy efficiency.

First Chosen Project

What Research Would Best Support Your Firm?

Empirical evidence supporting the value of high-performance design at our fingertips.

Rosetta Stone: A Translational Tool for Research-Informed Practice

- Daylight
- Electric Lighting
- Biophilia
- Air Quality
- Thermal Comfort
- Acoustics
- Economics

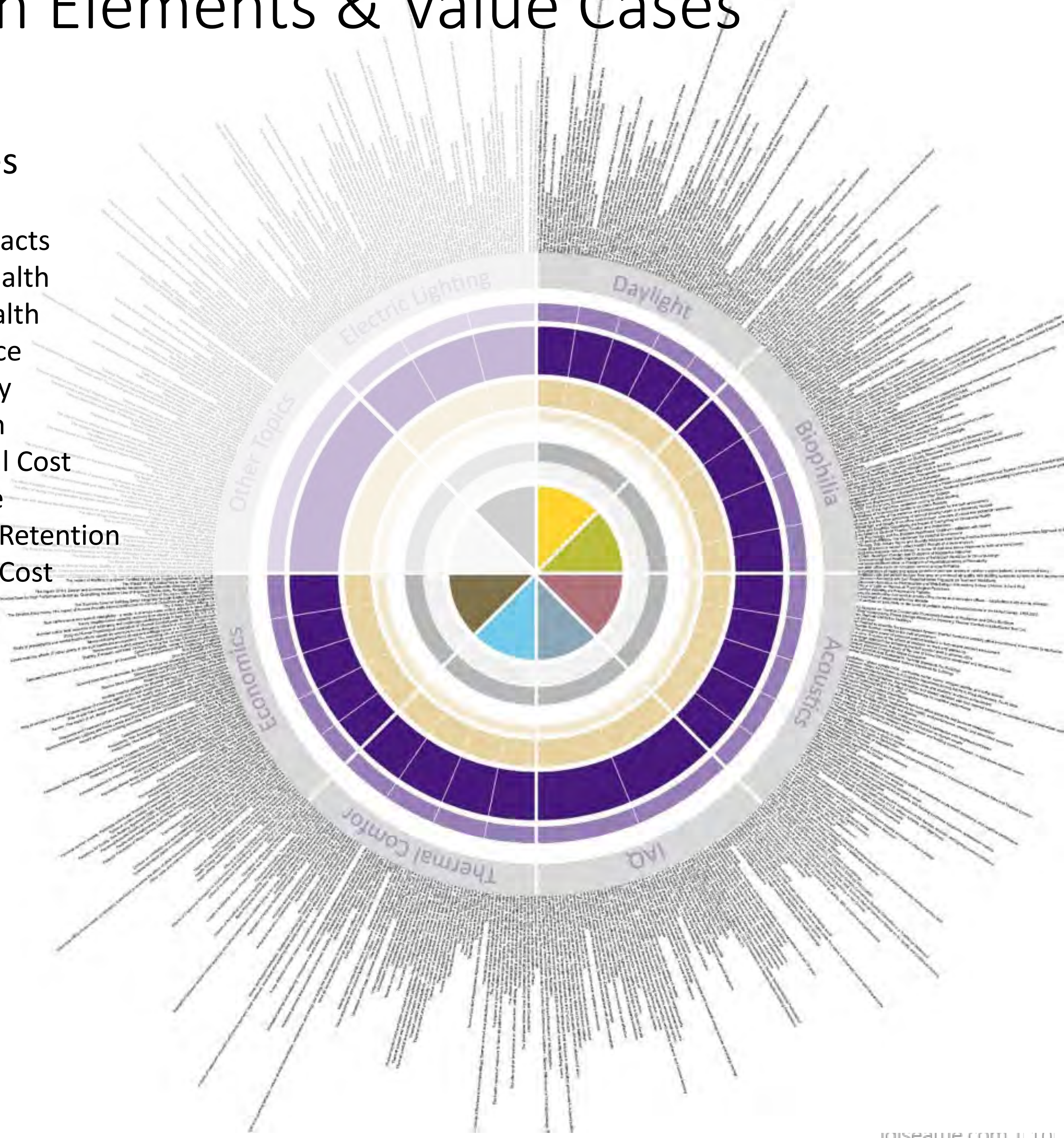
Structure – Design Elements & Value Cases

Design Elements

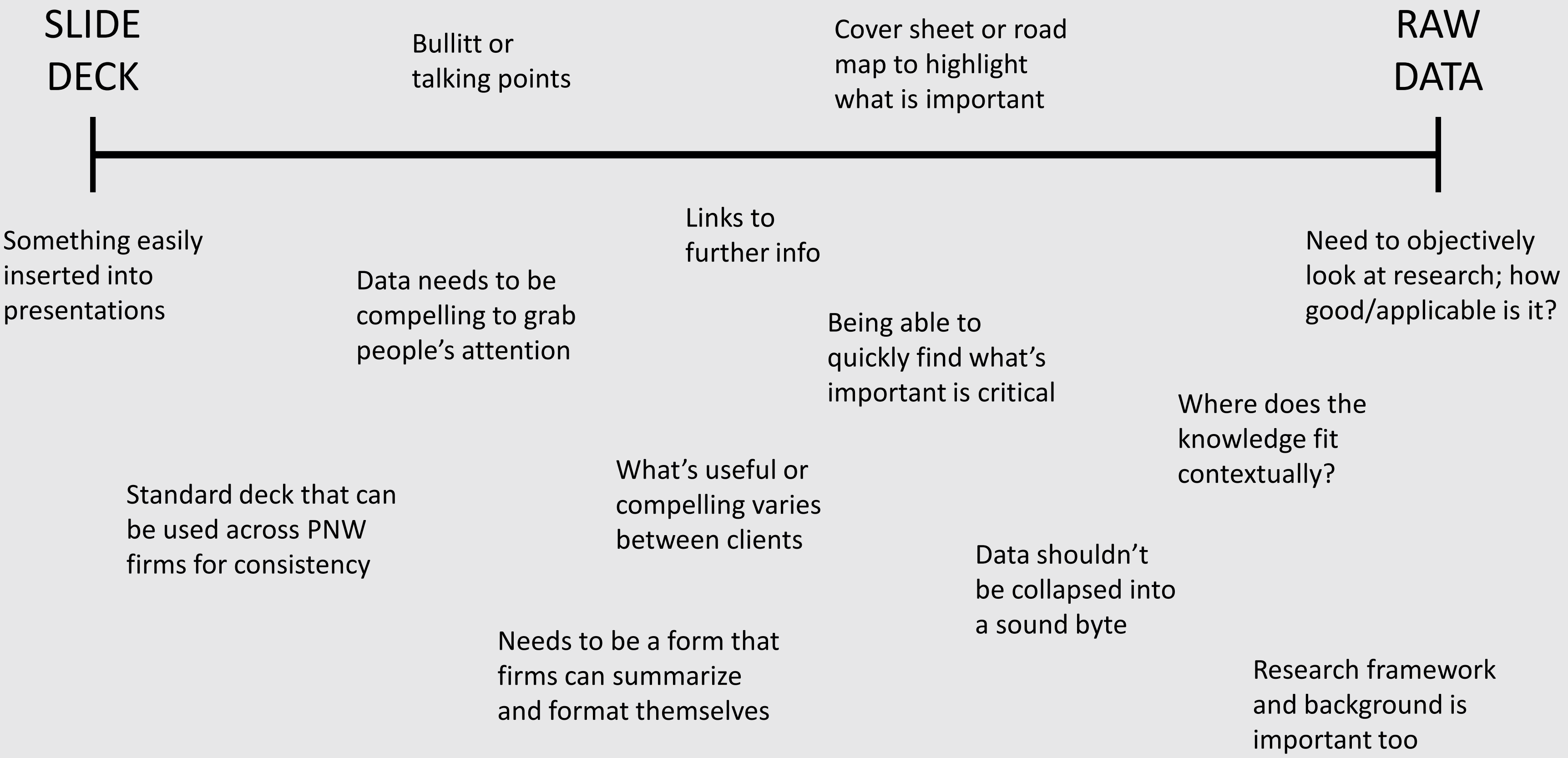
- Daylight
- Biophilia
- Indoor Air Quality
- Thermal Comfort
- Acoustics
- Economics
- Electric Lighting
- Equity
- View
- Water
- Materials

Value Cases

- Design Impacts
- Physical Health
- Mental Health
- Performance
- Productivity
- Satisfaction
- Operational Cost
- Asset Value
- Attraction/Retention
- Initial First Cost
- Stress
- Equity
- Carbon



Most Useful Types of Information



SLIDE DECK

Bullitt or talking points

Cover sheet or road map to highlight what is important

RAW DATA

Something easily inserted into presentations

Data needs to be compelling to grab people's attention

Links to further info

Being able to quickly find what's important is critical

Need to objectively look at research; how good/applicable is it?

Where does the knowledge fit contextually?

Standard deck that can be used across PNW firms for consistency

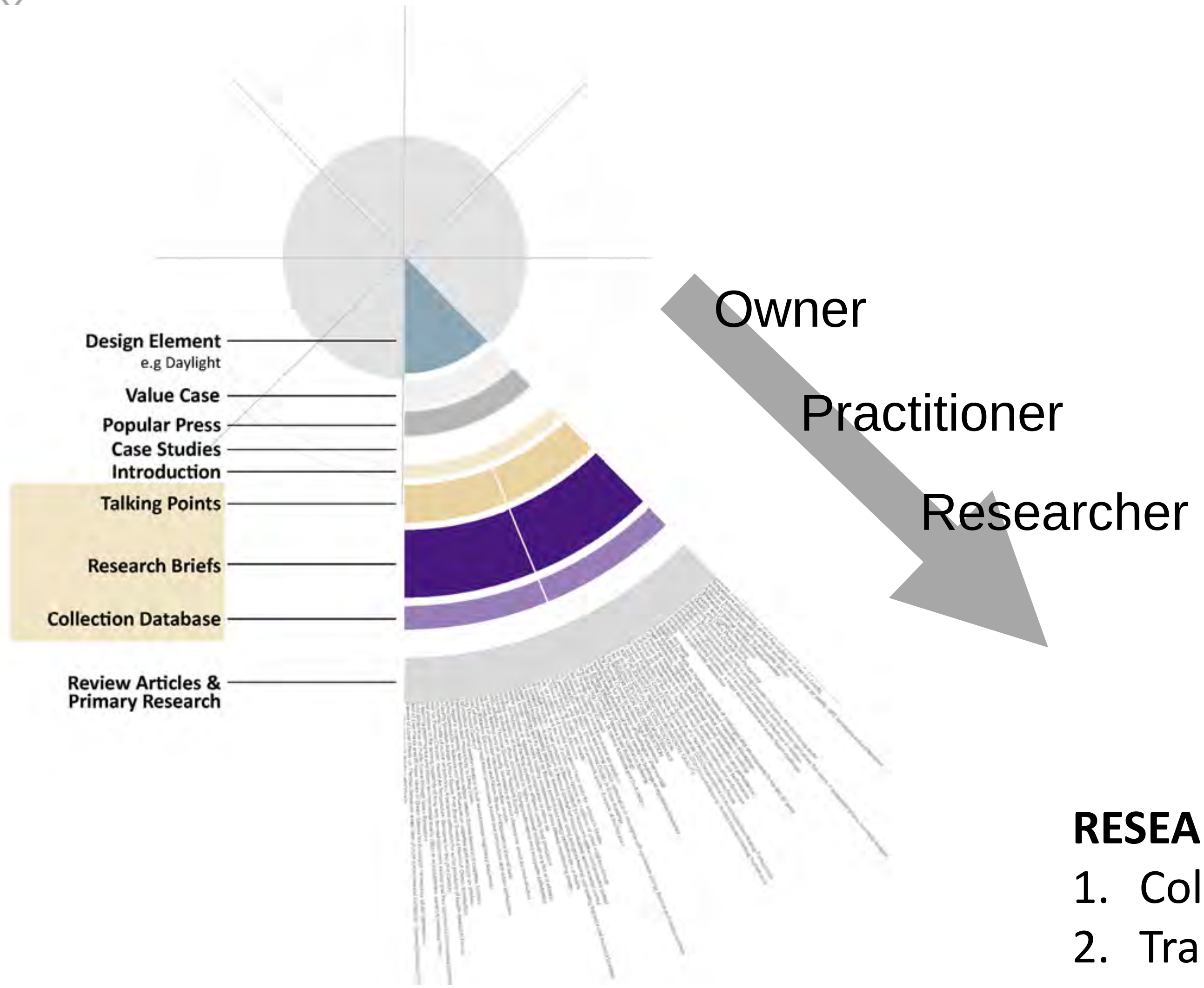
What's useful or compelling varies between clients

Data shouldn't be collapsed into a sound byte

Needs to be a form that firms can summarize and format themselves

Research framework and background is important too

Nomenclature & Structure



Owner

Practitioner

Researcher

RESEARCH PROCESS

1. Collect
2. Translate
3. Communicate

Current Status

Six Design Elements

(number of value cases developed)

- Daylight (5)
- Biophilia (4)
- Indoor Air Quality (2)
- Thermal Comfort (4)
- Acoustics (5)
- Economics (5)
- Electric Lighting (7)
- View (tbd)
- Water
- Materials

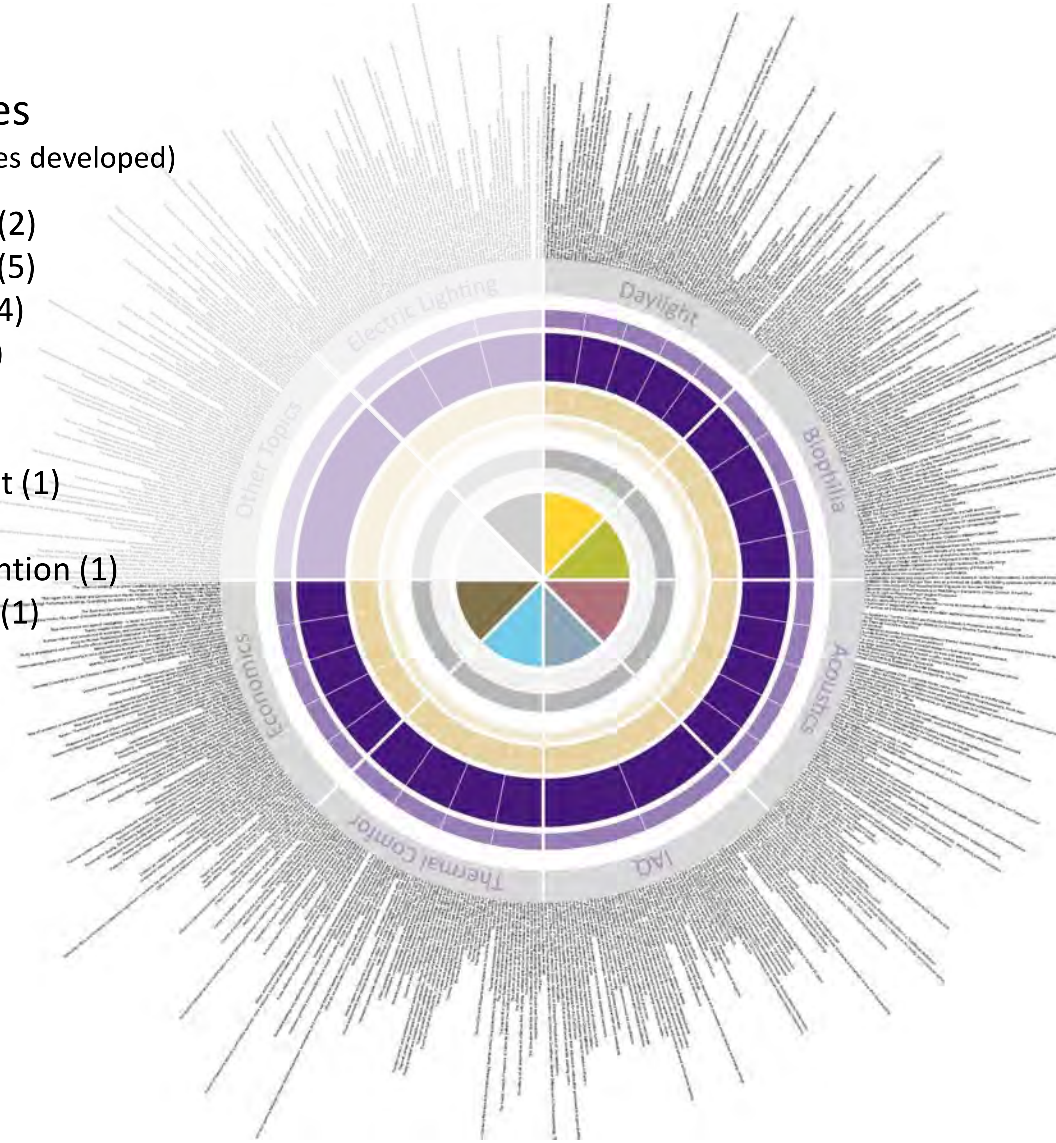
Ten Value Cases

(number of value cases developed)

- Design Impacts (2)
- Physical Health (5)
- Mental Health (4)
- Performance (3)
- Productivity (2)
- Satisfaction (2)
- Operational Cost (1)
- Asset Value (1)
- Attraction/Retention (1)
- Initial First Cost (1)
- Stress (3)
- Equity
- Carbon

Total Content Pieces

- 663 articles reviewed
- 6 Collection Databases
- 32 Research Briefs
- 32 Talking Points



RS Web Tool:

https://rosetta.be.uw.edu/

About

The Rosetta Stone Translational Tool for Research-informed Practice is a joint collaboration between the University of Washington's Integrated Design Lab and design industry partners. The tool developed out of a collective desire to clearly communicate the synergies of high performance design, in a way that is backed by research and evidence.

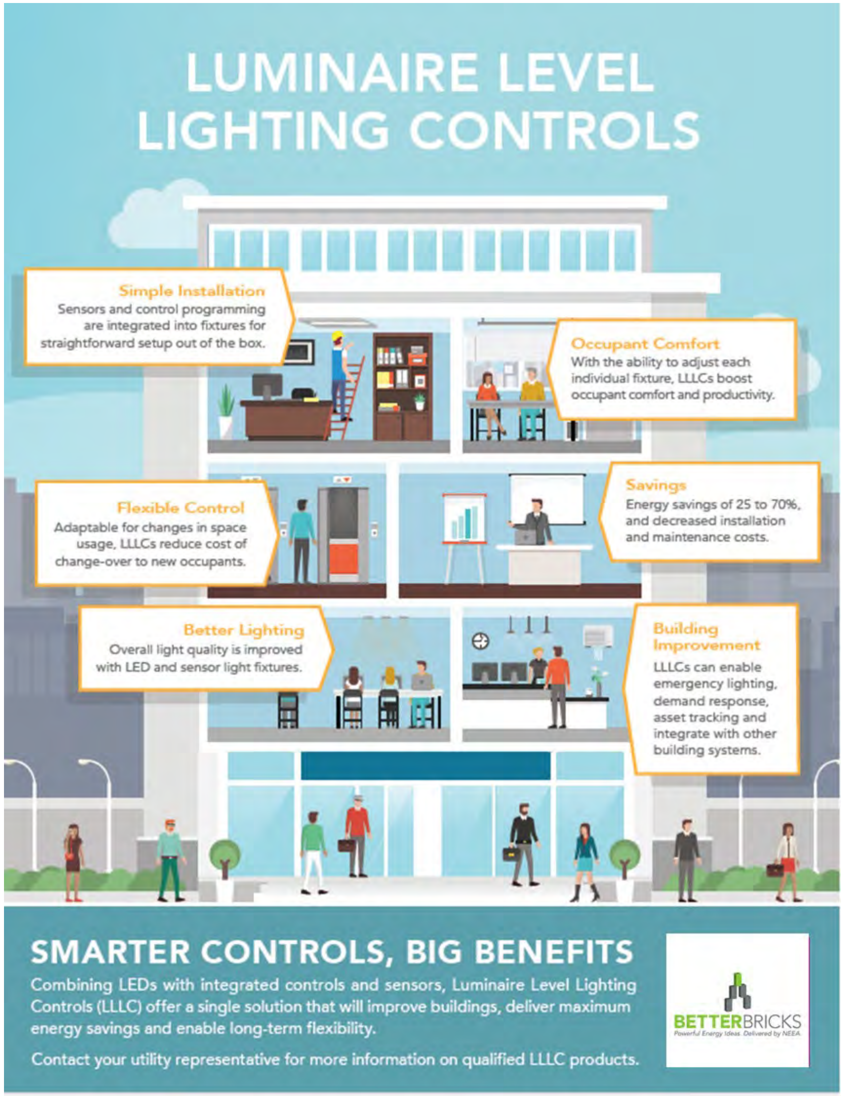
Its aim is to create a high-level translational literature review tool to help disseminate knowledge and information for a range of targeted audiences at varying level of depths of information and to equip firms with consistent, fit-for-purpose messaging and guidance to discuss different Value Cases of High Performance Design.

The Framework

The tool is comprised of design elements and value cases that describe attributes of building design that impact the human health and perceptions of the built environment. These themes are driven by from empirical evidence. Example architectural design elements include Daylight, Acoustics, Biophilia, Indoor Air Quality, and Thermal Comfort with value

Learn more about how to access the tool in this short video presented by the UW IDL.

LLLC Awareness Building



LUMINAIRE LEVEL LIGHTING CONTROLS

Simple Installation
Sensors and control programming are integrated into fixtures for straightforward setup out of the box.

Occupant Comfort
With the ability to adjust each individual fixture, LLLCs boost occupant comfort and productivity.

Flexible Control
Adaptable for changes in space usage, LLLCs reduce cost of change-over to new occupants.

Savings
Energy savings of 25 to 70%, and decreased installation and maintenance costs.

Better Lighting
Overall light quality is improved with LED and sensor light fixtures.

Building Improvement
LLLCs can enable emergency lighting, demand response, asset tracking and integrate with other building systems.

SMARTER CONTROLS, BIG BENEFITS

Combining LEDs with integrated controls and sensors, Luminaire Level Lighting Controls (LLLC) offer a single solution that will improve buildings, deliver maximum energy savings and enable long-term flexibility.

Contact your utility representative for more information on qualified LLLC products.

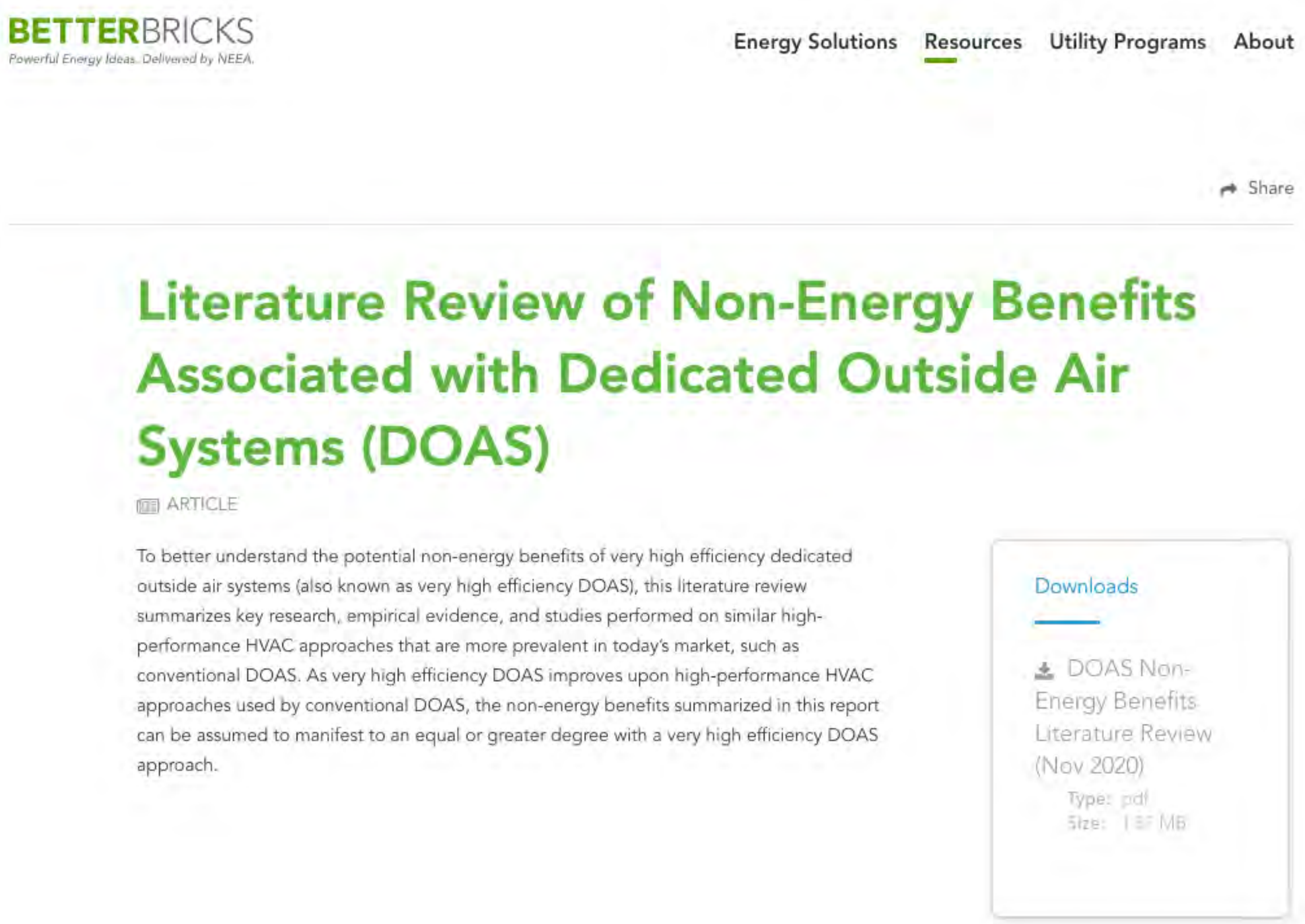
LUMINAIRE LEVEL LIGHTING CONTROLS
TECHNOLOGY FOCUS
Talking Points

- Integrated building systems retrofits have been shown to increase savings over single end-use retrofits. One study found 30% whole building energy savings from component retrofits, but over 80% savings for integrated systems retrofits (Shackelford et. al., 2020).
- Savings ranged from around 20% for the system with daylight dimming and automated shading controls, but no source change savings (fluorescent to LED), to over 70% savings for retrofit packages that included source change to LEDs with advanced controls and either shading system changes (venetian blinds to mechanical roller shades with daylight redirecting blinds) or lighting layout improvements (workstation-specific lighting design) (Shackelford et. al., 2020).
- With a delay time of 20 min and not grouping the troffers, LLLCs with wide fields of view reduce energy use by 40% compared with the base case, resulting in electricity cost savings of US$6.20 per year per troffer. LLLCs with narrow fields of view reduce energy use by 48% compared with the base case, resulting in electricity cost savings of US$7.50 per year per troffer (Snyder, 2020).
- Reducing the delay period time from 20 min (a typical default value) to 5 min reduces energy use by an additional 14% for the wide field of view and by an additional 21% for the narrow field of view relative to the 20-min-delay energy use, providing an additional electricity cost savings of US$1.40 to US$2.70 per year per troffer (Snyder, 2020).
- The results show that when LLLCs are grouped into pairs, energy use is increased by 10% for the wide field of view and by 18% for the narrow field of view compared with ungrouped LLLCs (Snyder, 2020).
- The scenario leading to the least energy use (narrow field of view, 1-min delay period, ungrouped, turn off when unoccupied) uses 35% of the base case (manual switches) energy use, while the scenario leading to the most energy use (wide field of view, 20-min delay period nominal groups of 8, turning off during vacancy) uses 75% of the base case energy, more than double the lowest energy use case (Snyder, 2020).
- The energy cost savings ranged from $6.20 for an ungrouped wide-field-of-view LLLC with a 20-min delay to $9.10 for an ungrouped narrow-field-of-view LLLC with a 5-min delay (Snyder, 2020).

Luminaire-level lighting controls simplifies code compliance and promotes future technological integration

- Advanced wireless lighting control systems currently available are meant to simplify the installation process for lighting controls, potentially reducing material and labor costs by negating the need for long runs of controls and communication wiring (Wei et. al., 2015).
- Cost-effectiveness results for new construction and major renovation scenarios, with the much lower incremental installed project costs (close to $1/ft2), are much better. With paybacks ranging from 3 to 6 years, adding wireless advanced lighting controls to lighting projects is a compelling opportunity in new construction and major renovation (Wei et. al., 2015).

VHE DOAS Non-Energy Benefits



Literature Review of Non-Energy Benefits Associated with Dedicated Outside Air Systems (DOAS)

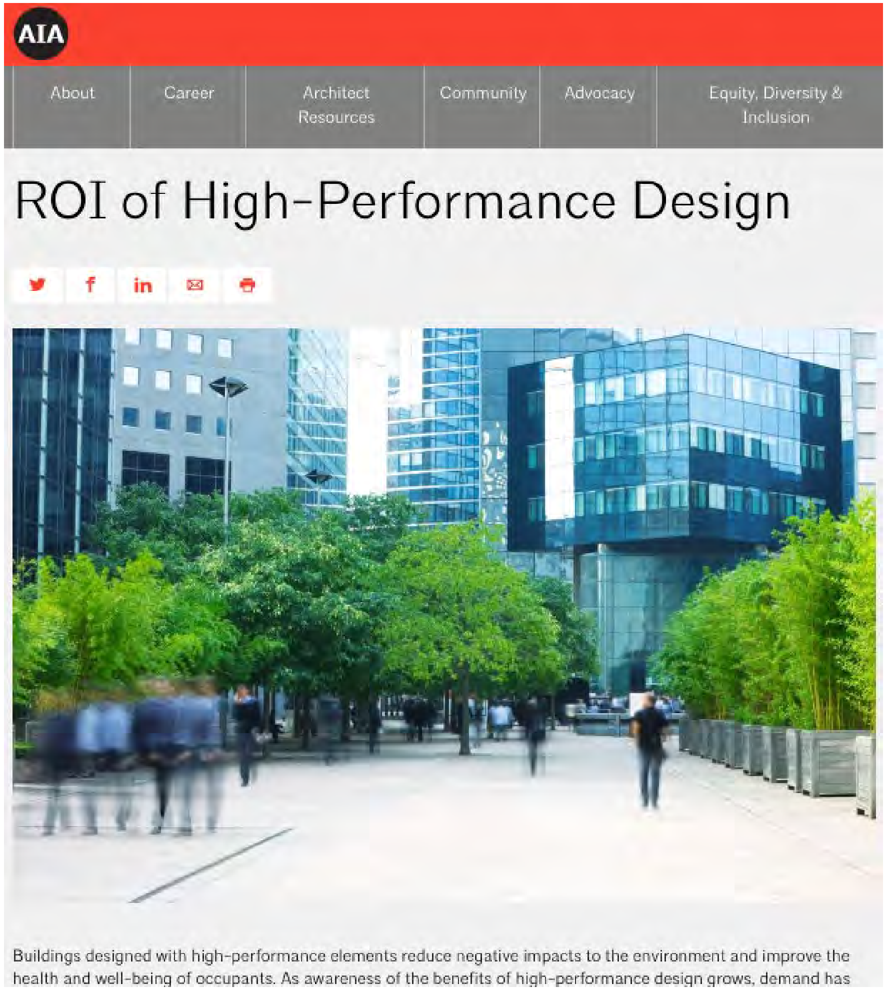
ARTICLE

To better understand the potential non-energy benefits of very high efficiency dedicated outside air systems (also known as very high efficiency DOAS), this literature review summarizes key research, empirical evidence, and studies performed on similar high-performance HVAC approaches that are more prevalent in today's market, such as conventional DOAS. As very high efficiency DOAS improves upon high-performance HVAC approaches used by conventional DOAS, the non-energy benefits summarized in this report can be assumed to manifest to an equal or greater degree with a very high efficiency DOAS approach.

Downloads

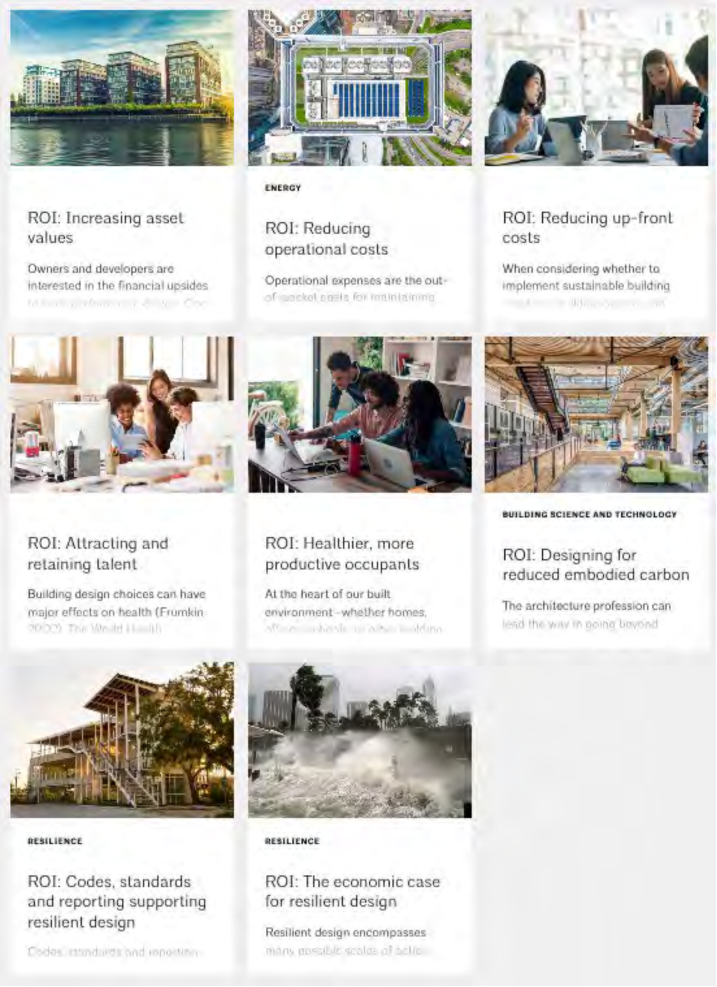
DOAS Non-Energy Benefits Literature Review (Nov 2020)
Type: pdf
Size: 1.87 MB

AIA Return on Investment Lit Reviews



ROI of High-Performance Design

Buildings designed with high-performance elements reduce negative impacts to the environment and improve the health and well-being of occupants. As awareness of the benefits of high-performance design grows, demand has



ROI: Increasing asset values

Owners and developers are interested in the financial upsides

ENERGY

ROI: Reducing operational costs

Operational expenses are the out-of-pocket costs for maintaining

ROI: Reducing up-front costs

When considering whether to implement sustainable building

ROI: Attracting and retaining talent

Building design choices can have major effects on health (Frumkin 2000). The World Health

ROI: Healthier, more productive occupants

At the heart of our built environment - whether homes,

BUILDING SCIENCE AND TECHNOLOGY

ROI: Designing for reduced embodied carbon

The architecture profession can lead the way in going beyond

RESILIENCE

ROI: Codes, standards and reporting supporting resilient design

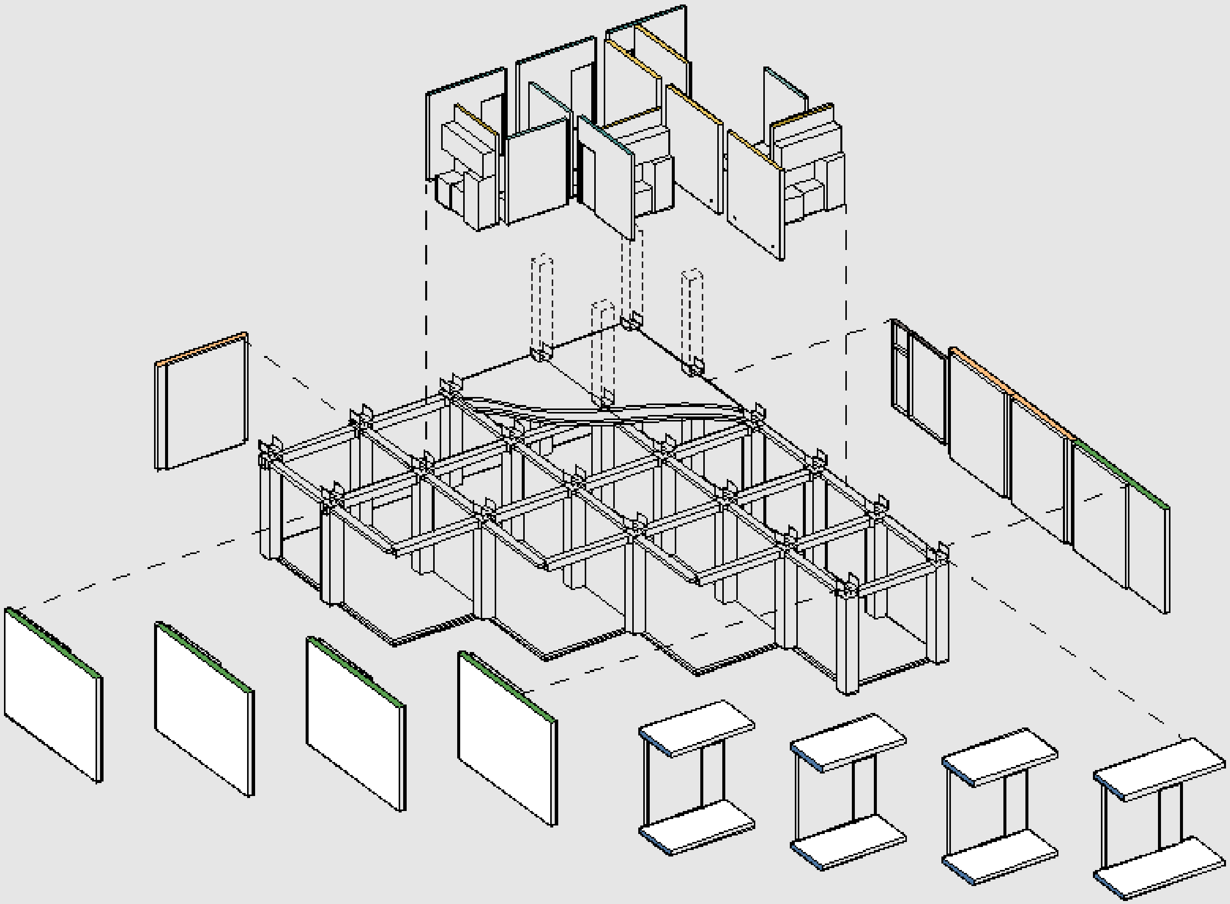
Codes, standards and reporting

RESILIENCE

ROI: The economic case for resilient design

Resilient design encompasses many possible scales of actio

https://www.aia.org/resources/6409378-roi-of-high-performance-design



CARBON RESEARCH STUDIO 2021

DESIGNING FOR LOW EMISSIONS

A COMPUTATIONAL APPROACH TO MASS TIMBER BUILDINGS

TOMÁS MÉNDEZ ECHENAGUCIA AND CHRISTOPHER MEEK

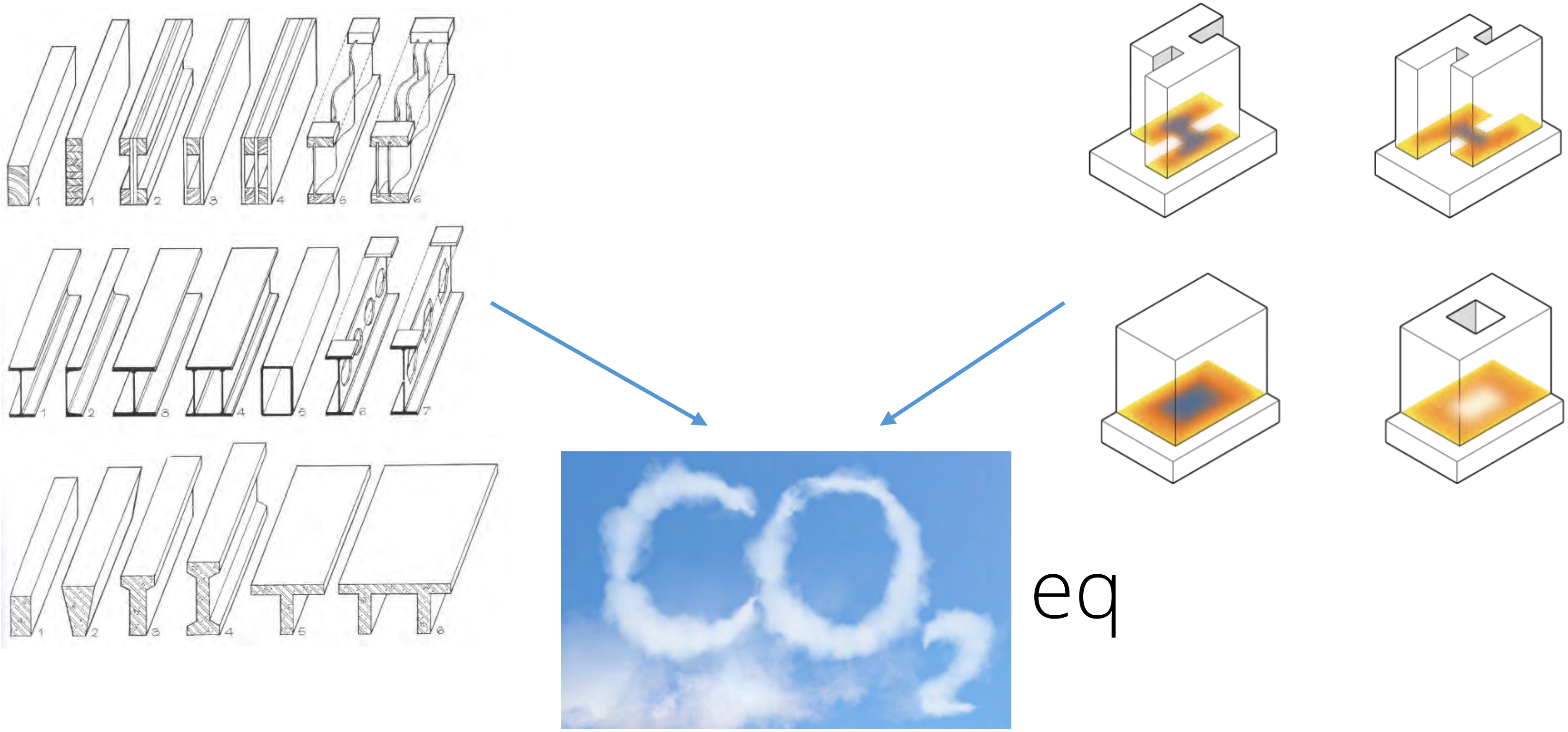
UNIVERSITY of WASHINGTON

Research Questions

- What are trade-offs between embodied & operational carbon of building facade design?
- How do various climate types impact the trade-offs?
- How does the carbon intensity of the electricity grid impact trade-offs?
- How do the trade-offs differ between office and apartment typology?

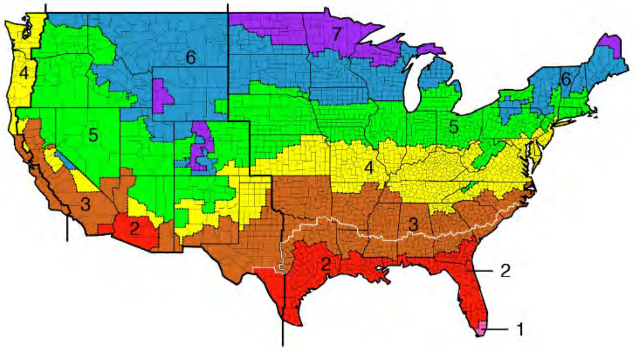
Embodied

Operational



eq

Supply Chain

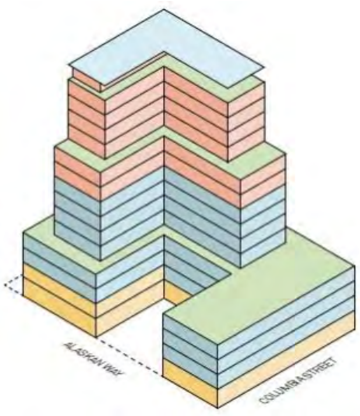


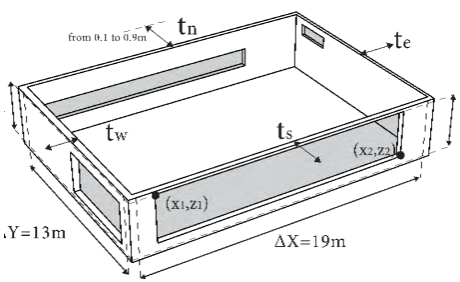
Climate

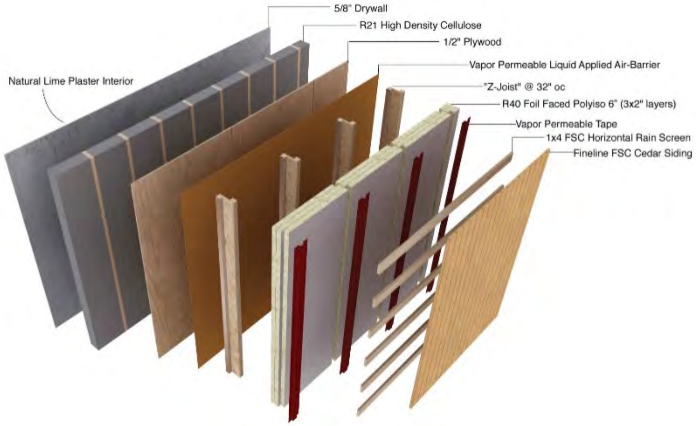
Grid Carbon Intensity

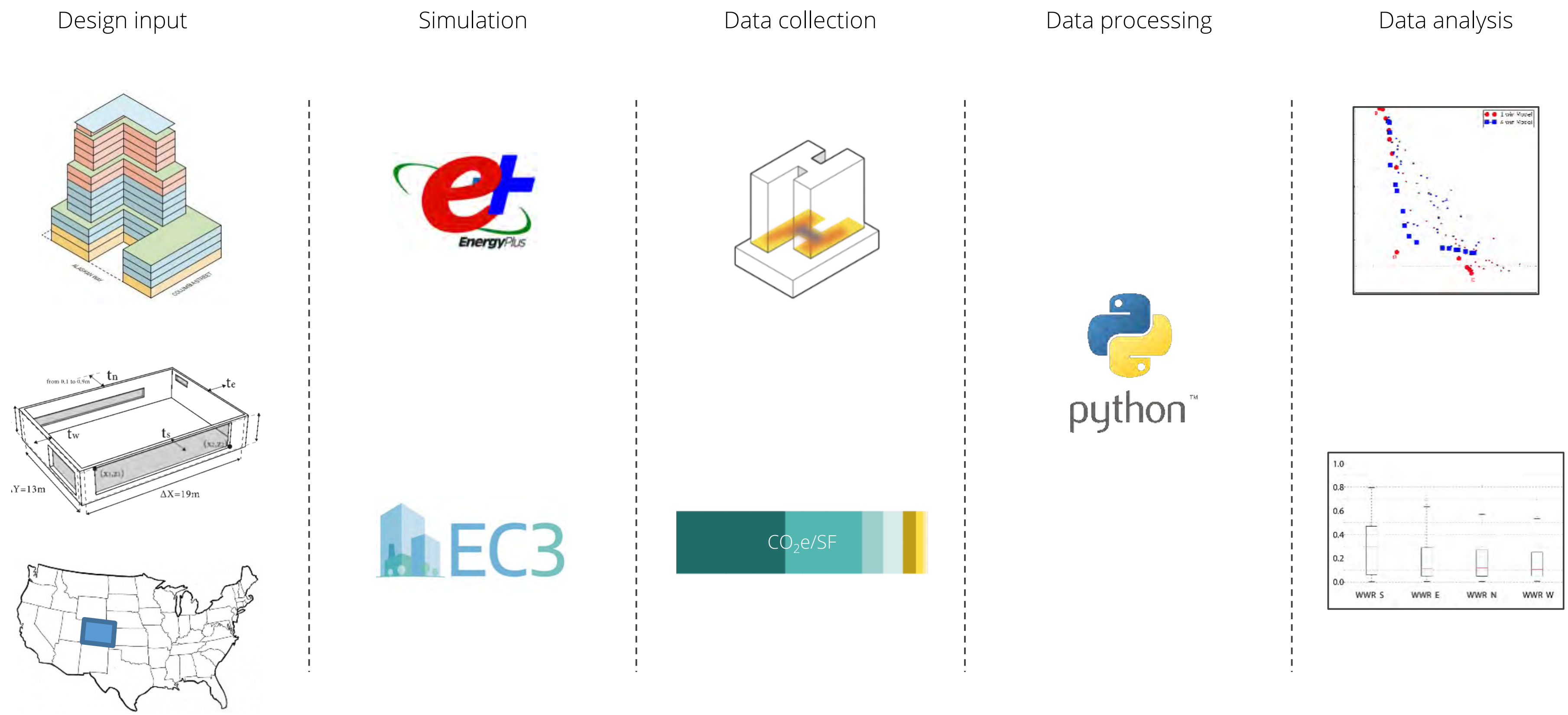
Crescent Electric Supply Company (2018)

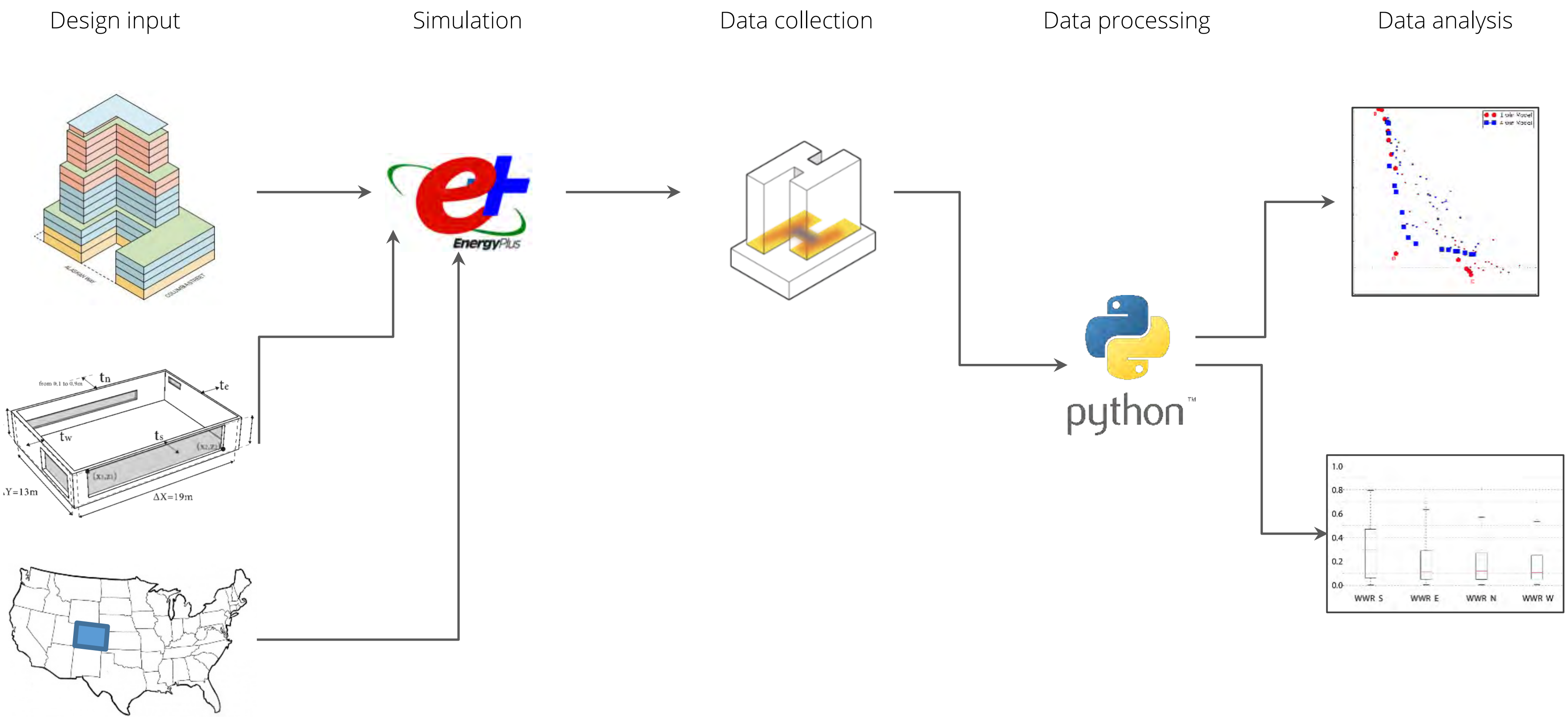
Design input








Design input
Simulation
Data collection
Data processing
Data analysis
from 0.1 to 0.9m
tn
te
tw
ts
(x1,z1)
(x2,z2)
.Y=13m
ΔX=19m
EnergyPlus
EC3
CO2e/SF
python
1.0
0.8
0.6
0.4
0.2
0.0
WWR S
WWR E
WWR N
WWR W



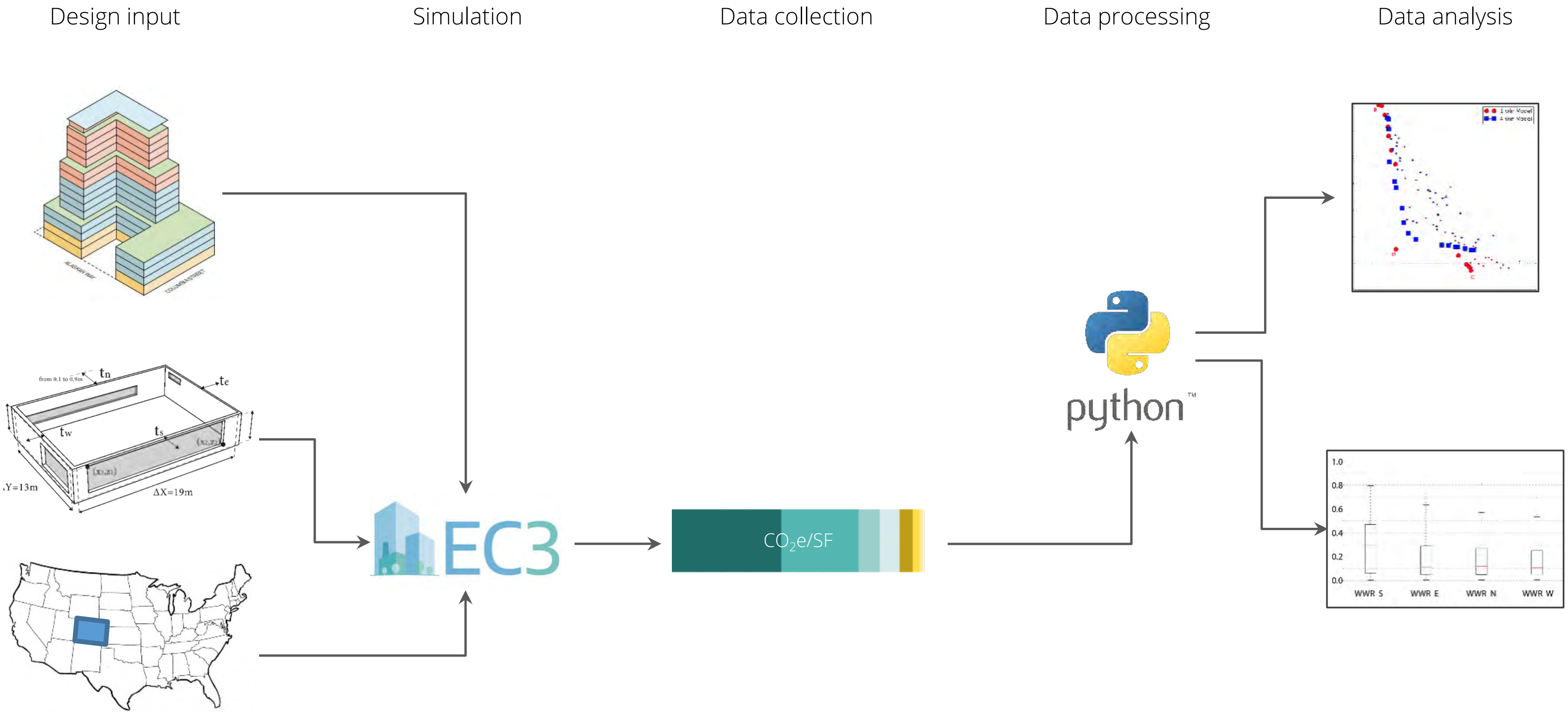
Design input

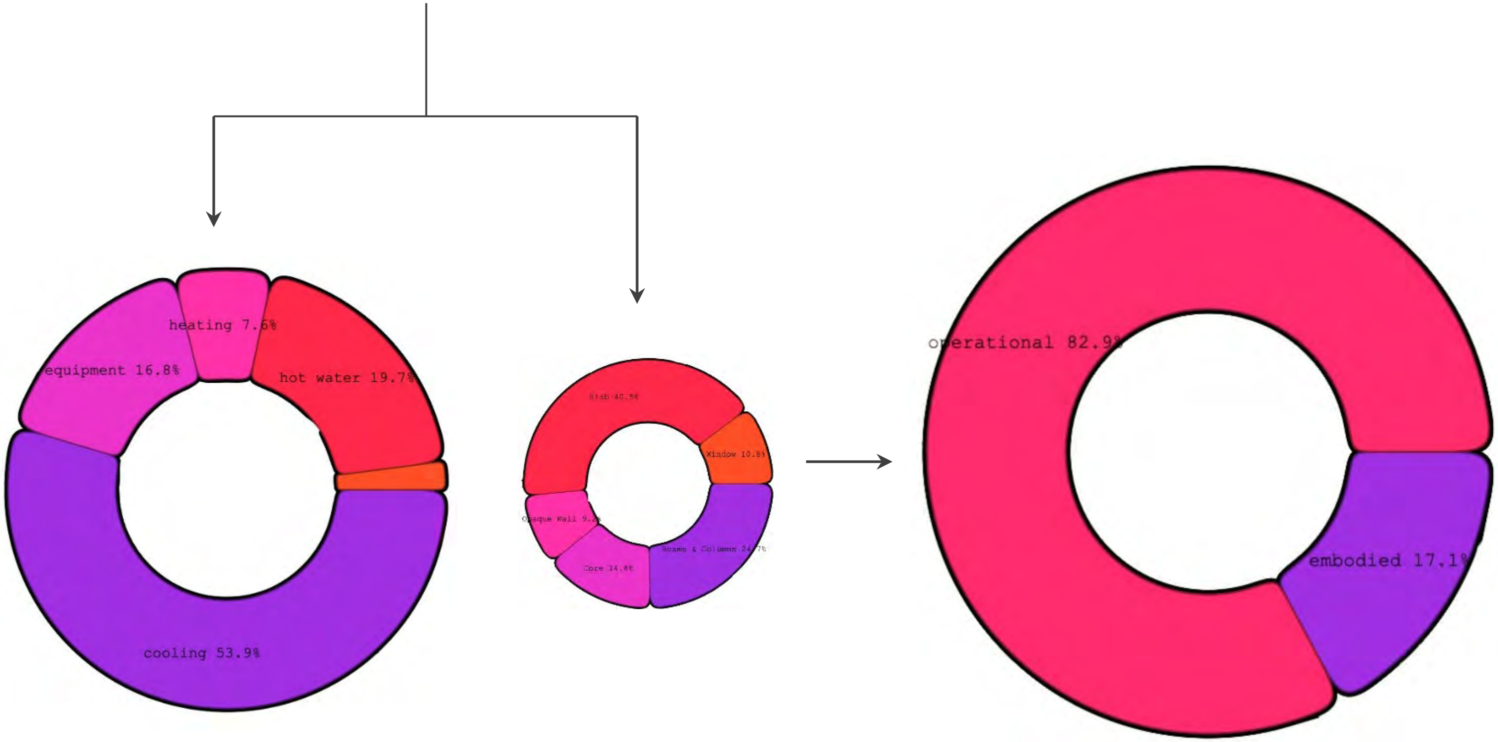
Simulation

Data collection

Data processing

Data analysis

Design input
Simulation
Data collection
Data processing
Data analysis
from 0.1 to 0.9m
t_n
t_e
t_w
t_s
(x_2,z_2)
(x_1,z_1)
ΔY=13m
ΔX=19m
EC3
CO_2e/SF
python™
1.0
0.8
0.6
0.4
0.2
0.0
WWR S
WWR E
WWR N
WWR W



Operational

Embodied

Embodied /
Operational

https://www.sciencedirect.com/science/article/pii/S0378778822007605?dgcid=author

Contents lists available at ScienceDirect

Energy & Buildings

journal homepage: www.elsevier.com/locate/enb

On the tradeoffs between embodied and operational carbon in building envelope design: The impact of local climates and energy grids

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ABSTRACT

The building envelope has a substantial influence on a building's life cycle operational and embodied carbon emissions. Window-to-wall ratios, wall assemblies, shading and glazing types, have been shown to have a significant impact on total emissions. This paper provides building designers, owners, and policy makers with actionable guidance and a prioritization framework for establishing co-optimized lifecycle carbon performance of facade assembly components in a broad spectrum of climate contexts and energy carbon intensities. A large parametric study of building envelopes is conducted using building performance simulation and cradle-to-gate embodied carbon calculations in 6 US cities. The authors derive the total carbon emissions optimization for commercial office and residential space types using standard code-reference models and open-source lifecycle data. Comparisons between optimal total carbon solutions and (i) optimal operational carbon and (ii) minimum required assemblies, show the impact of under and over investing in envelope-related efficiency measures for each climate. Results show how the relationship between embodied and operational carbon is highly localized, that optimal design variables can vary significantly. In low carbon intensity energy grids, over investment in envelope embodied carbon can exceed as 10 $kgCO_2e/m^2$, while under investment in high carbon intensity grids can be higher than 150 $kgCO_2e/m^2$.

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1. Introduction

The construction sector has dedicated significant investments in research and legislation toward energy efficiency and reduced operational carbon emissions, while embodied emissions have historically received far less attention. More recently, increased attention has been given to embodied carbon due to the realization that they are increasingly representing a large percentage of the total lifecycle GHG emissions, in some cases representing more than 50% of the lifecycle emissions [1]. As buildings become more energy efficient, and energy sources, especially grid electricity become less carbon intensive, embodied emissions will represent an even higher percentage of lifecycle emissions [2].

In most buildings, the envelope is responsible for a high percentage of the embodied emissions [3]. It is made up of high carbon intensity materials such as aluminum, glass, gypsum and insulation. Operationally, managing unwanted heat gain and loss through the building enclosure including windows represents over 30% of the primary energy consumed in residential and commercial buildings in the United States [4] translating to approximately 483.6 *MMmt* CO_2 [5]. This makes the envelope a critical building component in terms of embodied, operational and total carbon emissions.

As such, the design of the building envelope is a multi-criteria problem that has to factor a large number of contrasting environmental metrics that all share the same design parameters, i.e. wall assemblies, window-to-wall ratios (WWRs), shading devices, glazing types, etc. Designers have to consider the tradeoff between embodied and operational emissions over the lifespan of the building. Operational emissions are also largely determined by the local climate and the carbon intensity of the local energy grid. The embodied emissions of the envelope are determined by the quantity and choice of materials (glass, insulation, cladding, internal finishes) and their carbon intensity. While it is considered ideal to have materials come from local sources to minimize transportation costs and emissions, material supply chains are often very complex and globalized. This scenario implies that the study of the tradeoffs between operational and embodied emissions is very localized, high variations in total emissions as well as optimal solutions can be expected between cities.

Several studies have started to look into the embodied and operational tradeoffs in several ways. Röck et al. looked into

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0378-7788/Published by Elsevier B.V.

Table 1: Variable Simulation Inputs

Variable Inputs	Values	Additional Description
Program *(2 options)*	1) Residential 2) Office	See description in Section 2.2.1
Weather File *(5 options)*	1) SeaTac International Airport 2) Milwaukee Intl Airport 3) San Antonio Intl Airport 4) Los Angeles Intl Airport 5) Atlanta Intl Airport 6) New York Central Park	TMY3 Energy Plus Weather File
Façade Orientation *(4 options)*	1) North 2) South 3) East 4) West	Direction façade is facing
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U-Factor Window *(2 options)*	1) 0.35 BTU/ft2·°F·h 2) 0.15 BTU/ft2·°F·h	Typical for double pane windows Typical for triple pane windows

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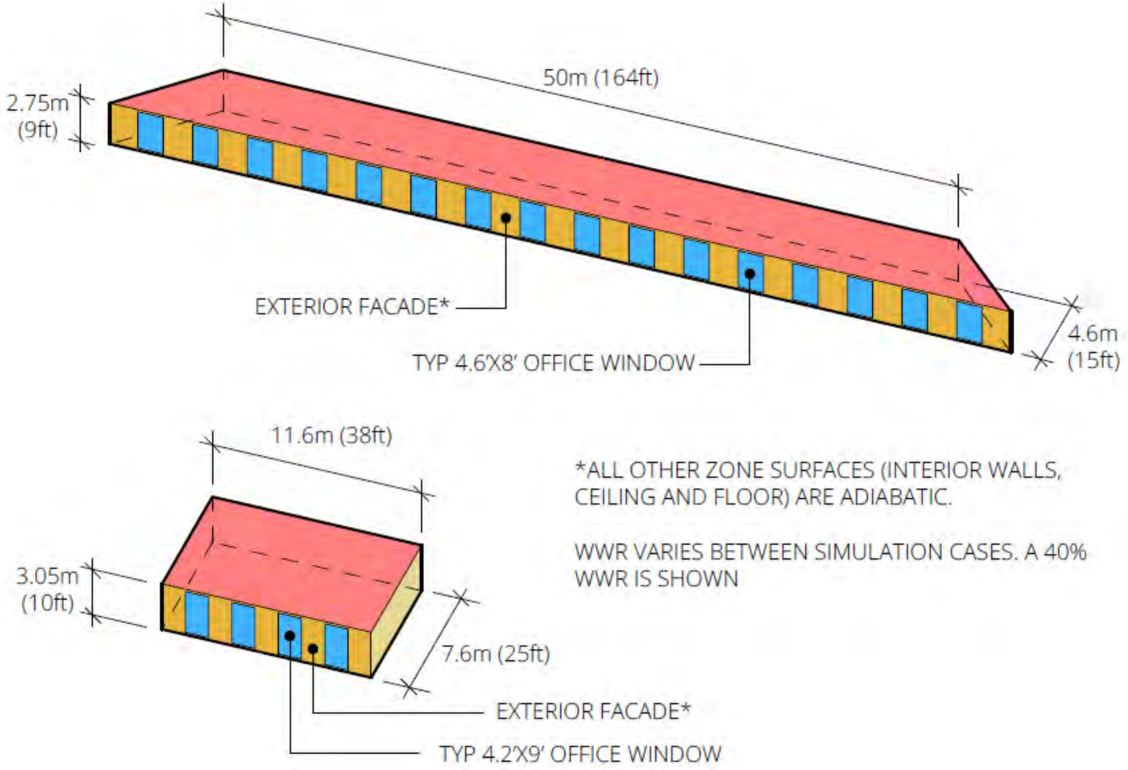

Figure 2: Massing geometry for building performance simulation of an office zone (top) and a residential zone (bottom).

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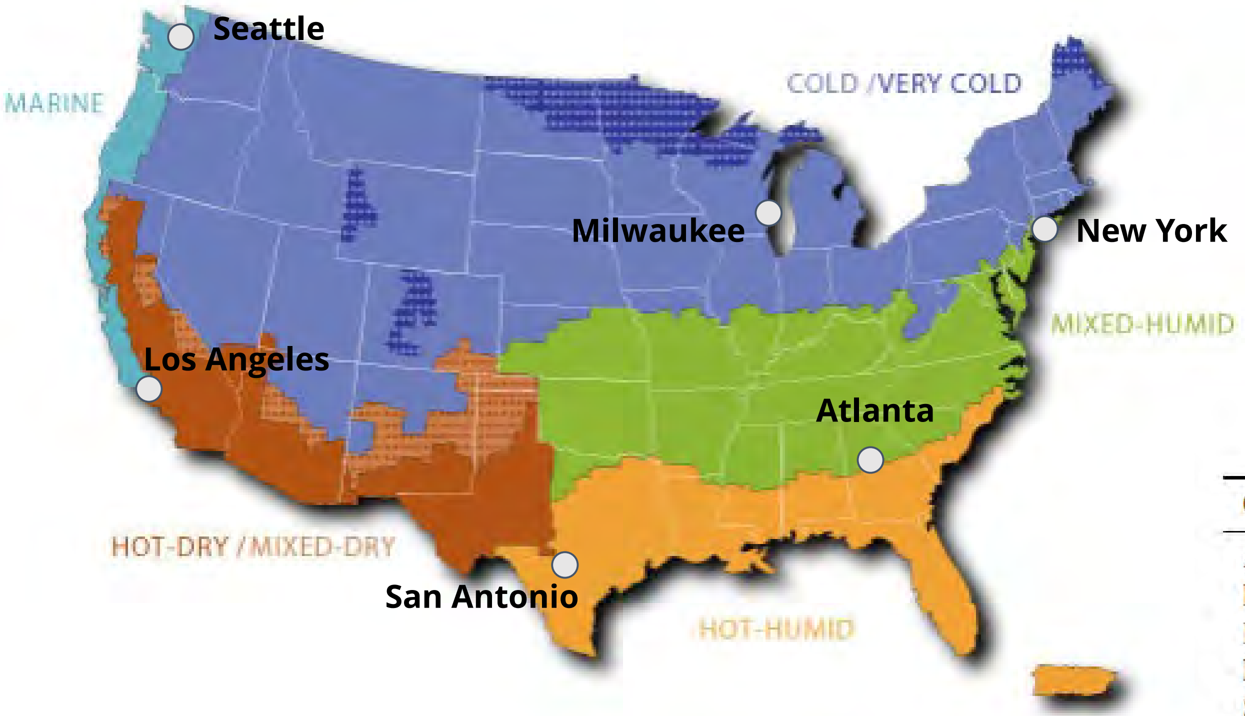

Source: US Energy Information Administration

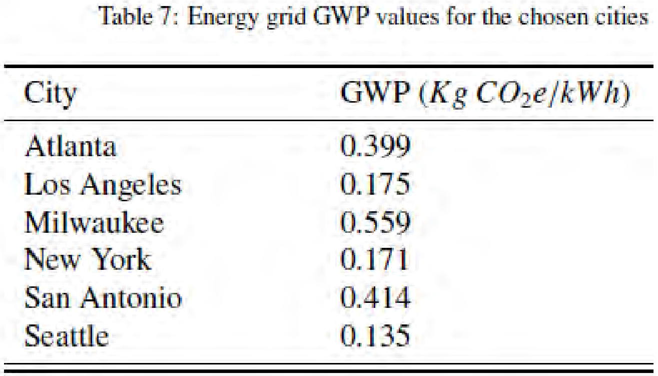

Table 7: Energy grid GWP values for the chosen cities

City	GWP ($Kg\ CO_2e/kWh$)
Atlanta	0.399
Los Angeles	0.175
Milwaukee	0.559
New York	0.171
San Antonio	0.414
Seattle	0.135

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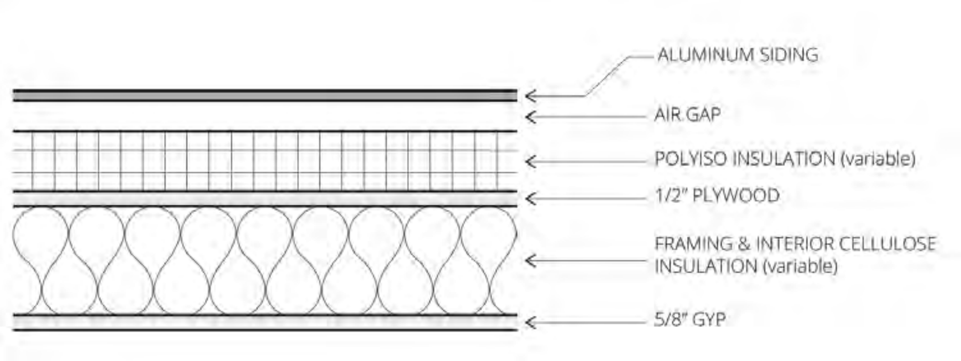
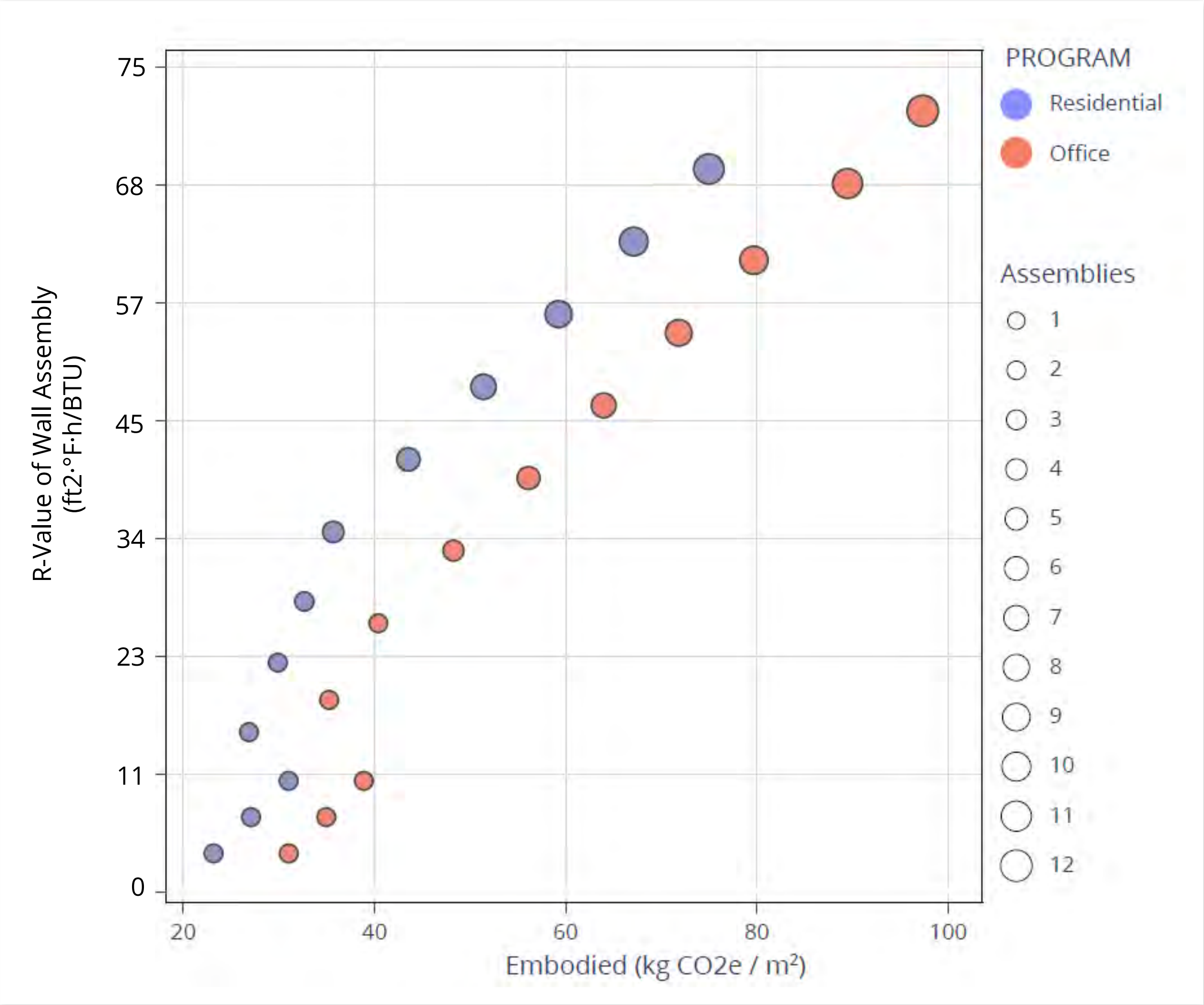
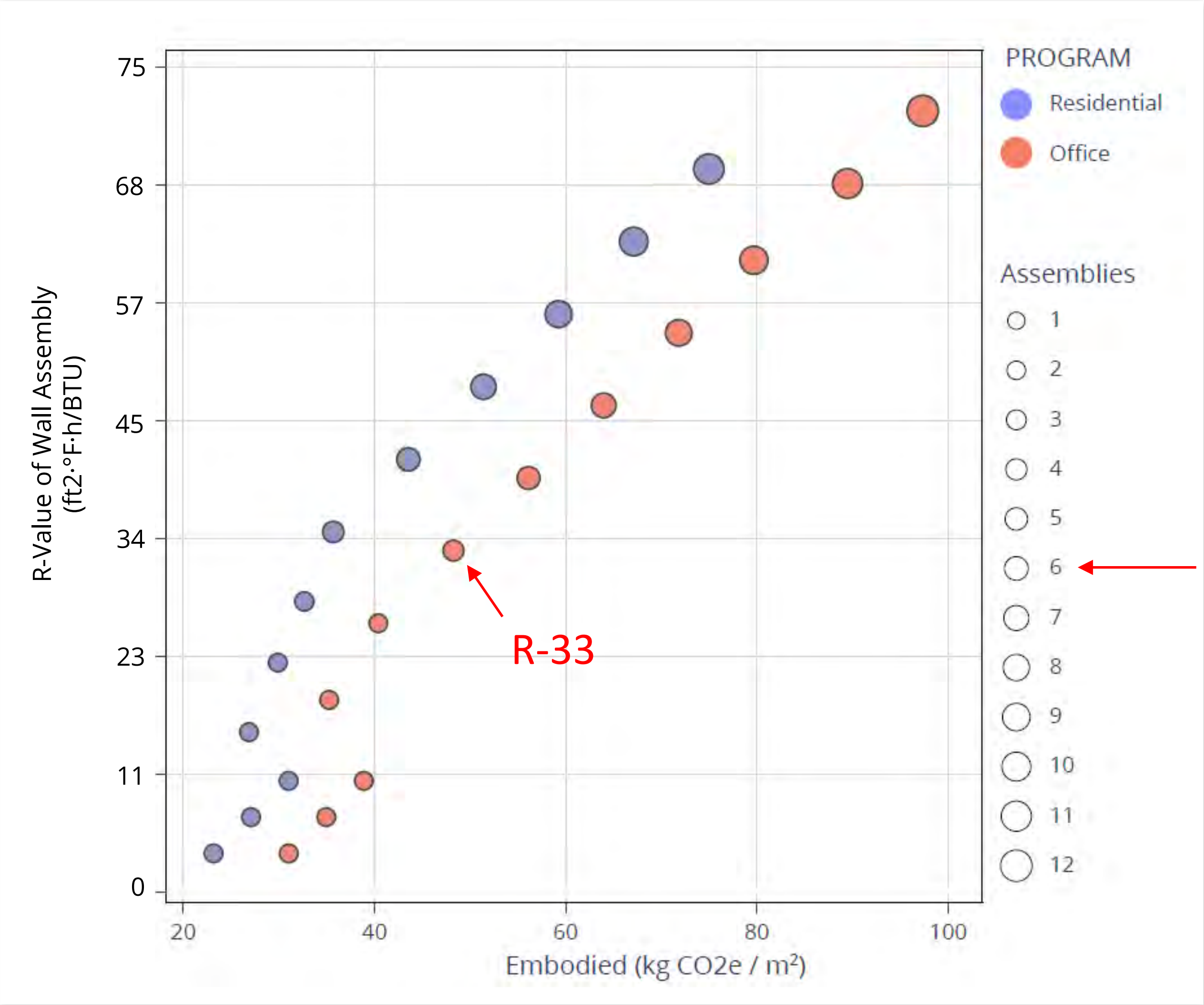


Office Assemblies

Assembly #	Cladding	Air Gap (in)	Polyiso (in)	Plywood (in)	Steel Stud (in)	Cellulose (in)	Gypsum (in)	R-Value (ft2·°F·h/BTU)
1	Aluminum	0.5	0	0.5	4	0	0.625	4
2	Aluminum	0.5	0.5	0.5	4	0	0.625	7
3	Aluminum	0.5	1	0.5	4	0	0.625	11
4	Aluminum	0.5	0	0.5	4	4	0.625	19
5	Aluminum	0.5	0	0.5	6	6	0.625	26
6	Aluminum	0.5	1	0.5	6	6	0.625	33
7	Aluminum	0.5	2	0.5	6	6	0.625	40
8	Aluminum	0.5	3	0.5	6	6	0.625	47
9	Aluminum	0.5	4	0.5	6	6	0.625	54
10	Aluminum	0.5	5	0.5	6	6	0.625	61
11	Aluminum	0.5	5	0.5	6	6	0.625	68
12	Aluminum	0.5	6	0.5	6	6	0.625	75


PROGRAM
Residential
Office
Assemblies
1
2
3
4
5
6
7
8
9
10
11
12
R-Value of Wall Assembly (ft2·°F·h/BTU)
75
68
57
45
34
23
11
0
20
40
60
80
100
Embodied (kg CO2e / m²)


R-Value of Wall Assembly
(ft2·°F·h/BTU)
75
68
57
45
34
23
11
0
20
40
60
80
100
Embodied (kg CO2e / m²)
PROGRAM
Residential
Office
Assemblies
1
2
3
4
5
6
7
8
9
10
11
12
R-33

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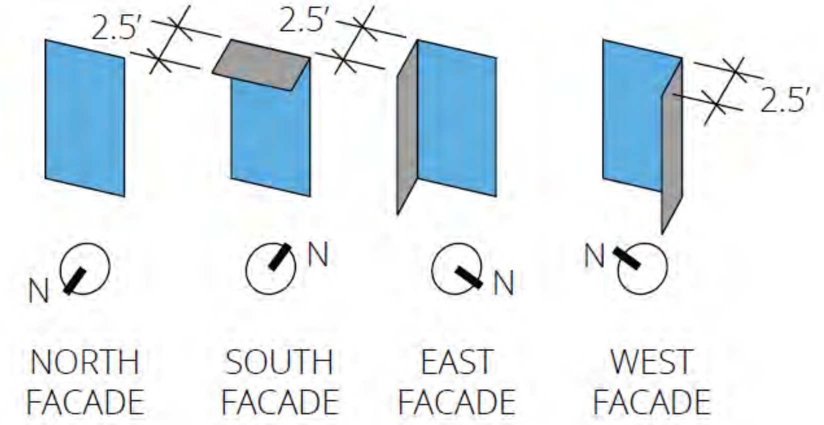
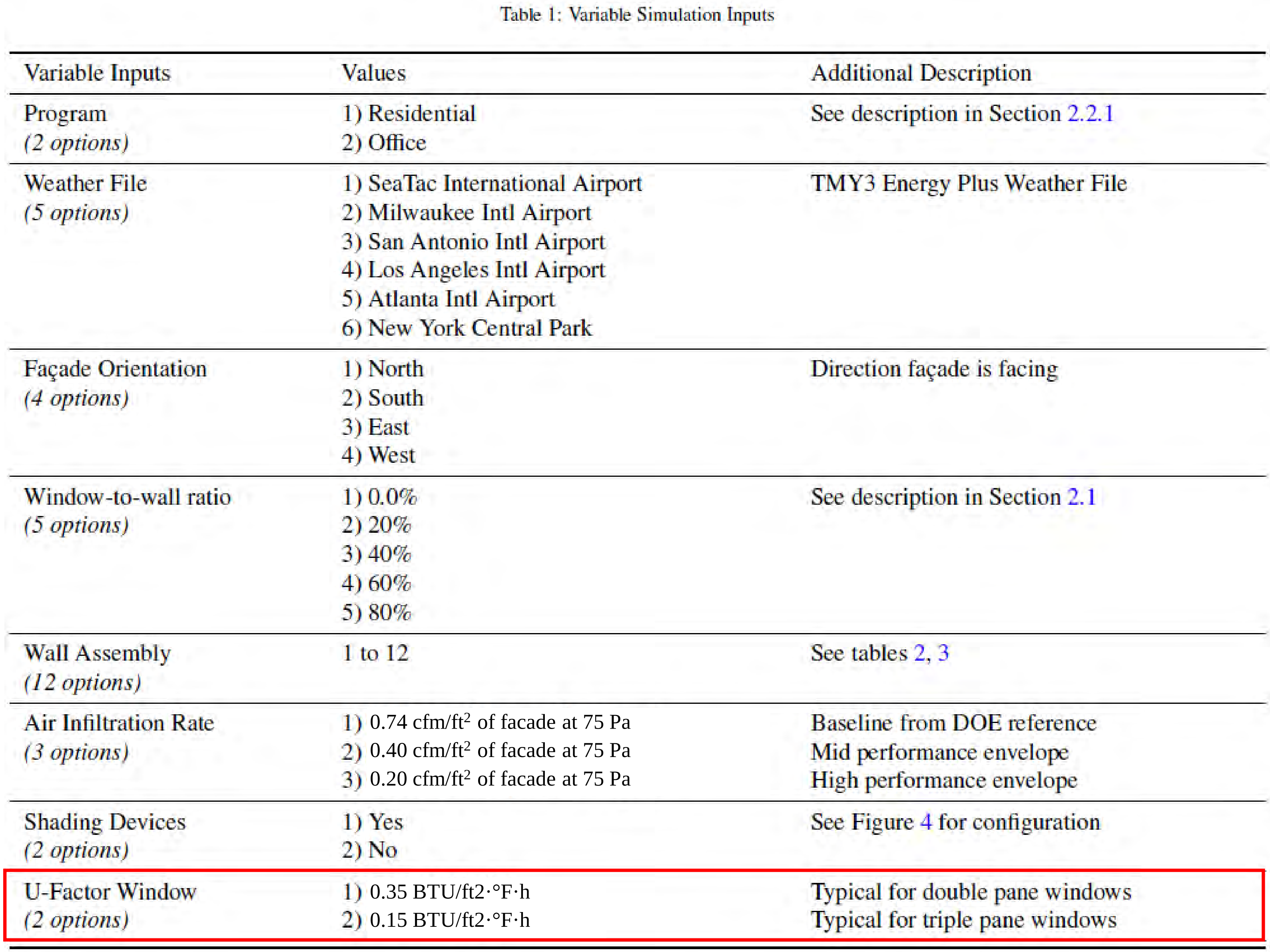

2.5′
2.5′
2.5′
N
N
N
N
NORTH FACADE
SOUTH FACADE
EAST FACADE
WEST FACADE



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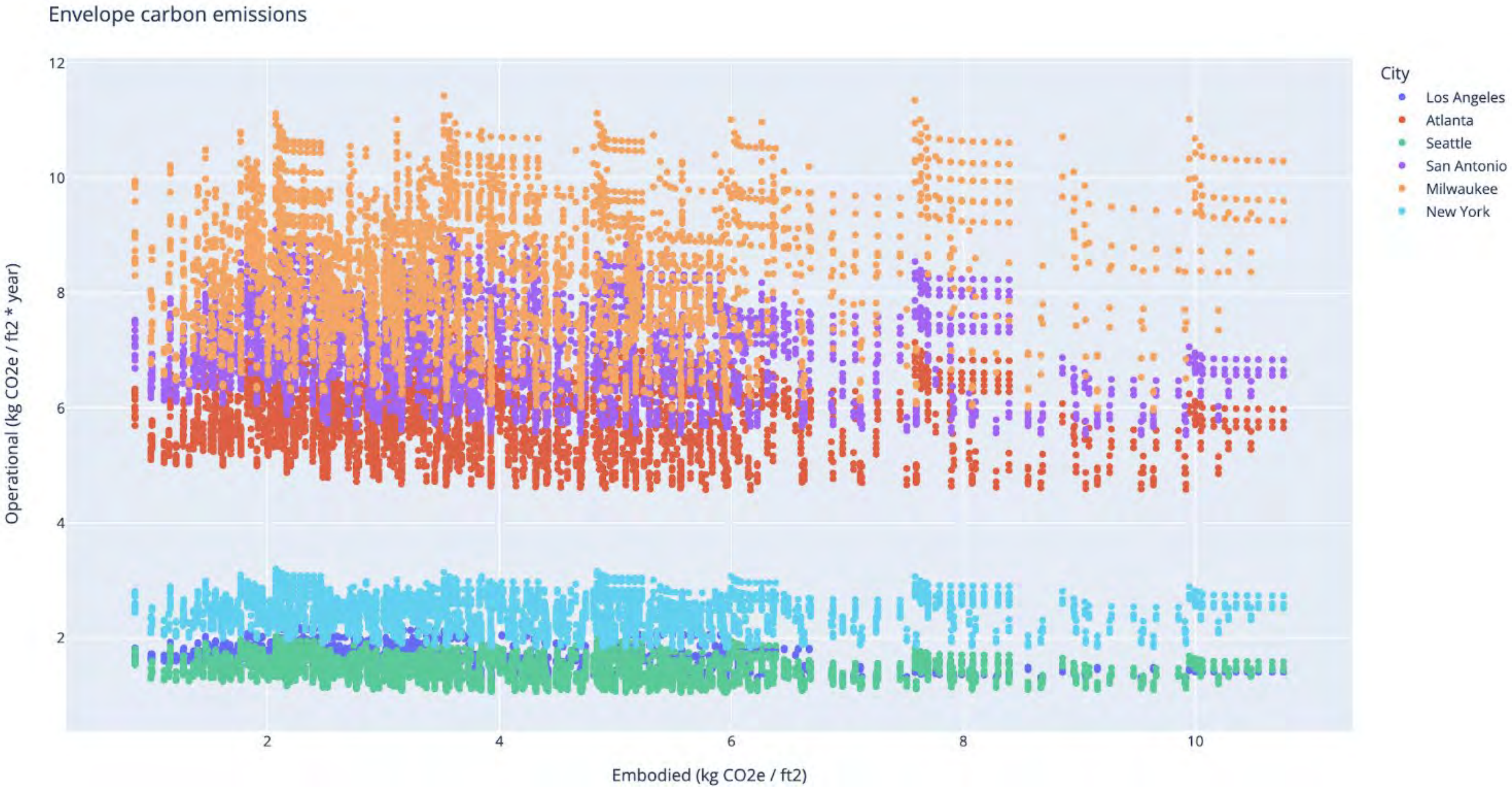
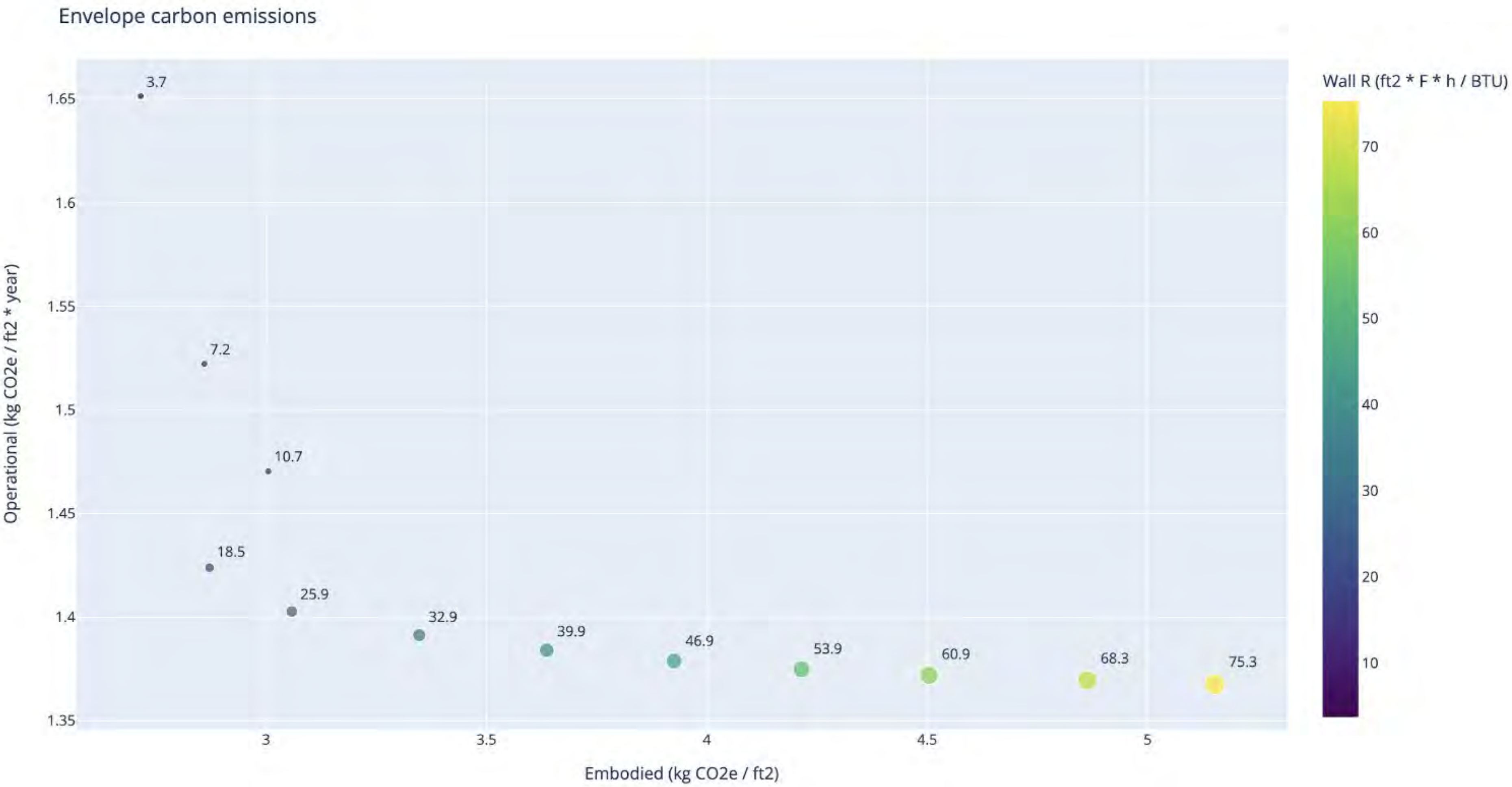
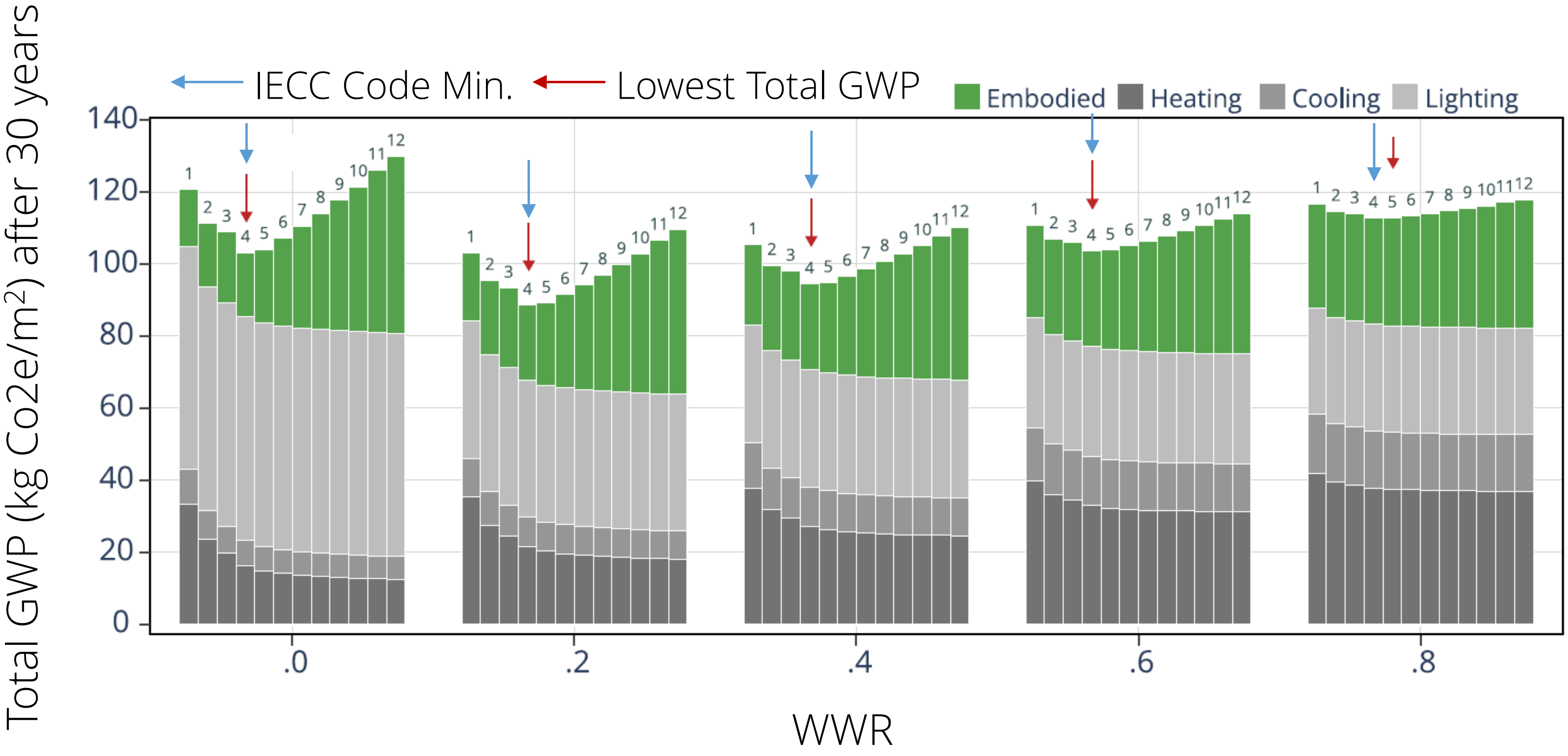
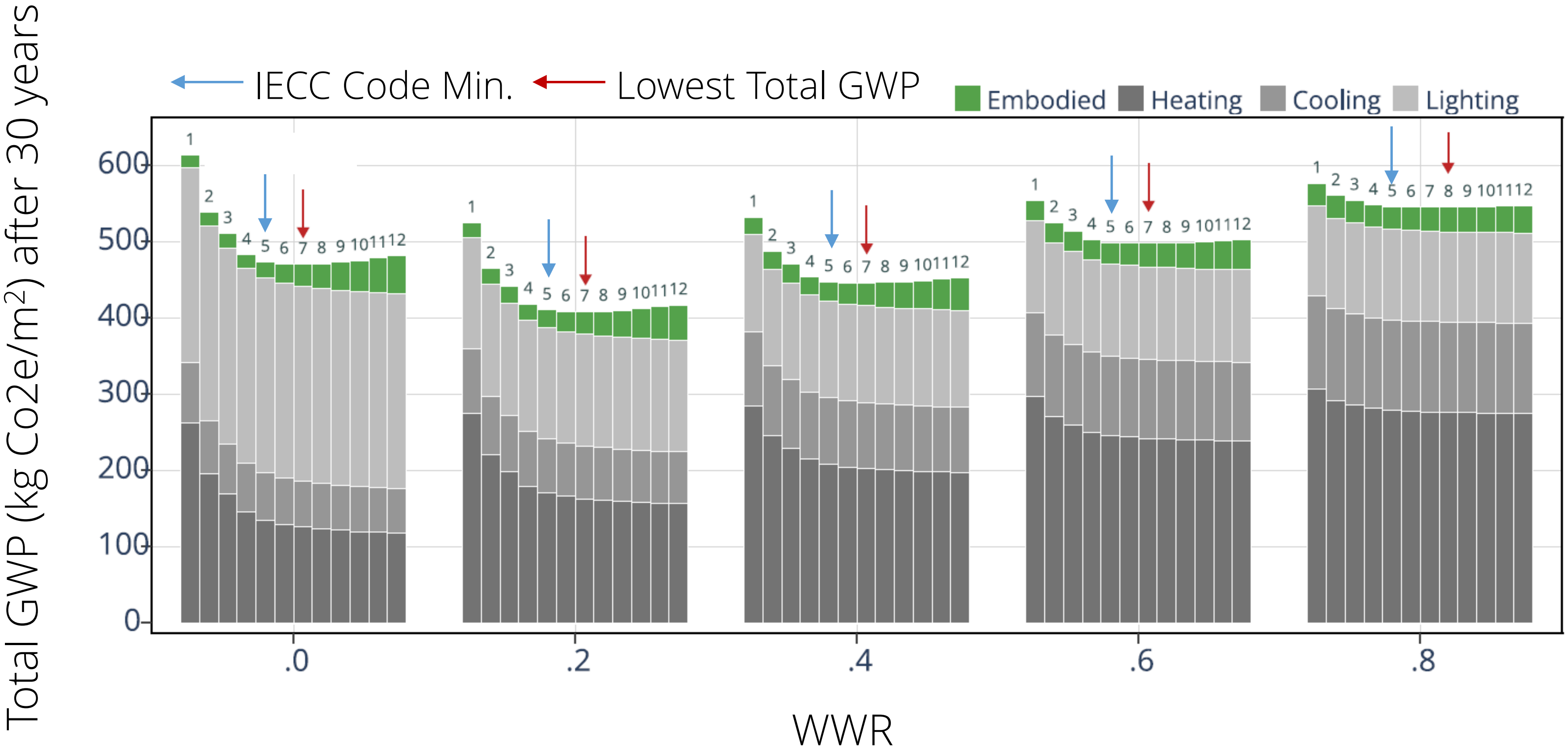

Envelope carbon emissions
12
10
8
6
4
2
Operational (kg CO2e / ft2 * year)
2
4
6
8
10
Embodied (kg CO2e / ft2)
City
Los Angeles
Atlanta
Seattle
San Antonio
Milwaukee
New York


Envelope carbon emissions

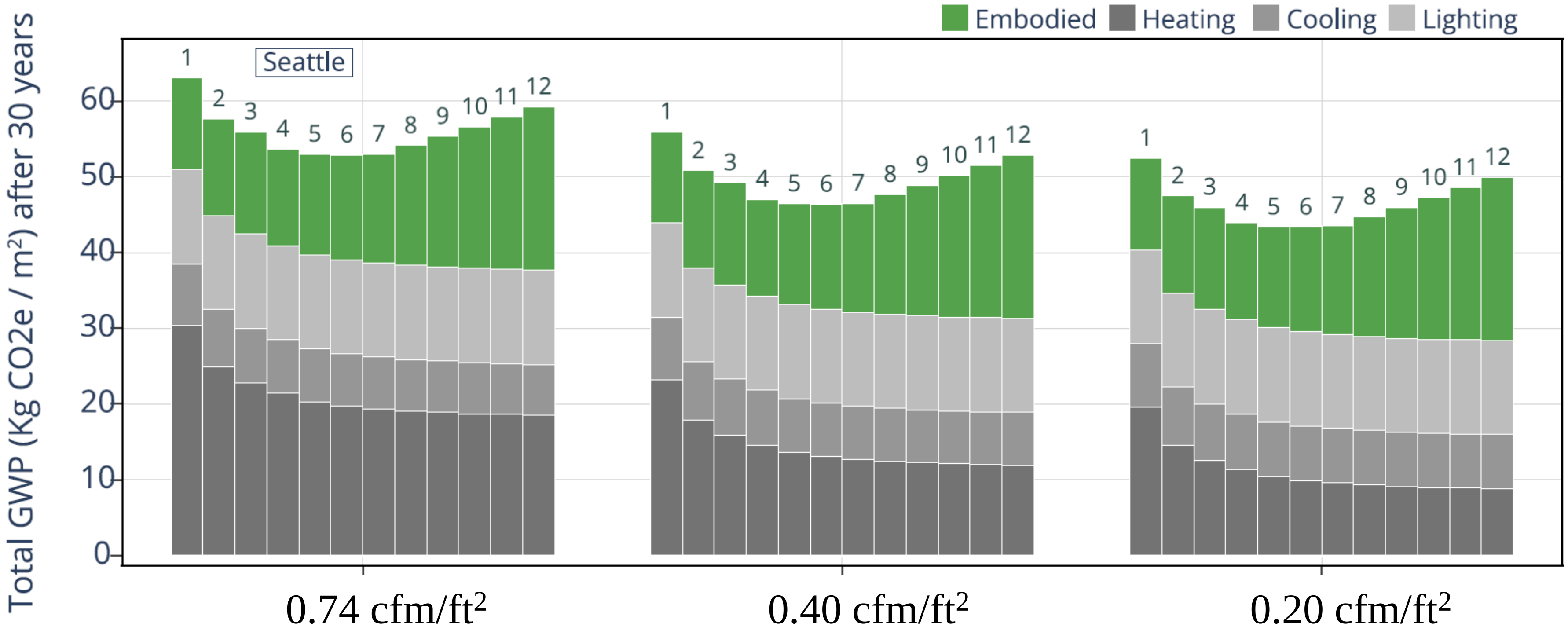
Impact of Envelope & WWR on GWP in south facing office zone - **Seattle**



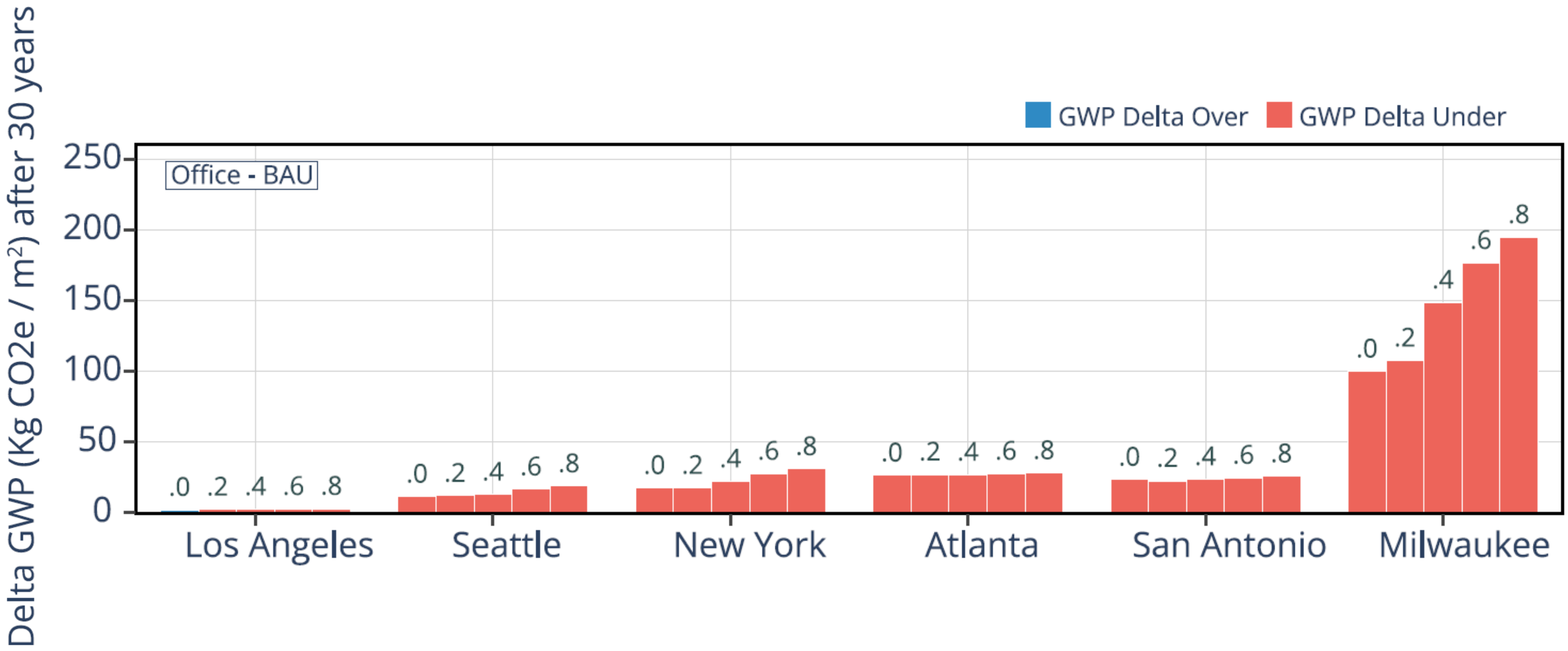
Impact of Envelope & WWR on GWP in south facing office zone - **Milwaukee**



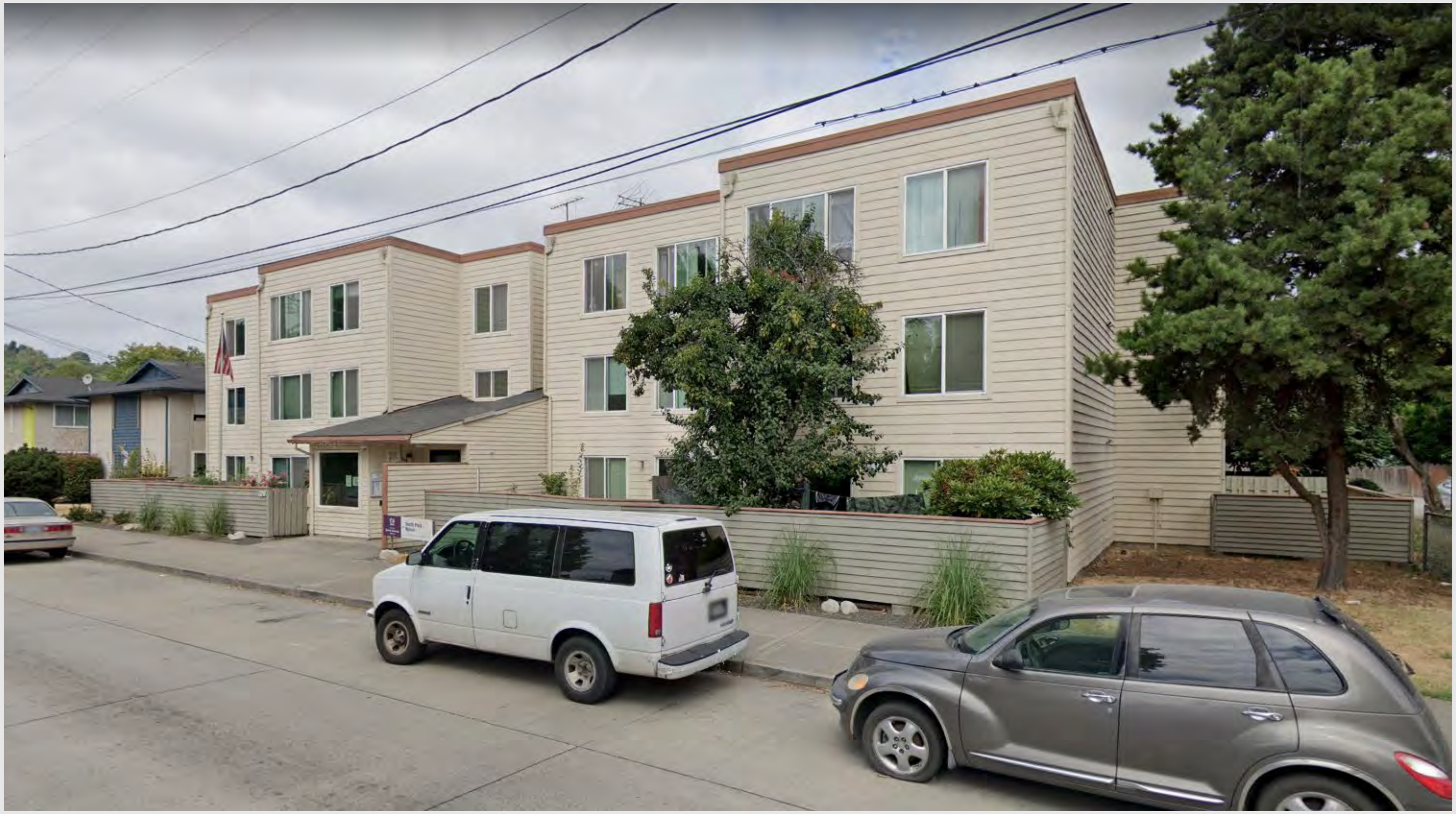
Impact of Envelope & Infiltration on GWP in south facing residential zone – **Seattle**



Delta GWP: Code Versus Optimum Envelope – BAU Decarb Model



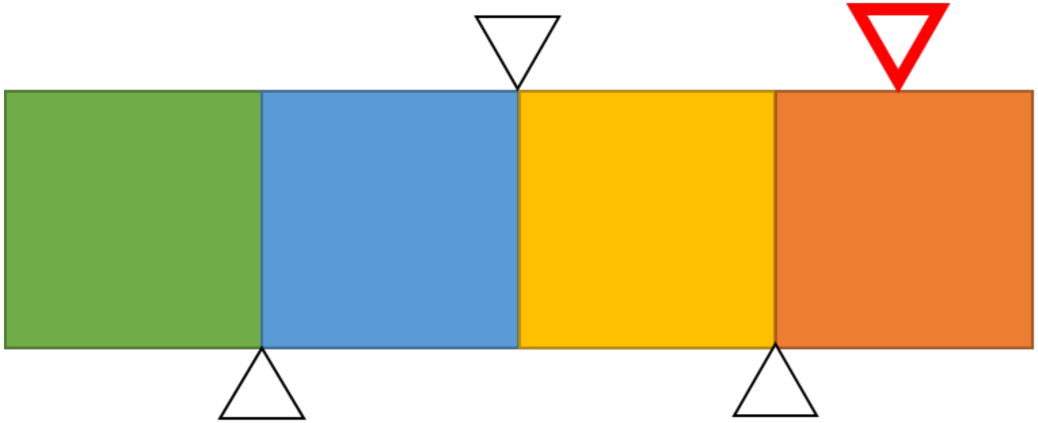
South Park Manor (SPM)



27 apartment units (25 1-bedroom, 2 2-bedroom)
19,170 ft2

Seattle 2020 Benchmarking Data

Low-Rise Multifamily Energy Use Intensity (EUI)
Results from 1,025 Buildings



Median:
29.8 kBtu/sf/year

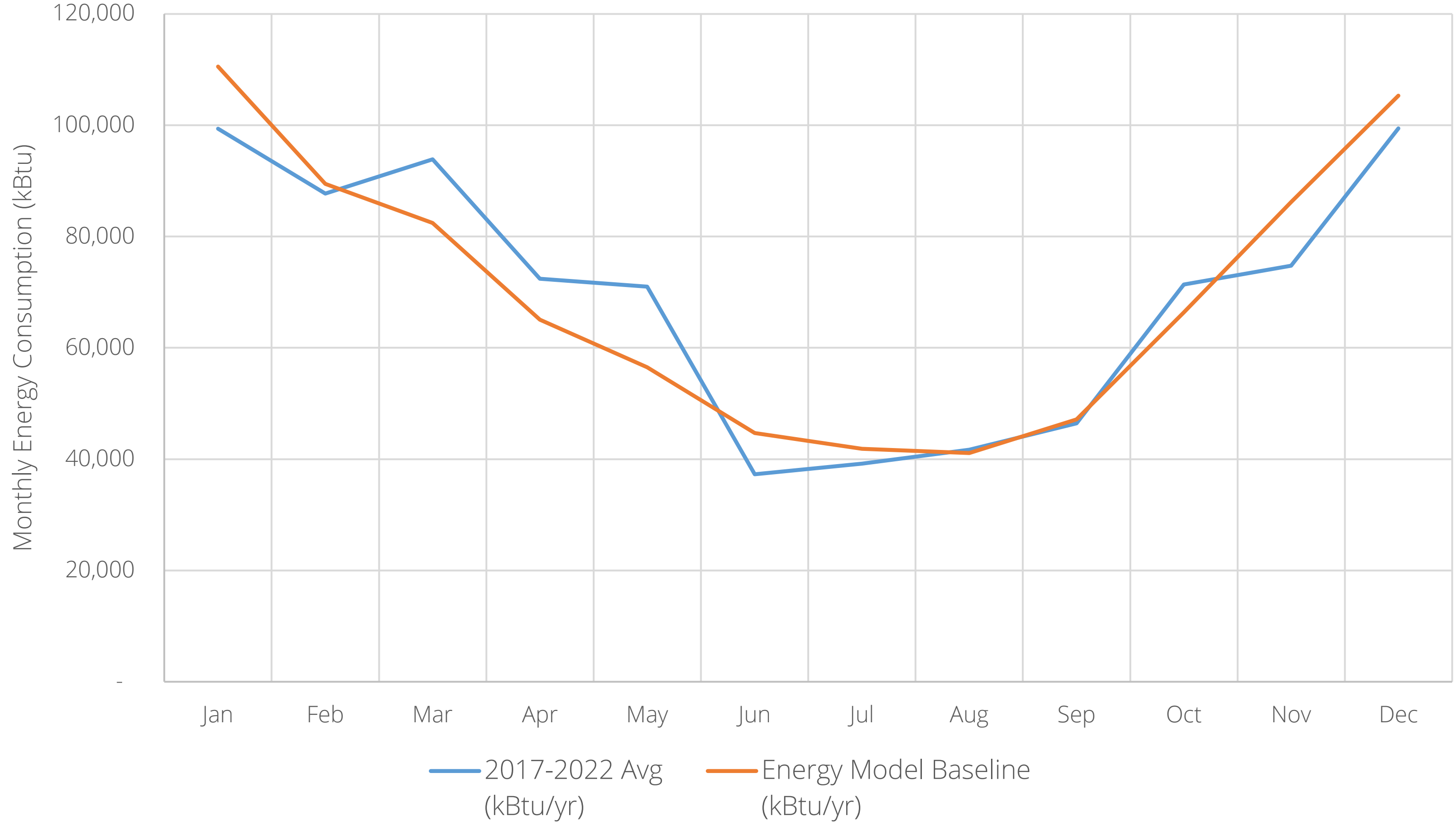
South Park Manor:
43.8 kBtu/sf/year

25th Percentile:
25.3 kBtu/sf/year

75th Percentile:
37.0 kBtu/sf/year

Source: *Seattle Energy Benchmarking Data, Office of Sustainability & Environment*

Actual & Simulated Monthly Energy Use

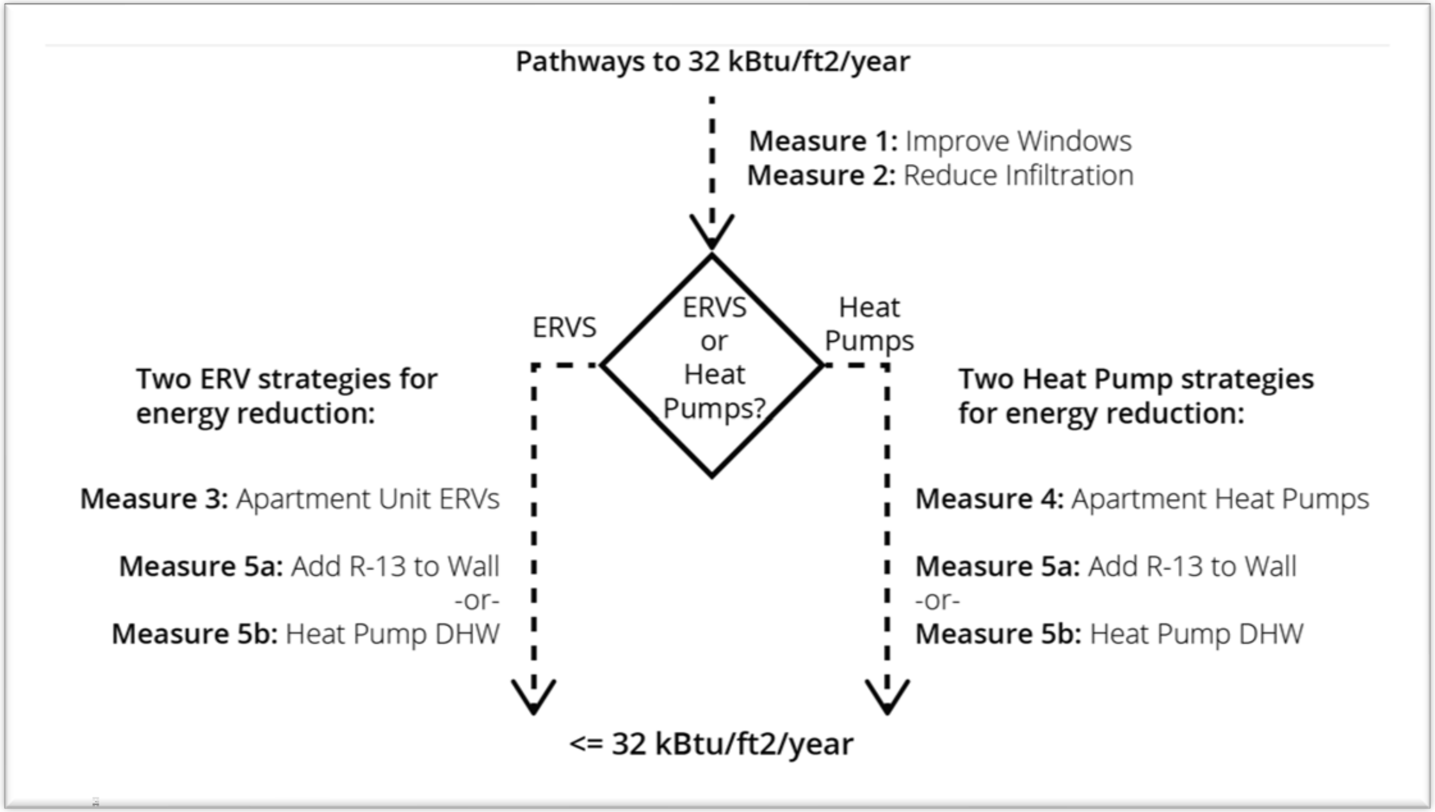


Proposed Retrofit Pathways

Retrofit Strategies for Improved Indoor Comfort & Health and Reduced Energy Use

EUI Goal = 32 kBTU/ft2/year

Two Comprehensive Pathways to 32 EUI



Pathways to 32 kBtu/ft2/year

Measure 1: Improve Windows
Measure 2: Reduce Infiltration

ERVS or Heat Pumps?

ERVS

Two ERV strategies for energy reduction:

Measure 3: Apartment Unit ERVs

Measure 5a: Add R-13 to Wall
-or-
Measure 5b: Heat Pump DHW

Heat Pumps

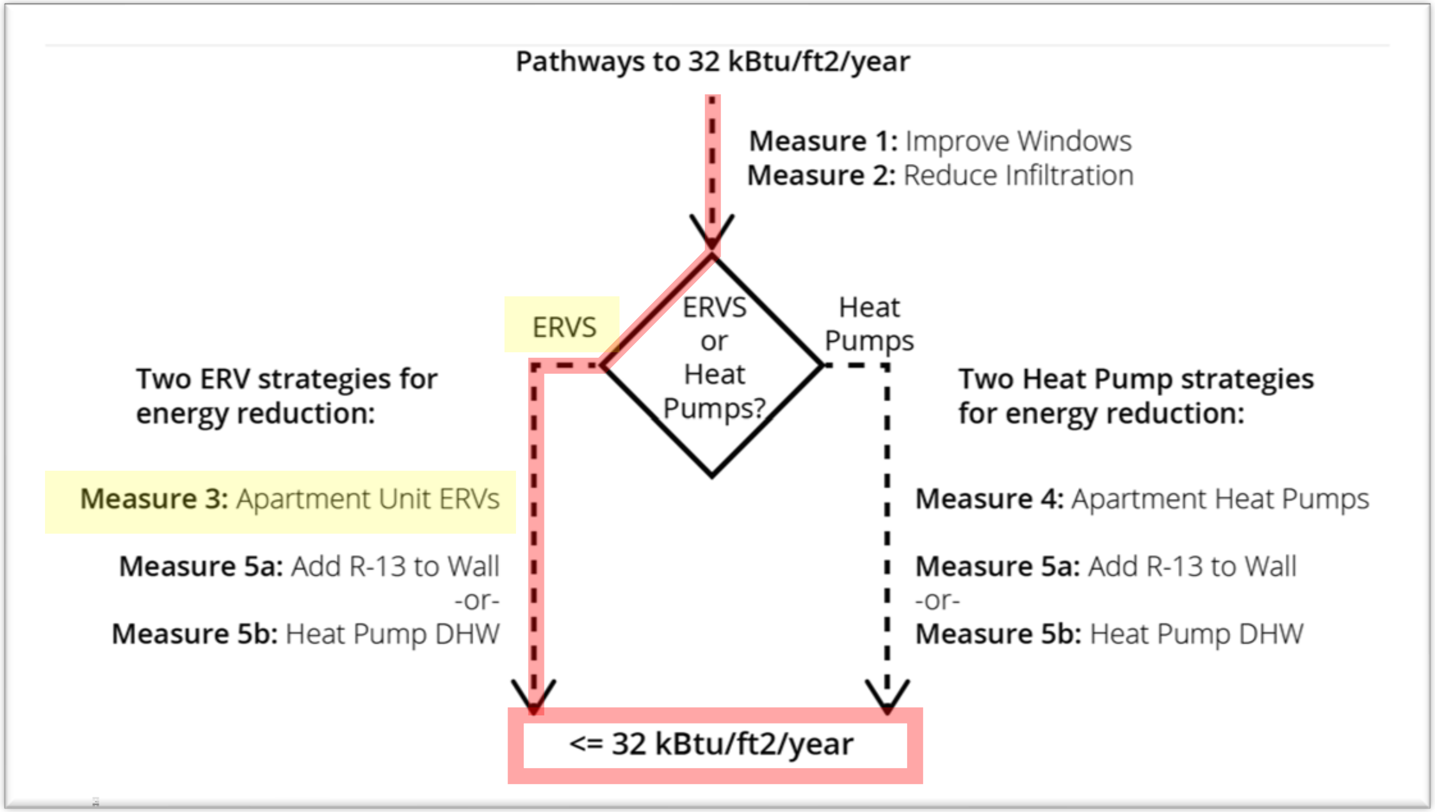
Two Heat Pump strategies for energy reduction:

Measure 4: Apartment Heat Pumps

Measure 5a: Add R-13 to Wall
-or-
Measure 5b: Heat Pump DHW

<= 32 kBtu/ft2/year

Pathway 1: Energy Recovery Ventilation (ERV)



Pathways to 32 kBtu/ft2/year

Measure 1: Improve Windows
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Two ERV strategies for energy reduction:

Measure 3: Apartment Unit ERVs

Measure 5a: Add R-13 to Wall
-or-
Measure 5b: Heat Pump DHW

Two Heat Pump strategies for energy reduction:

Measure 4: Apartment Heat Pumps

Measure 5a: Add R-13 to Wall
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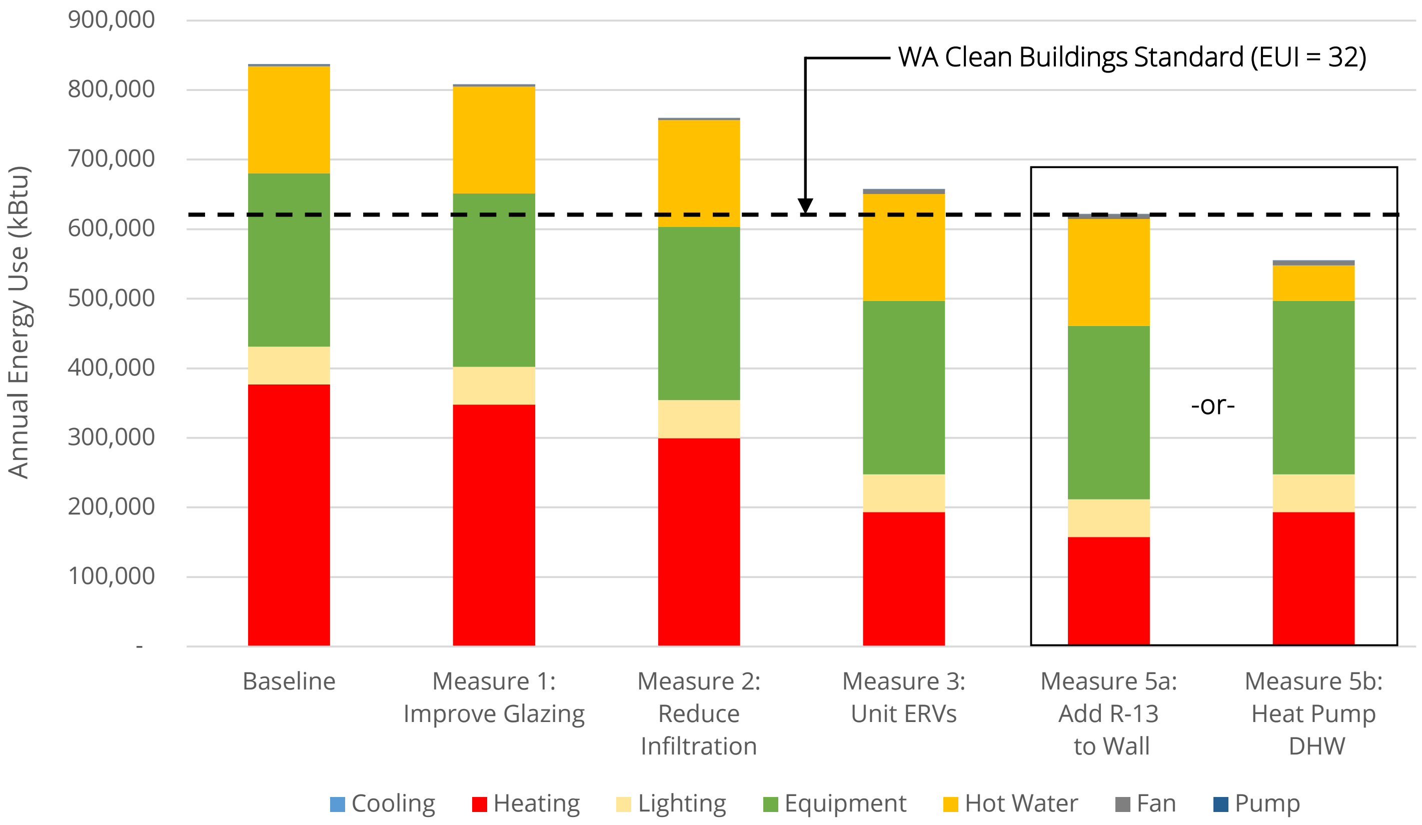
<= 32 kBtu/ft2/year

Pathway 1: ERV Solution Energy Savings



Energy Recovery Ventilator: Pros/Cons

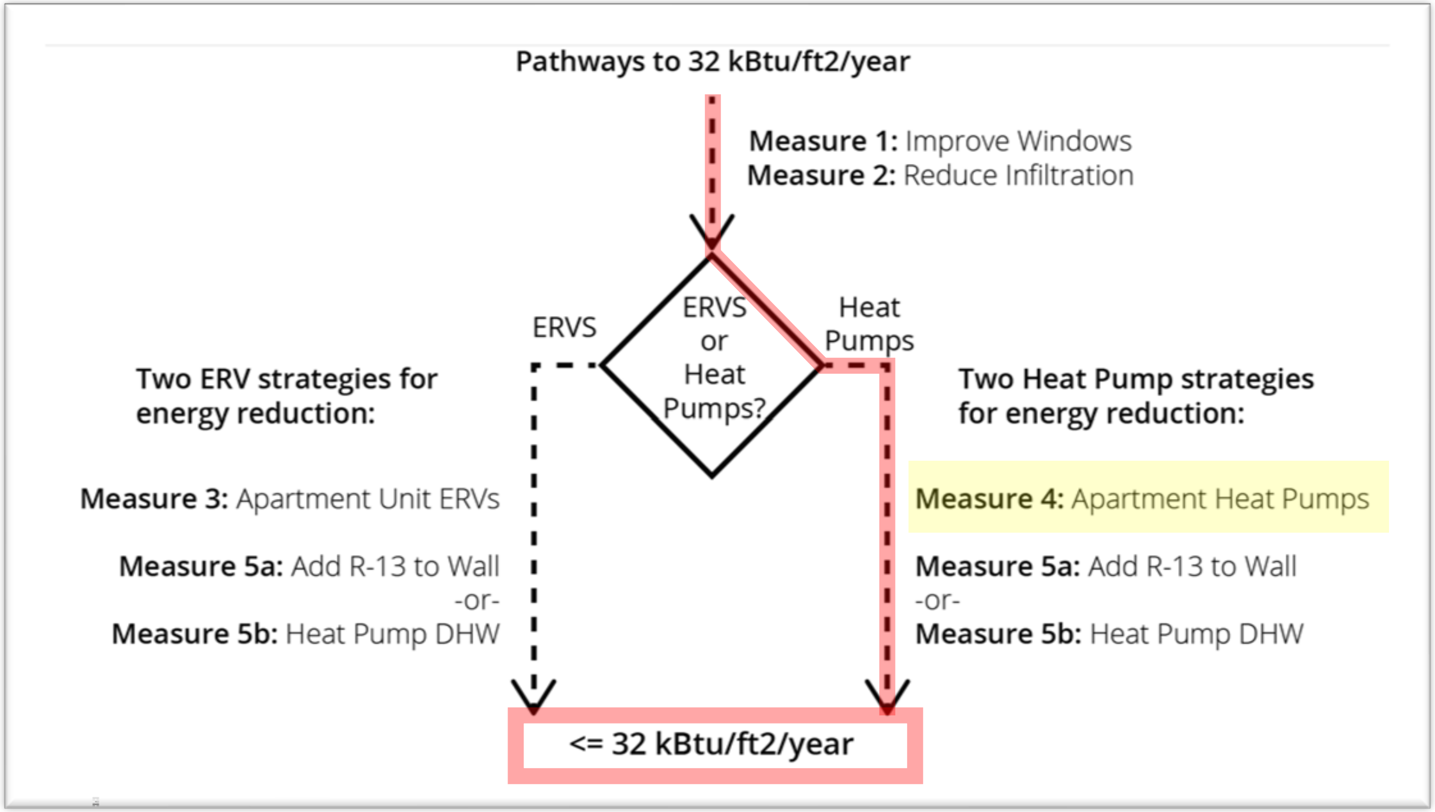
Pros:

- Bringing filtered 100% OA into apartment → Improved air quality
- Reduced Energy Use
- Lower cost than heat pump (~$68,000)

Cons:

- Need to change ERV filters regularly
- Significant ductwork required
- No significant impact on space temperatures in summer

Pathway 2: Heat Pump for Heating/Cooling



Pathways to 32 kBtu/ft2/year

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Two ERV strategies for energy reduction:

Measure 3: Apartment Unit ERVs

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Two Heat Pump strategies for energy reduction:

Measure 4: Apartment Heat Pumps

Measure 5a: Add R-13 to Wall
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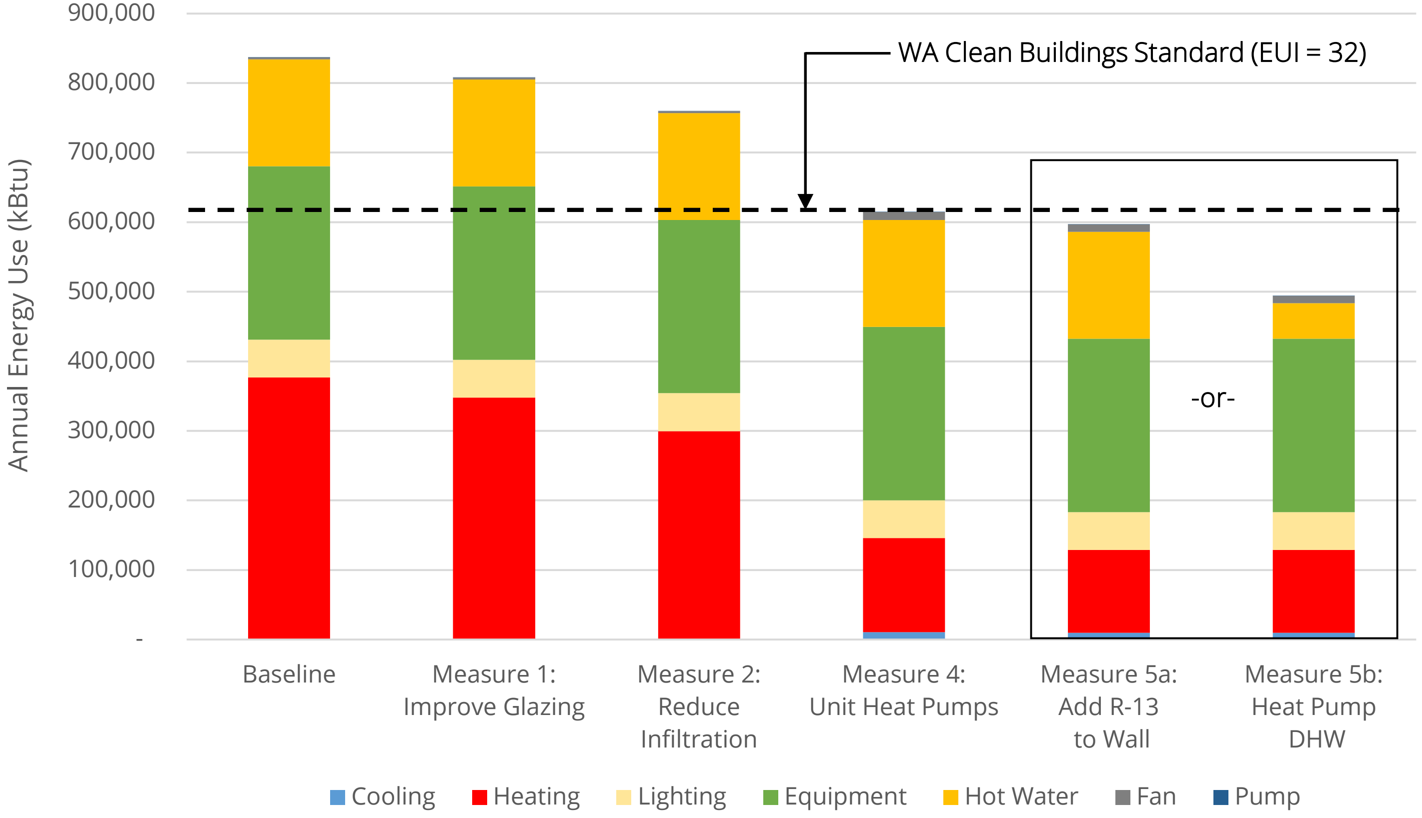
Measure 5b: Heat Pump DHW

<= 32 kBtu/ft2/year

Pathway 2: Heat Pump Solution Energy Savings

INTEGRATED DESIGN LAB

at the Center for Integrated Design



Heat Pump for Space Conditioning: Pros/Cons

Pros:
- Space cooling provides thermal comfort in summer
- Reduced Energy Use

Cons:
- Need to locate outdoor units
- More Expensive (~$411,000 total)

Multi-Property Tool

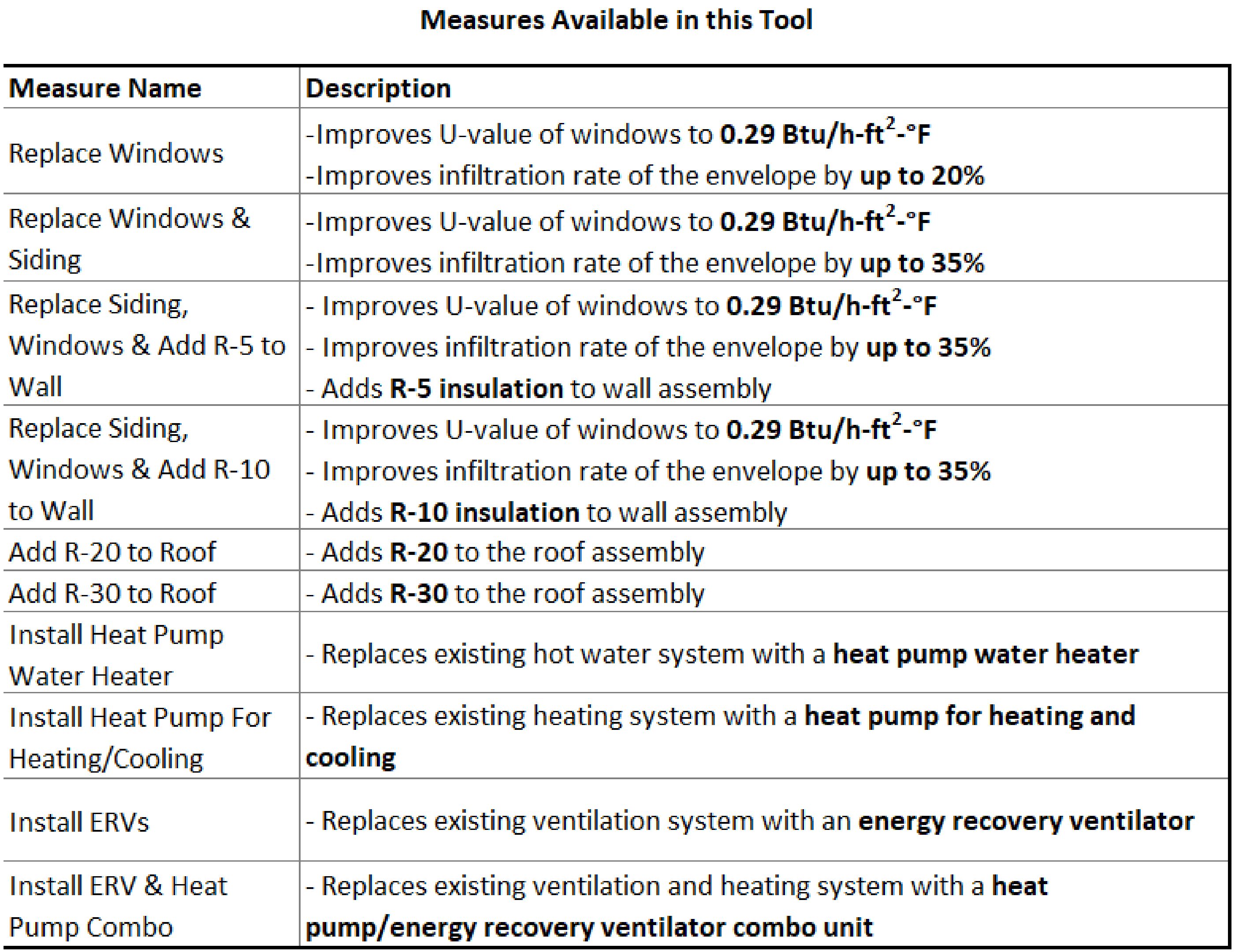
Prototypical buildings used in this tool:

2,400 ft2 Duplex
(4117 25th Ave W)

3,400 ft2 Quadplex
(14036 Greenwood)

8,100 ft2 10-Unit
(14349 32nd Ave)

Available Measures



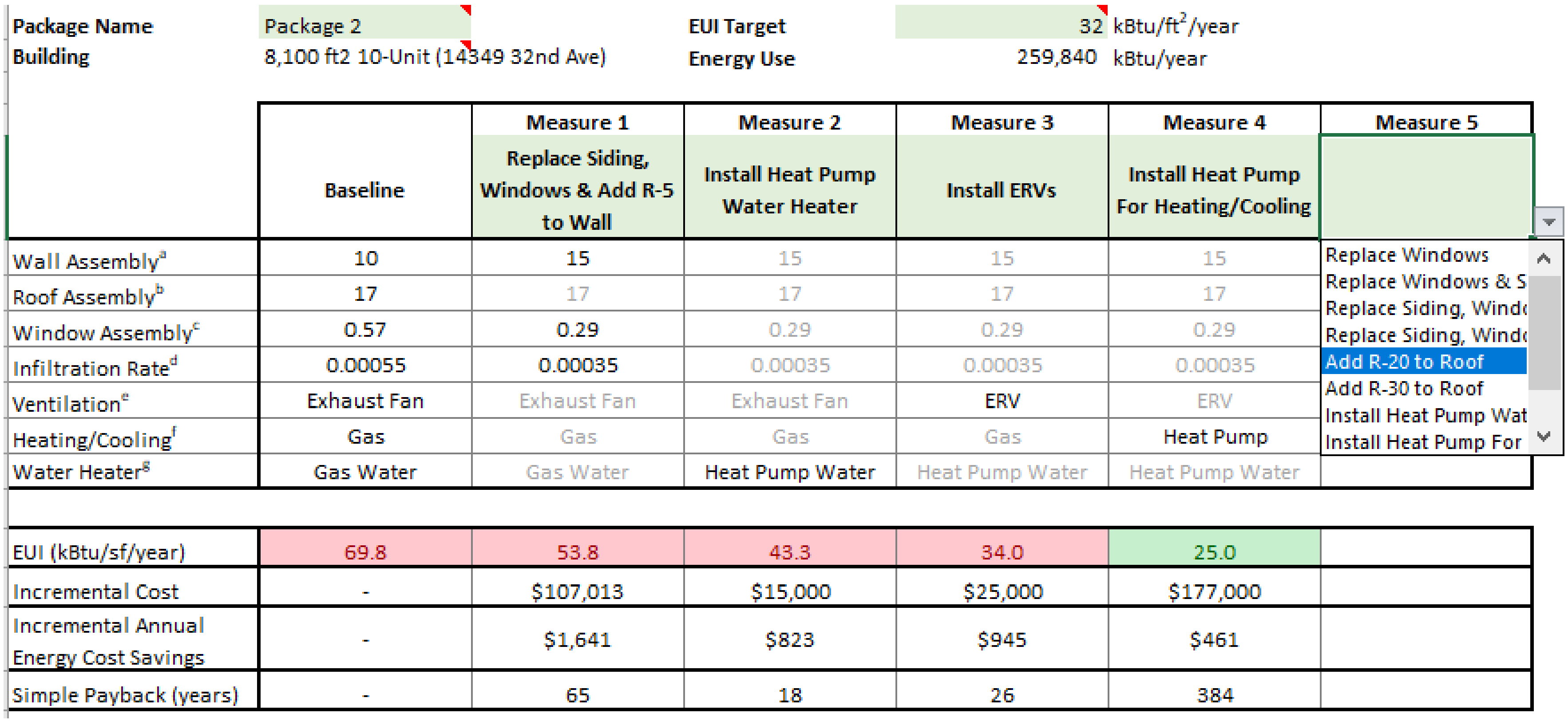
Measures Available in this Tool

Measure Name	Description
Replace Windows	-Improves U-value of windows to **0.29 Btu/h-ft^2-°F** -Improves infiltration rate of the envelope by **up to 20%**
Replace Windows & Siding	-Improves U-value of windows to **0.29 Btu/h-ft^2-°F** -Improves infiltration rate of the envelope by **up to 35%**
Replace Siding, Windows & Add R-5 to Wall	- Improves U-value of windows to **0.29 Btu/h-ft^2-°F** - Improves infiltration rate of the envelope by **up to 35%** - Adds **R-5 insulation** to wall assembly
Replace Siding, Windows & Add R-10 to Wall	- Improves U-value of windows to **0.29 Btu/h-ft^2-°F** - Improves infiltration rate of the envelope by **up to 35%** - Adds **R-10 insulation** to wall assembly
Add R-20 to Roof	- Adds **R-20** to the roof assembly
Add R-30 to Roof	- Adds **R-30** to the roof assembly
Install Heat Pump Water Heater	- Replaces existing hot water system with a **heat pump water heater**
Install Heat Pump For Heating/Cooling	- Replaces existing heating system with a **heat pump for heating and cooling**
Install ERVs	- Replaces existing ventilation system with an **energy recovery ventilator**
Install ERV & Heat Pump Combo	- Replaces existing ventilation and heating system with a **heat pump/energy recovery ventilator combo unit**

Interactive Energy Retrofit Tool

INTEGRATED DESIGN LAB

at the Center for Integrated Design



Package Name Package 2

Building 8,100 ft2 10-Unit (14349 32nd Ave)

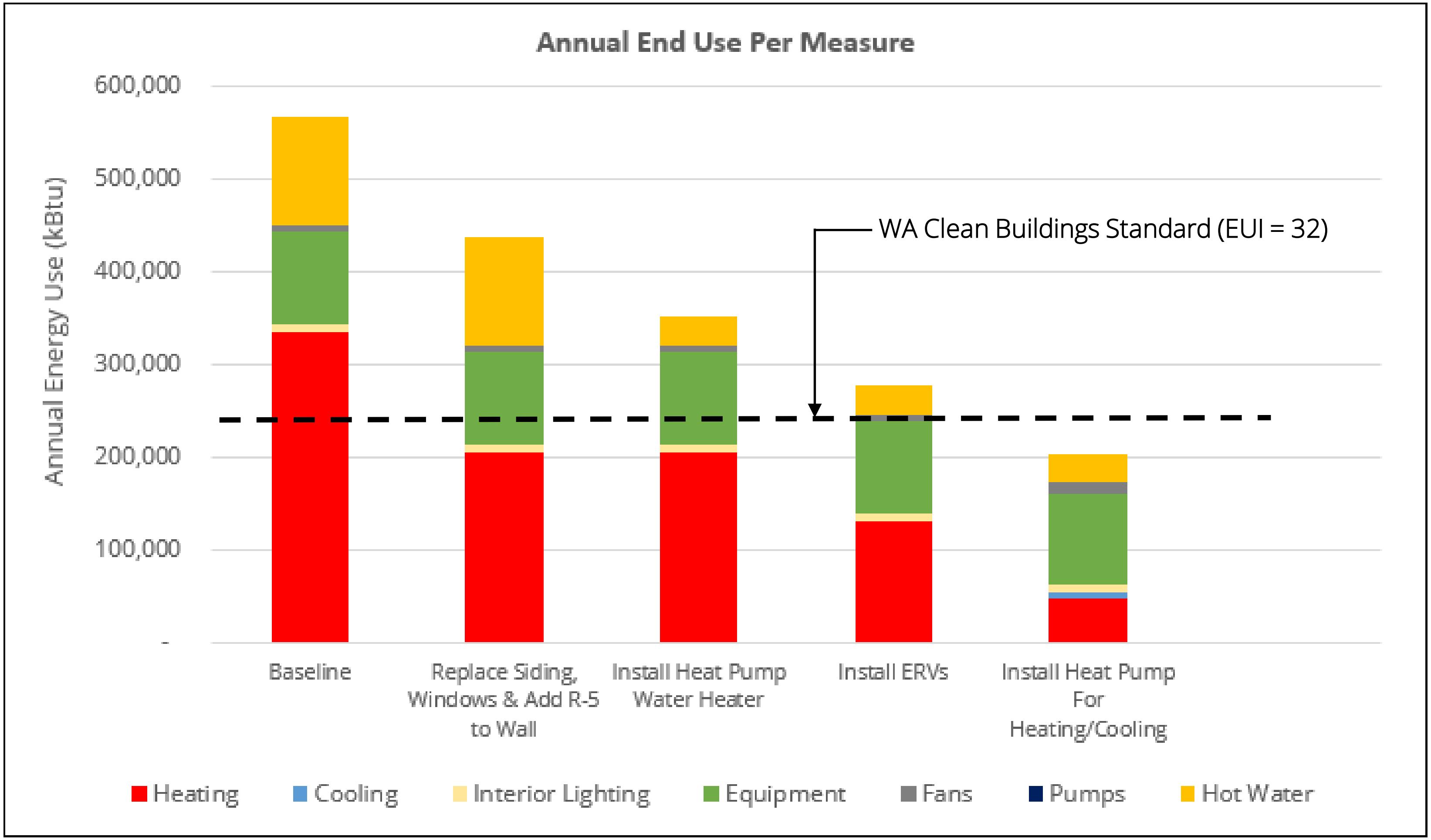
EUI Target 32 kBtu/ft^2/year

Energy Use 259,840 kBtu/year

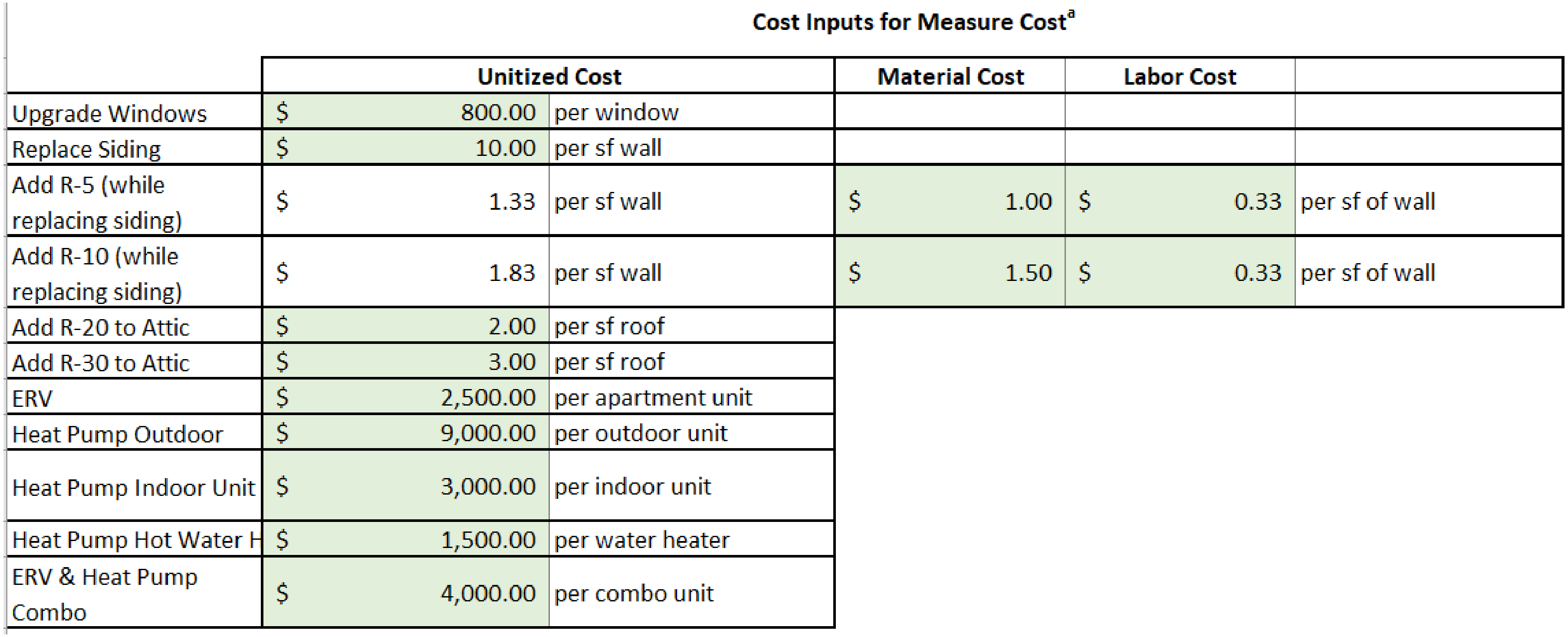
		Measure 1	Measure 2	Measure 3	Measure 4	Measure 5
	Baseline	Replace Siding, Windows & Add R-5 to Wall	Install Heat Pump Water Heater	Install ERVs	Install Heat Pump For Heating/Cooling	
Wall Assembly[a]	10	15	15	15	15	
Roof Assembly[b]	17	17	17	17	17	
Window Assembly[c]	0.57	0.29	0.29	0.29	0.29	
Infiltration Rate[d]	0.00055	0.00035	0.00035	0.00035	0.00035	
Ventilation[e]	Exhaust Fan	Exhaust Fan	Exhaust Fan	ERV	ERV	
Heating/Cooling[f]	Gas	Gas	Gas	Gas	Heat Pump	
Water Heater[g]	Gas Water	Gas Water	Heat Pump Water	Heat Pump Water	Heat Pump Water	

EUI (kBtu/sf/year)	69.8	53.8	43.3	34.0	25.0	
Incremental Cost	-	$107,013	$15,000	$25,000	$177,000	
Incremental Annual Energy Cost Savings	-	$1,641	$823	$945	$461	
Simple Payback (years)	-	65	18	26	384	

Interactive Energy Retrofit Tool



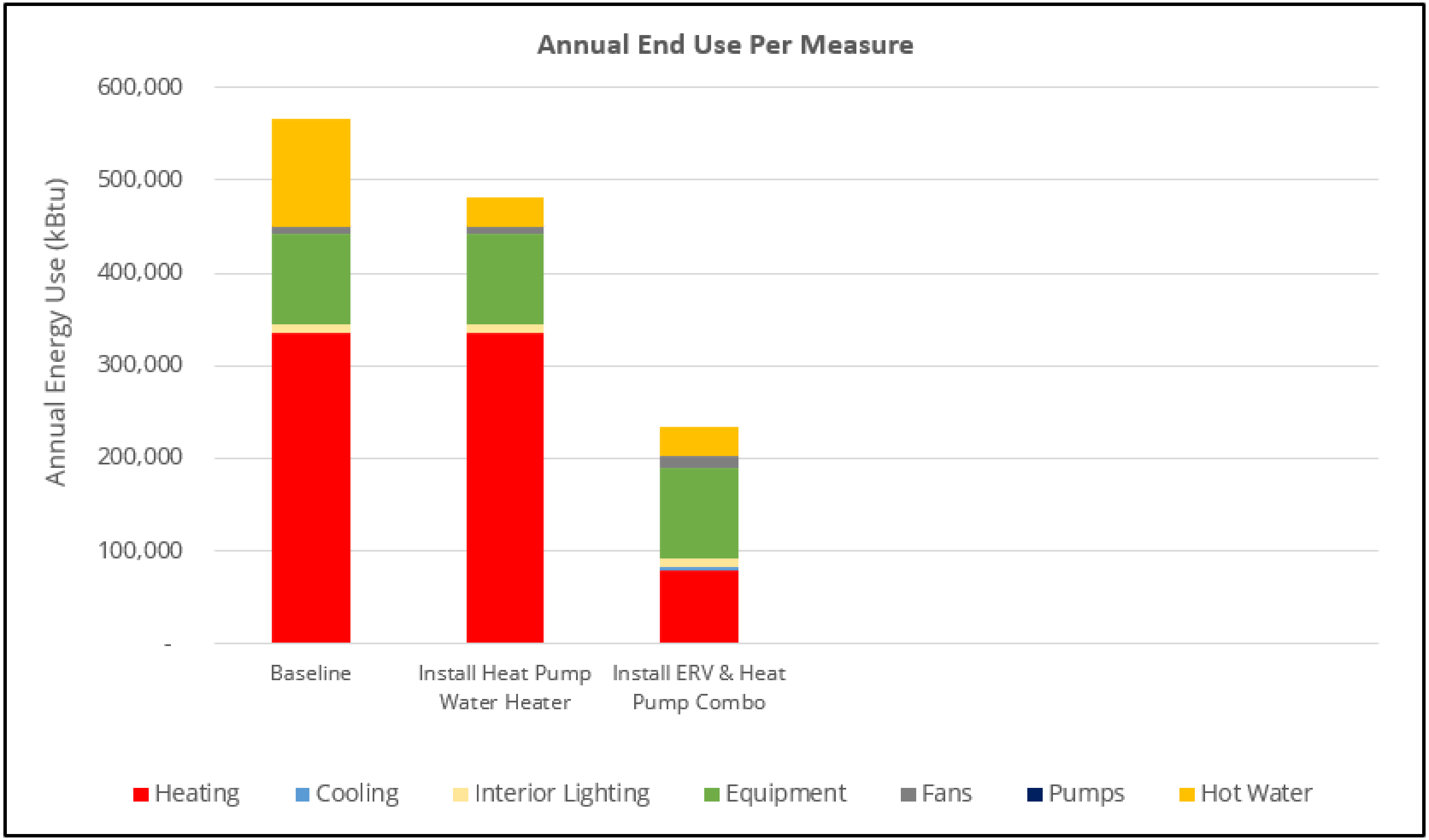
Costing Tables



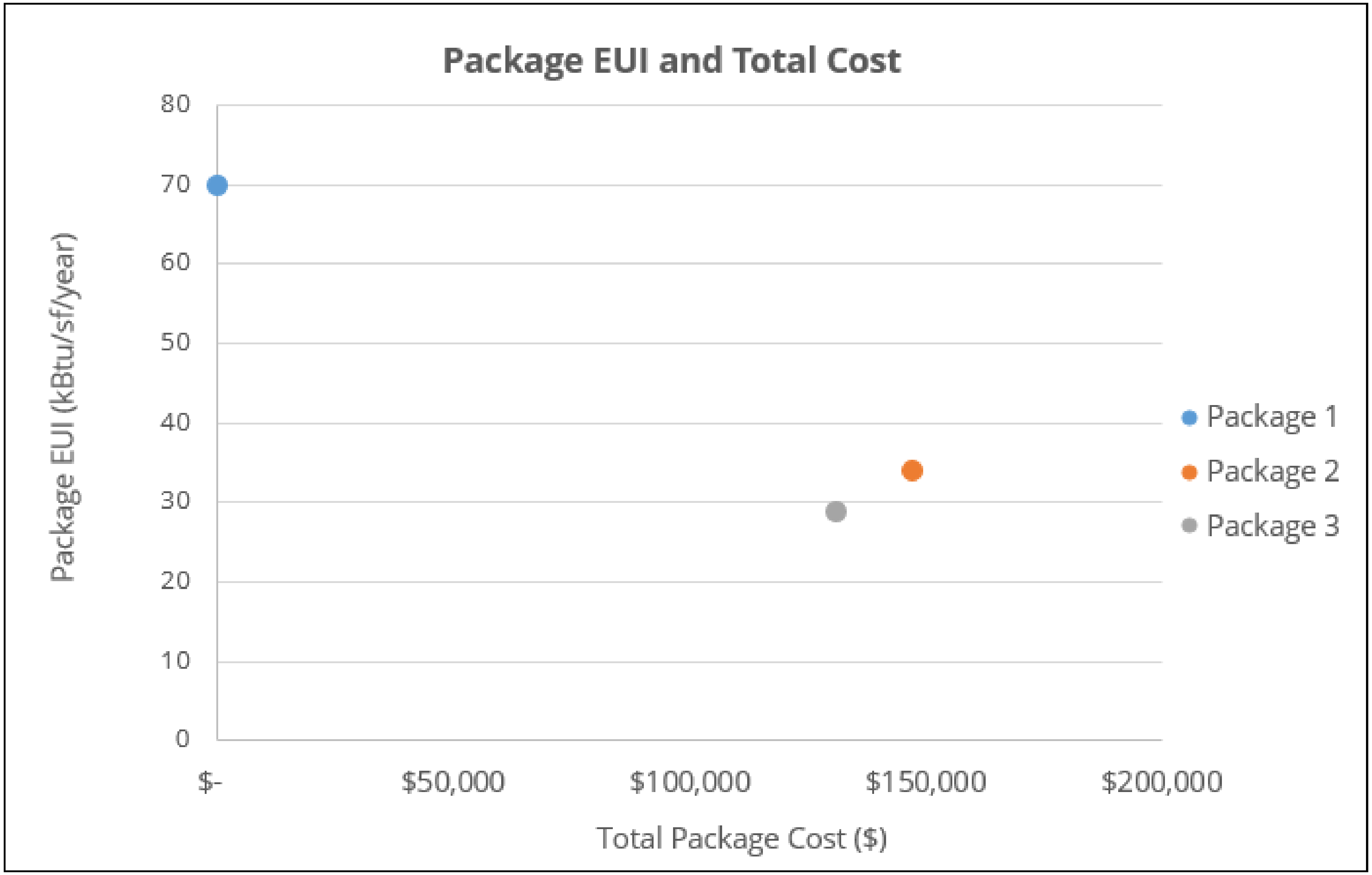
Cost Inputs for Measure Cost[a]

	Unitized Cost		**Material Cost**	**Labor Cost**	
Upgrade Windows	$ 800.00	per window			
Replace Siding	$ 10.00	per sf wall			
Add R-5 (while replacing siding)	$ 1.33	per sf wall	$ 1.00	$ 0.33	per sf of wall
Add R-10 (while replacing siding)	$ 1.83	per sf wall	$ 1.50	$ 0.33	per sf of wall
Add R-20 to Attic	$ 2.00	per sf roof			
Add R-30 to Attic	$ 3.00	per sf roof			
ERV	$ 2,500.00	per apartment unit			
Heat Pump Outdoor	$ 9,000.00	per outdoor unit			
Heat Pump Indoor Unit	$ 3,000.00	per indoor unit			
Heat Pump Hot Water H	$ 1,500.00	per water heater			
ERV & Heat Pump Combo	$ 4,000.00	per combo unit			

Energy End-Use Results



Capital Cost Analysis



Feedback for Application of Results

What questions does SHA have that data could answer?

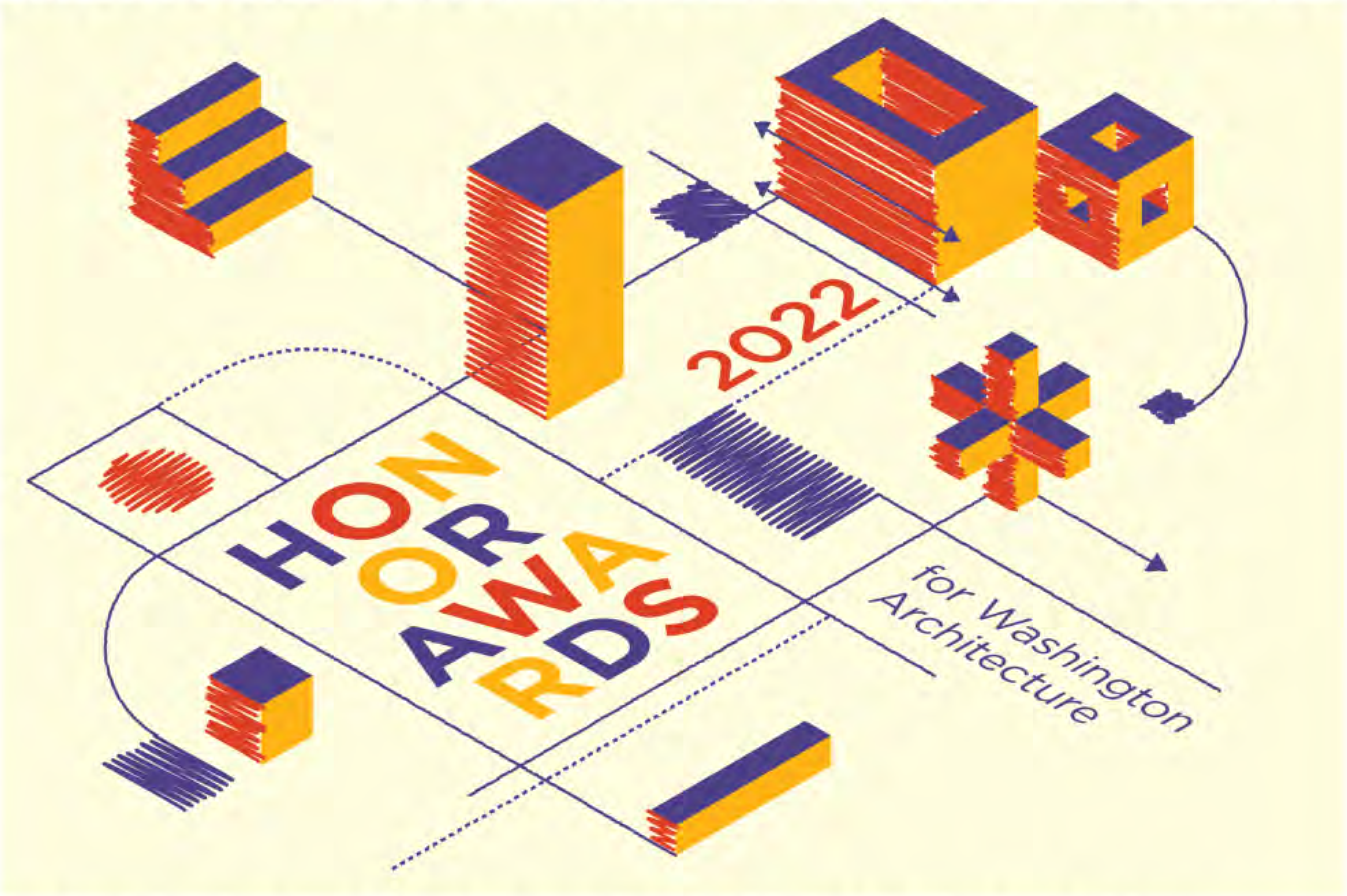
- Total Energy Use Savings
- Energy impacts per dollar
- Conditional performance of measures based on others
- Visual comparison of different packages

Barriers to Broad Scalability:

- Requires development of a calibrated energy model
- Needs continuous measure cost updating

AIA Seattle: Energy in Design Award

2022 HONOR AWARDS FOR WASHINGTON ARCHITECTURE



LIVE EVENT NOVEMBER 7 AT TOWN HALL SEATTLE

Energy in Design Award

AIA SEATTLE
THE AMERICAN INSTITUTE OF ARCHITECTS
COMMITTEE ON THE ENVIRONMENT

NORTHWEST ENERGY EFFICIENCY ALLIANCE

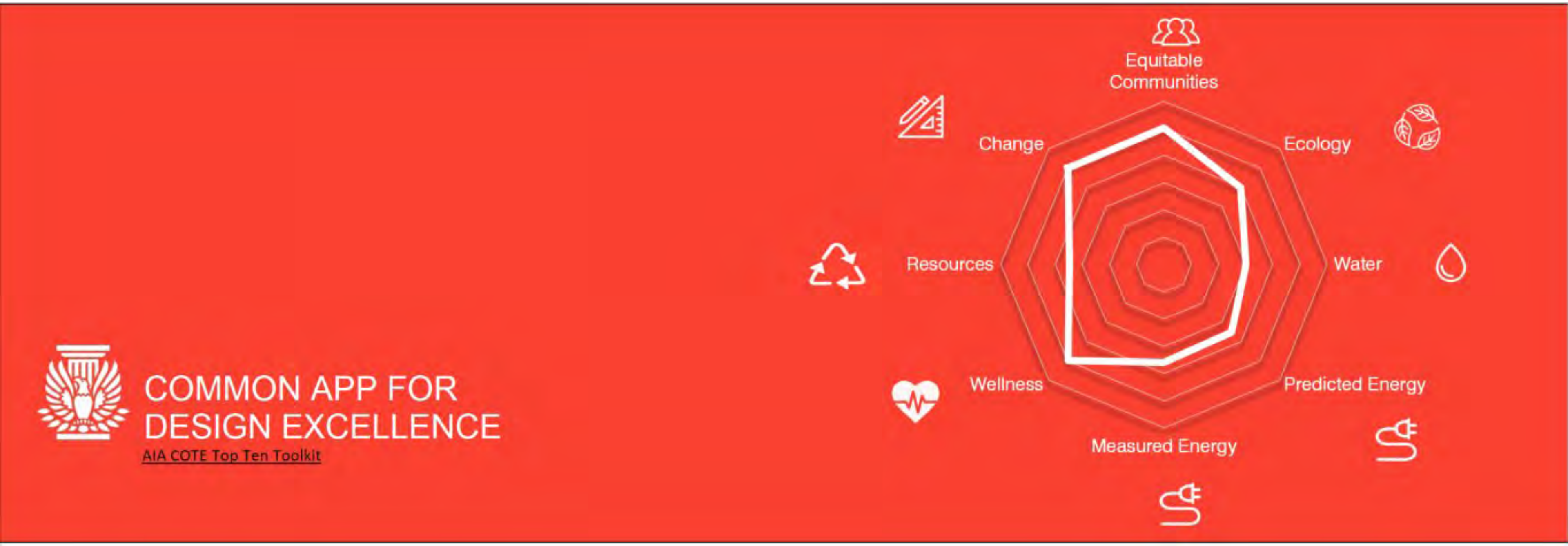
UW INTEGRATED DESIGN LAB

PROJECT GOALS

Transform the priorities of practitioners and building owners in three ways:

- ENCOURAGE AND ELEVATE THE CULTURAL STATURE OF PERFORMANCE-BASED ENERGY-EFFICIENT DESIGN
- RECOGNIZE INNOVATIVE OR EXEMPLARY PROJECTS
- PROVIDE A “REPORT CARD” TO THE DESIGN COMMUNITY ON THEIR PROGRESS TOWARD THE 2030 CHALLENGE COMMITMENT

AIA Common App for Design Excellence



COMMON APP FOR DESIGN EXCELLENCE

AIA COTE Top Ten Toolkit

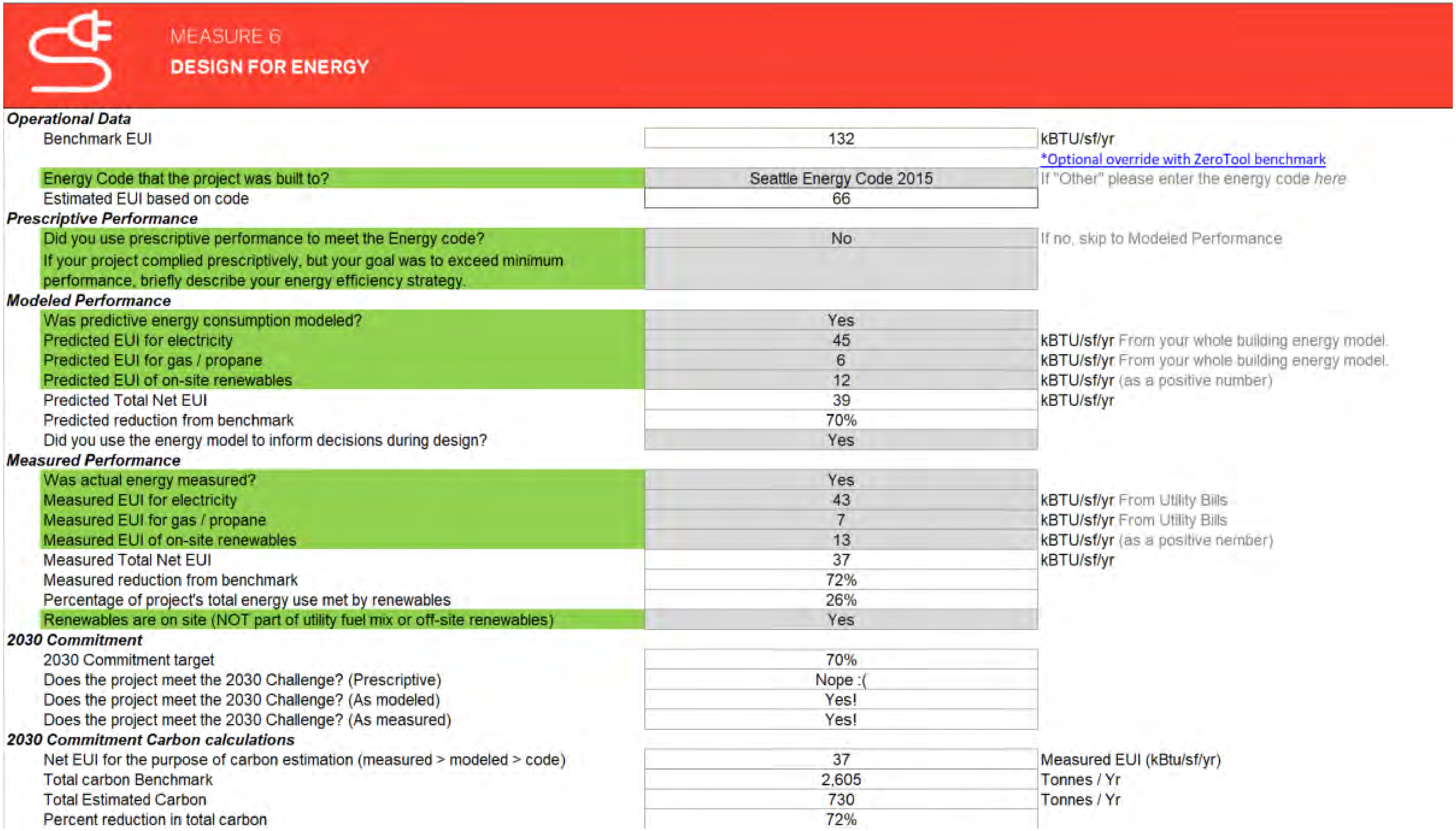
DEPT. of SUSTAINABILITY

INTEGRATED DESIGN LAB
UNIVERSITY of WASHINGTON // W

AIA Seattle

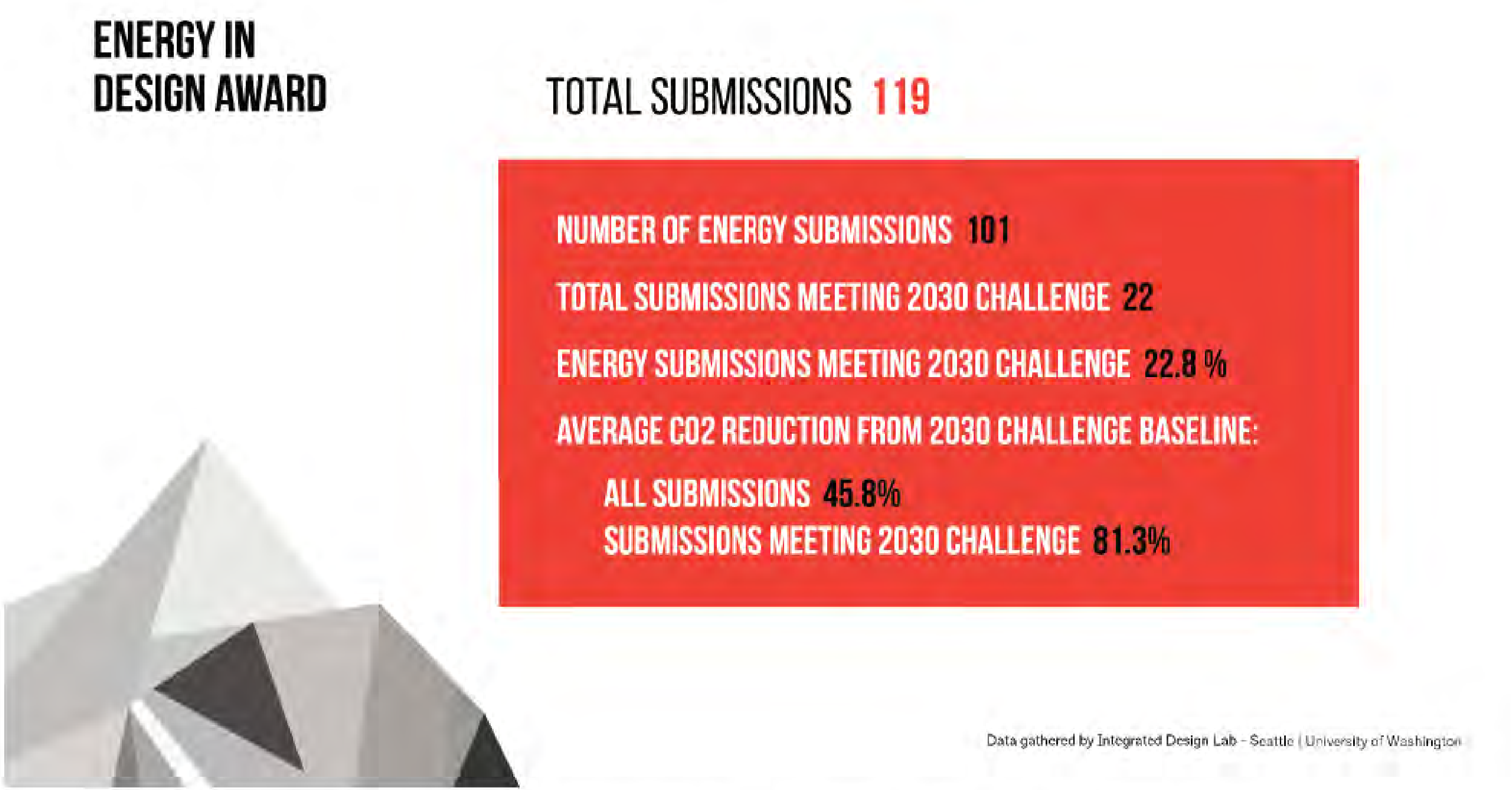
cote **AIA / Committee on the Environment**

Energy Reporting Paths



MEASURE 6
DESIGN FOR ENERGY

Operational Data		
Benchmark EUI	132	kBTU/sf/yr *Optional override with ZeroTool benchmark
Energy Code that the project was built to?	Seattle Energy Code 2015	If "Other" please enter the energy code *here*
Estimated EUI based on code	66	
Prescriptive Performance		
Did you use prescriptive performance to meet the Energy code?	No	If no, skip to Modeled Performance
If your project complied prescriptively, but your goal was to exceed minimum performance, briefly describe your energy efficiency strategy.		
Modeled Performance		
Was predictive energy consumption modeled?	Yes	
Predicted EUI for electricity	45	kBTU/sf/yr From your whole building energy model.
Predicted EUI for gas / propane	6	kBTU/sf/yr From your whole building energy model.
Predicted EUI of on-site renewables	12	kBTU/sf/yr (as a positive number)
Predicted Total Net EUI	39	kBTU/sf/yr
Predicted reduction from benchmark	70%	
Did you use the energy model to inform decisions during design?	Yes	
Measured Performance		
Was actual energy measured?	Yes	
Measured EUI for electricity	43	kBTU/sf/yr From Utility Bills
Measured EUI for gas / propane	7	kBTU/sf/yr From Utility Bills
Measured EUI of on-site renewables	13	kBTU/sf/yr (as a positive nember)
Measured Total Net EUI	37	kBTU/sf/yr
Measured reduction from benchmark	72%	
Percentage of project's total energy use met by renewables	26%	
Renewables are on site (NOT part of utility fuel mix or off-site renewables)	Yes	
2030 Commitment		
2030 Commitment target	70%	
Does the project meet the 2030 Challenge? (Prescriptive)	Nope :(	
Does the project meet the 2030 Challenge? (As modeled)	Yes!	
Does the project meet the 2030 Challenge? (As measured)	Yes!	
2030 Commitment Carbon calculations		
Net EUI for the purpose of carbon estimation (measured > modeled > code)	37	Measured EUI (kBtu/sf/yr)
Total carbon Benchmark	2,605	Tonnes / Yr
Total Estimated Carbon	730	Tonnes / Yr
Percent reduction in total carbon	72%	



ENERGY IN DESIGN AWARD

TOTAL SUBMISSIONS 119

NUMBER OF ENERGY SUBMISSIONS **101**

TOTAL SUBMISSIONS MEETING 2030 CHALLENGE **22**

ENERGY SUBMISSIONS MEETING 2030 CHALLENGE **22.8 %**

AVERAGE CO2 REDUCTION FROM 2030 CHALLENGE BASELINE:

- ALL SUBMISSIONS **45.8%**
- SUBMISSIONS MEETING 2030 CHALLENGE **81.3%**

Data gathered by Integrated Design Lab - Seattle | University of Washington

Figure 4: Example summary table given to Energy In Design Award jurors. Image: AIA Seattle.

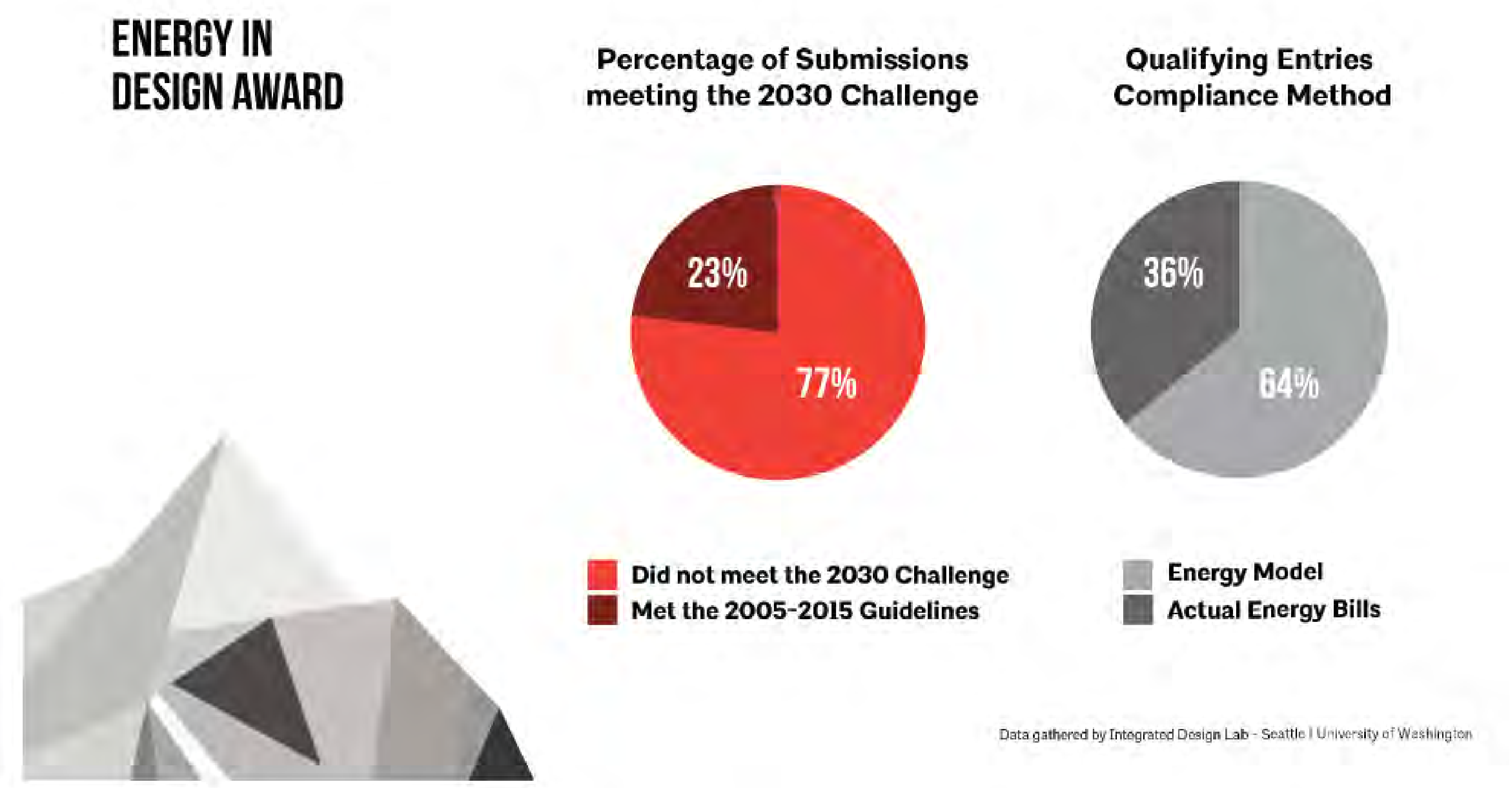
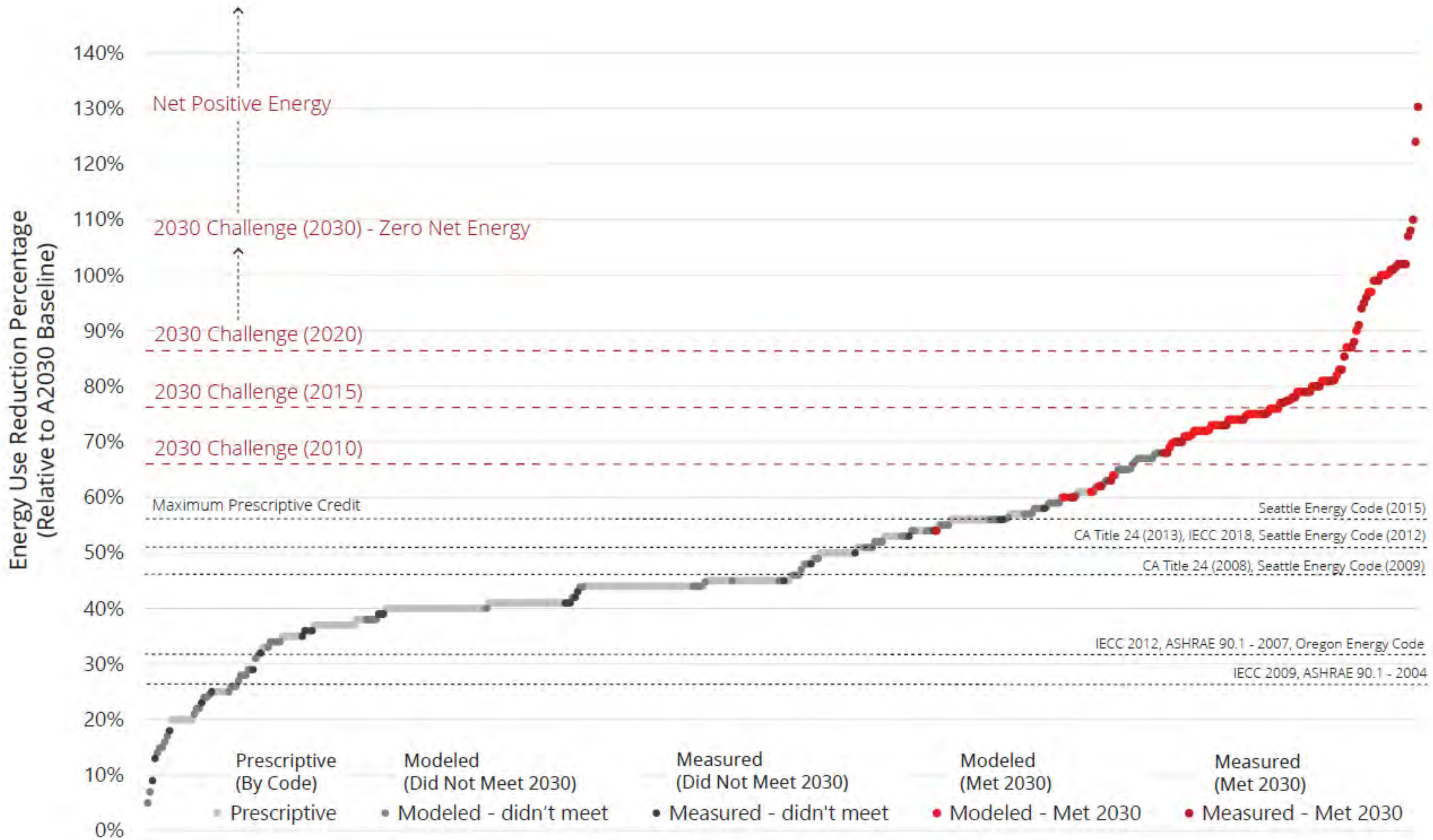


Figure 6: Compliance statistics and submission data for one year (2016). Image: AIA Seattle.



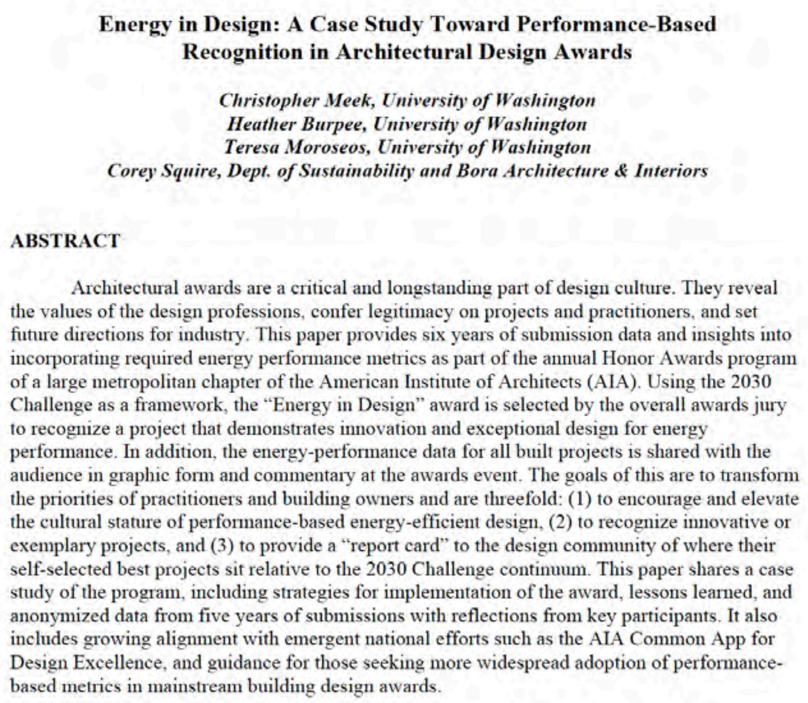
ENERGY USE REDUCTION FROM ALL SUBMISSIONS FROM 2016-2021

Figure 1. Energy use reduction percentage for all submissions to the Seattle Energy in Design award from 2016 to 2021. By method of energy use calculation and whether the project met the 2030 challenge, based on permit year.

Toward Performance-Based Recognition

ACEEE
Smart Energy. Clean Planet. Better Lives.

2022 ACEEE Summer Study on Energy Efficiency in Buildings
Climate Solutions: Efficiency, Equity, and Decarbonization



Energy in Design: A Case Study Toward Performance-Based Recognition in Architectural Design Awards

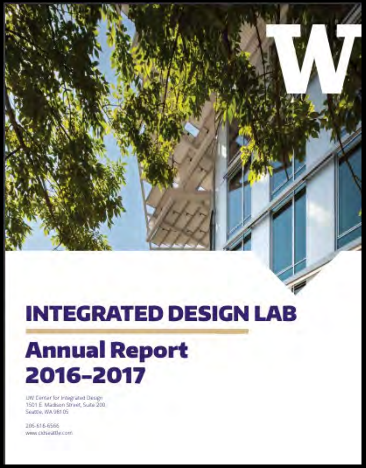
Christopher Meek, University of Washington
Heather Burpee, University of Washington
Teresa Moroseos, University of Washington
Corey Squire, Dept. of Sustainability and Bora Architecture & Interiors

ABSTRACT

Architectural awards are a critical and longstanding part of design culture. They reveal the values of the design professions, confer legitimacy on projects and practitioners, and set future directions for industry. This paper provides six years of submission data and insights into incorporating required energy performance metrics as part of the annual Honor Awards program of a large metropolitan chapter of the American Institute of Architects (AIA). Using the 2030 Challenge as a framework, the "Energy in Design" award is selected by the overall awards jury to recognize a project that demonstrates innovation and exceptional design for energy performance. In addition, the energy-performance data for all built projects is shared with the audience in graphic form and commentary at the awards event. The goals of this are to transform the priorities of practitioners and building owners and are threefold: (1) to encourage and elevate the cultural stature of performance-based energy-efficient design, (2) to recognize innovative or exemplary projects, and (3) to provide a "report card" to the design community of where their self-selected best projects sit relative to the 2030 Challenge continuum. This paper shares a case study of the program, including strategies for implementation of the award, lessons learned, and anonymized data from five years of submissions with reflections from key participants. It also includes growing alignment with emergent national efforts such as the AIA Common App for Design Excellence, and guidance for those seeking more widespread adoption of performance-based metrics in mainstream building design awards.

"Architectural awards are a critical and longstanding part of design culture. They reveal the values of the design professions, appropriating legitimacy on projects and practitioners, and set future directions for industry. In a profession where much of the work is subjective in nature, architecture awards provide a hierarchical ranking of what is deemed as 'success.'"

Past Annual Reports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2016–2017

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https://idl.be.uw.edu/index/annual-report/

Thank You!

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