A Deeper Dive into Zero Net Carbon Schools
May 14, 2020

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!
Part 1: Zero Net Carbon Schools Webinar

Intended for K-12 & community college administrators, operations managers, school board members, and other influencers, this online training goes into depth on zero net carbon (ZNC) school retrofit strategies, lessons learned of districts and technical experts, and resources in designing, constructing, retrofitting, and operating school facilities on the path to zero. Participants will walk away with an understanding of the overall process, technical design features, and practices from others who are making ZNC a reality in schools.

https://newbuildings.org/webinar/zero-net-carbon-schools-webinar/
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. Upon completion, participants will be able to understand how the sustainability champion can gain stakeholder buy to support their path to zero and how this sphere of influence can affect the decision-making process to achieve deep energy and carbon reductions.

2. Upon completion, participants will be able to understand and apply the technical aspects of the process for planning, designing, constructing and operating a school to zero net energy and zero net carbon.

3. Upon completion, 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. Upon completion, participants will be able to apply the technical tools and planning resources to achieve successful zero net carbon project planning, financing, design, construction and operations.
Recap of Getting to Zero in Schools

Getting to Zero in Schools

• Delivers cost avoidance from utility bills to classroom and facilities
• Creates comfortable and productive environment
• Provides hands-on, future focused learning opportunities
• Results in stronger, more resilient communities
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

Steps to Getting to Zero

- Gain Support for Energy & Sustainability
- Set Overarching Goals Align with Building Lifecycle Events
- Consider comfort & health first
- Set Energy Use Intensity Targets
- Utilize Policy Guidance Documents & Tech Specs
- Use an Integrated Design Process
- Design and Construct to the Target
- Verify and Report
- Involve Students and Staff!
The Importance of the Zero Hero and Storytelling

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
Zero Hero

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

Stakeholder Engagement to Ensure the Outcome

- Incorporate energy into overall process
- Establish trust with internal teams
- Find synergies with other projects
- Identify and capitalize on low-hanging fruit
Gaining Support for Getting 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
  • See NBI Getting to Zero list for locations
  • Patriot Hall Video - https://energytrust.org/pathtonetzero/
  • Discovery Elementary School Video - https://www.zeroenergy.org/video-case-study/

Involving the Community in Achieving Goals

Student Benchmarking Activity, Mukilteo SD, WA
Student Performing Energy Audit, Los Angeles USD, CA
Sacajawea Middle School Solar Project
Bozeman, MT

Credit: Bozeman Public Schools

Kern High School District
Bakersfield, CA

“The district will significantly reduce the percentage of our budget allocated for electricity, allowing us to enhance academic and extracurricular programs and plan additional facility upgrades.”

– Dr. Scott Cole, Associate Superintendent of Business, Kern High School District

Credit: Kern High School District
Los Osos Middle School

- Zero Hero brings all stakeholders to the table (utilities, staff, consultants, etc.)
- Zero Hero maintains status through construction and design
- Conversations with school staff after construction is crucial to the outcome

Garden Grove School District Retrofit

Ralston Intermediate School Multipurpose Building and Santiago High School Science Classroom
Zero Hero Success

- Establish your zero hero (maybe it’s you!)
- Gain support for your zero goal
- Use storytelling to showcase success (tell yours and listen to others)
- Engage internal and external stakeholders
- Identify synergies and capitalize on low hanging fruit
- Engage students!

Climate Smart Youth Leaders Pilot
Climate Smart Youth Leaders Pilot

- SVEW led 8 month pilot to empower youth to change energy policy on campus
- 4 schools in East Side Union High School District
- 2.5 day teacher workshop
- 10 step process (STEM/PBL/NGSS aligned)
- 240 high school students
- 24 energy resource partners
- 54 student driven energy projects
- 200 community members attended end-of-program celebration

Climate Smart Youth Leaders Pilot Takeaways

- Earth Force youth civic engagement model wherein students drive each step is key - ignited student passion & provided new framework for teachers to guide life-long learning concepts
- Semester long approach with policy project focus created lasting change (more than classroom presentation)
- PBL inspired exhibition gave students stage to be heard & showed local government, school leaders & community leaders want to hear student driven solutions
Zero Net Carbon School Case Studies
David Kaneda and John Andary, Integral Group

A Deeper Dive into Zero Net Carbon Schools

David Kaneda, Electrical Principal
John Andary, Mechanical Principal

Leyva Middle School Admin Building, San Jose, CA – AEDIS Architects
21
Global Offices

800+
Staff

100+
Zero Net Energy Projects
completed or in design

60+
LEED Platinum Certified Projects

22
AIA COTE
Top Ten Awards

15
ASHRAE 1st
Place Awards

100+
Zero Net Energy Projects

55+
LEED Platinum
Certified Projects

IMAGINE | PERFORM | ACCELERATE | SUSTAIN
### ZERO NET...

<table>
<thead>
<tr>
<th>Electric Energy (ZNEE)</th>
<th>Energy (NZE)</th>
<th>Carbon (ZNC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% of net annual electrical use is offset by on site renewable energy.</td>
<td>100% of net annual energy use (including fossil fuel use) is offset by on site renewable energy.</td>
<td>100% of net annual energy use is offset by on site renewable energy.</td>
</tr>
</tbody>
</table>

---

**WESTMONT HIGH SCHOOL SCIENCE WING - 2004**

**DREILING TERRONES ARCHITECTURE**

**ZNEE Educational Facility**
DELMAR HIGH SCHOOL SCIENCE WING
DREILING TERRONES ARCHITECTURE
ZNEE Educational Facility

CAMPBELL UNION HIGH SCHOOL DISTRICT PARKING PV'S
BARTOS ARCHITECTURE
ZNEE Educational Facility
LEYVA MIDDLE SCHOOL ADMINISTRATION BUILDING - 2011
AEDIS ARCHITECTS

ZNC Educational Facility

EWA BEACH ELEMENTARY SCHOOL PORTABLE BUILDING
ANDERSON ANDERSON ARCHITECTURE
ZNC School Portable
THE CASTILLEJA SCHOOL CAMPUS EXPANSION
WRNS STUDIO
ZNC Educational Facility (In design)

PITZER COLLEGE REDFORD CONSERVATORY
CARRIER JOHNSON + CULTURE
ZNC Educational Facility
INDIO BUILDING
RMW ARCHITECTURE & INTERIORS
For Profit Remodel ZNC Spec Office

Other significant ZNC Projects

BOULDER COMMONS I
EHDD ARCHITECTURE
For Profit New Construction ZNC Spec Office

Other significant ZNC Projects
Other significant ZNC Projects

PROCESS: TRADITIONAL VS HIGH PERFORMANCE DESIGN

BUILDING COMPONENTS

1. Conceptual Design
   - Using the Local Climate
   - Building Massing
   - Passive Architecture Design
   - Combining ideas
   - Simplify Mechanical
   - Cost Transfer

2. Schematic Design
   - Thermal Massing
   - Tipping Point Analysis
   - Detailed Energy Model
   - Detailed Design
   - Controls Optimization
   - Sizing Optimization

3. Detailed Design
   - Construction
   - Submit Models & Reports

4. Building Commissioning
   - Map Key Building Targets
   - Functional Tests
   - Trend Analysis & Tuning
   - Calibrated Control

Certifications: LEED, GSHP, ASHRAE

IMAGINE | PERFORM | ACCELERATE | SUSTAIN
PROCESS: PASSIVE SYSTEM COST TRANSFER

KEY STRATEGIES TO DECARBONIZATION
~90% Reduction in Solar Radiation striking the South Glass

UC Merced Downtown Center, Merced CA - Heller Manus Architects

AIR SOURCE HEAT PUMP

VRF HEAT PUMP

DOMESTIC HW HEAT PUMP

PACKAGED ROOFTOP HEAT PUMP

DOAS with Heat Recovery

CoP = Coefficient of Performance (AHR: 1060 Standard load @ 50% capacity)
Expanded Comfort With Ceiling Fans

Night Flush + Natural Ventilation
Daylighting
December 21, 12:00pm
Dark Overcast Skies
Clerestory Windows Option 01
58% Reduction

Current
Recommended

Kitchens: Induction Range, Combi Ovens, etc.

Sonoma Academy, Santa Rosa, CA – WRNS Studio
Prospect High School, San Jose, CA – Bartos Architecture
Pathway to ZNE

Estimated Benchmark Energy Use

Set Energy Target

17 to 24

44
Pathway to ZNE

Estimated Benchmark Energy Use

Great Envelope Unlock Simple HVAC

High Perf HVAC / Lights

Set Energy Target

17 to 24

17 to 24

17 to 24
Pathway to Zero Net Carbon

- Estimated Benchmark Energy Use
- Great Envelope Unlock Simple HVAC
- High Perf HVAC / Lights
- Effectively Manage Equipment Energy
- Set Energy Target

Mechanical Options – Schematic Design

- VRF HEAT PUMP
- AIR SOURCE HEAT PUMP
- FAN COIL UNIT
- RADIANT COOLING/HEATING
Daylight Modeling

Power generated from PV offsets annual energy use of all-electric buildings resulting in Zero Net Energy and Zero Net Carbon buildings.

Mechanical Options Refined – Design Development

Power generated from PV offsets annual energy use of all-electric buildings resulting in Zero Net Energy and Zero Net Carbon buildings.
PV Layout for Zero Net Energy + Zero Net Carbon Operation

- Radiant in topping slab
- Operable windows
- Ceiling fans
- Ceiling clouds for acoustics
- Dedicated outside air central supply
- Lab classroom central exhaust
- Air to water heat pump
- Inter-connection to theater
- All-electric operation
- Superior thermal comfort
- Superior indoor air quality
- Low displacement ventilation cooling
- CHW and HW from the other building (STEAM Building)
- Packaged heat pump for Stage
- All-electric operation
- Superior thermal comfort and indoor air quality
WHATS NEXT?

UCSC KRESGE COLLEGE
STUDIO GANG
Total Carbon Emissions of Global New Construction from 2020-2050
Business as Usual Projection

- Embodied Carbon: 49%
- Operational Carbon: 51%

Also available:
- 50% Solar
- 100% Solar
- 25% Regional Solar
- 100% Regional Solar

PG&E Standard Electric Power Mix

- 34% Nuclear
- 13% Large Hydro
- 39% Renewable

Also available:
- 50% Solar
- 100% Solar
- 25% Regional Solar
- 100% Regional Solar

Sierra Nevada Clean Energy

100% Carbon Free Power

SierraNevadaCleanEnergy.org
REAL TIME CARBON ON THE GRID

Emissions Intensity Relative to Natural Gas
WHY ON CAMPUS RENEWABLES?

RENEWABLES + ENERGY STORAGE

BloombergNEF Levelized Cost of Energy 2009-2019

Source: BloombergNEF Note: The global benchmark is a country weighted-average using the latest annual capacity additions. The storage LCOE is reflective of a 20-kilowatt-hour battery storage system with four-hour duration running at a daily cycle and includes charging costs assumed to be 60% of wholesale average power price. Data as of October 22, 2019.
FIRE SEASON RESILIENCE: SOLAR/BATTERY MICROGRID

Fire Season Utility Outage: Big Array and Small Battery

- Solar Modules
- PV Inverters
- Utility
- Main Switchboard
- Building Loads
- Small Battery + Full Size Inverter

FIRE SEASON RESILIENCE: SOLAR/BATTERY MICROGRID

Electric Outage Details
- START TIME: OCT 16, 3:03 PM
- ESTIMATED RECOMMENDATION: OCT 18, 4:03 PM
- CUSTOMERS AFFECTED: 1
- CAUSE: Unknown - PG&E will be assessing the cause.
- STATUS: PG&E assessment crew is en route to the outage.
- LAST UPDATED: OCT 16, 3:07 PM

- Resume Updates

FIRE SEASON RESILIENCE
and last... ELECTRIC VEHICLE CHARGING

Questions?

Thank You!

John Andary – jandary@integralgroup.com
David Kaneda – dkaneda@integralgroup.com
Technical Aspects of the Zero Net Carbon Process

Carrie Brown, Resource Refocus

A Deeper Dive into Zero Net Carbon Schools: Technical Aspects of the ZNC Process

Carrie Brown, PhD

5.14.2020
IOU Prop 39 ZNE Retrofit Pilot

Goal: Demonstrate the technical feasibility of ZNE retrofits in public K-14 schools

12 Statewide Demonstration projects:
- Design Consultation
- Construction Inspection and Commissioning Support
- Incremental Cost Buy-down
- Monitoring, Diagnosis, Correction and Validation


<table>
<thead>
<tr>
<th>Building Type</th>
<th>Baseline EUI kBtu/sf</th>
<th>Post-retrofit EUI kBtu/sf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>48.2</td>
<td>22.4</td>
</tr>
<tr>
<td>Secondary</td>
<td>52.2</td>
<td>20.4</td>
</tr>
<tr>
<td>Portable</td>
<td>89.1</td>
<td>29.2</td>
</tr>
</tbody>
</table>

Source: 2017 California K-12 and Community College Zero Net Energy Retrofit Readiness Study

ZNE retrofits in the pilot targeted 16-22 kBtu/sf EUI.
A Note on ZNE vs. ZC

**ZNE**

Site Energy:
Convert gas (therms) and electricity (kWh) to common unit (kBTU)

**ZC**

Emissions:
With more and more renewables on the grid, highly values electrification.

<table>
<thead>
<tr>
<th>Energy Form</th>
<th>Source Energy Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imported Electricity</td>
<td>3.15</td>
</tr>
<tr>
<td>Exported Renewable Elec</td>
<td>3.15</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1.09</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>1.19</td>
</tr>
<tr>
<td>Propane</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Source Energy: Apply source multipliers to site energy. *(Sometimes)* Encourages gas measures.

Guiding Lessons Learned

Technologies

Cost and Energy Impact
Guiding Lessons Learned

**Approach the retrofit in the right order.**

- Consider comfort and health first (thermal, acoustic comfort, daylight, views, etc.)
- Align with other retrofits such as a new roof, gut renovation, or plan for portable classrooms. When possible, the team can advocate to push known retrofits to be more energy efficient.
- Then…

Guiding Lessons Learned

**Approach the retrofit in the right order.**

- ...Start with load reduction,
  - Envelope (sealing/caulking, insulating, shading, windows)
  - Shedding unnecessary lighting and plug loads
- Optimized mechanical design, followed by optimized mechanical equipment
- Finally, consider PV and/or other renewables
Guiding Lessons Learned

**Rather than expecting energy savings alone** to pay for whole building retrofits, **highlight the non-energy / non-monetized benefits to school**, such as:

- Daylighting
- Indoor air quality
- Thermal comfort
- Acoustics
- Resiliency
- Educational potential

“The ultimate goal is a learning environment that’s the best that we can possibly get.”

-Sue Wesselius, Facilities Consultant for Newcastle ESD

Guiding Lessons Learned

**School construction timelines are severely impacted by delays**, since the windows of construction are so short (during summer, winter, and spring breaks). Typically, the preferred window of opportunity for major projects is during summer—so **delays often involve pushing a project from one summer to the following summer** even if the “delay” is minor.
Guiding Lessons Learned

Strong advocate at the school is critical.

- Often this isn’t the person who can make final decisions, but they can help navigate visits, materials, decisions, paperwork, etc.
- When on-site for meetings, both decision-makers and facilities staff should be present.
Common Targets

- Lighting: T-8 and T-12 fluorescent lighting
- Daylighting: Painted windows and blocked skylights
- Controls: Lighting, HVAC, plugs (including computer labs)
- DHW
- HVAC equipment (for comfort, efficiency, and noise)
- Deferred maintenance and existing retrofit projects, e.g. roof replacements

Lighting

- Interior and exterior LED -- Clear-cut no brainer!
  - Only question is which specific installation.
- Full fixture replacement
  - Best technical solution is full fixture replacement
  - Fixture replacement triggers T24 dimming controls
- Bulb replacement
  - Cost savings by avoiding dimming control
  - Free up funds for other EEMs
- Schedule and occupancy controls
Daylighting

Trend in the 70s to cover clerestories and skylights due to:
- Perceived distraction
- Poor thermal performance
- Glare issues

Daylighting

- **Harness existing systems first**
  - Blocked skylights, clerestories, and light shelves

- **Introduce**
  - Tubular skylights
  - Light shelf retrofits

**Daylighting**

*Before light shelf retrofit (lights off)*

High luminance difference; room feels dark

*After light shelf retrofit (lights off)*

Balanced reflected luminance; room feels comfortable


---

**Optimizing daylighting and PV**

Balance daylighting, PV, and roof repair/replacements.

- Tubular skylights great for daylighting, but require roof penetration.
- Canopy PV systems can free up more roof space, but may be more expensive.

HVAC

- Goal: Increased efficiency and improved ventilation, thermal comfort, and noise control.
- May only be cost effective if replacing at the end of useful life.
- Technology choice highly dependent on existing systems and whether fuel switching is being considered.
- School often attempted “like-for-like” replacement to avoid DSA review.
  - Worked with the equipment manufacturer to keep the rooftop unit within the original weight class.

HVAC

Common technology solutions:

- Electric:
  - Heat pumps: Mini-splits, Bard units w/ recovery wheel, Rooftop package units
- Gas:
  - High-efficiency condensing gas furnaces
- Dedicated outside air systems (DOAS)
- Variable refrigerant flow (VRF)
- Variable air volume (VAV)
- Motor (ECMs) and pump replacements (VFD)
- Climate permitting, economizers and evaporative condenser retrofits
- Ceiling fans
HVAC

Controls:
- Building management system (BMS) or smart thermostats
- Temperature setpoint management
- Occupancy sensing
- CO\textsubscript{2} based demand control ventilation
- Package unit interlocking

Portable Classroom Design

- Until 1998, to receive State funding, 30% of classrooms had to be portable
  - Many aging unit still in operation
  - Resistance to investment
- Simple replacement of HVAC Bard units
  - Noise reduction
  - Improved ventilation and thermal performance

“When the Newcastle Bard units were replaced with quiet, efficient new ones, those classrooms became the envy of the school—you couldn’t even tell the units were running while teachers were teaching, and the rooms were both comfortable and properly ventilated.”

- John Burdette, Director of Bundled Energy Solutions at ABM Building Solutions
Domestic Hot Water (DHW)

**First** consider whether the end use can be removed or downsized.
- Several schools have systems sized for daily showers, but no longer the norm

**Then**, meet required loads with:
- Electric: Heat pumps
- Gas: Tankless condensing gas water heaters (*min* thermal efficiency of 92%)

Envelope

- Sealing and caulking
  - Potential for student/staff engagement
- Exterior roof insulation
- Window films
- Low-emissivity windows (*if replacement required*)

Miscellaneous Electric Loads (MELs)

- Schedule control for plug loads
- Energy Star+ classroom and kitchen appliances
- Vending machine occupancy sensing
- High efficiency uninterruptible power systems (UPS) for server rooms

Guiding Lessons Learned

Technologies

Cost and Energy Impact
Cost Effectiveness

Statewide Prop 39 Program
• Savings to investment ratio (SIR) calculated with California Energy Commission’s Energy Savings Calculator\(^1\)
• Energy projects were originally only eligible to apply for funding if they achieved a minimum SIR of 1.05. In 2016, this minimum was reduced from 1.05 to 1.01.\(^2\)

With the intention of supporting more aggressive energy efficiency measures, the IOU Pilot did not have SIR limits.

---


Cost Effectiveness

The reported simple paybacks range from 18-30 years, while the SIRs range from 0.78 to 1.03.

<table>
<thead>
<tr>
<th>School</th>
<th>EEM cost (before PV)</th>
<th>Simple Payback (yrs)</th>
<th>NPV $</th>
<th>SIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Lagoon</td>
<td>$89,200</td>
<td>21</td>
<td>-</td>
<td>1.01</td>
</tr>
<tr>
<td>Newcastle</td>
<td>$511,240</td>
<td>-</td>
<td>-$2,100</td>
<td>1.00</td>
</tr>
<tr>
<td>Cleveland*</td>
<td>$339,314</td>
<td>-</td>
<td>-$6,417</td>
<td>1.03</td>
</tr>
<tr>
<td>Los Osos</td>
<td>$468,650</td>
<td>18</td>
<td>-</td>
<td>0.78</td>
</tr>
<tr>
<td>Egan</td>
<td>$221,080</td>
<td>22</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Garfield</td>
<td>$312,000</td>
<td>30</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Costs before DSA improvements.* Cleveland, which had the highest design SIR of 1.03, was estimated to more than double the project’s budget if required Department of State Architect (DSA) improvements had been performed. Doubling the budget without changing the energy savings would severely decrease the SIR.

Cost Effectiveness

- “Free”
  - Schedule changes
  - DHW disconnect
  - Sealing and caulking
- Generally cost effective
  - Interior and exterior lighting
  - Plug load management
- Maybe cost effective, if at end of useful life
  - HVAC, appliances
- Expensive, but enhanced non-energy benefits
  - Daylighting
Thanks!

Final Report:  

Carrie Brown  
carrie@resourcerefocus.com

Frontier Energy Heat Pump Water Heater Pilot  
Michael Slater, Frontier Energy
Using HPWHs in School Kitchens

Michael Slater, Engineer
mslater@frontierenergy.com
May 14, 2020

Outline

• Who is Frontier Energy?
• Previous work completed
• Current opportunity
32 years of Foodservice Energy Efficiency

Frontier energy operates The Food Service Technology Center

Original System Annual Operating Cost

- Water Heating Costs:
  - Gas cost $1,710
  - Electricity cost $25

- Dishwasher Costs:
  - Electricity cost $6,900

- Recirc. Pump and Recirc. Line Costs:
  - Gas cost $1,200
  - Electricity cost $160

- Water Use Costs:
  - Water/Sewer $13,770

Total Cost: $23,760
- Water Cost: $13,770
- Gas Cost: $2,910
- Electricity Cost: $7,080
Replacement System Operating Costs

**Original System Total: $23,760**
- Water Cost: $13,770
- Gas Cost: $2,910
- Electricity Cost: $7,080

**Replacement System Total: $18,112**
- Water Cost: $9,288 (32% savings)
- Gas Cost: $601 (77% savings)
- Electricity Cost: $8,223 (5% increase)

**Current Opportunity**
- California Title 24 has no mention of HPWHs as a commercial tech
- We want to retrofit schools and other CFS with HPWHs to write the new code guidelines for HPWHs for the 2022 revision
- We will solicit the IOUs for project funding in July 2020.
  - Project funding will include equipment and installation costs
- Currently looking for schools who:
  - Have functioning cafeterias
  - Are interested in participating in an energy savings program
  - Can write a letter of support to strengthen our proposal
Questions? Comments? Interest?

Please chat with me offline! Thanks for your time!

Michael Slater
mslater@frontierenergy.com
(916)832-6895

Technical Tools and Resources to Assist in Getting to Zero
HUB: Design and Process

ZERO ENERGY PROJECT GUIDE

A guide for planning, designing, constructing, and operating zero net energy buildings. This guide outlines the renewable energy systems, energy efficiency measures, and the design considerations to ensure a functional, sustainable, and healthy building.

SCHOOL REGENERATIVE ROADMAP NET ZERO SCHOOLS

This roadmap is designed for school stakeholders, including administrators, teachers, parents, and students to understand the process of transitioning to a zero net energy school. It includes the necessary steps and actions to achieve net zero energy status.

ZERO ENERGY SCHOOLS STAKEHOLDER MESSAGING GUIDE

This document provides guidance on how to effectively communicate the benefits of zero net energy schools to stakeholders. It includes messaging strategies and tips for engaging different audiences.

ZERO ENERGY SCHOOLS CHARRETTE TOOLKIT

A toolkit for school stakeholders to facilitate charrettes and workshops to discuss zero net energy schools. It includes resources for planning, executing, and following up on charrettes.

NBI's Tools for Zero Net Energy Schools
Zero Energy Schools Charrette Toolkit

- Leads you through the process of planning, hosting and executing a successful ZE school integrated design charrette
- Includes:
  - Checklists
  - Sample Agendas for attendees & facilitators
  - Sample Email Invitations
  - Activities
  - Templates

newbuildings.org/resource/zero-energy-schools-charrette-toolkit/

Zero Energy Schools Stakeholder Messaging Guide

- Key messages for communicating zero energy with stakeholders
- Supporting facts and citations for each key message targeted towards specific stakeholders
- Provides background on key stakeholders such as their mission and priorities
- Other key pieces of information for understanding each stakeholder and communicating effectively

newbuildings.org/resource/zero-energy-schools-stakeholder-engagement-guide/
Zero Net Energy Communications Toolkit

2019 Schools Zero Energy Watch List

- Find schools to tour
- Find schools that have verified to research or contact
- EUI, building size and other data of verified and emerging zero energy schools

newbuildings.org/resource/2019-zero-energy-schools-watchlist/
HUB: Existing Buildings

Filter by Topic:
- Select one or more topics to filter the list of resources:
  - CA
dependence
  - Communications
  - Design
  - Energy
  - Maintenance
  - Operational
  - Policies
  - Performance
  - Outreach

Benchmarking

Annually, in the U.S., K-12 schools spend $4 billion on energy—more than on print or computers and textbooks combined. Furthermore, one third of this energy is often wasted due to poorly functioning equipment, poor insulation, and outdated technology. Energy benchmarking can reduce the costs, especially if students and staff are actively engaged in monitoring and finding ways to reduce energy use.

California K-12 and Community College Zero Net Energy Retrofit Readiness Study

The California K-12 and Community College Zero Net Energy Retrofit Readiness Study provides recommendations to California’s K-12 school districts and other key stakeholders on how to reduce energy and water use. The study also identifies common barriers to implementing energy retrofits in California schools.

Advanced Energy Retrofit Guide for K-12 Schools

This guide provides step-by-step guidance on how to implement energy retrofits in K-12 schools. It includes case studies and best practices, as well as tools and resources for identifying and implementing energy savings opportunities.

HUB: Schools and Districts

Filter by Topic:
- Select one or more topics to filter the list of resources:
  - Planning
  - Design
  - Energy
  - Projects
  - Policies
  - Maintenance
  - Outreach

Getting to Zero Energy in Schools is Achievable: Stories from Schools on the Path to Zero

This report highlights projects that have demonstrated the successful implementation of low-energy school construction. It provides lessons learned from these projects and highlights the benefits of adopting energy-efficient design and construction practices.

San Francisco Unified School District Carbon Reduction Plan

This report outlines the strategies and actions taken by San Francisco Unified School District to achieve its carbon reduction goals. It includes details on the district’s energy management practices and how they have led to reduced energy usage and greenhouse gas emissions.

San Francisco Unified School District Project Requirements

This report lists the requirements and standards for energy-efficient design and construction practices in new and existing school buildings. It includes details on the district’s energy performance standards, building codes, and operational practices.
HUB: State and National

Filtered by Topic
Select one or more topics to filter the list of resources.
- Benchmarking
- Communications
- Design
- Energy
- Energy Efficiency
- Document Engagement
- Operation
- Policy
- Practices
- Renovations
- Partnerships
- Smart Energy
- Programs

California Prop 39 ZNE Pilot Program

The Proposition 39 ZNE School Refit Pilot Program provides school districts with additional financial resources to retrofit some of California’s existing K-12 and community college buildings to ZNE. In addition to the funding provided through the pilot program, some districts have implemented a district-wide ZNE retrofit program to accommodate the energy savings resulting from the initial funding.

Washington Sustainable Schools Protocol (WSSP)

The Washington Sustainable Schools Protocol (WSSP) is a framework for high-performance schools in Washington. WSSP is designed to support school districts in the design and construction of high-performance school buildings. The protocol focuses on energy efficiency, indoor air quality, water conservation, and other sustainability goals.

Maryland Net Zero Energy School Initiative Grant Program

The Maryland Net Zero Energy School Initiative Grant Program is a program that provides financial assistance to school districts to design and construct new or retrofits of K-12 schools to meet the net-zero energy standard. The program aims to reduce energy costs and greenhouse gas emissions associated with school facilities.

Zero Net Energy Case Studies

https://gettingtozeroforum.org/schools/
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
How to Use the AEDG

• New construction focused but very applicable to retrofits
• Prescriptive path to achieve zero energy
• How set energy (EUI) targets
• Use modeling throughout design and construction
• Strategies for plug loads, lighting, building envelope, HVAC and more!
• Includes guidance for on-site renewable energy generation
• Using zero energy as a catalyst for student learning

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
Zero Energy Process Guide

- Applicable to a broad stakeholder audience
- New construction focused but applicable to retrofits
- Outlines the steps to procuring a zero energy school
- Guidance on how process decisions affect energy

Center for Green Schools Learning Lab

Curriculum resources for climate literacy, energy efficiency… and more!

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

© New Buildings Institute 2020
Additional Resources

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

By Isabela R.
2nd Grade

Schools, schools, schools are great.
They help you learn with number plates.
Schools are awesome, math is too.
Some Desks seat 1 - Others seat 2.
At Recess you can go on merry-go-round,
or seesaw that goes up and down!