Zero Net Carbon Schools
April 1, 2020

This training is brought to you in partnership by the Silicon Valley Energy Watch and New Buildings Institute

Through a local government partnership administered by the City of San Jose, SVEW helps Santa Clara County Pacific Gas and Electric (PG&E) customers lower their energy use through upgrade programs, rebates, and educational materials.

Since 2010, SVEW has helped saved over 75 million kWh, which is enough savings to power 6,027 homes for a year!
SVEW Upcoming Events!

**Webinars**
- Energy and Water Efficient Cafeterias  
  *April 21st from 1-3 PM*

**In-Person Events**
- Energy Efficiency Update: Strategies for Reducing Energy Use, Operating Costs and Carbon Emissions:  
  *May 13th from 8:30 AM-4:30 PM, Environmental Innovation Center*
- Zero Net Carbon Schools Workshop  
  *May 14th from 10 AM-2 PM, Evergreen Valley High School*
- A Class for Control Freaks: Optimizing your Building Automation System  
  *June 18th from 8:30 AM-4:30 PM, Environmental Innovation Center*

For more info or to register visit: [www.sjenvironment.org/energytrainings](http://www.sjenvironment.org/energytrainings)
New Buildings Institute
Driving energy and carbon emissions reductions in the built environment.
Program areas include:
1. Advanced buildings
2. Getting to zero leadership
3. Code and policy innovation

Learning Objectives
1. Participants will be able to understand the current status of zero net energy and zero net carbon schools across North America.
2. Participants will be able to understand and apply the process and plan for zero net carbon schools associated with planning, designing, constructing and operating a school to zero net energy and zero net carbon.
3. Participants will be able to utilize lessons learned and approaches uncovered by other experts, schools, districts and student leaders on the path to zero.
4. Participants will understand the tools and resources provided by SVEW, NBI and others to assist on the path to zero net energy and zero net carbon.
Getting to Zero in Schools

Students Demand Climate Action!

Thousands of students from the across the Portland area walked out on Sept. 20, 2019, to join a global strike to fight climate change. A follow-up demonstration is scheduled for Friday in at least three metro-area cities. Oregonian file photo by Mark Graves, 2019
Getting to Zero in Schools

• Delivers cost avoidance from utility bills to classroom and facilities
• Creates comfortable and productive environment
• Provides hands-on, 21st century learning opportunities
• Results in stronger, more resilient communities
Schools are Leading in Getting to ZNE!

Building Type Breakdown

<table>
<thead>
<tr>
<th>Building Type</th>
<th>ZE - Emerging</th>
<th>ZE - Verified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>37%</td>
<td>1%</td>
</tr>
<tr>
<td>Office</td>
<td>19%</td>
<td>2%</td>
</tr>
<tr>
<td>Multifamily</td>
<td>16%</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>14%</td>
<td>1%</td>
</tr>
<tr>
<td>Public Assembly</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>Mercantile</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Public Order and Safety</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Warehouse and Storage</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Education Breakdown

<table>
<thead>
<tr>
<th>Education Type</th>
<th>Building Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-12 School</td>
<td>50%</td>
</tr>
<tr>
<td>Higher Education</td>
<td>35%</td>
</tr>
<tr>
<td>General Education</td>
<td>15%</td>
</tr>
</tbody>
</table>

Location of Zero Net Energy Schools

California Stats
ZNE Verified: 7
ZNE Emerging: 76
Common Terminology in Getting to Zero

- Zero Net Energy or Net Zero Energy
- Site or Source
- On-site or Off-site renewables
- Building, portfolio or campus
- Zero Net Carbon

Source Energy

148 kBtu/ft²/year Source

Site Energy

67 kBtu/ft²/year Site

Energy and Carbon – related but not the same

The carbon intensity of energy use depends on the local grid conditions, the time of the year and time of day.

Source: California Energy Commission
Carbon Intensity of the Electricity Grid

- Additional renewables at the utility scale will change the carbon intensity of the grid over time.

Increasingly Renewable Electrical Grid

Even as the grid decarbonizes, energy efficiency is still a key, cost effective strategy that improves the quality of the built environment.
Fuel Choice Greatly Impacts Carbon Emissions

Natural gas provides most space heating in the U.S., but regional differences exist, and climate differences are significant.

Use of Natural Gas in School Facilities
California Energy Efficiency Strategic Plan 2008

• All new residential construction will be Zero Net Energy by 2020

• All new commercial construction will be Zero Net Energy by 2030

• 50% of existing buildings will be Zero Net Energy by 2030
Title 24 Energy Code Cycles to Zero in CA

San Jose New Construction Reach Code*

Electric Vehicle (EV) Charging Infrastructure

*Building Electrification

Solar Ready (Photovoltaic)

* Note: San Jose New Construction Reach Code does not apply to public schools.
San Jose All Electric Building Requirements

<table>
<thead>
<tr>
<th>Modeled Compliance</th>
<th>Mixed-Fuel New Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-Electric in New Construction</td>
<td>Meet Title 24 - 2019</td>
</tr>
<tr>
<td></td>
<td>6% better than T24 +</td>
</tr>
<tr>
<td></td>
<td>Electrification Readiness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prescriptive Compliance</th>
<th>Mixed-Fuel New Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescriptive Compliance</td>
<td>Meet Title 24 - 2019</td>
</tr>
<tr>
<td></td>
<td>SHGC ≤ 0.22</td>
</tr>
<tr>
<td></td>
<td>50% reduction of East &amp; West fenestration area</td>
</tr>
<tr>
<td></td>
<td>Efficient Variable Air Volume airflow design</td>
</tr>
<tr>
<td></td>
<td>Economizer (≥ 33,000 Btu/h cooling)</td>
</tr>
<tr>
<td></td>
<td>10% Lighting Power Density reduction</td>
</tr>
<tr>
<td></td>
<td>Drain water heat recovery</td>
</tr>
<tr>
<td></td>
<td>Improved Daylighting Controls</td>
</tr>
<tr>
<td></td>
<td>Institutional Lighting Controls Tuning</td>
</tr>
<tr>
<td></td>
<td>Occupancy Controls in open area offices</td>
</tr>
<tr>
<td></td>
<td>Electrification Readiness</td>
</tr>
</tbody>
</table>

Note: San Jose New Construction Reach Code does not apply to public schools.

San Jose Electrification Readiness*

*Note: San Jose New Construction Reach Code does not apply to public schools.
San Jose Electric Vehicle Charging Infrastructure*

<table>
<thead>
<tr>
<th>EVCI for Schools</th>
<th>2019 Base Code</th>
<th>San Jose Reach Code</th>
<th>Code Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-10% spaces EV Ready</td>
<td>10% spaces EVSE</td>
<td>40% spaces EV Capable</td>
<td>Section 5.106.5.3.1</td>
</tr>
</tbody>
</table>

| EV Capable (Some assembly required) | Raceway (conduit), electrical capacity (breaker space) |
| EV Ready (Plug & Play) | Raceway (conduit), electrical service capacity, overcurrent protection devices, wire and outlet (i.e. full circuit) |
| EV Supply Equipment (EVSE) Installed (Level 2 Charge!) | All the equipment needed to deliver electrical energy from an electricity source to the EV |

*Note: San Jose New Construction Reach Code does not apply to public schools.

Solar Readiness in New Construction*

- Minimum Zone Size:
  - Schools – 15%
- Minimum segment size:
  - < 10,000 sf roof: 80sf
  - > 10,000 sf roof: 160 sf
- An installed PV system

* Note: San Jose New Construction Reach Code does not apply to public schools.
Getting to Zero Over Time in Schools: An Introduction to the Process

Getting to Zero Over Time

• Long term, strategic approach to energy management
• Set measurable goals and regularly report on progress
• Leverage every opportunity to improve energy performance
• Focus on the benefits to the learning environment
Zero Hero

- Energy champion is often on staff
- Establish goals
- Develop and implement policy
- Link to education

Gain Support for Energy and Sustainability

- Incorporate energy into overall process
- Establish trust with internal teams
- Find synergies with other projects
- Identify and capitalize on low-hanging fruit
Set Overarching Goals

- Measureable energy reduction, renewable energy and carbon emission reduction goals. Examples:
  - Reduce consumption by 50% below 2000 baseline by 2030
  - Eliminate combustion of natural gas by 2040
  - Generate 100% of power needs by 2030
  - Achieve an average portfolio site EUI of 25 kBtu/sf-yr by 2030

Align with Building Lifecycle Events

- New Construction
- Modernization
- System retrofit
- Equipment replacement
At Each Life Cycle Event:

- Consider comfort & health first (thermal, acoustic, lighting, views)
- Clarify sustainability and energy goals
- Start with load reduction
- Consider mechanical system selection decisions and long-term carbon impact
- Investigate EVs, PVs and renewables

Energy Use Intensity (EUI) Targets for New School Construction

![Energy Use Intensity (EUI) Targets for New School Construction](https://www.ashrae.org/technical-resources/aedgs/zero-energy-aedg-free-download)
EUI Targets for Existing School Renovation

EUI targets in existing school renovations may be slightly higher.

- Portland Public Schools (PPS) Modernization EUI Target: **30 kBtu/sf**

- Boulder Valley School District (BVSD) Energy Targets: **Reduce the average EUI to \( \leq 30 \) by FY2050**
Policy Guidance Documents Reference Goals

Examples include:

- Owners Program Requirements
- Requests for Proposals
- Technical specifications
- Facility Master Plans

Selecting the Project Team

- During interviews, ask about energy performance of the team’s previous projects
- Do the prospective design teams know how their buildings performing?
- NBI has a list of questions to ask
**Integrated Design**

- Host an integrated design charrette early in the process
- Engage multiple perspectives
- Continue throughout process through each design iteration
- Conduct pre-bid and pre-construction meetings

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**Common Technologies to Achieve ZNE Energy Target**

- Passive Measures
- Envelope and Air Tightness
- Space Conditioning (separate from ventilation)
- Plug Load Management
- On-site Renewable Energy
- Electric Vehicle / Bus charging
- Battery Storage
Key Checkpoints for Meeting Energy Goals in New Construction

• Early energy model
• Revised energy model
• End of each design phase
• Commissioning (in both design and construction)
• Mock ups

Common Pain Points in School Construction Projects

• Making it all work together
  • Building automation
  • Controls integration
• Value engineering
• Transition from design to operations
• Engagement of occupants over time
• Verifying that the performance goal was achieved (despite real world operations and occupancy!)
Retrofit and Modernizations

• Use energy as core assessment area in building assessments
• Beyond like-for-like replacements
• Every decision matters on the path to zero

Documents to Guide the Retrofit Process

• Facility assessment reports
• Facilities master plan
• Owners Project Requirements
• Tech specs
• Sustainability and energy checklists
Verify and Report

- Annual reporting to school board
- Benchmark energy use
- Visual display and feedback for users

Involve Students in Getting to Zero
Getting to Zero Over Time

- Long term, strategic approach to energy management
- Set measurable goals and regularly report on progress
- Leverage every opportunity to improve energy performance
- Focus on the benefits to the learning environment

Resources for Getting to Zero
Zero Energy Process Guide

By NREL and US Department of Energy

A complimentary guide to the Advanced Energy Design Guide for Zero Energy Schools

https://www.nrel.gov/docs/fy19osti/72847.pdf

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
Getting to Zero Resources HUB

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

Zero Net Energy Case Studies

https://gettingtozeroforum.org/schools/
2019 Schools Zero Energy Watch List

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

NBI’s Tools for Zero Net Energy Schools

NBI’s Tools for Zero Net Energy Schools

newbuildings.org/resource/2019-zero-energy-schools-watchlist/
Center for Green Schools Learning Lab
Curriculum resources for climate literacy, energy efficiency… and more!

Learning Lab
Access hands-on sustainability curriculum and resources to help K-12 educators bring classroom projects to life.
Additional Resources

- NEEP High Performance Schools: http://www.neep.org/initiatives/energy-efficient-buildings/high-performance-schools
- USGBC Center for Green Schools: https://www.centerforgreenschools.org/
- Green Ribbon Schools: https://www2.ed.gov/programs/green-ribbon-schools/index.html
- Collaborative for High Performance Schools: https://chps.net/chps-criteria

Thank you!

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Reilly Loveland, Amy Cortese and Sean Denniston, NBI