National Renewable Energy Laboratory
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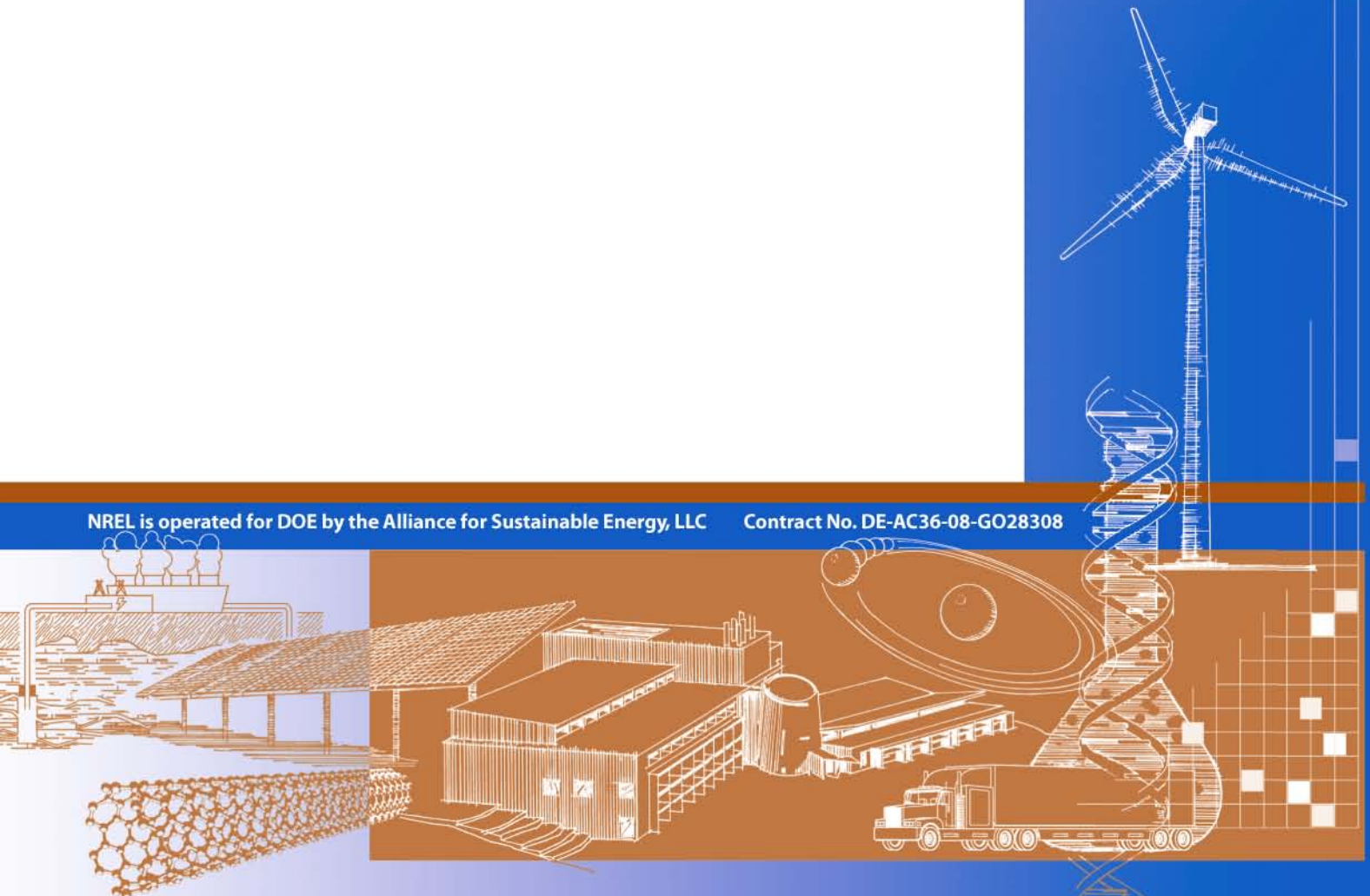
Innovation for Our Energy Future

Technical Approach for the Development of DOE Building America Builders Challenge Technology Information Packages

D.R. Roberts and R. Anderson

Technical Report
NREL/TP-550-44687
Revised August 2009



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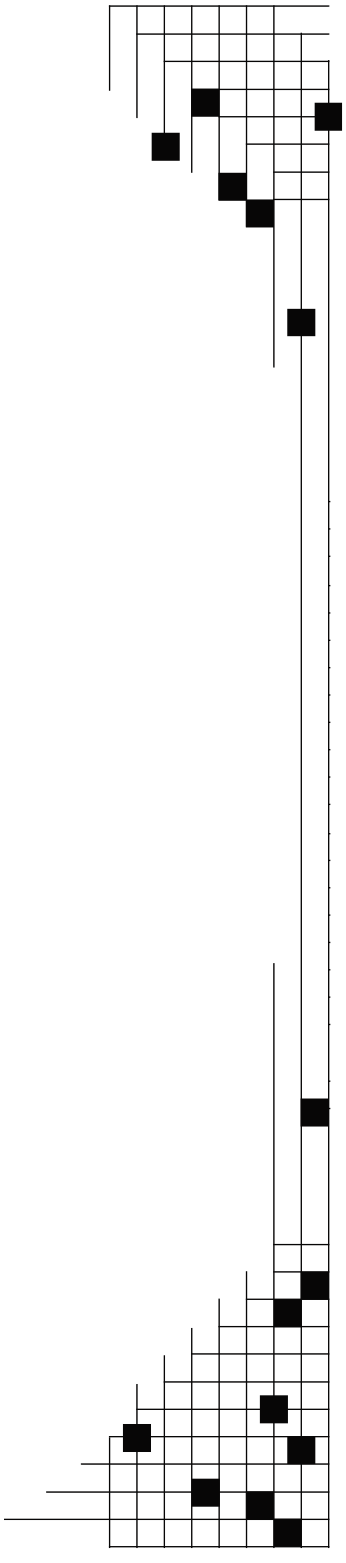
Prepared under Task No. BET88001

The addition of Appendix D is the only revision to the January 2009 version of this report.



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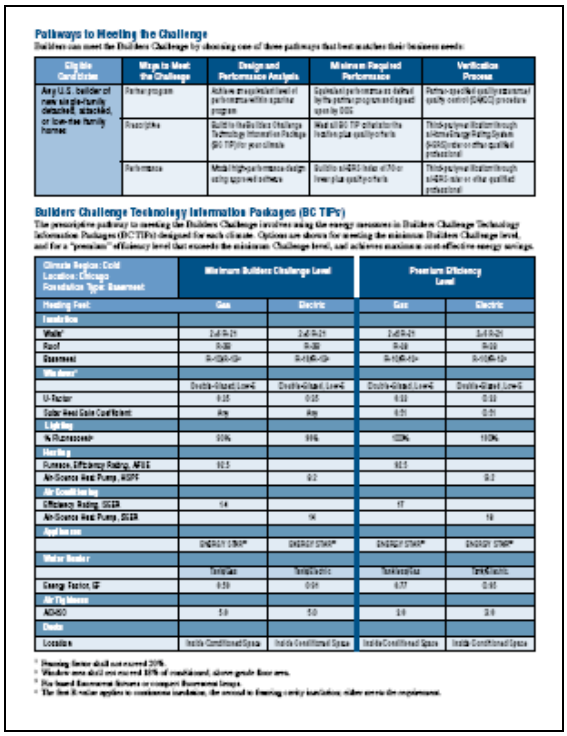
Executive Summary

The U.S. Department of Energy (DOE) has issued a challenge to the homebuilding industry to build 220,000 high-performance homes by 2012. The initiative is called *Builders Challenge*. To qualify, homes must meet the requirements of one of three compliance paths established by DOE: performance path, prescriptive path, or participating in a partner program. The performance path, expected to be the most widely used, requires that a home receive a home energy rating and score 70 or better (lower) on the EnergySmart Home Scale.

To provide builders with specific design specifications and a prescriptive path to compliance, DOE is developing a series of Builders Challenge Technology Information Packages (BC-TIPs) — climate-specific lists of energy features that must be installed in a home to meet minimum program requirements.

The National Renewable Energy Laboratory used the BEopt, REM/*Rate*, and EnergyGauge software programs to develop an initial batch of five BC-TIPs. The goal was to achieve optimal cost-effective approaches to meeting the 70 EnergySmart Home Scale requirement. Additional premium-efficiency packages were developed for each of the initial five climates to demonstrate higher levels of cost-effective energy savings. BC-TIP marketing materials targeting builders and consumers have been developed for the initial set of five climates and are available on the Building America Web site.

This report describes the technical approach used to develop the BC-TIPs.



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Introduction

The U.S. Department of Energy (DOE) has issued a challenge to the homebuilding industry to build 220,000 high-performance homes by 2012. The initiative is called *Builders Challenge*. To qualify, homes must meet the requirements of one of three compliance paths established by DOE: performance path, prescriptive path, or participating in a partner program. In addition to the requirements unique to each path, a common set of quality criteria must be verified via third-party inspection.

The performance path, expected to be the most widely used, requires that a home achieve a 70 or better (lower) on the EnergySmart Home Scale (E-Scale). The E-Scale (Figure 1) allows homebuyers to understand at a glance how the performance of a particular home compares to that of others. This scale is the same as that used in the home energy rating system (HERS) industry as defined by the industry organization, Residential Energy Services Network (RESNET).[1] A home that scores 70 on the E-Scale will use approximately 70% of the energy as the same home built to meet the minimum requirements of the 2004 International Energy Conservation Code (IECC).

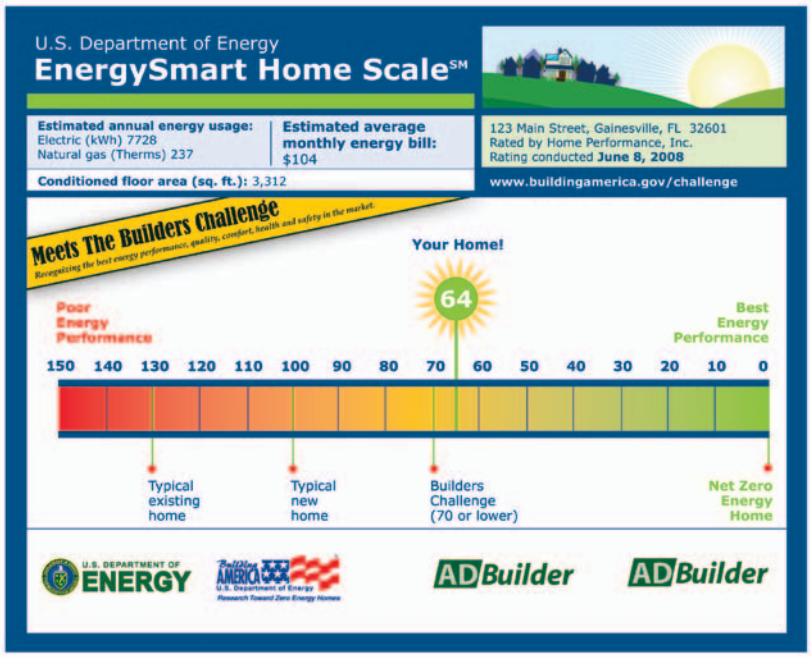

Figure 1. Builders Challenge EnergySmart Home Scale

The E-Scale Index is calculated using computer software programs that compare the estimated energy use of a proposed home design to the energy use of the same home built to meet the minimum requirements of the 2004 IECC. The software user, generally a HERS rater, will modify features of the home to achieve the target E-Scale Index, in this case 70 or lower. This is commonly referred to as the *performance path*, because any

[1] *2006 Mortgage Industry National Home Energy Rating System Standards,* Residential Energy Services Network, Inc., May 19, 2007.

combination of design features can be used to meet the overall performance objective for the home.

To provide builders with examples of specific design specifications and make the Builders Challenge more accessible in markets without a strong HERS presence, DOE developed a prescriptive path to meeting the Challenge. To facilitate this path, the National Renewable Energy Laboratory (NREL) was tasked with creating Builders Challenge Technology Information Packages (BC-TIPs).

A BC-TIP provides a list of energy features that must be installed in the home to meet minimum program requirements (Figure 2). TIPs offer an alternative to the performance-based approach. Builders who do not have access to HERS raters in their market, or who prefer the simplicity of a prescriptive list, can implement the features listed in a TIP for their climate region.

TIPs do not offer the full flexibility provided by the performance path and, by definition, cannot provide full credit for the performance of specific building characteristics and components.

This document outlines NREL's technical approach in developing the BC-TIPs for Builders Challenge.

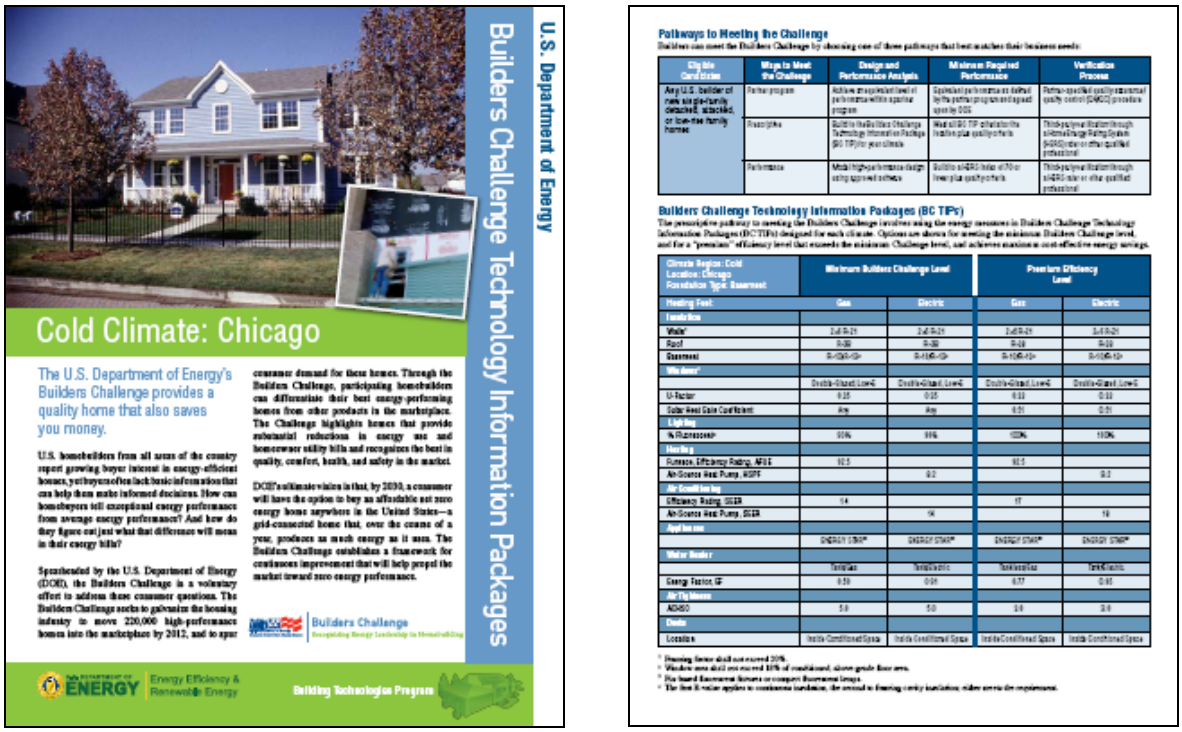

Figure 2. Example Builders Challenge Technology Information Package

Initial Set of Technical Information Packages

An initial set of BC-TIPs has been developed that includes one major metropolitan area in each of the five Building America Climate Regions: hot-humid, hot/mixed-dry, cold, mixed-humid, and marine. BC-TIPs were developed for all-electric and gas/electric homes. Table 1 shows the cities selected to initially represent each climate zone.

Table 1. Cities Selected for Initial Run of BC-TIPs

Climate Zone	City
Hot-Humid	Houston
Hot/Mixed-Dry	Phoenix
Cold	Chicago
Mixed-Humid	Atlanta
Marine	Seattle

Technical Approach for the Development of Builders Challenge Technical Information Packages

Overview

To develop the initial batch of BC-TIPs, NREL created energy models of prototypical, single-family homes for each of the five Building America Climate Regions. NREL used

BEopt[2] energy design optimization software, REM/*Rate*[3] HERS software, and EnergyGauge[4] HERS software to develop and analyze the models. The BEopt software tool was developed at NREL to identify optimal building energy designs aimed at minimizing the total of the amortized cost of improvements and the cost of energy. REM/*Rate* and EnergyGauge are two widely used HERS software programs accredited by RESNET[5] that produce the E-Scale Index. BEopt, REM/*Rate,* and EnergyGauge all utilize energy simulation engines that have passed the HERS building energy simulation test (Judkoff and Neymark, 1995).

BEopt was used to identify least-cost approaches to meeting two performance goals, each presented in the TIP documents: (1) minimum requirements for the Builders Challenge, and (2) a Building America package designed to achieve maximum cost-effective energy savings. The REM/*Rate* and EnergyGauge software were used to ensure the Builders Challenge-level recommendations are consistent with performance-based approaches to reaching the 70 E-Scale threshold.

Prototype Building Definition

The prototype building used to develop the TIPs is a 2,500-ft^2, 2-story, single-family home (Figure 3), sitting on a climate-appropriate foundation – slab, crawlspace, or conditioned basement as shown in Table 2. The home has a 1.3:1 aspect ratio, with the front (a long side) facing west. The home has total (frame and glass) window area equal to 18% of the conditioned floor area distributed equally on all four sides of the home. Detailed prototype model characteristics are shown in Table 3.

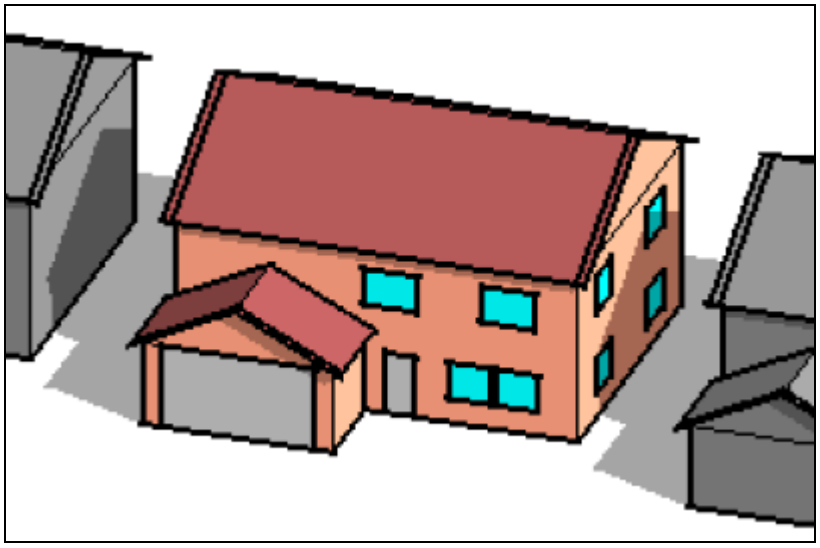

Figure 3. SketchUp rendering of prototype model

[2] v0.8.7, National Renewable Energy Laboratory
[3] v12.6, Architectural Energy Corporation
[4] v2.8.00, Florida Solar Energy Center
[5] *National Registry of Accredited Rating Software Programs*, Residential Energy Services Network, Inc.

Table 2. Foundation Types Used in the Prototype Models

City	Foundation Type
Houston	Slab
Phoenix	Slab
Chicago	Conditioned Basement
Atlanta	Crawlspace
Seattle	Crawlspace

Table 3. Prototype Model Characteristics

Conditioned floor area	2,500 ft^2, 3,750 ft^2 w/basement
Conditioned volume	22,500 ft^3, 33,750 ft^3 w/basement
Number of stories	2
Number of bedrooms	3
Gross above-grade wall area	2,574 ft^2
Window area	450 ft^2, 500 ft^2 w/basement
Window orientation	Equally distributed, 4 cardinal directions
Door area	40 ft^2
Setpoint temperatures	68 heating, 78 cooling
Mechanical ventilation	Exhaust only, ASHRAE 62.2 levels
Internal gains	Building America Benchmark (Hendron, 2008)
Lighting/appliance/plug schedules	Building America Benchmark

In developing the prototype building design, small studies were undertaken to examine the sensitivity of the E-Scale Index to window orientation and house size. Both studies involved changing HERS software prototype models to represent extreme cases:

- Window orientation was changed from equally distributed to 50% west-facing, 25% east-facing, and 12.5% north- and south-facing. This change increased the E-Scale Index for the 10 prototype models (five climates, gas & electric space heating) an average of 0.78 points.

- House size was reduced by removing the second floor from the prototype, resulting in 1,250-ft^2 homes without the basement and 2,500-ft^2 homes with the conditioned basement. This change increased the E-Scale Index by an average of 6.3 points for the 10 prototype models.

Analysis

BEopt was used in conjunction with the prototype building definition to develop the BC-TIPs. It produces building designs that minimize combined construction and energy costs by using the DOE-2.2 and TRNSYS energy simulation programs to automate a sequential search technique for locating least-cost solutions on a path toward net zero energy. The software and underlying methodology are described in detail by Christensen et al. (2005, 2006) and Horowitz et al. (2008).

Figure 4 shows typical output from BEopt. Each point of the graph indicates a unique combination of energy design features. The dark line at the bottom of the points indicates

the least-cost solution to achieving the source energy savings indicated on the X axis. An approximation of the Builders Challenge target is indicated on the graph. Although the actual Builders Challenge threshold is 70 or better on the E-Scale, source energy savings *relative to the 2006 IECC* were typically 18%–25% for the climates and heating fuels analyzed. Building configurations in this area were examined and analyzed as potential Builders Challenge-level packages. Additionally, premium-efficiency packages were selected from points at or near the minimum cost point. An example BEopt input file is included in Appendix A.

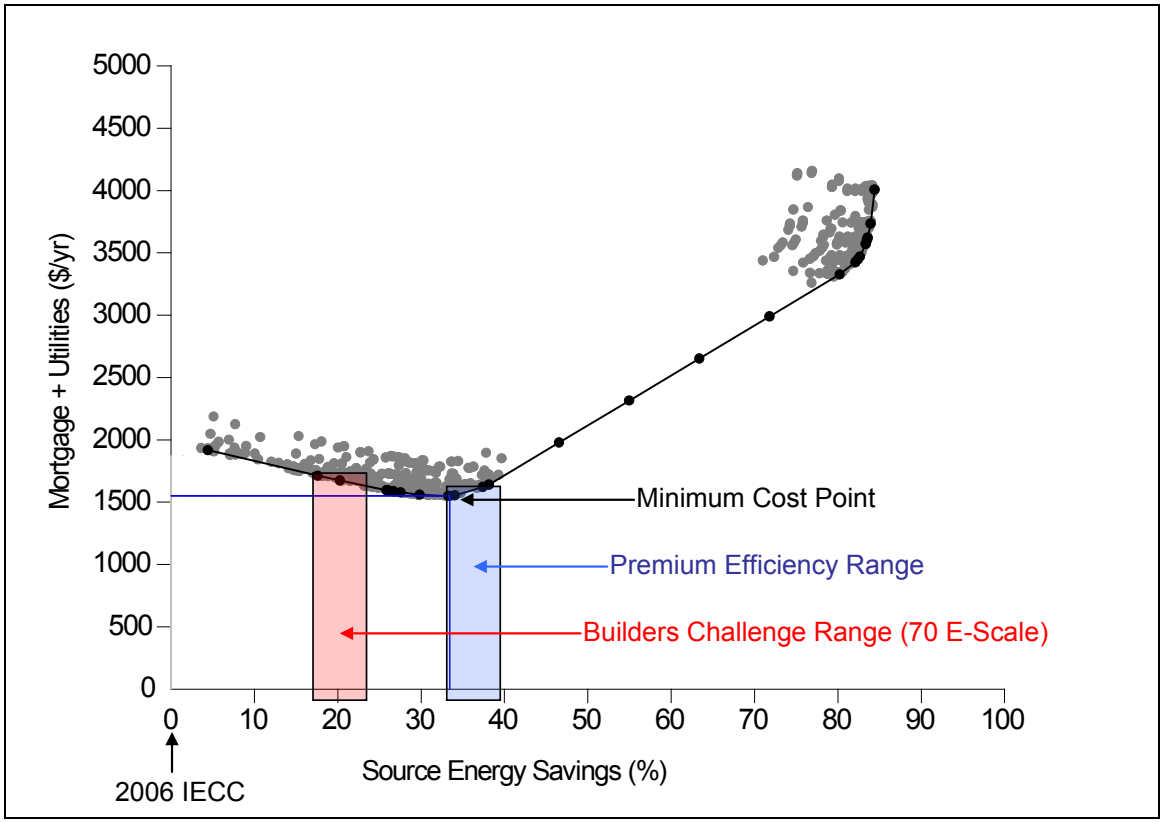

Figure 4. Example Output from BEopt

BEopt analysis was performed for each climate listed in Table 1. Standard BEopt default values were used in the analysis: statewide average utility rates (Table 4), economic factors, and source energy multipliers (Figure 5).

Table 4. BEopt Default (EIA 2006) Statewide Average Fuel Costs Used to Develop TIPs

City	$/kWh	$/Therm
Houston	0.1142	1.1544
Phoenix	0.0763	1.4376
Chicago	0.0685	1.0754
Atlanta	0.0792	1.7789
Seattle	0.0608	1.2786

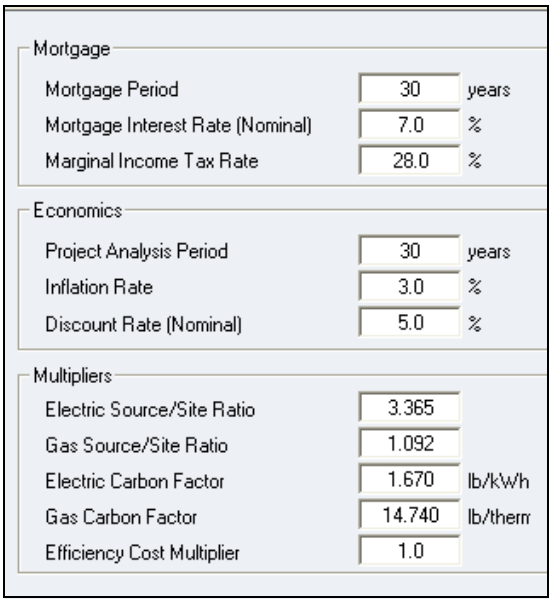

Figure 5. BEopt economic factors and energy source multipliers used in TIP analysis

To the extent possible, the 2006 IECC Standard Reference was used for the BEopt analysis so the resulting energy cost savings would be relative to current code. This reference is not built in to BEopt, and was hand-configured in the software. There are two aspects of the IECC Standard Reference as described in Section 404 of the 2006 IECC that could not be precisely configured: Distributions System Efficiency value of 0.8, and window U-value and SHGC. In these cases the closest possible approximations were used – code-level ducts and windows that most closely matched the code requirements. This reference is the point from which the cost of energy efficiency improvements and energy cost savings reported in the BC-TIPs are calculated. Because these results are not critical – reflecting typical, not actual performance – a close approximation of this "current code" suffices in the analysis.

Potential Builders Challenge-level prescriptive packages identified using BEopt were further analyzed using RESNET-accredited HERS software. It is important that the BC-TIPs be checked to ensure they achieve an E-Scale Index of 70 or lower (analogous to a 70 on the HERS Scale).

Analogous prototype models were created in the REM/*Rate* and EnergyGauge HERS software programs. The HERS software prototype models were configured to reflect energy efficiency features from BEopt associated with a specific point on the BEopt minimum-cost curve. If the E-Scale Index from the software was higher than 70, a point further along the savings curve was selected from BEopt, and the HERS prototypes reconfigured and reevaluated. Figure 6 shows the iterative process that was followed until a least-cost solution resulting in a HERS (E-Scale) Index below 70 was identified for each prototype home.

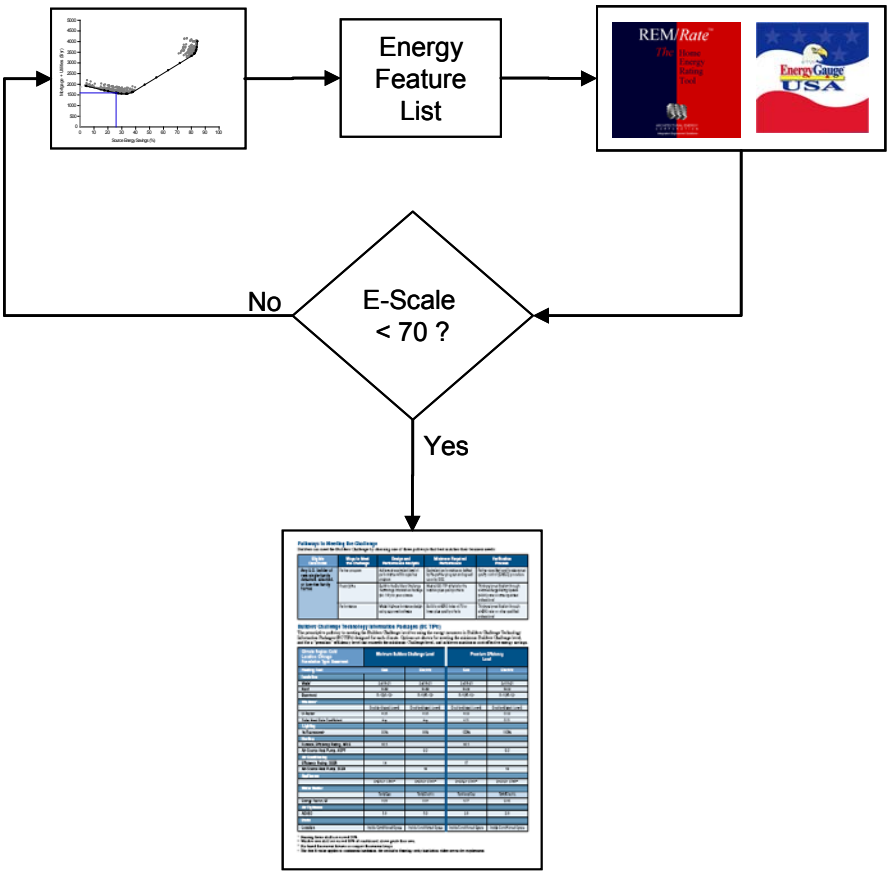

Figure 6. Analysis flow for developing BC-TIPs

The data presented in Figure 4 demonstrate that there are many solutions near the minimum cost point on the curve, and that source energy savings as high as 35% relative to 2006 IECC can be reached without deviating significantly from minimum cost. The cost for the 35% savings point is far below the annual cost point for a 2006 IECC-compliant home, which is the baseline for the data shown in Figure 4. To highlight the benefit of efficiency levels beyond the E-Scale criterion of 70, a second, higher performance package is included in the TIP documents. These packages generally produce greater cost savings for the homeowner, and in all cases produce greater source energy savings with positive cash flow.

Finalizing Technology Information Packages

Once potential Builders Challenge-level packages were identified for each climate and fuel type, they were vetted with the Builders Challenge Technical Working Group and adjusted slightly for consistency, flexibility, and practicality. For example, the Group requested 100% fluorescent lighting be reduced to 90% to provide some flexibility. The Group also decided that minimum seasonal energy efficiency ratio (SEER) values for air conditioners and heat pumps should be 14.0, that the minimum furnace efficiency should be 82.0 annual fuel utilization efficiency (AFUE), and that required window solar heat

gain coefficient (SHGC) values should be no lower than 0.35[6] to accommodate product availability. These changes were made to the prototype models in the HERS software, and the HERS indices were reevaluated.

Results

Table 5 shows the E-Scale Indices for the Builders Challenge performance level for each prototype model developed for this analysis.

Table 5. E-Scale Indices for Prototype Homes at Builders Challenge Performance Level

City/Heating Fuel	REM/*Rate*	EnergyGauge
Houston/Gas	68	64
Houston/Electric	68	65
Phoenix/Gas	67	63
Phoenix/Electric	67	64
Chicago/Gas	62	64
Chicago/Electric	68	69
Atlanta/Gas	66	63
Atlanta/Electric	68	65
Seattle/Gas	66	69
Seattle/Electric	67	70

Figure 7 shows a typical BC-TIP energy package, clipped from the builder-targeted marketing flyer. In addition to the energy packages, the estimated costs and savings associated with each package are also listed in the BC-TIP marketing flyer (Figure 8). As discussed earlier, these savings and construction costs are calculated by BEopt, relative to the hand-configured 2006 IECC Standard Reference. The complete TIP document and other BC-TIPs are available on the Building America Web site.

[6] The 2009 IECC will require SHGC values lower than 0.35 in warm climates, and the 2010 ENERGY STAR® window specification is expected to be even more stringent.

Climate Region: Cold Location: Chicago Foundation Type: Basement	Minimum Builders Challenge Level		Premium Efficiency Level	
Heating Fuel:	Gas	Electric	Gas	Electric
Insulation				
Walls[1]	2×6 R-21	2×6 R-21	2×6 R-21	2×6 R-21
Roof	R-38	R-38	R-38	R-38
Basement	R-10/R-13[4]	R-10/R-13[4]	R-10/R-13[4]	R-10/R-13[4]
Windows[2]				
	Double-Glazed, Low-E	Double-Glazed, Low-E	Double-Glazed, Low-E	Double-Glazed, Low-E
U-Factor	0.35	0.35	0.33	0.33
Solar Heat Gain Coefficient	Any	Any	0.51	0.51
Lighting				
% Fluorescent Fixtures[3]	90%	90%	100%	100%
Heating				
Furnace, Efficiency Rating, AFUE	92.5		92.5	
Air-Source Heat Pump, HSPF		8.2		9.2
Air Conditioning				
Efficiency Rating, SEER	14		17	
Air-Source Heat Pump, SEER		14		18
(Builder-Supplied) Appliances				
	ENERGY STAR®	ENERGY STAR®	ENERGY STAR®	ENERGY STAR®
Water Heater				
	Tank/Gas	Tank/Electric	Tankless/Gas	Tank/Electric
Energy Factor, EF	0.59	0.91	0.77	0.95
Air Tightness				
ACH50	5.0	5.0	3.0	3.0
Ducts				
Location	Inside Conditioned Space	Inside Conditioned Space	Inside Conditioned Space	Inside Conditioned Space

[1] Framing factor shall not exceed 20%.
[2] Window area shall not exceed 18% of conditioned, above-grade floor area.
[3] Pin-based fluorescent fixtures or compact fluorescent lamps.
[4] The first R-value applies to continuous insulation, the second to framing cavity insulation; either meets the requirement.

Figure 7. Sample package table from BC-TIP document

Upgraded Energy Savings Levels	Minimum Builders Challenge Level		Premium Efficiency Level	
	Gas	Electric	Gas	Electric
Savings on annual utility bill[1]	$375	$366	$570	$458
Increase in annual mortgage payment from energy upgrades[2]	$178	$151	$254	$204
Net annual savings	$197	$215	$316	$254

[1] Evaluated relative to the 2006 International Energy Conservation Code, using average utility rates and climate data for this location. Specific savings will vary.
[2] Based on a 30-year mortgage at 7% APR.

Figure 8. Example energy savings and cost of upgrades from BC-TIP document

Technical Information Package Design Limitations

Because of the TIP prototype building definition, builders who use TIPs will not be able to take advantage of performance tradeoffs based on window area, window location, building orientation, reduced infiltration, etc. Builders interested in receiving full credit for specific building designs and performance features are encouraged to use the performance path. A home that has a window area greater than 18% of conditioned floor area is required to use the performance path.

Conclusion

NREL used the BEopt, REM/*Rate*, and EnergyGauge software programs to develop an initial batch of five TIPs for DOE's Builder Challenge. The goal was to achieve optimal cost-effective approaches to meeting the 70 E-Scale requirement of the Challenge. Premium-efficiency packages were also developed for each of the initial five climates to demonstrate higher levels of cost-effective energy savings.

TIPs quickly and effectively communicate the technical specifications required to meet the Builders Challenge. TIPs do not provide the full design flexibility of the performance path.

BC-TIP marketing materials targeting builders and consumers have been developed for the initial set of five climates and are available on the Building America Web site.

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Appendix A: Example BEopt Input Echo Report – Phoenix, Gas Heating

GROUP	INPUT VARIABLE			VALUE	UNITS
Location	USA_AZ_Phoenix_TMY2				
Geometry	Total Finished Floor Area (Above Grade)			2500	ft ²
	# Floors (Above Grade)			2	
	Ceiling Height			9	ft
	Garage			Two Car	
	Garage Protrusion:			50	%
	Garage Position:			Left	
	Roof			Gable	
	Roof Pitch:			0.5	
	Number of Bedrooms			3	
	Number of Bathrooms			2	
Economics	Elec. Marginal			0.0763	$/kWh
	Elec. Fixed			8	$/month
	Elec. Average			0.0815	$/kWh
	Elec. Excess Sellback Rate			0.0763	$/kWh
	Gas Marginal			1.4376	$/therm
	Gas Fixed			8	$/month
	Gas Average			1.684	$/therm
	Mortgage Period			30	years
	Mortgage Interest Rate (Nominal)			7	%
	Marginal Income Tax Rate			28	%
	Project Analysis Period			30	years
	Inflation Rate			3	%
	Discount Rate (Nominal)			5	%
	Electric Source/Site Ratio			3.365	
	Gas Source/Site Ratio			1.092	
	Gas Carbon Factor			14.74	
	Electric Carbon Factor			1.67	
	Efficiency Cost Multiplier			1	
Photovoltaics	PV Module			Generic	
	Installed Cost			7.5	$/W DC
	Derate Factor			15	%

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
Building							
	Orientation						
				North-facing	$0.00	30	years
		x	x	West-facing	$0.00	30	years
				South-facing	$0.00	30	years
				East-facing	$0.00	30	years
				Southeast	$0.00	30	years
				Southwest	$0.00	30	years
				Northeast	$0.00	30	years
				Northwest	$0.00	30	years
				SSE	$0.00	30	years
				ESE	$0.00	30	years
				ENE	$0.00	30	years
				NNE	$0.00	30	years
				NNW	$0.00	30	years
				WNW	$0.00	30	years
				WSW	$0.00	30	years
				SSW	$0.00	30	years
Building							
	Neighbors						
				No Neighbors	$0.00	30	years
				at 20ft	$0.00	30	years
		x	x	at 15ft	$0.00	30	years
				at 10ft	$0.00	30	years
Building							
	Aspect Ratio						
				1.5	$0.00	30	years
		x	x	1.33	$0.00	30	years
				1	$0.00	30	years
				0.75	$0.00	30	years
				0.67	$0.00	30	years
Building							
	Misc Electric Loads						
				4	$0.00	30	years
				2	$0.00	30	years
				1.5	$0.00	30	years
		x	x	1	$0.00	30	years
				0.75	$0.00	30	years
				0.5	$0.00	30	years
				0.25	$0.00	30	years
Building							
	Misc Gas Loads						
				2	$0.00	30	years
		x	x	1	$0.00	30	years
				0.5	$0.00	30	years
				0	$0.00	30	years
Building							
	Heating Set Point						
		x	x	68 F	$0.00	30	years
				69 F	$0.00	30	years
				70 F	$0.00	30	years
				71 F	$0.00	30	years
				72 F	$0.00	30	years
				73 F	$0.00	30	years
				74 F	$0.00	30	years
				75 F	$0.00	30	years
				71 F w/ setback 65 F	$0.00	30	years
				71 F w/ setback 65 F (wkdy)	$0.00	30	years
Building							
	Cooling Set Point						
				73 F	$0.00	30	years
				74 F	$0.00	30	years
				75 F	$0.00	30	years
				76 F	$0.00	30	years
				77 F	$0.00	30	years
		x	x	78 F	$0.00	30	years
				79 F	$0.00	30	years
				80 F	$0.00	30	years

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
				76 F w/ setup 85 F	$0.00	30	years
				76 F w/ setup 81 F	$0.00	30	years
Building							
	Ventilation Rate						
				None	$	0	years
				Spot ventilation only	$	0	years
				50% ASHRAE 62.2	$	0	years
				60% ASHRAE 62.2	$	0	years
				70% ASHRAE 62.2	$	0	years
				80% ASHRAE 62.2	$	0	years
				90% ASHRAE 62.2	$	0	years
		x	x	100% ASHRAE 62.2	$	0	years
				110% ASHRAE 62.2	$	0	years
				120% ASHRAE 62.2	$	0	years
				130% ASHRAE 62.2	$	0	years
				140% ASHRAE 62.2	$	0	years
				150% ASHRAE 62.2	$	0	years
Building							
	Natural Ventilation						
				None	$0.00	30	years
		x	x	Benchmark	$0.00	30	years
				Smart	$0.00	30	years
Envelope							
	Wall Insulation						
				R11 batts, 2x4, 16"o.c.	$6.61	30	years
		x	x	R13 batts, 2x4, 16"o.c.	$6.65	30	years
			x	R15 batts, 2x4, 16"o.c.	$6.69	30	years
				R19 batts, 2x6, 24"o.c.	$6.78	30	years
				R21 batts, 2x6, 24"o.c.	$6.81	30	years
				R11 batts, 2x4, 16"o.c. + 1" foam	$7.45	30	years
				R13 batts, 2x4, 16"o.c. + 1" foam	$7.49	30	years
				R19 batts, 2x6, 24"o.c. + 1" foam	$7.61	30	years
				R21 batts, 2x6, 24"o.c. + 1" foam	$7.65	30	years
				R19 batts, 2x6, 24"o.c. + 2" foam	$8.09	30	years
				2-Stud, R33 2x4 24" o.c., 12" total	$8.46	30	years
				2-Stud, R39 2x4 24" o.c., 12" total	$8.58	30	years
				2-Stud, R45 2x4 24" o.c., 12" total	$8.70	30	years
				2-Stud, R51 2x4 24" o.c., 14" total	$8.80	30	years
				4.5" SIPs (3.5" Core)	$8.21	30	years
				6.5" SIPs (5.5" Core)	$9.12	30	years
				8.5" SIPs (7.5" Core)	$10.02	30	years
				10.5" SIPs (9.5" Core)	$11.25	30	years
Envelope							
	Ceiling Insulation						
				R30 Cellulose	$0.79	30	years
				R40 Cellulose	$1.02	30	years
				R50 Cellulose	$1.30	30	years
				R60 Cellulose	$1.53	30	years
		x	x	R30 Fiberglass	$1.20	30	years
			x	R40 Fiberglass	$1.55	30	years
			x	R50 Fiberglass	$1.89	30	years
			x	R60 Fiberglass	$2.32	30	years
Envelope							
	Garage Ceiling						
				None	$0.00	30	years
				R11 Fiberglass	$0.43	30	years
				R19 Fiberglass	$0.61	30	years
		x	x	R30 Fiberglass	$0.94	30	years
Envelope							
	Roofing Material						
				Asphalt Shingles, Dark	$1.25	25	years
		x	x	Asphalt Shinges, Medium	$1.25	25	years
				Asphalt Shingles, Light	$1.25	25	years
			x	Asphalt Shingles, White or cool colors	$1.25	25	years
				Tile, Dark	$4.23	30	years
				Tile, Medium (mottled, terra cotta, buff)	$4.23	30	years
				Tile, Light	$4.23	30	years
				Tile, White	$4.23	30	years

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
				Metal, Dark	$2.87	30	years
				Metal, Medium	$2.87	30	years
				Metal, Light	$2.87	30	years
				Metal, White	$2.87	30	years
				Galvanized Steel	$1.94	30	years
				Gavalume Steel	$2.47	30	years
Envelope							
	Radiant Barrier						
		x	x	None	$0.00	30	years
			x	Radiant Barrier	$0.32	30	years
Envelope							
	Infiltration						
		x		Typical	$0.00	13	years
			x	Tight	$0.54	13	years
			x	Tighter	$1.08	13	years
			x	Tightest	$1.62	13	years
Foundation							
	Slab						
				No Slab	$0.00|$0.00	30	years
		x	x	Uninsulated	$0.00|$0.00	30	years
			x	2ft R5 Perimeter, R5 Gap	$1.01|$1.01	30	years
				4ft R5 Perimeter, R5 Gap	$1.01|$1.01	30	years
				2ft R10 Perimeter, R5 Gap	$1.64|$1.01	30	years
				4ft R10 Perimeter, R5 Gap	$1.64|$1.01	30	years
				15ft R10 Perimeter, R5 Gap	$1.64|$1.01	30	years
Foundation							
	Basement						
		x	x	No Basement	$0.00\|$	30	years
				Uninsulated	$0.00|$0.00	30	years
				4ft R5 Exterior	$1.01|$0.00	30	years
				4ft R10 Exterior	$1.64|$0.00	30	years
				8ft R10 Exterior	$1.64|$0.00	30	years
				8ft R15 Exterior	$2.04|$0.00	30	years
				8ft R20 Exterior	$2.30|$0.00	30	years
				8ft R10 Interior	$1.64|$0.00	30	years
				Uninsulated Wood Frame	$0.13|$0.00	30	years
				R11 Wood Frame	$1.15|$0.00	30	years
				R19 Wood Frame	$1.33|$0.00	30	years
				R30 Wood Frame	$1.80|$0.00	30	years
				R11 Ceiling	$0.00|$1.16	30	years
				R19 Ceiling	$0.00|$1.63	30	years
Foundation							
	Crawl Space						
		x	x	No Crawl Space	$0.00|$0.00	30	years
				Unvented, Uninsulated	$0.00|$0.00	30	years
				Unvented, R10 Interior	$1.15|$0.00	30	years
				Vented, R19 Ceiling	$0.00|$1.16	30	years
				Vented, R30 Ceiling	$0.00|$1.63	30	years
Thermal Mass							
	Exposed Floor						
				No Exposed Floor	$0.00|$0.00	30	years
		x	x	20% Exposed	$0.00|$0.00	30	years
				40% Exposed	$0.00|$0.00	30	years
				60% Exposed	$0.00|$0.00	30	years
				80% Exposed	$0.00|$0.00	30	years
				100% Exposed	$0.00|$0.00	30	years
Thermal Mass							
	Ceiling Mass						
		x	x	1/2" Ceiling Drywall	$0.60	30	years
				5/8" Ceiling Drywall	$0.62	30	years
				2 x 1/2" Ceiling Drywall	$1.10	30	years
				2 x 5/8" Ceiling Drywall	$1.14	30	years
Thermal Mass							
	Wall Mass						
		x	x	Exterior and Partition, 1/2" Drywall	$0.60|$0.60	30	years
				Exterior, 5/8" Drywall	$0.62|$0.60	30	years
				Exterior, 2 x 1/2" Drywall	$1.10|$0.60	30	years
				Exterior, 2 x 5/8" Drywall	$1.14|$0.60	30	years

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
				Partition, 5/8" Drywall	$0.60|$0.62	30	years
				Partition, 2 x 1/2" Drywall	$0.60|$1.10	30	years
				Partition, 2 x 5/8" Drywall	$0.60|$1.14	30	years
				Exterior and Partition, 5/8" Drywall	$0.62|$0.62	30	years
				Exterior and Partition, 2 x 1/2" Drywall	$1.10|$1.10	30	years
				Exterior and Partition, 2 x 5/8" Drywall	$1.14|$1.14	30	years
Windows & Shading							
	Window Areas						
				20.0% F25 B25 L25 R25	$	0	years
				20.0% F20 B40 L20 R20	$	0	years
		x	x	18.0% F25 B25 L25 R25	$	0	years
				18.0% F20 B40 L20 R20	$	0	years
				16.0% F25 B25 L25 R25	$	0	years
				16.0% F20 B40 L20 R20	$	0	years
Windows & Shading							
	Window Type						
				Single Pane	$4.66	20	years
				Double Clear	$14.00	20	years
			x	Low-e low SHGC arg	$16.00	20	years
				Low-e std SHGC arg	$16.00	20	years
				Low-e high SHGC arg	$16.00	20	years
				Low-e v. high SHGC arg	$16.00	20	years
				3 pane, 1 HM	$18.00	20	years
				4 pane, 2 HM Kr	$24.00	20	years
		x	x	Low-e, low SHGC	$16.00	20	years
				Low-e std. SHGC	$16.00	20	years
				Low-e high SHGC	$16.00	20	years
				Low-e v. high SHGC	$16.00	20	years
Windows & Shading							
	Eaves						
				No eaves	$10.65	30	years
		x	x	1 ft overhang	$10.65	30	years
			x	2 ft overhang	$10.65	30	years
			x	3 ft overhang	$10.65	30	years
Lg. Appliances							
	Refrigerator						
		x	x	Standard	$1,100.00	18	years
				EnergyStar	$1,220.00	18	years
Lg. Appliances							
	Cooking Range						
				Electric	$350.00	13	years
		x	x	Gas	$350.00	15	years
Lg. Appliances							
	Dishwasher						
		x	x	Standard	$259.00	13	years
				EnergyStar	$329.00	13	years
Lg. Appliances							
	Clothes Dryer						
				Clothes Line	$0.01	30	years
		x	x	Electric	$269.00	18	years
				Gas	$319.00	18	years
Lg. Appliances							
	Clothes Washer						
		x	x	Standard (V-Axis)	$419.00	14	years
				EnergyStar (H-Axis)	$799.00	14	years
				Standard (V-Axis) - Cold Only	$419.00	14	years
				EnergyStar (H-Axis) - Cold Only	$799.00	14	years
Lighting							
	Hardwired Lighting						
		x	x	14% Fluorescent	$0.42|$3.79	1.33	years
				20% Fluorescent	$0.42|$3.79	1.66	years
				30% Fluorescent	$0.42|$3.79	2.46	years
				40% Fluorescent	$0.42|$3.79	3.25	years
			x	50% Fluorescent	$0.42|$3.79	4.03	years
				60% Fluorescent	$0.42|$3.79	4.81	years
				70% Fluorescent	$0.42|$3.79	5.59	years
				80% Fluorescent	$0.42|$3.79	6.39	years
				90% Fluorescent	$0.42|$3.79	7.19	years

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
			x	100% Fluorescent	$0.42|$3.79	8.01	years
Lighting							
	Plug-in Lighting						
		x	x	0% CFL	$0.42|$3.79	1.33	years
				10% CFL	$0.42|$3.79	1.92	years
				20% CFL	$0.42|$3.79	2.57	years
				30% CFL	$0.42|$3.79	3.23	years
				40% CFL	$0.42|$3.79	3.89	years
				50% CFL	$0.42|$3.79	4.55	years
				60% CFL	$0.42|$3.79	5.22	years
				70% CFL	$0.42|$3.79	5.9	years
				80% CFL	$0.42|$3.79	6.59	years
				90% CFL	$0.42|$3.79	7.3	years
				100% CFL	$0.42|$3.79	8.01	years
Equipment							
	Air Conditioner						
				No Air Conditioner	$0.00	18	years
				SEER 10	$266.00	18	years
		x	x	SEER 13	$721.00	18	years
			x	SEER 14	$873.00	18	years
			x	SEER 15	$1,025.00	18	years
			x	SEER 16	$1,177.00	18	years
			x	SEER 17	$1,329.00	18	years
			x	SEER 18	$1,481.00	18	years
Equipment							
	Furnace						
				No Furnace	$0.00	18	years
		x	x	AFUE 80%	$265.00	18	years
			x	AFUE 92.5%	$559.00	18	years
Equipment							
	Heat Pump						
		x	x	No Heat Pump	$0.00	15	years
				SEER 10. HSPF 7.2	$555.00	15	years
				SEER 13. HSPF 8.1	$1,216.00	15	years
				SEER 14. HSPF 8.6	$1,436.00	15	years
				SEER 15. HSPF 8.8	$1,656.00	15	years
				SEER 16. HSPF 8.4	$1,876.00	15	years
				SEER 17. HSPF 8.6	$2,096.00	15	years
				SEER 18. HSPF 9.2	$2,316.00	15	years
Equipment							
	Mechanical Ventilation						
				None	$0.00	20	years
		x	x	Upgraded Bathroom Exhaust	$463.00	20	years
				Balanced Energy-Recovery Ventilator	$1,838.00	20	years
Equipment							
	Water Heater						
				Electric Standard	$479.00	15	years
				Electric Premium	$570.00	15	years
				Electric Tankless	$1,075.00	20	years
		x	x	Gas Standard	$428.00	13	years
			x	Gas Premium	$624.00	13	years
			x	Gas Tankless	$1,050.00	20	years
Equipment							
	Ducts						
				None	$0.00	30	years
		x	x	Typical	$0.45	18	years
			x	Improved	$0.69	18	years
			x	Inside	$0.77	18	years
Renewables							
	Solar DHW						
		x	x	No Solar DHW	$0.00	30	years
			x	32 sq ft ICS	$2,654.00	30	years
				40 sq ft closed loop	$4,307.00	30	years
			x	64 sq ft closed loop	$4,768.00	30	years
Renewables							
	SDHW Azimuth						
				Back Roof	$	0	years
				Front Roof	$	0	years

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
				Left Roof	$	0	years
				Right Roof	$	0	years
				West	$	0	years
				Southwest	$	0	years
		x	x	South	$	0	years
				Southeast	$	0	years
				East	$	0	years
Renewables							
	SDHW Tilt						
				Roof Pitch	$	0	years
				0°	$	0	years
				10°	$	0	years
				20°	$	0	years
				30°	$	0	years
				40°	$	0	years
				50°	$	0	years
				60°	$	0	years
				70°	$	0	years
				80°	$	0	years
				90°	$	0	years
				Latitude - 15°	$	0	years
		x	x	Latitude	$	0	years
				Latitude + 15°	$	0	years
Renewables							
	PV Size						
		x	x	0 kW	$	0	years
				0.5 kW	$	0	years
			x	1.0 kW	$	0	years
				1.5 kW	$	0	years
			x	2.0 kW	$	0	years
				2.5 kW	$	0	years
			x	3.0 kW	$	0	years
				3.5 kW	$	0	years
			x	4.0 kW	$	0	years
				4.5 kW	$	0	years
			x	5.0 kW	$	0	years
				5.5 kW	$	0	years
				6.0 kW	$	0	years
				6.5 kW	$	0	years
				7.0 kW	$	0	years
				7.5 kW	$	0	years
				8.0 kW	$	0	years
				ZNE	$	0	years
Renewables							
	PV Azimuth						
				Back Roof	$	0	years
				Front Roof	$	0	years
				Left Roof	$	0	years
				Right Roof	$	0	years
				West	$	0	years
				Southwest	$	0	years
		x	x	South	$	0	years
				Southeast	$	0	years
				East	$	0	years
Renewables							
	PV Tilt						
				Roof Pitch	$	0	years
				0°	$	0	years
				10°	$	0	years
				20°	$	0	years
				30°	$	0	years
				40°	$	0	years
				50°	$	0	years
				60°	$	0	years
				70°	$	0	years
				80°	$	0	years
				90°	$	0	years
				Latitude - 15°	$	0	years

GROUP	CATEGORY	REF	SELECTED	OPTION NAME	UNIT COST	LIFETIME	
		x	x	Latitude	$	0	years
				Latitude + 15°	$	0	years
HVAC Sizing							
	Cooling Capacity						
			x	0 tons	$0.00|$0.00	0	years
			x	1.5 tons	$690.00|$554.00	0	years
			x	2.0 tons	$920.00|$738.00	0	years
			x	2.5 tons	$1,150.00|$923.00	0	years
			x	3.0 tons	$1,380.00|$1,107.00	0	years
			x	3.5 tons	$1,610.00|$1,292.00	0	years
			x	4.0 tons	$1,840.00|$1,476.00	0	years
			x	5.0 tons	$2,300.00|$1,845.00	0	years
HVAC Sizing							
	Heating Capacity						
			x	0 kBtu/hr	$0.00	0	years
			x	30 kBtu/hr	$88.00	0	years
			x	40 kBtu/hr	$117.00	0	years
			x	50 kBtu/hr	$146.00	0	years
			x	60 kBtu/hr	$175.00	0	years
			x	70 kBtu/hr	$204.00	0	years
			x	80 kBtu/hr	$234.00	0	years
			x	90 kBtu/hr	$263.00	0	years
			x	100 kBtu/hr	$292.00	0	years
			x	110 kBtu/hr	$321.00	0	years
			x	120 kBtu/hr	$350.00	0	years
			x	130 kBtu/hr	$380.00	0	years
			x	140 kBtu/hr	$409.00	0	years
			x	150 kBtu/hr	$438.00	0	years

Appendix B: Example REM/*Rate* Building File Report – Phoenix, Gas Heating

BUILDING FILE REPORT

File Name: Phoenix Gas.blg Date: October 28, 2008

Property/Builder:		Rating	
Building Name:	Phoenix - Gas	Org. Name:	
Owner's Name:		Address:	
Property Address:		City, St, Zip:	,
City, St, Zip:	,	Phone No:	
Phone No:		Website:	
		Rater's Name:	
Builder's Name:		Rater's No.:	
Phone No:		Rater's Email:	
Email Address:			
Model:		Rating Date:	
Development:		Rating Type:	
		Reason:	
		Rating No.:	

General Building Information	
Area of Cond. Space(sq ft):	2500
Volume of Cond. Space:	22500
Year Built:	2008
Housing Type:	Single-family detached
Level Type(Apartments Only):	None
Floors on or Above-Grade:	2
Number of Bedrooms:	3
Foundation Type:	Slab
Enclosed Crawl Space Type:	N/A

Slab Floor Info:	1		
Name			
Library Type	Uninsulated		
Area(sq ft)	1250		
Depth Below Grade(ft)	0.0		
Full Perimeter(ft)	143		
Exposed Perimeter(ft)	143		
On-Grade Perimeter(ft)	143		

Slab Floor: Uninsulated	
Slab Covering	Carpet
Perimeter Insulation (R-Value):	0.0
Perimeter Insulation Depth (ft):	0.0
Under-Slab Insulation (R-Value):	0.0
Under-Slab Insulation Width (ft):	0.0
Slab Insulation Grade:	1
Radiant Slab:	No
Note:	

Rim and Band Joist:	1		
Name			
Area(sq ft)	143.0		
Continuous Ins	0.0		
Framed Cavity Ins	15.0		
Cavity Ins Thk(in)	5.5		
Joist Spacing	24.0		
Location	Cond -> ambient		
Uo Value	0.057		

Above-Grade Wall:	1		
Name			
Library Type	R-15, Grade I		
Gross Area(sq ft)	2574.00		
Exterior Color	Medium		
Location	Cond -> ambient		
Uo Value	0.079		

Above-Grade Wall: R-15, Grade I

Information From Quick Fill Screen:

Standard Wood Frame

Continuous Insulation (R-Value)	0.0
Frame Cavity Insulation (R-Value)	15.0
Frame Cavity Insulation Thickness (in)	3.5
Frame Cavity Insulation Grade	1
Stud Size (w x d, in)	1.5 x 3.5
Stud Spacing (in o.c.)	16.0
Framing Factor - (default)	0.2300
Gypsum Thickness (in)	0.5

Note:

Layers	Paths		
	Cavity	Framing	Grade
Inside Air Film	0.680	0.680	0.680
Gyp board	0.450	0.450	0.450
Air Gap/Frm	0.000	0.000	0.000
Cavity ins/Frm	15.000	4.375	1.030
Continuous ins	0.000	0.000	0.000
Ext Finish	0.940	0.940	0.940
	0.000	0.000	0.000
Outside Air Film	0.170	0.170	0.170
Total R-Value	17.240	6.615	3.270
U-Value	0.058	0.151	0.306
Relative Area	0.770	0.230	0.000
UA	0.045	0.035	0.000

Total Component UA: 0.079
Total Component Area: 1.0

Component Uo: 0.079

Window Information:	1	2	3
Name	North	South	West
Library Type	U 0.35; SHGC 0.35	U 0.35; SHGC 0.35	U 0.35; SHGC 0.35
U-Value	0.350	0.350	0.350
SHGC	0.350	0.350	0.350
Area(sq ft)	112.50	112.50	112.50
Orientation	North	South	West
Overhang Depth	0.0	0.0	0.0
Overhang To Top	0.0	0.0	0.0
Overhang To Bottom	0.0	0.0	0.0
Interior Winter Shading	0.85	0.85	0.85
Interior Summer Shading	0.70	0.70	0.70
Adjacent Winter Shading	None	None	None
Adjacent Summer Shading	None	None	None
Wall Assignment	AGWall 1	AGWall 1	AGWall 1

Window Information:	4		
Name	East		
Library Type	U 0.35; SHGC 0.35		
U-Value	0.350		
SHGC	0.350		
Area(sq ft)	112.50		
Orientation	East		
Overhang Depth	0.0		
Overhang To Top	0.0		
Overhang To Bottom	0.0		
Interior Winter Shading	0.85		
Interior Summer Shading	0.70		
Adjacent Winter Shading	None		
Adjacent Summer Shading	None		
Wall Assignment	AGWall 1		

Window: U 0.35; SHGC 0.35	
U-Value:	0.350
Solar Heat Gain Coefficient:	0.350
Note:	

Door Information:	1		
Name			
Opaque Area(sq ft)	40.0		
Library Type	2-1/4 Wd solid, strm		
Wall Assignment	AGWall 1		
Uo Value	0.211		

Door: 2-1/4 Wd solid, strm	
R-Value of Opaque Area:	2.8
Storm Door:	Yes
Note:	

Roof Information:	1		
Name			
Library Type	R-30 Blown, Attic		
Gross Area(sq ft)	1250.00		
Color	Light		
Radiant Barrier	No		
Type(Attic)	Attic		
Uo Value	0.034		

Ceiling: R-30 Blown, Attic

Information From Quick Fill Screen:

Continous Insulation (R-Value)	17.0
Cavity Insulation (R-Value)	13.0
Cavity Insulation Thickness (in)	3.5
Cavity Insulation Grade	3.0
Gypsum Thickness (in)	0.500
Bottom Chord/Rafter Size(w x h, in)	1.5 x 3.5
Bottom Chord/Rafter Spacing (in o.c.)	24.0
Framing Factor - (default)	0.1100
Ceiling Type	Attic

Note:

Layers	Paths		
	Framing	Cavity	Grade
Inside Air Film	0.610	0.610	0.610
Gyp board	0.450	0.450	0.450
Cavity Ins/Frm	4.375	13.000	0.000
Continuous ins	17.000	17.000	17.000
	0.000	0.000	0.000
	0.000	0.000	0.000
	0.000	0.000	0.000
Outside Air Film	0.610	0.610	0.610
Total R-Value	23.045	31.670	18.670
U-Value	0.043	0.032	0.054
Relative Area	0.110	0.840	0.050
UA	0.005	0.027	0.003

Total Component UA: 0.034
Total Component Area: 1.0

Component Uo: 0.034

Mechanical Equipment: General

Number of Mechanical Systems:	3
Heating SetPoint(F):	68.00
Heating Setback Thermostat:	Present
Cooling SetPoint(F):	78.00
Cooling Setup Thermostat:	Present

Heat: 82AFUE Gas Furn 80k	
SystemType:	Fuel-fired air distribution
Fuel Type:	Natural gas
Rated Output Capacity (kBtuh):	80.0
Seasonal Equipment Efficiency:	82.0 AFUE
Auxiliary Electric:	910 Eae
Note:	
Location:	Attic
Performance Adjustment:	100
Percent Load Served:	100
Number Of Units:	1

Cooling Equipment: 14SEER A/C 2 ton	
System Type:	Air conditioner
Fuel Type:	Electric
Rated Output Capacity (kBtuh):	24.0
Seasonal Equipment Efficiency:	14.0 SEER
Sensible Heat Fraction (SHF):	0.70
Note:	
Location:	Attic
Performance Adjustment:	100
Percent Load Served:	100
Number Of Units:	1

Water Heating Equipment: 40 gal. 0.59EF Gas	
Water Heater Type:	Conventional
Fuel Type:	Natural gas
Energy Factor:	0.59
Recovery Efficiency:	0.76
Water Tank Size (gallons):	40
Extra Tank Insulation (R-Value):	0.0
Note:	
Location:	Attic
Percent Load Served:	100
Performance Adjustment:	100
Number Of Units:	1

Duct System Information:

Name	
Heating System	82AFUE Gas Furn 80k
Cooling System	14SEER A/C 2 ton
Supply Area(sq ft)	506.3
Return Area(sq ft)	281.3
# of Registers	3
Duct Leakage	
Qualitative Assessment - Not Applicable	
Total Duct Leakage - Not Applicable	
Supply Duct Leakage:	0.00 CFM @ 25 Pascals
Return Duct Leakage:	0.00 CFM @ 25 Pascals

Duct Information:	1	2	
Type	Supply	Return	
Percent Area	100.0	100.0	
R-Value	0.0	0.0	
Location	Conditioned space	Conditioned space	

Infiltration and Mechanical Ventilation

Whole House Infiltration	
Measurement Type:	Blower door test
Heating Season Infiltration Value:	5.00 ACH @ 50 Pascals
Cooling Season Infiltration Value:	5.00 ACH @ 50 Pascals
Mechanical Ventilation for IAQ	
Type:	Exhaust Only
Rate(cfm):	55
Sensible Recovery Efficiency(%):	0.00
Total Recovery Efficiency(%):	0.00
Hours per Day:	24.00
Fan Power (watts):	20.00
Ventilation Strategy for Cooling	
Cooling Season Ventilation:	Natural Ventilation

Lights and Appliances

Simplified Audit	
Oven/Range Fuel Type:	Natural gas
Clothes Dryer Fuel Type:	Natural gas
Percent Fluorescent - Pin-Based:	90.00
Percent Fluorescent - CFL:	0.00
Refrigerator KWh:	475

Lights and Appliances	
Dishwasher EF:	0.75
Ceiling Fan CFM / Watt:	0.00

Appendix C: Example EnergyGauge Building Input Report – Phoenix, Gas Heating

Building Input Summary Report

PROJECT

Title:	Phoenix Gas	Bedrooms:	3	Adress Type:	Street Address
Building Type:	User	Bathrooms:	2	Lot #	
Owner:		Conditioned Area:	2500	SubDivision:	
# of Units:	1	Total Stories:	2	PlatBook:	
Builder Name:		Worst Case:	No	Street:	
Permit Office:		Rotate Angle:	0	County:	
Jurisdiction:		Cross Ventilation:		City, State, Zip:	,
Family Type:	Single-family	Whole House Fan:			,
New/Existing:	New (From Plans)				
Comment:					

CLIMATE

Design Location	Tmy Site	Design Temp 97.5 %	Design Temp 2.5 %	Int Design Temp Winter	Int Design Temp Summer	Heating Degree Days	Design Moisture	Daily Temp Range
AZ, Phoenix	AZ_PHOENIX	34	107	70	75	1552	0	High

UTILITY RATES

Fuel	Unit	Utility Name	Monthly Fixed Cost	$/Unit
Electricity	kWh	Source Electric	0	0.0108
Natural Gas	Therm	Source Gas	0	0.102
Fuel Oil	Gallon	EnergyGauge Default	0	1.1
Propane	Gallon	EnergyGauge Default	0	1.4

SURROUNDINGS

Ornt	Type	Shade Trees Height	Shade Trees Width	Shade Trees Distance	Adjacent Buildings Exist	Adjacent Buildings Height	Adjacent Buildings Width	Adjacent Buildings Distance
N	None	ft	ft	ft		ft	ft	0 ft
NE	None	ft	ft	ft		ft	ft	0 ft
E	None	ft	ft	ft		ft	ft	0 ft
SE	None	ft	ft	ft		ft	ft	0 ft
S	None	ft	ft	ft		ft	ft	0 ft
SW	None	ft	ft	ft		ft	ft	0 ft
W	None	ft	ft	ft		ft	ft	0 ft
NW	None	ft	ft	ft		ft	ft	0 ft

FLOORS

#	Floor Type	Perimeter	R-Value	Area	Tile	Wood	Carpet
1	Slab-On-Grade Edge Insulatio	143 ft	0	1250 ft²	0.3	0	0.7

ROOF

#	Roof Type	Materials	Attic Type	Attic Area	Roof Color	Solar Absor.	RBS	Deck Insul.	Attic Vent Ratio (1in)	Pitch
1	Hip	Composition shingles	Full attic	1250 ft²	Light	0.96	N	0	300	22.6 deg

CEILING

#	Ceiling Type	R-Value	Area	Framing Fraction	Truss Type
1	Under Attic	30	1250 ft²	0.11	Wood

Building Input Summary Report

WALLS

Wall orientation below is as entered. Actual orientation is modified by rotate angle shown in "Project" section above.

#	Ornt	Adjacent To	Wall Type	Cavity R-Value	Width Ft	Width In	Height Ft	Height In	Area	Sheathing R-Value	Framing Fraction	Solar Absor.
1	N	Exterior	Frame - Wood	15	29.9		18		538.2 ft²		0.23	0.75
2	S	Exterior	Frame - Wood	15	29.9		18		538.2 ft²		0.23	0.75
3	E	Exterior	Frame - Wood	15	41.8		18		752.4 ft²		0.23	0.75
4	W	Exterior	Frame - Wood	15	41.8		18		752.4 ft²		0.23	0.75

DOORS

#	Ornt	Door Type	Storms	U-Value	Width Ft	Width In	Height Ft	Height In	Area
1		Wood	Metal	0.46		36		80	20 ft²
2		Wood	Metal	0.46		36		80	20 ft²

WINDOWS

#	Ornt	Frame	Panes	NFRC	U-Factor	SHGC	Storm	Area	Overhang Depth	Overhang Separation	Interior Shade	Screening
1	N	Vinyl	Low-E Double	Yes	0.35	0.35	N	112.52 ft²	0 ft 0 in	0 ft 0 in	Drapes/blinds	None
2	S	Vinyl	Low-E Double	Yes	0.35	0.35	N	112.52 ft²	0 ft 0 in	0 ft 0 in	Drapes/blinds	None
3	E	Vinyl	Low-E Double	Yes	0.35	0.35	N	112.52 ft²	0 ft 0 in	0 ft 0 in	Drapes/blinds	None
4	W	Vinyl	Low-E Double	Yes	0.35	0.35	N	112.52 ft²	0 ft 0 in	0 ft 0 in	Drapes/blinds	None

INFILTRATION & VENTING

Method	SLA	CFM 50	ELA	EqLA	ACH	ACH 50	---- Forced Ventilation ---- Supply	Exhaust	Run Time	Terrain/Wind Shielding
Proposed ACH(50)	0.00029	1875	102.9	193.6	0.239	5.00	0	55	100	Suburban / Suburban

MASS

Mass Type	Area	Thickness	Furniture Fraction
No Added Mass	0 ft²	0 ft	0.3

COOLING SYSTEM

#	System Type	Efficiency	Capacity	Air Flow	SHR	Ductless
1	Central Unit	SEER: 14	36 kBtu/hr	1080 cfm	0.75	

HEATING SYSTEM

#	System Type	Efficiency	Capacity	Ductless
1	Natural Gas Furnace	AFUE: 0.82	80 kBtu/hr	

HOT WATER SYSTEM

#	System Type	EF	Cap	Use	SetPnt	Credits
1	Natural Gas	0.59	40 gal	60 gal	120 deg	None

Building Input Summary Report

SOLAR HOT WATER

Collector Type	Collector Tilt	Azimuth	Surface Area	Loss Coef.	Absorp. Prod.	Trans Corr.	Tank Volume	Tank U-Value	Tank Surf Area	Heat Exch Eff	PV Pumped	Pump Energy

DUCTS

#	Location	---- Supply ---- R-Value	Area	Location	---- Return ---- Area	Number	Leakage Type	Air Handler	CFM 25	Percent Leakage	QN	RLF
1	Interior	4.2	1000 ft²	Interior	250 ft²	1	Proposed Qn	Interior	0.00 cfm	0.00 %	0.00	0.60

TEMPERATURES

Programable Thermostat: Y Ceiling Fans: N

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
Heating	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]
Venting	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]	[X]

Thermostat Schedule: HERS 2006 Reference

Schedule Type		Hours 1	2	3	4	5	6	7	8	9	10	11	12
Cooling (WD)	AM	78	78	78	78	78	78	78	78	80	80	80	80
	PM	80	80	78	78	78	78	78	78	78	78	78	78
Cooling (WEH)	AM	78	78	78	78	78	78	78	78	78	78	78	78
	PM	78	78	78	78	78	78	78	78	78	78	78	78
Heating (WD)	AM	66	66	66	66	66	68	68	68	68	68	68	68
	PM	68	68	68	68	68	68	68	68	68	68	66	66
Heating (WEH)	AM	66	66	66	66	66	68	68	68	68	68	68	68
	PM	68	68	68	68	68	68	68	68	68	68	66	66

Building Input Summary Report

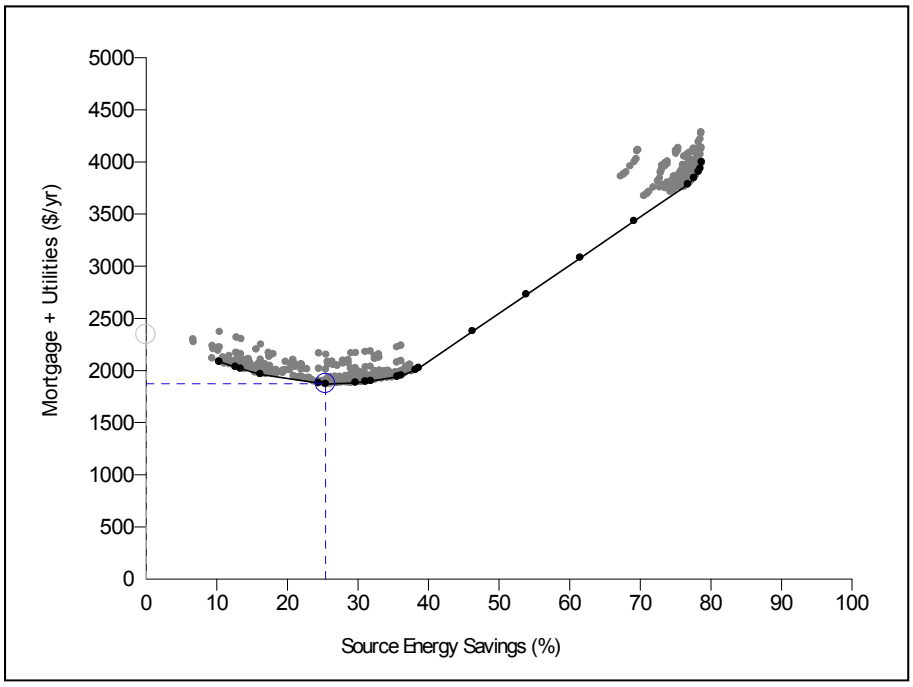
APPLIANCES & LIGHTING

Appliance Schedule: HERS 2006 Reference Schedule Type		Hours 1	2	3	4	5	6	7	8	9	10	11	12
Ceiling Fans (Summer)	AM	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.33	0.33	0.33	0.33	0.33
% Released: 100	PM	0.33	0.33	0.33	0.33	0.33	1	0.9	0.9	0.9	0.9	0.9	0.65
Annual Use: 0 kWh/Yr					Peak Value: 0 Watts								
Clothes Washer	AM	0.105	0.081	0.047	0.047	0.081	0.128	0.256	0.57	0.849	1	0.977	0.872
% Released: 60	PM	0.779	0.698	0.605	0.57	0.581	0.57	0.57	0.57	0.57	0.488	0.43	0.198
Annual Use: 105 kWh/Yr					Peak Value: 25 Watts								
Dishwasher	AM	0.139	0.05	0.028	0.024	0.029	0.09	0.169	0.303	0.541	0.594	0.502	0.443
% Released: 60	PM	0.377	0.396	0.335	0.323	0.344	0.448	0.791	1	0.8	0.597	0.383	0.281
Annual Use: 89 kWh/Yr					Peak Value: 27 Watts								
Dryer	AM	0.2	0.1	0.05	0.05	0.05	0.075	0.2	0.375	0.5	0.8	0.95	1
% Released: 10	PM	0.875	0.85	0.8	0.625	0.625	0.6	0.575	0.55	0.625	0.7	0.65	0.375
Annual Use: 891 kWh/Yr					Peak Value: 200 Watts								
Lighting	AM	0.16	0.15	0.16	0.18	0.23	0.45	0.4	0.26	0.19	0.16	0.12	0.11
% Released: 90	PM	0.16	0.17	0.25	0.27	0.34	0.55	0.55	0.88	1	0.86	0.51	0.28
Annual Use: 1181 kWh/Yr					Peak Value: 386 Watts								
Miscellaneous	AM	0.48	0.47	0.47	0.47	0.47	0.47	0.64	0.71	0.67	0.61	0.55	0.53
% Released: 90	PM	0.52	0.5	0.5	0.5	0.59	0.73	0.79	0.99	1	0.96	0.77	0.55
Annual Use: 3641 kWh/Yr					Peak Value: 668 Watts								
Pool Pump	AM	0	0	0	0	0	0	0	0	0	1	1	1
% Released: 0	PM	1	1	1	1	0	0	0	0	0	0	0	0
Annual Use: 0 kWh/Yr					Peak Value: 0 Watts								
Range	AM	0.057	0.057	0.057	0.057	0.057	0.114	0.171	0.286	0.343	0.343	0.343	0.4
% Released: 100	PM	0.457	0.343	0.286	0.4	0.571	1	0.857	0.429	0.286	0.229	0.171	0.114
Annual Use: 447 kWh/Yr					Peak Value: 165 Watts								
Refrigeration	AM	0.85	0.78	0.75	0.73	0.73	0.73	0.75	0.75	0.8	0.8	0.8	0.8
% Released: 100	PM	0.88	0.85	0.85	0.83	0.88	0.95	1	0.98	0.95	0.93	0.9	0.85
Annual Use: 475 kWh/Yr					Peak Value: 65 Watts								
Well Pump	AM	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.1
% Released: 0	PM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Annual Use: 0 kWh/Yr					Peak Value: 0 Watts								

Appendix D: BEopt Results

Figures

Minimum-Cost / Atlanta / Gas Heat

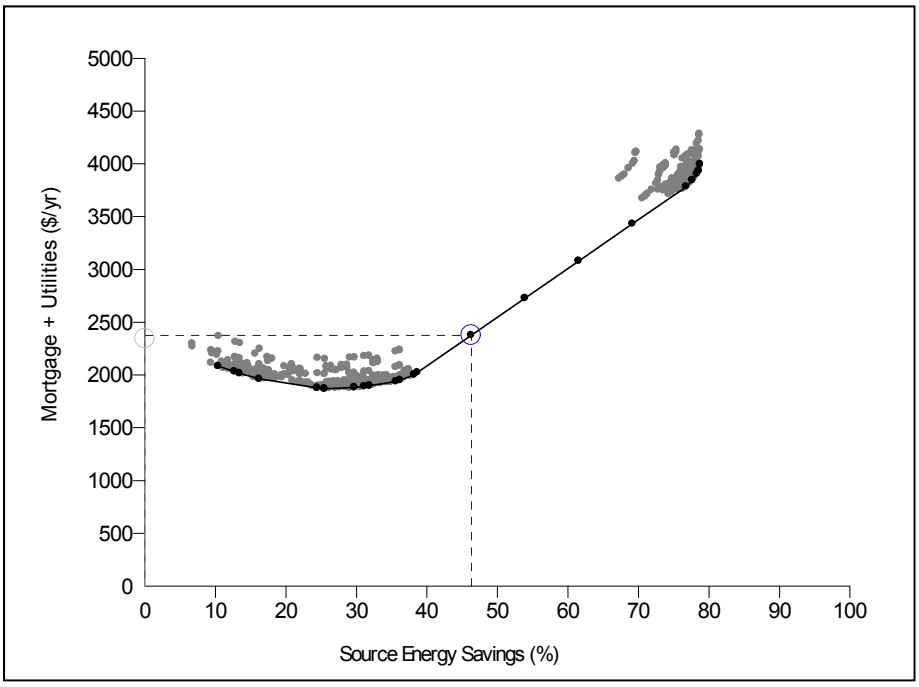


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($819)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 13	$0
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	R-4.2, 10% leakage	$0
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	0.5 tons	($272)
Heating Capacity Reduction	20 kBtu/hr	($70)
Total		**$1,914**

Savings on annual utility bill	$618
Increase in annual mortgage payment	$145
Net annual savings	$473

Figure D-1. Minimum-cost point for Atlanta with gas space- and water-heating.

Neutral-Cost / Atlanta / Gas Heat

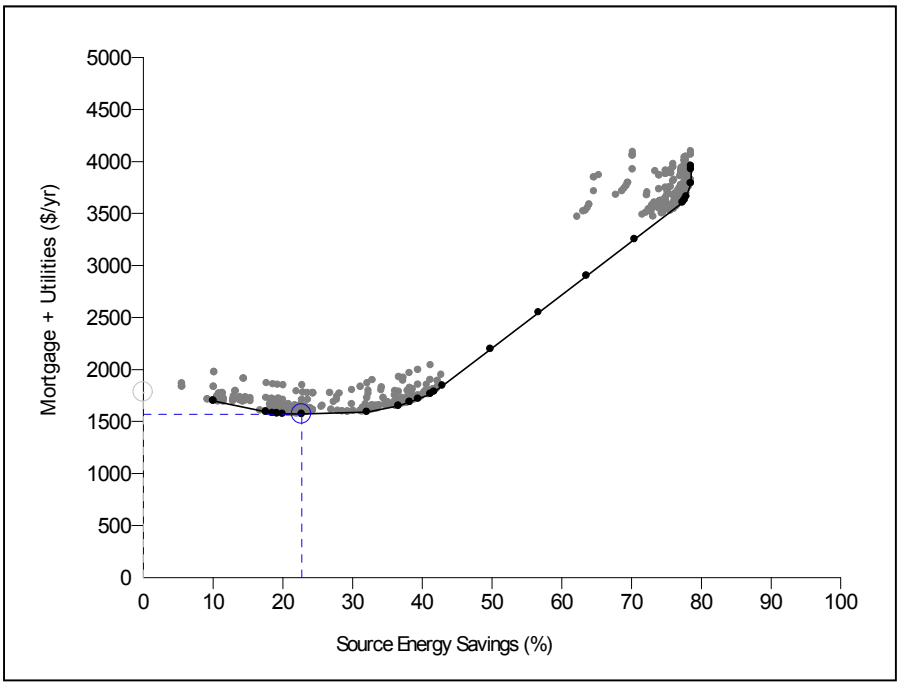


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R40	$472
Radiant Barrier	Radiant Barrier	$483
Infiltration	0.00015 SLA	$3,642
Window Type	Low-e low SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($819)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 17	$720
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	R-4.2, 10% leakage	$0
Solar DHW	64 sq ft closed loop	$4,768
PV Size	1.0 kW	$7,500
Cooling Capacity Reduction	1 tons	($545)
Heating Capacity Reduction	30 kBtu/hr	($104)
Total		**$17,371**

Savings on annual utility bill	$1,087
Increase in annual mortgage payment	$1,120
Net annual savings	($33)

Figure D-2. Near-neutral-cost point for Atlanta with gas space- and water-heating.

Minimum-Cost / Atlanta / Electric Heat

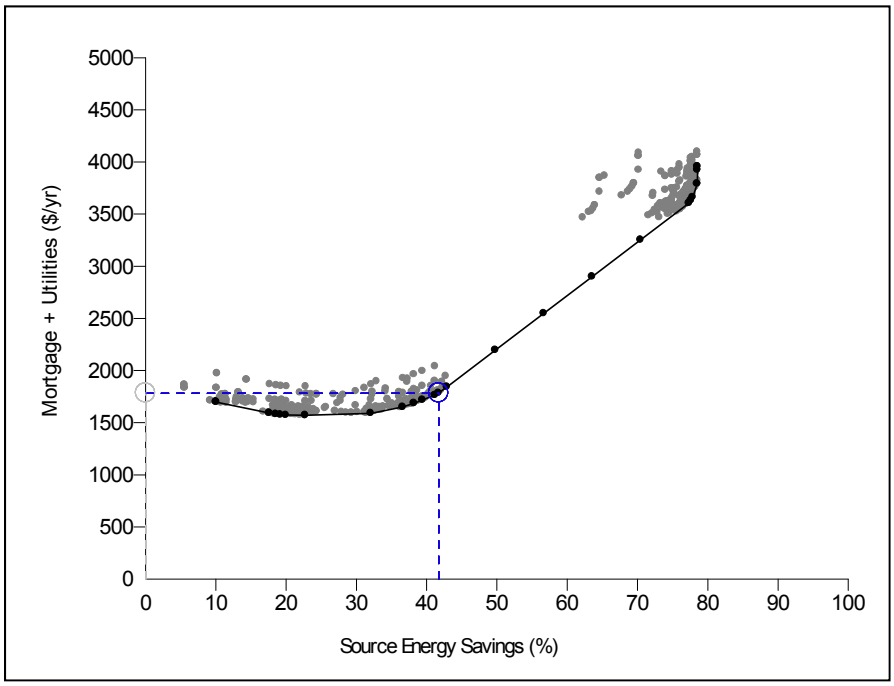


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($819)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 15. HSPF 8.8	$550
Water Heater	Electric Premium	$114
Ducts	R-4.2, 10% leakage	$0
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	0.5 tons	($231)
Heating Capacity Reduction	20 kBtu/hr	$0
Total		**$1,716**

Savings on annual utility bill	$348
Increase in annual mortgage payment	$140
Net annual savings	$208

Figure D-3. Minimum-cost point for Atlanta with electric space- and water-heating.

Neutral-Cost / Atlanta / Electric Heat

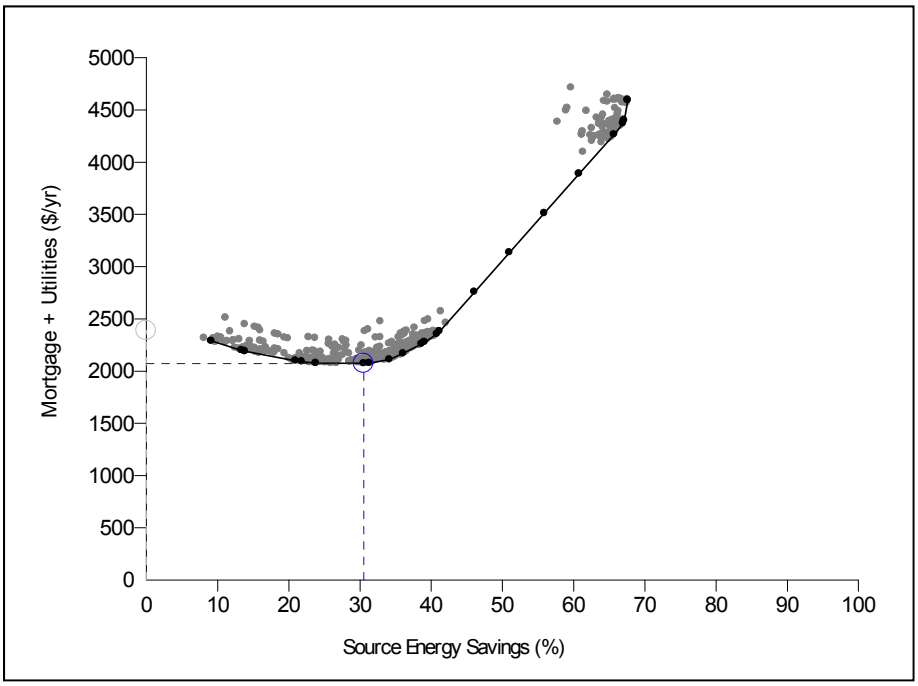


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R40	$472
Radiant Barrier	None	$0
Infiltration	0.00015 SLA	$3,642
Window Type	Low-e low SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($819)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 18. HSPF 9.2	$1,375
Water Heater	Electric Premium	$114
Ducts	R-4.2, 10% leakage	$0
Solar DHW	64 sq ft closed loop	$4,768
PV Size	0 kW	$0
Cooling Capacity Reduction	1 tons	($461)
Heating Capacity Reduction	30 kBtu/hr	$0
Total		**$9,372**

Savings on annual utility bill	$638
Increase in annual mortgage payment	$643
Net annual savings	($5)

Figure D-4. Near-neutral-cost point for Atlanta with electric space- and water-heating.

Minimum-Cost / Chicago / Gas Heat

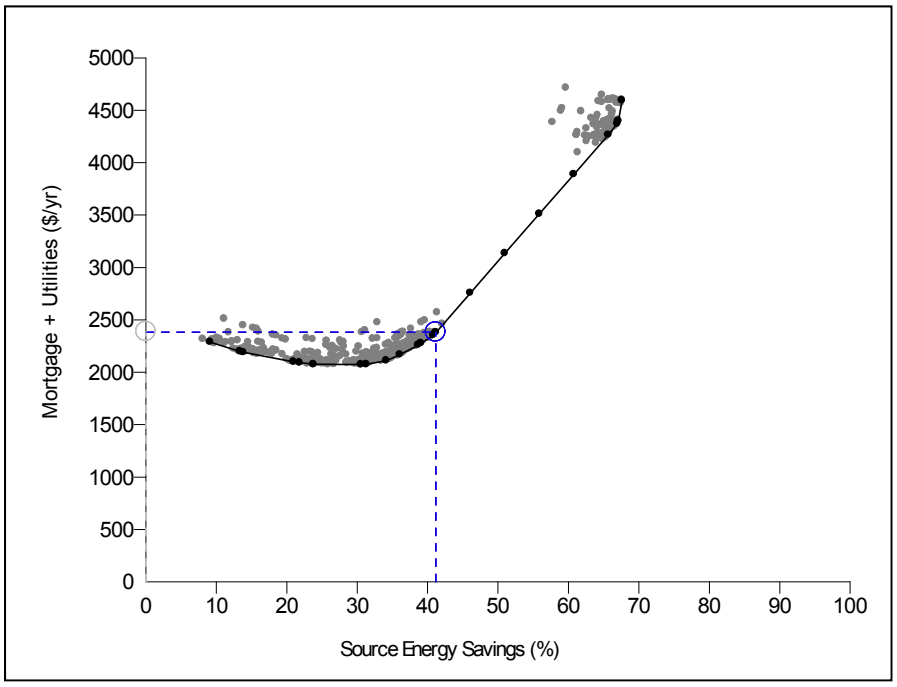


Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$65
Ceiling Insulation	R40	$0
Radiant Barrier	None	$0
Infiltration	0.00015 SLA	$3,642
Window Type	Low-e v. high SHGC arg	$0
Slab	No Slab	$0
Basement	8ft R10 Exterior	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$255
Air Conditioner	SEER 16	$540
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	Inside	$0
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	1 tons	($272)
Heating Capacity Reduction	20 kBtu/hr	$0
Total		**$5,203**

Savings on annual utility bill	$696
Increase in annual mortgage payment	$380
Net annual savings	$316

Figure D-5. Minimum-cost point for Chicago with gas space- and water-heating.

Neutral-Cost / Chicago / Gas Heat

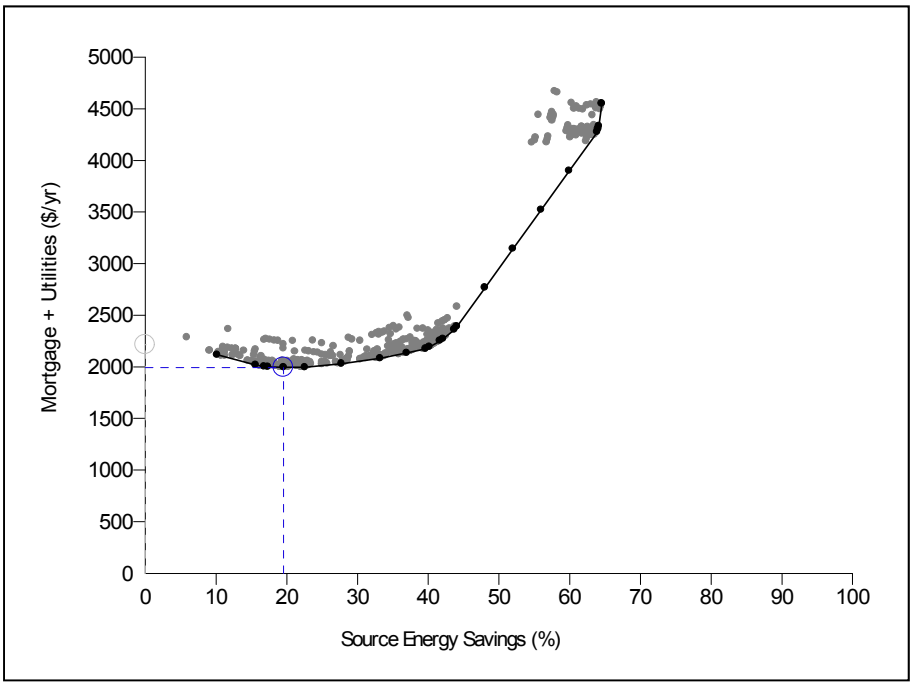


Wall Insulation	R21	$1,899
Ceiling Insulation	R60	$1,040
Radiant Barrier	None	$0
Infiltration	0.00015 SLA	$3,642
Window Type	3 pane 1 HM	$1,031
Slab	No Slab	$0
Basement	8ft R20 Exterior	$784
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$255
Air Conditioner	SEER 17	$720
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	Inside	$0
Solar DHW	64 sq ft closed loop	$4,768
PV Size	0 kW	$0
Cooling Capacity Reduction	1.5 tons	($545)
Heating Capacity Reduction	40 kBtu/hr	($69)
Total		**$14,498**

Savings on annual utility bill	$962
Increase in annual mortgage payment	$953
Net annual savings	$9

Figure D-6. Near-neutral-cost point for Chicago with gas space- and water-heating.

Minimum-Cost / Chicago / Electric Heat

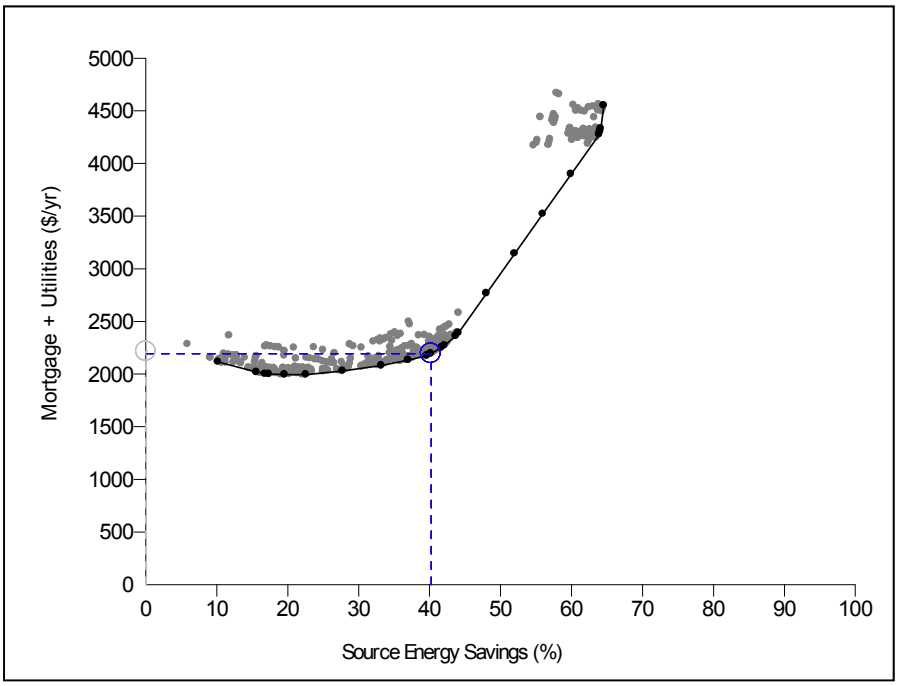


Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$65
Ceiling Insulation	R40	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e v. high SHGC arg	$0
Slab	No Slab	$0
Basement	8ft R10 Exterior	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$255
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 15. HSPF 8.8	$550
Water Heater	Electric Premium	$114
Ducts	Inside	$0
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	1 tons	($461)
Heating Capacity Reduction	10 kBtu/hr	$0
Total		**$2,344**

Savings on annual utility bill	$397
Increase in annual mortgage payment	$175
Net annual savings	$222

Figure D-7. Minimum-cost point for Chicago with electric space- and water-heating.

Neutral-Cost / Chicago / Electric Heat

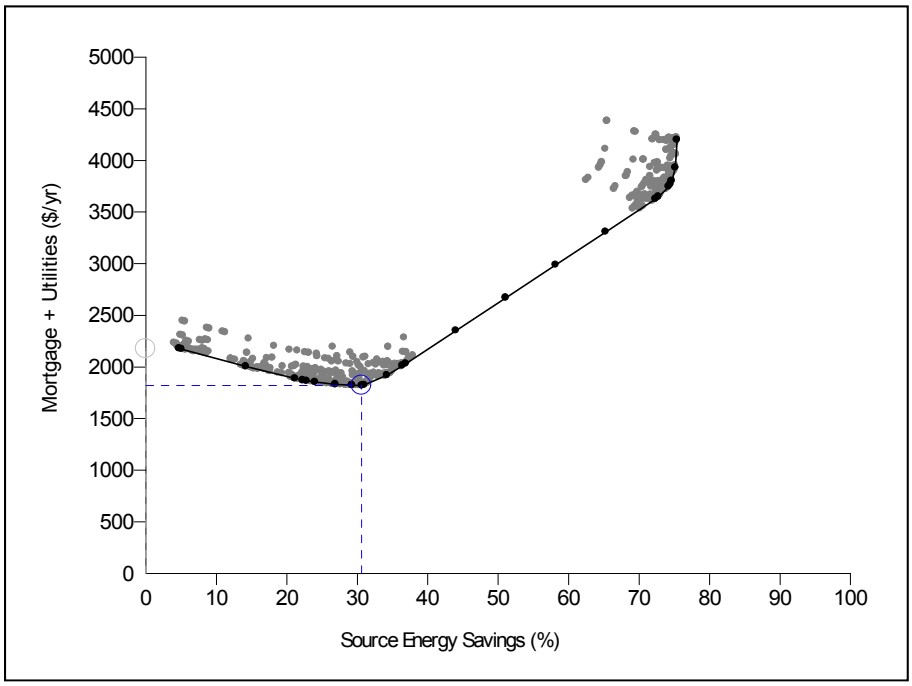


Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$1,899
Ceiling Insulation	R40	$0
Radiant Barrier	None	$0
Infiltration	0.00015 SLA	$3,642
Window Type	Low-e v. high SHGC arg	$0
Slab	No Slab	$0
Basement	8ft R15 Exterior	$475
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$255
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 18. HSPF 9.2	$1,375
Water Heater	Electric Premium	$114
Ducts	Inside	$0
Solar DHW	64 sq ft closed loop	$4,768
PV Size	0 kW	$0
Cooling Capacity Reduction	1.5 tons	($691)
Heating Capacity Reduction	40 kBtu/hr	$0
Total		**$11,837**

Savings on annual utility bill	$962
Increase in annual mortgage payment	$953
Net annual savings	$9

Figure D-8. Near-neutral-cost point for Chicago with electric space- and water-heating.

Minimum-Cost / Houston / Gas Heat

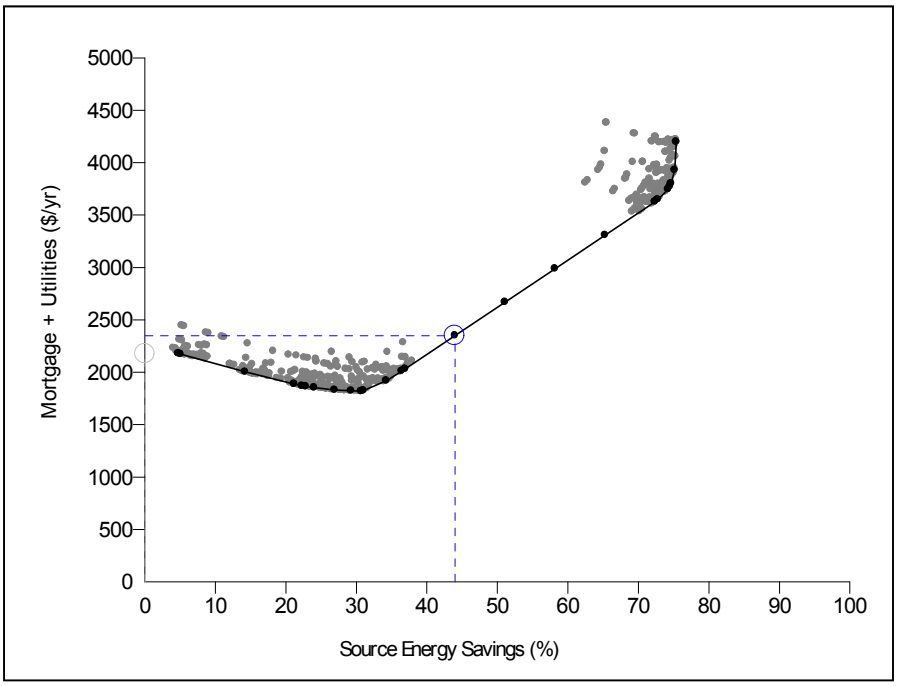


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 17	$720
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	Inside	$947
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	2.5 tons	($1,362)
Heating Capacity Reduction	-40 kBtu/hr	$139
Total		**$3,519**

Savings on annual utility bill	$608
Increase in annual mortgage payment	$250
Net annual savings	$358

Figure D-9. Minimum-cost point for Houston with gas space- and water-heating.

Neutral-Cost / Houston / Gas Heat

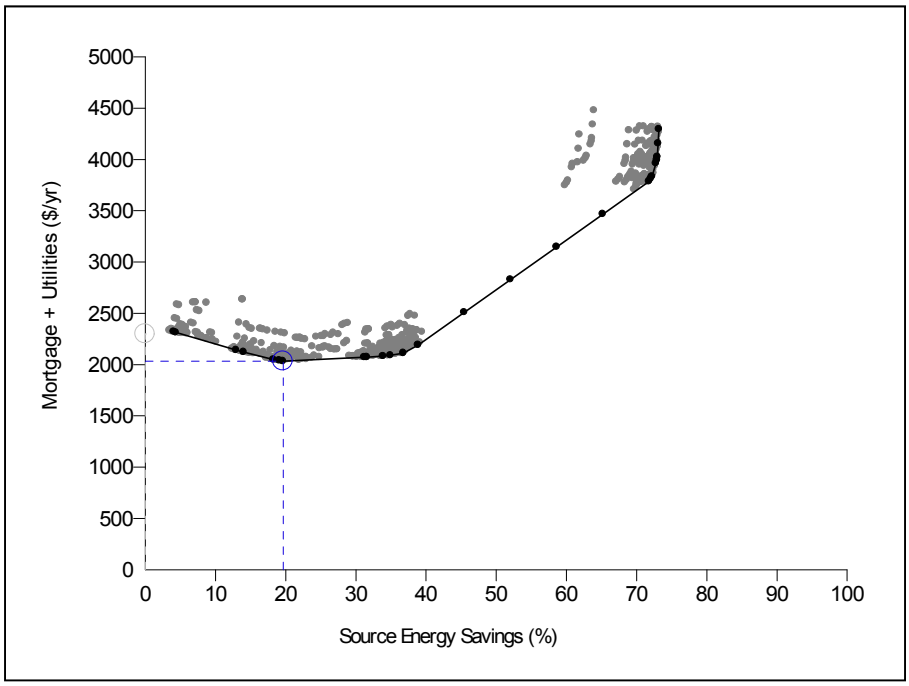


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	Radiant Barrier	$483
Infiltration	0.00015 SLA	$3,642
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 18	$900
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	Inside	$947
Solar DHW	32 sq ft ICS	$2,654
PV Size	1.0 kW	$7,500
Cooling Capacity Reduction	2.5 tons	($1,362)
Heating Capacity Reduction	-30 kBtu/hr	$103
Total		**$16,121**

Savings on annual utility bill	$875
Increase in annual mortgage payment	$1,049
Net annual savings	($174)

Figure D-10. Near-neutral-cost point for Houston with gas space- and water-heating.

Minimum-Cost / Houston / Electric Heat

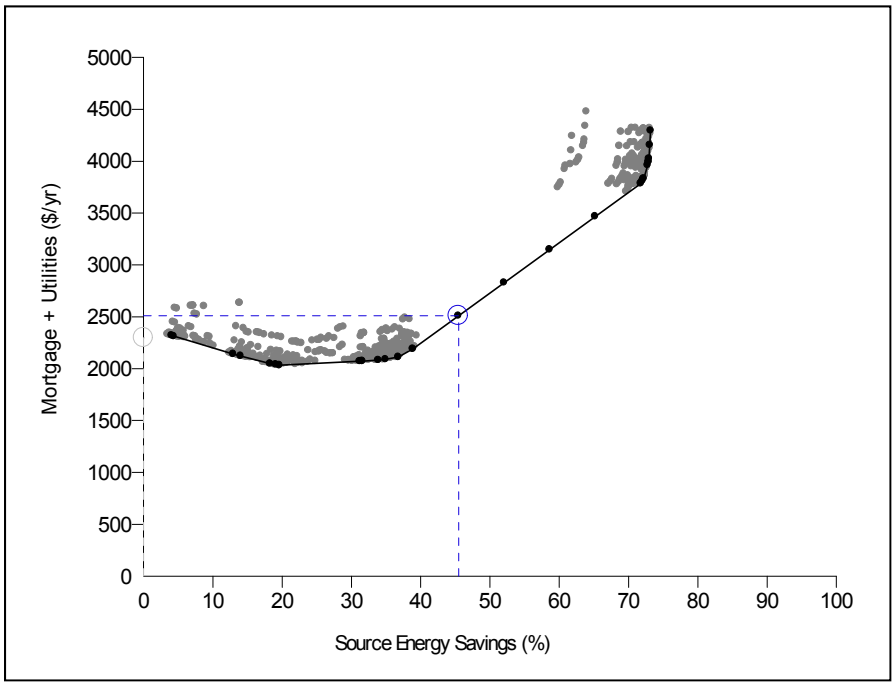


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 13. HSPF 8.1	$0
Water Heater	Electric Premium	$114
Ducts	Inside	$947
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	2.5 tons	($1,152)
Heating Capacity Reduction	-30 kBtu/hr	$0
Total		**$2,011**

Savings on annual utility bill	$412
Increase in annual mortgage payment	$146
Net annual savings	$266

Figure D-11. Minimum-cost point for Houston with electric space- and water-heating.

Neutral-Cost / Houston / Electric Heat

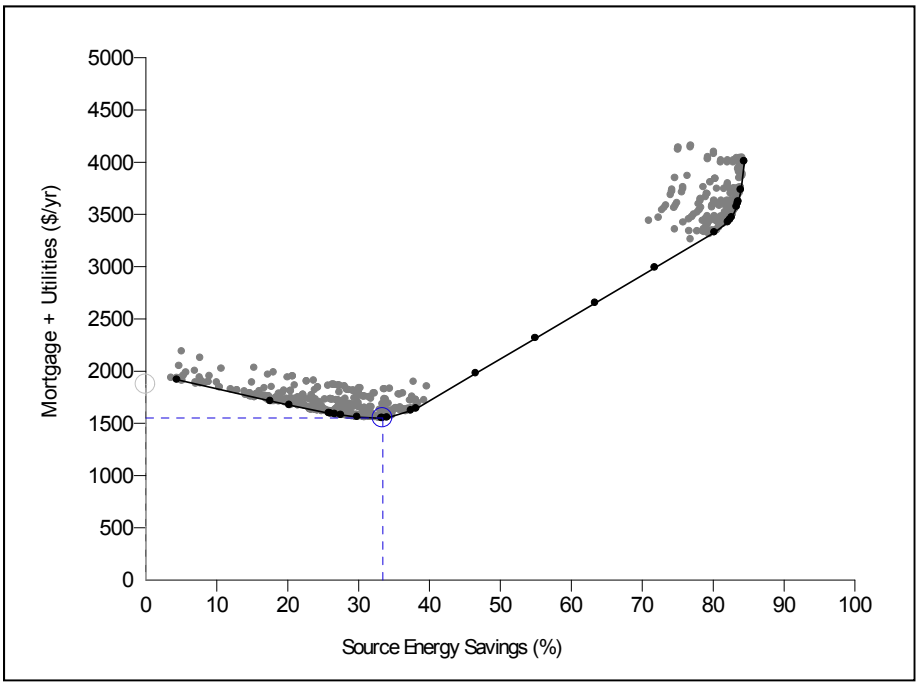


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	Radiant Barrier	$483
Infiltration	0.00015 SLA	$3,642
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 18. HSPF 9.2	$1,375
Water Heater	Electric Premium	$114
Ducts	R-8, 5.5% leakage	$710
Solar DHW	64 sq ft closed loop	$4,768
PV Size	1.0 kW	$7,500
Cooling Capacity Reduction	2 tons	($922)
Heating Capacity Reduction	20 kBtu/hr	$0
Total		**$17,951**

Savings on annual utility bill	$956
Increase in annual mortgage payment	$1,166
Net annual savings	($210)

Figure D-12. Near neutral-cost point for Houston with electric space- and water-heating.

Minimum-Cost / Phoenix / Gas Heat

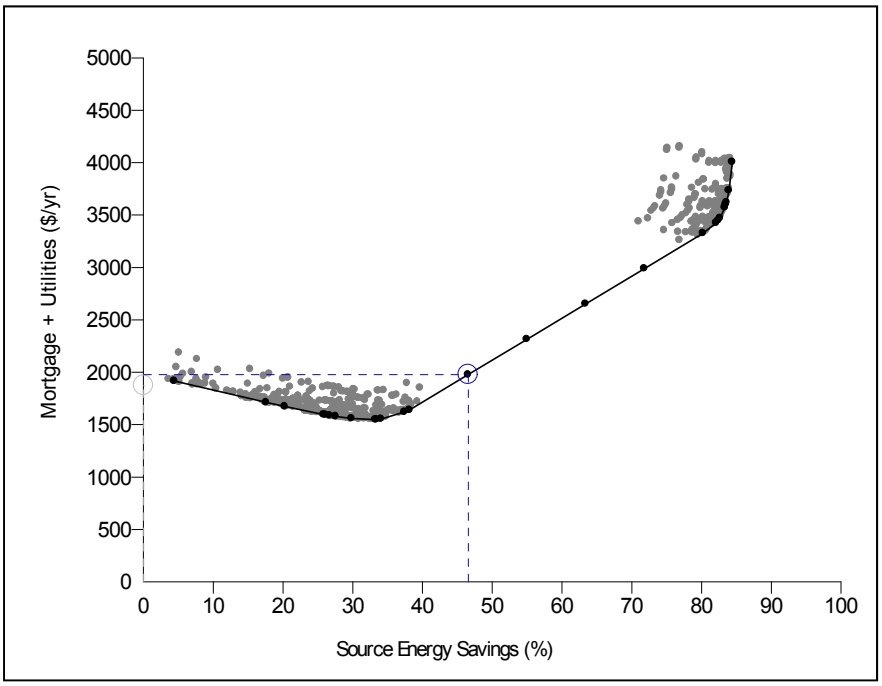


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 17	$720
Furnace	AFUE 80%	$0
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	Inside	$947
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	2 tons	($1,089)
Heating Capacity Reduction	30 kBtu/hr	($104)
Total		**$3,201**

Savings on annual utility bill	$550
Increase in annual mortgage payment	$228
Net annual savings	$322

Figure D-13. Minimum-cost point for Phoenix with gas space- and water-heating.

Neutral-Cost / Phoenix / Gas Heat

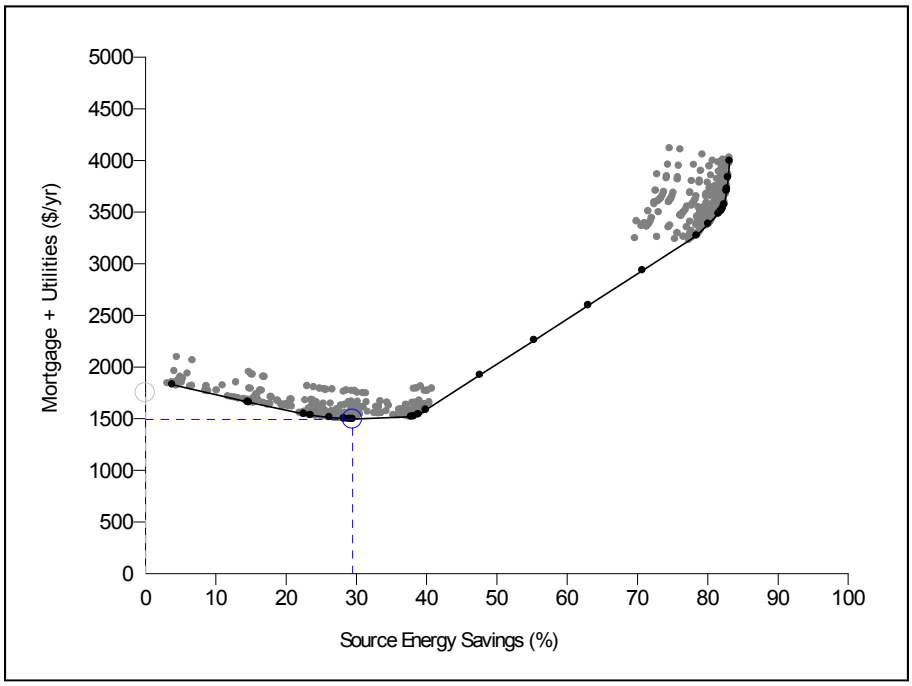


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	Radiant Barrier	$483
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 17	$720
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	Inside	$947
Solar DHW	32 sq ft ICS	$2,654
PV Size	1.0 kW	$7,500
Cooling Capacity Reduction	2 tons	($1,089)
Heating Capacity Reduction	30 kBtu/hr	($104)
Total		**$14,186**

Savings on annual utility bill	$795
Increase in annual mortgage payment	$902
Net annual savings	($107)

Figure D-14. Near-neutral-cost point for Phoenix with gas space- and water-heating.

Minimum-Cost / Phoenix / Electric Heat

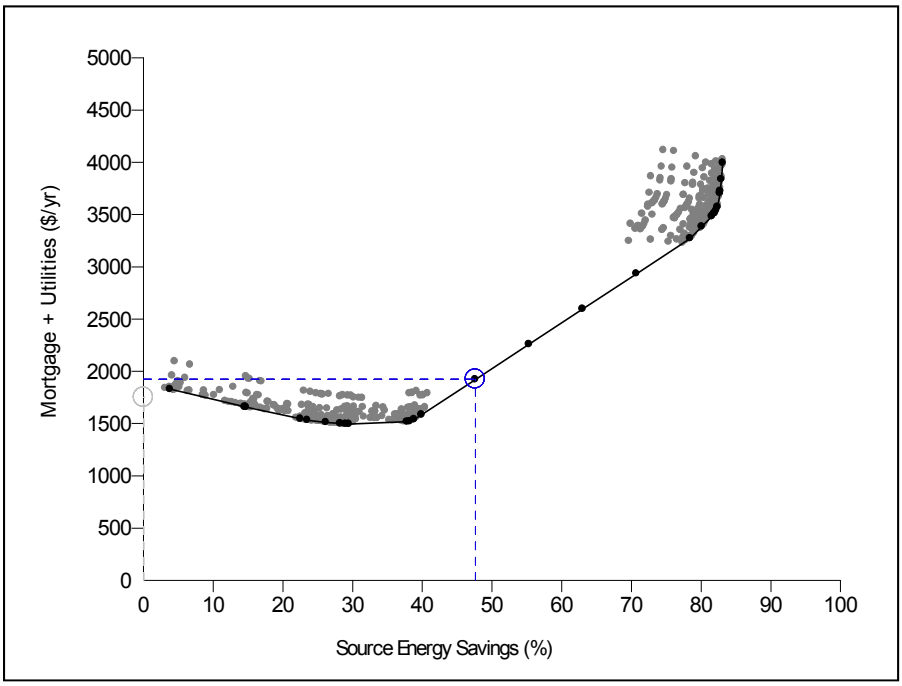


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 15. HSPF 8.8	$550
Water Heater	Electric Premium	$114
Ducts	Inside	$947
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	2 tons	($922)
Heating Capacity Reduction	30 kBtu/hr	$0
Total		**$2,791**

Savings on annual utility bill	$458
Increase in annual mortgage payment	$204
Net annual savings	$254

Figure D-15. Minimum-cost point for Phoenix with electric space- and water-heating.

Neutral-Cost / Phoenix / Electric Heat

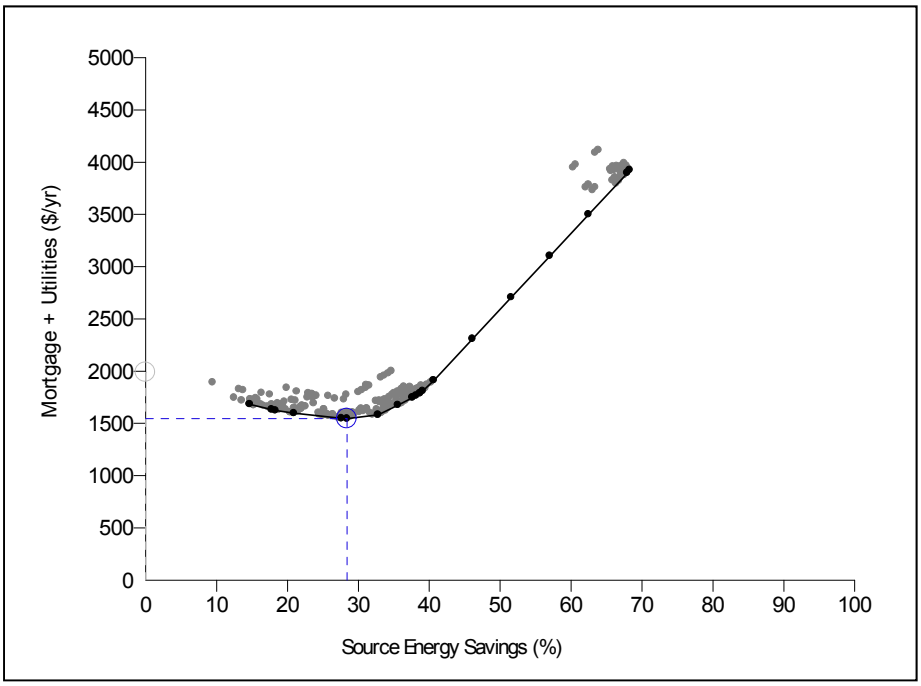


Component	Efficiency Level	Incremental Cost
Wall Insulation	R15	$87
Ceiling Insulation	R30	$0
Radiant Barrier	Radiant Barrier	$483
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e low SHGC arg	$0
Slab	Uninsulated	$0
Basement	No Basement	$0
Crawl Space	No Crawl Space	$0
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 18. HSPF 9.2	$1,375
Water Heater	Electric Premium	$114
Ducts	Inside	$947
Solar DHW	32 sq ft ICS	$2,654
PV Size	1.0 kW	$7,500
Cooling Capacity Reduction	2 tons	($922)
Heating Capacity Reduction	30 kBtu/hr	$0
Total		**$14,253**

Savings on annual utility bill	$621
Increase in annual mortgage payment	$794
Net annual savings	($173)

Figure D-16. Near-neutral-cost point for Phoenix with electric space- and water-heating.

Minimum-Cost / Seattle / Gas Heat

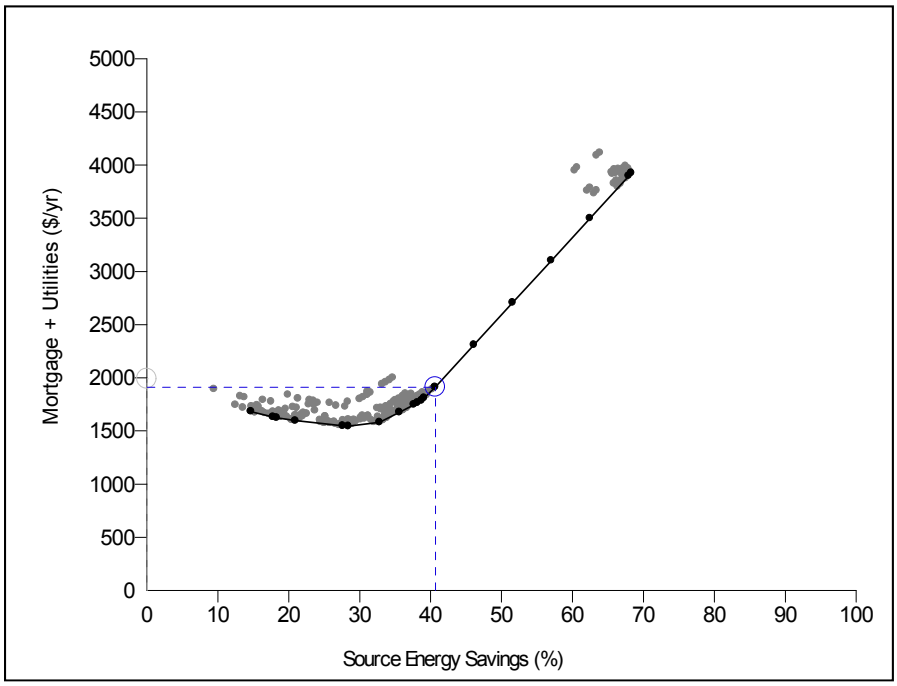


Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$65
Ceiling Insulation	R40	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e high SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($1,289)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 13	$0
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	R-4.2, 10% leakage	$0
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	0.5 tons	($272)
Heating Capacity Reduction	20 kBtu/hr	($69)
Total		**$1,423**

Savings on annual utility bill	$556
Increase in annual mortgage payment	$115
Net annual savings	$441

Figure D-17. Minimum-cost point for Seattle with gas space- and water-heating.

Neutral-Cost / Seattle / Gas Heat

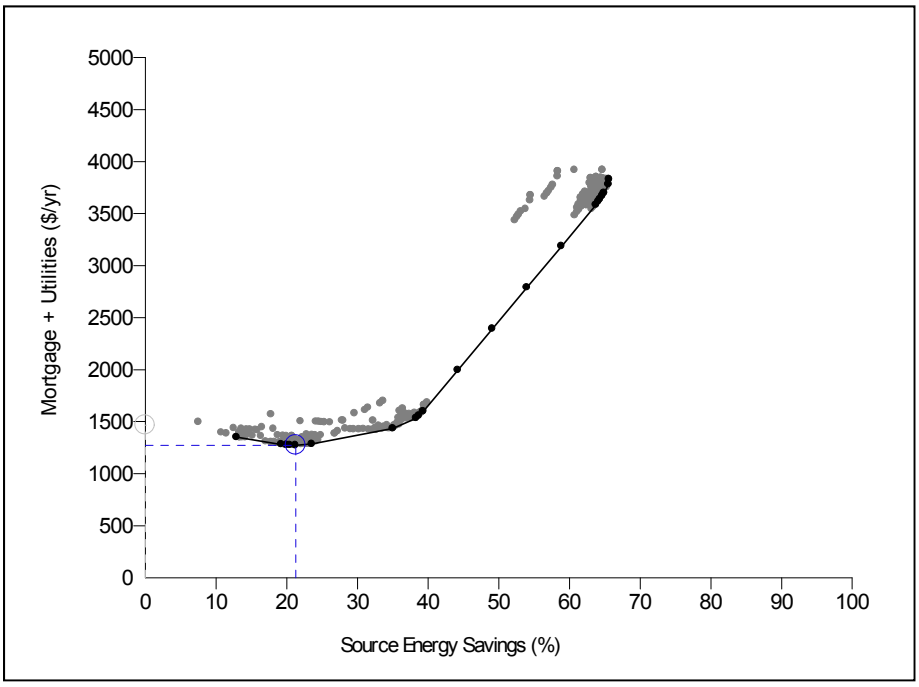


Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$65
Ceiling Insulation	R50	$459
Radiant Barrier	None	$0
Infiltration	0.00008 SLA	$5,463
Window Type	Low-e high SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($1,289)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	SEER 17	$720
Furnace	AFUE 92.5%	$348
Heat Pump	No Heat Pump	$0
Water Heater	Gas Tankless	$625
Ducts	R-4.2, 10% leakage	$0
Solar DHW	64 sq ft closed loop	$4,768
PV Size	0 kW	$0
Cooling Capacity Reduction	0.5 tons	($272)
Heating Capacity Reduction	20 kBtu/hr	($69)
Total		**$11,012**

Savings on annual utility bill	$839
Increase in annual mortgage payment	$763
Net annual savings	$76

Figure D-18. Near-neutral-cost point for Seattle with gas space- and water-heating.

Minimum-Cost / Seattle / Electric Heat

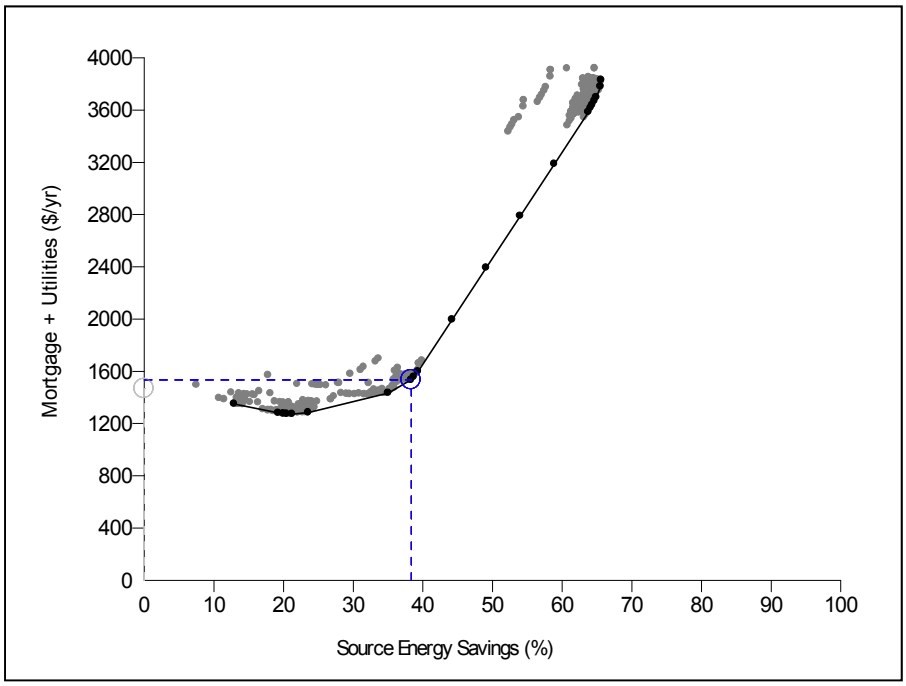


Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$65
Ceiling Insulation	R40	$0
Radiant Barrier	None	$0
Infiltration	0.0003 SLA	$1,821
Window Type	Low-e high SHGC arg	$0
Slab	No Slab	$0
Basement	No Basement	$0
Crawl Space	Unvented R10 Interior	($1,289)
Hardwired Lighting	100% Fluorescent	$194
Air Conditioner	No Air Conditioner	$0
Furnace	No Furnace	$0
Heat Pump	SEER 13. HSPF 8.1	$0
Water Heater	Electric Premium	$114
Ducts	R-4.2, 10% leakage	$0
Solar DHW	No Solar DHW	$0
PV Size	0 kW	$0
Cooling Capacity Reduction	0.5 tons	($230)
Heating Capacity Reduction	20 kBtu/hr	$0
Total		**$675**

Savings on annual utility bill	$262
Increase in annual mortgage payment	$69
Net annual savings	$193

Figure D-19. Minimum-cost point for Seattle with electric space- and water-heating.

Neutral-Cost / Seattle / Electric Heat



Component	Efficiency Level	Incremental Cost
Wall Insulation	R21	$ 65
Ceiling Insulation	R40	$ -
Radiant Barrier	None	$ -
Infiltration	0.0003 SLA	$ 1,821
Window Type	Low-e high SHGC arg	$ -
Slab	No Slab	$ -
Basement	No Basement	$ -
Crawl Space	Unvented R10 Interior	$ (1,289)
Hardwired Lighting	100% Fluorescent	$ 194
Air Conditioner	No Air Conditioner	$ -
Furnace	No Furnace	$ -
Heat Pump	SEER 15. HSPF 8.8	$ 550
Water Heater	Electric Premium	$ 114
Ducts	R-4.2, 10% leakage	$ -
Solar DHW	64 sq ft closed loop	$ 4,768
PV Size	0 kW	$ -
Cooling Capacity Reduction	0.5 tons	$ (230)
Heating Capacity Reduction	20 kBtu/hr	$ -
Total		**$ 5,993**

Savings on annual utility bill	$472
Increase in annual mortgage payment	$539
Net annual savings	($67)

Figure D-20. Near-neutral-cost point for Seattle with electric space- and water-heating.

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