Zero Energy Buildings
From Dream to Reality in Public and Private Sectors

March 7, 2016
3:00-4:00 PM ET
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solome Girma</td>
<td>US Department of Energy (DOE)</td>
</tr>
<tr>
<td>Reilly Loveland</td>
<td>New Buildings Institute (NBI)</td>
</tr>
<tr>
<td>Nate Kinsey</td>
<td>San Francisco Unified School District (SFUSD)</td>
</tr>
<tr>
<td>Jason Robbins</td>
<td>McDonald’s Corporation</td>
</tr>
</tbody>
</table>
Zero Energy Buildings: From Dream to Reality in Public and Private Sectors

Better Buildings March Webinar
Tuesday, March 7, 2017

New Buildings Institute
Reilly Loveland, Project Analyst
About New Buildings Institute

New Buildings Institute (NBI) is a national nonprofit organization working to improve buildings for people and the environment.

We assess technologies, promote design approaches, and help guide policies and programs that will significantly improve the energy efficiency of commercial buildings.
NBI is redefining energy efficiency in the built environment.

Program Areas:
1. Best practices in new and existing buildings
2. Zero net energy leadership and market development
3. Continuous code and policy innovation
Why ZNE?

• The next evolution in sustainable, high performance buildings
• Makes communities stronger, resilient and energy independent
• Comfortable and productive environment for working, learning and living
• Optimized building performance
• Lower net energy costs and higher asset value
• ZNE target can be specified in RFP’s and other building requirements
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

<table>
<thead>
<tr>
<th>Project Name</th>
<th>City</th>
<th>State/Province</th>
<th>Area (ft²)</th>
<th>Net EUI (kBtu/ft²/yr)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doyle Conservation Center (DCC)</td>
<td>Leominster</td>
<td>MA</td>
<td>22,001</td>
<td>52</td>
</tr>
<tr>
<td>Capitol Area East End, Block 225: California Department of Education Headquarters</td>
<td>Sacramento</td>
<td>CA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melink Corporation Headquarters</td>
<td>Milford</td>
<td>OH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redding School of the Arts</td>
<td>Redding</td>
<td>CA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ZNE is Gaining Momentum

Number of ZNE Projects

- 2012:
  - ZNE Verified Buildings and Districts: 21
  - ZNE Emerging Buildings and Districts: 39
  - Ultra-low Energy Buildings: 39

- 2014:
  - ZNE Verified Buildings and Districts: 33
  - ZNE Emerging Buildings and Districts: 127
  - Ultra-low Energy Buildings: 53

- 2016:
  - ZNE Verified Buildings and Districts: 53
  - ZNE Emerging Buildings and Districts: 279
  - Ultra-low Energy Buildings: 62

Legend:
- Green: ZNE Verified Buildings and Districts
- Blue: ZNE Emerging Buildings and Districts
- Orange: Ultra-low Energy Buildings
Growth in ZNE Buildings

Growth of ZNE and Ultra-Low Energy Buildings

Building Count

Year


- ZNE Verified
- ZNE Emerging
- Ultra-Low Energy
Where are ZNE Projects?

Number of ZNE Verified Buildings

States and Provinces with ZNE Emerging or Verified Buildings (44)
ZNE Buildings in Every Climate Zone

[Map showing distribution of ZNE buildings across climate zones]
ZNE and Ultra-Low Buildings are Possible in Many Building Types Across the US

Small-Med Commercial Offices

K-12 Schools

Large Office Facilities

Environmental Centers

Higher Education Institutions

Government Offices
Who is Aiming for ZNE?

ZNE Building Ownership Type

- Private - Non-profit: 9%
- Public - Federal: 5%
- Public - State: 10%
- Public - City: 12%
- Private - Multifamily: 12%
- Private - For-profit: 30%
- Public - County: 22%

ZNE and Ultra-Low Energy Building Types

- Office: 23%
- Education: 38%
- Other: 21%
- Multifamily: 11%
- Public Assembly: 7%
Schools are Leading

ZNE and Ultra-low Energy Building Types
- Education: 38%
- Office: 23%
- Other: 21%
- Multifamily: 11%
- Public Assembly: 7%

Breakdown of Education Building Types
- Higher Education: 29%
- General Education: 12%
- K-12 School: 59%

K-12 School Building Count
- Ultralow- Verified: 19
- ZNE - Verified: 9
- ZNE - Emerging: 50

16
Why Schools?

Why not?! Reverse the argument/conversation - Start from ground up with educating students about ZNE + sustainability - Set an example for ZNE/Environmental Leadership - Current path is unsustainable - Need a more financially sustainable route - Also spreading the message to school + broader community - Healthier buildings (e.g., daylighting, or relating to higher test scores) - Schools can be resilient resource centers - Wise use of public funds - Increased savings in operations, brings more money for programs - Showing students what is possible - Demonstrating how schools play a part in meeting state and city goals - Demonstrating good stewardship and leaving a positive legacy for future generations - Students are good advocates with parents - Owner occupied buildings have best payback over long term - Not an unlimited amount of energy - Carbon footprint - Next generation of leaders - Energy savings goes back to programs - Mandate is looming - Next step after LEED - Cost savings - School district as model for community - As a building type, it is ideal – low occupancy, sufficient land, owner-occupied - Greenhouse gas reductions and climate goals - Fiscally responsible with taxpayer dollars - Better financing terms - Education next generation of leaders - Better financing terms - Education next generation of leaders - Increased population, increased need for more schools, will be more cost-effective to build now - Learning/teaching benefits: daylighting enhances student performance and wellbeing, biophilia (connection to nature) - Easier to operate - Maintenance - Energy savings - Retention rates - School as teaching tool - Save planet one building at a time - Necessity - Electricity is expensive - Reinvest savings for other programs - Set a good example for kids - see us doing this - demonstrate leadership - Technology creates a better, more convenient building - Attract and retain students and faculty - Quantitative benefits - Integrate into curriculum - Building awareness - Stay with them whole lives - Change expectations of students - We are doing our part - Better test scores and health
Growth in ZNE and Ultra-Low Energy Education Buildings

<table>
<thead>
<tr>
<th>State</th>
<th>ZNE Verified</th>
<th>ZNE Emerging</th>
<th>Ultra-Low Energy Verified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>2</td>
<td>19</td>
<td>6</td>
<td>27</td>
</tr>
<tr>
<td>KY</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>NC</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>TX</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>SC</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>51</td>
<td>19</td>
<td>80</td>
</tr>
</tbody>
</table>
Significant Savings Potential

Roughly a 75% reduction compared to CBECS
ZNE Performance

![Graph showing energy use intensity (EUI) and building count for different categories of buildings: ZNE Verified Buildings, ZNE Emerging Buildings, and Ultra-Low Energy Buildings. The graph includes data from 2003 CBECS Average Office EUI = 93, 2012 CBECS Average Office EUI = 78, and 2006 CEUS Average Office EUI = 73. The average EUI for ZNE Verified Buildings is 22.](image-url)
Costs of ZNE Buildings

Total Building Cost for select ZNE Verified Buildings (n=29)

NBI © 2017
Common Technologies for Ultra-low Energy

• Building Orientation & Glazing ratio
• Highly Efficient Thermal Envelope
• Ventilation: Natural, Dedicated Outdoor Air Systems (DOAS), Demand Control Ventilation (DCV)
• Daylighting Access and Controls
• Solar Control - shading
• Energy Recovery Systems
• Plug load Reductions
• Radiant Heating / Cooling & Chilled Beams
• Energy Management Systems
• Building Dashboards
• Ground Source Heat Pumps

Redding School for the Arts, CA
Photo Courtesy: Trilogy Architecture, Steve Whittaker Photography
ZNE Resources
The ZNE buildings on this list have either achieved or committed to the goal of producing as much renewable energy onsite as they consume over the course of a year.

Have a project to share?

Please email: info@newbuildings.org
Existing 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
5 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.

4 Case Studies: ZNE & Ultra-Low Energy 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.
Fact Sheets & ZNE Companion Guide

- ZNE for Schools
- ZNE Design Fundamentals
- ZNE for Architecture & Engineering
- ZNE for Developers & Real Estate Professionals
- ZNE for Homeowners & Homebuyers
- ZNE for Lender’s Appraisers & Investors
- ZNE for Buildings Owners & Operators
- ZNE for Policymakers & Local Governments
- ZNE FAQ’s
ZNE Presentation Templates

- Primarily commercial
- Carries general messages
- Goals for ZNE
- ZNE building examples
- Open source platform! Slide collection will grow as champions and others develop their own ZNE presentations
- Agendas/Presentations from Previous NBI Workshops

Users of the Presentations:
- Champions & Early Adopters
- Utilities
- Communications staff
• ZNE Project Profiles
• News & Events
• Policy & Planning Updates
• Upcoming Training & Education
• New Research
• Low Energy Building Innovations

ZNE ACTION BULLETIN
Progress Towards Zero Net Energy Buildings
Soliciting Feedback from Schools at the Green Schools National Conference

This is your chance to let us know what tools your school district needs to be successful in ZNE.

The format will be a series of roundtables during the Green Schools National Conference in Atlanta, GA:

Tuesday, March 21, 12-1:30 pm
Wednesday, March 22, 12-1:30 pm
Wednesday, March 22, 5-6:30 pm

*While there will be multiple opportunities to provide feedback, participants need to only sign up for one of the roundtables.

How to Get Involved
Please email or call Reilly Loveland at:
reilly@newbuildings.org
(206) 229-2539
Zero Energy Buildings

March 7, 2017

Solome Girma, CEM
Building Technologies Office
Department of Energy’s long term goal is to reduce U.S. buildings EUI by 50% and the interim goal of reducing building energy use intensity 30% by 2030

ZE/R promotes 3 strategic areas:

1. **Research and Development** – ZE/R helps serve as an on-ramp for BTO’s emerging high impact technologies coming out of R&D

2. **Marketing Stimulation** - Stimulates markets by establishing business models, supporting workforce development, strengthening distribution channels

3. **Codes and Standards** - Puts DOE out in front of emerging zero energy codes and standards
## The Building Efficiency Opportunity – Commercial Market

<table>
<thead>
<tr>
<th></th>
<th><strong>Existing Buildings</strong></th>
<th><strong>New Construction</strong></th>
</tr>
</thead>
</table>
| **Size of Market**        | • 5.6 Million commercial buildings comprised of 14 principle buildings types, including education, health, office, public safety, warehouse, religious, and others that are owned and leased by private companies, governments and institutions  
                            • 87 billion sq. ft. in total                                                      | • ~1 million new buildings constructed between 2000 – 2012 comprising nearly 20 billion sq. ft., and many underwent major renovations |
| **Energy Used**           | • 18 quads of total energy or about 18% of all energy used in the U.S.                | • Average size of a new buildings constructed in 2000s is ~17% bigger than new buildings constructed between 1960 - 1999 |
                            • ~217 thousand BTU per sq. ft.                                                   |                                                                                      |
                            • Building stock is being retrofitted at a rate of ~2.2 % per year            |                                                                                      |
| **Cost of Energy**        | Total cost of energy used in U.S. commercial buildings is over $180 billion           |                                                                                      |
In September 2015, DOE released a common definition for a Zero Energy Building, or what is also referred to as a “net zero energy” or “zero net energy” building.

Source:
An energy-efficient building, where on a source energy basis, the actual annual delivered energy is 50-70% less than code.

Goal 1: Reduce Consumption 50 to 70 percent (from code)

Goal 2: Apply On-site Renewable Energy

BALANCE!
An energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.
DOE – Commercial Zero Energy Buildings

- Expand demand for ZE/R
- Expand ability of building design, construction, and operation industry to deliver extremely high-performing buildings.

- Accelerators - Partnerships
- Allies – A/E/C
- ZE Design Strategies Book
- Technical resources
- Case studies
- Recognition Program

Office Buildings
Districts
Schools
Others
Zero Energy Schools
Vision
K-12 school buildings provide healthy, dynamic learning environments and resilient community assets that have zero to minimal energy costs

Accelerator Goals
• **Identify** strategies to overcome barriers to building Zero Energy K-12 schools and realizing the associated health, savings, and resiliency benefits
• **Share** solutions, resources, and technologies that help schools achieve Zero Energy goals
• **Develop** replicable road maps to build Zero Energy schools and achieve associated benefits
• **Increase** visibility and replication of best practice approaches and successful models
Why Schools Focus? Opportunity Defined

• 1 in 6 Americans sets foot in a school each day
• 100,000 public K-12 schools in U.S.
• 7.5 billion square feet
• $6 billion annually on K-12 energy bills, more than is spent on textbooks and computers combined
• $49 billion annually for new construction and capital projects
• 2nd largest public infrastructure investment after transportation
Who is Aiming for ZE/R?

Source: New Buildings Institute (NBI)
DOE/NREL conducted a simulation-based technical feasibility study focused on:

- Technologies required to achieve ZE/R status
- Energy use intensity (EUI) targets for U.S. climate zones such that K-12 schools can be ZE/R

Source:
# Feasibility Study Prototype Characteristics

<table>
<thead>
<tr>
<th>Building Characteristic</th>
<th>Feasibility Study Prototype</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building type</strong></td>
<td>Primary school</td>
</tr>
<tr>
<td><strong>Secondary school</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Size (ft^2)</strong></td>
<td>82,500</td>
</tr>
<tr>
<td><strong>Secondary school</strong></td>
<td>227,700</td>
</tr>
<tr>
<td><strong>Number of floors</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Number of students</strong></td>
<td>650</td>
</tr>
<tr>
<td><strong>Secondary school</strong></td>
<td>1,200</td>
</tr>
</tbody>
</table>

**Space types**
- Art classroom, cafeteria, classroom, corridor, multipurpose room, kitchen, lobby, mechanical room, media center, office, restrooms
- Art classroom, auditorium, cafeteria, classroom, corridor, gyms, kitchen, library, lobby, mechanical room, office, restrooms

**Wall construction**
- Steel-framed
- Steel-framed

**Roof construction**
- Insulation entirely above deck
- Insulation entirely above deck

**Window area**
- 35% window to gross wall area
- 35% window to gross wall area

**Percent conditioned**
- Fully heated and cooled
- Fully heated and cooled

**HVAC system types**
- Zone-level ground source heat pump (GSHP) in classroom wings and common areas; packaged single zone GSHPs in gym, kitchen, cafeteria; dedicated outside air system with CO2 based flow for ventilation air.
- Zone-level ground source heat pump (GSHP) in classroom wings and common areas; packaged single zone GSHPs in gyms, kitchen, cafeteria, auditorium; dedicated outside air system with CO2 based flow for ventilation air.
Best-in-Class ZE/R for Schools

- Classroom orientation on a long east-west axis
- Enhanced building opaque envelope insulation, window glazing, and overhangs
- Reduced lighting power density based on LED technology
- Use of vacancy sensors to minimize lighting
- Enhanced controls for common areas and exterior lighting
- Daylighting in classrooms, resource rooms, cafeterias, gyms, and multipurpose rooms
- Plug load reductions and improved controls for shedding loads during unoccupied periods
- High-performance commercial kitchen equipment and ventilation
- Demand-controlled ventilation and energy-recovery ventilators using dedicated outside air system
- HVAC equipment including system configurations
- High-efficiency service water heating equipment and distribution systems
- Exterior LPD reductions
What Do ZE/R K-12 Schools Look Like?

- Generally 50-70% reduction in EUI
- Infrastructure & information to integrate renewables where appropriate

Site Energy Intensity Targets for ZE/R (Primary School)

For Example:
In KY, it was defined as “…achieving state-of-the-art energy efficiency – operation at or below 25 kBtus/sf/yr, with hardware and engineering in place to readily accept RE installations at a later date.”
### EUI Targets Needed to Meet or Exceed ZE/R

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Representative City</th>
<th>Primary School</th>
<th>Secondary School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Site Energy</td>
<td>Source Energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(kBTu/ft²·yr)</td>
<td>(kBTu/ft²·yr)</td>
</tr>
<tr>
<td>1A</td>
<td>Miami, FL</td>
<td>25.9</td>
<td>76.4</td>
</tr>
<tr>
<td>2A</td>
<td>Houston, TX</td>
<td>24.3</td>
<td>71.1</td>
</tr>
<tr>
<td>2B</td>
<td>Phoenix, AZ</td>
<td>24.7</td>
<td>72.5</td>
</tr>
<tr>
<td>3A</td>
<td>Memphis, TN</td>
<td>23.8</td>
<td>69.0</td>
</tr>
<tr>
<td>3B</td>
<td>El Paso, TX</td>
<td>23.4</td>
<td>67.8</td>
</tr>
<tr>
<td>3C</td>
<td>San Francisco, CA</td>
<td>21.6</td>
<td>61.9</td>
</tr>
<tr>
<td>4A</td>
<td>Baltimore, MD</td>
<td>23.5</td>
<td>67.6</td>
</tr>
<tr>
<td>4B</td>
<td>Albuquerque, NM</td>
<td>23.1</td>
<td>66.6</td>
</tr>
<tr>
<td>4C</td>
<td>Salem, OR</td>
<td>22.4</td>
<td>64.2</td>
</tr>
<tr>
<td>5A</td>
<td>Chicago, IL</td>
<td>24.3</td>
<td>69.9</td>
</tr>
<tr>
<td>5B</td>
<td>Boise, ID</td>
<td>23.2</td>
<td>66.7</td>
</tr>
<tr>
<td>6A</td>
<td>Burlington, VT</td>
<td>24.5</td>
<td>70.1</td>
</tr>
<tr>
<td>6B</td>
<td>Helena, MT</td>
<td>23.5</td>
<td>66.9</td>
</tr>
<tr>
<td>7</td>
<td>Duluth, MN</td>
<td>25.9</td>
<td>74.1</td>
</tr>
<tr>
<td>8</td>
<td>Fairbanks, AL</td>
<td>28.7</td>
<td>82.5</td>
</tr>
</tbody>
</table>
Current Accelerator Partners

• Implementing (Districts)
  – Hermosa Beach City School District
  – LA Unified School District
  – Arlington School District
  – Boulder Valley School District
  – Adams 12 - Five star schools

• Implementing (States)
  – California, Minnesota

• National
  – NEED
  – NEEP
  – SoCalEd
  – TEC
  – NBI
  – NASEO
  – RMI
  – A4LE
  – U.S. Department of Education
Zero Energy Districts
Accelerator Vision and Goals

Vision
Communities with energy efficient, resilient, cost-effective buildings and infrastructure are common throughout the U.S.

Goals
1. Support early adopters of ZED at two targeted and critical juncture points:
   - **Master Planning** - including optimal district configurations and layout, building efficiency, renewable integration, utility partnerships, and district energy systems
   - **Financing and ownership structure** – including how to plan for, navigate and manage joint ownership structures, financing, and operations

2. Develop case studies, best practices, and pilot examples to support the replication of ZED
Why Districts Focus for ZE/R?

Cities are setting aggressive energy transformation and resiliency goals and ZED are a key strategy to reach these energy goals.

“By 2030 900 billion ft$^2$ of new and rebuilt buildings will be constructed worldwide” -- State of the World’s Cities, McKinsey Global Institute

“The district is the optimal scale to accelerate sustainability — small enough to innovate quickly and big enough to have a meaningful impact.” – EcoDistricts

Districts are great testbeds to explore new technologies and business models. Economies of scale, shared energy infrastructure, and efficiently coordinated operations provide ZED cost-effective opportunities often not possible through individual buildings.
District Scale Opportunities

District scale introduces opportunities for coupling strategies and benefits in buildings with infrastructure improvements in different sectors.

Examples include:

– Industrial/sewer waste heat recovery for use in buildings
– Building load aggregation/control for grid interactions
– Solar canopy electric vehicle charging stations
– Sensor/communications networks to support advanced data analytics for optimal district operations
Accelerator Partners

6 Implementing Partners
- CA (2), CO (2), NY, and MN
- Cities, Developers, Housing Authorities and Core Stakeholders
- High demand - additional districts want to participate

5 National Partners
- RMI, EcoDistricts, NLC, USGBC, Xcel Energy
- Commit to provide resources and support to districts
<table>
<thead>
<tr>
<th>Partner</th>
<th>Location</th>
<th>Size</th>
<th>Parties</th>
<th>Phase</th>
<th>Unique Aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Western Center</td>
<td>Denver, CO</td>
<td>250 acres, 2.8M Ft$^2$</td>
<td>City, University, Utility</td>
<td>$900M raised, Beginning development plan</td>
<td>City Convention Center development</td>
</tr>
<tr>
<td>Sun Valley Eco District</td>
<td>Denver, CO</td>
<td>~100 acres in study area, 750+ Mixed use/Housing Units on 45 acres owned by Housing Authority</td>
<td>Housing Authority, Non-profit Developer</td>
<td>Received $30M HUD Choice Neighborhoods Implementation Grant to begin development planning and implementation</td>
<td>Public/low income housing mixed with market rate housing and commercial development</td>
</tr>
<tr>
<td>Huntington Beach Advanced Energy Community</td>
<td>Huntington Beach, CA</td>
<td>TBD</td>
<td>City, University</td>
<td>Beginning master planning and site considerations</td>
<td>California Advanced Energy Communities Program</td>
</tr>
<tr>
<td>Saint Paul Ford Site</td>
<td>Saint Paul, MN</td>
<td>135 acres, 3M Ft$^2$ Housing, mixed use, commercial</td>
<td>City, University</td>
<td>Early planning and ownership model development</td>
<td>Redeveloping old Ford manufacturing site</td>
</tr>
<tr>
<td>Fresno Advanced Energy Community</td>
<td>Fresno, CA</td>
<td>Downtown revitalization</td>
<td>City, Non-profit</td>
<td>Beginning master planning and site considerations</td>
<td>Revitalize the downtown, reinvest in older neighborhoods</td>
</tr>
<tr>
<td>Erie County Industrial Development Agency, NY</td>
<td>Erie County, NY</td>
<td>140 acres, Manufacturing and Commercial campus</td>
<td>County</td>
<td>First building in design, greater district master plan in development</td>
<td>Revitalization of old steel mill industrial site</td>
</tr>
</tbody>
</table>
“THE TALLEST OAK IN THE FOREST WAS ONCE JUST A TINY NUT THAT HELD ITS GROUND.”
THE END

For more questions contact:

Solome Girma, CEM
Department of Energy
202-287-1414
Solome.girma@ee.doe.gov
Nate Kinsey

SFUSD
Zero Carbon SFUSD
THE CASE FOR ZNE

The planet needs bold action.
Our buildings are not getting more efficient quickly enough.

Jurisdictions all over the world are stepping up.
San Francisco, CA, US, Germany, Europe, UN

Other districts have similar plans.
Boulder Valley has a goal to reach ZNE by 2050. San Diego is right behind.

Schools across the country are going ZNE.
There are examples in Seattle, New York, LA, Arizona, Texas, Kentucky...
HOW IS SFUSD DOING?
Pre-vs. Post-Modernization

ENERGY

12 months before 12 months after

<table>
<thead>
<tr>
<th>School</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesar Chavez ES</td>
<td>36</td>
<td>34</td>
</tr>
<tr>
<td>George Peabody ES</td>
<td>57</td>
<td>47</td>
</tr>
<tr>
<td>Monroe ES</td>
<td>36</td>
<td>19</td>
</tr>
<tr>
<td>Yick Wo ES</td>
<td>31</td>
<td>36</td>
</tr>
</tbody>
</table>
Pre- vs. Post- Modernization

NATURAL GAS

12 months before  12 months after

Therms

-15%  +10%  -60%  -2%

Cesar Chavez ES  George Peabody ES  Monroe ES  Yick Wo ES
Pre- vs. Post- Modernization

ELECTRICITY

12 months before  12 months after

Cesar Chavez ES: +22%
George Peabody ES: +9%
Monroe ES: -37%
Yick Wo ES: +49%
WHAT ABOUT NEW SCHOOLS?
Usage vs. Building Size

NATURAL GAS

Therms vs. Building Size (SqFt)

Usage for 2015-16 School Year
Therms Per Square Foot

NATURAL GAS

<table>
<thead>
<tr>
<th>School</th>
<th>Therms/SqFt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kipp/Gateway</td>
<td>0.05</td>
</tr>
<tr>
<td>Willie Brown</td>
<td>0.10</td>
</tr>
<tr>
<td>Herbert Hoover</td>
<td>0.15</td>
</tr>
<tr>
<td>James Denman</td>
<td>0.17</td>
</tr>
<tr>
<td>APTos</td>
<td>0.19</td>
</tr>
<tr>
<td>Everett</td>
<td>0.23</td>
</tr>
<tr>
<td>Francisco</td>
<td>0.24</td>
</tr>
<tr>
<td>A.P. Giannini</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Usage for 2015-16 School Year
Usage vs. Building Size

ELECTRICITY

Usage for 2015-16 School Year

Willie Brown
kWh Per Square Foot

ELECTRICITY

Usage for 2015-16 School Year

- Aptos
- A.P. Giannini
- Francisco
- Everett
- WB (net w/ solar)
- Kipp/Gateway
- James Denman
- Herbert Hoover
- Willie Brown
BEATING CODE IS NOT ENOUGH
LIGHT BULB MOMENT

Source: Harley Ellis Devereaux
7 x 7 x 7 CHALLENGE

Transforming California’s historic schools

An approach to stepping into the future

Case Study: Santa Barbara High School
SFUSD KICK-OFF

Source: WRNS Architects
BLACKFORD ELEMENTARY
“A Zero Net Energy building is an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.”

“California has a policy goal of achieving ZNE building standards for commercial buildings by 2030.”

“This definition requires “best practice” levels of efficiency...zeroing out the energy footprint of a building with average levels of efficiency by way of a large amount of renewable generation would not meet California’s definition of ZNE.”

We can expect “triennial building standards updates that increase the efficiency of new buildings by 20-30 percent in each update.”
GHG-FREE ELECTRICITY
TRANSITION FUEL?

Source: Environmental Defense Fund
DISTRICT STRATEGY

NEW SCHOOLS
→ ZNE Ready

MODERNIZATION
→ ZNE Two-Step

RENEWABLES
→ In Due Time
Shared Savings
- Champions
- Data Analysis
- Mini Capital
- Commissioning

Passive
- Dual Pane Windows
- Insulation
- Air Tightness

Lighting
- LEDs
- Solar Tubes
- Light Shelves
- Vacancy Controls
- Daylighting Controls

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

Renewables
- Onsite Solar PV
- Battery Storage
- EV Charging
STANDARDS

2011 Proposition A Bond Program
Procedures + Standards

San Francisco Unified School District
VOL. II: 6.0 – 20.0
Zero Net Energy Study for James Denman Middle School

September 7, 2016

Prepared By:
Ecology Action  |  877 Cedar Street, Suite 240  |  Santa Cruz, CA 95062
1st ZNE RETROFIT
1<sup>st</sup> ZNE BUILDING
WHY STOP THERE?

Vehicle Fuels
29%

Facility Energy
71%

MtCO2e
16,800
Introducing Zenith
Planet-Friendly Solution
Today's Transportation

BRANDS, COMPANIES, AND AGENCIES THAT USE ZENITH MOTORS:
RENEWABLE FUELS
CARBON NEUTRAL POLICY

Effective Immediately
- New buildings designed to ZNE
- No new gas heating systems

By 2020
- New fleet vehicles electric
- Buses fueled with renewable diesel
- Natural gas & water down 30%

By 2030
- All District vehicles emissions-free
- Natural gas & water down 50%

By 2040
The District will no longer burn fossil fuels for heat or transportation!
THANK YOU!
To create a showcase for innovative, sustainable, high-performance design at a retail location without altering the operational characteristics of the store in order to make it as highly-scalable as possible. To share this information with the sustainability, architecture, and retail communities in a completely transparent fashion as a means of encouraging the adoption of green building practices wherever reasonably feasible.
• First net-zero energy retail store in the US
• LEED Platinum Certification
• Better Building Challenge Showcase project
• Green Chill Platinum certification
• Energy Star
• Open before Thanksgiving 2013 (14 months for design & construction)
Energy reduction strategies

• Ultra-high-efficiency mechanical and refrigeration system with carbon dioxide as the refrigerant
  • Uses 8 geothermal bore holes, each 550’ deep, as main heat source and heat sink
• All LED lighting
• Daylight harvesting
• Natural ventilation with operable windows
• 5 separate dimming zones, including peak output reduction after dark
• Revolving door
• Building automation system and a weather station to allow building systems to react to local climate conditions
Everything should be made as simple as possible, but not simpler.

Albert Einstein
CO2 Central Plant Design
It’s not just about energy . . .

• Recycled of over 84% of the existing building
• Used natural and adaptive plant species and eliminated water used for irrigation
• All low flow water fixtures
• Stormwater from the site is captured beneath the parking lot and allowed to percolate back into the soil
• Low-VOC finishes and fixtures used throughout the space
• Electric vehicle charging station
• Educational signage throughout the site, including a viewable mechanical space.
The Results

Net zero predicted energy use comparison (not including solar and wind energy production)
The Results

WALGREENS EVANSTON NET ZERO STORE
YEAR-TO-DATE ENERGY PERFORMANCE

- Actual Net Electric (kWh)
- Predicted Net Energy Use (kWh)
The Results

Predicted EUI = -5
Actual EUI after 1st year of operation = 20
Last 12 Months = 15
Typical Store in Chicago = 105

Several corrective measures taken from issues found during commissioning.

- Replacing oversized refrigeration compressors
- Re-piping Dedicated outside air handler
- Diagnosing and repairing anti-condensate heaters
- Dimming system properly set up
- Replaced incorrect lighting fixtures
- Security system lighting override
- Malfunctioning Gas cooler
- Leaking CO2 bypass valve (deforming valve seat)
Overall Lessons Learned

Don’t Rush!
Commissioning before opening
Engage all contractors early
Punchlist
Plan on scheduled follow ups
Create corrective action plans
Incorporating HVAC into refrigeration rack breaks down historic barrier to innovation
Geothermal loop adds redundancy and increases operational flexibility
Real time monitoring and transparency are vital
Thermography
Additional Resources
Resources

- Walgreens Net Zero Video
  - [http://youtu.be/3J8x5he7xG4](http://youtu.be/3J8x5he7xG4)
**Additional Questions? Please Contact Us**

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