nbi new buildings institute

GETTING TO ZERO IN SCHOOLS

Sustainable Facilities Forum, May 16, 2019

Sacramento, CA

© New Buildings Institute 2019

Learning Objectives

Our learning obectives upon completion are:

1. Participants will be able to utilize lessons learned and approaches in the process of schools that have been successful on the path to zero net energy.
2. Participants will gain a greater understanding of the importance of discussing zero net energy early in the process with all stakeholders to successfully plan, design and operate a cost effective zero net energy school.
3. Participants will be able to identify the steps and needed actions throughout the whole zero net energy process including design, construction and operations in comparison to business-as-usual school design.
4. Participants will gain a greater understanding of the importance of teamwork, open communication, utilizing energy targets and designing for operations on a zero net energy outcome.

nbi new buildings institute

© New Buildings Institute 2019

Agenda

1:00 p.m. – 1:05 p.m.	**Welcome and Introductions**
1:05 p.m. – 1:30 p.m.	**Introduction and Overview: Getting to Zero in Schools** *Amy Cortese, New Buildings Institute*
1:30 p.m. – 2:00 p.m.	**Parkside Elementary School: A Zero Net Energy New Construction Project** *Alan Glass, Energy Supervisor, Pittsburg Unified School District*
2:00 p.m. – 2:20 p.m.	**Getting to Zero: Steps to Success** *Reilly Loveland, New Buildings Institute*
2:20 p.m. – 2:55 p.m.	**NOW THE HARD PART: Implementing a Districtwide ZNE Plan** *Kevin Connolly, Director of Buildings & Grounds, San Francisco Unified SD* *Nik Kaestner, Director of Sustainability, San Francisco Unified SD*
2:55 p.m. – 3:00 p.m.	**Resources for Getting to Zero**

nbi new buildings institute

© New Buildings Institute 2019

Redefining how energy is used in the built environment

NBI is a national nonprofit that drives energy and carbon reduction in buildings.

Program Areas:

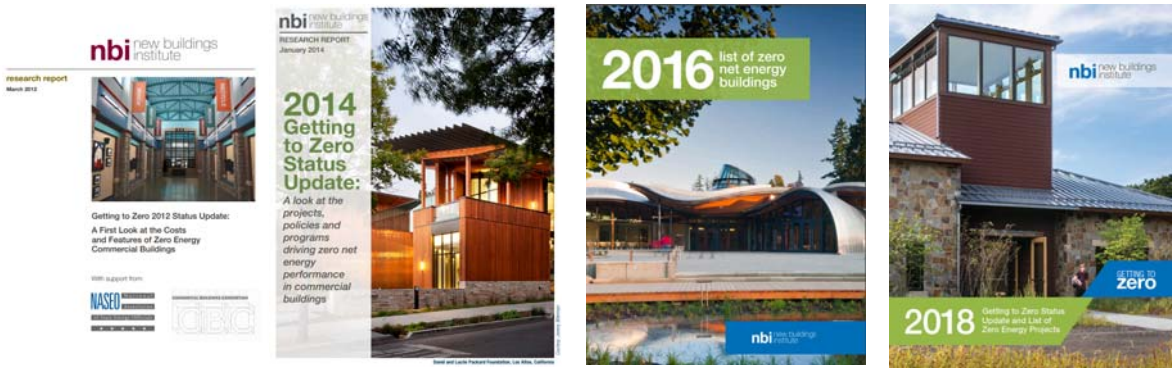
- Getting to zero leadership and market development
- Best practices in new and existing buildings
- Continuous code and policy innovation

nbi new buildings institute

© New Buildings Institute 2019

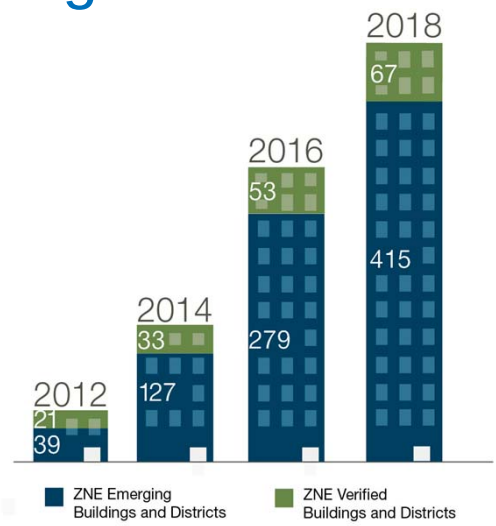
Getting to Zero Lists of Buildings

2012 2014 2016 2018



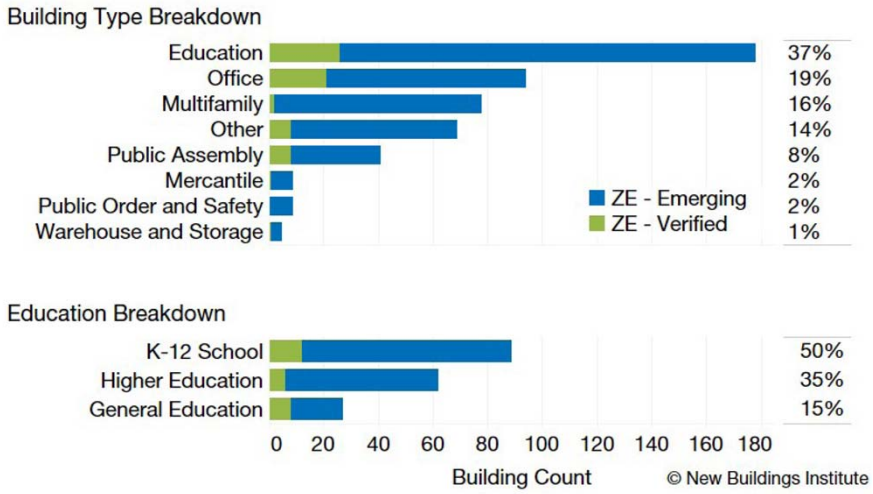
© New Buildings Institute 2019

2018 List of ZNE Buildings



© New Buildings Institute 2019

Schools are Leading in ZNE



nbi new buildings institute

© New Buildings Institute 2019

ZNE and Ultra-Low Energy in Education

K-12 Schools

Community Colleges

Higher Education

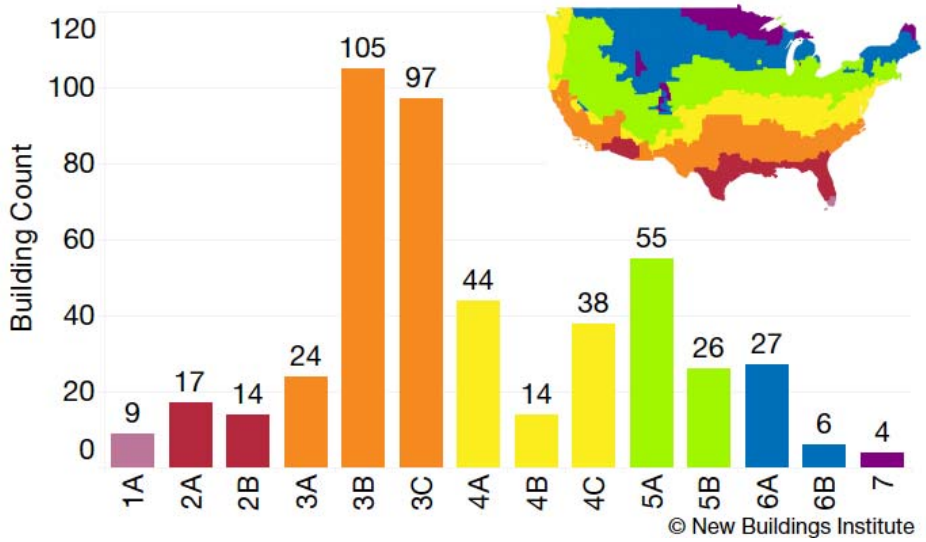
Libraries

Science Centers

nbi new buildings institute

© New Buildings Institute 2019

ZNE Buildings Span All Climate Zones



nbi new buildings institute

© New Buildings Institute 2019

The Name Game

Zero Energy Buildings

Zero Net Energy

Zero Carbon Buildings

Net Zero Energy

Zero Electric Buildings

Living Buildings

Zero Energy Cost

Passive House

Nearly Zero Energy Buildings

Zero Net Ready Buildings

Ultra-low Energy Buildings

Site vs. Source Energy

nbi new buildings institute

© New Buildings Institute 2019

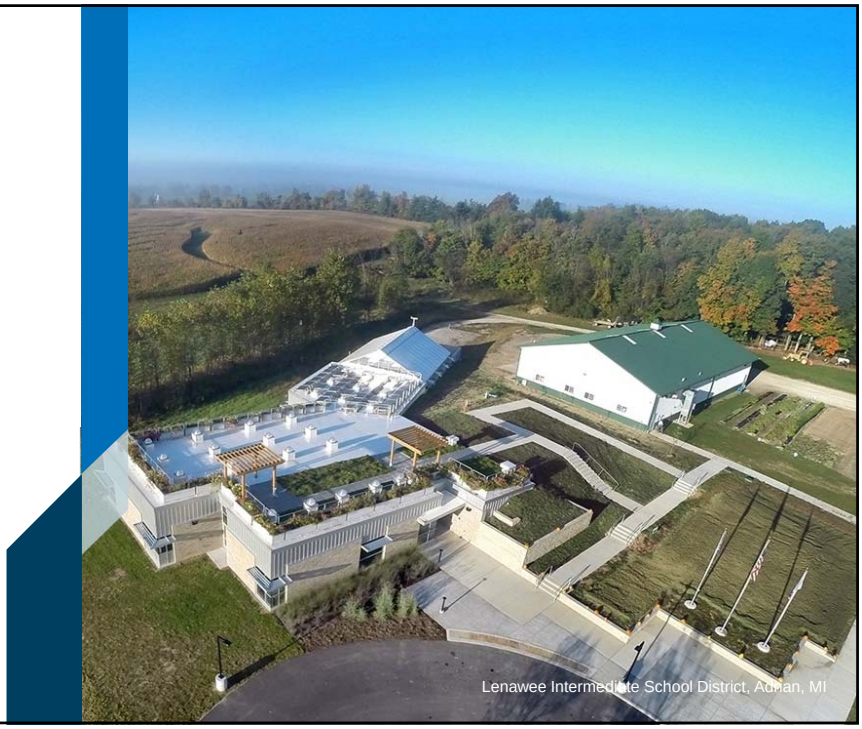
Energy Use Intensity

EUI =

Annual Energy Use
Square Footage

16-26 kBtu/SF-year

nbi new buildings institute



Lenawee Intermediate School District, Adrian, MI

Getting to Zero in Schools

- The next evolution in sustainable, high performance buildings
- Cost avoidance from utility bills to classroom and facilities
- Data shows they create comfortable and productive environment for teachers and students
- Provide hands-on, tangible learning opportunities for 21st century skills
- Make communities stronger, resilient and energy independent

nbi new buildings institute

Hood River School District Science Building, Hood River, OR
Credit: Opsis Architecture

Getting to Zero in Schools

- Grounded in efficiency
- Clear energy goals
- Benchmarking
- Strategic, portfolio-wide energy planning
- Measure and report regularly
- Involve students

Ferris High School, Spokane, WA
Credit: NAC Architecture

nbi new buildings institute

© New Buildings Institute 2019

Getting to Zero in Schools

While ZNE is a realistic end game, getting to sustainable, ultra-low energy schools with renewable energy production will take time to accomplish.

School districts can start now with benchmarking, energy targets, and other policies, plans and practices on the path to zero.

Redding School for the Arts, Redding, CA
Credit: TRILOGY Architecture

nbi new buildings institute

© New Buildings Institute 2019

Getting to Zero Portfolio Strategy

- Set clear energy goals
- Continuous energy improvement to target EUI
- Leverage projects as they naturally occur
- Benchmark and prioritize to identify opportunities
- Energy planning incorporated into Facilities Master Plan, OPRs, RFQs, etc

nbi new buildings institute

© New Buildings Institute 2019

Building Lifecycle Opportunities

- New Construction
- Major Renovation
- Equipment Replacement
- Operations and Retro-Commissioning
- Bond and Stakeholder Turnover

Madison Middle School, Seattle, WA
Credit: Seattle.gov

nbi new buildings institute

© New Buildings Institute 2019

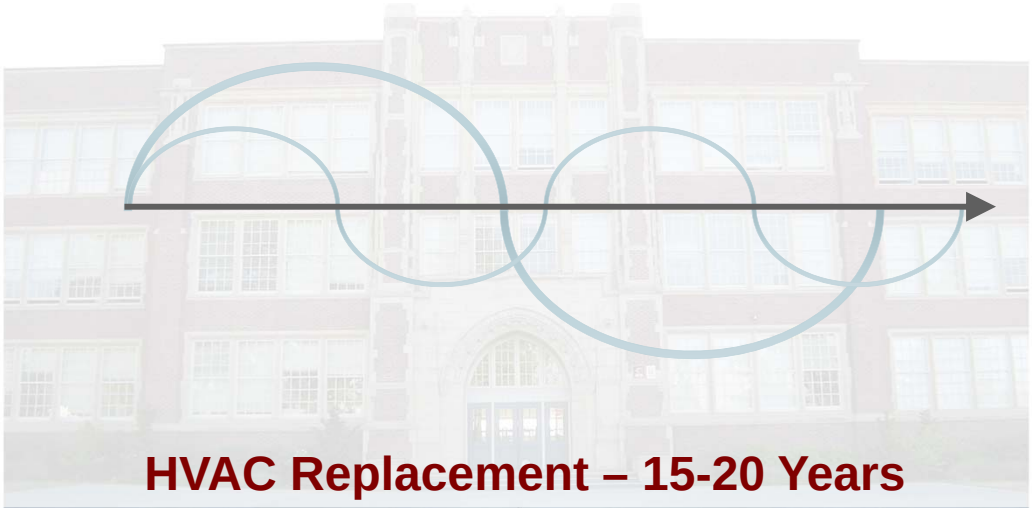
Lifecycle Opportunities

Madison Middle School, Seattle, WA
Credit: Seattle.gov

nbi new buildings institute

© New Buildings Institute 2019

Lifecycle Opportunities



Madison Middle School, Seattle, WA
Credit: Seattle.gov

nbi new buildings institute

© New Buildings Institute 2019

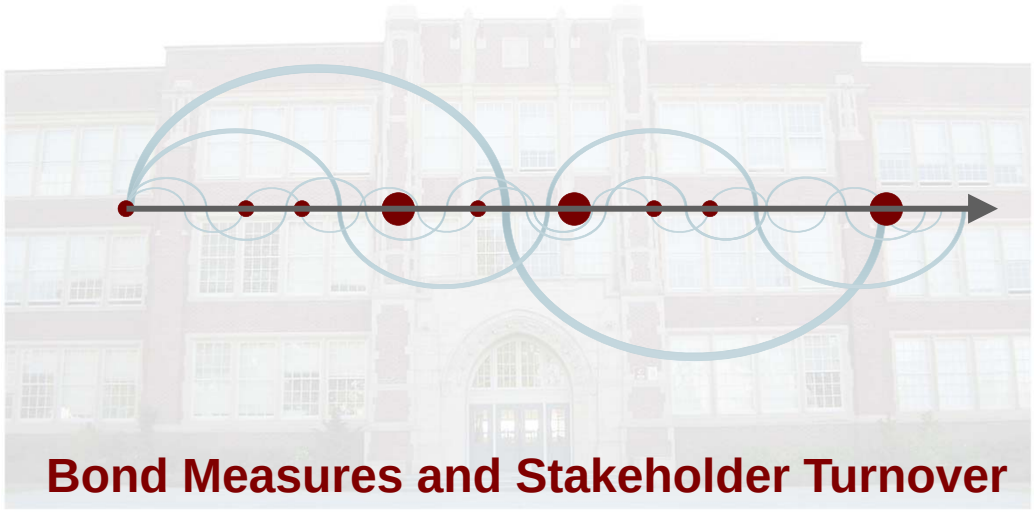
Lifecycle Opportunities

Madison Middle School, Seattle, WA
Credit: Seattle.gov

nbi new buildings institute

© New Buildings Institute 2019

Lifecycle Opportunities



Madison Middle School, Seattle, WA
Credit: Seattle.gov

nbi new buildings institute

© New Buildings Institute 2019

Take a Strategic Approach

- Consider comfort & health first (thermal, acoustic, lighting, views)
- Clarify sustainability and energy goals
- Align with building lifecycle opportunities
- Start with load reduction
- Consider mechanical system selection decisions
- Investigate EVs, PVs and renewables

Ralston Intermediate and Santiago High School, Garden Grove, CA
Credit: Garden Grove School District.

nbi new buildings institute

© New Buildings Institute 2019

IOU K-14 ZNE Pilot Project

- Technical proof-of-concept ZNE school retrofits pilots
- Training workshops and webinars
- Case study development
- ZNE School Recognition awards

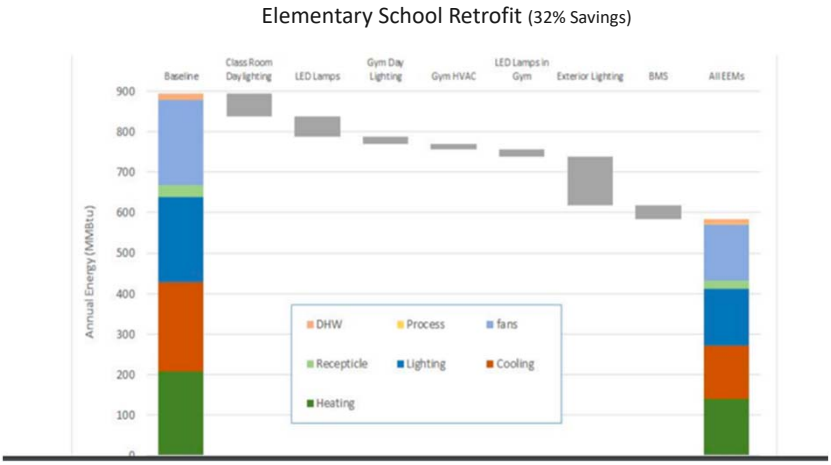


Chart courtesy of PG&E and Point Energy Innovation

nbi new buildings institute

© New Buildings Institute 2019

Existing Building Assessments

- Unique design features
- Daylighting opportunities, shading
- Air sealing and heat recovery ventilation
- Lighting, unique conditions
- HVAC condition and replacement schedule
- Portables – lighting and HVAC condition
- BMS/occupancy sensors and patterns
- Opportunities in the kitchen

Newcastle Elementary School, Newcastle, CA
Photo Courtesy of Point Energy Innovations

nbi new buildings institute

© New Buildings Institute 2019

Retrofit Considerations

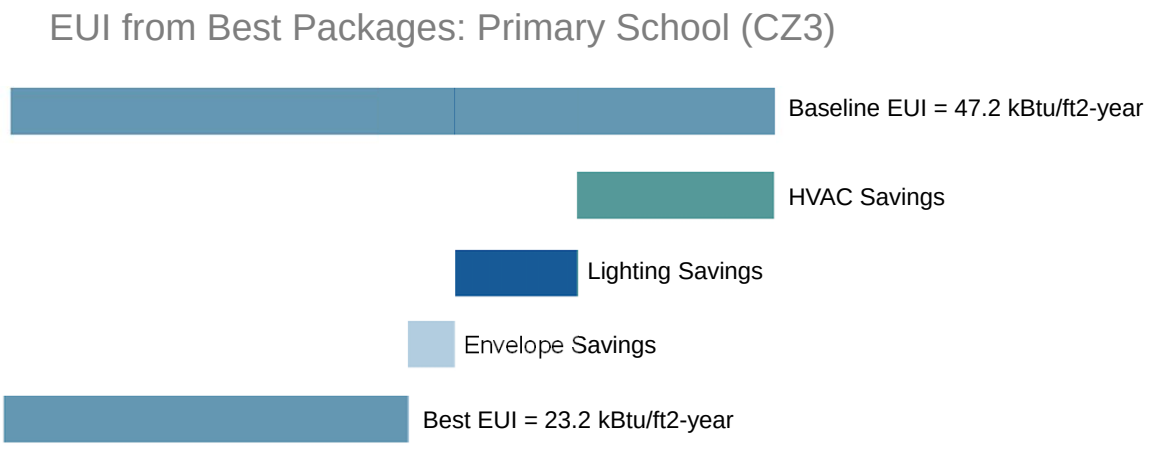
- Consider unique conditions:
  - Planned retrofits
  - Behavior and preferences
  - Maintenance team needs
  - Peculiar local requirements/inspectors
  - Savings-to-investment ratio limitations

Westside School | Seattle, WA
Photo Courtesy of SKL Architects

nbi new buildings institute

© New Buildings Institute 2019

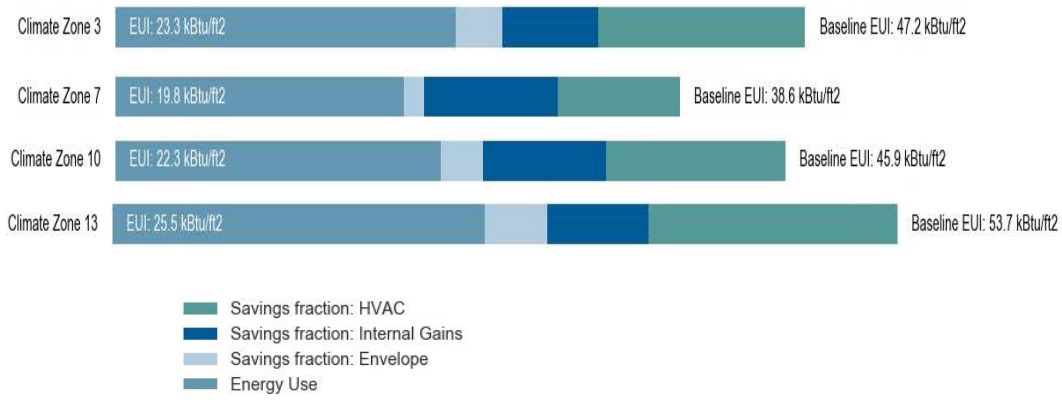
The Importance of HVAC in Getting to Zero



nbi new buildings institute

© New Buildings Institute 2019

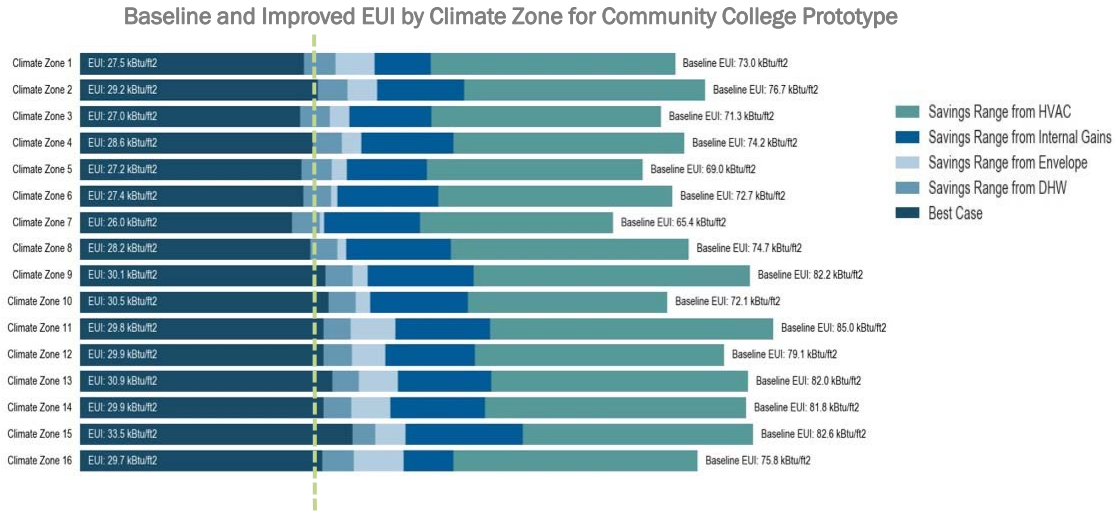
Primary School Comparison



nbi new buildings institute

© New Buildings Institute 2019

Opportunities by Climate Zone

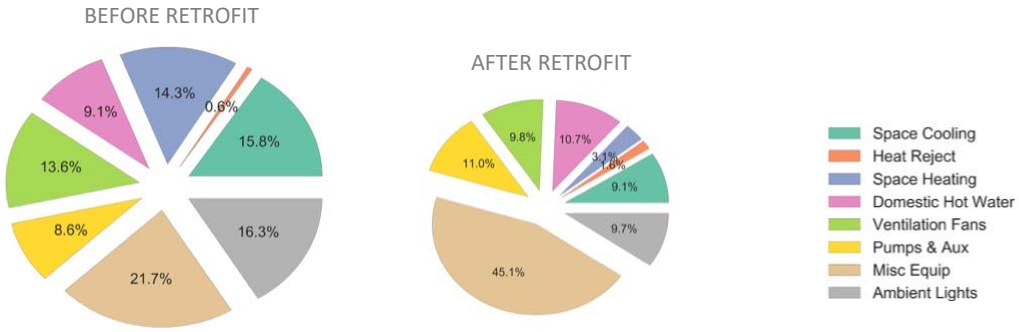


nbi new buildings institute

© New Buildings Institute 2019

The Changing Pie of ZNE

Energy Use For Community College Buildings Before And After Upgrade

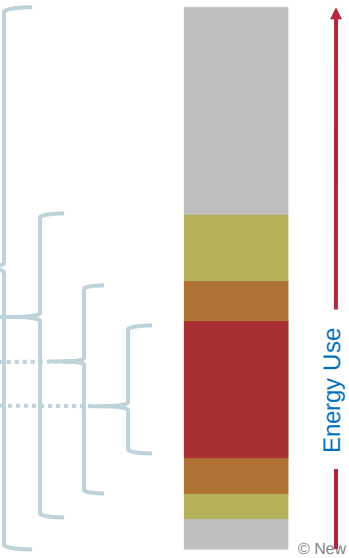


nbi new buildings institute

© New Buildings Institute 2019

Range of Energy Performance Outcome

OCCUPANT BEHAVIOR
SCHEDULE AND USE
ACTUAL SYSTEM OPERATION
MODELED SYSTEM OPERATION



nbi new buildings institute

© New Buildings Institute 2019

Overview: Getting to Zero

- Strategic, portfolio-wide energy planning
- Grounded in efficiency
- Clear energy goals
- Benchmarking
- Measure and report regularly
- Involve students

Ferris High School, Spokane, WA
Credit: NAC Architecture

Discovery School, Arlington, VA | Credit: VMDO
©2018, New Buildings Institute

PITTSBURG UNIFIED SCHOOL DISTRICT

SUSTAINABLE FACILITIES FORUM

PARKSIDE ELEMENTARY SCHOOL:
A ZERO NET ENERGY
NEW CONSTRUCTION PROJECT

Presented by: Alan E. Glass
Energy Supervisor/Special Projects Accountant
Pittsburg Unified School District
Date: May 16, 2019

WHO ARE WE?
PITTSBURG UNIFIED SCHOOL DISTRICT

- K-12 School District located in East Contra Costa County
- Thirteen school sites, all located in the City of Pittsburg, including:
  - Eight (8) Elementary Schools
  - Three (3) Junior High Schools
  - One (1) Comprehensive High School
  - One (1) Continuation High School
  - One (1) Adult Education Center
- Current ADA is 11,700
- Position: Special Projects Accountant and Energy Supervisor

SUSTAINABILITY AND ZERO NET ENERGY

How did we get to this point?

- PV solar arrays at sixteen (16) of the District's locations
- In calendar year 2018, we generated 5,300 MWh in energy from our solar arrays, producing close to 54% of the total electrical need of the District.
- For the last 5 ½ years, we have generated over 37.86 GWh of electricity
- We have avoided over 114,000,000 of CO2 because of our solar production.
- During 2018, we have had a cost avoidance of $900,000 as a result of our solar production.

SUSTAINABILITY AND ZERO NET ENERGY

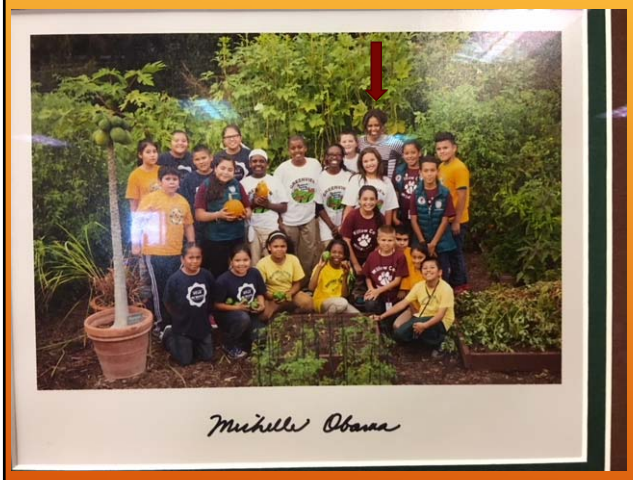
- Recycling and composting at all school sites
  - Foothill Elementary was awarded first place in a nation-wide recycling vs. waste contest
  - Students and staff work together to sort landfill waste from recycling and compostable materials
  - District –wide program for recycling of e-waste; donations to Oakland Technology West, which provides low-cost computers to low-income families instead of e-waste
- Active gardens at all school sites
  - Willow Cove Elementary 4th graders were invited and went to the White House to work in the garden with Michelle Obama
  - Produce from gardens served in cafeterias
  - Farm-to-school fresh produce served in salad bars district-wide

SUSTAINABILITY AND ZERO NET ENERGY

- Our transportation fleet has changed over the last year
  - Two new all-electric buses
  - Fourteen (14) new low-emission propane powered buses
  - Six (6) Kia Soul EV for white fleet
  - Twenty-four (24) electric vehicle chargers district wide. Staff can use chargers for free, to promote the use of EVs by staff.
  - Worked with PG&E on pilot bus charging program to install nine (9) new EV bus charging units for our yellow fleet.
  - Looking to purchase up to seven (7) more all-electric buses

SUSTAINABILITY AND ZERO NET ENERGY

- Idle-free program for vehicles waiting at school sites
- Recycled water currently used for irrigation at two schools where it is available pipe in, with one more site scheduled to be done, our ZNE site.
- Waterless urinals at all school and District sites, each saving close to 40,000 gallons of water per year
- Awarded the California Green Ribbon Schools award with Gold Distinction from the California Department of Education in 2015 and Bronze Distinction in 2019
- Awarded the Golden Bell Award by the California School Board Association (CSBA)
- Site Support Services Center has a new beta solar array over a one-acre bioswale and four (4) wind generated turbines, totaling over 200kW of energy production



SUSTAINABILITY AND ZERO NET ENERGY SO WHAT'S NEXT?

- Pittsburg Unified has had tremendous support from the community for school bonds
  - Since 1996, the District has passed four (4) school bonds and a parcel tax for school facility improvements, new schools, and educational programs. Bonds total over $300M since 2008
  - The District has built/re-built two new elementary schools, two new junior high schools, and both our comprehensive and continuation high schools
  - We have also fully modernized two other elementary school sites
  - We are currently constructing a new Parkside Elementary School. The current campus was built in 1958.

SUSTAINABILITY AND ZERO NET ENERGY SO WHAT'S NEXT?

- Who are the stakeholders and decision-makers for the District?
  - Board of Trustees
  - Superintendent
  - Cabinet – Associate Superintendent (CBO), Assistant Superintendent of HR, Executive Directors (2) of Educational Services
  - School Principal
  - Staff at site
  - Parents, community members, and students

With all the components of Sustainability and Energy Conservation that the District practices, what did that mean for the new Parkside Elementary School?

PARKSIDE ELEMENTARY AND ZERO NET ENERGY

It seemed like the next logical step for Pittsburg Unified was to build Parkside Elementary School as a Zero Net Energy School.

- **First, the former Deputy Superintendent, who oversaw the business side of the District, was approached with the concept.**
- **The timing was right for PUSD to make Parkside a ZNE school, to make it as efficient as we could for energy conservation and sustainability, given all of our "green efforts" leading to this time and have enough renewable energy to sustain a zero net energy facility.**
- **Use the site as a learning tool for students and staff.**
- **Continue to be a leader in the city and the educational community for energy conservation and sustainability**
- **Cost-effective, with a good return on investment**

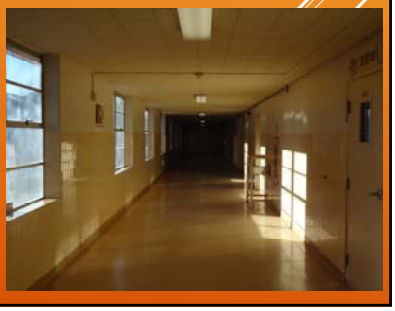
PARKSIDE ELEMENTARY AND ZERO NET ENERGY

- **We took the concept of a Zero Net Energy school to the Facilities Sub-Committee**
  - **Consists of two of the five Board members**
  - **Deputy Superintendent**
  - **Members of the Facilities Department team**
- **We explained exactly what it would take to make Parkside Elementary School a ZNE school and what that would mean to the District and the community**
- **The Committee was all in favor and the two members of the Board from the Committee shared with the rest of the Board what we were doing**

Gardens and Sustainability at PUSD schools!

PARKSIDE ELEMENTARY AND ZERO NET ENERGY

- As we were in the early development stages of the plans, the architect added a fee to their proposal to do the work needed to make Parkside a ZNE school
- Plans went to the Division of State Architects and were approved.
- We have calculated the need for about 400 kW of solar production to make this school a ZNE facility. The school will include carport-style solar arrays in the driveway in to the school and parking lot, as well as use of the red solar panels over the bioswale on the property
- Project funded from community-supported Bond issue and will be eligible for matching state funds.
- Community, families for school, and District staff have been very supportive of this being another example of how PUSD is leading the way in energy conservation and sustainability.



PARKSIDE ELEMENTARY AND ZERO NET ENERGY

PARKSIDE ELEMENTARY AND ZERO NET ENERGY

North exterior view of new Parkside Elementary, note windows for daylighting

Classrooms with large windows to provide daylighting in all rooms, view from northwest perspective

PARKSIDE ELEMENTARY AND ZERO NET ENERGY

Teachers can utilize hallways for learning spaces for small or larger groups

Learning spaces in the wider hallways, with natural lighting a priority.

PARKSIDE ELEMENTARY AND ZERO NET ENERGY

Contact info: Alan E. Glass
Energy Supervisor/Special Projects Accountant
Pittsburg Unified School District
aglass@pittsburg.k12.ca.us
925-473-2368

Getting to ZNE: Steps to Success

nbi new buildings institute

Lenawee Intermediate School District, Adrian, MI

Process to Achieve ZNE

- Get stakeholder support
- Make a commitment
- Set energy targets
- Integrate targets into policies and contracts
- Use integrated design to design and construct to target
- Optimize operations
- Measure, verify and report

Kathleen Grimm School, PS 62, New York, NY
Credit: James Ewing

nbi new buildings institute

© New Buildings Institute 2019

Gain Support for the Path to Zero

- Stakeholders and key messages
- Share case studies & fact sheets
- Tour nearby schools or share video case studies with decision makers
  - Patriot Hall Video - https://energytrust.org/pathtonetzero/
  - Discovery ES Video - https://www.zeroenergy.org/video-case-study/

Discovery Elementary School, Arlington, VA
Credit: VMDO Architects

nbi new buildings institute

© New Buildings Institute 2019

High Performance Schools Fast Facts!

Did you know that the classroom environment can affect a child's academic progress over a year by as much as **25%**[1]

65% Reduction in asthma cases among elementary students when school indoor environment quality improves.[2]

3% Reduction in teacher turnover in green schools - saving US$4 per square foot over a 20 year period.[3]

20% Faster progression in math in schools with good daylighting.[4]

26% Faster progression in reading in schools with good daylighting.[4]

10% Increase in overall performance in schools with good daylighting.[4]

1. Barett, P., Zhang, Y., Moffat, J., & Kobbacy, K. (2012, October 03). A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning.
2. Meng, Y., Babey, S. H., & Wolstein, J. (2012). Asthma-Related School Absenteeism and School Concentration of Low-Income Students in California.
3. Katz, G. (2006). Greening America's Schools: Costs and Benefits.
4. Heschong Mahone Group. (1999). Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance.

Credit: World GBC

nbi new buildings institute

© New Buildings Institute 2019

School buildings as a tool to enhance student learning

Student Performing Energy Audit, Los Angeles USD, CA
Credit: Los Angeles USD

nbi new buildings institute

© New Buildings Institute 2019

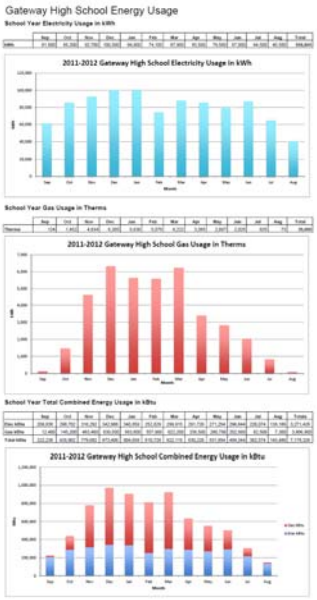
The Winning Pitch for Efficiency

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 highest 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	



nbi new buildings institute

© New Buildings Institute 2019

Financing Approaches

- School Bond Funding
- Solar Production Incentives
- Energy Efficiency Incentive Programs
- Energy Efficiency and Solar Grant Program
- School Bond Guarantee Program
- Local Option Capital Asset Lending (LOCAL)
- Power Purchase Agreements (PPAs)
- Energy Service Company contracts

Proposition 39 made $400 million / year available to fund school retrofits. Continuation of Prop 39 funding is now under consideration.

Northwood Elementary, Mercer Island, WA
Credit: Mahlum Architects

nbi new buildings institute

© New Buildings Institute 2019

Make a Commitment

- Benchmark
- Set goals
- Select a champion
- Regularly report progress toward goals
- Energy Manager/MEP systems coordinator (in larger districts)

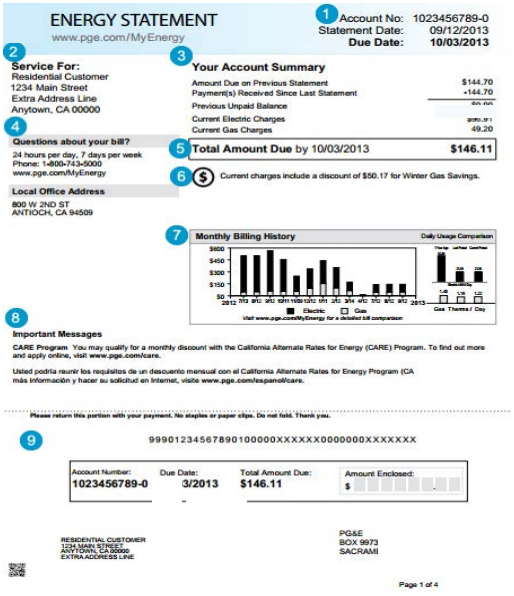
Sbrega Health & Science Building, Fall River, MA
Credit: Edward Caruso

nbi new buildings institute

© New Buildings Institute 2019

Benchmarking

- Collect energy consumption
  - 2-3 years
- Benchmark use against
  - CBECS, other schools in district
- Useful tools include :
  - ENERGY STAR Portfolio Manager
  - Online data tracking
  - School Dude & Others
  - Excel, google sheets



ENERGY STATEMENT
www.pge.com/MyEnergy

1 Account No: 1023456789-0
Statement Date: 09/12/2013
Due Date: 10/03/2013

2 Service For:
Residential Customer
1234 Main Street
Extra Address Line
Anytown, CA 00000

3 Your Account Summary
Amount Due on Previous Statement $144.70
Payment(s) Received Since Last Statement +144.70
Previous Unpaid Balance
Current Electric Charges
Current Gas Charges 49.20

4 Questions about your bill?
24 hours per day, 7 days per week
Phone: 1-800-743-5000
www.pge.com/MyEnergy

5 Total Amount Due by 10/03/2013 $146.11

6 Current charges include a discount of $50.17 for Winter Gas Savings.

Local Office Address
800 W 2ND ST
ANTIOCH, CA 94509

7 Monthly Billing History
Daily Usage Comparison
Electric Gas
Gas Therms / Day

8 Important Messages
CARE Program You may qualify for a monthly discount with the California Alternate Rates for Energy (CARE) Program. To find out more and apply online, visit www.pge.com/care.

Usted podría reunir los requisitos de un descuento mensual con el California Alternate Rates for Energy Program (CA más información y hacer su solicitud en Internet, visite www.pge.com/espanol/care.

Please return this portion with your payment. No staples or paper clips. Do not fold. Thank you.

9 9990123456789010000XXXXXX0000000XXXXXXX

Account Number: 1023456789-0
Due Date: 3/2013
Total Amount Due: $146.11
Amount Enclosed: $

RESIDENTIAL CUSTOMER
1234 MAIN STREET
ANYTOWN, CA 00000
EXTRA ADDRESS LINE

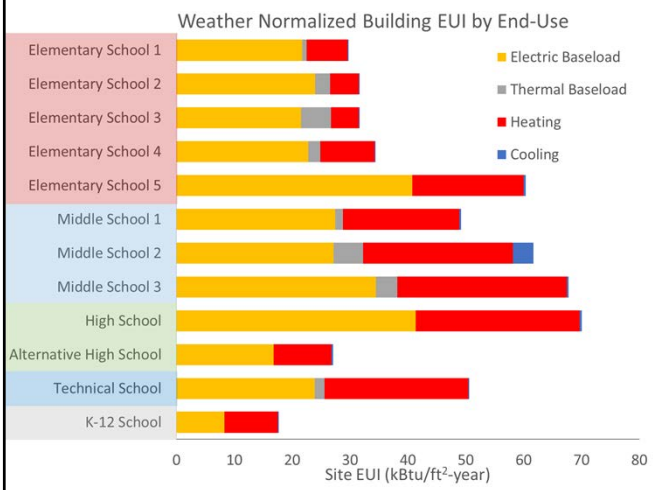
PG&E
BOX 9973
SACRAMI

Page 1 of 4

nbi new buildings institute

© New Buildings Institute 2019

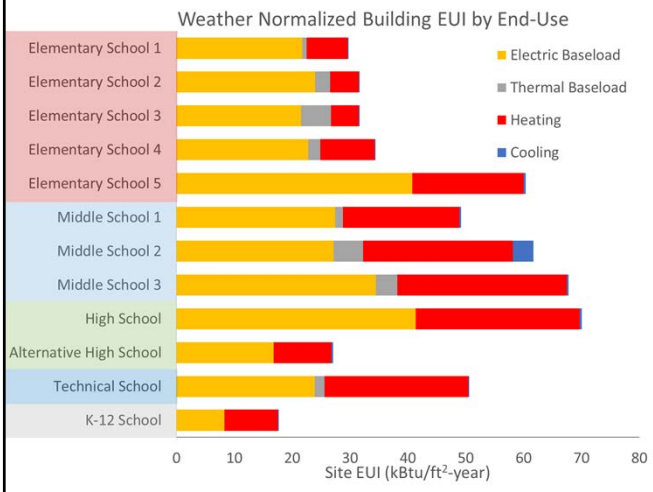
Portfolio-Level: Disaggregated Energy



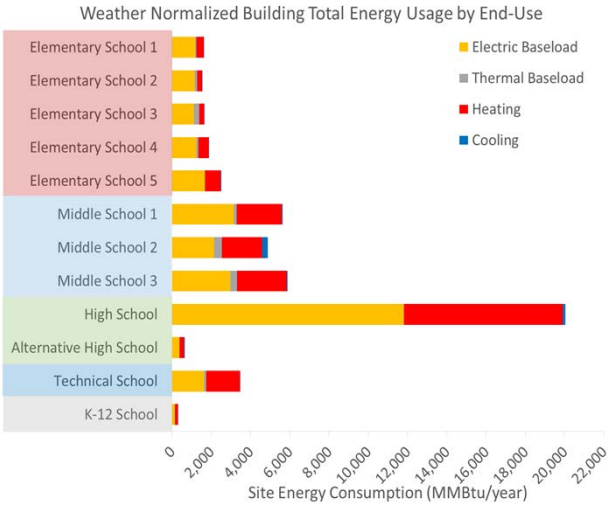
nbi new buildings institute

© New Buildings Institute 2019

EUI



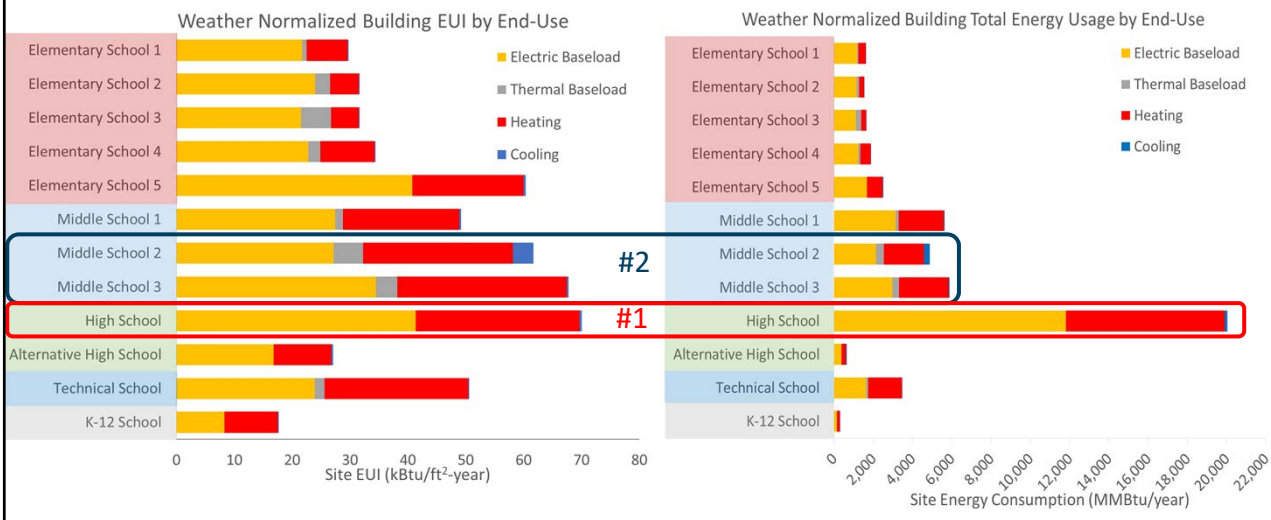
Total Consumption



nbi new buildings institute

© New Buildings Institute 2019

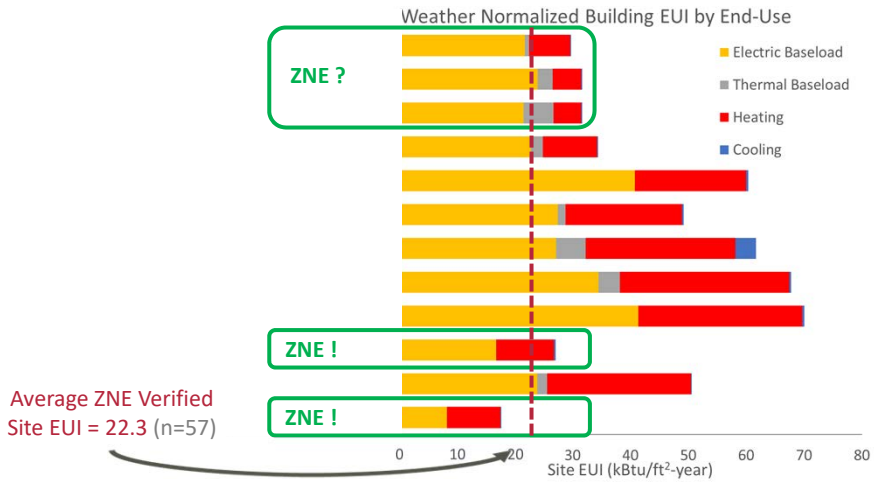
Strategic Approach to Retrofits & ZNE



nbi new buildings institute

© New Buildings Institute 2019

Other ZNE Pilot Candidates

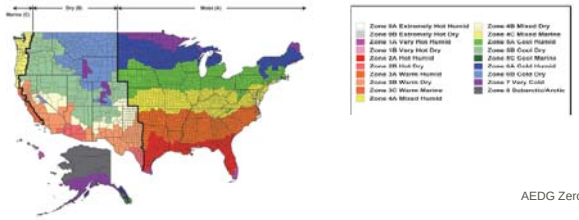


nbi new buildings institute

© New Buildings Institute 2019

ZNE Energy Use Intensity (EUI) Targets

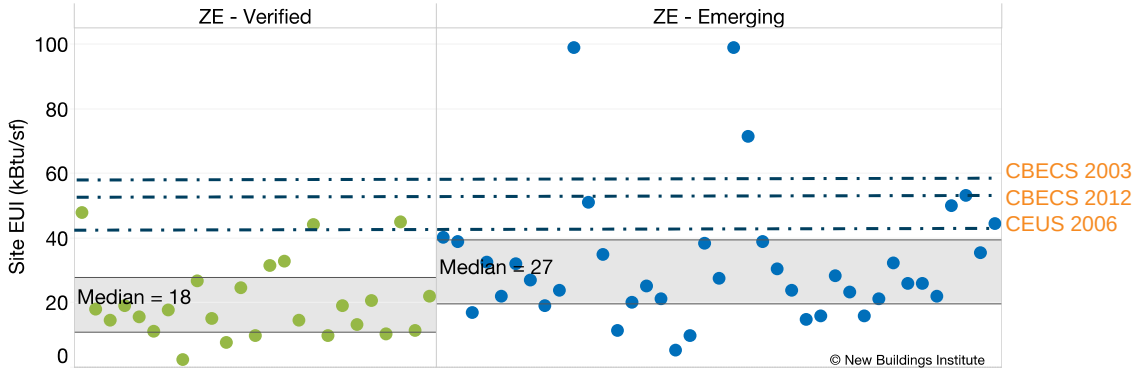
- More than beyond “xx% better than code”
- Absolute energy ”EUI” target
- For ZNE projects the site EUI target is between 17 and 22 kBtu/sf/year



Climate Zone	Site Energy		Source Energy	
	Primary School EUI, kBtu/ft^2·yr	Secondary School EUI, kBtu/ft^2·yr	Primary School EUI, kBtu/ft^2·yr	Secondary School EUI, kBtu/ft^2·yr
0A	22.5	22.9	69.1	70.5
0B	23.1	23.2	71.4	71.6
1A	21.3	21.1	65.5	65.0
1B	21.7	21.6	66.6	66.6
2A	20.9	21.3	63.8	65.1
2B	19.6	19.9	59.7	60.8
3A	18.8	19.1	56.7	57.7
3B	19.0	19.4	57.3	58.8
3C	17.5	17.6	52.6	52.8
4A	18.8	18.9	56.3	56.7
4B	18.4	18.5	55.1	55.5
4C	17.5	17.6	51.9	52.3
5A	19.2	19.1	57.1	56.9
5B	18.7	19.0	55.6	56.6
5C	17.4	17.6	49.7	52.3
6A	21.1	20.6	62.8	61.2
6B	19.5	19.5	57.9	57.9
7	22.3	21.5	66.2	63.7
8	25.2	23.8	71.1	70.7

AEDG Zero Energy K-12 Schools Guide: https://www.ashrae.org/technical-resources/aedgs/zero-energy-aedg-free-download

Energy Use Intensity (EUI) Range of Performance in Schools



nbi new buildings institute

Commercial Building Energy Use Consumption Survey (CBECS), EIA 2003 and 2012
California End Use Study (CEUS), CA 2006

© New Buildings Institute 2019

Using Energy Targets in Policies and Practices

SFUSD PROJECT REQUIREMENTS

ZERO NET ENERGY

All buildings will use less than 20 kBTU/sf/yr by 2040

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.

nbi new buildings institute

© New Buildings Institute 2019

Mention ZNE Goal and EUI Targets in Request for Proposals & Qualifications

- Define desired team
  - Engage team from design through operations
  - Energy modeler to inform the design
  - Building commissioner
  - Controls integration
- Incorporate energy targets into RFP/RFQ

D.C. DEPARTMENT OF GENERAL SERVICES

REQUEST FOR PROPOSALS
DCAM-18-AE-0125

ARCHITECTURAL/ENGINEERING SERVICES
WEST ELEMENTARY SCHOOL

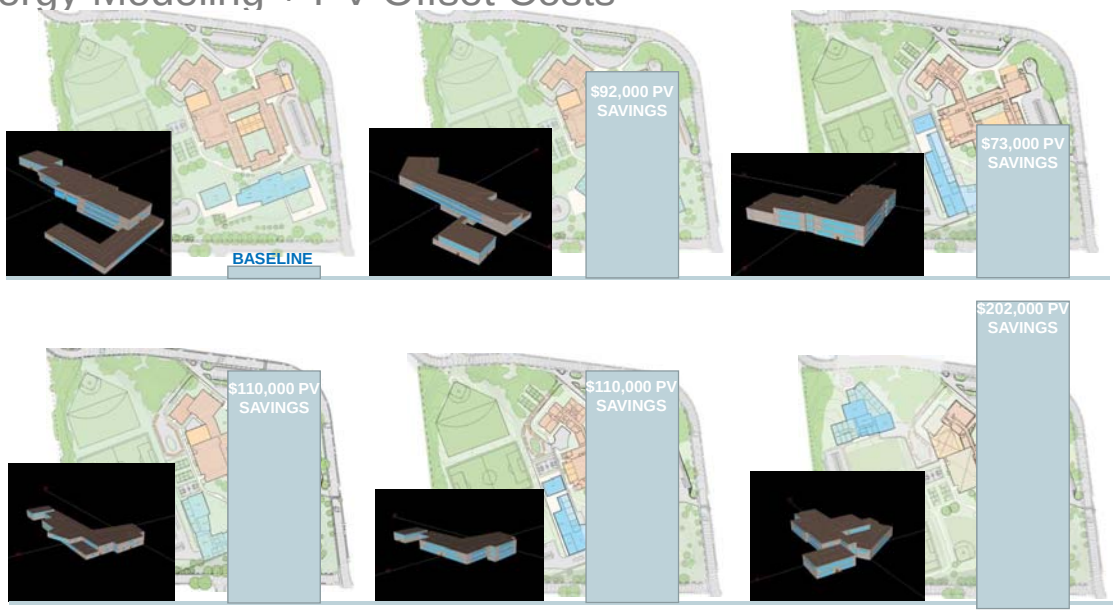
September 12, 2018

The A/E firm shall consider all DGS FM Building Standards, such as Sustainability/High Performance Best Practices, Building Automation Systems (BAS), Smart Roof Design Guide, and NREL Net Zero Guidelines. The Project shall be designed in such a way so as to achieve, at a minimum, LEED for Schools – Gold certification and must meet the requirements of the recently adopted International Green Construction Code and DOEE storm water management requirements. As part of the LEED certification, we will require the innovation LEED Pilot Credit – Integrative Process for Health Promotion (https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-healthc-106), the Green Roof Credit Program addressed, and Energy Star Certification. In addition, the District is particularly interested in West Elementary becoming a Net Zero energy building and require the A/E firm to explore net zero strategies in the building's design. The A/E firm shall apply for and achieve Energy Start Certification and file the DOEE Green Roof grant application.

The A/E firm shall use BIM, or similar type software (recognized in the industry), to develop and coordinate the Design Documents.

nbi new buildings institute

Energy Modeling + PV Offset Costs



nbi new buildings institute

Discovery Elementary SITE AND MASSING OPTIONS
Courtesy of VMDO Architects

Common Technologies for ZNE

- Passive measures
- Envelope and air tightness
- Space conditioning, separate from ventilation
- Plug load management
- On-site renewable energy generation, electric vehicle/bus charging and storage

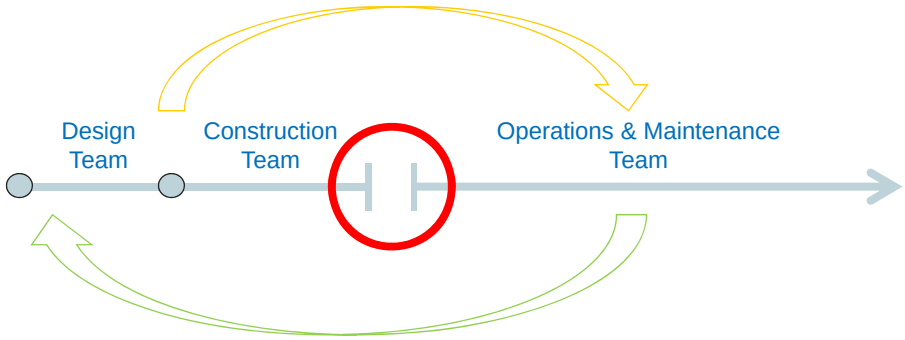
Redding School for the Arts, Redding, CA
Photo Courtesy: TRILOGY Architecture

nbi new buildings institute

© New Buildings Institute 2019

Hand Off from Design to Operations is Critical!

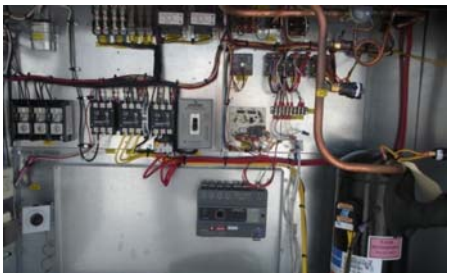
Integrating operations team into the design process



© New Buildings Institute 2019

Continue Design to Operations

- Develop O&M manual and program
- Train building operators and occupants
- Meter and monitor energy performance
- Coordinate with commissioning agent
- Building automation system review
- Compare to predictions
- Report on progress toward goals



nbi new buildings institute

© New Buildings Institute 2019

Engage Occupants and Operations

- Engage operations and occupants on design and O&M strategies
  - Share anticipated ZNE performance
  - Provide real time energy use feedback
- Integrate ZNE into facilities job descriptions
- Provide visual display and feedback for users
- Education program for teachers, staff and students
- Form a green team (students and staff)

Kathleen Grimm School, PS 62, New York, NY
Credit: James Ewing

nbi new buildings institute

© New Buildings Institute 2019

Verify Performance

Discovery Elementary School | Arlington, VA
Photo Courtesy of VMDO Architects

Status Update of IOU Pilot

71

- **Training:** We have teamed up with the New Buildings Institute to deliver many training sessions statewide, both technical and institutional, with more to come
- **School Projects**: About 12 ZNE retrofit projects are underway throughout the state; these will complete mainly in 2018, some in 2019
- **Energy Performance Targets:** We find that a site energy target of about 20 kBtu/square foot/year is commonly feasible for many schools; savings in the range of 30-40% is a typical savings range
- **Common Measures**: We find many similarities in the measures identified for implementation across many schools
- **Bulk Procurement Opportunity**: There appear to be opportunities for statewide or regional "bulk procurement" of common measures (tubular skylights, heat pumps)

Commonly Identified Features and Measures

72

Successful districts have a strong project champion—sometimes inside the district, sometimes a consultant to the district

Daylighting features are commonly present but "defeated" in many older schools; usually uncontrolled glare is the reason for the "defeat"

All schools within the program have refreshed daylighting measures in the ZNE retrofit plan

- Replacement or refurbishment of skylights and clerestories and accompanying light shelfs and shades
- Addition of "tubular" skylights
- Addition of daylighting controls (to turn off lights when daylight is adequate)

Replacement of noisy, inefficient "Bard" heat pumps is commonly recommended

Envelope sealing and caulking is commonly recommended

Whole building control systems are commonly recommended

AT A GLANCE

Dense/Urban

7th Largest

55K Students

Diverse

Low-Income

SFUSD

Voters

Private

GETTING TO zero FORUM

2019 PROGRAM SPONSORSHIP VENUE

THERE IS NO PLANET B

March 21, 2019

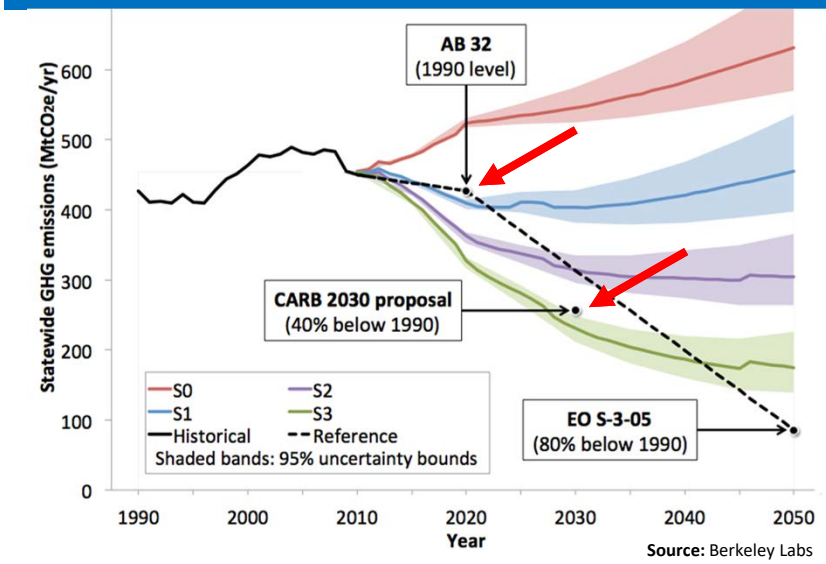
STUDENTS WHO STAND FOR CLIMATE ACTION CAN MAKE IMMEDIATE IMPACT BY WORKING FOR BETTER ENERGY PERFORMANCE AND LOW-CARBON OUTCOMES IN THEIR OWN SCHOOL BUILDINGS.

On March 15, an estimated 1.4 million young people from 123 countries did not go to school, but rather rallied to demand stronger climate action to protect the environment for their future. The students are supported by hundreds of scientists, who signed an open letter, saying their "goal and the need for immediate action is consistent with the most current scientific assessment of the challenge that climate change poses today. The world, including the U.S., is presently on an emissions trajectory that could see the planet warm by well over 3°C within most of their lifetimes. It is still possible to avert this future; but this can only be achieved by reversing our current trend of increasing emissions and decarbonizing the global economy at the pace and urgency of a moon race."

Ironically, the school buildings where these students spend their days offer one of the best opportunities for cutting carbon emissions from the built environment. Buildings account for 39% of carbon globally and leading districts are working now to achieve zero energy (ZE) and even zero carbon performance in their schools. ZE buildings use only as much energy as can be generated by clean, renewable resources, and ZE schools represent the largest segment in this market, showing a

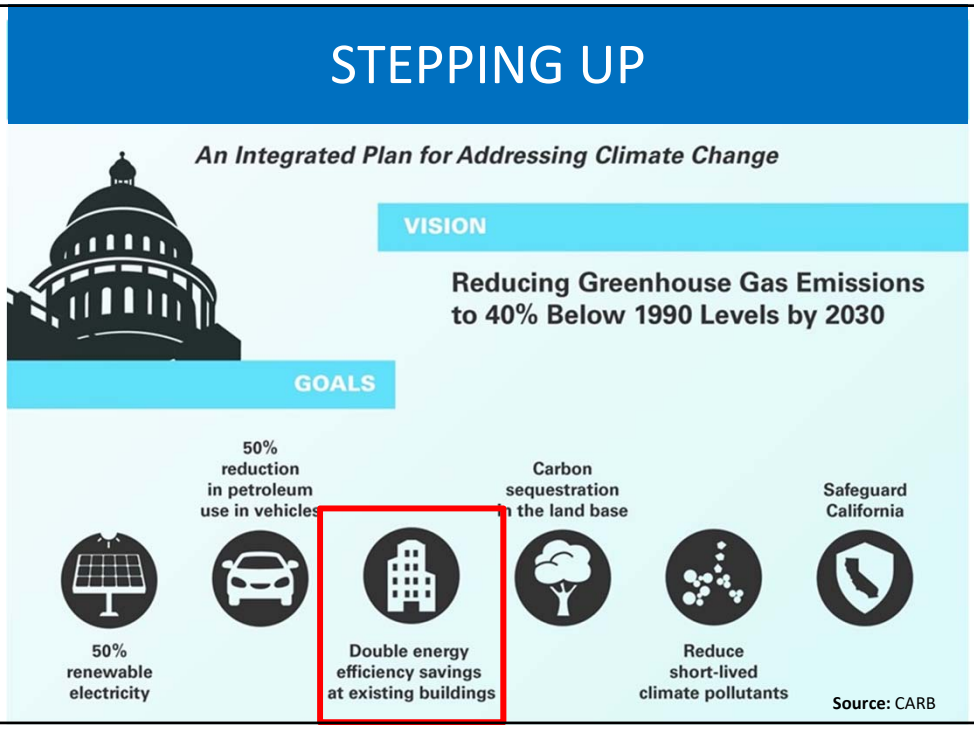
BOLD LEADERSHIP

BOLD GOALS



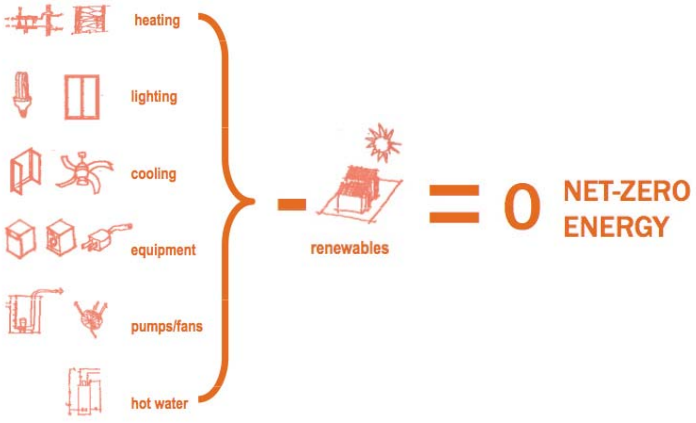
Source: Berkeley Labs

STEPPING UP



Source: CARB

ZERO NET ENERGY



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

2

THEIR SCHOOL

Source: SOM

OUR SCHOOLS

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

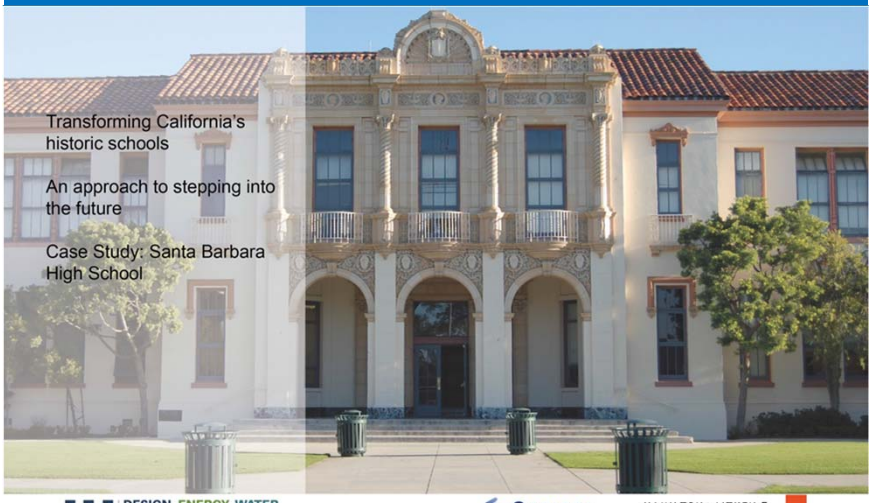
IBEW ZNE Center, San Leandro, renovation

Source: CPUC

2

Oh, SH%T!

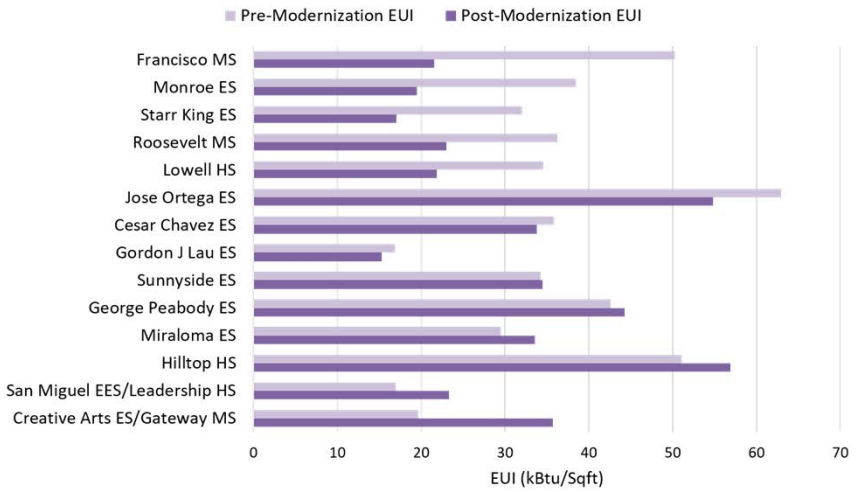
7 x 7 x 7 CHALLENGE



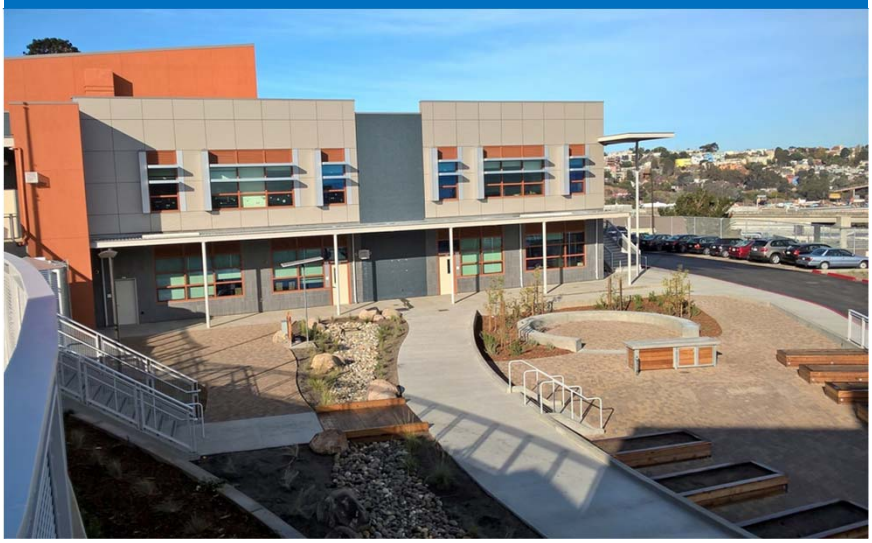
7x7x7 DESIGN ENERGY WATER 7 ARCHITECTS 7 SCHOOLS 7 INNOVATIONS
CAPITAL
HAMILTON+AITKEN Architects

HOW WAS SFUSD DOING?

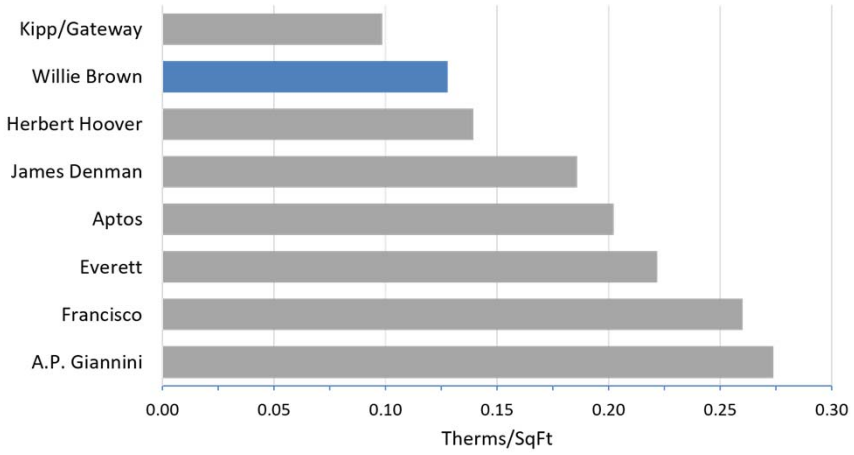
THERE'S HOPE



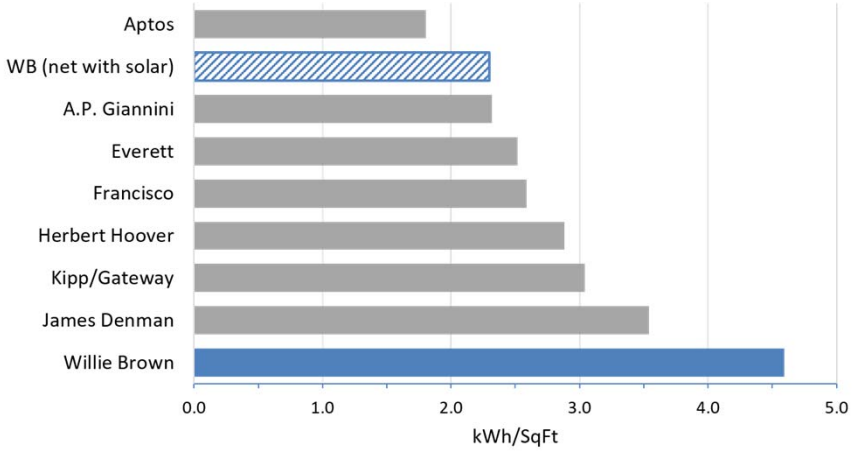
WHAT ABOUT NEW SCHOOLS?



PRETTY EFFICIENT…



…OR NOT!



BEATING CODE IS NOT ENOUGH

WORKING GROUP

Source: Yards Expert

KICK-OFF

Source: WRNS Architects

ROLE MODELS

Source: BVSD

SITE VISITS

Source: ZNE Training Center

SITE VISITS

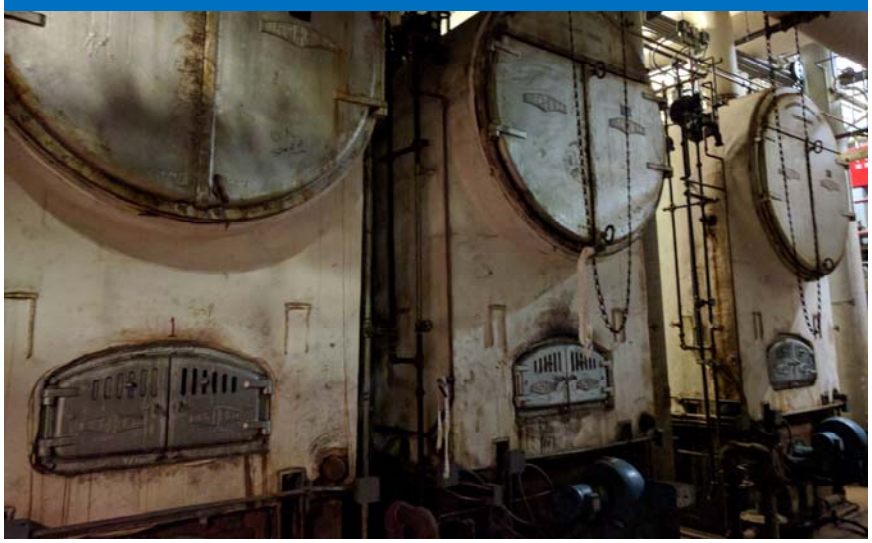
EUI GOAL

Table 29. Energy Intensity Values for Zero Energy Schools

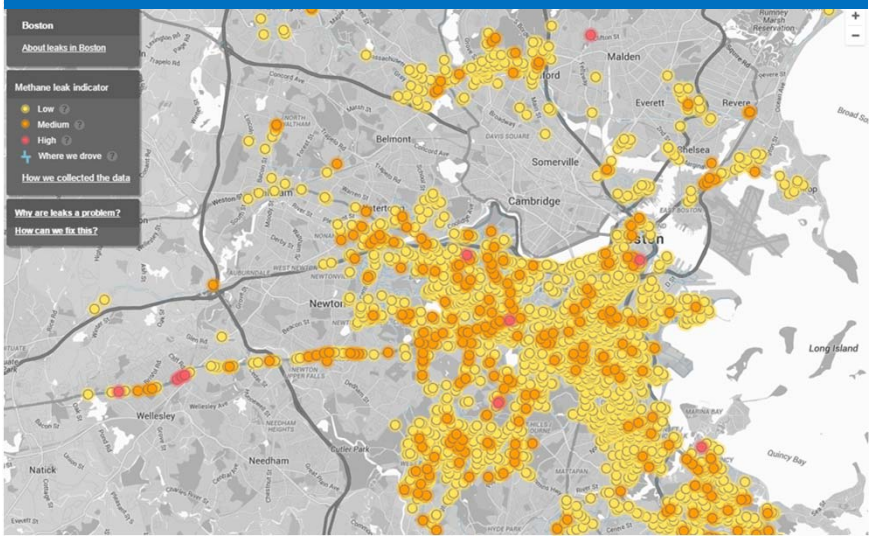
Climate Zone	Representative City	Primary School		Secondary School	
		Site Energy (kBtu/ft²·yr)	Source Energy (kBtu/ft²·yr)	Site Energy (kBtu/ft²·yr)	Source Energy (kBtu/ft²·yr)
1A	Miami, FL	25.9	76.4	23.1	68.5
2A	Houston, TX	24.3	71.1	21.7	63.5
2B	Phoenix, AZ	24.7	72.5	21.9	64.3
3A	Memphis, TN	23.8	69.0	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	[illegible]	67.6	[illegible]	60.1
4B	Albuquerque, NM	[illegible]	66.6	[illegible]	58.8
4C	Salem, OR	[illegible]	64.2	[illegible]	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

TECHNOLOGY

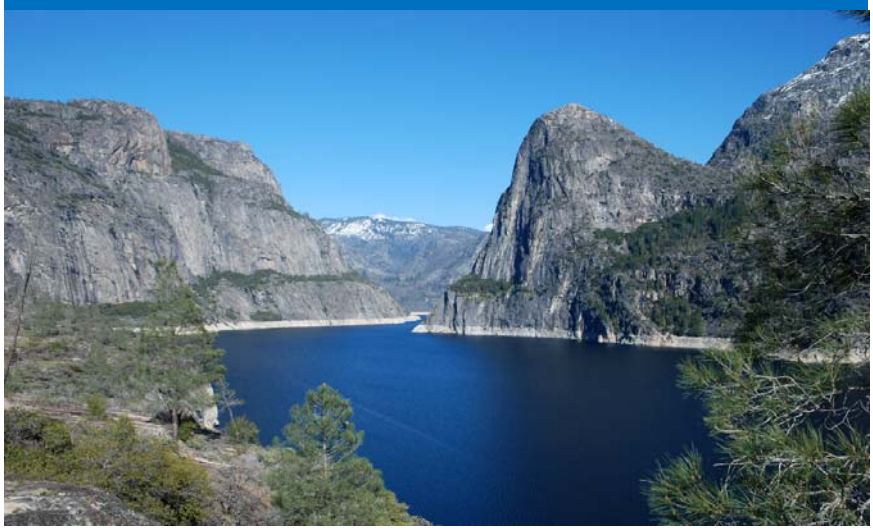


TRANSITION FUEL?



Source: Environmental Defense Fund

UTILITY PERKS



Source: SF Public Utilities Commission

THE ONLY WAY

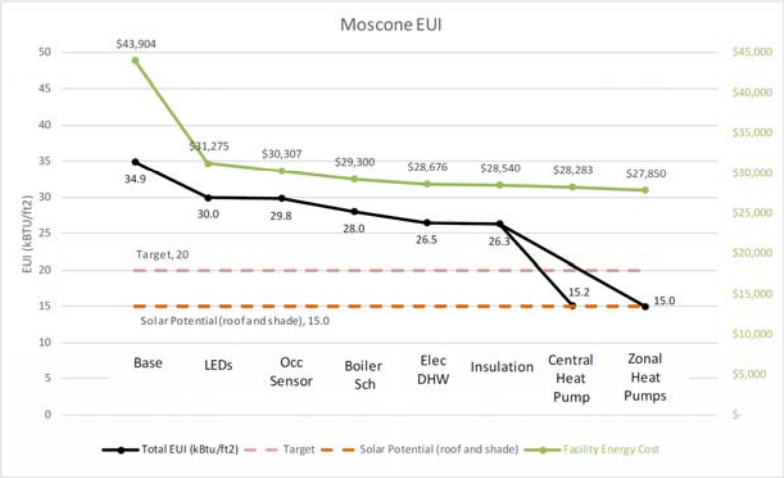
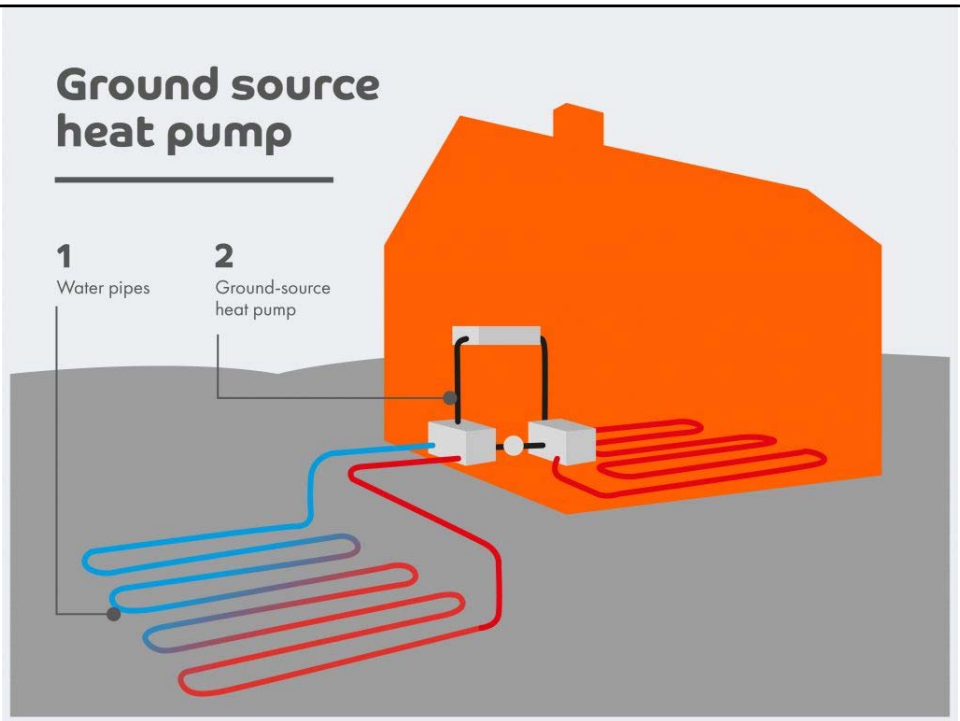


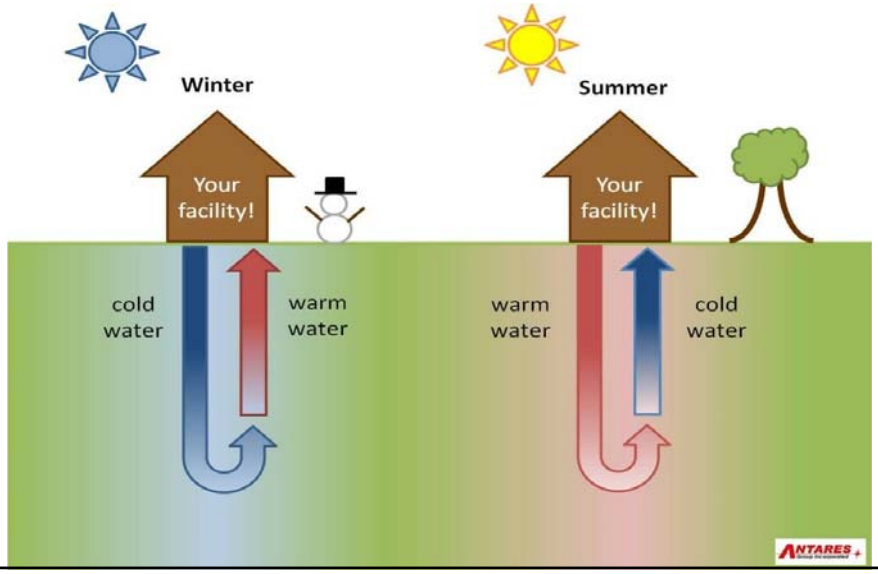
Figure 5.1: EUI and Total Energy Cost for Moscone ES

HEAT PUMPS

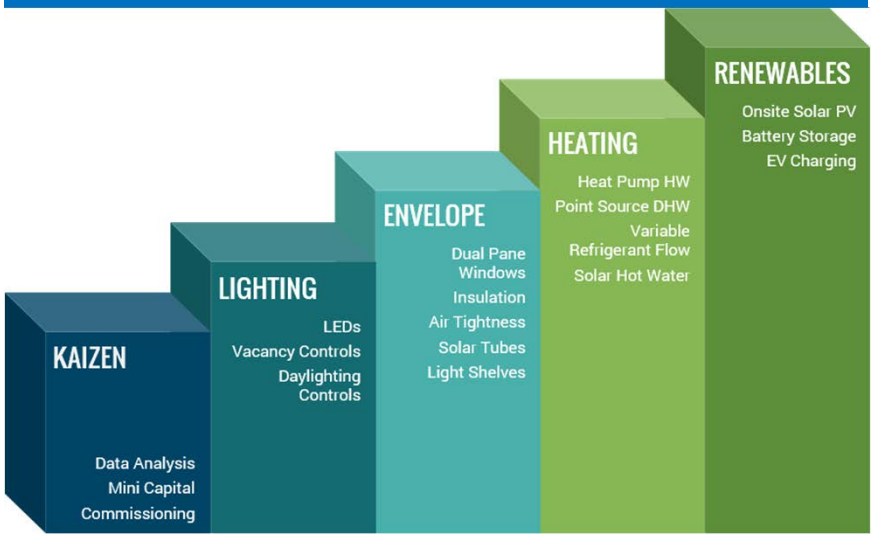
Source: Sanyo



AS EFFICIENT AS IT GETS



LABOR ISSUES

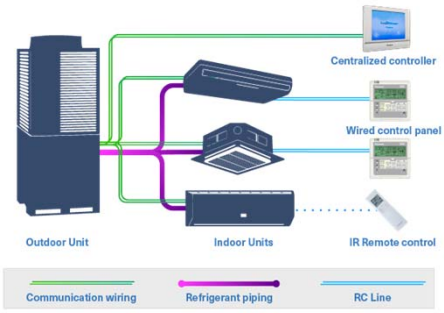


HOW TO PAY FOR IT ALL

- ➔ Bonds
- ➔ Deferred Maintenance
- ➔ Developer Fees
- ➔ Prop 39
- ➔ Utility Company
- ➔ ECAA Loans
- ➔ PPAs

Source: UC Berkeley

MINIMIZE THE DELTA



CONSTANT BATTLE

BUILDING STRATEGY

NEW SCHOOLS

→ ZNE Ready

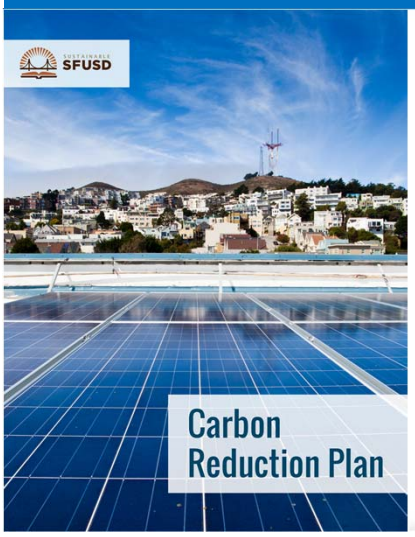
MODERNIZATION

→ System Replacements

RENEWABLES

→ In Due Time

THE POLICY



NEWS FIX

San Francisco Schools Aim for a Zero Carbon Footprint by 2040

KICK BACK, RIGHT?

EXECUTION IS EVERYTHING

Source: Pinterest

THE FRAMEWORK

SFUSD
PROJECT
REQUIREMENTS

July 1, 2017

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 Diviadero 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 OLD

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 modelling 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	✓		✓			
Window replacements		✓	✓			
Insulation	✓		✓			
LED lighting	✓		✓			
Solar tubes/skylights		✓		✓		
Light shelves/shading		✓	✓	✓		
EMS upgrades	✓		✓			
Building dashboard	✓			✓		
Fuel switch/transformer		✓	✓	✓	✓	✓
Heating optimization	✓		✓	✓	✓	✓
Solar readiness		✓	✓	✓		✓
Piping	✓		✓			
DHW reconfiguration		✓	✓	✓	✓	
Water fixture upgrades	✓		✓			
Shut-off valves	✓		✓			
RWH pre-plumbing		✓		✓		
Irrigation		✓		✓		
Turf replacement		✓		✓		✓
Stormwater control		✓	✓	✓		
Bottle fillers	✓		✓			
Washing machines	✓		✓			
Hand dryers	✓		✓			
Trash sorting		✓	✓			
Walking & biking infrastructure	✓			✓		

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.

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

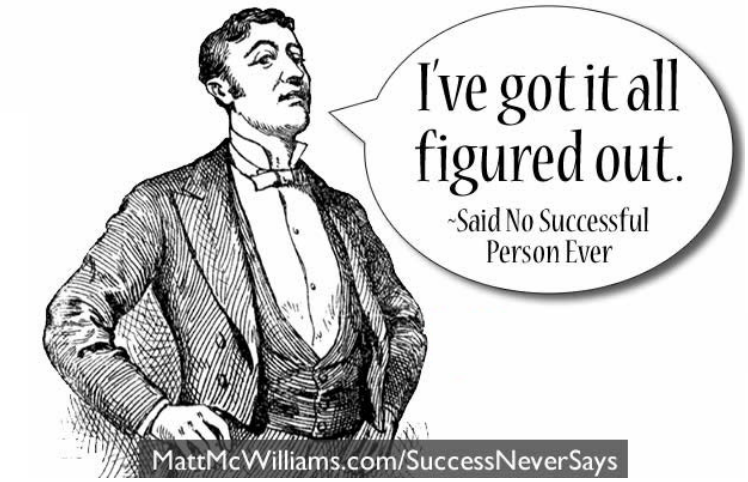
SAN FRANCISCO UNIFIED SCHOOL DISTRICT

DISTRICT DESIGN STANDARDS + GUIDELINES

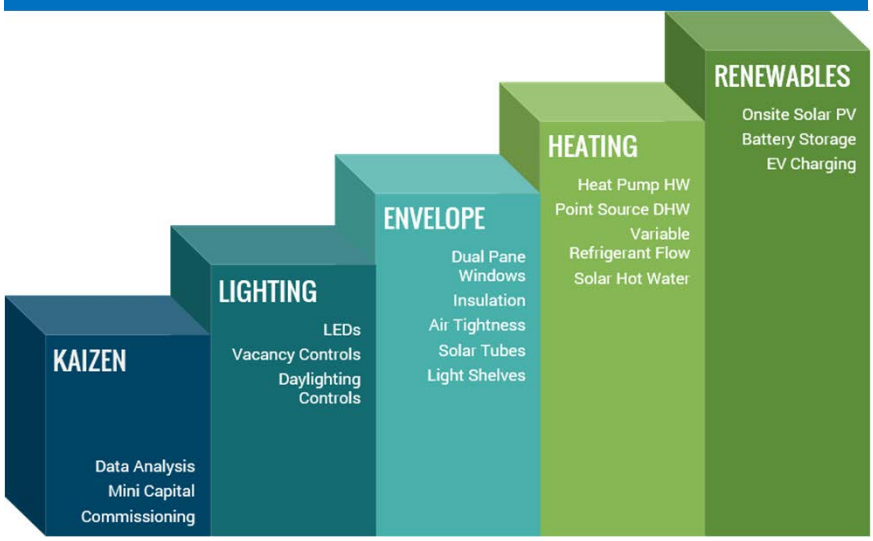
2016 PROPOSITION A BOND PROGRAM

SFUSD FACILITIES DESIGN + CONSTRUCTION

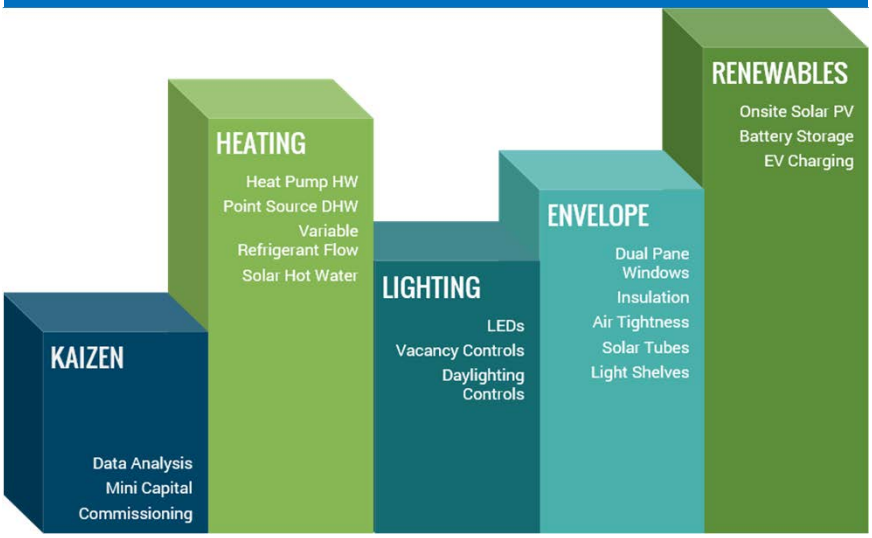
COMMISSIONING



ZNE STAIRCASE



ZNE ADVENTURE



NEW BUILDINGS

ZNC RETROFITS

PURE JOY

Source: NY Times

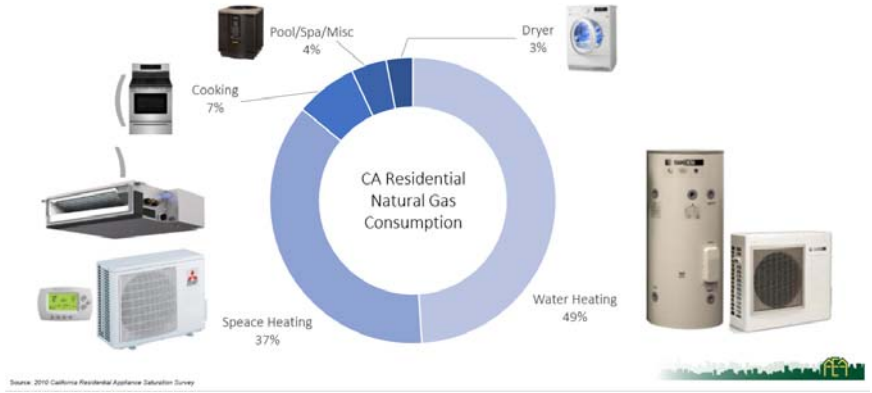
IT'S ON!

Source: NY Times

LESSONS LEARNED

HEAT PUMPS ARE COMING

"Electric equipment isn't available"



TAKE IT SLOW

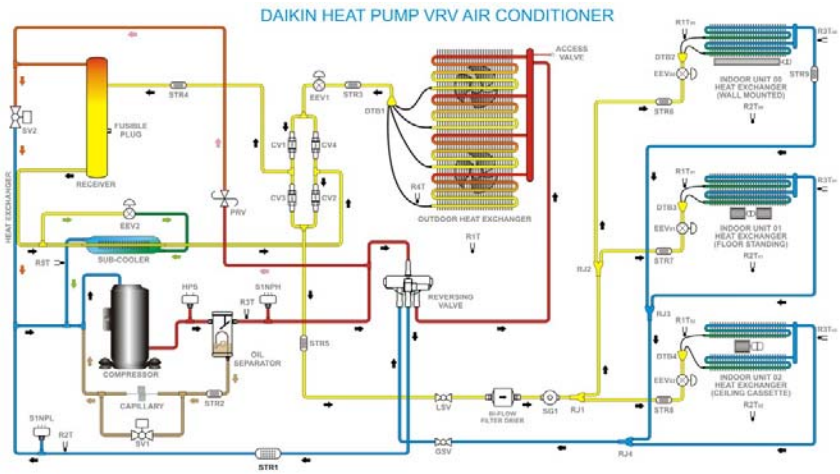
HEATING OPTIONS

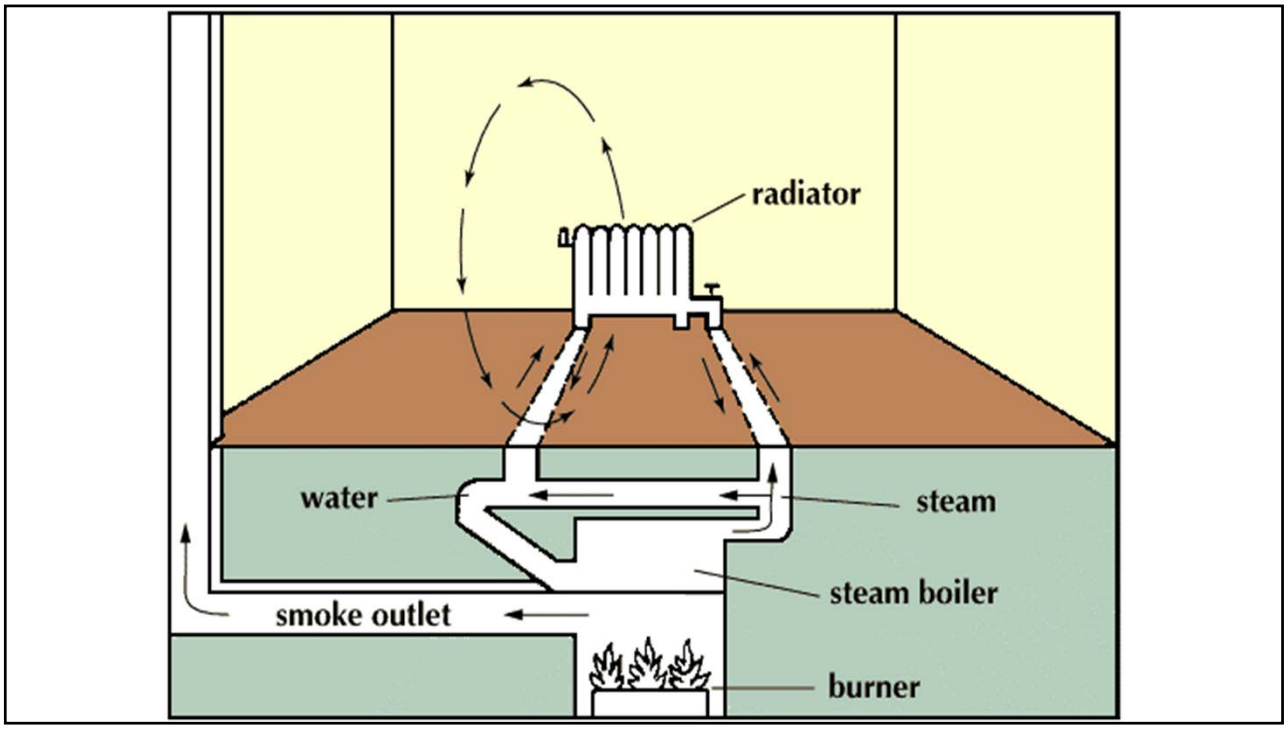
1. Pilot @ few sites
2. Choose passive strategies
3. Stick with working systems

→ There's always next time!

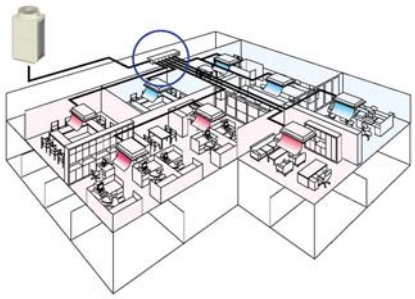
Figure 2: Original boilers natural gas-fired heating hot water boilers

HEAT PUMPS ARE COMPLEX





CHOOSE WISELY



HEAT PUMPS

1. Three types
2. Multiple brands
3. Interface w/EMS

→ Choose wisely!

HEAT PUMPS ARE NEW

TRAINING IS KEY

PLAN FOR THE FUTURE

DREADED UPGRADE

1. Panels
2. Switchgear
3. Transformer
4. Service

→ Rightsize for VRF

IS THIS YOUR SCHOOL?

COOKING IS EASY

KITCHEN EQUIPMENT

1. Fry & grill ☹
2. Combi/induction ☺
3. Up-front costs!

→ Chef training

SOME THINGS TAKE TIME

ELECTRIC DHW

1. Split maintenance
2. Recovery rate
3. Replacement costs

→ Only @ fuel switch

LOOK AHEAD

SPEAKING OF DHW

vs.

THE ART OF COMPROMISE

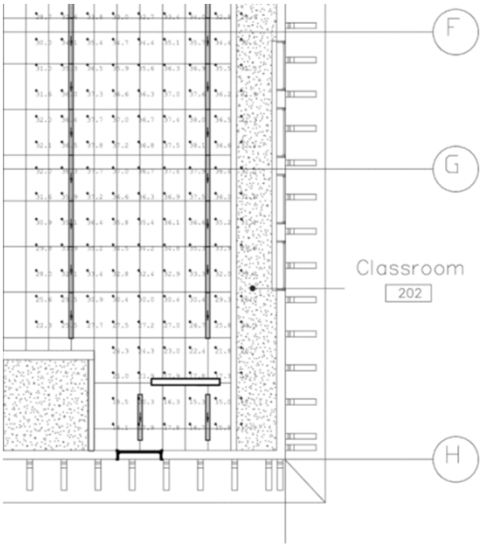
+

SAVE MONEY

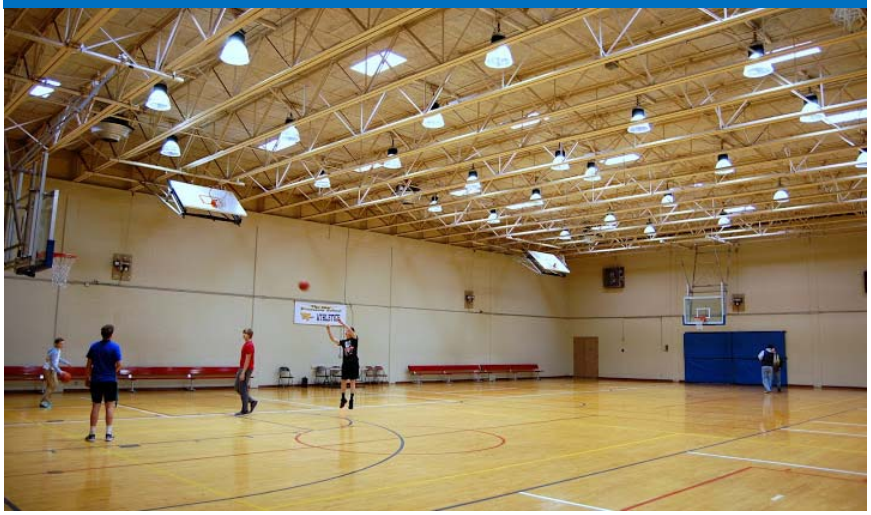
LIGHTING

1. Review photometrics
2. Illumination: 30-40 fc

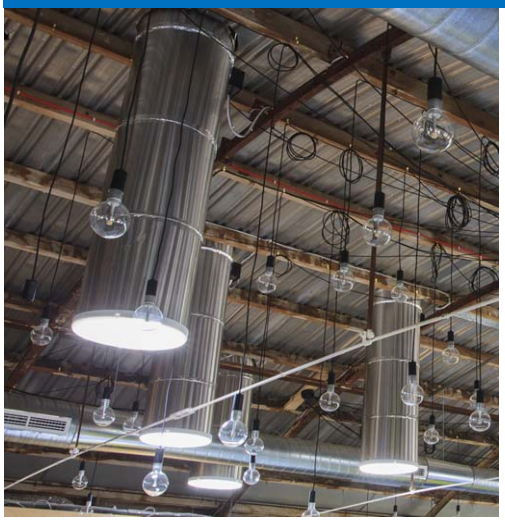
→ Avoid daylight controls!



OR NOT?



BE SMART



SUN TUBES

~~1. Corridors~~

~~2. Bathrooms~~

3. Interior offices

→ Space for PV

AVOID OVERKILL

SOLAR READINESS

~~1. Stanchions~~

~~2. Conduit~~

3. Hose bibbs

→ Leave for installer

LEARN FROM OTHERS

BUILDING DASHBOARD

1. Monitor
2. Bracket/blocking
3. Data/power

~~4. Touchscreen~~

KEY TAKEAWAYS

Create a framework

- involve stakeholders

- set energy targets

- consider utility rates

Share it with design teams

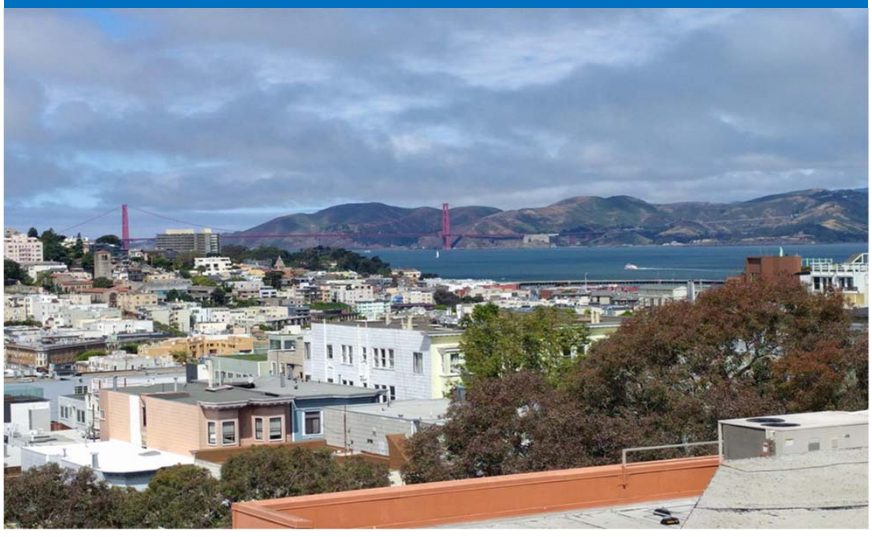
Check their work

Be ambitious & pragmatic

Be persistent but flexible

Source: FCPA

QUESTIONS?



Resources for Getting to Zero

Discovery Elementary School, Arlington, VA

nbi new buildings institute

Getting to Zero Resources HUB

STATE POLICIES & PROGRAMS | SCHOOL & DISTRICT LEADERSHIP | RESEARCH & TOOLS

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

nbi new buildings institute

© New Buildings Institute 2019

ZNE Case Studies

https://gettingtozeroforum.org/schools/

ULTRA-LOW ENERGY

BUILDING TYPE: K-12 SCHOOL

TURKEY FOOT MIDDLE SCHOOL

EDGEWOOD, KY

VIEW CASE STUDY

ZERO ENERGY

BUILDING TYPE: K-12 SCHOOL

HOOD RIVER MIDDLE SCHOOL MUSIC & SCIENCE BUILDING

HOOD RIVER, OR

VIEW CASE STUDY

COMMERCIAL

BUILDING TYPE: K-12 SCHOOL

GARDEN GROVE UNIFIED SCHOOL DISTRICT

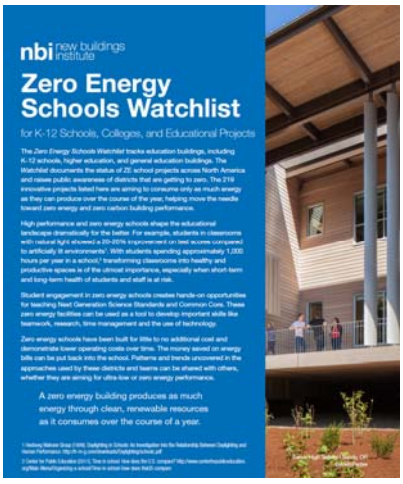
GARDEN GROVE, CA

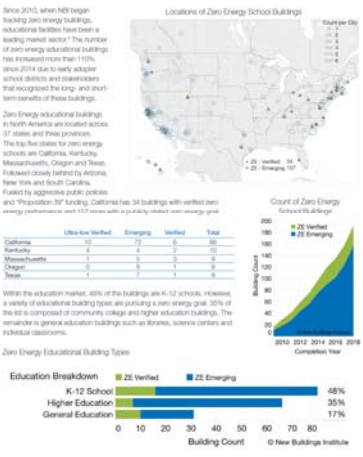
VIEW CASE STUDY

nbi new buildings institute

© New Buildings Institute 2019

2019 Schools Zero Energy Watch List



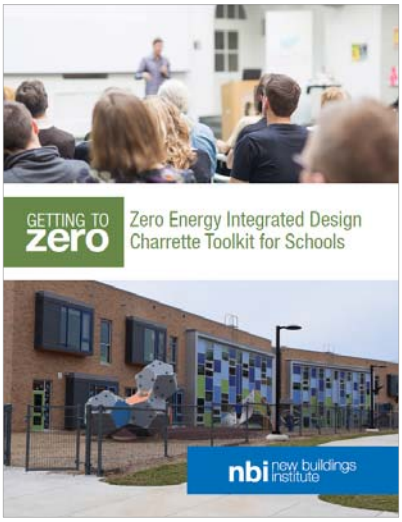


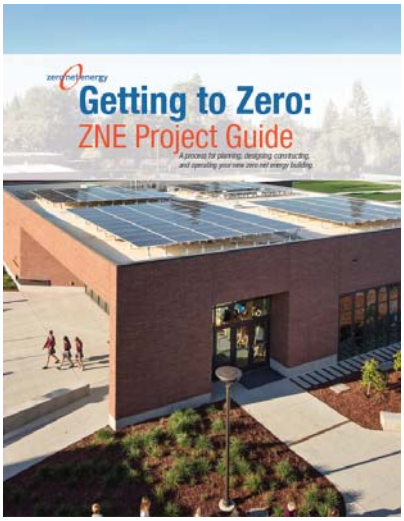
newbuildings.org/resource/2019-zero-energy-schools-watchlist/

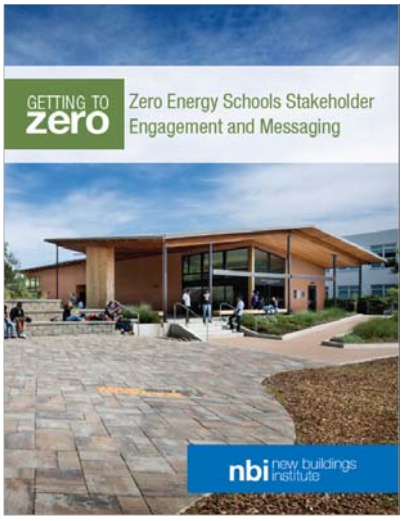
nbi new buildings institute

© New Buildings Institute 2019

NBI's Tools for Zero Energy Schools







nbi new buildings institute

© New Buildings Institute 2019

Seattle Public Schools Path to ZNE Resources

- The Green Resolution: https://www.seattleschools.org/UserFiles/Servers/Server_543/File/District/Departments/ResourceConservation/20130501_GreenResolution.pdf
- Climate Resolution: https://www.seattleschools.org/UserFiles/Servers/Server_543/File/District/Departments/ResourceConservation/climateresolution.pdf
- Policies and Procedures for Natural Resource Conservation: https://www.seattleschools.org/UserFiles/Servers/Server_543/File/District/Departments/School%20Board/Procedures/Series%206000/6810SP.pdf

nbi new buildings institute

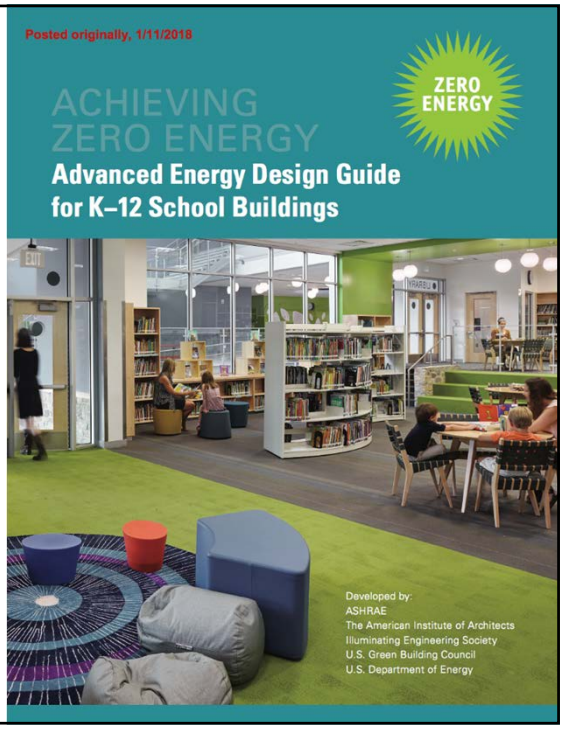
© New Buildings Institute 2019

Advanced Energy Design Guide (AEDG) for Zero Energy Schools

By ASHRAE

Free download available at:

https://www.ashrae.org/technical-resources/aedgs/zero-energy-aedg-free-download



nbi new buildings institute

Additional 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
- 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
- Collaborative for High Performance Schools: https://chps.net/chps-criteria
- 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

nbi new buildings institute

© New Buildings Institute 2019

Amy Cortese
Program Director
amy@newbuildings.org

Reilly Loveland
Project Manager
reilly@newbuildings.org

nbi new buildings institute

Redding School of the Arts, Redding, CA