ZNE Retrofit Home
M&E of EE, DR, Storage, HEMs & PV

California Solar Initiative (CSI)
RD&D Solicitation 5 (Small Grant)

Rob Hammon, Ph.D.
Principal Investigator
President, BIRAenergy
rob@biraenergy.com

Utility Partner
Nate Taylor
Emerging Technologies
San Diego Gas & Electric
Ntaylor@semprautilities.com
California Solar Initiative (CSI)

In 2006 the California Public Utilities Commission (CPUC) established a budget for the California Solar Initiative (CSI) Research, Development, Demonstration and Deployment Program (RD&D)

Goal:

• Install 3,000 megawatts of distributed solar by 2016
• Move the market from the current retail solar price to the retail price of electricity
• Develop new business models
Background & Benefits

- **Background:** 1980’s Home in Santee Retrofitted to be Source ZNE
  - CSI RD&D 2 Project (Low-Cost Solar Retrofit PV)
  - Efficiency, DR, Storage, HEMs, and PV
- **Continue Monitoring & Evaluating Retrofit**
  - Monitor savings – compare with simulations / predictions
  - Rooftop solar – Load profiles
  - Intelligent storage – Smart charging & discharging
    - Energy “cost” of storage
    - Load benefits
  - Demand Response
    - All GE DR-appliances
    - Nucleus controller
    - DR vs Storage
  - Home Energy Management System
    - Impacts
    - Comparisons and integration with other systems
- **Project Results:** Develop and Demonstrate Practical ZNE Retrofits
- **Large Potential Market:** 99% of Homes are Existing (1%/yr new)
PV System: GE Plug & Play AC-PV System

*Micro-inverter Integrated into Panel*

**Underside of Module**

- Micro-inverter
- Wire-Harness Connector

**Enphase “Envoy” Map of PV Array and Production**

**Modules:**
- Unshaded
- Shaded
  - A little
  - A lot

**GE Demand-Response (DR) Appliances**

AC System: Reduced Output due to Shading is limited to Shaded Modules, *Not Entire String*; Could be important in Retrofit Market
Retrofit: EE, DR, Storage, HEMs & PV

Sunverge SIS: Intelligent Battery Storage

**Efficiency Upgrades:**
- Attic Insulation
- Radiant Barrier
- Windows & Sliding Glass Door
- Furnace & AC Replaced
- Ceiling Fans
- HPWH
- LED Lighting
- On-Demand Hot Water System

**Home Energy Management System (HEMs):**
- GE Nucleus (DR Controller)
- Sunverge

Sunverge in ZNE Home
ZNE Baseline Energy Use

Simulations vs Actual - Calibrations

Calibrating Simulation: Match TStat Set-points & MELs to Occupant-Reported Values

Next: Compare ZNE Simulation Results to Actual using Calibrated Software (BEopt)
Simulation and Actual Usage - ZNE Baseline and Post-Retrofit

SDG&E Bill Data

Retrofit: EE & 4.8kW PV (Source ZNE)

Simulations Pre and Post Retrofit
Simulations of Daily Power From Grid By Season: PV on EE Home

- January Gross kWh Used
- April Gross kWh Used
- July Gross kWh Used
- October Gross kWh Used
- January kWh Generated
- April kWh Generated
- July kWh Generated
- October kWh Generated

Electricity (kWh)

Hour

“Duck Curve”
Project Deliverables

- >1yr Monitored Data from ZNE Retrofit - EE, DR, HEMs, PV:
- Simulation Calibrations
- Energy Savings
- Peak Reduction
- Optimizing ZNE Interactions with Grid

Data from Previous CSI Project Relating to Current Project
Improving ZNE Home Performance

**Example: Gross and Net Demands**

**Storage: Reducing “Duck Curve” Effect**

**Actual Data Example:**
6 Jan 2014

(Sunverge at initial settings – no tuning yet)

**Project Next Steps:**
- Train homeowners: HEMs, HPWH
- Configure & Evaluate HEMs
- DR Storage
- Run Tests, Collect data, Monitor & Evaluate Performance
- For 12 Months
Residential ZNE Retrofit
EE, DR, Storage, HEMs & PVs:
Testing, Monitoring & Evaluation

Questions?
Rob Hammon, Ph.D.
rob@biraenergy.com