DRIVING NZE TO SCALE

A Review of Two Recent Studies illuminating Drivers, Barriers, and Trends in the NZE market

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Two ZNE Market Studies

- California Zero Net Energy State Buildings Decision Maker Study
- ZNE New Home Construction Market Assessment
California Zero Net Energy State Buildings Decision Maker Study
California ZNE State Goals:

- 50% of all new state buildings beginning design after 2020 be ZNE;
- 100% of all new state buildings and major renovations beginning design after 2025 be ZNE; and,
- By 2025, state departments should take measures toward achieving ZNE for 50% of all existing state-owned building square footage.

Purpose of this study was to:

- Characterize state department pathways on their “road to ZNE” through the identification of barriers they face when contemplating ZNE; and,
- Profile the energy use characteristics and performance of state buildings, with particular focus on energy intensity and the presence of onsite electric generation.
Background: California State Agency ZNE Definition

**ZNE Source** – Produces as much energy as it consumes over the course of a year, when accounted for at the energy generation source. Source energy traces the heat and electricity requirements of a building back to the primary energy (raw fuel) input. Source Energy incorporates all production (e.g., generation), transmission, and delivery losses -- allowing for an equitable assessment of building-level energy efficiency, expressed in kBtu.*

California State Buildings

California is a large real estate holder and a major consumer of energy. State owned buildings accounts for:

- ✓ 35 state departments occupy 1,490 properties, which represent 8,612 buildings
- ✓ 112 million square feet
- ✓ 9.9 Billion kBtu of Grid Purchases
- ✓ 78.41 million kBtu of on-site renewable production

State-owned Building Concentration by Zip Code
Research Approach

1. Literature Review & Secondary Data Analysis
   - n=100+ docs
   - Goal: Develop context for interviews and data analysis

2. Interviews: Existing ZNE Building Staff
   - n=10 people
   - Goal: Characterize paths to ZNE (Experiences, Barriers, Solutions, Lessons Learned)

3. Interviews: ZNE Experts, Utilities, & Regulatory
   - n=16 people
   - Goal: Understand policy drivers, Utility roles, Context for barriers, Solutions

4. Interviews: State Agency Decision Makers
   - n=60 people
   - Goal: Understand progress towards ZNE, Barriers, Solutions

5. ESPM Data Analysis
   - n=1,540 Facilities
   - Goal: Characterize state buildings & related energy use variables

Opinion Dynamics

SWEEP 2017 Phoenix
Eight of thirty-five departments have achieved ZNE status for a given building or have a ZNE building in progress. The eight departments are:

- Air Resources Board,
- California Conservation Corps,
- California Department of Corrections and Rehabilitation,
- California Department of Transportation,
- California Lottery Commission,
- Department of Motor Vehicles,
- Department of Public Health, and
- California Office of Emergency Services.
Typical Pathway to ZNE

Phase 1: Consensus Building

Phase 2: Planning

Phase 3: Execution

Phase 4: Monitoring and Verification
4 Key Barriers

- Managing Competing Priorities
- Securing Funding
- Planning & Installing Renewables
- Beginning the ZNE Journey
Barrier: Managing Competing Priorities

Green Executive Order Milestones and Timeline

2012
- Executive Order B-18-12 & B-16-12 Issued
- New & Renovated Buildings Exceed T-24 by 15%

2013
- Buildings <10,000 Sq. Ft. meet CALGREEN TIER 1
- Begin Water Use Benchmarking

2015
- LEED-EB Certification for all Existing Buildings >50,000 Sq. Ft.
- Reduce Water Use 10%
- 10% of Fleet Light Duty Vehicle Purchases Zero Emissions Vehicles
- Executive Order B-29-15 and B-30-15 Issued

2016
- Reduce Water Use 25% from 2013 to February 28, 2016

2018
- 20% Energy Use Reduction

2020
- 50% of New Buildings Zero Net Energy
- Reduce Water Use by 20%
- 25% of Fleet Light Duty Vehicle Purchases Zero Emissions Vehicles

2025
- 100% of New & Renovated Buildings Zero Net Energy
- Take measures toward 50% of Existing State-Owned Building Square Footage Zero Net Energy

2030
- Reduce GHG to 40% Below 1990 Levels
“I know we have those [ZNE] goals, and it's completely unclear to me how we ought to be moving towards trying to achieve them...I think one of the things that would be helpful for me, anyway, is if somebody said, "Here, start with this. Start working through this checklist." I've got a project checklist. I see all the ones for core and shell, I see the ones for mechanical. But is there some more systematic way to be approaching this?”

-State Agency Interviewee
"I mean it’s kind of the challenge with a number of the executive orders that we face, you know, like in a general sense there’s a huge number of requirements that have been laid out, but no additional budget to pursue those things and, a lot of them are very expensive undertakings. So given that we have an aging portfolio of buildings, pretty significant deferred maintenance needs, you know, that is where the priority is, in keeping things running and then a lot of the green initiatives are nice to have things frankly, so it’s just competing budget needs I guess would be the short answer [to the biggest barrier to ZNE]."

-State Agency Interviewee
Our buildings are the easiest type, I think. Our district offices, typically a single story, 10,000 to 15,000 square feet. Typically about 20% of that is warehouse, unconditioned. So almost just by that formula, we’re almost always going to have enough canvas on the roof to handle our [PV] array. Certainly other folks, multi-story, urban setting, it's certainly a whole different challenge than we've had.

-State Agency Interviewee
Progress Toward Source EUI Targets

- Source Energy Use Intensity (EUI):
  - Source energy (typically electricity and natural gas) use per square foot for a given building

- Source EUI targets set by the California Department of General Services (DGS) by Property Use Type

- Opinion Dynamics used Energy Star Portfolio Manager (ESPM) data to measure against DGS Source EUI targets
  - 27% of state owned square footage (21,468,135 sq. ft.) at or below the corresponding DGS target
  - 56,983,645 sq. ft. (73%) over the target, 50% of which within 50% of corresponding target
Progress Toward Source EUI Targets

- Total SF Over Source EUI Target
- Percent of SF Over Source EUI Target
Findings: ESPM Analysis and Decision Maker Interviews

- Energy use and building square footage are highly concentrated within a relatively small number of departments.

- Achieving ZNE through new construction is considerably easier (i.e., has fewer barriers) than through retrofitting existing buildings.

- Identifying buildings for ZNE retrofits is not an objective “one size fits all” process, as each building’s condition and circumstances are unique.

- The data available to assess (or rank) a given state-owned building’s suitability or readiness for ZNE is very limited.
Findings: Key Attributes of Successful ZNE Projects

- Executive sponsorship and careful planning are crucial
- Analysis and commissioning are key during design process
- For retrofit projects, iterate on building efficiency
  - Example: Department of Public Health Building P received Energy Star score of 91 in 2005, improved to 94 in 2008, and 98 in 2010
- Plan for future operations and maintenance challenges
- Communications and collaboration with all stakeholders from planning through occupancy
Recommendations

- Continue to pursue new ZNE funding sources
- Develop a ZNE Manual that includes information on:
  - Identifying key stakeholders early in the process;
  - Potential funding and how to secure them;
  - Procurement process and contracting guidelines; and
  - Assessing and prioritizing buildings based on condition, location, and site characteristics.
- Focus on departments that represent the most significant portion of state-owned building square footage
- Across all departments, identify high potential buildings and prioritize them
Recommendations

- Select buildings for energy efficiency retrofits, toward the goal of reaching ZNE, on a case-by-case basis as each building’s condition and circumstances are unique.

- Supplement ESPM data collection process with institutional knowledge and site suitability for solar PV.
  - Examples include: Building and site footprint, existence of surface parking lot, existing of surrounding green space, building condition, historical designation, presence of asbestos, and deferred maintenance.

- Develop a legal template to cover interconnection issues in situations where a state department own solar PV.

- Consider mechanisms to provide ZNE technical assistance to state departments.
ZNE New Home Construction Market Assessment
Background

Current State:

- In 2011, California mandated that all new residential construction should be ZNE by 2020.
- Presently, very little is known about how residents perceive ZNE, if they understand the concepts, or if they find ZNE homes desirable.

This purpose of this study was to:

- Assess awareness and understanding of ZNE,
- Determine the financial value placed on ZNE homes, and
- Assess the importance of different non-price characteristics in the home purchase decision.
Study Methodology

Results presented here include responses from a internet survey of 500 CA residents currently or recently active in the California homebuyer market.

<table>
<thead>
<tr>
<th>Respondent Group</th>
<th>Number of Completes</th>
<th>Percent of Total Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Homeowners:</strong> Bought a house</td>
<td>120</td>
<td>24%</td>
</tr>
<tr>
<td>in the last year</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Homebuyers:</strong> Actively</td>
<td>380</td>
<td>76%</td>
</tr>
<tr>
<td>looking for a home in CA</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>500</td>
<td>100%</td>
</tr>
</tbody>
</table>

The study aimed to understand differences in knowledge and perceptions between those that had recently purchased homes (homeowners) and those that were still in the market (homebuyers).
# Homebuyer Characteristics (n=380)

## Percentage of Homebuyers by Household Type:

<table>
<thead>
<tr>
<th>Single-Family Home</th>
<th>Townhome</th>
<th>Condo</th>
</tr>
</thead>
<tbody>
<tr>
<td>84%</td>
<td>23%</td>
<td>19%</td>
</tr>
</tbody>
</table>

## Percentage of first-time buyers:

- **43%**

## Planning to own for 6+ years:

- **62%**

## Owns solar panels:

- **19%**

## Over $75,000 household income:

- **33%**

## Has completed some college or more:

- **73%**

## Current home equipped with gas:

- **81%**
ZNE Awareness

Percent of Respondents

Homeowners (n=120)  Homebuyers (n=380)

Zero Net Energy Awareness

47%  27%

Opinion Dynamics

SWEEP 2017 Phoenix
ZNE Awareness

Knowledge of Zero Net Energy

I have only heard the name

I know a lot about it

Homebuyers

Homeowners

SWEEP 2017 Phoenix
Defining Zero Net Energy

- Don't know or never heard of it: 21%
- Low energy use, efficiency, no energy wasted: 16%
- Good idea, quality idea, excellent idea: 10%
- Correct definition of ZNE*: 8%
- Solar power/electricity: 8%
- Home has lower energy bills: 6%
- A company, brand, or program: 6%
- Environmentally friendly, sustainable, or...: 5%
- Home has no energy bills: 4%
- No energy: 4%
- Home uses no energy at all: 3%
- Energy, energy consumption: 2%
- Zero/lower CO2 emissions, climate change: 2%
- Home performance: 1%
- A network, networking, internet, or no...: 1%
- Off grid: 0.9%
- Wind energy or other renewables: 0.7%
- Scam, con: 0.4%
- Solar storage: 0.3%

Percent of Valid Responses

Opinion Dynamics

SWEEP 2017 Phoenix
Valuation of Non-price Home Attributes (n=500)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Percent that Reported Attribute as “Very Important”</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-end, Designer Appliances</td>
<td>27%</td>
</tr>
<tr>
<td>Electric Vehicle Charging</td>
<td>28%</td>
</tr>
<tr>
<td>High-end Finishes</td>
<td>42%</td>
</tr>
<tr>
<td>Solar panels that Produce Electricity</td>
<td>43%</td>
</tr>
<tr>
<td>Low-flow Water Fixtures</td>
<td>46%</td>
</tr>
<tr>
<td>Drought Tolerant Landscaping</td>
<td>46%</td>
</tr>
<tr>
<td>Curb Appeal</td>
<td>48%</td>
</tr>
<tr>
<td>Yard Square Footage</td>
<td>49%</td>
</tr>
<tr>
<td>School District</td>
<td>50%</td>
</tr>
<tr>
<td>Home Square Footage</td>
<td>56%</td>
</tr>
<tr>
<td>Gas Cooktop and/or Oven</td>
<td>57%</td>
</tr>
<tr>
<td>Energy Efficiency</td>
<td>72%</td>
</tr>
</tbody>
</table>
### Desirability of Potential Zero Net Energy Home Features (n=500)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Very Desirable</th>
<th>Desirable</th>
<th>No Opinion</th>
<th>Undesirable</th>
<th>Very Undesirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery for electricity storage</td>
<td>41%</td>
<td>35%</td>
<td>18%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>Energy-use monitoring</td>
<td>31%</td>
<td>39%</td>
<td>22%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Solar panels</td>
<td>48%</td>
<td>34%</td>
<td>12%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>High-efficiency appliances</td>
<td>52%</td>
<td>31%</td>
<td>13%</td>
<td>3%</td>
<td>1%</td>
</tr>
</tbody>
</table>
Homebuyer’s Willingness to Pay for ZNE

Low Home Price Range ($100k-350k)

Cumulative Percent of Homebuyers

- I am not willing to pay anything more: 12% (Purchase Scenario without Energy Savings Considered), 16% (Purchase Scenario with Energy Savings Considered)
- Total willing to pay at least 2% more: 88% (Purchase Scenario without Energy Savings Considered), 84% (Purchase Scenario with Energy Savings Considered)
- Total willing to pay at least 4% more: 51% (Purchase Scenario without Energy Savings Considered), 47% (Purchase Scenario with Energy Savings Considered)
- Total willing to pay at least 6% more: 18% (Purchase Scenario without Energy Savings Considered), 28% (Purchase Scenario with Energy Savings Considered)
- Total willing to pay at least 8% more: 8% (Purchase Scenario without Energy Savings Considered), 12% (Purchase Scenario with Energy Savings Considered)
- Total willing to pay 10% more: 1% (Purchase Scenario without Energy Savings Considered), 6% (Purchase Scenario with Energy Savings Considered)

Purchase Scenario without Energy Savings Considered
Purchase Scenario with Energy Savings Considered
California homebuyers value energy efficiency and ZNE attributes and are even willing to pay a premium for them. However, they are unfamiliar with the term “Zero Net Energy.” Promotion of Zero Net Energy concepts should focus on the attributes and principles of ZNE, not the name as a brand.

Energy efficiency is the highest rated non-price home attribute.

ZNE home attributes are desirable to a majority of homeowners and homebuyers.

Awareness of ZNE is low and most people do not have an accurate understanding of what it is.

The majority of homeowners and homebuyers were willing to pay at least 2-4% more for a ZNE home.
Key ZNE Market Takeaways
### Key ZNE Market Takeaways

#### Calculating the Renewable Offset
- Multiple definitions of ZNE exist that have important implications for the amount of renewables needed to offset building energy consumption.

#### Physical Location of Renewable Assets
- Determining the building system boundary is another key issue. Do renewables need to be located within the building footprint or onsite? Or are other alternatives appropriate?

#### Barriers Systemic in Nature
- Grid not designed to be dynamic
- Tariff structures that reward existing technologies and the status quo
- Legislation and policies that are at odds to the required speed of change
Key ZNE Market Takeaways

**Cost Premiums Mostly Not an Issue**
- ZNE buildings can be built for similar costs as standard buildings in most climate zones for most building types

**State of the Shelf Technologies**
- ZNE can and has been achieved with current off the shelf technologies and building construction practices

**Knowledge and Awareness are Challenges**
- Homeowners value ZNE attributes; but are unaware of the ZNE brand
- Training gaps exist for building operators, facility managers, designers, architects, etc. on how to design, build, operate and maintain ZNE buildings
Thank you!

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