

**nbi** new buildings  
institute

redefining  
what's possible  
in the built  
environment

## virtuous cycle

We are an engine of innovation for the energy efficiency industry. We drive research, uncover solutions, and advance industry practices and policies that deliver positive change in the built environment.





The screenshot shows the NBC News website interface. At the top, the NBC News logo is on the left, followed by navigation links: HOME, TOP VIDEOS, and ONGOING: UKRAINE CRISIS, AIRASIA PLANE CRASH. Below this is a secondary navigation bar with categories: U.S., WORLD, LOCAL, POLITICS, HEALTH, TECH, SCIENCE, POP CULTURE, BUSINESS, INVESTIGATIONS, SPORTS, and a MORE dropdown menu. The main content area is under the heading POLITICS / CONGRESS. The article title is "Senate Votes 98-1 That Climate Change 'Is Not A Hoax'". The text below the title reads: "United States senators are now on the record on the question of whether climate change is 'a hoax.' But a majority of the Senate, including 15 Republicans, are also on record stating that human activity contributes to climate change." A second paragraph states: "The Senate on Wednesday passed a measure stating that 'climate change is real and is not a hoax' by a margin of 98-1."

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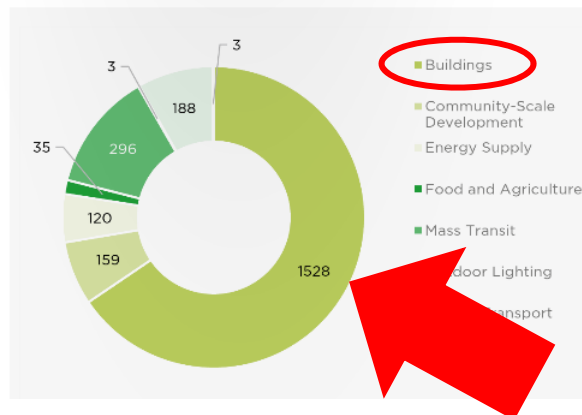




## Arup: Potential for Climate Action

Figure 2.04. Sector breakdown of first priority actions.

● **450 MtCO<sub>2</sub>e** could be saved by 2020 if the highest priority actions were implemented.



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http://publications.arup.com/Publications/P/Potential\_for\_Climate\_Action.aspx

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## Zero Net Energy – What is it?

*A ZNE building is an ultra-efficient building that generates as much energy as it consumes annually. Also known as Net Zero Energy.*



# Research



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advanced buildings

## GETTING TO zero BUILDINGS DATABASE

**New Buildings Institute is proud to introduce our Getting to Zero Buildings Database.**

**NBI Featured Project**

**Bullitt Foundation Cascadia Center**  
Building Type: Office  
Square Area: 11,000 sq ft  
Project Status: Completed  
Completion Date: Apr 2013

**Most Popular**

**Alford A. King United States District Courthouse**  
Building Construction New Office Building  
Target New Construction  
Target Energy Upgrade  
LEED Energy Upgrade

**Most Recent**

**University of Houston Public Library - Channing Branch**  
Renovation and Addition  
Full Renovation Building and Addition  
The Advanced House (The Ecological House of Pacific West)

**Featured Views**

**LEED Certified**  
LEED Platinum  
**Submit a Project**

RESEARCH CODES & POLICY

ZERO NET ENERGY ADVANCED

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SEARCH FOR PROJECTS

Keywords

LEED Certified  
 LEED Platinum  
 LEED Emerging  
 LEED Platinum  
 LEED Platinum  
 LEED Platinum

Primary Building Use

Net EUI (kBtu/sq ft/yr)

At Least:  Less Than:

Building Size (sq ft)

At Least:  Less Than:

Construction Type

Climate

State or Province

Project Name	City	State/Province	Area (ft <sup>2</sup> )
Diamond Ranch Student Intern Center at Santa Monica National Recreation Area	Malibu	CA	1,482

**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>

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## Definitions

- **Zero Net Energy Buildings**

- **Verified** - 1 year or more of measured energy data at ZNE performance reviewed by a third party

- **Emerging** – Identify ZNE as a target, operations or data not yet reviewed

- **Renewables** are onsite for the nbi study

- **Ultra-low Energy or ZNE-ready**

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*Project Profile*

**Ultra-Low Energy Building**

*Measured Energy Stats*

**19 - 1 = 18**

BUILDING'S TOTAL EUI	RENEWABLE PRODUCTION EUI	BUILDING'S NET EUI
----------------------	--------------------------	--------------------

Site Energy Use Index (EUI) kBtu/SF/year

The Energy Equation: the building energy use minus the renewables production equals the net energy of the building. Buildings may be "getting to zero" and have a net EUI above zero. If renewable production exceeds energy use its net EUI is below zero (negative) and it is creating surplus energy.



Photo courtesy of Sally Painter Photography

**Overview**

**THE RAMONA**

The Ramona is a mixed-use development in the urban Pearl District of Portland, Oregon. The building hosts 138 units of affordable housing and two educational facilities. Portland Public Schools rents 13,000 SF for programs for children ages 3 to 6. A nonprofit community group also leases space on the ground floor.

**Site Details**

**Building Size:** 230,760 SF (includes garage)

**Location:** Portland, Oregon

**Construction Type:** New

**Construction Year:** 2011

**Building Type:** Multifamily and Educational

**Planning & Design Approach**

The design team used the Architecture 2030 program goals as the primary driver for energy performance. The aim was to meet the 50% better than Commercial Building Energy Consumption Survey (CBECS) level, or an EUI of 23 kBtu/SF/year for a building of this type and size. The team strived to build a tight envelope, serve it with the most energy efficient equipment and fixtures available, and provide renewable energy systems such as photovoltaic and solar hot water.



New Buildings Institute © 2016

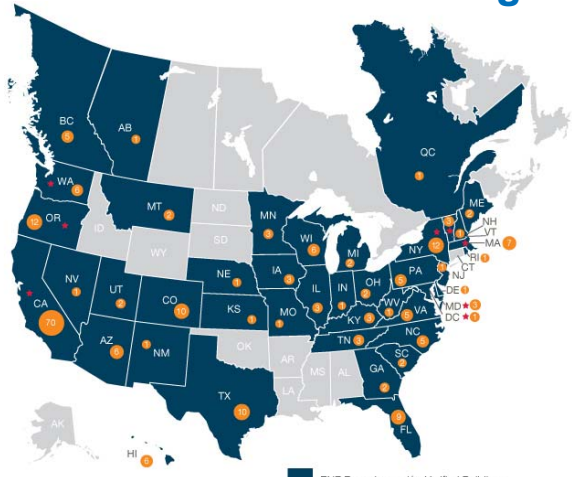
**44 States & Provinces with ZNE Buildings**

**2015 List of Zero Energy Buildings**

In 2011 and 2015 NBI conducted research to identify buildings with targets or actual reductions of net zero energy. These results were published in "ZNE Status Report" by NBI in early 2012 and 2015. NBI continues to track and document buildings with net zero energy to support the market and policy research efforts. This 2015 list of buildings is an effort to show the market's progress.

Most Zero Energy Buildings are classified as those with greatly reduced energy needs that have been decarbonized to have net use of zero or net energy use through renewable sources of energy. The energy use of all fuels (electric, natural gas, waste heat) is counted and listed. Buildings are in the list are in bold italics.

Year Completed	Name	Location	Grade	Building Type	Area (sq ft)	2005 Reference EUI	Site EUI	Net EUI
2009	<b><i>Oregon College of Arts and Sciences</i></b>	<b><i>Stress, OR</i></b>	<b><i>Undergraduate</i></b>	<b><i>College</i></b>	<b><i>13,910</i></b>	<b><i>32</i></b>	<b><i>19</i></b>	<b><i>-13</i></b>
2009	<b><i>Center for Sustainable Systems</i></b>	<b><i>Amherst, MA</i></b>	<b><i>Education</i></b>	<b><i>Single</i></b>	<b><i>2,000</i></b>	<b><i>3</i></b>	<b><i>4</i></b>	<b><i>-1</i></b>
2009	<b><i>California Institute of Technology</i></b>	<b><i>Los Angeles, CA</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,500</i></b>	<b><i>9</i></b>	<b><i>9</i></b>	<b><i>0</i></b>
2009	<b><i>Yale University (Wegman Hall)</i></b>	<b><i>Woolwich, CT</i></b>	<b><i>Education</i></b>	<b><i>Single</i></b>	<b><i>12,300</i></b>	<b><i>4</i></b>	<b><i>0</i></b>	<b><i>-4</i></b>
2009	<b><i>Advanced Power Electronics</i></b>	<b><i>El Estero, CA</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>5,200</i></b>	<b><i>17</i></b>	<b><i>17</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
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2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
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2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>
2009	<b><i>University of Colorado</i></b>	<b><i>Colorado, CO</i></b>	<b><i>Other</i></b>	<b><i>Other</i></b>	<b><i>1,000</i></b>	<b><i>10</i></b>	<b><i>10</i></b>	<b><i>0</i></b>



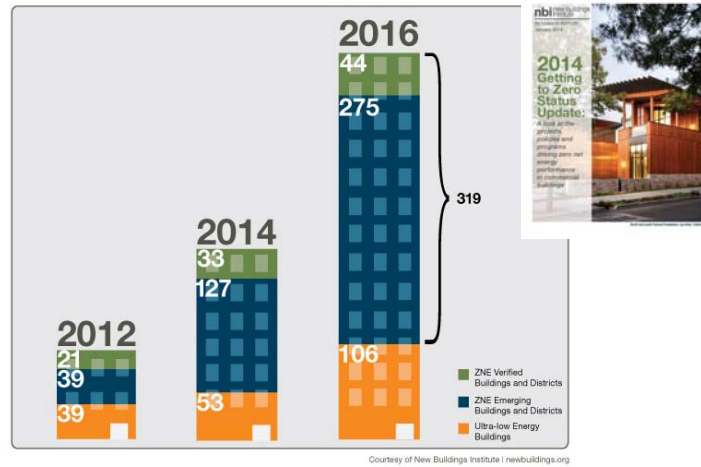
Number of Buildings and projects (225) ★ States with Reach Code Adopted or in Development



New Buildings Institute © 2016



# Zero Energy Buildings



## 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

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RESEARCH CODES & POLICY TOOLS & GUIDES EVENTS NEWS

ZERO NET ENERGY ADVANCED BUILDINGS OUTCOME-BA:

## ZHOME



**DESCRIPTION**

zHome is a ten unit townhome project designed to achieve zero net energy, as well as a number of other environmental benchmarks. One of the ten units is being used as a long term education center, and will become an affordable housing unit in 2016.

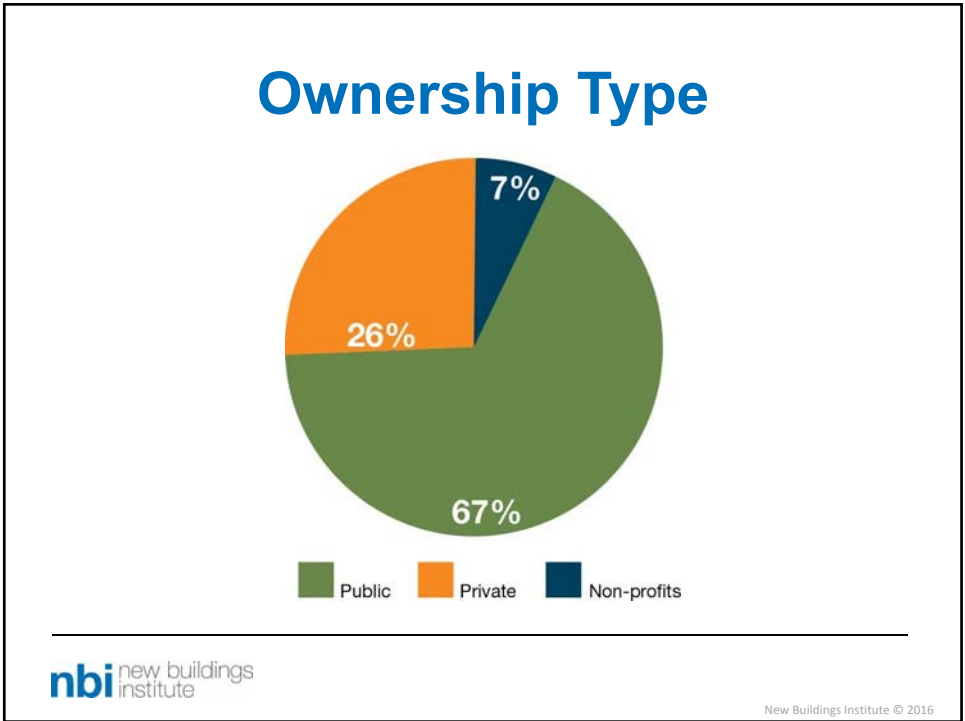
**LOCATION**

City: Issaquah  
State: WA

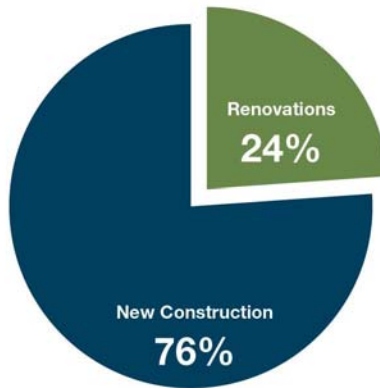
Total area: 5,813 ft<sup>2</sup>  
Building Type(s): Lodging, Multifamily 1-4, ZNE Verified,

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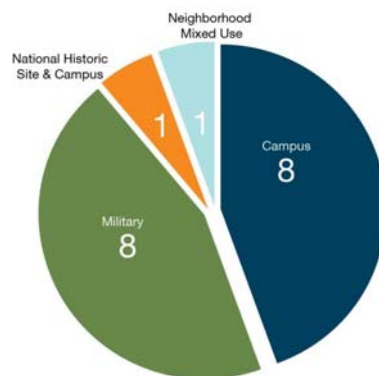
New Buildings Institute © 2016

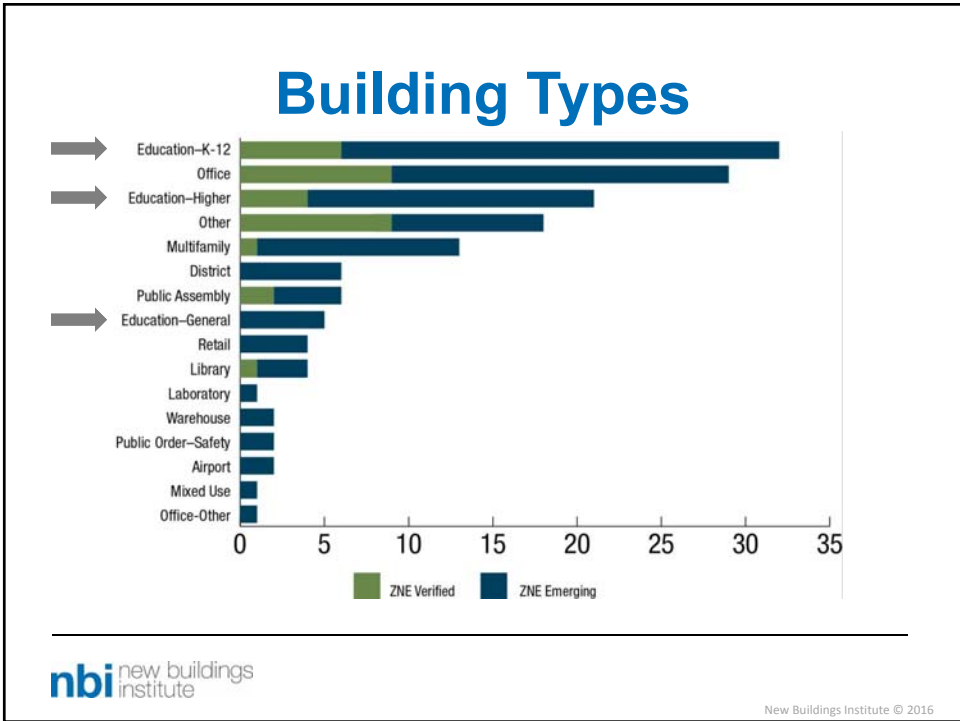
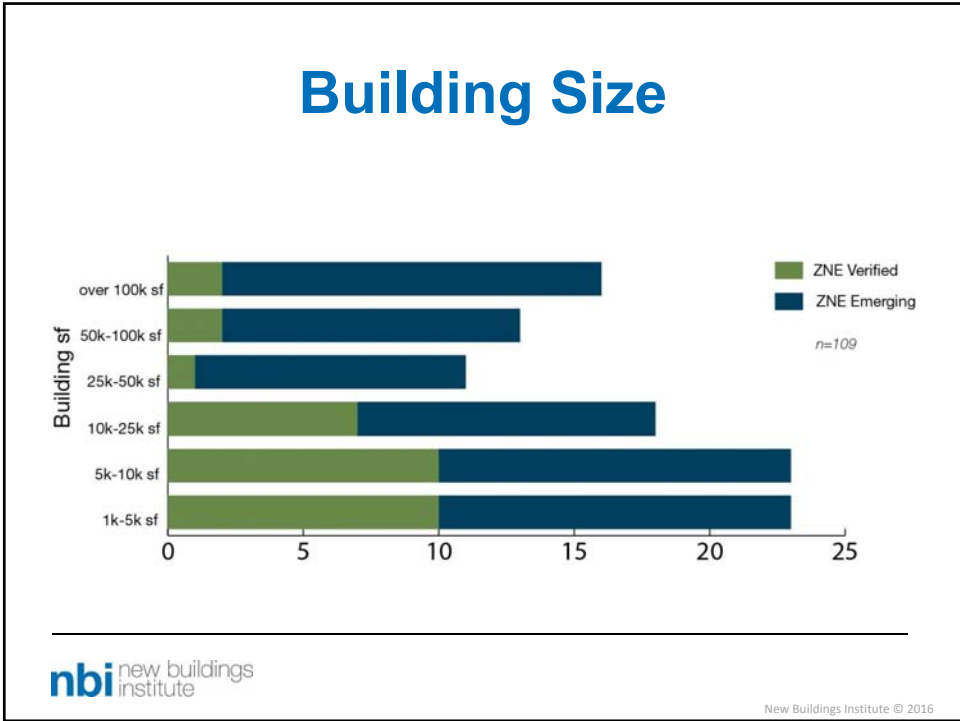


## Existing Building Renovation



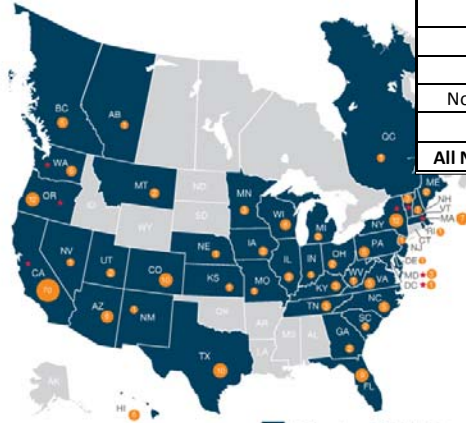
## 18 ZNE Districts







## Leading States for ZNE Schools

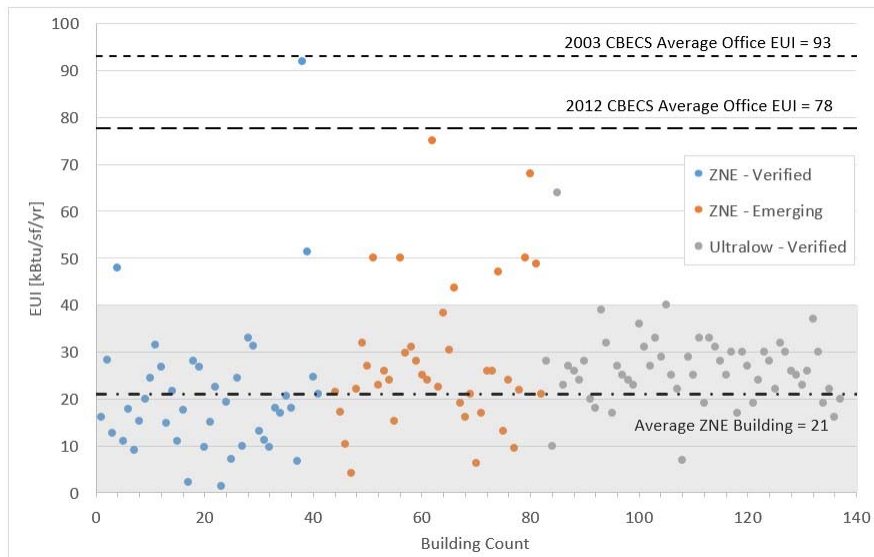


ZNE School Buildings - Top Three States			
State	Verified	Emerging	Total
California	3	20	23
North Carolina	1	5	6
Oregon	1	5	6
<b>All North America</b>	<b>12</b>	<b>65</b>	<b>77</b>

# Number of Buildings and projects (225)  
 ■ ZNE Emerging and/or Verified Buildings (42 states and provinces, and the District of Columbia)  
 ★ States with Reach Code Adopted or in Development

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## ZNE Performance Range



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## Common Technologies for Ultra-low Energy

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



Redding School for the Arts, CA

Courtesy : Trilogy Architecture Steve Whittaker Photography

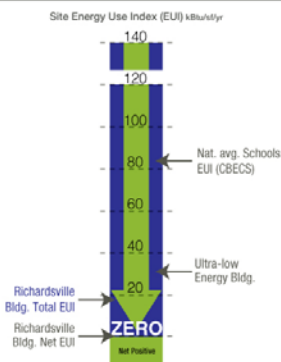


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## Richardsville Elementary School

$$18 - 18 = 0$$

BUILDING'S TOTAL EUI      RENEWABLE PRODUCTION EUI      BUILDING'S NET EUI



### Efficiency Measures:


- Ground source heat pump
- DOAS
- CO2 sensors
- Daylighting
- High performance lighting system with controls
- EMS & Energy Dashboard



Photo: Sherman Carter Barnhart



New Buildings Institute © 2016



Photos: Bruce Diamond

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**OVERVIEW**

*Site Details*

**Building Size:** 19,875 SF  
**Location:** Sacramento, California  
**Construction Type:** New  
**Construction Year:** 2012  
**Building Type:** Multifamily  
**CA Climate Zone:** 12

*Measured Energy Stats*

<b>31 - 6 = 25</b>		
BUILDING'S TOTAL EUI	RENEWABLE PRODUCTION EUI	BUILDING'S NET EUI

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

**LA VALENTINA NORTH TOWNHOMES**


The La Valentine North Townhome project is the result of a partnership between SMUD and the owner/developer of the project, Dornus Development LLC. The 18-unit affordable multifamily development is a research and demonstration project in SMUD's Townhouse Home of the Future (HOF) program. The team considered the reduction of solar heat gain, a large energy driver in Sacramento's hot climate, as a primary design objective. This Home of the Future Demonstration Program project features promising and efficient technologies that can be shared as lessons with local builders and ideally incorporated into SMUD's SolarSmart Homes program.

**Planning & Design Approach**

Overarching project goals:

- Cut annual source energy use by 80% and achieve zero peak electricity demand during SMUD's 4-7 pm summertime peak period
- Serve as a demonstration for advanced framing and construction techniques, efficient building features and equipment and a net-metered solar photovoltaic system


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New Buildings Institute © 2016

## NBI Zero Net Energy Building Controls Study

Characteristics, Energy Impacts, and Lessons from Zero Net Energy Buildings



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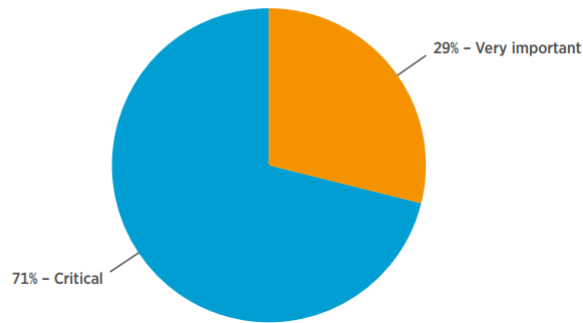


NBI © 2016

## Value of Setting the ZNE Target

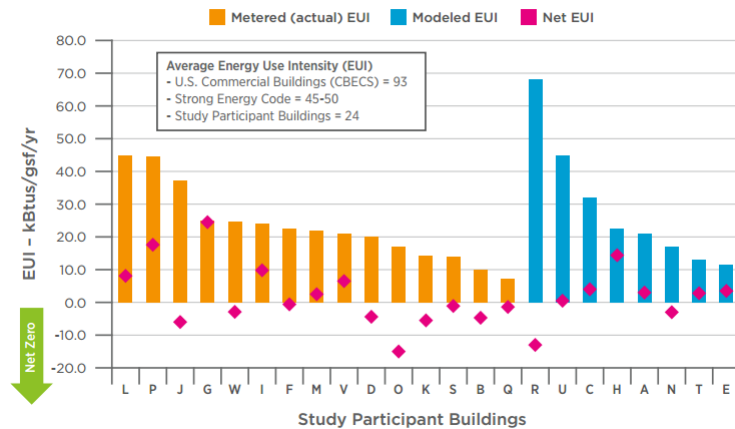
Figure 8: The Value of Setting Early Energy Targets to the Performance Outcome

■ Not important   
 ■ Somewhat important   
 ■ Important   
 ■ Very important   
 ■ Critical



## The EUI of ZNE Buildings

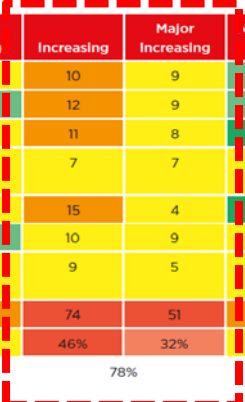
Figure 9: Energy Use Intensity (EUI) of Participant Buildings





# The Value of Controls in ZNE

	Major Decrease	Decreasing	No Change	Increasing	Major Increasing	No Opinion or N/A
Whole Building Controls	0	0	3	10	9	1
Lighting Systems	0	0	1	12	9	1
Daylighting Controls	0	2	2	11	8	0
Automated Shades & Glare Controls	0	0	5	7	7	4
HVAC Controls	0	0	4	15	4	0
Plug Loads	0	0	1	10	9	3
Server Closets and Data Mgmt	0	0	5	9	5	4
Totals	0	2	21	74	51	13
Percent per Response	0%	1%	13%	46%	32%	8%



Are Controls important to get to ZNE?  
 – Yes: 100%

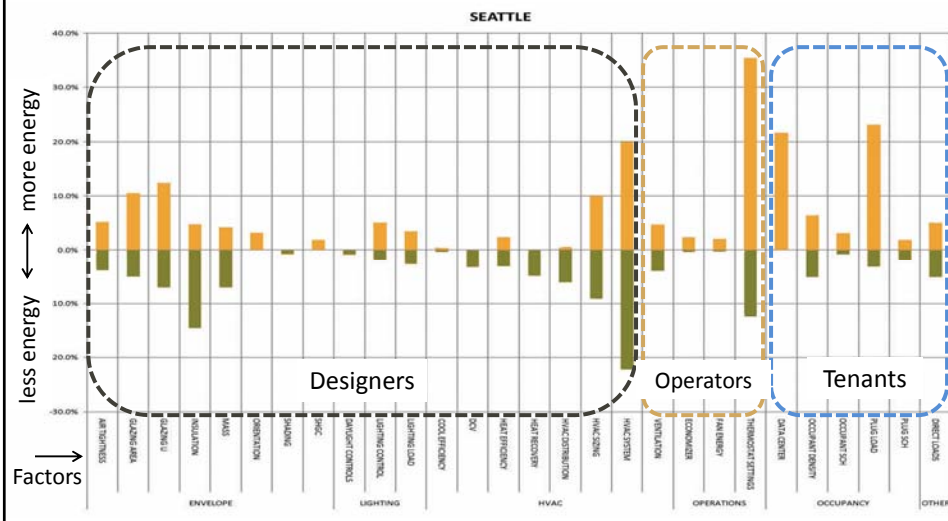
Would you select the same controls again?  
 – Yes: 78%



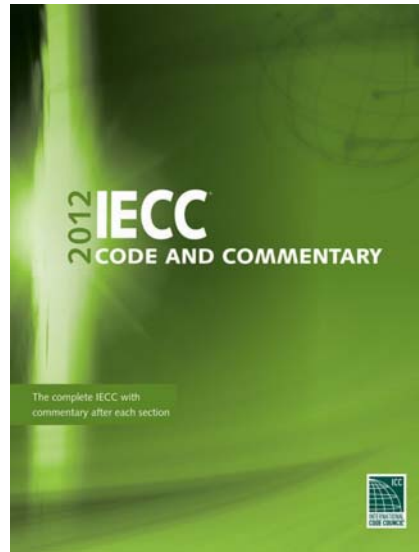
NBI © 2016

# Sensitivity Analysis

Comparing the Magnitude of Impact of **Design**, **Operation**, and **Tenant Behavior** on Building Energy Performance



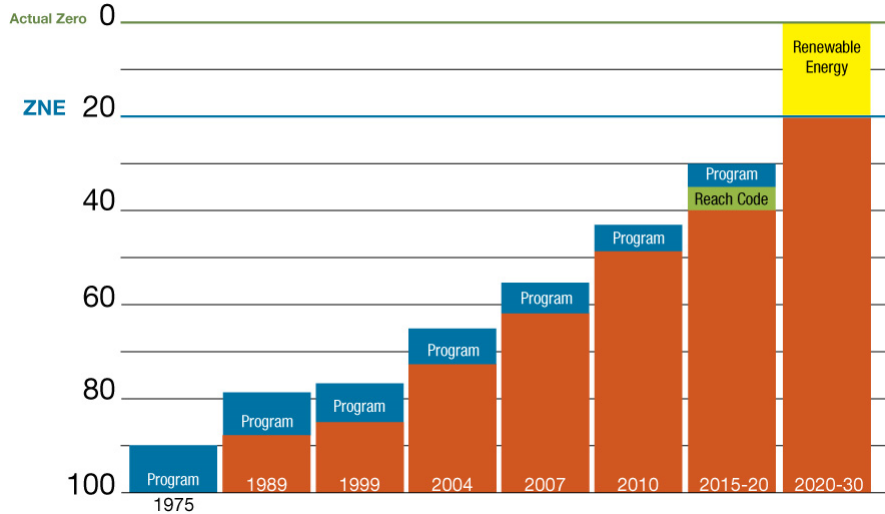
## Codes and Policy



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## Advancing Policy to Zero



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## “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

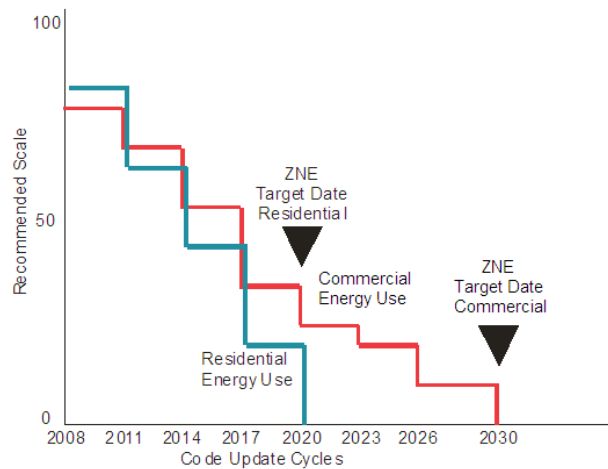
*The California Efficiency Strategic Plan (Sep 2008)*  
[californiaenergyefficiency.com/docs/EEStrategicPlan.pdf](http://californiaenergyefficiency.com/docs/EEStrategicPlan.pdf)

Exploratorium | San Francisco, CA

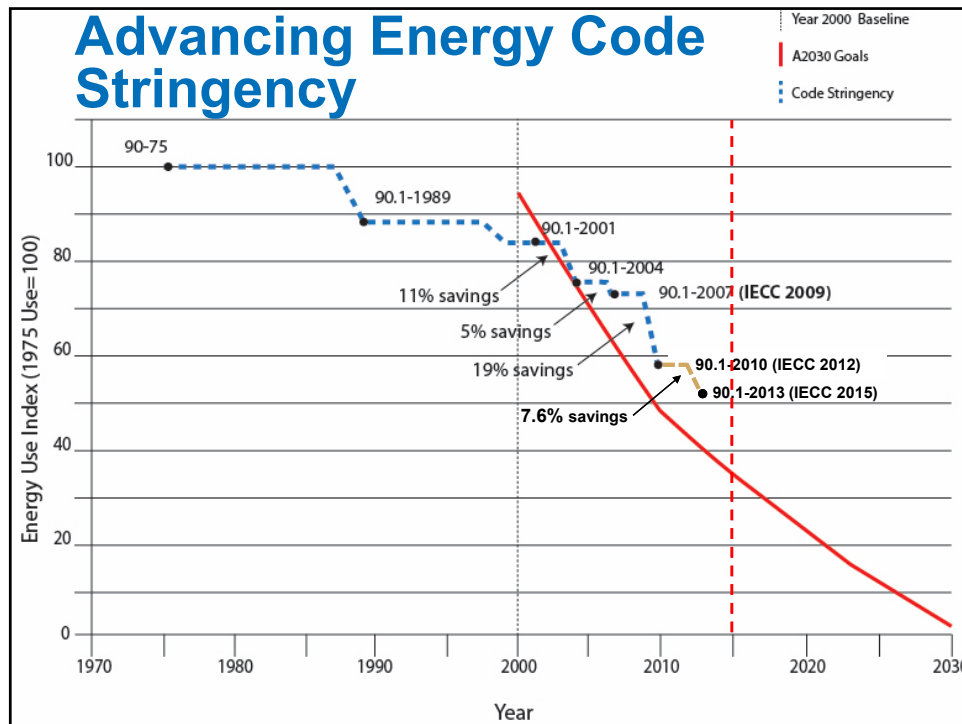


2016 Prop 39 ZNE School Retrofit Workshops

## Code Cycles to Net Zero in CA

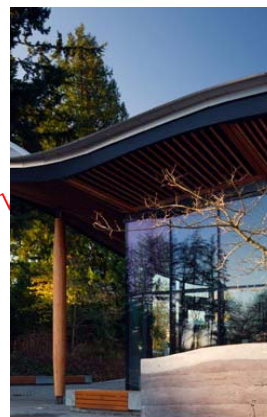


Code Cycles to ZNE, Source: SCE & AEC, 2009



## NBI Identified ZNE Challenges/Opportunities

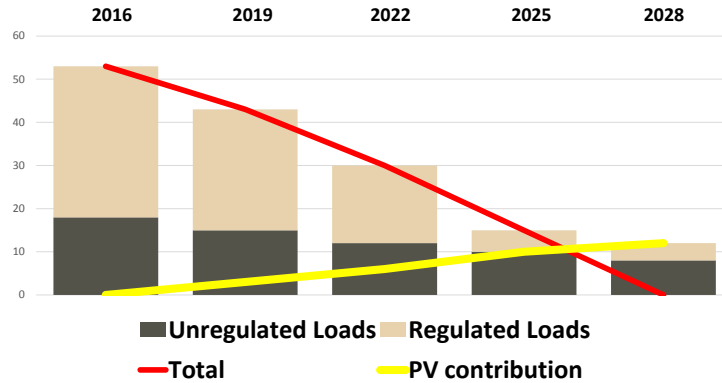
- Plug/Process Loads ✓
- Federal Pre-emption - codes ✓
- Energy Intensive Building Types ✓
- Efficiency vs. Renewables/Location ✓
- Existing Buildings ✓
- Operations and Outcomes ✓



VanDusen Botanical Garden Visitor Centre



# Code Progression to ZNE



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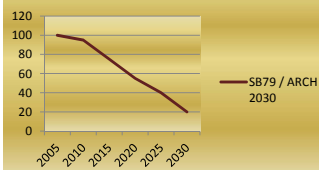
New Buildings Institute © 2016

## GETTING TO ZNE

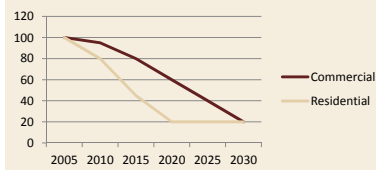
### Tools for the Policy:

1. Goals and Definitions
2. Market Readiness
3. Public Buildings
4. Case Studies
5. Outreach to Stakeholders
6. Emerging issues – DG, EV, etc...
7. Engagement w/ Energy Utilities

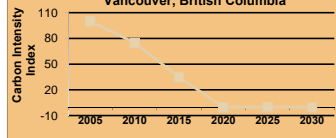
### OREGON SB 79



### California: Big Bold Goals



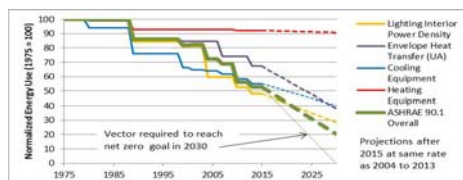
### CARBON NEUTRAL PATH Vancouver, British Columbia



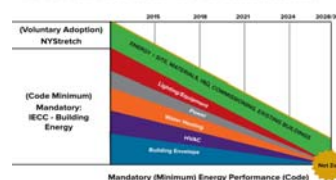
### WASHINGTON: SB 5854

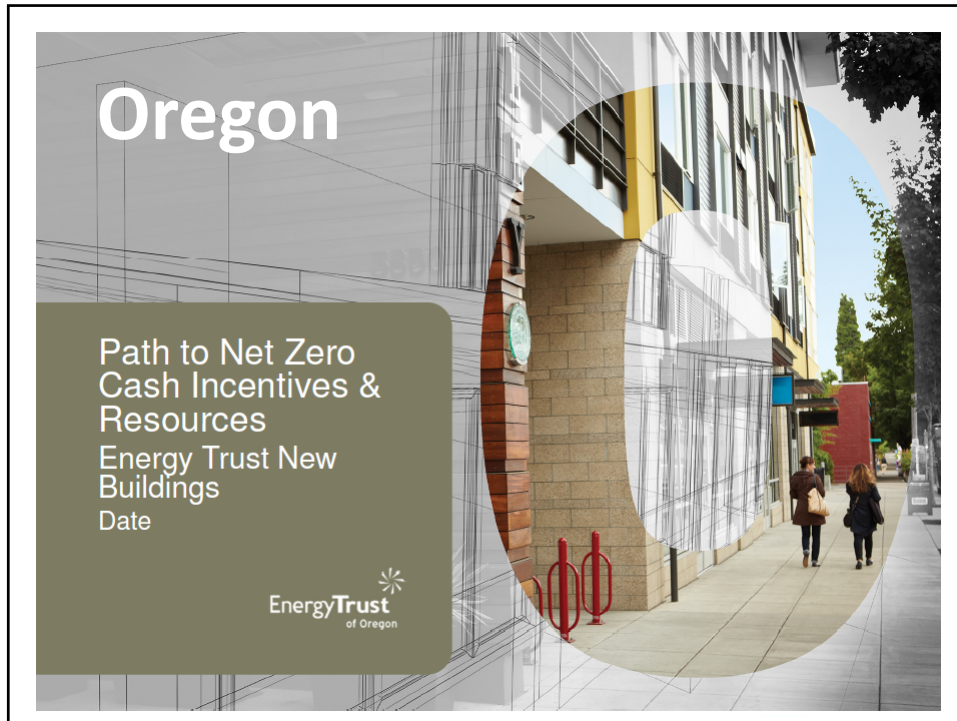


### ASHRAE 90.1 – Energy Use Targets



### NYStretch and Code Minimum





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institute

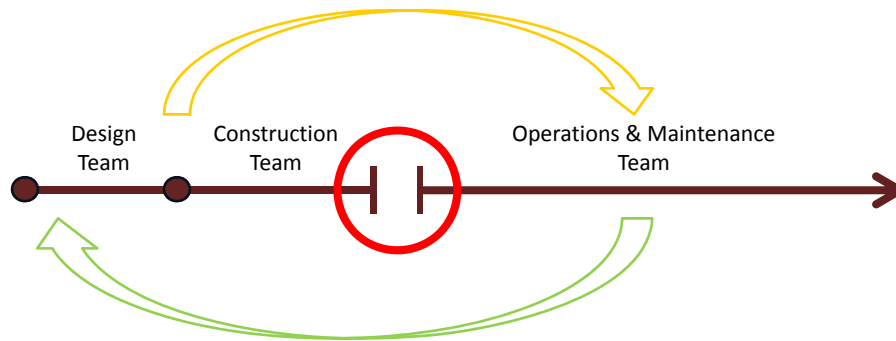
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***How do you Get to Zero?***

New Buildings Institute © 2016

## Start with an Integrated Development Process

Integrating operations team into the design process



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## Target ZNE

- Set ZNE Target Early
- Design to the target
- Build to the design
- Operate to the ZNE target
- Measure and verify performance



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## Integrate Efficiency First

– The Energy Loading Order



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## Integrate Efficiency First

### Renewable-Oriented

### Efficiency-Oriented

Minimally to moderately  
sensitive to the grid

Highly grid-integrated and  
responsive

Higher gross energy use

Lower gross energy use

Higher renewable generation

Lower renewable generation

#### Active Strategies Focus:

Mechanical HVAC Systems,  
Thermal Storage, Night Flush  
with Fans, Demand Response

#### Passive Strategies Focus:

Daylighting, Building Orientation,  
High Insulation Levels, Passive  
HVAC, Built-In Shading

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## Be a Good Grid Citizen

– Develop a grid friendly building

© New Buildings Institute, 2015

## Develop and Integrate EEMs

– Establishing your solar and energy budget

ARCHITECTURE & ENGINEERING
OCCUPANT

**HEATING/COOLING**

- + high performance glass
- + high performance walls & low infiltration
- + 65% effective heat recovery
- + ground source heat pumps
- + demand controlled ventilation
- ventilative cooling
- + radiant slab cooling

**TENANT**

- + "irresistible" stair to discourage elevator use
- heating setpoint w/radiant
- + cooling setpoint w/radiant
- + daytime office cleaning
- + 80% laptop, 20% desktop
- phantom loads

**BUILDING EUI**

ENERGY USE INTENSITY: ENERGY CONSUMPTION PER FLOOR AREA

**NET ZERO ENERGY**

© 2014 - The Miller Hull Partnership, LLP

© New Buildings Institute, 2015




## (Example) ZNE Energy Efficiency Measures (EEM)

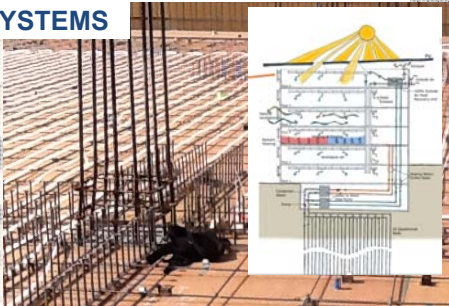
<b>Measure 1: Reduced Building Equipment Energy Use</b>
Strategy 1a. Receptacle Controls
Strategy 1b. Plug Load Management
Strategy 1c. Plug Load Equipment
<b>Measure 2: Heating and Cooling Strategies</b>
Strategy 2a. Dedicated Outdoor Air System (DOAS)
Strategy 2b. HVAC Zone Control
<b>Measure 3: Improved Overall Building Envelope Performance</b>
Strategy 3a. Thermal Load Intensity
Strategy 3b. Air Infiltration Testing
<b>Measure 4: Reduced Lighting Energy</b>
Strategy 4a. Luminaire Level Lighting Control
Strategy 4b. Interior LPDs and Exterior Lighting Efficacies Based on Solid-state Lighting


SPACE CONDITIONING

### Decoupling Space Conditioning from Ventilation

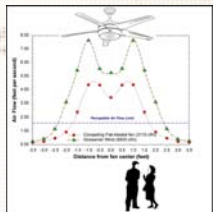


RADIANT SYSTEMS

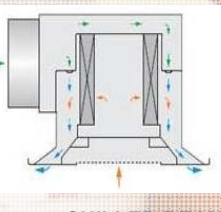





INDIRECT EVAPORATIVE COOLING



CEILING FANS

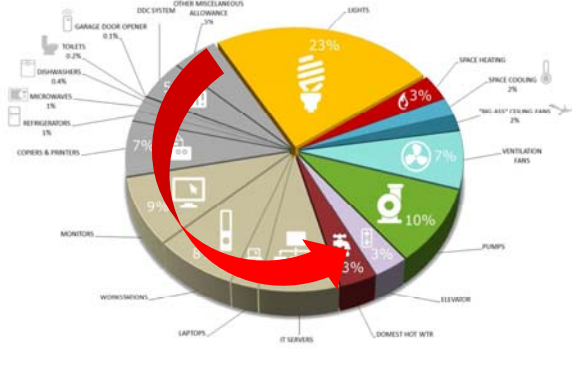


CHILLED BEAMS



# Address Plug Loads and Miscellaneous Equipment

## Occupancy and Plug Loads



Plug Load Best Practices Guide  
Managing Your Office  
Equipment Plug Load

### Guide to Energy Savings

Plug loads can be managed through low- and no-cost measures that are relatively straightforward to implement.

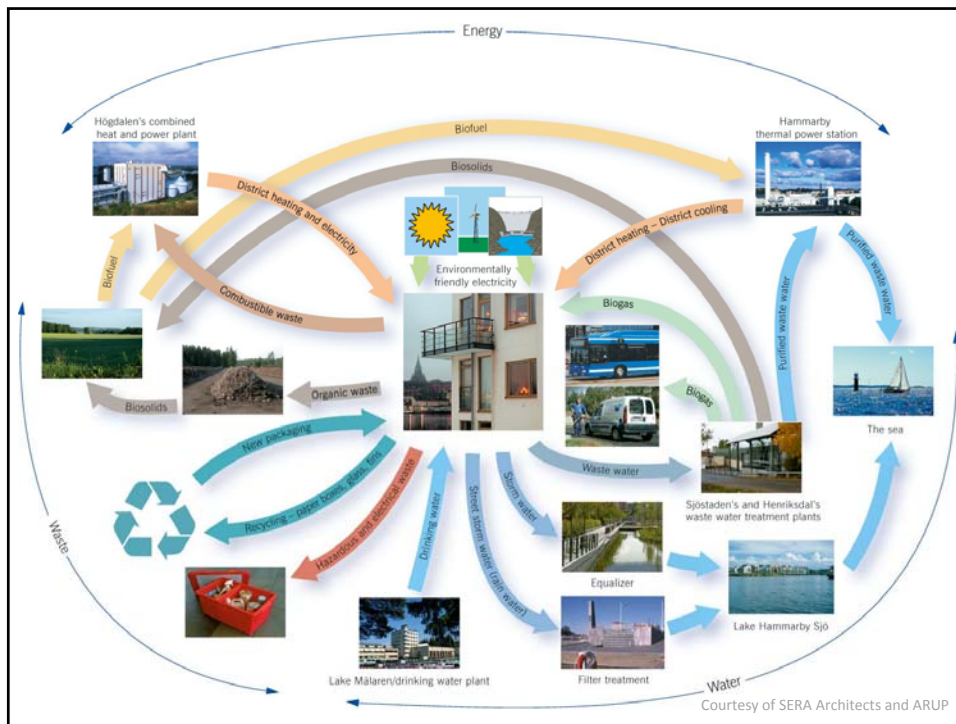
This Guide shows how simple changes can cut costs and save energy in offices.



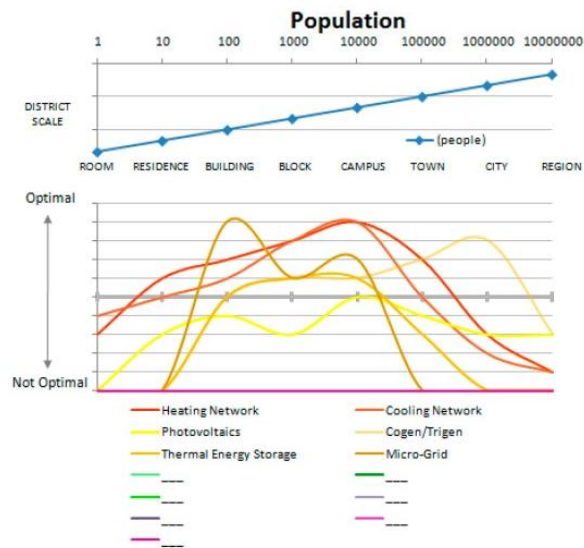
NBI © 2015



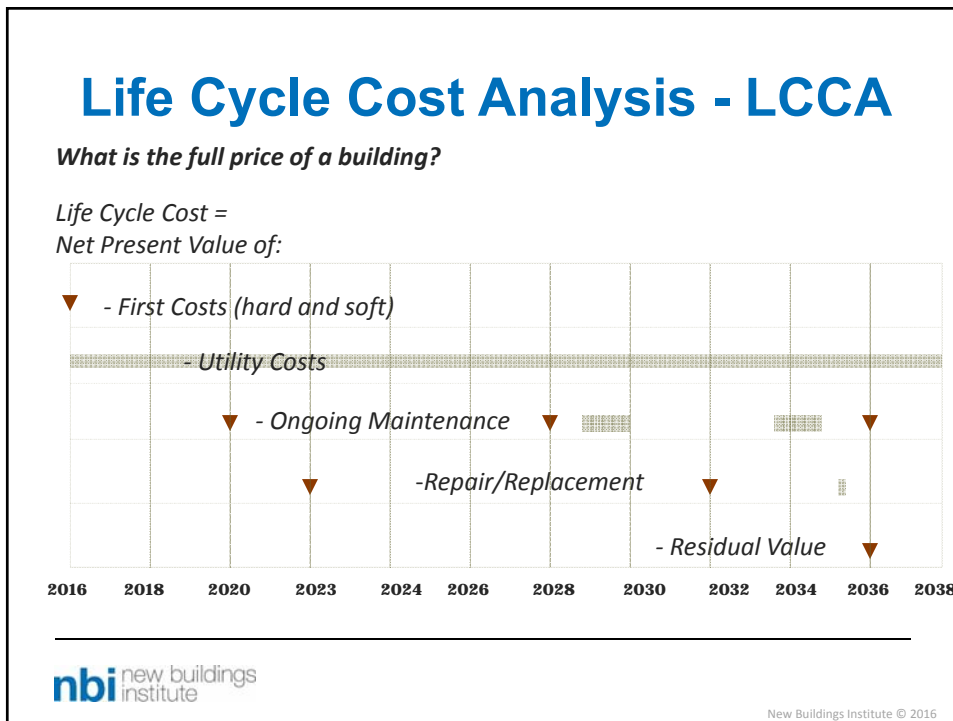
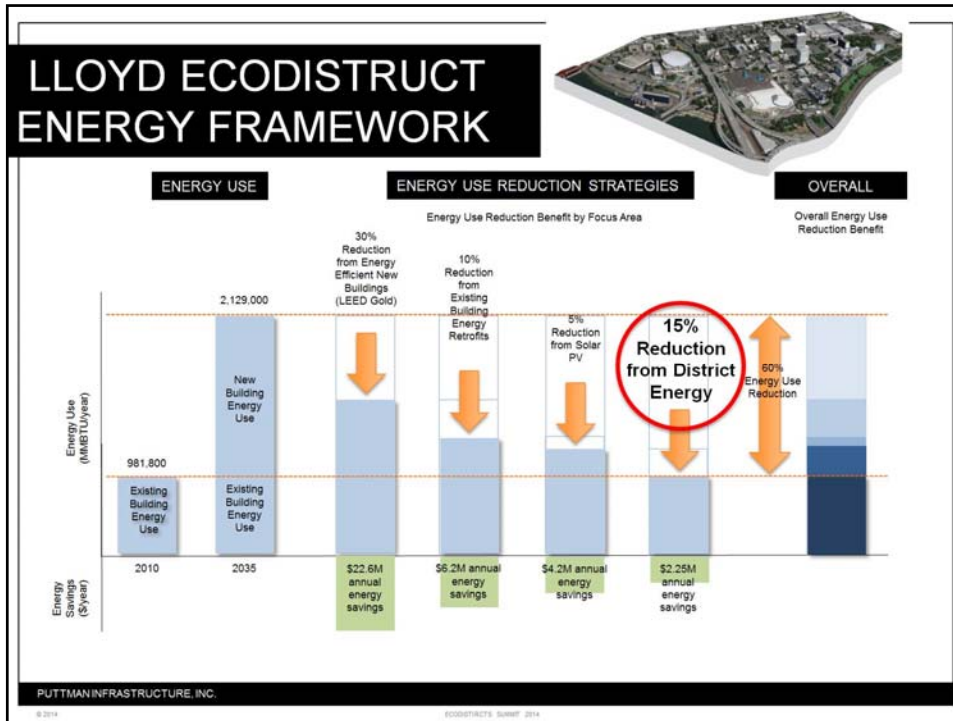
New Buildings Institute © 2016



# OPTIMAL SCALES ENERGY



Courtesy of SERA Architects and ARUP





5.1-energy-life-cycle-cost [Compatibility Mode] - Excel

**Figure 5.1 ENERGY LIFE CYCLE COST SPREADSHEET**  
ELCCA2005.xls 18-Apr-16

**PROJECT DATA**  
PROJECT Facility Name (Firm Name)  
ALT. No. Description (Analyst's Name)

**DISCOUNT & ESCALATION** Real Rates as of November 2004

Enter 1 or 0 for each fuel type:

Years:	Rate:
Real Discount Rate (r)	2005 - 2,040 2.0%
Electricity	2005 - 2,015 1.0%
Investor Owned Utility	2,016 - 2,025 2.0%
Natural Gas	2005 - 2,015 1.0%
And other fossil fuels	2,016 - 2,040 2.0%
Maintenance	2005 - 2,040 2.0%
Inflation (Nominal, not used)	2005 - 2,040 3.0%

\* IOU = Investor Owned Utility  
\*\* POU = Publicly Owned Utility

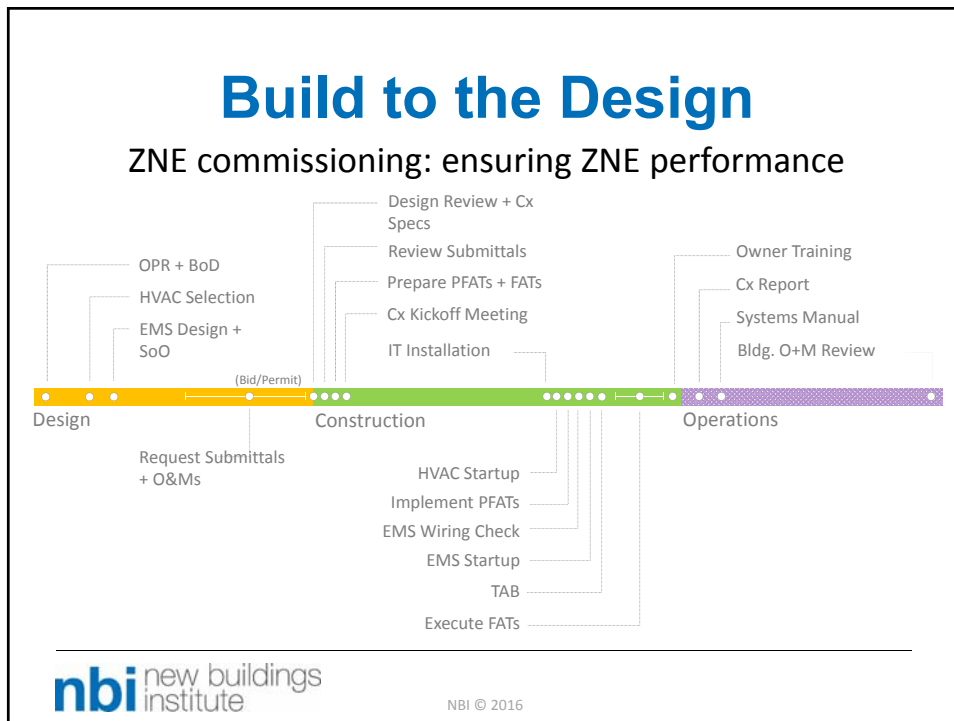
**ANNUAL REAL CASH FLOWS** \$3,312,896 ~30-year LCC

(Begin) Year	First & Replace Costs	Annual Maint Costs	Annual Nat Gas Costs	Annual Electric Costs	Total Annual Costs	Present Worth Factor (1+r) <sup>-n</sup>	Present Worth of Annual Costs	Present Worth of Cumulative Costs
2005	\$200,000	\$1,000	\$12,000	\$108,000	\$121,000	0.98	\$117,800	\$117,800
30	2,000	\$200,000	12,120	101,000	114,140	0.98	111,902	311,902
31	2,006	0	1,040	12,241	102,010	0.96	110,815	422,717
32	2,007	0	1,044	12,361	103,411	0.94	109,728	533,532

<http://des.wa.gov/services/facilities/Energy/ELCCA/Pages/default.aspx>

zeronetenergy

2016 Prop 39 ZNE School Retrofit Workshops





## Operate to ZNE Measure and Verify Performance

The image is a composite of three parts. On the left, three children are gathered around a large wall-mounted screen displaying energy data. In the top right, there is a close-up of a 'Vampire Switch' device, which is a red circular button with a white hand icon. In the bottom right, there is a screenshot of an energy monitoring dashboard. The dashboard includes a navigation menu with 'Home', 'Green Features', 'Virtual Tour', 'Energy Monitoring', and 'Animations'. It features 'Energy Monitoring' data powered by 'SIEMENS', 'Current Solar Array Production LIVE DATA' with four gauges for Array 1, Array 2, Array 3, and Array 4, and a line graph for 'Individual Solar Array Production'. The dashboard also shows a temperature of 37.1°F and weather conditions 'Partly Cloudy 8 mph East'. The 'nbi new buildings institute' logo is in the bottom left corner.

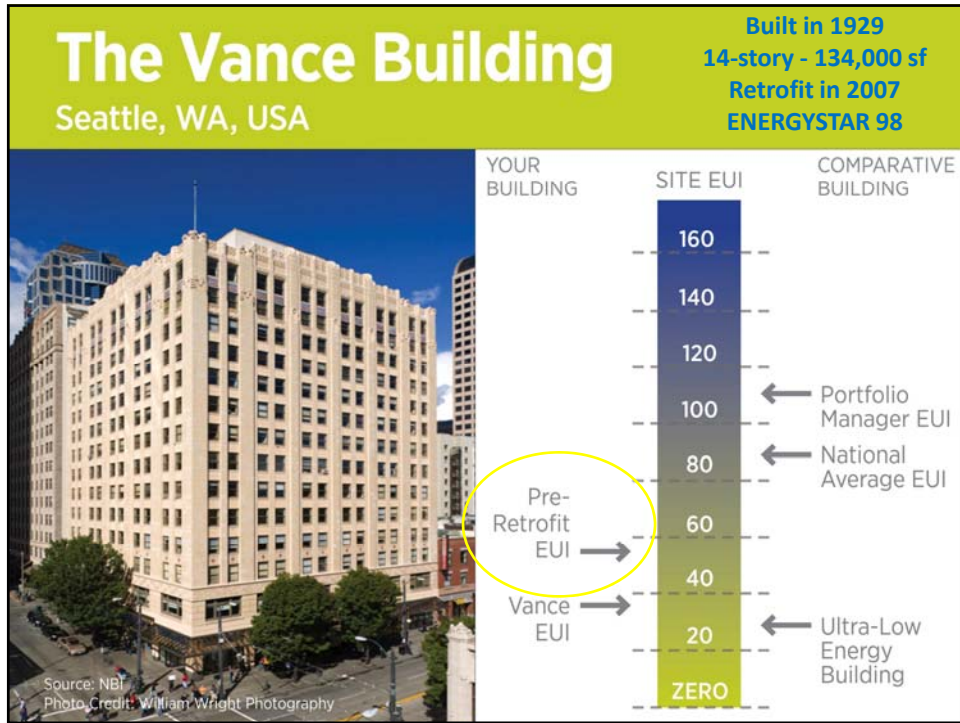
## The Importance of Existing Buildings

1. Make real estate transactions a mechanism for upgrading the existing building stock
2. Reserve federal incentives for building retrofits to zero net energy
3. Modify Title 42 federal preemption of local and state equipment standards to ensure reasonable standards are available to meet state and local energy goals.

The infographic is titled 'Reinventing Existing Buildings'. It features several key statistics and graphics:
 

- A bar chart showing 'There are 5.5 Million existing commercial buildings in the U.S.' with a city skyline background.
- A text box stating 'We will spend over \$1 trillion on construction in 2015 with only about \$50 billion focused on energy retrofits of commercial buildings.' accompanied by a money bag icon.
- A circular graphic stating 'The replacement rate (demolition & new construction) is less than 2% per year. This leaves a vast amount of outdated technologies in current building stock.' with a gear icon.
- A text box stating 'An investment of less than \$300 billion in existing building retrofits would yield more than \$1 trillion in energy savings over 10 years.\*' with a stack of coins and an upward arrow icon.
- A text box at the bottom stating 'The savings potential is equivalent to 30% of annual electricity spending, and would create more than 3.3 million job years.' with a power line icon and a group of people icon.

 The 'nbi new buildings institute' logo is in the bottom left corner, and the website 'newbuildings.org' is at the bottom.



## ZNE Retrofit Actions

### Low intervention:

- Remote Audit
- Retro-commissioning
- Controls: Building Tuning
- Plug Load Savings/Policy
- Operator and Occupant Training
- Infiltration Reduction Measures

### Medium intervention:

- Lighting/Daylighting
- HVAC Equipment Upgrades
- Controls: System Upgrade
- Opportunistic Envelope Insulation

### High intervention:

- HVAC System Switching
- Envelope Upgrade
- Window Replacement
- Renewable Energy System

## What Resources are Available?

New Buildings Institute © 2016

### 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](mailto:heather@newbuilding.org).

**zero net energy**

# ZNE Communications Toolkit

[www.newbuildings.org/zne-communications-toolkit](http://www.newbuildings.org/zne-communications-toolkit)

## 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  
<http://energydesignresources.com/resources/publications/case-studies/case-studies-zne-non-residential-buildings.aspx>
- NBI Registry  
<http://newbuildings.org/share>
- Getting to Zero Database  
<http://newbuildings.org/getting-to-zero-buildings-database>

**Zero Net Energy Project Profile**  
Small Office Retrofit

**OVERVIEW**

**Site Details**  
 Building Size: 4,500 SF  
 Location: San Diego, California  
 Construction Type: Retrofit  
 Construction Year: 1956, 2009  
 Building Type: Small Office  
 CA Climate Zone: 7

**Measured Energy Stats**

BUILDING TOTAL EUI	RENEWABLE PRODUCTION	BUILDING NET EUI
13	22	-9

**BACON STREET OFFICES**

The Bacon Street Office project is a 4,500 SF result of a single-story, 1950s-era auto repair shop into a high-performance office for the firm ARCHITECTS+interior architects. 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 lighting from diffuse skylights at the back of the office. Blue-tinted walls, ceiling, and tables.



NBI © 2015



## ZNE Presentation Templates

- ZNE building examples
- Primarily commercial
- Carries general messages
- CA Goals for ZNE
- Open source platform!  
Slide collection will grow as champions and others develop their own ZNE presentations

### Users of the Presentation:

- Champions & Early Adopters
- Utilities
- Communications staff

**Getting to ZNE**

**1 DESIGN PROCESS**  
Addressing systems through integrated design.

**2 TEC**  
Design, Lighting, HVAC, Controls, HVAC, Controls

**Why Should Building Owners Go ZNE?**

When committing to a high efficiency building, ZNE is the best business decision and adds the most value.

**Leading by Example**  
Bacon St. Offices

- Former auto-repair shop turned architect's office.
- 1<sup>st</sup> commercial bldg in SD to achieve ZNE usage.
- Monitoring system tracks the actual use of building systems, and "real world" data for educating others.
- All electrical systems designed to reduce energy loads by over 42,000 kWh per year.
- Remaining energy is offset by renewable electrical and water heating energy located on the roof top.







- 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*

Email [heather@newbuildings.org](mailto:heather@newbuildings.org) to sign up







## EARLY ADOPTERS NETWORK

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# TOOLS & RESOURCES FOR ZNE PLANS

1 Laying the FOUNDATION

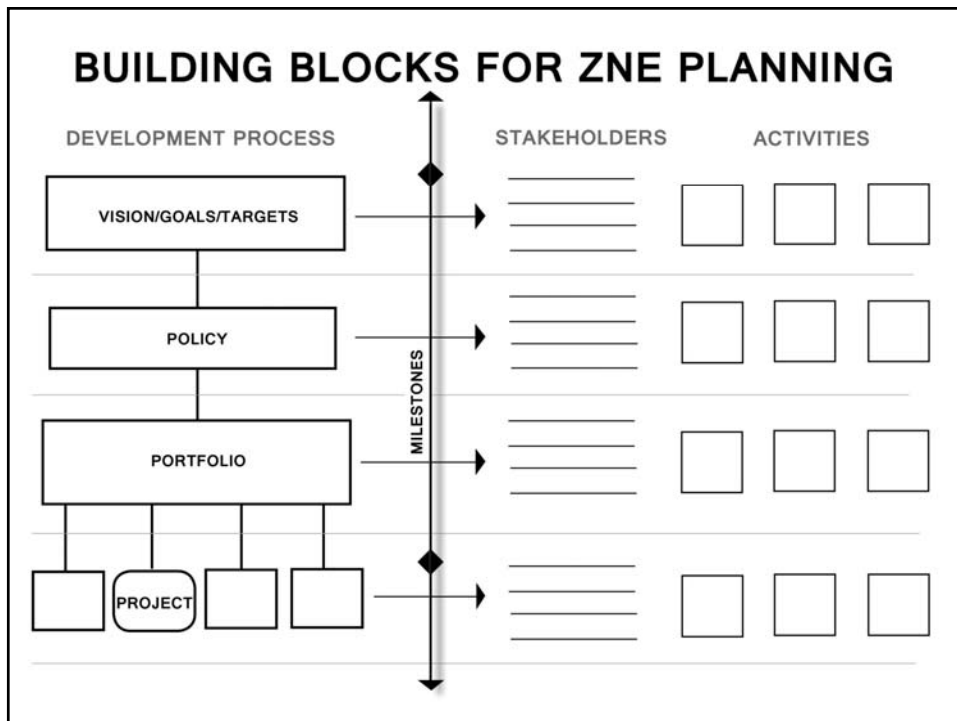
2 Orchestrating RESOURCES

3 Developing a ZNE PLAN

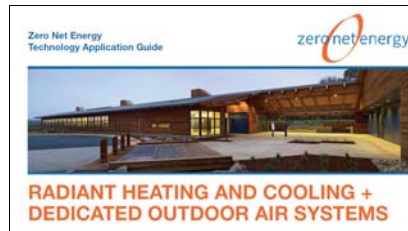


NBI © 2015





## ZNE Technology Application Guides



<http://newbuildings.org/zero-energy>



energy  
upgrade<sup>®</sup>  
CALIFORNIA

SavingsByDesign

nbi new buildings  
institute

*“The prevailing industry perception is that zero energy is cost prohibitive and suitable only for showcase projects with atypical, large budgets; however, **there is mounting evidence that zero energy can, in many cases, be achieved within typical construction budgets.**”*



zeronetenergy

2015 Prop 39 ZNE School Retrofit Workshops

[www.nrel.gov/docs/fy14osti/62752.pdf](http://www.nrel.gov/docs/fy14osti/62752.pdf)



**GETTING TO  
zero**  
NATIONAL FORUM 2016

**Save the Date**  
October 12-14, 2016 | Denver, CO

**nbi** new buildings  
institute

Bartschi School Science Wing, Seattle, WA / Photo: KMO Architects



what part will you play in  
solving the greatest  
challenge of our time?

Oberlin College Adam Joseph Lewis Center for Environmental Studies | Oberlin, OH

