ACEEE Market Transformaton Conference

ZNE Buildings and the Grid: *Least Cost Pathways for Every Building*

Peter Turnbull, Principal, PG&E

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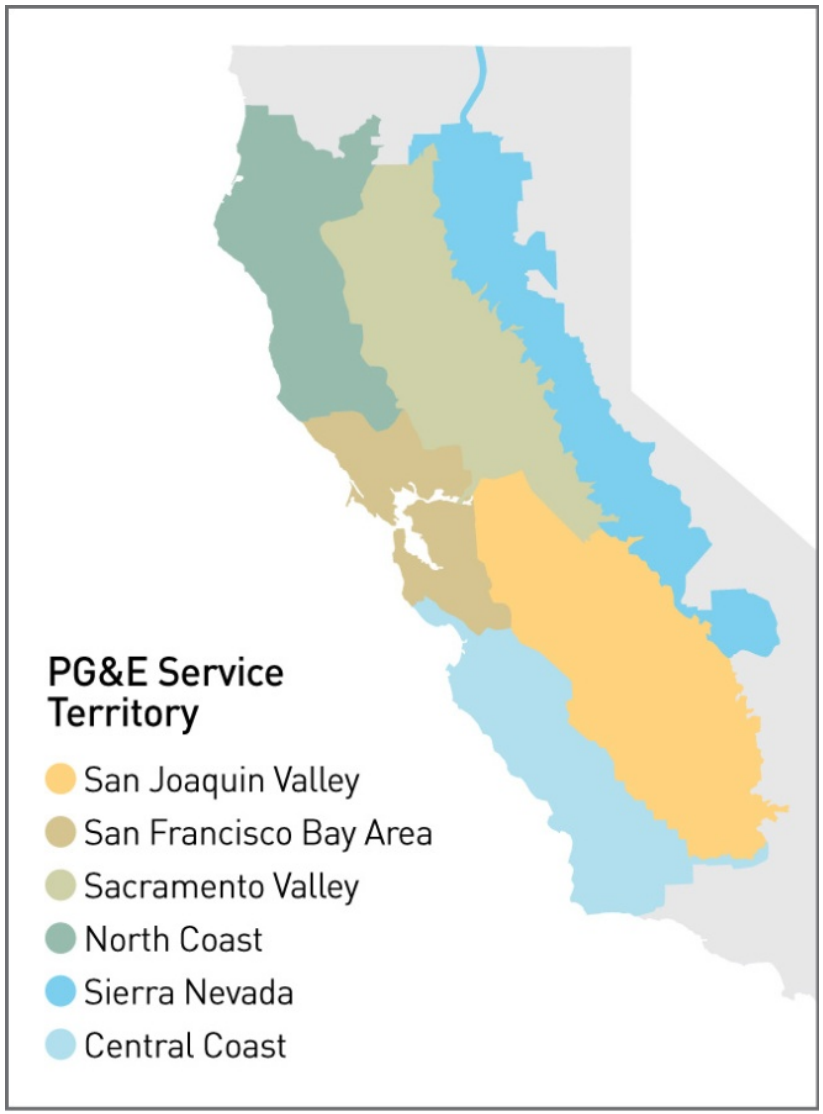
Pacific Gas and Electric Company

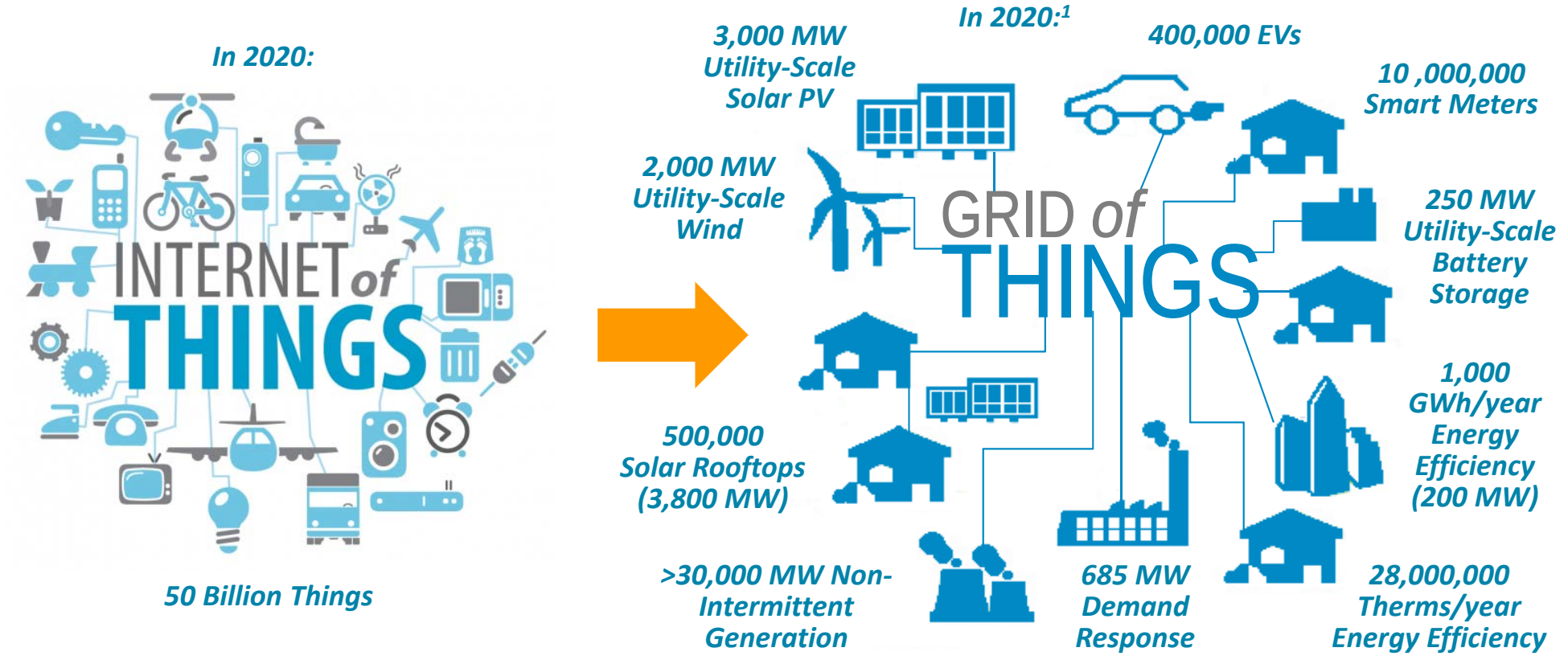
Our mission:

To provide safe, reliable, cost-effective, and clean gas and electric service to the 15 million residents of Northern and Central California we serve



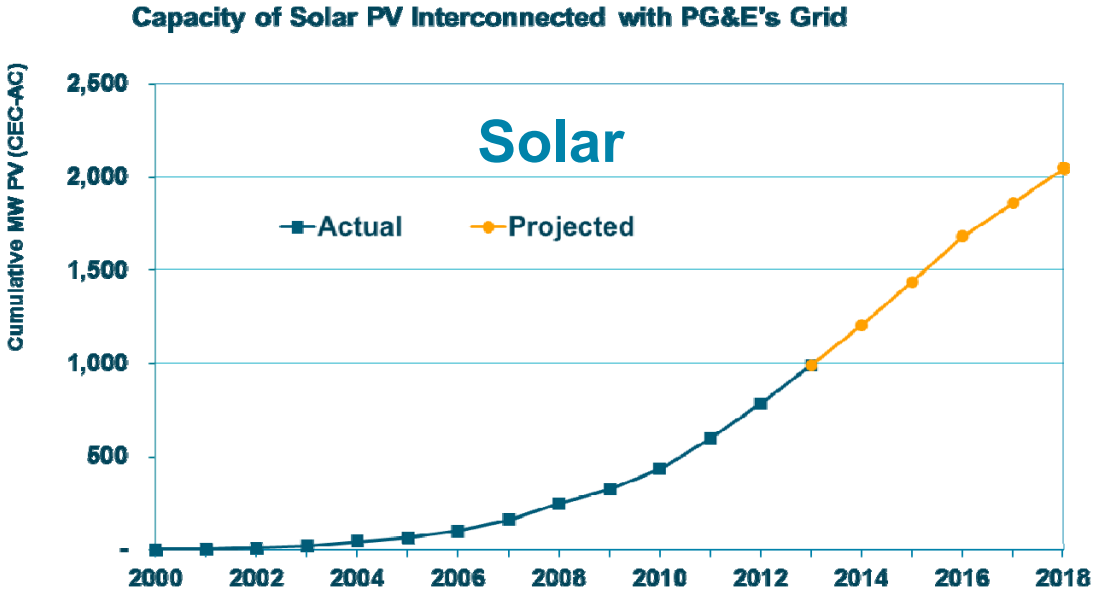
PG&E's Vision: The Grid of Things

The Grid of Things: the always there, always on platform that enables all the products and services customers need to engage with and use energy

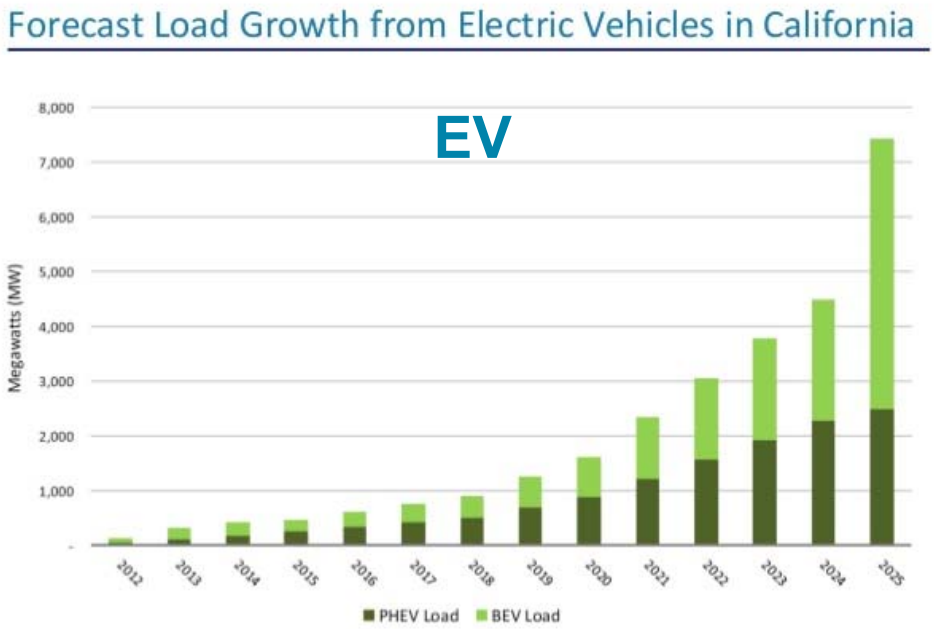


[1] Grid facts represent PG&E-specific, internal 2020 estimates for items in PG&E's service territory, excepting: 1) utility-scale solar and wind amounts, which include all resources under or expected to be under contract to PG&E in 2020; 2) utility-scale battery storage amounts, which use PG&E's transmission and distribution storage targets resulting from Assembly Bill 2514, assuming projects come online 2-3 years after the date procured; 3) energy efficiency estimates, which are based on 2014 PG&E goals; and 4) non-intermittent generation in PG&E's territory, which is sourced from the California Energy Commission's Energy Almanac (http://www.energyalmanac.ca.gov/powerplants/Power_Plants.xlsx).

California's Solar and EV Trajectory



PG&E is adding about 4,000 customer-side solar systems per month, and has over 150,000 installations



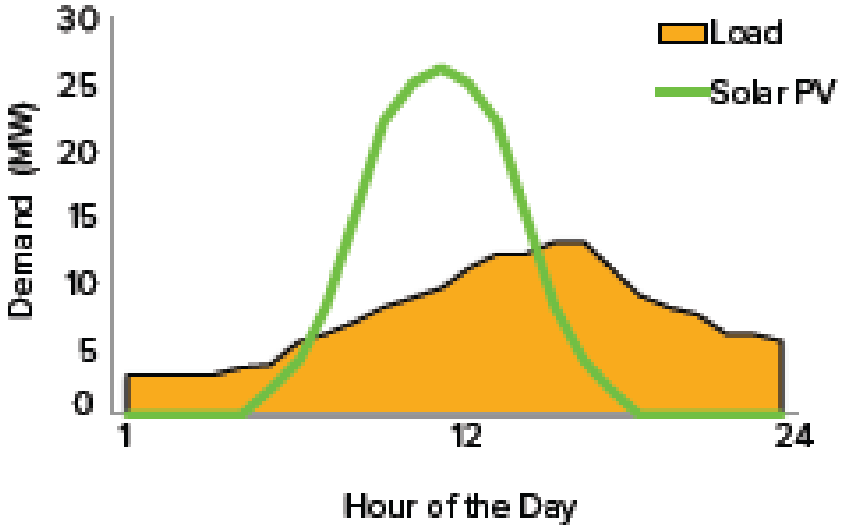
Key Points—Three Important ZNE Cost Considerations

- **Least cost, efficient building design matters to the grid and to society.**
- **The cost/configuration of renewables matters the same way**
- **The cost of grid integration likewise matters**

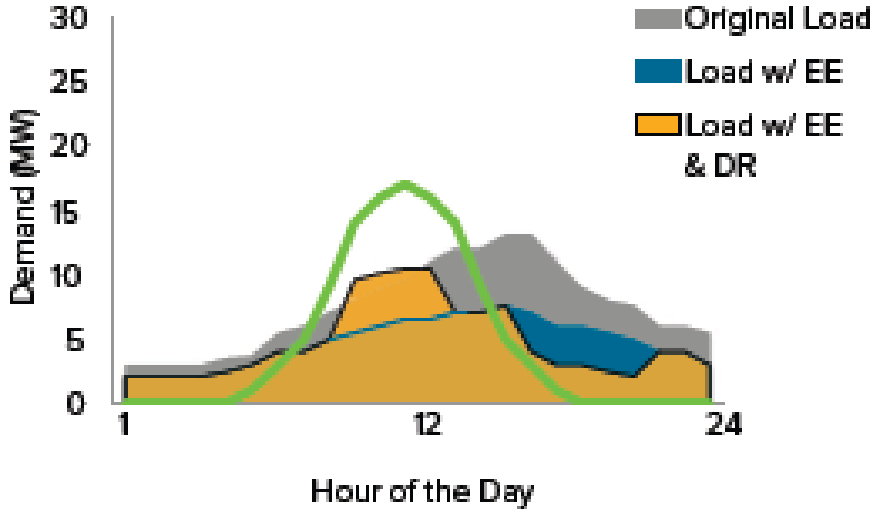
We need careful attention to least cost approaches in all three areas to succeed "at scale"

A Tale of 2 Buildings (from RMI)

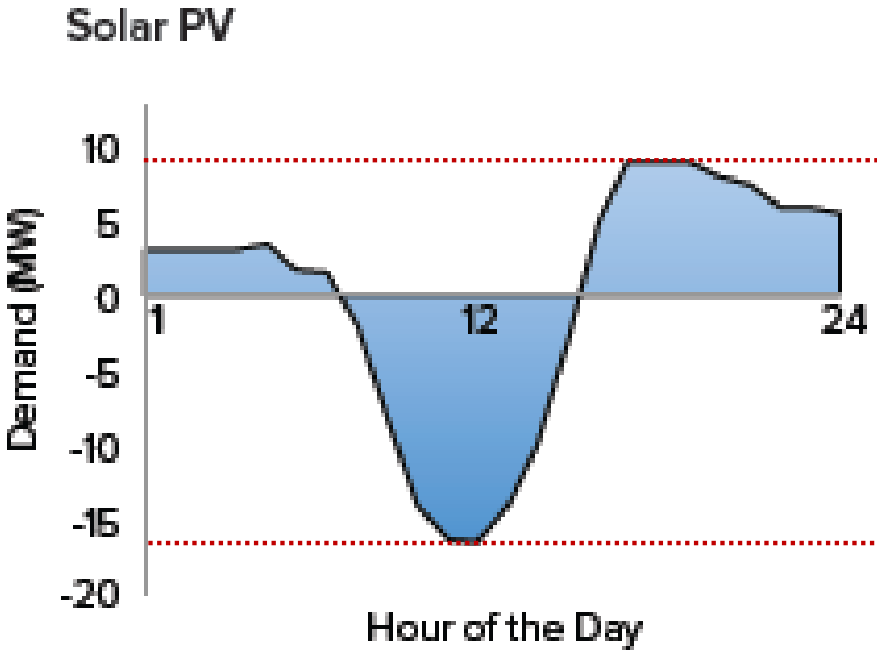
Solar PV

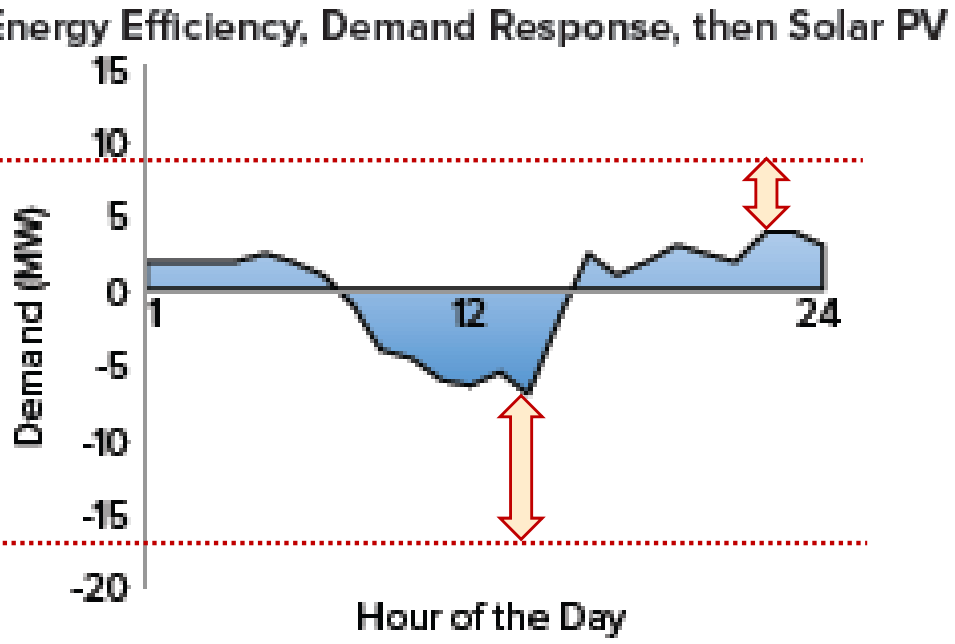


Energy Efficiency, Demand Response, then Solar PV

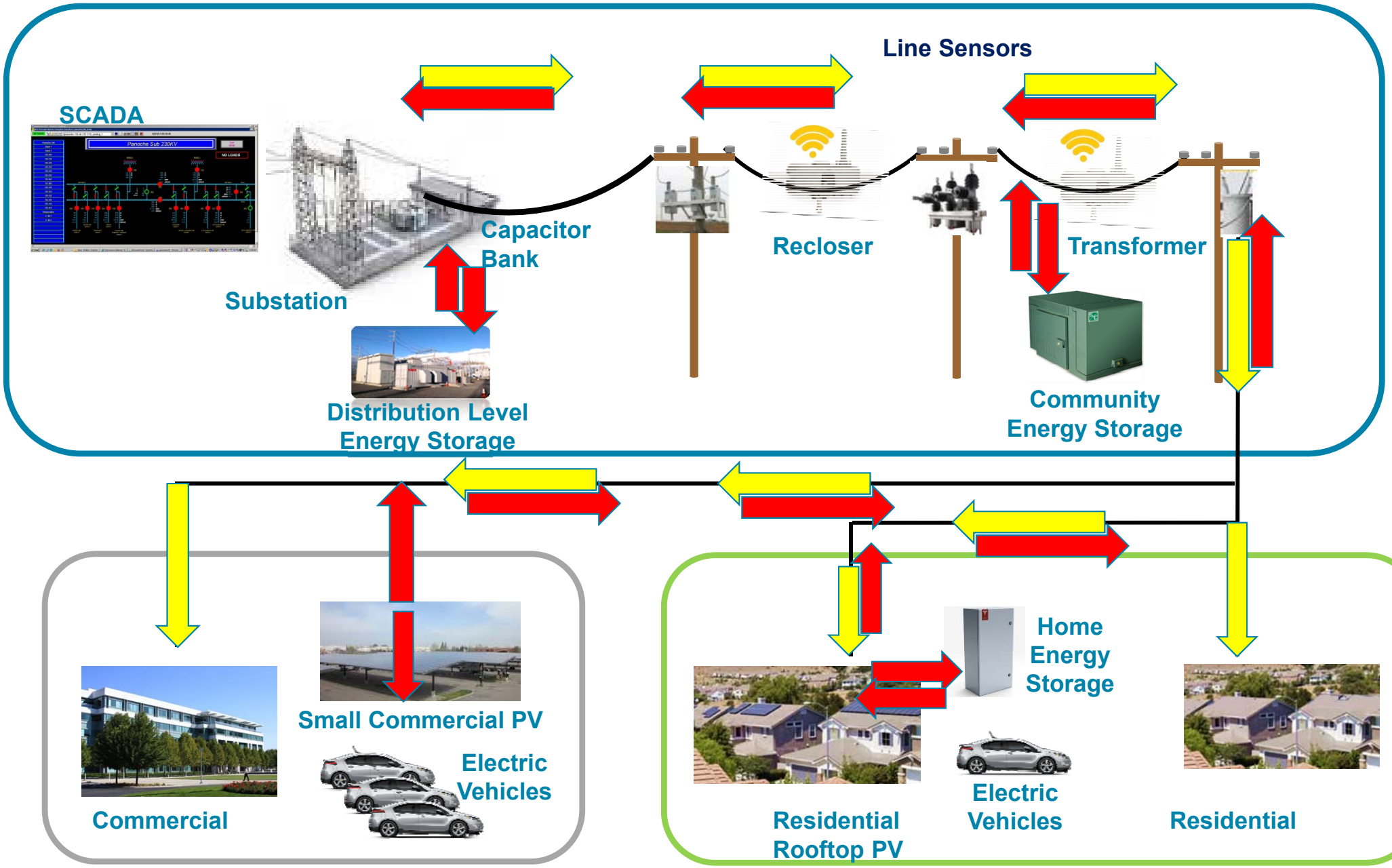


A Tale of 2 Buildings (credit to RMI)





Line Sensors



Process Steps to ZNE

- Set Targets Up-front
- Design to the Targets
- Build to the Design (no “de”-value engineering)
- Monitor, diagnose, correct, validate

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Key: Integrated Design

The building shell, the lighting system and the mechanical system all “talk to” each other

Take advantage of what’s available at the site “for free”—orientation, weather

Target Setting – for the building load

The Great Figure

Among the rain
and lights
I saw the figure 5
in gold
on a red
firetruck
moving
tense
unheeded
to gong clangs
siren howls
and wheels rumbling
through the dark city.

--William Carlos Williams

What he really meant:

If electric only: 5 kWh/sf/yr

In kBtu/sf/yr: 16-22 is the range to shoot for

This is without the addition of renewables

Richardsville Elementary (Kentucky)

Owner – Warren County Schools

Building Occupied – 2010

72,285 sf, 500 students

Total Construction Cost - $14,927,000

Total Cost/sf - $206.50

Solar PV Size – 348 kW

Performance EUI: 18 kBtu/sf yr

cmta
NET ZERO ENGINEERING

Kenneth L. Seibert, PE, LEED AP
President, CMTA Inc.


Sacred Heart Lower and Middle School, Atherton CA
84,000 sf on 10 acres
Stevens Library 6,300 sf
Target: low energy at low cost
Living Building Challenge Petal targets: Water and Energy
LEED Platinum submission
PG&E Net Zero Pilot Project
PG&E Case Study
Great daylighting story
Strongly positive (net)
large solar array serving additional buildings
Performance EUI: 16-17 kBtu/sf/yr

What About Incremental Cost?

Let's look at some northern California Library projects . . .

Costs Comparisons for Recently Completed Libraries in California

Date: 11/8/2013

Library	Gilroy Library*1	West Berkeley Library	Pico Branch Library*2	Berkeley Claremont Branch library *3	Berkeley North branch *4	Berkeley South Branch *5
ZNE (zero net energy)	No	Yes	No	No	No	No
LEED	Gold	Gold*	Platinum*	Silver	Silver	Silver
New/ Remodel	New	New	New	Remodel/ addition	Remodel/ addition	New
Completion Date	April, 2012	Dec-13	early 2014	2012	2012	May,2013
Area (sf)	52,600	9,399	8,690	7,800	9,900	8,700
Estimate	$18,200,000	$7,500,000	$6,900,000	$3,230,000	$4,560,000	$4,300,000
Bid	$18,177,226	$5,500,000	$6,915,020	$3,300,000	$4,360,000	$4,963,000
Final Construction costs	$19,200,000	N/A	$7,278,020	$4,600,000	$5,900,000	$5,000,000
costs/sf	$365	$585.17	$837.52	$589.74	$595.96	$574.71

Communications "Imperatives" to Reach ZNE at Scale

- **Integrated design**
  - Taking advantage of what's available "for free"
  - Reducing loads with shell and equipment improvements
  - Using integrated design to pay passionate attention to the needs of the occupants
- **ZNE (and high performance) buildings are better places for occupants**
  - Daylight and occupant delight
  - Health benefits—better space conditioning
- **ZNE is achievable within typical construction budgets for like facilities in a given area**
  - West Berkeley Public Library
  - Kentucky schools example

Summary Points and "Takeaways"

- **Technical feasibility of ZNE no longer in doubt**
- **Target setting up front is essential**
- **Integrated design is essential**
- **"Least cost" matters for**
  - Building design and construction
  - Renewables procurement
  - Grid integration
- **Lots of examples are popping up all over the country**
- **ZNE can be achieved for within typical construction costs for a given building type in given area**