Welcome and Introduction

Dan Kim, Director, DGS
Thanks to the Sponsors

PG&E

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL® Company

Introduction: ZNE

Ralph DiNola, CEO, NBI
Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 am – 9:15 am</td>
<td>Welcome and Introduction</td>
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<tr>
<td></td>
<td>Dan Kim, Director, DGS</td>
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<tr>
<td>9:15 am – 9:25 am</td>
<td>Introduction: Zero Net Energy</td>
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<tr>
<td></td>
<td>Ralph DiNola, CEO, NBI</td>
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<tr>
<td>9:25 am – 9:35 am</td>
<td>Utility Program Support and Project Engagement</td>
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<tr>
<td></td>
<td>Lisa Hannaman, Program Manager, SCE</td>
</tr>
<tr>
<td>9:35 am – 9:55 am</td>
<td>State ZNE Policy Review</td>
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<td>Dan Burgoyne, Sustainability Manager, DGS</td>
</tr>
<tr>
<td>9:55 am- 10:05 am</td>
<td>Break</td>
</tr>
<tr>
<td>10:05 am– 10:35 am</td>
<td>ZNE Project Guide for State Buildings</td>
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<tr>
<td></td>
<td>Ralph DiNola, CEO, NBI</td>
</tr>
<tr>
<td>10:35 am– 10:55 am</td>
<td>Power Purchase Agreements</td>
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<tr>
<td></td>
<td>Steve Nowell, Associate Construction Analyst at State of California, DGS</td>
</tr>
<tr>
<td>10:55 am– 11:25 am</td>
<td>Energy Modeling</td>
</tr>
<tr>
<td></td>
<td>Aaron Wintersmith, Associate and Senior Energy Analysts, Capital Engineering Consultants</td>
</tr>
<tr>
<td>11:25 am- 12:00 pm</td>
<td>Beyond T-24 Measures</td>
</tr>
<tr>
<td></td>
<td>Farhad Farahmand, Project Manager, TRC Solutions</td>
</tr>
</tbody>
</table>

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
Webyl 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

3:30 pm – 4:00 pm Tour: Arch-Nexus ZNE Office

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?"
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

CA Big Bold Energy Efficiency Strategies

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)
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

SAM Section 1815.31

- 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%
Management Memo 17-04

• 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.

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

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

Code Cycles to ZNE in CA

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

The 2016 List of ZNE Buildings

October 2017:
66 ZNE Verified
380 ZNE Emerging
446 ZNE!
ZNE Building Map

CA ZNE Building Types

- Building Type (General)
  - Education
  - Office
  - Multifamily
  - Other
  - Public Assembly
  - Public Order and Safety
  - Warehouse and Storage
  - Food Sales
  - Food Service
  - Health Care (Outpatient)
  - Lodging
  - Mercantile (Retail Other than Mall)

- Building Type(s) (Detailed, Primary First)
  - K-12 School
  - Higher Education
  - General Education

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**Getting Existing Buildings to Zero**

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

### Verified ZNE Commercial Buildings in California

#### Private – For-profit
- Jess Jackson Sustainable Winery Building
- AP+I Design
- Bagatelas 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)
Utility Program Support and Project Engagement

Lisa Hannaman, Program Manager, SCE
DGS ZNE Workshop

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
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

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Core Incentive

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

Up to $150,000 per project.

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.
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

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

Pursue low- or no-cost energy saving strategies first

Tools and Resources
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*

Compliance Improvement Activities

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

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

State ZNE Policy Review

Dan Burgoyne, Sustainability Manager, DGS
The Road to Zero: California ZNE Policy

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%)
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)

<table>
<thead>
<tr>
<th>National Average Source Energy Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of Energy</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Imported Electricity</td>
</tr>
<tr>
<td>Exported Renewable Electricity</td>
</tr>
<tr>
<td>Natural Gas</td>
</tr>
<tr>
<td>Fuel Oil (1,2,4,5,6,Diesel, Kerosene)</td>
</tr>
<tr>
<td>Propane &amp; Liquid Propane</td>
</tr>
<tr>
<td>Steam</td>
</tr>
<tr>
<td>Hot Water</td>
</tr>
<tr>
<td>Chilled Water</td>
</tr>
</tbody>
</table>

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

- 155 kBtu/sq. ft. Source EUI
- 65 kBtu/sq. ft. Source EUI

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

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

### Energy Efficiency Targets for Existing State Buildings (Source EUI)

<table>
<thead>
<tr>
<th>State Building Type</th>
<th>Source EUI Targets for State Climate Zones***</th>
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</thead>
<tbody>
<tr>
<td>Conversion Factors for Zones</td>
<td>CA Ave: 1.00 0.99 0.92 0.97 0.95 0.94 0.96 0.95 0.97 0.99 1.06 0.92 0.95 0.97 1.00 0.92 0.95 1.06 0.92 0.95 0.97 1.00 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06 0.92 0.95 1.06</td>
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</table>
Renewable Energy Generation Priority
1. On-site Generation

DMV Fresno Field Office – First State ZNE Building

Renewable Energy Generation Priority
2. Campus
Renewable Energy Generation Priority

3. Portfolio

4. Community Renewables
   • Dedicated renewable energy purchase
   • 20 year min. agreement
   • Retain/retire REC’s
   • Fixed for 20 years
   • i.e. SMUD SolarShares
     o 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

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

ZNE Project Guide for State Buildings
Webly Bowles, Project Manager, NBI
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.

ZNE Project Guide for State Buildings

ZNE Project Checklist for State Buildings

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 (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

Site Design
- Conduct bioclimatic analysis
- Analyze passive design and natural ventilation options
- Evaluate different building orientations to determine optimal layout
- Daylight 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 (AWR)

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 documents, include ZNE
- Select qualified ZNE team
- Set building energy performance targets

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ZNE Project Guide for State Buildings

Resources

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

Operation and Verification
Title 20 Appliance Efficiency Programs: http://www.energycodes.gov/appliances/

Space Conditioning

Ventilation

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 cladding
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%

Building Envelope

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

Source: Beausoleil Architects

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

• Seal all joints and seams

http://www.masonrymagazine.com/cr-air-barriers-new-breed
https://sites.google.com/site/metropolitanenvironmental/causes-of-failures-of-building-envelopes

Building Envelope

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

Source: BC Hydro
Source: Yourhome.gov.au

External balcony slab
Internal floor slab

Ensure sufficient bearing area on supporting wall
Thermal break equal to R1.0, e.g. 20mm polyurethane foam

Source: Yourhome.gov.au
## Building Envelope

### Location Codes and Factor

<table>
<thead>
<tr>
<th>Location</th>
<th>Code U-Factor</th>
<th>Effective U-Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A - Miami</td>
<td>U-0.077</td>
<td>U-0.199</td>
</tr>
<tr>
<td>2B - Phoenix</td>
<td>U-0.064</td>
<td>U-0.186</td>
</tr>
<tr>
<td>4C - Portland</td>
<td>U-0.064</td>
<td>U-0.145</td>
</tr>
<tr>
<td>5A - Boston</td>
<td>U-0.064</td>
<td>U-0.145</td>
</tr>
</tbody>
</table>

### Building Envelope

- Loss of building performance with actual wall u factor.

<table>
<thead>
<tr>
<th>Location</th>
<th>Low-Rise</th>
<th>Mid-Rise</th>
<th>High-Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A - Miami</td>
<td>-0.5%</td>
<td>-0.3%</td>
<td>-2.3%</td>
</tr>
<tr>
<td>2B - Phoenix</td>
<td>-1.4%</td>
<td>-0.8%</td>
<td>-4.0%</td>
</tr>
<tr>
<td>4C - Portland</td>
<td>-2.9%</td>
<td>-0.4%</td>
<td>-2.5%</td>
</tr>
<tr>
<td>5A - Boston</td>
<td>-2.7%</td>
<td>-0.5%</td>
<td>-3.5%</td>
</tr>
</tbody>
</table>

#### Aqua Building in Chicago

[Image of building envelope diagram]
ZNE Project Guide for State Buildings

• Questions?

Power Purchase Agreements

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

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

Energy Modeling

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

How to estimate energy use of a new building

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

<table>
<thead>
<tr>
<th>Programs</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Energy Pro</td>
<td>• Predict Actual Consumption</td>
</tr>
<tr>
<td>• CBECC Com</td>
<td>• Schedules</td>
</tr>
<tr>
<td>• EQuest</td>
<td>• Actual Energy (Future Validation)</td>
</tr>
<tr>
<td>• IES VE</td>
<td>• Advanced HVAC System Types</td>
</tr>
<tr>
<td>• Open Studio</td>
<td>• Plug/Process Loads</td>
</tr>
<tr>
<td>• Trace 700</td>
<td>• User Loads</td>
</tr>
<tr>
<td>• Design Builder</td>
<td>• Food Service</td>
</tr>
<tr>
<td></td>
<td>• IT/DATA</td>
</tr>
<tr>
<td></td>
<td>• Vertical Transportation</td>
</tr>
</tbody>
</table>

### 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

Cost-Effective Beyond-Title-24 Measures
Farhad Farahmand, Project Manager, TRC Solutions
Cost Effective Measures Beyond Title 24: Results from Nonresidential Reach Code Study

Farhad Farahmand, PE, MPP, LEED AP
Project Manager, Building Sciences
FFarahmand@trcsolutions.com

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 (%)
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/ft²·yr
  - Flexible

- www.localenergycodes.com

Cost effectiveness analysis necessary for CEC approval

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

<table>
<thead>
<tr>
<th>Energy Savings</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>$$$</td>
<td>$$</td>
</tr>
</tbody>
</table>

BENEFIT to COST RATIO (B/C)

Time Dependent Valuation

OR

Utility Bill Impacts

Construction

AND

Maintenance

Nonresidential prototype

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

<table>
<thead>
<tr>
<th>Building Type</th>
<th>2017 – 2019 Forecasted Construction (% of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small, Medium, and Large Office</td>
<td>22%</td>
</tr>
<tr>
<td>Retail</td>
<td>16%</td>
</tr>
<tr>
<td>Warehouse</td>
<td>14%</td>
</tr>
<tr>
<td>Restaurant/Food</td>
<td>7%</td>
</tr>
<tr>
<td>School</td>
<td>5%</td>
</tr>
<tr>
<td>Hotel</td>
<td>5%</td>
</tr>
<tr>
<td>College</td>
<td>4%</td>
</tr>
<tr>
<td>Hospital</td>
<td>4%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>23%</td>
</tr>
</tbody>
</table>
Office building analysis by CZ

Cooling and indoor lighting loads dominate kTDV/ft²

Lighting measures

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

Do NOT take the PAF tradeoff when implementing measures
**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/ft²

**Measure: Use LED fixtures**
- Can achieve 0.65 Watts/ft²
- Exact LPD depends on design goals

**Cost: $0**
- Manufacturers suggest cost equivalency – LED is market standard
- Range of product qualities available
- Eliminates need for dimming ballast

*Source: Cooper Lighting 2AC 232 UNV EBB1 U*

**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*
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 ft²)
- 59 sensors for the entire building
- Requires tuning

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

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

Cost: $0.06/ft²
- Labor only
- Based on number and layout of spaces

Source: www.ecmag.com
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/ft² 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

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)/ft² – $0.50/ft² of roof

- Some darker roofs have more expensive tints
- No additional labor
- 3x more products that achieve 0.70 than 0.63 (CRRC)
### TDV Cost Effectiveness by CZ

<table>
<thead>
<tr>
<th>CZ</th>
<th>Cool Roof ASR</th>
<th>Reduced RS HGC</th>
<th>Reduced LPD</th>
<th>Institutional Tuning</th>
<th>Lighting Controls (Daylight Dimming Plus Off, Open Office Occupancy Sensors)</th>
<th>Compliance %</th>
<th>NPV of Savings (kTDV)</th>
<th>Incremental Cost</th>
<th>B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>n/a</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>15.7%</td>
<td>$55,509</td>
<td>$18,112</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>12.8%</td>
<td>$70,400</td>
<td>$48,902</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>15.5%</td>
<td>$67,202</td>
<td>$55,390</td>
<td>1.2</td>
</tr>
<tr>
<td>4</td>
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<td>0.65</td>
<td>x</td>
<td>x</td>
<td>13.1%</td>
<td>$70,448</td>
<td>$49,284</td>
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<td>0.65</td>
<td>x</td>
<td>x</td>
<td>15.9%</td>
<td>$68,300</td>
<td>$55,390</td>
<td>1.2</td>
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<tr>
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<td>0.65</td>
<td>x</td>
<td>x</td>
<td>14.7%</td>
<td>$75,603</td>
<td>$55,636</td>
<td>1.4</td>
</tr>
<tr>
<td>7</td>
<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>15.6%</td>
<td>$76,319</td>
<td>$55,636</td>
<td>1.4</td>
</tr>
<tr>
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<td>0.65</td>
<td>x</td>
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<td>13.7%</td>
<td>$75,984</td>
<td>$55,636</td>
<td>1.4</td>
</tr>
<tr>
<td>9</td>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>12.6%</td>
<td>$78,466</td>
<td>$55,636</td>
<td>1.4</td>
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<td>10</td>
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<td>0.65</td>
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<td>11.0%</td>
<td>$74,075</td>
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<tr>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>11.8%</td>
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<td>0.65</td>
<td>x</td>
<td>x</td>
<td>10.8%</td>
<td>$73,216</td>
<td>$47,098</td>
<td>1.6</td>
</tr>
<tr>
<td>14</td>
<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>11.0%</td>
<td>$73,264</td>
<td>$45,781</td>
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<tr>
<td>15</td>
<td>0.70</td>
<td>0.20</td>
<td>0.65</td>
<td>x</td>
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<td>10.4%</td>
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<td>16</td>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
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<td>12.8%</td>
<td>$67,298</td>
<td>$45,781</td>
<td>1.5</td>
</tr>
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</table>

### Reach Code Recommendations

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

Questions or Comments (please)
FFarahmand@trcsolutions.com
916-844-1033
## On-bill cost effectiveness by CZ

<table>
<thead>
<tr>
<th>CZ</th>
<th>Cool Roof ASR</th>
<th>Reduced RS/SHGC</th>
<th>Reduced LPD</th>
<th>Institutional Tuning</th>
<th>Lighting Controls (Daylight Dimming Plus Off, Open Office Occupancy Sensors)</th>
<th>Compliance %</th>
<th>Annual kWh Savings</th>
<th>Annual Therm Savings</th>
<th>On-Bill Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>n/a</td>
<td>n/a</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>15.7%</td>
<td>26,084</td>
<td>(366)</td>
<td>$95,361</td>
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<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>12.8%</td>
<td>31,026</td>
<td>(433)</td>
<td>$114,859</td>
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<td>3</td>
<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>15.5%</td>
<td>29,508</td>
<td>(405)</td>
<td>$109,322</td>
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<tr>
<td>4</td>
<td>n/a</td>
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<td>0.65</td>
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<td>x</td>
<td>13.1%</td>
<td>31,028</td>
<td>(322)</td>
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<td>0.65</td>
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<td>15.9%</td>
<td>30,179</td>
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<td>0.65</td>
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<td>x</td>
<td>14.7%</td>
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<td>0.65</td>
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<td>32,678</td>
<td>(222)</td>
<td>$129,100</td>
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<td>0.65</td>
<td>x</td>
<td>x</td>
<td>13.7%</td>
<td>33,398</td>
<td>(240)</td>
<td>$83,662</td>
</tr>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>12.6%</td>
<td>33,510</td>
<td>(242)</td>
<td>$85,235</td>
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<td>0.70</td>
<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>11.6%</td>
<td>32,649</td>
<td>(244)</td>
<td>$121,226</td>
</tr>
<tr>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>11.0%</td>
<td>32,640</td>
<td>(351)</td>
<td>$118,022</td>
</tr>
<tr>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>11.8%</td>
<td>31,968</td>
<td>(371)</td>
<td>$116,533</td>
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<td>0.22</td>
<td>0.65</td>
<td>x</td>
<td>x</td>
<td>10.8%</td>
<td>32,744</td>
<td>(325)</td>
<td>$139,413</td>
</tr>
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<td>0.70</td>
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<td>x</td>
<td>11.0%</td>
<td>33,216</td>
<td>(353)</td>
<td>$80,520</td>
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<td>x</td>
<td>x</td>
<td>10.4%</td>
<td>38,959</td>
<td>(181)</td>
<td>$96,324</td>
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<td>0.65</td>
<td>x</td>
<td>x</td>
<td>12.8%</td>
<td>30,153</td>
<td>(603)</td>
<td>$106,614</td>
</tr>
</tbody>
</table>

*Note: All Rights Reserved © 2017 New Buildings Institute*
Energy and Sustainability Program

Valarie Keisler, Energy Retrofit Unit, DGS

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 Energy Savings Program

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

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
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

DGS Energy Savings Program

Let our team help you save energy!

Valerie Keisler
Energy Savings Program Manager
valerie.keisler@dgs.ca.gov
(916) 376-1600

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

Team:

- Abdi.Farhang@dgs (916) 376-5314
- Sergey.Makarenko@dgs (916) 376-5312
- Shari.Parrish@dgs (916) 375-4733
- Jethro.Tarn@dgs (916) 375-4337
DGS Existing Building ZNE Readiness Worksheet
Dan Burgoyne, Sustainability Manager, DGS

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**
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 | 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 | 64 | 53 | 65 | 50 | 52 | 51 | 48 | 51 | 52 | 53 | 57 | 57 | 57 | 57 | 57 | 57 | 57 | 60 |
| College/University | 142 | 141 | 143 | 131 | 138 | 135 | 133 | 128 | 135 | 138 | 141 | 151 | 149 | 151 | 153 | 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 | 89 | 90 | 93 | 95 |
| Laboratory | 261 | 259 | 264 | 240 | 254 | 248 | 246 | 238 | 248 | 254 | 259 | 277 | 267 | 274 | 277 | 285 | 293 |
| Library | 114 | 113 | 115 | 105 | 111 | 108 | 107 | 103 | 108 | 110 | 113 | 112 | 116 | 120 | 121 | 124 | 128 |
| Mixed Use Property (CALFIRE) | 40 | 48 | 49 | 45 | 47 | 46 | 46 | 44 | 46 | 47 | 48 | 52 | 50 | 51 | 52 | 53 | 55 |
| Office - Large >50K sq. ft. | 133 | 132 | 134 | 122 | 129 | 126 | 125 | 120 | 126 | 129 | 131 | 141 | 145 | 149 |
| Office - Small <50K sq. ft. - CHP | 37 | 37 | 37 | 34 | 36 | 35 | 35 | 33 | 35 | 36 | 38 | 40 | 40 | 41 | 40 | 40 | 40 |
| Office - Small <50K sq. ft. - CMD | 81 | 81 | 82 | 79 | 79 | 77 | 77 | 71 | 77 | 79 | 81 | 83 | 86 | 89 | 91 | 92 | 95 |
| Office - Small <50K sq. ft. - DMV | 128 | 127 | 129 | 128 | 124 | 122 | 120 | 116 | 120 | 122 | 124 | 126 | 128 | 130 | 132 | 134 | 138 |
| Office - Small <50K sq. ft. - EDD | 132 | 131 | 133 | 130 | 126 | 124 | 122 | 118 | 122 | 124 | 126 | 128 | 130 | 132 | 134 | 136 | 140 |
| Office - Small <50K sq. ft. - Others | 114 | 113 | 115 | 105 | 111 | 108 | 107 | 103 | 108 | 110 | 113 | 112 | 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 | 633 |
| Other - CDEA | 248 | 247 | 257 | 229 | 242 | 237 | 234 | 224 | 237 | 240 | 247 | 264 | 264 | 282 | 284 | 272 | 279 |

### DGS Existing Building ZNE Readiness Worksheet
## DGS Existing Building ZNE Readiness Worksheet

### DGS Managed State-Owned Buildings

<table>
<thead>
<tr>
<th>Facility Name (Cross REEM)</th>
<th>Current Year Energy Use (2016)</th>
<th>Zero Net Energy (ZNE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural Gas Thermo (MMBtu)</td>
<td>Electricity (MMBtu)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CA ZNE Technical Workshop – October 30, 2017

DGS Existing Building ZNE Readiness Worksheet

<table>
<thead>
<tr>
<th>Facility Name (Cross REEM)</th>
<th>Current Year Energy Use (2016)</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>Electricity (MMBtu)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------</td>
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<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### CA ZNE Technical Workshop – October 30, 2017

DGS Existing Building ZNE Readiness Worksheet

<table>
<thead>
<tr>
<th>Facility Name (Cross REEM)</th>
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</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

ZNE References and Webpage


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

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

New Construction vs Existing Buildings


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New Construction vs Existing Buildings

New Construction: Design decisions shape the building

New Construction vs Existing Buildings

Existing Buildings: The building shapes the design decisions
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.

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
Retrofit Scopes

Retrofit

vs

Deep Retrofit

vs

Major Renovation

---

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

Deep Retrofit

That Usually Means:

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

Major Renovation & DER

- Retrofit
- Deep Retrofit
- Major Renovation
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

Assess Performance
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

\[
\text{Annual Energy Use} \quad \frac{\text{Square Footage}}{\text{Btu}} = \text{Energy Use Intensity (EUI)}
\]

EUI = 186
Good? Bad? Ugly?

Santa Rosa State Building
Credit: http://www.prdemocrat.com
# Assess: Portfolio-Wide

## DDS Managed State-Owned Buildings

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Electric Purchased (kWh)</th>
<th>Gas/Electric Mix (kWh)</th>
<th>Natural Gas (kWh)</th>
<th>Current Year Energy Use (2016)</th>
<th>Current Year Target Use (kBtu)</th>
<th>Target Source Energy Intensity (kBtu/ft²)</th>
<th>Target Source Energy Intensity (kBtu/ft²)</th>
<th>Energy Use Intensity (kBtu/ft²)</th>
<th>Energy Use Intensity (kBtu/ft²)</th>
<th>Renewable Energy (kBtu)</th>
<th>Total Target Use (kBtu)</th>
<th>ESP Performance (Inventoried Property)</th>
<th>PV (kW)</th>
<th>Zero Net Energy (ZNE)</th>
<th>Capital Cost (kBtu)</th>
<th>Annualized Net Savings (kBtu)</th>
<th>ESP Performance (Non-Inventoried Property)</th>
<th>PV (kW)</th>
<th>Zero Net Energy (ZNE)</th>
<th>Capital Cost (kBtu)</th>
<th>Annualized Net Savings (kBtu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Bodenree Building</td>
<td>9,400,373</td>
<td>5,603,394</td>
<td>4,844,500</td>
<td>10,811,355</td>
<td>17,343,413</td>
<td>18,094,630</td>
<td>16,277,300</td>
<td>1,231</td>
<td>105</td>
<td>586</td>
<td>276</td>
<td>704</td>
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<td></td>
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<td>0</td>
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</tr>
<tr>
<td>State Printing Plant</td>
<td>31,629,583</td>
<td>26,900,393</td>
<td></td>
<td>32,390,393</td>
<td>42,390,393</td>
<td>47,590,393</td>
<td>43,690,393</td>
<td>4,290</td>
<td>2,290</td>
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<tr>
<td>Research Building</td>
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<td>26,900,393</td>
<td></td>
<td>32,390,393</td>
<td>42,390,393</td>
<td>47,590,393</td>
<td>43,690,393</td>
<td>4,290</td>
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<tr>
<td>State Personnel Building</td>
<td>21,400,383</td>
<td>26,900,393</td>
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<td>21,400,383</td>
<td>22,600,383</td>
<td>23,800,383</td>
<td>23,800,383</td>
<td>4,290</td>
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<tr>
<td>DDS Building</td>
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<td>26,900,393</td>
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<tr>
<td>BOB Building</td>
<td>21,400,383</td>
<td>26,900,393</td>
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<td>21,400,383</td>
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</tr>
<tr>
<td>BOB Main Building</td>
<td>8,940,233</td>
<td>7,290,393</td>
<td></td>
<td>8,940,233</td>
<td>11,600,233</td>
<td>12,600,233</td>
<td>12,600,233</td>
<td>4,290</td>
<td>2,290</td>
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<tr>
<td>BOB Administration Building</td>
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<td>7,290,393</td>
<td></td>
<td>11,052,233</td>
<td>13,600,233</td>
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<td>4,290</td>
<td>2,290</td>
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<tr>
<td>BOB Communications Annex</td>
<td>11,052,233</td>
<td>7,290,393</td>
<td></td>
<td>11,052,233</td>
<td>13,600,233</td>
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<tr>
<td>BOB General Office Building</td>
<td>21,400,383</td>
<td>26,900,393</td>
<td></td>
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<td>22,600,383</td>
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</tr>
</tbody>
</table>
Identify buildings for data quality check

Allocated SMUD SolarShares PV

Next steps:
- Verify data
Identify exemplars for best practices

Allocated SMUD SolarShares PV

Next steps:
- Evaluate energy use
- Occupant education

---

Identify buildings that are “almost there”

Next steps:
- Evaluate energy use
- Conduct onsite assessment
<table>
<thead>
<tr>
<th>Facility Name (from ESPM)</th>
<th>Current Year Source EUI (kBtu/sf.)</th>
<th>EUI Reduction Needed (to meet ZNE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>074 SACRAMENTO STATE GARAGE FLEET LOT 2</td>
<td>13</td>
<td>IN/A</td>
</tr>
<tr>
<td>120 R Street Warehouse</td>
<td>20</td>
<td>38</td>
</tr>
<tr>
<td>106 STATE RECORD CENTER and WISE</td>
<td>37</td>
<td>38</td>
</tr>
<tr>
<td>330 Cal Trans District Office 3</td>
<td>119</td>
<td>136</td>
</tr>
<tr>
<td>330 California Towers (Riverside State B)</td>
<td>121</td>
<td>127</td>
</tr>
<tr>
<td>038 LIBRARY and COURTS II ANNEX BUILDING</td>
<td>138</td>
<td>131</td>
</tr>
<tr>
<td>753 Fresno Water Resources Building</td>
<td>146</td>
<td>120</td>
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<tr>
<td>008 Energy Commission Building</td>
<td>146</td>
<td>131</td>
</tr>
<tr>
<td>509 Ronald Reagan State Building</td>
<td>158</td>
<td>124</td>
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<tr>
<td>520 Santa Ana State Building</td>
<td>160</td>
<td>122</td>
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<tr>
<td>028 BOARD OF EQUALIZATION BUILDING</td>
<td>162</td>
<td>131</td>
</tr>
<tr>
<td>051 THRU 054 EAST END COMPLEX</td>
<td>174</td>
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<tr>
<td>470 San Jose State Building</td>
<td>186</td>
<td>124</td>
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<td>025 EDD Building</td>
<td>198</td>
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<td>016 Paul Bonderson Building</td>
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<td>001 State Capitol Building</td>
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<td>131</td>
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<tr>
<td>075 DEPARTMENT OF JUSTICE BUILDING</td>
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<td>131</td>
</tr>
<tr>
<td>018 Resources Building</td>
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<td>131</td>
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<tr>
<td>057 CalNet Bldg</td>
<td>920</td>
<td>116</td>
</tr>
<tr>
<td>095 Central Plant</td>
<td>5,122</td>
<td>IN/A</td>
</tr>
</tbody>
</table>

Identify high EUI for deeper investigation

Next steps:
- Conduct deeper onsite assessment

Consider process load evaluation

Next steps:
- Consult with industrial energy consultant
Assessment

But WHY is the building performing like it is?

Remote Assessment
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)
Energy Signatures - Total

![Graph showing total energy usage vs. average monthly outside air temperature.](image)

Energy Signatures - Total

![Graph showing total energy usage vs. average monthly outside air temperature with the electric baseload highlighted.](image)
Energy Signatures - Total

Remote Assessment with FirstView
Identify Top Candidates

High thermal baseload
High heating use

High electric baseload
High Ventilation/Cooling Load
Energy Signatures and the Comparison Spectrum

FirstView Portfolio Prioritization

Weather Normalized Building EUI by End-Use
Prioritize the Opportunities

Successful Retrofits
Start with the Right Building
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

---

**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)

<table>
<thead>
<tr>
<th>Building</th>
<th>Building Type</th>
<th>Size, ft²</th>
<th>EUI, kbtu/ft²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building 1</td>
<td>Office</td>
<td>32,500</td>
<td>86</td>
</tr>
<tr>
<td>Building 2</td>
<td>Senior Care Community</td>
<td>12,122</td>
<td>154</td>
</tr>
<tr>
<td>Building 3</td>
<td>Office</td>
<td>52,200</td>
<td>83</td>
</tr>
<tr>
<td>Building 4</td>
<td>Police Station</td>
<td>73,000</td>
<td>89</td>
</tr>
</tbody>
</table>
# Assessment

## ASHRAE Energy Audits

### What's involved with each level?

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

---

# Scope Development
Establish the ZNE EUI Target

### DGS Managed State-Owned Buildings

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

Existing Buildings vs New Construction

**Existing Buildings:**  
The building shapes the design decisions

Matching Strengths & Weaknesses

Single Pane Window
No Insulation

Beaumont Middle School, Portland, OR

Matching Strengths & Weaknesses

Natural Ventilation & Daylighting
Thermal Mass

Beaumont Middle School, Portland, OR
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

Medium intervention

High intervention
ZNE Retrofit Opportunities

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

<table>
<thead>
<tr>
<th>Facility Name (from ESPM)</th>
<th>Current Year Source EUI (kBtu/sq. ft.)</th>
<th>EUI Target (to meet ZNE EE)</th>
<th>EUI Reduction Needed (to meet ZNE EE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>038 LIBRARY and COURTS II ANNEX BUILDING</td>
<td>138</td>
<td>131</td>
<td>7</td>
</tr>
<tr>
<td>753 Fresno Water Resources Building</td>
<td>146</td>
<td>120</td>
<td>26</td>
</tr>
<tr>
<td>006 Energy Commission Building</td>
<td>146</td>
<td>131</td>
<td>16</td>
</tr>
</tbody>
</table>

Central High School, Little Rock, AR

ZNE Retrofit Opportunities

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

<table>
<thead>
<tr>
<th>Facility Name (from ESPM)</th>
<th>Current Year Source EUI (kBtu/sq. ft.)</th>
<th>EUI Target (to meet ZNE EE)</th>
<th>EUI Reduction Needed (to meet ZNE EE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>470 San Jose State Building</td>
<td>186</td>
<td>124</td>
<td>61</td>
</tr>
<tr>
<td>075 EID Building</td>
<td>198</td>
<td>131</td>
<td>67</td>
</tr>
<tr>
<td>016 Paul Bonderson Building</td>
<td>232</td>
<td>131</td>
<td>102</td>
</tr>
<tr>
<td>001 State Capitol Building</td>
<td>278</td>
<td>131</td>
<td>147</td>
</tr>
<tr>
<td>075 DEPARTMENT OF JUSTICE BUILDING</td>
<td>280</td>
<td>131</td>
<td>149</td>
</tr>
</tbody>
</table>

The Banner Bank Building, Boise, ID
Complimentary Energy Elements

Lifecycle Opportunities
Lifecycle Opportunities

Major Renovation – 30-50 Years

Lifecycle Opportunities

HVAC Replacement – 15-20 Years
Lifecycle Opportunities

Lighting Retrofit – 5-7 Years

Lifecycle Opportunities

Lease Renewal– 2-5 Years
Lifecycle Opportunities

Real Estate Transactions

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
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

Leading in LA
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

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)
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

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
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

---

**Leading in LA**

- Aggregated Energy Savings Potential

<table>
<thead>
<tr>
<th></th>
<th>% of Energy Use</th>
<th>End Use Savings</th>
<th>Whole Building Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>37%</td>
<td>71%</td>
<td></td>
</tr>
<tr>
<td>Equip. + Misc.</td>
<td>21%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>20%</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td>14%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>All other Loads</td>
<td>8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>100%</strong></td>
<td></td>
<td><strong>32%</strong></td>
</tr>
</tbody>
</table>

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

Energy Savings Potential Applicable to DGS Projects

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

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

Resources
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

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!
**ZNE Technology Application Guides**

- **LUMINAIRE LEVEL LIGHTING CONTROL**
- **INDIRECT EVAPORATIVE COOLING**

---

**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

---

**ZNE Companion Guide to Zero Net Energy in CA**

Tools & Resources for Decisionmakers, Designers, Owners, Policymakers, & Champions

Frequently Asked Questions, Design Fundamentals, Project Profiles, A Resource for New Information

www.newbuildings.org/zne-communications-toolkit
ZNE & Ultra-Low Energy Case Studies

- CPUC Case Study Briefs & NBI ZNE Case Studies
  http://newbuildings.org/case-studies-zne-projects
- PG&E Case Studies
- NBI Registry
  http://newbuildings.org/share
- Getting to Zero Database
  http://newbuildings.org/getting-to-zero-buildings-database

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
ZNE ACTION BULLETIN
Progress Towards Zero Net Energy Buildings

Email webly@newbuildings.org to sign up

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
Existing Building ZNE Retrofit Case Study

Neil Bulger, Principal, Integral Group
Symposium on Zero Net Energy Buildings and Beyond: Balancing Building and Grid Objectives; October 25, 2017
SIZE: 14,800 SF
YEAR: 2015
TYPE: COMMERCIAL
POWER: NET ZERO ENERGY
RECYCLING: 92.5% OF ALL DEMO MATERIAL WAS REPURPOSED

117 EASY STREET, MOUNTAIN VIEW, CA
Figure 2 - Typical Day Demand Profiles

**Occupied - Plug Load Energy**
- Server Room, 22%
- Breakroom, 16%
- Printers, 15%
- Workstation, 47%

**Unoccupied - Plug Load Energy**
- Server Room, 58%
- Breakroom, 15%
- Printers, 13%
- Workstation, 14%

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Annual Plug Load Energy (kWh/yr)</th>
<th>Annual Unoccupied Plug Load Energy (kWh/yr)</th>
<th>% Total Plug Load Energy Unoccupied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workstation</td>
<td>10,000</td>
<td>2,000</td>
<td>20%</td>
</tr>
<tr>
<td>Printers</td>
<td>4,000</td>
<td>2,500</td>
<td>50%</td>
</tr>
<tr>
<td>Breakroom</td>
<td>5,000</td>
<td>2,500</td>
<td>40%</td>
</tr>
<tr>
<td>Server Room</td>
<td>12,000</td>
<td>8,000</td>
<td>67%</td>
</tr>
<tr>
<td>Total</td>
<td>31,000</td>
<td>14,000</td>
<td>45%</td>
</tr>
</tbody>
</table>
Thermal Comfort Fans: Haiku or Aeroton

- High-efficiency permanent magnet motor
- Patent-pending motor control system
- Predictive learning microprocessor
- Hand-balanced in a 10-step process

Sense me
technology
by
Key HVAC Measures: Replaced old roof top units (RTUs) with:
- Dedicated outside air system (DOAS) v/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
DOAS = Fully Separates Ventilation from Cooling/Heating

Packaged DX with Reheat

DOAS with VRF with Ref. Heat Recovery

http://www.ventacity.com/case-studies/
DOAS primarily, VRF secondary, potential combined installs

Stand Alone IOT (Internet of Things)

Online Dashboard
E-mailed Reports
Mobile Alerts

http://www.ventacity.com/case-studies/
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
Time-Averaged Ventilation (TAV) Controls for Variable Air Volume

- Soazig Kaam, Paul Raftery
  *CBE*
- Hwakong Cheng
  *Taylor Engineering*
- Gwelen Paliaga
  *TRC*
Time-averaged ventilation principle

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

- **desired airflow**
- **actual (pulsed) airflow**

Airflow [cfm]

<table>
<thead>
<tr>
<th>Time</th>
<th>Application</th>
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</thead>
<tbody>
<tr>
<td>full cycle</td>
<td>15 min</td>
</tr>
<tr>
<td>closed period</td>
<td>10 min</td>
</tr>
<tr>
<td>open period</td>
<td>5 min</td>
</tr>
</tbody>
</table>

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

Building control package

- **Cloud**
- **sMAP**
- **BACnet**
- **Building Management System**

Sutardja Dai Hall (SDH)
Source: Hathaway Dinwiddie
Results: Airflow

Zone ventilation rate

- Baseline ventilation rate
  Mean = 41%

- Desired ventilation rate
  Mean = 13%

- Intervention ventilation rate
  Mean = 15.7%

Results: Whole building airflow

Whole building airflow

21% reduction

- Baseline period
  N = 7356
  Mean = 43500 cfm

- Intervention period
  N = 7542
  Mean = 34500 cfm
Results: Energy savings

<table>
<thead>
<tr>
<th></th>
<th>Power consumption during intervention period</th>
<th>Savings compared to baseline period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply fan power</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Power</td>
<td>17</td>
<td>20%</td>
</tr>
<tr>
<td>Chilled water</td>
<td>96</td>
<td>74</td>
</tr>
<tr>
<td>Power</td>
<td>20%</td>
<td>23%</td>
</tr>
<tr>
<td>Reheat power</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Power</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Power</td>
<td>41%</td>
<td>34%</td>
</tr>
</tbody>
</table>

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

![UPS Efficiency Diagram](image-url)

**UPS Efficiencies**

- **Eaton UPS**
- **Legacy UPS**

**Typical Operation**

**Eaton UPS with ESS**

**Energy Saver System**
Install Right Size High Efficiency Uninterruptible Power Supply (UPS)

Figure 3: Existing and Proposed UPS Loading

Figure 4: Existing Data Center Configuration
Conclusion and Lessons Learned

Ralph DiNola, CEO, NBI
Thank You!

Ralph DiNola
CEO, NBI
ralph@newbuildings.org

Webly Bowles
Project Manager, NBI
webly@newbuildings.org

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
Tour: Arch-Nexus ZNE Office

4:00 pm – 5:00 pm
930 R Street, Sac, CA 95811

Arch-Nexus Office

930 R Street, Sacramento, CA 95811
Located across the street from the Fox & Goose Restaurant.
Parking: 90-minute street and $8.00 parking lot are nearby.
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

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

Metric by Jason Depompi