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Welcome and Introduction

Dan Kim, Director, DGS

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Thanks to the Sponsors

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Introduction: ZNE

Ralph DiNola, CEO, NBI

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Agenda

9:00 am – 9:15 am	**Welcome and Introduction** Dan Kim, Director, DGS
9:15 am – 9:25 am	**Introduction: Zero Net Energy** Ralph DiNola, CEO, NBI
9:25 am – 9:35 am	**Utility Program Support and Project Engagement** Lisa Hannaman, Program Manager, SCE
9:35 am – 9:55 am	**State ZNE Policy Review** Dan Burgoyne, Sustainability Manager, DGS
9:55 am- 10:05 am	**Break**
10:05 am– 10:35 am	**ZNE Project Guide for State Buildings** Ralph DiNola, CEO, NBI
10:35 am– 10:55 am	**Power Purchase Agreements** Steve Nowell, Associate Construction Analyst at State of California, DGS
10:55 am– 11:25 am	**Energy Modeling** Aaron Wintersmith, Associate and Senior Energy Analysts, Capital Engineering Consultants
11:25 am- 12:00 pm	**Beyond T-24 Measures** Farhad Farahmand, Project Manager, TRC Solutions
12:00 pm - 12:45 pm	**Lunch**
12:45 pm -1:05 pm	**Energy and Sustainability Program** Valarie Keisler, Energy Retrofit Unit, DGS
1:05 pm -1:25 pm	**DGS Existing Building ZNE Readiness Worksheet** Dan Burgoyne, Sustainability Manager, DGS
1:25 pm- 2:15 pm	**Existing Building Evaluation Process** Ralph DiNola, CEO, NBI Webly Bowles, Project Manager, NBI
2:15 pm- 2:30 pm	**Break**
2:30 pm- 3:15 pm	**Existing Building Energy Efficiency Retrofit Case Study** Neil bulger, Principal, Integral Group
3:15 pm – 3:30 pm	**Conclusion and Lessons Learned** Ralph DiNola, CEO, NBI
3:30 pm – 4:00 pm	**Travel**
4:00 pm – 5:00 pm	**Tour: Arch-Nexus ZNE Office**

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Expectations

- What are you expecting to take away at the end of day?
- What areas of ZNE are you struggling with?

"What did you take away from the meeting?"

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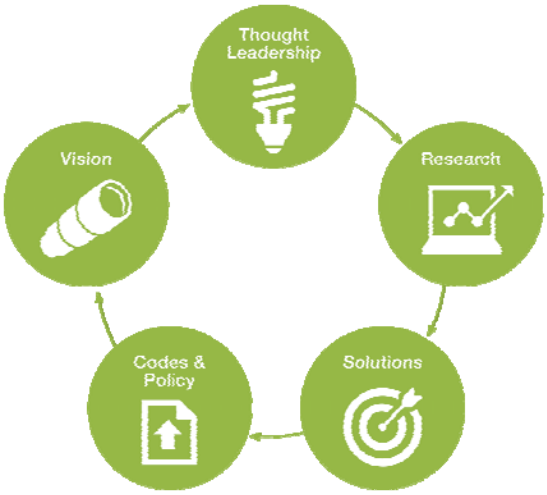
New Buildings Institute (NBI)

NBI is redefining energy efficiency in the built environment.



Program Areas

- Zero net energy leadership and market development
- Best practices in new and existing buildings
- Continuous code and policy innovation

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CA Big Bold Energy Efficiency Strategies

Exploratorium | San Francisco, CA
DPR Offices

1. All new residential construction in California will be ZNE by 2020.
2. All new commercial construction will be ZNE by 2030.
3. Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate.
4. All eligible low-income customers will be given the opportunity to participate in the low income energy efficiency program by 2020.

The California Efficiency Strategic Plan (Sep 2008)
http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5305

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State of California: Lead by Example

California's Policy for Public Buildings

Executive Order B-18-12 requires state buildings to significantly reduce over the next two decades.

- Any proposed new or major renovation of State buildings larger than 10,000 square feet use clean, on-site power generation, such as solar photovoltaic, solar thermal and wind power generation, and clean back-up power supplies
- 50% of new facilities beginning design after 2020 to be Zero Net Energy.
- 100% of new State buildings & major renovations beginning design after 2025 to be ZNE
- 50% of existing buildings (by SF) achieve ZNE by 2025

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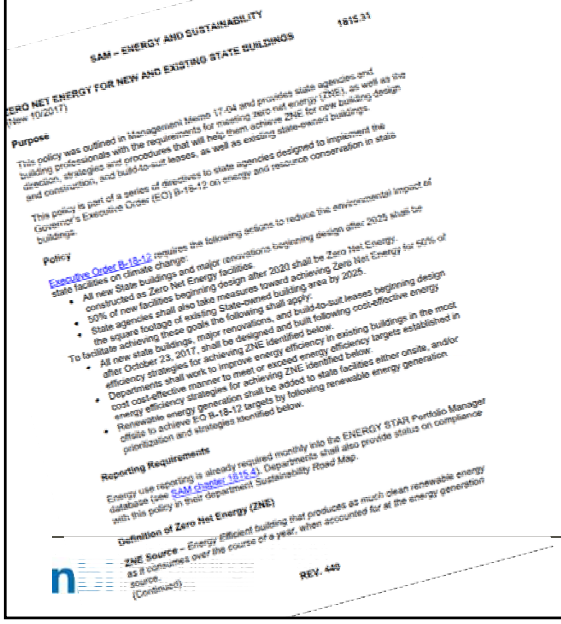
SAM Section 1815.31



SAM – ENERGY AND SUSTAINABILITY 1815.31

ZERO NET ENERGY FOR NEW AND EXISTING STATE BUILDINGS
(New 10/2017)

Purpose

This policy was outlined in Management Memo 17-04 and provides state agencies and building professionals with the requirements for meeting zero net energy (ZNE), as well as the direction, strategies and procedures that will help them achieve ZNE for new building design and construction, and build-to-suit leases, as well as existing state-owned buildings.

This policy is part of a series of directives to state agencies designed to implement the Governor's Executive Order (EO) B-18-12 on energy and resource conservation in state buildings.

Policy

Executive Order B-18-12 requires the following actions to reduce the environmental impact of state facilities on climate change:

- All new State buildings and major renovations beginning design after 2020 shall be Zero Net Energy constructed as Zero Net Energy facilities.
- 50% of new facilities beginning design after 2020 shall be Zero Net Energy.
- State agencies shall also take measures toward achieving Zero Net Energy for 50% of the square footage of existing State-owned building area by 2025.

To facilitate achieving these goals the following shall apply:

- All new state buildings, major renovations, and build-to-suit leases beginning design after October 23, 2017, shall be designed and built following cost-effective energy efficiency strategies for achieving ZNE identified below.
- Departments shall work to improve energy efficiency in existing buildings in the most cost cost-effective manner to meet or exceed energy efficiency targets established in energy efficiency strategies for achieving ZNE identified below.
- Renewable energy generation shall be added to state facilities either onsite, and/or offsite to achieve EO B-18-12 targets by following renewable energy generation prioritization and strategies identified below.

Reporting Requirements

Energy use reporting is already required monthly into the ENERGY STAR Portfolio Manager database (see SAM chapter 1815.4). Departments shall also provide status on compliance with this policy in their department Sustainability Road Map.

Definition of Zero Net Energy (ZNE)

ZNE Source – Energy Efficient building that produces as much clean renewable energy as it consumes over the course of a year, when accounted for at the energy generation source.

(Continued)

REV. 440

- Effective October 23, 2017 - All new and major renovations building designs as well as build-to-suit leases will include:
  - Achieve ZNE with cost-effective energy efficiency strategies
  - Exceed California Title-24 by 15%

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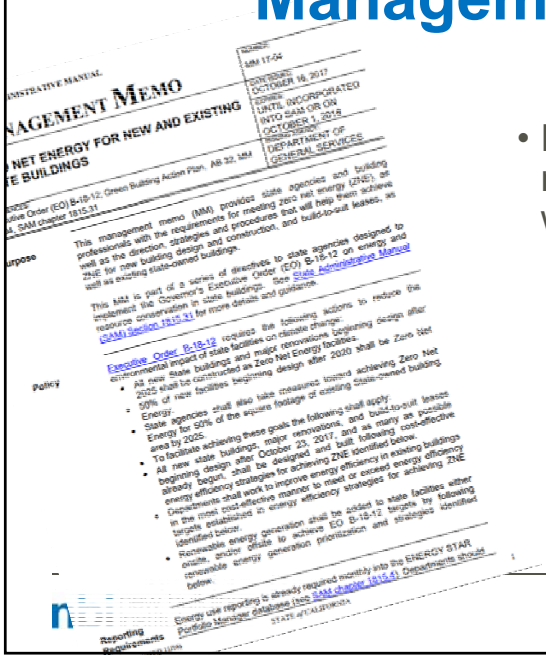
Management Memo 17-04


MANAGEMENT MEMO
NET ENERGY FOR NEW AND EXISTING
BUILDINGS

- Effective October 23, 2017 - All new and major renovations building designs as well as build-to-suit leases will include:
  - Achieve ZNE with cost-effective energy efficiency strategies
  - Exceed California Title-24 by 15%
  - Improve energy efficiency in existing buildings in the most cost-effective manner to meet or exceed source EUI targets.
  - Add renewable energy generation either onsite, and/or offsite to achieve EO B-18-12.

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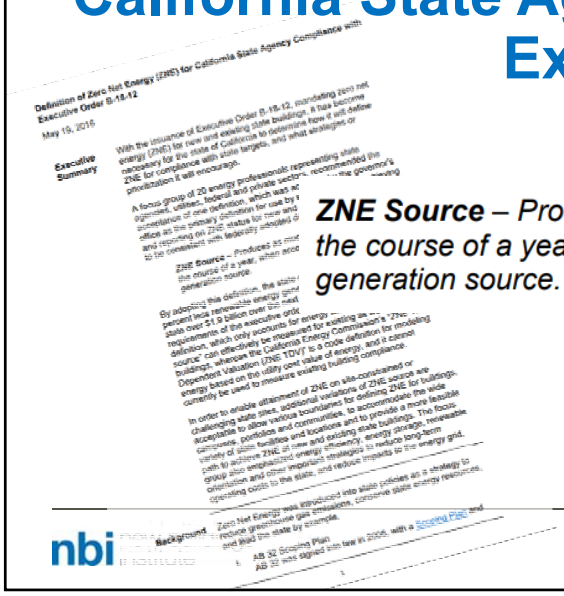
Definition of Zero Net Energy (ZNE) for California State Agency Compliance with Executive Order B-18-12


Definition of Zero Net Energy (ZNE) for California State Agency Compliance with Executive Order B-18-12
May 19, 2016

***ZNE Source** – Produces as much energy as it consumes over the course of a year, when accounted for at the energy generation source.*

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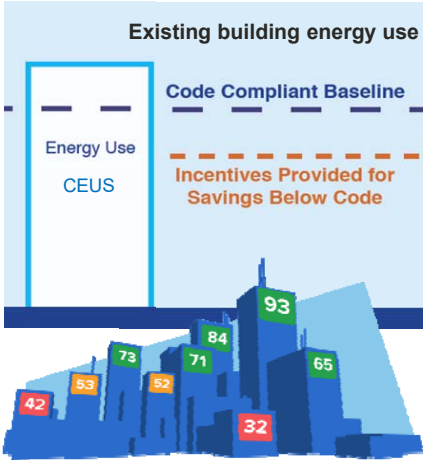
SAM Section 1815.4

- Develop annual energy use reduction goals
- Include energy use reduction goals in the five-year infrastructure plan
- Use ENERGY STAR Portfolio Manager database
  - Provide access to DGS



www.greenpsf.com

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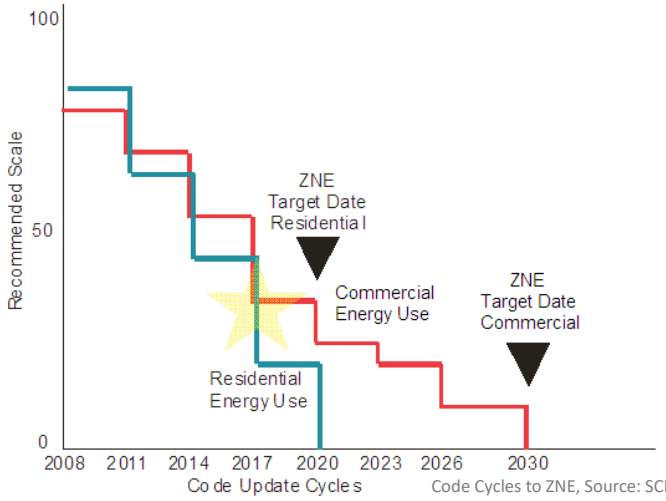
Code Cycles to ZNE in CA



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

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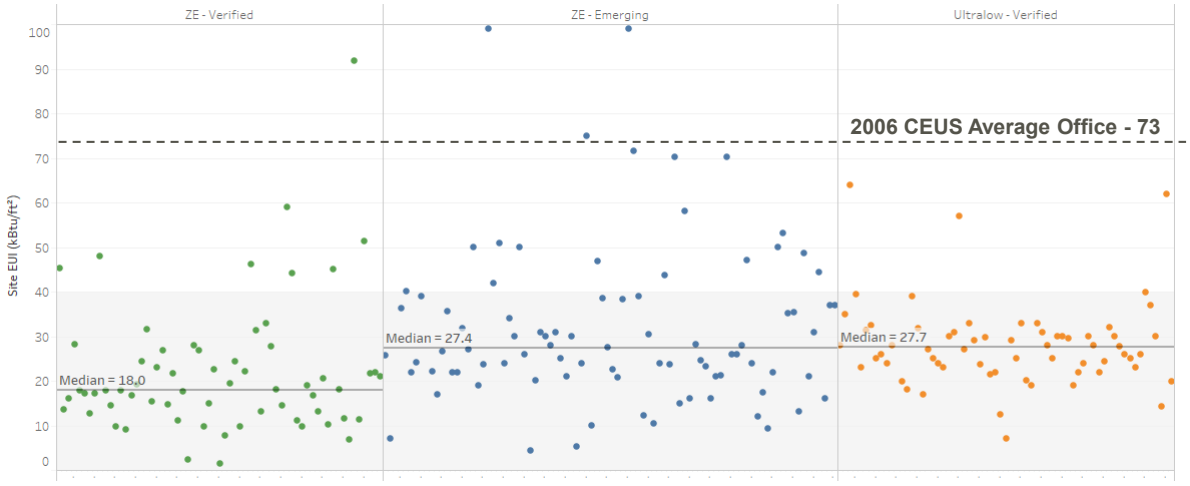
ZNE Performance



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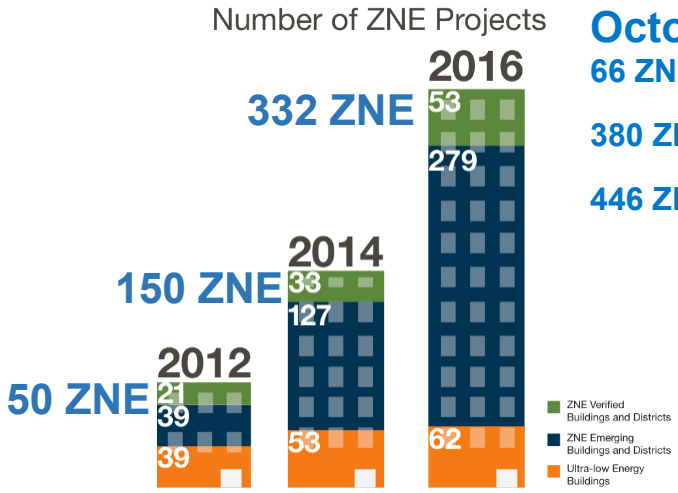
The 2016 List of ZNE Buildings



October 2017:

66 ZNE Verified

380 ZNE Emerging

446 ZNE!

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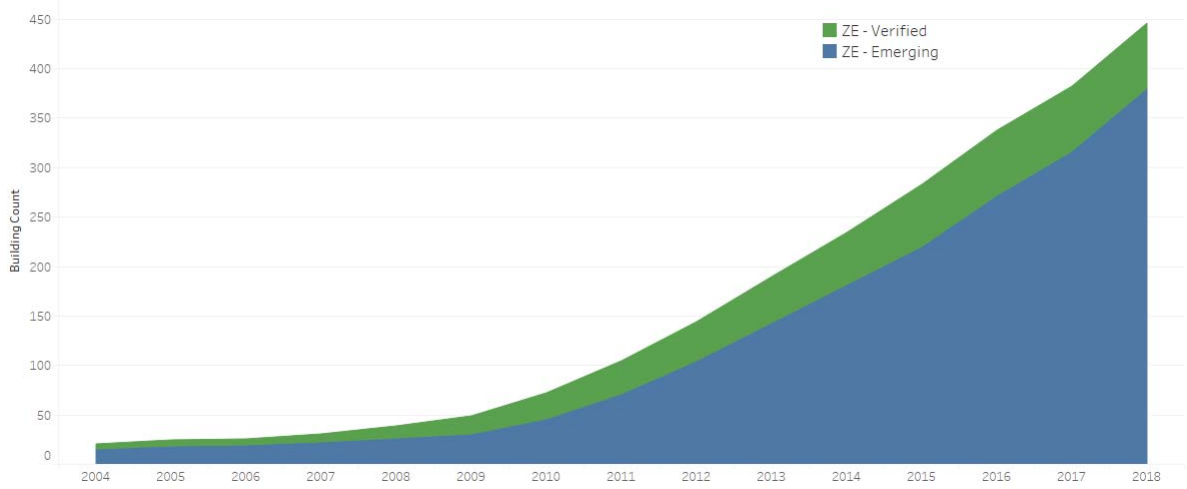
National ZNE Building Growth



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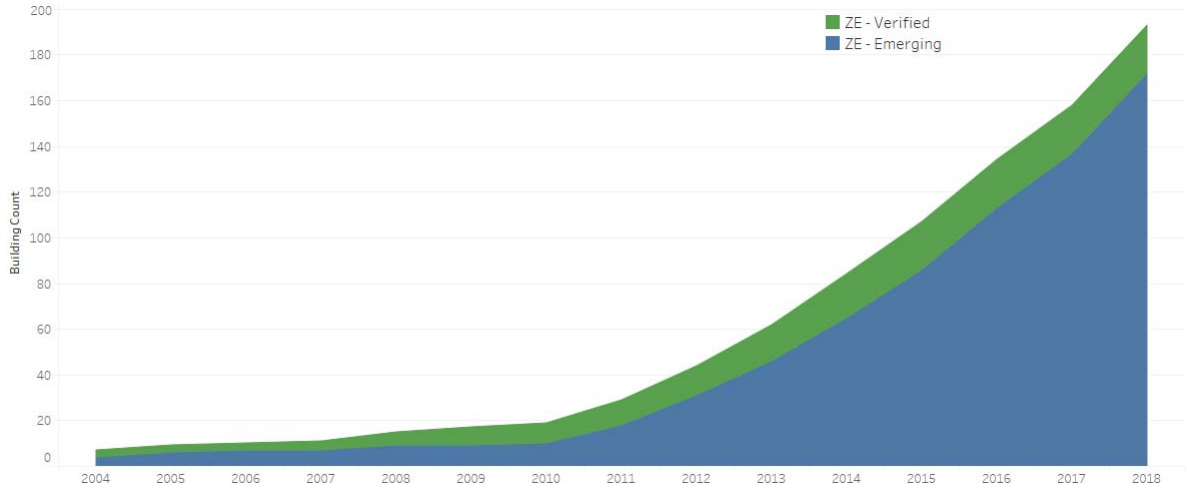
CA ZNE Building Growth Over Time



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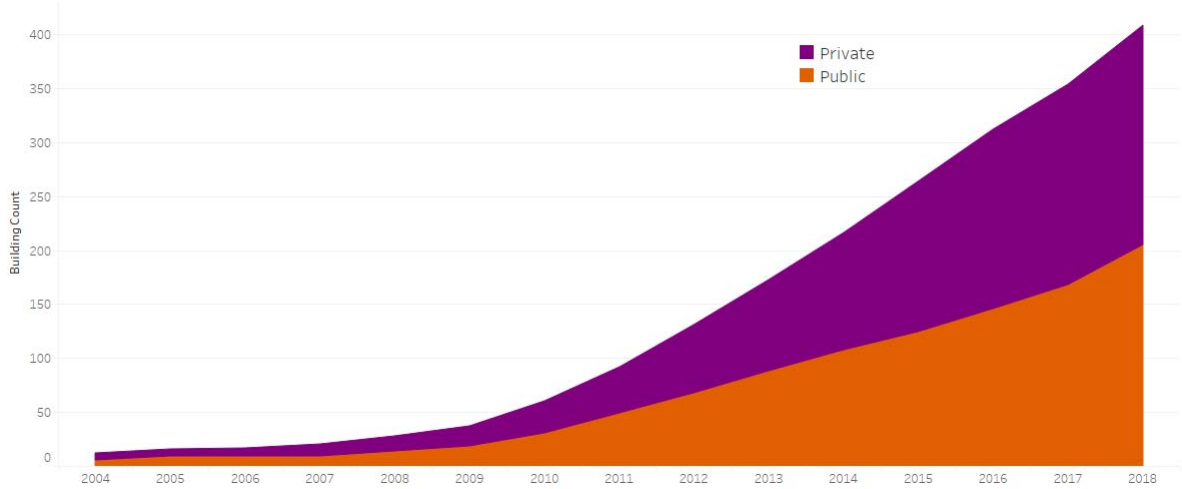
National Public/Private



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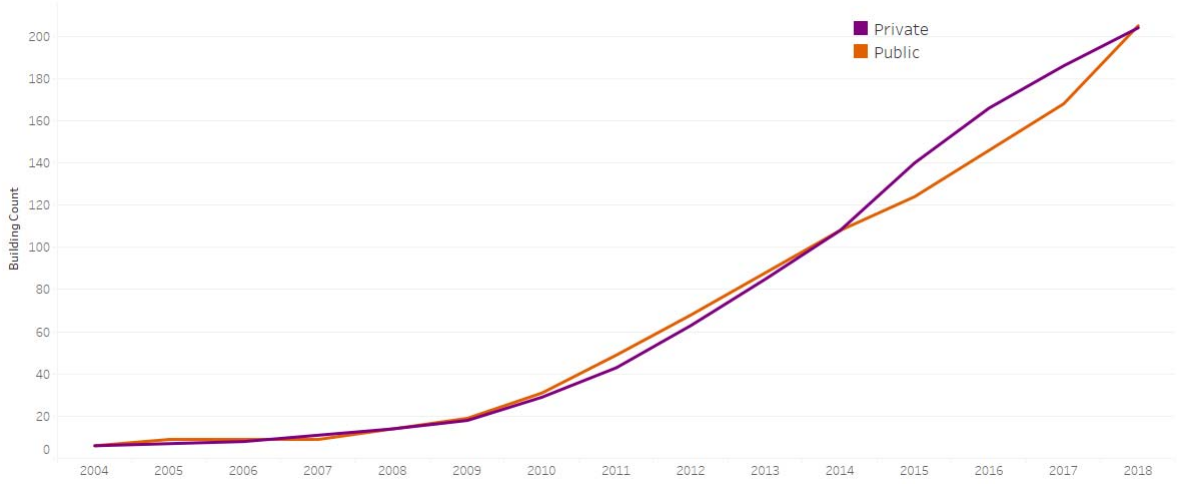

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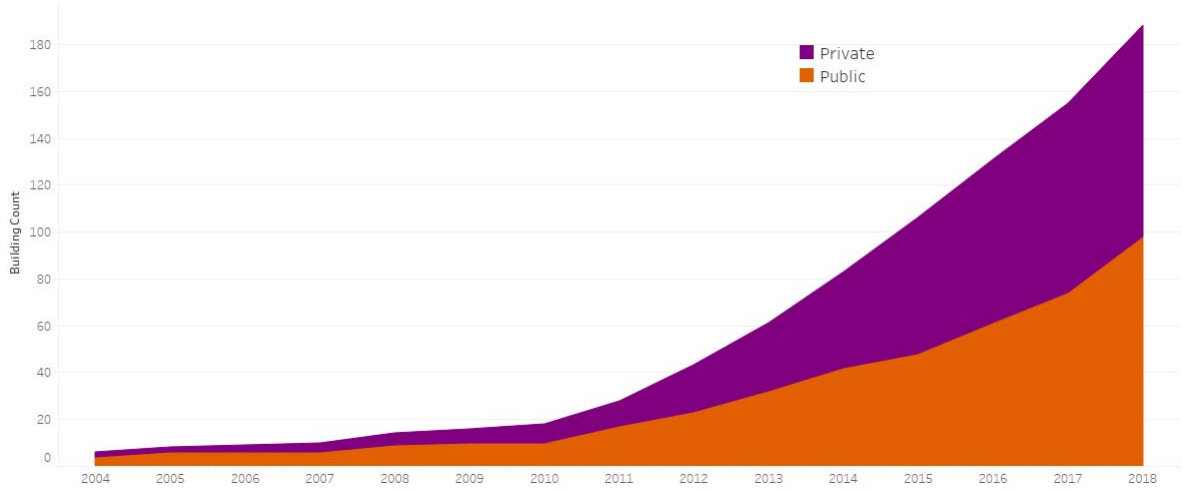
CA Public vs. Private Growth



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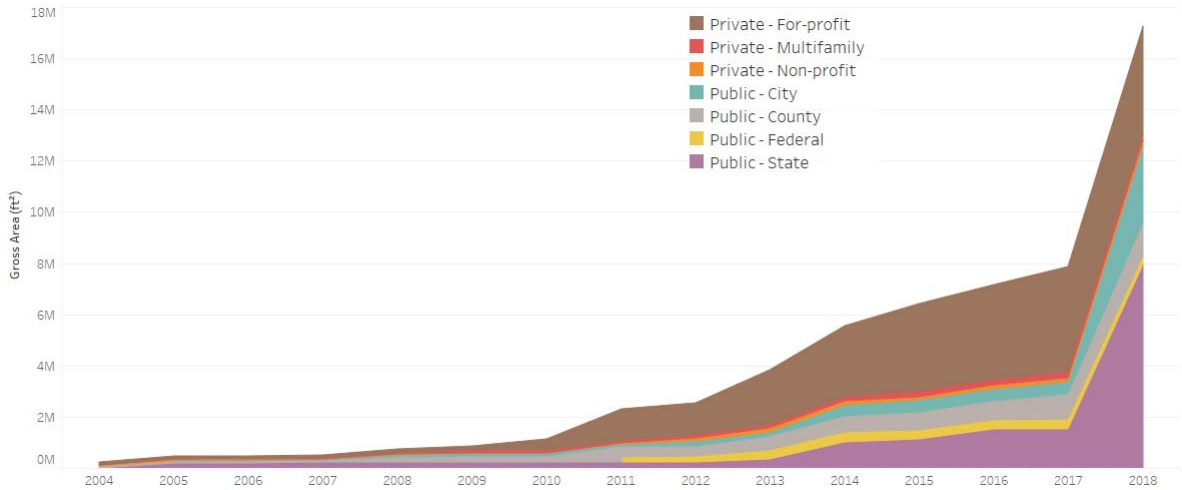
CA ZNE Building Ownership



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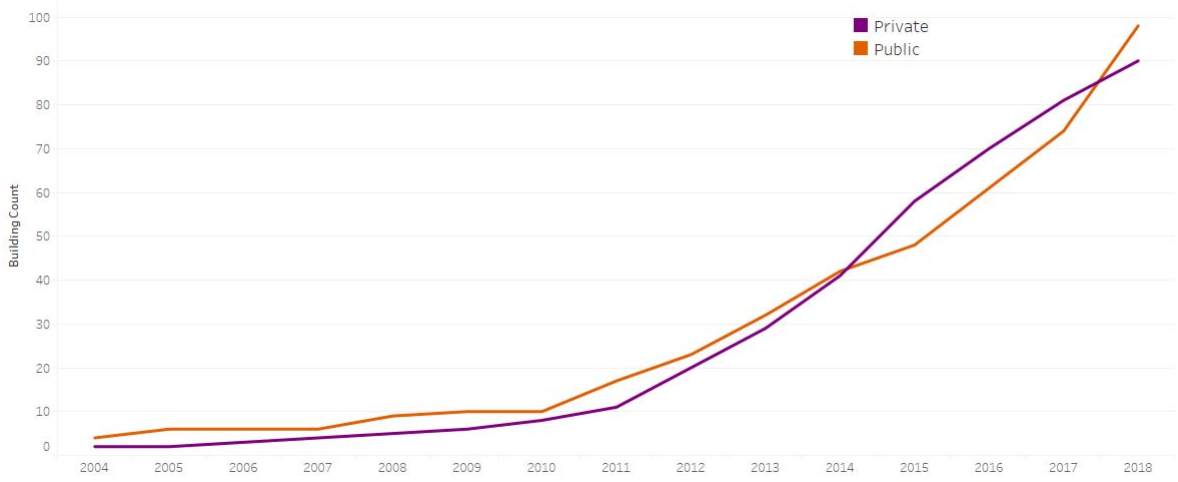
CA Public/Private



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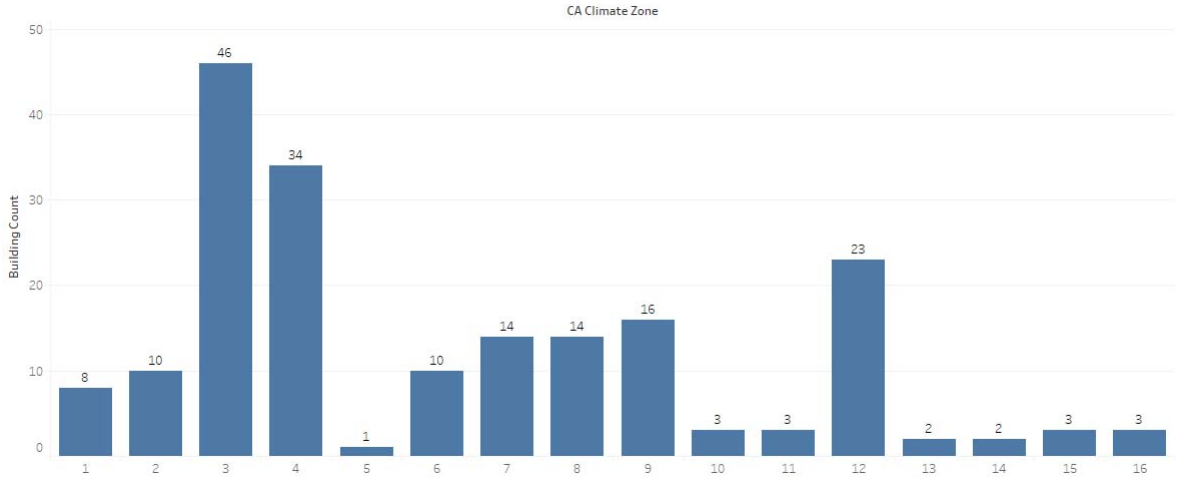
CA ZNE Building Climate Zones



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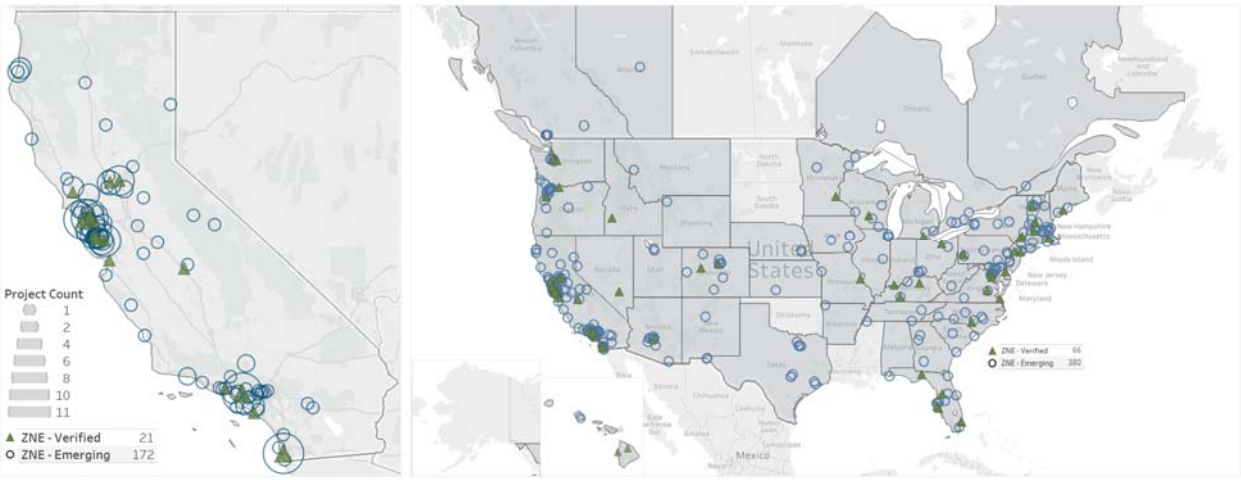
ZNE Building Map



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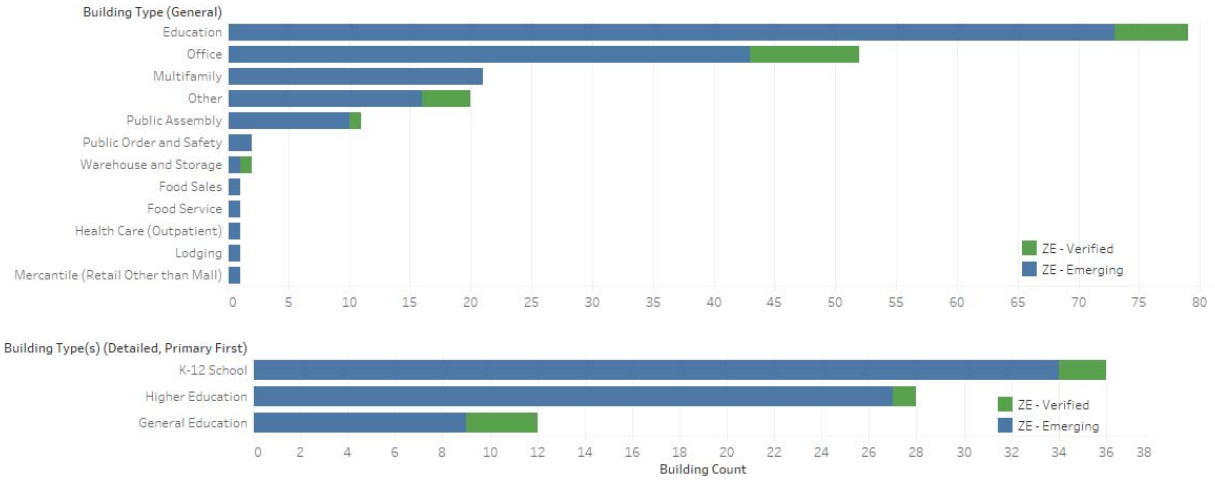
CA ZNE Building Types



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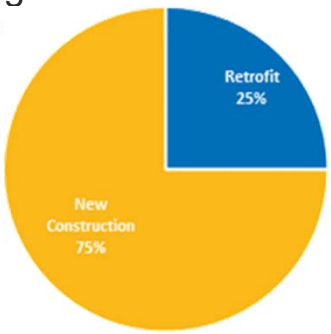
Getting Existing Buildings to Zero

- ~25% of ZNE projects tracked by NBI being tracked are retrofits
- Building lifecycle trigger points for upgrades
- Models from others



DPR Construction ZNE Offices| San Diego
Photo: David Hewitt

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Verified ZNE Commercial Buildings in California

Private – For-profit
- Jess Jackson Sustainable Winery Building
- AP+I Design
- Bagatelos Architectural Glass Solutions
- Bacon St. Offices (R)
- DPR Construction San Diego Net Zero Office (R)
- DPR San Francisco Office (R)
- IDeAs Z2 Design Facility (R)
- 435 Indio Ave (R)

Private – Non-profit
- David and Lucile Packard Foundation
- Audubon Center at Debs Park (off grid)
- Challengers Tennis Club
- IBEW Local 595 Zero Net Energy Center (R)

Public – City and County
- Sacred Heart Schools Stevens Family Library
- West Berkeley Public Library
- Environmental Nature Center
- Bishop O'Dowd High School, Environmental Science Center
- Watsonville Water Resources Center Admin Building

Public - State
- Diamond X Ranch Student Intern Center-Malibu

Public - Federal
- DMV Fresno Field Office
- Environmental Tech. Center Sonoma State
- EcoCenter at Heron's Head Park (off grid)

AP+I Design Mountain View, CA

Bacon St. Offices, SDG&E & Hanna Gabriel Wells Architects

(R) Indicates a an existing building retrofit

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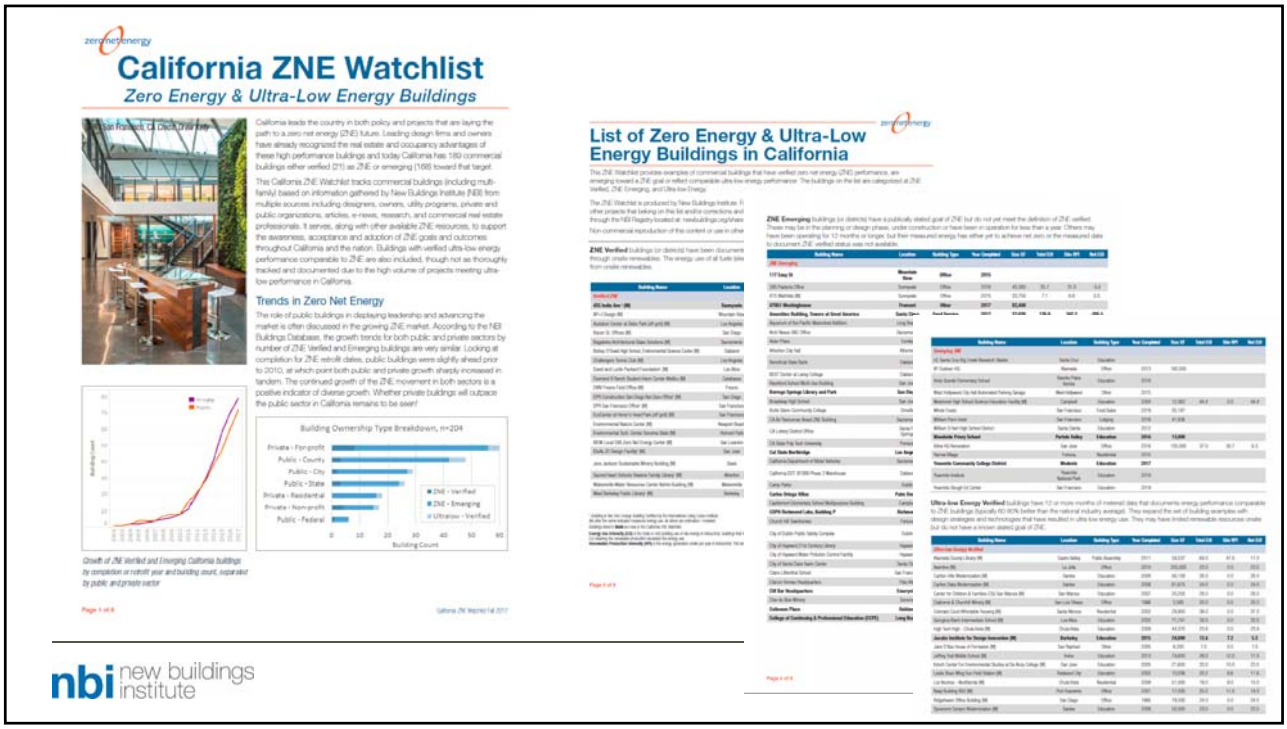

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Utility Program Support and Project Engagement

Lisa Hannaman, Program Manager, SCE

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SavingsByDesign

Successful Strategies

DGS ZNE Workshop

Lisa Hannaman| Southern California Edison | 10/30/17

SavingsByDesign

Introduction

Savings By Design is a statewide energy efficiency program available to new construction, additions, and major renovations.

The Program encourages high performance, sustainable, design and construction of non-residential buildings through:

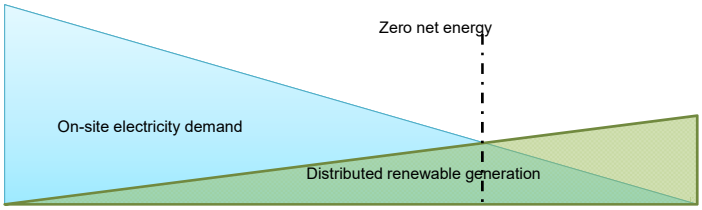
- Design Assistance
- Owner Incentives
- Design Team Incentives
- Energy Design Resources

Photo by Tim Griffith

UC Merced - Merced, CA

SavingsByDesign

SBD, Zero Net Energy, and Code



California's Long Term Energy Efficiency Strategic Plan

Statewide ZNE targets for building code:

2020 → All new Residential to be Zero Net Energy, by code

2030 → All new Commercial to be Zero Net Energy, by code

SavingsByDesign

Whole Building Approach - Owner

Core Incentive

Projects will receive $150 per peak kW saved. Subject to all applicable caps.

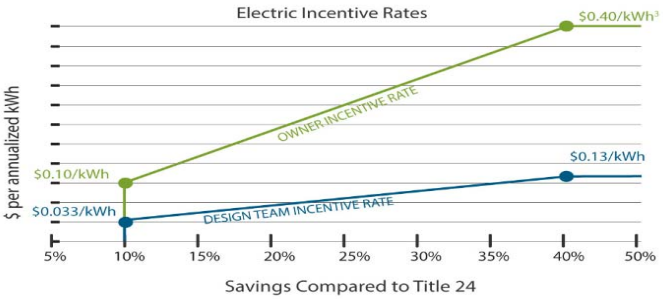
Up to $150,000 per project.

(Limited to 100% of incremental costs for energy efficiency measures.)

Owner Incentives range from $0.10 to $0.40 per annualized kWh savings, and $1.00 per annualized therm savings as the design becomes more efficient.

Owner Whole Building Incentives - up to $150,000
- 10% Bonus for end use monitoring

Design Team Whole Building Incentives - up to $50,000[1]



Peak Demand Incentive Rates:	$150/kW Owner	$50/kW Design Team[1]
[2]Therm Incentive Rate:	$1.00/therm Owner	$0.33/therm Design Team[1]

[1]Design Team Assistance to be offered in lieu of Design Team Incentives in SDG&E service territory.
[2]SCE therms incentive, offered in partnership with SCGC.
[3]Not available in PG&E service territory

SavingsByDesign

SBD Process

It's Easy To Work With Savings By Design

What We Need From You

Whole Building Approach - Team

Application
- Letter of Interest
- DT Incentive Application

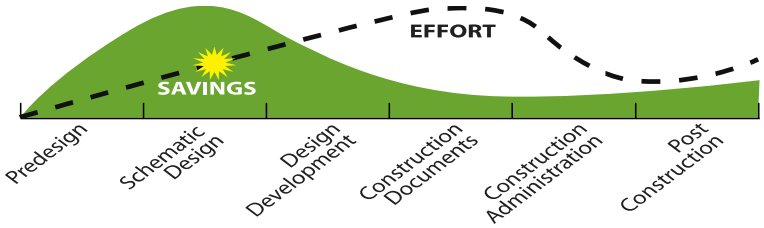
Owner's Agreement, with:
- WBA Summary Package
- Digital Set of Plans
- Spec's & Submittals on EE Measures
- Energy Model

SavingsByDesign

Whole Building Approach

Early Collaboration

Maximize your savings by having the Savings By Design team involved as soon as possible in the design of your project.

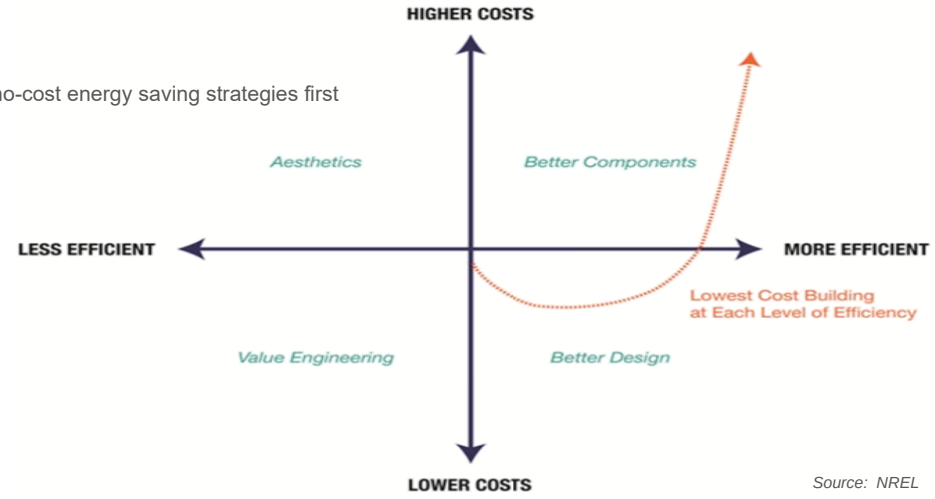


SavingsByDesign

Whole Building Approach

Integrative Design

Pursue low- or no-cost energy saving strategies first

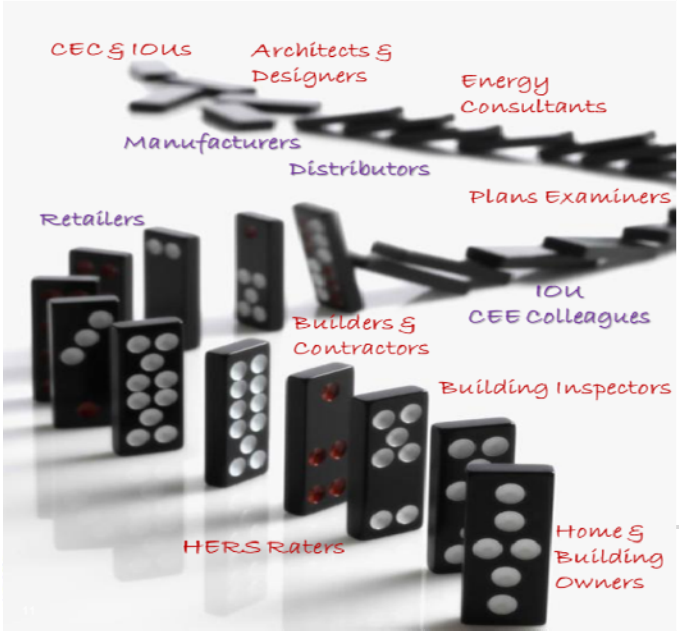


Source: NREL

Tools and Resources

Ace Training™

Our Approach



In order to improve compliance…

Analyze the compliance supply chain market actors' unique roles and needs

Determine:
1) How current performance compares to desired performance
2) Reasons for the gap
3) Appropriate solutions to improve code compliance

Apply appropriate performance-based solutions that meet stakeholders' specific needs and preferences

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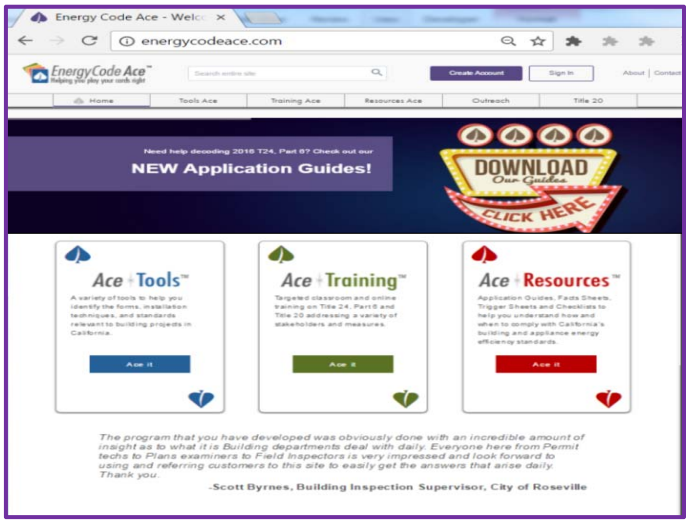
Compliance Improvement Activities

- Training – Increase knowledge
- Tools – Make it easier/faster, facilitate the process
- Resources – Help me teach others
- Outreach – Understand/demand proper performance

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

EnergyCodeAce.com is the gateway



- One-stop shop for tools, training and resources
- Designed to help building and appliance industries effectively comply with California's energy standards

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

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EnergyCode Ace™
Helping you play your cards right

Ace Training™

- **Various Modalities:**
  - Traditional Classroom
  - Virtual Classroom
  - Online Self-Studies
  - "Decoding" Talk Series
- **Target Audiences/Subjects:**
  - Building Dept. Personnel
  - Energy Consultants
  - Contractors/Installers
  - Architects/Designers
  - Lighting
  - AC QI
  - Refrigeration
  - Modeling Software

Ace Tools™

- Ace Forms™
- Ace Reference™
- Ace Installation™
- Crack The Code Industry Workshop™

Ace Resources™

- **Fact Sheets**
- **Trigger Sheets**
- **Applications Guides**
- **Checklists**
- **Useful Links**

Ace Outreach™

- **Website**
- **Press**
- **Presentations**
- **Partnerships**
- **Word On the Street**

On-going Needs Assessments Inform our Offerings
Consistent, Accurate, Repetitive Messages & Branding
Quality Control

Thank you.

Randall Higa, Southern California Edison
(626) 302-0789
randall.higa@sce.com
energycodeace.com

Submit questions via a form on the site
http://energycodeace.com/content/resource-faq/
Or directly to
info@energycodeace.com

A STATEWIDE UTILITY PROGRAM

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State ZNE Policy Review

Dan Burgoyne, Sustainability Manager, DGS

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The Road to Zero: California ZNE Policy

DGS
CALIFORNIA DEPARTMENT OF GENERAL SERVICES

CA ZNE Technical Workshop
Dan Burgoyne – October 30, 2017

Outline

1. State Zero Net Energy Mandates
   A. Executive Order B-18-12
   B. Management Memo 17-04
   C. State Administrative Manual (SAM) Section 1815.31
2. How does the State Define ZNE?
3. How Efficient is “Efficient Enough”?
4. Sources of Renewable Energy I can use?
5. Tools and Resources Available to Help

State of California ZNE Mandate

New Construction, Major Renovations, Build-to-Suit Leases:

EO B-18-12 & Green Building Action Plan

- 50% of buildings beginning design after 2020
- 100% of buildings beginning design after 2025
- Exceed CA T-24 by at least 15%
- Excludes electric vehicle charging

Management Memo 17-04

- Moves up start date for ZNE on new projects
- 100% of buildings beginning design after October 23, 2017
- Outlines sources of renewable energy that can be used

State of California ZNE Mandate

50% of Existing Building Area Square Footage:

EO B-18-12 & Green Building Action Plan

- 50% of existing building area ZNE by 2025
- Includes all forms of energy
- Excludes electric vehicle charging

Management Memo 17-04

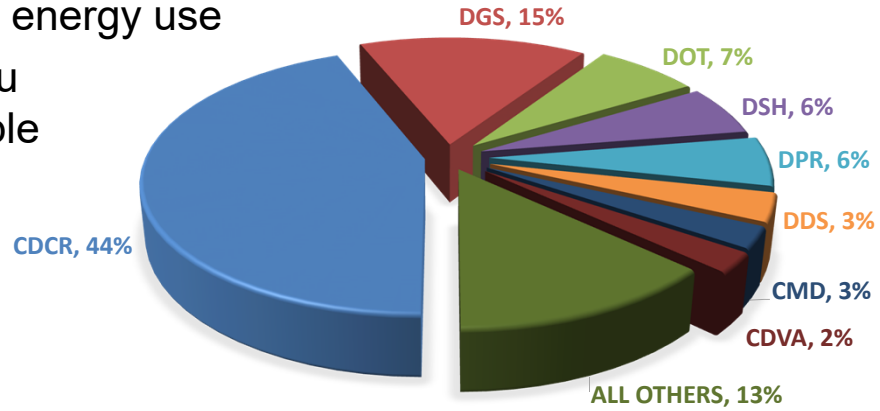
- Establishes energy efficiency targets
- Defines renewable energy sources & priorities

State Administrative Manual (SAM) Section 1815.31

- Outlines strategies for achieving efficiency and renewable energy generation

State-Owned Facilities

- 35 Executive Branch state agencies manage buildings
- >1,700 facilities, 112 million sq. ft., >20,000 structures
- 9.7 Billion kBtu energy use
- 267 Million kBtu onsite renewable energy (~3%)



State Building ZNE Challenge:

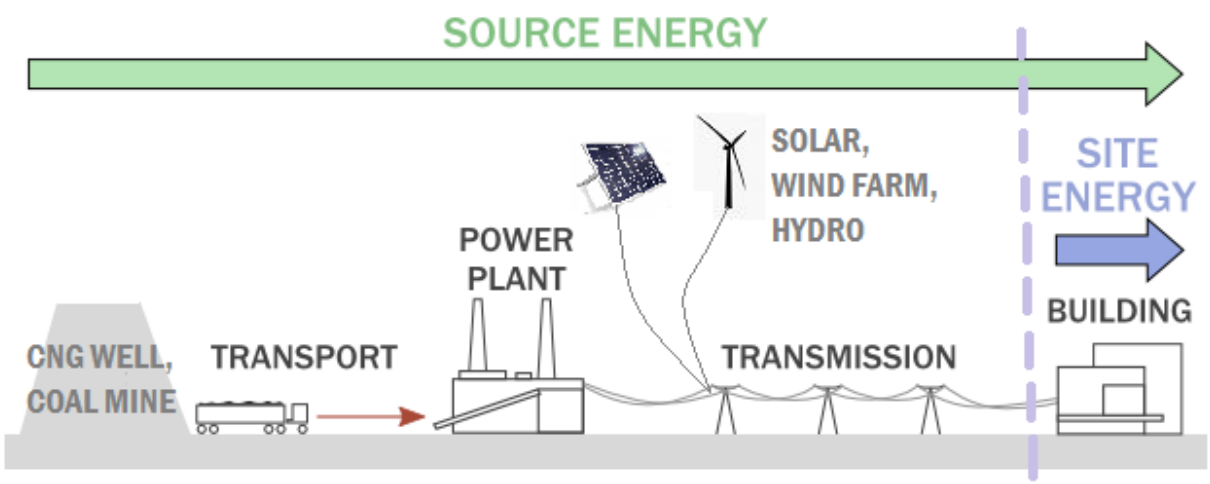
- How do we get 56 M sq. feet of occupied state buildings to ZNE by 2025? (w/ no funding)



How does the State Define ZNE?

***ZNE Source** – Energy efficient building that produces as much clean renewable energy as it consumes over the course of a year, when accounted for at the energy generation source.*

1. Energy Efficient
2. Produces as much Clean Renewable Energy as it Uses
3. Includes Source Energy in Calculations



- Represents the total amount of raw fuel that is required to operate the building
- Incorporates all fuel extraction, transmission, delivery, and production losses

How to Calculate Source Energy

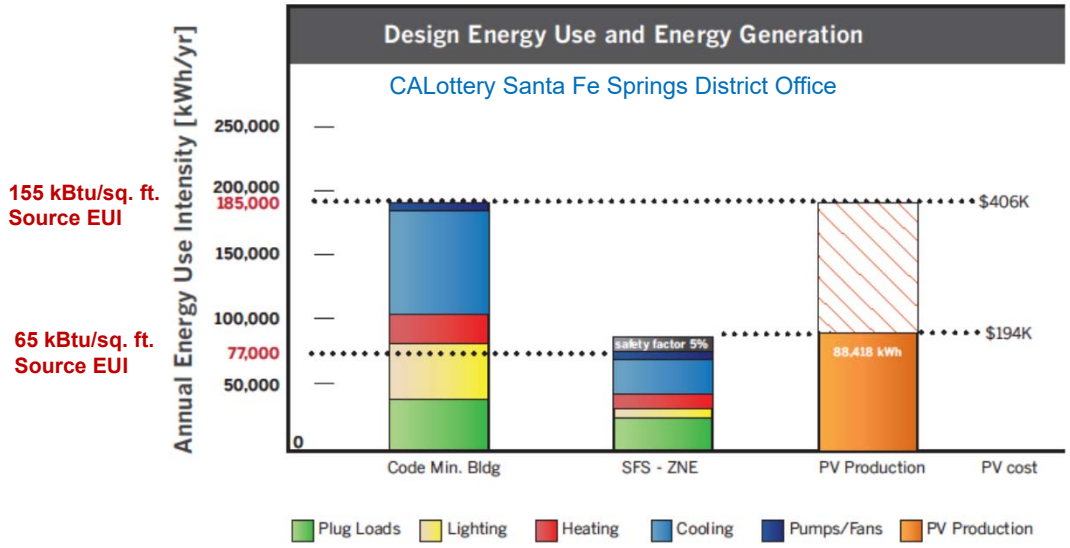
1. Source Energy Conversion Factors
   a) ZNE Calculator
      - http://www.dgs.ca.gov/dgs/Sustainability/ZeroNetEnergy.aspx
      - Built into calculator
   b) Energy Star Portfolio Manager
      - Except steam factor should be 1.45 (matching ASHRAE Standard 105)

National Average Source Energy Conversion Factors	
Form of Energy	
Imported Electricity	3.15
Exported Renewable Electricity	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04

Energy Efficiency for New Construction, Major Renovations & Build-to-Suit Leases

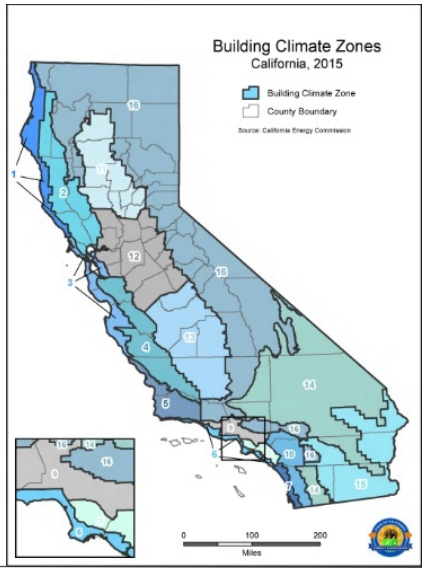
- Exceed California T-24 by 15% minimum
- Strategies often include:
  - Optimize building orientation
  - Daylighting
  - Well-insulated building envelope
  - Ultra-efficient lighting and HVAC systems & controls
  - Reduce plug loads
  - ZEV charging (does not count toward total energy)

Energy Efficiency in ZNE Pays Back



ZNE for Existing Buildings

- State Existing Building Portfolio ~112 Million Square Feet
- Energy Efficiency Targets
  - Energy Use Intensity Targets (Source EUI)
  - Top 25% Energy Use Targets
  - Based on 2015 State Energy Use Data
  - Over 1,700 state facilities
- Variations for 16 Climate Zones



34 State Building Types & Occupancies

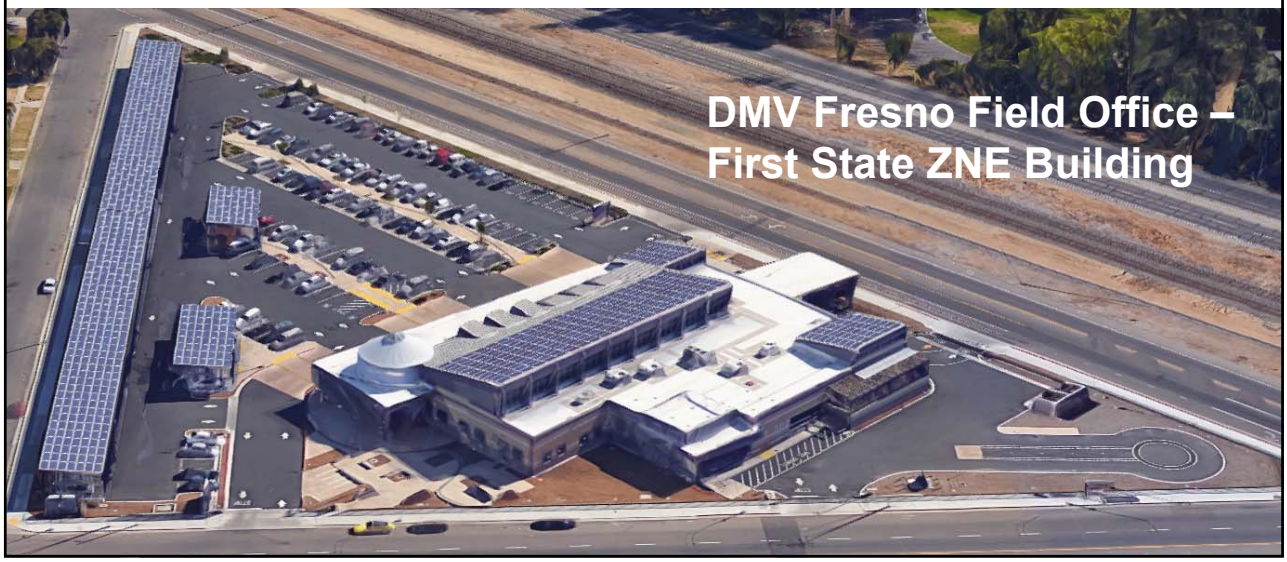
Laboratory	Other Building Categories
Library	• Maintenance DOT/DWR
Mixed Use Property (CALFIRE)	• Caltrans TMC
Multi-Family Housing	• CDFA
Non-Refrigerated Warehouse	• CDFW Ecological Reserve
Office - Large	• CDFW Fish Hatchery
• >50K sq. ft.	• CDFW Wildlife Area
Office - Small <50K sq. ft.	• DPR Park Structures
• CHP	• HCD Migrant Centers
• CMD	• Education
• DMV	• Entertainment public
• EDD	• Lodging/Residential
• All Other Small Offices	• Specialty Hospital - DSH
Outpatient Rehab/Phys - DSH	Residence Hall/Dorm - CALFIRE
Prison/Incarceration - CDCR	Senior Care Facility – CalVet

Energy Efficiency Targets for Existing State Buildings (Source EUI)

State Building Type	Source EUI Targets for State Climate Zones***																
	CA Ave	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion Factors for Zones	1.00	0.99	1.01	0.92	0.97	0.95	0.94	0.90	0.95	0.97	0.99	1.06	1.02	1.05	1.06	1.09	1.12
Adult Education - CCC	54	53	55	50	52	51	51	49	51	52	53	57	55	57	57	59	60
College/University	142	141	143	131	138	135	133	128	135	138	141	151	145	149	151	155	159
Data Center	100	99	101	92	97	95	94	90	95	97	99	106	102	105	106	109	112
Fire Station - CALFIRE	65	64	66	60	63	62	61	59	62	63	64	69	66	68	69	71	73
K-12 School	85	84	86	78	82	81	80	77	81	82	84	90	87	89	90	93	95
Laboratory	261	259	264	240	254	248	246	235	248	254	259	277	267	274	277	285	293
Library	114	113	115	105	111	108	107	103	108	111	113	121	116	120	121	124	128
Mixed Use Property (CALFIRE)	49	48	49	45	47	46	46	44	46	47	48	52	50	51	52	53	55
Multi-family Housing	133	132	134	122	129	126	125	120	126	129	132	141	136	140	141	145	149
Non-Refrig. Warehouse	37	37	37	34	36	35	35	33	35	36	[illegible]	[illegible]	[illegible]	[illegible]	39	40	41
[illegible]	81	81	82	75	79	77	77	73	77	79	[illegible]	[illegible]	[illegible]	[illegible]	86	89	91
Office - Large >50K sq. ft.	128	127	129	118	124	122	120	115	122	124	1[illegible]6	131	1[illegible]	[illegible]	36	140	143
[illegible]	201	199	203	185	195	191	189	181	191	195	1[illegible]	[illegible]	[illegible]	[illegible]	13	219	225
Office - Small <50K sq. ft. - CMD	30	30	30	28	29	29	28	27	29	29	30	32	31	32	32	33	34
Office - Small <50K sq. ft. - DMV	162	160	164	149	157	154	152	146	154	157	160	172	165	170	172	177	181
Office - Small <50K sq. ft. - EDD	132	131	133	121	128	125	124	119	125	128	131	140	135	139	140	144	148
Office - Small <50K sq. ft. - Others	114	113	115	105	111	108	107	103	108	111	113	121	116	120	121	124	128
Other - Maintenance DOT/DWR	71	70	72	65	69	67	67	64	67	69	70	75	72	75	75	77	80
Other - Caltrans TMC	567	561	573	522	550	539	533	510	539	550	561	601	578	595	601	618	635
Other - CDFA	249	247	252	229	242	237	234	224	237	242	247	264	254	262	264	272	279
Other - CDFW ecolog. reserve	22	22	22	20	21	21	21	20	21	21	22	23	22	23	23	24	25
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Renewable Energy Generation Priority

1. On-site Generation

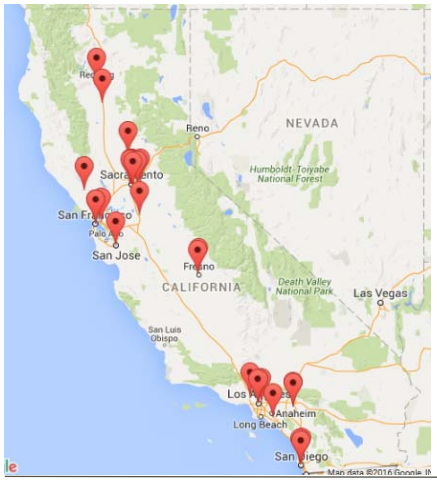


Renewable Energy Generation Priority

2. Campus

Renewable Energy Generation Priority

3. Portfolio



Renewable Energy Generation Priority

4. Community Renewables
   - Dedicated renewable energy purchase
   - 20 year min. agreement
   - Retain/retire REC's
   - Fixed for 20 years
   - i.e. SMUD SolarShares
     - Lower long-term cost than utility rate

Tools & Resources

- State ZNE Website: http://www.dgs.ca.gov/dgs/Sustainability/ZeroNetEnergy.aspx
- SAM Section 1815.31
  - Guidelines
  - Case Studies
  - Other Resources
- ZNE Calculator
- Source EUI Targets for Existing State Buildings
- ZNE Decision Making Matrix for State Agencies

Questions & Contact Info

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Department of General Services
Daniel.Burgoyne@dgs.ca.gov
(916) 376-5010
http://www.dgs.ca.gov/dgs/Sustainability.aspx

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Break

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ZNE Project Guide for State Buildings

Webly Bowles, Project Manager, NBI

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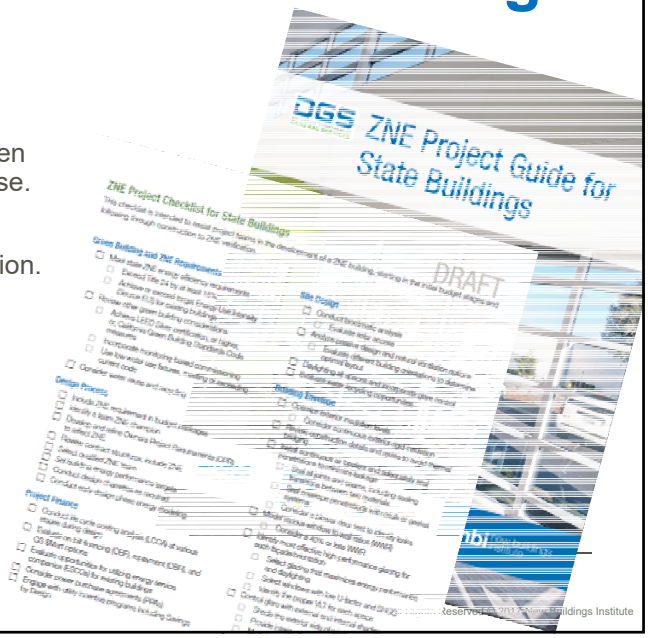
ZNE Project Guide for State Buildings

- ZNE Project Checklist
  - Evaluate topics and confirm items have been considered before the start of the next phase.
- ZNE Project Guide
  - Reference the guide as needed for inspiration.
- ZNE Project Tracking Tool
  - Describe how each item in the checklist.
- Resources
  - Find additional information about a topic.



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ZNE Project Guide for State Buildings

ZNE Project Checklist for State Buildings

DRAFT

This checklist is intended to assist project teams in the development of a ZNE building, starting in the initial budget stages and following through construction to ZNE verification.

Green Building and ZNE Requirements

- ☐ Meet state ZNE energy efficiency requirements
  - ☐ Exceed Title 24 by at least 15%
  - ☐ Achieve or exceed target Energy Use Intensity (Source EUI) for existing buildings
- ☐ Review other green building considerations
  - ☐ Achieve LEED Silver certification, or higher, or, California Green Building Standards Code measures
  - ☐ Incorporate monitoring-based commissioning
  - ☐ Use low water use fixtures, meeting or exceeding current code
- ☐ Consider water reuse and recycling

Design Process

- ☐ Include ZNE requirement in budget packages
- ☐ Identify a team ZNE champion
- ☐ Develop and refine Owners Project Requirements (OPR) to reflect ZNE
- ☐ Review contract structures, include ZNE
- ☐ Select qualified ZNE team
- ☐ Set building energy performance targets

Site Design

- ☐ Conduct bioclimatic analysis
  - ☐ Evaluate solar access
- ☐ Analyze passive design and natural ventilation options
  - ☐ Evaluate different building orientations to determine optimal layout
- ☐ Daylighting all spaces and incorporate glare control
- ☐ Evaluate water recycling opportunities

Building Envelope

- ☐ Optimize exterior insulation levels
  - ☐ Consider continuous exterior rigid insulation
- ☐ Review construction details and revise to avoid thermal bridging
- ☐ Install continuous air barriers and adequately seal penetrations to minimize leakage
  - ☐ Seal all joints and seams, including sealing transitions between two materials
  - ☐ Seal envelope penetrations with caulk or gasket systems
  - ☐ Consider a blower door test to identify leaks
- ☐ Model various window to wall ratios (WWR)

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ZNE Project Guide for State Buildings

- Resources

Renewables and Energy Storage

NREL Solar Ready Buildings Planning Guide: https://www.nrel.gov/docs/fy10osti/46078.pdf

SAM Management Memo 1815.31 - Zero Net Energy for New and Existing Buildings: https://www.documents.dgs.ca.gov/sam/SamPrint/new/sam_master/sam_master_file/chap1800/1815.31.pdf

Federal On-Site Renewable Power Purchase Agreements: https://energy.gov/eere/femp/federal-site-renewable-power-purchase-agreements

The Regulatory Assistance Project: http://www.raponline.org/document/download/id/7956

Operation and Verification

Title 20 Appliance Efficiency Program: http://www.energy.ca.gov/appliances/

DGS Standard Operating Procedures: http://www.documents.dgs.ca.gov/sam/SamPrint/new/sam_master/sam_master_file/chap1800/1805.3.pdf

Plug Load Guide: http://newbuildings.org/resource/plug-load-best-practices-guide/

Space Conditioning

Passive Solar Home Design: https://energy.gov/energysaver/passive-solar-home-design

Radiant Heating and Cooling + Dedicated Outdoor Air System: https://newbuildings.org/wp-content/uploads/2015/11/Radiant_ZNE_TAG1.pdf

Indirect Evaporative Cooling: http://newbuildings.org/resource/zero-net-energy-technology-application-guide-indirect-evaporative-cooling/

Ventilation

Radiant Heating and Cooling and Dedicated Outdoor Air Systems: https://newbuildings.org/wp-content/uploads/2015/11/Radiant_ZNE_TAG1.pdf

ASHRAE Standard 62.1: https://www.ashrae.org/resources--publications/bookstore/standards-62-1--62-2

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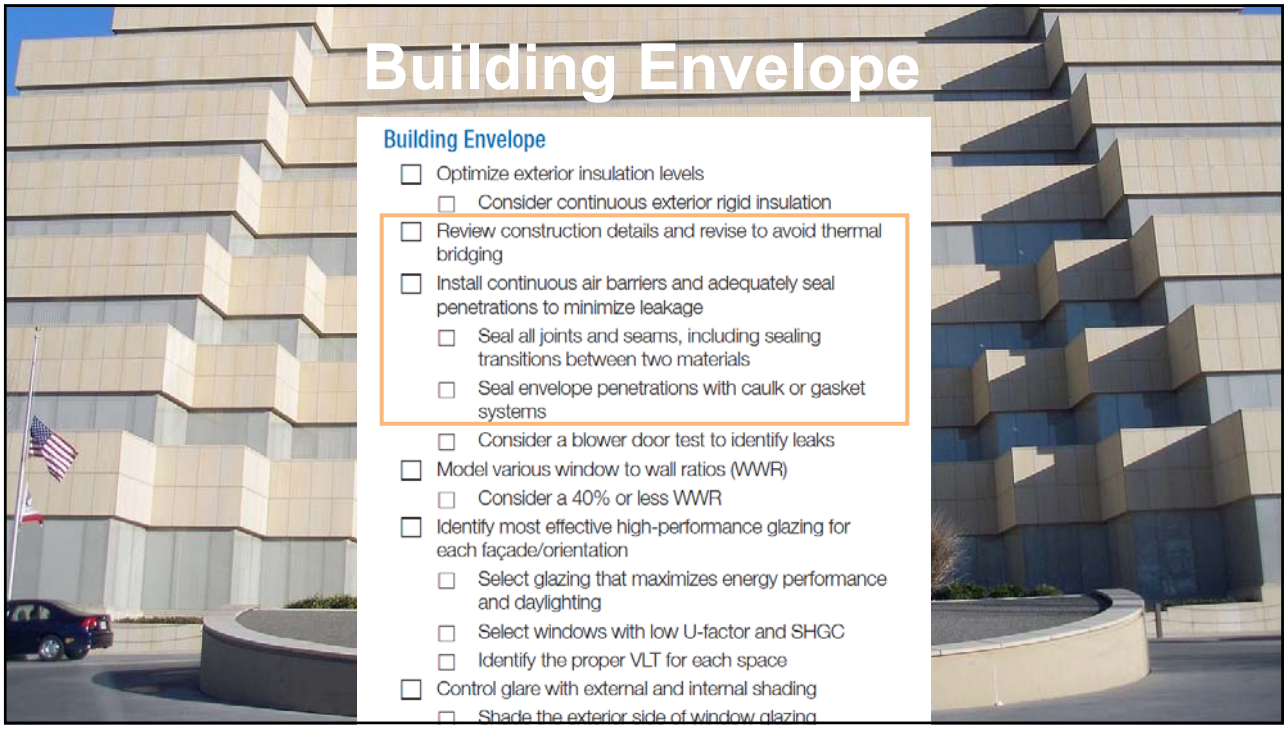


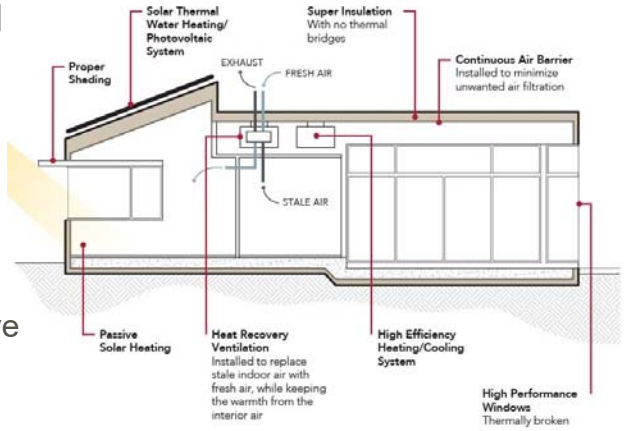
Building Envelope

Building Envelope

- ☐ Optimize exterior insulation levels
  - ☐ Consider continuous exterior rigid insulation
- ☐ Review construction details and revise to avoid thermal bridging
- ☐ Install continuous air barriers and adequately seal penetrations to minimize leakage
  - ☐ Seal all joints and seams, including sealing transitions between two materials
  - ☐ Seal envelope penetrations with caulk or gasket systems
  - ☐ Consider a blower door test to identify leaks
- ☐ Model various window to wall ratios (WWR)
  - ☐ Consider a 40% or less WWR
- ☐ Identify most effective high-performance glazing for each façade/orientation
  - ☐ Select glazing that maximizes energy performance and daylighting
  - ☐ Select windows with low U-factor and SHGC
  - ☐ Identify the proper VLT for each space
- ☐ Control glare with external and internal shading
  - ☐ Shade the exterior side of window glazing

Building Envelope

- ☐ Install continuous air barriers and adequately seal penetrations to minimize leakage
  - Continuous air barrier
    - Reduce temperature changes
    - Control outside air
    - Minimize moisture changes
  - Retrofit Option: Storm windows have been proven to reduce whole-building infiltration by 5.7% to 8.6%



Source: Beausoleil Architects

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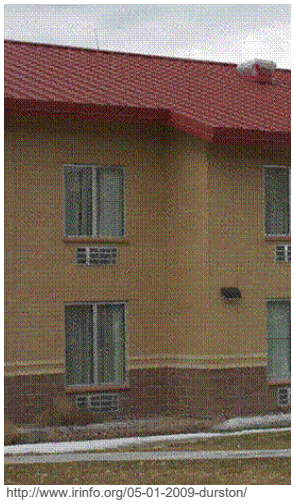
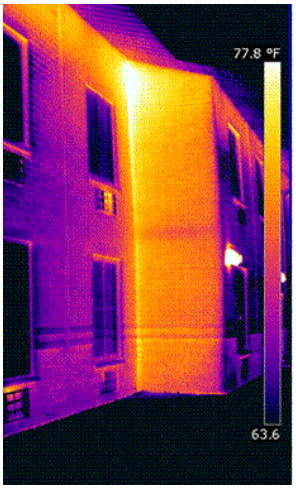
Building Envelope

- ☐ Seal all joints and seams
  - Joints
    - Changes in materials
    - Foundation
    - Walls
    - Windows
    - Doors
    - Roofs
    - Control and expansion joints
  - Penetrations
    - Pipe
    - Duct penetrations





http://www.irinfo.org/05-01-2009-durston/

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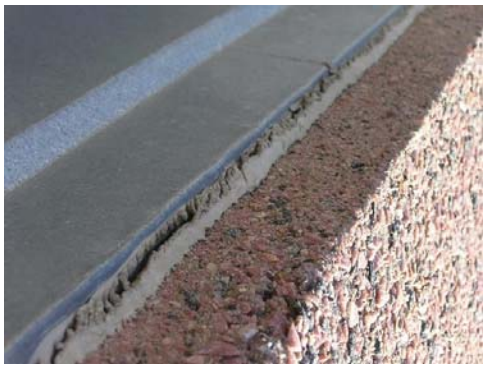
Building Envelope

- Seal all joints and seams



http://www.masonrymagazine.com/air-barriers-new-breed/

https://sites.google.com/site/metropolitanenvironmental/causes-of-failures-of-building-envelopes

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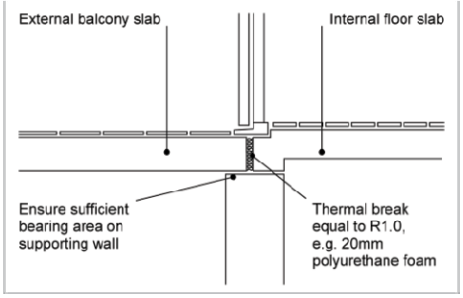
Building Envelope

- ☐ Review construction details and revise to avoid thermal bridging
  - Reduce heat transfers
  - Review details for materials that penetrate the thermal envelope



Source: Yourhome.gov.au

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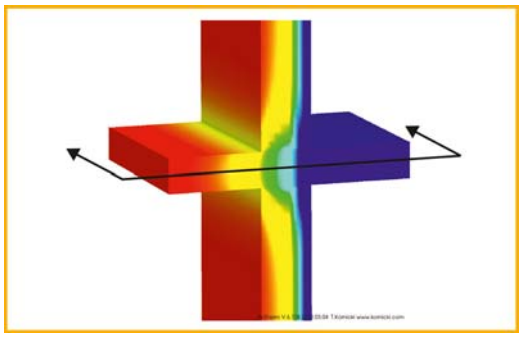
Building Envelope

MORRISON HERSHFIELD

Location	Code U-Factor	Effective U-Factor
1A - Miami	U-0.077	U-0.199
2B - Phoenix	U-0.064	U-0.186
4C - Portland	U-0.064	U-0.145
5A - Boston	U-0.064	U-0.145

IECC baselines



Thermal break

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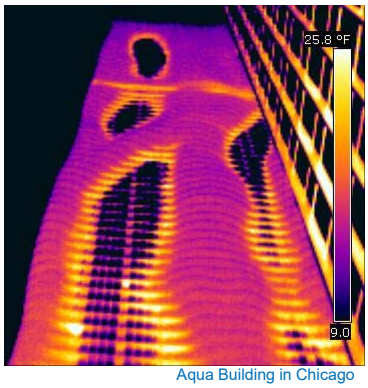
Building Envelope

- Loss of building performance with actual wall u factor.



Aqua Building in Chicago

Location	Low-Rise	Mid-Rise	High-Rise
1A - Miami	-0.5%	-0.3%	-2.3%
2B - Phoenix	-1.4%	-0.8%	-4.0%
4C - Portland	-2.9%	-0.4%	-2.5%
5A - Boston	-2.7%	-0.5%	-3.5%

Multifamily Buildings

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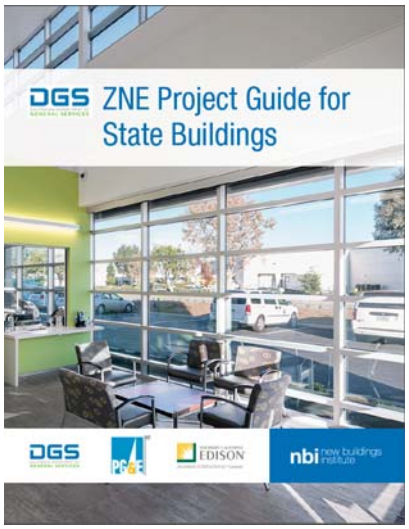
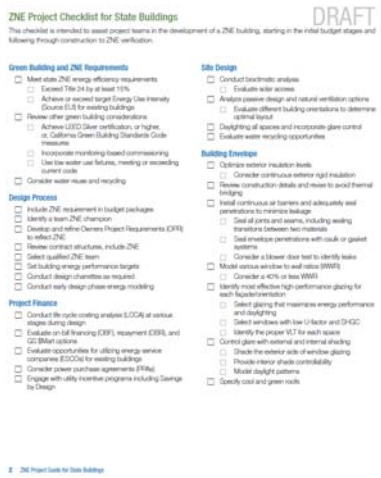
ZNE Project Guide for State Buildings

- Questions?





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Power Purchase Agreements

Steve Nowell, Associate Construction Analyst at State of California, DGS

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Power Purchase Agreements (PPA)

DGS Solar Program

- First Project Commercial operation date June 2006
- To Date 27 projects installed statewide > 44 MW
- Contracted an additional 22 projects > 33 MW
- Awarded 9 additional projects (>26 MW)
- Developing RFP's for additional 20+ projects
- DGS Goal to reach 100 MW by end of 2020

Prequalified Pool Of Solar Developers

- Pool members met min. qualifications
  - 3 Size Categories <200kW; 200kW - 1MW; >1 MW
  - Ground, Canopy and Rooftop
- 13 Developers In Qualified Solar Pool

DGS Solar Program – PPAs

Site License Agreements

- Allows vendors to install solar on state-owned facilities to offset grid energy purchases
- Documents drafted, reviewed and approved by DGS Leasing, DGS Legal, and DOF
- Participation is free of charge to agencies
  - No up-front costs to look into solar program
  - SPPA pricing is fixed for 20 year term of agreement

Project Scope

- DGS works with agencies to identify areas that can host PV system for 20 years
- DGS analyzes billing to understand annual facility kWh usage & size system at 75% to 90% of total annual energy usage if sufficient land, parking, or roof space is available
- Allows buffer for future EE projects, technology , etc.

DGS Solar Program – PPAs

Cost to Departments to Participate = $0.00

- DGS completes solar site assessment for solar project providing preliminary design and system sizing
- DGS includes project in a solar Request For Proposal (RFP) with other solar projects
- DGS and PV developers complete mandatory site walk attended by site facility personnel
- Developers submit project questions and DGS with facility provide answers
- Developers submit RFP project pricing bid response and DGS evaluates RFP bid package submittals
- DGS informs Host department of results and department confirms they want to proceed with contract
- Award based on greatest savings over the term of contract

DGS Solar Program – PPAs

Reasons to Participate

- Help state meet goals of EO B-18-12 reducing grid-based energy purchases
- **Save money!**
  - The solar projects to date have saved host agency money compared with existing utility bill
  - CDCR multi MW ground mount projects ~ SPPA costs of $0.06 to $0.08/kWhr, versus paying utility ~ $0.10/kWhr
- Helps meet LEED certification
- Helps towards achieving ZNE goals
  - CDPH Richmond Building P project
  - Campuses can utilize PPA for renewable energy to take a portion of campus buildings to ZNE

DGS Solar Program

Contact for more Information:

Department of General Services
Office of Sustainability
DGS Solar Program

Steven Nowell 916.375.5908 steven.nowell@dgs.ca.gov
Gonzalo Caceres 916.375.4892 gonzalo.caceres@dgs.ca.gov

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Energy Modeling

Aaron Wintersmith, Associate and Senior Energy Analysts,
Capital Engineering Consultants

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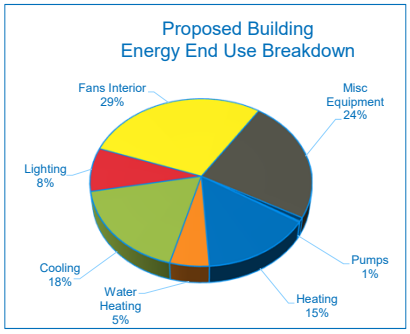
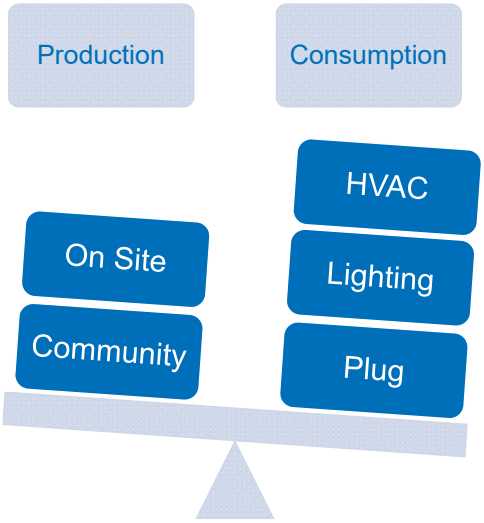
Energy Modeling

How to estimate energy use of a new building

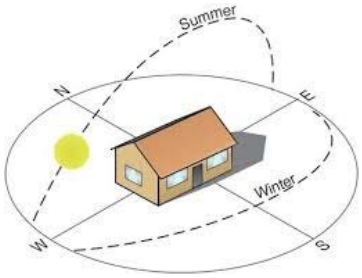


DGS
CALIFORNIA DEPARTMENT OF GENERAL SERVICES

Zero Net Energy – The Perfect Balance



How



- ANNUAL WEATHER FILES
- 8,760 HOURS
- SCHEDULES
- DIRECT USES
- INTERACTIVE EFFECTS
  - HEAT/COOLING LOADS
  - PEOPLE
  - LIGHTING
- OTHER

Compliance Models (CA Energy Code)

Programs

- Energy Pro
- CBECC Com
- IES VE

Limitations

- DO NOT Predict Actual Consumption
  - Rule Limitations
  - %% Better Than
  - TDV
  - HVAC System Types

Not for ZNE Analysis

Design Models

Programs

- Energy Pro
- ~~CBECC Com~~
- EQuest
- IES VE
- Open Studio
- Trace 700
- Design Builder

Requirements

- Predict Actual Consumption
  - Schedules
  - Actual Energy (Future Validation)
  - Advanced HVAC System Types
  - Plug/Process Loads
    - User Loads
    - Food Service
    - IT/DATA
    - Vertical Transportation

Limitations

Legacy Programs

- Energy Pro
- EQuest
- Trace 700

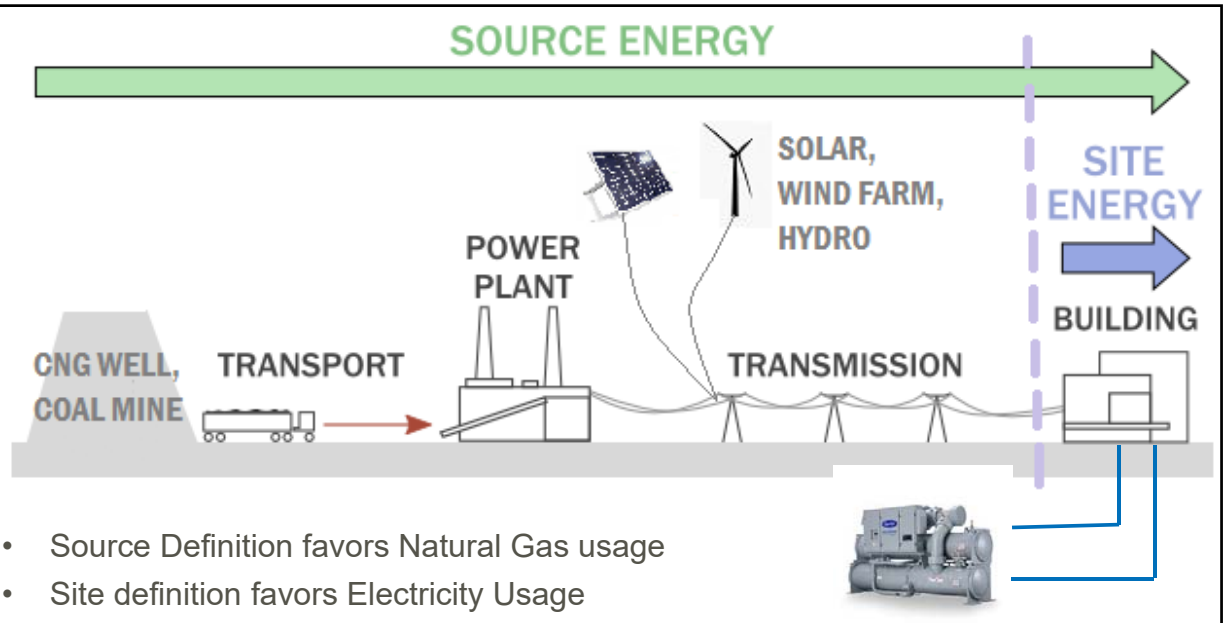
- Displacement Systems
- 1 System per Zone
- Unmet Load Hours

Humans

- Complexity
- Plug/Process Loads
- N.I.C
  - Furniture/Workstations
  - TI
- Perfect Function

Special ZNE Considerations

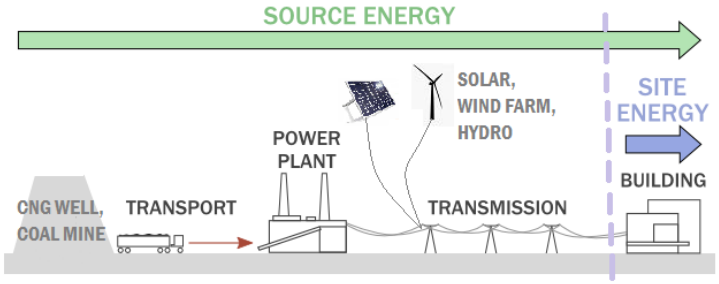
- Unregulated Loads
- Unsettled Calculation Method
- Tune Up Period
- Verification



- Source Definition favors Natural Gas usage
- Site definition favors Electricity Usage

DGS District Energy

- EPA ASSUMED EFF = 3.0 COP
- DSG PLANT EFF = 7.8 COP
- USE METERED CHW / HHW / STEAM VALUES AND ACTUAL PLANT EFF.
- DO NOT SIMULATE AS ON SITE CHW PLANT



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Cost-Effective Beyond-Title-24 Measures

Farhad Farahmand, Project Manager, TRC Solutions

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Cost Effective Measures Beyond Title 24: Results from Nonresidential Reach Code Study

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CA Department of General Services – Oct 30, 2017

Outline

1. Reach Code Analysis
- What is a reach code?
- Cost effectiveness methodologies

2. Measure Descriptions
- Cost estimates
- Quizzes!

3. Recommendations by Climate Zone
- Measure allocation
- Compliance margin (%)

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Reach Code Analysis

What is a reach code?

Mandates that buildings achieve energy performance better than Title 24 minimum requirements

- "Prescriptive"
  - Exactly 3 measures **or** 3 measures from 10 listed
  - Detailed guidance but restrictive
- "Performance"
  - 15% better than Title 24 **or** 9 kBtu/ft^2-yr
  - Flexible
- www.localenergycodes.com

Cost effectiveness analysis necessary for CEC approval

- We follow the CEC's life cycle cost (LCC) methodology

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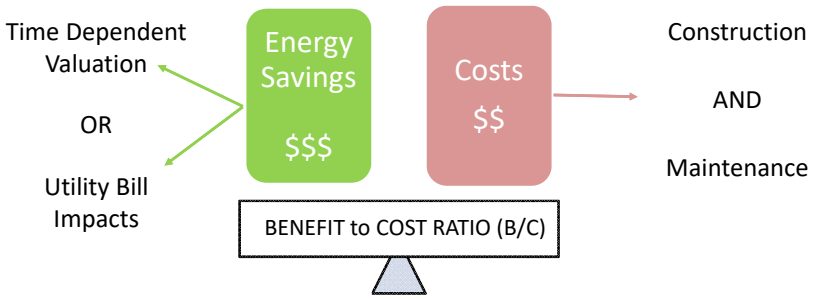
Cost effectiveness methodologies

Premise

- Title 24 prescriptive prototypes simulated in CBECC-Com
- Constraints: Prototypes, pre-emption, modeling software
- 30-year or 15-year Net Present Value
- **Package** of measures

Goal: B/C > 1.0



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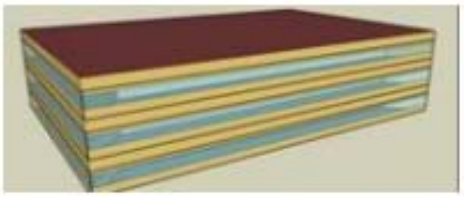
Nonresidential prototype

53,000 ft², 3-story, office with three packaged VAVs and 33% window-to wall ratio

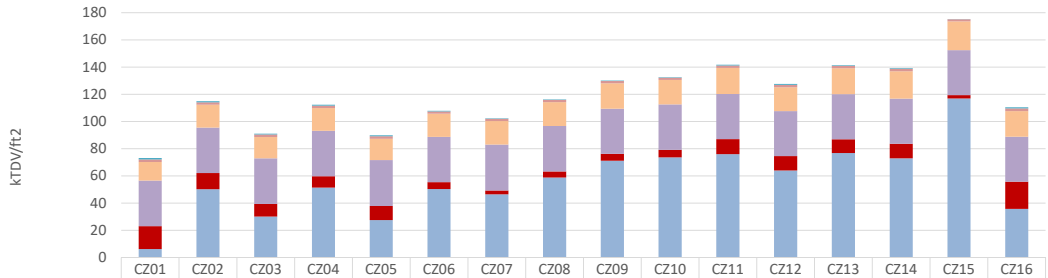
Building Type	2017 – 2019 Forecasted Construction (% of total)
Small, Medium, and Large Office	22%
Retail	16%
Warehouse	14%
Restaurant/Food	7%
School	5%
Hotel	5%
College	4%
Hospital	4%
Miscellaneous	23%



100

Office building analysis by CZ

Cooling and indoor lighting loads dominate kTDV/ft^2



	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08	CZ09	CZ10	CZ11	CZ12	CZ13	CZ14	CZ15	CZ16
Pumps & Misc	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1
DHW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Indoor Fans	14	17	16	17	16	17	17	18	19	18	19	18	19	20	21	19
Indoor Lighting	34	33	33	33	34	33	34	33	33	33	33	33	33	33	33	33
Heating	17	12	9	8	10	5	3	4	5	5	11	11	10	11	2	20
Cooling	6	50	30	51	27	50	46	59	71	74	76	64	77	73	117	36

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Lighting measures

LTG #1 - Reduced lighting power density (LPD)
LTG #2, 3, and 4 are based on Power Adjustment Factors (PAFs)

TABLE 140.6-A LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA		FACTOR
a. To qualify for any of the Power Adjustment Factors in this table, the installation shall comply with the applicable requirements in Section 140.6(a)2 b. Only one PAF may be used for each qualifying luminaire unless combined below. c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF			
1. Daylight Dimming plus OFF Control	Luminaires in skylit daylit zone or primary sidelit daylit zone		0.10
2. Occupant Sensing Controls in Large Open Plan Offices	In open plan offices > 250 square feet: One sensor controlling an area that is:	No larger than 125 square feet	0.40
		From 126 to 250 square feet	0.30
		From 251 to 500 square feet	0.20
3. Institutional Tuning	Luminaires in non-daylit areas: Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.		0.10
	Luminaires in daylit areas: Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.		0.05
4. Demand Responsive Control	All building types less than 10,000 square feet. Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF		0.05

Do NOT take the PAF tradeoff when implementing measures

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LTG #1: Reduce lighting power density

Quiz: What is the LPD prescriptively required by T24 for open office spaces (Area Category Method)?

- Answer: 0.75 Watts/ft^2

Measure: Use LED fixtures

- Can achieve 0.65 Watts/ft^2
- Exact LPD depends on design goals

Cooper Lighting 2AC 232 UNV EB81 U

Cost: $0

- Manufacturers suggest cost equivalency – LED is market standard
- Range of product qualities available
- Eliminates need for dimming ballast

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LTG #2: Daylight dimming + off

Quiz: What is the current daylight dimming level mandated by T24?

- Answer: 35%
- Prescriptive requirements range from 10% - 50%

Measure: Allow daylight to turn off lights entirely

- Daylight available is >150% of illuminance from lighting system

Cost: $0

- Simply a control setting change
- Daylight sensors and dimming ballasts already required

Source: www.thorlux.co.uk

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LTG #3: Open office occupancy sensors

Quiz: What two types of technologies do occupancy sensors use?

- Answer: Infrared and ultrasonic

Measure: One sensor per 4 workstations (500 ft^2)

- 59 sensors for the entire building
- Requires tuning

Leviton Ceiling Mounted Dual Tech

Cost: $252 per sensor

- $126 average material cost ($50 to $160 range)
- $50 - $75 per sensor installation, commissioning, and 10-year retrocommissioning
- 30% overhead and profit
- Costs can be reduced by coupling with daylight sensing capabilities

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LTG #4: Institutional tuning

Quiz: What problem is tuning intended to solve?

- Answer: Overlit spaces resulting from ceiling layout

Measure: Tune down lights

- Max light level is lower (≤ 85%) than fully installed light levels, but still acceptable for occupants.
- Continuous energy savings

Source: www.ecmag.com

Cost: $0.06/$ft^2$

- Labor only
- Based on number and layout of spaces

Schuetter, S., Li, J., and M. Lord. August 2015. Adjusting lighting levels in commercial buildings: energy savings from institutional tuning.

106

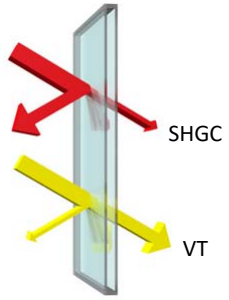
ENV #1 – Reduce solar heat gain coefficient

Measure: Use SHGC 0.22 or less products

- 0.25 is prescriptive
- Lower SHGC windows have heavy tint, blue or green appearance
- Maintain high visible transmittance (VT) for daylighting
- Alternatives include exterior shading and interior blinds

Cost: $4.50/ft^2 of window

- Cost does not directly correlate with SHGC reduction
- Variety of coating and tinting available
- Size of window and project affects cost



Source: www.efficientwindows.com

107

ENV #2 – Cool roof

Measure: Use aged solar reflectance (ASR) 0.70 or more

- 0.63 is prescriptive for low-sloped roofs

Cost: $(0.50)/ft^2 – $0.50/ft^2 of roof

- Some darker roofs have more expensive tints
- No additional labor
- 3x more products that achieve 0.70 than 0.63 (CRRC)

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TDV Cost effectiveness by CZ

CZ	Cool Roof ASR	Reduced RSHGC	Reduced LPD	Institutional Tuning	Lighting Controls (Daylight Dimming Plus Off, Open Office Occupancy Sensors)	Compliance %	NPV of Savings (kTDV)	Incremental Cost	B/C Ratio
1	n/a	n/a	0.65	x	x	15.7%	$55,509	$18,112	3.0
2	0.70	0.22	0.65	x	x	12.8%	$70,400	$48,902	1.4
3	0.70	0.22	0.65	x	x	15.5%	$67,202	$55,390	1.2
4	n/a	0.22	0.65	x	x	13.1%	$70,448	$49,284	1.4
5	0.70	0.22	0.65	x	x	15.9%	$68,300	$55,390	1.2
6	0.70	0.22	0.65	x	x	14.7%	$75,603	$55,636	1.4
7	0.70	0.22	0.65	x	x	15.6%	$76,319	$55,636	1.4
8	0.70	0.22	0.65	x	x	13.7%	$75,984	$55,636	1.4
9	0.70	0.22	0.65	x	x	12.6%	$78,466	$55,636	1.4
10	0.70	0.22	0.65	x	x	11.6%	$73,646	$48,676	1.5
11	0.70	0.22	0.65	x	x	11.0%	$74,075	$47,098	1.6
12	0.70	0.22	0.65	x	x	11.8%	$71,546	$51,988	1.4
13	0.70	0.22	0.65	x	x	10.8%	$73,216	$47,098	1.6
14	0.70	0.22	0.65	x	x	11.0%	$73,264	$45,781	1.6
15	0.70	0.20	0.65	x	x	10.4%	$87,058	$45,865	1.9
16	0.70	0.22	0.65	x	x	12.8%	$67,298	$45,781	1.5

Reach code recommendations

Climate Zone	Cost Effective Compliance Margin	Recommended Reach Code Compliance Margin	B/C Ratio (TDV)	B/C Ratio (On-Bill)
1	15.7%	15%	3.0	5.3
2	12.8%	10%	1.4	2.3
3	15.5%	15%	1.2	2.0
4	13.1%	10%	1.4	2.3
5	15.9%	15%	1.2	2.0
6	14.7%	10%	1.4	1.5
7	15.6%	15%	1.4	2.3
8	13.7%	10%	1.4	1.5
9	12.6%	10%	1.4	1.5
10	11.6%	10%	1.5	2.5
11	11.0%	10%	1.6	2.5
12	11.8%	10%	1.4	2.2
13	10.8%	10%	1.6	2.5
14	11.0%	10%	1.6	1.8
15	10.4%	10%	1.9	2.1
16	12.8%	10%	1.5	2.3

Other measures to consider (grab bag)

- Appliance efficiency improvements (HVAC/DHW)
  - SEER, AFUE, HSPF, fan efficiency
- HVAC window interlock
  - Prescriptive
- Specify ASHRAE Guideline 36
  - Ensures best-in-class controls sequences
  - Fault detection and diagnostics
  - When possible (e.g., VAV systems)
  - Soon to be finished

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Questions or Comments (please)

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916-844-1033

On-bill cost effectiveness by CZ

CZ	Cool Roof ASR	Reduced RSHGC	Reduced LPD	Institutional Tuning	Lighting Controls (Daylight Dimming Plus Off, Open Office Occupancy Sensors)	Compliance %	Annual kWh Savings	Annual Therm Savings	On-Bill Savings
1	n/a	n/a	0.65	x	x	15.7%	26,084	(366)	$95,361
2	0.70	0.22	0.65	x	x	12.8%	31,026	(433)	$114,859
3	0.70	0.22	0.65	x	x	15.5%	29,508	(405)	$109,322
4	n/a	0.22	0.65	x	x	13.1%	31,028	(322)	$114,311
5	0.70	0.22	0.65	x	x	15.9%	30,179	(414)	$111,303
6	0.70	0.22	0.65	x	x	14.7%	32,792	(185)	$82,359
7	0.70	0.22	0.65	x	x	15.6%	32,678	(222)	$129,100
8	0.70	0.22	0.65	x	x	13.7%	33,398	(240)	$83,662
9	0.70	0.22	0.65	x	x	12.6%	33,510	(242)	$85,235
10	0.70	0.22	0.65	x	x	11.6%	32,649	(244)	$121,226
11	0.70	0.22	0.65	x	x	11.0%	32,640	(351)	$118,022
12	0.70	0.22	0.65	x	x	11.8%	31,968	(371)	$116,533
13	0.70	0.22	0.65	x	x	10.8%	32,744	(325)	$119,413
14	0.70	0.22	0.65	x	x	11.0%	33,216	(353)	$80,520
15	0.70	0.20	0.65	x	x	10.4%	38,959	(181)	$96,324
16	0.70	0.22	0.65	x	x	12.8%	30,153	(603)	$106,614

Lunch

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Energy and Sustainability Program

Valarie Keisler, Energy Retrofit Unit, DGS

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DGS Energy Savings Program

- Develops and implements energy retrofit projects in existing state facilities
  - 15-20% achieved reduction in energy and water consumption.
- Assists state agencies in meeting energy reduction requirements.

DGS

CA ZNE Technical Workshop – October 30, 2017

DGS Energy Savings Program

- Energy retrofit measures, upgrades or replacements for:
  - Electrical Systems (lighting/power)
  - Mechanical systems
  - Building Envelope
  - Water Systems

CA Science Center, Los Angeles

DGS Energy Savings Program

- Energy savings projects require no or minimal upfront capital expenditure for state client agencies.
  - Loan payments are offset by the utility savings.
- Fund sources include:
  - DGS energy revolving fund
  - GS $Mart Loans
  - On-bill financing

CHP Academy, West Sacramento

DGS Energy Savings Program

Benefits of the DGS ESCO process:

- Qualified ESCO pools already established
- Can start projects immediately
- New streamlined process is much faster and as a result less expensive
  - Eliminates lengthy steps including RFP
- Can be budget neutral with no upfront costs

Office of Emergency Services

DGS Energy Savings Program Contacts

Let our team help you save energy!

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http://www.dgs.ca.gov/dgs/Sustainability.aspx

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DGS Existing Building ZNE Readiness Worksheet

Dan Burgoyne, Sustainability Manager, DGS

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Existing Building ZNE Readiness

50% of Existing Building Area Square Footage by 2025:

True or False?

1. Existing buildings are too hard to get to ZNE because they'll never be as efficient as new buildings. **False**
2. ZNE is not possible on buildings without clear rooftops or big parking lots. **False**
3. ZNE always costs more money that we don't have in our building budgets. **False**

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Existing Building ZNE Readiness

Pressing Questions for ZNE on Existing State Buildings:

1. How do we know what is efficient enough for ZNE?
   a) How do I get there?
   b) How much will it cost?

2. How do we know how much renewable energy we need for our building to achieve ZNE?

DGS Existing Building ZNE Readiness Worksheet

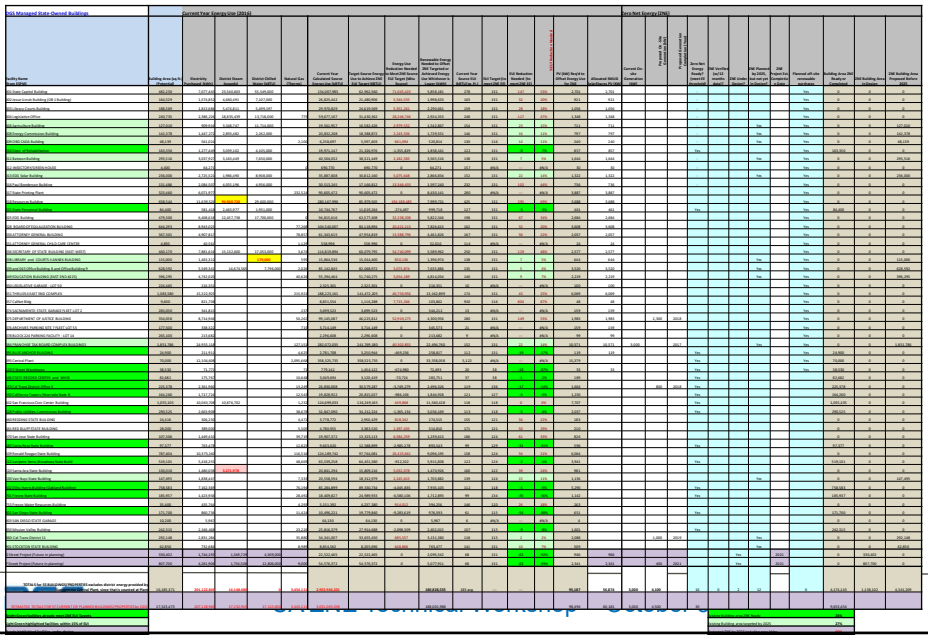
- Builds upon Department Roadmap Facility Data Workbook
  - Department Roadmaps due every two years
  - Next Roadmap due December 31, 2017
- Facility Data Workbooks required by each department with Roadmap
  - Workbook intended as a tool for planning and tracking progress
- DGS Facility Data Workbook customized to analyze and determine ZNE readiness
  - Also estimates renewable energy needed for each building to achieve ZNE

Energy Efficiency Targets for Existing State Buildings (Source EUI)

http://www.documents.dgs.ca.gov/os/ZNE/CaliforniaStateBuildingEfficiencyTargetsforZNE_1032017.xlsx

State Building Type	Source EUI Targets for State Climate Zones***																
	CA Ave	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Conversion Factors for Zones	1.00	0.99	1.01	0.92	0.97	0.95	0.94	0.90	0.95	0.97	0.99	1.06	1.02	1.05	1.06	1.09	1.12
Adult Education - CCC	54	53	55	50	52	51	51	49	51	52	53	57	55	57	57	59	60
College/University	142	141	143	131	138	135	133	128	135	138	141	151	145	149	151	155	159
Data Center	100	99	101	92	97	95	94	90	95	97	99	106	102	105	106	109	112
Fire Station - CALFIRE	65	64	66	60	63	62	61	59	62	63	64	69	66	68	69	71	73
K-12 School	85	84	86	78	82	81	80	77	81	82	84	90	87	89	90	93	95
Laboratory	261	259	264	240	254	248	246	235	248	254	259	277	267	274	277	285	293
Library	114	113	115	105	111	108	107	103	108	111	113	121	116	120	121	124	128
Mixed Use Property (CALFIRE)	49	48	49	45	47	46	46	44	46	47	48	52	50	51	52	53	55
Average All	133	132	134	122	129	126	125	120	126	129	1	[illegible]	[illegible]	[illegible]	141	145	149
Office - Large >50K sq. ft.	37	37	37	34	36	35	35	33	35	36	36	131	1	[illegible]	39	40	41
Small <50K sq. ft.	81	81	82	75	79	77	77	73	77	79	[illegible]	[illegible]	[illegible]	[illegible]	86	89	91
Office - Small <50K sq. ft. - CHP	128	127	129	118	124	122	120	115	122	124	1	[illegible]	[illegible]	[illegible]	136	140	143
Office - Small <50K sq. ft. - CMD	201	199	203	185	195	191	189	181	191	195	199	213	205	211	213	219	225
Office - Small <50K sq. ft. - DMV	30	30	30	28	29	29	28	27	29	29	30	32	31	32	32	33	34
Office - Small <50K sq. ft. - EDD	162	160	164	149	157	154	152	146	154	157	160	172	165	170	172	177	181
Office - Small <50K sq. ft. - Others	132	131	133	121	128	125	124	119	125	128	131	140	135	139	140	144	148
Other - Maintenance DOT/DWR	114	113	115	105	111	108	107	103	108	111	113	121	116	120	121	124	128
Other - Caltrans TMC	71	70	72	65	69	67	67	64	67	69	70	75	72	75	75	77	80
Other - CDFA	567	561	573	522	550	539	533	510	539	550	561	601	578	595	601	618	635
	249	247	252	229	242	237	234	224	237	242	247	264	254	262	264	272	279

DGS Existing Building ZNE Readiness Worksheet



DGS Existing Building ZNE Readiness Worksheet

	A	L	AN	AR	AT	AX	BB	BC	BD	BE	BF	BG	BH	BI	BK
1	DGS Managed State-Owned Buildings		Current Year Energy Use (2016)												
2	Facility Name (from ESPM)	Building Area (sq.ft.) (Potential)	Electricity Purchased (kWh)	District Steam (pounds)	District Chilled Water (kBTU)	Natural Gas (Therms)	Current Year Calculated Source Energy Use (kBTU)	Target Source Energy Use to Achieve ZNE EUI Target (KBTU)	Energy Use Reduction Needed to Meet ZNE Source EUI Target (kBtu Source)	Renewable Energy Needed to Offset ZNE Targeted or Achieved Energy Use Whichever is Lower (kWh)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)	% EUI Reduction Needed	PV (kW) Req'd to Offset Energy Use for ZNE
3	001 State Capitol Building	482,250	7,077,445	23,540,603	55,549,000		134,007,983	62,962,560	71,045,423	5,858,181	278	131	147	53%	2,701
4	002 Jesse Unruh Building (OB 1 Building)	164,529	1,574,852	4,660,491	7,107,000		26,825,442	21,480,906	5,344,535	1,998,633	163	131	32	20%	921
5	003 Library-Courts Building	188,569	1,813,686	5,474,811	5,499,197		29,970,829	24,619,569	5,351,261	2,290,661	159	131	28	18%	1,056
6	004 Legislative Office	240,735	2,386,226	18,835,439	13,718,000	775	59,677,107	31,430,362	28,246,746	2,924,353	248	131	117	47%	1,348
7	006 Agriculture Building	127,010	909,916	3,348,747	11,714,000		19,561,957	16,582,426	2,979,532	1,542,867	154	131	23	15%	711
8	008 Energy Commission Building	142,378	1,447,272	2,893,482	2,262,000		20,832,208	18,588,872	2,243,336	1,729,551	146	131	16	11%	797
9	009 OBG CADA Building	48,139	561,024			2,100	6,258,697	5,597,603	661,094	520,814	130	116	14	11%	240
10	010 Dept. of Rehabilitation	163,350	1,277,449	3,039,102	4,105,000		19,971,147	21,326,976	-1,355,829	1,858,161	122	131	-8	-7%	857
11	011 Bateson Building	293,516	3,037,927	3,163,449	7,630,000		40,504,032	38,321,449	2,182,583	3,565,516	138	131	7	5%	1,644
12	012-INSECTORY/GREEN HOUSE	4,400	64,271			0	690,770	690,770	0	64,271	157	#N/A	---	#N/A	30
13	013 EDD Solar Building	236,000	2,725,521	1,986,490	8,908,000		35,887,808	30,812,160	5,075,648	2,866,834	152	131	22	14%	1,322
14	016 Paul Bonderson Building	131,486	2,084,507	4,055,196	4,936,000		30,513,245	17,166,812	13,346,433	1,597,240	232	131	102	44%	736
15	017 State Printing Plant	323,460	6,071,977			232,524	90,605,472	90,605,472	0	8,430,141	280	#N/A	---	#N/A	3,887
16	018 Resources Building	658,544	11,639,526	94,900,728	29,600,000		280,167,990	85,979,505	194,188,485	7,999,731	425	131	295	69%	3,688
17	021 State Personnel Building	84,400	581,418	2,463,977	1,931,000		10,744,767	11,019,264	-274,497	999,718	127	131	-3	-3%	461
18	025 EDD Building	479,300	6,408,618	12,457,738	17,700,000	0	94,815,616	62,577,408	32,238,208	5,822,346	198	131	67	34%	2,684
19	028 BOARD OF EQUALIZATION BUILDING	644,293	8,943,023			77,268	104,540,007	84,118,894	20,421,113	7,826,615	162	131	32	20%	3,608
20	030 ATTORNEY GENERAL BUILDING	367,301	4,907,817			78,857	61,343,615	47,954,819	13,388,796	4,461,826	167	131	36	22%	2,057
21	031 ATTORNEY GENERAL CHILD CARE CENTER	4,893	40,561			1,128	558,896	558,896	0	52,010	114	#N/A	---	#N/A	24

	A	BF	BG	BH	BI	BK	BL	BU	BV	BW	BX	BY	BZ	CA	CC	CD	CE	CF	CG
1	DGS Managed State-Owned Buildings							Zero Net Energy (ZNE)											
2	Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)	% EUI Reduction Needed	PV (kW) Req'd to Offset Energy Use for ZNE	Allocated SMUD SolarShares PV (KW)	Current On-site Generation (kW)	Proposed On-Site Generation (kW)	Proposed Generation Completion (Year)	Zero Net Energy Ready? (meet EE threshold)	ZNE Verified (w/12 months data)?	ZNE Under Design?	ZNE Planned by 2025, but not yet in Design?	ZNE Project Est. Completion Date	Planned off-site renewable purchases	Building Area ZNE Ready or Completed	ZNE Building Area In Design	ZNE Building Area Proposed Before 2025
33	084 FRANCHISE TAX BOARD COMPLEX BUILDINGS	152	131	22	14%	10,371	10,371	3,000		2017				Yes		Yes	0	0	1,851,786
34	091 BLUE ANCHOR BUILDING	112	131	-19	-17%	119	119				Yes					Yes	24,900	0	0
35	095 Central Plant	5,122	#N/A	---	#N/A	15,379					Yes					Yes	70,000	0	0
36	120 R Street Warehouse	20	38	-18	-87%	33	33				Yes					Yes	38,530	0	0
37	106 STATE RECORD CENTER and WHSE	37	38	-1	-2%	189					Yes						82,682	0	0
38	153 Cal Trans District Office 3	119	136	-17	-14%	1,664			800	2018	Yes						225,378	0	0
39	330 California Towers (Riverside State B	121	127	-6	-5%	1,230					Yes						164,260	0	0
40	402 San Francisco Civic Center Building	118	118	0	0%	7,707					Yes						1,055,105	0	0
41	418 Public Utilities Commission Building	113	118	-5	-4%	2,037					Yes						290,525	0	0
42	460 REDDING STATE BUILDING	155	121	34	22%	183											0	0	0
43	461 RED BLUFF STATE BUILDING	171	121	50	29%	210											0	0	0
44	470 San Jose State Building	186	124	61	33%	826											0	0	0
45	480 Santa Rosa State Building	99	129	-31	-31%	596					Yes						97,377	0	0
46	509 Ronald Reagan State Building	158	124	34	21%	6,064											0	0	0
47	512 Junipero Serra (Broadway State Build	122	124	-2	-1%	3,941					Yes						519,101	0	0
48	520 Santa Ana State Building	160	122	39	24%	981											0	0	0
49	530 Van Nuys State Building	139	124	15	11%	1,136								Yes			0	0	147,495
50	602 Elihu Harris Building (Oakland Building)	112	118	-5	-5%	5,290					Yes						758,583	0	0
51	701 Fresno State Building	99	134	-35	-36%	1,142					Yes						185,937	0	0
52	753 Fresno Water Resources Building	146	120	26	18%	263											0	0	0
53	801 San Diego State Building	61	115	-54	-88%	651					Yes						171,700	0	0
54	803 SAN DIEGO STATE GARAGE	6	#N/A	---	#N/A	4											0	0	0
55	850 Mission Valley Building	107	115	-9	-8%	1,601					Yes						242,315	0	0
56	860-Cal-Trans-District 11	118	115	2	2%	2,088			1,000	2019				Yes			0	0	292,148
57	901 STOCKTON STATE BUILDING	141	131	10	7%	509								Yes			0	0	62,850
58	O Street Project (Future in planning)	68	131	-62	-92%	966	966						Yes		2021		0	330,402	0
59	P Street Project (Future in planning)	68	131	-63	-93%	2,341	2,341		400	2021			Yes		2021		0	807,700	0
62	**TOTALS for 55 BUILDINGS/PROPERTIES** excludes district energy provided by Sacramento Central Plant, since that is counted at Plant	183 avg.	---	---		**95,187**	**56,874**	**3,000**	**4,100**		16	0	2	12		0	4,174,143	1,138,102	4,341,209
63	ESTIMATED TOTALS FOR 57 CURRENT OR PLANNED BUILDINGS/PROPERTIES by 2025					98,494	60,181	3,000	4,500		30						9,653,454		
64	**Bright Green facilities already meet ZNE EUI Targets**											Existing Building area ZNE Ready					26%		
66	**Light Green highlighted facilities within 15% of EUI**											Existing Building area targeted by 2025					27%		
67	**Purple highlighted facilities under design**											Projected ZNE by 2025 including new bldg					60%		

State of California ZNE Calculator

- For New or Existing Buildings
  - Includes instruction sheet
  - Includes Existing Building Energy Efficiency Targets
  - Includes zip code reference

https://www.documents.dgs.ca.gov/os/ZNE/StateofCAZeroNetEnergyCalculator.xlsx

State of California Zero Net Energy Calculator

CDPH Building P - Richmond 9/28/2017

National Average Source Energy Conversion Factors	
Energy Form	Source Energy Conversion Factor (r)
Imported Electricity	3.15
Exported Renewable Electricity	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04

Energy Conversion Factors - Site Energy	
kBtu/kWh (Electricity)	3.412
kBtu/Therm (Natural Gas)	100
kBtu/Gal (Propane)	91.5
kBtu/pound (Steam)	1.04
kBtu/MBtu (Hot Water)	1000
kBtu/MBtu (Chilled Water)	1000

PV Assumptions		
Site Annual kWh per Installed kW	1,500	This may vary, higher output better*

State Building Results - Enter 12 months actual or estimated data (in outlined green boxes below)		
Building Area (sq. ft.)	205,153	sq. ft.
Total Electricity Consumed	1,432,411	kWh (can exclude EV charging here or below)
Total Natural Gas Consumed	17,724	Therms**
Total Propane Consumed	0	Gallons
Total Steam Consumed	0	Pounds
Total Hot Water Consumed	0	MBtu
Total Chilled Water Consumed	0	MBtu
Total Energy for Zero Emission Vehicle Charging	0	kWh (if included in total electricity consumed above)
Total Source Energy Consumed	17,327,183	kBtu Source
EUI (Source)	84	kBtu/sq. ft. (source)***
ZNE Source PV Required to Offset Natural Gas	110	kW
ZNE Total Source PV Required	1,075	kW
Total Electricity Generated On-Site (kWh)	1,760,000	kWh (est.)
Total Source Energy Generated On-Site (kBTU)	18,916,128	kBtu Source
ZNE Source Overgeneration	9%	****

* Typical fixed PV's in CA range from 1,500-1,800 kWh/kW (Tracking PV's ~2,200 kWh/kW)
** Do not include CNG vehicle fueling
*** See ref Source EUI for Exist. Bldgs tab for ZNE energy efficiency targets for existing buildings
**** Any negative value for over-generation indicates Zero Net Energy

DGS CALIFORNIA DEPARTMENT OF GENERAL SERVICES

CA ZNE Techi

ZNE References and Webpage

http://www.dgs.ca.gov/dgs/Sustainability/ZeroNetEnergy.aspx

Dan Burgoyne
Department of General Services
Daniel.Burgoyne@dgs.ca.gov
(916) 376-5010
http://www.dgs.ca.gov/dgs/Sustainability.aspx

DGS CALIFORNIA DEPARTMENT OF GENERAL SERVICES

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Existing Building Evaluation Process

Ralph DiNola, CEO, NBI
Webly Bowles, Project Manager, NBI

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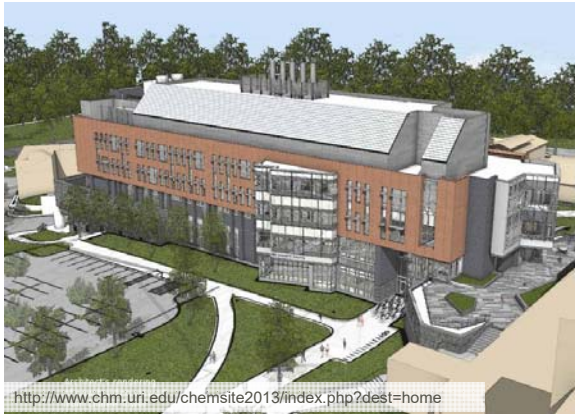
New Construction vs Existing Buildings



http://www.chm.uri.edu/chemsite2013/index.php?dest=home

https://en.wikipedia.org/wiki/University_of_Rhode_Island

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New Construction vs Existing Buildings


http://www.chm.uri.edu/chemsite2013/index.php?dest=home

New Construction:
Design decisions shape the building

https://en.wikipedia.org/wiki/University_of_Rhode_Island

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New Construction vs Existing Buildings

Existing Buildings:
The building shapes the design decisions

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https://en.wikipedia.org/wiki/University_of_Rhode_Island

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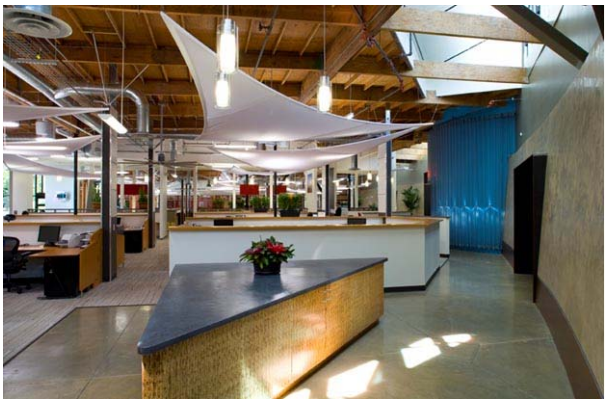
The 99%...Getting Existing Buildings to Zero

- 99% of the building stock already in place.
- New construction adds a little more than 1% to 2% the building stock annually.
- **25% of ZNE projects we are tracking are retrofits.**



DPR Construction ZNE Offices| San Diego
Photo: David Hewitt

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U.S. Existing Building Statistics

- 5.5 million commercial buildings
  = 87 billion sf

- ~75% are 10,000 sf or smaller
- ~50% are 5,000 sf or smaller
- ~2% are over 100,000 sf
  = 35% of floor area

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Retrofit Scopes

Retrofit

vs

Deep Retrofit

vs

Major Renovation

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Retrofit

- Building-System Focus
- Upgrade or Replacement
- Examples:
  - HVAC replacement or upgrade
  - Lamp or luminaire replacement
  - Controls upgrade: HVAC, lighting, etc.
  - Weatherization
  - Window replacement
  - Insulation retrofit

http://www.coacair.com/work/gallery-sacramento.php

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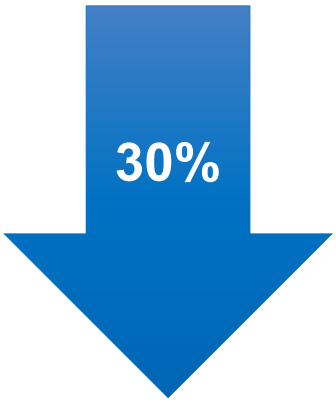
Deep Retrofit



newbuildings.org/resource/joseph-vance-building-case-study/

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Deep Retrofit

That <u>Usually</u> Means:

- Impacting Multiple Systems
- Some Full Equipment Replacement
- Retro-Commissioning
- Infiltration Reduction
- Controls Upgrades

newbuildings.org/resource/joseph-vance-building-case-study/

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Major Renovation

- Significant changes to building architecture and building systems
- Drivers:
  - End of service life for multiple building components
  - Market repositioning
  - Market/Architectural obsolescence/deficiencies
  - Change in Ownership
  - Change in Use

Edith Green-Wendell Wyatt Building

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Major Renovation & DER

Retrofit

Deep Retrofit

Major Renovation

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DGS Decision Making Matrix

State Owned Existing Building

1. Assess energy efficiency against ZNE target EUI
2. Determine which buildings in portfolio to be ZNE
3. Determine energy efficiency projects
4. Evaluate facility rooftops for onsite renewables
5. Consider EV if overcharging in necessary

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Assess Performance

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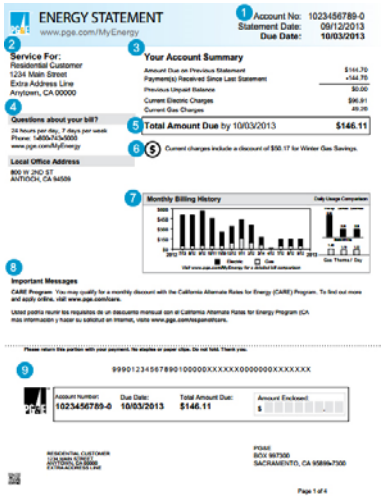
Benchmarking

- Required by SAM 1815.4
- Collect energy consumption
  - 2-3 years
- Energy use intensity - Btu/SF/yr (EUI)
- Tools:
  - ENERGY STAR Portfolio Manager
  - Excel

$$\frac{\text{Annual Energy Use}}{\text{Square Footage}} = \text{Energy Use Intensity}$$



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Benchmarking

Santa Rosa State Building
Credit: http://www.pressdemocrat.com

EUI = 186

Good?

Bad?

Ugly?

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Assess: Portfolio-Wide

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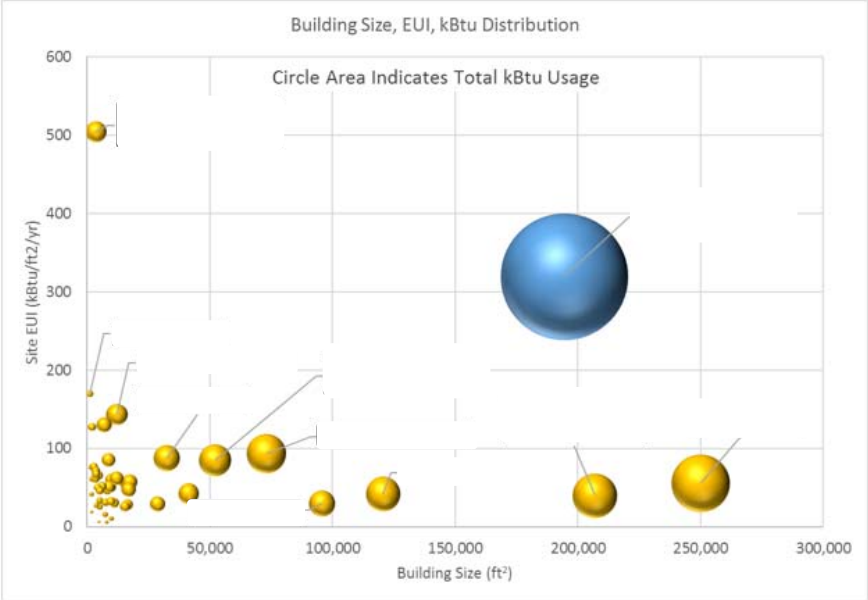
DGS Managed State-Owned Buildings	Current Year Energy Use (2016)													Zero Net Energy (ZNE)				
Facility Name (from ESPM)	Electricity Purchased (kWh)	ct Steam (po	District Chilled Water (kBTU)	Natural Gas (Therms)	Current Year Calculated Source Energy Use (kBTU)	Target Source Energy Use to Achieve ZNE EUI Target (KBTU)	Energy Use Reduction Needed to Meet ZNE Source EUI Target (kBtu Source)	Renewable Energy Needed to Offset ZNE Targeted or Achieved Energy Use Whichever is Lower (kWh)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reductio n Needed (to meet ZNE EE)	PV (kW) Req'd to Offset Energy Use for ZNE	Allocated SMUD SolarShares PV (KW)	Current On-site Generat ion (kW)	Proposed On-Site Generation (kW)	Proposed Generation Completion (Year)	Zero Net Energy Ready? (meet EE thresho ld)	ZNE Verifi d (w/12 month data)
016 Paul Bonderson Building	2,084,507	4,055,196	4,936,000		30,513,245	17,166,812	13,346,433	1,597,240	232	131	102	736	736				-	
017 State Printing Plant	6,071,977			232,524	90,605,472	90,605,472	0	8,430,141	280	#N/A	---	3,887	3,887					
018 Resources Building	11,639,526	94,900,728	29,600,000		280,167,990	85,979,505	194,188,485	7,999,731	425	131	295	3,688	3,688					
021 State Personnel Building	581,418	2,463,977	1,931,000		10,744,767	11,019,264	-274,497	999,718	127	131	-3	461	461				Yes	
025 EDD Building	6,408,618	12,457,738	17,700,000	0	94,815,616	62,577,408	32,238,208	5,822,346	198	131	67	2,684	2,684					
028 BOARD OF EQUALIZATION BUILDING	8,943,023			77,268	104,540,007	84,118,894	20,421,113	7,826,615	162	131	32	3,608	3,608					
030 ATTORNEY GENERAL BUILDING	4,907,817			78,857	61,343,615	47,954,819	13,388,796	4,461,826	167	131	36	2,057	2,057					
031 ATTORNEY GENERAL CHILD CARE CENTER	40,561			1,129	558,996	558,996	0	52,010	114	#N/A	---	24	24					
036 SECRETARY OF STATE BUILDING (EAST-WEST)	7,881,616	15,132,600	17,053,000	3,674	114,819,894	60,079,795	54,740,099	5,589,962	250	131	119	2,577	2,577					
038 LIBRARY and COURTS II ANNEX BUILDING	1,463,312		179,000	595	15,864,536	15,014,400	850,136	1,396,974	138	131	7	644	644					
039 and 045 Office Building 8 and Office Building 9	5,549,341	14,674,565	7,796,000	2,026	85,142,845	82,068,972	3,073,874	7,635,886	135	131	5	3,520	3,520					
049 EDUCATION BUILDING (EAST END #225)	4,749,020			40,626	55,394,464	51,740,275	3,654,189	4,814,034	140	131	9	2,219	2,219					
050 LEGISLATIVE GARAGE - LOT 50	216,351				2,325,301	2,325,301	0	216,351	10	#N/A	---	100	100					
051 THRU 054 EAST END COMPLEX	15,322,925			215,921	188,223,161	141,472,205	46,750,956	13,162,899	174	131	43	6,069	6,069					
057 CalNet Bldg	821,708				8,831,554	1,116,288	7,715,266	103,862	920	116	804	48	48					
074 SACRAMENTO STATE GARAGE FLEET LOT 2	341,813			237	3,699,523	3,699,523	0	344,212	13	#N/A	---	159	159					
075 DEPARTMENT OF JUSTICE BUILDING	8,714,946			50,262	99,145,087	46,225,812	52,919,275	4,300,956	280	131	149	1,983	1,983		2,300	2018		
076 ARCHIVES PARKING SITE ? FLEET LOT 55	338,322			715	3,714,149	3,714,149	0	345,573	21	#N/A	---	159	159					
078 BLOCK 224 PARKING FACILITY - LOT 14	213,682				2,296,608	2,296,608	0	213,682	9	#N/A	---	99	99					
084 FRANCHISE TAX BOARD COMPLEX BUILDINGS	24,955,118			127,151	282,072,035	241,769,180	40,302,855	22,494,760	152	131	22	10,371	10,371	3,000		2017		
091 BLUE ANCHOR BUILDING	211,911			4,625	2,781,708	3,250,944	-469,236	258,817	112	131	-19	119	119				Yes	
095 Central Plant	12,104,608			2,095,668	358,525,735	358,525,735	0	33,358,058	5,122	#N/A	---	15,379					Yes	
120 R Street Warehouse	71,771			71	779,142	1,454,122	-674,980	72,493	20	38	-18	33	33				Yes	
106 STATE RECORD CENTER and WHSE	175,767			10,648	3,049,694	3,120,419	-70,724	283,751	37	38	-1	189					Yes	
153 Cal Trans District Office 3	2,361,960			13,249	26,830,008	30,579,287	-3,749,279	2,496,326	119	136	-17	1,664			800	2018	Yes	
330 California Towers (Riverside State B	1,717,724			12,543	19,828,922	20,815,027	-986,106	1,844,928	121	127	-6	1,230					Yes	
402 San Francisco Civic Center Building	10,063,708	10,876,702		1,232	124,699,033	124,249,165	449,868	11,560,428	118	118	0	7,707					Yes	
418 Public Utilities Commission Building	2,663,908			38,678	32,847,090	34,212,224	-1,365,134	3,056,169	113	118	-5	2,037					Yes	
460 REDDING STATE BUILDING	306,230			4,472	3,778,772	2,950,429	828,342	274,515	155	121	34	183						
461 RED BLUFF STATE BUILDING	389,000			5,505	4,780,955	3,383,520	1,397,435	314,810	171	121	50	210						
470 San Jose State Building	1,449,410			39,719	19,907,372	13,323,113	6,584,259	1,239,613	186	124	61	826						
480 Santa Rosa State Building	763,478			12,825	9,603,620	12,588,899	-2,985,278	893,543	99	129	-31	596					Yes	
509 Ronald Reagan State Building	10,373,240			116,516	124,189,742	97,764,081	26,425,661	9,096,195	158	124	34	6,064						



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Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)
074 SACRAMENTO STATE GARAGE FLEET LOT 2	13	#N/A	---
120 R Street Warehouse	20	38	-18
106 STATE RECORD CENTER and WHSE	37	38	-1
153 Cal Trans District Office 3	119	136	-17
330 California Towers (Riverside State B	121	127	-6
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16
509 Ronald Reagan State Building	158	124	34
520 Santa Ana State Building	160	122	39
028 BOARD OF EQUALIZATION BUILDING	162	131	32
051 THRU 054 EAST END COMPLEX	174	131	43
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149
017 State Printing Plant	280	#N/A	---
018 Resources Building	425	131	295
057 CalNet Bldg	920	116	804
095 Central Plant	5,122	#N/A	---

Identify buildings for data quality check

Allocated SMUD SolarShares PV

Next steps:

- Verify data

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Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE E
074 SACRAMENTO STATE GARAGE FLEET LOT 2	13	#N/A	---
120 R Street Warehouse	20	38	-18
106 STATE RECORD CENTER and WHSE	37	38	-1
153 Cal Trans District Office 3	119	136	-17
330 California Towers (Riverside State B	121	127	-6
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16
509 Ronald Reagan State Building	158	124	34
520 Santa Ana State Building	160	122	39
028 BOARD OF EQUALIZATION BUILDING	162	131	32
051 THRU 054 EAST END COMPLEX	174	131	43
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149
017 State Printing Plant	280	#N/A	---
018 Resources Building	425	131	295
057 CalNet Bldg	920	116	804
095 Central Plant	5,122	#N/A	---

Identify exemplars for best practices

Allocated SMUD SolarShares PV

Next steps:

- Evaluate energy use
- Occupant education

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Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE E
074 SACRAMENTO STATE GARAGE FLEET LOT 2	13	#N/A	---
120 R Street Warehouse	20	38	-18
106 STATE RECORD CENTER and WHSE	37	38	-1
153 Cal Trans District Office 3	119	136	-17
330 California Towers (Riverside State B	121	127	-6
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16
509 Ronald Reagan State Building	158	124	34
520 Santa Ana State Building	160	122	39
028 BOARD OF EQUALIZATION BUILDING	162	131	32
051 THRU 054 EAST END COMPLEX	174	131	43
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149
017 State Printing Plant	280	#N/A	---
018 Resources Building	425	131	295
057 CalNet Bldg	920	116	804
095 Central Plant	5,122	#N/A	---

Identify buildings that are “almost there”

Next steps:

- Evaluate energy use
- Conduct onsite assessment

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Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE E
074 SACRAMENTO STATE GARAGE FLEET LOT 2	13	#N/A	---
120 R Street Warehouse	20	38	-18
106 STATE RECORD CENTER and WHSE	37	38	-1
153 Cal Trans District Office 3	119	136	-17
330 California Towers (Riverside State B	121	127	-6
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16
509 Ronald Reagan State Building	158	124	34
520 Santa Ana State Building	160	122	39
028 BOARD OF EQUALIZATION BUILDING	162	131	32
051 THRU 054 EAST END COMPLEX	174	131	43
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149
017 State Printing Plant	280	#N/A	---
018 Resources Building	425	131	295
057 CalNet Bldg	920	116	804
095 Central Plant	5,122	#N/A	---

Identify high EUI for deeper investigation

Next steps:

- Conduct deeper onsite assessment

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Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE E
074 SACRAMENTO STATE GARAGE FLEET LOT 2	13	#N/A	---
120 R Street Warehouse	20	38	-18
106 STATE RECORD CENTER and WHSE	37	38	-1
153 Cal Trans District Office 3	119	136	-17
330 California Towers (Riverside State B	121	127	-6
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16
509 Ronald Reagan State Building	158	124	34
520 Santa Ana State Building	160	122	39
028 BOARD OF EQUALIZATION BUILDING	162	131	32
051 THRU 054 EAST END COMPLEX	174	131	43
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149
017 State Printing Plant	280	#N/A	---
018 Resources Building	425	131	295
057 CalNet Bldg	920	116	804
095 Central Plant	5,122	#N/A	---

Consider process load evaluation

Next steps:

- Consult with industrial energy consultant

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Assessment

But WHY is the building performing like it is?

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Remote Assessment

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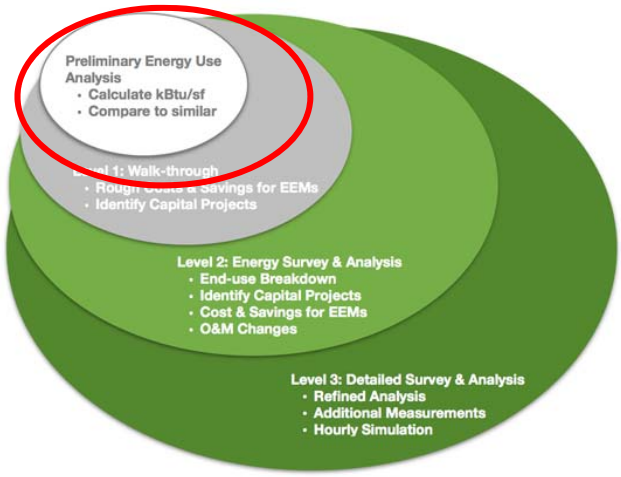
Assessment



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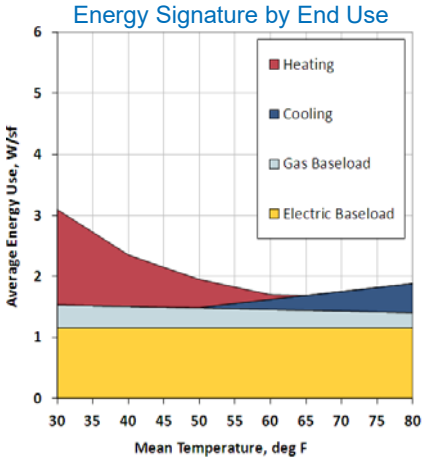
Remote Assessment with FirstView

- Inputs:
  - 1 year of monthly utility bills
    - All fuels – electric, gas, steam…
  - Building location, size, and type
- Outputs:
  - Heating profile
  - Cooling profile
  - Gas baseload (process, SHW)
  - Electric baseload (lights, plugs)



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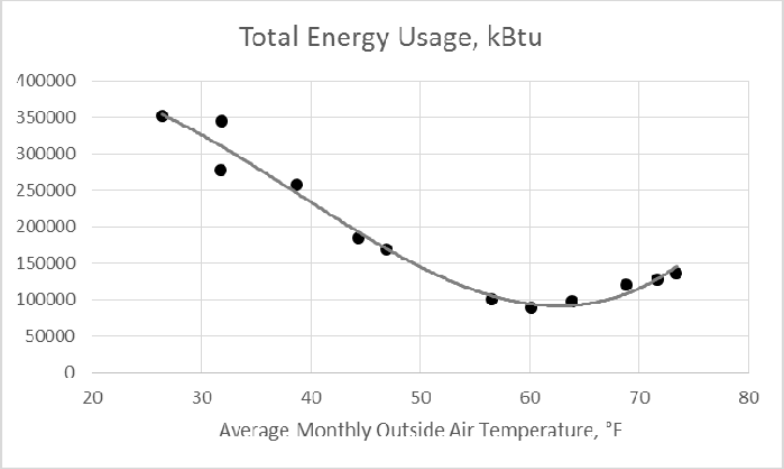
Energy Signatures - Total



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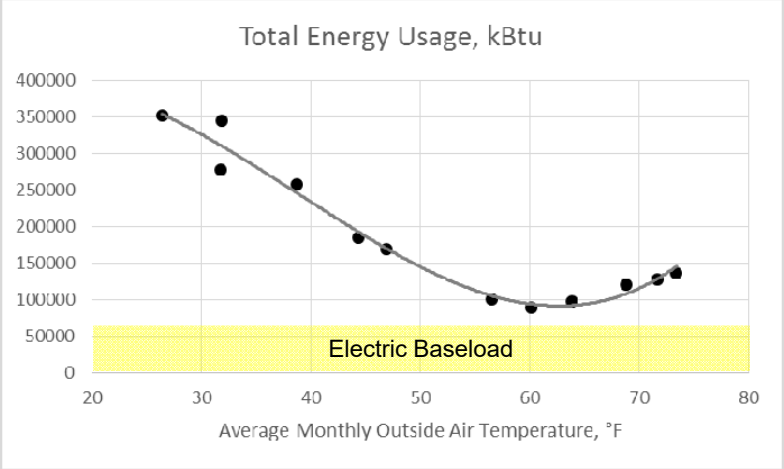
Energy Signatures - Total



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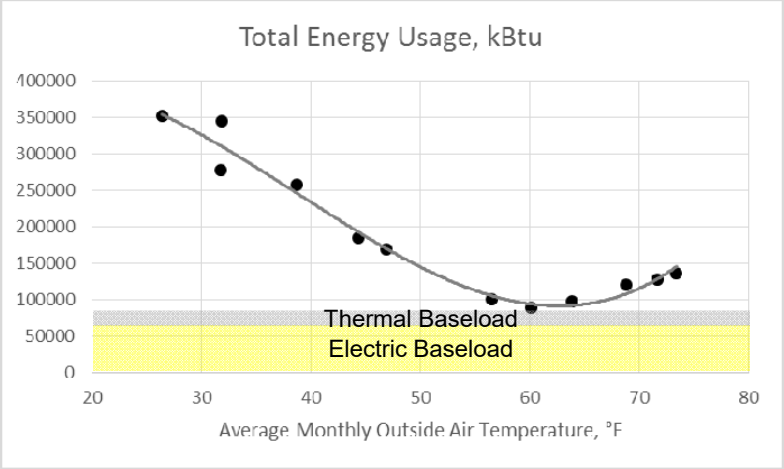
Energy Signatures - Total



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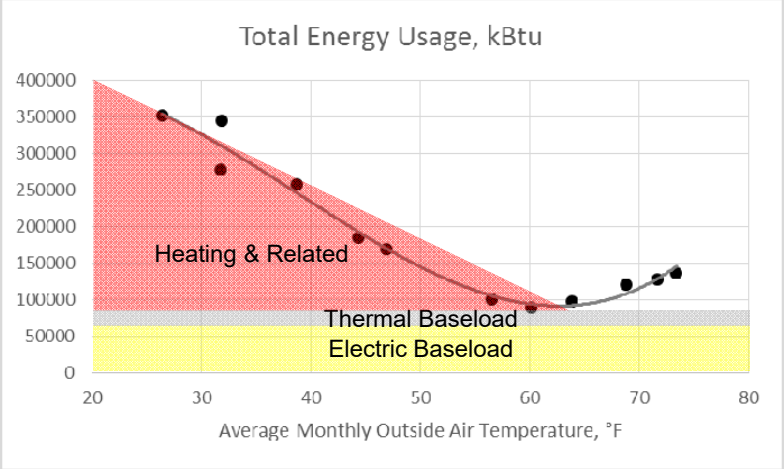

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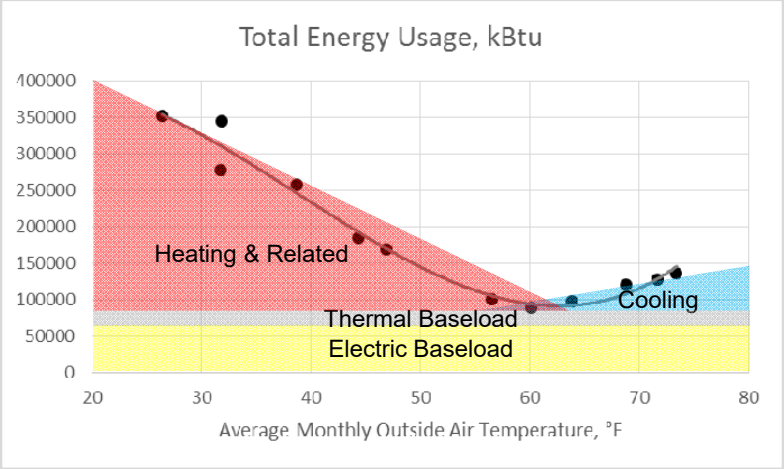
Energy Signatures - Total



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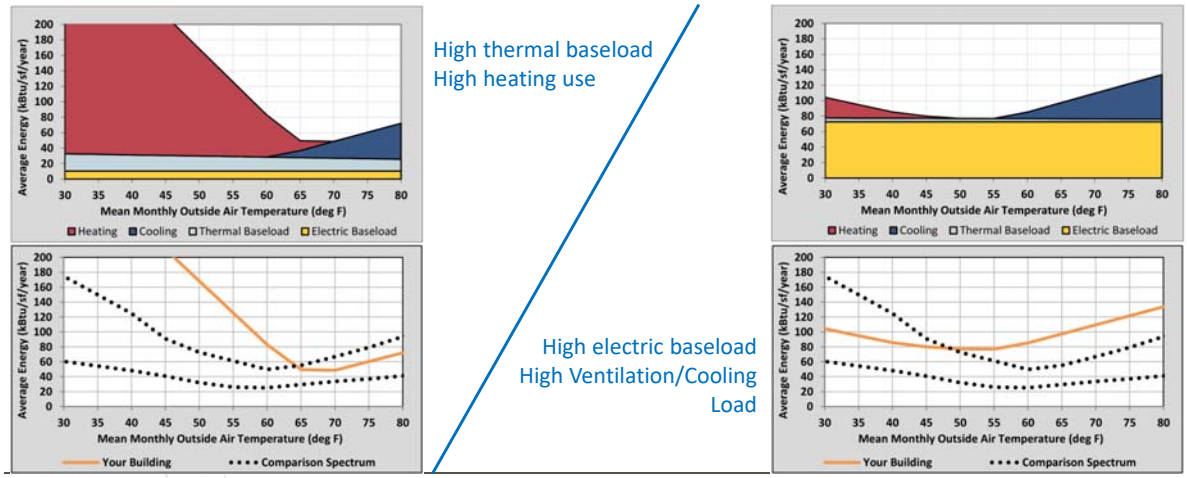
Remote Assessment with FirstView

Identify Top Candidates



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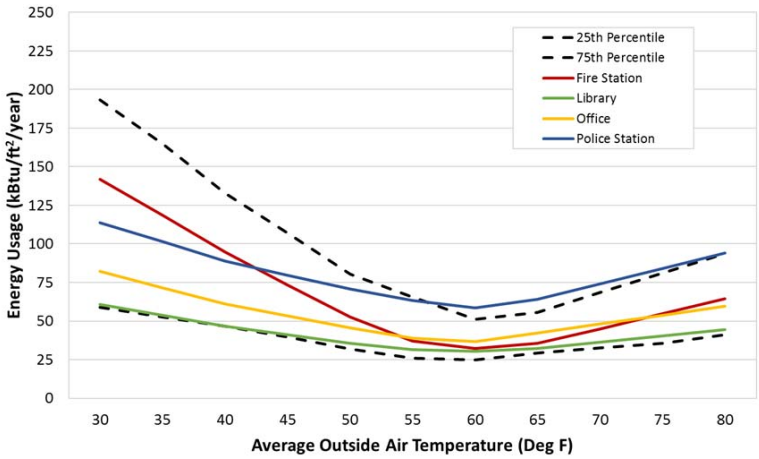
Energy Signatures and the Comparison Spectrum



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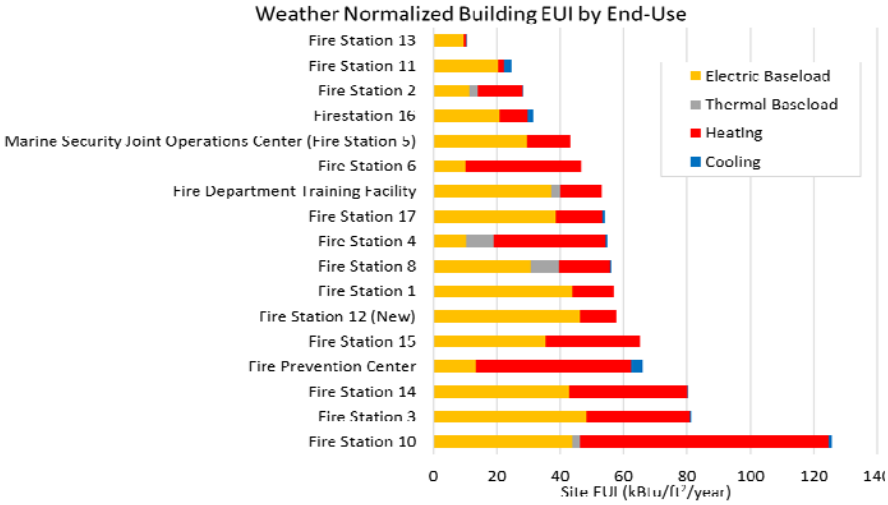
FirstView Portfolio Prioritization



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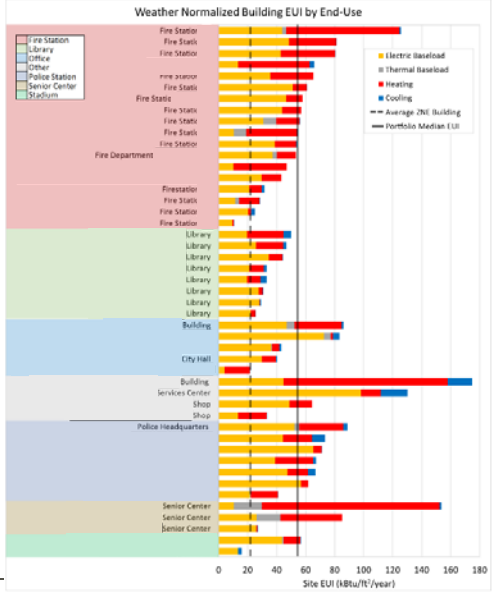
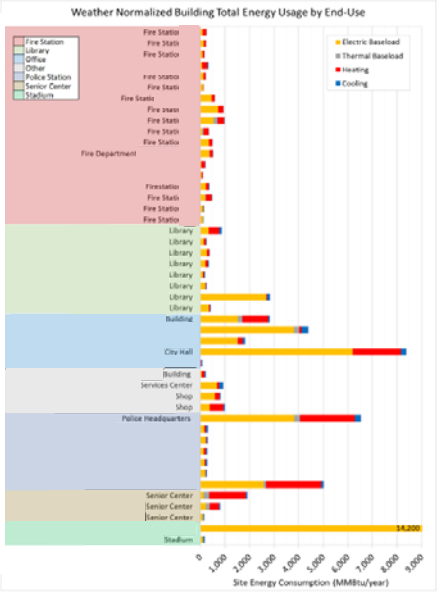
Building Energy Use Intensity (EUI) and Total Energy Usage by End-Use





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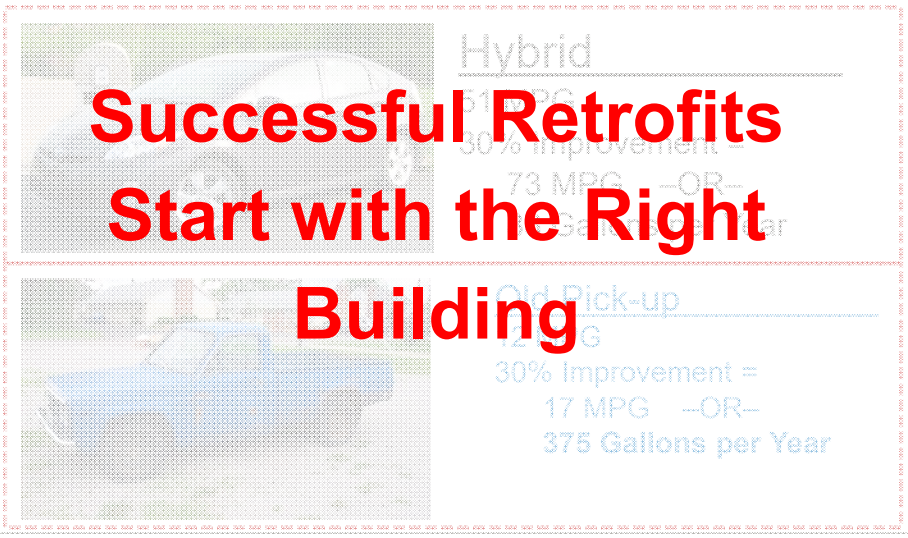
Prioritize the Opportunities



Successful Retrofits Start with the Right Building

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Assessment

- Target Individual Buildings for Assessment
  - **Physical:** Envelope, structural analysis, electrical
    - ID strengths and weaknesses in existing building systems
  - **Site analysis:** other site opportunities: temperature, wind, solar access
  - **Occupant interviews:** of facility managers and operators: ID known issues and possible solutions

Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149

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Assessment

FirstView Recommendations

- **Building 2**
  - Very energy intensive building, especially when compared to other senior centers.
  - High thermal baseload for this building – Savings in hot water usage likely.
  - The majority of the energy use goes towards heating – heating efficiency should be prioritized

Table 5: Top Candidates for Further Investigation (Retro-commissioning and Retrofit)

Building	Building Type	Size, ft^2	EUI, $kBtu/ft^2/yr$
Building 1	Office	32,500	86
Building 2	Senior Care Community	12,122	154
Building 3	Office	52,200	83
Building 4	Police Station	73,000	89

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Assessment

ASHRAE Energy Audits

What's involved with each level?

Type of Audit	Highlights
Level 1	Rapid Assessment of building energy systems
	Building energy benchmark
	High-level definition of energy system optimization opportunities
	Outline applicable incentive programs
Level 2	Detailed building survey of systems and operations
	Breakdown of energy source and end use
	Identification of energy-efficiency measures (EEMs) for each energy system
	Range of savings and costs for the EEMs
	Spotlight on operational discrepancies
	Outlining priorities for limited resources, next steps, and identification of EEMs requiring more thorough data collection and data analysis (Level 3)
Level 3	Longer-term data collection and analysis
	Whole-building computer simulation calibrated with field data
	Accurate modeling of EEMs and power/energy response
	Bid-level construction cost estimating
	Investment-grade, decision-making support

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Scope Development

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Establish the ZNE EUI Target

DGS Managed State-Owned Buildings				
Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)	CA Climate Zone (CZ)
330 California Towers (Riverside State B	121	127	-6	10
402 San Francisco Civic Center Building	118	118	0	3
418 Public Utilities Commission Building	113	118	-5	3
460 REDDING STATE BUILDING	155	121	34	11
461 RED BLUFF STATE BUILDING	171	121	50	11
470 San Jose State Building	186	124	61	4
480 Santa Rosa State Building	99	129	-31	2
509 Ronald Reagan State Building	158	124	34	9
512 Junipero Serra (Broadway State Build	122	124	-2	9
520 Santa Ana State Building	160	122	39	8
530 Van Nuys State Building	139	124	15	9

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Existing Buildings vs New Construction


https://en.wikipedia.org/wiki/University_of_Rhode_Island

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Matching Strengths & Weaknesses

Single Pane Window

No Insulation

Beaumont Middle School, Portland, OR

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Matching Strengths & Weaknesses

Natural Ventilation & Daylighting

Thermal Mass

Beaumont Middle School, Portland, OR

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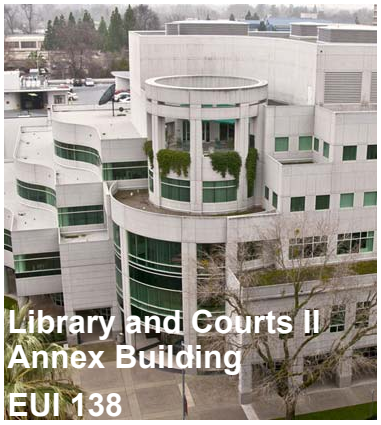
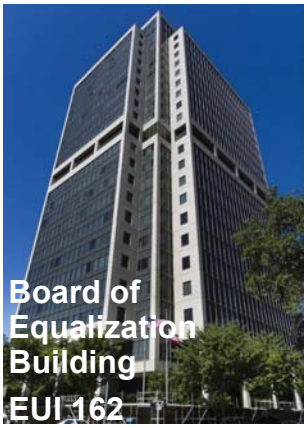
ZNE Retrofit Opportunities

Low intervention



Medium intervention



High intervention

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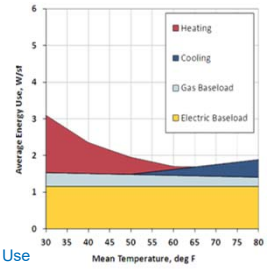
ZNE Retrofit Opportunities

Low intervention:

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

Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16



Energy Signature by End Use

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ZNE Retrofit Opportunities

Medium intervention:

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

Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)
038 LIBRARY and COURTS II ANNEX BUILDING	138	131	7
753 Fresno Water Resources Building	146	120	26
008 Energy Commission Building	146	131	16

Central High School, Little Rock, AR

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ZNE Retrofit Opportunities

High intervention:

- Onsite energy audit
- Systems commissioning
- HVAC system switching
- Envelope upgrade
- Window replacement
- Renewable energy system

Facility Name (from ESPM)	Current Year Source EUI (kBTU/sq. ft.)	EUI Target (to meet ZNE EE)	EUI Reduction Needed (to meet ZNE EE)
470 San Jose State Building	186	124	61
025 EDD Building	198	131	67
016 Paul Bonderson Building	232	131	102
001 State Capitol Building	278	131	147
075 DEPARTMENT OF JUSTICE BUILDING	280	131	149

The Banner Bank Building, Boise, ID

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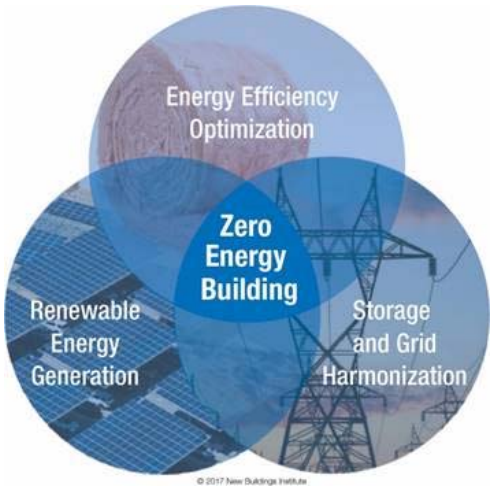
Complimentary Energy Elements



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Lifecycle Opportunities

Beaumont Middle School, Portland, OR

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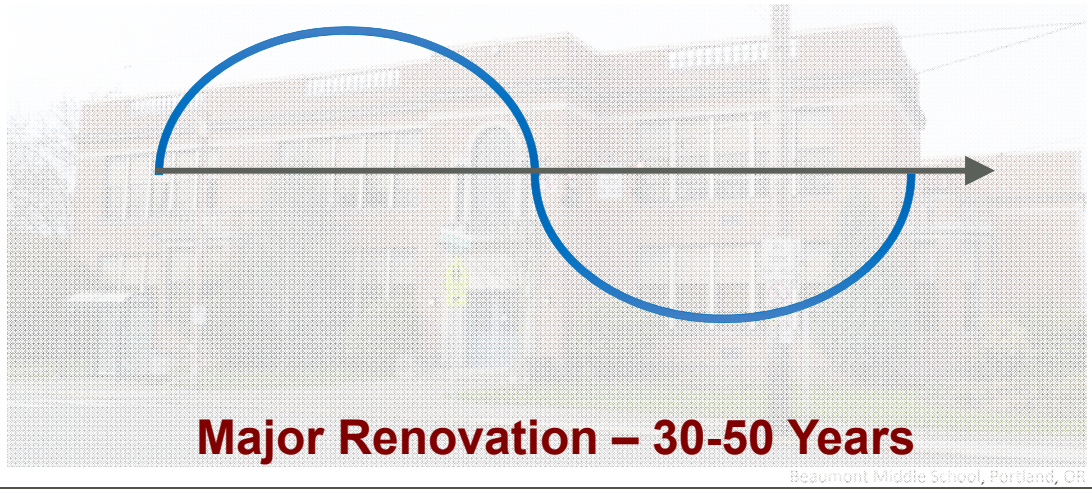
Lifecycle Opportunities



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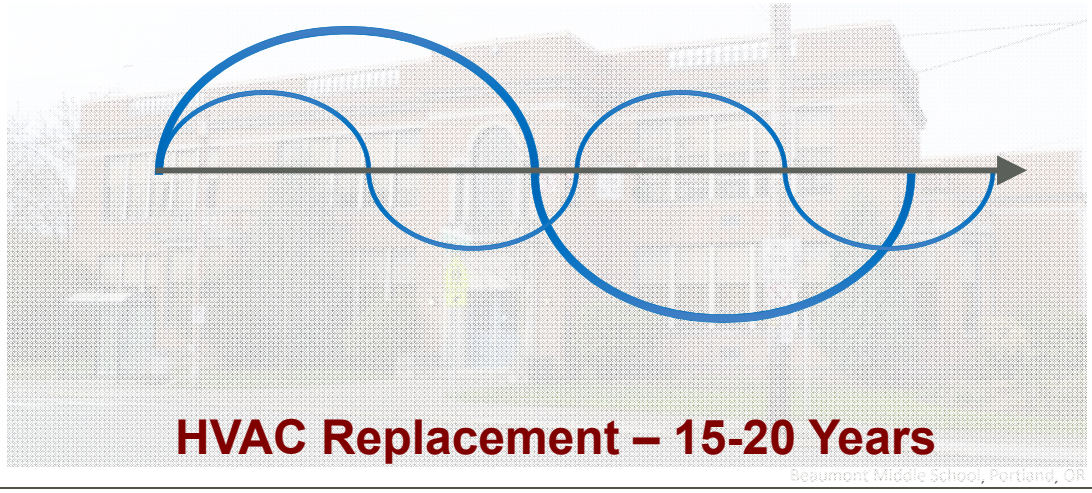
Lifecycle Opportunities



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Lifecycle Opportunities

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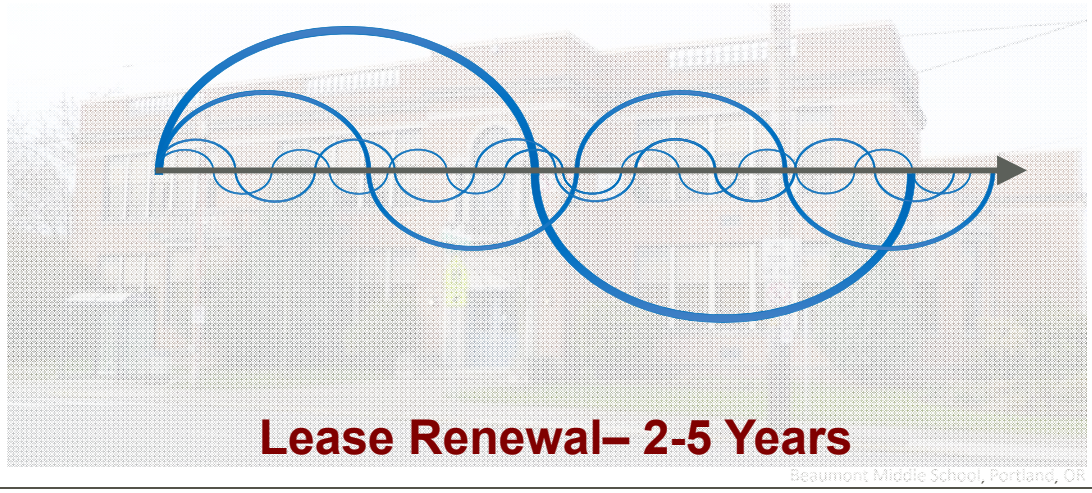
Lifecycle Opportunities



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Lifecycle Opportunities

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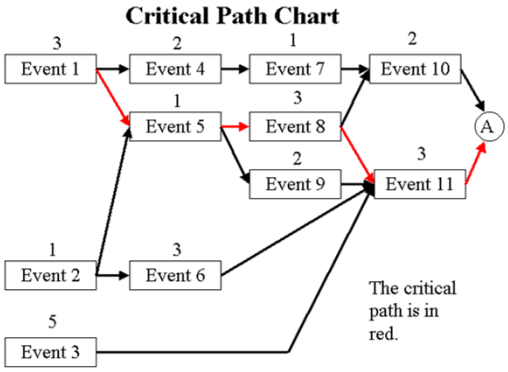
Phased Occupied Retrofits

- One-time project
  - Occupants may be disturbed or displaced
  - Work during nights and weekends
  - Realize anticipated savings
- Phased project
  - Upgrade measures independently
  - Occupants may remain
  - Fund in phases
  - Savings are accumulative



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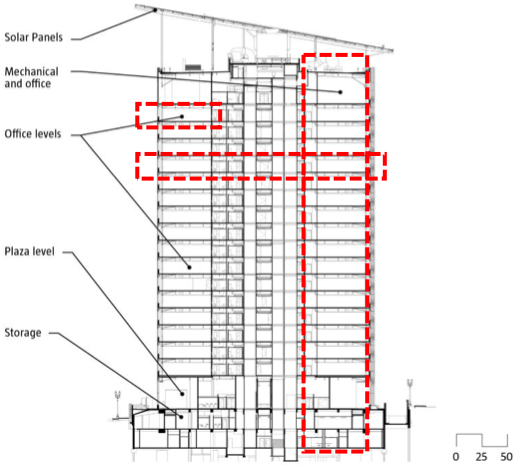
Phased Occupied Retrofits

- Phased projects
  - Create a plan and follow through
  - Upgrade with regular maintenance
  - Upgrade with equipment failure
- Phases by building portions
  - As tenants leave
  - By floor
  - By bay



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Leading in LA

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Leading in LA

Occupied Retrofit Challenges:

- Disruptive
- Diminishing cost effectiveness
- Customized solutions with high transaction cost

- Solution:
  - Low disruption retrofit
  - “Beyond Widgets” approach – integrated package
  - Technologies applicable to a wide stock of buildings

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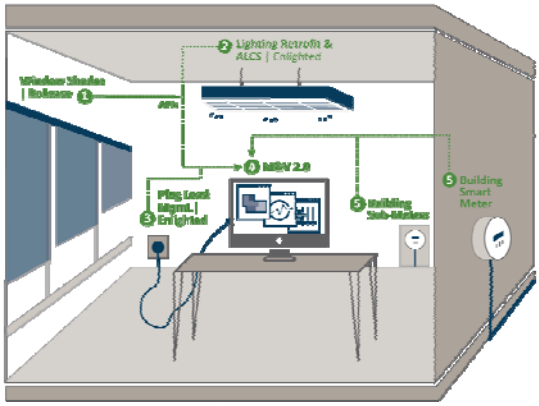
Leading in LA



- Scope:
  - Automated shades (Rollease Acmeda)
  - Advanced Lighting Controls (Enlighted)
  - Sensors Plug Load Mgmt. (Enlighted)
  - Sub-meters with M&V 2.0
  - HVAC Commissioning
- Whole Buildings savings 25-32%

Integrated New Technologies for Energy-efficient Retrofits (INTER)

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Leading in LA

Shading Innovation:

- Separation of daylight from view control
- 50% less cost – materials cost reduction and no electrician
- Tied to Building Mgmt. System with manual override
- Can be tied to low-light PVs that charge batteries so no energy use for shade

Figure 4: New Rollease Acmeda Illuminate™ Product

ROLLEASE ACMEDA

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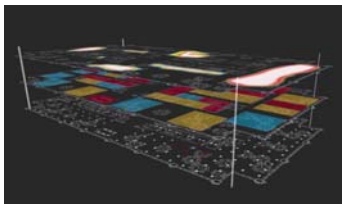
Leading in LA

Lighting and Plug Loads:

- Lighting Retrofit as a service
  - Comprehensive LED lighting retrofit
  - One point of contact for design – install - commissioning
- Advanced lighting & plug load controls
  - IoT architecture networks smart sensors
  - Luminaire-level occupancy and daylight sensing
  - Time-dependent scheduling
  - Occupancy based plug load controls
  - Integration with building automation system



enlighted

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Leading in LA

Whole Building Controls Measures:

- HVAC commissioning
  - Remove existing inefficiency
  - Ensure that HVAC system responds to reduced loads
- M&V 2.0
  - Real time M&V for operational optimization
  - Achieve savings persistence

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Leading in LA

- Aggregated Energy Savings Potential

	% of Energy Use	End Use Savings	Whole Building Energy Savings
Lighting	37%	71%	
Equip. + Misc.	21%	5%	
Cooling	20%	15%	
Ventilation	14%	7%	
All other Loads	8%		
Totals	100%		**32%**

Building energy use values from CEC Attachment 12 Energy Efficiency Data.xls for GFO 16-304

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Leading in LA

Energy Savings Potential Applicable to DGS Projects

- A 32% energy reduction would put nearly all DGS projects within ZNE range.

Facility Name (from ESPM)	Current Year Calculated Source Energy Use (kBTU)	Target Source Energy Use to Achieve ZNE EUI Target (KBTU)	Projected Source Energy Use with a 32% reduction	Within Range of ZNE?	Comments
001 State Capitol Building	134,007,983	62,962,560	91,125,429	No	
006 Agriculture Building	19,561,957	16,582,426	13,302,131	Yes	
008 Energy Commission Building	20,832,208	18,588,872	14,165,901	Yes	Targeted ZNE
010 Dept. of Rehabilitation	19,971,147	21,326,976	13,580,380	Yes	
011 Bateson Building	40,504,032	38,321,449	27,542,742	Yes	Targeted ZNE

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Resources

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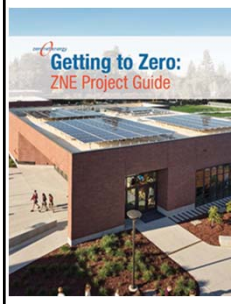
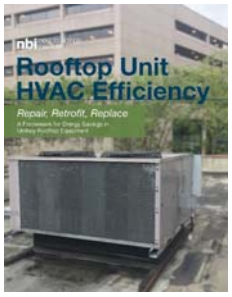
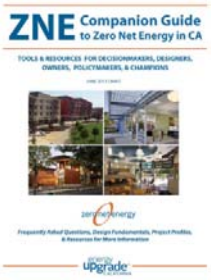
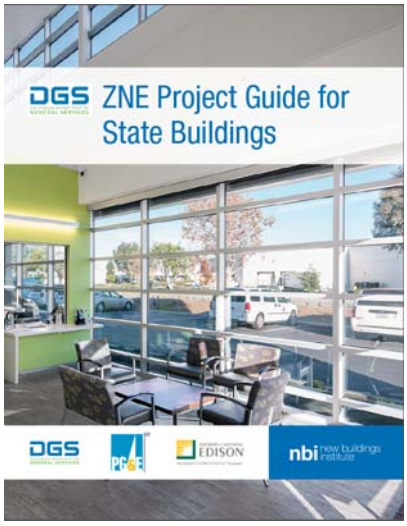
ZNE Tools & Resources







ZNE Project Guide



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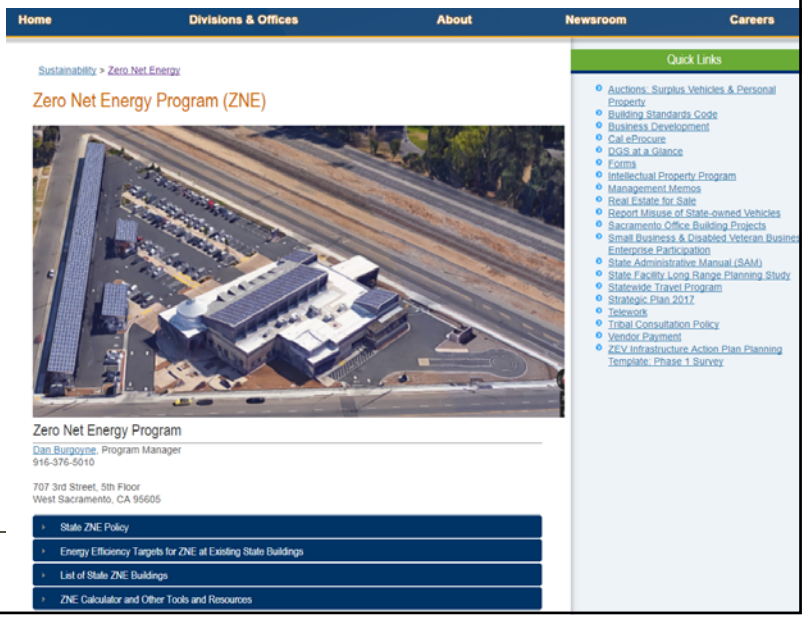
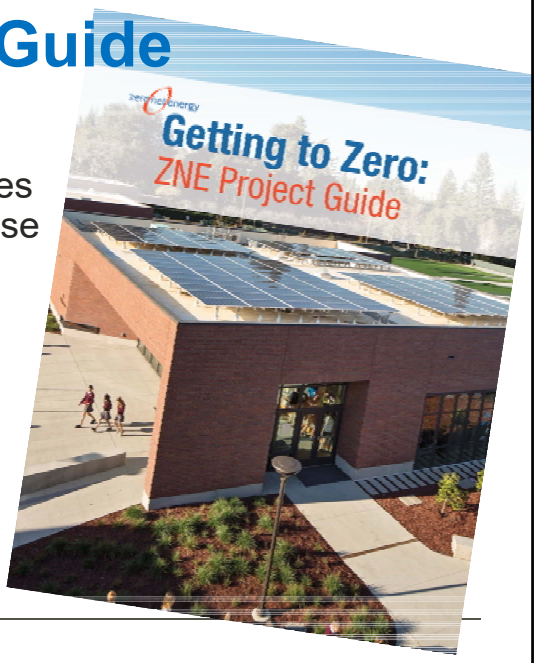


ZNE Project Guide

Getting to Zero: ZNE Project Guide outlines ZNE changes from traditional process those differences and provides a framework for planning any ZNE project.

- Resources
- Checklists
- Worksheets



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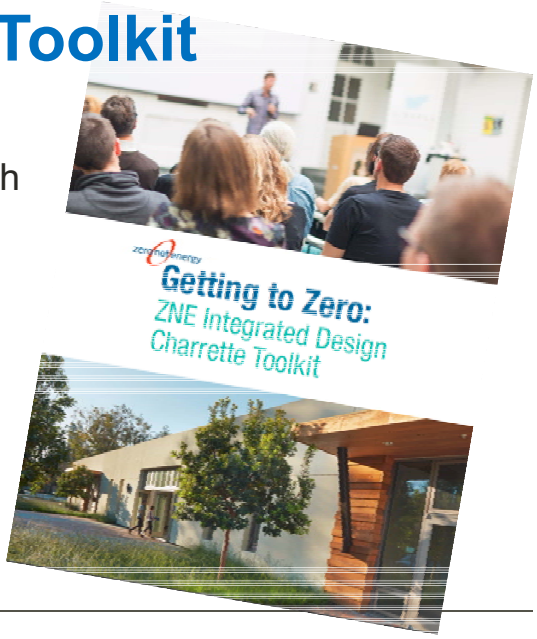
Charrette Toolkit

ZNE Charrette Toolkit provides you with materials to help plan and lead a successful charrette.

- Facilitator Guide
- Charrette Checklist
- Materials List
- Sample Agendas
- Presentation Template
- And more!



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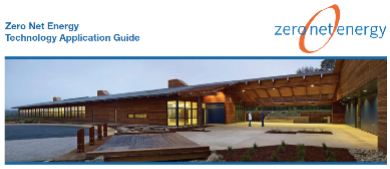
ZNE Technology Application Guides

LUMINAIRE LEVEL LIGHTING CONTROL

INDIRECT EVAPORATIVE COOLING



RADIANT HEATING AND COOLING + DEDICATED OUTDOOR AIR SYSTEMS

http://newbuildings.org/zero-energy

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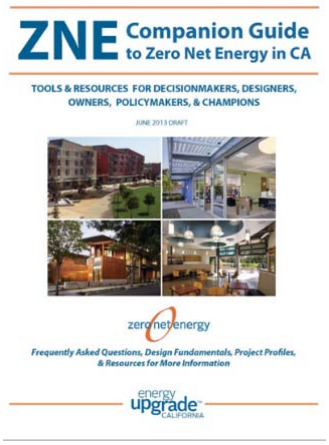
ZNE Communication Toolkit Contents

- Message Platform
  - Key target audience messages
- ZNE Companion Guide/Fact Sheets
  - General info, key audiences messages
- ZNE Action Bulletin
  - News, case studies, policy, research, events and trainings
- Case Studies
  - California project examples, including design strategies, planning, cost, and lessons learned
- Intro to ZNE Presentation
  - ZNE What, Why, and How



www.newbuildings.org/zne-communications-toolkit

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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

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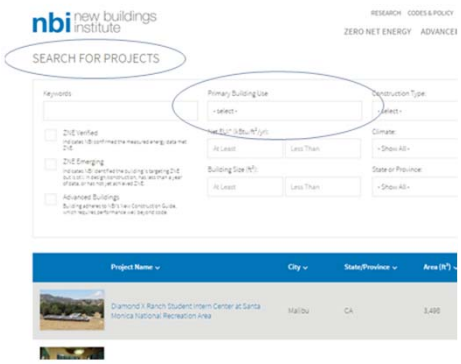
Getting to Zero Database

Look for Similar…
- Size
- Climate
- Use
- Shape
- Envelope
- Etc.



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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- 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

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Email webly@newbuildings.org to sign up

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GETTING TO zero NATIONAL FORUM 2018

April 17-19, 2018

Grand Wyndam | Pittsburgh

gettingtozeroforum.org

The premier global event dedicated to defining the future of low and zero energy buildings.

- Share perspectives on the growth of ZE
- Build knowledge on policies driving projects, and design and operation best practices
- Collaborate on opportunities for ZNE to transform the built environment

ROCKY MOUNTAIN INSTITUTE

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Break

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Existing Building ZNE Retrofit Case Study

Neil Bulger, Principal, Integral Group

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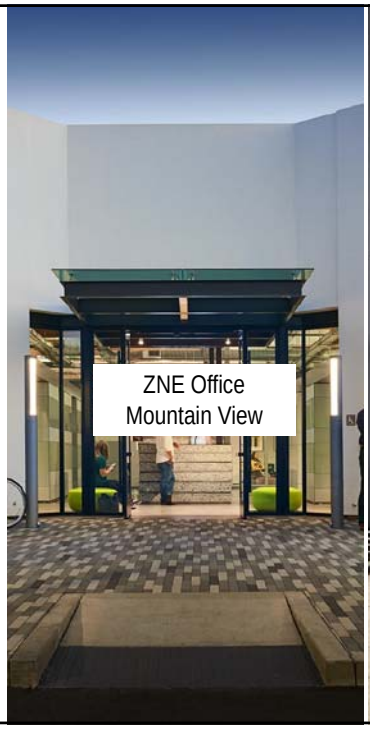
Net Zero at Scale
Technologies for deep Efficiency in Existing Buildings

10.30.2017

Neil Bulger, PE
Principal
427 13th Street
Oakland CA

INTEGRAL GROUP

Symposium on Zero Net Energy Buildings and Beyond: Balancing Building and Grid Objectives; October 25, 2017



ZNE Office
Mountain View

Single Story
Retrofit, Davis

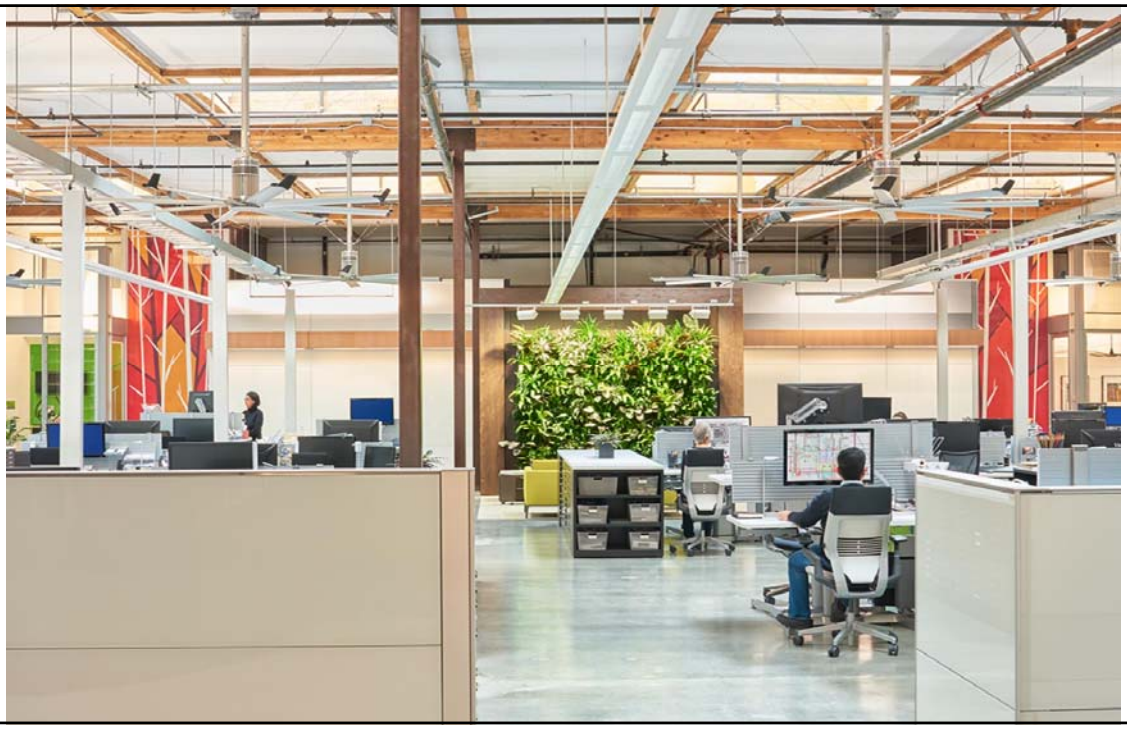
Opportunities for
Large Office Retrofits

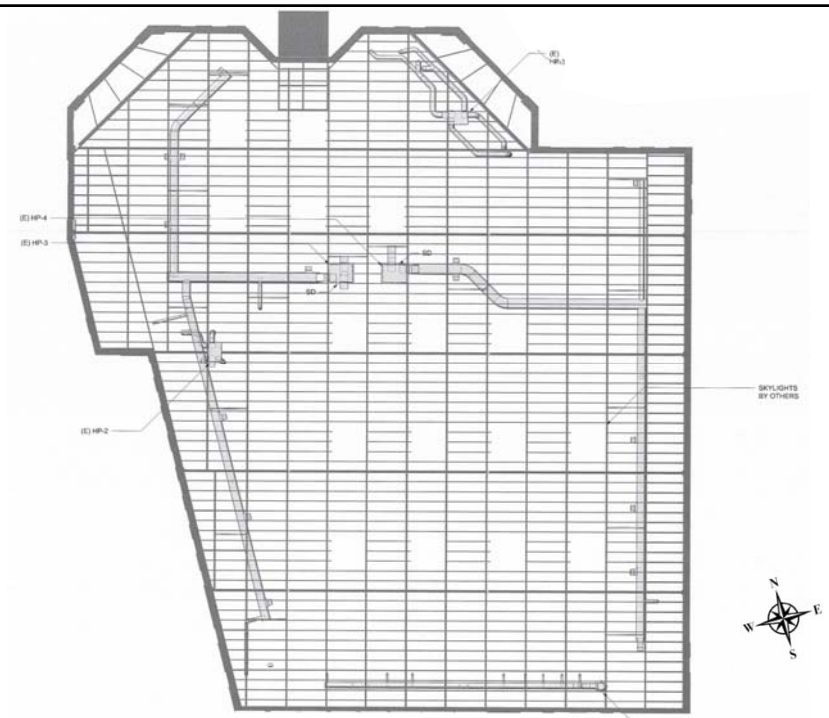
Center for the Built Environment

TRC

Taylor Engineering

SIZE: 14,800 SF
YEAR: 2015
TYPE: COMMERCIAL
POWER: NET ZERO ENERGY
RECYCLING: 92.5% OF ALL DEMO MATERIAL WAS RE-PURPOSED




(E) HP-4
(E) HP-3
(E) HP-2
SD
SD
SKYLIGHTS
BY OTHERS
N
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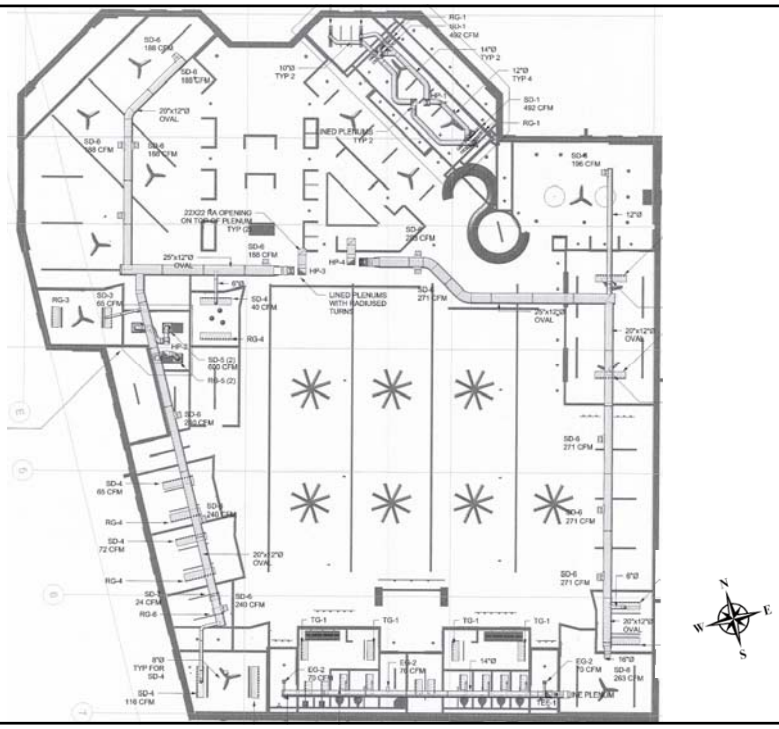

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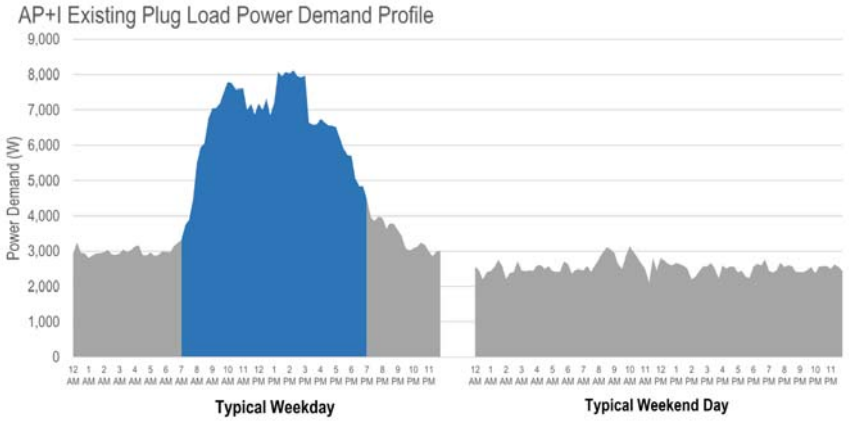
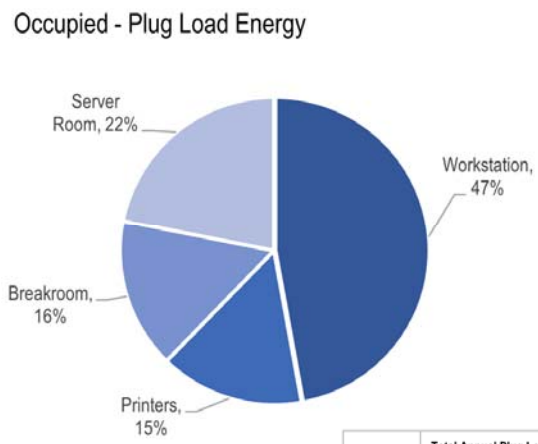
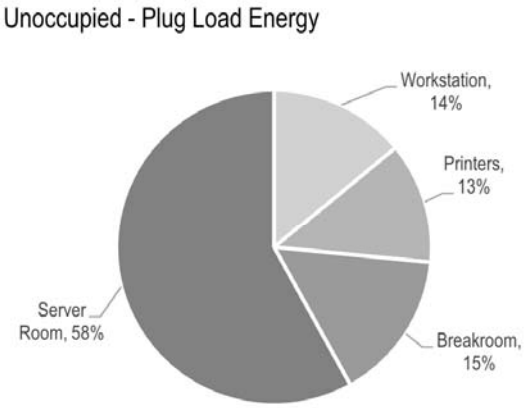


Figure 2 – Typical Day Demand Profiles





Category	Total Annual Plug Load Energy (kWh/yr)	Annual Unoccupied Plug Load Energy (kWh/yr)	% Total Plug Load Energy Unoccupied
Workstation	10,000	2,000	20%
Printers	4,000	2,000	50%
Breakroom	5,000	2,000	40%
Server Room	12,000	8,000	67%
Total	31,000	14,000	45%

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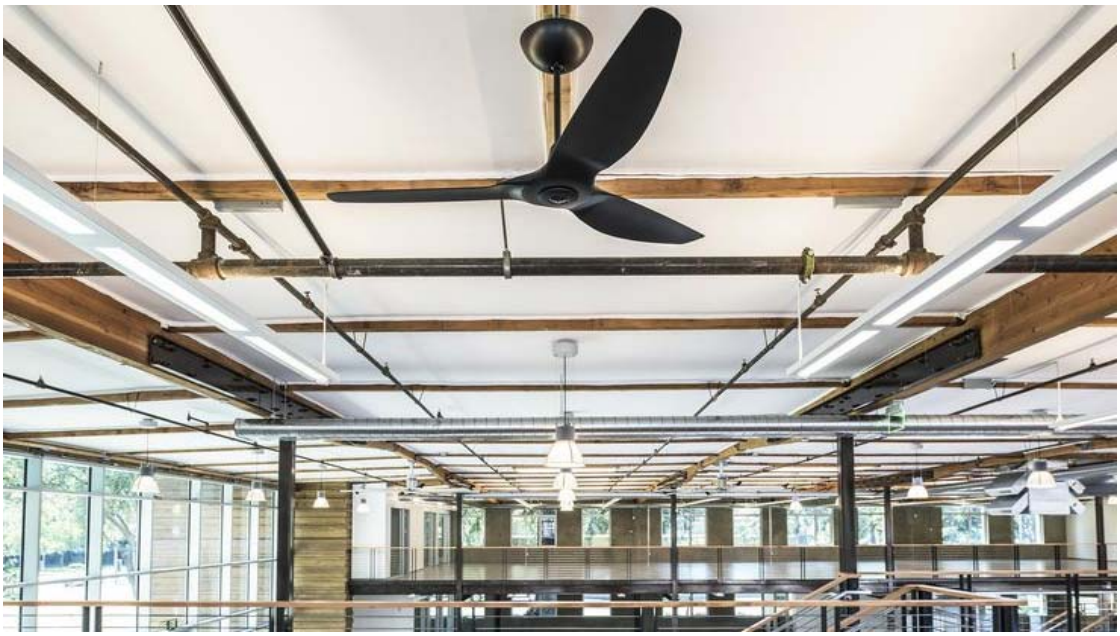

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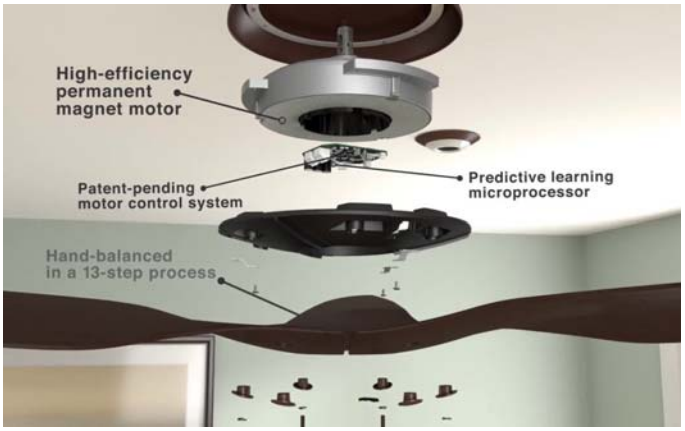
Thermal Comfort Fans: Haiku or Aeroton



Sense me technology

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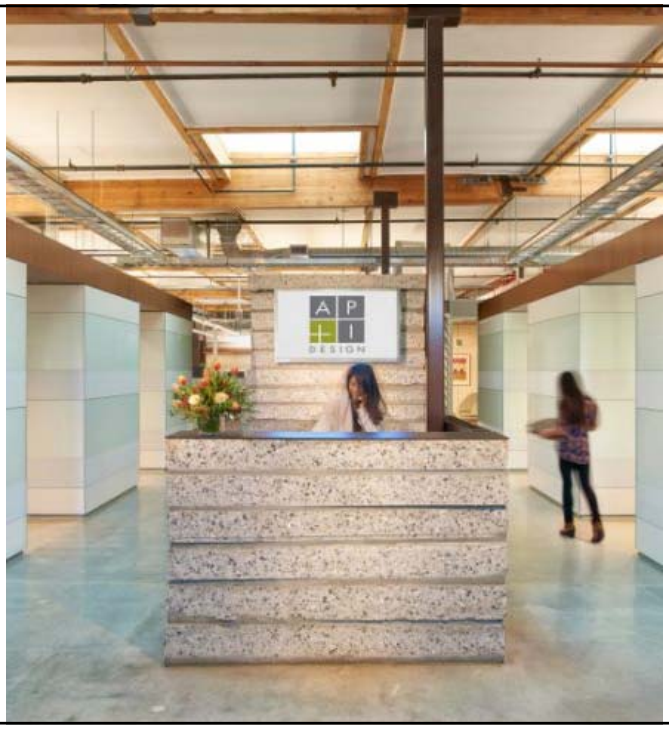

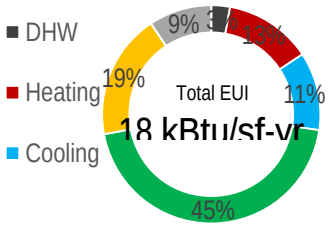
DHW
Heating
Cooling
9%
19%
Total EUI
11%
45%


ENERGY CONSERVATION OFFICE, UC DAVIS
PG&E

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Before

After

Key HVAC Measures: Replaced old roof top units (RTUs) with:
Dedicated outside air system (DOAS) w/heat recovery | Variable refrigerant flow (VRF) heating/cooling system*
Key Lighting Measures: High efficacy LED fixtures | Networked Power over Ethernet (PoE) lighting | Daylight dim to OFF | Occupancy sensor dim to OFF

*May inform future appliance standard rulemakings

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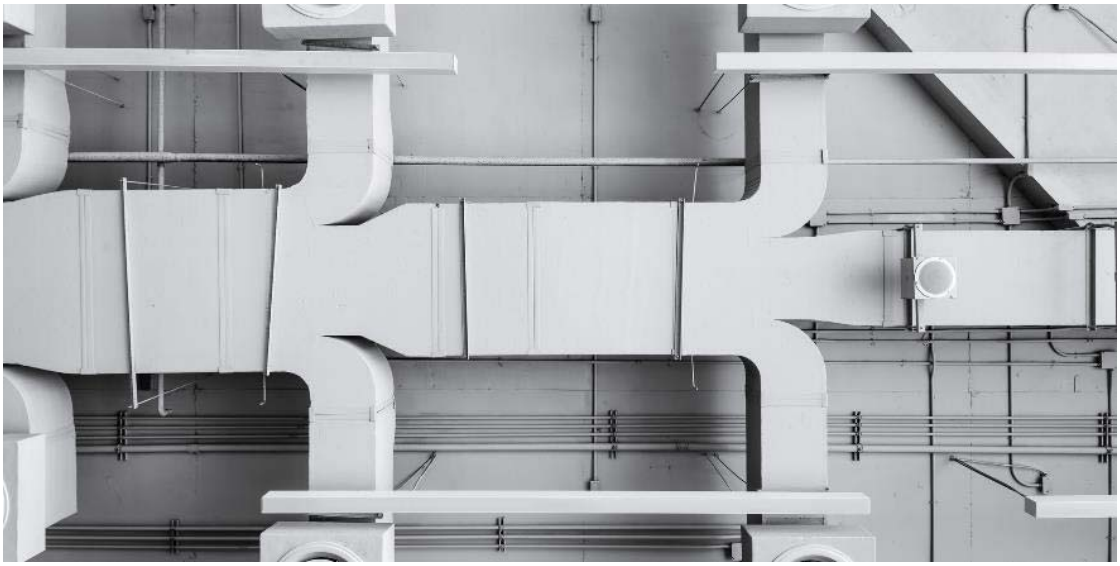
DOAS = Fully Separates Ventilation from Cooling/Heating



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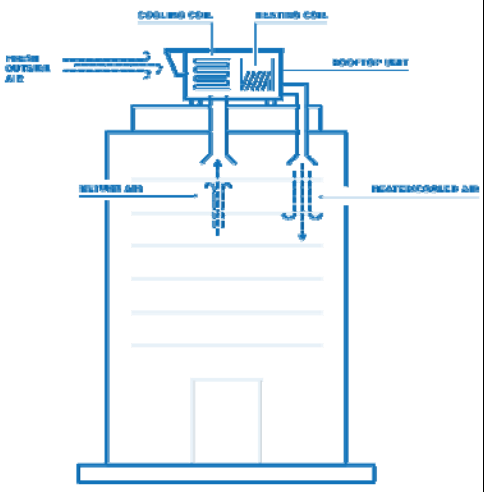
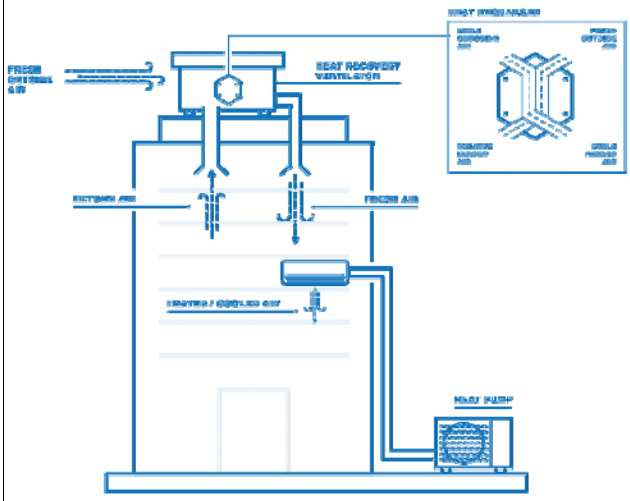
Packaged DX with Reheat



http://www.ventacity.com/case-studies/

DOAS with VRF with Ref. Heat Recovery



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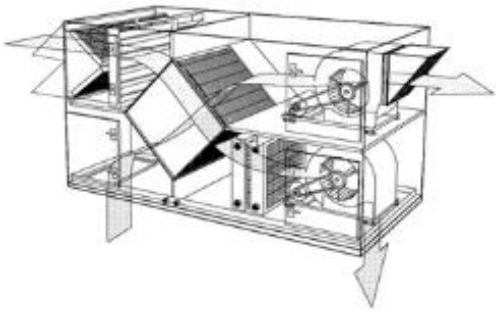

DOAS primarily,
VRF secondary,
potential combined
installs

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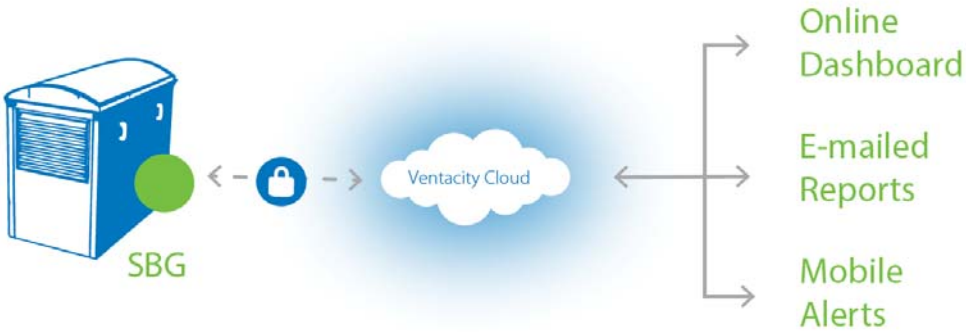
Stand Alone IOT (Internet of Things)



http://www.ventacity.com/case-studies/

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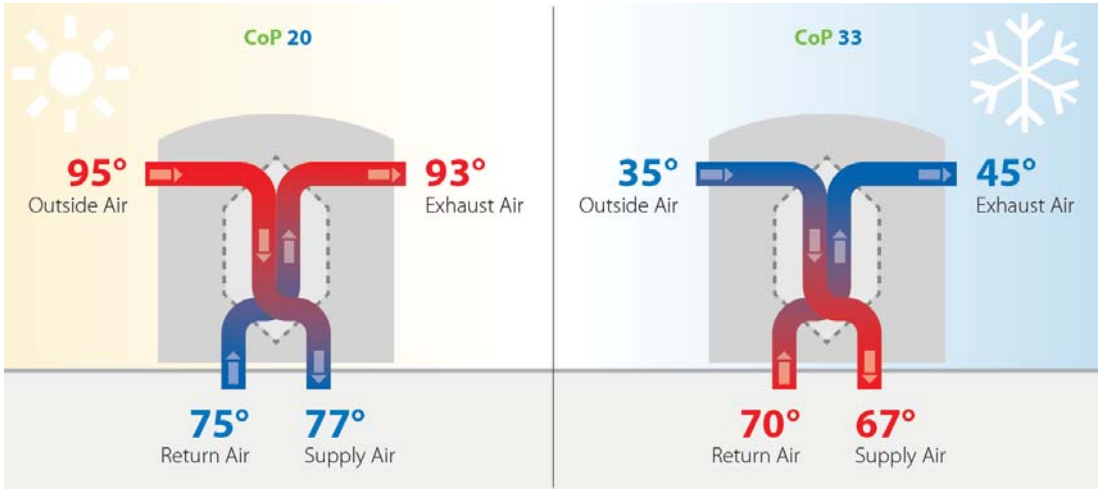

http://www.ventacity.com/case-studies/

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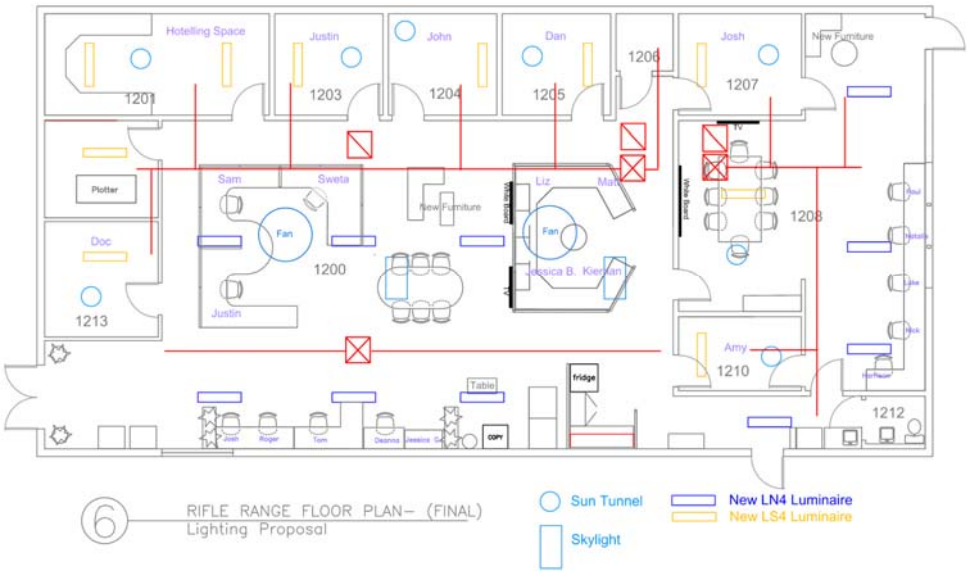

6 RIFLE RANGE FLOOR PLAN– (FINAL)
Lighting Proposal

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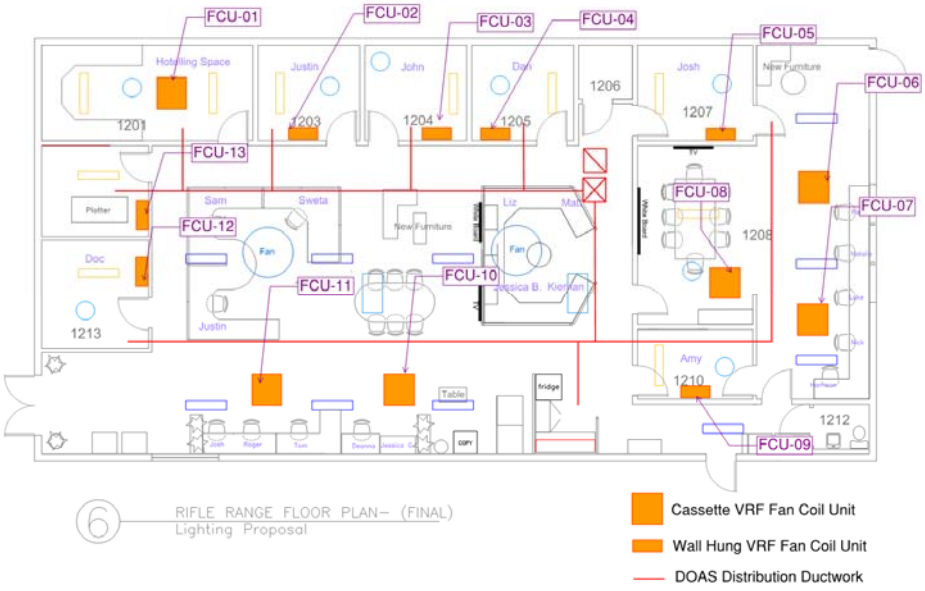
FCU-01
FCU-02
FCU-03
FCU-04
FCU-05
FCU-06
FCU-07
FCU-08
FCU-09
FCU-10
FCU-11
FCU-12
FCU-13
Hoteling Space
Justin
John
Dan
Josh
New Furniture
1201
1203
1204
1205
1206
1207
1208
1210
1212
1213
Plotter
Doc
Sam
Sweta
Fan
Liz
Matt
Jessica B. Kiernan
Amy
Table
fridge
COPY
6
RIFLE RANGE FLOOR PLAN– (FINAL)
Lighting Proposal
Cassette VRF Fan Coil Unit
Wall Hung VRF Fan Coil Unit
DOAS Distribution Ductwork
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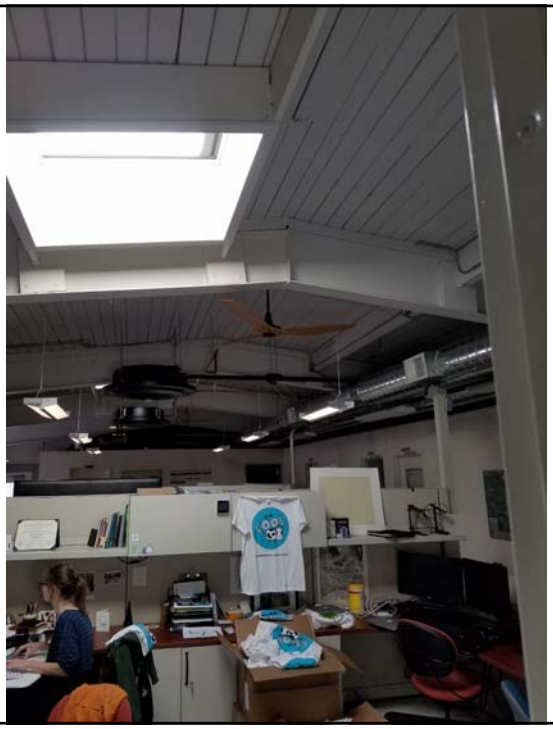

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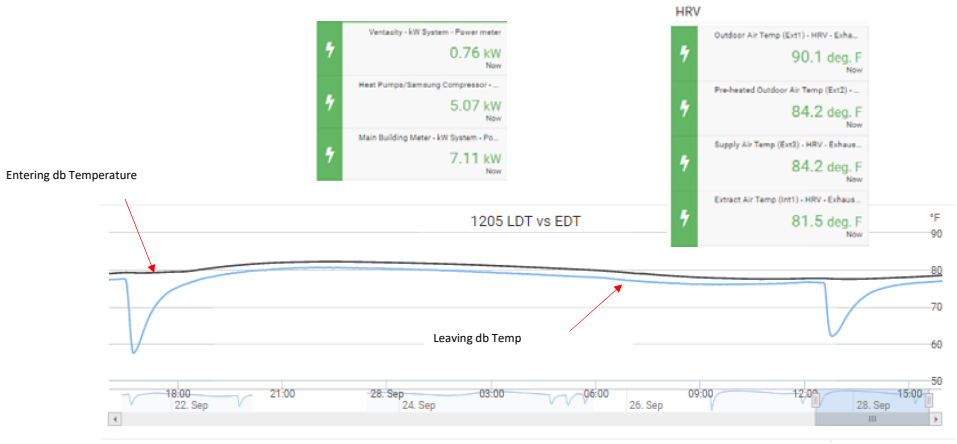

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Before

After

Key HVAC Measures: Replaced old roof top units (RTUs) with:
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Key Lighting Measures: High efficacy LED fixtures | Networked Power over Ethernet (PoE) lighting | Daylight dim to OFF | Occupancy sensor dim to OFF

*May inform future appliance standard rulemakings

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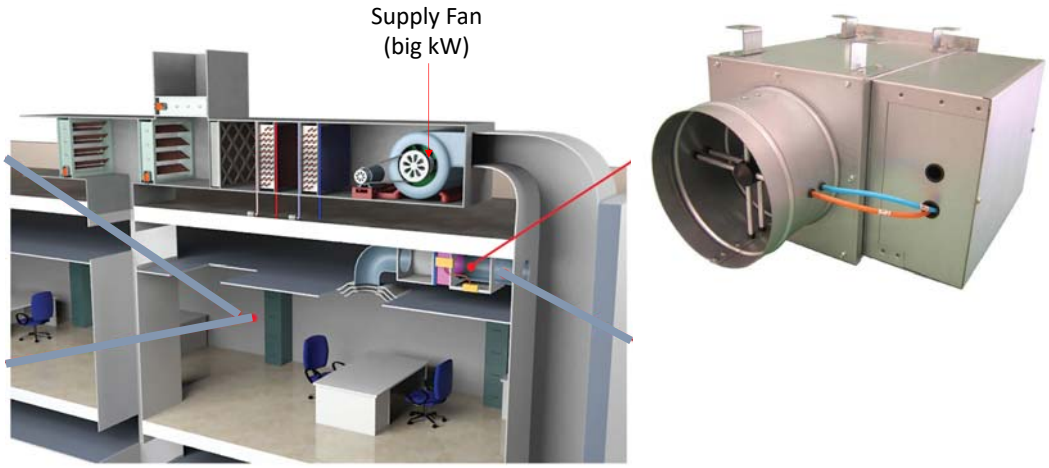
Time-Averaged Ventilation (TAV) Controls
for Variable Air Volume

- Soazig Kaam, Paul Raftery
  CBE
- Hwakong Cheng
  Taylor Engineering
- Gwelen Paliaga
  TRC

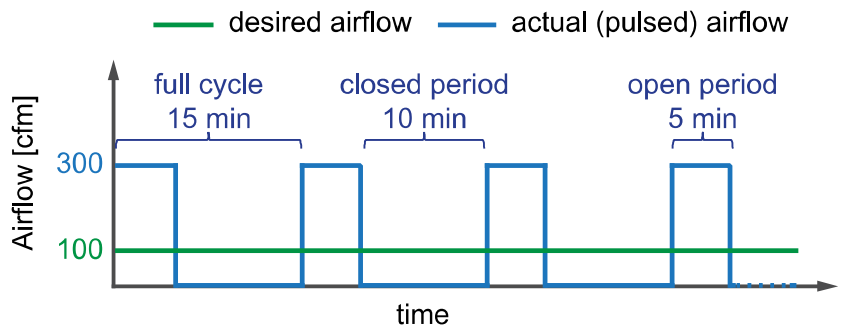
Sutardja Dai Hall (SDH)
Source: Hathaway Dinwiddie


VAV102
08/18/2006


Supply Fan
(big kW)

Time-averaged ventilation principle

TAV controls the average airflow of a zone
to the minimum ventilation rate required by code



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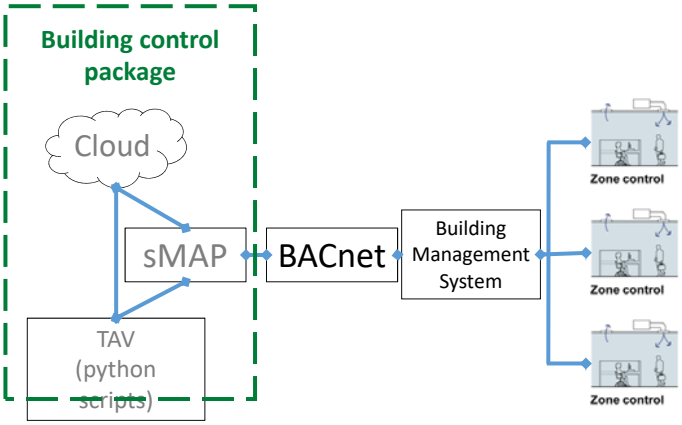
Time-Averaged Ventilation (TAV) Controls for Variable Air Volume Systems



Sutardja Dai Hall (SDH)
Source: Hathaway Dinwiddie

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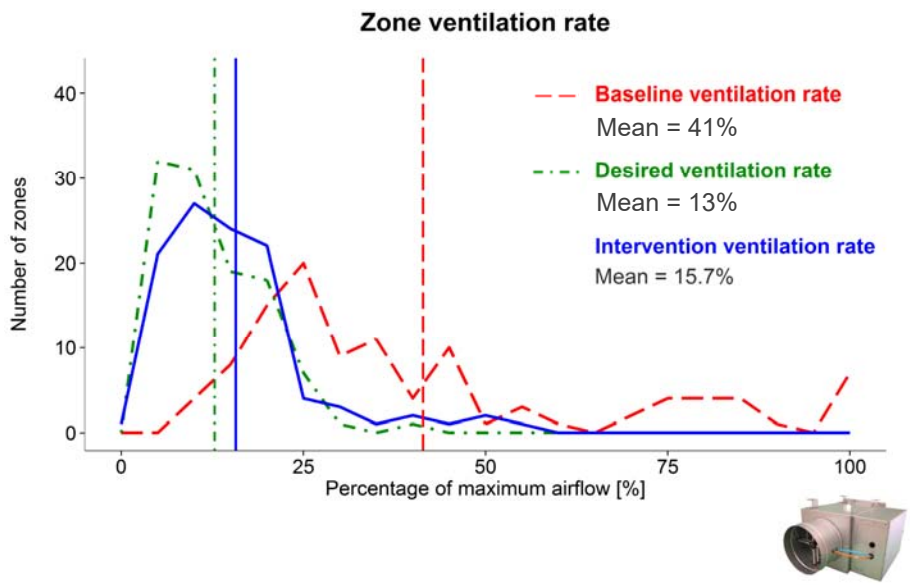
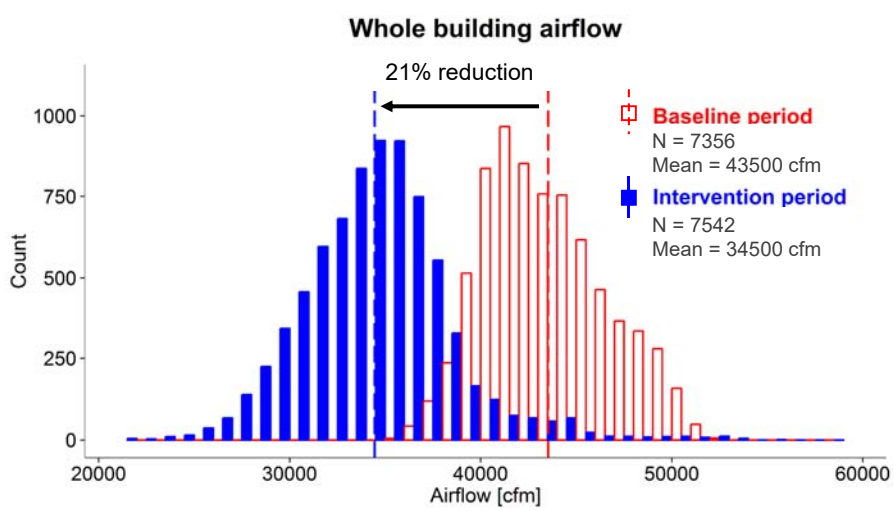
Results: Airflow



Results: Whole building airflow



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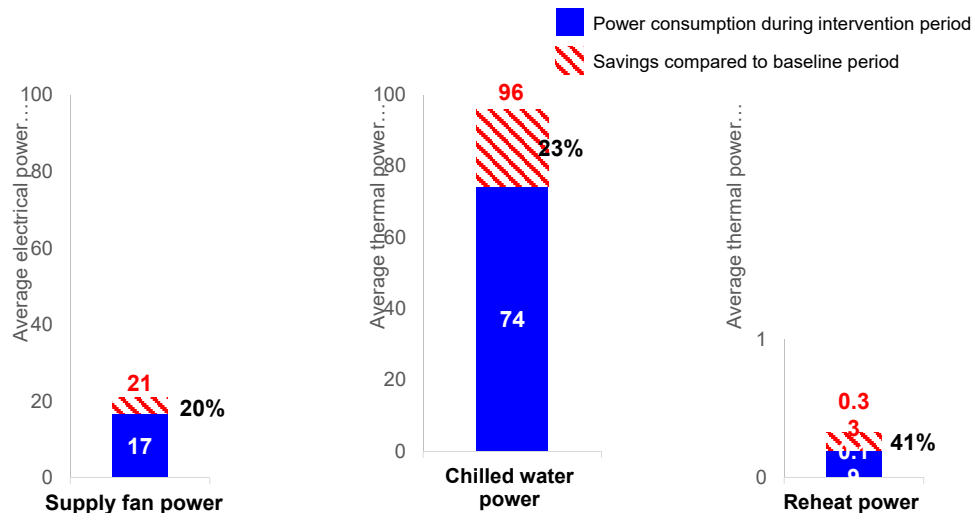
Results: Energy savings



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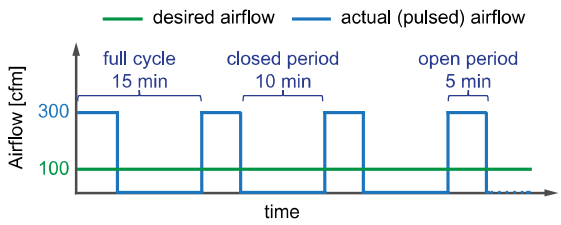
Conclusion

- TAV controls the average zone airflow to the minimum ventilation rate required by code
- TAV leverages the Internet of Things platform for buildings
- TAV has shown great potential for airflow and energy savings

TAV principle



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Thank You

Neil Bulger | PE, LEED AP | Principal
Building Performance Team

427 13th Street | Oakland CA
D 510.457.0135
nbulger@integralgroup.com

Trust | **Nurture** | **Inspire**


Mulit-Story Government Office
Retrofit & HVAC Upgrade
Oakland CA


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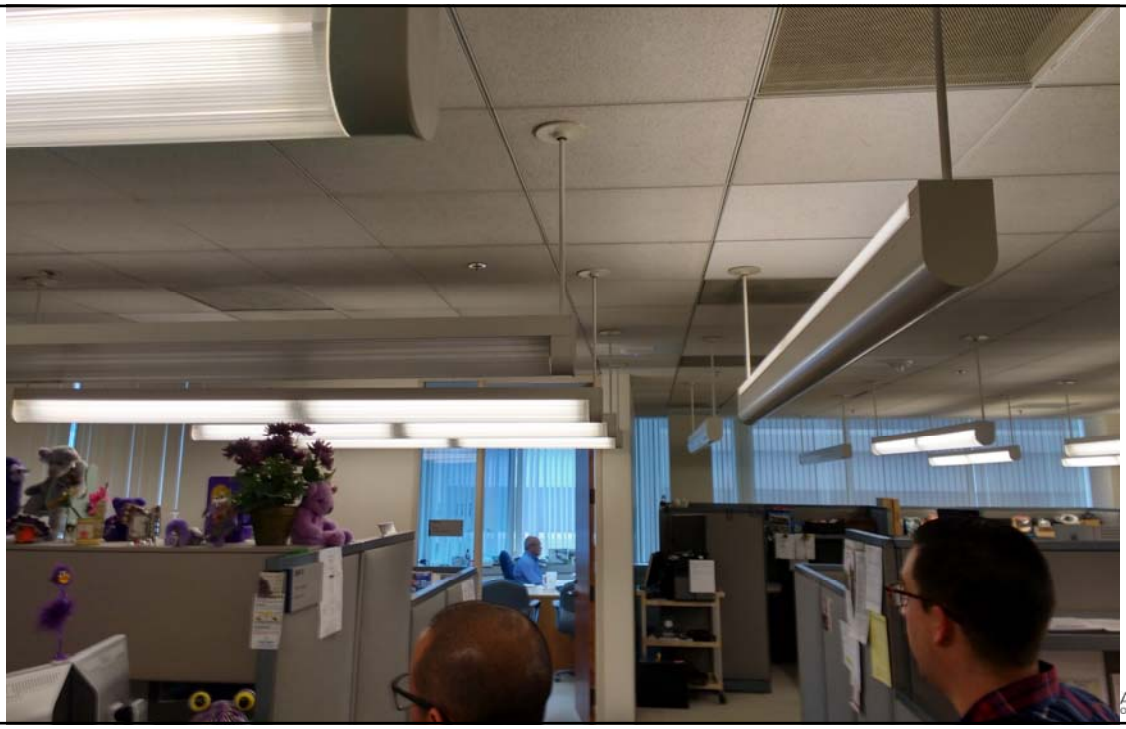
EXIT

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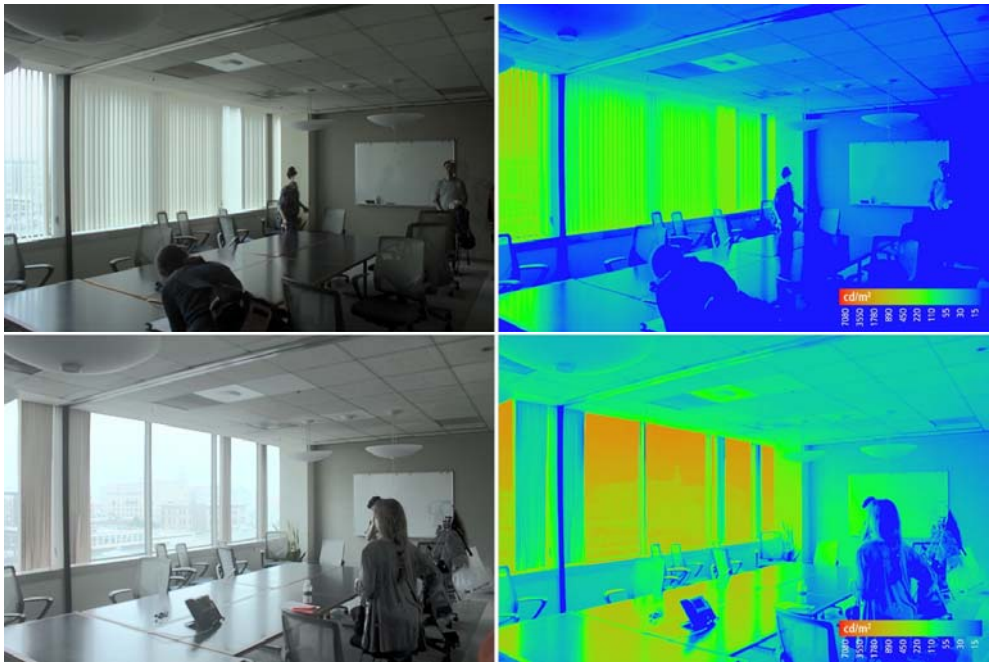
LISTED
INDUSTRIAL CONTROL EQUIPMENT
243C


LUTRON



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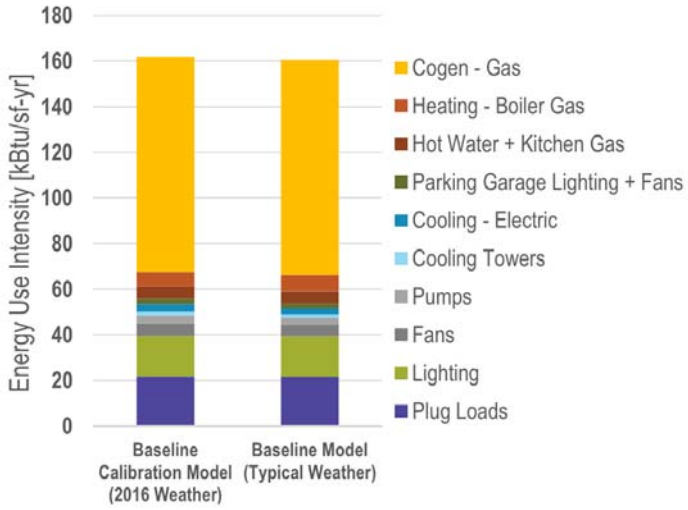

Figure 3 – Baseline for 2016 and Typical Year Weather

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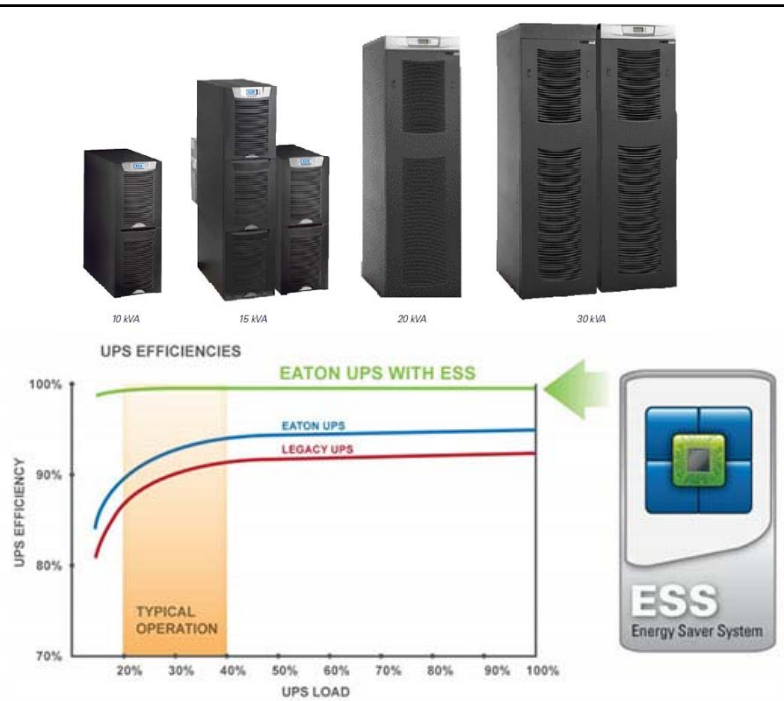
Space	System	EEM Number	Energy Efficiency Measure Name
Data Center	Data Center Electrical Support	1a	Install Right Size High Efficiency Uninterruptible Power Supply (UPS)
		1b	Install Right Size High Efficiency UPS: Operate UPS-A in Bypass Mode and Install Modular High Efficiency UPS-B
	HVAC	3	Install Right Size CRAHs with VFDs, Chimney Containment, and Airside Economizing
	Lighting	4	Install New LED Lighting in Data Center with Occupancy Controls
Occupied Space	HVAC	5a	Install Whole Building Zone DDC Controls and Optimize Zone Controls
		5c	Occupied Space DOAS + Radiant Conversion
	Envelope	6a	Replace Windows with Double-Paned, Low-e Coating Windows
		6b	Install Window Film
	Plug Loads	7	Install Breakroom and Office Plug Load Occupancy Controls
	Lighting	8	Install Bi-Level LED Lighting with Occupancy Controls in Stairwells
		9	Install Lighting Occupancy Controls in Private Offices, Breakrooms, and Conference Rooms
		10a	Install LEDs and Reduce Lighting Power Density and Daylight Dimming Controls in Occupied Spaces
		10b	Install LEDs and Reduce Lighting Power Density, Daylight Dimming Controls, and Automated Shades in Occupied Spaces
Central Plant	Cooling Plant	11	Upgrade Chiller Plant and Optimize Controls
		12	Convert Heat Pumps to Chilled Water Units
	Fans	13	Install VFDs on Floor 1 through 3 Relief Fans
	Heating Plant	14	Upgrade Heating Plant and Optimize Controls



Install Right Size High Efficiency Uninterruptible Power Supply (UPS)

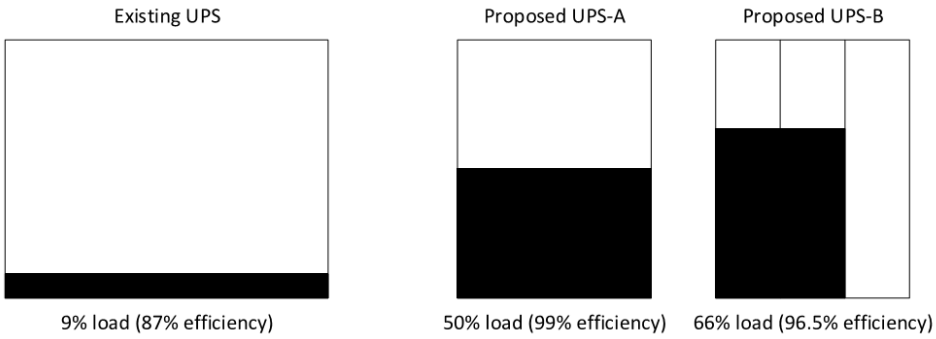


Figure 3: Existing and Proposed UPS Loading

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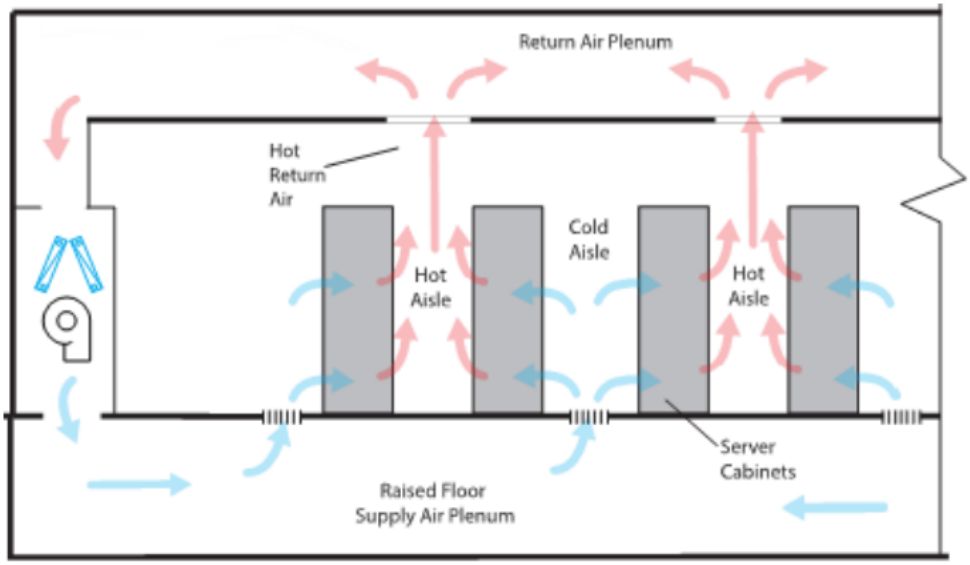

Figure 4: Existing Data Center Configuration

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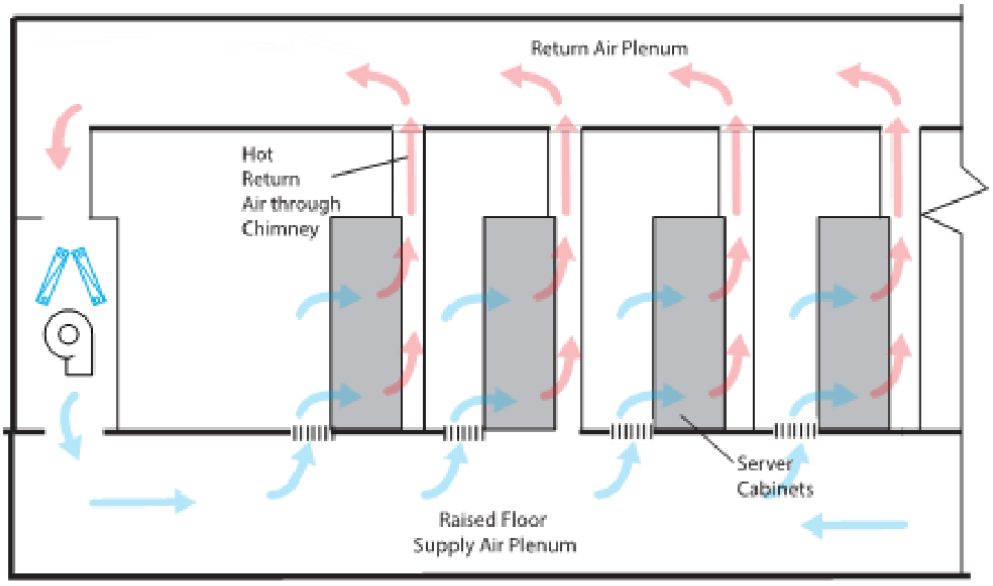

Figure 5: Proposed Data Center Configuration

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Conclusion and Lessons Learned

Ralph DiNola, CEO, NBI

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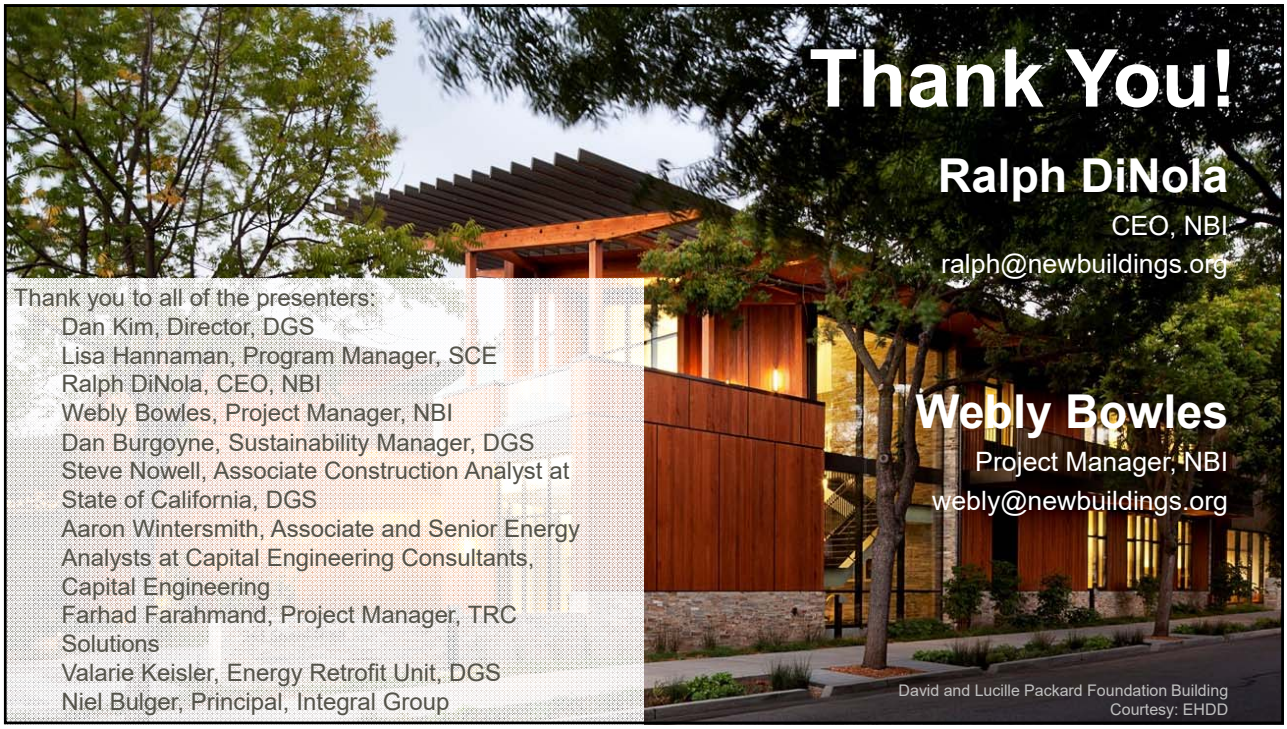

Thank You!

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Thank you to all of the presenters:

- Dan Kim, Director, DGS
- Lisa Hannaman, Program Manager, SCE
- Ralph DiNola, CEO, NBI
- Webly Bowles, Project Manager, NBI
- Dan Burgoyne, Sustainability Manager, DGS
- Steve Nowell, Associate Construction Analyst at State of California, DGS
- Aaron Wintersmith, Associate and Senior Energy Analysts at Capital Engineering Consultants, Capital Engineering
- Farhad Farahmand, Project Manager, TRC Solutions
- Valarie Keisler, Energy Retrofit Unit, DGS
- Niel Bulger, Principal, Integral Group

David and Lucille Packard Foundation Building
Courtesy: EHDD

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Tour: Arch-Nexus ZNE Office

4:00 pm – 5:00 pm

930 R Street, Sac, CA 95811

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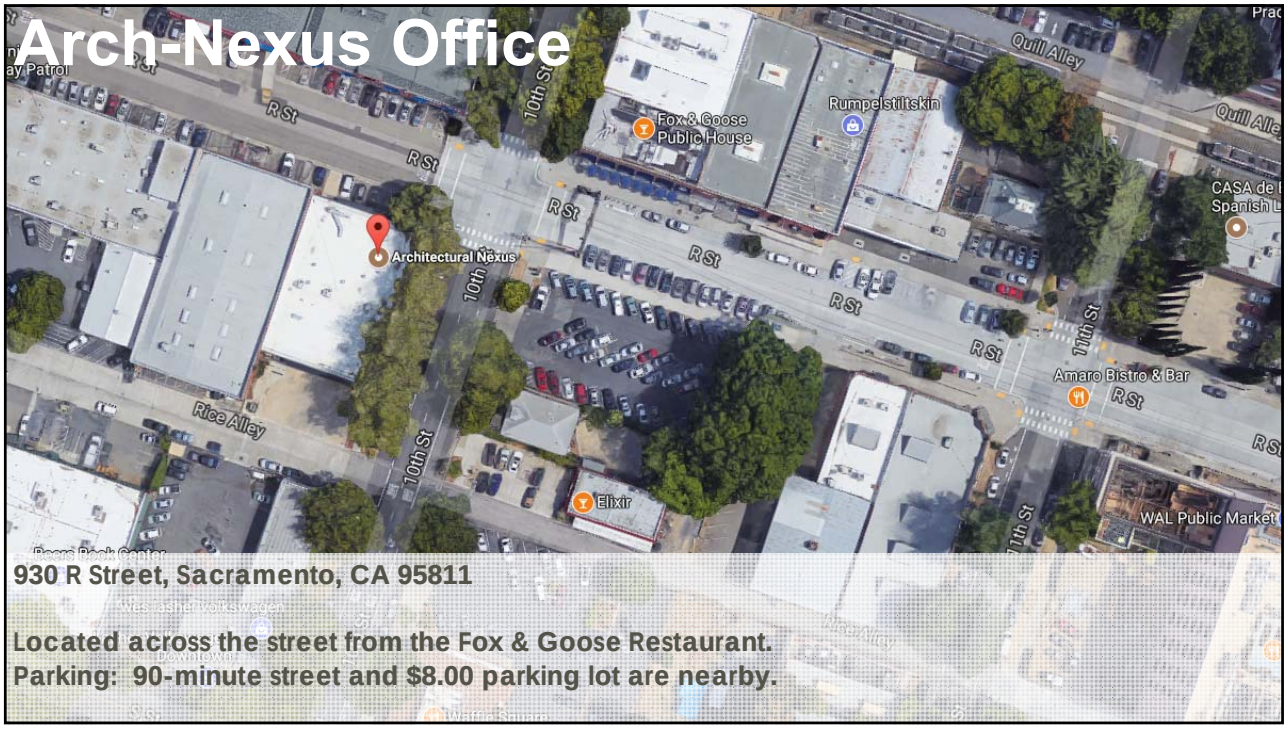

Common ZNE Technologies and Strategies

- Highly Efficient and Sealed Thermal Envelope
- Building Orientation and WWR
- Thermal Energy Storage
- Phase Change Material
- Daylighting Access and Controls
- Advanced Ventilation: Natural, Dedicated Outdoor Air Systems (DOAS), Demand Control Ventilation (DCV)
- Ground Source and CO2 Heat Pumps
- Night Flush
- Radiant Heating/Cooling
- Evaporative Cooling
- Ceiling Fans
- Fiber Optics
- Energy Recovery Systems
- Energy Generation and storage
- Plug load Reductions and Controls
- Energy Management Systems
- Design for "Off"
- Programmatic Zoning
- Sequence of Operations
- Direct Current Equipment
- EV Charging and Storage

Redding School for the Arts, CA
Courtesy : Trilogy Architecture Steve Whittaker Photography

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Common Operations and Occupancy Technologies and Strategies

- Occupant Engagement and Training
- Energy Displays (ie Dashboards)
- Green Leases
- Purchasing Policies
- Service Contracts
- Ongoing Energy Tracking
- System Calibration
- Sensor Evaluation
- Ongoing Commissioning
- Demand Response
- Load Shifting Software

eMetric by Jason Deperro

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