Emerging Technologies Summit

MAKING THE CONNECTION:

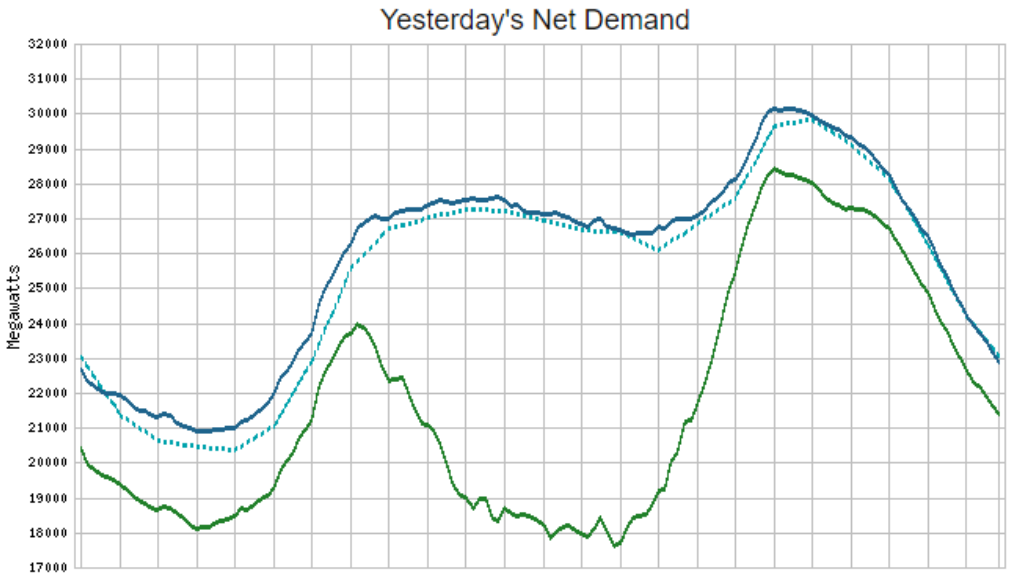
From Energy Efficiency Innovation to Delivery

April 19 – 21, 2017

Getting to 2020: Paving the Path to Zero Net Energy Homes

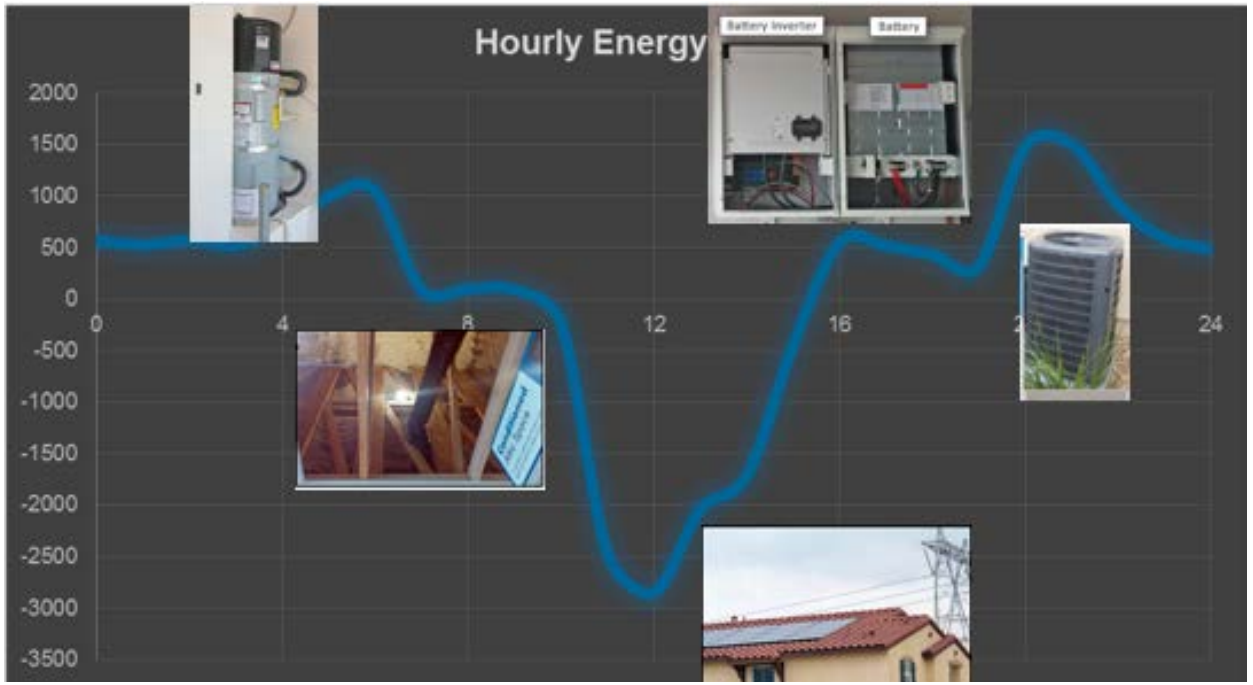
RAM NARAYANAMURTHY, PETER TURNBULL, CHRISTOPHER MEYER, RORY COX, JOHN MORTON, CR HERRO

Supply – Demand balance needs rising at all levels….



California ISO Demand Curve for Feb 7, 2017

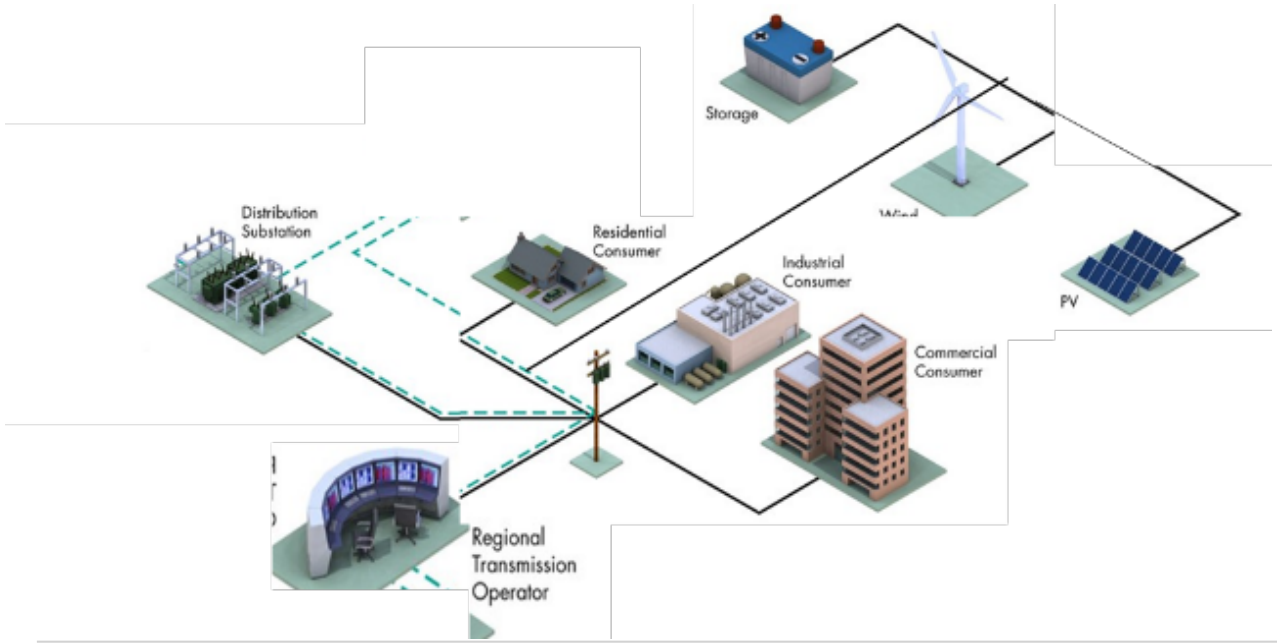
Net Demand for Advanced Energy home, Feb 1, 2017

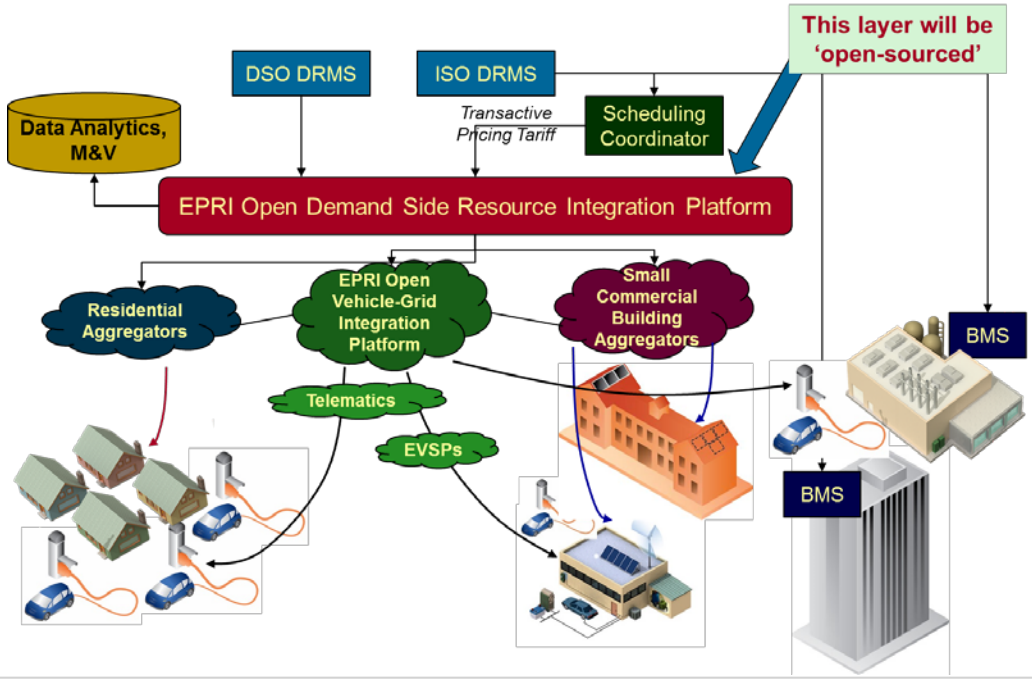


Customer technology evolution driving load shape changes, and increasing balancing needs from grid edge to the ISO

The concept of an Advanced Energy Community

Advanced Energy Communities (AEC) are customer focused communities that **integrate multiple customer resources** such as Energy Efficiency, Demand Response, Customer storage, PV (or other local generation), electrification and electric vehicles in an **electrically contiguous area** to achieve larger **utility and societal goals** such as decarbonization, grid hardening and grid support while enabling the utility customers with advanced technologies that **provide comfort, convenience, and cost benefits to the customer**





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ZNE and the 2020 Residential Goals

A Utility Perspective

Peter Turnbull, Principal, PG&E

ETCC Meeting
April 21, 2017

On Meeting the 2020 ZNE Residential Goals for California

Technical feasibility of ZNE in residential new construction: a settled issue for years

The "no regrets" approach to ZNE: Reduce, reduce, reduce the building's kBtu footprint

- Reducing the footprint means:
  - The shell is better and more durable
  - The major appliances and systems are more efficient and better performing
  - Ongoing innovations in the industry will continue to improve shells and systems
  - The reduced-footprint dwelling is more durable, more comfortable, quieter and more healthy than a standard dwelling
- Add renewables
  - Today, PVs on the roof is the viable option
  - Going forward, work with new renewables markets and structures as they evolve and become available

The cost of the reduced footprint is between zero and a few thousand dollars. New homes are typically priced well into six figures

“Issues” Moving forward with ZNE for 2020

Policy Objective and Definitions

- We notice that the “big picture” goal is carbon reduction—existing metrics for ZNE (TDV, source energy) appear to be diverging from alignment with carbon reduction: this issue needs attention from policy makers
- The multiple metrics for ZNE lead to marketplace confusion

Issues “At Scale” for utilities

- Utilities want satisfied customers; supporting customer efforts to “get to zero” is a great way to get there. Although there are multiple metrics for ZNE, meeting “zero” with any of them will produce an excellent house with a low bill.
- Utilities will need to recover costs; grid-related costs will not necessarily decline with high penetration of ZNE and customer-owned renewables. A robust grid is an imperative now and in the future—thus, “zero bill” is not a sustainable concept and it will not be productive to “message” ZNE in this manner

Builder Issues

- Establishing supply chain management innovations and practices to assure that the required labor force, materials, construction techniques and building systems are available at scale and at acceptable cost

Building Energy Efficiency Standards

2019 Building Energy Efficiency Standards ZNE Strategy

Building Standards Office:

Mazi Shirakh, PE
ZNE Lead and Advisor for Building Energy Standards Standards
Christopher Meyer
Manager, Building Standards Office
Bill Pennington
Senior Technical and Program Advisor to the Energy Efficiency Division

COUNTDOWN TO 2020

April 21, 2017

ZNE Goals – Lessons Learned

Reality turns out to be more nuanced - Since ZNE policy was first set we have learned about the impact of

- **50% RPS and** large scale PV deployment on the grid
- large scale deployment of **building-based PVs** which **lowers the value of additional electricity around midday**, coincident with utility solar production
- Net energy metering (**NEM)** and Time-Of-Use (**TOU**) on **compensation for residential customer-owned generation and cost effectiveness of PVs**

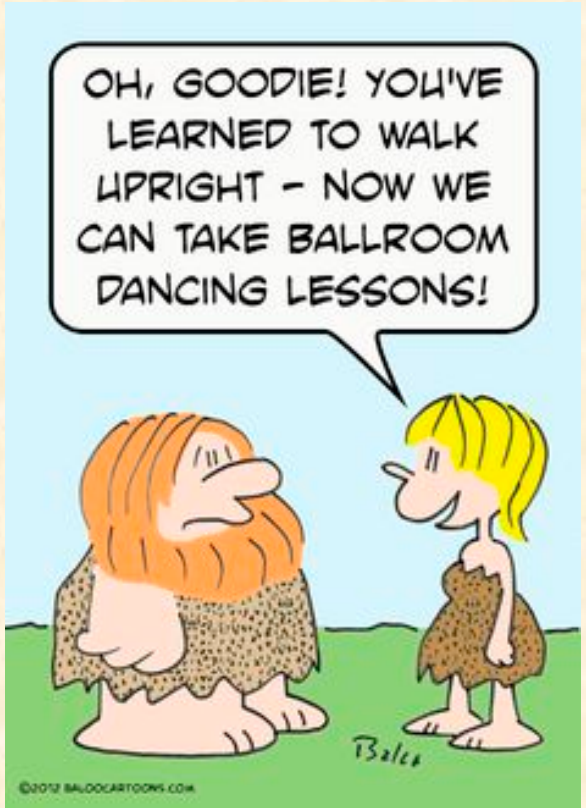
Also, we have learned that as the **electric grid becomes greener** in the future, rooftop **PVs will have diminished carbon reduction benefits**

ZNE Goals – Lessons Learned - Continued

The most important lesson is that **grid harmonization strategies (GHS) must be coupled with customer owned PV systems to bring maximum benefits to the grid, environment, and the home owner**

GHSs are strategies that maximize self-utilization of the PV array output and minimizes uneconomic exports to the grid, examples of GHS include but not limited to battery storage, demand response, thermal storage, and EV integration.

the 2019 Standards approach must consider these issues



Proposed 2019 Standards Approach

Energy Design Rating (EDR) targets for each climate zone:

1. An EDR level for energy efficiency features based on 2019 prescriptive measures – This EDR target can only be met using energy efficiency measures
2. An EDR Contribution for PV array that is sized to displace the annual site kWhs
3. Combine the energy efficiency EDR with the PV EDR for one final target EDR

The prescriptive PV size will be calculated as follows:

$$PV_s = W_{sf} \times CFA \times A_{aj} \times CZ_{aj}$$

Where
PV_s is the DC size of the PV system
W_{sf} is the PV size per square foot of the conditioned floor area
CFA is the conditioned floor area
A_{aj} is the area adjuster
CZ_{aj} is the climate zone adjuster

Proposed 2019 Standards Approach

1. Maximize envelope efficiency as allowed by LCC and calculate EE EDR
   i. HPA to R19 in severe CZs – Currently R13
   ii. HPW to 0.043 ~ 0.046 U-factor in severe CZs – Currently 0.051
   iii. Windows U-factor of 0.30 and SHGC of 0.23 – Currently 0.32 and 0.25
   iv. QII as a prescriptive requirement
2. Establish an Energy Design Rating (EDR) for energy efficiency in each CZ **that can only be met with efficiency measures (no PV tradeoff against EE)**
3. Calculate EDR of PV array as follows:
   i. Calculate the PV size required to displace the site kWh in each CZ
   ii. Calculate the EDR contribution of the PV array
4. Combine the EDR contribution of EE to the EDR contribution of PV and **establish a Target EDR in each CZ that the building must meet to comply**

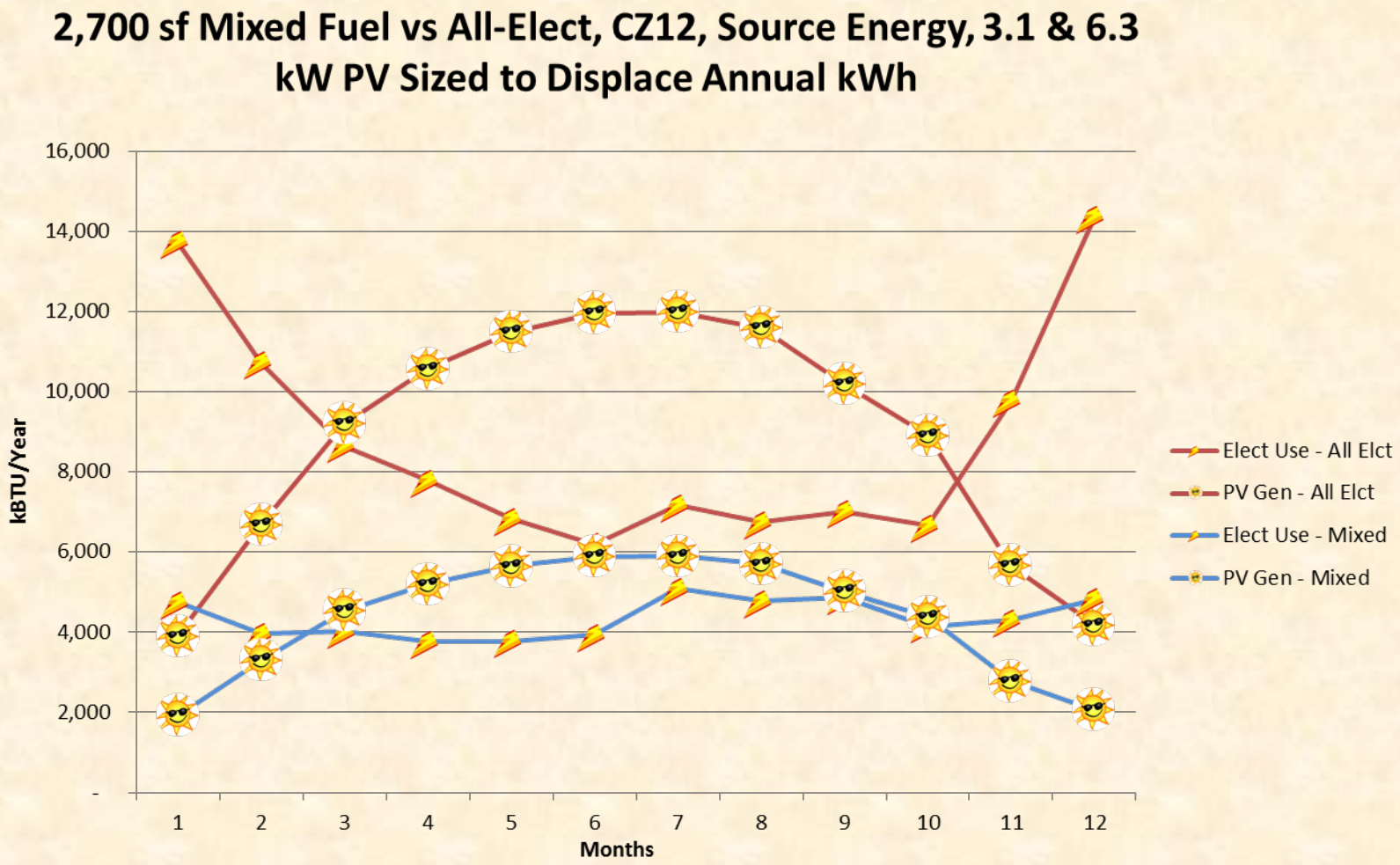
Note: Examples are presented in later slides

Target EDR's Many Advantages

1. A target EDR establishes a **performance benchmark that the building must meet to comply**; the concept is similar to **performance standards** consistent with the Warren-Alquist Act expectation to provide builders with compliance flexibility
2. As shown by the **2016 HPA and HPW approach, builders appreciated having many options** to comply, leading to a flurry of **innovation in attics and walls**, which continues to date
3. **Target EDR** can send the **right signals to the market about EE, PV sizing, storage, demand response and flexibility, and other grid harmonization strategies** that can achieve ZNE in the future
4. Target EDR allows the builder **to use more efficiency and less PV to get to the target**; the builder can also **use high performance glazing or appliances that are higher than minimum efficiency** levels that we are prevented to require because of preemption
5. Target EDR is fully **compatible with the reach codes**, local jurisdiction simply identify a lower target EDR (or zero) that can be met with a combination of additional EE, PV, demand response/flexibility, EV integration, or storage
6. Target EDR works well with **varying building sizes** – static PV size does not

All-Electric - Summer Duck vs Christmas Turkey

All-Electric homes use more kWhs in the winter than summer that may result in higher peak and demand in winter – Grid harmonization becomes more important – Like a broken clock, a dumb PV systems is correct twice a YEAR



Getting to Zero: The Regulatory Perspective

Rory Cox, CPUC, Energy Division

Emerging Technologies Summit

April 21, 2017

A few proceedings related to ZNE

- Energy Efficiency Proceeding (R.13-11-005) – Considering 10 year business plans
- Distributed Resource Planning (DRP) Proceeding (R. 14-08-013) - Identify optimal locations for optimal DER portfolios
- Integrated Distributed Energy Resources (IDER) Proceeding (R.14-10-003) – Competitive DER solicitation framework

ZNE Grid Integration Study – Purpose and Approach

- Study in progress by DNV-GL
- Purpose:
  - Evaluate the impacts of ZNE on the distribution grid to be included in Title 24 cost-effectiveness method
- Scope:
  - DNV GL's scope is to calculate the integration costs of ZNE to the grid and work with CEC to incorporate these costs into Title 24.
- Approach
  1. Create base case scenario using DRP circuits and IEPR housing and PV forecasts
  2. Overlay circuits, houses and PV on a map
  3. Cluster circuits into representative circuits for analysis
  4. Calculate ZNE integration costs per representative circuit
  5. Extrapolate costs to the rest of the IOU territory

ZNE Grid Integration Study – Preliminary Conclusions

- Projected ZNE integration costs per new ZNE home:
  - PG&E: $876/home ($586M across IOU territory – 670,000 homes)
  - SCE: $162/home ($53M across IOU territory – 325,000 homes)
  - Costs start to increase exponentially once storage is required to mitigate transient voltage problems
  - Costs are shared between building developer and utility ratepayers
- Projected feeders requiring storage for PV integration by 2024:
  - PG&E: 126 (out of 860)
  - SCE: 1 (out of 2189)
- Total MW of distributed storage (utility or customer-owned) required by 2024 to integrate the forecasted ZNEs:
  - PG&E: 133 MW
  - SCE: 0.22 MW

ZNE Grid Integration Study – Preliminary Conclusions Notes

The reasons for the cost differences between SCE and PG&E:

- PG&E has more homes projected over fewer feeders.
- PG&E has higher average PV penetration. (20% for PG&E and 12.7% for SCE.)
- PG&E feeders tend to have more need for energy storage as mitigation. Based on the sample circuits, PG&E circuits tend to be significantly longer from substation to the end of the circuit (average of around 11,400 ft for PG&E versus 6,600 ft for SCE), and for total length including all branches (74,000 ft for PG&E versus 27,500 ft for SCE). Longer circuits can lead to more sensitivity when it comes to voltage regulation.

Possible Mitigation Measures/Other factors to consider

- Energy Storage
- Smart Inverters – Phase 3
- Possible Waivers for some circuits
- Quantifying Additional Benefits
- Demand Response and Pre-cooling

Questions?

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WISE
Workforce Instructions for
Standards and Efficiency
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EPIC WISE

Builder Solutions to Meeting Compliance

Meet with Builders to present solutions:

Including the senior management, project management and purchasing for the project

- WISE team will present multiple solutions for meeting high performance walls and attics along with projected cost
  - WISE team will work to understand builder concerns and address each one
  - Builder team will select a solution best suited for their product

EPIC WISE

On the Job TRAINING!

Create a working group including:

Builder, WISE team, Architect, Engineers, Energy Consultant, HERS Rater, Relevant Subcontractors and Product Manufactures

- Working Group will ensure that:
  - All plans and details are done correctly to implement the chosen solution;
  - All subcontractors, consultants and builder staff understand all installation requirements;
  - Nothing is being bid that is unnecessary by reviewing all contract scopes of work and subcontractor bids;
  - Installers are working efficiently and the product is installed properly through on-site training.

Website Resource

WISE
Workforce Instructions for Standards and Efficiency

www.wisewarehouse.org

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WISE
Workforce Instructions for Standards and Efficiency

Thank you.

Presented by: John Morton, Senior Project Manager
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Meritage Homes

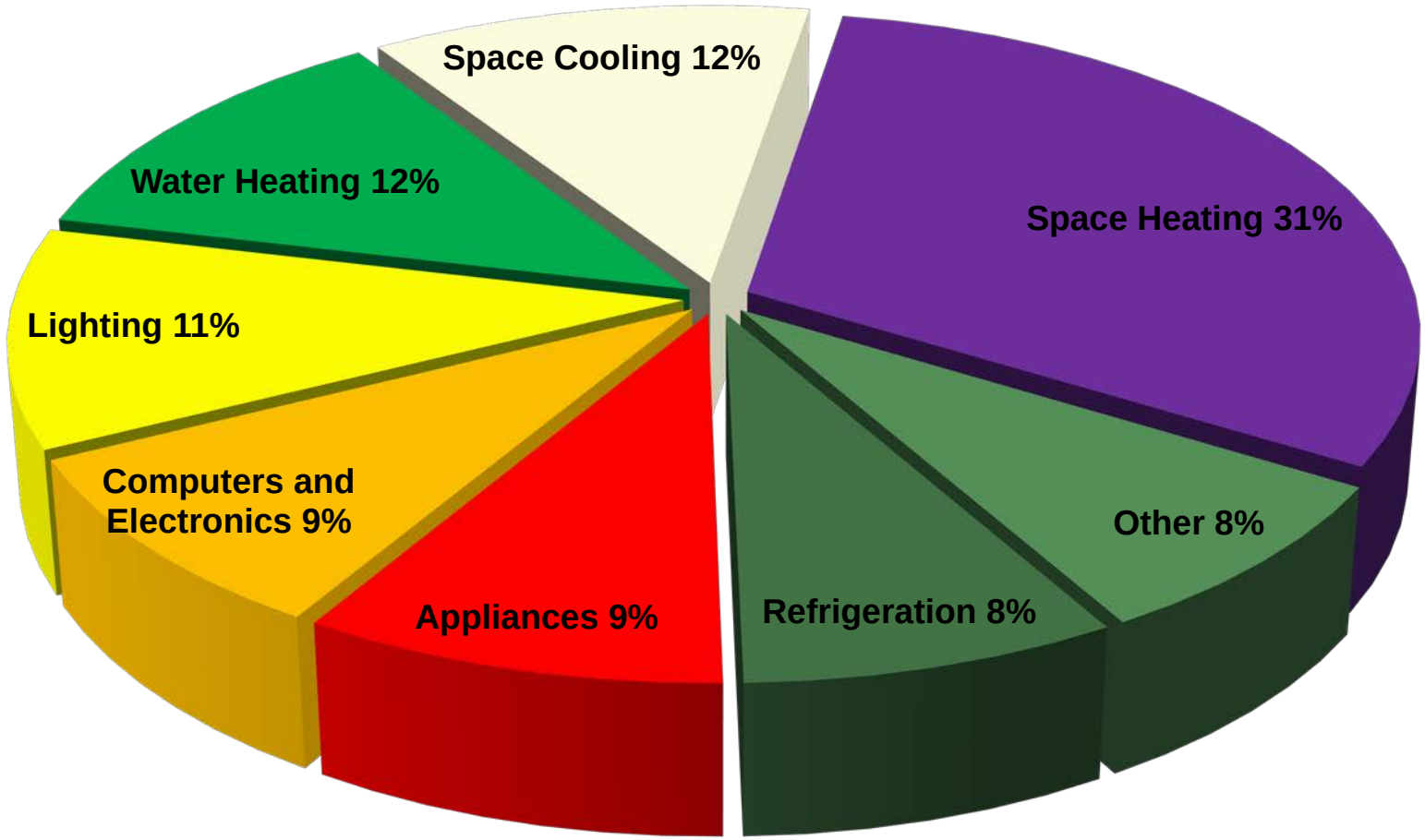
“Skate to Where the Puck Is Gonna Be”

Wayne Gretzky

81%

say higher energy efficiency would cause them to choose one new home over another.

Designing and Permitting Zero

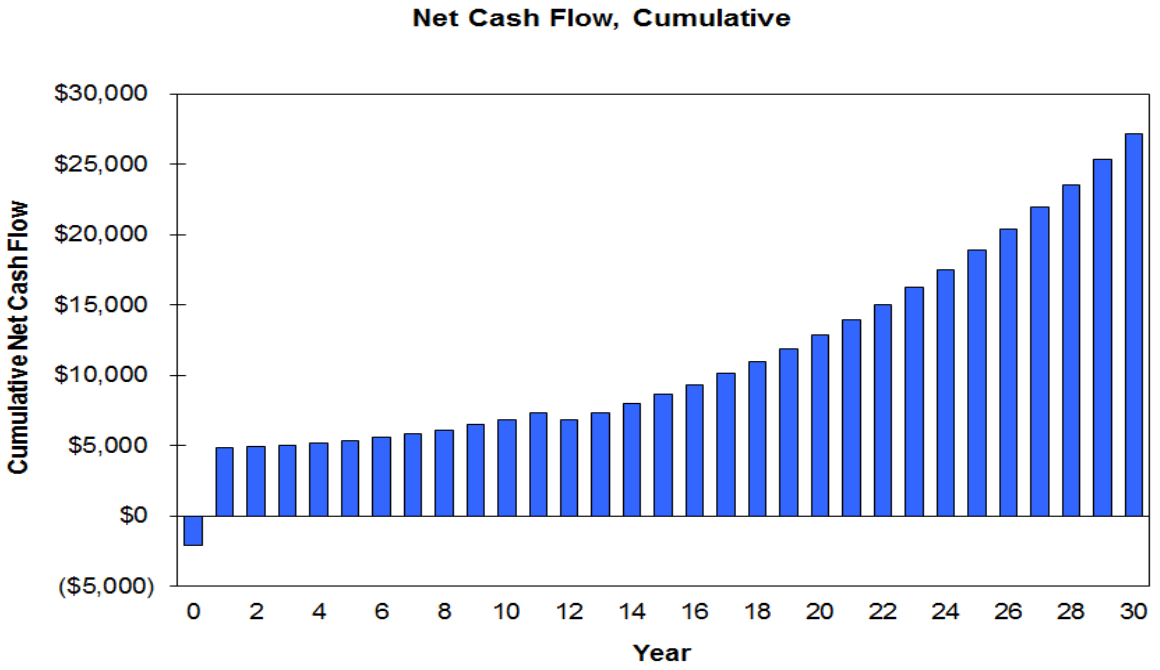


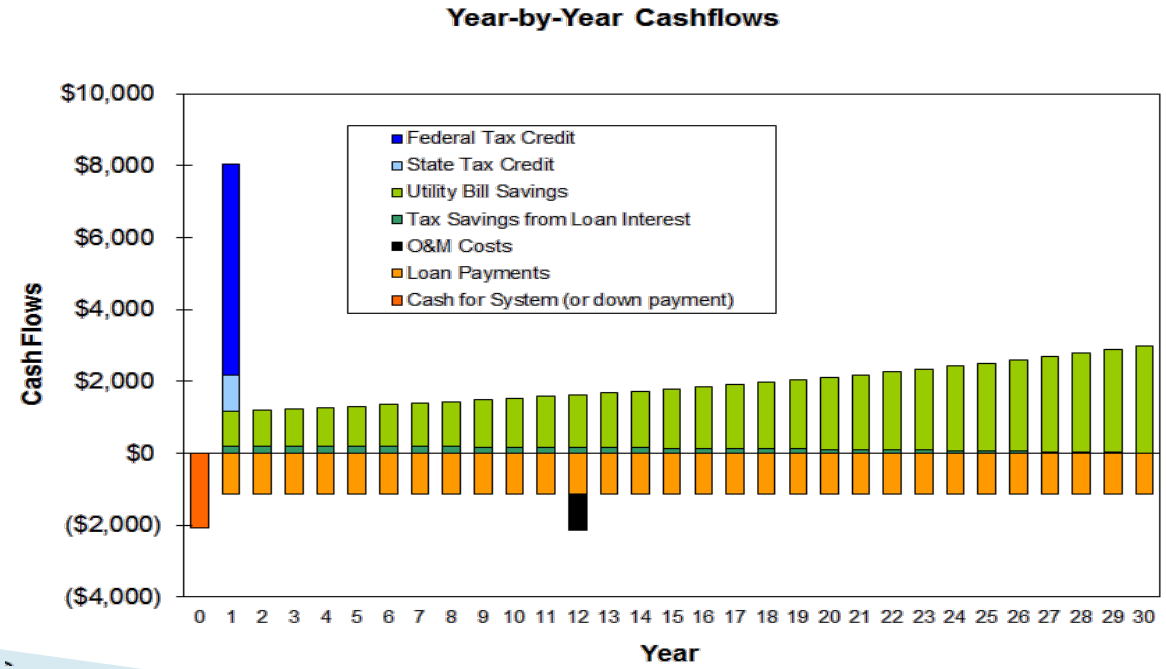
Cash Flow Analysis Example:

4.6kW system

Assumptions

- 10% down, 30-yr FMR at 4.6%
- Avg. rate of $0.12 per kWh
- Electricity rate of inflation = 4%

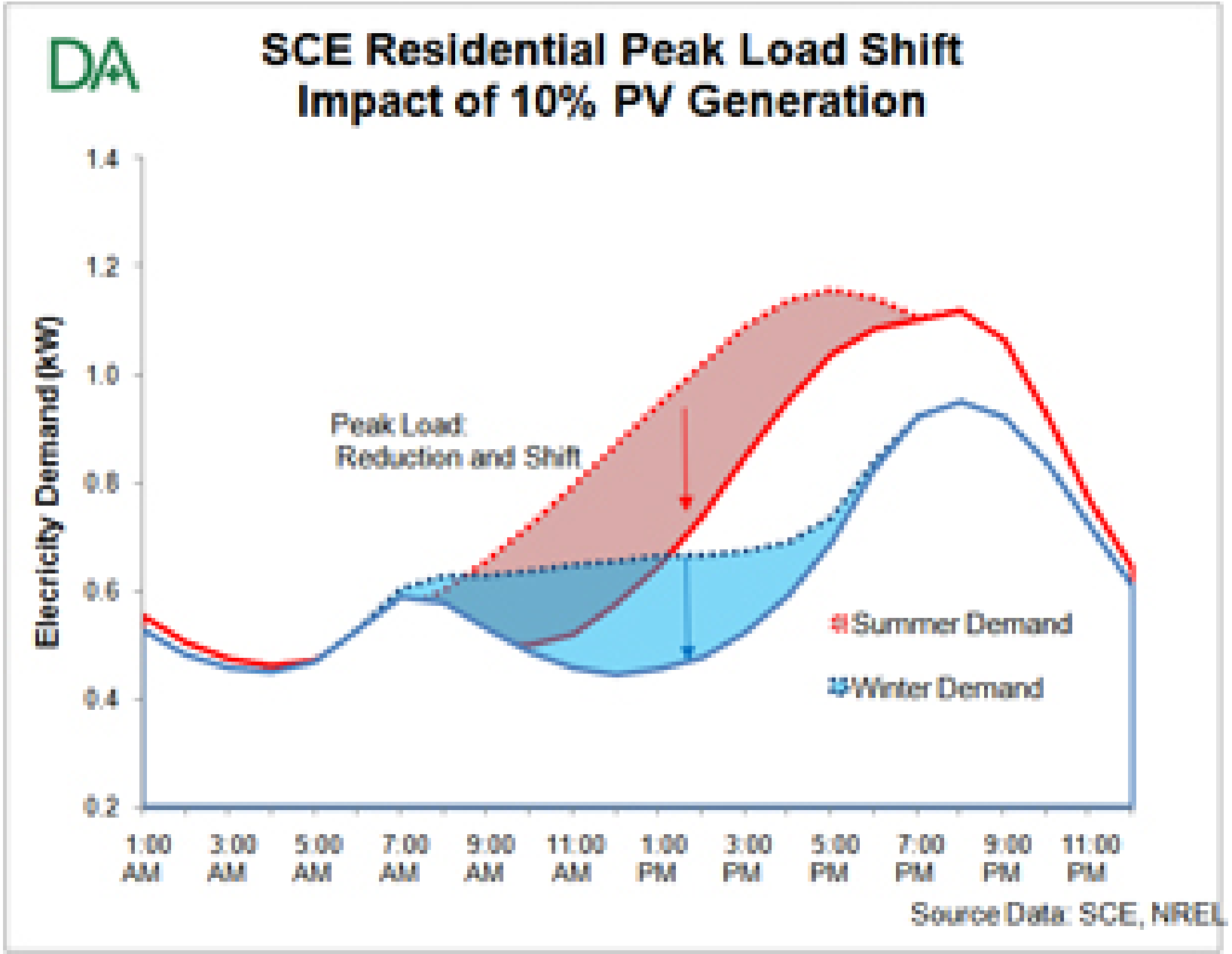




Selling: Zero

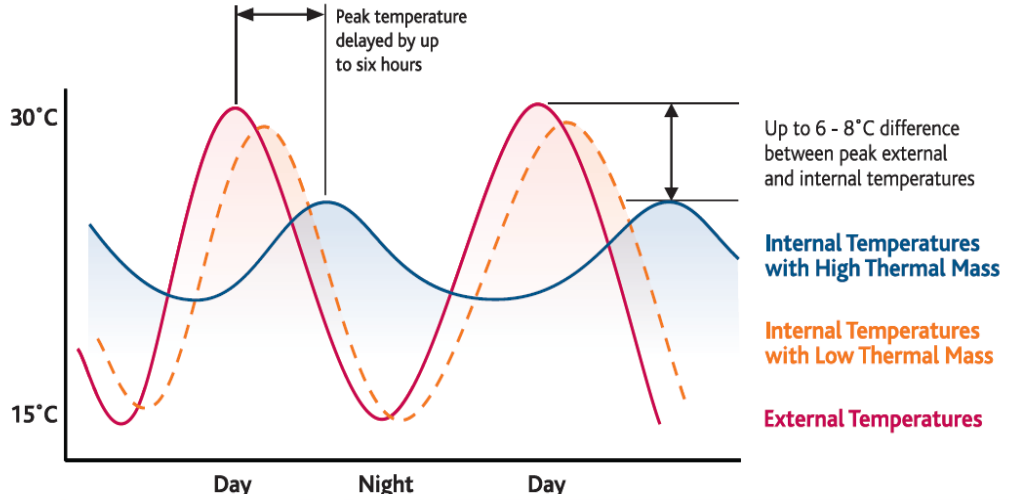
Sierra Crest

Renewable Energy: Duck Curve



Moving the Energy Demand

1. West facing solar.
2. Smart ventilation (off peak)
3. Isolated Thermal mass / phase change
4. Thermal storage (heatpump HVAC precool off peak)
5. Low solar heat gain (reflective / vented cladding materials)
6. Smart appliances
7. Large hot water storage w/ heat pump.



Policies to Support Zero

Questions?