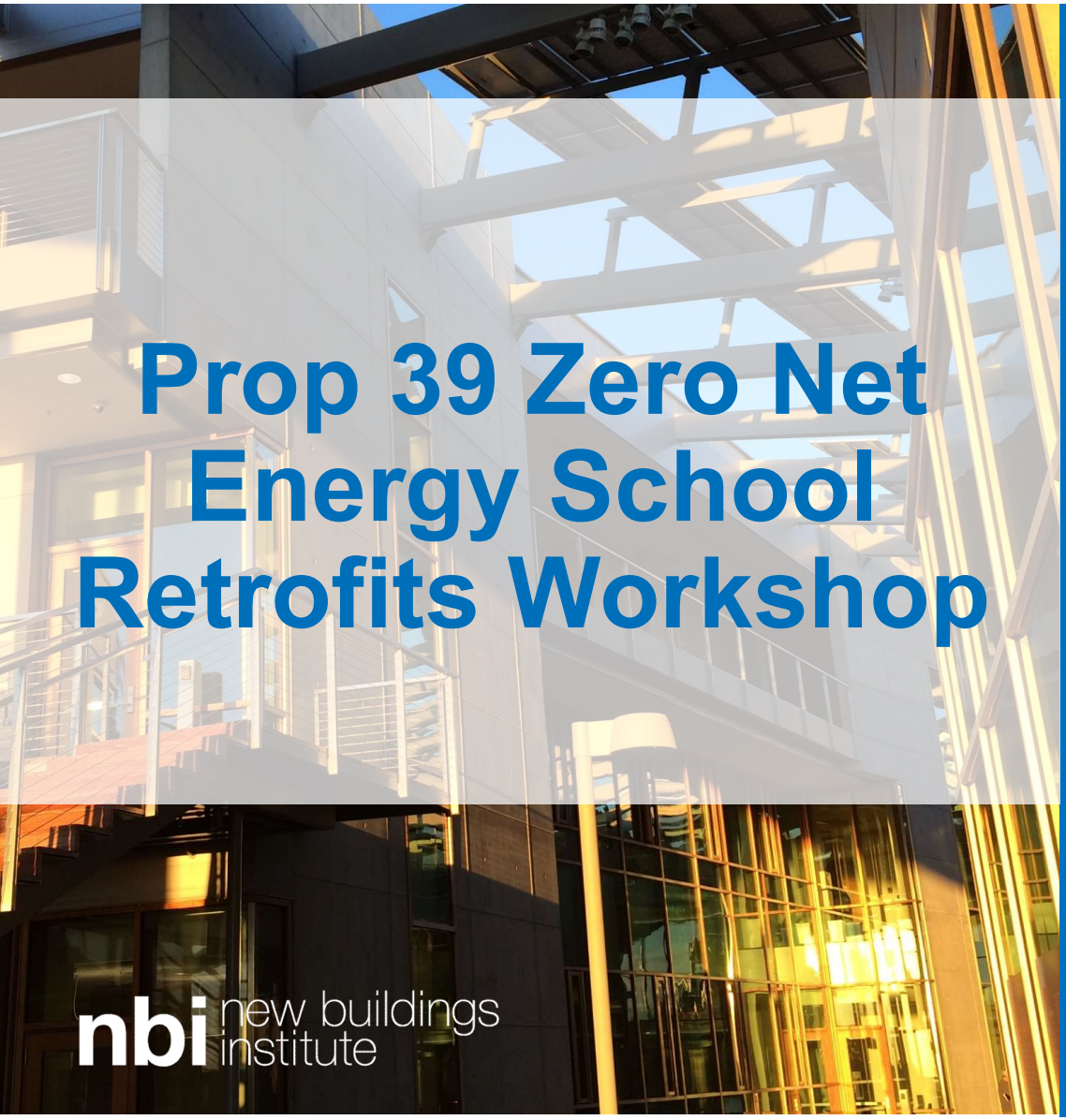

Prop 39 Zero Net Energy School Retrofits Workshop

The Business and Community Impacts of ZNE School Retrofits

November 27, 2017

New Buildings Institute
Amy Cortese, Associate Director
Reilly Loveland, Project Analyst

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Prop 39 ZNE School Retrofit Pilot Program Workshops

The Prop 39 ZNE Pilot Program s funded by California utility customers and administered by Pacific Gas and Electric Company, San Diego Gas & Electric Company, Southern California Edison Company, and Southern California Gas Company under the auspices of the California Public Utilities Commission. The California investor-owned utilities are not responsible for the preparation of this presentation, nor do any of them make any representation concerning the quality, accuracy or suitability of the information set forth herein. As the author of this presentation, the New Building Institute is solely responsible for this presentation and its contents.

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Welcome & Introductions

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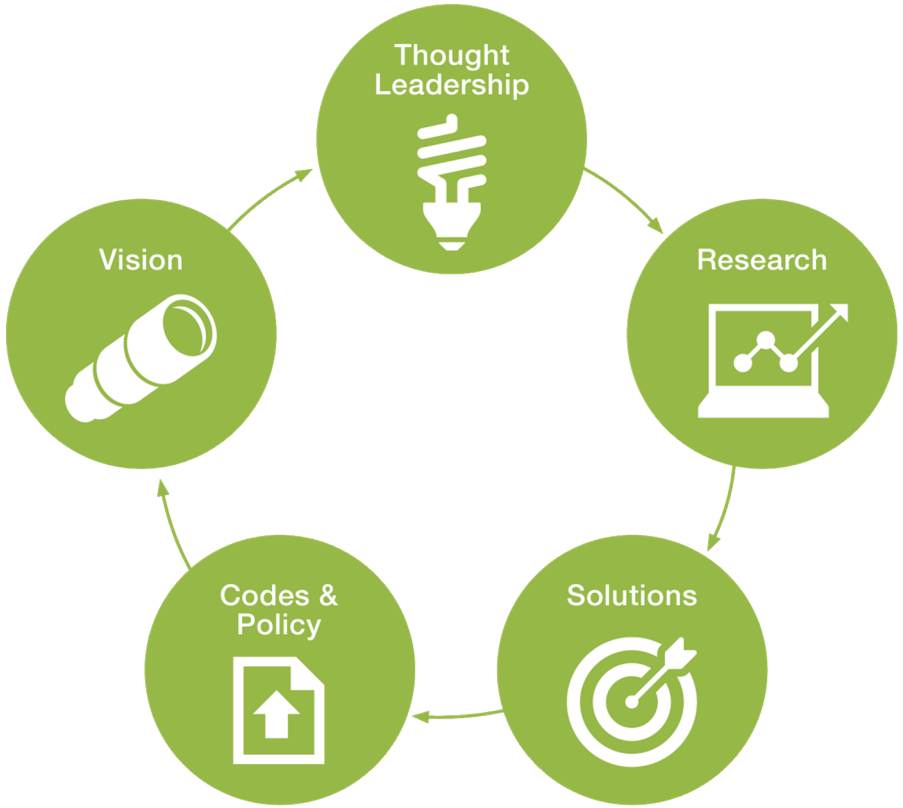
Redefining energy efficiency in the built environment

NBI is a national nonprofit working to improve buildings for people and the environment.

Program Areas:

1. *Best practices in new and existing buildings*
2. *Continuous code and policy innovation*
3. *Zero net energy leadership and market development*



Workshop Agenda

1:00 p.m. – 1:15 p.m.	**Welcome: Workshop Goals & Expectations**
1:15 p.m. – 1:35 p.m.	**Introduction: Zero Net Energy & Prop 39** *Presented by NBI and Southern California Edison and Southern California Gas Company*
1:35 p.m. – 2:15 p.m.	**Retrofit Case Study: San Francisco Unified School District** *Presented by Nik Kaestner, San Francisco Unified School District, Director of Sustainability*
2:15 p.m. – 2:25 p.m.	**Process of ZNE & Stakeholder Engagement** *Presented by NBI*
2:25 p.m. – 2:40 p.m.	Break
2:40 p.m. – 3:10 p.m.	**Designing and Operating to ZNE** *Presented by NBI and Nik Kaestner*
3:10 p.m. – 3:45 p.m.	**Activity: Paths to ZNE Worksheet**
3:45 p.m. – 4:00 p.m.	**Closing Discussion**

Learning Objectives

1. Understand the process associated with retrofitting a school to ZNE.
2. Utilize lessons learned and approaches used by a current Prop 39 ZNE Pilot School.
3. Apply planning and technical tools needed to achieve successful zero net energy project planning, financing, design, construction, and operations.
4. Participants have access to zero net energy school experts and the opportunity to collaborate with other district staff as they brainstorm how to implement and support zero net energy school projects in their own communities.

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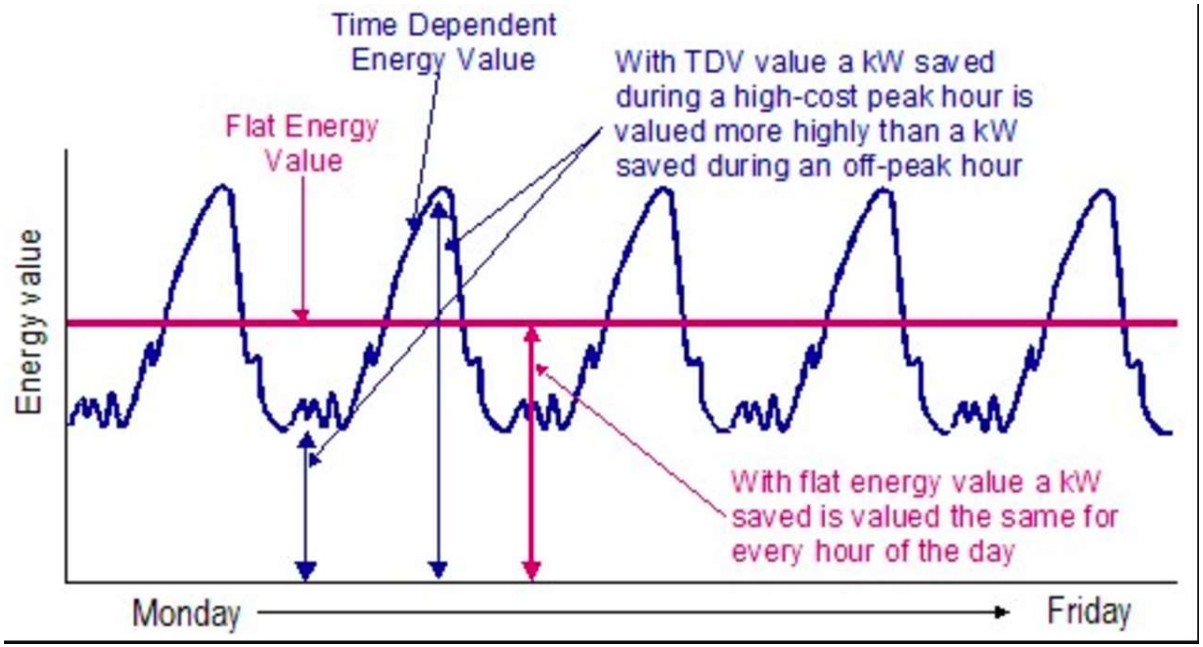
Introduction to Zero Net Energy

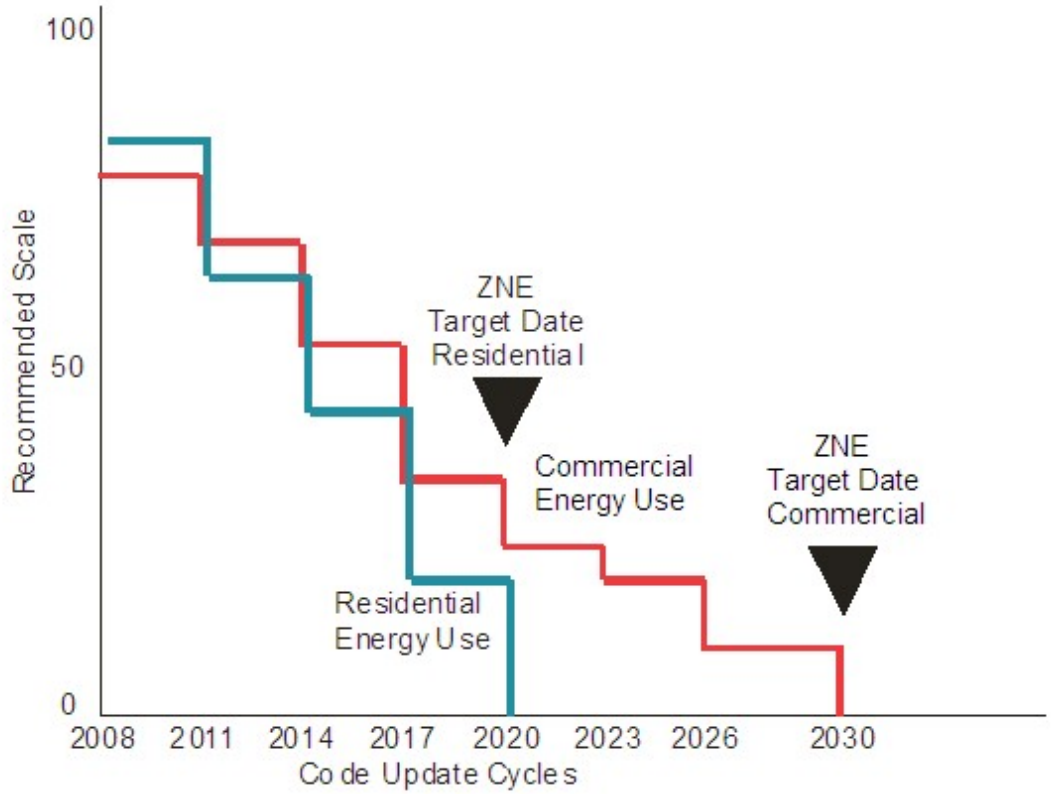
Zero Net Energy (ZNE) Definitions

- ***Time Dependent Value (TDV):*** *ZNE Code Building in California*
- ***ZNE Site:*** *A building that produces at least as much energy as it uses in a year, when grid-supplied energy is accounted for at the site boundary*
- ***ZNE Source:*** *A building that produces at least as much energy s it uses in a year when grid-supplied energy (including primary energy for generation, transmission and delivery to the site) is taken into account*
- ***Definitions vary!***



Time Dependent Valuation graphic source: Heshong Mahone Group, 2002 at http://h-m-g.com/Projects/TDV/TDVDefault.htm

Code Cycles to Net Zero in California



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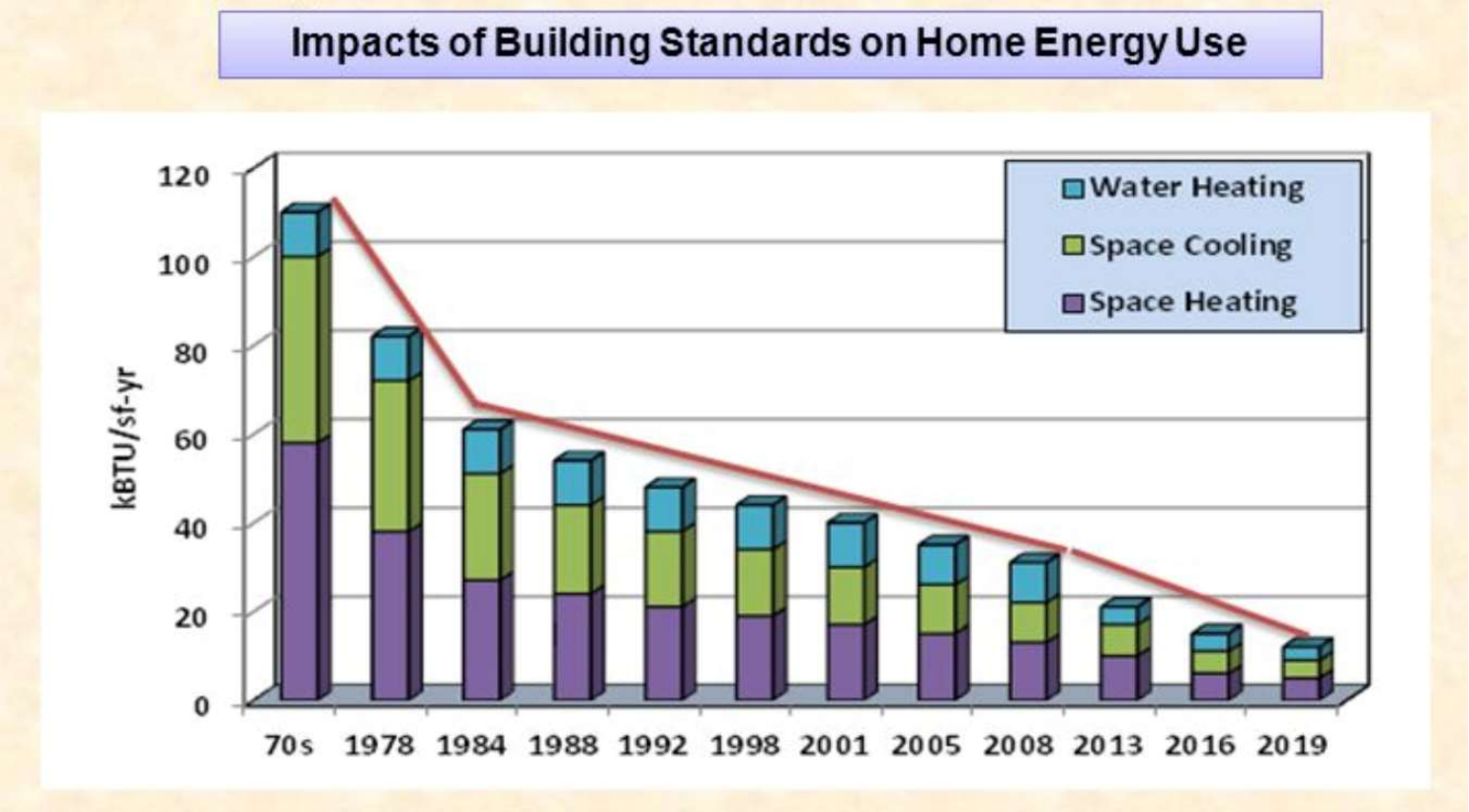
Source: SCE & AEC, 2009

Code Cycles to Net Zero in California



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Source: CEC 2016

Why Zero Net Energy Schools?

- The next evolution in sustainable, high performance buildings
- Redirect money from utility bills to classroom
- Create comfortable and productive environment for teachers and students
- Provide hands-on, tangible learning opportunities for 21st century skills
- Make schools and communities stronger, resilient and energy independent

Hood River School District Science Building | Hood River, OR

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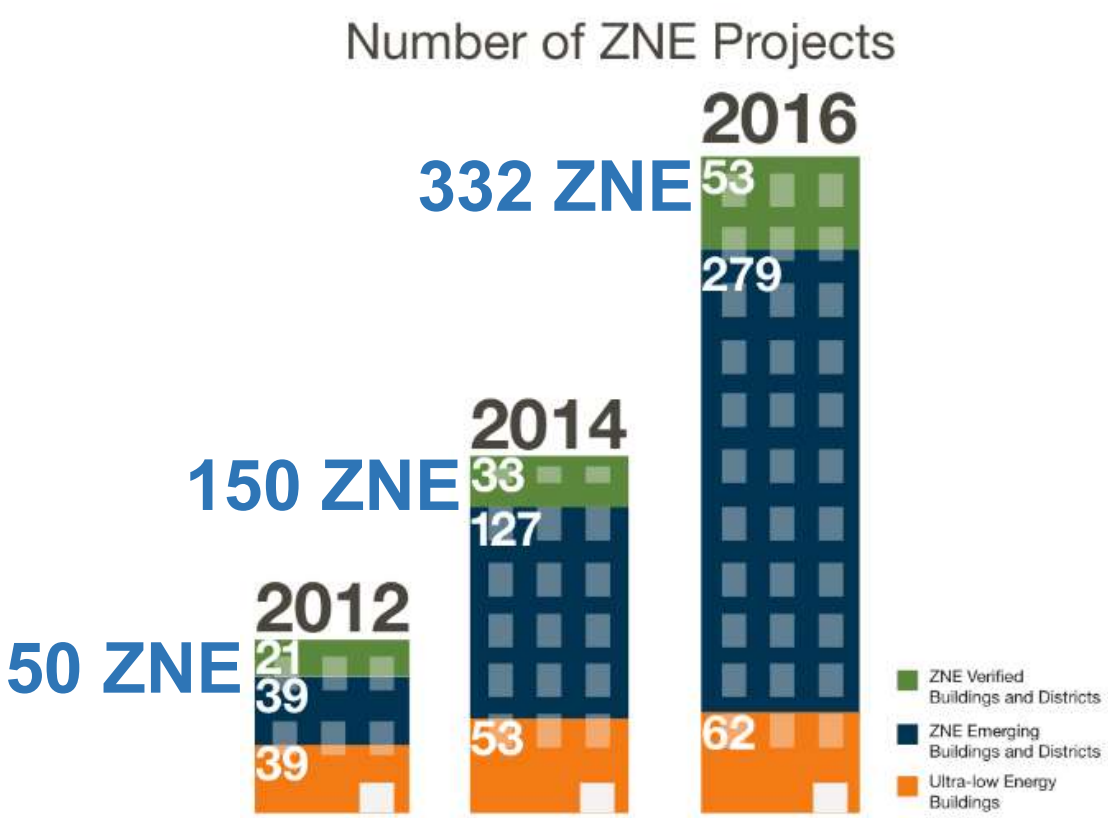
The 2016 List of ZNE Buildings



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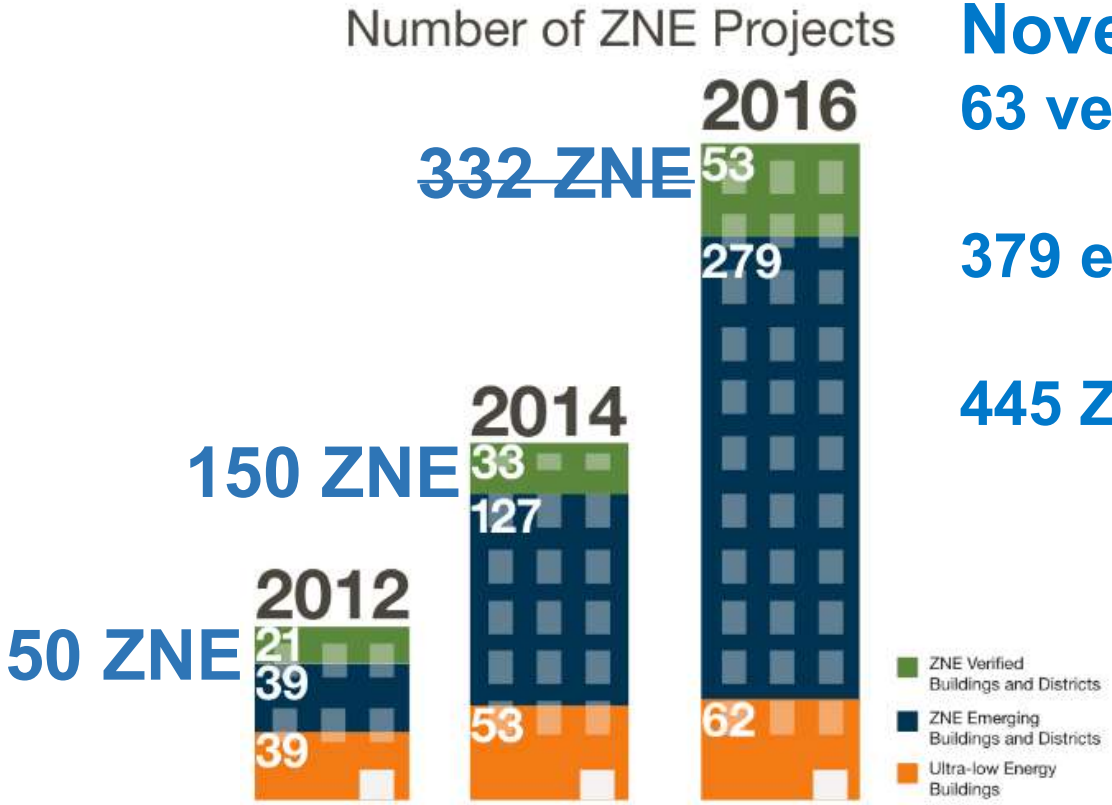
The 2017 List of ZNE Buildings



November 2017:

63 verified

379 emerging

445 ZNE

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GETTING TO
zero
BUILDINGS DATABASE

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

RESEARCH CODES & POLICY TOOLS & GUIDES EVENTS NEWS

			ZERO NET ENERGY	ADVANCED BUILDINGS	OUTCOME
	Leslie Shao-ming Sun Field Station at Jasper Ridge Biological Preserve	Woodside	CA	13,197	3
	Adam Joseph Lewis Center for Environmental Studies--Oberlin College	Oberlin	OH	13,595	-11
	Omega Center for Sustainable Living	Rhinebeck	NY	6,200	-8
	Plano Elementary School	Bowling Green	KY	81,149	26

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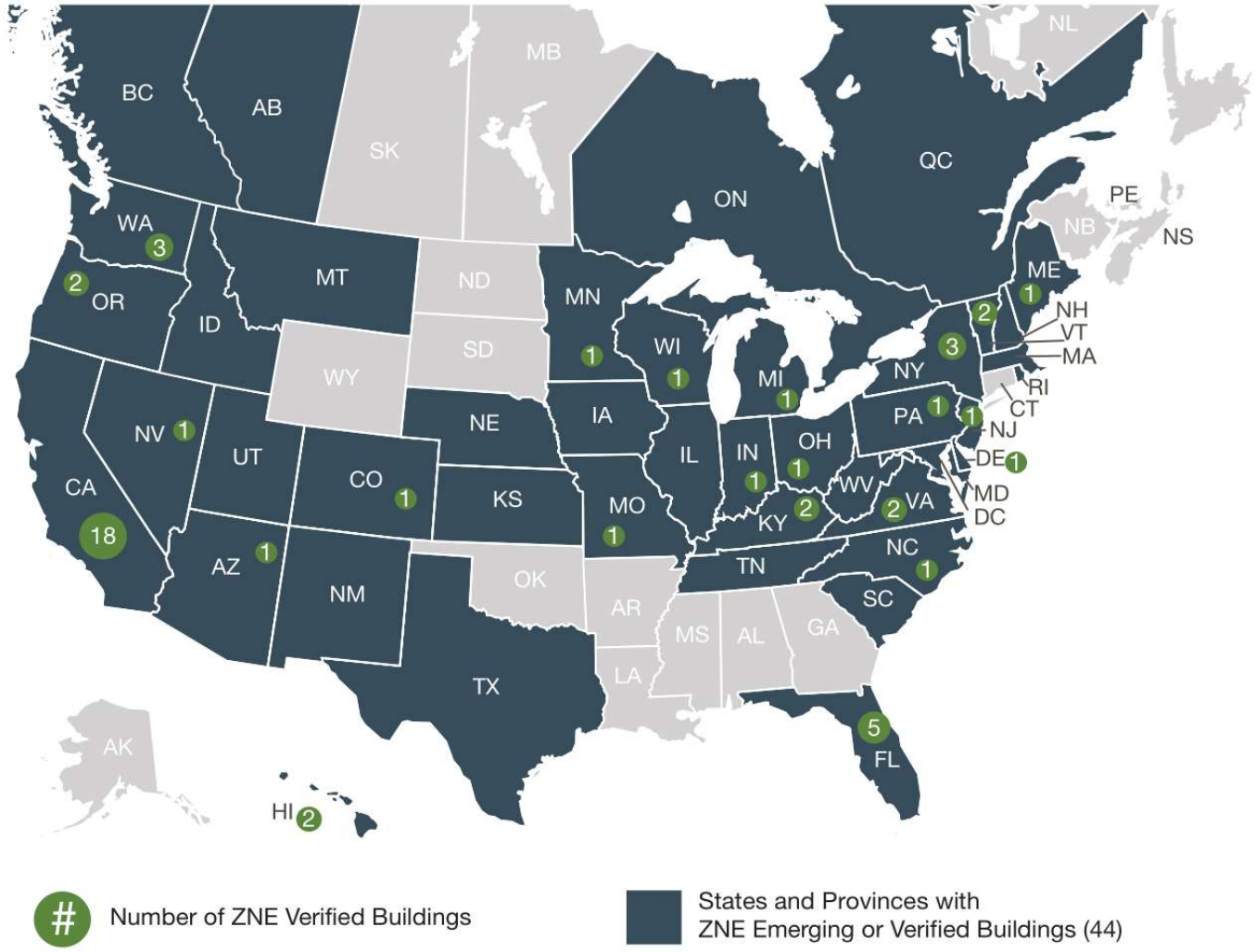
Where are ZNE Projects?



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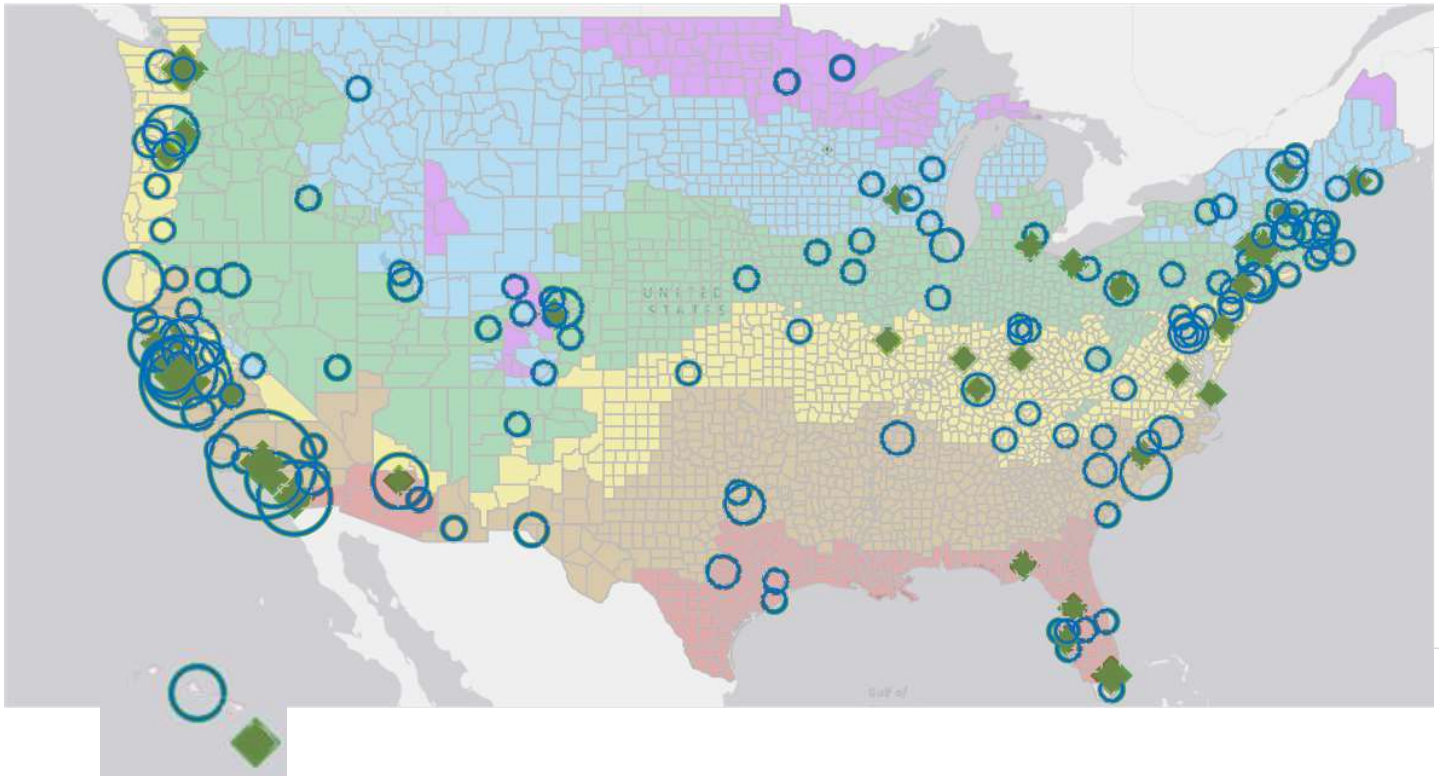
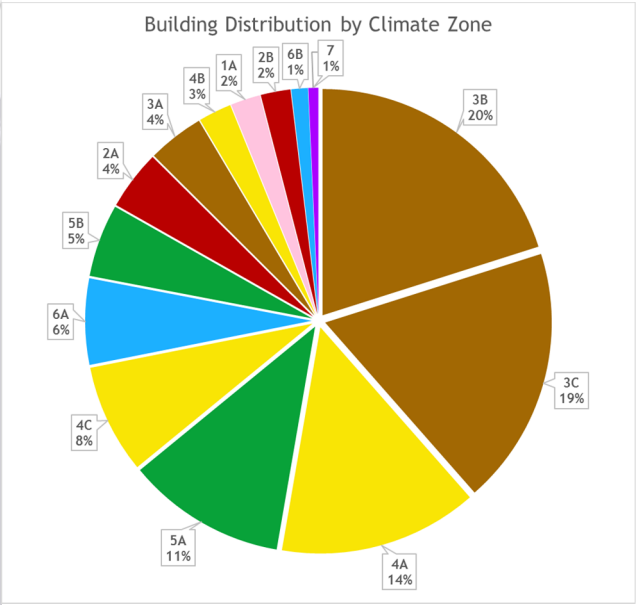
ZNE Buildings in Every Climate Zone





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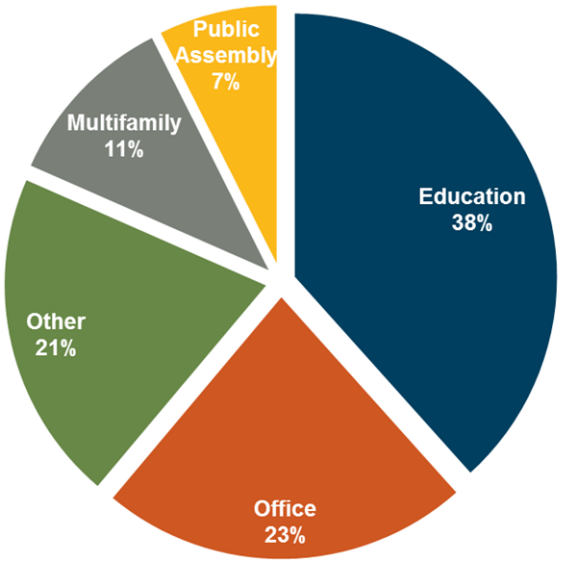
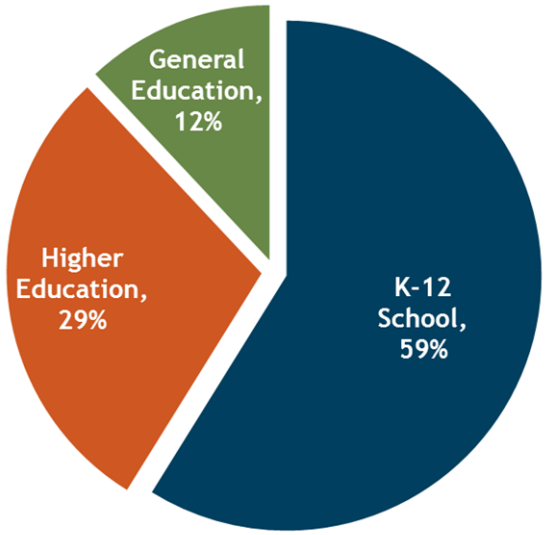
Schools are Leading

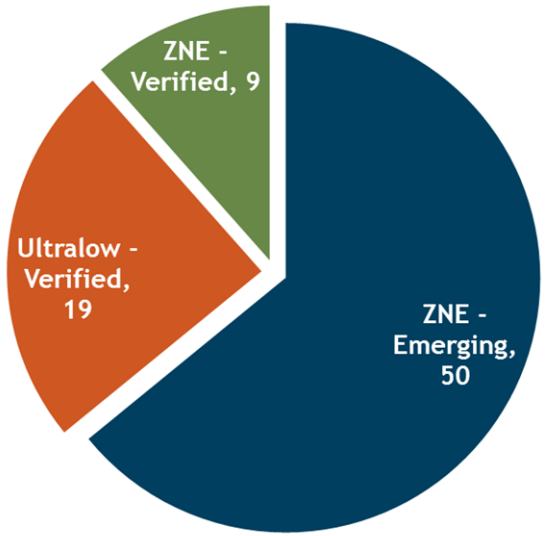
ZNE and Ultra-low Energy Building Types



Breakdown of Education Building Types



K-12 School Building Count



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ZNE and Ultra-Low Energy in Education

K-12 Schools

Community Colleges

Higher Education

Libraries

Science Centers

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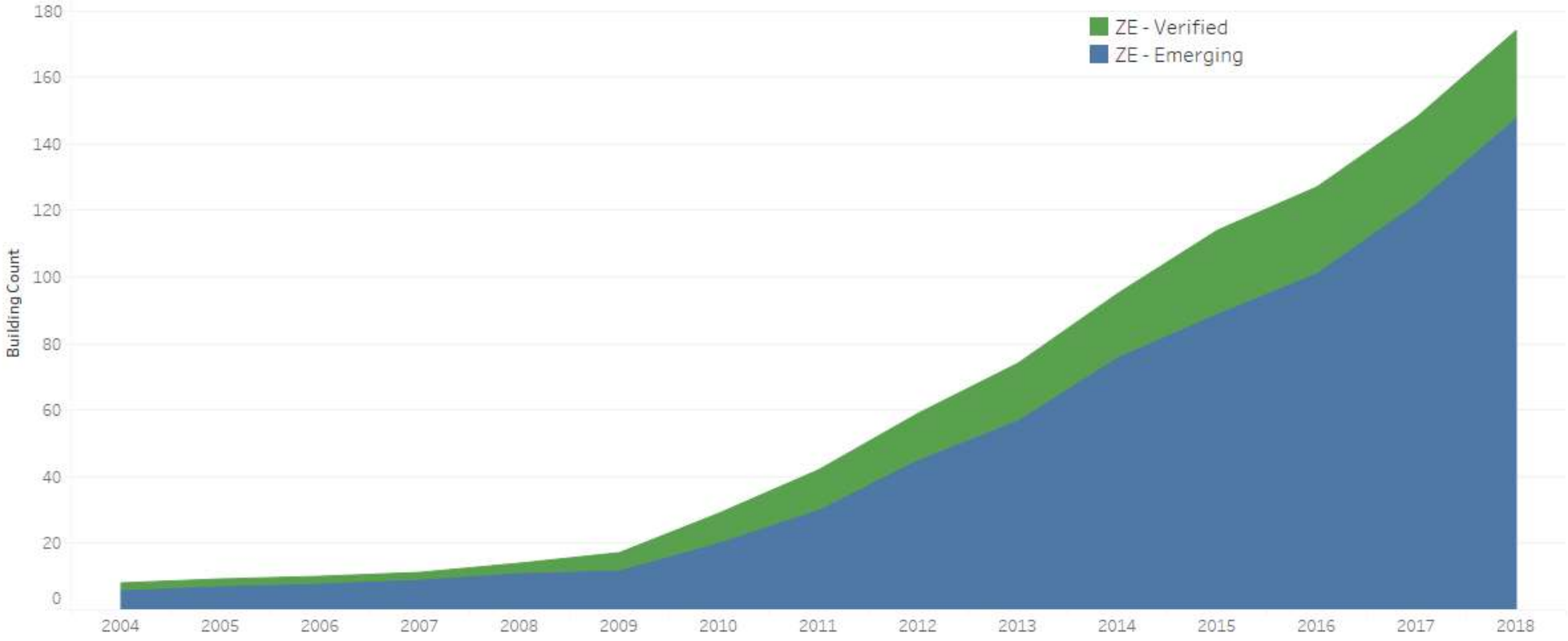
2017 ZE Schools: Top Five States

State	ZE Verified	ZE Emerging	Ultra-Low Energy Verified	Grand Total
CA	2	27	6	35
KY	2	3	4	9
NC	1	4	2	7
TX	0	5	1	6
SC	0	5	0	5
Total	**11**	**63**	**20**	**94**

Growth of ZNE Educational Buildings



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Why Schools?

Why not?! Reverse the argument/conversation - Start from ground up with educating students about ZNE + sustainability - Set an example for ZNE/Env. Leadership - Current path is unsustainable -Need a more financially sustainable route - Also spreading the message to school + broader community - Healthier buildings (e.g., daylighting, or relating to higher test scores) - Schools can be resilient resource centers - Wise use of public funds - Increased savings in operations, brings more money for programs - Showing students what is possible - Demonstrating how schools play a part in meeting state and city goals - Demonstrating good stewardship and leaving a positive legacy for future generations - Students are good advocates with parents - Owner occupied buildings have best payback over long term - Not an unlimited amount of energy - Carbon footprint - Next generation of leaders - Energy savings goes back to programs - Mandate is looming - Next step after LEED - Cost savings - School district as model for community - As a building type, it is ideal – low occupancy, sufficient land, owner-occupied - Greenhouse gas reductions and climate goals - Fiscally responsible with taxpayer dollars - Better financing terms - Education next generation of leaders - Better financing terms - Education next generation of leaders - Increased population, increased need for more schools, will be more cost-effective to build now - Learning/teaching benefits: daylighting enhances student performance and wellbeing, biophilia (connection to nature) - Easier to operate - Maintenance - Energy savings - Retention rates - School as teaching tool - Save planet one building at a time - Necessity - Electricity is expensive - Reinvest savings for other programs - Set a good example for kids - see us doing this - demonstrate leadership - Technology creates a better, more convenient building - Attract and retain students and faculty - Quantitative benefits - Integrate into curriculum - Building awareness - Stay with them whole lives - Change expectations of students - We are doing our part - Better test scores and health

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SCE – SCG
Prop 39 ZNE Pilot

Efren Villasenor P.E. – SCE Engineering Project Management
Robert Arredondo – SCE Program/Contracts Management

Prop 39 ZNE Pilot Overview

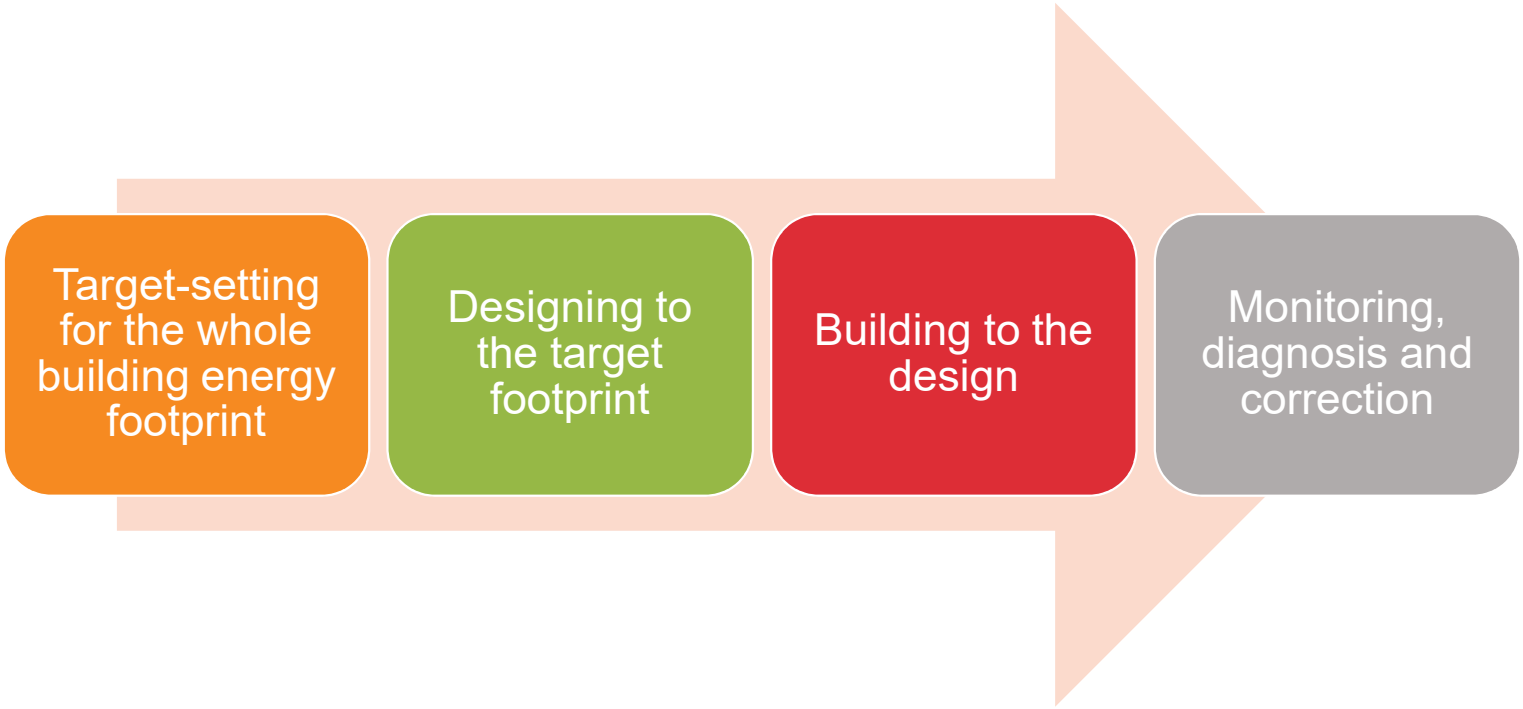
- Program Goals
  - Leverage Prop 39 funds
  - Retrofitting “existing” buildings in public schools & community colleges
  - Establish “Proof of Concept” of feasibility across California
  - Document findings & Best Practices
  - Future Program Development
- Prop 39 ZNE Value to the Schools
  - Socialize awareness to Stakeholders
    - District staff members, students, parents, & community
  - Design Assistance
  - Training
    - Implementation & on-going maintenance of these retrofits

Prop 39 ZNE Rounds 1 and 2 Screening

- Selection Criteria
  - Potential to reach an EUI of 16-22 kBtu/sqft/year after measures are applied
  - Project currently has Prop 39 funding or other Non-Prop 39 funds
  - Onsite renewable will be installed at the site.
    - Funded separately from ZNE Pilot
  - Must meet Prop 39 ZNE Pilot Schedule

Achieving ZNE

Utilities have observed that ZNE buildings can be achieved only by way of an integrated, multidisciplinary design process that includes:



Utility Support

Design Consultation

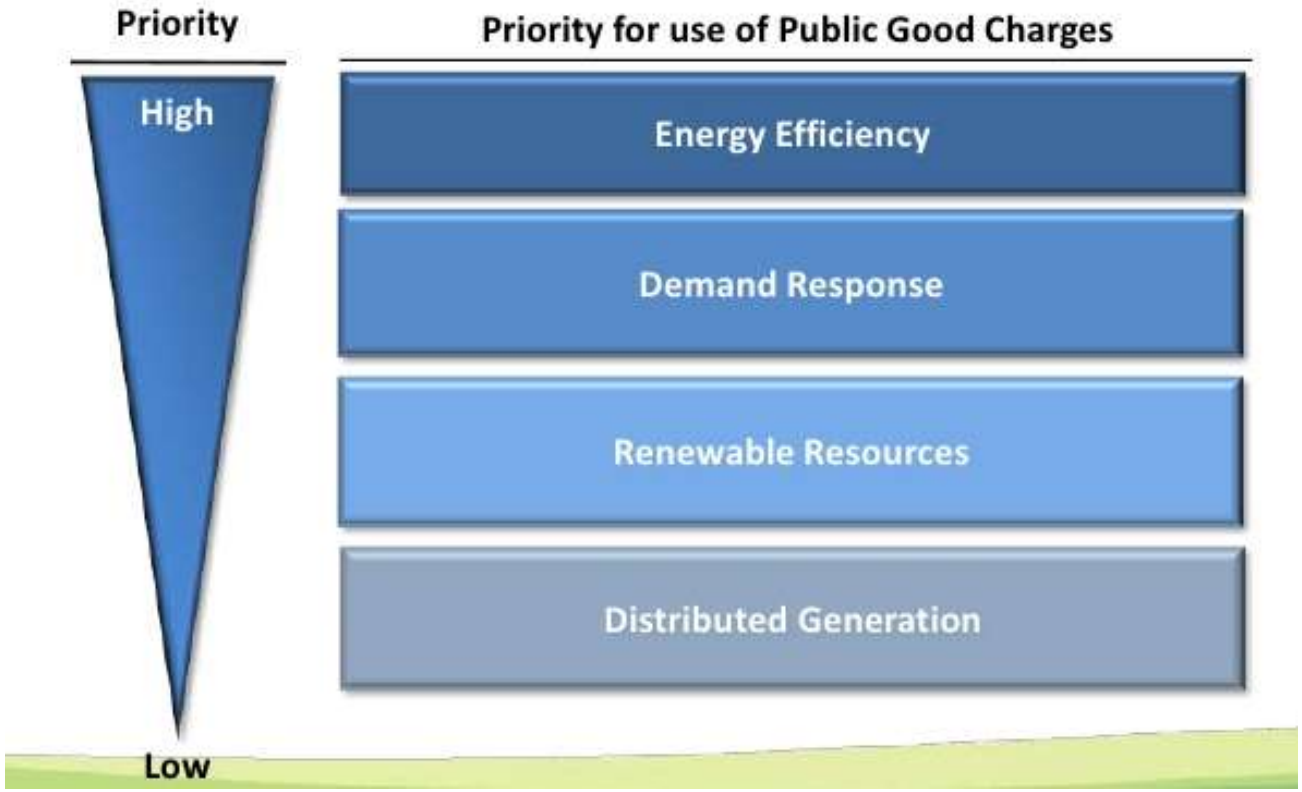
Construction Inspection and Commissioning Support

Incremental Cost Buy Down

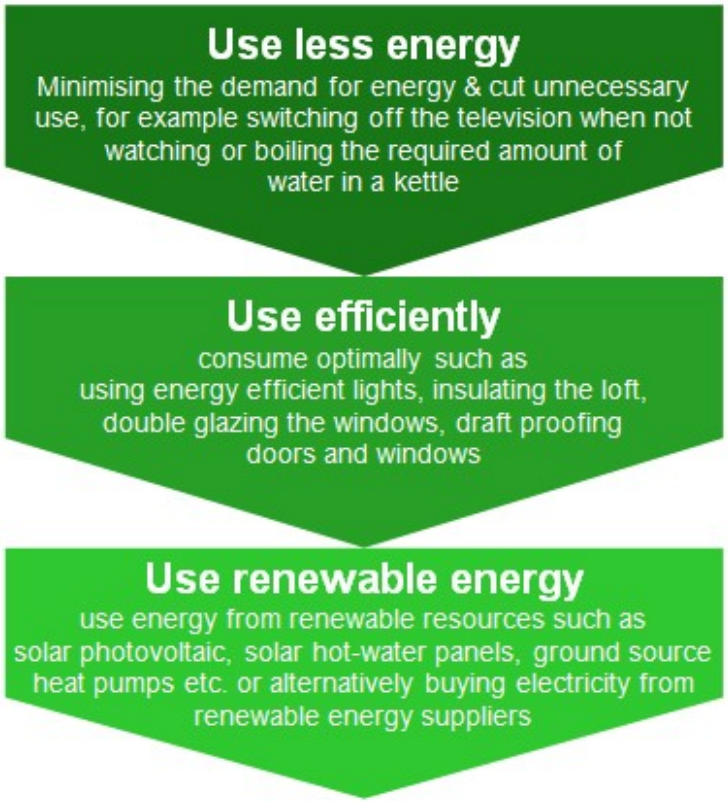
Monitoring, Diagnosis, Correction and Validation

Coordination with Prop 39

CEC Loading Order



Energy Hierarchy



Prop 39 ZNE Pilot Status – Southern California

Milestone	Date
Site Visit, ZNE Viability Test, Selection	**Completed**
Agreement in Place	**Completed**
Project Kick-Off Meeting	**Completed**
Design Report / Enhanced Design Report	**Feb 2016 – Nov 2017**
Construction/M&V	**July 2017- September 2018**
Final Design Report	**December 2019**

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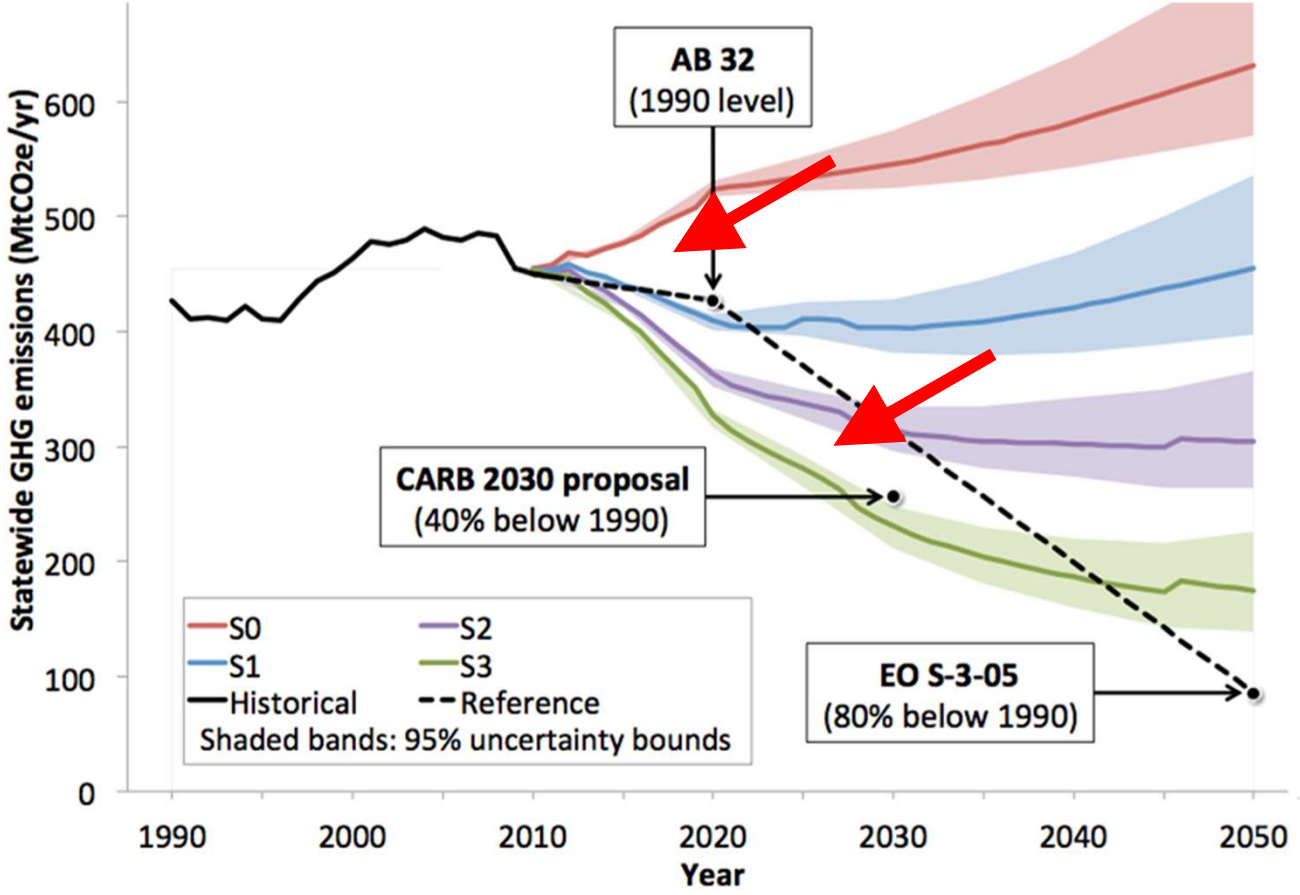
Retrofit Case Study:

San Francisco Unified School District

Nik Kaestner, Director of Sustainability

BOLD ACTION



Source: Berkeley Labs

STEPPING UP

An Integrated Plan for Addressing Climate Change

VISION

Reducing Greenhouse Gas Emissions to 40% Below 1990 Levels by 2030

GOALS

50% renewable electricity

50% reduction in petroleum use in vehicles

Double energy efficiency savings at existing buildings

Carbon sequestration in the land base

Reduce short-lived climate pollutants

Safeguard California

Source: CARB

California's ZNE Building Goals

- *All new residential construction and all new commercial construction in California will be zero net energy by 2020 and 2030, respectively*
- *50% of existing commercial buildings will be retrofit to ZNE by 2030*
- *All new state buildings and major renovations shall be ZNE (2025)*
  - *50% of existing state-owned building area by 2025 shall be ZNE*
- *IOUs shall launch and ramp a ZNE K-12 Schools and Community College Pilot Program in 2015-18*

DPR Construction San Diego Corporate Office , Chip Fox, DG&E, renovation

IBEW ZNE Center, San Leandro, renovation

Source: CPUC

AT A GLANCE

Dense/Urban

7th Largest

57K Students

Diverse

Poor

Renters

Private

SFUSD

THE JOURNEY BEGINS

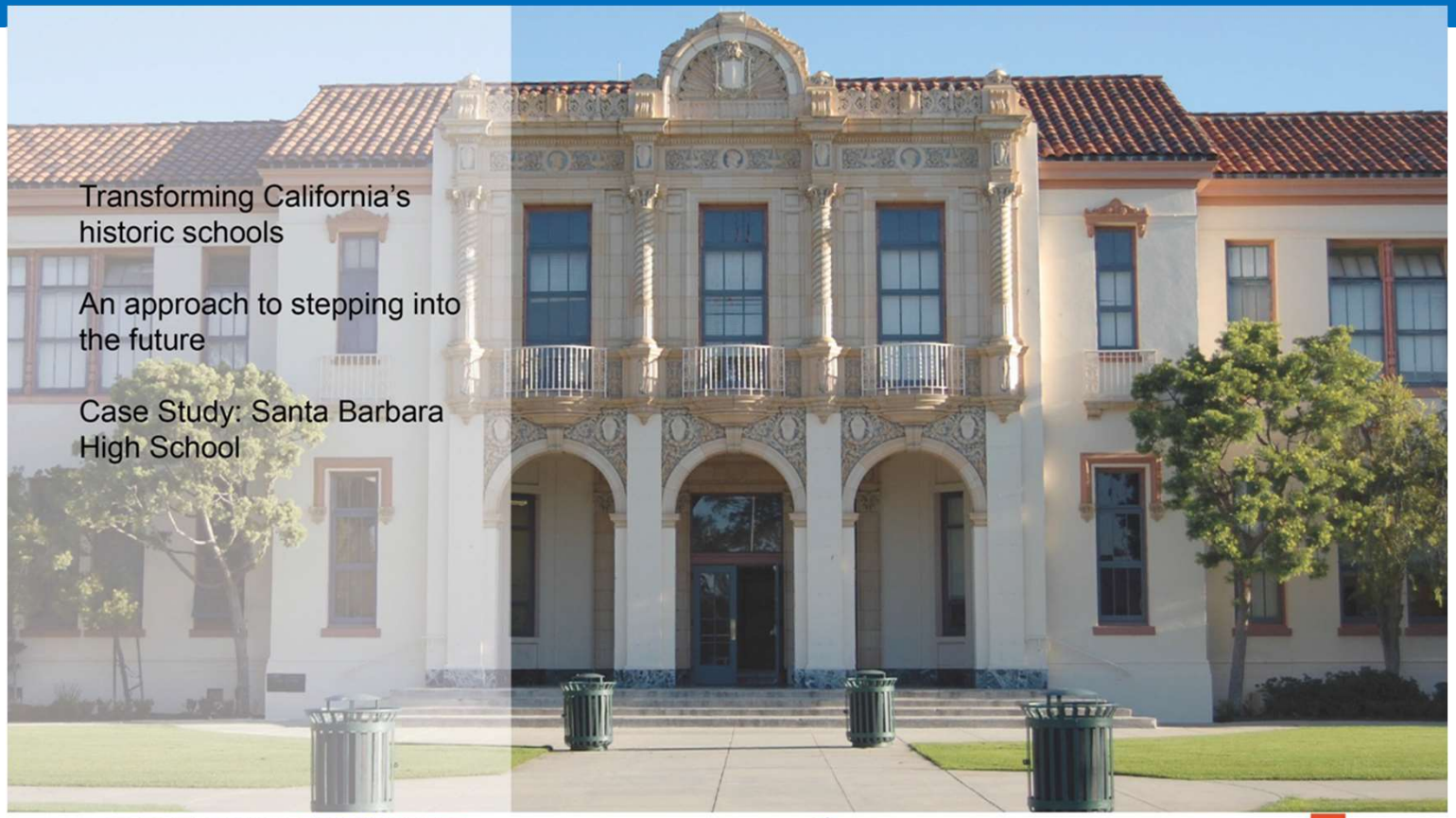
Source: Harley Ellis Devereaux

ZNE SCHOOLS

Source: SOM

BUILDING STOCK

7 x 7 x 7 CHALLENGE



7x7x7 DESIGN ENERGY WATER
7 ARCHITECTS 7 SCHOOLS 7 INNOVATIONS

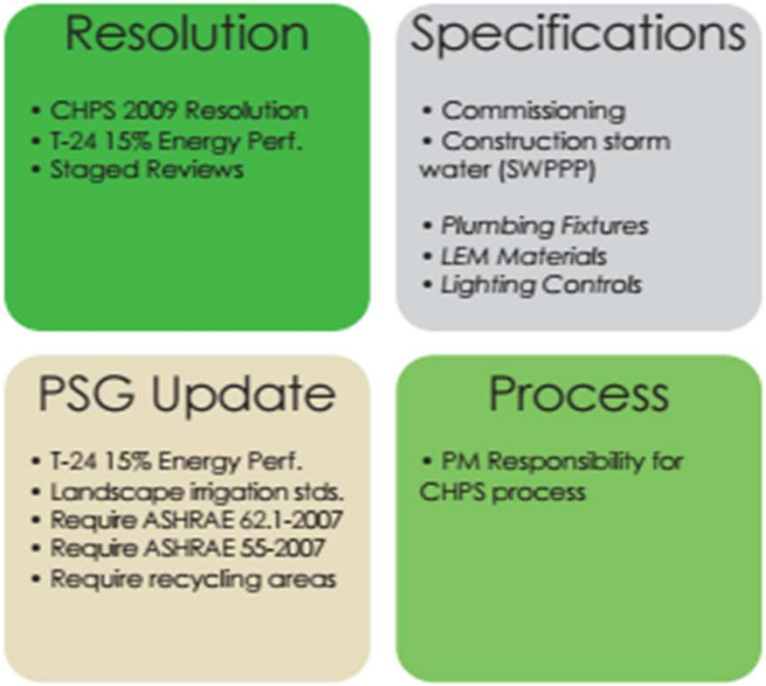
CAPITAL
ENGINEERING CONSULTANTS, INC.

HAMILTON+AITKEN
Architects

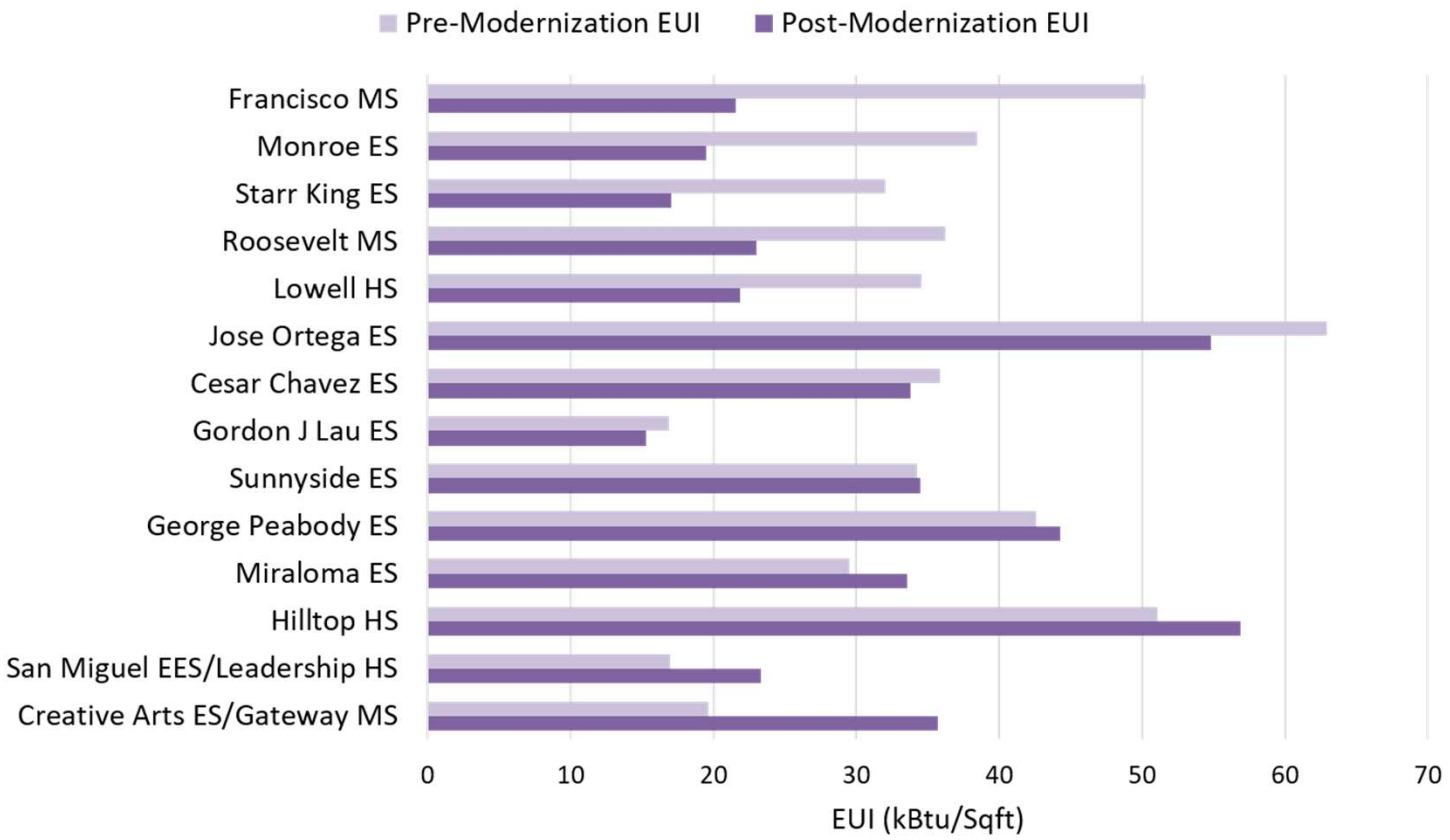
HOW IS SFUSD DOING?

Sustainability Lite

Initial Strategies for Increasing CHPS 2009 Compatibility



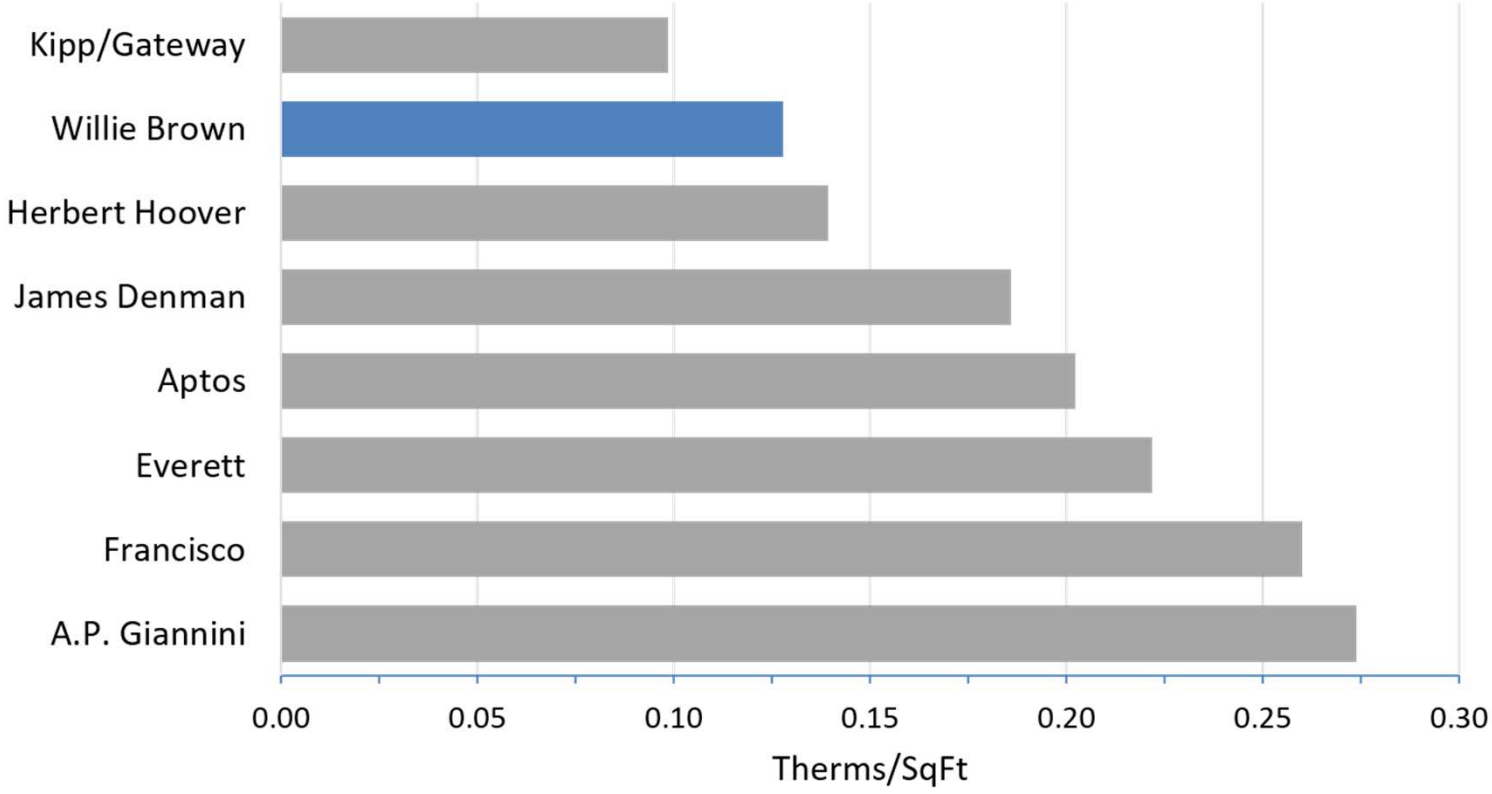
Pre- vs. Post- Modernization
ENERGY



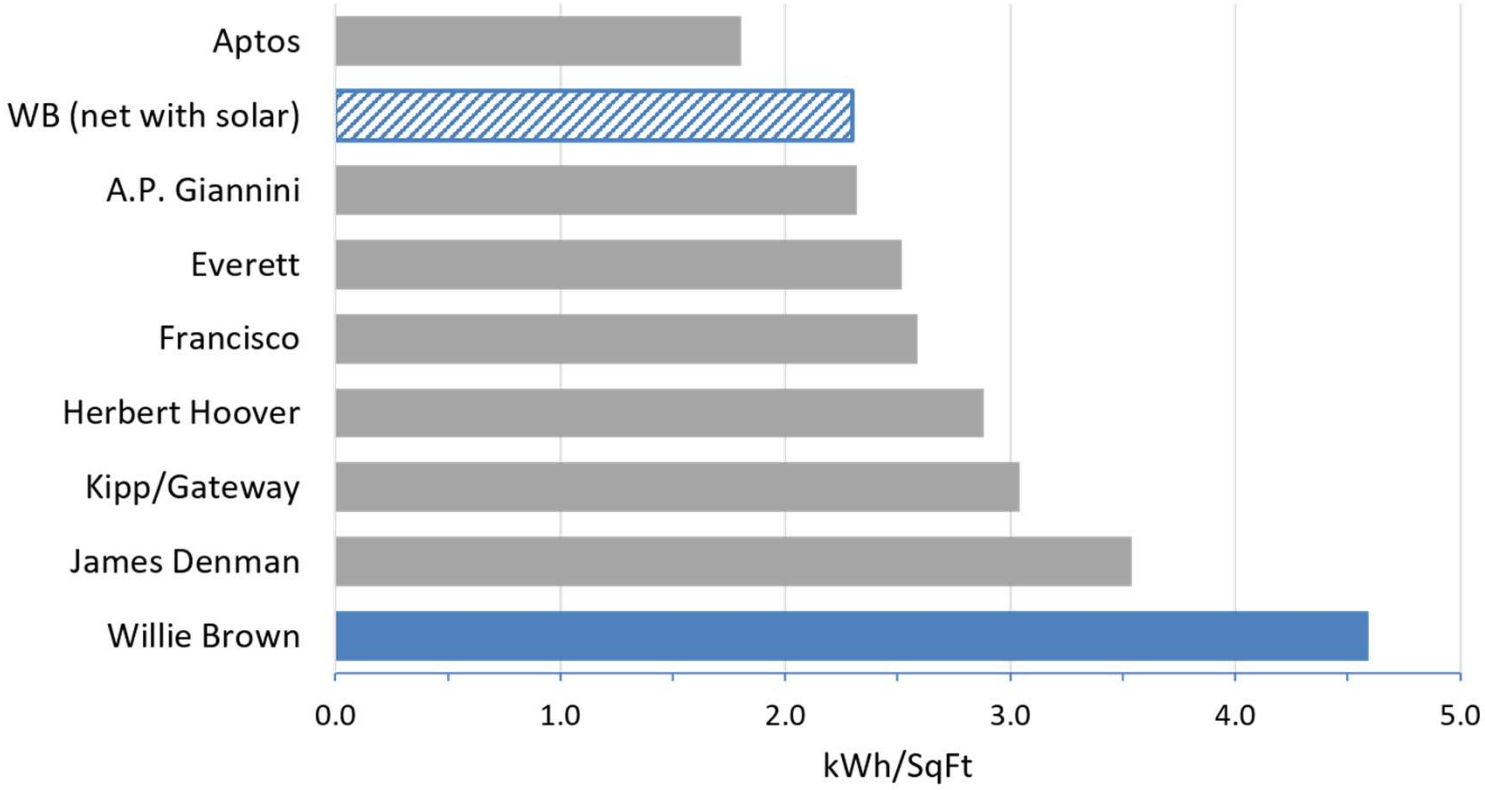
WHAT ABOUT NEW SCHOOLS?

Therms Per Square Foot

NATURAL GAS



kWh Per Square Foot
ELECTRICITY



BEATING CODE IS NOT ENOUGH

KICK-OFF

Source: WRNS Architects

WORKING GROUP

Source: Tarus Expert

ROLE MODELS

Boulder Valley School District
Excellence and Equity

Español Deutsch Русский 日本語 Français Italiano 中国 | Sign In

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- Greening BVSD
- Awards and Grants
- BVSD Green Policy
- Energy Challenge
- Green Buildings in BVSD
- Green Resources
- **Sustainability Management System**
- Teaching Sustainability
- Zero Waste and Green Star Schools
- Alternative Transportation (leaves greenBVSD)
- greenBVSD News
- 2014 Eco Champions

Sustainability Management System

The Boulder Valley School District is building on 20 plus years of environmental stewardship and further embracing environmental sustainability. The district hired a Sustainability Coordinator in the summer of 2008 and launched its first version of the Sustainability Management System in 2009. The SMS is a comprehensive approach for identifying and coordinating existing efforts, establishing baselines, defining sustainability for BVSD, and creating plans to integrate sustainability into our operations and curriculum. The SMS is used as a roadmap for future years and is reviewed annually. The SMS also has an annual public reporting measure which leads to accountable actions and future goal setting.

In 2015, BVSD released the updated Sustainability Management System to reflect new 5-year goals and updated visions.

2015 Sustainability Management System - Updated

2012 Sustainability Management System Progress Report

2009 Sustainability Management System

BVSD is striving toward net zero energy* buildings with 100 percent reuse of indoor water and no potable water used for irrigation.

- New Sustainable Energy Plan
- 2012 SMS Report on 5-year goals related to buildings (page 3)
- Green building in BVSD
- Check out the green features and live data for LEED Platinum Casey Middle School!

Source:
BVSD

SITE VISITS

Source: ZNE Training Center

SITE VISITS

TECHNOLOGIES

Source:
Kadva Corp

STATUS QUO

YESTERDAY

Source: Lochinvar

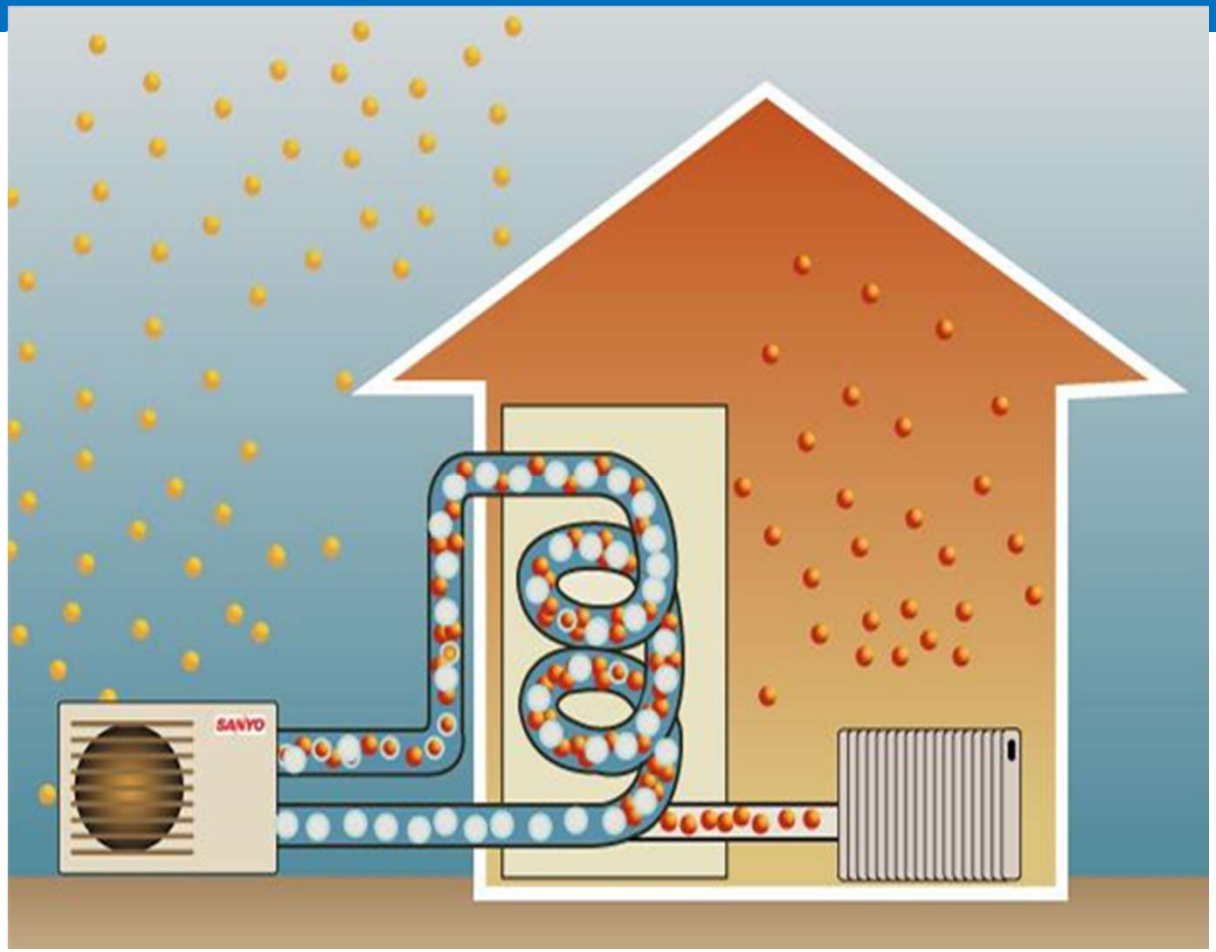
PURE JOY

Source: NY Times

UTILITY PERKS

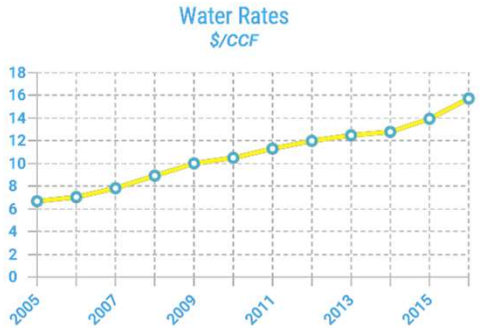
Source: SF Public Utilities Commission

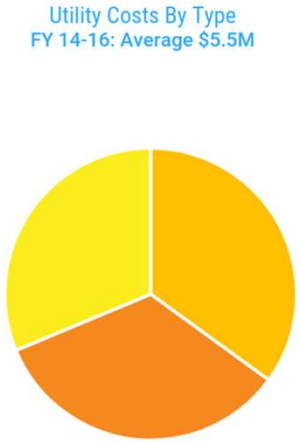
TODAY

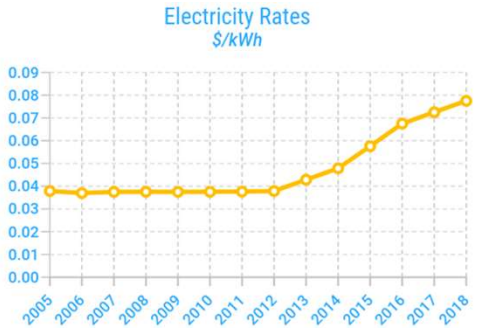


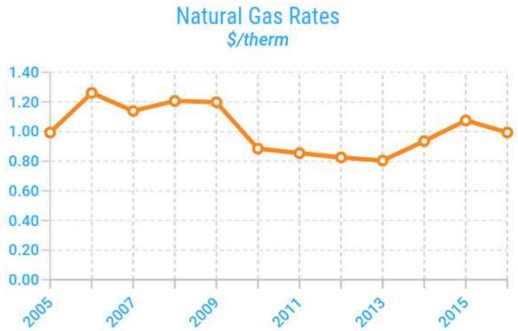
Source: Sanyo

POTENTIAL RISKS



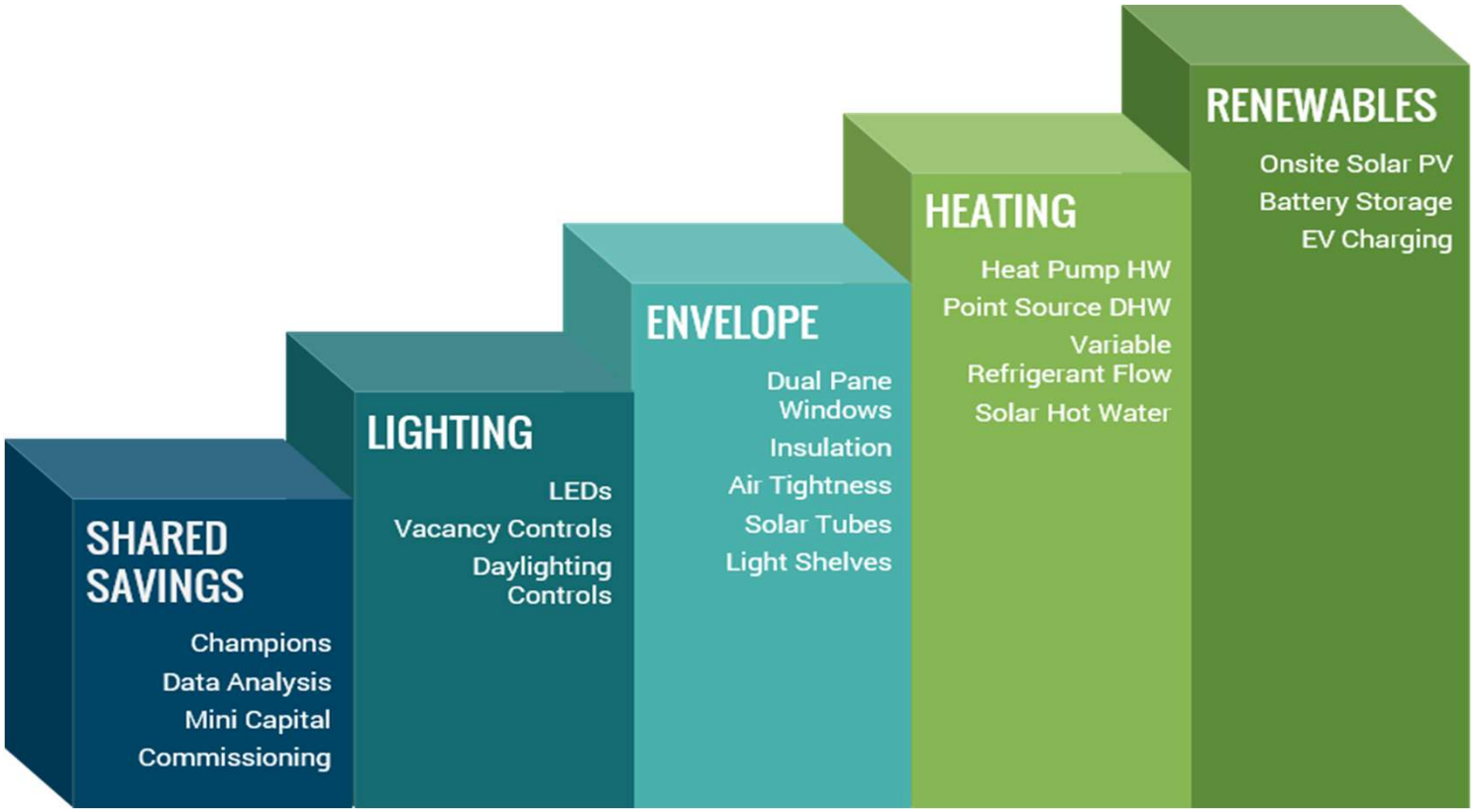






KNOW YOUR RATES

LABOR ISSUES



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Process of ZNE: Stakeholder Engagement

Gain Support for your ZNE Vision

- **Stakeholder mapping:**
  - Who are the stakeholders?
  - What are their drivers?
  - What are the key messages?
- Share case studies, fact sheets and other ZE materials
- Attend webinars and trainings
- **Identify sources to support your efforts**
  - Prop 39 & California IOU's
  - NBI Getting to Zero Project Guide
- **Visit a ZE school!**

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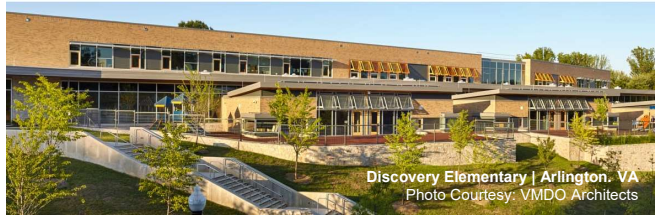
Six Key Messages for Communicating Zero Net Energy

Redding School for the Arts | Redding, CA
Photo Courtesy: TRILOGY Architecture

1. Zero net energy is possible in new construction and existing building retrofits.
2. ZNE lowers operating costs.
3. High performance, ZNE schools improve student performance and occupant satisfaction.
4. ZNE schools are living laboratories, stimulating learning and innovation.
5. ZNE schools are also more resilient and serve as safe havens for the community during emergencies.
6. While ZNE is the end game, the path to zero is a process and will take time to accomplish. School districts can start now with policies, plans and practices to get to zero.

Focus on the Benefits of High Performance Schools

- Occupants in ventilated spaces with low CO2 and low volatile organic compounds (VOCs) had improved scores in crisis response, information usage, and strategy ranging from 100 to 300%.[1]
- Students in daylit environments showed a 20-26% improvement on test scores compared to traditionally lit environments[2].
- Students with operable windows progressed 7-8% faster than those without operable windows[2].
- Students with the most daylighting performed 7-18% better in math and reading than those without[2].
- Students exposed to daylight attended school 3.2 to 3.810 more days per year[3]



Discovery Elementary | Arlington, VA
Photo Courtesy: VMDO Architects

1. Bakó-Biró, Zs., Kochhar, N., Clements-Croome, D.J., Awbi, H.B. & Williams, M. (2007, January). Ventilation Rates in Schools and Learning Performance. https://www.researchgate.net/publication
2. Heshong Mahone Group. (1999, August 20). Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance. http://h-m-g.com/downloads/Daylighting/schoolc.pdf
3. Healthy Schools Network, Inc. (2012) Daylighting. http://www.healthyschools.org/downloads/Daylighting.pdf

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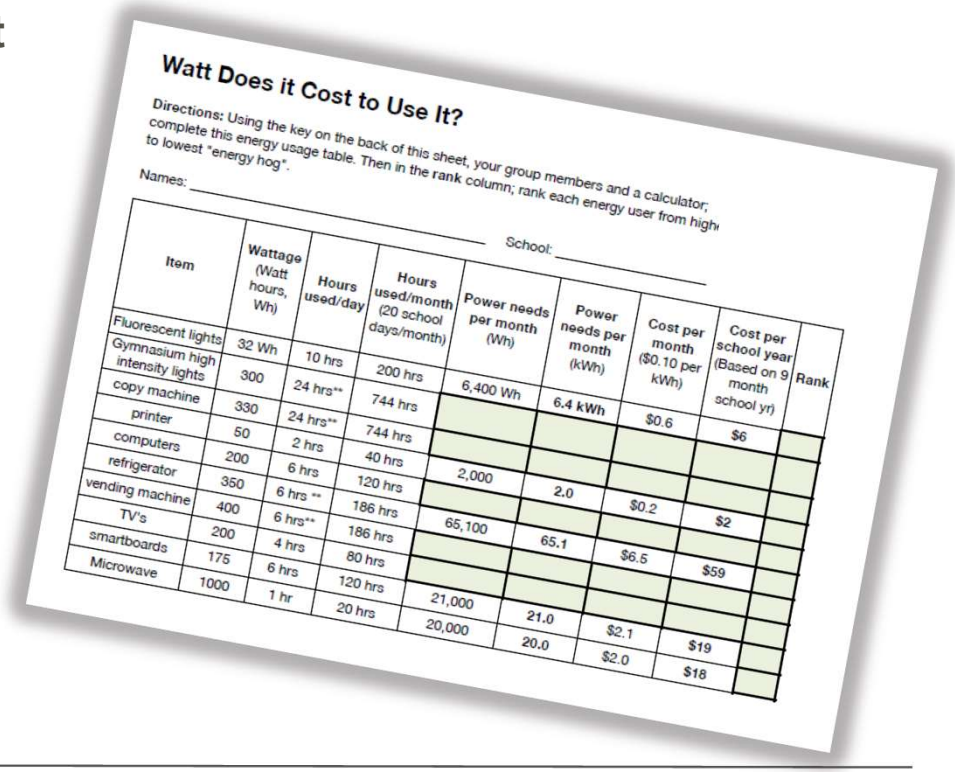
Use the Building as an Opportunity for Education

- **Hands on learning** opportunities increase **student performance** and **lesson retention**.
- **Use daily building operations as educational opportunities**.
- Adapts students to a knowledge-based **technologically advanced society**.
- Students grasp **21st century skills** like teamwork, research gathering, time management, information synthesizing, independence and utilizing high tech tools.
- Schools house **the next generation of environmental leaders**.



Watt Does it Cost to Use It?

Directions: Using the key on the back of this sheet, your group members and a calculator; complete this energy usage table. Then in the rank column; rank each energy user from high to lowest "energy hog".

Names: _____ School: _____

Item	Wattage (Watt hours, Wh)	Hours used/day	Hours used/month (20 school days/month)	Power needs per month (Wh)	Power needs per month (kWh)	Cost per month ($0.10 per kWh)	Cost per school year (Based on 9 month school yr)	Rank
Fluorescent lights	32 Wh	10 hrs	200 hrs	6,400 Wh	6.4 kWh	$0.6	$6	
Gymnasium high intensity lights	300	24 hrs**	744 hrs					
copy machine	330	24 hrs**	744 hrs					
printer	50	2 hrs	40 hrs	2,000	2.0	$0.2	$2	
computers	200	6 hrs	120 hrs					
refrigerator	350	6 hrs **	186 hrs	65,100	65.1	$6.5	$59	
vending machine	400	6 hrs**	186 hrs					
TV's	200	4 hrs	80 hrs					
smartboards	175	6 hrs	120 hrs	21,000	21.0	$2.1	$19	
Microwave	1000	1 hr	20 hrs	20,000	20.0	$2.0	$18	

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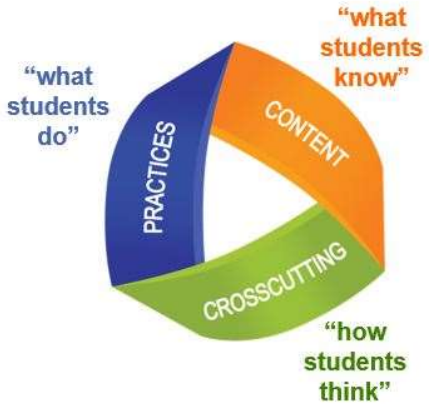
ZNE Supports Next Generation Science Standards & Skills

- **Analyzing and Interpreting Data**
  - Engineering Design and Human Impacts
  - Energy
- **Influence of Science, Engineering, and Technology on Society and the Natural World**
  - Engineering Design
- **ESS3.C: Human Impacts on Earth Systems**
  - Human Impacts
- **Science Addresses Questions About the Natural and Material World**
  - Human Impacts
- **Constructing Explanations and Designing Solutions**
  - Energy
- **Engaging in Argument from Evidence**
  - Energy
- **ETS1.B: Developing Possible Solutions**
  - Energy



… among others!

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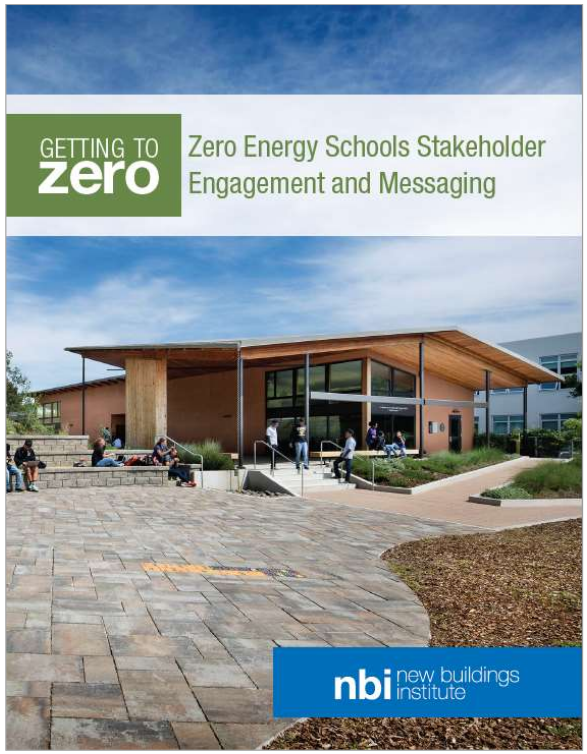
Zero Energy Schools Stakeholder Messaging Guide



Zero Energy Schools Stakeholder Engagement and Messaging

Effective communication is critical to successfully engage your audience and ultimately achieve your goal of designing, constructing, and operating a zero energy (ZE) school. This document will help you to address key questions around your communication effort and engage stakeholders in the integrated ZE process.

Effective communication revolves around understanding the drivers that motivate decisions made by each stakeholder. In the school market, student educational outcomes are the primary driver of stakeholders. Framing messages with this driver in mind is key to communicating with them on a level that they understand and that motivates them. In addition, most audiences are not very technical so focusing on outcomes rather than the technical way ZE will be achieved may be a more successful strategy.

How to Use This Document

Below is a list of overarching messages about ZE schools. The Stakeholders and Drivers table that follows identifies key market actors and their drivers. Finally, the Supporting Facts for Key Messages table outlines key messages and provides supporting research and facts that might appeal to the various audiences. This information is helpful when honing messages to gain support your overall ZE implementation plan, depending on drivers of particular stakeholders.

Six Key Messages for Communicating ZE

1. **ZERO ENERGY:** Zero energy (ZE) schools are low energy buildings coupled with renewables that provide a ready generation resource. A school achieves zero when the energy produced meets or exceeds the energy used over the course of a year. Schools are early leaders in ZE and serve as hubs to educate others.
2. **LOWER OPERATING COSTS:** K-12 schools spend $8 billion on energy, more than is spent on computers and textbooks combined. Schools built to ZE performance have lower operating costs and over time, save money on energy bills that can be spent on educating students. ZE also reduces exposure of school budgets to the volatility of shifting energy prices.
3. **INCREASED STUDENT PERFORMANCE:** Occupants of ZE schools benefit from heightened student performance, increased average attendance, better occupant health and improved teacher satisfaction and retention.
4. **EDUCATIONAL BENEFITS:** ZE schools are living laboratories, stimulating learning and innovation. Occupant engagement in ZE schools can provide additional energy savings and serve as a teaching tool for students, STEM programs and the larger community. This greater understanding and deeper knowledge of concepts like science, math, and technology in relation to their surroundings give students the confidence to take leadership roles in their schools as advocates for environmental sustainability and their own learning needs.
5. **RESILIENCY:** ZE schools are also more resilient in severe weather events. They can create safe havens for the community during emergencies since the building energy generation systems can be islanded and remain functional continuing to provide light and space conditioning during an outage, they also use daylighting and natural ventilation.
6. **GETTING TO ZERO:** While ZE is the end game for building sustainably, it is a process and can take time to accomplish. School districts can start now on this path to zero.

Supporting Facts for Key Messages

Audience	School Board & Bond Oversight Committee	Superintendent & Assistant Superintendent	Capital Projects & Planning Department	Director of Facilities & Grounds	Sustainability & Energy Managers	Principal	Curriculum & Education Planners	Building Operators; Teachers, School Staff & Students	Design Team: Architects, Engineers & Other Consultants	PTA & School Community	County or State Dept. of Education	Voters & Community Organizations	Utility Companies	Other Public Interest Groups
1. Zero energy														
The ZE market is growing rapidly—nearly doubling every year in the numbers of verified and emerging projects. Since 2015—the number of ZE verified, emerging and ultra-low schools has grown by almost 40%.[1]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
The education sector—particularly K-12 schools—are leading with 88 projects across the U.S. that are achieving ZE or have a stated goal of ZE performance.[1]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Those who have visited a ZE school came back and reported they were enthused and that this idea of a living breathing interactive school is a feasible and achievable reality.	X				X				X			X		X
2. LOWER OPERATING COSTS														
Annually in the U.S., K-12 schools spend $8 billion on energy—more than is spent on computers and textbooks combined.[2]	X	X												
ZE is fiscally responsible with tax payer dollars - it puts more money back into the schools because of lower utility & building operating costs.	X									X		X		X
Given that the educational sector consumes over 2,000 trillion BTUs of energy for all types per year, savings across a district could mean hundreds of thousands of dollars that can go back into the classroom or building itself.[3]		X	X	X		X								
Owner occupied buildings (like schools) have the best payback over the long term.[4]	X	X							X			X		X

1. New Buildings Institute. (2016, October). 2016 List of Zero energy Buildings. http://newbuildings.org/resource/2016-list-of-ZE-buildings/
2. US Department of Energy, EnergySmart Schools Program. (2008) Guide to Financing EnergySmart Schools. https://www1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_finance-guide_070108.pdf
3. Commercial Buildings Energy Consumption Survey (CBECS). (2012, May) Total energy consumption by major fuel, 2012. https://www.eia.gov/consumption/commercial/data/2012/bc/cfm/c1.php
4. U.S. Green Building Council. (2015, February). The Business Case for Green Building. https://www.usgbc.org/articles/business-case-green-building

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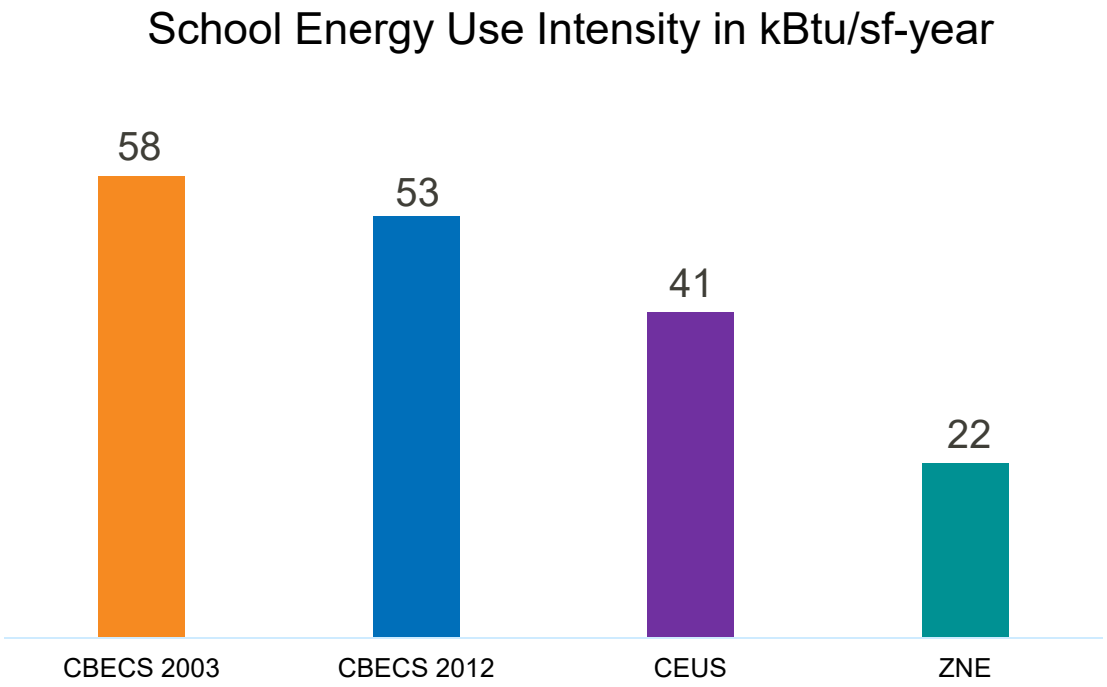
Energy Benchmarking

What is Benchmarking?

Benchmarking
is the practice of comparing the measured performance of a facility, or organization to itself, its peers, or established norms, with the goal of informing and motivating performance improvement.

Energy Use Intensity
Energy use per square foot



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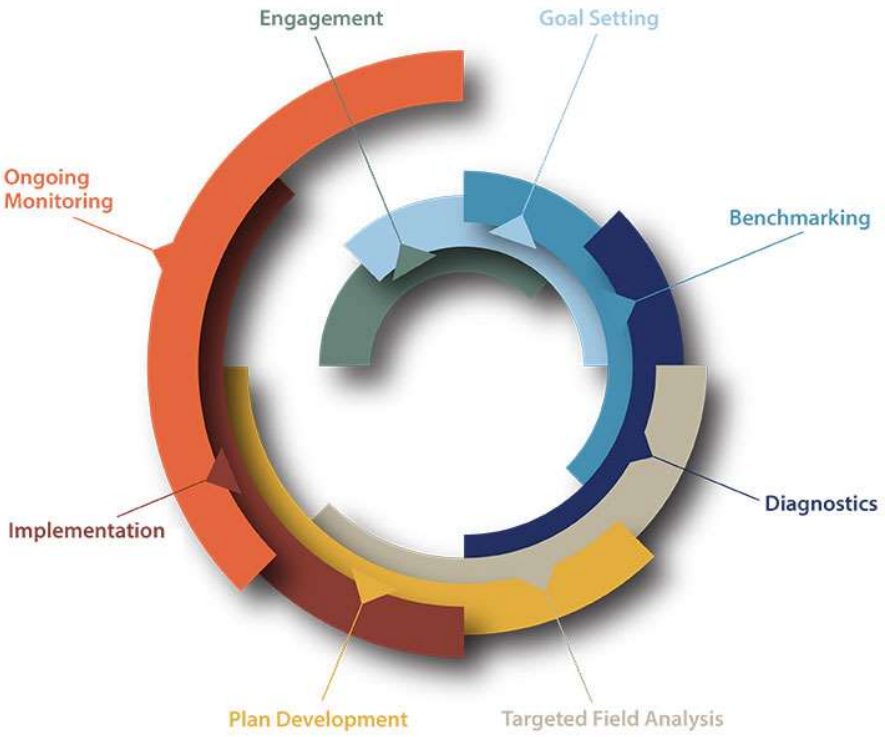
Portfolio Benchmarking

Benchmark and analyze data to prioritize opportunities for:

- Selecting which buildings warrant in-field assessments
- Uncovering performance issues and opportunities for operational improvements
- Identifying candidates for deep energy retrofits and ZNE pilot projects



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Energy Targets

Define your Energy Target

CA Schools EUI target is **15-25 kBtu/sf-year**!

Sources of data for absolute energy target goals include:

- Portfolio Analysis
- Solar budget
- Modeling analysis
- ZNE building comparisons

In Practice: Benchmarking and Targets

- Consistently collect and analyze data
- Use information to make decisions
- Use targets in request for proposals and building procurement process
- Combine targets with other programs to set goals (for ex. CHPS, LEED)
- Document targets in plans and policies (like Owners Project Requirements)
- Ongoing benchmarking, monitoring of metrics and evaluation of performance

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Getting to Zero Resources HUB

https://gettingtozeroforum.org/zero-energy-schools-resources/

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Break!

SFUSD GOAL

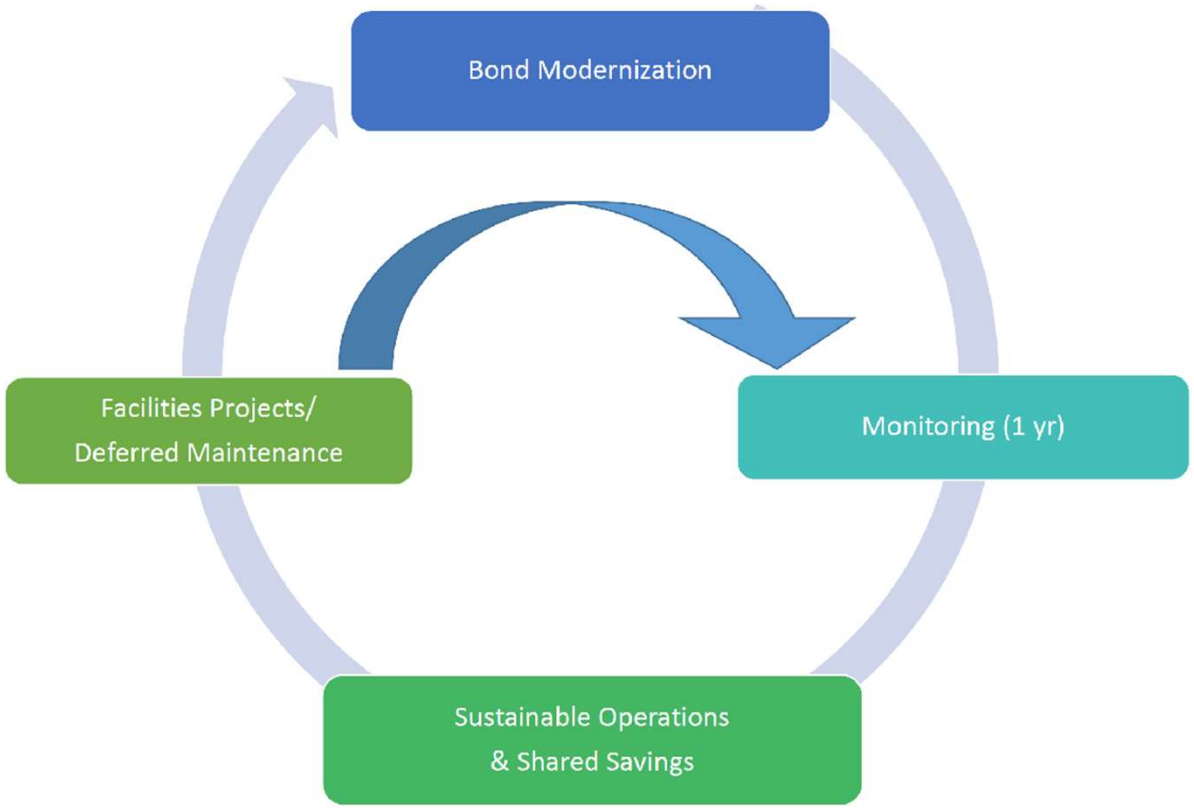
Table 29. Energy Intensity Values for Zero Energy Schools

Climate Zone	Representative City	Primary School		Secondary School	
		Site Energy (kBtu/ft²·yr)	Source Energy (kBtu/ft²·yr)	Site Energy (kBtu/ft²·yr)	Source Energy (kBtu/ft²·yr)
1A	Miami, FL	25.9	76.4	23.1	68.5
2A	Houston, TX	24.3	71.1	21.7	63.5
2B	Phoenix, AZ	24.7	72.5	21.9	64.3
3A	Memphis, TN	23.8	69.0	21.2	61.6
3B	El Paso, TX	23.4	67.8	20.7	60.2
3C	San Francisco, CA	21.6	61.9	19.0	54.3
4A	Baltimore, MD	23.5	67.6	20.9	60.1
4B	Albuquerque, NM	23	66.6	0.4	58.8
4C	Salem, OR	22	64.2	9.7	56.4
5A	Chicago, IL	24.3	69.9	21.6	62.2
5B	Boise, ID	23.2	66.7	20.4	58.4
6A	Burlington, VT	24.5	70.1	21.6	61.9
6B	Helena, MT	23.5	66.9	20.5	58.4
7	Duluth, MN	25.9	74.1	22.8	65.1
8	Fairbanks, AL	28.7	82.5	25.0	71.5

Source: DOE

NO POT LYING AROUND

OPPORTUNITIES



BUILDING STRATEGY

NEW SCHOOLS

→ ZNE Ready

MODERNIZATION

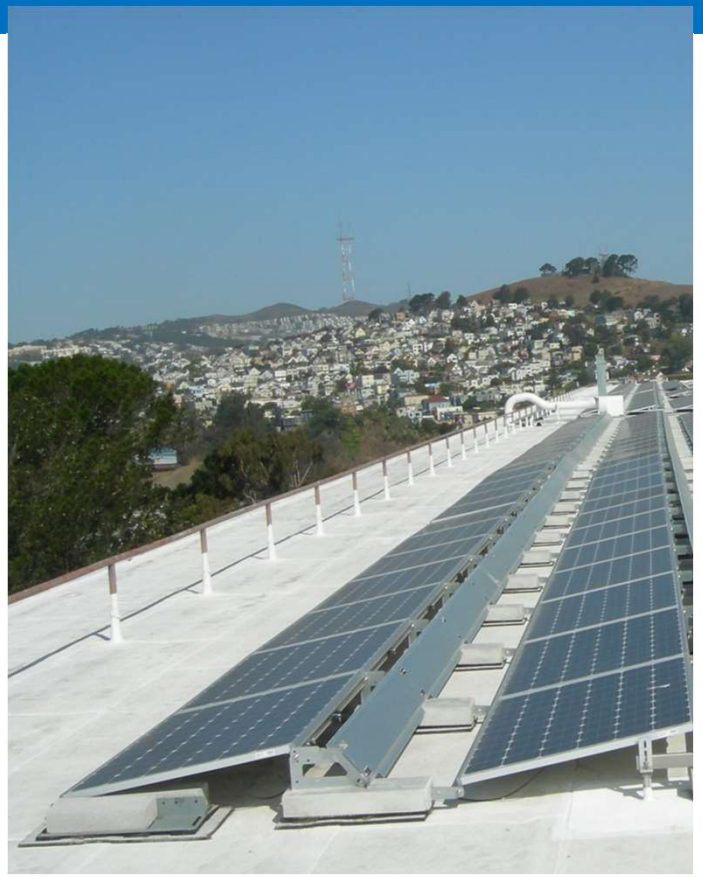
→ ZNE Two-Step

SMALL PROJECTS

→ Guidelines

RENEWABLES

→ In Due Time



THE DETAILS

SFUSD PROJECT REQUIREMENTS

July 1, 2017

SUSTAINABLE SFUSD

STRATEGY

The District has many opportunities to improve the carbon footprint of its buildings:

BOND PROJECTS: voter-approved funding for new construction & major renovations provides the best opportunity for deep energy retrofits

MONITORING: post-occupancy commissioning and energy monitoring can identify opportunities to adjust operation to meet design intent

OPERATIONS & SHARED SAVINGS: preventative maintenance, energy and water monitoring, and engagement of users prevent rising energy and water usage as buildings age

FACILITIES PROJECTS: major repairs and deferred maintenance projects provide an opportunity to improve energy and water efficiency

These *SFUSD Owner's Project Requirements* were created to assist design teams in supporting the District's ambitious zero carbon goals. The following pages describe the process for incorporating ZNE-ready design into new buildings, bond modernizations, and facilities projects. In summary:

New Buildings will be designed to achieve an Energy Use Intensity (EUI) < 20 kBTU/sf/yr. SFUSD's preferred strategies for achieving such exemplary energy efficiency are outlined in the *ZNE Guidelines* at the end of this document. While the addition of renewable energy is generally outside the scope of new projects, solar readiness should be built into the building.

Bond Modernizations will focus on improvements to the lighting systems and building envelope as outlined in *ZNE Assessments* commissioned by the District for every project prior to the design phase. These assessments will also look for opportunities to improve heating and ventilation systems, but these items will generally be tackled in future bonds unless broken equipment necessitates earlier action.

Facilities Projects generally have limited scope and will support ZNE goals by upgrading building elements as they wear out. In each case, the *ZNE Guidelines* below and *District Design Standards + Guidelines* (DDSG) will inform the design and selection of materials and/or equipment for these projects.

THE NEW

PROCESS

New Buildings

Ensuring that the District's energy targets are faithfully met in new construction projects requires a rigorous design process, stellar construction techniques, and attention to quality control. To ensure the best possible outcome on each and every project, SFUSD requires architects to incorporate the following elements into the process of creating new buildings:

CHARRETTE: All projects will commence with an architect-led design charrette specifically focused on identifying the strategies and systems necessary for meeting the EUI performance goal. At a minimum, the Project Manager, Sustainability Office, Buildings & Grounds, Design Team, Commissioning Agent, and Electrical/Mechanical/Civil consultants will attend.

ENERGY MODELING: Building form, massing, orientation, and roof layout (among other design parameters) have a significant impact on energy usage and solar energy production. Therefore, design decisions shall be evaluated against a constantly refined energy model from the earliest stages of a project. In this way, project architects will have many opportunities for course correction should site conditions or non-energy parameters make achievement of ZNE goals difficult.

COMMISSIONING: Commissioning agents hired by the District will be brought into the design process early on and follow each project through design, construction, and post-occupancy to ensure that design intent is achieved as outlined in this document and reflected in the Basis of Design (BOD). The *Commissioning Plan* will include design reviews, construction inspections, functional testing, development of a maintenance manual, and systems training (see Commissioning Procedures in the 2016 Bond Program *Procedures + Standards Binder*).

First ZNE Projects

SFUSD is in the process of designing its first new ZNE building at Claire Lilienthal School on Divisadero St. The building will house the middle school program of this K-8 school and replaced eight existing bungalows. The second ZNE project is a PG&E-supported modernization of Garfield Elementary on Telegraph Hill. The utility is particularly interested in identifying design solutions in the constrained urban environment.

TRAINING: In addition to the thorough training of Buildings & Grounds staff, it is critical that building occupants are properly engaged in order to operate a building efficiently and obtain feedback about building operation. Thus, the Sustainability Office will work with the Commissioning Agent to conduct rigorous maintenance and occupant training as well as post-occupancy commissioning.

VERIFICATION: The Sustainability Office will monitor building and end-use utility data before and after a project to see if performance specifications were truly met. Given the constrained nature of many school sites in San Francisco, attaining low energy usage is of paramount importance if future solar installations are to cover the entire energy demands of a site.

Bond Modernizations

While new buildings can be designed and built to meet ZNE-ready status relatively easily and with minimal additional cost, renovating existing buildings to reach similar levels of efficiency presents a much bigger hurdle. This is because many parts of the building cannot be cost-effectively upgraded. For example, improving envelope insulation levels cannot readily be done without removing an entire building façade. In addition to the enormous expense, upgrades of this kind do not lead to dramatic energy savings in the mild San Francisco climate zone.

For this reason, SFUSD has decided to hire energy modeling firms to conduct *ZNE Assessments* of all sites named in the 2016 bond in order to identify the importance of various energy efficiency measures in achieving an EUI of less than 20 kBTU/sf/yr. These firms will also calculate the area of solar generation required to offset predicted site energy usage. Thus, design teams will be able to combine this information with project cost estimates to select a package of efficiency improvements that most cost-effectively achieves the District's EUI targets.

In deciding which recommendations from *ZNE Assessments* to include in the project scope, design teams will be guided by an implementation hierarchy that calls for lighting retrofits and envelope improvements to be adopted first, followed by heating upgrades, and finally renewable generation. In other words, the goal is to minimize heating load before implementing system upgrades, thereby avoiding possible oversizing of equipment.

This strategy also allows the work to achieve ZNE

THE RULES

ZNE GUIDELINES

Design teams working with SFUSD are asked to design buildings that are:

HEALTHY... maximizing daylight and air quality and minimizing harmful pollutants.

BEAUTIFUL... encouraging pride and engagement among families and the community.

EFFICIENT... reducing energy use to a minimum to facilitate achievement of ZNE.

VALUABLE... minimizing lifecycle costs and reducing maintenance as much as possible.

In order to achieve adequate levels of efficiency in San Francisco, design teams should consult the Department of Energy's (DOE) Technical Feasibility Study for Zero Energy K-12 Schools and follow the *ZNE Guidelines* below. While these guidelines are most easily implemented in new construction, they should also be utilized where applicable in bond modernization and facilities projects.

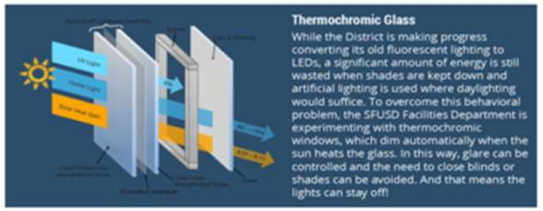
ENERGY: New buildings should be designed to achieve a modeled **Energy Use Intensity (EUI) of 15-20 kBTU/sf/yr**, a value that allows rooftop solar to offset yearly energy usage for a typical 2-3 story San Francisco school. Building systems should be **"designed for off"**, meaning that they will shut down without user intervention. **Solar analysis** during **Schematic Design (SD)** should confirm that rooftop solar potential will be adequate to cover modeled energy usage.

FORM: Buildings should be simple and compact, oriented to the sun, with a depth & layout that allows **daylight harvesting**, **natural ventilation**, **outside views**, and use of **thermal mass**.

MAINTENANCE: Every effort should be made to **facilitate maintenance access** to building systems (without ladders/lifts and without disturbing classes), materials should be chosen that are **easy to clean** and **inexpensive to maintain**, and design teams are encouraged to **expose** the **functional elements** of the building for students to see.

ENVELOPE: In order to minimize the heating load, wall, window, and door **insulation** levels should be **optimized** via building modeling to comply with the EUI target above. **Exterior insulation** should be specified **over cavity insulation** where possible. **Fiberglass batts** are **never allowed** due to poor thermal performance in the field. Moisture and air **control layers** should reside on the **warm side of exterior insulation** and architects should specify **airtight construction** practices. **Rain screens** are encouraged to enhance durability.

WINDOWS: Windows size and specifications should be tuned based on building **orientation**, with north and shaded, south-facing glass being larger and/or having higher **Solar Heat Gain Coefficients** (SHGC) than east or west-facing glass. **U-values** should be **less than 0.30** on all sides (including roof). Where budget allows, glare and heat control should be provided via **heat-responsive glass** and/or **exterior shading**. In addition, **interior shades** should always be provided.



Thermochromic Glass

While the District is making progress converting its old fluorescent lighting to LEDs, a significant amount of energy is still wasted when shades are kept down and artificial lighting is used where daylighting would suffice. To overcome this behavioral problem, the SFUSD Facilities Department is experimenting with thermochromic windows, which dim automatically when the sun heats the glass. In this way, glare can be controlled and the need to close blinds or shades can be avoided. And that means the lights can stay off!

LIGHTING: Whenever possible, buildings should utilize **natural light** to meet lighting needs. **Interior** lighting shall be **100% LED**, with **vacancy sensors** (not occupancy) and **daylighting controls per Title 24** (see the DDSG for guidance on shut-off delays). Classroom light levels of **35 foot-candles** are sufficient. **Skylights**, **sun tubes**, or **light wells** should be included in sufficient quantity to allow zero artificial lighting in **common areas** during daytime hours. **Exterior** lighting should incorporate **bi-level control** and astronomical **time clocks**.

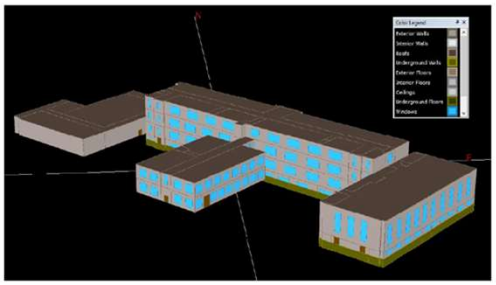
HEATING: Space conditioning should be limited to **permanently occupied areas**; no conditioning is needed in foyers, hallways, restrooms, or closets. Heating shall be provided by **Variable Refrigerant Flow** (VRF) systems or high-efficiency **heat pumps**; NO FOSSIL FUEL-BASED HEATING (natural gas) IS ALLOWED. Space heating should be controlled **separately for each zone**, with set points of **66-72 °F** in **occupied** spaces. Occupied hours should be aggressive (**M-F: 7am-6pm**); the system should be off after hours and on weekends (w/the possibility of limited duration and zone-specific overrides).

COOLING/VENTILATION: **Occupied spaces** should rely on **natural ventilation** unless schools are located in close proximity to a major pollutant source (e.g. freeway, major arterial). If mechanical ventilation is required, schools should incorporate **dedicated outside air systems (DOAS)** designed to **ASHRAE 62.1** or **CEC T24** requirements in permanently occupied spaces, **demand-based (CO2)** controls in auditoriums, gyms, and cafeterias, and **MERV 13** final filters throughout. The **fresh air** should be delivered **low in the room** and originate from a shaded

1st ZNE BUILDING

Source: Lionakis

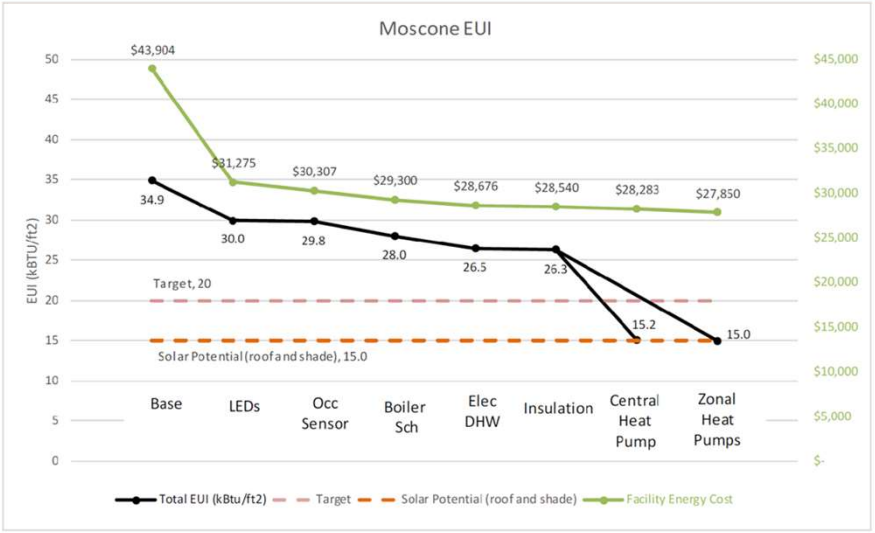
THE OLD



Zero Net Energy Study for James Denman Middle School

September 7, 2016

Prepared By:
Ecology Action | 877 Cedar Street, Suite 240 | Santa Cruz, CA 95062
T: 831.426.5925 | F: 831.427.1368 | www.ecoact.org



Source: Ecology Action

PRIORITIES

TRAINING: In addition to the thorough training of Buildings & Grounds staff, it is critical that building occupants are properly engaged in order to operate a building efficiently and obtain feedback about building operation. Thus, the Sustainability Office will work with the Commissioning Agent to conduct rigorous maintenance and occupant training as well as post-occupancy commissioning.

VERIFICATION: The Sustainability Office will monitor building and end-use utility data before and after a project to see if performance specifications were truly met. Given the constrained nature of many school sites in San Francisco, attaining low energy usage is of paramount importance if future solar installations are to cover the entire energy demands of a site.

Bond Modernizations

While new buildings can be designed and built to meet ZNE-ready status relatively easily and with minimal additional cost, renovating existing buildings to reach similar levels of efficiency presents a much bigger hurdle. This is because many parts of the building cannot be cost-effectively upgraded. For example, improving envelope insulation levels cannot readily be done without removing an entire building façade. In addition to the enormous expense, upgrades of this kind do not lead to dramatic energy savings in the mild San Francisco climate zone.

For this reason, SFUSD has decided to hire energy modeling firms to conduct *ZNE Assessments* of all sites named in the 2016 bond in order to identify the importance of various energy efficiency measures in achieving an EUI of less than 20 kBTU/sf/yr. These firms will also calculate the area of solar generation required to offset predicted site energy usage. Thus, design teams will be able to combine this information with project cost estimates to select a package of efficiency improvements that most cost-effectively achieves the District's EUI targets.

In deciding which recommendations from *ZNE Assessments* to include in the project scope, design teams will be guided by an implementation hierarchy that calls for lighting retrofits and envelope improvements to be adopted first, followed by heating upgrades, and finally renewable generation. In other words, the goal is to minimize heating load before implementing system upgrades, thereby avoiding possible oversizing of equipment.

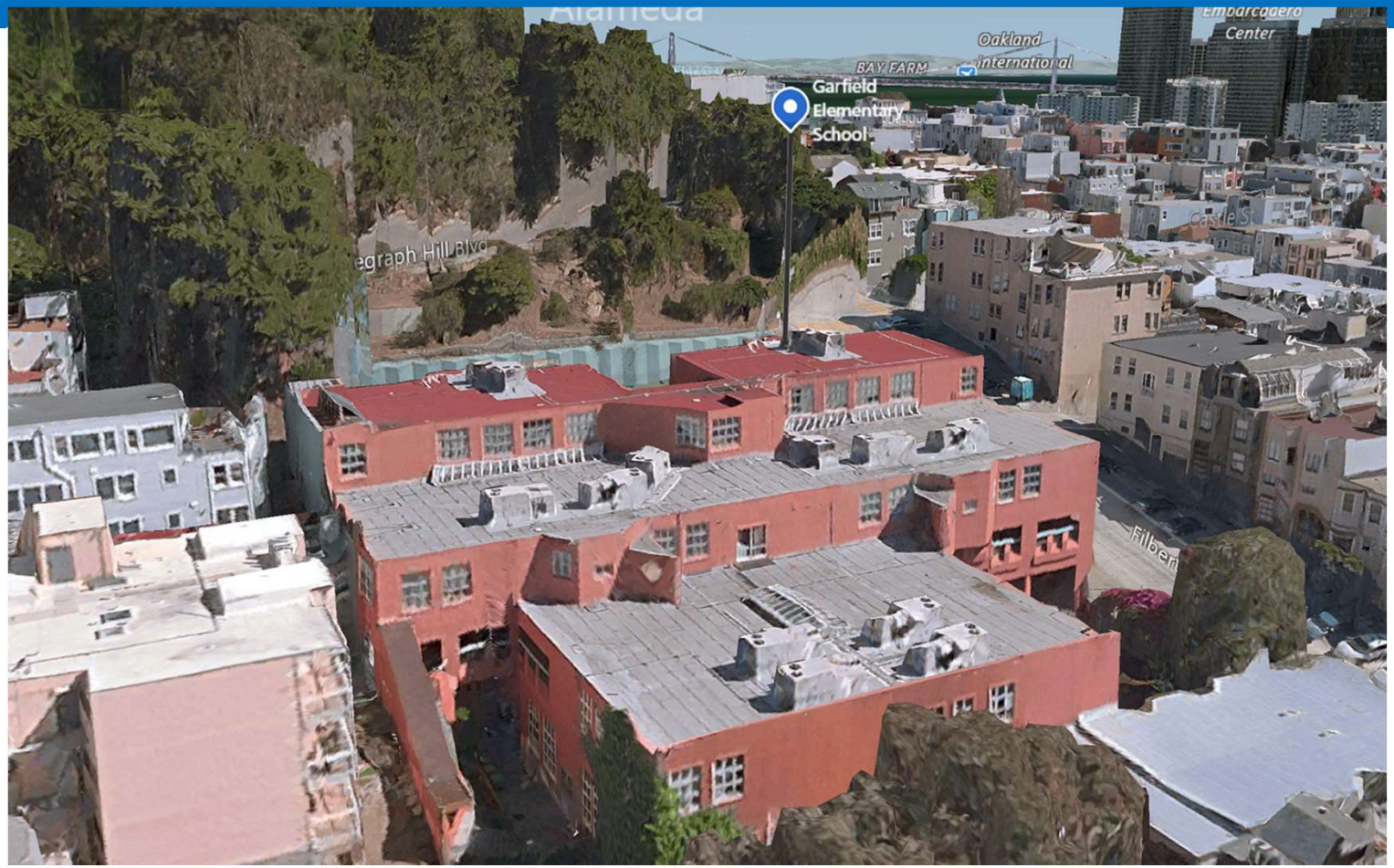
This strategy also allows the work to achieve ZNE

to be spread out over multiple bond cycles, recognizing that there generally are not enough funds assigned to each site to do all necessary work in one round of modernization. In cases where unique opportunities arise to replace an entire heating system, bond sustainability funds, Prop 39 funding, and/or support from the SF Public Utilities Commission (SFPUC) may allow a quicker approach.

The chart below summarizes which elements will be incorporated into each 2016 bond project and which will only be included on a case-by-case basis. Design teams will consider recommendations from the ZNE audit, synergies with other scope, available funding, and site-specific design parameters to determine which of the latter to include.

	MODERNIZATION		FUNDING			
SCOPE	Mandatory	Case-by-case	Bond	Sustainability	Prop 39	Utility
Air sealing weather-stripping around all doors/windows	✓		✓			
Window replacements if windows deteriorating		✓	✓			
Insulation cost-effective (reroofing, attics, open walls)	✓		✓			
LED lighting with daylighting and vacancy controls	✓		✓			
Solar tubes/skylights common areas		✓		✓		
Light shelves/shading classrooms and offices		✓	✓	✓		
EMS upgrades latest standard; connect all spaces	✓		✓			
Building dashboard site usage & solar (if applicable)	✓			✓		
Fuel switch/transformer when replacing end-of-life heating/DHW systems		✓	✓	✓	✓	✓
Heating optimization boiler, VFD, econ pumps, pipe insulation, steam traps, radiator bypass	✓		✓	✓	✓	✓
Solar readiness roofing, conduit, space		✓	✓	✓		✓
Piping leak repairs and pipe insulation	✓		✓			
DHW reconfiguration close to use; eliminate recirc		✓	✓	✓	✓	
Water fixture upgrades high-flow fixtures	✓		✓			
Shut-off valves at all upgraded bathrooms	✓		✓			
RWH pre-plumbing where wall cavity accessible		✓		✓		
Irrigation as identified in SFPUC Landscape Technical Assistance Program (LTAP)		✓		✓		
Turf replacement where existing lawn sports field		✓		✓		✓
Stormwater control where > 5000sf disturbance		✓	✓	✓		
Bottle fillers cafeteria & one per floor	✓		✓			
Washing machines stub out and appliance, no dryer	✓		✓			
Hand dryers upon approval of spec	✓		✓			
Trash sorting outdoor/indoor sorting areas where space		✓	✓			
Walking & biking infrastructure striping, bike racks	✓			✓		

1st ZNE BUILDING



Source: Google Maps

WHAT ABOUT A POLICY?

SFUSD CARBON REDUCTION PLAN

July 1, 2017

SUSTAINABLE SFUSD

1

GOALS

The SFUSD School Board, via its *Carbon Neutral Schools* Resolution, is calling on the District to achieve the following targets as it seeks to phase out fossil fuel use by 2040:

Buildings

- New buildings will be designed with the goal of using no more energy than they could generate on site (conditions permitting).
- New and modernized buildings will be plumbed for rainwater collection where feasible.
- The District will reduce gas usage 50% by 2030 and stop burning natural gas by 2040.
- The District will reduce its water usage 30% by 2020 and 50% by 2030.

Fleet

- All new District-owned vehicles shall be emissions-free by 2020.
- Diesel-powered buses will be fueled with renewable diesel by 2020.
- All district-owned vehicles will be electric or powered by low-carbon fuels by 2030.

Renewables

- The District will strive to generate all of its own power on site by 2050.
- The District will provide 50% of water demand via rainwater.

What about electricity?

SFUSD receives its power and water from the SFPUC's Hetch Hetchy Power System, which generates 1.6 billion kilowatt hours of clean, hydroelectric energy each year. As a result, the District's electricity is already 100% greenhouse gas-free. To achieve carbon neutrality in its buildings, SFUSD is therefore focusing its efforts of switching its heating systems from natural gas to electricity.

4

Design for Education:
The Process for ZNE Schools

VMDO Architects

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ZNE Building Assessments

Perform in-field evaluations:

- Address known comfort issues
- Daylighting, shading, glare control
- Air sealing, heat recovery ventilation
- HVAC schedules, replacement cycles
- Kitchen equipment
- Solar access and location
- Consider unusual circumstances that may be relevant on site
- Portables

Newcastle Elementary School Retrofit | Newcastle, CA
Photo Courtesy of Newcastle Elementary School District

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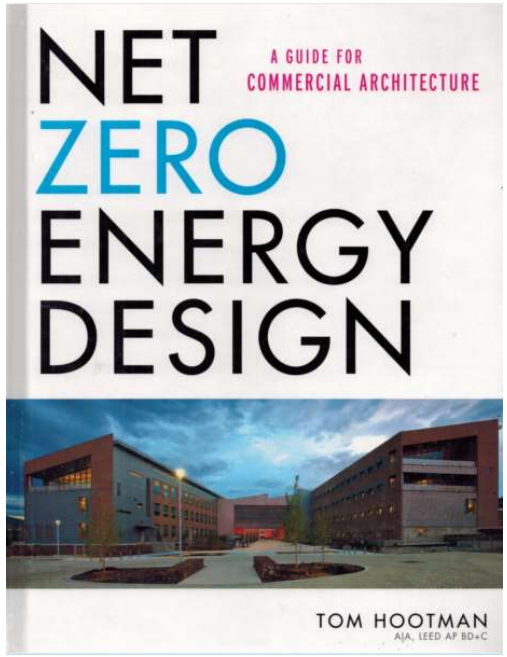
Request for Proposals & Qualifications (RFPs & RFQs)

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

Owners Project Requirements

SFUSD PROJECT REQUIREMENTS

May 1, 2017

STRATEGY

The District has many opportunities to improve the carbon footprint of its buildings:

BOND PROJECTS: voter-approved funding for new construction & major renovations provides the best opportunity for deep energy retrofits

MONITORING: post-occupancy commissioning and energy monitoring can identify opportunities to adjust operation to meet design intent

OPERATIONS & SHARED SAVINGS: preventative maintenance, energy and water monitoring, and engagement of users prevent rising energy and water usage as buildings age

FACILITIES PROJECTS: major repairs and deferred maintenance projects provide an opportunity to improve energy and water efficiency

These *SFUSD Owner's Project Requirements* were created to assist design teams in supporting the District's ambitious zero carbon goals. The following pages describe the process for incorporating ZNE-ready design into new buildings, bond modernizations, and facilities projects. In summary:

New Buildings will be designed to achieve an Energy Use Intensity (EUI) < 20 kBTU/sf/yr. SFUSD's preferred strategies for achieving such exemplary energy efficiency are outlined in the *ZNE Guidelines* at the end of this document. While the addition of renewable energy is generally outside the scope of new projects, solar readiness should be built into the building.

Bond Modernizations will focus on improvements to the lighting systems and building envelope as outlined in *ZNE Assessments* commissioned by the District for every project prior to the design phase. These assessments will also look for opportunities to improve heating and ventilation systems, but these items will generally be tackled in future bonds unless broken equipment necessitates earlier action.

Facilities Projects generally have limited scope and will support ZNE goals by upgrading building elements as they wear out. In each case, the *ZNE Guidelines* below and *District Design Standards + Guidelines* (DDSG) will inform the design and selection of materials and/or equipment for these projects.

PROCESS

New Buildings

Ensuring that the District's energy targets are faithfully met in new construction projects requires a rigorous design process, stellar construction techniques, and attention to quality control. To ensure the best possible outcome on each and every project, SFUSD requires architects to incorporate the following elements into the process of creating new buildings:

CHARRETTE: All projects will commence with an architect-led design charrette specifically focused on identifying the strategies and systems necessary for meeting the EUI performance goal. At a minimum, the Project Manager, Sustainability Office, Buildings & Grounds, Design Team, Commissioning Agent, and Electrical/Mechanical/Civil consultants will attend.

ENERGY MODELING: Building form, massing, orientation, and roof layout (among other design parameters) have a significant impact on energy usage and solar energy production. Therefore, design decisions shall be evaluated against a constantly refined energy model from the earliest stages of a project. In this way, project architects will have many opportunities for course correction should site conditions or non-energy parameters make achievement of ZNE goals difficult.

COMMISSIONING: Commissioning agents hired by the District will be brought into the design process early on and follow each project through design, construction, and post-occupancy to ensure that design intent is achieved as outlined in this document and reflected in the Basis of Design (BOD). The *Commissioning Plan* will include design reviews, construction inspections, functional testing, development of a maintenance manual, and systems training (see Commissioning Procedures in the 2016 Bond Program *Procedures + Standards Binder*).

First ZNE Projects

SFUSD is in the process of designing its first new ZNE building at Claire Lilienthal School on Divisadero St. The building will house the middle school program of this K-8 school and replaced eight existing bungalows. The second ZNE project is a PG&E-supported modernization of Garfield Elementary on Telegraph Hill. The utility is particularly interested in identifying design solutions in the constrained urban environment.

SUSTAINABLE SFUSD

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Team Selection

- Define your ZNE targets and incorporate into Request for Proposal (RFP) and Owners Project Requirements (OPRs)
- During interviews ask about ultra-low energy experience
  - NBI has a list of questions to ask
- Performance based procurement
- Pre-bid and pre-construction conferences
- Clarify how renewables will be addressed

Performance Based Procurement

Make Energy Performance Targets Part of the Contract:

- Influences the scope of work:
  - Engage the entire team for design through operations
  - Use “shoebox” energy modeling to inform the design
  - Include building commissioning and post-construction team involvement
  - Include controls integration

Whole Building, Integrated Design

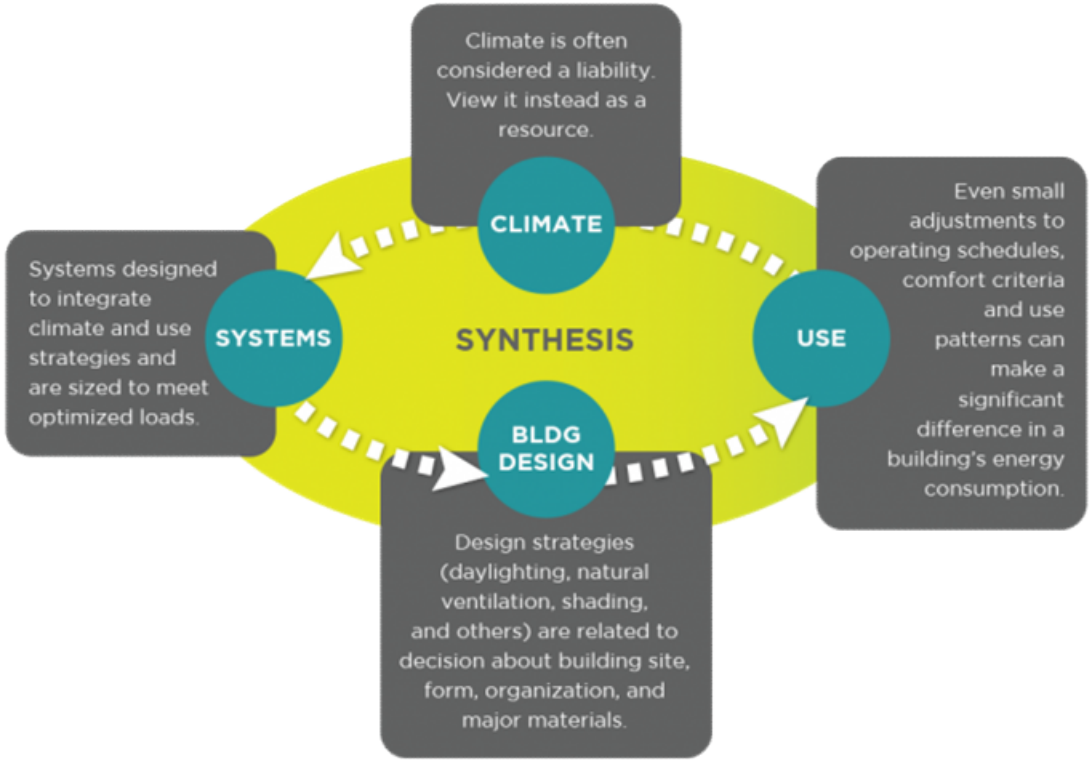
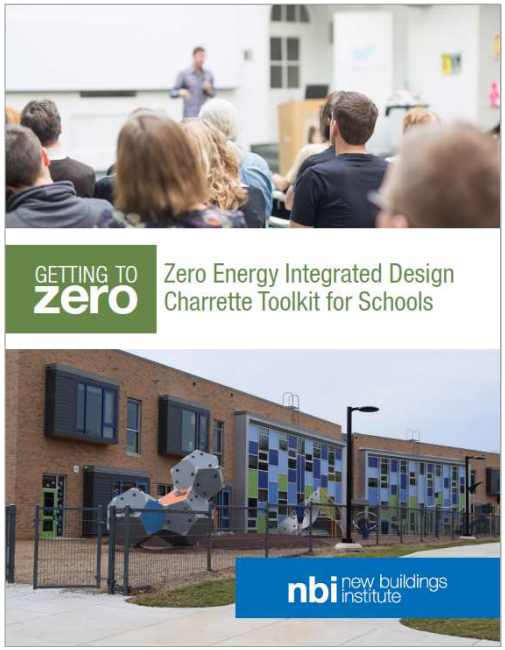


Image Courtesy of Better Bricks/NEEA

Integrated Design Charrette

Early Design Team meeting to:

- Establish common understanding of project goals and energy targets
- Engage stakeholders
- Foster teamwork
- Examine options and constraints
- Solicit feedback from decision makers, operators and occupants
- Define next steps



SAMPLE CHARRETTE AGENDA

Sample Charrette Agenda

Below is a sample agenda for an Integrated Design Charrette. A more detailed, Facilitator's Version of the Agenda is located at the end of this document.

Event Title

Day of the Week, Date, Year
Time (Hour AM – Hour PM)
Address: Street
City, State Zip
XX Room Number

Map

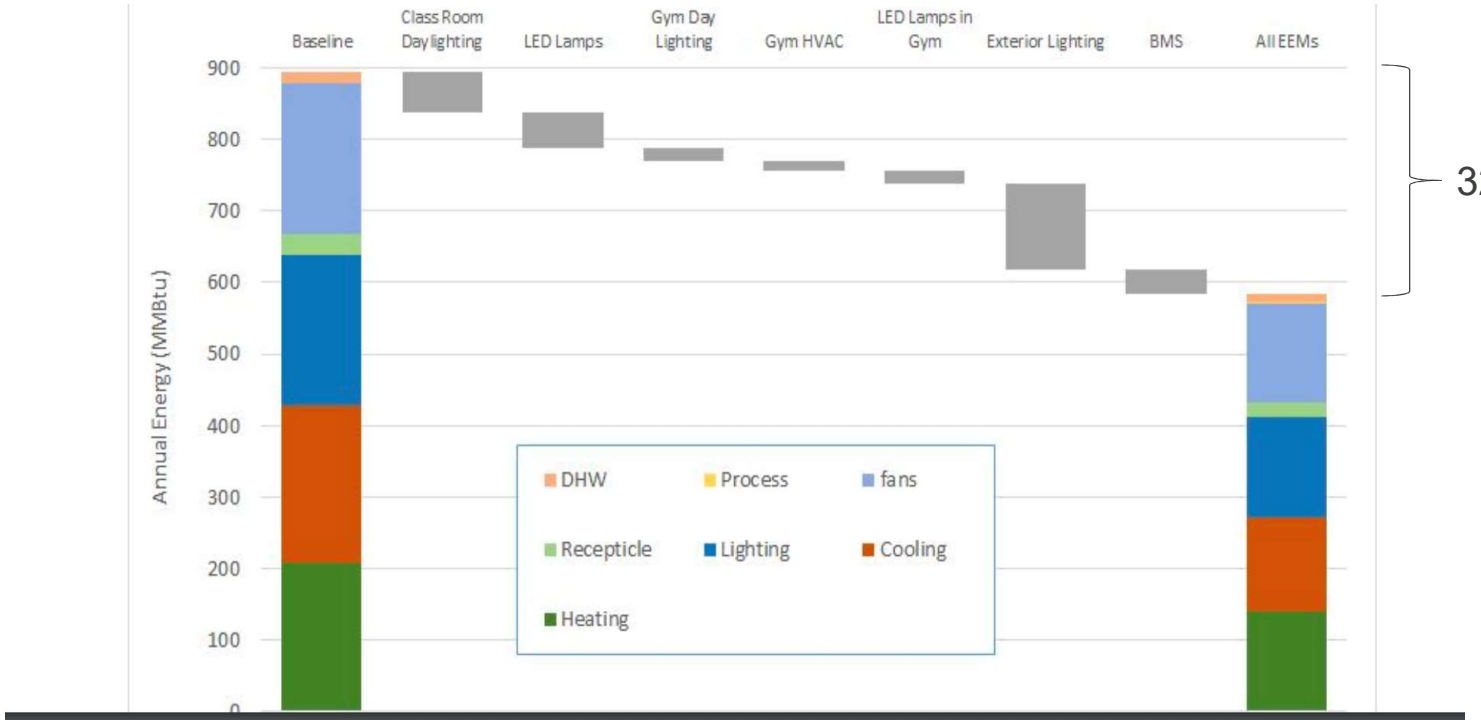
Time	Content	Who
8:30-9:00 am	GATHER AND SETTLE IN	All
9:00-9:10 am	Welcome & Introductions	All
9:10-9:15 am	Purpose and Introductions	Facilitator Owner
9:15-9:20 am	Agenda and Expectations	Facilitator
9:20-9:30 am	Overview of Sustainable, ZE Schools	Facilitator
9:30-9:50 am	Activity: What is Your Vision of a Sustainable, ZE School?	All
9:50-10:05 am	Project Overview and Goals	Architect
10:05-10:45 am	Site, Stormwater, and Water Strategies	Civil & Plumbing Engineers
10:45-11:00 am	BREAK	All
11:00-11:40 am	Energy Strategies to Achieve ZE	Architect, Mechanical
11:40 am-noon	Strategies to Support Superior Indoor Environmental Quality	Architect
12:00-12:20 pm	Designing & Operating to ZE	Facilitator, All
12:20-12:40 pm	Review Sustainability & Energy Targets and Identify Action Items	Facilitator, All
12:40-12:45 pm	Wrap Up and Conclusion	Facilitator

8 Getting to Zero: Zero Energy Integrated Design Charrette Toolkit for Schools

(Example) ZNE Retrofit 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

Elementary School ZNE Retrofit



Design to the Target

Owner's Project Requirements (OPR)

template revised November 2009

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:

Use the Owners Project Requirements to guide the ZNE process:

- Define Owner's Project Requirements (OPR)
- Establish the Basis of Design (BoD) (The BoD is the design team's response to the OPR)

Design to the Target

Building automation and controls integration

Making It All Work Together: Key Points

- Use the **Owners Project Requirements (OPR's)** to guide the ZNE process
- **Plan for Measurement and Verification**
- **Beware of Value Engineering!**
- **Controls considered** from design through operation
- **Keep the Operators** and **Occupants in mind**

Controls

- User-friendly/intuitive
- Over-rides contribute to the confusion
- Consistent – across an institution if possible
- Organized

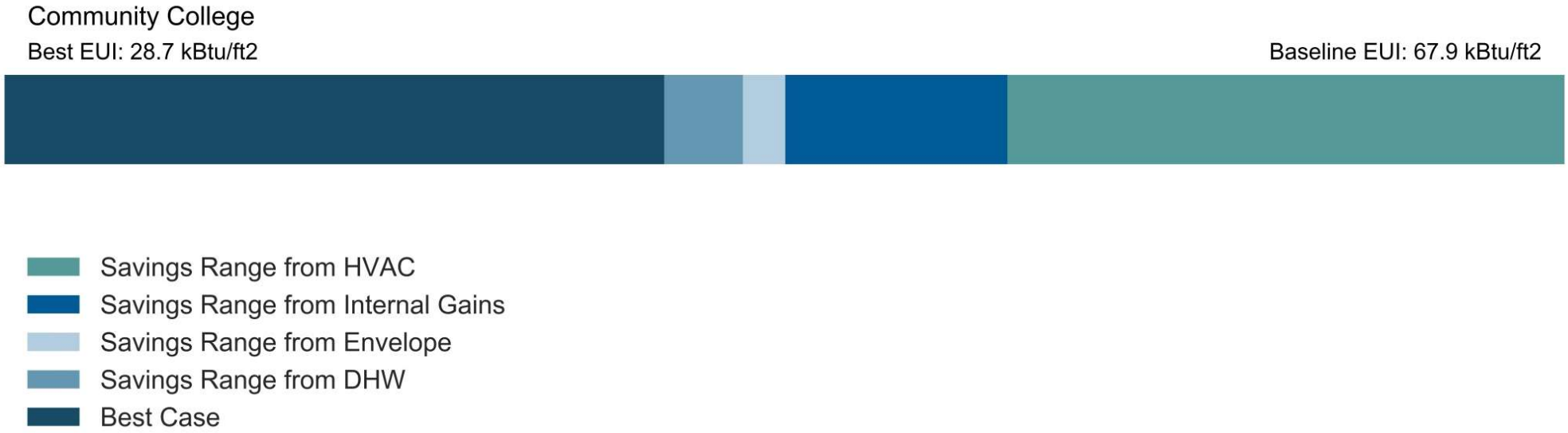
Common Technologies for ZNE and Ultra-low Energy

- Building Orientation, Window to Wall Ratio, and Glazing Location/Optimization
- Highly Efficient Thermal Envelope
- Ventilation: Natural, Dedicated Outdoor Air Systems (DOAS), Demand Control Ventilation (DCV)
- Conditioning: Ground Source, Radiant, Chilled Beams
- Controls Integration
- Daylighting Access and Controls
- Solar and Glare Control - shading
- Energy Recovery Systems
- Plug Load Reductions
- Energy Management Systems
- Building Dashboards

Redding School for the Arts, CA
Photo Courtesy: Trilogy Architecture Steve Whittaker Photography

The Influence of Systems on ZNE

Energy Use For Community College Buildings Before And After Upgrade



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Manage Plug Loads

Image: St Lucie K-12 Schools https://schools.stlucie.k12.fl.us/fks/programs/technology/

Image: Shorewood K-12 Schools
http://www.shorewood.k12.wi.us/page.cfm?id=1642&noticeid=42&isnewsletter=YES&sitechoice=0

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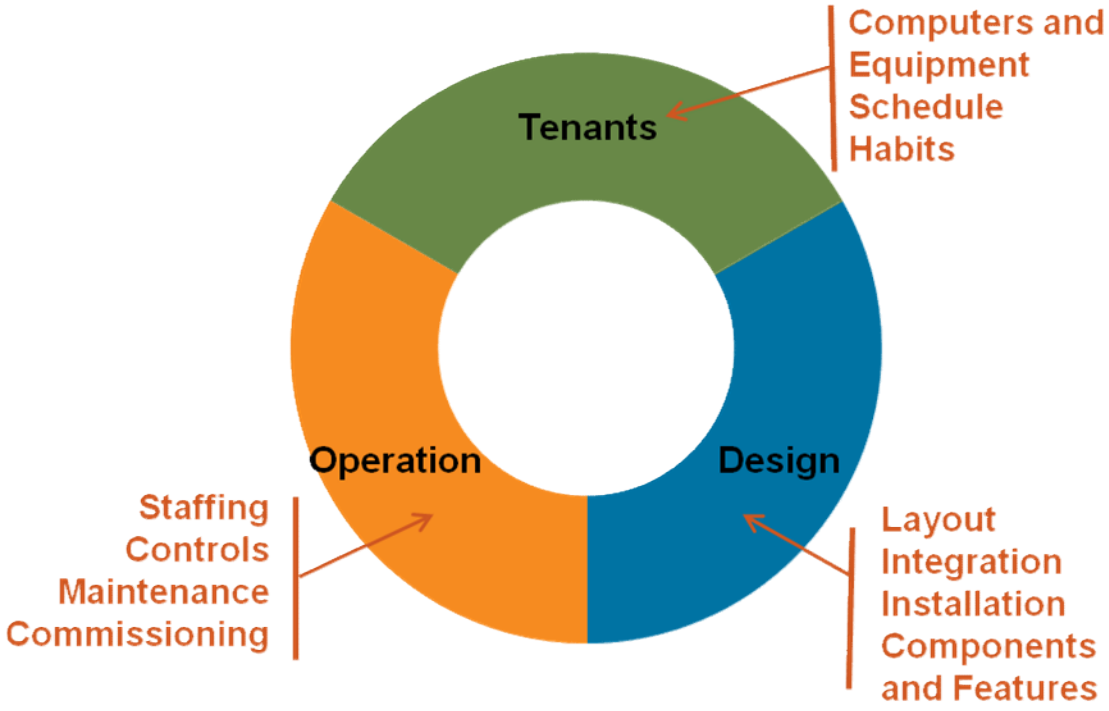
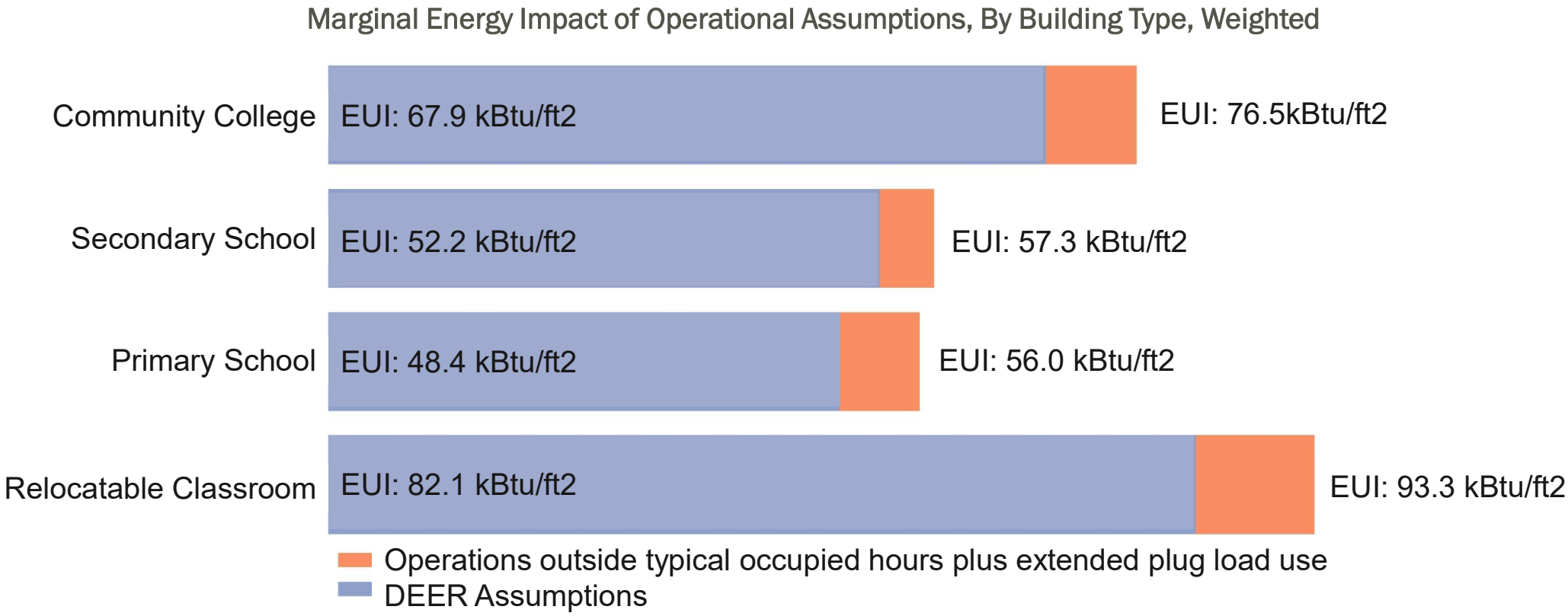
Operate to the Target



- Operator training & guides
- Monitor & benchmark energy use
- Engage occupants
- Plug load management
- Seek continuous improvement & performance data review
- Use operator, occupant & public feedback

Operations Matter!



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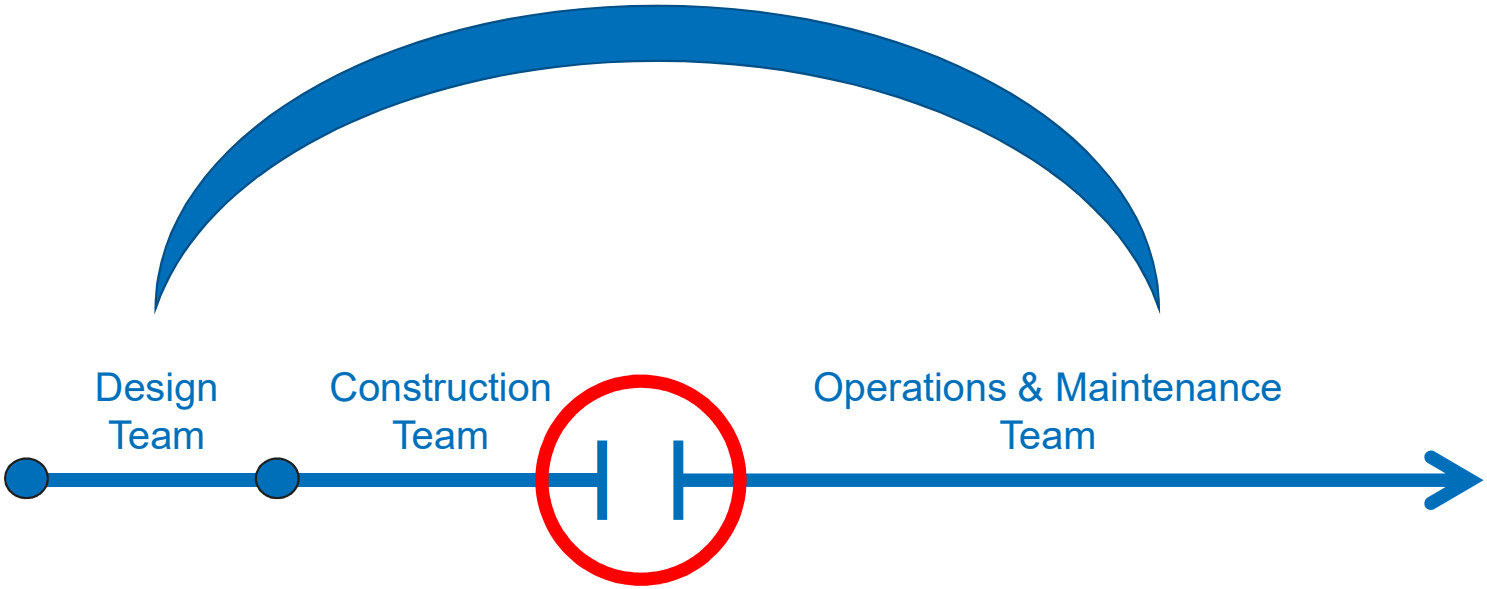
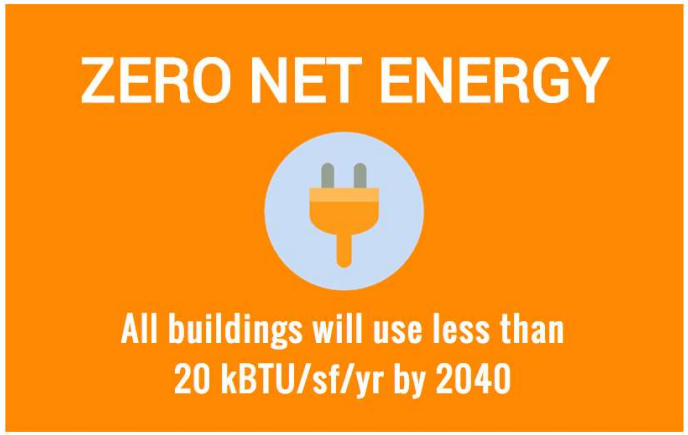
Arch of Continuity



Engage Students & Verify Performance

Recommendations for School Districts

San Francisco USD
Sustainability Goals



https://www.earthdayeverydaysf.com/district-goals

- Inform stakeholders
- Integrate energy and facilities into learning
- Incorporate energy into policies and plans
  - CHPS policies with energy targets
  - Owners Project Requirements
  - Facilities Master Plans
- Consider energy in contracting methods
  - Performance based procurement
- Support staff in advanced energy practices
  - Benchmarking
  - Strategic Energy Management (SEM)

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Activity: Pursuing the Roadmap to ZNE

Pursuing the Roadmap to ZNE

Instructions:

1. On your sheet, put in order which of the Roads to ZNE make the most sense to you and your district.
2. Identify which Road to ZNE you are either currently pursuing or would like to pursue. This is your “First Road”.
3. Find your group.
4. Take 10 minutes to discuss/identify 2-3 goals and targets to successfully achieve your chosen path to ZNE.

Paths to ZNE

- Creating Policy/Mandates
- Setting Energy Targets
- Benchmarking Energy Use
- Designing ZNE Curriculum
- Planning ZNE Pilot Project(s)
- Identifying Financing/Incentive Opportunities
- Operating and Maintaining to ZNE
- Recognition for ZNE Efforts
- Educate Yourself and Stakeholders on ZNE


Santa Rita Elementary School | Los Altos, CA

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ZNE Resources

Join us!

The Second Annual ZNE Recognition Awards!

Tomorrow, November 28 from 4:30-6:00 PM
Ballroom D & E at the Pasadena Convention Center

Recognition Categories

ZNE Leadership Award

Honoring the leaders, both **individuals** who inspire others on the path to ZNE and **project teams** that work effectively together to achieve ZNE goals.

Outstanding Buildings Award

Spotlighting **ZNE verified**, **ZNE emerging** and **ultra-low projects** at K-12 schools and community college campuses.

Visionary School District Award

Recognizing both **large** and **small districts** that have utilized policies, programs or plans that results in larger scale advancement of zero energy buildings.

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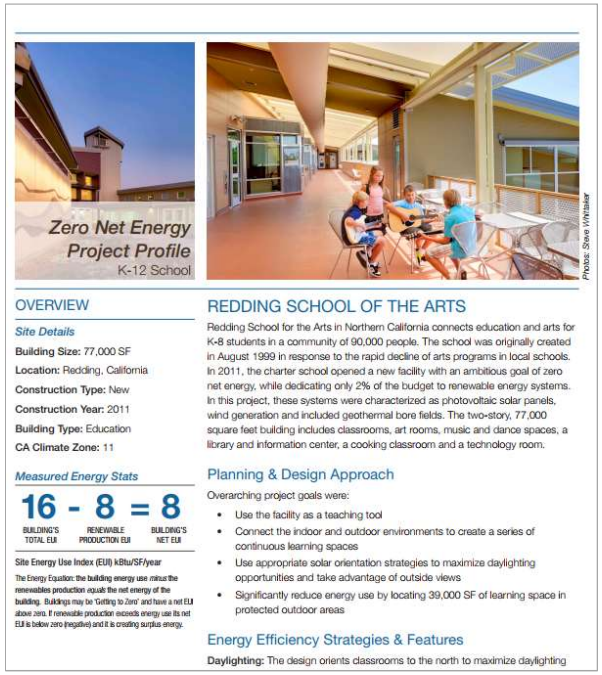
CASE STUDIES



Zero Net Energy
Project Profile
K-12 School

Photos: Steve Whitaker

OVERVIEW

Site Details

Building Size: 77,000 SF
Location: Redding, California
Construction Type: New
Construction Year: 2011
Building Type: Education
CA Climate Zone: 11

Measured Energy Stats

16 - 8 = 8

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

Site Energy Use Index (EUI) kBtu/SF/year

The Energy Equation: the building energy use *minus* the renewables production *equals* the net energy of the building. Buildings may be 'Getting to Zero' and have a net EUI above zero. If renewable production exceeds energy use its net EUI is below zero (negative) and it is creating surplus energy.

REDDING SCHOOL OF THE ARTS

Redding School for the Arts in Northern California connects education and arts for K-8 students in a community of 90,000 people. The school was originally created in August 1999 in response to the rapid decline of arts programs in local schools. In 2011, the charter school opened a new facility with an ambitious goal of zero net energy, while dedicating only 2% of the budget to renewable energy systems. In this project, these systems were characterized as photovoltaic solar panels, wind generation and included geothermal bore fields. The two-story, 77,000 square feet building includes classrooms, art rooms, music and dance spaces, a library and information center, a cooking classroom and a technology room.

Planning & Design Approach

Overarching project goals were:

- Use the facility as a teaching tool
- Connect the indoor and outdoor environments to create a series of continuous learning spaces
- Use appropriate solar orientation strategies to maximize daylighting opportunities and take advantage of outside views
- Significantly reduce energy use by locating 39,000 SF of learning space in protected outdoor areas

Energy Efficiency Strategies & Features

Daylighting: The design orients classrooms to the north to maximize daylighting

Verified
Zero Net Energy
Building Case Study

Photo: Van Bogaert

Photo: Google

OVERVIEW

Location: Sacramento, CA
Project Size: 63,000 SF
Construction Type: Retrofit
Construction Date: 1969, Retrofit in 2008, additional PVs added 2012
Building Type: Manufacturing facility
CA Climate Zone: 12
Total Building Cost: $2,000,000
Cost/SF: $32
Hard costs: $2,000,000

Measured Energy Stats

17.1 - 17.5 = -0.4

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

Site Energy Use Index (EUI) kBtu/SF/year

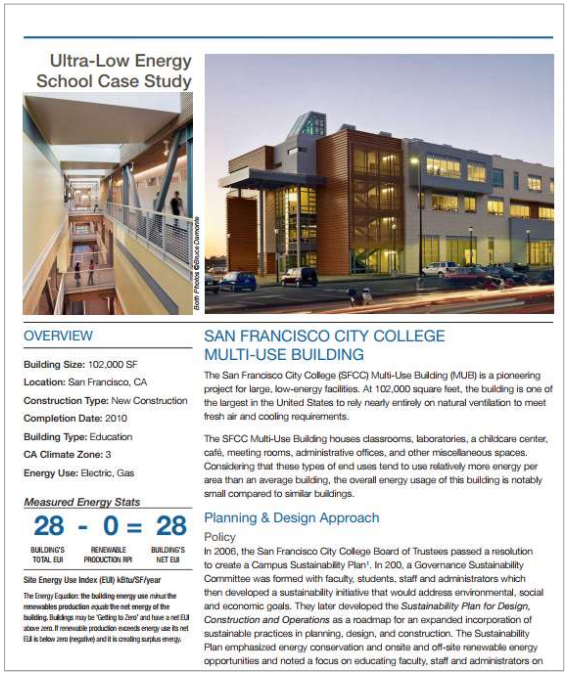
The Energy Equation: the building energy use *minus* the renewables production *equals* the net energy of the building. Buildings may be 'Getting to Zero' and have a net EUI above zero. If renewable production exceeds energy use its net EUI is below zero (negative) and it is creating surplus energy.

BAGATELOS ARCHITECTURAL GLASS SYSTEMS MANUFACTURING FACILITY

The Bagatelos Architectural Glass Systems (BAGS) manufacturing facility is a retrofit of a 1969 concrete warehouse that was renovated in 2008 to be a zero net energy (ZNE) building. The 63,000-square-foot Bagatelos Architectural Glass Systems manufacturing facility produces custom glass curtain wall systems for buildings throughout the state of California. Approximately 80% of the facility is dedicated to the manufacturing of glass and aluminum components, while the remaining space houses offices. After the company's production increased, in 2012 an installation of additional photovoltaic (PV) panels was necessary to return the 50-person operation to ZNE. Efficient lighting and mechanical systems reduced the energy consumption of the facility by 40% of the average for comparable building types, and the PV panels produce enough electricity to offset the remaining energy load.

Planning & Design Approach

The first step of the project was to design an ultra-efficient building. Because budget was a primary concern, Bagatelos gave strong preference to highly efficient systems, and deployed technologies that are commonly used in construction, rather than higher cost advanced technologies. Bagatelos used building energy modeling and daylighting modeling to estimate the building's energy performance and provided valuable studies to identify opportunities for additional efficiency improvements. Energy consumption that could not be economically reduced further was offset with PV panels.



Ultra-Low Energy
School Case Study

Both Photos ©Bruce Damonte

OVERVIEW

Building Size: 102,000 SF
Location: San Francisco, CA
Construction Type: New Construction
Completion Date: 2010
Building Type: Education
CA Climate Zone: 3
Energy Use: Electric, Gas

Measured Energy Stats

28 - 0 = 28

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

Site Energy Use Index (EUI) kBtu/SF/year

The Energy Equation: the building energy use *minus* the renewables production *equals* the net energy of the building. Buildings may be 'Getting to Zero' and have a net EUI above zero. If renewable production exceeds energy use its net EUI is below zero (negative) and it is creating surplus energy.

SAN FRANCISCO CITY COLLEGE MULTI-USE BUILDING

The San Francisco City College (SFCC) Multi-Use Building (MUB) is a pioneering project for large, low-energy facilities. At 102,000 square feet, the building is one of the largest in the United States to rely nearly entirely on natural ventilation to meet fresh air and cooling requirements.

The SFCC Multi-Use Building houses classrooms, laboratories, a childcare center, café, meeting rooms, administrative offices, and other miscellaneous spaces. Considering that these types of end uses tend to use relatively more energy per area than an average building, the overall energy usage of this building is notably small compared to similar buildings.

Planning & Design Approach

Policy

In 2006, the San Francisco City College Board of Trustees passed a resolution to create a Campus Sustainability Plan[1]. In 200, a Governance Sustainability Committee was formed with faculty, students, staff and administrators which then developed a sustainability initiative that would address environmental, social and economic goals. They later developed the *Sustainability Plan for Design, Construction and Operations* as a roadmap for an expanded incorporation of sustainable practices in planning, design, and construction. The Sustainability Plan emphasized energy conservation and onsite and off-site renewable energy opportunities and noted a focus on educating faculty, staff and administrators on

Getting to Zero Case Studies: https://gettingtozeroforum.org/case-studies/

Getting to Zero Database: http://newbuildings.org/getting-to-zero-buildings-database

PG&E Case Studies: http://energydesignresources.com/resources/publications/case-studies/case-studies-ZE-non-residential-buildings.aspx

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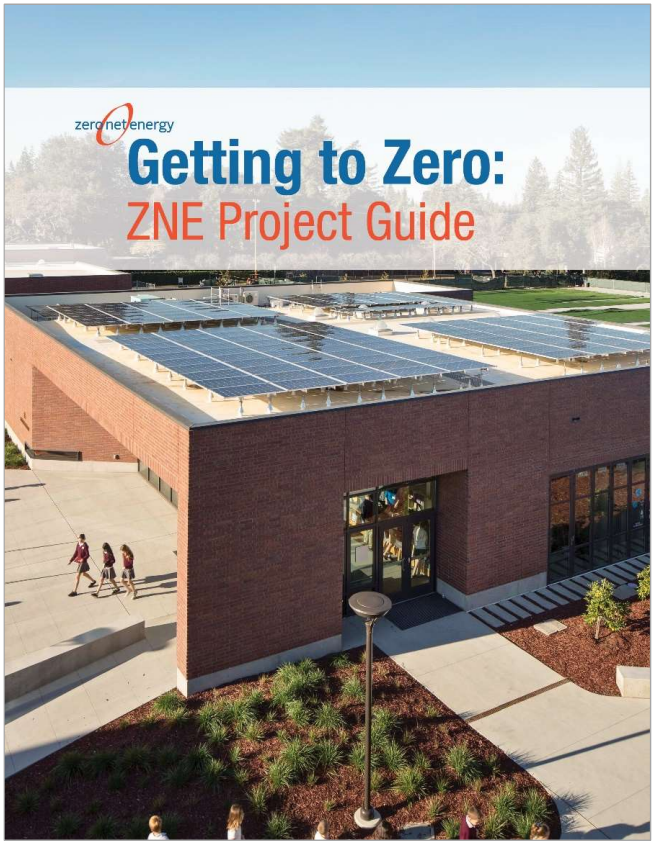
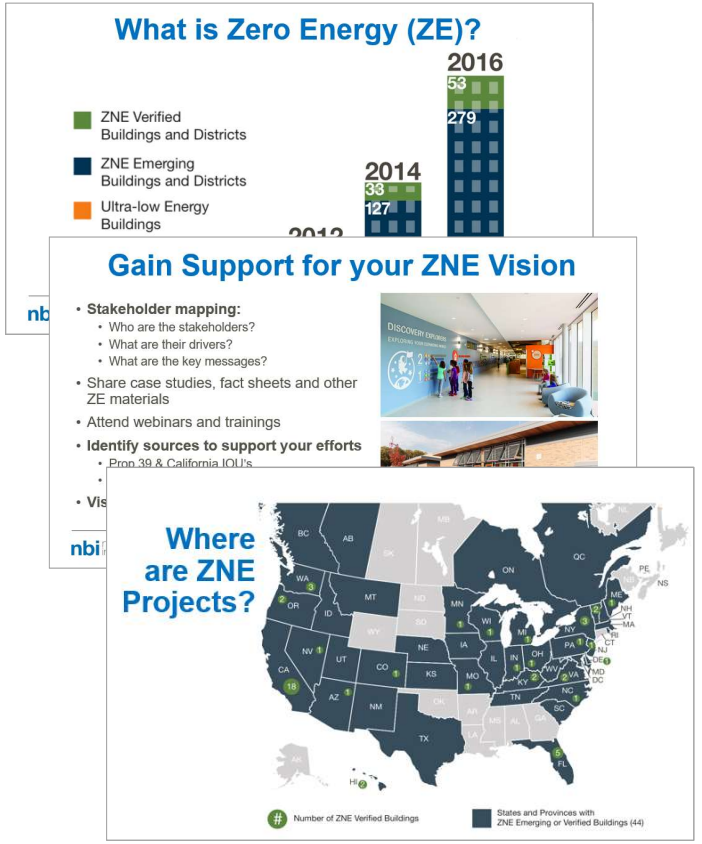
NBI Stakeholder Resources





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Getting to Zero Resources HUB

https://gettingtozeroforum.org/zero-energy-schools-resources/

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Other Resources

- **Energy Star Portfolio Manager:** https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager
- **NEEP High Performance Schools:** http://www.neep.org/initiatives/energy-efficient-buildings/high-performance-schools
- **Collaborative for High Performance Schools (CHPS) Criteria:** http://www.chps.net/dev/Drupal/node/212
- **Green Ribbon Schools:** https://www2.ed.gov/programs/green-ribbon-schools/index.html
- **NCEF School Buildings Assessment Methods:** http://www.ncef.org/pubs/sanoffassess.pdf
- **U.S. DOE Zero Energy School Accelerator:** www.zeroenergy.org
- **NREL Technical Feasibility for K-12 Schools:** http://www.nrel.gov/docs/fy17osti/67233.pdf
- **DOE Toolkit: K-12 Solutions for Building Energy Excellence:** https://betterbuildingsinitiative.energy.gov/toolkits/k-12-solutions-building-energy-excellence

GETTING TO zero
NATIONAL FORUM 2018

April 17-19, 2018
Grand Wyndam | Pittsburgh

gettingtozeroforum.org

The premier global event dedicated to defining the future of low and zero energy buildings.

- Share perspectives on the growth of ZE
- Build knowledge on policies driving projects, and design and operation best practices
- Collaborate on opportunities for ZNE to transform the built environment

ROCKY MOUNTAIN INSTITUTE

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Thank You!

New Buildings Institute
Amy Cortese, Associate Director, amy@newbuildings.org
Reilly Loveland, Project Analyst, reilly@newbuildings.org

Marin Country Day School
Photo Courtesy: EHDD Architects