SOUTHERN CALIFORNIA EDISON
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Accelerating the Advancement & Adoption of ZNE

Jerine Ahmed
Southern California Edison

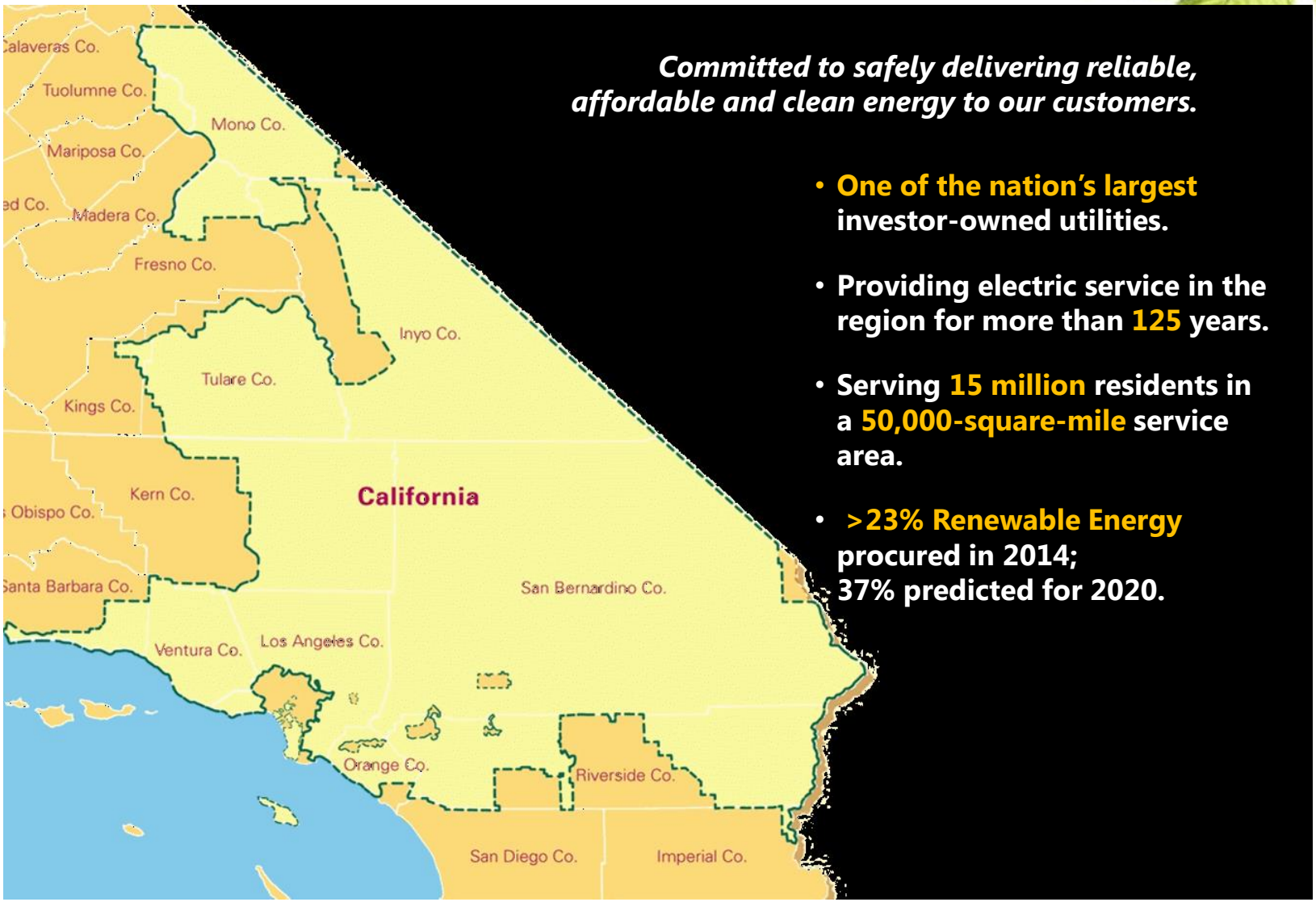
January 26, 2017

Agenda

Overview of SCE's involvement with ZNE

Emerging Products

SCE Highlights



Committed to safely delivering reliable, affordable and clean energy to our customers.

- **One of the nation's largest investor-owned utilities.**
- **Providing electric service in the region for more than 125 years.**
- **Serving 15 million residents in a 50,000-square-mile service area.**
- **>23% Renewable Energy procured in 2014; 37% predicted for 2020.**

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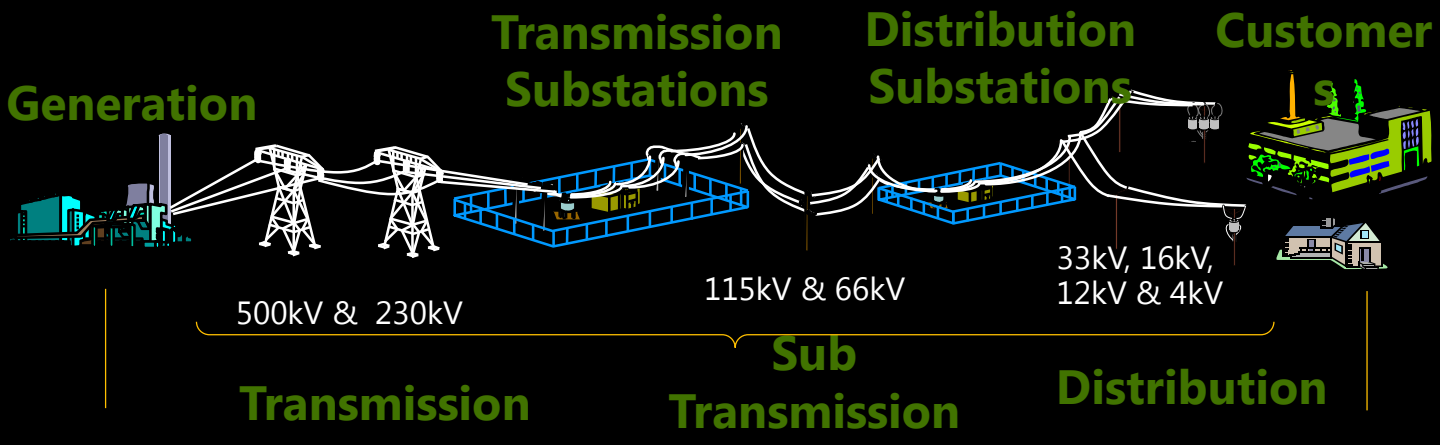
SCE and the Utility Business



3,100 MW owned generation

- SCE owns less than 20% of its power generation needs
- The rest is procured on a competitive market

Our "Wires Business"

- 1.4 million power poles
- 725,000 transformers
- 103,000 miles of power lines

Revenue Decoupling

- SCE earning are not affected by changes in electricity sales
- Promotes energy conservation

California Pursuing Aggressive Energy Policy

Technology Promotion

- Integrated Distributed Energy Resource (IDER) Proceeding
- 1,325 MW Energy Storage Mandate
- "Charge Ready": Transportation Electrification

Senate Bill 350 (2015)

- 50% Renewable Portfolio Standard (RPS) by 2030
- 50% increase in building Energy Efficiency by 2030
- Integrated resource planning
- Transportation Electrification

Assembly Bill 327 (2013)

- Net Energy Metering Successor Tariff
- Residential rates reform
- Distribution Resources Plan (DRP)

Distribution Resources Plan Goals

- Modernize distribution system to accommodate customer choice
- Enable new technologies/services that reduce emissions, improve reliability
- Provide opportunities for Distributed Energy Resources to provide grid

DRP → Grid Modernization

Grid Modernization will enable customer choice and maximize the benefits of integrating Distributed Energy Resources (DERs), while ensuring the safety and reliability of the electric grid in the future.

Customer Resources

ELECTRIC VEHICLE INTEGRATION

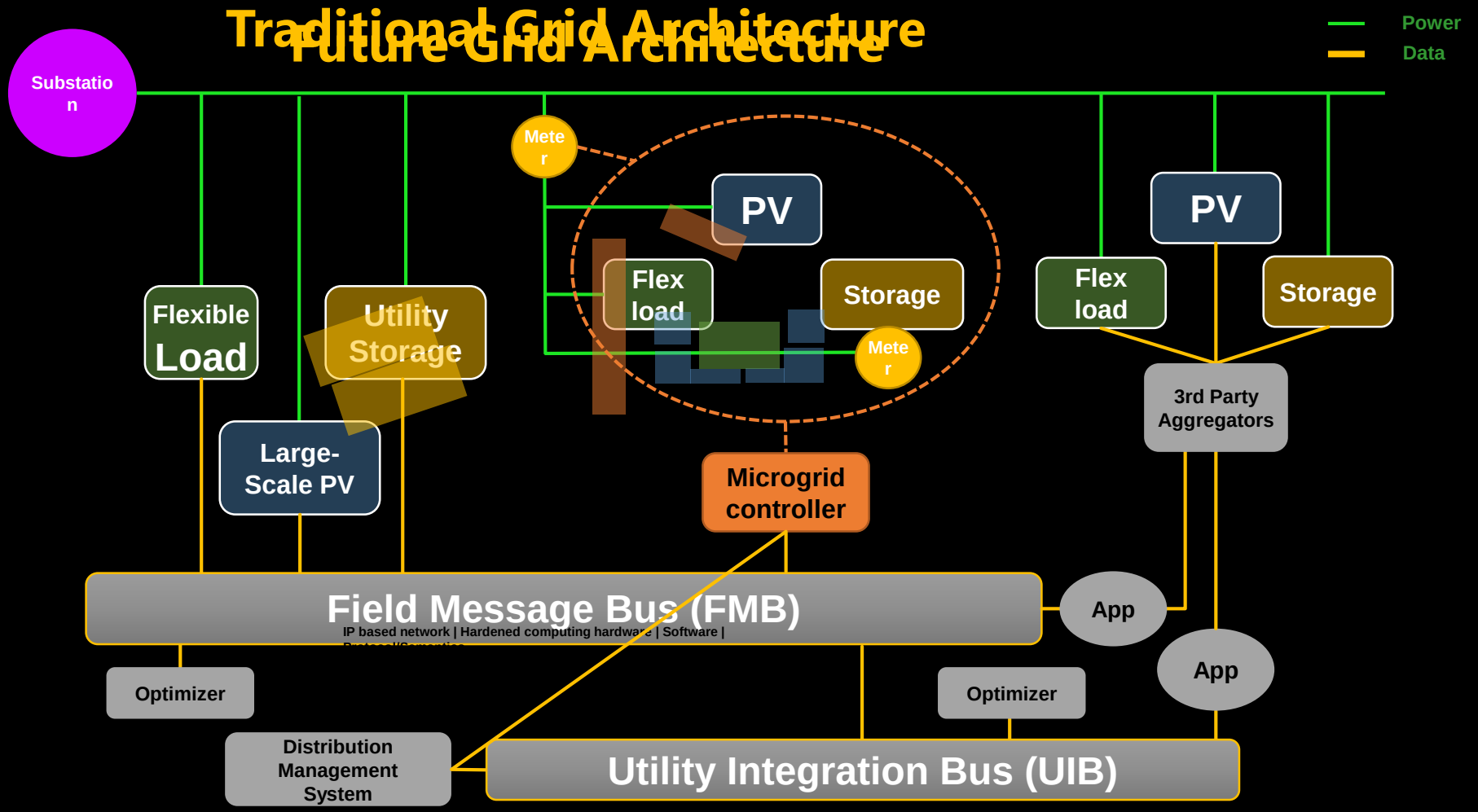
BATTERY ENERGY STORAGE

ROOFTOP SOLAR PV

FLEXIBLE LOAD

Resource Integration

Traditional Grid Architecture
Future Grid Architecture



Enabling New Opportunities

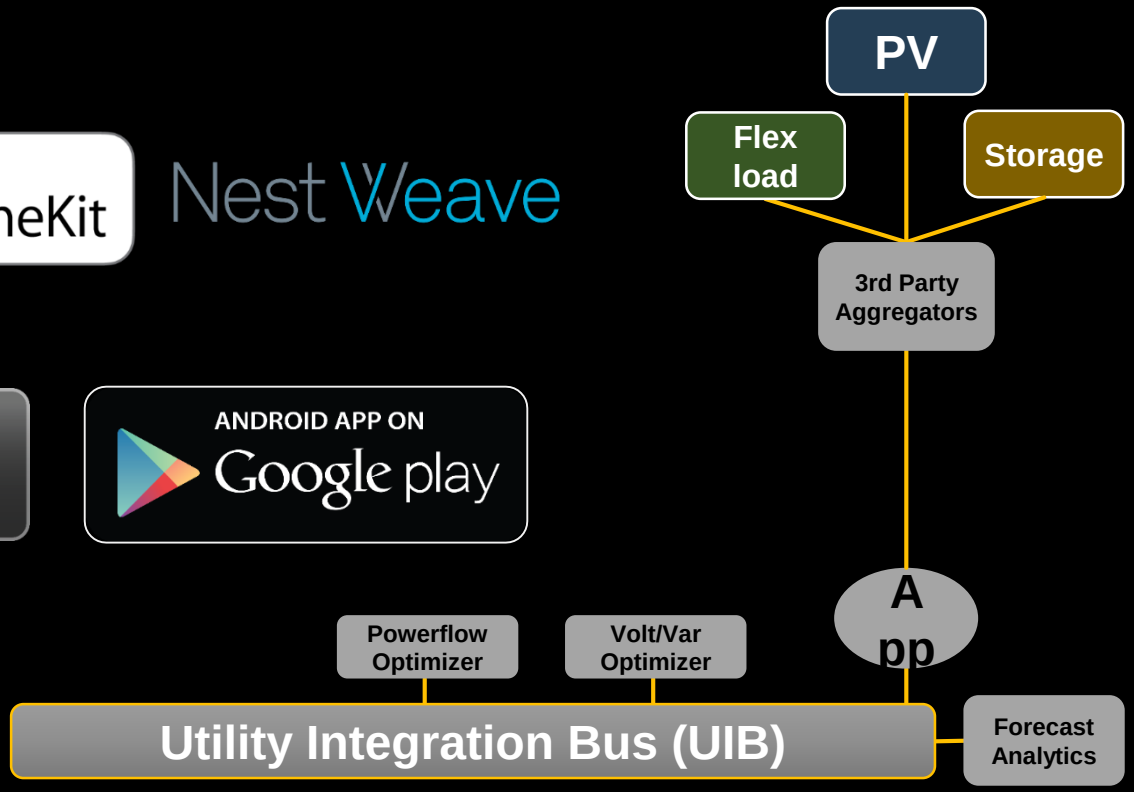
Works with Apple HomeKit

Nest Weave

Available on the App Store

ANDROID APP ON Google play

Predix



Emerging Technologies Program (ETP)

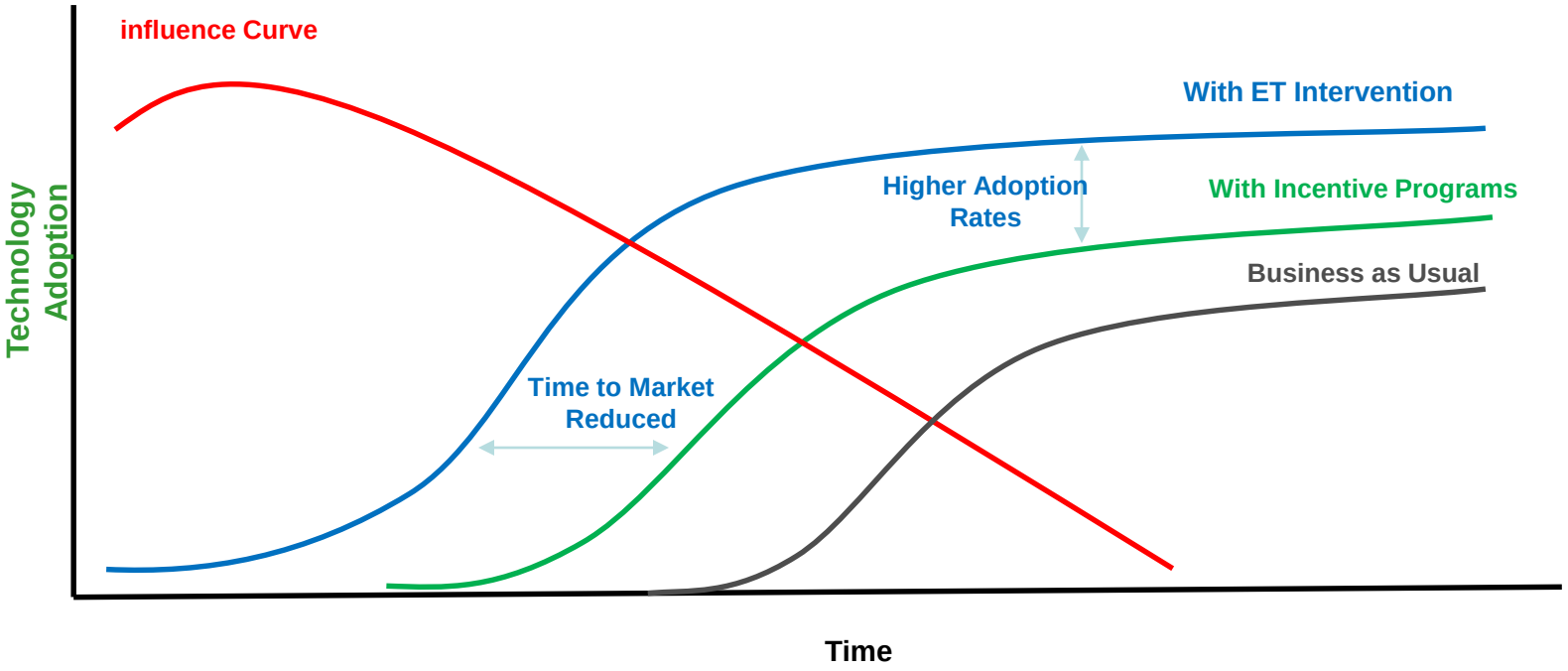
Mission

To support increased energy efficiency market demand and technology supply by contributing to development and deployment of new and underutilized energy efficiency (EE) and demand response (DR) measures (that is, technologies, practices, and tools), and by facilitating their adoption as measures supporting California's aggressive energy and demand savings goals.

What is Emerging Technology?

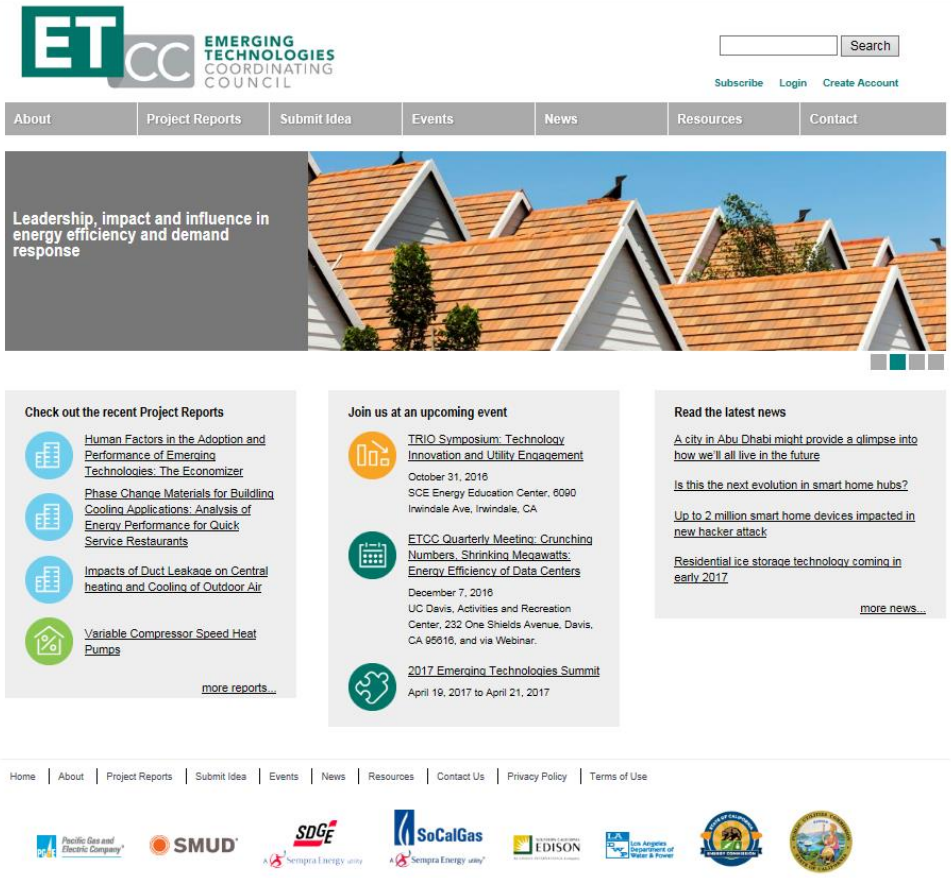
A market-ready or near market-ready technology that needs validation, technical assistance, and/or increased visibility to succeed in the marketplace. ETs include hardware, software, design tools, strategies, and other services.

Technology Influence and Adoption Life Cycle

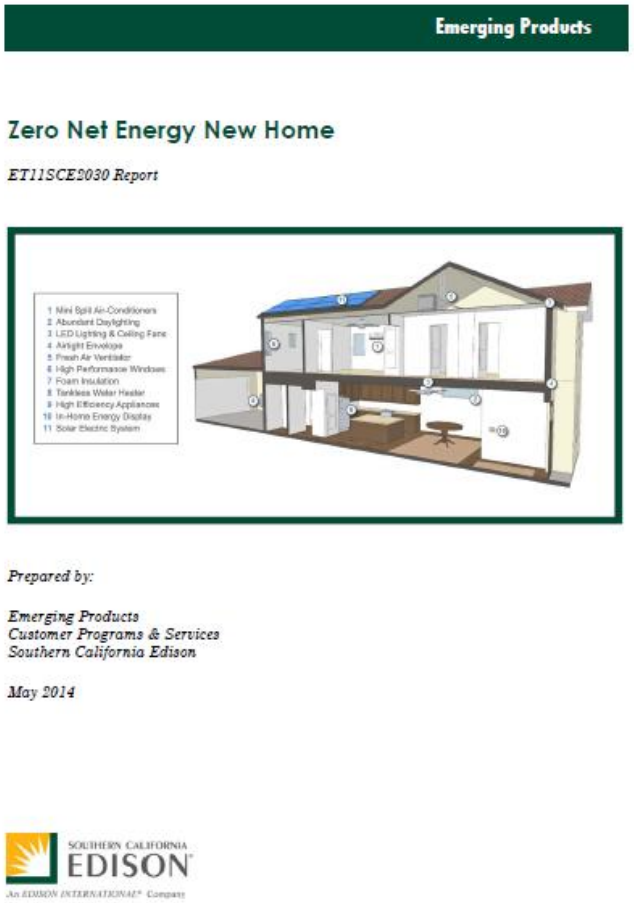


ET Dissemination

Emerging Technologies Coordinating Council (ETCC)



Sample Report…



SCE's ZNE Demonstration Projects*

There are a wide range of ZNE projects within SCE. These projects are being championed by a number of teams within SCE.

	Project Name	Sector	Vintage	Type	Status
1	Low-Income Multifamily, Pomona	Residential	New Construction	Low-Income Community	In Progress
2	ZNE Schools Pilot (Prop 39)	Commercial	Retrofit	Education	In Progress
3	Low-Income Multifamily (LIMF), Lancaster	Residential	Retrofit	Low-Income Community	In Progress
4	ZNE Training Facility Retrofit, ETI in Commerce	Commercial	Retrofit	Training Facility	In Progress
5	Grid Integration of ZNE Communities, Fontana	Residential	New Construction	Production Community	In Progress
6	ZNE Office, South Pasadena	Commercial	New Construction	Office Development	In Progress
7	ZNE New Home, Ontario	Residential	New Construction	Production Home	Complete
8	ZNE Recreation Facility Retrofit, UCSB	Commercial	Retrofit	College Recreation	Complete
9	Solar Decathlon Student Mentorship	Residential	New Construction	Residential Education	Complete
10	ABC Green Home 1.0, 2.0, 3.0	Residential	New Construction	Custom Homes	In Progress
11	Irvine Smart Grid Demonstration (ISGD)	Residential	Retrofit	Community	Complete
12	Low-Income Residential Retrofit, San Bernardino	Residential	Retrofit	Low-Income Home	Complete

*listing of relevant projects – not comprehensive

Grid Integration of ZNE Communities

Project Partners

PUBLIC UTILITIES COMMISSION EUREKA STATE OF CALIFORNIA

GO solar CALIFORNIA

Itron CSI RD&D Program Manager

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

MeritageHomes

biraenergy

Project Goals

Evaluate impact of ZNE communities on electrical grid and technology strategies to enhance grid benefit

- Demonstrate new technologies and strategies that enable cost effective Zero Net Energy homes and resulting high PV adoption
- Measure the impact of concentrations of ZNE homes on electrical distribution
- Demonstrate how residential Energy Management systems can balance PV with loads and support power system needs
- Evaluate and demonstrate optimal location of Energy Storage in ZNE communities (residential vs. neighborhood)
- Develop integrated modeling approach to integrate building and distribution models

The Community

Sierra Crest

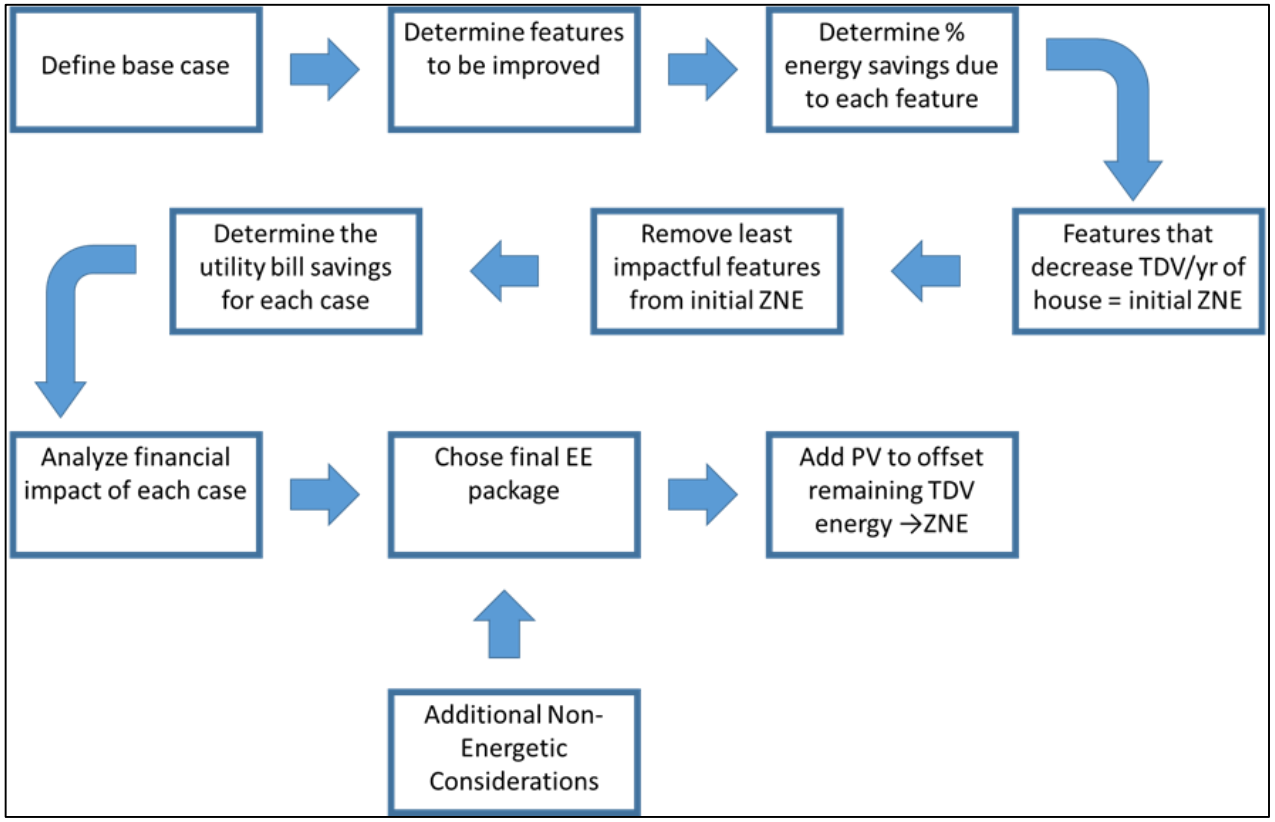
MeritageHomes

Net Zero Energy Homes

Designed to generate as much energy as it uses over the course of a year.

Building Modeling for ZNE – EE and PV sizing

Energy Efficiency has capacity benefits as a DER for both distribution and bulk grid



General approach to designing ZNE homes for Fontana community

- Lead w/ efficiency
- Consider production builder requirements
- Consider customer and builder costs
- PV offsets remaining TDV energy

Annual Energy Use and PV sizing

	Annual Energy Usage			PV Sizing	
Home	Modeled Annual Energy Used (kWh)	kWh Needed for ZNE (kWh)	kWh/sq. ft	Base Case PV	Integrated EE PV
6	6,923	6,099	2.59	6.1kW	4.5kW
7	7,485	6,518	2.57	6.4kW	4.5kW
8	6,882	6,199	2.57	5.5kW	4.0kW
9	7,485	6,518	2.63	6.4kW	4.5kW
10	6,882	6,445	2.36	5.7kW	4.0kW
11	6,923	6,208	2.44	5.3kW	4.0kW
12	7,518	7,213	2.58	5.5kW	4.0kW
13	6,926	5,956	2.44	5.5kW	4.0kW
14	7,512	7,213	3.24	5.5kW	4.0kW
15	6,902	5,961	3.16	5.5kW	4.0kW
16	6,773	5,768	3.5	5.5kW	4.0kW
121	6,331	5,801	2.73	5.5kW	4.0kW
122	6,550	5,800	3	4.6kW	3.5kW
123	6,143	5,021	3.17	5.0kW	3.8kW
124	6,521	5,759	2.99	5.3kW	4.0kW
125	6,559	5,560	3.01	4.7kW	3.5kW
126	6,521	5,568	2.99	5.0kW	3.8kW
127	6,035	5,798	3.12	5.5kW	4.0kW
128	6,451	5,800	2.96	5.0kW	3.8kW
129	6,451	5,800	2.96	5.0kW	3.8kW
AVG.	**6,789 kWh**	**6,050kWh**	**2.85**	**5.4kW**	**4.0kW**

Comparing PV Sizing – With and Without EE Measures

- Energy Efficiency measures result in reduced PV size of 1.4kW/home (~$5000)
- Evening peak load reduction of 1.6 kW
- Approx. $17,000 incremental cost to attain Zero Net Energy
- With CA NEM rules:
  - annual energy cost to customer is around $350 (electric + gas)
  - Electrification of water heating helps offset net annual generation

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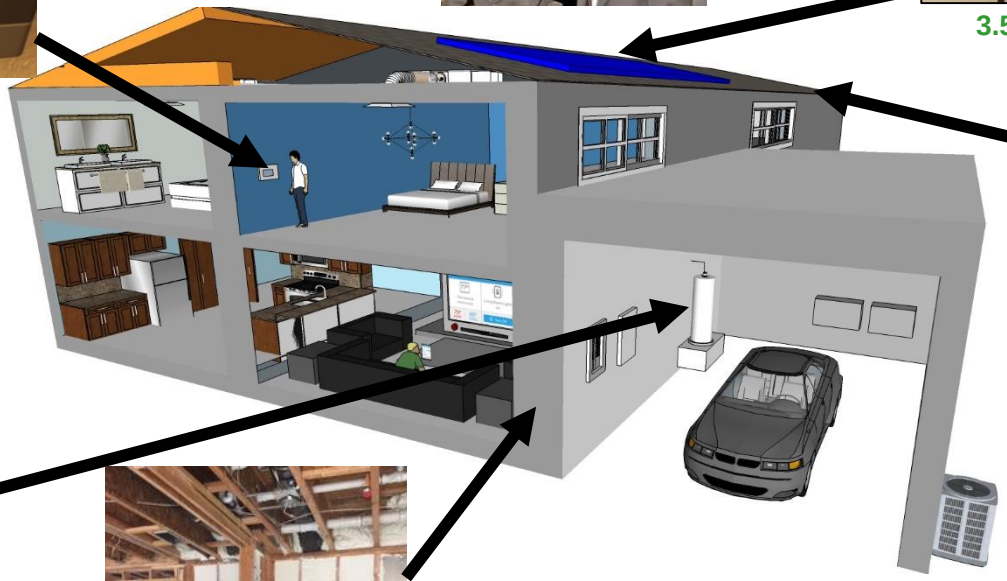
Implemented ZNE Measures

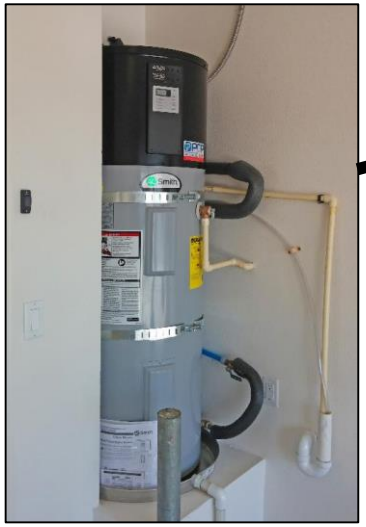
Thermostats/HEMS

All LED lighting

3.5 – 4.5 kW PV



High Performance Envelope



Electric Heating and Water Heating

Foam Insulation

Plus:

- Plug load controllers
- Circuit-level monitoring

Value Proposition

*"We actually explain to them just briefly some of the components that are included in the net zero home, but primarily the **huge savings** that they're going to have, year after year, by purchasing a net zero home."*

	Meritage Standard New Home	Meritage ZNE New Home	Difference
Purchase Price	$410,000	$428,000	$18,000
Mortgage Amount	$369,000	$385,200	$16,200
Mortgage Payment [1]	($1,709)	($1,784)	$75
Estimated Annual Utility Bill	$1,591	$273	$1,318
Monthly Cash Flow Savings	-	**$35**	-

[1] Based on 10% down, 3.75% interest rate

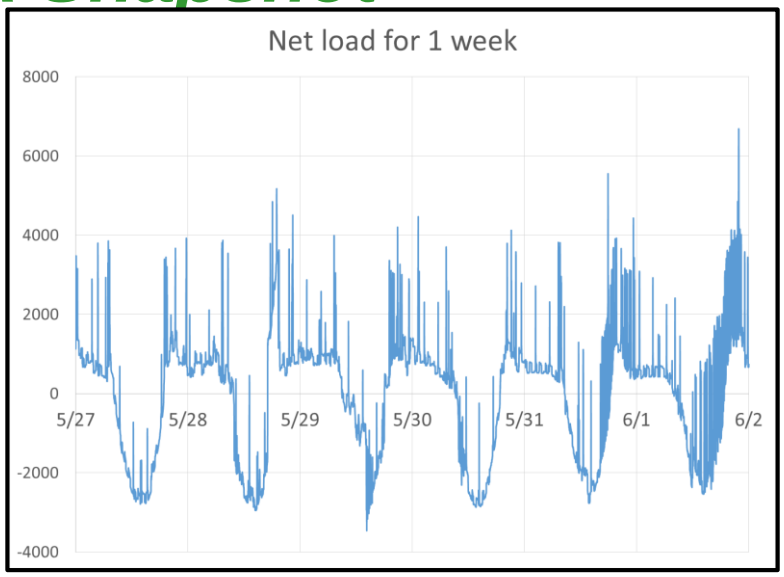
Customer Perspectives

*"…we actually bought in this community **because of net zero.**"*

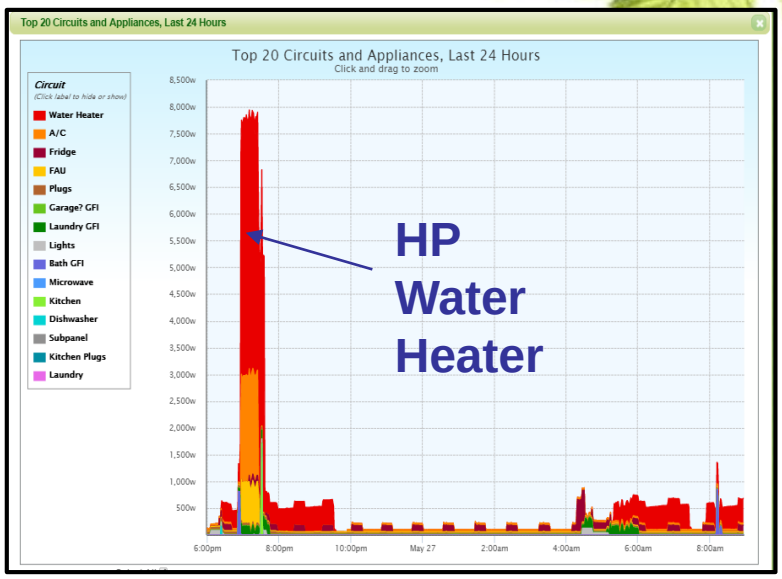
*"The possibility of not having to pay an electric bill every month is a big deal for us, going from $400 plus dollars a month to potentially zero is a **big selling point.**"*

*"I have some friends & family, they continually spend $100, $200, maybe $300 on their **electricity bills** every month & they complain about it. So not having one, I'll get to laugh at them a little bit."*

How Are These Homes Performing? - A Snapshot



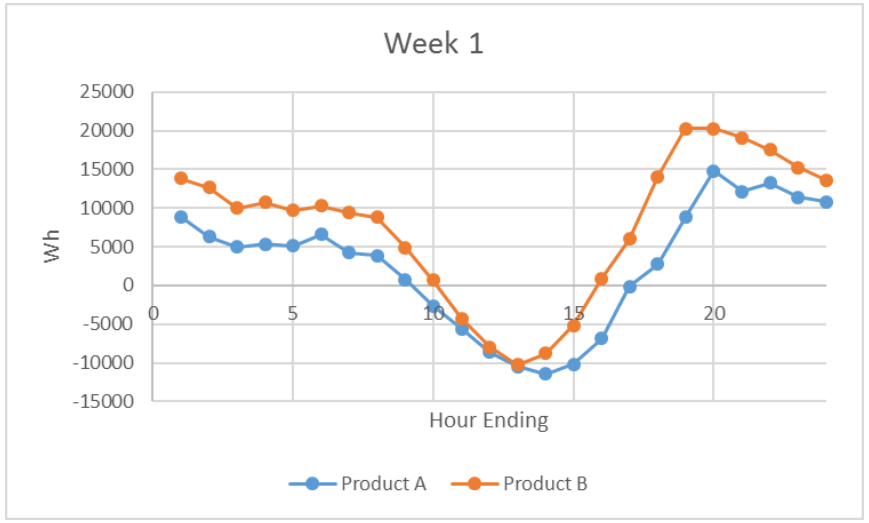
Energy Usage in Watts (1 min interval)

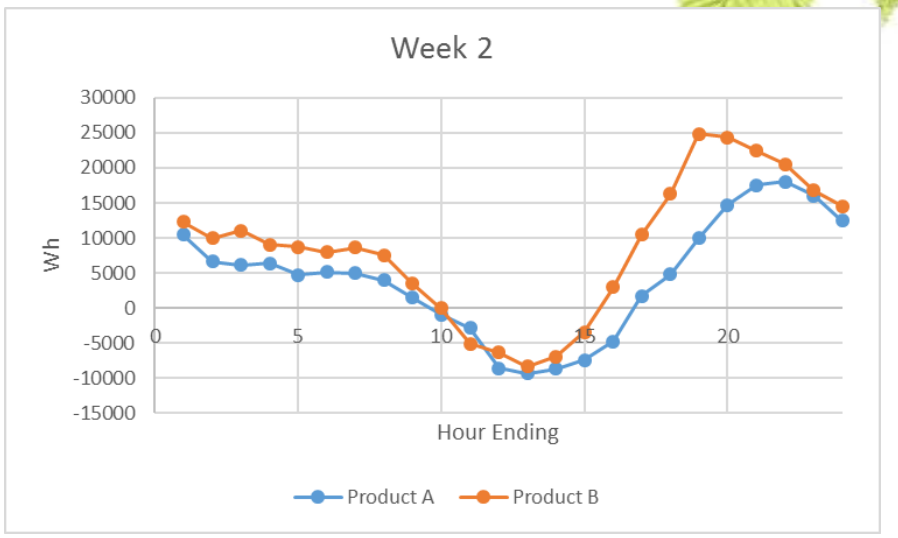


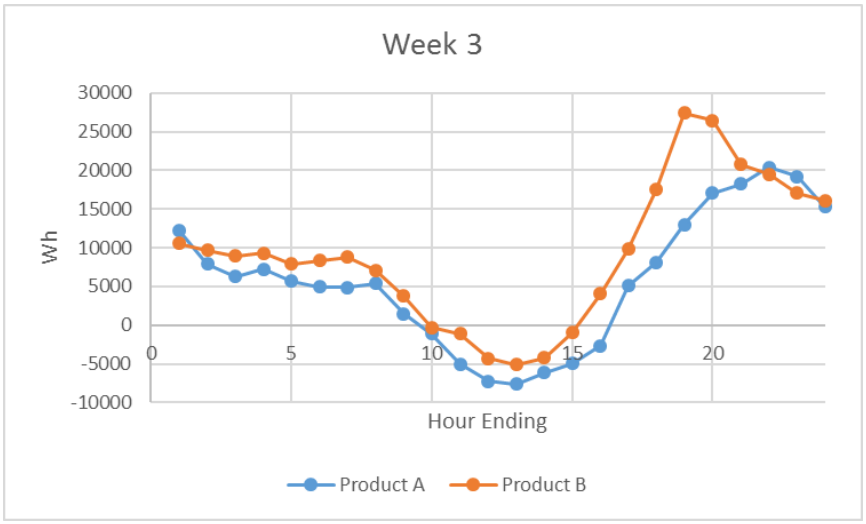
Disaggregated load profile

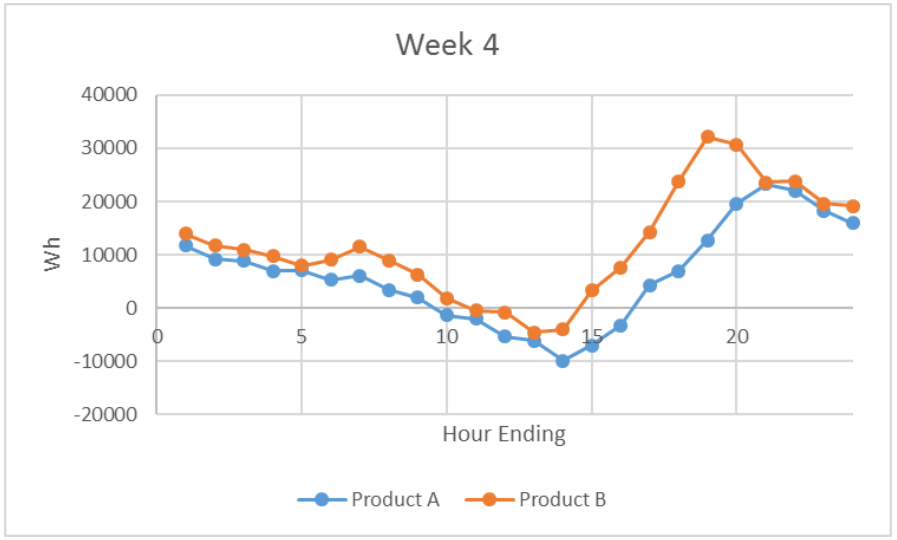
- ZNE homes are occupied by first time home buyers, not energy enthusiasts
- HPWH and appliance driven peaks
- Models: relatively accurate, but not picking up peak energy usage
- Does not account for variability due to customer behavior/preference
- Intermittent loads coincident → large, unanticipated peaks

What Does This Mean to the Grid?

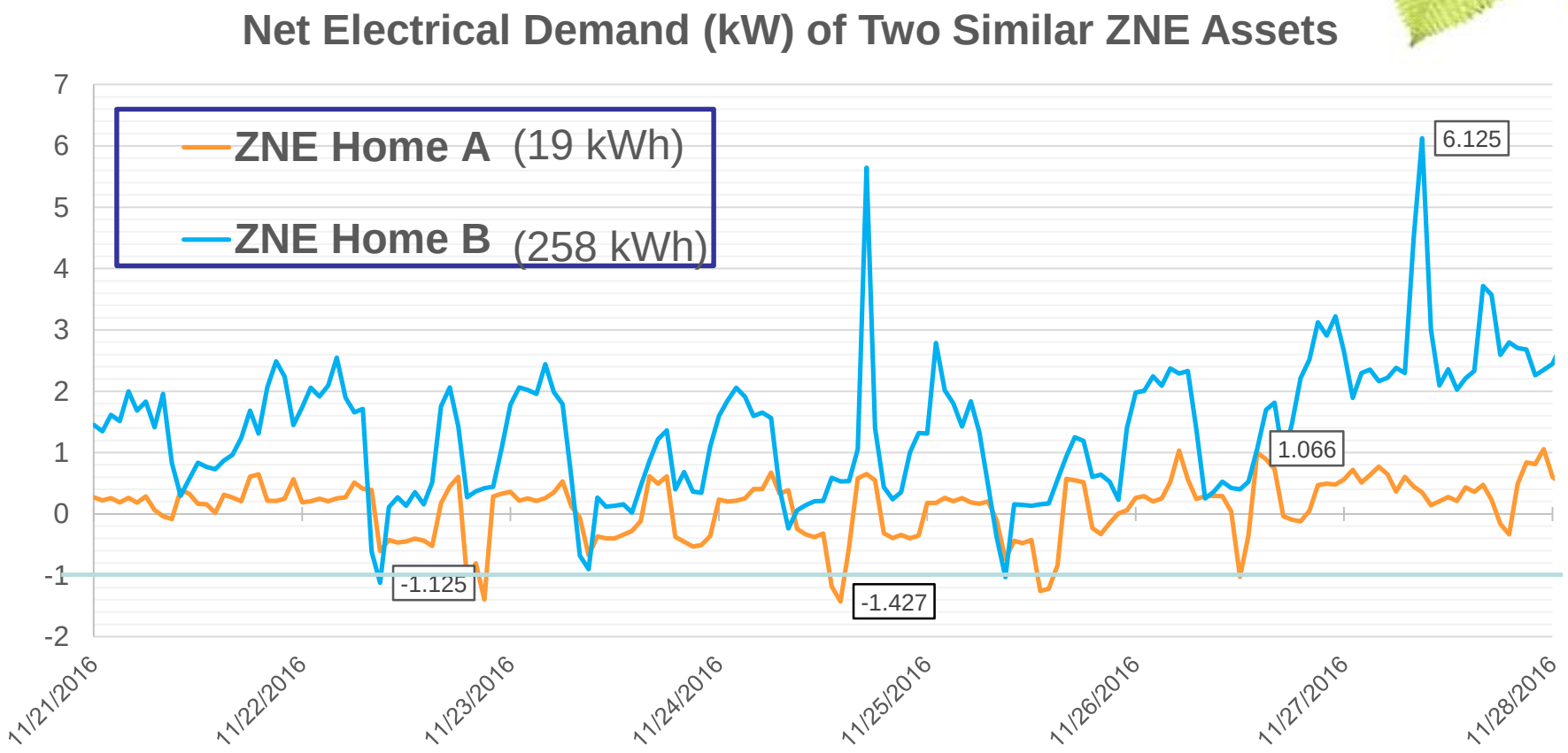








ZNE May Vary



Distribution Impacts Modeling

Scenario #1 – Tariff Optimization

- Energy storage is operated to optimize for current TOU rates
- Benefit to customer
- Peak is Noon to 6 PM
- Off-peak is 6 PM to 6 AM

Scenario #2 – Grid Balancing

- Energy storage systems are operated with simulated peak and off-peak
- Benefit to grid
- Peak is 5 PM to 8 PM
- Off-peak is 9 AM to 1 PM

	Transformer 1	Transformer 2	Lateral	Load Block	Feeder
# Homes	11	9	60	240	12,000
Typical Rating (KVA)	75	50	375	1,500	10,000
Peak kW (Scenario #1 – Tariff Opt)	110	114	727	2826	13735
% of Nameplate (Scenario #1 – Tariff Opt)	147%	228%	194%	188%	137%
Peak kW (Scenario #2 - Grid Balancing)	87.7	63.3	388	1520	7739
% of Nameplate (Scenario #2 - Grid Balancing)	117%	127%	104%	101%	77%
Difference Between #1 & #2	**30%**	**101%**	**90%**	**87%**	**60%**

SCE's Initial Findings and Potential Challenges

Findings, opportunities and challenges may change as more ZNE projects are completed, and data is analyzed.

Initial Findings

- The number of ZNE builders are increasing
- Incremental costs per home for ZNE capability is shrinking
- Trend towards increased electrification
- Prominent technologies in ZNE Homes include LED lighting, electric heat pumps for cooling, space and water heating applications, PV, foam insulation, controls
- ZNE success highly depends on sales/marketing strategies

Potential Challenges

- ZNE does not mean zero bills
- Understanding impacts (asset/liability) to the electrical grid
- Finance industry plays a key role in ZNE – comps do not exist for appraisers
- Energy simulation tools
- Standardized Permitting process for DERs
- Regulatory alignment between ZNE definition and ZNE implementation

Thank you!