California’s Zero Net Energy Goals
Grid Integration Issues and
Commercial ZNE Action Plan Update

CPUC Emerging Trends
November 29, 2017
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Mindy Craig, BluePoint Planning
CPUC’s Role in Zero Net Energy

- Long Term Energy Efficiency Strategic Plan (approved in D.08-09-040)
  - New Residential ZNE Action Plan
  - Commercial ZNE Action Plan Update
  - Working with CEC on meeting SB350 & other goals
- Oversee and direct funds for IOU new construction and key energy efficiency programs
  - CA Advanced Home Program (New Construction)
  - Savings By Design (Commercial New Construction)
  - Emerging Technologies
  - Studies on Market, Feasibility, and Costs of ZNE
  - Codes Programs
- Leading State Policy-maker for ZNE

Woodlake – Affordable ZNE Housing
CA Energy Commission and 2019 Residential Building Code

- CEC is on a trajectory to have a near-ZNE new residential building code by 1/1/20
- Based on an “Energy Design Rating” Score
- Requires all cost-effective EE measures first
- Requires PV to off-set residual elec. (not NG) demand
- Provide “compliance credits” to minimize PV size
- Mitigation measures: on-site storage, demand response
- Exemptions for extreme climate zones, shaded structures, etc.
# Energy Design Rating Dashboard

EDR of Proposed Efficiency: 41.9  -  EDR of Prop PV + Flexibility: 19.1 = Final Proposed EDR: 22.8
EDR of Standard Efficiency: 43.2  -  EDR of Minimum Required PV: 18.5 = Final Std Design EDR: 24.7

<table>
<thead>
<tr>
<th>End Use</th>
<th>Reference Design Site (kWh)</th>
<th>Reference Design Site (therms)</th>
<th>Reference Design Site (kTDV/ft²-y)</th>
<th>Proposed Design Site (kWh)</th>
<th>Proposed Design Site (therms)</th>
<th>Proposed Design Site (kTDV/ft²-y)</th>
<th>Design Rating Margin (kTDV/ft²-y)</th>
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<td>Space Heating</td>
<td>584</td>
<td>466.0</td>
<td>45.09</td>
<td>187</td>
<td>217.2</td>
<td>19.51</td>
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<td>Space Cooling</td>
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<td>317</td>
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<td>IAQ Ventilation</td>
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<td>Other HVAC</td>
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<td>13.03</td>
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<td>-43.51</td>
<td>-43.51</td>
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<td>1.61</td>
<td>616</td>
<td>6.98</td>
<td>23.44</td>
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<td>Photovoltaics</td>
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<td>73.4</td>
<td>15.65</td>
<td>1,040</td>
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<td>Battery</td>
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<td>35.06</td>
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<td>3.54</td>
<td>152</td>
<td>1.61</td>
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<td>TOTAL</td>
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<td>735.7</td>
<td>204.49</td>
<td>-146</td>
<td>382.3</td>
<td>52.15</td>
<td>152.34</td>
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</tbody>
</table>

[Image of the Energy Design Rating Dashboard]
CPUC Consultant (DNV-GL) Study of Residential ZNE Distribution Upgrade Costs

- Residential ZNE Policy forecasted to increased PV capacity by 6.2 GW by 2026
- Study estimates distribution upgrade costs of ZNE code
- Study objectives
  - Inform CEC’s ZNE policies
  - Inform NEM policies
- Evaluate 2 cases (2016-2025)
  - Base case (based on IEPR demand forecast)
  - Residential ZNE case (base plus incremental growth)
- Not a cost-benefit study
DNV-GL Methodology

- Mapped annual PV growth to distribution circuits, using a geographic allocation method.
- Assumed 2kW system size per home
- Categorized into representative circuits
- Performed flow studies on 75 sample circuits assuming up to 160% penetration
- Evaluated technical criteria: voltage, thermal, reverse power flow
- Added mitigation measures: traditional measures, energy storage, smart inverters, optimal location
- Examined 2 scenarios:
  - High Cost case - all ZNE homes lumped together in one place
  - Low Cost case – ZNE homes distributed throughout feeder
Conclusions of DNV-GL Study

- **Integration costs** of high penetration PV – whether driven by ZNE policy or NEM policy alone – **can be high if not mitigated**.

- **Mitigation measures are available** to reduce grid upgrade costs to more acceptable levels, and can reduce costs by 85% to 95%  
  – **Smart inverters**: CPUC should update required smart inverter settings.
  – **Optimal location**: IOUs Integration Cost Analysis (ICA) tool should be helpful to indicate low cost locations.

- **Most likely case** is probably in the range indicated by the Smart Inverter Sensitivity Case  
  – Effective Sept 2017: Smart Inverter Phase 1 capabilities will be required  
  – CPUC staff proposal to modify Rule 21 to require reactive power priority (in Volt / Var settings)  
  – Debatable whether realistic to assume that PV will be installed throughout a circuit

- Study available at www.cpuc.ca.gov/zne
Moving Forward . . .

From the ZNE we are getting, to the ZNE we want!
• Some Market actors think ZNE = Solar on Roof
• Residential Title 24 moves to ZNE/ZNE Ready in 2020
• State goals and research recognizes need for:
  – Need to catalyze and leverage Distributed Energy Resources
  – Localized value of ZNE to the Grid
  – Manage and flatten energy loads
• Utilities engagement in ZNE effort and EE Business Plans
Why is ZNE Important?

• Zero has market cache and inspires
• For new commercial and residential buildings, savings equivalent to 14 - 500MW power plants
• ZNE drives Energy Efficiency gains (60-70% reduction)
Evolution and Need to Refocus
Commercial ZNE Action Plan
Goal: Beginning in 2030, all new commercial buildings and major renovations of existing buildings achieve zero net energy performance (onsite/offsite renewables) and grid optimization.

Objective: ZNE Buildings and Districts are integrated as key distributed energy resources that reduce carbon emissions, enhance customer experience and create more resilient communities.
Focus on Drivers of ZNE

1. Programs Enable ZNE/ZNE Ready Buildings & Districts
2. Informed Customer Decisions
3. Integrated ZNE Districts
4. Market Capacity & Readiness
5. Targeted Technology R&D
6. Codes & Standards
Path to ZNE (DER) Discussion Tool

Informed by CPUC, CEC policy goals:

- Grid Friendly/Load Balancing
- Locational Value
- Cost Effective
- Equity for Ratepayers
- Reduce Transmission & Distribution Investments
- Distributed Energy Resources
- Reliability
- Powered by Customer needs and objectives

Goal – Better decision making with Customer Choice
## Example 1. Sustainability Focused Customer

<table>
<thead>
<tr>
<th>Value</th>
<th>Objective</th>
<th>Building Scale ZNE</th>
<th>Community Scale DE</th>
<th>Utility Scale Renewables</th>
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<td></td>
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<td>Value</td>
<td>Score</td>
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<td>5</td>
<td>Sustainability</td>
<td>4</td>
<td>20</td>
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<td>5</td>
<td>Resiliency</td>
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<td>25</td>
<td>4</td>
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<tr>
<td>5</td>
<td>Carbon Zero/Neutral</td>
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<td>15</td>
<td>4</td>
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<tr>
<td>4</td>
<td>Infrastructure Modernization</td>
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<td>4</td>
<td>3</td>
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<td>Local Energy Supply</td>
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<td>3</td>
<td>Monetization Of Energy</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>3</td>
<td>Load Management</td>
<td>1</td>
<td>3</td>
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<tr>
<td>2</td>
<td>Asset Control/Management</td>
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<td>District Energy/CHP</td>
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<td>5</td>
<td>Ease of Access</td>
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**Score** | **118** | **130** | **85**
## Example 2. Economic Focused Customer

<table>
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<tr>
<th>Value</th>
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<th>Building Scale ZNE</th>
<th>DER/Community Scale</th>
<th>Utility Scale Renewables</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Value</td>
<td>Score</td>
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<td>Carbon Zero/Neutral</td>
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<td>Infrastructure Modernization</td>
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<td>Grid Optimization</td>
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<td>4</td>
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<td>5</td>
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<td>Ease of Access</td>
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| Score | 125 | 122 | 70  |
Questions?

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Appendix
## Results: High Cost Scenario

Grid Integration Costs for new PV between 2016 and 2026

<table>
<thead>
<tr>
<th>High Cost Case</th>
<th>PG&amp;E</th>
<th>SCE</th>
<th>SDG&amp;E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Cost</td>
<td>Cost Per Ratepayer</td>
<td>Total Cost</td>
</tr>
<tr>
<td>Without ZNE</td>
<td>$850 M</td>
<td>$157</td>
<td>$134 M</td>
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<tr>
<td>With ZNE</td>
<td>$1,473 M</td>
<td>$273</td>
<td>$179 M</td>
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<tr>
<td>Difference</td>
<td>$623 M</td>
<td>$116</td>
<td>$45 M</td>
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</table>
Smart Inverter Sensitivity Case

Use of smart inverter functions (i.e., Volt / Var control) as mitigation measure

Assumptions:

- Used IOUs’ Volt / Var curves
- **Reactive power priority** assumed.
- Where smart inverters absorbed reactive power, a **capacitor bank** was assumed to be installed on the feeder. Functionality is assumed autonomous, so **no other costs were added**.
- **Real power losses not been included** (max loss is 5% at any time; total energy loss would be significantly lower than this).

Affects **high cost case only**. The low cost case results remain the same, as there was no requirement for energy storage to mitigate problems in that case.
### Results: Smart Inverter Sensitivity Case

Grid Integration Costs for new PV between 2016 and 2026

<table>
<thead>
<tr>
<th>Smart Inverter Study</th>
<th>PG&amp;E</th>
<th>SCE</th>
<th>SDG&amp;E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Cost</td>
<td>Cost Per Ratepayer</td>
<td>Total Cost</td>
</tr>
<tr>
<td>Without ZNE</td>
<td>$262 M</td>
<td>$48</td>
<td>$92 M</td>
</tr>
<tr>
<td>With ZNE</td>
<td>$510 M</td>
<td>$94</td>
<td>$116 M</td>
</tr>
<tr>
<td>Difference</td>
<td>$248 M</td>
<td>$46</td>
<td>$24 M</td>
</tr>
</tbody>
</table>

1/3 to 2/3 lower than High Cost Scenario
Results: Low Cost Scenario

Grid Integration Costs for new PV between 2016 and 2026

<table>
<thead>
<tr>
<th>Low Cost Case</th>
<th>PG&amp;E</th>
<th>SCE</th>
<th>SDG&amp;E</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Total Cost</td>
<td>Cost Per Ratepayer</td>
<td>Total Cost</td>
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<tr>
<td>Without ZNE</td>
<td>$75 M</td>
<td>$14</td>
<td>$51 M</td>
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<tr>
<td>With ZNE</td>
<td>$117 M</td>
<td>$21</td>
<td>$36 M</td>
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<tr>
<td>Difference</td>
<td>$42 M</td>
<td>$7</td>
<td>$15 M</td>
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</tbody>
</table>

80% – 95% lower than High Cost Scenario
Reasons for the Cost Differences

• Average PV penetration
  PG&E has the highest
• Number of homes projected per feeder
  PG&E has the highest home:feeder ratio
• Distance from substation to end of circuit. Longer circuits are more sensitive to voltage issues
  PG&E circuits are generally the longest
Meeting Future Need

Energy Consumption

- Fossil Fuels/Natural Gas Use
- Grid Capacity
- Kwh - iElectric Use

Energy Efficiency + Local/Onsite ZNE and DER

Utility Scale Renewables + Storage

Moving to Fuel California’s Economy with Renewable Energy

Time