Grid Integration of Zero Net Energy Communities: Understanding the near-term high PV penetration scenario

Final Webinar CSI RD&D-4 Grant Project

Project Manager: Ram Narayanamurthy

Project Team: CR Herro, Will Vicent, Jerine Ahmed, Edwin Hornquist, Rob Hammon, Ben Clarin, Arindam Maitra, Nick Tumilowicz, Rachna Handa, Sunil Shah

September 16, 2016

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Agenda

Item	Presenter	Time
Project Introduction	Smita Gupta	10.00 – 10.05
Project Objectives and highlights	Ram Narayanamurthy	10.05 – 10.10
EE packages and PV sizing	Rob Hammon	10.10 – 10.20
Questions		10.20 – 10.25
Electrification, Controls integration and data acquisition	Ben Clarin	10.25 – 10.35
Customer side energy storage	Nick Tumilowicz	10.35 – 10.45
Questions		10.45 – 10.50
Distribution impacts	Arindam Maitra	10.50 – 11.05
Questions		11.05 – 11.10
SCE engagement, objectives, benefits and strategic relevance	Jerine Ahmed Will Vicent	11.10 – 11.18
Builder perspective on EE, solar homes and ZNE communities	C.R. Herro	11.18 – 11.25
Lesson learned & future initiatives	Ram Narayanamurthy	11.25 – 11.35
Open Discussion	Team	11.35 – Noon

Project Objectives and Goals

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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

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Primary partners

California Solar Initiative (CSI) Research, Development, Demonstration and Deployment Program (RD&D)

Ram Narayanamurthy,
Arindam Maitra,
Ben Clarin, Nicholas Tumilowicz

Rob Hammon, Ph.D.

C.R.Herro

Jerine Ahmed
Will Vicent
Mark Martinez

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Community Groundbreaking Event

Itron CSI RD&D Program Manager

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integrated clean energy solutions

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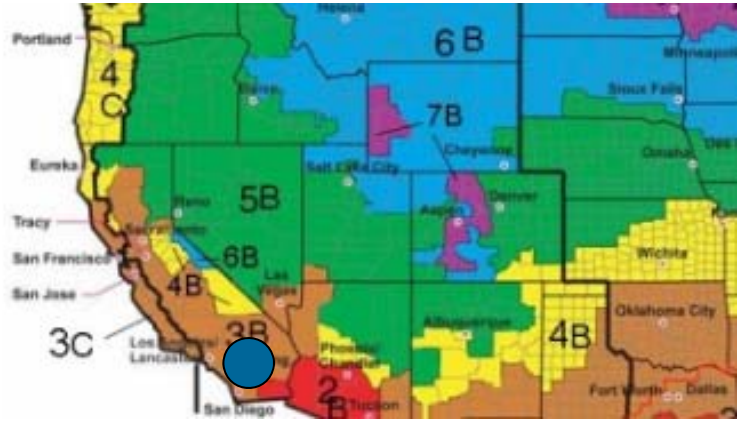
Project Scenario

Project Location 60 miles east of Los Angeles

Climate Zone 3B (warm and dry)

Annual peak temperatures ~ 105 F

20 homes on 2 transformers



Attained Zero Net Energy @ 4% of home price including PV

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Highlights

- First production builder ZNE neighborhood
- First time homebuyer community priced below LA area average
- Net cost less PV less than $1,000 per home

- Average PV size 4 kW due to EE (TDV ZNE)
- Electric heating and water heating
- Smart Home features

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Ratepayer Benefits

1. Demonstrated technical and economic feasibility of Zero Net Energy (including PV) for California new homes
   - Cash flow positive for homeowners with avoided utility costs
   - By 2020, reduce electric usage by 280 GWh and gas usage by 8 million therms
   - 120,000 tons of avoided carbon emissions for California
   - Viability of solar ready and neighborhood solar planning
   - Key milestone on pathway to reach AB 32 goals
2. Evaluation of “least cost” pathways to mitigate possible grid impacts to help reduce total system ratepayer cost
3. Demonstrated the “duck curve” effect of ZNE homes and need for distribution planning and operations solutions
4. Demonstrated viability of electrification of end loads, part of CA plan for meeting AB 32

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Designing ZNE Communities – EE Packages for ZNE Homes

Rob Hammon

BIRAenergy

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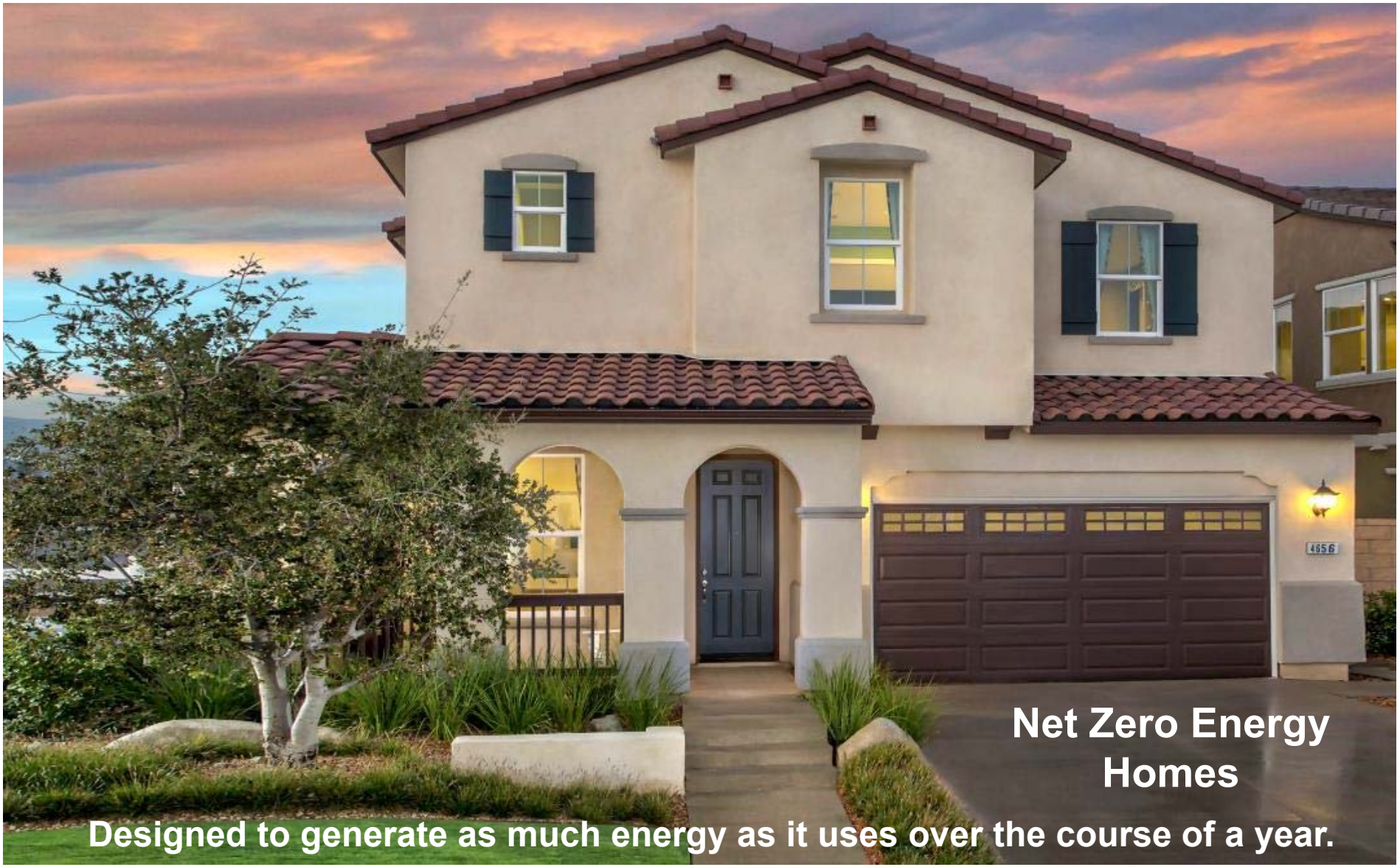

Net Zero Energy Homes

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

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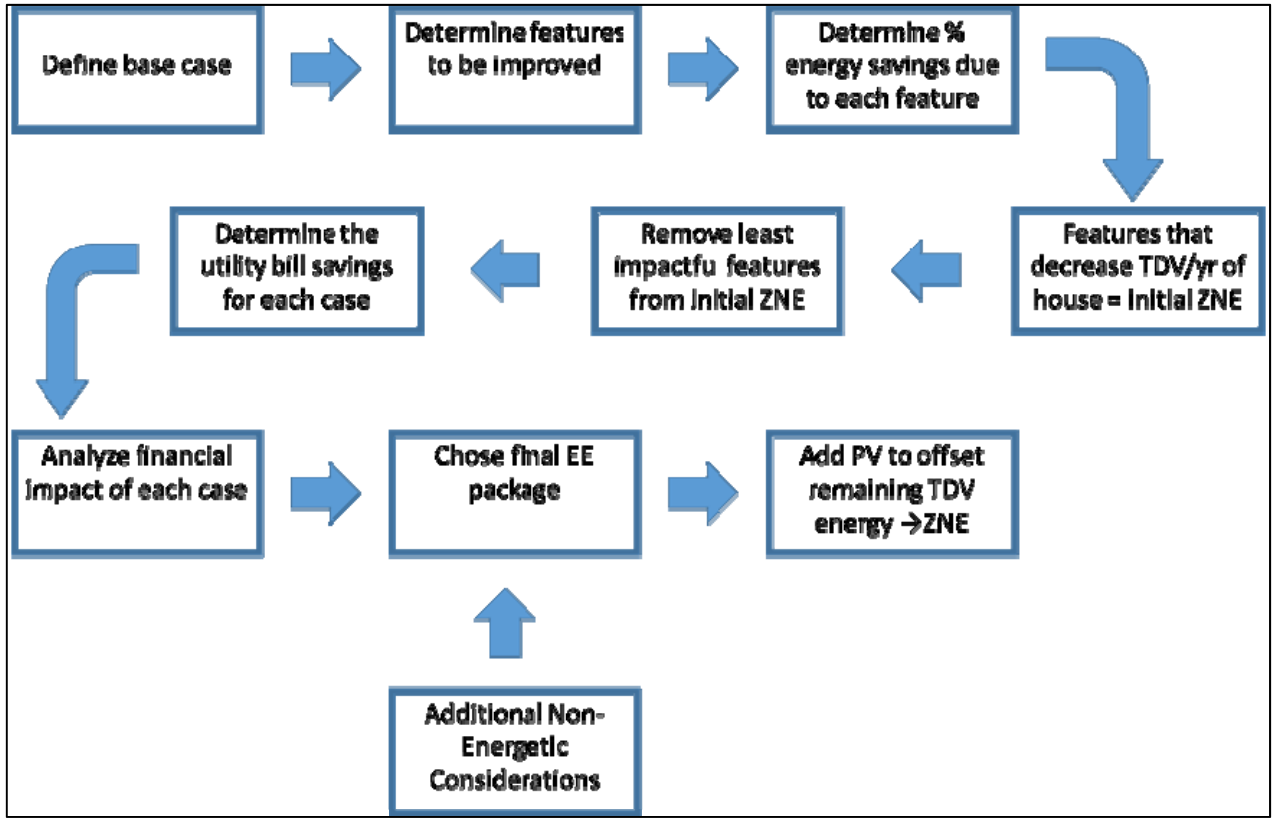
Building Modeling for ZNE – Energy Efficiency and PV sizing

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



General approach to designing ZNE homes for Fontana community

- 2013 CA Title 24 base case
- Lead w/ efficiency
- Consider production builder requirements
- Consider customer and builder costs
- PV offsets remaining TDV energy

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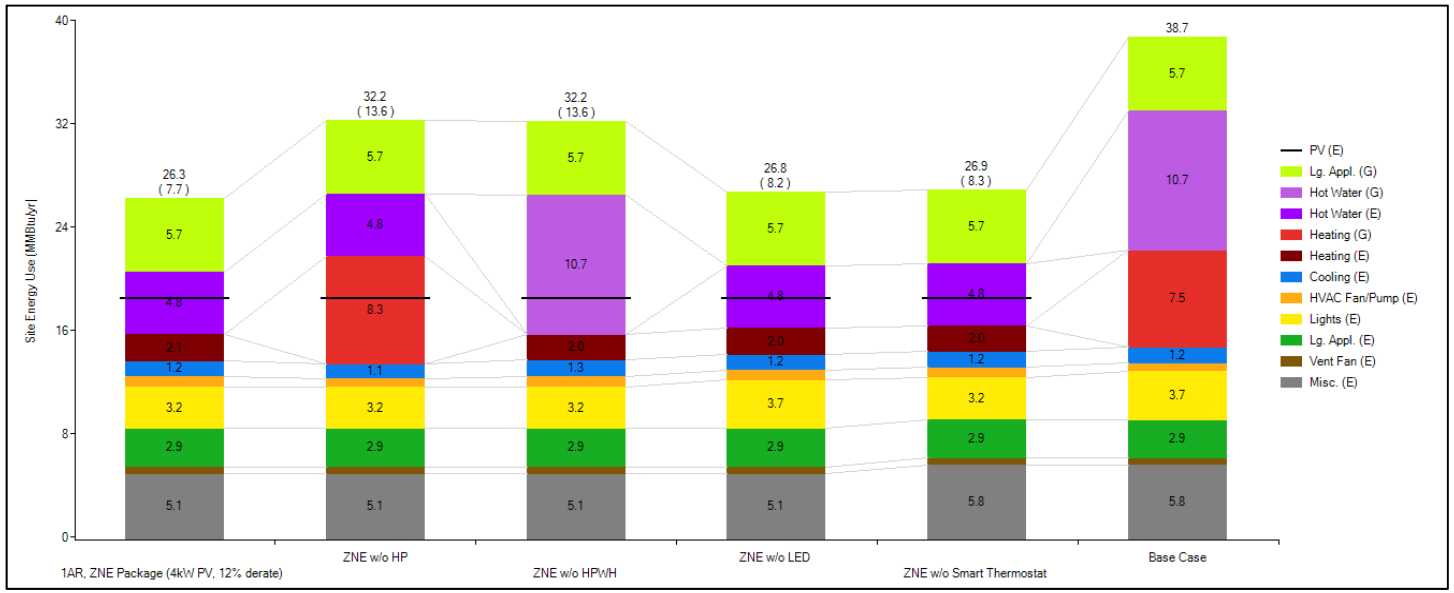
Modeling ZNE Communities – Some Results



Perturbation Analysis – Identifying Impacts Measure by Measure (Example Lot#127

Lot #127 Base Case	Initial Cost	Annual Utility Bill	Cost over 30yrs	Cost : Benefit	Rank
14 SEER AC / 92.5% AFUE	$ 5,351	$ 866.60	$ 31,349	36.17	7
15 SEER / 8.5 HSPF HP	$ 3,544	$ 878.90	$ 29,911	34.03	1
16 SEER / 8.6 HSPF HP	$ 3,689	$ 860.60	$ 29,507	34.29	2
17 SEER / 8.7 HSPF HP	$ 3,835	$ 856.70	$ 29,536	34.48	3
18 SEER / 9.3 HSPF HP	$ 3,980	$ 848.70	$ 29,441	34.69	4
19 SEER / 9.5 HSPF HP	$ 4,175	$ 843.50	$ 29,480	34.95	5
22 SEER / 10 HSPF HP	$ 4,561	$ 825.30	$ 29,320	35.53	6

Economic Analysis – Determining most cost-effective measure (est. 2015 costs

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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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Summary of Energy Efficiency measures

- All LED lighting
- Open cell spray foam insulation on roof deck and walls (2 x 4, 16 o.c.)
- Ducts in conditioned space
- 50 gal Heat Pump water heater (wifi)
- Heat Pumps (15 SEER, 9.0 HSPF)
- Variable speed indoor fan for efficient ventilation
- Nexia XL 824 wifi/Z-Wave thermostats with Energy Management system
- Circuit level metering for load analysis

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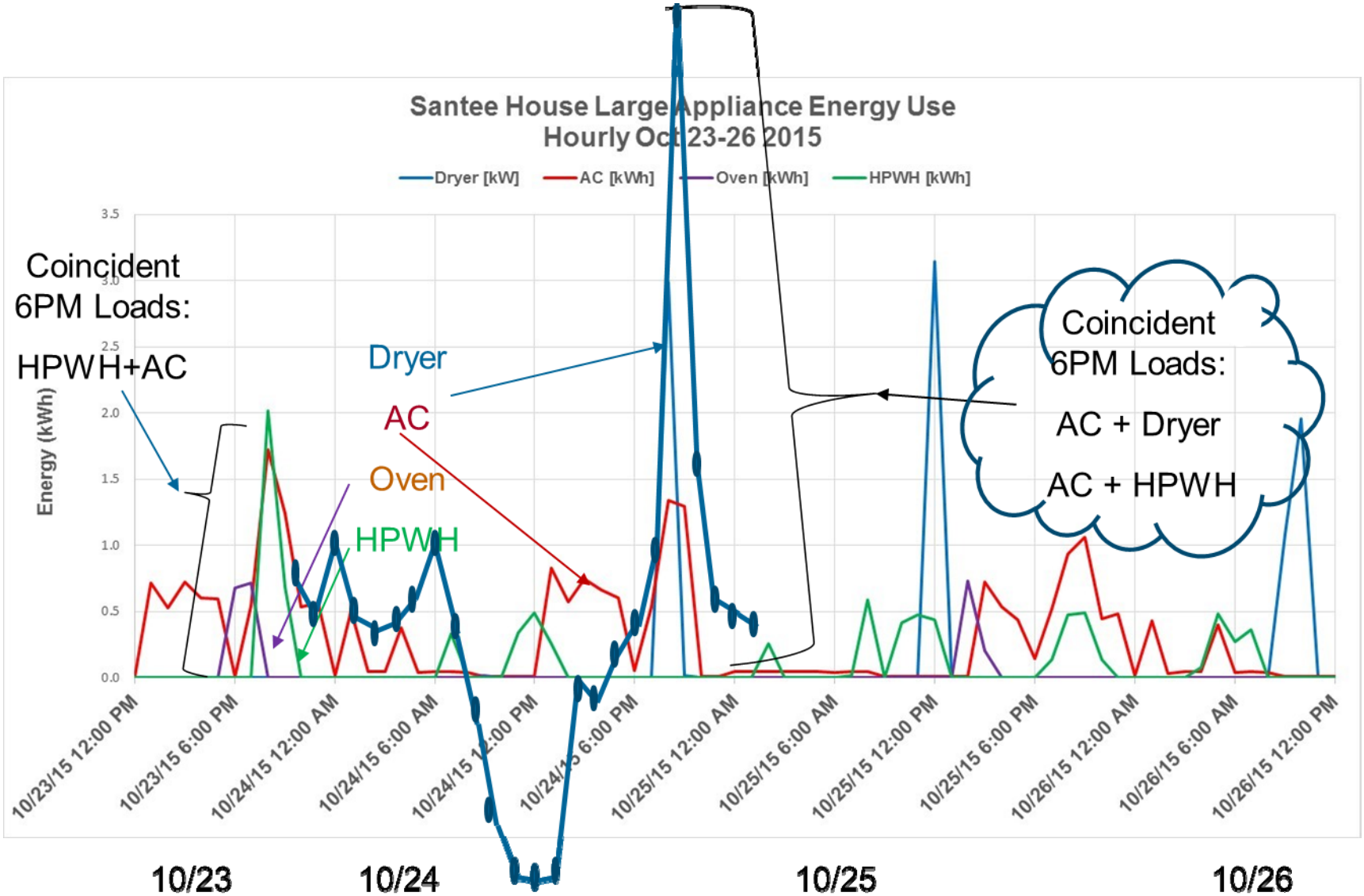
Hourly Loads by End-Use (actual)



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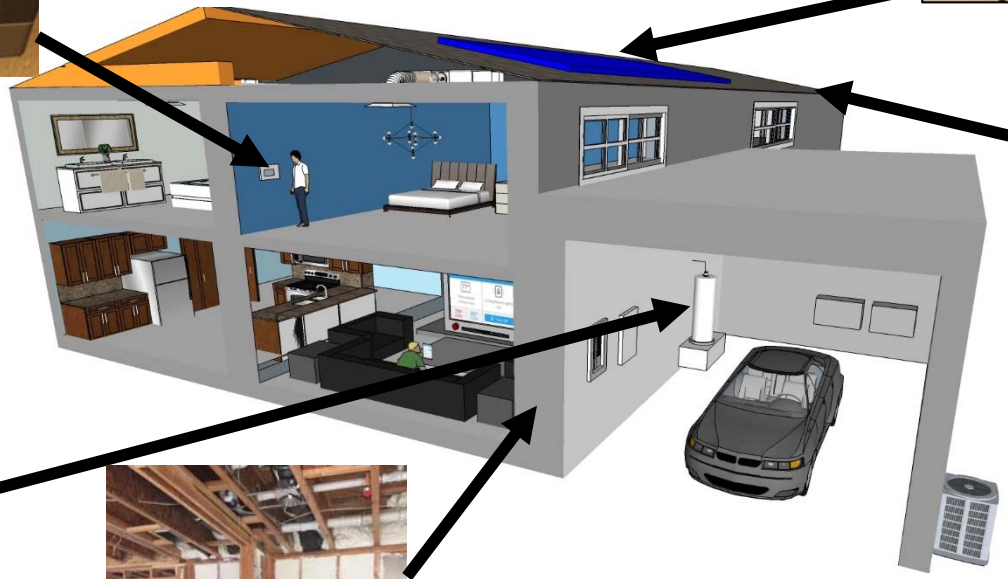
Implemented ZNE Measures

Nexia 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

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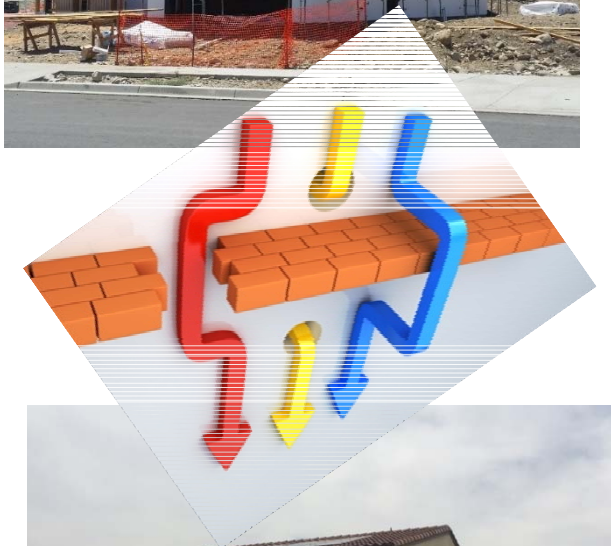
Marketing and Constructing ZNE Communities

Project Milestones:

- All 20 homes designed, sold and occupied in less than 1 year
- Data collected at each of the homes - up to 40 data parameters per home
- Residential storage operational on 9 homes



Project Barriers:

- Coordination between solar, storage and connected loads providers
- Customer-side storage permitting
- Solar roof fit for ZNE communities

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Questions?

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Electrification, Controls Integration and Data Acquisition

Ben Clarin

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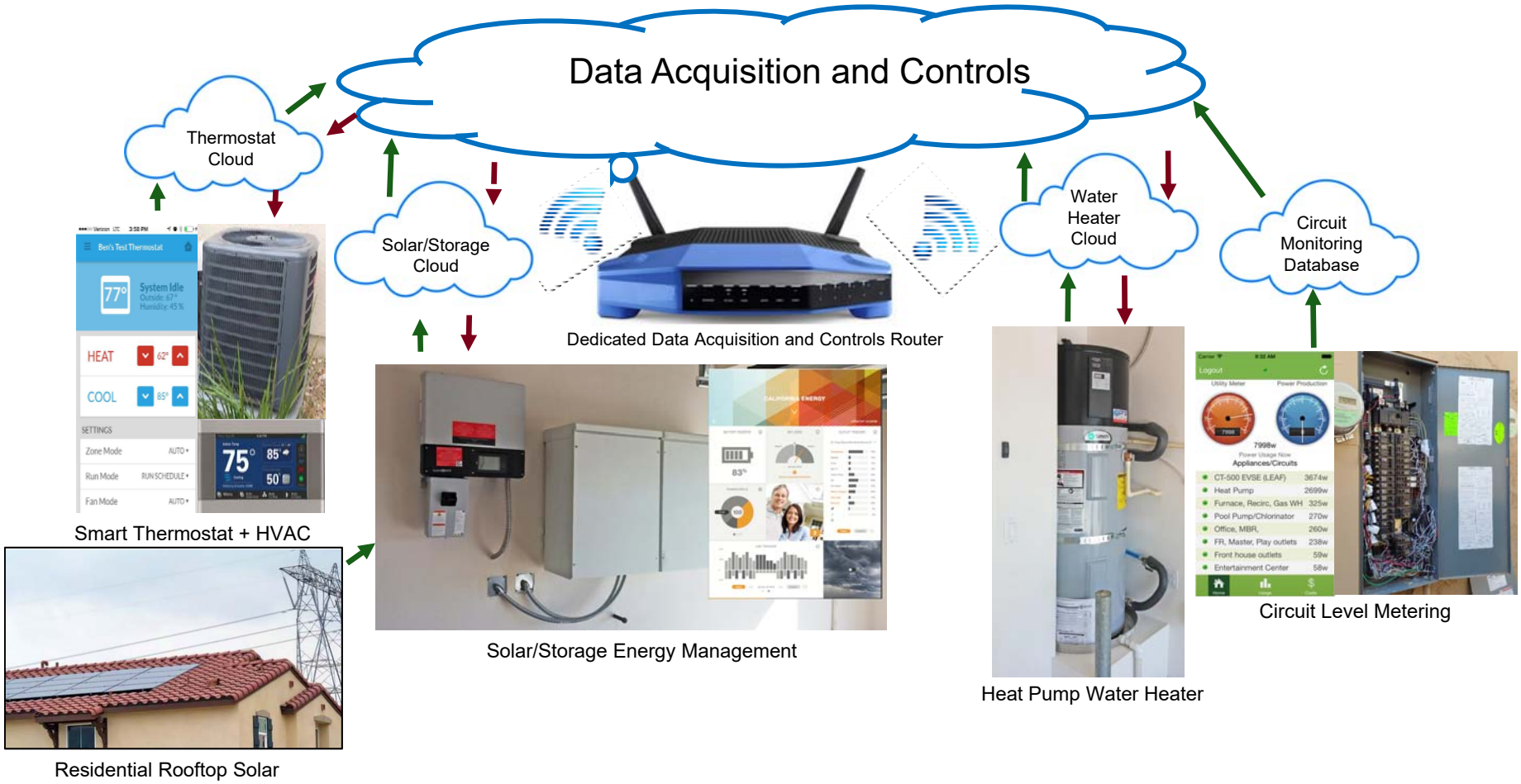
Data Acquisition and Distributed Energy Resource Controls



Objectives:

- Develop and vet "organic" data acquisition system
- Assess control scenarios for load-optimization

Key

Data Pathway

Controls Pathway

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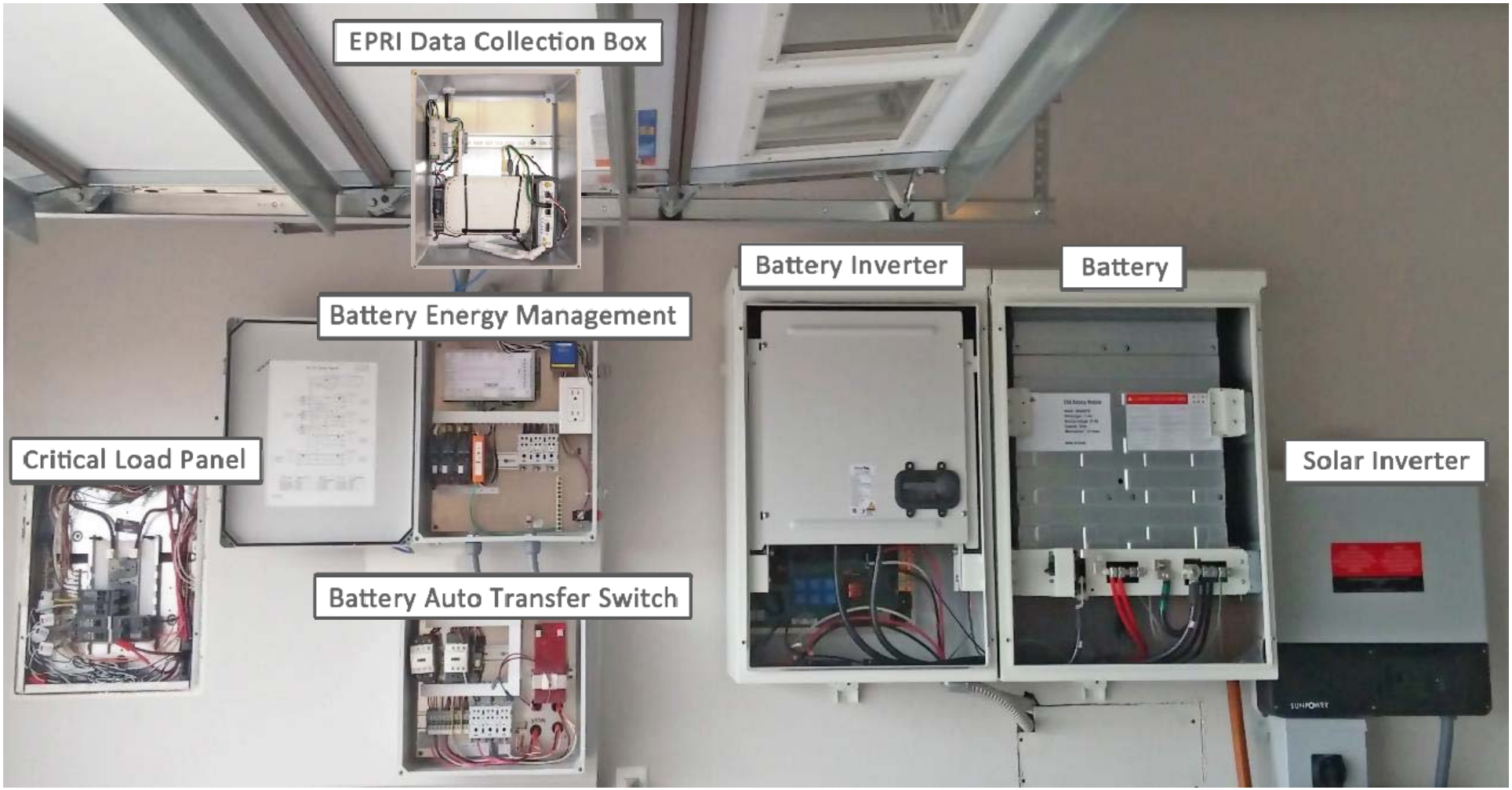
Home Integrated Battery Storage System



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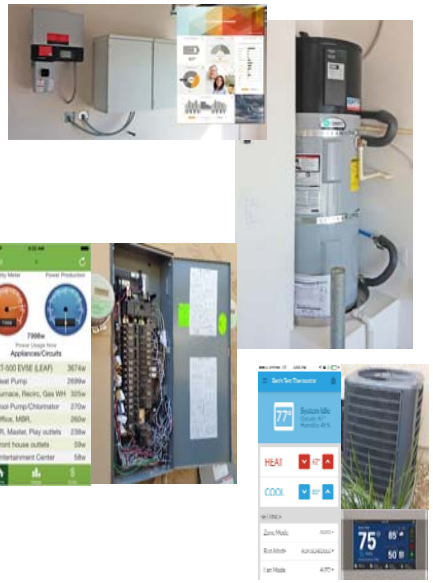
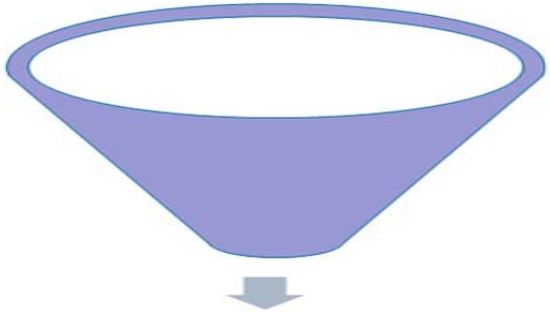
How We Measure – Using Low-Cost Data Acquisition





Results:

- Energy Performance
- Customer Preference
- Environmental Conditions

Device	Data Parameter(s)	Method of Obtaining
Circuit Level Monitoring	Main Power, Heat Pump & FAU, Water Heater, EV (2 in community), Microwave, Plug Loads, Light, Solar, etc.	Circuit breakers submetered. Trades informed to connect like loads. API agreement for data collection.
Solar/Storage BEMS	Frequency, Voltage, Main Power, Solar, Battery Energy, SoC, etc	Solar, storage and mains data metered by BEMS and shared via. reports
Smart Thermostat/Plug Loads	Setpoint, Indoor Temp, Outdoor Temp, HVAC Runtime, etc.	API agreement for data collection and device control
Heat Pump Water Heater	Water Temp, Runtime, Setpoints, Operating Mode, etc.	API agreement for data collection and device control

Planned Data Parameters Collected per Home and Method of Collection

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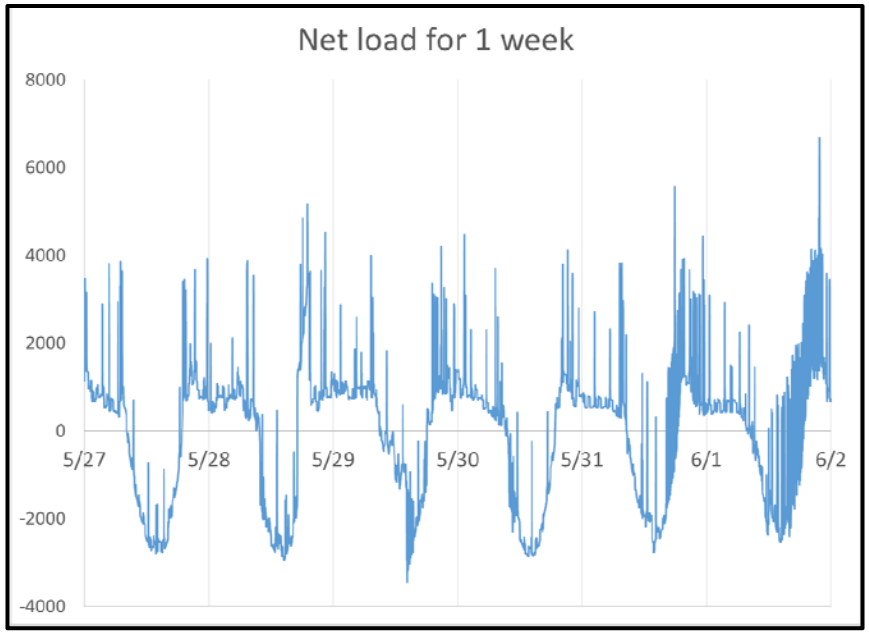
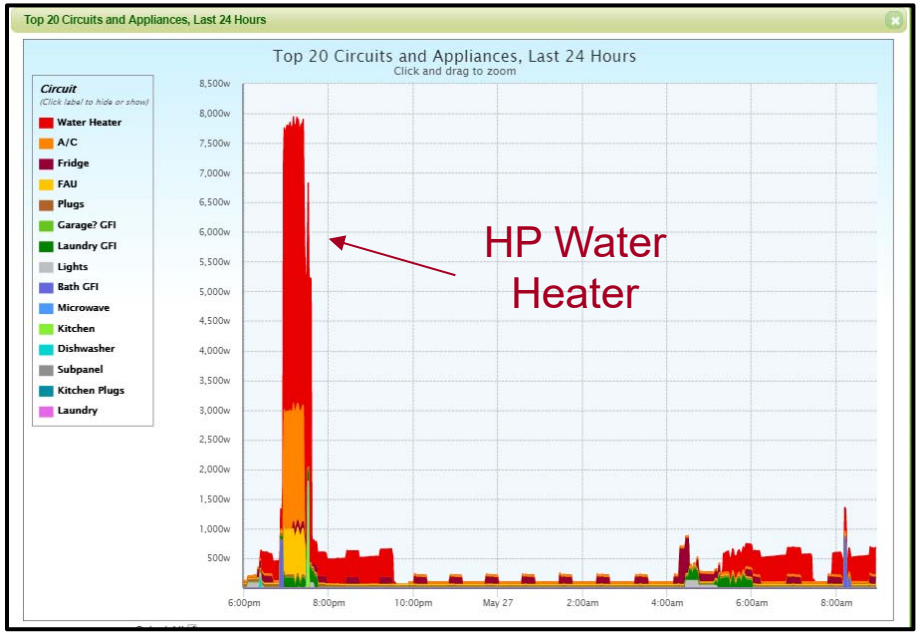
How Are These Homes Performing?



Energy Usage in Watts (1 min interval)



Disaggregated load profile

- These ZNE homes are occupied by first time home buyers, not energy enthusiasts
  - Anecdotal - $25 July bill with electric dryer, $0.64 bill in April
- Very erratic load shape with HPWH and appliance driven peaks
- Models: average loads/time-step; actually discrete, intermittent loads
- Intermittent loads coincident → large, unanticipated peaks

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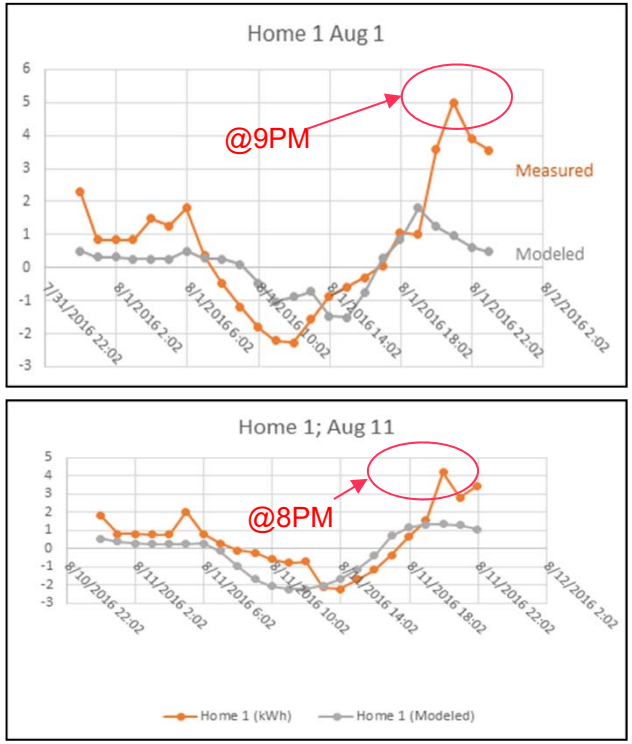
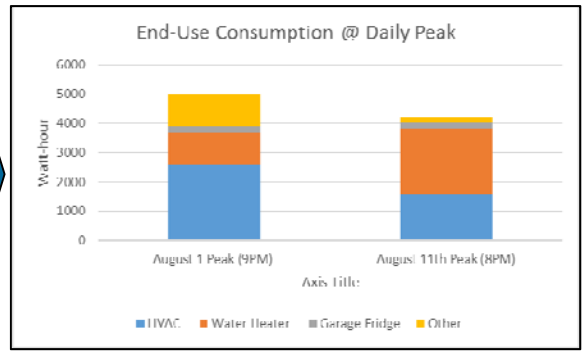
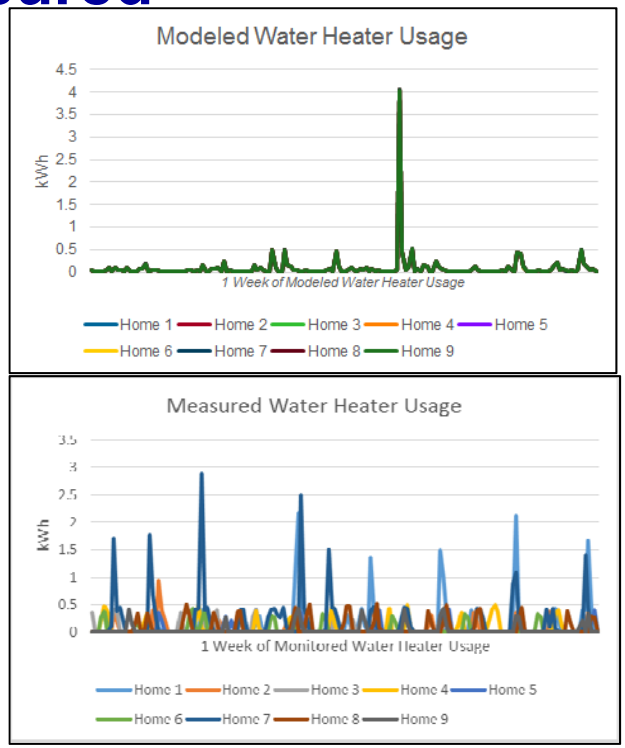
Home Performance – Modeled vs. Measured



Measured vs. Modeled – Two Representative August Days



Attributing Daily Peak Energy Consumption to End-Use Loads



Measured vs. Modeled – End-Use Attribution

Models vs. Measured:

- Models relatively accurate, but not picking up peak energy usage (Usually from HVAC + Water Heater loads)
- Does not account for variability due to customer behavior/preference
- Both require higher-level resolution to identify amplitude or duration of premise or system peaks to understand grid-impacts

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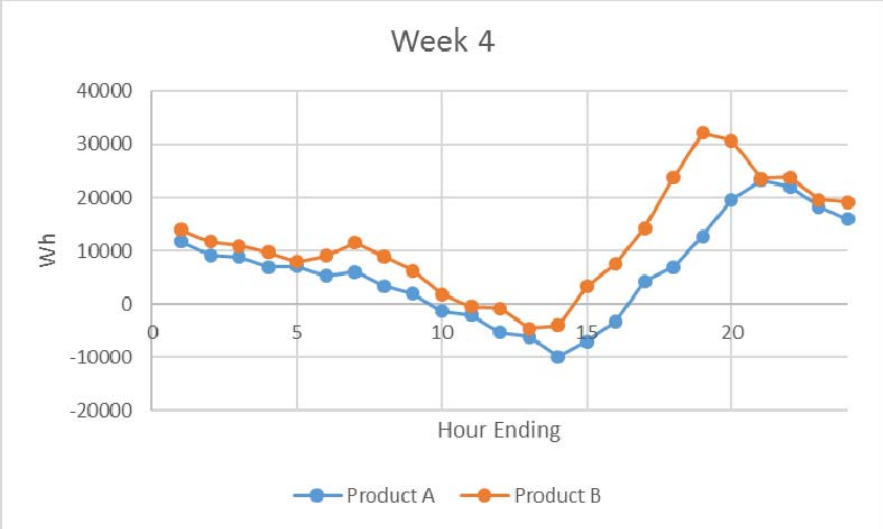
What Does This Mean to the Grid?



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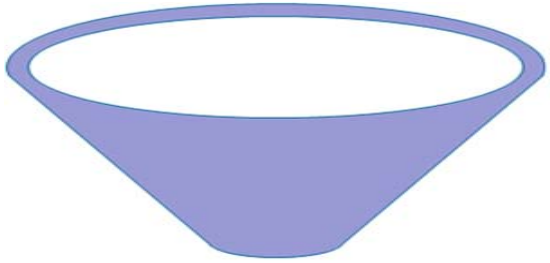
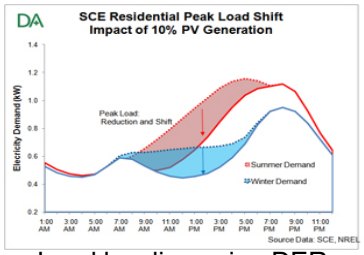
Controls Using Partner-Provided Functions





Load leveling using DER

Connected Device	Approach

Smart Thermostat	- Understand what can be controlled using thermostats and APIs.
	- Develop desired approaches:
	  - Precool during solar over generation
	  - Offset during ramping times

Storage Energy Management	- Request specific controls scenarios enabled only through BEMS - Controls scenarios evaluated:

Connected Water Heater	- Request specific controls enabled through AO Smith APIs
	- Develop desired approaches
	  - Store thermal energy during over-generation
	  - Release thermal energy using ramping
	  - Requires temperature adjustment

Planned Data Parameters Collected per Home and Method of Collection

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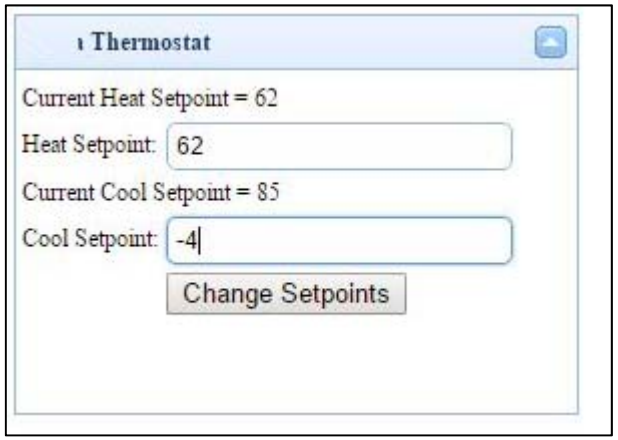
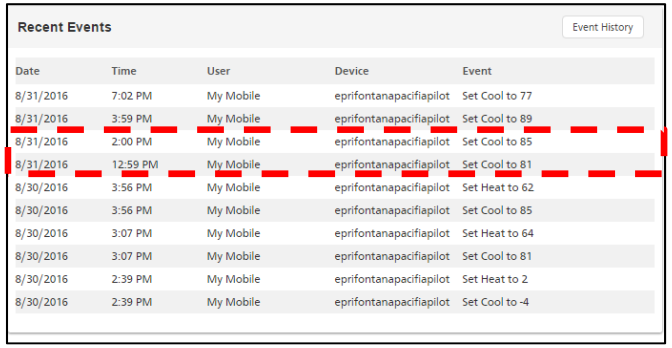
Energy Storage, Smart Thermostat and Water Heater Control

Thermostat Control



Thermostat Control Platform



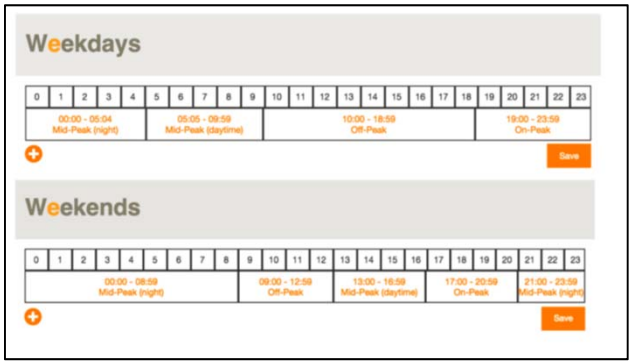
Recent Events

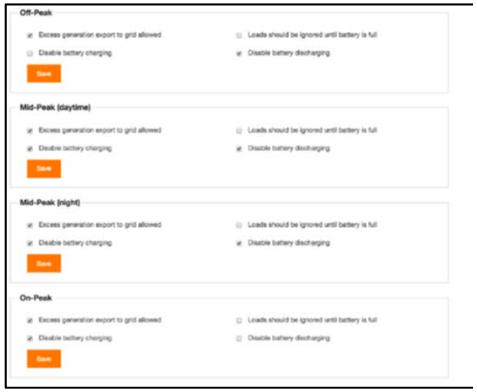
Event History

Date	Time	User	Device	Event
8/31/2016	7:02 PM	My Mobile	eprifontanapacifiapilot	Set Cool to 77
8/31/2016	3:59 PM	My Mobile	eprifontanapacifiapilot	Set Cool to 89
8/31/2016	2:00 PM	My Mobile	eprifontanapacifiapilot	Set Cool to 85
8/31/2016	12:59 PM	My Mobile	eprifontanapacifiapilot	Set Cool to 81
8/30/2016	3:56 PM	My Mobile	eprifontanapacifiapilot	Set Heat to 62
8/30/2016	3:56 PM	My Mobile	eprifontanapacifiapilot	Set Cool to 85
8/30/2016	3:07 PM	My Mobile	eprifontanapacifiapilot	Set Heat to 64
8/30/2016	3:07 PM	My Mobile	eprifontanapacifiapilot	Set Cool to 81
8/30/2016	2:39 PM	My Mobile	eprifontanapacifiapilot	Set Heat to 2
8/30/2016	2:39 PM	My Mobile	eprifontanapacifiapilot	Set Cool to -4

Verified Using Data + Customer App

Energy Storage Control





Storage EMS Platform

Verified using data + EMS portal

- Storage control vetted in 9 homes
- Thermostat control vetted in test home
- Water heater control in progress

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Customer Side Energy Storage

Nicholas Tumilowicz
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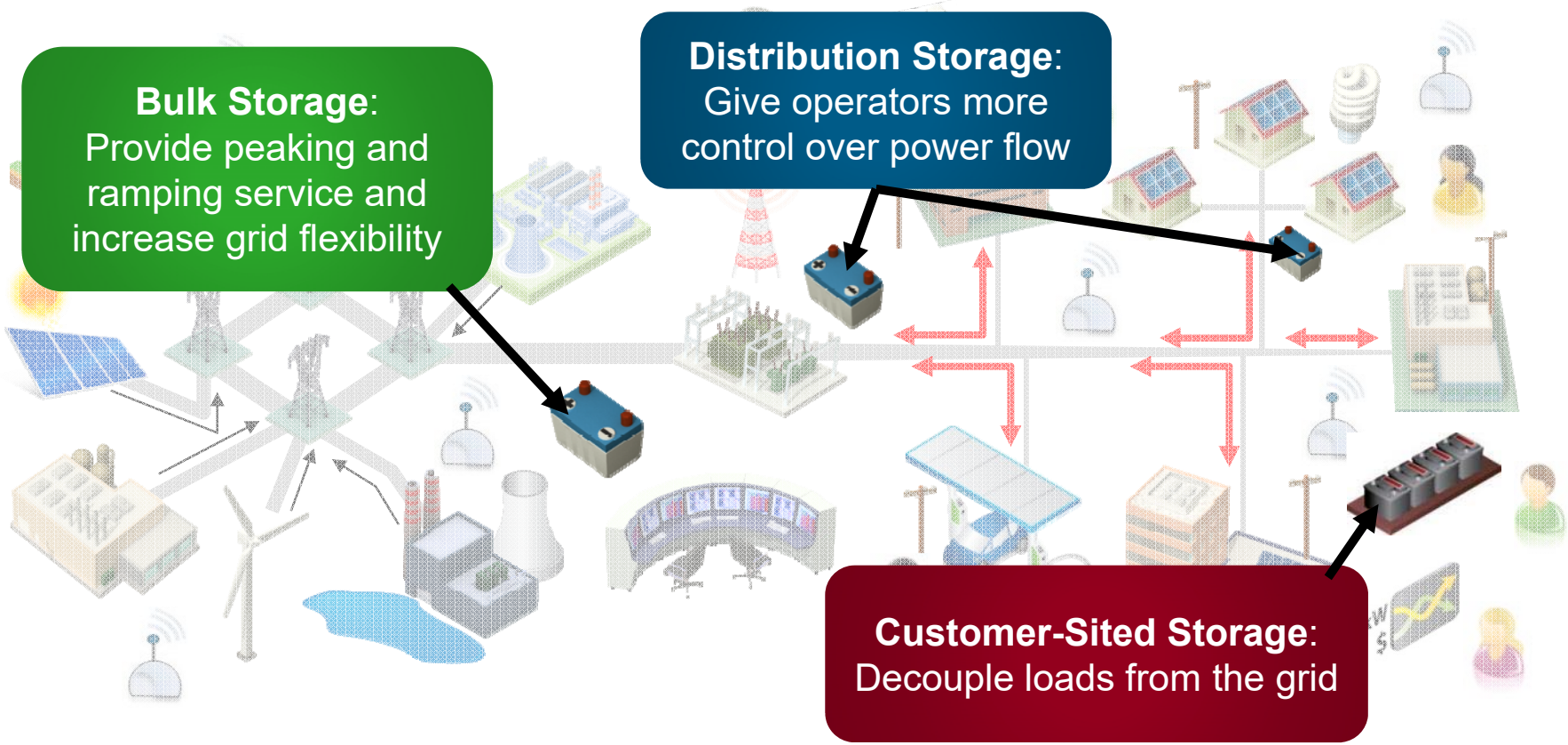
Customer-Sited Battery Storage



Solving for Loads at the Edge-of-Grid

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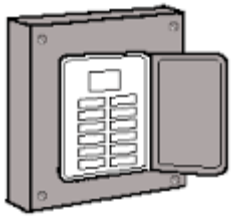
Inside the Smart, Connected, Controllable Home

Smart Thermostat

Solar & Storage

Smart Heat Pump Water Heater



Controllable Loads

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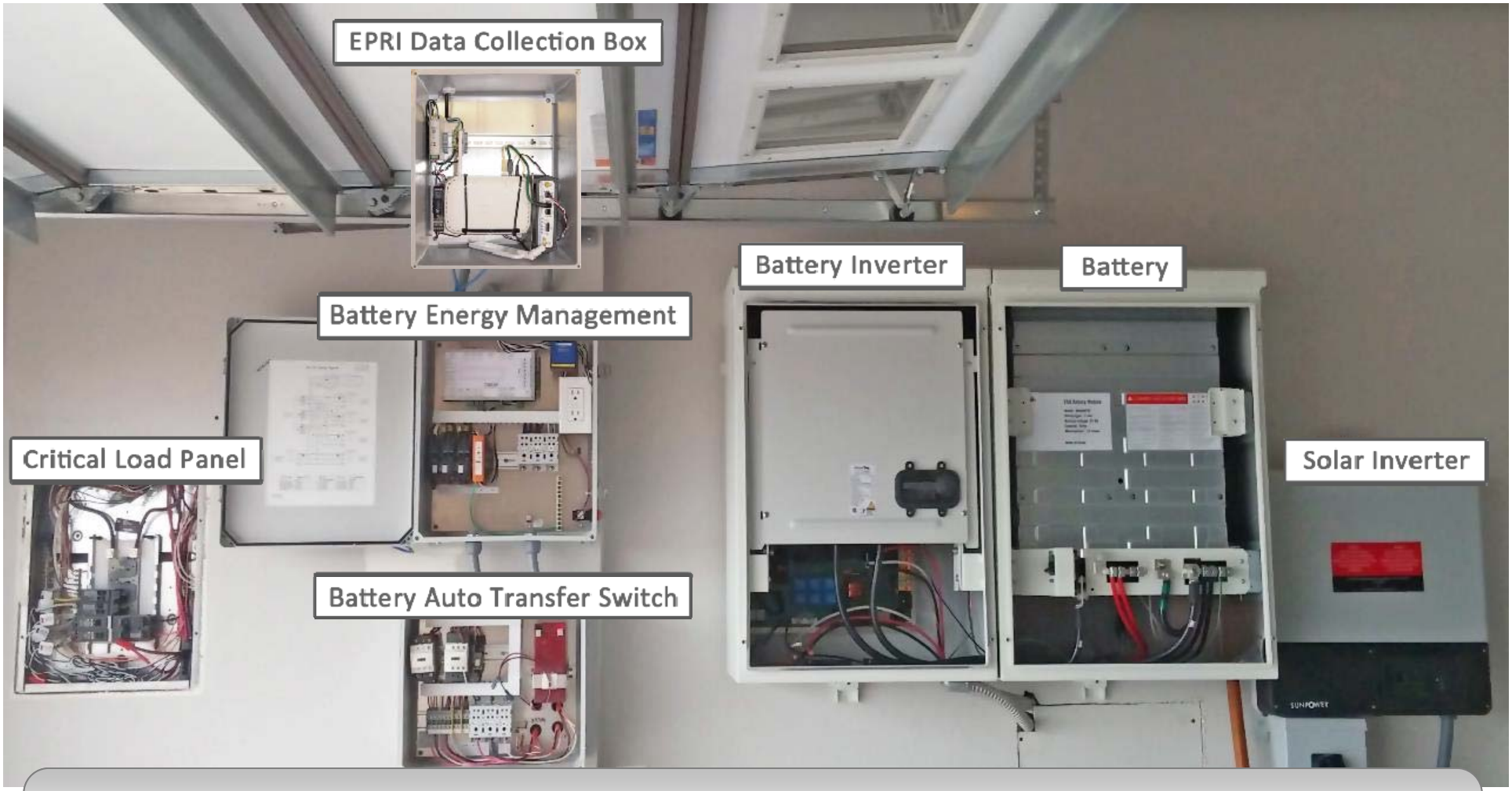
Home Integrated Battery Storage System



Components and System (Generally) Certified and Approved, Integration of this System to Grid required Effort

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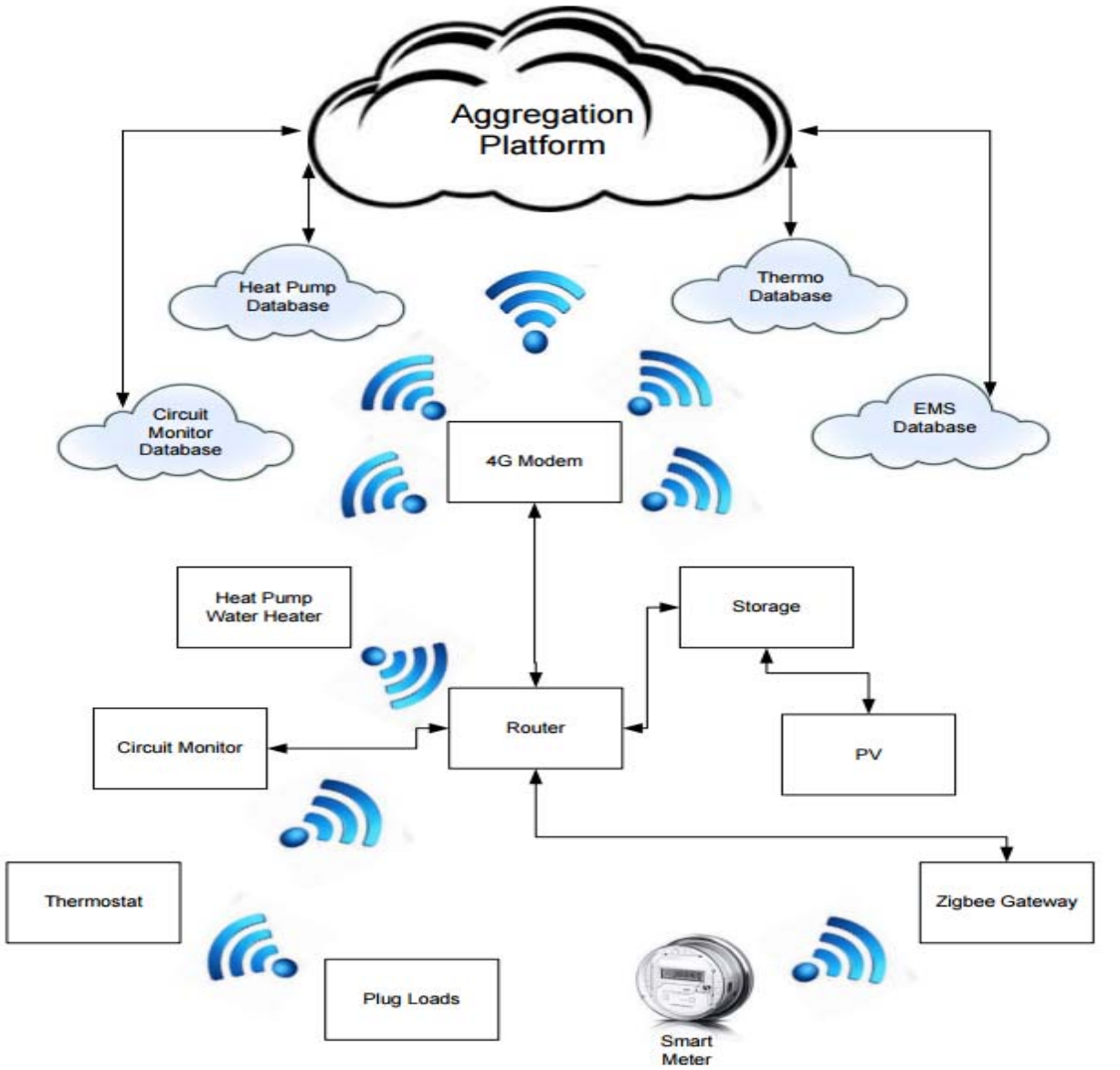
Single Home Device Aggregation & Control



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Permitting Approval Subject to Code

- **Building** Code - Natural gas line interference: Forced indoor installation
- **Mechanical** Code: 300lb, wall-mounted system required additional structure/bracing
- **Fire** Code: Stationary storage battery systems with total weight exceeding 1000 lb (454 kg) for lithium-ion and lithium ion and lithium metal polymer batteries used for facility standby power, emergency power, or uninterrupted power supplies shall be in accordance with additional spill control and enclosure requirements.
- **Electrical**
  - NEC 110.26(F): Energy storage systems in garage will need to be protected from physical damage.
  - NEC 480.9(A): Proper garage ventilation.
  - NEC 690.5(C) & 690.55: Battery warning labels and signage.

Standards are being agreed upon, however, it will take time for AHJ to interpret and adopt the new standards

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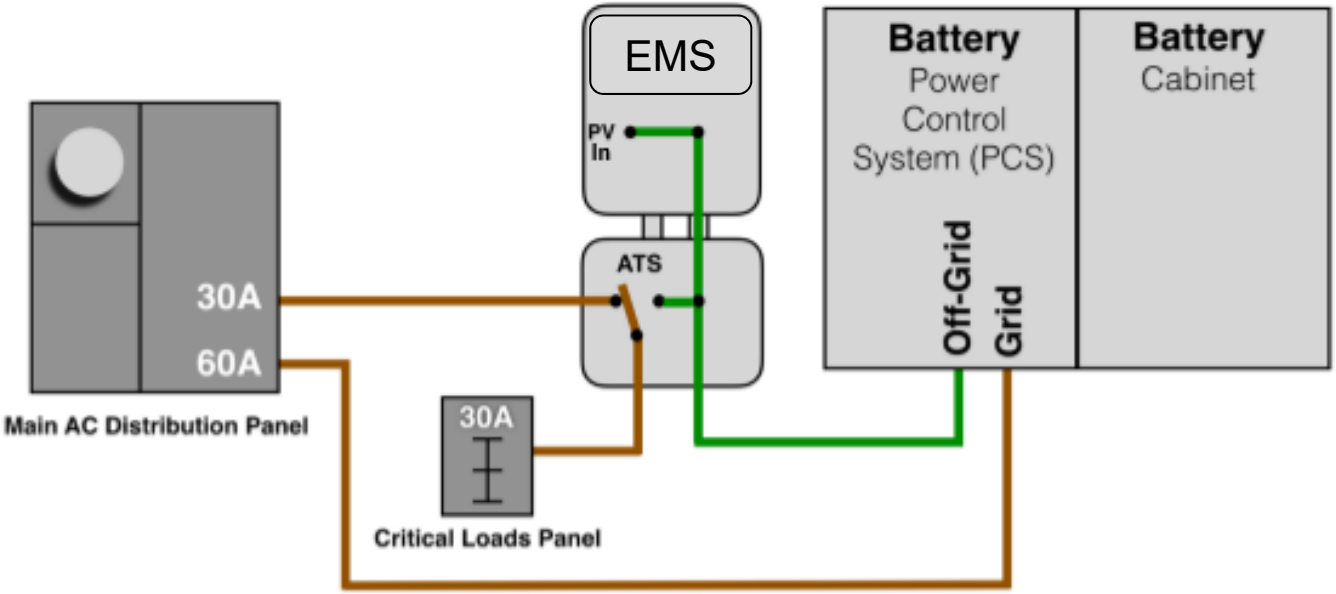
Interconnection Compliance



- **Rule 21 – California**
- **Testing for voltage and current at the meter when in a grid down condition.**
- **UL 1741, IEEE 1547 compliance**

Utilities are becoming familiar and more comfortable with advanced storage inverter capabilities.

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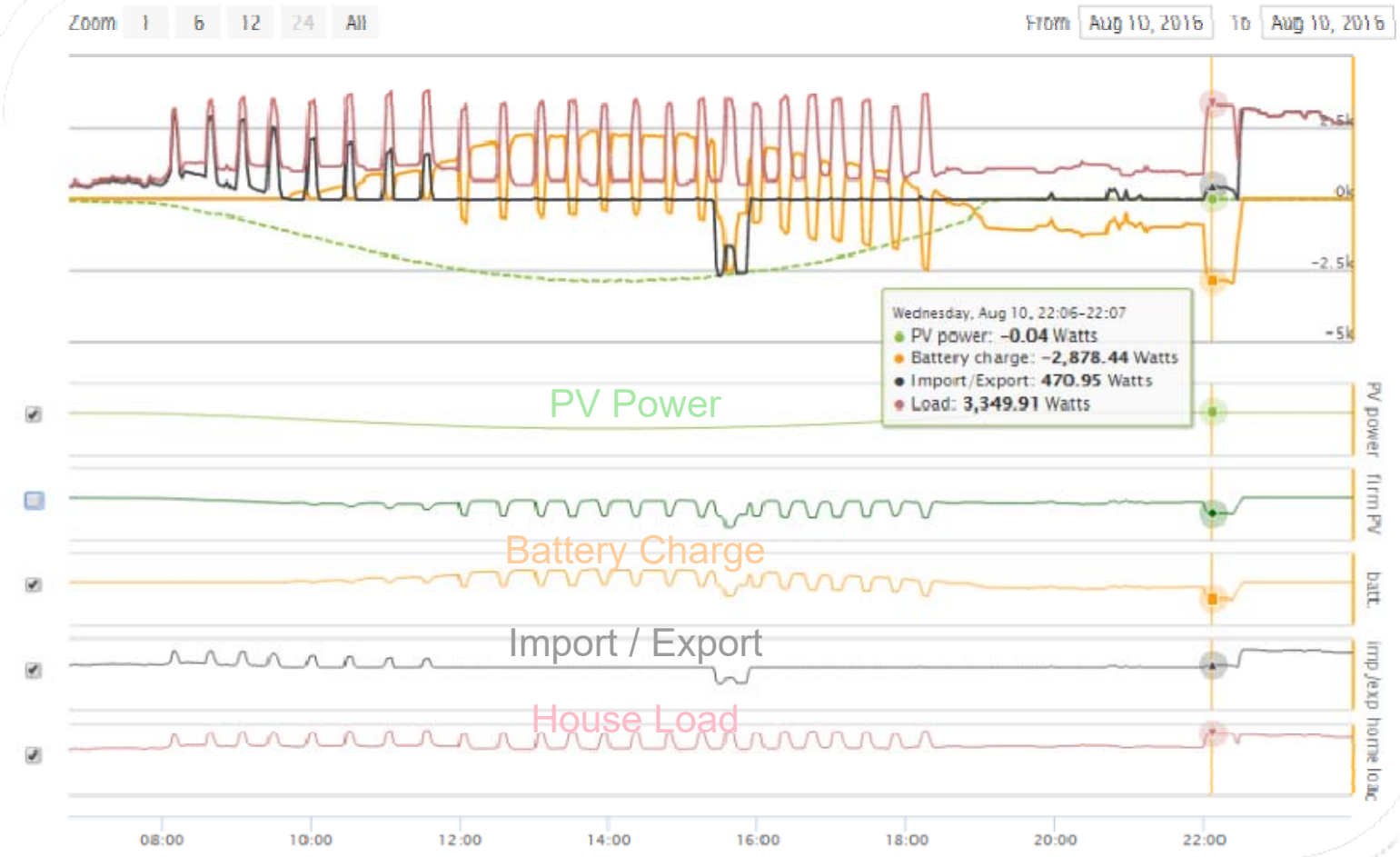
Autonomous Self-Consumption



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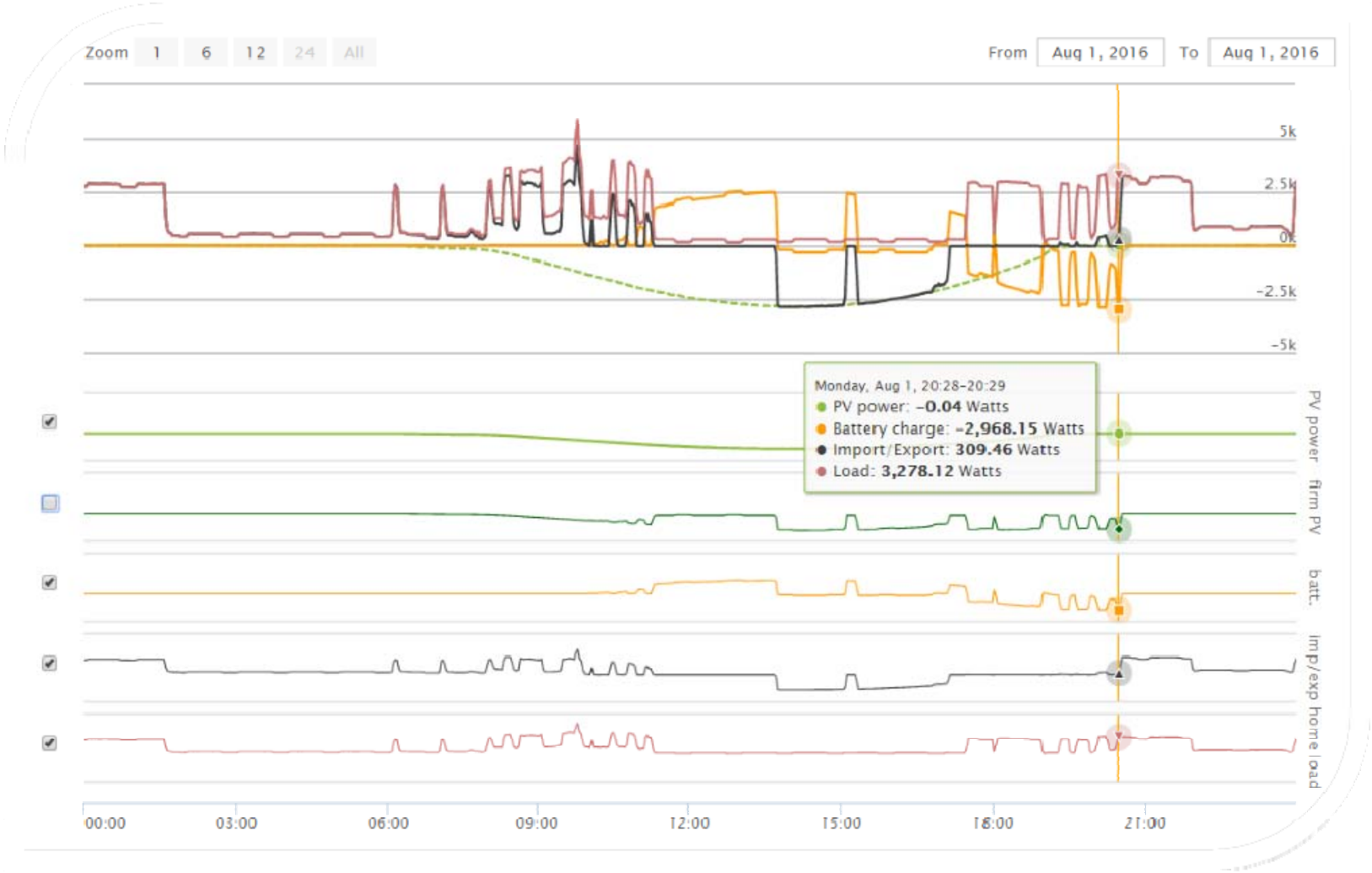
Hybrid Algorithm: NEM and TOU



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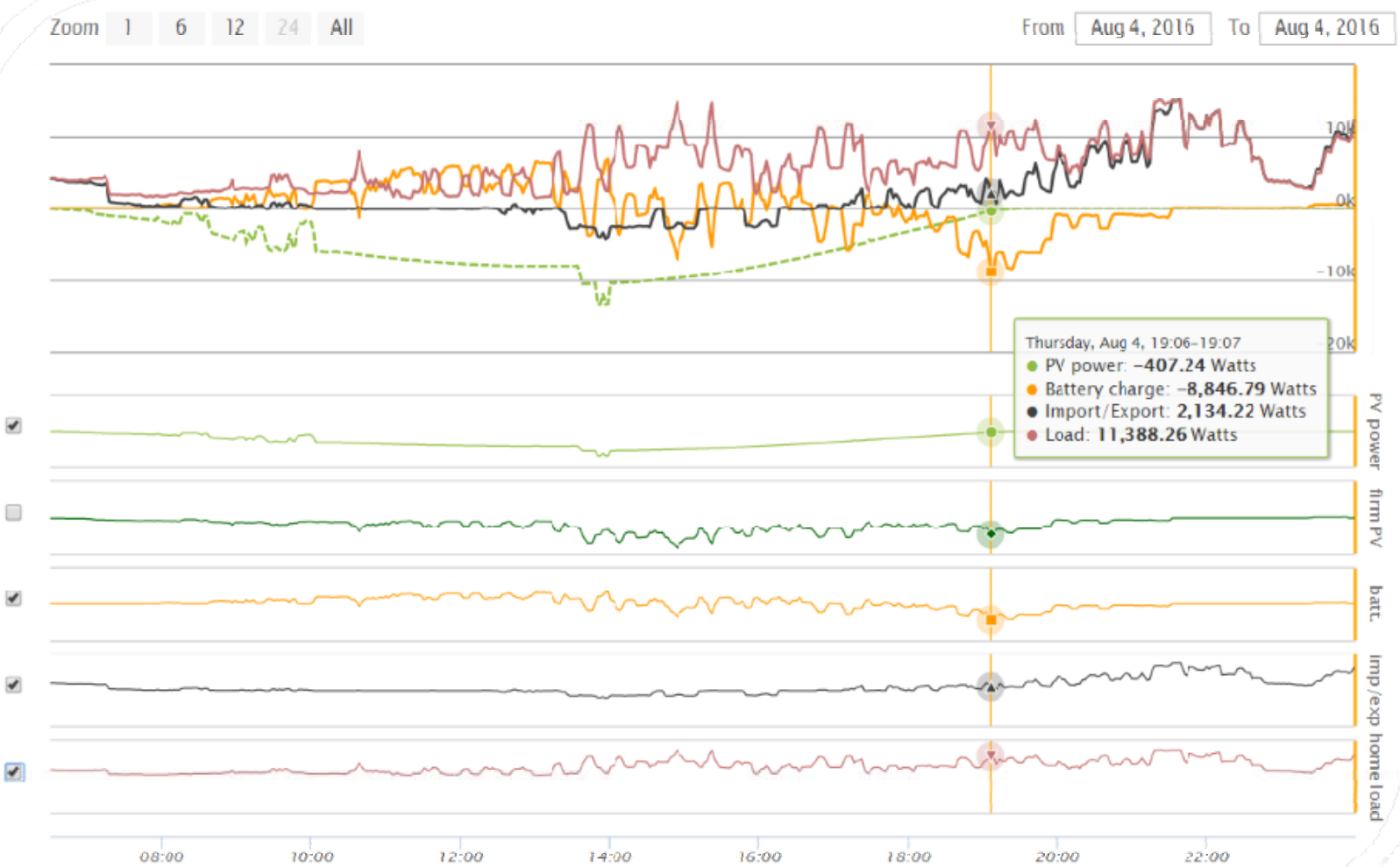
Virtual Aggregated Metering: Adjusted for Sundown



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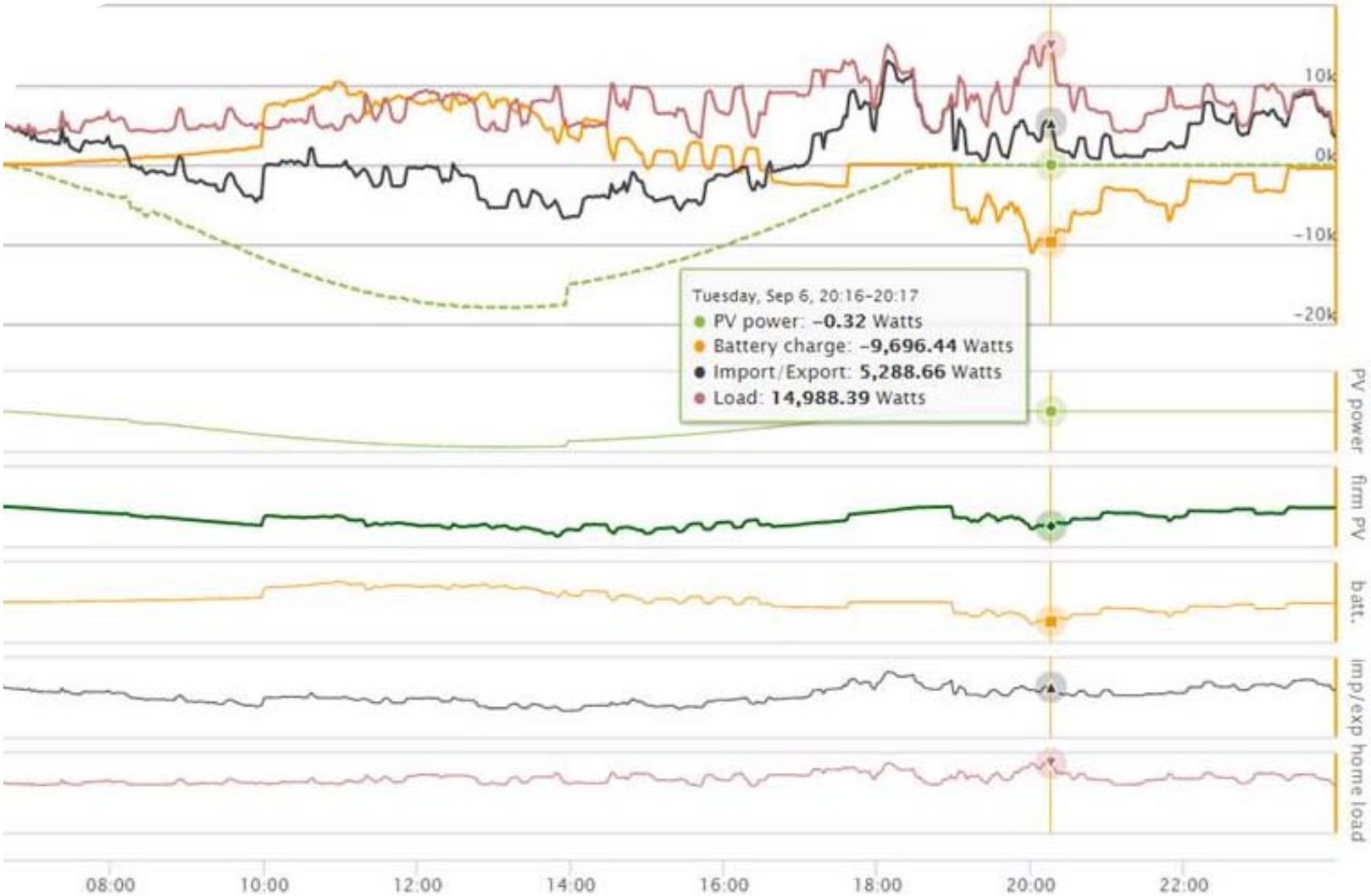
Virtual Aggregated Metering: Adjusted for Evening Peak



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Energy Storage takeaways

Homeowner, Builder, AHJ, Utility Require Education and Technology Transfer

Appropriate Resources Must be Identified for Efficient Implementation

Codes, Standards, and Regulations are Key to Safe, Efficient Integration

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Questions?

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Distribution System Modeling and Impacts

Arindam Maitra
EPRI

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Distribution System Impact Objectives

- What is the ZNE impact on the distribution system?
  - Measure performance of ZNE homes: Compare operational against modeled performance
- What does a large ZNE development look like?
  - Evaluate impact to distribution grid at various levels:
    - Lateral, Load Block and Feeder
  - Evaluate the effect of electrification of gas loads
- Can energy storage help mitigate negative ZNE impact?
- Do current distribution standards (sizing, planning, etc) suffice for integration of ZNE communities?

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SCE Distribution Standards

- Transformer sizing is based off of available load information, SCE climate zone, building sq. ft, # of customers, and installed HVAC system
- Distribution planning today is based on worst case scenario of total connected load. Storage is counted as a load

Factors	Xfmr T1 75kVA	Xfmr T2 50kVA
Building Sqft (Adj Ave)	~1800	~1800
Largest A/C (tons)	4	4
Avg A/C (tons)	3.5	3.5
# of customers	11	9
Peak Demand per lot (kW) *Based on SCE Planning Standard*	5.0-5.5kW	5.0-5.5kW
	Based on HVAC usage	
Panel Size	200A	200A
Climate Zone	7	7

Rating	# Cust
25 kVA	1-4
50 kVA	5-10
75 kVA	11-15

Residential Transformer Loading Limits @SCE

Date	Weekly Measured Xfmr T1	Weekly Measured Xfmr T2
	Peak Demand per lot (KW)	
July 17-24	4.9	3.8
Aug 20-27	4.7	3.6

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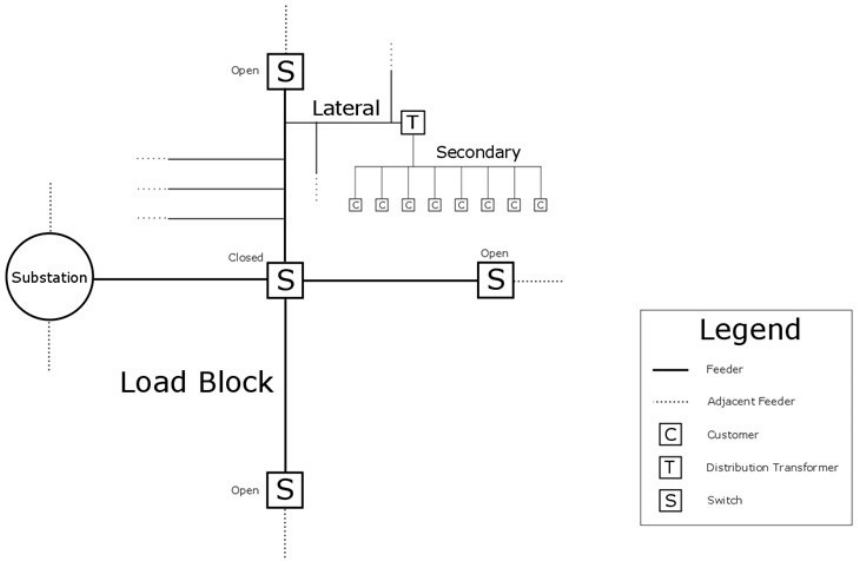
Current Distribution planning and operations practices and Concerns

- Distribution systems might not be designed for electrification of end loads, from either planning or operations viewpoint
- Distribution planning process fundamental assumption: <u>HVAC systems are the largest loads</u>
- ZNE homes will be more efficient and provide improved thermal envelopes.
- Electrification of gas loads within ZNE homes could create some new challenges to planning
- Need better customer models for planning and controls for operation



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Distribution Analysis Simulations

- Needed to extrapolate 20 home models into 1200 for feeder analysis
- Used multiple configurations to analyze potential peaks (kept home-transformer relationship).
- As the simulations grew in scope from transformer to feeder there is less variance since the original sample consists of 20 models
- Distribution losses were ignored

Home Count Per Simulation

Lot #	Median Case	Case 1	Case 2	Case X...
6	1	0	1	2
7	1	1	2	0
8	1	1	1	1
9	1	0	0	0
10	1	3	0	3
11	1	2	0	0
12	1	0	2	0
13	1	0	2	1
14	1	1	1	2
15	1	1	1	0
16	1	2	1	2
Total	11	11	11	11

Simulation Count per Scope

Scope	# Cases	T1 Homes	T2 Homes	Rating (kVA)
Transformer 1	300	11	0	75
Transformer 2	300	0	9	50
Lateral	200	33	27	375
Load Block	50	132	108	1500
Feeder	10	660	540	10000

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Potential Impacts of Electrification to Planning

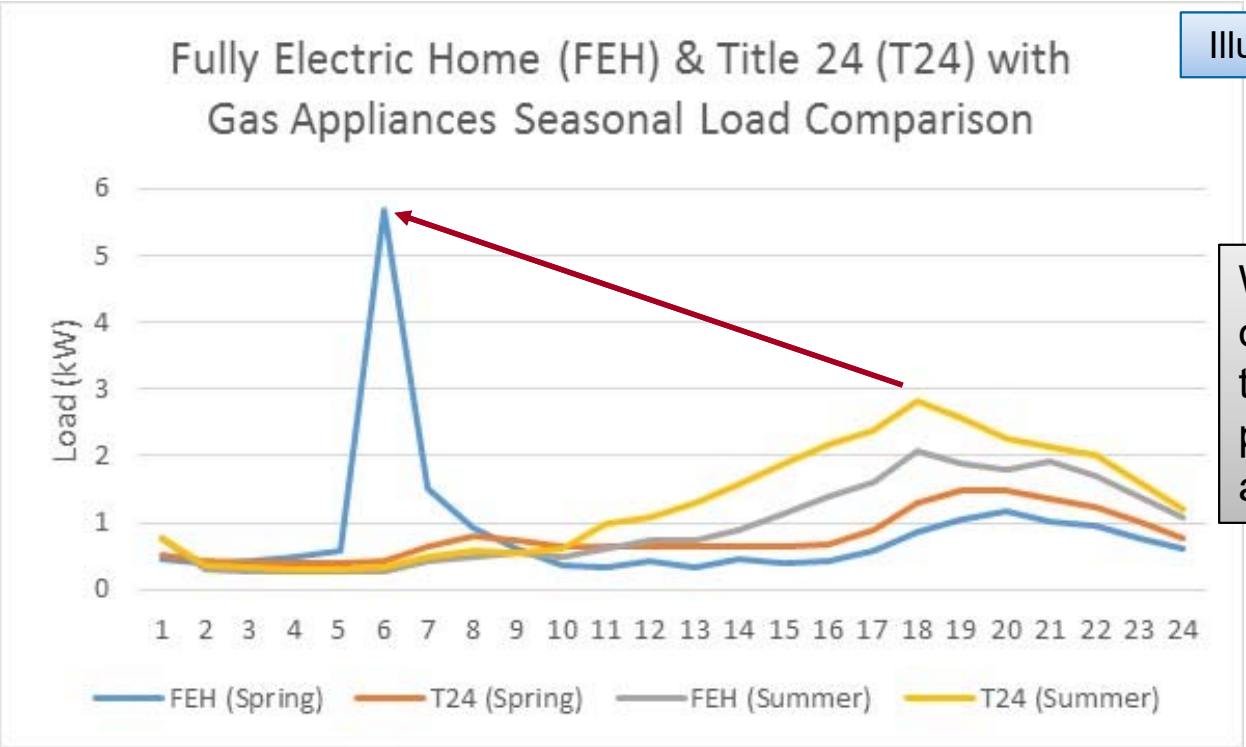

Illustration based on Modeling in BeOpt

When gas loads are switched over to electric they tend to be the largest loads and cause peaks during usage of hot water and electric heat pumps.

- Peak water usage occurs in spring time.
- In summer the heating load is reduced – Hot water heating system is designed to utilize ambient temperature from the garage.
- In spring the system will utilize the peak strip heating resistive element inside the unit as opposed to the 1st lower stage continuous 400-watt heating.

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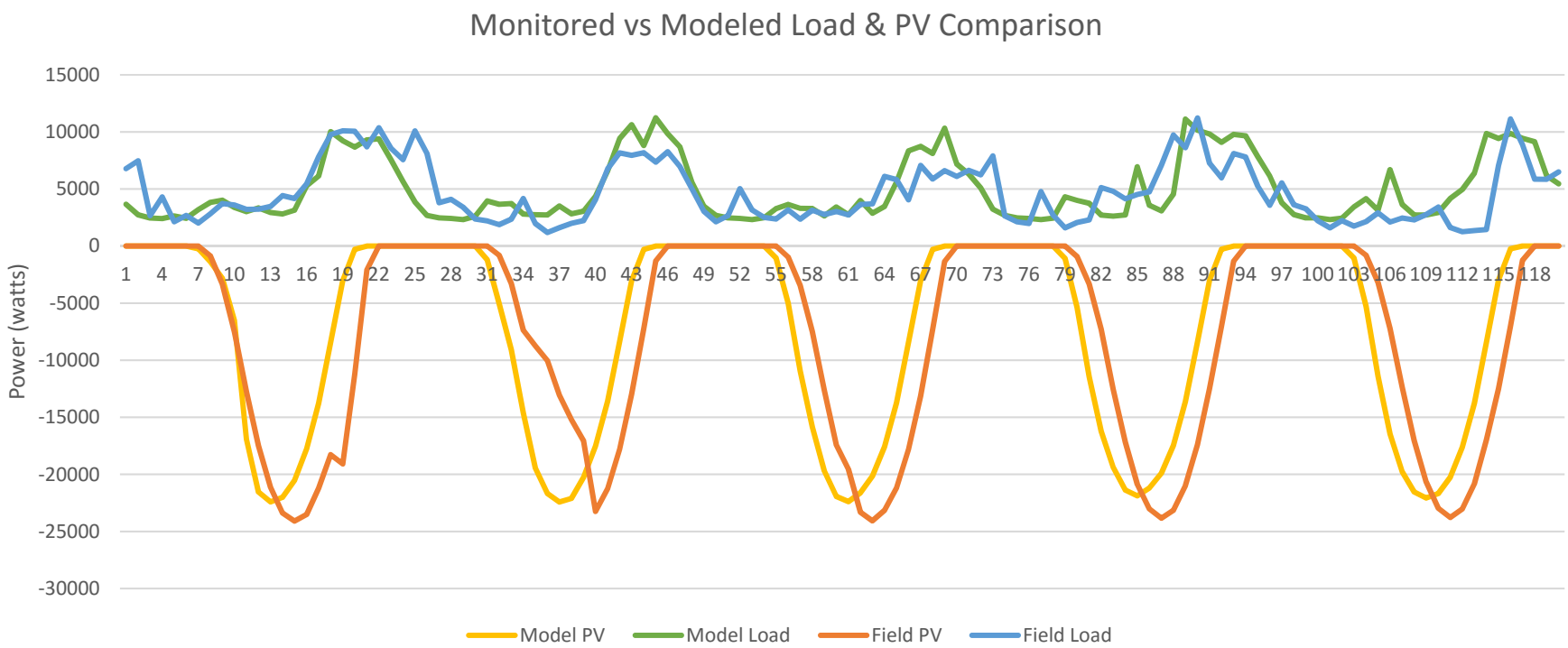
Weather Inputs to Home Models

- The monitored data matched up well with the model
- There was some discrepancies during high ambient temperature days.
- Modeled data used TMY3 weather inputs and therefore did not capture extremes.



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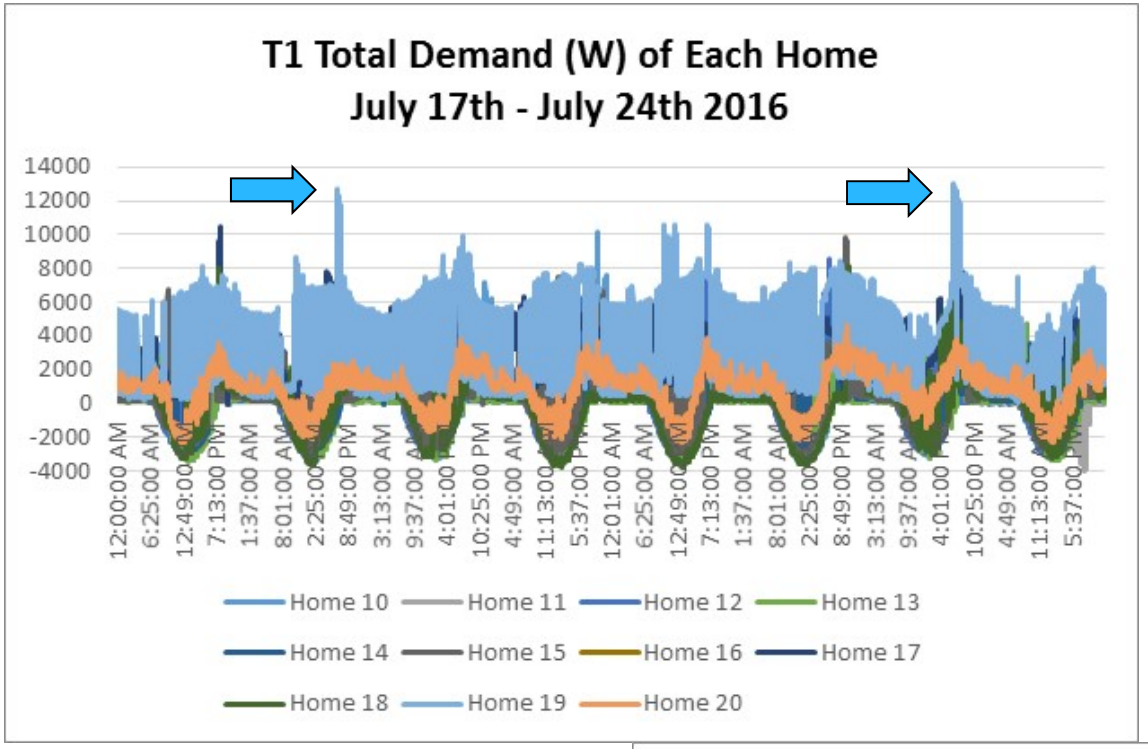
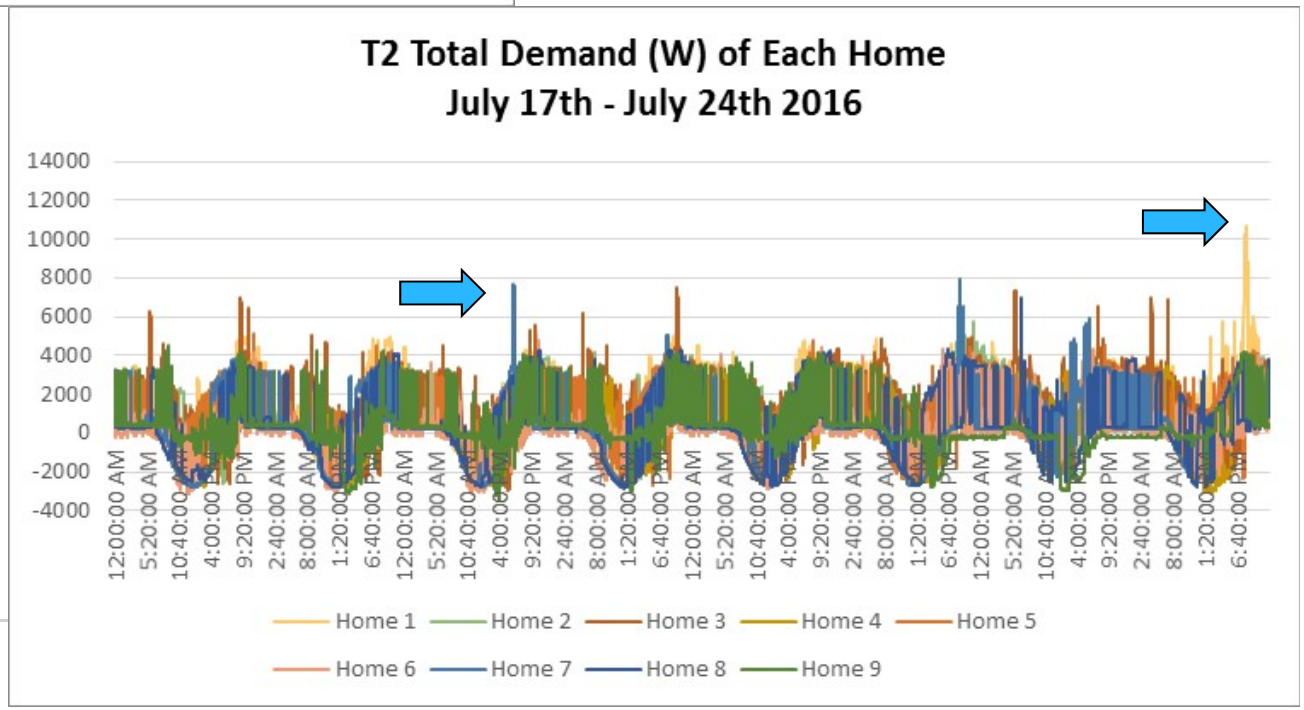


Electric Heating ZNE Homes

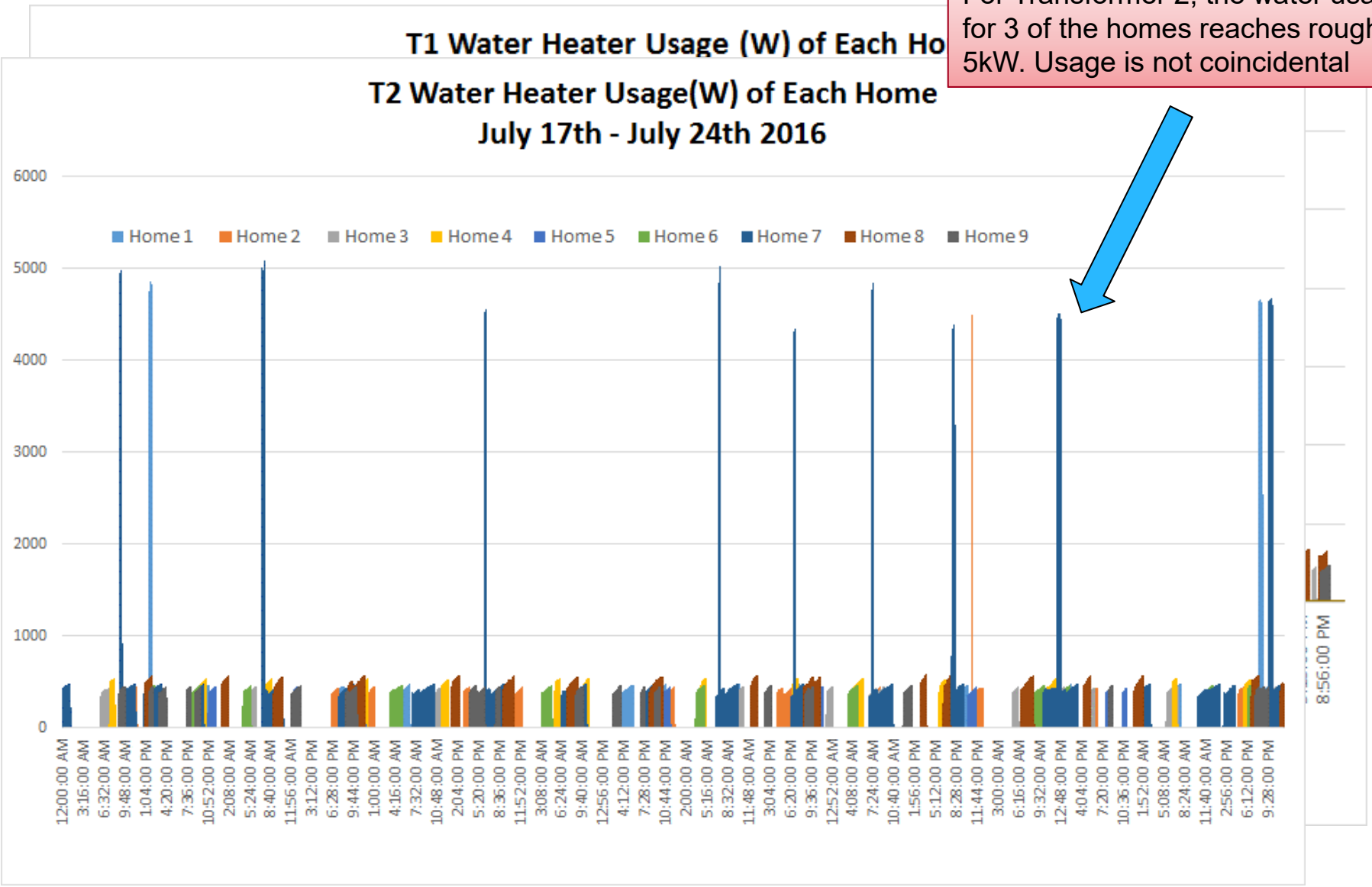
Actual Measurements

- Measurement data from homes built in Fontana



Measured Water Usage from ZNE-EHA (Electric Heating)

For Transformer 2, the water usage for 3 of the homes reaches roughly 5kW. Usage is not coincidental



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Distribution System Modeling for ZNE FHA, Title 24 compliant home, DER Modeling

Distribution Planning Zones

- The DER models constituted energy efficiency, solar PV, and energy storage
- Homes built to Title 24 baseline average 6 kW_{AC} PV for ZNE
- ZNE-EHA homes average 4 kW_{AC} PV
- Energy storage modeled 5kW, 6.4kWh with 25% of capacity for backup reserves

Circuit Segment	# Residential Cust. (avg)	Rating* (typical kVA)
Feeder	1200	10,000
Load Block	240	1,500
Lateral	60	375
Transformer	10	50-75

*These ratings are characteristics of the region that was under evaluation and not representative of the entire California

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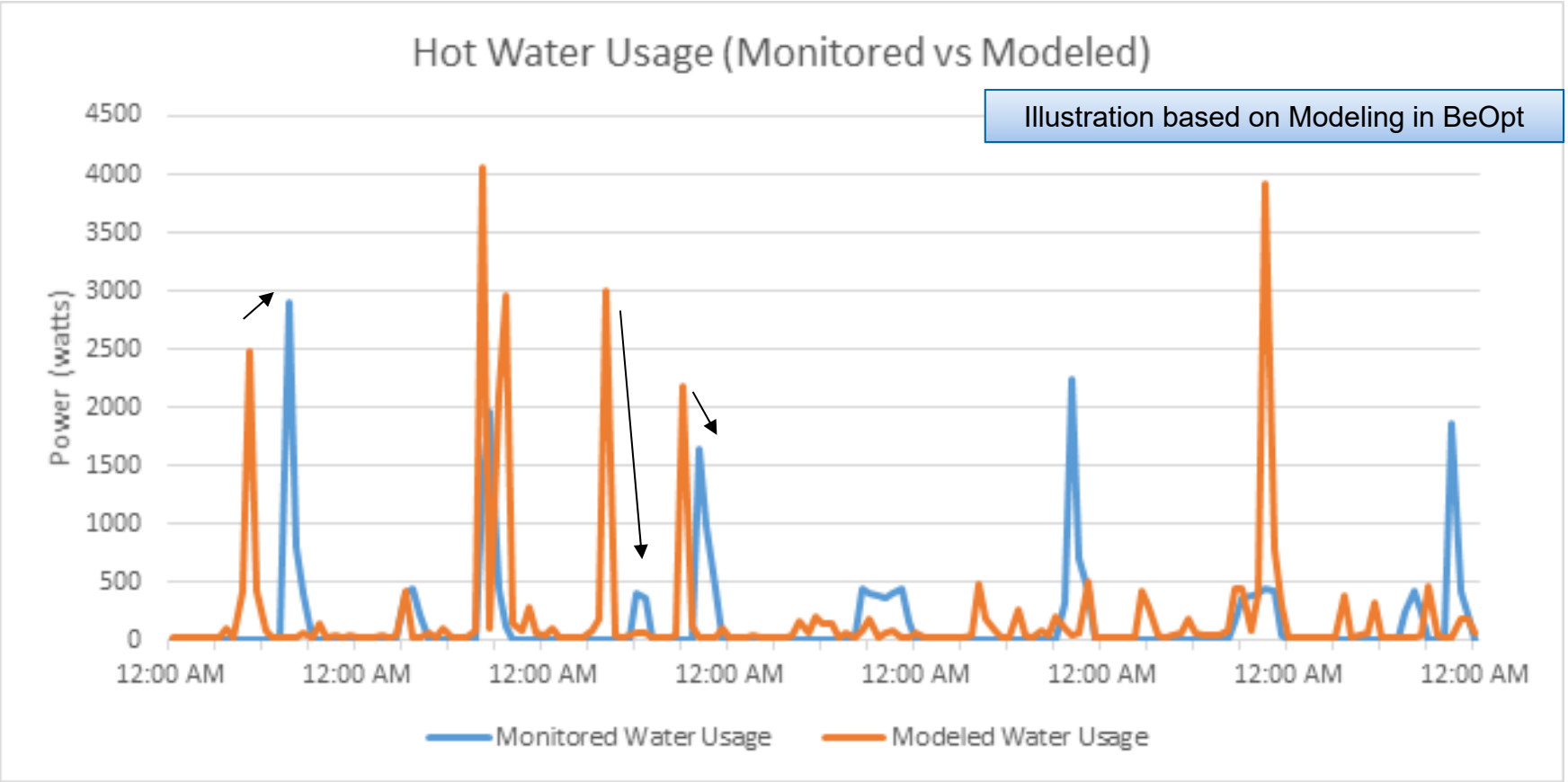
Validate Discrepancy Between Modeling and Measurements (May-June) from ZNE-EHA Homes in Fontana



- The models suffered from an overestimation of the hot water peak demand
- Need to more improved customer models

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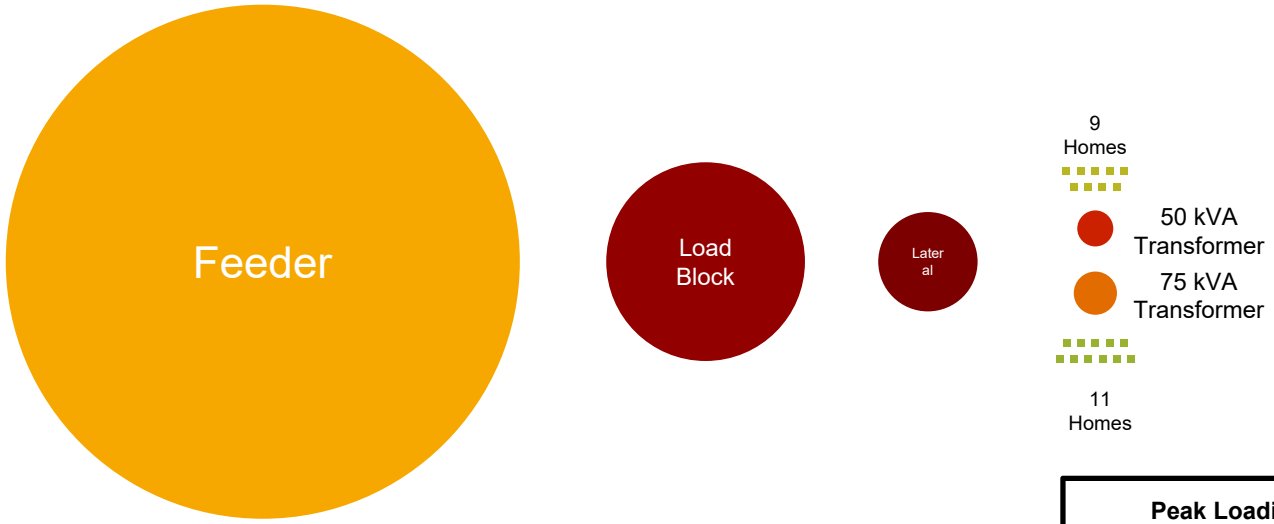
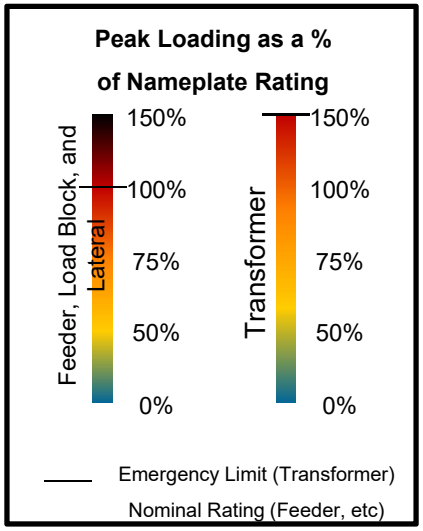
Distribution System loading without energy storage



*The size represents capacity

	T1	T2	Lateral	Load Block	Feeder
Peak kW	87.7	70.0	433	1652	7865
Rating	75	50	375	1500	10000
% of Namepla te	117%	140%	116%	110%	79%



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Feeder, Load Block, Laterals, and Transformer Conclusions

- **Transformers**
  - Better coordination and visibility of customer owned DER assets
  - Electrification to ZNE-EHA could push the transformer thermal limits
  - Customer peak usage tends to be in the spring and winter

- **Laterals and Load Center/ Load Block / Feeder**
  - Design standards should be reviewed
  - An increase in PV does not mitigate the overload
  - There is backflow even at small PV levels, but the backflow's difference between ZNE and T24 are minor
  - Diversity of customer behavior would prevent coincident peaks

- **Energy Storage as a potential solution?**
  - Can targeted ES controls contribute to peak reduction?
  - ES can be detrimental if there is a large quantity of customers that are operating to optimized their TOU tariffs

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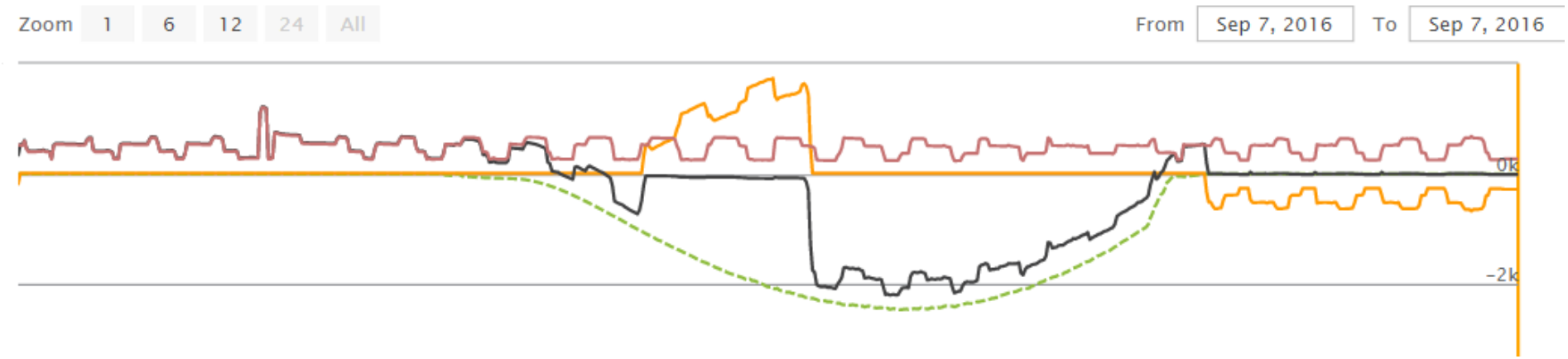
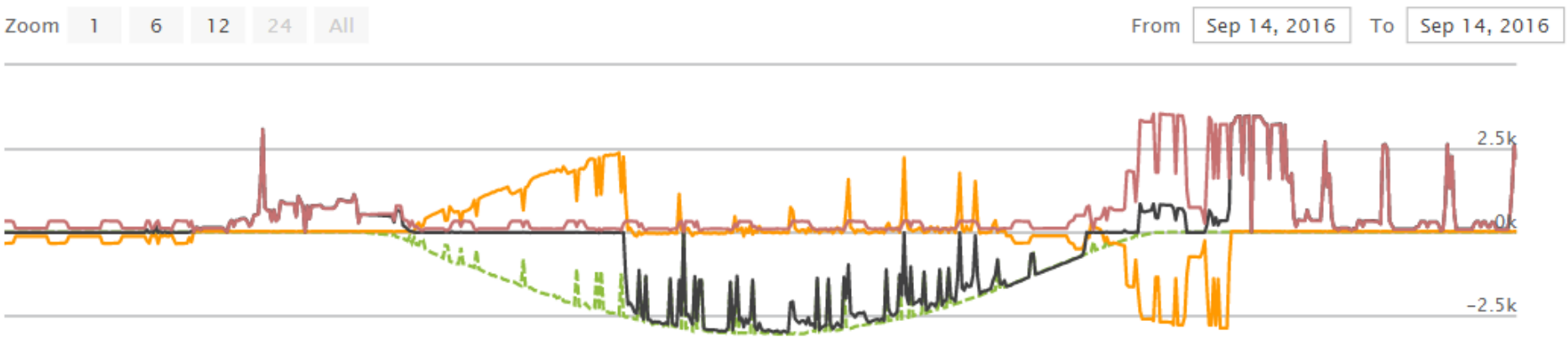
Performance with battery storage, EE and solar

- Batteries can operate in different control modes - self-consumption, Time of Use, Utility Aggregation
- Tested in self consumption and 2 different ToU modes





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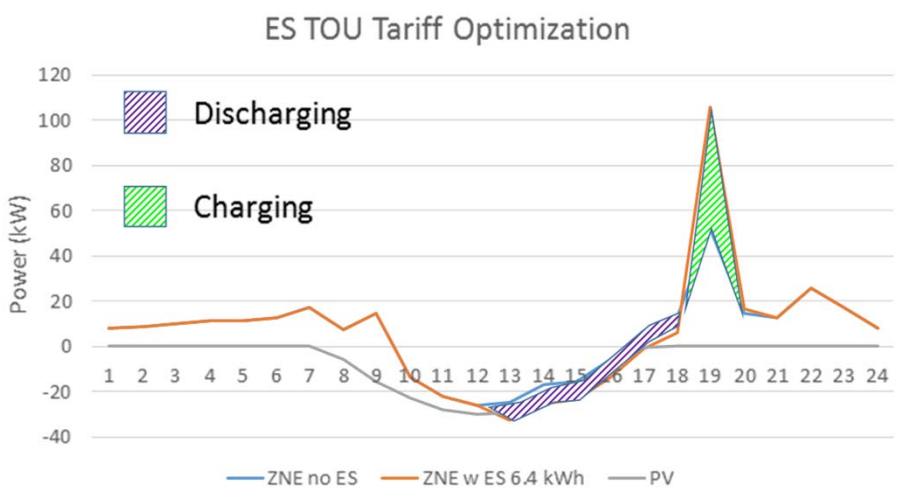
Could Energy storage Provide a Potential Solution

Controls are key

Operation based on ToU rates Optimization

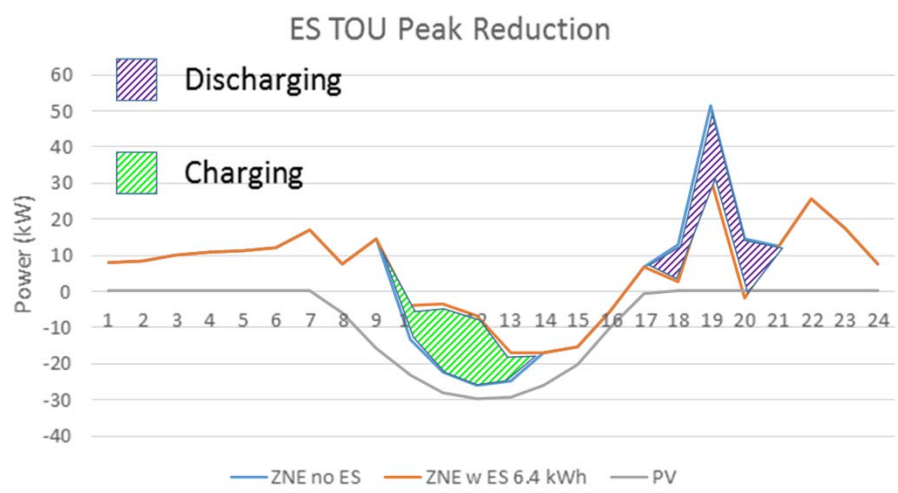
- Energy storage is operated to optimize for current ToU rates
  - Peak is Noon – 6 PM (ES discharge)
  - Off-peak is 6 PM – 6 AM (ES charge)
- 100% SOC maintained overnight



The ES TOU tariff optimization control scheme could potentially cause adverse impacts.

Operation based on ToU Peak Reduction

- Energy storage systems operated with "simulated peak and off-peak"
  - Peak is 5 PM – 8 PM (ES discharge)
  - Off-peak is 9 AM – 12 PM (ES charge)
- 25% SOC maintained overnight



The ES TOU grid balancing control scheme could be beneficial.

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Questions?

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Building Solar and Zero Net Energy Communities

C.R. Herro
Vice President, Sustainability
Meritage Homes

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Win – Win – Win Strategies

MeritageHomes CORPORATION

Setting the standard for energy-efficient homes™

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People Choose Better

- Comfort
- Health
- Quiet
- Lower Expense
- Builder Partner

Sierra Crest

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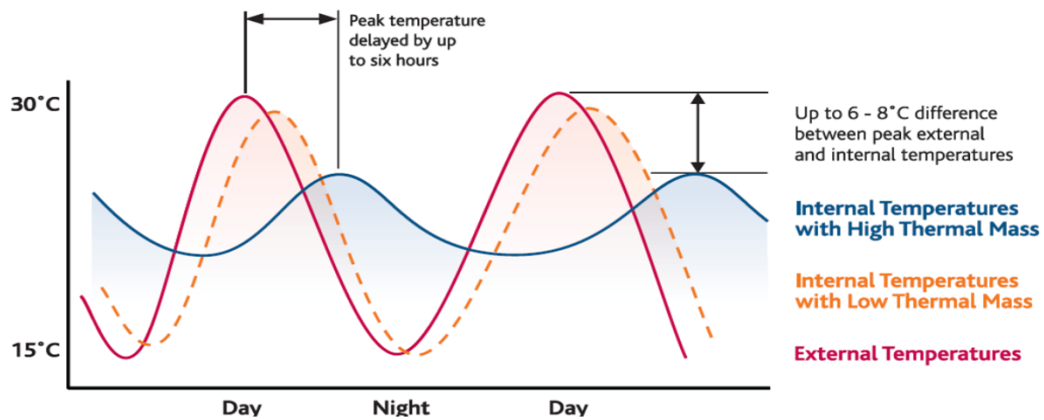
The Future: Moving the Energy Demand: Duck Curve

A. Smart ventilation (off peak)
B. Isolated Thermal mass / phase change
C. Thermal storage (heatpump HVAC precool off peak)
D. Low solar heat gain (reflective / vented cladding materials)
E. Smart appliances
F. Large hot water storage w/ heat pump.
G. West facing solar.



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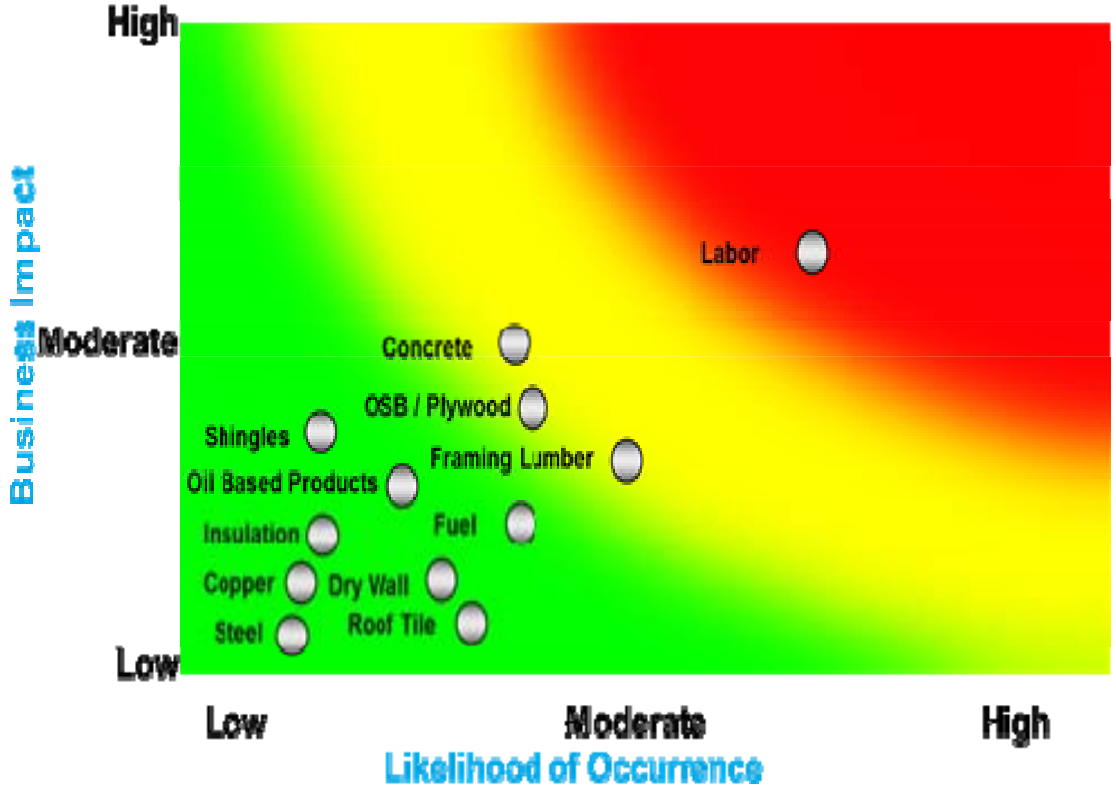
Future Upside

- Updated Energy Models
- Solar Incentives tied to peak reduction
- Utility Incentives tied to peak reduction
- Labor efficiencies
- Improved Performance
- Warranty



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Impacts to the Utility Grid and Customers

Jerine Ahmed
Southern California Edison

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About Southern California Edison

- **One of the Country's Largest Investor-Owned Utilities**
  - 50,000 square miles
  - 14 million residents
- **23 years of EE Results**
  - **23** Billion kWh Saved
    - ✓ Enough to power **3.4** million homes
    - ✓ GHG Reduction – **10.4** million metric tons
    - ✓ Equivalent of taking **2.2** million cars off the road
- **In 2015:** 857 Million kWh saved

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Emerging Technologies Program

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, 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.

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ZNE Demonstration Portfolio

- Irvine Smart Grid Demonstration
- ABC Green Home 1.0,2.0,3.0
- ZNE Home at Edenglen
- Low Income Multifamily
- Low Income Residential Retrofit
- ZNE Recreation Facility Retrofit
- ZNE Training Facility Retrofit
- ZNE Schools Pilot
- High Performance New Construction Production Home
- Advanced Retrofit of Modular Classrooms
- ZNE Medical Office Building
- Solar Decathlon
- **Grid Integration of ZNE Communities**

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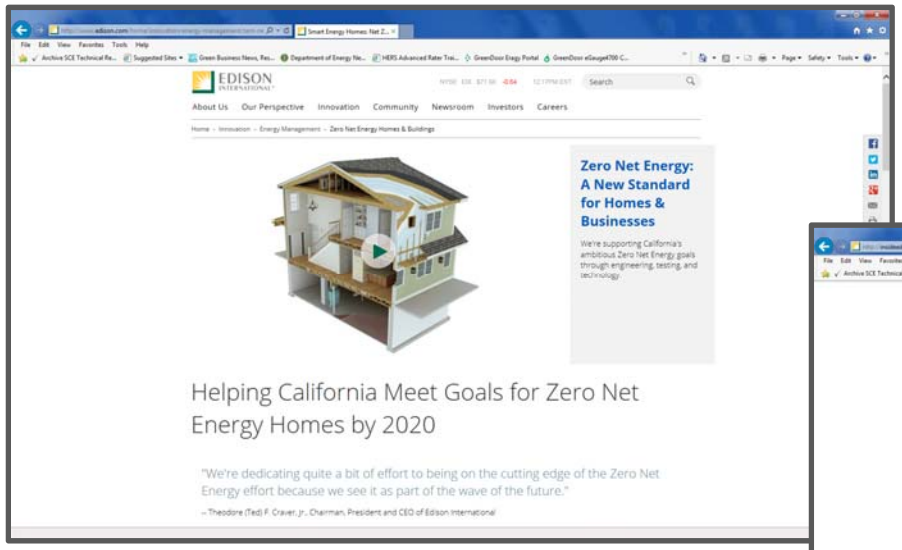
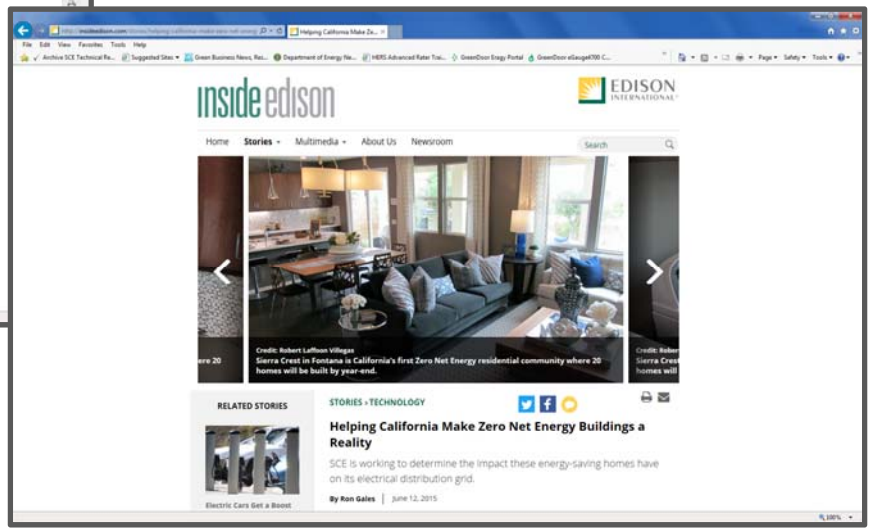
Market Transformation

http://www.edison.com/





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Understanding of ZNE Communities

- Technology packages that enable builders to build cost effective ZNE homes.
- Showcasing a sustainable community built to upcoming ZNE standards
- Demonstrating advanced residential EMS that can:
  - help shape grid-friendly building loads
  - are tuned to offset fluctuations from local PV generation
  - can receive and respond to DR signals
  - provide greater insight into consumer behavior and operation of low energy homes
- The role of energy storage in ZNE communities
- Systems that can help mitigate impact to distribution circuits from DERs
- Guidance for ZNE programs and building codes on technologies that can enhance utility service

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Key Takeaways from Homeowner Interviews

- Most customers have not heard of ZNE
- Once informed, customers had a positive view of the concept
- The potential for low to no energy costs was a significant driver for customers who opted to purchase a ZNE home vs a non-ZNE home
- Environmental leadership and energy independence are increasingly popular drivers for customers who proactively build a home to ZNE standards

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Lessons Learned and Future Initiatives

Ram Narayanamurthy
EPRI

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Lessons learned – Planning and design

1. Minimize the size of PV arrays for multiple benefits:
   - Neighborhood planning and lot fits
   - Least cost pathways
   - Reduce peak backflow
   - Reduce late evening ramps
2. NEM drives electrification of heating loads
   - TDV (or source) ZNE definition accounts for gas consumption, and gas heating results in excess annual generation at low payback
   - TDV ZNE favors gas heating – lowest first-cost for ZNE_{TDV}
   - → Naïve T24 analyst/designer spec gas despite no gas NEM
3. Neighborhood solar planning could be a big barrier to reaching current ZNE goals
4. Energy efficiency has more capacity benefits than PV
   - PV production is non-coincident with loads

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Lessons learned – Construction

1. A standardized permitting process for customer side energy storage needs to be developed working with building code officials
2. Solar – storage interface needs improvement to avoid “lock in” from solar providers
3. Demand response capability from connected devices is “there but not there” – requires a lot of custom integration
4. Need standardization of storage interconnection process
5. We can attain low cost intensive data acquisition
6. Level of subcontractor training requires on-site expert handholding when implementing new technologies
   - Electrical panels labeling and wiring needs to be more standardized
   - More rigorous commissioning by HERS raters

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Lessons learned – Operating results

1. Zero Net Energy homes can be more comfortable and reduce home operating costs
   - Still awaiting winter operation and one-year data
   - Spring energy use matches models, summer usage higher
2. PV and load peaks (8 PM – 12 AM) are not coincident
   - Peaks driven by heat pump water heater and late evening cooling
3. Energy storage operating algorithms designed for ToU arbitrage (with today's rates) do not help distribution grid
4. Energy storage controls optimized for grid benefits (tuned to duck curve) can help distribution grid
5. End to end models integrating building and distribution models are achievable and can enable better grid planning
   - Building models are not (yet) accurate at predicting ZNE peaks
   - Models need to be more granular, not averages

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Lessons learned – Grid Impacts and future initiatives

1. In distribution planning, most reliable path forward is to increase transformer and wire sizing for ZNE and high PV penetration
   - 50 year planning horizon cannot rely on controls (including storage)
   - Future loads – EV and electrified heating are not coincident with PV
   - Customer controlled energy storage is not reliable for grid needs.
2. The problem spots for distribution systems is load blocks, laterals where the protection devices lie and wire sizing
3. Distribution systems will need to manage for load peaks almost as much as high penetration PV (coincident loads)
   - Passive energy storage, demand response and energy storage can provide integrated load management
4. Research community solar and storage options for ZNE

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Technology Transfer

ARCH

The New York Times

Senate Approves Funding for Flint Water Crisis

Southern California Gas Reaches $4 Million Settlement Over Natural Gas Leak

Saudi Bid on a Houston Oil Refinery Is a Big Strategic Bet

ENERGY & ENVIRONMENT

A Suburban Experiment Aims for Free Energy

By DIANE CARDWELL JUNE 3, 2016

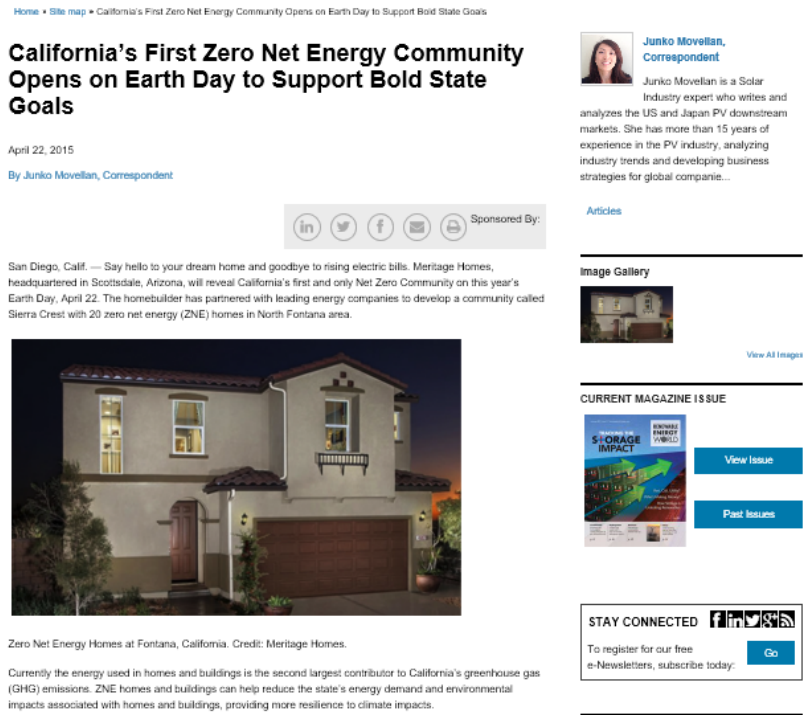
SLIDE SHOW | 6 Photos

Getting to Zero

Carlos Gonzalez for The New York Times

FONTANA, Calif. — At first glance, Anthony and Vanessa Genau's home in a

- **100 + Media mentions and articles**



Home • Site map • California's First Zero Net Energy Community Opens on Earth Day to Support Bold State Goals

California's First Zero Net Energy Community Opens on Earth Day to Support Bold State Goals

April 22, 2015

By Junko Movellan, Correspondent

Sponsored By:

San Diego, Calif. — Say hello to your dream home and goodbye to rising electric bills. Meritage Homes, headquartered in Scottsdale, Arizona, will reveal California's first and only Net Zero Community on this year's Earth Day, April 22. The homebuilder has partnered with leading energy companies to develop a community called Sierra Crest with 20 zero net energy (ZNE) homes in North Fontana area.

Zero Net Energy Homes at Fontana, California. Credit: Meritage Homes.

Currently the energy used in homes and buildings is the second largest contributor to California's greenhouse gas (GHG) emissions. ZNE homes and buildings can help reduce the state's energy demand and environmental impacts associated with homes and buildings, providing more resilience to climate impacts.

Junko Movellan, Correspondent

Junko Movellan is a Solar Industry expert who writes and analyzes the US and Japan PV downstream markets. She has more than 15 years of experience in the PV industry, analyzing industry trends and developing business strategies for global companie...

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The Future

- Evaluating community scale ZNE
  - Community solar to meet ZNE goals and grid balancing
  - 4 communities in Northern, Central and Southern CA (EPIC)
- Neighborhood level planning tools
- Grid integrated community scale solar and storage for ZNE
- Measure long term performance
- Impact of electric vehicles
- Drive integration of various DERs including PV, energy efficiency, demand response, energy storage

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Together…Shaping the Future of Electricity

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