Going Deep on Plug Loads: Strategies from the Bullitt Center

12th Annual Energy/Facilities Connections (EFC) Conference
4 May 2016
Leavenworth, WA

Christopher Meek, AIA , IESNA
Associate Professor + Director
Integrated Design Lab

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Department of Architecture
cmeek@uw.edu

@ the Bullitt Center

The Integrated Design Lab

The Discovery Commons

www.idlseattle.com

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The Bullitt Center

"The greenest commercial building in the world."
- http://www.bullittcenter.org

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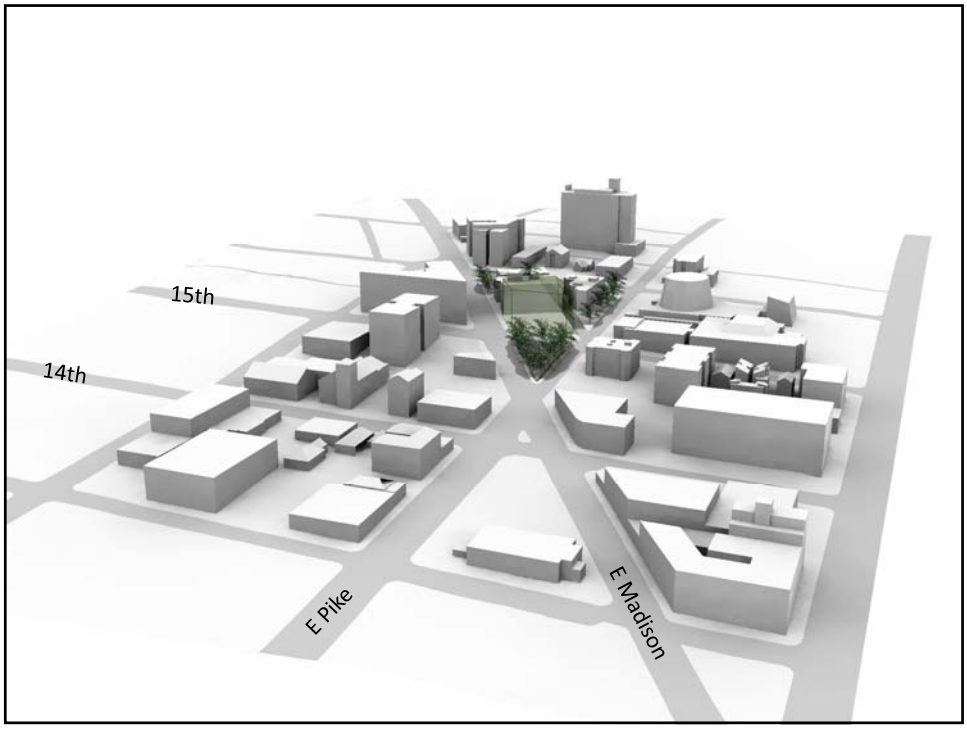
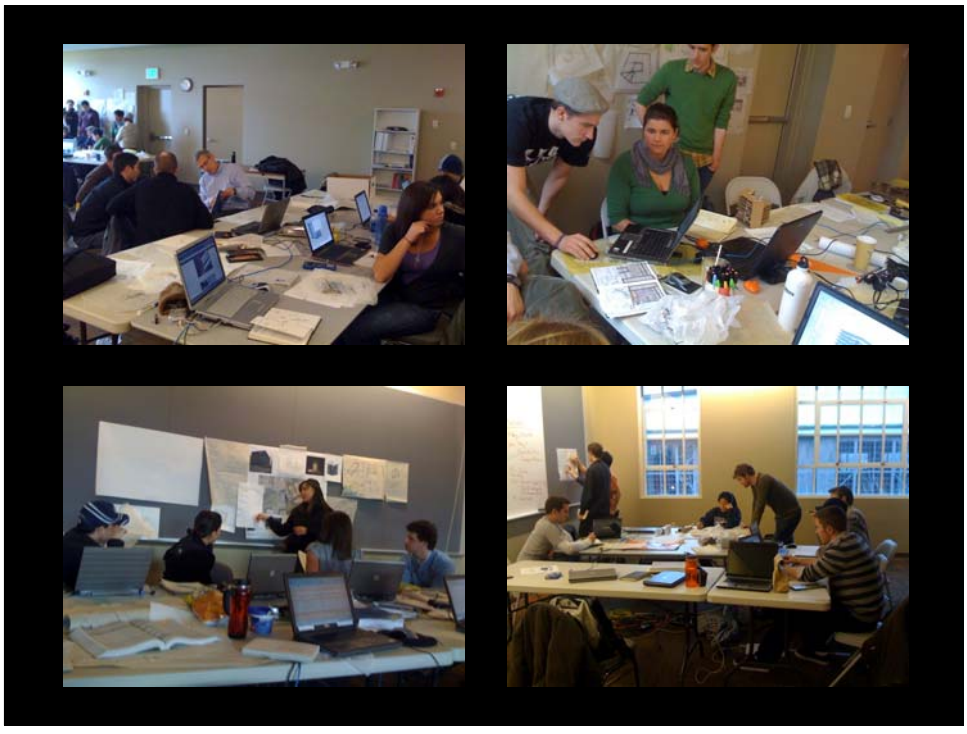
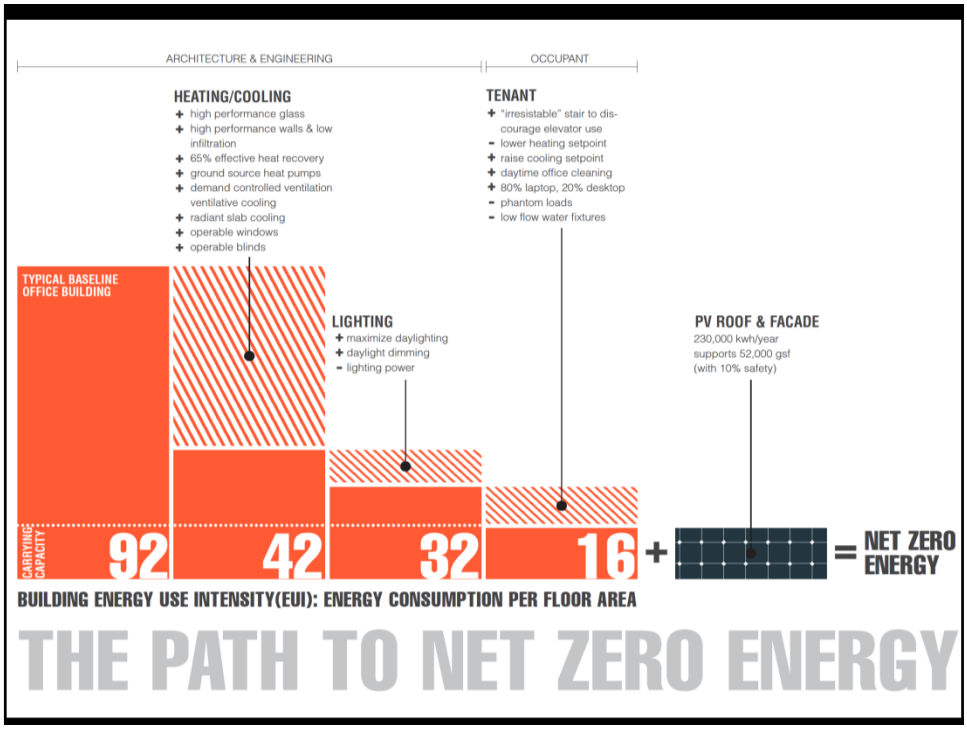
Design and Construction Team

The Bullitt Foundation	Client
The Miller Hull Partnership	Architecture
PAE Engineers	Mechanical & Electrical
Solar Design Associates	Solar Array Consultant
Luma Lighting Design	Lighting
The Berger Partnership	Landscape
Springline Design	Civil
DCI Engineers	Structural
UW Integrated Design Lab	Daylighting and Solar Shading Design
2020 Engineering	Natural Waste Treatment Systems
RDH	Building Envelope
Point32	Developer
Schuchart Construction	General Contractor

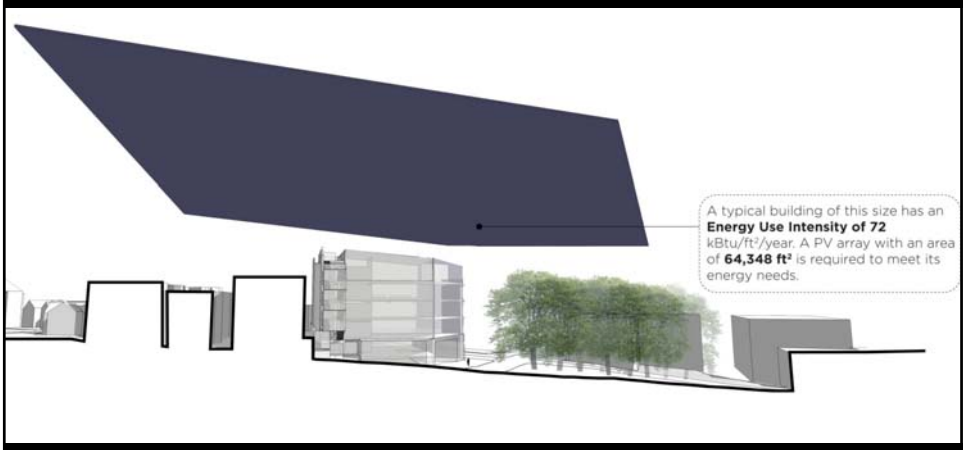

15th
14th
E Pike
E Madison



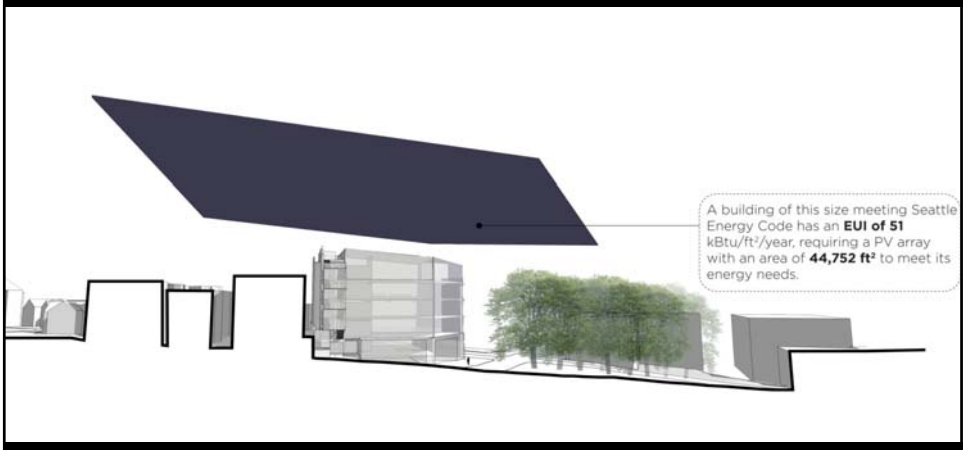
Asbestos
Cadmium
Chlorinated Polyethylene
Chlorosulfonated Polyethlene
Chlorofluorocarbons (CFC)
Chloroprene (neoprene)
Formaldehyde
Halogenated Flame Retardants
Hydrochlorofluorcarbons (HCFC)
Lead
Mercury
Petrochemical Fertilizers and Pesticides
Phthalates
Polyvinyl Chloride (PVC)
Creosote, Arsenic Wood treatment



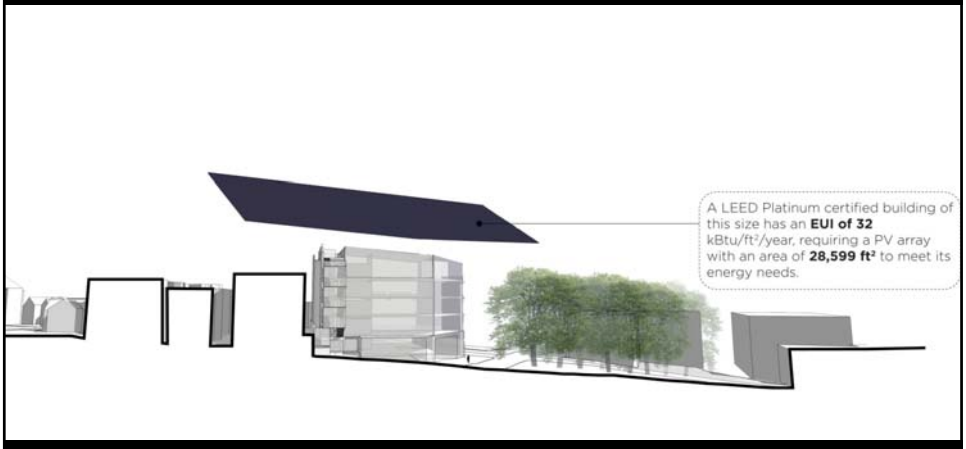
Net Zero Operation: CBECS Median US Office Building



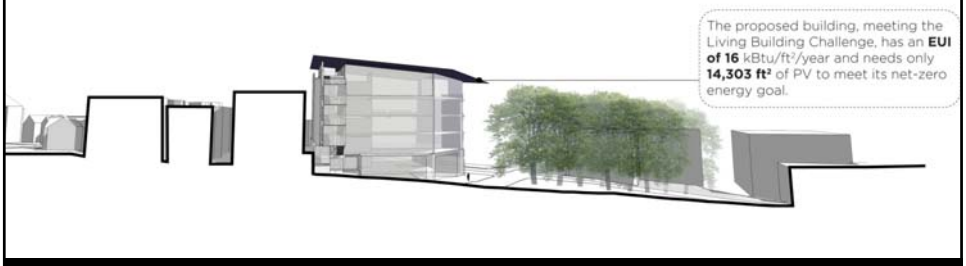
Net Zero Operation: Seattle Energy Code Building



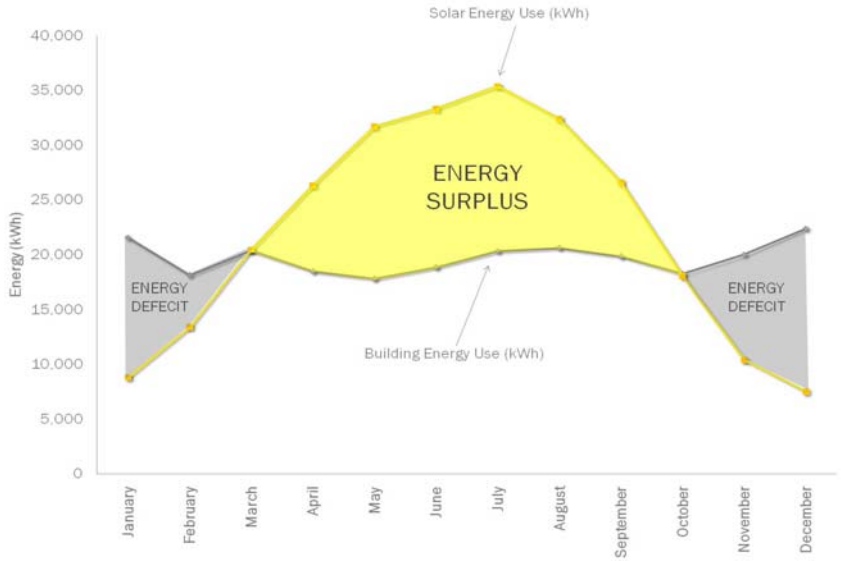
Net Zero Operation: LEED Platinum Building



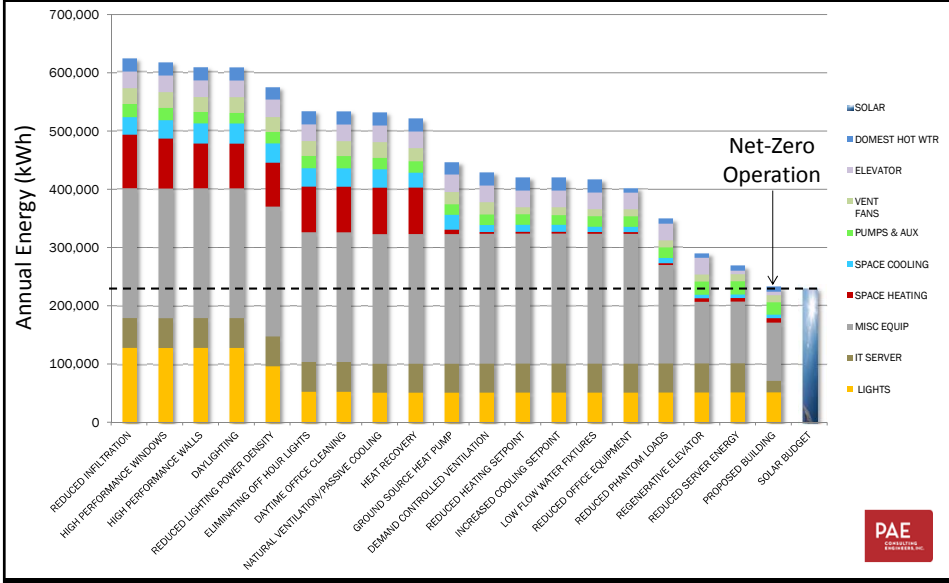
Net Zero Operation: Bullitt Center Design



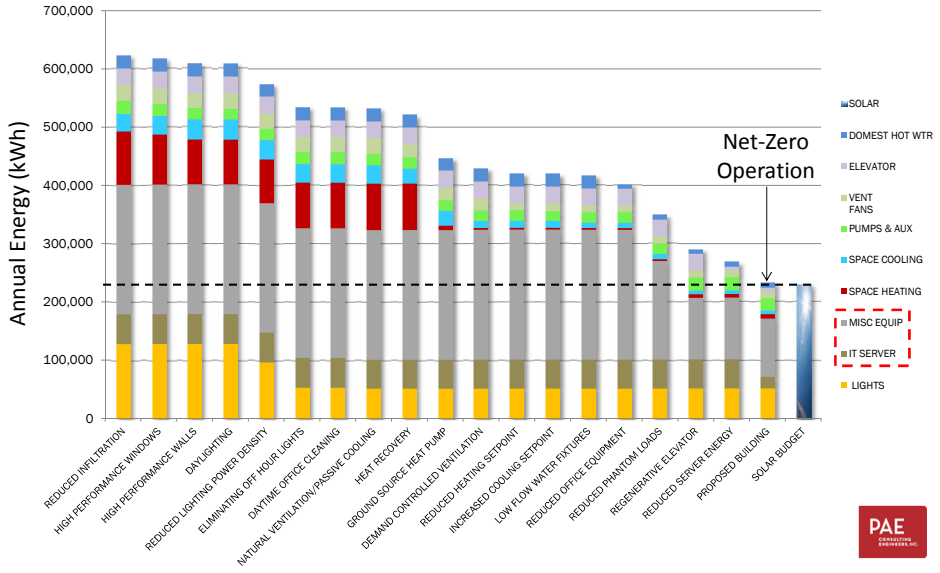
Solar Budget: Net-Metering

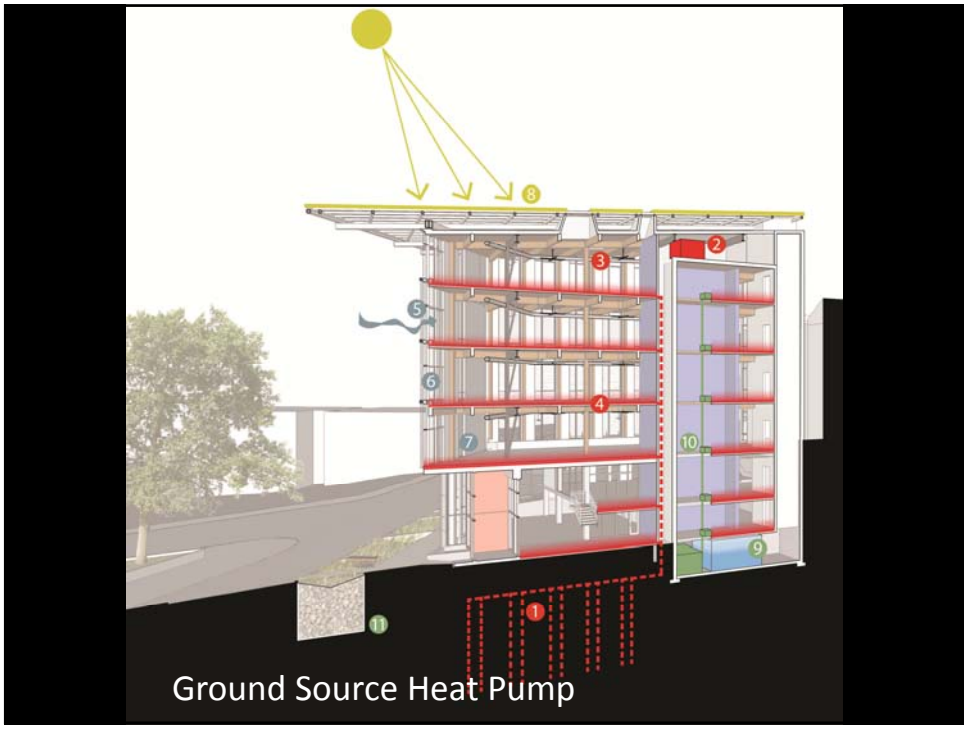


The Road to Net Zero

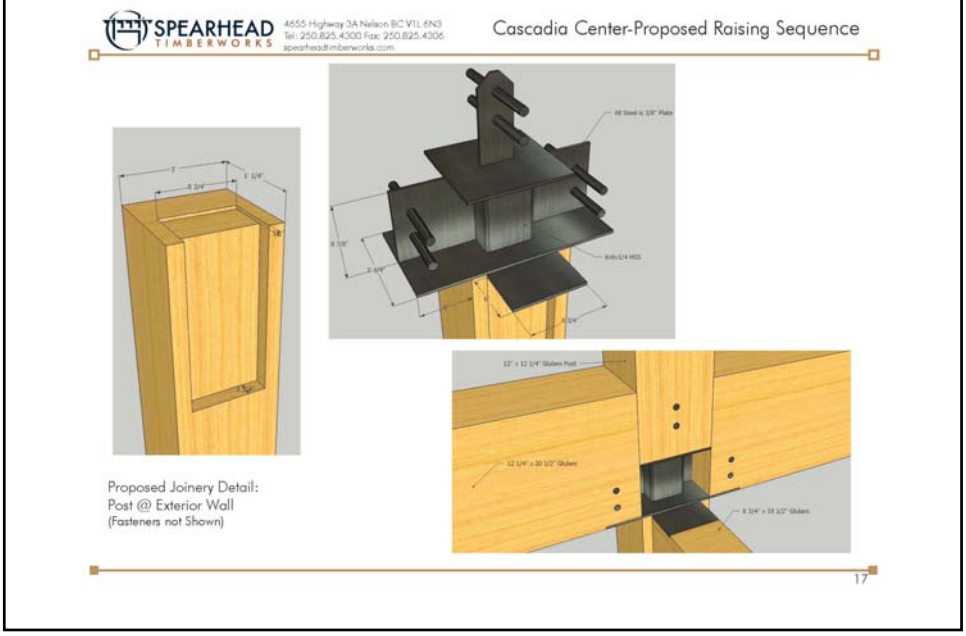


The Road to Net Zero



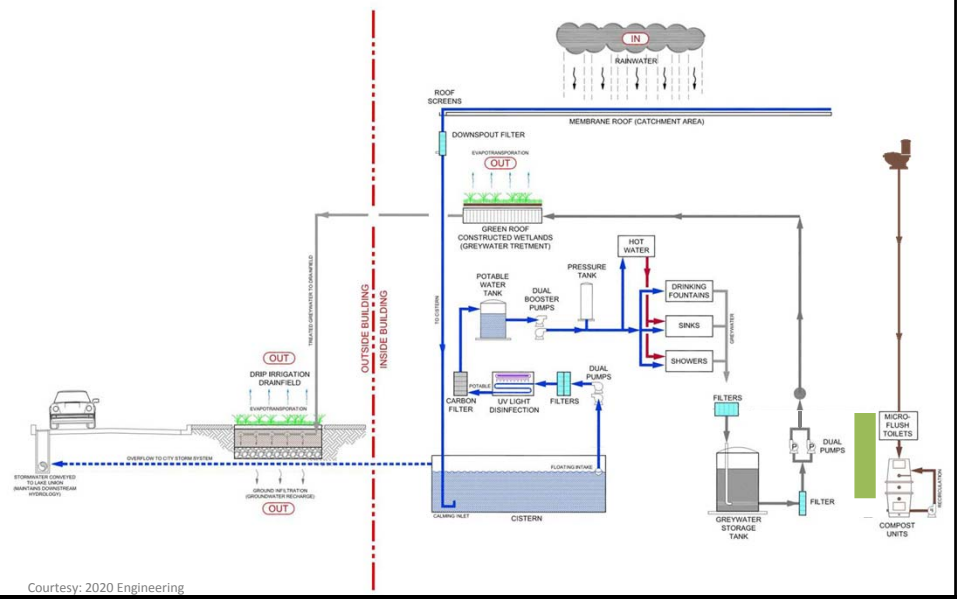


Heavy Timber Structure: A 250 Year Building



Water Conservation

Water and Waste Systems: rainwater harvesting and composting toilets



Courtesy: 2020 Engineering

Modeled End-Use Energy Distribution

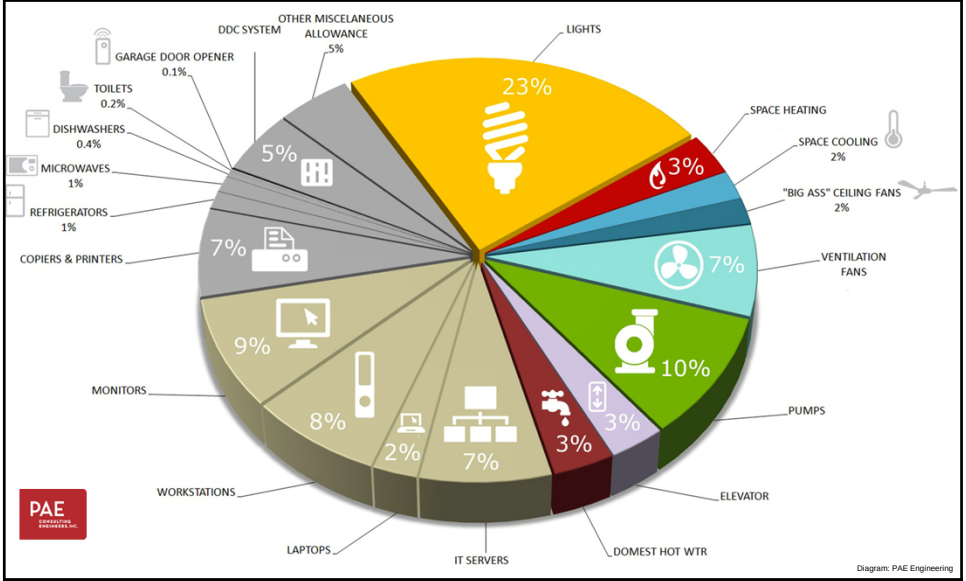


Diagram: PAE Engineering

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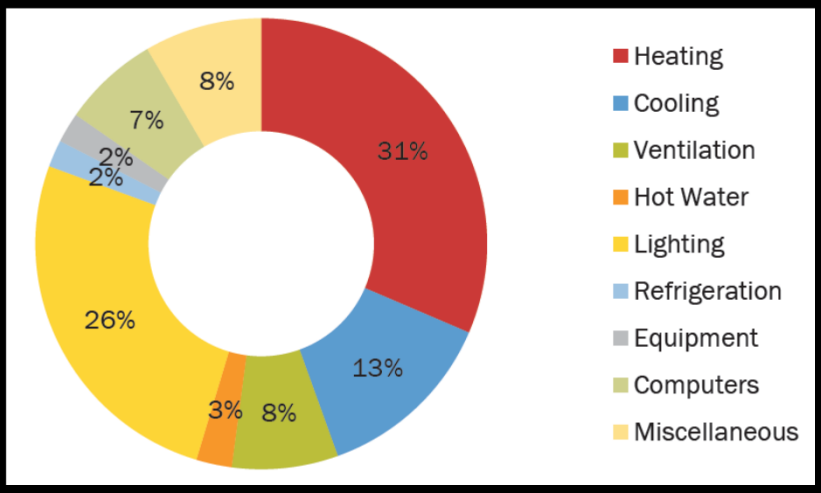
CBECS Climate Zone 3 Averages



Plug loads are ~ 17% on an EUI of 92 kBtu/ft²-yr (15.6)

Plug Loads Consume Approx. 29%* of Seattle Energy Code Office Building Site Energy and 38% of Site Electricity (SEC, 2009)

Plug Load Energy in NW Buildings

Office Building: Seattle Energy Code 2009 (SEC, 2009)

EUI ~42 kBtu/ft²-yr

Plug loads alone = ~12.8 kBtu/ft²-yr

*This is based on modeling done in 2009 – I presume the wattage is dropping somewhat die to adoption of more laptop computers.

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Plug Loads Consume Approx. 29%* of Seattle Energy Code Office Building Site Energy and 38% of Site Electricity (SEC, 2009)

Plug Load Energy in NW Buildings

Office Building: Seattle Energy Code 2009 (SEC, 2009)

EUI ~42 kBtu/ft²-yr

Plug loads alone = ~12.8 kBtu/ft²-yr

Bullitt Center

EUI ~16 kBtu/ft²-yr (Now operating ~10 kBtu/ft²-yr)

Plugs alone = ~7.6 (3.1) kBtu/ft²-yr- with controls

If plug load reduction performance is not *persistent* over time the project will not meet net-zero operation.

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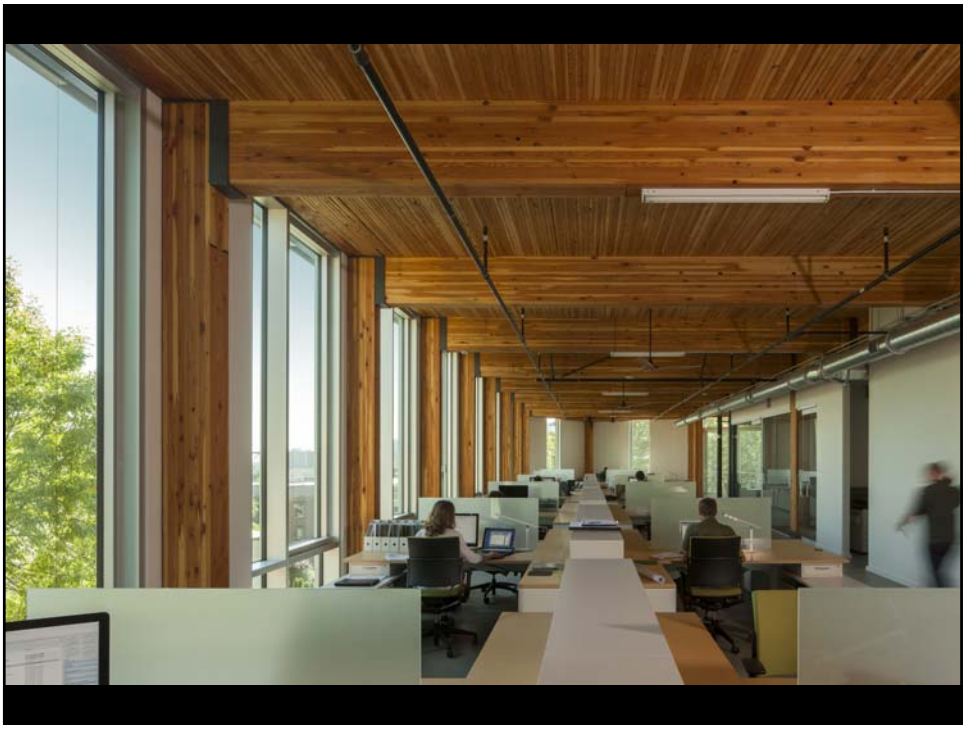
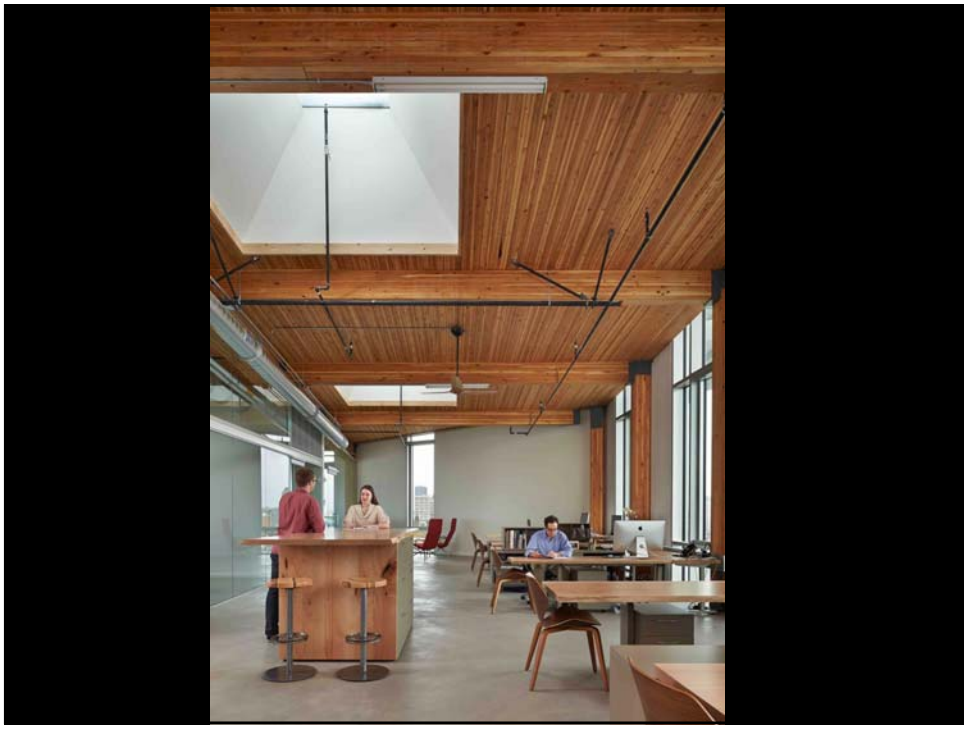
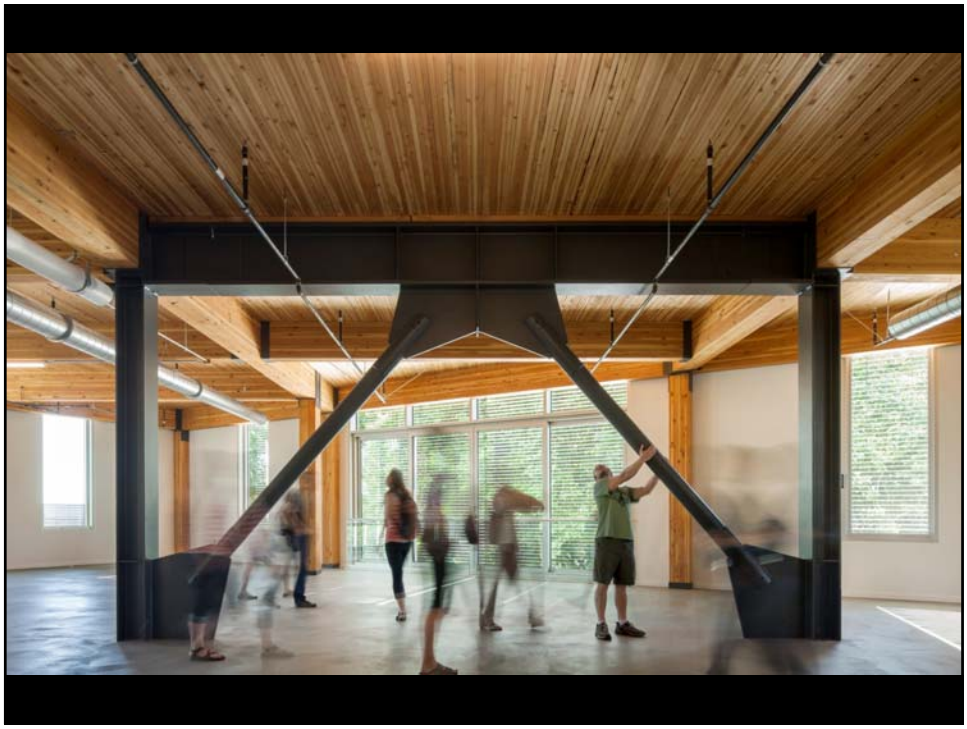
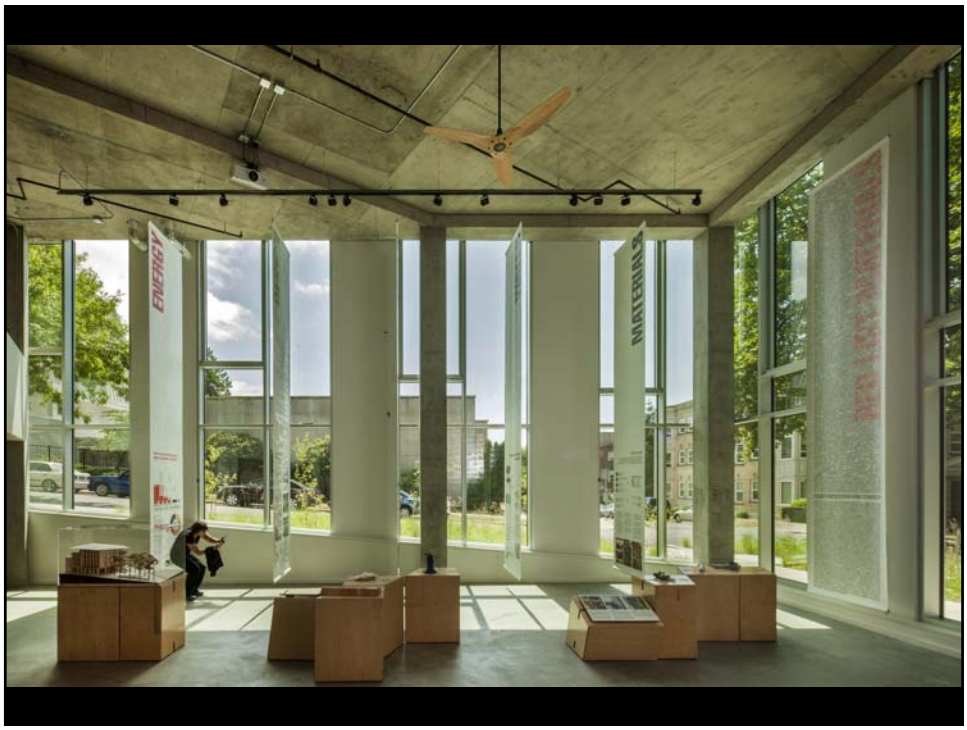
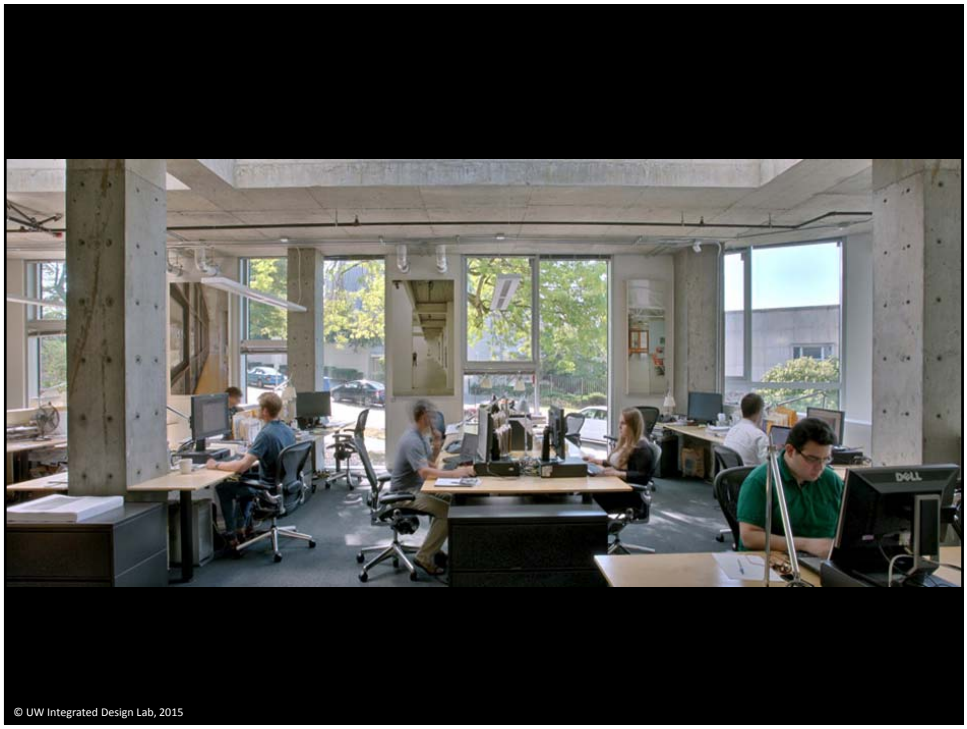







DESIGN
MATERIALS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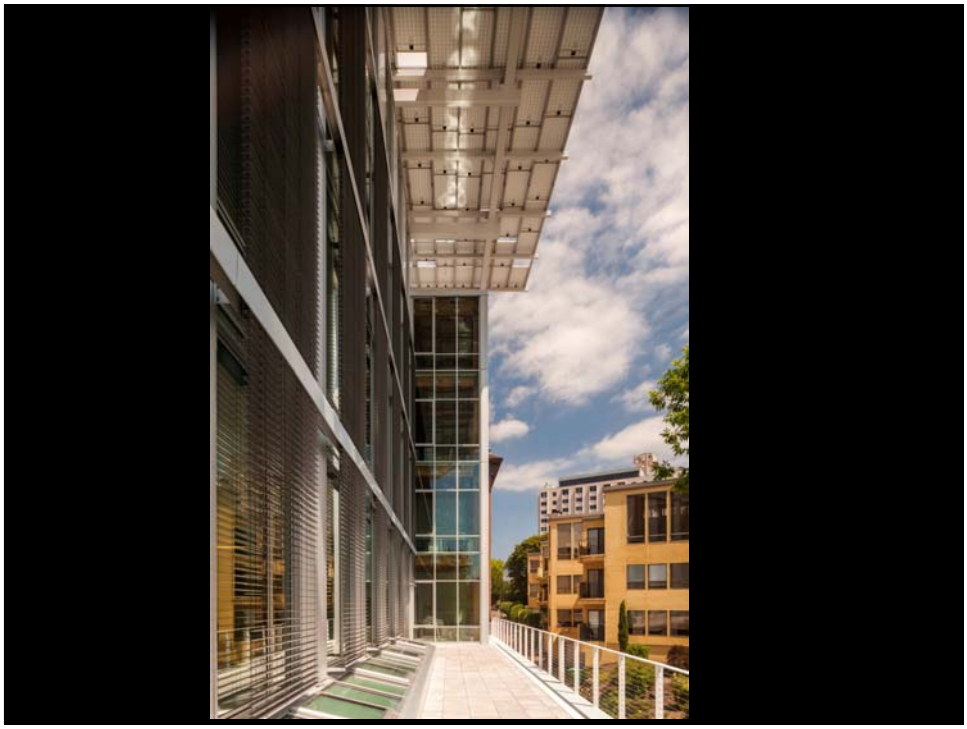
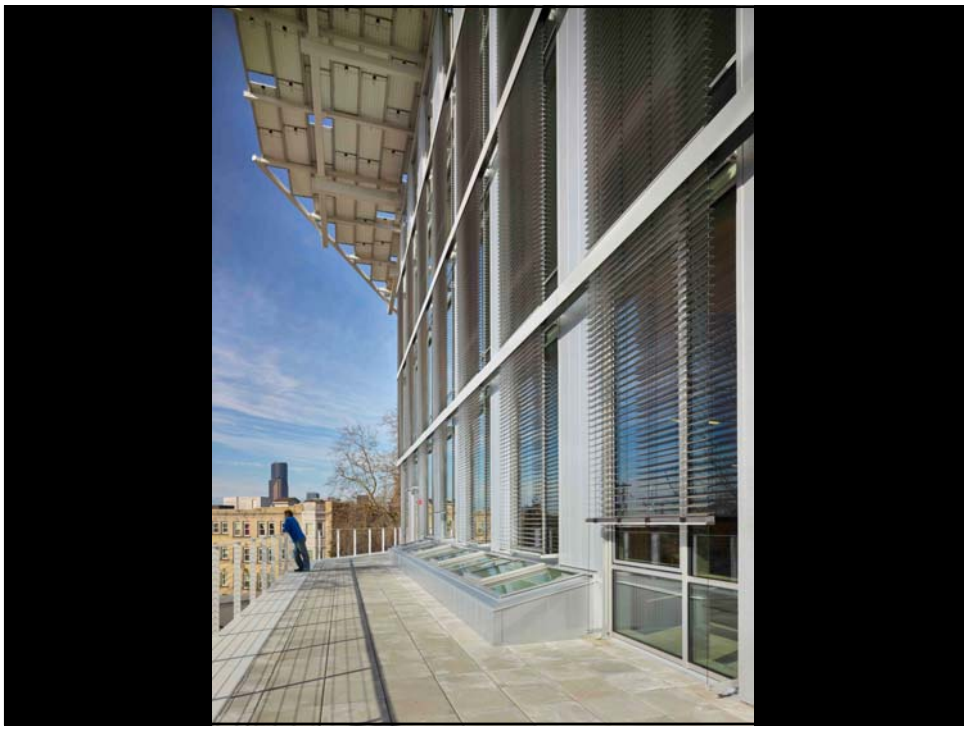
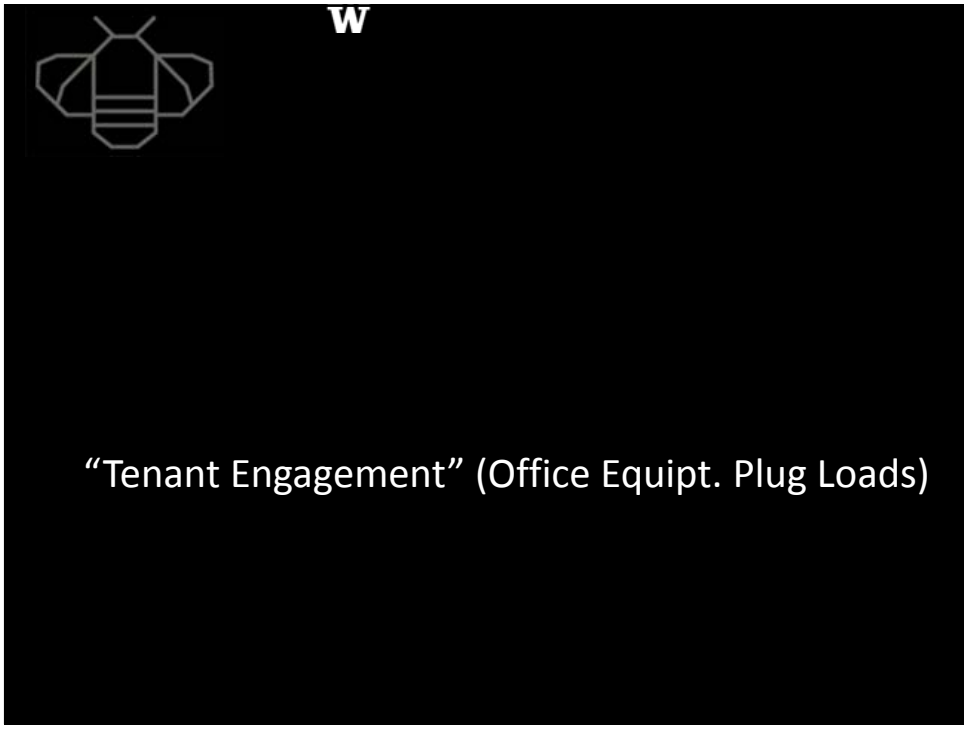
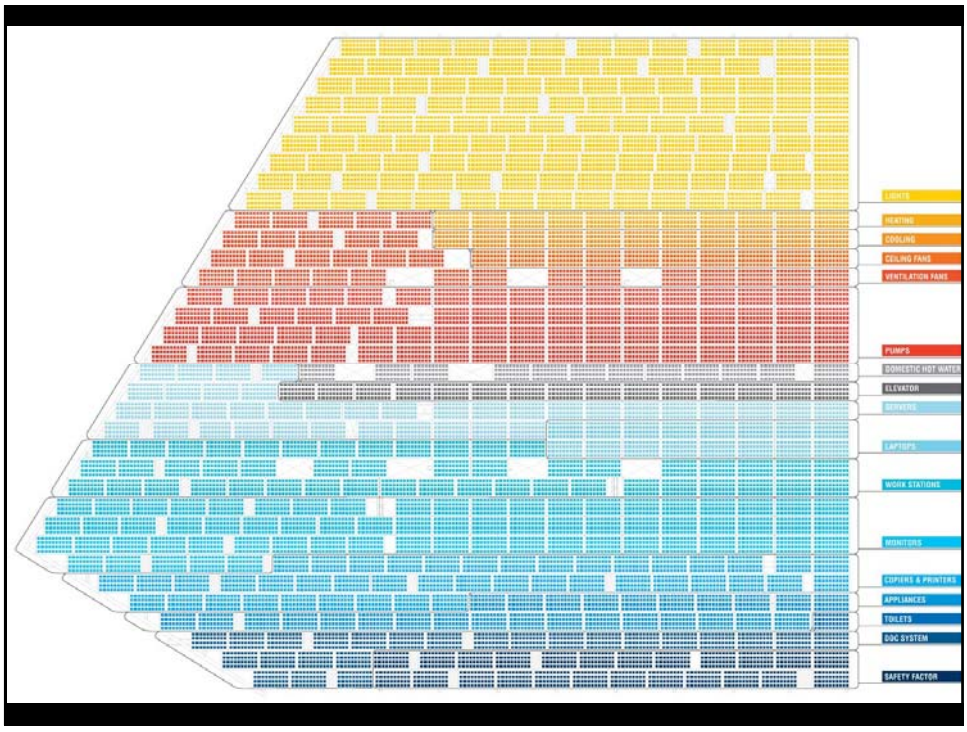
DESIGN
WATER
MATERIALS



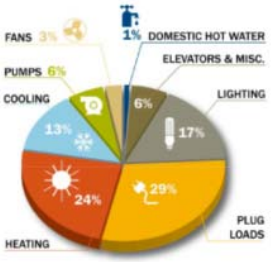



W
"Tenant Engagement" (Office Equipt. Plug Loads)

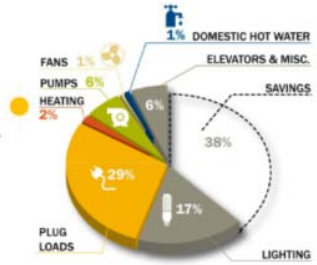

LIGHTS
HEATING
COOLING
CEILING FANS
VENTILATION FANS
PUMPS
DOMESTIC HOT WATER
ELEVATOR
SERVERS
LAPTOPS
WORK STATIONS
MONITORS
COPIERS & PRINTERS
APPLIANCES
TOILETS
DDC SYSTEM
SAFETY FACTOR

Energy Conservation Measures

TYPICAL BUILDING

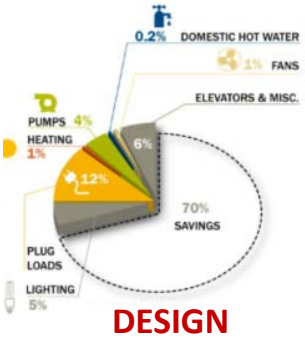


With ENERGY CONSERVATION



DESIGN = 38%

With OCCUPANT ENGAGEMENT



DESIGN + PEOPLE = 70%

PAE CONSULTING ENGINEERS, INC

UNICO

Unico Properties LLC
2003 Western Avenue, Suite 200
Seattle, WA 98121
Ph: 425.462.2100
Fax: 425.462.2108

April 15, 2016

Board of Regents – Integrated Design Lab
1501 E. Madison St.
Suite 100
Seattle, WA 98122

RE: *2016 Q1 Energy Consumption*

Dear Board of Regents:

One of the benefits of leasing with the Bullitt Center is the building's electric bills are not included in tenant's operating expenses as long as they do not exceed their annual kWh allowance. We will be providing you reports of your allocation and usage quarterly so that you can make informed decisions about how you operate in the building. Please find your Q1 information below.

Please let us know if you have any questions or if we can assist in finding solutions to further reduce energy consumption in your space.

Tenant Report	Prorata Share	Q1 kWh Allocation	Q1 2016 Usage	Difference	% Used	Q1 2015 Usage	Q1 2015 vs Q1 2016 Difference	% Difference
UW 1st floor	10.40%	3297.03	387.575	2909.46	11.76%	436.115	-48.54	-12.52%
UW 2nd floor	6.80%	2155.73	935.805	1219.92	43.41%	930.21	5.59	0.60%

Sincerely,

Nai Chao
Property Manager

Green Lease at Bullitt Center

- Many provisions…
- Includes tenant energy budget apportioned by square footage of leased area.

UW Leased Area: 7950 ft²
Annual Energy budget: 5452 kWh

Plug Load Energy Allocation Density: 0.69 kWh/ft²
Plug Load "Density" @ 2000 hrs: 0.345 W/ft² (whole building)
@ 200 ft²/person: ~70 W/workstation

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Office Plug Load Survey: Workstations

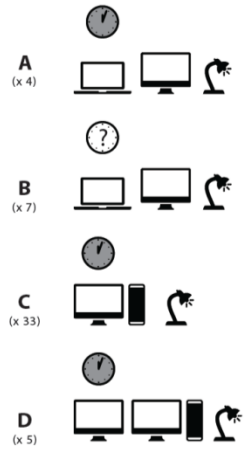


Figure 9. Perkins + Will Workstation Types

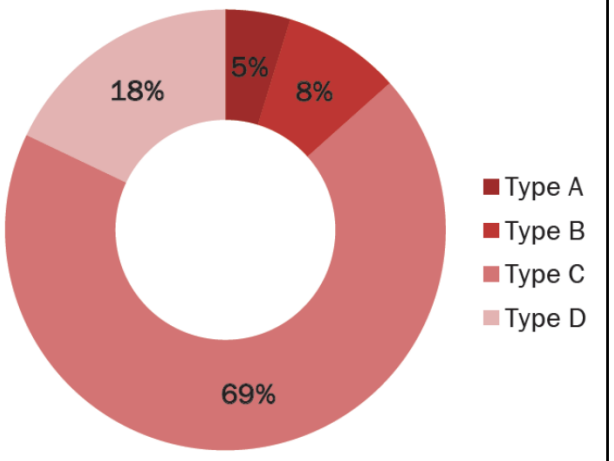


Figure 10. Workstation Energy Com

Office Plug Load Survey: Copy Room

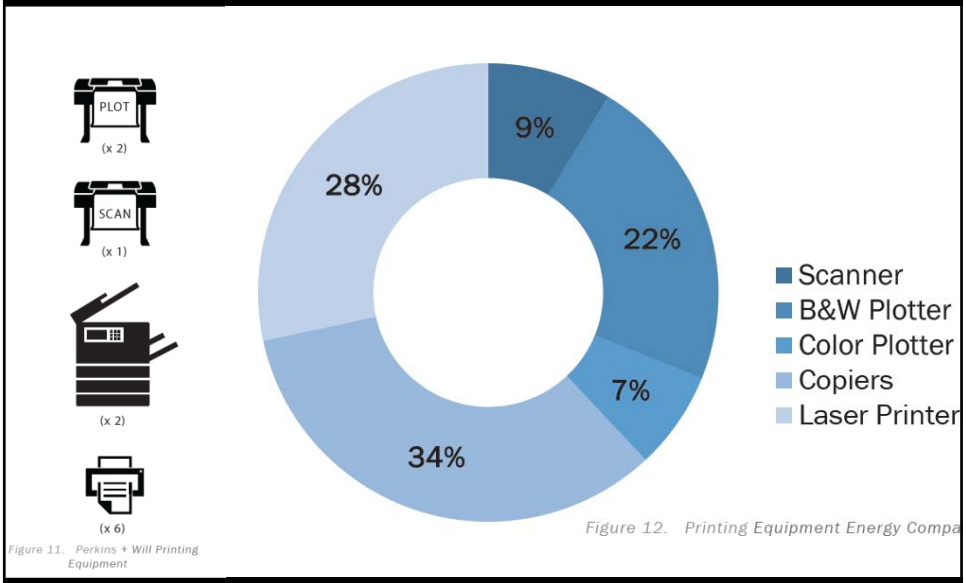


Figure 11. Perkins + Will Printing Equipment

Figure 12. Printing Equipment Energy Compa

Office Plug Load Survey: Kitchen

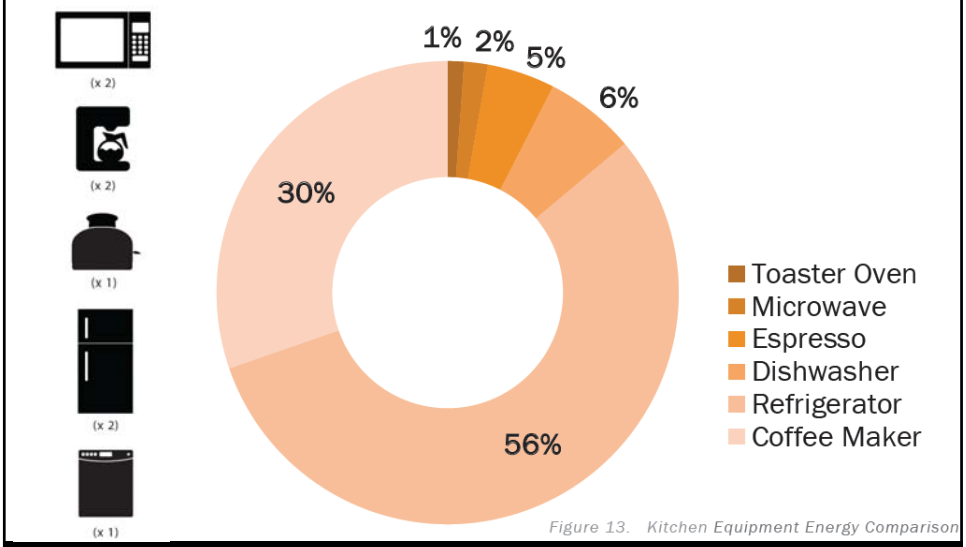


Figure 13. Kitchen Equipment Energy Comparison

Work Station Efficiencies

		Monitors	Computer
typical	250 watts	2 – 20” CFL-LCD @ 75 Watts each	1 - Desktop @ 100 Watts
good (2009)	160 watts	2 – 22” LED-LCD @ 40 Watts each	1 - Desktop @ 80 Watts
better (2010)	90 watts	2 – 22” LED-LCD @ 14 Watts each	1 - Laptop @ 62 Watts

Graphic: PAE Engineering

Thin-client Workstation

Smart Plug Strips

control: switches and sensors
meter: plugs and lights
monitor: visualize and inform

Comprehensive Plug-Load/Task Lighting Management

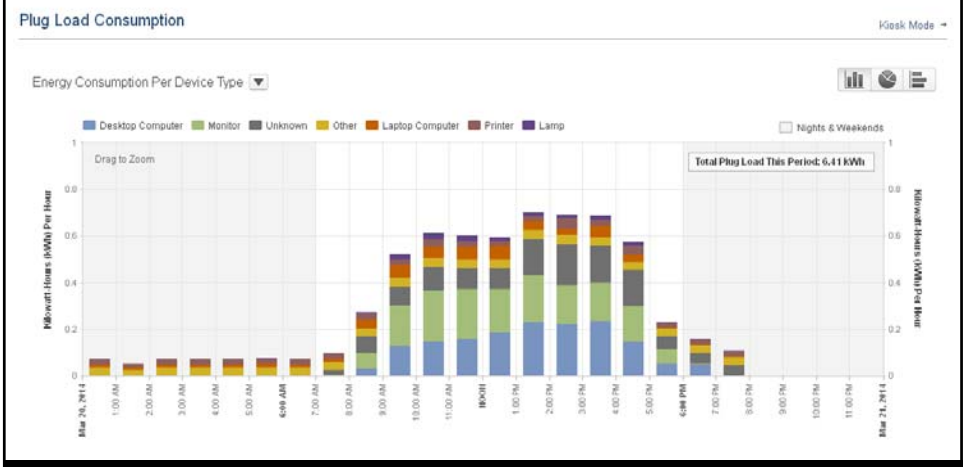


Image: Enmetric Plug Load Manager/UW IDL

Web-based Real Time Plug Load Data Collection, Scheduling, and Reporting at Each Receptacle.

© UW Integrated Design Lab, 2014

Live Demo*

Enmetric Plugstrips
https://prod.enmetric.com/
Username: enmetric@idl.com
Password: idl@enm

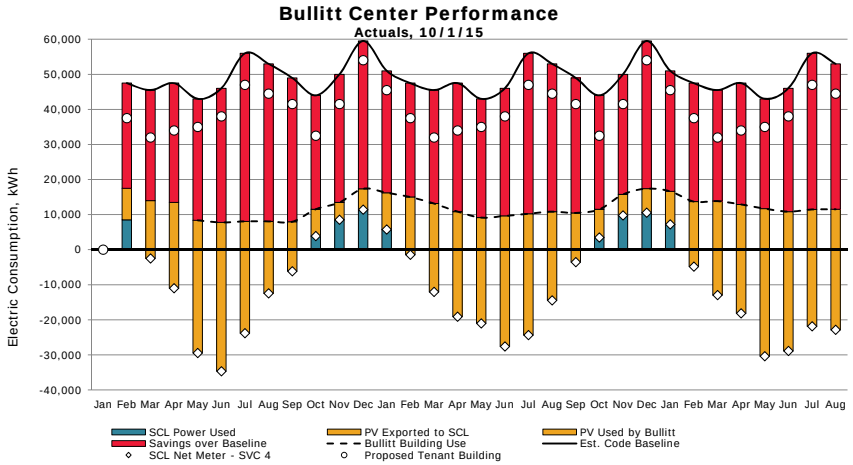
* fingers crossed

Occupant Feedback and Energy Performance Documentation

© UW Integrated Design Lab, 2015

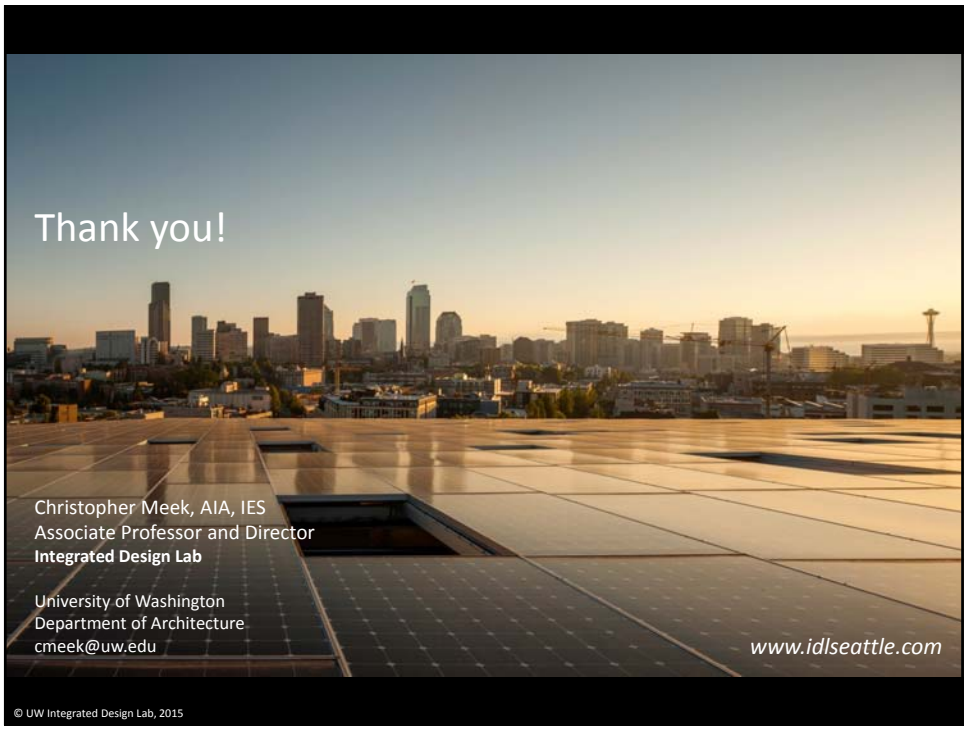
Predicted vs. Actual

Bullitt Center Performance



Graph: PAE Engineering

PAE



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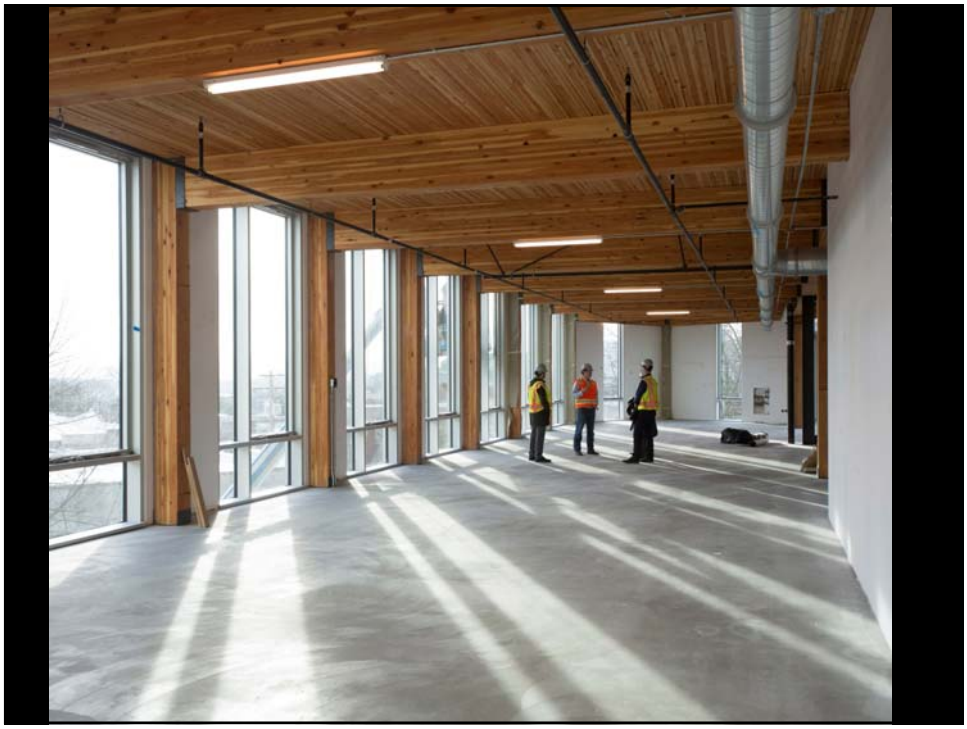
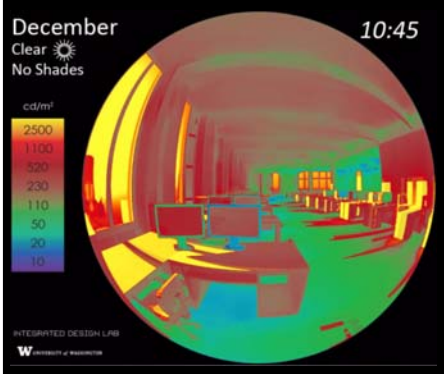
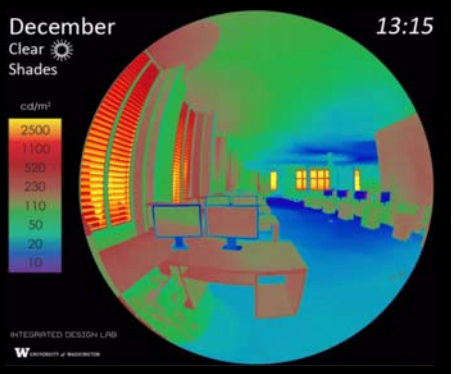


Dynamic Solar Shading: Glare Control and Daylight Persistence Measure



Baseline Windows



Automated Exterior Blinds

© UW Integrated Design Lab, 2015

Dynamic Luminance Map: *Automated Blinds Deployment*

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