2012 Smart Grid Program Peer Review Meeting

"Dramatic Demand Reduction in the Desert Southwest"

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June 8, 2012

"Dramatic Demand Reduction in the Desert Southwest"

Objective

Decrease the peak electrical demand by 65% over code-built houses in a new development of 185 homes.

Life-cycle Funding ($K)

FY08 – FY13 (now FY15)
$6948k

Technical Scope

1. Build energy conserving residences.
2. Include PV on the residences.
3. Develop a demand control system that gives the customer options and that is enhanced by an artificial intelligence supplemental system. Instantaneous power pricing information will be available to the customer, as well as cost incentives.
4. Evaluate battery load shifting effects.

Needs and Project Targets

RD&D Areas Touched Upon

1. Smart grid with renewable penetration.
2. Microgrid enhancements.
3. Improved grid resiliency.
4. Customer participation and choice.
5. Increased automation.

Challenges:

Biggest challenges have been developing the automated systems and working around coincident major equipment changes by the utility.

Cost/Performance Target

Develop a residentially-based system that can reduce peak electrical demand by 65%, while accomplishing this with units that have very little premium cost over code-built homes. Batteries are also evaluated.

Technical Approach (1/2)

1. Start with energy conserving empty-nester houses (185 total).
    a) Must be cost-competitive (when initial cost and operating costs are considered together).
    b) All are LEED Platinum certified.
    c) Use conditioned attic spaces, cellulose blown-in insulation, higher performance air conditioning systems and windows, etc.
    d) Actual performance has been compared to time-varying energy measurements used to calibrate computer analysis codes for "what-if" kinds of studies related to peak demand reduction.

2. Incorporate moderate-sized PV arrays (1.75 kW_p)
    a) Contribute to the peak reduction without adding large premium costs.
    b) The arrays assist in mitigating the peak but do not produce energy over the complete peak time.

Technical Approach (2/2)

3. Development of an artificial intelligence system ("Intelligent Agent") for load control and customer cost savings.
    a) Shows residents their instantaneous energy use and the instantaneous price of power.
    b) Residents can set the degree of energy/cost savings they wish and the system will automatically manage the load control.
    c) Uses calibration of the customer's normal energy use patterns.
    d) Residents will be given a monetary benefit when they participate in major demand-reduction events.
    e) Critical to the operation of this system is the access to the time varying energy use and the ability to interface to remotely-controllable thermostats in the house. It will later include access to control other major loads as allowed by the customer.

3. Limited study of load shifting battery units.
    a) Uses 2.2 kW-hr, 44 A-hr Silent Power units
    b) Only minor number of homes slated for this.
    c) First type of system like this on the NV Energy grid
    d) A number of interface issues are being evaluated including ownership, maintenance, dispatchability, …….

Technical Accomplishments (1/3)
Already Accomplished

Pulte performed the design of the basic residences to be included.

Pulte initiated construction and sales of these residences, approximately 80 completed.

UNLV began monitoring time-varying energy use of various units within the development.

UNLV began a system for accessing the performance data remotely and using it for future studies.

UNLV developed a building energy analysis code that was “calibrated” with the actual performance data from the monitored homes.

UNLV performed many “what-if” studies related to possible load control strategies to evaluate the potential impact of these on the reduction of loads during peak times.

UNLV and NV Energy began the development of the “Intelligent Agent” approach for potential customer energy cost savings and load control of the development.

UNLV and NV Energy evaluated the possible impact of a battery load-shifting system.

Technical Accomplishments (2/3) Forward Look

5/12 Continue to attempt to gain access to the in-house NV Energy thermostats to be able to more fully evaluate the Intelligent Agent system function.

5/12 Acquire one individual home battery load shifting unit.

6/12 Accessing NV Energy load data from Smart Meters in place on each house.

6/12 Enhance the archiving of data flowing from the complete development.

6/12 Initiate evaluation of the individual home battery load shifting unit.

8/12 Perform an initial test of the Intelligent Agent load system to assess the effectiveness on a limited number of residences.

8/12 Compare time-varying energy use to existing code-standard homes.

1/13 Install load-shifting battery units on 6 homes and evaluate impacts.

3/13 Complete the Intelligent Agent functional evaluation and install on homes.

5/15 Build-out of Villa Trieste development completed.

Project End: Document the complete project accomplishments.

Technical Accomplishments (3/3)
Major Advancements

1. Developed a residential design for a new community that warrants a LEED Platinum designation that carries the project toward its goals at a premium price of only $15k-$20k over a code-built design or $5k-$10k over conventional Pulte construction of a similarly sized residence. The Villa Trieste system includes a photovoltaic system on every residence.
2. Using actual energy-use data the team is able to predict accurately each house's time-varying energy consumption.
3. Have developed a master system for data archiving that allows after-the-fact analyses of actual energy performance.
4. Have designed an Intelligent Agent for automatically applying load control aspects in harmony with customers' preferences accessible by the customer through a web-based system via computer, smart phone, and in-home dashboard.
5. Have partially worked out approaches to both data monitoring and load control with utility, while preserving necessary data privacy concerns and security of the utility.
6. Have initiated the evaluation of a single residence peak shifting battery.

Significance and Impact

1. Using a combination of technology and financial incentives we have addressed the issue of developing low-customer-impact load control approach that can be interfaced through a web-based computer, smart phone, or dashboard.

1. A technical strategy for doing this is nearly completed.

1. Techniques of using calibrated building energy computer models have been developed and have demonstrated the ability for realistic “what if” alternative designs as well as showing the impacts of various load control strategies.

4. An artificial intelligence approach to load control that interfaces features of the customers’ energy use preferences has been developed that could have extremely wide use in the utility industry.

5. A load-shifting battery system in selected houses that can be dispatched by the utility operators is being developed.

Interactions & Collaborations

These are two major subcontractors to UNLV on this project:

1. **Pulte Homes, Las Vegas Division**—Developed design of buildings, is constructing units (slightly over 80 of the total anticipated185 units have been completed currently), and advises UNLV on residential customer impact of various aspects of project.

2. **NV Energy**—Advises on all grid-impacting aspects of the project. Furnishes some of the grid-tie equipment, including smart meters (current Trilliant units to be ultimately replaced by Sensus devices), two-zone, load-control thermostats, and the load-shifting battery devices.

Contact Information

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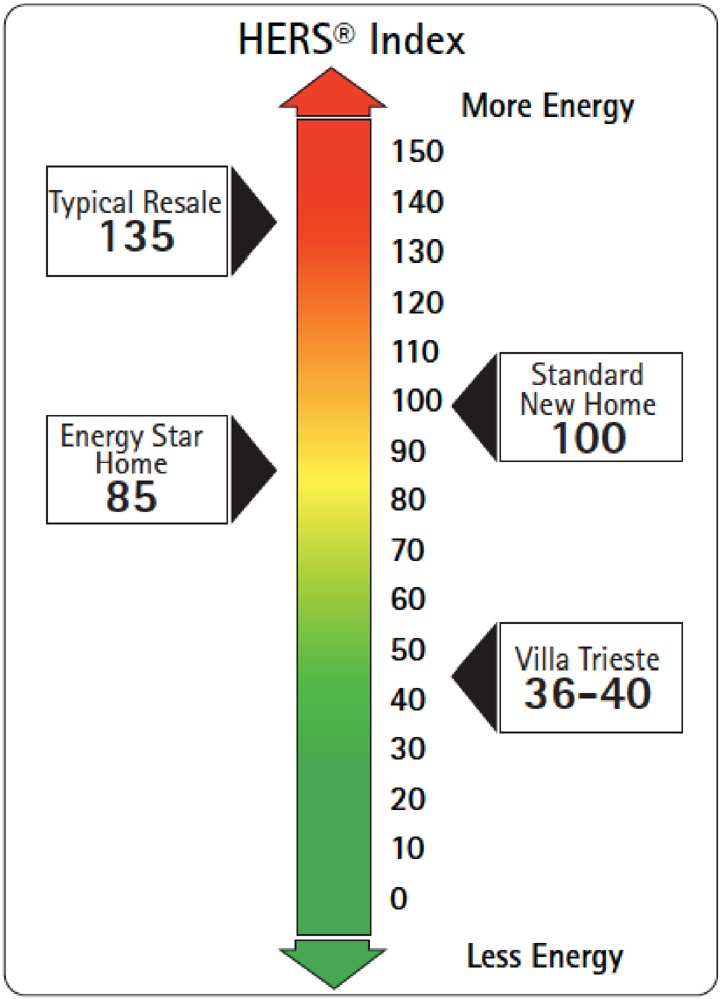
Back-up Slides

Villa Trieste Home Energy Performance

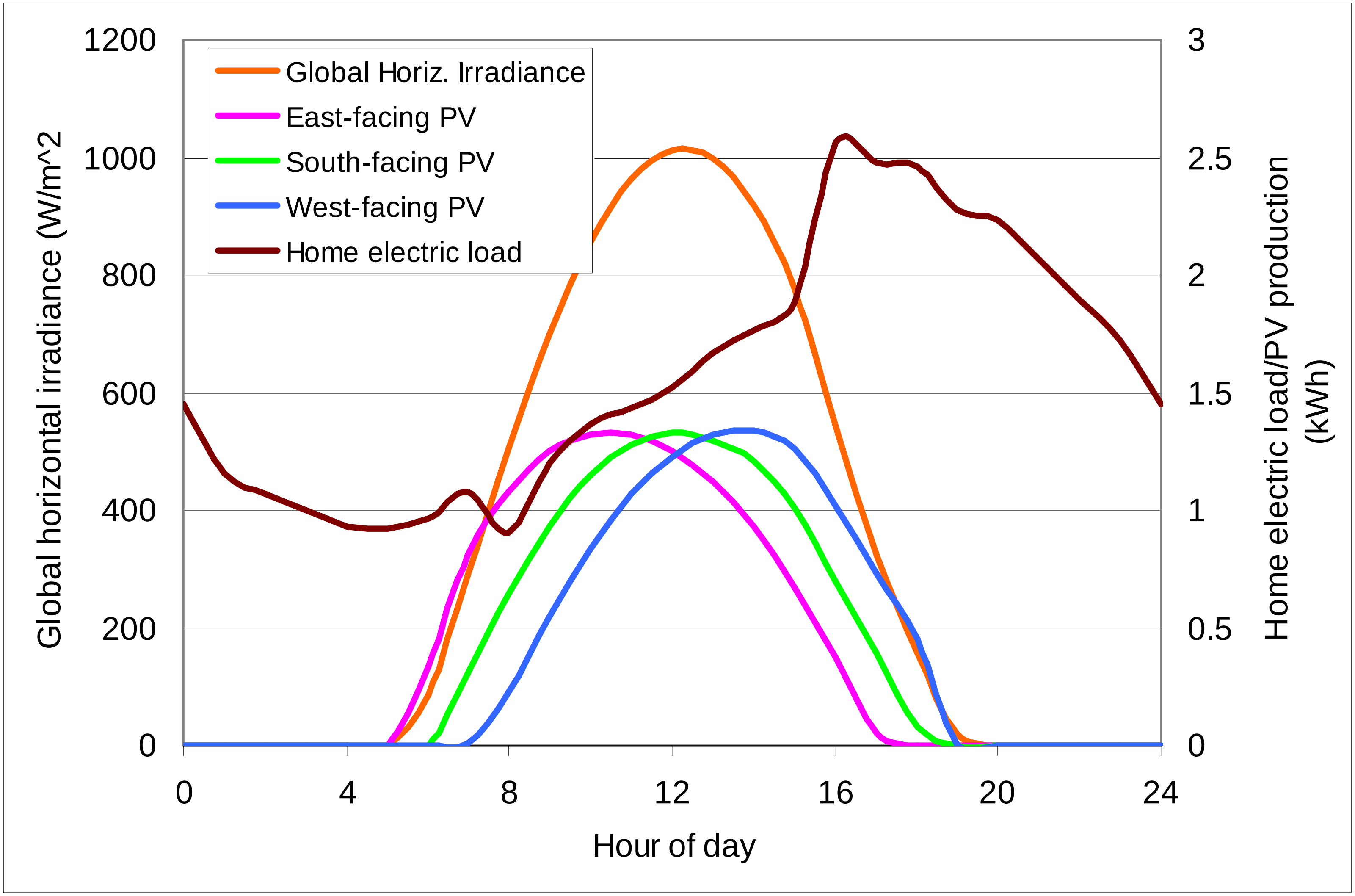


Heating and Cooling Energy Usage Guarantee

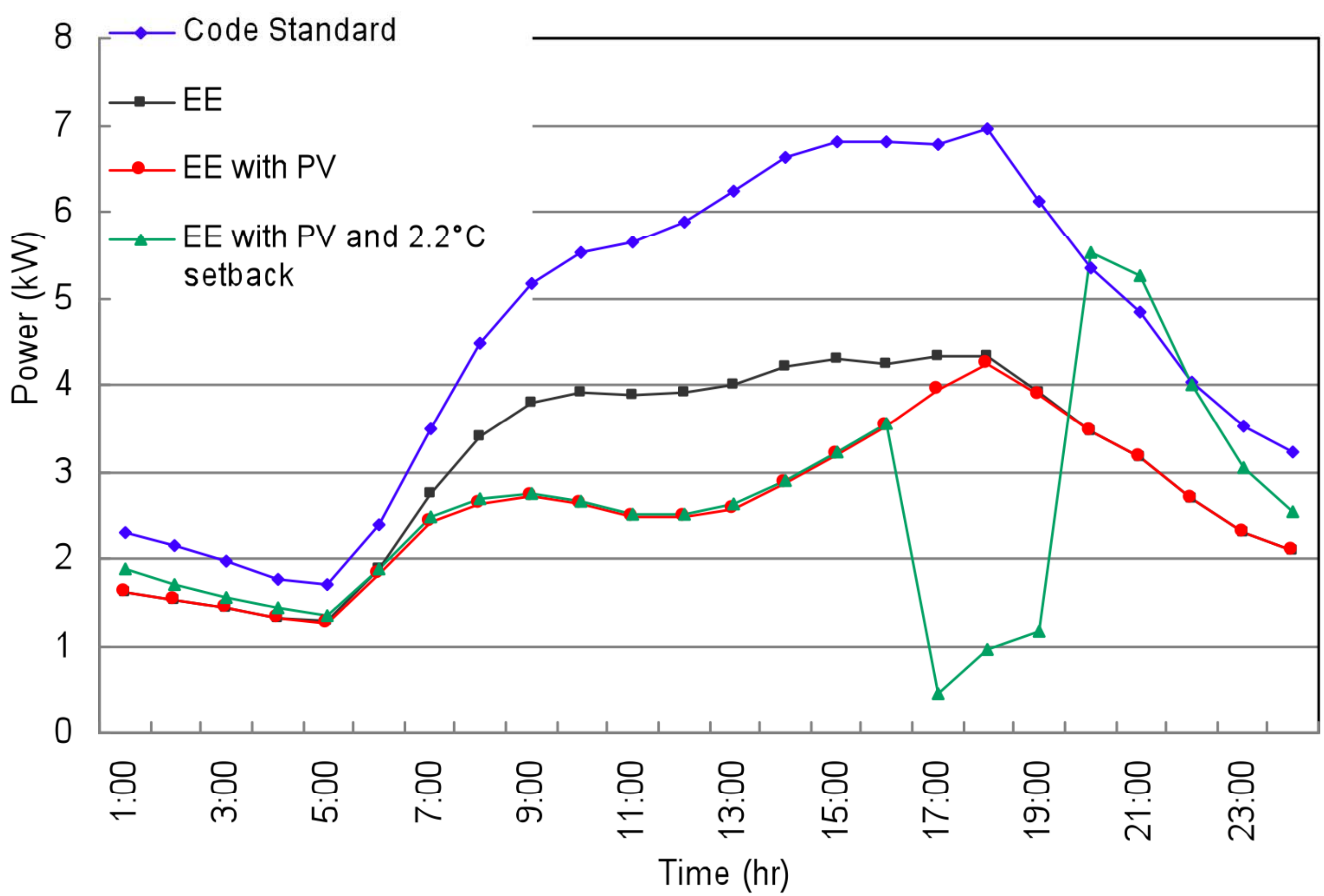
Model	Square Footage	Annual KWH Usage*	Estimated Cost Monthly/Annually*		HERS
Roma	*1,487*	*4,763*	*$76*	*$913*	*44*
Torino	*1,612*	*4,707*	*$78*	*$941*	*44*
Venezia	*1,777*	*4,979*	*$81*	*$969*	*46*
Milano	*1,758*	*5,541*	*$89*	*$1,068*	*44*
Firenze	*1,960*	*5,668*	*$91*	*$1,088*	*46*

*Based on NV Energy and Southwest Gas rates as of July 1, 2007. Guarantee is for energy usage not cost since local utility rates vary. Please see Environments for Living® limited guarantee for details.

PV Impact on Summer Peak Power Load



Impact of Summer Load Control Strategies



Silent Power
Storage Battery System

Energy storage module - Cycle life at +25°C/+77°F

Parameter	Performance
Nominal Voltage	50V
Capacity	44Ah
Energy	2.2kWh
Dimensions (mm)	445 (w) x 131 (H) x 375 (D)
Mass (kg)	21
Max continuous discharge current (A)	90
Max continuous charge current - normal rate (A)	13
Continuous Power (50% SOC, 20℃) (kW)	4.5
Round trip efficiency	96%
Operating Temperature	-25 / +60℃ *
Storage Temperature	-40 / +65℃
Safety	UL1642

* Charging shall be prohibited by the battery management below 0℃