Deep Energy Retrofits: Six Real World Examples and Lessons Learned

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ABSTRACT

The Obama Administration's Economic Stimulus Plan contains billions of dollars for improving the energy efficiency of existing homes, while the California Energy Efficiency Strategic Plan calls for reducing energy use in existing homes 40% by 2020. How will we get these energy savings out of existing homes?

The Sacramento Municipal Utility District (SMUD) and the National Renewable Energy Laboratory (NREL) have partnered on a research and development program that works with local builders in dramatically improving the energy performance of existing homes. These "Deep Energy Retrofits" feature advanced construction techniques and energy efficiency measures designed to reduce an existing home's energy use by 50% or more. This paper describes six completed DER demonstration projects, monitoring results to date, and lessons learned. Results from these DER demonstration projects suggest that utility whole house performance programs should focus on developing climate zone specific energy efficiency packages and target un-served utility customer markets, including the existing home re-sale market, especially foreclosures, and re-modeling projects. In particular combining an energy efficient mortgage at re-sale with state and utility home performance programs represent a huge untapped opportunity to gain cost effective energy savings.

Background

SMUD's Energy R&D program partnered with the National Renewable Energy Laboratory (NREL) to develop a new approach to achieving dramatic energy savings in existing homes, "Deep Energy Retrofits" (DERs) and demonstrate the results. SMUD and NREL set a simple design goal for the demonstration program: reduce an existing home's total energy use by at least 50 percent. To achieve this goal meant using a whole house (or systems) methodology to retrofit the home. DERs can also involve major remodeling of the home which means dealing with existing conditions that might range from room configuration to hazards such as mold, lead and asbestos. Six DER projects were completed under the demonstration program. NREL provided energy analysis using its BEopt energy simulation software, including assistance in identifying energy efficiency measures (EEMs), and monitoring services for select DER projects.[1] All the projects incorporated a comprehensive package of EEMs which are described below. Two projects featured solar PV and/or solar thermal systems. A summary of results to date will follow DER project descriptions. The paper will conclude with several "Lessons Learned" from the DER projects.

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[1] The BEopt™ (Building Energy Optimization) software provides capabilities to evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings. BEopt has been developed by the National Renewable Energy Laboratory in support of the U. S. Department of Energy Building America program goal to develop market-ready energy solutions for new and existing homes. Go to http://beopt.nrel.gov/ for more information and to download a free copy of the program.

Market Rate DERs[2]

Two market rate DERs were completed under the DER demonstration program. SMUD collaborated with Greenbuilt, a local home performance contractor, on the first SMUD DER project, a 1980s-era, abandoned, foreclosed all electric, single-story residence undergoing a complete remodel in advance of re-sale. A list of before and after features is found in Table 1 below.

Table 1. Greenbuilt Existing vs. DER Specifications

System	Existing Features	DER Features
Ceilings	R-19	R-42 blown-in cellulose
Roofing	Asphalt Composition	Asphalt Composition w/ Radiant Barrier
Knee Walls	R-11	1" metallic-reflective face Rigid Foam (R-6) over R-15
West Wall	R-11	R-15 blown in cellulose insulation
Infiltration	6830 CFM @ 50 pa; 21.6 ACH @ 50 pa	1080 cfm @ 50 pa; 4.1 ACH @ 50 pa
Windows & Sliding Glass Door	Aluminum Frame, Single Pane, 1.07 U-Factor: 0.70 SHGC	Vinyl Frame, Dual Pane, Low e, Argon Filled 0.29 to 0.28 U-Factor: 0.22 to 0.19 SHGC
Space Heating	HSPF 7.75	HSPF 9.75
Central A/C	SEER 13/EER 10	SEER 16/EER 13
Ducts	R-2 insulated in attic	R-6 insulated , "Tight" tested to 4.5% leakage @ 25 Pa in attic
Thermostat	Manual	Programmable Communicating Thermostat
Whole House Fan	None	Two Speed Whole House Fan
Water Htg	.97 Energy Factor Electric Storage Tank	.97 Energy Factor Electric Storage Tank w/ 2.11 Coefficient of Performance (COP) add on Heat Pump
Spot Ventilation	None	Energy Start Bathroom Fans with Timer
Lighting & Ceiling Fans	Incandescent	100% hardwired Energy Star Compact Fluorescent & LED Fixtures in master bath
SolarTubes	None	Energy Star rated
Refrigerator	Existing	Tier 2 (.25% Federal Standards) Energy Star
Dishwasher	Existing	Tier 2 (EF = .69) Energy Star
Shading on West	None	Retractable Shading w/ wind sensors and timer
HERS Score	182	78
Controls	None	Control4 Home Area Network with Wireless “Green” Switch and programmable communicating thermostat
Solar Domestic Hot Water	None	40 gallon Integrated Solar Water Collector 50% Solar Fraction
Photovoltaics	None	2,295 Watt AC Photovoltaic system

[2] Additional information on SMUD’s Deep Energy Retrofit R&D projects, including detailed graphs, are available at: http://www.smud.org/en/residential/EERD/

BEopt simulation results showed a 61% reduction in annual energy use and 80% reduction in the home's peak demand. The Greenbuilt DER was used as an energy efficiency retrofit showcase by SMUD and a "lab home" by NREL for one year, September 2009-2010.

32nd Avenue DER

SMUD worked with the Housing Group Fund (HGF) on the second market rate DER, 32nd Avenue. The 32nd Avenue home was an abandoned 1950s vintage, Eichler style 1,340 square foot, single story four-bedroom, two-bath, and 1-car garage tract home requiring extensive renovation. A list of efficiency measures incorporated into the project is found in Table 2 below.

Table 2. 32nd Avenue Existing Vs. DER Specifications

BY SYSTEM	EXISTING	ENERGY EFFICIENT REMODEL
Air Sealing	None	Air Sealed the home (caulking and weather-stripping)
Roof Insulation	None	6" exterior rigid foam (R-38)
Wall Insulation	None,	4" Quad Lock® exterior rigid foam (EXP) (R-18)
Infiltration	Unknown	1100 cfm @ 50 pa; 6.3 ACH @ 50 pa
Windows	Aluminum Frame single pane, clear 1.07 U-value 0.70 SHGC	Energy Star, Vinyl Frame dual pane, low e 0.29 U-value 0.24 SHGC
Space Heating	.58 AFUE Gas Wall Mounted Furnace	0 .95 AFUE Sealed Combustion Gas Furnace
A/C	None	SEER 14.5, EER 12
Ducts	None	R-6 insulated tested to 3.75% leakage @ 25 pa in conditioned space
Spot Ventilation	None	Energy Start Bathroom Fans with Timer
Water Heating	0.52 EF 50 gal. Gas	0.62 EF 40 gal. Gas
Lighting	Incandescent	100% hardwired Energy Star CFLs
Dishwasher	None	Tier 2 (EF = .69) Energy Star
HERSII Rating[3]	259	80, a 69% improvement

The 32nd Avenue BEopt simulation showed upwards of 66% energy savings, including an estimated electric use savings of 68%, estimated natural gas use savings of 63%, and 82% average peak demand savings . The home renovation was completed in March, 2010 and sold to a first-time home buyer in April, 2010.

Neighborhood Stabilization Program DERs

SMUD partnered with the Sacramento Housing and Redevelopment Agency (SHRA) to improve the energy efficiency of abandoned, foreclosed homes in neighborhoods particularly affected by the recession. Under SHRA's Vacant Properties Program (VPP), qualified single-family developers/builders renovate abandoned homes in low income neighborhoods and sell

[3] Per California State law, California has a Home Energy Rating system referred to as HERSII, which provides a HERS Rating as defined and regulated by the California Energy Commission (CEC). The California HERSII rating system is different and works under different criteria than the national HERS system created by RESNET.

them to qualified low- and middle-income families. SMUD worked with three VPP contractors, Housing Group Fund (HGF), Del Paso Solutions and the Sacramento Chapter of Habitat for Humanity (HfH).

Mascot DER

Under the VPP, HGF bought an abandoned 1950s vintage single-story 1,260 square foot, four-bedrooms, two-bath home with a two-car garage. A "package" of energy efficiency measures was installed in the home (see Table 3 below).

Table 3. Mascot Existing Vs. DER Specifications

SYSTEM	EXISTING FEATURES	DER FEATURES
Flat Ceilings	R-19	R-44 blown-in cellulose w/ Radiant Barrier
West Wall	R-11	R-15 blown in cellulose insulation
Infiltration	Unknown	1121 cfm @ 50 pa; 6.7 ACH @ 50 pa
Windows	Aluminum Frame Single Pane 1.07 U-Factor; 0.70 SHGC	Energy Star, Vinyl Frame Dual Pane, Low e 0.29 to 0.28 U-Factor; 0.22 to 0.24 SHGC
Space Heating	Package Gas .78 AFUE Furnace	Package Gas 0.80 AFUE France
A/C	SEER 10/EER 8	SEER 16/EER 13
Ducts	"Leaky" R-2 ducts in attic	"Tight," R-6 insulated tested to 3.75% leakage @ 25 Pa
Thermostat	Manual	Energy Star Programmable Thermostat
Spot Ventilation	None	Energy Star Bathroom Fans with Timer
Water Heating	0.52 Energy Factor 50 gal. Gas Storage Tank	0.98 Energy Factor Condensing, Tankless Gas Water Heater
Lighting & Ceiling Fans	Incandescent	100% hardwired Energy Star CFLS
Dishwasher	None	Tier 2 (EF = .69) Energy Star
HERS Score	241	86

The BEopt simulation showed annual electricity and natural gas use reduced 47% and 59%, respectively, and 68% average peak demand savings. HGF completed retrofitting the home in October, 2009 and then sold it to a first-time home-buying family in November 2009. NREL monitored the performance of the condensing tankless gas water heater and published a final report in October, 2011. [4]

Jean Avenue DER

SMUD worked on a second VPP home with Del Paso Solutions. Under the VPP, Del Paso solutions purchased an all electric, 1040 square foot, 3 bedrooms, and 2 bath, abandoned home on Jean Avenue in the Del Paso Heights neighborhood of Sacramento. Table 4 shows the energy efficiency upgrades compared to the home's existing features.

[4] Summary of Condensing Hybrid Water Heater Monitoring at Mascot, Technical Report, NREL/TP-5500-52234, October 2011, Contract No. DE-AC36-08GO28308

Table 4. Jean Existing Vs. DER Specifications

BY SYSTEM	EXISTING	DER FEATURES
Air Sealing	None	Air Sealed the home
Attic Insulation	R-19	15" blown in cellulose (R-49) attic insulation
Room Addition	NA	2x6, 16" o.c. framing with R-20 cellulose
Infiltration	1880 cfm@ 50 pa 13.6 ACH @ 50 pa	408 cfm @ 50 pa; 2.9 ACH @ 50 pa
Windows	Aluminum Frame Dual pane, clear 0.71 U-value 0.73 SHGC	Energy Star®, Vinyl Frame dual pane, low e 0.32 U-value 0.25 SHGC
Space Heating	Heat Pump 7.0 HSPF	Tri-Zone Mini-split Heat Pump 9.0 HSPF
A/C	3 ton Heat Pump SEER 8, EER 7	2 ton Ductless, mini-split Heat Pump SEER 15, EER 9.2
Ducts	Leaky R-2.1	Ductless
Water Heating	40 gal. Electric 0.90 EF	40 gal. Electric Storage Tank 0.98 Energy Factor with 2.5 COP add on heat pump water heater
Lighting	Incandescent	100% hardwired Energy Star CFLs
Ceiling Fans	Incandescent	Energy Star with pin-based CFLs
HERS Rating	195	86

The Jean Avenue BEopt simulation showed 60% annual energy savings and 67% average peak demand savings. The home was sold and occupied in June, 2011.

Habitat for Humanity (HfH) DER

SMUD worked with the Sacramento Habitat for Humanity (HfH) chapter on abandoned 1946 built 3 bedroom, 1 bath, 1,107 square feet home that required extensive work. A list of efficiency measures incorporated into the project is found in Table 5 below.

Table 5. HfH Existing Vs. DER Specifications

BY SYSTEM	EXISTING	ENERGY EFFICIENT REMODEL
Air Sealing	None	Air Sealed the Home
Floor	Vented Un-insulated	Conditioned Crawlspace with R-10 Close Cell Spray Foam in the Rim Joists Crawlspace
Roof Insulation	None	R-38 with Radiant Barrier
Wall Insulation	Original insulation estimated R-11	R-13 Fiberglass Batts + 1 ½ inch rigid XPS in south wall; original insulation in remaining walls
Infiltration	1724 cfm @ 50 pa 10.8 ACH @ 50 pa	1015 cfm @ 50 pa 6.9 ACH @ 50 pa
Windows	Dual pane Vinyl Framed .55 U-Factor 0.67 SHGC	Dual Pane, Vinyl Framed Energy Star Windows Installed on south and east 0.29 U-Factor 0.21 SHGC
Space Heating	60% AFUE Gas	0.95 AFUE Sealed Combustion Gas Furnace
A/C	SEER 8, EER 6	SEER 16.5, EER 13
Ducts	Leaky R-4	"Tight," R-8 insulated tested to 5% leakage @ 25 Pa
BY SYSTEM	**EXISTING**	**ENERGY EFFICIENT REMODEL**
Thermostat	Non-programmable	Energy Star Programmable Thermostat
Spot Ventilation	None	Energy Start Low Sone Fans with Timer Controls
Water Heating	.62 EF 50 gal. Gas	62 EF 50 gal. Gas Water Heater
Lighting (units)	Incandescent	100% hardwired Energy Star Compact Fluorescent
Ceiling Fans	Incandescent	Energy Star with pin-based Energy Star CFLs
Range Hood	Standard	Energy Star
Dishwasher	None	Energy Star EF = .63
Refrigerator	Standard	Energy Star
Solar PV	None	1,673 watt AC system (estimated 2,460 kWh/yr)
HERS Rating	194	29

The BEopt analysis of the HfH home showed that the package of energy efficiency upgrades, including the PV system, is estimated to reduce the home's annual electricity use by up to 93% , its annual natural gas consumption by up to 74% , and its average peak demand 80% compare to the estimated energy use . The home was sold and occupied in July, 2011.

Homes by Town (HBT) DER

SMUD worked with Homes by Town (HBT) on a foreclosure under the City of Elk Grove's VPP program. The home was originally built in 1989, has 3 bedrooms, 2.5 baths, and is approximately 1,500 square feet. A list of efficiency measures incorporated into the project is found in Table 6 below.

Table 6. Homes by Town Existing Vs. DER Specifications

BY SYSTEM	EXISTING	ENERGY EFFICIENT REMODEL
Air Sealing	None	Air Sealed the attic
Attic	R-30	R-38 in cathedral ceiling area & R-49 flat in ceiling area Radiant Barrier roof sheathing
Infiltration	Unknown	744 cfm @ 50 pa; 4.3 ACH @ 50 pa
Space Heating	0.78 AFUE Gas	0.95AFUE Sealed Gas Combustion Furnace
A/C	SEER 10, EER 8	SEER 15, EER 12.5
Ducts	R- 5 insulation 25% leakage @ 25 pa	R-8 insulated 3.75% leakage @ 25 pa
Thermostat	Existing	Energy Star Programmable Thermostat
Lighting (units)	Incandescent	100% hardwired Energy Star (CFLs)
Ceiling Fans	Incandescent	Energy Star CFLs
Dishwasher	Existing	Tier 2 (EF = .69) Energy Star
HERSII Rating	174	107

The HBT BEopt simulation showed 33% annual energy savings, including an estimated 44% electric use savings and 18% natural gas use savings, and 49% reduction in average peak demand. The HBT DER was sold and occupy in July, 2011.

RESULTS TO DATE

The DERs' electric and natural gas usage have been monitored since occupancy. Since all the DER projects were abandoned homes without utility bill data comparisons to pre-retrofit consumption could not be made. As expected, electricity and natural gas use varied greatly among the DER homeowners (see Table 7 below).

Table 7. DER Avg. Monthly Electricity and Natural Gas Use Compared to SMUD Average Residential Electricity Use and PG&E Average Residential Natural Gas Use

	DER Avg. Monthly Electric Use (kWh)	% over/under SMUD Avg. Residential Customer Use (750 kWh)	DER Avg. Monthly Natural Gas Use	% over/under PG&E Avg. Monthly Residential Natural Gas Use (41 Therms)
Greenbuilt	550	-27%	all electric home	
Jean	908	21%	all electric home	
HfH*	464	-38%	30	-27%
32nd Ave	632	-16%	unavailable	
Mascot	922	23%	21.5	-48%
HbT*	721	-4%	51	24%

*less than one year of data

Based on a bill analysis, it appears that a majority of the DERs' electricity use is being driven by miscellaneous plug loads with non-peak month electricity use between 60 to 96% of peak month electricity use. (see Table 8 below)

Table 8. DER Peak Monthly vs. Non-Peak Monthly Electivity Use

	Summer (May-Sept) Monthly kWh	Winter Monthly (Nov-March) Monthly kWh	Spring/Fall kWh	% Spring/Fall
Greenbuilt		704	422	60%**
Jean		1116	698	63%**
HfH*	557	417		78%
32nd Ave	767		526	69%
Mascot	946		904	96%
HbT*	537	614		78%

*less than a year's worth of data
** All electric homes' Spring/Fall electric usage compared to highest use winter months

Although the summer of 2011 was unusually mild in Sacramento with only six days over 100° F and no days over 105° F, [5] monitored data[6] collected during the summer's only "heat storm, " [7] July 3-5, with an average high temperature of 102° F showed that the DERS' average peak demand (4-7pm)[8] ranged from -1.2 kW to 3.87 kW [9]. Five of the six DERs showed significant average 4-7 peak demand savings when compared to monitored SMUD residential gas and electric heated single-family homes (see Table 9 below)[10]

Table 9. DER vs. SMUD Residential Electric & Gas Heated Single Family Home (SFH) Customers Average Peak Demand (kW) July 3-5, 2011 4-7 pm

	Avg. kW	Electric/Gas Heated SFH Customer Avg. kW	% Difference
Greenbuilt*	-1.2*	3.39	-135%
Mascot	3.05	3.29	-7%
Habitat*	0.6*	3.29	-82%
32nd Ave	1.8	3.29	-45%
HBT	3.87	3.29	18%

* PV production contributed 1.43 Average kW to the Greenbuilt DER and 0.60 kW to the Habitat DER during the July 3-5, 2011 4-7 pm peak period.

DERs are not inexpensive propositions. Costs for the six DERs ranged from a high of $42,000 to $25,000, not unexpected given the fact that DERs involved major work and equipment replacement. As mentioned, all six of the SMUD DER projects involved abandoned,

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5 Sacramento typically experiences 15 days over 100°F May-October.
6 Interval data was collected via SMUD's Smart Meter system including over 190,000 gas heated and over 36,000 electric heated single-family customers.
7 SMUD's resource planners define a heat storm as three consecutive weekdays with maximum high temperatures >105°F.
8 SMUD's peak period is from July-August, weekdays, 4-7 pm with an average maximum temperature of 94° in July and 93° in August. .
9 No interval data was available for Jean as it did not have an interval meter.
10 SMUD's Automated Metering system collected hourly interval data from over 190,000 gas and 36,000 electrically heated customers in July, 2011.

foreclosed homes that required major renovation to make them "market ready," including major structural repair and re-design. For example, all of the projects required extensive interior repairs; three of the projects required a new roof; and so on. However, the cost of a DER's efficiency upgrades only represents a portion of the cost of a major renovation of a home, especially when major repairs and equipment replacement is required. The energy efficiency portion of the four DER projects was a fraction of the total cost of the project (see Table 10 below):

Table 10. Total DER Project Costs vs. Energy Efficiency Upgrade Costs

	Total Project Cost	Energy Efficiency Upgrade	% of Total Cost
Greenbuilt[11]	$141,000	$42,000	30%
Mascot	$ 86,050	$25,000	29%
Jean	$120,000	$40,800	34%
32nd Avenue	$ 77,000	$26,769	35%
Habitat	$184,386	$24,635	13%
HBT	$ 66,500	$16,957	25%

LESSONS LEARNED

DERs have the potential to dramatically reduce an existing home's energy use and peak demand. Based on the experience of the SMUD DER projects, a standardized package of upgrades could result in up to 60% annual energy savings, especially for Sacramento area homes built before 1978 (homes built before the introduction of the California Title-24 Standards). Furthermore, the use of energy efficiency "packages," could provide predictable energy savings in an easy to understand format for DER contractors to use and homeowners to understand. Such a DER package would include:

- Air Sealing the home to a minimum 7.5 Air Changes per Hour (@ 50 pa of pressure
- R-38 attic insulation
- Energy Star Windows (.30 U-Factor and Solar Heat Gain Coefficient)
- "Right sized" (ACCA Manual D) SEER 14 air conditioner, 0.95 AFUE furnace or 9.5 HSPF Heat Pump with tight (less than 6% leakage), with R-8 insulated ducts
- .65 EF Gas Storage Water heater or 2.0 COP Heat Pump Water Heater
- Energy Star Hard Wired CFL Fixtures

Using a "package approach" for DERs also has important implications for utility program planning. To date, utility whole home efficiency programs have emphasized or relied largely on energy simulation to determine incentive levels. In fact, SMUD's Home Performance Program was mandated to use Title-24 Time Dependent Valuation (TDV) by the California Energy Commission (CEC). The shortcomings of energy simulation software are well known – it's time consuming, expensive, does not accurately predict bill impacts and can be "gamed" – simulation results can be manipulated to show exaggerated savings results. Furthermore, energy simulation should be completed by trained, experienced professionals. Asking home improvement

[11] Greenbuilt energy efficiency upgrades excluded the awnings, PV system and home area network.

contractors to become experts in energy simulation and rely on simulation estimates is unrealistic and will lead to problems in the field and confuse home owners. Relying on energy simulation estimates could also result in over inflated utility program energy savings results. Energy simulation should be used to develop DER packages for a variety of climate zones and building vintage types. These DER packages should then be tested in the field to verify energy savings and the DER packages modified, if necessary based on field experience. The Department of Energy has suggested such an approach with the publication of "Energy Savings Measure Packages: Existing Homes."[12]

DER packages should also be designed to reduce utility peak demand, meaning that the DER package results in the installation of "right-sized," reduced tonnage air conditioning units. Quite simply, reduced air conditioning tonnage results in lower peak demands and energy use and doesn't require energy simulation to estimate savings. Redding Electric Utility has pioneered such an approach with impressive results to date, averaging 2.5 kW savings per home in their home performance program.[13]

Utility planners also need to account for the contribution made by PV systems, especially in reducing a home's peak demand. Although PV systems may displace kWh sales and revenues they provide critical peak power. PV system peak contributions are typically unrecognized not only by utility resource planners but utility efficiency staff. The results from the Greenbuilt and HfH DERs show how PV production can result in near or zero peak homes even in late afternoon situations.

The extensive work involved in DERs incurs high costs. DER efficiency measure costs can be mitigated if included in major renovation or rehabilitation projects, such as turning abandoned, foreclosed properties into marketable properties. Moreover, to work, DERs require low interest, long-term financing. With the demise of the PACE program there is only one low interest, long-term financing option available – the Energy Efficient Mortgage (EEM). EEMs were created under the Carter Administration in 1978 but have languished due to indifference on the part of real estate industry and lack of promotion. Currently 30-year mortgages interest rates are at historically low levels (< 4%) and represent an unprecedented opportunity to finance DERs under the EEM. An analysis of the six DER Demonstration projects shows that using the low interest loans available through an EEM provides positive returns on investment and positive cash flow for homeowners, especially when combined with generous utility home performance incentives (see Table 11 below).

[12] "Energy Savings Measure Packages: Existing Homes" Prepared for: Building America, Better Buildings Neighborhood Program, Building Technologies Program Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy Prepared by: Sean Casey and Chuck Booten , National Renewable Energy Laboratory, November, 2011

[13] "Measure Home Performance- Best Practices for Home Energy Retrofits," Rick Chitwood and Lewis G. Harriman, ASHREA Journal, Jan., 2012, pp. 16-26

Table 11. Cash Flow and Return on Investment (ROI) of DERS with 4.25% EEM

	GreenBuilt	Mascot	Jean	Habitat	32nd Ave	HBT
EE/PV Costs	$60,813	$25,000	$40,759	$24,000[14]	$26,789	$16,957
Loan Amt (10% down)	$54,732	$22,500	$36,683	$23,160	$24,110	$15,261
Down Payment	-6,081	-$2,500	-4,076	-$2,400	-2,679	-1,696
Annual Mortgage Payment	-$3,231	-$1,328	-$2,166	-$1,367	-$1,423	-$901
First Year Utility Savings (2.5% Annual Inflation Rate)	$2,444	$1,264	$1,686	$1,204	$2,240	$737
Utility Incentives[15]	$11,235	$9,000	$5,000	$9,000	$5,000	$3,000
Fed. Tax Credits	$5,173	$500	$500	$0	$500	$500
Mortgage Deduction (25% Federal Tax Rate)	$577	$237	$387	$244	$254	$161
First Year Net Cash Flow	$10,117	$7,173	$1,331	$6,681	$3,892	$1,801
10-Yr Cumulative Cash Flow	$5,663	$7,954	$1,969	$10,891	$15,716	$2,428
First Year ROI	18.48%	31.88%	5.63%	28.85%	16.14%	11.80%

Until recently not all the elements were in place to drive the EEM. It is the opinion of this author that an indifferent, sometimes hostile real estate industry and a lack of certified home energy raters (HERS) and home performance contractors have made it difficult for home buyers to take advantage of the EEM. The nation-wide push for home performance created by the Obama Administration and State and utility home performance programs represents an unprecedented opportunity to realize the potential of the EEM. To date, state and utility home performance programs have concentrated their efforts on existing home owners, rather than the re-sale market. ESource reports that there has only been one utility sponsored EEM program, PG&E's Time of Sale Energy Renovation (TOSER) Program, which was offered by between 1999 and 2001. During that period 4,804 EEMs were completed and total estimated energy savings were the following:

- 15.7 million kWh (15.7 GWh) per year;
- 1.84 million therms per year; and
- Electricity demand savings totaling 3.73 average megawatts.[16]

In addition to the high costs of DERS and indifferent real estate market, utility home performance programs will labor with low participation rates given current economic conditions

[14] HfH family received their PV system for free under SMUD's Community Solar Program.
[15] Utility Incentives include SMUD PV and Whole House Performance and PG&E Natural Gas Incentives available at end of project.
[16] ESource Member Inquiry, #00017018, 9/13/2011, 2000 Market Effects Study Of The TOSER EEM Program – Updated Final Report, Prepared for Pacific Gas and Electric Company and Staples-Hutchinson, San Francisco, California, Prepared by XENERGY Inc, Oakland, California. March 1, 2001

that have large numbers of homeowners with negative equity. [17] It is unrealistic to expect large numbers of home owners to invest in their homes, especially for energy savings reasons, until the real estate market improves, an unlikely prospect in the near term. However, more than 4 million existing homes are sold annually. Each sale represents a unique opportunity to improve the energy performance of the home. If state and utility home performance programs were expanded to include EEMs, not only would new home owners realize cost effective energy saving improvements to their new homes, but home performance contractors (and HERS raters) could see steady business. The re-sale market represents a market that could provide contractors steady and predictable work with which to grow their businesses. It could also lead to greater homeowner interest in energy performance and help transform the market. Finally, the re-sale market is the only market that can produce the numbers needed to affect significant energy savings in a short period of time.[18]

Another promising area for DERS would be major remodeling projects, such as additions, and kitchen and bathroom remodels. Major remodeling projects typically entail extensive structural modifications to the home and often require new equipment, and they are usually very costly. A DER package of energy efficiency upgrades would represent a minor portion of the total remodel cost and potentially deliver significant energy and utility bill savings to the homeowner. The homeowner would also gain the non-financial benefits associated with increasing a home's performance, such as increased comfort and reduced maintenance costs.

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[17] Current figures show more than 50% of Sacramento homeowners are "underwater," owning more on their mortgages than what their home is worth.

[18] See "Making Homes Part of the Climate Solution: Policy Options to Promote Energy Efficiency," Brown, Marilyn, et. al., Prepared by Oak Ridge National Laboratory for the U.S. Climate Change Technology Program, June 2009, Rebuilding Mortgages for Energy Efficiency Todd Gerarden Federation of American Scientists, "Recovery Through Retrofit," October 2009 , Middle Class Task Force Council On Environmental Quality, Updating Federal Mortgage Programs to Encourage Energy Efficiency, Legislative Brief Institute for Market Transformation, http://www.imt.org/residential-finance.html,
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