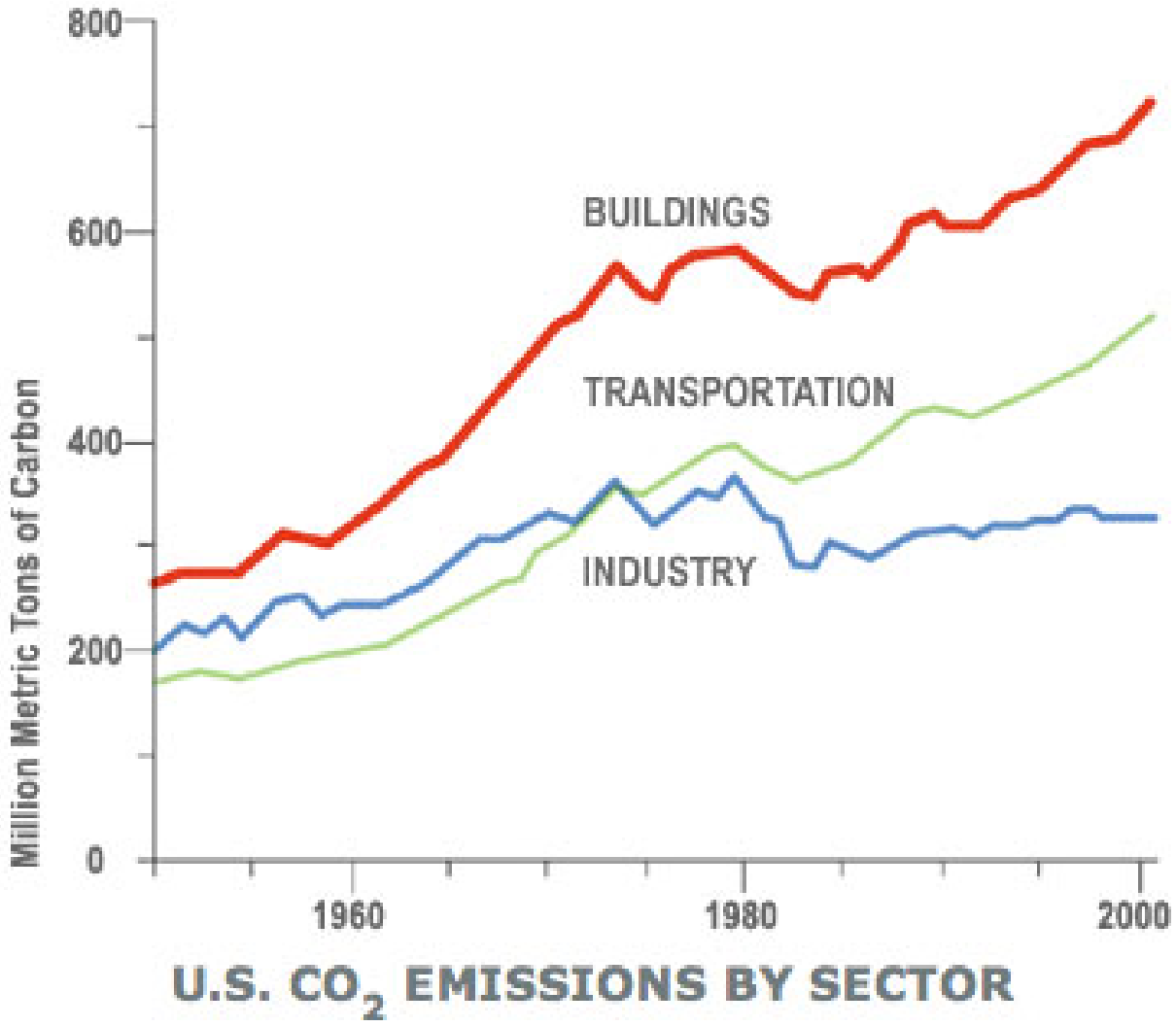
Net Zero Energy

1. Why is net zero important?
2. Embodied carbon vs operational carbon
3. What is net zero?
4. Certifications
5. Codes

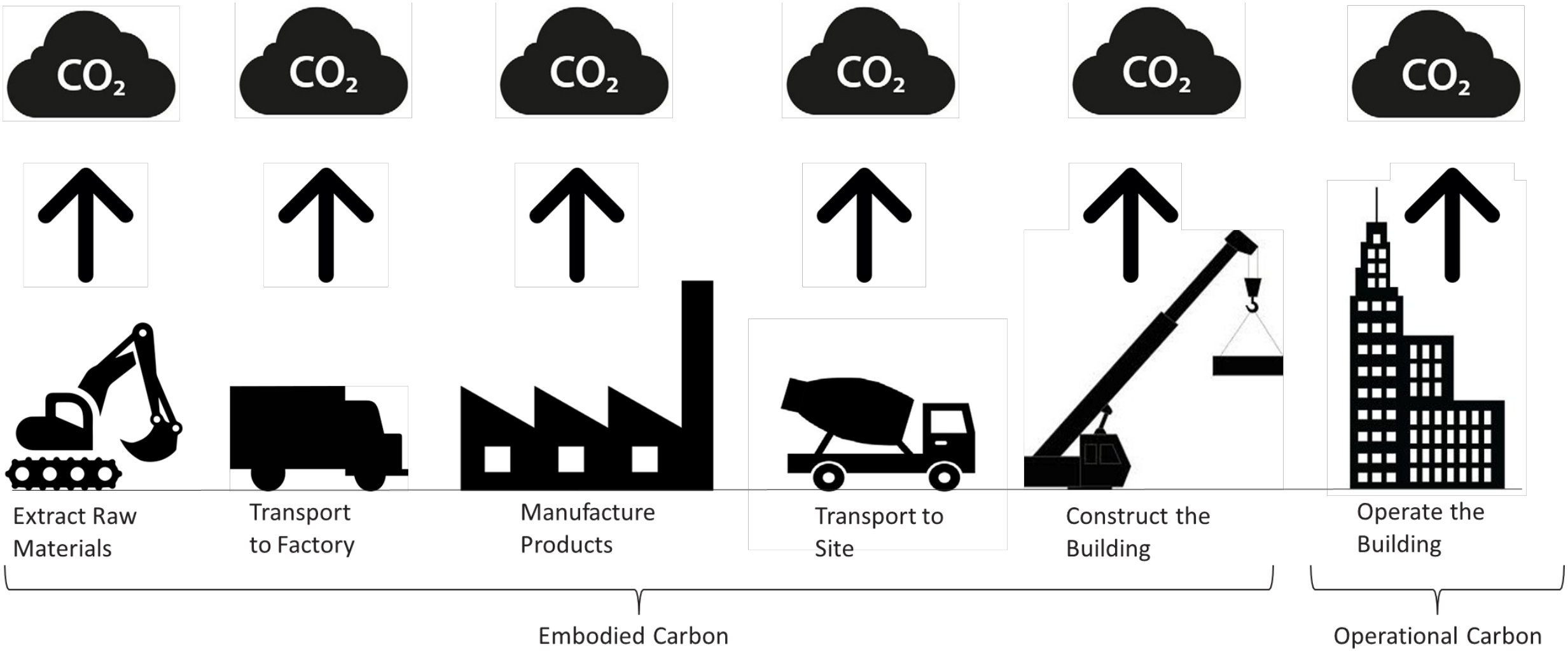
Break

1. Design process: Passive strategies, Active strategies, Renewables, cost strategies, district scale strategies
2. Operating process: Owner-driven decisions, post-occupancy cx

Net Zero Energy – Why?



Embodied vs. Operational Carbon



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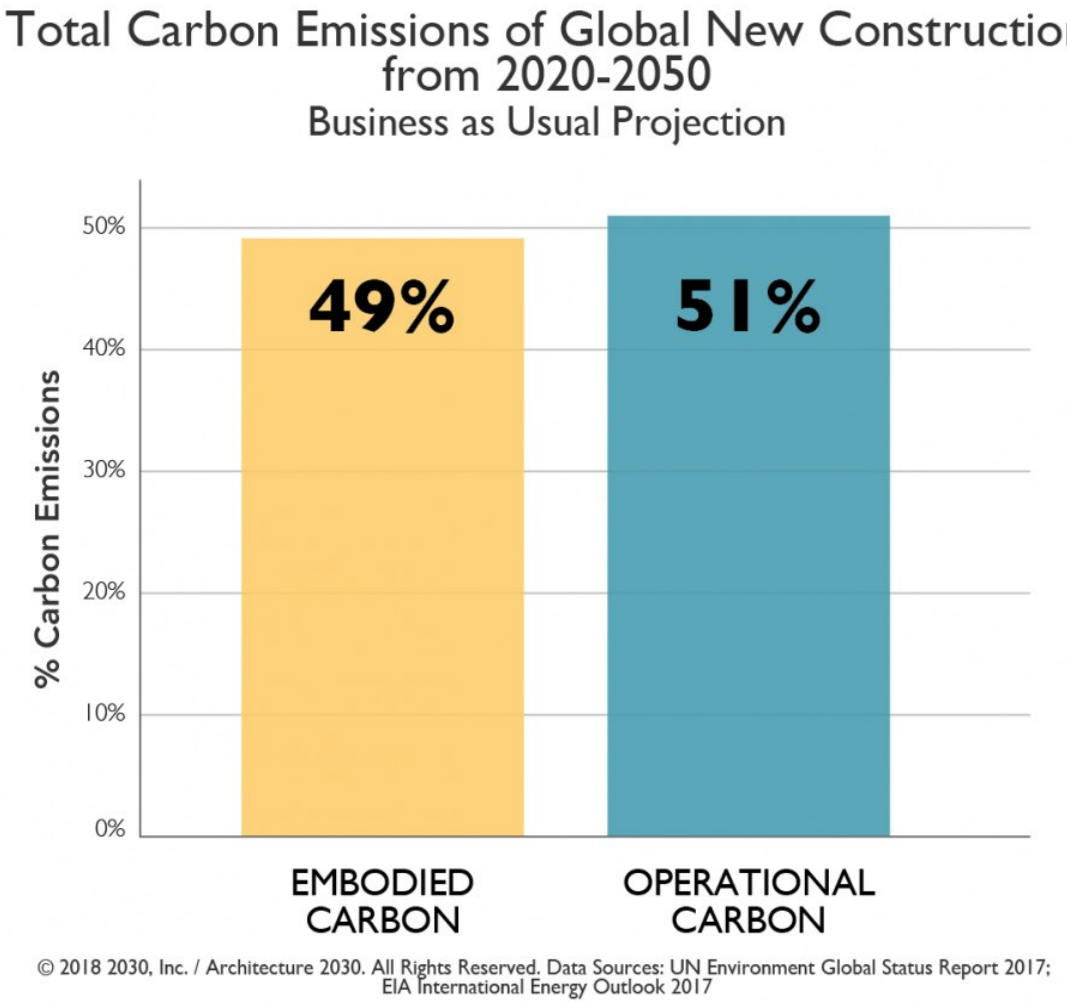

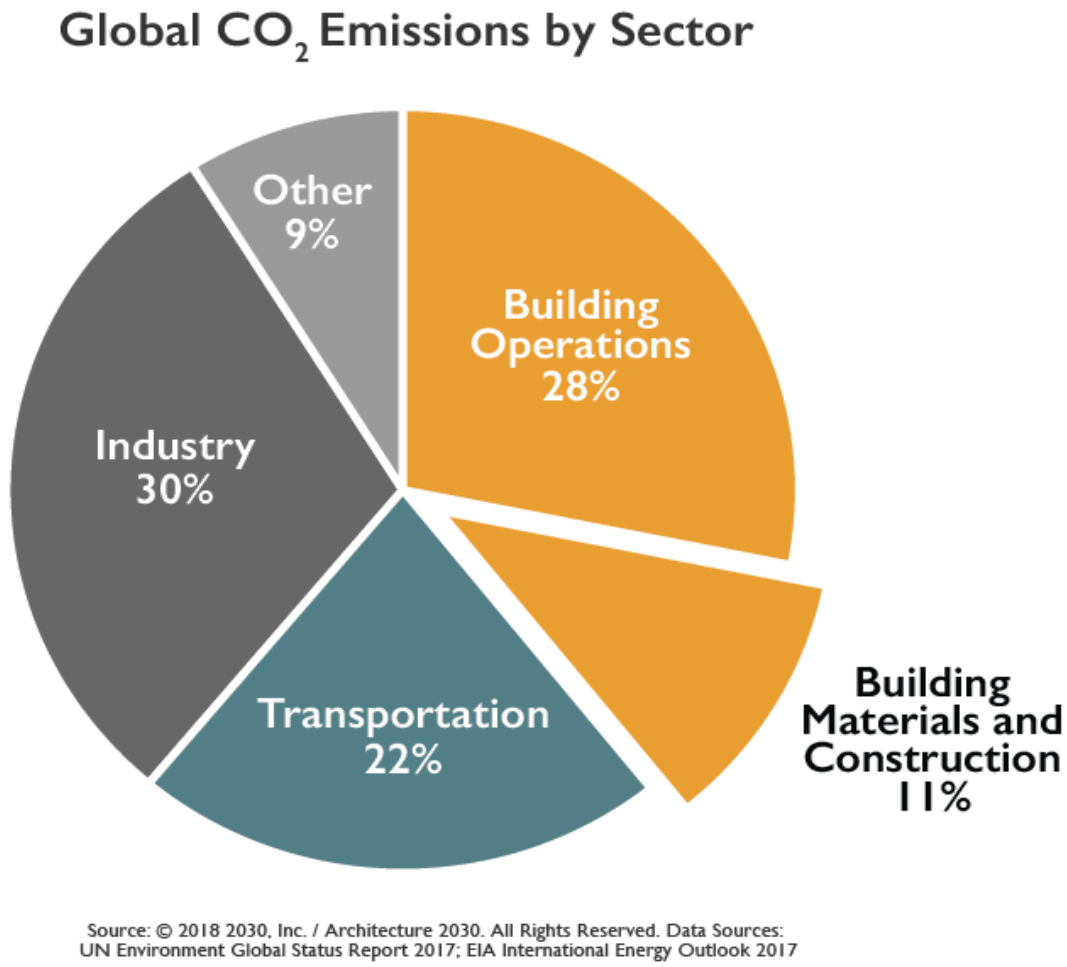

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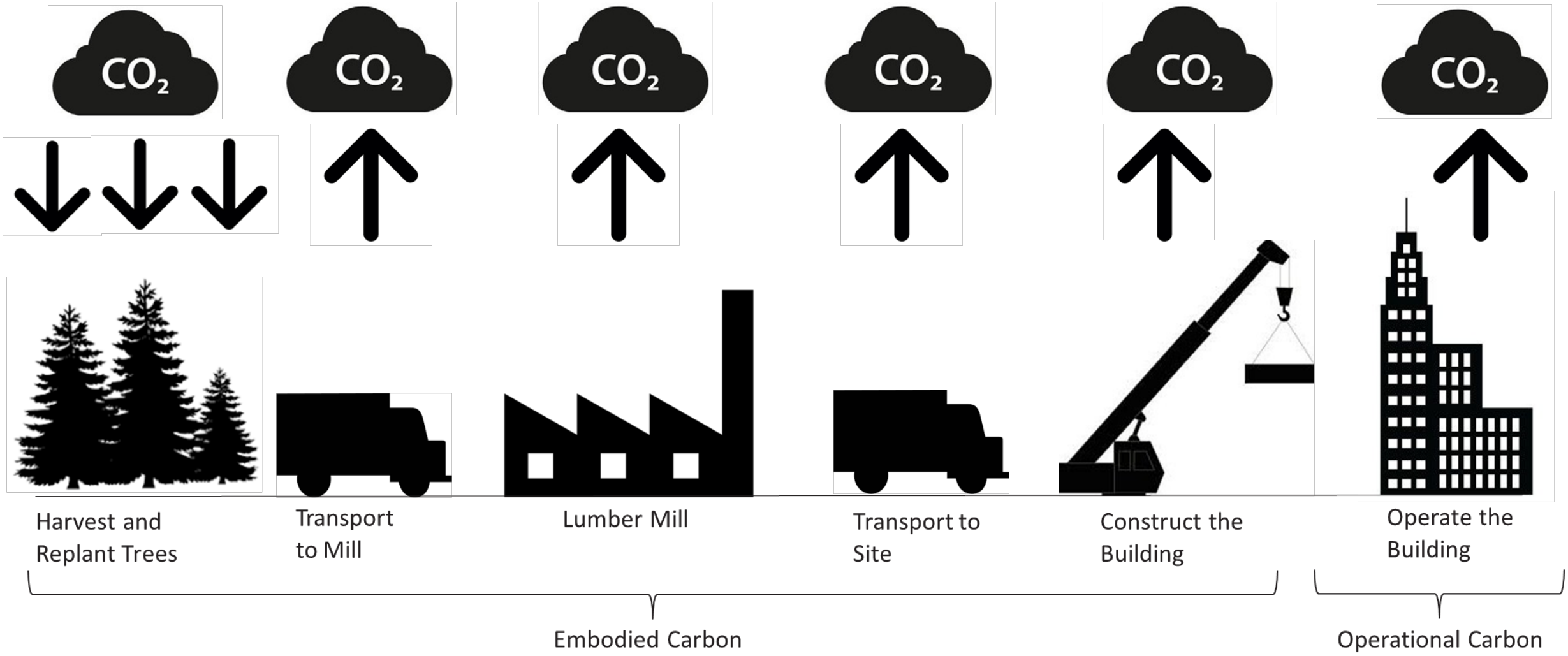

Net Zero Energy – Definitions

Net Zero Site Energy

A site zero energy building produces at least as much energy as it uses in a year, when accounted for at the site. The measurement time frame is annual.

Net Zero Source Energy

A source zero energy building produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy required to generate and deliver the energy to the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.

Net Zero Energy Costs

In a net zero energy costs building, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.

Net Zero Energy Emissions

A net zero energy emissions building produces at least as much emissions-free renewable energy as it uses from emission-producing energy sources annually. Carbon, NOx, and SOx are common emissions that ZEBs offset.

Near Zero Energy

A near zero energy building produces at least 75% of its required energy through the use of on-site renewable energy. Off-grid buildings that use some non-renewable energy generation for backup are considered near zero energy buildings because they typically cannot export excess renewable generation to account for fossil fuel energy use.

Source: National Renewable Energy Lab

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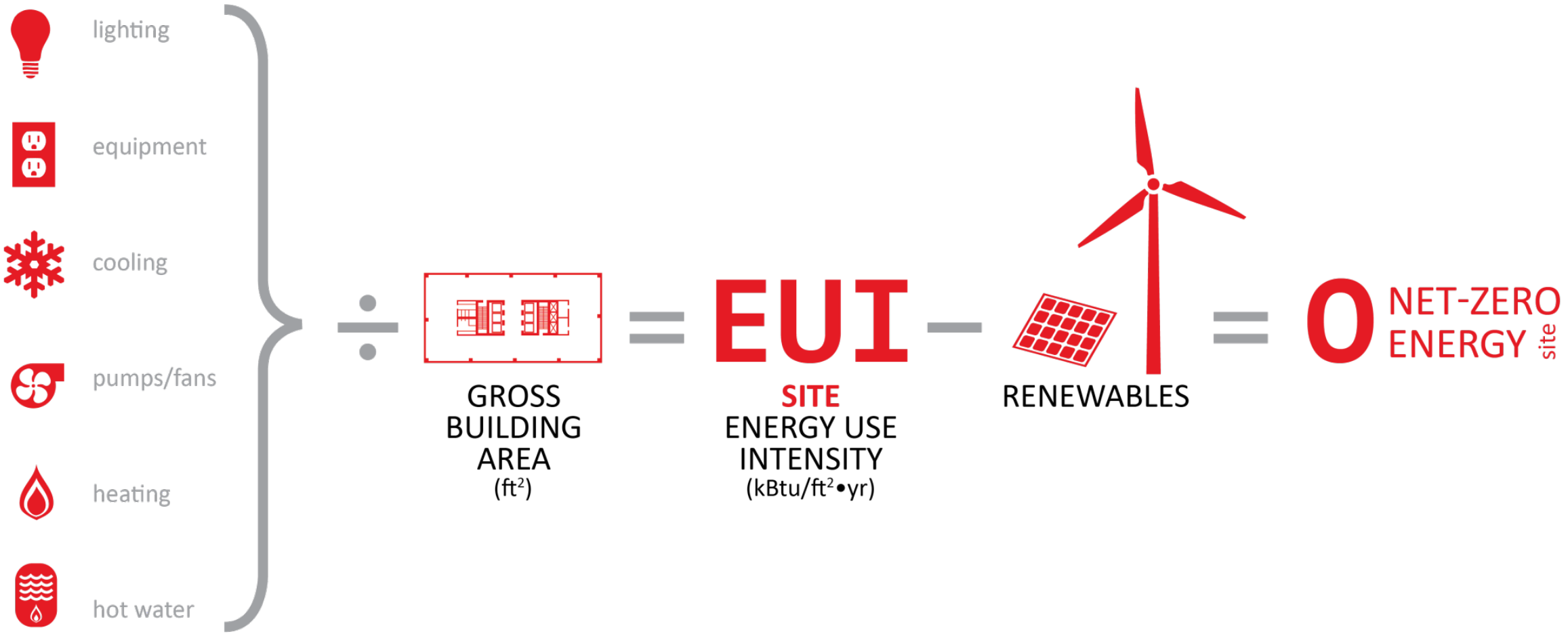
Source: National Renewable Energy Lab

Net Zero Energy – ILFI Certification

100% of the building's energy needs on a net annual basis must be supplied by on-site renewable energy (with some exceptions).

No combustion is allowed.

Net Zero Energy



Net Zero Energy – Other Certifications

LEED ZERO CARBON

Offset carbon created by building operations, transportation, potable water usage, waste removal. Embodied carbon is optional. Onsite or offset renewables can be used, as can carbon offsets.

LEED ZERO ENERGY

Offset energy consumed by building over 12 months. Source energy must be offset, not site energy. Onsite or offset renewables can be used, but carbon offsets are not recognized.

ILFI ZERO CARBON

Offset 100% of operational carbon through on-site or off-site renewables as well as 100% of embodied energy through offsets.

Code Impacts

Clean Energy DC Omnibus Act of 2018

By 2032, phase in a 100% renewable energy portfolio and cut greenhouse emissions in half.
By 2045, city's public transportation and fleet vehicles will be switched over to electric.
By 2050, the district will be carbon neutral.

Existing buildings 10,000sf or larger must participate in building performance benchmarking program (the previous threshold was 50,000sf or larger).
Data will be used to establish a Building Energy Performance Standard (BEPS) for each building type (similar to Energy Star score).
Buildings 10,000sf or larger will need to be equal to or better than the BEPS for that building type.
Building that do not meet this will be required to make improvements, such as improving the building's energy performance by 20%, or they will be fined.

Green financing options are also being implemented in DC (such as the $40 million DC Green Bank) to provide loans and financing for these improvements.

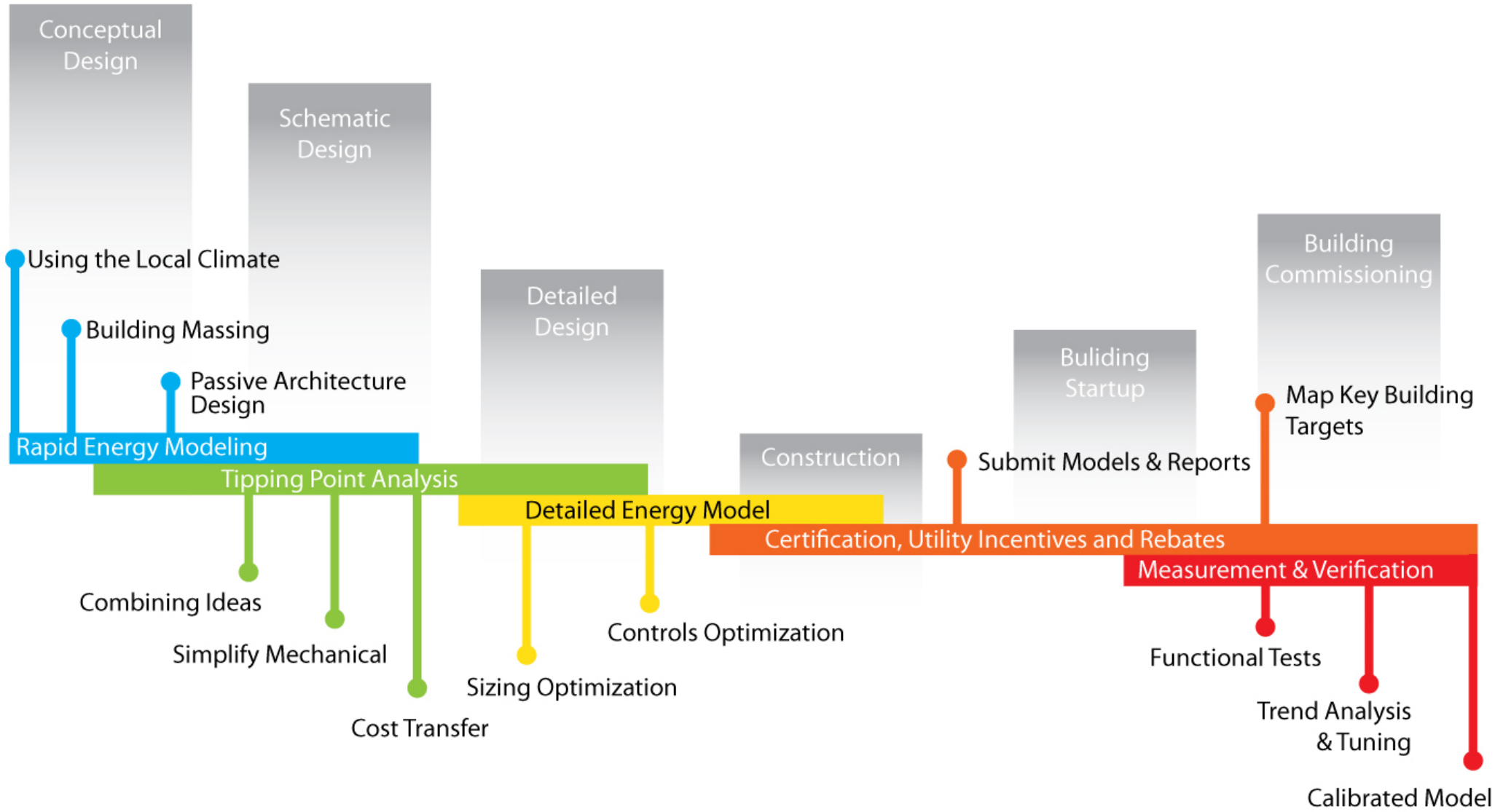
DC Energy Code Appendix Z

An optional code-compliance path for net zero energy buildings. This also provides a framework for phasing this in as a requirement for certain buildings in the future.

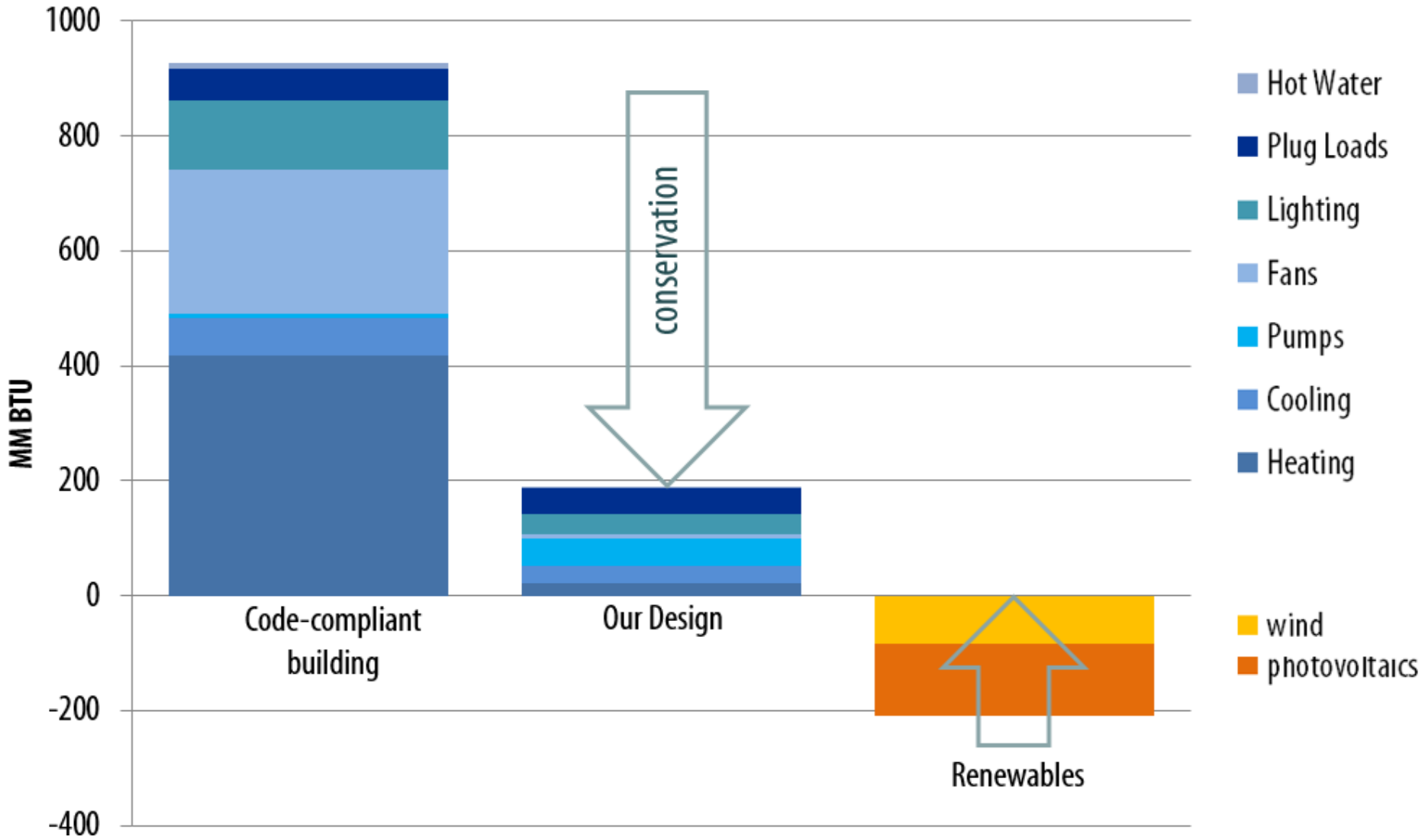
Code Impacts - Alexandria

Break Time!

Design Process



Design Process



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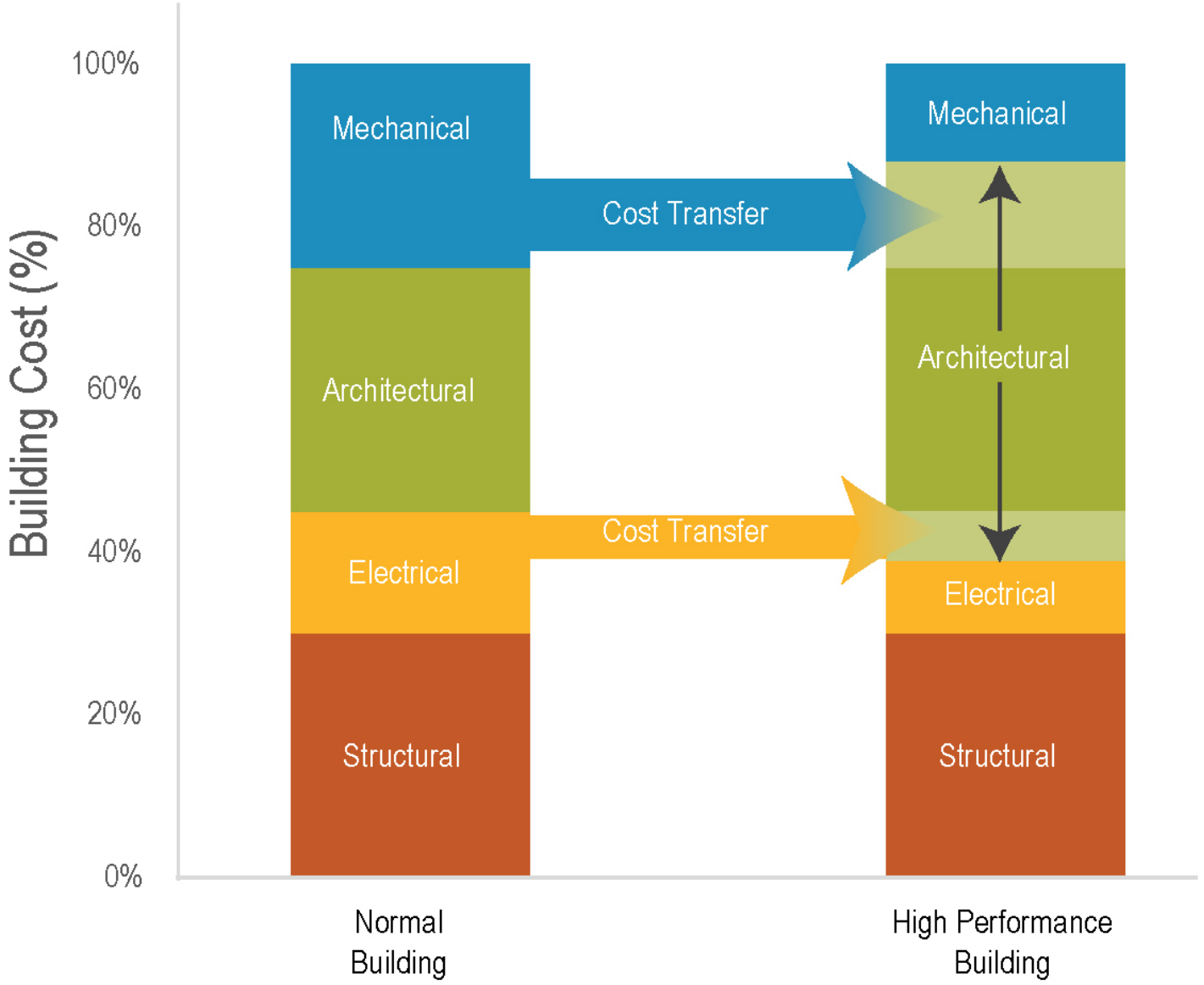
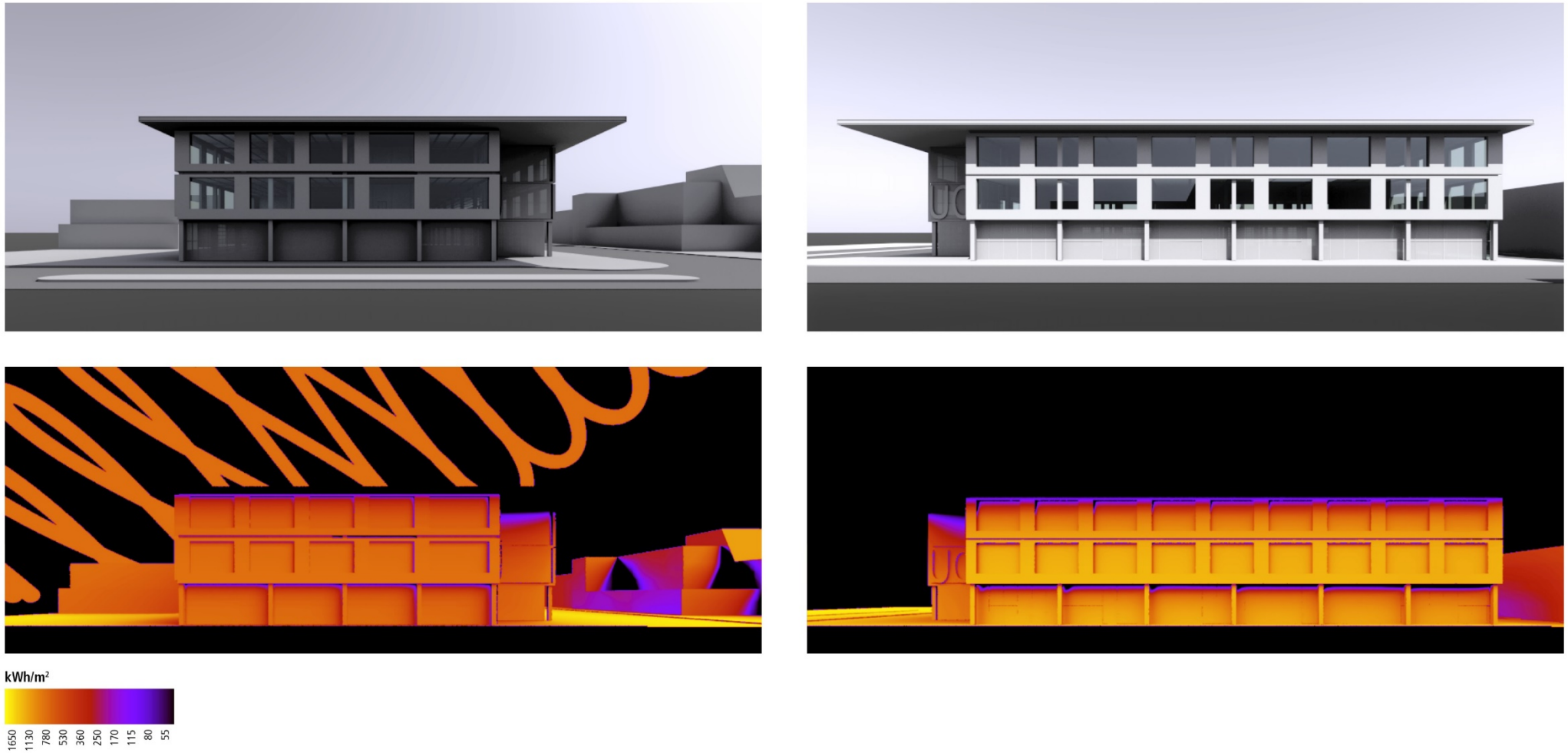


Passive Strategies

Passive Strategies – Façade Study without Shade Structure

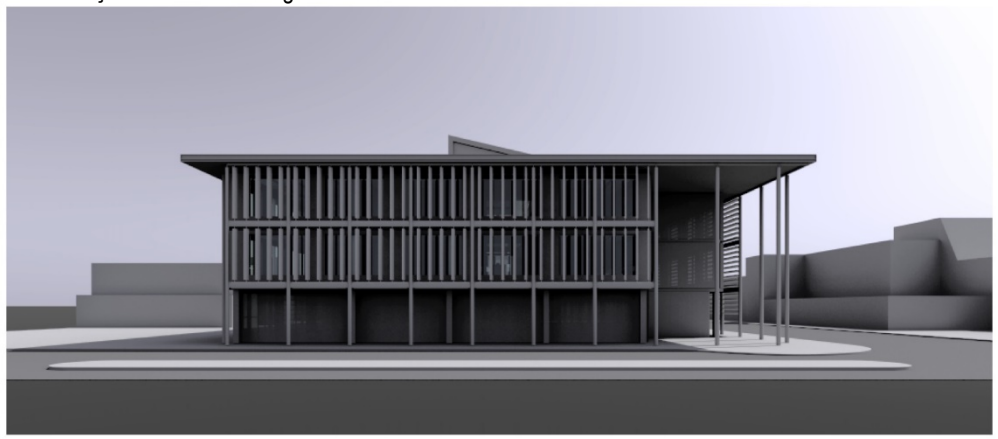
Cumulative Direct Solar Radiation Falling on Building Skin



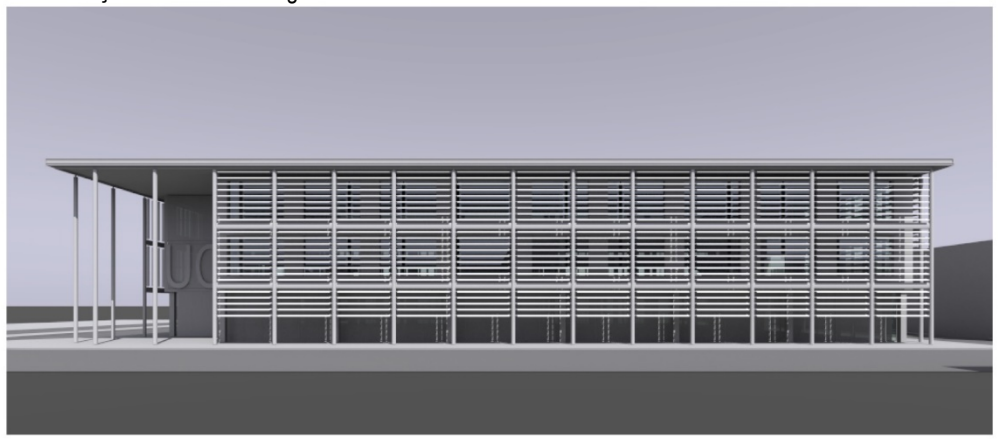
Passive Strategies – Façade Study with Shade Structure

Cumulative Direct Solar Radiation Falling on Building Skin

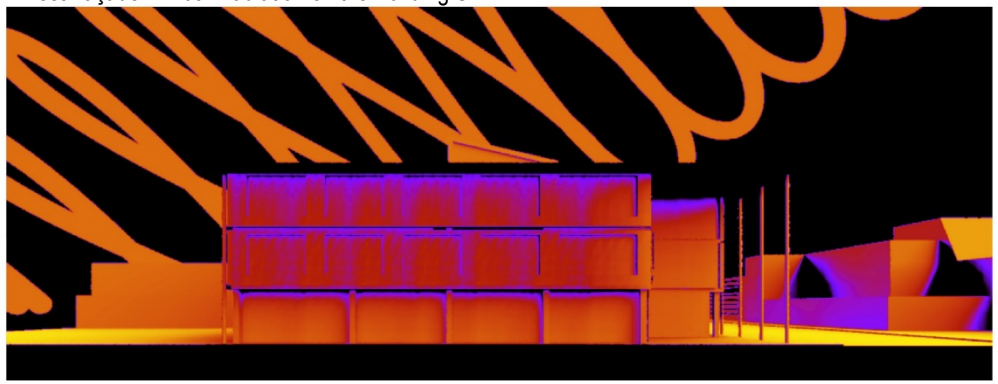
West Façade Reference Image



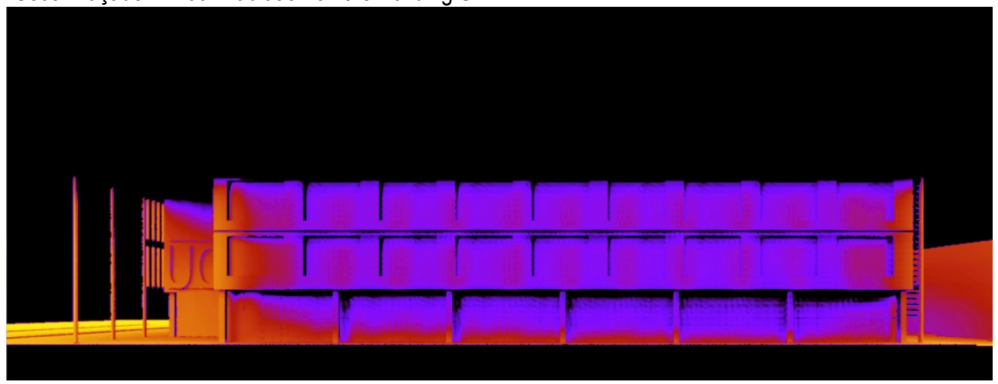
South Façade Reference Image

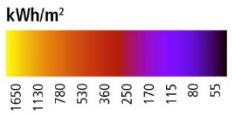


West Façade Annual Radiation on the Building Skin



South Façade Annual Radiation on the Building Skin

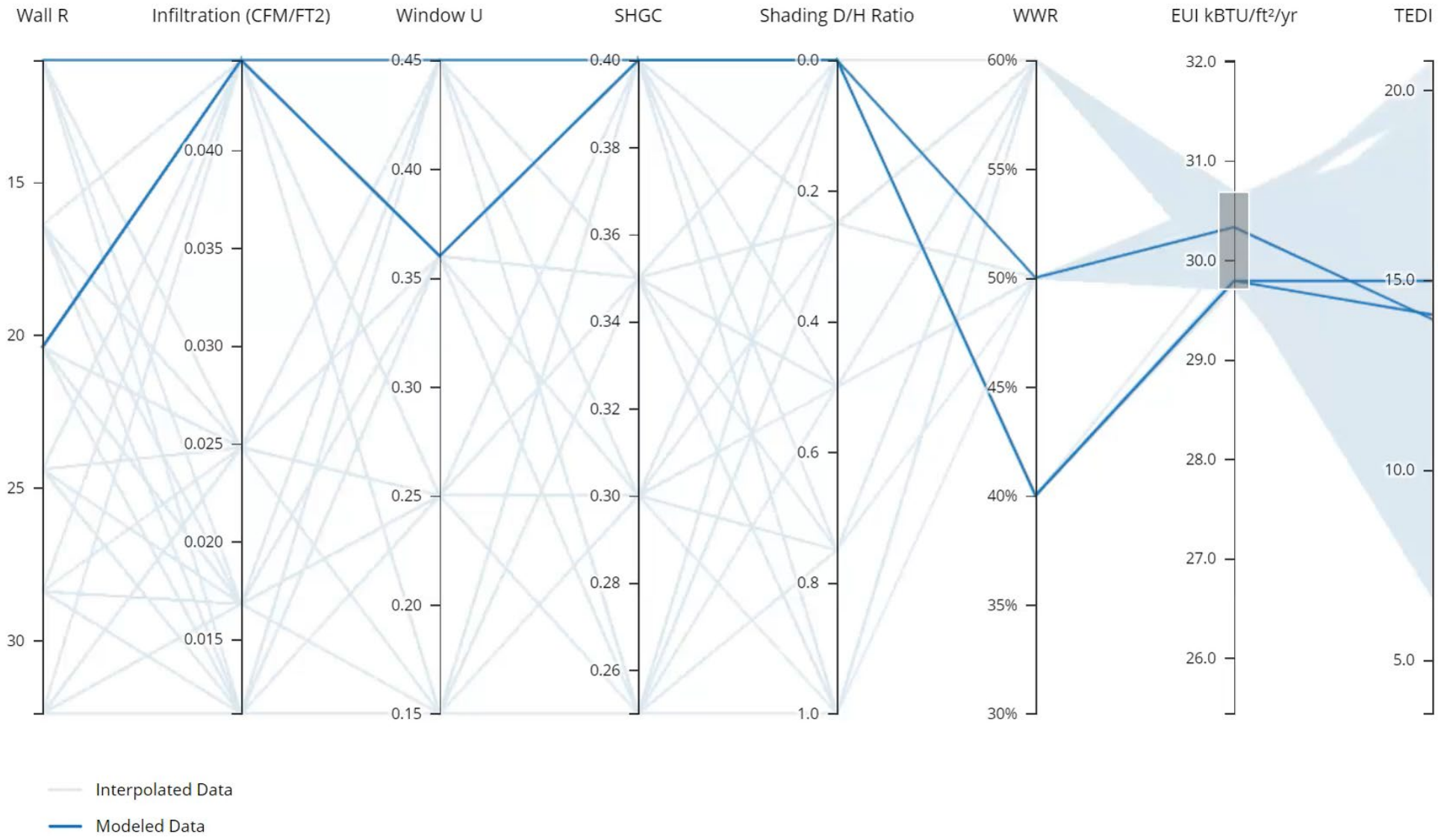




~ 65% Reduction in Solar Radiation Striking the West Glass

~ 90 % Reduction in Solar Radiation Striking the South Glass

Passive Strategies – Parametric Analysis



Passive Strategies

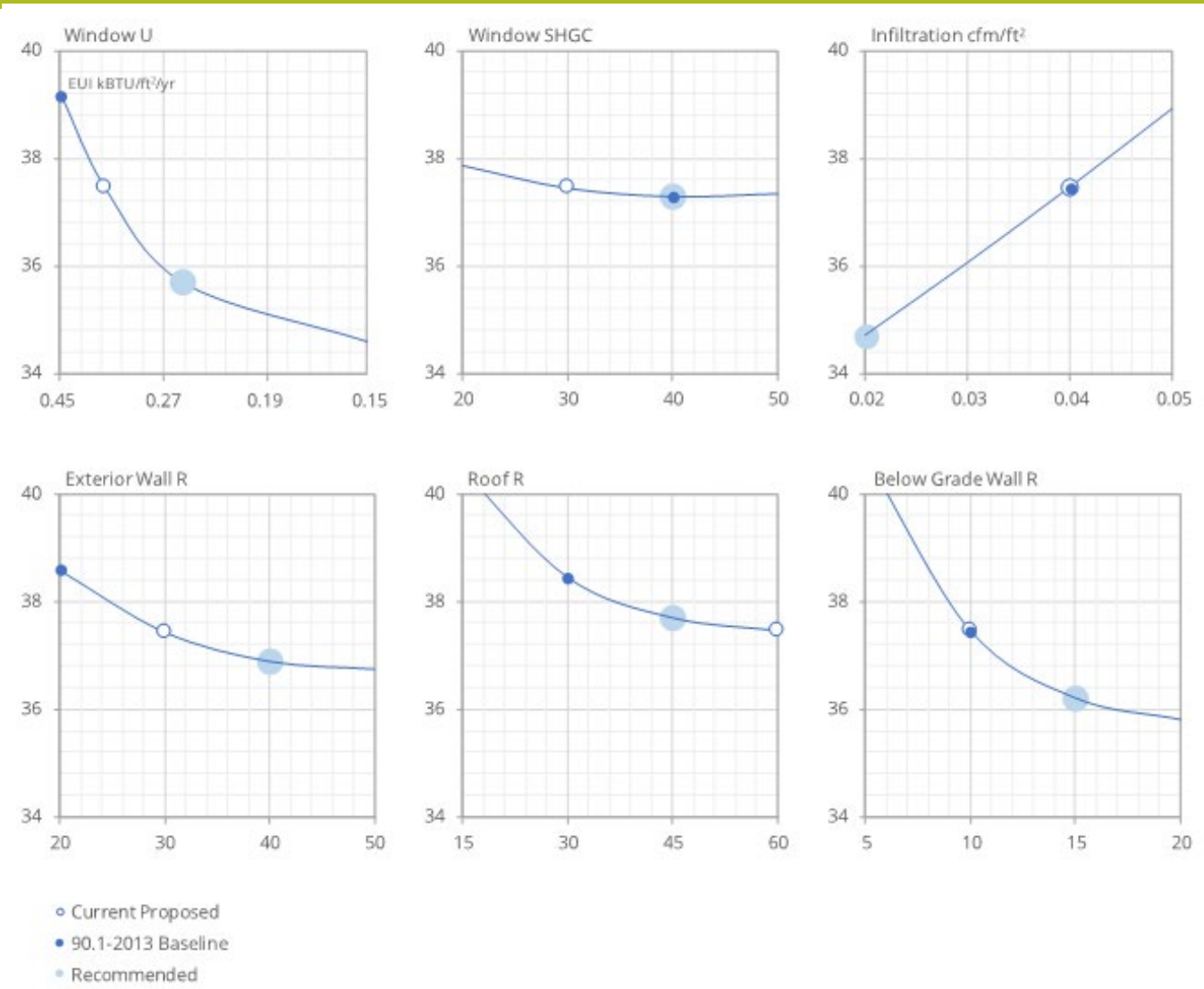
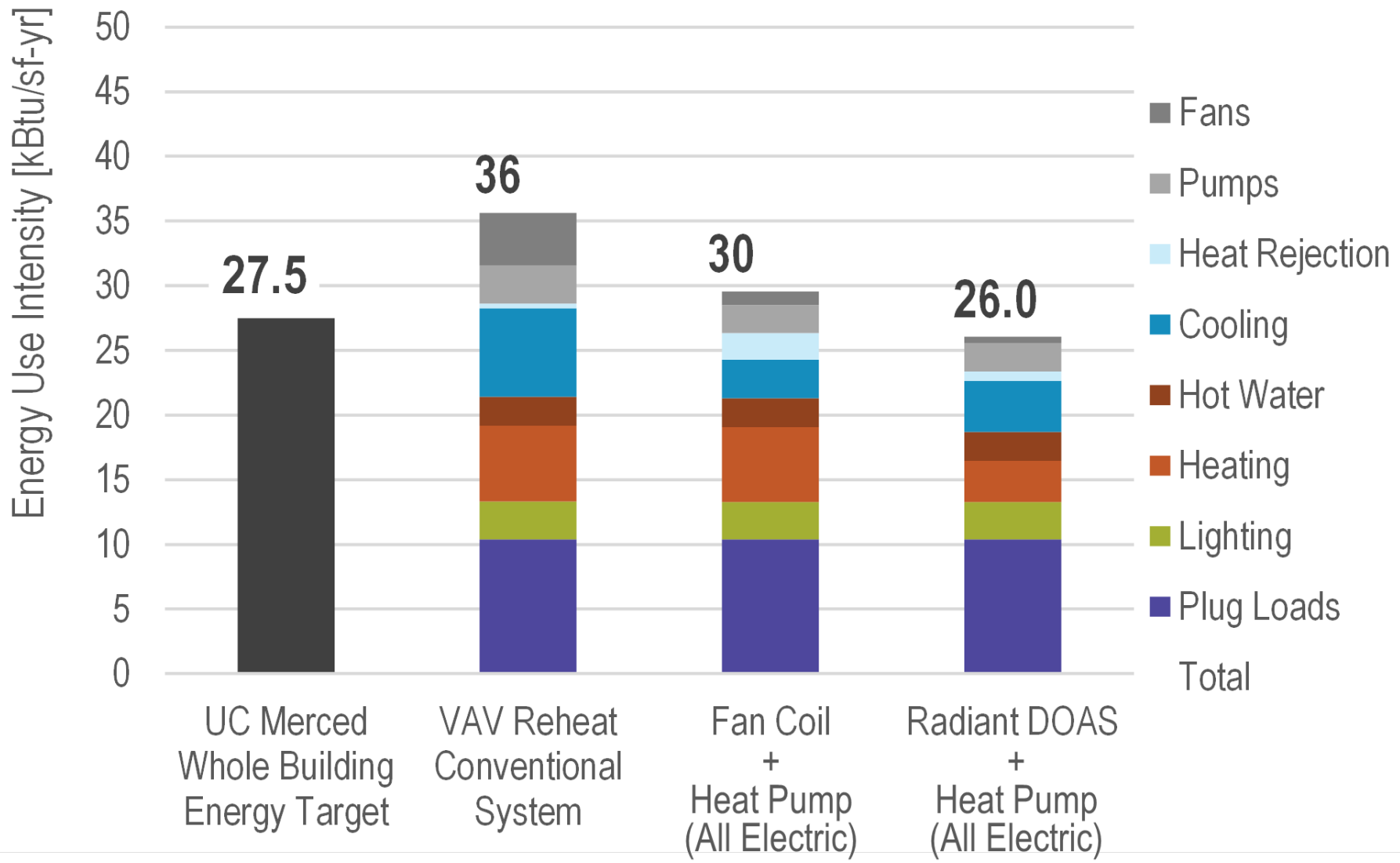
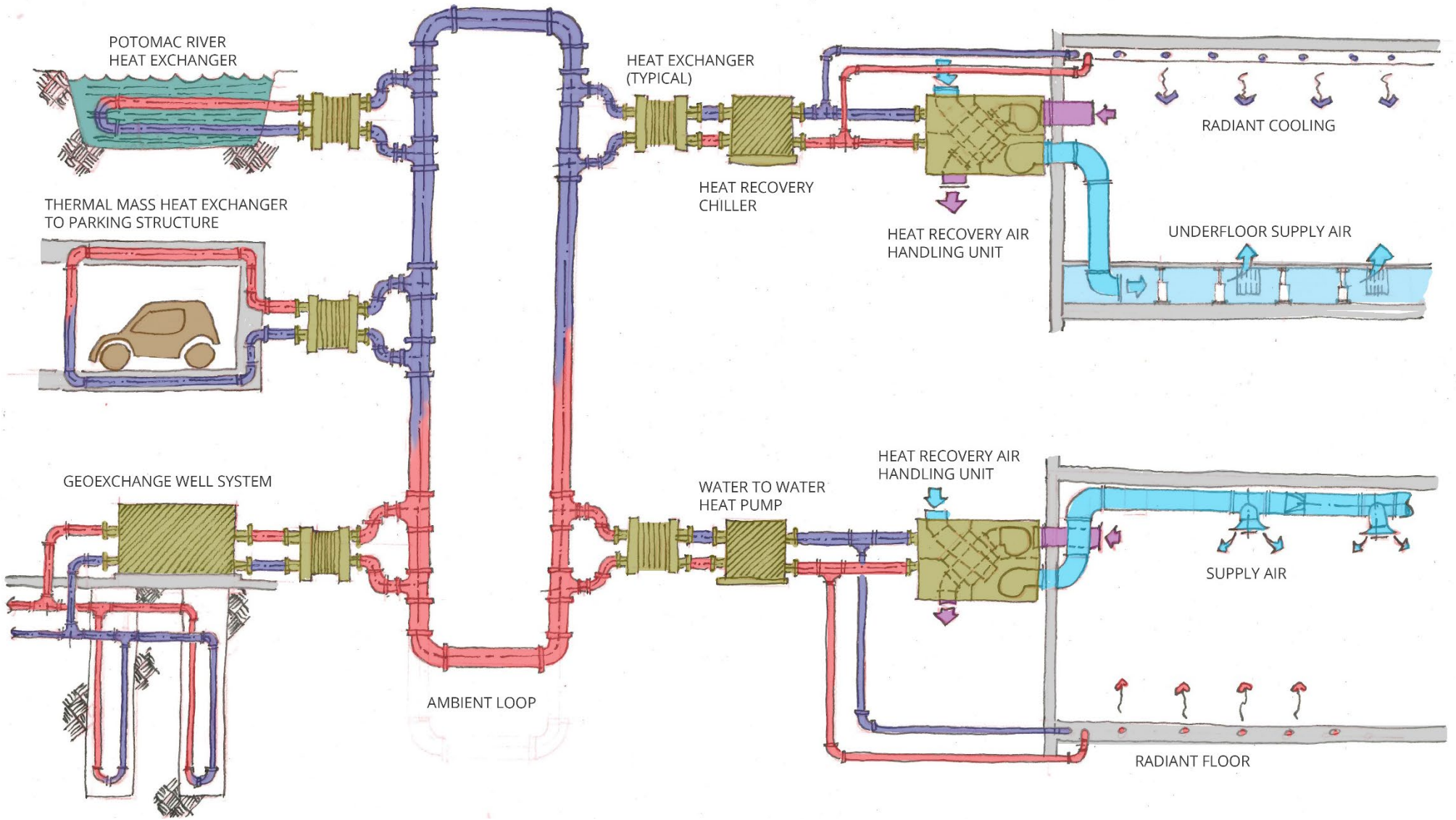


Figure 3: Sensitivity of studied envelope characteristics on building energy use intensity.

Active Strategies – HVAC System Analysis

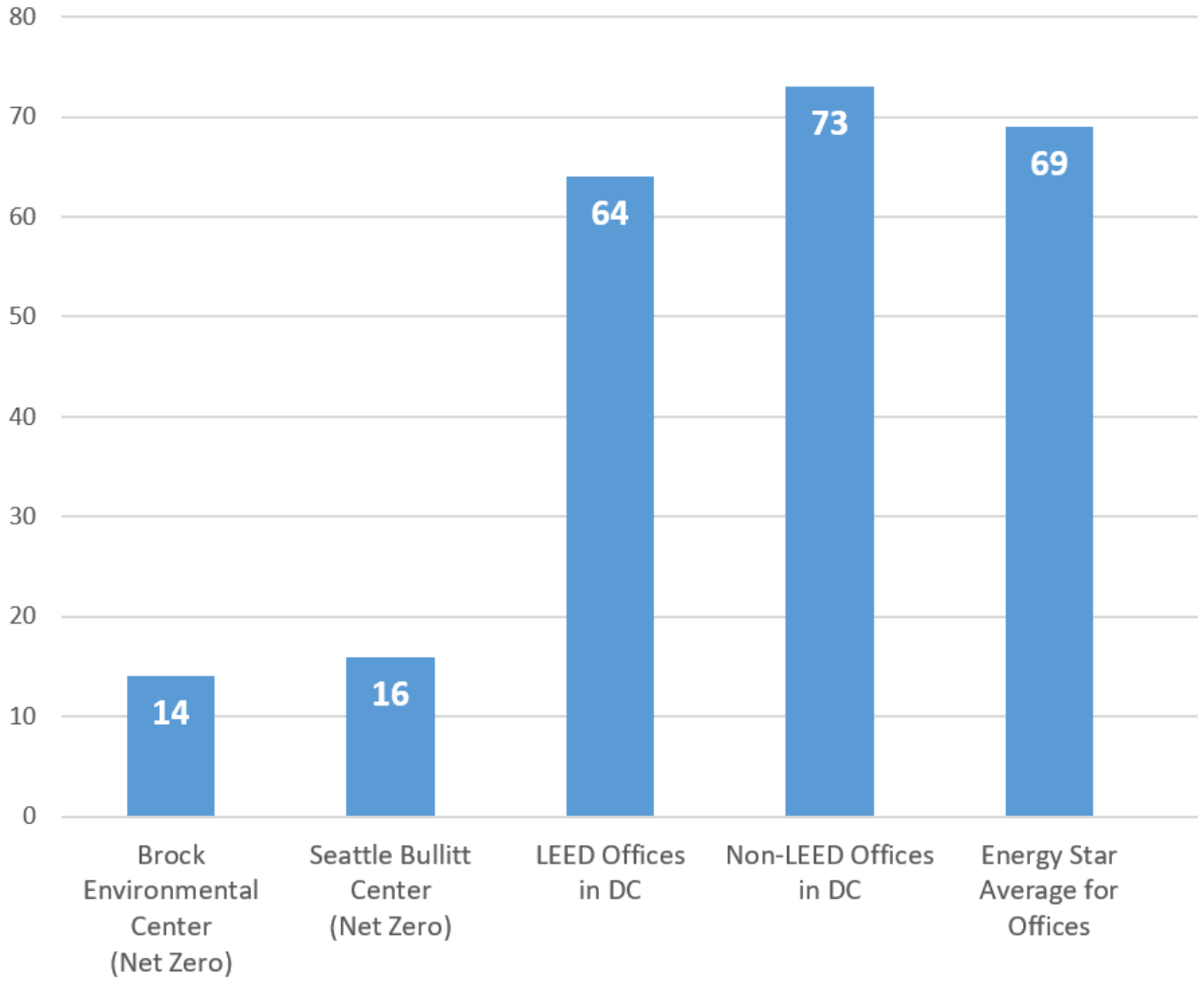


District Scale Systems



Renewable Power

EUI Benchmarking



EUI Benchmarking

Benchmarking Net Zero Projects in Region

Project	Location	Building Type	Size	Site EUI
Putney Field House	Putney, VT	Education	16,800	9.7
Hudson Valley Clean Energy HQ	Rhinebeck, NY	Other	5,470	9.8
Omega Center for Sustainable Living	Rhinebeck, NY	Other	6,200	13.2
Coastal Main Botanical Gardens Bosarge Family Education Center	Boothbay, ME	Education	8,200	19.2
Willow School	Gladstone, NY	Education	20,000	21.8
Maclay Architects' Office	Wattsfield, NY	Office	2,568	22.1
231 Main Street	New Paltz, NY	Office	5,400	45.2

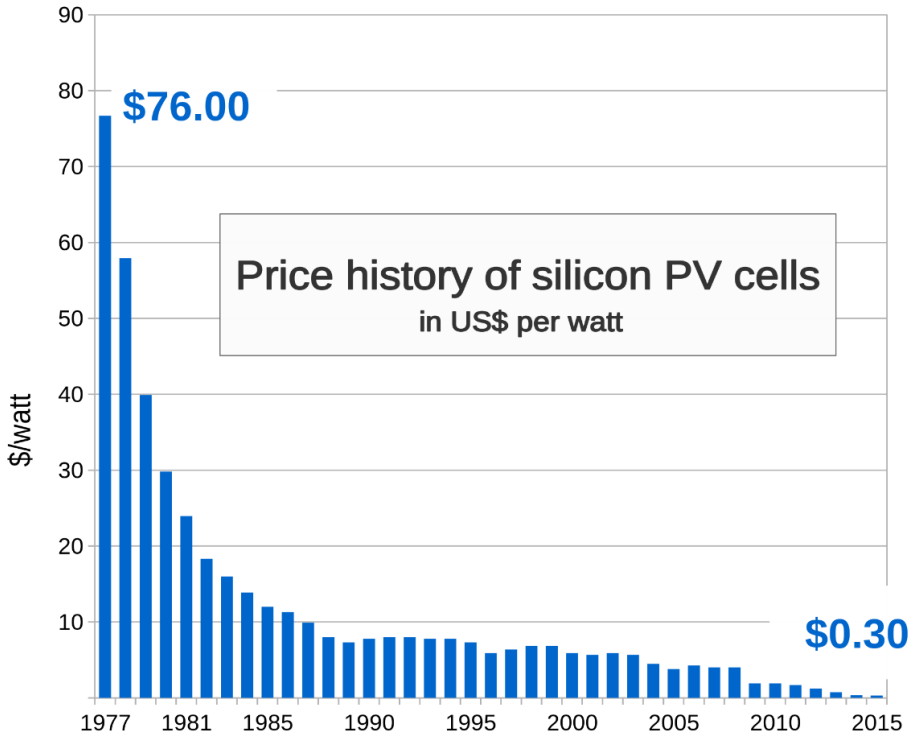
EUI Benchmarking

Comparison of Building EUI vs. Roof Area Required

Building Area (sf):	21,260
Roof Area (sf):	9,036
Max PV size (kw):	120
Tilt	15deg
Annual output kwh	154,603
Equivalent kbtu	527,527
Max EUI for Roof Area	25

Site EUI	Roof Area Req'd (sf)	kW of PV Req'd
10	3642	48
15	5462	73
25	9104	121
30	10925	145

Renewable Power



Source: Bloomberg New Energy Finance & pv.energytrend.com

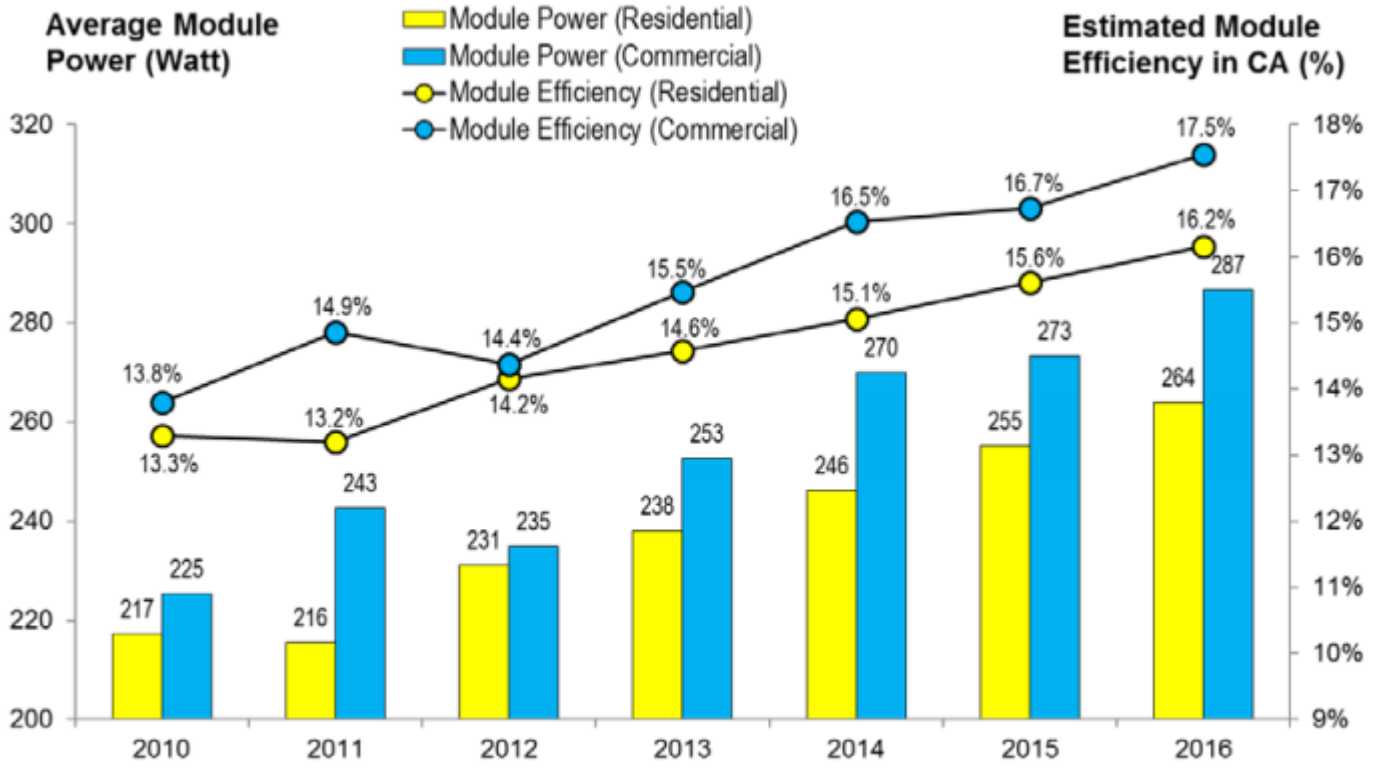


Figure 3. Module power and efficiency trends from the California NEM database (Go Solar CA 2017), 2010–2016

Renewable Power

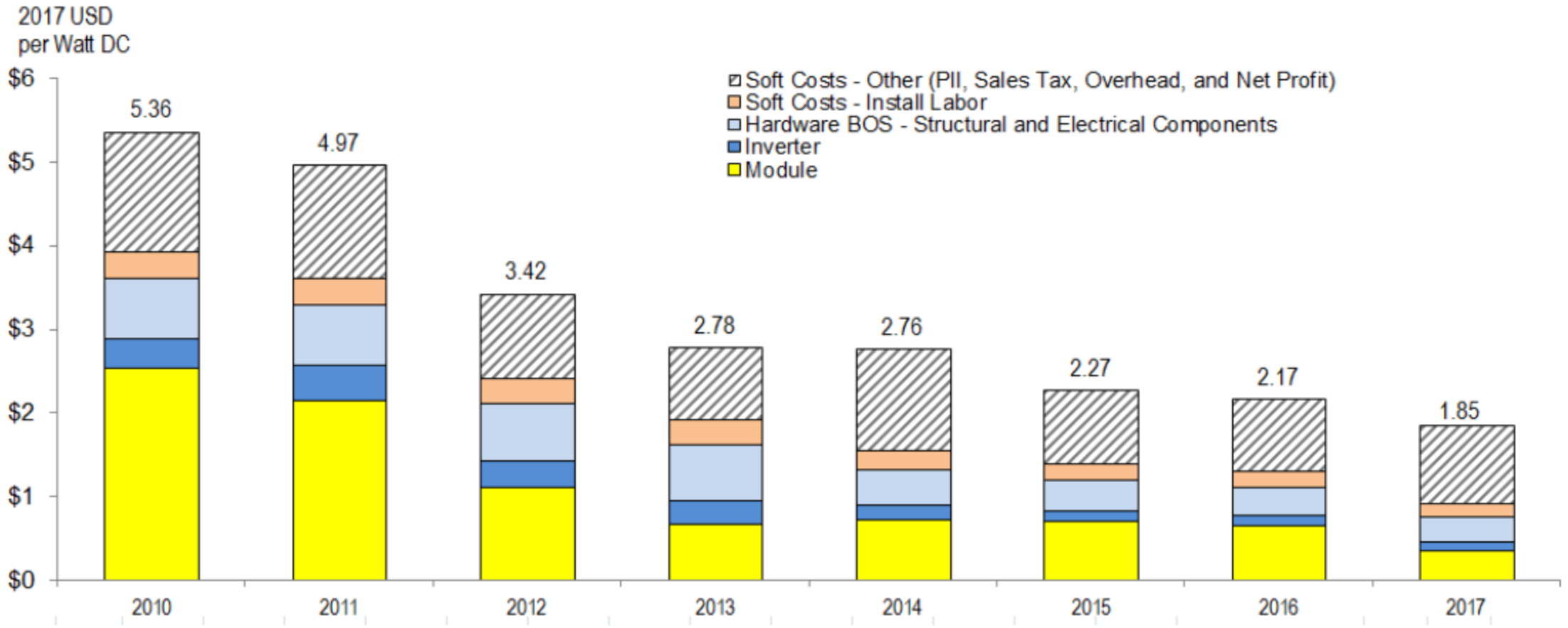


Figure 22. NREL commercial PV system cost benchmark summary (inflation adjusted), Q4 2009–Q1 2017

Maximizing Photovoltaics

Maximizing Photovoltaics

Offsite Renewables Exception

- Tenant improvement projects where there is no ownership interest by the project owner or developer in the core building HVAC systems, and/or the building envelope or grounds

- Projects which even after the highest level of efficiency is attained are unable to offset their energy use onsite due to project density/height or inherently very high baseline EUI's (such as a hospital or data center)

- Projects that are not able to provide onsite renewables due to substantial limitations of the local grid to absorb the generated energy, or jurisdiction-related limitations (such as military restrictions on wind turbine placement)

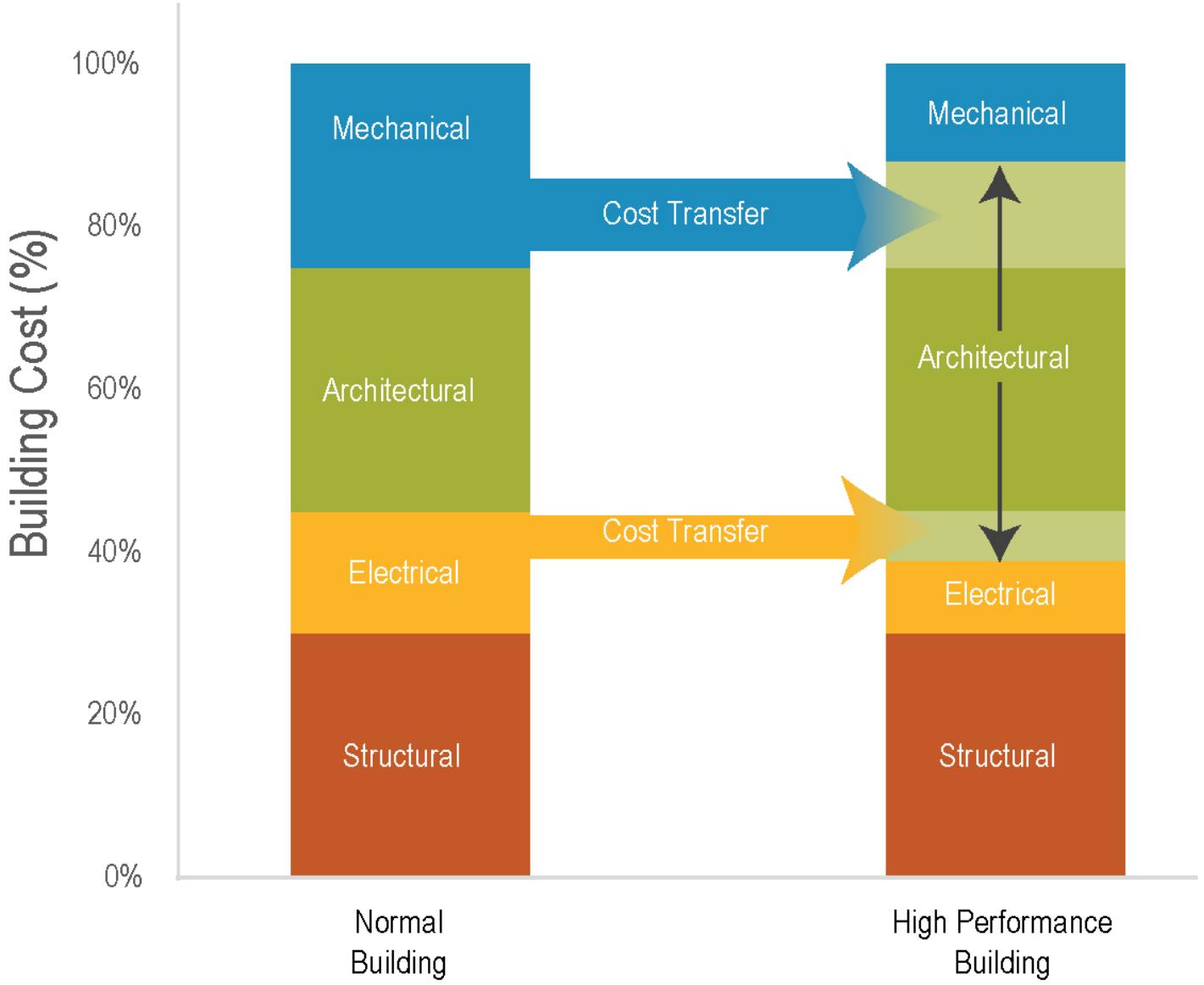
Offsite Renewables Exception

- The offsite renewables must be located in the same regional grid as the project.

- Sensitive siting criteria consistent with ILFI's Limits to Growth imperative is required for the offsite renewable energy generation facilities.

- Legal assignment is required for ownership of the offsite renewables' energy output using a standard agreement such as a Power Purchase Agreement (PPA), with a minimum required term length of 15 years. Tenant Improvement projects may align the PPA term length with the length of their building lease.

Cost Strategies



Net Zero Energy

Peter Morris, MRICS

Lisa Matthiessen, FAIA

Laura Lesniewski, AIA

Davis Langdon
An AECOM Company

2011 AIA NATIONAL ARCHITECTURE FIRM AWARD
BNIM

Net Zero Energy

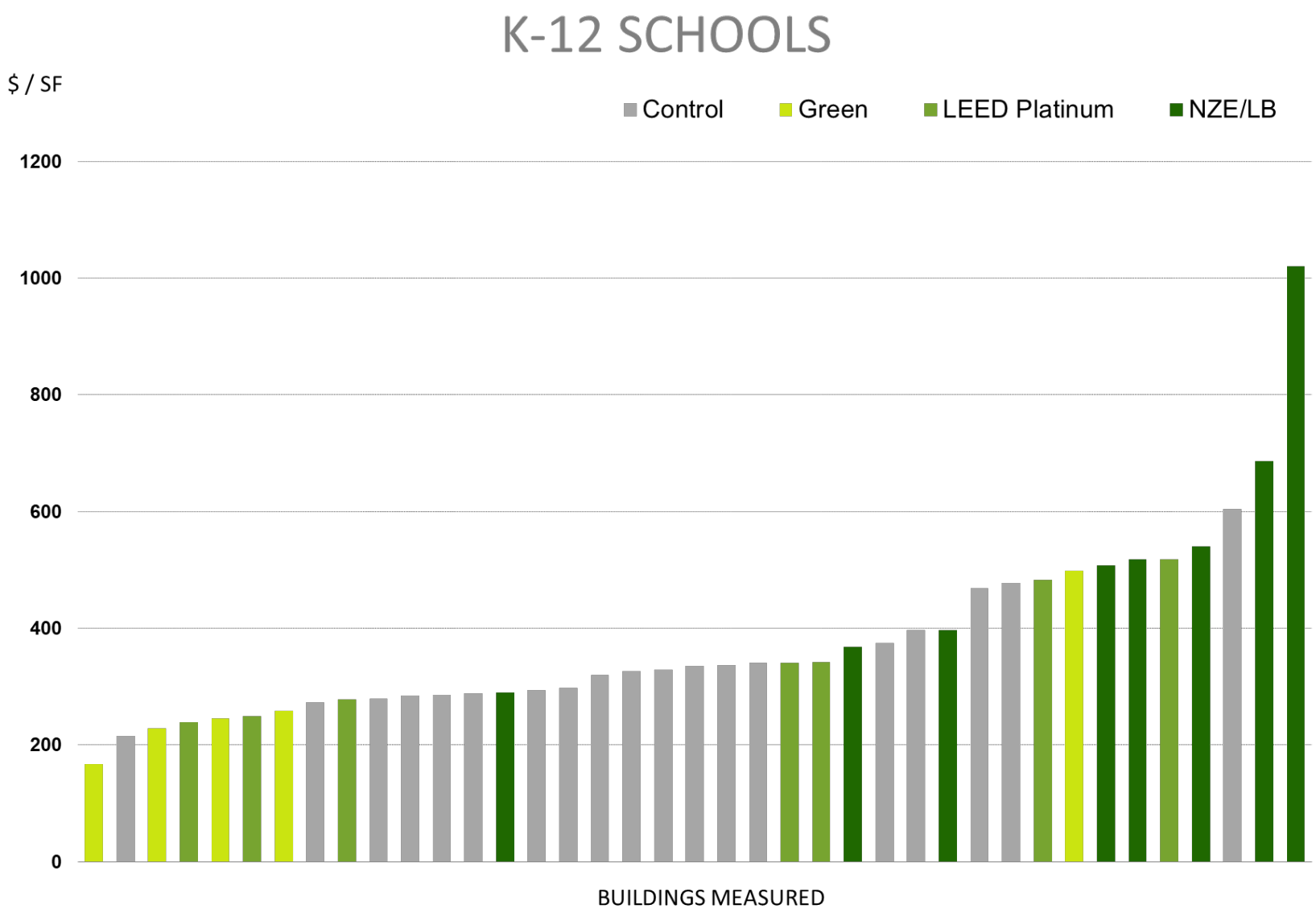
statistical analysis

- community centers (learning/visitor)
- k-12 schools
- office buildings – low-rise
- wet labs

88

high-performance buildings

Net Zero Energy



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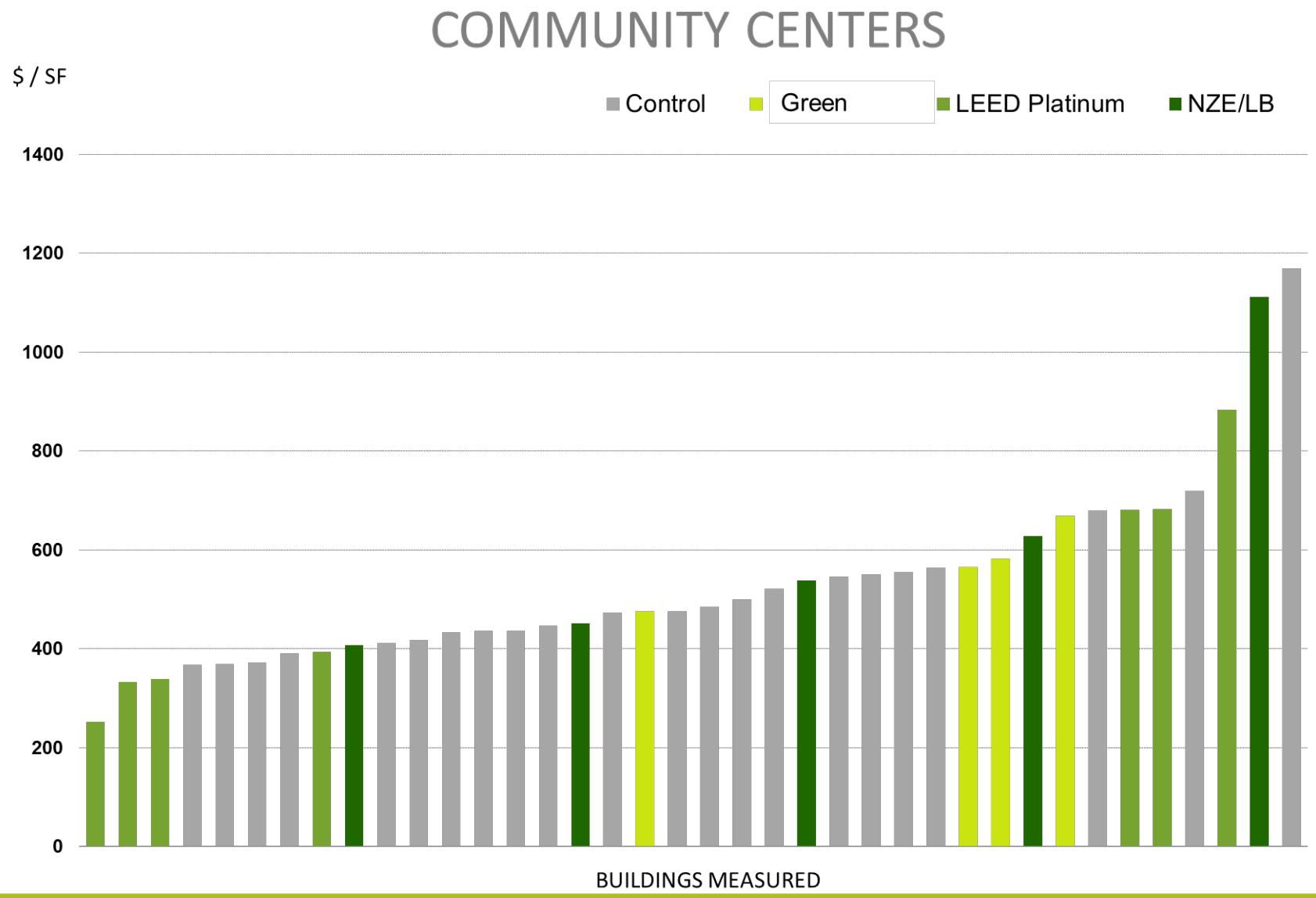

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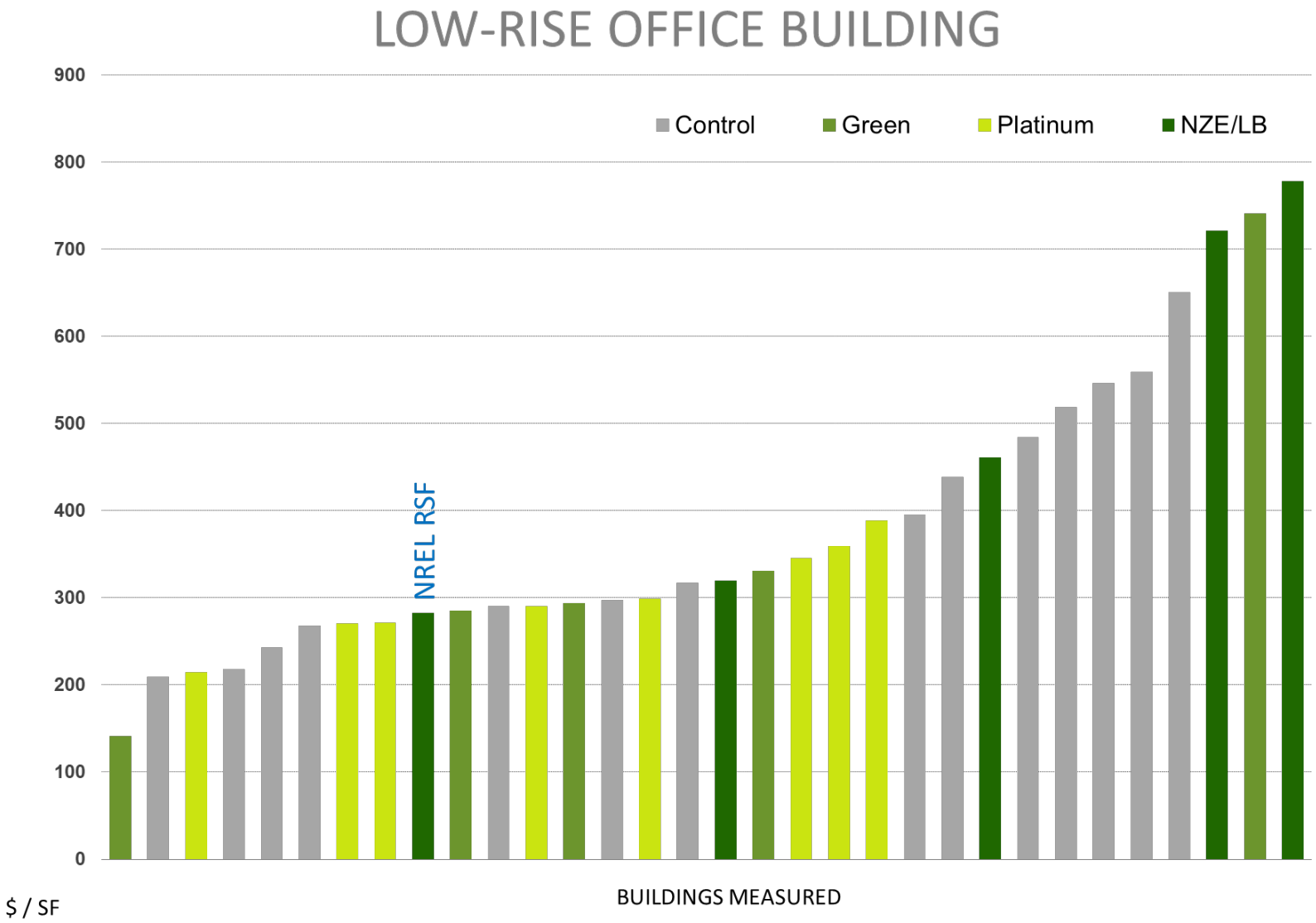
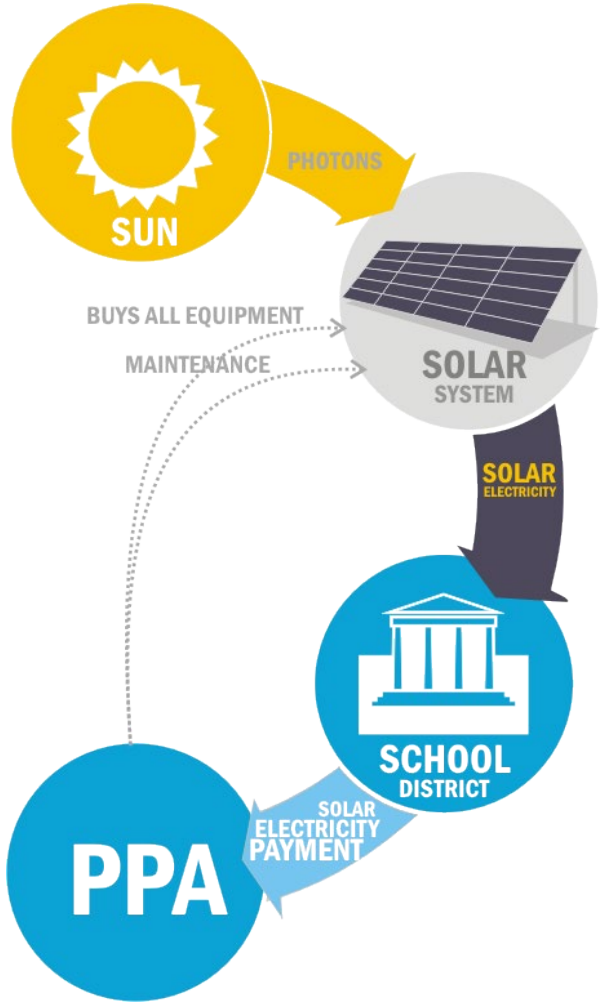


Financing Options – Power Purchase Agreements (PPA)



Benefits

- No or low upfront costs
- Predictable and possibly reduced energy costs
- Limited risk to building owner

Considerations

- PV system owner/developer owns right to sell SRECs
- Long term owners who are not tax exempt may want to purchase PV themselves and get tax and payback benefits
- Some additional building costs may be required, such as structural upgrades

Financing Options – Outright Ownership

Benefits

- Owner receives any tax rebates
- Once payback is achieved, “free” power

Considerations

- Requires more initial investment
- Owner responsible for maintenance
- Payback varies widely based on tax rebates, but currently is about 10 years

Financing Options – Selling SRECs (Solar Renewable Energy Credits)

1 SREC = 1 Mwh of generated electricity

Washington DC

- $370/SREC

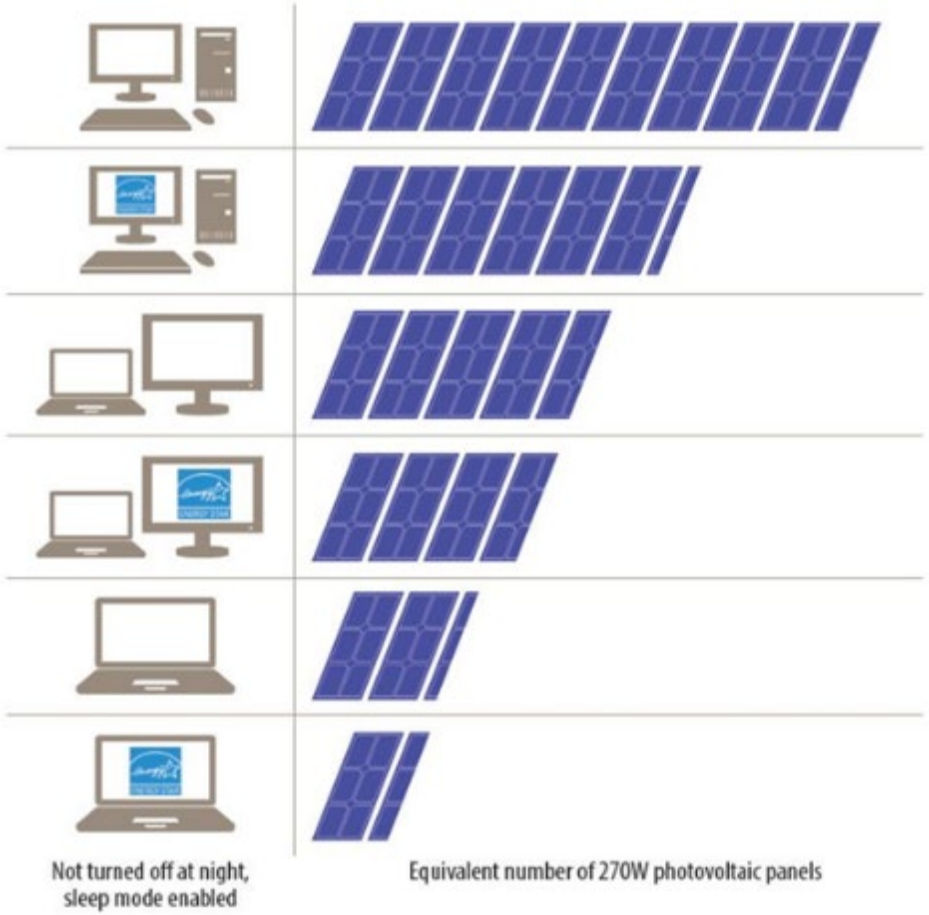
Virginia

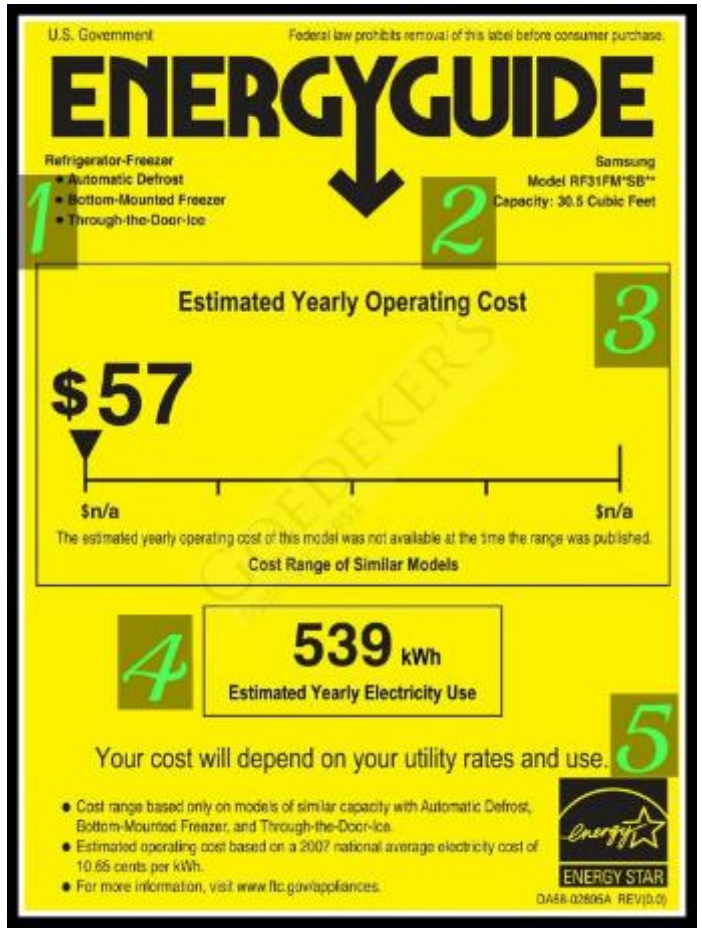
- $0/SREC
- No mandatory renewable portfolio standard

Maryland

- $8/SREC

Owner-Driven Decisions



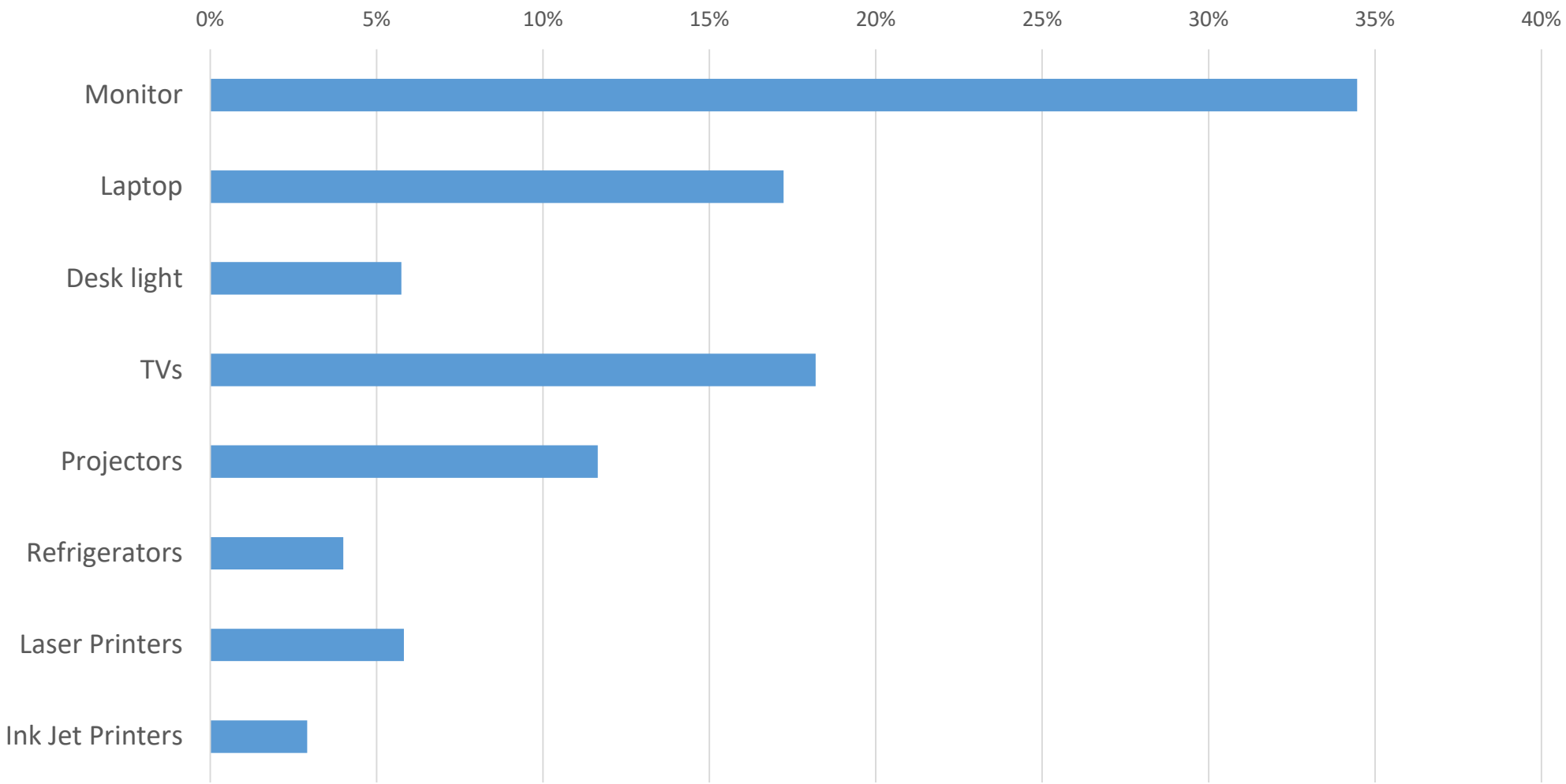


Owner-Driven Decisions

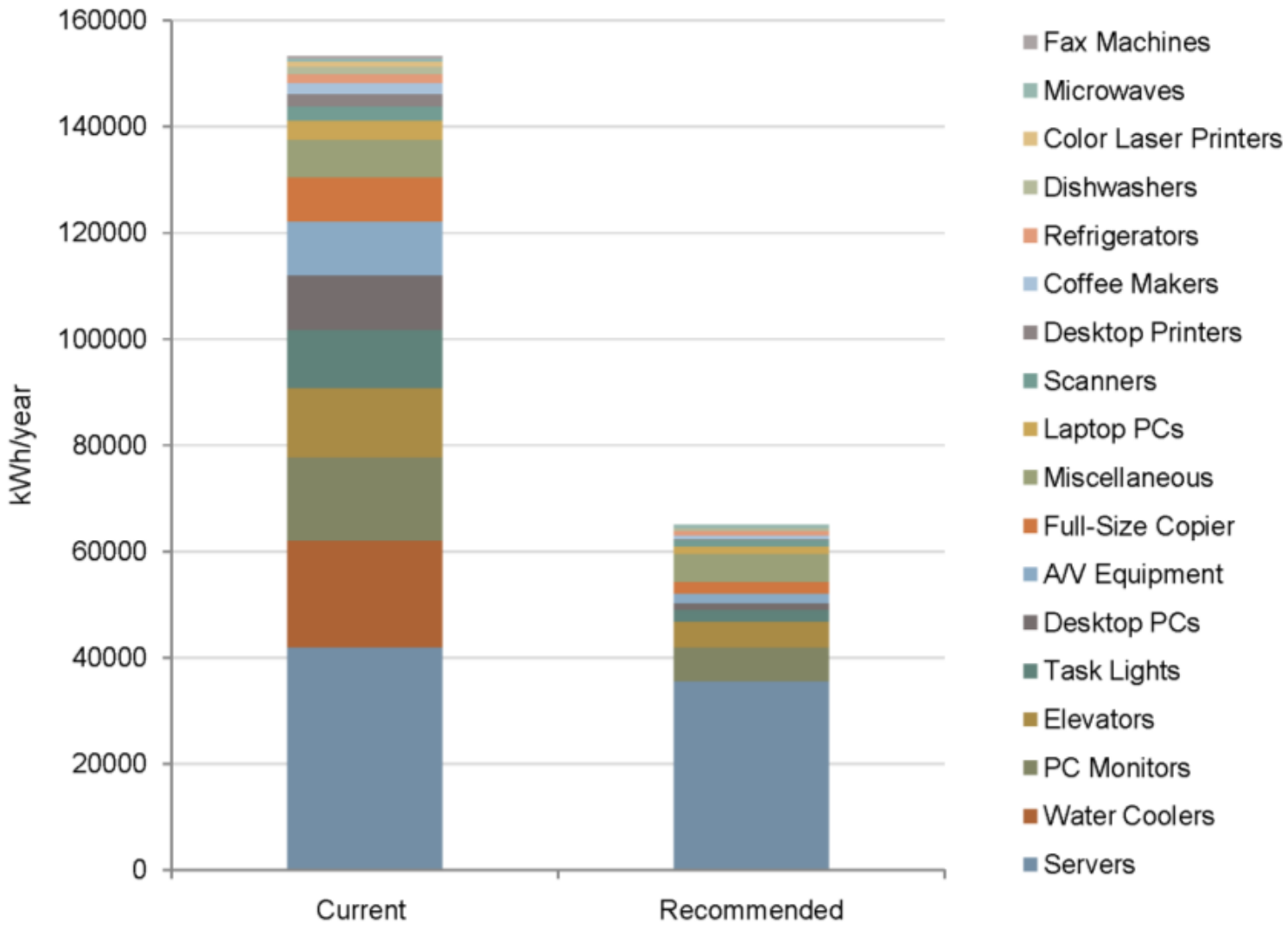
Selecting the Right Computer Plug Loads

	50% Design Intent (assumed)	Plug Load Study Finding (data driven)	With Thin- Clients and Remote -computers	With Thin-Clients and virtualized computers
	540 W@ desk	330 W@ desk	110 W@ desk 75 W remote	110 W@ desk 25 W remote
Workfloor cfm/sf	0.41 cfm/sf	0.36 cfm/sf	0.33 cfm/sf	0.33 cfm/sf
Plant Sizing tons	1,950 tons	1,772 tons	1,651 tons	1,562 tons
Energy Use Intensity	90 kBtu/sf	85 kBtu/sf	74 kBtu/sf	61 kBtu/sf

Owner-Driven Decisions



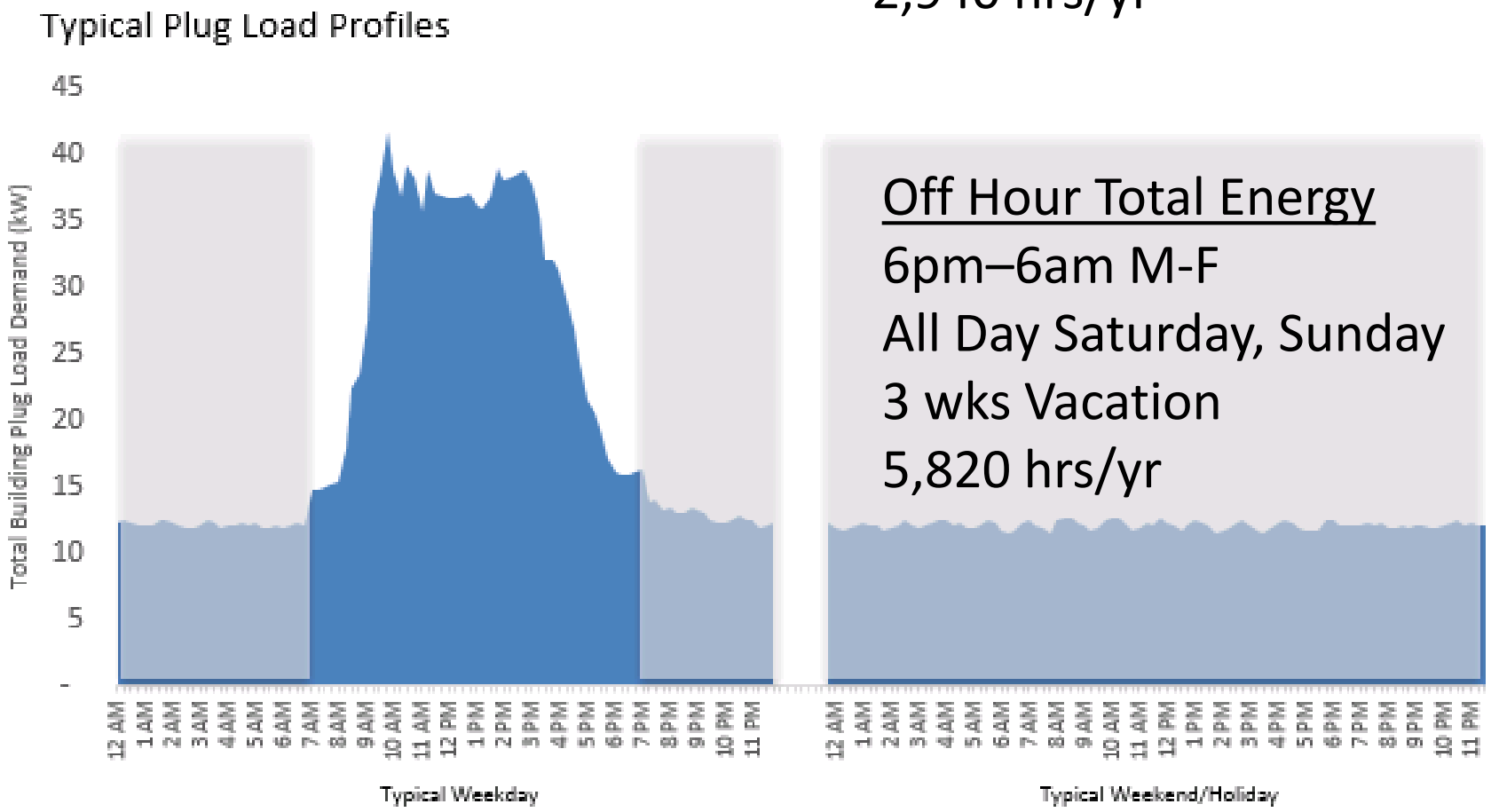
Owner-Driven Decisions



More efficient equipment = $120,000 savings in PV array

Owner-Driven Decisions

<u>Work Hour Total Energy</u>
6am–6pm M-F
2,940 hrs/yr



<u>Off Hour Total Energy</u>
6pm–6am M-F
All Day Saturday, Sunday
3 wks Vacation
5,820 hrs/yr

Owner-Driven Decisions

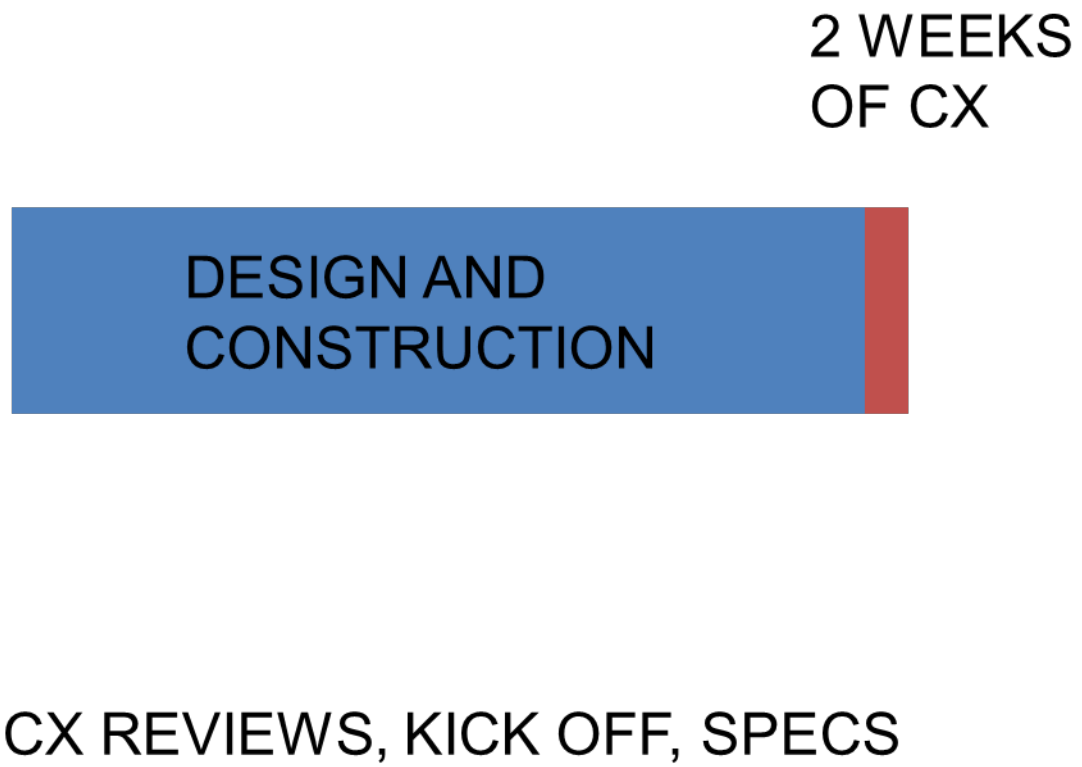
Operating Schedule

Occupant Education/Engagement

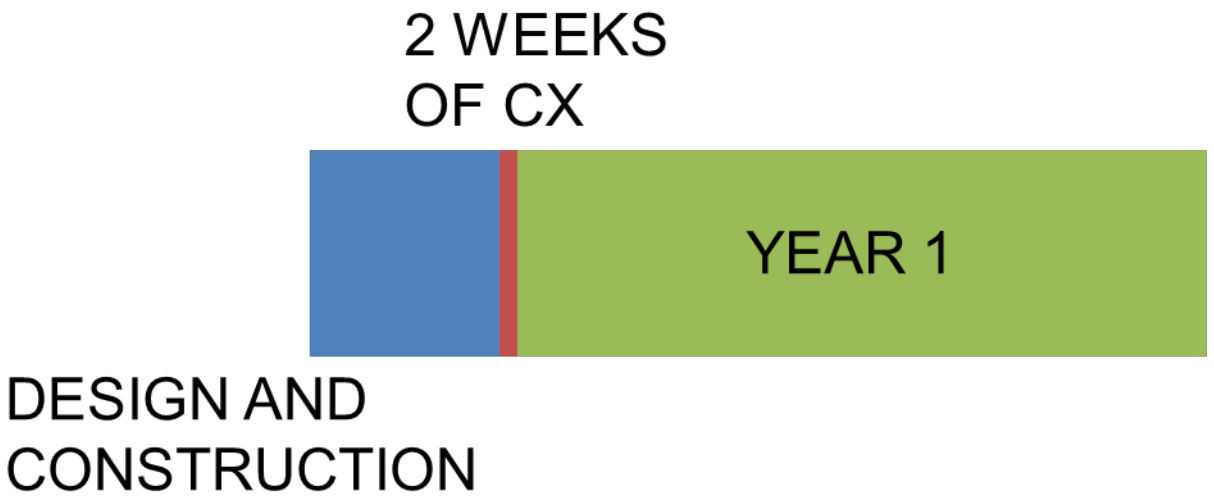
Temperature Set Points

On-Site Net Zero “Champion”

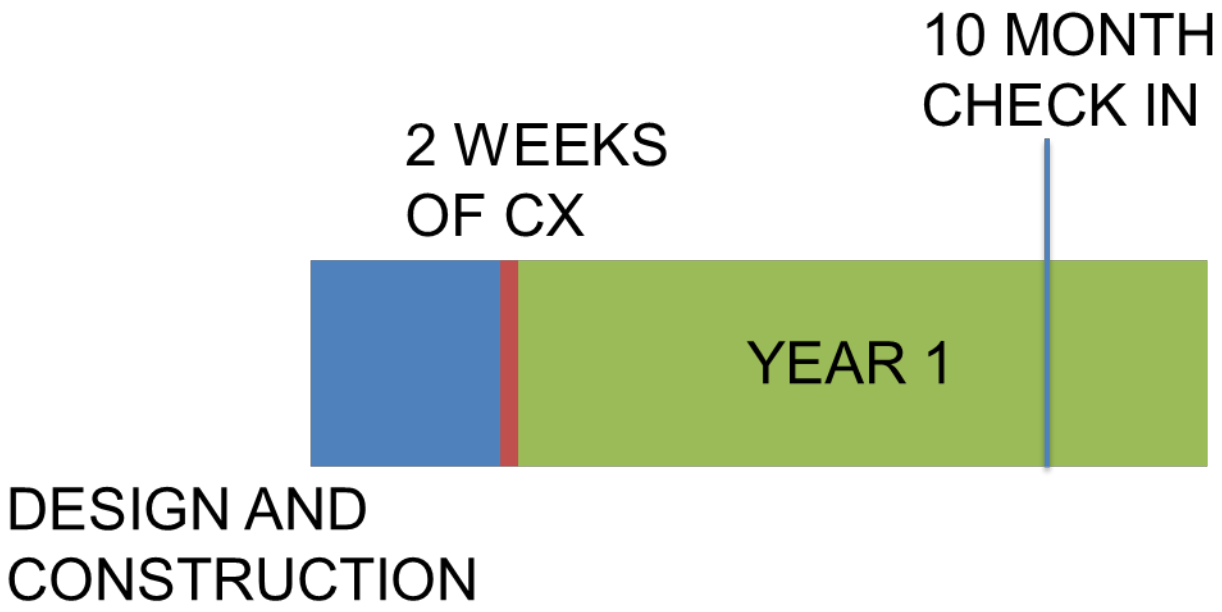
Cx Timeline - Typical



Cx Timeline – Net Zero



Cx Timeline – Net Zero (minimal check-ins)



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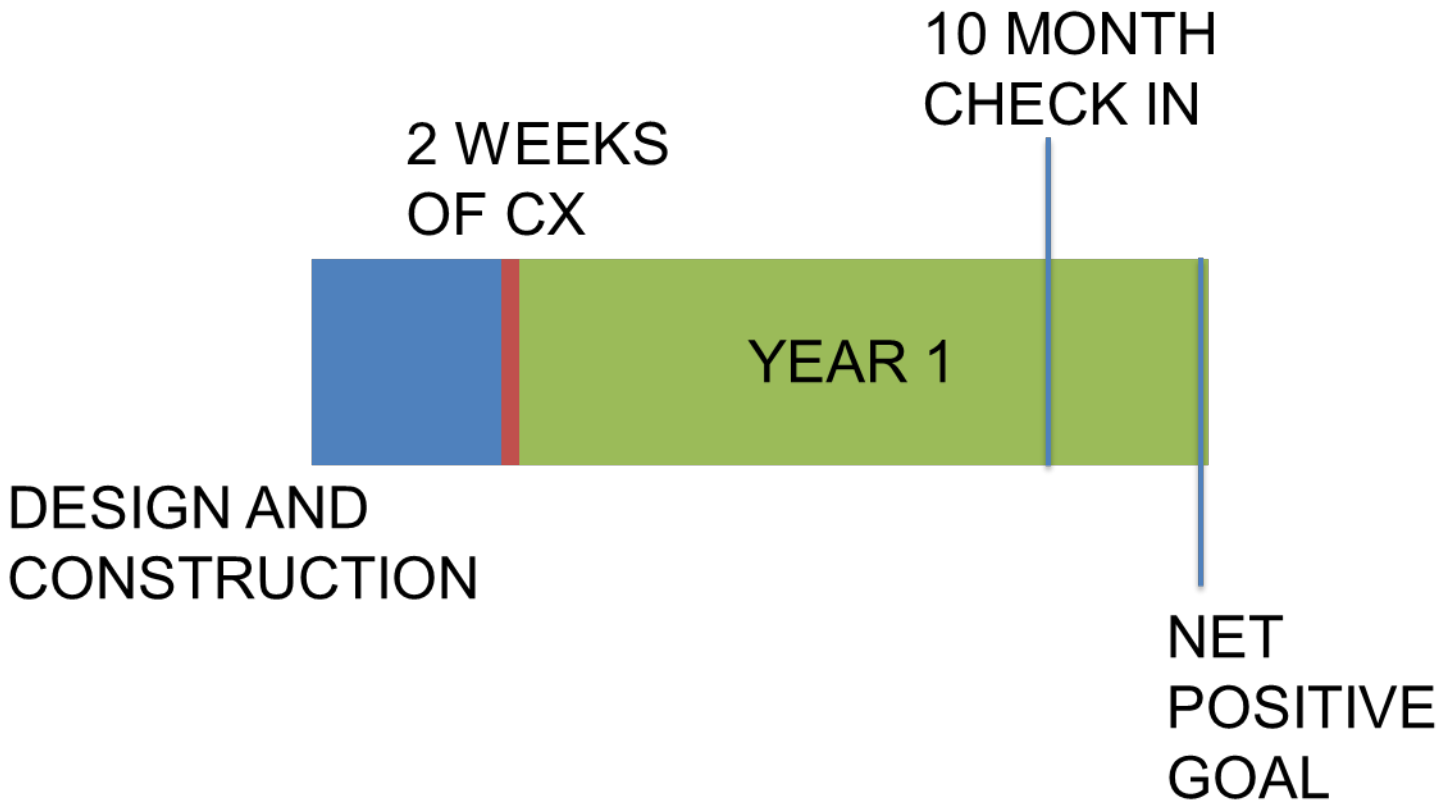
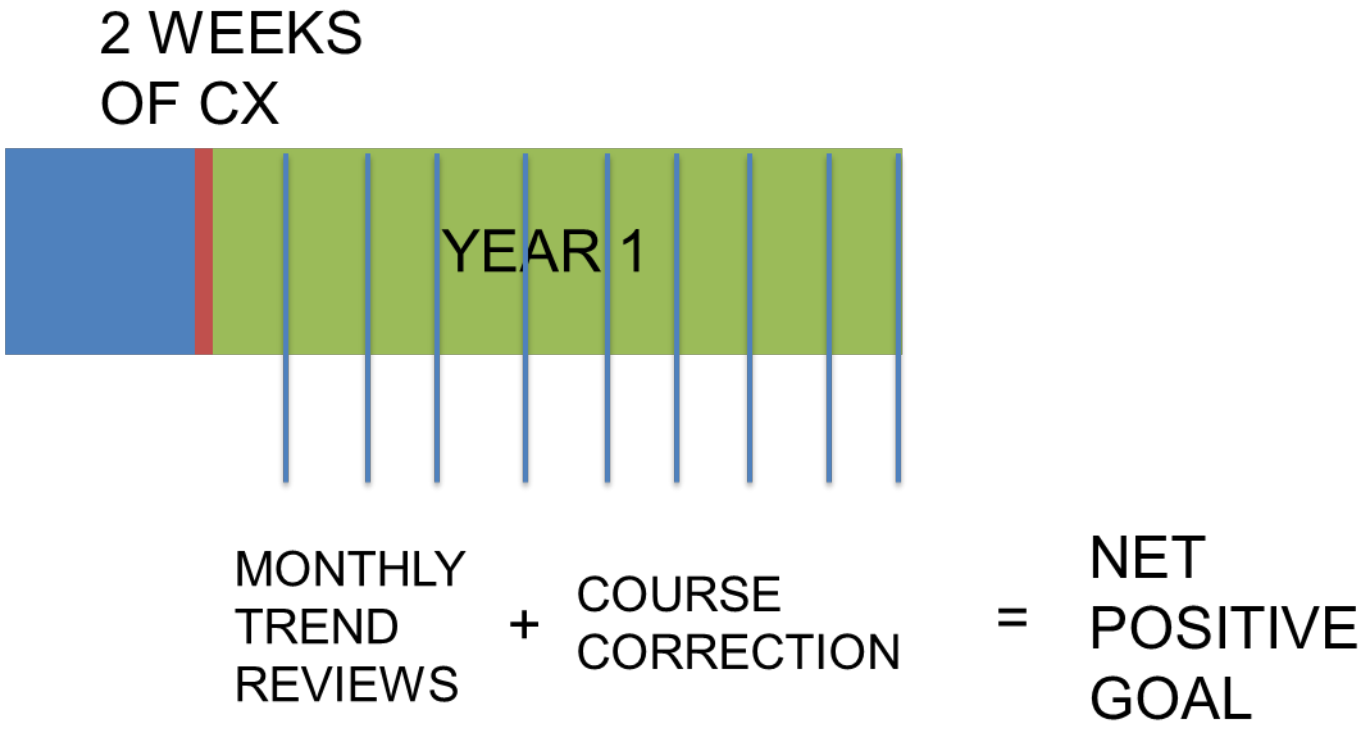
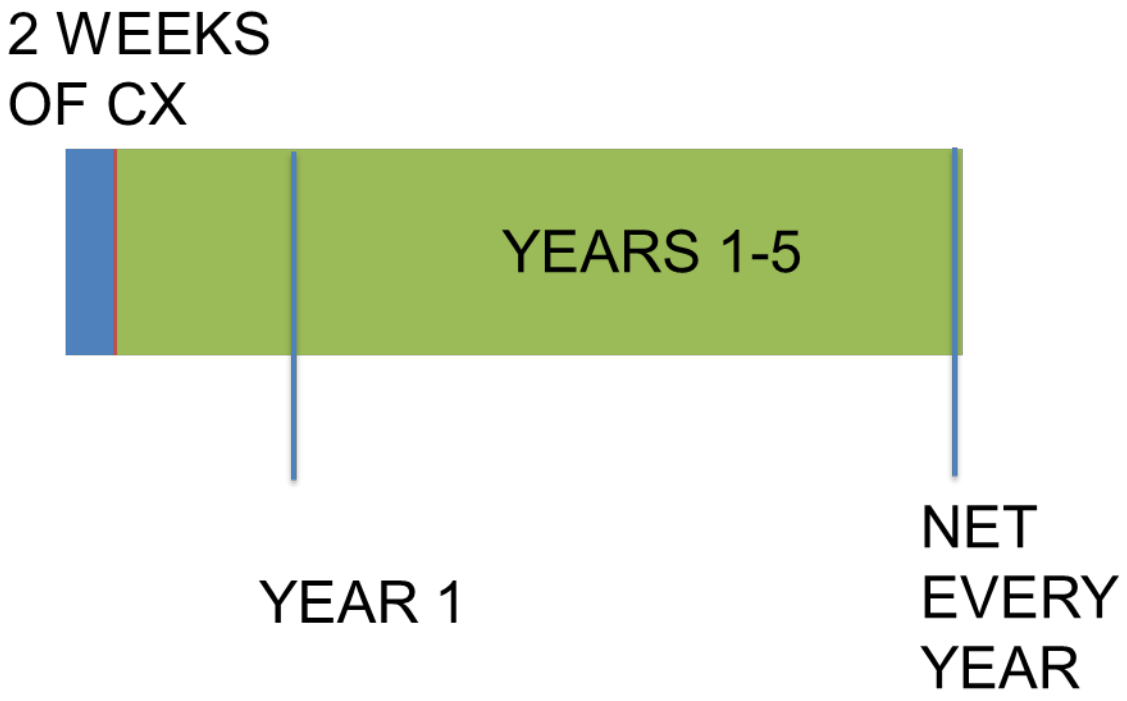


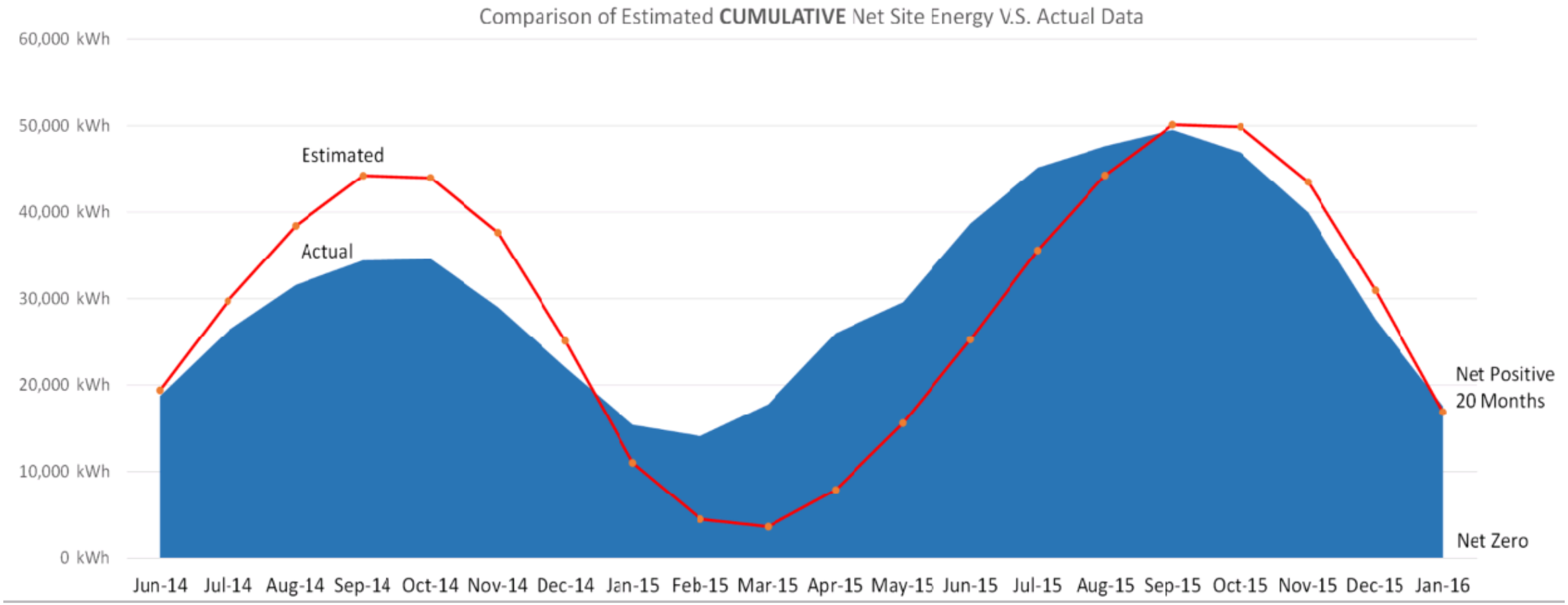
Cx Timeline – Net Zero (monthly check-ins)



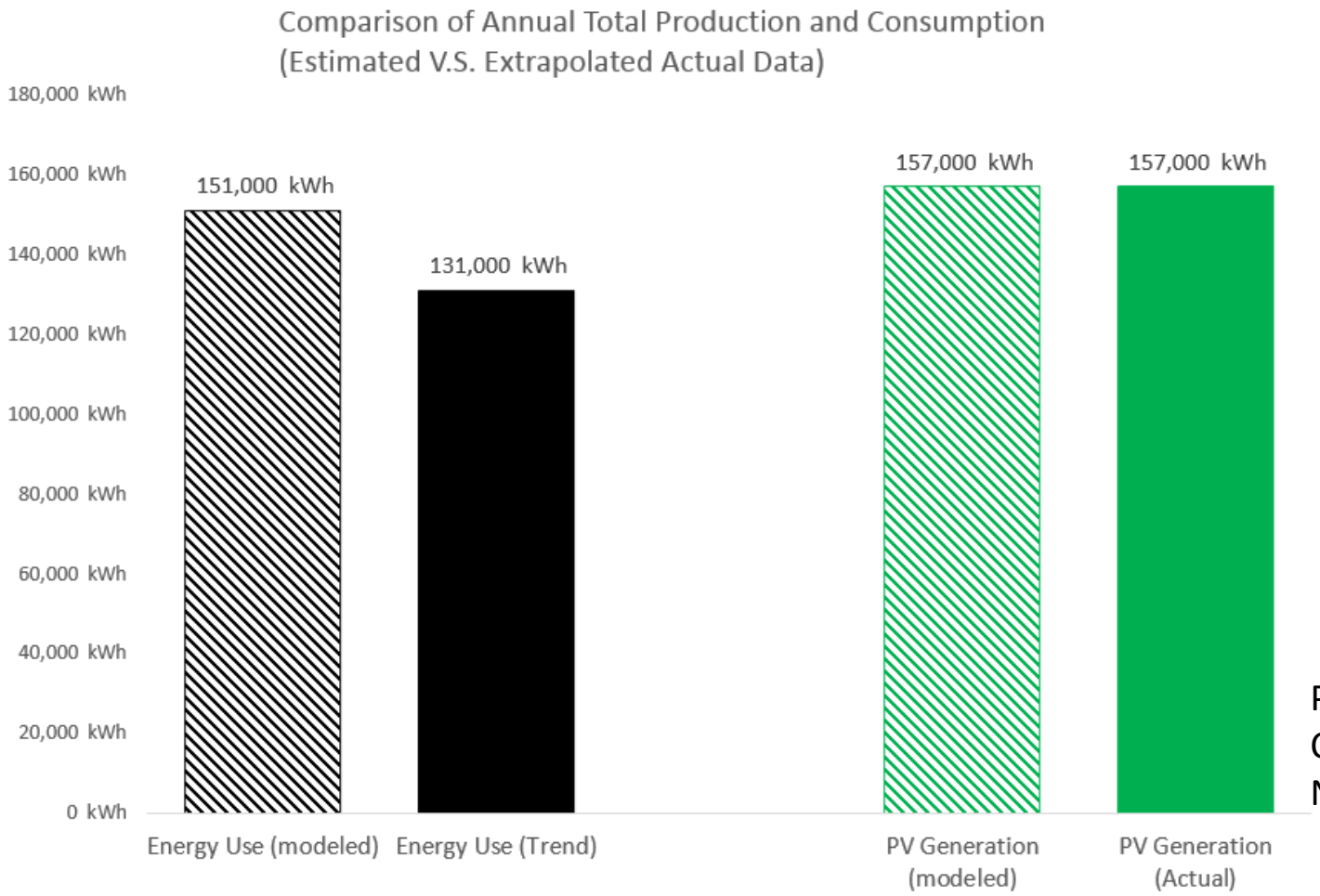
Cx Timeline – Net Zero Annually



Analyze the Results



Annual Total Production and Consumption



PV production is **equal** to predictions.
Consumption is **13% below** prediction.
Net site production is **20% above NZE** AKA Net Positive.

Make Recommendations and Action Items

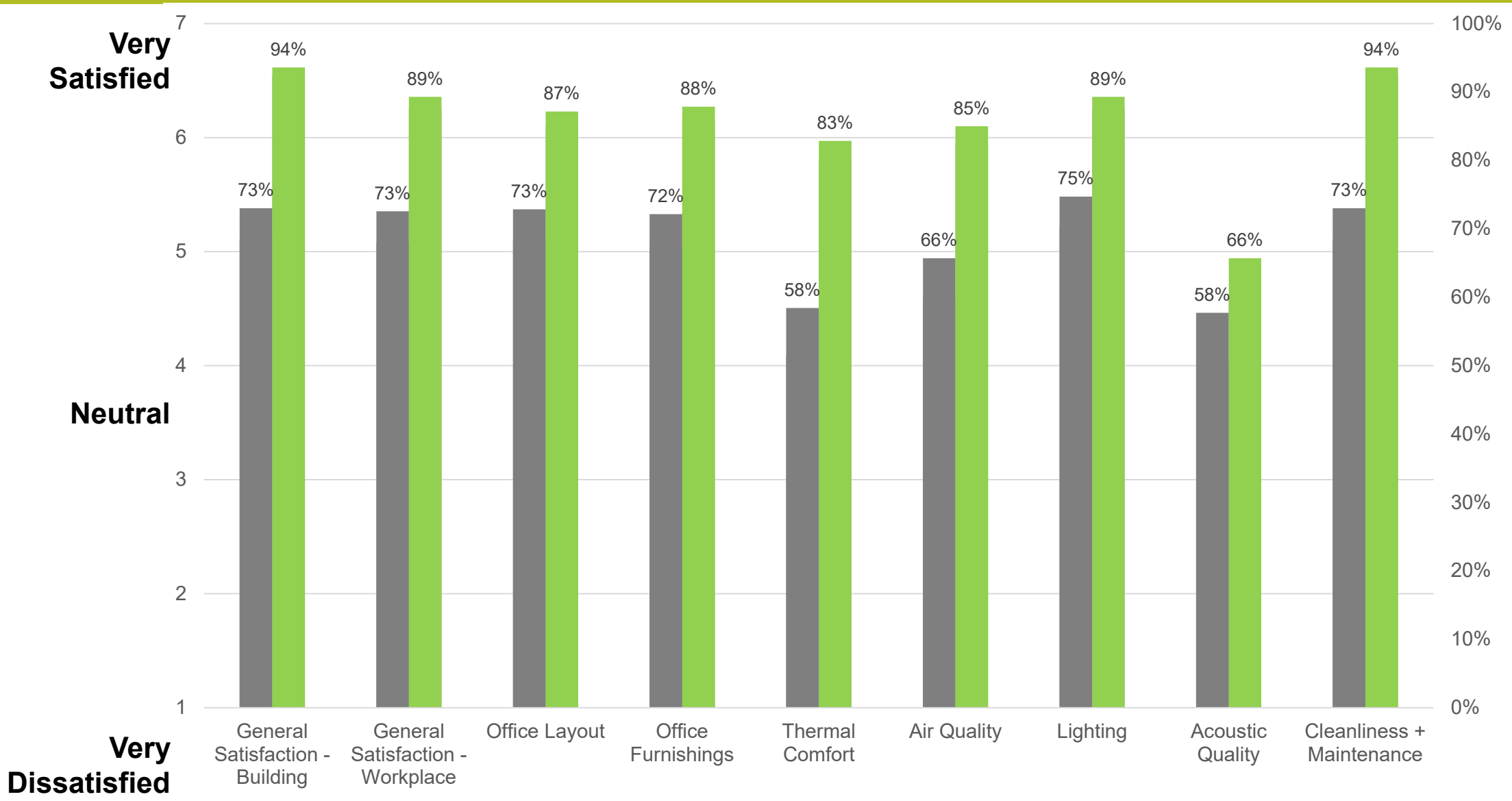
Energy:

- Solar Under performing → Clean PV Panels
- Better programming Event Modes, Nighttime sweeps
- Lighting isn't dimming enough
- Lighting daylighting controls were switched off

Comfort:

- Start the morning warm up earlier (people come in earlier and are cold)
- Educate the staff – see something, say something. You don't have to suck it up and be cold when its hot outside
- Add more controllability for multiply conference rooms on a single FCU

Net Zero Energy – Occupant Happiness



Achieving Net Zero Energy

How do we get there?

- Reduce demand
- Maximize on-site production
- Expand to off-site production
- Identify financing strategies