Bishop O'Dowd High School | Oakland, CA *Credit: David Wakely Photography*

A Deeper Dive into Zero Net Carbon Schools

May 14, 2020

nbi new buildings institute

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

SILICON VALLEY energy watch

Pacific Gas and Electric Company

City of San Jose Capital of Silicon Valley Environmental Services

Partnership for Energy Efficiency

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/

nbi new buildings institute

nbi new buildings institute

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

The Kathleen Grimm School for Leadership and Sustainability | Staten Island, NY
Credit: SOM

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

Richardsville Elementary | Bowling Green, KY
Creditt: Sherman-Carter-Barnhart Architects

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 Kathleen Grimm School for Leadership and Sustainability | Staten Island, New York Credit: SOM

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

Credit: San Francisco Unified School District

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/

The Kathleen Grimm School for Leadership and Sustainability | **Staten Island, New York** Credit: SOM

Involving the Community in Achieving Goals

Student Benchhmarking 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

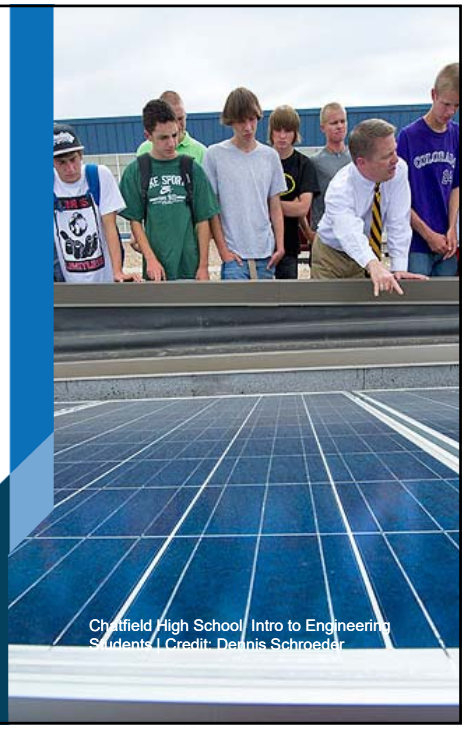
- Zero Hero brings all stakeholders to the table (utilities, staff, consultants, etc.)
- Zero Hero maintains status through construction and design
- Conversations with school staff after construction is crucial to the outcome

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

SILICON VALLEY energy watch
Pacific Gas and Electric Company
CITY OF SAN JOSE
Partnership for Energy Efficiency

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

INTEGRAL

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

IMAGINE | PERFORM | ACCELERATE | SUSTAIN

22
AIA COTE Top Ten Awards

15
ASHRAE 1st Place Awards

100+ Zero Net Energy Projects

TOP ZERO ENERGY MEP FIRM
BASED ON NBI'S 2018 GETTING TO ZERO REPORT

55+
LEED Platinum Certified Projects

IMAGINE | PERFORM | ACCELERATE | SUSTAIN

ZERO NET…

Electric Energy (ZNEE)

Building burns fossil fuel.

100% of net annual electrical use is offset by on site renewable energy.

Energy (NZE)

Building burns fossil fuel.

100% of net annual energy use (including fossil fuel use) is offset by on site renewable energy.

Carbon (ZNC)

Building does not burn fossil fuel.

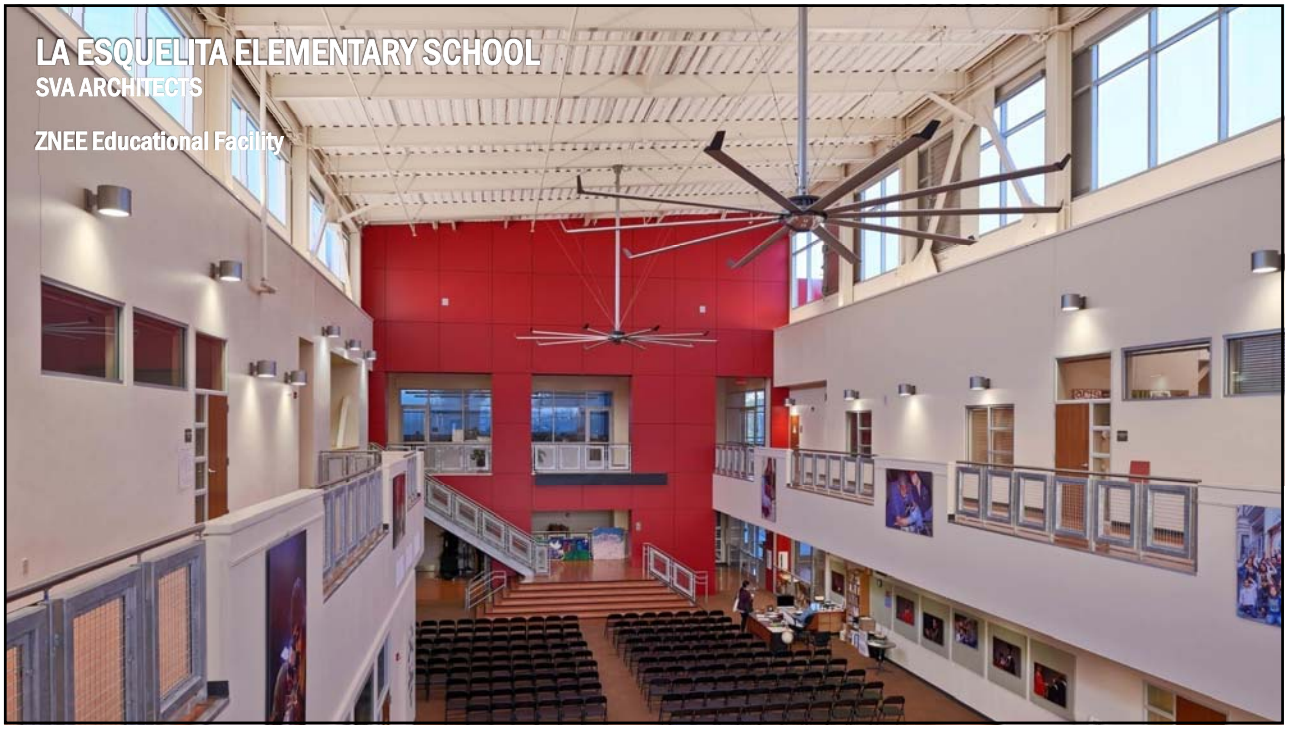
100% of net annual energy use is offset by on site renewable energy.

IMAGINE | PERFORM | ACCELERATE | SUSTAIN


DELMAR HIGH SCHOOL SCIENCE WING
DREILING TERRONES ARCHITECTURE
ZNEE Educational Facility


CAMPBELL UNION HIGH SCHOOL DISTRICT PARKING PV'S
BARTOS ARCHITECTURE
ZNEE Educational Facility


METWEST HIGH SCHOOL
SVA ARCHITECTS
ZNEE Educational Facility

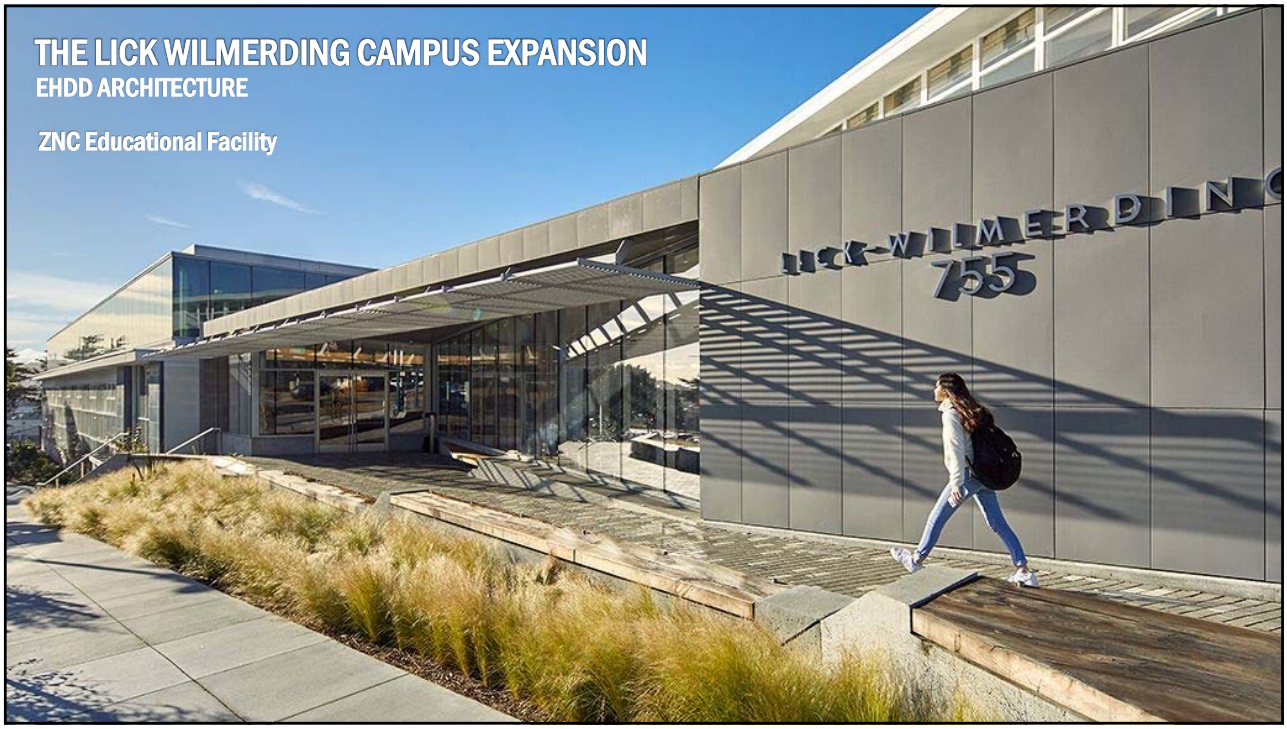

LA ESQUELITA ELEMENTARY SCHOOL
SVA ARCHITECTS
ZNEE Educational Facility


LEYVA MIDDLE SCHOOL ADMINISTRATION BUILDING - 2011
AEDIS ARCHITECTS
ZNC Educational Facility
GEORGE V. LEYVA
MIDDLE SCHOOL
FIRE LANE


EWA BEACH ELEMENTARY SCHOOL PORTABLE BUILDING
ANDERSON ANDERSON ARCHITECTURE
ZNC School Portable


CAMPBELL UNION SCHOOL DISTRICT MULTIPURPOSE BUILDINGS
AEDIS ARCHITECTS
ZNC Educational Facility
Wed. Aug. 28th
6:00PM
Blackford
ELEMENTARY SCHOOL
Campbell

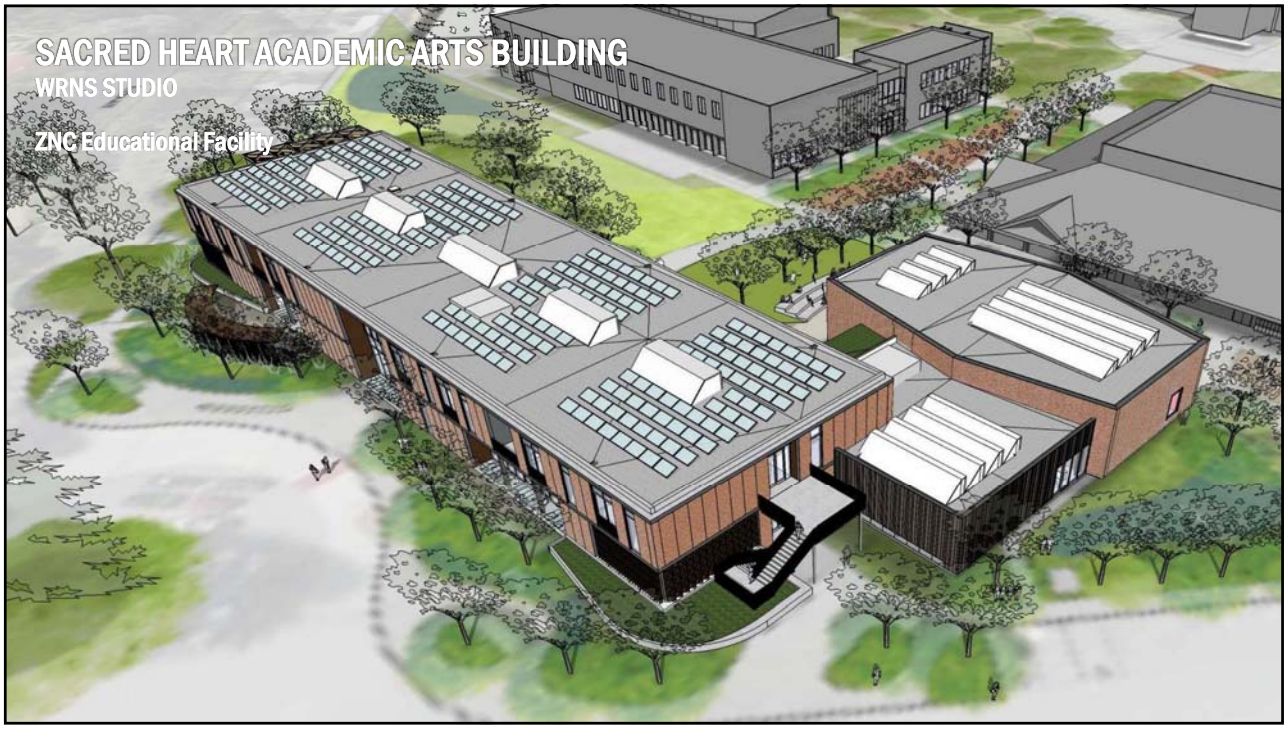

OUSD GLENVIEW ELEMENTARY
HKIT ARCHITECTS
ZNC Educational Facility


THE LICK WILMERDING CAMPUS EXPANSION
EHDD ARCHITECTURE
ZNC Educational Facility
755


SONOMA ACADEMY GRANGE BUILDING
WRNS STUDIO
ZNC Educational Facility


BISHOP O'DOWD H.S. ENVIRONMENTAL EDUCATION BUILDING
SIEGEL + STRAIN ARCHITECTS
ZNC Educational Facility


THE MARK DAY SCHOOL
EHDD ARCHITECTURE
ZNC Educational Facility


SACRED HEART ACADEMIC ARTS BUILDING
WRNS STUDIO
ZNC Educational Facility


THE MARIN COUNTRY DAY SCHOOL SCIENCES BUILDING
EHDD ARCHITECTURE
ZNC Educational Facility


THE CASTILLEJA SCHOOL CAMPUS EXPANSION
WRNS STUDIO
ZNC Educational Facility (In design)


PITZER COLLEGE REDFORD CONSERVATORY
CARRIER JOHNSON + CULTURE
ZNC Educational Facility


CSU EAST BAY CORE LIBRARY
CARRIER JOHNSON + CULTURE
ZNC Educational Facility (In design)


UC MERCED DOWNTOWN CENTER
HELLER MANUS ARCHITECTS
ZNC Educational Facility

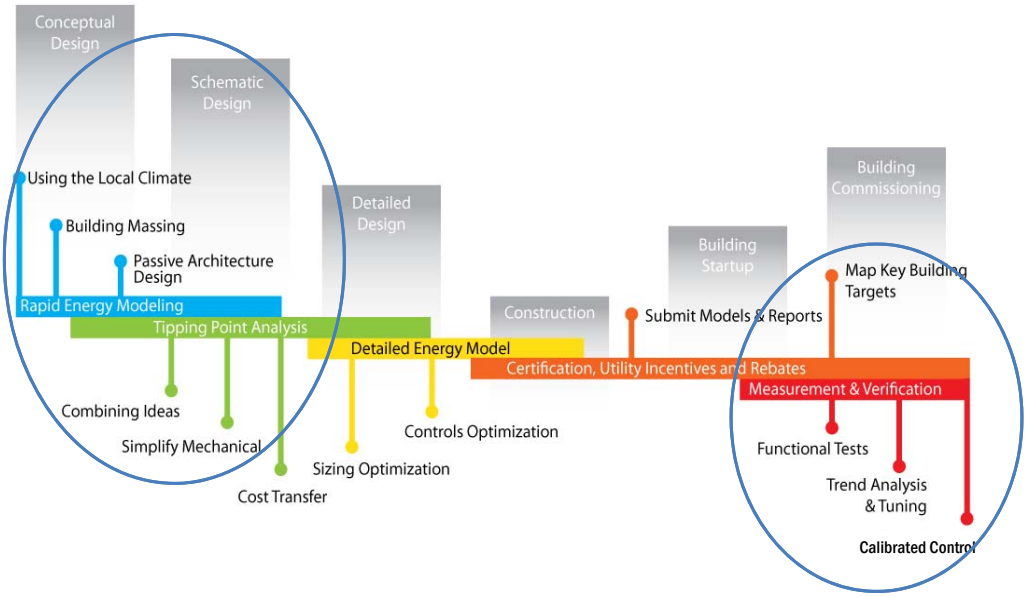

INDIO BUILDING
RMW ARCHITECTURE & INTERIORS
For Profit Remodel ZNC Spec Office
Other significant ZNC Projects
435


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


WATSONVILLE WATER CENTER
WRNS STUDIO
ZNC Municipal Building
Other significant ZNC Projects

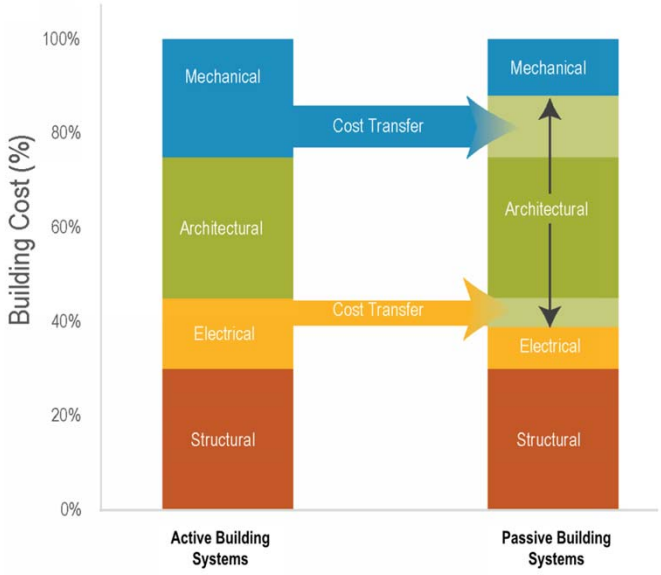

HALF MOON BAY LIBRARY
NOLL & TAM ARCHITECTS
ZNC Community Building
Other significant ZNC Projects

PROCESS: TRADITIONAL VS HIGH PERFORMANCE DESIGN



IMAGINE | PERFORM | ACCELERATE | SUSTAIN

PROCESS: PASSIVE SYSTEM COST TRANSFER



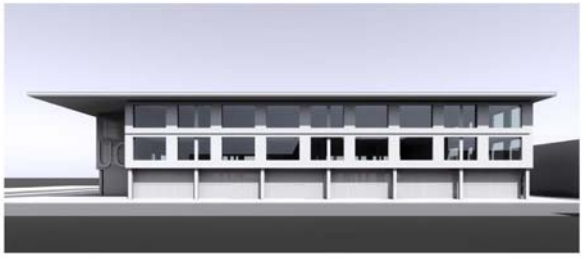
IMAGINE | PERFORM | ACCELERATE | SUSTAIN

SKIN :: HVAC :: LIGHT :: PLUGS :: RENEWABLES

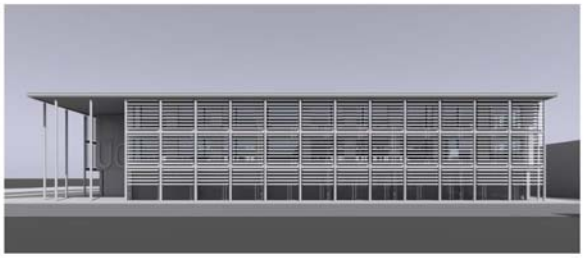
PPG Solarban 70xl	Saint Gobain CLEX 60/28 II	PPG Solarban 70xl + 9" West Façade Fins	PPG Solarban 70xl + 30" West Façade Fins	PPG Solarban 70xl + 50% WWR
EUI: **72**	EUI: **65**	EUI: **65**	EUI: **55**	EUI: **54**
Tonnage: **580**	Tonnage: **530**	Tonnage: **570**	Tonnage: **570**	Tonnage: **430**
System Cost: **$696,000**	System Cost: **$636,000**	System Cost: **$684,000**	System Cost: **684,000**	System Cost: **$516,000**
$/sf **3.1**	$/sf **2.8**	$/sf **3.0**	$/sf **3.0**	$/sf **2.3**

SKIN :: HVAC :: LIGHT :: PLUGS :: RENEWABLES

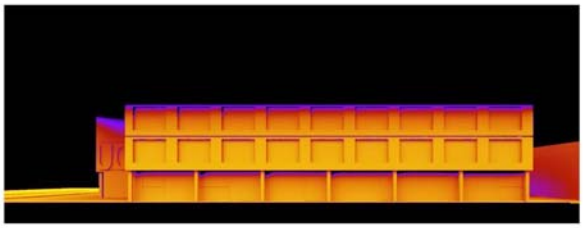
South Façade Reference Image



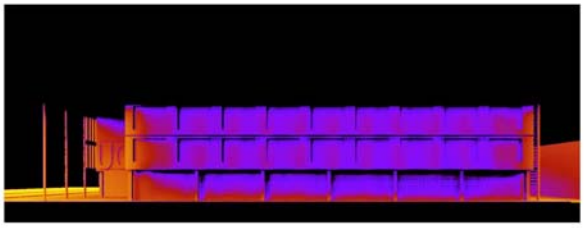
South Façade Reference Image

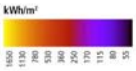


South Façade Annual Radiation on the Building Skin



South Façade Annual Radiation on the Building Skin





~ 90 % Reduction in Solar Radiation Striking the South Glass

UC Merced Downtown Center, Merced CA - Heller Manus Architects

SKIN :: **HVAC** :: LIGHT :: PLUGS :: RENEWABLES

Heat Pumps. Heat Pumps. Heat Pumps.

AIR SOURCE HEAT PUMP

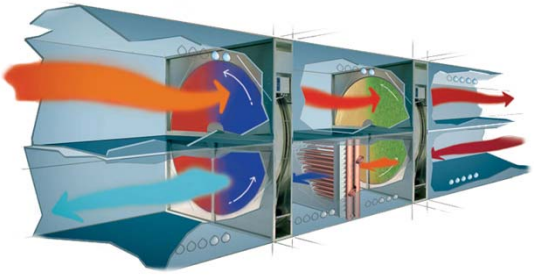
VRF HEAT PUMP

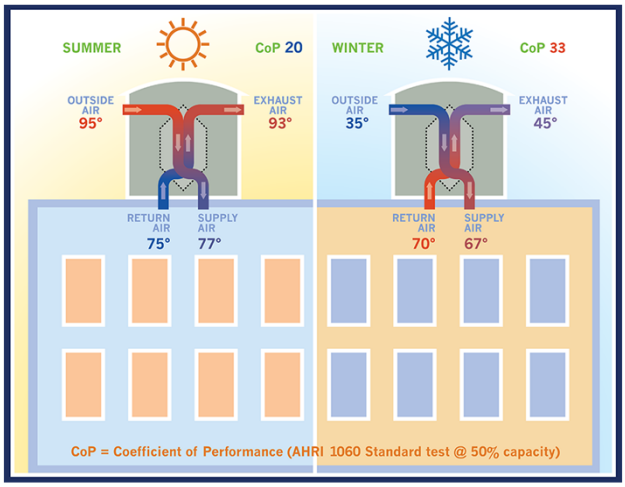
DOMESTIC HW HEAT PUMP

PACKAGED ROOFTOP HEAT PUMP

SKIN :: **HVAC** :: LIGHT :: PLUGS :: RENEWABLES

DOAS with Heat Recovery

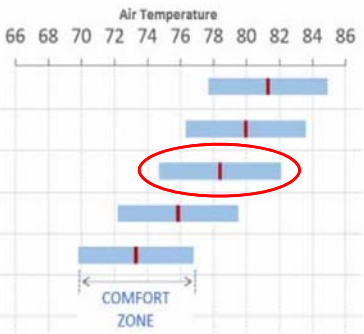




SKIN :: **HVAC** :: LIGHT :: PLUGS :: RENEWABLES

Expanded Comfort With Ceiling Fans

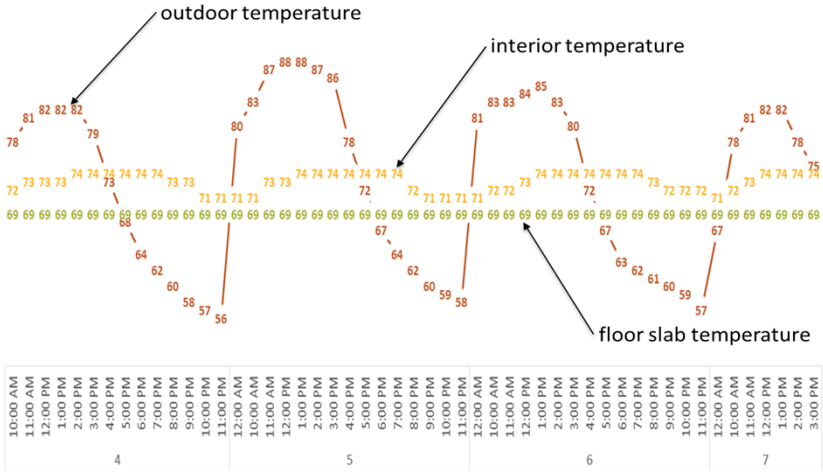
	Air Speed (ft/min)	CENTER OF COMFORT ZONE (°F)	FAN COOLING (ΔT°F)
Walking Speed	260	81	8
Max without control - ASHRAE 55	160	80	7
Typical Design Speed	100	79	5
Low speed	50	76	3
Still air	20	73	-



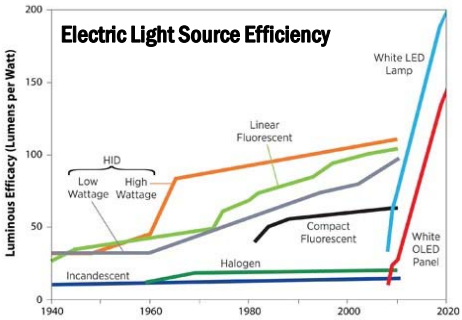
From the Center for Built Environment & TRC

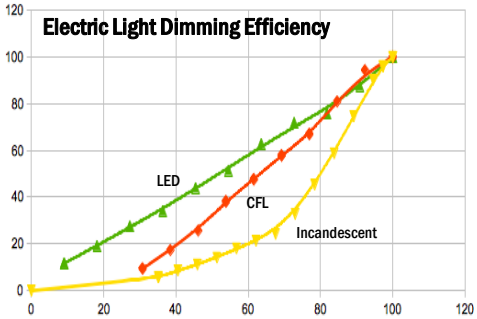
SKIN :: **HVAC** :: LIGHT :: PLUGS :: RENEWABLES

Night Flush + Natural Ventilation



SKIN :: HVAC :: **LIGHT** :: PLUGS :: RENEWABLES

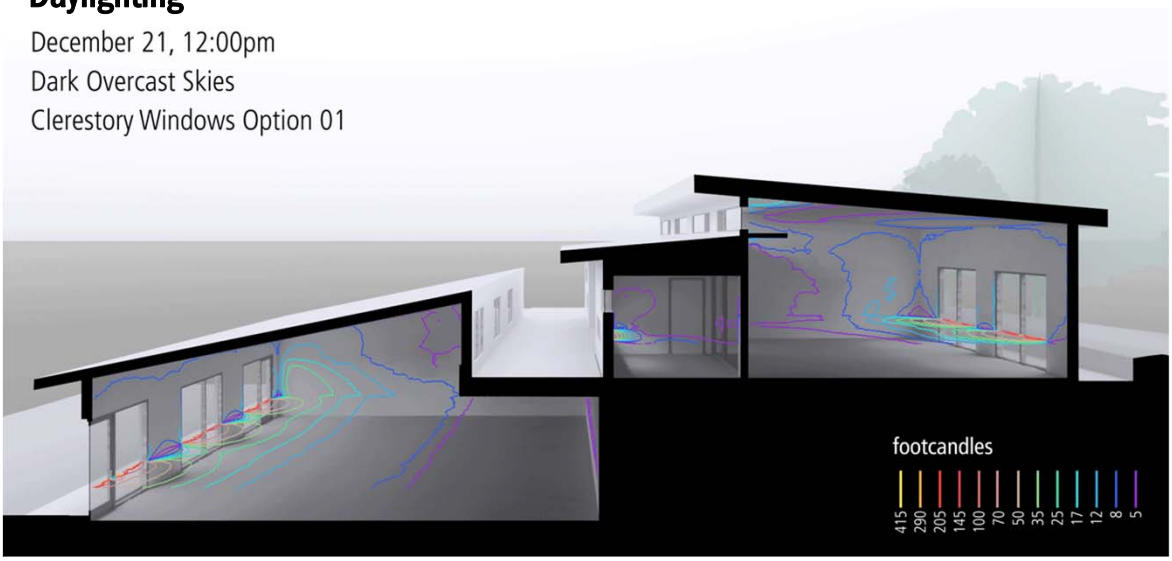




SKIN :: HVAC :: **LIGHT** :: PLUGS :: RENEWABLES

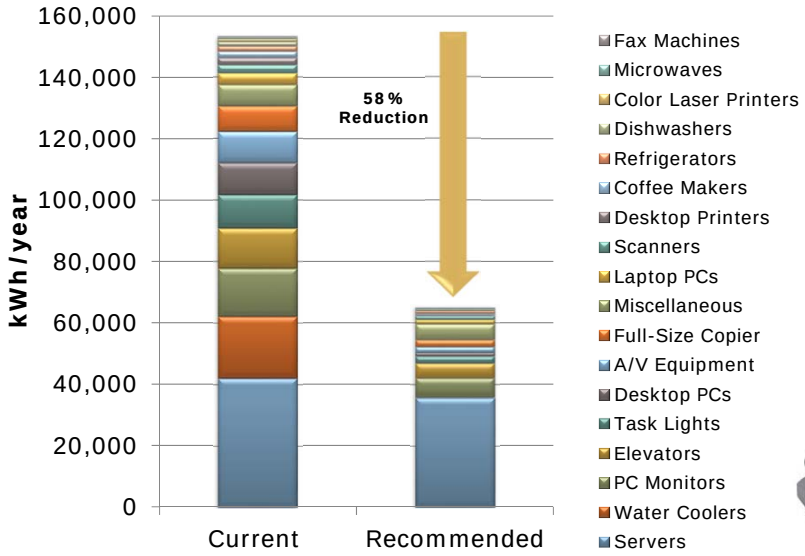
Daylighting

December 21, 12:00pm
Dark Overcast Skies
Clerestory Windows Option 01



SKIN :: HVAC :: LIGHT :: **PLUGS** :: RENEWABLES

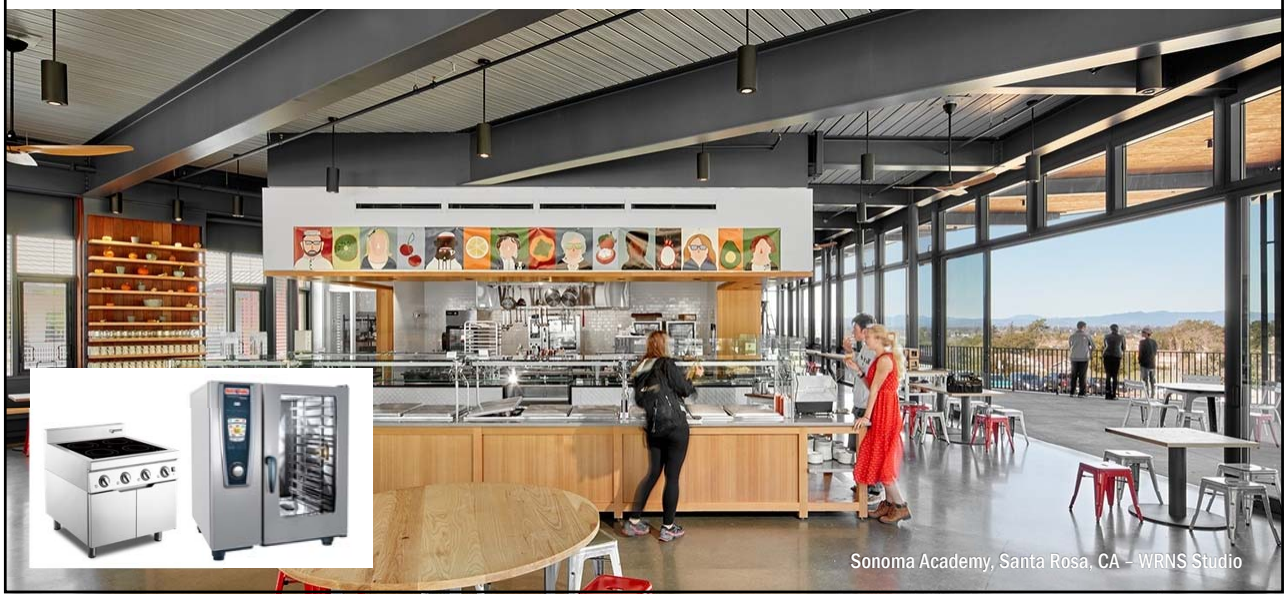
Packard Foundation – Plug Load Reduction



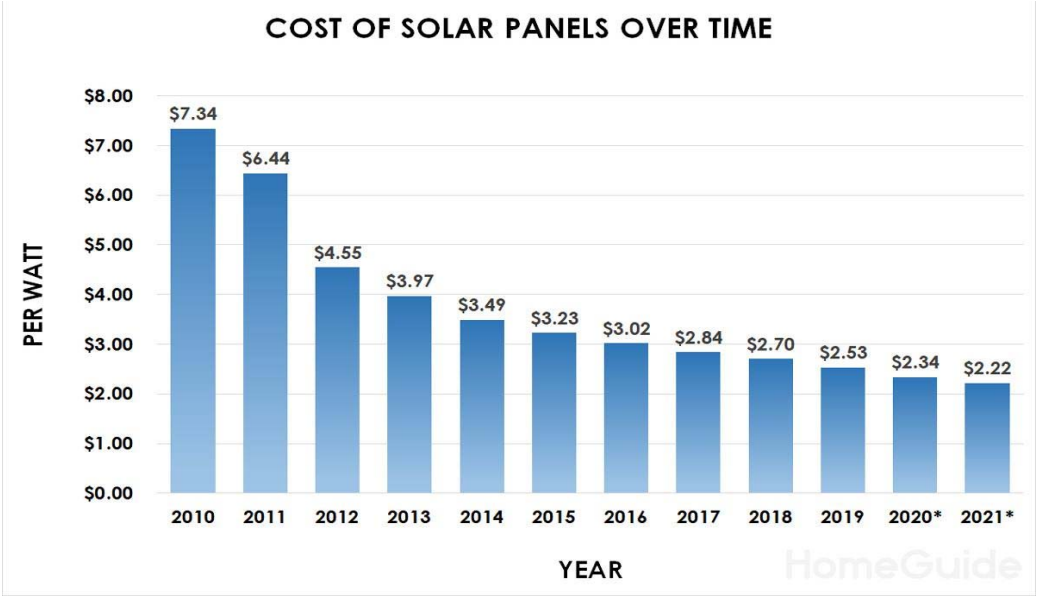
Plug Load Controls

SKIN :: HVAC :: LIGHT :: **PLUGS** :: RENEWABLES

Kitchens: Induction Range, Combi Ovens, etc.


Sonoma Academy, Santa Rosa, CA – WRNS Studio

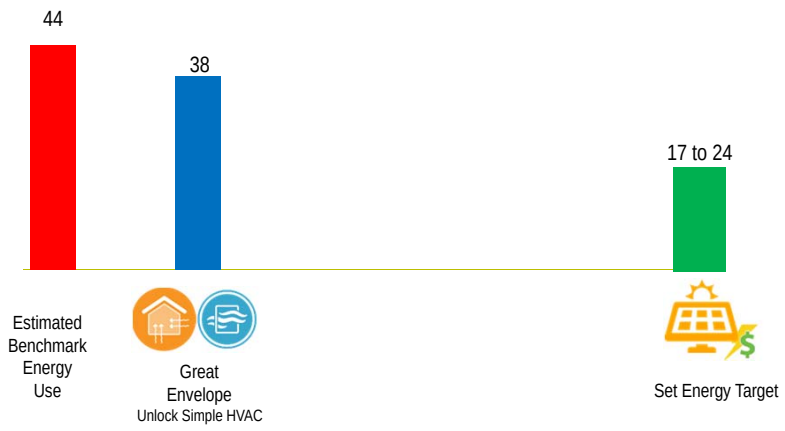
SKIN :: LIGHT :: HVAC :: PLUGS :: RENEWABLES



Pathway to ZNE

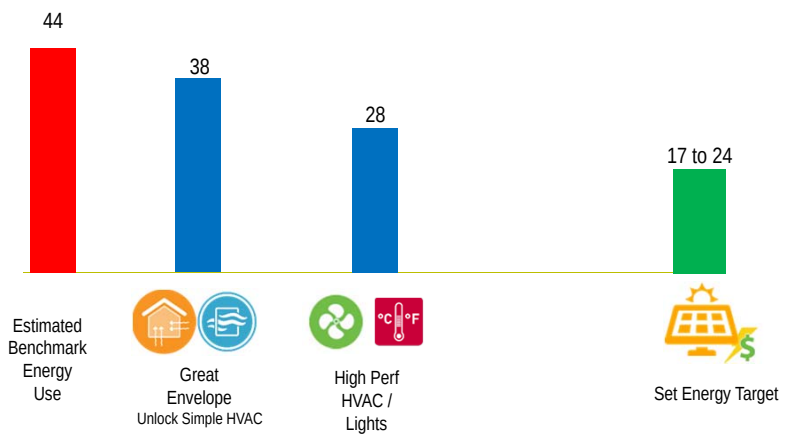
IMAGINE | PERFORM | ACCELERATE | SUSTAIN

Pathway to ZNE



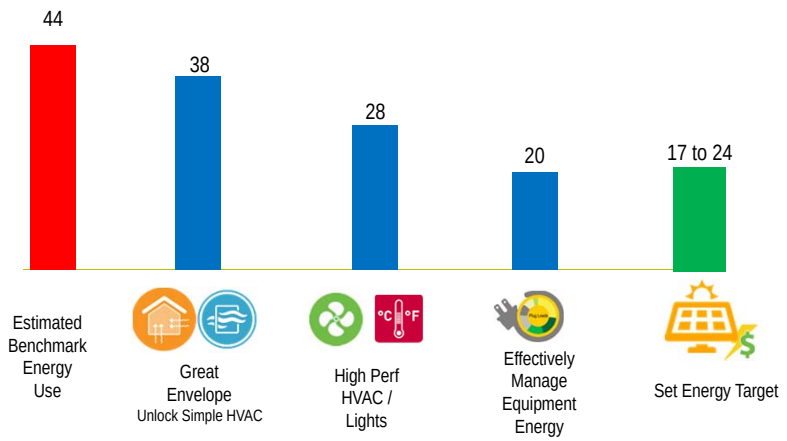
IMAGINE | PERFORM | ACCELERATE | SUSTAIN

Pathway to ZNE



IMAGINE | PERFORM | ACCELERATE | SUSTAIN

Pathway to Zero Net Carbon

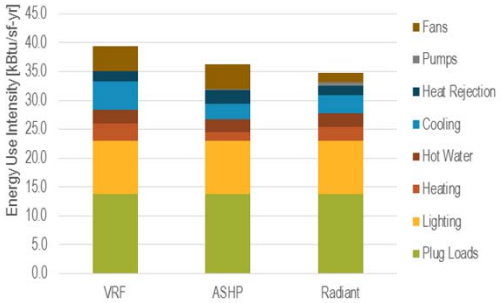


IMAGINE | PERFORM | ACCELERATE | SUSTAIN

Mechanical Options – Schematic Design

VRF HEAT PUMP

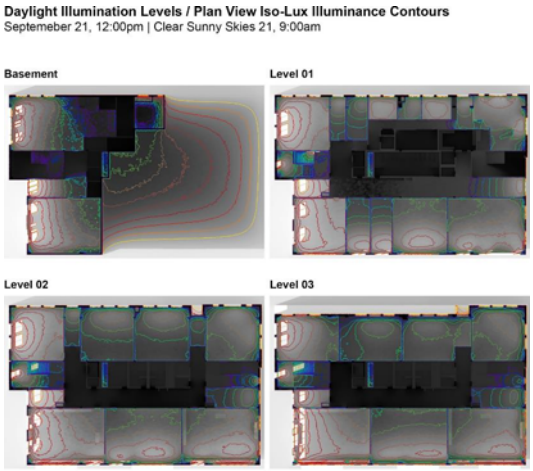
AIR SOURCE HEAT PUMP

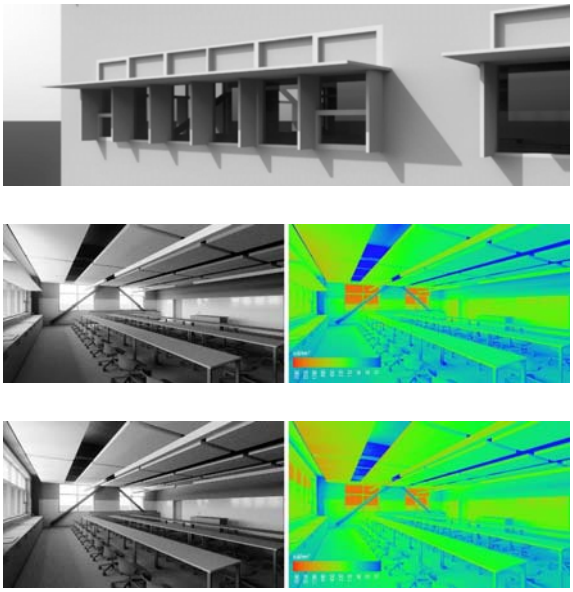


FAN COIL UNIT

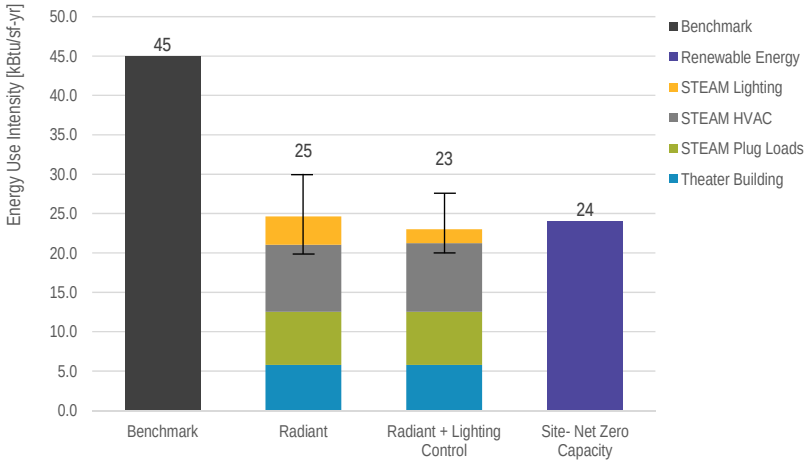
RADIANT COOLING/HEATING

Daylight Modeling



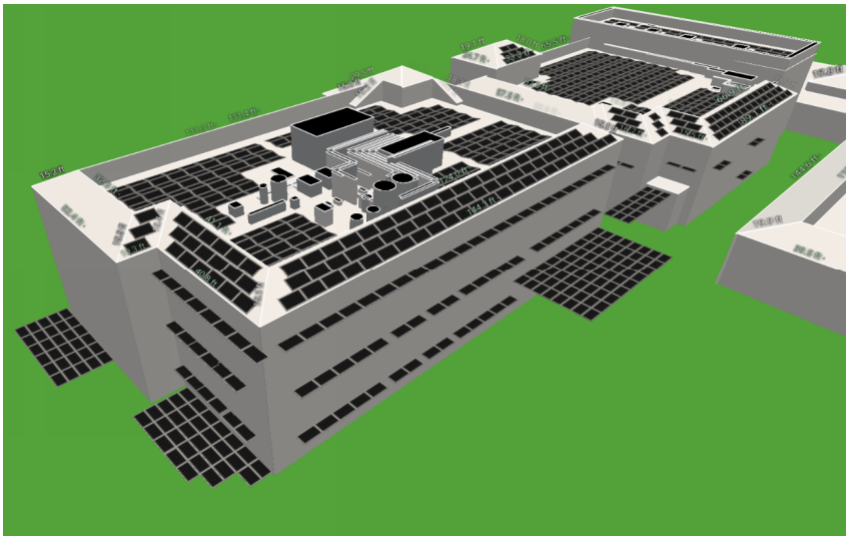


Mechanical Options Refined – Design Development



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

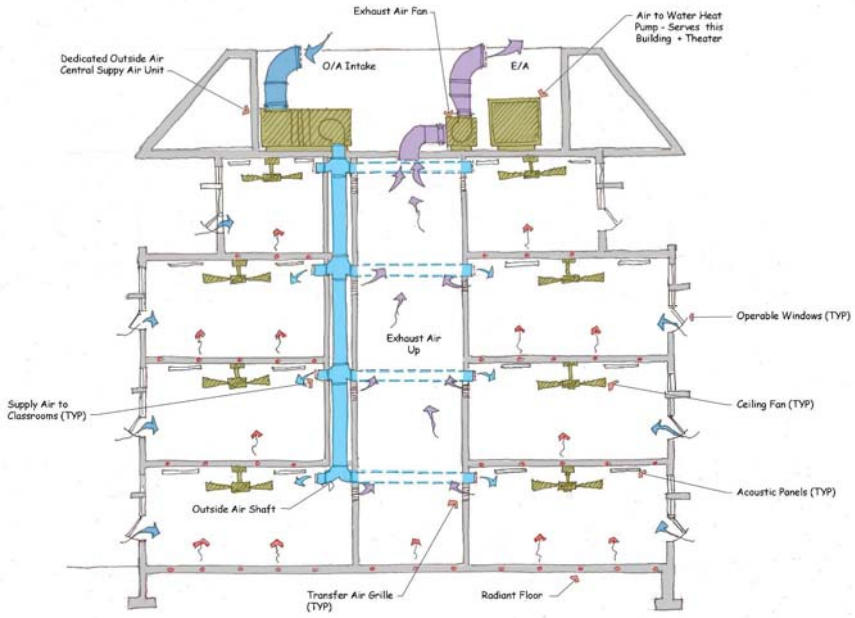
PV Layout for Zero Net Energy + Zero Net Carbon Operation



IMAGINE | PERFORM | ACCELERATE | SUSTAIN

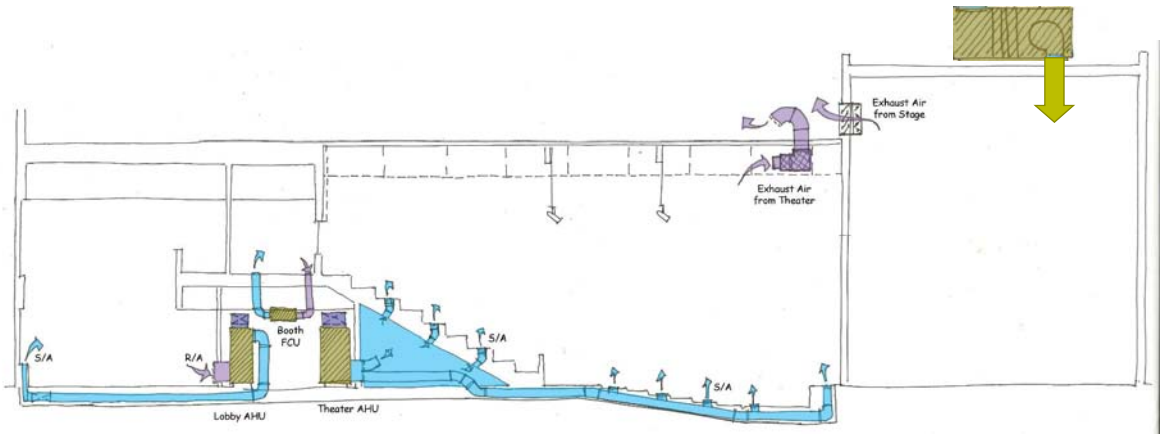
PUSD STEAM

- 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



IMAGINE | PERFORM | ACCELERATE | SUSTAIN

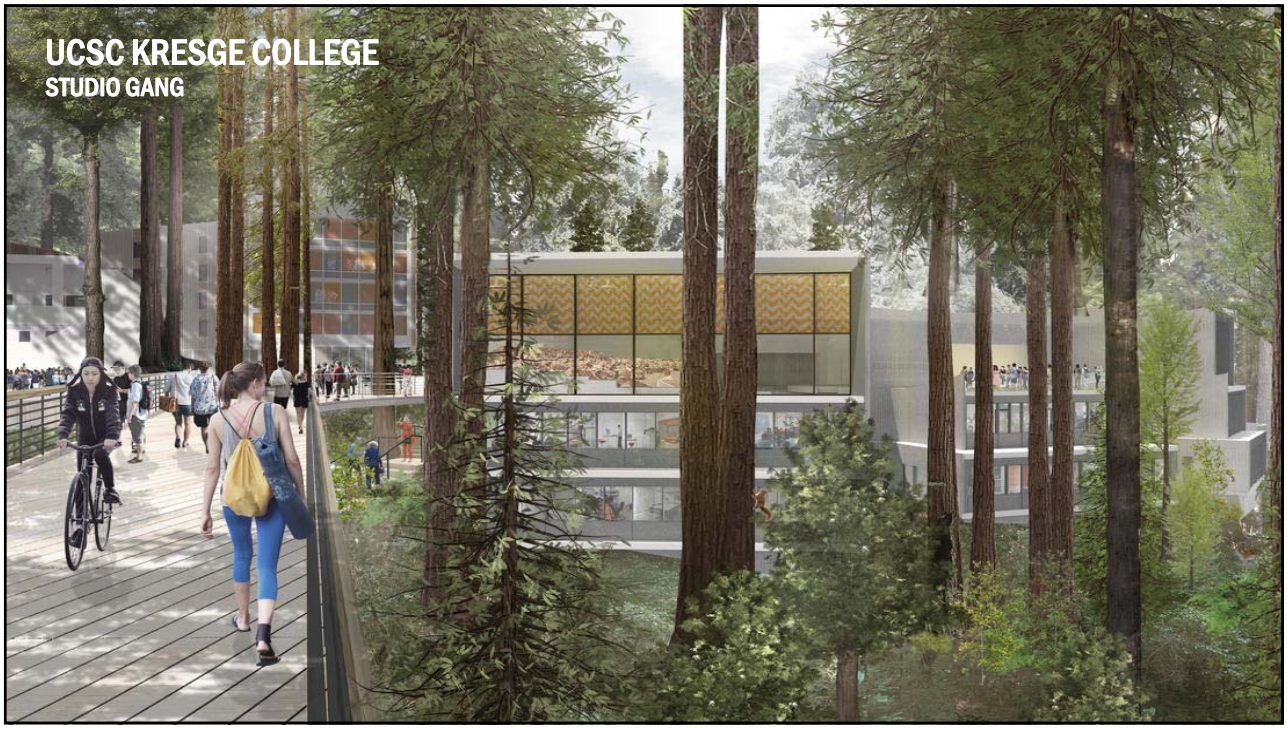
PUSD Theater

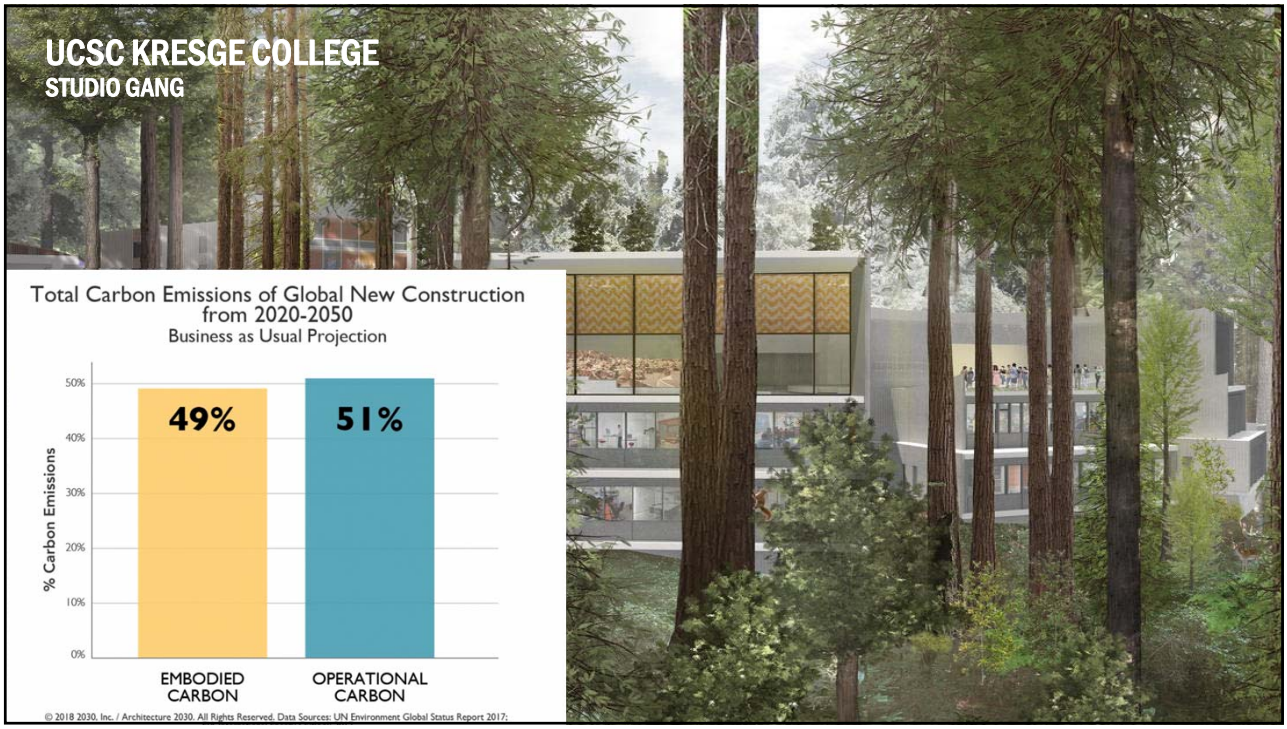


- Low displacement ventilation cooling
- CHW and HW from the other building (STEAM Building)
- Packaged heat pump for Stage
- All-electric operation
- Superior thermal comfort and indoor air quality

IMAGINE | PERFORM | ACCELERATE | SUSTAIN

WHATS NEXT?



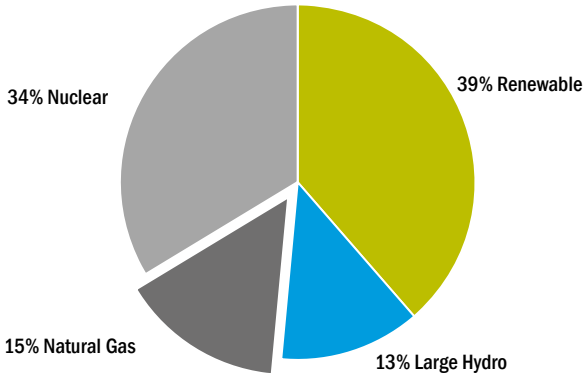


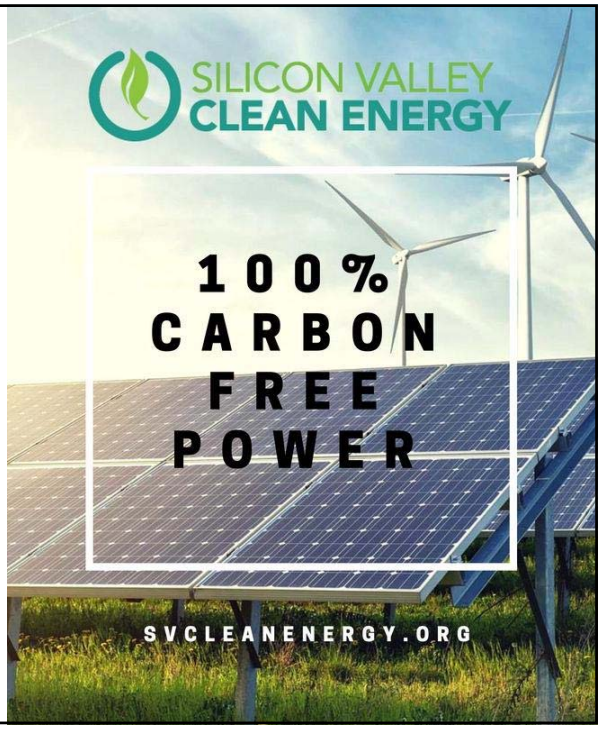
NET CARBON FREE UTILITY POWER

Also available:

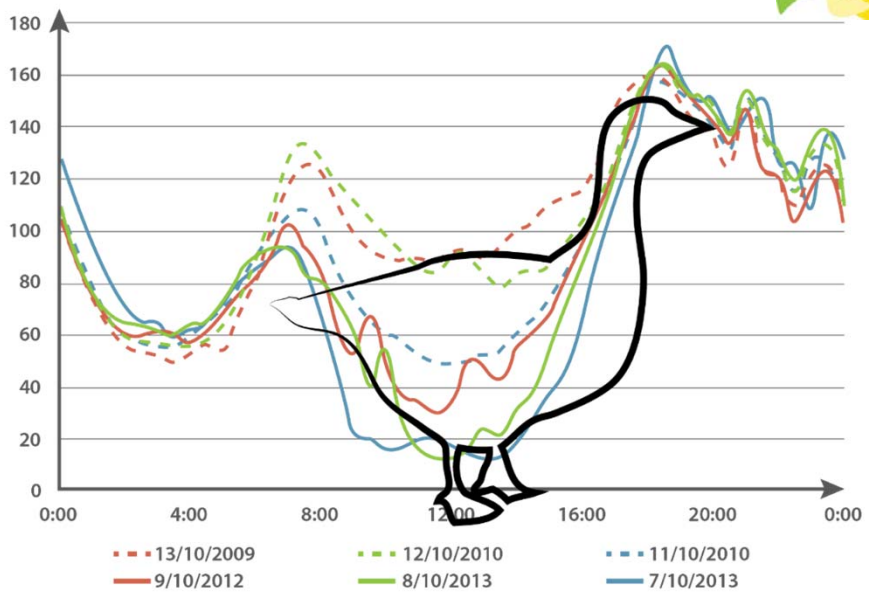
- 50% Solar
- 100% Solar
- 25% Regional Solar
- 100% Regional Solar

PG&E Standard Electric Power Mix



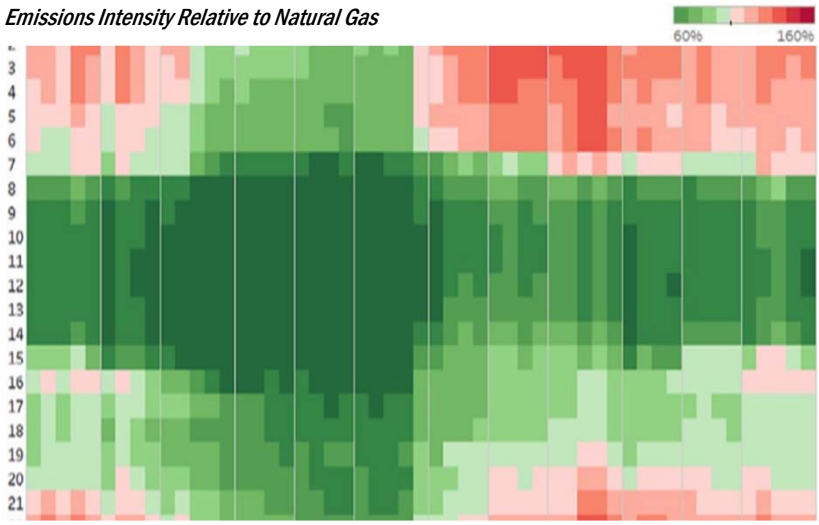


REAL TIME CARBON ON THE GRID



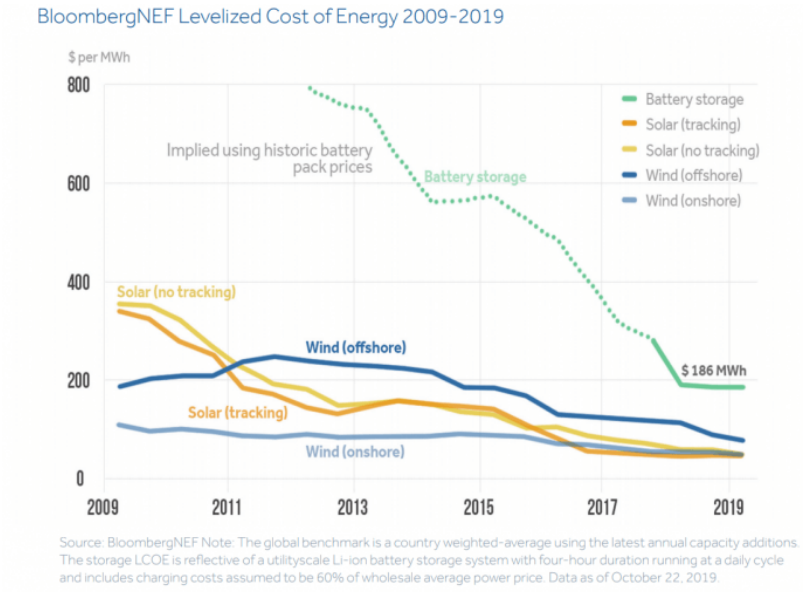
REAL TIME CARBON ON THE GRID

Emissions Intensity Relative to Natural Gas



WHY ON CAMPUS RENEWABLES?

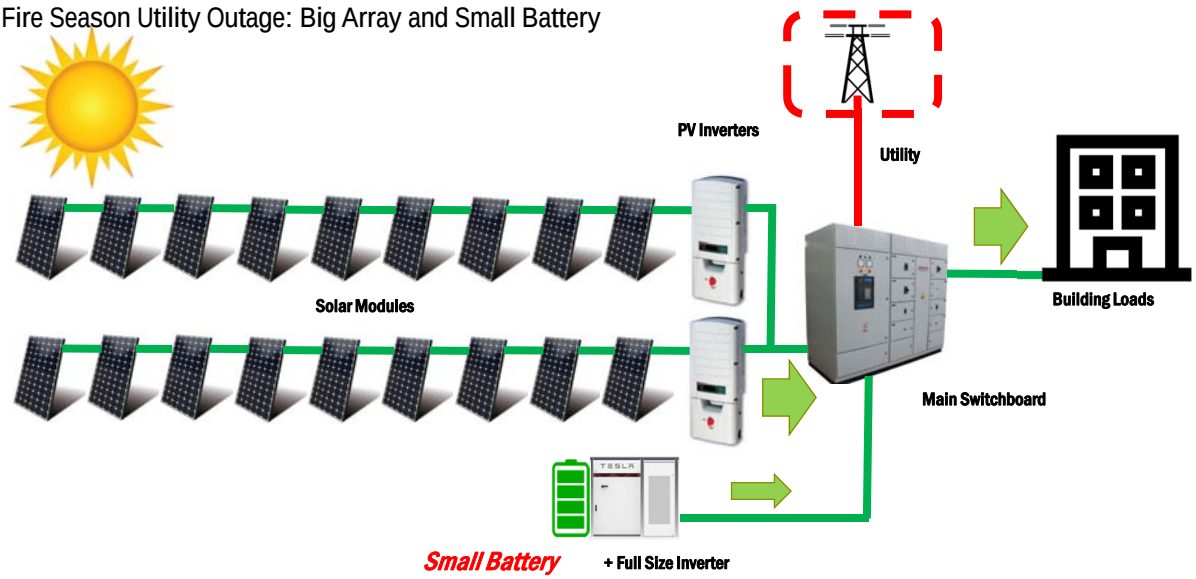
RENEWABLES + ENERGY STORAGE



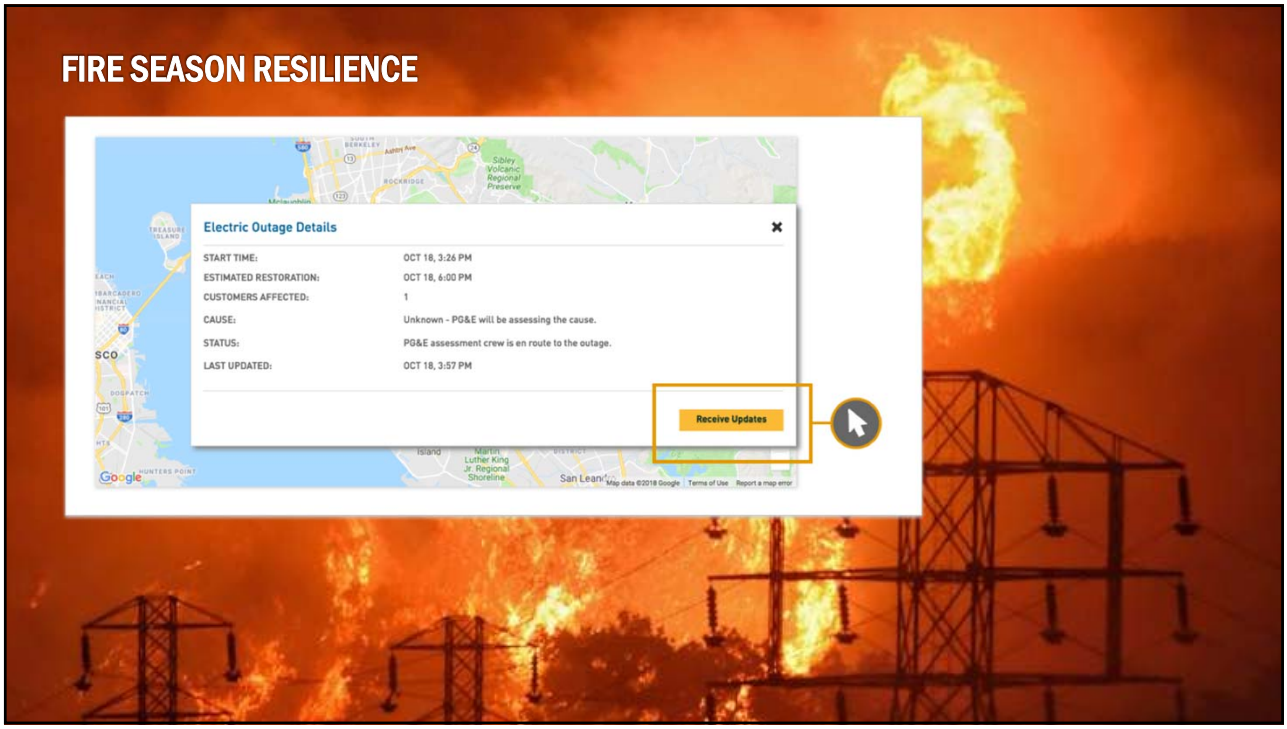
Source: BloombergNEF Note: The global benchmark is a country weighted-average using the latest annual capacity additions. The storage LCOE is reflective of a utilityscale Li-ion battery storage system with four-hour duration running at a daily cycle and includes charging costs assumed to be 60% of wholesale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

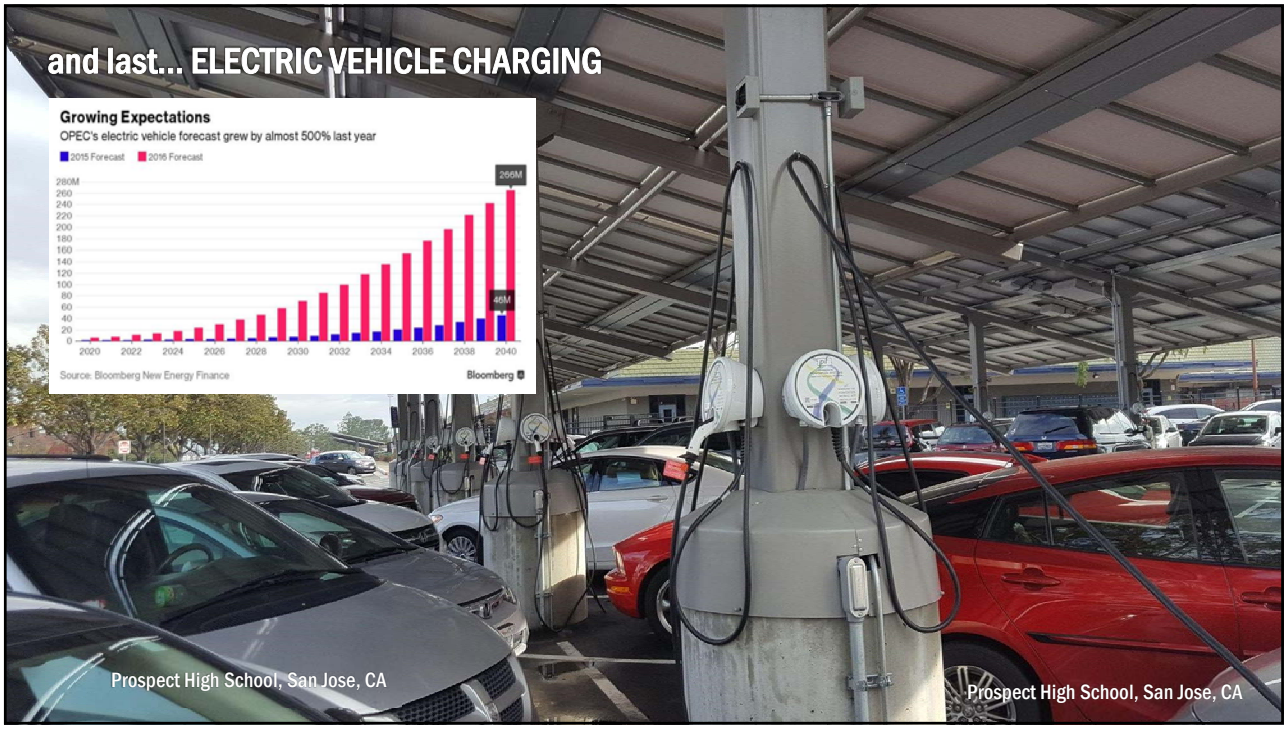
FIRE SEASON RESILIENCE: SOLAR/BATTERY MICROGRID

Fire Season Utility Outage: Big Array and Small Battery



FIRE SEASON RESILIENCE





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

RESOURCE REFOCUS

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

Final Report: https://www.etcc-ca.com/reports/zero-net-energy-pilot-local-educational-agencies-and-community-colleges

IOU Prop 39 ZNE Retrofit Pilot

EUI Reduction Potential by Building Type

Building Type	Baseline EUI kBtu/sf	Post-retrofit EUI kBtu/sf
Primary	48.2	22.4
Secondary	52.2	20.4
Portable	89.1	29.2

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

ZNE retrofits in the pilot targeted16-22 kBtu/sf EUI.

A Note on ZNE vs. ZC

ZNE

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

Energy Form	Source Energy Conversion Factors
Imported Electricity	3.15
Exported Renewable Elec	3.15
Natural Gas	1.09
Fuel Oil	1.19
Propane	1.15

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

ZC

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

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.

Guiding Lessons Learned

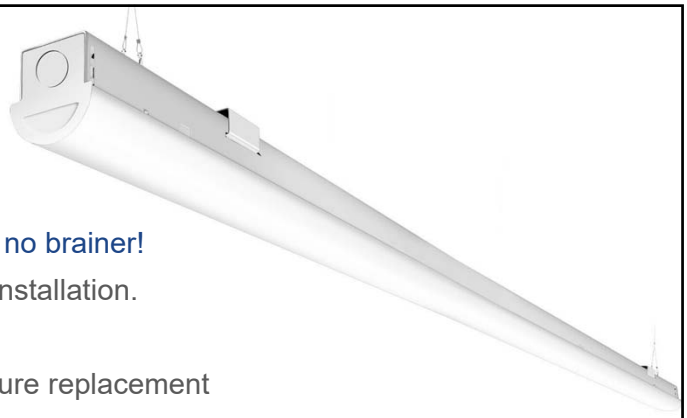
Technologies

Cost and Energy Impact

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

Credit: Newcastle Elementary School District

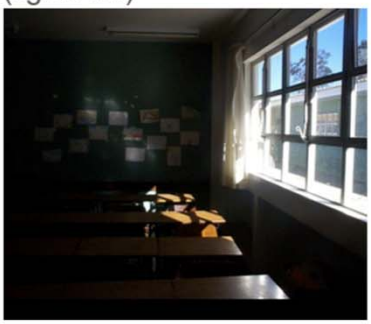
Daylighting

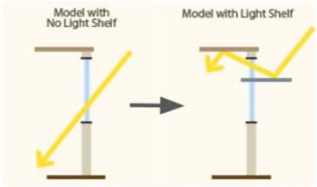
- Harness existing systems first
  - Blocked skylights, clerestories, and light shelves
- Introduce
  - Tubular skylights
  - Light shelf retrofits

Image source: Point Energy Innovations. 2018 Getting to Zero Forum.

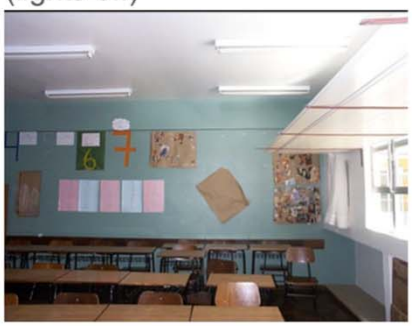
Daylighting

Before light shelf retrofit
(lights off)





After light shelf retrofit
(lights off)



High luminance difference;
room feels dark

Balanced reflected luminance;
room feels comfortable

Image source: Point Energy Innovations. Newcastle Daylighting presentation.

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.

Image sources: Point Energy Innovation. Cleveland Elementary School
Oakland Unified School District (OUSD) Oakland, CA
Zero Net Energy Study

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_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 has 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*)

Image source: http://news.mit.edu/2009/caulk-0518

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

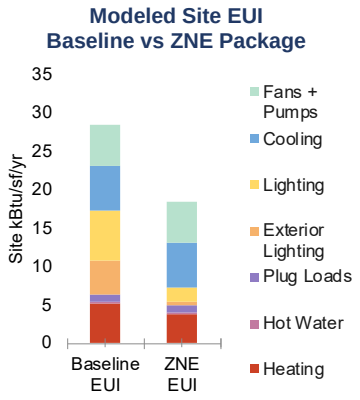
Technologies

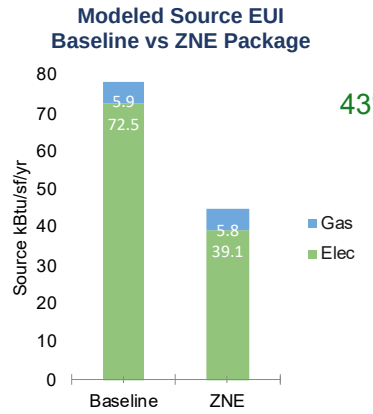
Cost and Energy Impact

	SITE ENERGY*					SOURCE ENERGY*				
	Baseline EUI kBtu/sf/yr	ZNE EUI kBtu/sf/yr	% Savings	ZNE Net EUI kBtu/sf/yr	% Savings	Baseline EUI kBtu/sf/yr	ZNE EUI kBtu/sf/yr	% Savings	ZNE Net EUI kBtu/sf/yr	% Savings
Average	**32.4**	**18.9**	**39%**	**-1.1**	**102%**	**88.6**	**51.5**	**40%**	**-10.7**	**112%**
Min	17.3	5.3	14%	-18.3	63%	33.6	13.4	14%	-57.7	90%
Max	67.2	26.9	69%	11.6	160%	170.3	73.2	60%	8.5	178%

37% savings

Lighting often the highest savings, followed by HVAC





43% savings

*1 outlier removed

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.

[1] https://ww2.energy.ca.gov/efficiency/proposition39/ee_plans/documents/Energy_Savings_Calculator_Version_8-1.xlsx

[2] Proposition 39 K-12 Program: California Clean Energy Jobs Act – 2016 Energy Expenditure Plan Handbook. https://ww2.energy.ca.gov/2016publications/CEC-400-2016-013/CEC-400-2016-013.pdf

Cost Effectiveness

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

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

***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:
https://www.etcc-ca.com/reports/zero-net-energy-pilot-local-educational-agencies-and-community-colleges

Carrie Brown
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Frontier Energy Heat Pump Water Heater Pilot

Michael Slater, Frontier Energy

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

fishnick.com

partners

Pacific Gas and Electric Company®

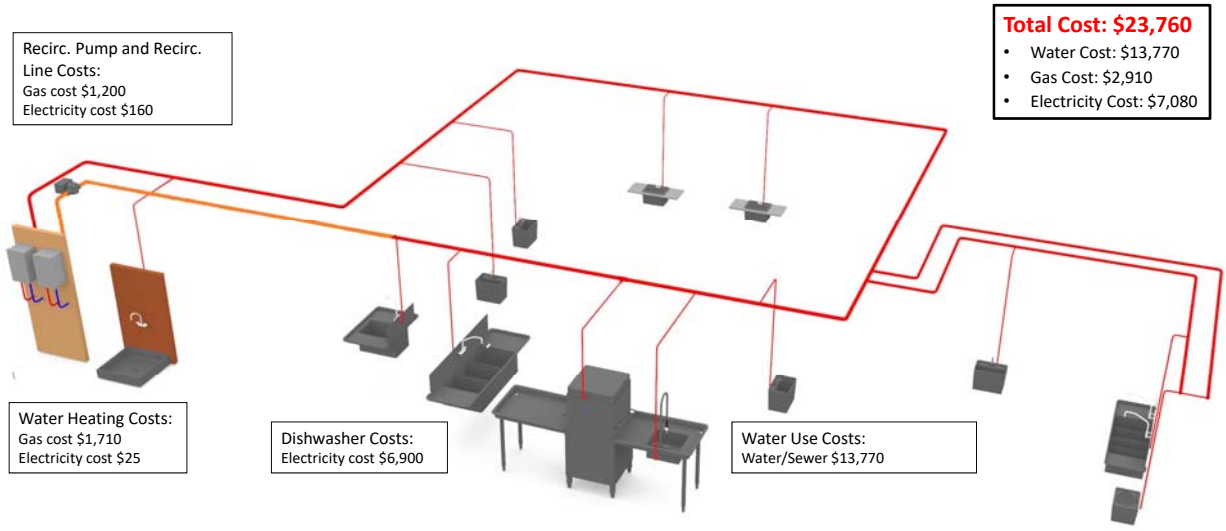
SoCalGas
A Sempra Energy utility®

SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead℠

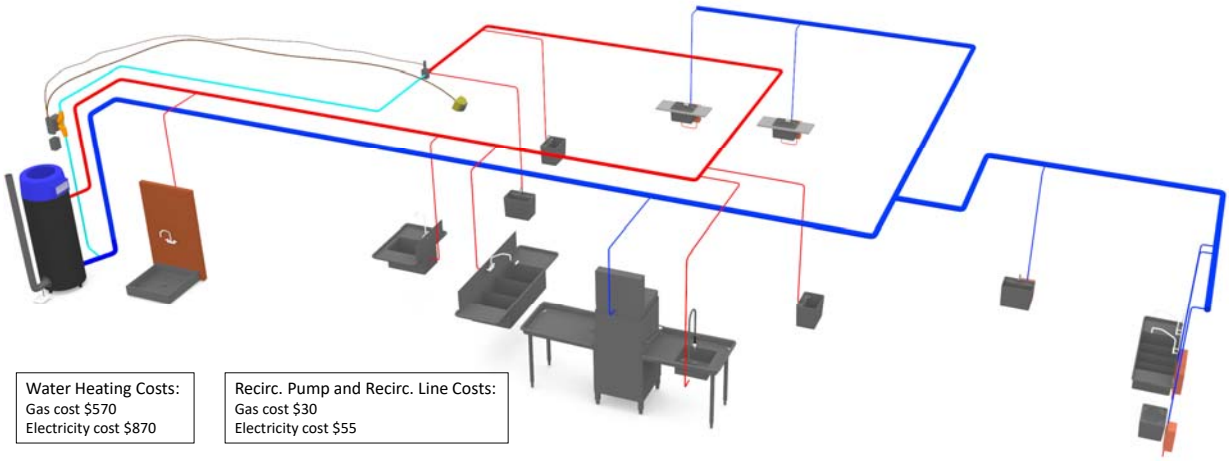
SDGE
A Sempra Energy utility®

FRONTIER energy

Original System Annual Operating Cost



Replacement System Operating Costs



Water Heating Costs:
Gas cost $570
Electricity cost $870

Recirc. Pump and Recirc. Line Costs:
Gas cost $30
Electricity cost $55

Water Use Costs:
Water/Sewer $9,288

Dishwasher Costs:
Electricity cost $7,310

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

FRONTIER energy

Questions? Comments? Interest?

Please chat with me offline! Thanks for your time!

Michael Slater
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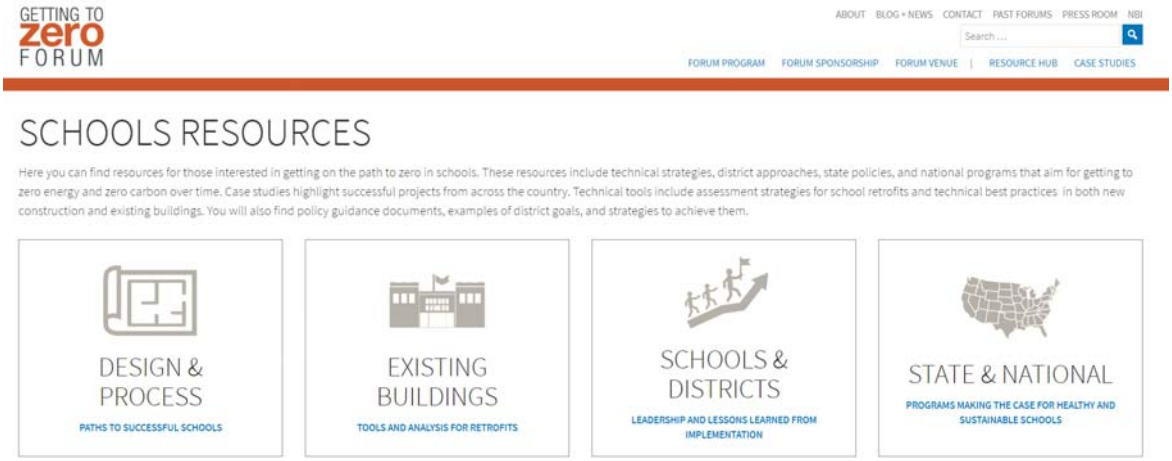
(916)832-6895

FRONTIER energy

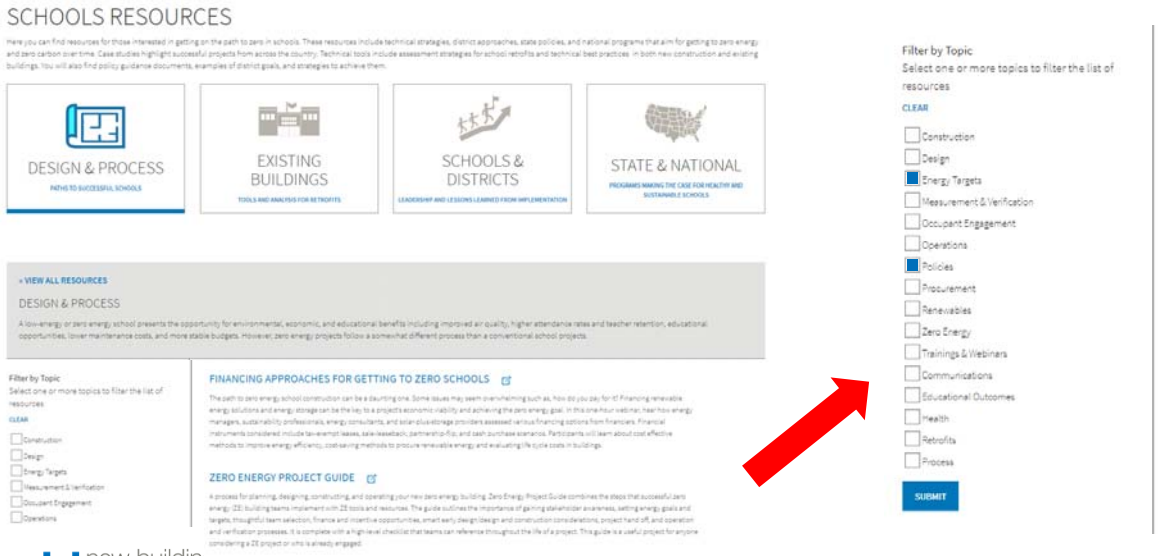
Technical Tools and Resources to Assist in Getting to Zero

Getting to Zero Resources HUB



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

Navigating the Getting to Zero HUB



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HUB: Design and Process

« VIEW ALL RESOURCES

DESIGN & PROCESS

A low-energy or zero energy school presents the opportunity for environmental, economic, and educational benefits including improved air quality, higher attendance rates and teacher retention, educational opportunities, lower maintenance costs, and more stable budgets. However, zero energy projects follow a somewhat different process than a conventional school projects.

ZERO ENERGY PROJECT GUIDE

A process for planning, designing, constructing, and operating your new zero energy building. Zero Energy Project Guide combines the steps that successful zero energy (ZE) building teams implement with ZE tools and resources. The guide outlines the importance of gaining stakeholder awareness, setting energy goals and targets, thoughtful team selection, finance and incentive opportunities, smart early design/design and construction considerations, project hand off, and operation and verification processes. It is complete with a high-level checklist that teams can reference throughout the life of a project. This guide is a useful project for anyone considering a ZE project or who is already engaged.

SCHOOL REGENERATIVE ROADMAP NET ZERO SCHOOLS

This roadmap is designed for school district board members, administrators and facilities staff, funders, architects, engineers, builders, teachers, parents, students, and other K-12 stakeholders. It provides reasons why schools are one of the most promising building types for zero energy, and tips on how to incorporate zero energy concepts in a school design and operation.

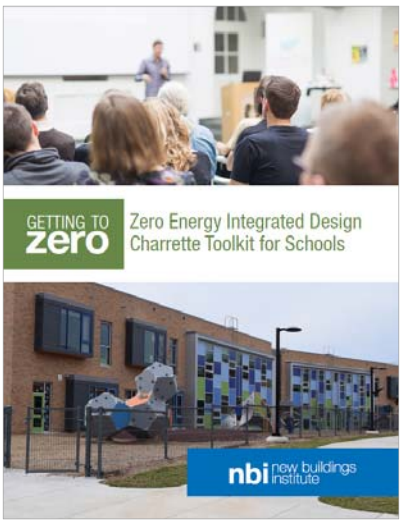
ZERO ENERGY SCHOOLS STAKEHOLDER MESSAGING GUIDE

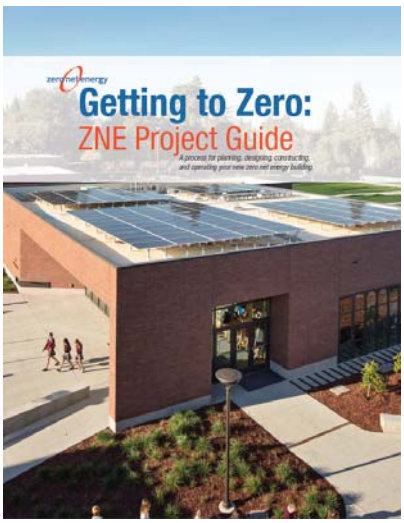
This document is a companion piece to the Zero Energy Integrated Design Toolkit for Schools and provides overarching messaging with supporting facts, and identifies key stakeholders and drivers. Effective communication revolves around understanding the drivers that motivate decisions made by each stakeholder. In the school market, student educational outcomes are the primary driver of stakeholders. Framing messages with this driver in mind is key to communicating with them on a level that they understand and that motivates them.

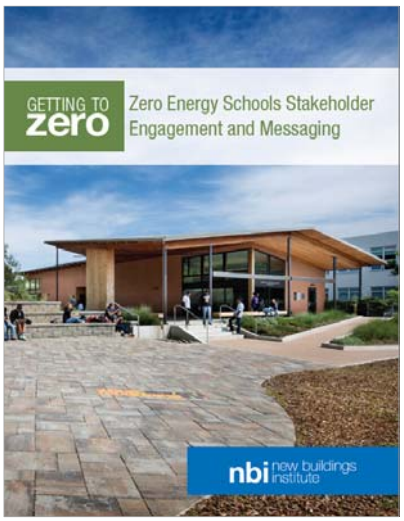
ZERO ENERGY SCHOOLS CHARRETTE TOOLKIT

NBI's toolkit for schools provides you with materials to help plan and lead a successful charrette for your school project. It can be used for almost any team aiming for high levels of energy efficiency or sustainability whether actively pursuing zero energy (ZE) or not. The toolkit lays out a step-by-step process, starting with pre-charrette planning through post-charrette actions and includes information specifically for a ZE building.

NBI's Tools for Zero Net Energy Schools







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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/

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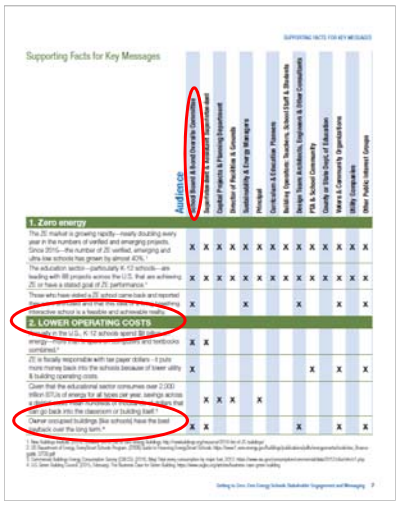
Zero Energy Schools Stakeholder Messaging Guide

- 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/

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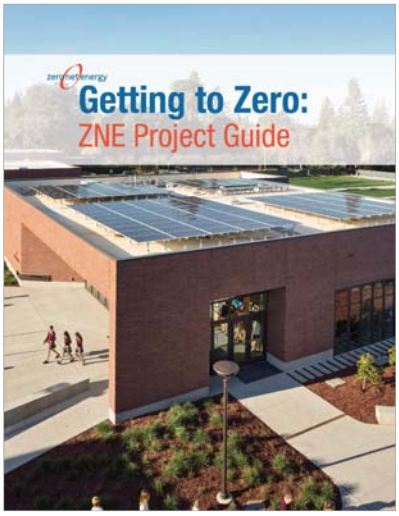
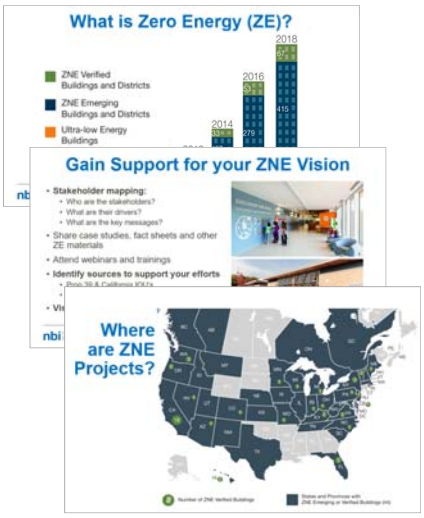
Zero Net Energy Communications Toolkit





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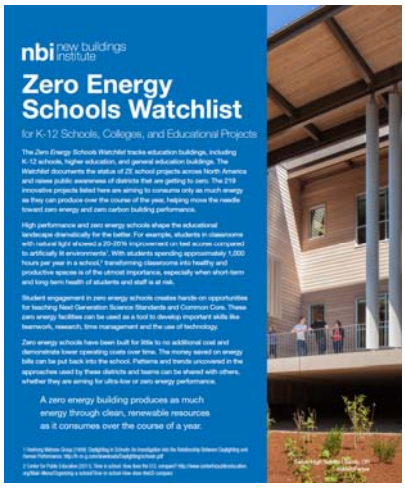
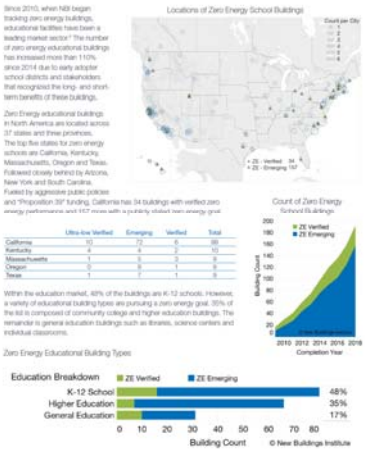
2019 Schools Zero Energy Watch List

- 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/

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HUB: Existing Buildings

« VIEW ALL RESOURCES

EXISTING BUILDINGS

Existing buildings can present a challenge and an opportunity for school districts. Many are unsure how to begin reducing energy across a portfolio. This section provides resources to help school districts assess, plan, and implement energy improvement projects in their existing facilities to get to zero over time.

Filter by Topic
Select one or more topics to filter the list of resources

CLEAR

- Benchmarking
- Communications
- Design
- Retrofits
- Educational Outcomes
- Health
- Occupant Engagement
- Operations
- Policies
- Trainings & Webinars
- Energy Targets
- Measurement & Verification

SUBMIT

BENCHMARKING

Annually in the U.S., K-12 schools spend $14 billion on energy—more than is spent on computers and textbooks combined . Furthermore, one third of the 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 (ZNE) Retrofit Readiness Study provides recommendations to California Program Administrators and other key market actors on how to best stimulate and enable the public school market to meet California's aggressive ZNE targets. The report includes two primary components, a market characterization and a technical sensitivity analysis. The market characterization examines the existing K-14 building stock, as well as the stakeholders, decision-making process and funding involved in school retrofits in California. The sensitivity analysis uses energy modeling to determine the relative magnitude of the impacts of various building factors that contribute to energy use in schools, including physical building characteristics, operational practices and occupant schedules. Researchers provide an update on the current status of ZNE retrofits in schools in California and recommendations to key market actors on steps they can take to accelerate public schools on the path to ZNE.

ADVANCED ENERGY RETROFIT GUIDE FOR K-12 SCHOOLS

The Advanced Energy Retrofit Guide for K-12 Schools is one of five retrofit guides commissioned by the U.S. Department of Energy. By presenting general project planning guidance as well as more detailed descriptions and financial payback metrics for the most important and relevant energy efficiency measures, the guides provide a practical roadmap for effectively planning and implementing performance improvements in existing buildings. The K-12 Schools guide provides convenient and practical guidance for making cost-effective energy efficiency improvements in public, private, and parochial schools.

HUB: Schools and Districts

« VIEW ALL RESOURCES

SCHOOLS & DISTRICTS

Many schools face growing populations, aging buildings, constrained operating budgets, and increasing energy bills. Bonds to fund renovations in existing buildings and new construction projects offer a critical opportunity to drive better energy performance in schools. Examples of other district and school leadership on the path to zero can be extremely valuable when formulating your own plan. The outstanding examples here provide insight into successful implementation, starting the process, and maintaining momentum throughout the project life cycle.

Filter by Topic
Select one or more topics to filter the list of resources

CLEAR

- Construction
- Design
- Energy Targets
- Operations
- Policies
- Renewables
- Zero Energy
- Communications
- Educational Outcomes
- Health
- Measurement & Verification
- Occupant Engagement
- Procurement
- Trainings & Webinars

GETTING TO ZERO ENERGY IN SCHOOLS IS ACHIEVABLE! STORIES FROM SCHOOLS ON THE PATH TO ZERO

This one-hour webinar will highlight two projects that demonstrate the proof-of concept in zero energy school construction: P.S. 62 – the Kathleen Grimm School in Staten Island, NY and John J. Sbrega Health & Science Building at the Bristol Community College, Fall River, MA. This webinar will weave the experiences and lessons learned of districts and technical experts as they share resources, tools, and steps to success in designing, constructing and operating school facilities to an ultra-low energy target and adding renewable systems to offset their annual consumption.

SAN FRANCISCO UNIFIED SCHOOL DISTRICT CARBON REDUCTION PLAN

SFUSD is embarking on a multi-decade effort to achieve carbon neutrality by 2040. The technology exists to construct buildings that use no more energy than they generate, and all new SFUSD buildings will be built to this standard. SFUSD's goal is to achieve a 50% reduction in natural gas usage by 2030 and to stop burning it entirely by 2040. This document was developed with input from Facilities, Buildings & Grounds, the Bond Department, and numerous other stakeholders from the City of San Francisco and elsewhere. It spells out the District's board-adopted goal to be carbon neutral by 2040 and the manner in which that goal shall be achieved.

SAN FRANCISCO UNIFIED SCHOOL DISTRICT PROJECT REQUIREMENTS

Motivated by the California State Architect's 7x7x7: Design Energy Water Challenge, SFUSD has completely transformed the process by which it designs, constructs, and modernizes its buildings in order to achieve a carbon neutral district by 2040. New buildings must be Zero Net Energy (ZNE) ready, modernized buildings are modeled so a pathway to ZNE can be incorporated into the design phase, and all facilities and deferred maintenance projects must adhere to a strict set of requirements to ensure alignment with ZNE goals. This document outlines the district's requirements for windows, insulation, building controls, boiler replacement, plumbing fixtures, and rainwater catchment in building projects.

HUB: State and National

« VIEW ALL RESOURCES

STATE & NATIONAL

Currently, schools make up the third largest subsector of commercial building energy usage and energy consumption plays a significant role in the operational expenses of schools. Each year, a portion of taxpayer dollars is spent on school utility expenses, thereby cutting into funding that could be allocated to resources for students. The resources here provide state and national programs with applicable context and examples.

Filter by Topic

Select one or more topics to filter the list of resources

CLEAR

- Benchmarking
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- Occupant Engagement
- Operations
- Policies
- Procurement
- Renewables
- Trainings & Webinars
- Zero Energy
- Prop 39

CALIFORNIA PROP 39 ZNE PILOT PROGRAM

The Proposition 39 ZNE School Retrofit 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 on-the-ground pilots, the program supported the development of case studies, training webinars and workshops as well as the ZNE School Leadership awards and recognition program.

WASHINGTON SUSTAINABLE SCHOOLS PROTOCOL (WSSP)

State-funded school construction projects greater than 5,000 square feet are required by Chapter 39.35 RCW – High Performance Public Buildings to incorporate high-performance features into their school design and construction. School districts can use either Washington Sustainable Schools Protocol (WSSP) or Leadership in Energy and Environmental Design (LEED). WSSP is modeled after the Collaborative for High Performance Schools (CHPS) green building protocol and adapted to reflect characteristics that optimize high performance in Washington schools. WSSP is a self-certifying standard developed to help school districts comply with the goals of the law. It is a planning tool that allows designers to plan a high-performance school while considering the regional, district, and site-specific possibilities and constraints for each project. The categories in the protocol include those related to Site, Water, Materials, Energy, Indoor Environmental Quality, and Planning and Operations.

MARYLAND NET ZERO ENERGY SCHOOL INITIATIVE GRANT PROGRAM

The Maryland Energy Administration (MEA) and the Public School Construction Program (PSCP) have partnered in a Net Zero School Initiative to construct three new net zero energy schools in Maryland. Through the 2012 merger of Constellation Energy, the parent company of Baltimore Gas and Electric Company (BGE), and Exelon Corporation, a Customer Investment Fund (CIF) was established to provide financial resources for long term energy efficiency and conservation goals. The Maryland Public Service Commission, the State of Maryland's utility regulator, has approved the use of $9 million of CIF funding to create a program to enable the design and construction of three net zero energy public schools within the BGE service territory.

Zero Net Energy Case Studies

ULTRA-LOW ENERGY

BUILDING TYPE: K-12 SCHOOL

TURKEY FOOT MIDDLE SCHOOL

EDGEWOOD, KY

VIEW CASE STUDY

ZERO ENERGY

BUILDING TYPE: K-12 SCHOOL

HOOD RIVER MIDDLE SCHOOL MUSIC & SCIENCE BUILDING

HOOD RIVER, OR

VIEW CASE STUDY

COMMERCIAL

BUILDING TYPE: K-12 SCHOOL

GARDEN GROVE UNIFIED SCHOOL DISTRICT

GARDEN GROVE, CA

VIEW CASE STUDY

https://gettingtozeroforum.org/schools/

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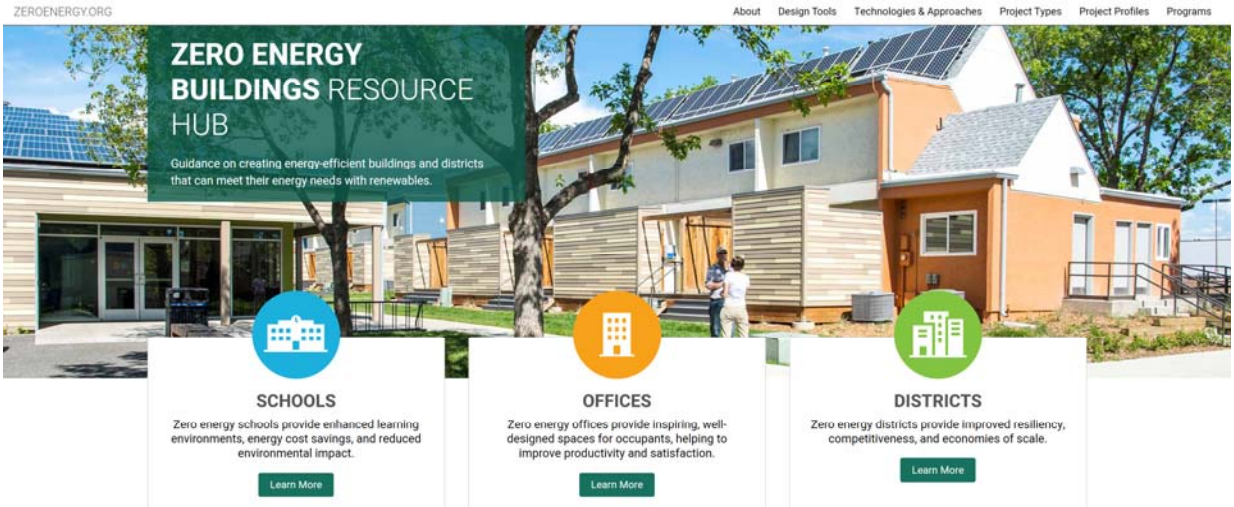
ZEROENERGY.ORG



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

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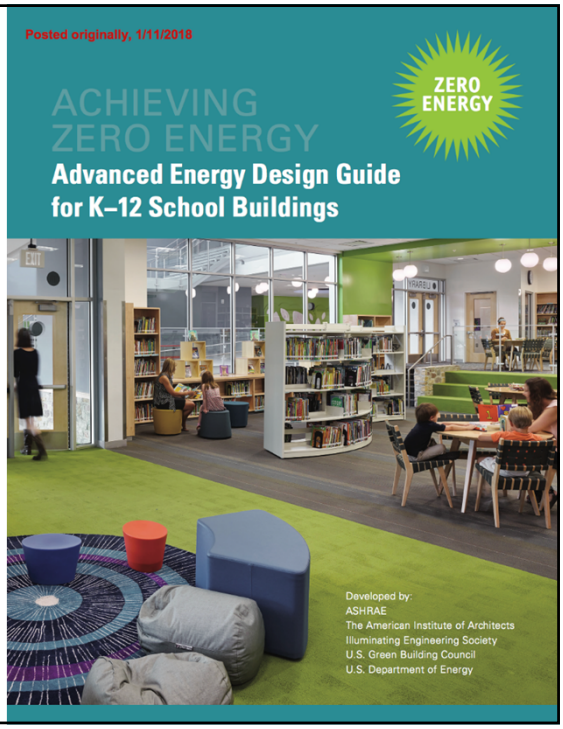
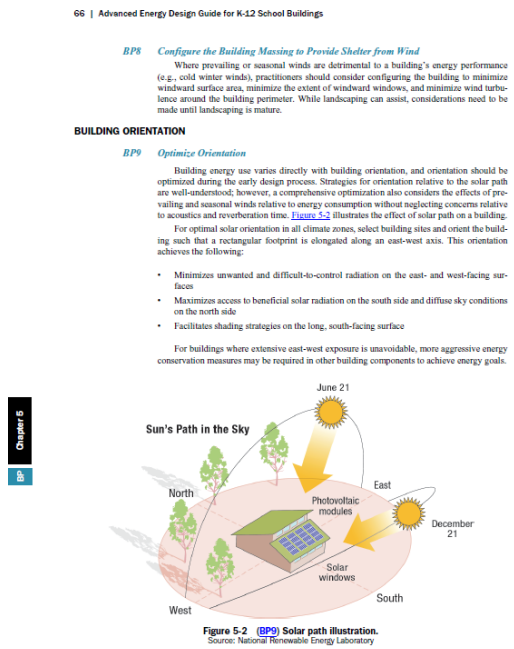


How to Use the AEDG

- 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



66 | Advanced Energy Design Guide for K-12 School Buildings

BP8 Configure the Building Massing to Provide Shelter from Wind

Where prevailing or seasonal winds are detrimental to a building's energy performance (e.g., cold winter winds), practitioners should consider configuring the building to minimize windward surface area, minimize the extent of windward windows, and minimize wind turbulence around the building perimeter. While landscaping can assist, considerations need to be made until landscaping is mature.

BUILDING ORIENTATION

BP9 Optimize Orientation

Building energy use varies directly with building orientation, and orientation should be optimized during the early design process. Strategies for orientation relative to the solar path are well-understood; however, a comprehensive optimization also considers the effects of prevailing and seasonal winds relative to energy consumption without neglecting concerns relative to acoustics and reverberation time. Figure 5-2 illustrates the effect of solar path on a building.

For optimal solar orientation in all climate zones, select building sites and orient the building such that a rectangular footprint is elongated along an east-west axis. This orientation achieves the following:

- Minimizes unwanted and difficult-to-control radiation on the east- and west-facing surfaces
- Maximizes access to beneficial solar radiation on the south side and diffuse sky conditions on the north side
- Facilitates shading strategies on the long, south-facing surface

For buildings where extensive east-west exposure is unavoidable, more aggressive energy conservation measures may be required in other building components to achieve energy goals.

Chapter 5

BP

Figure 5-2 (BP9) Solar path illustration.
Source: National Renewable Energy Laboratory

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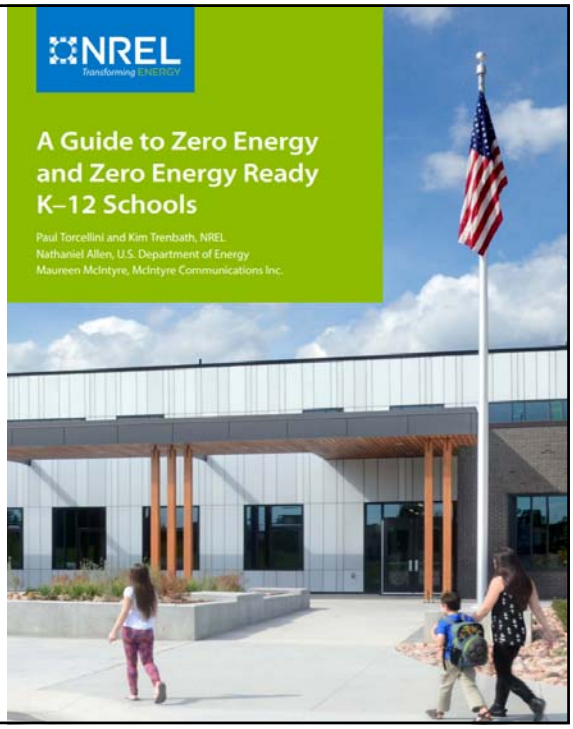
Zero Energy Process Guide

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



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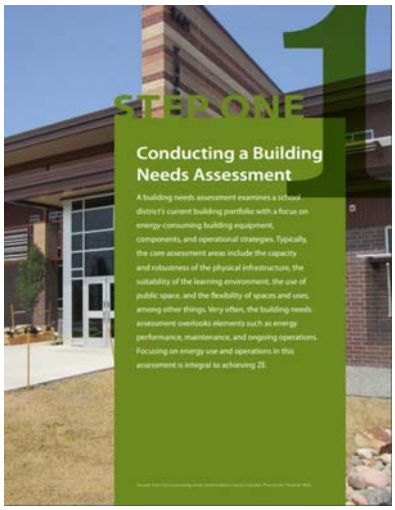
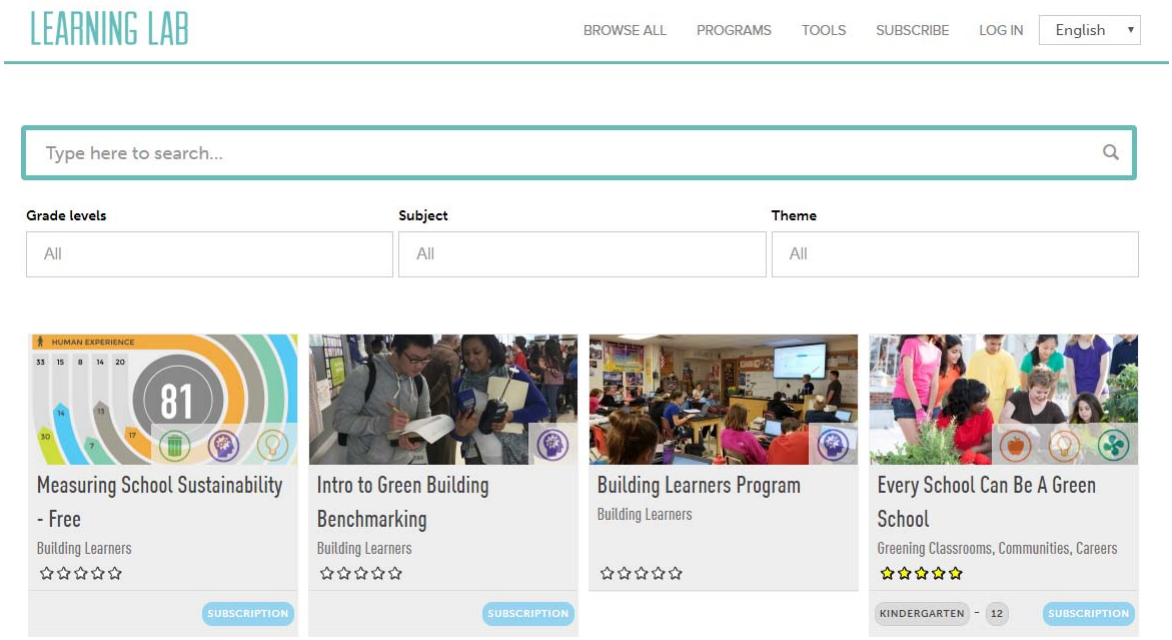
Zero Energy Process Guide

- 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!



Additional Resources

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

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SILICON VALLEY energy watch

Pacific Gas and Electric Company®

CITY OF SAN JOSE CAPITAL OF SILICON VALLEY Environmental Services

Partnership for Energy Efficiency

Thank you!

Tina Gonterman and Harry Lowenthal, SVEW

Reilly Loveland and Amy Cortese, NBI

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www.newbuildings.org

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!