

Getting to Zero with K-12 Schools

**CHPS Training: Solutions for
Green Schools in Massachusetts**

April 21, 2016



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CEO
New Buildings Institute

Zero Net Energy – What is it?


A ZNE building is an ultra-efficient building that generates as much energy as it consumes annually. Also known as Net Zero Energy.



GETTING TO **zero** BUILDINGS DATABASE


New Buildings Institute is proud to introduce
our **Getting to Zero Buildings Database**.

NBI Featured Project




Bullitt Foundation Cascadia Center
Building Type: Office
Gross Area: 11,000 SF
Project Status: Completed
Completion Date: Apr 2011
[Learn more about this project](#)

Most Popular




Allred A. Aron United States District Court House
Bradshaw Construction New Office Building
Target New Construction
Target Energy Upgrade
Kohl's Energy Upgrade
[Read More >](#)

Most Recent



Lincoln Heritage Public Library - Chelmsky Branch
Kinkas Hall at the University of Florida
Yale Sculpture Building and Gallery
The Moxey House: The Ecological House of Puerto Rico
Sho's Z Squared Design Facility
[Read More >](#)

Featured Views



ZNE Verified
ZNE Emerging
Advanced Buildings
Submit a Project
Want to contribute? Submit a Project.
Resources:
The Getting to Zero Project Portal is an access point to the DOE's High Performance Buildings Database. For more information on the database [click here](#).

NBI Getting to Zero Buildings Database

Search Projects: **Search**

ZNE Verified ZNE Emerging
 Advanced Buildings
 Primary Building Use:
 Construction Type:
 Net EUI (kBtu/yr): Less Than
 Building Size (SF): Less Than
 Climate: Show All
 State or Province: California

Filter Results

* The 3rd Energy Use Intensity (EUI) includes both whole-building energy use and on-site renewable generation. It may be modeled, estimated, or measured (actual). ZNE buildings will have an EUI of 0.0. It is negative if on-site renewable generation exceeds use. For each project's energy system.

Project Name	City	State	Area (SF)	Net EUI (kBtu/yr)*
 Argonne Child Development Center	San Francisco	CA	6052	97.14
 Aushon Center at Debs Park	Los Angeles	CA	5027	0.00
 Backup Entry- Do Not Publish- IDEAs Z2 Design Facility	San Jose	CA	6555	-0.61
 Bacon St Offices	San Diego	CA	4439	-8.53
 Bagatelos Architectural Glass Systems Net Zero Manufacturing Facility	Sacramento	CA	63001	
 Bren School of Environmental Science & Management	Santa Barbara	CA	84569	106.71
 California College of Arts, Montgomery Building	San Francisco	CA	90996	
 Carnegie Institution of Washington Global Ecology Center	Stanford	CA	10904	
 Cesar Chavez Elementary School	Long Beach	CA	69599	33.54
 Challengers Tennis Club for Boys and Girls	Los Angeles	CA	3498	-0.10
 Chet Holtfield Federal Building	Laguna Niguel	CA	46500	7.25
 Colorado Court Affordable Housing	Santa Monica	CA	30150	38.81
 Cottage Way Federal Building in Sacramento, CA	Sacramento	CA	74217	5.16
 David and Lucile Packard Foundation	Los Altos	CA	45997	-4.65

The largest database on **ZNE** buildings in North America and the only database searchable by **ZNE Status & Energy Performance**

<http://newbuildings.org/getting-to-zero-buildings-database>

44 States & Provinces with ZNE Buildings

2015 List of Zero Energy Buildings

nbi new buildings institute

In 2011 and 2012 NBI conducted research to identify buildings with targets or actual outcomes of net-zero energy. These results were published in "ZNE: Status Report" by NBI in early 2012 and 2014. NBI continues to track and document buildings with live and real energy to support the market and policy interest in the data. The 2015 list of buildings is an interim report based on the ongoing work.

Verified Zero Energy Buildings (or Clearing air) those with greatly reduced energy loads that have been documented to have met, over the course of a year, all net energy use through on-site renewable sources of energy. The energy use of all fuels (electric, natural gas, steam, etc.) is counted and offset. Buildings new to the list are in bold italics.

Verified Zero Energy Buildings

Year Completed	Name	Location	State	Building Type	Size (sq ft)	Total Building Annual CO ₂ e	On-site Renewable kWh	Net Building CO ₂ e
2008	Shodor College-Lewis Center	Shelby	IN	Education	12,000	31	36	-4
2009	Environmental Technology Center Science Data	Golden Park	CO	Education	2,200	0	4	-4
2010	Challenging Series C&K	Los Angeles	CA	Other	3,000	9	9	0
2010	Lewis-Clark-Wing San-Francisco Station	Woodside	CA	Education	15,200	4	0	0
2010	Golden Center at Delta Park	1 Los Angeles	CA	Other	6,000	17	17	0
2010	Green House	St. Paul	MN	Other	1,100	10	10	0
2010	Steel Learning Center Center	Indian Rock	IL	Other	6,000	30	31	-1
2011	Risk Capital Energy Center	San Jose	CA	Office	11,000	10	10	0
2011	Earth 21 Design Hub	San Jose	CA	Office	6,500	21	26	-4
2011	London-Lewis-Memorial Social Hall	London	OK	Park/Assembly	2,800	16	20	-4
2011	Environmental Museum Center	Beaumont Beach	CA	Other	6,000	16	20	-4
2011	Autism Society Clear Energy Headquarters	Woodstock	NY	Other	5,400	10	10	0
2011	Beacon Street Office	San Diego	CA	Office	4,000	10	20	-9
2011	Discovery Library	Chicopee	MA	Library	2,400	10	10	0
2011	Living Learning Center at Open Research Center	London	MD	Education	2,300	24	24	0
2011	Orange Center for Sustainable Living	Woodstock	NY	Laboratory	4,500	10	21	-9
2011	Pringle Creek Pavilion's Hall	Salmon	OR	Park/Assembly	3,000	21	21	0

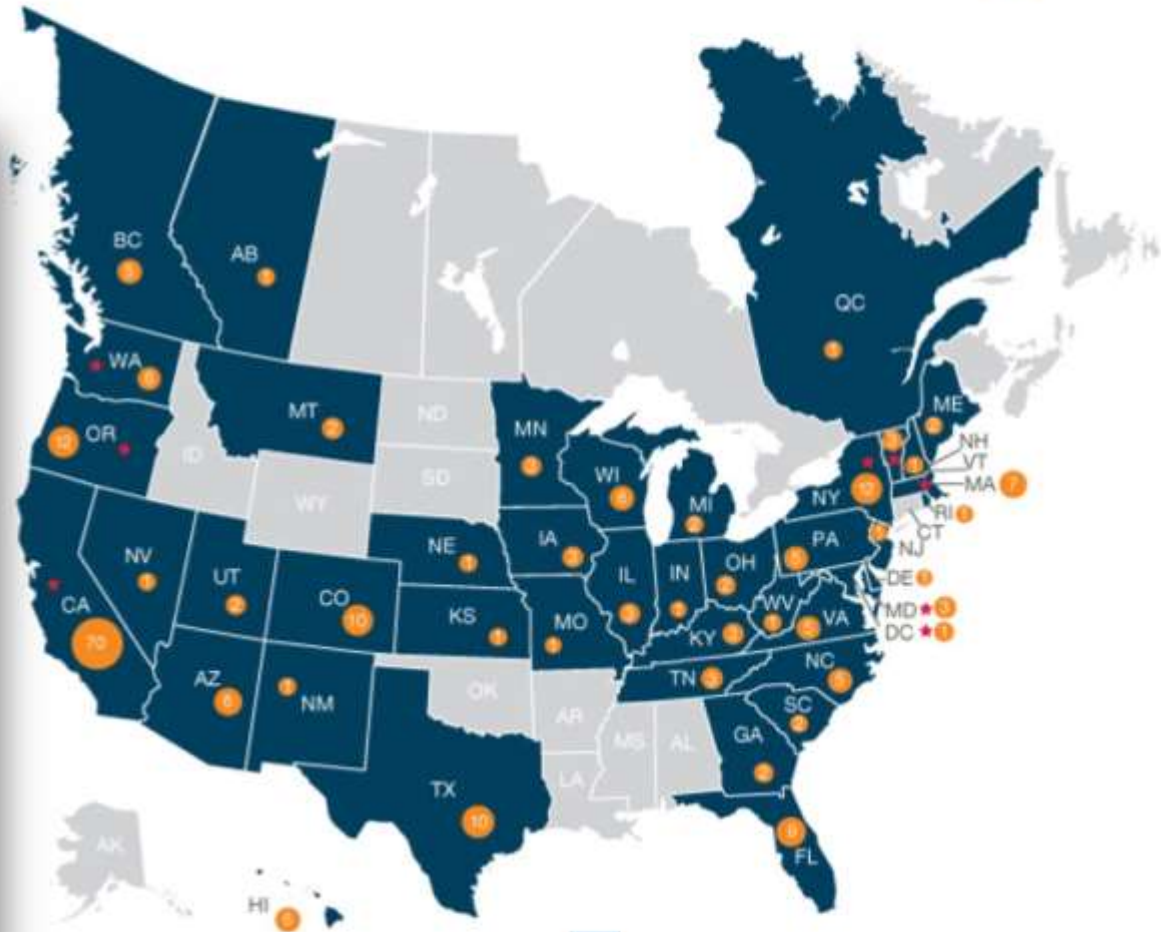
1. See a building's website page.

2. See a building's website page.

The net energy use (kWh) is calculated as the total energy use (kWh) minus the on-site renewable energy (kWh). Buildings with a net energy use of 0 kWh or less are considered net-zero energy buildings.

© New Buildings Institute, 2015

Page 1 of 2 - Verified Buildings



Number of Buildings and projects (225)

ZNE Emerging and/or Verified Buildings (42 states and provinces, and the District of Columbia)

★ States with Reach Code Adopted or in Development

© New Buildings Institute, 2015

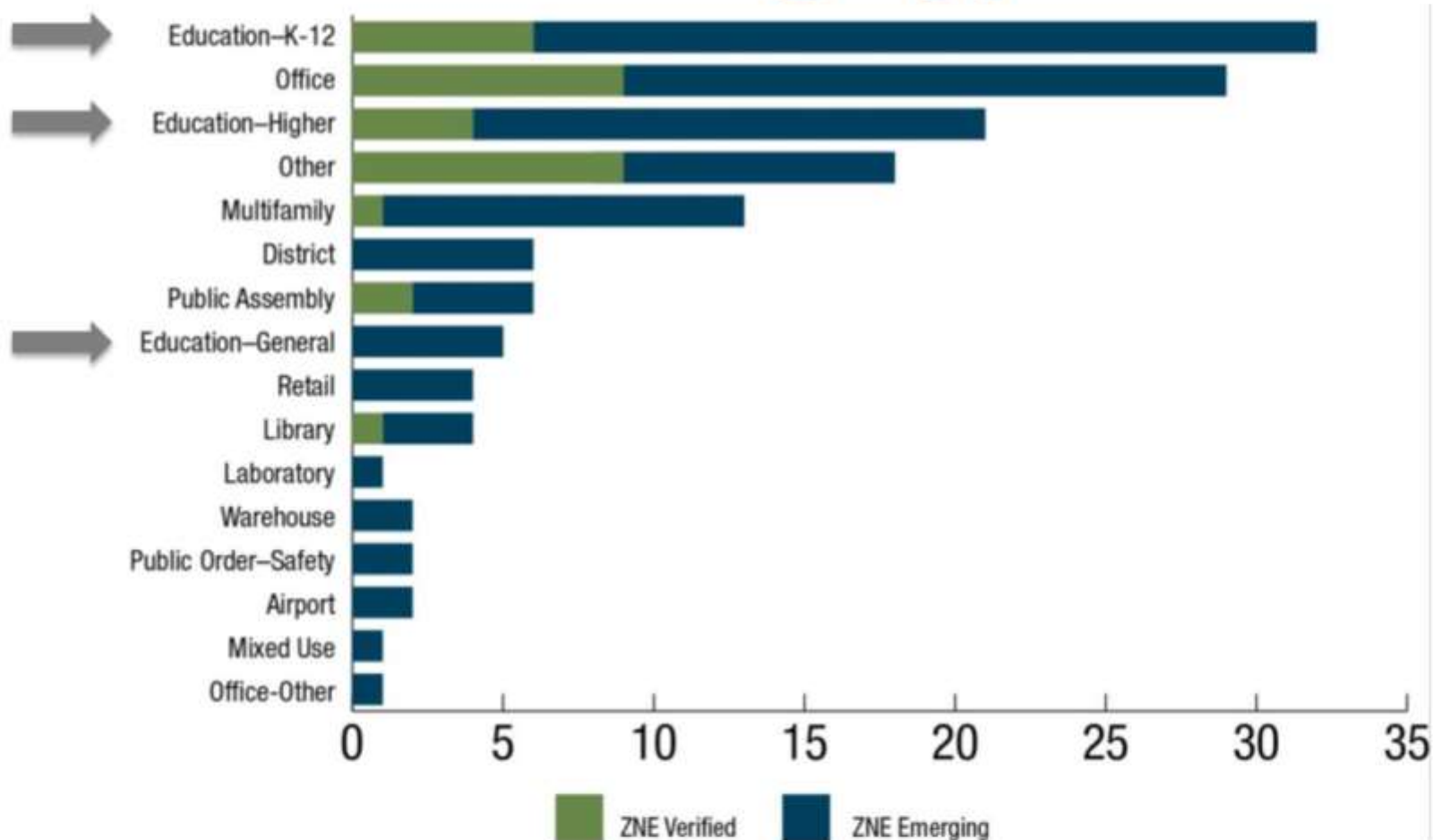
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Growth in Zero Net Energy Buildings

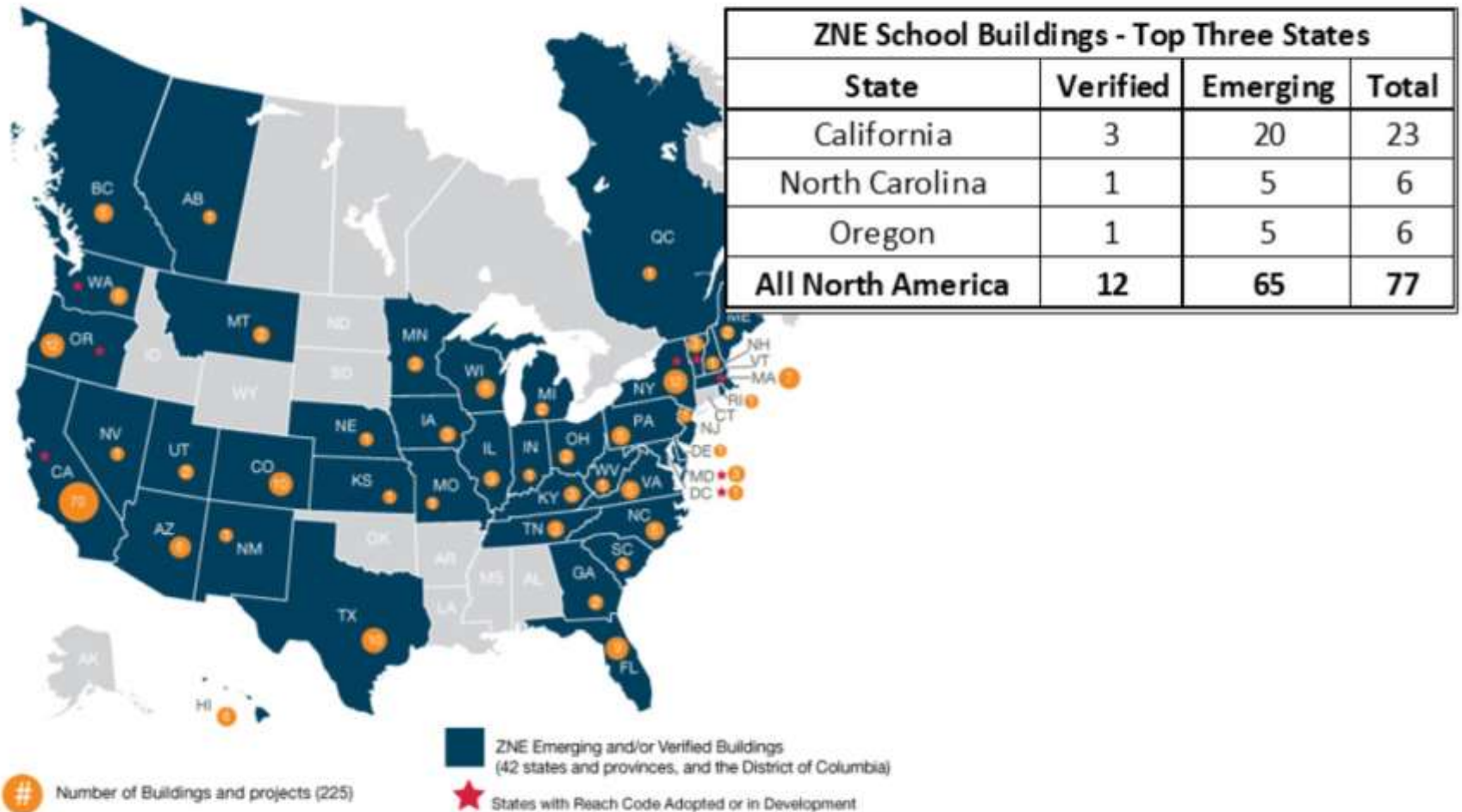


Courtesy of New Buildings Institute | newbuildings.org

Building Types

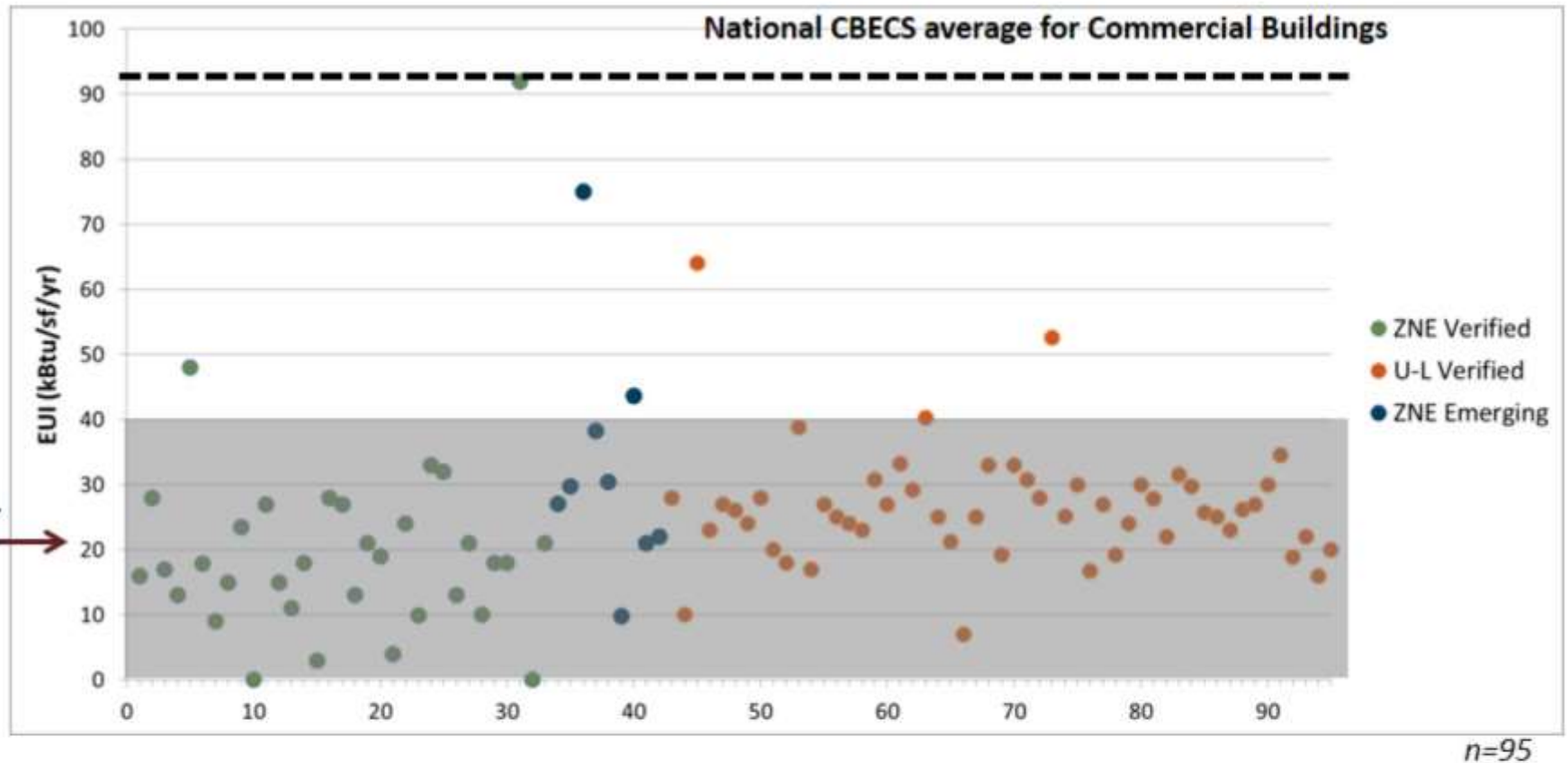


Leadership in ZNE Schools



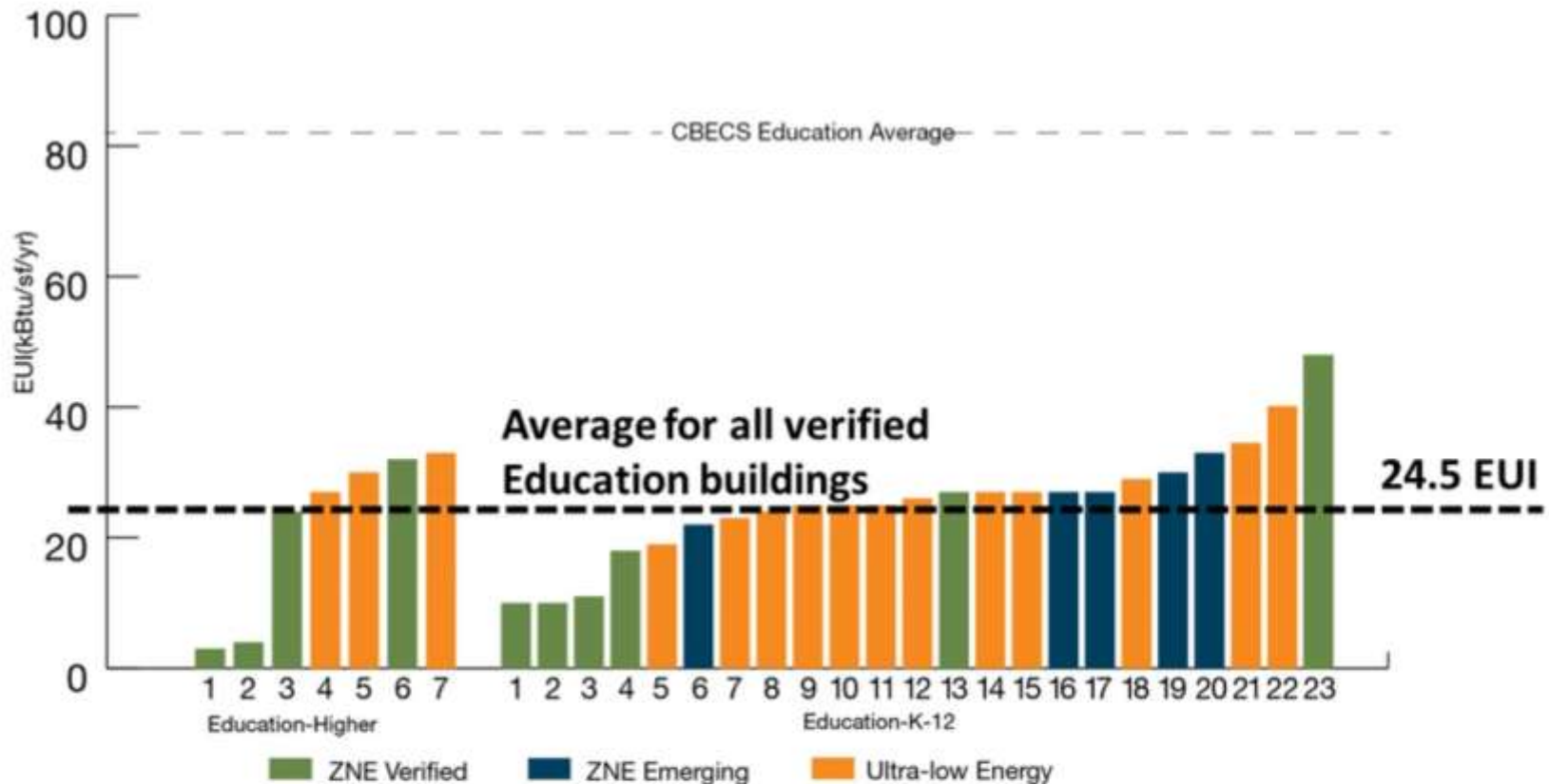
Performance Range

(all projects w/ measured performance data)



Performance Range - Education

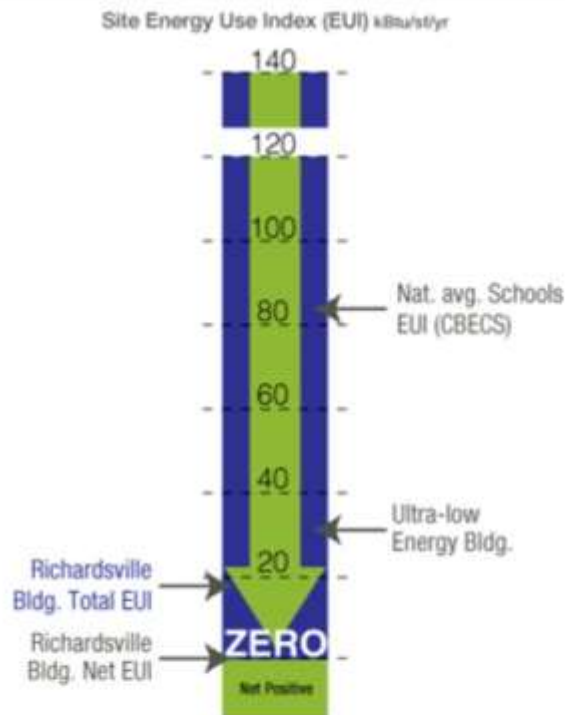
Measured EUIs of Educational Buildings



Richardsville Elementary School

$$18 - 18 = 0$$

BUILDING'S TOTAL EUI RENEWABLE PRODUCTION EUI BUILDING'S NET EUI



Efficiency Measures:

- Ground source heat pump
- DOAS
- CO2 sensors
- Daylighting
- High performance lighting system with controls
- EMS & Energy Dashboard



Common Technologies for Ultra-low Energy

- Ground Source Heat Pumps
- Ventilation: Natural, Dedicated Outdoor Air Systems (DOAS), Demand Control Ventilation (DCV)
- Highly Efficient Thermal Envelope
- Building Orientation & Glazing ratio
- Solar Control - shading
- Daylighting Access and Controls
- Energy Management Systems
- Building Dashboards
- Radiant Heating/Cooling & Chilled Beams
- Plug load Reductions
- Energy Recovery Systems



Redding School for the Arts, CA

Courtesy : Trilogy Architecture Steve Whittaker Photography

Getting to Zero in K-12 Schools

(in five easy steps)

1. Developing your ZNE Plan and Targeting ZNE
2. Designing to the ZNE Target – Part 1: Design for performance
3. Designing to the ZNE Target – Part 2: Design for Operations
4. Building to the ZNE Design
5. Operating to the ZNE Design



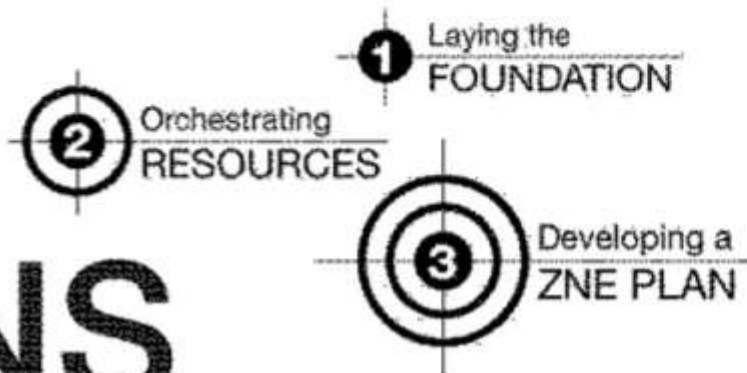
Developing your ZNE Plan & Targeting ZNE



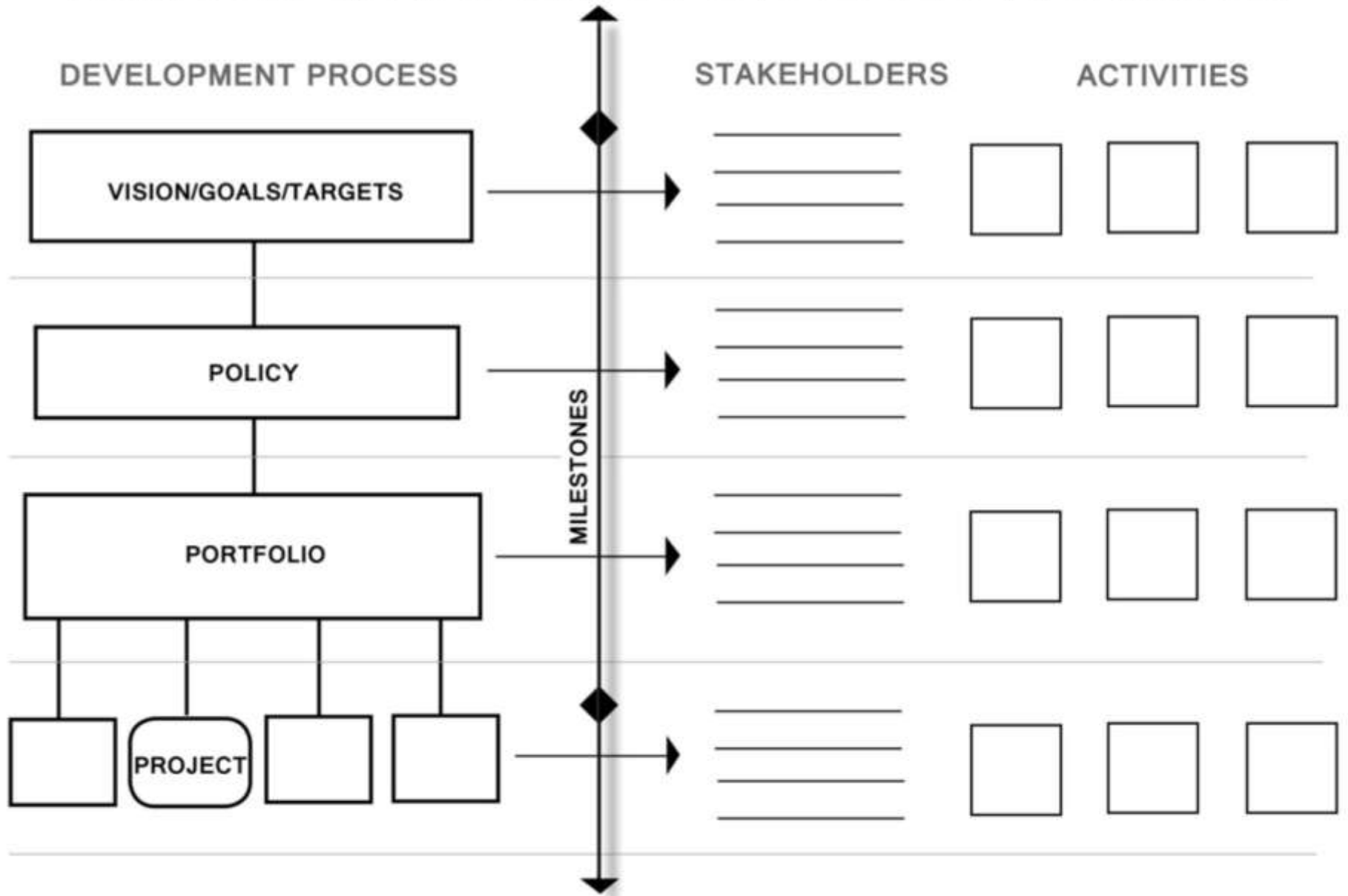
EARLY ADOPTERS NETWORK

TOOLS & RESOURCES FOR

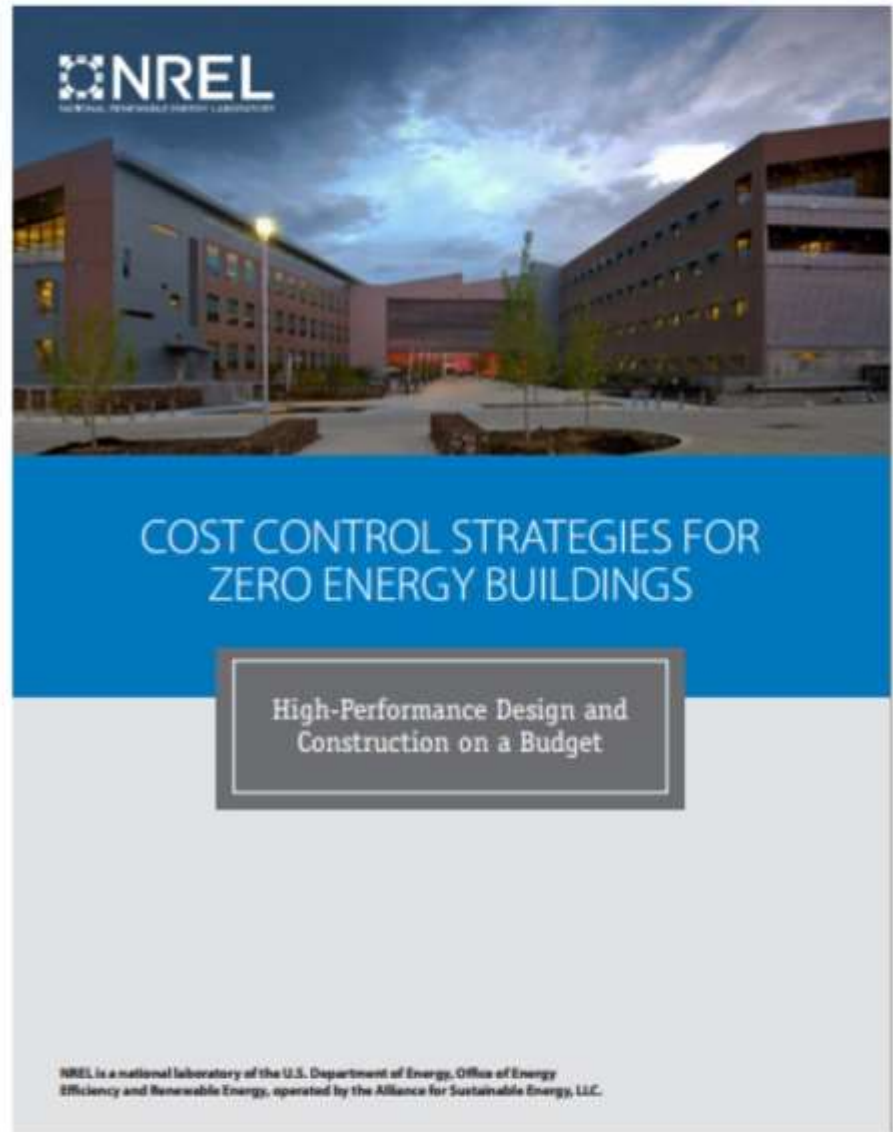
ZNE PLANS



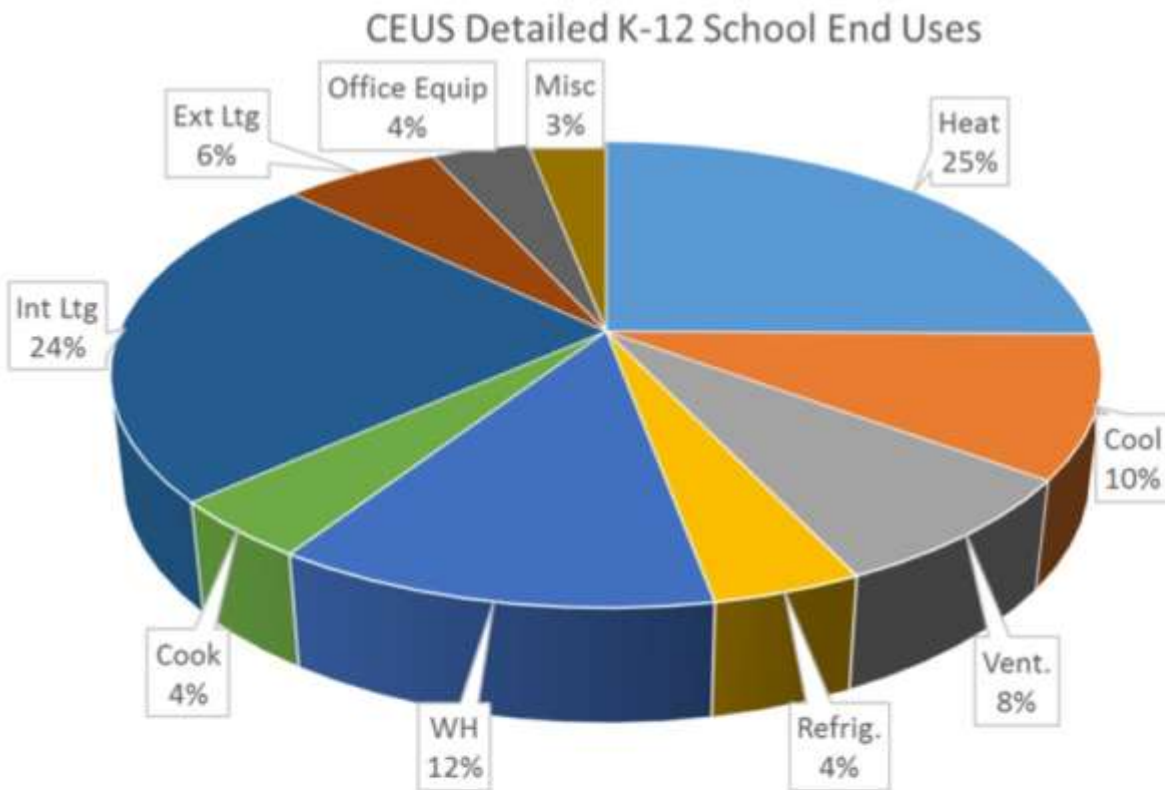
BUILDING BLOCKS FOR ZNE PLANNING



*“The prevailing industry perception is that zero energy is cost prohibitive and suitable only for showcase projects with atypical, large budgets; however, **there is mounting evidence that zero energy can, in many cases, be achieved within typical construction budgets.**”*



Benchmarking Existing Facilities: Understanding Energy End Uses



Heating, Cooling, Ventilation
= **Envelope & HVAC Equip.**

Lighting, Plugs, Cooking, Refrig.
= **Interior Equipment**

All Usage
= **Controls & Occupants**

Developing your ZNE Plan & Targeting ZNE

– The Energy Loading Order



Two ZNE Building Typologies

Renewable-Oriented

Minimally to moderately sensitive to the grid

Higher gross energy use

Higher renewable generation

Active Strategies Focus:
Mechanical HVAC Systems, Thermal Storage, Night Flush with Fans, Demand Response

Efficiency-Oriented

Highly grid-integrated and responsive

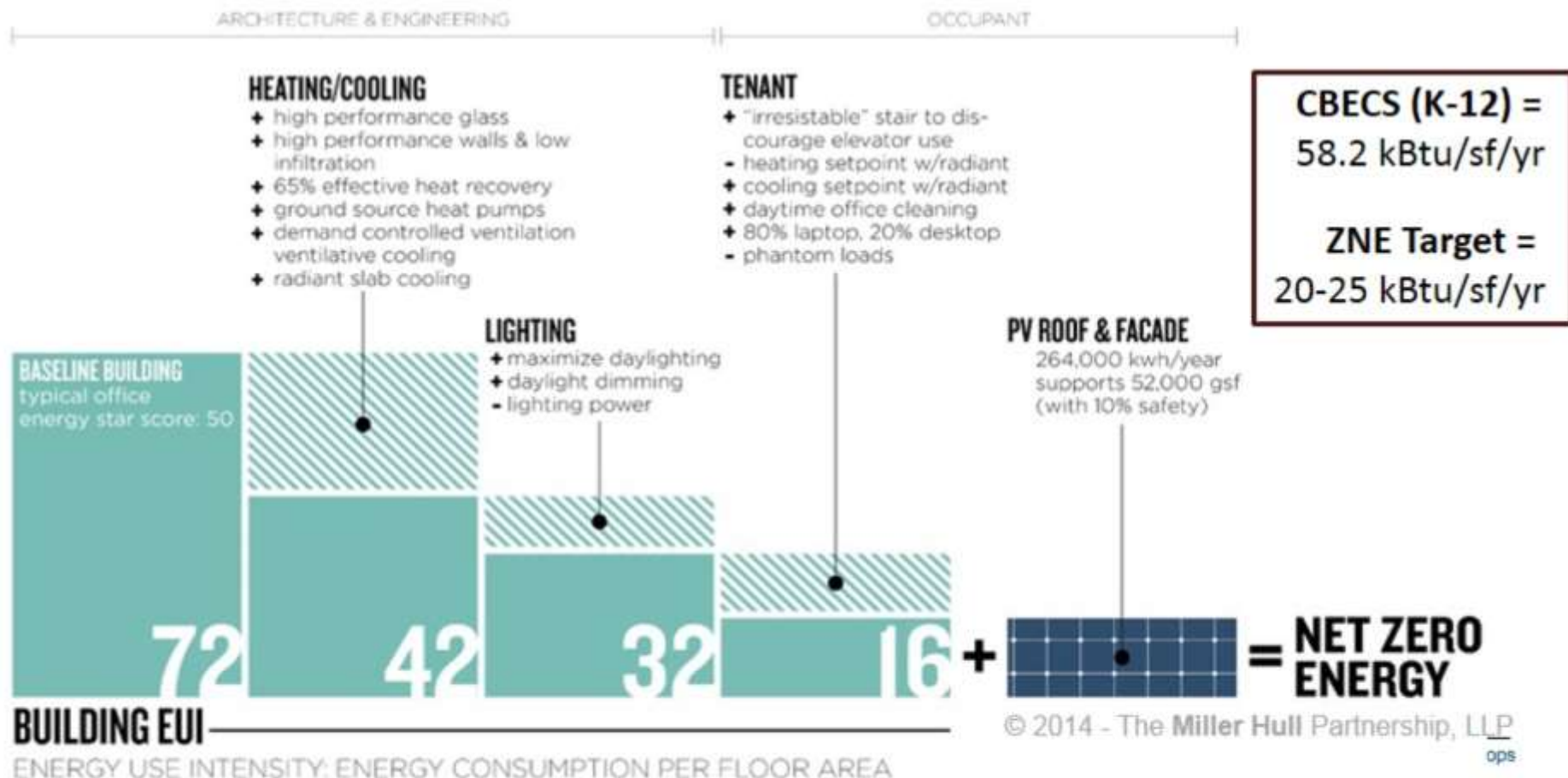
Lower gross energy use

Lower renewable generation

Passive Strategies Focus:
Daylighting, Building Orientation, High Insulation Levels, Passive HVAC, Built-In Shading

Developing your ZNE Plan & Targeting ZNE

Establishing your solar and energy budget



CBECS (K-12) = 58.2 kBtu/sf/yr

ZNE Target = 20-25 kBtu/sf/yr

ENERGY USE INTENSITY: ENERGY CONSUMPTION PER FLOOR AREA

Developing your ZNE Plan & Targeting ZNE

Defining your EUI Target:

1. Define cost effective EEMs from Audit
2. Define your operating schedule compared to annual renewable energy generation
3. Develop iterative energy model (include TDV)
4. Understand PV feasibility
5. Determine solar budget



(Example) Advanced Energy Efficiency Measures (EEM)

Measure 1: Reduced Building Equipment Energy Use

Strategy 1a. Receptacle Controls

Strategy 1b. Plug Load Management

Strategy 1c. Plug Load Equipment

Measure 2: Heating and Cooling Strategies

Strategy 2a. Dedicated Outdoor Air System (DOAS)

Strategy 2b. HVAC Zone Control

Measure 3: Improved Overall Building Envelope Performance

Strategy 3a. Thermal Load Intensity

Strategy 3b. Air Infiltration Testing

Measure 4: Reduced Lighting Energy

Strategy 4a. Luminaire Level Lighting Control

Strategy 4b. Interior LPDs and Exterior Lighting Efficacies Based on Solid-state Lighting

Developing your ZNE Plan & Targeting ZNE

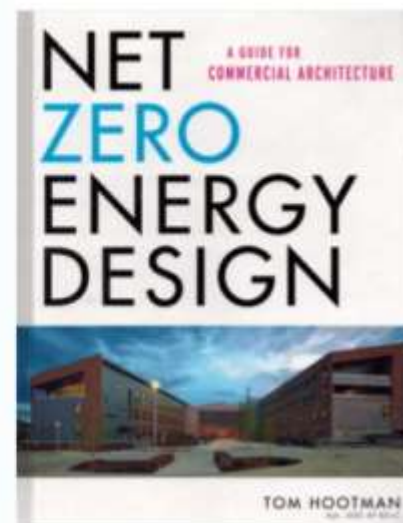
Making ZNE a Part of the Designer Contract:

- Developing RFP language
- Defining scopes of work
 - Design through operations
 - Energy modeling
 - ZNE Commissioning
 - Controls integration

Request for Proposals & Qualifications (RFPs & RFQs)

RFP Guidelines for Net Zero Energy Projects

- Establish net zero energy as one of the key project objectives.
- Set an annual energy use target appropriate for the net zero energy objective.
- Clarify whether or not on-site renewable energy systems will be part of the RFP; in either case, consider how they will be coordinated with building design and construction.
- Provide a well-crafted project definition, one that takes into account the opportunities and challenges of net zero energy.
- If a separate RFQ is not used prior to the RFP, integrate the guidelines for RFQs stated in the previous RFQ section.
- Establish the selection process and delivery method in support of forming a trust-based, integrated delivery team, whose members are aligned with the project objectives.



Net Zero Energy Design: Tom Hootman

Developing your ZNE Plan & Targeting ZNE

Selecting your project team:

- Pre-bid and pre-construction conferences, project team interviews



Developing your ZNE Plan & Targeting ZNE

Using the Owners Project Requirements to guide the ZNE process:

- Defining Owner's Project Requirements (OPR)
- Establishing the Basis of Design (BoD)
 - (the design team approach)

Example OPR Table of Contents

Owner's Project Requirements (OPR)

template revised November 2009

- 17.1 [Introduction](#)
- 17.2 [Owner Requirements Covered Elsewhere](#)
- 17.3 [Project-Specific Design Goals](#)
- 17.4 [Occupancy & Use](#)
- 17.5 [Sustainability and Energy Efficiency](#)
- 17.6 [Building Site](#)
- 17.7 [Transportation & Parking](#)
- 17.8 [Building Envelope](#)
- 17.9 [Indoor Environmental Quality](#)
- 17.10 [Emergency or Backup Power](#)
- 17.11 [Telecommunications and A/V Systems](#)
- 17.12 [Security](#)
- 17.13 [Hazardous Materials](#)
- 17.14 [Furnishings & Equipment](#)
- 17.15 [Commissioning, Inspection, and Q.A.](#)
- 17.16 [Construction Completion & Turnover](#)
- 17.17 [Operation & Maintenance](#)
- 17.18 [Owner Training](#)
- 17.19 [Post-Occupancy and Warranty](#)

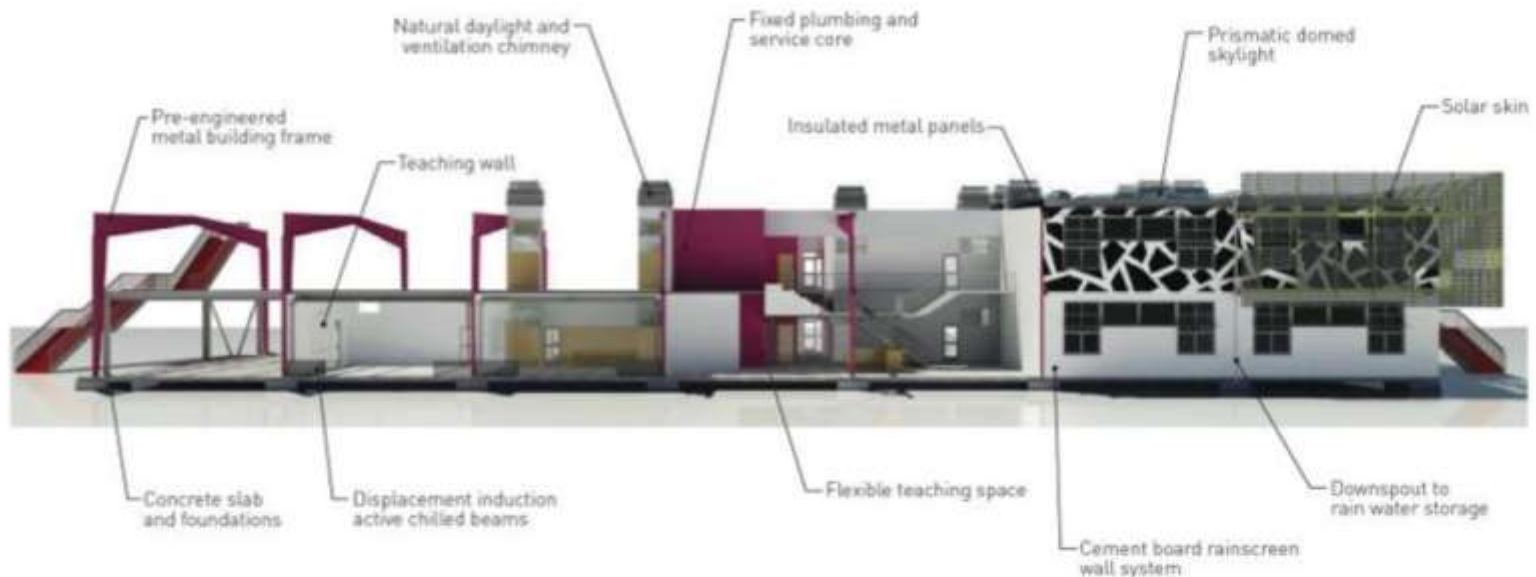
NOTE to PM/Author: Enter the project # in the footer, left side ... delete this + other notes-to-author)

17.1 INTRODUCTION

Along with the other sections of this Facilities Program, this Owner's Project Requirements (OPR) document outlines functional requirements of the project and expectations of how the facility and its systems will be used and operated. The OPR is required for LEED certification of the project, but also serves three broader vital purposes:

Designing to the ZNE Target

Part 1: Design for performance



LAUSD ZNE Prototype Classroom, designed by Swift Lee

Designing to the ZNE Target

Part 1: Design for performance

- Implementing an integrated design process:
ZNE Workshop



ZNE Workshop: Team Building

- Sets green building **goals**
- Identifies **strategies**
- Develops an **action plan**



Designing to the ZNE Target

Part 1: Design for performance

- ZNE design strategies: Passive design approaches and designing for OFF
- Lighting and daylighting controls
- Occupancy/vacancy sensors
- Plug load controls

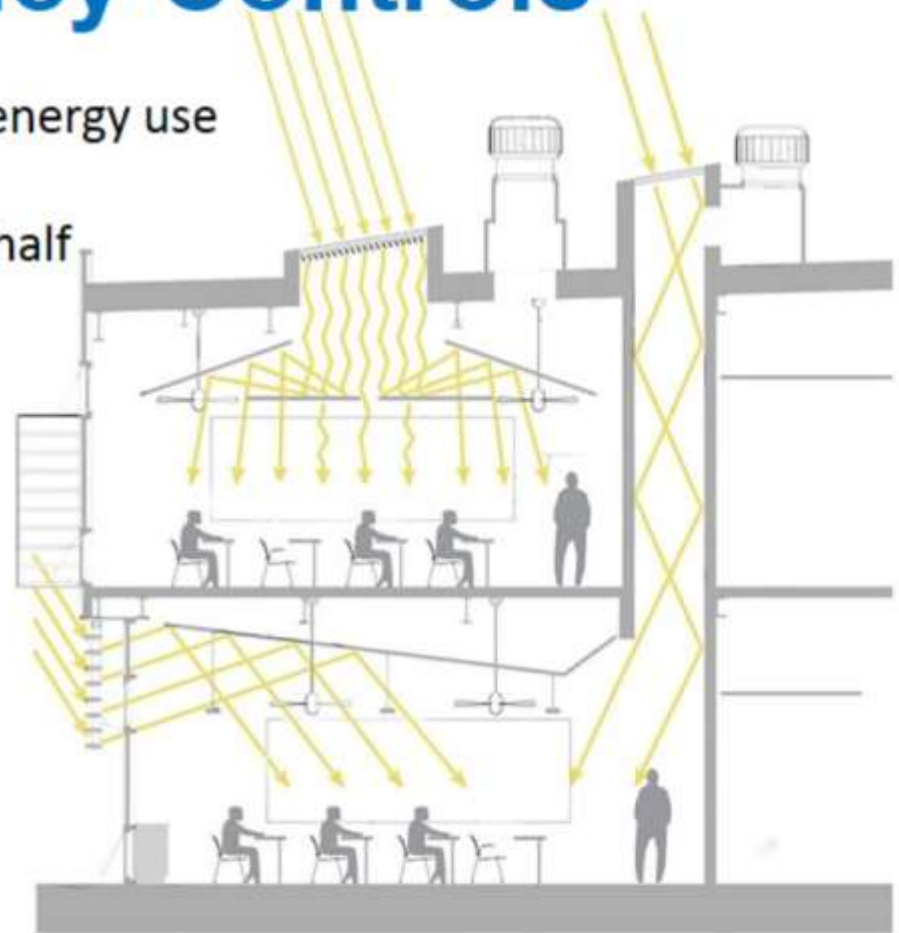


Integrated Daylighting and Occupancy Controls

- Lighting can reach 20% of energy use
- School hours are optimal
- Cut lighting energy use by half



Source: Boora Architects



Source: <http://www.srgpartnership.com/>

ZNE Retrofit Actions

High intervention:

- HVAC System Switching
- Envelope Upgrade
- Window Replacement
- Renewable Energy System

Medium intervention:

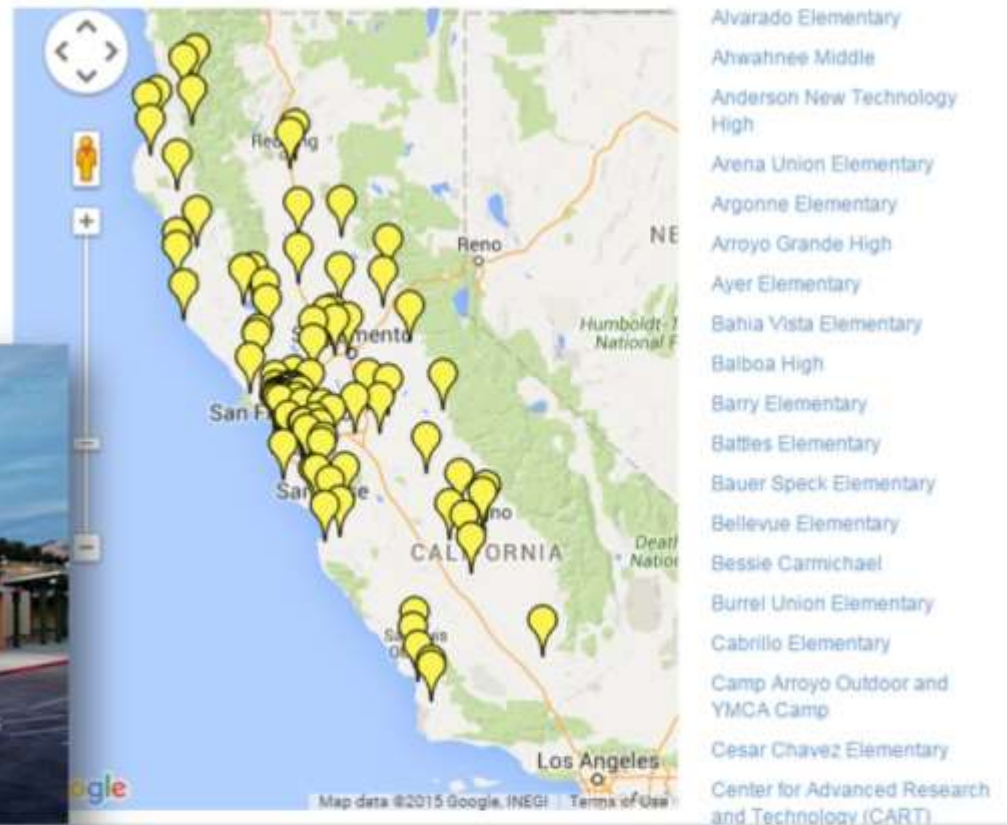
- Lighting/Daylighting
- HVAC Equipment Upgrades
- Controls: System Upgrade
- Opportunistic Envelope Insulation

Low intervention:

- Remote Audit
- Retro-commissioning
- Controls: Building Tuning
- Plug Load Savings/Policy
- Operator and Occupant Training
- Infiltration Reduction Measures

Renewable Energy Integration

- The Final step
- Solar most common
- Size as feasible



Designing to the ZNE Target

Part 1: Design for performance

– Developing a grid friendly building

