ZNE and High Performance – The Perfect Partnership for Schools

Stephany Mason, Technical Director / Program Manager, Collaborative for High Performance Schools (CHPS)
Heather Flint Chatto, ZNE Project Manager, New Buildings Institute (NBI)
John Balfe, High Performance Buildings Associate, Northeast Energy Efficiency Partnerships (NEEP)
Sean O'Donnell, Principal, Perkins Eastman
What is ZNE????

ZNE = Zero Net Energy
NZE = Net Zero Energy
ZEB = Zero Energy Building
Carbon Neutral*

From DOE:
“produces enough renewable energy to meet its own annual energy consumption requirements”

* Uses no Fossil Fuel Greenhouse Gas Emitting Energy to Operate
The 2030 Challenge

“All new buildings, developments, and major renovations shall be carbon-neutral by 2030”
What is High Performance????

Aka: Sustainable, Green…

From EPA:
“High performance schools are energy and resource efficient”

From NIBS:
“a building that integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity”
1. Protect student and staff health and enhance the learning environment
2. Conserve energy, water and other resources thereby reducing operating costs
3. Minimize waste, pollution and environmental degradation

From CHPS – High Performance Buildings
Green Schools Initiatives/Missions

• USGBC - green schools for everyone within this generation

• CHPS – make every school an ideal place to learn; working towards the day when a green, healthy school is simply called a school
High Performance
The Three Pillars

1. Reduced Environmental Impact and Costs
2. Improved Health and Wellness
3. Effective Environmental and Sustainability Education

High Performance and ZNE
CHPS CRITERIA

Design:
- Integration – 8.5%
- Indoor Environmental Quality – 33%
- Energy – 25%
- Water – 8%
- Site – 9.5%
- Materials & Waste Management – 8.5%
- Operations & Metrics – 7.5%
CHPS CRITERIA: ENERGY

Design Toward Zero Net Energy (ZNE)

• Energy Prerequisite
• Superior Energy Performance
• ZNE Bonus
  • ZNE Ready
  • ZNE Capable
  • ZNE (Innovation)

East Bay Met, Newport, RI
zEPI Scale

Moving down the scale can be achieved by:

• Code compliance
• More efficient
  • Windows
  • HVAC
  • Lighting
• Integrated design
  • Daylighting
  • Natural ventilation
• Plug load reductions
• Renewables
High Performance -> ZNE

• Integration=2
  • ZNE Bonus=2
• IEQ=29
• Energy=12
  • Sup EE=40
  • ZNE Capable=2
• Water=3
• Site=3
• Materials=4
• O&M=4
• TOTAL=101 of 110 needed points
Getting to Zero Net Energy in Schools

Green Schools Conference
Pittsburg, PA

April 1, 2016

Heather Flint Chatto
ZNE Project Manager
New Buildings Institute
New Buildings Institute is proud to introduce our Getting to Zero Buildings Database.

The largest database on ZNE buildings in North America and the only database searchable by ZNE Status & Energy Performance

http://newbuildings.org/getting-to-zero-buildings-database
Zero Energy Buildings

- 2014: 33 ZNE Verified Buildings and Districts, 53 ZNE Emerging Buildings and Districts
- 2016: 44 ZNE Verified Buildings and Districts, 275 ZNE Emerging Buildings and Districts

Total: 319 projects as of 2016

Courtesy of New Buildings Institute | newbuildings.org
40 States with ZNE Buildings
PV cost trend makes ZNE accessible

Source: P. Mints, Navigant Solar Services Program, 2011
Building Types

- Education–K-12
- Office
- Education–Higher
- Other
- Multifamily
- District
- Public Assembly
- Education–General
- Retail
- Library
- Laboratory
- Warehouse
- Public Order–Safety
- Airport
- Mixed Use
- Office-Other

Legend:
- Green: ZNE Verified
- Blue: ZNE Emerging

NBI © 2016
Performance Range - Education

Measured EUIs of Educational Buildings

Average for all verified Education buildings

EUI (kBtu/sf/yr)

CBECS Education Average

ZNE Verified
ZNE Emerging
Ultra-low Energy

Education-Higher
Education-K-12
ZNE Schools: Developing the Next Generation of Leaders

- ZNE is possible within the cost of a conventional school
- Anticipate a significant expansion of ZNE school activity across the U.S

ZNE Workshop for Schools
CA Green Schools Summit, 2014
Richardsville Elementary School

- Bowling Green, KY
- 72,300 SF
- Education K-12
- Completed in 2010
- LEED Gold
- $206/SF
- Warren County Public Schools
- Sherman Carter Barnhart, Architect
- CMTA, Mechanical and Electrical

Photo: Sherman Carter Barnhart
Richardsville Elementary School

Efficiency Measures:
- Ground source heat pump
- DOAS
- CO2 sensors
- Daylighting
- High performance lighting system with controls
- EMS & Energy Dashboard
Redding (CA) School for the Arts

Redding School for the Arts, CA
Courtesy: Trilogy Architecture
Steve Whittaker Photography
Establishing your ZNE Target

– The Energy Loading Order
Why ZNE Schools?

- **Innovation & Leadership** - When public sector leads, others will follow. A commitment to zero energy buildings is an important demonstration of leadership, and innovation in education.
- **Resiliency** – School facilities often serve as community centers for refuge in times of emergency.
- **Climate & Environmental Sustainability Goals** – Climate Action Plans, State goals, Green Schools Sustainability Roadmap
- **Energy & Cost Savings** mean more financial resources are available to support students, educational programs and facilities
- **Long Term Savings** in efficiency, cost, operations, climate
- **Innovative Educational Approaches** – Experiential Learning
What Buildings Make Sense for ZNE?

Most Building Types are feasible
• Administrative buildings
• Classrooms
• Service buildings
• Warehouses
• Recreation & environmental centers
• Libraries
• Low occupancy buildings/facilities

Priority Buildings
• New school buildings/campuses
• Buildings needing major replacement, big energy hogs, buildings where systems are needing major retrofits
How are Schools Getting to ZNE?

• Assessment of existing building stock to find opportunities
• Capital improvement projects - Look at pipeline of coming up needed
• Existing building renewal - Making major retrofits to get to ZNE when significant system or structural upgrades are made
• Pilot ZNE Building for new and existing facilities – CA Prop 39 ZNE retrofit pilots
• Campus-wide ZNE – OUSD high school, Hi-tech High School in Chula Vista, Redding School for the Arts
• Prototype Approach – Campbell School District targeting 8 ZNE schools
• Portfolio-wide Policy Approach – IUSD, LASD energy and solar investments
California Leads in ZNE Schools

ZNE School Buildings - Top Three States

<table>
<thead>
<tr>
<th>State</th>
<th>Verified</th>
<th>Emerging</th>
<th>Total</th>
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<tbody>
<tr>
<td>California</td>
<td>3</td>
<td>20</td>
<td>23</td>
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<tr>
<td>North Carolina</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Oregon</td>
<td>1</td>
<td>5</td>
<td>6</td>
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<tr>
<td>All North America</td>
<td>12</td>
<td>65</td>
<td>77</td>
</tr>
</tbody>
</table>

The map shows the number of ZNE (Zero Net Energy) school buildings in various states, with California leading in ZNE school buildings with a total of 23 verified and emerging buildings. North Carolina and Oregon also have significant numbers, with 6 total buildings each. All North America has a total of 77 ZNE school buildings, with 12 verified buildings and 65 emerging buildings.

The map also highlights states with energy code adopted or in development, as indicated by a star symbol. The map includes 42 states and provinces, and the District of Columbia.
“Big Bold” Goals for ZNE in California

1. All new commercial construction will be ZNE by 2030
2. 50% of existing buildings will be retrofit to ZNE by 2030
3. All new residential construction in California will be ZNE by 2020

The California Efficiency Strategic Plan (Sep 2008) californiaenergyefficiency.com/docs/EEStrategicPlan.pdf
• ZNE Project Profiles
• News & Events
• Policy & Planning Updates
• Upcoming Training & Education
• New Research
• Low Energy Building Innovations

Email heather@newbuildings.org to sign up
GREAT NEW TOOLS FOR ZNE BUILDINGS

1. ZNE Message Platform
   Key messages for target audiences on the what and why of ZNE.

2. “Intro to ZNE” Presentation
   Customizable powerpoint presentation provides an overview of California’s goals and policies for ZNE, key strategies, and case study examples.

3. ZNE Companion Guide/Fact Sheets
   Collection of FAQs, resources, design strategies, and key messages for designers, commercial building owners, policymakers, and decisionmakers of schools and public buildings.

   Read about ZNE and ultra-low energy building examples, including design strategies, costs, and lessons learned.

5. ZNE Action Bulletin
   Sign up for our quarterly e-newsletter for updates on ZNE news, events, trainings, case studies, planning, policy, and research. To sign up, or to get more info about the toolkit, email heather@newbuilding.org.

www.newbuildings.org/zne-communications-toolkit
Case Study Briefs

Redding School of the Arts

Site Details
Building Size: 77,000 SF
Location: Redding, California
Construction Type: New
Construction Year: 2011
Building Type: Education
CA Climate Zone: 11

Energy Efficiency Strategies & Features

Daylighting: The design directs classrooms to the north to maximize daylighting with minimal heat and glare. Lighting controls reduce or eliminate electric lighting in response to daylighting to encourage natural light as the primary source of illumination in spaces and "learning streets."

Efficient HVAC: The school utilizes a geothermal HVAC system. Windows are sized and located to provide occupant control and cross an airflow through classrooms.

Planning & Design Approach

Overarching project goals were:
- Use the facility as a teaching tool
- Connect the indoor and outdoor environments to create a series of continuous learning spaces
- Use appropriate solar orientation strategies to maximize daylighting opportunities and take advantage of outside views
- Significantly reduce energy use by locating 38,000 SF of learning space in protected outdoor areas

Site Energy Use Index (EUI) kWh/ft²/year

The site energy use index (EUI) is calculated as follows:

EUI = (Total energy use / Total square footage) * 100

For more information: newbuildings.org/zero-energy

nbi new buildings institute
Project Profile developed by New Buildings Institute 4/2013

Redding School of the Arts
K-12 School

Overview

Zero Net Energy Project Profile

Energy Upgrade California™ is a program of the California Public Utilities Commission in collaboration with the California Energy Commission, California counties, cities, special districts, and the State’s investor-owned utilities. Funding comes from the utilities’ ratepayers under the authority of the California Public Utilities Commission in addition to supplemental funding from the Department of Energy. © 2011 Energy Upgrade California. Trademarks are property of their respective owners. All rights reserved.

Team/Owner Details
Owner: The McConnell Foundation
Architect: TRILOGY® Architecture
Contractor: Gifford Construction
Structural Engineering: Kubler & Kubler Architecture and Engineering
Mechanical/Plumbing: M&E Systems Engineering
Electrical Engineering: PACE Engineering
Lighting Designer: Benya Lighting Design
Sustainability Consultant: Green Building Services

Financing & Cost
Total Construction Cost: $28 million

Awards
LEED® Platinum for Schools 2009

Improved envelope: The building envelope consists of a rain screen wall system with cement siding and ultra-high efficiency glazing and rammed-earth walls.

Maximize outdoor learning spaces: Despite being in a climate with hot, dry summers and rainy, cool winters, more than half of the school’s learning spaces are outdoors, protected by roof overhangs and operable garage-style doors.

Building dashboard: The web-based building dashboard system monitors and reports energy and water use, separating out lighting energy use and renewable systems production. Information from the dashboard is used to teach students about the school and their environment.

Renewables: Photovoltaics (PV) systems include a large roof-mounted PV array, vertical axis wind turbine and solar thermal hot water systems. Both the PV and wind turbine are connected to the utility grid via net metering, thus allowing the school to be credited for energy it produces in the summer even when the school’s energy use is minimal.

Lessons Learned
- Building occupant use in summer is higher than expected. Ongoing commissioning would be helpful to draw attention to minimizing HVAC operating hours, managing set points and ensuring that lighting and plug loads are turned off when the building is unoccupied.
- Lighting systems are operating at an average of 0.35 watts per square foot, or 60% less than code. Two occupant use factors that may be impacting daylighting performance are that window blinds are closed more often than was expected during design and the windows themselves are used to pin up student’s art work, which may be contributing to less-than-optimal daylighting performance.
- Plug load energy uses, such as refrigeration, space heaters and ventilation lights, is higher than expected. Procurement of high efficiency equipment is recommended to manage plug loads. For example, using powerful display projectors to increase contrast and/or locating projection screens on walls perpendicular to windows to help prevent use of blinds may help optimize daylighting performance.
ZNE & Ultra-Low Energy Case Studies

CPUC Case Study Briefs & NBI ZNE Case Studies
http://newbuildings.org/case-studies-zne-projects

PG&E Case Studies

NBI Registry
http://newbuildings.org/share

Getting to Zero Database
http://newbuildings.org/getting-to-zero-buildings-database

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BACON STREET OFFICES

The Bacon Street Office project is a 4,500 SF retrofit of a single-story, 1950's-era auto repair shop into a high performance office for the firm ARCHITECTS hannah gabilan wells. Through creative design strategies, renewable energy generation and with support from local utilities; including the Savings by Design program, the project has achieved zero net energy goals. In fact, this project is so energy efficient it returns power to the grid.

Planning & Design Approach
The project demonstrates the difference between typical projects and ZNE projects. The following steps were critical to success:
- Start early and use an integrated design process
- Outline goals and benefits
- Structure fees to provide more research and design iterations
- Stay flexible and inclusive with the design process

Energy Efficiency Strategies and Features

Daylighting: A wall of windows along the public street side of the building provides daylight and views of a new landscaped parking court with native vegetation and canopy trees. This light is balanced with top-lighting from diffuse sunlight at the back of the space. Illumination walls,ceilings and balance...
Fact Sheets/ZNE Companion Guide

- Policymakers
- Decisionmakers of Schools & Public Buildings
- Architecture & Engineering
- Commercial Owners
- FAQ's
Jeffrey Trail Middle School & Irvine Unified School District

PEOPLE, POLICY & PROCESS

- CHPS High Performance schools resolution
- Irvine pursued a district-wide approach to energy efficiency
- Bonded for solar on all schools
- Power Purchase Agreement (PPA) to fund solar
- Capital outlay=$0

Irvine Unified School District saves money and enriches learning with solar

Located in Orange County, California, the Irvine Unified School District (IUSD) comprises a community of learners, committed to the highest quality educational experience. IUSD educates a diverse population of more than 30,000 K-12 students in 22 elementary schools, six middle schools, four comprehensive high schools and one continuation high school.

Project Profile: Irvine Unified School District
- Industry: K-12 Education
- System Size: 5 MW over 27 Operational Projects
- Savings: $5-11 million over 20 years
- Capital Outlay: $0
IUSD set energy-wise guidelines to help make its heating, ventilation, and air conditioning systems (HVAC) more efficient. The District also issued conservation mandates for lighting, thermostat settings, classroom and office equipment, and a variety of other areas. These measures are intended to reduce district-wide electrical usage by 15 percent.
We have developed our own fifth and sixth grade curriculum that lets students learn about a variety of types of renewable energy. We discuss the pros and cons of different types of renewable energy. We are hearing that kids are more aware of things like conservation, recycling, and global warming. And the community appreciates the nonpartisan way we present the education.”

– Mark Sontag, UC Irvine Energy Consultant
"The business case for making the building net zero energy is that it will not just lower our energy bill, but it also will allow us to put those savings straight back to the top line of our operations budget for maintaining programs for kids."

- Assistant Superintendent Kathy Gomez, Evergreen School District
Proposition 39, the California Clean Energy Jobs Act of 2012 (Prop 39), provides up to $550 million per year to improve energy efficiency and increase the use of clean energy in public schools and community colleges.

The Prop 39 ZNE Schools Pilot will assist schools in retrofitting existing facilities to ZNE by leveraging Prop 39 funding. The Pilot will establish "proof of concept" that ZNE retrofits of schools is feasible across California. The utilities are targeting approximately 13-18 projects in 13-18 school districts or community colleges for the Pilot.

Interested K-12 public school districts and community colleges were invited to respond to the Opportunity Announcement posted to this website prior to May 22nd 2015. Interested schools are encouraged to revisit this website for updates.
A zero net energy (ZNE) building generates as much energy as it consumes annually. With energy bills at California’s schools totaling more than $700 million a year*, innovative energy solutions for schools like ZNE buildings are being proposed as a way to save energy and put money back into classrooms.

A number of upcoming, no-cost interactive workshops are being offered to explain how California’s K-12 schools and community colleges can achieve ZNE through whole-building retrofits.

These workshops are part of an investor-owned utility (IOU) pilot program aimed at leveraging Proposition 39 dollars to test how some of the state’s existing K-12 and community college buildings can be transformed into ZNE facilities.

Full-day technical sessions will focus on best practices in design and operations. Half-day school community workshops will cover design approaches, planning and financing.

School administrators, operations managers, business officers, construction managers, community stakeholders, building designers, operations staff and others interested in ZNE are invited to attend. Space is limited, so please register and reserve your spot today at energydesignresources.com/zneworkshops.


This program is funded by California utility customers and administered by California’s investor-owned utilities under the auspices of the California Public Utilities Commission.

To help schools achieve successful ZNE retrofits, we’re offering the following upcoming no-cost ZNE workshops:

**ZNE Technical Training for School & Building Industry Professionals**

- 10:00 am-4:00 pm  
  February 26, Downey | SoCalGas Energy Resource Center
  April 18, San Francisco | Pacific Energy Center

- 9:00 am-3:00 pm  
  May 9, San Diego | SDG&E Energy Innovation Center

**ZNE & the School Community for Administrators and Stakeholders**

- 1:00 pm-3:00 pm  
  March 2, Webinar format, will also be available on-demand

- 1:00 pm-4:00 pm  
  March 14, San Mateo | Office of Education

- 2:00 pm-5:00 pm  
  April 20, Sacramento | Green Technology Summit

- 9:00 am-12:00 pm  
  May 10, San Diego | SDG&E Energy Innovation Center

*More dates to be announced soon*

Register or learn more at energydesignresources.com/zneworkshops
Actions to Get to ZNE Schools

1) Set ZNE Goals, Targets & Policy
   • Engage leadership to adopt a formal policy for ZNE
   • Assess existing facilities for opportunities & needs

2) Initiate one or more ZNE Pilots
   • Amend contract RFP/RFQ Requirements for ZNE performance goals and priorities: for contractors, performance targets, required specifications, documentation and persistence

3) Explore funding opportunities for ZNE:
   • Pilot programs, utility incentives, technology demonstration, bonds, establish efficiency reserve funds.

4) Engage and educate stakeholders (use the ZNE Toolkit!)
   • Policymakers – Superintendent, School Boards, Principals
   • Facilities and operations staff – much of ZNE happens downstream
   • Internal staff – faculty, administration and maintenance need some operations training, as well as public facing staff (especially communication and media)
   • Students – living classroom for experiential, scientific and climate-based learning
What you can do today to get started

1. Develop your ZNE Plan
2. Create the supporting policy
3. Get & Use the ZNE Communication Tools & Planning Workbook
4. Build capacity through education, collaboration, and convening
GETTING TO ZERO
NATIONAL FORUM 2016

Save the Date
October 12-14, 2016 | Denver, CO
gettingtozeroforum.org/call-for-speakers/

Thank You!
Heather Flint Chatto, ZNE Project Manager | Heather@newbuildings.org
ZNE and High Performance
The Perfect Partnership for Schools

Green Schools Conference
Friday, April 1, 2016
2:00 – 3:00 PM
John Balfe
About NEEP

Mission
Accelerate energy efficiency as an essential part of demand-side solutions that enable a sustainable regional energy system

Approach
Overcome barriers and transform markets via Collaboration, Education and Enterprise

Vision
Region embraces next generation energy efficiency as a core strategy to meet energy needs in a carbon-constrained world

One of six regional energy efficiency organizations (REEOs) funded by the US Department of Energy (US DOE) to link regions to US DOE guidance, products and programs
NEEP’s Zero Energy Roadmap

- Developed by regional stakeholders
- Focused on new construction in the public sector
  - Lead by example
  - Longer investment horizon
- How do we get there from here?
  - Includes “critical next steps” and “intermediate term steps”
- 2016: Progress Report
  - “Zero Energy Buildings”

ZNEB’s produce as much energy as they consume over the course of a year
Rhode Island and NE-CHPS

- NE-CHPS required for all schools in RI
- 6 NE-CHPS Verified Schools
- NEEP been engaged in this process since 2011
- NE-CHPS puts schools on the pathway to ZNE
Case Study: East Bay MET Center
Newport, RI

1st zero energy capable public school facility in the region
Case Study: East Bay Met Center

• 16,800 Square Feet - New Construction Project
• LED Lighting / Daylighting exposure maximized
• Water consumption reduced by more than 20%
• Renewable Energy Systems:
  – 150 kW PV solar energy system
  – Geothermal heating system
• School as a teaching tool initiative
• 50% of construction waste was recycled or redirected from landfill

“The greatest aspect of this school is the incredible indoor air quality”
-Taylor Rocc, Teacher
ENERGY EFFICIENCY

Your East Bay MET School incorporates design features and systems that provide superior performance with the minimum possible energy usage in order to offset energy use with on-site energy generation. Making the school energy efficient reduces operating costs while helping to conserve energy resources and reduce environmental pollution associated with energy production.
The East Bay MET School’s **solar thermal energy** system provides more than 20% of the building’s domestic hot water heating consumption. The school’s on-site renewable energy can be monitored on the school’s website and a renewable energy educational display was installed in the building.

Credit: RGB Architects
The MET is implementing:
• EPA’s Tools for Schools
• No idling policy for buses
• All newly purchased equipment will be ENERGY STAR
• **Zero net energy plan**

A zero net energy school facility is designed to be optimally efficient and, over the course of a year, generates energy on-site, using clean renewable resources, in a quantity equal or greater than the total amount of energy consumed on-site.

And of course, the School will be used as a teaching tool for environmental quality, energy efficiency and renewable energy - starting right here in the stairwell.

**Credit: East Bay Met School**
Case Study: Pell Elementary School
Newport, RI

- CHPS Verified
- 40% Water Reduction
- 50% above energy code
- Effective Daylighting features
- 35 EUI (median = 58)
Students exposed to natural daylight in classrooms progress as much as 20 percent faster on math tests and as much as 26 percent faster on reading tests than students with no daylight exposure. (EPA, K-12 Guide)

Green building measures in school designs improves indoor air quality and can reduce absenteeism rates by as much as 15 percent. (EPA, K-12 Guide)
Resources

• NE-CHPS V3.1
• School Exemplars
• Roadmap to Zero Energy Public Buildings
• Regional Operations & Maintenance Guide
• LED Street Lighting Report

Additional Resources: http://neep.org/resources
High Performance Schools Training
Free Training April 21, 2016
Maynard High School in Massachusetts
Register on the NEEP Website Today!
2016 NEEP Summit

June 13-14, 2016
Omni Mt. Washington Resort
Next Generation Energy Efficiency

Information on registration, sponsorship opportunities, and program:
http://neep.org/events/2016-summit or contact Lucie Carriou at lcarriou@neep.org
Thank you!

• Contact information
  John Balfe, High Performance Buildings Associate
  Northeast Energy Efficiency Partnerships (NEEP)
  jbalfe@neep.org
  781-860-7177 x 109
NZE & the MLK Jr. School

Perkins Eastman
1. Innovation Agenda

The Innovation Agenda is an ambitious plan that will propel Cambridge Public Schools into the 21st century, and prepare all our students for life in a world we cannot fully imagine today. The Innovation Agenda is a design for excellent education rather than adequate education - merging Cambridge Public Schools’ twin goals of academic excellence and social justice.

- Superintendent Young

2. Net Zero Energy

“For Cambridge the process of planning and designing a net-zero school has changed the way we think about energy in all our buildings. It has made us think about what energy we really need to use in our existing city buildings and will surely change some of what we do even in buildings not slated for full scale renovation or rebuilding.”

- Former Mayor Davis
THREE SCHOOLS: ONE CAMPUS

Program: 740 Students

- **Lower School:**
  400 JK-5th Graders
- **Upper School:**
  300 6th – 8th Graders
- **Human Services:**
  40 PreSchool Students, Community School & After School Programs

Other Criteria

- **Hours of Operation:**
  6:00 am to 11:00 pm
- **Able to be Maintained:**
  Defines “sustainable”
- **Site Water:**
  High Water table; Poor Storm System; Charles River Watershed
- **Responsive to Neighbors:**
  Tight urban site
THREE SCHOOLS: ONE CAMPUS
REAL PERFORMANCE

Annual Energy Used vs. Energy Made

kWh

Building Energy Usage
Photovoltaic Energy Production

ENERGY USED = ENERGY MADE
REAL PERFORMANCE

NOT THEORETICAL PERFORMANCE

Annual Energy Used vs. Energy Made

- Building Energy Usage
- Photovoltaic Energy Production
## Defining It

### Accounting for Energy
- **Net-Zero Site Energy**
- **Net-Zero Source Energy**
- **Net-Zero Energy Cost**
- **Net-Zero Energy Emissions**

### Where Is Energy Harvested
<table>
<thead>
<tr>
<th>NZEB:A</th>
<th>Within building footprint</th>
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</thead>
<tbody>
<tr>
<td>NZEB:B</td>
<td>within building footprint + the site</td>
</tr>
<tr>
<td>NZEB:C</td>
<td>Within building footprint, on site + imported renewables</td>
</tr>
<tr>
<td>NZEB:D</td>
<td>Within building footprint and/or on site + REC’s</td>
</tr>
</tbody>
</table>


*Net-Zero Energy Buildings: A Classification System Based on Renewable Energy Supply Options, NREL, June 2010*
STEPS TO NZE – ESTABLISH ENERGY BUDGET

MAXIMUM POSSIBLE

• 2,700,000 kWh/year with **site fully covered** (140,000 sf)
• 57.6 kbtu/sf/year

LIKELY REQUIRED

• 1,410,000 kWh/year with approximately 73,500 sf of PV with **over half of site covered**
• **30 kbtu/sf/year**
STEPS TO NZE – UNDERSTAND EXPECTED ENERGY USE
STEPS TO NZE – OPTIMIZE THE DESIGN

• Optimize the building
  – *Reduce loads & demands on systems*
STEPS TO NZE – OPTIMIZE THE DESIGN

- Optimize passive systems
  - *Reduce energy use*
STEPS TO NZE – OPTIMIZE THE DESIGN

- Optimize active systems
  - Use energy efficiently
STEPS TO NZE – USERS TAKE OWNERSHIP

Plug Loads: 41%
STEPS TO NZE – OCCUPANT ENGAGEMENT

• Owner/Client
  – *Understanding motivation*

• Teachers/Staff
  – *Understanding needs*

• Facilities/Maintenance
  – *Understanding resources*

CONTINUED FEEDBACK & EDUCATION
**MLK PV Design Estimate**

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<tr>
<th>Location</th>
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<td>Total for Project</td>
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**METRICS**

- **Proposed EUI:** 33.4 kBtu/sf/yr
- **Energy Savings:** 69% (42% w/o PV’s)
- **Energy Generation:** 705,110 kWh (47%)
- **No. PV Panels:** 1615 panels
### METRICS

#### LEED 2009 FOR SCHOOLS

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<th>Category</th>
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<tr>
<th>Category</th>
<th>Points</th>
<th>Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites (SS)</td>
<td>20 Y/1 M</td>
<td></td>
</tr>
<tr>
<td>Water Efficiency (WE)</td>
<td>8 Y/1 M</td>
<td></td>
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<tr>
<td>Energy &amp; Atmosphere (EA)</td>
<td>33 Y/0 M</td>
<td></td>
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<tr>
<td>Materials &amp; Resources (MR)</td>
<td>5 Y/2 M</td>
<td></td>
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<tr>
<td>Indoor Environ. Quality (IEQ)</td>
<td>13 Y/1 M</td>
<td></td>
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<tr>
<td>Innovation &amp; Design (ID)</td>
<td>6 Y/0 M</td>
<td></td>
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<tr>
<td>Regional Priority (RP)</td>
<td>4 Y/0 M</td>
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</tr>
</tbody>
</table>

- 85% Reduction in Potable Water Use
- Two 10,000 gal. rainwater collection tanks: flush toilets & phosphorous removal
- 65 Geothermal well (7 miles of piping)
Lessons Learned….

- Process must be flexible, responsive & adaptable
- Program for mechanical space
- Set design criteria and stick to it - Keep track of the team
- Find your story: inspire action
- Engage the users, engage the users, engage the users!
LOWER & UPPER SCHOOL ENTRY COURTYARD
FACADES DESIGNED FOR THEIR ORIENTATION

EAST/WEST SUNSHADES

LOWER SCHOOL
SOUTH FACING FAÇADE & COMMUNITY ENTRANCE

"KING STREET" / COMMUNITY ENTRANCE

WINDOW BOX @ CLASSROOMS
DAYLIT CLASSROOMS

WINDOW SEATS

CLASSROOM W/ LIGHT SHELF
DAYLIT CLASSROOM

LIGHT SHELF IN THE CLASSROOM
DAYLIGHT THROUGHOUT

KING STREET

“SPRING” STAIR
BUILDING AS A TEACHING TOOL

PHOTO-VOLTAICS ON TRELLIS OVER ROOF GARDEN & LOWER SCHOOL GYM
THE NEXT GENERATION