Proposition 39 ZNE School Retrofit Pilot Workshop

Delivering the Winning Pitch: Making the Business Case for ZNE Schools

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East Bay AIA
June 26, 2018
Prop 39 ZNE School Retrofit Pilot Program Workshops

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Learning Objectives

1. Participants understand the fundamental principles and planning processes of getting to ZNE in the built environment.

2. Participants are given the opportunity to build on the real-world experiences of school districts in their efforts to engage stakeholders in their community.

3. Participants can describe best practices and key components of ZNE building success based upon real-world experiences of school districts that are pursuing and achieving zero net energy schools.

4. Participants have access to ZNE school experts and the opportunity to collaborate with other district staff as they brainstorm how to implement and support ZNE policies and programs.
Agenda

9:00 a.m. – 9:15 a.m.  Welcome: Workshop Goals & Expectations

9:15 a.m. – 9:30 a.m.  Introduction: Zero Net Energy & Prop 39

9:30 a.m. – 10:20 a.m.  The Winning Pitch: K-12 School Strategy

Nate Kinsey, Energy Manager, San Francisco Unified School District &
Alan Glass, Energy Supervisor, Pittsburg Unified School District

10:20 a.m. – 10:35 a.m.  Break

10:35 a.m. – 11:00 a.m.  The Winning Pitch: Community College Strategy

Joe Fullerton, Facilities, Planning and Operations, San Mateo Community College District

11:00 a.m. – 11:50 a.m.  Activity: Developing Your Pitch to ZNE

11:50 a.m. – 12:00 p.m.  Closing Discussion & Resources
School District Presenters

**Joe Fullerton**  
San Mateo Community College District  
Facilities Planning and Operations

**Nate Kinsey**  
San Francisco Unified School District  
Energy Manager

**Alan Glass**  
Pittsburg Unified School District  
Special Projects Accountant/ Energy Supervisor
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 energy leadership and market development*
What is a Zero Net Energy Building?

**ZNE Source Definition:**
A building that produces at least as much energy as it uses in a year when grid-supplied energy (including primary energy for generation, transmission and delivery to the site) is taken into account.
Code Cycles to Net Zero in California

Source: SCE & AEC, 2009
Code Cycles to Net Zero in California

Impacts of Building Standards on Home Energy Use

Source: CEC 2016
Why Zero Net Energy Schools?

- The next evolution in sustainable, high performance buildings
- Cost avoidance 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
2018 List of ZNE Buildings

700% growth since 2012 with nearly 500 projects
Schools are Leading in ZNE

Building Type Breakdown

- Education: 37%
- Office: 19%
- Multifamily: 16%
- Other: 14%
- Public Assembly: 8%
- Mercantile: 2%
- Public Order and Safety: 2%
- Warehouse and Storage: 1%

Education Breakdown

- K-12 School: 50%
- Higher Education: 35%
- General Education: 15%

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ZNE and Ultra-Low Energy in Education

- K-12 Schools
- Community Colleges
- Higher Education
- Libraries
- Science Centers
Path to Zero Net Energy Schools:

While ZNE is a realistic end game, the path to sustainable, zero net energy schools is a process that will take time to accomplish.

School districts can start now with benchmarking, energy targets, policies, plans and practices on the path to zero.
Prop 39 ZNE Pilot Program

Overview

June 26, 2018

Anna LaRue
presenting on behalf of Peter Turnbull
Core Idea: Create an “adjunct” pilot to Prop 39 focused on ZNE

- **Demonstrate the technical feasibility of ZNE retrofits** in public K-14 schools statewide
  - Implement 12-14 total ZNE retrofit projects statewide
  - Use expert technical consultants to develop projects
  - Choose geographically, demographically diverse schools to work with

- **Provide training, recognition and communication**: Disseminate lessons learned regarding the technical design process and the implementation process broadly throughout the state
  - Technical and Institutional Training
  - Recognition Events
  - Publications
Method to Demonstrate Technical Feasibility of ZNE Retrofits

1. Set a consumption target
   • Conduct “no stone left unturned” energy analysis of the building; develop fully calibrated energy model of the building
   • Set an energy consumption target based on the model a kBtu/square foot/year consumption target to get to zero (pre-renewables)

2. Design to the energy consumption target (no “de”-value engineering)
   • Establish measure package lists (usually with multiple options)
   • Provide incremental cost buy-down to implement the measures (Utilities supplement state Prop 39 funds)

3. Build out and implement the measures at the school

4. Provide end use monitoring, post-construction, for validation, diagnosis and correction
Status Update of IOU Pilot

- **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

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 shelves 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.
Process to Achieve Zero Net Energy
Steps to Success in Sustainable Design

- Get Stakeholder Support
- Make a Commitment
- Use an Integrated Design Process
- Set Energy Targets
- Design and Construct To The Target
- Optimize Operations
- Measure and Verify

Discovery Elementary School | Arlington, VA
Photo Courtesy of VMDO Architects
Gain Support for the Path to Zero

• Stakeholder mapping:
  • Who are the stakeholders?
  • What are their drivers?
  • What are the key messages?

• Share case studies & fact sheets

• Tour nearby schools or share video case studies with decision makers
  • Patriot Hall - https://energytrust.org/pathtonetzero/
  • Discovery Elementary School - https://www.zeroenergy.org/video-case-study/
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 environments².

• Students with operable windows progressed 7-8% faster than those without operable windows².

• Students with the most daylighting performed 7-18% better in math and reading than those without².

• Students exposed to daylight attended school 3.2 to 3.810 more days per year³.

Six Key Messages for Communicating Zero Net Energy

1. **ZERO NET ENERGY**: Zero net energy (ZNE) schools are low energy buildings coupled with renewables that provide a ready generation resource.

2. **LOWER OPERATING COSTS**: Schools built to ZNE performance avoid utility costs that can be spent on educating students or further improving facilities.

3. **INCREASED STUDENT PERFORMANCE**: Occupants of ZNE schools benefit from heightened student performance, increased attendance, better occupant health and improved teacher satisfaction and retention.
Six Key Messages for Communicating Zero Net Energy

4. **EDUCATIONAL BENEFITS:** ZNE schools are living laboratories, stimulating learning and innovation.

5. **RESILIENCY:** ZNE 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.

6. **GETTING TO ZERO:** While ZNE 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.
Make a Commitment

• Start early!
• Benchmark
• Establish goals
• Attend webinars and trainings
• Visit an ultra-low or zero net energy building
• Identify sources to support efforts
Financing and Incentives

Zero net energy projects do not need to cost more, but they can…

Funding Opportunities:
• Solar Tax Credit
• Energy Efficiency Incentive Programs
• Bond funding
• Power Purchase Agreements
Establish the EUI Target

• Set absolute energy targets instead of simply “% better than code”
• Couple with other sustainability goals and policies (CHPS, LEED, etc.)
• Consider existing facility benchmarking results
• Determine solar capacity on roof and/or campus
Energy Use Intensity (EUI)
Range of Performance in Schools

- ZE - Verified
  - Median = 18

- ZE - Emerging
  - Median = 27

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## Zero Net Energy Targets

### Table 29. Energy Intensity Values for Zero Energy Schools

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Representative City</th>
<th>Primary School</th>
<th>Secondary School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Site Energy (kBtu/ft²·yr)</td>
<td>Source Energy (kBtu/ft²·yr)</td>
</tr>
<tr>
<td>1A</td>
<td>Miami, FL</td>
<td>25.9</td>
<td>76.4</td>
</tr>
<tr>
<td>2A</td>
<td>Houston, TX</td>
<td>24.3</td>
<td>71.1</td>
</tr>
<tr>
<td>2B</td>
<td>Phoenix, AZ</td>
<td>24.7</td>
<td>72.5</td>
</tr>
<tr>
<td>3A</td>
<td>Memphis, TN</td>
<td>23.8</td>
<td>69.0</td>
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<tr>
<td>3B</td>
<td>El Paso, TX</td>
<td>23.4</td>
<td>67.8</td>
</tr>
<tr>
<td>3C</td>
<td>San Francisco, CA</td>
<td>21.6</td>
<td>61.9</td>
</tr>
<tr>
<td>4A</td>
<td>Baltimore, MD</td>
<td>23.5</td>
<td>67.6</td>
</tr>
<tr>
<td>4B</td>
<td>Albuquerque, NM</td>
<td>23.1</td>
<td>66.6</td>
</tr>
<tr>
<td>4C</td>
<td>Salem, OR</td>
<td>22.4</td>
<td>64.2</td>
</tr>
<tr>
<td>5A</td>
<td>Chicago, IL</td>
<td>24.3</td>
<td>69.9</td>
</tr>
<tr>
<td>5B</td>
<td>Boise, ID</td>
<td>23.2</td>
<td>66.7</td>
</tr>
<tr>
<td>6A</td>
<td>Burlington, VT</td>
<td>24.5</td>
<td>70.1</td>
</tr>
<tr>
<td>6B</td>
<td>Helena, MT</td>
<td>23.5</td>
<td>66.9</td>
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<td>7</td>
<td>Duluth, MN</td>
<td>25.9</td>
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<td>8</td>
<td>Fairbanks, AL</td>
<td>28.7</td>
<td>82.5</td>
</tr>
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</table>

Integrating Zero Net Energy Into the Process

- Integrate energy targets and solar considerations into RFP, OPR and contract language
- Host integrated design charrette early in design
- Use energy modeling to inform decisions
- Consider controls that allow for centralized management
- Include “net zero” building commissioning
- Keep team involved after substantial completion
Example OPR’s

**STRATEGY**

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

- **BOND PROJECTS**- viable new or major renovation projects offer 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 & MAINTENANCE**- preventative maintenance, energy, and water monitoring, as well as engagement of users, can reduce energy and water usage at buildings age.

- **FACILITIES PROJECTS**- major repair and deferred maintenance projects provide an opportunity to improve energy and water efficiency.

These District’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) of 20 kBTU/sf/yr.
- **Bond Projects** will focus on improvements to the lighting, systems, and building envelope.

- **Facilities Projects** will generally have limited scope and will support ZNE goals by upgrading building elements as they wear out. In each case, the ZNE Workgroup The District Design Standards will inform the design and selection of materials and equipment for each project.

**PROCESS**

**New Buildings**

Ensuring that the District’s energy targets are met in new construction projects requires rigorous design process, strict 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:

- **CHARGE**: The project’s goal, performance, and key recommendations are clearly stated in the base document. Thereafter, project stakeholders will need to understand the District’s vision for the project.

- **ENERGY**: Building form, envelope, orientation, and roof layout together determine system performance. The design of the building must be evaluated against a consistently refined energy model from the earliest stage of the project. Funding agencies and project architects will have the opportunity to improve the design and comply with the District’s energy and water efficiency standards.

- **COMMISSIONING**: The project team will be required to achieve the project’s performance goals. This includes the installation of all systems, and any ongoing commissioning will be required to ensure that the system functions as intended.

**First ZNE Projects**

- **SFUSD is in the process of designing its first new ZNE building at Clare Elementary School on Divisadero St. The building will house the middle school program of this historic school and replace eight existing bungalows. The second ZNE project is a PMSI-supported renovation of Galileo Elementary on Telegraph Hill. The utility is particularly interested in identifying design solutions in the constrained urban environment.**

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Integrated Design Charrette Toolkit for Schools

SAMPLE CHARRETTE

Stakeholder Identification and Engagement

When key stakeholders are involved from the outset, they are more likely to buy into a series of ownership and contribute to the success of the project. Since ZE buildings require optimal operations, buy-in from facility managers and building occupants is crucial to successful success. A sample ZE Charrette Messaging Guide provides insights on how to communicate the importance of the project.

Below is a list of potential key stakeholders to invite to the charrette and a sample email invitation you can customize.

<table>
<thead>
<tr>
<th>School District Stakeholders</th>
<th>Design/Construction Team</th>
<th>Optional Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Board Members</td>
<td>Architect</td>
<td>Consultant Architect</td>
</tr>
</tbody>
</table>
| Superintendent | Electrical Engineer | \*
| Finance/Operations Officer | Mechanical Engineer | \*
| Facilities Director | Plumbing Engineer | \*
| Sustainability Manager | Civil Engineer | \*
| Teachers | Contractor | \*
| Students | Utility Representation | \*
| 

Sample Email Invitation

- **To**: XX Charrette Participants
- **From**: Charrette Facilitator or Owner/Developer Representative
- **Subject**: XX School ZE Planning Charrette
- **Date**: [Suggested date]

I would like to invite you to participate in the Zero energy (ZE) planning Charrette. This is the start of an integrated design process for XX school. The meeting date is scheduled for XX date at XX time.

The purpose of this charrette is to promote a collaborative planning process that incorporates the expertise, ideas, and goals of all interested parties. The charrette is happening at the beginning of the process to fully integrate the design team, school district and other key stakeholders. During the charrette, we will finalize plans for the project, solidify your ideas, and develop an implementation strategy.

Please respond to this email to let us know if you will be able to attend the charrette. We value your participation and insights.

[Insert name],
[Your Name Here]

[Event Title and Contact Information]

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**: [Start Time – [End Time]]
**Address**: Street, City, State Zip
**XX Charrette Number**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Facilitator</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-9:00 am</td>
<td>GATHER AND SETTLE IN</td>
<td>All</td>
</tr>
<tr>
<td>9:00-9:10 am</td>
<td>Welcome and Introductions</td>
<td>All</td>
</tr>
<tr>
<td>9:10-9:15 am</td>
<td>Purpose and Introductions</td>
<td>Facilitator / Owner</td>
</tr>
<tr>
<td>9:15-9:20 am</td>
<td>Agenda and Expectations</td>
<td>Facilitator</td>
</tr>
<tr>
<td>9:20-9:30 am</td>
<td>Overview of Sustainable, ZE Schools</td>
<td>Facilitator</td>
</tr>
<tr>
<td>9:30-9:50 am</td>
<td>Activity: What is Your Vision of a Sustainable, ZE School?</td>
<td>All</td>
</tr>
<tr>
<td>9:50-10:00 am</td>
<td>Project Overview and Goals</td>
<td>Architect</td>
</tr>
<tr>
<td>10:00-10:15 am</td>
<td>Site, Stormwater, and Water Strategies</td>
<td>Civil &amp; Plumbing Engineering</td>
</tr>
<tr>
<td>10:15-11:00 am</td>
<td>BREAK</td>
<td>All</td>
</tr>
<tr>
<td>11:00-11:45 am</td>
<td>Energy Strategies to Achieve ZE</td>
<td>Architect, Mechanical</td>
</tr>
<tr>
<td>11:45-12:30 pm</td>
<td>Strategies to Support Support Indoor Environmental Quality</td>
<td>Architect</td>
</tr>
<tr>
<td>12:30-12:45 pm</td>
<td>Designing &amp; Operating to ZE</td>
<td>Facilitator, All</td>
</tr>
<tr>
<td>12:45-1:45 pm</td>
<td>Review Sustainability &amp; Energy Targets and Identify Action Items</td>
<td>Facilitator, All</td>
</tr>
<tr>
<td>1:45-2:45 pm</td>
<td>Wrap Up and Conclusion</td>
<td>Facilitator</td>
</tr>
</tbody>
</table>

[Insert name],
[Your Name Here]

[Event Title and Contact Information]
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
Common Technologies for ZNE

• Building Orientation, Window to Wall Ratio, and Glazing Location/Optimization
• Highly Efficient Thermal Envelope
• Ventilation Options: 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
Contract to Achieve the Target

Integrating operations team into the design process
Operate to the Target

- **Operator training & guides** (on-going)
- **Monitor & benchmark** energy use
- **Engage occupants**
  - Use your building as an educational tool for 21st Century Skills & STEAM
  - Create awareness of environmental stewardship & the energy supply chain
- **Plug load management**
- **Seek continuous improvement & performance data review**
- **Use** operator, occupant & public feedback
Measure and Verify Performance
Case Studies
Garden Grove School District Retrofit

Location: Garden Grove, CA
Construction Type: Retrofit
Schools: Ralston Intermediate & Santiago High School
Building Size: Ralston: 6,200 SF
Santiago HS: 8,069 SF
Building Completed: 2018
Energy Target: Zero Net Energy
Predicted EUI: 24.7 kBtu/sf/yr

GGUSD is a large, low income school district in California. It ranks among the lowest 20% of districts in terms of household income and top 20% test scores. Their culture of frugality means they have consistently invested in students over facilities.
Garden Grove School District Retrofit

Technologies:

• LED Lighting Upgrade
• Lighting & HVAC Controls
• Tubular skylights and daylighting
• High Efficiency HVAC
• Energy Star Appliances
• Energy Dashboard
• 38 kW Photovoltaic Array (proposed)

Retrofits will focus on classrooms and kitchens. The Santiago project will serve as a hub for the school’s environmental student groups where students use energy data as a hands-on STEM learning opportunity.
San Francisco City College Multi-Use Building

Location: San Francisco, CA
Construction Type: New Construction, Ultra-Low
School Type: Community College
Building Size: 102,000 ft²
Building Completed: 2010
Energy Target: 40% better than Title 24 energy code
EUI: 28 (Building total EUI) – 0 (RPI) = 28 (Net EUI)

Photo Courtesy of Bruce Damonte
San Francisco City College Multi-Use Building

The Multi-Use Building (MUB) is a pioneering project for large, low-energy facilities. The building is one of the largest in the U.S. to rely nearly entirely on natural ventilation to meet fresh air and cooling requirements.

The SFCC MUB houses classrooms, laboratories, a childcare center, café, meeting rooms, administrative offices, and other miscellaneous spaces.
San Francisco City College Multi-Use Building

Technologies:
• Daylighting
• Lighting Controls
• Natural Ventilation
• Radiant Heating System
• Temperature Controls
• Demonstration PV Array & the plan for more panels in the future

Lessons Learned:
• Natural ventilation (wind) poses challenges with occupants/operators.
• Staff turnover causes major gaps in operational efficiency.
SFUSD Carbon Neutrality

Pitching for Zero, Again...
FAST FACILITY FACTS

- Dense/Urban
- 7th Largest
- 57K Students
- Diverse
- Poor
- Old Buildings
- Supportive Voters
SUSTAINABILITY BACKGROUND
UTILITY RATES... THEY BE RISING!
2011 Bond “Sustainability Lite”

Initial Strategies for Increasing CHPS 2009 Compatibility

Resolution
- CHPS 2009 Resolution
- T-24 15% Energy Perf.
- Staged Reviews

Specifications
- Commissioning
- Construction storm water (SWPPP)
  - Plumbing Fixtures
  - LEM Materials
  - Lighting Controls

PSG Update
- T-24 15% Energy Perf.
- Landscape irrigation stds.
- Require ASHRAE 62.1-2007
- Require ASHRAE 55-2007
- Require recycling areas

Process
- PM Responsibility for CHPS process
ZERO NET ENERGY MANDATED
ZERO NET ENERGY
CARBON NEUTRAL SCHOOLS

San Francisco Schools Aim for a Zero Carbon Footprint by 2040
THE DETAILS

SFUSD PROJECT REQUIREMENTS

July 1, 2017

STRATEGY

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

- **BOND PROJECTS**: water-approved funding for new constructions & 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) < 120\(\text{Btu/ft}^2\text{yr}\). 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 tasked 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 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 Reference 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 those modernization and facility 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 obstructions, 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.

ENVOLPE: 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, glazing and heat control should be provided via heat-responsive glass and/or exterior shading. In addition, interior shades should always be provided.

Thermochromic Glass

LITING: 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 SGSD 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-8pm); the system should be off after hours and on weekends (with 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 airport). 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, gymnasiums, and cafeterias, and MERV 13 final filters throughout. The fresh air should be delivered low in the room and originate from a shaded
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

Source: Ecology Action
ZNE ADVENTURE

HEATING
- Heat Pump HW
- Point Source DHW
- Variable Refrigerant Flow
- Solar Hot Water

LIGHTING
- LEDs
- Vacancy Controls
- Daylighting Controls

ENVELOPE
- Dual Pane Windows
- Insulation
- Air Tightness
- Solar Tubes
- Light Shelves

KAIZEN
- Data Analysis
- Mini Capital
- Commissioning

RENEWABLES
- Onsite Solar PV
- Battery Storage
- EV Charging
1st ZNE BUILDING

Source: Lionakis
ZNE RETROFITS
EXECUTION IS EVERYTHING

Source: Pinterest
San Francisco smashes all-time record high temperature, hits 106 degrees
Identify the “Why”
Educate yourself & stakeholders
Listen and build Consensus
Provide an Ambitious but Pragmatic Path Forward

Source: FCPA
THANK YOU
PRIORITIES

TRAVEL: 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 operations. 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 facade. 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 EU of less than 20 kWh/sqft. 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 EU 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 over-sizing 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 5P Public Utilities Commission (5P PUC) 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 audits, synergies with other scopes, available funding, and site-specific design parameters to determine which of the latter to include.

<table>
<thead>
<tr>
<th>SCOPE</th>
<th>MODERNIZATION</th>
<th>FUNDING</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Mandatory</td>
<td>Case-by-</td>
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<tr>
<td>Air sealing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window replacements</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Insulation</td>
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</tr>
<tr>
<td>Lighting</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Solar tubes/skylights</td>
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<td>✓</td>
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<tr>
<td>Light shelves/reading</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>EMU upgrades</td>
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<td>✓</td>
</tr>
<tr>
<td>Building dashboard and energy management</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Fuel switch/transformer</td>
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<td>✓</td>
</tr>
<tr>
<td>Heating optimization</td>
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<td>✓</td>
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<tr>
<td>Solar readiness</td>
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<td>✓</td>
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<tr>
<td>Pipework</td>
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<tr>
<td>CIP reconfiguration</td>
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<td>✓</td>
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<tr>
<td>Water fixtures</td>
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<td>✓</td>
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<td>Shut-off valves</td>
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<td>✓</td>
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<tr>
<td>Stormwater controls</td>
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<td>✓</td>
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<tr>
<td>Irrigation</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Turf replacement</td>
<td></td>
<td>✓</td>
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<tr>
<td>Trash sorting</td>
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</tbody>
</table>
BUILDING STRATEGY

NEW SCHOOLS
  → ZNE Ready
MODERNIZATION
  → ZNE Two-Step
SMALL PROJECTS
  → Guidelines
RENEWABLES
  → In Due Time
FUNDING OPTIONS

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

Source: UC Berkeley
WILLIE BROWN MIDDLE SCHOOL
Therms Per Square Foot

NATURAL GAS

- Kipp/Gateway
- Willie Brown
- Herbert Hoover
- James Denman
- Aptos
- Everett
- Francisco
- A.P. Giannini
OPPORTUNITIES

- Bond Modernization
- Facilities Projects/Deferred Maintenance
- Monitoring (1 yr)
- Sustainable Operations & Shared Savings
SMALLER PROJECTS

→ LED Lighting
→ Windows
→ DHW Replacement
→ Heating Controls/EMS
→ Ventilation/VFD
→ Pipe Insulation/Capping
→ NO: New Gas Boilers

Source: Alta Planning
SUSTAINABILITY LITE & BEATING CODE ARE NOT ENOUGH
7 x 7 x 7 CHALLENGE

Transforming California’s historic schools
An approach to stepping into the future
Case Study: Santa Barbara High School
ZNE EDUCATION

Source: WRNS Architects
KICK-OFF

Source: WRNS Architects
SITE VISITS

Source: ZNE Training Center
SITE VISITS
### Table 29. Energy Intensity Values for Zero Energy Schools

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Representative City</th>
<th>Primary School</th>
<th>Secondary School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Site Energy (kBtu/ft²-yr)</td>
<td>Source Energy (kBtu/ft²-yr)</td>
</tr>
<tr>
<td>1A</td>
<td>Miami, FL</td>
<td>25.9</td>
<td>76.4</td>
</tr>
<tr>
<td>2A</td>
<td>Houston, TX</td>
<td>24.3</td>
<td>71.1</td>
</tr>
<tr>
<td>2B</td>
<td>Phoenix, AZ</td>
<td>24.7</td>
<td>72.5</td>
</tr>
<tr>
<td>3A</td>
<td>Memphis, TN</td>
<td>23.8</td>
<td>69.0</td>
</tr>
<tr>
<td>3B</td>
<td>El Paso, TX</td>
<td>23.4</td>
<td>67.8</td>
</tr>
<tr>
<td><strong>3C</strong></td>
<td>San Francisco, CA</td>
<td><strong>21.6</strong></td>
<td><strong>61.9</strong></td>
</tr>
<tr>
<td>4A</td>
<td>Baltimore, MD</td>
<td>25.5</td>
<td>67.6</td>
</tr>
<tr>
<td>4B</td>
<td>Albuquerque, NM</td>
<td>21.1</td>
<td>66.6</td>
</tr>
<tr>
<td>4C</td>
<td>Salem, OR</td>
<td>22.4</td>
<td>64.2</td>
</tr>
<tr>
<td>5A</td>
<td>Chicago, IL</td>
<td>24.3</td>
<td>69.9</td>
</tr>
<tr>
<td>5B</td>
<td>Boise, ID</td>
<td>23.2</td>
<td>66.7</td>
</tr>
<tr>
<td>6A</td>
<td>Burlington, VT</td>
<td>24.5</td>
<td>70.1</td>
</tr>
<tr>
<td>6B</td>
<td>Helena, MT</td>
<td>23.5</td>
<td>66.9</td>
</tr>
<tr>
<td>7</td>
<td>Duluth, MN</td>
<td>25.9</td>
<td>74.1</td>
</tr>
<tr>
<td>8</td>
<td>Fairbanks, AL</td>
<td>28.7</td>
<td>82.5</td>
</tr>
</tbody>
</table>

Source: DOE
ROLE MODELS

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
BUILD A CONSENSUS

Source: NY Times
FINDING THE MAINTENANCE LOVE
INDUSTRY NORM

Source: Lochinvar
NO POT LYING AROUND
PRAGMATIC PATH FORWARD
DIVING INTO THE DEEP END
BUT YOUR SAN FRANCISCO
Painting a Picture of Change
WE DID IT!
WHY ZNE? WHY NOW?
PITTSBURG UNIFIED SCHOOL DISTRICT

PARKSIDE ELEMENTARY SCHOOL:
A ZERO NET ENERGY NEW CONSTRUCTION PROJECT

Presented by: Alan E. Glass
Energy Supervisor
Pittsburg Unified School District
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 11,300
- Position: Special Projects Accountant and Energy Supervisor
SUSTAINABILITY AND ZERO NET ENERGY

How did we get to this point?

- PV solar arrays at fifteen (15) of the District’s locations
- In calendar year 2017, we generated 4,888,589 kWh in energy from our solar arrays, producing close to 50% of the total electrical need of the District.
- For the last 5 ½ years, we have generated over 33GWh of electricity
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
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.
- Working with PG&E to install seven new EV charging units for our yellow fleet.
- Looking to purchase five (5) 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
- Awarded the Golden Bell Award by the California School Board Association (CSBA)
- Site Support Services Center is getting new beta solar panels over a one-acre bioswale and four (4) wind generated turbines, totaling 200kW of energy production
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 in the planning stages of building 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 – Deputy Superintendent (CBO), Assistant Superintendent of HR, Executive Director and Director 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 Deputy Superintendent, who oversees the business side of the District, was approached with the concept.

- The time is 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

- Use the site as a learning tool for students and staff.

- Continue to be a leader in the community for energy conservation and sustainability

- Cost-effective, with a good return on investment
We took the concept of a Zero Net Energy school to the Facilities Sub-Committee, which consists of two of the five Board members, the Deputy Superintendent, and 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!
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 a couple of months ago.

We are finalizing the energy calculations now to determine how much alternative energy we will need for the school.

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

Current PV arrays at site

Potential site for additional PV carport array or wind turbines

HVAC minimizing space usage, Rooftop PV array covering balance of classroom building

PARKSIDE ELEMENTARY SCHOOL
PITTSBURG UNIFIED SCHOOL DISTRICT
PARKSIDE ELEMENTARY AND ZERO NET ENERGY

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

North exterior view of new Parkside Elementary, note windows for daylighting.
PARKSIDE ELEMENTARY AND ZERO NET ENERGY

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

Teachers can utilize hallways for learning spaces for small or larger groups.
QUESTIONS?
SMCCD Sustainability Initiative
Zero Net Energy Strategy
A Road Map to Energy Security
ZNE Strategy
Identified Measures

Simple Payback Period vs. Energy Savings

- Light Sensors
- LEDs
- Window Film
- VFDs - Gyms
- CO2 Sensors - Gyms
- CO2 Sensors - All other
- Heat Recovery
EDUCATIONAL BUILDING - FUEL CONSUMPTION BY END USE

- Space heating
- Computing
- Office equipment
- Refrigeration
- Cooking
- Lighting
- Water heating
- Ventilation
- Cooling
- Other
Site Energy Use Intensity (EUI)

<table>
<thead>
<tr>
<th></th>
<th>Cañada College</th>
<th>College of San Mateo</th>
<th>Skyline College</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Buildings</td>
<td>14</td>
<td>20</td>
<td>11</td>
<td>45</td>
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<tr>
<td>Square Footage</td>
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<td>743,000</td>
<td>544,000</td>
<td>1.7 million</td>
</tr>
<tr>
<td>Generated Electricity (kWh/yr)</td>
<td>2.2 million</td>
<td>--</td>
<td>--</td>
<td>2.2 million</td>
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<tr>
<td>Consumed Electricity (kWh)</td>
<td>4.3 million</td>
<td>8.7 million</td>
<td>5.2 million</td>
<td>18.2 million</td>
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<td>Consumed Natural Gas (therms)</td>
<td>140,000</td>
<td>560,000</td>
<td>310,000</td>
<td>1 million</td>
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<td>Site EUI (kBtu/ft²/year)</td>
<td>57</td>
<td>115</td>
<td>89</td>
<td>91</td>
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Cañada College Building EUI

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<tr>
<td>31-40</td>
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<td>41-50</td>
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<td>125-150</td>
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</table>
College of San Mateo Building EUI
Skyline College Building EUI
Skyline ’15–’16
Facilities Planning Maintenance and Operations

All Buildings

Existing Buildings

1. Older buildings with high EUI
2. High Energy Use Buildings
3. Remaining buildings

Planned Demolished/Renovated Buildings
Next Steps

- ZNE Ready New Buildings

- Building Occupancy vs. Building Schedule Analysis

- Massive MBCx Effort

- Renewable Energy and Other DER Analyses

- Training and development of staff with emphasis on trouble shooting and PM

- Continued Coordination/Collaboration with BUG’s and other stakeholders

- Plug-Load controls integration
Discussion....

Thank You

Contact information:

Joe Fullerton
Energy and Sustainability Manager
San Mateo County Community College District
Facilities Planning, Maintenance and Operations
650-358-3848
fullertonj@smccd.edu
www.smccd.edu/sustainability
Developing Your Pitch to ZNE
1. Who are your primary stakeholders? What are the key messages for those decision makers about high performance schools and ZE schools?

2. What communication tactics did you learn that might be successful with your decision makers? I.e. communicating benefits, highlighting the current progress of your district, etc.

3. Are there stakeholders mentioned that you had not considered targeting before? Who and why?

4. What other comments do you have about the presentations that you would liked to have see more of?
ZNE Resources
Join us!
2018 Proposition 39 ZNE School Trainings

Workshops
Inefficiency is Old School: A Technical Deep Dive Into ZNE School Retrofits
October 30, 1-5 PM
Pasadena, CA

Webinars
More webinars scheduled for September 27, 2018 and November 29, 2018!
Check back for details at: https://newbuildings.org/proposition-39-trainings/
You can also listen to the previous Prop 39 Webinars on demand at:

• Dreaming the Future: How Zero Net Energy Design Can Transform the School Environment:
Tools for Zero Net Energy Schools
AEDG Zero Energy K-12 Schools Guide

Achieving Zero Energy
Advanced Energy Design Guide
for K-12 School Buildings

Developed by

AIA/EDG

The American Institute of Architects
Renewable Energy Design Group
Sustainable Energy Partners
U.S. Department of Energy

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Getting to Zero Resources HUB

Zero Energy Schools Resources

Learn how zero energy schools are leading the zero energy buildings trend through policy and design.

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

- 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
- U.S. DOE Zero Energy School Accelerator: www.zeroenergy.org
Thank You!

Amy Cortese, Director, amy@newbuildings.org
Reilly Loveland, Project Analyst, reilly@newbuildings.org