Venter Institute HQ, La Jolla, California | Credit: [illegible]

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The Getting to Zero Market Landscape and 2020 Zero Energy Buildings List

September 24, 2020

Efficiency delivered.

NBI is responding to increasing urgency to reduce carbon emissions and increased demand for improved energy performance of new and existing buildings.

NBI's Theory of Market Change:

VanDusen Botanical Gardens Visitor Centre | Vancouver, BC
Source: Nic Lehoux

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Today's panelists:

Alexi Miller
Associate Director
NBI

Kevin Carbonnier
Project Manager
NBI

Kathryn Wright
Program Director for Buildings
USDN

Michelle Amt
Director of Sustainability
VMDO

Dan Arons
Principal
Perkins Eastman

Darryl Boyce
Past President
ASHRAE

Today's Agenda

- Getting to Zero Insights, Trends, and Progress
  – *Alexi Miller & Kevin Carbonnier, NBI*
- Key ZE Policy Trends – *Kathryn Wright, USDN*
- Clarifying Questions
- Three Case Studies:
  - *Michelle Amt, VMDO Architects*
  - *Darryl Boyce, ASHRAE*
  - *Dan Eastman, Perkins & Eastman Architects*
- Questions and Answers

ZE Definitions and Data

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California Lottery, Santa Fe Springs, CA | Credit: LPAS Arch + Design

What's in a name?

The Name Game

Zero Net Energy
Zero Energy Buildings
Zero Carbon Buildings
Carbon Neutral Buildings
Zero Energy Cost
Zero Net Ready Buildings

Net Zero Energy
Nearly Zero Energy Buildings
Ultra-low Energy Buildings
High Performance Buildings
Living Buildings
Passive House

Emerging Buildings
Verified Buildings
Certified Buildings

Today's Terminology

- A **Zero Energy Project** is a highly energy efficient project (building, district, campus…) that meets 100% of annual energy with renewables.
  - » **Emerging**[1] – targeting ZE
    - » *May be in planning, design, construction, occupied for less than a year, or yet to document ZE performance*
  - » **Verified**[1] – A year of more of documented performance by NBI
  - » **Certified** – A year of more documented performance by a third-party program (e.g. ILFI, USGBC)


Marin Country Day School (Photo: Michael David Rose)

- **Energy Performance** - All energy (electric, gas, steam, liquid fuel etc.) consumed onsite:
  - » **EUI** - Energy Use Intensity in kBtu/sf/yr
    - » The most common metric of energy performance

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[1] *Terms used by NBI for our Getting to Zero List*

Zero Energy Project Counts

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NBI ZE Regional/Continental Watchlists and Status Report

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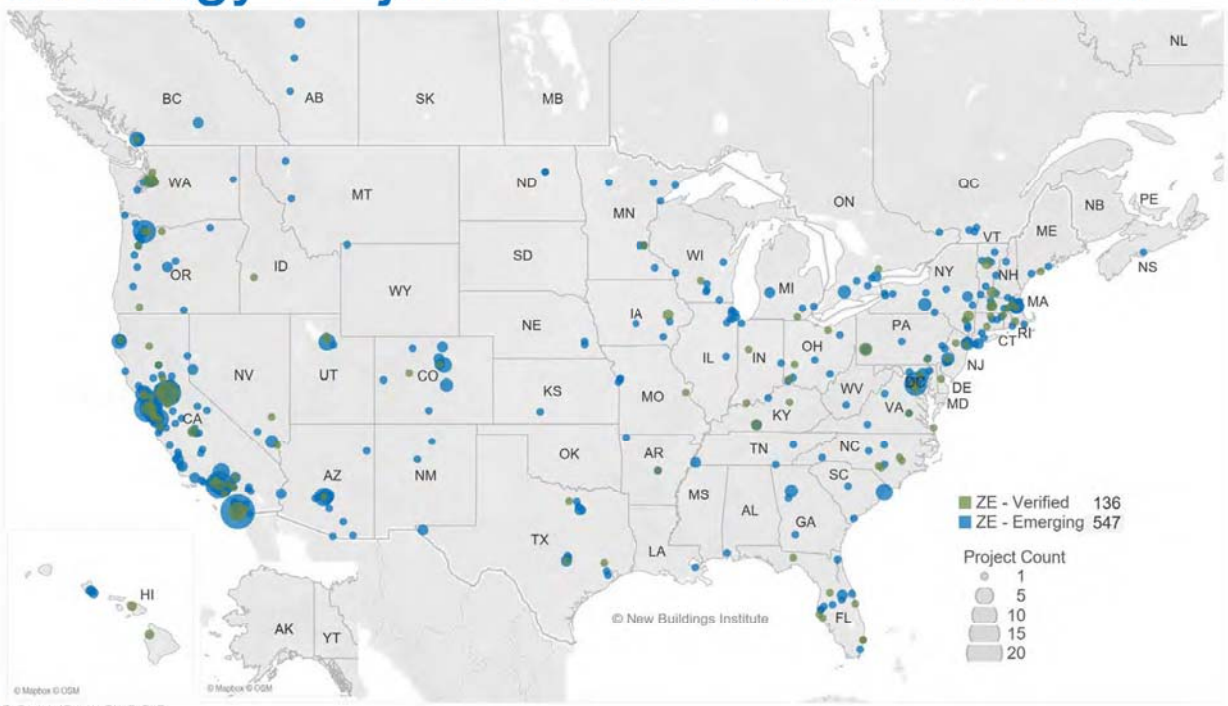
Midwest ZE Project List Coming Soon!

Zero Energy Projects Across North America



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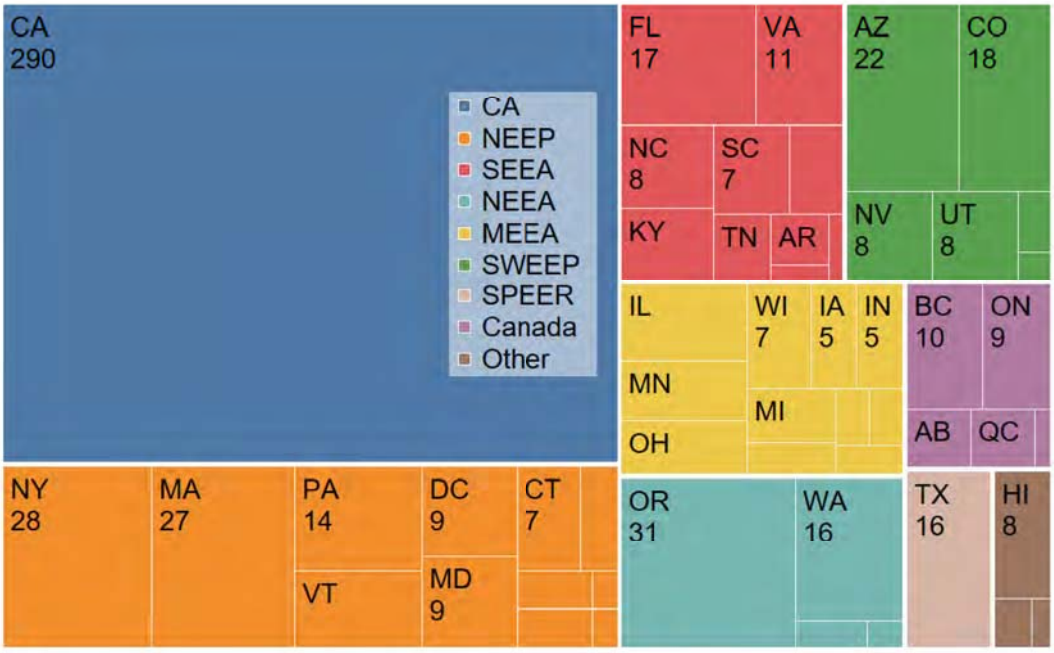
ZE Distribution by State and Region



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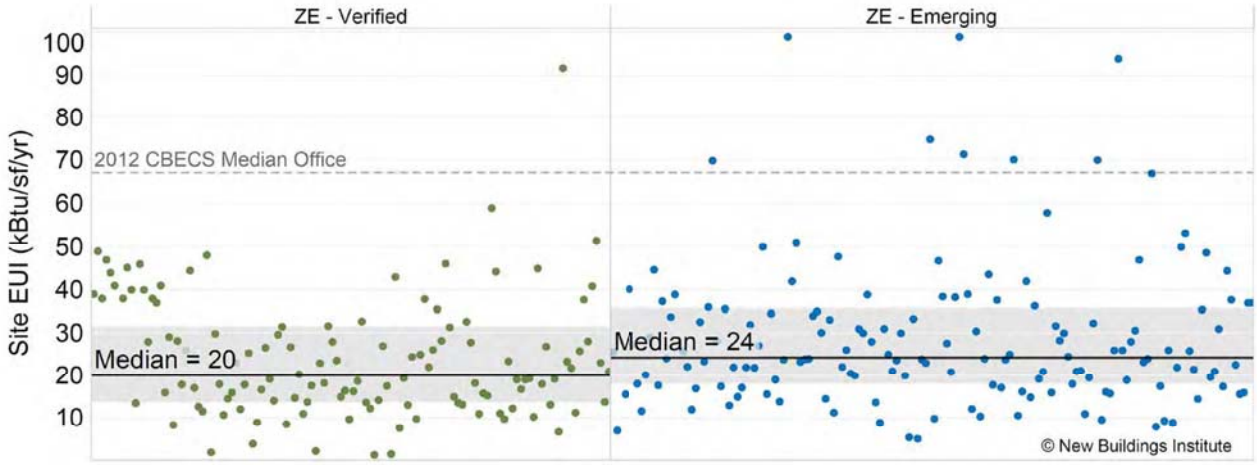
Efficiency First: Energy Performance Data



ZE buildings on average use **half the energy** of comparable existing U.S. buildings[1]

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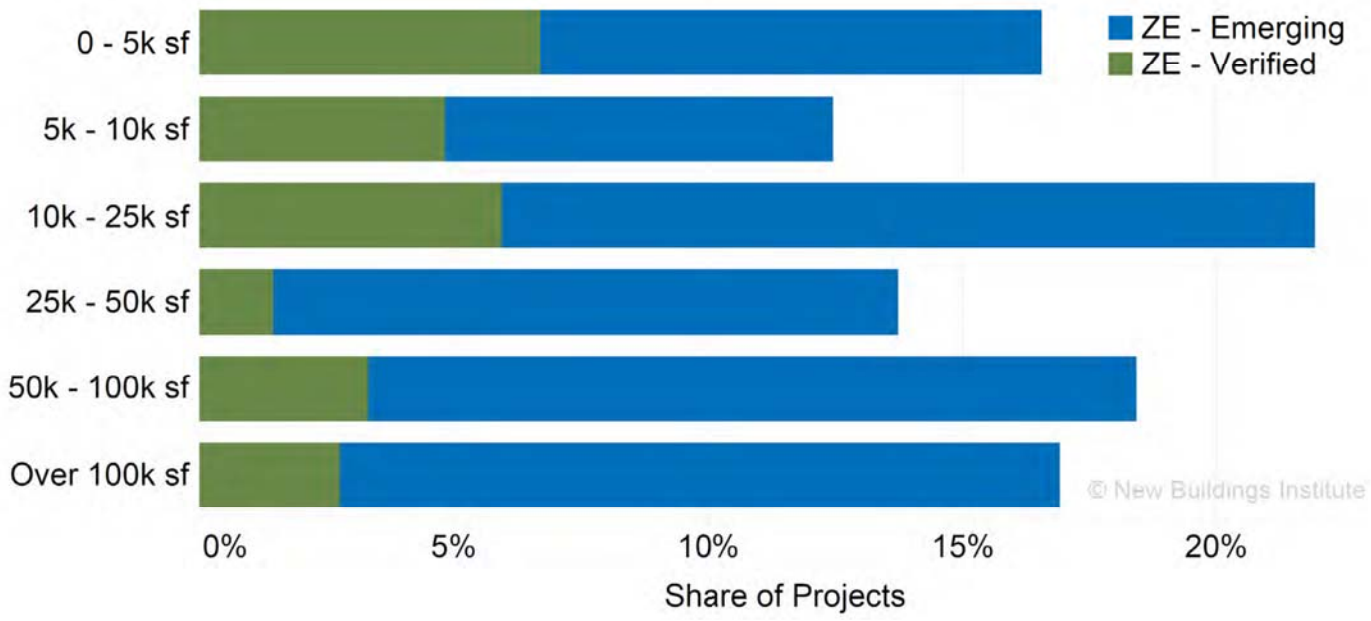
1. Compared to CBECS 2012 (commercial) and RECS 2015 (multifamily); weighted by building type.

Building Size Diversity – Small, Medium, & Large



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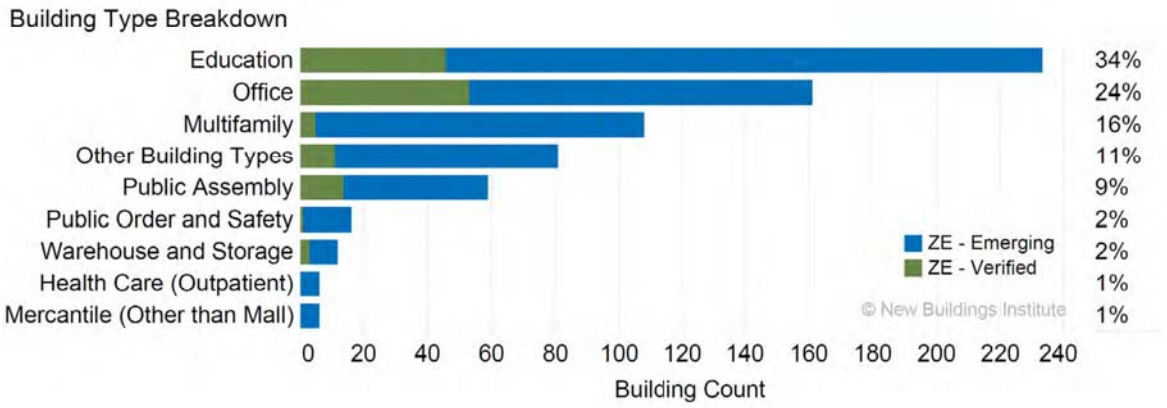
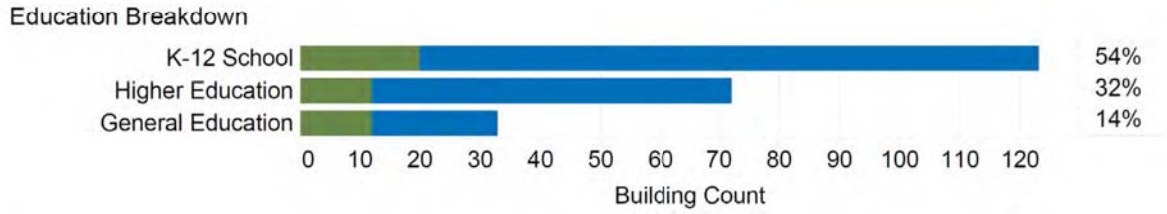
100+ Distinct ZE Building Types





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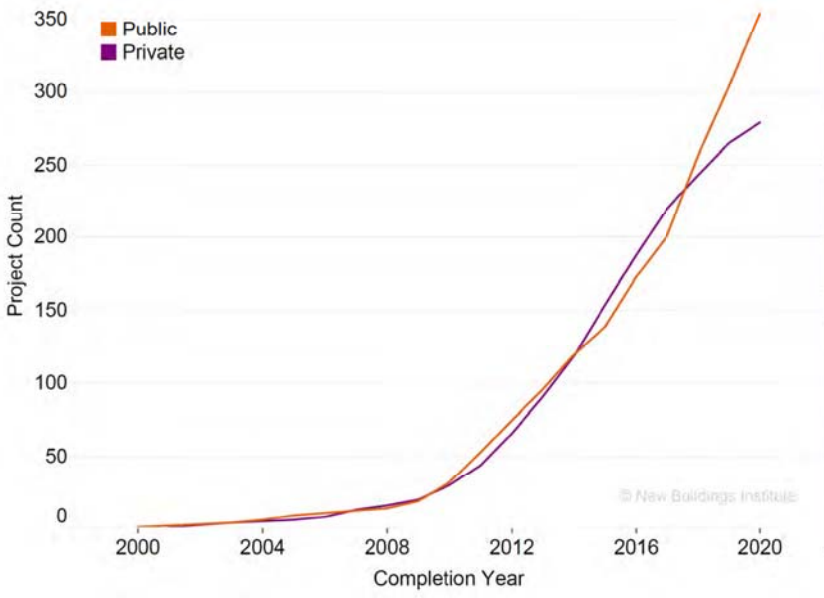
Public and Private Sector Growth



Richardsville Elementary | Bowling Green, KY
Photo: Warren County Public Schools, CMTA, Inc.

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Getting to Zero Trends Summary

ZE Buildings across N. America
Every Climate Zone | 46 States + DC | 5 Provinces

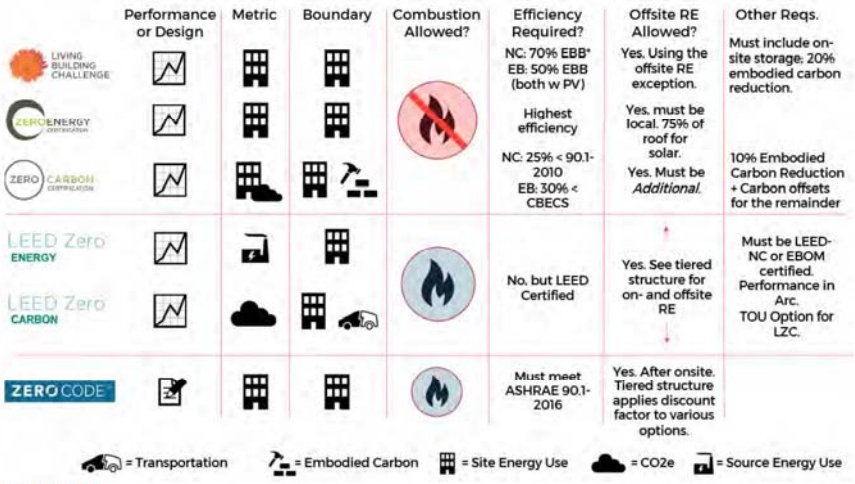
Districts and Portfolios
Large property owners making commitments to Get to Zero

Beyond Zero Energy
Targeting Zero Carbon / Carbon Neutral, Expanding the scope

Decarbonization + Grid Integration
Complementary trends building from demonstrated ZE leadership

Zero Carbon / Carbon Neutral Building Programs

- Zero Energy ≠ Zero Carbon
  - 15+ Zero Carbon specs
  - Vary by:
    - Efficiency requirements
    - Onsite fuel combustion
    - Offsite renewables quality limitations, RECs…
    - Boundaries/scope: embodied carbon, refrigerants, water…



Credit: WSP
Source: https://www.buildinggreen.com/news-analysis/review-current-net-zero-energy-and-net-zero-carbon-certification-programs

Common Technologies to Get to Zero

- Heat pumps for **space** and **water** heating
- Ventilation: natural, hybrid, dedicated outdoor air systems (DOAS), demand control ventilation (DCV)
- Highly efficient thermal envelope
- Building orientation & glazing ratio
- Solar control – daylighting and shading
- Energy management systems
- Radiant heating/cooling & chilled beams
- Plug load controls
- Energy recovery systems
- Solar PV

Chemeketa Community College Health Services Building | Salem, OR | Photo: Alexi Miller, NBI

Selected Emerging Technologies

- Central and 120V unitary heat pump water heaters
- Lower-GWP refrigerants (esp. natural refrigerants)
- Grid-Interactive energy management systems
- Thermal and battery energy storage
- Advanced envelopes: airsealing, thermal bridging
- Automated shading controls
- Advanced lighting control systems (networked)
- Multi-end use integrated controls
- Lower embodied carbon materials

David & Lucile Packard Foundation HQ Los Altos, CA | Photo: Jeremy Bittermann

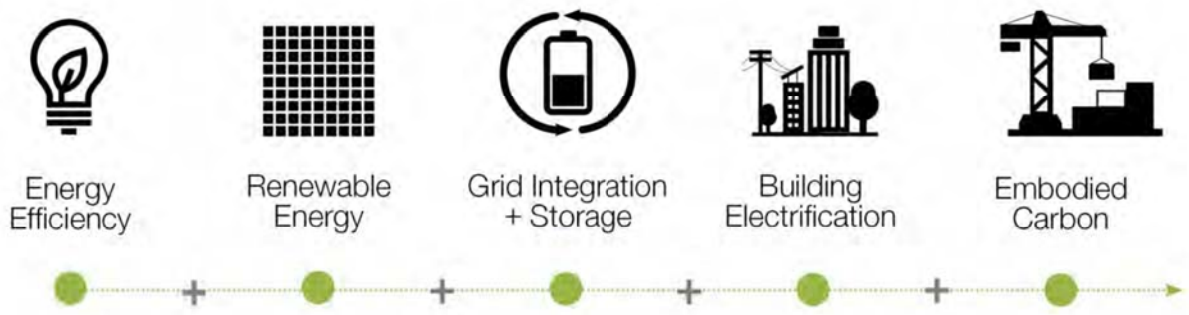
Technology Spotlight: Heat Pump Water Heaters

- Proven technology: on the market for decades
- High Efficiency: 2-4x more energy efficient than conventional water heaters
- Have potential to serve as smart grid-interactive clean energy batteries
- Deliver energy and lifetime cost savings
- Offer dramatic reductions in use of fossil fuel (onsite and at power plants) and GHG emissions

Advanced Water Heating Initiative: newbuildings.org/resource/advanced-water-heating-initiative/

Recent HPWH DIY Install in the basement of Alexi Miller's mother-in-law (Eugene, Oregon)

Moving Forward: The Five Foundations



The Getting to Zero Database

Live and Interactive List, Maps, and Analytics

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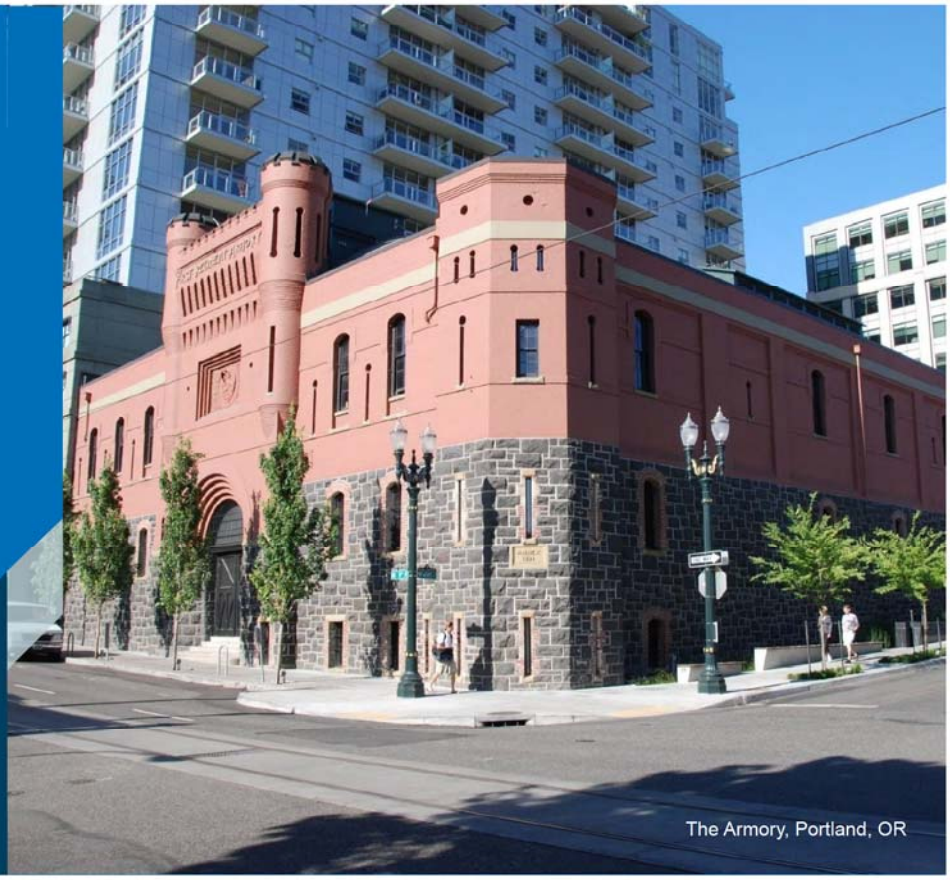
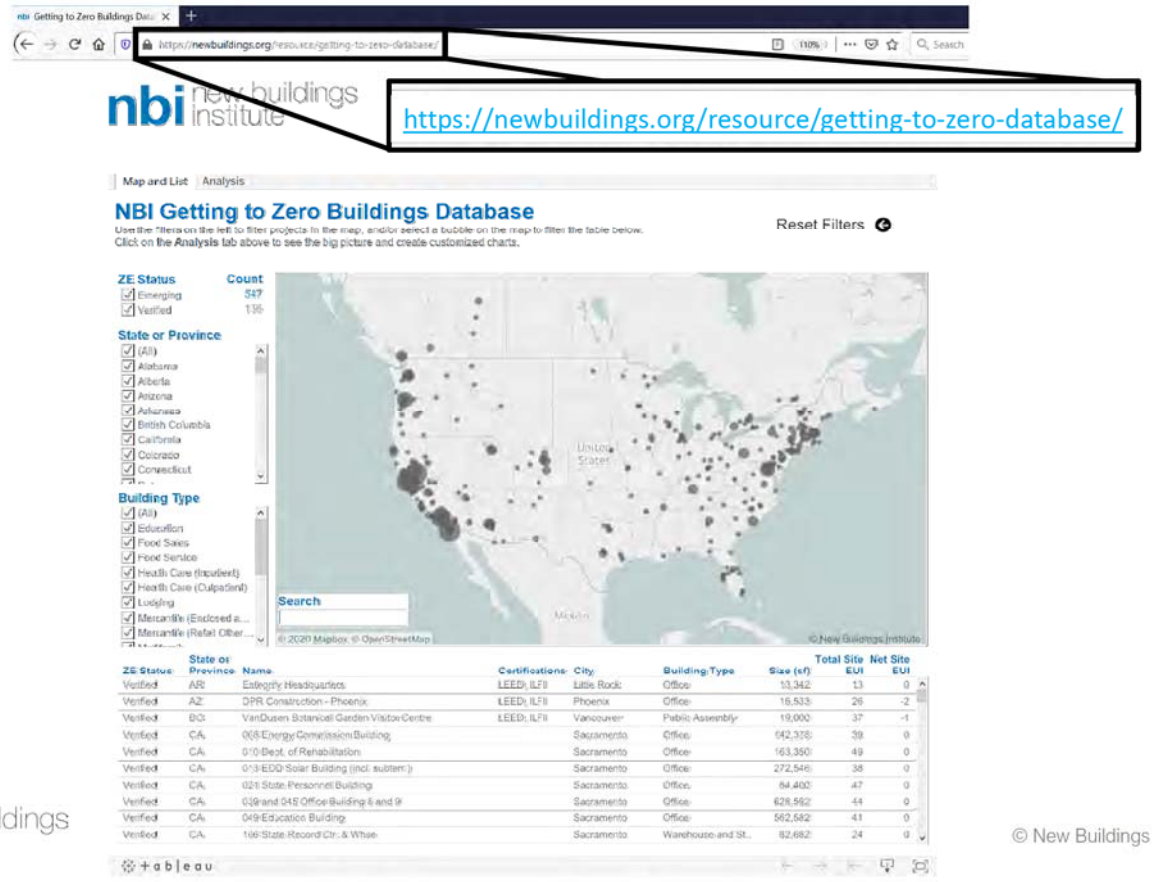

The Armory, Portland, OR



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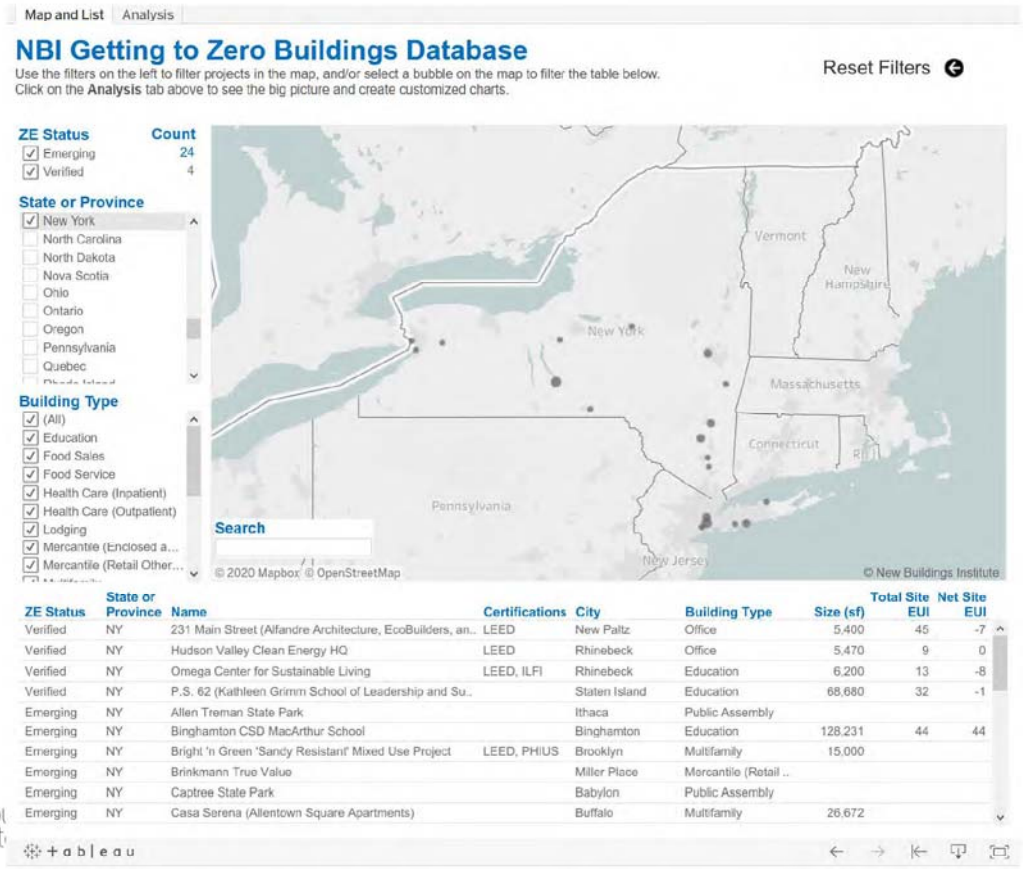

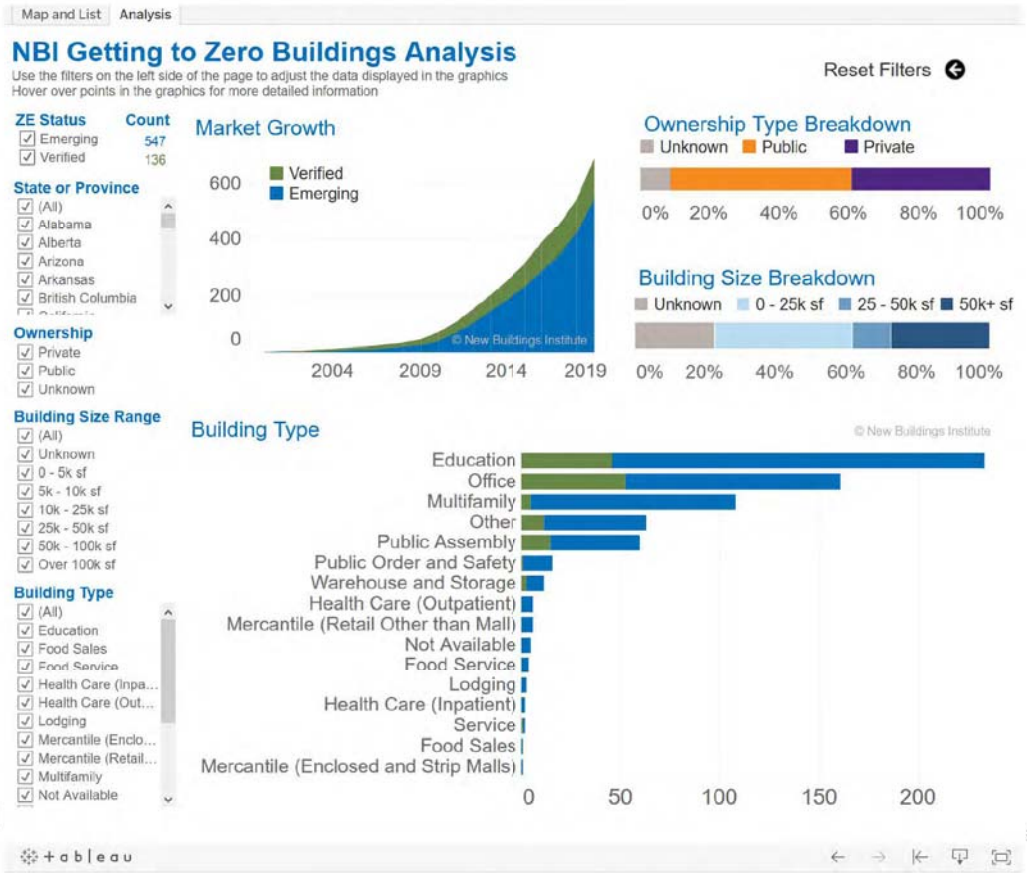

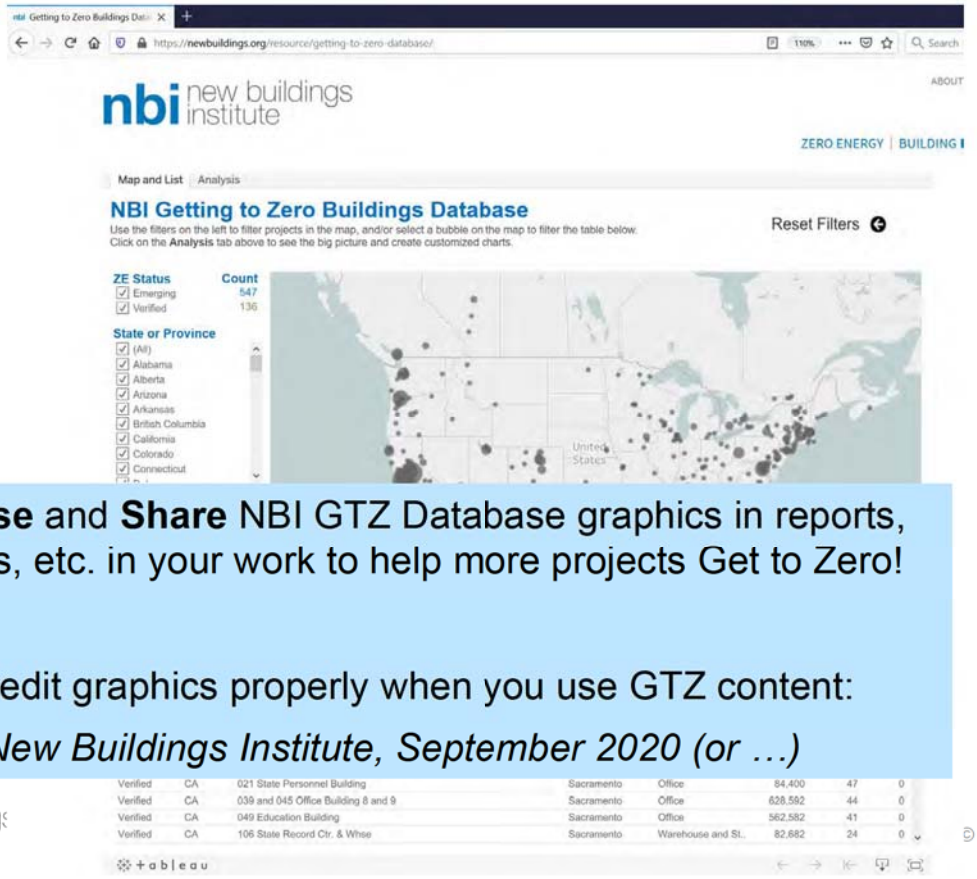

Please do **Use** and **Share** NBI GTZ Database graphics in reports, presentations, etc. in your work to help more projects Get to Zero!

Be sure to credit graphics properly when you use GTZ content:

Source: New Buildings Institute, September 2020 (or …)

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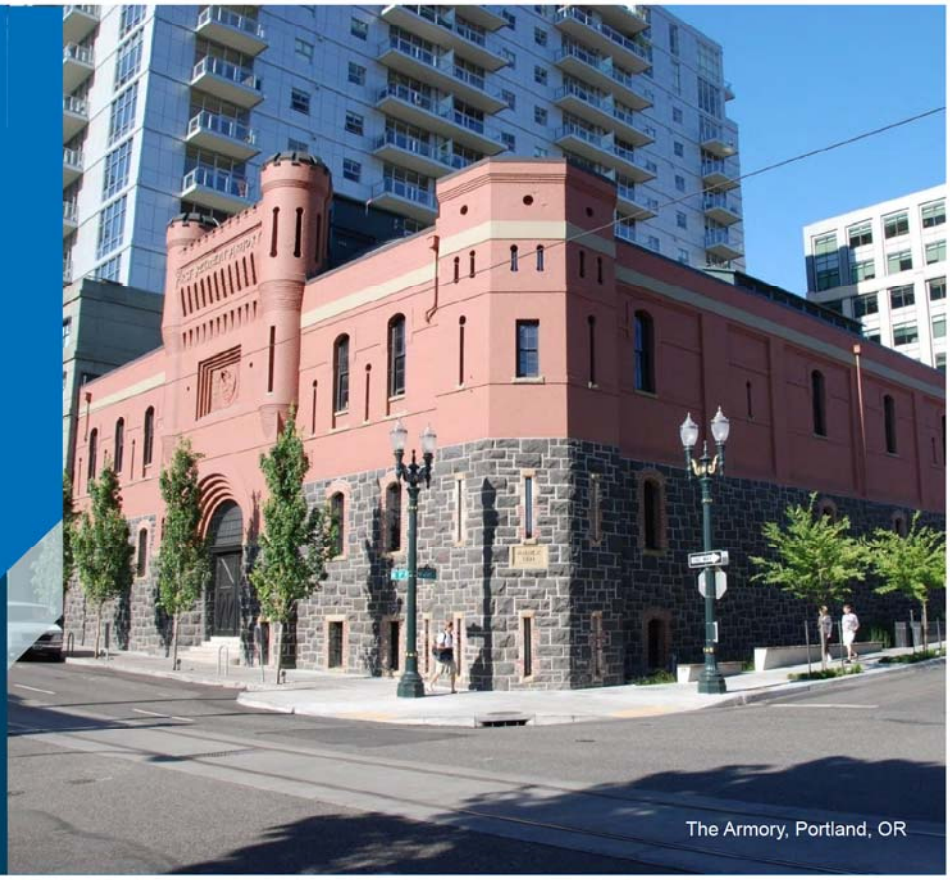
Your building has been discussed, designed, modeled, permitted, built, inspected, tested, operated, measured and monitored.

Now take your place as a **#ZeroHero** and add it to NBI's Getting to Zero Database.

newbuildings.org/project-registry/

Policy Trends


The Armory, Portland, OR

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Emerging Trends Building Energy Policy

Connecting People. Fostering Innovation.

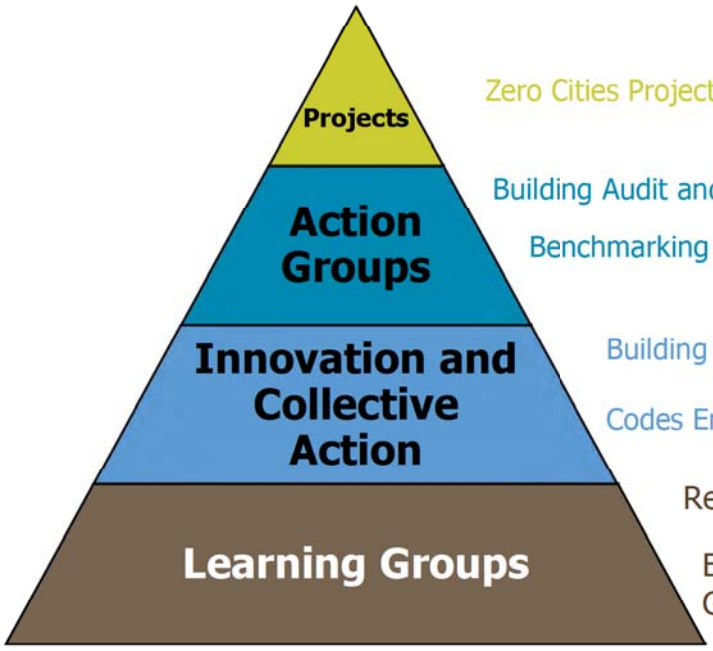
USDN urban sustainability directors network

ABOUT USDN

USDN Members

USDN.org

ABOUT USDN



Zero Cities Project

Building Audit and Tune-Up Policies

Benchmarking Adoption and Transparency

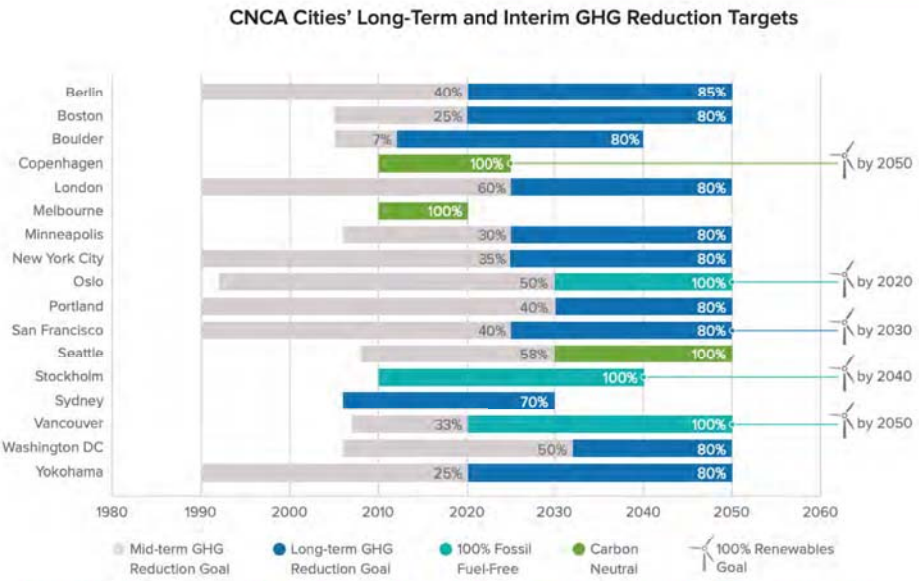
Building Performance Standards

Codes Engagement

Rental Energy Efficiency

Electrification and Natural Gas Transition

GHG AMBITIONS



CNCA: Framework for Long-term Deep Carbon Reduction Planning

GHG AMBITIONS

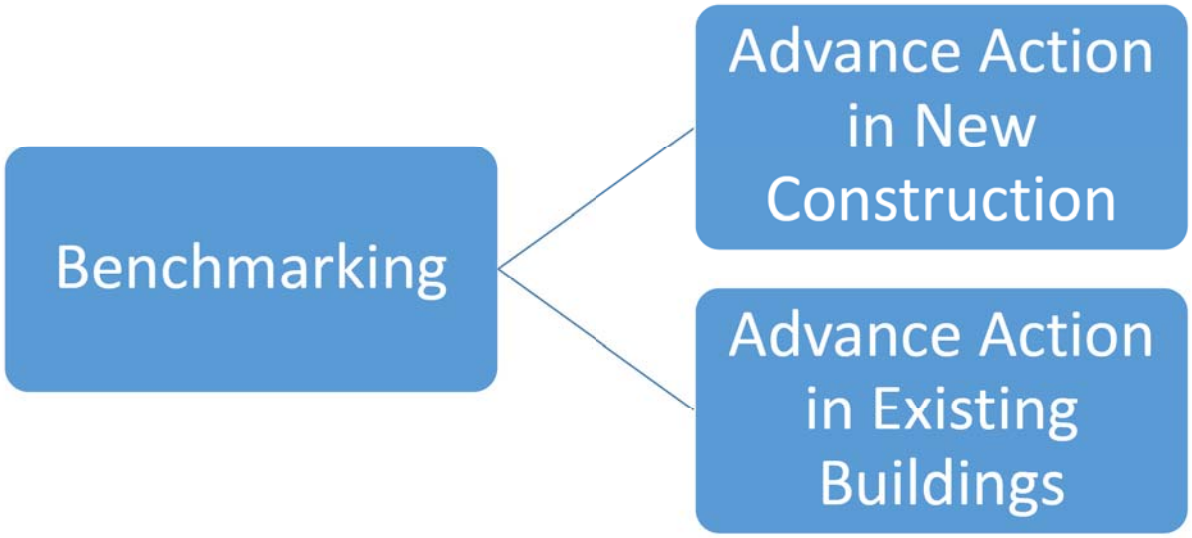
SYSTEM	PERCENTAGE OF C40 CITIES WITH "STRONG POWER" TO...			
	Own/Operate	Set/Enforce Policies	Control Budget	Set Vision
Energy Supply	27%	32%	15%	25%
Energy Efficiency	57%	68%	29%	39%
Transportation	53%	54%	35%	44%
Waste Management	53%	56%	35%	44%

Source: C40, "Powering Climate Action" hyperlink: http://c40-production-images.s3.amazonaws.com/other_uploads/images/295_Powering_Climate_Action_Full_Report.original.pdf?1435760139

POLICY ACTION

Benchmarking

POLICY ACTION



ZERO CITIES PROJECT

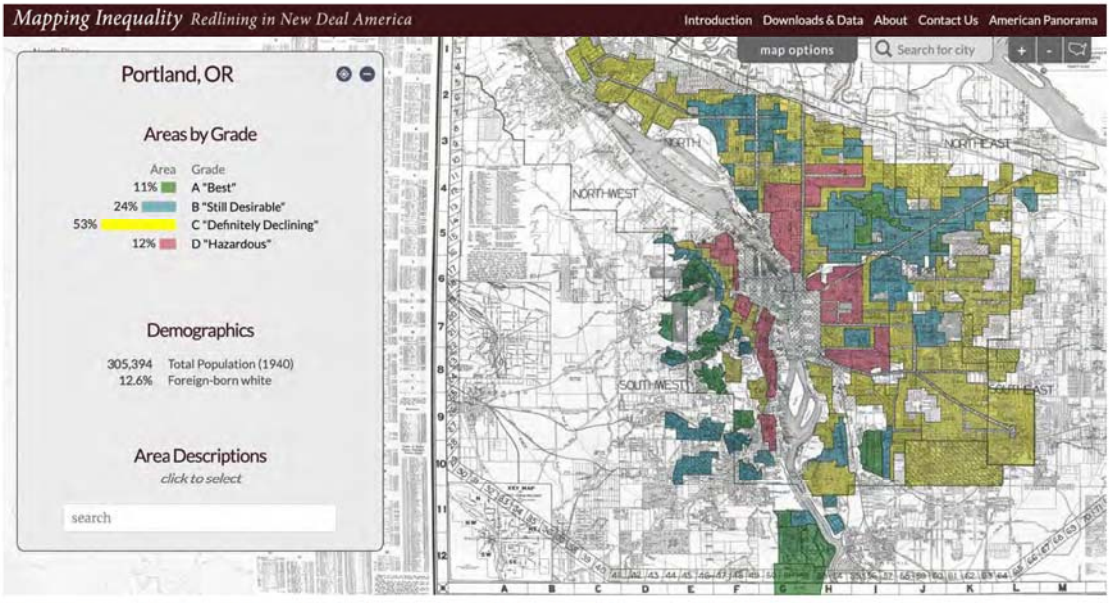
- **Collaboration centering equity and building decarbonization**
- **11 cities and community-based organizations across the U.S. from 2017-2020**
- **Showcase emerging, representative trends**

National Partners

Local Partners

USDN.org

EXISTING BUILDINGS – FOCUS ON EQUITY

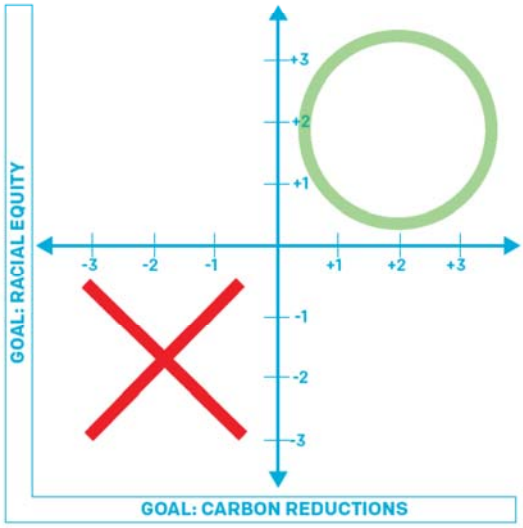


For More: https://www.portland.gov/bps/history-racist-planning-portland

USDN.org

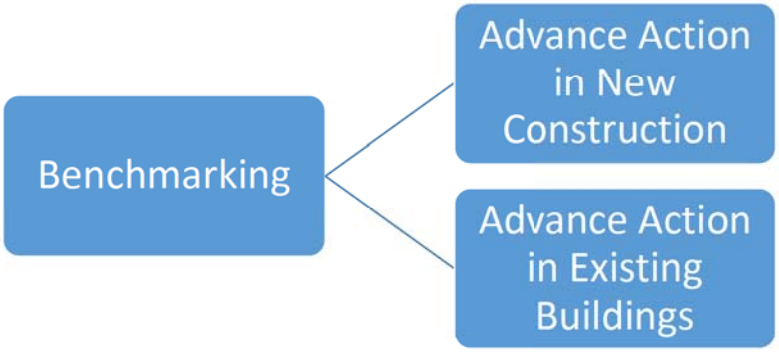
EXISTING BUILDINGS: FOCUS ON EQUITY

USDN Equity Assessment Tool



- **Community Engagement**
- **Gentrification and Displacement**
- **Energy Cost Burden on People of Color**
- **Economic Prosperity for People of Color**
- **Substandard Housing and Exposure to Health Risk**
- **Geographic Location and Environmental Risk**

EXISTING BUILDINGS: ENSURING PERFORMANCE



NYC

SUSTAIN ABLE DC

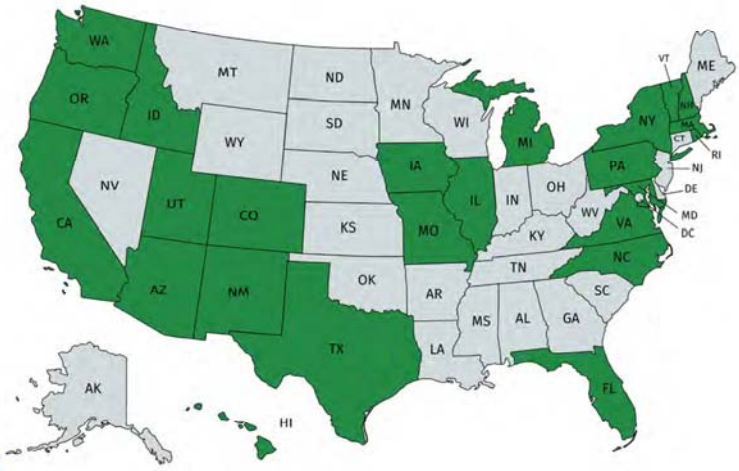
Exploration in 10+ other cities

NEW CONSTRUCTION - CODES

- **Increasing interest in codes as pathway to guarantee emissions reductions**
- **Stretch code support and using codes to define performance targets**
- **Growing interest in voting in codes and future codes changes**

NEW CONSTRUCTION – ELECTRIFICATION

- **Growing interest supporting the electrification of new construction through incentive and policy. Retrofit interest increasing in certain climate zones**
- **Growing number of all-electric zoning provisions and interest natural gas phaseout**
- **Growing interest in local governments participation at regulatory/state-level to support electrification**



FOR MORE

https://www.usdn.org/projects/zero-cities-project.html#/

Discussion
Q & A

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Case Studies

Cincinnati Police Station, Cincinnati, OH | Credit: Darrin Hunter, Dish Design LLC

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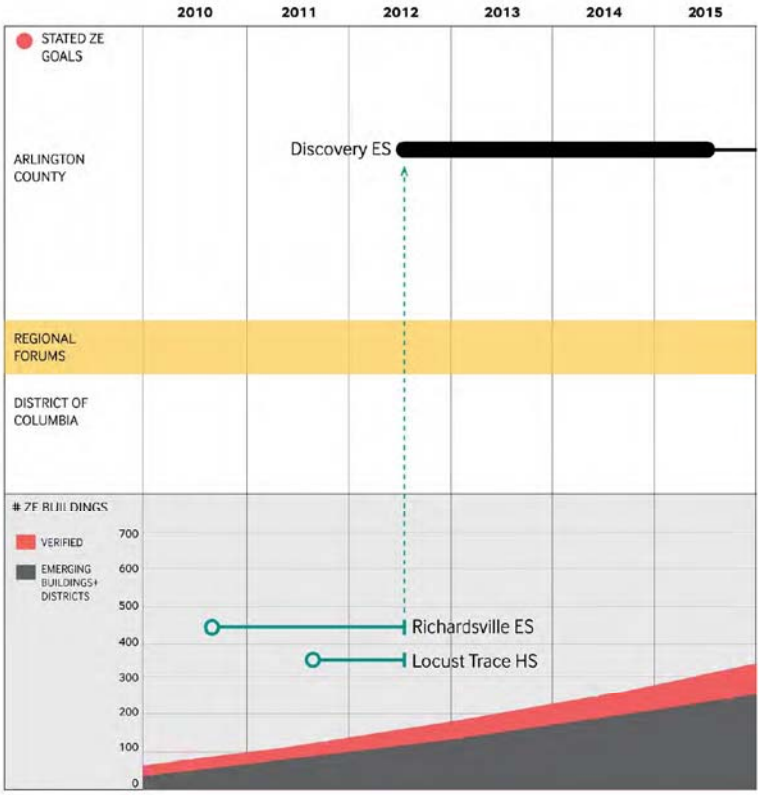
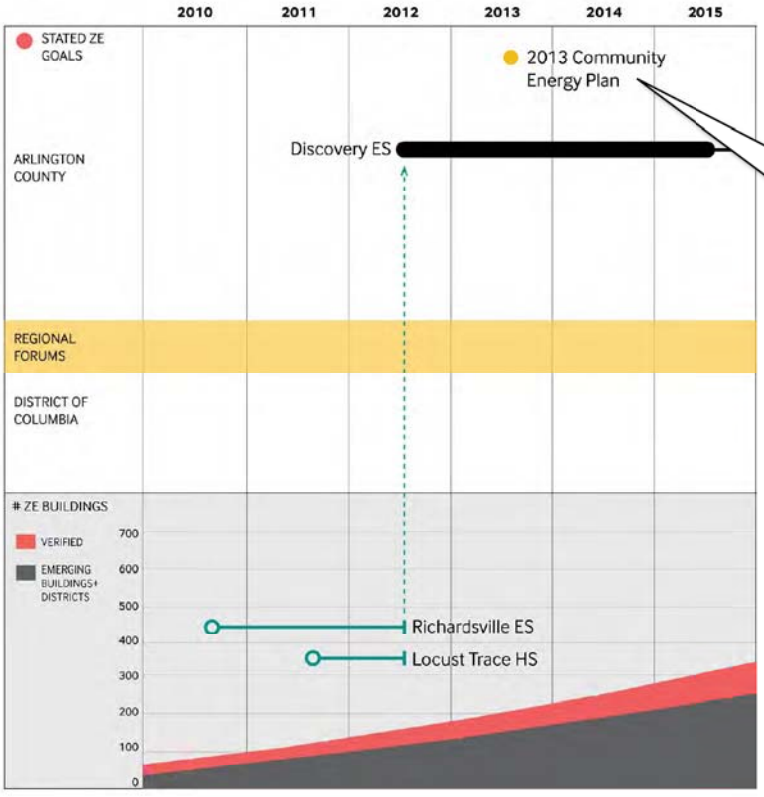




"It **may be possible** for a building to be…capable of generating enough energy from renewable sources to compensate for the project's own energy use.

To this end, Arlington County will facilitate creation of a net-zero energy development to demonstrate net-zero energy concepts in a relatively large-scale project."

p11, A.C. Community Energy Plan. (2013)

Discovery Opened in 2015

VMDO

2015: Discovery Elementary School

VMDO

Dominion Net Energy Meter data (school year: July through June)

FY 2017: (95,538 kWh)

FY 2018: (66,881 kWh)

FY 2019: 1,677 kWh *due to heavy rains from Fall 2018 – Spring 2019*

Discovery dashboard: 107,891 kWh net positive in 2017 calendar year

VMDO

Capital Investment

Bid $2 Million under budget
(with PV array and 2 turf fields)

$32,710,130	Final hard costs <u>at close-out</u> in 2016
$333 / sf	all in
$300 / sf	w/o PV array and 2 turf fields

Returned $900K in project costs to SB at close-out

$100K to $118K of annual cost avoidance in total utility costs

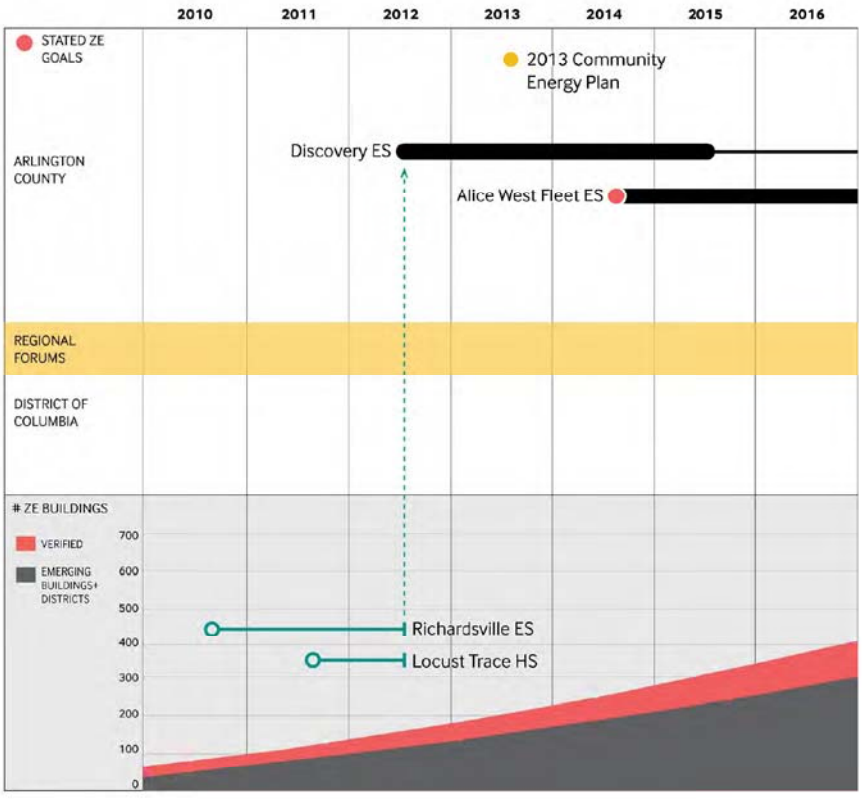
ANNUAL COST OF OWNERSHIP

$0.11/SF

Discovery Elementary

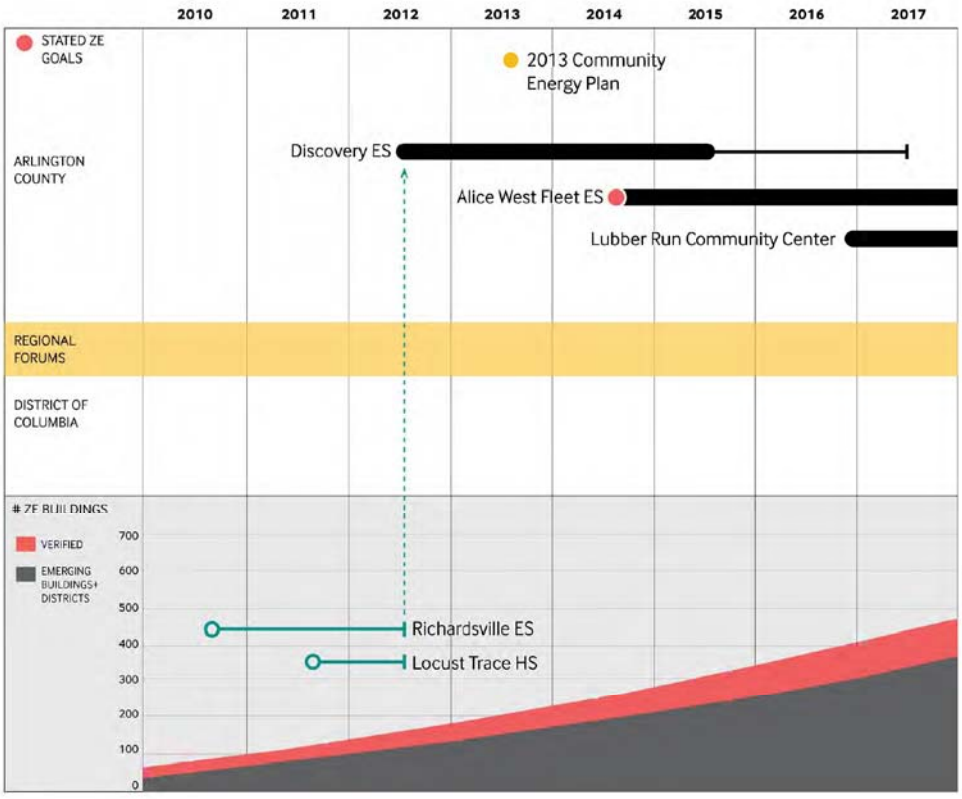
$1.32/SF

Average APS Elementary



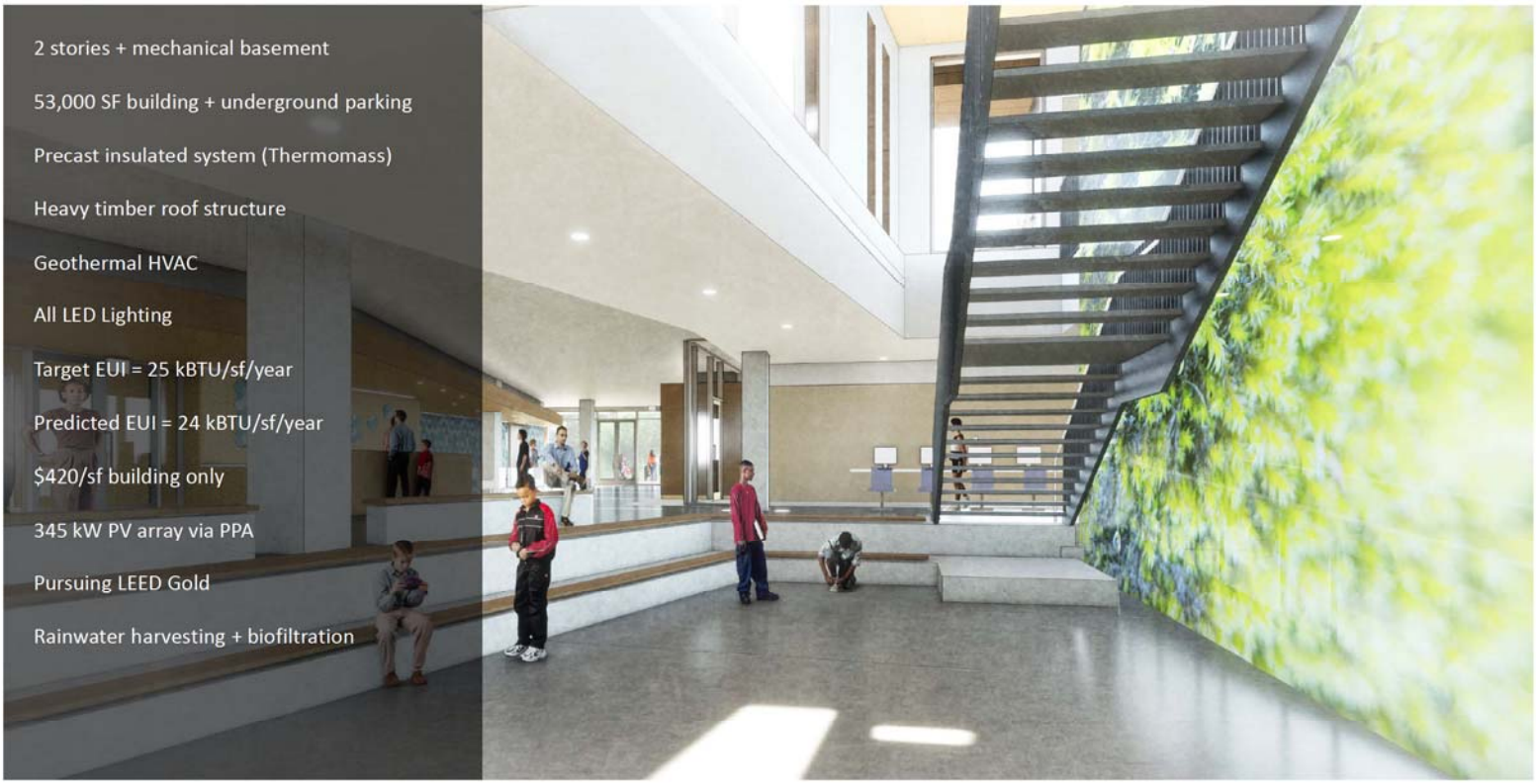
Fleet Elementary opened 2019 with PV via PPA $236/sf; $335/sf building only VMDO

2019 - Fleet Elementary School VMDO



2020 - Lubber Run Recreation Center

VMDO



2020 - Lubber Run Recreation Center

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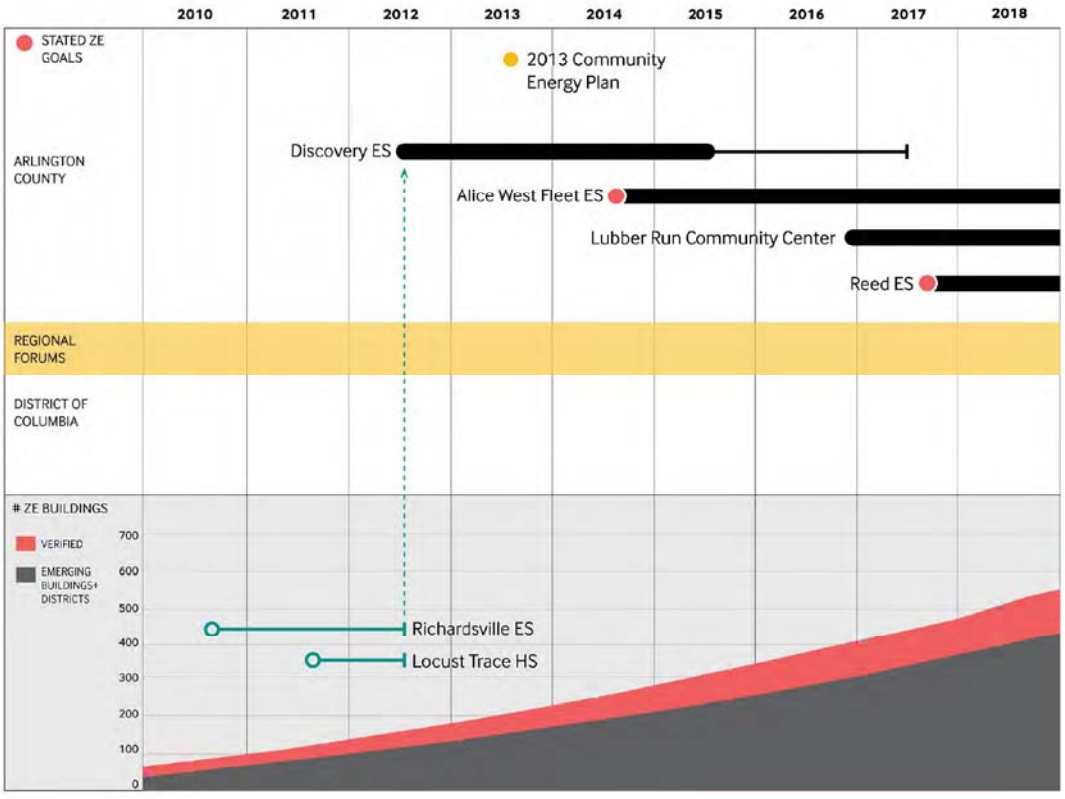
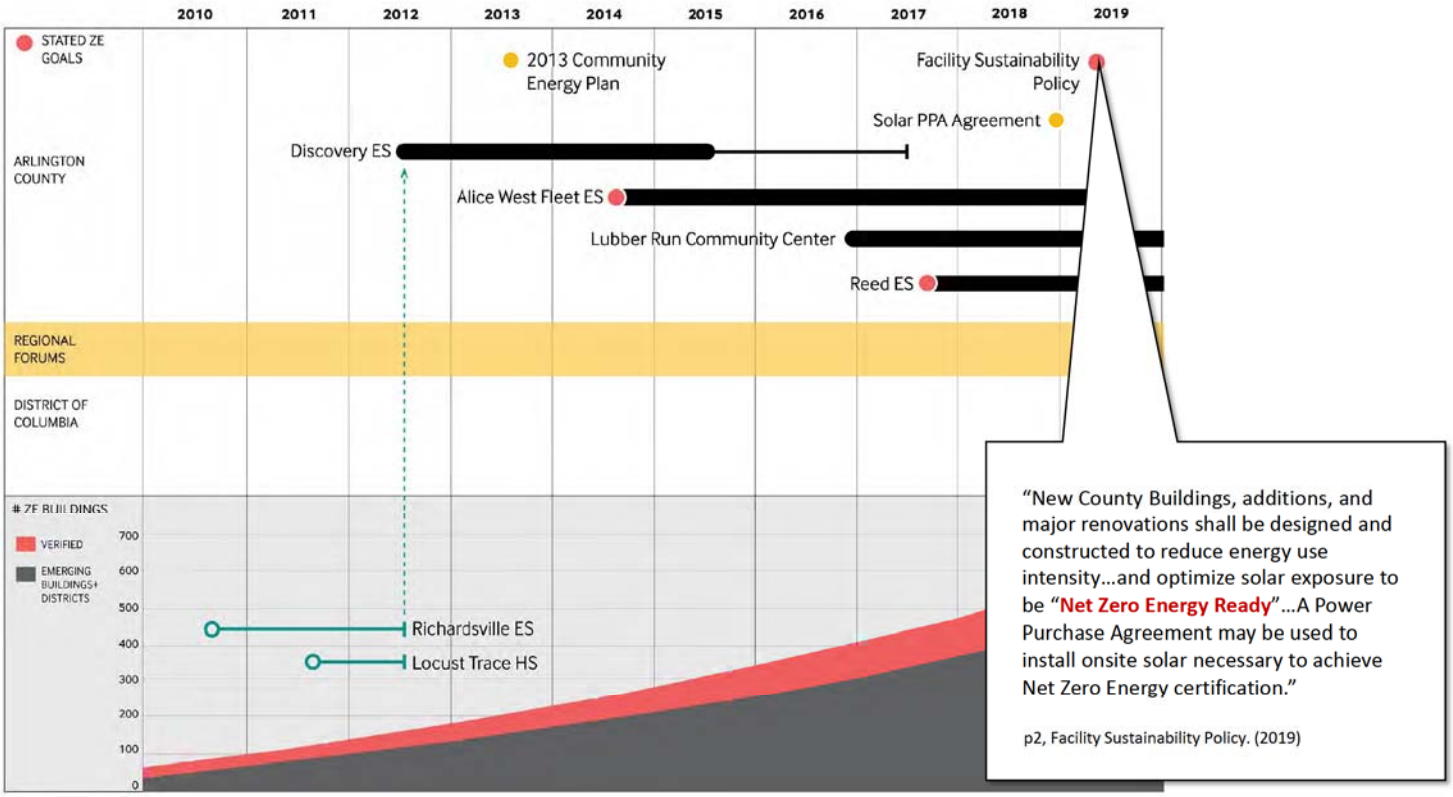


New Elementary at Westover/Reed site opening in 2021 $382/sf GMP VMDO

2021 - New Elementary School at Westover / Reed VMDO

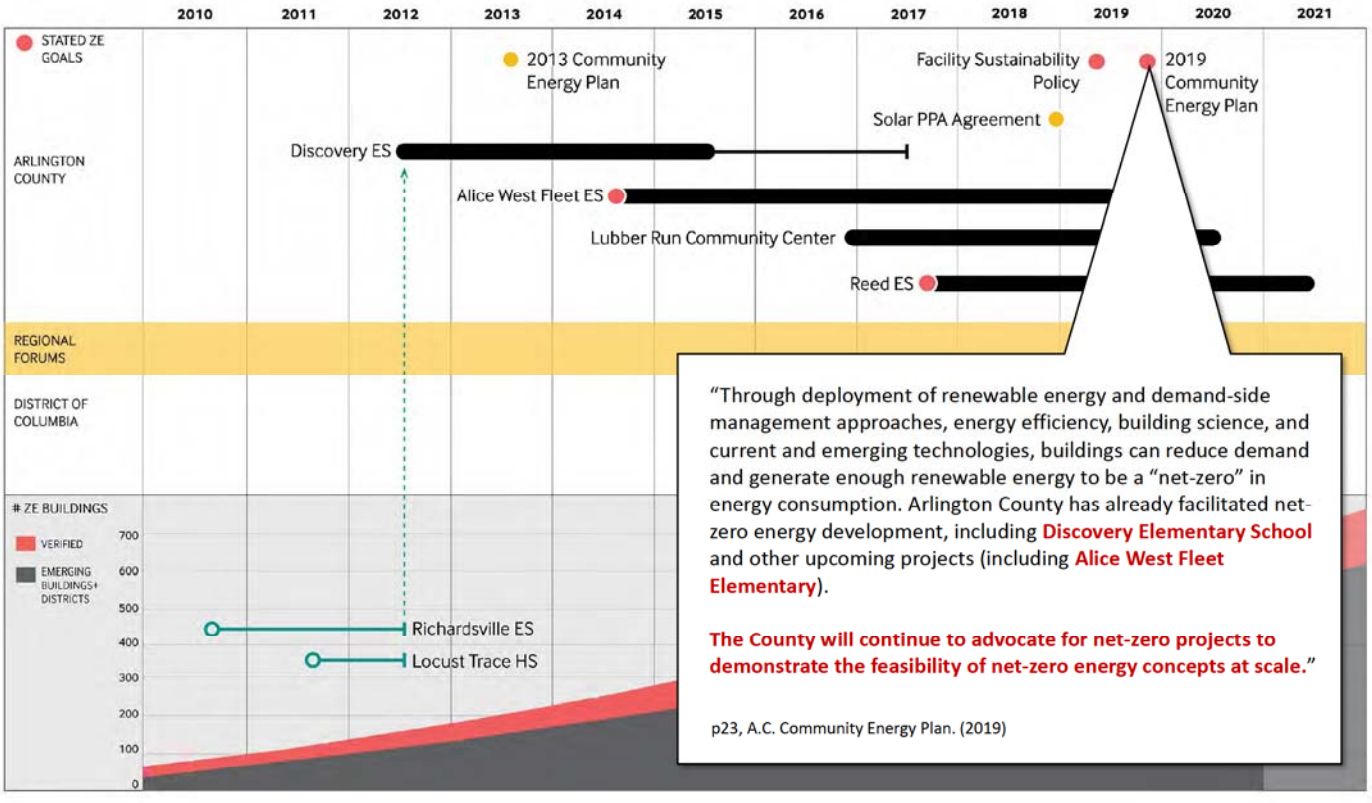


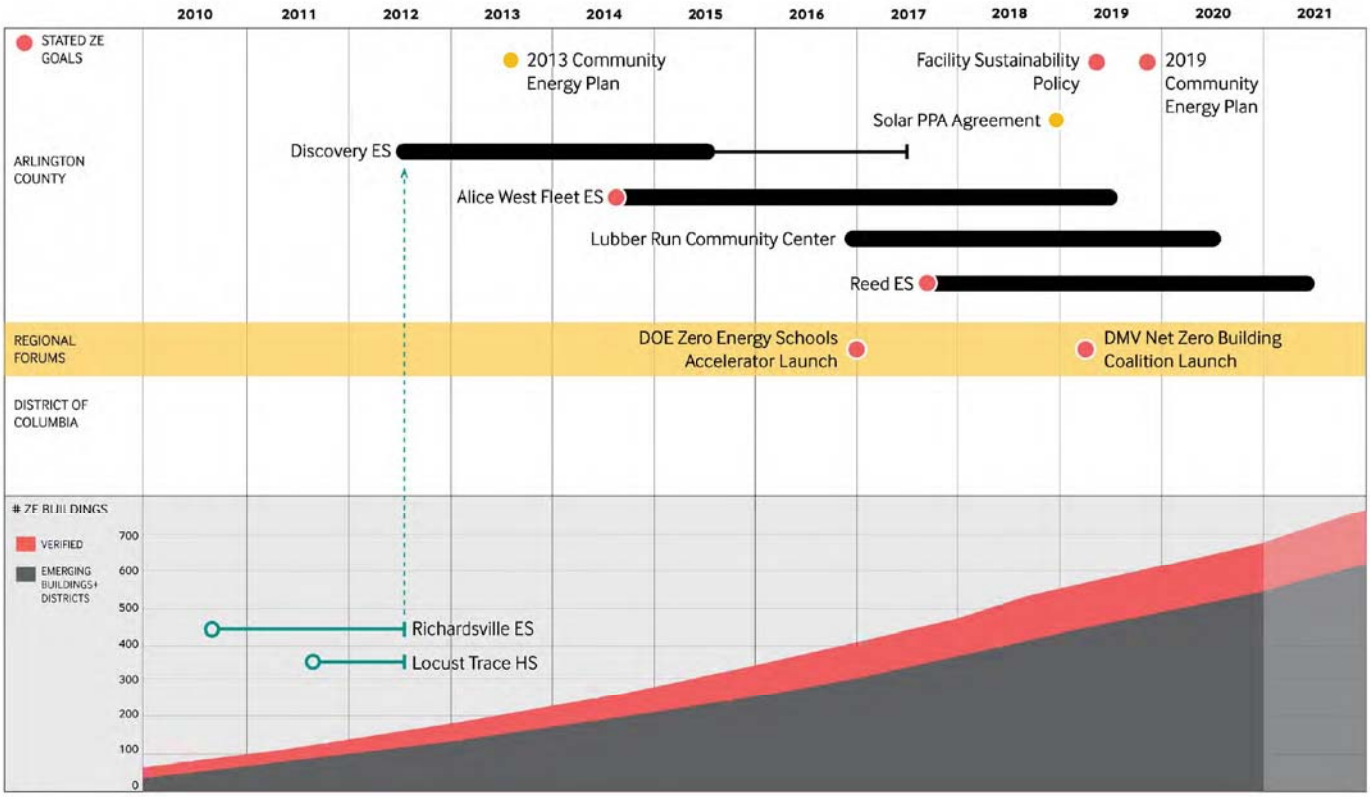
- Integrate learning, design, sustainable design, and environmental stewardship so that it supports and enhances student learning and student success
- Deliver a balanced design that achieves **Zero Energy** status as defined by the United States Department of Energy
- Meet these measurable high performance criteria
    - Maximum Energy Use Intensity (EUI): 21
    - On-site renewable energy generation that exceeds the EUI via a solar photovoltaic array
    - Overall minimum insulation R-values: 30-roof, 25-wall, 10-under-slab
    - Thermally broken windows with insulated glass
    - Glazing percentage: 35-40%
    - Airtightness: 0.15 cfm/sf
    - HVAC System: ground source heat pump with dedicated outdoor air system
    - Lighting System: all LED
- Provide building systems that are durable, straightforward to operate/control, and are easily maintained
- Consider Indoor Air Quality, Thermal/Acoustic/Visual Comfort, and Universal Design standards beyond the minimums required by building code

		RFP Req's: LEED	RFP Req's: Zero Energy
2012	Discovery ES	Silver Min. (2009)	Nothing on Zero Energy
2014	Fleet ES	Silver Min. (v4)	Zero Energy Goal
2017	Reed ES	Silver Min. (v4)	Zero Energy Requirement + specific targets for EUI, envelope, HVAC

Evolving RFP Language: 2012 - 2017

VMDO




2010
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2012
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2016
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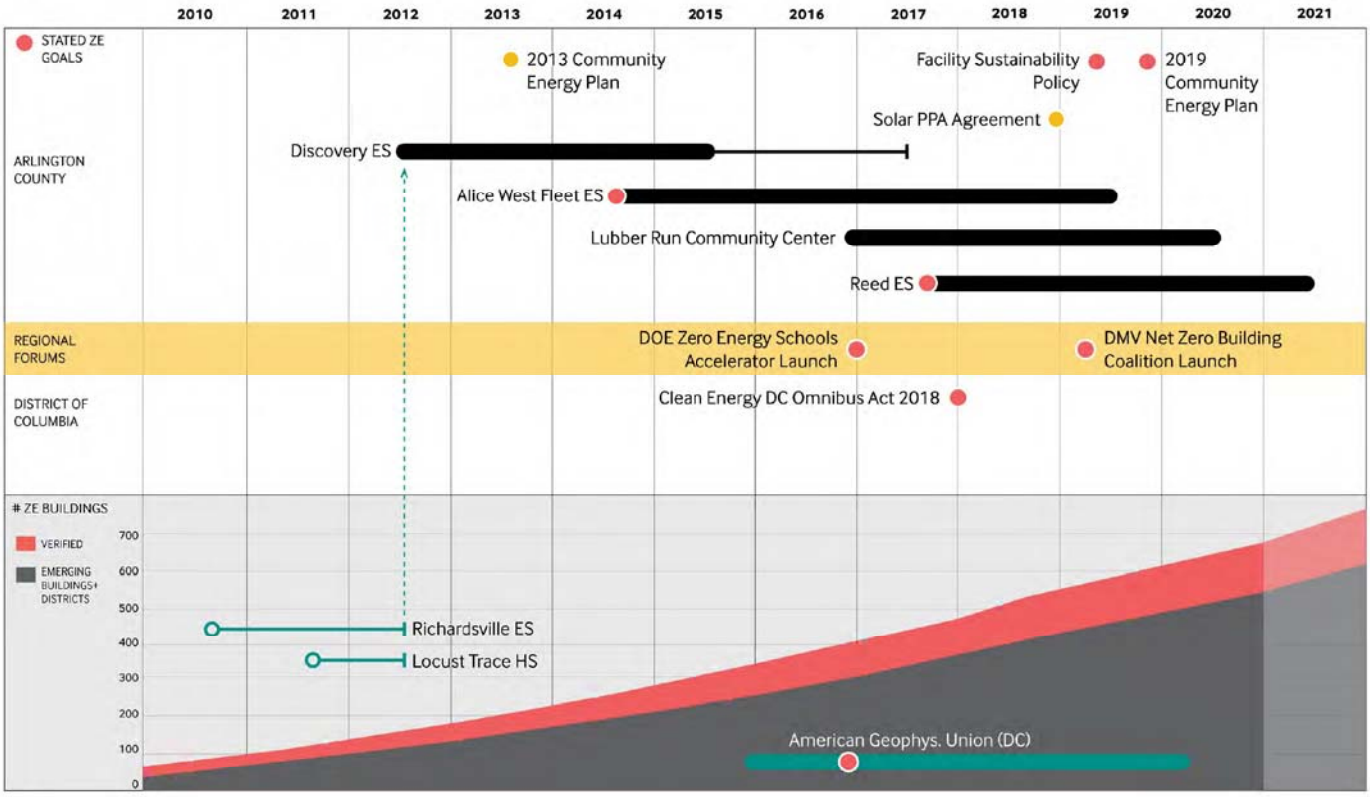
2018
2019
2020
2021
STATED ZE GOALS
2013 Community Energy Plan
Facility Sustainability Policy
2019 Community Energy Plan
Solar PPA Agreement
ARLINGTON COUNTY
Discovery ES
Alice West Fleet ES
Lubber Run Community Center
Reed ES
REGIONAL FORUMS
DOE Zero Energy Schools Accelerator Launch
DMV Net Zero Building Coalition Launch
DISTRICT OF COLUMBIA
ZE BUILDINGS
VERIFIED
EMERGING BUILDINGS+ DISTRICTS
700
600
500
400
300
200
100
0
Richardsville ES
Locust Trace HS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DISTRICT OF COLUMBIA
Clean Energy DC Omnibus Act 2018
ZE BUILDINGS
VERIFIED
EMERGING BUILDINGS+ DISTRICTS
700
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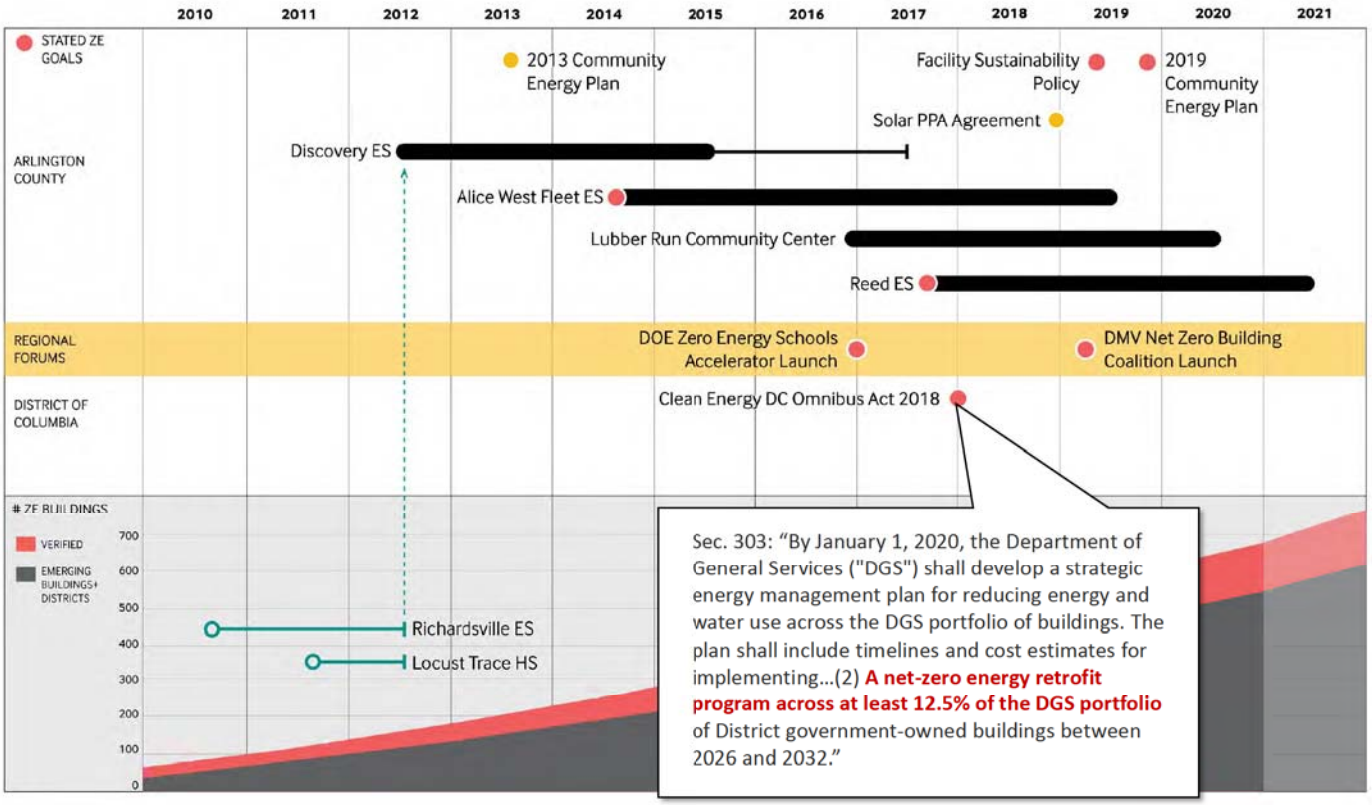
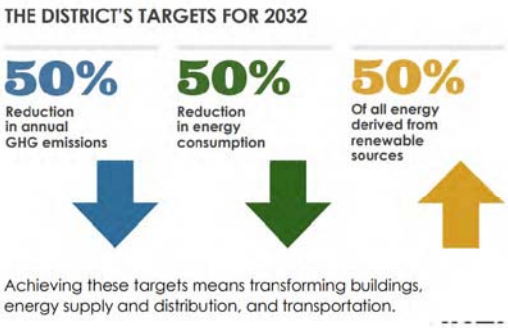
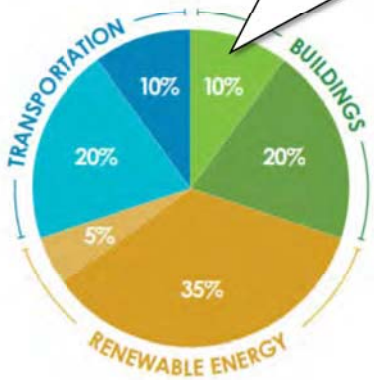
400
300
200
100
0
Richardsville ES
Locust Trace HS
American Geophys. Union (DC)

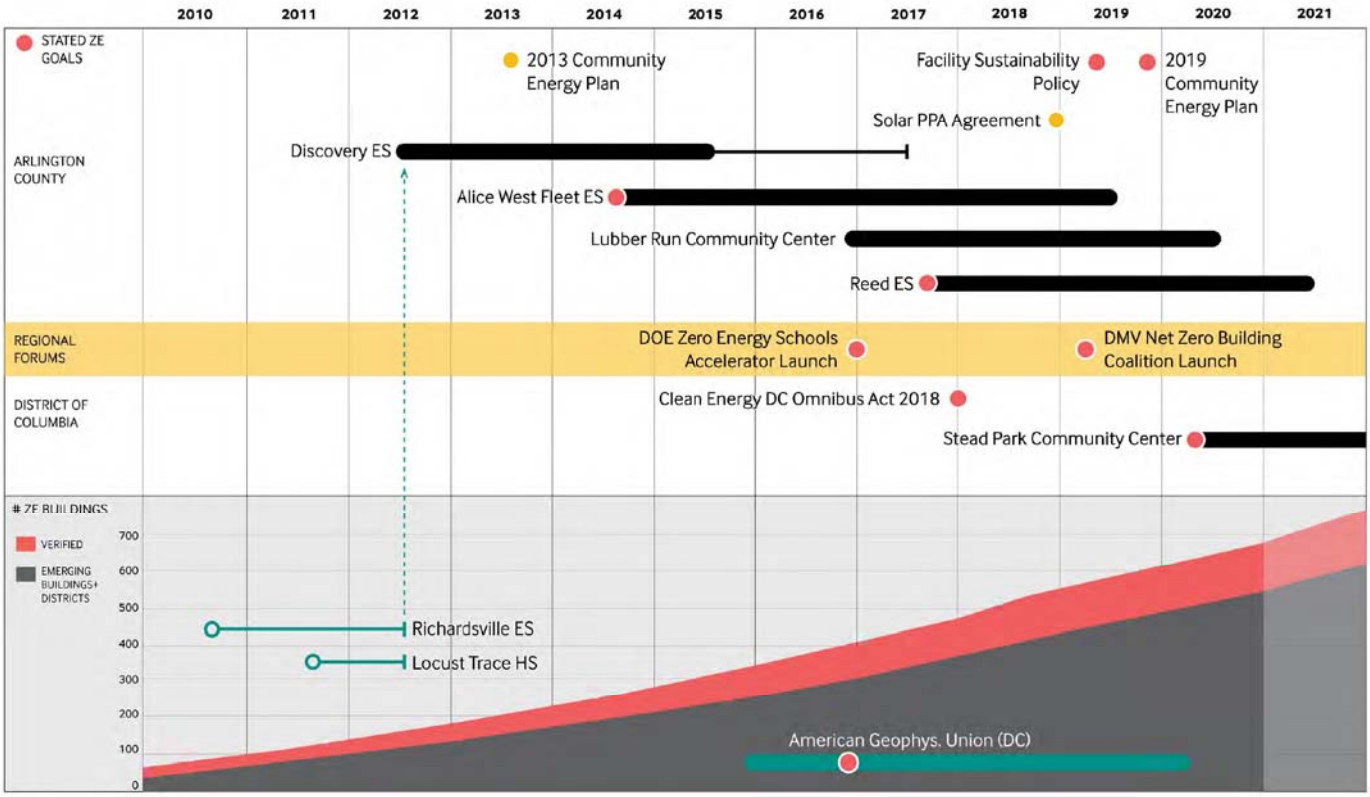


CLEAN ENERGY DC



ACTION AREAS:





Stead Park Community Center opening in 2022

VMDO

Keys to Transforming Markets

VMDO

1

Develop long-term relationships with key decision-makers

VMDO

2

Demonstrate how new buildings can be Zero Energy Ready…within current construction budgets.

VMDO

3

Leverage successful projects and happy clients

VMDO

4

Educate, educate, educate

VMDO

5

Work with municipalities to incorporate ZE criteria into their policies, RFPs and Codes.

VMDO

GETTING TO ZERO MARKET LANDSCAPE

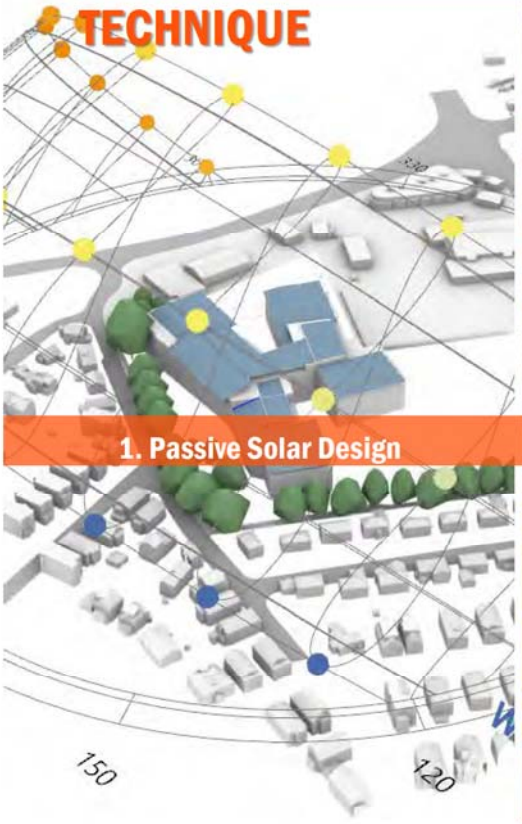
Technology + Technique

New Buildings Institute
September 24, 2020

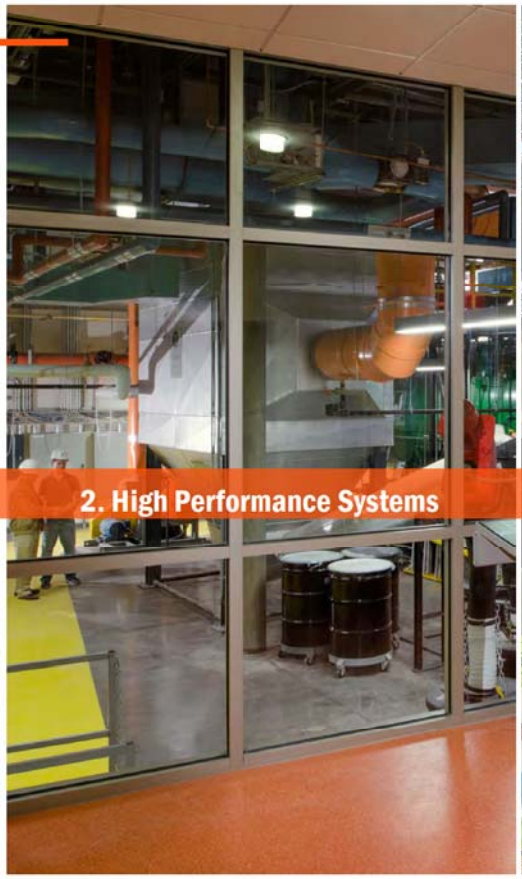
Dan Arons AIA, LEED
d.arons @ perkinseastman.com

PERKINS EASTMAN

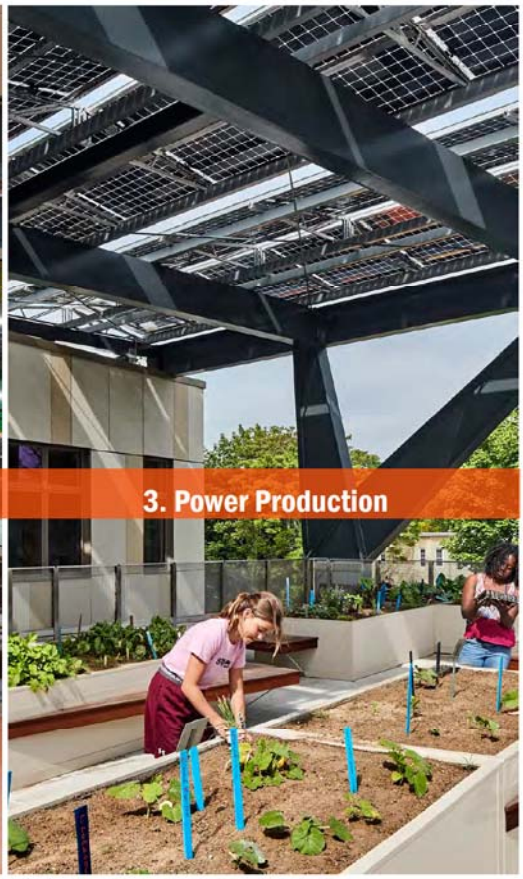
TECHNIQUE



1. Passive Solar Design

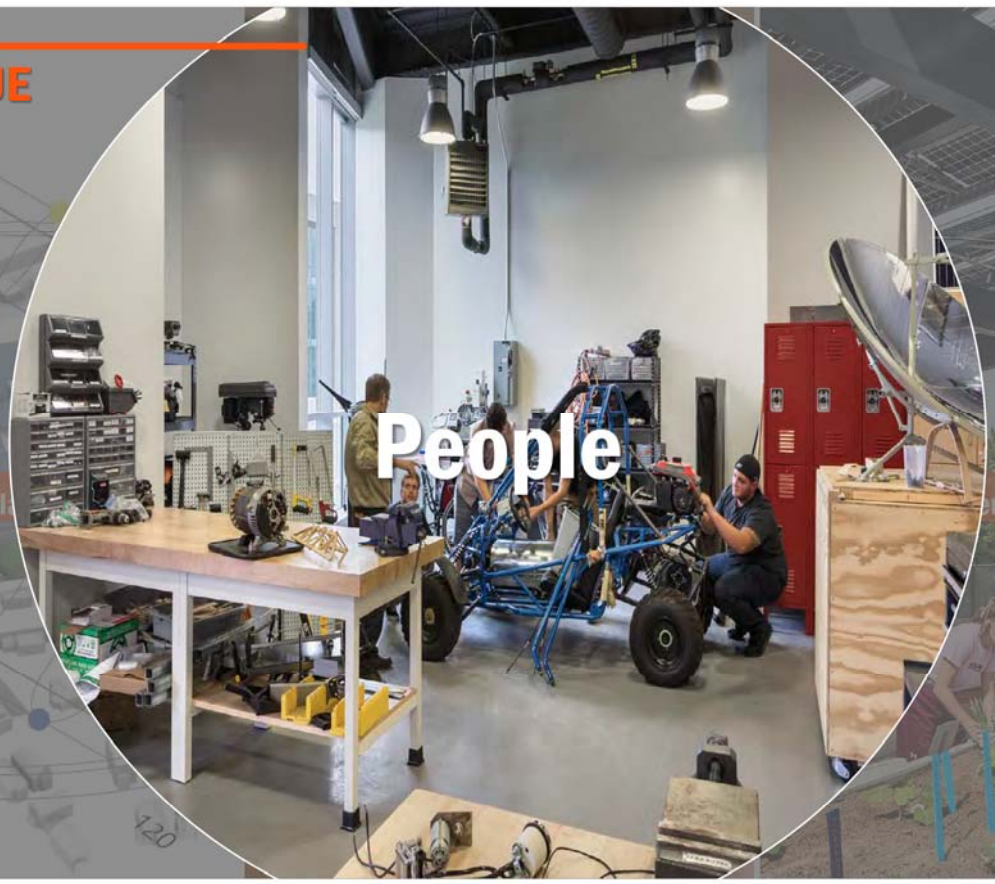


2. High Performance Systems



3. Power Production

TECHNIQUE

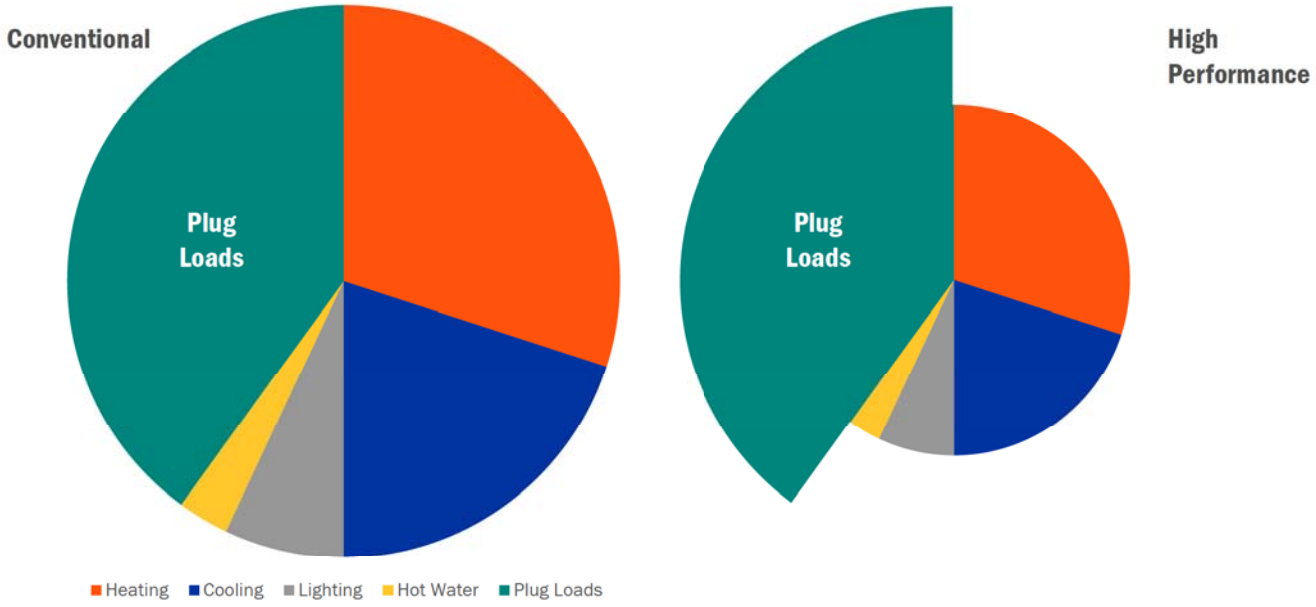


People

1. Passive Sol
er Production

THE POWER FACTOR

ENERGY COMPONENTS



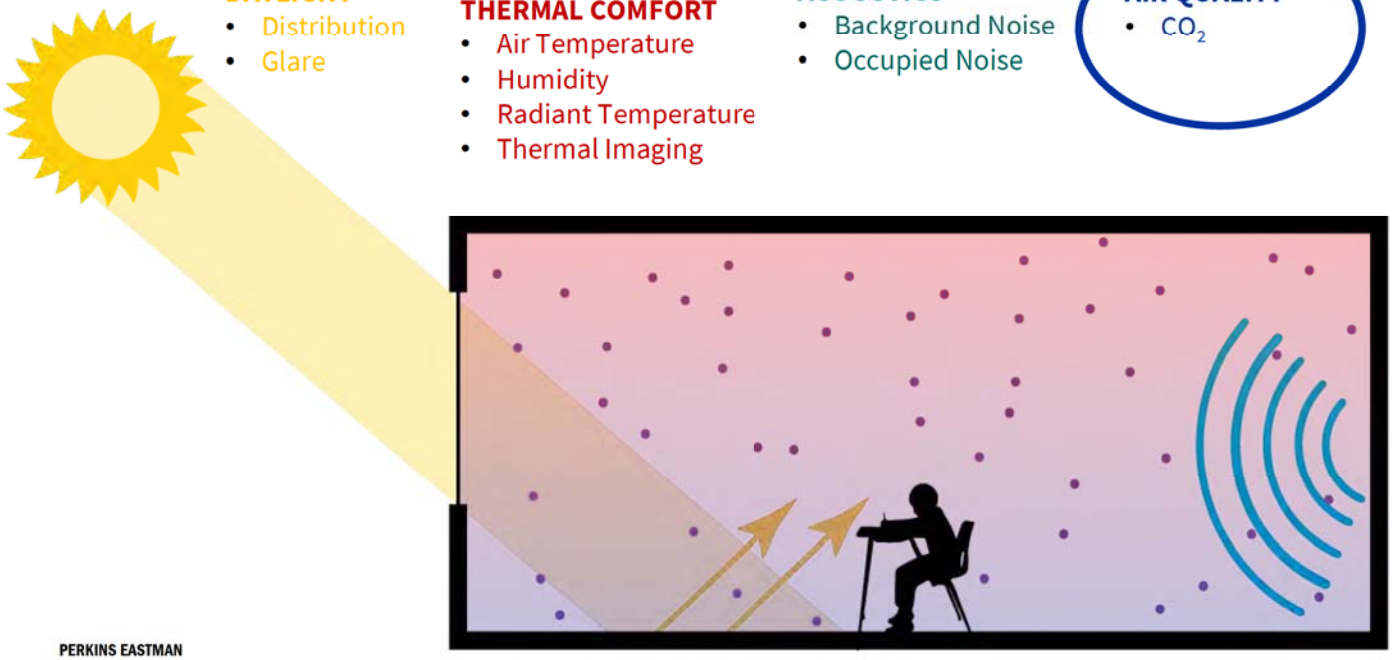
INDOOR ENVIRONMENTAL QUALITY

DAYLIGHT
- Distribution
- Glare

THERMAL COMFORT
- Air Temperature
- Humidity
- Radiant Temperature
- Thermal Imaging

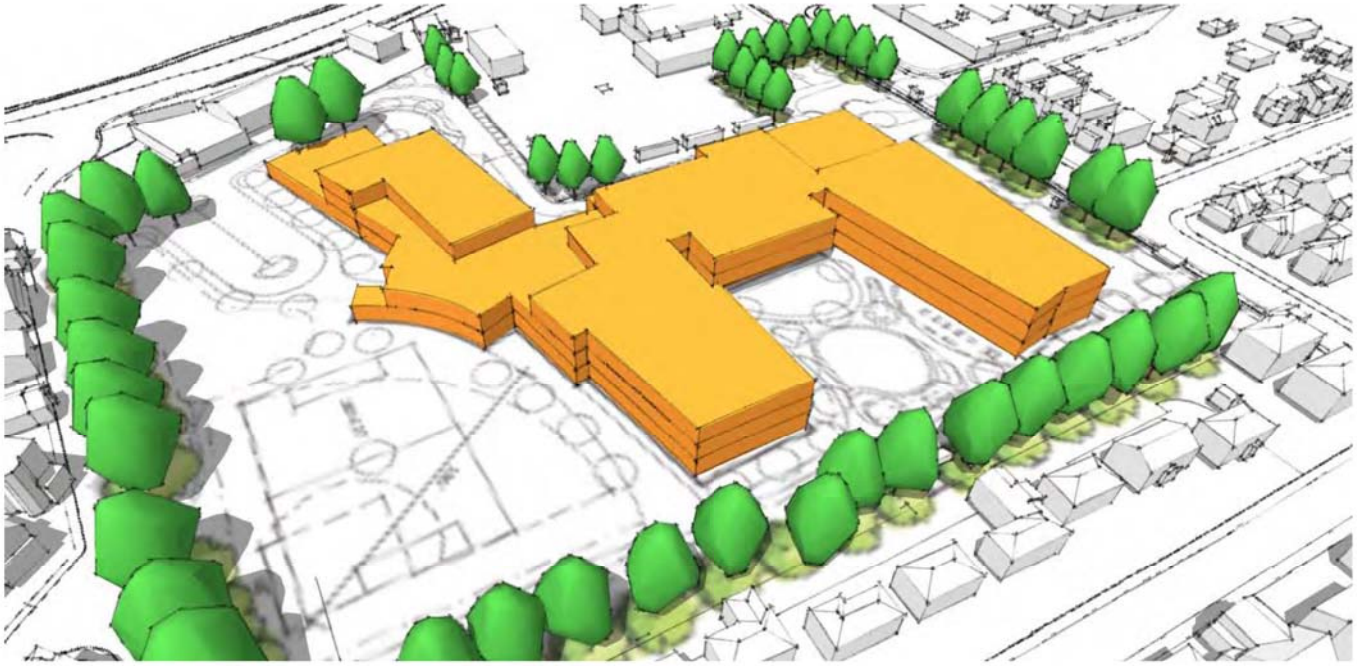
ACOUSTICS
- Background Noise
- Occupied Noise

AIR QUALITY
- CO_2



TOBIN MONTESSORI/VASSAL LANE SCHOOLS

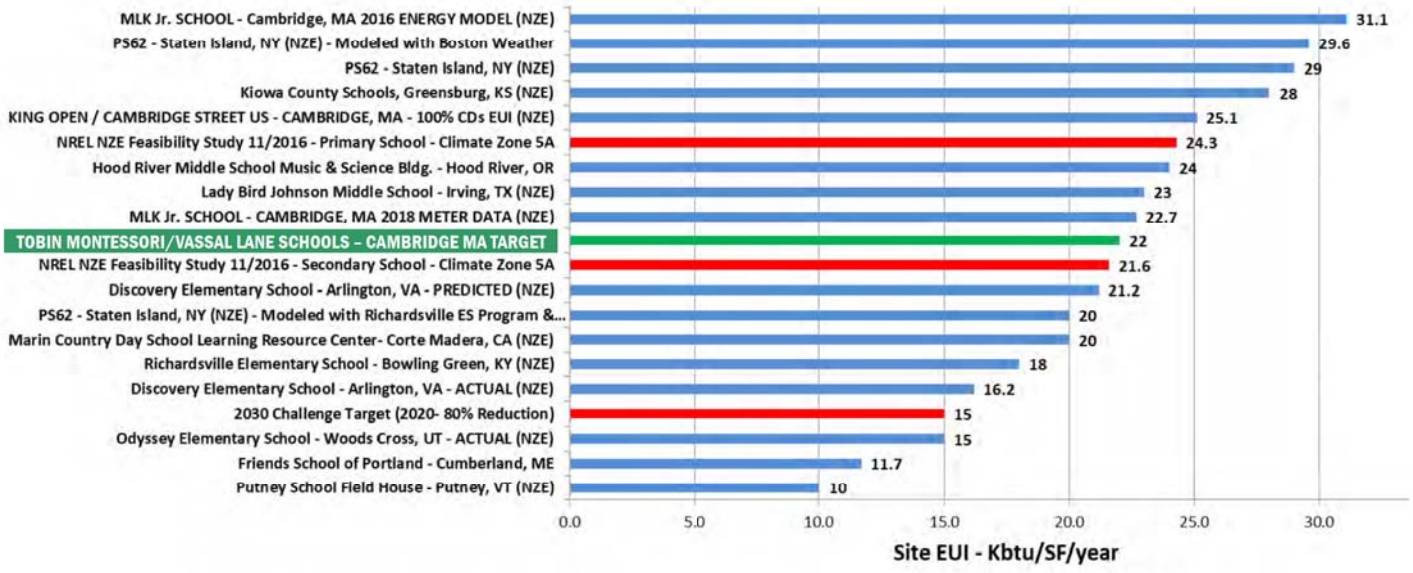
NZE CONCEPT



TOBIN MONTESSORI/VASSAL LANE SCHOOLS

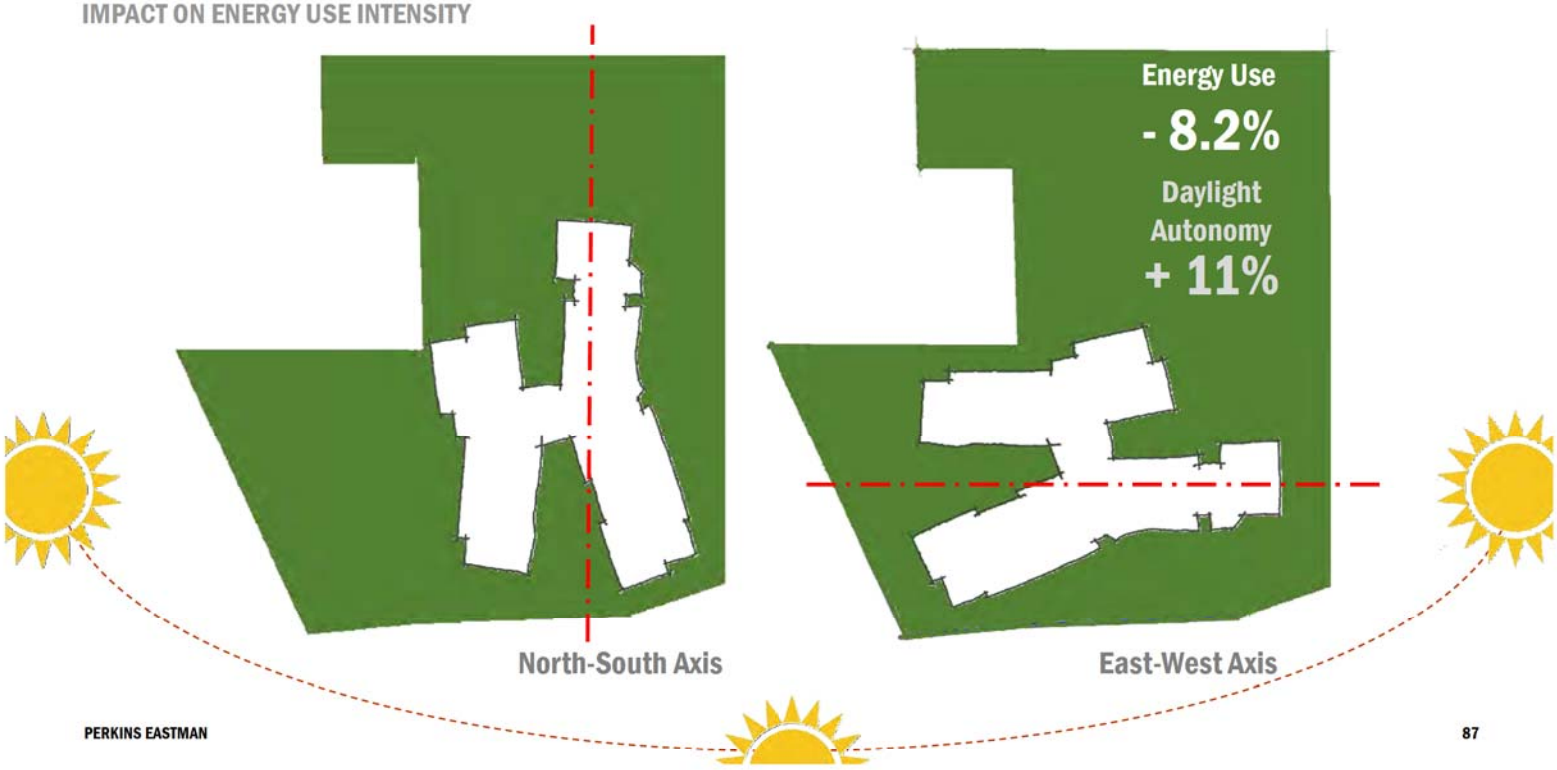
EUI BENCHMARKING VS NZE SCHOOLS

Load = 22 kbtu/sf-yr
PV Power = 66 kbtu/sf-yr
So Power = 3 X Load



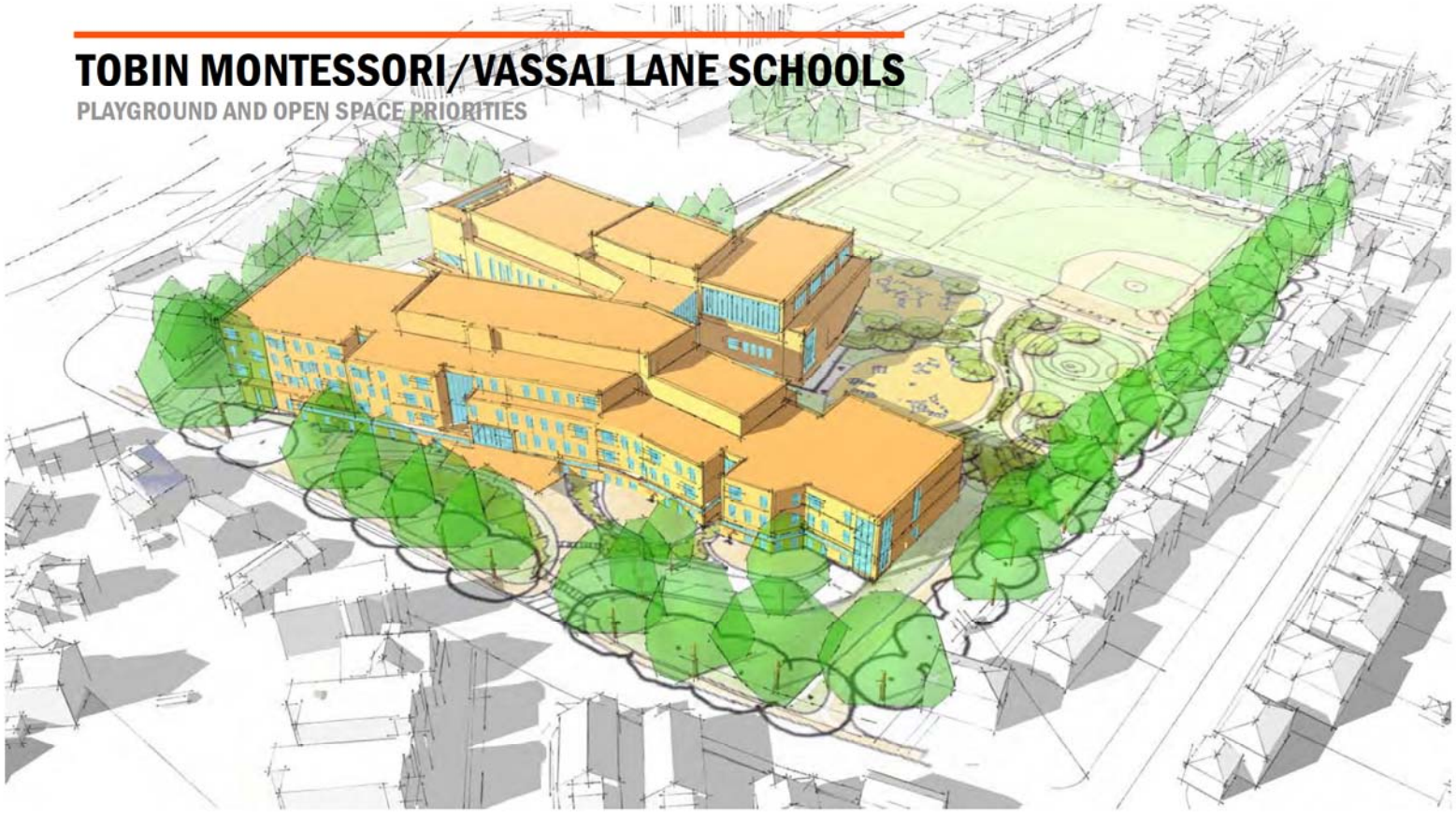
BENEFIT OF SOLAR ORIENTATION

IMPACT ON ENERGY USE INTENSITY



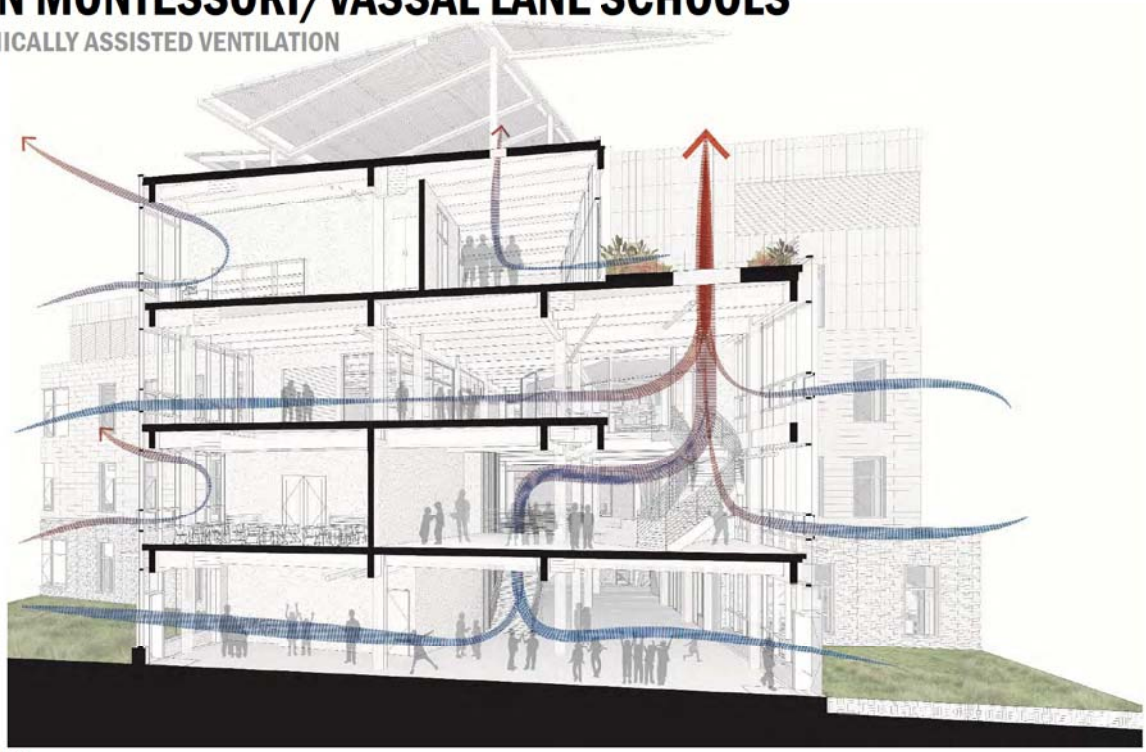
TOBIN MONTESSORI/VASSAL LANE SCHOOLS

PLAYGROUND AND OPEN SPACE PRIORITIES



TOBIN MONTESSORI/VASSAL LANE SCHOOLS

MECHANICALLY ASSISTED VENTILATION



TOBIN MONTESSORI/VASSAL LANE SCHOOLS

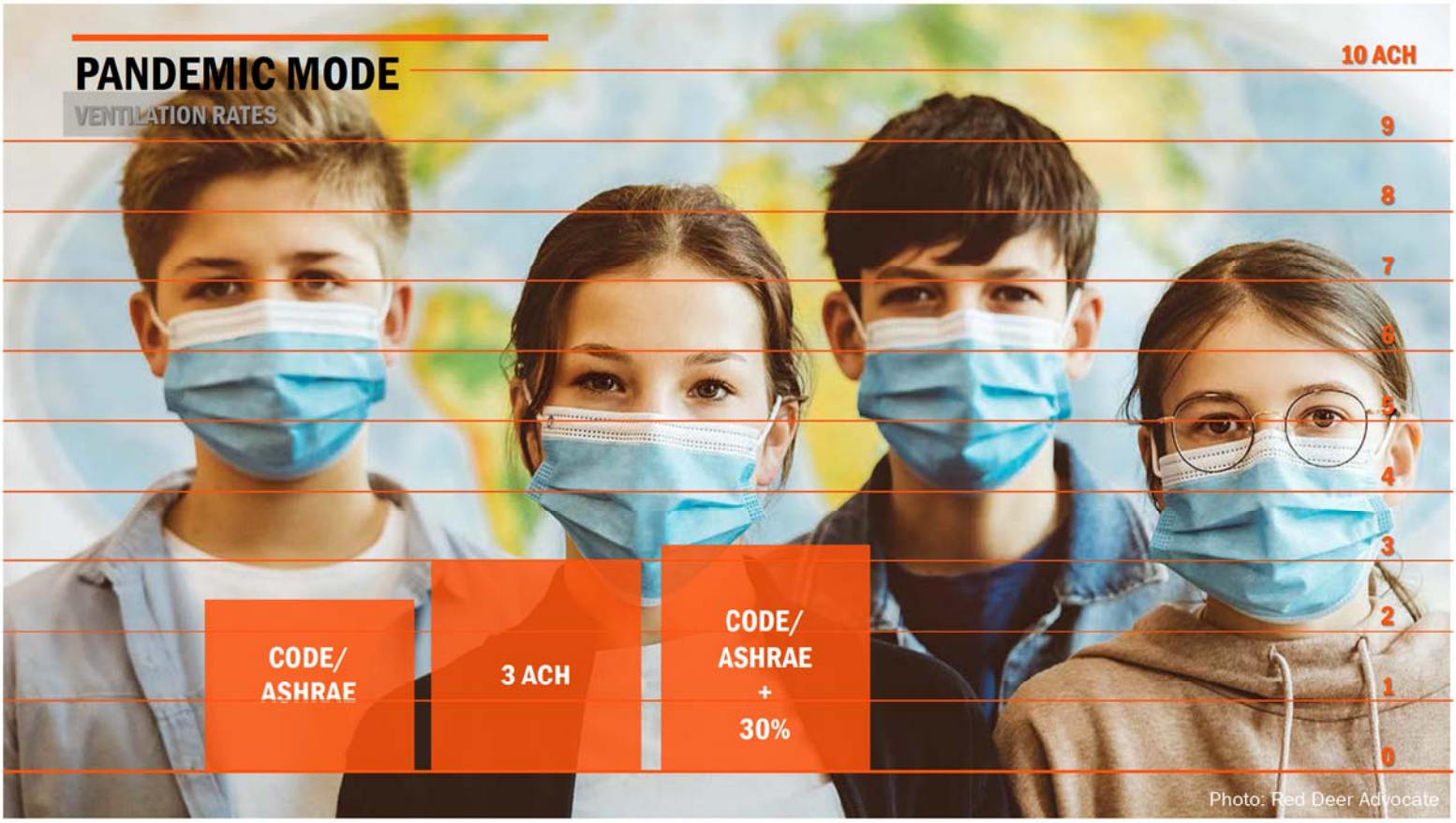
PV FINESSE

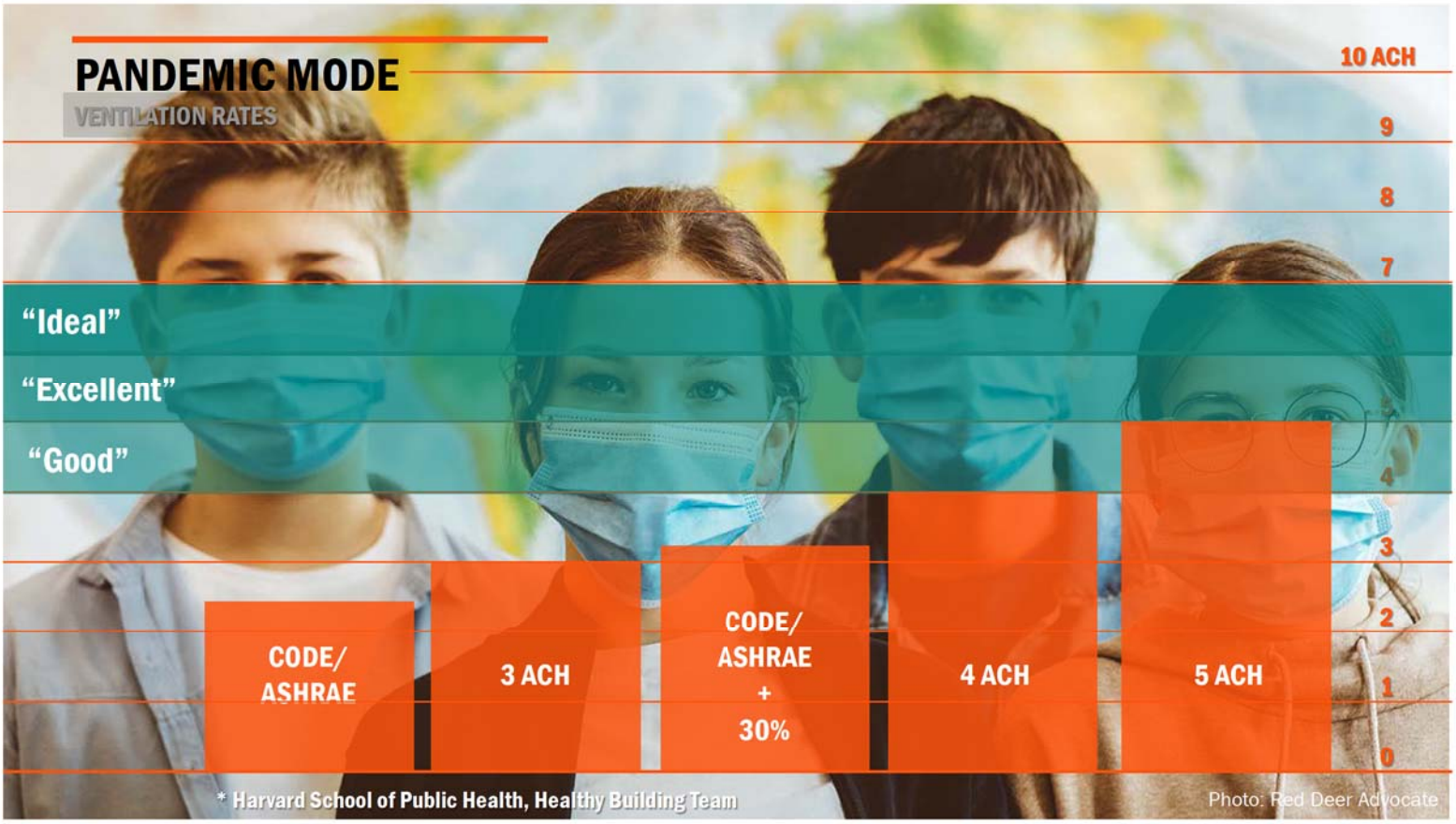
Spotlight Solar

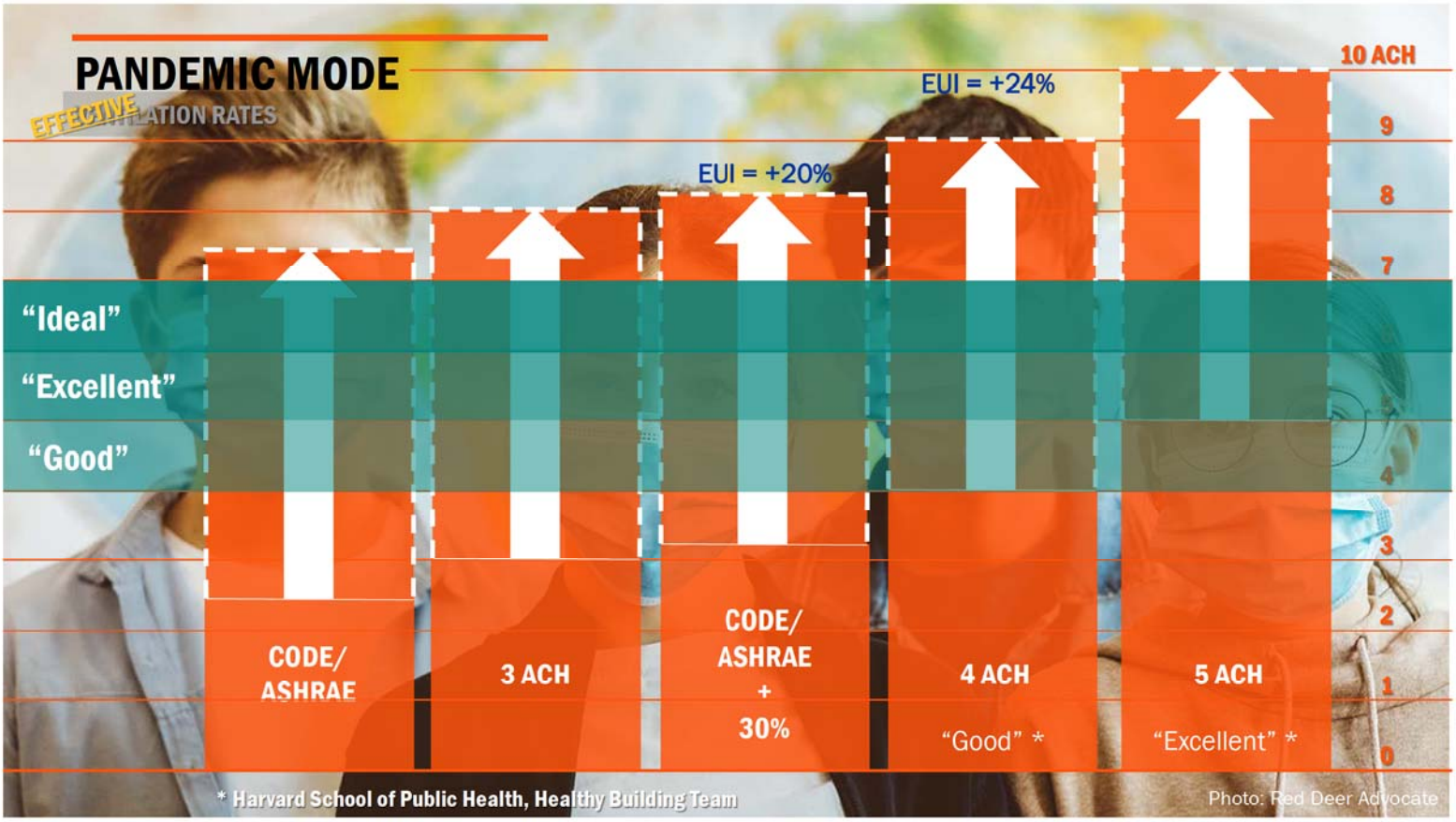
PANDEMIC MODE

VENTILATION RATES

Photo: Red Deer Advocate


PANDEMIC MODE
VENTILATION RATES
10 ACH
9
8
7
6
5
4
3
2
1
0
CODE/ ASHRAE
3 ACH
CODE/ ASHRAE + 30%
Photo: Red Deer Advocate


PANDEMIC MODE
VENTILATION RATES
10 ACH
9
8
7
"Ideal"
"Excellent"
"Good"
4
3
2
1
0
CODE/ ASHRAE
3 ACH
CODE/ ASHRAE + 30%
4 ACH
5 ACH
* Harvard School of Public Health, Healthy Building Team
Photo: Red Deer Advocate



PROJECT PRIORITIES

- **High Performance Education –**
  healthy, vibrant, effective
- **Low Energy, Low Carbon Building**
  including passive solar and hybrid wood structure
- **Maximum Power Production**
  "Power and Finesse" for building, façade and site
- **Sustainable, Educational Site Integration**
  ecological landscape and materials, rainwater reuse

PERKINS EASTMAN

Technology + Technique

Image Credits:

Slide 1.	Perkins Eastman, Tobin/Vassal Schools
Slide 2.	Architerra, Keene State College, MA Division of Fisheries and Wildlife, SUNY Environmental Sciences and Forestry College, Mount Wachusett CC
Slide 3.	Perkins Eastman, Solar Study and MLK School Architerra, SUNY ESF
Slide 4.	Perkins Eastman, Stockton University Maker Space
Slide 16.	Perkins Eastman, MLK School Architerra, Mount Wachusett CC
All Others	Perkins Eastman, Tobin/Vassal Schools

Dan Arons AIA, LEED
d.arons @ perkinseastman.com

PERKINS EASTMAN

ASHRAE®

ASHRAE's New Headquarters: Applying Sustainable Development Principles in the Real World

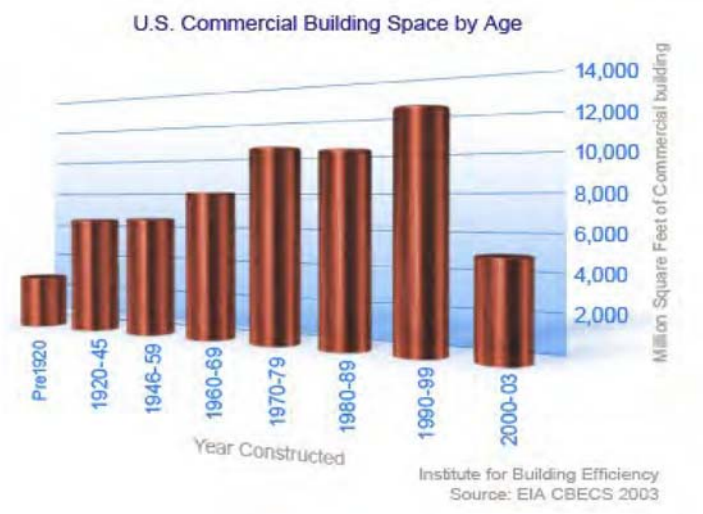
Darryl K. Boyce, P.Eng.
2019-20 ASHRAE President

Existing ASHRAE Headquarters

- *1791 Tullie Circle NE, Atlanta, GA*
- *35,000 sq. ft. building – 2 stories with learning center on 1st level*
- *Renovated in 2008 to LEED Platinum level*
- *Sold to CHOA in 2018*

New ASHRAE Headquarters

- *180 Technology Parkway, Peachtree Corners, GA*
- *66,000 sq. ft. building – 3 stories*
- *Built in 1970's*
- *Purchased in Dec. 2018*



PROJECT GOAL

In developed economies, at least half of the buildings that will be in use in 2050 *have already been built.*[4 5] According to a recent survey by the U.S. Energy Information Agency, 72 percent of floorstock in the U.S., or 46 billion square feet, belongs to buildings over twenty years old.[6]

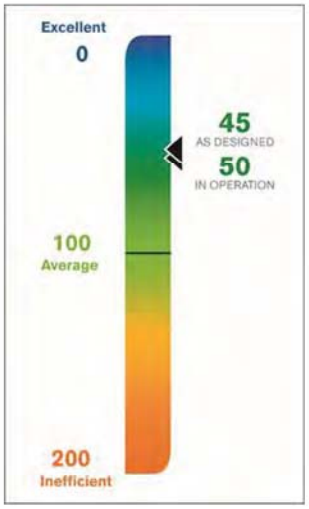
Project Goal:

To renovate a 1970's building into a high-performing net-zero-ready facility in a cost-effective method that can be replicated in the industry.

Owner's Project Requirements (OPR)

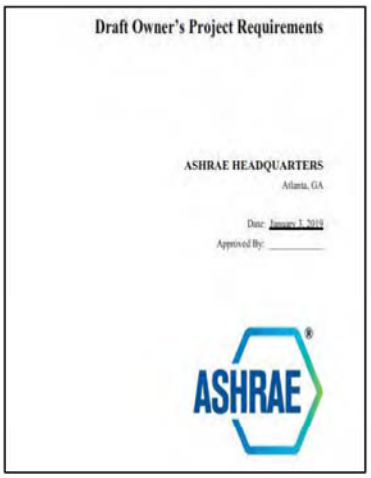
Item	OPR	Actual
ASHRAE 189.1-2017	Exceed Requirements	
Demand Side Site Energy Consumption	21.4 kBTU/SF/year 15 kBTU/SF/year (stretch)	
Water Efficiency	Obtain 11 of 11 LEED Water Use Efficiency Points	
Daytime Plug Load	0.04 W/SF	
Acoustics	Exceed requirements by 3-5 NC/RNC	
Outside Air Rate	1.3 times ASHRAE 62.1	
Outside Air Control	Demand Control Ventilation (DCV) for high occupancy spaces	
Daylighting	Majority of Occupants achieve generous daylighting 55% of the time	
Resiliency	Achieve resiliency in OPR	

OWNER PROJECT REQUIREMENTS



Certification Programs Considered

- LEED
- Green Globes
- WELL Building
- FitWel
- Living Building Challenge
- **ASHRAE Building EQ**


Draft Owner's Project Requirements

ASHRAE HEADQUARTERS

Atlanta, GA

Date: January 1, 2018

Approved By: _____

ASHRAE

ASHRAE STANDARDS we must meet or exceed…

ANSI/ASHRAE/IES Standard 90.1-2016

ANSI/ASHRAE 55-2017

ANSI/ASHRAE 62.1-2016

ASHRAE Standard 189.1-2017

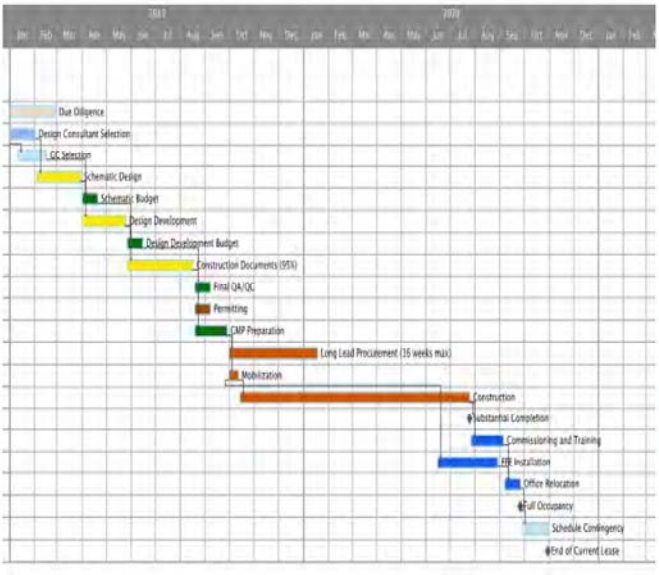
ASHRAE Guideline 0-2013

ASHRAE Guideline 1-2017

ASHRAE Thermal Guidelines for Data Processing Environments

ASHRAE Advanced Energy Design Guide for Zero Energy Office Buildings

Schedule Constraints



Jan., 2019: Design Team Selection

Feb., 2019: Construction Manager Selection

April 1, 2019: Schematic Design Complete

May 15, 2019: Design Development Complete

August 1, 2019: Construction Documents Complete

Sept. 15, 2019 – Start Construction Phase

August 15, 2020 – Construction Complete

August – Sept., 2020 – Commissioning Efforts

October 2020 – Full Occupancy

ASHRAE®

Request for Proposal for Planning and Design Services

ASHRAE

New Headquarters Building

Peachtree Corners, GA

January 4, 2019

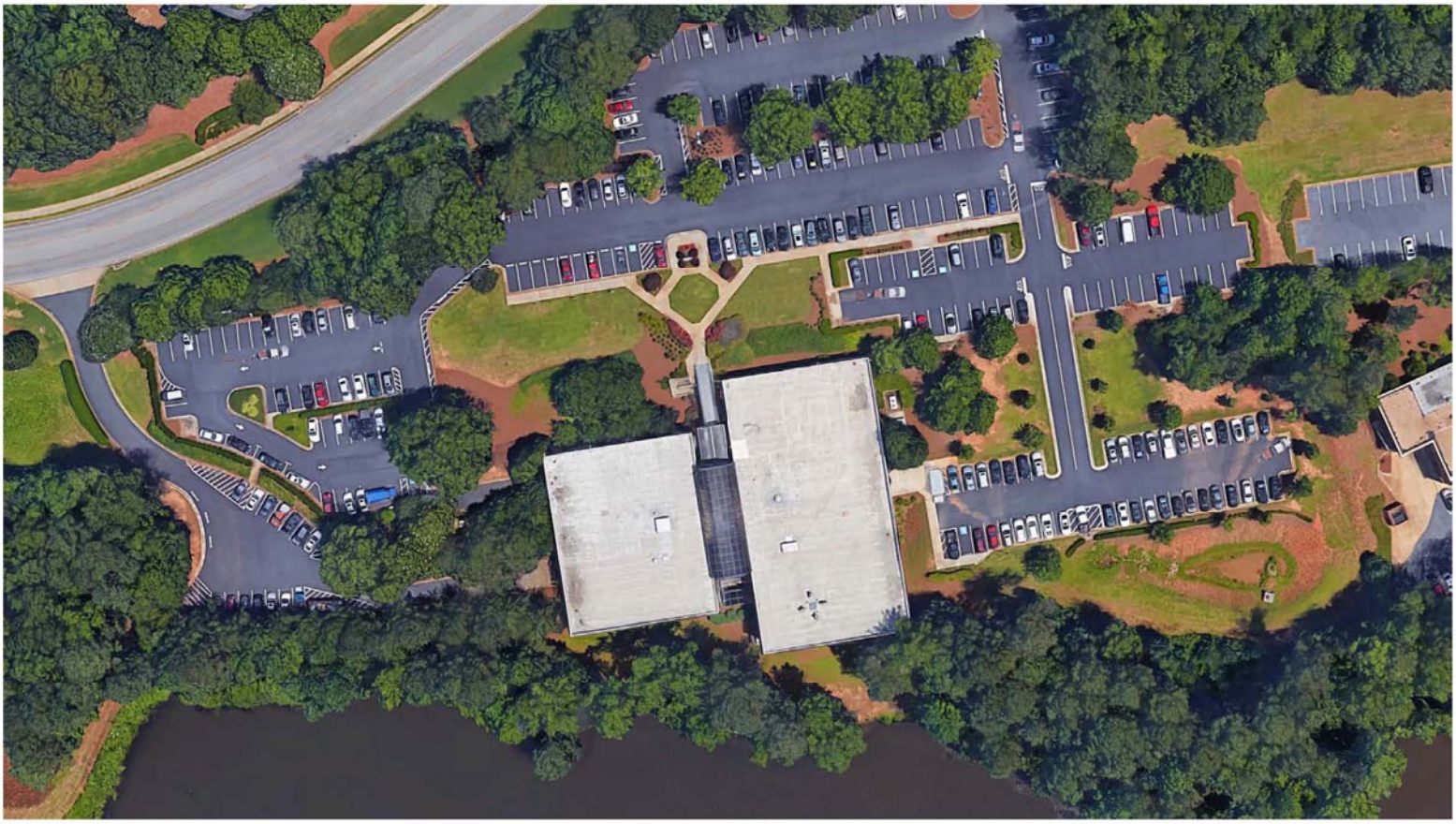
TABLE OF CONTENTS

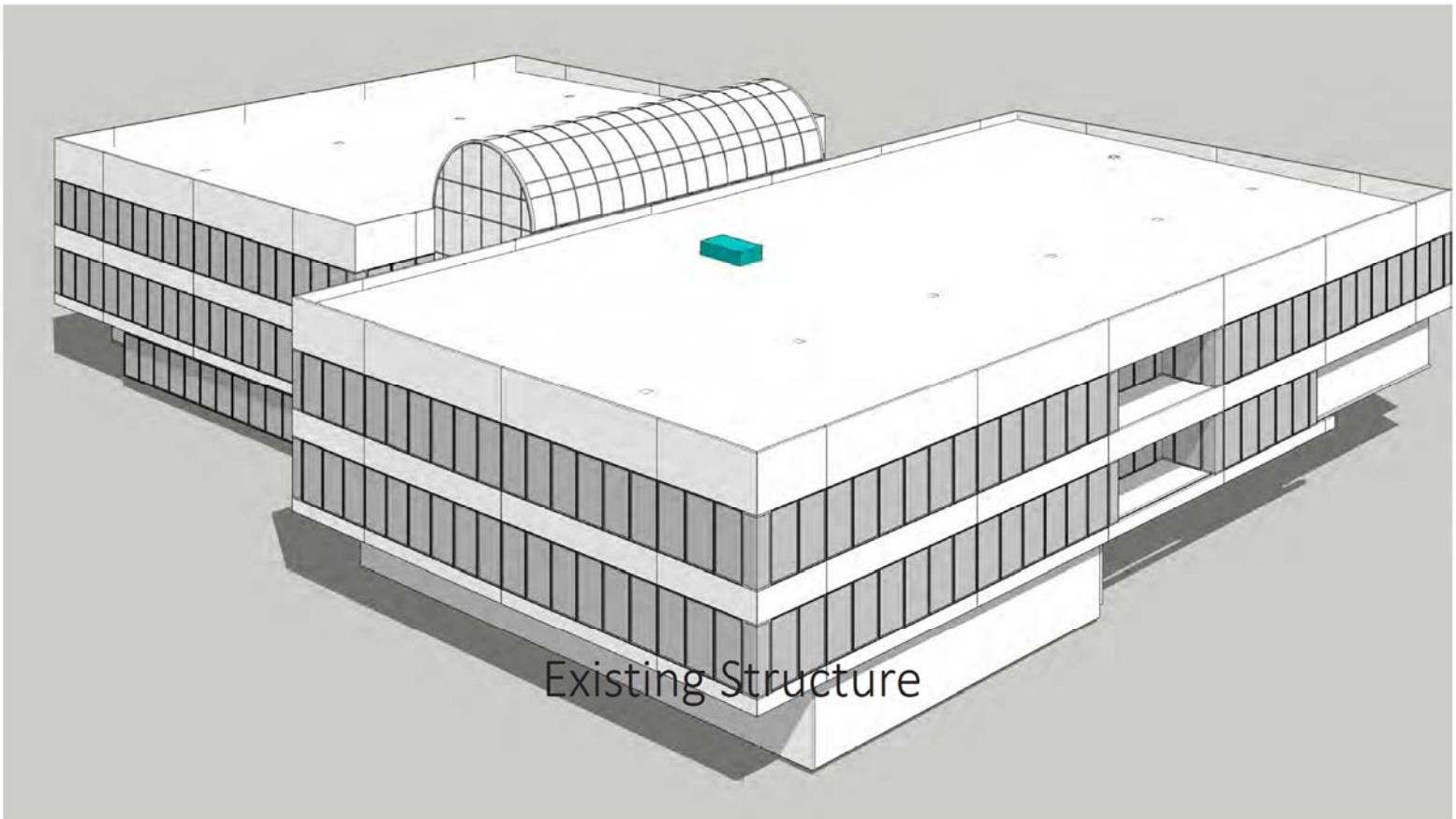
1. Introduction and Project Description
2. Proposal Requirements
3. Instructions

COLLINS PROJECT MANAGEMENT

HOW DO WE ACHIEVE OUR PROJECT GOAL?

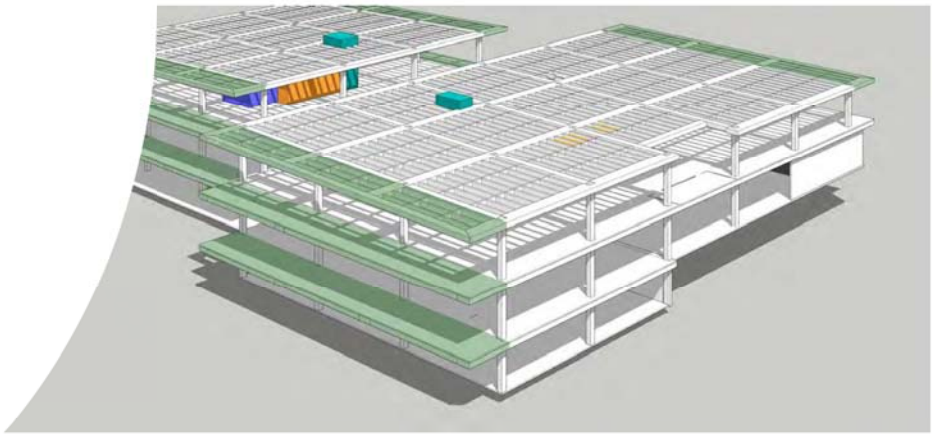
- Set Construction Budget: $ 10,905,000 ($165/sq. ft. minus donations & PV)
- Total project budget including purchase of the property and fit-up: $20,000,000.
- Set Project Schedule: Must move in by Oct. 2020
- Set Project Criteria: Owner Project Requirements were set
- Hire a competent team!

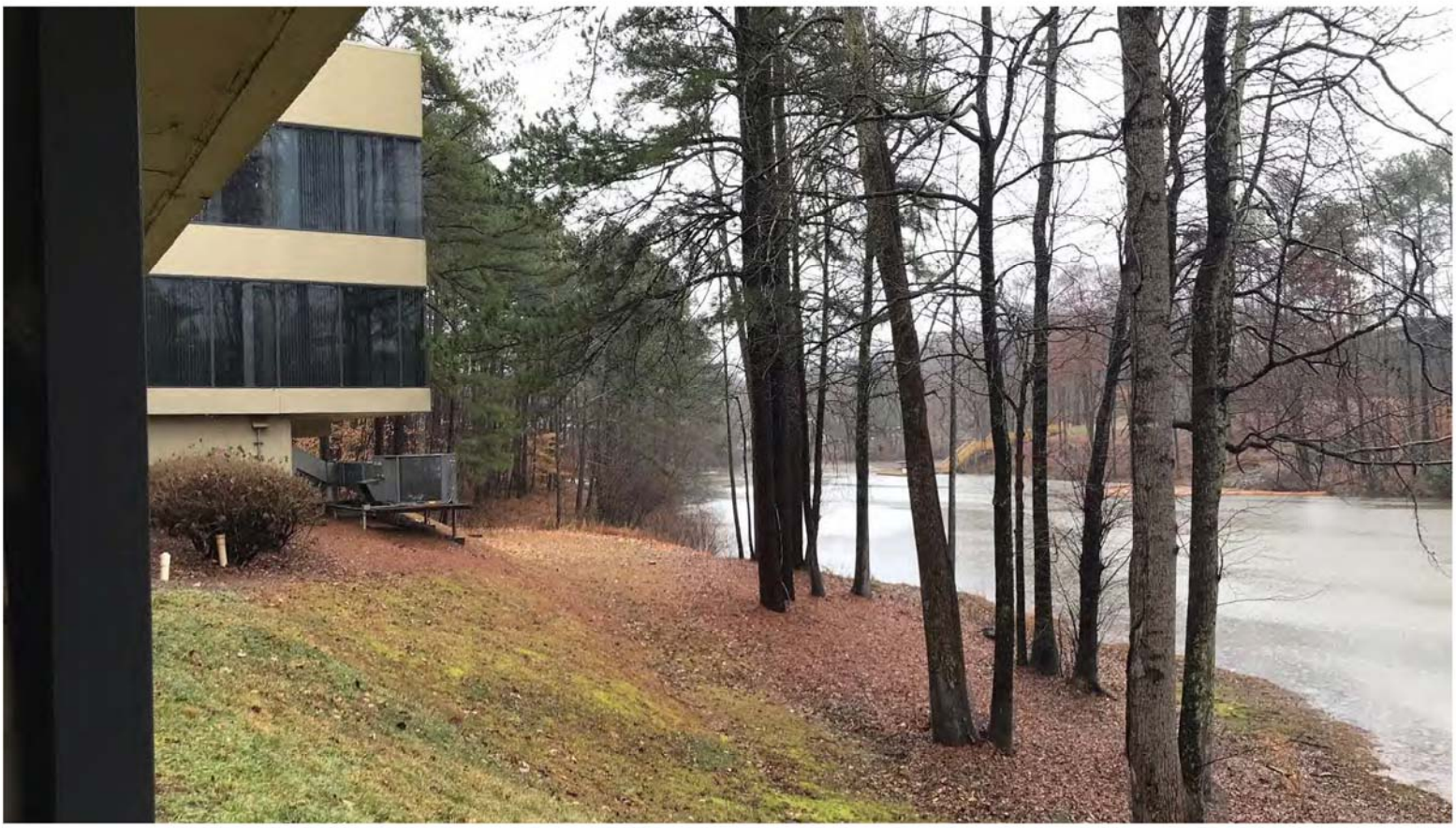




Existing Structure

Frame



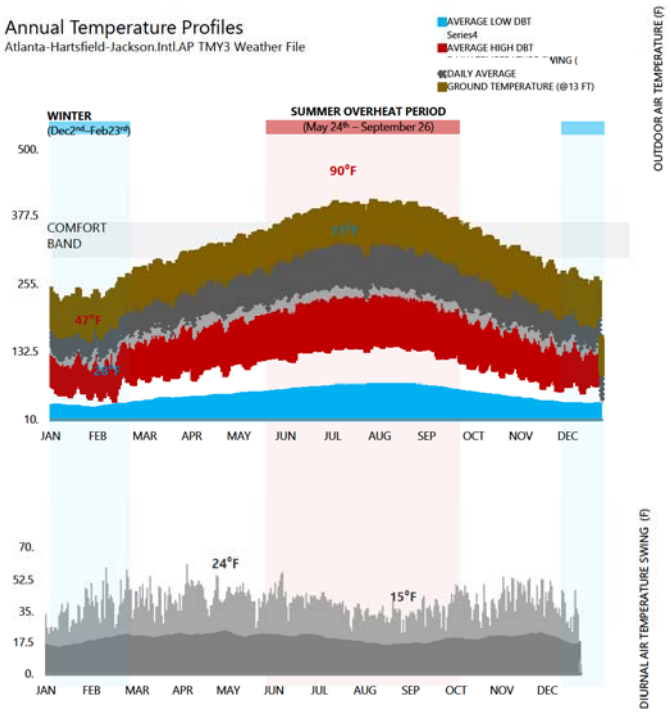


Annual Air & Ground Temperature Profiles

Key Climate Factors: Atlanta Georgia

Key Climate Design Drivers

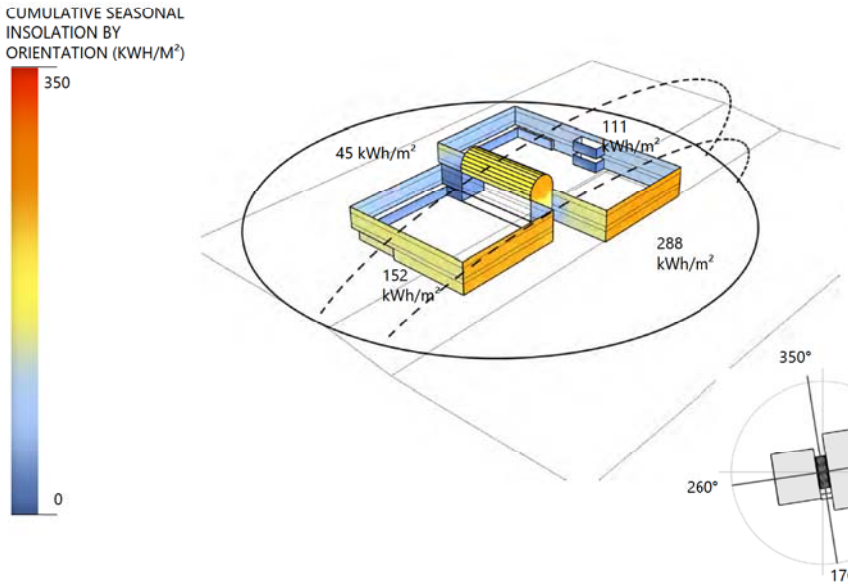
- **Summer:** May to September (Avg. OA>70^{0}F)
  - Extreme Hot Week Period: Jul 6 - Jul 12, Maximum Temp= 98.06F (36.7C). Future climate to be accounted for.
  - Exterior shading beneficial May-September to minimize unwanted summertime solar gains and enable low-energy passive cooling strategies.
- **Winter**: December to February (Avg. OA< 50^{0}F)
  - Extreme Cold Week Period : Jan 6 to Jan 12, Minimum Temp= 8.96F (-12.8C)
  - Leverage passive solar gains through south-facing façade fenestration to offset supplemental heating requirements.
- **Diurnal Swing**: Average Diurnal swing between 15-24^{0}F suggests an opportunity to leverage thermal mass to reduce peak indoor temperatures, reduce cooling energy, and improve occupant thermal comfort.
- **Ground and Water Temperatures:** Relatively stable ground (and Lake) temperatures suggest a potential heat source and sink for the HVAC system.



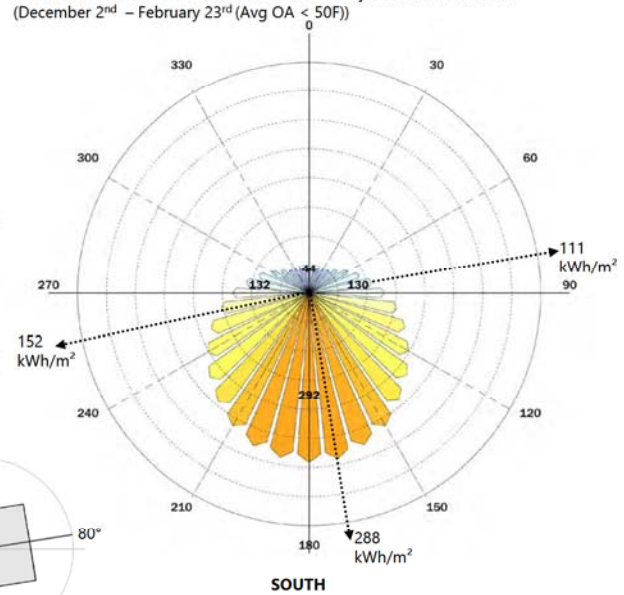
Incident Solar Radiation - WINTER

Key Climate Factors: Atlanta Georgia

WINTER INCIDENT SOLAR RADIATION - BASELINE
(December 2nd – February 23rd (Avg OA < 50F))

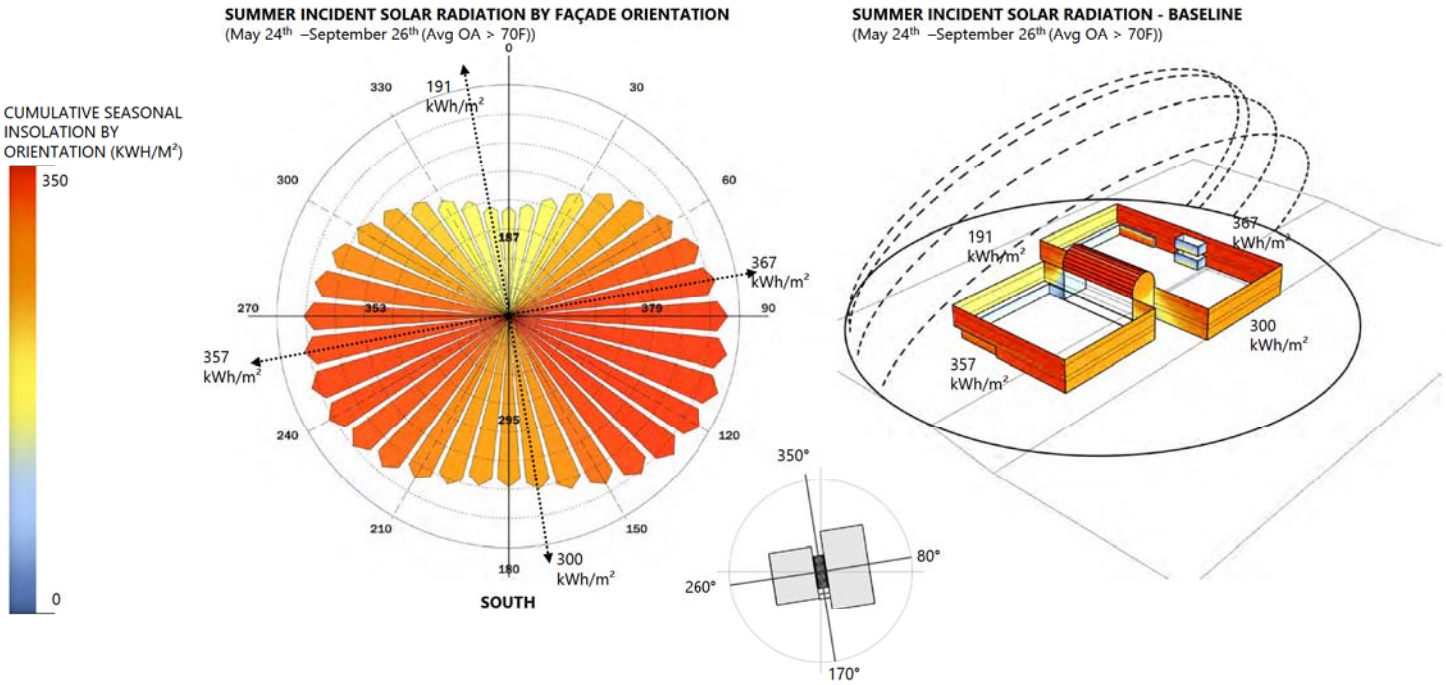


WINTER INCIDENT SOLAR RADIATION BY FAÇADE ORIENTATION
(December 2nd – February 23rd (Avg OA < 50F))



Incident Solar Radiation - SUMMER

Key Climate Factors: Atlanta Georgia



Adding Solar PV

System Size **331.88 kW DC**

Estimated Energy Production (Year 1): 457,713 kWh

Capacity:

- 250kW AC
- Capped by Georgia Power Net Metering

Costs:

- PV $500,000
- Site $50,000
- Total $550,000

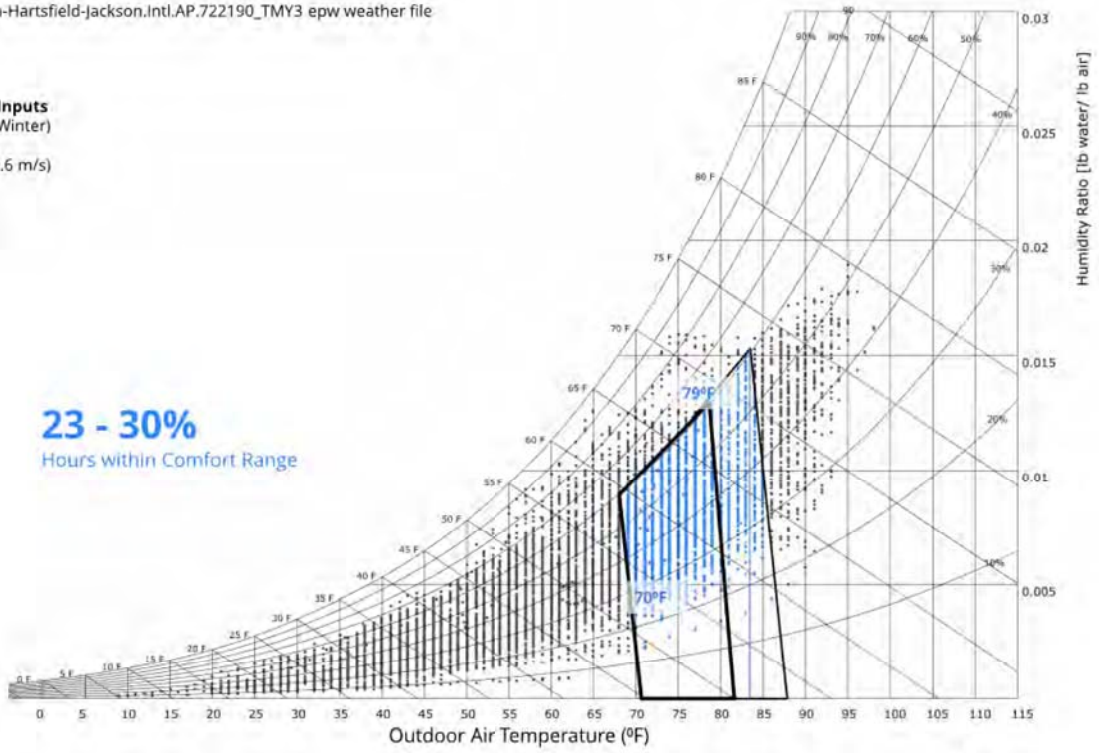
Psychrometric Chart

Key Climate Factors: Atlanta-Hartsfield-Jackson.Intl.AP.722190_TMY3 epw weather file

ASHRAE- 55 PMV Method Inputs

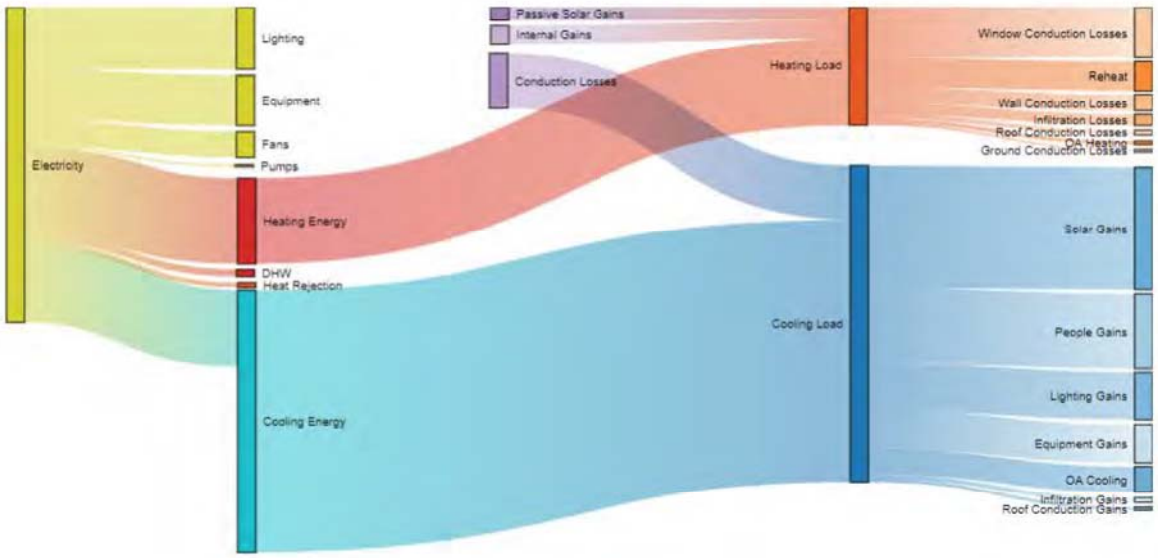
- Clo: 0.61-1.0 (Summer/ Winter)
- Met: 1.1 (Typing)
- Air Speed: 0 -118 fpm (0.6 m/s)

- RH Upper Limit: 60%

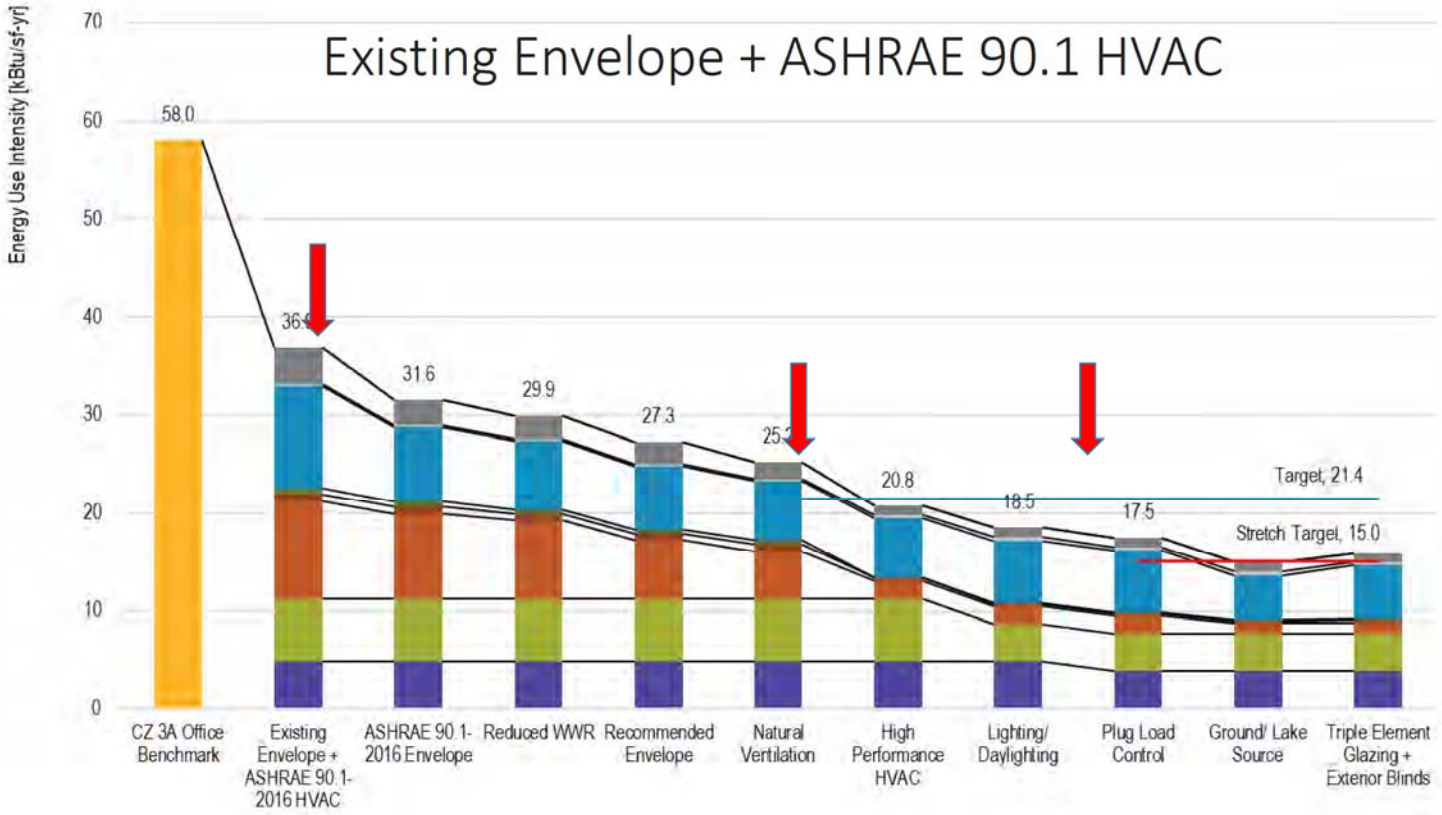


Energy Use Characterization

ASHRAE Headquarters



Interactive Graph: https://www.elementa.nyc/projects/ashrae/



Primary Envelope Factors

- **Window to Wall Ratios (WWR)**
- **Important to define the optimum area of openings relative to achieving daylight autonomy goals, as well as maximize the thermal efficiency of the wall.**
- **Air Infiltration and Insulation**
- **Where was the optimal R-Value for each part of the exterior envelope and how were we containing air infiltration.**

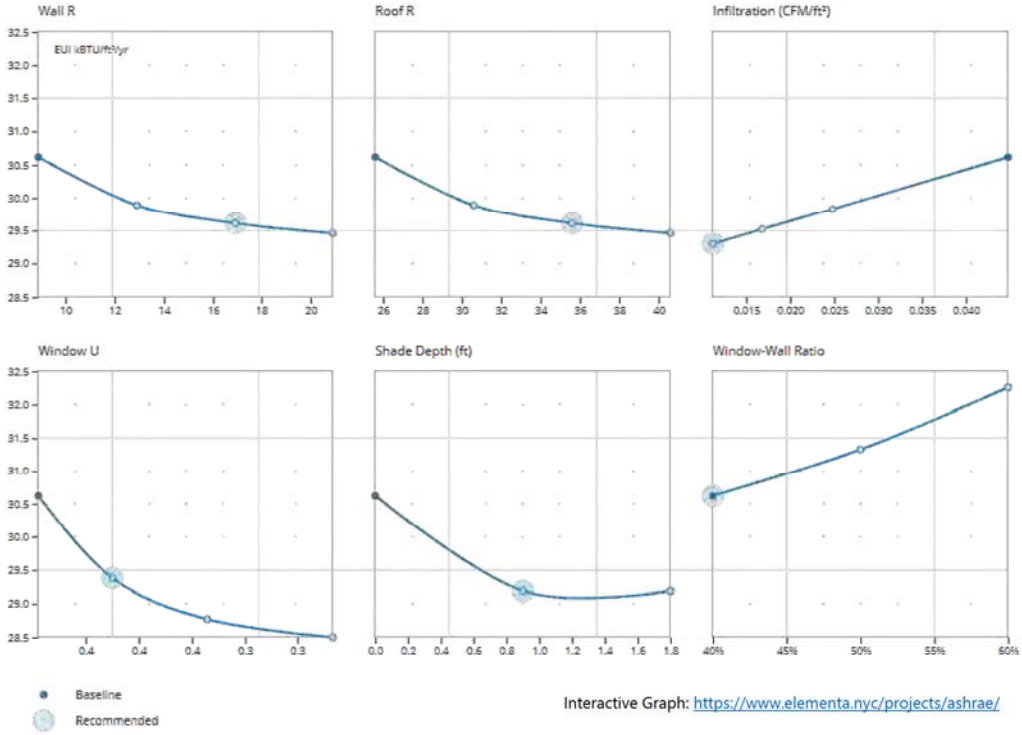
Envelope Sensitivity Analysis

ASHRAE Headquarters

Preliminary envelope performance targets based on point of diminishing Energy Use Intensity (EUI) savings shown at right:

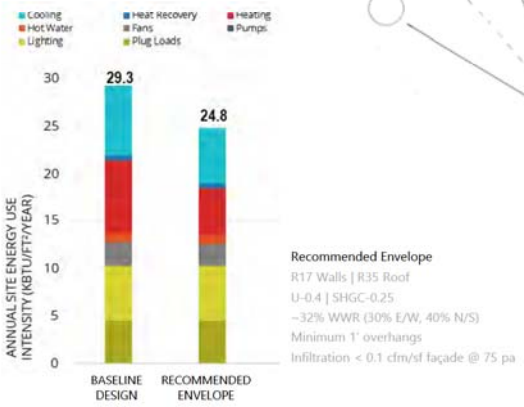
Parameter	Existing Performance	ASHRAE 90.1-2016	Recommended
Wall Assembly	U-0.3 (R-3.0)	U-0.122 (R-8.0)	**U-0.058 (R-17)**
Roof Assembly	U0.047 (R-21)	U-0.039 (R-25)	**U-0.028 (R-35)**
Window Assembly	U-0.59 SHGC-0.52	U-0.45 SHGC-0.25	**U-0.40 SHGC-0.25**
Window to Wall Ratio	~50%	40%	**40%**
External Shade Depth	N/A	N/A	**1'** (to be further optimized for visual, thermal comfort)
Infiltration	0.025 cfm/ft²	0.045 cfm/ft²	**0.011 cfm/ft²**

ASHRAE NZE AEDG recommends R-15.6 wall for Climate Zone 3!

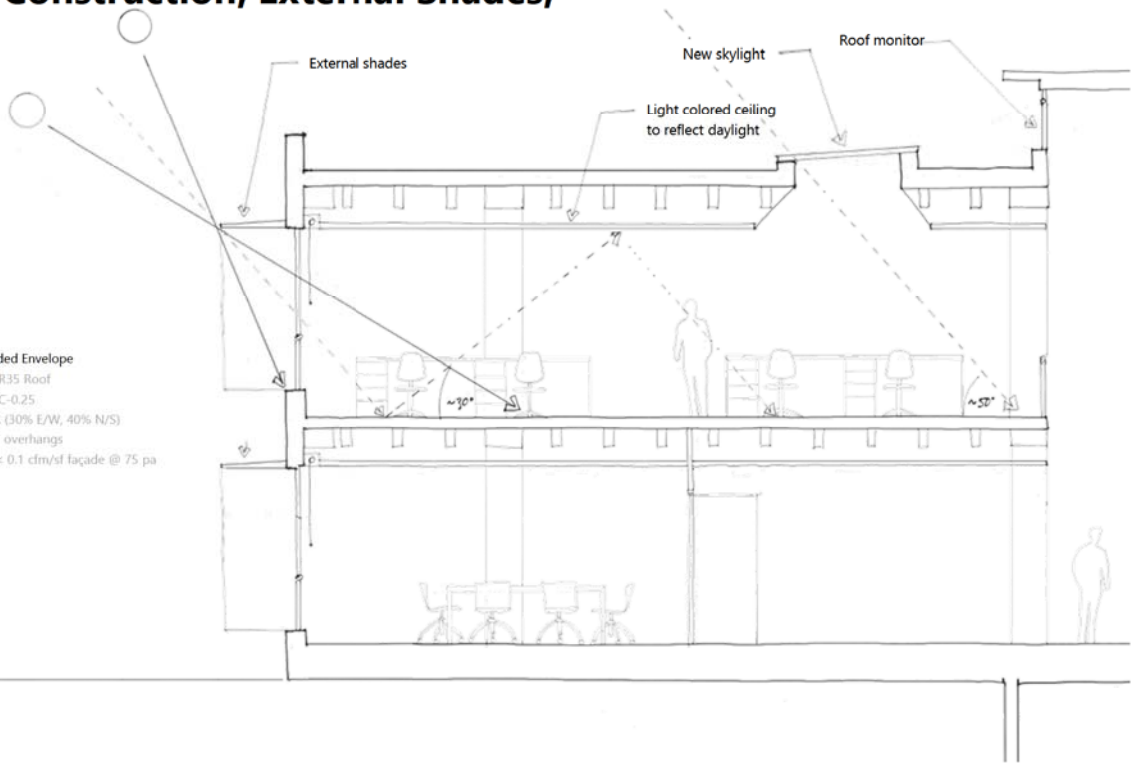


Interactive Graph: https://www.elementa.nyc/projects/ashrae/

High Performance Envelope
Insulation, Air Tight Construction, External Shades, Daylighting



Recommended Envelope
R17 Walls | R35 Roof
U-0.4 | SHGC-0.25
~32% WWR (30% E/W, 40% N/S)
Minimum 1' overhangs
Infiltration < 0.1 cfm/sf façade @ 75 pa

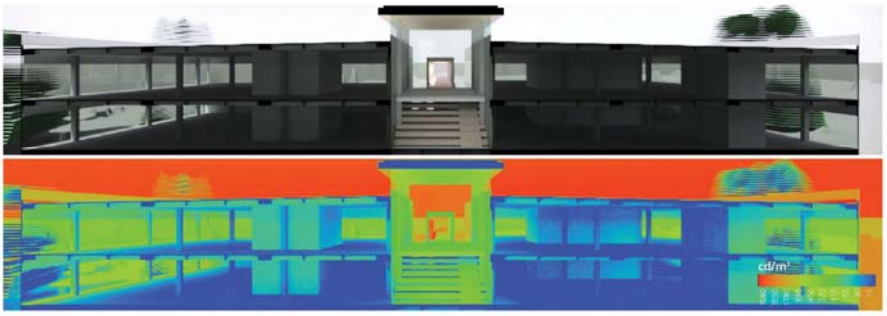


Construction Photos – August 2020

Final Window Wall Ratios

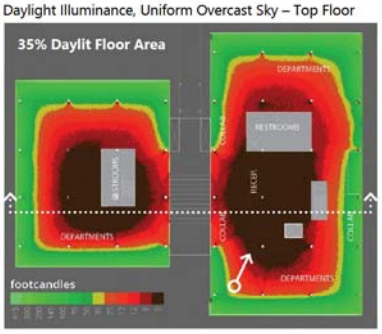
EXISTING RIBBON WINDOWS AND EXISTING GLASS
DAYLIGHT PATTERNS

Section View and Falsecolor Luminance Map, Equinox at 12pm, Clear Sky with Sun

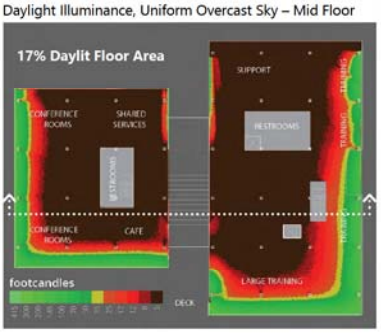


Perspective View and Falsecolor Luminance Map, Equinox at 12pm, Clear Sky with Sun

Daylight Illuminance, Uniform Overcast Sky – Top Floor



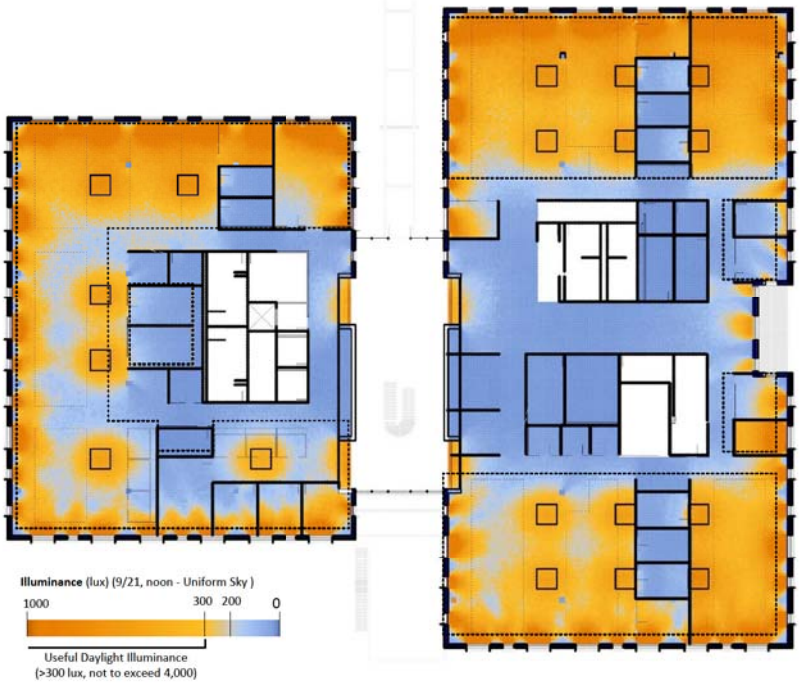
Daylight Illuminance, Uniform Overcast Sky – Mid Floor



Short Windows, 18 Skylights

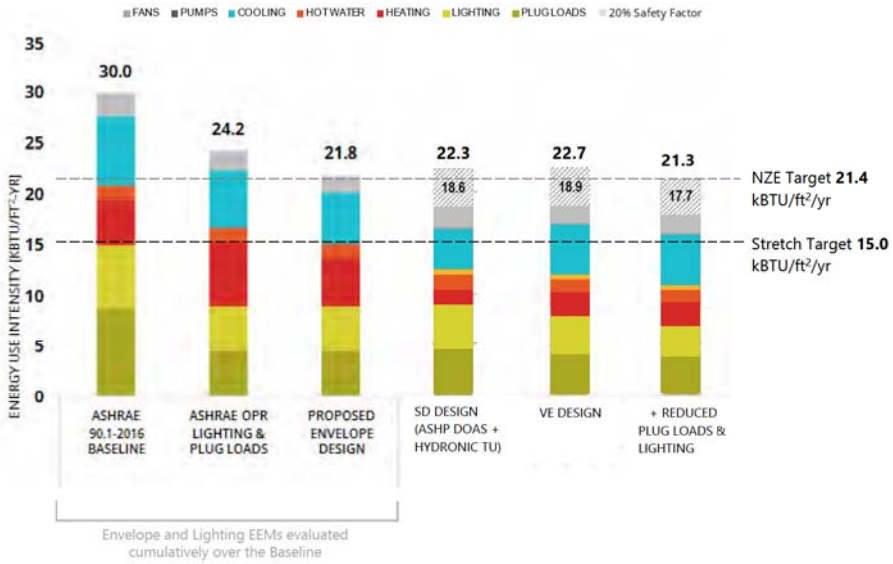
57%

Percentage of regularly occupied work spaces on the upper level with useful daylight illuminance (>300 lux) at the work plane



Path to NZE Update

ANNUAL SITE ENERGY USE



CHANGES TO THE 100% SD DESIGN

- Insulation removed at overhang
- 3" New Roof Insulation in lieu of 4": R-30 assembly
- Existing Atrium to remain
- Skylights removed
- Detailed thermal zoning added to model based on latest floor plan
- Internal gains & diversities updated based on latest floor plan
- HVAC updated to match latest design

TAKEAWAYS

- 50% increase in heating energy
- 25% increase in cooling energy
- Atrium alone accounts for 15% of EUI
- With 20% safety factor, current design is above NZE target

HVAC Concept Overview

<u>Process</u>

1. Demand more from the building envelope both thermally and tightness - Architect
2. Demand more from the building occupants in terms of plug loads and day lighting - Owner
3. Utilize high efficiency systems to reduce energy demands (hydronic vs. airside, DOAS) - Engineer
4. Right size equipment based on these demands – Accountability Required
5. Provide flexible and systems which provide exemplary environmental comfort

HVAC Concept Overview

Resulting System Needs

- Hydronic Systems reduce energy - Radiant
- Smaller, modular control – control valves and ceiling fans vs VAV terminal units and ductwork
- Simultaneous heating and cooling – Heat Pump and/or heat recovery machines
- Decouple temperature from humidity – DOAS
- Recover energy whenever possible

System Overview

Outdoor Air Cooled Modular Heat Pump

Staged Pumping

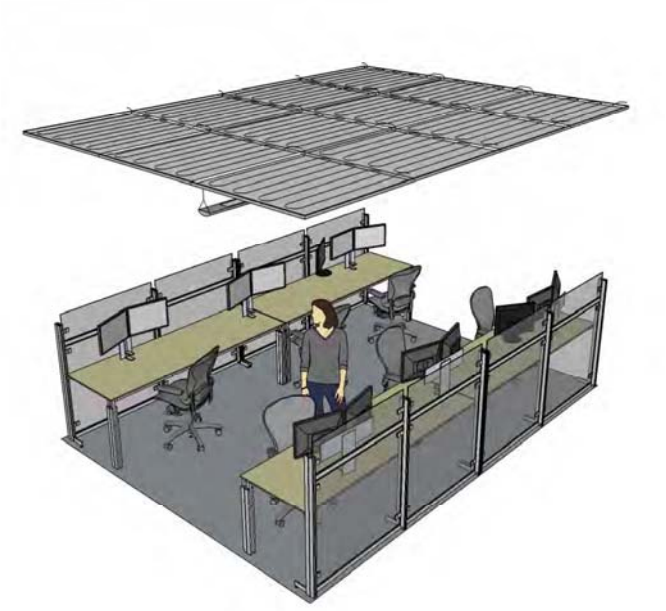
Air Cooled DOAS decoupled from waterside systems

WSHP for transient or potentially humid spaces utilize CHWR.

Overhead Radiant Panels for heating/cooling at exterior zones, cooling only at interior zones.

Ceiling Fans to induce cooling and improve environmental comfort.

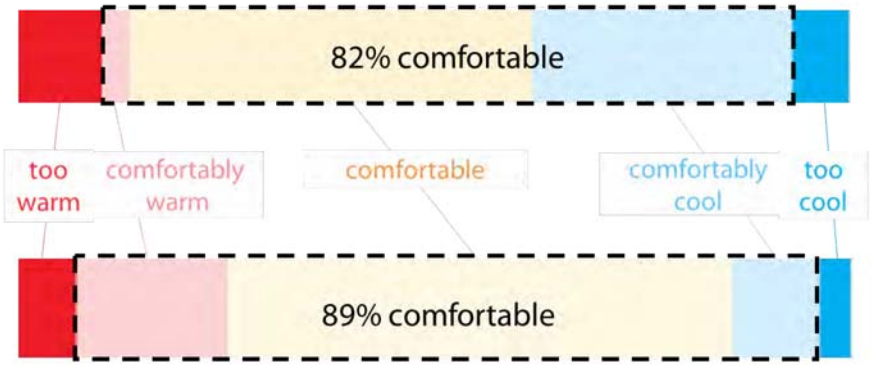
Overhead Radiant Systems



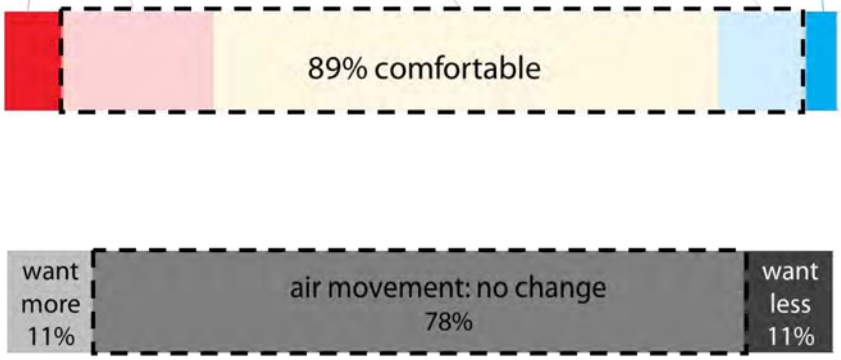
- Radiant Panels form clouds above the occupied spaces
- All heating and cooling in these spaces are provided by the panels.
- Ventilation is cool/neutral temperature air delivered directly to the space and not directly responsible for temperature control within the zone.

Supplemental Ceiling Fans

Before fan install
Indoor temperature ~ 72 °F
(n = 29)

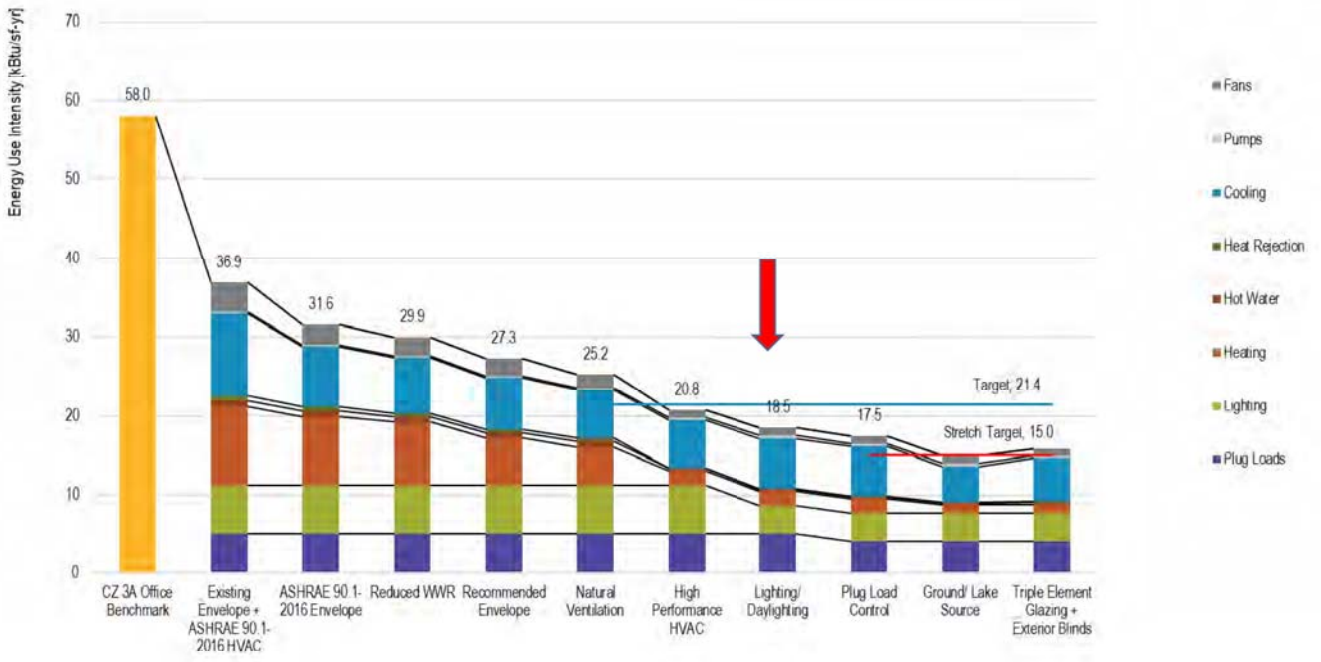


After fan install
and air conditioning failure
Indoor temperature ~ 80 °F
(n = 28)



Air speeds
~40 – 150 fpm

Overhead Radiant Systems



Interior Lobby

Staff Common Room

Owner's Project Requirements (OPR)

Item	OPR	Actual
ASHRAE 189.1-2017	Exceed Requirements	Achieved?
Demand Side Site Energy Consumption	21.4 kBTU/SF/year 15 kBTU/SF/year (stretch)	18.5 kBTU/SF/year
Water Efficiency	Obtain 11 of 11 LEED Water Use Efficiency Points	Unknown, LEED rating not sought
Daytime Plug Load	0.04 W/SF	Achieved?
Acoustics	Exceed requirements by 3-5 NC/RNC	Achieved?
Outside Air Rate	1.3 times ASHRAE 62.1	1.3 times achieved?
Outside Air Control	Demand Control Ventilation (DCV) for high occupancy spaces	Achieved?
Daylighting	Majority of Occupants achieve generous daylighting 55% of the time	57% on upper level >300 lux 23% on middle level >300 lux
Resiliency	Achieve resiliency in OPR	Achieved?

Lessons Learned

- Understanding the local Market Capabilities
- Condition Assessment & Building Infrastructure Systems
  - Plumbing System Replacement
  - Electrical System Replacement
  - Fire Protection System Replacement
- Scope of Envelope Improvement needed to meet EUI
- Value of Expertise
  - Engagement of individuals with knowledge important
  - When that knowledge was held back, the project suffered

Lessons Learned

- Understand The Utilities approach to onsite generation
- Strong engagement of the owner's representatives and the implementation team at the design development stage
- The importance of setting project goals in the OPR early before the design team was selected.
- Earlier involvement of the Sub Contractors would have improved the implementation.

Questions:

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Discussion
Q & A


California Lottery, Santa Fe Springs, CA | Credit: LPAS Arch + Design

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Thank you!

You will receive an email tomorrow with links to the on demand recording and a PDF of the slides.

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