Welcome

Welcome to the Design Professionals Guide to Zero Net Energy Buildings

Mitchell Park Library
May 23rd , 2017

Welcome

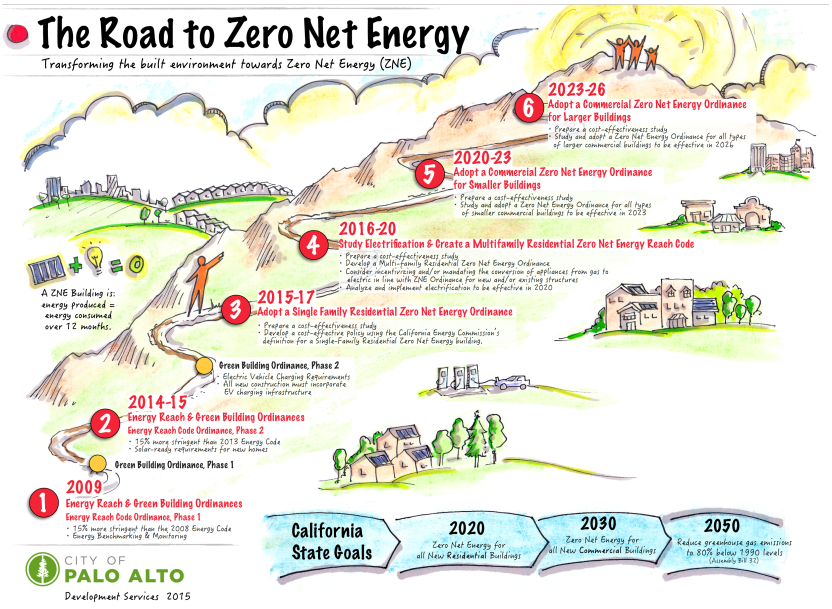
Training Agenda

- 9:00 – 9:15 AM Welcome, Housekeeping items, Introductions & Training Overview
- 9:15 – 10:30 AM Training Begins
- 10:30-10:40 AM Break
- 10:40 11:50 AM Training Resumes
- 11:50– 12:00 PM Closing Remarks

ZNE Readiness Ordinance

Zero Net Energy Video

ZNE Readiness Ordinance



ZNE Readiness Ordinance

Palo Alto ZNE Readiness Ordinance Background

October 4th, 2016	- First reading of ordinances - Public hearing (Passed unanimously)
October 24th, 2016	- Second reading of ordinance - Signed by council and filed with California
January 1st, 2017	- Now effective

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ZNE Readiness Ordinance

Palo Alto ZNE Readiness Ordinance - Residential

	New Single-Family Residential	New Multi-Family Residential
No PV	10% More efficient than Base Code (16.17.050.a.1)	10% More efficient than Base Code (16.17.050.b.1)
With PV	20% More efficient than Base Code[1] (16.17.050.a.2)	12% More efficient than Base Code[1] (16.17.050.b.2)

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ZNE Readiness Ordinance

Palo Alto ZNE Readiness Ordinance – Commercial

	New Commercial
No PV	10% More efficient than Base Code (16.17.050.c.1)
With PV	Comply with minimum Base Code + Install a 5 kW or larger PV system (16.17.050.c.2)

ZNE Readiness Ordinance

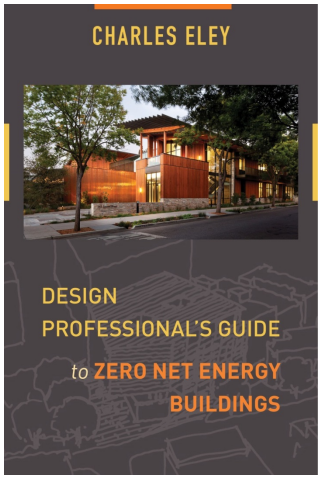
Questions?

Upcoming Training Opportunities:

Heat Pump Water Heater Workshop
Mitchell Park Community Center
Wednesday, May 24, 2017 from 3:00 to 6:00 PM (PDT)
Palo Alto, CA

Overview of Palo Alto's Current Green Building and Energy Reach Code Requirements
Palo Alto City Council Chambers
Monday, June 5, 2017 from 12:00 PM to 1:00 PM (PDT)
Palo Alto, CA

Today's Program



ZNE Training

Mitchell Park Library
Conference Center,
Palo Alto, May 23, 2017

Charles Eley, FAIA, PE

Today's Program

Learning Objectives

At the conclusion of this course, attendees will :

1. Have a basic understanding of the contribution of the North American building sector to greenhouse gas emissions
2. Be able to explain why increasing basic building energy efficiency is essential to achieving zero net energy
3. Be able to describe how building form and configuration and enclosure design, a prime area of responsibility for architects, can make possible deep reductions in the need for energy
4. Be able to site two building types that are the easiest to achieve ZNE, and two building types likely to require off-site renewable energy

Today's Program

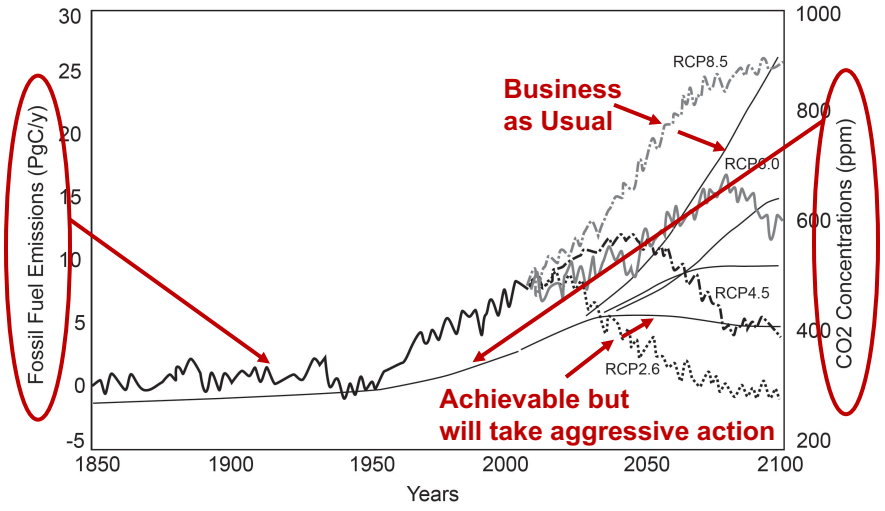
Book Contents

1. **Introduction**: *We Have But One Earth*
2. **Smart Building Design**: *Contextual Design, Energy Efficiency and Curtailment*
3. **Here Comes the Sun**: *The Future of Renewable-Energy Systems*
4. **Making it All Wor**k: *Integrated Project Delivery, Commissioning, Intelligent Controls and Mobile Devices*
5. **Metrics and Boundaries**: *What Exactly is a Zero Net-Energy Building?*
6. **Energy Modeling**: *Evaluating ZNE before the Utility Bills Arrive*
7. **ZNE for the Mainstream**: *Scaling Up the Concept*
8. **Beyond ZNE**: *The World of Our Grandchildren*

Chapter 1 - We Have But One Earth

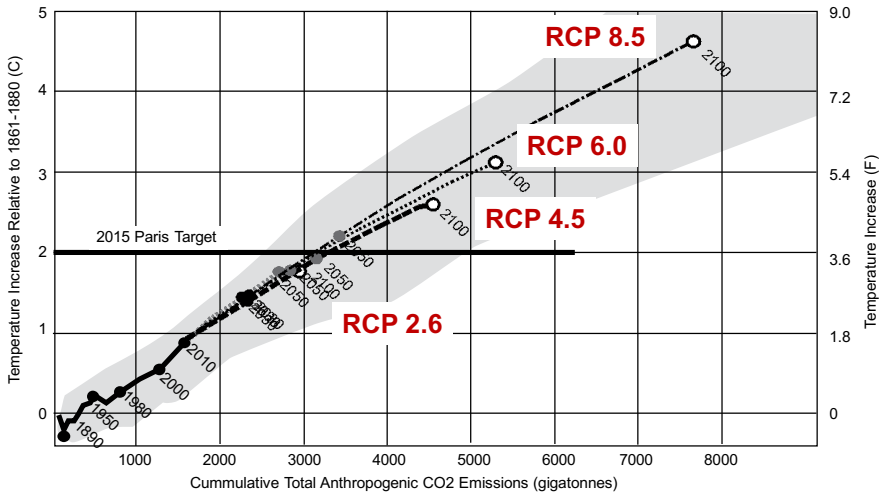
Chapter 1 - We Have But One Earth

International Panel on Climate Change (IPCC)



Chapter 1 - We Have But One Earth

Global Temperature Rise vs. Cumulative Emissions

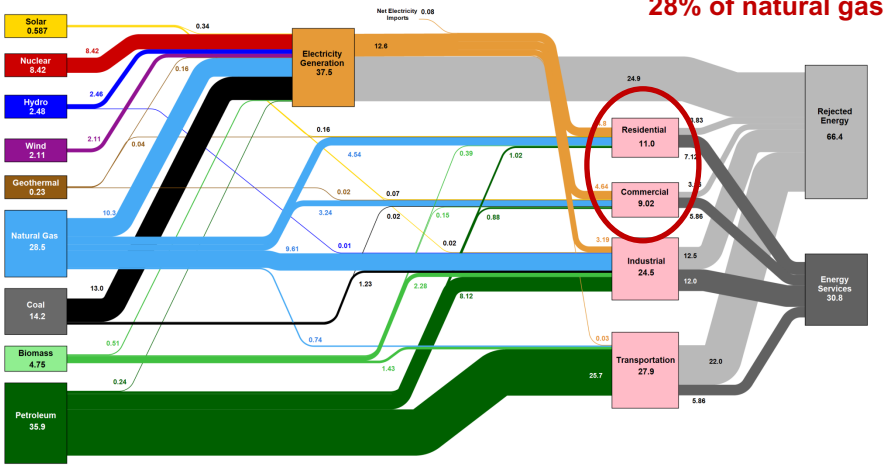


Chapter 1 - We Have But One Earth

United States Energy Flows – 2016

Buildings use 75% of electricity and 28% of natural gas

Estimated U.S. Energy Consumption in 2016: 97.3 Quads



Source: LLNL March, 2017. Data is based on DOE/EIA MER (2016). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector, and 49% for the industrial sector which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

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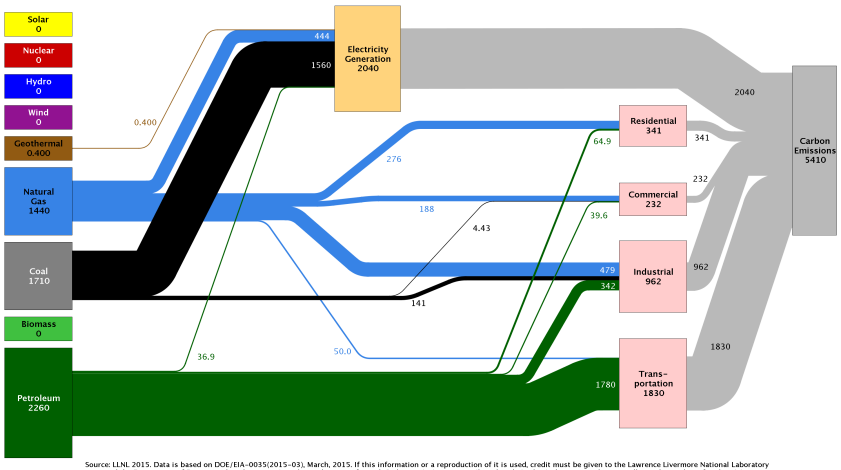
Chapter 1 - We Have But One Earth

United States Carbon Emissions

Estimated U.S. Carbon Emissions in 2014: ~5,410 Million Metric Tons

Lawrence Livermore National Laboratory



Source: LLNL 2015. Data is based on DOE/EIA-0035(2015-03), March, 2015. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Carbon emissions are attributed to their physical source, and are not allocated to end use for electricity consumption in the residential, commercial, industrial and transportation sectors. Petroleum consumption in the electric power sector includes the non-renewable portion of municipal solid waste. Combustion of biologically derived fuels is assumed to have zero net carbon emissions – the lifecycle emissions associated with producing biofuels are included in commercial and industrial emissions. Totals may not equal sum of components due to independent rounding errors. LLNL-MI-410527

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Chapter 1 - We Have But One Earth

DOE Common Definition

http://energy.gov/eere/buildings/downloads/common-definition-zero-energy-buildings

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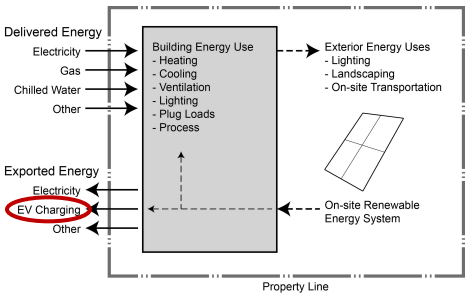
Chapter 1 - We Have But One Earth

ZNE Definition

- The sum of all energy that is **delivered** to the property line must be less than the energy that is **exported** from the property.
- All energy use is included.
  - Electricity
  - Gas
  - District energy
- EV charging is considered exported energy.
- No combustion is allowed for International Living Building Institute certified ZNE buildings



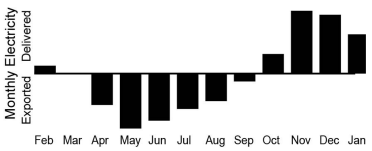


Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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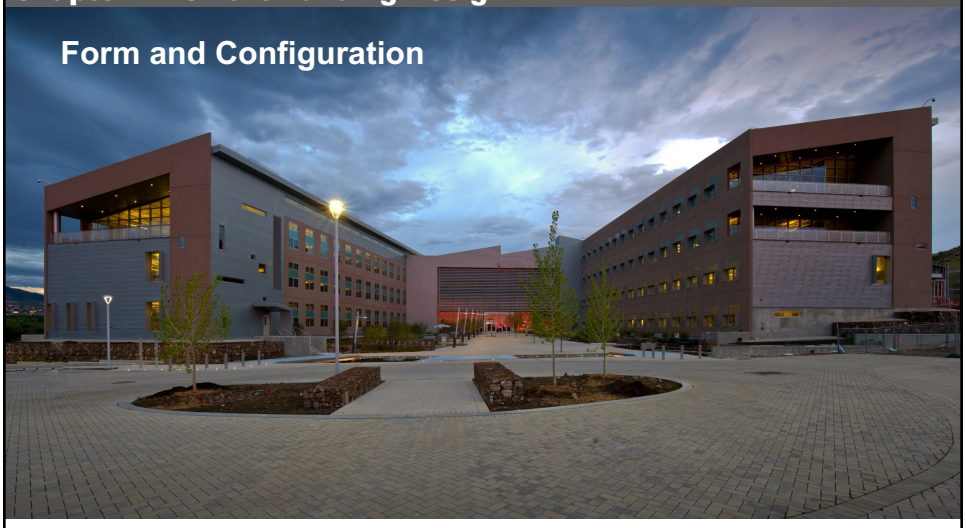
Chapter 2 - Smart Building Design

Chapter 2 - Smart Building Design

Long Life, Loose Fit

Chapter 2 - Smart Building Design

Form and Configuration



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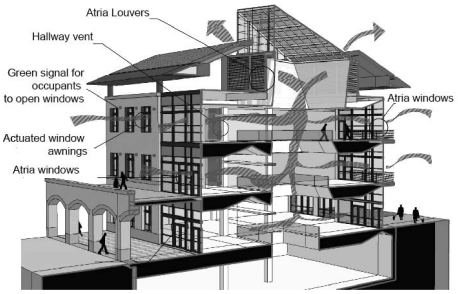
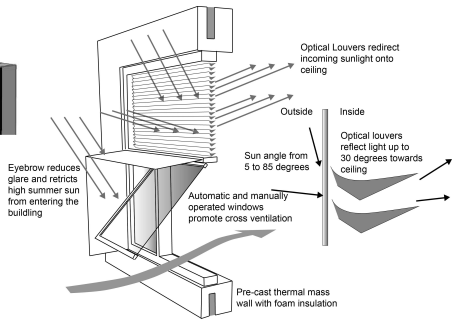
Chapter 2 - Smart Building Design

Building Envelope



Y2E2 Stanford



NREL RSF South Window

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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Chapter 2 - Smart Building Design

Lighting and Visual Comfort

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Chapter 2 - Smart Building Design

HVAC and Thermal Comfort

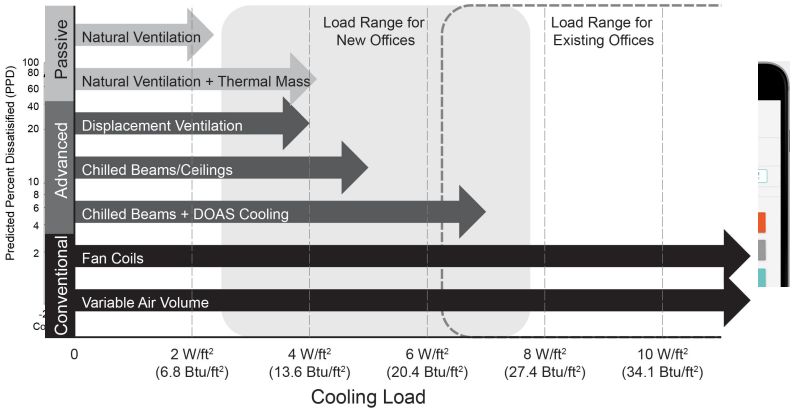

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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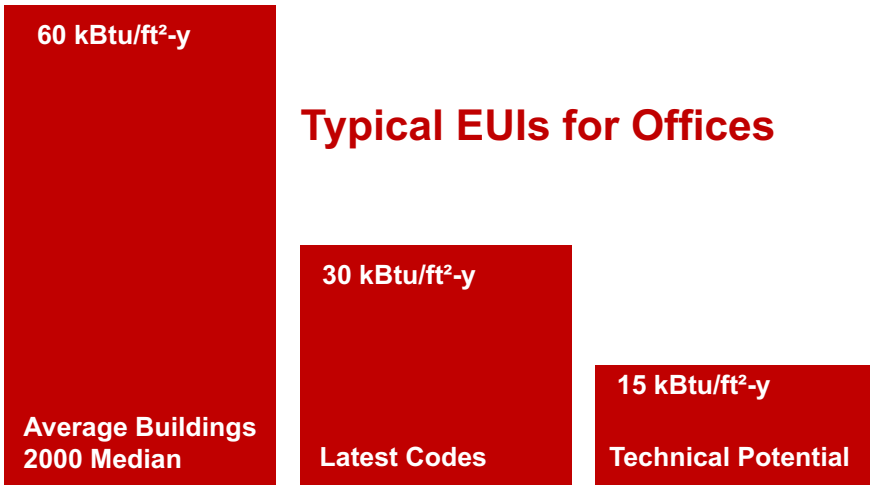
Chapter 2 - Smart Building Design

How Low Can We Go?



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Chapter 2 - Smart Building Design

Climate Zones and Regions

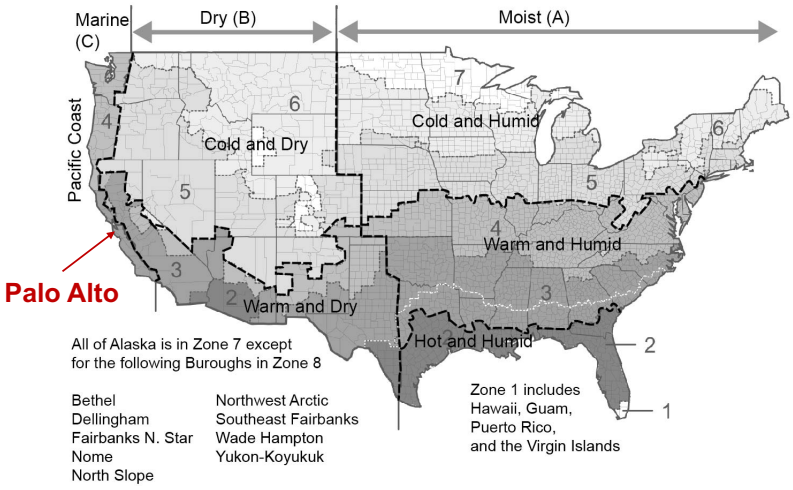

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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Chapter 2 - Smart Building Design

Turn-of-the-Millennium Buildings (site kBtu/ft²-y)

	Pacific Coast	Warm and Dry	Hot and Humid	Warm and Humid	Cold and Dry	Cold and Humid	Artic
	(3c, 4c)	2b, 3b, 4b)	(1a, 2a)	(3a, 4a)	(5b, 6b)	(5a, 6a, 7)	(8)
Warehouses	34	20	23	40	53	65	161
Offices	58	62	69	69	69	77	126
Retail	101	86	99	114	122	142	249
Schools	70	59	71	78	77	91	165
Apartments	62	42	52	69	73	86	153
Hotels	122	99	119	126	126	134	151
Healthcare	232	202	232	242	218	238	281
Restaurants	558	497	522	569	598	660	965

Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Chapter 2 - Smart Building Design

Standard 90.1-2013 (site kBtu/ft²-y) Title 24 is similar

	Pacific Coast	Warm and Dry	Hot and Humid	Warm and Humid	Cold and Dry	Cold and Humid	Artic
	(3c, 4c)	(2b, 3b, 4b)	(1a, 2a)	(3a, 4a)	(5b, 6b)	(5a, 6a, 7)	(8)
Warehouses	16	15	12	17	20	26	33
Offices	22	31	33	32	31	34	41
Retail	35	49	48	50	53	59	81
Schools	35	46	49	47	48	50	68
Apartments	35	48	48	51	53	61	76
Office w/ Data Center	62	69	71	70	72	77	88
Hotels	57	75	80	78	77	83	100
Healthcare	101	108	117	116	111	120	140
Restaurants	360	431	414	471	513	574	759

Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Chapter 2 - Smart Building Design

Maximum Technical Potential (site kBtu/ft²-y)

	Pacific Coast	Warm and Dry	Hot and Humid	Warm and Humid	Cold and Dry	Cold and Humid	Artic
	(3c, 4c)	(2b, 3b, 4b)	(1a, 2a)	(3a, 4a)	(5b, 6b)	(5a, 6a, 7)	(8)
Warehouses	6	6	5	6	7	8	7
Offices	8	10	11	11	11	11	12
Retail	13	18	18	17	18	19	27
Schools	16	21	23	22	21	23	26
Apartments	24	30	29	31	32	34	35
Offices/Data Cente	43	47	47	44	47	46	47
Hotels	40	49	49	51	51	54	58
Restaurants	265	323	324	336	343	353	377

Study did not look at comprehensive measures to reduce cooking and refrigeration energy.

Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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Chapter 3 - Here Comes the Sun

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Chapter 3 - Here Comes the Sun

Solar

Primary source of on-site renewable energy for ZNE buildings

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Chapter 3 - Here Comes the Sun

Wind

- Limited on-site potential for ZNE buildings
- More potential is at the utility scale

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Chapter 3 - Here Comes the Sun

Hydro

Limited or no on-site renewable energy potential

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Chapter 3 - Here Comes the Sun

Geothermal

Limited or no on-site renewable energy potential

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Chapter 3 - Here Comes the Sun

Biomass

Regenerative, but not renewable in the same sense as wind and solar.

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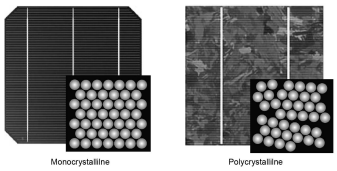
Chapter 3 - Here Comes the Sun

Solar PV is Affordable



Costs are less than $4/W before tax credits or incentives

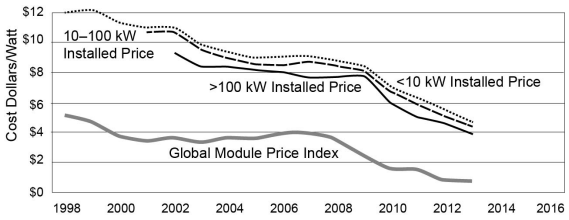


Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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Chapter 3 - Here Comes the Sun

Renewable Energy Production (kWh/y)/kW$_{stc}$

Climate	*Orientation*	*0° Tilt*	*10° Tilt*	*20° Tilt*	*30° Tilt*	*40° Tilt*	*50° Tilt*	*60° Tilt*
Warm and Dry	East	1,414	1,385	1,336	1,269	1,191	1,105	1,013
	Southeast	1,414	1,470	1,493	1,486	1,450	1,383	1,292
	South	1,414	1,518	1,581	1,605	1,594	1,540	1,451
	Southwest	1,414	1,498	1,545	1,560	1,537	1,483	1,399
	West	1,414	1,425	1,409	1,368	1,310	1,236	1,149
Pacific Coast	East	1,378	1,353	1,304	1,244	1,172	1,092	1,010
	Southeast	1,378	1,437	1,467	1,466	1,434	1,373	1,289
	South	1,378	1,485	1,553	1,582	1,571	1,523	1,436
	Southwest	1,378	1,464	1,518	1,534	1,518	1,466	1,389
	West	1,378	1,389	1,372	1,336	1,282	1,213	1,132

Source: PV Watt Calculations

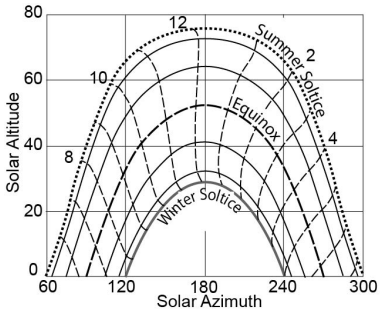
Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Chapter 3 - Here Comes the Sun

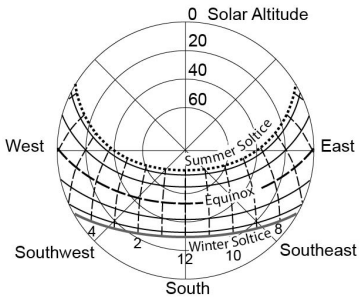
Shading is a Big Issue

(especially in Palo Alto)

Cutomized charts available at http://solardat.uoregon.edu/



Cartesian Coordinates

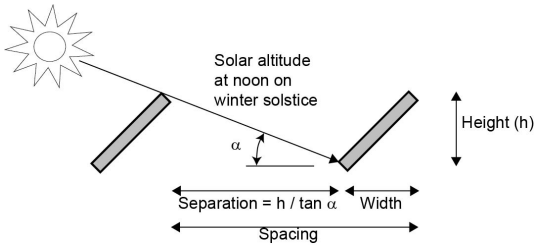


Polar Coordinates

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Chapter 3 - Here Comes the Sun

The Benefit of (near) Horizontal Tilt



Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Bullitt Center

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Chapter 3 - Here Comes the Sun

Production per Square Foot

	Pacific Coast	Warm and Dry	Hot and Humid	Warm and Humid	Cold and Dry	Cold and Humid	Artic
	(3c, 4c)	(2b, 3b, 4b)	(1a, 2a)	(3a, 4a)	(5b, 6b)	(5a, 6a, 7)	(8)
Horizontal Production (kWh/y)/kW (stc)	1,378	1,414	1,359	1,316	1,311	1,138	748
Horizontal Production	4,702	4,825	4,637	4,490	4,473	3,883	2,552
kBtu/ft²-y of Collector Area	72	74	71	69	69	60	39

Maximum site EUI to achieve ZNE for a one story building with the roof covered with PVs.

Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

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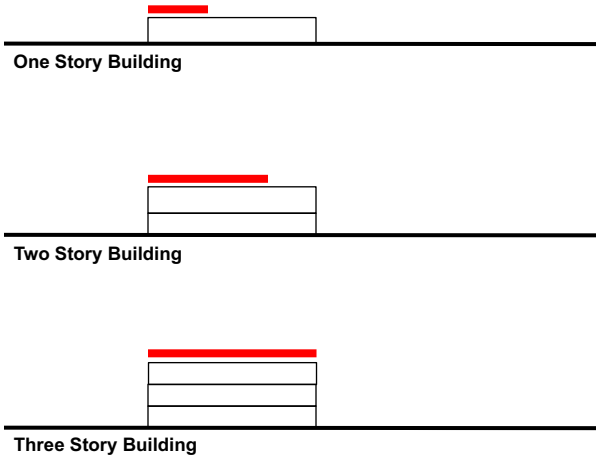
Challenging Building Types and Climates

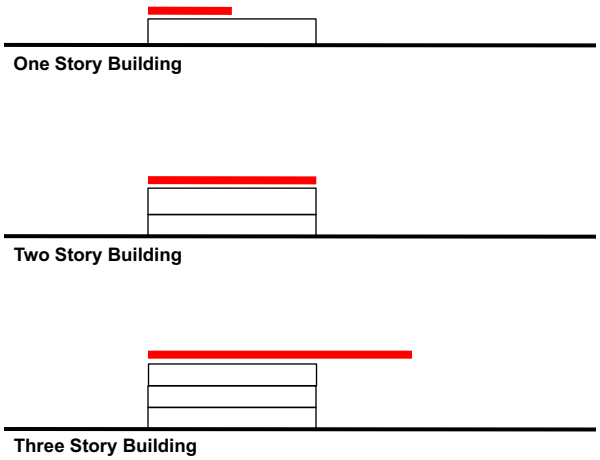
Challenging Building Types and Climates

Collector to Floor Area Ratio of 0.33



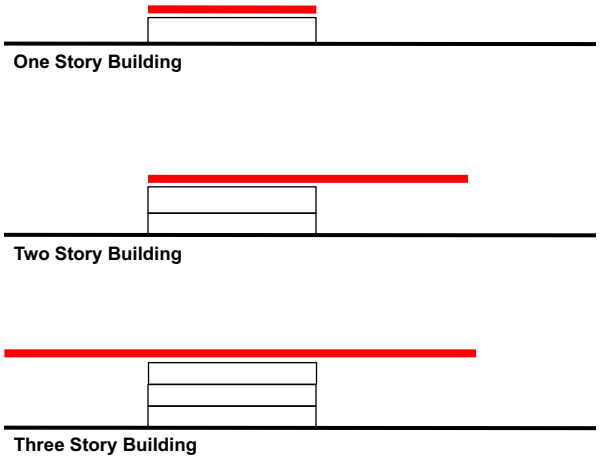
Challenging Building Types and Climates

Collector to Floor Area Ratio of 0.5



Challenging Building Types and Climates

Collector to Floor Area Ratio of 1.0



Challenging Building Types and Climates

Collector Area to Floor Area Ratio
Maximum Technical Potential

	Pacific Coast	Warm and Dry	Hot and Humid	Warm and Humid	Cold and Dry	Cold and Humid	Artic
Warehouses	0.08	0.08	0.07	0.09	0.10	0.13	0.19
Offices	0.11	0.14	0.13	0.13	0.15	0.18	0.30
Retail	0.18	0.24	0.25	0.25	0.26	0.32	0.67
Schools	0.22	0.28	0.32	0.32	0.31	0.38	0.66
Apartments	0.33	0.40	0.41	0.44	0.5	0.57	0.90
Off/Data Center	0.59	0.63	0.66	0.64	0.68	0.77	1.19
Hotels	0.55	0.66	0.69	0.74	0.75	0.90	1.48
Healthcare	0.87	0.86	0.96	0.96	0.95	1.1	1.83
Restaurants	3.66	4.35	4.53	4.87	4.99	5.9	9.31

ZNE feasible for four stories or more

ZNE feasible for two-story buildings

ZNE feasible for one-story buildings

PV on roof not enough

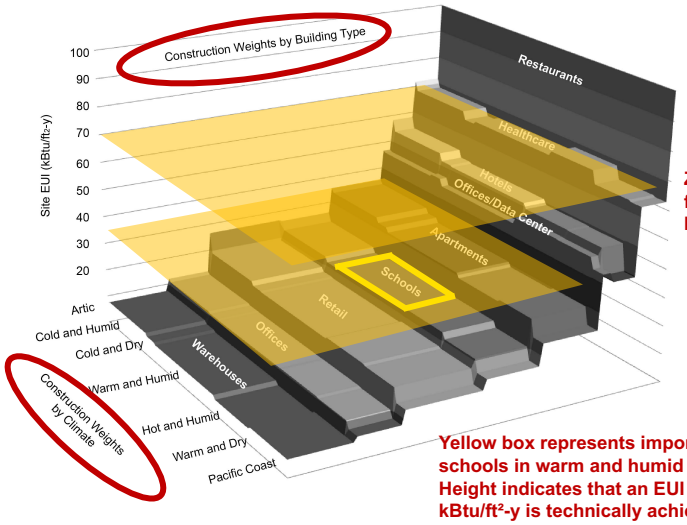
Bay Area

Central Valley

Source: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Challenging Building Types and Climates

Maximum Technical Potential



ZNE feasible for one-story buildings

ZNE feasible for two-story buildings

Yellow box represents importance of schools in warm and humid climate. Height indicates that an EUI of 23 kBtu/ft²-y is technically achievable.

Image from Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Chapter 4 - Energy Modeling

Methods of Assessing ZNE

Operational Assessment

- Based on utility bills
- Actual building operation
- Based on actual weather
- DGS uses source energy

Asset Assessment

- Based on energy model
- Standard modeling assumptions
- Standard weather file
- CEC uses TDV as metric

Chapter 4 - Energy Modeling

Energy Model Uncertainties

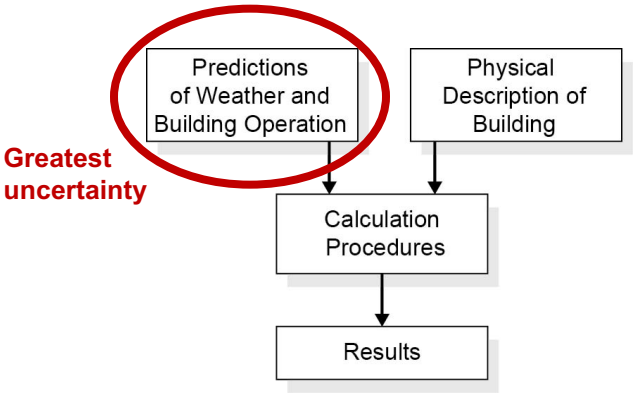
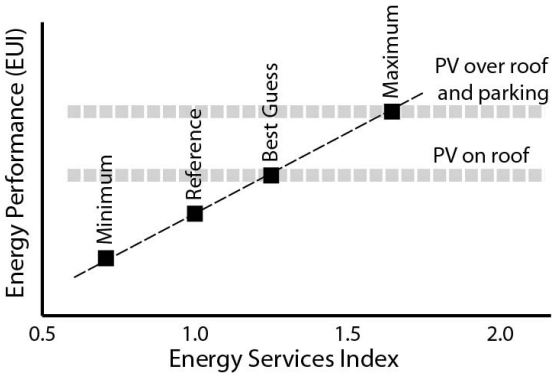


Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Chapter 4 - Energy Modeling

Scenario Analysis



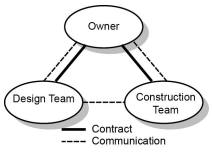
Accuracy is critically important when the target is ZNE.

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

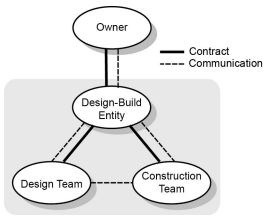
Chapter 5 - Making it all Work

Project Delivery Methods

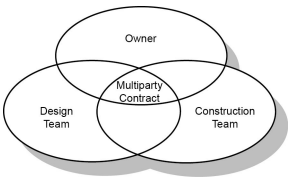
Design-Bid-Build



Design-Build

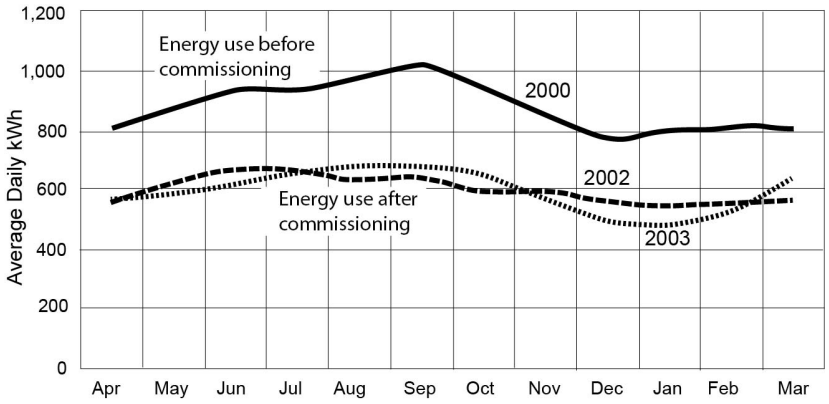


Integrated Project Delivery



Chapter 5 - Making it all Work

Commissioning



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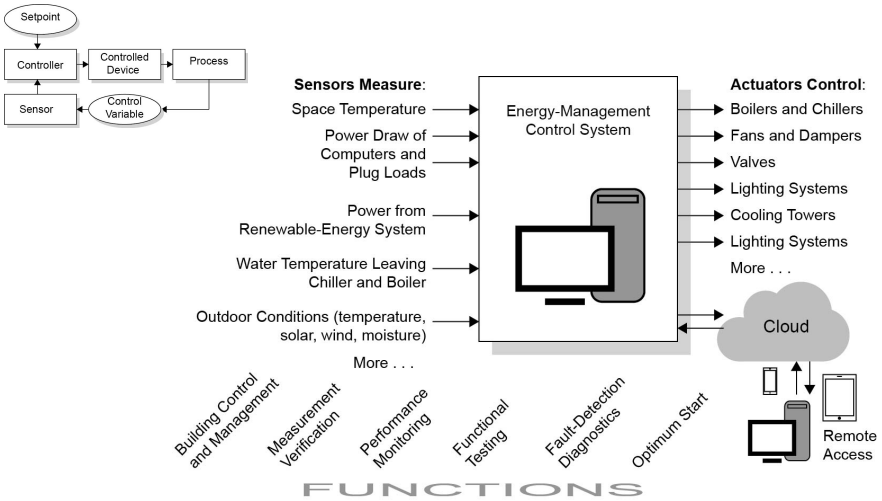
Chapter 5 - Making it all Work

Building Management



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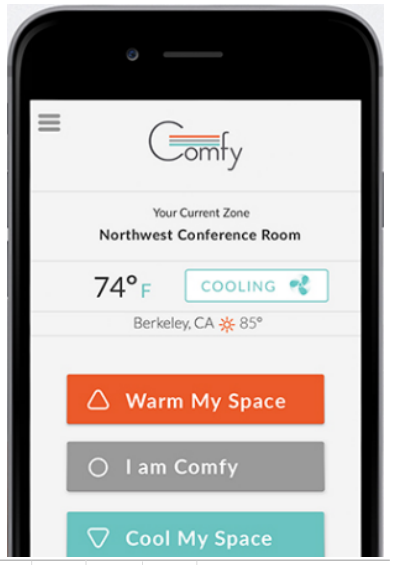
Chapter 5 - Making it all Work

Mobil Devices and Occupant Interaction



Chapter 5 - Making it all Work

Managing Plug Loads – Bullitt Center

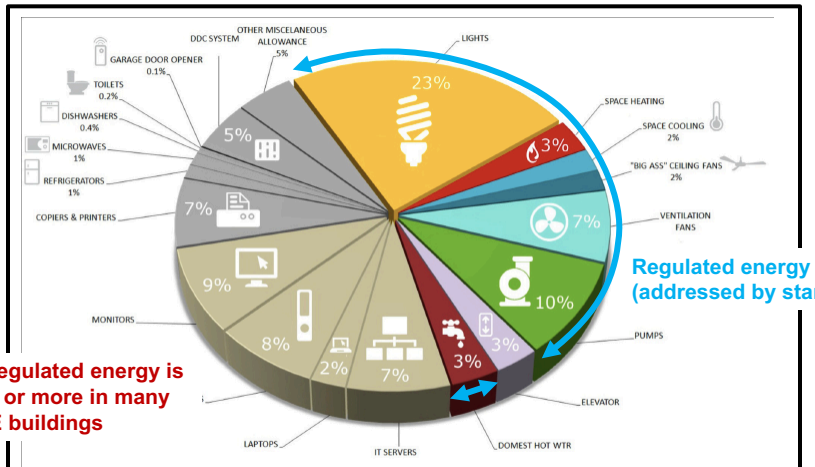
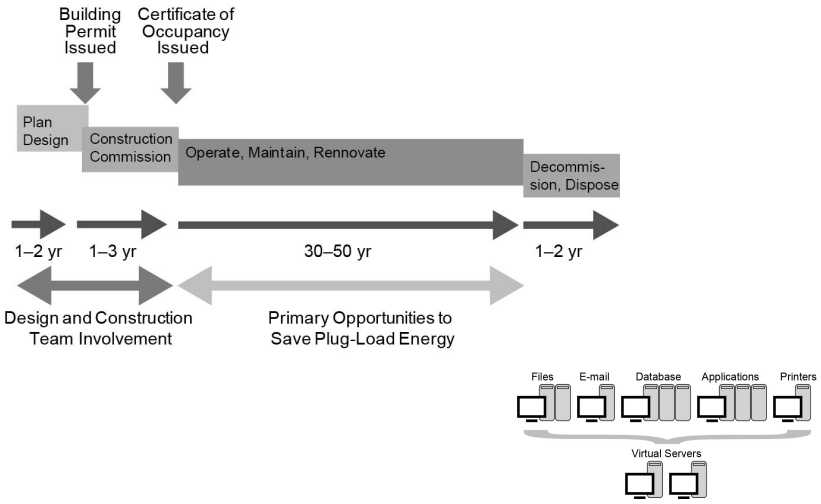


Figure 1: Bullitt Center - Energy Use

http://greentechadvocates.com/2013/05/07/plug-loads-a-growing-concern/

Chapter 5 - Making it all Work

Plug Loads are an Operational Issue



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Chapter 6 - Metrics and Boundaries

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Energy Accounting

Energy Accounting

Site Energy

British Thermal Unit (Btu)		kiloWatt-hour (kWh)		kiloJoule (kJ)
1 Btu	=	.000293 kWh	=	1.055 kJ
3,412 Btu	=	1 kWh	=	3,600 kJ
0.948 Btu	=	.000278 kWh	=	1 kJ

Energy Accounting

Source Energy

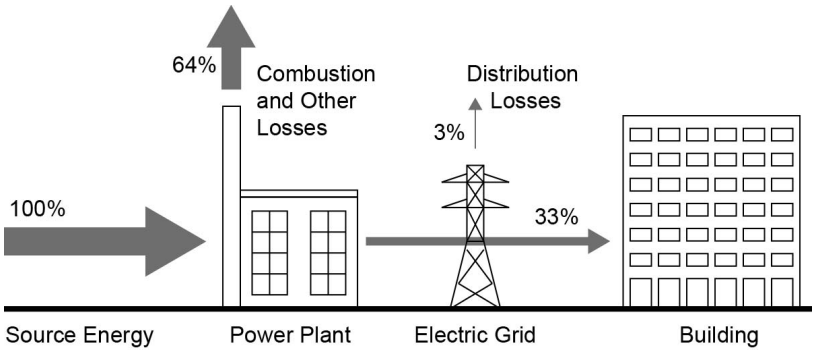


Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Energy Accounting

Site Source Multipliers

Energy Type	Source Multiplier	Common Units	Site Btu / unit	Source Btu / unit
Imported Electricity	3.15	kWh	3,412	10,751
Exported Renewable Electricity	3.15	kWh	3,412	10,751
Natural Gas	1.09	Therms	100,000	109,000
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19	Gallons	138,000	164,220
Propane & Liquid Propane	1.15	Gallons	91,000	104,650
Steam	1.45	lb	1,000	1,450
Hot Water	1.35	millions Btu	1,000,000	1,350,000
Chilled Water	1.04	millions Btu	1,000,000	1,040,000
Coal or Other	1.05	short ton	19,210,000	20,170,000
Notes: The Btu per lb of steam will vary depending on how much the steam is superheated.				

Source: DOE Common Definition and ASHRAE Standard 105

Energy Accounting

Time Dependent Valued Energy

- Used by the California Energy Commission for performance calculations.
- Proposed as the metric for meeting the code-based ZNE requirement.

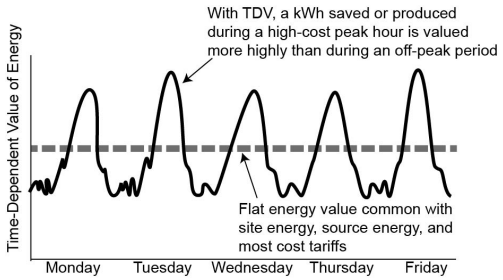


Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Energy Accounting

Comparison of Metrics

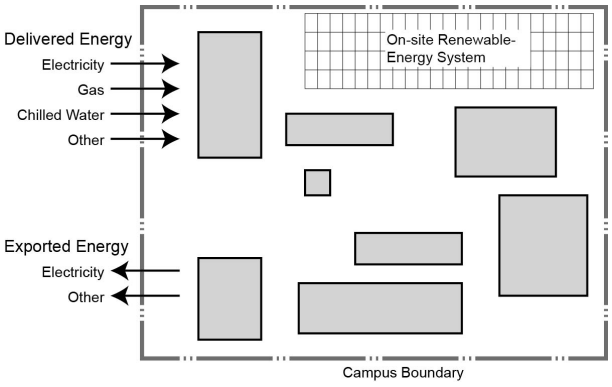
	All Electric Buildings	Mixed Fuel Buildings
Site Energy	Equal difficulty in achieving ZNE	Most difficult to achieve ZNE
Source Energy (recommended)		Easier to achieve ZNE
Energy Cost (flat rate)		
TDV or Energy Cost (time-of-use)	Used to be the easiest to achieve ZNE, but this is changing	

Table: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Campuses, Communities and Portfolios

Campuses, Communities and Portfolios

ZNE Campus

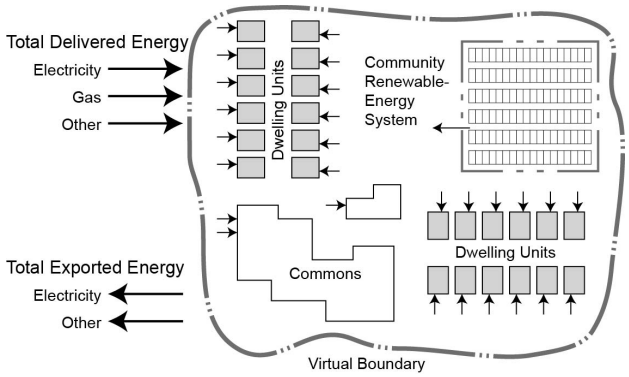


Contiguous boundary, usually the same owner

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Campuses, Communities and Portfolios

ZNE Communities

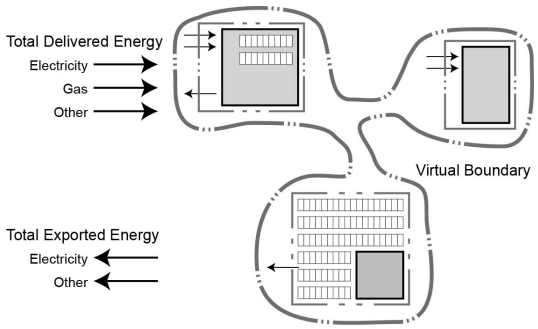


Multiple owners, non-contiguous boundary

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Campuses, Communities and Portfolios

ZNE Portfolio



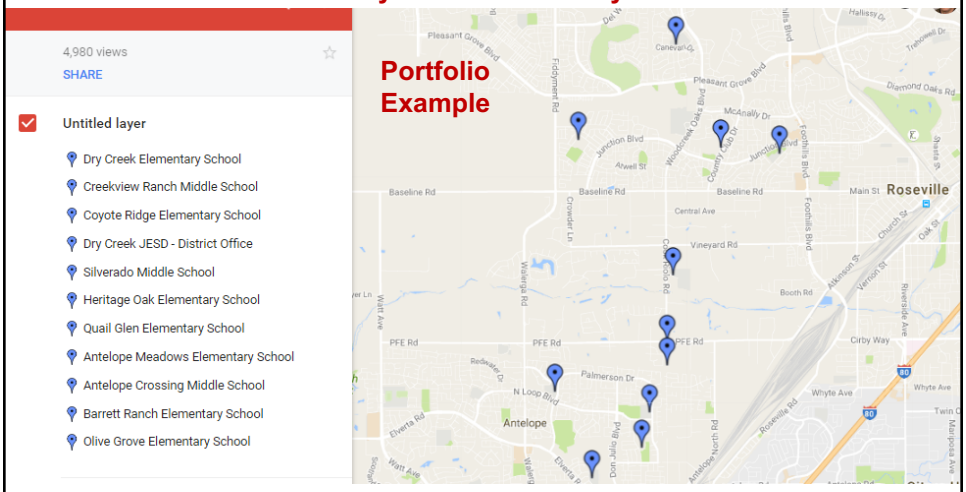
Single owner or manager, non-contiguous boundary

Image: Design Professionals Guide to Zero Net Energy Buildings, Charles Eley, Island Press, 2016

Campuses, Communities and Portfolios

Combining Buildings within a School District

Dry Creek Elementary School District



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Campuses, Communities and Portfolios

Combining Supermarkets with Distribution Centers

Portfolio Example

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Off-Site Renewable Energy

Off-Site Renewable Energy

Off-Site Renewable Energy

Off-Site Renewable Energy

Stanford University

Palo Alto Campus

All Electric Central Plant

73 MW Solar System in California Desert

Not the actual site

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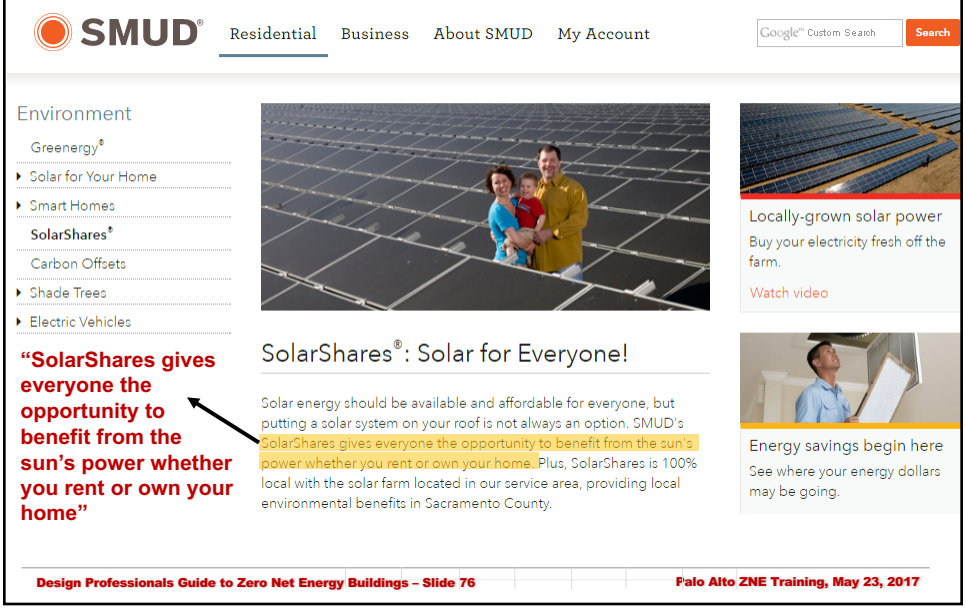
Community Solar

Community Solar

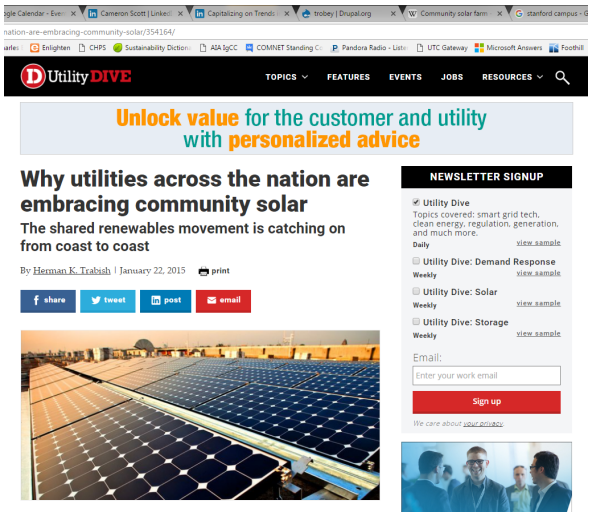
One of the first examples . . .



"SolarShares gives everyone the opportunity to benefit from the sun's power whether you rent or own your home"

Community Solar

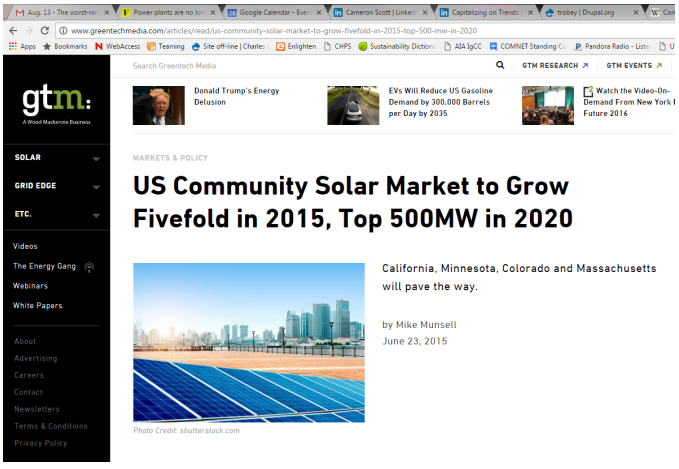
Electric Utilities are Embracing the Concept



http://www.utilitydive.com/news/why-utilities-across-the-nation-are-embracing-community-solar/354164/

Community Solar

Significant Growth is Expected



http://www.greentechmedia.com/articles/read/us-community-solar-market-to-grow-fivefold-in-2015-top-500-mw-in-2020

Community Solar

Participation Models

Capacity Model

A participant pays money up front (or arranges financing) to lease a certain number of panels

High additionality probability

Likely included in **capital improvement budget**

Subscription Model

A participant contracts to purchase output from the system on a monthly basis

Low additionality probability

Likely included in **operating budget**

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Renewable Energy Credits (RECs)

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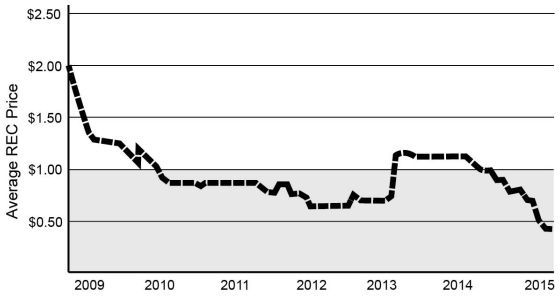
Renewable Energy Credits (RECs)

RECs

Per Year				
Annual Revenue/Cost	=	Electricity Sales/Cost	+	Renewable Energy Certificate Sales/Cost
For the Life of the System				
Value of Renewable Generation Asset	=	Net Present Value of Electricity Production	+	Net Present Value of Future RECs



National average price for RECs ($/MWh)

Important qualifiers:
- Vintage (year of production)
- Source (solar, wind, etc.)
- Location (of energy system)

Renewable Energy Credits (RECs)

RECs are often retained by Solar Service Providers

Feeling smug about your solar rooftop? Not so fast

Severin Borenstein, professor of business | January 21, 2016
11 comments | Leave a comment

If you installed solar panels on your roof and feel aglow with environmental virtue, you may be in for a rude awakening. There's a good chance someone else has purchased your halo and is wearing it right now.

In most states (including California) power generated by rooftop solar panels earns Renewable Energy Certificates, which quantify how much clean electricity they produce. But if panels are leased or installed under a power purchase agreement, it's the "third-party owner" — not the homeowner — who gets those certificates. Most then turn around and sell the RECs, which magically turns some other brown electrons green.

Here's how it works: Joe's Solar puts panels on your roof that produce 7,500 kilowatt-hours a year, and Joe sells you the electricity under a power purchase agreement. Because Joe still owns the panels, he gets credit — in the form of RECs — for that renewable electricity. Meanwhile, Bob's all-fossil utility wants to "green up" so it buys the RECs from Joe. That allows Bob to relabel 7,500 kilowatt-hours of its coal or gas-fired power generation as "renewable energy."

(Photo: Roofjockey via Wikimedia Commons)

It may sound strange, but a market

All Authors
More than 350 UC Berkeley scholars share their perspectives on local, national and global issues.

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- Harvard Business Review
- Marginal Revolution
- Marketplace
- Medium

http://blogs.berkeley.edu/2016/01/21/feeling-smug-about-your-solar-rooftop-not-so-fast/

Prioritizing Off-Site Options

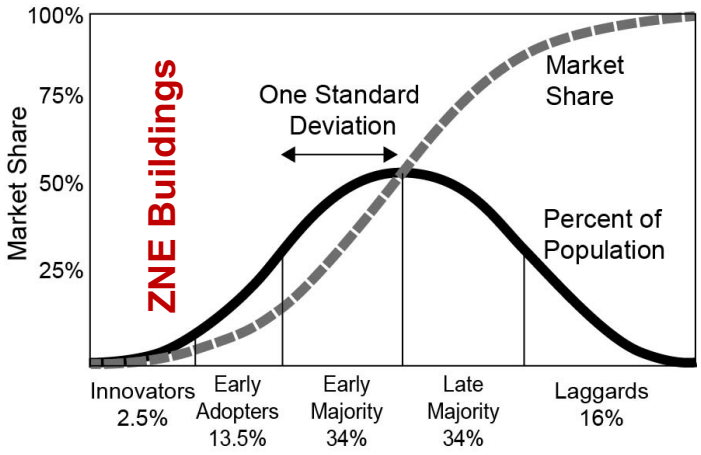
Prioritizing Off-Site Options

Off-Site Priorities

1	On-Site Test	The Zero Net-Energy Criteria
	[$Q_{Delivered} - Q_{Exported}$	≤ 0
Description	Basic definition of on-site zero net-energy building	
Additionality	New renewable energy is added as part of the construction project	
Funding	Capital Improvement Budget	

Chapter 7 - ZNE for the Mainstream

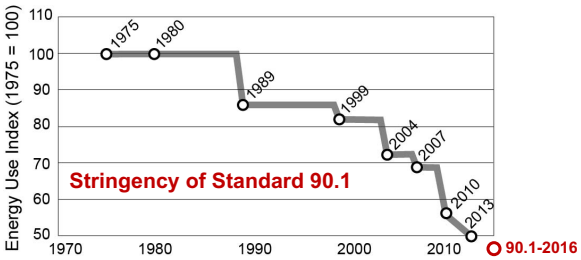
Innovation Diffusion Curves

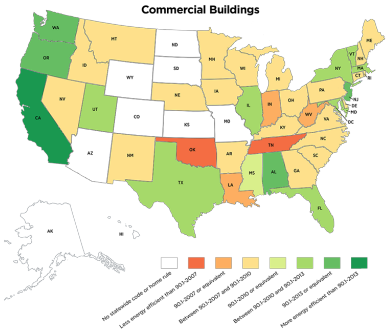


Chapter 7 - ZNE for the Mainstream

Standards

- Appliance Standards
- Building Standards
  - Prescriptive
  - Performance





Energy Code Adoption in the United States

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Chapter 7 - ZNE for the Mainstream

Making the Market Work

- Cap and Trade
- Carbon Taxes
- Subsidizing Renewable Energy
- Reducing Subsidies for Fossil Fuels
- Labeling Programs and Mandatory Disclosure
- Recognition Programs
  - LEED
  - Zero Energy Building Certification (LBC)
  - New Buildings Institute Verified Zero Energy Buildings List

- **EPA estimates that the cost of carbon emissions is about $60/ton, which would cause electricity to increase by $0.037/kWh**
- **Harvard Medical School study estimates externalities from coal would cause electricity to increase an average of $0.18/kWh**

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Chapter 7 - ZNE for the Mainstream

SUNSHINE STATE

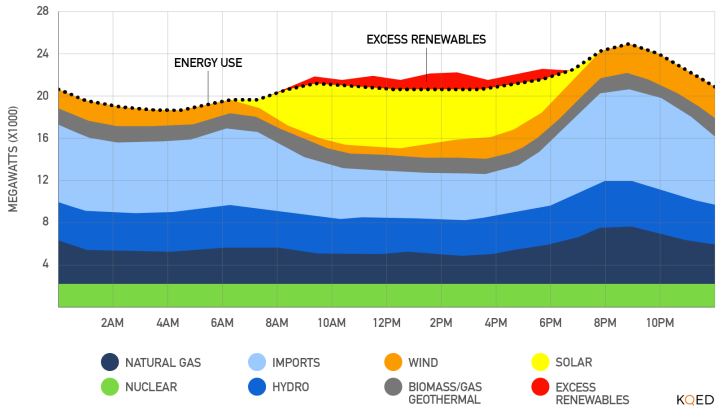
California is getting so much power from solar that wholesale electricity prices are turning negative

Chapter 7 - ZNE for the Mainstream

California Power Generation – March 2016

On March 27, a sunny day, some solar farms had to shut down because there was more power on the grid than Californians were using.

https://ww2.kqed.org/science/2016/04/04/what-will-california-do-with-too-much-solar/



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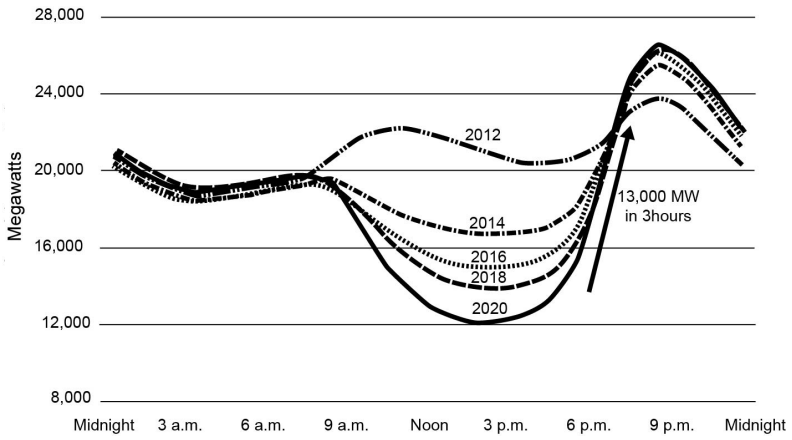
Chapter 7 - ZNE for the Mainstream

ZNE and the Future of Electric Utilities

- Utility Tariffs and Net-Metering Policies
- Elephants, Camels and Ducks



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Chapter 8 - Beyond ZNE

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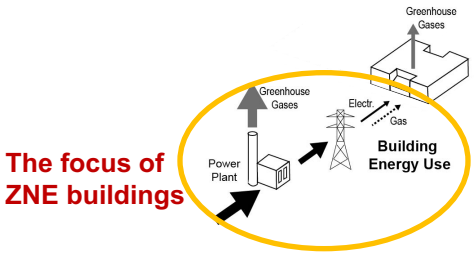
Chapter 8 - Beyond ZNE

Indirect Building Energy Use

- Transportation
- Water
- Materials and products



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Resources and Wrapup

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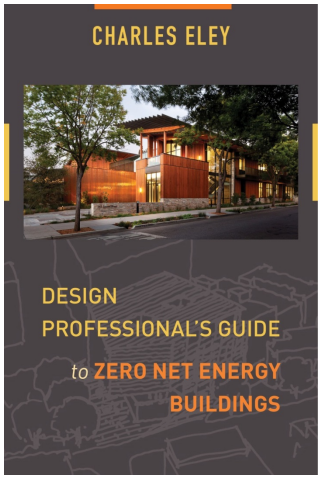
Resources and Wrapup

Design Professionals Guide



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charles@eley.com