Southwest Energy Efficiency Project

Saving Money and Reducing Pollution Through Energy Conservation

High Performance Homes in the Southwest: Savings Potential, Cost Effectiveness and Policy Options

Executive Summary

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Executive Summary

Introduction

The six-state Southwest region of the United States (Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming) is a fast-growing region that is experiencing a boom in population and new housing construction. Nearly 2 million homes are projected to be built in the Southwest between 2008 and 2020, equivalent to about 150,000 new homes per year. Growth rates are as much as triple the national average in parts of Arizona and Nevada, and electricity demand is growing at rates as high as 4% per year. Total peak electricity demand in just three of the Southwest States (AZ, NM, and NV) is expected to grow by 2,000 MW per year for the next 15 years. Two-thirds or more (as high as 89% in New Mexico and 95% in Utah) of the electricity generated in the Southwest comes from coal-fired power plants, which release emissions of air pollutants that harm public health and contribute to global warming.

Benefits of High Performance Homes

High performance homes are capable of achieving 40-60% energy savings by combining energy-efficient technologies and solar energy systems. These homes save homeowners an average of $1,600 annually on their energy bills, with positive monthly cash flow immediately.

Homebuyers benefit by having lower energy bills and a home that is more energy efficient, comfortable, durable, and environmentally friendly.

Homebuilders benefit by marketing a higher quality, higher value product, and one that costs less to own and operate.

States and cities benefit by having desirable communities that reduce demand for energy and natural resources.

Purpose and Scope of the Report

The purpose of this report is to analyze the energy savings, cost and cost effectiveness of high performance homes for five Southwest states (AZ, CO, NV, NM and UT). Utilities, states, local governments and home builders can use the information in the report to develop new programs, policies and strategies for increasing the energy efficiency of new homes.

SWEEP analyzed the energy savings and net economic benefits to each state and the region of significantly increasing the energy efficiency of new homes, versus typical homes built to minimum requirements of currently adopted state or local energy codes. The report makes recommendations for utility, state and local government programs and incentives to accelerate the adoption of high performance building practices in the new homes industry, including a 3-tiered incentive structure for ENERGY STAR, Best Practice and Net Zero-Energy Homes.

The report includes several case studies and examples of high performance homes and communities in the Southwest –ranging from ENERGY STAR qualified homes to net-Zero Energy Homes –that document the energy and cost savings achieved from increasing the efficiency of new homes. It also addresses the technical, financial and institutional barriers to constructing high performance homes, and presents strategies and best practices for overcoming each barrier, based on lessons learned and successful programs that have been adopted by utilities, states and local governments.

Recommendations for Utilities, States and Local Governments

Utilities, states and local governments all play an important role in advancing high performance homes. This report identifies best practices, implementation strategies and incentive programs that can significantly improve the energy efficiency of new homes. Key recommendations from the report include the following actions for utilities, states and local governments:

Utilities

- Offer a 3-tiered incentive package for high performance homes, including incentives for best practice and net zero-energy homes.
- Support high performance building practices by providing technical assistance, training and marketing and outreach support to the building industry.
- Conduct evaluation and field monitoring studies to document home performance.

State governments

- Provide financial incentives for high performance homes, including tax credits and exemptions for high performing homes, energy efficient products and renewable energy systems.
- Adopt updated residential building codes that achieve at least 15% energy savings over model codes.
- Partner with utilities and local governments to offer technical assistance, training and outreach to builders and homebuyers.

Local governments

- Adopt a green building program with mandatory energy efficiency criteria for new homes.
- Offer incentives to builders for constructing high performance homes.
- Educate homeowners about the features and benefits of high performance homes.

For more information about these and other recommendations, see Chapter 8 of the report.

Features and Benefits of High Performance Homes

Increasing the energy efficiency of new homes offers a cost-effective way to help homeowners save money and lower their energy use, while reducing the energy and environmental impacts of new homes. High performance homes —defined as homes that maximize energy efficiency, comfort, and durability —can be built cost-effectively while achieving energy savings of up to 50% through energy efficiency measures, and up to 65% savings by incorporating on-site renewable energy systems, such as solar PV and solar thermal systems. High performance homes are also designed to reduce the risk of indoor air quality problems, through programs such as the ENERGY STAR Indoor Air Package.

The energy, economic and environmental benefits of improving the efficiency of new homes in the Southwest region are significant.[1] Achieving the high performance home scenario analyzed in this report would result in the following energy and cost savings between 2008 and 2020:

- Over 2.7 million GWh of grid electricity savings —enough electricity to meet the annual electricity consumption of approximately 250,000 typical households.
- Reduction in residential natural gas consumption of 228 million therms (up to 50% reduction in natural gas use per household).
- Summertime peak electricity demand would be reduced by nearly 200 MW annually by 2020; average hourly summertime peak loads per home would be reduced between 50 and 67%.
- Southwest households would reap $500 million in reduced electricity and natural gas bills, with savings of $30 million in the first three years alone.
- Electricity from customer-sited solar PV systems would generate more than 500 GWhs of electricity from 2008 to 2020, worth $52 million to homeowners.
- Emissions of greenhouse gases from power plants would be reduced by 2.4 million tons of CO_2 between 2008 and 2020.

Cost and Cost Effectiveness of High Performance Homes

Energy Efficiency

There are many cost-effective opportunities to improve the energy efficiency of new homes through a combination of improvements to residential building design, construction practices, higher efficiency levels of installed equipment, and homeowner education about ways to save energy. Common energy efficiency design practices and measures that are used in high performance homes include:

- Proper site selection and building orientation, which can help reduce heating costs in the winter and cooling costs in the summer, and facilitate the use of on-site PV to generate electricity. Where

[1] States included in the analysis are Arizona, Colorado, Nevada, New Mexico and Utah.

feasible, choose sites with good southern exposure without significant shading from mountains, trees or buildings and orient subdivision parcels and homes to maximize southern exposure for buildings. Rooms and windows should be designed to maximize solar heat gain in the winter but with proper window shading to reduce heat gain in the summer.

- Higher levels of ceiling and wall insulation (R-40 or higher) coupled with advanced framing techniques to minimize thermal bypasses.
- Radiant barrier installed on the inside of the roof to reduce solar heat gain and help keep the attic cool, particularly in hot-dry climates.
- Use of thermal mass for improved heating and cooling performance, including additional insulation in ceilings and walls, and use of 5/8" drywall ins
- Properly designed and installed heating and cooling systems that help keep energy costs low and improve indoor air quality.
- High-performance windows with spectrally selective glass, which reduces solar heat gain in summer and reduces heating costs in the wintertime.
- Highly-efficient heating and cooling systems, including:
    - Engineered HVAC (proper sizing and diagnostic testing of HVAC systems by mechanical engineers)
    - Advanced evaporative cooling systems such as direct-indirect evaporative cooling systems
    - Ducts placed inside conditioned space, with sealing and diagnostic testing
- Tankless or solar water heating.
- High-efficiency lighting (e.g., fluorescent lamps and fixtures), or a combination of fluorescent and incandescent lighting with lighting controls (e.g., dimmers and occupancy sensors).
- Energy-efficient appliances, including refrigerators, clothes washers, dryers, dishwashers and consumer electronics.
- Integration of controls to monitor home energy use, including switches and controls for turning off designated electrical outlets (to reduce losses from standby devices).
- Third-party verification (analysis of home design and onsite inspections and testing to verify and rate the energy performance of the home on the HERS scale).

The additional cost of using energy-efficient building designs and systems can be partially offset by reductions in the size of cooling and heating equipment (particularly if proper equipment sizing procedures are followed and adhered to during construction and equipment installation) and other building design changes (e.g., reducing framing m with studs spaced 24” apart). When done properly, this can represent a significant cost savings to the builder and homeowner, as the smaller systems and reduce material requirements reduce construction and operation costs.

Renewable Energy Systems and Design Features

Renewable energy systems and design features – such as incorporating passive solar thermal design strategies, solar PV electric systems and solar thermal hot water – can reduce the heating and cooling load of the home and generate a portion of a home’s electricity and water heating needs. Passive solar thermal design strategies can often be implemented at little or no incremental cost through proper building orientation, daylighting, and use of thermal mass.

Typical residential solar PV systems are between 2 kW and 4 kW in size, and are capable of offsetting approximately 25-30% of total household electricity consumption. Although the initial cost of renewable energy systems remains high (approximately $15-20,000 for a 2 kW solar PV system), the system costs are expected to continue to decline, and are made more affordable to the builder and homeowner by a combination of federal, state and utility tax credits or rebates now available in most Southwest states.[2] Utilities can also utilize residential PV systems to satisfy state renewable portfolio standard requirements by offering renewable energy credits to homeowners that have installed grid-tied PV systems. Colorado, Nevada and New Mexico already offer homeowners a RECs purchase option for solar PV systems.

Analytical Methodology

The analyses in this report were prepared using the BEopt building optimization software and its related components, developed by the National Renewable Energy Laboratory (NREL). BEopt analyzes a range of home energy designs, operating conditions and technologies to identify optimal combinations of energy efficiency and renewable energy measures that achieve maximum savings at the lowest cost. BEopt has been used to design and analyze many zero-energy homes, such as Habitat for Huma affordable zero energy home in Denver, Colorado.[3]

Using BEopt, SWEEP analyzed four levels of home performance for five Southwest states (AZ, CO, NV, NM and UT):

- A reference case home built to current state or local building energy code requirements (i.e., IECC 2003 or 2006), using standard home building industry construction practices and equipment.
- An ENERGY STAR qualified new home (20-30% savings).

[2] For a complete list of federal, state, and utility incentives for energy efficiency and renewable energy by state, see the Database of State Incentives for Renewables and Energy Efficiency (DSIRE) at: www.dsireusa.org.

[3] For more information, see: http://www.eere.energy.gov/buildings/building_america/affordable_housing.html.

- An energy-efficient ‘Best Practice’ Home (30-50% savings).
- A so-called “Zero Energy Home” incorporating renewable energy measures as well as being high energy efficient (50% or greater savings).

Separate market penetration scenarios were developed and analyzed for each state, based upon the current building code in effect, levels of ENERGY STAR market penetration, and housing styles and preferences (e.g., 1 versus 2 story, basement, slab on grade, etc.). The per home savings estimates for each city (or average of cities in cases where more than one city per state was analyzed) were scaled up to the state level using historical estimates of total and single-family housing units by state, and population projections from the U.S. Census Bureau for the 2008-2020 time period.

Each of the scenarios is designed to achieve a minimum of 50% market penetration for ENERGY STAR Homes by 2020, 20% market share for Best Practice homes and 20% zero energy homes. The Best Practice and Zero Energy Home levels set aggressive yet achievable near, mid and long-term goals for raising the overall performance of residential new home construction, using readily available efficiency measures and construction techniques (e.g., SEER 15 AC, 2x6 framing, etc.). The average annual market penetration rate for Best Practice and Zero Energy Homes increases in each state by 2% per year, allowing time to train additional builders and contractors as the programs expand. The Best Practice and Zero Energy Home performance levels will help make progress toward the DOE Building America Program goal of developing a marketable home that achieves net-zero energy use by 2020.[4]

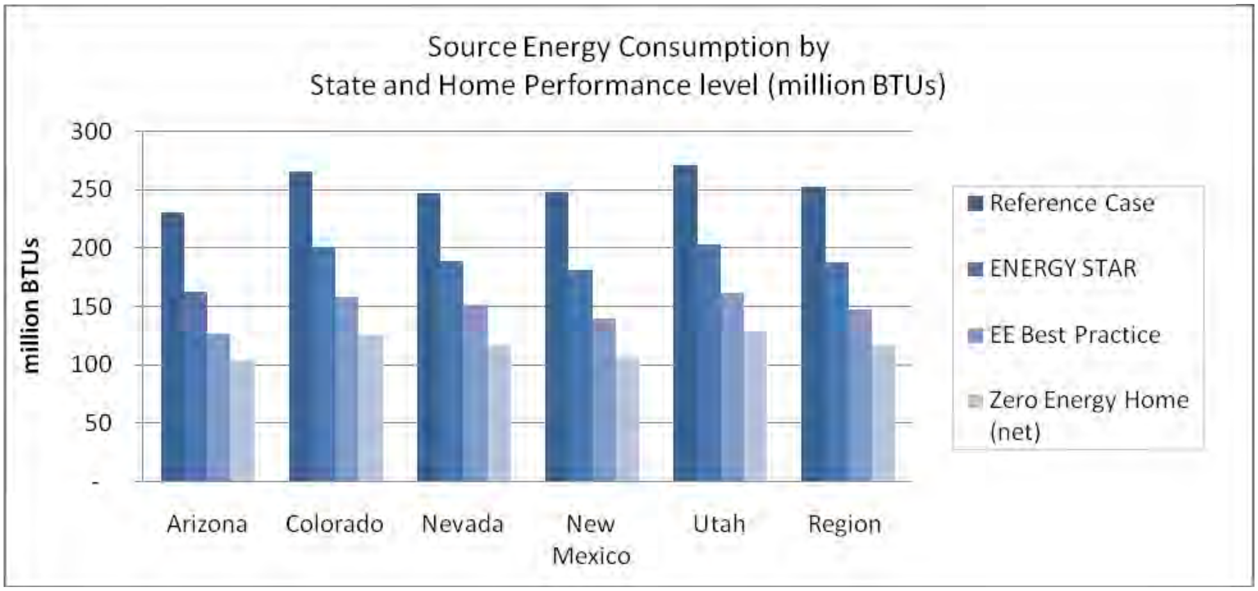
Results

Home energy savings by performance level

The analysis of energy savings was conducted for each home performance level and main city in each state. The energy consumption and net cost savings for each home performance level are summarized in Tables ES-1 and ES-2. The average source energy savings across the region are 25% for the ENERGY STAR home, 42% for the Best Practice home, and 54% for the Zero Energy Home.

[4] For more information about the Building America program, see: http://www.eere.energy.gov/buildings/building_america/. The Building America residential goals are described in more detail at: http://www.eere.energy.gov/buildings/building_america/pdfs/35851_ba_puts_research.pdf

Figure ES-1. Source energy consumption by state and home performance level



Cost savings per household

High performance homes are cost-effective for homeowners, with net savings versus a code-built home when compared on the basis of the total cost of mortgage and utilities payments.[5] The incremental costs and net savings of each performance level are shown in Table ES-1. Energy efficiency measures reduce energy costs for single-family households by up to 50%, equivalent to a net cost savings of up to $1,085 per year. Averaged across the region, the annual energy savings per household is $743 for ENERGY STAR Homes, $1,172 for the Best Practice Home, and $1,523 for the Zero Energy Home. Combining energy efficiency and customer-sited renewable energy systems reduces net energy consumption by 60% or more, with net annual cost savings of up to $960 per household, before state or utility incentives are applied.[6]

[5] The homeowner cashflow analysis assumes a 30-year fixed rate mortgage with a 7% annual interest rate.

[6] Detailed descriptions of energy and cost savings are provided in Chapter 5, "Benefits of to the Southwest Region," and Appendix A, Table A-3.

Table ES-1. Incremental costs and net savings per home

State	Incremental cost			Net savings, annual ($)**		
	ENERGY STAR	Best Practice	Zero Energy Home*	ENERGY STAR	Best Practice	Zero Energy Home
Arizona (Phoenix)	$3,218	$3,474	$15,210	$552	$946	$767
Colorado (Denver)	$2,917	$6,588	$19,895	$432	$616	$271
Nevada (Las Vegas)	$3,236	$5,547	$16,231	$550	$961	$960
Nevada (Reno)	$3,653	$5,640	$18,491	$139	$262	$97
New Mexico (Albuquerque)	$2,464	$5,539	$16,629	$763	$884	$834
Utah (Salt Lake City)	$2,946	$6,588	$19,331	$434	$636	$247

*Includes adjustment for federal tax credits for energy efficiency ($2,000) and renewable energy systems ($2,000 for solar hot water and $2,000 for solar PV).
** Net savings represents the savings to the homeowner in the annual cost of the mortgage plus utility bills versus a typical home.

Avoided Peak Electricity Demand

Peak electricity demand in high growth states such as Arizona has doubled in the past 15 years, and is expected to double again in the next two decades.[7] Much of the growth in peak electricity demand is driven by increased air conditioning loads from new homes, and retrofits to existing homes that either had evaporative cooling or no cooling at all.

Energy efficiency design features that achieve peak savings include, but are not limited to:

- Proper orientation of the parcel and the home, with shading to reduce cooling loads,
- Improving the efficiency of AC systems through higher SEER levels, or use of evaporative cooling,

[7] Presentation by Jeff Schlegel, SWEEP Arizona representative. Available online at: http://www.swenergy.org/pubs/Energy_Efficiency_and_Climate_Change-Jeff_Schlegel_03292007.pdf.

- Tightening the thermal envelope, and placing ducts inside conditioned space with proper sealing and diagnostic testing, and
- Reducing indoor loads from lighting, appliances and consumer electronics

The expected summertime peak savings by home performance level are shown in Table ES-2. Improving the energy efficiency of new homes can reduce the average daily peak electricity demand per home in the region by 55%. As a fraction of electricity demand in the region, the reductions in peak electricity demand achieved by high performances homes are much more significant than the total electricity savings.

The combination of a highly-efficient home with solar PV can achieve even greater peak reductions, eliminating 70 - 85% of the peak load throughout the afternoon and early evening hours on hot summer days. Maximum peak demand levels in zero energy homes are reduced by as much as 6 kW per home in hot climates, such as Las Vegas, Nevada and Phoenix, Arizona. In some cases, the net power draw from the utility grid drops to less than 1 kW at system peak (typically 4pm) on a hot summer day.

Table ES-2. Average summertime peak electricity demand (kW) and % savings by home performance level.

State	Reference Case	ENERGY STAR	% Savings	Best Practice	% Savings	ZEH - Net	% Savings
AZ	5.17	3.61	30%	2.67	48%	1.71	67%
CO	2.32	1.28	45%	1.06	54%	0.38	84%
NV	4.96	2.74	45%	1.64	67%	0.65	87%
NM	2.70	1.94	28%	1.18	56%	0.35	87%
UT	2.36	1.37	42%	1.14	51%	0.41	82%
Region	3.50	2.19	38%	1.54	55%	0.70	81%

Statewide and regional savings potential, costs and cost effectiveness

The cumulative electricity, natural gas and peak demand savings from the high performance scenario for all new single-family homes expected to be built in each state and the Southwest region (1.8 million homes total) are shown in Table ES-3. The annual electricity savings in the region in 2020 are 427 GWh, and the annual reduction in peak electricity demand is 224 MW. The total annual electricity generation from PV systems installed on new homes is 81 GWh per year in 2020.

The high performance scenario achieves significant cost savings for Southwest households, with net economic benefits of $4.3 billion from efficiency measures between 2008 and 2020, and an additional $430,000 in net benefits from renewable energy measures (see Table ES-4). While on-site renewables are marginally cost-effective on a lifecycle basis (excluding utility and state incentives), many types of readily available energy efficiency measures are highly cost-effective.

Approximately 95% of the net economic benefits come from energy efficiency measures; the remainder comes from a combination of rooftop solar PV and solar thermal hot water systems. Each home performance level, however, has a positive benefit-cost ratio in every state and region of the Southwest. The highest savings ratios are in Arizona and Nevada, which are also the fastest-growing states in the region (see Table ES-4). The energy efficiency measures have a higher benefit-cost ratio than the combination of energy efficiency and renewable energy measures. Renewable energy measures, however, are capable of delivering significant reductions in peak electricity demand (up to 100% at system peak loads), and are expected to become more cost-effective in the future as the cost of PV systems continues to decline and additional federal, state and utility incentives for solar systems become available.

Table ES-3. Summary of Analysis Results: Annual Savings in 2020 and Cumulative Energy Savings, 2008-2020

State	Annual Savings, 2020		Cumulative electricity savings (GWh)	Avoided Peak Demand (MW)	Cumulative Natural gas savings (million therms)	Cumulative Primary Energy Savings (trillion Btus)
	Electric (GWhs)	Natural Gas (million therms)				
Arizona	183	5.4	1,159	592	34	21
Colorado	94	16.4	606	293	106	18
Nevada	69	2.1	425	309	13	8
New Mexico	25	3.0	166	68	20	4
Utah	56	8.7	354	153	55	10
Region	**427**	**35.5**	**2,710**	**1,416**	**228**	**62**

Table ES-4. Summary of Incremental Costs and Savings: 2008-2020 (millions 2008 $)

State	Total investment, energy efficiency	Net economic benefit, energy efficiency	Benefit-cost ratio: energy efficiency measures	Total Investment, energy efficiency & renewables	Net economic benefit, energy efficiency & renewables	Benefit-cost ratio: energy efficiency & renewables
Arizona	401	1,296	3.2	1,034	1,455	1.4
Colorado	443	1,409	3.2	974	1,493	1.5
Nevada	279	583	3.1	905	699	1.2
New Mexico	94	338	3.6	191	366	1.9
Utah	229	757	3.3	538	802	1.5
Region	**1,446**	**4,383**	**3.3**	**3,642**	**4,815**	**1.5**

Notes: EE measures include the incremental cost of all energy efficiency measures, excluding renewable energy system costs. Net present value assumptions: 20 year lifetime for energy efficiency and renewable energy measures and 5% real discount rate (capital recovery factor = 12.5). The benefit-cost ratios are based upon annual incremental costs and savings; RE incentives include federal tax credits only and exclude state and utility incentives.

Case Studies: Observations and Lessons Learned from Field Monitored Homes

The following case studies provide real-world examples of high performance home projects that incorporate highly-efficient features and on-site renewable energy systems. The case studies also illustrate the role of utilities, government and home builders in developing successful high performance home projects.[8]

The Sacramento Municipal Utility District (SMUD) SolarSmart New Homes Program

Since 2001, the Sacramento Municipal Utility District (SMUD) has sponsored several ZEH projects within its service territory through partnerships with the DOE Building America program. In 2007, SMUD initiated the "SolarSmart New Homes" program, in which SMUD is partnering with builders to achieve up to 60% savings in electricity costs, and peak electricity demand reductions of up to 65% in new homes (BIRA 2006 and US DOE 2006). The SMUD

Figure ES-1. Photo of zero energy homes at Premier Gardens, Sacramento, CO (Credit: SMUD)

[8] For additional information on high performance home projects, see the U.S. DOE Building America research projects database at: http://www.eere.energy.gov/buildings/building_america/cfm/project_locations.cfm.

projects show how a public utility can help drive the market for new homes that offer energy efficiency and renewable energy as standard features.

Lessons learned include: 1) homebuyers find highly-efficient homes with solar PV attractive and cost-effective; 2) high performance homes offer potential for significant peak load reduction, and 3) solar PV systems and rooflines should be oriented to optimize afternoon peak savings.

Pulte Homes, Las Vegas, Nevada

Pulte provides a good example of how a large-scale production builder can cost-effectively achieve a highly-efficient home through a combination of advanced design and construction practices and use of highly-efficient products and equipment. Since 2002, Pulte has built nearly 15,000 ENERGY STAR qualified homes in the Las Vegas area. Innovative design features implemented by Pulte include use of unvented roofs, placement of ducts inside conditioned space, spectrally selective windows and integrated space heating, hot water and ventilation systems. The improvements resulted from a collaboration between Pulte Homes, the Nevada State Energy Office, and Building Science Industries as an initiative of the U.S. Department of Energy's Building America program.

Lessons learned: 1) the whole-house approach to the design and construction of homes achieves greater energy savings at lower cost than applying measures individually; 2) Design and construction teams must be properly trained and educated about high performance construction practices; and 3) public-private partnerships can help accelerate the development and adoption of advanced building design and construction practices.

Aspen Homes of Colorado

Aspen Homes is a small production builder that constructs homes that will perform 40 percent better than a typical home built to code, yet are affordable to the average homebuyer. 100% of Aspen homes exceed the requirements of ENERGY STAR and Built Green Colorado. Each home also includes a 2-year heating consumption guarantee.[9] Since 2002, the company has built more than 500 ENERGY STAR qualified homes, and has received numerous local and national awards for its highly-efficient and affordable homes. Aspen Homes demonstrates how a production builder can construct highly efficient, affordable homes using advanced building design and construction techniques.

Lessons learned: 1) highly efficient affordable homes can be built cost-effectively in cold climates; 2) homeowner involvement is critical to achieving high savings levels; and 3) high performance homes can help improve sales, particularly during market downturns.

[9] A copy of the heating consumption guarantee is available at: http://www.aspenhomesco.com/index.php?pr=Heating_Guarantee.

Findings and Recommendations

Major findings and recommendations from this report are summarized below. For additional information see Chapter 8, Summary and Recommendations.

Energy performance and savings

- High performance homes are capable of achieving whole-house, source energy savings of up to 50% in both cooling-dominated and heating-dominated climate zones in the Southwest. These savings estimates are supported by ongoing monitoring studies conducted by the U.S. DOE Building America Team.
- Maximum energy savings are achieved when energy efficiency and renewable energy features are implemented together, in an optimized way beginning with highly cost-effective energy efficiency measures.
- High performance homes significantly reduce peak electricity demand – eliminating 80% or more of afternoon peak electric loads and cutting evening peak demand levels in half.
- Reducing household 'plug loads' (e.g., consumer electronics, large and small appliances, and plug-in lighting) and occupant behavior (e.g., using setback thermostats, turning off electronic and other devices when not in use) could achieve additional energy savings. Lighting, appliances, and miscellaneous electric loads now represent 60% or more of energy use in high performance homes (Brown et al 2007).

Cost and cost effectiveness

- High performance homes can be built cost-effectively, with annual net savings to the homebuyer when annual mortgage and utility costs are considered together.
- Energy efficiency measures are more cost-effective to implement than renewable energy measures. Combinations of efficiency and renewables, however, are also cost-effective to the homeowner, and deliver valuable peak electricity savings for utilities.

Environmental benefits

- High performance homes can reduce the environmental impact of new home construction in the Southwest – the nation's fastest growing region. C reductions from the SWEEP high performance homes scenario are 2.3 million tons of CO_2 in 2020.
- Emissions of air pollutants from coal-fired power plants that harm public health (i.e., sulfur dioxide, nitrogen dioxide, and mercury) would also be lowered because of reduced electricity demand.

Implementation issues and strategies

- Building design, construction practices and minimum code requirements vary considerably within the region, with some regions building the majority of homes at or above code (e.g., Las Vegas) and others that are using older, outdated building codes with varying levels of compliance and enforcement.
- The home building industry, including builders, contractors and trade allies need additional education and training on all aspects of high-performance home design and building practices.

- The design and construction process needs to be better supported by a robust QA/QC infrastructure, including visual inspections and performance testing at key stages of construction.
- Public-private partnerships involving federal, state, and local government, utilities and the home building industry play an important role in successfully implementing high performance home projects because builders continue to have concerns about recovering first costs in a highly competitive new homes marketplace. Utility incentives and marketing programs can help reduce this risk, and help builders differentiate high performance homes in the marketplace.
- The new homes industry –including builders, sales professionals, realtors and appraisers – needs better tools and guidelines for establishing and incorporating the value of high performance home features into home valuations.
- Production built high performance home projects are most successful when efficiency and renewable energy improvements are offered as standard home features, as opposed to optional upgrades for the homebuyer. Studies have shown that very few homebuyers select high performance features when offered as a builder option (Farhar and Coburn, 2006).

Recommendations for Utilities

- SWEEP recommends that utilities with low levels of market penetration for ENERGY STAR new homes (<10%) offer a 3-tiered incentive package to builders, beginning at ENERGY STAR ($350 - $500) and going up to a Net-Zero Energy Home level of performance ($750 - $1,000 for energy efficiency measures and $4,000 - $8,000 for renewable energy measures). A few Southwest utilities (e.g. Rocky Mountain Power, Arizona Public Service) are already offering incentives at the ENERGY STAR level that are achieving cost-effective savings.

- For utilities that already have high levels of market penetration for ENERGY STAR new homes (>35%), utility programs and incentives should focus on achieving the higher performance levels of Best Practice and Net-Zero Energy Homes, or include incentives for optional ENERGY STAR measures, such as the Advanced Lighting Package. Utilities should also consider offering additional incentives for measures that reduce miscellaneous electrical loads in the home, such as ENERGY STAR appliances.

- Improve coordination between energy efficiency and renewable energy incentive programs. In most cases, these programs are administered and marketed separately, and not always to the same groups (i.e., builders versus homeowners). All new homes that receive renewable energy incentives should be required to meet high performance efficiency criteria (i.e., 30-50% improvement in efficiency). Improving program coordination will also help maximize savings, reduce program administration costs, and promote improved technical assistance to builders, contractors and leverage marketing dollars.

- Conduct rigorous evaluations, measurement and verification of new home performance to assess the actual performance of new homes and the impacts of utility incentives and technical assistance programs. If feasible, the assessments should also include evaluations of traditional, code-built homes to provide a more accurate baseline for evaluating home performance.

Recommendations for State Governments

States play an important role in advancing high performance homes by adopting a comprehensive and coordinated portfolio of policies designed to promote investment in energy-efficient building and renewable energy systems. States can implement the following incentives, programs and policies to support high performance homes:

- Adopting statewide residential building energy codes that exceed the requirements of the 2006 International Energy Conservation Code (IECC) by 15% or more.
- Offering targeted training and technical assistance to builders on energy-efficient construction practices and installation and maintenance of residential solar PV and thermal hot water systems.
- Expanding training, education and outreach activities to architects, builders, building contractors, real estate professionals and local building code officials on the features and benefits of high performance homes.
- Providing tax credits for energy-efficient home purchases, including income tax credits and reductions in property taxes for highly-efficient homes.
- Providing property tax exemptions for energy efficiency improvements and renewable energy systems.
- Require homes that are receiving incentives for renewable energy to also meet high performance efficiency criteria (i.e., 30-50% improvement in efficiency).
- Partnering with utilities and the home building industry to conduct homeowner education and outreach campaigns on the benefits of energy efficient homes.

Recommendations for Local Governments

Local governments play an important role in high performance home projects through the siting, permitting and building inspection and approval process. Recommended actions that local governments can take to promote high performance homes include:

- Initiating a green building program that includes minimum energy efficiency standards that are well beyond minimum code requirements.
- Providing incentives to builders, including permit fee waivers or deferrals, density bonuses, per home incentives, and priority plan reviews and field inspection.
- Conducting educational programs, training and outreach to architects, designers, builders and trades on energy and resource efficient home building practices and their benefits.
- Promoting high performance homes through public recognition, including newspaper ads/articles, access to promotional packages, job site signs, and recognition by city officials. Develop a directory or network of participating architects, builders, suppliers, realtors and lenders that offer high performance home products or services.