Reducing Home Energy Costs by Combining Solar and Energy Efficiency

A White Paper

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Abstract

Energy efficiency and solar energy generation can effectively reduce -- and in many cases virtually eliminate -- residential energy bills. However, factors such as climate, age of the home and utility rates all dramatically affect the relative economic benefits of these measures. Since homeowners bear the brunt of these expenses, policies must be designed that are consistent with individual homeowner economics. For example, policies that mandate defined energy efficiency retrofit measures before solar energy generation result in bad economic investments for many homeowners. This paper examines the tradeoffs between energy efficiency retrofits and solar energy generation systems for homeowners throughout the U.S., and proposes solutions to encourage investments by homeowners that make good economic sense for their particular situation.

Executive Summary

Saving energy in the U.S. starts right at home. The residential sector consumes 22% of the energy in the United States; by comparison, cars use about 17%. Actions that individuals take to reduce home energy costs will give them more disposable income -- while simultaneously creating good local jobs, improving our environment and reducing our dependence on foreign oil.

Numerous surveys validate that homeowners' first goal is to save money when making efficiency and solar improvements. Homeowners have two ways to structurally reduce their energy costs: retrofit energy efficiency measures and solar energy generation. Although they bear most of the cost for these retrofits, it is very confusing to sort out the various energy savings claims from contractors, retailers and manufacturers of these products and services.

In order to objectively determine what combination of energy efficiency and renewable generation makes the most sense for homeowners, this White Paper uses Department of Energy software to evaluate three different ages of homes (old, typical and new) in ten cities in the U.S. The results of these 30 different home simulations are that climate, local utility rates and home condition are the biggest factors in determining what are the most cost effective energy savings measures for homeowners. In particular:

- Lighting retrofits are always cost effective (paybacks < 1 year).
- Weatherization and insulation energy efficiency measures are most cost effective in old homes in cold climates (paybacks <3 years), but are not cost effective in newer homes or in temperate climates.
- Basic building shell and ventilation energy efficiency measures are most cost-effective in cold climates, but have long paybacks in more temperate zones (paybacks 20+ years).
- Rooftop solar power systems have good paybacks regardless of home condition in sunny areas and in areas with either high electric rates or high solar incentives (paybacks 5-15 years).
- Solar thermal systems have good paybacks when the fuel source for hot water is electricity, or if there are local incentives in areas using natural gas with a tiered rate structure.
- Upgrades to Energy Star appliances and equipment are generally cost-effective when replacing broken or obsolete equipment, but are generally not cost effective when the existing equipment is still functional (analogous to not upgrading to a new, higher mileage car if the old one still works).

In almost all of the typical and new housing stock in the U.S., the "low hanging fruit" of basic energy saving measures have already been harvested. Consequently, for a typical home in the U.S., rooftop solar energy systems (electric and thermal), will generate six times more

energy than can be saved with lighting, weatherization and insulation retrofits combined. Generating the remaining energy required by the home will have the biggest impact on home energy consumption. Put simply, we cannot conserve our way to energy independence.

The results are somewhat contrary to the “conventional wisdom” regarding cost effectiveness for energy efficiency and solar power systems. However, these results are not surprising when one considers the range of U.S. housing stock, varying climate conditions and current costs of various retrofit and renewable energy options. Most importantly, these results provide guidance for good national energy efficiency and solar policies that are consistent with homeowner economics.

1. Introduction

In order for the U.S. to consume less energy, the place to start is right at home. The residential sector consumes 22% of the energy in the United States; by comparison, cars use about 17%. Actions that individuals take to reduce home energy costs will give them more disposable income -- while simultaneously creating good local jobs, improving our environment and reducing our dependence on foreign oil.

Homeowners have two ways to structurally reduce their energy costs: retrofit energy efficiency measures and solar energy generation. Retrofit energy efficiency measures include caulking, ceiling insulation, energy efficient heating and air conditioning systems, appliances (laundry, refrigerator), lighting, and windows. Solar energy generation includes solar power (photovoltaic), solar water heating, and solar space conditioning. Each of these measures address specific aspects of a home's energy requirements. For example, insulation addresses heating and cooling requirements, and energy efficient appliances address electricity demand. Photovoltaic systems reduce overall electricity demand by generating electricity on-site, including 'plug loads' from televisions and appliances, as well as the electricity needed to run heating and air conditioning systems.

In all cases, homeowners bear most of the costs for selecting and implementing these measures. Their individual economic situation and energy usage patterns directly impact their choice of which measure or combination of measures to implement. Although some portion of these costs can be reduced through local rebate programs and federal tax credits, the majority of the cost of these improvements is borne by the individual. Therefore, their specific preferences and economic choices must be addressed when establishing energy savings policies. Failure to consider these consumer economic factors risks creating policies that may look good on paper but will fail in practice.

For the last few decades, energy efficiency measures and rooftop solar power have proven their ability to reduce homeowner's utility bills. While it is indeed important for energy consumers to reduce energy consumption, it is not true that all efficiency measures make sense for all homes. The reality is that the climate region in which the home is located, the age and condition of the home, and utility rates dramatically change the cost-effectiveness and preference for various energy saving and energy generating measures. To succeed in home energy reduction goals policymakers must encourage consumers to reduce their energy consumption in a way that is consistent with their best economic interests.

Numerous surveys validate that homeowners' first goal is to save money when making efficiency and solar improvements. However, there is a wide range of retrofit and energy audit options available to homeowners to reduce their energy costs. Moreover, it can be quite confusing to sort out the various energy savings claims from contractors, retailers and

manufacturers of these products and services. The primary goal of this White Paper was to use widely accepted software to determine if generalizations about the best energy savings measures can be made for homeowners.

2. Methodology

Home energy audit software has come a long way since the first punch card mainframe programs were used by utilities in the late 1970s. One of the best programs available is the U.S. Department of Energy's "Home Energy Saver" program, developed by the Lawrence Berkeley National Laboratory[1]. This program has a comprehensive set of parameters that can be used to model all of a home's energy usage, taking into account heating loads, cooling loads, hot water usage, lighting and appliance usage – all adjusted for local climate and energy costs.

In order to provide policy guidance that would be relevant throughout the U.S., homes were modeled in ten different cities: New York, San Jose, Los Angeles, Boston, Miami, Raleigh, Cleveland, Dallas, Denver and Phoenix. Since a key hypothesis is that the actual condition of the home will have a big impact on the prioritization of energy efficiency and solar measures, three different types of homes were modeled in each location: old, typical and new. Old homes were pre-war, constructed before 1940; typical homes were constructed between 1940 and 1975 (post war and pre-Carter), and new homes were constructed after 1975. Obviously there is a great deal of variability of home construction practice in different areas of the country during these timeframes, but these ranges roughly approximate periods during which increasing attention was paid to home energy consumption.

The average home was defined to be 2,000 square feet, one story, 50x40 rectangle with construction practices typical for the vintage of the home. All home-specific parameters were kept constant for each of the 30 different simulations except for minor heating system variations (boiler in cold areas, furnace in temperate areas, heat pump in warmer areas), foundations (basement in cold areas, crawl space in warmer areas), and siding (wood siding in cold areas, stucco in warmer areas).

DOE program defaults were used for retrofit recommendations, savings and costs. No attempt was made to change the default recommendations and savings produced by the DOE program, although these defaults were adjusted for local energy efficiency and solar incentives where applicable. Since the DOE program did not consider solar power or solar thermal retrofit measures, industry-accepted calculations were used to determine solar retrofit savings based on home electricity usage and hot water usage as modeled by the program. Local utility rates were used where possible, and adjustments were made to reflect marginal electric rates.

Retrofit costs for solar power systems (not including incentives) were $5.50/watt, which is consistent with current California Solar Initiative costs for residential systems[2]. In cases

[1] http://hes.lbl.gov/consumer/

[2] 23% of residential systems reserved throughout 2010 were between $5 and $6/DC watt. See http://www.californiasolarstatistics.ca.gov/reports/cost_per_watt/

where retrofit costs were specified on an incremental basis (for example, the “extra” amount to install a high efficiency appliance or building shell measures compared to normal), the cost for the entire retrofit measure was used instead of the incremental cost to provide a more accurate retrofit payback. For new homes, retrofit work suggested by the program for air leakage and weatherization was not considered since these homes should, by definition, be in good shape – and if work were required it would be covered by an existing home warranty.

3. Results

A key first step in validating the accuracy of the modeled consumption for typical homes is to verify that the home's energy consumption is realistic. The table below shows the modeled home energy usage for old, typical and new homes in the ten home simulation cities.

Condition	City, ST	Annual Therms	Annual Therm ($)	Annual kWh	Annual kWh ($)	Total
NEW	Boston, MA	1,735	$ 2,967	7,313	$ 1,281	$ 4,248
OLD	Boston, MA	5,800	$ 9,918	8,268	$ 1,448	$ 11,366
Typical	Boston, MA	1,097	$ 1,876	7,849	$ 1,375	$ 3,251
NEW	Cleveland, OH	1,009	$ 1,463	4,423	$ 446	$ 1,909
OLD	Cleveland, OH	2,835	$ 4,111	11,796	$ 1,191	$ 5,302
Typical	Cleveland, OH	1,812	$ 2,628	10,827	$ 1,092	$ 3,720
NEW	Dallas, TX	348	$ 480	10,505	$ 1,345	$ 1,825
OLD	Dallas, TX	1,592	$ 2,197	34,976	$ 4,476	$ 6,673
TYPICAL	Dallas, TX	839	$ 1,158	19,267	$ 2,465	$ 3,623
NEW	Denver, CO	909	$ 891	4,246	$ 431	$ 1,322
OLD	Denver, CO	2,493	$ 2,443	8,336	$ 849	$ 3,292
Typical	Denver, CO	1,804	$ 1,768	8,219	$ 838	$ 2,606
NEW	Los Angeles, CA	273	$ 347	4,785	$ 689	$ 1,036
OLD	Los Angeles, CA	742	$ 943	11,941	$ 1,719	$ 2,662
Typical	Los Angeles, CA	624	$ 794	9,801	$ 1,411	$ 2,205
NEW	Miami, FL	-	$ -	16,157	$ 1,891	$ 1,891
OLD	Miami, FL	276	$ 588	45,900	$ 5,368	$ 5,956
Typical	Miami, FL	-	$ -	31,456	$ 3,679	$ 3,679
NEW	NYC, NY	1,225	$ 2,058	7,202	$ 1,585	$ 3,643
OLD	NYC, NY	3,112	$ 5,228	15,824	$ 3,483	$ 8,711
TYPICAL	NYC, NY	2,265	$ 3,805	14,841	$ 3,266	$ 7,071
NEW	Phoenix, AZ	190	$ 333	16,192	$ 1,669	$ 2,002
OLD	Phoenix, AZ	854	$ 1,495	47,309	$ 4,876	$ 6,371
Typical	Phoenix, AZ	574	$ 1,005	26,194	$ 2,700	$ 3,705
NEW	Raleigh, NC	-	$ -	15,958	$ 1,547	$ 1,547
OLD	Raleigh, NC	-	$ -	56,841	$ 5,514	$ 5,514
TYPICAL	Raleigh, NC	-	$ -	35,325	$ 3,427	$ 3,427
NEW	San Jose, CA	293	$ 372	3,061	$ 612	$ 984
OLD	San Jose, CA	1,563	$ 1,985	10,422	$ 2,084	$ 4,069
TYPICAL	San Jose, CA	761	$ 967	8,843	$ 1,768	$ 2,735

Modeled home energy consumption is reasonable based on age-specific factors and climate. U.S. average electric consumption is approximately 1,000 kwh/month. Heating and cooling energy consumption varies by climate, as one would expect. Variations by home condition reflect the expected relatively higher heating and cooling requirements for old homes compared to new homes.

The table below shows the average simple paybacks for categorized retrofit measures in all ten cities, calculated across all old, typical and new homes in these locations. The "payback" metric, calculated as net retrofit cost (after incentives) divided by first year savings, is a simple and intuitive way to prioritize retrofit measures. More refined metrics such as Net Present Value or Return on Investment can be used, but since the average tenure of home ownership is about seven years – payback provides a good representation of the cost effectiveness of various retrofit measures.

Category	Average Net Cost to Install	Average Annual Savings	Payback
Lighting	$ 88	$ 70	1.3
Weatherization and Insulation	$ 4,508	$ 1,449	3.1
Solar Power	$ 10,105	$ 922	11.0
Solar Thermal	$ 3,579	$ 242	14.8
HVAC	$ 5,535	$ 274	20.2
Major Appliances	$ 5,004	$ 229	21.9
Building Shell Improvements	$ 9,008	$ 377	23.9
Grand Total	$ 5,449	$ 462	11.8

It is extremely important to note that the payback table above showing national averages is very misleading as far as guidance towards specific retrofit measures. As discussed in the following section, the large energy savings potential for older homes in cold climates distorts the picture for more typical homes throughout the United States.

Categorizing retrofit measures is important since different types of contractors specialize in different types of retrofits. From a practical standpoint, if a homeowner wanted to upgrade their furnace, install attic insulation, double-pane windows and solar – they would have to hire four different contractors. This type of multi-contractor buying process is complicated for a homeowner. Homeowners are more likely to do the retrofits in one contractor category than the “best” retrofits in multiple categories.

Appendix 1 shows the details of all energy retrofit measures recommended by the DOE Home Energy Saver program in each of the 30 modeled home scenarios, ranked by payback.

4. Analysis

Given the right information and a simple “buying” process, consumers will generally act quickly on retrofit measures that have paybacks of less than one year. Lighting retrofits -- generally replacing incandescent lights with compact fluorescent lights -- almost always have a very short payback. On the average, weatherization and insulation measures have short paybacks where they are lacking– but are very sensitive to the location and condition of the home, as described below. Solar power retrofits show a fairly consistent payback regardless of location or home condition; paybacks are mostly dependent on local electric rates and incentives. HVAC retrofits have moderate paybacks for old and cold homes, but long paybacks in newer homes and homes in more temperate regions.

Old Versus New Homes

Differences in paybacks are very sensitive to both a home’s condition and location. The differences in home condition can be seen in the two tables below, in which an old house in San Jose (circa 1935) is compared to a new house in San Jose (circa 1980).

OLD San Jose, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$ 88	$ 101	0.9
Attic insulation	$ 1,029	$ 684	1.5
Duct Insulation	$ 637	$ 414	1.5
Duct Sealing	$ 623	$ 118	5.3
Air sealing	$ 595	$ 112	5.3
Solar Power	$ 15,687	$ 1,951	8.0
Electric clothes dryer	$ 950	$ 118	8.1
Clothes washer	$ 780	$ 78	10.0
Gas water heater	$ 500	$ 48	10.4
Wall insulation	$ 2,916	$ 259	11.3
Solar Thermal	$ 2,800	$ 226	12.4
Gas furnace	$ 2,450	$ 165	14.8
Dishwasher	$ 700	$ 24	29.2
Windows	$ 8,500	$ 287	29.6
Well pump	$ 600	$ 9	66.7
First Refrigerator	$ 987	$ 12	82.3
Second Refrigerator	$ 887	$ 10	88.7
Ceiling fan	$ 200	$ 2	100.0
Central air conditioner	$ 2,450	$ 23	106.5

NEW San Jose, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$ 88	$ 101	0.9
Solar Power	$ 15,687	$ 1,951	8.0
Electric clothes dryer	$ 950	$ 118	8.1
Clothes washer	$ 780	$ 78	10.0
Gas water heater	$ 500	$ 48	10.4
Solar Thermal	$ 2,800	$ 226	12.4
Water Cooler	$ 120	$ 8	15.0
Dishwasher	$ 700	$ 23	30.4
Gas furnace	$ 2,450	$ 53	46.2
Well pump	$ 600	$ 9	66.7
Windows	$ 8,500	$ 105	81.0
First Refrigerator	$ 987	$ 12	82.3
Second Refrigerator	$ 887	$ 10	88.7
Ceiling fan	$ 200	$ 2	100.0
Central air conditioner	$ 2,450	$ 9	272.2

For the Old house in San Jose, attic and duct insulation have a short payback (since there was originally no insulation at all), and duct sealing and air sealing have a moderate payback (since these items are “leaky” in the old house). However, popular retrofit measures such as wall insulation and double pane windows have 11 and 30 year paybacks respectively– primarily because in the relatively temperate San Jose climate the conductive energy losses through the building shell do not justify the expense of retrofitting these items.

For the new house in San Jose -- since it is assumed to already have reasonably effective weatherization, insulation and building systems – only lighting upgrades, solar power and appliance upgrades have short paybacks. Generally, as long as new homes were built properly up to modern construction standards, there is virtually no opportunity at all for weatherization, insulation, building shell and HVAC upgrades.

Cold Climate Versus Temperate Climate Homes

The differences that climate have on similarly constructed homes can be seen in the two tables below, in which a typical house in New York City is compared to a typical house in Los Angeles.

Typical Los Angeles, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$ 88	$ 73	1.2
Attic insulation	$ 430	$ 55	7.8
Solar Power	$ 7,340	$ 825	8.9
Gas water heater	$ 500	$ 38	13.2
Solar Thermal	$ 2,800	$ 198	14.1
Clothes washer	$ 780	$ 52	15.0
Water Cooler	$ 120	$ 6	20.0
Duct Sealing	$ 623	$ 30	20.8
Air sealing	$ 595	$ 25	23.8
Dishwasher	$ 700	$ 18	38.9
Windows	$ 8,500	$ 193	44.0
Duct Insulation	$ 637	$ 10	63.7
Gas furnace	$ 2,450	$ 36	68.1
Central air conditioner	$ 2,450	$ 28	87.5
Well pump	$ 600	$ 6	100.0
First Refrigerator	$ 987	$ 9	109.7
Second Refrigerator	$ 887	$ 7	126.7
Ceiling fan	$ 200	$ 1	200.0

TYPICAL NYC, NY	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$ 88	$ 112	0.8
Duct Sealing	$ 623	$ 549	1.1
Air sealing	$ 595	$ 332	1.8
Boiler pipes	$ 416	$ 170	2.4
Attic insulation	$ 1,449	$ 477	3.0
Duct Insulation	$ 637	$ 112	5.7
Floor insulation	$ 1,232	$ 199	6.2
Electric clothes dryer	$ 950	$ 153	6.2
Gas water heater	$ 500	$ 72	6.9
Gas boiler	$ 1,569	$ 224	7.0
Solar Power	$ 8,859	$ 1,242	7.1
Clothes washer	$ 780	$ 91	8.6
Windows	$ 8,500	$ 834	10.2
Water Cooler	$ 120	$ 9	13.3
Solar Thermal	$ 3,900	$ 249	15.7
Dishwasher	$ 700	$ 29	24.1
Well pump	$ 600	$ 10	60.0
First Refrigerator	$ 987	$ 13	75.9
Second Refrigerator	$ 887	$ 11	80.6
Central air conditioner	$ 2,450	$ 25	98.0
Ceiling fan	$ 200	$ 2	100.0

For the typical house in New York City, retrofit items that reduce heating requirements, such as air infiltration and easily accessible insulation, have good paybacks. Because of high electric rates and favorable incentives, solar power systems also show a good payback.

On the other hand, for a typical house in Los Angeles, building shell, insulation (except for attic insulation) and air sealing measures have long paybacks. Measures directed towards reducing electrical costs such as solar power and appliance upgrades show the fastest paybacks.

Making a Big Dent in Home Energy Expenses

In almost all of the typical and new housing stock in the U.S., the "low hanging fruit" of basic energy saving measures has already been harvested. Generating the remaining energy required will have the biggest impact on home energy consumption. The table below shows the annual energy savings achievable in each retrofit category for typical homes averaged across all ten cities.

Typical			
Category	**Average Net Cost to Install**	**Average Annual Savings**	**Payback**
Lighting	$ 88	$ 70	1.3
Weatherization and Insulation	$ 829	$ 126	6.6
Solar Power	$ 10,105	$ 922	11.0
Solar Thermal	$ 3,579	$ 242	14.8
HVAC	$ 1,175	$ 59	19.8
Major Appliances	$ 568	$ 33	17.0
Building Shell Improvements	$ 3,336	$ 130	25.6
Grand Total	$ 19,681	$ 1,583	12.4

For a typical home in the U.S., rooftop solar energy systems (electric and thermal), will generate six times more energy than can be saved with lighting, weatherization and insulation retrofits combined. Rooftop solar energy systems can reduce annual energy expenses by an average of 32%, whereas basic lighting, weatherization and insulation retrofits combined can reduce energy expenses by only 5%. It is clear that policies focusing on energy efficiency alone will not make a meaningful dent in home energy expenses. Put another way, we simply cannot conserve our way to energy independence.

5. Retrofit Recommendations

One cannot generalize retrofit priorities for the entire U.S. However, certain retrofit priorities are clear when considering the location and condition of the home, as summarized below:

- Lighting retrofits always show a rapid payback (< 1 year); these are low cost, mostly DIY activities.
- Weatherization energy efficiency measures are most cost effective in old homes in cold climates (<3 years), but are not cost effective at all in newer homes or in temperate climates.
- Basic building shell and ventilation energy efficiency measures are most cost-effective in cold climates (5-15 years), but have long paybacks in more temperate zones (20+ years).
- Rooftop solar power systems have good paybacks, in the range of 5-15 years regardless of home age and climate as long as there are either high electric rates or high solar incentives. Due to technology advancements and mass production, costs for rooftop solar power systems are dropping rapidly – likely making these measures even more cost effective in future years.
- Solar thermal systems have good paybacks when the fuel source for hot water is electricity, or if there are local incentives in areas using natural gas with a tiered rate structure.
- Upgrades to Energy Star appliances and equipment are generally cost-effective when replacing broken or obsolete equipment, but are generally not cost effective when the existing equipment is still functional (analogous to not upgrading to a new, higher mileage car if the old one still works).

Financing of retrofit measures is a critical consideration to homeowners. Many homeowners decide to take out a bank loan, PACE loan or lease financing. These loans have fixed transaction costs that make them impractical for low cost retrofits. When one considers both the financing costs and contractor project costs, packages of retrofits with relatively high costs (justifying the financing) and high annual savings (generating a short payback) are most likely to be widely adopted – saving the most residential energy in the U.S.

6. Conclusions and Policy Recommendations

Public policy that is well aligned with consumer economics will have a tremendously positive impact in reducing home energy costs. In the course of doing this research it is apparent that some of these factors are being overlooked in the overall debate about energy savings. Policy recommendations are summarized below.

Conclusions

- "Loading Orders"[3] or retrofit priorities that do not consider actual homeowner economics can lead to public policies that fail in the marketplace.
- The conventional wisdom approach of "energy efficiency first" does not consider four factors: the actual condition of the housing stock; local climatic conditions; electricity rates that are escalating faster than heating fuel rates; and the rapidly declining costs for solar and lighting upgrades.
- If the goal is to reduce our dependence on foreign energy sources, then rooftop solar electric and thermal systems are clearly the best retrofit option. For a typical home in the U.S., these systems will generate six times more energy than can be saved with lighting, weatherization and insulation retrofits combined.
- Overall, solar upgrades will save eight times more energy for typical California homeowners than lighting, weatherization and insulation measures combined -- and should therefore be the first priority rather than the last option.
- Traditional retrofit measures such as insulation, weatherstripping and HVAC upgrades do not show fast paybacks, except in old homes in cold climates.
- Homeowners should be encouraged to implement retrofits in payback or NPV order rather than in an arbitrary fashion
- The DOE Home Energy Saver program is a tremendously useful web-based tool for both homeowners and energy auditors to use. The internal energy simulation and recommendations it provides are well calibrated to local climate and home design parameters. However, the program should be adjusted for local energy costs, total (not incremental) retrofit costs, marginal electric rates, and solar power and solar thermal retrofit measures.
- Energy audits are not necessary to determine the suitability of a home for some of the most cost effective retrofits (note that some home energy audits cost as much as $1,000 per homes – and this cost is generally not factored in to energy efficiency cost-effectiveness evaluations). Old homes in poor condition in cold areas will almost always need insulation and air infiltration improvements – these homes are good energy audit candidates. However, new homes and most homes in temperate areas may not justify the cost of an expensive HERS-type energy audit; moreover, these audits are simply not necessary to determine the applicability of the obvious lighting and solar retrofits.
- Monitoring and control systems have great potential for reducing home energy consumption, although they were not considered in this analysis. Part of the problem is that thermostats can be over-ridden and consumption monitors can be ignored – whereas efficient lighting, rooftop solar or building insulation will deliver savings regardless of homeowner actions (or inactions). Nevertheless, innovations such as

[3] . For example, the California Energy Commission has adopted a "Loading Order" requiring comprehensive home insulation, envelope sealing, HVAC upgrades and comprehensive energy auditing before considering solar retrofits. Lighting upgrades (which have the fastest payback) are not eligible, and solar upgrades are at the end of the list.

the “smart grid”, internet-connected thermostats and automatic load-shedding appliances can overcome some of the behavioral limitations that inhibit many energy savings efforts.
- Due to technology advancements and mass production, costs for rooftop solar power systems are dropping rapidly – likely making rooftop solar even more cost effective in future years. On the other hand, since building shell and weatherization retrofits use conventional construction materials and labor techniques it is not likely that these costs will be substantially less in future years.

Policy Recommendations:

- Modify loading order policies to encourage homeowners to select energy efficiency and self-generation in the appropriate payback order for their individual situation.
- Modify loading order policies to take into account factors such as the actual condition of the housing stock and local climate conditions,
- The cost of energy audits should be incorporated into the cost effectiveness evaluations for home energy efficiency retrofit measures.
- The DOE Home Energy Saver program should be adjusted for local energy costs, total (not incremental) retrofit costs, marginal electric rates, and solar power and solar thermal retrofit measures.
- Policies that anticipate long-term programs should consider likely future costs of retrofit measures.

Appendix 1 – Location and Condition-Specific Retrofit Recommendations

Typical Boston, MA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$89	1.0
Duct Sealing	$623	$73	8.5
Clothes washer	$780	$88	8.9
Air sealing	$595	$58	10.3
Solar Power	$9,710	$816	11.9
Duct Insulation	$637	$40	15.9
Solar Thermal	$4,500	$238	18.9
Attic insulation	$1,449	$72	20.1
Dishwasher	$700	$29	24.1
Floor insulation	$938	$21	44.7
Well pump	$600	$8	75.0
First Refrigerator	$987	$11	89.7
Second Refrigerator	$887	$9	98.6
Windows	$8,500	$58	146.6
Ceiling fan	$200	$1	200.0
Central air conditioner	$2,450	$9	272.2

Typical Cleveland, OH	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$51	1.7
Air sealing	$595	$211	2.8
Attic insulation	$1,449	$295	4.9
Duct Sealing	$623	$106	5.9
Electric clothes dryer	$950	$124	7.7
Floor insulation	$1,232	$151	8.2
Gas water heater	$500	$61	8.2
Solar Thermal	$2,520	$277	9.1
Gas furnace	$2,450	$266	9.2
Duct Insulation	$637	$58	11.0
Clothes washer	$780	$67	11.6
Solar Power	$7,875	$524	15.0
Water Cooler	$120	$4	30.0
Dishwasher	$700	$22	31.8
Windows	$8,500	$188	45.2
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Central air conditioner	$2,450	$13	188.5
Ceiling fan	$200	$1	200.0

TYPICAL Dallas, TX	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$65	1.4

Air sealing	$595	$183	3.3
Duct Sealing	$623	$131	4.8
Attic insulation	$1,449	$218	6.6
Electric clothes dryer	$950	$121	7.9
Solar Power	$9,450	$911	10.4
Gas water heater	$500	$48	10.4
Clothes washer	$780	$66	11.8
Duct Insulation	$637	$53	12.0
Windows	$8,500	$476	17.9
Water Cooler	$120	$5	24.0
Solar Thermal	$4,740	$194	24.4
Gas furnace	$2,450	$98	25.0
Dishwasher	$700	$21	33.3
Central air conditioner	$2,450	$72	34.0
Well pump	$600	$6	100.0
First Refrigerator	$987	$8	123.4
Second Refrigerator	$887	$7	126.7
Ceiling fan	$200	$1	200.0

Typical Denver, CO	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$52	1.7
Air sealing	$595	$87	6.8
Attic insulation	$1,449	$170	8.5
Electric clothes dryer	$950	$87	10.9
Gas water heater	$500	$44	11.4
Clothes washer	$780	$60	13.0
Gas furnace	$2,450	$184	13.3
Solar Power	$9,608	$714	13.5
Wall insulation	$2,916	$162	18.0
Solar Thermal	$2,800	$139	20.1
Water Cooler	$120	$4	30.0
Dishwasher	$700	$18	38.9
Windows	$8,500	$127	66.9
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

Typical Los Angeles, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$73	1.2
Attic insulation	$430	$55	7.8
Solar Power	$7,340	$825	8.9
Gas water heater	$500	$38	13.2
Solar Thermal	$2,800	$198	14.1
Clothes washer	$780	$52	15.0
Water Cooler	$120	$6	20.0
Duct Sealing	$623	$30	20.8
Air sealing	$595	$25	23.8
Dishwasher	$700	$18	38.9

Windows	$8,500	$193	44.0
Duct Insulation	$637	$10	63.7
Gas furnace	$2,450	$36	68.1
Central air conditioner	$2,450	$28	87.5
Well pump	$600	$6	100.0
First Refrigerator	$987	$9	109.7
Second Refrigerator	$887	$7	126.7
Ceiling fan	$200	$1	200.0

Typical Miami, FL	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$59	1.5
Air sealing	$595	$165	3.6
Duct Sealing	$623	$93	6.7
Attic insulation	$1,449	$134	10.8
Electric water heater	$500	$46	10.9
Clothes washer	$780	$68	11.5
Solar Thermal	$4,500	$322	14.0
Solar Power	$12,600	$804	15.7
Windows	$8,500	$446	19.1
Central air conditioner	$2,450	$108	22.7
Duct Insulation	$637	$28	22.8
Dishwasher	$700	$22	31.8
Heat pump	$3,500	$109	32.1
Well pump	$600	$5	120.0
First Refrigerator	$987	$7	141.0
Second Refrigerator	$887	$6	147.8
Ceiling fan	$200	$1	200.0

TYPICAL NYC, NY	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$112	0.8
Duct Sealing	$623	$549	1.1
Air sealing	$595	$332	1.8
Boiler pipes	$416	$170	2.4
Attic insulation	$1,449	$477	3.0
Duct Insulation	$637	$112	5.7
Floor insulation	$1,232	$199	6.2
Electric clothes dryer	$950	$153	6.2
Gas water heater	$500	$72	6.9
Gas boiler	$1,569	$224	7.0
Solar Power	$8,859	$1,242	7.1
Clothes washer	$780	$91	8.6
Windows	$8,500	$834	10.2
Water Cooler	$120	$9	13.3
Solar Thermal	$3,900	$249	15.7
Dishwasher	$700	$29	24.1
Well pump	$600	$10	60.0
First Refrigerator	$987	$13	75.9
Second Refrigerator	$887	$11	80.6
Central air conditioner	$2,450	$25	98.0

Ceiling fan	$200	$2	100.0

Typical Phoenix, AZ	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$52	1.7
Floor insulation	$270	$52	5.2
Air sealing	$595	$106	5.6
Electric clothes dryer	$950	$149	6.4
Attic insulation	$1,449	$218	6.6
Gas water heater	$500	$53	9.4
Solar Power	$8,663	$834	10.4
Clothes washer	$780	$62	12.6
Duct Sealing	$623	$48	13.0
Solar Thermal	$4,500	$272	16.5
Windows	$8,500	$440	19.3
Central air conditioner	$2,450	$91	26.9
Water Cooler	$120	$4	30.0
Dishwasher	$700	$20	35.0
Duct Insulation	$637	$16	39.8
Gas furnace	$2,450	$58	42.2
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

TYPICAL Raleigh, NC	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$49	1.8
Air sealing	$595	$117	5.1
Electric clothes dryer	$950	$121	7.9
Solar Thermal	$2,730	$302	9.1
Attic insulation	$1,449	$145	10.0
Electric water heater	$500	$49	10.2
Clothes washer	$780	$67	11.6
Duct Sealing	$623	$46	13.5
Solar Power	$11,261	$595	18.9
Windows	$8,500	$310	27.4
Water Cooler	$120	$4	30.0
Dishwasher	$700	$22	31.8
Duct Insulation	$637	$19	33.5
Heat pump	$3,500	$81	43.2
Central air conditioner	$2,450	$28	87.5
Well pump	$600	$4	150.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

TYPICAL San Jose, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$101	0.9
Attic insulation	$430	$67	6.4

Solar Power	$15,687	$1,951	8.0
Electric clothes dryer	$950	$118	8.1
Clothes washer	$780	$78	10.0
Gas water heater	$500	$48	10.4
Solar Thermal	$2,800	$226	12.4
Water Cooler	$120	$8	15.0
Air sealing	$595	$34	17.5
Floor insulation	$270	$14	19.3
Dishwasher	$700	$24	29.2
Duct Sealing	$623	$19	32.8
Gas furnace	$2,450	$70	35.0
Duct Insulation	$637	$10	63.7
Windows	$8,500	$132	64.4
Well pump	$600	$9	66.7
First Refrigerator	$987	$12	82.3
Second Refrigerator	$887	$10	88.7
Ceiling fan	$200	$2	100.0
Central air conditioner	$2,450	$11	222.7

OLD Boston, MA	Net Cost to Install	Yearly Savings	PayBack
Duct Insulation	$637	$2,251	0.3
Air sealing	$595	$1,397	0.4
Duct Sealing	$623	$1,086	0.6
Indoor lights	$88	$89	1.0
Floor insulation	$938	$332	2.8
Attic insulation	$1,449	$479	3.0
Wall insulation	$8,714	$1,207	7.2
Clothes washer	$780	$88	8.9
Solar Power	$9,710	$816	11.9
Solar Thermal	$4,500	$238	18.9
Windows	$8,500	$417	20.4
Dishwasher	$700	$29	24.1
Well pump	$600	$8	75.0
First Refrigerator	$987	$11	89.7
Second Refrigerator	$887	$9	98.6
Ceiling fan	$200	$1	200.0
Central air conditioner	$2,450	$7	350.0

OLD Cleveland, OH	Net Cost to Install	Yearly Savings	PayBack
Air sealing	$595	$389	1.5
Wall insulation	$736	$434	1.7
Indoor lights	$88	$51	1.7
Attic insulation	$1,449	$366	4.0
Gas furnace	$2,450	$372	6.6
Electric clothes dryer	$950	$124	7.7
Gas water heater	$500	$61	8.2
Solar Thermal	$2,520	$277	9.1
Clothes washer	$780	$67	11.6
Solar Power	$7,875	$524	15.0

Windows	$8,500	$316	26.9
Water Cooler	$120	$4	30.0
Dishwasher	$700	$22	31.8
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Central air conditioner	$2,450	$13	188.5
Ceiling fan	$200	$1	200.0

OLD Dallas, TX	Net Cost to Install	Yearly Savings	PayBack
Duct Insulation	$637	$1,640	0.4
Duct Sealing	$623	$795	0.8
Air sealing	$595	$456	1.3
Indoor lights	$88	$65	1.4
Attic insulation	$1,449	$425	3.4
Wall insulation	$2,916	$393	7.4
Electric clothes dryer	$950	$121	7.9
Windows	$8,500	$1,023	8.3
Solar Power	$9,450	$911	10.4
Gas water heater	$500	$48	10.4
Clothes washer	$780	$66	11.8
Gas furnace	$2,450	$190	12.9
Central air conditioner	$2,450	$124	19.8
Water Cooler	$120	$5	24.0
Solar Thermal	$4,740	$194	24.4
Dishwasher	$700	$21	33.3
Well pump	$600	$6	100.0
First Refrigerator	$987	$8	123.4
Second Refrigerator	$887	$7	126.7
Ceiling fan	$200	$1	200.0

OLD Denver, CO	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$52	1.7
Air sealing	$595	$166	3.6
Attic insulation	$1,449	$207	7.0
Electric clothes dryer	$950	$87	10.9
Gas furnace	$2,450	$220	11.1
Gas water heater	$500	$44	11.4
Clothes washer	$780	$60	13.0
Solar Power	$9,608	$714	13.5
Wall insulation	$2,916	$190	15.3
Solar Thermal	$2,800	$139	20.1
Water Cooler	$120	$4	30.0
Dishwasher	$700	$19	36.8
Windows	$8,500	$222	38.3
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

OLD Los Angeles, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$73	1.2
Attic insulation	$430	$88	4.9
Duct Insulation	$637	$81	7.9
Duct Sealing	$623	$74	8.4
Solar Power	$7,340	$825	8.9
Air sealing	$595	$53	11.2
Gas water heater	$500	$38	13.2
Solar Thermal	$2,800	$198	14.1
Clothes washer	$780	$52	15.0
Wall insulation	$2,916	$163	17.9
Water Cooler	$120	$6	20.0
Windows	$8,500	$269	31.6
Dishwasher	$700	$18	38.9
Gas furnace	$2,450	$46	53.3
Central air conditioner	$2,450	$32	76.6
Well pump	$600	$6	100.0
First Refrigerator	$987	$9	109.7
Second Refrigerator	$887	$7	126.7
Ceiling fan	$200	$1	200.0

OLD Miami, FL	Net Cost to Install	Yearly Savings	PayBack
Duct Insulation	$637	$749	0.9
Duct Sealing	$623	$476	1.3
Indoor lights	$88	$59	1.5
Air sealing	$595	$264	2.3
Electric clothes dryer	$950	$180	5.3
Attic insulation	$1,449	$226	6.4
Gas water heater	$500	$62	8.1
Windows	$8,500	$809	10.5
Clothes washer	$780	$69	11.3
Wall insulation	$2,916	$233	12.5
Solar Thermal	$4,500	$322	14.0
Central air conditioner	$2,450	$157	15.6
Solar Power	$12,600	$804	15.7
Heat pump	$3,500	$159	22.0
Water Cooler	$120	$5	24.0
Dishwasher	$700	$22	31.8
Well pump	$600	$5	120.0
First Refrigerator	$987	$7	141.0
Second Refrigerator	$887	$6	147.8
Ceiling fan	$200	$1	200.0

OLD NYC, NY	Net Cost to Install	Yearly Savings	PayBack
Duct Insulation	$637	$1,938	0.3
Indoor lights	$88	$112	0.8
Duct Sealing	$623	$649	1.0

Air sealing	$595	$611	1.0
Wall insulation	$736	$686	1.1
Boiler pipes	$416	$246	1.7
Attic insulation	$1,449	$574	2.5
Floor insulation	$1,232	$248	5.0
Gas boiler	$1,569	$282	5.6
Electric clothes dryer	$950	$153	6.2
Gas water heater	$500	$72	6.9
Solar Power	$8,859	$1,242	7.1
Clothes washer	$780	$91	8.6
Solar Thermal	$3,900	$249	15.7
Windows	$8,500	$413	20.6
Dishwasher	$700	$29	24.1
Well pump	$600	$10	60.0
First Refrigerator	$987	$13	75.9
Second Refrigerator	$887	$11	80.6
Central air conditioner	$2,450	$25	98.0
Ceiling fan	$200	$2	100.0

OLD Phoenix, AZ	Net Cost to Install	Yearly Savings	PayBack
Duct Insulation	$637	$923	0.7
Duct Sealing	$623	$393	1.6
Air sealing	$595	$355	1.7
Indoor lights	$88	$52	1.7
Floor insulation	$270	$144	1.9
Attic insulation	$1,449	$422	3.4
Electric clothes dryer	$950	$149	6.4
Wall insulation	$2,916	$373	7.8
Gas water heater	$500	$53	9.4
Windows	$8,500	$880	9.7
Solar Power	$8,663	$834	10.4
Clothes washer	$780	$62	12.6
Solar Thermal	$4,500	$272	16.5
Central air conditioner	$2,450	$146	16.8
Gas furnace	$2,450	$99	24.7
Water Cooler	$120	$4	30.0
Dishwasher	$700	$20	35.0
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

OLD Raleigh, NC	Net Cost to Install	Yearly Savings	PayBack
Duct Insulation	$637	$471	1.4
Indoor lights	$88	$49	1.8
Air sealing	$595	$239	2.5
Wall insulation	$736	$262	2.8
Duct Sealing	$623	$216	2.9
Attic insulation	$1,449	$216	6.7

Electric clothes dryer	$950	$121	7.9
Solar Thermal	$2,730	$302	9.1
Electric water heater	$500	$49	10.2
Clothes washer	$780	$67	11.6
Windows	$8,500	$534	15.9
Solar Power	$11,261	$595	18.9
Water Cooler	$120	$4	30.0
Dishwasher	$700	$22	31.8
Heat pump	$3,500	$107	32.7
Central air conditioner	$2,450	$36	68.1
Well pump	$600	$4	150.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

OLD San Jose, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$101	0.9
Attic insulation	$1,029	$684	1.5
Duct Insulation	$637	$414	1.5
Duct Sealing	$623	$118	5.3
Air sealing	$595	$112	5.3
Solar Power	$15,687	$1,951	8.0
Electric clothes dryer	$950	$118	8.1
Clothes washer	$780	$78	10.0
Gas water heater	$500	$48	10.4
Wall insulation	$2,916	$259	11.3
Solar Thermal	$2,800	$226	12.4
Gas furnace	$2,450	$165	14.8
Dishwasher	$700	$24	29.2
Windows	$8,500	$287	29.6
Well pump	$600	$9	66.7
First Refrigerator	$987	$12	82.3
Second Refrigerator	$887	$10	88.7
Ceiling fan	$200	$2	100.0
Central air conditioner	$2,450	$23	106.5

NEW Boston, MA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$89	1.0
Electric clothes dryer	$950	$152	6.3
Gas water heater	$500	$72	6.9
Clothes washer	$780	$86	9.1
Solar Power	$9,710	$816	11.9
Water Cooler	$120	$7	17.1
Solar Thermal	$4,500	$238	18.9
Dishwasher	$700	$29	24.1
Windows	$8,500	$161	52.8
Well pump	$600	$8	75.0
First Refrigerator	$987	$11	89.7
Second Refrigerator	$887	$9	98.6

Ceiling fan	$200	$1	200.0
Central air conditioner	$2,450	$8	306.3

NEW Cleveland, OH	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$51	1.7
Electric clothes dryer	$950	$124	7.7
Gas water heater	$500	$61	8.2
Solar Thermal	$2,520	$277	9.1
Clothes washer	$780	$66	11.8
Gas furnace	$2,450	$200	12.3
Solar Power	$7,875	$524	15.0
Water Cooler	$120	$4	30.0
Dishwasher	$700	$21	33.3
Windows	$8,500	$123	69.1
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0
Central air conditioner	$2,450	$9	272.2

NEW Dallas, TX	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$65	1.4
Electric clothes dryer	$950	$121	7.9
Solar Power	$9,450	$911	10.4
Gas water heater	$500	$48	10.4
Clothes washer	$780	$65	12.0
Water Cooler	$120	$5	24.0
Solar Thermal	$4,740	$194	24.4
Windows	$8,500	$324	26.2
Dishwasher	$700	$20	35.0
Gas furnace	$2,450	$66	37.1
Central air conditioner	$2,450	$59	41.5
Well pump	$600	$6	100.0
First Refrigerator	$987	$8	123.4
Second Refrigerator	$887	$7	126.7
Ceiling fan	$200	$1	200.0

NEW Denver, CO	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$52	1.7
Electric clothes dryer	$950	$87	10.9
Gas water heater	$500	$44	11.4
Clothes washer	$780	$59	13.2
Solar Power	$9,608	$714	13.5
Gas furnace	$2,450	$124	19.8
Solar Thermal	$2,800	$139	20.1
Water Cooler	$120	$4	30.0
Dishwasher	$700	$18	38.9
Windows	$8,500	$157	54.1

Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0
Central air conditioner	$2,450	$8	306.3

NEW Los Angeles, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$73	1.2
Solar Power	$7,340	$825	8.9
Gas water heater	$500	$38	13.2
Solar Thermal	$2,800	$198	14.1
Clothes washer	$780	$51	15.3
Water Cooler	$120	$6	20.0
Dishwasher	$700	$18	38.9
Windows	$8,500	$130	65.4
Gas furnace	$2,450	$29	84.5
Central air conditioner	$2,450	$25	98.0
Well pump	$600	$6	100.0
First Refrigerator	$987	$9	109.7
Second Refrigerator	$887	$7	126.7
Ceiling fan	$200	$1	200.0

NEW Miami, FL	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$59	1.5
Electric clothes dryer	$950	$180	5.3
Gas water heater	$500	$62	8.1
Clothes washer	$780	$68	11.5
Solar Thermal	$4,500	$322	14.0
Solar Power	$12,600	$804	15.7
Water Cooler	$120	$5	24.0
Dishwasher	$700	$22	31.8
Windows	$8,500	$257	33.1
Heat pump	$3,500	$99	35.4
Well pump	$600	$5	120.0
First Refrigerator	$987	$7	141.0
Second Refrigerator	$887	$6	147.8
Ceiling fan	$200	$1	200.0

NEW NYC, NY	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$112	0.8
Electric clothes dryer	$950	$153	6.2
Gas water heater	$500	$72	6.9
Solar Power	$8,859	$1,242	7.1
Clothes washer	$780	$93	8.4
Gas boiler	$1,569	$150	10.5
Water Cooler	$120	$9	13.3
Solar Thermal	$3,900	$249	15.7
Dishwasher	$700	$30	23.3

Windows	$8,500	$165	51.5
Well pump	$600	$10	60.0
First Refrigerator	$987	$13	75.9
Second Refrigerator	$887	$11	80.6
Ceiling fan	$200	$2	100.0
Central air conditioner	$2,450	$18	136.1

NEW Phoenix, AZ	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$52	1.7
Electric clothes dryer	$950	$149	6.4
Gas water heater	$500	$53	9.4
Solar Power	$8,663	$834	10.4
Clothes washer	$780	$61	12.8
Solar Thermal	$4,500	$272	16.5
Windows	$8,500	$375	22.7
Central air conditioner	$2,450	$82	29.9
Water Cooler	$120	$4	30.0
Dishwasher	$700	$19	36.8
Gas furnace	$2,450	$47	52.1
Well pump	$600	$5	120.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

NEW Raleigh, NC	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$49	1.8
Solar Thermal	$2,730	$302	9.1
Electric water heater	$500	$49	10.2
Clothes washer	$780	$66	11.8
Solar Power	$11,261	$595	18.9
Water Cooler	$120	$4	30.0
Dishwasher	$700	$22	31.8
Windows	$8,500	$196	43.4
Heat pump	$3,500	$44	79.5
Central air conditioner	$2,450	$23	106.5
Well pump	$600	$4	150.0
First Refrigerator	$987	$6	164.5
Second Refrigerator	$887	$5	177.4
Ceiling fan	$200	$1	200.0

NEW San Jose, CA	Net Cost to Install	Yearly Savings	PayBack
Indoor lights	$88	$101	0.9
Solar Power	$15,687	$1,951	8.0
Electric clothes dryer	$950	$118	8.1
Clothes washer	$780	$78	10.0
Gas water heater	$500	$48	10.4
Solar Thermal	$2,800	$226	12.4
Water Cooler	$120	$8	15.0

Dishwasher	$700	$23	30.4
Gas furnace	$2,450	$53	46.2
Well pump	$600	$9	66.7
Windows	$8,500	$105	81.0
First Refrigerator	$987	$12	82.3
Second Refrigerator	$887	$10	88.7
Ceiling fan	$200	$2	100.0
Central air conditioner	$2,450	$9	272.2